Mt. Umunhum Vegetation Restoration Plan

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Executive Summary

The Mt. Umunhum Restoration Vegetation Plan is intended to help guide the process of restoring ecologically appropriate vegetation to the summit of Mt. Umunhum. This plan provides site background, constraints analysis and recommendations for planting areas and densities that will meet a set of ecological restoration goals, while also aligning with aesthetic and recreation goals. Upon the completion of the two-phase planting recommendations, the document recommends qualitative and quantitative monitoring methods to ensure that the promulgated goals are met. This document also provides guidance with regard to plant pathogens.

1 INTRODUCTION

1.1 BACKGROUND

Mount Umunhum is the fourth-highest peak in the Santa Cruz Mountains of California. The mountain is in Santa Clara County, southeast of Los Gatos and south of South San Jose. The summit of Mount Umunhum is the site of the former Almaden Air Force Station, an early-warning radar station built in 1957 that operated from 1958 to 1980. In constructing the Air Force Station, the U.S. Air Force leveled the summit and other nearby areas, built roads, and constructed nearly 80 structures.

In 1981, the Midpeninsula Regional Open Space District (MROSD) acquired the property and included it within the Sierra Azul Open Space Preserve. In 2009, MROSD received federal funding to clean up the site and subsequently removed all structures except the 80-foot tall support for the radar sail near the summit known as the Tower. In 2015, MROSD initiated regrading of the summit to return it to a more natural condition. In 2016, MROSD will continue the regrading while improving public access facilities (e.g., parking, trails, ADA access, and staircases) to accommodate visitors when the site opens to the public.

This revegetation plan for the summit of Mount Umunhum has been developed in conjunction with MROSD's summit grading and soil amendments that will be completed by Spring 2017. Plants and seeds for revegetation will be provided by Acterra Native Plant Nursery. This document provides a revegetation plan for the summit that directs the installation of Acterra's plants, establishes performance criteria, outlines a monitoring plan, and recommends adaptive management approaches in response to monitoring results.

1.2 REVEGETATION GOALS

The general goal of the summit revegetation is to install appropriate native plants, via direct seeding and container plant installation, onto the summit with the intent that they will eventually self-propagate and spread throughout the summit with minimal management. More specifically, the main goals of the revegetation are to:

- Re-establish appropriate native vegetation on the summit from locally appropriate and available materials so that the revegetated summit will start to be indistinguishable from surrounding vegetation after a period of approximately 10 years.
- Restore summit vegetation so that it becomes naturally recruiting and reproducing with minimal annual input from stewardship actions.
- Installed plants in Phase 1 and 2 should meet a 60% survival performance criterion within 3-years of the initial installation. In Year 5, survival shall not be lower than 80%. Installed plants should also be a minimum of 20% absolute cover in the restoration areas after 5 years.

Achieving these goals will require an initial investment of time associated with planning, propagule and plant material collection, growing the plants, and replanting following by regular maintenance and monitoring. To achieve these goals, MROSD intends to:

- Successfully install all the plants provided by the nursery in the defined planting areas and replace failed plants.

- Directly sow collected seed into the soil in delineated seeding sites. Determine which plants establish successfully from seed. In subsequent years, collect seed from a suite of established plants and continue direct seeding of bare areas with appropriate soils.
- Record and assess survivorship based on site, aspect and species planted. Use survivorship information to prioritize nursery recommendations for the following year.

1.3 Success Criteria

Establishing success criteria is essential for reviewing the success of a given project. This restoration plan recommends the use of both qualitative photopoints and quantitative measurements to ensure that vegetation is establishing as anticipated. Since few mountaintop restoration projects of this magnitude have occurred in the Bay Area, this plan attempts to provide reasonable success criteria based on professional opinion. Success criteria are presented and discussed in detail in Section 5.

1.4 Implementation Phasing

Revegetation for this project is divided into two initial stages: Phase 1, to be completed in Year 1 (Oct 2016-Sept 2017) and Phase 2, to be completed in Year 2 (Oct 2017-Sept 2018). Phase 1 is will install plants and directly sow seed into priority areas defined by the Restoration Design Group (project landscape architects) and MROSD staff. Phase 2 will ensure that Phase 1 areas are established and replanted as needed in those areas, and then expand into new Phase 2 areas. Implementation phasing is further discussed in Section 3.

1.5 Project Expectations and Limitations

Re-establishing plants on a summit with highly altered soils will be difficult. This plan is attempting to use all known and reasonable methods to increase plant establishment on site. Successful plant establishment will require proper timing of installation (cooler, wet season), proper microsite selection, local soil amendment, proper watering and weeding. Even with successful installation and maintenance, we expect that mortality will occur. With this expectation, monitoring will be critical to determine what species are favored by various microsite variables, by tracking which plants successfully establish in what location. This monitoring information will then be used to instruct Phase 2. Phase 1 is expected to have a learning curve which should be applied to Phase 2.

2 Existing Conditions

2.1 Climate

The Santa Cruz Mountains climate is considered to be a “cool summer Mediterranean climate, characterized by low average summer temperatures.” (Thomas, 1961) Yearly average temperatures are approximately 56F (Thomas, 1961) in the Ben Lomond area, which is most similar to Mt. Umunhum. Average annual precipitation can vary from 15 to 60 inches in this area, with Mt. Umunhum usually on the higher end of this spectrum. Summer months often bring coastal fog that extend over Mt. Umunhum which may be advantageous for plant establishment. Fog drip is also known to provide significant precipitation to plants if plants are within the drip line of larger trees.

2.2 Existing Soil Types on Adjacent slopes and Reconstructed Summit Substrates

A soil scientist, Vic Claassen, PhD, based in Davis CA, who specializes in evaluation and regeneration of drastically disturbed substrates, was involved with project planning and development. He visited the site numerous times, evaluated soils and excavated substrates and worked to integrate soil regeneration with other project activities. His findings are presented here below. Soil amendments and treatment recommends are included later in this plan.

Santa Clara County soil surveys mapped the original Mt Umunhum summit and the surrounding slopes as 'complexes' of soils, meaning a repeated combination of several different soils that are grouped into a single unit. The general characteristics of these various reference soils that are located around and adjacent to the summit are summarized in Table 1. The following narrative describes the various characteristics that support vegetation cover under local climatic conditions.

In general, the current growth environment of the summit project is intermediate between the existing north-facing and south-facing slopes. Temperatures and evapotranspiration rates are also expected to be intermediate. Therefore, the substrate to be used for planting on the summit is designed to be intermediate between the described characteristics of the surrounding soils.

Table 1. Summary of basic soil conditions of mapped soil series from around the Mt Umunhum summit.

Soil	Elsman	Maymen	Sanikara	Mouser	Katykat
geological parent material	sandstone shale	shale schist greenstone sandstone	sandstone greenstone	sandstone mudstone greenstone	sandstone mudstone
texture: surface subsurf	sandy loam sand clay loam	sand clay loam sand clay loam	sandy loam sandy loam	loam	loam clay loam
structure surf subsurf	SBK to granular SBK	SBK massive	SBK to gran SBK	granular SBK	SBK to granular massive
horizonation	O /A /Bw /Bt	A /Bw / Cr	O / A / R	O /A /Bt / Cr	O /A /Bt / BCt
coarse fragment	very gravelly	gravelly	very gravelly	gravelly	paragravelly
soil pH	5.6 to 6.5	5.3 to 5.5	6.6 to 6.8	5.7 to 6.3	5.7 to 6.7
rooting depth	66 inches	10 inches	12 inches	51 inches	50 inches

Key to abbreviations: *texture modifier: for 15-35% rocks add 'gravelly or stony' texture; 35 to 60% add 'very gravelly or stony' texture; > 60 % add 'extremely' gravelly or stony texture; SBK is sub angular blocky structure.

Geological parent materials of all soils are generally from the same source. These are seafloor sediments that are fractured and lofted to this summit position. The soils with the deepest rooting depths are those with shale or mudstone included in the geological strata. These rocks are weaker and weather more easily than the hard dense quartz-sourced rocks like sandstone or the heated and metamorphosed schists. The hardest stones and cobbles found in the summit substrates are dense sandstones. The fine soil fraction materials are a mix of all rocks, but probably contain more material weathered from the softer rock types. The sand and gravel sized materials are probably derived from the harder sandstones and metamorphosed minerals that persist.

The texture of the fine soil material (< 2 mm fraction) is similar for all soils and project substrates, ranging from sandy loam to loams to clay loams. The samples collected from the summit materials during construction during had clay contents ranging from 10 to 31 % with an average of 17 %. The average texture of all sampled materials is 68 % sand, 15 % silt and 17 % clay, which is classified as a sandy loam texture. This suggests that the fine soil fractions of the substrates are a viable growth media on the summit as they are on the existing slopes. The high rock content, however, is an issue for the summit substrates and appears to be higher than on many mapped slope soils.

The soil aggregate structure (subangular blocky (SBK) or granular or uniformly packed and non-structured (massive) are indicators of growth conditions on the slope soils but these characteristics would be destroyed during excavation and grading.

Soil horizonation is also mixed during excavation. Organic enriched A horizons, clay enriched B horizons and decomposed rock Cr horizon and the growth influences they generate are all disintegrated and blended, either by historic or current excavation activity.

Coarse fragment content in all soils is greater than 15 % gravels and some are greater than 35 %. These gravels displace fine soil materials that hold moisture, lowering the moisture retaining capacity of the profile as a whole. Materials exposed after initial landscape grading at the summit were about 50% rocks

greater than 3 inches (cobble and stone sized). This decreases the moisture retention by half. But during non-saturating rains it also delivers moisture more deeply and encourages plants to root more deeply as well. If the substrates are supported by rock-to-rock contact (i.e. clast-supported) rather than resting on compacted fine soil materials (i.e. matrix-supported), the potential for compaction may be reduced.

Soil acidity (pH) ranges from 5.6 to 6.8, which is typical for similar soils and is not growth limiting. Substrates sampled through the project had a similar range and averaged 6.3, which is ideal for plant growth.

Rooting depth appears to occur over a mixture of deep and shallow soils. Roots can spread many feet laterally to access moist substrates. Extensive fracturing of these geological materials suggests that rooting may be available beyond the mapped soil profiles.

In each of the soil mapping units on or around the summit area, about a third of the area is indicated to have a soil that has very deep rooting, ranging from 50 to 66 inches deep (Table 1). About two-thirds of each mapping unit has soils with shallow rooting from 10 to 12 inches deep. Since the summit is relatively flat compared to the steep north-facing or south-facing slopes, an adequate rooting depth for plant cover is also expected to be intermediate between the very deep and very shallow soil depths.

The reconstructed summit substrates have rocks mixed throughout the profile and in greater concentrations than indicated on the mapped soils. Therefore, several steps should be taken to ensure adequate rooting. One approach is to have wider plant to plant spacing to allow adequate rooting volume since rooting is less deep. Another strategy is to selectively remove rock from the local planting area or “planting pocket” to facilitate initial plant establishment.

Because of the heterogeneity of substrate conditions following land-forming work at the summit, rock content must be determined on the final grade surface and substrates for each planting area. Three potential rooting issues may occur that would make these substrates less able to support plant growth than the reference soils on the slopes:

1) Open void spaces between rocks in the near-surface substrates:

Some substrates are clast-supported (rock to rock contact) and may have pore space or voids between the rocks that are not filled. Roots perceive these voids as very dry and un-rootable compared to the adjacent soils. Larger void spaces must be filled with fine soil material.

2) Filled and compacted substrate materials in the spaces between rocks:

When the space between the rocks in clast-supported substrates is filled with soil material, the soil should not be compacted. This condition slows infiltration, retains moisture nearer to saturation and prevents aeration and root growth.

3) Compacted fine substrates in non-rocky substrates:

In areas with low rock content the soil matrix itself carries the weight of soil, water and surface traffic. These matrix-supported substrates may become compacted and should receive a final mechanical decompaction treatment but no rock removal is needed.

Because the high rock content and the variable status of the rooting substrates is potentially limiting for infiltration and revegetation, a modified planting method is recommended that combines cursory evaluation of local substrate conditions and decompaction or rock removal. It also integrates incorporation of organics and creation of a small planting hole at the same time, to fully prepare the site

for the planting crew. Most of these substrates are so rocky that they are practically unworkable by hand labor and tools. These recommendations are described below and also in Section 3.5.3. Plant Installation into Soil.

Figure 1: Detail photograph of soils on summit. Note the occurrence of small spaces between gravels and roots extending several feet into the soil (arrows)

Figure 2. As the vegetated edge of the summit is pulled back, the existing root channels and soil structure is mixed. Existing root channels and drainage pores are destroyed. Mixing of coarse wood materials and care to not re-compact the substrates are the primary treatments to regenerate pore space for root growth and drainage.

Figure 3. Existing or regraded areas of excavated soils have various dense subsoil layers or are compacted. A final re-excavation, mixing of coarse organics, and replacement without compaction are basic treatments to regenerate infiltration and allow root growth to re-enter these substrate volumes.

