Arana Gulch

FEBRUARY 2006

DRAFT MASTER PLAN

Arana Gulch

prepared by the

City of Santa Cruz

Parks and Recreation Deparment

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ACKNOWLEDGEMENTS

The *Arana Gulch Master Plan* was prepared by the Parks and Recreation Department of the City of Santa Cruz. The primary author is Susan Harris, Associate Planner. Ray Bramson served as editor and contributing author. Bruce Pavlik and Erin K. Espeland, BMP Ecosciences, authored the Santa Cruz Tarplant Adaptive Management Program, Appendix A. Dannettee Shoemaker, Parks and Recreation Director, and Steve Hammack, Superintendent of Parks oversaw preparation of the Arana Gulch Master Plan. RRM Design Group, with guidance from Chris Schneiter and Tom Sharp of the City Public Works Department, prepared the design for the multi-use trails including the Hagemann Gulch bridge. Ken Thomas of the City Planning Department provided guidance regarding associated General Plan/Local Coastal Program amendments.

Concept: Sharon Erspamer
Graphic design, maps & layout: Jane Bolling Design
Photography: Don Nielsen

TABLE OF CONTENTS

section		page
1	INTRODUCTION	1
1.1	Introduction to Arana Gulch	1
1.2	Master Plan Purpose and Planning Process	2
1.3	Overview of the Arana Gulch Master Plan	3
2	EXISTING CONDITIONS	7
2.1	Existing Setting and Uses	7
2.2	Geology and Hydrology	8
2.3	Biotic Resources	15
2.4	Historic Resources	27
3	THE PLAN	29
3.1	Arana Gulch Vision and Goals	29
3.2	Management Areas	30
3.2.1	Coastal Prairie/Tarplant	31
3.2.2	Arana Gulch Creek Riparian and Wetland	35
3.2.3	Hagemann Gulch Riparian Woodland	37
3.3	Interpretive Themes and Programs	38
3.4	Trail System	38
3.4.1	Existing Trails	39
3.4.2	Trail Alignments and Improvements	40
3.4.3	Trail Design and Management Guidelines	44
3.5	Operations and Staffing	45
3.6	Phasing and Implementation	47
3.6.1	Preliminary Phasing Plan	47
3.6.2	Funding Sources	48
REFERENCES		49

FIGURES

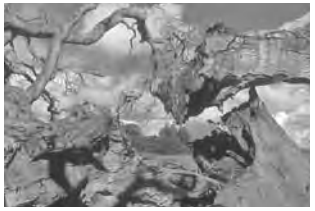
1	Site Location	3
2	Existing Setting	9
3	Habitat Areas	17
4	Management Areas	33
5	Proposed Trail System	41

TABLES

3	Management Area Matrix	32
	Preliminary Phasing Plan	47

APPENDICES

A	Santa Cruz Tarplant Adaptive Management Program	51



1

INTRODUCTION

1.1 INTRODUCTION TO ARANA GULCH

Arana Gulch is a scenic natural area situated along the eastern boundary of Santa Cruz. This 67.7-acre City-owned property features unique natural resources such as coastal prairie, Santa Cruz tarplant, and riparian and wetland habitat areas of Arana Gulch Creek. Bounded by neighborhoods and the Santa Cruz Harbor, this refuge of open space—with rich biological diversity, sweeping vistas, and tranquility—is of great value to the people of Santa Cruz.

Overlooking the Upper Harbor, a coastal terrace comprises the central portion of Arana Gulch. Here, grassland covers the expanse of open meadow, with majestic oak trees dotting the edges of the bluff. To the east, the grassland gives way to riparian forest and scrub, sloping down toward the broad floodplain of Arana Gulch Creek. Hagemann Gulch, a steep wooded canyon, forms the southwestern boundary of the property.

The City of Santa Cruz acquired Arana Gulch in 1994 as one of the Greenbelt lands, and shortly thereafter opened the property to the public. While popular with hikers strolling along the meadow, bicyclists riding to the Upper Harbor, and visitors of all ages enjoying the scenery and wildlife, recreational use on the property is limited to earthen trails, most of which existed prior to the City's ownership. Only two visitor entrances currently exist—the north entrance off of Agnes Street and the south entrance at the Upper Harbor—and there are no visitor facilities, except trails and associated signage.

1.2 MASTER PLAN PURPOSE AND PLANNING PROCESS

The intent of this Master Plan is to establish a vision and goals that will shape the future of Arana Gulch as a unique open space within the City of Santa Cruz. The guiding vision and goals, presented in Section 3.1, reflect guidance from the Santa Cruz City Council, community input, and policies of the City's General Plan. In addition, this Master Plan identifies recreational uses and resource management guidelines to direct future management and enhancement of this natural area.

The *Arana Gulch Master Plan* has evolved from planning efforts spanning over two decades. Throughout this process, considerable public interest and discussion—coupled with scientific surveys and evaluations—have contributed to this Master Plan. Highlights of the planning background, as well as an overview of the document's development and the required review and approval process, are also presented.

Planning Background

The preservation of open space in Santa Cruz, including Arana Gulch, has its roots in the late 1970s. In 1979, community interest led to the voters' approval of Measure O, which identified specific Greenbelt lands worthy of preservation for their special scenic, aesthetic, environmental, and economic benefits to the citizens of the City. One of the designated Greenbelt lands was the 63-acre Arana Gulch property, then privately owned.

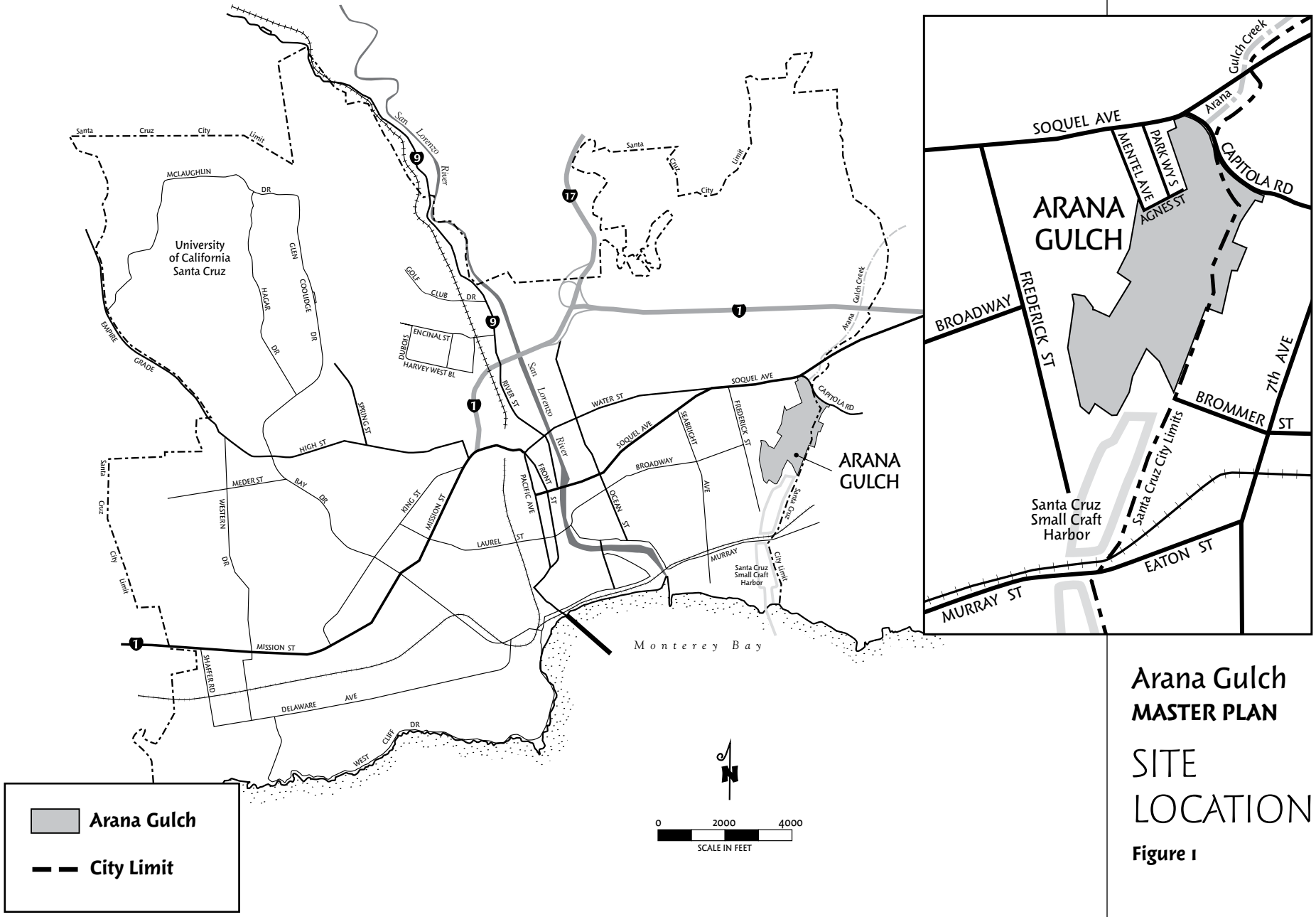
During the early 1990s, the City's General Plan process was also underway. Adopted in 1992, the City's 1990-2005 General Plan included policies relating to the Arana Gulch property; in addition to protecting open space, the plan envisioned potential development of a school, playing field, and an area for residential use. At that time, the School District had identified a need for a new elementary school within the area to meet enrollment projections. The General Plan required preparation of a Specific Plan for the Arana Gulch property that would incorporate these various land uses.

In 1992, with the Greenbelt Overlay District designation set to expire at the end of the year, Santa Cruz voters approved Measure I which extended the Greenbelt Overlay District through 1994 and required preparation and adoption of a Greenbelt Master Plan. A citizens' Greenbelt Committee was established in 1993 to guide preparation of the plan. The intent of the plan was to evaluate the conditions of the Greenbelt lands, recommend public uses, estimate acquisition and improvement costs, and identify funding mechanisms. Upon completion in 1994, the City Council accepted *The Greenbelt Master Plan—A Planning and Feasibility Study*. Recommended public uses for Arana Gulch included: protection of views, habitats, and watershed areas, nature preserve areas, trails (nature, hiking and bicycle), a playground, a sports field, picnic sites, a restroom, and small parking area. The final document was considered a feasibility study rather than an adopted Master Plan, and therefore did not require environmental review under the California Environmental Quality Act (CEQA).

Also in 1994, the City purchased the 63-acre Arana Gulch property for $3.4 million. Years prior to this purchase, the City had acquired a narrow strip of land in the central portion of the property, approximately 4.7 acres. This strip of land was originally intended for a roadway extension between Broadway Avenue and Brommer Street. Thus, the City owned property totaled approximately 67.7 acres, though only 63 acres had been designated as Greenbelt Overlay District lands.

Shortly after the acquisition of Arana Gulch, the City opened the property to limited public use, with the City Parks and Recreation Department maintaining and managing the area. In 1997, the City Council approved the *Arana Gulch Interim Management Plan*, outlining the actions necessary to manage and maintain the existing natural resources within Arana Gulch. The Interim Plan, however, did not include any land use decisions, which were intended to be addressed at a future date in a long-term Master Plan. As such, this document, the *Arana Gulch Master Plan*, supercedes the *Interim Management Plan*.

Over the past decade, the City Council has also reviewed potential development scenarios within a portion of Arana Gulch, including the possibility of residential use to recover some of the acquisition cost. In 1996, the *Arana Gulch Land Use and Revenue Study* and the *Arana Gulch Biotic Assessment* were prepared to evaluate various land use options and associated environmental effects. After a review of the studies and considerable public comment, the City Council voted in 1996 to only consider possible development in the northern area of Arana Gulch along the alleyway. In 2000, however, the City



Arana Gulch
MASTER PLAN

SITE LOCATION

Figure 1

Council provided new direction that there would be no residential development within Arana Gulch. During preparation of this Master Plan, the City Council reconsidered the possibility of potential future development options, as discussed in the following section.

A proposal for a multi-use pathway connecting Broadway Avenue and Brommer Street through Arana Gulch has also evolved over the past decade. The *City's General Plan* (1992) and the *Greenbelt Master Plan* (1994) identified the concept of an east-west bicycle/pedestrian connection between the City and County of Santa Cruz. In 1995, an initial Scope of Work for this bicycle/pedestrian path connection was prepared. Since that time, the proposed pathway and alternative routes have undergone several rounds of environmental evaluation and review.

In May 2003, the City Council certified the environmental document—*Broadway-Brommer Bicycle/Pedestrian Path Connection Environmental Impact Report/Environmental Assessment*—but did not take action on the project itself. The City Council provided direction to prepare the long-term Master Plan for Arana Gulch, with the proposed east-west multi-use trail through Arana Gulch to be included in the Draft Master Plan.

This Master Plan has reduced the scope and scale of the proposed east-west multi-use trail originally evaluated in the certified *Final EIR/EA*. There is no longer a bridge proposed over Arana Gulch Creek and the multi-use trail has been decreased in width. Additionally, the plans for the proposed bridge spanning Hagemann Gulch have been redesigned to further minimize impacts.

Arana Gulch Master Plan

In late 2003, the City began the planning process for the *Arana Gulch Master Plan*. As an initial step, the Parks and Recreation Department sought direction from City Council regarding the specific uses for Arana Gulch. In October 2003, the Council directed that the following uses be included in the Draft Master Plan: resource enhancement and protection, a trail system that includes an east-west multi-use trail, interpretive displays and overlook areas.

These uses were based on the concepts identified in the 1994 Greenbelt Master Plan, though the scope of uses was substantially reduced to include passive, rather than more active, recreational uses. This Master Plan does not include a sports field, playground parking lot, and restroom. Further, from the City's understanding of the combined factors of declining enrollment and school closures, a school site is no longer included.

In addition to providing guidance on uses in October 2003, City Council also provided direction to exclude an area 300 feet from the northwest boundaries of the property (approximately 5.7 acres) from the Master Plan. This area was to remain "undesignated" until the Draft Master Plan was completed and brought to the Council for consideration. This "undesignated area" was later included back into the Master Plan boundaries, as discussed below under Environmental Review.

This Master Plan was prepared by the City Parks and Recreation Department. The *Santa Cruz Tarplant Adaptive Management Program*, included as Appendix A, was prepared by BMP Ecosciences. Planning and detailed design for the east-west multi-use trail was prepared by RRM Design Group, in coordination with the City Public Works Department.

Environmental Review

Early in the Master Plan process, the City determined that the proposed uses for Arana Gulch may have a significant effect on the environment. In accordance with the California Environmental Quality Act (CEQA), a decision was made to prepare an Environmental Impact Report (EIR). An environmental consulting team led by Amy Skewes-Cox was contracted by the City to prepare the EIR. The Draft Master Plan and EIR were prepared concurrently.

As stated in CEQA Section 21002.1: "The purpose of an EIR is to identify the significant effects of a project on the environment, to identify alternatives to the project, and to indicate the manner in which significant effects can be mitigated or avoided." The EIR also serves to involve members of the public in the decision-making process. The primary issues addressed in the Arana Gulch Master Plan EIR include: land use and planning, biological resources, geology and soils, hydrology and water quality, and visual quality and aesthetics.

As part of the EIR process, the City held a public scoping meeting in July 2005 to provide an opportunity for the community to comment on the potential environmental effects of the proposed uses for Arana Gulch. Some of the main issues of concern voiced by the public focused on the following topics: use of the 5.7 acre excluded area and potential impacts if housing were developed; biological impacts of the proposed paved pathways, especially related to the Santa Cruz tarplant; erosion and sedimentation impacts; increase in public use and lack of City personnel to patrol and maintain the property. The Draft EIR includes a more detailed list of public comments from the scoping meeting. In response to strong concerns raised by the public regarding the excluded area, the City Council subsequently determined the Master Plan boundaries would encompass all of the City-owned Arana Gulch property (67.7 acres).

The City will hold a public review period to solicit comments regarding the Draft EIR. Concurrently, the Draft EIR will be circulated to the appropriate agencies for comments. After closure of the review period, the consultant will prepare a Final EIR, including both responses to the received comments and any necessary changes. The City Council must certify the Final EIR before taking action on the *Arana Gulch Master Plan*.

Master Plan Review and Approval Process

The City is preparing this Master Plan in accordance with the City of Santa Cruz Zoning Ordinance which requires a Park Master Plan, or special use permit, to establish use and design parameters within a specific park. Although Arana Gulch is generally referred to as a Greenbelt property, the appropriate Zoning designation for a City-owned open space is Park, while the appropriate General Plan land use designation is Natural Area. This designation is consistent with Pogonip and the intent for the other Greenbelt lands

The existing General Plan land use designations within the Arana Gulch property include Natural Area, Very Low Residential and Community Facility. The existing Zoning Designations include Residential and Floodplain. As part of the Master Plan approval process, the City Council will also consider a General Plan Amendment and rezoning so the land use designation for the entire 67.7 property is Natural Area. The Residential designation would be rezoned to Park. The Floodplain designation would remain unchanged.

Other City Council actions related to the project include General Plan Amendments to revise policies in the 1992 *General Plan/Local Coastal Program*. For example, the current General Plan requires preparation of a specific plan for the Arana Gulch property; such a plan, however, is no longer necessary because this Park Master Plan addresses the entire property. The California Coastal Commission must also approve this project because the property is located within the Coastal Zone. Lastly, annexation of the parcels currently within the County along the eastern boundary of the property is also recommended.

The City Parks and Recreation Commission is the lead advisory body to the City Council for review of the *Arana Gulch Master Plan* and EIR. The Planning Commission has responsibility as the advisory body to the City Council for the General

Plan Amendments, rezoning, and annexation of County parcels. The Council is the City's final decision maker for approval of the *Arana Gulch Master Plan* and the related actions described above. Prior to adopting the Master Plan, the City Council must review and consider the information in the EIR. Prior to implementation of the Master Plan, the required approvals must be received from the California Coastal Commission.

1.3 OVERVIEW OF ARANA GULCH MASTER PLAN

This Master Plan is organized into three sections: 1) Introduction, 2) Existing Conditions, and 3) The Plan. The intent of this first section is to provide a brief introduction to Arana Gulch and the planning process. Section 2 provides a description of the geologic and hydrologic conditions, biotic resources, and history of the property. The final section presents the key components of the Master Plan itself. These elements include the vision, goals, and management areas. Three management areas are identified, based on existing natural resources within Arana Gulch. Specific guidelines are also outlined for each management area to provide a framework for future management and use. Section 3 also presents a detailed description of the trail system.

2

EXISTING CONDITIONS

The purpose of the Existing Conditions Section of the Master Plan is to describe the setting and conditions found within Arana Gulch. Presented below are highlights of Arana Gulch's natural resources, including: geology, hydrology, plant communities and sensitive biotic resources. Key geologic and hydrologic features such as Arana Gulch Creek, the coastal terrace, and Hagemann Gulch are described, as well as some of the most significant biotic resources, consisting of Santa Cruz tarplant populations, coastal prairie habitat, and the riparian and wetland habitats. In addition, this section provides an overview of the history of Arana Gulch.

2.1 EXISTING SETTING AND USES

Arana Gulch is an undeveloped 67.7-acre open space, surrounded by an urban landscape (Figure 2). Located approximately 1.5 miles from downtown Santa Cruz, Arana Gulch is situated along the eastern boundary of the City. Surrounding land uses include residential development and the Santa Cruz Bible Church to the west, residential and commercial uses to the north, residential properties in the Live Oak area of Santa Cruz County to the east, and the Santa Cruz Harbor to the south. The Harbor is owned and managed by the Santa Cruz Port District.

The southernmost reach of Arana Gulch Creek flows along the eastern portion of the property. Hagemann Gulch, a steep canyon with an intermittent drainage, forms the southwestern boundary. A description of both creeks is presented in the Geology and Hydrology, Section 2.2. Also described in greater detail in the Geology section is the uplifted coastal terrace that characterizes the central portion of Arana Gulch.

Arana Gulch features several types of plant communities, including grassland, riparian scrub and woodland, oak woodland, seasonal wetland, emergent wetland and open water. Grassland occurs on the coastal terrace and upper slopes of Arana Gulch Creek and Hagemann Gulch. Although largely dominated by non-native species, the grassland also features some characteristics of coastal prairie including the Santa Cruz tarplant. Riparian woodland and scrub is found along much of the broad floodplain adjacent to Arana Gulch Creek and narrow lower slopes of Hagemann Gulch. Tidal flow from Monterey Bay influences areas of emergent wetland within the central portion of the Arana Gulch Creek bottomland. These habitat

types and the wildlife species that depend on them are shown in Figure 3 and described in Biotic Resources, Section 2.3.

A history of grazing on the property has bolstered the survival of native grassland species. Used as ranchland since the 1800s, Arana Gulch became the site of the East Side Dairy in the 1920s. Many of the existing pathways within Arana Gulch existed prior to the City's ownership, and several were likely cattle paths. When the City acquired the property in 1994, there were no structures on the property, though remnants of foundations associated with the dairy operation remain near Agnes Street.

An existing unpaved trail connecting the northern entrance at Agnes Street and the Santa Cruz Harbor to the south was the only trail formally designated as a City maintained trail in the Interim Management Plan (1997). Bicycles and pedestrians are permitted on this trail. In recent years, the City Parks and Recreation Department has also maintained a popular pedestrian trail that encircles the grassland. These trails are depicted in Figure 3 and are described in more detail in Section 3.4.1.

In addition to the two trails maintained by the City Parks and Recreation Department, there are numerous unauthorized pathways crossing the property. Some of these undesignated pathways existed prior to City ownership, while unauthorized off-trail use has created other pathways. Many of these unauthorized pathways are located in the southern grassland and tarplant population areas, and, though the City has made efforts to close these pathways and restore the habitat, management actions have been somewhat limited under the *Arana Gulch Interim Management Plan*.

Existing public uses within Arana Gulch include hiking and bicycling. Dogs are required to be on-leash at all times; however, there are problems with non-compliance with the leash laws. Other violations that have occurred at Arana Gulch include illegal camping along the Arana Gulch Creek corridor, vandalism to park signs and trees, and after-hours use. A Park Ranger conducts daytime patrols of the property and enforces regulations regarding dogs off leash, camping, etc. Park Ranger staffing levels have varied from one Ranger citywide to several rangers, depending on City budget constraints. The Police Department responds to incidents that occur at night and other illegal activity that may occur within the property boundaries.

There are two designated entrances to Arana Gulch. The north entrance is located off of Agnes Street and the south entrance is located at the Upper Santa Cruz Harbor. A trail from the Upper Harbor parking lot extends along the western side of the Harbor dry storage area. Due to the steep topography and dense vegetation of Hagemann Gulch, there is no entrance along the west boundary to the Seabright neighborhood.

