The San Rafael Rock Quarry
Preferred Marsh Restoration Plan, 2012

1. CONTEXT FOR RESTORATION

San Rafael Rock Quarry Marsh Restoration Plan

This report has been prepared, and is hereby submitted, to satisfy Condition of Approval (COA) 113 from the September 28, 2010 Board of Supervisors' approval of the Amended Reclamation Plan for the San Rafael Rock Quarry (SRRQ). The report memorializes the process by which SRRQ has pursued various alternatives to enhance the marsh and has vetted the alternatives with the County of Marin and various resource agencies. The result is a plan to improve what turns out to be an existing successful and vibrant marsh by controlling invasive species and revitalizing portions of the marsh though extensive revegetation. SRRQ has presented the restoration alternatives to the County, to the Marin Coordinating Committee and to multiple resources agencies at the U.S. Army Corps of Engineers' Interagency Meeting. These forums allowed SRRQ to review the feasible restoration alternatives with numerous stakeholders for the purpose of analyzing the limitations and constraints of each alternative and to receive input from multiple agencies and jurisdictions. Based on the input we received, we have developed one preferred alternative which will achieve the mitigation set forth by COA 113. This report reflects the Preferred Marsh Restoration Plan developed by CSW|ST2 and WRA for SRRQ.

Project Description and History

The San Rafael Rock Quarry marsh is located at 1000 Point San Pedro Road along the northwestern edge of the SRRQ property, parallel to a portion of Point San Pedro Road, and consists of approximately 50 acres of low-lying land which is periodically inundated during the rainy season (see Figure 1-1). The marsh area currently receives water from upland areas on SRRQ property as well as adjacent streets and the hills and homes northwest of Point San Pedro Road. The marsh is bisected by the main access road to the quarry operation. The marsh consists of three separate, easily identifiable areas: the west marsh, the northeast marsh, and the east marsh. Collected water flows from the east marsh to the northeast marsh and then into the west marsh through a series of ditches delivering water to a pump at the southwesterly corner of the west marsh. The site was originally a dairy farm in the late 1800s and operated simultaneously with the McNear brickyard. After the dairy farm declined and hard rock was discovered below the shale brick resource, the hard-rock mining operation was commenced in 1939 by the Basalt Rock Company.

In 1971, the County of Marin adopted a surface mining ordinance, and in 1972 the County issued a mining permit to the quarry. In 1976, the state adopted legislation that required mining operators to develop a reclamation plan, and the Basalt Rock Company submitted a reclamation plan to the County. However, this reclamation plan was never adopted by the County.

In the 1980s, the quarry changed hands from Basalt Rock Company to Dillingham Corporation, and the quarry became a non-conforming use in 1981. The Dillingham

Corporation submitted an amended reclamation plan in 1982, and it was approved. At that time it was expected that reclamation would start in 1998.

In 1986, the property again changed hands when Dillingham Corporation sold the quarry to Dutra, which continued to operate the quarry and ancillary facilities under the existing mining permits. In 2002, SRRQ's right to operate and continue mining was challenged in court. In 2004, the Marin County Superior court found that SRRQ had a vested right to continue mining. The County was required to review SRRQ's operations, and SRRQ was required to submit an amended reclamation plan and to comply with certain interim operating conditions. SRRQ submitted an Amended Reclamation Plan and a proposal for an Amended Surface Mining and Quarrying Permit in 2004 in conformance with the Court order. During the subsequent entitlement process, the County prepared an EIR, held public hearings, and ultimately approved the plan with numerous Conditions of Approval (COA).

As a part of the COA, the quarry is required to mitigate for the cumulative impacts of the mining operations within specific Phases as laid out in the reclamation plan. The COA state that within Phase I of the reclamation, SRRQ will need to implement a marsh restoration plan.

Final COA and Compliance

The final Condition of Approval 113, including 113.a and subsections i-viii, requires that the marsh restoration plan include a baseline study of the existing marsh and a detailed plan for marsh restoration. As directed by COA 113.a.iii, we have evaluated a "suite of restoration alternatives" and have developed a Preferred Restoration Alternative, which (1) enhances existing habitat by preserving native pickleweed and potential salt marsh harvest mouse habitat, (2) improves upland buffers and restores upland transition areas, and (3) reduces non-native weed species which currently dominate upland areas.

As directed in COA 113.a.iii, we have also evaluated a tidal restoration and determined that a Full Tidal Alternative creates significant unintended consequences which would eliminate successful pickleweed and marsh species, flood Point San Pedro Road, and would leave the marsh as a barren mudflat. In order to minimize flooding on Point San Pedro Road from sea level rise, new levees would need to be constructed and that would further impact existing marsh vegetation. This alternative is discussed in additional detail below.

The second alternative, Invasive Species Control and Hydrology Enhancement, included refurbishing the existing sump and pump system and creating new channels and ponds that would draw tidal water into the west and northeast marsh up into the southeast marsh to create an open water habitat and winter mosquito fish breeding pond. As this alternative was studied, we found that very minimal additional benefit was gained by introducing a muted tidal regime, and it caused additional impacts to the marsh as well as required significant additional initial and long-term maintenance and costs. This alternative also increased the potential for flooding along Point San Pedro Road.

2. OVERVIEW OF EXISTING CONDITION

The marsh at SRRQ is a remnant of an area that was diked in the late 1800s to provide pasture for the dairy operation existing in the area. Since that time, the area has subsided significantly so that present elevations outside the channels range from -3.0 to +2.0 msl (mean sea level 1929 datum). The vegetation is primarily a pickleweed marsh surrounded by many invasive plants and shrubs. Since the channels are below sea level, pumping is required to drain the marsh of the storm water which enters from Point San Pedro Road and the surrounding development to the north, as well as hills on the SRRQ property to the south and east. While the marsh supports a relatively healthy pickleweed habitat, the elevations are lower than would be normally expected if the area were subject to direct tidal action. The roadways connecting Point San Pedro Road with the McNear Brick and Block company yard and SRRQ act as levees, allowing the conditions to support the pickleweed marsh.

The primary hydrology within the marsh is seasonal – storm water runoff drains into the marsh at the eastern end via a natural stream channel. Urban runoff from the adjacent development that is located on the north side of Point San Pedro Road also drains into the marsh at several points along Point San Pedro Road. There is a pumping facility that is used to pump storm water from the marsh into San Rafael Bay when needed. The marsh has internal levees which divide the marsh into western, northeastern, and eastern areas. The western area is primarily pickleweed habitat. The northeastern area is primarily shallow fresh water habitat. The eastern area is primarily shallow freshwater habitat with interspersed uplands areas. A review of elevation data indicates that the marsh has subsided considerably and is currently at approximately mean sea level. The marsh has many non-native invasive plant species in the upland buffer areas that surround the marsh and some limited occurrences within the seasonal pickleweed and freshwater marsh areas. Figure 2-1 illustrates the habitat types within the marsh and location of storm water pipes that discharge urban runoff into the marsh. Maps illustrating the location and extent of non-native invasive plant species within the marsh and upland buffer areas are included in Appendix B.

There are two activities around the marsh which are currently being actively managed. The first is removal of storm water by the existing pumping system. The second is controlling the mosquito population during the spring and early summer through spraying the ponded water.

The first activity is managed by SRRQ as it maintains and operates the pump system. The pump is controlled by float switches which turn the pump on at high water and then off as the water level drops to a predetermined level. In addition, the marsh has a large 48 inch outfall with a slide gate at the outfall. Unfortunately, the outfall is at an elevation that allows sediment to collect around the outfall of the pipe making it difficult to open.

The second activity is managed by the Marin Sonoma Mosquito Abatement District. The District schedules site visits and monitors mosquito production and sprays to reduce the overall mosquito population. SRRQ has historically allowed access to the District and helped manage the mosquito issue by unplugging the roadway culverts which move the water from the easterly marshes into the west marsh.

3. PREFERRED MARSH RESTORATION PLAN

The preferred marsh restoration plan was developed based on the results of a three-tiered wetland assessment, which identified the removal and control of non-native invasive plant species as the primary focus of restoration activities. The plan identifies target plant species and removal/control methods. The plan includes planting of replacement native plant species in the areas where non-native invasive species are removed. The preferred plan was selected because it represents an opportunity to significantly improve the wetlands, minimizes unintended negative impacts, and provides a feasible approach with immediate results. Other alternatives were evaluated such as converting the hydrology to full tidal and various modifications to grades within the wetland to alter hydrology, however these were not selected because they did not significantly improve the marsh, had a number of technical challenges, and caused potential adverse side effects.

The preferred marsh restoration plan consists of a comprehensive plan to remove and control non-native plant species within the marsh and adjacent uplands and replant these areas with native plant species. The plan includes two, 5-year implementation phases. Phase I focuses on areas that can be addressed in the near term and will be implemented prior to completion of the Phase I reclamation plan. Phase I will focus on areas adjacent to Point San Pedro Road, areas within the marsh, and a portion of the entry roads from Point San Pedro Road to the security gates for the quarry and brick yard. Phase II focuses on areas that will likely be affected by the closure of the quarry and activities associated with the potential redevelopment of the site. Phase II will focus on the areas between the marsh and the quarry/brick yard and the portions of the access roads that are internal to the security gates. Implementation of Phase II will be delayed because these areas may be impacted by the potential redevelopment. In addition, some of the Phase II areas may be cleared and grubbed as part of the redevelopment activities, which represents a significant cost saving for implementing the plan. Figure 3-1 illustrates the location and size of the 12 restoration areas and several blue gum removal areas that comprise the plan.

The following sections summarize the methods used to perform the wetland assessment, the results of the wetland assessment, and the goals of restoration. These sections also provide details regarding the preferred marsh restoration plan, including the target species, control methods, benefits, success criteria, implementation schedule, monitoring, and maintenance.

A. Three-Tiered Approach for Wetland Assessment

Wetland conditions and mitigation opportunities at the San Rafael Rock Quarry were assessed using guidance from the United States Environmental Protection Agency (USEPA). The Regional Water Quality Control Board (RWQCB) is the local authority on USEPA matters, and other agencies such as the U.S. Army Corps of Engineers (Corps) and California Department of Fish and Game (CDFG) are, in many cases, beginning to take a similar approach to wetland assessment.

In recent years, the USEPA developed a "three-tiered" approach to wetland assessment and monitoring (USEPA 2006). The three tiers, or levels, are summarized as follows:

> Level 1 – Landscape Assessment. Use GIS and remote sensing to gain a landscape view of watershed and wetland condition. Typical assessment indicators include wetland coverage, land use, and land cover.
>
> Level 2 – Rapid Wetland Assessment. Evaluate the general condition of individual wetlands using relatively simple field indicators. Assessment is often based on the characterization of stressors known to limit wetland functions such as road crossings, tile drainage, ditching, and other factors.
>
> Level 3 – Intensive Site Assessment. Produce quantitative data with known certainty of wetland condition within an assessment area, used to refine rapid wetland assessment methods and diagnose the causes of wetland degradation. Assessment is typically accomplished using indices of biological integrity or hydro-geomorphic function.

Under this approach, Level 1 studies are generally a mapping exercise with a relatively low level of detail, while Level 3 studies are those which produce quantitative or highly detailed information on a specific area related to wetlands. Level 2 studies have an intermediate level of detail, producing a simple evaluation of wetland condition based on a qualitative assessment of the basic components understood to be essential to healthy wetlands. Thus, Level 1 data can generally be used to identify areas within a landscape where wetlands of a certain type may occur, while Level 2 data provides a simple evaluation of their condition. Level 3 data may include assessments of the precise extent of the wetlands, the species that occur or do not occur there, the hydrology of the wetlands, the chemical composition of the soil or water, the effects on the wetland of certain weather patterns or management techniques, and much more.

The traditional approach to the study of wetlands has produced a great deal of Level 1 and Level 3 data. However, due in part to the lack of a standardized assessment methodology, the production of Level 2 data has been limited. In recent years, many states have developed wetland assessment methodologies to meet the need for Level 2 data. The California Rapid Assessment Method for wetlands (CRAM) is recognized by many agencies as California's primary Level 2 assessment methodology.

B. CRAM Methodology

CRAM provides a rapid, cost-effective, scientifically robust method to evaluate the condition of wetlands and waters. This method was developed by the San Francisco Estuary Institute in cooperation with the United States Environmental Protection Agency (USEPA), and the use of this method is gradually being implemented by regulatory agencies throughout the State. CRAM is considered a "Level 2" assessment according to the USEPA's 3-tiered framework for assessing and monitoring surface waters (USEPA 2006).