2.2.1 Soil Fertility Analysis for Plant Growth

A total of 20 soil samples were collected during the planning and pre-construction phases of the project (Appendix 7.5). These were evaluated for soil fertility and interpreted for wildlands planting conditions. Substrates varied greatly from sample to sample. But, in general, fertility levels in these substrates are not limiting to growth of wildlands plants. Because of their low organic content and because of disturbance from excavation, they are expected to be susceptible to compaction and are expected to be droughty in late summer. The general fertility from organic amendments is expected to provide basic, modest fertility for plant establishment. A critical emphasis is placed on treatments that regenerate rooting volume to allow plants to acquire moisture in the droughty late summer season, as discussed in the previous section.

2.3 Vegetation Types

Undisturbed vegetation downslope of the active restoration site is being used as a reference for what we expect to establish on the summit. This section will provide a brief description of adjacent vegetation types that will serve as references for the restoration goals.

Due to differences in wind exposure, hydrology, and different soils, the downslope vegetation can differ from what is expected on an undisturbed summit. Since the scope of our surveys extends only 100-200 feet from the summit, we expect the reference systems to present a similar community of plants and vegetation stands as the summit prior to the development and grading of the site by the Air Force. A preliminary list of plants considered appropriate for restoration (from 9/10/2014) was compiled by Deanna Giuliano and can be used to present a more detailed snapshot of the vegetation present near the summit (Appendix 7.3).

The south facing slopes (Figure 4) are particularly applicable of our project goals. Vegetation on these slopes are characterized by patchiness, bare ground and rocky, exposed soils; this is the natural

vegetation of a mountain summit. The vegetation on these slopes is dominated by 4-8 foot tall shrubs primarily consisting of: mountain mahogany (*Cercocapus betuloides*), chamise *(Adenostoma fasciculatum*), redberry (*Rhamnus crocea*), coyote brush (*Bacharris pilularis*), and black sage (*Salvia melifera*). There is a diverse mix of subshrubs present (1-4 foot tall) as well, including: golden fleece (*Ericameria arborescens*), yerba santa (*Eriodictyon californicum*), red rock penstemmon (*Keckiella cormybosa*), and many others. A few larger foothill pines (*Pinus sabiniana*) occur in groves scattered across this exposure. Annuals (such as *Clarkia spp.*, *Chaenactis glabriuscula, Madia spp.* and *Trifloium spp.*), bulbs (such as soap plant (*Chlorogalum pomeridanum*) and blue dicks (*Dichelostemma capitatum*)), and perennial grasses (blue wild rye (*Elymus glaucus*) and one-sided bluegrass (*Poa* secunda) are a notable portion of this vegetation.

Mosses and lichens are an important aspect of this system often occurring on rocks and bare soils. Two rapid assessments were completed on site in February 2015, in order to provide information on existing vegetation, planting density and composition. One assessment site was located near the West Summit and a second assessment was conducted on the southern slopes near the West Summit. Notable results from these two rapid assessments of reference areas is that bare ground, including rock, was visually estimated to be approximately 45% (West Summit) and 70% (East Summit Area) of the absolute cover. Planting recommendations were derived from what was observed at these two reference sites near the summit.

Figure 4: South facing slope just below the re-contoured East Summit Area. This vegetation community is serving as a reference and restoration target for much of the summit restoration. Note plant locations along cracks and fissures. These locations may lead roots to deeper, late-season soil moisture or may allow subsurface moisture during rains to seep from up-slope locations to the plant roots.

North facing slopes are characterized as a diverse bay-oak woodland vegetation dominated by mature trees such as coast live oak (*Quercus agrifolia*), bay trees (*Umbellularia californica*), canyon live oak (*Quercus chrysolepis*) and California buckeyes (*Aesculus californica*) which create large expanses of closed canopy forest. The shrub layer fills in the majority of the openings in the forest canopy. Dominant shrubs include leather oak (*Quercus durata*), holly-leaf cherry (*Prunus ilicifolia*), wavy leaf ceanothus (*Ceanothus papilosus*), coast silktassel (*Garrya elliptica*). There are a few bare, rocky areas which hold a

unique assemblage of plants including red rock penstemon, various *Clarkia* species, rock sanicle (*Sanicula saxatilis*), rock buckwheat (*Eriogonum confertiflorum*) and a diversity of other annuals, bulbs, and unique perennials. This vegetation occurs directly north of the restoration site and represents a later seral stage than is expected on the restoration site for some years. It is possible that in the long term (20-50 years) the existing woodland will extend up toward the restoration site.

2.4 Site Landform Restoration and Soil Amendment

As described above, the site has been highly modified over the course of the past 80 years. The restoration of the summit was initiated in 2015, and at the date of this document, restoration of the site topography is well underway. MROSD staff began rough grading at the summit in the fall of 2015 summit (Figure 5) with available on-site material. Throughout the summit area, side cast materials on the sides of the existing flattened top were pulled up to establish a naturalized summit topography. Soils were over-excavated, mixed and filled to establish a soil profile that will support plant growth: a mixed soil depth of 5 feet was targeted to promote deep root penetration.

The following soil amendment prescription has been recommended by Vic Claassen, Ph.D. and is expected to be completed during the construction phase, before the planting described in this document.

In order to regenerate some portion of this growth potential on the final grade surface, the recommended treatment was to dig, decompact, and mix in coarse organic matter to 18 inches depth at coarse, 1 – 2 foot intervals across the planting area. It is assumed that the underlying substrates below 18 inches are not extensively compacted which can restrict downward root growth.

Because of the great variability of rock content, compaction, grade and landscape position across the site, more detailed specifications were not made for particular locations or plant types. Rather, a general treatment was recommended to remediate growth limitations resulting from construction activities. Going forward, more specific substrate treatments can be made on a case-by-case basis for specific plantings in specific substrate locations. Details of these compensatory treatments will need to be made based on the resulting as-built conditions and the vegetative plantings designed for each location.

Figure 5: Before and after photos of re-contoured east summit area after rough grading and structure removal. Grading will be refined in 2016-2017.

2.5 Constraints to Revegetation Success

The most difficult ecological component to restore on this project site is related to soil structure and soil microbiota. In particular, the soils of this site have been greatly altered by grading and mixing, which has completely destroyed the native soil and its physical properties. Soils are notably important in areas

with nutrient limitations, such as mountain summits. In addition, semi-angular crust was observed on site in 2015, which will increase runoff and decrease water infiltration. Soil amendments have been used to reduce crust formation.

Soil pathogens also pose a threat to restoration. *Phytophthora* species have been identified to be both in the vicinity of the project area and known to be in nursery stock. This pathogen is known to infect over 100 different host plants, ultimately causing a high degree of plant mortality in infected areas. Understanding about this genus of pathogens is rapidly developing. Seed collection, nursery growing conditions and outplanting all need to consider the risk of spreading this pathogen. For instance, plant cuttings that were collected in 2015 tested positive for *Phytophthora* in 2016. These plants were removed from the project stock. With added vigilance and sensitivity around this pathogen, historic plant propagation methods have been dramatically altered. We anticipate a greater effort will be required to grow fewer plants.

Environmental variability is likely the most important factor to weigh on restoration success. Given the stretch of drought, likely El Nino precipitation and hot summers, container plants and seedlings will likely have a more difficult time establishing.

3 REVEGETATION PLAN

3.1 GENERAL CONSIDERATIONS

The revegetation plan for this site includes 3 distinct methods of revegetation:

- Container planting
- Direct seeding
- Natural recruitment

Each of these methods is anticipated to play a critical role in establishing the target vegetation onsite. In this portion of the document, the container plantings (out-planting) and direct seeding strategy are presented. Natural recruitment will naturally follow if the out-planted and seeded plants establish and reproduce successfully. After 5 years, it is anticipated that natural recruitment will start to be a visible mechanism by which the site continues to mature and restore as native mountain-top vegetation.

As stated in the Section 1.2, the main revegetation goals for this project are as follows:

- Re-establish appropriate native vegetation on the summit from locally appropriate and available materials so that the revegetated summit will start to be indistinguishable from surrounding vegetation after a period of approximately 10 years.
- Restore summit vegetation so that it becomes naturally recruiting and reproducing with minimal annual input from stewardship actions.
- Installed plants in Phase 1 and 2 should meet a 60% survival performance criterion within 3-years of the initial installation. In Year 5, survival shall not be lower than 80%. Installed plants should also be a minimum of 20% absolute cover in the restoration areas after 5 years.

3.2 SPECIES SELECTION AND PLANT PROPAGATION

To determine an appropriate species palette for direct seeding and container plant installation, a series of field surveys of nearby reference sites were conducted by the revegetation team in 2014 and 2015. Direct-seeded species selection focused on identifying early successional, often annual or short-lived

species which colonize disturbed, bare ground. Reference sites for this suite of species included recently-graded areas along Mt Umunhum Road and the new Summit Trail, as well as two recently-burned sites near Loma Prieta. The Loma Prieta sites were particularly informative due to the similar elevation, slope, and aspect, and close proximity to, the restoration site. The sites were heavily disturbed by the Loma Fire of 2009, and more recent disturbance was evident along power-line corridors.

Container plant species selection was based on numerous reconnaissance-level surveys of undisturbed habitat in the Mt Umunhum vicinity, and focused on identifying the dominant species of the mature mixed evergreen forest, oak woodland, and chaparral in the region. A comprehensive species list of the summit area (Hickman and Rawlings 2016) was also consulted.

Following compilation of an initial species list (Appendix 7.3), which was expanded to include traditional or medicinal use of each species, the revegetation team met with representatives from the Amah Mutsun Tribal Band, including the Tribal Ecologist, to gather input on specific ceremonial or management requests. Feedback received at this meeting confirmed the general goals to use local, native species that provide habitat for wildlife. Individual species were not identified beyond those already listed for revegetation.

The container plant species list was then refined to identify “core” plants, locally-dominant species known for ease of propagation and transplanting, as well as hardiness and aesthetic qualities. These core plants are targeted to be the dominant constituents of the Summit plant community and include deer weed (*Acmispon glaber* var. *glaber*), California fucshia (*Epilobium canum*), golden yarrow (*Eriophyllum confertiflorum*), silver bush lupine (*Lupinus albifrons* var. *albifrons*), foothill penstemon (*Penstemon heterophyllus*), coyote mint (*Mondardella villosa*), and imbricate phacelia (*Phacelia imbricata*).

Plant propagation was completed by Deanna Giuliano and the staff and volunteers of Acterra Nursery. The nursery has adopted strict standards for limiting plant pathogen spread (Appendix 7.2) which include best management practices around seed collection, plant growing areas and various other propagation and cultural practices. In addition, annual plant seed was collected and will be used in order to attempt to grow annual seed in the nursery. The nursery has since been updated with a new, sterile growing area that follows best management practices for the control of plant pathogens such as *Phytophthora.*

3.3 PLANTING PLAN

The planting plan presented includes several elements designed to increase the project's success. Additionally, the plan incorporates several redundancy measures to ensure vegetation establishes in important Phase 1 areas. Nutrient and microbial soils amendments, planting palette, a high density planting layout, direct seeding, phasing and monitoring will all help ensure goals for this project are met. The overall planting diagram is presented in Figure 6.

A total area of approximately 13,000 ft^2 will be planted with container plants in Phase 1. Phase 2 total planting area is highly dependent on the establishment of Phase 1 plants, but it is anticipated that another 5-10,000 ft^2 will likely be planted with container stock in Phase 2.

Total seeded area is anticipated to be on the order to 5,000 ft^2 per year. The actual area seeded will be subject to seed availability, notably the seed collected and propagated by the nursery. We anticipate this number will be highly variable dependent upon environmental factors such as climate and precipitation in any given year.