With no public parking on-site, visitors may either walk or bicycle to Arana Gulch from adjacent neighborhoods or park on public streets at the north entrance. Also, though there is no restroom within Arana Gulch, there is a restroom at Frederick Street Park and the adjacent Harbor has several facilities, some of which are open to public use.

2.2 GEOLOGY AND HYDROLOGY

This section presents an overview of the geology, soils and groundwater conditions, while also discussing the hydrologic conditions of Arana Gulch Creek and Hagemann Gulch. These hydrologic and geologic conditions influence the landscape and biotic resources within Arana Gulch.

Geology

Coastal terraces, rising up from Monterey Bay, are prominent land features within Santa Cruz. Earlier high sea levels created uplifted ocean floors that formed these broad flat terraces found here today. The Arana Gulch property is situated on the lowest and youngest emergent coastal terrace, with elevation levels ranging between 60 to 70 feet above sea level.

Approximately 3 to 14 feet of coastal terrace deposits (Qcl) underlay the Arana Gulch terrace. These deposits include

N

0 200 400

SCALE IN FEET

Bicycle/Pedestrian Trail
(Designated trail in Interim Management Plan, 1997)

Existing Informal Use Trail
(Maintained by the city)

Property Boundary

City Limit

Note: Trail width symbol not to scale

Arana Gulch
MASTER PLAN

EXISTING SETTING

Figure 2

well-sorted sands, with layers of both clayey and silty sand. Beneath the coastal terrace deposits is the Purisima Formation--sedimentary bedrock of marine origin consisting primarily of sandstone. The underlying bedrock can be seen in the bluffs at the southern end of the property, overlooking the Santa Cruz Harbor.

Arana Gulch Creek has incised the coastal terrace over time, resulting in a low-lying floodplain along the eastern boundary of the greenbelt property. Alluvial sediments underlay this relatively flat-floored valley. Along the southwestern boundary of the property, surface flow has steadily incised a steep sided canyon, known as Hagemann Gulch.

At the end of Agnes Street in the northern portion of the property, an eroded gully has developed on the slope descending to Arana Gulch Creek. Years of storm water runoff from the adjacent neighborhood appears to have accelerated the erosion. The *Arana Gulch Watershed Enhancement Plan*, prepared by Balance Hydrologics in 2002 for the Arana Gulch Watershed Alliance, recommends stabilization of this gully to avoid further erosion of the hillside and decrease sedimentation into Arana Gulch Creek.

Groundwater

The Purisima Formation is less impervious to groundwater than the coastal terrace deposits, resulting in a shallow perched water table at the contact between the unconsolidated terrace deposits and underlying Purisima bedrock. The groundwater flows from the northwest, downslope toward Arana Gulch Creek. Variations of several feet in the bedrock subsurface topography result in variations in the groundwater levels within Arana Gulch.

The depth of the groundwater also fluctuates seasonally. During high intensity rainfall in the wet season, groundwater may be found near the surface. In the dry summer months, however, the groundwater is substantially lower and may disappear in some locations. Groundwater levels also vary year to year, depending on the amount and intensity of rainfalls. Groundwater monitoring conducted in 1996 to 1997 found substantial seasonal variation in the groundwater levels (Weber, Hayes & Associates, 1997). In October prior to the rainy season, groundwater depths ranged from approximately 6 feet to over 14 feet below ground surface (bgs). During the wet season, there was a dramatic rise in groundwater elevations. The highest groundwater level encountered was approximately 2.3 feet bgs.

Arana Gulch Creek

Headwaters of Arana Gulch Creek begin in the foothills of the Santa Cruz Mountains. The three upper branches of the Creek flow southward through largely rural lands within Santa Cruz County. At the northern boundary of the City limits near DeLaveaga Park, a relatively narrow corridor confines the Creek. Upstream of Arana Gulch, the creek is channelized with a sediment basin at Harbor High School. The creek then flows through a culvert under Capitola Road before entering the broader flood plain within Arana Gulch. At the southern end of the greenbelt property, the Arana Gulch Creek flows through culverts into the upper Santa Cruz Harbor.

The Arana Gulch Creek watershed, totaling approximately 3.5 square miles, is a relatively small drainage basin. The watershed area is long and narrow, ranging from over 600 feet in elevation at its headwaters to sea level at the Harbor. The underlying Purisima Formation and terrace deposits within the watershed weather to sand, silt and clay, which, in turn are transported to Arana Gulch Creek during storm events. The stream flow swiftly carries much of the silts and clays, and deposits a significant amount of sand in the creek channel and floodplain or transports it further downstream to the Harbor and Monterey Bay. Sand fills most of the pools and holes within the channel along the length of Arana Gulch Creek.

While the Arana Gulch Creek watershed is considered an intrinsically sandy watershed, sedimentation in Arana Gulch Creek has increased over time due to man-made disturbances

and development within the watershed. The *Arana Gulch Watershed Enhancement Plan* provides further information regarding watershed and creek conditions. The Enhancement Plan also identifies opportunities to reduce sedimentation levels and improve fisheries habitat. Two of the sites identified are located within the greenbelt property: the gully discussed previously and the lower reach of Arana Gulch Creek just north of the Harbor.

Similar to other coastal streams within the Central Coast region, Arana Gulch Creek has historically provided habitat for fish, including steelhead. The fisheries habitat has declined due to development and alteration of the creek and watershed. Although it is considered substandard fisheries habitat compared to other coastal streams in Santa Cruz County, steelhead and other fish have been observed. Further information about fisheries in Arana Gulch Creek is presented in Biotic Resources, Section 2.3.

Freshwater stream flow enters the Arana Gulch property through a culvert under Capitola Road. Meandering along the eastern boundary of the property, the Creek flows southward toward the Santa Cruz Harbor. Upstream within Arana Gulch, a canopy of willow and other trees cover a much narrower creek channel. Pools within the channel are generally shallow, with fine sediment filling in a majority of the pool habitat, limiting the rearing habitat for steelhead. As discussed above, the *Arana Gulch Watershed Enhancement Plan* found that although sand is intrinsic to Arana Gulch Creek, the extent to which sand-sized sediment has filled the pools is probably much greater than natural conditions due to development and disturbances within the watershed.

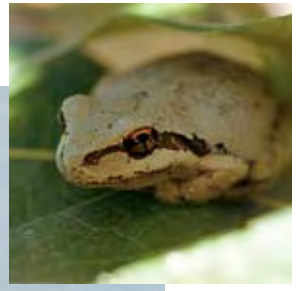
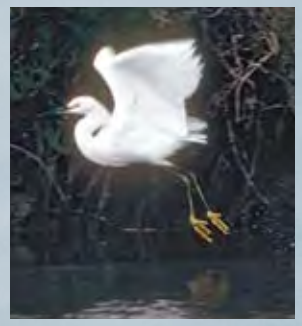
The lowest reach of Arana Gulch Creek features a unique distinction from the upper reaches: a tidally influenced, brackish habitat. Four large culverts (72-inch diameter) extend 300 feet under the Harbor parking area to allow flow between Arana Gulch and the Harbor. Within this tidal reach, marsh vegetation differs compared to freshwater reaches further upstream. The salinity also affects the type of fish and amphibians that rely on this brackish habitat. The tidal channel north of the Harbor shows signs of stream bank erosion.

As part of the development of the Upper Harbor in the early 1970s, the culverts were installed. The culverts are approximately 2 feet below the grade of the original stream elevation. This man-made lowering of the base level of Arana Gulch Creek has led to channel incision and bank collapse in this tidal reach. During some storm events, the culverts also result in ponding of storm water runoff within Arana Gulch which can increase erosion. The *Arana Gulch Watershed Enhancement Plan* identifies this tidal reach channel bank failure as a medium priority project.

In addition, the development of the Harbor and culverts has also affected habitat values for fisheries and other aquatic species within Arana Gulch. Prior to development of the lower Santa Cruz Harbor in 1964, a lagoon existed at the mouth of Arana Gulch Creek, known as Wood's Lagoon.

Water quality of Arana Gulch Creek is relatively good based on sampling conducted at various times over the past 30 years. Sampling conducted in 1982 just upstream of the Arana Gulch property included testing for minerals and heavy metals. Results showed the freshwater inflow to be of good quality and comparable or better than the water quality in coastal streams of similar flows. Sampling of the tidal reach was also conducted in 1977 and found the water quality to be within the ranges typically found in estuarine systems. The salinity increases during summer months as inflow of surface and groundwater flow decreases (Harvey and Hecht, 1982).

More recently from 1996 to 1999, the Coastal Watershed Council (CWC), a non-profit volunteer organization, conducted water sampling throughout the Arana Gulch watershed. Samples were taken at 3 locations along the Creek within the Arana Gulch property, measuring turbidity (concentration of sediment or algal matter in water), dissolved oxygen, water temperature, specific conductance (water's capacity to transmit an electrical current) and pH (acidity). The results met

Arana Gulch Creek Views

the water quality standards for domestic consumption and were within the acceptable ranges for fisheries and other aquatic species habitat. The monitoring analysis also noted that turbidity was at its highest levels during the winter months and lowest levels during summer, as would be expected (Coastal Watershed Council, 2000).

Depending on the amount of rainfall and intensity of storm events, the volume of stream flow in Arana Gulch Creek varies seasonally and annually. However, no records of stream volume are available prior to 1982. Harvey and Hecht, a hydrologic consulting firm, conducted an analysis in 1982 that estimated mean monthly stream flow for Arana Gulch Creek at the culverts could vary from 0 (summer months of very dry years) to 35 cfs during winter months (a rough estimate mean flow for January 1982). In the late 1970s, flood events for Arana Gulch Creek upstream of the culverts were estimated as follows:

Recurrence	Peak Flows
10-year event	650 cfs
50-year event	1180 cfs
100-year event	1420 cfs
500-year event	2010 cfs

In January 1982, an approximately 25-year storm event was estimated to have generated peak flows of 870 cfs. During this event, the storm water exceeded the capacity of the culverts at the Upper Harbor, temporarily impounding an estimated 100 acre-feet of storm water within Arana Gulch. The floodplain within the Arana Gulch property comprises approximately 21.6 acres.

Hagemann Gulch

A seasonal drainage is located at the bottom of a steep-sided canyon known as Hagemann Gulch that runs along the southwestern boundary of the property. Hagemann Gulch extends north of the property boundaries for approximately 600 feet. Within the Arana Gulch property, Hagemann Gulch extends for approximately 1,200 feet. A Santa Cruz Harbor maintenance facility is located at the terminus of Hagemann Gulch.

Hagemann Gulch is situated within the Arana Gulch watershed. Storm water from Hagemann Gulch flows into the Upper Santa Cruz Harbor. The City Parks and Recreation Department is not aware of any historic stream flow data for Hagemann Gulch. In 1998, the Coastal Watershed Council conducted limited monitoring of the intermittent drainage along Hagemann Gulch.

2.3 BIOTIC RESOURCES

This section provides an overview of plant communities, wildlife, and sensitive biotic resources within Arana Gulch. Sensitive biotic resources include plant and wildlife species that are listed by the State and/or Federal government and the California Native Plant Society (CPNS) as having special status. Listed below are the plant communities and special status species identified in recent surveys within Arana Gulch. Potential habitat areas for additional special status plant and wildlife are also found within Arana Gulch, and are discussed later in this section.

Plant Communities

- Grassland
- Riparian scrub and woodland
- Oak woodland
- Seasonal wetland
- Emergent wetland
- Open water

Special Status Species

- Santa Cruz tarplant
- Steelhead trout
- Great blue heron
- San Francisco dusky-footed woodrat

Figure 3 shows the location of the plant communities. Surveys conducted as part of the *Draft Broadway-Brommer Bicycle/Pedestrian Path Connection Environmental Impact Report/ Environmental Assessment* (1999) and the *Arana Gulch Biotic Assessment* (1996) account for much of the general information regarding observed species and plant communities. Since completion of these reports, biologists and botanists have conducted additional surveys to update distribution and abundance information.

Plant Communities

Grassland

Non-native annual grasses presently dominate the broad sweep of grassland habitat at Arana Gulch, though some native coastal prairie species occur to a limited extent. Non-native grasses like ryegrass *(Lolium multiflorum)*, ripgut brome *(Bromus diandrus)*, soft chess *(Bromus hordaceus)* rattlesnake grass *(Briza maxima)*, wild oat *(Avena fatua)*, and slender wild oat *(Avena barbata)* and accumulated thatch pervade much of landscape.

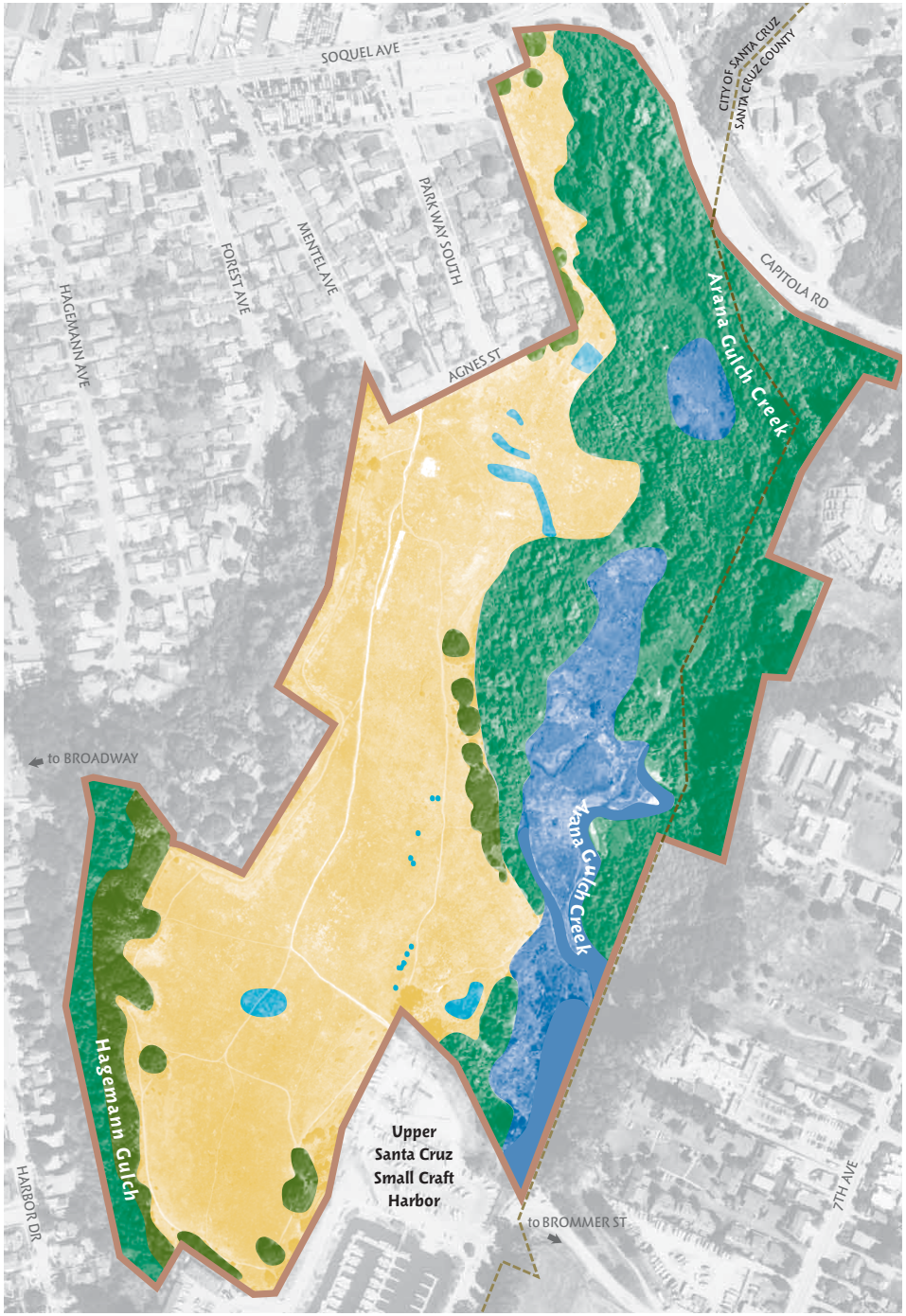
Scattered throughout the coastal terrace, however, are remnants of native coastal prairie—a vestige of a much larger native prairie that inhabited the site in the past. Within the southern upland area, several small sites feature a higher frequency of native grasses, including purple needlegrass *(Nassella pulchra)* and California oatgrass *(Danthonia californica)*. Other common plants typically found in the coastal prairie habitat include: California poppy *(Eschscholzia californica)*, yarrow *(Achillea millefolium)*, owl's clover *(Castilleja densiflora ssp. Densiflora)*, Indian soap root *(Chlorogalum pomeridianum var. divaricatum)*, yellow Mariposa lily *(Calochortus luteus)*, and golden brodiaea *(Triteleia ixioides ssp. ixioides)*.

Santa Cruz tarplant *(Holocarpha macradenia)*, a native annual herb, was historically widespread throughout the coastal terrace of Arana Gulch. In more recent years, Santa Cruz tarplant occurrences have been localized, primarily appearing in the southwestern portion of Arana Gulch. Aromatic and sticky with resin, the bright yellow bloom stands out against the drier grasses during summer months. Santa Cruz tarplant is listed as "endangered" under the California Endangered Species Act and as "threatened" under the federal Endangered Species Act. The Tarplant Adaptive Management Program, Appendix A, includes further information and maps depicting historic populations and recent survey. This tarplant is also described in more detail in the following section, Special Status Species.

Choris's popcorn flower *(Plagiobothrys chorisianus)*, a locally unique forb species, has also been observed within the southern portion of the coastal prairie (1998). The California Native Plant Society considers this popcorn flower a species of limited distribution. Other native special status species with the potential to occur at Arana Gulch include San Francisco popcorn flower *(Plagiobothrys diffuses)* and Gairdner's yampah *(Perideridia gairdneri ssp. Gairdneri)*.

An extremely high habitat value for wildlife generally exists in coastal prairie due to the clumped nature of the native grasses and the prevalence of native forbs. In contrast, while the grassland at Arana Gulch still provides important foraging and breeding grounds for wildlife, the predominance of non-native, invasive grasses has reduced the overall habitat value of the area.

Native plants of coastal prairie yield a wealth of seeds that attract many insects, supplying granivorous and insectivorous species—sparrows and several rodent populations, including California voles *(Microtus californicus)*, Norway rats *(Rattus norvegicus)*, and botta's pocket gopher *(Thomomys bottae)*—with ample food reserves. The presence of these smaller mammals attracts larger terrestrial predators and raptors to the area. Fox, skunk, long-tailed weasel and snakes all hunt within the habitat, and raptors such as red-tailed hawk, red-shoulder hawk, American kestrel, and great horned owl search for prey from above. Bats also catch insects emerging from the open grassland. Reptiles like northern alligator lizard, western fence lizard, and gopher and garter snakes make use of abandoned mammal burrows.



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SCALE IN FEET

HABITAT AREAS

- Grassland (Coastal Prairie and Annual Grassland)
- Riparian Scrub and Woodland
- Oak Woodland
- Seasonal Wetland
- Emergent Wetland
- Open Water
- Master Plan Boundary
- City Limit

NOTES

- Areas shown are approximate boundaries and may not represent exact limits of habitats.
- Density and diversity of native plant species varies within the Grassland.

Arana Gulch
MASTER PLAN

HABITAT AREAS

Figure 3

In addition to degradation of the coastal prairie habitat from invasive non-native vegetation, human activity can also harm the habitat value. Unauthorized pathways, erosion, and off-leash dog use contribute to the decline in the overall health of the grasslands at Arana Gulch.

Riparian Scrub and Woodland

Found on the upper slopes of Arana Gulch Creek and Hagemann Gulch is central coast live oak riparian forest. Distinguished by the presence of large, heritage coast live oak *(Quercus agrifolia)* and an understory consisting of poison oak *(Toxicodendron diversilobum)* and California blackberry *(Rubus ursinus)*, the oak forest enhances the habitat value of both gulches. In Hagemann Gulch, however, invasive, non-native species like English ivy *(Hedera helix)*, have somewhat degraded the botanical quality of the understory. Much of this habitat is dense and impenetrable.

The oak trees provide nourishment and shelter for many of the resident wildlife. Fox squirrels, with other mammal and bird species, utilize the tree's acorns as a food source, and mature trees contain natural cavities used by small animals for nesting. Even snags (i.e. standing, dead trees) offer a place for woodpeckers to excavate roost and nest sites. Subsequently, those sites are then occupied by secondary cavity nesting birds such as tree swallows and owls.

Riparian scrub occurs along the broad Arana Gulch Creek floodplain, featuring thick growths of arroyo willow *(Salix lasiolepis)*, yellow willow *(Salix lucida ssp. lasiandra)* red willow *(Salix lasiolepis)*, and coffeeberry *(Rhamnus californica)*. Native thickets of poison oak, California wild rose *(Rosa californica)*, sporadic straggly gooseberry bushes *(Ribes divaricatum ssp. pubiflorum)*, and tangles of Himalaya blackberry *(Rubus discolor)*—a non-native, invasive woody vine—dominate the understory growth, making the scrub extremely dense. In some areas, high soil moisture and saturation increase the botanical value of the habitat by permitting the occurrence of plant species typical of a marsh habitat, such as giant chain fern *(Woodwardia fimbriata)*, Douglas baccharis *(Baccharis douglasii)*, small-fruited bulrush *(Scirpus microcarpus)*, Santa Barbara sedge *(Carex barbarae)*, spikerush *(Eleocharis macrostachya)* and water parsley *(Oenanthe sarmentosa)*. Riparian scrub also occurs along the bottom of Hagemann Gulch, but suffers from the spread of invasive, non-native species.

Due to the varied character of the habitat, the riparian scrub along Arana Gulch Creek may have one of the highest concentrations of wildlife diversity and abundance in all of Arana Gulch. The presence of surface water, the thick foliage cover, and the abundance of plant life offer food, water, cover, nesting sites, and movement and dispersal corridors for wildlife. Virginia opossum, striped skunk, and raccoon travel through the protected corridors of the scrub and drink from the surface water. Neotropical migrant birds—including the yellow warbler *(Dendrocia petechia brewsteri)*, a State species of special concern—replenish their fat reserves by consuming the numerous insects found in the habitat, and Wilson's warbler, warbling vireo, and Pacific-coast flycatcher all nest in the willow and cottonwood trees. The moist habitat also presents amphibian species like California slender salamander *(Batrachoseps attenuatus)*, western toad *(Bufo boreas)*, and Pacific treefrog *(Hyla regilla)* with the conditions necessary for breeding and refuge.

Human activity has caused disturbances to the particularly sensitive habitat of riparian scrub within Hagemann Gulch and along Arana Gulch Creek. Illegal encampments, unauthorized pathways and trash degrade the various niches of these areas, disrupting bird and animal nesting sites, and trampling vegetation.