The CRAM method relies on rating wetlands with regard to four main attributes:

- Buffer and Landscape Context
- Hydrology
- Physical Structure
- Biotic Structure

Each of these four main attributes is divided into several key functional components or metrics. Each metric provides a score which is used in calculating an overall score for each of the four attributes. Attribute scores are expressed as percentages, with the highest score being 100% and the lowest score being 25%. An overall CRAM score is also presented for each area assessed with CRAM, calculated by taking the average of the four attribute scores.

A component of the CRAM process is to identify stressors for the wetland being assessed. A stressor is defined as an anthropogenic perturbation within a wetland or its environmental setting (Collins et al. 2008b). Stressors, when present, are likely to negatively impact the condition and function of the wetland. Stressors that relate to the four CRAM attributes are identified in the field. Stressors may or may not affect a wetland's CRAM score, but their identification is an important component of the CRAM procedure.

1. Results of the Wetland Assessment

    a. Results of Level 1 Wetland Assessment

        The wetlands are well-documented in Level 1 data, visible in aerial photographs, soil survey data (USDA 1985), the National Wetland Inventory (NWI) (USFWS 2012), and other sources. The *Soil Survey of Marin County* (USDA 1985) illustrates that the marsh is underlain by one native soil type, Hydraquents (saline). Saline hydraquents are hydric soils that formed from sediments deposited under saltwater. The NWI classifies the marsh as a Palustrine, Emergent, Semipermanently Flooded-Tidal, diked/impounded (PEMTh) (USFWS 2012). The San Quentin 7.5-minute USGS quadrangle shows that the marsh was accurately mapped as wetland habitat. This assessment helped establish the historic context and existing conditions of the marsh, which are described in Section 2; however, WRA's extensive studies and mapping of the marsh at SRRQ has provided greater detail than those provided in Level 1 Wetland Assessment.

    b. Results of Level 2 Wetland Assessment

        A Level 2 assessment of wetland condition was performed using the CRAM methodology (Appendix A). CRAM scores for the San Rafael Rock Quarry marsh indicate that its condition has been moderately impacted by human

activities (Appendix A). Compared to CRAM scores from similar wetlands throughout California, scores for the San Rafael Rock Quarry marsh fell near the middle or lower end of the range. In spite of low overall scores, some portions of the marsh received favorable ratings for having relatively healthy plant communities, a large amount of surrounding open space, or ideal marsh structure.

During the assessment it was determined that CRAM scores for the SRRQ marsh were reduced by unavoidable limitations and did not fully capture the extent of certain positive and negative factors. These considerations became evident during the assessment of stressors affecting the marsh, and were examined in greater detail in Level 3 studies.

c. Results of Level 3 Wetland Assessment

Property managers and consultants for the SRRQ conducted a number of detailed studies with regard to the marsh and surrounding land. These studies assessed factors identified as stressors to the marsh during the CRAM analysis, and included the following:

- A detailed botanical survey of the marsh and its surroundings
- A tidal elevation study of the marsh and its surroundings
- An analysis of potential hydrological enhancements

A botanical survey was performed to assess the extent of native and invasive vegetation in and around the marsh. Invasive vegetation can be a major stressor affecting many types of wetlands. The botanical survey identified several highly invaded areas, and also defined the portions of the marsh with low levels of invasion and healthy communities of native species (Appendix B).

A tidal elevation study of the marsh and its surroundings was performed to analyze the potential effects of returning the marsh to full tidal action. The marsh is a historic tidal salt marsh which has been separated from San Rafael Bay by a levee. A tide gate is present in the levee, but this gate is very rarely opened, and the marsh is effectively cut off from San Rafael Bay. Tidal action provides a number of functions in salt marsh habitats, and the lack of tidal action within the marsh can be viewed as a substantial stressor or detriment to the condition of the marsh. However, the tidal elevation study revealed that the marsh and its surroundings have subsided during the approximately 100 years that the levee has been in place. If the levee were breached to allow full tidal action, flooding from high tides could threaten Point San Pedro Road and the homes west of the marsh, as well as the McNear brickyard to the south. Thus, substantial upgrades to infrastructure and property would be required if the levee currently providing necessary flood protection to the surrounding area were breached. In addition, the

marsh itself would be inundated with greater frequency if full tidal action were present. This shift in the hydrologic regime caused by frequent flooding is expected to drastically change the vegetation community within the majority of the marsh, changing the current pickleweed-dominated marsh habitat to a mostly un-vegetated mudflat.

An analysis of hydrological enhancements was performed after observing that a number of urban storm drains empty into the marsh, and that mosquito abatement personnel routinely drive amphibious vehicles through the marsh. The input of untreated urban runoff is believed to be a stressor to the marsh, while amphibious vehicle traffic may cause impacts including physical damage to vegetation, harassment of wildlife, erosion, and introduction of pollutants. The analysis investigated methods to improve flow channels in the marsh and contain urban runoff from spreading beyond the channels, and also investigated the possibility of using biological controls to reduce the need for mosquito abatement. Mosquito fish are commonly used to eradicate mosquito larvae throughout California, and the possibility of deepening a portion of the marsh to accommodate mosquito fish was investigated. These enhancements would involve significant grading within the existing wetland to deepen the channel and create permanent open water habitat. These enhancements were not selected because of the extent of impacts on existing wetland habitat, cost and permit constraints.

2. Restoration Goals

The removal and control of non-native invasive plants from the marsh and adjacent uplands was identified as the prime goal of the restoration plan. This was based on several factors including the following: the invasive species was identified as a key stressor; this stressor is one that the landowner has some control over; actions to reduce the impact of this stressor are technically and financial feasible; and the removal of non-native plant species will have a significant beneficial impact on the marsh.

Several other stress factors were evaluated for inclusion in the restoration plan but these were not selected for several reasons including: the landowner did not have control over the stressor; actions to reduce the stressor were likely to have significant adverse side effects such as flooding of adjacent property and roadways, and undesired habitat conversion. The following section provides a summary evaluation of the stressors that were evaluated for inclusion in the restoration plan and rationale for their selection and omission.

The wetland assessment evaluated several stress factors and potential enhancement measures that could form the basis of a restoration plan. Unfortunately, the majority were not feasible because the stress factor was outside of the control of the existing landowner. Examples of this are: the proximity of the marsh to urbanized areas is detrimental to the CRAM score, but is beyond the control of

SRRQ; restoration of the marsh to full tidal action was not considered to be a viable option, because tidal inundation would result in the loss of pickleweed habitat because the land has subsided and would subject surrounding areas to flooding. The removal of invasive plant species was identified as a viable restoration alternative that would significantly improve the wetland habitat. This goal is feasible since the removal of invasive species is within control of the landowner. As such the removal of invasive species was identified as the main goal of restoration plan.

3. Detailed Description of the Preferred Restoration Plan

The preferred marsh restoration plan for the SRRQ is composed of the removal and control of non-native invasive plants species and the planting of replacement native plant species. Figure 3-1 (Appendix C) illustrates the location and size of the 12 restoration areas and several selected blue gum removal areas that comprise the plan. Blue gum removal areas include areas U-1 through U-9. Some blue gum areas will not be removed because they provide an important visual screen between the adjacent development and the quarry and there is strong public support for preserving these trees. Weed removal and control will occur in two phases, which will be outlined in more detail in the following sections. The following sections identify the main components of the restoration plan including: target species; control methods; benefits of the plan; the duration and timing requirements for the control methods; replacement with native plant species; implementation phases; maintenance requirements; monitoring requirements; and success criteria.

a. Target Species, Control Methods, and Replacement Plantings

WRA assessed the invasive species within the marsh (Appendix B). The extent and density of sixteen invasive plant species were mapped within and around the marsh. Target species were identified based on which species represented a substantial threat to the habitat, wildlife, and native vegetation of the marsh. These species were characterized as marsh, marsh fringe, or upland species based on their topographic position within the site and their hydrologic requirements.

b. Control Methods and Replacement Plantings

To effectively remove and control invasive species a set of combined physical and chemical controls, followed by native species planting/seeding has been tailored to each invasive species specifically, and will be applied to each restoration area. Table 3-1 summarizes the invasive species, their invasive rank, ecological, and control methods. Table 3-2 summarizes estimated timing and duration of control methods, and recommended native species replacement planting. The subsequent paragraphs in the section detail control methods and the approach to planting native species.

Table 3-1: SRRQ Invasive Species, Status, Ecology, and Control Methods

Invasive Species	Cal-IPC Rank	Ecology	Control Methods
perennial pepperweed (*Lepidium latifolium*)	High	Wetland (FACW); perennial forb with abundant seed set and extensive rhizomes; located in the West Marsh; can preclude native marsh species and increase soil surface salinity	Physical: hand removal, followed by native species planting Chemical: herbicide treatment, but may not be suitable for wetlands
pennyroyal (*Mentha pulegium*)	moderate	Wetland (OBL); perennial forb with abundant seed set and extensive rhizomes; located in East Marshes and eastern portion of the West Marsh; can preclude low-growing native marsh species; toxic to livestock	Physical: hand removal, followed by native species planting; flooding with salt water Chemical: herbicide treatment, but may not be suitable for wetlands
Himalaya blackberry (*Rubus armeniacus*)	High	Fringe (FACU); perennial vine/shrub with extensive root structures; located on marsh edge, banks, and roadsides; can preclude native vegetation and invade drier portions of wetlands	Physical: hand removal, mechanical removal of roots, followed by chemical controls Chemical: herbicide treatment, repeated application and spot application for re-emergent
iceplant (*Carpobrotus edulis*)	High	Fringe (FACU); perennial herb with extensive root structures; small patch located adjacent to Point San Pedro Road; rapid and expansive growth; can preclude low-growing native herbs; low wildlife value	Physical: hand removal, typically very effective Chemical: likely unnecessary given the current size (small) of this population in the site
Pampas grass (*Cortaderia jubata*)	High	Fringe (FACU); perennial graminoid; located on marsh fringe and drier areas of marsh; rapid growth and dispersal forming monotypic stands; precludes native herbs and shrubs	Physical: mechanical removal of roots, followed by chemical control or fire Chemical: herbicide treatment; repeated application and spot application for re-emergent
Fuller's teasel (*Dipsacus fullonum*)	moderate	Fringe (FAC); perennial forb with abundant seed set; located on marsh fringe and drier areas of marsh; rapid growth and dispersal; precludes native herbs and small shrubs	Physical: hand removal, repeated weed whipping in spring Chemical: herbicide treatment; spot treatment for seedlings
fennel (*Foeniculum vulgare*)	High	Fringe (NL); perennial forb with abundant seed set and aggressive rooting structures; located on marsh fringe and roadsides; rapid growth and dispersal; precludes native herbs and small shrubs; low wildlife value	Physical: mechanical removal of roots Chemical: herbicide treatment; spot treatment for seedlings
date palm (*Phoenix canariensis*)	Limited	Fringe (NL); evergreen tree; located on marsh edges and roadsides; rapid growth, rapid dispersal	Physical: mechanical removal and off-siting disposal of material Chemical: likely unnecessary as each individual can be removed permanently through physical means
wild radish (*Raphanus sativus*)	limited	Upland (NL); annual forb with abundant seed set; located on roadsides, marsh edge; rapid growth, precludes native herbs	Physical: repeated weed whipping Chemical: herbicide treatment with broadleaf specific pre-emergent
black mustard	moderate	Upland (NL); annual forb with abundant	Physical: repeated weed whipping

(*Brassica nigra*)		seed set; located on roadsides, marsh edge; rapid growth, precludes native herbs and small shrubs	Chemical: herbicide treatment with broadleaf specific pre-emergent
Italian thistle (*Carduus pycnocephalus*)	moderate	Upland (NL); annual forb with abundant seed set; located on roadsides, marsh edge; rapid growth, precludes native herbs; increase fire hazard	Physical: repeated weed whipping Chemical: herbicide treatment with broadleaf specific pre-emergent
yellow star thistle (*Centaurea solstitialis*)	High	Upland (NL); annual forb with abundant seed set; located on central berm in West Marsh and roadsides; rapid growth which can preclude native herbs; can be toxic to livestock and increase fire hazard	Physical: repeated weed whipping Chemical: herbicide treatment with broadleaf specific pre-emergent
Scotch broom (*Cytisus scoparius*)	High	Upland (NL); evergreen shrub with abundant seed set; located on central berm in East Marsh; rapid, monotypic growth; rapidly outcompetes native shrubs and herbs, moderate fire hazard, low wildlife values	Physical: mechanical removal, hand removal Chemical: herbicide treatment, spot treatment for emergent seedlings
blue gum (*Eucalyptus globulus*)	moderate	Upland (NL); evergreen tree; located throughout edge of marsh; rapid, monotypic growth; can overtop native shrubs, create "hazard" trees, and increase fire hazard	Physical: mechanical removal and off-siting each tree Chemical: herbicide application to cut stumps
French broom (*Genista monspessulana*)	High	Upland (NL); evergreen shrub with abundant seed set; located on edge of marsh; rapid, monotypic growth; rapidly outcompetes native shrubs and herbs, increased fire hazard, and low-quality wildlife value	Physical: mechanical removal, hand removal Chemical: herbicide treatment, spot treatment for emergent seedlings
periwinkle (*Vinca major*)	moderate	Upland (NL); perennial vine with extensive root structure; small patch located adjacent to Point San Pedro Road; rapid, stand-forming growth through can preclude low-growing native species riparian, roadsides, and shaded areas	Physical: hand removal Chemical: herbicide treatment following hand removal to re-emergent individuals