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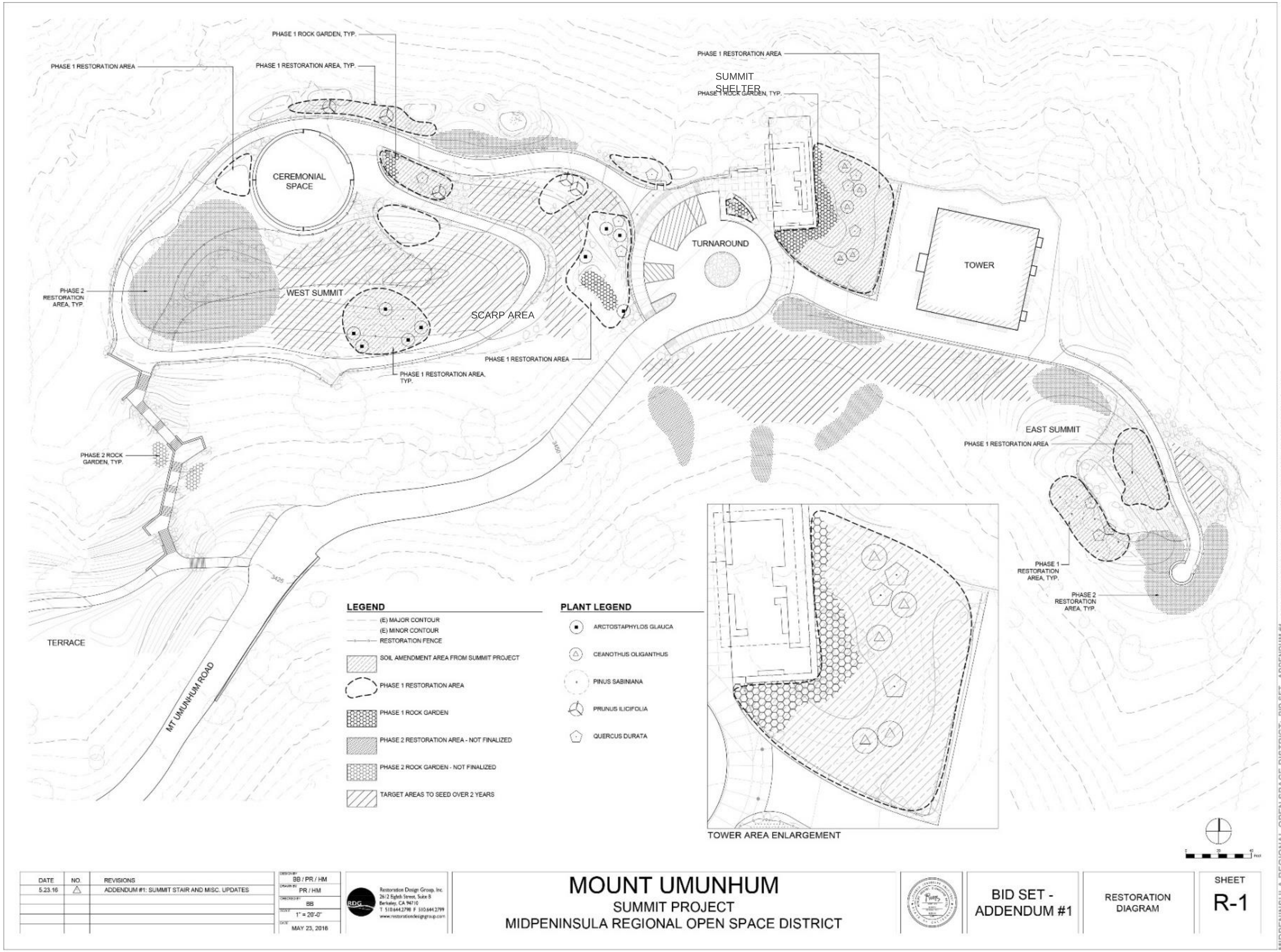

PHASE 1 ROCK GARDEN, TYP.
PHASE 1 RESTORATION AREA
PHASE 1 RESTORATION AREA, TYP.
SUMMIT SHELTER
PHASE 1 ROCK GARDEN, TYP.
CEREMONIAL SPACE
TURNAROUND
TOWER
PHASE 2 RESTORATION AREA, TYP.
WEST SUMMIT
SCARP AREA
PHASE 1 RESTORATION AREA
PHASE 1 RESTORATION AREA, TYP.
EAST SUMMIT
PHASE 2 ROCK GARDEN, TYP.
TERRACE
MT UMUNHUM ROAD
LEGEND
(E) MAJOR CONTOUR
(E) MINOR CONTOUR
RESTORATION FENCE
SOIL AMENDMENT AREA FROM SUMMIT PROJECT
PHASE 1 RESTORATION AREA
PHASE 1 ROCK GARDEN
PHASE 2 RESTORATION AREA - NOT FINALIZED
PHASE 2 ROCK GARDEN - NOT FINALIZED
TARGET AREAS TO SEED OVER 2 YEARS
PLANT LEGEND
ARCTOSTAPHYLOS GLAUCA
CEANOTHUS OLIGANTHUS
PINUS SABINIANA
PRUNUS ILICIFOLIA
QUERCUS DURATA
TOWER AREA ENLARGEMENT
DATE
NO.
REVISIONS
5.23.16
ADDENDUM #1: SUMMIT STAIR AND MISC. UPDATES
BB / PR / HM
PR / HM
BB
1" = 20'-0"
MAY 23, 2016
MOUNT UMUNHUM
SUMMIT PROJECT
MIDPENINSULA REGIONAL OPEN SPACE DISTRICT
BID SET - ADDENDUM #1
RESTORATION DIAGRAM
SHEET
R-1
MIDPENINSULA REGIONAL OPEN SPACE DISTRICT: BID SET - ADDENDUM #1

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Planting areas have been divided into two phases: Phase 1 planting to be completed in fall-winter of 2016-2017 and Phase 2 to be completed in fall-winter of 2017-2018. *This phasing is subject to change based on the Summit Project construction schedule and staffing availability.* The total area to be planted was planned based on anticipated plant availability from Acterra Nursery.

Phase 1 planting areas are typically considered to be higher priority and should receive attention before Phase 2 areas. Planting areas have been selected based on a number of factors including, but not limited to:

- Potential for restoration and plant establishment, which is derived from a combination of factors including:
    a. north facing (cooler, wetter) slopes,
    b. areas adjacent to standing native vegetation which may provide incidental propagules,
    c. anticipated soil fertility for plant growth
- Ability to steward and maintain areas – areas with easy access for staff and volunteers where slopes not too steep, nor eroding
- User visibility and aesthetics – locations where park users will congregate and observe vegetation
- Areas where vegetation will interact with interpretative information – locations such as rock gardens in the Tower area may help with the interpretation of the site by users

Planting priorities were established after discussion with the project team. **The sites are presented in order of importance for Phase I planting.** If plants are missing, or haven't been grown for Phase I, they should first be removed from the lower priority areas. Those plants will then be inserted into the appropriate area in Phase II.

Tables include two calculations to allow for understanding the plant density in each planting area. The first figure states the overall density of plants, which tend to be from 9 to 10 ft^2 per plant. The second number "clustered spacing" assumes that plants will be in clusters, rather than regularly distributed on site. Therefore, if one assumes on average 30% of the site will be in a clustered planting area, plant density increases to an average of 2.7 to about 3.2 ft^2 per plant, or roughly the area of a medium sized cooler. If adjustments are needed on site, this calculation allows one to move plants from one denser planting area to another which may need more plants.

3.3.1 Tower Area

The Tower Area is a 4,000 square foot area located between the Tower and the Summit Shelter and Turnaround. This area will likely be the most visited revegetation area since the trail to the East Summit, the Tower, and interpretative displays all converge near this area. This area will receive the highest number of plants (326) and relatively high density of plants (average of one plant per 10.7 ft^2). In additional, the Tower Area will be the site of a storm water swale which will have specific vegetation cover requirements outlined in the final engineering documents.

Table 2: Tower Area Planting Plan

Scientific Name	Common name	Quantity
TREES		
Ceanothus oliganthus	Hairy Ceanothus	5
Quercus durata (*may be planted by acorn)	Leather Oak	3
TOTALS		***8***
SHRUBS		
Artemisia californica	California Sagebrush	5
Keckiella corymbosa	Red Rock Penstemon	20
TOTALS		***25***
PERENNIALS		
Acmispon glaber var. glaber	Deerweed	3
Dudleya cymosa	Canyon Dudleya	20
Epiloium canum	California Fucshia	20
Eriogonum saxitile	Rock Eriogonum	20
Eriophyllum confertiflorum	Golden Yarrow	20
Lomatium dasycarpum	Biscuit root	40
Lupinus albifrons var. albifrons	Silver Bush Lupine	5
Penstemon heterophyllus	Foothill Penstemon	40
Monardella villosa	Coyote Mint	40
Phacelia imbricata	Imbricate Phacelia	30
TOTALS		***238***
GRASSES		
Koeleria macrantha	Junegrass	40
Melica californica	California Melic	15
TOTALS		***55***
SITE TOTAL		***326***
Spacing (sf per plant)		**10.7**
Clustered Spacing at 30% (sf per plant)		**3.2**

3.3.2 West Summit

The West Summit is a 1,665 square foot area that faces south between the Ceremonial Space, a loop trail, and the entry to the Summit Stair. This area will include the expansion of a grove of pine trees as well as other well-suited perennial vegetation that may break up the rocky, barren appearance of this summit while not obscuring views. This area will receive the second densest spacing (1 plant per 9.2 ft^2) in order to allow for small, dense clusters of vegetation to establish on this exposed summit. We expect plants in this area may have a difficult time establishing due to the exposure and highly graded nature of the soils.

Table 3: West Summit Planting Plan

Scientific Name	Common name	Quantity
TREES		
Arctostaphylos glauca	Manzanita	5
Pinus sabiniana	Grey Pine	3
TOTALS		***8***
SHRUBS		
Keckiella corymbosa	Red Rock Penstemon	10
TOTALS		***10***
PERENNIALS		
Epiloium canum	California Fuchsia	20
Eriogonum saxitile	Rock Eriogonum	15
Eriophyllum confertiflorum	Golden Yarrow	20
Lupinus albifrons var. albifrons	Silver Bush Lupine	6
Penstemon heterophyllus	Foothill Penstemon	20
Monardella villosa	Coyote Mint	40
Phacelia imbricata	Imbricate Phacelia	10
TOTALS		***131***
GRASSES		
Melica californica	California Melic	30
TOTALS		***30***
SITE TOTAL		***179***
Spacing (sf per plant)		**9.2**
Clustered Spacing at 30% (sf per plant)		**2.7**

3.3.3 Ceremonial Space

This 2,540 square foot area will be near the site of Native American (Amah Mutsun) and other group ceremonies. This area will be vegetated with appropriate summit vegetation and include rock garden features. This area will highlight vegetation around trails and paths allowing for users to enjoy the summit and its views without tall vegetation being planted in view-sheds. Due to the inherently small plants used in rock gardens and around the ceremonial space, this location will have the highest density of plants (1 per 9 ft^2).

Table 4: Ceremonial Space Planting Plan

Scientific Name	Common name	Quantity
TREES		
Arctostaphylos glauca	Manzanita	4
Prunus ilicifolia	Holly Leaf Cherry	4
Quercus durata (*may be planted by acorn)	Leather Oak	1
TOTALS		***9***
SHRUBS		
Artemisia californica	California Sagebrush	4
TOTALS		***4***
PERENNIALS		
Dudleya cymosa	Dudleya	5
Epiloium canum	California Fuchsia	13
Eriogonum saxitile	Rock Eriogonum	15
Eriophyllum confertiflorum	Golden Yarrow	15
Lomatium dasycarpum	Biscuit root	20
Penstemon heterophyllus	Foothill Penstemon	15
Monardella villosa	Coyote Mint	30
Phacelia imbricata	Imbricate Phacelia	20
TOTALS		***133***
GRASSES		
Poa secunda	Junegrass	30
TOTALS		***30***
SITE TOTAL		***176***
Spacing (sf per plant)		**9.0**
Clustered Spacing at 30% (sf per plant)		**2.7**

3.3.4 East Summit

The East Summit provides one of the best views from Mt. Umunhum. This 2,420 square foot site will be restored to vegetation that will blend with plants downslope. Much of this site is rocky and hot and will support a stand of pines near the summit to provide a shade opportunity. This area is listed as the fourth priority because it is physically separate from the other areas and can be easily signed with a "restoration coming soon sign" while minimally impacting the user experience and effort occurring near the tower and West Summit.

Table 5: East Summit Planting Plan

Scientific Name	Common name	Quantity
TREES		
Pinus sabiniana	Grey Pine	7
Quercus durata (*may be planted by acorn)	Leather Oak	3
TOTALS		***10***
SHRUBS		
Artemisia californica	California Sagebrush	10
Keckiella corymbosa	Red Rock Penstemon	10
TOTALS		***20***
PERENNIALS		
Acmispon glaber var. glaber	Deerweed	11
Epiloium canum	California Fuchsia	20
Eriogonum saxitile	Rock Eriogonum	15
Eriophyllum confertiflorum	Golden Yarrow	20
Monardella villosa	Coyote Mint	40
Phacelia imbricata	Imbricate Phacelia	10
TOTALS		***116***
GRASSES		
Poa secunda	Junegrass	20
Melica californica	California Melic	30
TOTALS		***50***
SITE TOTAL		**196**
Spacing (sf per plant)		**10.20**
Clustered Spacing at 30% (sf per plant)		**3.06**

3.3.5 Scarp Area

The 2,840 square foot Scarp Area is a previous road cut that has been regraded and now slowly ascends upwards towards the West Summit. This area is unique because as it was re-graded exposing two large boulders which can serve as native landscaping features. These boulders will serve as an anchor for the restoration plantings. This area is selected as the lowest priority because it is a steep slope which is exposed and not expected to be a location where visitors might expect to see plants establishing. Additionally, the exposed boulders alone provide a unique view of the bedrock geology.

Table 6: Scarp Area Planting Plan

Scientific Name	Common name	Quantity
TREES		
Prunus ilicifolia	Holly Leaf Cherry	2
Quercus durata (*may be planted by acorn)	Leather Oak	3
TOTALS		***5***
SHRUBS		
Artemisia californica	California Sagebrush	15
Keckiella corymbosa	Red Rock Penstemon	25
TOTALS		***40***
PERENNIALS		
Acmispon glaber var. glaber	Deerweed	10
Dudleya cymosa	Dudleya	5
Epiloium canum	California Fuchsia	25
Eriophyllum confertiflorum	Golden Yarrow	25
Lomatium dasycarpum	Biscuit root	40
Lupinus albifrons var. albifrons	Silver Bush Lupine	5
Penstemon heterophyllus	Foothill Penstemon	25
Monardella villosa	Coyote Mint	50
Phacelia imbricata	Imbricate Phacelia	20
TOTALS		***205***
GRASSES		
Poa secunda	Junegrass	20
Melica californica	California Melic	25
TOTALS		***45***
SITE TOTAL		***295***
Spacing (sf per plant)		**10.17**
Clustered Spacing at 30% (sf per plant)		**3.05**

3.3.6 Rock Garden detail: sub-areas

For planning ease, all rock garden sub-areas are included as part of three of the above five mentioned areas: Tower Area, Scarp, and Ceremonial Space. These special "sub-areas" are included here to highlight their importance in the restoration of appropriate summit vegetation.