Oak Woodland

Oak woodland is found along the upper western edge of Arana Gulch Creek and the upper eastern slope of Hagemann Gulch. Above the Upper Harbor, additional clusters of oaks dot the edges of the coastal terrace. Past grazing and other human disturbances influenced the present frequency and distribution of oak trees.

Within the oak woodland, coast live oak *(Quercus agrifolia)* dominates the tree canopy. California Bay *(Umbellularia californica)* and non-native trees such as blue gum eucalyptus and Monterey Pine have spread into the native oak woodland from nearby plantings. Poison-oak, Pacific blackberry, and non native vines such as Himalayan blackberry and English ivy comprise much of the understory.

Many bird and mammal species rely on oak woodland habitat for food and cover. Acorns are particularly important as a seasonal food source for wildlife in the fall and winter. Bat species may also potentially use these stands of oaks to roost in the winter.

Seasonal Wetland

Within the coastal terrace, limited areas of seasonal wetland are found. These seasonal wetlands likely occur when water—trapped by a layer of sandstone in the near surface substrate—collects and ponds in topographic depressions. One of the seasonal wetlands is located to the southeast, near the riparian scrub and woodland. This well-defined depression features a mix of native and non-native grasses and herbs. Another seasonal wetland is located in the central southern portion of the coastal terrace; however, the vegetation is much like the surrounding grassland with only scattered creeping wild rye *(Leymus triicoides)*.

Several smaller seasonal wetlands also occur with Arana Gulch, but do not contain vegetation distinct from the surrounding grassland, except for relatively abundant velvet grass *(Holcus lanatus)*. The lack of surface water retention neither provides a suitable breeding ground for amphibians nor offers any foraging opportunities for waterfowl. The wildlife habitat value of the seasonal wetlands in Arana Gulch is low as compared to the emergent wetlands along Arana Gulch Creek.

Emergent Wetland

Much of the central portion of the Arana Gulch Creek floodplain is characterized as emergent wetland. Within these areas, water-loving plants thrive. Salt and brackish water plant species are found upstream of the Santa Cruz harbor—adjacent to the tidal channel of Arana Gulch Creek—where vegetation is subject to salt water influences from Monterey Bay.

Within the tidally influenced wetland close to the creek channel, dense patches of native plant species characteristic of salt and brackish water habitats are found. These plants include alkali heath *(Frankenia salina)*, jumea *(Jaumea carnosa)*, and pickleweed *(Salicornia virginica)*. Perennial non-native grasses, such as velvet grass and Italian rye grass, also dominate much of this wetland area. Further upstream in a marshy area bordering riparian scrub and woodland, common marsh species include Pacific Oenanthe *(Oenanthe sarmentosa)*, California bulrush and Pacific silverweed *(Potentilla anserina ssp. Pacifica)*. Other native and non-native wetland and marsh species can be seen throughout the emergent wetland.

The verdant mosaic of marsh and wetland vegetation provides escape cover and corridors for reptiles, birds, insects, and mammals. Many animals utilize the succulent forage of this habitat long after the grassland has dried and gone to seed. The emergent vegetation also provides reproductive habitat for invertebrates, which are an important food source for birds and mammals such as egrets, shorebirds, and raccoons. Freshwater marsh areas offer breeding and foraging opportunities for amphibians, aquatic reptiles, waterfowl, and mammals, including the Pacific tree frog, mallard and voles.

Open Water

Shallow, warm and protected, the open water of the lower reach of Arana Gulch Creek provides valuable habitat for fisheries, amphibians, and waterfowl. Influenced by the ebb and flow of tides passing through the culverts to the Upper Harbor, the water forms a salinity gradient which diversifies the habitat enough to provide nursery and transition zones for many species of fish, including steelhead and potentially tidewater goby.

This estuarine environment also serves as an ideal feeding ground for aquatic birds, like double-crested cormorant and

great blue heron. The tidal reach and surrounding estuary also provide shelter for water birds during strong winter storms.

Wildlife

A number of wildlife species rely on the biotic resources of Arana Gulch, ranging from raptors and small mammals to Steelhead trout and common reptiles and amphibians. The grassland, riparian scrub, and wetlands provide prime foraging, shelter, and nesting for the many different animal inhabitants of the area.

Of the larger terrestrial mammals, striped skunk, Virginia opossum, and raccoon have been observed throughout the riparian habitat. Long-tailed weasel, fox, and skunk utilize the grasslands for foraging, sometimes preying on the smaller resident species, including thriving rodent populations of California voles and botta's pocket gopher.

The wide variety of habitats found within Arana Gulch allows for a great diversity of bird species. Within the marsh along the Arana Gulch creek corridor, great blue herons, belted kingfishers, and waterfowl nest and feed. During winter storms, many birds use the wetland as a place for shelter. In the riparian areas, the deciduous trees and snags provide a number of neotropical migrant birds such as yellow warblers, warbling vireo, Pacific-slope flycatchers, and the Wilson's warbler with feeding grounds and seasonal roosting and nesting sites. The grassland offers several raptors species, including red-tailed hawk, red-shoulder hawk, American kestrel, and great horned owl, a place to hunt for small mammals. The oak and eucalyptus trees bordering this habitat serve as perch and nest sites for the raptors as well as other birds.

Reptiles living throughout the grassland include northern and southern alligator lizard, western fence lizard, common garter snake, western terrestrial garter snake, common king snake, ringneck snake, and gopher snake. These reptiles inhabit abandoned dwellings of small mammals and feed off of the insect life present in the area. While western aquatic garter snake is the only reptile known to reside in the in the wetlands and the riparian scrub, a multitude of amphibians such as the California slender salamander, western toad, and Pacific tree frog utilize the streamside pools and low-flow shallows for breeding.

Arana Gulch Creek provides habitat for several species of fish, typical of freshwater and estuarine habitats. Recent surveys have observed the presence of steelhead trout—listed as a federally "threatened" species—and have identified potential spawning areas. The Special Status Species section describes the steelhead in greater detail. Tidewater goby, listed as federally "endangered," was not observed in a fisheries survey conducted in 2004, though, potential habitat does continue to exist within the lower tidal reach of Arana Gulch Creek. Fish that were observed in 2004 (Entrix, Inc.) in the lower reach included topsmelt, shiner surfperch, staghorn sculpin, coastal prickly sculpin, arrow goby, bay pipefish. Further upstream in the freshwater creek, stickleback were observed. These fish are typical of a small coastal estuarine environment given the alterations associated with the harbor development. King Salmon have also been observed in Arana Gulch Creek.

Special Status Species

Special status species are those species that are listed by the State and/or federal government and the California Native Plant Society (CNPS) as having special status. Several special status plant and animals species are presently found within Arana Gulch, with potential habitat existing for several other species.

One special status plant species, Santa Cruz tarplant, exists within Arana Gulch and is described below. Potential habitat occurs within Arana Gulch for several other special status plants including San Francisco popcorn-flower *(Plagiobothrys diffuses)*, Santa Cruz clover *(Trifolium buckwestiorum)*, and maple-leaved checkerbloom *(Sidalcea malachroides)*. These species are typically associated with coastal prairie habitat, but they have not been identified in recent botanical surveys.

Choris's popcorn flower *(Plagiobothrys chorisianus)* has historically been identified within Arana Gulch, but may not be legally protected depending on which variety is presented. Two varieties of this low-growing, white flowering annual herb are known to occur in Santa Cruz County, one of which (var. *chorisianus)* is legally protected while the other (var. *hickmanii)* does not have specific protection. CNPS representatives conducted a survey in 1998 that identified Choris's popcorn flower; however, the survey did not satisfactorily ascertain the specific variety. While no observation of the popcorn flower has occurred since 1998, a seed bank may still exist.

Special status animal species dwelling within Arana Gulch include steelhead trout, great blue heron, and San Francisco dusky-footed woodrat. These species and their habitat areas are briefly described below. Potential habitat exists for several other special status species, including Western pond turtle, merlin (wintering bird), yellow warbler, pallid bat, and fringed myotis. Western red bat was observed on the east bank of Arana Gulch Creek, beyond the property boundary. Recent surveys for tidewater goby and California red-legged frog have not found presence of these special status species.

Santa Cruz Tarplant

Santa Cruz tarplant *(Holocarpha macradenia)* is a member of the sunflower family (Asteraceae) which grows within coastal prairie grassland habitat. Flower heads feature prominent yellow ray flowers, which are aromatic and sticky to the touch. Santa Cruz tarplant is federally-listed as "threatened" and State-listed as "endangered."

Historically, Santa Cruz tarplant occurred along northern Monterey Bay and along portions of San Francisco Bay. As of 2000, 11 Santa Cruz County populations continued to exist, though most of the populations have declined substantially since the early 1990s. The decline of the Santa Cruz tarplant abundance along Monterey Bay appears to be correlated with removal of cattle grazing at those sites.

At the time of the discovery of Santa Cruz tarplant at Arana Gulch, the property was privately owned and grazed by cattle. In 1986, over 100,000 plants were present within the property. These plants were clustered in four distinct areas within the coastal terrace, which were later designated as Areas A, B, C, and D (see maps in Appendix A). After cattle grazing ended in the late 1980s, the Santa Cruz tarplant populations declined significantly.

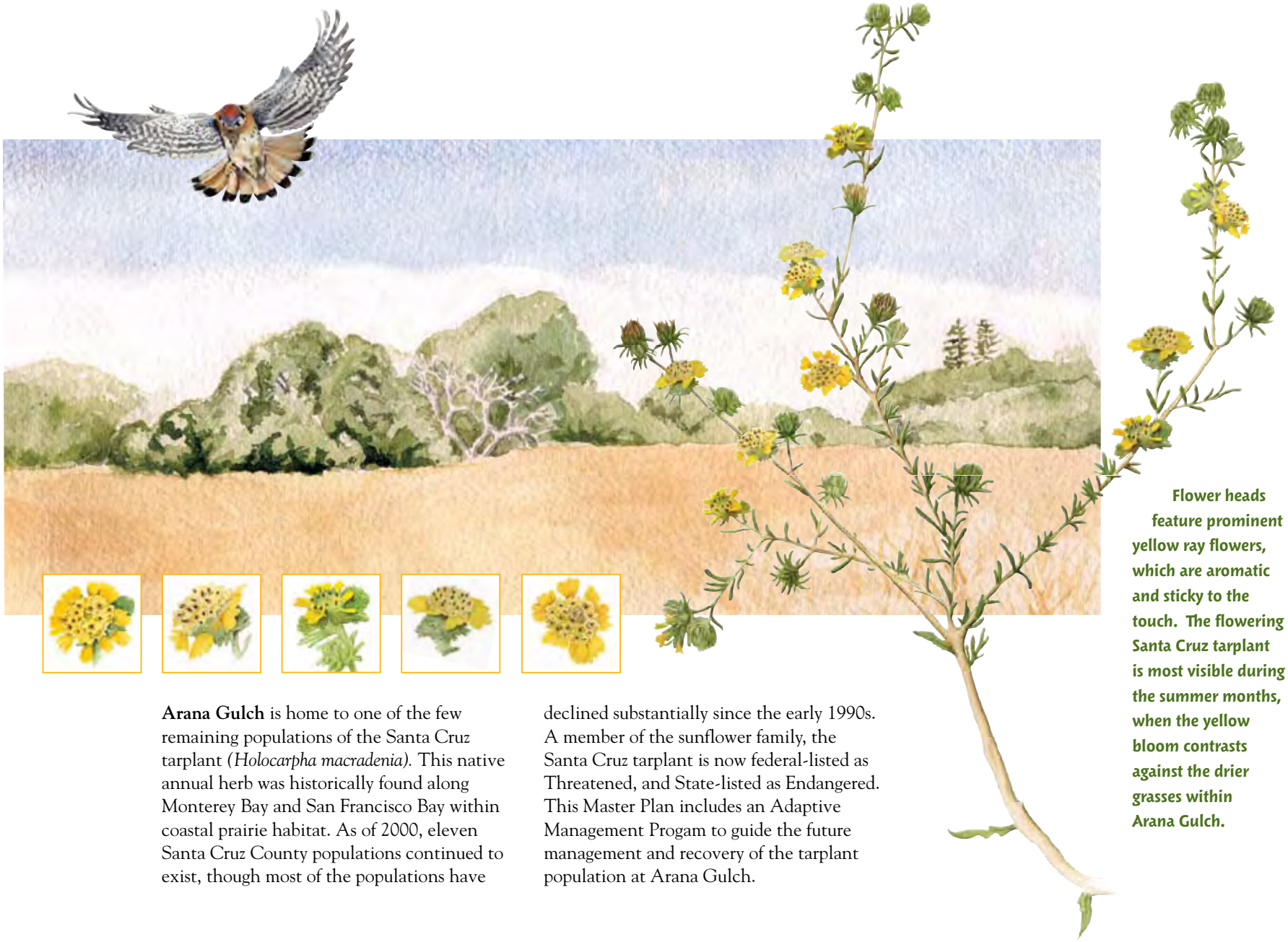
Historically Areas A and D were the largest Santa Cruz tarplant colonies within the property. Area A is located in the southern portion of the grassland and historically spanned the width of the coastal terrace. Area D includes the eastern grassland area adjacent to the Arana Gulch Creek floodplain. The largest remaining population within Arana Gulch is found in Area A. Survey data from recent years and recommended management strategies to ensure the long-term viability of Santa Cruz tarplant within Arana Gulch are presented in Appendix A, Santa Cruz Tarplant Adaptive Management Program.

Steelhead Trout

Within the Central California region, steelhead trout are federally listed as "threatened." Steelhead are anadromous salmonids—returning from the ocean to their native waterways to reproduce. Steelhead require spawning sites with loose gravels, a minimum of sand and silt, and clean flowing water. Spawning migration is primarily January through April. Fry usually emerge between April and June. Juvenile steelhead remain in fresh water streams and lagoons for 1 to 3 years, preferring deep pools higher stream flow to enhance food availability. Canopies of vegetation along streams are important for steelhead habitat, providing shade and keeping water temperatures cool. Eddies created by instream logs, boulders and vegetation, also provide cover and refuge.

After undergoing a physiological transformation to adapt to saltwater, called smolting, steelhead migrate to the ocean. This migration typically occurs in their second or third year, mostly in late March through May. After traveling along the

Arana Gulch Prairie Views



Arana Gulch is home to one of the few remaining populations of the Santa Cruz tarplant *(Holocarpha macradenia).* This native annual herb was historically found along Monterey Bay and San Francisco Bay within coastal prairie habitat. As of 2000, eleven Santa Cruz County populations continued to exist, though most of the populations have declined substantially since the early 1990s. A member of the sunflower family, the Santa Cruz tarplant is now federal-listed as Threatened, and State-listed as Endangered. This Master Plan includes an Adaptive Management Progam to guide the future management and recovery of the tarplant population at Arana Gulch.

Flower heads feature prominent yellow ray flowers, which are aromatic and sticky to the touch. The flowering Santa Cruz tarplant is most visible during the summer months, when the yellow bloom contrasts against the drier grasses within Arana Gulch.

Santa Cruz Tarplant

Pacific Coast for 1 to 2 years and reaching maturity, steelhead return to their native waterways to spawn. Migration may be blocked by log jams, bedrock falls, and shallow riffles, or man-made alterations to the stream.

While Arana Gulch Creek supports a small steelhead population, the habitat is considered substandard compared to the San Lorenzo River and other coastal streams in the region. An assessment of steelhead densities and habitat conditions within Arana Gulch Creek conducted in 1999 surveyed six reaches of the Creek (D.W. Alley and Associates). Within the first reach flowing through the greenbelt property, the survey recorded an extremely low density of all sizes of steelhead. Extremely poor spawning habitat conditions and limited rearing habitat (cover and food) were most likely responsible for the low density. High levels of fine sediment in the streambed reduce the quality habitat for spawning and aquatic insects (food). Steelhead habitat generally improves slightly upstream.

Great Blue Heron

The great blue heron has a wide range within North America and is found in wetland environments. The California Department of Forestry lists Great blue heron nests and rookeries/night roosts as "sensitive." Most great blue herons nest and perch in colonies in tall trees.

Previous studies have documented great blue heron night roosting and nesting in a stand of eucalyptus trees along the east bank of Arana Gulch Creek. In 2005, great blue herons were also observed roosting in the same stand of eucalyptus along the creek. While the eucalyptus trees used for roosting and nesting may be beyond the property boundaries of Arana Gulch, great blue heron hunt for prey within Arana Gulch.

San Francisco Dusky-footed Woodrat

The California Department of Fish and Game considers the San Francisco dusky-footed woodrat a "Species of Special Concern." This unique woodrat species is found along the Coast Range of California within riparian, oak woodland, and redwood forest habitats. Within natural areas, the woodrat builds stick nests in the ground, in hollow trees or in shrubs. Multiple generations of woodrat may use the nests, which may reach heights of 3 to 4 feet, and may colonize and recolonize them over a span of decades.

Previous surveys within Arana Gulch documented a San Francisco dusky-footed woodrat nest in the Hagemann Gulch riparian scrub habitat (Habitat Restoration Group, 1996). A survey conducted in 2005 also documented a nest in Hagemann Gulch.

2.4 HISTORIC RESOURCES

Granted in 1838, Arana Gulch was once part of a larger rancho, Rancho Potrero y Rincon de San Pedro Regaldo. This initial claim, however, was rejected in 1842 and the 92-acre rancho was regranted to Jose Arana in 1842. Arana settled in the area, which now bears his name, until he died in 1868.

In 1878, Frederick Hagemann acquired 110 acres of ranch lands, extending beyond the Arana Gulch property. A native of Germany, Mr. Hagemann came to California in 1853 with hopes of making a fortune gold prospecting; instead, he prospered as a merchant, eventually constructing a retirement estate on his lands, which he named Live Oak Ranch. He constructed his home at the end of a long lane, planted with non-native blue gum eucalyptus trees, near the terminus of Mentel Avenue. In the 1880s, the Hagemann Ranch house was enlarged and remodeled.

On the vast ranchland, the Hagemanns raised cattle, horses, hogs, and poultry and planted wheat, vegetables, and an orchard. An illustration of the Live Oak residence during that time period appears to depict the home and grounds from the end of Mentel Avenue. The cultivated areas are located near the home and to the west toward Frederick Street. The Arana Gulch property appears to be grazed and uncultivated, with boats sailing in what was historically Woods Lagoon. After Frederick Hagemann died, his wife sold the home and property.

The portion of the ranch—now known as Arana Gulch—was sold separately from the ranch home and garden.

In the 1920s, the Arana Gulch property, then owned by the Kinzli family, became the site of the East Side Dairy. Cattle grazing and the dairy operation continued through the mid-1950s. The barn and other dairy structures were located at the northwestern end of the property, near Agnes Street. The structures are still standing in photos taken during the mid-1970s, but were later demolished. The Kinzli family maintained ownership of the property until the City acquired Arana Gulch in 1994. Cattle grazing continued there until the late 1980s.

Today, the "Hagemann" house continues to be privately owned. The unique home and grounds were listed in the National Register of Historic Places in 1975. Eucalyptus trees planted along the long entrance lane continue to stand along the northwestern boundary of the Arana Gulch greenbelt property. Dense vegetation and fencing screen views from Arana Gulch into the historic estate.

Within the Arana Gulch property, no historic buildings exist from either the Live Oak Ranch or dairy operations. An illustration of the Live Oak Ranch does not show any structures within Arana Gulch and no remnants of structures have been found within the property predating the dairy operations. Foundations remain from some of the structures associated with the East Side Dairy, but these are not considered significant historic resources.

Although no historic structures exist within Arana Gulch, a row of heritage roses continues to thrive along the top of the east side of Hagemann Gulch, just to the south of historic Live Oak Ranch home and garden property. These "Rose of Castile" roses are believed to be over 150 years old. Originally brought from Spain to all of the Spanish colonies, this rose was grown at the Mission Santa Cruz. The source of the roses found at Arana Gulch may be cuttings taken from the Mission grounds. During that period, hedges of the "Roses of Castile" would have been common throughout Santa Cruz County. Today, however, these heritage roses at Arana Gulch are the only apparent remnants left from that earlier time period, thus potentially making them the oldest roses in the City of Santa Cruz. As heritage shrubs, the City Parks and Recreation Department protects the roses and prohibits unauthorized cuttings.

3

THE PLAN

The guiding vision for Arana Gulch is to preserve open space along the eastern boundary of Santa Cruz. Unique natural resources such as coastal prairie, Santa Cruz tarplant, riparian, and wetland habitat areas will be protected and enhanced. Opportunities for public use, including trails and interpretive areas, will be provided in a manner that ensures continued protection of natural resources.

The *Arana Gulch Master Plan* provides a guide for the long-term uses and resource management of this unique natural area. This section of the Master Plan presents the Plan's key elements, including: the vision, goals, management areas and guidelines. An overview of the planning process and background is also presented in this section.

The future vision and goals for Arana Gulch, presented in Section 3.1, focus on natural resource protection, trails and interpretive opportunities. Three Management Areas have been designated to help focus future resource management of Arana Gulch. These areas, Coastal Prairie/Tarplant, Arana Gulch Creek Riparian and Wetland, and Hagemann Gulch Riparian Woodland were identified based on natural resources. Section 3.2 outlines specific management guidelines for each area, while Sections 3.3 and 3.4 offer an overview of the interpretive themes and trail system. Implementation and operations are discussed in the final section of this plan.

3.1 ARANA GULCH VISION AND GOALS

Future Vision for Arana Gulch

The future vision for Arana Gulch and the goals reflect guidance from the Santa Cruz City Council and Environmental Quality Policies from the *City's General Plan/Local Coastal Program* (1992). Although these policies initially proposed an active recreation area and a school site for Arana Gulch, the Santa Cruz City Council has refined the vision and goals over recent years to focus on natural resource protection and passive recreation.

General Goals for Arana Gulch

The future of Arana Gulch open space will be guided by the following general goals:

Resource Protection and Enhancement

- Protect and enhance sensitive habitat areas, including coastal prairie, riparian woodland and scrub, and wetlands.
- Implement an adaptive management program to ensure the long-term viability of the Santa Cruz tarplant within Arana Gulch.
- Educate the public about natural resource protection and enhancement through interpretive displays and programs.
- Reduce sedimentation through stabilization and restoration of eroded areas, trail improvements, and other Best Management Practices.

Public Use

- Provide a trail system that allows public access within habitat areas in a manner that does not result in significant degradation of habitat values.
- Provide trail connections through Arana Gulch that provide access from adjacent communities to the coastline and the Monterey Bay National Marine Sanctuary Trail. Provide multi-use trail connections that would comply with the Americans with Disabilities Act (ADA) requirements, and provide pedestrian, wheelchair and bicycle access.
- Provide areas for nature viewing and interpretive displays. Design the interpretive displays to complement and blend with the natural environment.
- To protect sensitive habitat areas, restrict dogs to on-leash use at all times on designated trails.
- Close unauthorized, non-designated pathways.
- No new vehicle parking with the Arana Gulch boundaries will be provided, as there is adequate existing parking near the entrances.

