SECRET RAVINE ADAPTIVE MANAGEMENT PLAN

A PLACER COUNTY TRIBUTARY OF THE DRY CREEK WATERSHED

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DECEMBER 2001

Continue

Secret Ravine Adaptive Management Plan

This version of the Secret Ravine AMP incorporates comments received afterdistribution of the draft to stakeholders and technical advisors. The revision benefitsgreatly from those comments and especially from review by Tom Cannon, LoriWebber, and Kelly Finn.

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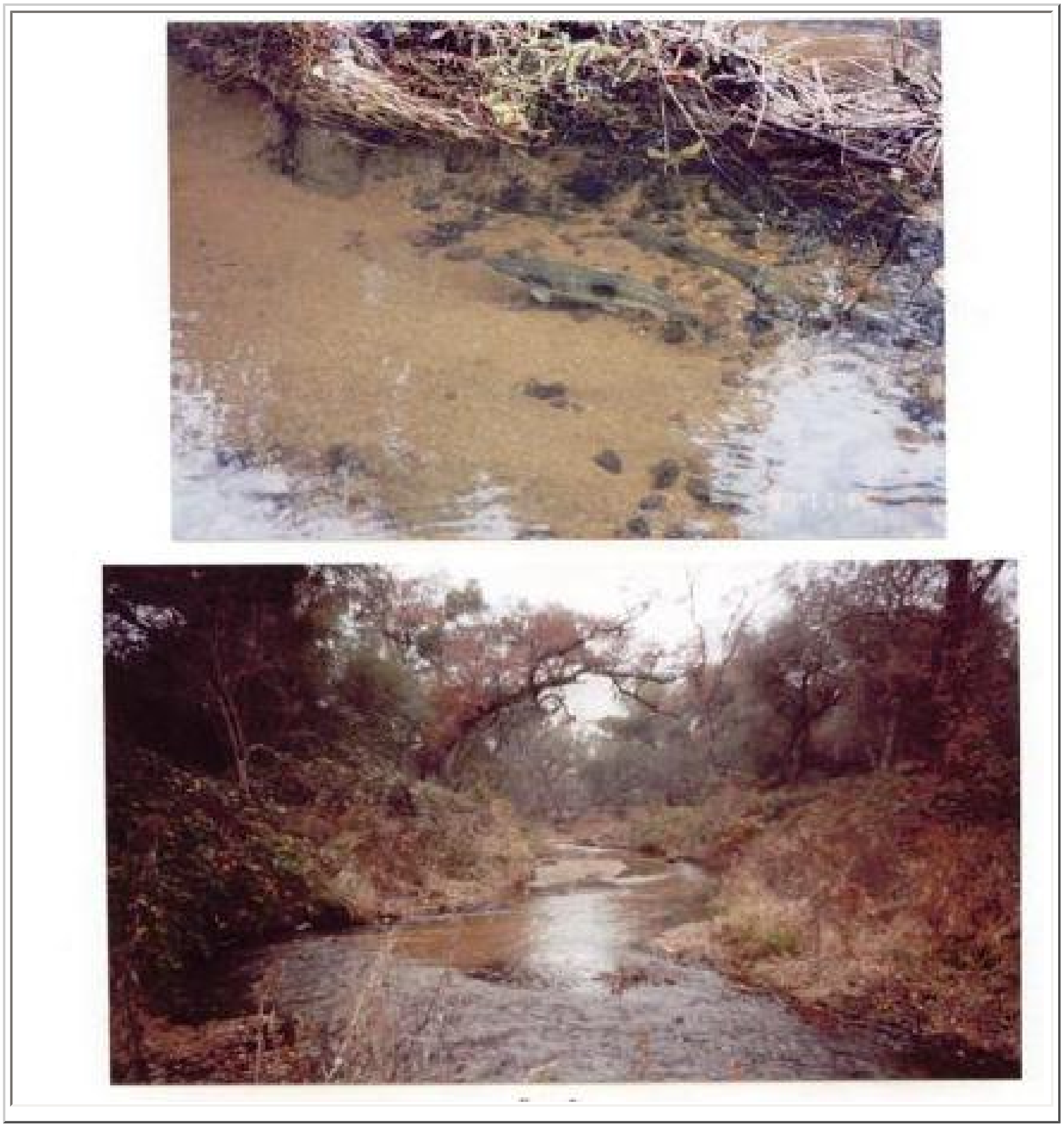

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1 INTRODUCTION

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The goal of the Secret Ravine Adaptive Management Plan (AMP) is to define a process to restore the approximately 10 miles of instream and riparian habitats between Rock Springs Road and the confluence with Miners Ravine (See Map 1) to sustain native terrestrial and aquatic species of Dry Creek Watershed, and to help meet the Central Valley Project Improvement Act (CVPIA) goal to double natural production of Chinook salmon and steelhead.The importance of small tributaries such as Secret Ravine to salmonid restoration is explained by McEwan, (2001):

> Due to highly variable natural conditions in the Central Valley, inter- population dynamics may be essential to the persistence of rainbow trout populations in the smaller stream systems. Historically, larger source populations occupying more stable habitats (for example, upper Sacramento, Feather, Yuba, and American rivers) provided a source for recolonization and gene flow to the smaller, less-persistent sink populations occupying more hydrologically unstable stream systems. Conversely, the long-term persistence of the source populations may be affected by the diversity and viability of the smaller subpopulations. The precipitous decline of Central Valley steelhead has been alarming not only from the standpoint of reduction in absolute numbers, but also in the elimination of the populations that occupied the many tributaries. A reduction in the large river source populations may also explain the precipitous decline of steelhead in smaller streams, in spite of the large amount of quality habitat that still exists in these systems. Thus, restoration that focuses only on increasing absolute numbers and ignores the need to increase population diversity may be inadequate.

Although this plan is focused on restoring salmonids and their habitat, it recognizes diverse interests of a variety of stakeholders. Remedial actions that satisfy multiple interests and attempt to avoid conflict with other interests receive highest priority. To a large extent salmonids are indicators of watershed health, so enhancing their use of the watershed enhances all natural values of the watershed.

Dry Creek Conservancy has documented a self-sustaining run of Fall Run Chinook Salmon with Fall surveys during the four seasons of 1998 to 2001. The California Department of Fish and Game (CDFG) has records (memos to file, 1964 to 1992) showing salmonid populations in the 1960's, and there is plentiful anecdotal evidence showing salmonid populations for more than a century (personal communication from watershed residents). A recent study by the Native Anadromous Fish and

Watershed Branch of CDFG (Titus, 2001, Appendix D) concluded that:

> …the upper Dry Creek drainage continues to support production of steelhead, as recognized historically but presumably at lower levels due to habitat impacts from urban development. The upper creek areas appear to be especially important for spawning and rearing, given the stream gradient and temperature condition there. Any actions which protect or improve access to and the quality of these areas will benefit steelhead production in the system.
>
> The lower creek areas, including mainstem Dry Creek, need to be protected and improved for Chinook salmon spawning, juvenile rearing and emigration and for seasonal rearing and migration of steelhead. The most conspicuous needs are to identify, control and prevent sources of sediment pollution, and to discourage land-use and waterway practices that favor production of introduced warmwater fishes, especially as related to pond development and stocking of these species within the system.

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The remedial actions described in the AMP are those that Dry Creek Conservancy (DCC) and the Dry Creek Coordinated Resource Management and Planning Group (CRMP) believe have a high probability of increasing natural salmonid production and satisfying a wide array of stakeholder interests. It is unknown whether all important environmental factors limiting fish production have been identified and whether the identified problems can be remedied. The AMP will be implemented with the goal of resolving the uncertainty regarding restoration actions and of improving the effectiveness of future restoration actions.

Figure 1 Study Area Map

The AMP is not intended to restore the watershed to pre-Columbian condition. The watershed has been permanently altered by human activities such as mining, agriculture, and urban development. Stakeholders must now work with the existing conditions to achieve the best attainable condition.

This plan is based on information in four reports prepared by resource consultants (Stacey Li, Wayne Fields, Mitchell Swanson, and Robert Holland) that comprise an existing conditions report (ECR), as well as other studies and observations. A set of stressors (environmental factors that constrain ecosystem health) specific to Secret Ravine is derived from this information. Hypotheses are made to precisely define issues so experiments can be designed to test them. As new data are collected, the restoration actions and hypotheses will be periodically refined.

Success will be dependent on the continued existence of a stakeholder group such as the Dry Creek CRMP and DCC, and landowners willing to work together with the CRMP to implement AMP actions.

The AMP relates to several other planning processes involving Secret Ravine. First, a Prop 204 grant awarded Placer County includes developing a watershed management plan for the Dry Creek Watershed. The Secret Ravine AMP will provide information to the larger watershed plan. Second, a Calfed Watershed Group grant was awarded to City of Roseville to develop a stream channel and riparian management plan for streams within the city. The Secret Ravine AMP will contribute to management of the portion of Secret Ravine that is within City of Roseville. In addition, DCC has been granted Calfed funds to develop GIS mapping, ongoing stewardship, and other projects.

2 BACKGROUND

Dry Creek Conservancy was formed as a nonprofit, charitable corporation in 1996 to preserve and restore the resources of the Dry Creek Watershed. The board of directors is comprised of interested citizens. DCC organizes activities for education, planning and management, restoration, and monitoring.

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The Dry Creek CRMP was formed in 1996 by Dry Creek Conservancy, Placer County Resource Conservation District, and the National Park Service Rivers, Trails, and Conservation Assistance Program. The CRMP is a collection of stakeholders including agencies, landowners, and other interested parties. Participants may sign a voluntary memorandum of understanding "…to work together toward common goals…to improve resource management and minimize conflict between landowners, land users, recreational users, governmental agencies and conservation groups." The AMP will be implemented with CRMP support. Stakeholders to the AMP will be considered CRMP participants.

A summary of the goals of the Dry Creek CRMP follows:

1. Protect and restore the watershed to enhance fish, wildlife, and other natural resources.

2. Recognize the rights and cultural heritage of landowners in the watershed.

3. Promote recreational use of the watershed consistent with protection of private property and natural and cultural resources.

4. Promote cooperative partnerships among federal, state and local agencies, landowners and other stakeholders.

5. Promote the education of individuals, organizations and agencies on the function and management of a healthy watershed.

6. Enhance the general public's understanding and support.

7. Promote individual projects along the creeks to protect and enhance the anadromous fishery and riparian corridors.

8. Promote optimal passage of stormwater to:

  o Minimize future flood losses

  o Protect streambanks from accelerated erosion

  o Protect riparian vegetation

  o Properly manage stream environment flora and fauna

  o Provide for recreation and open space needs where possible

  o Discourage filling and building in the floodplain

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Implementation of this AMP will contribute directly to goals 1, 4, 5, 6, and 7. Understanding gained from working with the AMP will improve the CRMP's ability to meet goals 2, 3, and 8. Chinook Salmon and Steelhead have a charismatic quality that helps people understand and identify with the effort to protect watershed resources. Their threatened status on the West Coast draws resources to restoration efforts. The California Department of Fish and Game has supported DCC efforts to improve habitat for salmonids for over four years. John Nelson, Region II anadromous fisheries biologist, has consistently been an advisor to and supporter of DCC and the Dry Creek CRMP. Also, CALFED and CVPIA funding is strategically directed toward restoring salmon and steelhead populations in the Central Valley.

Funding for developing this plan comes from the Anadromous Fish Restoration Program (AFRP), a program of the Central Valley Project Improvement Act (CVPIA). TheCVPIA was enacted to restore resources lost as a result of dams and other projects thatare part of California's history of developing water supply for agriculture and cities. TheAFRP is a component of the CVPIA and is administered by the U. S. Fish and WildlifeService. Additional funds for salmonid related projects on Secret Ravine have comefrom National Fish and Wildlife Foundation, California Department of Fish and Game,and AKT and Actium Development companies.

3 STAKEHOLDERS

About one half of the creek side property is or will be held by the county, cities, and Sierra College. Homeowners and small landowners comprise most remaining land. Categories of stakeholders include:

- Businesses &endash; hotels, gas stations
- Union Pacific Railroad
- Homeowners and homeowner associations
- Landowners &endash; ranchettes and small agriculture, land developers
- Sierra College
- Placer County
- Cities of Roseville, Rocklin, Town of Loomis
- Special Districts - School Districts, Park Districts, Mormon Park (private park),
- Placer County Flood Control and Water Conservation District
- Utilities providers &endash; Placer County Water Agency, South Placer Municipal Utilities
- District
- State and federal agencies
  - Department of Fish and Game, Central Valley Regional
  - Water Quality Control Board, State Water Resources Control Board, US Fish and
  - Wildlife Service, National Marine Fisheries Service, Army Corps of Engineers,
  - Department of Water Resources, Caltrans, Calfed
- Conservation organizations
  - Dry Creek Conservancy, Granite Bay Flycasters, Sierra Club, Audubon,
  - Environmental Council of Placer, Sacramento River Watershed Program

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3.1 Stakeholder Interests

Dry Creek Conservancy has met with homeowner associations, municipal advisory councils, Sierra College, Sutter Hospital, city departments, agency representatives, individuals and others to discuss their interests. Stakeholders also participate regularly in the Dry Creek CRMP. Some of the interests stakeholders express are:

- Homeowners and small landowners are typically concerned with flood control, fire control and erosion. Remedies for these problems have often historically been in conflict with preserving the natural values of streams, however, most homeowners live in the area because they value the natural environment and want to preserve it. Many are very concerned about trespassers, but most are receptive to DCC monitoring and surveying efforts.

- Municipalities use the stream for stormwater drainage, and use the riparian area and floodplain for open space and recreation. They also maintain access to creeks and floodplains for utilities pipelines and roads. There is very little removal of vegetation, large woody debris, and sediment for flood control maintenance on Secret Ravine. These activities are conducted on other parts of Dry Creek and are harmful to ecosystem health. Since there are few properties at risk of flooding on Secret Ravine, we don't expect there will be much flood control maintenance.
- Sierra College preserves its section of creek as a natural area and classroom lab.
- Sutter Hospital desires to limit entry to open space through their property.
- Placer County Water Agency uses the stream to collect runoff from deliveries to customers, and to a limited extent for conveyance to customers.
- State and Federal agencies and conservation groups use open space and riparian resources to pursue their missions.

As entities pursue their interests, they often cause some of the stressors identified inthe watershed. This plan will strive to find solutions that satisfy mutual interests.

4 CONCEPTUAL MODEL

4.1 Landscape Level Conceptual Model

Figure 2

A graphic representation of the salmon life cycle. A summary of the life history follows.

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4.1.1. Chinook Salmon Life History

Chinook, especially fall run, have a capability of using intermittent streams such as the Dry Creek system by migrating, spawning, incubating, and emerging all during the winter rainy season. Adult fall-run Chinook salmon migrate upstream into freshwater from July through December and spawn from early October through late December. Migration activity increases with seasonal rainstorms. If high flows don't occur there may be little spawning or fry or smolt production from the stream that year. So Chinook depend on several years of spawners from each spawn returning or from strays from other rivers to repopulate intermittent streams that have lost their populations during extended droughts. Fall-run Chinook salmon spawn in the low gradient portions of Central Valley streams such as the main stem Sacramento River, Mill Creek, Deer Creek, Feather River, Yuba River, Bear River, American River, Cosumnes River, Mokelumne River, Stanislaus River, Tuolumne River and Merced River and their tributaries. Peak spawning occurs in October and November, although the timing of runs varies from stream to stream. Embryo incubation occurs from October through March, and juvenile rearing and smolt emigration occurs from January through June. Timing of emigration varies with the amount of rainfall for the year. The majority of young fall-run Chinook salmon emigrate to the ocean during the first few months following fry emergence from the spawning gravels.

Chinook salmon spawning typically occurs in swift, relatively shallow riffles, along edges of fast runs where there is an abundance of loose gravel, or in tailouts of pools where depth declines, water velocity increases and 1-4 inch gravels settle out, and where water flows down into gravel to oxygenate the eggs. Chinook salmon require clean and loose gravel that will remain stable during embryo incubation, while the larvae reside in the gravel, and when they emergence from the gravel. Sufficient water must percolate through the gravel to supply oxygen and remove metabolic wastes from the developing embryos. Eggs and fry are extremely sensitive to sand and suspended sediments that may block flow and interrupt the oxygen supply or the ability of fry to eventually escape from the gravel beds.

The female digs a spawning redd in the gravels and deposits her eggs in several egg pockets. The eggs are fertilized by the male and buried in the gravel by the female. The adults die within a few days or weeks after spawning. An average female Chinook salmon produces 3,000-6,000 eggs depending on the size and race of fish.

Embryos usually hatch in 40 to 60 days. Alevins usually remain in the gravel for an additional four to six weeks until the yolk sac is completely absorbed; then they emerge from the gravel as fry. Fall-run Chinook salmon fry can begin emigrating to the estuary soon after emerging from the gravel and emigrate January through June.

