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SAN ANDREAS RESERVOIR WETLAND CREATION MITIGATION & MONITORING PLAN

Prepared by:

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In Association with:

RMC
Water and Environment

Prepared for:

San Francisco Public Utilities Commission
1145 Market Street, 5th Floor
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18 October 2010 Project # 3129-02 (formerly 3135-01)

San Francisco Public Utilities Commission
Mitigation and Monitoring Plan for the
San Andreas Reservoir Wetland Creation Project

SFPUC Water Enterprise, Natural Resources and Lands Management staff, are aware of the following Mitigation and Monitoring Plan (Plan) and agree to oversee its implementation as described, including monitoring and reporting, unless otherwise agreed to by the appropriate regulatory resource agencies. Implementation funding, through the contractor's "warranty period", will be provided via the individual Water System Improvement Program project (WSIP) budgets. The SFPUC Water Enterprise, Natural Resources and Lands Management Division, will fund post-warranty implementation to meet site restoration requirements.

10/20/10

Tim Ramirez — Date
Manager, Natural Resources & Lands Management Division

10/20/10

Greg Lyman — Date
WSIP Habitat Compensation Manager, Bureau of Environmental Management

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1.0 INTRODUCTION

This Mitigation and Monitoring Plan (MMP) for the San Andreas Reservoir Wetland Creation Project describes part of the Habitat Reserve Program (HRP) that the San Francisco Public Utilities Commission (SFPUC) will implement to create 4.8 ac of seasonal and emergent wetlands to compensate for impacts to jurisdictional wetlands as well as aquatic habitat for the California red-legged frog (CRLF) and San Francisco garter snake (SFGS) from SFPUC projects, and enhance riparian habitat and wildlife connectivity (by upgrading existing culvert crossings within the existing road) near the northwestern end of San Andreas Reservoir, located in San Mateo County, California (Figure 1). The HRP focuses on developing consolidated compensation for the series of projects included in the Water System Improvement Program (WSIP). This MMP follows the SFPUC Guidance for Consultants Preparing Mitigation and Monitoring Plans (April 2009 Review Draft) prepared by May and Associates (2009) and, more generally, the mitigation and monitoring guidance issued by the U.S. Army Corps of Engineers (USACE, 2004), but has been modified and broadened to include site specific factors and upland habitats.

1.1 RESPONSIBLE PARTIES

The applicant is the San Francisco Public Utilities Commission, 1145 Market Street, San Francisco CA, 94103. The contact person is Greg Lyman, 415.554.1601.

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Figure 1: Vicinity Map
San Andreas Reservoir Wetland Creation
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2.0 PROJECT REQUIRING MITIGATION

The habitats enhanced and created at the San Andreas Reservoir site would be used to compensate for impacts from SFPUC projects. This MMP may be referenced in permit applications for SFPUC Water System Improvement Program (WSIP) projects and SFPUC projects not included in the WSIP. The San Andreas project is contributing to the mitigation programs for impacts from the following projects: Crystal Springs San Andreas (CSSA) Transmission Upgrade and Lower Crystal Springs Reservoir (LCSR) Dam Improvements. For a description of the habitat compensated by San Andreas Wetland Creation Project and the associated impacts from other SFPUC projects, refer to Table 1.

Table 1. San Andreas Wetland Creation Compensation for Impacts.

Project	Total Impacts by Type[1]	Impact Type	Mitigation Contributed by San Andreas Wetland[2] (4.45 ac for LCSR and 0.35 ac for CSSA)	
			Wetlands A & D Compensation Type	Wetlands B & C Compensation Type
Lower Crystal Springs Reservoir Dam (LCSR)	14.11 permanent 1.03 temporary	wetlands, including seasonal wetlands and aquatic habitat for CRLF and SFGS	seasonal wetland created and aquatic habitat (breeding and foraging for CRLF and foraging for SFGS) (2.90 ac)	emergent wetland created (foraging for SFGS) (1.55 ac)
Crystal Springs San Andreas Transmission Upgrade (CSSA)	0.12 permanent 0.37 temporary	wetland – freshwater marsh and aquatic habitat for CRLF and SFGS	N/A	emergent wetland created (foraging for SFGS) (0.35 ac)

[1] Total includes impacts to be compensated for at other SFPUC projects.
[2] Total impacts at LCSR and CSSA are compensated for by mitigation at the San Andreas wetlands and other SFPUC sites; these acreage values do not include the mitigation at the other SFPUC sites.

3.0 PROPOSED MITIGATION SITE

3.1 LOCATION AND BOUNDARIES

The San Andreas Reservoir Wetland Creation site is located near the northern tip of the SFPUC Peninsula Watershed, northwest of the San Andreas Reservoir (Figure 1), in San Mateo County, CA. An approximately 3,350-ft existing fire access road traverses the length of the site at distances ranging from 300 to 600 ft west of the reservoir.

The project site is situated along the northwestern shoreline of San Andreas Reservoir and includes the creation of 4 wetlands. The northern seasonal wetland (Wetland A) is situated adjacent to an unnamed drainage that empties into the reservoir from the northwest. The north-central and south-central emergent wetlands (Wetlands B and C) will receive incidental rainfall and will also intercept sub-surface flows from contributing upslope watersheds. The southern seasonal wetland (Wetland D) is situated near the mouth of an unnamed drainage that empties into the reservoir from the southwest. A roadway improvement would raise the roadway crown at the southern wetland to provide year-round access to the fuel breaks along the ridge. A rolling dip would be constructed along the roadway embankment within a spillway to facilitate drainage across the road and into existing wetlands to the east.

Access to the site would occur from the north via a paved, main service road and the fire access road. Construction staging and temporary soil stockpiling would occur in the northern portion of the project site at the intersection of the main service road and fire access road.

3.2 SELECTION PROCESS AND OWNERSHIP

This site is owned by the SFPUC. Its selection as a mitigation site resulted from a comprehensive search of SFPUC property by staff and Winzler & Kelly as part of the Habitat Reserve Program. Conceptual design elements have been reviewed during meetings and site visits with resource agency personnel, the SFPUC and their consultants.

The site provides 4 locations suitable for wetland creation based on a combination of their geomorphic positions, hydrology, proximity to existing habitat, and accessibility for construction and maintenance. A hydrology report prepared for the project provides further details regarding the hydrology of the 4 proposed wetlands (Appendix A).

The project site boundary is configured to optimize the use of the existing fire access road while minimizing adverse impacts to sensitive communities, including wetland habitats that border the fire access road. Each of the wetland creation sites are directly accessible from the fire access road and are comprised of coyote scrub brush and/or annual grassland. The wetland boundaries respect adjacent existing wetland and riparian communities and are situated to avoid any permanent effects to these areas. The location of the staging area was selected because it contains ruderal, previously disturbed habitat and provides a central location for heavy equipment access and storage.

Additionally, the site was selected because of the potential for the federally endangered, San Francisco garter snake and federally threatened, California red-legged frog to utilize the created seasonal and emergent wetlands; both special-status species have been documented in the freshwater emergent wetlands immediately east of the project site (ESA+Orion 2009 and Figure 2). At the landscape scale, the current site boundary has the potential to create a more continuous habitat corridor connecting to the northwest with Sharp Park (Figure 1), a known breeding ground for California red-legged frog and foraging area for San Francisco garter snake. That increased connectivity for California red-legged frog would also benefit the San Francisco garter snake, as the frog provides a prey base for the snake. Additionally, habitat credits for San Francisco garter snake foraging habitat would be pursued for the central 2 wetland areas by creating breeding habitat for Pacific treefrog.

3.3 EXISTING CONDITIONS OF COMPENSATION SITE

3.3.1 Vegetation

Scrub habitats are the dominant vegetation communities within the project boundary with willow thickets and coast live oak forest present along the 4 seasonal drainages traversing the project site (Figure 3). Annual grassland and existing seasonal wetlands are present within the northern portion of the project site. Portions of the project area support riparian scrub; these are at the junction of the main service road and the access to the project area, and at drainage crossings. The staging area is ruderal, since it is previously disturbed. The low area to the east of the access road is a seasonal wetland area that is infrequently inundated. A short distance east in the shallows of San Andreas Reservoir is a fairly extensive area of freshwater marsh dominated by tules and cattails. Most of the higher areas nearby support dense stands of northern coyote bush scrub. The southern portion of the project area is especially diverse. Two small hills west of the access road support small stands of coast live oak forest. Some small areas of uplands at the southern part of the project area support holly-leafed cherry scrub (ESA+Orion 2009).

3.3.2 Threatened, Endangered, Special Status Species or Sensitive Habitats

The San Andreas Reservoir Wetland Creation project area supports the following wildlife habitat types — fresh emergent wetland, coastal scrub, and valley foothill riparian as observed during the wetland delineation completed in October 2009. Wildlife species observed during the December 2008 survey include the wrentit, black phoebe, California towhee, Anna's hummingbird, and San Francisco dusky-footed woodrat nests.

Special-status Species. A single western leatherwood was observed at the southeastern most portion of the site in an area managed for brush control. The species is likely to occur elsewhere in the dense holly-leafed cherry scrub and northern coyote bush scrub, although it was searched for in the identified site footprint in 2009, and no leatherwood was observed. A CNDDB record of arcuate bush-mallow is located a short distance to the north of the site; the species could occur elsewhere in the general area, although it is typically found on south-facing slopes, which are not present in the site. It was not observed at the site during 2009 surveys. Choris' popcorn flower is known from a wet meadow approximately 0.5 mi south of the San Andreas Reservoir site, and suitable habitat was considered to be potentially present in the low-lying, moist habitats at the site. However, it was searched for in 2009 and was not found (ESA+Orion 2009).

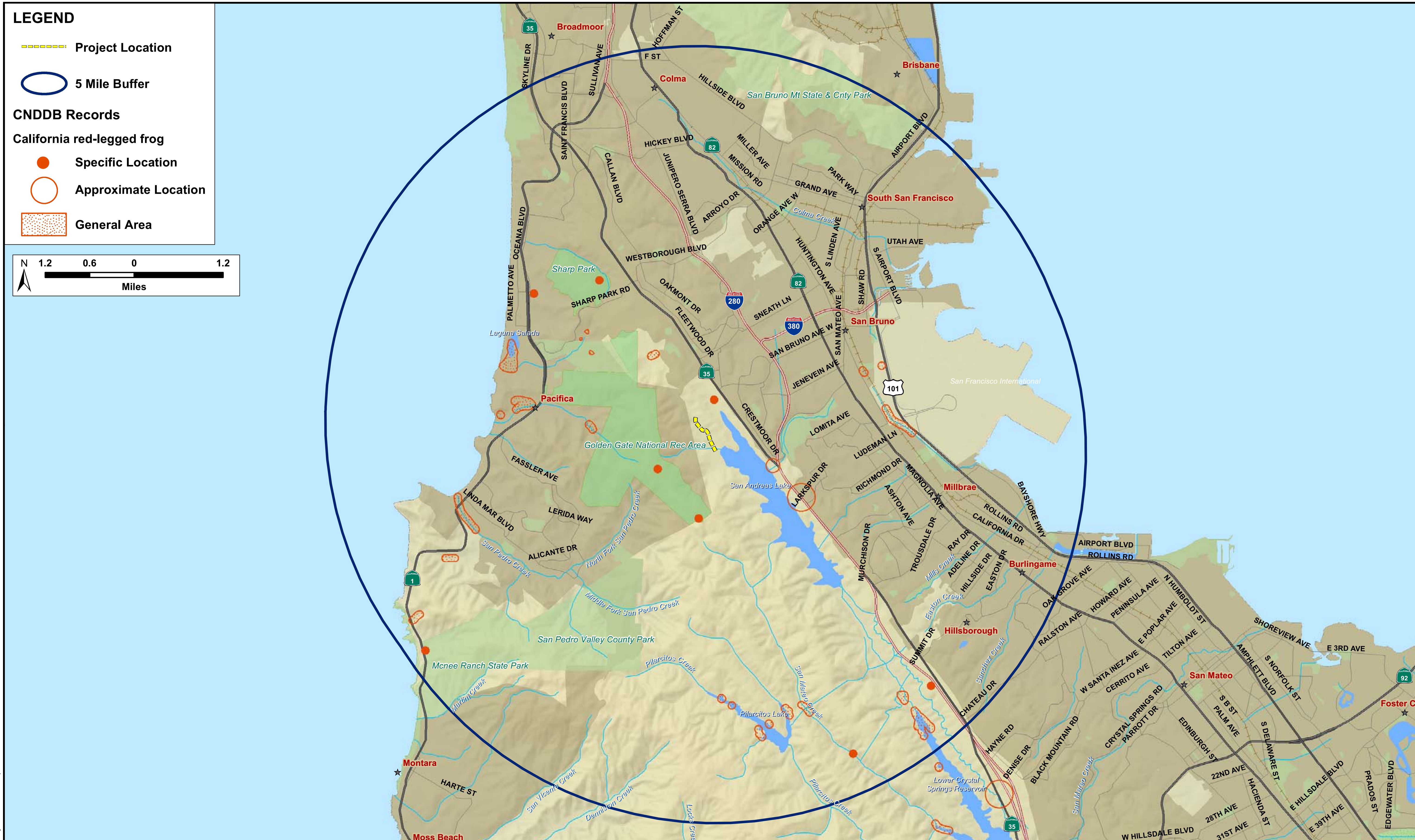

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Figure 2: California red-legged frog CNDDB Records

San Andreas Reservoir Wetland Creation Mitigation & Monitoring Plan (3129-02)

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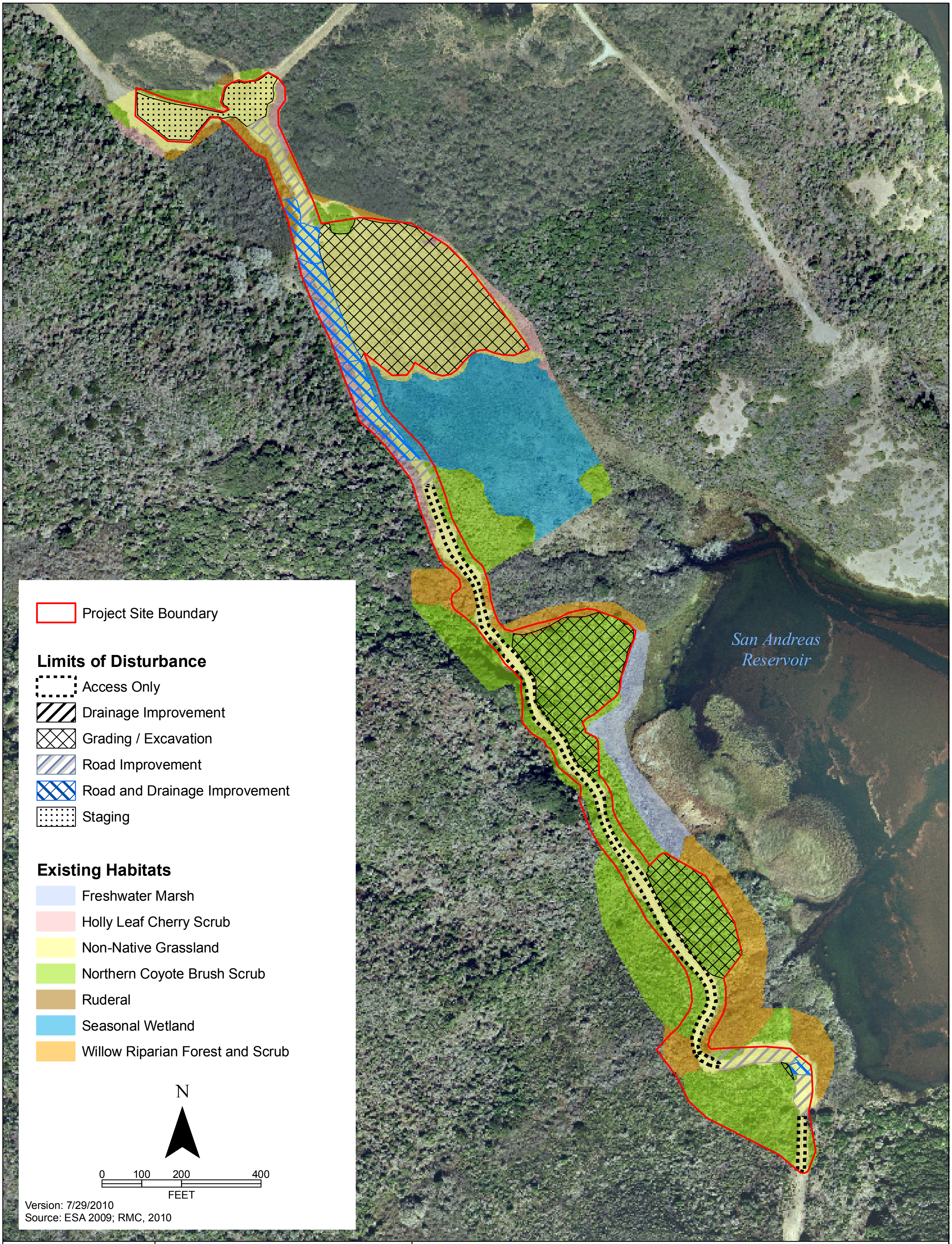


San Francisco Public Utilities Commission
Habitat Reserve Program

Figure 3: San Andreas Reservoir Wetland Creation Existing Habitats

Special-status wildlife with suitable habitat at the site include San Francisco garter snake and California red-legged frog, known to occur in San Andreas Reservoir and the fresh emergent wetlands immediately east of the site; they are assumed to be present at the site itself. San Francisco dusky-footed woodrat stick nests were observed frequently at the site, particularly in coastal scrub and valley foothill riparian habitats. Other species that may occur at the site include western pond turtle in the fresh emergent wetland; tricolored blackbird, saltmarsh common yellowthroat, and yellow warbler in the valley foothill riparian habitat; and breeding birds and roosting bats in all habitats (ESA+Orion 2009).

Although there are nearby records for Mission blue butterfly, the site was searched for perennial lupines at a time when this species' foodplant would have been blooming and detectable, but none were found within the site (ESA+Orion 2009; HTH 2010).

Special-status Species Habitat Requirements. Habitat within the San Andreas Reservoir Wetland Creation site supports the federally-listed California red-legged frog and San Francisco garter snake. Primary constituent elements (PCEs) for the California red-legged frog are discussed below. Similar PCEs for the San Francisco garter snake have not been formalized by the U.S. Fish and Wildlife Service (USFWS) as critical habitat for the San Francisco garter snake has not been designated.

- **California Red-legged Frog.** California red-legged frog habitat is composed of the following primary constituent elements: aquatic breeding habitat, aquatic non-breeding habitat, upland habitat, and dispersal habitat. A discussion of each of the PCEs deemed essential to the conservation of California red-legged frog is provided below (as described in USFWS 2008).
  - <u>Aquatic Breeding Habitat.</u> Standing bodies of fresh water (with salinities less than 7.0 ppt), including: natural and manmade (e.g., stock) ponds, slow-moving streams or pools within streams, and other ephemeral or permanent water bodies that typically become inundated during winter rains and hold water for a minimum of 20 weeks in all but the driest of years.
  - <u>Non-Breeding Aquatic Habitat.</u> Freshwater and wetted riparian habitats, as described above, that may not hold water long enough for the subspecies to hatch and complete its aquatic life cycle but that do provide for shelter, foraging, predator avoidance, and aquatic dispersal for juvenile and adult California red-legged frogs. Other wetland habitats that would be considered to meet these elements include, but are not limited to: plunge pools within intermittent creeks; seeps; quiet water refugia during high water flows; and springs of sufficient flow to withstand the summer dry period.
  - <u>Upland Habitat.</u> Upland areas adjacent to or surrounding breeding and non-breeding aquatic and riparian habitat up to a distance of 1 mi (1.6 km) in most cases and comprised of various vegetative series such as grasslands, woodlands, wetland, or riparian plant species that provides the frog shelter, forage, and predator avoidance. Upland features are also essential in that they are needed to maintain the hydrologic, geographic, topographic, ecological, and edaphic features that support and surround the wetland or riparian habitat. These upland features contribute to the filling and drying of the wetland or riparian habitat and are responsible for maintaining suitable periods of

pool inundation for larval frogs and their food sources, and provide breeding, non-breeding, feeding, and sheltering habitat for juvenile and adult frogs (e.g., shelter, shade, moisture, cooler temperatures, a prey base, foraging opportunities, and areas for predator avoidance). Upland habitat should include structural features such as boulders, rocks and organic debris (e.g., downed trees, logs), as well as small mammal burrows and moist leaf litter.

- Dispersal Habitat. Accessible upland or riparian dispersal habitat within designated units and between occupied locations within a minimum of 1 mi (1.6 km) of each other and that allows for movement between such sites. Dispersal habitat includes various natural habitats and altered habitats such as agricultural fields, which do not contain dispersal barriers (e.g., heavily traveled road without bridges or culverts). Dispersal habitat does not include moderate- to high-density urban or industrial developments with large expanses of asphalt or concrete, nor does it include large reservoirs over 50 ac (20 ha) in size, or other areas that do not contain those features identified in PCE 1, 2, or 3 as essential to the conservation of the subspecies.

- **San Francisco Garter Snake.** Though PCEs are not designated for the San Francisco garter snake, presence of the species is closely tied to the presence of frogs, and in particular the California red-legged frog, which is a prey item for the adult snake (Jennings and Hayes 1994), and the Pacific treefrog (*Pseudacris regilla*), which is a prey item for both the juvenile and adult snake (USFWS 2006). The snake frequents ponds, streams, emergent wetlands, and other similar habitats to forage on California red-legged frogs and/or Pacific treefrogs. As a result, enhancing or creating aquatic breeding habitat for the California red-legged frog and/or Pacific treefrog will also enhance or create aquatic foraging habitat for the San Francisco garter snake.

3.3.3 Aquatic Features and Jurisdictional Areas

The northern wetland creation area is situated in a broad swale draining to an upper arm of San Andreas Reservoir. Several large, existing wetland features are situated immediately downhill of the project area. These existing wetlands receive flow from contributing drainages (detailed in the hydrologic technical memorandum prepared by RMC, Appendix A) and also receive some inundation from the reservoir, especially during high reservoir levels in the summer (Figure 3).

3.3.4 Topography, Soils, Substrate, Hydrology

Based on a review of available soil survey maps for the area including those by the U.S. Geologic Survey (USGS), the U.S. Department of Agriculture's Natural Resources Conservation Service (NRCS), and the California Geologic Survey (CGS), the project site generally comprises shallow hillslope soils, ranging from 16 to 24 in prior to transitioning to weathered sandstone. These soils are identified as the Candlestick series, which is characterized by a sandy loam within the upper 8 to 12 in of the soil column that grades to a clay loam at depth.

Site specific soil sampling was completed by AEW Engineering (AEW) in March 2010 at each of the 4 proposed wetland sites. The upper 4 ft of the north wetland comprised a sticky clay and from 4 to 6 ft s a sandy clay. At the south wetland the sample of 7 ft revealed dark brown, clay rich soil within the upper 3 ft, followed by a transition to a higher sand/gravel content in the lower profile. Field observations conducted in the north- and south-central wetlands document coarse soils. More information is provided in Appendices A and B regarding the soil conditions at the wetland sites.

The project is located in a seismically active region at the boundary between 2 major tectonic plates: the Pacific Plate to the southwest and the North American Plate to the northeast. The San Andreas Fault, which exists in the project area, is the dominant structure in the system that defines the boundary between the 2 tectonic plates, spanning nearly the full length of the state of California. Other major faults associated with the San Andreas system include the San Gregorio Fault about 7 mi west of the site, and the Hayward Fault about 18 mi east of the Peninsula watershed. Earthquakes occurring along these and other faults are capable of generating strong ground shaking at the sites. However, the project location is in areas with low susceptibility to landslides, and with very low to moderate susceptibility to liquefaction (USGS, 1999; 2006).

The San Andreas Wetland Creation Project Hydrologic Technical Memorandum prepared by RMC (Appendix A) describes the existing hydrologic conditions at the 4 wetland creation sites. The hydrology at the sites is driven by inflow from contributing drainages and surface runoff, and sub-surface seepage of seasonally high water elevations from San Andreas Reservoir (based on the last ten years of data, the San Andreas Reservoir has maintained an average surface elevation of approximately 450 ft from June through August; this existing hydrology is expected to continue in the future, based on planned reservoir operations). The inflow from hillslopes and surface runoff contributing to the hydrology were calculated by RMC (Appendix A). There are 15 watersheds, 3 of which are greater than 200 ac, intersecting with the project site boundary. More detailed information is included in Table 1 of Appendix A and further detailed in Section 4.0, Mitigation Proposal.

4.0 MITIGATION PROPOSAL

4.1 TARGET HABITATS AND QUANTITIES

The overall design concept for the project site involves the creation of 4 wetlands, 2 seasonal and 2 emergent, (and several small riparian enhancements) along the existing fire access road (Figure 4). The northern and southern wetlands (Wetlands A and D) have been designed for aquatic breeding and foraging by California red-legged frog and foraging by San Francisco garter snake. The wetlands will provide seasonal wetland habitat for the California red-legged frog and the San Francisco garter snake but not perennial wetlands that could support exotic predators (e.g., bullfrogs and predatory fish). Additionally, the seasonal habitat provides greater habitat diversity. The central wetlands (Wetlands B and C) have been designed as emergent wetlands for breeding by Pacific treefrog and foraging by San Francisco garter snake. The creation of the 4 wetlands and the enhancement of riparian habitat would be achieved through a series of drainage improvements along the existing fire access road. These roadway drainage improvements would improve water movement across the existing fire access road to benefit the created wetland and riparian areas while not degrading the existing adjacent habitats. The northern-most drainage improvements are proposed to reconnect pre-existing drainage patterns prior to the construction of the fire access road to benefit overall water movement across both the road and the alluvial fan that slopes down to the reservoir. A secondary objective of the roadway improvements is to provide all-season access[3] and long-term monitoring to the extent feasible. Each wetland creation site (and associated riparian enhancements) is discussed below.

4.1.1 Northern Wetland Creation (Wetland A) & Riparian Enhancement

The northern wetland (Wetland A) design aims to reestablish the surface hydrology as it was prior to construction of the fire access road. Under existing conditions, surface flows originating from an approximately 305-ac watershed travel parallel to the northern segment of the fire access road via a braided channel system, just south of the proposed staging area. These surface flows, producing on average approximately 200-acre ft of runoff annually, are subsequently conveyed southward along the existing fire access road, thereby bypassing the proposed northern wetland site (Appendix A).

The proposed roadway drainage improvements would facilitate passage of surface waters flows from the contributing drainage via a series of large, rolling dips across the existing fire access road. Overflows from the existing drainage on the western side of the road would be discharged into a seasonal Wetland A, which would be up to 2.7 ac in size, via the northern-most rolling dip. The proposed seasonal Wetland A currently comprises of non-native, annual grassland. Its construction would involve excavation of no more than 4 ft to establish connectivity with the existing drainage and seasonal wetlands to the south. The primary flows from the existing drainage would continue to flow south before crossing the road and discharging into the existing seasonal wetland immediately to the south. The current design concept also proposes the

[3] Note that the all-season access road would be designed to provide seasonal access, but may remain inaccessible during peak rainfall events.

creation/enhancement of up to 750 ln ft (approximately 0.45 ac) of riparian habitat to the east and west of the existing fire access road.

Wetland A would be designed to support shallow ponding within a series of 3 large depressional areas that would be separated by shallow berms. Water depths in these areas would generally be limited to 1 ft or less. Greater inundation (with water depths up to 3 ft) would be provided in several deeper pools within the depressional areas to provide habitat diversity as well as aquatic non-breeding, potential breeding, and foraging habitat for California red-legged frogs and foraging habitat for the San Francisco garter snake. In addition, Wetland A will provide aquatic non-breeding and breeding habitat for the Pacific treefrog. The berms would consist of a combination of unexcavated and excavated soil materials depending on the final grade to be achieved. The current design would facilitate water flow north to south through the wetland via a broad meandering pattern to maximize water distribution throughout the wetland while minimizing erosive flow velocities. The southern perimeter of the wetland would be designed to conform to the existing grade of the adjacent seasonal wetland to the south to maximize hydrologic connectivity.

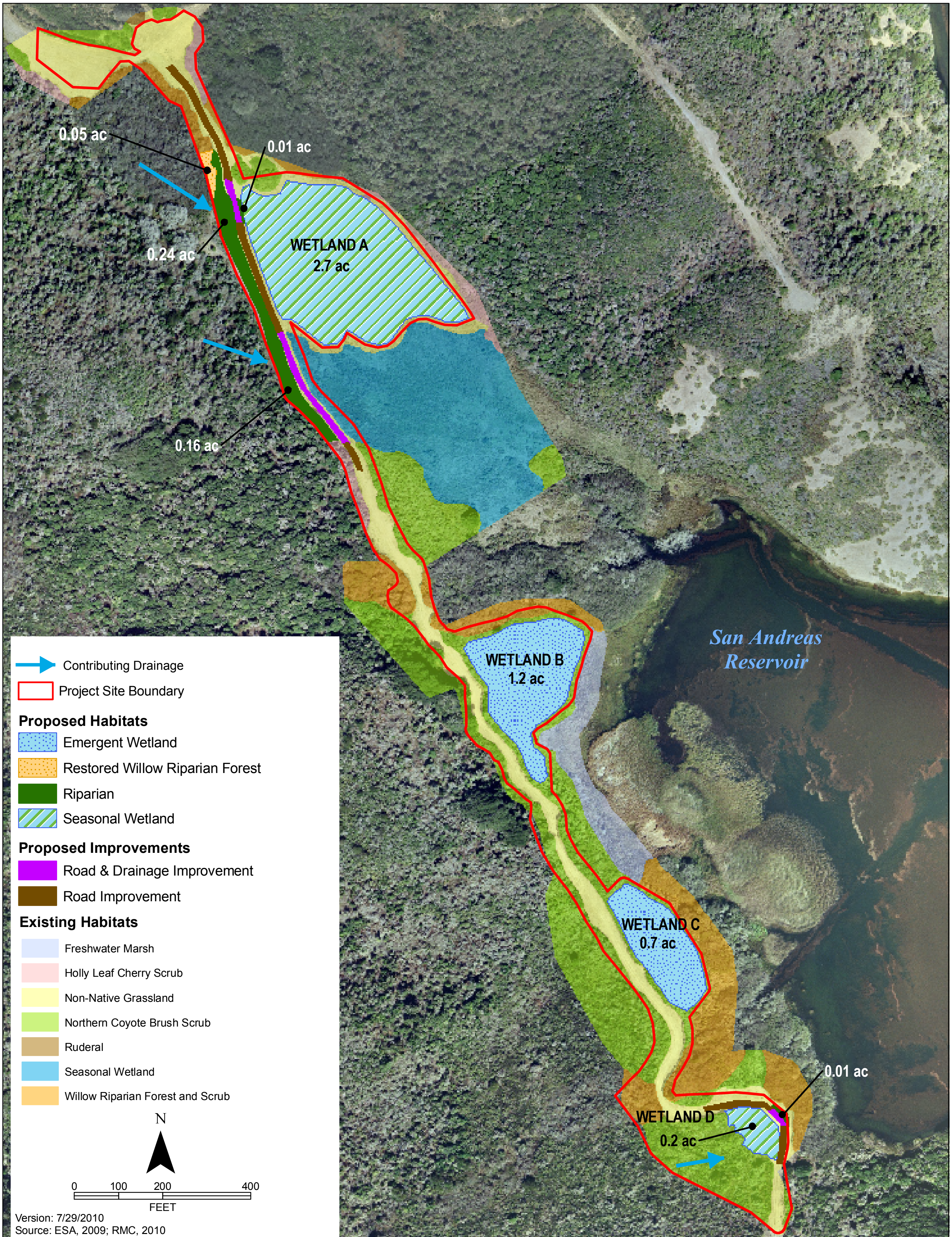
At locations along the existing fire access road where surface water currently flows over and along a portion of the roadway, the design concept is to include sufficient armoring of the road surface using concrete-grass pavers. This would allow for continued water flow over the road surface while maintaining direct surface flow into the proposed wetland and existing seasonal wetland to the south. Due to the presence of existing seasonal wetland and willow riparian habitat adjacent to these improvements, SFPUC has conservatively estimated <0.1 ac of potential temporary, construction-related impact to these sensitive areas. Following construction, these areas would be restored to pre-project conditions.

4.1.2 North-Central & South-Central Wetland Creation (Wetlands B & C)

Two emergent wetlands would be excavated within the central portions of the project site, with the south-central wetland (Wetland C) comprising approximately 0.7 ac and the north-central wetland (Wetland B) comprising approximately 1.2 ac. Both wetland features would be designed to intercept sub-surface groundwater flow from contributing upslope watersheds.

Wetland B would be excavated to a base elevation of approximately 451 to 452 ft mean sea level (msl).[4] Wetland C would be graded to a slightly lower base elevation of approximately 450 to 451 ft msl. The wetland bottoms would be graded to create undulating microtopography that would facilitate ponding of up to 1 ft in depth. The excavation will create a seasonal subsurface inflow of groundwater from up-gradient locations with the hydraulic gradient controlled by surface water levels within San Andreas Reservoir. For purposes of analysis, SFPUC assumes that surface water elevations will be maintained at 450 ft msl, on average, during the months of June through August. The north-central wetland will be excavated up to 7 ft and the south-central wetland up to 5 ft. The undulations of micro-depressions within each wetland will provide habitat diversity as well as aquatic non-breeding and breeding habitat for the Pacific treefrog and foraging habitat for the San Francisco garter snake.

[4] Elevation is based on the NAV88 Datum.



San Francisco Public Utilities Commission
Habitat Reserve Program

Figure 4: San Andreas Reservoir Wetland Creation Preliminary Design Site Plan

In addition to intercepting incidental rainfall and groundwater transmitted from the up-gradient hillslopes, the Wetland B would receive surface runoff from an approximately 7.3 ac drainage area and Wetland C would receive surface water inputs from an approximately 12-ac drainage area. In general, surface drainage into these 2 wetland areas occurs via sheet flow across the existing fire road and no additional road improvements are contemplated for these locations. The eastern perimeter of both wetland features would be designed to achieve a final grade of above 451 ft msl to facilitate a smooth topographical transition to the adjacent freshwater marsh.

4.1.3 Southern Wetland Creation (Wetland D) & Riparian Enhancement

The southern-most wetland (Wetland D), up to 0.2 ac in size, would be created at the southern end of the project area and would be supported by a combination of intercepted base-groundwater and incidental rainfall inflows from adjacent hillslopes and surface water inputs from an approximately 11-ac upslope watershed (detailed in Appendix A). The concept for the southern wetland is to build an embankment along the existing fire access road to encourage ponding to the west of the raised roadway. This improvement would achieve 2 goals: (1) improved roadway conditions thereby providing all-season access; and (2) the creation of a depressional area that would encourage a passive transition from upland to wetland habitat. Within the 0.2-ac wetland, limited grading is proposed in an approximately 400 sq ft area (within the 453 ft contour) adjacent to the roadway to achieve the appropriate rate of permeability and duration of inundation through the summer. Inundation of up to 3 ft would be provided by this design; however, average ponding depths are expected to be 2 ft. The design will provide habitat diversity as well as aquatic non-breeding, potential breeding, and foraging habitat for California red-legged frogs and foraging habitat for the San Francisco garter snake. In addition, Wetland D will provide aquatic non-breeding and breeding habitat for the Pacific treefrog.

The roadway improvement would raise the roadway crown. A rolling dip would be constructed along the roadway embankment within a spillway to facilitate drainage across the road and into existing wetlands to the east. Willow plantings associated with the drainage improvements proposed in conjunction with the raising of the road are expected to enhance approximately 0.01 ac of riparian habitat.

4.1.4 Construction Considerations

Excavation would likely take place when reservoir water elevations are lowest (between August and October). Based on the condition of the existing roadway, combined with the timing of construction, the roadway and wetland improvements are expected to occur north to south to provide roadway stabilization. Soil materials excavated for the wetland creation areas would be used as fill, to the extent they are suitable, to improve the existing seasonal fire road to an all-season access road. Excavated soil and fill materials would be temporarily stockpiled at the 0.6 ac staging area, located at the northern end of the project area, and within the wetland excavations prior to use for the road. Engineered fill may also be required to supplement onsite sources and to support truck movement on the existing road during construction. Any excavated soil materials determined to be unsuitable for roadway fill would be hauled offsite to the nearest landfill or soil recycling facility.

To achieve the necessary rate of infiltration for the final wetland design, SFPUC will engineer the wetland floor prior to planting to provide the desired level of permeability. This would be accomplished through a process of over-excavation of the wetland bottom, placement and compaction of sub-grade materials, and placement of topsoil. Over-excavation of the wetland bottom will be achieved by excavating approximately 1 ft below the design elevation. Once over-excavated, clayey soil materials would be placed in the lower 6 in and compacted to achieve the desired rate of permeability. Topsoil will then be placed in the upper 6 in to provide a suitable medium for plant growth.

4.2 HYDROLOGY AND SOILS

The San Andreas Wetland Creation Project Hydrologic Technical Memorandum prepared by RMC (Appendix A) supports the design decisions outlined above through an analysis of existing and proposed hydrologic site conditions. To determine the hydrologic feasibility of each of the proposed wetland sites and the sustainability of adjacent existing habitats, RMC prepared a water balance. The water balance quantified the combined inputs of surface water and groundwater with the associated outflows (such as evapotranspiration and surface water outflows), and analyzed the effects of the proposed design. The results of the water balance for Wetland A indicate that during the average rainfall years, the wetland would stay wet through May and ponding in the deeper pools would dry out in June or July. The water balance prepared for Wetland D under existing soil conditions demonstrates that the wetland would be dry in May with a permeability rate of $4.0x10^{-4}$ cm/sec; however, with an engineered bottom, Wetland D would not dry out until August or September during most years (assuming compaction achieves a permeability rate of $1.0x10^{-6}$ cm/sec). The 2 central wetlands (Wetlands B and C) will be supplied mainly by subsurface flows from areas upslope and to the west of the existing access road. The water balance for the 2 central wetlands indicates that the sites would maintain a sufficient water level whenever the water level of the reservoir (approximately 450 ft msl during June, July, and August) is above finish ground level of the proposed wetlands. Surface water levels in north-central wetland (Wetland B) are projected to be dry by September and surface water levels at south-central wetland (Wetland C) would be projected to be dry sometime between July and August with deeper micro-depressions remaining inundated through August (further detailed in Appendix A, Figure 11). Groundwater readings taken at piezometers throughout the 4 wetland sites further support the design intentions outlined in Section 4.0, Mitigation Design Proposal. Refer to Appendix A for a detailed evaluation of the piezometer readings.

Existing soil conditions in the 4 wetlands are suitable for the creation of wetlands. In the southern and northern wetlands (which will be primarily supported by surface flows), the predominant soil type is clay to a depth of 6-7 ft. This clay layer will facilitate wetland ponding. The 2008 NRCS Soil Survey indicates that the central wetlands (which will be primarily supported by subsurface flows from up-slope watersheds) have soils comprised of a sandy loam (Candlestick series). Field observations at these wetland sites found similar coarse soils. Appendices A and B include additional information regarding soil data and analysis.

5.0 IMPLEMENTATION

Site implementation activities are described below. The Draft Project Drawings are included in Appendix C (note that these 100% drawings have revisions outstanding and are not finalized).

5.1 SITE PREPARATION

Site preparation primarily involves the grading of the site to an elevation appropriate to support seasonal and emergent wetland habitats.

5.1.1 Native Species Protections and Exclusions

To minimize effects on desirable habitats and species, avoidance measures will be implemented. Temporary access lanes and staging areas will be identified, and equipment movement will be restricted to these areas by environmentally sensitive area (ESA) fencing, signage and other appropriate measures.

Western leatherwood (Federally listed species) is known to occur onsite: it will be avoided where possible or compensated onsite if affected by implementation.

5.1.2 Clearing and Grubbing

Clearing and grubbing will include the removal and disposal of all objectionable material, including trees (those with less than a 6 in diameter measured 4 ft from the ground), shrubs, other vegetation, and debris and rubbish of any nature. Earthwork operations will not begin in areas where clearing and grubbing are not complete, except that stumps and large roots may be removed concurrently with excavation. All existing vegetation, outside the areas to be graded will be protected from injury or damage resulting from the Contractor's operations. However, selective removal of invasive non-native species will take place in the adjacent grassland areas.

5.1.3 Grading

The final grading plan will include the placement of a 1 ft thick layer of topsoil across the design grade on the wetland bottoms to encourage the rapid establishment of invertebrates and wetland vegetation. This would require a 1 ft over-excavation of the wetland surface to accommodate topsoil placement to meet design grades. Topsoil for the northern wetland will be salvaged within the wetland’s grading footprint, while topsoil for the central wetlands will be salvaged from the nearby roadway improvement areas.

As mentioned above, grading limits will be clearly defined in the field to prevent damage to existing wetlands or high quality upland habitat. Temporary impacts to any adjacent habitats will be mitigated through in situ restoration activities including revegetation with native species. The temporary loss of habitat will be compensated by reducing the amount of habitat credit available to compensate other SFPUC projects.

A construction monitor will be onsite during grading and any other activities which include use of equipment or ground disturbance. The monitor will be experienced with and have appropriate permits to handle the protected species known to potentially occur onsite. The monitor will check under and around equipment before it is moved after a period of inactivity, and will visually clear each area to be disturbed immediately before work begins. If a protected or sensitive species is located during grading or other ground disturbing activity, construction activity will cease while the monitor determines an appropriate course of action. When practical, an animal will be allowed to move out of the construction area on its own. In some circumstances the monitor may elect to move the animal a short distance within the site and into appropriate habitat with adequate cover from predators. All other protective measures included in the project regulatory permits and agreements will also be fully implemented.

5.1.4 Coarse Woody Debris

Coarse woody debris piles may be included in the 2 central wetlands if material is available from work occurring at nearby SFPUC sites.

5.1.5 Water Supply

No irrigation will be necessary for this project as the proposed wetland creation areas are designed to be supported by groundwater and/or the adjacent contributing watershed.

5.1.6 Invasive Plant Control

It is expected that invasive species control will be necessary prior to project implementation. Invasive control should be planned ahead of time and could be started prior to anticipated initial planting. Follow up treatments (detailed in the Vegetation Management Plan, Appendix D) for invasive species will also be required during the monitoring period.

Target species for non-aquatic, upland habitats are species with high or moderate impacts rankings in the California Invasive Plant Council's (Cal-IPC) Central West list (excluding those listed as exempt below), as well as those species that are rated as high or moderate by the Cal-IPC list in the future (but excluding species that are considered to appear rarely in monotypic stands or to have low/minor impacts in our region).

Target invasive species for wetland habitats, riparian habitats, and other aquatic habitats regulated by USACE, RWQCB, and CDFG are the same as for non-aquatic/upland habitats, with the addition of the species ranked as Tier 1 and Tier 2 in the Water Board's Fact Sheet for Wetland Projects http://www.waterboards.ca.gov/sanfranciscobay/certs.shtml.

Scientific Name	Common Name	Cal-IPC rating	Considered a Target Invasive by SFPUC?	Rationale for not being considered exempt from the list of target invasives in non-wetland areas
Bromus diandrus	ripgut brome	Moderate	N	Monotypic stands uncommon.
Cynosurus echinatus	hedgehog dogtailgrass	Moderate	N	Impacts vary regionally, but typically not in monotypic stands.
Erechtites glomerata, E. minima	Australian fireweed, Australian burnweed	Moderate	N	Impacts low overall. May vary locally.
Hordeum marinum, H. murinum	Mediterranean barley, hare barley, wall barley	Moderate	N	Generally do not form dominant stands.
Hypericum perforatum	common St. John's wort, klamathweed	Moderate	N	Abiotic impacts low.
Hypochaeris radicata	rough catsear, hairy dandelion	Moderate	N	Impacts appear to be minor.
Lolium multiflorum	Italian ryegrass	Moderate	N	Impacts vary with region.
Rumex acetosella	red sorrel, sheep sorrel	Moderate	N	Widespread. Impacts vary locally.
Trifolium hirtum	rose clover	Moderate	N	Impacts relatively minor in most areas.
Vulpia myuros	rattail fescue	Moderate	N	Rarely forms monotypic stands

5.2 PLANTING MATERIAL

5.2.1 Plant Species List

Table 2 provides a list of container plants and willow cuttings to be used. Less common species may also be planted throughout the 4 wetland sites in coordination with the California Native Plant Society; however, their establishment will not be part of the project's performance criteria.

Table 2. Plant Species List.

Scientific Name	Common Name	Estimated Quantity for Wetland A	Estimated Quantity for Wetlands B &C
Carex barbarae	Santa Barbara sedge	286	213
Carex harfordii	Harford's sedge	475	0
Eleocharis macrostachya	spike rush	712	142
Euthamia occidentalis	western goldenrod	239	142
Juncus balticus	Baltic rush	437	213
Juncus effusus	soft rush	341	213
Juncus occidentalis	western rush	575	71
Juncus patens	spreading rush	324	213

Scientific Name	Common Name	Estimated Quantity for Wetland A	Estimated Quantity for Wetlands B &C
Juncus xiphioides	iris-leaved rush	691	71
Leymus triticoides	creeping wild rye	374	142
Salix laevigata	red willow	298	0
Salix lasiolepis	arroyo willow	298	0
Scirpus acutus	hardstem bulrush	0	60
Scirpus californicus	California bulrush	0	60

5.2.2 Sources and Storage

Mitigation plants will be contract grown by a qualified native plant nursery. The propagules should be collected from appropriate wetland and riparian habitats within the Peninsula watershed to ensure that native and local material is used. After plant propagules (seeds, plugs, and cuttings) are collected, approximately 12 months of lead time will be required before the plants are ready for installation.

5.2.3 Plant Size and Estimated Number of Installed Plants

Estimated numbers of required container plants for each species are listed in Table 2. The wetland plugs will be delivered (rushes and sedge) in Super Cell containers.

5.3 PLANT INSTALLATION METHODS

5.3.1 Hydroseeding and Broadcast Seeding

Hydroseeding or broadcast seeding will be employed in erosion control areas and highly disturbed areas. Either seed application technique will be used with a native grass and forb seed mix (Table 3). The seed in the northern wetland may be irrigated following application to germinate the seed early and thereby establish some erosion protection prior to the rainy season.

Table 3. Hydroseed Mix.

Scientific Name	Common Name	Pounds of Pure Live Seed / Acre
Achillea millefolium	yarrow	1.0
Artemisia douglasiana	mugwort	0.5
Bromus carinatus	California brome	8.0
Cyperus eragrostis	umbrella sedge / tall flatsedge	4.0
Eschscholzia californica	California poppy	2.0
Hordeum brachyantherum	meadow barley	8.0
Lupinus succulentus	arroyo lupine	8.0
Melica californica	California melic	5.0
Scrophularia californica	beeplant	2.0
Trifolium obtusiflorum	creek clover	6.0
Vulpia microstachys	small fescue / 3 weeks fescue	6.0

5.3.2 Wetland Plug Container Planting Methods

Wetland plugs will be planted on 3 ft centers in clusters of 10-20 plants throughout the wetland footprint (with the exception of the deeper pools in Wetlands A and D).

1. Immediately prior to planting, all container plants will be thoroughly moistened.
2. Plants will be removed from containers in such a manner that the root ball is not broken and installed immediately after removal from the container.
3. Plants with damaged rootballs will not be installed.
4. If plants are rootbound, the contractor will gently break up lower 1/3 of rootball prior to installation.
5. The contractor will minimize the exposure of the root ball to the air while placing the root ball in the ground.

Planting holes will be created using a shovel or trowel and will, at a minimum, be large enough to accommodate the plant rootball without restriction or distortion. The plants will be installed in the center of the plant hole so that their root crowns are at grade. Planting holes will be backfilled and lightly compacted to remove air spaces between roots and soil. Each plant will be irrigated immediately following installation, if soils are not moist at that time.

5.3.3 Willow Cutting Installation Methods and Protections

The willow cuttings will be installed at the northern and southern wetlands as enhancement plantings (i.e., not mitigation plantings) and spaced a maximum of 3 ft on center. The recommended arroyo willow cuttings (Table 2) will be harvested and installed in January or February when the trees are dormant. The cuttings will be approximately 24 in long with a diameter of 0.5-1.5 in. Pilot holes will be created by pounding a 1 in diameter section of rebar perpendicular to the soil surface to a depth of approximately 18 in. The willow cuttings will be irrigated immediately following installation, if soils are not moist at that time. A restoration biologist will supervise the installation efforts. Deer repellent will be applied to the foliage to minimize or prevent herbivory.

Willow cuttings will be handled carefully to ensure that cuttings are not damaged or subjected to excessive heat, wind, or desiccation during handling, transportation, and storage. The bottom ¾ of the cuttings will be placed in buckets filled with water immediately after they are harvested until they are installed. Cuttings should be installed with 24 hours (hr) of harvesting.

5.4 WATER SOURCES

5.4.1 Irrigation Methods

As the wetlands will be designed to be supported by groundwater or surface flows, it is not anticipated that the wetland plugs or willow cuttings will require irrigation. However, if conditions are dry and the planted materials show signs of drought stress within 2-4 months of installation, a water truck may be required to allow for hand watering. Refer to Section 8.3.5 for more information regarding supplemental irrigation.

5.5 IMPLEMENTATION SCHEDULE

Container plants will be installed between early December and late February unless otherwise permitted in writing by the SFPUC. Planting will occur after the onset of winter rain when the soil becomes moist to a minimum depth of 8 in.

6.0 MONITORING

Monitoring data will be collected and used to evaluate the success of the mitigation sites. Information from this monitoring program will provide feedback to direct necessary maintenance and adjustments to planting areas or techniques to ensure the success of the mitigation site.

6.1 MONITORING & DATA COLLECTION METHODS

6.1.1 Permanent Photo Documentation Points

Permanent photo documentation points will be established within the project site prior to construction. A minimum of 2 photo documentation points per created wetland site will be established to document site conditions. The location of the photo documentation site will be GPS'd to facilitate relocation and a GIS map of the location created as part of the first monitoring report. The photo documentation points should include landscape features that are unlikely to change over several years (buildings, other structures, and landscape features such as peaks, rock outcrops, large trees, etc.) so that repeat photos will be easy to position. The placement of a permanent T-post or metal fence post marking the photo points will improve consistency between years (SWRCB 2010).

Photos will be taken from these photo documentation points each monitoring year at the same camera angle, using a north, south, east, west compass bearing axis at the selected photo points, as appropriate to illustrate site conditions.

Photographs will be taken from approximately five feet in height, with exact height recorded using a standardized tripod or rod to ensure consistency of height from year to year.

In addition to the permanent photo stations, photographs will also be taken from the origin of each vegetation monitoring transect looking north, south, east, and west.

6.1.2 Vegetation Monitoring

Vegetation monitoring will be performed using a statistically robust method known as power analysis to assess percent cover of native, and invasive, perennial forbs and grasses. Power analysis would measure percent cover to within a margin of error of 10% at the 95% confidence interval (i.e., assesses to within +/- 10% of the true value, with a 95% likelihood of covering the true value in that range). The proposed power analysis method includes:

- Development of a monitoring protocol describing data collection techniques;
- Sub-sampling across different planting areas, sites and habitats; and

The proposed method would minimize the data collection effort while meeting requirements for statistical rigor.

Vegetation monitoring will be conducted during Years 1-5 for planted or established wetlands. The point-line intercept method will be used to estimate total vegetative cover, native cover, hydrophytic cover, and non-native invasive cover. This method will be used to determine whether the mitigation area is meeting set success criteria for vegetative cover.

Power Analysis. An *a priori* power analysis will be used to determine the monitoring effort required for the statistical analysis. The design of the statistical analysis influences the power analysis, including: a specific question to be answered and related statistical parameters; in this case, the allowable margins of error and confidence intervals. We define the specific question to be addressed as follows:

Is the true value of the percent cover less than or equal to the percent cover requirement?

The allowable certainty for percent cover will be a margin of error of +/- 10% at the 95% confidence interval. The confidence interval is the probability that the true value would be encapsulated in the margin of error around the reported percentage; the lower the confidence interval, the smaller the margin of error. Margin of error (ME), confidence interval and required number of sampling points (n) are related by the following equation for the 95 % confidence interval:

$$ME = 0.98/\text{sqrt}(n)$$

The number of sampling points required to evaluate percent cover will be calculated using this equation. However, the following factors will be considered in estimating the number of transects and/or sample points to estimate cover:

- The specific monitoring targets (e.g., such as whether survival of some planted species can be pooled resulting in fewer sampling points or must be examined separately by species),
- The target wetland acreage of different mitigation areas.

Monitoring Protocol and Analysis for Estimating Vegetative Cover. Point-line intercept surveys will be used to estimate absolute vegetative cover, native cover, and hydrophytic cover in wetlands. Point-line intercept surveys will also be used to estimate non-native invasive species cover. The number of transects and/or sampling points would be determined as described in the previous section.[5]

Data will be collected along randomly located transects at points established by placing a 2-meter metal rod vertically (perpendicular to the ground) at defined intervals (1 or 5 meters) along a transect tape. The plant species touching the rod within each height category (low, medium, and high) will be recorded. Plant species that touch the rod in more than one height category will be recorded in each height category. The two smallest vegetation height categories, Low (0.0 meter to 0.5 meter) and Medium (0.5 meter to 2 meters), are captured by the height of the

[5] Note that a margin of error will increase the uncertainty around the percent cover of invasive species. The threshold for invasive species 5% cover, however, a value of 4% could represent a value of 0 to 9% cover of invasive species (at the 95% confidence interval). Reducing the margin of error requires increasing the sampling effort, and margins of error within 1% would require prohibitively intensive sampling efforts.

rod (2 meters tall). The High category (over 2 meters) will be estimated using eyesight. In addition to vegetative cover, each point where there is no vegetation, bare ground will be noted.

A t-test will be used to evaluate whether or not percent cover is less than or equal to the interim or final success criteria.

Percent cover trends will be analyzed after collecting three years of data, the minimum required to plot a line. Percent cover mean and 95% confidence interval will be plotted against time along with the percent cover success criterion. Trend analysis may be more informative than examining threshold exceedance because invasive species percent cover increases often are predictive of long-term ecological composition. Trend analysis would be conducted and take annual climatic variation into account, as this variation may influence the rate of increase in percent cover.

Non-native Invasive Plant Monitoring. During spring or early summer of Years 1-5, non-native invasive plant cover will be calculated from the point intercept data collected from all sites, as described above. In addition to this monitoring, areas with greater than 5 percent cover of target non-native species will be mapped using GPS as long as areas are safely accessible. Maintenance activities to control non-native invasive species will be targeted in these areas. Each year the acreage of mapped highly invasive species will be compared.

A spring inspection in subsequent years comparing mapped non-native invasive cover from the prior year will be conducted to determine if a non-native invasive species population has spread or a new species has invaded. In either scenario, maintenance activities may be required.

6.1.3 General Site Assessments

Qualitative data will also be collected each year of monitoring for the purpose of informing management. These general site assessments are intended to assess the overall functioning of the site as a whole, and also to help identify localized or low-level trends such as new invasive species formations, localized changes in species abundance, and other changes that might be important to address through remedial management actions.

The following data will be collected during the site assessment:

- Species richness. This general site data will be used for calibrating similar data taken at transects, but is not intended for comparison with success criteria. Data will also help to evaluate whether invasive or non-native species are out-competing native plants, and whether more active management might be required.
- A visual assessment of cover in planted areas, invasive species over the entire site, and related observations of vegetation and habitat condition.
- Other site characteristics, including patterns of plant die-offs, erosion, hydrological issues, trespass, herbivory or grazing pressure, or other land use issues. This information is intended for use in recommending management actions as necessary.

Table 4. Qualitative Score for Assessing the Health and Vigor of Planted Stock

Score	Description of Score
Excellent	No evidence of stress; minor pest or pathogen damage may be present. No chlorotic leaves, no or very minor herbivory (browse). Evidence of new growth, flowering, seed set on majority (greater than 75 %) of plants observed.
Good	Some evidence of stress. Pest or pathogen damage present, few chlorotic leaves (> 5%), minor evidence of herbivory (browse). Evidence of new growth, flowering, seed set on most (greater than 50%) of plants observed.
Fair	Moderate level of stress; high levels of pest or pathogen damage, some chlorotic leaves (> 10%), some herbivory damage (few snapped leaves, stems, wear mamrks etc.). Evidence of new growth, flowering, seed set on some (less than 50%) of plants observed.
Poor	High level of stress; high levels of pest or pathogen damage, many chlorotic leaves (> 30%), severe herbivory damage (massive forage damage, main stems/leaves stripped etc.). No evidence of new growth, flowering, or seed set, or only a few plants (less than 25%) with these characteristics.

6.1.4 Wildlife Monitoring

Wildlife Assessment. To document wildlife use of the site, wildlife assessments will be conducted each monitoring year in the spring and summer (Tables 5 and 6). The data will be used to assess overall use of the site by wildlife, and not as a performance measure.

Aquatic Habitat Monitoring for California Red-legged Frog, Pacific Treefrog, and San Francisco Garter Snake. A qualified biologist familiar with the species will monitor California red-legged frog, Pacific treefrog, and San Francisco garter snake habitat. Survey events will consist of both daytime and nighttime surveys and will be conducted at the deeper pools within Wetlands A and D, and at the micro-depressions in Wetlands B and C in Years 1–5 (Tables 5 and 6). Survey events will occur 2-4 times annually from March through June; if species presence is not documented during the 2 March and April survey events, additional survey events will be required in May and June. It should be noted that seeing San Francisco garter snakes is unlikely because their population is very small and dispersed. It will therefore be important to document habitat conditions (per the general site assessment described above) and the presence or absence of prey, which includes the California red-legged frog and the Pacific treefrog. The following parameters will be analyzed at each survey event:

- Pool or micro-depression depth (minimum and maximum)
- Availability of water in appropriate seasons and for appropriate lengths of time to support breeding for populations of California red-legged frog (in Wetlands A and D) and Pacific treefrog (in Wetlands A, B, C, and D)
- Water temperature in shade and in sun, near surface and near bottom
- Percent cover of emergent vegetation
- Presence of San Francisco garter snake, California red-legged frog, Pacific treefrog, and other species of amphibian adults, juveniles or larvae. This may consist of dipnet, visual, auditory, larval, and egg-mass surveys.

- Presence of any potential predator, including snakes, birds, bullfrogs, and fish. Presence of native predator species will not be construed as a failure to provide appropriate habitat.

6.1.5 Special Site Assessments

Invasive Plant Assessment. Each monitoring year, an inspection for invasive species will occur once a month in March, May, and July in Years 1 through 5 (Tables 5 and 6).

Wetland Delineation. A formal delineation of the created wetlands will be undertaken at the site 5 years following site construction (Tables 5 and 6). The delineation will include an examination of vegetation, soils, and hydrology to determine the acreage and distribution of the jurisdictional areas associated with each wetland. However, field indicators of hydric soils are not anticipated to be present by Year 5 in the created wetlands. Such features typically develop over long periods of time (e.g., tens to hundreds of years). As such, the protocol outlined in Section F "Atypical Situations," Subsection 4 "Man-Induced Wetlands" of the *Corps of Engineers Wetlands Delineation Manual* (Environmental Laboratory 1987) describing the use of two parameters (hydrology and plants) will be followed.

If the desired jurisdictional acreage is not achieved in Year 5 or if climatic conditions were atypical in that year, a delineation will be repeated at the site in subsequent years to accurately determine the wetland acreage achieved.

Frequency and Volume of Surface Water Inputs (for Wetland A Only). Surface water inputs into the northern wetland are expected to be the primary driver of wetland hydrology. For this reason, field observations of the actual flow conditions will be necessary to demonstrate that the created wetland is receiving surface water inputs similar to those modeled in the wetland water balance in addition to evaluating the performance of erosion control BMPs and/or road improvements (e.g., rolling dips). Flows from the northern contributing drainage should be recorded with a flow meter and correlated with actual rainfall (e.g., in of rainfall in 24 hours) from data produced by the California Data Exchange Center (CDEC) for the Crystal Springs Cottage (CSC) weather station. SFPUC will establish permanent monitoring points at the rolling dips for the northern wetland to enable for sampling and confirmation of the flow distribution applied in the northern wetland water balance. This information combined with measuring the water depth at the rolling dip during monitoring will enable for a computation of a volumetric flow rate. The field data collection should capture 3 to 5 rain events (minimum of a 2-year event) per season. Particular emphasis should be placed on capturing peak flows during each event sampled, if possible. Monitoring shall occur in the first 2 years to ensure the site design is functioning as planned.

Wetland Hydrologic Functioning Assessment (for Wetlands A and D Only). To better assess the hydrologic functioning of Wetlands A and D it is important to assess their hydrological functioning, both immediately after construction, and long-term over the monitoring period. Each monitoring year, wetland assessments will occur monthly, December – August (Tables 5 and 6).

Hydrological functions to be documented include the following:

- **Rainfall Data.** A rain gauge will be installed and data collected monthly to catalogue inter-annual variations in precipitation.
- **Duration and Depth of Ponding.** Monitoring of the wetland ponding (hydroperiod) will be conducted monthly from February through August. Monitoring activities will focus on the collection of water depths via a staff gauge installed in the low point of Wetlands A and D. If ponding is no longer observed, a small excavation of no more than 12 in will be completed using an auger to assess soil moisture conditions within the upper 12 in.

A hydrological assessment will be conducted at Wetlands A and D during Year 1 to document "as built" hydrological functions, and to demonstrate compliance with wetland permit requirements for restoring wetland habitats pursuant to Section 404 and 401 of the CWA. The baseline "as built" hydrologic monitoring will be timed to correspond to initial filling of the wetland, with repeat visits to document the duration, and areal extent and depth of inundation, ponding, or flow in seasonal, intermittent, and perennial wetland habitats. If the created wetland is not functioning as designed, groundwater levels may need to be assessed via sampling wells or piezometers.

Subsequent hydrologic assessments will be conducted in monitoring Years 2-5 to document that the wetland is functioning properly (i.e., is not eroding or accumulating silt), has a lateral extent (i.e., area as expressed in square ft or ac), hydro-period, and depth of ponding similar to Year 1 "as-built" conditions, and as necessary to sustain the intended habitat types.

6.2 MONITORING SCHEDULE

Data should be collected at approximately the same time each year to standardize results (i.e., within a 2 week window, adjusted annually to account for seasonal variations in vegetation conditions, weather, precipitation, and temperature).

Tables 5 and 6 provide an overview of the monitoring schedule.

Table 5. Project Monitoring Timeline.

Monitoring Element	Year 1	Year 2	Year 3	Year 4	Year 5
Vegetation Survey[1], Photo Documentation, & General Site Assessment	X	X	X	X	X
Wildlife Assessment	X	X	X	X	X
Aquatic Habitat Monitoring	X	X	X	X	X
Invasive Plant Assessment	X	X	X	X	X
Wetland Delineation					X
Frequency and Volume of Surface Water Inputs (for Wetland A only)	X	X			
Wetland Hydrologic Functioning Assessment (for Wetlands A and D only)	X	X	X	X	X

[1] Monitoring transects and quadrats

Table 6. Annual Monitoring Schedule for Wetlands.

Monitoring Element	Suggested Schedule											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Vegetation Survey, Photo Documentation, & General Site Assessment			X	X								
Wildlife Assessment				X		X						
Aquatic Habitat Monitoring			X	X	X[1]	X[1]						
Invasive Plant Assessment			X		X		X					
Wetland Delineation				X								
Frequency and Volume of Surface Water Inputs (for Wetland A only)[2]	X	X	X	X								X
Wetland Hydrologic Functioning Assessment[3] (for Wetlands A and D only)	R	R	R	R								R
		P	P	P	P	P	P	P				

[1] Per section 6.1.4, the May and June survey events are not required if presence of CRLF is documented during the March and April survey events.
[2] Per section 6.1.5, this monitoring should capture 3 to 5 rain events.
[3] R = Rainfall, P = Ponding

7.0 SUCCESS CRITERIA

All information included in this section refers only to the wetland vegetation, as the willows installed at the drainage improvement areas are considered enhancement plantings.

7.1 FINAL SUCCESS CRITERIA

7.1.1 Vegetative Cover

For the areas within the mitigation sites expected to have wetland vegetation (i.e., not the deeper pools at Wetlands A and D) by the end of Monitoring Year 5, the following will apply:

- Seasonal wetlands (Wetlands A and D): Greater than 70 % absolute cover of hydrophytic seasonal wetland indicator plant species (as defined in Table 9)
- Emergent wetlands (Wetlands B and C): Greater than 75 % absolute cover of hydrophytic emergent wetland indicator plant species (as defined in Table 9)

7.1.2 Invasive Species

No more than 5% absolute cover of target invasive plants in the wetland habitat. Target species for non-aquatic, upland habitats are species with high or moderate impacts rankings in the California Invasive Plant Council's (Cal-IPC) Central West list (excluding those listed as exempt below), as well as those species that are rated as high or moderate by the Cal-IPC list in the future (but excluding species that are considered to appear rarely in monotypic stands or to have low/minor impacts in our region).

Target invasive species for wetland habitats, riparian habitats, and other aquatic habitats regulated by USACE, RWQCB, and CDFG species are the same as for non-aquatic/upland habitats, with the addition of the species ranked as Tier 1 and Tier 2 in the Water Board's Fact Sheet for Wetland Projects http://www.waterboards.ca.gov/sanfranciscobay/certs.shtml.

Scientific Name	Common Name	Cal-IPC rating	Considered a Target Invasive by SFPUC?	Rationale for not being considered exempt from the list of target invasives in non-wetland areas
Bromus diandrus	ripgut brome	Moderate	N	Monotypic stands uncommon.
Cynosurus echinatus	hedgehog dogtailgrass	Moderate	N	Impacts vary regionally, but typically not in monotypic stands.
Erechtites glomerata, E. minima	Australian fireweed, Australian burnweed	Moderate	N	Impacts low overall. May vary locally.
Hordeum marinum, H. murinum	Mediterranean barley, hare barley, wall barley	Moderate	N	Generally do not form dominant stands.
Hypericum perforatum	common St. John's wort, klamathweed	Moderate	N	Abiotic impacts low.
Hypochaeris radicata	rough catsear, hairy dandelion	Moderate	N	Impacts appear to be minor.
Lolium multiflorum	Italian ryegrass	Moderate	N	Impacts vary with region.
Rumex acetosella	red sorrel, sheep sorrel	Moderate	N	Widespread. Impacts vary locally.
Trifolium hirtum	rose clover	Moderate	N	Impacts relatively minor in most areas.
Vulpia myuros	rattail fescue	Moderate	N	Rarely forms monotypic stands

7.1.3 Wildlife Criteria

This section describes the success criteria for California red-legged frog and San Francisco garter snake, including:

- Creation of aquatic non-breeding, breeding, and foraging habitat for California red-legged frog (thereby creating foraging habitat for the San Francisco garter snake)
- Creation of aquatic non-breeding and breeding habitat for Pacific treefrog (thereby creating foraging habitat for the San Francisco garter snake)
- Predator removal activities

Habitat restoration for California red-legged frog and San Francisco garter snake will be successful if 2 of the primary constituent elements as described by the USFWS, aquatic non-breeding and breeding habitat, are documented at the deeper pools within Wetlands A and D, and at the micro-depressions in Wetlands B and C during the monitoring period and if predator removal programs are successful. Habitat related information will be used to determine whether the mitigation at each site is deemed successful or requires remediation, as described below:

Rehabilitation and Enhancement of Aquatic Breeding and Non-breeding Habitat for Red-legged Frog. Even if no individuals or egg masses are observed, the aquatic breeding and non-breeding habitat for California red-legged frog will be considered successful if the following habitat attributes are present:

- Protection from predators (e.g., deep pools or complex cover such as root masses or thick vegetation)
- Sunny areas appropriate for red-legged frog basking available within 100 ft of the deeper pools.
- A mixture of open water and emergent vegetation within the deeper pools. Suitable open water is necessary for foraging, while vegetative cover is necessary for shelter, protection from predators, and egg attachment. However, emergent vegetation will not exceed 35% cover of deeper pools' surface area.
- Deeper pools hold water for a minimum of 9 months/year for California red-legged frog breeding cycles.
- Water in the deeper pools does not exceed 21º C (Jennings and Hayes 1989) during breeding season and when metamorphs are present. This will be measured at the deepest point in the pool by a Hobo temperature logger (or other similar device).
- The deeper pools will be free of non-native predators to the extent practicable during each year of the post-construction monitoring.

Rehabilitation and Enhancement of Aquatic Breeding and Non-breeding Habitat for Pacific Treefrog. Even if no individuals or egg masses are observed, the aquatic breeding and non-breeding habitat for Pacific treefrog will be considered successful if the following habitat attributes are present:

- A mixture of open water and emergent vegetation during the spring breeding season. This matrix of open water and emergent vegetation is necessary for adults to attach egg masses, and for tadpoles to forage and hide from predators.
- Pools and micro-depressions hold water for a minimum of 3 months/year for Pacific treefrog breeding cycles.
- The deeper pools will be free of non-native predators to the extent practicable during each year of the post-construction monitoring.

7.2 ANNUAL SUCCESS CRITERIA

This section contains the annual success criteria for the San Andreas Reservoir Creation project. The wetland indicator status of each species from the quadrat and transect data will be determined, and the average percent cover attributed to wetland indicator species, as a group, will be calculated. Obligate and facultative wetland indicator species are hydrophytes that occur "in areas where the frequency and duration of inundation or soil saturation produce permanently or periodically saturated soils of sufficient duration to exert a controlling influence on the plant species present" (Wetland Training Institute 1995; http://plants.usda.gov/wetinfo.html).

Facultative indicator species may be considered wetland indicator species when found growing in hydric soils that experience periodic saturation. The wetland indicator status of each species will be determined and the average percent cover attributed to wetland indicator species, as a group, will be calculated.

Monitoring of performance criteria will evaluate the extent to which the created wetland sites are incrementally developing high quality wetland habitat values.

Percent Cover. The percent cover values will have shown steady trends towards, or will have met the percent cover success criteria of wetland indicator species. Percent cover goals differ between the seasonal and emergent wetland types. The final success criterion for seasonal wetlands is lower than that for the emergent wetland, based on estimates of adjacent reference habitats. For example, the seasonal wetland just south of Wetland A is estimated to have a percent cover of 70-80% native wetland vegetation, whereas emergent wetlands around the perimeter of the reservoir are observed to have a percent cover in excess of 80%.

Percent cover as a success criterion will only apply for the areas that are intended to the vegetated (i.e., not the deeper pools at Wetlands A and D). The percent cover performance criteria for the mitigation site is shown in Tables 7 and 8. Success guidelines for wetland habitats will include both parameters for hydrologic functioning and for vegetative cover of typical hydrophytic species.

Table 7. Seasonal Wetland Habitat Success Criteria.

Seasonal Wetland[1]	**Year 1:** 5 % or greater absolute cover of seasonal wetland species.[2] Positive evidence of proper hydrological functioning (i.e., saturated or inundated soils in the winter, with the upper soil layer drying out in the summer, during a year with normal rainfall amount[3] and distribution[4]). No more than 5% absolute cover of target invasive plants. No evidence of oversaturation or permanent inundation. **Year 2:** 20 % or greater absolute cover of seasonal wetland species Positive evidence of proper hydrological functioning. No more than 5% absolute cover of target invasive plants. No evidence of oversaturation or permanent inundation. **Year 3:** 45 % or greater absolute cover of seasonal wetland species, Positive evidence of proper hydrological functioning. No more than 5% absolute cover of target invasive plants. No large[5] unvegetated bare spots or erosional areas, no evidence of oversaturation or permanent inundation. **Year 4:** 60 % or greater absolute cover of seasonal wetland species, Positive evidence of proper hydrological functioning. No more than 5% absolute cover of target invasive plants. No large unvegetated bare spots or erosional areas, no evidence of oversaturation or permanent inundation. **Year 5:** Greater than 70 % absolute cover of seasonal wetland species, Positive evidence of proper hydrological functioning. No more than 5% absolute cover of target invasive plants. No large unvegetated bare spots or erosional areas, no evidence of oversaturation or permanent inundation.

[1] Note: Uneven vegetative cover success criteria between monitoring years allows for slow growth rates of newly-planted material, and accelerated growth rates and natural spread of plants outward from planted material in subsequent years after establishment.
[2] See Table 9 for representative species.
[3] The average rainfall amount will be based on data from California Data Exchange Center (CDEC) for the Crystal Springs Cottage (CSC) weather station.

[4] The average rainfall distribution will be based on data from Weatherunderground.com's San Francisco International (KSFO) station. (http://www.wunderground.com/NORMS/DisplayNORMS.asp?AirportCode=KSFO&StateCode=CA&SafeCityName=Hillsborough&Units=none&IATA=SFO&normals=on).
[5] One contiguous area measuring 2% or more of the total wetland area.

Table 8. Emergent Wetland Habitat Success Criteria.

Emergent Wetland[1]	**Year 1:** 15 % or greater absolute cover of emergent wetland species.[2] Positive evidence of proper hydrological functioning (i.e., saturated or inundated soils in summer during a year with normal rainfall amount[3] and distribution[4] when San Andreas Reservoir elevations are at or above 450 msl in summer). No more than 5% absolute cover of target invasive plants. **Year 2:** 30 % or greater absolute cover of emergent wetland species. Positive evidence of proper hydrological functioning. No more than 5% absolute cover of target invasive plants. **Year 3:** 50 % or greater absolute cover of emergent wetland species. Positive evidence of proper hydrological functioning. No more than 5% absolute cover of target invasive plants. No large unvegetated bare spots or erosional areas. **Year 4:** 65 % or greater absolute cover of emergent wetland species. Positive evidence of proper hydrological functioning. No more than 5% absolute cover of target invasive plants. No large unvegetated bare spots or erosional areas. **Year 5:** Greater than 75 % absolute cover of emergent wetland species. Positive evidence of proper hydrological functioning. No more than 5% absolute cover of target invasive plants. No large unvegetated bare spots or erosional areas.

[1] Note: Uneven vegetative cover success criteria between monitoring years allows for slow growth rates of newly-planted material, and accelerated growth rates and natural spread of plants outward from planted material in subsequent years after establishment.
[2] See Table 9 for representative species.
[3] The average rainfall amount will be based on data from California Data Exchange Center (CDEC) for the Crystal Springs Cottage (CSC) weather station.
[4] The average rainfall distribution will be based on data from Weatherunderground.com's San Francisco International (KSFO) station. (http://www.wunderground.com/NORMS/DisplayNORMS.asp?AirportCode=KSFO&StateCode=CA&SafeCityName=Hillsborough&Units=none&IATA=SFO&normals=on).

Table 9. Representative Seasonal and Emergent Wetland Species.

Seasonal Wetland Species	
Scientific Name	**Common Name**
Carex barbarae	Santa Barbara sedge
Carex harfordii	Harford's sedge
Cyperus eragrostis	umbrella sedge / tall flatsedge
Eleocharis macrostachya	spike rush
Euthamia occidentalis	western goldenrod
Juncus balticus	Baltic rush
Juncus effusus	soft rush
Juncus occidentalis	western rush
Juncus patens	spreading rush
Juncus xiphioides	iris-leaved rush
Leymus triticoides	creeping wild rye
Salix laevigata	red willow
Salix lasiolepis	arroyo willow
Emergent Wetland Species	
Carex barbarae	Santa Barbara sedge
Eleocharis macrostachya	spike rush
Juncus balticus	Baltic rush
Juncus effusus	soft rush
Juncus occidentalis	western rush
Juncus patens	spreading rush
Juncus xiphioides	iris-leaved rush
Scirpus acutus	hardstem bulrush
Scirpus californicus	California bulrush
Typha sp.	cattail

The list provided in Table 9 is not intended to be exhaustive, but rather a list of species anticipated to be present based on adjacent reference wetlands. Other native wetland species appropriate to the respective target habitat type may be added upon approval from the RWQCB and CDFG.

Deeper Pool Hydrology. The deeper pools at Wetlands A and D will provide appropriate conditions to allow for successful breeding of California red-legged frog. The pools will be a minimum depth of 3 ft and will remain ponded long enough into the summer (generally through July) to allow for complete metamorphosis of tadpoles. However, to ensure that bullfrog breeding habitat is not created, these areas must also dry out completely each year.

Wetland Delineation. The total acreage of created jurisdictional seasonal and emergent wetlands (meeting success criteria for hydrophytic vegetation and wetland hydrology, but not for hydric soils) will be equal to or greater than 4.8 ac.

8.0 MAINTENANCE

8.1 OVERALL DESCRIPTION

Maintenance will be required during the monitoring period at the created wetlands and adjacent riparian and upland habitats within the project site boundary (see Figure 3) to provide the desired conditions for the California red-legged frog and the San Francisco garter snake. Maintenance and management activities will be designed to avoid and minimize take of federally listed species (ICF 2010).

The results of monitoring will be conveyed to the SFPUC to allow the information to be factored into their ongoing maintenance program. Annual reports will be provided to those associated with the site's maintenance. In addition, if monitoring crews notice significant problems related to the site's maintenance and performance, verbal reporting will initiate remediation.

8.2 APPLICABLE CONSERVATION MEASURES (FROM BIOLOGICAL ASSESSMENT)

The following conservation measures from the SFPUC Peninsula Region Habitat Reserve Program Biological Assessment will be implemented to avoid and minimize effects to special-status species during maintenance and long-term management activities (ICF 2010).

8.2.1 Worker Awareness Training

The SFPUC will develop and implement a worker awareness program (environmental education) to inform project workers of their responsibilities regarding listed species and their habitats present in the action area and vicinity. The program would comply with the following measures:

- **Program Development.** A biologist familiar with the listed species in the action area will develop the training program.
- **Training.** Before any ground disturbing work (including vegetation clearing and grading) occurs in the construction area or spoils disposal areas, a Service and CDFG approved biologist will conduct a mandatory biological resources awareness training for all construction personnel about federally listed species that could potentially occur onsite (California red-legged frog, and San Francisco garter snake, western leatherwood, San Francisco dusky-footed woodrat). Proof of personnel attendance will be kept on file at the SFPUC. Interpretation will be provided for non-English speaking workers. If new construction personnel are added to the project, the SFPUC will ensure that the new personnel receive the mandatory training before starting work. The subsequent training of personnel can include videotape of the initial training and/or the use of written materials rather than in-person training by a biologist.
- **Content.** The biological resource awareness training will include specific information to educate construction workers on how they can minimize and avoid potential mortality of listed species while working on the project site and driving on access roads.

- Training will provide educational information on the natural history of the listed species that could occur in the area, representative photographs, how to identify the species, legal status of each federally listed species, terms and conditions of the USFWS Biological Opinion and penalties for noncompliance with the terms and conditions.
- The training will provide the time periods when listed species are more likely to be crossing the roadway, will describe the need to drive more slowly in rainy conditions, and will describe the need to be aware of snakes that could be basking in or crossing the road.
- Workers clearing in the vicinity of woodrat nests will be taught how to avoid these nests or how to relocate them off-site without damage.
- Workers hand clearing in the vicinity of the listed plant will be taught how to avoid effects to these plants.
- The training will provide information regarding the importance of preventing the spread of non-native invasive species.

8.2.2 General Procedures

- **Delineate Limits of Work.** The contractor will clearly delineate the limits of work and prohibit any construction-related traffic outside these boundaries.
- **Off-road Travel.** Project-related vehicles and equipment will restrict off-road travel to the designated work area.
- **Trash Disposal.** The contractor will provide closed garbage containers for the disposal of all food-related trash items (e.g., wrappers, cans, bottles, food scraps). All garbage will be collected at the end of each workday from the action area and placed in a closed container that will be emptied weekly at an approved offsite location. Construction personnel will not feed or otherwise attract fish or wildlife.
- **Speed Limit.** Project-related vehicles will observe a 15 MPH speed limit on unpaved roads throughout the project areas.
- **Pets and Firearms.** No pets or firearms will be allowed in the project areas.
- **Inspect Open Trenches and Pits.** Any open trenches or pits 2 or more ft deep will be covered before the end of construction activities each day. If this is not feasible, the trenches or pits will be equipped with ramps every 150 ft to allow any animals that might become trapped to escape overnight. Ramps will be constructed of dirt fill, wood planking, or other suitable materials placed at an angle of no greater than 30 degrees. Before any such trenches or pits are filled, they will be thoroughly inspected for trapped animals.
- **Remove All Project Debris.** Upon project completion, the SFPUC will remove from the project site and properly dispose of all construction refuse, including, but not limited to, broken equipment parts, wrapping material, cords, cables, wire, rope, strapping, twine, buckets, metal or plastic containers, and boxes.

- **Maintenance-related Measures to Avoid Spread of Invasive Weeds or Chytrid Fungus.** To reduce the possibility of spreading invasive plants or chytrid fungus to listed species habitat the following measures will be implemented:
  - All contractors will have sanitation kits on the site for cleaning equipment (sanitation kits should contain chlorine bleach [10/90 mixture bleach to water] or Clorox® Clean-Up® or Lysol®, scrub brush, metal scraper, boot brush, and plastic gloves).
  - After the completion of work activities, any accumulation of plant debris (especially leaves), soil, and mud will be washed off equipment or otherwise removed on the site, and radiators will be blown out.
  - Any imported fill material, soil amendments, gravel, and the like required for construction and/or restoration activities to be placed within the upper 12 in of the ground surface will be free of vegetation or plant material.
- **Fueling and Vehicle Maintenance Buffers.** All fueling and maintenance of vehicles and other equipment will be at least 50 ft from riparian habitat or water bodies to the extent feasible.
- **Compliance with Biological Opinion.** To ensure compliance with the conservation measures of the project's Biological Opinion, the USFWS and CDFG-approved biologist will have authority to immediately stop any activity that is not in compliance with the Biological Opinion, and/or order any reasonable measure to avoid the unauthorized take of an individual of the listed species.

8.2.3 Herbicide Use

- **Avoid Herbicide Use.** Use chemical weed control methods only when other methods (e.g., weed wrenches, string trimmers, hand removal, mowing, disking, grazing) are unsuccessful. If needed, use only herbicides that are approved for use in California and specific habitats and meet the City of San Francisco's pesticide policy, as appropriate, and do not use any chemicals that are considered a threat to any special-status species have the potential to occur in the area.
- **Exclusion Buffer for Herbicides.** Sensitive locations will be marked on a map and provided to the SFPUC herbicide contractors before any herbicide application begins. If federal or state regulations require a buffer around these habitats, that buffer would be delineated in the field with pin flags prior to herbicide application.
- **Weather Constraints on Herbicide Application.** Restrict herbicide use to the weather conditions allowed by regulations as indicated by manufacturer use restrictions.

8.3 REVEGETATION INSPECTION AND MAINTENANCE

Inspections will take place as outlined in the maintenance schedule (Table 10). The summer inspection will be conducted by SFPUC personnel, or their designee.

The revegetation inspection should include the following parameters:

1. Erosion control is in place and functioning properly.

2. Wetland habitats are exhibiting proper hydrological functioning.
3. Plants are not exhibiting water or drought stress.
4. Pioneering populations of invasive plants are absent within the project site boundary, or are to be treated immediately whenever detected. Refer to Section 8.3.2 for further detail concerning invasive plants.
5. Distinctive patterns of plant die off (i.e., all species of a single plant die, a cluster of plants within a small area all die).

8.4 INVASIVE PLANT INSPECTION AND MAINTENANCE

Inspections will take place as outlined in the maintenance schedule (Table 10).

Maintenance will be conducted annually as outlined in Table 10, unless another time of year is deemed more appropriate by the project monitor to avoid disturbance to sensitive species or to prevent seed set of invasive species (see Vegetation Management Plan, Appendix D). Invasive plant populations within the project site boundary are to be removed/treated as soon as possible following detection. Appropriate control methods will be utilized depending on the species, the abundance and distribution of the species, and the location within the site and relative to wetlands or other sensitive resources. Adaptive management is emphasized wherein various strategies will be employed, depending on site-specific conditions and invasive species issues at the time of management/maintenance activity.

The maintenance contractor, site supervisor, or monitoring biologist, should have a good understanding of native and invasive plant species so that spot control of invasive species does not impede the establishment of the plantings, or the natural recruitment of desirable native species. If timing of maintenance needs to be modified for certain items, the rationale for the decision will be documented in annual reports.

8.5 PREDATOR INSPECTION AND MAINTENANCE

Management for predators will include monitoring their presence during the annual wildlife assessments (Tables 6 and 10). As noted above, the main species of concern are bullfrogs, fish, and other predators that would negatively impact CRLF and SFGS populations.

Each monitoring year, if predators are detected in the wetlands and a pond has standing water in September, the affected wetland will be drained for 10 days in late September or early October if it is not expected to dry out on its own. For bullfrog control, draining of the ponds disrupts the 2-year development cycle of the bullfrog and substantially reduces or eliminates successful reproduction. For predatory fish species, draining the ponds would kill adult and juvenile individuals. Manual predator removal measures, such as gigging and taking by hand, may also be implemented to reduce the predator population.

8.6 INFRASTRUCTURE INSPECTION AND MAINTENANCE

The San Andreas site includes improvements to an existing unpaved roadway that is expected to require long-term maintenance to sustain all-season access[6]. The road would be constructed using a combination of aggregate base material and materials excavated onsite. Annual inspection of the roadway should be performed along the entire roadway within the project site to assess its overall condition to determine whether repairs are needed. The roadway at the southern wetland would be constructed to retain water to the west so section of the roadway should also be inspected annually for burrowing rodents.

The roadway improvements include 4 rolling dips, which would allow surface water runoff to pass over the road and into either the northern wetland or toward the reservoir. The locations of these drainage improvements are shown in Figure 4. The dips would be reinforced with PVC grass pavers that are capable of supporting the anticipated vehicular loads. The PVC grass pavers should be inspected annually to check for differential settlement, loss of soils in pavers (foundation erosion), and for damage such as cracking. The edges of the pavers should also be inspected to ensure that excessive erosion into the roadway is not occurring. Careful inspection of the rolling dips for any signs of settlement of the grass pavers will be critical to minimize the potential for the creation of concentrated flows. Road sections adjacent to the grass pavers should be inspected annually for evidence of erosion at the edges of the pavers.

Monitoring of the roadway and drainage improvements should be done using a GPS unit and digital photo-documentation. Changes in the size and/or shape of these improvements should be monitored. Depending on the extent of erosion observed, various corrective measures could be undertaken to minimize erosion-related impacts. These include installing erosion control blankets, hydroseeding, providing additional plantings, and installing additional fiber rolls or other erosion control methods. Monitoring frequency at locations subject to any corrective measures would be adjusted as needed to ensure the applied measures are successful.

Inspection of the flow patterns within the wetlands would also be completed to assess for any scour conditions. Two inspections would be completed annually; in mid–January to observe active flow patterns through the wetlands and in July to inspect for bare, non-vegetated areas and any evidence of burrowing rodents. Established wetland vegetation is the preferred long-term method of soil stabilization and, therefore, careful attention should be paid to bare areas along the flow path. Depending on the severity and extent of any scouring observed, maintenance measures that could be undertaken to minimize further scour may include installation of erosion control blankets, hydroseeding, provision of additional planting, or installation of fiber rolls or other erosion control methods.

[6] Note that the all-season access road would be designed to provide seasonal access, but may remain inaccessible during peak rainfall events.

8.7 REMEDIAL ACTIONS

8.7.1 Potential Actions

Potential remedial actions could include some or all of the following:

1. Weeding around planting sites to reduce competition from non-native grasses and forbs;
2. Supplemental watering: If rainfall is more than 20% below average in Years 1 and/or 2, supplemental irrigation may be applied. However, if the site is irrigated during Years 3 through 5, the 5 year monitoring requirement will be reset to Year 1 and monitoring will resume for a minimum of 5 years after irrigation has ceased;
3. Additional erosion control;
4. Additional invasive plant control; and
5. Supplemental replacement plantings (may be in-kind, or if a particular species is not doing well at the site, a replacement species can be substituted for the original plant) if it is deemed that no other procedure could be employed to restore the target habitat to meet monitoring criteria
6. Hydrologic modification: Based on the results of the wetland hydrologic functioning assessment (Section 6.1.5 and Tables 5 and 6), maintenance may be required. If too little or too much water is entering the northern wetland, adjustments to the dips/grass pavers may be necessary. Modifications could include increased size of the dip area or changing the dip elevation. In addition, if ponding conditions observed suggest a lack of seasonal wetland hydrology (e.g., too wet or too dry), additional grading within the wetland feature may be required to achieve the appropriate topographical elevation(s).
7. Regrading could be recommended if it is deemed that no other procedure could be employed to create/restore the target habitat to meet monitoring criteria

8.7.2 Initiating Procedures

If annual success criteria are not achieved for any portion of the mitigation project in any year, or if any of the final success criteria (Year 5) are not met, the SFPUC will work with the permitting agencies to prepare an analysis of the cause(s) of failure. If requested by the permitting agencies, a remedial action plan will be prepared in concert with the permitting agencies' action plan within 2 months of the initial request. Implementation of remedial actions would depend on the nature of the work; thus a schedule will be presented to the agencies for review and approval as part of the remedial action plan. Alternative mitigation sites have not been considered at present since the sites appear to be fully suitable for restoration. Alternative mitigation site planning will begin if it becomes apparent that the long-term success criteria for the sites will not be achieved in a timely fashion.

8.8 MAINTENANCE SCHEDULE

The maintenance schedule for the wetland creation sites during the 5-year monitoring period is provided in Table 10.

Table 10. Maintenance Schedule during the Monitoring Period.