3.2 MANAGEMENT AREAS

Management Areas have been designated within the approximately 67.7-acre Arana Gulch open space based on natural resources. The intent of designating these areas is to more effectively focus resource management and enhancement efforts. The three Management Areas include Coastal Prairie/Tarplant, Arana Gulch Creek Riparian and Wetland, and Hagemann Gulch Riparian Woodland. Specific management guidelines have been developed for each Management Area. These Management Areas are briefly highlighted below and described in more detail in the following sections.

With views of open prairie and the summer bloom of the Santa Cruz tarplant, the Coastal Prairie/Tarplant Management Area exemplifies the natural beauty and diversity found by visitors coming to Arana Gulch. A key goal within this approximate 30-acre area is to enhance the tarplant and other native prairie species populations, while reducing the abundance of invasive non-native grasses. This area offers opportunities for visitors to enjoy meadow views and observe prairie habitat.

Arana Gulch Creek and the broad floodplain along the eastern portion of the property comprise the second Management Area. The Arana Gulch Riparian and Wetland Management Area, totaling approximately 34.5 acres, features valuable habitat for aquatic species and birds. A pedestrian trail along the western edge offers overlooks of the creek and coastal marsh. To protect wildlife habitat, public access within the wetland habitat areas would be prohibited.

Along the southwestern boundary of Arana Gulch is the smallest of the Management Areas, Hagemann Gulch Riparian Woodland. Though the habitat value is lessened by the number of invasive species, this 3-acre wooded canyon features a mix of riparian trees and scrub. While the steep terrain considerably limits public use, a proposed bridge would provide a key trail connection between Arana Gulch and the adjoining neighborhoods. This bridge over Hagemann Gulch would offer an interpretive overlook into the canyon and tree canopy, but would not provide access into the gulch.

Set forth in the following sections is a more detailed description of these areas and specific management guidelines. Further discussion of the interpretive opportunities and trail system are presented in Sections 3.3 and 3.4.

3.2.1 COASTAL PRAIRIE/TARPLANT MANAGEMENT AREA

Situated on the coastal terrace in the central portion of the open space is the Coastal Prairie/Tarplant Management Area. Oak trees dot the edges of the landscape, with small seasonal wetlands within the expanse of grassland (See Habitat Areas, Figure 3). With a greatly varied diversity and density of grassland species, this approximately 30-acre area provides foraging habitat for birds, including hawks and American kestrel, and small mammals. This area is most appropriate for public trails and interpretive opportunities due to the relatively gentle and stable terrain, as compared to the steep sloped Hagemann Gulch and the wet marshy areas along Arana Gulch Creek.

Within this Management Area, a key goal is to preserve and restore coastal prairie habitat, particularly Santa Cruz tarplant populations. Since the late 1980s after cattle grazing ended, the abundance and diversity of native prairie species has declined. Grazing helped reduce competition from non-native invasive grasses and likely enhanced the Santa Cruz tarplant populations. By the mid-1990s, the Santa Cruz tarplant populations had dramatically declined, leading to a meadow now dominated by non-native grasses. The City has undertaken management efforts, such as mowing, controlled burns, and scraping, in an effort to reduce non-native grasses and increase the Santa Cruz tarplant population. A long-term, empirical program is needed to prevent continued decline and to ensure the viability of the Santa Cruz tarplant. As part of this Master Plan process, a long-term adaptive management program has been developed for Santa Cruz tarplant (see Appendix A of this Master Plan).

Another key goal within the Coastal Prairie/Tarplant Management Area is to close unauthorized trails that transect the areas with the highest tarplant populations. Since the City purchased the Arana Gulch property in 1994, the trail system has been limited to earthen service roads and unimproved paths that existed prior to acquisition. Over the past decade, visitors have developed other unauthorized pathways, particularly in the southern portion of the property where the largest remaining tarplant population is found. These undesignated pathways, as well as a steep eroded path leading down to the harbor entrance, would be closed and the areas would be restored.

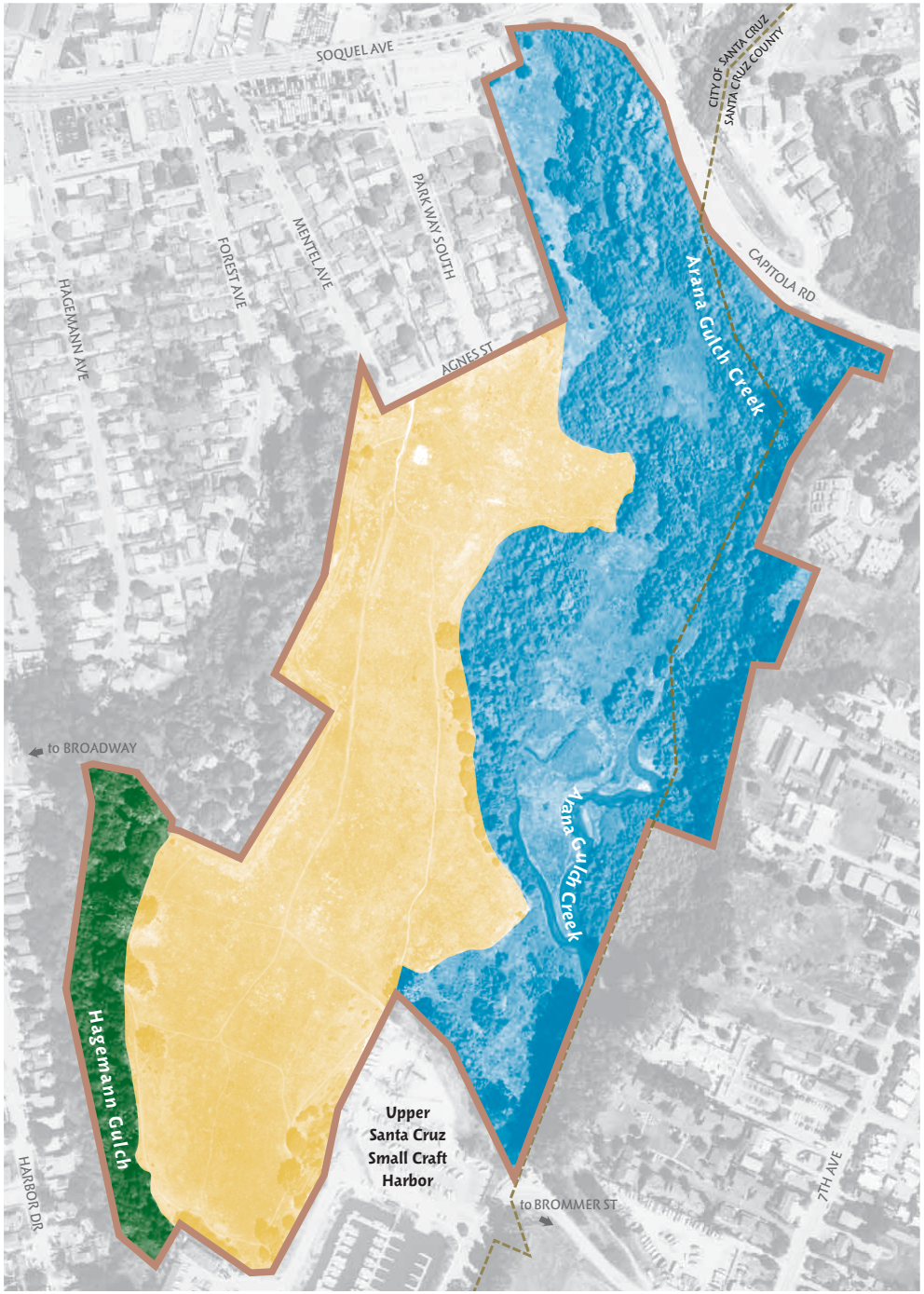
In addition to closing unauthorized pathways, this Master Plan calls for the establishment of designated interpretive multi-use and pedestrian trails. Multi-use trails would provide opportunities for pedestrians, wheelchair users, and bicyclists to enjoy and learn about prairie habitat. These multi-use trails would also provide valuable connections to adjacent neighborhoods and the upper Santa Cruz Harbor. Maintained as a pedestrian-only trail, an existing loop trail would encircle most of the prairie habitat. Designated trails within the Coastal Prairie/Tarplant Management Area will be designed to minimize and avoid disruption to higher density tarplant populations. Within this Management Area, dogs will be permitted on trails only and must be on-leash at all times. The trails are described in more detail in the following guidelines and in Section 3.4.

The Coastal Prairie/Tarplant Management Area offers opportunities to interpret both natural and cultural resources. Interpretive displays and educational materials would focus primarily on the values of coastal prairie habitat and the Santa Cruz Tarplant Adaptive Management Program. Additionally, displays would highlight the history of the area, including the dairy operations during the 20th century. Interpretive opportunities are presented further in Section 3.3.

TABLE 1

Management Area Matrix

Management Area	Natural Resources	Public Use
Coastal Prairie/Tarplant (30.2 acres)	Santa Cruz tarplant populations, annual grassland with scattered wildflowers and native grasses, and seasonal wetlands	Nature viewing, multi-use and pedestrian interpretive trails, dogs on leash
Arana Gulch Creek Riparian and Wetland (34.5 acres)	Arana Gulch Creek, salt and brackish marsh, willow riparian forest, emergent wetland, steelhead trout and great blue heron habitat	Nature viewing, pedestrian interpretive trail, no dogs
Hagemann Gulch Riparian Woodland (3 acres)	Oak woodland, riparian forest, and San Francisco dusky-footed woodrat habitat	Nature viewing, multi-use interpretive trail, dogs on leash



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SCALE IN FEET

- Coastal Prairie/Tarplant
- Arana Gulch Creek Riparian and Wetland
- Hagemann Gulch Riparian Woodland
- Master Plan Boundary
- City Limit

Arana Gulch
MASTER PLAN

MANAGEMENT AREAS

Figure 4

Specific guidelines regarding natural resource management and public use for the Coastal Prairie/Tarplant Management Area are listed below:

Resource Management Guidelines

- Implement the Santa Cruz Tarplant Adaptive Management Program to ensure the long-term viability of the Santa Cruz tarplant subpopulations. This Program (Appendix A) sets forth potential management actions, monitoring protocols, and an organizational framework involving botanists to ensure the program is carried out in the long-term. Management actions may include grazing, mowing, scraping and prescribed burns.
- Preserve designated seasonal wetlands located within the grassland.
- Monitor impacts of trail users near sensitive species. As needed, install fencing, signs or implement other strategies to deter off-trail use.
- Close unauthorized pathways transecting the coastal prairie habitat.
- Remove blackberry, poison oak, and non-native invasive shrubs to prevent further loss of coastal prairie acreage.
- Conduct annual fuel break mowing along the property boundaries to reduce the fuel load within the grassland areas.
- Coordinate with the City of Santa Cruz Fire Department to conduct prescribed burns. Consult with a qualified botanist under the Santa Cruz Tarplant Adaptive Management Program to determine the appropriate timing and location of the prescribed burns.

Public Use Guidelines

- Provide multi-use interpretive trails connecting the surrounding neighborhoods to the Upper Santa Cruz Harbor area. Multi-use trails shall be wheelchair accessible. Ensure the pathways minimize disturbance to the coastal prairie habitat and Santa Cruz tarplant populations (see Section 3.4 for further trail information). Minimize grading and alteration of natural drainage patterns. Align trails to avoid smaller, isolated seasonal wetlands where feasible.
- Provide a pedestrian-only interpretive loop trail encircling the coastal prairie to allow visitors to enjoy the scenic vistas of the meadows and the harbor overlook (see Section 3.4).
- Allow dogs on-leash on designated trails. Strictly prohibit off-leash dog use and off-trail use to avoid impacts to tarplant populations and other plant and animal species.
- Provide interpretive displays along trails at designated locations. Displays shall be compatible with the open space setting.

3.2.2 ARANA GULCH CREEK RIPARIAN AND WETLAND MANAGEMENT AREA

The Arana Gulch Creek Riparian and Wetland Management Area encompasses the lower reach of Arana Gulch Creek, wetlands along the creek channel, dense willow stands, and riparian forest and scrub. These habitat areas, totaling approximately 34.5 acres, provide valuable habitat for numerous birds, small mammals, fish, amphibians, reptiles and insects. Despite sedimentation within the Creek and the development of the Santa Cruz Harbor, Arana Gulch Creek continues to provide habitat for steelhead trout.

The main branch of Arana Gulch Creek meanders along the eastern boundary of this Management Area. The creek flows into northern Arana Gulch through a culvert under Capitola Road. At the southern end, the creek flows through four large culverts to the Santa Cruz Harbor. Influenced by the tides of Monterey Bay, this southernmost reach of Arana Gulch Creek is a brackish habitat created by the blending of salt and fresh water.

Within the southern tidal reach, to the north of the Harbor culverts, the stream banks are eroded and there is substantial channel head cutting. Previous studies (Harvey and Hecht, 1982) identified tidal action as the primary cause of bank instability and collapse. Increasing sedimentation from the upper

watershed may also be contributing to the channel widening. Restoration of the stream banks and prevention of future head cutting are important goals for this Management Area. To identify possible solutions, more research into the causes of excessive head cutting and bank erosion is needed. The detailed hydrologic analysis and actual repair is beyond the scope of this Master Plan; however this Plan includes goals to move forward with additional analysis and eventual restoration.

A gully in the northern portion of Arana Gulch has also been identified as a priority for restoration. This gully, located at the end of Agnes Street and the alleyway, has experienced accelerated erosion due to storm water runoff from the adjacent streets. By employing a bioengineering solution, restoration and stabilization of the gully would focus on reducing sedimentation while visually blending with the natural setting.

In addition to stream bank and gully restoration, resource management in this area will focus on removing non-native invasive vegetation. Unlike the Coastal Prairie/Tarplant Management Area, the wetlands and willow stands do not need active management such as mowing or controlled burns. The riparian habitat areas would also be excluded from any future grazing within Arana Gulch.

Public use would be limited within this Management Area to minimize impacts to wildlife species. No trails would be located within the wetlands or willow stands along the riparian corridor. Improvements to an existing informal path along the western edge of this area would provide a pedestrian trail overlooking the creek and floodplain. Formalizing this trail along the Arana Creek riparian corridor would increase visibility into the creek area and introduce appropriate public use. Camping and other illegal activities have resulted in habitat degradation and public safety concerns in this area. Within the Port District property along the southern boundary of this Management Area, a new multi-use trail is proposed. This trail route would provide an overlook and interpretive opportunities for the tidal reach of Arana Gulch Creek (see Section 3.4.2).

Specific guidelines regarding natural resource management and public use for the Arana Gulch Creek Riparian and Wetland Management Area are listed below:

Resource Management Guidelines

- Conduct further hydrologic analysis regarding accelerated head cutting and bank erosion along the tidal reach of Arana Gulch Creek. Design and implement a bank restoration project that reduces sedimentation and enhances fisheries and wildlife habitat along Arana Gulch Creek.
- Restore the eroded gully in the northern portion of Arana Gulch. Design and implement a restoration project that reduces sedimentation and blends with the natural setting.
- Remove non-native invasive vegetation.
- Close unauthorized pathways within the wetland and riparian habitat areas.
- Monitor impacts of trail users near sensitive wetland and riparian habitats. As needed, install fencing, signs, or implement other strategies to deter off-trail use.

Public Use Guidelines

- Enhance the existing trail along the western boundary of this Management Area. The trail shall be pedestrian-only.
- To avoid disturbance to wildlife, primarily waterfowl, prohibit dogs within the riparian and wetland habitat of Arana Gulch Creek and on the pedestrian trail.
- Conduct non-toxic mosquito abatement as needed in a manner that minimizes impacts to the wildlife species.

3.2.3 HAGEMANN GULCH RIPARIAN WOODLAND MANAGEMENT AREA

Hagemann Gulch Riparian Woodland Management Area is a steep-sided canyon with a seasonal drainage. This 3-acre area features a dense canopy of trees and scrub, though the habitat value has been degraded by a number of invasive species. The upper slope is comprised primarily of coast live oak woodland, California bay, and an understory of poison oak and California blackberry. Riparian scrub and woodland occurs on the lower slopes. Non-native trees such as poplars and eucalyptus are also found in the canyon. Larger trees within the canyon can provide roost and perching sites for raptors, such as red-tailed hawk. Some nesting has also been documented in years past.

Non-native species such as ivy and broom dominate much of the understory. Due to the steep canyon sides and soil erodibility, the feasibility of removing non-native vegetation is particularly challenging. The terrain also limits the opportunities for trails and public access. The canyon has effectively served as a barrier between the Arana Gulch open space and the neighborhoods to the west.

A key public access goal for Arana Gulch is to provide a western entrance, which would require a new bridge across Hagemann Gulch. Designed to minimize impacts to the habitat values of Hagemann Gulch and blend with the natural setting, the new entrance, bridge and trail would accommodate pedestrian, wheelchair and bicycle use. The overlook into Hagemann Gulch from the bridge would provide a unique opportunity to educate visitors about riparian and oak woodland habitats. The new trail and bridge are described further in Section 3.4.

Along the upper eastern slope of Hagemann Gulch is a row of "Rose of Castile" roses. These roses, believed to have originally been planted over 150 years ago, are considered heritage shrubs and should remain undisturbed to the extent feasible. The heritage roses and history of the site is discussed further in Section 2.2.3, Historic Resources.

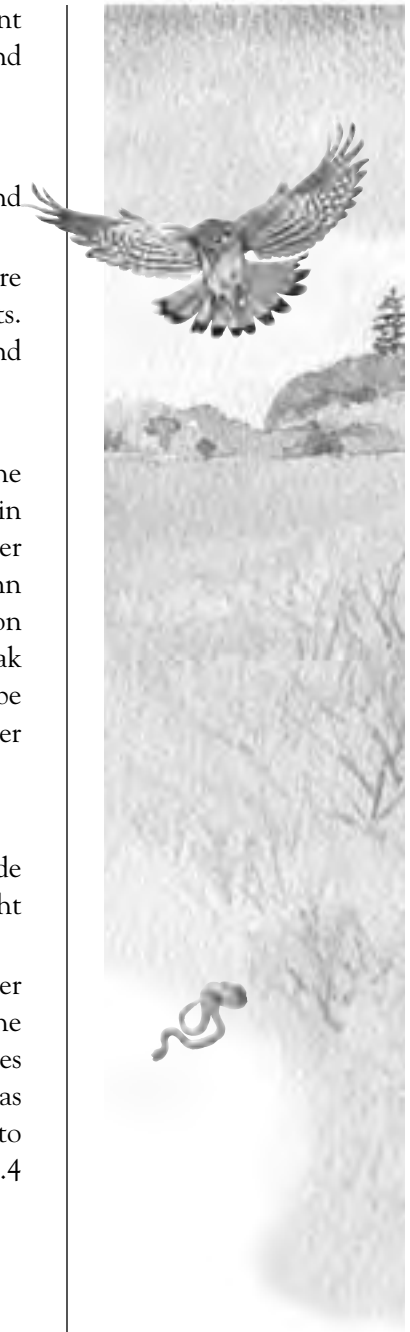
Specific guidelines regarding natural resource management and public use for the Hagemann Gulch Riparian Woodland Management Area are listed below:

Resource Management Guidelines

- Remove non-native understory species, such as broom and ivy, to the extent feasible.
- Contain expansion of the eucalyptus trees and reduce the fire hazard within Hagemann Gulch through various treatments. These may include pruning lower branches of eucalyptus, and removal of smaller trees and saplings.
- Close unauthorized pathways within Hagemann Gulch.
- Preserve the "Rose of Castile" heritage roses located on the upper slope of Hagemann Gulch. Relocate the roses within Arana Gulch in the vicinity of existing roses, only if no other alternative is feasible for development of the Hagemann Gulch Bridge. Any relocation should be done in consultation with the Central Coast Heritage Rose Group. Removal of oak saplings in the immediate vicinity of heritage roses may be needed. Oak saplings may be replanted as feasible in another location.

Public Use Guidelines

- Establish a new west entrance at Hagemann Gulch to provide a trail connection between Arana Gulch and the Seabright neighborhood of Santa Cruz.
- Provide a new multi-use trail and bridge crossing over Hagemann Gulch, featuring an interpretive overlook. The bridge shall be designed to minimize impacts to heritage trees and habitat values, and to blend with the natural setting as much as possible. The new multi-use trail would be open to pedestrians, wheelchair users, and bicyclists (see Section 3.4 for further trail and bridge information).



3.3 INTERPRETIVE THEMES AND PROGRAMS

Arana Gulch's setting offers opportunities for two primary interpretive themes:

- Preservation and enhancement of the Santa Cruz tarplant/ coastal prairie habitat, and
- Riparian/wetland wildlife viewing and nature observation.

These themes are discussed in greater detail below. Future educational programs, interpretive displays, and brochures will convey educational information about these resources. There are no developed facilities, such as educational centers or group seating areas, proposed within Arana Gulch.

Interpretive displays would be designed to complement the natural setting. These displays would benefit both self-guided and docent-led tours. Brochures would also be created to enhance the educational experience. Volunteer-docent led walks could potentially be established in the future, similar to the "Wetland Walk"—a program created for the City's Neary Lagoon Wildlife Refuge. This program, developed in cooperation with the Santa Cruz Museum of Natural History, offers interactive outdoor exploration for elementary school children. The proximity to several public, private, and home schools makes Arana Gulch convenient for outdoor education programs. The immediate proximity of Harbor High School to Arana Gulch could allow for development of a more advanced educational program.

One of the primary interpretive themes will focus on efforts to ensure the long-term viability of the Santa Cruz tarplant and coastal prairie habitat. Interpretive displays and programs will highlight the importance of preserving this unique tarplant population. Management strategies, such as grazing, controlled burns, scraping, and mowing will also be explained. The history of the property's land use, notably cattle grazing, and its impact on the habitat area will also be presented. Interpretive displays, brochures, and programs will also emphasize the importance of being a responsible visitor and abiding by the park regulations to ensure the tarplant and other coastal prairie species are not harmed.

The second interpretive theme will focus on the riparian and wetland habitat areas along Arana Gulch Creek and Hagemann Gulch. The proposed Hagemann Gulch Bridge and a number of trail overlooks would provide opportunities for nature observation and wildlife viewing. These overlooks would benefit birdwatching in particular. Interpretive displays and brochures would highlight the tidal reach area of Arana Gulch Creek and the importance of preserving and enhancing the creek for fisheries habitat, focusing specifically on steelhead trout. Although the young fish rearing potential and steelhead habitat values are at low levels relative to other streams in the Santa Cruz Mountains region, the close proximity to schools offers a unique learning opportunity. The Arana Gulch Watershed Alliance (AGWA), Harbor High School and several other agencies collaborated to install a fully functional fish ladder and sediment pond upstream of Arana Gulch. Similar opportunities exist within Arana Gulch to develop educational projects in the future that would enhance steelhead habitat.