Chinook salmon embryo, alevin, and fry development is stream temperature dependent. The embryo life stage is more sensitive to water temperature stress than any other Chinook salmon life stage. The fry (30-50 mm) typically seek out low velocity stream margins and backwaters attempt to hold position in the water column and feed mostly on drifting aquatic invertebrates in low velocity water or in eddies. Many fry migrate from Secret Ravine, but some remain. The proportion that migrate as fry may be a function of available habitat and total numbers using that habitat as well as river and habitat conditions at the time. As young grow from Fry to fingerlings they move into stations with higher stream velocities that carry larger food. Fry, fingerling, and smolts that migrate from Secret Ravine may rear from weeks to months in the lower watershed, Sacramento River, or the Bay-Delta before migrating to the ocean where they may spend one to three years feeding before returning to spawn. Chinook salmon generally mature at three to four years of age.

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The abundance of Chinook salmon has declined in the Sacramento River from as many as one million spawners prior to 1915 (Reynolds et al. 1990), to an average of 176,000 between 1967 and 1991 (Mills and Fisher 1994). There are no accurate records of the run size in Secret Ravine or whether fall run were the only historic race in the stream.

4.1.2 Steelhead Trout Life History

Steelhead trout are anadromous rainbow trout that emigrate to sea and later return to inland waters as adults to spawn. California steelhead total age rarely exceeds six years. Unlike Pacific salmon, not all steelhead die after spawning.

Steelhead spawn in winter or early spring after salmon have spawned. They often require high water to provide access to upper watershed spawning and rearing areas. Because steelhead young remain at least a year in freshwater, they usually spawn at higher elevations where water temperatures are cooler in late spring and summer. Access to cool summer water temperature is perhaps the single most important limiting factor for steelhead in Central Valley streams.

Steelhead prefer to spawn in clean, loose gravel, and swift, shallow water. The female steelhead digs six to seven egg pockets in each redd. The male steelhead fertilizes the eggs as they are deposited. The female then covers the eggs with gravel. A female steelhead from the American River produces an average of 3,500 eggs.

Steelhead tend to prefer shallower stream depths and smaller gravel but the same water velocities for spawning as the Chinook salmon. Steelhead are even less tolerant of fine sediment in the gravel than Chinook salmon, probably because the eggs are smaller and the oxygen requirements for developing embryos are higher. Steelhead generally spawn in different stream areas when they spawn in the same stream stretch as salmon, thus special attention has to be focused on both spawning habitat types in streams.

The rate of steelhead embryo development is stream temperature dependent, and consistency of stream temperature is also important. Embryos usually hatch in about 30 days. Fry usually emerge from the gravel about four to six weeks after hatching. Juvenile steelhead usually remain in freshwater for at least one year before emigrating to the ocean. Unless there are adequate water temperatures, high rearing mortality will occur. The lethal temperature for young steelhead is about 77F. Temperatures of 65F can be stressful depending on other factors such as food. Optimal temperatures for steelhead are 50-60 F.

Historically, steelhead were distributed throughout the tributaries and headwaters of the Sacramento prior to closure of rivers by dams, water manipulation, and watershed perturbations of the 19th and 20th centuries. The Central Valley Steelhead ESU was listed as threatened by the National Marine Fisheries Service on March 19, 1998 (63 FR 13347).

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4.1.3 Current Habitat Conditions for Salmonids

Diversions, elevated stream temperatures, pollution, channelization and the Delta pumps are important factors in the decline of anadromous fishes in the mainstem Sacramento River. Levee stabilization projects remove riparian vegetation and destroy habitat through replacement of natural bank with large rock riprap. Extensive removal of large tracts of riparian forest results in reduced shading, reduction of instream habitat, and reduction of organic inputs. Central Valley riparian forests have been reduced to about one percent of the pre-gold rush acreage (Abell 1989 cited in McEwan and Jackson 1994).

4.2 Summary of Existing Conditions Report

The team approach was used to get a broad knowledge of the conditions. A multidisciplinary team consisting of Stacy Li, fisheries biologist, Wayne Fields, aquatic entomologist, Robert Holland, geobotanist, and Mitchell Swanson, geomorphologist worked on their respective aspects of the stream corridor.

4.2.1 Geomorphology

Hydrologic and Physiographic

Setting Secret Ravine is a perennially flowing stream that drains a 19.7 square mile basin within the Sierra Nevada foothills of western Placer County (Figure 1). Secret Ravine flows 10.5 miles from its headwaters in the Newcastle area (elevation 1285 feet) to its confluence with Miners Ravine Creek (elevation 165 feet) near Eureka Road in Roseville. Streamflow is augmented by an unknown volume of tailwater delivered by Placer County Water Agency's irrigation releases. We observed flows in the early fall between 0.5 and 2-3 cfs. No continuous recording stream gage exists on Secret Ravine, but there is a flood activated warning gage operated by Roseville located in Rocklin near Sierra College Boulevard.

The Secret Ravine drainage basin experiences a Mediterranean climate with warm dry conditions between April and October and wet and mild weather between November and March. Average rainfall is 25.0 inches per year with most occurring during the peak rain months of December through February. The basin is underlain by granitic rocks of Mesozoic age and is capped unconformably by volcanic and volcaniclastic rocks of the Miocene Merhten Formation (occurring primarily in the lower watershed) and by Pleistocene alluvial fan and fluvial deposits of the Turlock Lake and Riverbank Formations. In the watershed hillslopes, Mehrten volcanic bedrock units develop shallow soils that generally have very high runoff rates. The granitic soils vary from shallow veneer over bedrock to deeper soils over zones of deeply weathered and decomposed granite.

Fig 3

Digital Elevation Model (DEM) Watershed Map for Secret Ravine

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Secret Ravine flows within a narrow valley underlain by recent alluvial deposits. The valley width expands in places to over 1,000 feet likely as the result of geologic controls. The central alluvial valley is bound by hills that are composed of granitic rock in the upper watershed and volcanic cap rock in the lower watershed. Soils in the alluvial valley vary from coarse-grained and highly permeable decomposed granite units (resulting from waste products of placer mining and sluicing and runoff from quarry spoils) to dense organic soils typical of perennial wetlands. The valley floor vegetation types include valley oak grasslands, riparian forest, and patches of seasonal wetlands.

Channel Morphology Secret Ravine flows within a channel that is entrenched within the alluvial valley floor. This appears to be the result of: 1) historical filling of the alluvial valleys with re- deposited placer and quarry mining spoils; and 2) possible channelization for subsequent agricultural use and urban development. As a result, Secret Ravine is not close to the ideal three stage channel. The channel is typically 6 to 8 feet deep (in some reaches over 12 feet deep), flat bottomed and rectangular in shape and anywhere from 10 to 25 feet wide. A large range of flows is contained within the channel which leads to further lateral and vertical erosion. In addition, the ability of the channel to dispose of excess sediment by carrying it onto the floodplain in overbank flows is diminished. Moreover, the deeply incised channel places the summer groundwater table well below the valley floor. This, combined with the historically deposited surface layer of mining spoils, makes conditions highly unfavorable for the development of riparian vegetation.

This type of channel (likely a Rosgen "F" type) is stable in that it doesn't move much laterally. Meandering is slight in most reaches: generally with a sinuosity less than 1.2 with short reaches above 1.5. This channel type does not generally produce good fish habitat unless there is an abundance of instream large roughness objects such as boulders, large logs and/or root wads to produce pools, instream cover and sorting mechanisms for spawning gravel.

4.2.2 Vegetation

There are several natural communities present along Secret Ravine: _ Naturalized Annual Grassland mantles the shallowest soils on the volcanic mudflows. It also is common on granitic soils no longer under cultivation. _ There is a Freshwater Seep just south of Interstate 80 about 500 feet beyond the end of China Gardens Road. _ Great Valley Willow Scrub is mixture of fast-growing deciduous shrubs including several species of willow, buttonwillow, coyote bush, sapling white alders and Fremont cottonwood. _ Great Valley Riparian Forest is best developed in the formerly dredged areas from the confluence upstream to near the hospital, where large valley oaks and Fremont cottonwoods form a nearly closed canopy. _ White Alder Riparian Forest is the principal riparian community along Secret Ravine above about 220 feet elevation, where the geology changes from sedimentary to granitic. _ Oak Woodlands dominated by interior live oak and blue oak probably mantled the entire Loomis Basin in pre-

Spanish time.

Appendix B is an aerial photo atlas of natural vegetation along the stream corridor.

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4.2.3 Stream Habitat

Method Physical stream habitat is documented while wading upstream. Discreet channel features, called habitat types, are identified, measured, assessed, and recorded. Their proportion of the total stream is calculated. Most habitat types fall into three broad categories called riffles, runs, and pools. A set of stream features such as instream and overhead cover, and substrate quality is also graded.

Findings The proportion of riffle area to total area was small. This is a negative factor since most benthic macroinvertebrates (fish food) are produced in riffles. Riffles are also important in spawning as the optimal spawning conditions occur in the hydraulic transition zone between pool and riffles.

Sand was the overwhelming dominant substrate element. Sand reduces the amount of riffles by burying them. Excess sand also may block fry emergence from the gravel to the stream. Sand has degraded rearing habitat quality for aquatic invertebrates and salmon and steelhead rearing habitat. Sand has buried most of the cobbles and filled in the interstitial space where aquatic invertebrates live. Fish inhabiting a sand covered stream channel have shallower pools, smoother substrates, greater energy expenditures, less complex rearing habitat, and less food from the benthos. Sand contributes to unhealthy warming of the stream, by slowing water flow (travel time) and making the stream shallower, which allows greater solar penetration and more rapid warming.

4.2.4 Conclusions of existing conditions report

The existing deeply entrenched channel, which has apparently formed as a result of human land use practices, theoretically could be reconstructed to a more favorable stable form that could be sustained by current hydrologic and geomorphic conditions. Improvements such as channel re-construction or installation of roughness objects will increase pool depth, gravel quality, etc.

4.2.5 Recommendations of Existing Conditions Report

For restoration of vegetation Opportunities are greatest where the valley floor is broadest, mostly downstream of Rustic Hills. Terraces outside the flood channel are appropriate for valley oak-dominated communities. Floodplains are more appropriately planted with species of the cottonwood and willow dominated communities. While plantings within the bankfull channels may be considered, for example to armor a channel modification, they must be recognized as temporary.

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For stream morphology _ Develop and implement projects that introduce large roughness objects into stream channels to promote greater hydraulic diversity, bed scour for pools and sorting and flushing mechanisms for gravel. These objects could include logs, root wads and boulders placed along the edges of the entrenched channel. _ Where channels are excessively eroding in the headwaters, the channel banks should be regraded to create the natural three-stage channel configuration (low flow, bankfull and flood channel). This would be accomplished by excavating one side of the channel to the proper overall flood channel width with a flat geomorphic flood plain at the proper elevation and a transition slope no steeper than 2:1 _ Off Road Vehicle Access to the creek should be eliminated. Significant erosion and water quality impacts are occurring in several reaches. The entry points should be identified and closed off.

4.3 Stressors and Impacts

Table 1 lists basic requirements for each stage of the salmonid life cycle. Stressors affecting requirements are listed based on information in the existing conditions report and other observations. Stressors related to flow are included since sources of flow are in flux and it is possible that flows could change due to policies of local agencies. The table presents specific impacts of stressors on each stage of the life cycle.

Information in sections 4.3, 4.4, and 4.5 includes issues within all of the Dry Creek Watershed since getting salmonids to and from spawning areas in Secret Ravine is necessary to make habitat improvement in Secret Ravine worthwhile. Unlike river, estuary, and ocean problems, the entire watershed is within the scope of DCC and the Dry Creek CRMP. However, the focus of this AMP is on Secret Ravine since it is the most productive area for salmonids, and the area where the most sensitive life stages occur. There are other processes such as Placer County's Prop 204 grant, and City of Roseville's Riparian Management Plan that will address problems in other areas of the watershed.

Table 1 Summary of Stressors and impacts for salmon and steelhead in Dry Creek

4.4 Hypotheses Concerning Restoration and Management

In Table 2 hypotheses are made regarding the negative impacts of stressors on the salmonid life cycle. The hypotheses define the problem so that remedial actions and adaptive management studies can be formulated. Implementing the actions and studies will test the hypotheses and define future actions and studies. The following section discusses the basis for the hypotheses. The order of the hypotheses does not indicate order of importance. Hypotheses are listed in the same order as in the tables to make it easier to follow the discussion.

Table 2 Summary of Hypotheses

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4.4.1 Adult migration

Flow

Streams in the Dry Creek Watershed drain into Steelhead Creek (formerly the Natomas East Main Drainage Canal) a tributary to the Sacramento River that enters just upstream of the mouth of the American River. Each fall upstream migrating adult fall-run Chinook salmon must wait until there is sufficient runoff to increase flow in Steelhead Creek to enter the Dry Creek Watershed. Increased impervious surface in the watershed due to urbanization may result in earlier high flows that stimulate entry from the river to Steelhead Creek and Dry Creek, however, increased impervious surface may also lower baseflows due to reduced groundwater recharge. Major tributaries of the watershed are relatively small (first to third order streams) and have no major dams. The headwaters are at an elevation too low to collect snowpack, so the hydrology of the streams is dependent on rain in addition to groundwater and ag and urban returns. Secret Ravine is a major tributary in the Dry Creek Watershed.

Hypothesis 1: Dry Creek watershed is dependent upon surface runoff to attract upstream migrating adults

Years of late rainfall, change in effluent discharge from wastewater treatment plants, and change in additions to flow from Placer County Water Agency can result in reduced flow during the fall migration season and in non-optimal flows after migration has begun. Low flows contribute to higher water temperatures.

Currently the West Placer Regional Wastewater Treatment Plant being developed by Roseville has potential to reduce flows as effluent is transferred from the existing plant on Booth Road. This could have a negative affect on fall migration by increasing the periods that barriers are impassable.

Placer County Water Agency (PCWA) delivers water for domestic, agricultural, and municipal use. Water is imported from northern watersheds such as the Bear and Yuba and delivered through a series of canals built to supply mining interests during the gold rush and later used for agriculture. PCWA is increasingly important in providing municipal water for rapidly urbanizing Western Placer County. PCWA water enters the Dry Creek system in several ways. It enters Secret Ravine at the end of the Boardman Canal. This water has been impounded by a dam on Dry Creek at Watt Avenue for an agricultural user. PCWA water also is reported to enter Secret Ravine and other tributaries through leakage from inefficient canals. It also enters Secret Ravine from small tributary drainages that gather runoff from agricultural use.

As PCWA adapts to new end users and attempts to improve the efficiency of its delivery system, flows may change on Secret Ravine. The effect on stream ecology should be studied and solutions should be sought that minimize negative impacts.

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Hypothesis 2: Low flows in Dry Creek and tributaries result in unhealthy temperatures for all life stages.

Migration barriers Steven Thomas (2001), NMFS hydraulic engineer, examined a suspected barrier at the mouth of Secret Ravine and one downstream at the confluence with Cirby Creek and found both to have the potential to take salmon and steelhead. He suggested improvement options and recommended further studies. (See Appendix D.)

Hallock et al. (1970) studied the migration of adult Chinook salmon through the Delta in the 1950's and found that when the Head of the Old River Barrier was installed in fall 1964, adult salmon migrated through the mainstem San Joaquin River. However, when the barrier was not installed in fall 1965 and 1967, some of the salmon migrated through the South Delta. Their study suggests that barriers may block the flows that attract migrating adults and send them to non-natal tributaries (Mesick). Although Dry Creek and Secret Ravine have no total barriers, low flows make some barriers impassable. Pulses of fish move upstream past barriers during and after storms.

*Hypothesis 3***:** Partial barriers in Dry Creek and Secret Ravine in combination with rainfall patterns and other sources of flow influence run timing and geographical distribution sending fish to less suitable habitat

In 1997 many fish were observed being taken by poachers at the Watt Ave. agricultural diversion on Dry Creek. When passage was opened that year poachers didn't return, and in subsequent years when passage has been required by CDFG, little poaching has been observed. Poaching has been observed and reported at barriers throughout the watershed.

Hypothesis 4: Partial barriers in Dry Creek and tributaries cause significant prespawning mortality due to poaching

Channel complexity The most obvious constraint to habitat quality in Secret Ravine is excess sand. Fish inhabiting a sand covered stream channel have shallower pools, smoother substrates, greater energy expenditures, less complex rearing habitat, and less food from the benthos (Li and Fields 1999). Vanicek (1993) in an evaluation of Dry Creek fisheries habitat notes that salmon require deep-holding pools during their upstream migration, especially during low water years or years of late rainfall. He notes that pool quantity and quality is poor in the lower reaches of Dry Creek. In recent years homeowners along Secret Ravine have often noted the decrease in pools and observed that sand seems to be filling them.

Hypothesis 5: Lack of channel complexity in Secret Ravine causes prespawning mortality due to excess expenditure of energy

4.4.2 Spawning

Flow Reduced flows can reduce the amount of usable spawning habitat which may increase redd superimposition rates (Mesick). Fish have been observed building redds on top of existing redds, particularly late in the season after a rain brings in fresh spawners.

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Hypothesis 6: Low flows cause superimposition of redds in Secret Ravine.