Maintenance Item	**Suggested Schedule**											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Revegetation Inspection and Maintenance	M	M	I	I			I					M
Invasive Plant Inspection and Maintenance	I, M		I, M	I, M	I, M		I, M		I, M		I, M	
Predator Inspection and Maintenance[1]				I		I			M	M		
Infrastructure Inspection and Maintenance	I						I	M	M			

I = Inspection, M = Maintenance

[1] Predator inspection to occur during wildlife assessment (Table 6)

9.0 LONG-TERM MANAGEMENT

Long-term management will be required at the created wetlands. A Long-Term Management Plan for all of the Peninsula HRP sites, including the site described in this MMP, will be prepared and submitted for agency review by November 2010. This Plan will provide information concerning ongoing management of this site by SFPUC after the final success criteria described herein have been met. The Long-Term Management Plan will define the goals and objectives for each habitat type and prescribe management actions to meet them. Activities that will be addressed in the Plan will include but not be limited to: invasive plant management (including native as well as non-native plants), invasive predator control, erosion and sedimentation, infrastructure management, and grazing. Monitoring, contingency measures, and schedules associated with these activities will also be addressed in the Plan. The Plan will also be of sufficient detail to feed into the PAR analysis and the development of the endowment for the conservation easement.

10.0 PROPERTY MANAGEMENT

10.1 MANAGERS

The SFPUC is responsible for the long-term management of the site.

10.2 LONG-TERM FUNDING

SFPUC is responsible for funding any adaptive management or additional measures which it determines are necessary and with which the appropriate agencies concur. Letters of credit will be prepared as needed, unless other methods of financial assurance are negotiated with CDFG.

10.3 PROPERTY PROTECTION

The SFPUC will place a permanent conservation easement on the project areas and will create an endowment to ensure that funds are available for all required maintenance, management, and monitoring activities.

11.0 REPORTING

11.1 RECORD DOCUMENTATION

11.1.1 Content

The Record Documentation (commonly referred to as an As-Built Plan) will describe all significant deviations from the conceptual design presented in this document.

11.1.2 Schedule

The Record Documentation will be prepared by a qualified biologist and be provided to the regulatory agencies within 8 weeks of completing mitigation construction and planting. The agencies will be notified that mitigation construction and planting has been completed within 72 hours of concluding these activities.

11.2 MONITORING PERIOD REPORTS

11.2.1 Content

Maps showing monitoring locations and copies of photo-documentation will be provided along with reports. Field data sheets will be available for review by the agencies upon request.

Reports will be prepared in the following format:

1. Report Summary
2. Introduction
3. Methods
4. Results
5. Discussion
6. Management Recommendations
7. Literature Cited
8. Appendices

All monitoring reports will include the following photographic documentation (see Section 6.1.1):

- Photographs of baseline photo documentation locations, comparing Years 1 (Baseline) to Years 2, 3, 4, and 5.
- The format and layout for the comparison photographs should be standardized. The report will provide 4 photos per page with the photo site and date beneath each photo.
- A photograph of each end of the sampling transect facing the opposite end of the sampling transect comparing Years 1 (Baseline) to Years 2, 3, 4, and 5.

In addition, the following information will be provided to SFPUC:

- Transect photo documentation data should be provided to SFPUC in printed form, as part of the annual monitoring reports comparing photographs of the same locations over time, and electronically on a separate CD so that SFPUC can prepare and maintain a long-term image database for all its monitoring sites.
- A photograph of each sampling quadrat for future reference (should be provided to SFPUC electronically, but does not need to be part of written monitoring reports).

11.2.2 Schedule

Annual monitoring reports should be due for submittal to SFPUC by 1 November and submitted to the regulatory agencies by 31 December of each year of the monitoring period.

11.2.3 Completion of Mitigation Responsibilities

Notification. When final monitoring goals have been met, a final report will be prepared to establish that the mitigation site has successfully met the final success criteria. The report will summarize the mitigation project, evaluate the site's overall performance, and provide ongoing maintenance recommendations. If the site has successfully met the final success criteria, the project proponent will submit a letter to the permitting agencies requesting approval to cease monitoring.

Agency Confirmation. Monitoring will cease when the site has met all of the project goals or when the reviewing agencies agree that the site is expected to meet those goals with little chance of failure. Upon notification of completion the agencies identified above may concur based on written documentation or, at their discretion, may request a site visit to observe the completed project. Following completion of mitigation responsibilities, the site will be managed in perpetuity as described above.

11.3 LONG-TERM MANAGEMENT REPORTS

An annual account and property management report identifying the management and monitoring actions taken will be produced by the SFPUC and provided to the permitting and resource agencies as well as the conservation easement grantor.

11.3.1 Content

The annual long-term monitoring report will include the following information:

- An accounting of funds received and expended in the management of the site during the previous year;
- A general description of the status of the biological and physical resources located within the site;
- The results of biological and physical monitoring or studies conducted on the site;

- A description of all management actions taken on the site;
- A description of any problems encountered while managing and monitoring the site, and;
- Management recommendations for the upcoming year, including any necessary remedial actions.

11.3.2 Schedule

Annual monitoring reports should be submitted to the regulatory agencies by 31 December.

12.0 REFERENCES

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APPENDIX A.
HYDROLOGY REPORT

Final Technical Memorandum

SFPUC Habitat Reserve Program

Subject: **San Andreas Wetland Creation Project Hydrologic Evaluation**

Prepared by: Chris van Lienden, RMC
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Date: July 14, 2010

Reference: 0092-006.03 (formerly 0092-005.21)

1 Introduction

The San Andreas Wetland Creation Project proposed as part of the Habitat Reserve Program (HRP) is intended to satisfy the wetland compensation needs identified by the San Francisco Public Utilities Commission (SFPUC) for impacts to jurisdictional wetlands associated with the Lower Crystal Springs Reservoir (LCSR) Dam Project and the Crystal Springs-San Andreas (CSSA) Transmission Upgrade Project. The wetland creation areas proposed for the San Andreas Project site would provide up to 4.8 acres of out-of-kind wetland mitigation. This Project site, located in San Mateo County, California (CA), is owned entirely by SFPUC. This document is intended to summarize the hydrologic characteristics of the site and evaluate the capacity of the contributing surface or groundwater hydrology to support the proposed wetlands.

The San Andreas area provides four opportunistic locations for wetland creation based on a combination of geomorphic positions, contributing hydrology from upslope drainages, and previous disturbance resulting from the installation of the existing dirt and gravel surfaced fire access road, which traverses north-south through the Project area. The locations of the wetland creation sites are shown in **Figure 1**. As shown, these sites are in close proximity to the northwestern shoreline of San Andreas Reservoir. Scrub habitats are the dominant vegetation community within the Project site boundary and surrounding landscape; willow thickets are also present along the reservoir shoreline just east of the project boundary and along major drainage features. Site elevations within the Project boundary range from 452 feet to 475 feet. All elevations are based on North American Vertical Datum (NAVD) 1988.

2 Goals and Objectives

SFPUC's goal and objectives for the project include the following:

- Maximize opportunities for the compensation of wetland impacts resulting from the implementation of the LCSR and CSSA projects on lands owned by SFPUC.
- Demonstrate the feasibility of creating seasonal wetlands at the proposed locations by verifying that the localized hydrology satisfies the Army Corps of Engineer's (ACOE) hydrologic criteria[1] for defining wetlands.
- Complete limited roadway improvements to the existing fire access road to facilitate access to the proposed wetland sites in the spring, to the extent feasible, and to facilitate long-term monitoring.
- Design the wetland features to minimize perennial ponding conditions and avoid the creation of bullfrog breeding habitat.

[1] The criteria for Wetland Hydrology (ACOE Manual, 1987) state, "Area is inundated or saturated to the surface for at least 5% of the growing season in most years." This equates to saturated or near saturated soil conditions near the surface for at least 14 consecutive days during the growing season in most years. Where defining soil saturation, the substrate may be considered saturated if the water table is within: (1) 0.5 ft of the surface for sands; or (2) 1.0 ft of the surface for all other soils (e.g. clay loams, sandy loams, etc.).

3 Project Design Concept

The overall design concept for the Project site involves the creation of two seasonal wetland features, two emergent wetlands, and several small riparian enhancements along the existing fire access road (see **Figure 1**). The creation of these wetland and riparian features would be enabled through a series of drainage improvements along the existing fire access road. These roadway drainage improvements would improve water movement across the existing fire access road to benefit the created wetlands (where applicable), riparian areas, and existing habitats. The northern-most drainage improvements are proposed to mimic pre-existing drainage patterns prior to the construction of the fire access road to benefit overall water movement across the roadway. Each wetland and associated riparian feature is discussed below.

3.1 North Wetland (Wetland A)

The North wetland site (Wetland A in 65% design drawings) would consist of approximately 2.7 acres of new seasonal wetland immediately upslope of an existing wetland. The wetland is envisioned to be supported completely by annual rainfall and a portion of runoff from a 300-acre watershed to the north.

Currently, overflow from an existing drainage swale results in flows across the existing maintenance road. This overflow would be routed into the proposed wetland through the northern drainage improvement indicated in **Figure 1**. Based on the geometry of the swale and RMC's engineering judgment, as much as 40% of average annual watershed runoff volume could overflow using proposed drainage improvements into the proposed wetland. This overflow runoff would be diverted into the wetland while the remaining swale flow would continue south and maintain the hydrologic connection with the existing seasonal wetland. To facilitate wetland plants, a series of ponds would be used to increase detention time within the wetland. Once the ponds are full, flow would travel through the ponds and into the existing wetland. The design incorporates a minimum slope of 10H:1V for the flow path to minimize erosion potential.

3.2 North-Central and -South-Central Wetlands (Wetland B and C)

The North-Central (Site B in 65% design drawings) and South-Central fresh emergent wetland features (Site C in 65% design drawings) would be excavated to depths of up to 9 and 6 feet, respectively, to facilitate interaction with sub-surface water originating from several, small and highly dissected watersheds extending further upslope. These two sites would generally be supported by precipitation that falls on the area and groundwater draining from higher elevations.

Based on San Andreas Reservoir operations over the last 10 years, the reservoir water levels are maintained, on average, at an elevation above 450 ft during the months of June, July and August. **Figure 2** illustrates the historic operational water levels, which are assumed to continue during the operational life of the reservoir. This reservoir level is generally expected to control the hydraulic gradient for groundwater levels at these two wetland sites, thereby restricting any further downward movement of groundwater until reservoir levels begin to lower in September. The current expectation is that water levels will remain at or above 450 ft through August during most years.

Wetland B would be approximately 1.2-acres with a finish bottom elevation ranging between 450 to 451 feet. The approximately 0.7-acre Wetland C site would be lowered to similar elevations. Both emergent wetland features would be graded to include micro-depressions of no more than 1 ft in depth. The eastern boundaries of Wetlands B and C would intersect with the existing grade of the adjacent freshwater marsh estimate at approximately 451 feet. Side slopes of 4H:1V would be used around the perimeter of the wetland that border the existing access road. **Figure 2** shows a sketch of the proposed cross section.

Figure 1: Proposed Habitats

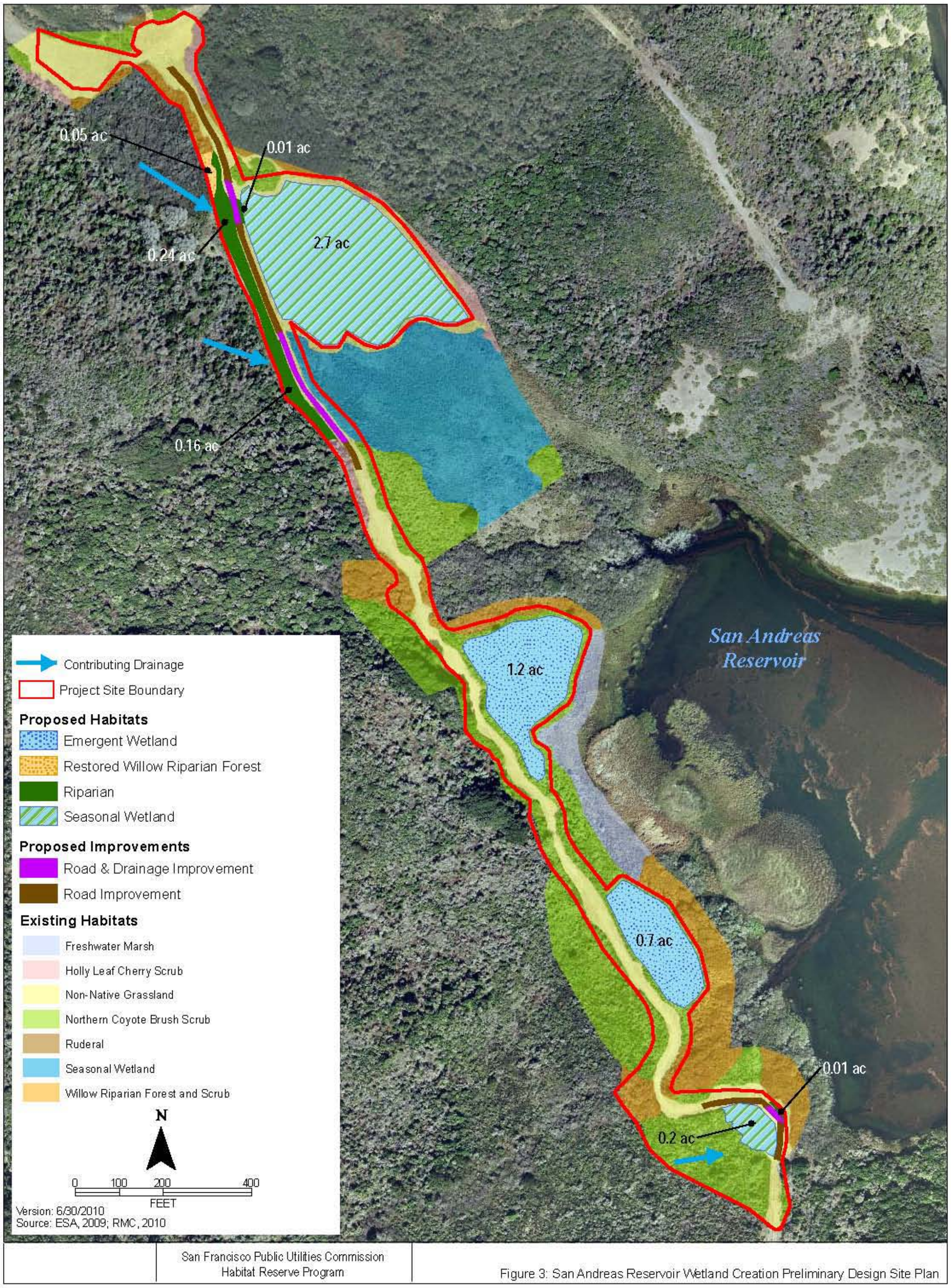
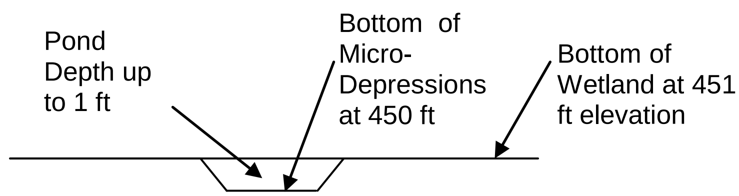


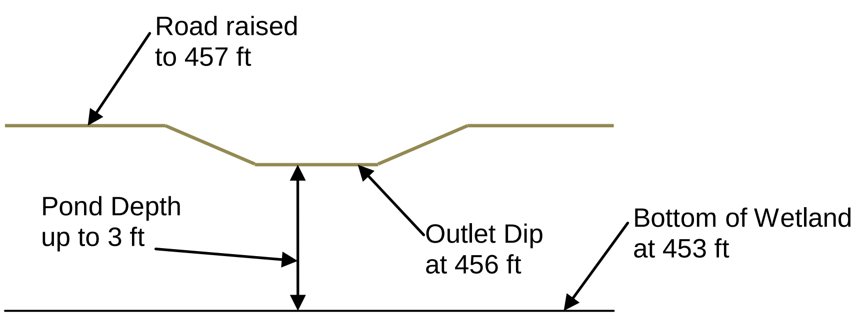
Figure 2: Cross-section Sketch of Proposed Central Wetlands



3.3 South Wetland (Wetland D)

The proposed seasonal Wetland D (65% design drawings) would be created by raising the road adjacent to the proposed wetland site to an elevation of 457 ft, with an outlet dip at 456 feet. This would detain water currently flowing over the road and facilitate wetland creation with <1 to 3 feet of ponding depth occurring within the approximately 0.2 acre inundation area. Areas below the 453 ft contour would be graded and the wetland bottom engineered to reduce soil permeability; remaining areas would be allowed to passively transition to wetland vegetation. Side slopes of the raised road would be 1.5H:1V. **Figure 3** shows a sketch of the proposed cross section.

Figure 3: Cross-section Sketch of Proposed South Wetland



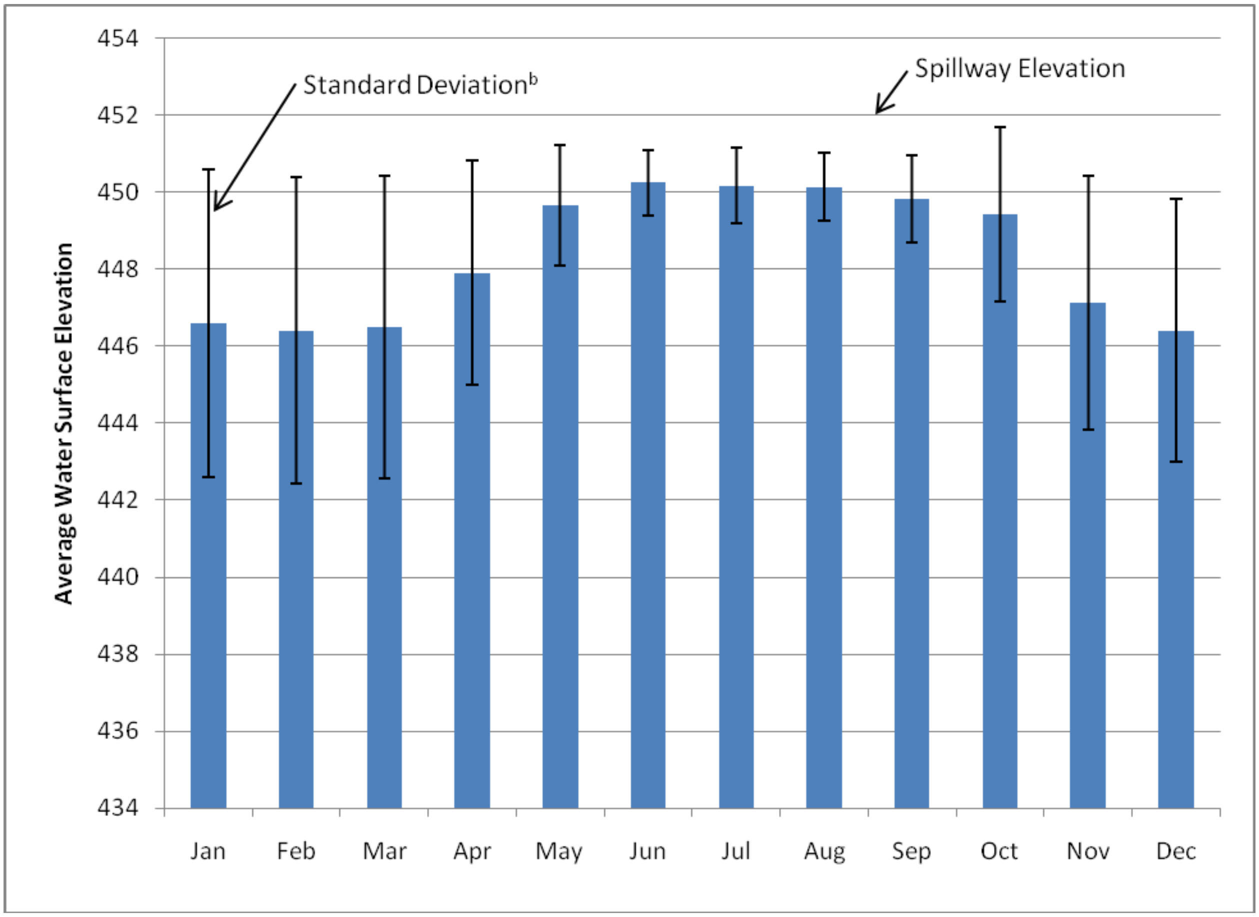
4 Existing Hydrologic Conditions

This section describes the existing hydrologic conditions for the proposed wetland sites. In general terms, the hydrology for the four wetland creation sites are driven by groundwater inflow from adjacent hillslopes and surface runoff from contributing drainage features.

4.1 San Andreas Reservoir

For each of the wetland creation sites, groundwater levels are expected to be supported by upslope groundwater contributions with the hydraulic gradient set by actual water levels in the San Andreas reservoir. **Figure 4** shows the average monthly water surface elevation of the reservoir based on the last 10 years of data along with the standard deviation. As shown, over the last ten years San Andreas Reservoir has typically maintained an average surface elevation of about 450 feet from June through August. Based on planned reservoir operations, this condition is expected to continue in the future.

Figure 4: San Andreas Reservoir Average Monthly Water Surface Elevation[a]



Footnotes:

a. Based on data from January 1, 2000 to February 28, 2010 from SFPUC - Water Enterprise.
b. Typically, 68% of days fall within the first standard deviation of the average, which is shown.

4.2 Delineation of Watershed Catchments

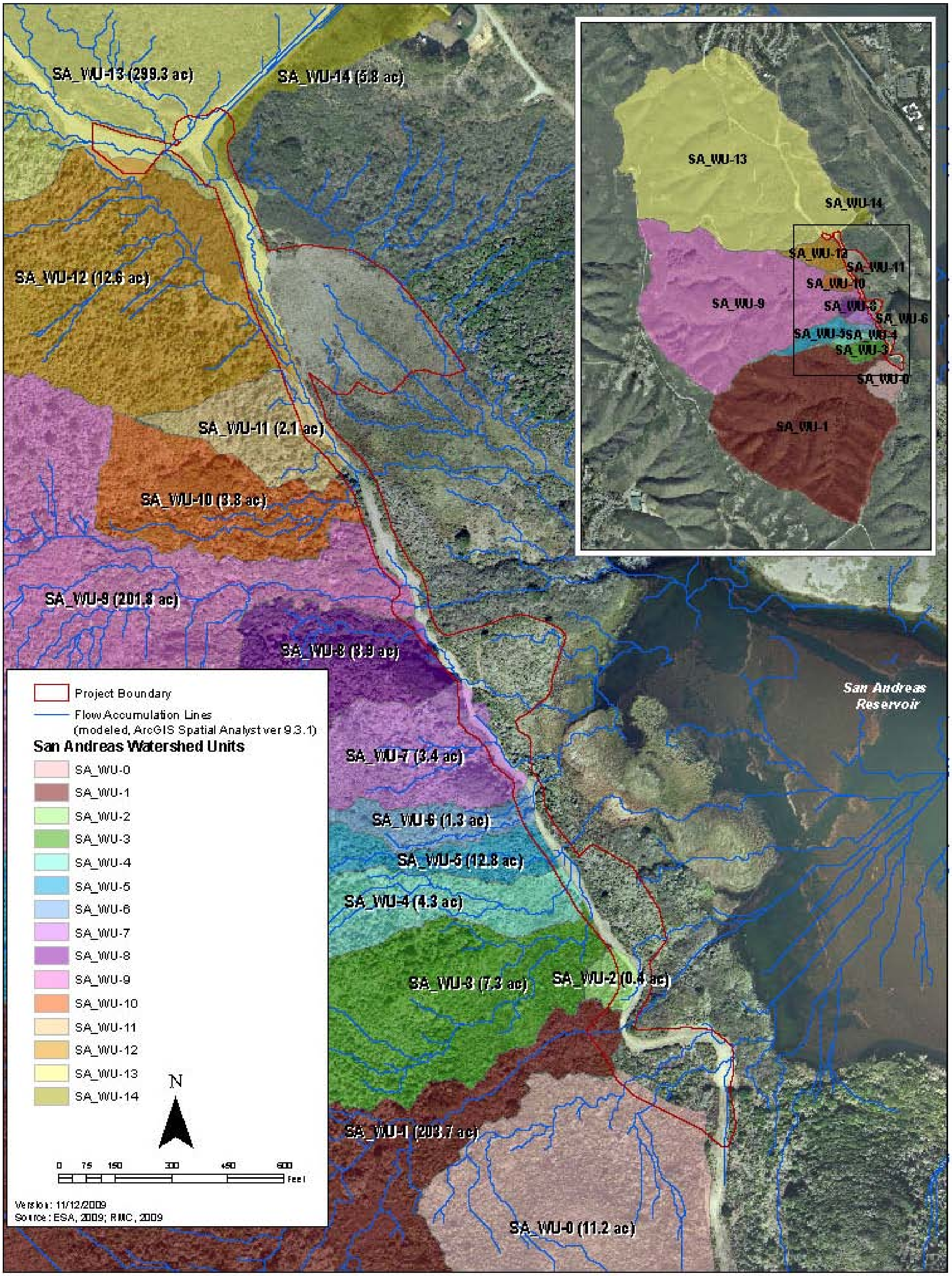
The watershed catchments contributing surface water runoff to areas within the San Andreas project boundary drain through the project site and empty into the reservoir. These watersheds have been delineated using ArcGIS, Spatial Analyst, and routing was evaluated to determine contribution to the proposed North and South wetland sites. The watershed delineations were based on topographic data gathered using USGS Light Detection and Ranging (LIDAR) data from 2007 and supplemented by 1990 USGS NED data where the 2007 data had insufficient coverage. As shown in **Figure 5**, there are 15 watersheds delineated that intersect with the Project site boundary. Three of these watersheds are greater than 200 acres with the remaining watershed catchments being highly dissected and smaller than 15 acres. The characteristics of the watersheds are summarized in **Table 1**. Routing was determined based on the surface interpolation of the LIDAR data and verified through site visits by RMC staff. Flow accumulation lines shown in **Figure 5** are considered approximate, particularly for small drainage areas that contain no defined drainage features. In these locations, there is evidence of sheet flow across the roadway, but no defined channel is present.

Table 1: Watershed Characteristics[a]

Watershed Unit	Routing	Area (acres)	Drainage Length (ft)	Average Slope (ft/ft)
SA_WU_0	South wetland	11.2	1,100	0.09
SA_WU_1	Southern culvert to SA Reservoir	203.7	4,300	0.15
SA_WU_2	Sheet flow over road to SA reservoir	0.4	150	0.03
SA_WU_3	Sheet flow over road to SA reservoir	7.3	1,100	0.06
SA_WU_4	Sheet flow over road to SA reservoir	4.3	1,200	0.07
SA_WU_5	Sheet flow over road to SA reservoir	12.8	2,200	0.09
SA_WU_6	Sheet flow over road to SA reservoir	1.3	600	0.05
SA_WU_7	Sheet flow over road to SA reservoir	3.4	600	0.06
SA_WU_8	Sheet flow over road to SA reservoir	3.9	650	0.07
SA_WU_9	North culvert to SA Reservoir	201.8	4,900	0.14
SA_WU_10	south of proposed North wetland (into existing wetland)	3.8	700	0.07
SA_WU_11	south of proposed North wetland (into existing wetland)	2.1	400	0.06
SA_WU_12	south of proposed North wetland (into existing wetland)	12.6	1,400	0.09
SA_WU_13	North wetland (proposed site) & culvert split flow	299.3	6,600	0.13
SA_WU_14	North wetland (proposed site) & North culvert split flow	5.8	1,500	0.07

Footnotes:
a. Based on 2007 and 1990 USGS LIDAR data and RMC field visits.

Figure 5: Watershed Delineation Map



4.3 Field Data Acquisition

Site specific soil sampling was completed by AEW Engineering (AEW) on March 25 and 26, 2010 at each of the four proposed wetland sites to assess groundwater levels, and the soil's suitability for wetland vegetation, excavation, and use as fill for segments of the access road. Piezometers were also installed to allow monitoring and data collection for groundwater depth and seasonal fluctuation. A map indicating the locations of the piezometer and soil tests is included in **Appendix A**. Test results data sheets are included in **Appendix A**.

4.3.1 North Wetland (Wetland A)

AEW installed a piezometer in the North wetland area at an elevation of 470.5 feet that extends to a depth 6.5 feet below the existing grade – or 464 feet. Initial soil sampling was also completed by AEW down to a depth 6 feet below the ground surface (bgs). The upper 4 feet was comprised of a sticky clay that grades to a sandy clay below 4 feet to the bottom depth of sampling[2]. The 2008 Natural Resources Conservation Service (NRCS) Soil Survey maps indicate this site is comprised of soil map unit 111 (Candlestick variant). A more detailed description of the soil map unit is provided in **Appendix A** and **B**. AEW documented the soil as being saturated on the dates of March 25 and 29, 2010, indicating that groundwater was at or near the surface elevation of approximately 470.5 feet. A piezometer reading taken on April 6, 2010 indicated groundwater at an elevation of 469.6 ft. This groundwater level has remained relatively stable at this elevation through June 28, 2010.

For the purposes of simulating the water balance for Wetland A, it should be noted that groundwater levels were estimated to restrict infiltration during the months of November through May due to the presence of high groundwater; at <1 ft bgs. For the month of June through October, groundwater levels were then assumed to lower to the base of the soil column, assumed to be 10 ft for the purposes of the model, thereby allowing infiltration to occur. In reality, this sudden drop may actually not occur due to the continued presence of high groundwater levels through the summer months. However, without actual groundwater data through the end of August and given the above-average rainfall experienced in the 2009-10 water year, a conservative approach was selected. Nevertheless, is it possible that the impact of infiltration on the results of the water balance maybe overstated for Wetland A.

4.3.2 North-Central and South-Central Wetland (Wetland B and C)

For the North-Central wetland site, AEW installed a piezometer at elevation 458 feet and to a depth of 7 feet below the existing grade. AEW also completed soil sampling at the site to a depth of 7 feet bgs with the substrate generally comprised of a sandy clay down to the depth of sampling. The 2008 NRCS Soil Survey indicates the North-Central Wetland site is comprised of soil map unit 111 (Candlestick variant), which is described in **Appendix B**. Groundwater was encountered at 16 inches bgs on March 25, 2010 during the soil investigation, which roughly corresponds with an elevation of 457 feet. A piezometer reading taken on April 6, 2010 indicated groundwater occurring at an elevation of 457.0 ft. Groundwater levels have since declined at a rate of about a foot a month with groundwater levels recorded at 454.5 ft on June 28, 2010.

AEW installed a piezometer in the South-Central wetland site at an elevation of 455 feet to a depth of 7 feet. Initial soil sampling was also completed by AEW to a depth of 7.5 feet bgs with the soil comprised of a sandy clay to the depth of sampling site. The 2008 NRCS soil survey assigns the South-Central wetland site to soil map unit 105 (Barnabe/Candlestick). Groundwater was encountered at 13 inches bgs on March 25, 2010, which corresponds with an elevation of 454 feet. A piezometer reading taken on April 6, 2010 indicated groundwater occurring at an elevation of 453.6 ft. Groundwater levels have since declined at a rate of about a foot a month with groundwater levels recorded at 451.2 ft on June 28, 2010.

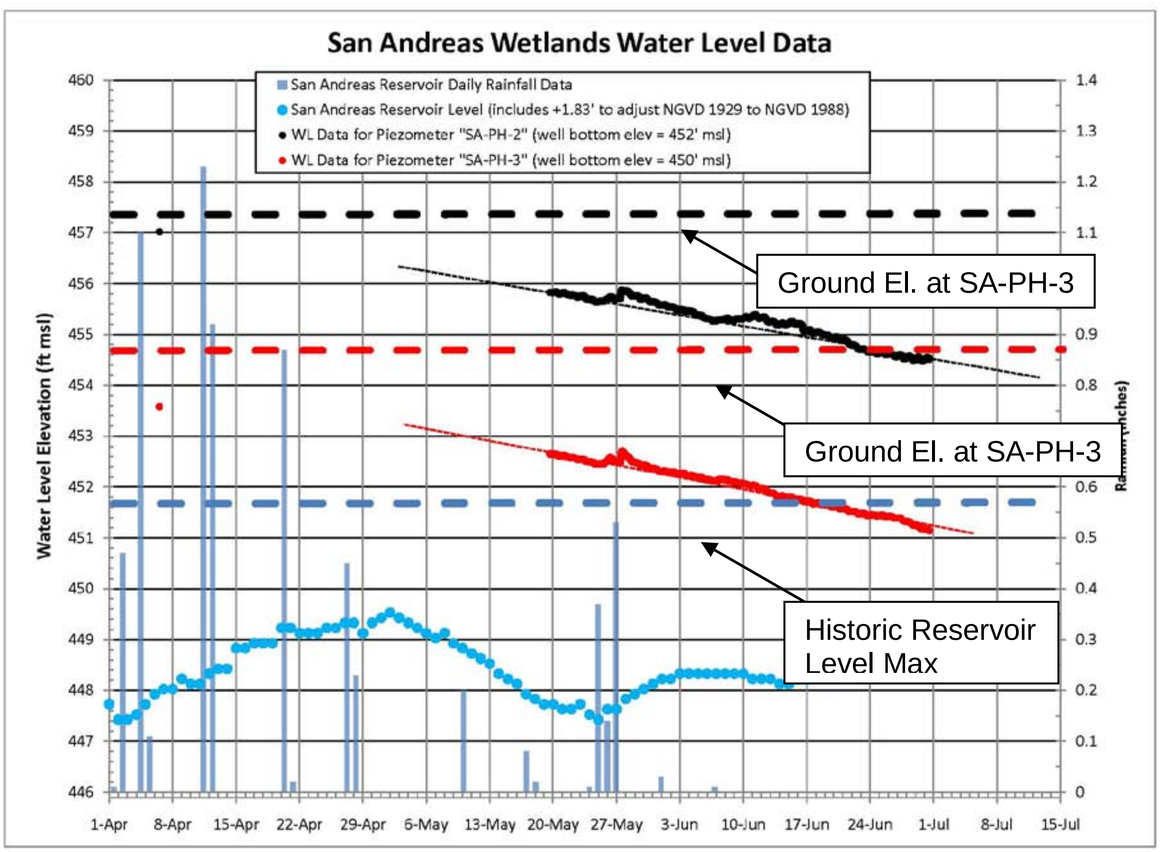
[2] All soil characteristics are preliminary and are presented in the Sampling and Analyses Technical Memorandum prepared by AEW and included in Appendix A.

Groundwater data collected through June 30, 2010 for the two central sites are summarized in **Figure 6**. The data indicates that the groundwater was 2 feet above the proposed elevation of the wetland sites at least through the middle of June 2010. Based on the limited data available, groundwater appears to recede at a rate of approximately one foot per month. It should however be noted that 2010 had above average rainfall, including several late rain events, and therefore it is likely that in average years the groundwater levels would recede earlier than indicated in the Figure 6, though we expect the rate of recession would be similar. Groundwater levels will continue to be monitored to evaluate the groundwater recession and to confirm the base elevations of the proposed wetlands.

4.3.3 South Wetland (Wetland D)

AEW installed a piezometer at the southern seasonal wetland site on March 26, 2010 at an elevation of 459 feet to a depth of 7 feet. Initial soil sampling was also completed by AEW to a depth of 7.0 feet bgs with the soil comprised of a dark brown, clay-rich soil within the upper 3 feet, followed by a transition to a higher sand/gravel content in the lower profile. The 2008 NRCS Soil Survey maps indicate this site is comprised of soil map unit 105 (Barnabe/Candlestick), which is described in more detail in **Appendix A** and **B**. Groundwater was encountered at 20 inches bgs at the southern wetland site during the March 25, 2010 field investigation, which corresponds with an elevation of greater than 457 feet. A piezometer reading taken on April 6, 2010 indicated groundwater at an elevation of 455.2 ft.

Figure 6: San Andreas Wetland Water Level Data



5 Wetland Water Balance Methodology

RMC prepared a surface water balance for the North and South seasonal wetland sites (Wetlands A and D) to determine the suitability for wetland creation. The water balance was used to establish a hydroperiod[3] for each wetland feature by quantifying the combined inputs of surface water and groundwater and associated outflows. The water balance was performed on an hourly basis over a 40 year (1966-2006) simulation period using historical meteorological data. The basic water balance equation (Mitsch & Gosselink, 2007) is

$$\frac{\Delta V}{\Delta t} = P - ETo + S_i - S_o - G_i + G_o$$

Where:

$\frac{\Delta V}{\Delta t}$ = Change in volume of wetland during that timestep

P = Direct Precipitation in the pond

ETo = Evapotranspiration

S_i = Surface water inflows (runoff)

S_o = Surface water outflows

G_i = Groundwater inflow

G_o = Groundwater losses (infiltration)

It was assumed that when the water depth exceeded the depth of the wetland, any excess water would leave as surface water outflow. The basis of assumptions for the water balance are described below.

5.1 Precipitation

Hourly Precipitation data were obtained from the Environmental Protection Agency's (EPA's) BASINS software database for the simulation period at the San Francisco Weather Service Office located in South San Francisco near the San Francisco International airport (SFO). This site was chosen for the proximity to the proposed wetland sites (approximately 3 miles from the sites), and the extended history of available data (>40 years). The site data indicates that annual average rainfall is 20.9 inches/year. **Table 2** summarizes the average rainfall on a monthly basis.

Table 2: Monthly Average Precipitation (inches)[a]

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
4.58	3.86	3.09	1.37	0.36	0.12	0.02	0.05	0.16	0.96	2.56	3.78

Footnotes:

a. Based on hourly precipitation data obtained from the EPA's Basins software database at the San Francisco Weather Service Office located in South San Francisco near the SFO airport.

5.2 Evapotranspiration

Hourly Potential Evapo-transpiration (PEVT) data were obtained from EPA's BASINS software database for the simulation period at a weather station located in Duboce Park in San Francisco. This dataset is calculated from daily Min/Max Temperature using Hamon's method (Hamon, 1961). The Duboce park station was chosen due to the extended history of available data. The hourly data were then adjusted to match the annual average ETo data from the nearest CIMIS station, located in San Mateo County (Station #96, Woodside).

Table 3 indicates the average ETo on a monthly basis.

[3] A hydroperiod refers to the seasonal pattern of the water level within a wetland. This approximates the hydrologic signature of each wetland type.

Table 3: Monthly Average Evapotranspiration (inches)

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2.12	2.53	3.64	4.41	5.57	6.15	6.20	5.63	4.80	3.86	2.59	2.05

Footnotes:

b. Based on hourly ETo data from EPA BASINS software for a weather station in Duboce Park in San Francisco, adjusted to the annual average ETO for CIMIS station #96 (Woodside) in San Mateo County.

5.3 Runoff

Surface inflow was developed using the Bay Area Hydrology Model (BAHM). BAHM incorporates calibrated model parameters for an internal modeling engine using the Hydrologic Simulation Program – Fortran (HSPF) model. BAHM was sponsored by the Santa Clara Valley Urban Runoff Pollution Prevention Program (SCVURPPP), Alameda Countywide Clean Water Program (ACCWP) and San Mateo Countywide Water Pollution Prevention Program (SMCWPPP) and developed by Clear Creek Solutions for use in the counties of Alameda, Santa Clara, and San Mateo. Calibration was performed based on Castro Valley Creek and Alameda Creek data in Alameda County. The modeling engine, HSPF, was developed by the United States Geological Survey (USGS) and uses meteorologic records and watershed soil, slope and vegetation information to compute streamflow hydrographs. The model incorporates surface runoff, subsurface flow, evapotranspiration, and groundwater storage features to predict the overall surface flows from the watersheds.

Due to the braided and poorly defined channel system, no site-specific calibration could be performed. Results of the model were compared with the mean annual runoff estimates for this area generated by Rantz (USGS, 1974). Both the model and the USGS study estimated the mean annual runoff volume to be approximately 8 acre-inches/acre.

5.3.1 Watershed Slope properties

The slope of the watershed was determined based on the LIDAR data provided by SFPUC. Slopes were separated into four categories and the area of each category was entered into the runoff model. The categories used were: very steep (>20%), steep (10%-20%), moderate (5%-10%), and flat (0-5%). The average watershed slope is indicated in **Table** 1. **Appendix B** includes a breakdown of the watershed areas by slope category.

5.3.2 Watershed Vegetation

Vegetation cover for each contributing watershed was determined by overlaying the delineated watersheds with the data produced by the California Department of Fish and Game's California Wildlife Habitat Relationships (CWHR). The vegetation classification outputs from CWHR were then re-classified into the closest category provided in BAHM. The vegetation in the project area is summarized in **Appendix B**. In general, the vegetation in the area was a mix of annual grasslands, coastal scrub, and mixed chaparral.

5.3.3 Watershed Soil

Soil survey data produced by the Natural Resources Conservation District (NRCS) for San Mateo County, Eastern Part, and San Francisco County, California (CA689, 2008) were used to characterize soil conditions within contributing watersheds. This data were used to determine the proportion of each hydrologic soil group within the contributing watershed. The hydrologic soil group is an identifier given to a soil which describes its ability to infiltrate water and produce water runoff. For example, a hydrologic soil group of A means that soil infiltrates water quickly, and thus does not produce much runoff, while a hydrologic soil group of D means that a soil infiltrates water slowly, thus producing a lot of runoff. In cases where more than one hydrologic soil group is applied to a individual soil map unit, a weighted average of the major hydrologic groups was used. The soil survey for the area is included in **Appendix B.** In general, the soil survey maps out most of the area as hydrologic soil group C or D.

5.4 Infiltration

It was assumed that three inches of soil moisture could be retained in the rooting layer (for the purposes of this report, this includes the upper 12 inches of soil) of the wetland before complete saturation. Groundwater flows out of the wetland were determined based on Darcy's law:

$$Q = AK_{sat}\frac{\Delta h}{L}$$

Where:

Q = flow rate (ft^3/s)

A= Flow area (ft^2)

K_{sat} = Hydraulic Conductivity (ft/s)

$\Delta h/L$ = hydraulic Gradient (ft/ft)

K_{sat} was based on a combination of literature review, laboratory analysis, and field testing results from April and June 2010. Flow area is the perimeter of the wetland times the flow depth, which is either the depth to bedrock or the depth to the groundwater table. The San Andreas Reservoir is expected to set the groundwater table for sites near the reservoir (all sites except the North wetland). For the North wetland site, a depth to bedrock of 10 feet was assumed.

The hydraulic gradient downslope of the proposed wetland was assumed to be the same as the average slope of the ground surface to the edge of the reservoir. It was assumed that during summer months, no groundwater contributions occurred upslope of the reservoir[4], and the upslope hydraulic gradient was therefore zero. During winter months (January – March), upslope hydraulic gradients were estimated assuming groundwater levels identified in the field during the March 2010 soil investigation were representative of typical winter groundwater levels. The downslope hydraulic gradients for the North and South sites are summarized in **Table 4**.

Table 4: North and South Wetland Hydraulic Gradients

Wetland Site	Elevation (ft)	Distance to Reservoir (ft)	Downslope Gradient
North wetland	475[a]-465[b]	1,100[a] – 700[b]	2.3%
South wetland	455	~200	2%

Footnotes:
a. At the upslope edge of the proposed wetland.
b. At the downslope edge of the proposed wetland.

The effective summer infiltration rates for the North and South wetland sites were modeled using a saturated hydraulic conductivity (Ksat) value of $4x10^{-4}$ cm/sec to characterize existing conditions and $1x10^{-6}$ cm/sec to represented a compacted bottom. This approach was taken to not only characterize existing soil conditions, but also allow for an assessment of potential soil compaction and/or application of a clay-type liner on the wetland floor or within the subgrade. **Table 5** identifies the sources considered a part of the selection of a Ksat value, which included a combination of field data collection, laboratory analysis, ands literature review.

[4] Summer upslope groundwater contributions to be confirmed via summer piezometer depth readings.

Table 5: Saturated Hydraulic Conductivity Values Considered in for the Water Balance

RANGE IN PERMEABILITY VALUES	SOURCE
$1.0x10^{-4}$ cm/sec to $1.0x10^{-6}$ cm/sec	AEW Draft TM; Freeze and Cherry, 1979
$6.2x10^{-4}$cm/sec	AEW Pump/Slug Testing at SA-PH-1 and SA-PH-2
$1.0x10^{-8}$ cm/sec ($1.4x10^{-4}$ in/hr)	Falling Head Test by Laboratory
$1.4x10^{-4}$ cm/sec to $4.0x10^{-4}$ cm/sec (0.198 in/hr to 0.567 in/hr)	Soil Survey, 2010 – Candlestick Loam
Impermeable to $3.4x10^{-4}$ cm/sec (0 to 0.5 in/hr)	National Engineering Handbook – Ksat values for soils with >15% clay; note the higher range occurs when the soil is no longer saturated.

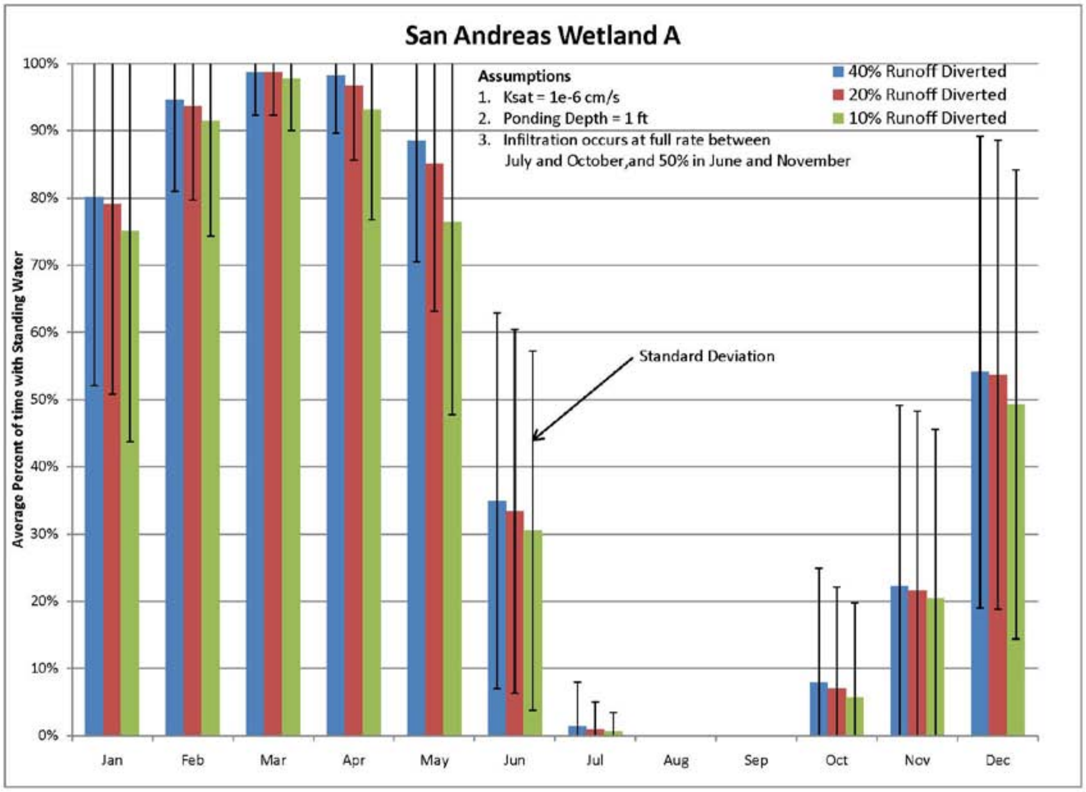
6 Results

A water balance was used to identify the cumulative impact of the various inputs to and losses from the wetland sites over the course of a year. The inputs include direct precipitation, runoff, and groundwater inflow. Losses included direct outflow, evapotranspiration, and groundwater outflow (infiltration). The water balance is determined through an analysis of the average conditions that are expected and the basis of design for the system to support the growth of hydrophytic vegetation and limit undesirable conditions such as ponding throughout the year that would encourage bullfrog breeding. The water balance is a projection of average conditions based on historic data and variations in annual climate conditions that are expected to occur, which may require an adaptive management approach.

6.1 North Wetland (Wetland A)

The runoff model indicates average yearly runoff of approximately 200 AF from the contributing watersheds (SA_WU_13 & 14) to the North seasonal wetland site. Based on the size of the existing swale, RMC estimates that 40% of the annual average runoff volume could be overflowing into the proposed wetland area. However, due to the braided nature of flows in this area, no calibration could be performed. The model was therefore run assuming 40%, 20% and 10% of the total runoff was supplied to the wetland to cover the full range of potential inflows. The average percentage of days inundated by month for the three scenarios are summarized in **Figure 7**. The results of the water balance indicate that during average rainfall years, the wetland would stay wet through May and ponding would dry out in June or July, with the corresponding water levels lowering to below the ground surface. Isolated areas within the wetland that are deeper than one foot would remain inundated for a longer duration, but would be expected to dry out within the following month as a result of evaporation combined with infiltration.

Figure 7: North (Proposed) Wetland Average Inundation

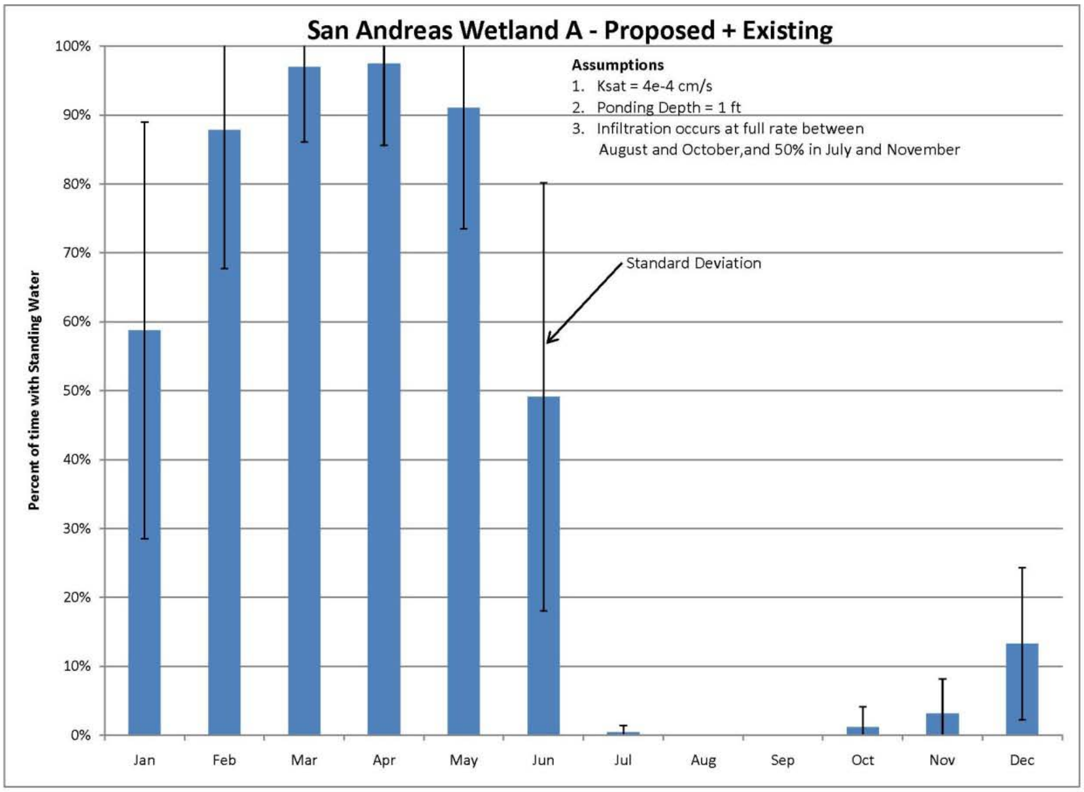


Footnotes:

a. Approximately 68% of years will fall within the first standard deviation of the average, which is shown.

To verify that the new seasonal wetland would not dry out the existing wetland to the south, a separate water balance of the combined existing plus proposed wetland was also performed. For the combined model all the flow from watersheds SA_WU_10-14 are expected to flow into the combined system. Based on field observations, RMC assumed that the existing wetland has a capacity to hold up to one foot of ponded water. The size of the combined wetland area (existing and proposed) was approximated at 6.2 acres. **Figure 8** shows the average percentage of time the wetland would be inundated by month. Similar to the proposed wetland, the results of the water balance indicate that during average years, the combined wetland area would stay wet through May and dry out in June or July, with the corresponding water level lowering to below the ground surface.

Figure 8: North (Proposed + Existing) Wetland Average Inundation



Footnotes:

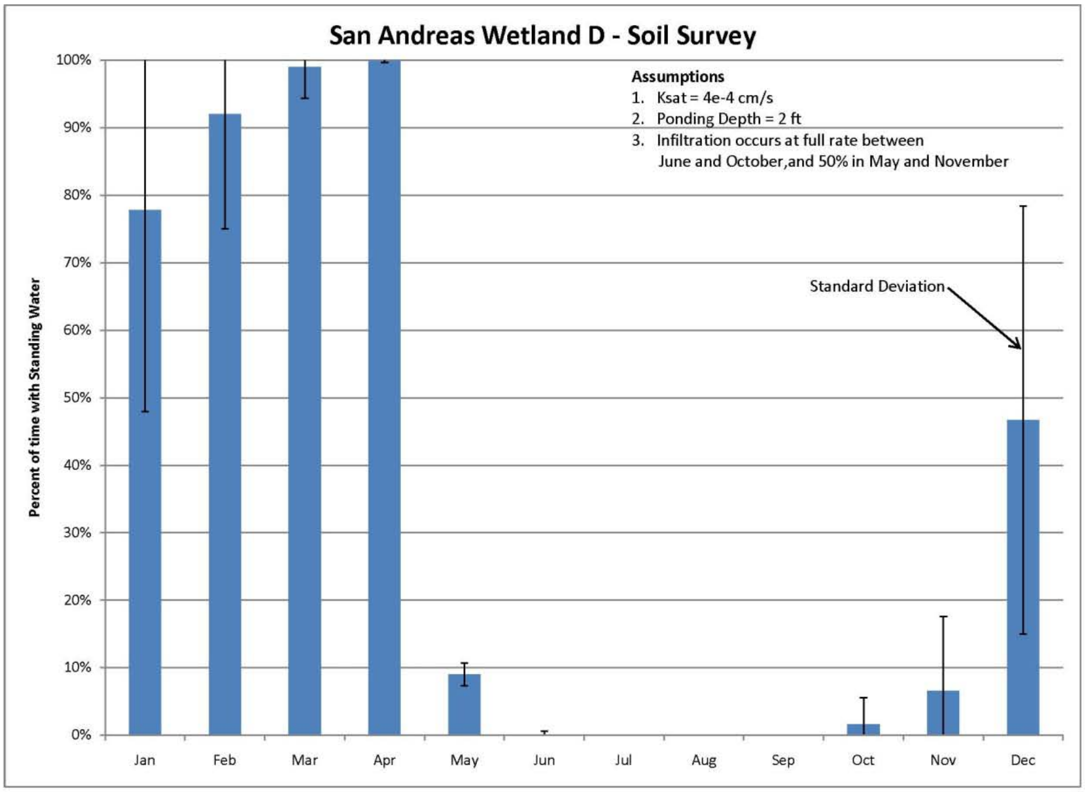
a. Approximately 68% of years will fall within the first standard deviation of the average, which is shown.

6.2 South Wetland (Wetland D)

The runoff model calculated average yearly runoff from the contributing upslope watershed at approximately 8 AF. With a proposed wetland size of 0.2 acres, sufficient water should be available to support the proposed wetland. For a conservative estimate of inundation, it was assumed that the ponding depth was 2 feet; although actual depths would range from 1 to 3 feet. The results of the water balance at this site suggest a strong influence from soil infiltration under natural soil conditions, which influences whether the wetland would dry out in May or stay wet through July.

RMC prepared two charts for Wetland D showing the results of the water balance using a Ksat value of 4.0×10^{-4} cm/sec and 1.0×10^{-6} cm/sec to see how the duration of ponding is affected by the rate of infiltration. As shown in **Figure 9**, when applying a 4.0×10^{-4} cm/sec, Wetland D would be dry in May in most years. This period of inundation would be on the low end of the time necessary for the formation of hydric soils and establishment of wetland plants. Just as important, drying in May would not provide the duration of inundation required to qualify for CRLF breeding habitat. For these reasons, a separate water balance was prepared using a lower permeability value of 1.0×10^{-6}. The results of this model run are presented in **Figure 10**.

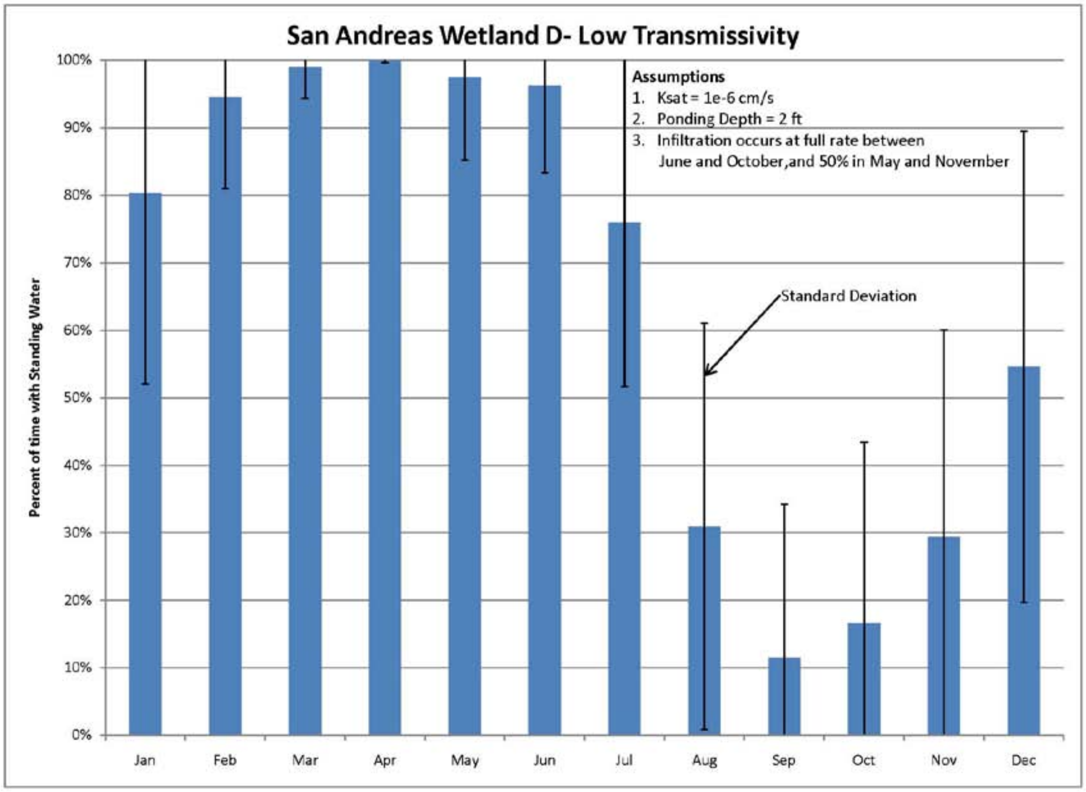
Figure 9: Southern Wetland Average Inundation – Existing Soil Conditions



Footnotes:

a. Approximately 68% of years will fall within the first standard deviation of the average, which is shown.

Figure 10: Southern Wetland Average Inundation – Engineered Soil Conditions



Footnotes:

a. Approximately 68% of years will fall within the first standard deviation of the average, which is shown.

7 North-Central & South-Central Wetland Hydrology (Wetlands B and C)

The North-Central and South-Central wetland sites are anticipated to be supplied by groundwater from areas upslope and to the west of the existing access road. The hydrologic basis for the design of these wetlands is based on groundwater data collected through June 2010 and correlated with water levels within San Andreas Reservoir. **Table 6** summarizes the monthly difference between precipitation and evaporation that would need to be made up for with groundwater inflows to maintain inundated conditions.

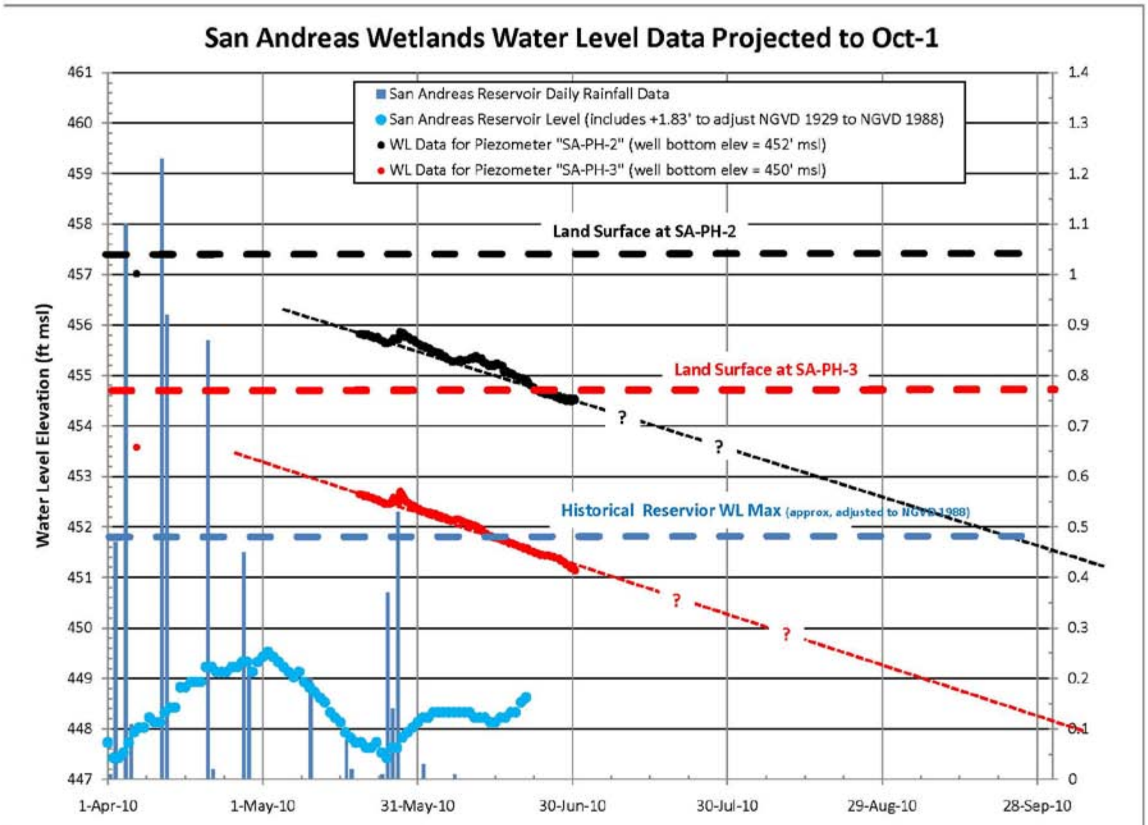
Table 6: Monthly Water Deficit (Precipitation – Evapotranspiration) (inches)

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2.46	1.33	-0.55	-3.04	-5.21	-6.03	-6.18	-5.58	-4.64	-2.9	-0.03	1.73

It is expected that the site would maintain a sufficient water level whenever the water level of the reservoir is above the finished ground level of the proposed wetlands. As demonstrated in **Figure 4**, the reservoir is expected to maintain an average water level above 450 feet during June, July and August. The proposed wetlands are proposed to be excavated to below 451 ft with smaller depressions extending down to 450 ft. This finished elevation for the sites may need to be adjusted based on continued groundwater observations that are planned extend through August 2010. The groundwater observations will provide one snap shot into how hillslope groundwater inflows combined with reservoir levels may be influencing groundwater in the Wetland B and C sites. With the limited groundwater data, annual fluctuations in groundwater due to precipitation will not be fully understood. Therefore, an adaptive management approach may be necessary to meet all project objectives.

Figure 11 illustrates the projected decline in groundwater levels through the month of August and is based on the current average rate of decline. As shown, the groundwater levels at Wetland B are not projected to reach the proposed finished wetland floor elevation of 451 ft until the end of the August. Groundwater levels at Wetland C would be expected to reach the finished floor elevations sometime between June and July with deeper pockets remaining inundated through July. Further, given that the reservoir operations would generally maintain an average water elevation of >450 ft, it is assumed that groundwater levels would not decline below the 450 ft elevation as shown in the chart until actual water levels within the reservoir begin to decline.

Figure 11: Central Wetland Groundwater Levels – Projected



8 Roadway Design and Flow Analysis

In contrast to the hydrological considerations evaluated for the North and South wetland features, which focus on the range in hydrologic variability and averages, the design of roadway drainage facilities is typically more concerned with the peak flows that would need to be accommodated by the proposed structures. The Rational Method is one standard method used for estimating peak drainage discharges from small watersheds 330-acres or less in size per the recommendations of the California Department of Transportation (Caltrans). The basic assumptions for the Rational Method are:

- The maximum runoff rate at any design point is a function of the average rate of rainfall during the time of concentration.
- The maximum rate of rainfall occurs during the time of concentration, whereby the variability of the storm pattern is neglected.

The methodology described in the Caltran's Highway Design Manual Section 819 (Department of Transportation, 2001) was used to evaluate design flows for the SA-WU_10 through 14 and SA_WU_0 watersheds. As currently proposed, the SA-WU_10 through 14 watersheds would continue to intersect with the fire access road at several locations to the west of the proposed North wetland and the flows conveyed across via a series of large, armored[5] rolling dips. The SA-WU_0 watershed would cross to the east of the proposed south wetland feature in a similar fashion.

Peak rainfall intensity was based on the flow length and time of concentration of the watershed.

8.1 Times of Concentration and Intensity

The rainfall intensity for the Rational Method depends on both the duration and return period of the storm event. The duration used in calculations is generally equal to the time of concentration, or the time when all of the drainage area's flow reaches the discharge point. For the SA-WU-13 watershed, the time of concentration was estimated based on methods described in the Highway Design Manual. The other watersheds were determined to have a time of concentration shorter than the 10 minute minimum recommended in the Highway Design Manual, so a 10 minute duration was used. Rainfall intensity was determined by the return period-duration-specific (TDS) Regional Equation using the constants from the Santa Clara County Drainage Manual (Santa Clara County, 2007) and a mean annual precipitation of 20.9 inches. The TDS Regional Equation is given by:

$$x_{T,D} = A_{T,D} + (B_{T,D} MAP)$$

Where:

$X_{T,D}$ = precipitation depth for a specific return period storm and storm duration (inches)

T = Return Period (years)

D = Storm duration (hours)

$A_{T,D}$, $B_{T,D}$ = Constants from Santa Clara County Drainage Manual Table B-1 (see **Appendix C**)

MAP = Mean Annual Precipitation (inches)

Precipitation intensity (iT,D) is given by:

$$i_{T,D} = \frac{x_{T,D}}{D}$$

Rainfall intensities for the sites are summarized in **Table 7**.

[5] Consisting of concrete grass pavers.

Table 6: Rainfall Intensity

Year	Intensity for Watersheds SA_WU_0,10,11,12,14 (in/hr)	Intensity for Watershed SA_WU_13 (in/hr)
2 year	1.2	0.6
5 year	1.7	0.8
10 year	2.0	0.9
20 year	2.3	1.1
50 year	2.6	1.2
100 year	2.8	1.3

8.2 Design Flows

Peak flows were determined using the Rational Method equation:

$$Q = CIA$$

Where:

Q = Peak Flow (cfs)

C = Rational Method Runoff Coefficient

I = Rainfall Intensity (in/hr)

A = Drainage Area (acres)

Runoff coefficients were developed for each watershed using guidelines presented in Figure 819.2A in the Highway Design Manual (see **Appendix C**). The coefficients were estimated to range between 0.36-0.42. The results of the analysis are presented in

Table 8.

Table 7: Peak Flows for Various Rainfall Events

Year	SA_WU_0 (cfs)	SA_WU_10 (cfs)	SA_WU_11 (cfs)	SA_WU_12 (cfs)	SA_WU_13 (cfs)	SA_WU_14 (cfs)
2 year	6	2	1	7	80	3
5 year	8	3	1	9	108	4
10 year	9	3	2	10	126	4
20 year	12	4	2	14	162	6
100 year	14	5	3	16	196	7

9 Limitations of the Analysis

RMC took advantage of the efficiencies offered by BAHM in terms of the readily available meteorological data and calibrated runoff for generating the hydrographs. As BAHM's calibration was performed for other watersheds in the Bay Area, no site specific calibration was deemed necessary. A comparison of peak flows generated by BAHM with those calculated by the rational method indicate that BAHM predicts a significantly higher peak flow. It is believed that BAHM adequately estimates total runoff for the water balance, but the model is not believed to reliably estimate peak flows. As the average annual runoff volume is comparable to the average runoff estimated in the USGS study (Rantz, 1974), it was deemed that BAHM was suitable for the purpose of developing a wetland water balance.

The soil sampling conducted in support of the project site is limited in spatial extent and, therefore, may not detect subtle changes in bedrock lithology, soil stratigraphy, or macroporosity at each wetland site. Additionally, groundwater sampling is limited to a only a few data points collected in advance of the preparation of this report and, therefore, does not reflect the seasonal fluctuations in groundwater levels or multiple water years. For example, groundwater levels could remain higher at Wetland A than assumed in the water balance, which assumed groundwater levels would lower and no longer prevent infiltration in June, thereby potentially contributing to longer periods of inundation through the summer months.

Based on the field and laboratory data collected for the wetlands sites combined with extensive literature review, a range of Ksat values were assessed in the water balance for the soil types present across the project site, which can generally be characterized by clayey surfaces that grade to a clay or sandy clay loam at depth. Permeability rates based on these sources for clay and clay loam materials indicate a broad range of hydraulic conductivities as described in **Table 5**. Following the application of different Ksat values, it was determined that soil permeability could have profound effects on the success of the wetlands. To assess the implications of this broad range in values, a permeability rate was selected to characterize existing conditions and a rate was chosen to represent the design conditions. A permeability rate of $4.0x10^{-4}$ cm/sec was applied to characterize natural soil conditions and a rate of $1.0x10^{-6}$ cm/sec was applied to characterize the design condition. As the field and lab testing were completed at discrete locations, involve some manipulation of the sample, and in the context of the significant range in results, both methods may not be representative of the overall conductivity at each site. Further, the application of a Ksat value from the soil survey for natural conditions may over-estimate drying, as shown for Wetland D in Figure 9.

Groundwater data was collected between May 19, 2010 and June 30, 2010 at the central wetland sites. As 2010 was a wet rain year, with significant late-season storms, there is significant uncertainty in groundwater behavior during average and drought years. Additional monitoring of groundwater levels during the summer months will be necessary to confirm the proposed groundwater levels. Likewise, groundwater levels at Wetland A may not decline as rapidly as modeled for June; however, the current methodology provides a conservative estimate in the event that groundwater levels drop earlier in the season during normal and dry years.

10 References

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Santa Clara County, (2007). Drainage Manual

USDA (1993); Soil Survey Manual: USDA Handbook No. 18

Appendices

Appendix A – Field Data and Soils Technical Memorandum

Appendix B – Soil Survey & Watershed Data

Appendix C – Rational Method Supporting Data

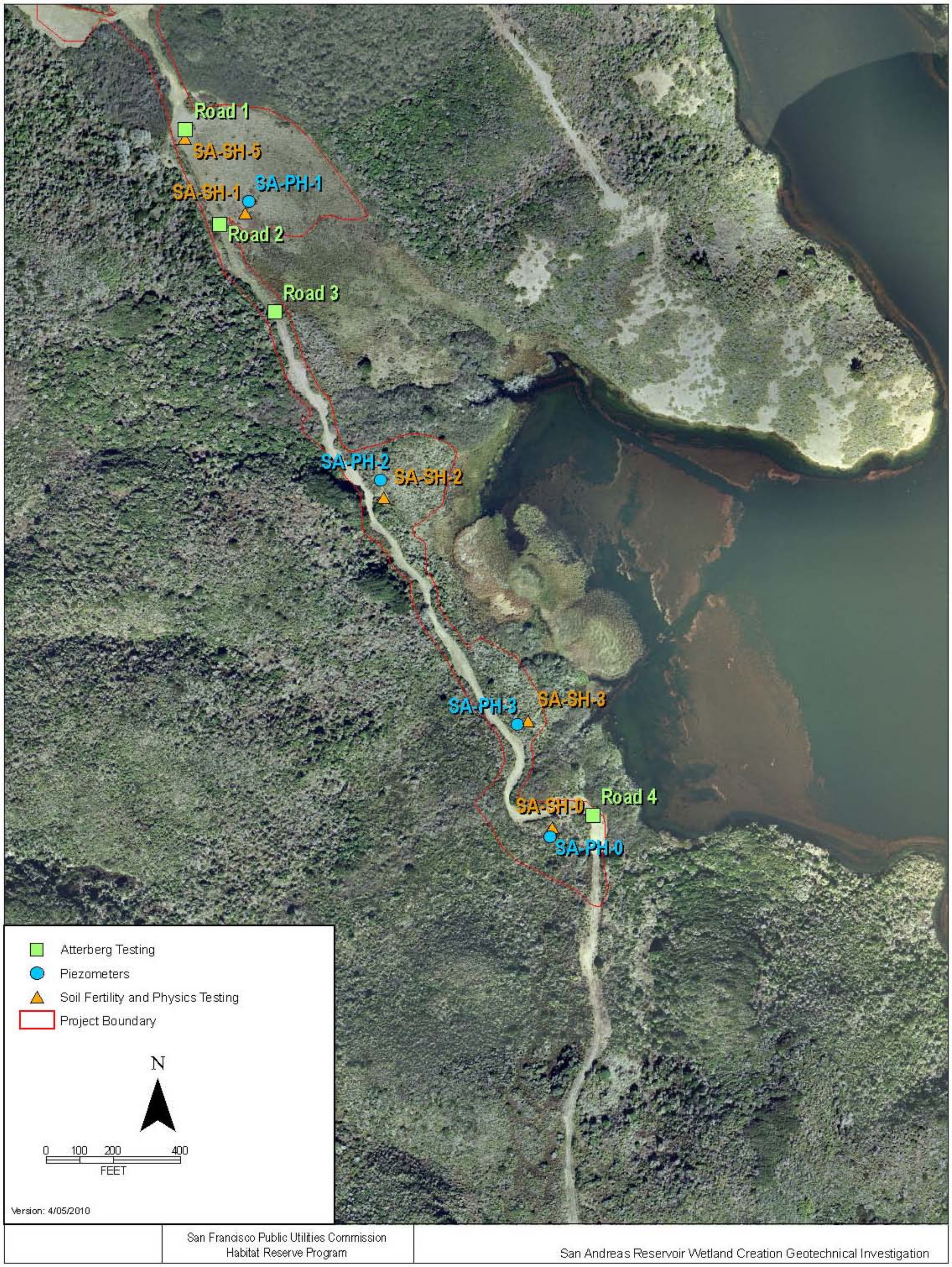
Appendix A – Field Data and Soils Technical Memorandum

Geotechnical Test Locations

Geotechnical Analysis Data Sheets

Soils Technical Memorandum prepared by AEW

Geotechnical Test Locations



DRAFT TECHNICAL MEMORANDUM

Date : July 16, 2010

To : Suet Chau, RMC Water and Environment

From: Randall Young

Subject: San Andreas Reservoir Wetland Creation Geotechnical Investigation

Reference: 2009-021

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This technical memorandum presents the results of the geotechnical investigation conducted at the San Andreas Reservoir Wetland Creation site (the project site), within the San Francisco Public Utilities Commission's (SFPUC's) Habitat Reserve Program (HRP) in San Mateo County, California.

The primary objective of the field investigation is to collect site information to develop an understanding of the soil and groundwater conditions at the project site for proposed construction for the wetland creation design.

1. PROJECT OVERVIEW

The Peninsula Watershed Geotechnical Investigations Project (project) is planned by SFPUC in support of the proposed HRP located on SFPUC watershed land, in unincorporated San Mateo County. The proposed investigation was designed to collect site information on local watershed geologic and hydrologic conditions for the design and implementation of the HRP at the project site.

The SFPUC's proposed HRP provides a comprehensive approach to compensation for habitat (biological) impacts that are expected to result from implementation of the Water System Improvement Program (WSIP) facility improvement projects in the San Joaquin Valley, Alameda Creek watershed, and Peninsula watershed regions of the SFPUC water system. On the SFPUC Peninsula watershed region, the SFPUC proposes to implement 23 habitat improvement projects that would preserve, enhance, restore, and create a variety of the types of habitats that would be affected by construction and operation of multiple WSIP facility improvements. The project site studied under this geotechnical investigation is one of the 23 habitat improvement projects.

2. FIELD INVESTIGATION

The geotechnical investigation conducted at this project site included the following:

- Collection and analyses of soil samples;
- Piezometer installations; and
- Hydraulic conductivity testing in four proposed areas along the western margin of the San Andreas Reservoir within the project site. These four areas, as shown on Figure 1, are designated as:
    - Wetland A (northern wetland creation area);
    - Wetland B (north-central wetland creation area);
    - Wetland C (south central wetland creation area); and
    - Wetland D (southern wetland creation area).

2.1. PERMITS AND PRE-CONSTRUCTION ACTIVITIES

The following permits and notifications were obtained prior to performing the work at the site:

- **SFPUC Access Permit** obtained by RMC Water and Environment (RMC) was approved on January 5, 2010; and

- **Subsurface Drilling Permit Application** was obtained by AEW Engineering, Inc. (AEW) from the San Mateo County Environmental Health (Permit 10-0189, approved on February 12, 2010).

In addition, notification was made to Underground Services Alert (USA) at least 48-hours prior to the start of the field sampling activities (USA Number: 0077875). A subsurface utility locator was contracted to conduct underground utilities clearance at each of the boring locations prior to actual field work.

Within two weeks prior to the field work, the soil boring and piezometer locations were marked in the field with wooden stakes and a SFPUC approved biologist (the Project Biologist) conducted pre-construction surveys at each location for biological resources. Prior to the start of the actual filed work, the Project Biologist provided AEW field personnel with training on the sensitive species present at the project site.

2.2. SOIL SAMPLING AND TESTING

Between March 25 and March 29, 2010, one soil boring at each of the four areas (Wetlands A through D) was advanced using a manual auger kit for the purpose of collecting soil samples. The soil borings were identified in each of the four wetland areas using the following designations:

- SA-SH-1: Wetland A (northern wetland creation area);

- SA-SH-2: Wetland B (north-central wetland creation area);

- SA-SH-3: Wetland C (south central wetland creation area); and

- SA-SH-0: Wetland D (southern wetland creation area).

The approximate locations of these four borings are shown on Figure 1. Photographs of the boring locations are presented in Attachment B. The soil borings were advanced using a soil sampling auger kit equipped with a 3.25-inch diameter mud auger head, 4-foot extension rods and a "T" handle. The borings were advanced to depths ranging between 6 feet to 7.5 feet below ground surface (bgs). Lithologic descriptions of the material were logged in the field in accordance with the Unified Soil Classification System (USCS) visual-manual procedures (ASTM D-2488-90). Copies of the boring logs for these four borings are included in Attachment A.

Soil samples were collected at the target depth by pushing a clean stainless steel liner into the soil brought up in auger head. For each boring, soil samples were collected from approximate 1-foot depth intervals. Immediately after sample collection, each end of the liner was covered with Teflon sheet and secured with plastic cap. Immediately following soil sampling, chain-of-custody (COC) documentation was completed. The COC documentation included the following information:

- Project name and number;
- Project contact;
- Name of field samplers;
- Sample identification numbers;
- Sample date and time of collection;
- Sample matrix;
- Sample container type;
- Analyses requested;
- Turnaround time requested for analyses;
- Preservation of sample containers (if applicable);
- Name and address of analytical laboratory; and
- Comments if applicable.

The samples were transported in a cooler with sufficient wet ice to maintain the samples at approximately 4^{o}C until arrival at the designated laboratory for chemical analysis. Soil samples were transported to McCampbell Analytical Inc., Pittsburg, California (MAI) under proper chain-of-custody documentation for chemical and physical testing as presented in Table 1 below.

TABLE 1 LIST OF CHEMICAL AND PHYSICAL ANALYSES

SOIL SAMPLE INFORMATION			CHEMICAL ANALYSES						
Sample ID	Sampling Location	Sample Depth (ft)	Inorganic Anions (1)	Specific Conductivity (1)	Total & Speciated Alkalinity (1)	Total Nitrogen (1)	Total Organic Carbon (1)	pH (1)	ICP Metals (1)
SA-SH-1-0.5	SA-SH-1	0.5'-1.0'	√	√	√	√	√	√	√
SA-SH-1-3.5	SA-SH-1	3.5'-4.0'	√	√	√	√	√	√	√
SA-SH-1-5.0	SA-SH-1	5.0'-5.5'	NA	NA	NA	NA	NA	NA	NA
SA-SH-2-1.75	SA-SH-2	1.75'-2.4'	√	√	√	√	√	√	√
SA-SH-2-7.0	SA-SH-2	7.0'-7.5'	√	√	√	√	√	√	√
SA-SH-3-1.5	SA-SH-3	1.5'-2.0'	√	√	√	√	√	√	√
SA-SH-3-4.5	SA-SH-3	4.5'-5.0'	√	√	√	√	√	√	√
SA-SH-0-1.0	SA-SH-0	1.0'-1.5'	√	√	√	√	√	√	√
Road 1	Access road	0.3'-1.0'	NA	NA	NA	NA	NA	NA	NA
Road 2	Access road	0.3'-1.0'	NA	NA	NA	NA	NA	NA	NA
Road 3	Access road	0.3'-1.0'	NA	NA	NA	NA	NA	NA	NA
Road 4	Access road	0.3'-1.0'	NA	NA	NA	NA	NA	NA	NA

SOIL SAMPLE INFORMATION			CHEMICAL ANALYSES				PHYSICAL ANALYSES		
Sample ID	Sampling Location	Sample Depth (ft)	Boron (1)	Sulfur (1)	Metals (1)	Total Phosphorous as P (1)	Sieve Analyses (1)	Hydraulic Conductivity (1)	Atterberg Limit (1)
SA-SH-1-0.5	SA-SH-1	0.5'-1.0'	√	√	√	√	√	√	NA (2)
SA-SH-1-3.5	SA-SH-1	3.5'-4.0'	√	√	√	√	√	√	√
SA-SH-1-5.0	SA-SH-1	5.0'-5.5'	NA	NA	NA	NA	√	√	NA
SA-SH-2-1.75	SA-SH-2	1.75'-2.4'	√	√	√	√	√	√	√
SA-SH-2-7.0	SA-SH-2	7.0'-7.5'	√	√	√	√	√	√	NA
SA-SH-3-1.5	SA-SH-3	1.5'-2.0'	√	√	√	√	√	√	NA
SA-SH-3-4.5	SA-SH-3	4.5'-5.0'	√	√	√	√	√	√	NA
SA-SH-0-1.0	SA-SH-0	1.0'-1.5'	√	√	√	√	√	√	NA
Road 1	Access road	0.3'-1.0'	NA	NA	NA	NA	√	NA	√
Road 2	Access road	0.3'-1.0'	NA	NA	NA	NA	NA	NA	√
Road 3	Access road	0.3'-1.0'	NA	NA	NA	NA	NA	NA	√
Road 4	Access road	0.3'-1.0'	NA	NA	NA	NA	NA	NA	√

Notes:

1. Inorganic Anions includes bromide, chloride, Nitrate as N, Nitrate as No3, Nitrite as N, and Sulfate by method E300.0
   Specific Conductivity by method CATTest424
   Total & Speciated Alkalinity as Calcium Carbonate includes carbonate, bicarbonate, and hydroxide by method SM2320B
   Total Nitrogen by method E415.1
   Total Organic Carbon by method SM5310B
   pH by method SW9045D
   ICP metals includes calcium, iron, magnesium, manganese, potassium, and sodium by method SW6010B
   Boron by method SW6010B
   Sulfur by method 6010B
   Metals includes copper and zinc by method 6020A
   Cation Exchange Capacity as Sodium by method SW6010B
   Total Phosphorous as P by method E365.1
   Sieve Analyses by method ASTM D422
   Hydraulic Conductivity by method ASTM D5084
   Atterberg Limit by method ASTM 4318

2. NA = not analyzed

2.3. PIEZOMETER INSTALLATION

Between March 26 and March 29, 2010, one piezometer was installed at each of the four wetland areas (Wetlands A throud D). The piezometers were identified in each of the four wetland areas using the following designations:

- SA-PH-1: Wetland A (northern wetland creation area);
- SA-PH-2: Wetland B (north-central wetland creation area);
- SA-PH-3: Wetland C (south central wetland creation area); and
- SA-PH-0: Wetland D (southern wetland creation area).

The approximate locations of these four piezometers are shown on Figure 1. Photographs of the piezometers are presented in Attachment B. The soil borings were advanced utilizing a manual auger kit to depths between 6.25 feet to 6.8 feet bgs. The piezometers were constructed using 2-inch-diameter, schedule 40, polyvinylchloride (PVC) well casing and 0.020-inch machine-slotted well screen. For piezometers SA-PH-1 through SA-PH-3, the piezometers were constructed using a 4-foot-long screen interval. For piezometer SA-PH-0, the piezometer was constructed using a 5-foot-long screen. A slip cap was secured on the bottom of each of the well screens. The four piezometers were then completed using a blank section which extended between 1.5 feet to 2.5 feet above ground surface and fitted with a slip cap. After the casing was emplaced to the bottom of the borehole, granular filter pack material was poured into the annular space of the borehole. The filter pack consisted of Monterey #3 gradation sand, which was emplaced in the annular space to a level approximately 6 inches above the top of the screen interval. The piezometers were sealed using hydrated bentonite-pellets overlying the filter pack to the ground surface. Piezometer construction details are included in Attachment A.

2.4. SOIL BORING AND PIEZOMETER SURVEY

An elevation and location survey of the completed soil boring and piezometer locations was conducted by SFPUC within 24 hours of completing the field work. Survey data included both the ground surface elevations and horizontal coordinates for the boring and piezometers. In addition, elevation surveys of the top-of-casing on the north side of the piezometers were performed. During May 2010, SFPUC conducted a topographic survey along transects within the project site. During the May 2010 topographic survey, the elevations and locations of the piezometers and soil borings were re-surveyed which revealed minor discrepancies between the two survey data sets. According to SFPUC, the discrepancy was attributed to variations in satellite geometry during the two surveys. The April survey data had poorer quality in the satellite geometry which resulted in an influence of the Geometric Dilution of Precision (GDOP). According to SFPUC, the May survey data had a better GDOP, and is therefore more representative. A summary of the May survey data is presented below in Table 2.

TABLE 2 SURVEY DATA

BORING/PIEZOMETER ID	NORTHING	EASTING	ELEVATION
SA-SH-0	2048039	5999602	456.1444- ground surface
SA-SH-1	2049900	5998732	468.858- ground surface
SA-SH-2	2049037	5999124	457.0975- ground surface
SA-SH-3	2048361	5999536	453.8106- ground surface
SA-PH-0	2048010	5999595	456.997- ground surface 458.1998- top of casing
SA-PH-1	2049935	5998744	469.1978- ground surface 471.9658- top of casing
SA-PH-2	2049091	5999115	457.2929- ground surface 458.6877- top of casing
SA-PH-3	2048351	5999504	454.6209- ground surface 456.6105- top of casing

Note: Survey data is based on state plane coordinates and GPS derived orthometric height. The derived orthometric heights are based on the Geoid 09 model.

2.5. FIELD HYDRAULIC CONDUCTIVITY TESTING

Hydraulic conductivity tests were conducted in the field in May and June 2010 for the purpose of evaluating in-situ permeability of the shallow saturated soil at each of the wetland creation sites.

2.5.1. May 2010 Event

The in-situ permeability test method involved a "rising head" test at each of the four piezometer locations (SA-PH-0 through SA-PH-3). This "rising head" or "slug test" protocol was appropriate for the site since the test were conducted below the water column and within the zone of saturation. On May 19, 2010, hydraulic conductivity tests were conducted by the following field activities in sequential order:

- The depth to water from the top of the piezometer casing and the total depth of the piezometer were measured;
- The volume of water within the piezometer casing was calculated;
- A 3-foot long polyethylene bailer was then slowly lowered in the water column and the depth to water was re-measured and recorded;
- The bailer was then rapidly removed resulting in the removal of a "slug" of groundwater; and
- The depth to water was measured at known time intervals. Depth to water was measured and recorded to 1/100th of a foot using an electronic water level meter. Water depth measurements were initially collected at 30 seconds intervals to measure observable changes in the water column height during the first few minutes of the test. The frequency of water depth measurements was then reduced to 1 minute and 5 minute intervals in order to record an observable change in the water column height. Measurements were taken consistently until the water column had reached approximately 95% of the original static water level at the beginning of the test.

Three "rising head" test were conducted at the first piezometer (SA-PH-2) by removing increasing volumes of water using the bailer in order to obtain the maximum draw-down of the water column height. At this location, multiple field trials involving water volume removals of approximately 0.25 gallons, 0.75 gallons, and 5 gallons were conducted to evaluate the response of groundwater water recharge into the piezometer. Water level measurements during each of the three tests indicated that the maximum draw-down of the water column height was 0.05 feet observed during the removal of 5 gallons from the piezometer casing. Based on these water level observations, removal volumes of 2 gallons and 5 gallons were selected for "rising head" tests at piezometers SA-PH-3 and SA-PH-0 and a removal volume of 5 gallons was selected at piezometer SA-PH-1. A summary of the hydraulic conductivity testing field parameters is presented below in Section 3.4.1.

2.5.2. June 2010 Event

As described in Section 3.4.1, the results of the slug test performed in May 2010 only provided general observation on the site hydraulic conductivity. Additional hydraulic conductivity testing using a submersible pump was conducted to collect additional information for estimating the site hydraulic conductivity values. On June 28, 2010, reconnaissance testing was conducted in the field at piezometers SA-PH-1 and SA-PH-0 to gain additional information on the hydraulic conductivity within the proposed wetlands. Hydraulic conductivity testing was not conducted at piezometers SA-PH-2 and SA-PH-3 due to the presence of transducers installed within these piezometers by RMC after the installation of these two piezometers. The additional testing was conducted using a submersible 12 volt pump to evacuate the maximum volume of groundwater in the piezometers and recording the depth to water during the groundwater removal and immediately following the removal of the pump. This methodology allowed for a deeper sustained drawdown of the water column. A summary of the hydraulic conductivity testing field parameters is presented below in Section 3.4.2.