3.4 TRAIL SYSTEM

An interpretive trail system is the focus of public use within Arana Gulch. The proposed trail system, totaling approximately 2 miles, would provide public access for pedestrians, wheelchair users, and bicyclists. A key goal of the trail system is to provide visitors of all abilities with a place for outdoor observation and education about sensitive habitats. This trail system would be developed and maintained in a manner that does not result in significant degradation of habitat values. Another important goal it to close and restore informal or unauthorized pathways within Arana Gulch.

The existing trail system provides access for pedestrians and bicycles; however there are no trails accessible to wheelchair users. The proposed trail system would include trails that are fully compliant with the Americans with Disabilities Act (ADA), affording public access to a City greenbelt property by

visitors of all abilities. Within the City's other greenbelt properties, the steep terrain and site constraints have precluded developing ADA compliant trails.

In addition to providing opportunities to view nature and wildlife, the Arana Gulch trail system would also provide trail connections from adjacent communities through Arana Gulch to the coast and the Monterey Bay Sanctuary Scenic Trail. Envisioned as a continuous trail along the coastline of Monterey Bay, the Sanctuary Scenic Trail provides an interpretive and recreational trail for walkers, joggers, bicyclists, local residents, and visitors.

Within Arana Gulch, an existing north-south unpaved trail provides access for pedestrians and bicyclists from the Agnes Street entrance to the Upper Santa Cruz Harbor. The proposed trail system would improve this north-south trail route to provide for wheelchair users. The new trail system would also feature a new west-east trail connection between the Seabright neighborhood and the Harbor.

The existing trail system and trail-related issues at Arana Gulch are discussed in following Section. A detailed description of the proposed trail system is presented in Section 3.4.2, Trail Alignments and Improvements. The proposed trail system is depicted in Figure 7. The final section includes Trail Design and Management Guidelines.

3.4.1 EXISTING TRAILS

Prior to the City's ownership of Arana Gulch, the meadow area featured numerous cattle paths. These paths are visible on aerial photographs taken over the past several decades. When the City acquired the property in 1994, several informal pathways continued to exist. Many of these appear to have originally been cattle paths.

The *Arana Gulch Interim Management Plan*, adopted by City Council in 1997, identifies only one of these informal pathways as a "designated trail" to be maintained by the City Parks and Recreation Department. This unpaved trail, less than ¼ mile in length, is the primary north-south connection between Agnes Street and the Santa Cruz Harbor. The Interim Plan also identifies this north-south trail as a maintenance/emergency vehicle access route. Pedestrian and bicycle use are allowed on this trail, with dogs limited to on-leash use only. The southernmost segment of this trail has experienced substantial erosion due to the steep gradient of the trail route and needs to be realigned.

Since the City approved the Interim Management Plan, an unpaved loop trail along the perimeter of the meadow area has become increasingly popular with pedestrians. Much of this loop trail, approximately 0.8 miles in length, appears to have existed previously when cattle were grazed on the property.

At present, the existing trail system maintained by the Parks and Recreation Department totals approximately 1.2 miles (Figure 2, Existing Setting). This includes the north-south trail and loop trail encircling the meadow area. Neither of these existing trails is accessible to wheelchair users due to the unpaved, rough surface and steep gradients in some trail sections.

In addition to these designated trails, there are numerous unauthorized pathways crossing the coastal prairie and tarplant habitat areas. These pathways are either used as cut-through routes by pedestrians and bicycles, or for illegal off-leash dog use. The Parks and Recreation Department has made efforts to close these undesignated pathways and enforce leash laws, but available resources and management actions have been limited under the *Interim Management Plan*. A key goal of this Master Plan is to close unauthorized pathways and discourage off-trail use to better protect sensitive habitat areas.

Along Arana Gulch Creek there are also problems with undesignated pathways and illegal activities, including camping. The dense riparian vegetation helps to shield unauthorized users from public view. In addition to closing undesignated pathways within the riparian and wetland habitat areas, there is a need for a designated trail along the edge of the corridor that would increase visibility into the area and encourage appropriate public trail use and nature viewing.

3.4.2 TRAIL ALIGNMENTS AND IMPROVEMENTS

This section describes the proposed Arana Gulch trail system, totaling approximately 2 miles. The system would feature two types of trails: multi-use trails and pedestrian-only trails. Most of the trails, approximately 1.4 miles, would be limited to pedestrian use only, with dogs restricted to on-leash use at all times. Multi-use trails would be designed for pedestrian, bicycle, wheelchair, and on-leash dog use. Less than one-third of the total trail system within Arana Gulch would be multi-use trails.

The multi-use trails would include Arana Meadow, Creek View, and Canyon Trails. These trails would enable visitors of all abilities to experience and learn about the different habitat areas: the coastal prairie, Arana Gulch Creek, and Hagemann Gulch. These trails also provide key trail connections between adjoining neighborhoods and the coastline. Together, Canyon View and Creek View Trail would provide a continuous west-east trail connection through the Arana Gulch property and Upper Harbor.

Multi-use trails would feature a hardened surface and gradient that is compliant with the Americans with Disabilities Act (ADA) requirements. The trail width would be no greater than 8 feet wide, except for the proposed bridge over Hagemann Gulch and Arana Gulch Creek overlook which may be wider to accommodate interpretive displays and nature viewing areas.

Pedestrian-only trails would include the Coastal Prairie Loop Trail and Marsh Vista Trail. These pedestrian trails would be maintained as narrow, earthen footpaths. Most of the pedestrian trails in the trail system presently exist, though some realignments and improvements are necessary for erosion control and to enhance interpretive opportunities. The trail bed width for pedestrian trails would be approximately 18 to 24 inches.

Interpretive overlooks and displays would be located along the trail routes at locations that minimize impacts to sensitive habitats. Seating would be provided at scenic overlooks, but the number of benches would be limited. To discourage off-trail use, fencing and signs would be installed as needed. The amount of fencing would be limited to those locations where off-trail use cannot be controlled through other measures. No lighting would be installed along the trails within the meadow area of Arana Gulch. If deemed necessary for public safety, low level lighting may be installed at the Hagemann Gulch bridge and Upper Harbor area.

Multi-Use Interpretive Trails

Arana Meadow Trail (0.3 mile)

Arana Meadow Trail provides access to the coastal prairie habitat from the northern entrance at Agnes Street. The existing earthen trail is open to bicyclists, pedestrians, and on-leash dogs. During the rainy season, the trail surface is often muddy and rutted. This trail would be improved to meet ADA requirements to provide for wheelchair use. Improvements would include a hardened surface, not to exceed 8 feet in width. This would provide a fully accessible trail connection to Creek View Trail, and ultimately the upper Santa Cruz Harbor.

An interpretive display would be provided near the northern entrance to the trail. This display would focus on the resource values of coastal prairie habitat and Santa Cruz tarplant adaptive management. The display would also educate visitors about the importance of staying on designated trails and keeping dogs on leash at all times.

Creek View Trail (0.2 mile)

Creek View Trail is a new trail route, which would provide a fully accessible trail from Arana Meadow Trail to the Upper Harbor and Brommer Street. This trail route would be located on City and Port District property. Previously, the City of Santa Cruz had proposed constructing a pedestrian/bicycle bridge across Arana Gulch Creek, but this bridge is no longer being considered. Instead, the eastern segment of this trail route would be located along the north side of the Upper Harbor dry

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SCALE IN FEET

- Pedestrian/Bicycle Trail (wheelchair accessible)
- Pedestrian Trail (unpaved)
- Pedestrian Trail (unpaved/no dogs)
- Interpretive Display
- Overlook
- Master Plan Boundary
- City Limit

Note: Trail width symbol not to scale

Arana Gulch
MASTER PLAN

PROPOSED TRAIL SYSTEM

Figure 5

boat storage area, featuring an overlook of Arana Gulch Creek. This creek view would provide a unique opportunity to educate the public about coastal streams.

The proposed Creek View Trail segment within Arana Gulch would replace an existing earthen trail that is very steep and eroded as it descends the slope to the Upper Harbor. The existing trail route would be closed and the grassland would be restored on the steep slope. Approximately 575 linear feet of the new trail route would be located along the sloping meadow, while 600 linear feet of existing trail would be closed and restored to grassland habitat. Without the Creek View Trail, there would be no ADA compliant trail from the southern entrance of Arana Gulch.

Within the Port District property, the new trail route would follow the edge of the dry boat storage area for approximately 500 linear feet. An existing chain link fence separates the storage area from the proposed trail route. This corridor immediately adjacent to the storage area has been disturbed in past years and has limited habitat value, serving as a buffer between the Upper Harbor and the riparian habitat of Arana Gulch Creek to the north. Residents from nearby neighborhoods currently use this corridor as an informal pathway.

The new trail improvements within the Port District property would include an ADA compliant trail, approximately 8 feet in width along the perimeter of the storage area. At the eastern end of the storage area, a retaining wall would be needed in order to construct a new trail up the slope to the Upper Harbor entrance road. Improvements would also be made to the Upper Harbor entrance road to provide a safe connection to 7th Avenue and Brommer Street. An existing decomposed granite trail within the Port District property along the western edge of the dry boat storage area would continue to remain in place.

Creek View Trail would provide a unique opportunity in an urbanized area: a scenic overlook of a coastal stream in a more natural setting. At the overlook, interpretive displays would focus on birds, fisheries, and other wildlife that depend on the creek habitat. The displays would also explain the tidal influence in the lower reach of the creek, as well as broader information about the Arana Gulch watershed. This close up view of the creek is not possible from the other trails in Arana Gulch.

Canyon Trail (0.1 mile)

Canyon Trail would provide a new entrance and trail connection to Arana Gulch from the Seabright neighborhood area of Santa Cruz. This trail would feature a new bridge spanning Hagemann Gulch. Without a bridge, it is not feasible to create a multi-use, wheelchair accessible trail through the steep sided canyon. On the east side of Hagemann Gulch, the trail would continue through the meadow and connect with the other multi-use trails. The new bridge would also provide convenient access for visitors to the Coastal Prairie Loop Trail, a pedestrian trail encircling the meadow.

Access to the Canyon Trail entrance to Arana Gulch would be from the end of Broadway Avenue along a strip of property owned by the City of Santa Cruz. A multi-use trail, approximately 450 feet in length, would be developed at the end of Broadway. This new trail would connect to the proposed Hagemann Gulch bridge.

A new bridge spanning Hagemann Gulch would be designed to minimize impacts to native heritage trees and avoid substantial disturbance to the canyon. The bridge, approximately 330 feet in length, would avoid the need for structural supports within the steep canyon through cables anchored in abutments located at each end of the bridge. Minimal security lighting may be provided along the bridge as needed.

Views of the canyon from the Hagemann Gulch bridge would present opportunities for interpretive displays about riparian and oak woodland habitats, as well as bird watching. It would also provide a chance to share information about the challenges of managing invasive non-native vegetation in riparian habitat areas.

Pedestrian Interpretive Trails

Coastal Prairie Loop Trail (1 mile)

The Coastal Prairie Loop Trail is an existing trail encircling the Coastal Prairie/Tarplant Management Area. Much of this trail appears to have been a cattle path in previous decades when the property was grazed. Only minimal erosion control improvements are needed for this trail route. In addition to the larger loop trail, a short spur trail continuing along the eastern edge of the terrace would allow a shorter loop trail route. This spur trail presently exists, but would be realigned as needed to create a smooth transition to the multi-use trails. Existing unauthorized and cut-through pathways that cross the meadow area would be closed and the grassland restored.

Trail use would be open to pedestrians only, with dogs restricted to on-leash use at all times. To protect sensitive habitat, particularly Santa Cruz tarplant, visitors and their dogs would not be permitted off trail in the open meadow. Signs and fencing, as needed, would be installed along the trail to discourage future unauthorized pathways.

This Loop Trail offers scenic views of open meadow, majestic oak trees, the Santa Cruz Harbor, and a diversity of plant and animal life. On the upper slope of Hagemann Gulch, "Rose of Castile" heritage roses appear along the trail. In spring, prairie wildflowers can be observed along the trail while summertime visitors can look across the meadow to see the yellow bloom of the Santa Cruz tarplant. Near the Agnes Street trail entrance and near the Hagemann Gulch bridge entrance to the meadow, interpretive displays would feature information describing the coastal prairie habitat and the Santa Cruz tarplant. At the Harbor overlook along the Loop Trail, seating may be installed.

Marsh Vista Trail (0.4 mile)

Marsh Vista Trail would offer vistas of Arana Gulch Creek and the broad, marshy floodplain. Segments of the trail route presently exist and are likely the remnants of cattle paths. This trail would be realigned and improved to follow along the western edge of the Arana Gulch Creek Riparian and Wetland Management Area.

Trail use would be limited to pedestrian use only. Waterfowl, such as great blue heron and a number of other bird species, forage and thrive along Arana Gulch Creek, utilizing the area for food and sanctuary. Dogs would be prohibited on this trail at all times to protect this sensitive habitat from unnecessary disturbances.

As part of the new trail route improvements, unauthorized pathways into the riparian and wetland habitat areas would also be closed and restored. These paths have typically been used for illegal camping and other inappropriate activities. Increasing public views into this area would help to deter possible future illegal activities.

Marsh Vista Trail provides valuable opportunities for bird watching and nature viewing. A small overlook, with seating and an interpretive display, would be provided along the trail route. To protect wildlife and fragile riparian and wetland vegetation, no direct public access into the creek or marshland would be allowed

3.4.3 TRAIL DESIGN AND MANAGEMENT GUIDELINES

This section outlines trail design guidelines and management actions. A multi-faceted approach is recommended for trail management and enforcement of trail regulations. This approach involves appropriate trail design, education, regulations, enforcement and monitoring.

Trail Design Guidelines

- Construct multi-use trails (pedestrian, wheelchair, and bicycle use) to be 8 feet-wide. Trail surfacing shall be compliant with Americans with Disabilities Act (ADA) requirements. Trail design would minimize impacts to natural drainage patterns.

- Develop a new western entrance to Arana Gulch and construct a new bridge across Hagemann Gulch, approximately 330 feet in length. The bridge would be designed to avoid structural supports within the steep-sided canyon. The bridge would minimize impacts to the steep sided canyon and heritage trees.
- Coordinate with Santa Cruz Harbor representatives regarding the design and construction of Creek View Trail within the Port District property.
- Construct interpretive displays and overlook viewpoints along multi-use trails to comply with ADA requirements. Interpretive displays shall be designed to blend with natural setting and be vandal resistant.
- Provide seating at overlooks along Marsh Vista and Coastal Prairie Loop Trails. Seating shall be designed to complement the natural setting and be vandal resistant.
- Construct and maintain pedestrian trails to be 18 to 24 inches wide, with natural surfacing. Provide drainage improvements along trails to include drainage dips and water bars.
- Develop and implement a coordinated trail sign program to ensure signs are easy to read, consistent in design and message, and do not detract from the visual quality of Arana Gulch. Post trail markers including trail use designations at appropriate locations. Trail sign program shall be consistent with the other City greenbelt properties.
- Install fencing as needed to deter off-trail use and short cuts. Fencing shall blend with the natural environment and be installed in a manner that does not limit future resource management actions.

Trail Management

- Conduct annual maintenance including trail mowing, brushing and erosion control repairs.
- Monitor trail use to ensure negative impacts to sensitive habitat areas and wildlife do not occur. Utilize various techniques to discourage establishment of unauthorized pathways or cut-through routes. These techniques shall include planting native vegetation, installing logs or other natural debris to cover pathway, posting signs, or installing fencing as needed.
- Conduct Park Ranger patrols to ensure appropriate trail use and enforce trail regulations.
- Distribute trail brochures describing the trail system, regulations and appropriate trail etiquette. Post trail etiquette signs if needed.
- Identify reduced speed (slow) trail segments, as needed. Signs would be installed, only as needed, at trail intersections, areas with limited visibility and steeper gradients.

3.5 OPERATIONS AND STAFFING

Management of Arana Gulch lies within the area of responsibility of the Parks Division within the City's Parks and Recreation Department. The Parks Division is under the operational supervision of the Superintendent of Parks, who reports directly to the Director of the Parks and Recreation Department. A Parks Maintenance Supervisor oversees the daily maintenance and resource management activities at Arana Gulch. Other City staff and consultants may assist the Supervisor as needed.

Management and maintenance responsibilities for Arana Gulch can be organized under four general categories: maintenance, resource management, interpretation and education, and enforcement/public safety. The areas of responsibility are described in greater detail below.

Maintenance

The *Arana Gulch Interim Management Plan* limits existing maintenance responsibilities to annual fuel break and trail mowing, emptying trash containers, and clean-up of refuse and illegal campsites. Routine repairs typically involve damage to entrance and regulatory signs due to vandalism and minor trail maintenance.

Implementation of the *Arana Gulch Master Plan* will result in an increase in trail maintenance and trail use monitoring due to the improved trail system. The new trails, however, will be constructed in a manner that requires minimal trail maintenance needs and addresses existing erosion problems. New trail markers and interpretive displays will also require additional maintenance. City Parks Maintenance Workers will perform most of the maintenance activities.

Resource Management

The primary resource management responsibility within Arana Gulch is implementation of the Tarplant Adaptive Management Program, which is included as Appendix A. This program was developed to ensure the long-term viability of the Santa Cruz tarplant and coastal prairie habitat. Specific management actions will include annual census surveys and activities such as mowing, scraping, grazing and controlled burns. City contractors—under the guidance of the Technical Advisory Group comprised of tarplant researchers and botanists—would carry out the majority of these activities. The Santa Cruz Fire Department, in cooperation with other fire agencies, would conduct any controlled burns.

Other resource management responsibilities include: monitoring sensitive resource conditions, protecting wildlife, wildland fire management, invasive species removal, and habitat enhancement projects. These activities will be undertaken by City Parks Maintenance Workers and Rangers, with technical consultants and contractors utilized as needed. Volunteers may also assist with invasive species removal and habitat enhancement activities.

Law Enforcement and Public Safety

The Park Ranger program is responsible for routine patrols to ensure public safety and enforce park regulations. Park Ranger staffing levels have varied over the years, based on the City's budget conditions. The Santa Cruz Police Department responds to specific requests for assistance and coordinates with Park Rangers regarding illegal camping and other illegal activity problems. Some of the problems occurring within Arana Gulch include illegal camping and associated refuse and environmental damage, vandalism of signs and trees, and off-leash dog use.

Interpretation and Education

Park Rangers provide a visible presence within the City's greenbelt properties, including Arana Gulch, and serve as contacts for the public. In addition to law enforcement and public safety, Park Rangers can provide educational information and lead interpretive walks as duties allow. Cooperative programs have also been established with City of Santa Cruz Natural History Museum to conduct interpretive walks through other City parklands. A similar program could be developed for Arana Gulch. Volunteer docents may also be considered to lead tours for school fieldtrips.

Staffing Levels

In the past, Parks Maintenance Workers, Park Rangers, and Park Planning Division staff have fulfilled these responsibilities. Park Maintenance and Park Ranger staffing levels have varied over the years due to City budget conditions. Implementation of the *Arana Gulch Master Plan* will require continued assignment of Parks Maintenance Workers and Park Rangers to maintain and patrol Arana Gulch.

3.6 PHASING AND IMPLEMENTATION

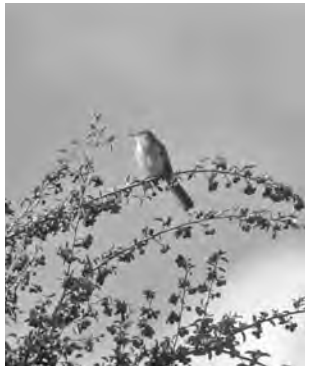
This section presents a preliminary phasing plan for implementation of the *Arana Gulch Master Plan*. This phasing plan provides general recommendations and should be viewed only as a tool to guide implementation. The City Council may determine that specific projects should receive higher priority than presented in this section. Where improvements are identified as part of mitigation measures in the *Arana Gulch Master Plan–Environmental Impact Report*, however, they must occur as required by the environmental document.

3.6.1 PRELIMINARY PHASING PLAN

The preliminary phasing plan is organized into two phases, based on fiscal year cycles which begin in July of each calendar year. The first phase focuses on establishing the Tarplant Management Program and developing the multi-use interpretive trail system. The second phase largely focused on continued implementation of the Tarplant Management Program, management of the trail system, and restoration of eroded areas. The phasing plan is outlined below.

3.6.2 FUNDING SOURCES

Implementation of the *Arana Gulch Master Plan* is dependent on the availability of funding to accomplish various projects. Specific cost estimates for these projects, including trails and erosion control projects, are not included as part of this Master Plan. Cost estimates will be prepared separately as analysis and detailed designs are completed. Several funding sources will likely be utilized to fund projects, including federal, state and regional grant programs, and City funds. A brief discussion of these funding sources follows.



Preliminary Phasing Plan for Implementation of the Arana Gulch Master Plan

PHASE I (July 2006–June 2009)

Resource Management

- Establish Adaptive Management Working Group and conduct management actions under the Tarplant Management Program
- Pursue funding to conduct gully repair and to further analyze Arana Gulch Creek tidal reach erosion.
- Remove non-native vegetation within riparian habitat areas.

Trails

- Develop interpretive displays and educational programs.
- Close undesignated pathways throughout Arana Gulch.
- Construct new Canyon Trail (multi-use), including Hagemann Gulch bridge. Install interpretive displays.
- Construct new Creek View Trail (multi-use) within Arana Gulch property. Creek View Trail segment through Port District property may be constructed in Phase II depending on available funding.
- Construct improvements to Arana Meadow Trail (multi-use trail)
- Construct improvements to Marsh Vista Trail (pedestrian only)

PHASE II (July 2009–ongoing)

Resource Management

- Conduct management actions under the Tarplant Management Program.
- Continue removal of non-native invasive vegetation within riparian habitat areas.
- Repair and restore eroded gully near Agnes Street.
- Conduct analysis of eroded tidal reach of Arana Gulch Creek and identify possible solutions. Implement stabilization of tidal reach.

Trails

- Monitor trail use and implement appropriate measures to ensure visitors do not degrade habitat areas through off-trail use or other unauthorized activities.

Major multi-use trail improvements, including the Hagemann Gulch Bridge, Canyon Trail and Creek View Trail would be largely funded through federal and state grants previously received by the City. These federal and state grants were received in order to fund the east-west multi-use trail, including the new bridge over Hagemann Gulch. The grant funding totals approximately $1.6 million.

Future state and federal grant opportunities will also be pursued to help fund natural resource enhancement and erosion control studies and implementation. Some of the state grant programs that may be applicable include programs administered through the Resources Agency, Department of Parks and Recreation, and Department of Water Resources.