Figure 7: Rock Garden detail plants including geophytes and other wildflowers.

Rock Gardens are an essential part of vegetation typically found on summits in the Santa Cruz Mountains. These areas are typified by lots of bare ground, large rocks, and distinct microsites where plants grow and thrive. These often diminutive plants produce beautiful flowers and deserve more attention (Figure 7). Plant species closely associated with rocks found near the Mt. Umunhum summit include: canyon dudleya (*Dudleya cymosa*), rock eriogonum, California fuchsia, flat-leaved onion *(Allium falcifoium*), most-beautiful jewelflower (*Streptanthus glandulosus*), rock sanicle (*Sanicula saxatilis*), Santa Clara red-ribbons (*Clarkia concinna* ssp. *automixa*), and biscuit root, to name a few.

3.4 Soil Preparation

There are two aspects of soils that need to be considered prior to planting: how to speed up the soil rehabilitation process so that the substrate supports vigorous plant growth and how to ensure that bare soils will not erode during early plant establishment and revegetation. In order to improve soils, we recommended following soil amendment actions occur in Phase I Planting Areas (Pers. Comm. Claassen 2015). These treatments will be completed by the contractor pre-revegetation, thus preparing the site for planting the container stock.

1. Wood shreds should be incorporated into the fill substrate at low volumes, 5 to 10 %, to facilitate rooting. University of California Davis plant pathologists say the risk of root pathogens is not with dead woody material in the field but with contaminated nursery stock. This shredded material will be added to soils as outlined in the formal Construction Bid documents (RDG, 2016).

2. Final surface grading and drainage will be completed in order to mitigate surface runoff.

All other soil amendments will be limited to direct placement in the planting holes when plants are installed. These amendments will be added by persons planting the container stock. Amending each planting with a cup (8 oz dry, native soil) at the base of each hole can greatly help plant establishment.

This native soil will serve as an inoculum in order to help build bacterial and mycorrhizal associations with the plant. A topsoil donor sites near the summit will be approved with MROSD staff where impact to existing vegetation will be minimal and where there are no weed seeds or soil diseases. This site will be pretested for the presence of *Phytophthora* in 2016 by MROSD.

3.5 Phase I and II Plant Installation Methodology

Plant layout, microsite selection and plant installation into soil are all presented in this section. Proper plant installation is vital for survival and this plan details step-by-step instructions for plant installation. As work proceeds on-site, some steps may be amended or altered as needed.

3.5.1 Planting density and physical arrangement of plants

Because this is a harsh environment, higher density, clumped planting will be utilized. Instead of typical plant spacing of 24-36", smaller more condensed patches of vegetation are recommended where plants can grow together and form a distinct "vegetation island". Plants will be planted on approximately 18" centers, as a general rule (see spacing recommendations below).

Each of these island areas will include 20-40 plants of several species. One such typical island is diagramed (Figure 8) where plants are noted as polygons and inside each of those polygons, numbers denote the plant center (where it is to be installed). This diagram includes 4 plant taxa: CF = California fuchsia, CM = coyote mint, SBL = silver bush lupine, IP = imbricate phacelia.

Planting areas will be laid out with color-coded flags and/or other marking prior to installation.

One section should be completed at a time, from most important to less important. We recommend the following order of plant installation: Tower Area, West Summit, Ceremonial Site, East Summit, and finally the Scarp area.

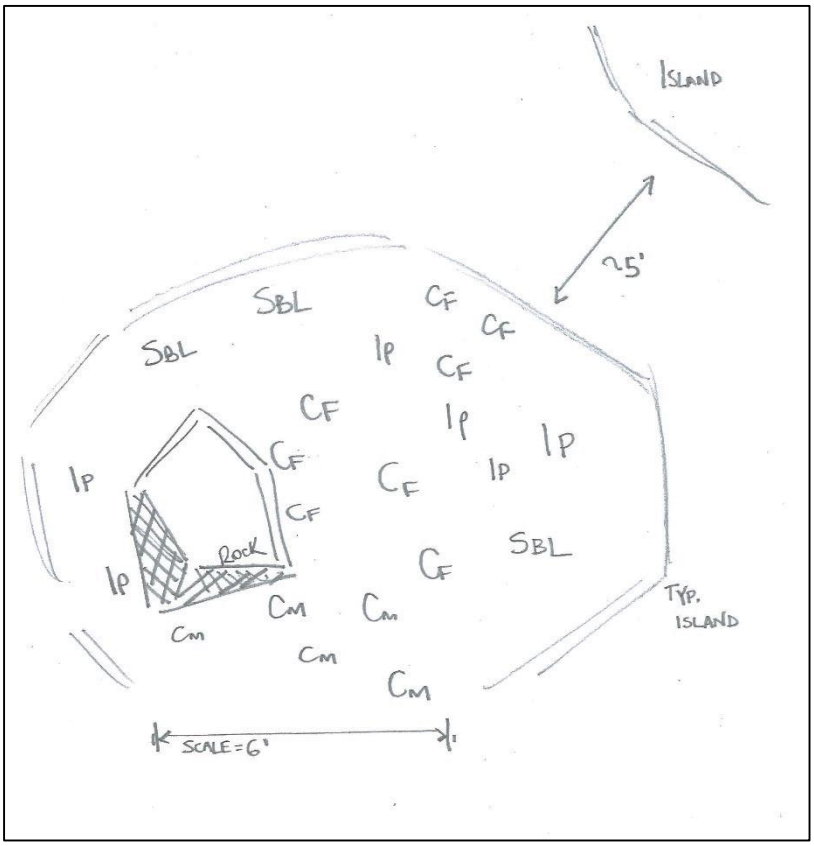

Figure 8: Planting island with 4 species of plants around a prominent rock feature.

3.5.2 Microsite selection

Successful plant establishment will require plants to quickly adapt to rocky soils conditions and have adequate rooting opportunity. In addition, any form of shade from rocks may help retain moisture in the soil for the plant to use. Therefore, plants should be placed to the north and east of any large rock, with rock mulch to be installed from large rock fragments found in the planting hole (see more in following section on plant installation into soil).

3.5.3 Plant Installation into Soil

Proper installation of plants is critical to their survival and establishment. Although this task is seemingly simple in fertile, loamy soils, this task will be more difficult and include more steps in the rock substrate.

The procedure for installing plants is based on numerous training techniques. Figure 9 serves as a visual guide that will help explain the procedure.

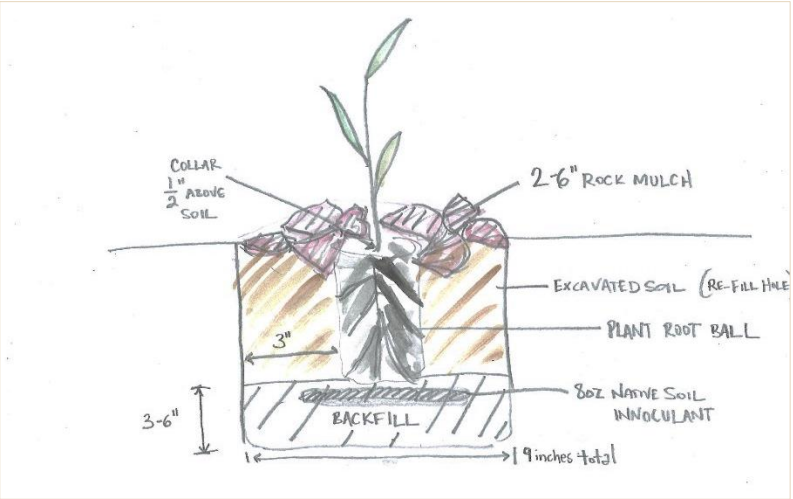

Figure 9: General planting diagram with approximate hole depth, width, inoculant placement, and rock mulch placement.

The standard planting sequence for substrates that are ready to plant are as follows:

1. Flag all planting sites with color coded flags to allow for a visual inspection prior to installation. Planting should commence from the upper portion of the planting island, moving downward on a slope so fewer plants are impacted as additional plants are installed.
2. Plant is selected and hole is dug to approximately two times the diameter of the pot (e.g. if a plant is in a 5 inch pot that is 5 inches tall, a hole that is 10 inches in diameter and 10 inches deep should be excavated. Large rocks should be removed and placed in a separate pile for rock mulching.
3. 6 inches of soil should be returned to the bottom of the hole. This soil will provide an easy rooting area for the new plant.
4. Soils at base of hole should be watered with approximately 4 inches of water.
5. Plant should be inspected and removed from pot. If plant is root-bound at bottom, roots should be separated "tickled" such that the plant "knows" it is out of the pot

Figure 10: Sample rock mulching technique.

and new roots can grow downward and sideways. Root-bound plants whose roots are not properly released often fail to establish.

6. Plant should be placed in hole and the plant collar should be placed 0.5 inches above the soil grade.
7. Remaining soil will be used to fill around edges. Soils should be compacted by hand to remove large air pockets.
8. Place large rocks (2-6" diameter) around the plant collar, acting as a mulch (Figure 8), downhill and far enough away that rocks will not slide and impact plant collar. Rock mulching will be critical for the establishment of plants on hot slopes. A small cover of rocks near the base of a plant can greatly increase soil-water retention and provide a cooler microsite for the plant to flourish.
9. Plant should be irrigated with water within 5 hours of installation, preferably over two courses with 3-5 minutes in between watering.

3.5.4 Recommended treatments for treating subsurface conditions: Create a 'planting pocket'

Rocky soils or substrates may be very difficult to dig using hand tools. A special treatment step is recommended that utilizes small equipment (low ground pressure mini-excavator) to combine the final excavation activity with plant installation (Details in Section 2.2.1) and organic amendment (specification in Appendix 7.5). If the subsurface condition of the substrate is not known ahead of time (open void spaces, compacted fines), a recommended treatment involves using a 12-inch excavator bucket to pull back the material in a 18 – 24 inch deep planting pocket. The area may vary from a foot across to 10 ft or more for a planting bed. This step allows the crew to evaluate rock content and confirm that there is at least 50% finer soil content in the rooting volume (< gravel in size). Add the equivalent volume of a 3" layer of organic amendment across the area of the planting pocket. Areas may vary by planting location. At this point, rocks can be removed to increase the proportion of fine soil. The loose material can be roughly mixed by pushing with the back of the bucket into the pocket such that the organic material is roughly mixed throughout the pocket volume and so that about 25 % is left on the surface as a mulch. This creates an approximate 10 % mixture of organics to total planting volume. A small, 12-inch-deep divot may be left in the specific planting location for easy installation of container plants.

A. "Open void spaces" substrates:

These are clast-supported materials with rock to rock contact open void spaces between the rocks. The treatment is to pull bucket through the substrate to scoop out 18 – 24 inch depths in the planting area; remove rocks from the excavated material until the spaces between the rocks (approximately 50% of total volume) is filled with gravel size material or finer; apply a 3 inch surface layer of organics over the spoil pile (or an area equivalent to the area of the planting pocket), mix organics and finer soil with the back of the bucket while replacing spoil in the planting pocket. Approximately 25 % of the organic amendment should remain on the surface as a mulch.

B. "Filled and compacted" substrates:

These areas have the spaces between clast-supported rocks filled with non-compacted, gravel-sized material or finer. The treatment is to scoop out a plant rooting volume 18-24 inches deep; apply a 3 inch surface layer of organics equivalent to the area of the planting pocket, mix organics and finer soil with

the back of the bucket while replacing spoil in the planting pocket. Approximately 25 % of the organic amendment should remain on the surface as a mulch.

C. “Compacted fine” substrates:

These are matrix-supported areas with load-bearing substrates that are gravel-sized or finer that may be compacted during construction. The treatment is to scoop out a 18-24 inch depth to decompact fine substrates, apply a 3 inch surface layer of organics equivalent to the area of the planting pocket, mix organics and finer soil with the back of the bucket while replacing spoil in the planting pocket. Approximately 25 % of the organic amendment should remain on the surface as a mulch.

*treatments are envisioned to be installed with a small 10,000 to 25,000 lb tracked excavator. The bucket width should be 12 inches for more small-scale mixing.

*specifications for organic amendments, amounts and incorporation method are listed in Appendix 7.5.

3.6 SEEDING PLAN

Direct seeding can be a cost effective way to revegetate a disturbed site with little financial and labor input. Direct seeding, or broadcast seeding, can be completed in a variety of manners. Critical aspects for direct seeding are ensuring that seeds are fresh (1-2 years old optimally), seeds are pathogen-free and fungus-free, proper soil contact is possible so that germination will occur, and timing is coordinated with natural cycle of target plants. We recommend the use of seeds that do not require stratification.

Seeds should be collected on site using proper seed collection protocol so as not to impact the existing vegetation or future seed sets (Appendix 7-4). If seeding and planting efforts are successful, seeds should be collected from those plants for use in Phase 2 and beyond. Recommended taxa for collection include a mix of location specific annuals that may grow quickly along with perennials that may root more deeply. Based on what was observed on site in May 2016, we recommend the following preliminary list for seed collection (Table 7).