Table 3-2 SRRQ Invasive Species, Control Duration and Timing, and Replacement Native Species

Invasive Species	**Duration and Timing**	**Replacement Native Species**
date palm blue gum	cutting: any season mechanical removal: any season herbicide application: immediately following cutting repeated treatment: spot removal	coast live oak (*Quercus agrifolia*) California bay (*Umbellularia californica*) California buckeye (*Aesculus californica*) Pacific madrone (*Arbutus menziesii*)
Himalaya blackberry Pampas grass	hand cutting: mid-winter to spring mechanical removal: mid-winter to spring burning: spring herbicide application: spring to summer repeated treatment: spot removal, herbicide application	California blackberry (*Rubus ursinus*) willows (*Salix* spp.) blue wild rye (*Elymus glaucus*) creeping wild rye (*Elymus triticoides*) marsh baccharis (*Baccharis glutinosa*) western goldentop (*Euthamia occidentalis*)
fennel French broom Scotch broom	hand cutting: late winter to spring mechanical removal: spring herbicide application: spring to summer repeated treatment: spot removal, herbicide	coyote brush (*Baccharis pilularis*) California coffeeberry (*Frangula californica*) toyon (*Heteromeles arbutifolia*) California sagebrush (*Artemisia californica*)

	application	sticky monkey (*Mimulus aurantiacus*)
perennial pepperweed pennyroyal Fuller's teasel	hand removal: mid-winter to early spring weed-whipping: late spring (before seed set) herbicide application: spring to summer repeated treatment: spot removal, weed-whip, herbicide application	marsh baccharis western goldentop fleshy jaumea (*Jaumea carnosa*) pickleweed (*Salicornia pacifica*) salt grass (*Distichlis spicata*) Pacific aster (*Symphyotrichum chilense*)
iceplant periwinkle	hand removal: spring mechanical removal: spring herbicide application: spring to summer repeated treatment: unlikely	blue wild rye creeping wild rye California blackberry
wild radish black mustard Italian thistle yellow star thistle	weed whipping: spring to early summer (before seed set) herbicide application: spring to summer repeated treatment: weed-whip, herbicide application	purple needlegrass (*Stipa pulchra*) foothill needlegrass (*Stipa lepida*) California oat grass (*Danthonia californica*) Torrey's onion grass (*Melica torreyana*) red fescue (*Festuca rubra*) Idaho fescue (*Festuca idahoense*) meadow barley (*Hordeum brachyantherum*) blue-eyed grass (*Sisyrinchium bellum*) common yarrow (*Achillea millefolium*) California poppy (*Eschscholzia californica*) bee plant (*Scrophularia californica*) mugwort (*Artemisia douglasiana*) common tarweed (*Hemizonia congesta*)

Physical Control Methods: Physical methods vary per species, and will require landscape contractors and arborists. Control of blue gum and date palms will most effectively be accomplished through the complete removal of the entire trees, followed by herbicide application to cut trunks (see Chemical Control Methods below). Due to the extent of rooting structures, complete removal of roots is not recommended. Although it may take greater than one year to remove all blue gum and date palms, repeated treatments for removed individuals are not likely to be necessary. Spot removal of seedlings may be warranted.

French broom, Scotch broom, fennel, Himalaya blackberry, and Pampas grass removal should be accomplished in one season, followed by repeated spot treatments. Initial removal should include hand (i.e. pruning shears) and mechanical (i.e. chainsaw) cutting of upper vegetative structures. The berms adjacent to the marsh in the Phase II restoration areas will be cleared and grubbed, effectively removing rooting structures and reducing the seed bank. For individual infestations on the marsh surface and/or herbicide application (see below) immediately following the removal of upper vegetative structures should be utilized in lieu of soil/root removal. Periodic monitoring and maintenance to remove seedlings and prevent future infestation shall occur in the restoration areas.

Perennial pepperweed, pennyroyal, and Fuller's teasel control shall be accomplished over several seasons. Initial removal will include hand pruning of upper structures and hand removal of rooting structures. These species

reproduce rapidly from root structures and are difficult to control through physical methods alone, and therefore repeated treatments are likely necessary. Physical controls shall be implemented in spring during flowering, but before seed set occurs.

Iceplant and periwinkle can be effectively controlled through hand removal of all vegetative structures. The rooting structures of these species are relatively shallow and should be effectively removed through pulling in one season. Spot removal in subsequent years may be necessary for seedlings of these species.

Wild radish, black mustard, Italian thistle and yellow star thistle control shall be accomplished over several seasons. These species contain an abundant seed set, and therefore repeated treatment will be necessary to exhaust the seed bank. Initial removal should include weed-whipping in late spring into summer during flowering and before seed set. Chemical controls (see below) will likely be more effective when utilized with physical controls.

Chemical Control Methods: These methods should be utilized in coordination with physical control methods, and will entail the use of species-specific herbicide applications employed by qualified individuals with the appropriate certification to apply herbicides. Herbicide applications to blue gum and date palm stumps shall be applied to trunk stumps immediately following physical removal to prevent trunk-sprouting, particularly in the case of blue gum.

French broom, Scotch broom, fennel, Himalaya blackberry, and Pampas grass shall have targeted herbicide applications to remnant root structures following physical removal of upper vegetative structures. Herbicides approved for use in wetlands will be necessary for applications on or immediately adjacent to the marsh surface. Repeated applications over several seasons may be necessary to effectively control infestation of these species.

Perennial pepperweed, pennyroyal, and Fuller's teasel shall have targeted herbicide applications to remnant root structures following physical removal of upper vegetative structures. Herbicides approved for use in wetlands will be necessary for these species. Repeated applications over several seasons may be necessary to effectively control infestation of these species.

It is unlikely that herbicide applications will be necessary for iceplant and periwinkle as the infestations of these species are relatively small and hand removal will likely be effective.

Wild radish, black mustard, Italian thistle, and yellow star thistle shall have targeted herbicide applications following weed-whipping. A broadleaf-

specific herbicide should be employed to prevent targeting of replacement native grasses (see Replacement Native Species below). Repeated applications will likely be necessary for these species.

Tidal Flushing: The majority of non-native invasive species within the marsh can be controlled by flushing the area with salt water. There are tidal gates and a pumping facility that can be used to temporarily flood the marsh area with tidal water. The following is an outline of a typical treatment scenario.

- Open the tide gate for a period of time to fill the target areas with salt water.
- Close the tide gate and allow salt water to remain for a prescribed period of time.
- Pump saltwater out of the marsh at the end of the treatment period.
- Monitor results and adjust scenario as needed

Replacement Native Species: Planting and seeding with native species shall occur within the same season following physical removal of infested areas. Table 3-2 includes a species planting palette that replicates the ecological requirements, height, density, and structure of those invasive species they are meant to replace. Additionally, these species are found in the immediate vicinity and are readily available as nursery or seed stock from local sources and suppliers. Coast live oak, California bay, California buckeye, and Pacific madrone should replace blue gum and date palm trees. Plantings should be caged to reduce predation, and irrigation may be necessary for the first five years. To better adapt to existing soil conditions, locally collected fruits from these species should be scattered in treatment areas in conjunction with plantings.

Restoration areas (Phase II) receiving clearing and grubbing of the soil, shall be immediately planted with coast live oak, California bay, California buckeye, and Pacific madrone trees as well as a suite of native shrubs. Plantings will be along an elevation gradient with willows and California blackberry at the toe-of-slope, coyote brush and coffeeberry at mid-slope, and sticky monkey, toyon, and California sagebrush on the upper slope. Tree species will be planted in the mid and upper slope. In addition to plantings, broadcast seeding from these species as well as native forbs and grasses will be applied at the time of planting. Planted shrubs and trees should be caged, and irrigation may be necessary to bolster growth in the first few years.

Pickleweed, fleshy jaumea, salt grass, marsh baccharis, western goldentop, and Pacific aster should be planted in restoration areas on the marsh surface. Propagation from local stock will increase potential establishment of these species and should be used if feasible. California blackberry, creeping wild rye, and blue wild rye should be planted and seeded in areas where

periwinkle and iceplant have been removed, as well as on lower slopes of marsh berms.

Seeding of native grasses and forbs in replacement of wild radish, black mustard, Italian thistle, and yellow star thistle should occur in phases. The first or second weed-whipping and herbicide treatment should be followed immediately by seeding of native grasses including purple needlegrass, foothill needlegrass, California oat grass, Torrey's onion grass, red fescue, Idaho fescue, and meadow barley. Seeding with native grasses in the first two to three years will allow for repeated treatment with a broadleaf-specific herbicide to control invasive annual forbs while protecting native grasses. In subsequent years, a reduction in herbicide treatment should be accompanied by seeding of native forbs including blue-eyed grass, common yarrow, California poppy, bee plant, mugwort, and common tarweed. Seeds should be collected from local sources if feasible.

c. Public Access Control and Signage

The preferred plan will include access control fencing to discourage pedestrians and dogs from entering the marsh. The fencing will be installed in two phases. Phase I will include fencing along Point San Pedro Road and along the entrance roads from Point San Pedro Road to the existing security gates of the quarry and brick yard. Phase II will include fencing along the rest of the access roads and the border between the marsh and the quarry/brick yard. The perimeter of the marsh will be posted with signs that identify the area as sensitive habitat and indicate that entry to the area is restricted for the public and their dogs.

4. Benefits of Preferred Restoration Plan

The preferred plan will confer a number of benefits to the function and value of the marsh. Invasive plant species pose substantial challenges to human safety and native habitats including increased fire hazard, increased road hazard (e.g. fallen limbs from blue gum), reduced forage for wildlife, exclusion of native plant species, altered hydrologic regime, and exacerbated erosion. The Baylands Ecosystem Habitat Goals specifically encourage a "natural transition to adjacent uplands" and "upland buffers to minimize human disturbance" to marshes (SFEI 1999). Invasive species removal and replacement native species planting/seeding in the SRRQ meets these goals.

Although often costly, labor intensive, and time-consuming, removing or reducing invasive species infestations is typically lower risk with a lower degree of uncertainty than significant infrastructural improvements or alteration of natural systems, such as channelization or flood control. The removal of invasive shrubs and trees, followed by replacement with native, fire resistant, vegetation, can

substantially reduce fire and road hazards, thereby saving potential infrastructural and hazard costs in the future.

A reduction in invasive species can alleviate pressure on native plants and wildlife, thereby increasing the quality of native habitats. Specifically, infestations of perennial pepperweed and pennyroyal on the marsh surface reduce the extensiveness of salt grass and pickleweed, essential plant species for the endangered salt marsh harvest mouse. Therefore, controlling the spread of perennial pepperweed and increasing pickleweed will maintain habitat for the mouse.

Invasive species typically form monotypic stands thereby reducing the diversity of forage and cover types for local wildlife. Replacement of invasive species with native species on roadsides and marsh berms will improve the habitat for a broader range of native wildlife, particularly song birds which rely on a diversity of food sources throughout the year. Additionally, a greater diversity of native trees, shrubs, and herbs provides aesthetic value through wildflower blooms, and distinct foliar coloring and texture.

5. Phased Implementation Plan

The preferred restoration plan will be implemented in 12 restoration areas over two 5-year phases. Table 3-3 summarizes the recommended timelines to address all invasive species within the SRRQ marsh restoration areas.