Channel complexity Fish must clean sandy gravel to spawn in Secret Ravine. When spawning area is limited by low flows, excessive sand, or beaver dams, redds are observed in substrate that is mainly sand with very little gravel. Swanson (2000) notes that the sand substrate problem in Secret Ravine is probably due both to excessive supply and (poor) channel hydraulics. The present hydraulics are monotonous due to an overly deep and wide channel. Large roughness objects such as woody debris and boulders in stream channels cause hydraulic diversity that scours pools and sorts and flushes gravel. Meanders and correctly sized bankfull channels also create hydraulic diversity. Hydraulic diversity increases spawning habitat area by sorting and cleaning gravels and by allowing fine particles to flow overbank during high flows.

Hypothesis 7: Lack of channel complexity in Secret Ravine leads to reduced spawning habitat and causes fish to build redds in substrate impacted by sand.

Hypothesis 8: Lack of channel complexity in Secret Ravine leads to reduced spawning gravel area and to superimposition of redds.

4.4.3 Incubation and emergence

Fall-run Chinook eggs incubate for about 43 days at 52oF whereas cooler temperatures increase the incubation period. After hatching, the alevins remain in the gravel until most of their yolk sac has been absorbed, which requires from 45 to 90 days after hatching (EA Engineering, Science, and Technology 1991). Based on this information and the timing of spawning, incubation and alevin development occurs from late October through March in most Central Valley rivers. This period is probably longer in the American and Yuba Rivers, and particularly the Feather River, where water temperatures are low compared to the San Joaquin basin and incubation and alevin development probably occur from September to April (Mesick).

Steelhead eggs are smaller than fall-run Chinook salmon eggs, and so steelhead eggs develop faster. At water temperatures of 55oF, incubation takes about 25 days (Barnhart 1991) and emergence requires about four to six weeks (Shapovalov and Taft 1954). Assuming that the spawning peak occurs in January and February, the peak period for incubation and emergence would occur from January through mid May. This corresponds to the catches of steelhead fry at the Hallwood-Cordua trap on the Yuba River in May and June (John Nelson, Department of Fish and Game, personal communication) (Mesick). Flow The survival of eggs to emergence depends on flow in the intragravel environment which affects dissolved oxygen concentration and water temperature. Low flow can make migration difficult and expose redds.

Hypothesis 9: Low flows in Secret Ravine increase mortality.

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Hypothesis 10: Low flows in Secret Ravine decrease healthy development

Channel complexity High concentrations of fine sediment in spawning riffles reduce intragravel flow and egg survival, and entomb embryos. Potential sources of fine sediments include (1) erosion due to removal of riparian vegetation and livestock grazing in the floodplain and along streambanks; (2) urban runoff; (3) incorrectly designed and inadequate maintenance of roads and culverts; and (4) leakage from canals, (5) unauthorized ORV trails and fords. (See DCC memo, 2000 regarding ATV access, Appendix D) Fine sediment has been observed entering Secret Ravine from small side streams. Although spawning salmon reduce the concentration of fines in their redds, high rates of fine sediment intrusion occur after redd construction due to storm runoff, redd construction activities from other nearby salmon, and possibly due to intragravel movement of fines (Mesick), (Li).

Observers are nearly unanimous in pointing out that sand is a major problem limiting spawning habitat in Secret Ravine. (Li, Swanson, Nelson, Meyers, Titus, Dvorsky)

Hypothesis 11: Lack of channel complexity in Secret Ravine causes excessive sand in gravel, which leads to lack of vigor and increased mortality due to poor percolation and entombment of fry.

Degraded channel complexity, defined as a relatively flat, uniform streambed, reduces diversity of water depths and velocities. Streambed complexity may be lost due to removal of large woody debris for flood control, urban hydrograph patterns that form incised channels that confine storm flows, and modified channel morphology from mining, agriculture, and urbanization. These elements create a flashy flow pattern during storms that erodes channels deeper and wider.

Hypothesis 12: Lack of channel complexity in Secret Ravine causes scouring of redds due to increased channel velocity at high flows.

4.4.4 Juvenile rearing

Juvenile fall-run Chinook salmon rear in the rivers beginning in late January after emergence. Recent screw trap studies in the Stanislaus and Tuolumne rivers suggest that a majority of the juveniles produced emigrate from the rivers as fry in February and March during peak flows (S.P. Cramer &

Associates, various annual reports). In the Feather and American rivers, approximately 95% of the juveniles emigrate as fry from January through March (Snider and Titus 1995; Ted Sommer, Department of Water Resources, personal communication). Of the juveniles that rear in the rivers, they remain until mid April through early June. Juveniles rear in the rivers until they reach an average length of 70 to 80 mm in the Yuba River (S.P. Cramer & Associates 1995a), 80 to 100 mm in the Stanislaus and Tuolumne rivers (S.P. Cramer & Associates), and during low flow conditions to 100 to 110 mm in the Mokelumne River (BioSystems Analysis, Inc. 1992).

Juvenile steelhead rear in the Stanislaus and Feather rivers for at least one year when they typically reach between 200 and 300 mm in length (S.P. Cramer & Associates, Inc; Ted Sommer, Department of Water Resources, personal communication).

Such studies are not currently available specifically for Dry Creek and will be part of an adaptive management studies program.

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Non-natal Rearing: Non-natal rearing of fall-run Chinook salmon or steelhead juveniles may occur in the Dry Creek Watershed. The watershed consists of relatively low order streams similar to those used extensively around Chico by Chinook salmon not spawned in these creeks (Maslin et al. 1997, Maslin and McKinney 1994).

Hypothesis 13: Dry Creek and Secret Ravine support a non-natal population of juvenile salmon and steelhead.

Temperature As discussed in the Life History sections, the survival of juvenile salmon and steelhead rearing in the rivers is very dependent on water temperature. Temperature is affected by instream and riparian cover.

Hypothesis 14: Lack of riparian and channel complexity causes lack of vigor and mortality due to unhealthy temperature in Secret Ravine.

Water quality Many chemical byproducts of urbanization are present on the ground surfaces of the watershed. Impervious surfaces due to urbanization combined with efficient stormwater collection systems gather and deliver contaminants to the stream.

Hypothesis 15: Stormwater delivers pollutants from urban sources into Secret Ravine in quantities which negatively impact stream ecology.

Hypothesis 16: Pollutants from urban sources cause poor development and increased mortality of juvenile salmonids.

4.4.5 Juvenile migration

Juvenile fall-run Chinook salmon emigrate from the rivers to the Delta as fry in February through March, and as smolts from mid April through early June (Joe Merz, EBMUD, personal communication; Snider and Titus 1995; Ted Sommer, Department of Water Resources, personal communication; S.P. Cramer & Associates, Inc.).

There is very little information on the timing of steelhead smolt outmigration, because they emigrate as large fish (200-300 mm) and most avoid capture by screw traps. Screw trapping in the Stanislaus River suggests that migration occurs from February through May, but most were collected in April and May (S. P. Cramer & Associates, Inc.). In the Mokelumne River, fry and yearlings (mostly hatchery releases) are typically captured from February through July in screw traps at Woodbridge Dam (Joe Merz, EBMUD, personal communication). In the American River, steelhead fry were captured in screw traps in March and April whereas smolt-sized fish were captured between December and February (Snider and Titus 1995). In the Feather River, large schools of smolt-sized fish are observed in the river until September, which is presumed to be the end of the outmigration period (Ted Sommer, Department of Water Resources, personal communication) (Mesick).

Flow It is generally believed that high flows during outmigration improve fry and smolt survival. The possible mechanisms by which flow increases smolt survival include reduced predation rates and reduced entrainment at unscreened and inadequately screened diversions. However, high flows may strand juveniles in bypasses, and other high flow areas.

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Hypothesis 17: Low flows in Dry Creek and Secret Ravine increase mortality due to predation

Temperature Laboratory studies conducted in Washington indicate that the upper incipient lethal temperature for juvenile Chinook salmon is about 75oF (Brett 1952), whereas the highest growth rates occur between 60oF and 65oF (Banks et al. 1971). However, the San Joaquin basin has higher water temperatures than most other rivers that support Chinook salmon and new studies conduced by Chris Myrick at the University of California at Davis suggest that Central Valley fish have evolved to grow well at higher temperatures than previously reported. Myrick's studies were not completed and there is a need for additional work (Mesick).

The preferred rearing temperatures for steelhead are reported by Bjornn and Reiser (1979), Rich (1987), and Barnhart (1991) to be 45 to 60oF, with an optimum of about 50oF and an upper lethal limit of 75oF. However, these reports are based on laboratory studies of temperature tolerance for rainbow trout and not Central Valley steelhead. Chris Myrick at the University of California at Davis has recently completed temperature tolerance studies with Central Valley steelhead and the report has just been submitted for publication (Mesick).

Barriers Delayed spawning in the Fall results in a later emergence and outmigration of juvenile salmon. Secret Ravine juveniles that are in the lower reaches of Dry Creek and Steelhead Creek in late spring and summer likely encounter unhealthy temperatures during late outmigration.

Hypothesis 18: Partial barriers delay fall spawning resulting in outmigration during times of unhealthy temperature.

Studies suggest that predators congregate immediately downstream of small dams and diversion weirs, possibly feeding on the juvenile salmon as they spill over the dam. Preliminary studies on the Mokelumne River suggest that predation by striped bass in the Woodbridge Dam afterbay may be as high as 50% of total outmigration (Boyd 1994). Other small dams, such as Daguerre Point Dam on the Yuba River, Granlees Dam on the Cosumnes River, the many small diversion weirs on the Calaveras River, and a small illegal weir constructed on the lower Mokelumne River during dry years are examples where predators may congregate (Mesick).

Hypothesis 19: Partial barriers on Dry Creek and Secret Ravine provide opportunity for exotic species predators such as bass to congregate and prey on migrating juveniles.

Unscreened Diversions: There are many small unscreened or inadequately screened diversions in Secret Ravine, but entrainment rates have not been directly studied. Notable diversions on Dry Creek are the ag pump at Watt Avenue and the gravity fed out take at Hayer Dam. There are numerous small pumps for agriculture and homeowner use throughout the Dry Creek Watershed. Spring through fall diversions can significantly affect trout fry production especially in small streams. Diversion should be carefully studied, and kept out of low-flow, over-summering, headwater, refuge areas. Studies in the Delta suggest that entrainment rates increase exponentially with increases in diversion rate. The extent of entrainment in Secret Ravine and Dry Creek is unknown, however, small diversions may have a significant impact on juvenile salmonids due to the small size of the water column.

Hypothesis 20: Unscreened diversions on Dry Creek and Secret Ravine increase mortality by diverting fish from the stream.

Channel complexity Overhead cover provides protection from aerial predators and enhances habitat complexity (Li, 1999).

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Hypothesis 21: Lack of channel complexity causes increased predation due to lack of cover.

Food Supply Food supply and growth rates of juvenile salmon have not been extensively studied in most of the tributaries. Stomach content analysis of juvenile Chinook salmon in the lower American (Brown et al. 1992; Merz and Vanicek 1994) and Mokelumne rivers (Department of Fish and Game 1991; Merz 1998b) suggest that zooplankton from the upstream reservoirs and terrestrial macroinvertebrates occasionally supply as much as 50% and 25% of the fishes' diet, respectively. Invertebrate surveys have also been conducted in the Tuolumne and Calaveras rivers. Although the studies have not resolved whether the food supply limits the growth and survival of juvenile salmon, there are concerns that habitat degradation and contamination has reduced the supply of food from macroinvertebrates in the benthos and drift, plankton from reservoirs, and terrestrial invertebrates. High concentrations of fine sediments in the substrate may shift the benthic invertebrate populations toward smaller species that may be less useful as food for juveniles. It is also likely that channel incision, degraded riparian vegetation, and degraded streambed complexity have reduced the supply of organic detritus that is required by many invertebrate species for food (Allan 1995). The supply of terrestrial invertebrates may be affected by the spraying of pesticides near the floodplain and by levees/channel incision that reduce flooding which allows juveniles to feed in terrestrial zones and helps flush terrestrial invertebrates into the river.

Hypothesis 22: Lack of channel complexity causes decreased food supply due to lack of benthic macroinvertebrate and terrestrial habitat.

An increase in the roughness of the streambed provides a boundary layer that makes holding station less energetically expensive for salmon and steelhead. (Li, 1999)

Hypothesis 23: Lack of channel complexity causes unfavorable velocities resulting in excess energy expenditure and less than optimal growth.

4.5 Suggested Actions and Adaptive Management Studies

Table 3 summarizes remedial actions and Table 4 summarizes adaptive management studies. The restoration actions and adaptive management studies are based on the existing conditions analysis and the Conceptual Model. The actions and studies were categorized as high, medium, and low priorities based on the following criteria:

- Positive benefit for several life cycle stages,
- The severity of the impact of the stressor,
- Likelihood of gaining cooperation and/or permits necessary to take the action,
- Unanimity among observers regarding need for the action,
- Importance of knowledge to be gained by the action,
- Probability of obtaining resources necessary to take the action,

° Risk-management considerations (e.g., potential damage to people and property).

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Table 3 Summary of Suggested Remedial Actions for Stressors

Table 4 Summary of Adaptive Management Studies

High priority actions are those that will have the greatest positive impact and are most feasible to implement.

The Remedial Actions are categorized in the following discussion as either Education, Coordinated Management, or Restoration. It is assumed that Education and Coordinated Management remedial Actions will have a positive effect on watershed health by increasing the knowledge of parties whose actions impact the watershed.

The Restoration Actions are aimed at correcting stressors that have been identified by the Existing Conditions Report and other sources. The twenty-three Hypotheses express a probable relationship between stressors and Life Stage Function. It is expected that Restoration Actions will improve watershed functioning. Actually implementing the Restoration Actions will show how effective they are. If actions are correctly designed they will provide information about the validity of the Hypotheses. Implementing the Restoration Actions will also show whether they are cost effective and otherwise feasible.

In addition, Adaptive Management Studies are suggested in association with Remedial Actions. In some cases, Adaptive Management Studies are required to gather basic information about watershed processes before Actions can be implemented. In other cases Adaptive Management Studies will be designed to shed light on the validity of Hypotheses. Finally, Studies will show the effectiveness of Remedial Actions. In all cases the adaptive management studies should be designed to resolve the uncertainties in the hypotheses.

Tables 1-4 may be used to see which Stressors the Hypotheses are associated with. They can also be used to see which Hypotheses and Stressors the Remedial Actions and Adaptive Management Studies are associated with.

4.5.1 Education-Actions and Adaptive Management Studies

In many instances elected officials, agency and municipal staff, and local residents are unaware of the consequences of their decisions for stream resources. They may also be unaware of the importance of stream resources to their communities. Providing information at critical times can be an effective way to preserve and improve ecological function of stream resources. Flow Action 1 &endash; Provide decision makers with information on the importance of adequate groundwater as a component of stream ecology. High priority

Adaptive management study 1: Gather stream flow data for the watershed. Peak flow is available from Placer County Control District studies and City of Roseville monitoring stations. DCC has funding to develop methods to gather data throughout the day and through the seasons. Flow data will contribute to water quality studies, sediment studies as well as provide information about conditions for salmonid life cycle. High priority

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Migration Barriers Actions 4b and 4c: Provide decision makers and landowners with information about the salmonid life cycle in Dry Creek and Secret Ravine. Focus on migration requirements and how various stream installations affect them. High priority

Channel Complexity Action 7: Provide decision makers with information about how flood control programs affect the ecology of streams. Describe solutions to flood control that preserve stream function. Use existing material such as Placer County Flood Control and Water Conservation District's GOAL, POLICY AND STRATEGY RECOMMENDATIONS FOR STREAM MANAGEMENT IN PLACER COUNTY, 1991. Medium priority

Adaptive management study 9: Running hydraulic calculations to calculate the benefit of existing methods of stream maintenance that clear riparian vegetation. Use this information to propose the most beneficial maintenance programs. High priority

Action 9: Educate homeowners and landowners about stream ecology and how their actions can affect it. Distribute information such as the DRY CREEK WATERSHED map and description produced by Dry Creek Conservancy and the STREAM CARE GUIDE produced by Placer County RCD and Dry Creek CRMP. Attend local forums such as Municipal Advisory Councils and homeowners associations. High priority

Adaptive management study 11: Catalogue sediment sources and estimate their contribution to instream sediment loads. high priority

Water quality and temperature Actions 10, 11 and 14: Report the results of ongoing water quality investigations in the Dry Creek Watershed to a wide range of stakeholders including residents, government, schools, and business. Information is available from Dry Creek Conservancy programs funded by EPA and Prop 204 funding. Medium priority

Adaptive management study 12: Assess temperature data to determine when and where there are unhealthy temperatures, and to guide further temperature studies. High priority

Adaptive management study 13: Assess water quality data to determine if contamination is present at critical times in the salmonid life cycle. Use data to locate areas where water quality is a concern to salmonids, and sources of contamination. High priority

Adaptive management study 14: Assess stormwater quality to determine what pollutants are present, and if they are at a level unhealthy to salmonids. Locate source of unhealthy discharge. High priority

Adaptive management study 16: Locate sources of industrial and municipal discharge and assess the quality of the discharge. Low priority

Action 13: Provide residents with information about how their home maintenance practices affect stream ecology. Use existing materials from various agencies. Work with local agencies to distribute information. Medium priority

Adaptive management study 15: Gather information about contamination in water entering the stream from urban drains during the non-peak season. This should be coordinated with the more general studies of adaptive management study 13. Medium priority

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4.5.2 Coordinated Management-Actions and Adaptive Management Studies

Many agencies operate in the watershed and often take actions that directly affect streams. Dry Creek and Miners Ravine downstream of wastewater treatment plants are classified as effluent dominated by the Regional Water Quality Control Board. Although fall migrating fish depend on rainfall to provide sufficient flow, other sources such as wastewater and water deliveries are important to all stages of the life cycle. This water is sometimes said not to be "natural", but very little is natural in a watershed like Dry Creek where land uses have made major changes to the hydrological cycle. Stream and other resources require thoughtful, collaborative management. The Dry Creek Coordinated Resource Management and Planning Group (CRMP) was formed for that purpose.