Table 7: Plant species suitable for seed collection

SHRUBS	
Cercocarpus betuloides	Mountain Mahogany
Ericameria arborescens	Golden Fleece
Keckiella corymbosa	Red Rock Penstemon
ANNUALS AND SUBSHRUBS	
Acmispon glaber var. glaber	Deerweed
Clarkia spp.	Annual clarkia around summit
Chaenactis glabriscula	Inner Coast Range Chaenactis
Delphinium nudicale	Red larkspur
Dudleya cymosa	Dudleya
Epiloium canum	California Fuchsia
Eriogonum nudum	naked-stem buckwheat
Eriogonum saxitile	Rock eriogonum
Eriophyllum confertiflorum	Golden Yarrow
Lomatium spp.	Biscuit root
Lupinus annual spp.	Annual lupines
Lupinus albifrons var. albifrons	Silver Bush Lupine
Penstemon heterophyllus	Foothill Penstemon
Monardella villosa	Coyote Mint
Phacelia imbricata	Rock Phacelia
Trifolium willdenovii	tomcat clover
GRASSES	
Koeleria macrantha	Junegrass
Melica torreyana	Torrey's Melic
Poa secunda	One-sided bluegrass

Direct seeding (broadcast seeding) will be employed in specified areas in Phase 1 and 2 (Figure 4 from Section 3 of this document, also located in Appendix 7.3) if seeds are available.

The following general instructions are recommended (adapted from Bankosh, 2008).

1. When soils are lightly wet (but not muddy or dry), use a heavy-tined rake or McLeod, to create swath measuring 3' in width. Make sure the swathes are perpendicular to the slope to ensure that seeds don't drain down the slope during the rainy season. Swaths should be about 10' apart. Swathes should not be straight lines, but should be wavy and irregular so site does not look "row-cropped".

2. Spread 1-2 handfuls of seed mix over every 10 feet in length (seeding rate= 15 and 20 lbs/acre). Example: If you create a swath measuring 3' across and 20' long, you would spread 2 handfuls of shrub mix and 2 handfuls of annuals and grass mix over the area. If unequal amounts of seed is present, adjust seeding such that annuals and grass seed is evenly spread throughout the target area.

3. Lightly rake loose soil over seeds to cover to a depth of about ¼".

4. Soil should be lightly tamped with back of shovel or tamper to increase soil contact with seeds.

4 MAINTENANCE

4.1 INSTALLATION MAINTENANCE

The revegetation of site will require persistence and regular maintenance. Anticipated activities include: plant protection from herbivory, weed control, and replacement of dead plants. Due to the difficult climate and soil conditions, plant establishment may be difficult. The following protocol is adapted from Bankosh, 2008 with some minor changes.

4.1.1 Plant Protection

Browse damage to the plantings from wildlife could be severe if protective measures are not taken, but herbivory is not well documented in this restoration area. It is possible that herbivory will be negligible, and plant protection is not warranted. One method of plant protection is offered below. This method can be replaced by another method as appropriate.

As a first step, it is recommended that ecologically sensitive browsing deterrents be used at the time of plant installation. Perennial and annual plants can be sprayed with a deer deterrent such as rotten eggs (active ingredient in Liquid Fence) or capsicum (pepper) spray. Liquid fence, if used, should be applied immediately at installation and after any heavy rains. Instructions for each product should be followed. The specific product needs to be approved by MROSD staff and is subject to substitution as appropriate.

If herbivory continues to be a significant problem on the summit, temporary caging of plants may be necessary until those plants can get established. Cages should be used as a last resort.

4.1.2 Post-installation Maintenance: Weed Control

Maintenance is expected to be necessary at regular intervals. During the active growing season as possible) for the first few years and will decrease over time. Maintenance includes the removal of invasive, non-native vegetation, such as yellow star-thistle; replacement of dead plants; and irrigation.

During the first growing season after plant installation, site monitors should maintain a record of invasive vegetation found on-site, distribution, population and how it was treated. These records will allow for land managers to prioritize weeds and fit maintenance tasks into a budget. We recommend the following target weeds receive treatment with the goal of eradication: yellow star-thistle (*Centaurea solstitialis*), tocolote (*Centaurea melitensis*), non-native thistles (*Carduus spp.*, *Cirsium vulgare*). A decision will need to be made by staff whether to treat other weeds such as non-native *Fabaceae* (for example, rose clover, *Trifolium hirtum)* and annual grasses. We recommend that if populations are

small, these plants should be treated. Information on best management practices for treatment of various invasives is found at the California Invasive Plant Council website (www.cal-ipc.org).

In general, hand tools and hand pulling are the preferred management methods for invasive plants, with the goal of minimizing soils disturbance while not using herbicides.

Monitoring data (see following section) will be used to evaluate the continued need for maintenance to ensure the success of the restoration project.

4.1.3 Dead Plant Replacement

During the first three years of the five-year Plant Establishment Period, dead plants will be replaced if the average plant survival for all installed species combined falls below the 80% plant survival criterion outlined in the next section. An adaptive management approach towards plant replacement will be instituted. Thus, the plant species chosen for replacement will be based upon a critical evaluation of the vigor and growth of the plantings installed. Those species that are well adapted to the plantings sites and are rapidly establishing will generally be used to replace dead plants. Phase 2 will include the replacement of plants lost from Phase 1 planting areas. These replacements will occur when weather is cooler and season is conducive (fall-winter 2017).

4.1.4 Irrigation

Irrigation will not be installed in this project. If plants are properly installed at the correct time of year, hand watering with a water truck during extended periods of heat (7-10 days of extreme heat combined with lack of rainfall). Bridging the gap for first year plants during these extreme weather periods is important for plant establishment.

5 Success Criteria and Monitoring

5.1 Section Overview

The ultimate goal of this revegetation plan is to restore the summit of Mt. Umunhum with appropriate summit vegetation. The following 5-year success criteria are recommended:

1. After 5 years, 80% of the container plants have established
2. After 5 years, percent cover of container plants and natural propagules is 20% absolute cover
3. After 5 years, there are recognizable patches of seeded areas
4. After 5 years, invasive plant cover in restoration areas is less than 5% absolute cover

Each success criteria will be measured using a specific monitoring protocols mentioned below. Monitoring of the mitigation site by a qualified biologist will be conducted throughout the five-year plant establishment period, and monitoring reports will be prepared annually. Monitoring once every 6 months should provide adequate information on how Phase 2 can be improved. By the final year of monitoring, native habitat should be sufficiently well established to determine if they would eventually achieve the long-term goals of establishing native vegetation on the summit and less than 5% cover of invasive species. The following elements will be monitored to evaluate the site's progression towards this goal:

5.2 Percent Cover Monitoring and Success Criteria

Percent cover will be used as the primary indicator of restoration success. There are numerous ways of measuring percent cover, and we provide one such method that can be used efficiently, accurately and repeatedly.

The goal for percent cover is a steady increase in native cover over time. Percent cover will be determined using the line intercept method employed along 20 meter transects in 2-3 representative areas. Absolute percent cover of both the installed, seeded and naturally recruiting plants will be reported in years 2 and 5. Table 8 offers percent cover success criteria.

Table 8: Percent Cover Criteria

Restoration Site	Year 2	Year 5
Phase I	10%	20%
Phase II	N/A	20%

Installed plants in Phase 1 and 2 should meet a 60% survival performance criterion within 3-years of the initial installation. In Year 5, survival shall not be lower than 80%. If by Year 5, 80% survival has been achieved, plant survival monitoring can cease. Plant survival monitoring will take place in Years 1-3 and 5.

5.3 Seeding success

Direct seeding and seeding success will be measure by a simple 10-meter band transect through 3 seeded areas. This transect will measure presence/absence of seeded plants in 1 m^2 plots (typically using 1 meter PVC transect squares) lined up as follows along the transect: e.g. read cover at 1-2m plot, 4.5-5.5m and 8-9m plot along the 10 meter transect. Density will be reported in 4 absolute cover classes: not present (0% cover), low (< 1 % cover), medium (1-5% cover), high (> 6% cover) for annual and short-lived perennial plants. If recognizable patches of seeded areas are present after 5 years, the seeding was successful. If woody perennials establish from seed, they will be measured by ocular estimate in each plot.

5.4 Invasive plant cover

A preliminary list of invasive plants that are recommended for control are listed in Section 4.1.2. Invasive cover of target plants should ultimately be determined by field staff one full year after site grading has been finalized. This timeframe allows likely invasives to germinate and then be identified. We recommend creating this target list of invasives to control with the goal of having their cover (total) be no greater than 5% in another restoration area. A visual estimate of percent cover can be conducted at the end of the growing year for each site.

5.5 Photo-documentation

Annual photo-documentation of the site will be conducted throughout the 5-year plant establishment period. Photographs will also be taken to record any events that may have a significant effect on the success of restoration such as flood, fire, or vandalism. The locations for photo-documentation will be selected during initial site monitoring and will be clearly marked on a figure as well as in the field with a

labeled metal t-post, or less obtrusive ground marker such as a round orange rebar cap buried to be just above soil surface. Caps can be engraved with a number to denote the photopoint ID and the direction the photo should be taken.

5.6 Management Recommendations

Management recommendations will be included in each monitoring report. Recommendations will identify potential impediments to restoration efforts and will propose solutions to site problems as appropriate.

5.7 Pathogen testing

Although best management practices are being used in order to minimize pathogen spread, it will be important to observe, record, and test areas where plant mortality is higher than expected. *Phytophthora* testing was considered prior to planting, but it seems as though this technique will likely not produce reliable results because typically plant material is tested, rather than soil without vegetation (Swiecki, pers. com.).

Instead, after Phase I, it is recommended that material from dead and dying plants (as per stated protocol by Phytosphere Research) is collected for analysis in their laboratory (or other equipped laboratory).

5.8 Other Considerations

Significant aspects of site performance and conditions not covered in the formal monitoring plan will also be discussed. These will include such items as vandalism, irrigation problems, maintenance requirements, and any aspects of the site that may be inhibiting restoration efforts.

6 References

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7 APPENDICES

7.1 RAPID ASSESSMENT SURVEY FORMS PROVIDING INFORMATION ON REFERENCE VEGETATION (UNDISTURBED SITES NEAR THE SUMMIT) FROM FEBRUARY 2015

Please see adjoining pages.

Lech Naumovich Rapid Assessment DATE 2/25/15 UTM (NAD83) 597892 E 4113194 N
SITE ID: MT. UM REF2 Polygon/Survey Size: Elevation 3435 ft / m

Photograph #'s: PHONE X2

Soil Texture code: _____ | SOIL SAMPLE IDS: _____

Topography: Macro: top upper mid lower bottom | Micro: convex flat concave undulating (circle one)

% Surface cover (sum to 100%) Lg rock: 30 Sm rock 20 Bare/Fine: ___ Litter: ___ BA Stems: ___ Water: ___

Slope exposure, Actual °: ____ General: NE NW SE SW Flat Variable /All (circle one)

Slope steepness, Actual °: ____ General: 0° 1-5° 5-25° > 25° (circle one)

Size of stand: <1 acre 1-5 acres >5 acres Plot: Yes / No If yes, denote size: 100 m² / 400m² / 1000 m² / Other

DISTURBANCE TYPES:

Site history, stand age, and additional comments:

BREAK IN SCRUB W/ CEANOTHUS, CERCOCARPUS

PROVISIONAL VEGETATION ALLIANCE (MCV):

Dominant SPECIES LIST	% Cover	PH	SPECIES	% Cover	PH
MOSSELLA SP.	1		CHRYSOPSIS VILLOSA VAR. FOLIOSA		
MOSS	2		DELLUM PARRYI	1	
PHACELIA SP.	2				
ERODIUM SP.	5				
ANNUAL GRASS	5				
ERIOPHYLLUM	2				
DICHELOSTEMMA	1				
ERIOGONUM NUDUM	1				
ERIOPHYLLUM	1				
PENSTEMON HETEROPHYLLUS	1				
CHRYSOTHAMNUS NAUS	1				
ELYMUS MULTISETUS	1				

PHENOLOGY CODE : F – flowering, B – bud, V – vegetative growth only, S – fruit and seed developed, D – dying, senescing

UNUSUAL TAXA, GPS points taken:

STREP ALS. PERM. → 597916, 4115095

DUDLEYA CF. CYMOSA

→ DOWNSLOPE

NOTE: list species codes (i.e. BROMAD = *Bromus madritensis*) from 100 point wandering transect on reverse of this page, additional taxa listed on back also

Lech Naumovich Rapid Assessment DATE 2/25/15 UTM (NAD83) E N

SITE ID: REF 1 : WEST SUMMIT - MTUM Polygon/Survey Size: 10 x 2M Elevation: 3470 ft / m

Photograph #'s: PHOTO - CONTACT

Soil Texture code: _____ | SOIL SAMPLE IDS: _____

Topography: Macro: top upper mid lower bottom | Micro: convex flat concave undulating (circle one)

% Surface cover (sum to 100%) Lg rock: 5 Sm rock 10 Bare/Fine: ___ Litter: ___ BA Stems: ___ Water: ___

Slope exposure, Actual °: ____ General: NE NW SE SW Flat Variable / All (circle one)