Local funding will likely be the source for implementation of minor trail improvements and on-going resource management. The City Council has previously determined that a portion of the revenue generated by the Parks and Recreation Facilities fees collected by the City would go toward the greenbelt properties. In addition, the City Council may consider utilizing the sale of City-owned property, such as the Broadway extension alignment outside of the Master Plan boundaries, to help fund implementation of the Santa Cruz Tarplant Adaptive Management Program and provide the local match for state and federal grants.

In order to ensure long-term management of the Santa Cruz tarplant, a sustained funding program must be established within the City. This program would be separate from the ongoing annual maintenance funding and Capital Improvement Projects. Ideally, the tarplant management program would be structured similar to an endowment program.

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A

APPENDIX A

SANTA CRUZ TARPLANT ADAPTIVE MANAGEMENT PROGRAM

This Appendix includes excerpts from *A Management Program for Santa Cruz Tarplant (Holocarpha macradenia) at Arana Gulch*, prepared by Bruce M. Pavlik and Erin K. Espeland of BMP Ecosciences for the City of Santa Cruz. The report in its entirety includes further technical information regarding the Santa Cruz tarplant. These excerpts include a general discussion of the tarplant and the text regarding tarplant management at Arana Gulch.

TABLE OF CONTENTS

1 Introduction 52
2 An Overview of Santa Cruz Tarplant Biology Highlights 53
3 Santa Cruz Tarplant Population at Arana Gulch 55
4 Managing Populations of Santa Cruz Tarplant 57
5 Santa Cruz Tarplant Management Plan 2006-2026 67

Figures

1 Santa Cruz Tarplant Subpopulation Areas Map 59
2 Tarplant Census Map 2004 61
3 Tarplant Census Map 2005 63

Tables

1 Census Estimates and Management Actions for Subpopulations at Arana Gulch 1989-2005 56

Literature Cited 73

Appendix 1

Suggestions for Census at Arana Gulch 75

Appendix 2

Suggestions for Implementation of this Program 77

1 INTRODUCTION

Purpose of this Management Program

The purpose of this program is to provide an adaptive management framework for enlarging the population of the Santa Cruz tarplant *(Holocarpha macradenia)* by improving the quality of coastal prairie habitat at Arana Gulch. Persistence in its coastal prairie habitat completely depends upon successful completion of the process of sexual reproduction and the production of seeds. The seeds probably reside in the soil seed bank for five to ten years, providing a reserve of dormant meristems that can wait until favorable conditions (moisture, light, temperature) return. Those conditions are promoted by periodic disturbance by fire, grazing, soil surface exposure or "scraping," that reduce non-native grass cover and thatch, especially with coincidence of ample winter rainfall. Without natural periodic disturbance, or active management such as grazing, mowing, scraping, or controlled burns, to reduce non-native grasses and thatch, Santa Cruz tarplant populations dramatically decline.

These management actions, however, are not well understood, nor have they been consistently applied at Arana Gulch. In the absence of a science-driven, long-term and consistent program of management, the quality of coastal prairie and the vigor of Santa Cruz tarplant will continue to degrade. A framework for guiding the program, known as adaptive management, is needed to bring together motivated stakeholders (the City, scientists, environmental and user groups) in an objective, cooperative process of ecological restoration.

This document provides guidelines for establishing an Adaptive Management Working Group, comprised of stakeholders, to provide direction and oversight of future long-term management efforts at Arana Gulch.

Sections 1 through 4 of this document provide an overview of the biology of the Santa Cruz tarplant and its status within Arana Gulch. Sections 5 and 6 include specific information regarding management techniques and establishing a long-term Adaptive Management Program for Arana Gulch.

Background

Santa Cruz tarplant *(Holocarpha macradenia)* was once abundant and widespread from Marin to Monterey counties, however, it is now known only from nine natural populations that vary greatly in size and stability. The species is listed under the California Endangered Species Act as "endangered" and under the federal Endangered Species Act as "threatened." Critical habitat under the latter statute was designated in 2002, which included the population at Arana Gulch.

At Arana Gulch, the City of Santa Cruz owns a significant remnant of coastal prairie, situated on a coastal terrace with many of its geological and biological features intact. Here, the population of Santa Cruz tarplant has fluctuated greatly in size and spatial extent. Before cessation of cattle grazing in 1988, there were more than 100,000 individuals in four large patches, or subpopulations, spread across the central and southern end of the prairie at Arana Gulch. In subsequent years, the number of plants could vary from zero to 65,000 in two or three subpopulations, depending on the occurrence of fire, soil scraping, or other management actions that removed grass cover and thatch.

The City of Santa Cruz acquired the Arana Gulch property in 1994, after a long history of grazing by dairy cattle. The site is opportunistically managed (i.e. actions are taken when possible, but not consistently or in a programmatic way). Current threats to the Santa Cruz tarplant subpopulations include illegal activities (e.g. arson, off-road vehicles, vandalism) or other activities that bring accidental impacts to plants (e.g. by hikers, mountain bikers, or domestic animals). Development around the perimeter of the site has certainly altered historic hydrology patterns, changing water runoff patterns and perhaps even the total amount of water flowing in the soil column beneath the grassland. Shading by introduced trees creates inhospitable habitat for Santa Cruz tarplant, as could other landscaping associated with development. Development also curtails or greatly complicates the use of certain management actions, such as controlled burns or fire.

But the greatest current threat to Santa Cruz tarplant at Arana Gulch comes from invasion of the coastal prairie by non-native plants, combined with a lack of a program of consistent, appropriate management (Hayes 2002, Hayes, pers. comm., Bainbridge, pers. comm., Hillyard, pers. comm.). Much of the site is home to weedy, non-native plant populations such as the annual grasses. Dense stands of these invasive species provide poor quality habitat for Santa Cruz tarplant. Non-native grasses contribute 38 to 88% of the vegetation cover within subpopulations at Arana Gulch, while non-native annual forbs contribute 30 to 55% (Bainbridge 2003).

Prior to removal of livestock, grazing provided an excellent tool for reducing the cover of non-native plants and the accumulation of thatch. It may also have provided other forms of disturbance to the soil surface, as well as a mechanism for Santa Cruz tarplant seed dispersal among subpopulations. In general, tarplant species are associated with grasslands that receive one or more forms of disturbance, either by fire (Carlsen and Espeland in review) or grazing (Hayes 2002).

2 AN OVERVIEW OF SANTA CRUZ TARPLANT BIOLOGY HIGHLIGHTS

Santa Cruz tarplant is a member of the sunflower family (Asteraceae), long recognized as a unique species in the genus Holocarpha. This unique tarplant is an aromatic, resinous annual with linear, toothed leaves. The basal leaves form a rosette. Flowering individuals can become as tall as 1 meter, with terminal spreading branches that produce multiple inflorescence heads (Keil 1993, Hayes 2002). The leaves on the stem and branches are smaller than those found on the rosette and are hairier.

Flower heads are terminal on the branches, and each head contains both ray and disk flowers. Ray flowers are the outermost flowers on the head, producing a long petal that comprises the showiest part of the inflorescence, while the disk flowers are the innermost flowers with minute petals and protruding black stamens. Each flower produces a dry fruit, known as an achene, which contains one seed.

Santa Cruz tarplant germinates after the first significant rainfall event, usually in the late fall, and the basal rosette of leaves increases in size throughout the growing season until late June (Hayes 2002), although plants can bolt much earlier in the year as well (Bainbridge memo 7/20/05). As the plants near reproduction, a stem bolts from the center of the rosette and eventually produces anywhere from one to 60 flower heads that average 1cm in diameter each (Hayes 2002). Flowers of Santa Cruz tarplant are produced in the summer, any time between April and November (Bainbridge 7/20/05).

Annual plants, such as Santa Cruz tarplant, are completely dependent upon successful completion of the process of sexual reproduction. Unlike perennials, they do not maintain long-lived growing points (meristems) that allow persistence in the vegetative state. Such meristems allow trees and shrubs to live through and recover from adverse environmental conditions, even if sexual reproduction fails. The meristems of annuals, however, are stored in seeds, which only become activated during germination. Once they begin growing, they must produce enough stem length and leaf area to support the costly and uncertain processes of flower formation, pollination and seed formation. During this time they are vulnerable to predation, disease, drought, and other sources of mortality that could defeat reproduction and lead to population decline. In the case of annuals, this decline is best measured as a decrease in the size and quality of the seed bank—the reservoir of dormant meristems that reside at or below the soil surface. It is the seed bank of Santa Cruz tarplant and its attendant processes that will determine persistence at Arana Gulch.

General Distribution and Habitat Characteristics

Santa Cruz tarplant has historically been found in coastal prairies and coastal range grasslands at low elevations (below 300m) in northern and central California. All extant populations of Santa Cruz tarplant occur on marine deposits or on alluvial deposits derived from marine parent materials (Palmer 1982).

The species is currently limited to nine or ten natural populations in Santa Cruz and northern Monterey counties. Eighteen sites in Alameda County have recently supported small reintroduced populations (attachment to Morey memo 12/12/94). The population at Arana Gulch in the City of Santa Cruz (Santa Cruz County) occurs on an ancient coastal terrace hypothesized to be about 100,000 years old (Palmer 1982).

Natural Disturbance Processes in Coastal Prairie

Wildfire was a common feature in the California landscape prior to European colonization and the adoption of suppression policies (Keeley 2002). Natural fires in coastal prairies were probably started by lightning strikes in the late spring or fall when storms were likely and fuels dry, but human-ignited fires were probably more common. Some have suggested that prior to arrival of Europeans; the frequency of fire in coastal prairie may have been as high as once per year (Heady et al. 1988). The indigenous people of the Santa Cruz area regularly used fire as a vegetation management tool to increase local biotic productivity, to facilitate the growth of their food plants, and to maintain open landscapes for ease of human and large mammal movement (Skowronek 1998). Early explorers frequently mentioned the burning practices of the indigenous peoples of California, and Father Juan Crespi's diary of the Portolá Expedition described entirely burned grasslands all along the Santa Cruz coastline in October of 1769 (Bolton 1971).

Grazing by large herbivores has been important in California grasslands—historically by elk and more recently by cattle and sheep. During the late Pleistocene, up until the appearance of indigenous peoples, California sustained as heavy a grazing pressure as the East African savannah does today (Wagner 1989). Certain grazing regimes appear to favor establishment of some native perennial grasses (e.g. *Danthonia californica)* in coastal prairies (Hayes 2003).

Research in the Central Valley grassland has shown that grazing reduces competition between developing perennial grass seedlings and non-native annual grasses (Marty et al. in review)—a competitive interaction that California's native plants generally lose (Heady 1956, Bartolome 1979, Carlsen et al. 2000). Many tarplant species respond well to grazing disturbance. Like other California wildflowers, they can benefit from removal of aboveground thatch (Meyer and Schiffman 1999) and a more open canopy environment (Hayes 2003). It is possible that these effects are more pronounced since the invasion of non-native annual grasses, which have higher thatch accumulation rates and form denser canopies over the landscape than typical California native perennial grasses (Meyer and Schiffman 1999). Grazing at Arana Gulch has been intense in the past, with a dairy operation persisting until 1988 (Hayes 1997), and prior to that, Spanish colonists submitted the state's grasslands to intense grazing pressure starting in the mid 1800s (Stromberg and Griffin 1996).

Fossorial mammals can be another source of disturbance in coastal prairie. Gophers can slow the aboveground accumulation of phytomass (Stromberg and Griffin 1996). This accumulation, which results in thatch, can be quite large in communities with introduced annual grasses. This thatch can greatly inhibit both the growth and survivorship of California native plants (Meyer and Schiffman 1999, Carlsen et al. 2000). By reducing thatch accumulation, gophers and cattle can have a similar effect on stimulating the growth and persistence of California native plants. However, while gophers have the positive effect of reducing the competitive effect of annual grasses, the disturbance they create can inhibit establishment of California native plants by creating inhospitable germination environments (soil of gopher mounds, while open, has lower water-holding capacity then surrounding areas) or by simply burying developing seedlings (Stromberg and Griffin 1996). However, Santa Cruz tarplant appears to respond poorly to conditions on mounds (low germination, seedling death due to burial) (Bainbridge memo 7/20/05), perhaps because the small scale of gopher disturbance may not significantly enhance light levels or deter herbivory by slugs and other microherbivores (Hayes memo 8/8/05, Maze unpublished ms. 2005).

3 SANTA CRUZ TARPLANT POPULATION AT ARANA GULCH

Census data for Santa Cruz Tarplant at Arana Gulch were first obtained by Randy Morgan in 1977 (CNDDB # SPNXFJ3). Previous to this, the plant was thought to be extinct (Munz 1959, Palmer 1982). In the early 1980s, Palmer visited many occurrences of the species in Northern California during his dissertation research. Details of how the Palmer's census was originally conducted at Arana Gulch are absent from his dissertation. Anecdotally, Bill Davilla who actively participated on many field trips recalls that Santa Cruz tarplant population density at Arana Gulch was moderate to low and the plants were small and unbranched. The coastal prairie community was dominated by non-native grasses and heavily impacted by cattle traffic and foraging. At that time, the dairy was still in operation and 35-40 head were routinely kept on the property.

At that time, collections of Santa Cruz tarplant were taken mostly from the southern portion of the property, which is now designated subpopulation A. No comprehensive census or survey took place on those trips, and there was no awareness at that time of separate subpopulations. After the cattle were removed, Santa Cruz tarplant plants became apparent in areas of the site where they had not been observed on cursory surveys, but in subsequent years non-native forbs to develop dense cover, especially in the northern half of the property (Davilla, pers. comm.).

In 1989, R. Doug Stone at EA Engineering Science and Technology Inc. (EAESTI) first designated and roughly mapped the subpopulation structure of Santa Cruz tarplant at Arana Gulch (Stone memo 7/11/89). He recognized four subpopulation areas, A, B, C, and D that occupied what appeared to be distinct areas in the southern end of the property (Figure 1). Stone did not find any plants in area C in either 1988 or 1989, but confirmed that Randy Morgan had observed around 10,000 plants in that area in 1986 (Stone memo 7/11/89).

These four recognized subpopulations (A, B, C and D) became the basis of all subsequent census efforts, although it was not until 2004 that they were accurately documented and logged with GPS data. The subpopulations became the focus of management activities and observations at Arana Gulch, in particular the largest and southernmost subpopulation A (Bainbridge 2003), although in 1998 plants were found in areas between the mapped subpopulations (CNDDB 2000) and Bainbridge's experiments include areas within subpopulation D and other areas at Arana Gulch.

Demographic data for Santa Cruz tarplant were collected by Dr. Susan Bainbridge (UC Jepson Herbarium) at Arana Gulch during 2000-2002 as part of her experiments on management techniques. Although much of these data are not yet available, it is clear that information on germination, survivorship, plant growth, and reproduction were obtained in response to small-scale, replicated mowing, soil scraping, and burning treatments. Demographic data were also obtained by Dr. Grey Hayes for artificial populations used in his dissertation research (Hayes 2002). Hayes, working on questions of coastal prairie ecology and management with Dr. Karen Holl at UC Santa Cruz, conducted his field experiments on three introduced populations to the north and south of Arana Gulch.

Population Census at Arana Gulch

The total number of aboveground plants at Arana Gulch has ranged from zero to an estimated 115,000 during the 18 census years of 1977 to 2004 (City of Santa Cruz memo, December 2004). The authors of this document assume that all of the plants found and tallied were reproductive, but this was not always indicated by the field worker. The largest reproductive population sizes, 10,000, were observed in 1986, 1988, 1997, 1998, and 2002. The smallest sizes, 100 or less, were observed in 1977, 1993, and 1995, the latter year producing no aboveground individuals. A summary of census data at Arana Gulch is included in Table 1. Census data for 2004 and 2005 are depicted in Figures 2 and 3.

Table 1 Census Estimates and Management Actions for Subpopulations at Arana Gulch **1989-2005**

Y = present, but no counts available U indicates mowing type (scythe-type or chopped mulch) unknown M indicates chopped mulch type mowing conducted

subpop/year	total # of plants[a]	management: July (previous) to June
SUBPOPULATION A		
1989	Y[b]	no management
1993	2	no management
1994	0	no management
1995	0	mowed[M], mowed[M]/raked
1996	7,420	mowed[U]/raked, scraped
1997	12,941	fall fire (arson) 10/96
1998	65,000	fall fire (prescribed) 10/97
1999	1,228	mowed[M], fall fire (prescribed) 10/98
2000	1,053	no management
2001	619	experiment (see Table 6)
2002	10,230	no management
2003	2,536	no management
2004	797	no management
2005	1,552	no management
SUBPOPULATION B		
1989	Y[b]	no management
1993	0	no management
1994	0	no management
1995	0	mowed[M], mowed[M] /some raked
1996	0	mowed[U]
1997	0	mowed[U], scraped small plots 10/96
1998	5[c]	mowed[U]
1999	0	mowed[U], fall fire (prescribed) 10/98
2000	0	mowed[U] (*)
2001	n/a	mowed[U]
2002	0	mowed[U]
2003	0	mowed[U]
2004	0	mowed[U]
2005	0	mowed[U]

subpop/year	total # of plants[a]	management: July (previous) to June
SUBPOPULATION C		
1989	0	no management
1993	0	no management
1994	0	no management
1995	0	mowed[M], mowed[M] /some raked
1996	0	mowed[U]
1997	0	mowed[U]
1998	20[c]	mowed[U]
1999	0	mowed[U]
2000	0	mowed[U]
2001	na	mowed[U]
2002	0	mowed[U]
2003	0	mowed[U]
2004	0	mowed[U]
2005	0	no management
SUBPOPULATION D		
1989	Y[b]	no management
1993	131	no management
1994	0	no management
1995	0	mowed[M], mowed[M] /some raked
1996	0	mowed[U]/raked/scraped
1997	21	mowed[U]/raked /scraped (small plots)
1998	60	no management
1999	1	fall fire (prescribed) 10/98
2000	1	no management
2001	na	experiment (no data available)
2002	156	no management
2003	57	no management
2004	2	no management
2005	0	no management

[a] When more than one population estimate is provided, the larger is used for this table

[b] Plants recorded as present in this subpopulation but no census data are provided

[c] Plants found at the periphery of this subpopulation location included

(*) Harris (memo 10/16/99) indicates that spring 2000 mows would be bailed (scythe-type and "raked") but there is no confirmation that this type of mow was performed

Seed Bank Dynamics

Seed bank studies found only ray seeds [achenes] in the soil (Palmer 1982, Bainbridge 2003), indicating that nearly all disk seeds germinate or are eaten in the year following production (it is possible but unlikely that these achenes could have also dispersed. Seed bank densities can be highly variable due to the spatial aggregation of dispersal in the landscape and also possibly due to different environmental conditions, including those due to different management practices.

Ray seeds comprise the persistent seed bank in the soil because the more easily germinable disk achene may mostly germinate each year, or, disk achenes may be more likely to be eaten due to their more delicate seed coats. The lack of a thick pericarp for disk seeds means that not only are they more likely to germinate with the first rains, but if they don't germinate, they are extremely likely to get eaten and therefore die. Predation experiments conducted on Santa Cruz tarplant disk achenes found predation rates of well over 90% in a 1-month interval (Hayes 2002). Seed predation, infection, and death all contribute to the loss of seeds from plant seed banks. Persistent seed banks can be quite low, even for annual plants that depend on seed banks as the only mechanism to maintain their populations over reproductive cycles.

Seeds of Santa Cruz tarplant can germinate after 6 to 9 years of room temperature storage (attachment to Morey memo 4/25/95), so may be able to persist even longer in the soil if they avoid predation, although older seeds, in general, have been found to produce less robust plants than younger ones (Priestley 1986).

4 MANAGING POPULATIONS OF SANTA CRUZ TARPLANT

The Arana Gulch population of Santa Cruz tarplant has been subjected to a wide range of management actions in the past. A few years after grazing cattle were removed in 1988; the number of aboveground individuals began to rapidly decline, leading to the conclusion Santa Cruz tarplant cannot persist without management.

In January of 1995, after the City acquired the Arana Gulch property, a Santa Cruz tarplant recovery workshop was convened by the California Department of Fish and Game. The workshop was attended by local botanists, Santa Cruz City staff, and concerned citizens. As a result of this workshop, several management actions were prescribed and implemented, including soil scraping and mowing. Similar workshops were held in subsequent years, through 2003. These workshops served to collate and disseminate information on much of the conservation and restoration research conducted on Santa Cruz tarplant at Arana Gulch and other population locations

It is now understood that long-term effective tarplant management would need to replace natural disturbance by native grazers, herbivores, and intense, regular fires that had long been absent from this fragment of coastal prairie. In the absence of these disturbances, grasses would out compete forbs such as Santa Cruz tarplant, especially non-native annual grasses that form thick stands with dense canopies and root systems. The grass stands provide low quality habitat (e.g. limited light and water) and build a thatch layer on the soil surface that probably retards Santa Cruz tarplant germination (Hayes and Holl, in review).

While effective management increases Santa Cruz tarplant population viability and decreases non-native grass cover, it may also control noxious weeds. It is important to recognize that effective management may have the unwanted effect of abetting the establishment of noxious weeds and additional weed control measures may be needed to prevent a biological invasion. Actions and research efforts focused around non-native grass control have attempted to determine what management actions might benefit Santa Cruz tarplant subpopulations and their ability to persist by simulating disturbance of the non-native grass canopy. Typically, these studies have measured demographic or individual plant characteristics in the summer

following some kind of site manipulation (e.g. soil scraping) or accidental disturbance (e.g. uncontrolled fire).

Soil Scraping

During November and December of 1995, two types of scraping were used to remove the canopy, thatch and upper organic layers of the soil at Arana Gulch. A bulldozer was used to scrape the soil surface of Santa Cruz tarplant subpopulation A after no plants had been found during the previous summer. This mechanical form of soil scraping was considered a drastic action, required to simulate catastrophic disturbance over a fairly large area of habitat. Hand scraping using garden hoes was also performed to remove the same canopy and soil surface layers. In the following summer of 1996 over 7,000 plants flowered and reproduced in the scraped areas and mechanical scraping appeared to be slightly more effective (although rigorous evaluation was not performed). Subsequent management actions and experiments examined soil scraping as a technique for releasing tarplant seeds from the seed bank. Experimental scraping at Arana Gulch resulted in high recruitment of tarplant compared with mowing, burning, or no management (Bainbridge 2003).