Table 3-3: Phase I and Phase II Implementation Schedule

PHASE I

Restoration Area	Invasive Species Present	Treatment Activities				
		Year 1	**Year 2**	**Year 3**	**Year 4**	**Year 5**
C	Himalaya blackberry Perennial pepperweed	-Initial removal of large perennials -Herbicide application -Native shrub planting -Native grass seeding -Monitoring	-Spot removal of large perennial seedlings -Herbicide application -Native grass seeding -Monitoring	-Spot removal of large perennial seedlings -Herbicide application -Native grass seeding -Native forb seeding -Monitoring	-Spot removal of large perennial seedlings -Native forb seeding -Monitoring	-Spot removal of large perennial seedlings -Monitoring
D	Date palm French broom Himalaya blackberry Fennel Fuller's teasel Periwinkle Wild radish Black mustard Italian thistle Yellow star thistle	-Initial removal of trees -Initial removal of shrubs -Initial removal large perennial forbs -Weed-whip annual herbs -Herbicide application -Native tree planting -Native shrub planting -Native grass seeding -Monitoring	-Spot removal of tree & shrub seedlings -Weed-whip herbs -Herbicide application -Native grass seeding -Monitoring	-Spot removal of tree & shrub seedlings -Weed-whipping herbs -Herbicide application -Native grass seeding -Native forb seeding -Monitoring	-Spot removal of tree & shrub seedlings -Weed-whipping herbs -Native forb seeding -Monitoring	-Spot removal of tree & shrub seedlings -Weed-whipping herbs -Monitoring
F	Pennyroyal	-Initial removal of perennials -Native perennial plantings -Herbicide application -Monitoring	-Spot removal of perennial seedlings -Herbicide application -Native perennial plantings -Monitoring	-Spot removal of perennial seedlings -Herbicide application -Native perennial plantings -Monitoring	-Spot removal of perennial seedlings -Monitoring	-Spot removal of perennial seedlings -Monitoring
G	Pennyroyal	-Initial removal of perennials -Herbicide application -Native perennial planting -Monitoring	-Spot removal of large perennial seedlings -Herbicide application -Native perennial planting -Monitoring	-Spot removal of large perennial seedlings -Herbicide application -Native perennial planting -Monitoring	-Spot removal of large perennial seedlings -Monitoring	-Spot removal of large perennial seedlings -Monitoring

The San Rafael Rock Quarry
Preferred Marsh Restoration Plan, 2012

Restoration Area	Invasive Species Present	Treatment Activities				
		Year 1	**Year 2**	**Year 3**	**Year 4**	**Year 5**
H	Date palm French broom Scotch broom Pampas grass	-Clear and grub entire area -Initial removal of trees -Initial removal of shrubs -Herbicide application -Irrigation installation -Native tree planting -Native shrub planting -Native grass seeding -Monitoring	-Spot removal of tree & shrub seedlings -Herbicide application -Native grass seeding -Monitoring	-Spot removal of tree & shrub seedlings -Herbicide application -Native grass seeding -Native forb seeding -Monitoring	-Spot removal of tree & shrubs seedlings -Native forb seeding -Monitoring	-Spot removal of tree & shrub seedlings -Monitoring
J	Date palm French broom Himalaya blackberry Fennel Fuller's teasel Iceplant Italian thistle Yellow star thistle	-Initial removal of trees -Initial removal of shrubs -Initial removal large perennial forbs -Weed-whip annual herbs -Herbicide application -Irrigation installation -Native tree planting -Native shrub planting -Monitoring	-Spot removal of tree & shrub seedlings -Weed-whip herbs -Herbicide application -Native grass seeding -Monitoring	-Spot removal of tree & shrub seedlings -Weed-whipping herbs -Herbicide application -Native grass seeding -Native forb seeding -Monitoring	-Spot removal of tree & shrub seedlings -Weed-whipping herbs -Native forb seeding -Monitoring	-Spot removal of tree & shrub seedlings -Weed-whipping herbs -Monitoring
K	Himalaya blackberry Pampas grass	-Clear and grub entire area -Initial removal large perennial forbs -Herbicide application -Irrigation installation -Native tree planting -Native shrub planting -Native grass seeding -Monitoring	-Herbicide application -Native grass seeding -Monitoring	-Spot removal of tree & shrub seedlings -Herbicide application -Native grass seeding -Native forb seeding -Monitoring	-Spot removal of tree & shrub seedlings -Native forb seeding -Monitoring	-Spot removal of tree & shrub seedlings -Monitoring

The San Rafael Rock Quarry
Preferred Marsh Restoration Plan, 2012

Restoration Area	Invasive Species Present	Treatment Activities				
		Year 1	Year 2	Year 3	Year 4	Year 5
PHASE II						
A	Blue gum Date palm French broom Fennel Wild radish	-Clear and grub entire area -Initial removal of selected trees -Initial removal of shrubs -Initial removal large perennial forbs -Weed-whip annual herbs -Herbicide application -Irrigation installation -Native tree planting -Native shrub planting -Native grass seeding -Monitoring	-Spot removal of tree & shrub seedlings -Weed-whip herbs -Herbicide application -Native grass seeding -Monitoring	-Spot removal of tree & shrub seedlings -Weed-whipping herbs -Herbicide application -Native grass seeding -Native forb seeding -Monitoring	-Spot removal of tree & shrub seedlings -Weed-whipping herbs -Native forb seeding -Monitoring	-Spot removal of tree & shrub seedlings -Weed-whipping herbs -Monitoring
B	Blue gum Date palm French broom Himalaya blackberry Pampas grass Fennel Fuller's teasel Italian thistle	-Initial removal of selected trees -Initial removal of shrubs -Initial removal large perennial forbs -Weed-whip annual herbs -Herbicide application -Irrigation installation -Native tree planting -Native shrub planting -Monitoring	-Spot removal of tree & shrub seedlings -Weed-whip herbs -Herbicide application -Native grass seeding -Monitoring	-Spot removal of tree & shrub seedlings -Weed-whipping herbs -Herbicide application -Native grass seeding -Native forb seeding -Monitoring	-Spot removal of tree & shrub seedlings -Weed-whipping herbs -Native forb seeding -Monitoring	-Spot removal of tree & shrub seedlings -Weed-whipping herbs -Monitoring

The San Rafael Rock Quarry
Preferred Marsh Restoration Plan, 2012

Restoration Area	Invasive Species Present	Treatment Activities				
		Year 1	**Year 2**	**Year 3**	**Year 4**	**Year 5**
E	Date palm Black mustard	-Clear and grub entire area -Initial removal of trees -Weed-whip annual herbs -Herbicide application -Irrigation installation -Native tree plantings -Monitoring	-Spot removal of tree seedlings -Weed-whip annual herbs -Herbicide application -Native grass seeding -Monitoring	-Spot removal of tree seedlings -Weed-whip annual herbs -Herbicide application -Native grass seeding -Native forb seeding -Monitoring	-Spot removal of tree seedlings -Weed-whip annual herbs -Native forb seeding -Monitoring	-Spot removal of tree seedlings -Weed-whip annual herbs -Monitoring
I	Blue gum Date palm French broom Himalaya blackberry Pampas grass Fennel Fuller's teasel Wild radish Black mustard Italian thistle	-Clear and grub entire area -Initial removal of selected trees -Initial removal of shrubs -Initial removal large perennial forbs -Weed-whip annual herbs -Herbicide application -Irrigation installation -Native tree planting -Native shrub planting -Native grass seeding -Monitoring	-Spot removal of tree & shrub seedlings -Weed-whip herbs -Herbicide application -Native grass seeding -Monitoring	-Spot removal of tree & shrub seedlings -Weed-whipping herbs -Herbicide application -Native grass seeding -Native forb seeding -Monitoring	-Spot removal of tree & shrub seedlings -Weed-whipping herbs -Native forb seeding -Monitoring	-Spot removal of tree & shrub seedlings -Weed-whipping herbs -Monitoring
L	Perennial pepperweed Pennyroyal Black mustard Italian thistle Yellow star thistle	-Initial removal large perennial forbs -Weed-whip annual herbs -Herbicide application -Native grass seeding -Monitoring	-Spot removal large perennial seedlings -Weed-whip annual herbs -Herbicide application -Native grass seeding -Monitoring	-Spot removal large perennial seedlings -Weed-whip annual herbs -Herbicide application -Native forb seeding -Monitoring	-Spot removal large perennial seedlings -Weed-whip annual herbs -Native forb seeding -Monitoring	-Spot removal large perennial seedlings -Weed-whip annual herbs -Monitoring

6. Monitoring

Although a baseline mapping of invasive species was conducted in 2011, a second baseline survey should be conducted prior to each restoration phase to accurately record the extent and density of the existing infestations. Baseline monitoring will consist of traversing the entire site and mapping the extent of the 16 previously documented invasive species infestations as well as additional invasive species that may have become established in the interim. One to three permanent transects shall be located in each restoration area bisecting the densest invasive species infestations. Cover density will be estimated at fixed locations along transects using cover classes (Table 3-4).

Table 3-4: SRRQ Cover Classes and Midpoint Values

Cover Class	Percent Cover Range	Percent Cover Midpoint
1	1 – 5 percent	2.5 percent
2	5 – 25 percent	15 percent
3	25 – 50 percent	37.5 percent
4	50 – 75 percent	62.5 percent
5	75 – 95 percent	85 percent
6	95 – 100 percent	97.5 percent

Annual monitoring of the treatment areas shall be conducted to detect re-infestation and evaluate native species planting/seeding. Monitoring will be evaluated based on success criteria (see Success Criteria below), with specific triggers for maintenance to address re-infestations. Monitoring will be conducted by a qualified biologist to ensure accurate identification of plant species, and will occur in spring when all invasive species and native species plantings are at their height of growth.

General observations on soil condition, irrigation equipment, plant cages, litter, and vandalism will be recorded during the monitoring visit. Each year a monitoring report will be drafted summarizing monitoring results, evaluation of each success criteria, and include recommended maintenance actions.

7. Maintenance

Regular maintenance of the treated areas shall be conducted to prevent re-infestation of invasive species and ensure survival of native species plantings. The annual monitoring report will outline recommended maintenance actions. Physical and/or chemical control methods may be reapplied to new or recurring infestations. Irrigation and protective cages will be inspected annually, and may be replaced or repaired if the biologist deems necessary.

8. Success Criteria

Although a desired outcome, it is not realistic to expect a complete eradication of invasive species from the SRRQ. However, to ensure sustained improvement through the restoration plan, the following success criteria (Table 3-5) will be utilized to evaluate the restoration activities.

Table 3-5: SRRQ Restoration Plan Success Criteria

Criteria	Year 1	Year 2	Year 3	Year 4	Year 5
No increase in spatial extent of baseline infestations	No increase	No increase	No increase	No increase	No increase
No increase in cover of baseline infestations	No increase	No increase	No increase	No increase	No increase
Decrease in cover of baseline infestations	-90%	-80%	-70%	-60%	-50%
Percent survival of native species plantings	90%	85%	80%	75%	70%
Percent relative cover of native trees & shrubs in woody layer	25%	30%	40%	50%	75%
Percent relative cover of native herbs in herbaceous layer	5%	10%	15%	20%	25%

4. APPENDIX

A. CRAM Wetland Assessment
B. Invasive Plant Species Survey
C. Hydrology background
D. Alternative Analysis
    1. Full Tidal
    2. Limited Tidal

APPENDIX A
RESULTS OF CRAM WETLAND ASSESSMENT

The San Rafael Rock Quarry Marsh was assessed using the California Rapid Assessment Method (CRAM) for wetlands (Collins *et al* 2008; Appendix A) in the spring of 2012. The results of the analysis are summarized below.

The analysis utilized five separate assessment areas (AAs). Each AA represents an assessment of conditions at a specific location, and multiple AAs are generally performed in large areas to determine whether there is significant variance in scores. The AAs were circular with a radius of 55 meters, as is recommended for estuarine wetlands. Three AAs were located within the west marsh, and the average of these scores was taken to represent this area. The northeast and east marshes were represented by one AA each. These scores are presented in Figure A-1, and for comparison the calibration average for California estuarine saline wetlands is also included. The calibration average is not a true average of all saline estuarine wetlands within California, and was likely obtained from a sample set of wetlands in relatively good condition. However, the calibration average is one of the simplest standards available for comparing scores to existing CRAM data.