Slope steepness, Actual °: ____ General: 0° 1-5° 5-25° > 25° (circle one) BENCH ON ~20° SLOPE

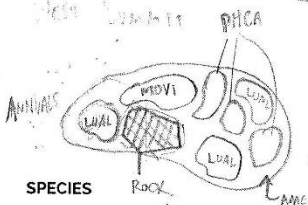
Size of stand: <1 acre__ 1-5 acres__ >5 acres__ Plot: Yes / No If yes, denote size: 100 m² / 400m² / 1000 m² / Other

DISTURBANCE TYPES: 0

Site history, stand age, and additional comments:

REF - FILL PILE WEST OF SUMMIT PHCA

SAMPLE FOR SUMMIT AREA:



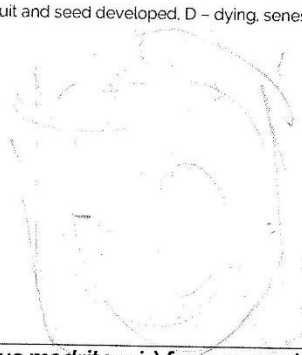
PLANTING ISLE

PROVISIONAL VEGETATION ALLIANCE (MCV):

Dominant SPECIES LIST	% Cover	PH	SPECIES	% Cover	PH
MONARD [illegible]	10				
ERIOPHYLLUM	2				
ACHILLEA GLABRA	3				
CAMISSONIA OPC.	1				
PHACELIA	1				
GILIA MACRO	1				
PENSTEMON	2				
ERIOGONUM NUDUM	2				
ANNUAL GRASSES -	~30				
CHLOROGALUM PUNC.	1				
ALOPECURUS					
BARE	~30				

PHENOLOGY CODE : F – flowering. B – bud. V – vegetative growth only. S – fruit and seed developed. D – dying, senescing

UNUSUAL TAXA, GPS points taken:



NOTE: list species codes (i.e. BROMAD = *Bromus madritensis*) from 100 point wandering transect on reverse of this page, additional taxa listed on back also

7.2 BEST MANAGEMENT PRACTICES PROGRAM

These are the current best management practices (BMPs) for as of 12/1/2016. These guidelines will likely change and be updated. Please check the California Oak Mortality Task Force website for the most current standards. Information presented in this Appendix is linked to webpages with the appropriate information.

Main Webpage: www.SuddenOakDeath.org

Nursery Management Resources

Guidelines to Minimize *Phytophthora* Pathogens in Restoration Nurseries – The Working Group for Phytophthoras in Native Habitats complied these guidelines to help design and maintain a nursery system that excludes *Phytophthora* and other plant pathogens to the best extent possible. These are intended for professional nursery growers that supply plants to wildland restoration projects. (Latest draft updated September 22, 2016)

Understanding results from the CDFA lab – a handout for nurseries

A systems approach to producing healthy container-grown plants: webinar with Dr. Jennifer Parke, Oregon State University. April 28, 2015. See all online resources and view a recording at http://uc-d.adobeconnect.com/r91g3to9726/.

Presentations from the Do No Harm Restoration workshop, Palm Desert, November 2015

Exotic Phytophthora Species in Native Plant Nurseries, Restoration Plantings, and Wildlands, video recording. Courtesy of the Central California Native Plant Nursery Network, December 2, 2014

- Plant pathogen movement: around the world on planting stock – Susan Frankel, USDA-Forest Service, Pacific Southwest Research Station (http://youtu.be/KZAlexLWNGY)
- *Phytophthora* species: life cycle, distribution, dispersal, impacts in California – Ted Swiecki, Phytosphere Research (http://youtu.be/lMw4NpDgCTs)
- *P. tentaculata*: History, Host Range, and Status in California Nurseries – Suzanne Rooney Latham, CDFA (http://youtu.be/HK4-NMsDbm8)
- Best Management Practices to minimize the risk of *Phytophthora* and other pests and pathogen introductions into nurseries – Kathy Kosta, CDFA (http://youtu.be/oKEQqDBU3vw)
- Systems approach to Phytophthoras in nurseries – Karen Suslow, NORS-DUC (http://youtu.be/CuPYc9lcCcc)
- *Phytophthora* Effects on Native Habitat Restoration – Greg Lyman, SF Public Utilities Commission (http://youtu.be/ypRe4nX6fSo)
- Case Study: Incorporating CDFA BMPs at a restoration nursery – Diana Benner, The Watershed Nursery (http://youtu.be/7AEnZp2-_14)

Resources from the "Managing *Phytophthora*s in Native Plant Nurseries: A hands-on workshop on prevention and early detection," June 16, 2015

- Workshop agenda and speaker information
- The horticulture behind *Phytophthora* management
- Hands-on Irrigation Training
- Determining container physical properties worksheet
- Recognizing disease symptoms and sampling plants for the lab
- Examination & sampling for rotten roots and stems – root diagram
- CDFA Protocol for Baiting the Root Ball in a Pot for *Phytophthora* spp.
- CDFA Flow Through Protocol for Baiting of potted plants to detect presence of *Phytophthora* spp.
- Video overview of hand-on stations

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Guidelines for Restoration Activities

These draft guidelines were developed to prevent and manage Phytophthoras during various aspects of restoration. This guidance is targeted for use in rare plant and other high-value habitats.

- "Restoration guidance" covers General Construction; Guidelines for Planting at Field Sites; Procedures for sanitizing tools, surfaces, and footwear; and Clean water specifications.
- "Contaminated site guidance" is for restoration sites that has been confirmed to contain an *Phytophthora* infestation.
- "Holding nursery guidance" presents a set of practices to avoid contamination of nursery stock being held for planting at restoration sites.

7.3 ACTERRA NURSERY SPREADSHEET AND NOTES FROM DEANNA GIULIANO

9/10/2014 **Plant Species Observed** **Mt Umunhum Near Summit / Summit**

List compiled By Deanna Giuliano
Nursery Manager/Botanical Consultant
Acterra Native Plant Nursery

Trees	**Species**	**Common**	**Part Used**	**Uses**
	Aesculus californica	California Buckeye	Wood,Bark, Fruit	Tools, Medicine, Fish poison, Food when leached
	Cercocarpus betuloides	Mountain Mahogany	Wood	Tools
	Pinus sabiniana	Foothill Pine	Pitch, Nuts, Needles	Medicine, Food, Basketry
	Prunus ilicifolius	Hollyleaf Cherry	Bark, Fruit	Medicine, Food
	Quercus chysolepias	Canyon Live Oak	Bark, Galls, Acorn	Medicine, Food
	Quercus durata	Leather Oak	Bark, Galls, Acorn	Medicine, Food
	Sambucus nigra var caerulea	Blue Elderberry	Wood,Bark, Fruit	Instruments, Medicine, Food
	Umbellularia californica	California Bay	Leaves, Fruit	Medicine, Food
Shrubs				
	Adenostomma fasciculatum	Chamise	Wood,Leaves	Tools, Medicine
	Arctostaphylos crustacea	Brille leaf Manzanita	Whole Plant	Medicine, Food
	Arctostaphylos glauca	Big Berry manzanita	Whole Plant	Medicine, Food
	Artemisia californica	Sagebrush	Whole Plant	Ritual, Medicine, Tools
	Bachcharis pilularis	Coyote Brush	Leaves	External Medicine
	Ceanothus papilosus	Wavy Leaf Ceanothus	Root, Bark,Branches, Seed	Medicine, Basketry, Food
	Dendromecon rigida	Bush Poppy	Leaves	Smoking
	Ericameria arborescens	Golden Fleece	Whole Plant	Medicine
	Ericameria nauseosa var. speciosa	Showy Rabitbrush	Whole Plant	Medicine
	Garrya elliptica	Coast Silktassl	Leaves, Bark	Medicine
	Keckiella corymbosa	Red Rock Penstemon		
	Lepichina calycinia	Pitcher Sage	Whole Plant	Medicine
	Salvia melifera	Black sage	Leaves, Seeds	Medicine
	Eriodictyon californicum	Yerba santa	Leaves, Branches	Medicine
	Pickeringia montana	Chaparral Pea		
	Rhamnus crocea	Redberry		

Perennials				
	Achiellea millefoilium	Yarrow	Whole Plant	Medicine
	Acmispon glaber var. glaber	Deerweed	Leaves	Medicine
	Epilobium canum	California Fuchsia	Whole Plant	External Medicine
	Erigeron petrophilus	Rock Daisy		
	Eriogonum nudum	Naked stem Buckwheat	Whole Plant, Seeds	Medicine, Food
	Eriogonum saxatile	Rock Buckwheat	Seeds	Food
	Eriophyllum confertiflorum	Golden Yarrow		
	Escscholzia californica	Poppy	Whole Plant	Medicine
	Corethrogyne filaginifolia	California Aster		
	Lupinus albifrons var. albifrons	Silver Bush Lupine	Whole Plant	Medicine
	Penstemon heterophyllus	Foothill Penstemon	Leaves, Roots	Medicine
	Monardella villosa	Coyote Mint	Whole Plant	Medicine
	Phacelia imbricata	Rock Phacelia	Leaves, Roots	Medicine
	Pseudonaphalium californica	Everlasting	Whole Plant	Medicine
	Rubus ursinus	Western Blackberry	Whole Plant	Medicine, Food
	Toxicodendron diversilobum	Poison Oak	Leaves, Roots	External Medicine
Grasses				
	Elymus glaucus	Blue Wild Rye		
	Festuca idahoensis	Idaho Fescue		
	Koeleria macrantha	June Grass		
	Melica californica	California Melic		
Bulbs				
	Allium falcifolium	Sickle Leaved Onion	Root	Food
	Chlorogalum pomeridanum	Soap Plant	Root	Fish Poison, Food, Soap
	Dichelostemma capitatum	Blue Dicks	Root	Food
Annual				
	Acmispon brachycarpus	Hillside Lotus		
	Cirsium occidentale var. venustum	Venus Thistle	Stems, Seeds	Medicine, Food
	Clarkia brewerii	Brewers Clarkia	Seeds	Food
	Clarkia purpurea var. quadrivulnera	Winecup Clarkia	Seeds	Food
	Chorizanthe membranacea	Pink Spineflower	Whole Plant	Medicine
	Cryptantha flaccida	Crypthantha		

	Eriogonum luteolum	Goldencarpet Buckwheat	Seeds	Food
	Gilia achilleifolia ssp. multicaulis	Few Flowered Gilia		
	Madia gracilis	Slender Tarweed	Seeds	Food
	Mentzelia lindleyi	Lindleys Blazzing Star		
	Plagiobotrys spp.	Popcorn Flower		
	Phacelia rattanii	Phacelia		
	Salvia columbariae	Chia	Leaves, Seeds	Medicine, Food
	Trifollium microdon	Thimble Clover	Leaves, Seeds	Food
	Trifolium willdenovii	Tomcat Clover	Leaves, Seeds	Food
	Uropappus lindleyii	Silverpuffs		

7.4 Seed Collection Protocol and Recommendations (From Golden Hour Restoration Institute)

Steps to a Maximizing Seed Collection Effort

- **Identify locations** – Acquiring permission, permits, do no harm by ensuring that collection will not negatively impact population of native plants
- **Identify target taxa** – What species will you collect, can you accurately identify them later in the season? Plants tend to look very different in fruit!
- **Planning ahead for proper phenology** – When is plant in flower, in seed, allow for a 2-3 week collection buffer
- **Preparing information on collection area** – Find collection location on map, take a GPS point for future reference. Note your collection location with respect to the larger distribution of the taxon. Is it on an edge, or in the middle of the range? Is this a unique ecotype?
- **How much to collect** – Always start with a small percentage of the population – say 2-5%. Never collect more than 10-20% of the seed of an established population (source). Seed collection should allow for collection from at least 30-50 individuals to ensure genetic diversity. No more than 5% of rare plant seeds should ever be collected in one year (for an annual).

Eschscholzia californica (California Poppy)

- **Identify mature seeds** – Make sure the seeds have hardened and matured if planned for storage. *Some signs of maturity*: Characteristics to observe include the size and color of the fruit, whether the embryo is firm and swollen and whether the seed coat collapses when cut, is the seed is easily collected, is the fruit/capsule/etc. dry and mature, are the berries/drupes wrinkled.
- **Inspect seed quality** - Look for infestations of insects, bugs, grubs in seeds and on plant. Avoid collections wherein pests are obvious. Earliest seeds for each individual tend have the highest fertility and energy stores. Later seeds are often less productive/fertile.
- **Collection vessels** – Envelops are an industry standard, although brown paper bags can work – use paper. Separate seeds by taxon as possible.
- **Storage** – Store seeds in a cool dry place – like a low humidity fridge. Check for stratification needs of seeds – freezing, desiccation, etc. Make sure your seeds are mature and dry before any long-term storage, otherwise you will have some unpleasant guests.
- **Distribution** – Please limit seed distribution to the watershed wherein the seed was collected. For gardening, this is less sensitive unless your property is on a wildland boundary. Help preserve unique ecotypes!
- **Germination** – High germination rates (>80%) are achievable for most well collected and stored seeds. Variation from species to species is normal

7.5 Organic Amendment and Soil Installation Specifications

(Reference: Mount Umunhum Summit Project 90% Set / 11 April 2016. SECTION 02300 – EARTHWORK and DRAINAGE)

Subsection 2.1 K.