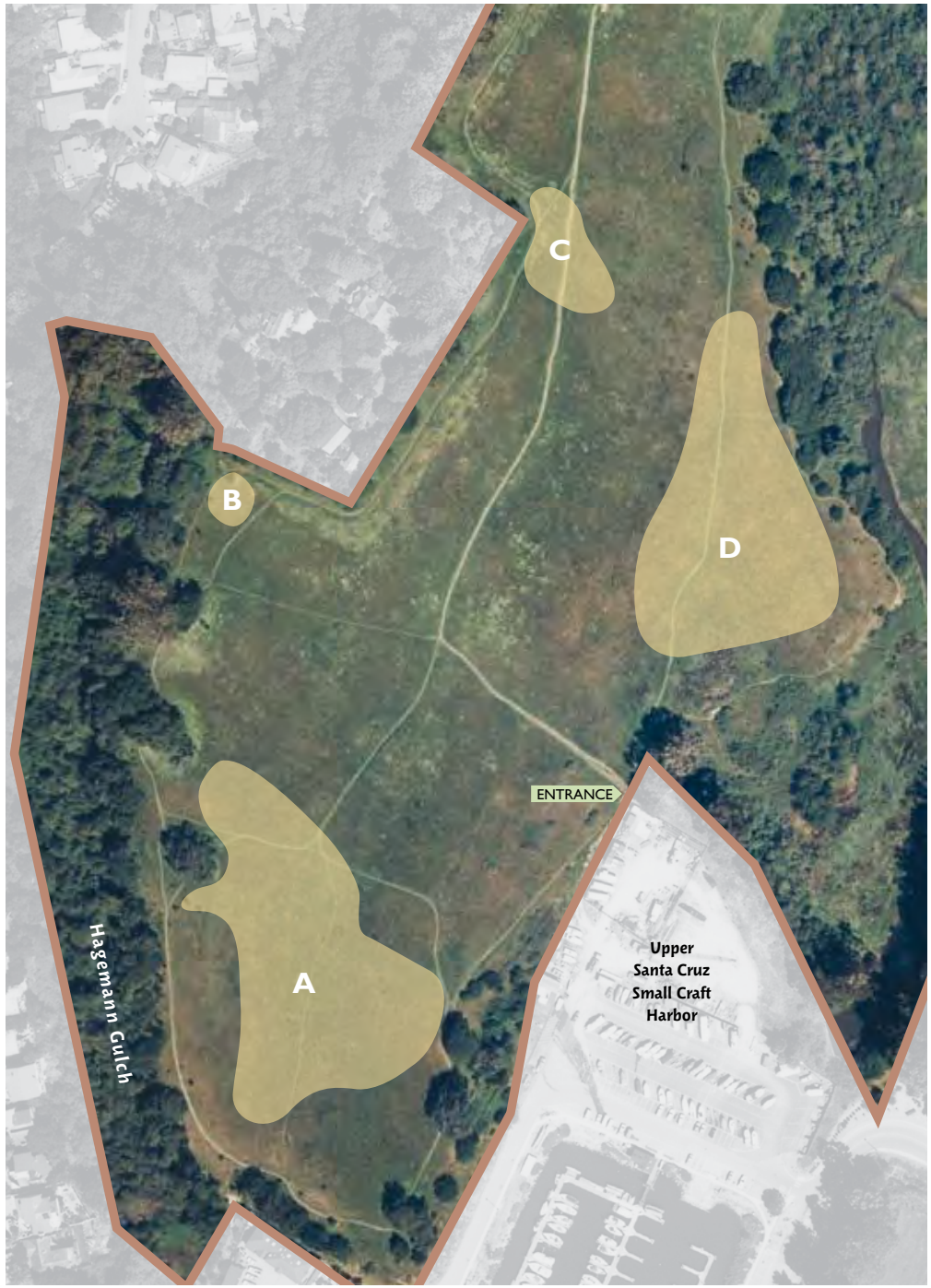
The precise mechanism for the increased tarplant population in scraped areas is unclear. Other native forbs also benefit from scraping (Bainbridge 2003) and the mechanisms may be similar among species. Bainbridge (memo 7/20/05) found that survivorship was similar among grazing, mowing, burning, and no management treatments and found that fall thatch cover significantly affected tarplant recruitment (Bainbridge 2003). The effects of scraping may be some combination of soil compaction, removal of thatch, removal of competitor seed, soil nutrient depletion via biomass removal, or removal of indirectly harmful agents (e.g. herbivores). Hayes (2002) found that large amounts of thatch were associated with higher levels of herbivory on tarplants. Thatch removal might then deter herbivores from finding and eating tarplant (Maze unpublished ms, 2005).

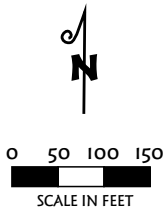
Soil scraping could also have adverse effects, including removal of tarplant seed, removal of seeds of other native forbs and grasses, increased predator access to seeds, soil nutrient depletion and excessive soil compaction. Recent modeling has demonstrated that forcing seeds to germinate ("flushing") can reduce the buffering effect of a large seed bank and diminish persistence across unfavorable years (Satterthwaite et al. unpublished ms, 2005). Given its drastic impacts on the soil surface and its ability to stimulate release of tarplant from the seed bank, scraping should be regarded as a catastrophic form of disturbance to be used infrequently through time and sparingly across Santa Cruz tarplant habitat.

Fire

During the fall of 1996, a portion of subpopulation A within the previously scraped area was burned in an accidental fire. By summer of 1997, the subpopulation had greatly increased to about 12,000 reproductive plants and expanded its distribution inside and outside the fire's boundary. The relative contributions of scraping and burning could not be ascertained. A prescribed burn conducted in the fall of 1997 was followed by the summer 1998 appearance of over 65,000 reproductive plants in subpopulation A. But the prescribed burn of October 1998 in subpopulation D produced only 1 plant in 1999 where 17 had occurred in the prior year (Table 1). Experimental fires in 2001 at Arana Gulch did not result in increased germination or survivorship of SCT (Bainbridge 2003), and laboratory experiments show that fire may stimulate germination of ray fruits but that resulting plant vigor is lower (Bainbridge memo 7/20/05).

Fire can be beneficial by removing thatch that inhibits native forb germination (Carlsen et al. 2000), and by destroying seeds of competing non-native grasses (Meyer and Schiffman 1999). Santa Cruz tarplant germination may respond positively to the fire itself, not just the associated thatch removal. Creating open areas through fire may also facilitate seed dis-



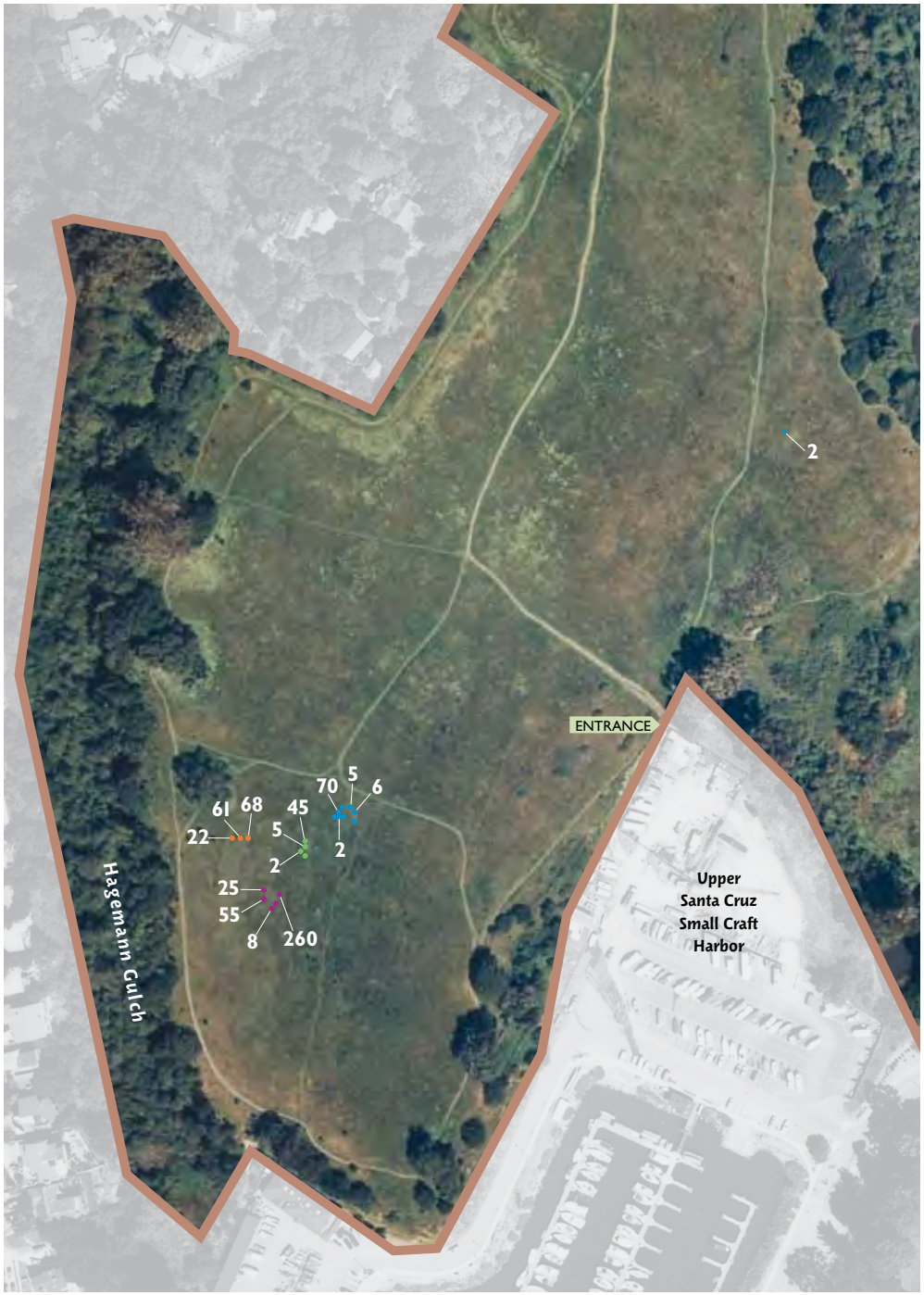


Approximate location of Santa Cruz Tarplant subpopulation areas identified in 1989.

Arana Gulch
MASTER PLAN

TARPLANT SUBPOPULATION AREAS

Figure 1



N

0 50 100 150

SCALE IN FEET

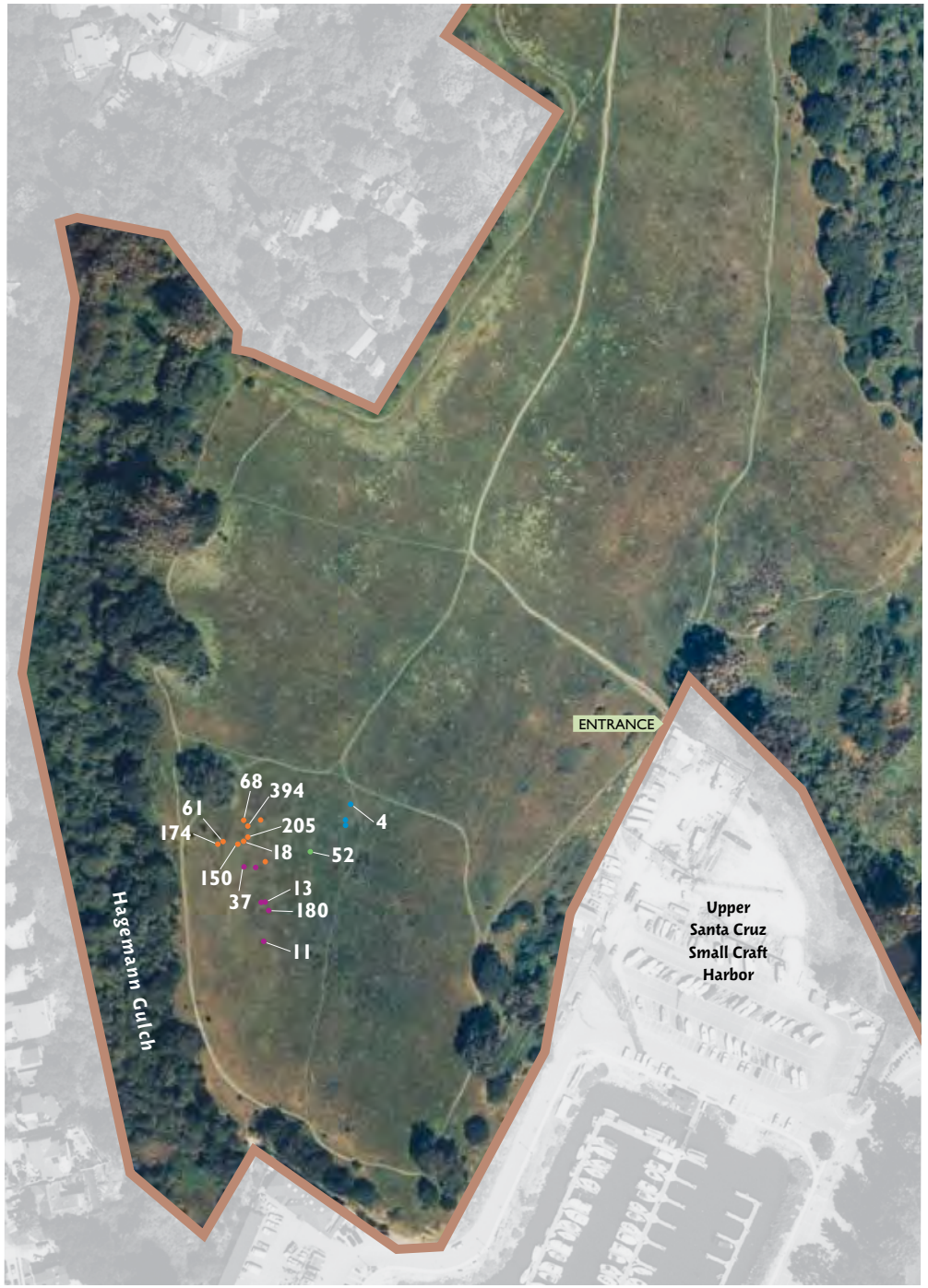
Positions of patches and individual Santa Cruz Tarplants in subpopulations A and D from the 2004 Census at Arana Gulch. Subpopulations B and C had no above-ground individuals. Colors indicate patches (see Appendix A data tables), the pointers indicate the number of individuals at a particular GPS location (WGS 84) within a patch. Unlabled points represent single SCT plants.

2004 PATCH			
• 1	• 2	• 3	• 4

Arana Gulch
MASTER PLAN

SANTA CRUZ TARPLANT 2004 Census

Figure 2



N

0 50 100 150

SCALE IN FEET

Positions of patches and individual Santa Cruz Tarplants in subpopulations A from the 2005 Census at Arana Gulch. Subpopulations B, C and D had no above-ground individuals. Colors indicate patches (see Appendix A data tables), the pointers indicate the number of individuals at a particular GPS location (WGS 84) within a patch. Unlabled points represent single SCT plants.

2005 PATCH			
• 1	• 2	• 3	• 4

Arana Gulch
MASTER PLAN

SANTA CRUZ TARPLANT

2005 Census

Figure 3

persal into these open areas (Carlsen and Espeland in review). However, fire can also have adverse effects on the target species by killing seeds with high temperatures (Odion 2000, Brooks 2002), and increasing seed predation (Espeland et al. 2004). Timing of fire may be important.

Overall, a controlled burn at should be regarded as a catastrophic form of disturbance to be used infrequently to drastically alter soil surface conditions. On a large scale, controlled burns have many logistic hurtles to be resolved, including safety requirements (e.g. trained burn control crew, fire control vehicle access), regulatory constraints (e.g. air quality, "burn day" system), and potential public relations problems (e.g. neighbor objections, user disappointment). On a small scale, however, they can be an important experimental treatment that returns an important disturbance factor to the habitat. Small-scale techniques (Pavlik et al. 1993, 2000) should be used for research purposes at Arana Gulch.

Grazing

The Santa Cruz tarplant population at Arana Gulch was able to maintain a large size, greater than 10,000 plants, under a high intensity, year-round grazing regime produced by domestic dairy cattle. This regime came to an abrupt end in 1988.

Grazing probably improves habitat quality for Santa Cruz tarplant by removing annual grass cover and phytomass, thus preventing aboveground competition during the growing season and reducing thatch accumulations that inhibit tarplant germination. Grazing also brings trampling, which opens, roughens and compacts surface layers of soil.

Grazers might also have been responsible for most of the pre-1988 dispersal of Santa Cruz tarplant seeds at Arana Gulch, as the sticky ray seeds could have adhered to the legs of passing animals. If long-distance dispersal was facilitated by these large, mobile grazers, then there must have been more genetic exchange between subpopulations in the past. The importance of this exchange to maintaining large, vigorous subpopulations and seed banks is currently unknown.

Grazing should be considered as an appropriate form of long-term, frequent disturbance that can benefit Santa Cruz tarplant and its coastal prairie habitat at Arana Gulch. However, there are significant logistical constraints associated with using cattle for this purpose, including requirements for substantial barbed wire or electric fencing, transport to and from the site, contractual specifications for intensity, duration and timing, and public relations. Other domesticated grazers, such as goats and sheep, may provide a similar service with fewer problems. Grazing should be regarded as an important experimental treatment that returns a critical disturbance factor to the habitat.

Mowing With Phytomass Removal

Many management experiments involving Santa Cruz tarplant have utilized mowing to simulate grazing disturbance with varying degrees of success. Mowing may be the most practical method for uniformly removing large amounts of grass biomass and accumulated thatch over large areas of an isolated fragment of coastal prairie. However, timing of mowing may be important, so as not to injure already-bolted tarplant or prematurely kill senescing plants.

Between 1995 and 2003, mowing has been performed every year at Arana Gulch in subpopulations B and C, with no reproductive tarplant individuals ever emerging from the seed bank (which may or may not have been present prior to treatment). This mowing was conducted as part of the City's fuel break mowing and did not include phytomass removal. Other mowed plots at Arana Gulch exhibited no germination compared to burned and scraped plots.

The effects of mowing with phytomass removal on the coastal prairie habitat of Santa Cruz tarplant can be similar to those of fire and intense grazing because all reduce thatch accumulation and aboveground competition from the grass canopy. However, mowing may be different than grazing in that it is less effective at creating open patches and less selective than

would-be grazers. Research in Midwestern prairies has shown that mowing and raking can have similar effects as burning (Tix and Charvat 2005). However, the timing of mowing must take into account different parameters than determining the timing of fire: in order to be effective in the following year: if mowing occurs after non-native grass seeds becomes ripe and disperse, then it may facilitate grass dispersal and increase competition with tarplant during the following year.

Timing is critical to the effects of mowing on tarplants, as is whether the cut grass is removed. Many commercial mowers do not remove thatch or the mowed grass material (phytomass), but merely break it into a mulch of smaller pieces that adheres to the soil surface like a blanket. This type of mowing was performed at Arana Gulch in 1995 (Quintanar 1995) and may have been responsible for the lack of a visible demographic response by the tarplant.

Mowing is less effective than fire, grazing, and scraping at creating bare ground, and it may be bare ground that is ultimately necessary for a positive demographic response. Other California native forbs have had a positive response to the creation of bare ground patches within grassland habitats (Meyer and Schiffman 1999, Espeland and Carlsen 2002). Bare ground can be important if germination and/or survivorship are sensitive to light availability, and bare soils are more compacted than those that have roots in them, possibly increasing seed-soil contact and aiding water imbibition of seeds.

Another benefit of mowing, however, could be the reduction in grass canopy height, which allows the seeds of late-flowering forbs to disperse a greater distance (Coulson et al. 2001). Mowing with phytomass removal should be investigated as an appropriate form of long-term, frequent disturbance that can benefit Santa Cruz tarplant and its coastal prairie habitat at Arana Gulch.

No Management

After the removal of cattle grazing from Arana Gulch in 1988, the number of reproductive Santa Cruz tarplant individuals dropped to less than 1,000 in 1989 (Morey 1995). With no disturbance from grazing, and no surrogate management regime, the number of aboveground, reproductive plants precipitously declined to 133 by 1993 and to zero plants in 1994 and 1995, after a period of only seven years. The population had evidently persisted in the seed bank because more plants were produced after treatment with soil scraping in 1995 and fire in 1996. Presumably the treatments were able to counteract unfavorable habitat conditions that developed between 1989 and 1994. These observations underscore the importance of the seed bank to population persistence of annual forbs like Santa Cruz tarplant.

Varied Responses to Management Regimes

As the multi-year management experiments by Hayes (2002) and Bainbridge (2003) show, management efforts may produce different results at different sites and years. Other studies have found that a management action that is beneficial in one year may be detrimental the next (Schultz and Crone 1998, Lesica and Martin 2003, Espeland et al. 2004, Carlsen and Espeland in review). It may not be possible to predict if an action will be beneficial in the upcoming year, but with a consistent schedule of actions and appropriate data feedbacks (i.e. monitoring programs), evaluation and adjustment will be possible.

Perhaps only certain subpopulations or even portions of subpopulations would receive the same management every year, allowing for variable responses across the Coastal Prairie/Tarplant Management Area within Arana Gulch. Although detrimental responses to consistent management may occur, it is probably more important to increase the probability of a favorable coincidence between the seed bank, the conditions of the growing season and the management regime. This coincidence would result in maximum seed production and replenishment of the seed bank, which in turn will allow persistence.

A more sophisticated aspect of developing a management regime is being able to respond to "good years" and "bad years" as they develop during the growing season. A season with early rainfall and warm temperatures can produce a dense, competitive sward of grasses that ultimately will inhibit subpopulations of Santa Cruz tarplant. Careful clipping and early removal of this canopy could maximize tarplant survivorship in what would otherwise be a "bad year". Other, "surgical" actions might be used to maximize seed output in "good years" by removing grass cover in spring. The mechanisms by which such actions survivorship or fecundity (by soil compaction, light infiltration, fire-cued germination, aboveground competition) need to be more clearly elucidated with a focused program of research as discussed in the next section.

5 SANTA CRUZ TARPLANT MANAGEMENT PROGRAM 2006-2026

Given the present understanding of Santa Cruz tarplant, this management program is based upon the following emergent biological principles:

1) the distribution, abundance and persistence of Santa Cruz tarplant subpopulations at Arana Gulch are largely controlled by factors affecting the size and dynamics of the seed bank,
2) seed bank characteristics are primarily determined by habitat quality within and between the subpopulations,
3) habitat quality mostly depends on minimizing the detrimental effects of high cover by non-native grasses, and
4) non-native annual grass cover can be reduced by restoring the proper disturbance regime to the coastal prairie of Arana Gulch.

This program is also based upon the following management principles:

1) stakeholders (with respect to Santa Cruz tarplant and coastal prairie) must commit adequate time and resources to a cooperative, decision-making process known as adaptive management,
2) the initial phases of the adaptive management program will emphasize consistency and precision, rather than optimization, of actions,
3) all management actions and research must be evaluated and reported within the annual cycle of Santa Cruz tarplant activity to allow timely adjustments, and
4) enlarging and expanding the seed bank of Santa Cruz tarplant by restoring disturbance to its habitat will require a long-term, science-driven commitment by all stakeholders.