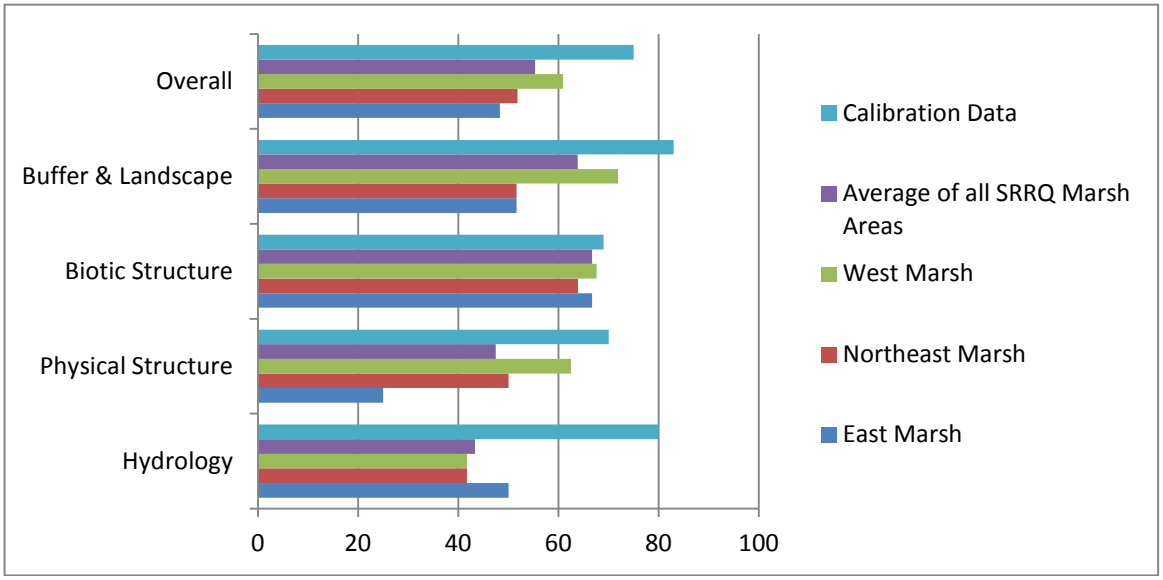


Figure A-1: CRAM Scores from the San Rafael Rock Quarry

As indicated in Figure A-1, AAs at the San Rafael Rock Quarry performed lower than the calibration average in both overall score and individual attribute scores. The west marsh generally scored better than the northeast marsh, which in turn generally scored better than the east marsh. Marshes at the San Rafael Rock Quarry scored particularly well in the Biotic Structure attribute, which examines the vegetation, in comparison to the calibration average. All portions of the marsh had high cover of native species and relatively desirable structure for estuarine saline wetlands. The Hydrology scores for the marshes at the San Rafael Rock Quarry were notably poor in comparison to the calibration average. This was due to the fact that the area rarely, if ever, receives input from the tidal waters of San Francisco Bay, in addition to the fact that the wetlands are mostly surrounded by levees and

receive urban runoff. The Physical Structure attribute was variable. The west marsh retains a number of physical features that would be found in a fully tidal marsh area, while the northeast and east marshes appear to have mostly lost their historic channels and other physical structure. The AAs of the west marsh scored relatively well in the Buffer and Landscape Connectivity metric, largely because this area is larger, is surrounded by relatively high-quality habitat, and contains areas not in close proximity to urban development.

CRAM was used as a tool to provide a general assessment of condition and to identify stressors to the wetlands. Level 3 studies were ultimately necessary to provide a sufficient basis for the development of the marsh restoration plan.

APPENDIX B
RESULTS OF INVASIVE PLANT SPECIES SURVEY

On August 19, 2011, WRA conducted a survey for invasive plant species within the west, northeast, and east Marshes and their fringes of the SRRQ. The extent of each invasive species was drawn on a high resolution aerial photograph. The absolute cover density of each invasive species population was then estimated. Additionally, all plant species observed within the marsh and marsh fringe were recorded.

Hand-drawn populations were then digitized in ArcGIS 9 to determine acreages and produce maps for planning purposes. Although these data are comprehensive, future monitoring and invasive species management should incorporate a baseline monitoring effort to account for invasive species expansion and develop a quantitative and repeatable monitoring method. Invasive species maps are included in the following (Figures B-1 – B-3).

The San Rafael Rock Quarry
Preferred Marsh Restoration Plan, 2012

APPENDIX C
ALTERNATIVE ANALYSIS

An analysis of alternative restoration approaches was performed, which included an evaluation of the feasibility and desirability of two alternatives: 1) full tidal; 2) enhanced hydrology. The full tidal alternative focused on modification that would recreate full tidal hydrology throughout the marsh area. The Enhanced Hydrology Alternative focused on modifications to alter the hydrology to 1) better isolate urban runoff from the marsh area; 2) create deep water, seasonal habitat for mosquito fish to eliminate the need for mosquito abatement to drive through the marsh; 3) lower the elevation of the western marsh to create tidal hydrology; and 4) redesign the water control structures to increase functionality. The following sections describe the evaluation process and results of the alternative analysis.

ALTERNATIVE 1 - FULL TIDAL

A Full Tidal Alternative was developed to explore the potential beneficial and detrimental impacts of returning the area to a tidal regime that existed prior to the mid 1800s. The COA for SRRQ specifically directs that a full tidal option be explored (COA 113.a.iii). When first discussed, many felt that a full tidal option could bring enhanced benefits to the marsh by mimicking its former functions. To this end the full tidal option was explored. However, as discussed below, the benefits are somewhat elusive, and the negative impacts are significant:

Implementing a Full Tidal Alternative - The alternative assumed that the levee along the western boarder of the marsh would be breached through a box culvert or bridge under the main access road to the McNear brickyard. A model was developed of the existing marsh channels and topography to test the effects of a full tidal regime on the Marsh and the surrounding area. Using 1-in-100 year tidal information available from the Corps of Engineers, the topographic model subject to tidal flooding and a map of the flooded areas produced as shown in the light blue color on Figure C-1. The figure shows the extent of flooding which would result from a full tidal regime.

Loss of Critical Habitat - As part of this process, we estimated the tidal elevation ranges for mud flat, low marsh (cordgrass), high marsh (pickleweed), and transition zone habitats in the vicinity of the SRRQ and then compared these to the existing elevations within the marsh in order to predict the type of tidal marsh habitat that would be created if the area was opened to full tidal hydrology. The results indicated that the existing elevations are located at elevations that fall within the typical elevation range for mudflats (Figure C-2). This indicated that the land within the marsh has subsided, which is consistent with the historic land use, which includes diked grass land. As a result the existing pickleweed habitat would convert almost entirely to mudflat. This conversion would result in the loss of potential habitat for both the salt marsh harvest mouse and clapper rail species. In the context of regional restoration goals this outcome was not desirable. See Figure C-2.

Potential Flooding of Adjacent Infrastructure - Using the Corps of Engineers' 100-year tide as shown in Figure C-1, adjacent infrastructure and property would be regularly inundated. Figure C-1 shows that flows would impact Point San Pedro Road, the adjacent roads into the Chapel Cove Subdivision and the access roads to SRRQ and McNear's brickyard. In addition, a large portion of the McNear operations area would be flooded at high tides.

Sea Level Rise and Increased Chance of Flooding - As noted above, flooding would occur under current sea levels. Using the Bay Conservation and Development Commission's (BCDC's) predicted 2035 and 2100 elevations for sea level of 7.12 and 10.62 respectively, the increase in sea level exacerbates the impact of flooding to habitat and infrastructure. In order to protect existing facilities additional levees would need to be constructed. While levees along the south edge of the marsh could be constructed without impacting existing marsh habitat (which as noted above would revert to mud flat under a full tidal regime), levees to protect the access roads and Point San Pedro Road would need to be constructed within the current marsh area. Using a levee top elevation of one foot above the predicted tide (elev.12), the levee footprint would be approximately 50 feet wide and over 4,000 feet long and would reduce the marsh habitat by over 4 acres. See Figure C-1 medium and dark blue areas.

CONCLUSION

While initially thought to be an appealing option to enhance the SRRQ marsh, the analysis establishes that full tidal restoration would have unacceptable impacts on both infrastructure and habitat. Impacts to existing infrastructure could be mitigated by constructing new levees, but those levees would reduce the effective area of the marsh and eliminate existing viable habitat. Impacts to the habitat would require fill to bring the marsh to a level that supports habitat similar to the existing pickleweed and would take multiple decades to establish. The full tidal alternative is not viable.

ALTERNATIVE 2 – INVASIVE SPECIES CONTROL AND LIMITED HYDROLOGICAL ENHANCEMENTS

Alternative 2 was developed to evaluate whether the marsh could be significantly enhanced by augmenting the invasive species controls proposed in the Preferred Alternative with some limited hydrological enhancements. The proposed hydrological enhancements included: 1) deepening and widening the existing drainage channel that is located along the northern edge of the western marsh area; 2) creating deep-water, seasonal habitat for mosquito fish in the northern marsh area; and 3) removing remnant levees and lower grades in the northeast marsh area. The enhancements were developed to reduce the effects of the following wetland stressors respectively: 1) urban runoff; 2) damage from mosquito abatement vehicles driving through the marsh; 3) large areas with non-native invasive upland plant species located on interspersed remnant levees and in areas with inadequate seasonal wetland hydrology. Figure 3-1 illustrates the invasive plant species control components of this alternative and Figure D-3 illustrates the hydrological enhancement components of this alternative.

All of the hydrological enhancements would involve excavation within the existing marsh and damage existing pickleweed and freshwater marsh habitat. These types of impacts would require permits from the US Army Corps and BCDC and others. In addition, the cost of the associated grading would exceed the financial resources of the landowner. The results of the analysis indicated that this alternative was not desirable because the associated costs were too high to justify the limited benefits and potential environmental impacts.

Figure 1-1 San Rafael Rock Quarry
Wetland Restoration Site

N
W E
S

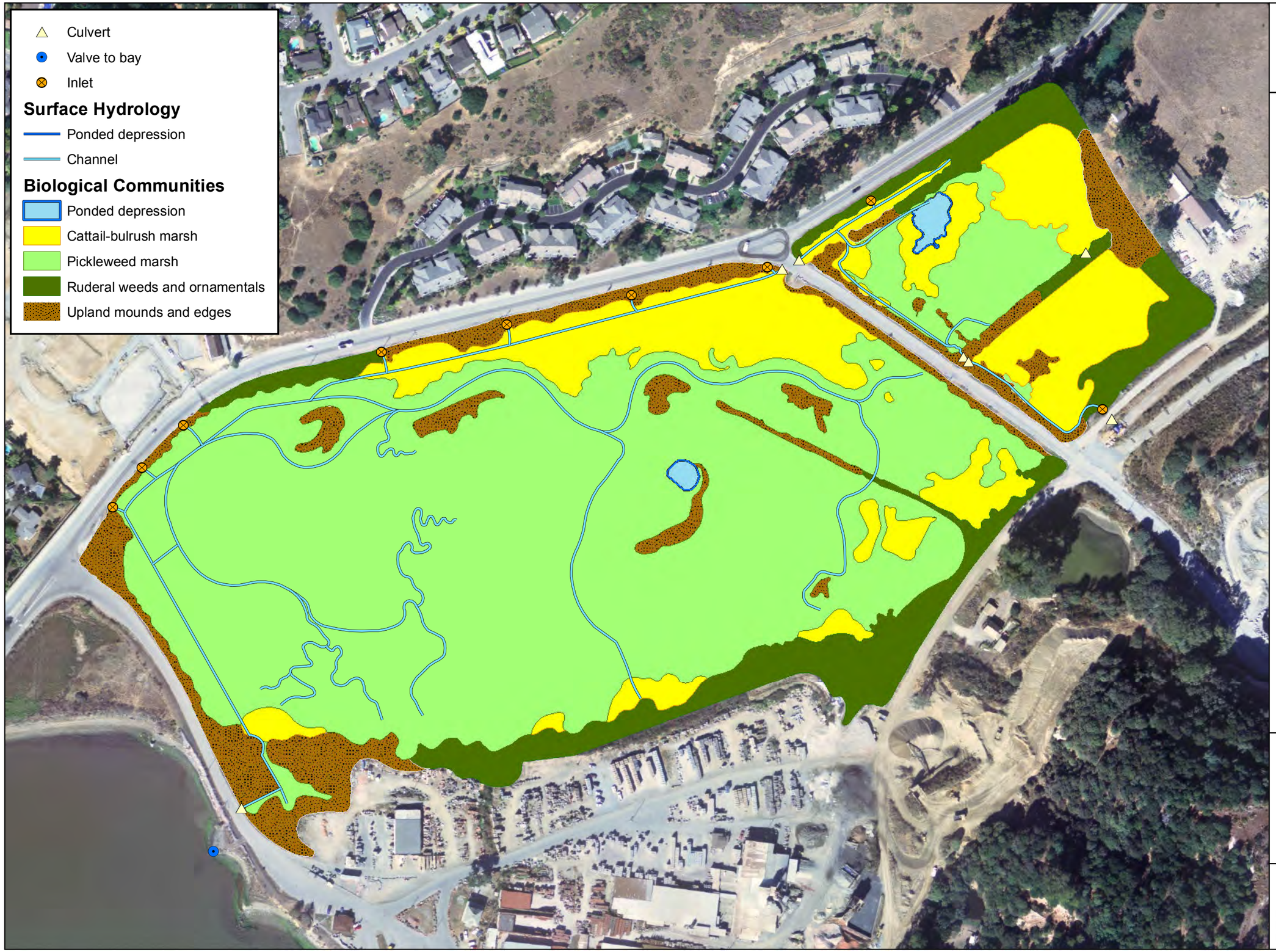
0 0.5 1 2
Miles

wra
ENVIRONMENTAL CONSULTANTS

San Rafael Rock Quarry
San Rafael, Marin County, CA

Date: March 2012
Basemap: USGS 2011
Map By: Michael Rochelle

Path: L:\Acad 2000 Files\17000\17037\gis\ArcMap\2012\Location.mxd



wra
ENVIRONMENTAL CONSULTANTS

San Rafael Rock Quarry

San Rafael,
Marin County,
California

Figure 2-1.