K. Soil Amendment for amending Restoration Areas shall be produced from a City of San Jose certified waste diversion facility or equal approved by O.R. The fine or coarse compost materials shall be derived from composted green / yard waste debris only and shall otherwise conform to Caltrans 2015 Standard Specification section 21-2.02K. Wood chip materials shall be derived from clean recycled construction wood debris only and shall otherwise conform to Caltrans 2015 Standard Specification 20-5.03E(2)(c)#3. All materials shall be free of phyophthora and canker pathogens. Caltrans 2015 Standard Specification source: http://www.dot.ca.gov/hq/esc/oe/construction_contract_standards/std_specs/2015_StdSpecs/2015_StdSpecs.pdf.

The soil amendment material may be composed of 100 % Coarse Compost as specified in Caltrans 2015 Standard Specification section 21-2.02K.

Alternatively the soil amendment material may be composed of a mixture of one quarter (volume basis) of Fine Compost as specified Caltrans 2015 Standard Specification section 21-2.02K mixed uniformly with three quarters Wood Chips as specified in Caltrans 2015 Standard Specification 20-5.03E(2)(c)#3.

Subsection 3.5 A – E.

3.5 RESTORATION AREA EXISTING SOIL AMENDMENT

A. Flag (visually delineate) soil amendment restoration area (SARA) onsite (See Attached Figure for SARA)
B. Install Soil Amendment to all restoration areas at the rate of either: 1) a 3 inch surface-applied layer of Wood Chips plus an additional 3/4 inch layer of Fine Compost or 2) a single 3 inch surface layer of Coarse Compost (a.k.a. compost overs).
C. Mix Soil Amendment into the existing soil with excavators or backhoes to incorporate the specified Soil Amendment into the top 18 inches of existing soil by digging at intervals of one- to two-feet with a 12 inch bucket or such that, after incorporation, a quarter of the surface is remains covered with organic materials.
D. Fine grade the surface of the SARA under the direction of O.R. to original grade to shed surface water and to not erode onto adjacent pavements, drainage inlets, or structures. Site should have smooth, non-furrowed, and de-compacted appearance at completion.
E. Leave non-SARA sites untracked and uncompacted.

7.6 Soil Fertility Analyses for Mt Umunhum summit substrates

Mt Umunhum summit substrate samples																	
Set 1		OM	ENR	P1	HCO3_P	pH	pH	CEC	K	Ca	Mg	Na	K	Ca	Mg	Na	Ca:Mg
SAMPLE		%	lb/ac	ppm	ppm	water	buffer	cmol/kg	ppm	ppm	ppm	ppm	%	%	%	%	ratio
MUB		2.1	71	14.9	11.3	5.7	6.6	15.6	89.9	1632	471.5	24.8	1.5	52.1	24.8	0.7	2.1
MUV		3.7	104.8	23.4	12.6	5.8	6.7	11.0	119.1	1146	344.3	11.2	2.8	52.0	25.8	0.4	2.0
MUE	east	3.6	102.8	47.4	26.5	5.6	6.7	9.9	52.9	1041	267.8	16.4	1.4	52.3	22.2	0.7	2.4
MUS	saddle	1.4	58.8	9.5	9.2	6	6.7	16.4	57.7	1858	534.5	20.0	0.9	56.7	26.9	0.5	2.1
MUC	center	2.3	76	6.8	6.2	6.3	6.8	16.5	46.4	1807	670.9	28.8	0.7	54.6	33.4	0.8	1.6
MUW	west	2.2	74.8	7.5	6.5	6.2	6.7	16.9	39.7	1722	739.2	28.8	0.6	50.8	35.9	0.7	1.4
Set 2	location	OM	ENR	P1	HCO3_P	pH	pH	CEC	K	Ca	Mg	Na	K	Ca	Mg	Na	Ca:Mg
trailhead		%	lb/ac	ppm	ppm	water	buffer	cmol/kg	ppm	ppm	ppm	ppm	%	%	%	%	ratio
M9B	trail area 60-110cm,no fuel	3.0	90.6	7.5	3.8	6.7	--	16.7	36.4	1983.0	683.0	68.2	0.6	59.4	33.7	1.8	1.8
M9SUB	gray subsoil, fuel smell	2.3	76.6	12.1	1.2	8.2	--	16.2	14.7	1755.0	674.5	423.0	0.2	54.1	34.3	11.4	1.6
lower west parking																	
MP2	lower parking S end	2.0	70.6	17.3	7.5	7.2	--	11.9	47.0	1743.0	363.4	32.6	1.0	72.8	25.0	1.2	2.9
M14T	lower park N end, dist topsoil	2.9	87.6	12.5	6.1	6.8	--	11.6	56.1	1804.0	250.2	13.2	1.2	77.5	17.7	0.5	4.4
west summit area																	
M6A	C west sum, flat	1.9	68.4	11.3	7.9	6.8	--	13.6	58.1	2032.0	349.9	16.7	1.1	74.3	21.1	0.5	3.5
6BT	C west sum, side, buried topsoil	2.1	72.0	10.2	5.1	5.7	6.6	15.7	31.2	1792.0	396.4	18.9	0.5	57.1	20.8	0.5	2.7
M11	E west sum, flat, yellow gravel	2.9	87.0	14.8	8.7	6.2	6.8	13.6	43.6	1718.0	398.2	11.6	0.8	62.8	24.0	0.4	2.6
M13T	NW west sum, buried topsoil	8.8	206.6	22.2	15.0	5.4	6.5	15.9	45.8	1783.0	277.7	14.3	0.7	56.0	14.4	0.4	3.9
M7	SW west sum, typical push matl	2.6	82.2	10.7	5.8	6.3	6.8	15.3	53.7	1949.0	449.6	21.6	0.9	63.8	24.2	0.6	2.6
M12BT	W west sum, buried topsoil	3.1	91.8	34.8	17.8	5.8	6.7	10.5	29.0	1306.0	205.7	45.6	0.7	62.2	16.2	1.9	3.8
M12A	W west sum, yellow fill	2.7	83.4	12.1	4.9	5.7	6.7	12.1	39.2	1339.0	333.3	17.4	0.8	55.0	22.6	0.6	2.4
Set 3	SAMPLE DESCRIPTION	OM	ENR	P1	HCO3_P	pH	buf	CEC	K	Ca	Mg	Na	K	Ca	Mg	Na	Ca:Mg
	Mt Um rough grades	%	lb/ac	ppm	ppm		pH	cmol/kg	ppm	ppm	ppm	ppm	%	%	%	%	ratio
	'fine' substrate	2.1	72.0	29.0	13.0	6.7	--	11.5	44.4	1448.0	423.3	31.1	1.0	63.0	30.3	1.2	2.1
	'typical' substrate	4.0	109.6	14.0	10.9	6.9	--	14.2	69.3	2005.0	457.9	20.3	1.2	70.2	26.4	0.6	2.7
	organics-rich layer	6.6	162.8	15.0	10.7	5.9	6.7	12.0	64.1	1354.0	357.5	13.6	1.4	56.5	24.6	0.5	2.3
		OM	ENR	P1	HCO3_P	pH	buf	CEC	K	Ca	Mg	Na	K	Ca	Mg	Na	Ca:Mg
		%	lb/ac	ppm	ppm		pH	cmol/kg	ppm	ppm	ppm	ppm	%	%	%	%	ratio
AVERAGES		3.1	92.5	16.7	9.5	6.3	6.7	13.9	51.9	1660.9	432.4	43.9	1.0	63.2	25.2	0.8	2.5
Set 1		NO3	S	Zn	Mn	Fe	Cu	B	EC (salts)		SAND	SILT	CLAY	Textural			
SAMPLE		ppm	ppm	ppm	ppm	ppm	ppm	ppm	mmhos/cm		%	%	%	class			
MUB		1.7	3.7	0.9	2.7	14.4	0.9	0.3	0.2		81.6	8.0	10.4	LOAMY SAND			
MUV		4.4	3.2	4.9	5.2	20.6	1.1	0.3	0.2		77.6	12.0	10.4	SANDY LOAM			
MUE		1.8	2.7	17.7	3.2	29.4	1.2	0.3	0.1		67.6	20.0	12.4	SANDY LOAM			
MUS		1.2	2.2	2.5	2.5	17.8	0.8	0.3	0.1		75.6	12.0	12.4	SANDY LOAM			
MUC		0.8	3.4	2.1	4.3	12.7	0.8	0.3	0.1		63.6	14.0	22.4	SANDY CLAY LOAM			
MUW		1.7	3.0	1.5	4.5	13.0	0.9	0.3	0.1		63.6	20.0	16.4	SANDY LOAM			
Set 2	location	NO3	S	Zn	Mn	Fe	Cu	B	C (salts)		SAND	SILT	CLAY	Textural			
trailhead		ppm	ppm	ppm	ppm	ppm	ppm	ppm	mmhos/cm		%	%	%	class			
M9B	trail area 60-110cm,no fuel	2.9	6.4	0.4	2.3	26.2	2.5	0.7	0.1		62.8	18.0	19.2	SANDY LOAM			
M9SUB	gray subsoil, fuel smell	3.5	9.4	0.4	60.9	16.4	3.2	0.2	0.2		68.8	12.0	19.2	SANDY LOAM			
lower west parking																	
MP2	lower parking S end	3.6	12.7	2.0	1.5	14.9	1.0	0.2	0.3		66.8	14.0	19.2	SANDY LOAM			
M14T	lower park N end, dist topsoil	7.7	1.8	6.0	2.4	14.1	3.6	0.2	0.1		70.8	14.0	15.2	SANDY LOAM			
west summit area																	
M6A	C west sum, flat	21.1	3.1	56.9	1.1	13.7	0.6	0.2	0.1		70.8	12.0	17.2	SANDY LOAM			
M6BT	C west sum, side, buried topsoil	3.1	1.3	5.1	1.1	19.4	0.4	0.1	0.1		76.8	10.0	13.2	SANDY LOAM			
M11	E west sum, flat, yellow gravel	5.1	1.4	0.6	2.1	18.1	0.9	0.2	0.1		72.8	12.0	15.2	SANDY LOAM			
M13T	NW west sum, buried topsoil	4.0	2.6	1.2	4.6	61.3	0.6	0.1	0.1		76.8	12.0	11.2	SANDY LOAM			
M7	SW west sum, typical push matl	4.1	1.3	0.6	1.6	23.3	0.7	0.1	0.1		76.8	8.0	15.2	SANDY LOAM			
M12BT	W west sum, buried topsoil	13.6	6.2	0.9	1.4	17.2	0.9	0.1	0.2		70.8	16.0	13.2	SANDY LOAM			
M12A	W west sum, yellow fill	4.3	1.8	0.2	1.3	22.9	0.8	0.1	0.1		70.8	14.0	15.2	SANDY LOAM			
Set 3		NO3	S	Zn	Mn	Fe	Cu	B	EC		sand	silt	clay	texture			
Mt Um rough grades		ppm	ppm	ppm	ppm	ppm	ppm	ppm	dS/m		%	%	%				
'better' substrate		10.8	4.4	1.9	3.1	16.5	1.4	0.1	0.2		52.8	20.0	27.2	SANDY CLAY LOAM			
'typical' substrate		8.4	3.4	0.2	1.3	26.8	0.8	0.1	0.2		52.8	16.0	31.2	SANDY CLAY LOAM			
organics-rich layer		24.8	8.5	19.3	4.9	34.8	1.6	0.2	0.5		38.8	30.0	31.2	CLAY LOAM			
		NO3	S	Zn	Mn	Fe	Cu	B	EC		sand	silt	clay	Textural			
		ppm	ppm	ppm	ppm	ppm	ppm	ppm	dS/m		%	%	%	class			
AVERAGES		6.4	4.1	6.3	5.6	21.7	1.2	0.2	0.1		71.6	14.3	14.1				

Overall nutrient status of Mt Um soils using averages for 20 samples gathered throughout the planning and construction process.

In general, these substrates are not limiting to growth of wildlands plants, but they are expected to be droughty in late summer.

Organic Matter (OM%)
Organic matter levels are moderately low but not atypical for wildlands soils. The surfaces will need mulch or accumulated organics to avoid surface crusting, as was observed. The low organic levels are expected to provide limited long term nitrogen or sulfur for extended plant growth. A few samples came from darker, well rooted horizons indicating concentrations of former topsoil materials.

Phosphorus (P1 or P_{HCO3})
Phosphorus levels vary widely at different amoung different substrates. Other than at start-up, these are not growth limiting levels for wildlands plants. A modest amount of slow-release nutrient should be provided in the planting hole. The higher levels of the east samples for the PHCO3 extract relates to the higher organic content.

pH
These soil acidity levels are not limiting to plants. The Buffer pH indicates that pH levels can be easily elevated with other potential amendments such as composts.

Cation Exchange Capacity (CEC)
Cation Exchange Capacity is the amount of ionic charge on the mineral surface that attracts and holds cations. Nearly all samples have adequate exchange capacity.

Potassium (K)
Potassium levels should approach 100 ppm and should exceed 1.5 % of the CEC. Various samples are low in this nutrient. Organic amendments (composts, woodchips) as specified can supply this nutrient.

Calcium (Ca)
Calcium levels are high in total availability (ppm) and as proportion of all available cation nutrients (Ca %exch). No amendment is needed.