3. FINDINGS

3.1. SUBSURFACE CONDITIONS

Soil borings were advanced in each of the four wetlands creation areas (Wetlands A through D) within the project site to evaluate subsurface conditions and collect soil samples for testing. Copies of the soil boring logs are presented in Attachment A.

The soils mapped at the sites and encountered in the soil borings consists of alluvium material. The alluvium was encountered in each of the four borings starting at the ground surface and ranging to the maximum explored depths between 6 to 7.5 feet below ground surface. For boring SA-SH-1, clay with minor amounts of sand was observed to a depth of 3.5 feet bgs. This upper clay horizon graded into a lower horizon characterized by an increase in sand content to the total explored depth of 6 feet bgs. In borings SA-SH-2 and SA-SH-3, the upper clay horizon was thinner and observed to depths ranging between 18 inches (SA-SH-2) to 12 inches (SA-SH-3). For these two borings, the upper clay horizon graded into a lower horizon characterized by an increase in sand content with trace fine gravel to the total explored depth of 7.5 feet bgs. In boring SA-SH-0, the upper clay horizon was not observed and the subsurface soils consisted predominately of Sandy Clay with minor amounts of gravel. Plant roots and organic matter were observed to depths up to 8 inches in boring SA-SH-1 through SA-SH-3 and up to 30 inches in boring SA-SH-0. According to the physical testing laboratory reports presented in Attachment D, the upper clay horizon in boring SA-SH-1 contained 9% well graded sand. The lower Sandy Clay horizon observed in borings SA-SH-1, SA-SH-2, and SA-SH-3 contained a sand content between 37 to 53%. Boring SA-SH-0 contained a sand content between 40% and 45%. Minor amounts of fine subangular gravel were also encountered in this lower Sandy Clay/Clayey Sand horizon.

Groundwater was initially encountered below ground surface during the field exploration at depths of 21 inches, 13 inches, and 26 inches in borings SA-SH-2, SA-SH-3, and SA-SH-0, respectively. Due to the saturated surface conditions in Wetland A (northern wetland area), standing water approximately 4 inches deep above the ground surface was encountered at boring location SA-SH-1. Saturated conditions were observed throughout the subsurface soil to the total explored depth of 6 feet bgs at this location.

Depths to groundwater were measured following the installation of the piezometers in April, May, and June 2010. Depths to groundwater were measured from the north side of the top of piezometer casing using an electronic water level instrument. A summary of the water level measurements is presented below in Table 3.

TABLE 3 PIEZOMETER WATER LEVELS

PIEZOMETER ID	DATE	DEPTH TO WATER (FT BELOW TOP OF CASING)	DEPTH TO WATER (FT BELOW GROUND SURFACE[1])
SA-PH-1	4/6/10 5/19/10 6/3/10 6/28/10	2.48 2.48 2.56 3.28	+0.29 +0.29 +0.21 -0.51
SA-PH-2	4/6/10 5/19/10 6/3/10 6/30/10	2.08 3.27 3.65 4.56	-0.69 -1.88 -2.26 -3.17
SA-PH-3	4/6/10 5/19/10 6/3/10 6/30/10	3.36 4.29 4.65 5.79	-1.37 -2.30 -2.66 -3.80
SA-PH-0	4/6/10 5/19/10 6/3/10 6.28/10	3.19 4.52 5.07 6.42	-1.99 -3.32 -3.87 -5.22

Notes:

1. Depth to water below ground surface was calculated using survey data presented in Table 2.

3.2. REVIEW OF SOIL PROFILE INFORMATION FROM NATIONAL RESOURCES CONSERVATION SERVICE

The National Resources Conservation Service (NRCS) soil survey was reviewed to obtain further useful information on the soil profile and its properties within the project site. Soil profile information was gathered using the NRCS on-line Web Soil Survey and then mapping the San Andreas Wetlands Creation area as the Area of Interest (AOI). The Map Unit Descriptions for the AOI included soil compositions describes as Candlestick variant loam and Barnabe-Candlestick complex. Based on the locations of the San Andreas Wetlands Creation areas, it appears the Wetlands A and B are located within the Candlestick variant and Wetlands C and D are located along the boundary of the Candlestick variant loam and Barnabe-Candlestick complex. The Map Unit Descriptions are different in that the Candlestick variant is characterized by alluvial fans while the Barnabe-Candlestick complex is characterized by Mountain slopes. The Map Unit Description for the Candlestick variant included the following information:

- **Map Unit Setting;**
  - Elevation: 30 to 400 feet;
  - Mean annual precipitation: 20 to 30 inches;
  - Mean annual air temperature: 54 to 57 degrees: and
  - Frost-free period: 300 to 350 days.
- **Map Unit Composition;**
  - Candlestick variant loam, 2 to 15 percent slopes.
- **Setting;**
  - Landform: Alluvial fans;
  - Landform position (two-dimensional): Footslope, toeslope;
  - Landform position (three-dimensional): Tread
  - Down-slope shape: Linear;
  - Across-slope shape: Linear;
  - Parent material: Alluvium derived from mixed; and
  - Candlestick variant loam, 2 to 15 percent slopes.
- **Properties and qualities;**
  - Slope: 2 to 15 percent;
  - Depth to restrictive feature: more than 80 inches;
  - Drainage class: Well drained;
  - Capacity of the most limiting layer to transmit water 9Ksat); Moderately high (0.20 to 0.57 in/hr;
  - Depth to water table: more than 80 inches
  - Frequency of flooding: none

- Frequency of ponding: None;
- Maximum salinity: Nonsaline(0.0 to 2.0 mmhos/cm: and
- Available water capacity: High (about 9.5 inches).

- **Interpretive groups; and**
  - Land capability (nonirrigated): 3e.
- **Typical profile.**
  - 0 to 21 inches: Loam; and
  - 21 to 65 inches: Clay loam.

3.3. Soil Testing

Results of the chemical testing are summarized in the Table 4 below. Copies of the MAI reports are presented in Attachment C. Copies of the physical testing results are presented in Attachment D.

TABLE 4 RESULTS OF CHEMICAL ANALYSES

Analyses		Inorganic Anions						Specific Conductivity
Parameter		Bromide	Chloride	Nitrate as N	Nitrate as NO3	Nitrite as N	Sulfate	
Unit		mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	25 µmhos/cm
Soil Boring ID	Depth							
Wetland A								
SA-SH-1	0.5'-1.0'	<10	<10	<10	<45	<10	***10***	***165.0***
SA-SH-1	3.5'-4.0'	<10	<10	<10	<45	<10	<10	***75.2***
Wetland B								
SA-SH-2	1.75'-2.4'	<10	<10	<10	<45	<10	***12***	***56.6***
SA-SH-2	7.0'-7.5'	<10	<10	<10	<45	<10	***17***	***65.2***
Wetland C								
SA-SH-3	1.5'-2.0'	<10	***12***	<10	<45	<10	<10	***48***
SA-SH-3	4.5'-5.0'	<10	<10	<10	<45	<10	<10	***53***
Wetland D								
SA-SH-0	1.0'-1.5'	<10	<10	<10	<45	<10	<10	***38.8***

TABLE 4 RESULTS OF CHEMICAL ANALYSES (CONT'D)

ANALYSES		TOTAL & SPECIATED ALKALINITY AS CALCIUM CARBONATE				TOTAL NITROGEN	TOTAL ORGANIC CARBON	pH
PARAMETER		TOTAL	CARBONATE	BICARBONATE	HYDROXIDE			
Unit		mg CaCo3/kg	mg CaCo3/kg	mg CaCo3/kg	mg CaCo3/kg	mg/Kg	mg/Kg	
Soil Boring ID	Depth							
Wetland A								
SA-SH-1	0.5'-1.0'	4160	<1.0	4160	<1.0	2700	21,000	7.01
SA-SH-1	3.5'-4.0'	2500	<1.0	2500	<1.0	1300	6900	7.67
Wetland B								
SA-SH-2	1.75'-2.4'	1930	<1.0	1930	<1.0	1600	10,000	7.24
SA-SH-2	7.0'-7.5'	1050	<1.0	1050	<1.0	740	1900	7.15
Wetland C								
SA-SH-3	1.5'-2.0'	1650	<1.0	1650	<1.0	1400	8500	7.11
SA-SH-3	4.5'-5.0'	1490	<1.0	1490	<1.0	840	5300	7.41
Wetland D								
SA-SH-0	1.0'-1.5'	1640	<1.0	1640	<1.0	1600	13,000	7.01

TABLE 4 RESULTS OF CHEMICAL ANALYSES (CONT'D)

Analyses		ICP Metals						Boron	Sulfur
Parameter		Calcium	Iron	Magnesium	Manganese	Potassium	Sodium		
Unit		mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg
Soil Boring ID	Depth								
Wetland A									
SA-SH-1	0.5'-1.0'	7500	31,000	11,000	310	2000	200	21	440
SA-SH-1	3.5'-4.0'	7400	38,000	14,000	770	1900	180	21	170
Wetland B									
SA-SH-2	1.75'-2.4'	3500	28,000	9300	370	3000	<150	18	160
SA-SH-2	7.0'-7.5'	2700	38,000	11,000	570	2400	<150	20	37
Wetland C									
SA-SH-3	1.5'-2.0'	6000	34,000	15,000	580	2300	<150	21	120
SA-SH-3	4.5'-5.0'	5400	31,000	10,000	380	2200	<150	18	79
Wetland D									
SA-SH-0	1.0'-1.5'	4800	34,000	11,000	630	2500	<150	20	150

TABLE 4 RESULTS OF CHEMICAL ANALYSES (CONT'D)

ANALYSES		METALS		CATION EXCHANGE CAPACITY AS SODIUM	TOTAL PHOSPHOROUS AS P
PARAMETER		COPPER	ZINC		
Unit		mg/Kg	mg/Kg	meq/g	mg/Kg
Soil Boring ID	Soil Sample Depth				
Wetland A					
SA-SH-1	0.5'-1.0'	31	61	0.52	110
SA-SH-1	3.5'-4.0'	40	76	0.36	140
Wetland B					
SA-SH-2	1.75'-2.4'	26	58	0.35	210
SA-SH-2	7.0'-7.5'	25	63	0.24	120
Wetland C					
SA-SH-3	1.5'-2.0'	27	56	0.3	95
SA-SH-3	4.5'-5.0'	24	51	0.3	110
Wetland D					
SA-SH-0	1.0'-1.5'	25	58	0.33	110

3.4. Hydraulic Conductivity

Results of the field hydraulic conductivity testing conducted during May and June 2010 and evaluation of the data is presented below.

3.4.1. May 2010 Event

The field hydraulic conductivity testing parameters recorded during May, 2010 are presented below in Table 5. Results of the individual trials performed on piezometers: SA-PH0, SA-PH1, SA-PH2, and SA-PH3 are presented in Tables 6, 7, 8, and 9, respectively.

Table 5 Hydraulic Conductivity Testing Field Parameters by Slug Test, May 2010.

Piezometer ID	Water Column Thickness (ft)[1]	Groundwater Volume per Casing[2]	Groundwater Volume Removed (gallons)
SA-PH-1	5.32	0.87	Trial 1 – 5 gallons
SA-PH-2	4.13	0.67	Trial 1 – 0.25 gallons Trial 2 – 0.75 gallons Trial 3 – 5 gallons
SA-PH-3	2.76	0.45	Trial 1 – 2 gallons Trial 2 – 5 gallons
SA-PH-0	3.16	0.52	Trial 1 – 2 gallons Trial 2 – 5 gallons

Notes:

1. Water column calculated using difference between depth to water and total piezometer depth.

2. Groundwater volume per casing calculated using water column multiplying by 0.163 gallons/ft.

Table 6 SA-PH-0 Field Hydraulic Testing Measurements, May 2010

Time (minutes)	Trial 1 Depth to Water[1] (ft below top of casing)	Trial 2 Depth to Water[1] (ft below top of casing)
0.0	4.52	4.52
0.5	4.54	4.56
1.0	4.53	4.55

TIME (MINUTES)	TRIAL 1 DEPTH TO WATER[1] (FT BELOW TOP OF CASING)	TRIAL 2 DEPTH TO WATER[1] (FT BELOW TOP OF CASING)
1.5	4.52	4.53
2.0	4.52	4.53
2.5	4.52	4.53
3.0	4.52 (end of test)	4.53
4.0		4.52
5.0		4.52 (end of test)

Note:

1. Time 0.0 equals initial static water level prior to removing "slug".

TABLE 7 SA-PH-1 FIELD HYDRAULIC TESTING MEASUREMENTS, MAY 2010

TIME (MINUTES)	TRIAL 1 DEPTH TO WATER[1] (FT BELOW TOP OF CASING)
0.0	2.48
0.5	2.51
1.0	2.51
1.5	2.50
2.0	2.50
2.5	2.50
3.0	2.50 (end of test)

Note:

1. Time 0.0 equals initial static water level prior to removing "slug".

TABLE 8 SA-PH-2 FIELD HYDRAULIC TESTING MEASUREMENTS, MAY 2010

TIME (MINUTES)	TRIAL 1 DEPTH TO WATER[1] (FT BELOW TOP OF CASING)	TRIAL 2 DEPTH TO WATER[1] (FT BELOW TOP OF CASING)	TRIAL 3 DEPTH TO WATER[1] (FT BELOW TOP OF CASING)
0.0	3.28	3.32	3.30

Time (minutes)	Trial 1 Depth to Water[1] (ft below top of casing)	Trial 2 Depth to Water[1] (ft below top of casing)	Trial 3 Depth to Water[1] (ft below top of casing)
0.5	3.32	3.3.1	3.35 (end of test)
1.0	3.31	3.3.1	
1.5	3.31	3.30	
2.0	3.31	3.30	
2.5	3.31	3.30	
3.0	3.30	3.30	
4.0	3.30	3.30	
5.0	3.30	3.30	
6.0	3.30	3.30	
7.0	3.30	3.30 (end of test)	
8.0	3.30		
9.0	3.30		
10.0	3.30		
15.0	3.30		
20.0	3.30		

Notes:

1. Time 0.0 equals initial static water level prior to removing "slug".

Table 9 SA-PH-3 Field Hydraulic Testing Measurements, May 2010

Time (minutes)	Trial 1 Depth to Water[1] (ft below top of casing)	Trial 2 Depth to Water[1] (ft below top of casing)
0.0	4.29	4.28
0.5	4.32	4.31
1.0	4.31	4.31
1.5	4.30	4.31

TIME (MINUTES)	TRIAL 1 DEPTH TO WATER[1] (FT BELOW TOP OF CASING)	TRIAL 2 DEPTH TO WATER[1] (FT BELOW TOP OF CASING)
2.0	4.30	4.30
2.5	4.30	4.30
3.0	4.29	4.30
4.0	4.29 (end of test)	4.30
5.0		4.29
6.0		4.29 (end of test)

Note:

1. Time 0.0 equals initial static water level prior to removing "slug".

As indicated on the above tables, the maximum drawdown of the water column was 0.05 feet during the removal of approximately 5 gallons of water during the trials at each of the piezometers. Due to the observed rapid recharge of groundwater into the piezometers, these data sets did not provide sufficient data sensitively for estimating hydraulic conductivity value. However, the field observations and data were considered useful to indicate that the general hydraulic conductivity appeared to be higher than the laboratory hydraulic conductivity test results of 1 X 10^{-8}, as presented in the laboratory reports in Attachment D.

3.4.2. June 2010 Event

As described above, the results of the slug tests performed in May 2010 only provided general observation on the site hydraulic conductivity. Additional hydraulic conductivity testing using submersible pump was conducted at SA-PH-0, and SA-PH-1 to collect additional information for estimating the site hydraulic conductivity values. The June 10 event did not include the piezometers: SA-PH-2 and SA-PH-3 due the presence of the transducers at well heads.

The field hydraulic conductivity testing parameters recorded during June, 2010 are presented below in Table 10. Results of the individual trial performed on piezometers: SA-PH-0 and SA-PH-1 are presented in Tables 11 and 12, respectively.

Table 10 Hydraulic Conductivity Testing Field Parameters by Submersible Pump, June 2010

Piezometer ID	Water Column Thickness (ft)[1]	Groundwater volume per casing (gallons)[2]	Pump Rate (gallons per minute)
SA-PH-1	4.52	0.74	2.6
SA-PH-0	1.26	0.21	2.6

Notes:

1. Water column calculated using difference between depth to water and total piezometer depth.

2. Groundwater volume per casing calculated using water column multiplying by factor 0.163 gallons/ft.

Table 11 SA-PH-0 Field Hydraulic Testing Measurements, June 2010

Time (minutes)	Trial 1 Depth to Water[1] (ft below top of casing)	Trial 2 Depth to Water[1] (ft below top of casing)
0.0	6.42	6.42
0.25	6.90	6.91
0.5	6.69	6.65
0.75	6.56	6.53
1.0	6.50	6.49
1.25	6.45	6.47
1.50	6.44	6.44
1.75	6.43	6.43
2.0	6.42	6.43
2.25	6.42	6.42
2.50	6.42 (end of test)	6.42 (end of test)

Note:

1. Time 0.0 equals initial static water level prior to removing the pump.

TABLE 12 SA-PH-1 FIELD HYDRAULIC TESTING MEASUREMENTS, JUNE 2010

TIME (MINUTES)	TRIAL 1 DEPTH TO WATER[1] (FT BELOW TOP OF CASING)	TRIAL 2 DEPTH TO WATER[1] (FT BELOW TOP OF CASING)
0.0	3.28	3.23
0.25	3.71	3.75
0.5	3.38	3.40
0.75	3.32	3.32
1.0	3.28	3.30
1.25	3.28	3.28
1.50	3.27	3.27
1.75	3.25	3.27
2.0	3.25	3.26
2.25	3.25	3.26
2.50	3.24	3.25
2.75	3.24	3.25
3.0	3.23 (end of test)	3.25 (end of test)

Note:

1. Time 0.0 equals initial static water level prior to removing the pump.

The review of the June 2010 hydraulic testing data set indicates the hydraulic responses observed in SA-PH-1 were better than the data observed in SA-PH-0 due to the saturated thickness in SA-PH-0 was significantly less than the 5-foot well screen length for meaningful estimation of the hydraulic conductivity.

The SA-PH-01 June 2010 hydraulic testing data set (two trials as presented in Table 12) were evaluated using two data evaluation methods, which were considered to be appropriate for estimating the saturated hydraulic conductivities (k_{sat}) in the vicinity of the piezometer. Details of these two data evaluation methods were described in the following references:

- ***Ferris and Knowles Method***: J.G. Ferris and D.B. Knowles, The Slug-Injection Test for Estimating the Coefficient of Transmissibility of an Aquifer, 1963, United States Geological Survey, Water Supply Paper 1536-I, Volume on Ground-Water Hydraulics, compiled by R. Bentall (Ferris and Knowles 1963); and

- ***Water and Power Resources Method***: Water and Power Resources Service, United States Department of Interior, 1981, *Ground Water Manual*: Denver, US Government Printing Office (Water and Power Resources Service, 1981).

Results of the hydraulic conductivity evaluation using these two methods are describe below

3.4.2.1. Ferris and Knowles Method

Following the assumptions and methods described by Ferris and Knowles (1963), the value of transmissivity (T) of a saturated thickness of soil (b) was estimated from the following relationship:

$$T = \frac{114.6q(1/t_m)}{s}$$

Where: T is transmissivity in gallons per day per foot;
q is the volume of water removed – "the slug" (gallons);
t_m is the duration of the slug (minutes); and
s is the residual hydraulic head after the 'slug" was removed or "drawdown" (feet).

The parameters and assumptions estimated for the two trial runs (Trial 1 and Trial 2) conducted on the SA-PH-01 piezometer are summarized in the following table:

Trial 1 – SA-PH-01	q: 0.403 gallons	*t:* 1 min. (60 sec.)	*s* : 2.37 feet	*T* : 19.49 gpd/ft.
Trial 2 – SA-PH-01	*q* : 0.352 gallons	*t:* 3 min. (180 sec.)	*s* : 2.07 feet	*T* : 6.489 gpd/ft.

The saturated thickness of soil for this reconnaissance-level evaluation was assumed to be the length of the piezometer screen, which is 5-feet (152 cm). As describe by the method, transmissivity is defined as:

$T = k_{sat} * b$

where T is transmissivity;
b is saturated thickness; and
k_{sat} is the hydraulic conductivity.

Using the conversion factor of 1-gpd/ft^2 is 4.716x10^{-5} cm/sec., the k_{sat} values for the two Trials are determined to be:

Trial 1: k_{sat} : **1.84x10^{-3}** cm/sec, and
Trial 2: k_{sat} : **6.12x10^{-4}** cm/sec

3.4.2.2. *Water and Power Resources Method*

Applying a similar analytical method, described on page 283 in the *Ground Water Manual* (1981), the transmissivity (in units of ft.^{2}/sec), parameter values and other assumptions estimated for the two trials conducted on the SA-PH-01 piezometer are summarized in the table below:

Trial 1 – SA-PH-01	*V* : 0.403 gallons	Δt : 1 min. (60 sec)	S_t : 2.37 feet	*T*: 4.51x10^{-4} ft.^{2}/sec
Trial 2 – SA-PH-01	*V* : 0.352 gallons	Δt: 3 min. (180 sec)	s_t : 2.05 feet	*T*: 1.51x10^{-4} ft.^{2}/sec

Using the conversion factor of 1-ft.^{2}/sec is 929 cm^2, the k_{sat} values for the two Trials based on the transmissivity estimates are determined to be:

Trial 1 k_{sat} : **2.75x10^{-3}** cm/sec, and
Trial 2 k_{sat} : **9.2x10^{-4}** cm/sec

3.4.3. Summary of k_{sat} Values

In summary, Table 13 lists the k_{sat} values calculated and researched for purposes of evaluating hydraulic conductivity at this project site. In an effort to validate the observed k_{sat} values, a review of the available USDA Soil Survey data on soil properties was conducted. Soil Survey data for this portion of the San Andreas Reservoir watershed indicates the piezometers are likely installed in the **Candlestick variant loam**, which is typically located on 0 to 2% slopes in the area as presented in Section 3.2. The listed soil profile is very similar to the soil boring log description as presented in Attachment A, except that AEW observed a notable sand content.

TABLE 13 SUMMARY OF ESTIMATED K_{SAT} VALUES

METHODOLOGY OR SOURCE	K_{SAT} (CM/SEC) VALUES PROPOSED FOR SATURATED SOILS AROUND SA-PH-01	
	TRIAL 1	TRIAL 2
Ferris and Knowles (1963)	**1.84x10^{-3}** cm/sec	**6.12x10^{-4}** cm/sec
Ground Water Manual (1981)	**2.75x10^{-3}** cm/sec	**9.2x10^{-4}** cm/sec
Soil Survey Staff, Natural Resources Conservation Service, USDA Web Soil Survey. http://websoilsurvey.nrcs.usda.gov/ accessed [06/14/2010]	0.20-in./hr (**1.4x10^{-4} cm/sec**) to 0.57 in./hr (**4.0x10^{-4} cm/sec**) The mapped soils are illustrated on a preliminary soils map, which is attached to this memorandum. The soils are described as "well drained", and k_{sat} values listed are described as "moderately high". In their assessment, the k_{sat} values listed above are applicable to the "most limiting soil layer" in the soil profile.	

Given the results of the two Trials, and the apparent similar orders of magnitudes in the k_{sat} values calculated between two estimation methods, the more realistic or "reliable" k_{sat} value for planning purposes would likely be the Trial 2 results. The measured values of rising hydraulic head in the piezometer (once the test began) were rapid and steady in both Trials. However, during Trial 1, the measured values of rising hydraulic head exceeded the initial static water level after only 60-seconds; consequently "drawdown" in the piezometer became negative, therefore Trial 2 is considered more representative of in-situ k_{sat} values. Additionally, the results of Trial 2 falls closer to the range of permeabilities identified in the Soil Survey. Therefore the results of these field tests support the application of a Ksat value that corresponds with the range of permeability values provided in the Soil Survey (2010) when characterizing natural soil conditions across the project site.

4. REFERENCES

J.G. Ferris and D.B. Knowles, The Slug-Injection Test for Estimating the Coefficient of Transmissibility of an Aquifer, 1963, United States Geological Survey, Water Supply Paper 1536-I, Volume on Ground-Water Hydraulics, compiled by R. Bentall

Water and Power Resources Service, United States Department of Interior, 1981, *Ground Water Manual*: Denver, US Government Printing Office.

Soil Survey Staff, Natural Resources Conservation Service, United States Department of Agriculture. Web Soil Survey. Available online at http://websoilsurvey.nrcs.usda.gov/ accessed [06/14/2010].

FIGURES

Source: RMC Water and Environment

AEW Engineering, Inc.
55 New Montgomery Street
Suite 722
San Francisco, CA 94105

Designed by: LF	Drawn by: LF
Reviewed by: RY	Approved by: RY
Date: 7/1/2010	Project No: 2009-021
Version Number:	File Name: Location Map.dwg

Soil Boring and Piezometer Location Map
San Andreas Reservoir Wetland Creation
San Mateo County, California

Figure 1

ATTACHMENT A

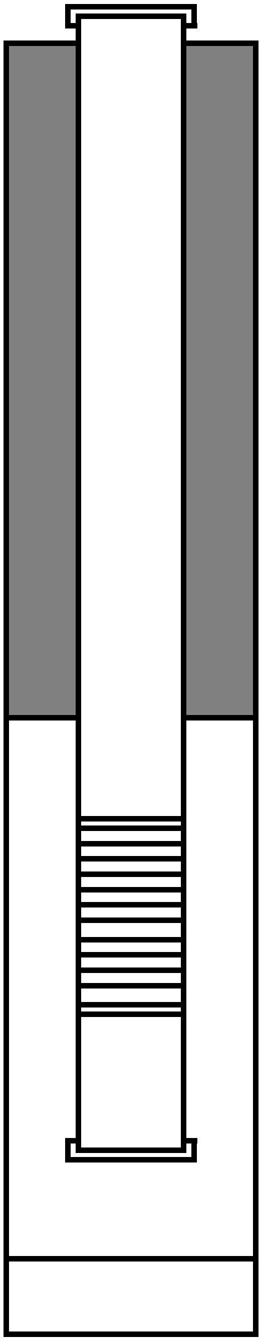
BORING LOGS AND PIEZOMETER CONSTRUCTION DETAILS

DATE DRILLED:	3/25/2010	Log of Boring:	SA-SH-1
DRILLING METHOD:	Hand Auger		
HAMMER WEIGHT:	NA	DROP: NA	LOGGED BY: RSY
SAMPLER(S):	JM/RY	TIME	
Surface Conditions:	Wetland grasses, saturated	START 1045	FINISH 1300

Depth (feet)	Sample	Sample Type	Blows per 6 inches	Sample No.	SPT N-value	Inches Driven/ Inches Recovered	U.S.C.S. Classification	Description
0								Approximately 2 inches of standing water at ground surface
0.5	■	SS		SA-SH-1-0.5'			CL	CLAY (CL), very dark gray, medium stiff, saturated, low to medium plasticity, some coarse grain sand, plants roots to 8 inches
1.25	■	SS		SA-SH-1-1.25'			CL	
2.25	■	SS		SA-SH-1-2.25'			CL	becoming stiff at 2 feet, some light brown to orange coarse grain sand
3.5	■	SS		SA-SH-1-3.5'			CL/SC	SANDY CLAY/CLAYEY SAND (CL/SC), brownish gray, soft to medium stiff, saturated, fine to coarse grain sand, trace fine subangular gravel
4.0	■	SS		SA-SH-1-4.0'			CL/SC	
5.0	■	SS		SA-SH-1-5.0'			CL/SC	
6								Boring terminated at 6 feet below ground surface

Depth scale: 0.5, 1, 1.5, 2, 2.5, 3, 3.5, 4, 4.5, 5, 5.5, 6, 6.5, 7, 7.5, 8, 8.5, 9, 9.5, 10, 10.5, 11, 11.5, 12, 12.5

AEW Engineering, Inc. ***55 New Montgomery Street, Suite 722*** ***San Francisco, CA 94105***	Drawn By: RSY	**San Francisco Public Utilities Commission** **Habitat Reserve Project** **San Mateo, California**	Project No. 2009-021
	Reviewed By:		Sheet



TOP OF CASING APPROXIMATELY
__2.5___ FEET ABOVE GROUND LEVEL

__3.25__ INCH DIAMETER
BOREHOLE
__0__ to __6.5_ feet bgs

__2__ INCH DIAMETER
SCHEDULE 40 PVC
BLANK CASING
__+2.5___ to __2.5___ feet bgs

BENTONITE PELLET
SEAL FROM
__0__ to __2__ feet bgs

Monterey #3
SANDPACK
__2__ to __6.5_ feet bgs

__2__ INCH DIAMETER
SCHEDULE 40 PVC
WELL SCREEN
__2.5__ to __6.5_ feet bgs

SLIP CAP

BOTTOM WELL CAP
__6.5_ feet bgs

BOTTOM OF BOREHOLE
__6.5_ feet bgs

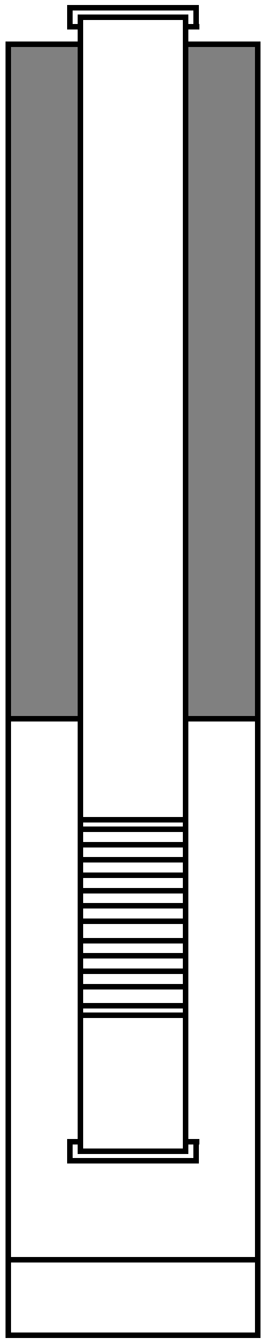
AEW Engineering, Inc. **55 New Montgomery Street, Suite 722** **San Francisco, CA 94121**	Drawn By: RSY Reviewed By:	**Piezometer Construction Details For SA-PH-1** **San Andreas Reservoir Wetlands Creation** **Habitat Reserve Project**	Project No. 2009-021 Sheet 1 of 1

DATE DRILLED:	3/25/2010	Log of Boring:	SA-SH-2
DRILLING METHOD:	Hand Auger		
HAMMER WEIGHT:	NA	DROP: NA	LOGGED BY: RSY
SAMPLER(S):	JM/RY	TIME	
Surface Conditions:	Open space with native plants	START: 1420	FINISH: 1520

Depth (feet)	Sample Type	Blows per 6 inches	Sample No.	SPT N-value	Inches Driven/ Inches Recovered	U.S.C.S. Classification	Description
0.5						CL	CLAY (CL), very dark brown, medium stiff, moist, low plasticity, some fine subangular gravel, plants roots to 3 inches
1	SS		SA-SH-2-1.0'				
1.5							Saturated at 21 inches
2	SS		SA-SH-2-1.25'			CL/SC	SANDY CLAY (CL/SC), dark gray, medium stiff, saturated, fine to coarse grain angular sand, trace fine subangular gravel,
3	SS		SA-SH-2-3.0'				color change to brownish gray
4	SS		SA-SH-2-4.0'				increase sand/gravel content
5	SS		SA-SH-2-5.0'			SC	CLAYEY SAND (SC), dark brown, medium dense, saturated, trace fine to medium subangular gravel
6	SS		SA-SH-2-6.0'				
7	SS		SA-SH-2-7.0'				
7.5							Boring terminated at 7.5 feet below ground surface

AEW Engineering, Inc.
55 New Montgomery Street, Suite 722
San Francisco, CA 94105

Drawn By: RSY	**San Francisco Public Utilities Commission Habitat Reserve Project San Mateo, California**	Project No. 2009-021
Reviewed By:		Sheet



TOP OF CASING APPROXIMATELY
__1.2___ FEET ABOVE GROUND LEVEL

__3.25__ INCH DIAMETER
BOREHOLE
__0__ to __6.8_ feet bgs

__2__ INCH DIAMETER
SCHEDULE 40 PVC
BLANK CASING
__+1.2___ to __2.8___ feet bgs

BENTONITE PELLET
SEAL FROM
__0__ to __2__ feet bgs

Monterey #3
SANDPACK
__2__ to __6.8_ feet bgs

__2__ INCH DIAMETER
SCHEDULE 40 PVC
WELL SCREEN
__2.8__ to __6.8_ feet bgs

SLIP CAP

BOTTOM WELL CAP
__6.8_ feet bgs

BOTTOM OF BOREHOLE
__6.8_ feet bgs

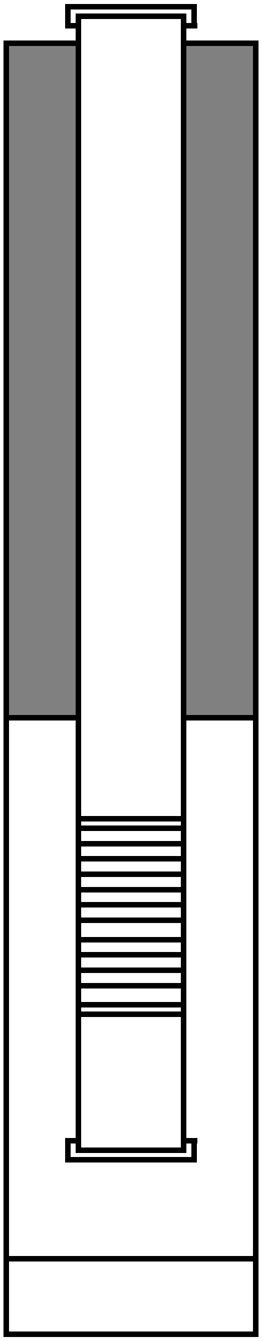
AEW Engineering, Inc. **55 New Montgomery Street, Suite 722** **San Francisco, CA 94121**	Drawn By: RSY Reviewed By:	**Piezometer Construction Details For SA-PH-2** **San Andreas Reservoir Wetlands Creation** **Habitat Reserve Project**	Project No. 2009-021 Sheet 1 of 1

DATE DRILLED:	3/25/2010	Log of Boring:	SA-SH-3
DRILLING METHOD:	Hand Auger		
HAMMER WEIGHT: NA	DROP: NA	LOGGED BY:	RSY
SAMPLER(S):	JM/RY	TIME	
Surface Conditions:	Open space with native plants	START 1420	FINISH 1520

Depth (feet)	Sample	Sample Type	Blows per 6 inches	Sample No.	SPT N-value	Inches Driven/ Inches Recovered	U.S.C.S. Classification	Description
0.5–1	■	SS		SA-SH-3-05'			CL	CLAY (CL), very dark brown, medium stiff, moist, some fine grain sand, plants roots, organic matter ▼ Saturated at 13 inches
1.5–2	■	SS		SA-SH-3-1.5'				
2.5–3	■	SS		SA-SH-3-2.5'			CL/SC	SANDY CLAY- CLAYEY SAND (CL/SC), dark gray, medium stiff, saturated, fine to coarse grain angular sand, trace fine subanguarlr gravel
3.5–4	■	SS		SA-SH-3-3.5'				color change to dark brown
4.5–5	■	SS		SA-SH-3-4.5'				
5.5–6	■	SS		SA-SH-3-5.5'				
6.75–7.25	■	SS		SA-SH-3-6.75'				
7.5								Boring terminated at 7.5 feet below ground surface

Depth scale (feet): 0.5, 1, 1.5, 2, 2.5, 3, 3.5, 4, 4.5, 5, 5.5, 6, 6.5, 7, 7.5, 8, 8.5, 9, 9.5, 10, 10.5, 11, 11.5, 12, 12.5

AEW Engineering, Inc. *55 New Montgomery Street, Suite 722* *San Francisco, CA 94105*	Drawn By: RSY	**San Francisco Public Utilities Commission**	Project No. 2009-021
	Reviewed By:	**Habitat Reserve Project** **San Mateo, California**	Sheet



TOP OF CASING APPROXIMATELY
__1.75___ FEET ABOVE GROUND LEVEL

__3.25__ INCH DIAMETER
BOREHOLE
__0__ to __6.25_ feet bgs

__2__ INCH DIAMETER
SCHEDULE 40 PVC
BLANK CASING
__+1.75___ to __2.25___ feet bgs

BENTONITE PELLET
SEAL FROM
__0__ to __1.5__ feet bgs

Monterey #3
SANDPACK
__1.5_ to __6.25_ feet bgs

__2__ INCH DIAMETER
SCHEDULE 40 PVC
WELL SCREEN
__2.25__ to __6.25_ feet bgs

SLIP CAP

BOTTOM WELL CAP
__6.25_ feet bgs

BOTTOM OF BOREHOLE
__6.25_ feet bgs

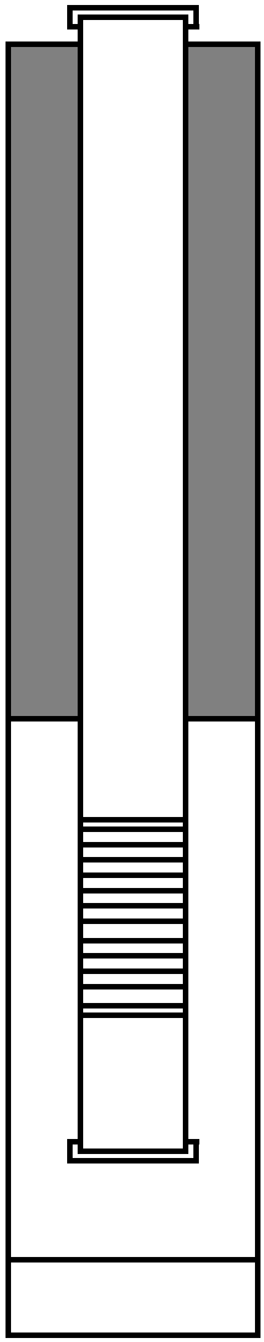
AEW Engineering, Inc. **55 New Montgomery Street, Suite 722** **San Francisco, CA 94121**	Drawn By: RSY Reviewed By:	**Piezometer Construction Details For SA-PH-3** **San Andreas Reservoir Wetlands Creation** **Habitat Reserve Project**	Project No. 2009-021 Sheet 1 of 1

DATE DRILLED:	3/26/2010	**Log of Boring:**	**SA-SH-0**
DRILLING METHOD:	Hand Auger		
HAMMER WEIGHT:	NA	DROP: NA	LOGGED BY: RSY
SAMPLER(S):	JM/RY	TIME	
Surface Conditions:	Open space with native plants	START: 1045	FINISH: 1150

Depth (feet)	Sample	Sample Type	Blows per 6 inches	Sample No.	SPT N-value	Inches Driven/ Inches Recovered	U.S.C.S. Classification	Description
0.5								SANDY CLAY (CL), dark gray, medium stiff, moist, trace fine grain sand, plants roots, organic matter
1	■	SS		SA-SH-0-1.0'			**CL**	increasing sand content, trace fine gravel
2	■	SS		SA-SH-0-2.0'				saturated at 2.2'
2.5–3							**CL**	color change to dark brown, saturated, trace fine grain sand, plants roots, organic matter
3	■	SS		SA-SH-0-3.0'				
4	■	SS		SA-SH-0-4.0'				
5	■	SS		SA-SH-0-5.0'			**CL/SC**	SANDY CLAY- CLAYEY SAND (CL/SC), dark brown, medium stiff, saturated, fine to coarse grain angular sand, trace fine subangualr gravel
6.75								Boring terminated at 6.75 feet below ground surface.

Depth scale: 0.5, 1, 1.5, 2, 2.5, 3, 3.5, 4, 4.5, 5, 5.5, 6, 6.5, 7, 7.5, 8, 8.5, 9, 9.5, 10, 10.5, 11, 11.5, 12, 12.5

AEW Engineering, Inc. ***55 New Montgomery Street, Suite 722*** ***San Francisco, CA 94105***	Drawn By: RSY Reviewed By:	**San Francisco Public Utilities Commission** **Habitat Reserve Project** **San Mateo, California**	Project No. 2009-021 Sheet



TOP OF CASING APPROXIMATELY
__1.5___ FEET ABOVE GROUND LEVEL

__3.25__ INCH DIAMETER
BOREHOLE
__0__ to __6.5_ feet bgs

__2__ INCH DIAMETER
SCHEDULE 40 PVC
BLANK CASING
__+1.5___ to __1.5___ feet bgs

BENTONITE PELLET
SEAL FROM
__0__ to __1__ feet bgs

Monterey #3
SANDPACK
__1_ to __6.5_ feet bgs

__2__ INCH DIAMETER
SCHEDULE 40 PVC
WELL SCREEN
__1.5__ to __6.5_ feet bgs

SLIP CAP

BOTTOM WELL CAP
__6.5_ feet bgs

BOTTOM OF BOREHOLE
__6.5_ feet bgs

AEW Engineering, Inc. **55 New Montgomery Street, Suite 722** **San Francisco, CA 94121**	Drawn By: RSY Reviewed By:	**Piezometer Construction Details For SA-PH-0** **San Andreas Reservoir Wetlands Creation** **Habitat Reserve Project**	Project No. 2009-021 Sheet 1 of 1

ATTACHMENT B

PHOTOGRAPHS

Piezometer SA-PH-1 in Wetland A

Boring SA-SH-1 in Wetland A

Piezometer SA-PH-2 in Wetland B

Boring SA-SH-2 in Wetland B

Piezometer SA-PH-3 in Wetland C

Boring SA-SH-3 in Wetland C

Piezometer SA-PH-0 in Wetland D

Boring SA-SH-0 in Wetland D

ATTACHMENT C

CHEMICAL TESTING LABORATORY REPORTS

McCampbell Analytical, Inc.
"When Quality Counts"

1534 Willow Pass Road, Pittsburg, CA 94565-1701
Web: www.mccampbell.com E-mail: main@mccampbell.com
Telephone: 877-252-9262 Fax: 925-252-9269

AEW Engineering, Inc.	Client Project ID: #2009-021; SFPUC Habitat Restoration	Date Sampled:	03/25/10-03/26/10
55 New Montgomery St, Ste 722		Date Received:	03/31/10
	Client Contact: Randall Young	Date Reported:	04/07/10
San Francisco, CA 94105	Client P.O.:	Date Completed:	04/08/10

WorkOrder: 1003897

April 13, 2010

Dear Randall:

Enclosed within are:

1) The results of the **7** analyzed samples from your project: **#2009-021; SFPUC Habitat Restorati**
2) A QC report for the above samples,
3) A copy of the chain of custody, and
4) An invoice for analytical services.

All analyses were completed satisfactorily and all QC samples were found to be within our control limits.

If you have any questions or concerns, please feel free to give me a call. Thank you for choosing McCampbell Analytical Laboratories for your analytical needs.

Best regards,

Angela Rydelius
Laboratory Manager
McCampbell Analytical, Inc.

1003897

AEW ENGINEERING, INC.

55 New Montgomery Street, Suite 722, San Francisco, CA 94105
Telephone: (415) 495-8400 Fax: (415) 358-5598

CHAIN OF CUSTODY RECORD

Page 1 of 3

TURN AROUND TIME: ☐ 24 HOUR ☐ 48 HOUR ☐ 1 WEEK ☒ Normal Others:

LABORATORY: MAI

Date: 3/30/10

Report To: Randall young eMail: ryoung@aewengineering.com
Company: AEW Engineering, Inc. Project No.: 2009-021
Project Name: SFPUC Habitiat Restoration Location: San Mateo
Sampler: RANDALL YOUNG Project No.: 2009-021
Sampler: Signature: [signature] Bill To: AEW Engineering
Reporting Requirement: Hard Copy : Yes ☑ No ☐
PDF File: Yes ☑ No ☐ Electronic : Yes ☐ No ☑

SAMPLE ID	LOCATION	Sampling Date	Sampling Time	# of Containers	Type of Container	Matrix: Water	Matrix: Soil	Matrix: Air	Matrix: Sludge	Matrix: Other	Method Perserved: Ice	HCl	HNO_3	Other
SA-SH-1-0.5'	San Mateo	3/25/10	1050	1	SS		X				X			
SA-SH-1-3.5'	San Mateo		1215	1	SS		X				X			
SA-SH-1-5.0'	San Mateo		1250	1	SS		X				X			
SA-SH-2-1.75'	San Mateo		1430	1	SS		X				X			
SA-SH-2-7.0'	San Mateo		1520	1	SS		X				X			
SA-SH-3-1.5'	San Mateo		1550	1	SS		X				X			
SA-SH-3-4.5'	San Mateo		1610	1	SS		X				X			
SA-SH-0-1.0'	San Mateo	3/26/10	1050	1	SS		X				X			
SA-SH-0-5.0'	San Mateo		1115	1	SS		X				X			
Road-1	San Mateo		1500	1	bag		X							
Road-2	San Mateo		1510	1	bag		X							
Road-3	San Mateo		1520	1	bag		X							
Road-4	San Mateo		1530	1	bag		X							

Analysis Request / Other* / Comments

SAMPLE ID	Total organic carbon by SM 5310B	Total nitrogen by EPA Method 415.1m	Total phosphorus by EPA 365.3	Metals (K, Mg, Ca, Na, Mn, Fe, Zn, Cu) by EPA 6010B, 602	pH by EPA 9045D	Cation exchange capacity by EPA 9080	Chloride (soluble salt), nitrate (nitrogen) and sulfate by 30	Alkalinity by EPA 2320B	Sulfur by EPA 6010B	Extractable anions by Cal. Title 22	Boron by EPA 6010B	Specific conductivity	Sieve analyses/200 wash by ASTM D 422	Hydraulic conductivity	Atterberg Limit by ASTM 4318	Comments
SA-SH-1-0.5'	X	X	X	X	X	X	X	X	X	X	X	X	X	X		North Wetland
SA-SH-1-3.5'	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	North Wetland
SA-SH-1-5.0'													X	X		North Wetland
SA-SH-2-1.75'	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	N. Central Wetland
SA-SH-2-7.0'	X	X	X	X	X	X	X	X	X	X	X	X	X	X		N. Central Wetland
SA-SH-3-1.5'	X	X	X	X	X	X	X	X	X	X	X	X	X	X		S. Central Wetland
SA-SH-3-4.5'	X	X	X	X	X	X	X	X	X	X	X	X	X	X		S. Central Wetland
SA-SH-0-1.0'	X	X	X	X	X	X	X	X	X	X	X	X	X	X		South Wetland
SA-SH-0-5.0'													X	X		South Wetland
Road-1													X		X	
Road-2															X	
Road-3															X	
Road-4															X	

Relinquished By:	Date:	Time:	Received By:
Randall Young [signature]	3/31/10	245	
[signature]	3/31/10	430	[signature]

Remarks:
* please request tests on a 5 day turn-around-time
Please hold samples for 6 months

AEW ENGINEERING, INC.
55 New Montgomery Street, Suite 722, San Francisco, CA 94105
Telephone: (415) 495-8400 Fax: (415) 358-5598

CHAIN OF CUSTODY RECORD Page 2 of 3

TURN AROUND TIME ☐ 24 HOUR ☐ 48 HOUR ☐ 1 WEEK ☐ Normal **Others:**
LABORATORY: MAI

Date: 3/30/10
Report To: Randall young **eMail:** ryoung@aewengineering.com
Company: AEW Engineering, Inc. **Project No.:** 2009-021
Project Name: SFPUC Habitiat Restoration **Location:** San Mateo
Sampler: RANDALL YOUNG **Project No.:** 2009-021
Sampler: Signature: Randall Young **Bill To:** AEW Engineering
Reporting Requirement: Hard Copy : Yes ☑ No ☐
PDF File: Yes ☑ No ☐ Electronic : Yes ☐ No ☑

SAMPLE ID	LOCATION	Sampling Date	Sampling Time	# of Containers	Type of Container	Matrix: Water	Soil	Air	Sludge	Other	Method Perserved: Ice	HCl	HNO_3	Other	Hold	Analysis Request	Other	Comments
SA-SH-1-1.25	San Mateo	3/25/10	1100	1	SS		X				X				X			
SA-SH-1-2.25	San Mateo		1145	1	SS		X				X				X			
SA-SH-1-4.0	San Mateo		1230	1	SS		X				X				X			
SA-SH-2 12"	San Mateo		1425	1	SS		X				X				X			
SA-SH-2-3.0	San Mateo		1440	1	SS		X				X				X			
SA-SH-2-4.0	San Mateo		1450	1	SS		X				X				X			
SA-SH-2-5.0	San Mateo		1505	1	SS		X				X				X			
SA-SH-3-0.5	San Mateo		1545	1	SS		X				X				X			
SA-SH-3-2.5	San Mateo		1555	1	SS		X				X				X			
SA-SH-3-3.5	San Mateo		1600	1	SS		X				X				X			
SA-SH-3-5.5	San Mateo		1615	1	SS		X				X				X			
SA-SH-3-6.8	San Mateo	↓	1620	1	SS		X				X				X			
SA-SH-0-2.0	San Mateo	3/24/10	1055	1	SS		X											

Relinquished By:	Date:	Time:	Received By:
Randall Young	3/31/10	345	
Relinquished By:	3/31/10	430	Received By: [signature]
Relinquished By:	Date:	Time:	Received By:

Remarks: ICE / t° 6.0°C
GOOD CONDITION ✓
HEAD SPACE ABSENT ___
DECHLORINATED IN LAB ___
APPROPRIATE CONTAINERS ✓
PRESERVED IN LAB ___
PRESERVATION ___ VOAS | O & G | METALS | OTHER

AEW ENGINEERING, INC.

55 New Montgomery Street, Suite 722, San Francisco, CA 94105
Telephone: (415) 495-8400 Fax: (415) 358-5598

CHAIN OF CUSTODY RECORD

TURN AROUND TIME: ☐ 24 HOUR ☐ 48 HOUR ☐ 1 WEEK ☐ Normal Others:

LABORATORY: MAI

Date:

Report To: Randall young eMail: ryoung@aewengineering.com

Company: AEW Engineering, Inc. Project No.: 2009-021

Project Name: SFPUC Habitiat Restoration Location: San Mateo

Sampler: Project No.: 2009-021

Sampler: Signature: Bill To: AEW Engineering

Reporting Requirement: Hard Copy : Yes ☑ No ☐

PDF File: Yes ☑ No ☐ Electronic : Yes ☐ No ☑

SAMPLE ID	LOCATION	Sampling Date	Sampling Time	# of Containers	Type of Container	Matrix: Water	Matrix: Soil	Matrix: Air	Matrix: Sludge	Matrix: Other	Method Perserved: Ice	Method Perserved: HCl	Method Perserved: HNO_3	Method Perserved: Other	Hold	Analysis Request	Other	Comments
SA-SH-0-3.0		3/26/10	1100	1	SS		X				X				X			
SA-SH-0-4.0		✓	1105	1	SS		X				X				X			
SA-SH-2-6.0		3/26	1510												X			

Relinquished By:	Date:	Time:	Received By:
Randall Young	3/31/10	2:45	[signature]
[signature]	3/31/10	930	[signature]

Remarks:

McCampbell Analytical, Inc.
1534 Willow Pass Rd
Pittsburg, CA 94565-1701
(925) 252-9262

CHAIN-OF-CUSTODY RECORD

WorkOrder: 1003897 **ClientCode: AEW**

☐ WaterTrax ☐ WriteOn ☐ EDF ☑ Excel ☐ Fax ☑ Email ☐ HardCopy ☐ ThirdParty ☐ J-flag

Report to:
Randall Young
AEW Engineering, Inc.
55 New Montgomery St, Ste 722
San Francisco, CA 94105
(415) 495-8401 FAX (415) 358-5598

Email: ryoung@aewengineering.com
cc:
PO:
ProjectNo: #2009-021; SFPUC Habitat Restoration

Bill to:
Kenneth Leung
AEW Engineering, Inc.
55 New Montgomery St, Ste 507
San Francisco, CA 94105
byeung@aewengineering.com

Requested TAT: **5 days**

Date Received: **03/31/2010**
Date Printed: **04/05/2010**

Lab ID	Client ID	Matrix	Collection Date	Hold	Requested Tests (See legend below) 1	2	3	4	5	6	7	8	9	10	11	12
1003897-001	SA-SH-1-0.5'	Soil	3/25/2010 10:50	☐	A	A	A	A	A	A	A	A	A	A	A	A
1003897-002	SA-SH-1-3.5'	Soil	3/25/2010 12:15	☐	A	A	A	A	A	A	A	A	A	A	A	A
1003897-004	SA-SH-2-1.75'	Soil	3/25/2010 14:30	☐	A	A	A	A	A	A	A	A	A	A	A	A
1003897-005	SA-SH-2-7.0'	Soil	3/25/2010 15:20	☐	A	A	A	A	A	A	A	A	A	A	A	A
1003897-006	SA-SH-3-1.5'	Soil	3/25/2010 15:50	☐	A	A	A	A	A	A	A	A	A	A	A	A
1003897-007	SA-SH-3-4.5'	Soil	3/25/2010 16:10	☐	A	A	A	A	A	A	A	A	A	A	A	A
1003897-008	SA-SH-0-1.0'	Soil	3/26/2010 10:50	☐	A	A	A	A	A	A	A	A	A	A	A	A

Test Legend:

1	300_1_S	2	Alka(spe)_S	3	ALKIMET_S	4	BORON_S	5	CEC_S
6	METALSMS_S	7	PH_S	8	SC_S	9	SULFUR_S	10	TN_S
11	TOC_S	12	TotalP_S						

Prepared by: Melissa Valles

Comments:

NOTE: Soil samples are discarded 60 days after results are reported unless other arrangements are made (Water samples are 30 days).
Hazardous samples will be returned to client or disposed of at client expense.

McCampbell Analytical, Inc.
"When Quality Counts"
1534 Willow Pass Road, Pittsburg, CA 94565-1701
Web: www.mccampbell.com E-mail: main@mccampbell.com
Telephone: 877-252-9262 Fax: 925-252-9269

Sample Receipt Checklist

Client Name: **AEW Engineering, Inc.**
Date and Time Received: **3/31/2010 7:25:14 PM**
Project Name: **#2009-021; SFPUC Habitat Restoration**
Checklist completed and reviewed by: Melissa Valles
WorkOrder N°: **1003897** Matrix Soil
Carrier: Rob Pringle (MAI Courier)

Chain of Custody (COC) Information

Chain of custody present?	Yes ☑	No ☐	
Chain of custody signed when relinquished and received?	Yes ☑	No ☐	
Chain of custody agrees with sample labels?	Yes ☑	No ☐	
Sample IDs noted by Client on COC?	Yes ☑	No ☐	
Date and Time of collection noted by Client on COC?	Yes ☑	No ☐	
Sampler's name noted on COC?	Yes ☑	No ☐	

Sample Receipt Information

Custody seals intact on shipping container/cooler?	Yes ☐	No ☐	NA ☑
Shipping container/cooler in good condition?	Yes ☑	No ☐	
Samples in proper containers/bottles?	Yes ☑	No ☐	
Sample containers intact?	Yes ☑	No ☐	
Sufficient sample volume for indicated test?	Yes ☑	No ☐	

Sample Preservation and Hold Time (HT) Information

All samples received within holding time?	Yes ☑	No ☐	
Container/Temp Blank temperature	Cooler Temp: 6°C		NA ☐
Water - VOA vials have zero headspace / no bubbles?	Yes ☐	No ☐	No VOA vials submitted ☑
Sample labels checked for correct preservation?	Yes ☑	No ☐	
Metal - pH acceptable upon receipt (pH<2)?	Yes ☐	No ☐	NA ☑
Samples Received on Ice?	Yes ☑	No ☐	
	(Ice Type: WET ICE)		

** NOTE: If the "No" box is checked, see comments below.*

Client contacted: Date contacted: Contacted by:

Comments:

McCampbell Analytical, Inc.
"When Quality Counts"
1534 Willow Pass Road, Pittsburg, CA 94565-1701
Web: www.mccampbell.com E-mail: main@mccampbell.com
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AEW Engineering, Inc. 55 New Montgomery St, Ste 722 San Francisco, CA 94105	Client Project ID: #2009-021; SFPUC Habitat Restoration	Date Sampled: 03/25/10-03/26/10
		Date Received: 03/31/10
	Client Contact: Randall Young	Date Extracted: 03/31/10-04/02/10
	Client P.O.:	Date Analyzed: 04/03/10-04/06/10

Inorganic Anions by IC*

Extraction Method: CA Title 22 modified (DISTLC) Analytical Method: E300.0 Work Order: 1003897

Lab ID	1003897-001A	1003897-002A	1003897-004A	1003897-005A	Reporting Limit for DF =1	
Client ID	SA-SH-1-0.5'	SA-SH-1-3.5'	SA-SH-2-1.75'	SA-SH-2-7.0'		
Matrix	Soil	Soil	Soil	Soil		
DF	1	1	1	1		
Extraction Type	DI WET	DI WET	DI WET	DI WET	S	W
Compound	**Concentration**				mg/kg	µg/L
Bromide	ND	ND	ND	ND	10	NA
Chloride	ND	ND	ND	ND	10	NA
Nitrate as N	ND	ND	ND	ND	10	NA
Nitrate as NO_3^-	ND	ND	ND	ND	45	NA
Nitrite as N	ND	ND	ND	ND	10	NA
Sulfate	10	ND	12	17	10	NA
Surrogate Recoveries (%)						
%SS:	102	103	102	102		
Comments						

* water are reported in mg/L, soil/sludge/solid samples in mg/kg (all soils extracted using DI WET methodology; extraction efficiency is unknown), wipe samples in mg/wipe, product/oil/non-aqueous liquid samples in mg/L.

surrogate diluted out of range or surrogate coelutes with another peak; N/A means surrogate not applicable to this analysis.

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	Client Contact: Randall Young	Date Extracted: 03/31/10-04/02/10
	Client P.O.:	Date Analyzed: 04/03/10-04/06/10

Inorganic Anions by IC*

Extraction Method: CA Title 22 modified (DISTLC) Analytical Method: E300.0 Work Order: 1003897

Lab ID	1003897-006A	1003897-007A	1003897-008A		Reporting Limit for DF =1	
Client ID	SA-SH-3-1.5'	SA-SH-3-4.5'	SA-SH-0-1.0'			
Matrix	Soil	Soil	Soil			
DF	1	1	1			
Extraction Type	DI WET	DI WET	DI WET		S	W
Compound	**Concentration**				mg/kg	µg/L
Bromide	ND	ND	ND		10	NA
Chloride	12	ND	ND		10	NA
Nitrate as N	ND	ND	ND		10	NA
Nitrate as $NO3^{-}$	ND	ND	ND		45	NA
Nitrite as N	ND	ND	ND		10	NA
Sulfate	ND	ND	ND		10	NA
Surrogate Recoveries (%)						
%SS:	98	98	98			
Comments						

* water are reported in mg/L, soil/sludge/solid samples in mg/kg (all soils extracted using DI WET methodology; extraction efficiency is unknown), wipe samples in mg/wipe, product/oil/non-aqueous liquid samples in mg/L.

surrogate diluted out of range or surrogate coelutes with another peak; N/A means surrogate not applicable to this analysis.

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		Date Received: 03/31/10
	Client Contact: Randall Young	Date Extracted: 04/06/10
	Client P.O.:	Date Analyzed: 04/06/10

Total & Speciated Alkalinity as Calcium Carbonate*

Extraction method: SM2320B Analytical methods: SM2320Bm Work Order: 1003897

Lab ID	Client ID	Matrix	Total*	Carbonate*	Bicarbonate*	Hydroxide*	DF	Comments
001A	SA-SH-1-0.5'	S	4160	ND	4160	ND	1	
002A	SA-SH-1-3.5'	S	2500	ND	2500	ND	1	
004A	SA-SH-2-1.75'	S	1930	ND	1930	ND	1	
005A	SA-SH-2-7.0'	S	1050	ND	1050	ND	1	
006A	SA-SH-3-1.5'	S	1650	ND	1650	ND	1	
007A	SA-SH-3-4.5'	S	1490	ND	1490	ND	1	
008A	SA-SH-0-1.0'	S	1640	ND	1640	ND	1	

Reporting Limit for DF =1; ND means not detected at or above the reporting limit						
	W	NA	NA	NA	NA	ug/L
	S	1.0	1.0	1.0	1.0	mg CaCO3/kg

*water samples are reported in mg calcium carbonate/L and soil/sludge samples in mg calcium carbonate/kg. Hydroxide, Carbonate & Bicarbonate alkalinity measure @ end-point of pH = 8.3 & 4.5 per SM2320B.

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AEW Engineering, Inc.	Client Project ID: #2009-021; SFPUC Habitat Restoration	Date Sampled: 03/25/10-03/26/10
55 New Montgomery St, Ste 722		Date Received: 03/31/10
	Client Contact: Randall Young	Date Extracted: 03/31/10
San Francisco, CA 94105	Client P.O.:	Date Analyzed: 04/01/10-04/02/10

ICP Metals*

Extraction method: SW3050B   Analytical methods: SW6010B   Work Order: 1003897

Lab ID	Client ID	Matrix	Extraction Type	Calcium	Iron	Magnesium	Manganese	Potassium	Sodium	DF	% SS	Comments
001A	SA-SH-1-0.5'	S	TOTAL	7500	31,000	11,000	310	2000	200	1	106	
002A	SA-SH-1-3.5'	S	TOTAL	7400	38,000	14,000	770	1900	180	1	102	
004A	SA-SH-2-1.75'	S	TOTAL	3500	28,000	9300	370	3000	ND	1	104	
005A	SA-SH-2-7.0'	S	TOTAL	2700	38,000	11,000	570	2400	ND	1	104	
006A	SA-SH-3-1.5'	S	TOTAL	6000	34,000	15,000	580	2300	ND	1	101	
007A	SA-SH-3-4.5'	S	TOTAL	5400	31,000	10,000	380	2200	ND	1	100	
008A	SA-SH-0-1.0'	S	TOTAL	4800	34,000	11,000	630	2500	ND	1	98	

Reporting Limit for DF =1; ND means not detected at or above the reporting limit	W	TOTAL	NA	NA	NA	NA	NA	NA	NA
	S	TOTAL	250	15	15	5.0	150	150	mg/Kg

*water/product/oil/non-aqueous liquid samples and all TCLP / STLC / DISTLC / SPLP extracts are reported in mg/L, soil/sludge/solid samples in mg/kg, wipe samples in µg/wipe, filter samples in µg/filter.

means surrogate recovery outside of acceptance range due to matrix interference; & means low or no surrogate due to matrix interference; ND means not detected above the reporting limit/method detection limit; N/A means not applicable to this sample or instrument.

TOTAL = Hot acid digestion of a representative sample aliquot.
TRM = Total recoverable metals is the "direct analysis" of a sample aliquot taken from its acid-preserved container.
DISS = Dissolved metals by direct analysis of 0.45 µm filtered and acidified sample.

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		Date Received: 03/31/10
	Client Contact: Randall Young	Date Extracted: 03/31/10
	Client P.O.:	Date Analyzed: 04/01/10

Boron by ICP*

Extraction method: SW3050B Analytical methods: SW6010B Work Order: 1003897

Lab ID	Client ID	Matrix	Extraction Type	Boron	DF	%SS	Comments
1003897-001A	SA-SH-1-0.5'	S	TOTAL	21	1	110	
1003897-002A	SA-SH-1-3.5'	S	TOTAL	21	1	103	
1003897-004A	SA-SH-2-1.75'	S	TOTAL	18	1	111	
1003897-005A	SA-SH-2-7.0'	S	TOTAL	20	1	106	
1003897-006A	SA-SH-3-1.5'	S	TOTAL	21	1	109	
1003897-007A	SA-SH-3-4.5'	S	TOTAL	18	1	105	
1003897-008A	SA-SH-0-1.0'	S	TOTAL	20	1	111	

Reporting Limit for DF =1; ND means not detected at or above the reporting limit	W	TOTAL	NA	µg/L
	S	TOTAL	5.0	mg/Kg

*water/product/oil/non-aqueous liquid samples and all TCLP / STLC / DISTLC / SPLP extracts are reported in mg/L, soil/sludge/solid samples in mg/kg, wipe samples in µg/wipe, filter samples in µg/filter.

means surrogate recovery outside of acceptance range due to matrix interference; & means low or no surrogate due to matrix interference; ND means not detected above the reporting limit/method detection limit; N/A means not applicable to this sample or instrument.

TOTAL = Hot acid digestion of a representative sample aliquot.
TRM = Total recoverable metals is the "direct analysis" of a sample aliquot taken from its acid-preserved container.
DISS = Dissolved metals by direct analysis of 0.45 µm filtered and acidified sample.

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55 New Montgomery St, Ste 722		Date Received: 03/31/10
	Client Contact: Randall Young	Date Extracted: 03/31/10
San Francisco, CA 94105	Client P.O.:	Date Analyzed 04/06/10

Cation Exchange Capacity (CEC) as Sodium*

Extraction method SW9081 Analytical methods SW6010B Work Order: 1003897

Lab ID	Client ID	Matrix	Sodium	DF	%SS	Comments
1003897-001A	SA-SH-1-0.5'	S	0.52	1	N/A	
1003897-002A	SA-SH-1-3.5'	S	0.36	1	N/A	
1003897-004A	SA-SH-2-1.75'	S	0.35	1	N/A	
1003897-005A	SA-SH-2-7.0'	S	0.24	1	N/A	
1003897-006A	SA-SH-3-1.5'	S	0.30	1	N/A	
1003897-007A	SA-SH-3-4.5'	S	0.30	1	N/A	
1003897-008A	SA-SH-0-1.0'	S	0.33	1	N/A	

Reporting Limit for DF =1; ND means not detected at or above the reporting limit	W	NA	NA
	S	0.05	meq/g

*soil/sludge/solid samples are reported in meq/g (milliequivalent/gram). 1 milliequivalent = 0.023g Sodium.

means surrogate diluted out of range; ND means not detected above the reporting limit/method detection limit; N/A means not applicable to this sample or instrument.

TOTAL = Hot acid digestion of a representative sample aliquot.
TRM = Total recoverable metals is the "direct analysis" of a sample aliquot taken from its acid-preserved container.
DISS = Dissolved metals by direct analysis of 0.45 µm filtered and acidified sample.

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		Date Received: 03/31/10
	Client Contact: Randall Young	Date Extracted: 03/31/10
	Client P.O.:	Date Analyzed: 04/07/10

Metals*

Extraction method: SW3050B Analytical methods: 6020A Work Order: 1003897

Lab ID	Client ID	Matrix	Extraction Type	Copper	Zinc	DF	% SS	Comments
001A	SA-SH-1-0.5'	S	TOTAL	31	61	1	106	
002A	SA-SH-1-3.5'	S	TOTAL	40	76	1	117	
004A	SA-SH-2-1.75'	S	TOTAL	26	58	1	102	
005A	SA-SH-2-7.0'	S	TOTAL	25	63	1	107	
006A	SA-SH-3-1.5'	S	TOTAL	27	56	1	103	
007A	SA-SH-3-4.5'	S	TOTAL	24	51	1	102	
008A	SA-SH-0-1.0'	S	TOTAL	25	58	1	102	

Reporting Limit for DF =1; ND means not detected at or above the reporting limit	W	TOTAL	NA	NA	NA
	S	TOTAL	0.5	5.0	mg/kg

*water samples are reported in µg/L, product/oil/non-aqueous liquid samples and all TCLP / STLC / DISTLC / SPLP extracts are reported in mg/L, soil/sludge/solid samples in mg/kg, wipe samples in µg/wipe, filter samples in µg/filter.

means surrogate diluted out of range; ND means not detected above the reporting limit/method detection limit; N/A means not applicable to this sample or instrument.

TOTAL = Hot acid digestion of a representative sample aliquot.
TRM = Total recoverable metals is the "direct analysis" of a sample aliquot taken from its acid-preserved container.
DISS = Dissolved metals by direct analysis of 0.45 µm filtered and acidified sample.

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AEW Engineering, Inc.	Client Project ID: #2009-021; SFPUC Habitat Restoration	Date Sampled: 03/25/10-03/26/10
55 New Montgomery St, Ste 722		Date Received: 03/31/10
	Client Contact: Randall Young	Date Extracted: 04/01/10
San Francisco, CA 94105	Client P.O.:	Date Analyzed: 04/01/10

pH*

Analytical Method: SW9045D Work Order: 1003897

Lab ID	Client ID	Matrix	pH	DF	Comments
1003897-001A	SA-SH-1-0.5'	S	7.01 @ 23.0°C	1	
1003897-002A	SA-SH-1-3.5'	S	7.67 @ 23.1°C	1	
1003897-004A	SA-SH-2-1.75'	S	7.24 @ 21.8°C	1	
1003897-005A	SA-SH-2-7.0'	S	7.15 @ 22.6°C	1	
1003897-006A	SA-SH-3-1.5'	S	7.11 @ 23.1°C	1	
1003897-007A	SA-SH-3-4.5'	S	7.41 @ 23.1°C	1	
1003897-008A	SA-SH-0-1.0'	S	7.01 @ 23.0°C	1	

Method Accuracy and Reporting Units	W	NA	
	S	±0.05, pH units @ °C	

* EPA method 9045; pH = -log(aH+) @ _°C; ± 0.1 units

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	Client Contact: Randall Young	Date Extracted: 04/02/10
	Client P.O.:	Date Analyzed: 04/02/10

Specific Conductivity*

Analytical Method: CATest424m Work Order: 1003897

Lab ID	Client ID	Matrix	Specific Conductivity	DF	Comments
1003897-001A	SA-SH-1-0.5'	S	165 @ 25.0°C	1	
1003897-002A	SA-SH-1-3.5'	S	75.2 @ 25.0°C	1	
1003897-004A	SA-SH-2-1.75'	S	56.6 @ 25.0°C	1	
1003897-005A	SA-SH-2-7.0'	S	65.2 @ 25.0°C	1	
1003897-006A	SA-SH-3-1.5'	S	48.0 @ 25.0°C	1	
1003897-007A	SA-SH-3-4.5'	S	53.0 @ 25.0°C	1	
1003897-008A	SA-SH-0-1.0'	S	38.8 @ 25.0°C	1	

Reporting Limit for DF = 1; ND means not detected at or above the reporting limit	W	NA	
	S	25 µmhos/cm @ 25°C	

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	Client Contact: Randall Young	Date Extracted: 04/01/10
	Client P.O.:	Date Analyzed: 04/01/10

Suflur*

Extraction method: SW3050B Analytical methods: SW6010B Work Order: 1003897

Lab ID	Client ID	Matrix	Extraction Type	Sulfur	DF	% SS	Comments
1003897-001A	SA-SH-1-0.5'	S	TOTAL	440	1	101	
1003897-002A	SA-SH-1-3.5'	S	TOTAL	170	1	99	
1003897-004A	SA-SH-2-1.75'	S	TOTAL	160	1	96	
1003897-005A	SA-SH-2-7.0'	S	TOTAL	37	1	94	
1003897-006A	SA-SH-3-1.5'	S	TOTAL	120	1	97	
1003897-007A	SA-SH-3-4.5'	S	TOTAL	79	1	96	
1003897-008A	SA-SH-0-1.0'	S	TOTAL	150	1	100	

Reporting Limit for DF =1; ND means not detected at or above the reporting limit	W	TOTAL	NA	µg/L
	S	TOTAL	15	mg/kg

*water samples are reported in µg/L, product/oil/non-aqueous liquid samples and all TCLP / STLC / DISTLC / SPLP extracts are reported in mg/L, soil/sludge/solid samples in mg/kg, wipe samples in µg/wipe, filter samples in µg/filter.

means surrogate diluted out of range; ND means not detected above the reporting limit/method detection limit; N/A means not applicable to this sample or instrument.

TOTAL = Hot acid digestion of a representative sample aliquot.
TRM = Total recoverable metals is the "direct analysis" of a sample aliquot taken from its acid-preserved container.
DISS = Dissolved metals by direct analysis of 0.45 µm filtered and acidified sample.

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	Client Contact: Randall Young	Date Extracted: 04/05/10
	Client P.O.:	Date Analyzed: 04/05/10

Total Nitrogen*

Analytical Method: E415.1m Work Order: 1003897

Lab ID	Client ID	Matrix	Total Nitrogen	DF	Comments
1003897-001A	SA-SH-1-0.5'	S	2700	1	
1003897-002A	SA-SH-1-3.5'	S	1300	1	
1003897-004A	SA-SH-2-1.75'	S	1600	1	
1003897-005A	SA-SH-2-7.0'	S	740	1	
1003897-006A	SA-SH-3-1.5'	S	1400	1	
1003897-007A	SA-SH-3-4.5'	S	840	1	
1003897-008A	SA-SH-0-1.0'	S	1600	1	

Reporting Limit for DF = 1; ND means not detected at or above the reporting limit	W	NA	
	S	200 mg/Kg	

* water samples are reported in mg/L, soil/sludge/solid samples in mg/kg.

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		Date Received: 03/31/10
	Client Contact: Randall Young	Date Extracted: 04/05/10
	Client P.O.:	Date Analyzed: 04/05/10

Total Organic Carbon (TOC)*

Analytical Method: SM5310Bm Work Order: 1003897

Lab ID	Client ID	Matrix	TOC	DF	Comments
1003897-001A	SA-SH-1-0.5'	S	21,000	1	
1003897-002A	SA-SH-1-3.5'	S	6900	1	
1003897-004A	SA-SH-2-1.75'	S	10,000	1	
1003897-005A	SA-SH-2-7.0'	S	1900	1	
1003897-006A	SA-SH-3-1.5'	S	8500	1	
1003897-007A	SA-SH-3-4.5'	S	5300	1	
1003897-008A	SA-SH-0-1.0'	S	13,000	1	

Reporting Limit for DF = 1; ND means not detected at or above the reporting limit	W	NA	
	S	200 mg/Kg	

* water samples are reported in mg/L, soil/sludge/solid samples in mg/kg.

* Non-Purgeable Organic Carbon=NPOC; TOC=Total Organic Carbon; DOC=Dissolved Organic Carbon; POC=Purgeable Organic Cabon; IC=Inorganic Carbon.

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55 New Montgomery St, Ste 722		Date Received: 03/31/10
	Client Contact: Randall Young	Date Extracted: 03/31/10
San Francisco, CA 94105	Client P.O.:	Date Analyzed: 04/01/10

Total Phosphorous as P*

Analytical Method: E365.1m Work Order: 1003897

Lab ID	Client ID	Matrix	Total Phosphorous as P	DF	Comments
1003897-001A	SA-SH-1-0.5'	S	110	10	
1003897-002A	SA-SH-1-3.5'	S	140	10	
1003897-004A	SA-SH-2-1.75'	S	210	10	
1003897-005A	SA-SH-2-7.0'	S	120	10	
1003897-006A	SA-SH-3-1.5'	S	95	10	
1003897-007A	SA-SH-3-4.5'	S	110	10	
1003897-008A	SA-SH-0-1.0'	S	110	10	

Reporting Limit for DF = 1; ND means not detected at or above the reporting limit	W	NA	
	S	4.0 mg/Kg	

*water/product/oil/non-aqueous liquid samples and all TCLP / STLC / DISTLC / SPLP extracts are reported in mg/L, soil/sludge/solid samples in mg/kg, wipe samples in µg/wipe, filter samples in µg/filter.

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Angela Rydelius, Lab Manager

QC SUMMARY REPORT FOR E300.0

W.O. Sample Matrix: Soil | QC Matrix: Soil | BatchID: 49677 | WorkOrder 1003897

EPA Method E300.0 | **Extraction CA Title 22 modified** | **Spiked Sample ID: N/A**

Analyte	Sample	Spiked	MS	MSD	MS-MSD	LCS	LCSD	LCS-LCSD	Acceptance Criteria (%)			
	mg/kg	mg/kg	% Rec.	% Rec.	% RPD	% Rec.	% Rec.	% RPD	MS / MSD	RPD	LCS/LCSD	RPD
Bromide	N/A	100	N/A	N/A	N/A	107	105	2.24	N/A	N/A	80 - 120	20
Chloride	N/A	100	N/A	N/A	N/A	100	101	0.118	N/A	N/A	80 - 120	20
Nitrate as N	N/A	100	N/A	N/A	N/A	92	91.9	0.0522	N/A	N/A	80 - 120	20
Nitrate as $NO3^{-}$	N/A	440	N/A	N/A	N/A	92	91.9	0.0522	N/A	N/A	80 - 120	20
Nitrite as N	N/A	100	N/A	N/A	N/A	94.9	94.6	0.319	N/A	N/A	80 - 120	20
Sulfate	N/A	100	N/A	N/A	N/A	99.7	100	0.366	N/A	N/A	80 - 120	20
%SS:	N/A	10	N/A	N/A	N/A	99	99	0	N/A	N/A	80 - 120	20

All target compounds in the Method Blank of this extraction batch were ND less than the method RL with the following exceptions:
NONE

BATCH 49677 SUMMARY

Lab ID	Date Sampled	Date Extracted	Date Analyzed	Lab ID	Date Sampled	Date Extracted	Date Analyzed
1003897-001A	03/25/10 10:50 AM	03/31/10	04/03/10 9:49 AM	1003897-001A	03/25/10 10:50 AM	03/31/10	04/06/10 12:59 AM
1003897-002A	03/25/10 12:15 PM	03/31/10	04/03/10 10:33 AM	1003897-002A	03/25/10 12:15 PM	03/31/10	04/06/10 1:34 PM
1003897-004A	03/25/10 2:30 PM	03/31/10	04/03/10 11:17 AM	1003897-004A	03/25/10 2:30 PM	03/31/10	04/06/10 2:08 AM
1003897-005A	03/25/10 3:20 PM	03/31/10	04/03/10 12:00 PM	1003897-005A	03/25/10 3:20 PM	03/31/10	04/06/10 2:43 AM
1003897-006A	03/25/10 3:50 PM	03/31/10	04/06/10 3:18 PM	1003897-007A	03/25/10 4:10 PM	03/31/10	04/06/10 3:52 AM
1003897-008A	03/26/10 10:50 AM	03/31/10	04/06/10 4:27 AM				

MS = Matrix Spike; MSD = Matrix Spike Duplicate; LCS = Laboratory Control Sample; LCSD = Laboratory Control Sample Duplicate; RPD = Relative Percent Deviation.

% Recovery = 100 * (MS-Sample) / (Amount Spiked); RPD = 100 * (MS - MSD) / ((MS + MSD) / 2).

MS / MSD spike recoveries and / or %RPD may fall outside of laboratory acceptance criteria due to one or more of the following reasons: a) the sample is inhomogenous AND contains significant concentrations of analyte relative to the amount spiked, or b) the spiked sample's matrix interferes with the spike recovery.

N/A = not applicable to this method, or not enough sample to perform matrix spike and matrix spike duplicate.

NR = analyte concentration in sample exceeds spike amount for soil matrix or exceeds 2x spike amount for water matrix or sample diluted due to high matrix or analyte content.

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QC SUMMARY REPORT FOR WET CHEMISTRY TESTS

Test Method: Alkalinity **Matrix: S** **WorkOrder: 1003897**

Method Name: SM2320Bm Units mg CaCO3/kg BatchID: 49678

Lab ID	Sample	DF	Dup / Ser. Dil.	DF	% RPD	Acceptance Criteria (%)
1003897-001A	4160	1	4310	1	3.54	<20
1003897-002A	2500	1	2210	1	12.3	<20
1003897-004A	1930	1	1980	1	2.56	<20
1003897-005A	1050	1	1050	1	0	<20
1003897-006A	1650	1	1630	1	1.22	<20
1003897-007A	1490	1	1410	1	5.52	<20
1003897-008A	1640	1	1590	1	3.1	<20

BATCH 49678 SUMMARY

Lab ID	Date Sampled	Date Extracted	Date Analyzed	Lab ID	Date Sampled	Date Extracted	Date Analyzed
1003897-001A	)3/25/10 10:50 AM	04/06/10	04/06/10 3:12 PM	1003897-002A	)3/25/10 12:15 PM	04/06/10	04/06/10 3:26 PM
1003897-004A	03/25/10 2:30 PM	04/06/10	04/06/10 3:45 PM	1003897-005A	03/25/10 3:20 PM	04/06/10	04/06/10 2:56 PM
1003897-006A	03/25/10 3:50 PM	04/06/10	04/06/10 4:03 PM	1003897-007A	03/25/10 4:10 PM	04/06/10	04/06/10 4:15 PM
1003897-008A	)3/26/10 10:50 AM	04/06/10	04/06/10 4:28 PM				

Dup = Duplicate; Ser. Dil. = Serial Dilution; MS = Matrix Spike; RPD = Relative Percent Deviation.

Precision = Absolute Value (Sample - Duplicate)

RPD = 100 * (Sample - Duplicate) / [(Sample + Duplicate) / 2]

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QC SUMMARY REPORT FOR 6010C

W.O. Sample Matrix: Soil QC Matrix: Soil WorkOrder 1003897

EPA Method SW6010B **Extraction SW3050B** **BatchID: 49675** **Spiked Sample ID: 1003897-008A**

Analyte	Sample	Spiked	MS	MSD	MS-MSD	Spiked	LCS	LCSD	LCS-LCSD	Acceptance Criteria (%)			
	mg/Kg	mg/Kg	% Rec.	% Rec.	% RPD	mg/Kg	% Rec.	% Rec.	% RPD	MS / MSD	RPD	LCS/LCSD	RPD
Calcium	4,800	5000	101	100	0.456	1000	99	104	4.47	75 - 125	25	75 - 125	25
Iron	34,000	500	NR	NR	NR	100	108	107	0.512	75 - 125	25	75 - 125	25
Magnesium	11,000	500	NR	NR	NR	100	100	103	2.78	75 - 125	25	75 - 125	25
Manganese	630	500	NR	NR	NR	100	115	113	1.60	75 - 125	25	75 - 125	25
Potassium	2,500	5000	NR	NR	NR	1000	108	104	3.26	75 - 125	25	75 - 125	25
Sodium	ND	5000	105	101	3.74	1000	94.4	100	6.16	75 - 125	25	75 - 125	25
%SS:	98	250	105	109	3.36	250	107	103	3.14	70 - 130	30	70 - 130	30

All target compounds in the Method Blank of this extraction batch were ND less than the method RL with the following exceptions:
NONE

BATCH 49675 SUMMARY

Lab ID	Date Sampled	Date Extracted	Date Analyzed	Lab ID	Date Sampled	Date Extracted	Date Analyzed
1003897-001A	03/25/10 10:50 AM	03/31/10	04/01/10 10:17 PM	1003897-001A	03/25/10 10:50 AM	03/31/10	04/02/10 6:19 PM
1003897-002A	03/25/10 12:15 PM	03/31/10	04/01/10 10:23 PM	1003897-002A	03/25/10 12:15 PM	03/31/10	04/02/10 6:23 PM
1003897-004A	03/25/10 2:30 PM	03/31/10	04/01/10 10:28 PM	1003897-004A	03/25/10 2:30 PM	03/31/10	04/02/10 6:28 PM
1003897-005A	03/25/10 3:20 PM	03/31/10	04/01/10 10:34 PM	1003897-005A	03/25/10 3:20 PM	03/31/10	04/02/10 6:33 PM
1003897-006A	03/25/10 3:50 PM	03/31/10	04/01/10 10:40 PM	1003897-006A	03/25/10 3:50 PM	03/31/10	04/02/10 6:38 PM
1003897-007A	03/25/10 4:10 PM	03/31/10	04/01/10 10:45 PM	1003897-007A	03/25/10 4:10 PM	03/31/10	04/02/10 6:42 PM
1003897-008A	03/26/10 10:50 AM	03/31/10	04/01/10 9:48 PM	1003897-008A	03/26/10 10:50 AM	03/31/10	04/02/10 6:47 PM

MS = Matrix Spike; MSD = Matrix Spike Duplicate; LCS = Laboratory Control Sample; LCSD = Laboratory Control Sample Duplicate; RPD = Relative Percent Deviation.

% Recovery = 100 * (MS-Sample) / (Amount Spiked); RPD = 100 * (MS - MSD) / ((MS + MSD) / 2).

* MS / MSD spike recoveries and / or %RPD may fall outside of laboratory acceptance criteria due to one or more of the following reasons: a) the sample is inhomogenous AND contains significant concentrations of analyte relative to the amount spiked, or b) the spiked sample's matrix interferes with the spike recovery.

N/A = not applicable to this method.

NR = analyte concentration in sample exceeds spike amount for soil matrix or exceeds 2x spike amount for water matrix or sample diluted due to high matrix or analyte content.

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QC SUMMARY REPORT FOR 6010B

W.O. Sample Matrix: Soil QC Matrix: Soil WorkOrder 1003897

EPA Method SW6010B **Extraction SW3050B** **BatchID: 49640** **Spiked Sample ID: 1003897-008A**

Analyte	Sample	Spiked	MS	MSD	MS-MSD	Spiked	LCS	LCSD	LCS-LCSD	Acceptance Criteria (%)			
	mg/Kg	mg/Kg	% Rec.	% Rec.	% RPD	mg/Kg	% Rec.	% Rec.	% RPD	MS / MSD	RPD	LCS/LCSD	RPD
Boron	20	50	101	97.6	2.22	10	111	104	6.39	75 - 125	20	75 - 125	20
%SS:	111	250	106	112	6.15	250	110	99	10.6	70 - 130	30	70 - 130	30

All target compounds in the Method Blank of this extraction batch were ND less than the method RL with the following exceptions:
NONE

BATCH 49640 SUMMARY

Lab ID	Date Sampled	Date Extracted	Date Analyzed	Lab ID	Date Sampled	Date Extracted	Date Analyzed
1003897-001A	03/25/10 10:50 AM	03/31/10	04/01/10 1:37 PM	1003897-002A	03/25/10 12:15 PM	03/31/10	04/01/10 1:41 PM
1003897-004A	03/25/10 2:30 PM	03/31/10	04/01/10 1:44 PM	1003897-005A	03/25/10 3:20 PM	03/31/10	04/01/10 1:47 PM
1003897-006A	03/25/10 3:50 PM	03/31/10	04/01/10 1:50 PM	1003897-007A	03/25/10 4:10 PM	03/31/10	04/01/10 1:53 PM
1003897-008A	03/26/10 10:50 AM	03/31/10	04/01/10 1:28 PM				

MS = Matrix Spike; MSD = Matrix Spike Duplicate; LCS = Laboratory Control Sample; LCSD = Laboratory Control Sample Duplicate; RPD = Relative Percent Deviation.

% Recovery = 100 * (MS-Sample) / (Amount Spiked); RPD = 100 * (MS - MSD) / ((MS + MSD) / 2).

* Acceptance Criteria for MS / MSD is between 70% and 130%. MS / MSD spike recoveries and / or %RPD may fall outside of laboratory acceptance criteria due to one or more of the following reasons: a) the sample is inhomogenous AND contains significant concentrations of analyte relative to the amount spiked, or b) the spiked sample's matrix interferes with the spike recovery.

N/A = not applicable to this method.

NR = analyte concentration in sample exceeds spike amount for soil matrix or exceeds 2x spike amount for water matrix or sample diluted due to high matrix or analyte content.

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QC SUMMARY REPORT FOR 6020A

W.O. Sample Matrix: Soil QC Matrix: Soil WorkOrder 1003897

EPA Method 6020A **Extraction SW3050B** **BatchID: 49595** **Spiked Sample ID: 1003897-008A**

Analyte	Sample	Spiked	MS	MSD	MS-MSD	Spiked	LCS	LCSD	LCS-LCSD	Acceptance Criteria (%)			
	mg/Kg	mg/Kg	% Rec.	% Rec.	% RPD	mg/Kg	% Rec.	% Rec.	% RPD	MS / MSD	RPD	LCS/LCSD	RPD
Copper	25	50	102	109	4.58	10	110	111	1.45	75 - 125	20	75 - 125	20
Zinc	58	500	97.1	103	5.07	100	108	99.2	8.73	75 - 125	20	75 - 125	20
%SS:	102	250	103	106	3.13	250	104	97	7.55	70 - 130	20	70 - 130	20

All target compounds in the Method Blank of this extraction batch were ND less than the method RL with the following exceptions:
NONE

BATCH 49595 SUMMARY

Lab ID	Date Sampled	Date Extracted	Date Analyzed	Lab ID	Date Sampled	Date Extracted	Date Analyzed
1003897-001A	03/25/10 10:50 AM	03/31/10	04/07/10 1:35 PM	1003897-002A	03/25/10 12:15 PM	03/31/10	04/07/10 1:44 PM
1003897-004A	03/25/10 2:30 PM	03/31/10	04/07/10 1:52 PM	1003897-005A	03/25/10 3:20 PM	03/31/10	04/07/10 2:00 PM
1003897-006A	03/25/10 3:50 PM	03/31/10	04/07/10 2:09 PM	1003897-007A	03/25/10 4:10 PM	03/31/10	04/07/10 2:17 PM
1003897-008A	03/26/10 10:50 AM	03/31/10	04/07/10 2:26 PM				

MS = Matrix Spike; MSD = Matrix Spike Duplicate; LCS = Laboratory Control Sample; LCSD = Laboratory Control Sample Duplicate; RPD = Relative Percent Deviation.

% Recovery = 100 * (MS-Sample) / (Amount Spiked); RPD = 100 * (MS - MSD) / ((MS + MSD) / 2).

MS / MSD spike recoveries and / or %RPD may fall outside of laboratory acceptance criteria due to one or more of the following reasons: a) the sample is inhomogenous AND contains significant concentrations of analyte relative to the amount spiked, or b) the spiked sample's matrix interferes with the spike recovery.

N/A = not applicable to this method.

NR = matrix interference and/or analyte concentration in sample exceeds spike amount for soil matrix or exceeds 2x spike amount for water matrix or sample diluted due to high matrix or analyte content.