Existing Conditions of the San Rafael Rock Quarry Wetland Restoration Site:

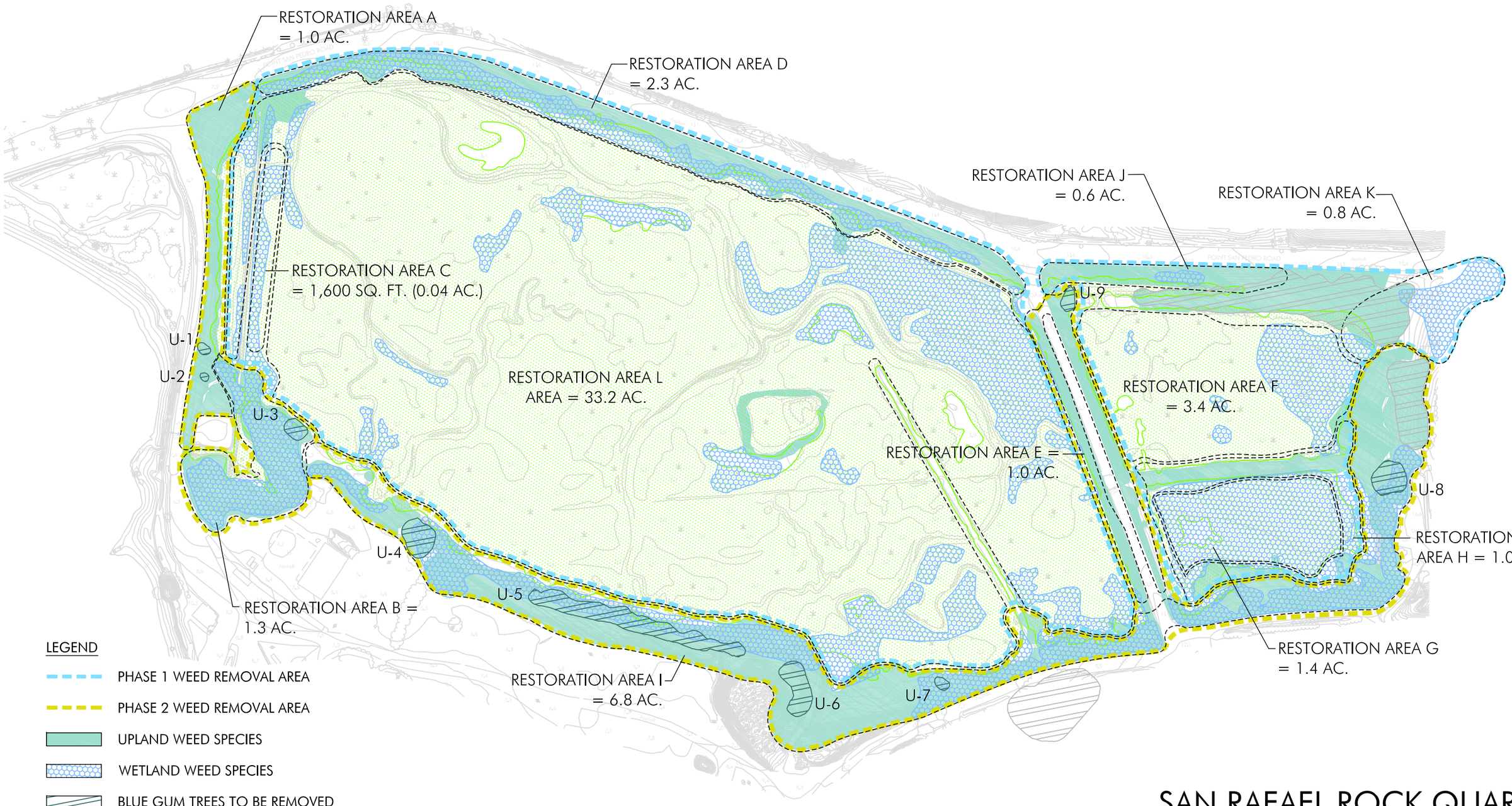
Biological Communities and Surface Hydrology

N
W E
S

0 100 200 400
Feet

Map Date: March 2012
Map By: Michael Rochelle
Base Source: TerraServer 2004

Path: L:\Acad 2000 Files\17000\17037\gis\ArcMap\2012\BioComm_11x17.mxd



LEGEND

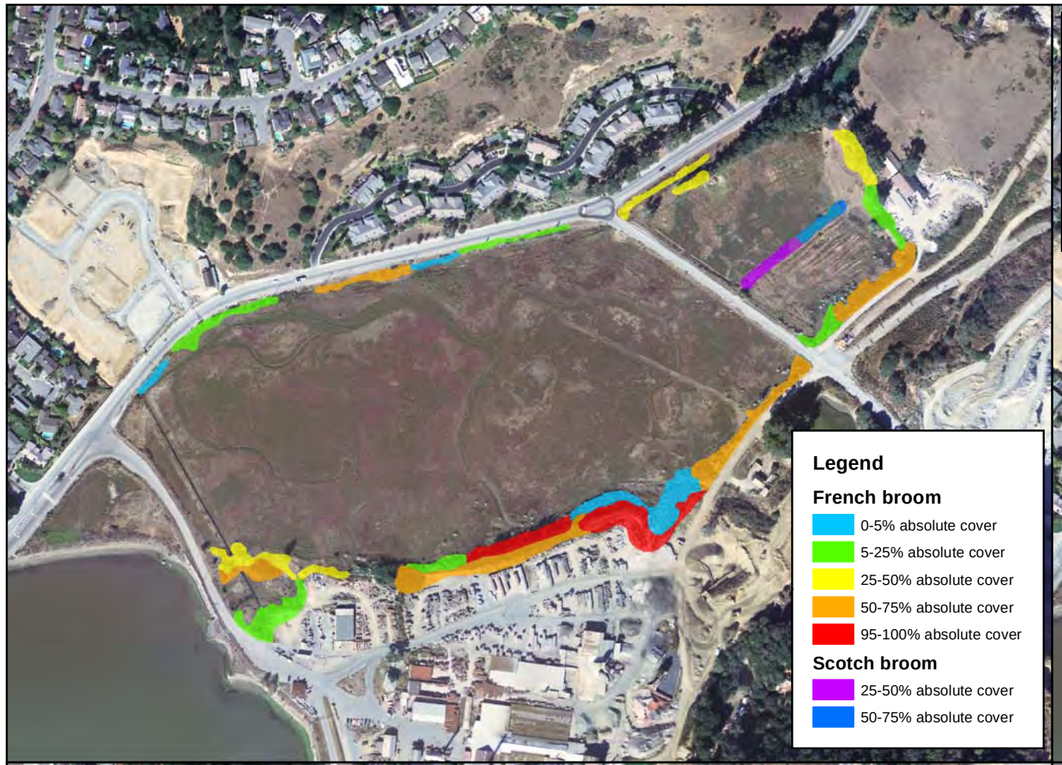
- PHASE 1 WEED REMOVAL AREA
- PHASE 2 WEED REMOVAL AREA
- UPLAND WEED SPECIES
- WETLAND WEED SPECIES
- BLUE GUM TREES TO BE REMOVED
- BLUE GUM TREES TO REMAIN
- PROPOSED WEED REMOVAL/CONTROL RESTORATION AREA
- EXISTING WETLAND

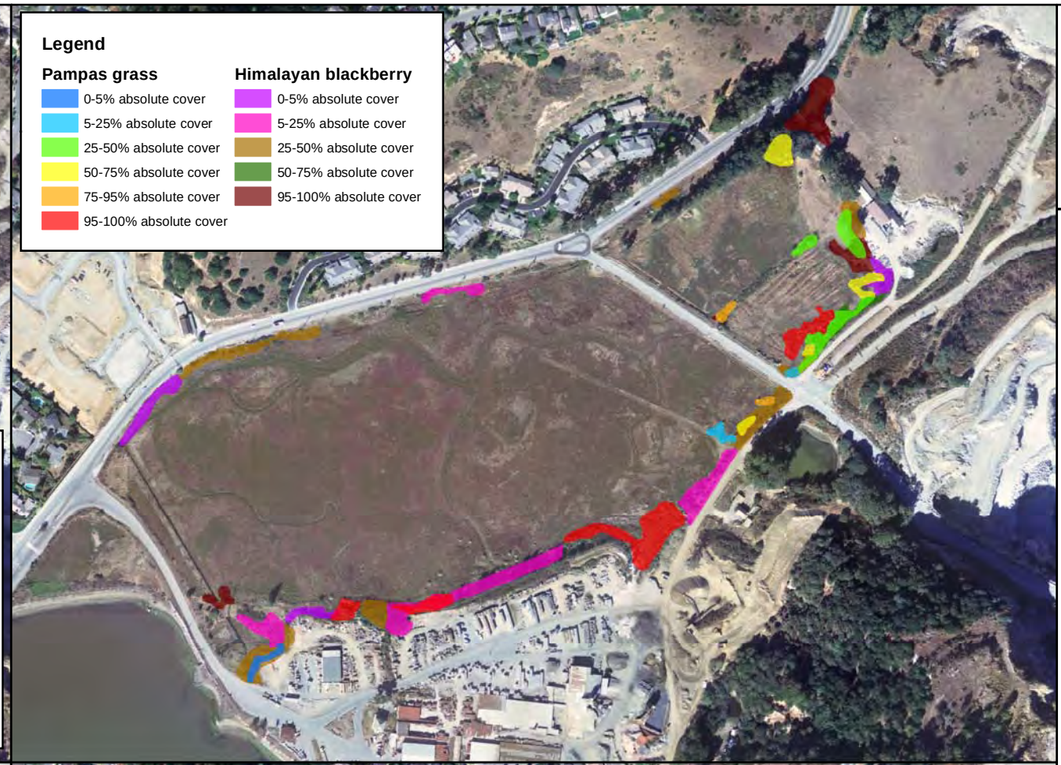
SAN RAFAEL ROCK QUARY MARSH RESTORATION PLAN

N

FIGURE 3-1. PREFERRED MARSH RESTORATION PLAN

SCALE 1" = 200'





wra
ENVIRONMENTAL CONSULTANTS

San Rafael Rock Quarry
Marin County, California

Figure B-1.
Invasive Plant Species within the Study Area

N

0 100 200 400 600 800
Feet

Date: August 2011
Map By: Sundaran Gillespie
Base Photo: TerraServer, 2004

ENVIRONMENTAL CONSULTANTS

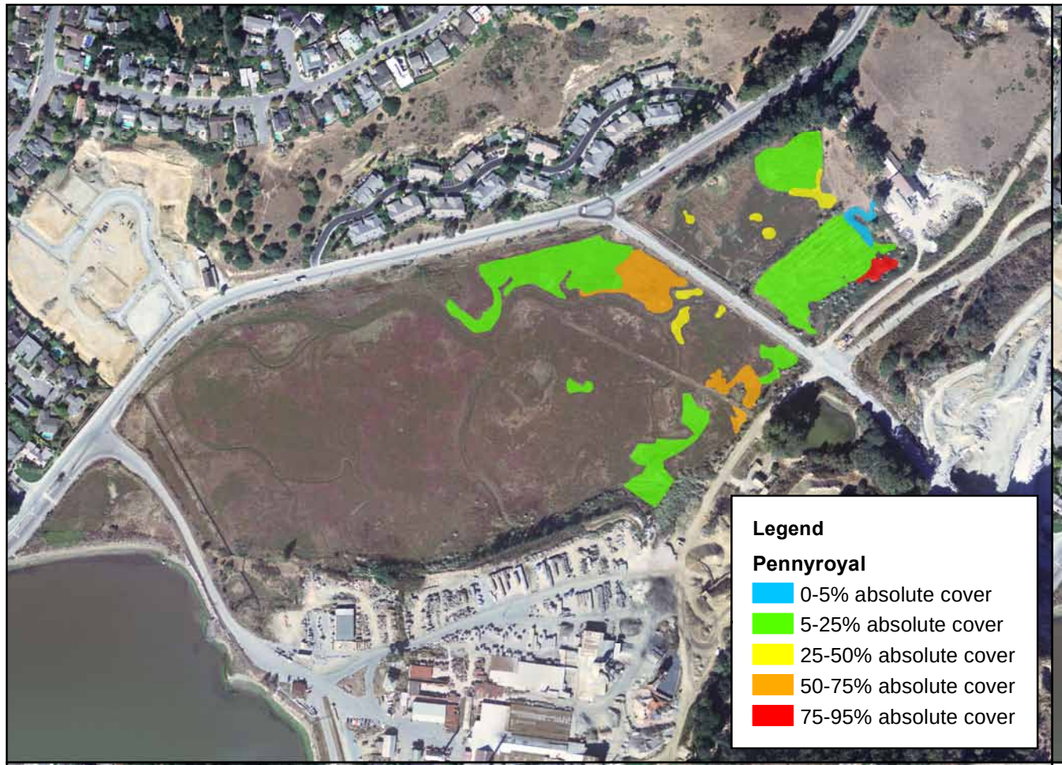
San Rafael Rock Quarry
Marin County, California