Magnesium (Mg)
Magnesium levels are adequate for plant growth. Magnesium levels are not at high enough amounts relative to Ca to indicate a serpentinitic character. Serpentine growth conditions are indicated by Ca:Mg ratios of less than about 1.0. All of these samples are easily above this ratio and are interpreted as having no exclusionary serpentine edaphic quality.

Sodium (Na)
Sodium is low enough to have no negative effect on plant growth.

Nitrate (NO3)
Nitrate extraction levels are variable but not limiting to plant growth. A main source for nitrate in this location will be atmospheric N deposition. Organic amendments are designed to limit the effect of excess nitrate inputs from local airsheds.

Sulfur (S)
Sulfur is present in modest levels, but this indicator is a poor indicator for wildlands systems. This is not a growth limiting condition.

Zinc (Zn)

Zinc levels should be above 1 ppm so these levels are not limiting.

Manganese (Mn)
Manganese levels are not growth limiting for wildlands plants.

Iron (Fe)
Iron levels should be above 10 ppm. All samples have adequate iron levels for wildlands plants.

Copper (Cu)
Target levels for copper levels are around 1 ppm and nearly all samples are close to this level. Organic amendments will additionally supplement this micronutrient.

Boron (B)
Boron target levels are 1 ppm, so these samples are uniformly low in B. Organic amendment materials can safely add the small amounts of B needed.

Salts (EC)
Salts are uniformly low and are not limiting to plant growth.

Soil particle size distribution (texture).
Substrates generally have sandy loam textures. Samples from the non-vegetated bench had loamy sand textures while samples from the central part of the west summit had sandy clay loam textures. Clays ranged from 10 to 31 % clay with an average of 14.1%. These clay levels are adequate for moisture holding capacity within the fine soil fraction itself (< 2 mm). But a much larger issue is that the whole soil volume is excessively rocky. Even though these fine soil fractions are amenable for plant growth, large rooting volumes are needed to provide adequate levels of nutrients and moisture given the high rock content of the whole soil volume in its entirety. For these reasons, soil regeneration recommendations focus on maintaining infiltration, percolation to the subsurface horizons and adequate rooting volumes.

7.7 IMAGES OF MAPPED SOILS AND POTENTIAL EXAMPLE OF SOIL PARENT MATERIAL EFFECT ON NORTH-SLOPE VS SOUTH-SLOPE VEGETATIVE COVER

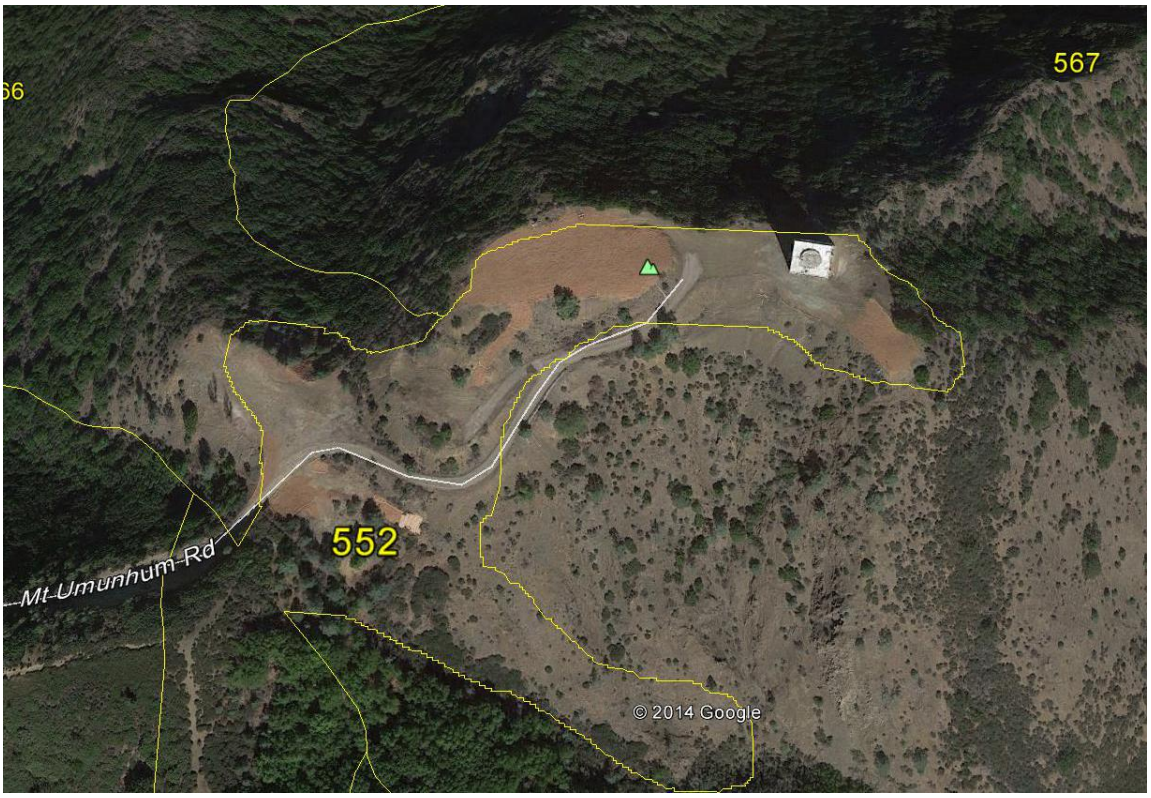


Figure 7.7.1. Each of the groups of intermixed soils surrounding Mt Umunhum are given a mapping unit number.

Map Unit 552 contains Elsman (35%)-Maymen (25%)-Sanikara (20%), 30 to 50 percent slopes.
It is mapped on the summit area and has the following soil series in a repeating pattern:
35 % of the area is Elsman; 25% Maymen; 20 % Sanikara; 10 % Mouser; 5 % Elsman; 3 % Santerhill.

Map Unit 567 contains Sanikara (45%)-Mouser (30%)-Rock outcrop complex, 50 to 75 percent slopes
This mapping unit is located on the N, S, and E slopes of the summit.

Map Unit 566 contains Mouser (40%)-Katykat (30%)-Sanikara (25%) complex, 50 to 75 percent slopes.
This mapping unit occurs on the NW slopes.

The fact that the soils are mapped as intermixed 'complexes' indicates that the group of soils occurs in a repeating pattern that is too small in scale to be delineated on a soils map. The soil series covering the majority of these areas were evaluated and the critical components for revegetation were listed in Table 1. These are compared in the narrative to describe the average growing condition surrounding the Mt Umunhum summit. From these reference site examples, the soil functions that are needed on the summit project itself can be estimated.

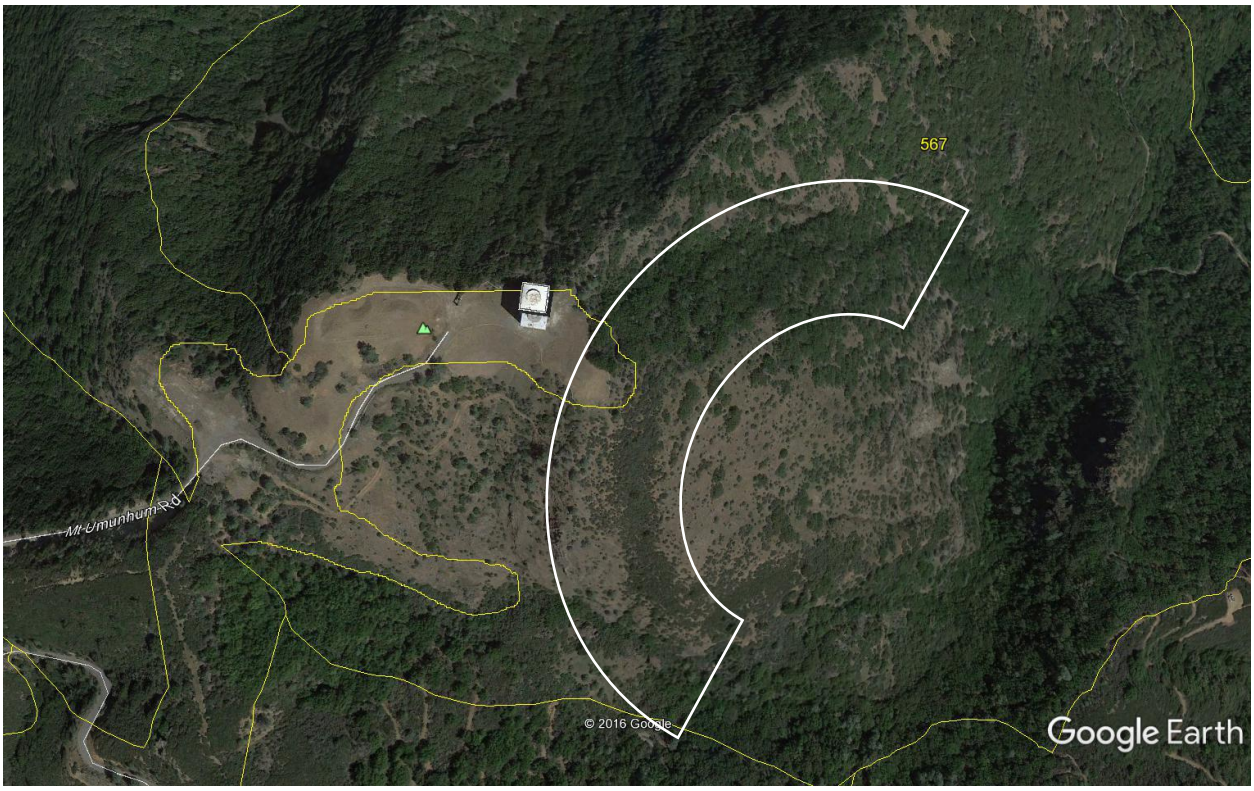
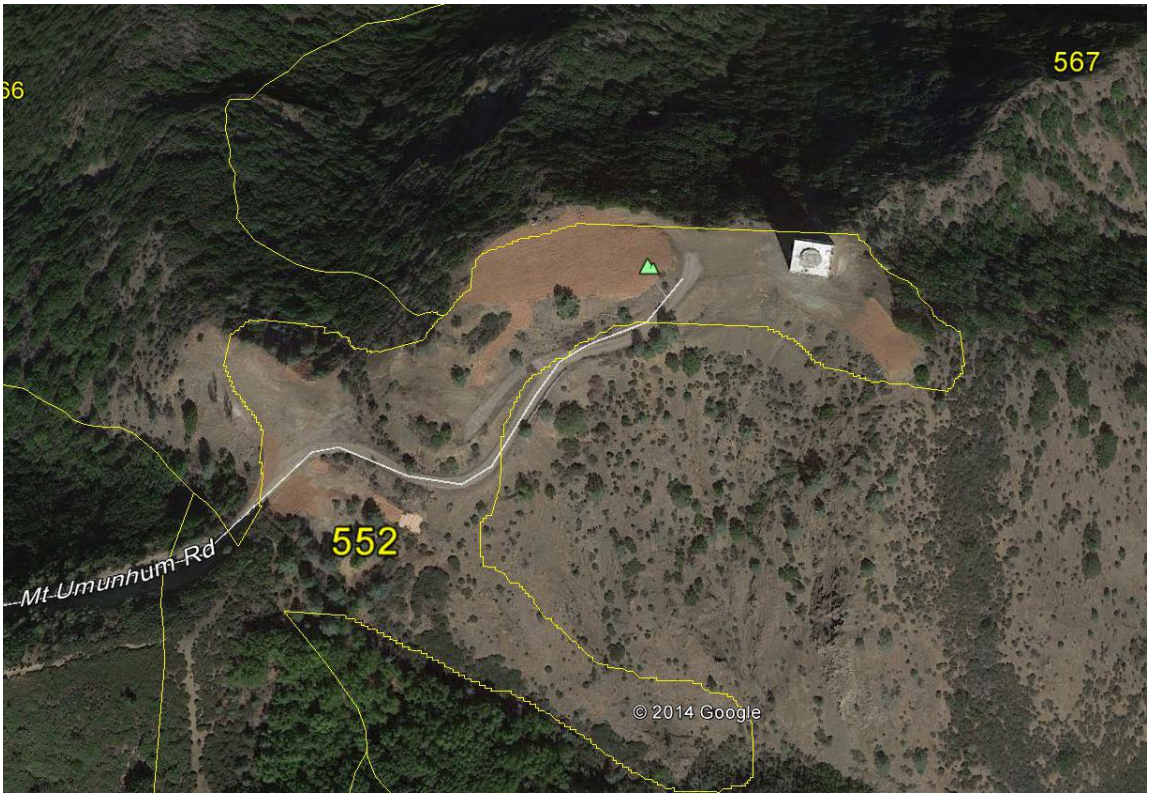


Figure 7.7.2. A potential example of the effect of aspect on vegetation growth. The curved band could be explained by an upturned layer of more easily weathered rock is tilted downward to the east and is exposed on the south and north sides of this ridge. These geological strata are visible elsewhere in the local area. The south slope half can be expected to be hotter and drier and less soil formation through centuries of time. The north-facing slope could be expected to be cooler and retain more moisture after rains. It would therefore develop more vegetation inputs and a deeper soil. Sampling of this band should show weaker sedimentary rocks such as shales and weakly cemented sandstones. This has not been confirmed in the field.



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