Flow

Action 2: Provide stakeholders with information about the effect of effluent on stream flows and functioning. Work with agencies and local government to develop strategies that maximize healthy stream function. Medium priority

Action 3: Provide information to PCWA decision makers about PCWA impact on local stream ecology. Engage in PCWA management process to develop solutions that satisfy stream ecology requirements as well as water supply. Encourage PCWA to participate in the Dry Creek CRMP. Medium priority

Adaptive management study 2: Gather information about PCWA operations and determine how operations relate to stream flow data. High priority

4.5.3 Restoration-Actions and Adaptive Management Studies

The cumulative effects of mining, agricultural, and urbanization have degraded stream functioning. Stressors that have negative impacts have been identified in the conceptual model and the existing conditions report. The following actions are suggested to begin to restore proper stream functioning to benefit salmonids. It is expected that installation of these projects will significantly improve habitat on Secret Ravine.

Action 4a: Cooperate and coordinate with California Department of Water Resources Fish Passage Improvement Program to design and permit barrier improvements, and to work with landowners to fund improvements. The Fish Passage Improvement Program has chosen the Dry Creek Watershed as one of its projects. They have mapped barriers in the watershed and are evaluating habitat on Miners Ravine. The program participates in the Dry Creek CRMP and has begun a stakeholder process for Hayer Dam operation in lower Dry Creek. High priority

Adaptive management study 3: Determine run timing of salmon and steelhead from the Sacramento River to the spawning riffles in Secret Ravine. High priority

Adaptive management study 4: Design studies to estimate Steelhead spawning population. Observation can be difficult since Steelhead migrate during the season when storms increase flows and turbidity. High priority

Adaptive management study 5: Investigate methods to estimate salmon spawning population in order to assess the effectiveness of management and restoration activities. DCC has done surveys for the four years 1998 to 2001. More tightly designed studies are necessary to relate to juvenile outmigrant counts. Medium priority

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Adaptive management study 6: Survey predators such as bass during the outmigration season. Collect stomach samples from each species. Most predation is believed to occur below barriers. This survey would quantify the problem and provide a baseline for evaluating barrier improvements. Medium priority

Action 5 and 6: Work with local stakeholders to identify, design and install streambank stabilization, revegetation, instream complexity, and stream channel morphology projects. Projects should be controlled to determine what response in spawning, habitat use, or juvenile production occurs. Projects have been identified by the existing conditions report and the survey by Bishop (1997). A designed demonstration project and concept designs for five additional projects are included in Appendix C. High priority

There are substantial areas of public land where restoration may be installed:

Roseville - This section extends from the mouth to the Rocklin City line and is wholly within a preserve controlled by Army Corps of Engineers. All the restoration types named in action 5 and 6 are appropriate. *High priority*

Rocklin - Immediately upstream of the Roseville preserve development projects are projected to dedicate floodplain areas to the city. DCC and DC CRMP should work with City of Rocklin to improve degraded areas there. DCC has been working with the homeowner association upstream of Roseville. A good possibility of instituting homeowner-supported projects exists there. *High priority*

Off road vehicles &endash; Unauthorized roads are a major problem throughout the Roseville preserve and the area extending to Rocklin Road. DCC has provided a report of entry areas to City of Roseville and worked with City of Rocklin, Sutter Hospital, and residents to solve this problem. Rocklin and Roseville have increased policing of these areas and landowners have installed barriers, but controlling access is difficult because there are many entry points. (See DCC memo in Appendix D.) It is expected that land development projects will eventually limit access almost entirely. DCC was recently awarded funding for an education and signage program for the area. Restoration projects will be designed to exclude vehicles from sensitive areas. *High priority*

The Sierra College campus upstream of Rocklin Road includes a preserved section of creek. The Biology Department is interested in participating in habitat improvement projects. Channel complexity would be the most appropriate treatment. Dry Creek Conservancy has had a working relationship with the faculty for over 5 years. A recent Calfed grant facilitates further development of stream related projects there. Medium priority The Loomis Basin Regional Park owned by Placer County includes a section of stream near King Road that has been straightened and overgrown with blackberries. Placer County has shown interest in water quality and stream improvement projects by sponsoring a Prop 204 grant. DCC has met with landowners around the park and one downstream landowner adjacent to the park is very receptive to restoration projects. *High priority*

Projects in these areas would encompass nearly all the recommendations from the existing conditions report and subsequent reports by consultants. A pilot project designed for the Roseville preserve is included in an appendix. Five more conceptual designs for projects are also included along with a map of recommended treatments for specific areas.

In addition, Bishop, (1997) has identified similar projects that should be undertaken along the length of Secret Ravine. High priority

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Adaptive management study 7: Survey habitat types and type distribution. Li and Fields (1999) surveyed habitat for the existing conditions report. Subsequent surveys will determine if management and restoration have resulted in more optimal proportions of habitat types and in better quality habitat that support a diverse stream and riparian community. *High priority*

Adaptive management study 8: Assess juvenile habitat quality and complexity. Juvenile rearing habitat quality and complexity affect relative abundance of rearing salmonids. Few assessments have documented the value of various parameters. Depth, velocity, substrate, and cover are some of the parameters (Bovee 1978), however these parameters vary depending on water temperature (Smith and Li 1983). Sedimentation and fish food availability are generally not considered. Habitat complexity is an important habitat factor that has not been clearly defined. Complexity provides diverse habitat that allows spatial segregation that may increase relative abundance. For example, a simple pool that is excellent in quality will not support as many fish as an excellent and complex pool of the same dimensions. (Li) *Low priority*

Action 8: Identify problem stormwater entry points and design and install retrofit projects to reduce erosion and delivery of sediment. *High priority*

Adaptive management study 10: Survey riparian quality near stormwater outflows. *high priority*

Action 12: Design and install retrofit projects to reduce delivery of pollutants to the stream. *Medium priority*

4.5.4 Additional Adaptive Management Studies

Several other studies are suggested to gather information to improve understanding of salmonids in the Dry Creek Watershed.

Reproductive success

Adaptive management study 17: Conduct juvenile outmigration study on Secret Ravine. Rob Titus used a screw trap during the seasons of 1998-99 and 1999-2000 to estimate out migration (Titus, 2001, Appendix D). Subsequent efforts should gather data for comparison. Other methods of observing juveniles should be investigated. *Medium priority*

Adaptive management study 17a: Correlate outmigration with adult spawning. To accomplish this, accurate spawning population estimates are required and the age distribution of the adult fish must be known so that adult abundance can be segregated into broods (i.e., year classes) that correspond to a particular juvenile outmigration period. *Medium priority*

Adaptive management study 18: Analyze juvenile stomach samples to correlate with growth, health and habitat. *Medium priority*

Non-natal rearing

Adaptive management study 19: Investigate methods to study the extent of non-natal rearing in Secret Ravine. *Medium priority*

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5 IMPLEMENTATION

A number of resources will contribute to implementation of the Secret Ravine AMP.

Table 5

Secret Ravine AMP Resources

Resource	Period
The DWR Fish Passage Improvement Program will contribute resources to achieve consensus, design, and permits for barrier improvement.	Current
Inclusion of elements of the AMP in the Dry creek watershed management plan and the Roseville Riparian Management Plan will make it part of implementation of those plans using City and County resources.	2002-2003
Prop 204 programs will gather data for adaptive management studies.	Current-2002
319h grants awarded DCC will support monitoring and some restoration.	Current-2003
The DCC Calfed grant will develop GIS capabilities to organize data, will provide for volunteer training and involvement, will support flow monitoring, and will provide $20K for restoration on Secret Ravine.	2002-2003
A CDFG proposal to be developed would provide for design, permitting and some construction of projects on Secret Ravine.	2002- 2003
National Fish and Wildlife funds will support restoration projects.	2003

In summary, data gathering under existing programs will continue through 2003. Design and permitting of projects will take place in 2002. Construction of initial projects will begin in 2003.

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APPENDIX A

Executive Summary of Secret Ravine Existing Conditions Report

Purpose The purpose of the study is to collect information to determine the existing condition of Secret Ravine. The ECR will serve as a baseline for assessing watershed function and will be used to develop an Adaptive Management Plan that will discuss impacts, hypotheses, and develop prioritized restoration actions for the Cry Creek Watershed. The data will serve as a baseline for evaluating the effectiveness of remedial measures as part of a long term monitoring program.

This study is funded by grants from the Anadromous Fish Restoration Program of the US Fish and Wildlife Service, and the National Fish and Wildlife Foundation Grassroots Salmon Initiative. A benthic macroinvertabrate study was funded separately with funds provided Dry Creek Conservancy by the 319h grant program of the State Water Resources Control Board.

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Methods

This study focuses on the stream corridor of the main stem of Secret Ravine. The area covered was approximately ten miles from the confluence with Miners Ravine to Rock Springs Road. (Map 1) The team approach was used to get a broad knowledge of the conditions. A multidisciplinary team consisting of Stacy Li, fisheries biologist, Wayne Fields, aquatic entomologist, Robert Holland, geobotanist, and Mitchell Swanson, geomorphologist worked on their respective aspects of the stream corridor. The corridor was walked in its entirety by three of the consultants. Homeowners and landowners throughout this area were notified of the study and several meetings were held to discuss the purpose of the study and include landowner concerns. The team met at areas of special interest or concern to discuss indications or approaches. The following sections draw from the consultants' reports.

Geomorphology

Hydrologic and Physiographic Setting

Secret Ravine is a perennially flowing stream that drains a 19.7 square mile basin within the Sierra Nevada foothills of western Placer County. Secret Ravine flows 10.5 miles from its headwaters in the Newcastle area (elevation 1285 feet) to its confluence with Miners Ravine Creek (elevation 165 feet) near Eureka Road in Roseville. (Figure 1) Streamflow is augmented by an unknown volume of tailwater delivered by Placer County Water Agency's irrigation releases. We observed flows in the early fall between 0.5 and 2-3 cfs. No continuous recording stream gage exists on Secret Ravine, but there is a flood activated warning gage operated by Roseville located in Rocklin near Sierra College Boulevard.

The Secret Ravine drainage basin experiences a Mediterranean climate with warm dry conditions between April and October and wet and mild weather between November and March. Average rainfall is 25.0 inches per year with most occurring during the peak rain months of December through February. The basin is underlain by granitic rocks of Mesozoic age and is capped unconformably by volcanic and volcaniclastic rocks of the Miocene Merhten Formation (occurring primarily in the lower watershed) and by Pleistocene alluvial fan and fluvial deposits of the Turlock Lake and Riverbank Formations. In the watershed hillslopes, Mehrten volcanic bedrock units develop shallow soils that generally have very high runoff rates. The granitic soils vary from shallow veneer over bedrock to deeper soils over zones of deeply weathered and decomposed granite.

Appenix A Fig. 1 - Study Area Line Map

Appendix A Fig. 2 - DEM Watershed map for Secret Ravine

Secret Ravine flows within a narrow valley underlain by recent alluvial deposits. The valley width expands in places to over 1,000 feet likely as the result of geologic controls. The central alluvial valley is bound by hills that are composed of granitic rock in the upper watershed and volcanic cap rock in the lower watershed. Soils in the alluvial valley vary from coarse-grained and highly permeable decomposed granite units (resulting from waste products of placer mining and sluicing and runoff from quarry spoils) to dense organic soils typical of perennial wetlands. The valley floor vegetation types include valley oak grasslands, riparian forest, and patches of seasonal wetlands.

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Channel Morphology

Stream channels are described by their, their slope (or gradient), width and depth (cross sectional shape) and their meander pattern as seen from above. The size and shape of a channel depend on the balance of water flow and sediment supply (sediment volume and sediment sizes). Channel morphology with a low ratio of width to depth and a meandering pattern with a sinuosity (the ratio of the channel length to the longitudinal valley length) greater than 1.3 is highly correlated to the favorable development of pools and gravel riffles important for good salmonid spawning and rearing habitat.

The stability of a channel is determined by its ability to pass the sediment load from upstream without dramatically changing channel width, depth or meander pattern. Channels may change pattern and shift location across an alluvial valley floor, but if they maintain consistent width, depth and meander characteristics they are considered "stable," or in "dynamic equilibrium."

GRADIENT

Different areas of a watershed have different slopes (or gradients) that determine the amount of sediment in the channel. For example, in the upper watershed steep channels and hillsides (the zone of erosion or depletion) are subject to net erosion because flow is too swift to allow for significant sediment storage. In the middle watershed (the zone of transportation) the stream flows within a sloping, alluvium-filled valley and temporarily stores sediment so that the sediment load coming in is equal to that going out. In the lower watershed (zone of net deposition) the stream meets its "base" level (such as a delta or the ocean) and sediment accumulates.

The gradient of a channel can be plotted by finding its lowest points all along the stream. The gradient of the channel may indicate the type and quality of its fish habitat. In general, channels over 2 percent gradient are confined in width and are entrenched within the low point of the valley; as is typical of headwater streams. Channels with gradients below 2 percent are often the classic meandering channel type with point bars, outer bank pools (good for adult salmonid migration, feeding and cover) and intervening gravel riffles (good for salmonid spawning and juvenile rearing). Properly functioning meandering channels have diverse water depth and velocity with stable size and shape, and produce high quality fish habitat in pools and riffles.

Figure 3 is a graph of the gradient of Secret Ravine and shows an average slope of 2.4% in the upper third of the stream, and an average slope of about 0.6% in the lower two thirds. This fits the model of a headwaters stream making a transition to a middle watershed pattern that can have a classic meandering pattern rich in salmonid habitat. However, Secret Ravine has other channel characteristics that limit its habitat value.

CROSS SECTIONAL SHAPE

Figure 4 shows a cross-section of an idealized valley. The channel has three stages: the low flow channel which often carries well over 90% of the flows and contains much of the aquatic habitat important for fish; the bankfull channel which carries flows of 1.5 to 3 year storms; and the geomorphic flood plain (not FEMA "100-year flood plain") which is the low, flat area adjacent to the bankfull channel and is subject to frequent flooding and fine sediment deposition.

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The bankfull channel carries small- to intermediate-sized floods that occur fairly often and has the most influence on channel size and shape. The bankfull channel is indicated by features such as the level of the flood plain surfaces, the predominant scour lines, and in some climates by particular species of vegetation. The flood channel carries the larger flows, generally no less than a 5-year event. The flood channel, ultimately bound by the surrounding hillslopes, includes older geomorphic flood plain surfaces termed "terraces", that are the result of channel incision or entrenchment into the valley floor. Terraces are formed by climatic change, tectonic uplift, progressive erosion, or a short term filling by a large flood event.

SECRET RAVINE MORPHOLOGY

Secret Ravine flows within a channel that is entrenched within the alluvial valley floor. This appears to be the result of: 1) historical filling of the alluvial valleys with re- deposited placer and quarry mining spoils; and 2) possible channelization for subsequent agricultural use and urban development. As a result, Secret Ravine is not close to the ideal three stage channel described above. The channel is typically 6 to 8 feet deep (in some reaches over 12 feet deep), flat bottomed and rectangular in shape and anywhere from 10 to 25 feet wide. A large range of flows are contained within the channel which leads to further lateral and vertical erosion. In addition, the ability of the channel to dispose of excess sediment by carrying it onto the floodplain in overbank flows is diminished. Moreover, the deeply incised channel places the summer groundwater table well below the valley floor. This, combined with the historically deposited surface layer of mining spoils, makes conditions highly unfavorable for the development of riparian vegetation.

Appendix A Fig. 3 - Longitudinal profile of Secret Ravine measured upstream from cnfluence with Miner's Ravine.

Appendix A Fig. 4 - Idealized valley floor cross-section showing typical geomorphologic features

This type of channel (likely a Rosgen "F" type) is stable in that it doesn't move much laterally. Meandering is slight in most reaches: generally with a sinuosity less than 1.2 with short reaches above 1.5. This channel type does not generally produce good fish habitat unless there is an abundance of instream large roughness objects such as boulders, large logs and/or root wads to produce pools, instream cover and sorting mechanisms for spawning gravel.

In disturbed watersheds such as Secret Ravine, it may be possible to promote a shift from a stable degraded channel form with low habitat value to a form that sustains better fish habitat. A full geomorphic assessment of Secret Ravine should develop over time as a habitat improvement program develops and the appropriate hydrological and geomorphic data is collected. Analysis of the data can lead to designs for channels with improved hydraulics and habitat value.