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QC SUMMARY REPORT FOR WET CHEMISTRY TESTS

Test Method: pH **Matrix: S** **WorkOrder: 1003897**

Method Name: SW9045D Units ±, pH units @ °C BatchID: 49555

Lab ID	Sample	DF	Dup / Ser. Dil.	DF	Precision	Acceptance Criteria
1003897-001A	7.01 @ 23.0°C	1	7.00 @ 23.0°C	1	0.01	0.1
1003897-002A	7.67 @ 23.1°C	1	7.70 @ 23.1°C	1	0.03	0.1
1003897-004A	7.24 @ 21.8°C	1	7.22 @ 21.8°C	1	0.02	0.1
1003897-005A	7.15 @ 22.6°C	1	7.18 @ 22.6°C	1	0.03	0.1
1003897-006A	7.11 @ 23.1°C	1	7.10 @ 23.1°C	1	0.01	0.1
1003897-007A	7.41 @ 23.1°C	1	7.40 @ 23.1°C	1	0.01	0.1
1003897-008A	7.01 @ 23.0°C	1	7.00 @ 23.0¦C	1	0.01	0.1

BATCH 49555 SUMMARY

Lab ID	Date Sampled	Date Extracted	Date Analyzed	Lab ID	Date Sampled	Date Extracted	Date Analyzed
1003897-001A	)3/25/10 10:50 AM	04/01/10	04/01/10 7:48 PM	1003897-002A	)3/25/10 12:15 PM	04/01/10	04/01/10 7:36 PM
1003897-004A	03/25/10 2:30 PM	04/01/10	04/01/10 7:18 PM	1003897-005A	03/25/10 3:20 PM	04/01/10	04/01/10 7:24 PM
1003897-006A	03/25/10 3:50 PM	04/01/10	04/01/10 7:30 PM	1003897-007A	03/25/10 4:10 PM	04/01/10	04/01/10 7:42 PM
1003897-008A	)3/26/10 10:50 AM	04/01/10	04/01/10 7:54 PM				

Dup = Duplicate; Ser. Dil. = Serial Dilution; MS = Matrix Spike; RD = Relative Difference; RPD = Relative Percent Deviation.

Precision = Absolute Value (Sample - Duplicate)

RPD = 100 * (Sample - Duplicate) / [(Sample + Duplicate) / 2]

%RPD is calculated using results of up to 10 significant figures, however the reported results are rounded to 2 or 3 significant figures. Therefore there may be a slight discrepancy between the %RPD displayed above and %RPD calculated using the reported results. MAI considers %RPD based upon more significant figures to be more accurate.

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QC SUMMARY REPORT FOR WET CHEMISTRY TESTS

Test Method: Specific Conductivity **Matrix: S** **WorkOrder: 1003897**

Method Name: CATest424m Units µmhos/cm @ 25°C BatchID: 49680

Lab ID	Sample	DF	Dup / Ser. Dil.	DF	% RPD	Acceptance Criteria (%)
1003897-001A	165 @ 25.0°C	1	164 @ 25.0°C	1	1.03	<5
1003897-002A	75.2 @ 25.0°C	1	75.3 @ 25.0°C	1	0.093	<5
1003897-004A	56.6 @ 25.0°C	1	56.7 @ 25.0°C	1	0.141	<5
1003897-005A	65.2 @ 25.0°C	1	65.1 @ 25.0°C	1	0.0614	<5
1003897-006A	48.0 @ 25.0°C	1	47.9 @ 25.0°C	1	0.125	<5
1003897-007A	53.0 @ 25.0°C	1	53.0 @ 25.0°C	1	0.0566	<5
1003897-008A	38.8 @ 25.0°C	1	38.6 @ 25.0°C	1	0.284	<5

BATCH 49680 SUMMARY

Lab ID	Date Sampled	Date Extracted	Date Analyzed	Lab ID	Date Sampled	Date Extracted	Date Analyzed
1003897-001A	)3/25/10 10:50 AM	04/02/10	04/02/10 3:10 PM	1003897-002A	)3/25/10 12:15 PM	04/02/10	04/02/10 3:20 PM
1003897-004A	03/25/10 2:30 PM	04/02/10	04/02/10 3:30 PM	1003897-005A	03/25/10 3:20 PM	04/02/10	04/02/10 3:40 PM
1003897-006A	03/25/10 3:50 PM	04/02/10	04/02/10 3:50 PM	1003897-007A	03/25/10 4:10 PM	04/02/10	04/02/10 4:00 PM
1003897-008A	)3/26/10 10:50 AM	04/02/10	04/02/10 4:10 PM				

Dup = Duplicate; Ser. Dil. = Serial Dilution; MS = Matrix Spike; RD = Relative Difference; RPD = Relative Percent Deviation.

Precision = Absolute Value (Sample - Duplicate)

RPD = 100 * (Sample - Duplicate) / [(Sample + Duplicate) / 2]

%RPD is calculated using results of up to 10 significant figures, however the reported results are rounded to 2 or 3 significant figures. Therefore there may be a slight discrepancy between the %RPD displayed above and %RPD calculated using the reported results. MAI considers %RPD based upon more significant figures to be more accurate.

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QC SUMMARY REPORT FOR SM5310Bm

W.O. Sample Matrix: Soil QC Matrix: Soil BatchID: 49672 WorkOrder 1003897

EPA Method SM5310Bm **Extraction SM5310Bm** **Spiked Sample ID: 1003897-001A**

Analyte	Sample	Spiked	MS	MSD	MS-MSD	LCS	LCSD	LCS-LCSD	Acceptance Criteria (%)			
	mg/Kg	mg/Kg	% Rec.	% Rec.	% RPD	% Rec.	% Rec.	% RPD	MS / MSD	RPD	LCS/LCSD	RPD
TOC	21,000	8200	75.1	76.3	0.343	98.8	99.2	0.379	70 - 130	20	80 - 120	20

All target compounds in the Method Blank of this extraction batch were ND less than the method RL with the following exceptions:
NONE

BATCH 49672 SUMMARY

Lab ID	Date Sampled	Date Extracted	Date Analyzed	Lab ID	Date Sampled	Date Extracted	Date Analyzed
1003897-001A	03/25/10 10:50 AM	04/05/10	04/05/10 4:32 PM	1003897-002A	03/25/10 12:15 PM	04/05/10	04/05/10 5:52 PM
1003897-004A	03/25/10 2:30 PM	04/05/10	04/05/10 6:15 PM	1003897-005A	03/25/10 3:20 PM	04/05/10	04/05/10 6:29 PM
1003897-006A	03/25/10 3:50 PM	04/05/10	04/05/10 7:19 PM	1003897-007A	03/25/10 4:10 PM	04/05/10	04/05/10 7:37 PM
1003897-008A	03/26/10 10:50 AM	04/05/10	04/05/10 8:01 PM				

MS = Matrix Spike; MSD = Matrix Spike Duplicate; LCS = Laboratory Control Sample; LCSD = Laboratory Control Sample Duplicate; RPD = Relative Percent Deviation.

% Recovery = 100 * (MS-Sample) / (Amount Spiked); RPD = 100 * (MS - MSD) / ((MS + MSD) / 2).

MS / MSD spike recoveries and / or %RPD may fall outside of laboratory acceptance criteria due to one or more of the following reasons: a) the sample is inhomogenous AND contains significant concentrations of analyte relative to the amount spiked, or b) the spiked sample's matrix interferes with the spike recovery.

N/A = not applicable to this method.

NR = analyte concentration in sample exceeds spike amount for soil matrix or exceeds 2x spike amount for water matrix or sample diluted due to high matrix or analyte content.

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QC SUMMARY REPORT FOR E365.1m

W.O. Sample Matrix: Soil | QC Matrix: Soil | BatchID: 49674 | WorkOrder 1003897

EPA Method E365.1m **Extraction E365.1m** **Spiked Sample ID: 1003897-001A**

Analyte	Sample	Spiked	MS	MSD	MS-MSD	LCS	LCSD	LCS-LCSD	Acceptance Criteria (%)			
	mg/Kg	mg/Kg	% Rec.	% Rec.	% RPD	% Rec.	% Rec.	% RPD	MS / MSD	RPD	LCS/LCSD	RPD
Total Phosphorous as P	110	40	NR	NR	NR	99.2	99.3	0.144	80 - 120	20	90 - 110	20

All target compounds in the Method Blank of this extraction batch were ND less than the method RL with the following exceptions:
NONE

BATCH 49674 SUMMARY

Lab ID	Date Sampled	Date Extracted	Date Analyzed	Lab ID	Date Sampled	Date Extracted	Date Analyzed
1003897-001A	03/25/10 10:50 AM	03/31/10	04/01/10 2:26 PM	1003897-002A	03/25/10 12:15 PM	03/31/10	04/01/10 2:30 PM
1003897-004A	03/25/10 2:30 PM	03/31/10	04/01/10 2:34 PM	1003897-005A	03/25/10 3:20 PM	03/31/10	04/01/10 2:37 PM
1003897-006A	03/25/10 3:50 PM	03/31/10	04/01/10 2:41 PM	1003897-007A	03/25/10 4:10 PM	03/31/10	04/01/10 2:45 PM
1003897-008A	03/26/10 10:50 AM	03/31/10	04/01/10 2:48 PM				

MS = Matrix Spike; MSD = Matrix Spike Duplicate; LCS = Laboratory Control Sample; LCSD = Laboratory Control Sample Duplicate; RPD = Relative Percent Deviation.

% Recovery = 100 * (MS-Sample) / (Amount Spiked); RPD = 100 * (MS - MSD) / ((MS + MSD) / 2).

MS / MSD spike recoveries and / or %RPD may fall outside of laboratory acceptance criteria due to one or more of the following reasons: a) the sample is inhomogenous AND contains significant concentrations of analyte relative to the amount spiked, or b) the spiked sample's matrix interferes with the spike recovery.

N/A = not enough sample to perform matrix spike and matrix spike duplicate.

NR = analyte concentration in sample exceeds spike amount for soil matrix or exceeds 2x spike amount for water matrix or sample diluted due to high matrix or analyte content.

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QC SUMMARY REPORT FOR 6010C

W.O. Sample Matrix: Soil QC Matrix: Soil BatchID: 49679 WorkOrder 1003897

EPA Method SW6010B **Extraction SW3050B** **Spiked Sample ID: 1003897-008A**

Analyte	Sample	Spiked	MS	MSD	MS-MSD	LCS	LCSD	LCS-LCSD	Acceptance Criteria (%)			
	mg/kg	mg/kg	% Rec.	% Rec.	% RPD	% Rec.	% Rec.	% RPD	MS / MSD	RPD	LCS/LCSD	RPD
Sulfur	150	100	103	102	0.676	106	100	5.49	75 - 125	20	80 - 120	20
%SS:	100	250	103	106	2.49	103	108	4.84	70 - 130	20	70 - 130	20

All target compounds in the Method Blank of this extraction batch were ND less than the method RL with the following exceptions:
NONE

BATCH 49679 SUMMARY

Lab ID	Date Sampled	Date Extracted	Date Analyzed	Lab ID	Date Sampled	Date Extracted	Date Analyzed
1003897-001A	03/25/10 10:50 AM	04/01/10	04/01/10 3:53 PM	1003897-002A	03/25/10 12:15 PM	04/01/10	04/01/10 3:56 PM
1003897-004A	03/25/10 2:30 PM	04/01/10	04/01/10 3:58 PM	1003897-005A	03/25/10 3:20 PM	04/01/10	04/01/10 4:01 PM
1003897-006A	03/25/10 3:50 PM	04/01/10	04/01/10 4:03 PM	1003897-007A	03/25/10 4:10 PM	04/01/10	04/01/10 4:05 PM
1003897-008A	03/26/10 10:50 AM	04/01/10	04/01/10 3:46 PM				

MS = Matrix Spike; MSD = Matrix Spike Duplicate; LCS = Laboratory Control Sample; LCSD = Laboratory Control Sample Duplicate; RPD = Relative Percent Deviation.

% Recovery = 100 * (MS-Sample) / (Amount Spiked); RPD = 100 * (MS - MSD) / ((MS + MSD) / 2).

MS / MSD spike recoveries and / or %RPD may fall outside of laboratory acceptance criteria due to one or more of the following reasons: a) the sample is inhomogenous AND contains significant concentrations of analyte relative to the amount spiked, or b) the spiked sample's matrix interferes with the spike recovery.

N/A = not applicable to this method.

NR = analyte concentration in sample exceeds spike amount for soil matrix or exceeds 2x spike amount for water matrix or sample diluted due to high matrix or analyte content.

DHS ELAP Certification 1644 QA/QC Officer

McCampbell Analytical, Inc.
"When Quality Counts"
1534 Willow Pass Road, Pittsburg, CA 94565-1701
Web: www.mccampbell.com E-mail: main@mccampbell.com
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QC SUMMARY REPORT FOR E415.1m

W.O. Sample Matrix: Soil | QC Matrix: Soil | BatchID: 49673 | WorkOrder 1003897

EPA Method E415.1m | **Extraction E415.1m** | **Spiked Sample ID: 1003897-001A**

Analyte	Sample	Spiked	MS	MSD	MS-MSD	LCS	LCSD	LCS-LCSD	Acceptance Criteria (%)			
	mg/Kg	mg/Kg	% Rec.	% Rec.	% RPD	% Rec.	% Rec.	% RPD	MS / MSD	RPD	LCS/LCSD	RPD
Total Nitrogen	2,700	1900	98	97.2	0.338	106	104	1.71	70 - 130	20	80 - 120	20

All target compounds in the Method Blank of this extraction batch were ND less than the method RL with the following exceptions:
NONE

BATCH 49673 SUMMARY

Lab ID	Date Sampled	Date Extracted	Date Analyzed	Lab ID	Date Sampled	Date Extracted	Date Analyzed
1003897-001A	03/25/10 10:50 AM	04/05/10	04/05/10 4:32 PM	1003897-002A	03/25/10 12:15 PM	04/05/10	04/05/10 5:52 PM
1003897-004A	03/25/10 2:30 PM	04/05/10	04/05/10 6:15 PM	1003897-005A	03/25/10 3:20 PM	04/05/10	04/05/10 6:29 PM
1003897-006A	03/25/10 3:50 PM	04/05/10	04/05/10 7:19 PM	1003897-007A	03/25/10 4:10 PM	04/05/10	04/05/10 7:37 PM
1003897-008A	03/26/10 10:50 AM	04/05/10	04/05/10 8:01 PM				

MS = Matrix Spike; MSD = Matrix Spike Duplicate; LCS = Laboratory Control Sample; LCSD = Laboratory Control Sample Duplicate; RPD = Relative Percent Deviation.

% Recovery = 100 * (MS-Sample) / (Amount Spiked); RPD = 100 * (MS - MSD) / ((MS + MSD) / 2).

MS / MSD spike recoveries and / or %RPD may fall outside of laboratory acceptance criteria due to one or more of the following reasons: a) the sample is inhomogenous AND contains significant concentrations of analyte relative to the amount spiked, or b) the spiked sample's matrix interferes with the spike recovery.

N/A = not applicable to this method.

NR = analyte concentration in sample exceeds spike amount for soil matrix or exceeds 2x spike amount for water matrix or sample diluted due to high matrix or analyte content.

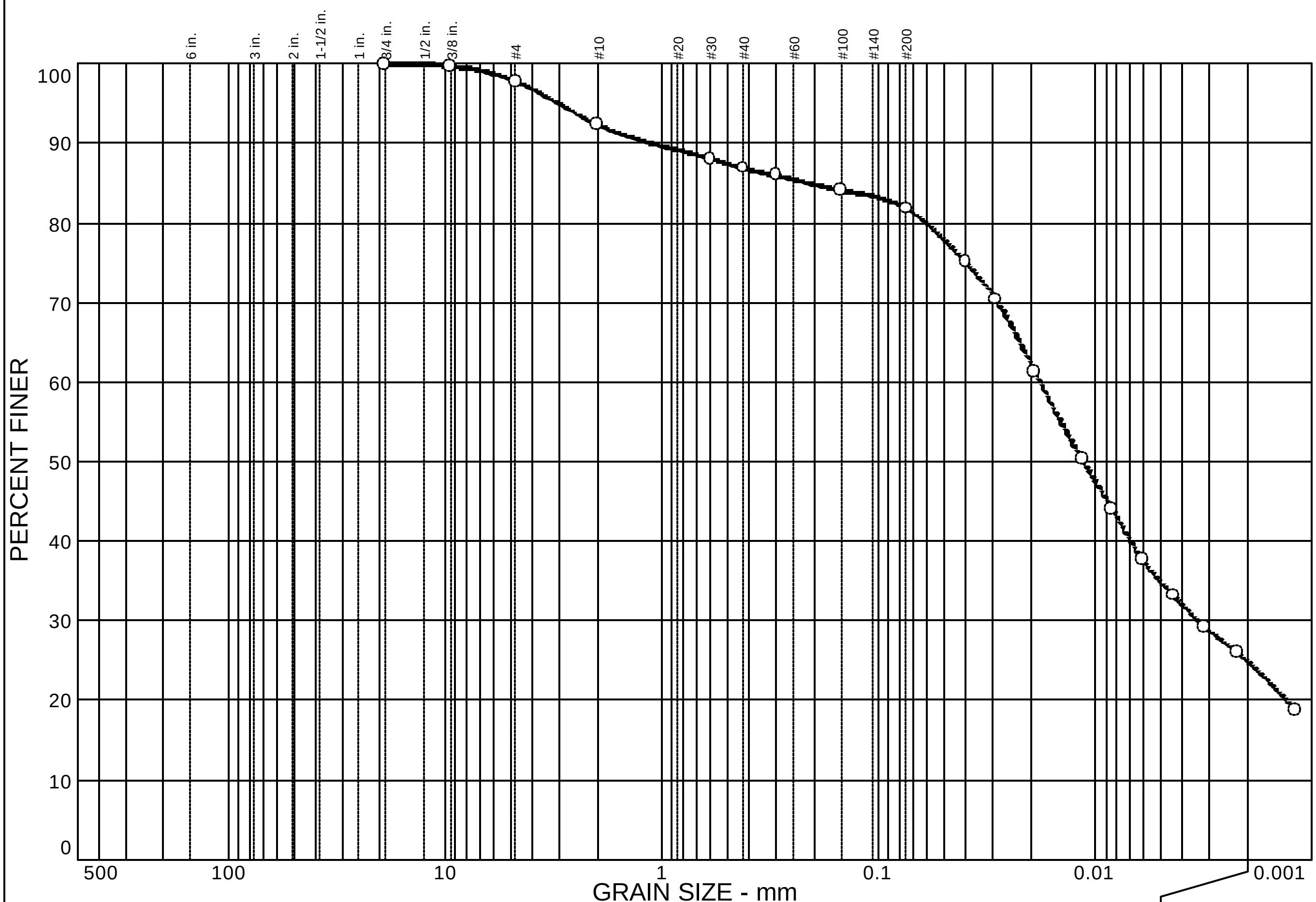
DHS ELAP Certification 1644

QA/QC Officer

ATTACHMENT D

PHYSICAL TESTING LABORATORY REPORTS

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0.0	2.2	16.0	56.9	24.9

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3/4 in.	100.0		
3/8 in.	99.7		
#4	97.8		
#10	92.4		
#30	88.1		
#40	86.9		
#50	86.0		
#100	84.1		
#200	81.8		
0.0400 mm.	75.1		
0.0290 mm.	70.4		
0.0192 mm.	61.2		
0.0116 mm.	50.3		
0.0084 mm.	44.0		
0.0061 mm.	37.7		
0.0044 mm.	33.2		
0.0031 mm.	29.2		
0.0022 mm.	26.0		
0.0012 mm.	18.7		

* (no specification provided)

Soil Description

Dark Gray Elastic SILT w/ Sand

Atterberg Limits

PL= 40.2 LL= 65.7 PI= 25.5

Coefficients

D_{85}= 0.211 D_{60}= 0.0182 D_{50}= 0.0114
D_{30}= 0.0034 D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= MH AASHTO=

Remarks

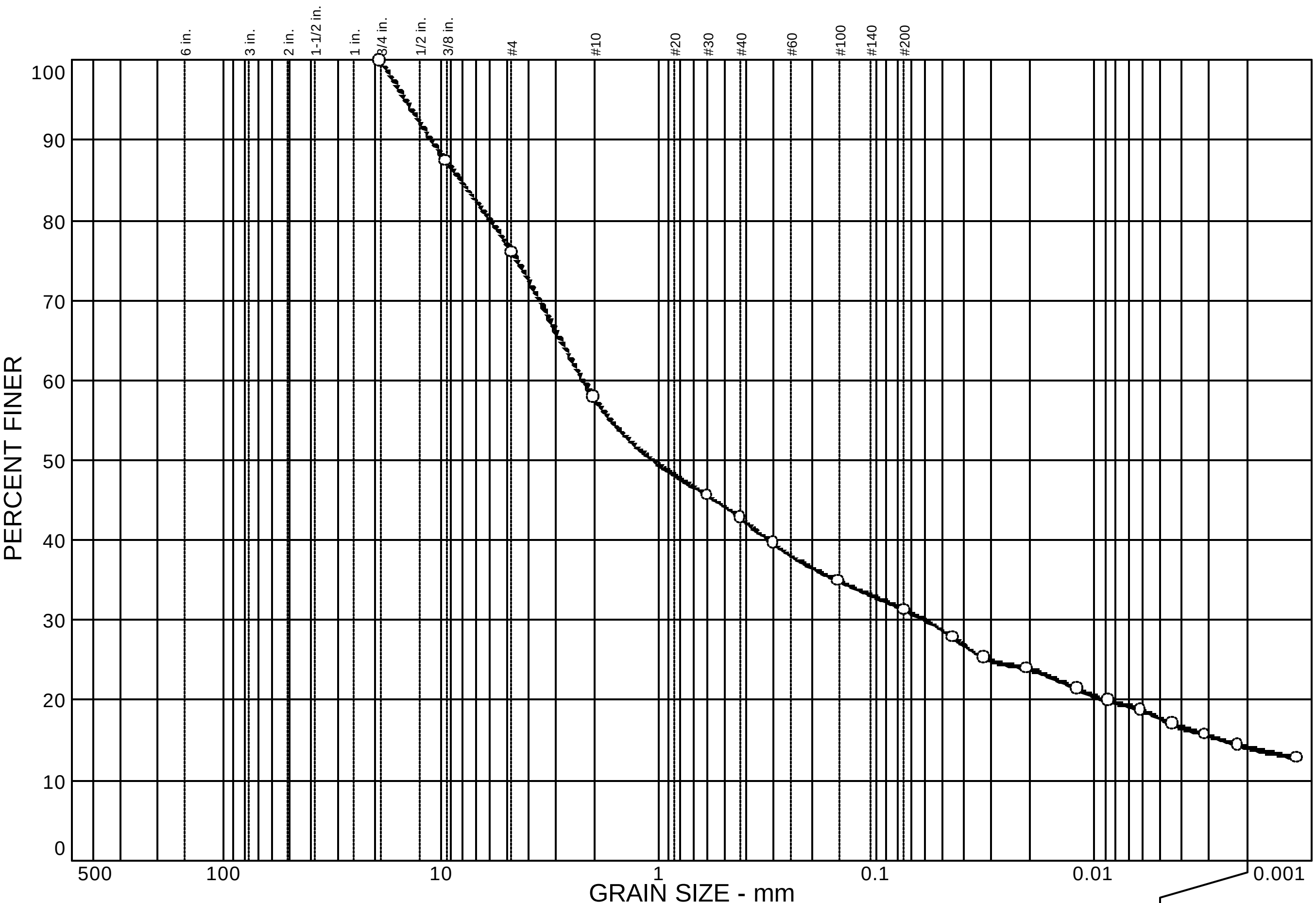
Sample No.: 1003897-010 **Source of Sample:** Road 1 **Date:**
Location: **Elev./Depth:**

COOPER TESTING LABORATORY

Client: McCampbell Analytical Inc.
Project: SFPUC Habitat Restoration - 2009-021

Project No: 385-059 **Figure**

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0.0	24.0	44.7	17.2	14.1

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3/4 in.	100.0		
3/8 in.	87.4		
#4	76.0		
#10	57.9		
#30	45.6		
#40	42.8		
#50	39.6		
#100	34.9		
#200	31.3		
0.0448 mm.	27.9		
0.0322 mm.	25.3		
0.0206 mm.	24.0		
0.0121 mm.	21.4		
0.0086 mm.	19.9		
0.0061 mm.	18.8		
0.0044 mm.	17.0		
0.0031 mm.	15.7		
0.0022 mm.	14.4		
0.0012 mm.	12.8		

* (no specification provided)

Soil Description

Dark Gray Clayey SAND w/ Gravel

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= 8.19 D_{60}= 2.24 D_{50}= 1.07
D_{30}= 0.0599 D_{15}= 0.0026 D_{10}=
C_u= C_c=

Classification

USCS= AASHTO=

Remarks

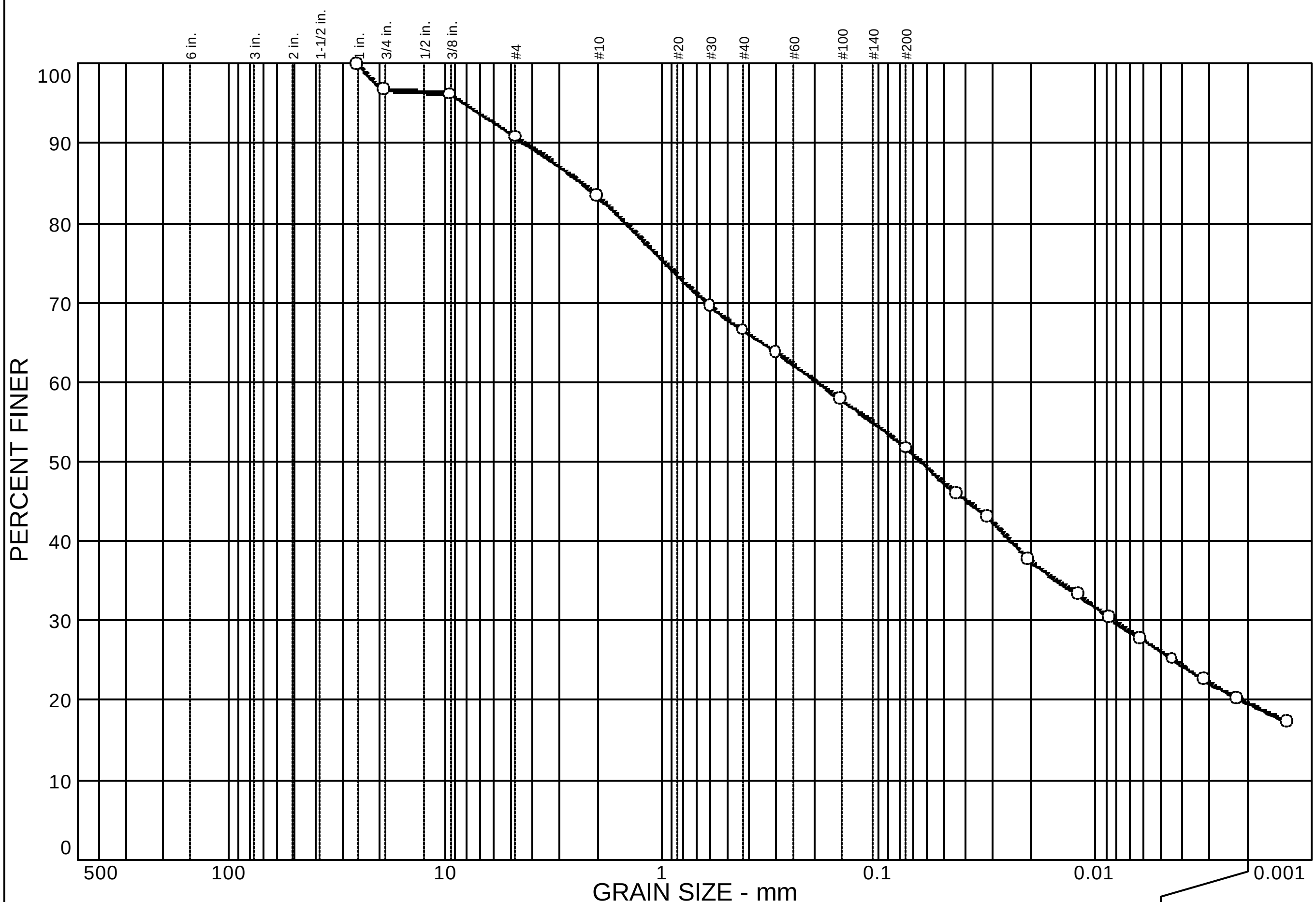
Sample No.: 1003897-008 **Source of Sample:** SA-SH-0 **Date:**
Location: **Elev./Depth:** 1.0'

COOPER TESTING LABORATORY

Client: McCampbell Analytical Inc.
Project: SFPUC Habitat Restoration - 2009-021

Project No: 385-059 **Figure**

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0.0	9.2	39.1	32.1	19.6

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1 in.	100.0		
3/4 in.	96.7		
3/8 in.	96.2		
#4	90.8		
#10	83.4		
#30	69.6		
#40	66.5		
#50	63.8		
#100	57.8		
#200	51.7		
0.0439 mm.	46.0		
0.0315 mm.	43.0		
0.0205 mm.	37.8		
0.0121 mm.	33.3		
0.0086 mm.	30.4		
0.0062 mm.	27.8		
0.0044 mm.	25.2		
0.0032 mm.	22.6		
0.0022 mm.	20.3		
0.0013 mm.	17.3		

* (no specification provided)

Soil Description

Dark Brown Sandy CLAY

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= 2.35 D_{60}= 0.193 D_{50}= 0.0640
D_{30}= 0.0082 D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= AASHTO=

Remarks

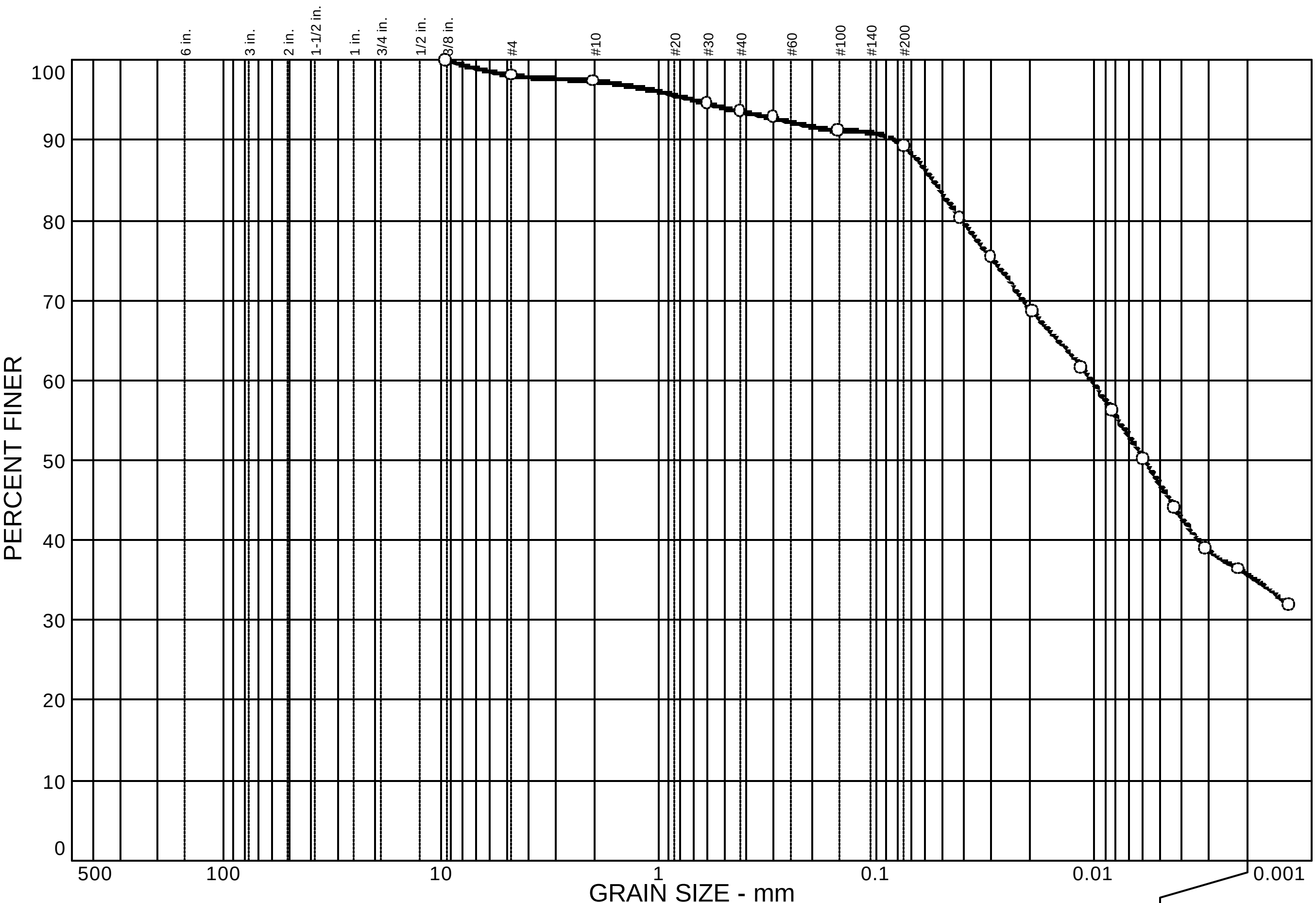
Sample No.: 1003897-009 **Source of Sample:** SA-SH-0 **Date:**
Location: **Elev./Depth:** 5.0'

COOPER TESTING LABORATORY

Client: McCampbell Analytical Inc.
Project: SFPUC Habitat Restoration - 2009-021

Project No: 385-059 **Figure**

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0.0	1.9	8.9	53.4	35.8

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3/8 in.	100.0		
#4	98.1		
#10	97.4		
#30	94.6		
#40	93.6		
#50	92.8		
#100	91.2		
#200	89.2		
0.0415 mm.	80.2		
0.0300 mm.	75.4		
0.0193 mm.	68.6		
0.0115 mm.	61.6		
0.0083 mm.	56.1		
0.0059 mm.	50.1		
0.0043 mm.	44.0		
0.0031 mm.	39.0		
0.0022 mm.	36.4		
0.0013 mm.	31.9		

* (no specification provided)

Soil Description

Dark Gray CLAY (slightly plastic)

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= 0.0553 D_{60}= 0.0104 D_{50}= 0.0059
D_{30}= D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= AASHTO=

Remarks

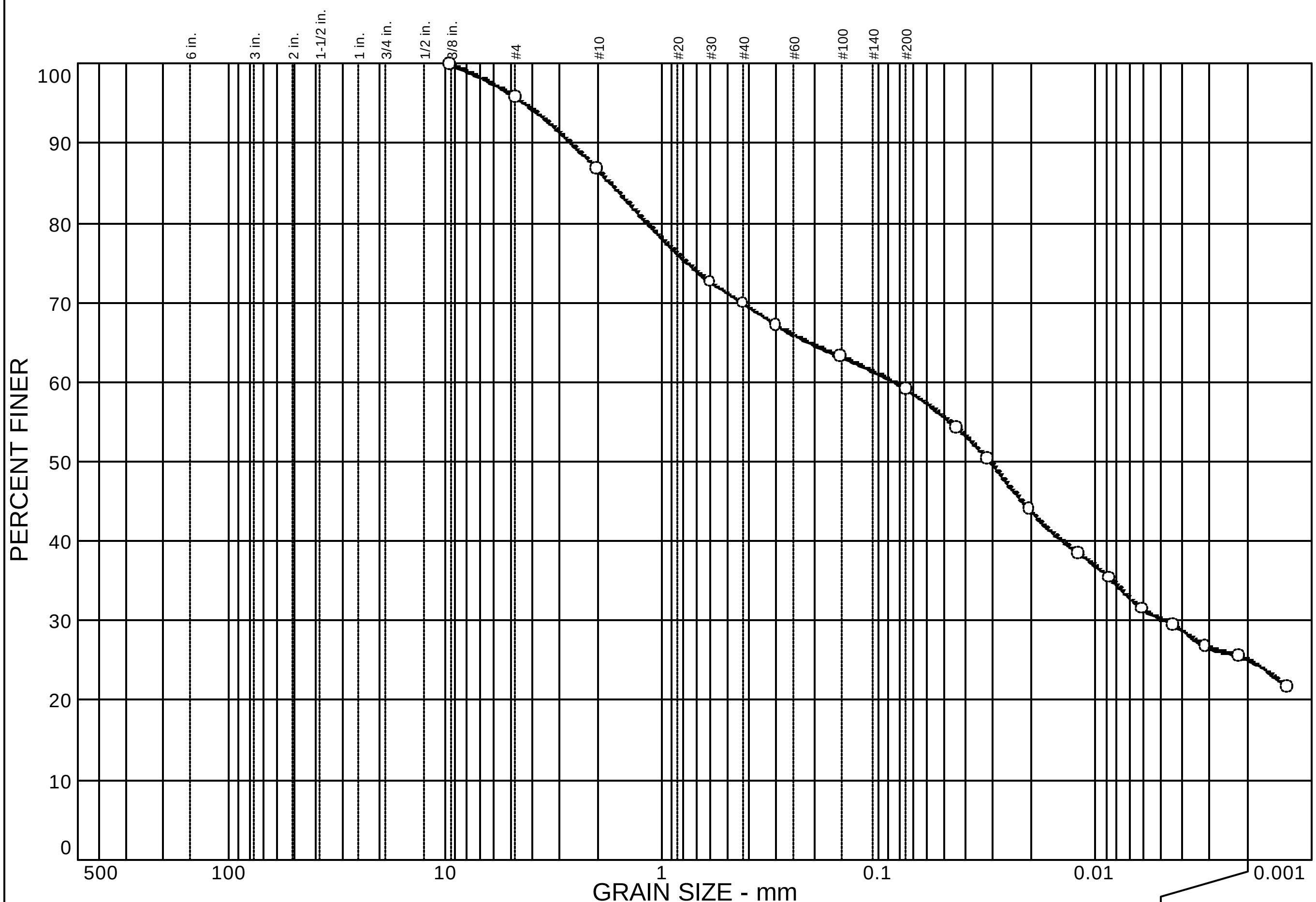
Sample No.: 1003897-001 **Source of Sample:** SA-SH-1 **Date:**
Location: **Elev./Depth:** 0.5'

COOPER TESTING LABORATORY

Client: McCampbell Analytical Inc.
Project: SFPUC Habitat Restoration - 2009-021

Project No: 385-059 **Figure**

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0.0	4.2	36.7	34.0	25.1

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3/8 in.	100.0		
#4	95.8		
#10	86.8		
#30	72.6		
#40	69.9		
#50	67.2		
#100	63.2		
#200	59.1		
0.0435 mm.	54.2		
0.0314 mm.	50.3		
0.0203 mm.	44.0		
0.0120 mm.	38.5		
0.0086 mm.	35.4		
0.0061 mm.	31.5		
0.0044 mm.	29.5		
0.0031 mm.	26.8		
0.0022 mm.	25.6		
0.0013 mm.	21.7		

* (no specification provided)

Soil Description

Dark Gray Sandy Lean CLAY

Atterberg Limits

PL= 21.3 LL= 37.3 PI= 16.0

Coefficients

D_{85}= 1.73 D_{60}= 0.0853 D_{50}= 0.0307
D_{30}= 0.0047 D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= CL AASHTO=

Remarks

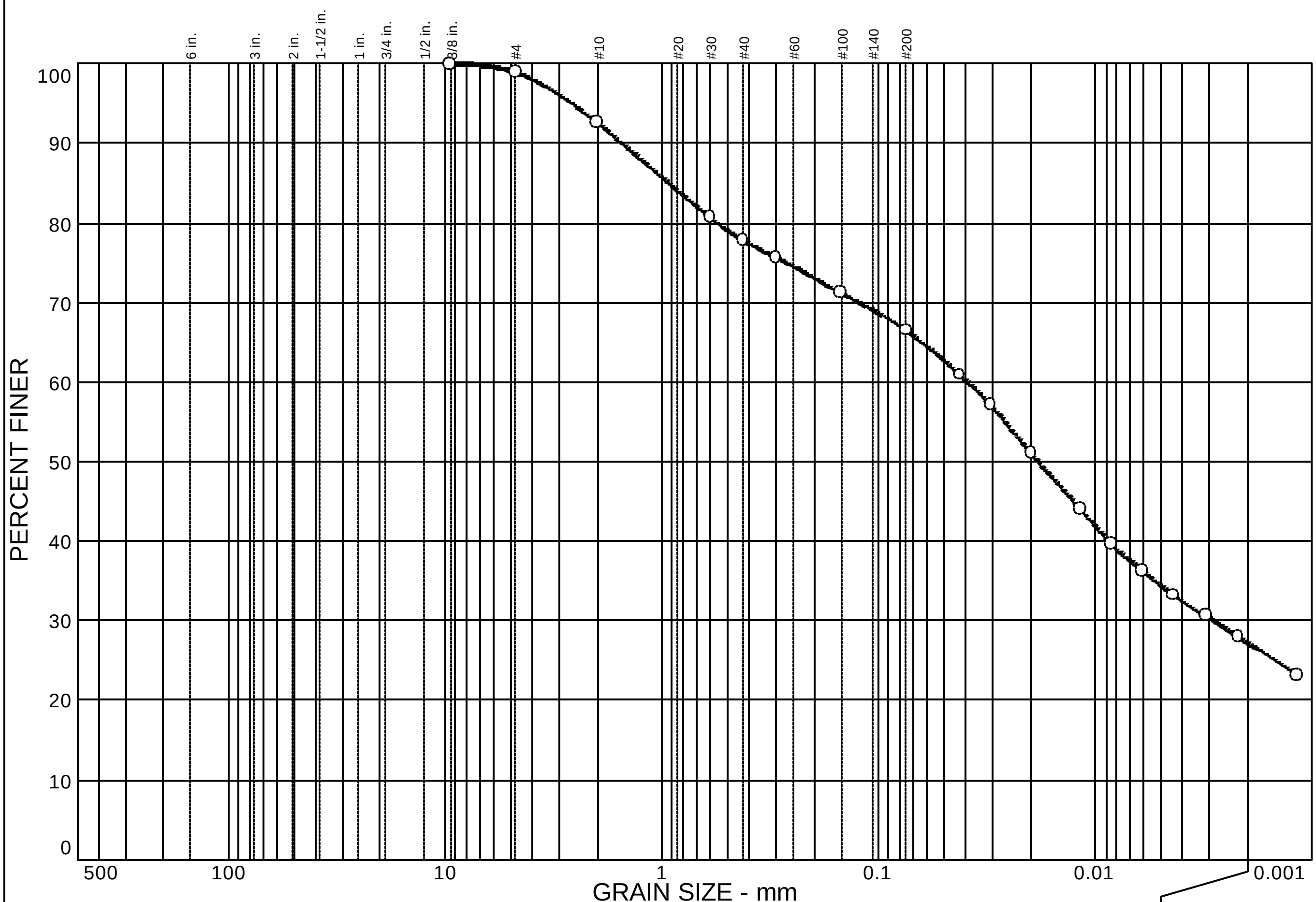
Sample No.: 1003897-002 **Source of Sample:** SA-SH-1 **Date:**
Location: **Elev./Depth:** 3.5'

COOPER TESTING LABORATORY

Client: McCampbell Analytical Inc.
Project: SFPUC Habitat Restoration - 2009-021

Project No: 385-059 **Figure**

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0.0	1.1	32.4	39.2	27.3

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3/8 in.	100.0		
#4	98.9		
#10	92.6		
#30	80.7		
#40	77.8		
#50	75.7		
#100	71.2		
#200	66.5		
0.0424 mm.	60.9		
0.0305 mm.	57.1		
0.0199 mm.	51.0		
0.0118 mm.	44.1		
0.0085 mm.	39.7		
0.0061 mm.	36.3		
0.0044 mm.	33.2		
0.0031 mm.	30.6		
0.0022 mm.	28.0		
0.0012 mm.	23.2		

* (no specification provided)

Soil Description

Dark Brown Sandy CLAY

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= 0.932 D_{60}= 0.0390 D_{50}= 0.0185
D_{30}= 0.0029 D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= AASHTO=

Remarks

Sample No.: 1003897-003 **Source of Sample:** SA-SH-1 **Date:**
Location: **Elev./Depth:** 5.0'

COOPER TESTING LABORATORY

Client: McCampbell Analytical Inc.
Project: SFPUC Habitat Restoration - 2009-021

Project No: 385-059 **Figure**

Particle Size Distribution Report

% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0.0	7.3	33.7	31.6	27.4

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3/4 in.	100.0		
3/8 in.	98.6		
#4	92.7		
#10	81.9		
#30	73.6		
#40	71.6		
#50	69.2		
#100	64.3		
#200	59.0		
0.0428 mm.	51.7		
0.0309 mm.	47.9		
0.0199 mm.	44.1		
0.0117 mm.	39.9		
0.0084 mm.	38.0		
0.0060 mm.	34.2		
0.0043 mm.	32.3		
0.0031 mm.	30.4		
0.0022 mm.	28.0		
0.0012 mm.	23.8		

* (no specification provided)

Soil Description

Dark Gray Sandy Lean CLAY

Atterberg Limits

PL= 24.8 LL= 43.3 PI= 18.5

Coefficients

D_{85}= 2.60 D_{60}= 0.0828 D_{50}= 0.0374
D_{30}= 0.0029 D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= CL AASHTO=

Remarks

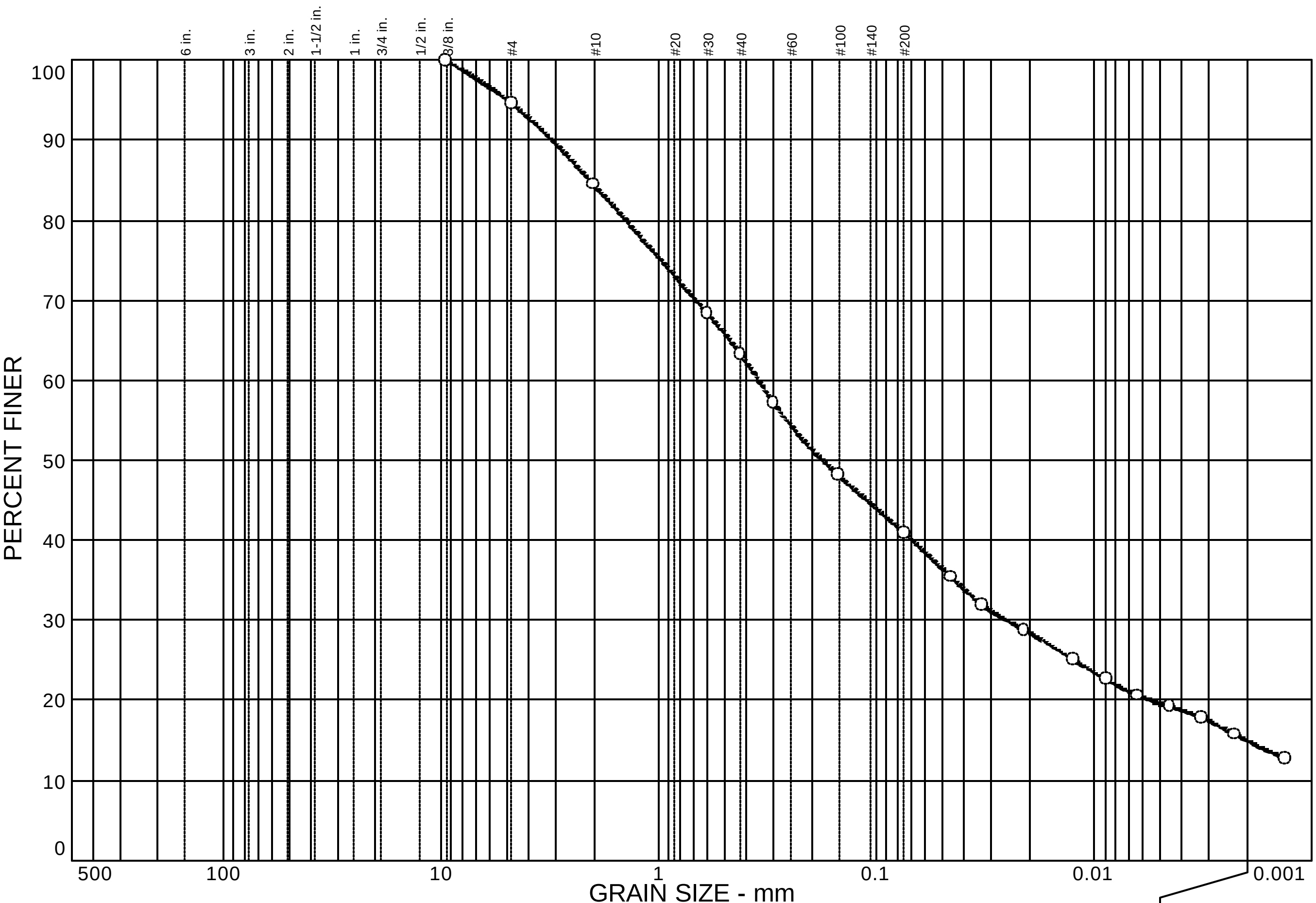
Sample No.: 1003897-004 **Source of Sample:** SA-SH-2 **Date:**
Location: **Elev./Depth:** 1.75'

COOPER TESTING LABORATORY

Client: McCampbell Analytical Inc.
Project: SFPUC Habitat Restoration - 2009-021

Project No: 385-059 **Figure**

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0.0	5.4	53.7	26.0	14.9

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3/8 in.	100.0		
#4	94.6		
#10	84.5		
#30	68.3		
#40	63.3		
#50	57.2		
#100	48.1		
#200	40.9		
0.0457 mm.	35.4		
0.0329 mm.	31.9		
0.0211 mm.	28.8		
0.0124 mm.	25.0		
0.0089 mm.	22.6		
0.0063 mm.	20.6		
0.0045 mm.	19.2		
0.0032 mm.	17.8		
0.0023 mm.	15.7		
0.0013 mm.	12.6		

* (no specification provided)

Soil Description

Brown Clayey Brown Clayey SAND

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= 2.08 D_{60}= 0.352 D_{50}= 0.178
D_{30}= 0.0255 D_{15}= 0.0020 D_{10}=
C_u= C_c=

Classification

USCS= AASHTO=

Remarks

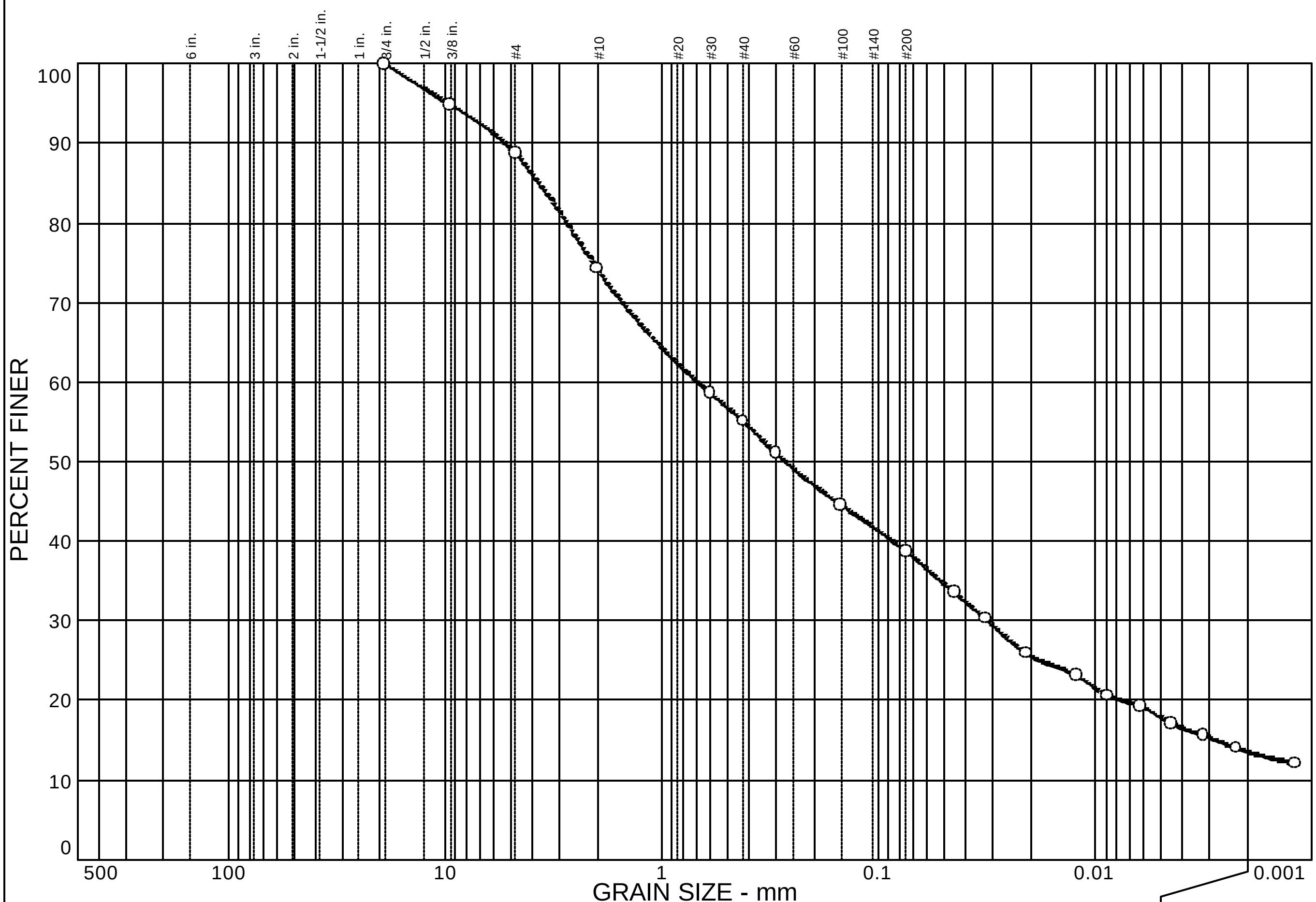
Sample No.: 1003897-005 **Source of Sample:** SA-SH-2 **Date:**
Location: **Elev./Depth:** 7.0

COOPER TESTING LABORATORY

Client: McCampbell Analytical Inc.
Project: SFPUC Habitat Restoration - 2009-021

Project No: 385-059 **Figure**

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0.0	11.3	50.0	25.2	13.5

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3/4 in.	100.0		
3/8 in.	94.9		
#4	88.7		
#10	74.3		
#30	58.6		
#40	55.1		
#50	51.1		
#100	44.6		
#200	38.7		
0.0448 mm.	33.5		
0.0323 mm.	30.3		
0.0209 mm.	25.9		
0.0123 mm.	23.1		
0.0088 mm.	20.6		
0.0063 mm.	19.3		
0.0045 mm.	17.1		
0.0032 mm.	15.6		
0.0022 mm.	14.0		
0.0012 mm.	12.1		

* (no specification provided)

Soil Description

Dark Gray Clayey SAND

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= 3.69 D_{60}= 0.687 D_{50}= 0.271
D_{30}= 0.0314 D_{15}= 0.0028 D_{10}=
C_u= C_c=

Classification

USCS= AASHTO=

Remarks

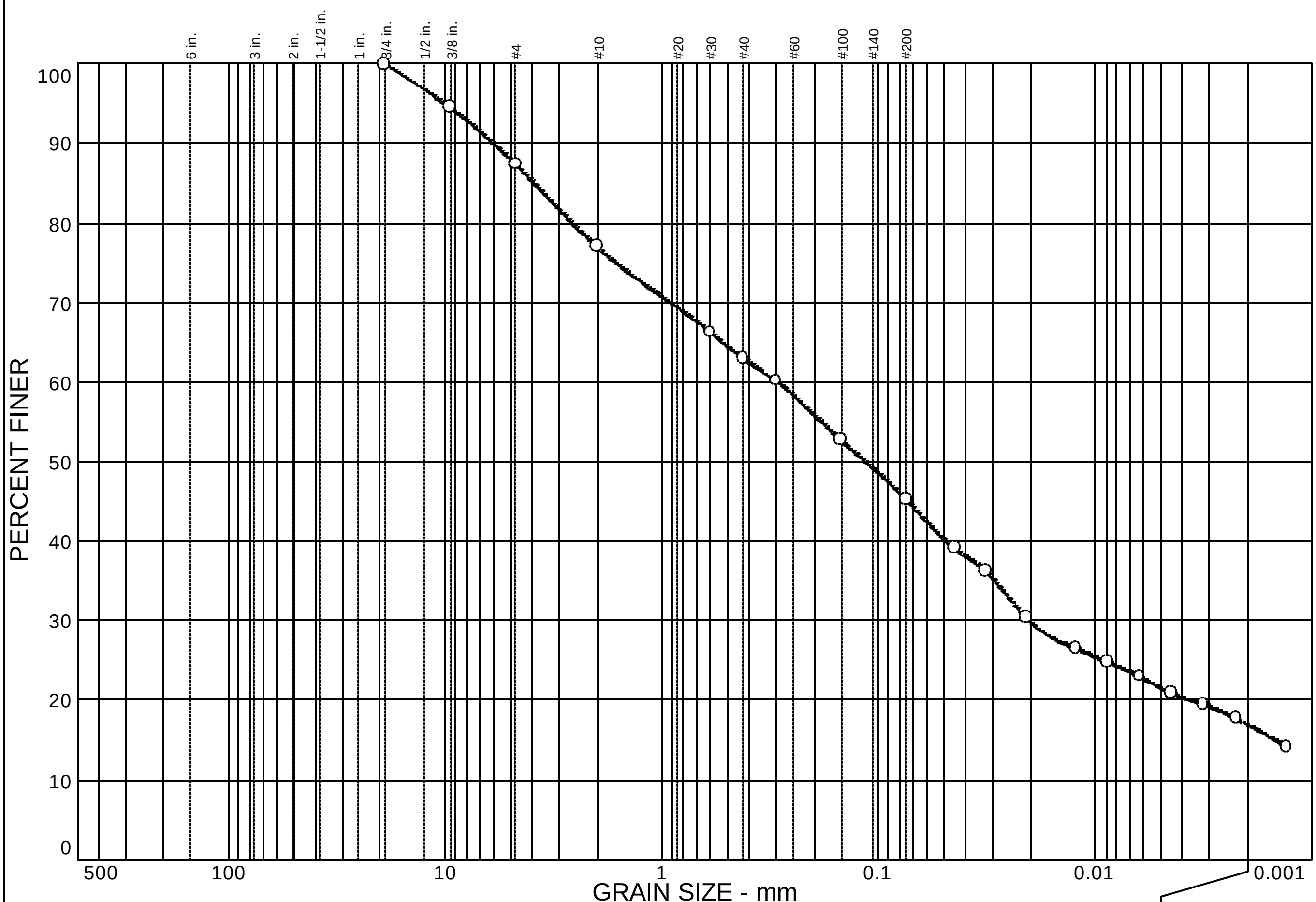
Sample No.: 1003897-006 **Source of Sample:** SA-SH-3 **Date:**
Location: **Elev./Depth:** 1.5'

COOPER TESTING LABORATORY

Client: McCampbell Analytical Inc.
Project: SFPUC Habitat Restoration - 2009-021

Project No: 385-059 **Figure**

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0.0	12.6	42.1	28.3	17.0

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3/4 in.	100.0		
3/8 in.	94.5		
#4	87.4		
#10	77.0		
#30	66.3		
#40	63.0		
#50	60.2		
#100	52.7		
#200	45.3		
0.0449 mm.	39.1		
0.0322 mm.	36.3		
0.0210 mm.	30.4		
0.0124 mm.	26.5		
0.0088 mm.	24.8		
0.0063 mm.	23.0		
0.0045 mm.	20.9		
0.0032 mm.	19.5		
0.0022 mm.	17.7		
0.0013 mm.	14.2		

* (no specification provided)

Soil Description

Dark Brown Clayey SAND

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= 3.89 D_{60}= 0.293 D_{50}= 0.116
D_{30}= 0.0203 D_{15}= 0.0015 D_{10}=
C_u= C_c=

Classification

USCS= AASHTO=

Remarks

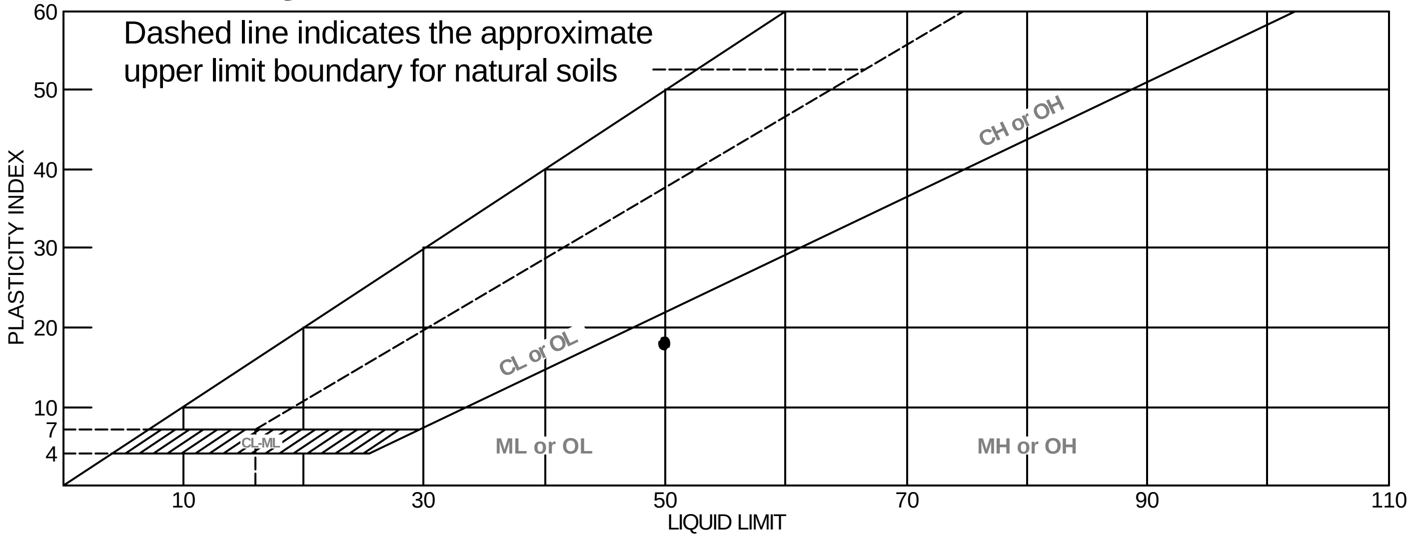
Sample No.: 1003897-007 **Source of Sample:** SA-SH-3 **Date:**
Location: **Elev./Depth:** 4.5'

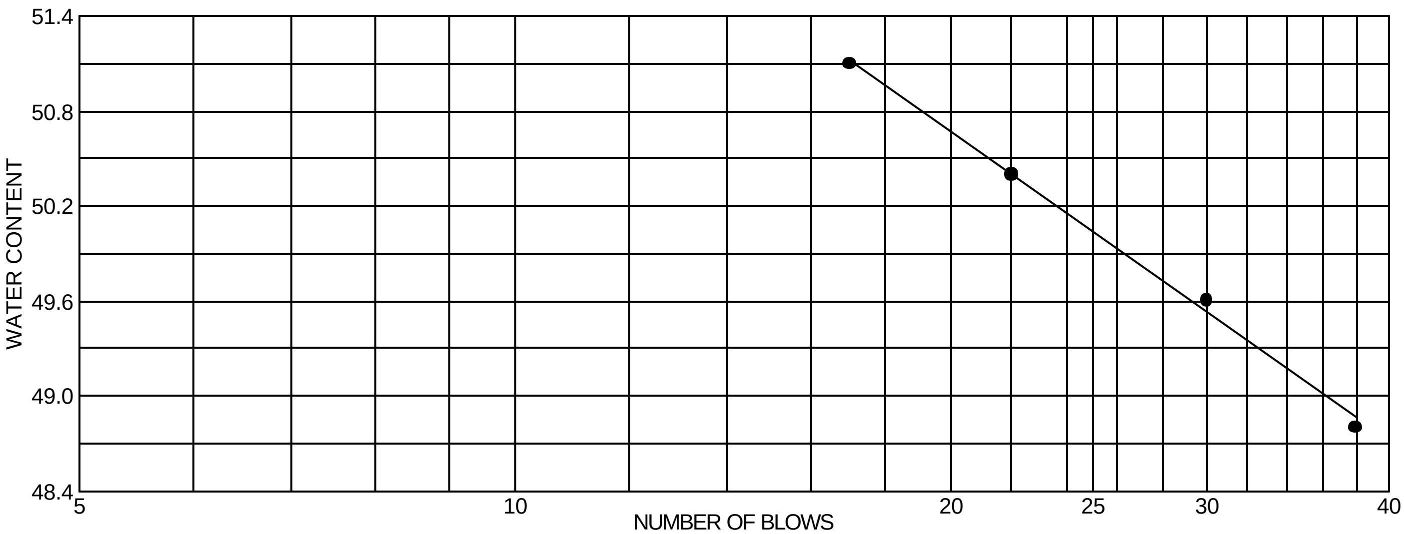
COOPER TESTING LABORATORY

Client: McCampbell Analytical Inc.
Project: SFPUC Habitat Restoration - 2009-021

Project No: 385-059 **Figure**

LIQUID AND PLASTIC LIMITS TEST REPORT





	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	Dark Gray SILT w/ Sand, Gravel & surface organics	50.0	32.1	17.9			

Project No. 385-059 **Client:** McCampbell Analytical Inc.

Project: SFPUC Habitat Restoration - 2009-021

● **Source:** Road 4 **Sample No.:** 1003897-013

Remarks:

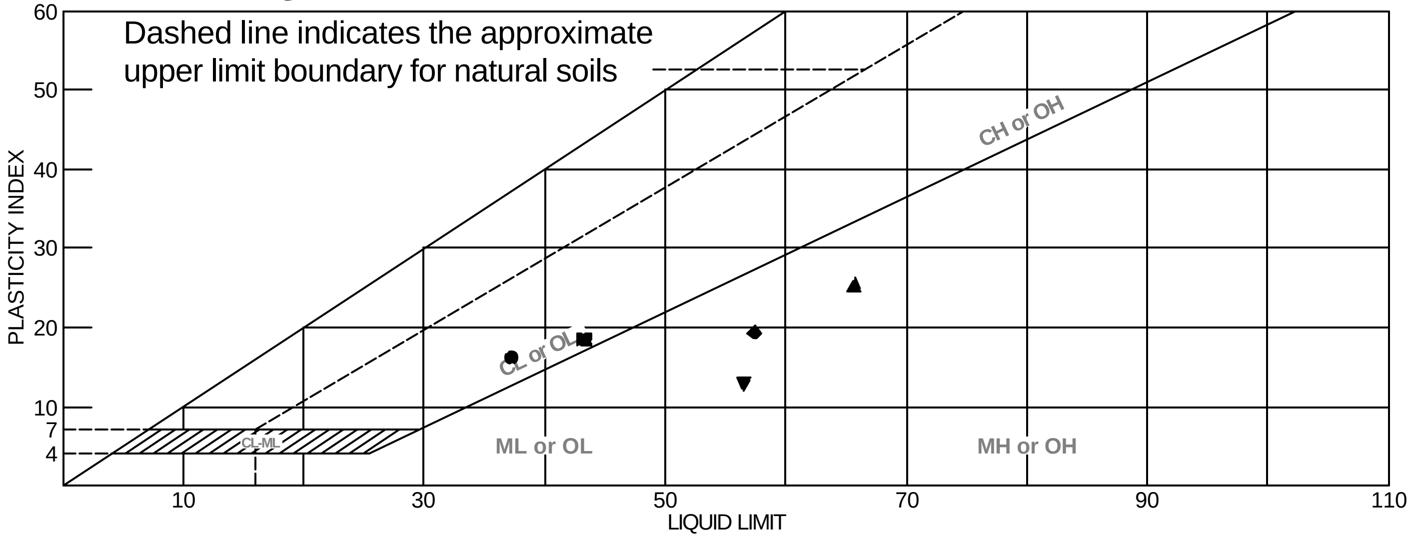
●

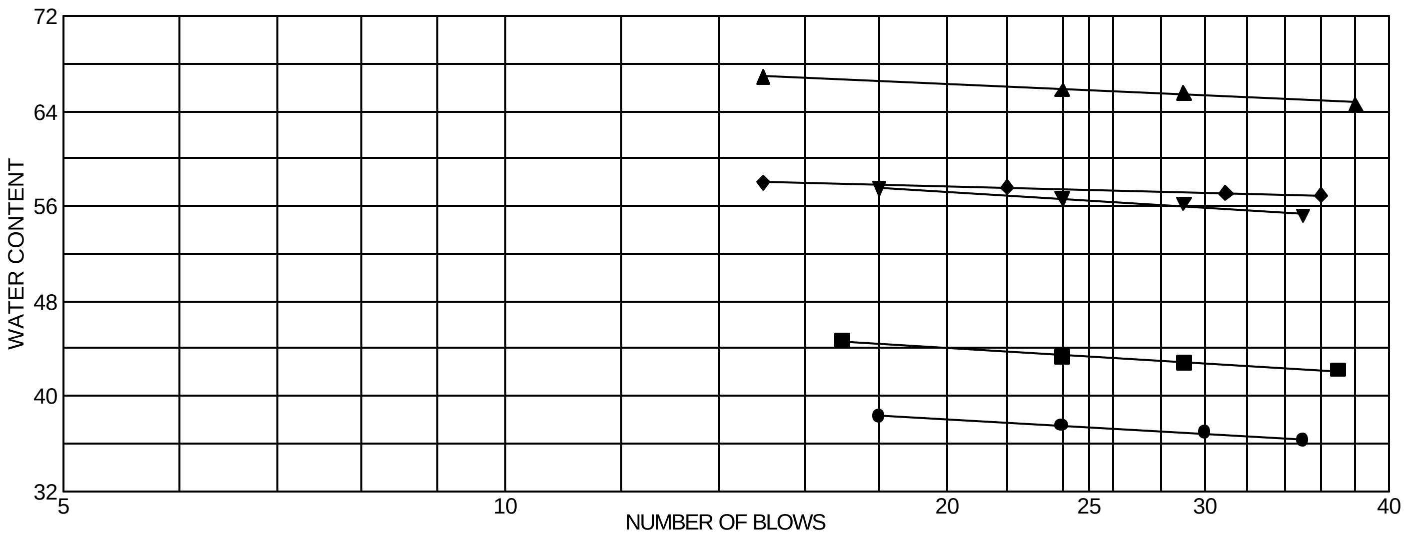
LIQUID AND PLASTIC LIMITS TEST REPORT

COOPER TESTING LABORATORY

Figure

LIQUID AND PLASTIC LIMITS TEST REPORT





	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	Dark Gray Sandy Lean CLAY	37.3	21.3	16.0	69.9	59.1	CL
■	Dark Gray Sandy Lean CLAY	43.3	24.8	18.5	71.6	59.0	CL
▲	Dark Gray Elastic SILT w/ Sand	65.7	40.2	25.5	86.9	81.8	MH
◆	Dark Gray Elastic SILT w/ surface organics	57.4	38.1	19.3			
▼	Dark Gray Elastic SILT w/ Sand & surface organics	56.5	43.8	12.7			

Project No. 385-059 **Client:** McCampbell Analytical Inc.

Project: SFPUC Habitat Restoration - 2009-021

● **Source:** SA-SH-1 **Sample No.:** 1003897-002 **Elev./Depth:** 3.5'

■ **Source:** SA-SH-2 **Sample No.:** 1003897-004 **Elev./Depth:** 1.75'

▲ **Source:** Road 1 **Sample No.:** 1003897-010

◆ **Source:** Road 2 **Sample No.:** 1003897-011

▼ **Source:** Road 3 **Sample No.:** 1003897-012

Remarks:

●

■

▲

◆

▼

LIQUID AND PLASTIC LIMITS TEST REPORT

COOPER TESTING LABORATORY

Figure

Hydraulic Conductivity
ASTM D 5084
Method C: Falling Head Rising Tailwater

COOPER TESTING LABORATORY

Job No:	385-059	**Boring:**	SA-SH-1	**Date:**	04/16/10
Client:	McCampbell Analytical	**Sample:**	1003897-001	**By:**	MD/PJ
Project:	2009-021	**Depth, ft.:**	0.5	**Remolded:**	

Visual Classification: Dark Gray CLAY (slightly plastic)

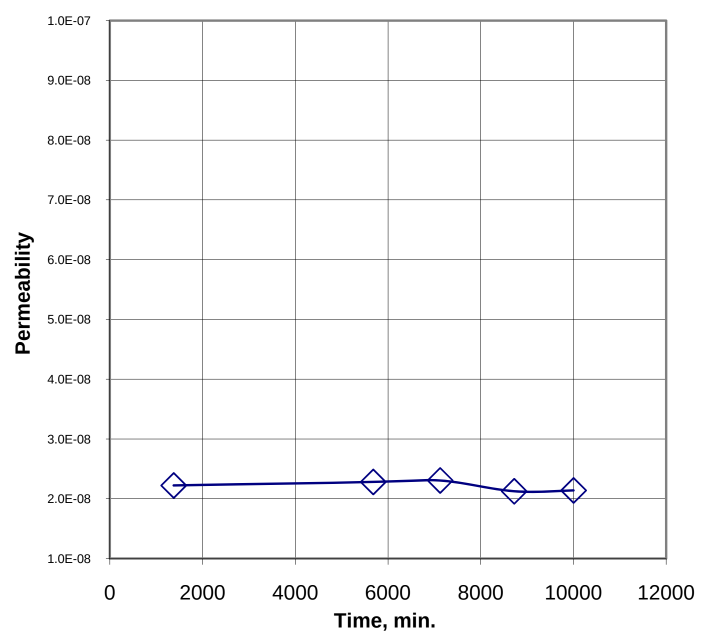
Max Sample Pressures, psi:

Cell:	Bottom	Top	Avg. Sigma3
43.5	39.5	37.5	5

B: = >0.95 **("B" is an indication of saturation)**

Max Hydraulic Gradient: = 39

Date	Minutes	Head, (in)	K,cm/sec
4/8/2010	0.00	74.38	Start of Test
4/9/2010	1377.00	73.38	2.2E-08
4/12/2010	5681.00	70.38	2.3E-08
4/13/2010	7125.00	69.38	2.3E-08
4/14/2010	8722.00	68.78	2.1E-08
4/15/2010	10003.00	67.98	2.1E-08



Average Permeability: **2.E-08** **cm/sec**

Sample Data:	Initial		Final
Height, in	2.00		1.92
Diameter, in	1.92		1.85
Area, in2	2.90		2.69
Volume in3	5.79		5.16
Total Volume, cc	94.9		84.6
Volume Solids, cc	33.6		33.6
Volume Voids, cc	61.3		50.9
Void Ratio	1.8		1.5
Total Porosity, %	64.6		60.2
Air-Filled Porosity, %	1.6		1.4
Water-Filled Porosity,%	62.9		58.8
Saturation, %	97.5		97.7
Specific Gravity	2.80	Assumed	2.80
Wet Weight, gm	153.9		143.9
Dry Weight, gm	94.1		94.1
Tare, gm	0.00		0.00
Moisture, %	63.4		52.8
Dry Density, pcf	61.9		69.5

Remarks:

Hydraulic Conductivity
ASTM D 5084
Method C: Falling Head Rising Tailwater

Job No:	385-059	**Boring:**	SA-SH-1	**Date:**	04/14/10
Client:	McCampbell Analytical	**Sample:**	1003897-002	**By:**	MD/PJ
Project:	2009-021	**Depth, ft.:**	3.5	**Remolded:**	

Visual Classification: Dark Gray Sandy Lean CLAY

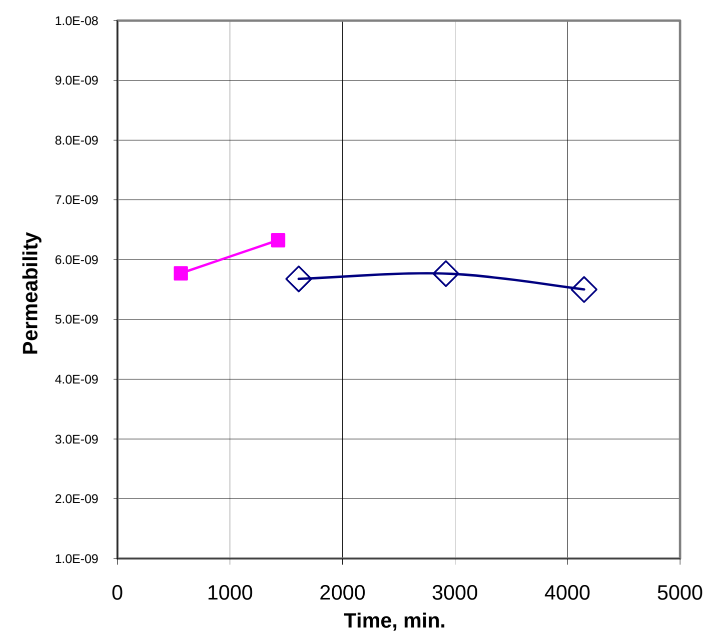
Max Sample Pressures, psi:

Cell:	Bottom	Top	Avg. Sigma3
54	50	48	5

B: = >0.95 **("B" is an indication of saturation)**

Max Hydraulic Gradient: = 35

Date	Minutes	Head, (in)	K,cm/sec
4/9/2010	0.00	42.69	**Start of Test**
4/10/2010	1611.00	42.44	5.7E-09
4/11/2010	2919.00	42.24	5.8E-09
4/12/2010	4147.00	42.09	5.5E-09
4/12/2010	563.00	70.23	5.8E-09
4/13/2010	1428.00	69.98	6.3E-09



Average Permeability: **6.E-09** **cm/sec**

Sample Data:	**Initial**		**Final**
Height, in	2.01		2.00
Diameter, in	1.93		1.93
Area, in2	2.93		2.91
Volume in3	5.88		5.82
Total Volume, cc	96.4		95.3
Volume Solids, cc	58.4		58.4
Volume Voids, cc	38.0		36.9
Void Ratio	0.7		0.6
Total Porosity, %	39.4		38.8
Air-Filled Porosity, %	0.4		0.0
Water-Filled Porosity,%	39.0		38.7
Saturation, %	99.1		99.9
Specific Gravity	2.80	Assumed	2.80
Wet Weight, gm	201.1		200.4
Dry Weight, gm	163.5		163.5
Tare, gm	0.00		0.00
Moisture, %	23.0		22.6
Dry Density, pcf	105.9		107.0

Remarks:

Hydraulic Conductivity
ASTM D 5084
Method C: Falling Head Rising Tailwater

COOPER TESTING LABORATORY

Job No:	385-059	**Boring:**	SA-SH-1	**Date:**	04/19/10
Client:	McCampbell Analytical	**Sample:**	1003897-003	**By:**	MD/PJ
Project:	2009-021	**Depth, ft.:**	5.0	**Remolded:**	

Visual Classification: Dark Brown Sandy CLAY

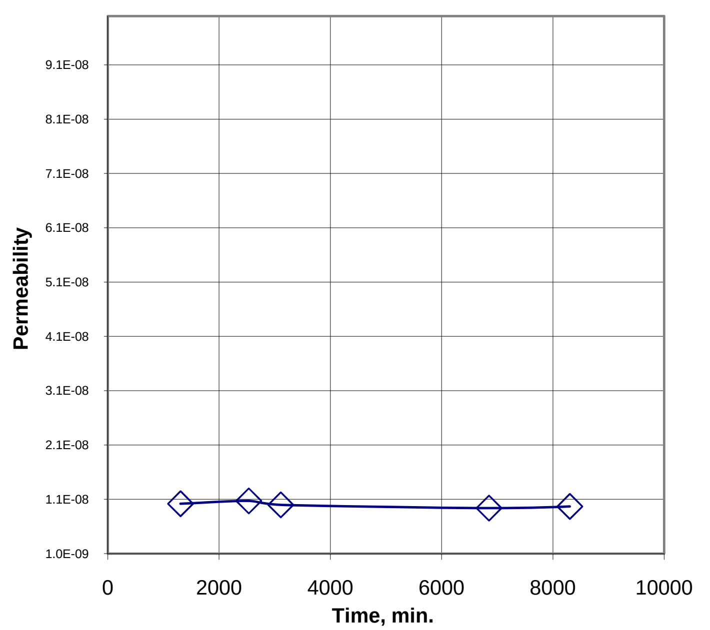
Max Sample Pressures, psi:

Cell:	Bottom	Top	Avg. Sigma3
74	70	68	5

B: = >0.95 **("B" is an indication of saturation)**

Max Hydraulic Gradient: = 36

Date	Minutes	Head, (in)	K,cm/sec
4/10/2010	0.00	70.38	**Start of Test**
4/11/2010	1307.00	69.78	1.0E-08
4/12/2010	2534.00	69.18	1.1E-08
4/12/2010	3109.00	68.93	1.0E-08
4/15/2010	6851.00	67.48	9.4E-09
4/16/2010	8304.00	66.78	9.7E-09



Average Permeability: **1.E-08** **cm/sec**

Sample Data:	Initial		Final
Height, in	2.00		1.96
Diameter, in	1.93		1.93
Area, in2	2.93		2.91
Volume in3	5.85		5.69
Total Volume, cc	95.9		93.2
Volume Solids, cc	56.5		56.5
Volume Voids, cc	39.4		36.8
Void Ratio	0.7		0.7
Total Porosity, %	41.1		39.4
Air-Filled Porosity, %	0.8		0.0
Water-Filled Porosity,%	40.3		39.4
Saturation, %	98.1		100.0
Specific Gravity	2.80	Assumed	2.80
Wet Weight, gm	196.8		194.9
Dry Weight, gm	158.1		158.1
Tare, gm	0.00		0.00
Moisture, %	24.4		23.2
Dry Density, pcf	102.9		105.8

Remarks: The measured diamters and associated values are approximate due to small voids in the side of this sample.

Hydraulic Conductivity
ASTM D 5084
Method C: Falling Head Rising Tailwater

Job No:	385-059	**Boring:**	SA-SH-2	**Date:**	04/14/10
Client:	McCampbell Analytical Inc.	**Sample:**	1003897-004	**By:**	MD/PJ
Project:	2009-021	**Depth, ft.:**	1.75	**Remolded:**	

Visual Classification: Dark Gray Sandy Lean CLAY

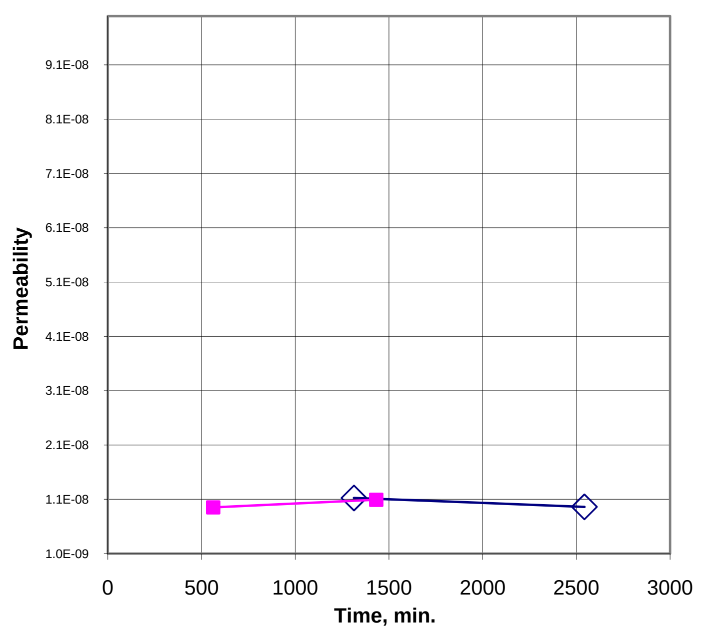
Max Sample Pressures, psi:

Cell:	Bottom	Top	Avg. Sigma3
64	60	58	5

B: = >0.95 **("B" is an indication of saturation)**

Max Hydraulic Gradient: = 37

Date	Minutes	Head, (in)	K,cm/sec
4/10/2010	0.00	42.69	Start of Test
4/11/2010	1313.00	42.29	1.1E-08
4/12/2010	2543.00	42.04	9.6E-09
4/12/2010	562.00	70.13	9.5E-09
4/13/2010	1432.00	69.68	1.1E-08



Average Permeability: **1.E-08** **cm/sec**

Sample Data:	Initial		Final
Height, in	2.00		1.92
Diameter, in	1.92		1.90
Area, in2	2.90		2.84
Volume in3	5.79		5.44
Total Volume, cc	94.9		89.2
Volume Solids, cc	53.6		53.6
Volume Voids, cc	41.3		35.7
Void Ratio	0.8		0.7
Total Porosity, %	43.6		40.0
Air-Filled Porosity, %	2.0		0.3
Water-Filled Porosity,%	41.5		39.7
Saturation, %	95.3		99.3
Specific Gravity	2.70	Assumed	2.70
Wet Weight, gm	184.0		180.0
Dry Weight, gm	144.6		144.6
Tare, gm	0.00		0.00
Moisture, %	27.3		24.5
Dry Density, pcf	95.1		101.1

Remarks:

Hydraulic Conductivity

ASTM D 5084

Method C: Falling Head Rising Tailwater

COOPER TESTING LABORATORY

Job No:	385-059	**Boring:**	SA-SH-2	**Date:**	04/21/10
Client:	McCampbell Analytical Inc.	**Sample:**	1003897-005	**By:**	MD/PJ
Project:	2009-021	**Depth, ft.:**	7.0	**Remolded:**	

Visual Classification: Brown Clayey SAND

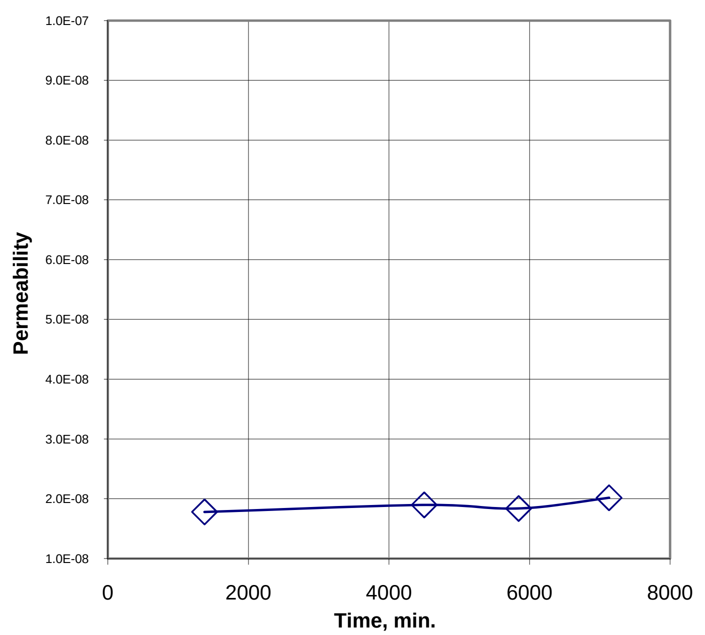
Max Sample Pressures, psi:

Cell:	Bottom	Top	Avg. Sigma3
43.5	39.5	37.5	5

B: = >0.95 **("B" is an indication of saturation)**

Max Hydraulic Gradient: = 43

Date	Minutes	Head, (in)	K,cm/sec
4/15/2010	0.00	79.38	Start of Test
4/16/2010	1376.00	77.98	1.8E-08
4/18/2010	4502.00	74.58	1.9E-08
4/19/2010	5845.00	72.98	1.8E-08
4/20/2010	7132.00	71.48	2.0E-08



Average Permeability: **2.E-08** **cm/sec**

Sample Data:	Initial		Final
Height, in	2.00		1.85
Diameter, in	1.92		1.97
Area, in2	2.90		3.06
Volume in3	5.79		5.64
Total Volume, cc	94.9		92.4
Volume Solids, cc	64.9		64.9
Volume Voids, cc	30.0		27.5
Void Ratio	0.5		0.4
Total Porosity, %	31.6		29.8
Air-Filled Porosity, %	0.2		0.0
Water-Filled Porosity,%	31.4		29.8
Saturation, %	99.5		100.0
Specific Gravity	2.75	Assumed	2.75
Wet Weight, gm	208.3		206.0
Dry Weight, gm	178.5		178.5
Tare, gm	0.00		0.00
Moisture, %	16.7		15.4
Dry Density, pcf	117.4		120.5

Remarks: The final dimensions and associated values are approximate due to slight slumping of the sample after the confining stress was removed.