Implementation of the Adaptive Management Framework

Given these biological and management principles listed above, there are five directives that should be implemented over the next 20 years (2006-2026). These include:

1) Implement an adaptive management framework which allows stakeholders to scientifically conduct and evaluate actions by establishing an Adaptive Management Working Group,
2) conduct a two-tracked program for improving overall habitat quality during the first seven years with

   a) semi-annual mowing with phytomass removal (or possibly prescription grazing) to reduce annual grass reproduction and cover over large portions of the Coastal Prairie/Tarplant Management Area, combined with

   b) ongoing experimental manipulations in reserved portions of the Management Area to improve existing, and to develop new, management actions
3) develop a schedule of "surgical" and "catastrophic" management actions,
4) build monitoring into the evaluation of every management action and research effort, and
5) develop public educational opportunities associated with

the coastal prairie of Arana Gulch and efforts to conserve and restore its rare resources.

Cooperative and committed management of Santa Cruz tarplant and coastal prairie habitat at Arana Gulch will depend on motivated stakeholders who participate in the decision-making process and work to implement basic actions. Those decisions and actions must be informed and evaluated by sound scientific, economic, and public policy information. Scientific information is generated by monitoring programs as well as directed (i.e. management-oriented) research. The best way to combine science with a stakeholder-controlled decision-making process is through an adaptive management framework.

Adaptive management is iterative: it evaluates decisions or actions through carefully designed monitoring and proposes subsequent modifications (Mulder et al. 2000). The modifications are in turn tested with an appropriate, perhaps redesigned, monitoring protocol. Adaptive management is logical, can deal with uncertainty and data gaps, and is similar to the scientific process of hypothesis testing. It recognizes that each stakeholder brings a unique perspective, but all are ultimately focused on enhancing Santa Cruz tarplant subpopulations and habitat quality by cooperating in an open, non-adversarial process.

The process of adaptive management is often represented as a cycle of strategy, design, implementation, monitoring, and evaluation. The first and most important task for implementation of the process is to develop a strategy that includes goals and objectives for Santa Cruz tarplant and its coastal prairie habitat, an inventory of known tools or actions for advancing the objectives (e.g. mowing, grazing), and the development of Key Management Questions that structure all subsequent monitoring and research activities. It is absolutely essential that stakeholders serving on the Adaptive Management Working Group cooperatively develop these elements of the strategy.

Goals and objectives are needed to provide a vision for the long-term conservation of Santa Cruz tarplant, its habitat and for Arana Gulch as a whole. That vision, whether it includes prairie restoration, subpopulation enhancement, or public access for education, must be defined through consensus in order to have the broadest possible stakeholder support. Without that support, opposition or apathy can prevent implementation to a halt. The vision cannot be forced upon stakeholders by regulatory agencies; it can only be guided and facilitated.

One of the first tasks of the Adaptive Management Working Group should be the development and adoption of broad, visionary goals and objectives that speak to the desired future state of Santa Cruz tar plant subpopulations and coastal prairie habitat at Arana Gulch. Once the goals and objectives are adopted, other elements in the strategy can be developed. Especially important will be the key management questions that focus science on specific management issues and data gaps and realize the vision set out in the goals and objectives.

Adaptive Management Working Group

Successful implementation of an adaptive management framework requires that committed stakeholders convene as an Adaptive Management Working Group. Stakeholders in this group should be interested in the outcomes of decision-making and in the technical process of managing the resources of Arana Gulch. This group may include personnel from public agencies (e.g. City of Santa Cruz, California Department of Fish and Game, U.S. Fish and Wildlife Service), private interests (e.g. California Native Plant Society) and scientific organizations (e.g. University of California).

Members of the Working Group would define and prioritize goals and objectives, develop key management questions, implement management actions, design and implement necessary monitoring programs, and utilize monitoring data to evaluate progress. A subset of the Adaptive Management Working Group, to be known as the Technical Advisory Group (TAG), would convene to address tactical scientific problems associ-

ated with data analysis and experimental design. The Working Group and Technical Advisory Group would utilize and expand this management program in concert with the efforts of state and federal agencies charged with conserving the species as a whole (including implementation of the federal recovery plan, when finalized).

The Adaptive Management Working Group would work cooperatively to enlarge and expand the seed bank of Santa Cruz tarplant at Arana Gulch by improving habitat conditions within the Coastal Prairie/Tarplant Management Program. The work would require a combination of management actions, research and monitoring while seeking public and private sector support for meeting the goals and objectives (vision) of the program.

Between the Adaptive Management Working Group, the public and representatives of the associated government agencies, there should be a structured flow of information. Policy and political issues can be brought to the Working Group for discussion. If a technical solution is appropriate, the Technical Advisory Group would be charged with its development using a science-based approach. Research and monitoring data can then be objectively reviewed and applied to the problem at hand. The results of the Technical Advisory Group deliberations are then taken back to the Adaptive Management Working Group for review. This flow is designed to bring issues to the table, provide objective feedback from monitoring and research, develop science-based solutions, and ensure that management actions, funding efforts, and regulatory requirements have follow-up and timely implementation. Although conflict among stakeholders is inevitable, structured information flow will help to resolve those conflicts over the long run and thus affect institutional synergy.

Conduct a Two-Tracked Habitat Management and Research Program

Evidence supports the conclusion that the average life of Santa Cruz tarplant seeds in the seed bank is between five and 10 years (Bainbridge pers. comm., Hayes pers. comm.). Appropriate disturbance must occur within that period to allow seeds to produce robust reproductive plants, thereby enlarging the seed bank. In the absence of that disturbance, annual grass and thatch cover inhibit germination and deter the establishment of large, reproductive individuals. Seeds that remain ungerminated in the seed bank die of old age, disease, or predation.

It is therefore critical that during the first seven years of this management program (at a minimum), a two-tracked program for enlarging the seed bank should be conducted by improving overall habitat quality in the coastal prairie of the Coastal Prairie/Tarplant Management Area. The emphasis would be on reducing cover and thatch by non-native annual grasses within the Management Area using a) semi-annual mowing regime (spring and fall, above 10 cm, with phytomass removal), combined with b) ongoing experimental manipulations (e.g. founding new subpopulations, plot-based testing of mowing, grazing and controlled burns) in reserved portions of the Management Area to improve existing, and develop new, management actions.

Invasion of coastal prairie by non-native grasses, combined with the elimination of disturbance by grazing and fire, have greatly modified the structure, composition and function of these grasslands. With respect to Santa Cruz tarplant, these changes have reduced the seed bank (and subpopulation sizes) by decreasing seed germination, plant survivorship and reproductive output. Annual grasses develop dense swards with high canopy cover, presumably leading to direct competition with young tarplant individuals. In the absence of disturbance (i.e. grazing and fire), the cover persists as an impenetrable overstory canopy or as a layer of dead thatch on the soil surface.

Reducing the canopy and removing the thatch have demonstrated beneficial effects on Santa Cruz tarplant demography (Hayes 2003, Hayes and Holl in review) and on grasslands in general (Meyer and Schiffman 1999). Therefore, improving the seed bank and habitat of Santa Cruz tarplant mostly depend on minimizing the detrimental effects of high cover by non-native grasses. These effects can by minimized by restoring the proper disturbance regime to the coastal prairie of Arana Gulch.

But exactly what is that disturbance regime? Recent research has shown that mowing the grass canopy and removing the clippings at least twice a year can improve germination, survivorship, flower output and seed output of Santa Cruz tarplant at some sites and in some years (Hayes and Holl in review). A small but heavy-duty lawn tractor, fitted with a mower and collector could readily navigate between the subpopulation areas, and would also be capable of treating the larger, unoccupied tracts of prairie within the Coastal Prairie/Tarplant Management Area.

The goal would be to reduce the standing cover of the grasses at least twice a year: once to cut off developing inflorescences in early spring, and once to reduce the final amount of grassland phytomass in late fall. The spring mowing could reduce grass reproduction (a greater detriment to the annual, non-native grasses than to native perennial grasses) and canopy cover without harming low-growing tarplant rosettes. The fall mowing would reduce thatch deposition, thus improving soil surface conditions for tarplant germination. It is important to note that fall mowing conducted before complete senescence would have a negative effect on the tarplant population.

The mowing disturbance regime would only mimic the phytomass removal effects of grazing by native and domesticated ungulates over large portions of the Coastal Prairie/Tarplant Management Area and would not incorporate soil disturbance or selectivity that grazers supply. However, this "Management Track" would be relatively easy and inexpensive to implement, with minimal regulatory uncertainty that complicates other possible habitat treatments (e.g. large-scale controlled burns). Semi-annual mowing could, therefore, be applied consistently every year for at least seven years to portions of Arana Gulch that are already occupied by Santa Cruz tarplant (the current subpopulation areas) or that could be occupied by tarplant in the future if habitat quality and seed bank distribution were not limiting.

However, the effects of the consistent, large-scale semi-annual mowing on Santa Cruz tarplant and its habitat are not predictable at present. The fall mowing, for example, might affect the dispersal of tarplant seeds, or even remove them from the site. Modifications to the regime, such as avoiding subpopulation areas in fall, may need to be tested (perhaps in control plots), as well as other possible treatments for reducing grass cover and thatch (e.g. small-scale prescription grazing, herbicide or burn treatments).

So, in addition to the first management track of the program, a second research track should be implemented to address key management questions regarding grass cover management. To support this "Research Track", portions of the subpopulations may be reserved as controls or as areas to receive a different treatment. Experimental subpopulations of Santa Cruz tarplant may be introduced to mowed areas beyond the existing subpopulations to test the efficacy of grass cover treatments, and to determine if introduction could be used as a way of enlarging the distribution of tarplant within the Coastal Prairie/Tarplant Management Area.

Develop a Schedule of Supplemental Surgical and Catastrophic Management Actions

Actions of the Management Track should take place on a seven-year cycle, owing to the postulated longevity of Santa Cruz tarplant seeds in the seed bank. In addition to regular mowing, relatively minor actions that affect small areas within the known subpopulation areas could be designed as sensitive responses to environmental conditions that develop within the current growing season. These "surgical" actions would counteract the detrimental affects of annual grasses on Santa Cruz

tarplant germination and establishment (Hayes and Holl, in review). For example, a typical surgical action might be hand clipping of the developing grass canopy during wet, warm fall and winter months (November to May) while carefully avoiding young Santa Cruz tarplant plants. The objective would be to keep the prairie canopy open to benefit Santa Cruz tarplant with additional light and soil water resources. A quasi-experimental framework would allow costs and benefits of such adjustments to be evaluated using cause-and-effect monitoring.

In year seven of the cycle, a major management action would take place. This "catastrophic" action would affect large areas within and around the subpopulation areas, or anywhere within the Coastal Prairie/Tarplant Management Area. It would take place without regard to (or prior knowledge of) conditions that will develop during the upcoming growing season and before tarplant germination. For example, a catastrophic action might be used to remove thatch and the upper few centimeters of soil organic material by mechanical scraping or an intense, controlled burn. Its timing would always be in late summer and early fall (August to October) before the first rains of the growing season.

A quasi-experimental framework would allow costs and benefits of such actions to be evaluated using cause-and-effect monitoring. If, however, the Santa Cruz tarplant population in year six happened to be very large (e.g. greater than 5,000 reproductive plants), then the catastrophic action should be delayed one or possibly two years before implementation. This is because the benefits of such an action might not compensate for the immediate losses (e.g. mortality of year six seeds). In general, the cyclical schedule should be regarded as flexible so that annual variations in climate can be taken advantage of (e.g. in "good" years) or compensated for (e.g. "bad" years). Guidelines for dealing with such variations are presented in Zedler and Black (1989).

The advantages of having a cyclical schedule of surgical and catastrophic management actions are; 1) surgical actions are immediate responses to each growing season that maximize Santa Cruz tarplant survivorship and reproductive output (seed bank replenishment), 2) catastrophic actions have a frequency that is matched to seed longevity in the seed bank, 3) catastrophic actions improve soil surface conditions to maximize tarplant germination without draining the seed bank, 4) efforts, costs and other logistical elements can be anticipated and developed well ahead of implementation and 5) simplification of the adaptive management process, including clarification of objectives and imposition of regularity on monitoring and evaluation.

Build Monitoring into Evaluation of Every Management Action and Research Effort

Monitoring informs adaptive management. It is designed and implemented with the expressed purpose of determining if the objectives of the adaptive management strategy are being met. Although the specific objectives of this management program have yet to be defined by the Adaptive Management Working Group, some basic elements of monitoring are universal; consistency (repeatable methods applied each year), constancy (applied every year), and appropriateness (for the focal resource). Such design elements are essential for evaluating actions and research efforts, as well as revealing the status of the focal resource, in this case, Santa Cruz tarplant. There are two general types of monitoring that should be used in this adaptive management program, which include "status and trend" monitoring and "cause and effect monitoring," which are described in more detail in the full report.

The AMWG should continue Santa Cruz tarplant subpopulation monitoring at Arana Gulch and integrate the data into the adaptive management framework. This would best be done by a qualified botanist or ecologist, approved by the Working Group and paid for time and expenses, to ensure high quality data collected at the right time of year. A standardized monitoring protocol (see suggestions, Appendix A) should be designed and adopted by the Working Group that would ensure the following:

1) similar effort and intensity of search from year-to-year,
2) inclusion of the entire area in the search (not just the known subpopulation areas,
3) use of GPS technology to map the locations of individual plants and subpopulations,
4) collection of relevant measures of habitat quality (e.g. cover by non-native grasses in subpopulation areas and invasive fronts of noxious weeds), and
5) an accounting of recent management actions or research.

Typically, status and trend monitoring places an emphasis on aboveground plants that survive to flower, but for annuals such as Santa Cruz tarplant, a supplemental program that examines trends in the seed banks of subpopulations is strongly recommended. A standardized data summary sheet and written report form should also be adopted to facilitate timely, year-to-year comparisons.

The seven year cycle proposed for Santa Cruz tarplant must be viewed as a series of management experiments that will test whether subpopulations (and their seed banks) are being enlarged and expanded by restoring disturbance to its coastal prairie habitat. The experiments would include:

1) the semi-annual mowing regime,
2) surgical actions, such as grass clipping, taken during the growing season, and
3) catastrophic actions, such as mechanical scraping of the soil surface, taken every seventh year. In addition, research efforts on the use of grazing animals, fire and other management tools would, by their scientific nature, include this kind of monitoring.

There is already a long history of Santa Cruz tarplant research with cause and effect monitoring at Arana Gulch (e.g. Bainbridge 2003) and elsewhere (Hayes 2003, Hayes and Holl in review) upon which to build. It is the task of the Adaptive Management Working Group to prioritize research needs (according to goals, objectives, and key management questions) for its own decision-making process and to help generate and allocate the necessary funds to support the research. Research funded through the Adaptive Management Working Group should require a final written report, with data files, to be delivered before contract payments have been completed.

Public Educational Opportunities

Broad public support for the management and restoration of Santa Cruz tarplant and its coastal prairie habitat at Arana Gulch are necessary and desirable. Gaining that support requires a demonstration that endangered species protection, habitat restoration, recreational access, and local governance can cooperatively work to protect the public trust. Part of the demonstration will come through concrete implementation of this management program by the Adaptive Management Program. Another part will come through a public access and education program that makes the resources, issues and solutions real; that allows citizens to see Santa Cruz tarplant flowers in a relatively intact natural landscape. Implementation of this program, along with an education and access program, could powerfully demonstrate that public agencies and resource advocates can find a way to make local governance work for the benefit of all.

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APPENDIX I

Suggestions for the Yearly Census of Santa Cruz Tarplant at Arana Gulch

1) The census should take place during the same period each and every year. Typically, this would be during the earliest reproductive peak, late June to early August, depending on rainfall, temperature and other factors that affect plant phenology.
2) The entire Coastal Prairie/Tarplant Management Area should be searched, including areas beyond occupied patches, treatment areas, and subpopulation centers (A,B,C, D). Detection of the location of quiescent seedbanks is a high priority. Portions of the entire property that burn should be searched during the following summer. The entire Arana Gulch property should be searched during the summer following a burn over the entire property.
3) A standard pattern of search should be adopted by the Technical Advisory Group of the Adaptive Management Working Group. The pattern would allow visual inspection for a thorough search as specified in #2 above. The pattern will be given to the botanist as part of an instruction sheet prior to census.
4) A standard field datasheet should be adopted by the Technical Advisory Group. The datasheet should record plant locations (GPS points), plant size, number of branches, number of floral heads, patch size, and other relevant data.
5) The census should be conducted by a qualified botanist familiar with the species and its habitat. Additional search personnel, trained to recognize the species, will probably be required to insure thorough search in the allotted time.
6) A total crew of four (including the botanist) should be allotted 8 hours in a year when the population totals less than 2,000 plants. In a year with more than 2,000 plants, more time could be required or a sampling protocol devised so that only a representative portion of the population is measured for plant size, etc. The Tehnical Advisory Group can provide the sampling protocol and/or modify these parameters depending on its data requirements.
7) The botanist should summarize the raw data on a standard summary datasheet and presented as a map with precise plant locations shown. These, along with the field datasheets, should be submitted to the Technical Advisory Group before September 30 of that census year.
8) The botanist and the crew should be paid to conduct the census and to submit the products as specified in #7.

APPENDIX 2

Suggestions for Implementation of the Santa Cruz Tarplant Adaptive Management Program

Formal and complete implementation of this Adaptive Management Program depends on coordination by the City of Santa Cruz, commitment of the participants, and acquisition of long-term funding. Until those components are in place, selected elements of this management program should be implemented to ensure persistence of Santa Cruz Tarplant at Arana Gulch. Such interim implementation focuses on taking actions in consultation with a "proto-Technical Advisory Group." Formal implementation involves establishing the entire adaptive management framework presented in this Program.

Interim Implementation

1) The City of Santa Cruz should establish the proto-Technical Advisory Group by inviting one regulatory scientist (from U.S. Fish and Wildlife Service, the California Department of Fish and Game, or the California Coastal Commission) and at least one academic or consulting scientist to serve. This group of two or three members must have expertise in conservation of rare plants and/or restoration of coastal grasslands.
2) The proto-Technical Advisory Group will work with representatives of the City of Santa Cruz to enact appropriate management actions that benefit Santa Cruz tarplant as reviewed in this program. Those actions could be mowing with phytomass removal, grazing, or other habitat manipulations that decrease the deleterious effects of annual grasses. Other actions that are more catastrophic in scale and intensity, such as soil scraping and controlled burning should only be conducted in consultation with a larger array of experts.
3) All actions taken must be properly documented and monitored as reviewed in the Adaptive Management Program with a written summary of results submitted to the City of Santa Cruz before the end of the current management year (December 31).
4) The yearly census of reproductive plants should be conducted every year using conventions and data formatting presented in Appendix A of this program. The results of the census submitted to the City of Santa Cruz before the end of the current management year (December 31).
5) Ongoing research on Santa Cruz Tarplant and Arana Gulch should be facilitated by the proto-Technical Advisory Group and the City of Santa Cruz during this interim period.

Formal Implementation

1) Establishment of the Adaptive Management Working Group should be conducted by the City of Santa Cruz with advice from the U.S. Fish and Wildlife Service, the California Department of Fish and Game, and the California Coastal Commission.
2) The three principal federal and state agencies charged with plant conservation and coastal zone management (U.S. Fish and Wildlife Service, the California Department of Fish and Game, and the California Coastal Commission) should each have a single representative on the Adaptive Management Working Group. In addition, at least two scientists with conservation and restoration experience in coastal grasslands and/or rare plant conservation should be invited to serve. The City of Santa Cruz, as the landowner and as the party responsible for implementation and funding of this program, could have up to two representatives on the Adaptive Management Working Group. These seven representatives constitute the core Working Group. Other parties with a direct interest in plant conservation and/or ecosystem restoration could be added with the approval of the core Working Group, but the total number should not exceed ten representatives for logistic purposes.
3) Funding for implementation of this program should rest in part with the City of Santa Cruz and in part with the agencies

represented on the Adaptive Management Working Group. Details on the origin, timing, and amount of that funding should be determined as soon as possible. Funding should be available to conduct the management program and convene the Working Group. Part of that funding should be used to provide support staffing for the chair of the Working Group as well as to pay expenses of the Working Group incurred for travel to meetings, if feasible.

4) The initial meeting of the Adaptive Management Working Group should include the accomplishment of the following tasks:

   a. Election of a chair to develop agenda, convenes the AMWG, and assigns tasks to others on the group (including appointment to the Technical Advisory Group. The chair should serve for three years.

   b. Election of a recorder to take and distribute minutes. The recorder should serve for two years.

   c. Development of basic operating "rules", especially the issue of quorum, and schedule of meetings and management events.

   d. Discussion of funding sources and acquisition.

   e. Discussion of the adaptive management process with respect to Santa Cruz tarplant and Arana Gulch, as outlined in this program (copies supplied to Working Group well in advance of the meeting). Construction of goals and objectives and key management questions will be postponed for the agenda other meetings to follow.

   f. Discussion of the two-tracked habitat management and research program and how to implement each track for the upcoming year and for the longer time framework of the program. Make a list of ongoing research projects at Arana Gulch.

   g. Achieve consensus on the "Management Track" actions for the upcoming year, including who will conduct them, when, and with what funding. Care should be taken so that these actions do not interfere with ongoing research projects. Determine the monitoring and reporting requirements for these actions and the timing of delivery of the final reports. Determine the permit requirements for these actions. The Technical Advisory Group may be asked to finalize protocols/requirements outside of the meeting and make them available to the party responsible for conducting the actions. Development of a schedule of surgical and catastrophic actions will be postponed for the agenda of other meetings to follow.

   h. Determine how a census of Santa Cruz tarplant at Arana Gulch will be conducted during the upcoming year (Appendix B), including who will conduct it, when and with what funding. Determine the reporting requirements for the census, and the timing of delivery of the final report. Determine the permit requirements for this census. The Technical Advisory Group may be asked to finalize protocols/requirements outside of the meeting and make them available to the party responsible for the census.

   i. Development of public educational opportunities will be postponed for the agenda of other meetings in the future.

   j. Schedule the next Adaptive Management Working Group meeting later in the same year. Assign subcommittees of 2 representatives each to prepare draft versions of the following: 1) goals and objectives, 2) key management questions, and the 3) schedule of surgical and catastrophic actions for discussion at the next meeting.

5) The Adaptive Management Working Group Chairperson should set the next meetings agenda and ensure that it and the minutes of the first meeting are distributed by the recorder. The Chairperson begins working with the City of Santa Cruz and other agencies to ensure funding will be available for the management actions, census, and Adaptive Management Working Group meetings.