Vegetation

There are two reaches along Secret Ravine with different geology, different valley forms, and different riparian vegetation. The upper three quarters of the stream is incised to numerous granitic local bedrock controls. Fine bedload accumulates above these controls, but there is little out-of-channel alluvium. The lower quarter of the stream course flows over Merhten volcanics. Here, there is a broad alluvial floodplain and field evidence of on-going overbank deposition in this lower reach. Valley oak forests develop on the highest alluvial surfaces, while cottonwood forests do better on the lower floodplain. The bankfull channels flood so frequently that only willows or alders can persist. Unfortunately, most of the terrace and floodplain in this lower reach has been mined and the original topography and vegetation have been obscured.

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The historical land uses have interacted with these geologic reaches resulting in several different plant communities today: Naturalized Annual Grassland mantles the shallowest soils on the volcanic mudflows. It also is common on granitic soils no longer under cultivation. It typically includes soft chess (Bromus hordaceus), ripgut brome (B. diandrus), medusa grass (Taeniatherum caput-medusae), and filaree (Erodium lotrys). Star thistle (Centaurea solstitialis) and wild lettuce (Lactuca serriola) have increased locally in the years since cattle were removed.

There is a Freshwater Seep just south of Interstate 80 about 500 feet beyond the end of China Gardens Road. A low levee parallel to the freeway appears to be impounding enough ground water to support a small clump of cattails (Typha latifolia) and a few willow clumps (Salix lasiolepis, S. exigua). These are surrounded by several hundred feet of weedy hydrophytes, especially baltic rush (Juncus balticus).

Great Valley Willow Scrub is mixture of fast-growing deciduous shrubs including several species of willow *(Salix exigua, S. lasiolepis, S. laevigata)*, buttonwillow *(Cephalanthus occidentalis)*, coyote bush *(Baccharis pilularis consanguinea)*, and sapling white alders (A*lnus rhombifolia*) and Fremont cottonwood (*Populus fremonti*i). It is an early seral community that quickly colonizes alluvial deposits disturbed during flooding. Trees that do establish seldom last many decades before they are toppled by undercutting or floating debris. Most stands consist of a single file thicket of shrubs up to 30 feet wide. These thickets are very efficient at retaining sediment during over-bank flows. The shrubs that grow here have well developed vegetative reproduction and quickly form enormous rootwads capable of enduring 100 year flows. Even stands that are completely decapitated by saltating bed load during peak flows can recolonize a bar within a growing season.

Great Valley Riparian Forest is best developed in the formerly dredged areas from the confluence upstream to near the hospital, where large valley oaks (Quercus lobata) and Fremont cottonwoods (Populus fremontii) form a nearly closed canopy. Upstream of the dredged area, Fremont cottonwoods are much less conspicuous, but large valley oaks continue to the contact with granite. There also is a small stand of cottonwood riparian forest near Sierra College.

White Alder Riparian Forest is the principal riparian community along Secret Ravine above about 220 feet elevation, where the geology changes from sedimentary to granitic. The stream is incised in bedrock and the riparian corridor is correspondingly narrow. Fast-growing alders (40 feet in 10 years) capitalize on light gaps and can reach the canopy, thereby shading out competitors. Alders cast dense shade and produce copious, nitrogen-rich leaf litter that is an important stream fauna resource. Alders are very shallow-rooted: only about 2 feet of alluvium over bedrock is necessary.

Oak Woodlands dominated by interior live oak (Quercus wislizenii) and blue oak (Q. douglasii) probably mantled the entire Loomis Basin in pre-Spanish time. All surviving woodlands in the basin include these two species, frequently plus valley oak and grey pine (Pinus sabiniana). Canopies usually are closed and abundant, persistent leaf litter keeps understories fairly open. Many surviving oak woodlands are in areas that were placer mined before agricultural development began. Apparently the mining rendered the land useless for agriculture and thus the forest never was cleared. Other oak woodlands survive in areas not served by gravity irrigation water.

Irrigated orchards replaced native oak woodlands where imported water was available. Irrigation tail water would have supplemented late season flows compared to pre-Spanish conditions, thereby irrigating riparian vegetation that was re-establishing along the water course in the wake of gold extraction.

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Stream Habitat

Method

Physical stream habitat is documented while wading upstream. Discreet channel features, called habitat types, are identified, measured, assessed, and recorded. Their proportion of the total stream is calculated. Most habitat types fall into three broad categories called riffles, runs, and pools. A set of stream features such as instream and overhead cover, and substrate quality is also graded.

Findings

Proportional area of run types was about 71%, pool types about 18%, and riffle types about 9%, with several minor habitat types comprising the rest. This is considered a less than ideal composition since most benthic macroinvertebrates are produced in riffles. Food supply for salmonids decreases with distance from riffles. Fish are dependent on insects from the bank (terrestrial drift) as they get further from riffles.

Sand was the overwhelming dominant substrate element representing 68% of the observations. The excess sand reduces the amount of riffles by burying them. Excess sand also may block fry emergence from the gravel to the stream. Sand has degraded rearing habitat quality for aquatic invertebrates and salmon and steelhead rearing habitat. Sand has buried most of the cobbles and filled in the interstitial space where aquatic invertebrates live. Fish inhabiting a sand covered stream channel have shallower pools, smoother substrates, greater energy expenditures, less complex rearing habitat, and less food from the benthos. Sand contributes to unhealthy warming of the stream, by slowing water flow (travel time) and making the stream more shallow, which allows greater solar penetration and more rapid warming.

Ratings for stream features were as follows:

Feature	Quality
Substrate roughness	Poor due to sand
Interstitial space	Poor due to sand
Benthic aquatic invertebrate habitat	Poor-sand decreases riffle frequency and quality
Salmonid feeding lanes	Poor
Surface turbulence	Good
Instream cover	Poor-channel simplified by sand
Riparian vegetation cover	Fair

Woody debris	Poor-very little
Overhead cover	Fair
Terrestrial drift	Fair
Juvenile rearing quality	Fair
Typical pool depth	Good
Substrate percolation	Good-despite sand
Overall rating	Fair-sand is the major constraint

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ECR Conclusions

The existing deeply entrenched channel, which has apparently formed as a result of human land use practices, theoretically could be reconstructed to a more favorable stable form that could be sustained by current hydrologic and geomorphic conditions. The slope of the channel and valleys (less than 1 percent) is within the range of a less entrenched, shallower and more sinuous channel that would have greater habitat value for fish (a Rosgen "C" channel type). It would also raise groundwater levels to promote favorable conditions for riparian and wetlands vegetation. The predominance of sand substrate in Secret Ravine is likely due to widely disturbed sources of channel erosion, historical disturbance associated with quarries and placer mining, and unfavorable channel morphology that does not flush pools and riffles. The sand substrate problem is probably due to both excessive supply and channel hydraulics. Improvements such as channel re-construction or installation of roughness objects will increase pool depth, gravel quality, etc. The present hydraulics are monotonous due to an overly deep and wide channel. Hydraulic diversity is needed to acquire the diversity in channel topography. These improvements aim to increase the relief within the channel so that there are drops into deep pools and rises to shallow riffles. The average drop will be the same, but the channel bottom will rise and fall.

Opportunities for restoration Of vegetation

The vegetation is in remarkably good shape given what has transpired in the watershed within the life spans of the dominant plants. The worst weed is wild blackberry, and most of what it infests is mine tailings. Any effort to control the blackberry, however, will need to address what plant will replace it in the landscape.

Restoration opportunities are greatest where the valley floor is broadest, mostly downstream of Rustic Hills. Terraces outside the flood channel are appropriate for valley oak-dominated communities. Floodplains are more appropriately planted with species of the cottonwood and willow dominated communities. While plantings within the bankfull channels may be considered, for example to armor a channel modification, they must be recognized as temporary.

Of stream morphology

a. Develop and implement projects that introduce large roughness objects into stream channels to promote greater hydraulic diversity, bed scour for pools and sorting and flushing mechanisms for gravel. These objects could include logs, root wads and boulders placed along the edges of the entrenched channel. Heavy equipment is usually required, but there may be some opportunities to move objects from the channel banks into the channel. These projects, when done correctly, would have immediate benefits.

b. Low-tech in-channel projects should be installed on a pilot project basis. These include log and hay bale structures (or perhaps coir biologs) planted with live willow stakes placed in the channel to reduce width, confine flow and create deeper pools and overhead cover. There are many places where this technique could be applied.

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c. Where channels are excessively eroding in the headwaters, the channel banks should be regraded to create the natural three-stage channel configuration (low flow, bankfull and flood channel). This would be accomplished by excavating one side of the channel to the proper overall flood channel width with a flat geomorphic flood plain at the proper elevation and a transition slope no steeper than 2:1 (horizontal:vertical). The channel dimensions would be determined by specific geomorphic survey. All surfaces would be re-vegetated with native species, especially willow (Salix sp.), sedges and other species that provide good erosion control. Logs, boulders and other elements should be incorporated. The project should be constructed under the supervision of an experienced stream restoration specialist to conduct favorable "fit-in-the-field" work. A planting, erosion control and irrigation plan must be completed and implemented in order to ensure success. An engineering analysis would be required to ensure no impact to adjacent banks or properties.

d. Re-construct channels in the lower alluvial valleys of Secret Ravine using a geomorphic design to 1) eliminate the entrenched condition and chronic sediment input from channel banks; 2) increase channel sinuosity to improve substrate conditions; and 3) improve conditions for riparian vegetation and wetlands by elevating the groundwater table. This would be accomplished by first constructing a new channel at a higher elevation on the valley floor in a new alignment located away from the existing channel. The new channel would be vegetated and irrigated for a period of about two years to stabilize the banks. Flow would be introduced in the spring of the third year and the old channel would be partially filled to prevent stream capture. Implementing this project appears technically feasible in several reaches summing to perhaps over 5,000 linear feet of channel. The benefits for fisheries would be substantial and the project presents an opportunity to restore stream habitats to their likely pre-Gold Rush Era condition and geomorphic processes.

[Note 1: A similar project is presently under construction on Trout Creek in South Lake Tahoe. The stream experienced channelization and impacts due to Comstock Era logging, grazing and road building. The Trout Creek project is more complicated than the Secret Ravine Project and is costing about $150 per linear foot.]

[Note 2: There could be significant flood control benefits in small floods if the channel were restored. Overbank flows would occur more often and flood plain storage would be increased. Local flood impacts would have to be addressed as part of the channel design].

e. Off Road Vehicle Access to the creek should be eliminated. Significant erosion and water quality impacts are occurring in several reaches. The entry points should be identified and closed off.

APPENDIX B AERIAL PHOTO ATLAS OF NATURAL VEGETATION

An air photo atlas of natural vegetation along portions of Dry Creek, Miner's Ravine, and Secret Ravine. The photobase has been electronically form original air photos nominally scaled at 1,000 ft per inch. The phtomosaic has not been georeferenced. The photos were taken in March, 1995. Several large developments have gone in within the study area that are not visible in the photos. Polygon boundaries reflect conditions in August, 1999.

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Click an image for a larger view.

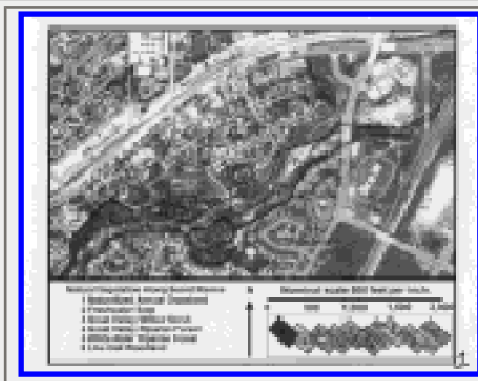

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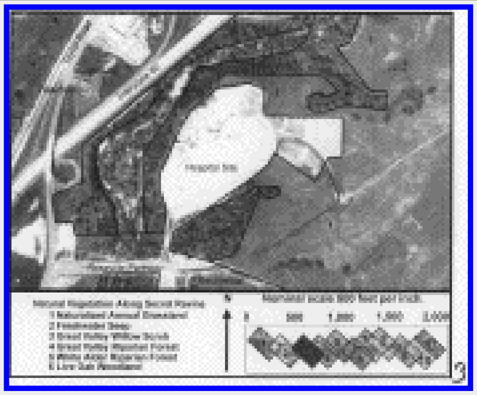
Plate 2



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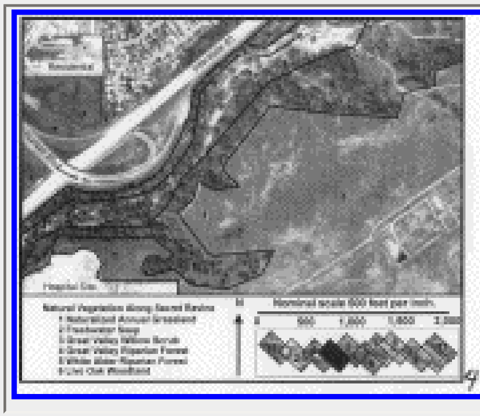

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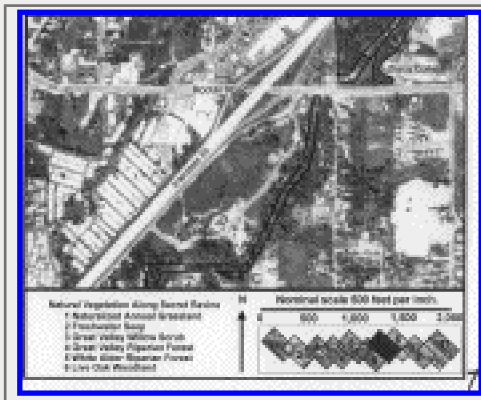

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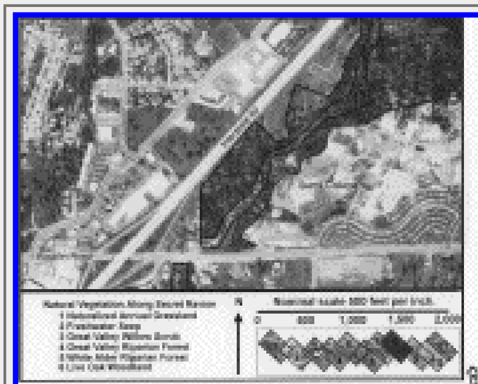

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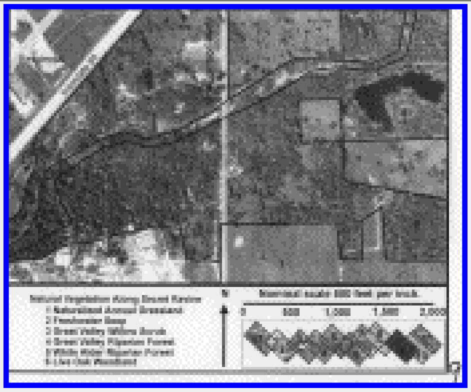

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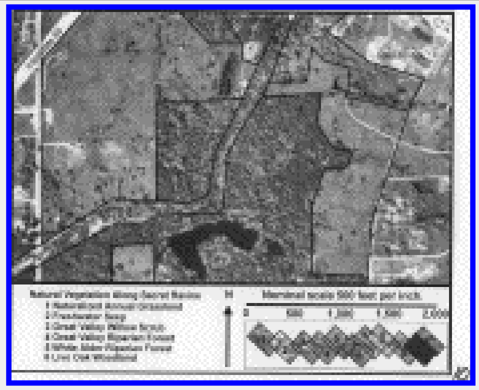