Hydraulic Conductivity
ASTM D 5084
Method C: Falling Head Rising Tailwater

Job No:	385-059	**Boring:**	SA-SH-3	**Date:**	04/21/10
Client:	McCampbell Analytical Inc.	**Sample:**	1003897-006	**By:**	MD/PJ
Project:	2009-021	**Depth, ft.:**	1.5	**Remolded:**	

Visual Classification: Dark Gray Clayey SAND

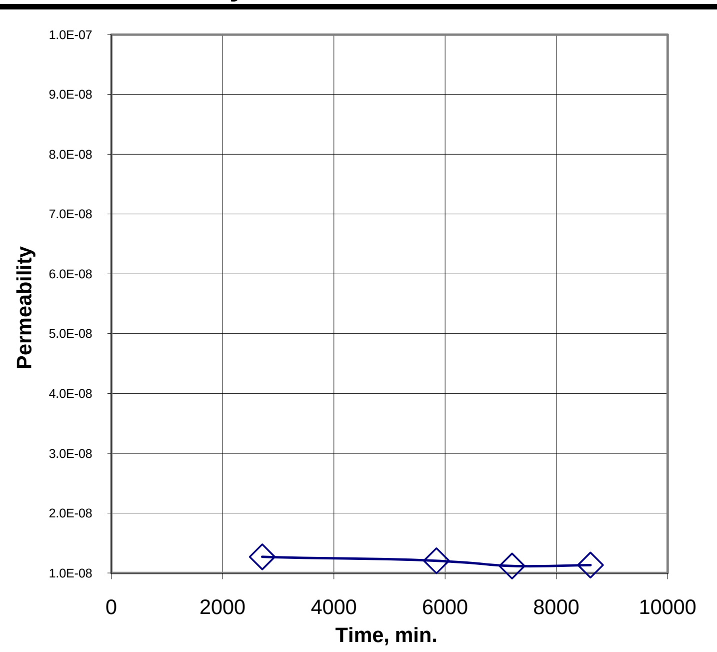
Max Sample Pressures, psi:

Cell:	Bottom	Top	Avg. Sigma3
53.5	49.5	47.5	5

B: = >0.95 **("B" is an indication of saturation)**

Max Hydraulic Gradient: = 42

Date	Minutes	Head, (in)	K,cm/sec
4/14/2010	0.00	79.38	Start of Test
4/16/2010	2713.00	77.58	1.3E-08
4/18/2010	5844.00	75.73	1.2E-08
4/19/2010	7203.00	74.98	1.1E-08
4/20/2010	8613.00	74.38	1.1E-08



Average Permeability: **1.E-08** **cm/sec**

Sample Data:	Initial		Final
Height, in	2.00		1.88
Diameter, in	1.92		1.91
Area, in2	2.90		2.85
Volume in3	5.79		5.36
Total Volume, cc	94.9		87.9
Volume Solids, cc	57.5		57.5
Volume Voids, cc	37.4		30.4
Void Ratio	0.6		0.5
Total Porosity, %	39.4		34.6
Air-Filled Porosity, %	0.7		0.1
Water-Filled Porosity,%	38.7		34.5
Saturation, %	98.3		99.8
Specific Gravity	2.75	Assumed	2.75
Wet Weight, gm	194.9		188.5
Dry Weight, gm	158.2		158.2
Tare, gm	0.00		0.00
Moisture, %	23.2		19.2
Dry Density, pcf	104.0		112.3

Remarks:

Hydraulic Conductivity
ASTM D 5084
Method C: Falling Head Rising Tailwater

Job No:	385-059	**Boring:**	SA-SH-3	**Date:**	04/21/10
Client:	McCampbell Analytical Inc.	**Sample:**	1003897-007	**By:**	MD/PJ
Project:	2009-021	**Depth, ft.:**	4.5	**Remolded:**	

Visual Classification: Dark Brown Clayey SAND

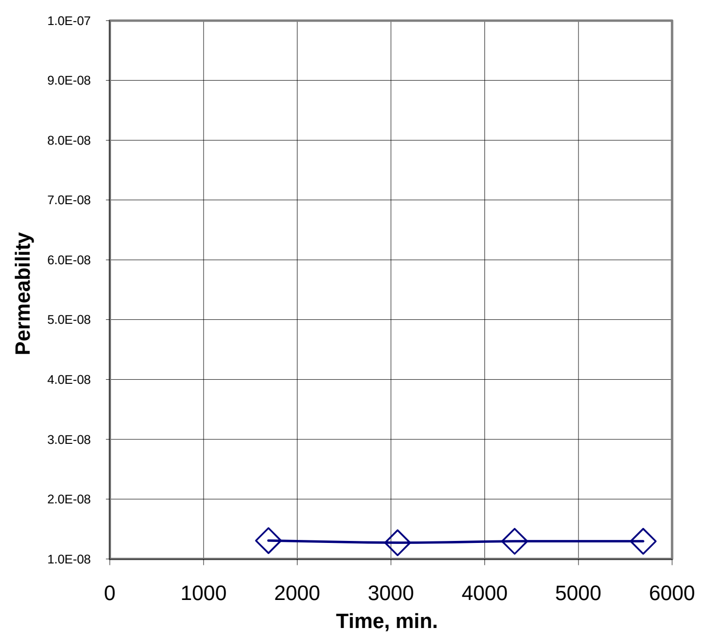
Max Sample Pressures, psi:

Cell:	Bottom	Top	Avg. Sigma3
74	70	68	5

B: = >0.95 **("B" is an indication of saturation)**

Max Hydraulic Gradient: = 36

Date	Minutes	Head, (in)	K,cm/sec
4/16/2010	0.00	70.38	**Start of Test**
4/17/2010	1692.00	69.38	1.3E-08
4/18/2010	3070.00	68.68	1.3E-08
4/19/2010	4319.00	67.78	1.3E-08
4/20/2010	5691.00	67.18	1.3E-08



Average Permeability: **1.E-08** **cm/sec**

Sample Data:	**Initial**		**Final**
Height, in	2.00		1.98
Diameter, in	1.92		1.90
Area, in2	2.90		2.83
Volume in3	5.79		5.59
Total Volume, cc	94.9		91.7
Volume Solids, cc	60.9		60.9
Volume Voids, cc	34.0		30.8
Void Ratio	0.6		0.5
Total Porosity, %	35.9		33.6
Air-Filled Porosity, %	0.1		0.1
Water-Filled Porosity,%	35.8		33.5
Saturation, %	99.7		99.8
Specific Gravity	2.75	Assumed	2.75
Wet Weight, gm	201.3		198.1
Dry Weight, gm	167.4		167.4
Tare, gm	0.00		0.00
Moisture, %	20.3		18.4
Dry Density, pcf	110.1		113.9

Remarks: The final dimensions and associated values are approximate due to slight slumping of the sample after the confining stress was removed.

Hydraulic Conductivity
ASTM D 5084
Method C: Falling Head Rising Tailwater

Job No:	385-059	**Boring:**	SA-SH-0	**Date:**	04/21/10
Client:	McCampbell Analytical Inc.	**Sample:**	1003897-008	**By:**	MD/PJ
Project:	2009-021	**Depth, ft.:**	1.0	**Remolded:**	

Visual Classification: Dark Gray Clayey SAND w/ Gravel

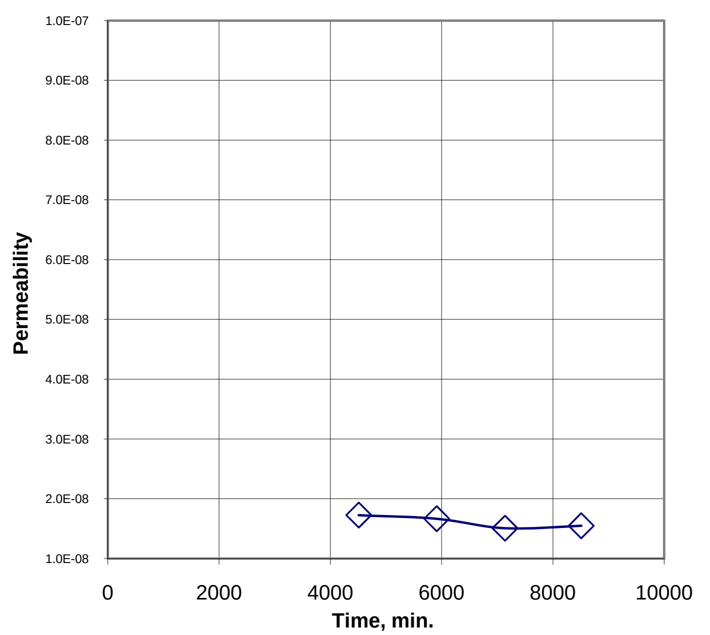
Max Sample Pressures, psi:

Cell:	Bottom	Top	Avg. Sigma3
44	40	38	5

B: = >0.95 **("B" is an indication of saturation)**

Max Hydraulic Gradient: = 36

Date	Minutes	Head, (in)	K,cm/sec
4/14/2010	0.00	70.38	**Start of Test**
4/17/2010	4510.00	66.93	1.7E-08
4/18/2010	5911.00	66.18	1.7E-08
4/19/2010	7139.00	65.48	1.5E-08
4/20/2010	8510.00	64.78	1.5E-08



Average Permeability: **2.E-08** **cm/sec**

Sample Data:	**Initial**		**Final**
Height, in	2.00		1.98
Diameter, in	1.92		1.90
Area, in2	2.90		2.84
Volume in3	5.79		5.61
Total Volume, cc	94.9		92.0
Volume Solids, cc	58.9		58.9
Volume Voids, cc	36.0		33.1
Void Ratio	0.6		0.6
Total Porosity, %	37.9		36.0
Air-Filled Porosity, %	4.8		0.9
Water-Filled Porosity,%	33.2		35.1
Saturation, %	87.5		97.5
Specific Gravity	2.70	Assumed	2.70
Wet Weight, gm	190.5		191.3
Dry Weight, gm	159.0		159.0
Tare, gm	0.00		0.00
Moisture, %	19.8		20.3
Dry Density, pcf	104.6		107.9

Remarks: The measured diameter and associated values are approximate due some voids on the side of the sample.

Hydraulic Conductivity

ASTM D 5084

Method C: Falling Head Rising Tailwater

Job No:	385-059	**Boring:**	SA-SH-0	**Date:**	04/20/10
Client:	McCampbell Analytical	**Sample:**	1003897-009	**By:**	MD/PJ
Project:	2009-021	**Depth, ft.:**	5.0	**Remolded:**	

Visual Classification: Dark Brown Sandy CLAY

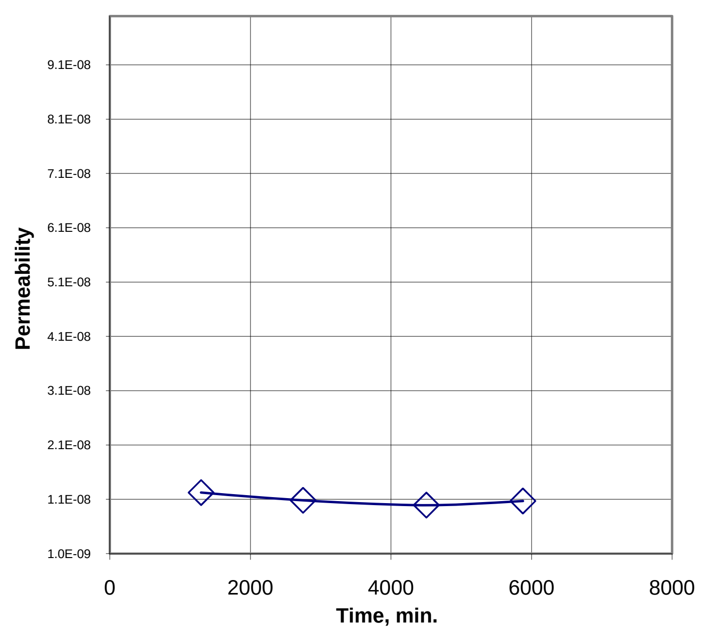
Max Sample Pressures, psi:

Cell:	Bottom	Top	Avg. Sigma3
54	50	48	5

B: = >0.95 **("B" is an indication of saturation)**

Max Hydraulic Gradient: = 36

Date	Minutes	Head, (in)	K,cm/sec
4/14/2010	0.00	70.38	Start of Test
4/15/2010	1298.00	69.68	1.2E-08
4/16/2010	2749.00	69.08	1.1E-08
4/17/2010	4503.00	68.38	9.9E-09
4/18/2010	5877.00	67.68	1.1E-08

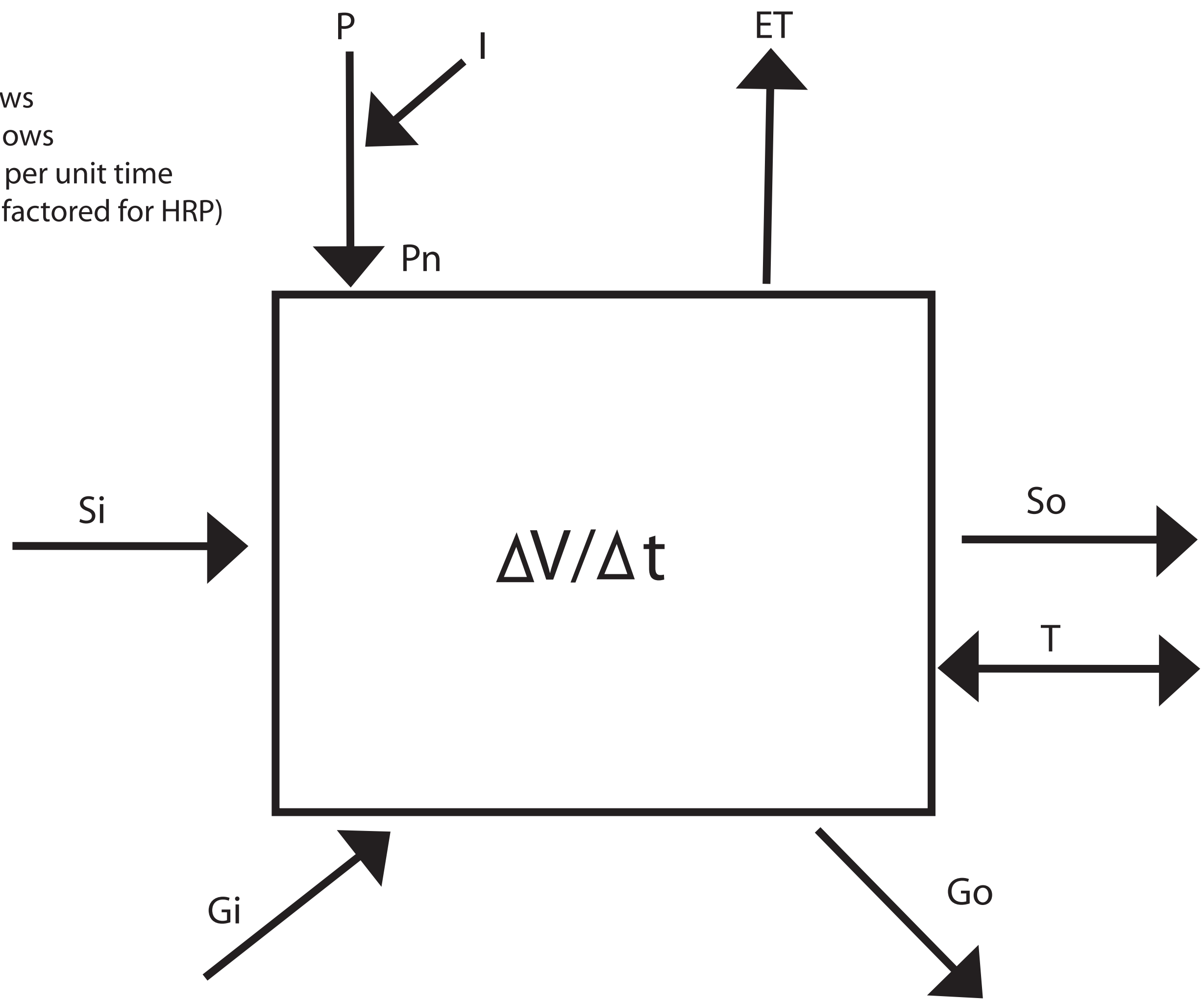


Average Permeability: **1.E-08** **cm/sec**

Sample Data:	Initial		Final
Height, in	2.00		1.96
Diameter, in	1.92		1.89
Area, in2	2.90		2.81
Volume in3	5.79		5.50
Total Volume, cc	94.9		90.1
Volume Solids, cc	56.7		56.7
Volume Voids, cc	38.2		33.4
Void Ratio	0.7		0.6
Total Porosity, %	40.2		37.0
Air-Filled Porosity, %	1.6		0.6
Water-Filled Porosity,%	38.6		36.5
Saturation, %	96.0		98.4
Specific Gravity	2.80	Assumed	2.80
Wet Weight, gm	195.5		191.7
Dry Weight, gm	158.9		158.9
Tare, gm	0.00		0.00
Moisture, %	23.1		20.7
Dry Density, pcf	104.5		110.0

Remarks:

P	Precipitation
ET	Evapotranspiration
I	Inception
Pn	Net Precipitation
Si	Surface inflows
So	Surface outflows
Gi	Groundwater inflows
Go	Groundwater outflows
V/t	Change in storage per unit time
T	tide or sieche (not factored for HRP)



Generalized Water Budget (from Mitsch & Gosselink, 2007)

Appendix B – Soil Survey & Watershed Data

Vegetation Map

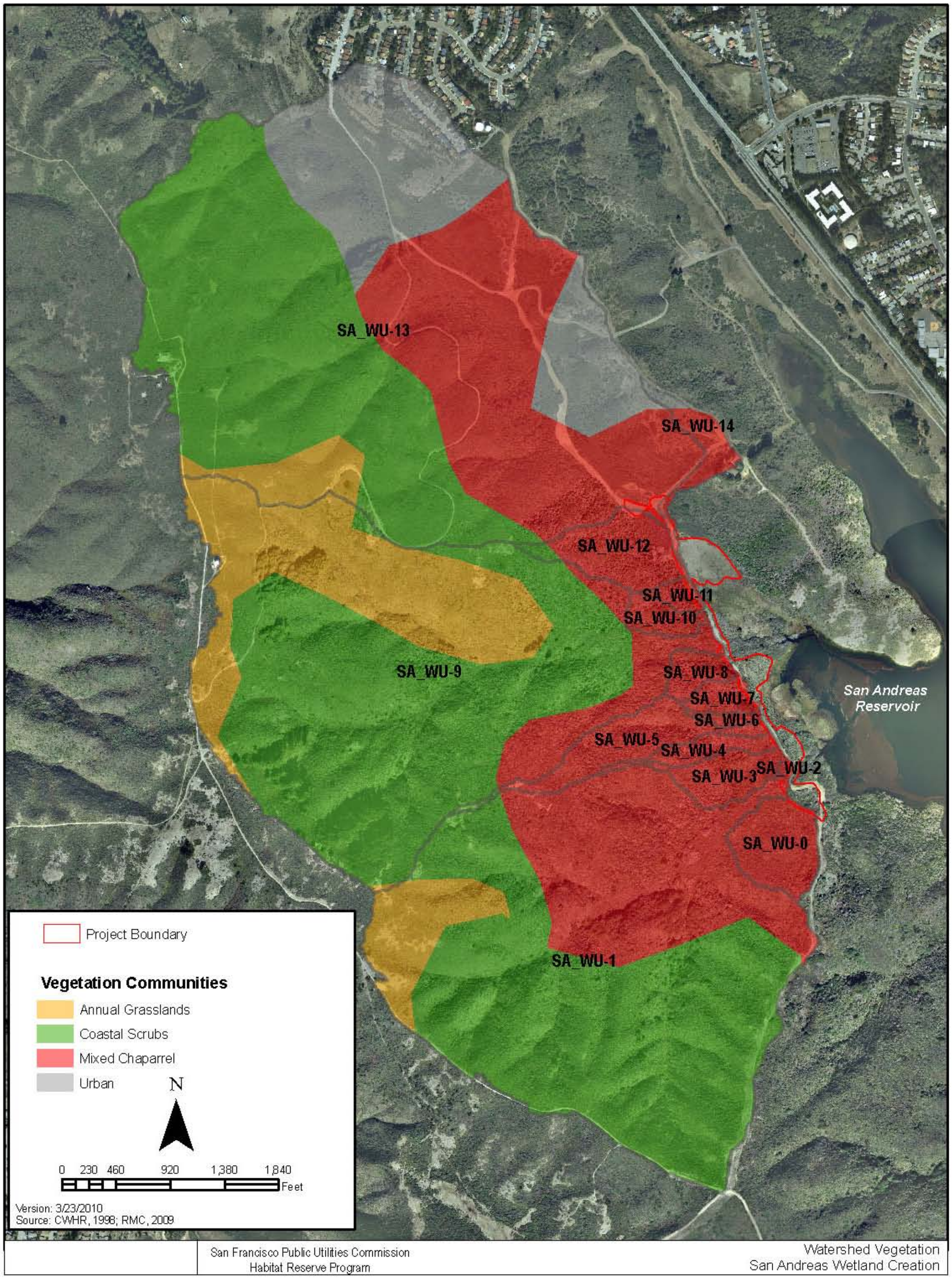
Soil Survey Map

Watershed Input Data

Physical Soil Properties

RUSLE2 Related Attributes

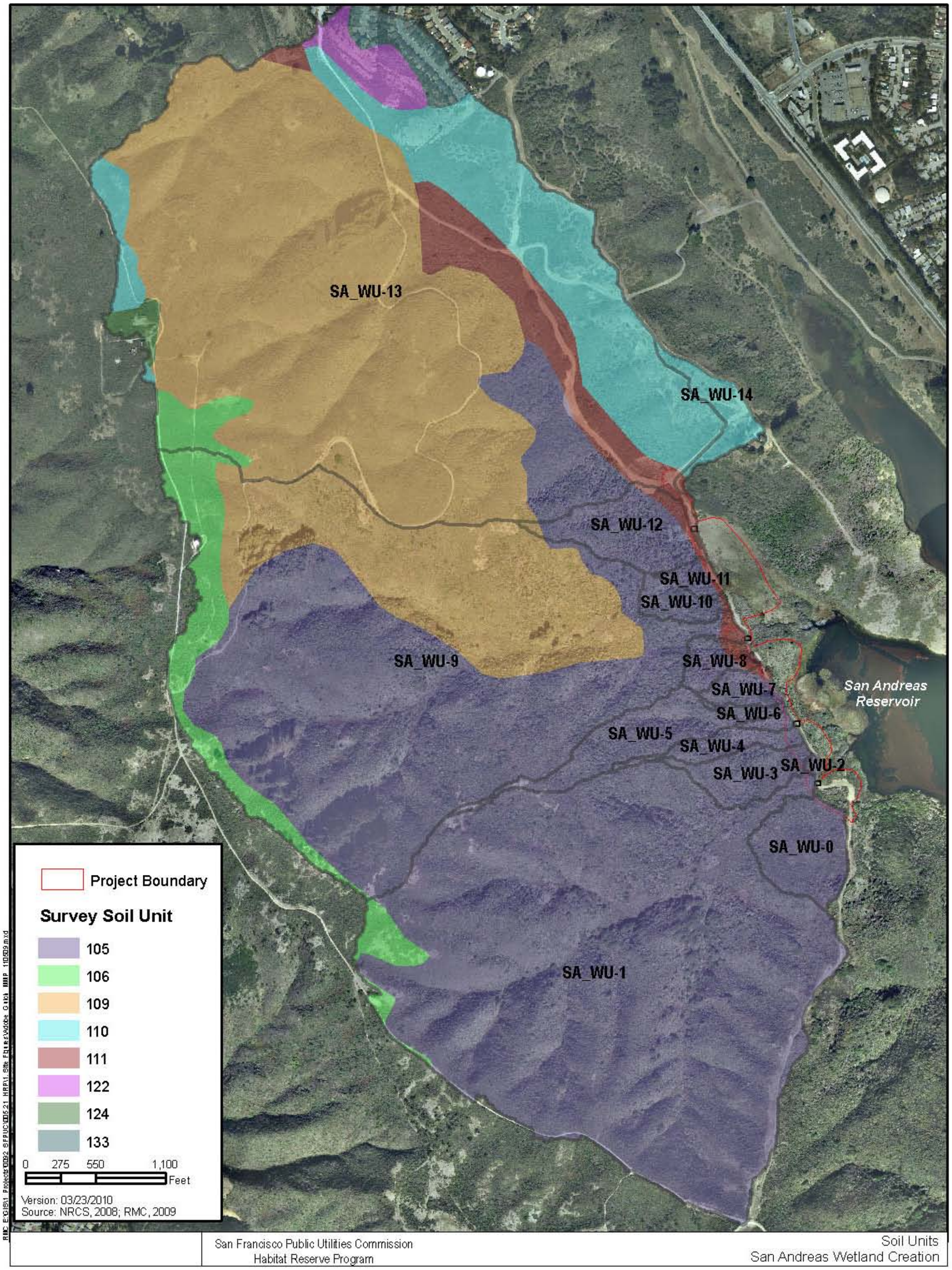
Vegetation Types



Footnotes:

a. Based on California Department of Fish and Game's California Wildlife Habitat Relationships Map, 1998.

Soil Map Units



Footnotes:

b. Based on Soil survey data produced by the Natural Resources Conservation District (NRCS) for San Mateo County, Eastern Part, and San Francisco County, California (CA689, 2008).

RUSLE2 Related Attributes

San Mateo County, Eastern Part, and San Francisco County, California

[. This report shows only the major soils in each map unit]

Map symbol and soil name	Depth	Sand	Silt	Clay	Moist bulk density	Saturated hydraulic conductivity	Available water capacity	Linear extensi-bility	Organic matter	Erosion factors			Wind erodi-bility group	Wind erodi-bility index
										Kw	Kf	T		
	In	*Pct*	*Pct*	*Pct*	*g/cc*	*micro m/sec*	*In/In*	*Pct*	*Pct*					
105:														
Barnabe	0-7	---	---	12-20	1.50-1.60	14.00-42.00	0.06-0.08	0.0-2.9	1.0-3.0	.10	.28	1	5	56
	7-12	---	---	15-27	1.50-1.60	4.00-14.00	0.07-0.10	0.0-2.9	1.0-2.0	.15	.32			
	12-16	---	---	---	---	---	---	---	---	---	---			
Candlestick	0-2	---	---	15-20	1.50-1.60	4.00-14.00	0.12-0.14	0.0-2.9	1.0-3.0	.24	.28	2	3	86
	2-20	---	---	18-25	1.45-1.55	4.00-14.00	0.14-0.16	0.0-2.9	1.0-2.0	.24	.28			
	20-24	---	---	27-30	1.45-1.55	1.40-4.00	0.14-0.18	3.0-5.9	0.0-0.5	.20	.24			
	24-28	---	---	---	---	---	---	---	---	---	---			
106:														
Barnabe	0-7	---	---	12-20	1.50-1.60	14.00-42.00	0.06-0.08	0.0-2.9	1.0-3.0	.10	.28	1	5	56
	7-12	---	---	15-27	1.45-1.55	4.00-14.00	0.07-0.10	0.0-2.9	1.0-2.0	.15	.32			
	12-16	---	---	---	---	---	---	---	---	---	---			
Rock outrock	0-60	---	---	---	---	0.00-0.01	---	---	---	---	---	---	---	---
109:														
Candlestick	0-2	---	---	15-20	1.50-1.60	4.00-14.00	0.12-0.14	0.0-2.9	1.0-3.0	.24	.28	2	3	86
	2-20	---	---	18-25	1.45-1.55	4.00-14.00	0.14-0.16	0.0-2.9	1.0-2.0	.24	.28			
	20-24	---	---	27-30	1.45-1.55	1.40-4.00	0.14-0.18	3.0-5.9	0.0-0.5	.20	.24			
	24-28	---	---	---	---	---	---	---	---	---	---			
Barnabe	0-7	---	---	12-20	1.50-1.60	14.00-42.00	0.06-0.08	0.0-2.9	1.0-3.0	.10	.28	1	5	56
	7-12	---	---	15-27	1.45-1.55	4.00-14.00	0.07-0.10	0.0-2.9	1.0-2.0	.15	.32			
	12-16	---	---	---	---	---	---	---	---	---	---			

RUSLE2 Related Attributes

San Mateo County, Eastern Part, and San Francisco County, California

Map symbol and soil name	Depth	Sand	Silt	Clay	Moist bulk density	Saturated hydraulic conductivity	Available water capacity	Linear extensi-bility	Organic matter	Erosion factors			Wind erodi-bility group	Wind erodi-bility index
										Kw	Kf	T		
	In	*Pct*	*Pct*	*Pct*	*g/cc*	*micro m/sec*	*In/In*	*Pct*	*Pct*					
110:														
Candlestick	0-2	---	---	15-20	1.50-1.60	4.00-14.00	0.12-0.14	0.0-2.9	1.0-3.0	.24	.28	2	3	86
	2-20	---	---	18-25	1.45-1.55	4.00-14.00	0.14-0.16	0.0-2.9	1.0-2.0	.24	.28			
	20-24	---	---	27-30	1.45-1.55	1.40-4.00	0.14-0.18	3.0-5.9	0.0-0.5	.20	.24			
	24-28	---	---	---	---	---	---	---	---	---	---			
Kron	0-3	---	---	15-20	1.50-1.60	14.00-42.00	0.11-0.13	0.0-2.9	1.0-5.0	.24	.28	1	3	86
	3-14	---	---	15-20	1.45-1.55	4.00-14.00	0.14-0.16	0.0-2.9	1.0-2.0	.49	.55			
	14-18	---	---	---	---	---	---	---	---	---	---			
Buriburi	0-30	---	---	18-27	1.45-1.55	4.00-14.00	0.10-0.14	0.0-2.9	1.0-3.0	.15	.28	2	7	38
	30-34	---	---	---	---	---	---	---	---	---	---			
111:														
Candlestick variant	0-21	---	---	18-27	1.45-1.55	4.00-14.00	0.12-0.15	0.0-2.9	1.0-3.0	.28	.32	5	6	48
	21-65	---	---	27-35	1.40-1.50	1.40-4.00	0.15-0.18	3.0-5.9	0.0-0.5	.24	.28			
115:														
Los Gatos	0-22	---	---	20-25	1.45-1.55	4.00-14.00	0.14-0.16	0.0-2.9	1.0-4.0	.28	.32	2	6	48
	22-36	---	---	25-35	1.45-1.55	1.40-4.00	0.14-0.20	3.0-5.9	0.0-0.5	.32	.37			
	36-40	---	---	---	---	---	---	---	---	---	---			
122:														
Orthents	0-60	---	---	---	1.45-1.55	---	0.00	---	0.0-0.5	---	---	5	3	86
124:														
Orthents	0-60	---	---	---	1.45-1.55	---	0.00	---	0.0-0.5	---	---	5	3	86
Urban land	0-6	---	---	---	---	0.00-0.01	---	---	---	---	---	---	---	---
133:														
Urban land	0-6	---	---	---	---	0.00-0.01	---	---	---	---	---	---	---	---

RUSLE2 Related Attributes

San Mateo County, Eastern Part, and San Francisco County, California

Map symbol and soil name	Depth	Sand	Silt	Clay	Moist bulk density	Saturated hydraulic conductivity	Available water capacity	Linear extensi-bility	Organic matter	Erosion factors			Wind erodi-bility group	Wind erodi-bility index
										Kw	Kf	T		
	In	*Pct*	*Pct*	*Pct*	*g/cc*	*micro m/sec*	*In/In*	*Pct*	*Pct*					
133:														
Orthents	0-60	---	---	---	1.45-1.55	---	0.00	---	0.0-0.5	---	---	5	3	86

San Mateo County, Eastern Part, and San Francisco County, California

[This report shows only the major soils in each map unit]

Map symbol and soil name	Pct. of map unit	Hydrologic group	Kf	T factor	Representative value		
					% Sand	% Silt	% Clay
105:							
Barnabe	45	D	.28	1	65.1	18.9	16.0
Candlestick	35	C	.28	2	63.1	19.4	17.5
106:							
Barnabe	40	D	.28	1	65.1	18.9	16.0
Rock outrock	40	D	---	---	---	---	---
109:							
Candlestick	45	C	.28	2	63.1	19.4	17.5
Barnabe	25	D	.28	1	65.1	18.9	16.0
110:							
Candlestick	40	C	.28	2	68.1	14.4	17.5
Kron	25	D	.28	1	67.2	15.3	17.5
Buriburi	20	C	.28	2	39.8	37.7	22.5
111:							
Candlestick variant	85	B	.32	5	39.8	37.7	22.5
115:							
Los Gatos	85	C	.32	2	39.8	37.7	22.5
122:							
Orthents	85	D	---	5	---	---	---
124:							
Orthents	50	D	---	5	---	---	---
Urban land	35	D	---	---	---	---	---
133:							
Urban land	50	D	---	---	---	---	---
Orthents	40	C	---	5	---	---	---

San Andreas

	Watershed Area	Routing
SA_WU_0	11.18	South wetland
SA_WU_1	203.7	Southern culvert to SA Reservoir
SA_WU_2	0.4	Sheet flow over road to SA reservoir
SA_WU_3	7.33	Sheet flow over road to SA reservoir
SA_WU_4	4.26	Sheet flow over road to SA reservoir
SA_WU_5	12.84	Sheet flow over road to SA reservoir
SA_WU_6	1.3	Sheet flow over road to SA reservoir
SA_WU_7	3.4	Sheet flow over road to SA reservoir
SA_WU_8	3.9	Sheet flow over road to SA reservoir
SA_WU_9	201.8	North culvert to SA Reservoir
SA_WU_10	3.84	south of proposed North Wetland (into existing wetland)
SA_WU_11	2.1	south of proposed North Wetland (into existing wetland
SA_WU_12	12.6	south of proposed North Wetland (into existing wetland
SA_WU_13	299.3	North Wetland (proposed site) & culvert split flow
SA_WU_14	5.8	North Wetland (proposed site) & North culvert split flow

Slope

	min	max	mean	SD	0-5%	5-10%	10-20%	>20%
SA_WU_0	0.06	28.13	8.87	4.48	25%	42%	33%	0%
SA_WU_1	0.00	59.08	15.30	7.56	4%	72%	17%	7%
SA_WU_2	0.00	13.05	3.39	2.24	83%	17%	0%	0%
SA_WU_3	0.00	29.55	5.64	3.54	55%	37%	8%	0%
SA_WU_4	0.00	20.69	6.56	3.66	43%	44%	13%	0%
SA_WU_5	0.06	46.53	8.74	4.65	27%	46%	27%	1%
SA_WU_6	0.12	19.68	5.33	2.81	58%	38%	4%	0%
SA_WU_7	0.08	22.04	5.79	2.64	47%	49%	3%	0%
SA_WU_8	0.06	28.52	7.23	4.84	44%	32%	24%	0%
SA_WU_9	0.00	70.50	14.01	7.15	13%	24%	50%	14%
SA_WU_10	0.00	30.96	6.81	5.42	53%	21%	25%	1%
SA_WU_11	0.00	21.97	6.37	4.12	46%	40%	14%	0%
SA_WU_12	0.00	30.88	8.57	4.31	25%	46%	29%	0%
SA_WU_13	0.00	86.42	12.73	7.39	18%	27%	43%	12%
SA_WU_14	0.00	27.62	6.79	4.55	45%	39%	14%	1%

Vegetation

	Acres	Type
SA_WU_0	11.2	MCH
SA_WU_1	63.7	MCH
SA_WU_1	15.1	CSC
SA_WU_1	16.6	AGS
SA_WU_1	108.3	CSC
SA_WU_2	0.4	CSC
SA_WU_3	7.3	MCH
SA_WU_4	4.26	MCH
SA_WU_5	12.4	MCH
SA_WU_5	0.4	MCH
SA_WU_6	1.24	MCH
SA_WU_7	3.4	MCH
SA_WU_8	3.9	MCH
SA_WU_9	16.8	MCH
SA_WU_9	124.5	CSC
SA_WU_9	60.5	AGS
SA_WU_10	3.8	MCH
SA_WU_11	2.1	MCH
SA_WU_12	11.7	CSC
SA_WU_12	0.9	CSC
SA_WU_13	68.2	URB
SA_WU_13	91.5	MCH
SA_WU_13	128.8	CSC
SA_WU_13	10.8	AGS
SA_WU_14	1	URB
SA_WU_14	4.8	MCH

Soils

	Unit	Acres	% Hydrologic Group B	C	D
SA_WU_0	105	11.2	0	35	45
SA_WU_1	105	199	0	35	45
SA_WU_1	106	4.74	0	0	80
SA_WU_1	111	0.11	85	0	0
SA_WU_2	105	0.4	0	35	45
SA_WU_2	105	0.003	0	35	45
SA_WU_3	105	7.3	0	35	45
SA_WU_4	105	4.3	0	35	45
SA_WU_5	105	12.8	0	35	45
SA_WU_6	105	1.25	0	35	45
SA_WU_7	111	0.26	85	0	0
SA_WU_7	105	3.1	0	35	45
SA_WU_8	111	1	85	0	0
SA_WU_8	105	2.9	0	35	45
SA_WU_9	109	61	0	45	25
SA_WU_9	111	0.8	85	0	0
SA_WU_9	105	121.3	0	35	45
SA_WU_9	106	18.7	0	0	80
SA_WU_10	105	3.7	0	35	45
SA_WU_10	111	0.4	85	0	0
SA_WU_11	105	1.7	0	35	45
SA_WU_11	109	0.3	0	45	25
SA_WU_12	111	1.4	85	0	0
SA_WU_12	105	10.9	0	35	45
SA_WU_12	111	1.1	85	0	0
SA_WU_13	105	15.9	0	35	45
SA_WU_13	106	5.8	0	0	80
SA_WU_13	109	179.7	0	45	25
SA_WU_13	110	53.1	0	60	25
SA_WU_13	110	5.4	0	60	25
SA_WU_13	111	1.1	85	0	0
SA_WU_13	111	21.1	85	0	0
SA_WU_13	122	7.3	0	0	85
SA_WU_13	124	2.6	0	0	85
SA_WU_13	133	7.3	0	40	50
SA_WU_14	111	0.21	85	0	0
SA_WU_14	110	5.6	0	60	25

Appendix C – Rational Method Supporting Data

Department of Transporation Figure 816.6 – Velocities for Upland Method of Estimating Travel Time for Shallow Concentrated Flow

Department of Transporation Figure 819.2A – Runoff Coefficients for Undeveloped Areas

Santa Clara Drainage Manual TDS Parameters Watershed Input Data

Figure 816.6

Velocities for Upland Method of Estimating Travel Time for Shallow Concentrated Flow

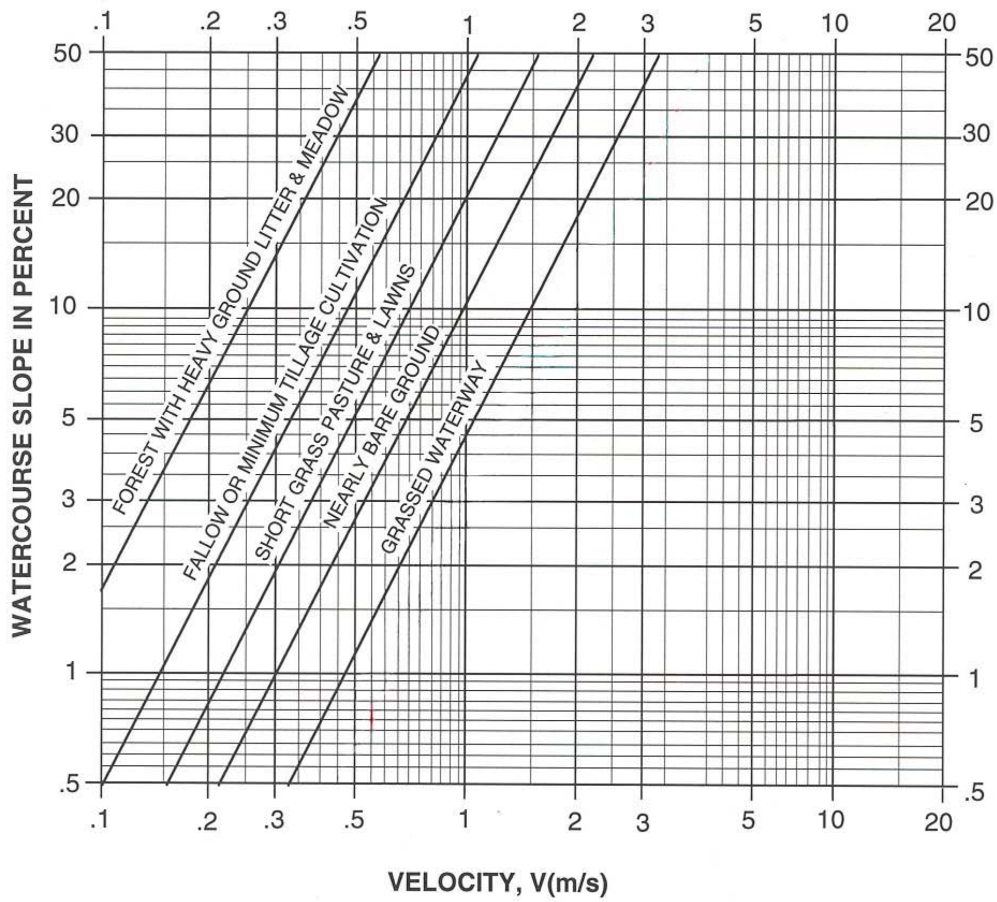


Figure 819.2A

Runoff Coefficients for Undeveloped Areas

Watershed Types

	Extreme	High	Normal	Low
Relief	.28 -.35 Steep, rugged terrain with average slopes above 30%	.20 -.28 Hilly, with average slopes of 10 to 30%	.14 -.20 Rolling, with average slopes of 5 to 10%	.08 -.14 Relatively flat land, with average slopes of 0 to 5%
Soil Infiltration	.12 -.16 No effective soil cover, either rock or thin soil mantle of negligible infiltration capacity	.08 -.12 Slow to take up water, clay or shallow loam soils of low infiltration capacity, imperfectly or poorly drained	.06 -.08 Normal; well drained light or medium textured soils, sandy loams, silt and silt loams	.04 -.06 High; deep sand or other soil that takes up water readily, very light well drained soils
Vegetal Cover	.12 -.16 No effective plant cover, bare or very sparse cover	.08 -.12 Poor to fair; clean cultivation crops, or poor natural cover, less than 20% of drainage area over good cover	.06 -.08 Fair to good; about 50% of area in good grassland or woodland, not more than 50% of area in cultivated crops	.04 -.06 Good to excellent; about 90% of drainage area in good grassland, woodland or equivalent cover
Surface Storage	.10 -.12 Negligible surface depression few and shallow; drainageways steep and small, no marshes	.08 -.10 Low; well defined system of small drainageways; no ponds or marshes	.06 -.08 Normal; considerable surface depression storage; lakes and pond marshes	.04 -.06 High; surface storage, high; drainage system not sharply defined; large flood plain storage or large number of ponds or marshes

Given: An undeveloped watershed consisting of;
1) rolling terrain with average slopes of 5%,
2) clay type soils,
3) good grassland area, and
4) normal surface depressions.

Solution:

Relief	0.14
Soil Infiltration	0.08
Vegetal Cover	0.04
Surface Storage	<u>0.06</u>
C=	0.32

Find: The runoff coefficient, C, for the above watershed.

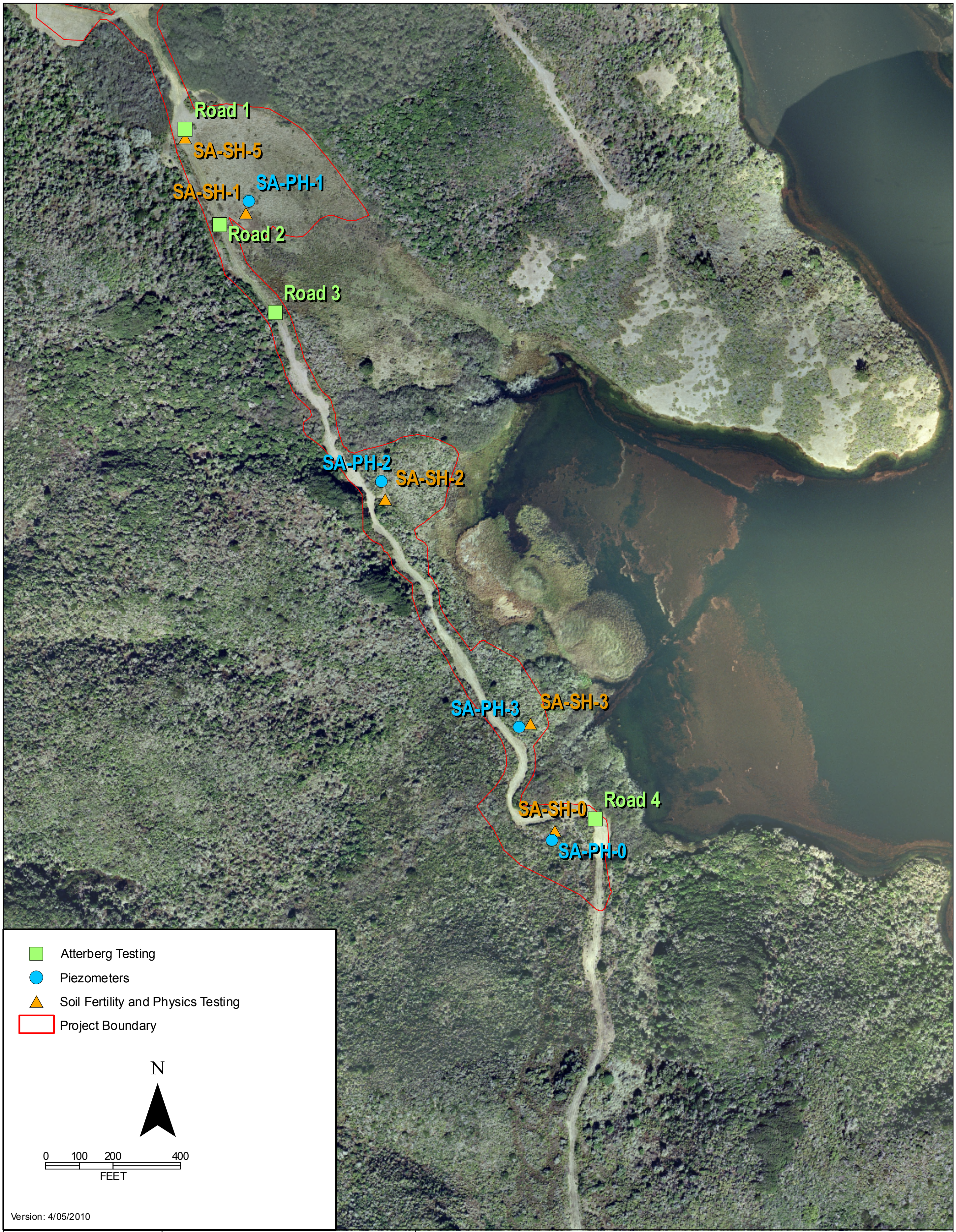
Table B-1: Parameters $A_{T,D}$ and $B_{T,D}$ for TDS Equation

2-YR RETURN PERIOD		
5-min	0.120194	0.001385
10-min	0.166507	0.001956
15-min	0.176618	0.003181
30-min	0.212497	0.005950
1-hr	0.253885	0.010792
2-hr	0.330848	0.019418
3-hr	0.374053	0.027327
6-hr	0.425178	0.045735
12-hr	0.409397	0.069267
24-hr	0.314185	0.096343
48-hr	0.444080	0.134537
72-hr	0.447104	0.159461
5-YR RETURN PERIOD		
5-min	0.170347	0.001857
10-min	0.228482	0.002758
15-min	0.250029	0.004036
30-min	0.307588	0.007082
1-hr	0.357109	0.013400
2-hr	0.451840	0.024242
3-hr	0.512583	0.034359
6-hr	0.554937	0.060859
12-hr	0.562227	0.094871
24-hr	0.474528	0.136056
48-hr	0.692427	0.187173
72-hr	0.673277	0.224003
10-YR RETURN PERIOD		
5-min	0.201876	0.002063
10-min	0.258682	0.003569
15-min	0.294808	0.004710
30-min	0.367861	0.007879
1-hr	0.427723	0.014802
2-hr	0.522608	0.027457
3-hr	0.591660	0.038944
6-hr	0.625054	0.070715
12-hr	0.641638	0.111660
24-hr	0.567017	0.162550
48-hr	0.832445	0.221820
72-hr	0.810509	0.265469

Table B-2: Parameters $A_{T,D}$ and $B_{T,D}$ for TDS Equation

Return Period/Duration	$A_{T,D}$	$B_{T,D}$
25-YR RETURN PERIOD		
5-min	0.230641	0.002691
10-min	0.287566	0.004930
15-min	0.348021	0.005594
30-min	0.443761	0.008719
1-hr	0.508791	0.016680
2-hr	0.612629	0.031025
3-hr	0.689252	0.044264
6-hr	0.693566	0.083195
12-hr	0.725892	0.132326
24-hr	0.675008	0.195496
48-hr	0.989588	0.264703
72-hr	0.967854	0.316424
50-YR RETURN PERIOD		
5-min	0.249324	0.003241
10-min	0.300971	0.006161
15-min	0.384016	0.006315
30-min	0.496301	0.009417
1-hr	0.568345	0.017953
2-hr	0.672662	0.033694
3-hr	0.754661	0.048157
6-hr	0.740666	0.092105
12-hr	0.779967	0.147303
24-hr	0.747121	0.219673
48-hr	1.108358	0.295510
72-hr	1.075643	0.353143
100-YR RETURN PERIOD		
5-min	0.269993	0.003580
10-min	0.315263	0.007312
15-min	0.421360	0.006957
30-min	0.553934	0.009857
1-hr	0.626608	0.019201
2-hr	0.732944	0.036193
3-hr	0.816471	0.051981
6-hr	0.776677	0.101053
12-hr	0.821859	0.162184
24-hr	0.814046	0.243391
48-hr	1.210895	0.325943
72-hr	1.175000	0.389038

APPENDIX B.
SOILS DATA



San Francisco Public Utilities Commission
Habitat Reserve Program

San Andreas Reservoir Wetland Creation Geotechnical Investigation

TABLE 1
RESULTS OF CHEMICAL ANALYSES ON SOIL SAMPLES
SAN ANDREAS WETLANDS CREATION
SAN FRANCISCO PUBLIC UTILITIES COMMISSION - HABITAT RESTORATION PROJECT

Analyses			Inorganic Anions						Specific Conductivity
Parameter			Bromide	Chloride	Nitrate as N	Nitrate as NO3	Nitrite as N	Sulfate	Specific Conductivity
Unit			mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	25 µmhos/cm
Soil Boring ID	Soil Sample Depth	Stratigraphic Unit							
			Northern Quadrant						
SA-SH-1	0.5'-1.0'		<10	<10	<10	<45	<10	**10**	**165.0**
SA-SH-1	3.5'-4.0'		<10	<10	<10	<45	<10	<10	**75.2**
			North Central Polygon						
SA-SH-2	1.75'-2.4'		<10	<10	<10	<45	<10	**12**	**56.6**
SA-SH-2	7.0'-7.5'		<10	<10	<10	<45	<10	**17**	**65.2**
			South Central Polygon						
SA-SH-3	1.5'-2.0'		<10	**12**	<10	<45	<10	<10	**48**
SA-SH-3	4.5'-5.0'		<10	<10	<10	<45	<10	<10	**53**
			Southern Quadrant						
SA-SH-0	1.0'-1.5'		<10	<10	<10	<45	<10	<10	**38.8**

Notes:

TABLE 1
RESULTS OF CHEMICAL ANALYSES ON SOIL SAMPLES
SAN ANDREAS WETLANDS CREATION
SAN FRACISCO PUBLIC UTILITES COMMISSION - HABITAT RESERVE PROJECT

Analyses			Total & Speciated Alkalinity as Calcium Carbonate				Total Nitrogen	Total Organic Carbon	pH
Parameter			Total	Carbonate	Bicarbonate	Hydroxide	Total Nitrogen	TOC	pH
Unit			mg CaCo3/kg	mg CaCo3/kg	mg CaCo3/kg	mg CaCo3/kg	mg/Kg	mg/Kg	
Soil Boring ID	Soil Sample Depth	Stratigraphic Unit							
			Northern Quadrant						
SA-SH-1	0.5'-1.0'		4160	<1.0	4160	<1.0	2700	21,000	7.01
SA-SH-1	3.5'-4.0'		2500	<1.0	2500	<1.0	1300	6900	7.67
			North Central Polygon						
SA-SH-2	1.75'-2.4'		1930	<1.0	1930	<1.0	1600	10,000	7.24
SA-SH-2	7.0'-7.5'		1050	<1.0	1050	<1.0	740	1900	7.15
			South Central Polygon						
SA-SH-3	1.5'-2.0'		1650	<1.0	1650	<1.0	1400	8500	7.11
SA-SH-3	4.5'-5.0'		1490	<1.0	1490	<1.0	840	5300	7.41
			Southern Quadrant						
SA-SH-0	1.0'-1.5'		1640	<1.0	1640	<1.0	1600	13,000	7.01

Notes:

TABLE 1
RESULTS OF CHEMICAL ANALYSES ON SOIL SAMPLES
SAN ANDREAS WETLANDS CREATION
SAN FRACISCO PUBLIC UTILITES COMMISSION - HABITAT RESERVE PROJECT

Analyses			ICP Metals						Boron	Sulfur
Parameter			Calcium	Iron	Magnesium	Manganese	Potassium	Sodium	Boron	Sulfur
Unit			mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg
Soil Boring ID	Soil Sample Depth	Stratigraphic Unit								
			Northern Quadrant							
SA-SH-1	0.5'-1.0'		7500	31,000	11,000	310	2000	200	21	440
SA-SH-1	3.5'-4.0'		7400	38,000	14,000	770	1900	180	21	170
			North Central Polygon							
SA-SH-2	1.75'-2.4'		3500	28,000	9300	370	3000	<150	18	160
SA-SH-2	7.0'-7.5'		2700	38,000	11,000	570	2400	<150	20	37
			South Central Polygon							
SA-SH-3	1.5'-2.0'		6000	34,000	15,000	580	2300	<150	21	120
SA-SH-3	4.5'-5.0'		5400	31,000	10,000	380	2200	<150	18	79
			Southern Quadrant							
SA-SH-0	1.0'-1.5'		4800	34,000	11,000	630	2500	<150	20	150

Notes:

TABLE 1
RESULTS OF CHEMICAL ANALYSES ON SOIL SAMPLES
SAN ANDREAS WETLANDS CREATION
SAN FRACISCO PUBLIC UTILITES COMMISSION - HABITAT RESERVE PROJECT

Analyses			Metals		Cation Exchange Capacity as Sodium	Total Phosphorous as P
Parameter			Copper	Zinc	CEC as Sodium	Total Phosphorous as P
Unit			mg/Kg	mg/Kg	meq/g	mg/Kg
Soil Boring ID	Soil Sample Depth	Stratigraphic Unit				
			Northern Quadrant			
SA-SH-1	0.5'-1.0'		31	61	0.52	110
SA-SH-1	3.5'-4.0'		40	76	0.36	140
			North Central Polygon			
SA-SH-2	1.75'-2.4'		26	58	0.35	210
SA-SH-2	7.0'-7.5'		25	63	0.24	120
			South Central Polygon			
SA-SH-3	1.5'-2.0'		27	56	0.3	95
SA-SH-3	4.5'-5.0'		24	51	0.3	110
			Southern Quadrant			
SA-SH-0	1.0'-1.5'		25	58	0.33	110

Notes:

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AEW Engineering, Inc. 55 New Montgomery St, Ste 722 San Francisco, CA 94105	Client Project ID: #2009-021; SFPUC Habitat Restoration	Date Sampled: 03/25/10-03/26/10
		Date Received: 03/31/10
	Client Contact: Randall Young	Date Extracted: 03/31/10-04/02/10
	Client P.O.:	Date Analyzed: 04/03/10-04/06/10

Inorganic Anions by IC*

Extraction Method: CA Title 22 modified (DISTLC) Analytical Method: E300.0 Work Order: 1003897

Lab ID	1003897-001A	1003897-002A	1003897-004A	1003897-005A	Reporting Limit for DF =1	
Client ID	SA-SH-1-0.5'	SA-SH-1-3.5'	SA-SH-2-1.75'	SA-SH-2-7.0'		
Matrix	Soil	Soil	Soil	Soil		
DF	1	1	1	1		
Extraction Type	DI WET	DI WET	DI WET	DI WET	S	W
Compound	**Concentration**				mg/kg	µg/L
Bromide	ND	ND	ND	ND	10	NA
Chloride	ND	ND	ND	ND	10	NA
Nitrate as N	ND	ND	ND	ND	10	NA
Nitrate as NO3¯	ND	ND	ND	ND	45	NA
Nitrite as N	ND	ND	ND	ND	10	NA
Sulfate	10	ND	12	17	10	NA
Surrogate Recoveries (%)						
%SS:	102	103	102	102		
Comments						

* water are reported in mg/L, soil/sludge/solid samples in mg/kg (all soils extracted using DI WET methodology; extraction efficiency is unknown), wipe samples in mg/wipe, product/oil/non-aqueous liquid samples in mg/L.

surrogate diluted out of range or surrogate coelutes with another peak; N/A means surrogate not applicable to this analysis.

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	Client Contact: Randall Young	Date Extracted: 03/31/10-04/02/10
	Client P.O.:	Date Analyzed: 04/03/10-04/06/10

Inorganic Anions by IC*

Extraction Method: CA Title 22 modified (DISTLC) Analytical Method: E300.0 Work Order: 1003897

Lab ID	1003897-006A	1003897-007A	1003897-008A		Reporting Limit for DF =1	
Client ID	SA-SH-3-1.5'	SA-SH-3-4.5'	SA-SH-0-1.0'			
Matrix	Soil	Soil	Soil			
DF	1	1	1			
Extraction Type	DI WET	DI WET	DI WET		S	W
Compound	**Concentration**				mg/kg	µg/L
Bromide	ND	ND	ND		10	NA
Chloride	12	ND	ND		10	NA
Nitrate as N	ND	ND	ND		10	NA
Nitrate as NO3¯	ND	ND	ND		45	NA
Nitrite as N	ND	ND	ND		10	NA
Sulfate	ND	ND	ND		10	NA
Surrogate Recoveries (%)						
%SS:	98	98	98			
Comments						

* water are reported in mg/L, soil/sludge/solid samples in mg/kg (all soils extracted using DI WET methodology; extraction efficiency is unknown), wipe samples in mg/wipe, product/oil/non-aqueous liquid samples in mg/L.

surrogate diluted out of range or surrogate coelutes with another peak; N/A means surrogate not applicable to this analysis.

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	Client Contact: Randall Young	Date Extracted: 04/06/10
	Client P.O.:	Date Analyzed: 04/06/10

Total & Speciated Alkalinity as Calcium Carbonate*

Extraction method: SM2320B Analytical methods: SM2320Bm Work Order: 1003897

Lab ID	Client ID	Matrix	Total*	Carbonate*	Bicarbonate*	Hydroxide*	DF	Comments
001A	SA-SH-1-0.5'	S	4160	ND	4160	ND	1	
002A	SA-SH-1-3.5'	S	2500	ND	2500	ND	1	
004A	SA-SH-2-1.75'	S	1930	ND	1930	ND	1	
005A	SA-SH-2-7.0'	S	1050	ND	1050	ND	1	
006A	SA-SH-3-1.5'	S	1650	ND	1650	ND	1	
007A	SA-SH-3-4.5'	S	1490	ND	1490	ND	1	
008A	SA-SH-0-1.0'	S	1640	ND	1640	ND	1	

Reporting Limit for DF =1; ND means not detected at or above the reporting limit						
	W	NA	NA	NA	NA	ug/L
	S	1.0	1.0	1.0	1.0	mg CaCO3/kg

*water samples are reported in mg calcium carbonate/L and soil/sludge samples in mg calcium carbonate/kg. Hydroxide, Carbonate & Bicarbonate alkalinity measure @ end-point of pH = 8.3 & 4.5 per SM2320B.

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	Client Contact: Randall Young	Date Extracted: 03/31/10
	Client P.O.:	Date Analyzed: 04/01/10-04/02/10

ICP Metals*

Extraction method: SW3050B Analytical methods: SW6010B Work Order: 1003897

Lab ID	Client ID	Matrix	Extraction Type	Calcium	Iron	Magnesium	Manganese	Potassium	Sodium	DF	% SS	Comments
001A	SA-SH-1-0.5'	S	TOTAL	7500	31,000	11,000	310	2000	200	1	106	
002A	SA-SH-1-3.5'	S	TOTAL	7400	38,000	14,000	770	1900	180	1	102	
004A	SA-SH-2-1.75'	S	TOTAL	3500	28,000	9300	370	3000	ND	1	104	
005A	SA-SH-2-7.0'	S	TOTAL	2700	38,000	11,000	570	2400	ND	1	104	
006A	SA-SH-3-1.5'	S	TOTAL	6000	34,000	15,000	580	2300	ND	1	101	
007A	SA-SH-3-4.5'	S	TOTAL	5400	31,000	10,000	380	2200	ND	1	100	
008A	SA-SH-0-1.0'	S	TOTAL	4800	34,000	11,000	630	2500	ND	1	98	

Reporting Limit for DF =1; ND means not detected at or above the reporting limit	Matrix	Extraction Type	Calcium	Iron	Magnesium	Manganese	Potassium	Sodium	Units
	W	TOTAL	NA	NA	NA	NA	NA	NA	NA
	S	TOTAL	250	15	15	5.0	150	150	mg/Kg

*water/product/oil/non-aqueous liquid samples and all TCLP / STLC / DISTLC / SPLP extracts are reported in mg/L, soil/sludge/solid samples in mg/kg, wipe samples in µg/wipe, filter samples in µg/filter.

means surrogate recovery outside of acceptance range due to matrix interference; & means low or no surrogate due to matrix interference; ND means not detected above the reporting limit/method detection limit; N/A means not applicable to this sample or instrument.

TOTAL = Hot acid digestion of a representative sample aliquot.
TRM = Total recoverable metals is the "direct analysis" of a sample aliquot taken from its acid-preserved container.
DISS = Dissolved metals by direct analysis of 0.45 µm filtered and acidified sample.

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AEW Engineering, Inc. 55 New Montgomery St, Ste 722 San Francisco, CA 94105	Client Project ID: #2009-021; SFPUC Habitat Restoration	Date Sampled: 03/25/10-03/26/10
		Date Received: 03/31/10
	Client Contact: Randall Young	Date Extracted: 03/31/10
	Client P.O.:	Date Analyzed: 04/01/10

Boron by ICP*

Extraction method: SW3050B Analytical methods: SW6010B Work Order: 1003897

Lab ID	Client ID	Matrix	Extraction Type	Boron	DF	% SS	Comments
1003897-001A	SA-SH-1-0.5'	S	TOTAL	21	1	110	
1003897-002A	SA-SH-1-3.5'	S	TOTAL	21	1	103	
1003897-004A	SA-SH-2-1.75'	S	TOTAL	18	1	111	
1003897-005A	SA-SH-2-7.0'	S	TOTAL	20	1	106	
1003897-006A	SA-SH-3-1.5'	S	TOTAL	21	1	109	
1003897-007A	SA-SH-3-4.5'	S	TOTAL	18	1	105	
1003897-008A	SA-SH-0-1.0'	S	TOTAL	20	1	111	

Reporting Limit for DF =1; ND means not detected at or above the reporting limit	W	TOTAL	NA	μg/L
	S	TOTAL	5.0	mg/Kg

*water/product/oil/non-aqueous liquid samples and all TCLP / STLC / DISTLC / SPLP extracts are reported in mg/L, soil/sludge/solid samples in mg/kg, wipe samples in μg/wipe, filter samples in μg/filter.

means surrogate recovery outside of acceptance range due to matrix interference; & means low or no surrogate due to matrix interference; ND means not detected above the reporting limit/method detection limit; N/A means not applicable to this sample or instrument.

TOTAL = Hot acid digestion of a representative sample aliquot.
TRM = Total recoverable metals is the "direct analysis" of a sample aliquot taken from its acid-preserved container.
DISS = Dissolved metals by direct analysis of 0.45 μm filtered and acidified sample.

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55 New Montgomery St, Ste 722		Date Received: 03/31/10
	Client Contact: Randall Young	Date Extracted: 03/31/10
San Francisco, CA 94105	Client P.O.:	Date Analyzed 04/06/10

Cation Exchange Capacity (CEC) as Sodium*

Extraction method SW9081 Analytical methods SW6010B Work Order: 1003897

Lab ID	Client ID	Matrix	Sodium	DF	% SS	Comments
1003897-001A	SA-SH-1-0.5'	S	0.52	1	N/A	
1003897-002A	SA-SH-1-3.5'	S	0.36	1	N/A	
1003897-004A	SA-SH-2-1.75'	S	0.35	1	N/A	
1003897-005A	SA-SH-2-7.0'	S	0.24	1	N/A	
1003897-006A	SA-SH-3-1.5'	S	0.30	1	N/A	
1003897-007A	SA-SH-3-4.5'	S	0.30	1	N/A	
1003897-008A	SA-SH-0-1.0'	S	0.33	1	N/A	

Reporting Limit for DF =1; ND means not detected at or above the reporting limit	W	NA	NA
	S	0.05	meq/g

*soil/sludge/solid samples are reported in meq/g (milliequivalent/gram). 1 milliequivalent = 0.023g Sodium.

means surrogate diluted out of range; ND means not detected above the reporting limit/method detection limit; N/A means not applicable to this sample or instrument.

TOTAL = Hot acid digestion of a representative sample aliquot.
TRM = Total recoverable metals is the "direct analysis" of a sample aliquot taken from its acid-preserved container.
DISS = Dissolved metals by direct analysis of 0.45 µm filtered and acidified sample.

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55 New Montgomery St, Ste 722		Date Received: 03/31/10
	Client Contact: Randall Young	Date Extracted: 03/31/10
San Francisco, CA 94105	Client P.O.:	Date Analyzed: 04/07/10

Metals*

Extraction method: SW3050B Analytical methods: 6020A Work Order: 1003897

Lab ID	Client ID	Matrix	Extraction Type	Copper	Zinc	DF	% SS	Comments
001A	SA-SH-1-0.5'	S	TOTAL	31	61	1	106	
002A	SA-SH-1-3.5'	S	TOTAL	40	76	1	117	
004A	SA-SH-2-1.75'	S	TOTAL	26	58	1	102	
005A	SA-SH-2-7.0'	S	TOTAL	25	63	1	107	
006A	SA-SH-3-1.5'	S	TOTAL	27	56	1	103	
007A	SA-SH-3-4.5'	S	TOTAL	24	51	1	102	
008A	SA-SH-0-1.0'	S	TOTAL	25	58	1	102	

Reporting Limit for DF =1; ND means not detected at or above the reporting limit	W	TOTAL	NA	NA	NA
	S	TOTAL	0.5	5.0	mg/kg

*water samples are reported in µg/L, product/oil/non-aqueous liquid samples and all TCLP / STLC / DISTLC / SPLP extracts are reported in mg/L, soil/sludge/solid samples in mg/kg, wipe samples in µg/wipe, filter samples in µg/filter.

means surrogate diluted out of range; ND means not detected above the reporting limit/method detection limit; N/A means not applicable to this sample or instrument.

TOTAL = Hot acid digestion of a representative sample aliquot.
TRM = Total recoverable metals is the "direct analysis" of a sample aliquot taken from its acid-preserved container.
DISS = Dissolved metals by direct analysis of 0.45 µm filtered and acidified sample.

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55 New Montgomery St, Ste 722		Date Received: 03/31/10
	Client Contact: Randall Young	Date Extracted: 04/01/10
San Francisco, CA 94105	Client P.O.:	Date Analyzed: 04/01/10

pH*

Analytical Method: SW9045D   Work Order: 1003897

Lab ID	Client ID	Matrix	pH	DF	Comments
1003897-001A	SA-SH-1-0.5'	S	7.01 @ 23.0°C	1	
1003897-002A	SA-SH-1-3.5'	S	7.67 @ 23.1°C	1	
1003897-004A	SA-SH-2-1.75'	S	7.24 @ 21.8°C	1	
1003897-005A	SA-SH-2-7.0'	S	7.15 @ 22.6°C	1	
1003897-006A	SA-SH-3-1.5'	S	7.11 @ 23.1°C	1	
1003897-007A	SA-SH-3-4.5'	S	7.41 @ 23.1°C	1	
1003897-008A	SA-SH-0-1.0'	S	7.01 @ 23.0°C	1	

Method Accuracy and Reporting Units			
	W	NA	
	S	±0.05, pH units @ °C	

* EPA method 9045; pH = -log(aH+) @ _°C; ± 0.1 units

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	Client Contact: Randall Young	Date Extracted: 04/02/10
	Client P.O.:	Date Analyzed: 04/02/10

Specific Conductivity*

Analytical Method: CATest424m Work Order: 1003897

Lab ID	Client ID	Matrix	Specific Conductivity	DF	Comments
1003897-001A	SA-SH-1-0.5'	S	165 @ 25.0°C	1	
1003897-002A	SA-SH-1-3.5'	S	75.2 @ 25.0°C	1	
1003897-004A	SA-SH-2-1.75'	S	56.6 @ 25.0°C	1	
1003897-005A	SA-SH-2-7.0'	S	65.2 @ 25.0°C	1	
1003897-006A	SA-SH-3-1.5'	S	48.0 @ 25.0°C	1	
1003897-007A	SA-SH-3-4.5'	S	53.0 @ 25.0°C	1	
1003897-008A	SA-SH-0-1.0'	S	38.8 @ 25.0°C	1	

Reporting Limit for DF = 1; ND means not detected at or above the reporting limit	W	NA	
	S	25 µmhos/cm @ 25°C	

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	Client Contact: Randall Young	Date Extracted: 04/01/10
	Client P.O.:	Date Analyzed: 04/01/10

Suflur*

Extraction method: SW3050B   Analytical methods: SW6010B   Work Order: 1003897

Lab ID	Client ID	Matrix	Extraction Type	Sulfur	DF	% SS	Comments
1003897-001A	SA-SH-1-0.5'	S	TOTAL	440	1	101	
1003897-002A	SA-SH-1-3.5'	S	TOTAL	170	1	99	
1003897-004A	SA-SH-2-1.75'	S	TOTAL	160	1	96	
1003897-005A	SA-SH-2-7.0'	S	TOTAL	37	1	94	
1003897-006A	SA-SH-3-1.5'	S	TOTAL	120	1	97	
1003897-007A	SA-SH-3-4.5'	S	TOTAL	79	1	96	
1003897-008A	SA-SH-0-1.0'	S	TOTAL	150	1	100	

Reporting Limit for DF =1; ND means not detected at or above the reporting limit	Matrix	Extraction Type	Sulfur	Units
	W	TOTAL	NA	µg/L
	S	TOTAL	15	mg/kg

*water samples are reported in µg/L, product/oil/non-aqueous liquid samples and all TCLP / STLC / DISTLC / SPLP extracts are reported in mg/L, soil/sludge/solid samples in mg/kg, wipe samples in µg/wipe, filter samples in µg/filter.

means surrogate diluted out of range; ND means not detected above the reporting limit/method detection limit; N/A means not applicable to this sample or instrument.

TOTAL = Hot acid digestion of a representative sample aliquot.
TRM = Total recoverable metals is the "direct analysis" of a sample aliquot taken from its acid-preserved container.
DISS = Dissolved metals by direct analysis of 0.45 µm filtered and acidified sample.

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	Client Contact: Randall Young	Date Extracted: 04/05/10
	Client P.O.:	Date Analyzed: 04/05/10

Total Nitrogen*

Analytical Method: E415.1m Work Order: 1003897

Lab ID	Client ID	Matrix	Total Nitrogen	DF	Comments
1003897-001A	SA-SH-1-0.5'	S	2700	1	
1003897-002A	SA-SH-1-3.5'	S	1300	1	
1003897-004A	SA-SH-2-1.75'	S	1600	1	
1003897-005A	SA-SH-2-7.0'	S	740	1	
1003897-006A	SA-SH-3-1.5'	S	1400	1	
1003897-007A	SA-SH-3-4.5'	S	840	1	
1003897-008A	SA-SH-0-1.0'	S	1600	1	

Reporting Limit for DF = 1; ND means not detected at or above the reporting limit	W	NA	
	S	200 mg/Kg	

* water samples are reported in mg/L, soil/sludge/solid samples in mg/kg.

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	Client Contact: Randall Young	Date Extracted: 04/05/10
	Client P.O.:	Date Analyzed: 04/05/10

Total Organic Carbon (TOC)*

Analytical Method: SM5310Bm Work Order: 1003897

Lab ID	Client ID	Matrix	TOC	DF	Comments
1003897-001A	SA-SH-1-0.5'	S	21,000	1	
1003897-002A	SA-SH-1-3.5'	S	6900	1	
1003897-004A	SA-SH-2-1.75'	S	10,000	1	
1003897-005A	SA-SH-2-7.0'	S	1900	1	
1003897-006A	SA-SH-3-1.5'	S	8500	1	
1003897-007A	SA-SH-3-4.5'	S	5300	1	
1003897-008A	SA-SH-0-1.0'	S	13,000	1	

Reporting Limit for DF = 1; ND means not detected at or above the reporting limit	W	NA	
	S	200 mg/Kg	

* water samples are reported in mg/L, soil/sludge/solid samples in mg/kg.

* Non-Purgeable Organic Carbon=NPOC; TOC=Total Organic Carbon; DOC=Dissolved Organic Carbon; POC=Purgeable Organic Cabon; IC=Inorganic Carbon.

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Angela Rydelius, Lab Manager

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AEW Engineering, Inc. 55 New Montgomery St, Ste 722 San Francisco, CA 94105	Client Project ID: #2009-021; SFPUC Habitat Restoration	Date Sampled: 03/25/10-03/26/10 Date Received: 03/31/10
	Client Contact: Randall Young	Date Extracted: 03/31/10
	Client P.O.:	Date Analyzed: 04/01/10

Total Phosphorous as P*

Analytical Method: E365.1m   Work Order: 1003897

Lab ID	Client ID	Matrix	Total Phosphorous as P	DF	Comments
1003897-001A	SA-SH-1-0.5'	S	110	10	
1003897-002A	SA-SH-1-3.5'	S	140	10	
1003897-004A	SA-SH-2-1.75'	S	210	10	
1003897-005A	SA-SH-2-7.0'	S	120	10	
1003897-006A	SA-SH-3-1.5'	S	95	10	
1003897-007A	SA-SH-3-4.5'	S	110	10	
1003897-008A	SA-SH-0-1.0'	S	110	10	

Reporting Limit for DF = 1; ND means not detected at or above the reporting limit	W	NA	
	S	4.0 mg/Kg	

*water/product/oil/non-aqueous liquid samples and all TCLP / STLC / DISTLC / SPLP extracts are reported in mg/L, soil/sludge/solid samples in mg/kg, wipe samples in µg/wipe, filter samples in µg/filter.

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QC SUMMARY REPORT FOR E300.0

W.O. Sample Matrix: Soil | QC Matrix: Soil | BatchID: 49677 | WorkOrder 1003897

EPA Method E300.0	Extraction CA Title 22 modified							Spiked Sample ID: N/A			
Analyte	Sample	Spiked	MS	MSD	MS-MSD	LCS	LCSD	LCS-LCSD	Acceptance Criteria (%)			
	mg/kg	mg/kg	% Rec.	% Rec.	% RPD	% Rec.	% Rec.	% RPD	MS / MSD	RPD	LCS/LCSD	RPD
Bromide	N/A	100	N/A	N/A	N/A	107	105	2.24	N/A	N/A	80 - 120	20
Chloride	N/A	100	N/A	N/A	N/A	100	101	0.118	N/A	N/A	80 - 120	20
Nitrate as N	N/A	100	N/A	N/A	N/A	92	91.9	0.0522	N/A	N/A	80 - 120	20
Nitrate as NO_3^-	N/A	440	N/A	N/A	N/A	92	91.9	0.0522	N/A	N/A	80 - 120	20
Nitrite as N	N/A	100	N/A	N/A	N/A	94.9	94.6	0.319	N/A	N/A	80 - 120	20
Sulfate	N/A	100	N/A	N/A	N/A	99.7	100	0.366	N/A	N/A	80 - 120	20
%SS:	N/A	10	N/A	N/A	N/A	99	99	0	N/A	N/A	80 - 120	20

All target compounds in the Method Blank of this extraction batch were ND less than the method RL with the following exceptions:
NONE

BATCH 49677 SUMMARY

Lab ID	Date Sampled	Date Extracted	Date Analyzed	Lab ID	Date Sampled	Date Extracted	Date Analyzed
1003897-001A	03/25/10 10:50 AM	03/31/10	04/03/10 9:49 AM	1003897-001A	03/25/10 10:50 AM	03/31/10	04/06/10 12:59 AM
1003897-002A	03/25/10 12:15 PM	03/31/10	04/03/10 10:33 AM	1003897-002A	03/25/10 12:15 PM	03/31/10	04/06/10 1:34 PM
1003897-004A	03/25/10 2:30 PM	03/31/10	04/03/10 11:17 AM	1003897-004A	03/25/10 2:30 PM	03/31/10	04/06/10 2:08 AM
1003897-005A	03/25/10 3:20 PM	03/31/10	04/03/10 12:00 PM	1003897-005A	03/25/10 3:20 PM	03/31/10	04/06/10 2:43 AM
1003897-006A	03/25/10 3:50 PM	03/31/10	04/06/10 3:18 PM	1003897-007A	03/25/10 4:10 PM	03/31/10	04/06/10 3:52 AM
1003897-008A	03/26/10 10:50 AM	03/31/10	04/06/10 4:27 AM				

MS = Matrix Spike; MSD = Matrix Spike Duplicate; LCS = Laboratory Control Sample; LCSD = Laboratory Control Sample Duplicate; RPD = Relative Percent Deviation.

% Recovery = 100 * (MS-Sample) / (Amount Spiked); RPD = 100 * (MS - MSD) / ((MS + MSD) / 2).

MS / MSD spike recoveries and / or %RPD may fall outside of laboratory acceptance criteria due to one or more of the following reasons: a) the sample is inhomogenous AND contains significant concentrations of analyte relative to the amount spiked, or b) the spiked sample's matrix interferes with the spike recovery.

N/A = not applicable to this method, or not enough sample to perform matrix spike and matrix spike duplicate.

NR = analyte concentration in sample exceeds spike amount for soil matrix or exceeds 2x spike amount for water matrix or sample diluted due to high matrix or analyte content.

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QC SUMMARY REPORT FOR WET CHEMISTRY TESTS

Test Method: Alkalinity **Matrix: S** **WorkOrder: 1003897**

Method Name: SM2320Bm Units mg CaCO3/kg BatchID: 49678

Lab ID	Sample	DF	Dup / Ser. Dil.	DF	% RPD	Acceptance Criteria (%)
1003897-001A	4160	1	4310	1	3.54	<20
1003897-002A	2500	1	2210	1	12.3	<20
1003897-004A	1930	1	1980	1	2.56	<20
1003897-005A	1050	1	1050	1	0	<20
1003897-006A	1650	1	1630	1	1.22	<20
1003897-007A	1490	1	1410	1	5.52	<20
1003897-008A	1640	1	1590	1	3.1	<20

BATCH 49678 SUMMARY

Lab ID	Date Sampled	Date Extracted	Date Analyzed	Lab ID	Date Sampled	Date Extracted	Date Analyzed
1003897-001A	)3/25/10 10:50 AM	04/06/10	04/06/10 3:12 PM	1003897-002A	)3/25/10 12:15 PM	04/06/10	04/06/10 3:26 PM
1003897-004A	03/25/10 2:30 PM	04/06/10	04/06/10 3:45 PM	1003897-005A	03/25/10 3:20 PM	04/06/10	04/06/10 2:56 PM
1003897-006A	03/25/10 3:50 PM	04/06/10	04/06/10 4:03 PM	1003897-007A	03/25/10 4:10 PM	04/06/10	04/06/10 4:15 PM
1003897-008A	)3/26/10 10:50 AM	04/06/10	04/06/10 4:28 PM				

Dup = Duplicate; Ser. Dil. = Serial Dilution; MS = Matrix Spike; RPD = Relative Percent Deviation.

Precision = Absolute Value (Sample - Duplicate)

RPD = 100 * (Sample - Duplicate) / [(Sample + Duplicate) / 2]

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QC SUMMARY REPORT FOR 6010C

W.O. Sample Matrix: Soil   QC Matrix: Soil   WorkOrder 1003897

EPA Method SW6010B   Extraction SW3050B   BatchID: 49675   Spiked Sample ID: 1003897-008A

Analyte	Sample	Spiked	MS	MSD	MS-MSD	Spiked	LCS	LCSD	LCS-LCSD	Acceptance Criteria (%)			
	mg/Kg	mg/Kg	% Rec.	% Rec.	% RPD	mg/Kg	% Rec.	% Rec.	% RPD	MS / MSD	RPD	LCS/LCSD	RPD
Calcium	4,800	5000	101	100	0.456	1000	99	104	4.47	75 - 125	25	75 - 125	25
Iron	34,000	500	NR	NR	NR	100	108	107	0.512	75 - 125	25	75 - 125	25
Magnesium	11,000	500	NR	NR	NR	100	100	103	2.78	75 - 125	25	75 - 125	25
Manganese	630	500	NR	NR	NR	100	115	113	1.60	75 - 125	25	75 - 125	25
Potassium	2,500	5000	NR	NR	NR	1000	108	104	3.26	75 - 125	25	75 - 125	25
Sodium	ND	5000	105	101	3.74	1000	94.4	100	6.16	75 - 125	25	75 - 125	25
%SS:	98	250	105	109	3.36	250	107	103	3.14	70 - 130	30	70 - 130	30

All target compounds in the Method Blank of this extraction batch were ND less than the method RL with the following exceptions:
NONE

BATCH 49675 SUMMARY

Lab ID	Date Sampled	Date Extracted	Date Analyzed	Lab ID	Date Sampled	Date Extracted	Date Analyzed
1003897-001A	03/25/10 10:50 AM	03/31/10	04/01/10 10:17 PM	1003897-001A	03/25/10 10:50 AM	03/31/10	04/02/10 6:19 PM
1003897-002A	03/25/10 12:15 PM	03/31/10	04/01/10 10:23 PM	1003897-002A	03/25/10 12:15 PM	03/31/10	04/02/10 6:23 PM
1003897-004A	03/25/10 2:30 PM	03/31/10	04/01/10 10:28 PM	1003897-004A	03/25/10 2:30 PM	03/31/10	04/02/10 6:28 PM
1003897-005A	03/25/10 3:20 PM	03/31/10	04/01/10 10:34 PM	1003897-005A	03/25/10 3:20 PM	03/31/10	04/02/10 6:33 PM
1003897-006A	03/25/10 3:50 PM	03/31/10	04/01/10 10:40 PM	1003897-006A	03/25/10 3:50 PM	03/31/10	04/02/10 6:38 PM
1003897-007A	03/25/10 4:10 PM	03/31/10	04/01/10 10:45 PM	1003897-007A	03/25/10 4:10 PM	03/31/10	04/02/10 6:42 PM
1003897-008A	03/26/10 10:50 AM	03/31/10	04/01/10 9:48 PM	1003897-008A	03/26/10 10:50 AM	03/31/10	04/02/10 6:47 PM

MS = Matrix Spike; MSD = Matrix Spike Duplicate; LCS = Laboratory Control Sample; LCSD = Laboratory Control Sample Duplicate; RPD = Relative Percent Deviation.

% Recovery = 100 * (MS-Sample) / (Amount Spiked); RPD = 100 * (MS - MSD) / ((MS + MSD) / 2).

* MS / MSD spike recoveries and / or %RPD may fall outside of laboratory acceptance criteria due to one or more of the following reasons: a) the sample is inhomogenous AND contains significant concentrations of analyte relative to the amount spiked, or b) the spiked sample's matrix interferes with the spike recovery.

N/A = not applicable to this method.

NR = analyte concentration in sample exceeds spike amount for soil matrix or exceeds 2x spike amount for water matrix or sample diluted due to high matrix or analyte content.

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QC SUMMARY REPORT FOR 6010B

W.O. Sample Matrix: Soil QC Matrix: Soil WorkOrder 1003897

EPA Method SW6010B **Extraction SW3050B** **BatchID: 49640** **Spiked Sample ID: 1003897-008A**

Analyte	Sample	Spiked	MS	MSD	MS-MSD	Spiked	LCS	LCSD	LCS-LCSD	Acceptance Criteria (%)			
	mg/Kg	mg/Kg	% Rec.	% Rec.	% RPD	mg/Kg	% Rec.	% Rec.	% RPD	MS / MSD	RPD	LCS/LCSD	RPD
Boron	20	50	101	97.6	2.22	10	111	104	6.39	75 - 125	20	75 - 125	20
%SS:	111	250	106	112	6.15	250	110	99	10.6	70 - 130	30	70 - 130	30

All target compounds in the Method Blank of this extraction batch were ND less than the method RL with the following exceptions:
NONE

BATCH 49640 SUMMARY

Lab ID	Date Sampled	Date Extracted	Date Analyzed	Lab ID	Date Sampled	Date Extracted	Date Analyzed
1003897-001A	03/25/10 10:50 AM	03/31/10	04/01/10 1:37 PM	1003897-002A	03/25/10 12:15 PM	03/31/10	04/01/10 1:41 PM
1003897-004A	03/25/10 2:30 PM	03/31/10	04/01/10 1:44 PM	1003897-005A	03/25/10 3:20 PM	03/31/10	04/01/10 1:47 PM
1003897-006A	03/25/10 3:50 PM	03/31/10	04/01/10 1:50 PM	1003897-007A	03/25/10 4:10 PM	03/31/10	04/01/10 1:53 PM
1003897-008A	03/26/10 10:50 AM	03/31/10	04/01/10 1:28 PM				

MS = Matrix Spike; MSD = Matrix Spike Duplicate; LCS = Laboratory Control Sample; LCSD = Laboratory Control Sample Duplicate; RPD = Relative Percent Deviation.

% Recovery = 100 * (MS-Sample) / (Amount Spiked); RPD = 100 * (MS - MSD) / ((MS + MSD) / 2).

* Acceptance Criteria for MS / MSD is between 70% and 130%. MS / MSD spike recoveries and / or %RPD may fall outside of laboratory acceptance criteria due to one or more of the following reasons: a) the sample is inhomogenous AND contains significant concentrations of analyte relative to the amount spiked, or b) the spiked sample's matrix interferes with the spike recovery.

N/A = not applicable to this method.

NR = analyte concentration in sample exceeds spike amount for soil matrix or exceeds 2x spike amount for water matrix or sample diluted due to high matrix or analyte content.

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QC SUMMARY REPORT FOR 6020A

W.O. Sample Matrix: Soil QC Matrix: Soil WorkOrder 1003897

EPA Method 6020A **Extraction SW3050B** **BatchID: 49595** **Spiked Sample ID: 1003897-008A**

Analyte	Sample	Spiked	MS	MSD	MS-MSD	Spiked	LCS	LCSD	LCS-LCSD	Acceptance Criteria (%)			
	mg/Kg	mg/Kg	% Rec.	% Rec.	% RPD	mg/Kg	% Rec.	% Rec.	% RPD	MS / MSD	RPD	LCS/LCSD	RPD
Copper	25	50	102	109	4.58	10	110	111	1.45	75 - 125	20	75 - 125	20
Zinc	58	500	97.1	103	5.07	100	108	99.2	8.73	75 - 125	20	75 - 125	20
%SS:	102	250	103	106	3.13	250	104	97	7.55	70 - 130	20	70 - 130	20

All target compounds in the Method Blank of this extraction batch were ND less than the method RL with the following exceptions:
NONE

BATCH 49595 SUMMARY

Lab ID	Date Sampled	Date Extracted	Date Analyzed	Lab ID	Date Sampled	Date Extracted	Date Analyzed
1003897-001A	03/25/10 10:50 AM	03/31/10	04/07/10 1:35 PM	1003897-002A	03/25/10 12:15 PM	03/31/10	04/07/10 1:44 PM
1003897-004A	03/25/10 2:30 PM	03/31/10	04/07/10 1:52 PM	1003897-005A	03/25/10 3:20 PM	03/31/10	04/07/10 2:00 PM
1003897-006A	03/25/10 3:50 PM	03/31/10	04/07/10 2:09 PM	1003897-007A	03/25/10 4:10 PM	03/31/10	04/07/10 2:17 PM
1003897-008A	03/26/10 10:50 AM	03/31/10	04/07/10 2:26 PM				

MS = Matrix Spike; MSD = Matrix Spike Duplicate; LCS = Laboratory Control Sample; LCSD = Laboratory Control Sample Duplicate; RPD = Relative Percent Deviation.

% Recovery = 100 * (MS-Sample) / (Amount Spiked); RPD = 100 * (MS - MSD) / ((MS + MSD) / 2).

MS / MSD spike recoveries and / or %RPD may fall outside of laboratory acceptance criteria due to one or more of the following reasons: a) the sample is inhomogenous AND contains significant concentrations of analyte relative to the amount spiked, or b) the spiked sample's matrix interferes with the spike recovery.

N/A = not applicable to this method.

NR = matrix interference and/or analyte concentration in sample exceeds spike amount for soil matrix or exceeds 2x spike amount for water matrix or sample diluted due to high matrix or analyte content.

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QC SUMMARY REPORT FOR WET CHEMISTRY TESTS

Test Method: pH **Matrix: S** **WorkOrder: 1003897**

Method Name: SW9045D Units ±, pH units @ °C BatchID: 49555

Lab ID	Sample	DF	Dup / Ser. Dil.	DF	Precision	Acceptance Criteria
1003897-001A	7.01 @ 23.0°C	1	7.00 @ 23.0°C	1	0.01	0.1
1003897-002A	7.67 @ 23.1°C	1	7.70 @ 23.1°C	1	0.03	0.1
1003897-004A	7.24 @ 21.8°C	1	7.22 @ 21.8°C	1	0.02	0.1
1003897-005A	7.15 @ 22.6°C	1	7.18 @ 22.6°C	1	0.03	0.1
1003897-006A	7.11 @ 23.1°C	1	7.10 @ 23.1°C	1	0.01	0.1
1003897-007A	7.41 @ 23.1°C	1	7.40 @ 23.1°C	1	0.01	0.1
1003897-008A	7.01 @ 23.0°C	1	7.00 @ 23.0¦C	1	0.01	0.1

BATCH 49555 SUMMARY

Lab ID	Date Sampled	Date Extracted	Date Analyzed	Lab ID	Date Sampled	Date Extracted	Date Analyzed
1003897-001A	)3/25/10 10:50 AM	04/01/10	04/01/10 7:48 PM	1003897-002A	)3/25/10 12:15 PM	04/01/10	04/01/10 7:36 PM
1003897-004A	03/25/10 2:30 PM	04/01/10	04/01/10 7:18 PM	1003897-005A	03/25/10 3:20 PM	04/01/10	04/01/10 7:24 PM
1003897-006A	03/25/10 3:50 PM	04/01/10	04/01/10 7:30 PM	1003897-007A	03/25/10 4:10 PM	04/01/10	04/01/10 7:42 PM
1003897-008A	)3/26/10 10:50 AM	04/01/10	04/01/10 7:54 PM				

Dup = Duplicate; Ser. Dil. = Serial Dilution; MS = Matrix Spike; RD = Relative Difference; RPD = Relative Percent Deviation.