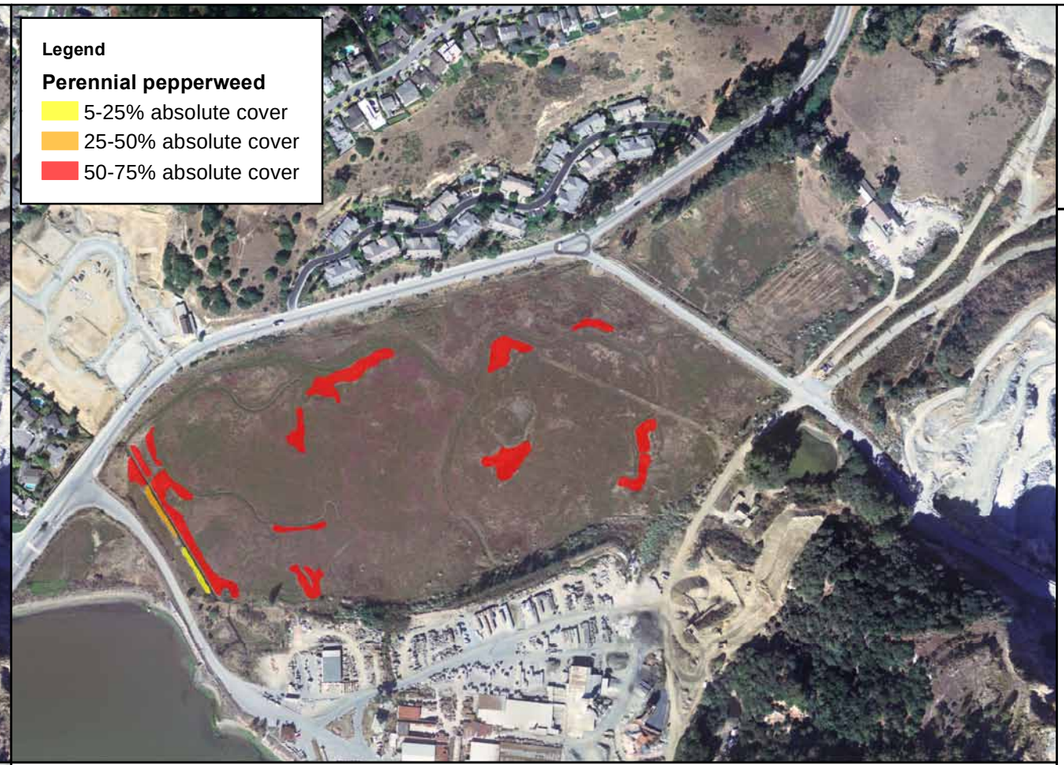
Figure B-2.
Invasive Plant Species within the Study Area

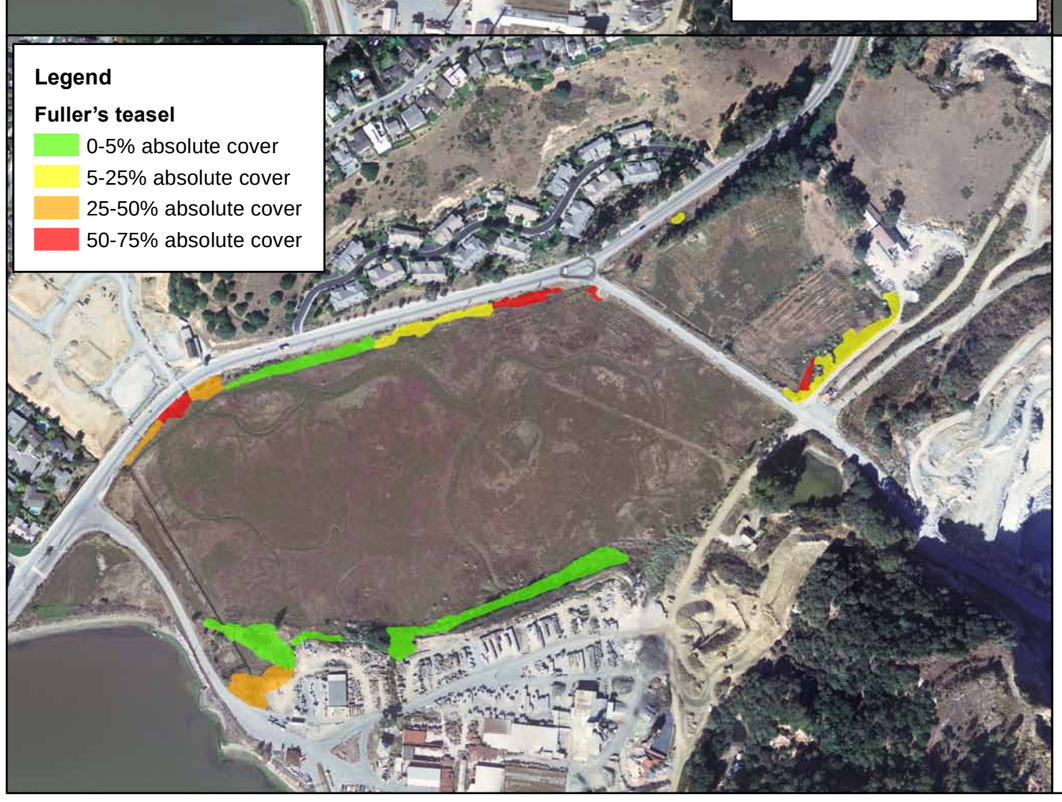
N

0 100 200 400 600 800
Feet

Date: August 2011
Map By: Sundaran Gillespie
Base Photo: TerraServer, 2004







ENVIRONMENTAL CONSULTANTS

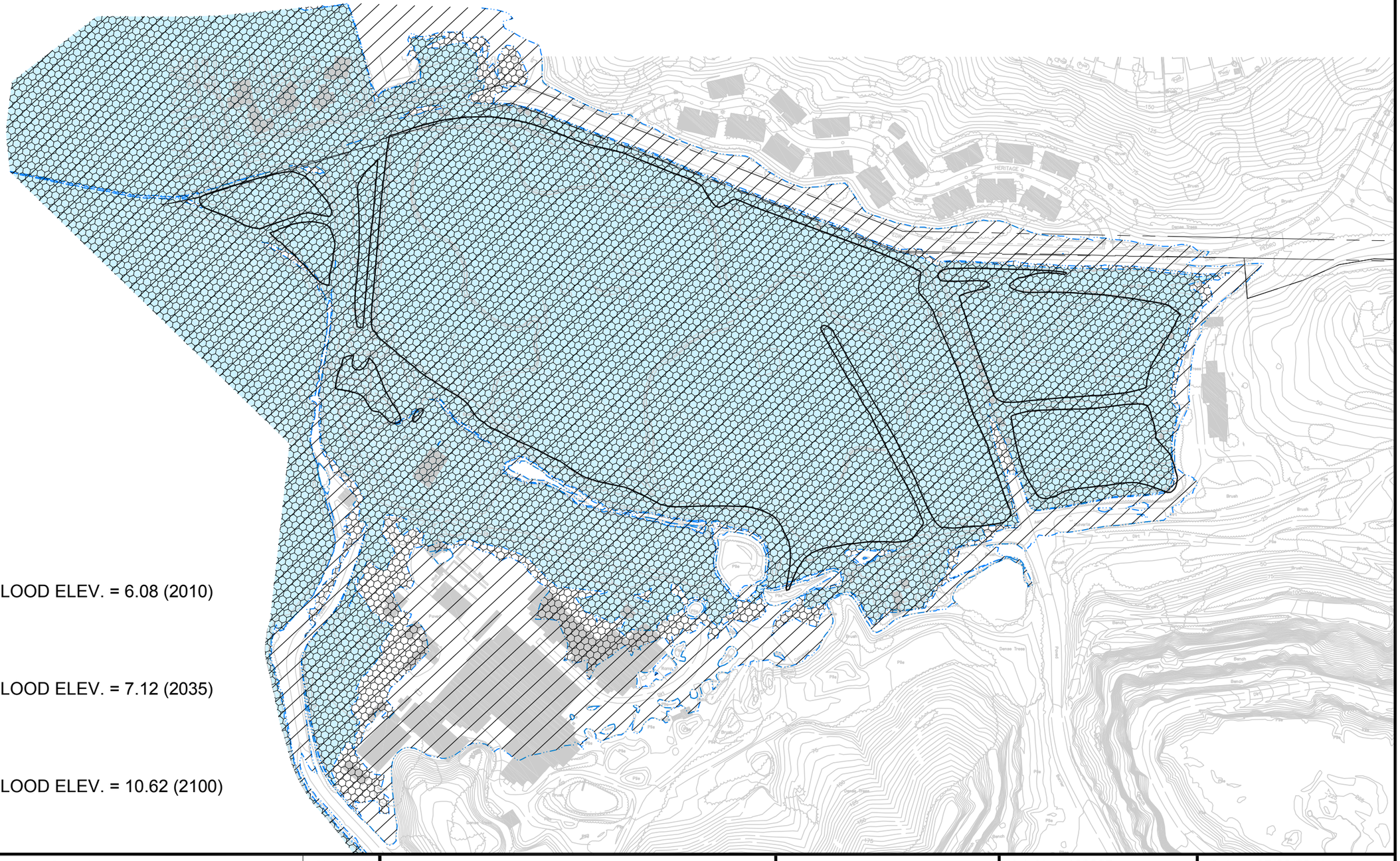
San Rafael Rock Quarry
Marin County, California

Figure B-3.
Invasive Plant Species within the Study Area

N

0 100 200 400 600 800
Feet

Date: August 2011
Map By: Sundaran Gillespie
Base Photo: TerraServer, 2004



LEGEND

FLOOD ELEV. = 6.08 (2010)

FLOOD ELEV. = 7.12 (2035)

FLOOD ELEV. = 10.62 (2100)

Rev	Date	Description	Checked
-	07/08/11	ISSUED FOR REVIEW	SAS

CSW | ST2
CSW/Stuber-Stroeh Engineering Group, Inc.
Civil & Structural Engineers | Surveying & Mapping | Environmental Planning
Land Planning | Construction Management
45 Leveroni Court
Novato, CA 94949
tel: 415.883.9850
fax: 415.883.9835
http://www.cswst2.com

Prepared Under the Direction of:

Job No. 169807

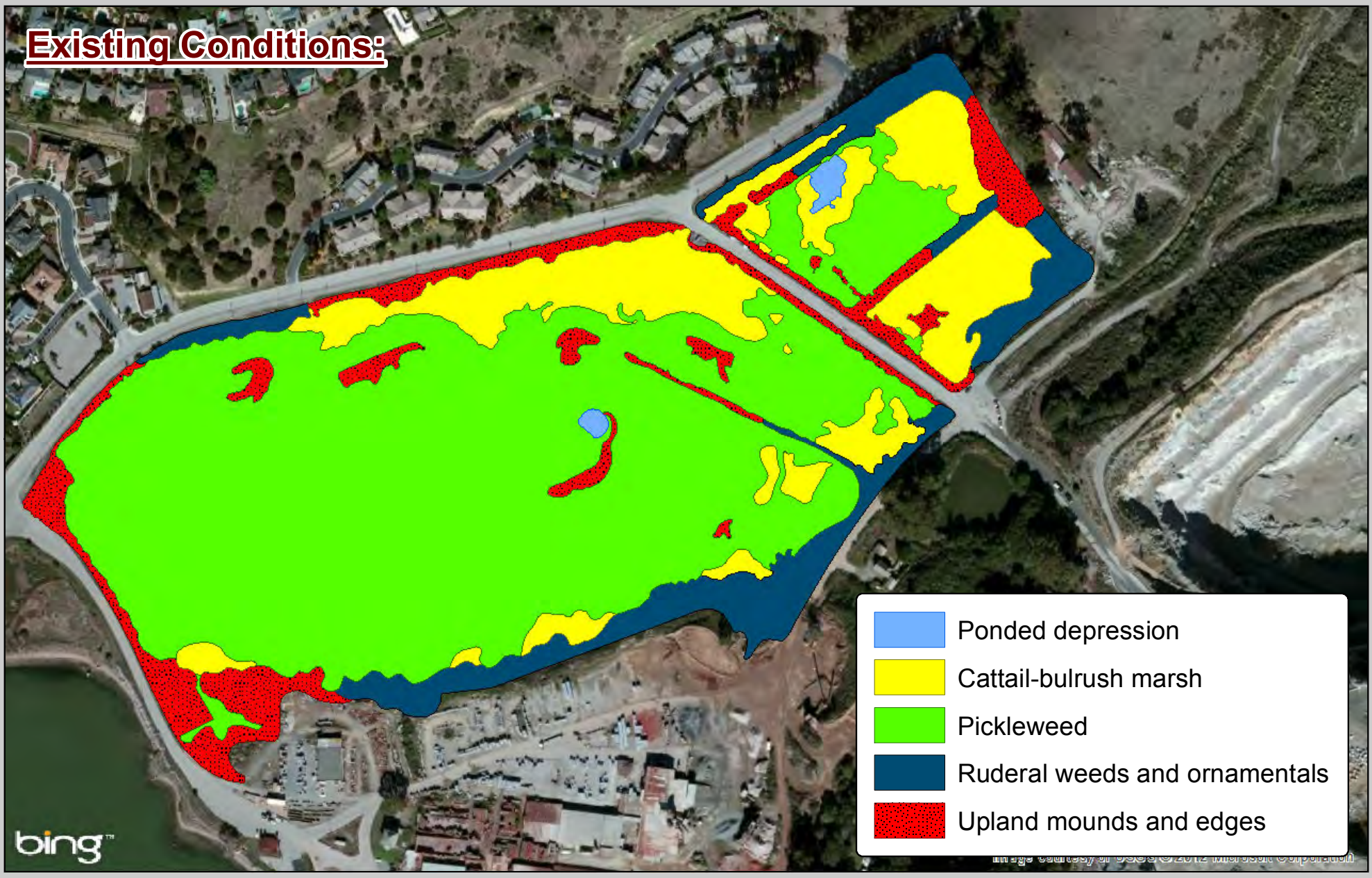
Date: 07/08/2011

Scale: 1" = 300'

FIG. C-1
COMPOSITE FLOOD EXHIBIT
SAN RAFAEL ROCK QUARRY
SAN RAFAEL MARIN COUNTY CALIFORNIA

P:\01\169807\DWG_2010\Exhibit\2012-09-27 Exhibit-Future_Flood_Elevations.dwg 09/27/2012 - 01:07 PM sperj 1:1

Existing Conditions:



Full Tidal Alternative:

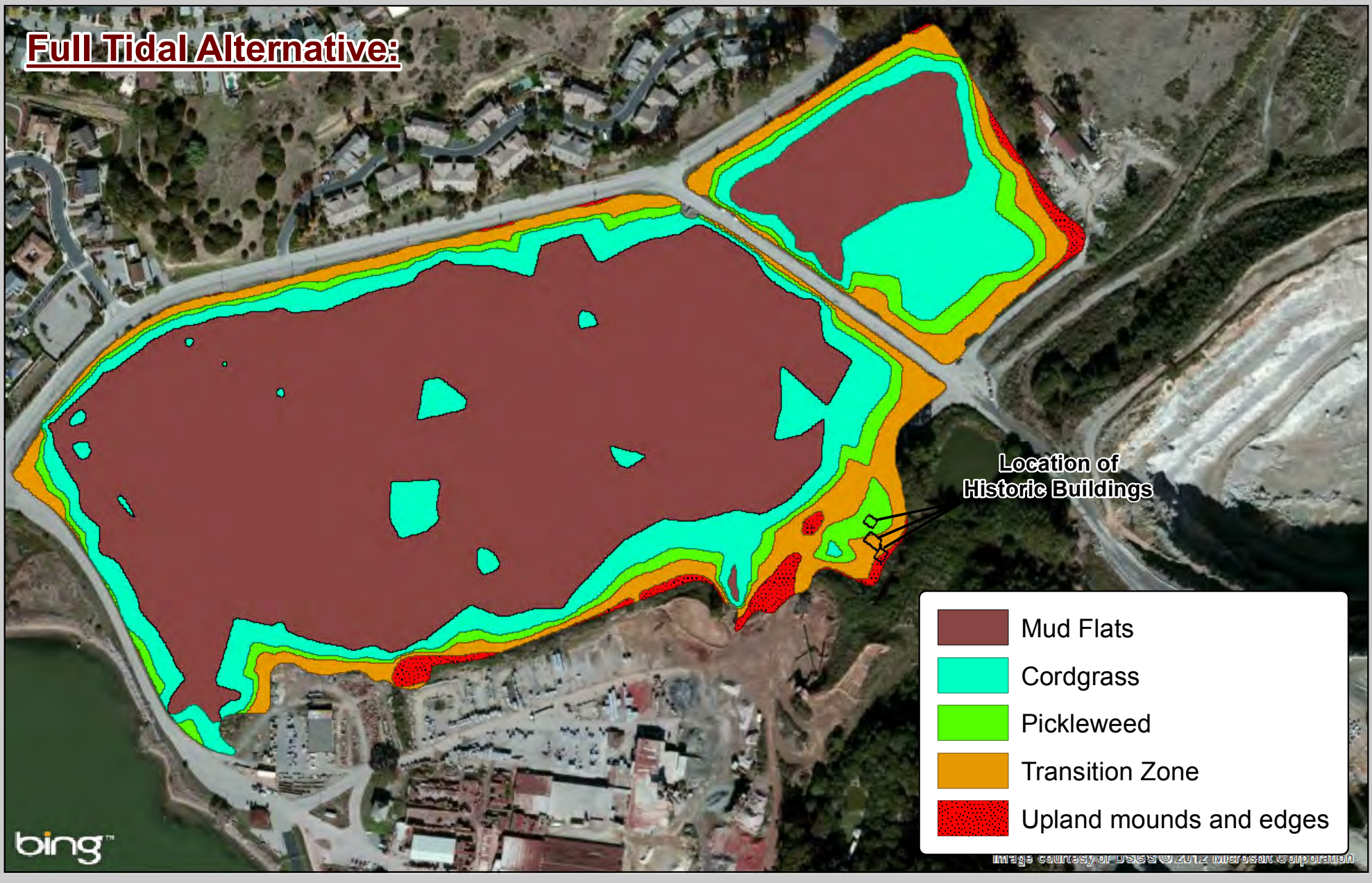


Figure C-2. Habitat Conversion for the Full Tidal Alternative

N
W E
S

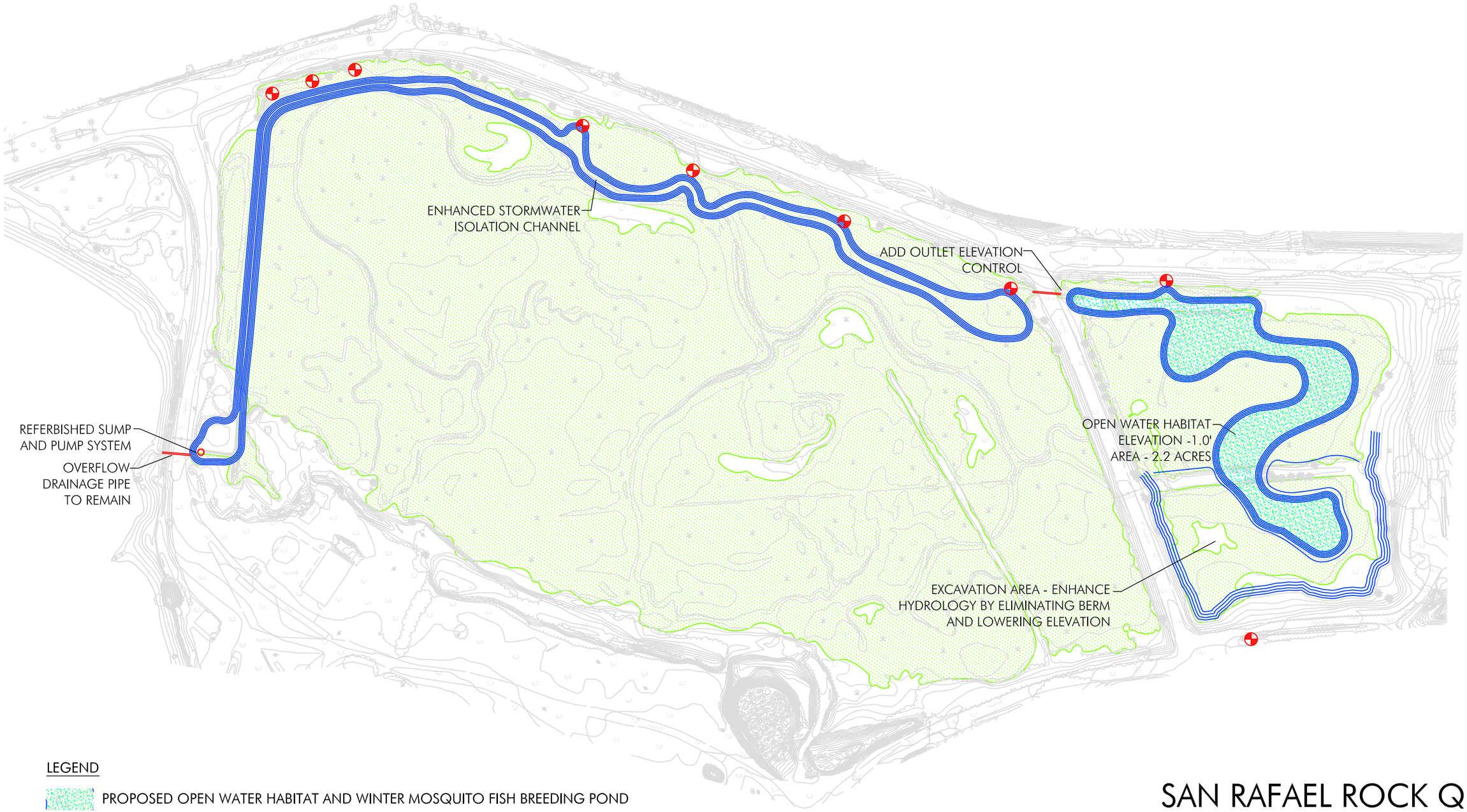
0 250 500 1,000
Feet

San Rafael Rock Quarry
Marin County, California

wra
ENVIRONMENTAL CONSULTANTS

Date: September 2012
Map By: Michael Rochelle
Basmeap: Bing Aerials

Path: L:\Acad 2000 Files\17000\17037\gis\ArcMap\2012\Full Tidal Alternative.mxd



LEGEND

- PROPOSED OPEN WATER HABITAT AND WINTER MOSQUITO FISH BREEDING POND
- URBAN STORMWATER RUNOFF DISCHARGE POINT
- PROPOSED GRADING
- EXISTING WETLAND

SAN RAFAEL ROCK QUARY
MARSH RESTORATION PLAN

FIGURE C-3. ALTERNATIVE 2: INVASIVE SPECIES CONTROL AND LIMITED HYDROLOGICAL ENHANCEMENTS

SCALE 1" = 200'

N