Plate 10

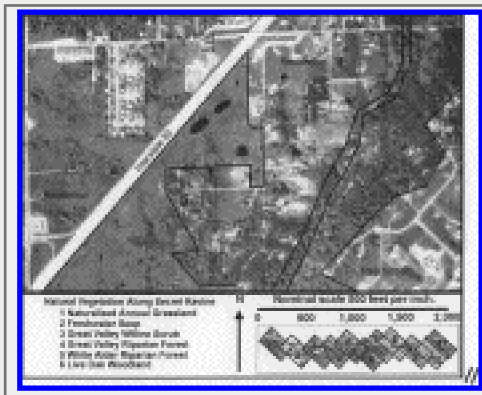

Plate 11

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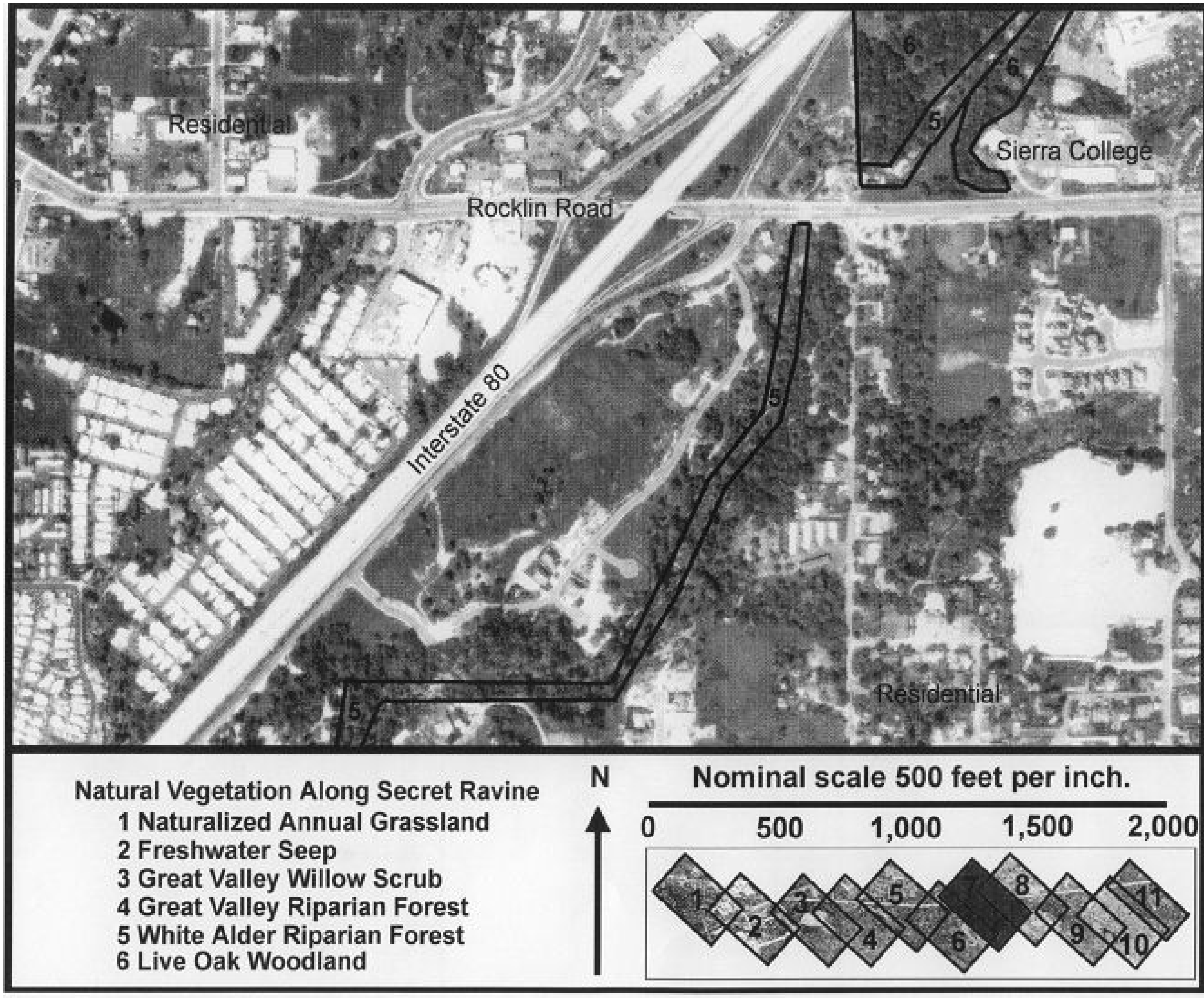
APPENDIX C Restoration Plans

APPENDIX D RELATED MEMOS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Rocklin Road
Interstate 80
Residential
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2 Freshwater Seep
3 Great Valley Willow Scrub
4 Great Valley Riparian Forest
5 White Alder Riparian Forest
6 Live Oak Woodland
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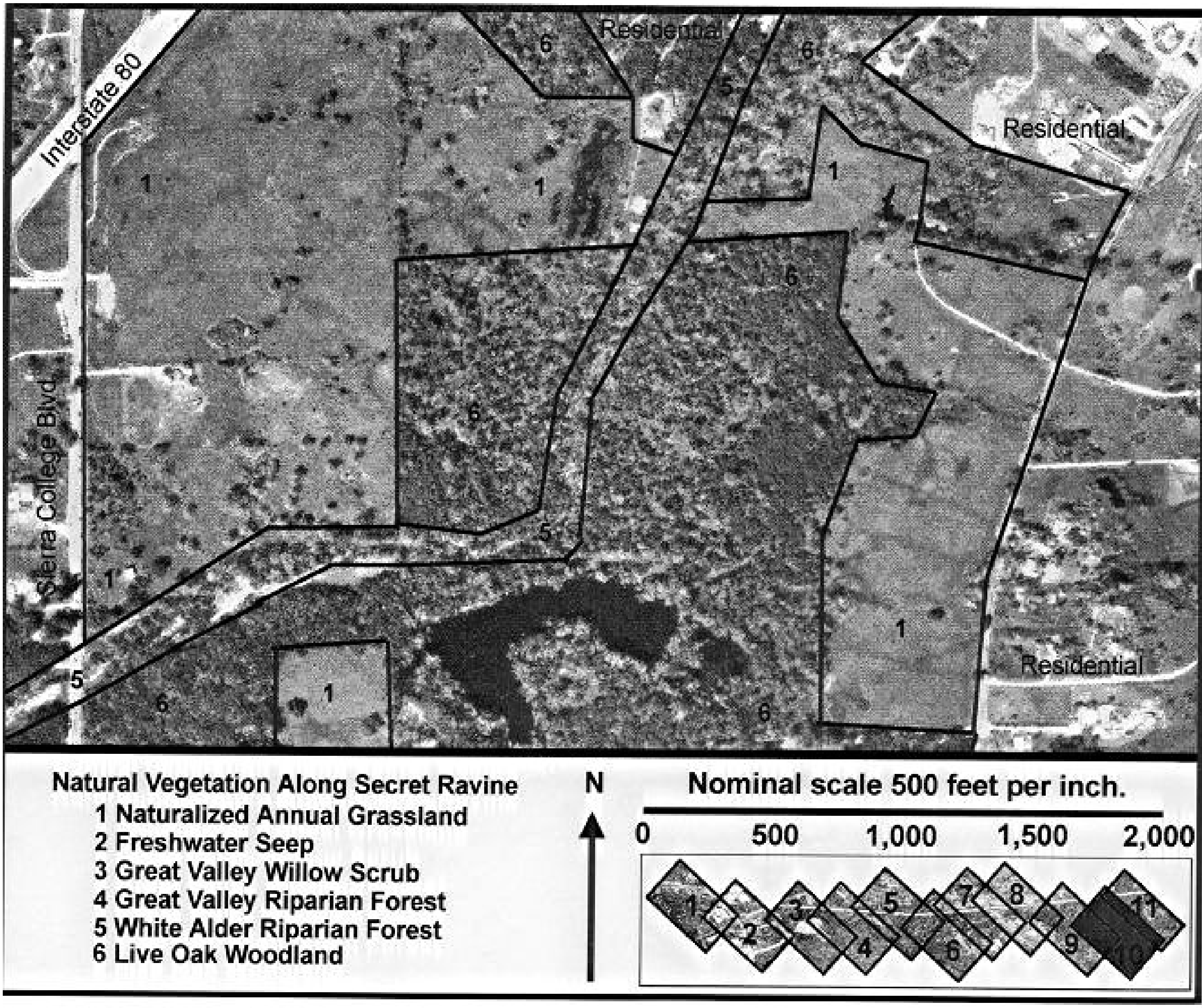
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Sierra College Blvd.
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Residential
Residential
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Natural Vegetation Along Secret Ravine
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4 Great Valley Riparian Forest
5 White Alder Riparian Forest
6 Live Oak Woodland
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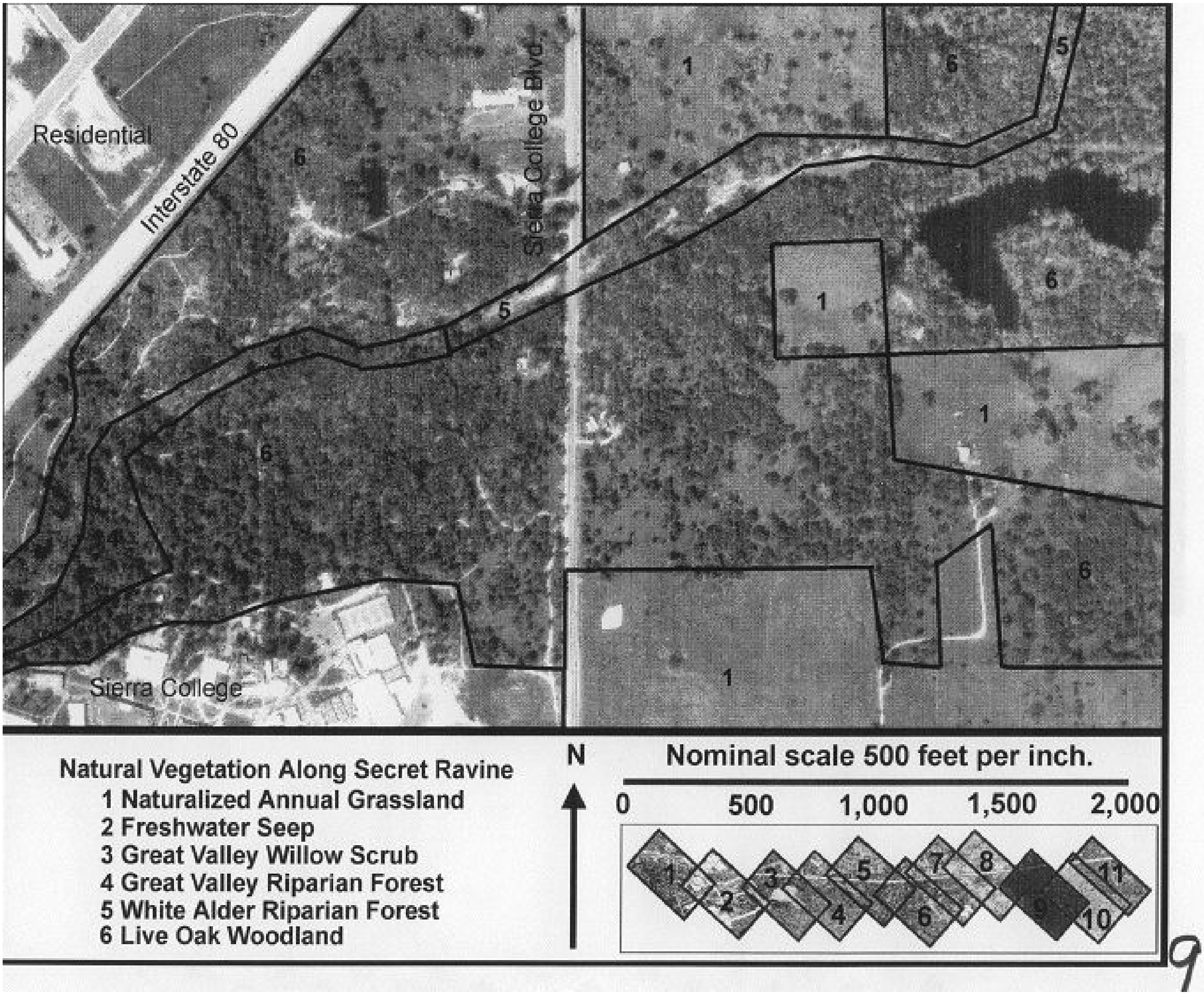
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Sierra College
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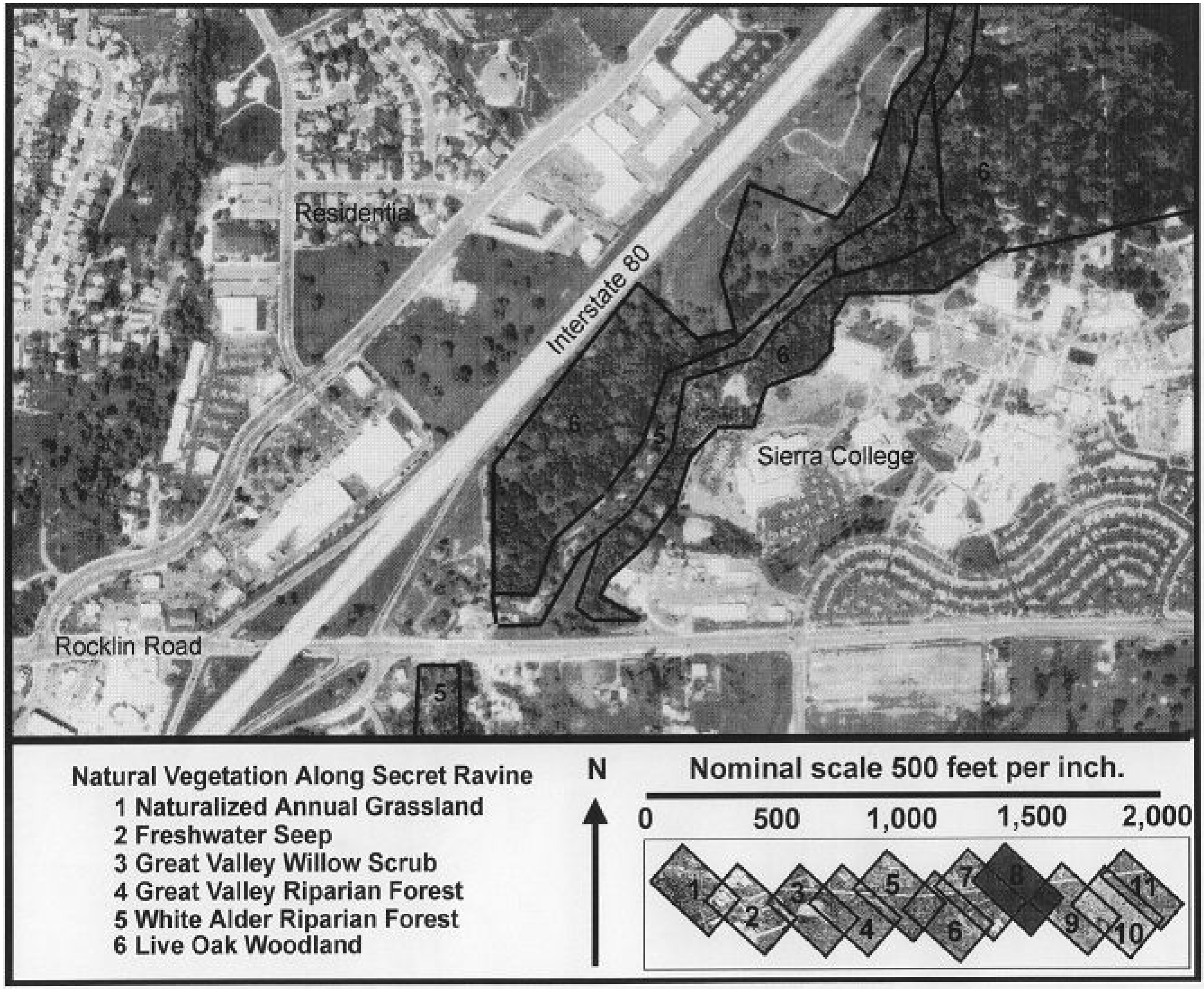
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3 Great Valley Willow Scrub
4 Great Valley Riparian Forest
5 White Alder Riparian Forest
6 Live Oak Woodland
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Nominal scale 500 feet per inch.
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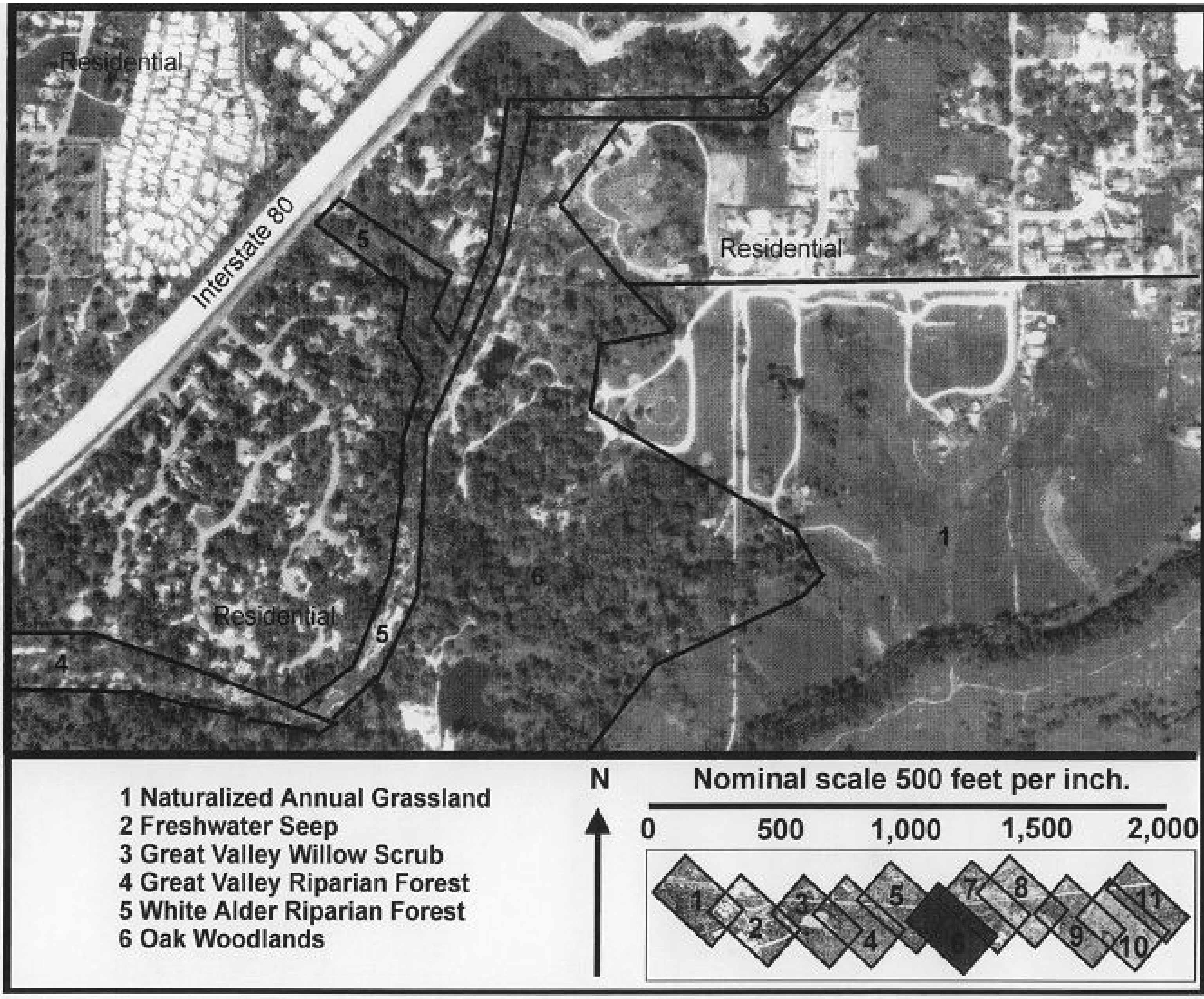
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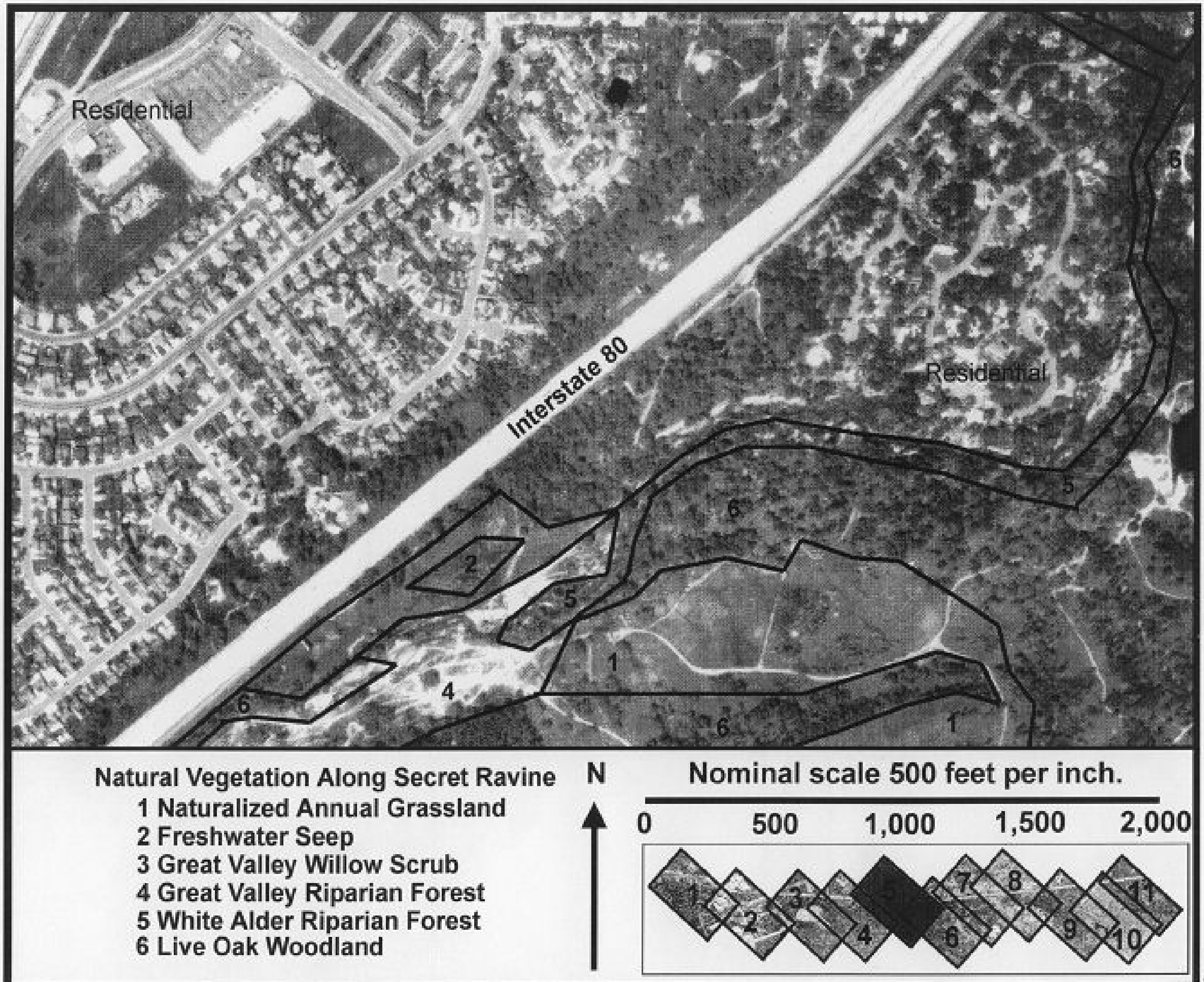
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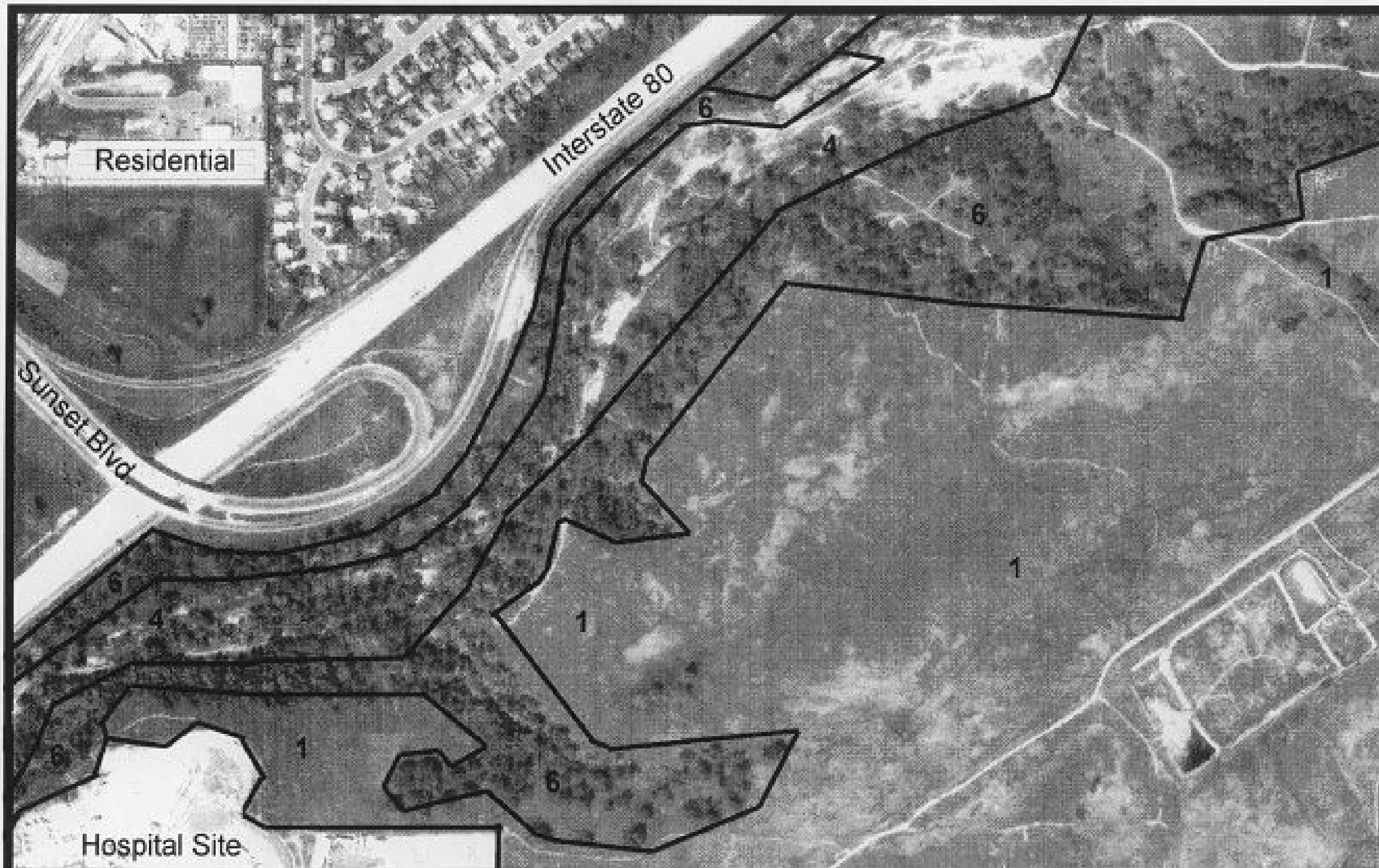