Precision = Absolute Value (Sample - Duplicate)

RPD = 100 * (Sample - Duplicate) / [(Sample + Duplicate) / 2]

%RPD is calculated using results of up to 10 significant figures, however the reported results are rounded to 2 or 3 significant figures. Therefore there may be a slight discrepancy between the %RPD displayed above and %RPD calculated using the reported results. MAI considers %RPD based upon more significant figures to be more accurate.

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QC SUMMARY REPORT FOR WET CHEMISTRY TESTS

Test Method: Specific Conductivity **Matrix: S** **WorkOrder: 1003897**

Method Name: CATest424m Units µmhos/cm @ 25°C BatchID: 49680

Lab ID	Sample	DF	Dup / Ser. Dil.	DF	% RPD	Acceptance Criteria (%)
1003897-001A	165 @ 25.0°C	1	164 @ 25.0°C	1	1.03	<5
1003897-002A	75.2 @ 25.0°C	1	75.3 @ 25.0°C	1	0.093	<5
1003897-004A	56.6 @ 25.0°C	1	56.7 @ 25.0°C	1	0.141	<5
1003897-005A	65.2 @ 25.0°C	1	65.1 @ 25.0°C	1	0.0614	<5
1003897-006A	48.0 @ 25.0°C	1	47.9 @ 25.0°C	1	0.125	<5
1003897-007A	53.0 @ 25.0°C	1	53.0 @ 25.0°C	1	0.0566	<5
1003897-008A	38.8 @ 25.0°C	1	38.6 @ 25.0°C	1	0.284	<5

BATCH 49680 SUMMARY

Lab ID	Date Sampled	Date Extracted	Date Analyzed	Lab ID	Date Sampled	Date Extracted	Date Analyzed
1003897-001A	)3/25/10 10:50 AM	04/02/10	04/02/10 3:10 PM	1003897-002A	)3/25/10 12:15 PM	04/02/10	04/02/10 3:20 PM
1003897-004A	03/25/10 2:30 PM	04/02/10	04/02/10 3:30 PM	1003897-005A	03/25/10 3:20 PM	04/02/10	04/02/10 3:40 PM
1003897-006A	03/25/10 3:50 PM	04/02/10	04/02/10 3:50 PM	1003897-007A	03/25/10 4:10 PM	04/02/10	04/02/10 4:00 PM
1003897-008A	)3/26/10 10:50 AM	04/02/10	04/02/10 4:10 PM				

Dup = Duplicate; Ser. Dil. = Serial Dilution; MS = Matrix Spike; RD = Relative Difference; RPD = Relative Percent Deviation.

Precision = Absolute Value (Sample - Duplicate)

RPD = 100 * (Sample - Duplicate) / [(Sample + Duplicate) / 2]

%RPD is calculated using results of up to 10 significant figures, however the reported results are rounded to 2 or 3 significant figures. Therefore there may be a slight discrepancy between the %RPD displayed above and %RPD calculated using the reported results. MAI considers %RPD based upon more significant figures to be more accurate.

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QC SUMMARY REPORT FOR SM5310Bm

W.O. Sample Matrix: Soil | QC Matrix: Soil | BatchID: 49672 | WorkOrder 1003897

EPA Method SM5310Bm **Extraction SM5310Bm** **Spiked Sample ID: 1003897-001A**

Analyte	Sample	Spiked	MS	MSD	MS-MSD	LCS	LCSD	LCS-LCSD	Acceptance Criteria (%)			
	mg/Kg	mg/Kg	% Rec.	% Rec.	% RPD	% Rec.	% Rec.	% RPD	MS / MSD	RPD	LCS/LCSD	RPD
TOC	21,000	8200	75.1	76.3	0.343	98.8	99.2	0.379	70 - 130	20	80 - 120	20

All target compounds in the Method Blank of this extraction batch were ND less than the method RL with the following exceptions:
NONE

BATCH 49672 SUMMARY

Lab ID	Date Sampled	Date Extracted	Date Analyzed	Lab ID	Date Sampled	Date Extracted	Date Analyzed
1003897-001A	03/25/10 10:50 AM	04/05/10	04/05/10 4:32 PM	1003897-002A	03/25/10 12:15 PM	04/05/10	04/05/10 5:52 PM
1003897-004A	03/25/10 2:30 PM	04/05/10	04/05/10 6:15 PM	1003897-005A	03/25/10 3:20 PM	04/05/10	04/05/10 6:29 PM
1003897-006A	03/25/10 3:50 PM	04/05/10	04/05/10 7:19 PM	1003897-007A	03/25/10 4:10 PM	04/05/10	04/05/10 7:37 PM
1003897-008A	03/26/10 10:50 AM	04/05/10	04/05/10 8:01 PM				

MS = Matrix Spike; MSD = Matrix Spike Duplicate; LCS = Laboratory Control Sample; LCSD = Laboratory Control Sample Duplicate; RPD = Relative Percent Deviation.

% Recovery = 100 * (MS-Sample) / (Amount Spiked); RPD = 100 * (MS - MSD) / ((MS + MSD) / 2).

MS / MSD spike recoveries and / or %RPD may fall outside of laboratory acceptance criteria due to one or more of the following reasons: a) the sample is inhomogenous AND contains significant concentrations of analyte relative to the amount spiked, or b) the spiked sample's matrix interferes with the spike recovery.

N/A = not applicable to this method.

NR = analyte concentration in sample exceeds spike amount for soil matrix or exceeds 2x spike amount for water matrix or sample diluted due to high matrix or analyte content.

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QC SUMMARY REPORT FOR E365.1m

W.O. Sample Matrix: Soil QC Matrix: Soil BatchID: 49674 WorkOrder 1003897

EPA Method E365.1m **Extraction E365.1m** **Spiked Sample ID: 1003897-001A**

Analyte	Sample	Spiked	MS	MSD	MS-MSD	LCS	LCSD	LCS-LCSD	Acceptance Criteria (%)			
	mg/Kg	mg/Kg	% Rec.	% Rec.	% RPD	% Rec.	% Rec.	% RPD	MS / MSD	RPD	LCS/LCSD	RPD
Total Phosphorous as P	110	40	NR	NR	NR	99.2	99.3	0.144	80 - 120	20	90 - 110	20

All target compounds in the Method Blank of this extraction batch were ND less than the method RL with the following exceptions:
NONE

BATCH 49674 SUMMARY

Lab ID	Date Sampled	Date Extracted	Date Analyzed	Lab ID	Date Sampled	Date Extracted	Date Analyzed
1003897-001A	03/25/10 10:50 AM	03/31/10	04/01/10 2:26 PM	1003897-002A	03/25/10 12:15 PM	03/31/10	04/01/10 2:30 PM
1003897-004A	03/25/10 2:30 PM	03/31/10	04/01/10 2:34 PM	1003897-005A	03/25/10 3:20 PM	03/31/10	04/01/10 2:37 PM
1003897-006A	03/25/10 3:50 PM	03/31/10	04/01/10 2:41 PM	1003897-007A	03/25/10 4:10 PM	03/31/10	04/01/10 2:45 PM
1003897-008A	03/26/10 10:50 AM	03/31/10	04/01/10 2:48 PM				

MS = Matrix Spike; MSD = Matrix Spike Duplicate; LCS = Laboratory Control Sample; LCSD = Laboratory Control Sample Duplicate; RPD = Relative Percent Deviation.

% Recovery = 100 * (MS-Sample) / (Amount Spiked); RPD = 100 * (MS - MSD) / ((MS + MSD) / 2).

MS / MSD spike recoveries and / or %RPD may fall outside of laboratory acceptance criteria due to one or more of the following reasons: a) the sample is inhomogenous AND contains significant concentrations of analyte relative to the amount spiked, or b) the spiked sample's matrix interferes with the spike recovery.

N/A = not enough sample to perform matrix spike and matrix spike duplicate.

NR = analyte concentration in sample exceeds spike amount for soil matrix or exceeds 2x spike amount for water matrix or sample diluted due to high matrix or analyte content.

DHS ELAP Certification 1644 QA/QC Officer

McCampbell Analytical, Inc.
"When Quality Counts"
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QC SUMMARY REPORT FOR 6010C

W.O. Sample Matrix: Soil QC Matrix: Soil BatchID: 49679 WorkOrder 1003897

EPA Method SW6010B **Extraction SW3050B** **Spiked Sample ID: 1003897-008A**

Analyte	Sample	Spiked	MS	MSD	MS-MSD	LCS	LCSD	LCS-LCSD	Acceptance Criteria (%)			
	mg/kg	mg/kg	% Rec.	% Rec.	% RPD	% Rec.	% Rec.	% RPD	MS / MSD	RPD	LCS/LCSD	RPD
Sulfur	150	100	103	102	0.676	106	100	5.49	75 - 125	20	80 - 120	20
%SS:	100	250	103	106	2.49	103	108	4.84	70 - 130	20	70 - 130	20

All target compounds in the Method Blank of this extraction batch were ND less than the method RL with the following exceptions:
NONE

BATCH 49679 SUMMARY

Lab ID	Date Sampled	Date Extracted	Date Analyzed	Lab ID	Date Sampled	Date Extracted	Date Analyzed
1003897-001A	03/25/10 10:50 AM	04/01/10	04/01/10 3:53 PM	1003897-002A	03/25/10 12:15 PM	04/01/10	04/01/10 3:56 PM
1003897-004A	03/25/10 2:30 PM	04/01/10	04/01/10 3:58 PM	1003897-005A	03/25/10 3:20 PM	04/01/10	04/01/10 4:01 PM
1003897-006A	03/25/10 3:50 PM	04/01/10	04/01/10 4:03 PM	1003897-007A	03/25/10 4:10 PM	04/01/10	04/01/10 4:05 PM
1003897-008A	03/26/10 10:50 AM	04/01/10	04/01/10 3:46 PM				

MS = Matrix Spike; MSD = Matrix Spike Duplicate; LCS = Laboratory Control Sample; LCSD = Laboratory Control Sample Duplicate; RPD = Relative Percent Deviation.

% Recovery = 100 * (MS-Sample) / (Amount Spiked); RPD = 100 * (MS - MSD) / ((MS + MSD) / 2).

MS / MSD spike recoveries and / or %RPD may fall outside of laboratory acceptance criteria due to one or more of the following reasons: a) the sample is inhomogenous AND contains significant concentrations of analyte relative to the amount spiked, or b) the spiked sample's matrix interferes with the spike recovery.

N/A = not applicable to this method.

NR = analyte concentration in sample exceeds spike amount for soil matrix or exceeds 2x spike amount for water matrix or sample diluted due to high matrix or analyte content.

DHS ELAP Certification 1644

QA/QC Officer

McCampbell Analytical, Inc.
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QC SUMMARY REPORT FOR E415.1m

W.O. Sample Matrix: Soil   QC Matrix: Soil   BatchID: 49673   WorkOrder 1003897

EPA Method E415.1m   **Extraction E415.1m**   **Spiked Sample ID: 1003897-001A**

Analyte	Sample	Spiked	MS	MSD	MS-MSD	LCS	LCSD	LCS-LCSD	Acceptance Criteria (%)			
	mg/Kg	mg/Kg	% Rec.	% Rec.	% RPD	% Rec.	% Rec.	% RPD	MS / MSD	RPD	LCS/LCSD	RPD
Total Nitrogen	2,700	1900	98	97.2	0.338	106	104	1.71	70 - 130	20	80 - 120	20

All target compounds in the Method Blank of this extraction batch were ND less than the method RL with the following exceptions:
NONE

BATCH 49673 SUMMARY

Lab ID	Date Sampled	Date Extracted	Date Analyzed	Lab ID	Date Sampled	Date Extracted	Date Analyzed
1003897-001A	03/25/10 10:50 AM	04/05/10	04/05/10 4:32 PM	1003897-002A	03/25/10 12:15 PM	04/05/10	04/05/10 5:52 PM
1003897-004A	03/25/10 2:30 PM	04/05/10	04/05/10 6:15 PM	1003897-005A	03/25/10 3:20 PM	04/05/10	04/05/10 6:29 PM
1003897-006A	03/25/10 3:50 PM	04/05/10	04/05/10 7:19 PM	1003897-007A	03/25/10 4:10 PM	04/05/10	04/05/10 7:37 PM
1003897-008A	03/26/10 10:50 AM	04/05/10	04/05/10 8:01 PM				

MS = Matrix Spike; MSD = Matrix Spike Duplicate; LCS = Laboratory Control Sample; LCSD = Laboratory Control Sample Duplicate; RPD = Relative Percent Deviation.

% Recovery = 100 * (MS-Sample) / (Amount Spiked); RPD = 100 * (MS - MSD) / ((MS + MSD) / 2).

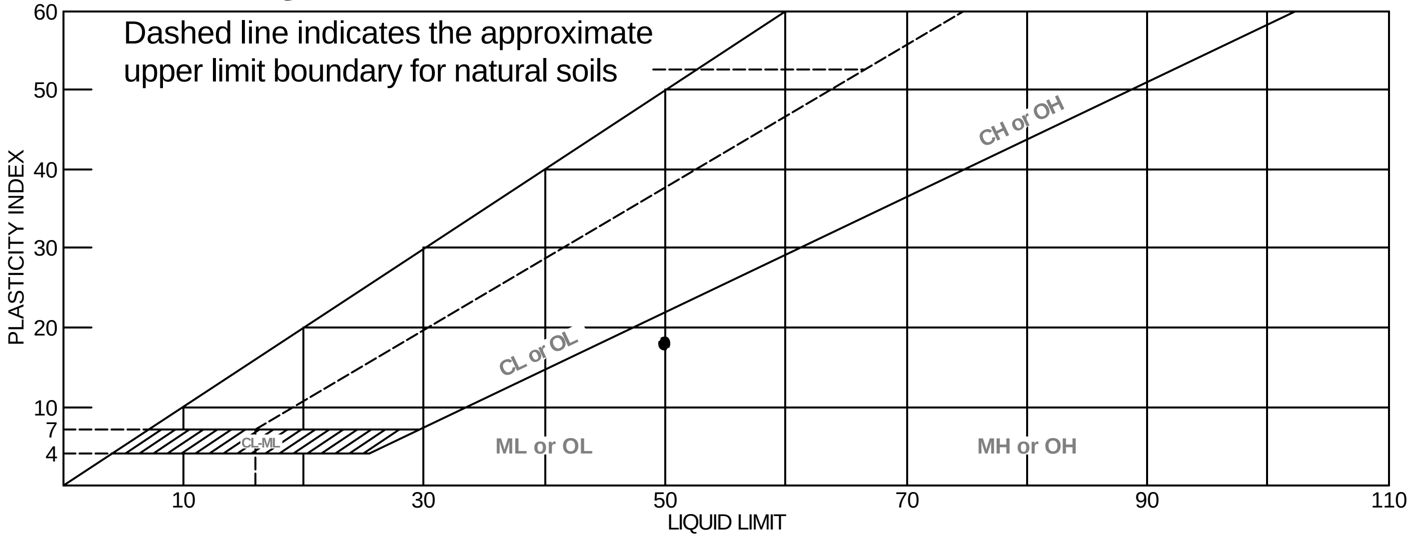
MS / MSD spike recoveries and / or %RPD may fall outside of laboratory acceptance criteria due to one or more of the following reasons: a) the sample is inhomogenous AND contains significant concentrations of analyte relative to the amount spiked, or b) the spiked sample's matrix interferes with the spike recovery.

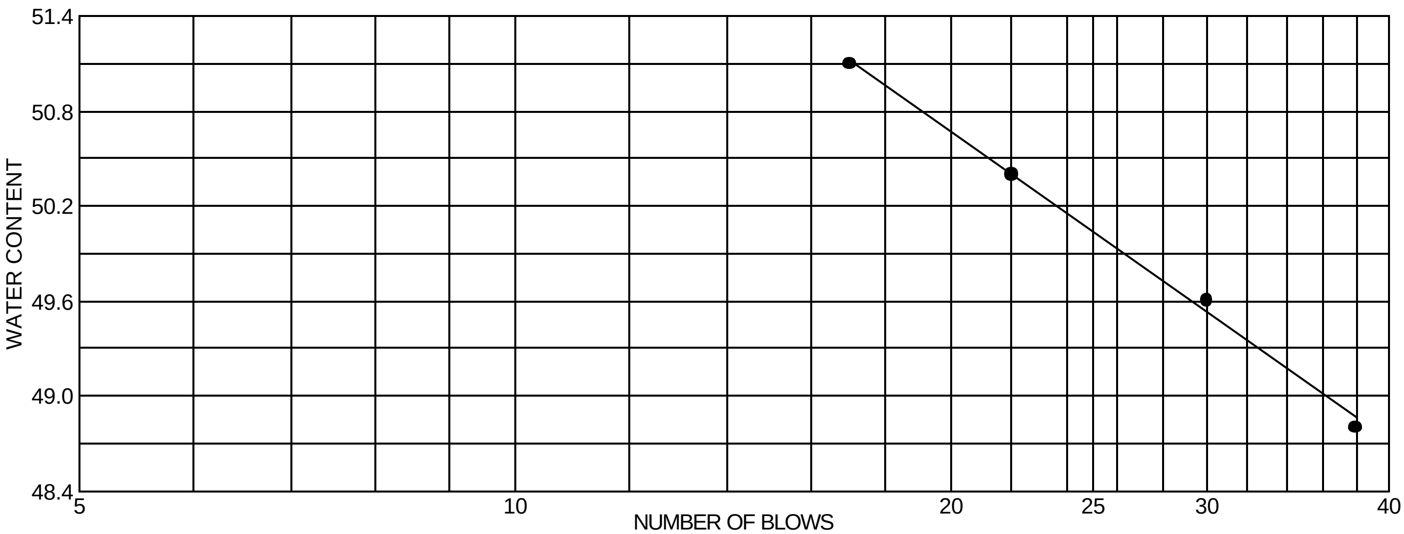
N/A = not applicable to this method.

NR = analyte concentration in sample exceeds spike amount for soil matrix or exceeds 2x spike amount for water matrix or sample diluted due to high matrix or analyte content.

DHS ELAP Certification 1644   QA/QC Officer

LIQUID AND PLASTIC LIMITS TEST REPORT





	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	Dark Gray SILT w/ Sand, Gravel & surface organics	50.0	32.1	17.9			

Project No. 385-059 **Client:** McCampbell Analytical Inc.

Project: SFPUC Habitat Restoration - 2009-021

● **Source:** Road 4 **Sample No.:** 1003897-013

Remarks:

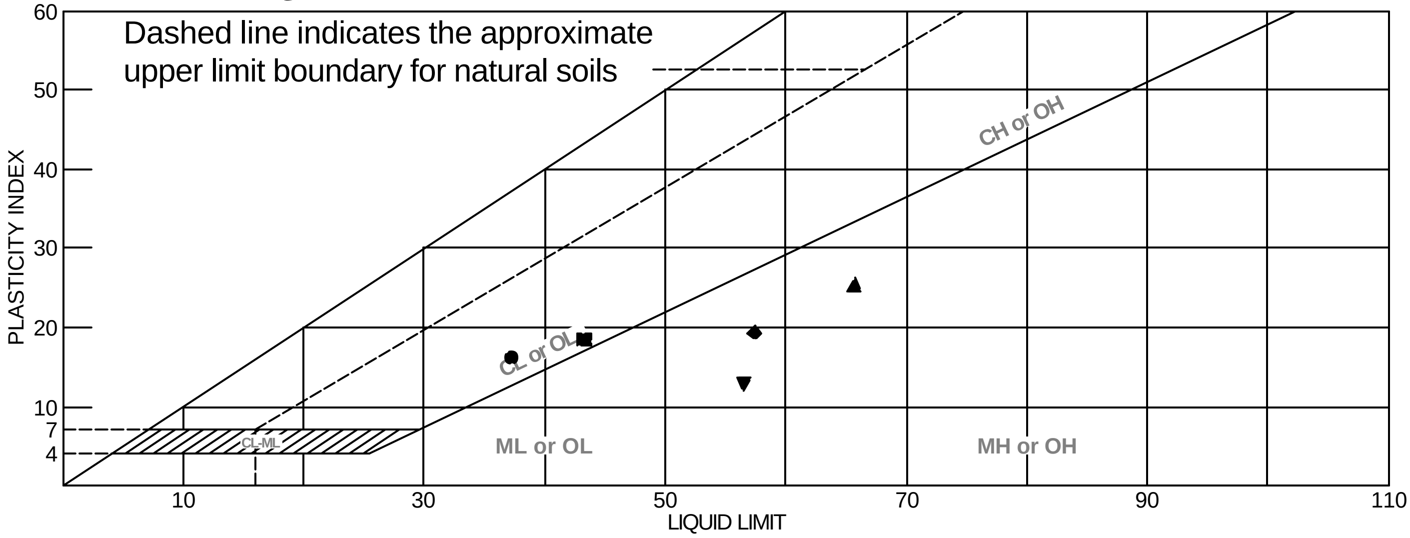
●

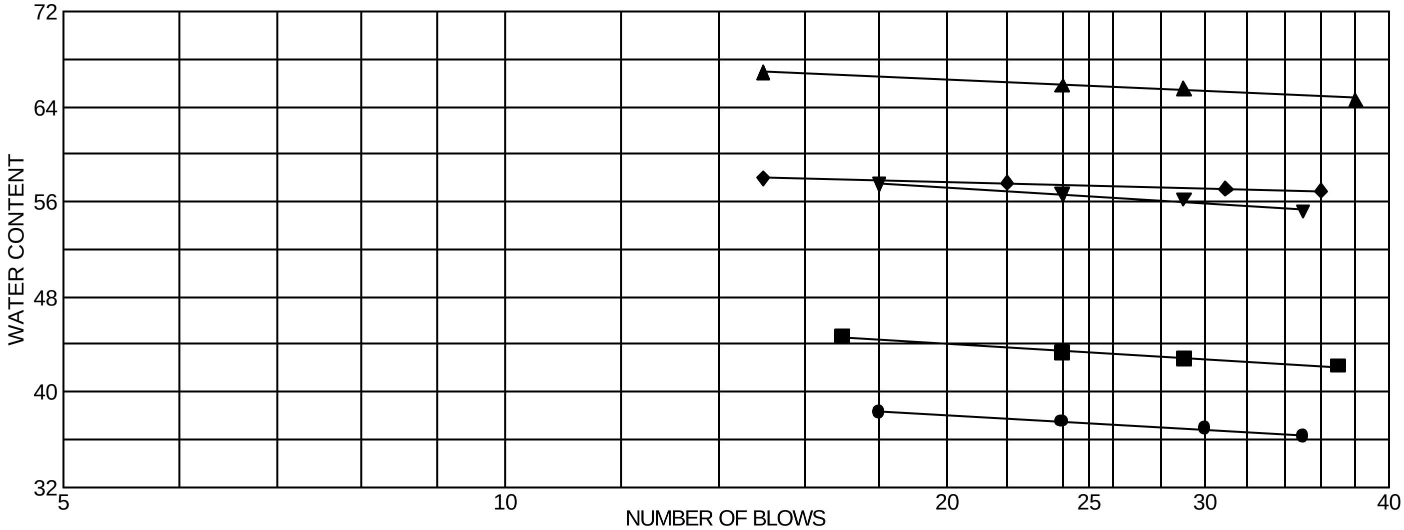
LIQUID AND PLASTIC LIMITS TEST REPORT

COOPER TESTING LABORATORY

Figure

LIQUID AND PLASTIC LIMITS TEST REPORT





	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	Dark Gray Sandy Lean CLAY	37.3	21.3	16.0	69.9	59.1	CL
■	Dark Gray Sandy Lean CLAY	43.3	24.8	18.5	71.6	59.0	CL
▲	Dark Gray Elastic SILT w/ Sand	65.7	40.2	25.5	86.9	81.8	MH
◆	Dark Gray Elastic SILT w/ surface organics	57.4	38.1	19.3			
▼	Dark Gray Elastic SILT w/ Sand & surface organics	56.5	43.8	12.7			

Project No. 385-059 **Client:** McCampbell Analytical Inc.

Project: SFPUC Habitat Restoration - 2009-021

● **Source:** SA-SH-1 **Sample No.:** 1003897-002 **Elev./Depth:** 3.5'

■ **Source:** SA-SH-2 **Sample No.:** 1003897-004 **Elev./Depth:** 1.75'

▲ **Source:** Road 1 **Sample No.:** 1003897-010

◆ **Source:** Road 2 **Sample No.:** 1003897-011

▼ **Source:** Road 3 **Sample No.:** 1003897-012

Remarks:

●

■

▲

◆

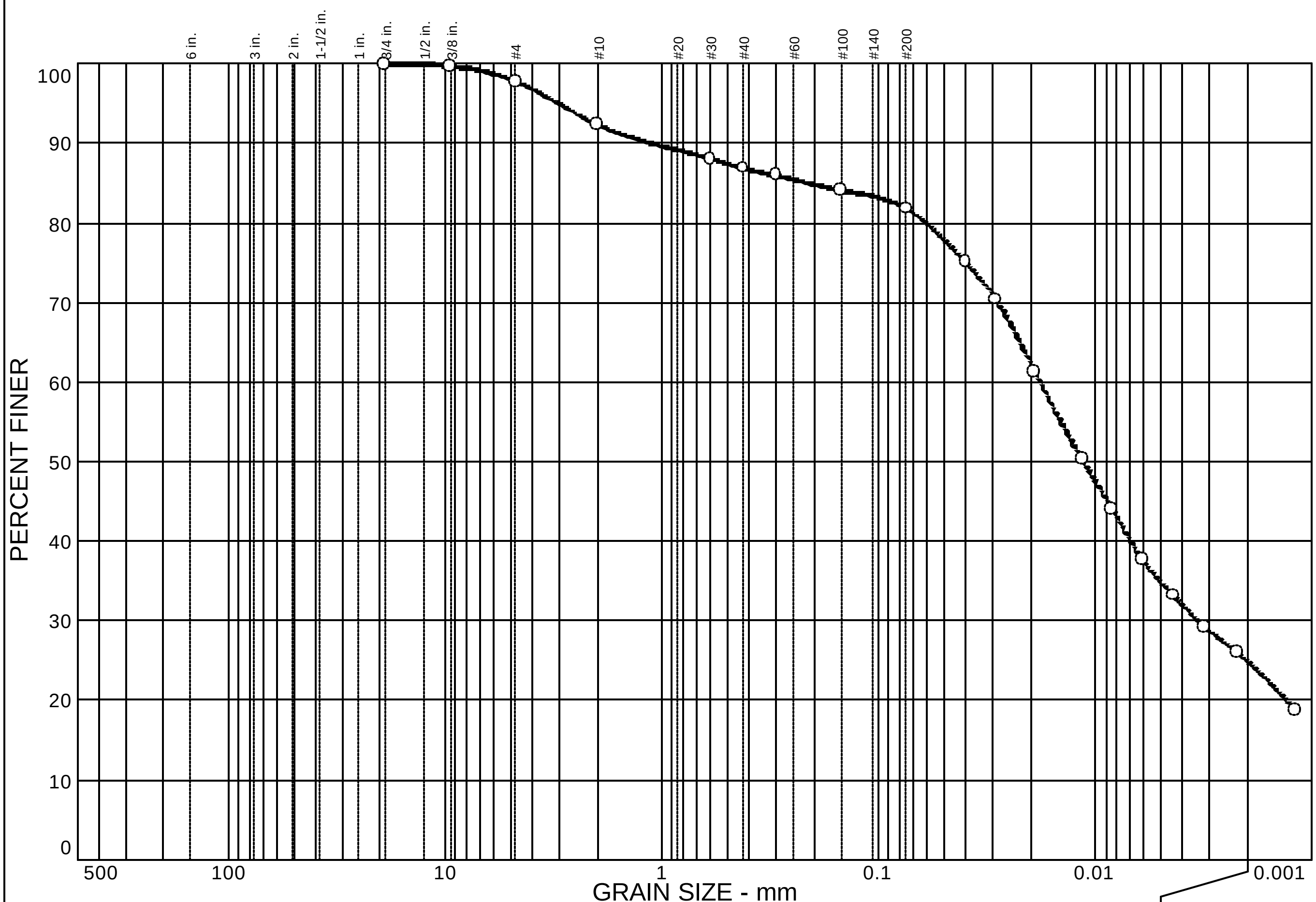
▼

LIQUID AND PLASTIC LIMITS TEST REPORT

COOPER TESTING LABORATORY

Figure

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0.0	2.2	16.0	56.9	24.9

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3/4 in.	100.0		
3/8 in.	99.7		
#4	97.8		
#10	92.4		
#30	88.1		
#40	86.9		
#50	86.0		
#100	84.1		
#200	81.8		
0.0400 mm.	75.1		
0.0290 mm.	70.4		
0.0192 mm.	61.2		
0.0116 mm.	50.3		
0.0084 mm.	44.0		
0.0061 mm.	37.7		
0.0044 mm.	33.2		
0.0031 mm.	29.2		
0.0022 mm.	26.0		
0.0012 mm.	18.7		

* (no specification provided)

Soil Description

Dark Gray Elastic SILT w/ Sand

Atterberg Limits

PL= 40.2 LL= 65.7 PI= 25.5

Coefficients

D_{85}= 0.211 D_{60}= 0.0182 D_{50}= 0.0114
D_{30}= 0.0034 D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= MH AASHTO=

Remarks

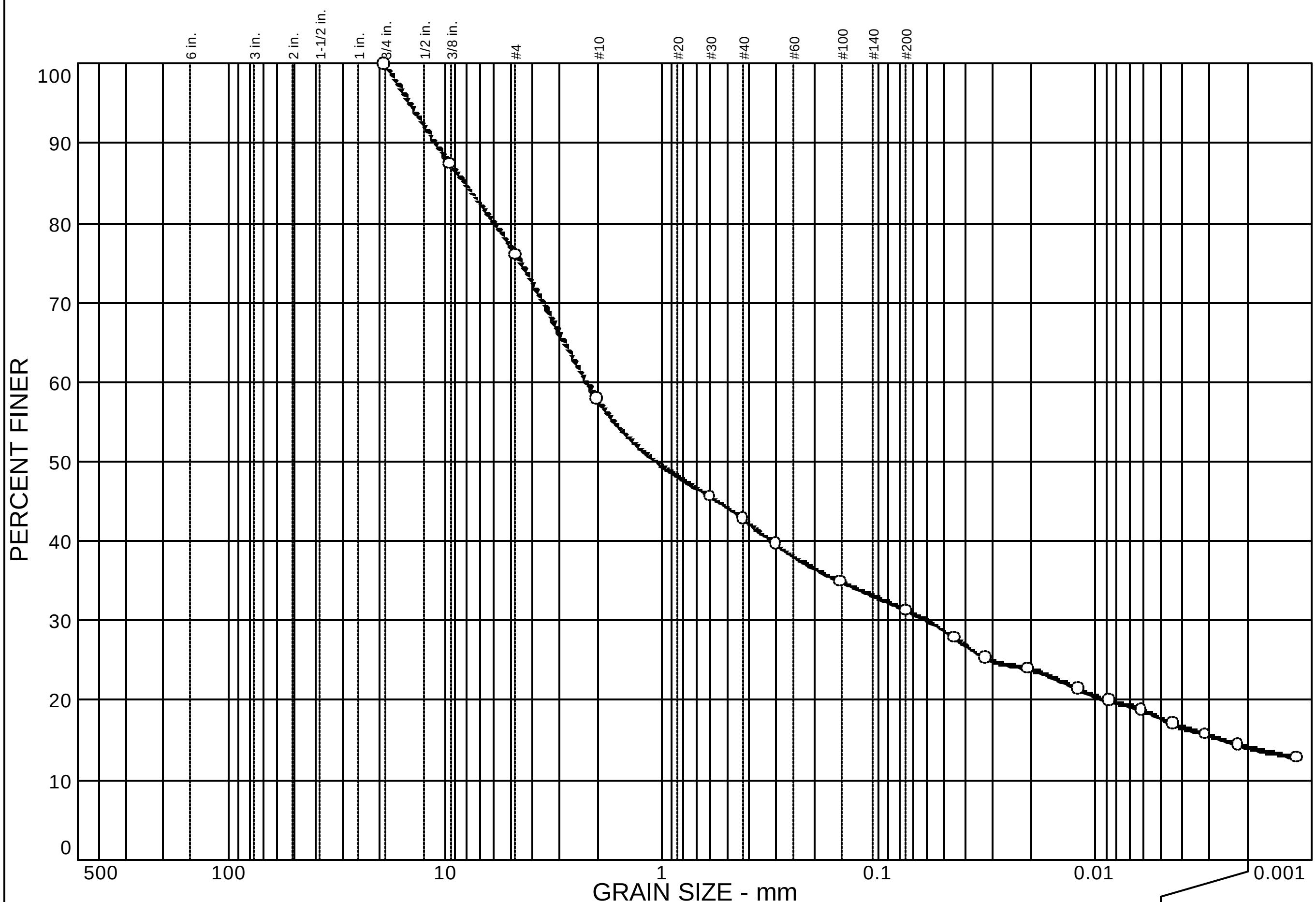
Sample No.: 1003897-010 **Source of Sample:** Road 1 **Date:**
Location: **Elev./Depth:**

COOPER TESTING LABORATORY

Client: McCampbell Analytical Inc.
Project: SFPUC Habitat Restoration - 2009-021

Project No: 385-059 **Figure**

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0.0	24.0	44.7	17.2	14.1

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3/4 in.	100.0		
3/8 in.	87.4		
#4	76.0		
#10	57.9		
#30	45.6		
#40	42.8		
#50	39.6		
#100	34.9		
#200	31.3		
0.0448 mm.	27.9		
0.0322 mm.	25.3		
0.0206 mm.	24.0		
0.0121 mm.	21.4		
0.0086 mm.	19.9		
0.0061 mm.	18.8		
0.0044 mm.	17.0		
0.0031 mm.	15.7		
0.0022 mm.	14.4		
0.0012 mm.	12.8		

* (no specification provided)

Soil Description

Dark Gray Clayey SAND w/ Gravel

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= 8.19 D_{60}= 2.24 D_{50}= 1.07
D_{30}= 0.0599 D_{15}= 0.0026 D_{10}=
C_u= C_c=

Classification

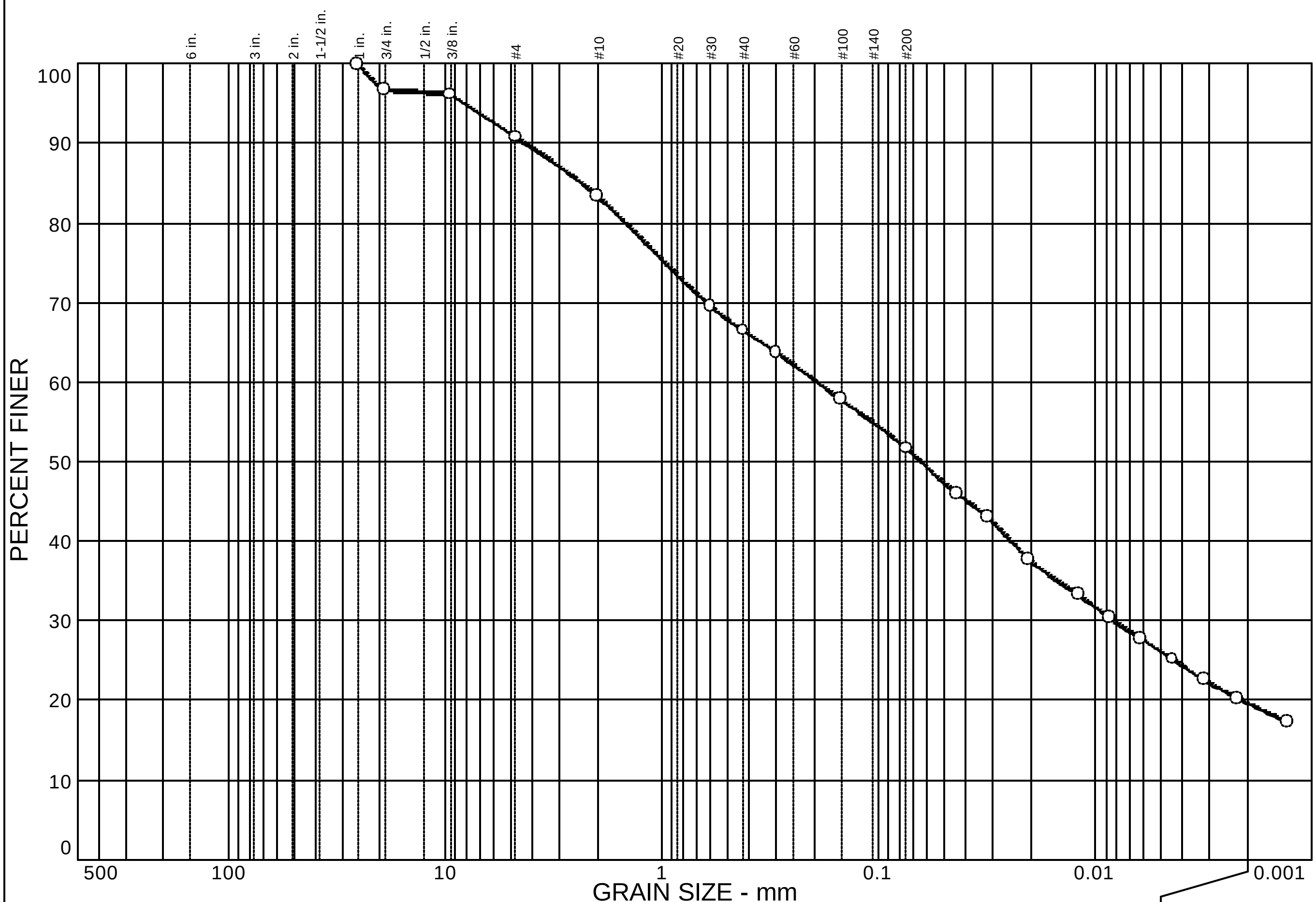
USCS= AASHTO=

Remarks

Sample No.: 1003897-008 **Source of Sample:** SA-SH-0 **Date:**
Location: **Elev./Depth:** 1.0'

COOPER TESTING LABORATORY	**Client:** McCampbell Analytical Inc. **Project:** SFPUC Habitat Restoration - 2009-021 **Project No:** 385-059 **Figure**

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0.0	9.2	39.1	32.1	19.6

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1 in.	100.0		
3/4 in.	96.7		
3/8 in.	96.2		
#4	90.8		
#10	83.4		
#30	69.6		
#40	66.5		
#50	63.8		
#100	57.8		
#200	51.7		
0.0439 mm.	46.0		
0.0315 mm.	43.0		
0.0205 mm.	37.8		
0.0121 mm.	33.3		
0.0086 mm.	30.4		
0.0062 mm.	27.8		
0.0044 mm.	25.2		
0.0032 mm.	22.6		
0.0022 mm.	20.3		
0.0013 mm.	17.3		

* (no specification provided)

Soil Description

Dark Brown Sandy CLAY

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= 2.35 D_{60}= 0.193 D_{50}= 0.0640
D_{30}= 0.0082 D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= AASHTO=

Remarks

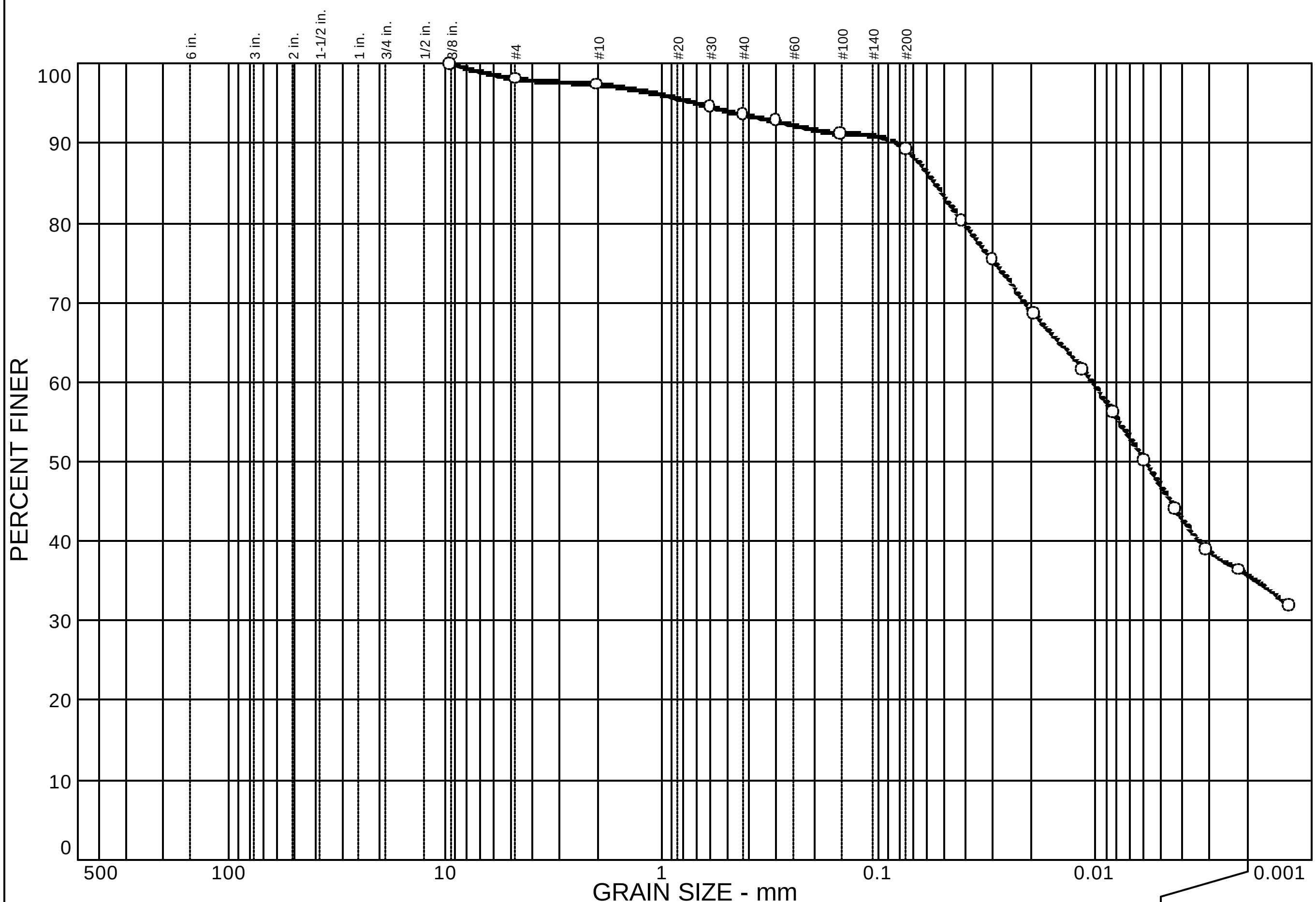
Sample No.: 1003897-009 **Source of Sample:** SA-SH-0 **Date:**
Location: **Elev./Depth:** 5.0'

COOPER TESTING LABORATORY

Client: McCampbell Analytical Inc.
Project: SFPUC Habitat Restoration - 2009-021

Project No: 385-059 **Figure**

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0.0	1.9	8.9	53.4	35.8

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3/8 in.	100.0		
#4	98.1		
#10	97.4		
#30	94.6		
#40	93.6		
#50	92.8		
#100	91.2		
#200	89.2		
0.0415 mm.	80.2		
0.0300 mm.	75.4		
0.0193 mm.	68.6		
0.0115 mm.	61.6		
0.0083 mm.	56.1		
0.0059 mm.	50.1		
0.0043 mm.	44.0		
0.0031 mm.	39.0		
0.0022 mm.	36.4		
0.0013 mm.	31.9		

* (no specification provided)

Soil Description

Dark Gray CLAY (slightly plastic)

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= 0.0553 D_{60}= 0.0104 D_{50}= 0.0059
D_{30}= D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= AASHTO=

Remarks

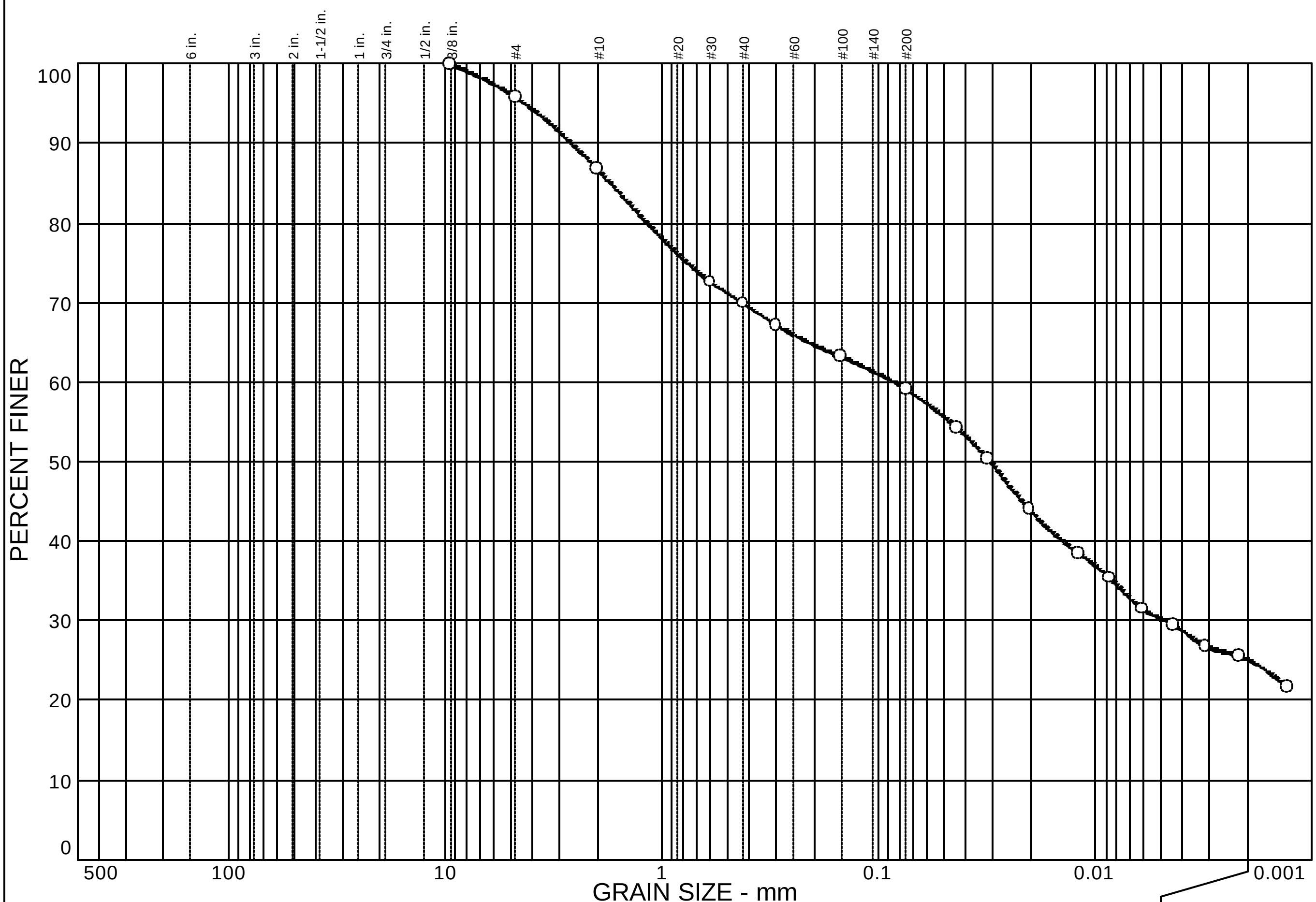
Sample No.: 1003897-001 **Source of Sample:** SA-SH-1 **Date:**
Location: **Elev./Depth:** 0.5'

COOPER TESTING LABORATORY

Client: McCampbell Analytical Inc.
Project: SFPUC Habitat Restoration - 2009-021

Project No: 385-059 **Figure**

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0.0	4.2	36.7	34.0	25.1

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3/8 in.	100.0		
#4	95.8		
#10	86.8		
#30	72.6		
#40	69.9		
#50	67.2		
#100	63.2		
#200	59.1		
0.0435 mm.	54.2		
0.0314 mm.	50.3		
0.0203 mm.	44.0		
0.0120 mm.	38.5		
0.0086 mm.	35.4		
0.0061 mm.	31.5		
0.0044 mm.	29.5		
0.0031 mm.	26.8		
0.0022 mm.	25.6		
0.0013 mm.	21.7		

* (no specification provided)

Soil Description

Dark Gray Sandy Lean CLAY

Atterberg Limits

PL= 21.3 LL= 37.3 PI= 16.0

Coefficients

D_{85}= 1.73 D_{60}= 0.0853 D_{50}= 0.0307
D_{30}= 0.0047 D_{15}= D_{10}=
C_u= C_c=

Classification

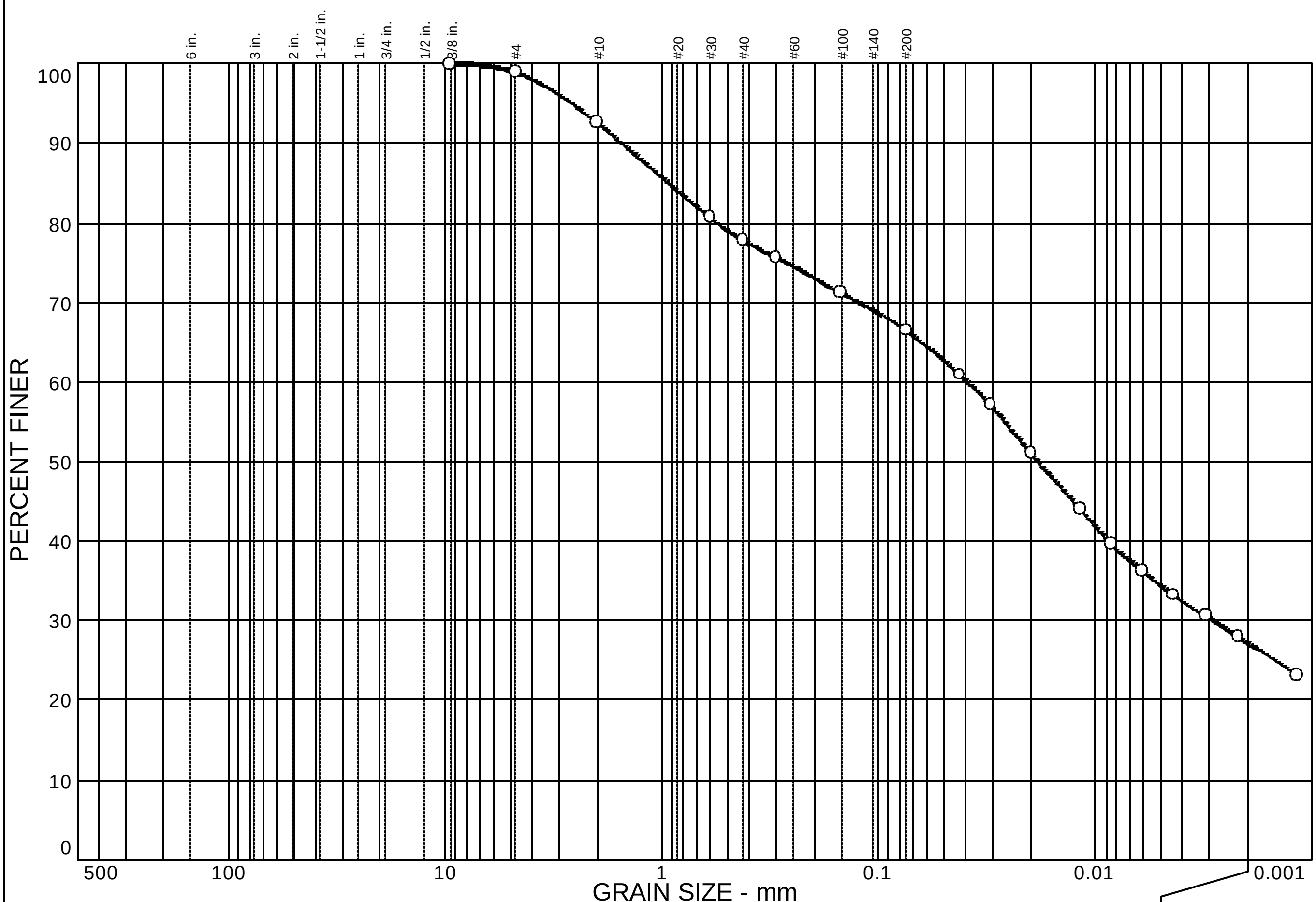
USCS= CL AASHTO=

Remarks

Sample No.: 1003897-002 **Source of Sample:** SA-SH-1 **Date:**
Location: **Elev./Depth:** 3.5'

COOPER TESTING LABORATORY	**Client:** McCampbell Analytical Inc. **Project:** SFPUC Habitat Restoration - 2009-021 **Project No:** 385-059 **Figure**

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0.0	1.1	32.4	39.2	27.3

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3/8 in.	100.0		
#4	98.9		
#10	92.6		
#30	80.7		
#40	77.8		
#50	75.7		
#100	71.2		
#200	66.5		
0.0424 mm.	60.9		
0.0305 mm.	57.1		
0.0199 mm.	51.0		
0.0118 mm.	44.1		
0.0085 mm.	39.7		
0.0061 mm.	36.3		
0.0044 mm.	33.2		
0.0031 mm.	30.6		
0.0022 mm.	28.0		
0.0012 mm.	23.2		

* (no specification provided)

Soil Description

Dark Brown Sandy CLAY

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= 0.932 D_{60}= 0.0390 D_{50}= 0.0185
D_{30}= 0.0029 D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= AASHTO=

Remarks

Sample No.: 1003897-003 **Source of Sample:** SA-SH-1 **Date:**
Location: **Elev./Depth:** 5.0'

COOPER TESTING LABORATORY

Client: McCampbell Analytical Inc.
Project: SFPUC Habitat Restoration - 2009-021

Project No: 385-059 **Figure**

Particle Size Distribution Report

% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0.0	7.3	33.7	31.6	27.4

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3/4 in.	100.0		
3/8 in.	98.6		
#4	92.7		
#10	81.9		
#30	73.6		
#40	71.6		
#50	69.2		
#100	64.3		
#200	59.0		
0.0428 mm.	51.7		
0.0309 mm.	47.9		
0.0199 mm.	44.1		
0.0117 mm.	39.9		
0.0084 mm.	38.0		
0.0060 mm.	34.2		
0.0043 mm.	32.3		
0.0031 mm.	30.4		
0.0022 mm.	28.0		
0.0012 mm.	23.8		

* (no specification provided)

Soil Description

Dark Gray Sandy Lean CLAY

Atterberg Limits

PL= 24.8 LL= 43.3 PI= 18.5

Coefficients

D_{85}= 2.60 D_{60}= 0.0828 D_{50}= 0.0374
D_{30}= 0.0029 D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= CL AASHTO=

Remarks

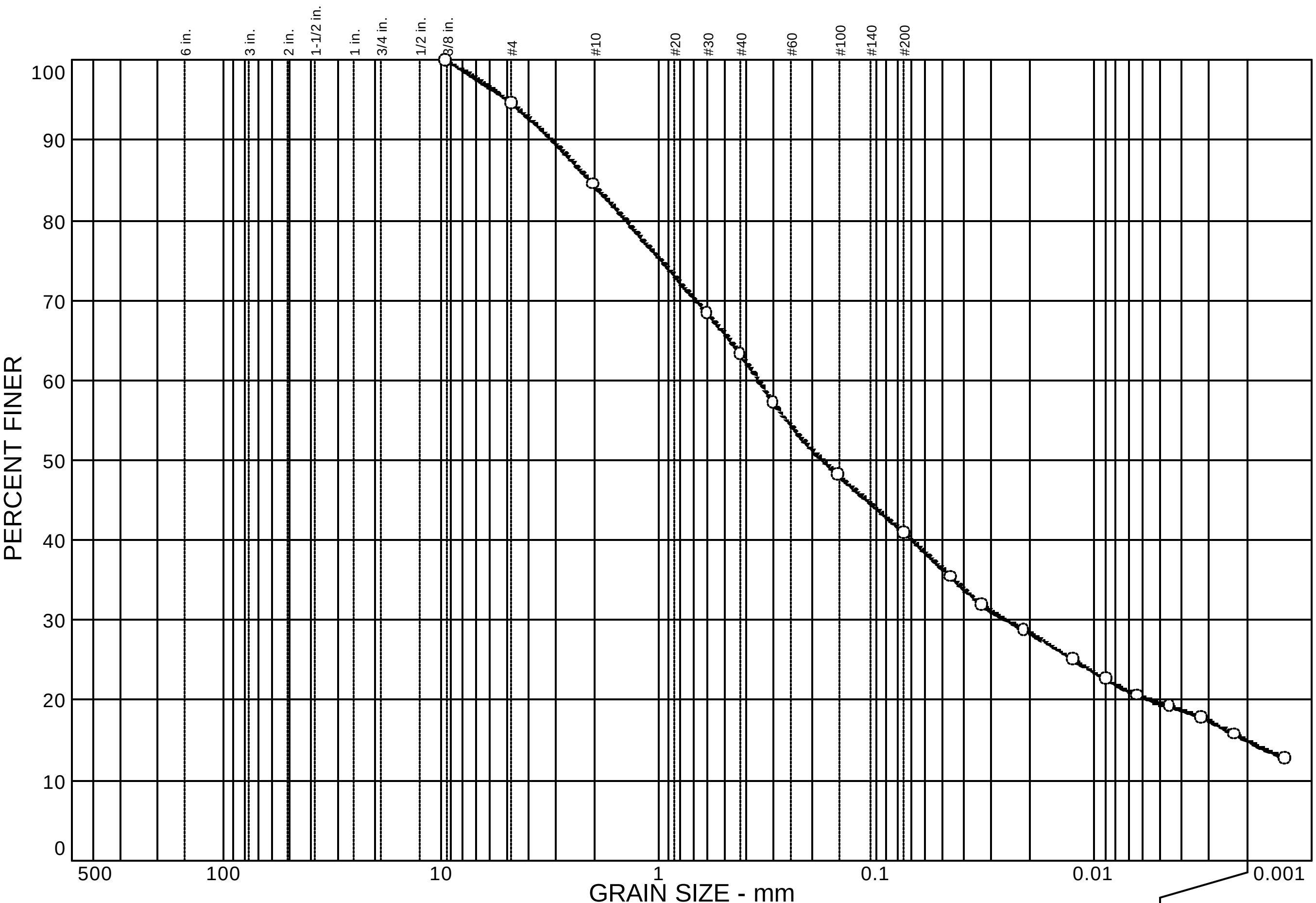
Sample No.: 1003897-004 **Source of Sample:** SA-SH-2 **Date:**
Location: **Elev./Depth:** 1.75'

COOPER TESTING LABORATORY

Client: McCampbell Analytical Inc.
Project: SFPUC Habitat Restoration - 2009-021

Project No: 385-059 **Figure**

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0.0	5.4	53.7	26.0	14.9

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3/8 in.	100.0		
#4	94.6		
#10	84.5		
#30	68.3		
#40	63.3		
#50	57.2		
#100	48.1		
#200	40.9		
0.0457 mm.	35.4		
0.0329 mm.	31.9		
0.0211 mm.	28.8		
0.0124 mm.	25.0		
0.0089 mm.	22.6		
0.0063 mm.	20.6		
0.0045 mm.	19.2		
0.0032 mm.	17.8		
0.0023 mm.	15.7		
0.0013 mm.	12.6		

* (no specification provided)

Soil Description

Brown Clayey Brown Clayey SAND

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= 2.08 D_{60}= 0.352 D_{50}= 0.178
D_{30}= 0.0255 D_{15}= 0.0020 D_{10}=
C_u= C_c=

Classification

USCS= AASHTO=

Remarks

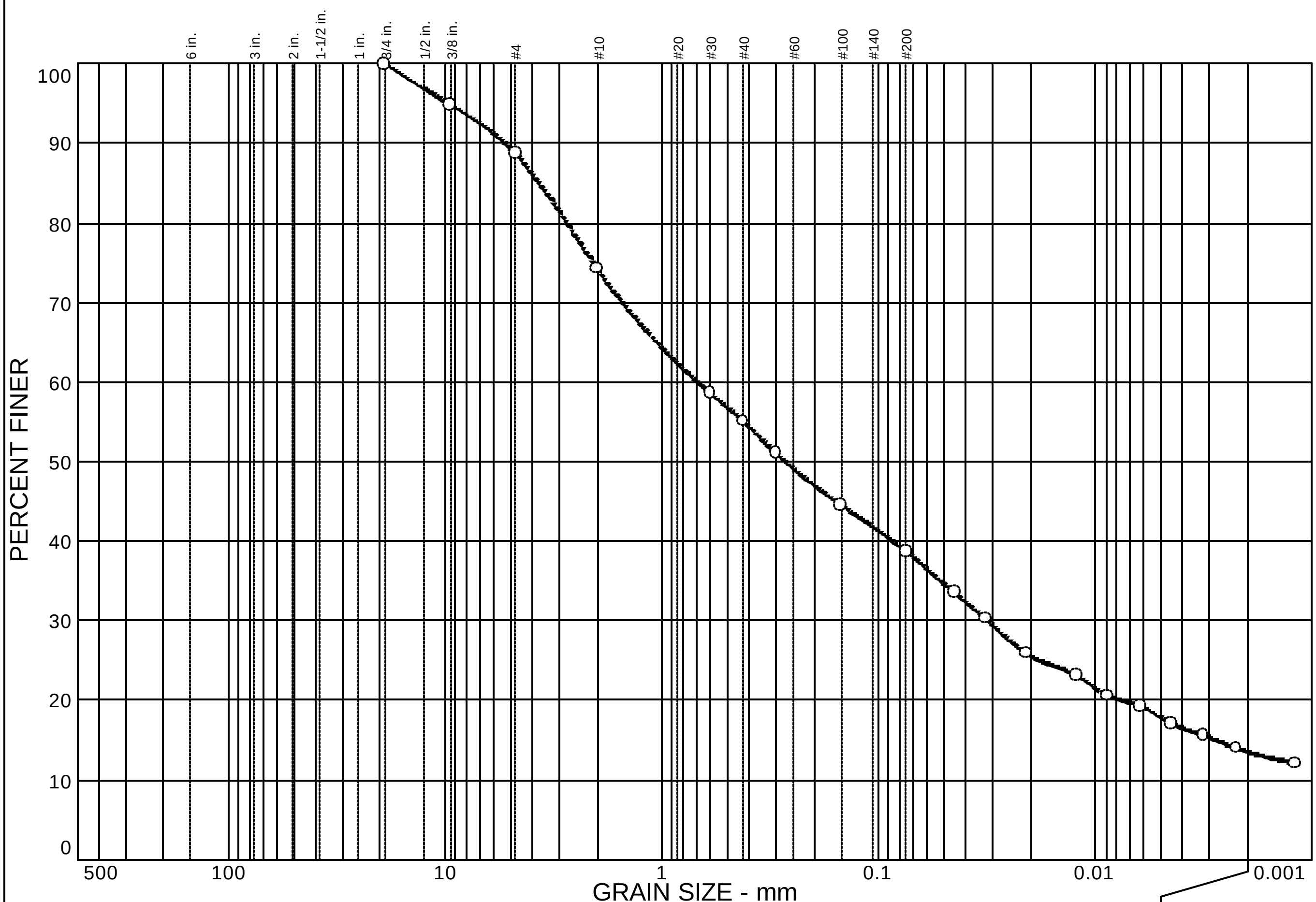
Sample No.: 1003897-005 **Source of Sample:** SA-SH-2 **Date:**
Location: **Elev./Depth:** 7.0

COOPER TESTING LABORATORY

Client: McCampbell Analytical Inc.
Project: SFPUC Habitat Restoration - 2009-021

Project No: 385-059 **Figure**

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0.0	11.3	50.0	25.2	13.5

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3/4 in.	100.0		
3/8 in.	94.9		
#4	88.7		
#10	74.3		
#30	58.6		
#40	55.1		
#50	51.1		
#100	44.6		
#200	38.7		
0.0448 mm.	33.5		
0.0323 mm.	30.3		
0.0209 mm.	25.9		
0.0123 mm.	23.1		
0.0088 mm.	20.6		
0.0063 mm.	19.3		
0.0045 mm.	17.1		
0.0032 mm.	15.6		
0.0022 mm.	14.0		
0.0012 mm.	12.1		

* (no specification provided)

Soil Description

Dark Gray Clayey SAND

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= 3.69 D_{60}= 0.687 D_{50}= 0.271
D_{30}= 0.0314 D_{15}= 0.0028 D_{10}=
C_u= C_c=

Classification

USCS= AASHTO=

Remarks

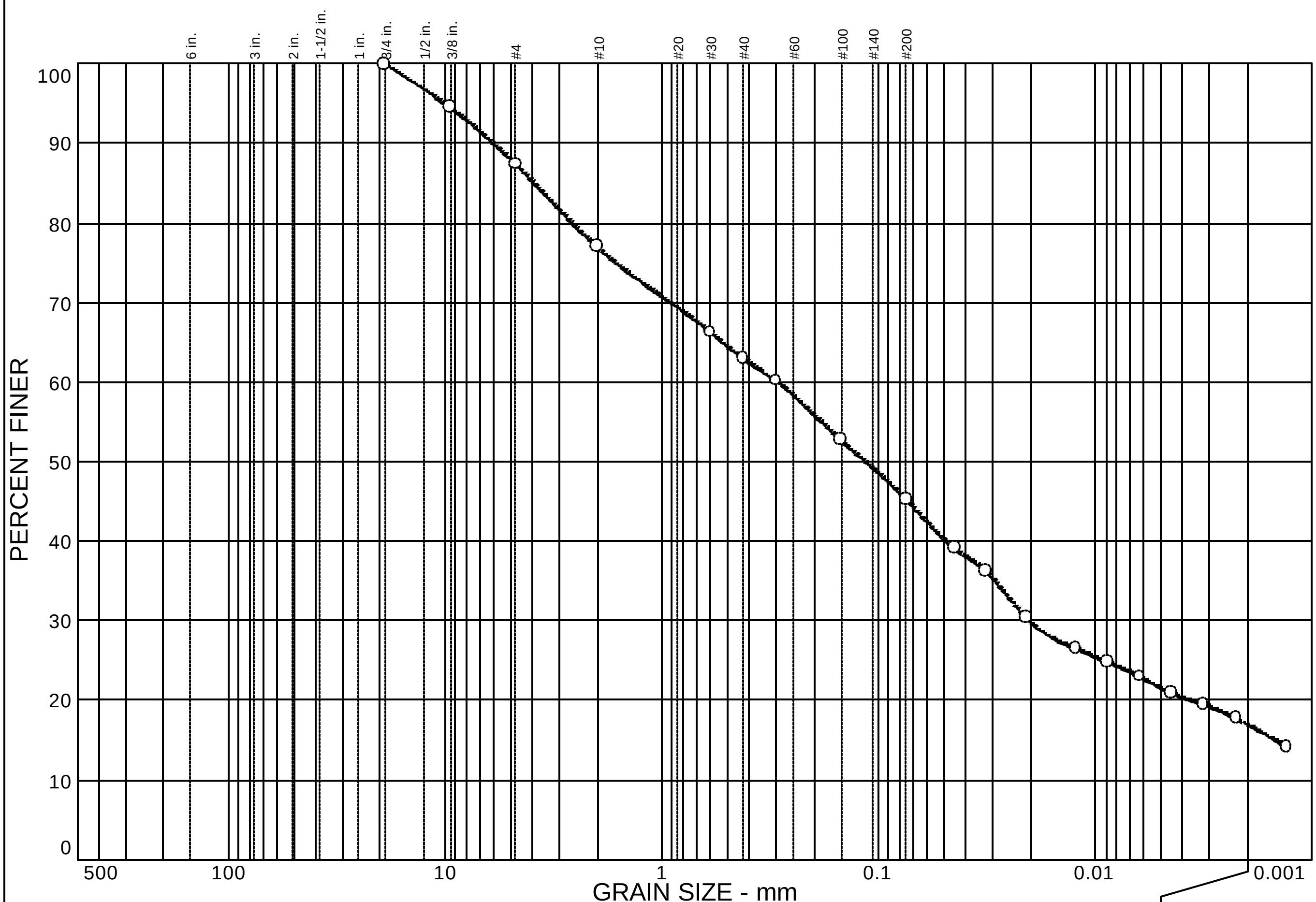
Sample No.: 1003897-006 **Source of Sample:** SA-SH-3 **Date:**
Location: **Elev./Depth:** 1.5'

COOPER TESTING LABORATORY

Client: McCampbell Analytical Inc.
Project: SFPUC Habitat Restoration - 2009-021

Project No: 385-059 **Figure**

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0.0	12.6	42.1	28.3	17.0

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3/4 in.	100.0		
3/8 in.	94.5		
#4	87.4		
#10	77.0		
#30	66.3		
#40	63.0		
#50	60.2		
#100	52.7		
#200	45.3		
0.0449 mm.	39.1		
0.0322 mm.	36.3		
0.0210 mm.	30.4		
0.0124 mm.	26.5		
0.0088 mm.	24.8		
0.0063 mm.	23.0		
0.0045 mm.	20.9		
0.0032 mm.	19.5		
0.0022 mm.	17.7		
0.0013 mm.	14.2		

* (no specification provided)

Soil Description

Dark Brown Clayey SAND

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= 3.89 D_{60}= 0.293 D_{50}= 0.116
D_{30}= 0.0203 D_{15}= 0.0015 D_{10}=
C_u= C_c=

Classification

USCS= AASHTO=

Remarks

Sample No.: 1003897-007 **Source of Sample:** SA-SH-3 **Date:**
Location: **Elev./Depth:** 4.5'

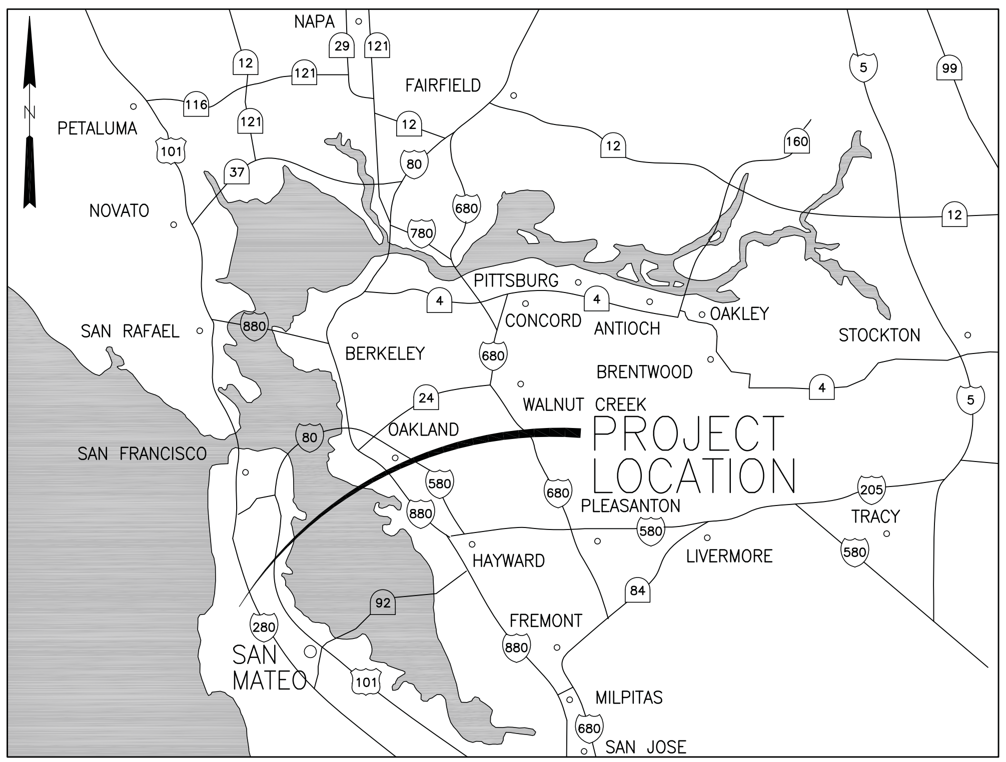
COOPER TESTING LABORATORY

Client: McCampbell Analytical Inc.
Project: SFPUC Habitat Restoration - 2009-021

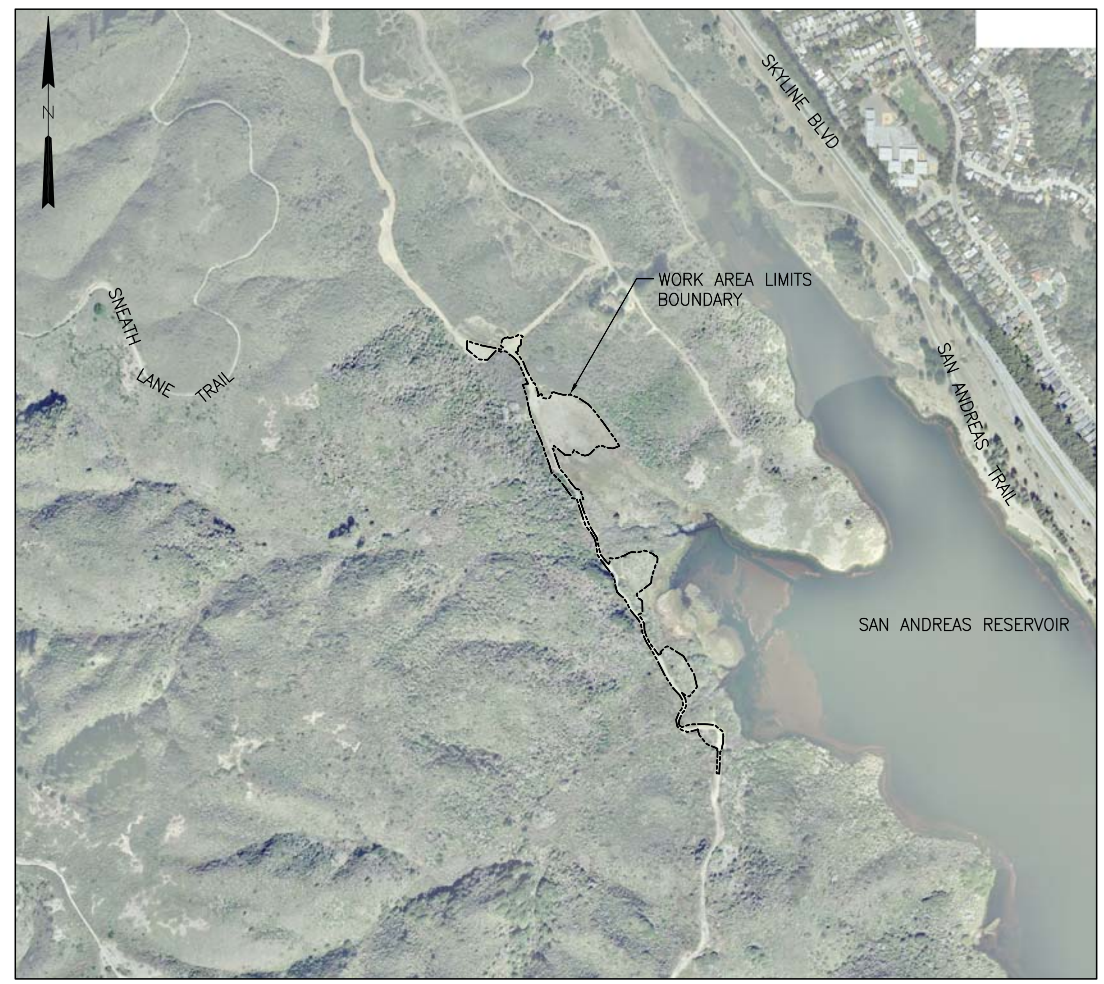
Project No: 385-059 **Figure**

APPENDIX C.
DRAFT PROJECT DRAWINGS

CITY AND COUNTY OF SAN FRANCISCO
PUBLIC UTILITIES COMMISSION
HABITAT RESERVE PROGRAM
SAN ANDREAS RESERVOIR WETLANDS CREATION PROJECT
CONTRACT NO. CS-954.B



VICINITY MAP
NTS



LOCATION MAP
NTS

INDEX OF DRAWINGS

Sht No.	Dwg. No.	Drawing Title
		GENERAL
1	G-1	COVER, VICINITY MAP, LOCATION MAP, AND INDEX OF DRAWINGS
2	G-2	ABBREVIATIONS, LEGENDS, SYMBOLS, AND GENERAL NOTES
3	G-3	KEY MAP, ACCESS ROAD, AND CONTRACTOR STAGING AREA
4	G-4	SURVEY CONTROL PLAN 1 OF 2
5	G-5	SURVEY CONTROL PLAN 2 OF 2
		CIVIL
6	GC-1	CIVIL DETAILS - 1
7	GC-2	CIVIL DETAILS - 2
8	GC-3	CIVIL DETAILS - 3
9	C-1	GRADING PLAN WETLAND A
10	C-2	GRADING PLAN WETLAND B
11	C-3	GRADING PLAN WETLANDS C & D
12	C-4	EXISTING CONDITIONS 1 OF 2
13	C-5	EXISTING CONDITIONS 2 OF 2
14	C-6	SWALE AND ROAD IMPROVEMENT SECTIONS - WETLAND A
		LANDSCAPE
15	L-1	SOIL PREPARATION, COARSE WOODY DEBRIS & HYDROSEEDING - WETLAND A
16	L-2	SOIL PREPARATION, COARSE WOODY DEBRIS & HYDROSEEDING - WETLAND B
17	L-3	SOIL PREPARATION, COARSE WOODY DEBRIS & HYDROSEEDING - WETLANDS C & D
18	L-4	PLANTING LEGEND, SCHEDULE & DETAILS
19	L-5	PLANTING PLAN - WETLAND A
20	L-6	PLANTING PLAN - WETLAND B
21	L-7	PLANTING PLAN - WETLANDS C & D

FOR THE SOLE USE OF THE DOCUMENT RECIPIENT - DO NOT CITE, COPY, OR CIRCULATE WITHOUT THE EXPRESSED PERMISSION OF THE SFPUC.

CONTRACT NO. CS-954.B

CITY AND COUNTY OF SAN FRANCISCO
PUBLIC UTILITIES COMMISSION
INFRASTRUCTURE DIVISION
ENGINEERING MANAGEMENT BUREAU

SAN ANDREAS WETLANDS CREATION PROJECT

COVER
VICINITY MAP, LOCATION MAP, AND INDEX OF DRAWINGS

RMC Water & Environment

PROJECT ENGINEER NBO	DRAWN SJ
PROJECT MANAGER MN	DESIGNED
APPROVAL	CHECKED MM

NO.	DATE	DESCRIPTION	BY	APPR'D

REVISIONS

CHECKED / APPROVED	DRAWN	SCALE AS SHOWN
SECTION MANAGER	DESIGNED	DATE
APPROVED MANAGER, ENGINEERING MANAGEMENT BUREAU	APPROVED MANAGER, WATER SUPPLY AND TREATMENT DIVISION	

SHEET	PLAN NO.	DRAWING NO.	REVISION NO.
1 OF 21		G-1	

100% SUBMITTAL

NOT FOR CONSTRUCTION

MAY 13, 2010

COORDINATE: NAD83
ELEVATION DATUM: NAVD 1988

PLOT: EXTEND
SCALE: 1:1
BORDER: 22,34
COLOR: No.
RED 0.70MM
YELLOW 0.20MM
GREEN 0.25MM
CYAN 0.40MM
BLUE 0.50MM
MAGENTA 0.20MM
WHITE 0.35MM
GRAY 0.15MM
9 0.15MM
10 1.00MM
100 0.70MM
210 0.60MM

FILE:

FOR REDUCED PLANS ORIGINAL SCALE IS IN INCHES
0 4

ABBREVIATIONS

@	AT
AB	ANCHOR BOLT, AGGREGATE BASE
ABC	AGGREGATE BASE COURSE (CALTRANS CLASS 2 AGGREGATE BASE)
ACI	AMERICAN CONCRETE INSTITUTE
ADJ	ADJACENT, ADJUSTABLE
ALT	ALTERNATE
ANSI	AMERICAN NATIONAL STANDARDS INSTITUTE
APPROX	APPROXIMATE
ARCH.	ARCHITECTURAL
AUX	AUXILIARY
BC	BOLT CIRCLE, BEGIN CURVE
BD	BOARD
BGS	BELOW GROUND SURFACE
BLDG	BUILDING
BM	BENCH MARK, BEAM
BOT	BOTTOM
BRG	BEARING
BVC	BEGINNING OF VERTICAL CURVE
C	CHANNEL (BEAM)
CB	CATCH BASIN
CDF	CONTROLLED DENSITY FILL
CFM	CUBIC FEET PER MINUTE
CFS	CUBIC FEET PER SECOND
CIRC	CIRCUMFERENTIAL
CLR	CLEAR
℄	CENTERLINE
CONC	CONCRETE, CONCENTRIC
COND	CONDUIT
CONT	CONTINUOUS
COORD	COORDINATE
CTD	CENTERED
CTR	CENTER
C TO C	CENTER TO CENTER
CU	CUBIC
CU FT	CUBIC FOOT
CU IN.	CUBIC INCH
CU YD	CUBIC YARD
°C	DEGREE CELSIUS
d	PENNY (NAIL SIZE)
D	DRAIN
DBL	DOUBLE
DET	DETAIL
DIA	DIAMETER
DIAG	DIAGONAL
DIR	DIRECTION
DN	DOWN
DWG	DRAWING
E	EAST
EA	EACH
EC	END CURVE
ECC	ECCENTRIC
EF	EACH FACE, EXHAUST FAN
EL, ELEV	ELEVATION
ENGR	ENGINEER
EP	EDGE OF PAVEMENT
EQ	EQUAL
EQ SP	EQUALLY SPACED, EQUAL SPACES
ESMT	EASEMENT
EVC	END OF VERTICAL CURVE
EW	EACH WAY
EWEF	EACH WAY, EACH FACE
EXC	EXCAVATE
EXP	EXPOSED
EXST	EXISTING
FAB	FABRICATION
FG	FINISH GRADE
FIG.	FIGURE
℄	FLOW LINE
FT	FOOT OR FEET
FUT	FUTURE
FWD	FORWARD
°F	DEGREE FAHRENHEIT
GAL	GALLON
GPD	GALLONS PER DAY
GPH	GALLONS PER HOUR
GPM	GALLONS PER MINUTE
GVL	GRAVEL
HGT	HEIGHT
HORIZ	HORIZONTAL
ID	INSIDE DIAMETER
IF.	INSIDE FACE
IN.	INCH
INSUL	INSULATE
INVT	INVERT
IRR, IRRIG	IRRIGATION
IE	INVERT ELEVATION
L	ANGLE, LENGTH
LB	POUNDS
LB/CU FT	POUNDS PER CUBIC FOOT
LF	LINEAR FEET
LONG.	LONGITUDINAL
LR	LONG RADIUS
LT	LEFT
MATL	MATERIAL
MAX	MAXIMUM
MFR	MANUFACTURER
MGD	MILLION GALLONS PER DAY
MIN	MINIMUM
MISC	MISCELLANEOUS
MTR	METER
MWS	MAXIMUM WATER SURFACE
N	NORTH
NIC	NOT IN CONTRACT
NO.	NUMBER
NTS	NOT TO SCALE
OC	ON CENTER
OD	OUTSIDE DIAMETER
OF.	OUTSIDE FACE, OVERFLOW
OSD	OPEN SITE DRAIN
OPNG	OPENING
OZ	OUNCE
PC	POINT OF CURVE
PCC	PORTLAND CEMENT CONCRETE, POINT OF COMPOUND CURVATURE
PE	PLAIN END
PH	POTHOLE
PI	POINT OF INTERSECTION
PL	PLASTIC, PROPERTY LINE, PLATE
ℙ	PLATE (STEEL)
PLYWD	PLYWOOD
PRC	POINT OF REVERSE CURVE
PRESS.	PRESSURE
PRI	PRIMARY
PROP	PROPERTY
PT	POINT, POINT OF TANGENCY
PVMT	PAVEMENT
R	RADIUS
RD	ROOF DRAIN, ROAD
RDW	REDWOOD
REF	REFER OR REFERENCE
REQD	REQUIRED
RM	ROOM
RO	ROUGH OPENING
RT	RIGHT
R/W	RIGHT-OF-WAY
SCFM	STANDARD CUBIC FEET PER MINUTE
SCH	SCHEDULE
SECT	SECTION
SHT	SHEET
SIM	SIMILAR
SL, SLP	SLOPE
SOLN	SOLUTION
SP	SPACE OR SPACES
SPEC	SPECIFICATIONS
SPLY	SUPPLY
SQ	SQUARE
SQ FT	SQUARE FOOT
SQ IN	SQUARE INCH
STA	STATION
STD	STANDARD
STR	STRAIGHT
STRL	STRUCTURAL
SYMM	SYMMETRICAL
T	TANGENT LENGTH
TAN.	TANGENT
TBM	TEMPORARY BENCH MARK
T&B	TOP AND BOTTOM
TC	TOP OF CURB
TECH	TECHNICAL
TEL	TELEPHONE
TEMP	TEMPERATURE
TF	TOP FACE, TOP FLAT
THD	THREAD
THK	THICK
THRU	THROUGH
TOS	TOP OF SLOPE, TOP OF STEEL
TP	TURNING POINT
TRANSV	TRANSVERSE
TW	TOP OF WALL
TYP	TYPICAL
UBC	UNIFORM BUILDING CODE
UNO	UNLESS NOTED OTHERWISE
USA	UNDERGROUND SERVICES ALERT
VAR	VARIOUS
VC	VERTICAL CURVE
VERT	VERTICAL
VPI	VERTICAL POINT OF INTERSECTION
W/	WITH
WP	WORK POINT
WS	WATER SURFACE, WATER STOP
WT	WEIGHT
WTR	WATER
YD	YARD

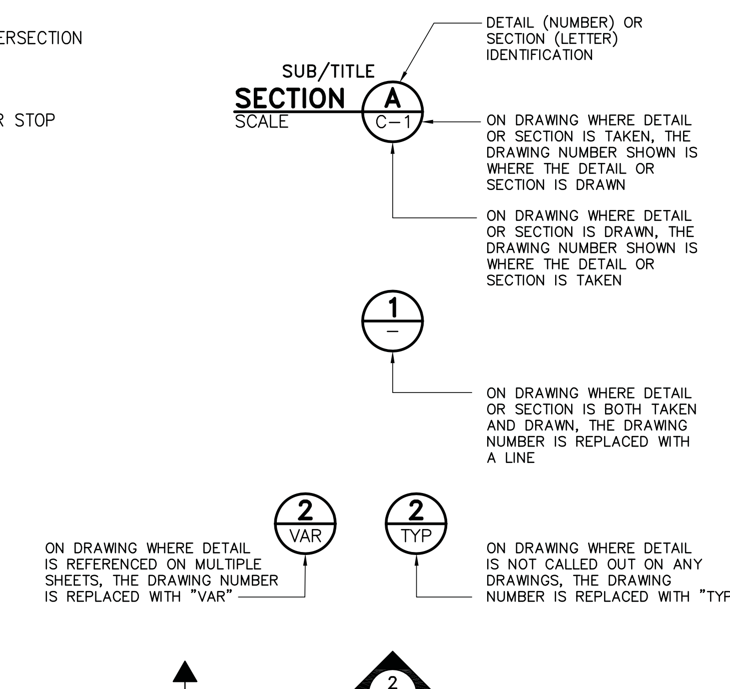
NOTE:

THIS IS A STANDARD ABBREVIATION SHEET. SOME ABBREVIATIONS THAT APPEAR ON THIS SHEET ARE NOT USED ON THIS PROJECT.