Natural Vegetation Along Secret Ravine

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2 Freshwater Seep
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5 White Alder Riparian Forest
6 Live Oak Woodland

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Nominal scale 500 feet per inch.

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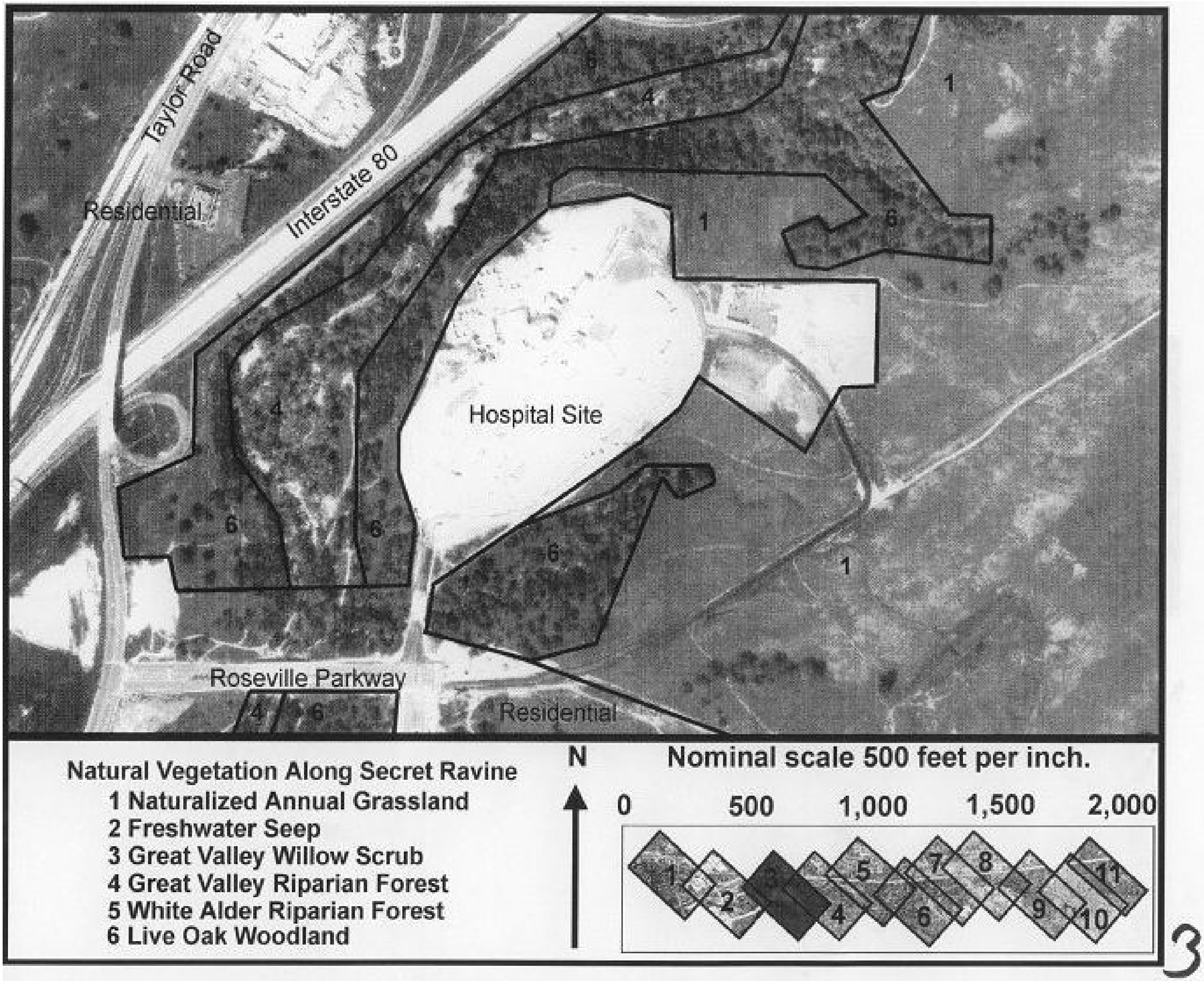
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Hospital Site
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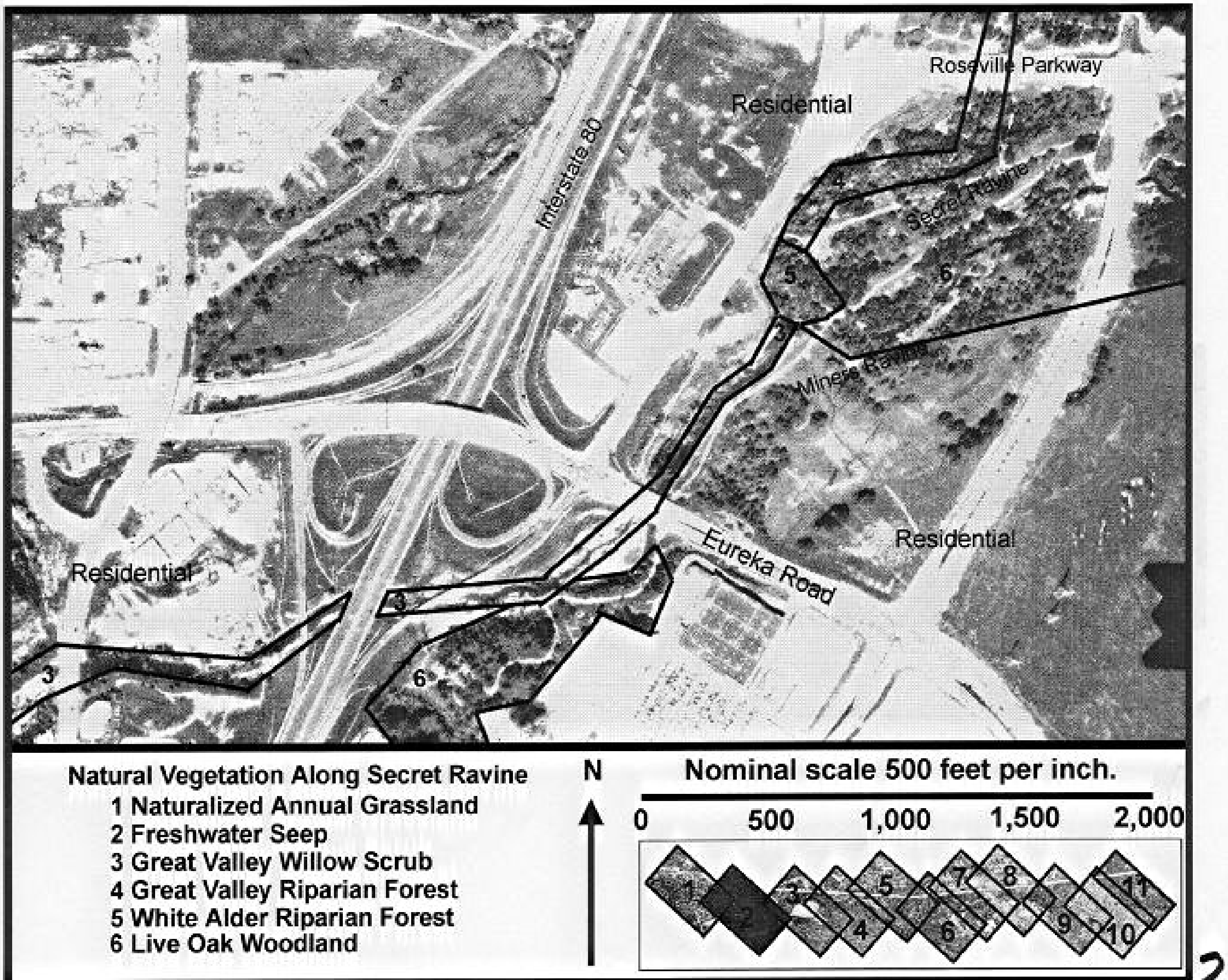
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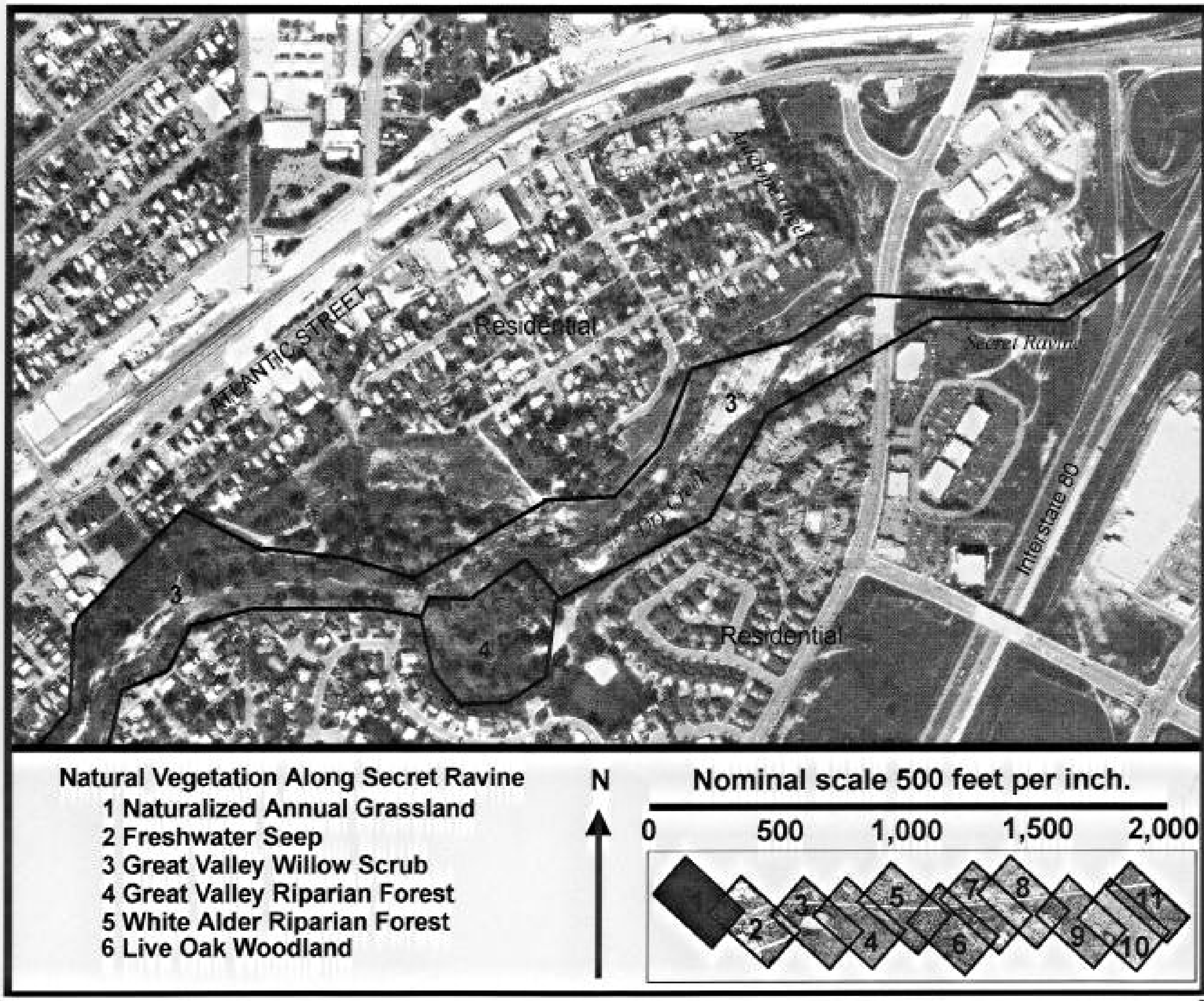
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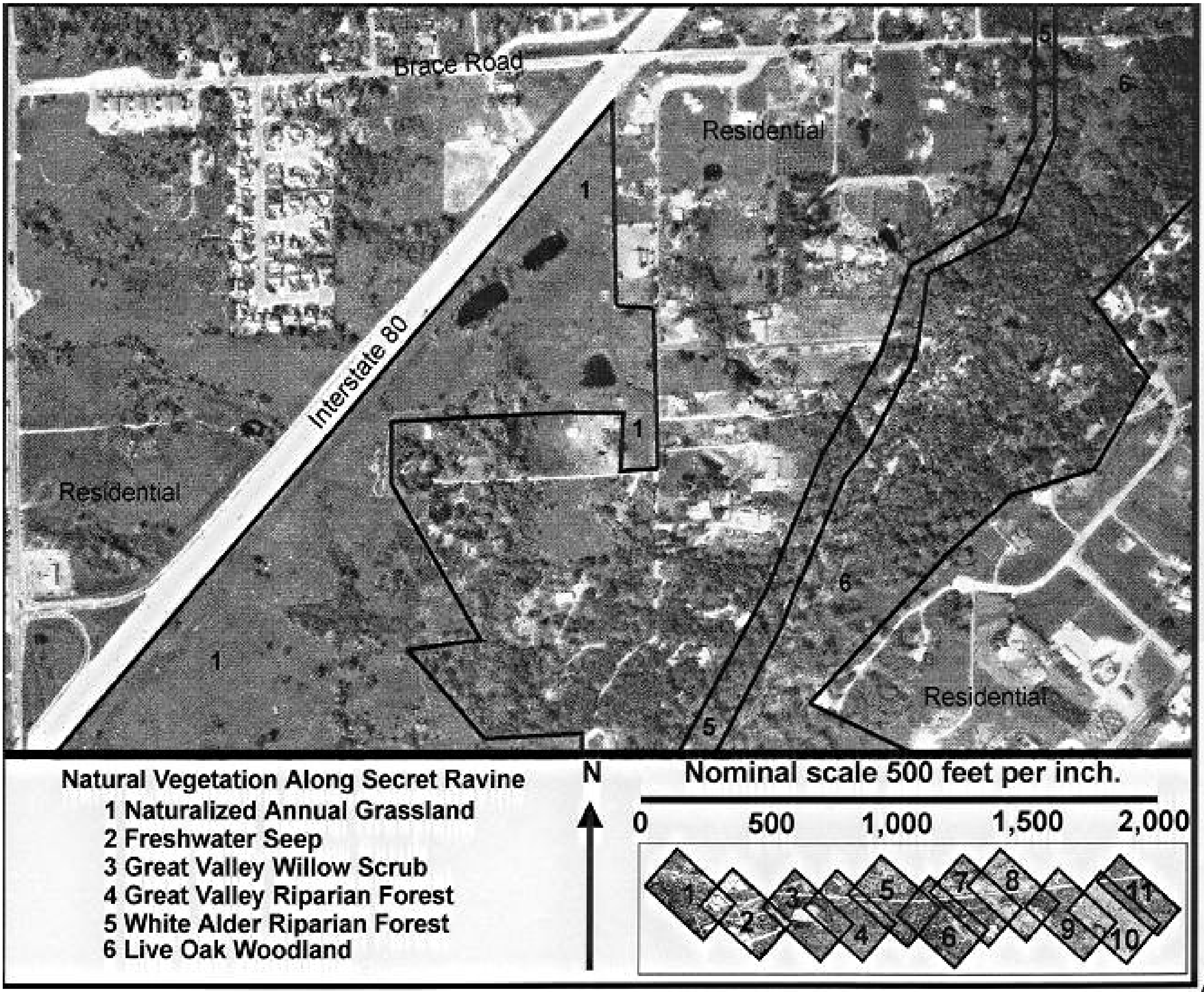
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4 Great Valley Riparian Forest
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6 Live Oak Woodland
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Nominal scale 500 feet per inch.
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Swanson Hydrology And Geomorphology