LEGEND

469	EXISTING CONTOURS
470	NEW CONTOURS
—x—x—x—	WILDLIFE EXCLUSION FENCING
— — —	WORK AREA LIMITS BOUNDARY
	GRASS PAVERS
	EROSION CONTROL BLANKET AND STRAW WATTLES
	ENVIRONMENTALLY SENSITIVE AREA
	BIOENGINEERED RIP RAP
	HYDROSEEDING
	SOIL PREPARATION
	COARSE WOODY DEBRIS
2	PHOTOGRAPH SYMBOL
	BOREHOLE SYMBOL
P	PIEZOMETER-WELL SYMBOL

SECTION AND DETAIL IDENTIFICATION



GENERAL NOTES

1. ELEVATIONS SHOWN ARE BASED ON THE NORTH AMERICAN VERTICAL DATUM 1988 (NAVD 88).
2. COORDINATES AND BEARINGS ARE BASED ON THE CALIFORNIA COORDINATE SYSTEM, ZONE 3 NORTH AMERICAN DATUM 1983 (NAD83).
3. CONTRACTOR SHALL RESTRICT ALL WORK TO BE WITHIN THE WORK AREA LIMITS BOUNDARY.
4. A TEMPORARY WILDLIFE EXCLUSION FENCE SHALL BE CONSTRUCTED ALONG THE WORK AREA LIMITS BOUNDARY AS SHOWN. IN AREAS WHERE FENCING IS NOT SHOWN, FENCING SHALL BE CONSTRUCTED WITHIN TWO (2) FEET FROM THE WORK AREA LIMITS BOUNDARY. CONTRACTOR SHALL COORDINATE EXACT LOCATION OF FENCING WITH THE CITY REPRESENTATIVE AND SHALL MAKE ADJUSTMENTS AS REQUIRED AT NO ADDITIONAL COST TO THE CITY. WILDLIFE EXCLUSION FENCE SHALL BE REMOVED AT THE COMPLETION OF PROJECT AND HOLES SHALL BE TILLED AND COMPACTED PER SPECIFICATION 01062.
5. CONTRACTOR SHALL MOW GRASSES ALONG THE ROADWAY LOCATED WITHIN THE WORK AREA LIMITS BOUNDARY. MOWING SHALL BE CONDUCTED ON A REGULAR BASIS DURING ACTIVE CONSTRUCTION PERIODS TO MAINTAIN GRASS HEIGHT AT 2-INCHES OR LESS.
6. CONTRACTOR SHALL CONDUCT ALL WORK IN ACCORDANCE WITH THE CONTRACT DOCUMENTS.
7. CONTRACTOR SHALL KEEP AND MAKE AVAILABLE A COPY OF THE APPROVED PLANS AND THE STORMWATER POLLUTION PREVENTION PLAN (SWPPP) AT THE JOB SITE WHEN WORK IS IN PROGRESS.
8. CONTRACTOR SHALL BE RESPONSIBLE FOR COORDINATING INSPECTIONS PERFORMED BY OTHER GOVERNMENTAL AGENCIES, AS PRESCRIBED IN THEIR PERMITS AND APPROVALS. THE PRESENCE OR ABSENCE OF A CITY OR OTHER INSPECTOR SHALL NOT RELIEVE THE CONTRACTOR OF FULL RESPONSIBILITY FOR THE PROPER PERFORMANCE OF THE WORK.
9. CONTRACTOR SHALL KEEP THE ROAD AND WORK SITE CLEAN AND FREE FROM RUBBISH AND DEBRIS. THIS REQUIRES PREVENTING SPILLAGE ON HAUL ROUTES, CLEANING UP SPILLAGE, AND KEEPING THE WORK SITE IN A CLEAN AND NEAT APPEARANCE. ANY SPILLAGE ON HAUL ROUTES SHALL BE IMMEDIATELY REMOVED AND CLEANED UP.
10. CONTRACTOR SHALL SUBMIT A STAGING AREA PLAN FOR THE CITY'S APPROVAL (SEE SHEET G-3).
11. CONTRACTOR SHALL FIELD VERIFY ALL DIMENSIONS AND CONDITIONS AND REPORT ALL MAJOR DISCREPANCIES TO THE ENGINEER AS A SUBMITTAL.
12. CONSTRUCTION EQUIPMENT USED ON THIS PROJECT SHALL BE SELECTED TO MINIMIZE DAMAGE TO THE EXISTING PAVEMENT ALONG THE ACCESS ROAD. THE CONTRACTOR SHALL REPLACE AT NO ADDITIONAL COST TO THE CITY DAMAGED AC PAVEMENT IN ACCORDANCE WITH THE CONTRACT DOCUMENTS.
13. THE CONTRACTOR SHALL MAINTAIN VEHICLE ACCESS ALONG THE ACCESS ROAD THROUGHOUT THE PERIOD OF CONSTRUCTION.
14. CONTRACTOR SHALL DEMOLISH PIEZOMETER WELLS ACCORDING TO THE CALIFORNIA DEPARTMENT OF WATER RESOURCES (DWR) BULLETIN 74-90 AND THE PROCEDURES REQUIRED BY THE SAN MATEO COUNTY ENVIRONMENTAL HEALTH DIVISION. REFER TO SPECIFICATION 01062 FOR ADDITIONAL DETAILS.
15. GRADES BETWEEN CONTOURS AND BETWEEN CONTOURS AND THE WILDLIFE EXCLUSION FENCE SHALL BE UNIFORM SLOPING.
16. HYDROSEEDING SHALL NOT EXTEND BEYOND THE WILDLIFE EXCLUSION FENCE LINE EXCEPT FOR THE UNPAVED ACCESS ROAD AS SHOWN ON DRAWING L-1.

CONTRACT NO. CS-954.B

CITY AND COUNTY OF SAN FRANCISCO
PUBLIC UTILITIES COMMISSION
INFRASTRUCTURE DIVISION
ENGINEERING MANAGEMENT BUREAU

SAN ANDREAS WETLANDS CREATION PROJECT

ABBREVIATIONS, LEGENDS, SYMBOLS AND GENERAL NOTES

RMC Water & Environment

PROJECT ENGINEER: NBO | DRAWN: SJ
PROJECT MANAGER: MN | DESIGNED:
APPROVAL: | CHECKED: MM

NO.	DATE	DESCRIPTION	BY	APPR'D
REVISIONS				

CHECKED / APPROVED | DRAWN | SCALE: AS SHOWN
SECTION MANAGER | DESIGNED | DATE
APPROVED | APPROVED
MANAGER, ENGINEERING MANAGEMENT BUREAU | MANAGER, WATER SUPPLY AND TREATMENT DIVISION

SHEET 2 OF 21 | PLAN NO. | DRAWING NO. G-2 | REVISION NO.

100% SUBMITTAL

NOT FOR CONSTRUCTION

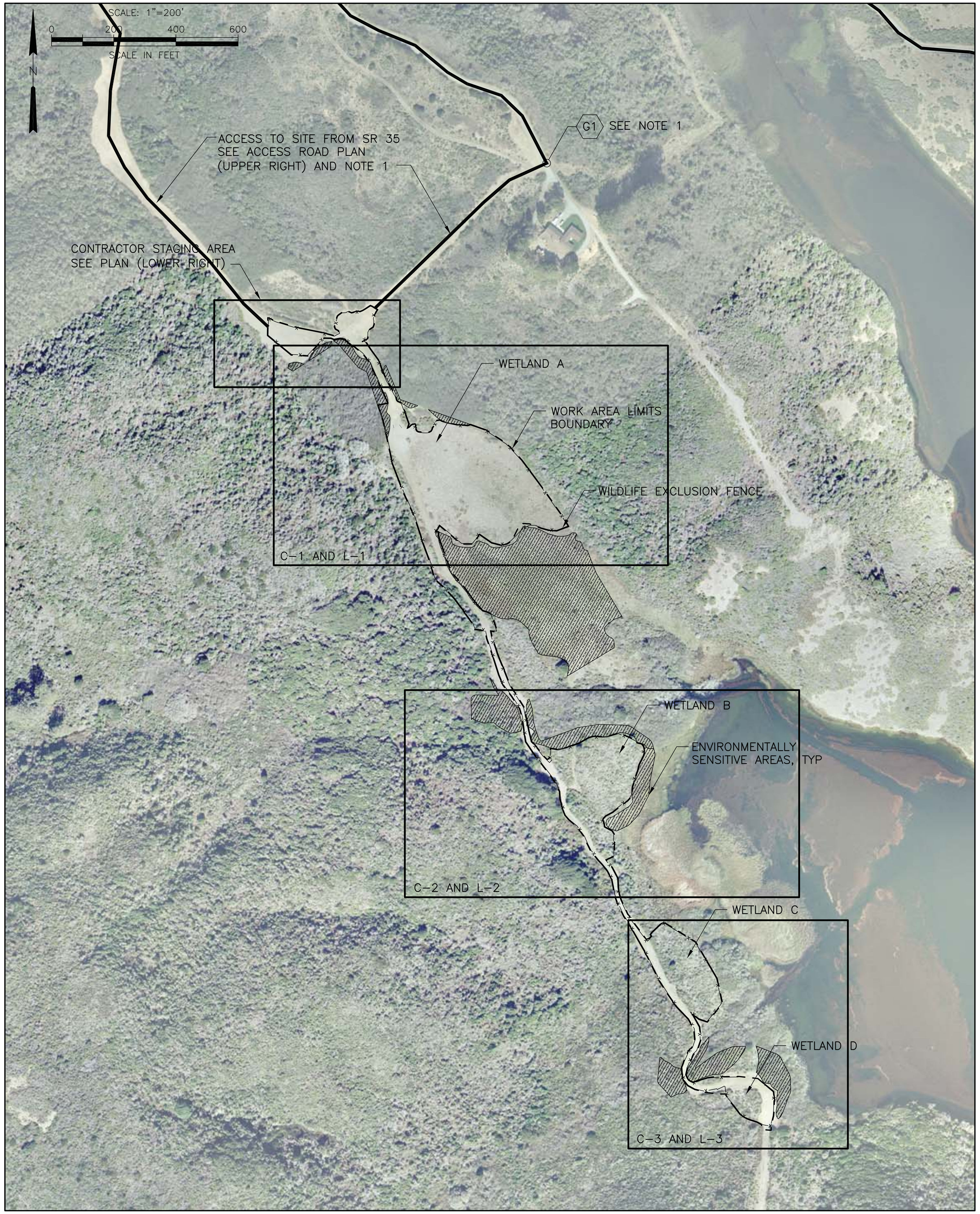
MAY 13, 2010

COORDINATE: NAD83
ELEVATION DATUM: NAVD 1988

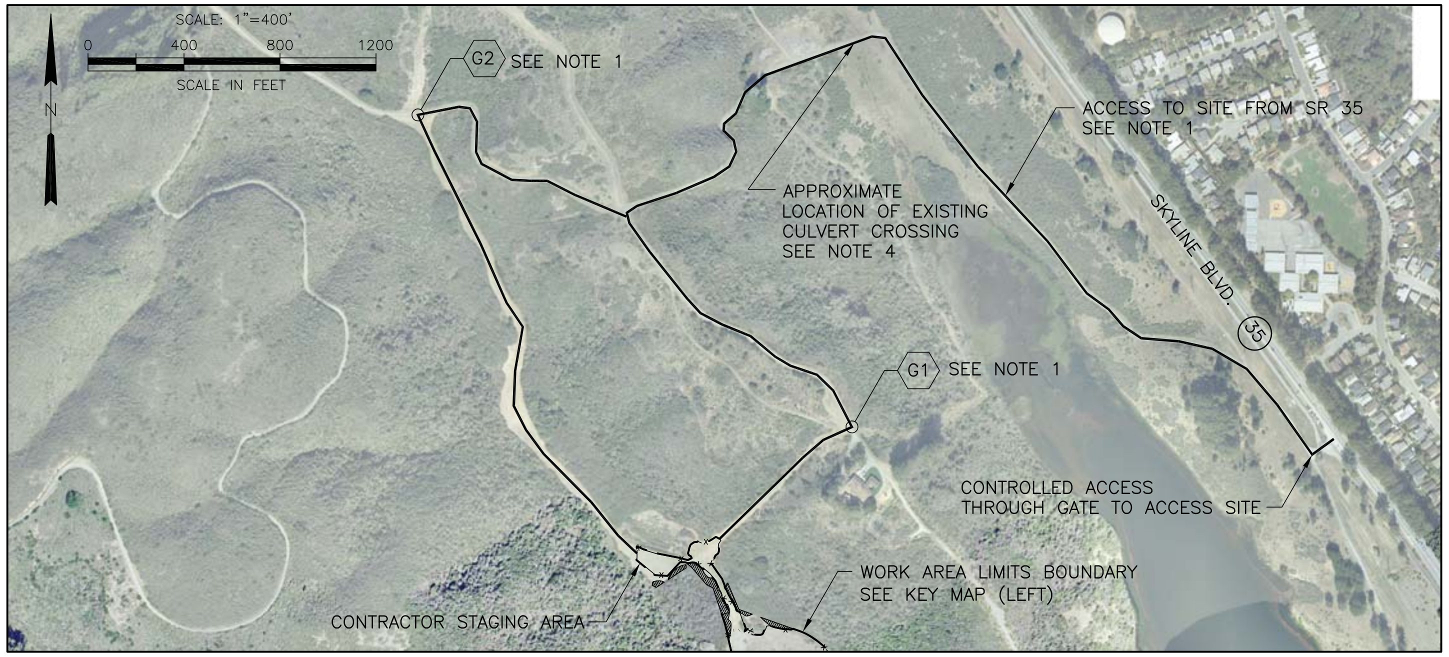
PLOT: EXTEND
SCALE: 1:1
BORDER: 22,34
COLOR: No.
RED 0.70MM
YELLOW 0.20MM
GREEN 0.25MM
CYAN 0.40MM
BLUE 0.50MM
MAGENTA 0.20MM
WHITE 0.35MM
GRAY 0.15MM
9 0.15MM
10 1.00MM
100 0.70MM
210 0.60MM

FILE:

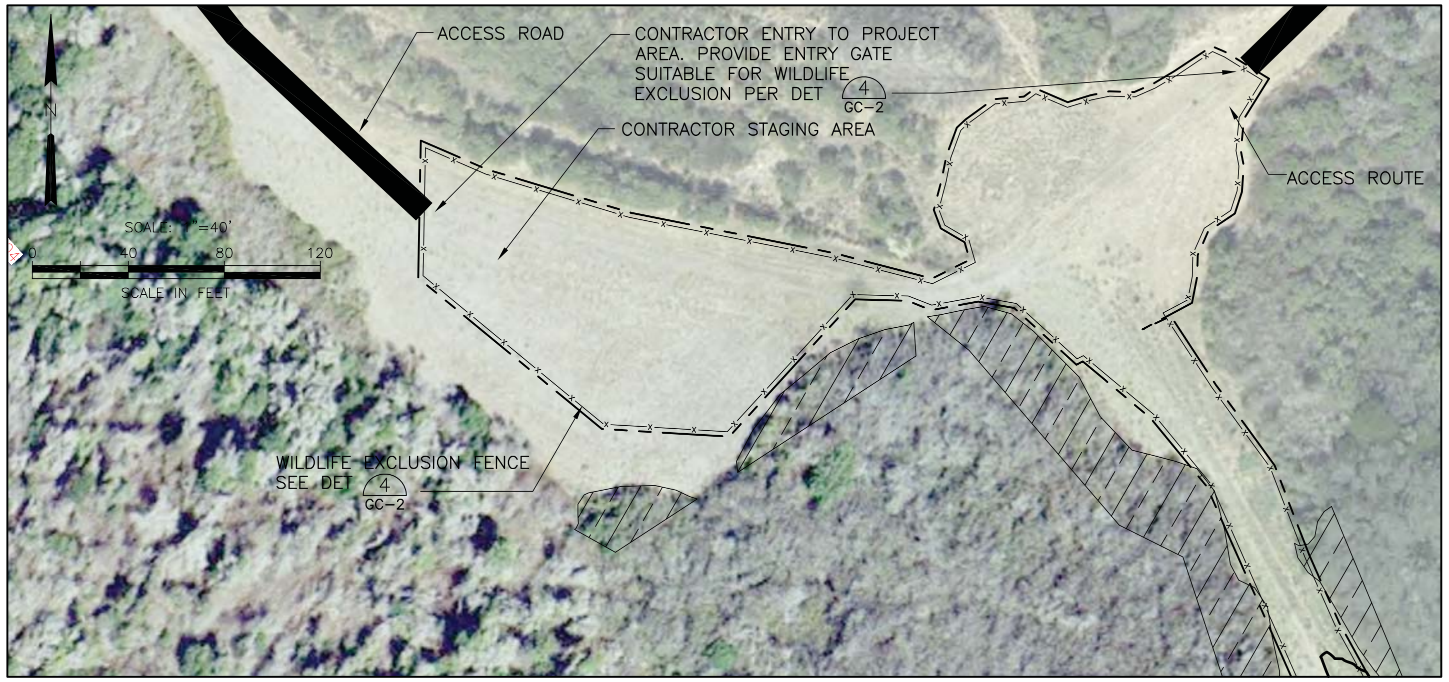
FOR REDUCED PLANS ORIGINAL SCALE IS IN INCHES 0 1 4



KEY MAP
PLAN
1" = 200'



ACCESS ROAD
PLAN
1" = 400'



STAGING AREA
PLAN
1" = 40'

NOTES:

1. ACCESS ROAD FROM SR 35 IS PAVED TO POINT G1 (NORTHING: 2051052; EASTING: 5999028) AND G2 (NORTHING: 2052352; EASTING: 5997219). ACCESS ROAD FROM POINT G1 OR G2 TO THE CONTRACTOR STAGING AREA IS UNPAVED.
2. CONTRACTOR SHALL KEEP PAVED ROADWAY CLEAN OF SOIL.
3. AT COMPLETION OF CONSTRUCTION ACTIVITIES CONTRACTOR SHALL RESTORE ORIGINAL EXISTING GRADES TO THE STAGING AREA.
4. CONTRACTOR SHALL PROTECT EXISTING CULVERT CROSSING FROM DAMAGE DUE TO TRAFFIC LOADS DURING CONSTRUCTION.

CONTRACT NO. CS-954.B

CITY AND COUNTY OF SAN FRANCISCO
PUBLIC UTILITIES COMMISSION
INFRASTRUCTURE DIVISION
ENGINEERING MANAGEMENT BUREAU

SAN ANDREAS WETLANDS CREATION PROJECT

KEY MAP,
ACCESS ROAD,
AND CONTRACTOR STAGING AREA

RMC
Water & Environment

PROJECT ENGINEER	DRAWN
NBO	SJ
PROJECT MANAGER	DESIGNED
MN	
APPROVAL	CHECKED
	MM

NO.	DATE	DESCRIPTION	BY	APPR'D
REVISIONS				

CHECKED / APPROVED	DRAWN	SCALE
		AS SHOWN
SECTION MANAGER	DESIGNED	DATE
APPROVED	APPROVED	
MANAGER, ENGINEERING MANAGEMENT BUREAU	MANAGER, WATER SUPPLY AND TREATMENT DIVISION	

SHEET	PLAN NO.	DRAWING NO.	REVISION NO.
3 OF 21		G-3	

100% SUBMITTAL

NOT FOR CONSTRUCTION

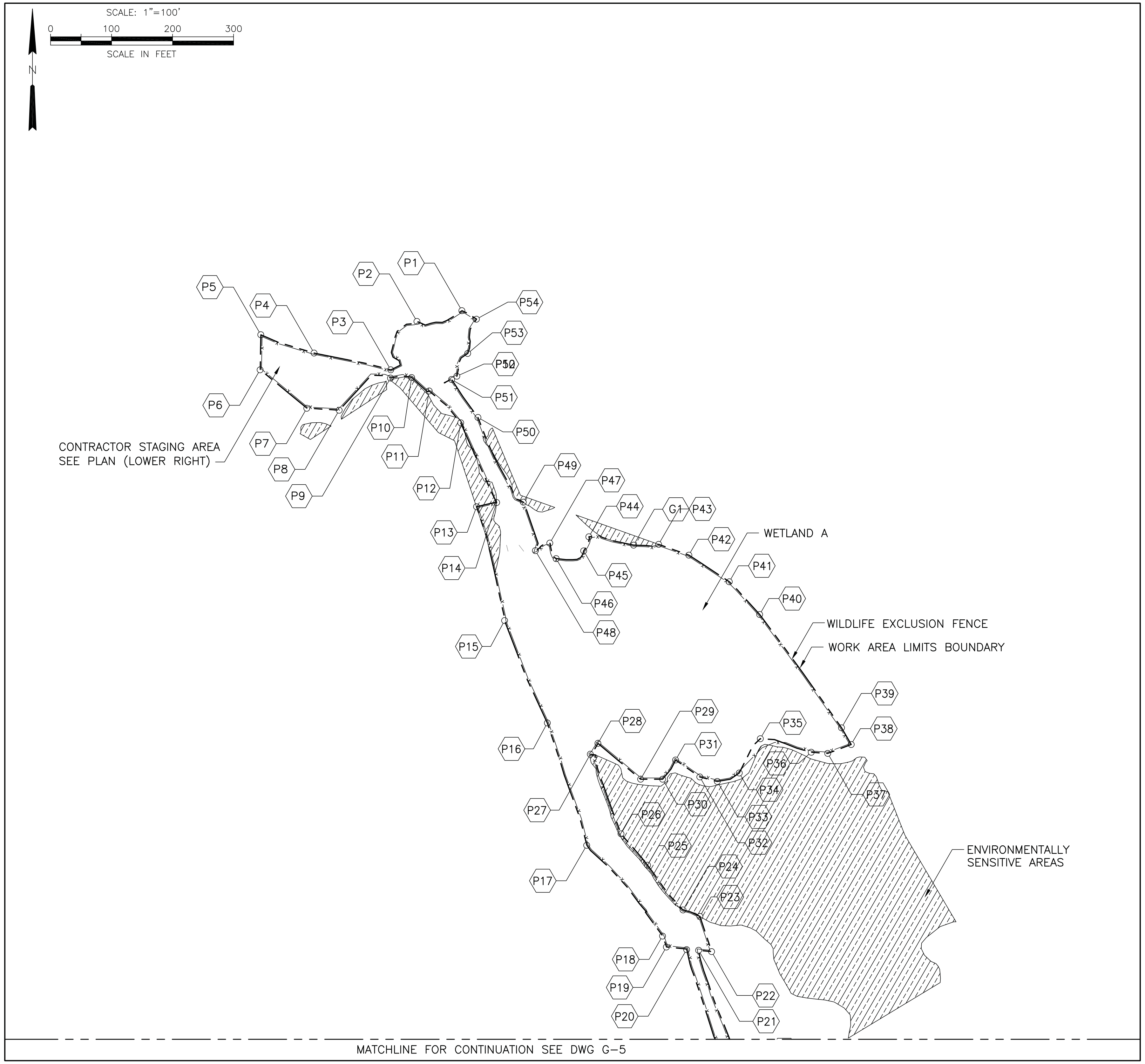
MAY 13, 2010

COORDINATE: NAD83
ELEVATION DATUM: NAVD 1988

PLOT: EXTEND
SCALE: 1:1
BORDER:
22,34
COLOR: No.
RED 0.70MM
YELLOW 0.20MM
GREEN 0.25MM
CYAN 0.40MM
BLUE 0.50MM
MAGENTA 0.20MM
WHITE 0.35MM
GRAY 0.15MM
9 0.15MM
10 1.00MM
100 0.70MM
210 0.60MM

FILE:

FOR REDUCED PLANS ORIGINAL SCALE IS IN INCHES
0 4



PLAN
1" = 100'

WORK AREA LIMITS BOUNDARY COORDINATES		
POINT ID	NORTHING	EASTING
P1	2050594.80	5998461.20
P2	2050577.22	5998387.55
P3	2050497.92	5998344.53
P4	2050525.36	5998218.91
P5	2050555.42	5998131.53
P6	2050498.18	5998130.46
P7	2050435.23	5998206.95
P8	2050432.00	5998260.05
P9	2050484.75	5998344.18
P10	2050485.64	5998378.74
P11	2050463.41	5998407.33
P12	2050411.23	5998459.02
P13	2050273.72	5998484.98
P14	2050280.58	5998517.95
P15	2050087.14	5998530.97
P16	2049919.35	5998601.04
P17	2049718.99	5998665.85
P18	2049570.17	5998790.11
P19	2049552.19	5998796.41
P20	2049548.03	5998829.60
P21	2049546.78	5998848.98
P22	2049544.59	5998870.27
P23	2049602.13	5998851.04
P24	2049612.87	5998823.43
P25	2049686.17	5998765.29
P26	2049737.61	5998721.78
P27	2049868.14	5998671.49

WORK AREA LIMITS BOUNDARY COORDINATES		
POINT ID	NORTHING	EASTING
P28	2049885.89	5998683.94
P29	2049827.16	5998753.94
P30	2049827.16	5998789.98
P31	2049858.57	5998811.23
P32	2049830.85	5998850.97
P33	2049823.46	5998879.61
P34	2049837.32	5998915.65
P35	2049893.45	5998950.13
P36	2049871.34	5999033.54
P37	2049869.45	5999060.65
P38	2049883.95	5999099.12
P39	2049911.36	5999083.20
P40	2050097.08	5998949.04
P41	2050150.68	5998899.22
P42	2050194.30	5998833.00
P43	2050212.00	5998783.42
P44	2050224.40	5998669.08
P45	2050201.35	5998660.59
P46	2050188.61	5998615.40
P47	2050214.09	5998605.09
P48	2050201.65	5998581.43
P49	2050281.20	5998561.58
P50	2050420.04	5998487.25
P51	2050482.24	5998444.06
P52	2050487.76	5998452.89
P53	2050525.00	5998470.70
P54	2050580.76	5998484.57

CONTRACT NO. CS-954.B

CITY AND COUNTY OF SAN FRANCISCO
PUBLIC UTILITIES COMMISSION
INFRASTRUCTURE DIVISION
ENGINEERING MANAGEMENT BUREAU

SAN ANDREAS WETLANDS CREATION PROJECT

SURVEY CONTROL PLAN 1 OF 2

RMC Water & Environment

PROJECT ENGINEER NBO | DRAWN SJ
PROJECT MANAGER MN | DESIGNED
APPROVAL | CHECKED MM

NO. | DATE | DESCRIPTION | BY | APPR'D
REVISIONS

CHECKED / APPROVED | DRAWN | SCALE AS SHOWN
SECTION MANAGER | DESIGNED | DATE
APPROVED | APPROVED
MANAGER, ENGINEERING MANAGEMENT BUREAU | MANAGER, WATER SUPPLY AND TREATMENT DIVISION

SHEET 4 OF 21 | PLAN NO. | DRAWING NO. G-4 | REVISION NO.

100% SUBMITTAL

NOT FOR CONSTRUCTION

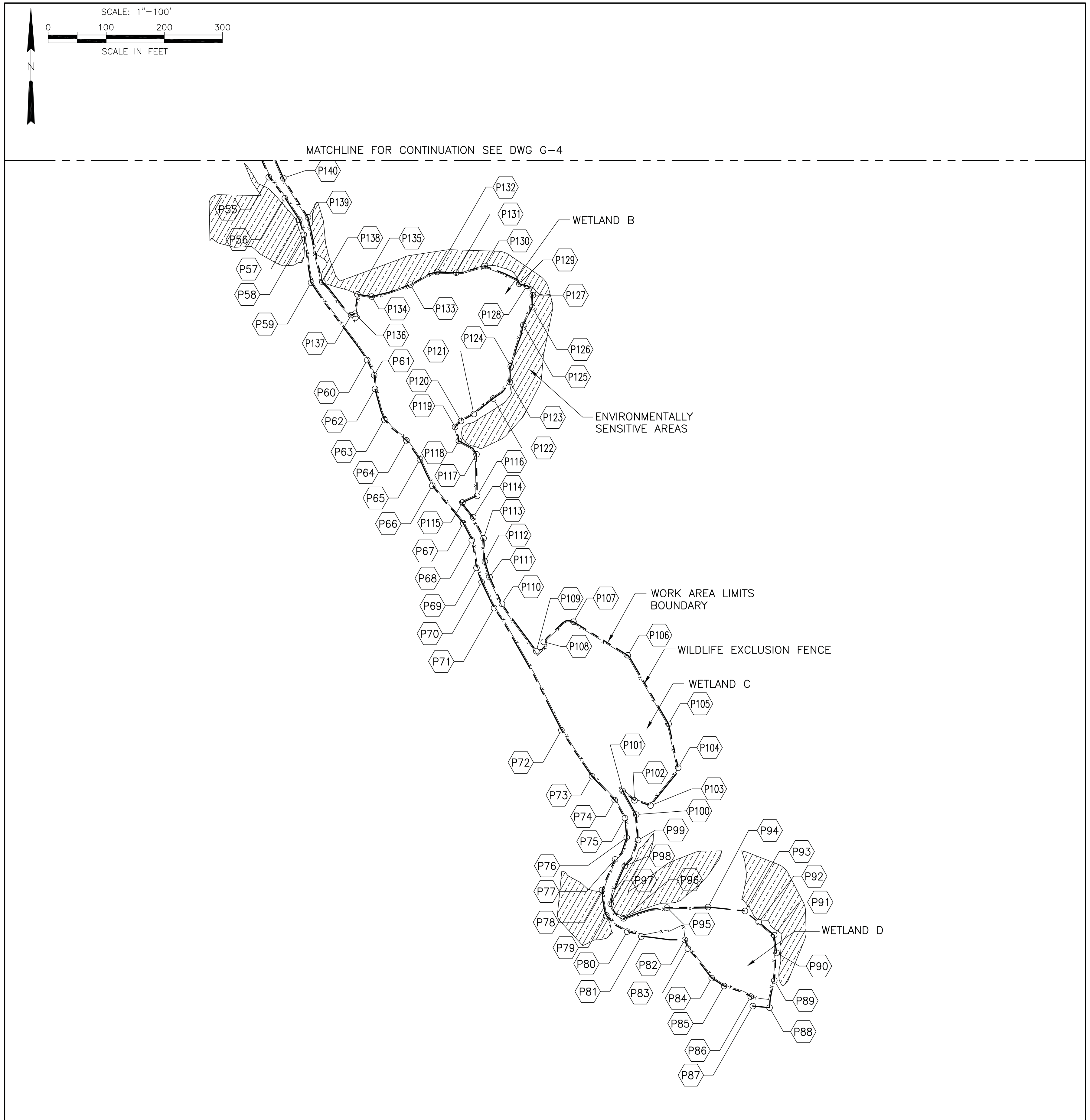
MAY 13, 2010

COORDINATE: NAD83
ELEVATION DATUM: NAVD 1988

PLOT: EXTEND
SCALE: 1:1
BORDER: 22,34
COLOR: No.
RED 0.70MM
YELLOW 0.20MM
GREEN 0.25MM
CYAN 0.40MM
BLUE 0.50MM
MAGENTA 0.20MM
WHITE 0.35MM
GRAY 0.15MM
9 0.15MM
10 1.00MM
100 0.70MM
210 0.60MM

FILE:

FOR REDUCED PLANS ORIGINAL SCALE IS IN INCHES 0 4



PLAN
1" = 100'

WORK AREA LIMITS BOUNDARY COORDINATES		
POINT ID	NORTHING	EASTING
P55	2049373.08	5998887.84
P56	2049336.82	5998915.52
P57	2049298.91	5998940.32
P58	2049272.91	5998948.08
P59	2049190.73	5998960.56
P60	2049057.03	5999057.30
P61	2049030.83	5999069.26
P62	2049007.53	5999070.73
P63	2048954.87	5999086.85
P64	2048918.76	5999124.81
P65	2048885.85	5999148.23
P66	2048840.79	5999169.27
P67	2048776.00	5999222.63
P68	2048746.75	5999237.29
P69	2048699.10	5999245.43
P70	2048674.60	5999254.29
P71	2048629.77	5999275.71
P72	2048419.54	5999391.74
P73	2048340.00	5999444.30
P74	2048298.99	5999483.49
P75	2048267.85	5999501.06
P76	2048234.51	5999504.16
P77	2048196.89	5999484.14
P78	2048144.16	5999461.76
P79	2048100.34	5999469.14
P80	2048072.52	5999504.76
P81	2048064.06	5999529.33
P82	2048058.24	5999604.23
P83	2048043.21	5999609.41
P84	2047992.46	5999650.44
P85	2047978.64	5999671.92
P86	2047960.58	5999717.69
P87	2047944.08	5999721.26
P88	2047941.44	5999750.14
P89	2047988.25	5999758.26
P90	2048035.69	5999762.13
P91	2048066.29	5999758.03
P92	2048088.96	5999731.42
P93	2048107.93	5999707.61
P94	2048114.73	5999644.33
P95	2048113.78	5999573.45
P96	2048095.20	5999498.72
P97	2048120.16	5999476.53
P98	2048185.57	5999500.83
P99	2048230.06	5999523.77
P100	2048274.11	5999520.29

WORK AREA LIMITS BOUNDARY COORDINATES		
POINT ID	NORTHING	EASTING
P101	2048314.59	5999497.13
P102	2048298.62	5999517.57
P103	2048289.55	5999545.07
P104	2048354.72	5999592.79
P105	2048430.28	5999576.23
P106	2048548.46	5999505.90
P107	2048606.30	5999412.47
P108	2048571.64	5999361.30
P109	2048555.62	5999348.47
P110	2048637.28	5999289.36
P111	2048683.09	5999267.96
P112	2048710.00	5999259.90
P113	2048750.03	5999257.64
P114	2048786.18	5999239.87
P115	2048811.77	5999221.37
P116	2048823.14	5999246.57
P117	2048894.80	5999245.53
P118	2048917.90	5999215.04
P119	2048941.93	5999208.57
P120	2048952.09	5999218.73
P121	2048964.11	5999240.91
P122	2048990.90	5999274.18
P123	2049019.55	5999302.82
P124	2049046.14	5999304.45
P125	2049117.35	5999326.00
P126	2049148.27	5999341.46
P127	2049168.88	5999342.39
P128	2049185.25	5999332.61
P129	2049188.46	5999319.11
P130	2049219.21	5999259.51
P131	2049207.68	5999210.47
P132	2049208.85	5999177.55
P133	2049187.00	5999131.82
P134	2049166.61	5999065.12
P135	2049170.40	5999040.36
P136	2049136.85	5999036.12
P137	2049134.55	5999029.61
P138	2049191.80	5998979.97
P139	2049302.92	5998955.32
P140	2049370.69	5998912.99

CONTRACT NO. CS-954.B

CITY AND COUNTY OF SAN FRANCISCO
PUBLIC UTILITIES COMMISSION
INFRASTRUCTURE DIVISION
ENGINEERING MANAGEMENT BUREAU

SAN ANDREAS WETLANDS CREATION PROJECT

SURVEY CONTROL PLAN 2 OF 2

RMC Water & Environment

PROJECT ENGINEER NBO | DRAWN SJ
PROJECT MANAGER MN | DESIGNED
APPROVAL | CHECKED MM

CHECKED / APPROVED | DRAWN | SCALE AS SHOWN
SECTION MANAGER | DESIGNED | DATE
APPROVED | APPROVED
MANAGER, ENGINEERING MANAGEMENT BUREAU | MANAGER, WATER SUPPLY AND TREATMENT DIVISION

NO.	DATE	DESCRIPTION	BY	APPR'D
REVISIONS				

100% SUBMITTAL

NOT FOR CONSTRUCTION

MAY 13, 2010

COORDINATE: NAD83
ELEVATION DATUM: NAVD 1988

SHEET 5 OF 21 | PLAN NO. | DRAWING NO. G-5 | REVISION NO.

PLOT: EXTEND
SCALE: 1:1
BORDER: 22,34
COLOR: No.
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YELLOW 0.20MM
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CYAN 0.40MM
BLUE 0.50MM
MAGENTA 0.20MM
WHITE 0.35MM
GRAY 0.15MM
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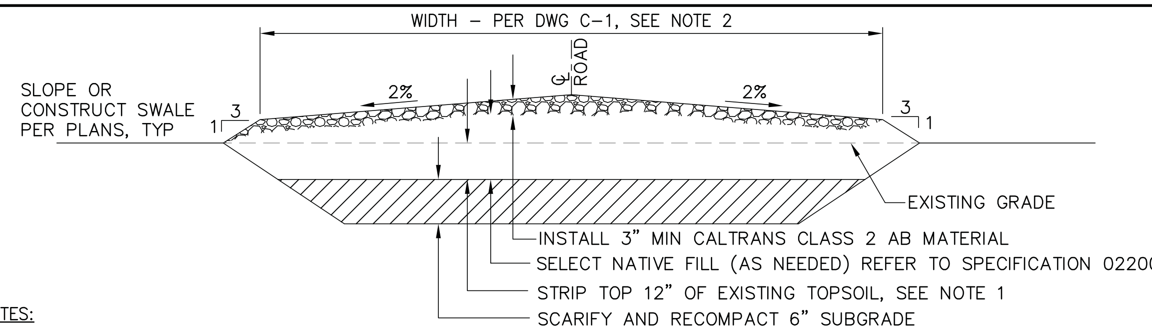
10 1.00MM
100 0.70MM
210 0.60MM

FILE:

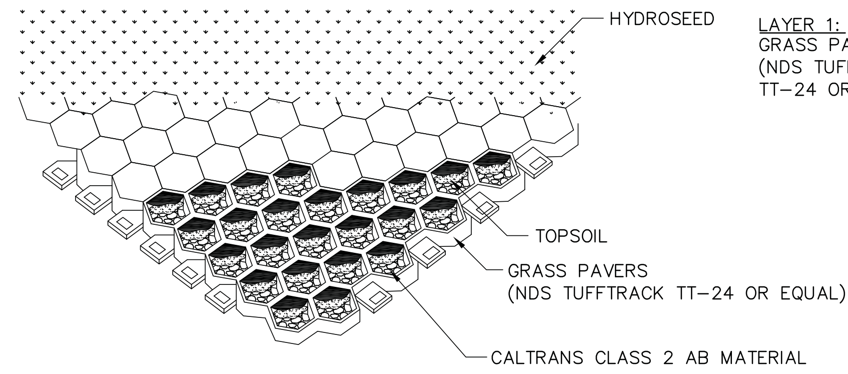
FOR REDUCED PLANS ORIGINAL SCALE IS IN INCHES 0 4



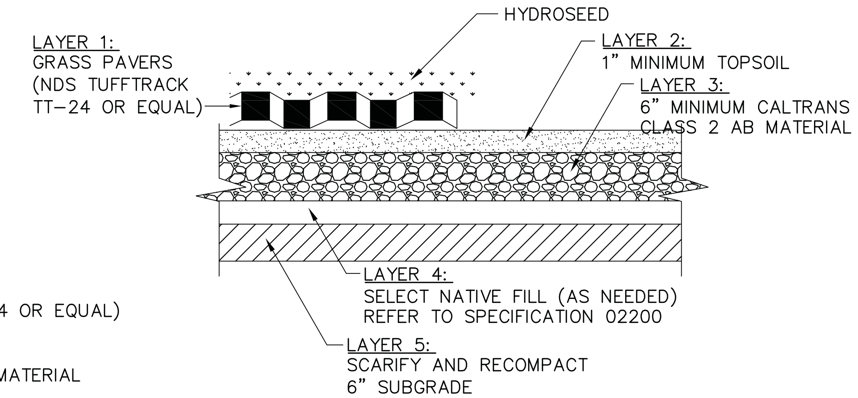
NOTES:

1. DISC EXISTING VEGETATION INTO TOP 8 TO 12 INCHES OF TOPSOIL THEN REMOVE TOP 12 INCHES OF TOPSOIL. STOCKPILE TOPSOIL TO BE LATER USED AS FINISH GRADING OF WETLANDS B AND C, OR OTHER PLANTED AREAS WHERE TOPSOIL IS NEEDED.
2. ROADWAY WIDTH SHALL GENERALLY CONFORM TO EXISTING ROADWAY WIDTH.
3. ONCE TOPSOIL HAS BEEN REMOVED, CONTRACTOR SHALL SCARIFY AND RECOMPACT THE TOP 6 INCHES OF SOIL TO AT LEAST 90 PERCENT RELATIVE COMPACTION BASED ON ASTM D1557. ALTERNATIVELY, CONTRACTOR MAY PLACE A BIAXIAL GEOGRID (TENSAR BX, MIRAFI BXG, OR EQUAL) OVER THE EXISTING ROAD MATERIAL IN LIEU OF OVER-EXCAVATION PRIOR TO PLACEMENT OF COMPACTED NEW SELECT NATIVE BACKFILL.

TYPICAL GRAVEL ROAD SECTION
DETAIL 1 NTS VAR

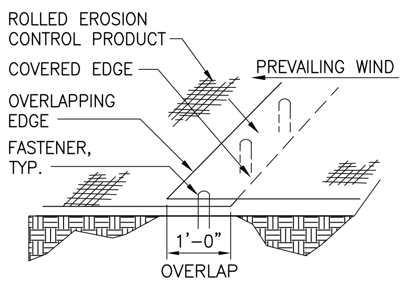


PERSPECTIVE
NTS



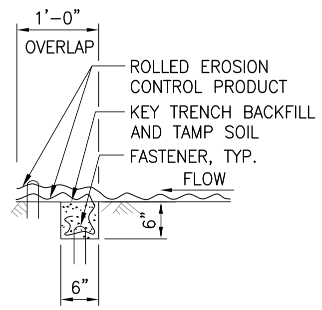
SECTION
NTS

GRASS PAVERS
DETAIL 2 NTS VAR



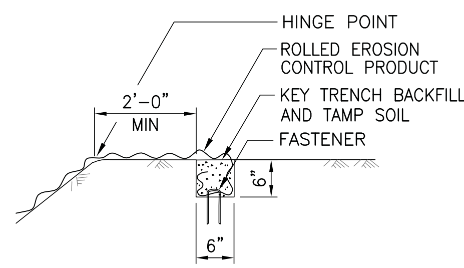
PERSPECTIVE

LONGITUDINAL ROLLED EROSION CONTROL PRODUCT JOINT
DETAIL A NTS –



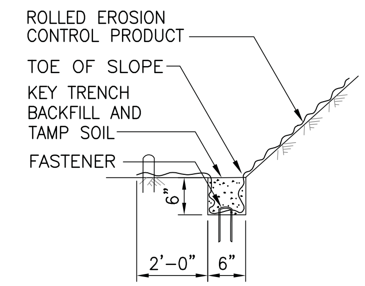
SECTION

TRANSVERSE ROLLED EROSION CONTROL PRODUCT JOINT
DETAIL B NTS –



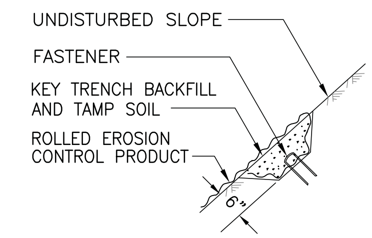
SECTION

KEY TRENCH AT TOP OF SLOPE
DETAIL C NTS –



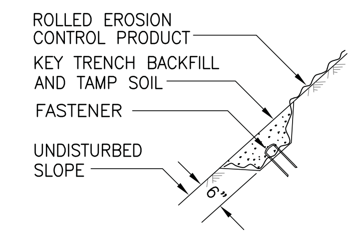
SECTION

KEY TRENCH AT TOE OF SLOPE
DETAIL D NTS –



SECTION

KEY TRENCH AT UPPER CONFORM
DETAIL E NTS –

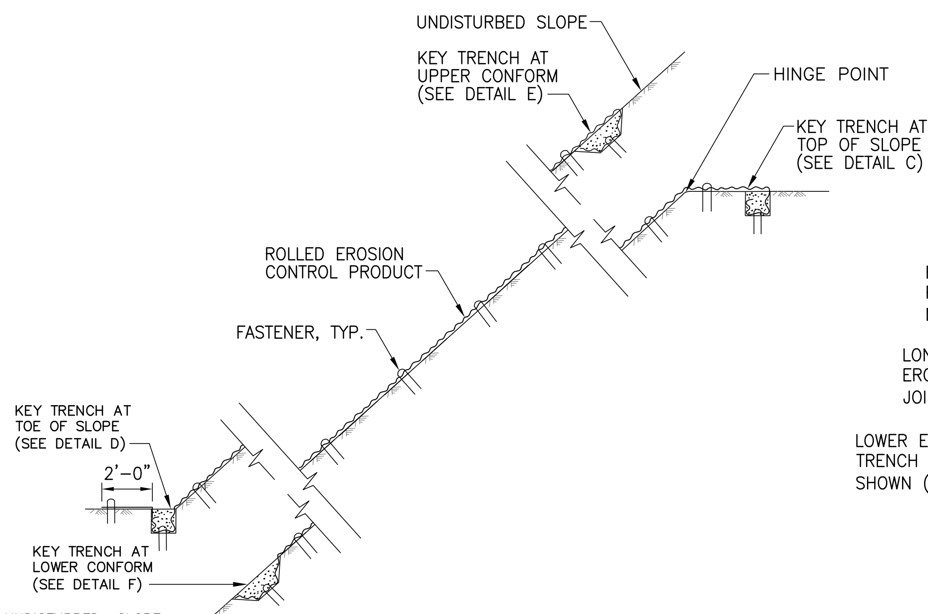


SECTION

KEY TRENCH AT LOWER CONFORM
DETAIL F NTS –

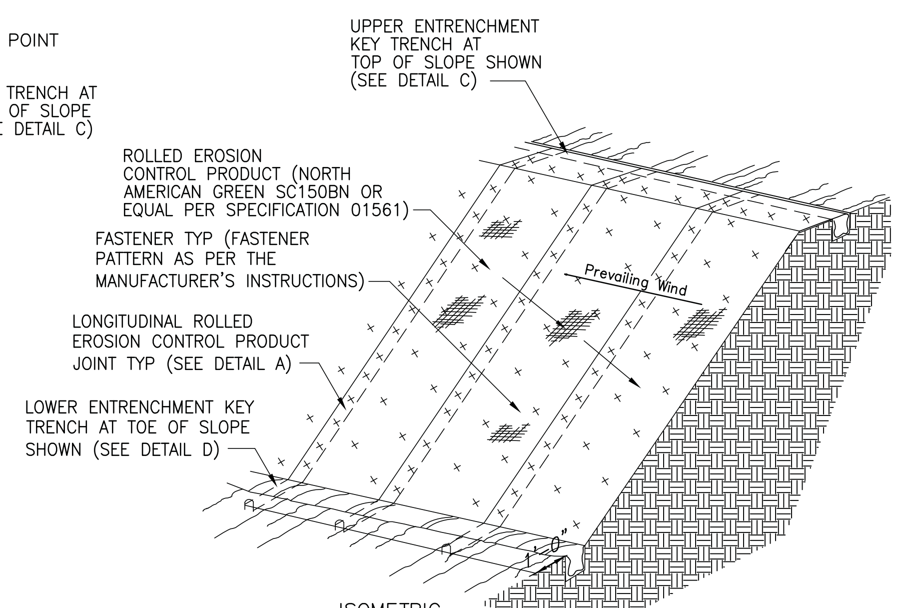
NOTES:

1. SLOPE SURFACE SHALL BE FREE OF ROCKS, CLODS, STICKS AND GRASS. MATS/BLANKETS SHALL HAVE GOOD SOIL CONTACT.
2. LAY BLANKETS LOOSELY AND STAKE OR STAPLE TO MAINTAIN DIRECT CONTACT WITH THE SOIL. DO NOT STRETCH.
3. INSTALL PER MANUFACTURER'S RECOMMENDATIONS.
4. IF TRANSVERSE ROLLED EROSION CONTROL PRODUCT JOINTS ARE REQUIRED ON SLOPE, SEE DETAIL B.



SECTION

ROLLED EROSION CONTROL PRODUCT ON SLOPE WITH VARIOUS KEY ENTRENCHMENTS



ISOMETRIC

ROLLED EROSION CONTROL PRODUCT ON SLOPE

EROSION CONTROL BLANKET
DETAIL 3 NTS VAR

CONTRACT NO. CS-954.B

CITY AND COUNTY OF SAN FRANCISCO
PUBLIC UTILITIES COMMISSION
INFRASTRUCTURE DIVISION
ENGINEERING MANAGEMENT BUREAU

SAN ANDREAS WETLANDS CREATION PROJECT

CIVIL DETAILS – 1

RMC Water & Environment

PROJECT ENGINEER NBO	DRAWN SJ
PROJECT MANAGER MN	DESIGNED
APPROVAL	CHECKED MM

NO.	DATE	DESCRIPTION	BY	APPR'D

REVISIONS

CHECKED / APPROVED	DRAWN	SCALE NO SCALE
SECTION MANAGER	DESIGNED	DATE
APPROVED	APPROVED	
MANAGER, ENGINEERING MANAGEMENT BUREAU	MANAGER, WATER SUPPLY AND TREATMENT DIVISION	
SHEET 6 OF 21	PLAN NO. / DRAWING NO. GC-1	REVISION NO.

100% SUBMITTAL

NOT FOR CONSTRUCTION

MAY 13, 2010

COORDINATE: NAD83
ELEVATION DATUM: NAVD 1988

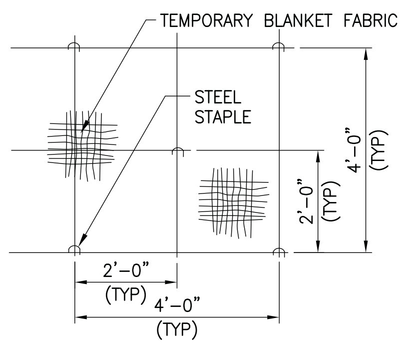
PLOT: EXTEND
SCALE: 1:1
BORDER: 22,34
COLOR: No.
RED 0.70MM
YELLOW 0.20MM
GREEN 0.25MM
CYAN 0.40MM
BLUE 0.50MM
MAGENTA 0.20MM
WHITE 0.35MM
GRAY 0.15MM
9 0.15MM
10 1.00MM
100 0.70MM
210 0.60MM

FILE:

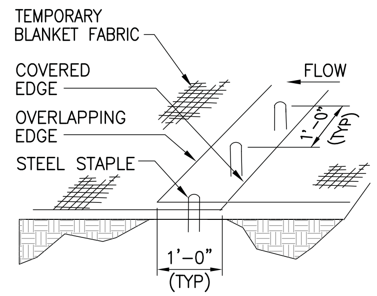
FOR REDUCED PLANS ORIGINAL SCALE IS IN INCHES 0 1 2 3 4

NOTES:

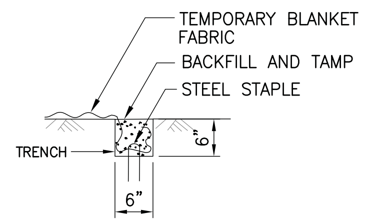
1. FOR CLARITY, PERSPECTIVE VIEW DOES NOT SHOW ALL STAPLES.
2. SLOPE SURFACE SHALL BE FREE OF ROCKS, CLODS, STICKS AND GRASS. MATS/BLANKETS SHALL HAVE GOOD SOIL CONTACT.
3. LAY BLANKETS LOOSELY AND STAKE OR STAPLE TO MAINTAIN DIRECT CONTACT WITH THE SOIL. DO NOT STRETCH.
4. INSTALL PER MANUFACTURER'S RECOMMENDATIONS.



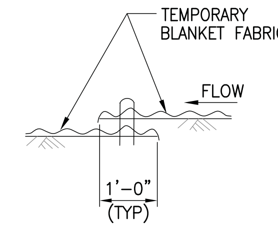
PLAN
STAPLE PATTERN
DETAIL A
NTS



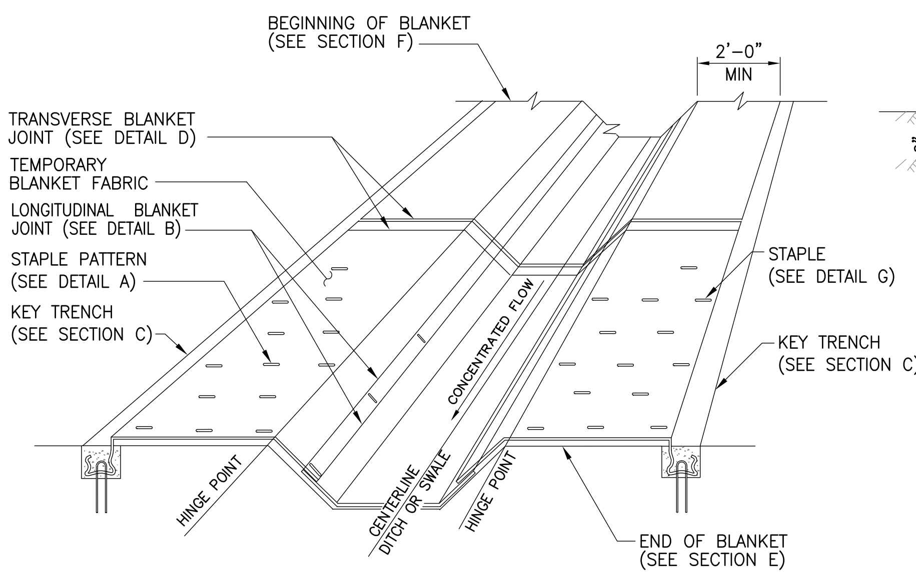
PERSPECTIVE
LONGITUDINAL BLANKET JOINT
DETAIL B
NTS



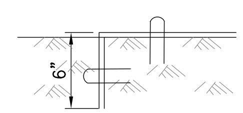
KEY TRENCH
SECTION C
NTS



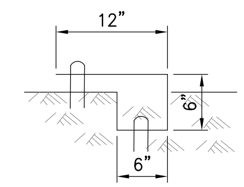
SECTION
TRANSVERSE BLANKET JOINT
DETAIL D
NTS



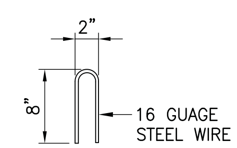
TEMPORARY EROSION CONTROL BLANKET
IN TRAPAZOIDAL DITCH OR SWALE
PERSPECTIVE
NTS



SECTION E
NTS

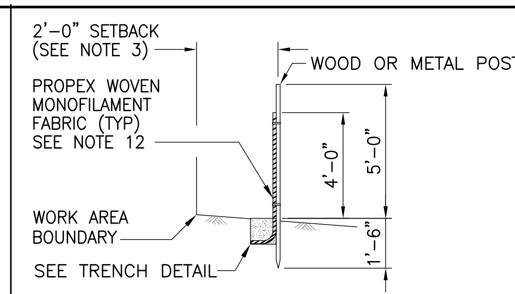


SECTION F
NTS

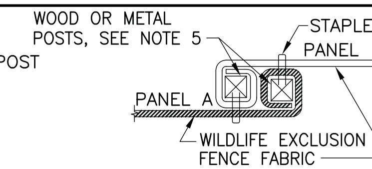


STAPLE
DETAIL G
NTS

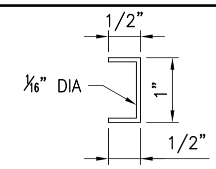
EROSION CONTROL BLANKET IN SWALE
DETAIL 4 / C-1
NTS



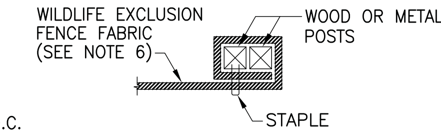
TEMPORARY WILDLIFE EXCLUSION FENCE
SECTION A
NTS



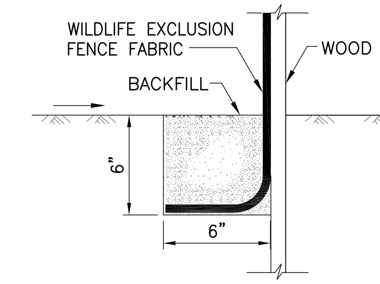
POST AT JOINTS
PLAN
NTS



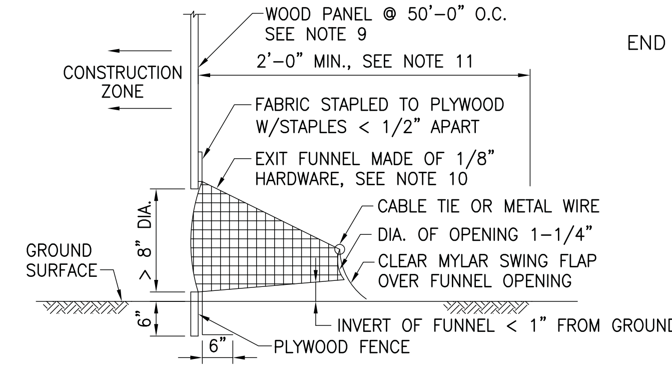
(SEE NOTE 7)
STAPLE DETAIL
NTS



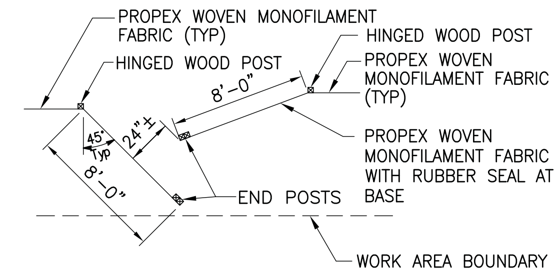
END POST DETAIL
PLAN
NTS



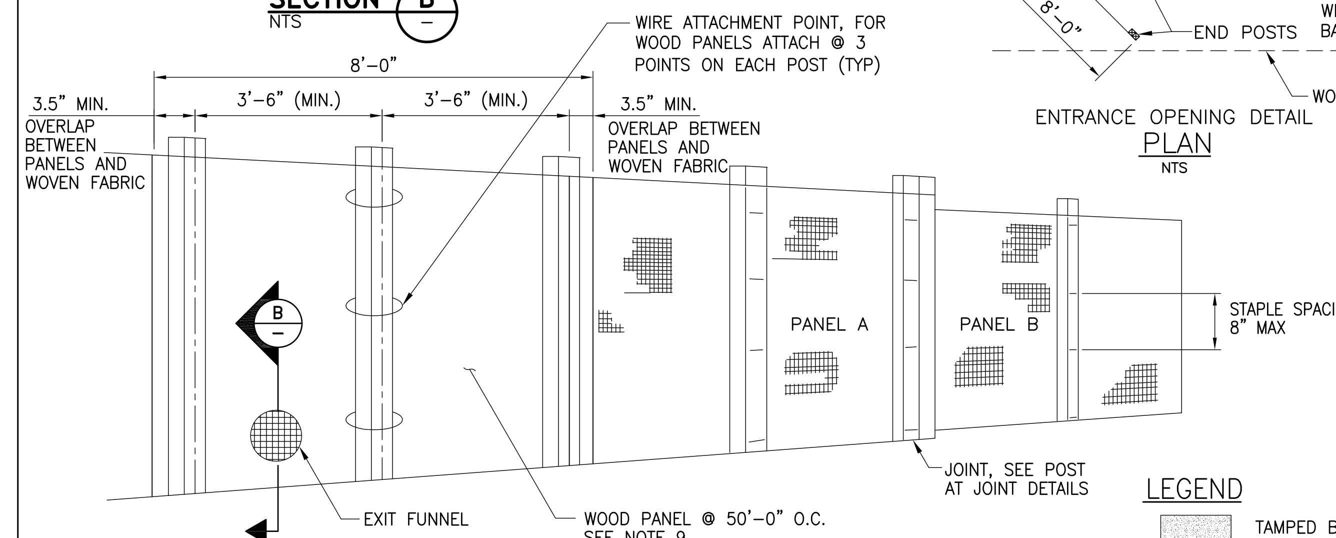
SECTION
TRENCH DETAIL
NTS



FENCE FUNNEL & DRAINAGE HOLE
SECTION B
NTS



ENTRANCE OPENING DETAIL
PLAN
NTS



WILDLIFE EXCLUSION FENCE PANELS AT JOINTS
PERSPECTIVE
NTS

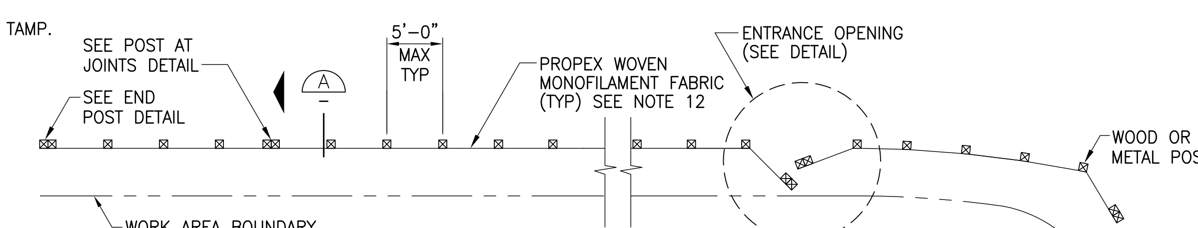
LEGEND

TAMPED BACKFILL

WILDLIFE EXCLUSION FENCING
DETAIL 5 / VAR
NTS

NOTES:

1. INSTALL TEMPORARY WILDLIFE EXCLUSION FENCE BY FIRST DIGGING TRENCH, DRIVING POSTS, PLACING AND SECURING FABRIC. THEN BACKFILL AND TAMP.
2. REACH LENGTH NOT TO EXCEED 500 FEET.
3. SETBACK DIMENSIONS MAY VARY TO FIT FIELD CONDITIONS. CONTRACTOR SHALL COORDINATE EXACT LOCATION OF FENCING WITH THE CITY REPRESENTATIVE AND SHALL MAKE ADJUSTMENTS AS REQUIRED AT NO ADDITIONAL COST TO THE CITY.
4. POSTS TO OVERLAP AND FENCE FABRIC TO FOLD AROUND EACH POST ONE FULL TURN. SECURE FABRIC WITH 4 STAPLES FOR EACH POST.
5. POSTS SHALL BE DRIVEN TIGHTLY TOGETHER. THE TOPS OF THE POSTS SHALL BE SECURED TO EACH OTHER WITH WIRE.
6. FOR EACH END POST, FENCE FABRIC SHALL BE FOLDED AROUND TWO POSTS ONE FULL TURN AND SECURED WITH 4 STAPLES.
7. MINIMUM OF 4 STAPLES SHALL BE INSTALLED PER POST. DIMENSIONS SHOWN ARE TYPICAL.
8. JOINT SECTIONS SHALL NOT BE PLACED AT SUMP LOCATIONS.
9. THE WOOD PANEL SHALL BE MADE OF 4'X8" HARDWOOD OR PLYWOOD (EXTERIOR GRADE) AND SHALL BE PLACED AT 50'-0" O.C. THE SURFACE OF THE HARDWOOD OR PLYWOOD PANELS SHALL BE FREE OF KNOT HOLES, CRACKS, AND HOLES.
10. EXIT FUNNELS SHALL BE PLACED 50 FEET APART ON ALL SIDES OF FENCE.
11. CONTRACTOR SHALL CLEAN VEGETATION HORIZONTALLY TO GROUND LEVEL WITHIN 2-FEET OF OUTSIDE FENCE AND PERMIT NO OVERHANGING BRANCHES.
12. FABRIC SHALL BE GEOTEX 104F OR EQUAL. REFER TO SECTION 01561 FOR MORE DETAILS.



TEMPORARY WILDLIFE EXCLUSION FENCE
PLAN
NTS

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CONTRACT NO. CS-954.B

CITY AND COUNTY OF SAN FRANCISCO
PUBLIC UTILITIES COMMISSION
INFRASTRUCTURE DIVISION
ENGINEERING MANAGEMENT BUREAU

SAN ANDREAS WETLANDS CREATION PROJECT

CIVIL DETAILS - 2

RMC Water & Environment

PROJECT ENGINEER	DRAWN
NBO	SJ
PROJECT MANAGER: MN	DESIGNED
APPROVAL	CHECKED: MM

NO.	DATE	DESCRIPTION	BY	APPR'D

REVISIONS

CHECKED / APPROVED	DRAWN	SCALE: NO SCALE
SECTION MANAGER	DESIGNED	DATE
APPROVED	APPROVED	
MANAGER, ENGINEERING MANAGEMENT BUREAU	MANAGER, WATER SUPPLY AND TREATMENT DIVISION	

SHEET	PLAN NO.	DRAWING NO.	REVISION NO.
7 OF 21		GC-2	

100% SUBMITTAL

NOT FOR CONSTRUCTION

MAY 13, 2010

COORDINATE: NAD83
ELEVATION DATUM: NAVD 1988

PLOT: EXTEND
SCALE: 1:1
BORDER: 22,34
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GREEN 0.25MM
CYAN 0.40MM
BLUE 0.50MM
MAGENTA 0.20MM
WHITE 0.35MM
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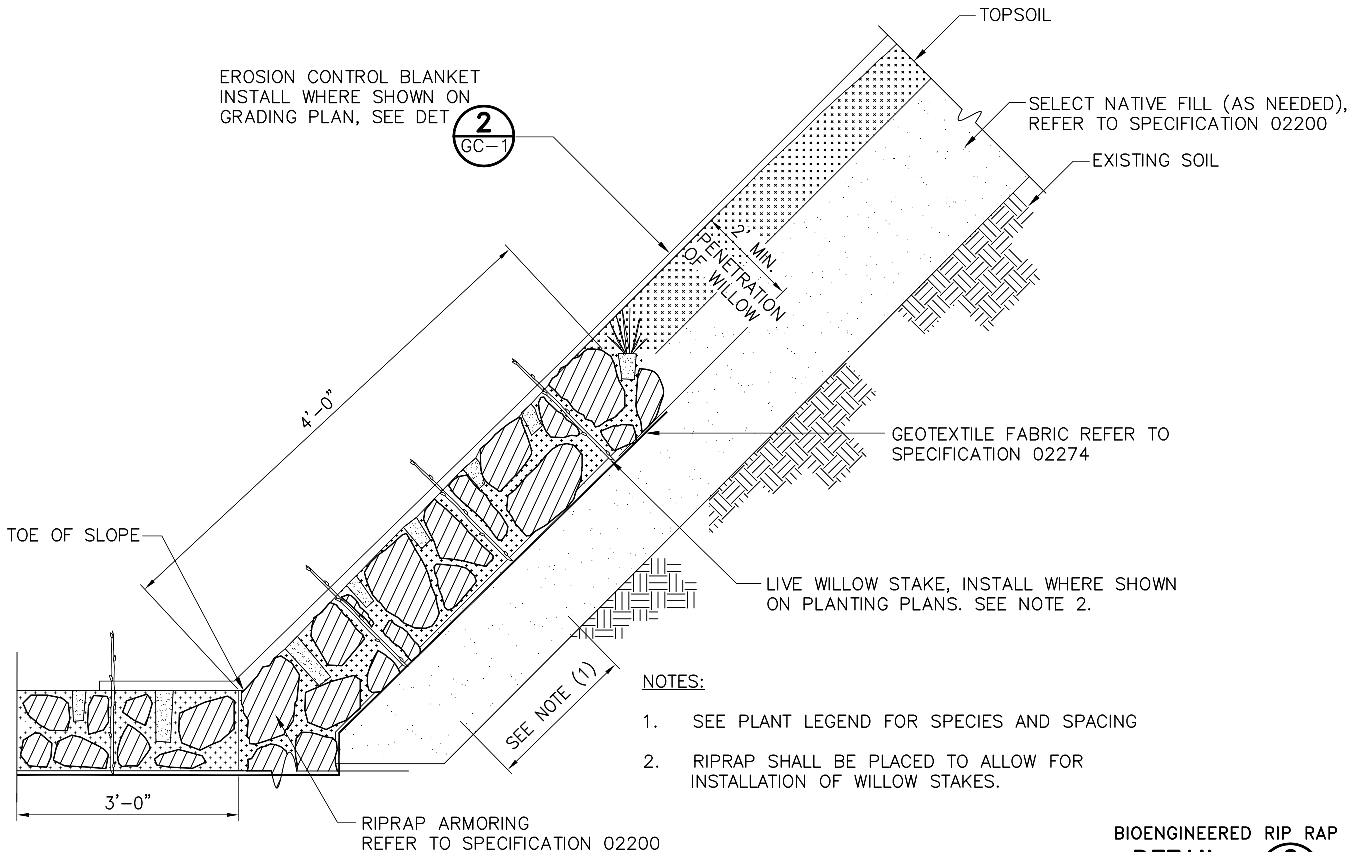
FILE:

FOR REDUCED PLANS ORIGINAL SCALE IS IN INCHES 0 4



NOTES:

1. SEE PLANT LEGEND FOR SPECIES AND SPACING
2. RIPRAP SHALL BE PLACED TO ALLOW FOR INSTALLATION OF WILLOW STAKES.

BIOENGINEERED RIP RAP
DETAIL 6 / VAR
NTS

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CONTRACT NO. CS–954.B

CITY AND COUNTY OF SAN FRANCISCO
PUBLIC UTILITIES COMMISSION
INFRASTRUCTURE DIVISION
ENGINEERING MANAGEMENT BUREAU

SAN ANDREAS WETLANDS CREATION PROJECT

CIVIL DETAILS – 3

RMC Water & Environment

PROJECT ENGINEER NBO	DRAWN SJ
PROJECT MANAGER MN	DESIGNED
APPROVAL	CHECKED MM

NO.	DATE	DESCRIPTION	BY	APPR'D

REVISIONS

CHECKED / APPROVED	DRAWN	SCALE NO SCALE
SECTION MANAGER	DESIGNED	DATE
APPROVED MANAGER, ENGINEERING MANAGEMENT BUREAU	APPROVED MANAGER, WATER SUPPLY AND TREATMENT DIVISION	
SHEET 8 OF 21	PLAN NO.	DRAWING NO. GC–3

REVISION NO.

100% SUBMITTAL

NOT FOR CONSTRUCTION

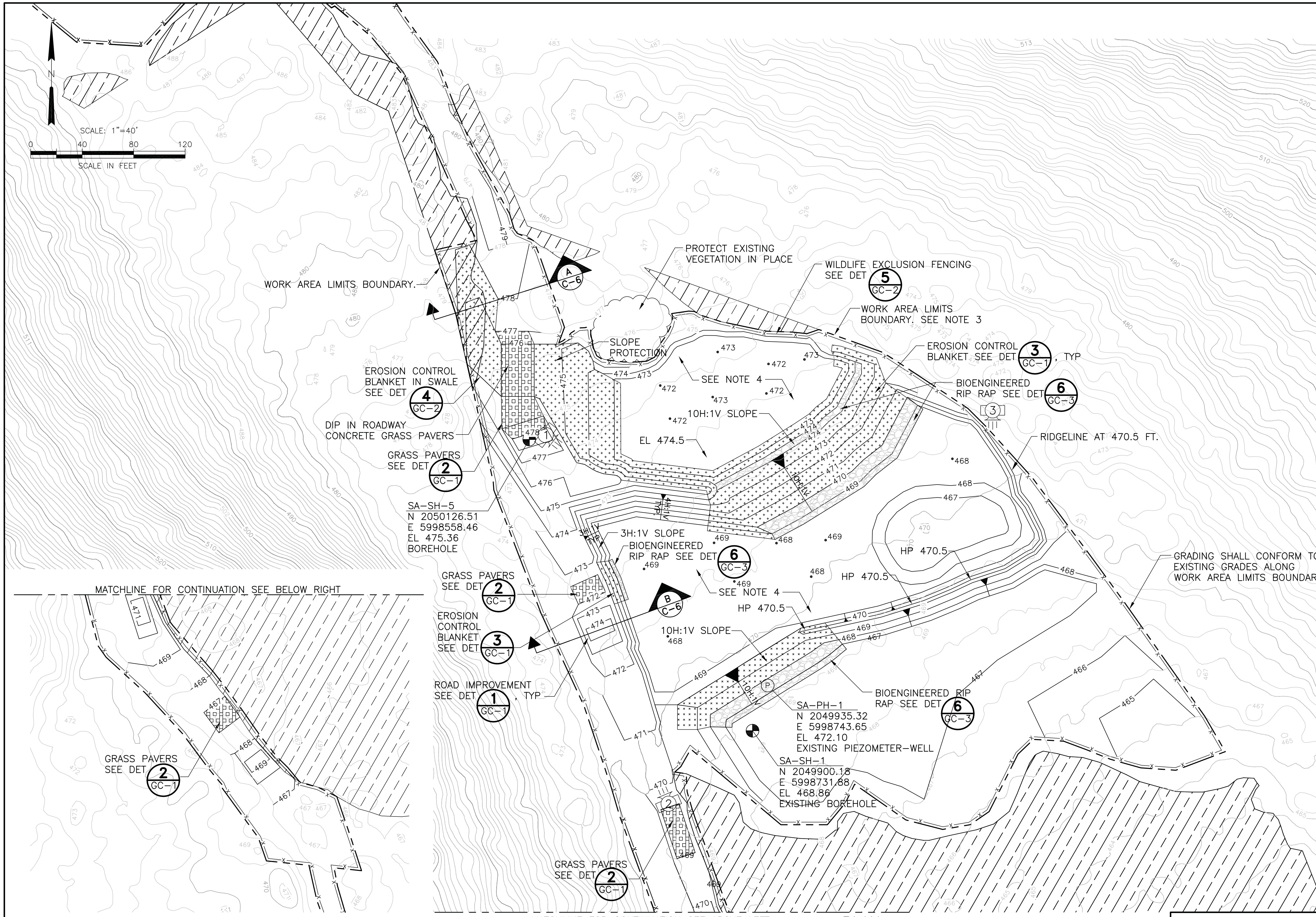
MAY 13, 2010

COORDINATE: NAD83
ELEVATION DATUM: NAVD 1988

PLOT: EXTEND
SCALE: 1:1
BORDER: 22,34
COLOR: No.
RED 0.70MM
YELLOW 0.20MM
GREEN 0.25MM
CYAN 0.40MM
BLUE 0.50MM
MAGENTA 0.20MM
WHITE 0.35MM
GRAY 0.15MM
9 0.15MM
10 1.00MM
100 0.70MM
210 0.60MM

FILE:

FOR REDUCED PLANS ORIGINAL SCALE IS IN INCHES 0 4



PLAN
1" = 40'

PLAN
1" = 40'

NOTES:

1. CONTRACTOR SHALL TILL EXISTING VEGETATION INTO TOP 12 INCHES OF TOPSOIL. THE TOP 12 INCHES OF TOPSOIL SHALL THEN BE STRIPPED AND STOCKPILED, THEN USED FOR FINISH GRADING. CONTRACTOR SHALL OVEREXCAVATE WETLAND AREA AS NEEDED TO REAPPLY TOPSOIL MATERIAL TO FINISH GRADES. CONTRACTOR SHALL TRACK THE WETLAND AREA TO CREATE UNDULATIONS AND MICROTOPOGRAPHY IN ACCORDANCE WITH SECTION 02200.

2. WHERE EXISTING ROADWAY IS TO BE IMPROVED (I.E. FILLED OR RAISED), CONTRACTOR SHALL DISC VEGETATION INTO TOP 8 TO 12 INCHES OF SOIL. CONTRACTOR SHALL THEN REMOVE TOP 12 INCHES OF EXISTING ROADWAY TOPSOIL. TOP SOIL SHALL BE STOCKPILED AND USED FOR FINISH GRADING OF WETLANDS B AND C, OR OTHER PLANTED AREAS WHERE TOPSOIL IS NEEDED.

3. CONTRACTOR SHALL CONTAIN ALL WORK WITHIN THE WORK AREA LIMITS BOUNDARY.

4. SPOT ELEVATIONS SHOWN TO REPRESENT UNDULATIONS AND MICROTOPOGRAPHY. CONTRACTOR SHALL CREATE RIDGES WITH SIDE CUTS DURING GRADING OF WETLAND BOTTOM TO ACHIEVE THE UNDULATIONS AND MICROTOPOGRAPHY.

CONTRACT NO. CS–954.B

CITY AND COUNTY OF SAN FRANCISCO
PUBLIC UTILITIES COMMISSION
INFRASTRUCTURE DIVISION
ENGINEERING MANAGEMENT BUREAU

SAN ANDREAS WETLANDS CREATION PROJECT

GRADING PLAN WETLAND A

RMC
Water & Environment

PROJECT ENGINEER NBO	DRAWN SJ
PROJECT MANAGER MN	DESIGNED
APPROVAL	CHECKED MM

NO.	DATE	DESCRIPTION	BY	APPR'D
		REVISIONS		

CHECKED / APPROVED	DRAWN	SCALE AS SHOWN
SECTION MANAGER	DESIGNED	DATE
APPROVED	APPROVED	
MANAGER, ENGINEERING MANAGEMENT BUREAU	MANAGER, WATER SUPPLY AND TREATMENT DIVISION	

SHEET	PLAN NO.	DRAWING NO.	REVISION NO.
9 OF 21		C–1	

100% SUBMITTAL

NOT FOR CONSTRUCTION

MAY 13, 2010

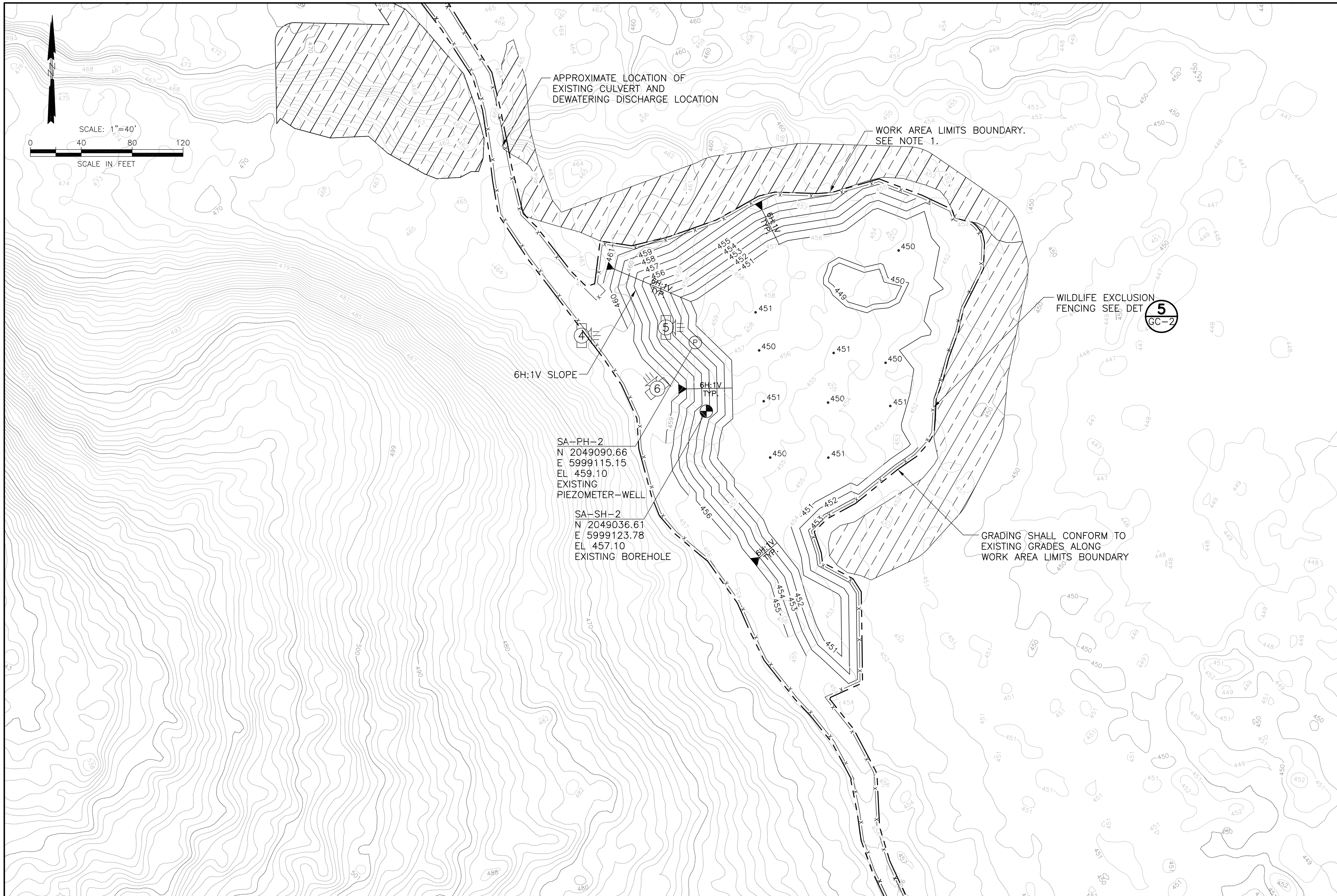
COORDINATE: NAD83

ELEVATION DATUM: NAVD 1988

PLOT: EXTEND
SCALE: 1:1
BORDER: 22,34
COLOR: No.
RED 0.70MM
YELLOW 0.20MM
GREEN 0.25MM
CYAN 0.40MM
BLUE 0.50MM
MAGENTA 0.20MM
WHITE 0.35MM
GRAY 0.15MM
9 0.15MM
10 1.00MM
100 0.70MM
210 0.60MM

FILE:

FOR REDUCED PLANS ORIGINAL SCALE IS IN INCHES 0 4



NOTES:

1. CONTRACTOR SHALL CONTAIN ALL WORK WITHIN THE WORK AREA LIMITS BOUNDARY.
2. SPOT ELEVATIONS SHOWN TO REPRESENT UNDULATIONS AND MICROTOPOGRAPHY. CONTRACTOR SHALL CREATE RIDGES WITH SIDE CUTS DURING GRADING OF WETLAND BOTTOM TO ACHIEVE THE UNDULATIONS AND MICROTOPOGRAPHY.
3. CONTRACTOR SHALL CLEAR, GRUB, AND DISPOSE OF EXISTING VEGETATION IN WETLAND AREA PER SECTION 02110. EXISTING VEGETATION MAY VARY AND MAY INCLUDE SHRUBS, BRUSH, LOGS, LOOSE BOULDERS, AND SMALL TREES. SEE PHOTOGRAPHS SHOWN ON DRAWING NO. C-4 FOR REPRESENTATIVE VEGETATION.
4. FOLLOWING REMOVAL OF ALL WOODY DEBRIS, CONTRACTOR SHALL STRIP THE TOP 12 INCHES OF TOPSOIL. CONTRACTOR SHALL OVEREXCAVATE WETLAND AREA AS REQUIRED AND APPLY 4 INCHES OF TOPSOIL MATERIAL TO FINISH GRADES. CONTRACTOR SHALL USE AVAILABLE TOP SOIL FROM ROADWAY IMPROVEMENTS AMENDED WITH IMPORTED COMPOST AS THE PREFERRED FINISH GRADING MATERIAL. CONTRACTOR SHALL TRACK THE WETLAND AREA IN ACCORDANCE WITH SECTION 02200.
5. CONTRACTOR IS NOTIFIED THAT AN OPTIONAL BID ITEM EXISTS TO REDUCE FINISH GRADES BY 0.5 FEET FROM BOTTOM ELEVATIONS SHOWN. REFER TO BID ITEM LIST IN DIVISION 00 OF THE SPECIFICATION PACKAGE.

PLAN
1" = 40'

PLOT: EXTEND
SCALE: 1:1
BORDER: 22,34
COLOR: No.
RED 0.70MM
YELLOW 0.20MM
GREEN 0.25MM
CYAN 0.40MM
BLUE 0.50MM
MAGENTA 0.20MM
WHITE 0.35MM
GRAY 0.15MM
9 0.15MM
10 1.00MM
100 0.70MM
210 0.60MM

COORDINATE: NAD83
ELEVATION DATUM: NAVD 1988

100% SUBMITTAL

NOT FOR CONSTRUCTION

MAY 13, 2010

RMC Water & Environment

PROJECT ENGINEER NBO | DRAWN SJ
PROJECT MANAGER MN | DESIGNED
APPROVAL | CHECKED MM

NO.	DATE	DESCRIPTION	BY	APPR'D

REVISIONS

CONTRACT NO. CS-954.B

CITY AND COUNTY OF SAN FRANCISCO
PUBLIC UTILITIES COMMISSION
INFRASTRUCTURE DIVISION
ENGINEERING MANAGEMENT BUREAU

SAN ANDREAS WETLANDS CREATION PROJECT

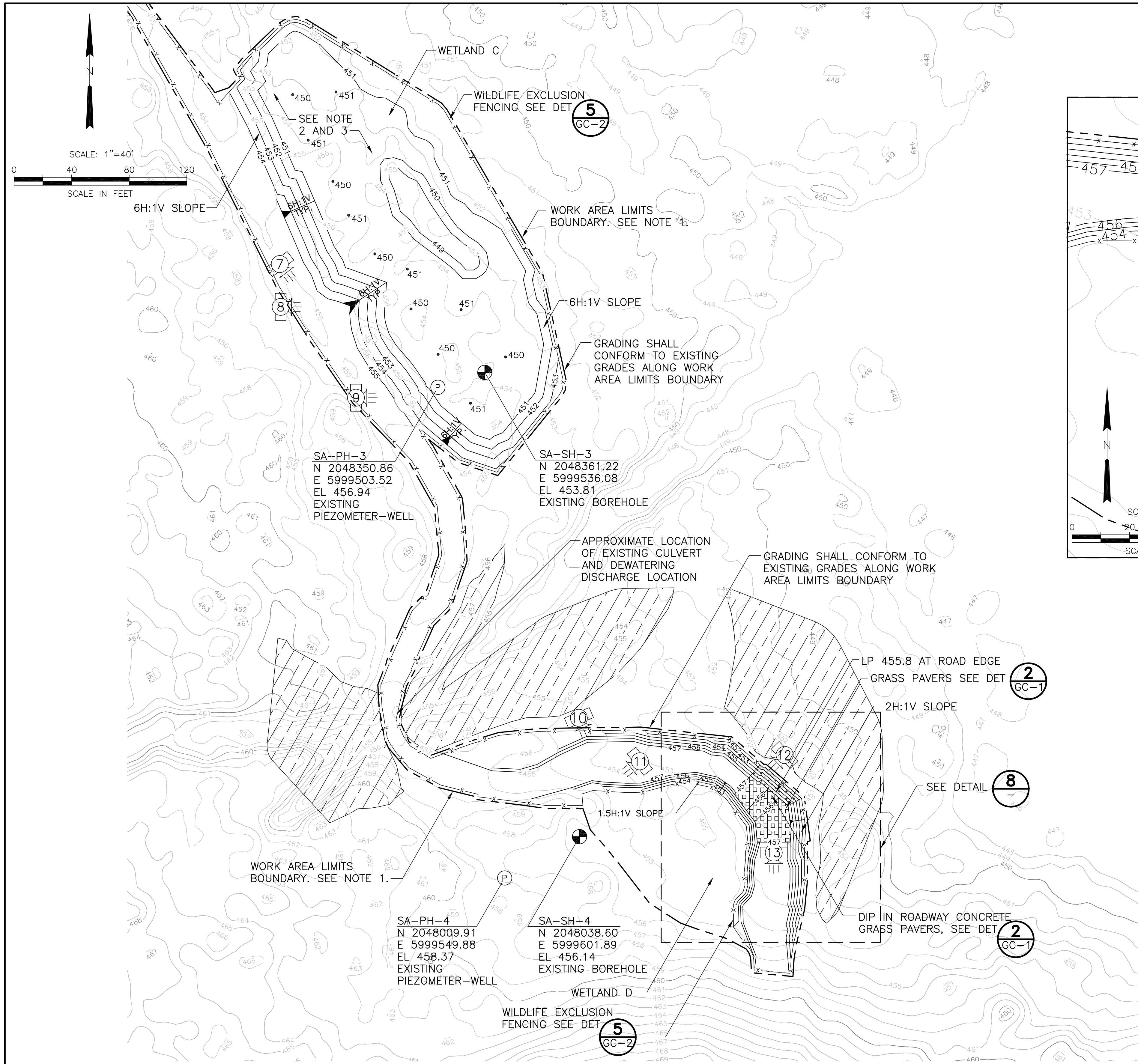
GRADING PLAN WETLAND B

CHECKED / APPROVED | DRAWN | SCALE AS SHOWN
SECTION MANAGER | DESIGNED | DATE
APPROVED | APPROVED
MANAGER, ENGINEERING MANAGEMENT BUREAU | MANAGER, WATER SUPPLY AND TREATMENT DIVISION

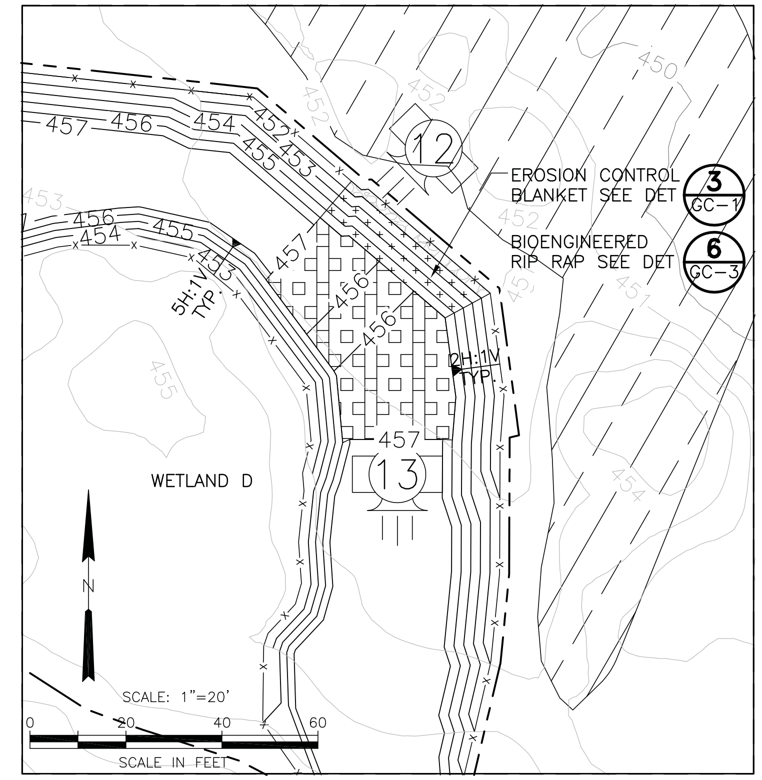
SHEET 10 OF 21 | PLAN NO. | DRAWING NO. C-2 | REVISION NO.

FILE:

FOR REDUCED PLANS ORIGINAL SCALE IS IN INCHES 0 4



PLAN
1" = 40'



DETAIL 8 –
1"=20'

NOTES:

1. CONTRACTOR SHALL CONTAIN ALL WORK WITHIN THE WORK AREA LIMITS BOUNDARY.
2. SPOT ELEVATIONS SHOWN TO REPRESENT UNDULATIONS AND MICROTOPOGRAPHY. CONTRACTOR SHALL CREATE RIDGES WITH SIDE CUTS DURING GRADING OF WETLAND BOTTOM TO ACHIEVE THE UNDULATIONS AND MICROTOPOGRAPHY.
3. CONTRACTOR SHALL CLEAR, GRUB, AND DISPOSE OF EXISTING VEGETATION IN WETLAND AREA PER SECTION 02110. EXISTING VEGETATION MAY VARY AND MAY INCLUDE SHRUBS, BRUSH, LOGS, LOOSE BOULDERS, AND SMALL TREES. SEE PHOTOGRAPHS SHOWN ON DRAWING NO. C-5 FOR REPRESENTATIVE VEGETATION.
4. FOLLOWING REMOVAL OF ALL WOODY DEBRIS, CONTRACTOR SHALL STRIP THE TOP 12 INCHES OF TOPSOIL. CONTRACTOR SHALL OVEREXCAVATE WETLAND AREA AS REQUIRED AND APPLY 4 INCHES OF TOPSOIL MATERIAL TO FINISH GRADES. CONTRACTOR SHALL USE AVAILABLE TOP SOIL FROM ROADWAY IMPROVEMENTS AMENDED WITH IMPORTED COMPOST AS THE PREFERRED FINISH GRADING MATERIAL. CONTRACTOR SHALL TRACK THE WETLAND AREA IN ACCORDANCE WITH SECTION 02200.
5. CONTRACTOR IS NOTIFIED THAT AN OPTIONAL BID ITEM EXISTS TO REDUCE FINISH GRADES OF WETLAND C BY 0.5 FEET FROM BOTTOM ELEVATIONS SHOWN. REFER TO BID ITEM LIST IN DIVISION 00 OF THE SPECIFICATION PACKAGE.

CONTRACT NO. CS-954.B

CITY AND COUNTY OF SAN FRANCISCO
PUBLIC UTILITIES COMMISSION
INFRASTRUCTURE DIVISION
ENGINEERING MANAGEMENT BUREAU

SAN ANDREAS WETLANDS CREATION PROJECT

GRADING PLAN WETLANDS C & D

CHECKED / APPROVED	DRAWN	SCALE
CHECKED BY	DRAWN BY	AS SHOWN
SECTION MANAGER: SECTION MANAGER	DESIGNED: DESIGNED BY	DATE: DATE
APPROVED	APPROVED	
MANAGER, ENGINEERING MANAGEMENT BUREAU	MANAGER, WATER SUPPLY AND TREATMENT DIVISION	
SHEET: 11 OF 21	PLAN NO. / DRAWING NO.: C-3	REVISION NO.

RMC
Water & Environment

PROJECT ENGINEER: PROJECT ENGINEER	DRAWN: DRAWN BY
PROJECT MANAGER: PROJECT ENGINEER	DESIGNED: DESIGNED BY 2
APPROVAL: APPROVAL BY 2	CHECKED: CHECKED BY 2

NO.	DATE	DESCRIPTION	BY	APPR'D

REVISIONS

100% SUBMITTAL

NOT FOR CONSTRUCTION

MAY 13, 2010

COORDINATE: NAD83

ELEVATION DATUM: NAVD 1988

PLOT: EXTEND
SCALE: 1:1
BORDER: 22,34
COLOR: No.
RED 0.70MM
YELLOW 0.20MM
GREEN 0.25MM
CYAN 0.40MM
BLUE 0.50MM
MAGENTA 0.20MM
WHITE 0.35MM
GRAY 0.15MM
9 0.15MM
10 1.00MM
100 0.70MM
210 0.60MM

FILE:

FOR REDUCED PLANS ORIGINAL SCALE IS IN INCHES 0 4

PHOTO 1/C-1

PHOTO 2/C-1

PHOTO 3/C-1

PHOTO 4/C-2

PHOTO 5/C-2

PHOTO 6/C-2

NOTES:

1. THE PHOTOGRAPHS SHOWN WERE TAKEN IN FEBRUARY 2010. SITE IS EXPECTED TO BE DRY DURING THE CONSTRUCTION PERIOD.
2. CONTRACTOR SHALL MOW GRASSES ALONG THE ROADWAY LOCATED WITHIN THE WORK AREA LIMITS BOUNDARY. MOWING SHALL BE CONDUCTED ON A REGULAR BASIS DURING ACTIVE CONSTRUCTION PERIODS TO MAINTAIN GRASS HEIGHT AT 2-INCHES OR BELOW.

CONTRACT NO. CS-954.B

CITY AND COUNTY OF SAN FRANCISCO
PUBLIC UTILITIES COMMISSION
INFRASTRUCTURE DIVISION
ENGINEERING MANAGEMENT BUREAU

SAN ANDREAS WETLANDS CREATION PROJECT

EXISTING CONDITIONS 1 OF 2

RMC Water & Environment

PROJECT ENGINEER NBO	DRAWN SJ
PROJECT MANAGER MN	DESIGNED
APPROVAL	CHECKED MM

NO.	DATE	DESCRIPTION	BY	APPR'D

REVISIONS

CHECKED / APPROVED	DRAWN	SCALE NO SCALE
SECTION MANAGER	DESIGNED	DATE
APPROVED	APPROVED	
MANAGER, ENGINEERING MANAGEMENT BUREAU	MANAGER, WATER SUPPLY AND TREATMENT DIVISION	
SHEET 12 OF 21	PLAN NO.	DRAWING NO. C-4	REVISION NO.

100% SUBMITTAL

NOT FOR CONSTRUCTION

MAY 13, 2010

COORDINATE: NAD83
ELEVATION DATUM: NAVD 1988

PLOT: EXTEND
SCALE: 1:1
BORDER: 22,34
COLOR: No.
RED 0.70MM
YELLOW 0.20MM
GREEN 0.25MM
CYAN 0.40MM
BLUE 0.50MM
MAGENTA 0.20MM
WHITE 0.35MM
GRAY 0.15MM
9 0.15MM
10 1.00MM
100 0.70MM
210 0.60MM

FILE:

FOR REDUCED PLANS ORIGINAL SCALE IS IN INCHES 0 4

PHOTO 7 C-3

ACCESS ROADWAY, SEE NOTE 1

PHOTO 8 C-3

PHOTO 9 C-3

PHOTO 10 C-3

PHOTO 11 C-3

ACCESS ROADWAY, SEE NOTE 1

LIMITED REMOVAL OF EXISTING VEGETATION FOR ROAD IMPROVEMENTS PER DWG. C-3

PHOTO 12 C-3

ACCESS ROADWAY TO BE RAISED. SEE DWG C-3 AND NOTE 1.

PHOTO 13 C-3

NOTES:

1. THE PHOTOGRAPHS SHOWN WERE TAKEN IN FEBRUARY 2010. SITE IS EXPECTED TO BE DRY DURING THE CONSTRUCTION PERIOD.
2. CONTRACTOR SHALL MOW GRASSES ALONG THE ROADWAY LOCATED WITHIN THE WORK AREA LIMITS BOUNDARY. MOWING SHALL BE CONDUCTED ON A REGULAR BASIS DURING ACTIVE CONSTRUCTION PERIODS TO MAINTAIN GRASS HEIGHT AT 2-INCHES OR BELOW.

PLOT: EXTEND
SCALE: 1:1
BORDER: 22,34
COLOR: No.

RED	0.70MM
YELLOW	0.20MM
GREEN	0.25MM
CYAN	0.40MM
BLUE	0.50MM
MAGENTA	0.20MM
WHITE	0.35MM
GRAY	0.15MM
9	0.15MM
10	1.00MM
100	0.70MM
210	0.60MM

CONTRACT NO. CS-954.B

CITY AND COUNTY OF SAN FRANCISCO
PUBLIC UTILITIES COMMISSION
INFRASTRUCTURE DIVISION
ENGINEERING MANAGEMENT BUREAU

SAN ANDREAS WETLANDS CREATION PROJECT

EXISTING CONDITIONS 2 OF 2

RMC Water & Environment

PROJECT ENGINEER: NBO
DRAWN: SJ
PROJECT MANAGER: MN
DESIGNED:
APPROVAL:
CHECKED: MM

NO.	DATE	DESCRIPTION	BY	APPR'D

REVISIONS

100% SUBMITTAL

NOT FOR CONSTRUCTION

MAY 13, 2010

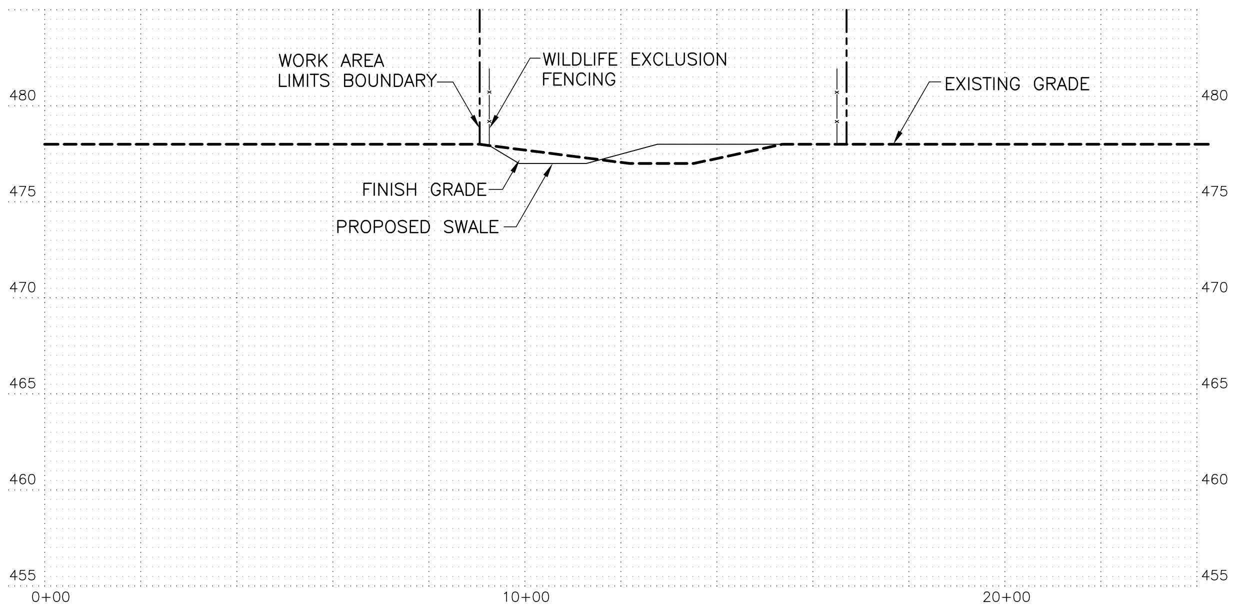
COORDINATE: NAD83
ELEVATION DATUM: NAVD 1988

CHECKED / APPROVED | DRAWN | SCALE: NO SCALE
SECTION MANAGER | DESIGNED | DATE
APPROVED | APPROVED
MANAGER, ENGINEERING MANAGEMENT BUREAU | MANAGER, WATER SUPPLY AND TREATMENT DIVISION

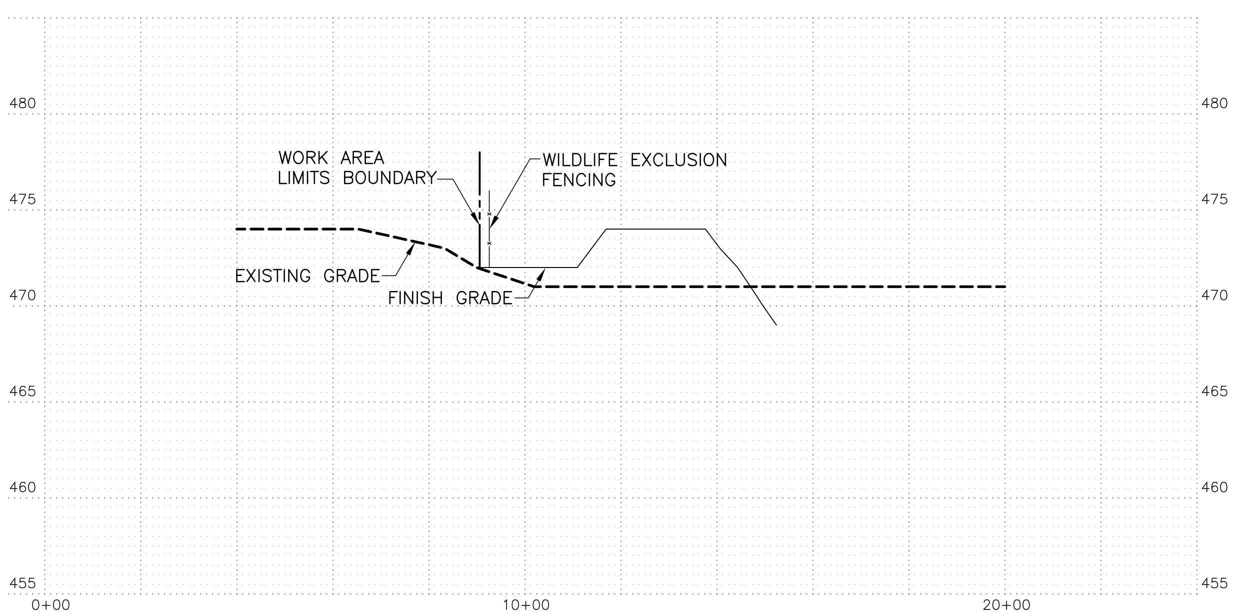
SHEET 13 OF 21 | PLAN NO. | DRAWING NO. C-5 | REVISION NO.

FILE:

FOR REDUCED PLANS ORIGINAL SCALE IS IN INCHES 0 4



SECTION (A / C-1)
HORZ. 1"=200'
VERT. 1"=5'



SECTION (B / C-1)
HORZ. 1"=200'
VERT. 1"=5'

PLOT: EXTEND
SCALE: 1:1
BORDER: 22,34
COLOR: No.
RED 0.70MM
YELLOW 0.20MM
GREEN 0.25MM
CYAN 0.40MM
BLUE 0.50MM
MAGENTA 0.20MM
WHITE 0.35MM
GRAY 0.15MM
9 0.15MM
10 1.00MM
100 0.70MM
210 0.60MM

COORDINATE: NAD83
ELEVATION DATUM: NAVD 1988

100% SUBMITTAL
NOT FOR CONSTRUCTION
MAY 13, 2010

RMC Water & Environment

PROJECT ENGINEER: NBO	DRAWN: SJ
PROJECT MANAGER: MN	DESIGNED
APPROVAL	CHECKED: MM

NO.	DATE	DESCRIPTION	BY	APPR'D

REVISIONS

CONTRACT NO. CS–954.B

CITY AND COUNTY OF SAN FRANCISCO
PUBLIC UTILITIES COMMISSION
INFRASTRUCTURE DIVISION
ENGINEERING MANAGEMENT BUREAU

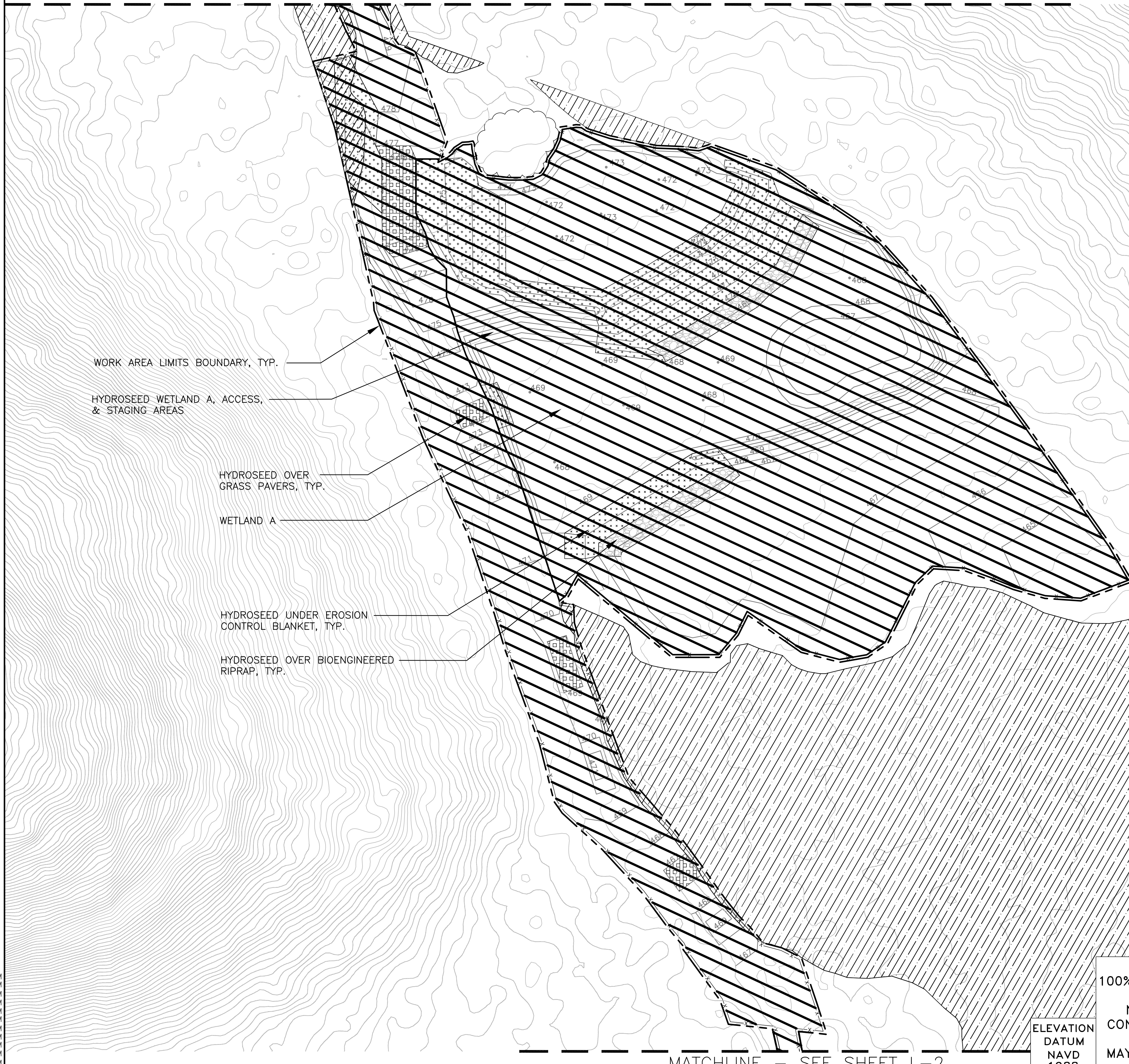
SAN ANDREAS WETLANDS CREATION PROJECT

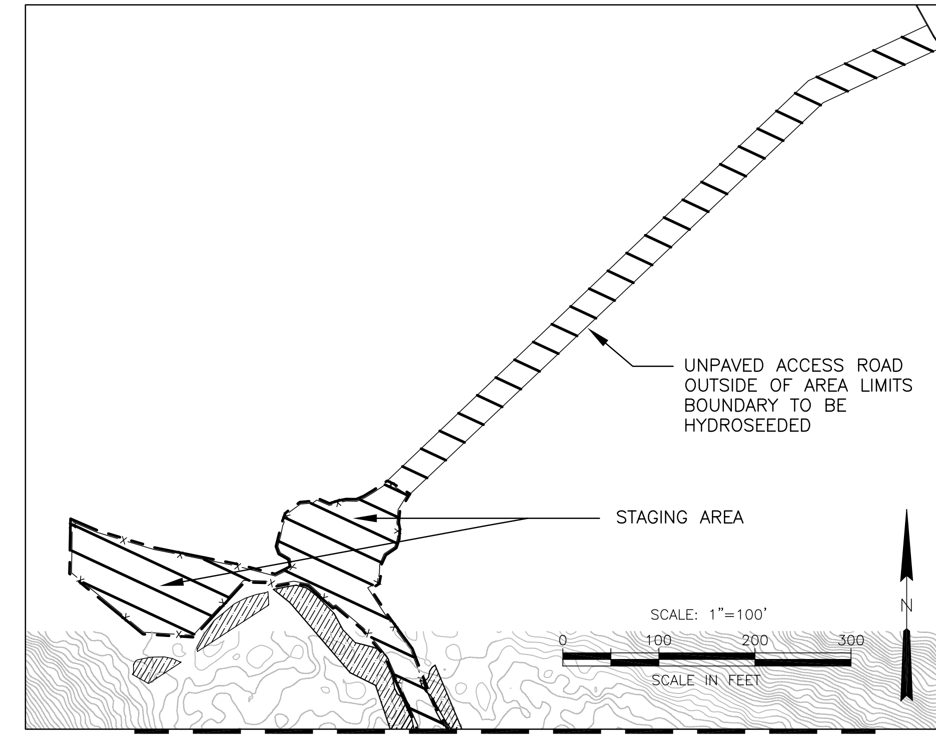
SWALE AND ROAD IMPROVEMENT SECTIONS – WETLAND A

CHECKED / APPROVED	DRAWN	SCALE: AS SHOWN
SECTION MANAGER	DESIGNED	DATE
APPROVED	APPROVED	
MANAGER, ENGINEERING MANAGEMENT BUREAU	MANAGER, WATER SUPPLY AND TREATMENT DIVISION	

SHEET	PLAN NO.	DRAWING NO.	REVISION NO.
14 OF 21		C–6	

FILE:
FOR REDUCED PLANS ORIGINAL SCALE IS IN INCHES 0 4





CONTRACT NO. CS-954.B

CITY AND COUNTY OF SAN FRANCISCO
PUBLIC UTILITIES COMMISSION
INFRASTRUCTURE DIVISION
ENGINEERING MANAGEMENT BUREAU

SAN ANDREAS RESERVOIR WETLANDS CREATION

SOIL PREPARATION, COARSE WOODY DEBRIS & HYDROSEEDING – WETLAND A

H. T. HARVEY & ASSOCIATES
ECOLOGICAL CONSULTANTS
www.harveyecology.com 408-458-3200

PROJECT ENGINEER N/A	DRAWN CJJ	CHECKED / APPROVED	DRAWN
PROJECT MANAGER KV	DESIGNED KV, JAB	SECTION MANAGER	DESIGNED
APPROVAL JAB	CHECKED JMH	APPROVED	APPROVED

NO.	DATE	DESCRIPTION	BY	APPR'D

REVISIONS

SCALE: AS SHOWN
DATE

MANAGER, ENGINEERING MANAGEMENT BUREAU
MANAGER, WATER SUPPLY AND TREATMENT DIVISION

SHEET 15 OF 21 | PLAN NO. | DRAWING NO. L-1 | REVISION NO.

100% SUBMITTAL

NOT FOR CONSTRUCTION

MAY 13, 2010

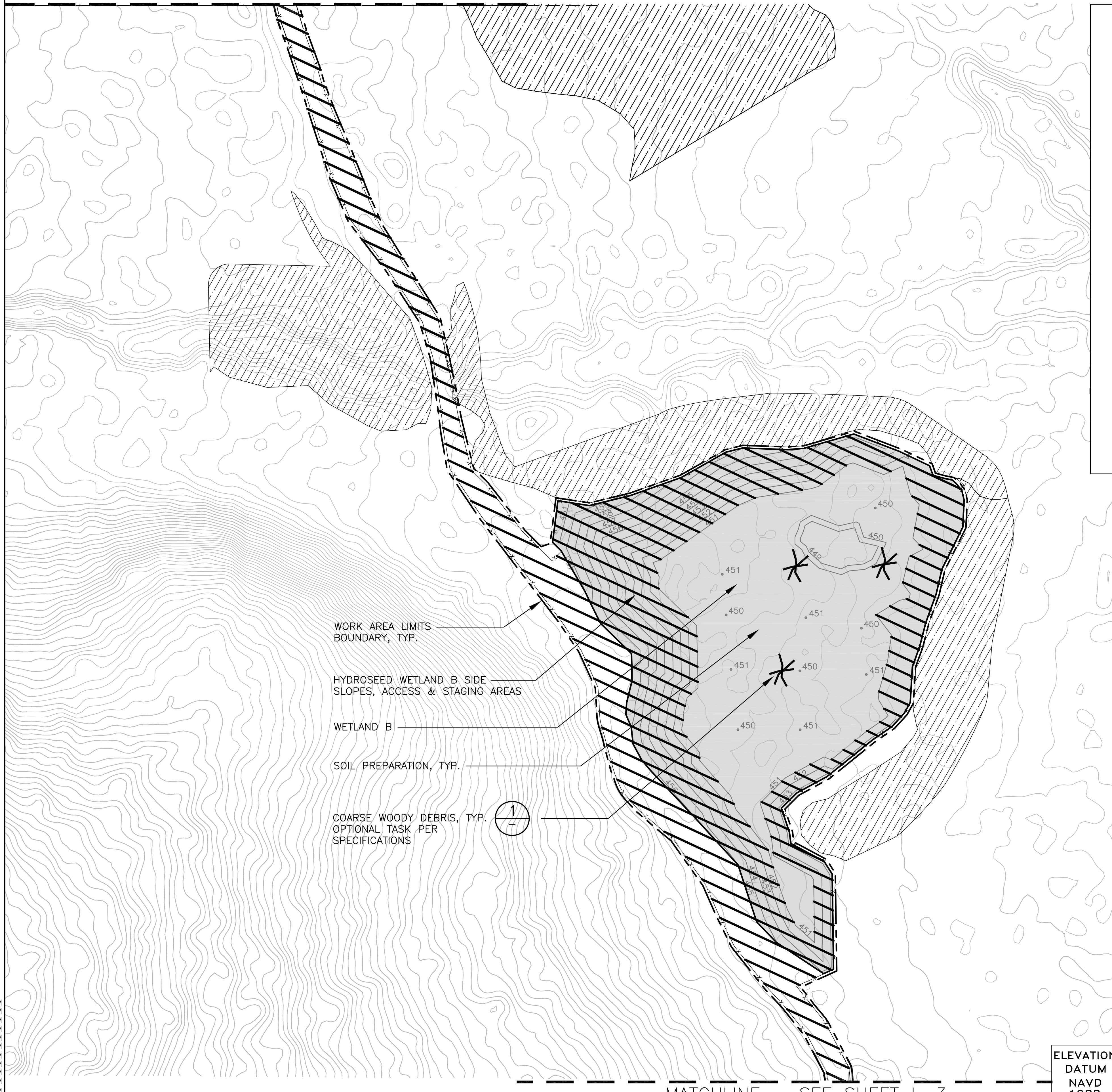
ELEVATION DATUM NAVD 1988

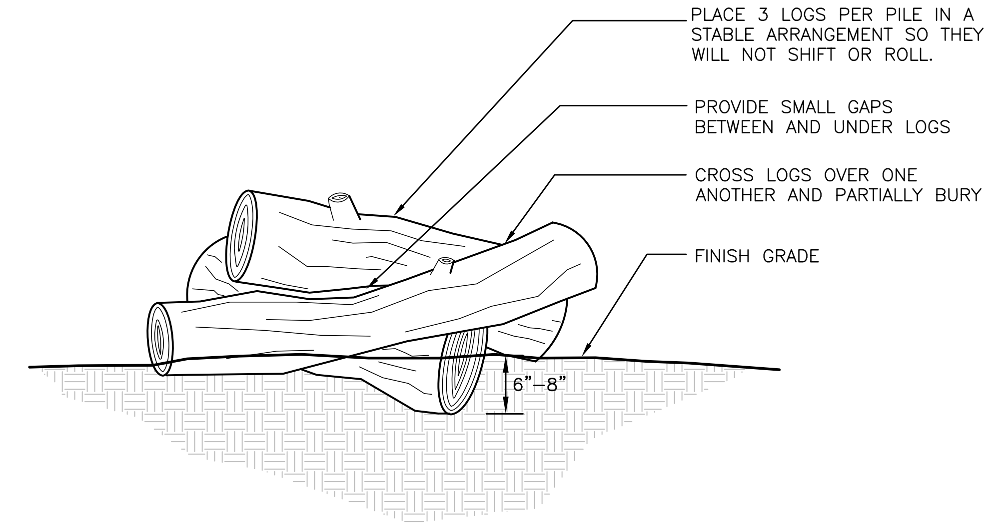
PLOT: EXTEND
SCALE: 1:1
BORDER: 22,34
COLOR: No.
RED 0.70MM
YELLOW 0.20MM
GREEN 0.25MM
CYAN 0.40MM
BLUE 0.50MM
MAGENTA 0.20MM
WHITE 0.35MM
GRAY 0.15MM
9 0.15MM
10 1.00MM
100 0.70MM
210 0.60MM

FILE:

FOR REDUCED PLANS ORIGINAL SCALE IS IN INCHES 0 1 2 3 4

MATCHLINE – SEE SHEET L-1





COARSE WOODY DEBRIS (1/–)

NOT TO SCALE

MATCHLINE – SEE SHEET L-3

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CITY AND COUNTY OF SAN FRANCISCO

PUBLIC UTILITIES COMMISSION

INFRASTRUCTURE DIVISION

ENGINEERING MANAGEMENT BUREAU

SAN ANDREAS RESERVOIR WETLANDS CREATION

SOIL PREPARATION, COARSE WOODY DEBRIS, & HYDROSEEDING – WETLAND B

H. T. HARVEY & ASSOCIATES
ECOLOGICAL CONSULTANTS
www.harveyecology.com 408-458-3200

PROJECT ENGINEER	DRAWN
N/A	CJJ
PROJECT MANAGER KV	DESIGNED KV/JAB
APPROVAL JAB	CHECKED JMH

NO.	DATE	DESCRIPTION	BY	APPR'D
		REVISIONS		

CHECKED / APPROVED	DRAWN	SCALE
SECTION MANAGER	DESIGNED	DATE
APPROVED	APPROVED	
MANAGER, ENGINEERING MANAGEMENT BUREAU	MANAGER, WATER SUPPLY AND TREATMENT DIVISION	

SHEET	PLAN NO.	DRAWING NO.	REVISION NO.
16 of 21		L-2	

100% SUBMITTAL

NOT FOR CONSTRUCTION

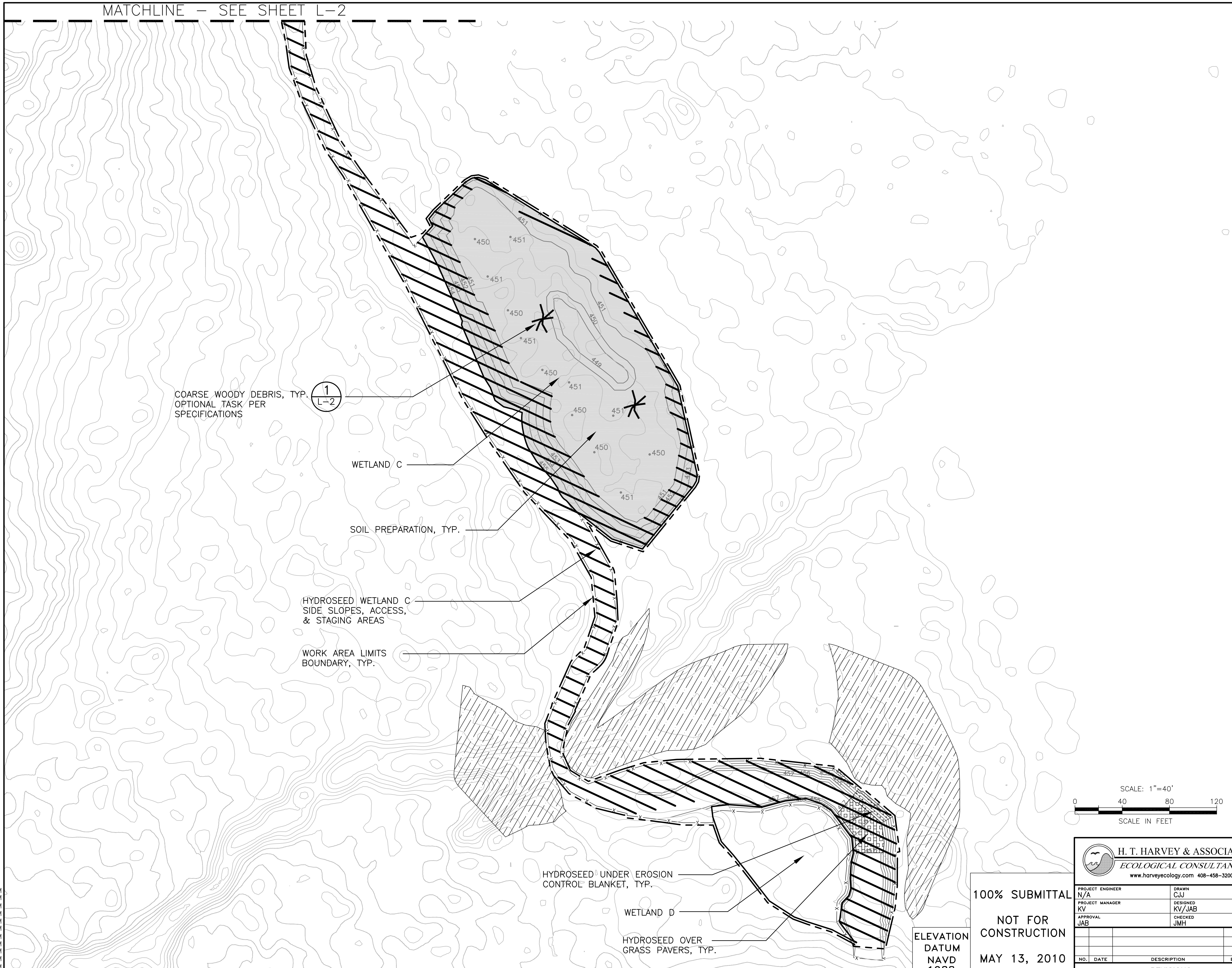
MAY 13, 2010

ELEVATION DATUM NAVD 1988

PLOT: EXTEND
SCALE: 1:1
BORDER: 22,34
COLOR: No.
RED 0.70MM
YELLOW 0.20MM
GREEN 0.25MM
CYAN 0.40MM
BLUE 0.50MM
MAGENTA 0.20MM
WHITE 0.35MM
GRAY 0.15MM
9 0.15MM
10 1.00MM
100 0.70MM
210 0.60MM

FILE:

FOR REDUCED PLANS ORIGINAL SCALE IS IN INCHES 0 1 2 3 4



ELEVATION DATUM NAVD 1988

100% SUBMITTAL

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MAY 13, 2010

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CONTRACT NO. CS-954.B

CITY AND COUNTY OF SAN FRANCISCO
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ENGINEERING MANAGEMENT BUREAU

H. T. HARVEY & ASSOCIATES
ECOLOGICAL CONSULTANTS
www.harveyecology.com 408-458-3200

SAN ANDREAS RESERVOIR WETLANDS CREATION

SOIL PREPARATION, COARSE WOODY DEBRIS, & HYDROSEEDING – WETLANDS C & D

PROJECT ENGINEER N/A	DRAWN CJJ
PROJECT MANAGER KV	DESIGNED KV/JAB
APPROVAL JAB	CHECKED JMH

NO.	DATE	DESCRIPTION	BY	APPR'D
		REVISIONS		

CHECKED / APPROVED	DRAWN	SCALE
SECTION MANAGER	DESIGNED	DATE
APPROVED	APPROVED	
MANAGER, ENGINEERING MANAGEMENT BUREAU	MANAGER, WATER SUPPLY AND TREATMENT DIVISION	
SHEET 17 OF 21	PLAN NO.	DRAWING NO. L-3	REVISION NO.

PLOT: EXTEND
SCALE: 1:1
BORDER: 22,34
COLOR: No.
RED 0.70MM
YELLOW 0.20MM
GREEN 0.25MM
CYAN 0.40MM
BLUE 0.50MM
MAGENTA 0.20MM
WHITE 0.35MM
GRAY 0.15MM
9 0.15MM
10 1.00MM
100 0.70MM
210 0.60MM

FILE:

FOR REDUCED PLANS ORIGINAL SCALE IS IN INCHES 0 4

PLANTING SCHEDULE

ABBREVIATION	SCIENTIFIC NAME	COMMON NAME	SIZE	TRIANGULAR SPACING*	QUANTITIES WETLAND A	WETLAND B	WETLAND C	WETLAND D	TOTAL	REMARKS
PLUG CONTAINER PLANTINGS										
ANE CAL	ANEMOPSIS CALIFORNICA	YERBA MANSA	PLUG	4 FT.	407	170	103	0	680	USE 1 FT. SPACING IN SPILLWAY ZONE
CAR BAR	CAREX BARBARAE	SANTA BARBARA SEDGE	PLUG	4 FT.	286	242	107	0	635	
CAR DEN	CAREX DENSA	DENSE SEDGE	PLUG	4 FT.	598	240	130	0	968	USE 1 FT. SPACING IN SPILLWAY ZONE
ELE MAC	ELEOCHARIS MACROSTACHYA	SPIKE RUSH	PLUG	4 FT.	621	240	130	0	991	USE 1 FT. SPACING IN SPILLWAY ZONE
EUT OCC	EUTHAMIA OCCIDENTALIS	WESTERN GOLDENROD	PLUG	4 FT.	377	275	133	0	785	
JUN EFF	JUNCUS EFFUSUS	SOFT RUSH	PLUG	4 FT.	341	242	107	0	690	
JUN OCC	JUNCUS OCCIDENTALIS	WESTERN RUSH	PLUG	4 FT.	528	206	105	0	839	USE 1 FT. SPACING IN SPILLWAY ZONE
JUN XIP	JUNCUS XIPHIOIDES	IRIS-LEAVED RUSH	PLUG	4 FT.	644	206	105	0	955	USE 1 FT. SPACING IN SPILLWAY ZONE
LEY TRI	LEYMUS TRITICOIDES	CREEPING WILD RYE	PLUG	4 FT.	374	139	54	0	567	USE 1 FT. SPACING IN SPILLWAY ZONE
SPA EUR	SPARGANIUM EURYCARPUM	BUR REED	PLUG	4 FT.	277	101	76	0	454	
							TOTAL		7564	
WILLOW STAKES										
SAL LAS	SALIX LASIOLEPIS	ARROYO WILLOW	STAKE	3 FT.	573	0	0	22	595	

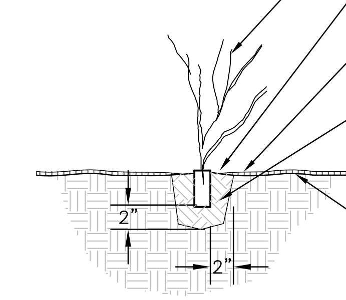
* UNLESS OTHERWISE NOTED

PLANTING LEGEND

- BASIN ZONE
- TRANSITION ZONE
- SLOPE ZONE
- SPILLWAY ZONE
- WILLOW ZONE

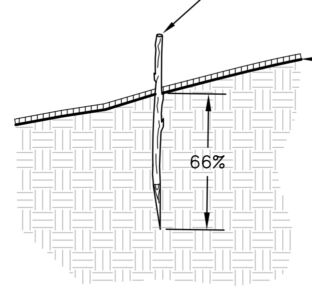
PLANTING NOTES

1. INSTALL ALL CONTAINER PLUG PLANTINGS PER DETAIL 1, THIS SHEET.
2. INSTALL ALL WILLOW STAKES PER DETAIL 3, THIS SHEET.
3. INSTALL BASIN ZONE PLANTS AT 4 FEET TRIANGULAR SPACING IN GROUPINGS OF 20 WITH APPROXIMATELY 25' BETWEEN GROUPINGS.
4. INSTALL SLOPE ZONE PLANTS AT 4 FEET TRIANGULAR SPACING IN GROUPINGS OF 20 WITH APPROXIMATELY 12' BETWEEN GROUPINGS.
5. INSTALL TRANSITION AND SPILLWAY ZONE PLANTS UNIFORMLY IN THE ZONE WITH THE SPACING SHOWN IN THE PLANTING SCHEDULE.



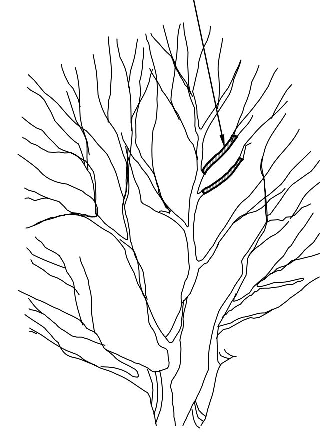
PLUG CONTAINER PLANTING (1)

NOT TO SCALE

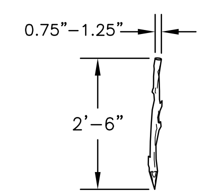


WILLOW STAKE INSTALLATION (3)

NOT TO SCALE



HARVESTING NOTES:
1. HARVEST MATERIAL FROM SELECT HEALTHY LIVING WOOD FROM LOCATIONS APPROVED BY THE PROJECT BIOLOGIST.
2. NO MORE THAN 30% OF ANY SINGLE TREE SHALL BE HARVESTED.
3. TRIM OFF ALL SIDE TWIGS AND BRANCHES FLUSH TO STAKE.
4. CUT BOTTOMS AT BASAL-END TO A POINT TO FACILITATE INSTALLATION.
5. CUT TOPS OFF FLAT FOR TAMPING.
6. IMMEDIATELY AFTER CUTTING SUBMERGE STAKES IN WATER TO PREVENT DESICCATION. STAKES SHALL BE PLANTED THE SAME DAY THEY ARE CUT.



WILLOW STAKE

NOTE:
ALL HARVESTING AND PLANTING OF STAKES SHALL BE DONE WITH CITY REPRESENTATIVE PRESENT.

WILLOW STAKE HARVESTING (2)

NOT TO SCALE

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CITY AND COUNTY OF SAN FRANCISCO
PUBLIC UTILITIES COMMISSION
INFRASTRUCTURE DIVISION
ENGINEERING MANAGEMENT BUREAU

SAN ANDREAS RESERVOIR WETLANDS CREATION

PLANTING LEGEND, SCHEDULE, & DETAILS

H. T. HARVEY & ASSOCIATES
ECOLOGICAL CONSULTANTS
www.harveyecology.com 408-458-3200

PROJECT ENGINEER N/A | DRAWN CJJ
PROJECT MANAGER KV | DESIGNED KV/JAB
APPROVAL JAB | CHECKED JMH

NO. | DATE | DESCRIPTION | BY | APPR'D
REVISIONS

CHECKED / APPROVED | DRAWN | SCALE
SECTION MANAGER | DESIGNED | DATE
APPROVED | APPROVED
MANAGER, ENGINEERING MANAGEMENT BUREAU | MANAGER, WATER SUPPLY AND TREATMENT DIVISION

SHEET 18 OF 21 | PLAN NO. | DRAWING NO. L-4 | REVISION NO.

100% SUBMITTAL

NOT FOR CONSTRUCTION

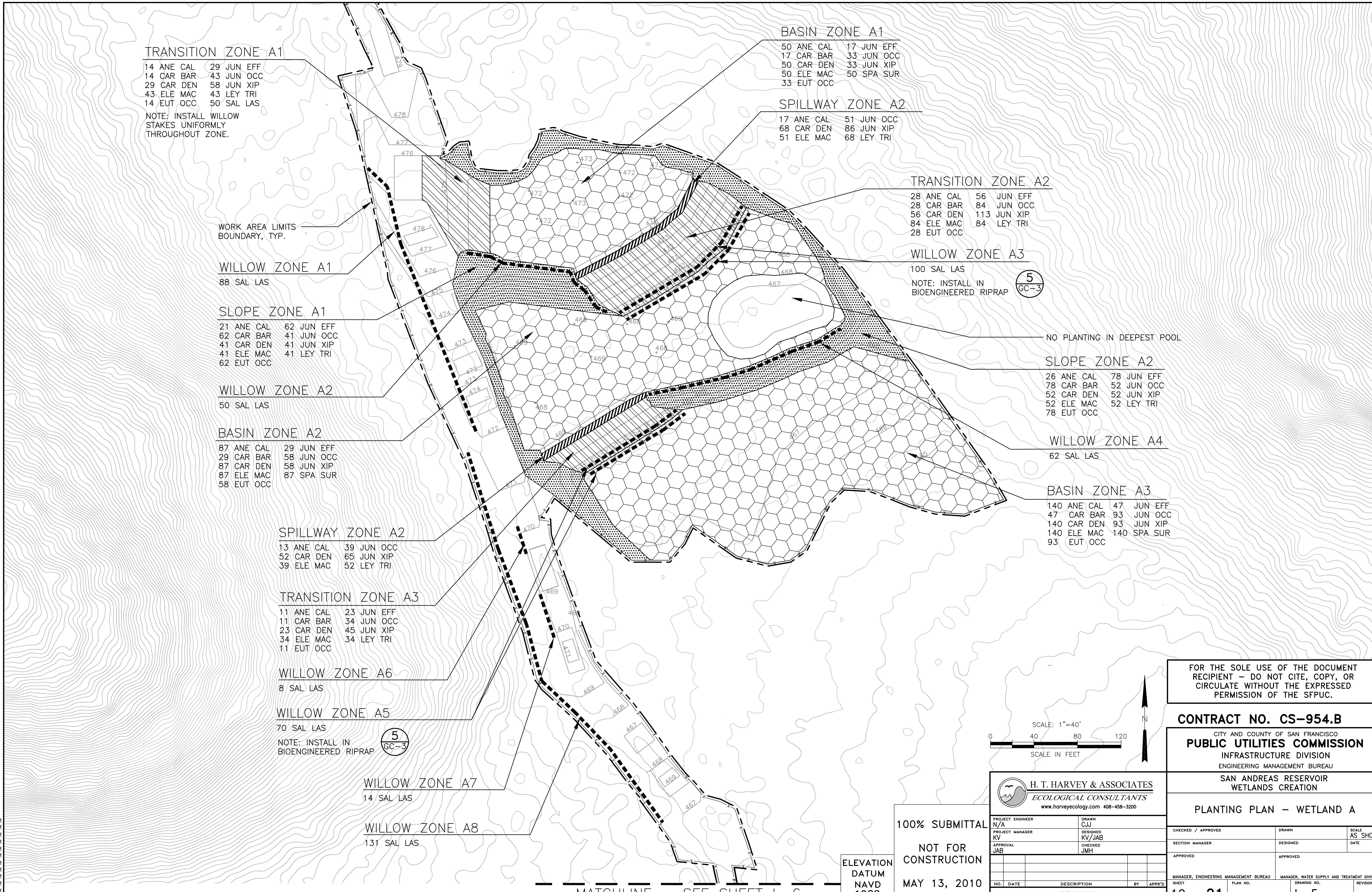
MAY 13, 2010

ELEVATION DATUM NAVD 1988

PLOT: EXTEND
SCALE: 1:1
BORDER: 22,34
COLOR: No.
RED 0.70MM
YELLOW 0.20MM
GREEN 0.25MM
CYAN 0.40MM
BLUE 0.50MM
MAGENTA 0.20MM
WHITE 0.35MM
GRAY 0.15MM
9 0.15MM
10 1.00MM
100 0.70MM
210 0.60MM

FILE:

FOR REDUCED PLANS ORIGINAL SCALE IS IN INCHES 0 4



ELEVATION DATUM NAVD 1988

100% SUBMITTAL

NOT FOR CONSTRUCTION

MAY 13, 2010

CONTRACT NO. CS-954.B

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ECOLOGICAL CONSULTANTS
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SAN ANDREAS RESERVOIR
WETLANDS CREATION

PLANTING PLAN – WETLAND A

PROJECT ENGINEER N/A	DRAWN CJJ
PROJECT MANAGER KV	DESIGNED KV/JAB
APPROVAL JAB	CHECKED JMH

NO.	DATE	DESCRIPTION	BY	APPR'D

REVISIONS

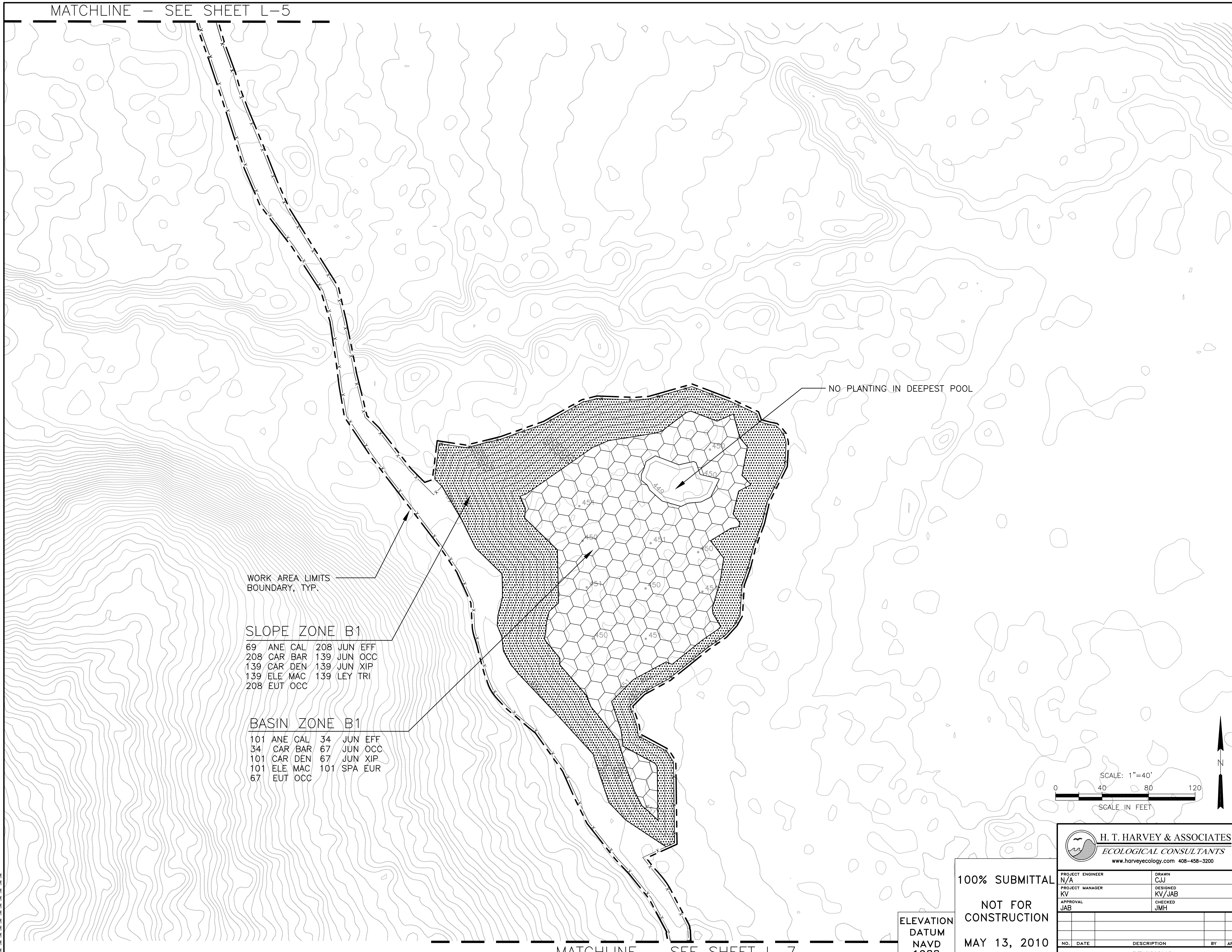
CHECKED / APPROVED	DRAWN	SCALE AS SHOWN
SECTION MANAGER	DESIGNED	DATE
APPROVED MANAGER, ENGINEERING MANAGEMENT BUREAU	APPROVED MANAGER, WATER SUPPLY AND TREATMENT DIVISION	

SHEET	PLAN NO.	DRAWING NO.	REVISION NO.
19 OF 21		L-5	

PLOT: EXTEND
SCALE: 1:1
BORDER: 22,34
COLOR: No.
RED 0.70MM
YELLOW 0.20MM
GREEN 0.25MM
CYAN 0.40MM
BLUE 0.50MM
MAGENTA 0.20MM
WHITE 0.35MM
GRAY 0.15MM
9 0.15MM
10 1.00MM
100 0.70MM
210 0.60MM

FILE:

FOR REDUCED PLANS ORIGINAL SCALE IS IN INCHES 0 1 2 3 4



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SAN ANDREAS RESERVOIR
WETLANDS CREATION

PLANTING PLAN – WETLAND B

H. T. HARVEY & ASSOCIATES
ECOLOGICAL CONSULTANTS
www.harveyecology.com 408–458–3200

PROJECT ENGINEER N/A	DRAWN CJJ
PROJECT MANAGER KV	DESIGNED KV/JAB
APPROVAL JAB	CHECKED JMH

NO.	DATE	DESCRIPTION	BY	APPR'D

REVISIONS

CHECKED / APPROVED	DRAWN	SCALE AS SHOWN
SECTION MANAGER	DESIGNED	DATE
APPROVED MANAGER, ENGINEERING MANAGEMENT BUREAU	APPROVED MANAGER, WATER SUPPLY AND TREATMENT DIVISION	

SHEET	PLAN NO.	DRAWING NO.	REVISION NO.
20 OF 21		L–6	

100% SUBMITTAL

NOT FOR CONSTRUCTION

MAY 13, 2010

ELEVATION DATUM NAVD 1988

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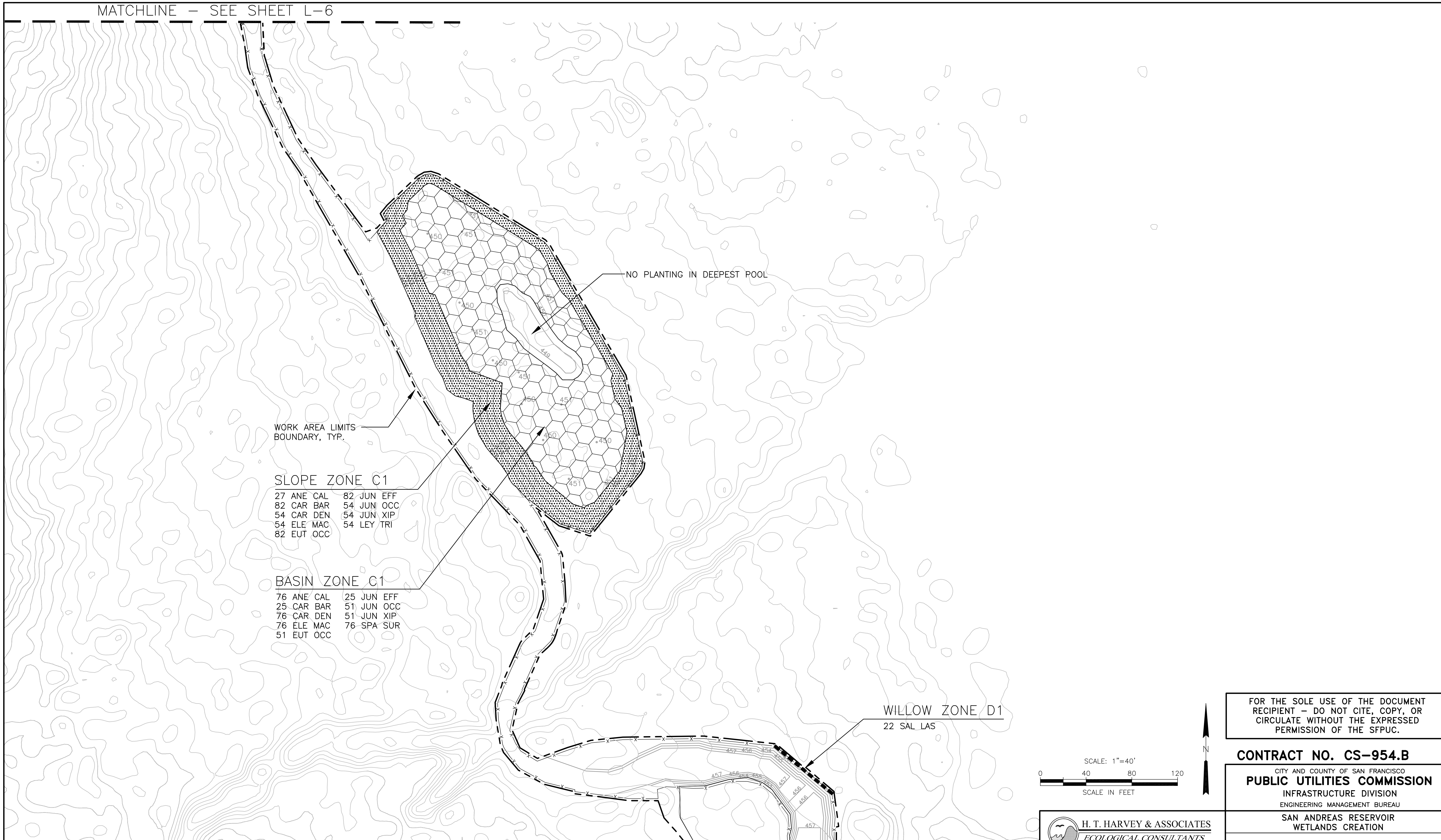
SCALE: 1:1
BORDER:
22,34
COLOR: No.
RED 0.70MM
YELLOW 0.20MM
GREEN 0.25MM
CYAN 0.40MM
BLUE 0.50MM
MAGENTA 0.20MM
WHITE 0.35MM
GRAY 0.15MM
9 0.15MM
10 1.00MM
100 0.70MM
210 0.60MM

FILE:

FOR REDUCED PLANS ORIGINAL SCALE IS IN INCHES 0 1 2 3 4



PLOT: EXTEND
SCALE: 1:1
BORDER:
22,34
COLOR: No.
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YELLOW 0.20MM
GREEN 0.25MM
CYAN 0.40MM
BLUE 0.50MM
MAGENTA 0.20MM
WHITE 0.35MM
GRAY 0.15MM
9 0.15MM
10 1.00MM
100 0.70MM
210 0.60MM

FILE:

FOR REDUCED PLANS ORIGINAL SCALE IS IN INCHES 0 4

ELEVATION DATUM NAVD 1988

100% SUBMITTAL

NOT FOR CONSTRUCTION

MAY 13, 2010

CONTRACT NO. CS–954.B

H. T. HARVEY & ASSOCIATES
ECOLOGICAL CONSULTANTS
www.harveyecology.com 408–458–3200

PROJECT ENGINEER N/A	DRAWN CJJ
PROJECT MANAGER KV	DESIGNED KV/JAB
APPROVAL JAB	CHECKED JMH

NO.	DATE	DESCRIPTION	BY	APPR'D

REVISIONS

CITY AND COUNTY OF SAN FRANCISCO
PUBLIC UTILITIES COMMISSION
INFRASTRUCTURE DIVISION
ENGINEERING MANAGEMENT BUREAU

SAN ANDREAS RESERVOIR
WETLANDS CREATION

PLANTING PLAN – WETLANDS C & D

CHECKED / APPROVED	DRAWN	SCALE AS SHOWN
SECTION MANAGER	DESIGNED	DATE
APPROVED MANAGER, ENGINEERING MANAGEMENT BUREAU	APPROVED MANAGER, WATER SUPPLY AND TREATMENT DIVISION	

SHEET	PLAN NO.	DRAWING NO.	REVISION NO.
21 OF 21		L–7	

APPENDIX D.
VEGETATION MANAGEMENT PLAN

H. T. HARVEY & ASSOCIATES
ECOLOGICAL CONSULTANTS

SAN FRANCISCO PUBLIC UTILITIES COMMISSION HABITAT RESERVE PROGRAM VEGETATION MANAGEMENT PLAN

Prepared by:

H. T. Harvey & Associates

Prepared for:

San Francisco Public Utilities Commission
1145 Market Street, 5th Floor
San Francisco, CA 94103

22 July 2010 Project No. 3135-01

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TABLES

INTRODUCTION

The spread of invasive species is one of the world's greatest threats to biological diversity (Bossard et al. 2000). They substantially alter ecosystem function and displace native species and the organisms that depend on them (Cal EPIC 2004; Tu et al. 2001). The eradication of invasive species combined with the replacement with native species is a common habitat restoration technique. Long-term control of invasive species is also generally a central element to long-term management of habitat restoration sites and conservation lands.

The San Francisco Public Utilities Commission (SFPUC) owns and manages lands within the watersheds of the Crystal Springs and San Andreas Reservoirs that serve to store drinking water for the City of San Francisco. Portions of these lands are used as habitat restoration sites that serve to mitigate impacts to biological resources from SFPUC projects. These habitat restoration sites often support invasive plants prior to implementation of restoration activities and/or are invaded by such species following restoration construction. As a result, eradication and control of invasive plant species is of great importance to the SFPUC for establishing successful mitigation sites.

This vegetation management plan provides a general overview of invasive species control approaches, control methods specific to individual invasive species that have been identified at the SFPUC San Andreas Reservoir Wetland Creation, Sherwood Point, Adobe Gulch Creek Wetland Creation, Skyline Quarry, and Skyline Boulevard Habitat Improvement mitigation sites, and a brief invasive species monitoring plan.

METHODS

VEGETATION MANAGEMENT TECHNIQUES

Successful control of invasive species often requires the use of multiple methods and implementation of adaptive management strategies to succeed in the short- and long-term. The methods most often employed include herbicides, mowing, grazing, hand removal, and prescribed fire. A general description of how each of these biological, chemical, and physical methods is typically utilized to control invasive plant species is provided below. Some of this general information was developed in the Homestead Pond Mitigation and Monitoring Plan (Winzler and Kelly 2009). This information, and additional research conducted for this plan, is presented here to provide an overview of the general techniques that are often utilized during the eradication and control of invasive species on SFPUC mitigation sites.

Biological Control

Introduced invasive usually have natural enemies in their native habitats, but this natural control mechanism is often absent in the invaded habitats (Keane and Crawley 2002). Released from their natural competitors, predators, herbivores, pathogens or disturbance regimes, these weeds become successful invaders in their new environment. Biological control is the introduction, or in some cases the re-introduction, of an "enemy" species to limit the spread of an invasive plant. These control agents may outcompete, feed upon, or otherwise limit an invasive species' ability to grow and reproduce. There are, however, several risks associated with biological control (Louda et al. 2003); control agents may impact non-targeted native species, alter ecosystem functions, and become invasive themselves (Simberloff and Stiling 1996). This technique should not be used unless controlled scientific experiments have shown it to be feasible for a particular agent and host and that risks are very minimal if not absent.

Competition. Plants compete for space, nutrients, pollinators, sunlight, and water. Non-invasive plants may effectively outcompete weeds in certain situations. However, in some situations, the aggressive establishment of native species is a potential form of invasive species control. For example, native trees and shrubs may be planted in deteriorating forests and woodlands to shade-out invasive grasses (Cole and Weltzin 2004). Planted subterranean clover may help control yellow starthistle when done in combination with grazing (Thomsen et al. 1997).

Grazing. While grazing alone will almost never completely eradicate invasive plant species (Tu et al. 2001), it is an important tool to limit the spread of many invasive species and to control large weed infestations (Sheley and Petroff 1999). Grazing in combination with other treatments can be extremely effective. The use of grazing as part of an invasive species control program should be done thoughtfully. The timing and intensity of grazing could be effective or alternatively could aid in the spread of particular invasive species if not done properly. Many invasive species, for example, require highly disturbed soils to create conditions to successfully spread. As a result, overgrazing can lead to the spread of some invasive species . In addition, caution should be used when bringing in animals from off site locations as this can also spread of invasive species through seed in their manure. Grazing during seed or flower production can be especially useful at damaging the invasive species without significantly impacting the desired native species. Finally, grazing can also negatively impact native species that are the target of restoration efforts. Thus, grazing is an excellent tool but careful planning is required to implement this strategy effectively.

Insects. Introduced insects have been used to successfully control invasive plants including Klamath weed (*Hypericum perforatum*; Huffaker and Kennett 1959) and ragwort (*Senecio jacobaea*; McEvoy et al. 1991); however, the introduction of insects and other organisms may have unintended consequences. For example, Callaway et al. (1999) introduced a bio-control moth, knapweed root moth (*Agapeta zoegana*), to the highly invasive spotted knapweed (*Centaurea maculosa*) and found that the introduced herbivory stimulated compensatory growth in the weed and increased its competitive ability. The Nature Conservancy prohibits the intentional release of non-indigenous biological control agents on their lands because of the associated risks.

Chemical Control

Herbicide Application. The use of herbicides is a very effective tool in the eradication and control of invasive plant species (Sheley and Petroff 1999, Bossard et al. 2000, Tu et al. 2001). However, great care must be taken in the planning for and application of herbicides to avoid inadvertent impacts to desirable native species, impacts water quality, and injury to herbicide applicators. As a result, the use of herbicides on a habitat restoration site generally requires that a written recommendation be developed by a certified pest control advisor before herbicides are applied. This recommendation should be obtained for herbicide treatments on SFPUC mitigation lands.

The City of San Francisco passed an Integrated Pest Management Ordinance in 1996 which restricts the use of herbicides on lands owned or leased by the City of San Francisco. The ordinance specifies that pesticides (including insecticides, herbicides/weed-killers) should be employed as a method of last resort and only after exploring all applicable non-chemical options. Further, only products listed on the San Francisco Reduced-Risk Pesticide List (RRPL) may be used on City-owned or leased properties. Table 1 below provides the herbicides that are approved for use on SFPUC lands and includes limitations and notes on the proper use of these herbicides. More information is available online at the following links:

- http://www.SFEnvironment.org/ipmchecklist
- http://www.sfenvironment.org/downloads/library/ipmordinance.pdf
- http://www.sfenvironment.org/downloads/library/20100420_sf_pesticide_list__red_legged_frog.pdf

Table 1. Herbicides and Surfactants Approved for Use on SFPUC Lands

Product and Type	Ingredients	Limitations / Notes
Aqua- master * (equivalent to Rodeo) --herbicide in Water	glyphosate, isopropylamine salt 53.8%	May damage non-target plants. Use for emergent plants in ponds, lakes, drainage canals, and areas around water or within watershed areas. Only as a last resort when other management practices are ineffective. NOTE: Equivalent to "Rodeo Emerged Aquatic Weed and Brush Herbicide," an older product. Rodeo in storage may be used under the same limitations. Note prohibition on use within buffer zone (generally 60 feet) around water bodies in red-legged frog habitat.
CMR Silicone Surfactant --adjuvant	polymethylsiloxane, nonionic	Use other alternatives pending new review of siloxanes
Eco Exempt HC --herbicide	eugenol (clove oil) 21.4%; 2-phenethylpropionate 21.4%	Do not use in enclosed areas.
EZject Selective Injection * --herbicide	glyphosate, isopropylamine salt 83.5%	Tree stump injection especially where resprouting is likely, prefer mechanical methods when possible
Garlon 4 * --herbicide	Triclopyr, butoxyethylester 61.6%; nonpetroleumbased methylated seed oils	Use only for targeted treatments of invasive exotics via dabbing or injection.
Garlon 4 Ultra * --herbicide	Triclopyr, butoxyethyl ester 60.45%	Use only for targeted treatments of invasive exotics via dabbing or injection.
Milestone --herbicide	Aminopyralid, triisopropanolamin e salt (5928) 40.6%	For invasive species in natural areas where other alternatives are ineffective, especially for invasive legumes and composites such as yellow star thistle and purple star thistle. *Listed as Tier I due to persistence but toxicity & potential exposure are very low.*
Roundup Pro * --herbicide	glyphosate, isopropylamine salt 41%	Spot application of areas inaccessible or too dangerous for hand methods, right of ways, utility access, or fire prevention. Use for cracks in hardscape, decomposed granite and edging only as last resort. OK for renovations but must put in place weed prevention measures. Note prohibition on use within buffer zone (generally 60 feet) around water bodies in red-legged frog habitat.
Roundup ProDry * --herbicide	glyphosate, ammonium salt 71.4%	Same limitations as Roundup Ultra
Sonar A.S. --herbicide in water	fluridone 41.7%	Emergent plants in ponds, lakes, drainage canals. Only as a last resort when other mgmt. practices are ineffective.
Turflon Ester * --herbicide	Triclopyr, butoxyethyl ester 61.6%	Targeted treatment of turf; broadcast application requires exemption. Note prohibition on use within buffer zone (generally 60 feet) around water bodies in red-legged frog habitat.

Source: City of San Francisco. 2009. SF Reduced Risk Pesticide List. City Department of the Environment. http://www.sfenvironment.org/. Accessed 11 March 2010.

* Can't be used within 60 feet of water bodies within California red-legged frog critical habitat

Physical Control

Cutting. Pruners, loppers, and saws can be effective tools for controlling invasive trees and shrubs (Holloran et al. 2004); however, some plants may respond to cutting by becoming more vigorous or by colonizing new locales via vegetation spread. Thus, the biology of the target species needs to be considered when considering cutting to control invasive species.

Hand Removal. Hand removal is often the most effective, easiest, and inexpensive way to control invasive plants, especially at the early stages of invasion and during the seedling stage of the plant's development (Tu et al. 2001). Local volunteers are often eager to help with invasive plant removal in their communities. Efforts should be made to remove the entire plant while minimizing soil disturbance that may facilitate invasion by other exotic and/or invasive plants. Proper disposal of removed plant material is important to avoid the spread of seeds and vegetative roots and stems.

Manual and Mechanical Removal. In instances when hand removal is not a feasible or effective means of controlling invasive plant species, manual removal by other means may be necessary. These means may include the use of tools such as weed wrenches, levers, or large equipment (e.g., bulldozers) to uproot and remove individual shrubs or trees.

Mowing. Mowing can be an effective means of controlling invasive annual species when grazing or fire is not feasible. When properly timed, mowing prevents seed development and dispersal, cuts off energy production in photosynthetic leaves, and reduces competition pressures on non-targeted species by exotic annuals (DiTomaso and Healy 2007). However, shifts in species composition from exotic annual grasses to exotic forbs have been observed in California coastal prairie following mowing treatments (Maron and Jefferies 2001; Hayes and Holl 2003a); therefore this control technique may need to be used in combination with others strategies. In addition, each site may respond differently to the same mowing treatment, so site-specific management plans will be needed in order to maximize the benefits of mowing (Hayes and Holl 2003b).

Mulching. Mulch applied as hay, leaf litter, wood chips, or black plastic sheets may be effective at excluding sunlight from invasive seedlings and grasses. Reducing the amount of sunlight a plant receives causes photosynthesis to slow down or stop, thereby cutting off the energy supply it needs to grow and reproduce. Care should be taken to avoid using hay bales and other mulch material that could be contaminated with seeds of invasive plants.

Successional Management

The biological, chemical, and physical techniques described above can control many invasive plant species. However, an ecological approach to weed management may further control these plants by applying successional models to direct plant species composition from invasive and exotic to native assemblages (Krueger-Mangold et al. 2006). Ecological succession refers to changes in natural communities through time. By understanding the causes of succession for a particular community (site and species availability/performance) and the processes associated with that community (e.g., disturbance, dispersal, life history, etc.), land managers can control invasive plant species occurrences and help prevent their future establishment (Sheley et al 2006).

Prescribed fire is a potentially effective tool to control some species of invasive plants which could be evaluate in the future when the need arises.

Target Invasive Species of SFPUC Mitigation Sites

Target species for non-aquatic, upland habitats are species with high or moderate impacts rankings in the California Invasive Plant Council's (Cal-IPC) Central West list (excluding those listed as exempt below), as well as those species that are rated as high or moderate by the Cal-IPC list in the future (but excluding species that are considered to appear rarely in monotypic stands or to have low/minor impacts in our region).

Target invasive species for wetland habitats, riparian habitats, and other aquatic habitats regulated by USACE, RWQCB, and CDFG are the same as for non-aquatic/upland habitats, with the addition of the species ranked as Tier 1 and Tier 2 in the Water Board's Fact Sheet for Wetland Projects http://www.waterboards.ca.gov/sanfranciscobay/certs.shtml.

Scientific Name	Common Name	Cal-IPC rating	Considered a Target Invasive by SFPUC?	Rationale for not being considered exempt from the list of target invasives in non-wetland areas
Bromus diandrus	ripgut brome	Moderate	N	Monotypic stands uncommon.
Cynosurus echinatus	hedgehog dogtailgrass	Moderate	N	Impacts vary regionally, but typically not in monotypic stands.
Erechtites glomerata, E. minima	Australian fireweed, Australian burnweed	Moderate	N	Impacts low overall. May vary locally.
Hordeum marinum, H. murinum	Mediterranean barley, hare barley, wall barley	Moderate	N	Generally do not form dominant stands.
Hypericum perforatum	common St. John's wort, klamathweed	Moderate	N	Abiotic impacts low.
Hypochaeris radicata	rough catsear, hairy dandelion	Moderate	N	Impacts appear to be minor.
Lolium multiflorum	Italian ryegrass	Moderate	N	Impacts vary with region.
Rumex acetosella	red sorrel, sheep sorrel	Moderate	N	Widespread. Impacts vary locally.
Trifolium hirtum	rose clover	Moderate	N	Impacts relatively minor in most areas.
Vulpia myuros	rattail fescue	Moderate	N	Rarely forms monotypic stands

TREATMENTS FOR INDIVIDUAL SPECIES

Potential treatments for individual species identified in Table 2 have been developed and are described below. The treatment descriptions for Australian burnweed (*Erechtites minima*), blue gum eucalyptus (*Eucalyptus globulus*), dogtail grass (*Cynosurus* spp.), European olive (*Olea europaea*), French broom (*Genista monspessulana*), Harding grass (*Phalaris aquatica*), Italian ryegrass (*Lolium multiflorum*), Italian thistle (*Carduus pycnocephalus*), Monterey cypress (*Cupressus macrocarpa*), oat grass (*Avena* spp.), periwinkle (*Vinca major*), Spanish broom (*Spartium junceum*), teasel (*Dipsacus sativus*), and yellow star-thistle (*Centaurea solstitialis*) were developed as part of the Homestead Pond Mitigation and Monitoring Plan (Winzler and Kelly 2009). These treatment descriptions were expanded and new treatments were developed for bull thistle (*Cirsium vulgare*), cutleaf fireweed (*Erechites glomerata*), milk thistle (*Silybum marianum*), Pampas grass (*Cortaderia jubata*; *C. selloana*), Scotch broom (*Cytisus scoparius*), and velvet grass (*Holcus lanatus*) using descriptions and methods found in Bossard et al. (2000) and DiTomaso and Healy (2007). The general control treatments for each invasive species have been summarized in Table 3.

Blue Gum Eucalyptus (*Eucalyptus globulus*). Blue gum eucalyptus is a perennial tree that can grow 150-180 ft tall. It is long-lived and grows well on a variety of soils. Native to Australia, blue gum displaces native plant communities and alters soil chemistry through the addition of chemicals from its leaves. Its impact rating by Cal-IPC is moderate and it is listed by the SFRWQCB as a Tier 1 species. Blue gum removal is recommended using the following physical and chemical techniques:

> **Manual Removal/Cutting.** Eucalyptus trees are often massive, and their removal can be difficult and expensive. Cutting and manual (or mechanical) removal will be needed followed immediately (within 5 minutes) by herbicide treatment of stumps. Cuts should be made as close to the ground as possible. When herbicide treatment of stumps is not feasible, resprout shoots should be cut after they reach 6 ft tall. Repeated treatment will cause the tree to die in 4 or more years. Stump grinding can be effective for eliminating sprouting when there are few individuals growing on gentle terrain; however, the area should be re-visited every 2 to 6 months for at least a year to check for resprouts. Saplings can be hand pulled to prevent the development of new groves. Grinding should occur in addition to and subsequent to herbicide applications. Prescribed burning can help control seedlings; however, this method is ineffective against the fire adapted adults.
>
> **Chemical.** Herbicides are the most effective method for the control of blue gum. Triclopyr (as Garlon 4® and Garlon 3A®) and glyphosate (as Roundup® or Rodeo®) have been shown to be effective at controlling sprouts when applied to freshly cut stumps. Stem or foliar application is less effective. It is important to spray the fresh cambium immediately after cutting in order to ensure the herbicide will be transported by the plant to its roots. A written recommendation from a certified pest control advisor should be obtained before the used of herbicides.

Bull Thistle (*Cirsium vulgare*). Bull thistle is a perennial or biennial forb that is common on grasslands, along the edges of marshes, and in mesic forest openings. It is native to Europe, western Asia and northern Africa, and in California it displaces native and forage plant species.

Its impact rating by Cal-IPC is moderate and it is listed by the SFRWQCB as a Tier 2 species. Physical and chemical techniques can be utilized to control this species.

Hand Pulling/Mowing/Cutting. Hand pulling, mowing or hand cutting 1-2 in below the soil surface shortly before plants begin to flower effectively controls bull thistle. Plants should be removed following cutting, because flower stalks left to decompose may continue to flower and produce viable seeds. Bull thistle can be mowed after it has bolted and before flowering. A second round of mowing one month later will be needed for success. Mowers and clippers should be cleaned so that they do not spread thistle seeds.

Chemical. Herbicides can effectively control bull thistle. Clopyralid, dicamba, MCPA, picloram, and 2,4-D have been shown to be effective when applied to rosettes in spring or fall. Chlorsulfuron and metsulfuron have been shown to be effective when applied to plants during bolting to bud stages. Prior to the use of herbicides a written recommendation should be obtained by a certified pest control advisor.

Dogtail Grass (*Cynosurus* spp.). Dogtail grass is an annual grass that came from Europe and invaded most of California's habitats. Its impact rating by Ca-IPC is moderate (*C. echinatus*), but it is not listed by the SFRWQCB. Mechanical removal is the best method for controlling dogtail grass.

Manual Removal. Manual removal before it sets seed may help control the spread of this species; however, disturbances associated with weeding may facilitate invasion by other invasive species.

Grazing. Grazing prior to planting natives to compete with dogtail grass could be highly effective in providing an initial reduction in this species.

French Broom (*Genista monspessulana*). French broom is a perennial shrub that was introduced as a landscape ornamental. A member of the pea family (Fabaceae), French broom forms dense thickets on coastal plains, mountain slopes and in disturbed places. It is rated by Cal-IPC as high impact and is listed by the SFRWQCB as a Tier 1 species. Removal can be achieved using physical, chemical, and biological techniques:

Hand Pulling/Manual Removal. Hand pulling and mechanical removal with a weed wrench can help control French broom. These methods are labor intensive and work best with small infestations. Soil disturbance associated with these kinds of physical removal may facilitate the establishment of broom seedlings from the seed bank or other invasive species.

Cutting. Cutting shrubs with loppers or saws just above ground level helps minimize soil disturbance; however, the stumps of French broom readily resprout, and they will need to be cut several more times to be eliminated. Stumps can be treated with herbicide to reduce resprouts.

Mulching. Mulch can be used to control French broom. A 3 in deep layer of wood bark mulch has been shown to significantly decrease seedling emergence (Bossard et al. 2000). This approach may help reduce impacts in areas where large seed banks have accumulated.

Herbicide. A two percent solution of glyphosate (as Roundup®) can be sprayed on the foliage. Prior to the use of herbicides a written recommendation should be obtained by a certified pest control advisor.

Biological. There are a number of potential biological control agents found in its native range including species of moths, beetles, and weevils (Sheppard 2000); however, none are USDA approved. These control agents would likely impact native species of lupine and should not be released. Another biological control technique is to plant native trees and shrubs within and around stands of broom to help control infestations through shading and competition.

Harding Grass (*Phalaris aquatica*). Harding grass is a deep-rooted perennial grass rated by Cal-IPC as moderate and listed by the SFRWQCB as a Tier 2 species. Physical, chemical, and biological treatments may be used to help control Harding grass.

Mowing. Mowing is an effective means of controlling Harding grass. If mowing is implemented, it is recommended to be very close to the ground and to occur at least three times within the growing season to keep the plants from overtaking native species. After mowing close to the ground, an herbicide can be applied to reduce the amount of effort needed for subsequent mowing (Cal-IPC, 2004).

Chemical. Spot treatment herbicide sprays with a 2 percent solution of glyphosate have been shown to be effective in the control of Harding grass. Prior to the use of herbicides a written recommendation should be obtained by a certified pest control advisor.

Grazing. Intense livestock and geese grazing have been effective at controlling Harding grass. Grazing can effectively decrease abundance of this species and it is known to be planted for forage, but can be toxic when consumed in large quantities by animals.

I**talian Ryegrass (*Lolium multiflorum*).** Italian ryegrass is a non-native annual grass rated by Cal-IPC as moderate and listed by SFRWQCB as a Tier 2 species.

Mowing. Mowing and biomass removal can significantly reduce the abundance of Italian ryegrass and other annual grasses (Maron and Jefferies 2001); however, the cut grass can be left on-site as long as cutting took place prior to the flowering stage of the grass' development.

Biological. Ryegrass can tolerate grazing, and germination may even be promoted under heavy grazing regimes (Deregibus et al. 1994). It does not compete well with other grasses or survive well on infertile soil (DiTomaso and Healy 2007).

Italian Thistle (*Carduus pycnocephalus*). Italian thistle is an annual plant rated by Cal-IPC as moderate and is a listed by the SFRWQCB as a Tier 2 species. There are several physical, chemical and biological techniques that can be utilized to control this species.

Hand Pulling. Small infestations can be controlled through hand pulling individuals during the bolting stage and before flowering while minimizing soil disturbance.

Cutting. Plants should be cut or weed whipped before they flower. During the summer months when the ground is hard, individuals can be cut below the crown with a small pick or trowel. Repeated treatments will likely be needed. Flower and seed heads should be removed from the site and burned.

Grazing. Sheep and goats will graze on the thistle during the early spring when plants are 4-6 in tall. Animals should be allowed to graze for 2-3 weeks and in large numbers (Cal-IPC 2004).

Herbicide. Herbicides can be effective in the control of Italian thistle. Glyphosate (as Roundup®) has been shown to be effective when applied before the flowers go to seed. Prior to the use of herbicides a written recommendation should be obtained by a certified pest control advisor.

Biological. The seed output of Italian thistle is increased when it co-occurs with yellow bush lupine (*Lupinus arboreus*), so removal of this lupine and other showy-flowered plants, may help control Italian thistle (Molina-Montenegro et al. 2008). Although yellow bush lupine is native, it is considered invasive by Cal-IPC with a limited rating.

Oat Grass (*Avena* spp.). Slender oat grass (*Avena barbata*) and wild oat (*A. fatua*) are annual grasses that were introduced as forage for livestock. They are rated by Cal-IPC as moderate and are listed by the SFRWQCB as Tier 2 species. Soil disturbance can stimulate germination, and repeated exposure to fire may increase its abundance (Giessow and Zedler 1996).

Biological. Crown rust of oats (*Puccinia coronata* f. sp. *avenae*) has been shown to reduce the competitive ability wild oats (*Avena fatua*; Carsten et al. 2001).

Mulch. Oat grass establishment can be suppressed with a thick layer of mulch (DiTomaso and Healy 2007).

Pampas Grass (*Cortaderia* spp.). Pampas grass is a large perennial grass that was introduced from South America as an ornamental. Its wind dispersed seeds are produced on large plumelike inflorescence. It is often used to control erosion. Pampas grass is rated by Cal-IPC as high and listed by the SFRWQCB as a Tier 1 species.

Hand Pulling/Manual Removal. Hand pulling seedlings limits the spread of Pampas grass. Larger plants will need a pulaski, mattock, or shovel for effective removal. Adult individuals can be removed using a choker cable attached to a truck hitch. Digging around the roots of the plant helps ensure the complete removal of the grass.

Cutting. Pampas grass can be controlled through cutting; however, care needs to be taken to properly dispose of seeds, plumes, and root crowns. Leaves and stems should be cut to the base using an ax, machete, or chainsaw. The exposed root mass will then need to be removed by chopping it into 4 or 5 inch squares and prying it out of the ground. Cutting is most effective when combined with an herbicide treatment.

Herbicide. A 2 percent glyphosate solution can be applied to the plant during active growing periods during the autumn months. Repeated applications will be necessary, even on plants that appear dead as they may survive and regrow the following year. Herbicide should be applied after the plumes and leaves have been cut and carefully disposed of. Prior to the use of herbicides a written recommendation should be obtained by a certified pest control advisor.

Periwinkle (*Vinca major*). Periwinkle is a non-native perennial vine from southern Europe and northern Africa. It grows well in damp shaded areas, and once established, becomes a thick groundcover. It is rated by Cal-IPC as moderate and is listed by the SFRWQCB as a Tier 1 species. This species can be controlled by physical and chemical means.

Hand Pulling. Hand pulling can be labor intensive but effective when all of the stolons and root nodes are removed. Areas should be rechecked every 3 months for resprouts.

Herbicide. Periwinkle has been successfully controlled using glyphosate herbicides (Twyford and Baxter 1999). Success is improved when periwinkle is cut with a weed whip or brush cutter prior to spraying in order to increase foliar penetration. Prior to the use of herbicides a written recommendation should be obtained by a certified pest control advisor.

Scotch Broom (*Cytisus scoparius*). Scotch broom is a non-native perennial shrub from Europe and northern Africa that grows best on sandy, high-phosphorous soils, but it tolerates a great range of conditions. It rated by Cal-IPC as high and listed as a Tier 1 species by SFRWQCB.

Hand Pulling/Manual Removal. Small plants can be pulled by hand or with a weed wrench. This should be done before they flower and set seed. Efforts should be made to minimize soil disturbance.

Cutting. Cutting is the preferred method of control over manual removal as it helps reduce soil disturbances that can deepen the broom's seed bank (Ussery and Krannitz

1998). Scotch broom can be cut using lopper or pruning saw. Plants should be cut during the end of the dry season to decrease the rate of resprouting (Bossard and Rejmanek 1994).

Herbicide. A 2 percent solution of glyphosate (as Roundup®) can be sprayed on the foliage. Triclopyr ester (as Garlon®) in seed press oil is also effective when it is applied with a wick to basal bark. Prior to the use of herbicides a written recommendation should be obtained by a certified pest control advisor.

Biological. Native trees and shrubs can be planted within and around stands of broom to help control infestations through shading and competition.

Spanish Broom (*Spartium junceum*). Spanish broom is a non-native perennial that grows well on poor, dry, stony soils and tolerates below freezing temperatures. Its impact rating by Cal-IPC is high, but is not listed by SFRWQCB. The best treatment options for Spanish broom are the same as those for Scotch and French broom.

Teasel (*Dipsacus sativus*). Teasel is a non-native biennial herb that grows in disturbed places. It is rated by Cal-IPC as moderate and is not listed by SFRWQCB. Manual removal and mowing are the best options for controlling teasel. Biological control agents are being studied and considered (Rector et al. 2006).

Manual Removal Plants should be removed before they flower and set seed. Removal of the plant to a few inches below the rosette will help control small populations.

Mowing. Mowing teasel before flowering will prevent seed production.

Velvet Grass (*Holcus lanatus*). Velvet grass is a tufted perennial grass that grows best in moist conditions. It is rated by Cal-IPC as moderate and listed by SFRWQCB as a Tier 2 species. Velvet grass can be controlled with manual removal, burning, mowing, grazing, and herbicide treatments.

Hand Pulling/Manual Removal. Clumps of velvet grass can be pulled or manually removed. This should be done prior to seed set. The roots of velvet grass can grow deep, especially in low-nitrogen soils, so care should be taken to avoid breaking them.

Mowing. Mowing treatments should be done in late March before seed set and repeated monthly until July (Holloran et al. 2004).

Grazing. Grazing may help reduce velvet grass cover by 50-75% in mesic grasslands along the central California coast (Hayes and Holl 2003b); however, low-intensity grazing may enhance its establishment and spread (DiTomaso and Healy 2007).

Chemical. The Nature Conservancy has had success using Glyphosate solutions to control velvet grass (Tu et al. 2001).

Yellow Starthistle (*Centaurea solstitialis*). Yellow starthistle is a winter annual (sometimes biennial) forb species that occurs in open hills, grasslands, roadsides, and rangelands. It is rated by Cal-IPC as high and listed by SFRWQCB as a Tier 1 species. Impacts of yellow starthistle include significant increased groundwater consumption, lower forage quality of rangelands, lower plant diversity, and fragmentation of sensitive plant and animal habitats (DiTomaso et al. 2006). These impacts represent a high economic and ecological cost to agriculture (crops and grazing) and sensitive native habitats such as native grasslands and blue oak woodlands. However, it is regarded as an important late-season food source for honey bees (DiTomaso et al. 2006). Numerous methods are employed to control yellow starthistle including mechanical, chemical, and biological; however, complete eradication is currently unlikely in larger sized infestations. The specific elements of an integrated management strategy to control yellow star thistle depend on the ultimate land use objectives for a given area (DiTomaso et al. 2006).

Mowing. Mowing can be an effective means of controlling yellow starthistle if done at a 4 inch blade height when 2 to 5 percent of the seed heads are flowering (Benefield et al. 1999).

Herbicides. Several chemical options are available for treating yellow star thistle including triclopyr and glyphosate. Glyphosate should be applied in late winter or early spring to control seedlings or in late spring or early summer after annual grasses and forbs have senesced.

Grazing. Grazing by cattle, sheep, or goats can effectively control yellow starthistle if it is done at a high intensity for short durations while the plant is bolting but before it becomes spiny.

Competition. Pastures planted with non-native subterranean clover (*Trifolium subterraneum*), rose clover (*T. hirtum*), and native bunchgrasses may benefit, as these plants can outcompete yellow starthistle.

Insects. Three species of weevils and three species of flies have been USDA approved for the control of yellow starthistle. The larvae of these insects feed on the seeds of this host plant; however, lack of successful treatment of this invasive weed has led some to suspect that yellow starthistle compensates by increasing seed production at lower plant densities (Gutierrez et al. 2005).

Table 2. General Control Techniques for Each Target Invasive Plant Species.

Common Name	Species Name	Physical					Chemical	Biological		
		Cutting	Hand Pulling	Manual Removal	Mowing	Mulching	Herbicide	Competition	Grazing	Insect/ Fungi
blue gum eucalyptus	*Eucalyptus globules*	X	X	X			X			
bull thistle	*Cirsium vulgare*	X	X		X		X			
dogtail grass	*Cynosurus echinatus*			X			X			
French broom	*Genista monspessulana*	X	X	X		X	X		X	
Harding grass	*Phalaris aquatica*				X		X	X	X	
Italian ryegrass	*Lolium multiflorum*							X		
Italian thistle	*Carduus pycnocephalus*		X				X		X	
oat grass; slender wild oat	*Avena barbata; A. fatua*					X		X		X

Common Name	Species Name	Physical					Chemical	Biological		
		Cutting	**Hand Pulling**	**Manual Removal**	**Mowing**	**Mulching**	**Herbicide**	**Competition**	**Grazing**	**Insect/ Fungi**
Pampas grass	*Cortaderia jubata; C. selloana*	X	X	X			X			
periwinkle	*Vinca major*		X	X			X			
Scotch broom	*Cytisus scoparius*	X	X	X		X	X		X	
Spanish broom	*Spartium junceum*	X	X	X		X	X		X	
teasel	*Dipsacus sativus*			X	X					
velvet grass	*Holcus lanatus*		X	X	X		X		X	
yellow star-thistle	*Centaurea solstitialis*				X		X	X	X	X

MONITORING

The species described above are rarely successfully controlled by a single treatment. Monitoring is therefore critical for assessing the need for follow-up treatments and ensuring the invasive species is properly controlled. Also, monitoring helps detect the recruitment or establishment of new invaders into a previously treated area. Early detection leads to greater success of controlling invasive plants.

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