115 Limekiln Street Santa Cruz, California USA 95060 phone 831-427-0288 email: swanson@swansonh20.com

SECRET RAVINE ADAPTIVE MANAGEMENT PLAN

DESCRIPTION OF PRELIMINARY MANAGEMENT AREAS

prepared by

Swanson Hydrology And Geomorphology

for

Dry Creek Conservancy

The Management Areas designated for the Adaptive Management Plan for Secret Ravine are meant to be a coarse-scale description of the restoration and enhancement practices that would be appropriate for each stream reach. The management areas were derived, and boundaries delineated, based on factors such as channel morphological character (e.g. - alluvial verses bedrock confined reaches), future land-use history (e.g. - private versus public ownership), channel health, access issues, and potential for restoration. Our initial delineation of reach breaks was based on familiarity with the channel and riparian area, brief field visits, and aerial photo analysis. Further field work and analysis of channel conditions is required to refine the management areas and broaden the recommendation made for each area. From the confluence of Secret Ravine with Miners Ravine to just above Horseshoe Bar Road, five management areas were delineated.

MANAGEMENT AREA A

Management Area A extends from the confluence with Miners Ravine upstream to the downstream boundary of the Guntert Property (see Plate 1). Much of Management Area A is public land held by the City of Roseville making it an area of high priority and feasibility for restoration. This reach of Secret Ravine is characterized by an incised channel that meanders through old floodplain and hydraulic mining debris deposits. Due to incision of the channel and heavy bank erosion, large amount of highly mobile sands dominate the bed of the channel, impairing salmonid spawning gravels and reducing rearing habitat through pool filling and loss of aquatic macroinvertebrate production. It is also very difficult for riparian

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vegetation to establish on the alternating sand bars due to deep, high velocity flood flows that have little access to, historic floodplain surfaces

Recommended treatments for Management Area A would be to stabilize existing alternate sand bars to allow them to become point bars through a process of establishing riparian vegetation, This can be accomplished by raising the elevation of the bars to bank full and armoring them with gravel and cobble-sized. material (see Site 3 and detailed engineering plans), Stable point bar development would allow a dense riparian overstory to develop and allow scout of the outside bends of the channel where pools could form for rearing habitat. Riffle gradients would also increase creating cleaner spawning areas for salmonids and should also be cut back to provide floodplain storage aid reduce velocities and shears acting an the channel bed and banks during high flow conditions.

In order for these restoration and enhancement actions to be successful, formalization of the City of Roseville‘s access road and cessation of illegal trespassers must be a top priority, Restoration actions cannot be successful if they are continually damaged by ORV uses.

MANAGEMENT AREA 8

The boundaries for Management Area B consist of the up and downstream edges-of the Guntert property (see Plate 1), This property is slated for development in the near future that may include provisions and mitigation measures to improve floodplain and channel conditions along the property.

Proposed restoration actions on this property could include rehabilitation of the floodplain and a channel realignment property that would move the channel away from Highway 80 (See Site 4), The existing floodplain surface on the property is a wide, heavily eroded area with multiple ORV trails gullies, and steep access roads from the adjacent hillside. Revegetation .and possible development of vernal pools and off-channel wetlands could be a viable option. Channel conditions in this section of stream are similar to conditions found in Management Area A. As part of this plan, we are recommending similar actions occur through Management Area B. Currently, the channel flows straight along edge of Highway 80 with riprap along the right bank of the channel (looking dowstream) There is an opportunity to meander the channel while maintaining riprap along the outside bends. An existing high flow channel adjacent to the active channel. can be filled with excess material from the channel, restoration portion of the project.

MANAGEMENT AREA C AND E

Very little is known about both Management Areas C and E due to access issues and the number of land owners that would be involved in any proposed restoration action see Plates 2 and 3). These areas have been encroached upon by commercial and residential development and may have limited restoration potential, Some pockets exist for restoration within Management Area E just upstream of Sierra College Blvd.

We recommend additional studies be conducted within these two areas to further identify restoration potential and the possibility of cooperative landowners.

Hydrology / Geomorphology /Restoration /Water Resources/ Construction Planning & Supervision

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Page 3

MANAGEMENT AREA D

Management Area D is bounded by Rocklin Road on the downstream end and Sierra College Blvd on the upstream end (see Plate 2). Morphologically this reach of stream is quite different from the other management areas described in this report. This reach consists of steeper valley walls that confine die channel with very little floodplain surface. Riparian vegetation is dense and mature, providing a shaded canyon with the potential for cooler water temperatures. The bed of the channel has more bedrock exposures and large boulders that control the grade of the channel and provide channel roughness, reducing bank scour and erosion. Though salmonid habitat conditions are better in this Management Area compared to others, excessive amounts of sand still fill pools and cover spawning beds.

Enhancement actions in Management Area D should focus on improving pool depths, quality of spawning beds, and escape cover for salmonids by introducing roughness elements into the channel (see Site 5). Roughness elements provide obstructions to flow allowing energy to be released at the point of contact and causing pools to scour and undercut banks to form. Roughness elements can include large woody debris, rootwads, or large boulders that do not move even under high flow conditions. The

Department of Fish and Game California Salmonid Habitat Restoration Manual (Flosi and Reynolds, 1998; see Section VII) outlines some of the potential treatments that could be used. We recommend a series of boulder log treatments each placed on the outside of a meander. Velocities will concentrate at these locations and the boulder log treatment will act to protect the bank from erosion but also induce pool scour, exposing buried gravel and providing a hiding spot for migrating or juvenile salmonids.

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Restoration & Enhancement Plan Areas

and Locations of Conceptual Design Projects

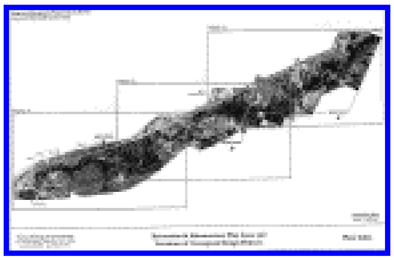
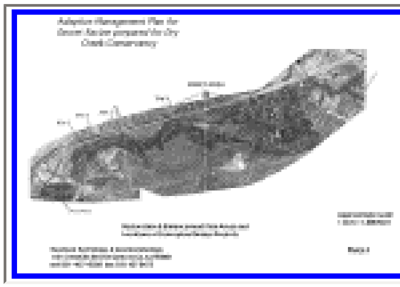


Plate Index



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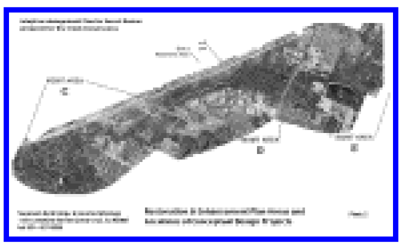

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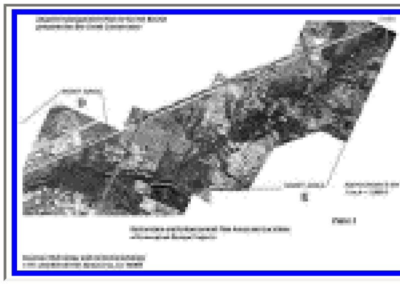

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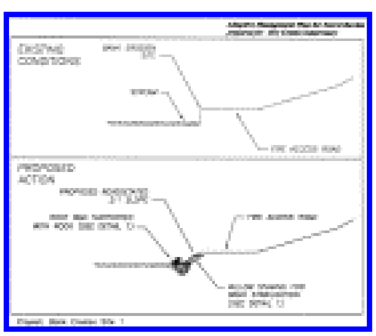
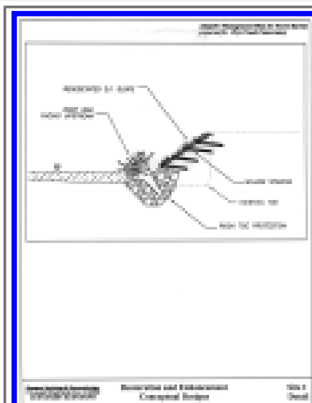


Project: Bank Erosion Site I



Site 1 Detail

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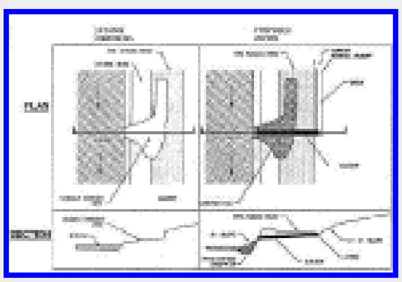
Location: Approximately 1500 feet upstream of confluence with Miner's Ravine. Adjacent to hospital and access road (See Plate 1).

Description: This site is experiencing erosion of the outside bend of the stream. This has been exacerbated by encroachment of a dirt road, illegal offroad vehicle use, and lack of vegetation to provide support and road strength. Due to access issues, the City of Roseville would like to maintain the adjacent road.

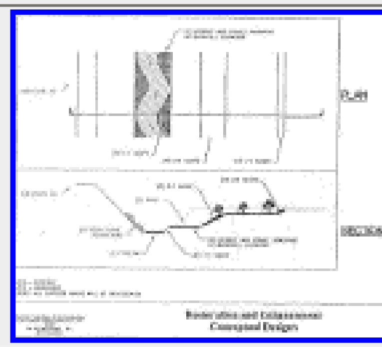
Treatment: The proposed treatment includes overexcavation of the toe of the failing bank allowing rock ormoring to support the toe. The bank would then be rebuilt and planted with live willow stakes and other appropriate riparian vegetation types. In addition, root wads will be added and keyed into the bank to provide cover for fish, protect the bank, and scour the stream bed.

Estimated Cost: $35,000. Cost depends on material availability and site accessibility.

Swanson Hydrology & Geomorphology 115 Limekiln Street Santa Cruz, Ca 95060	**Restoration and Enhancement Conceptual Designs**	**Site 1**

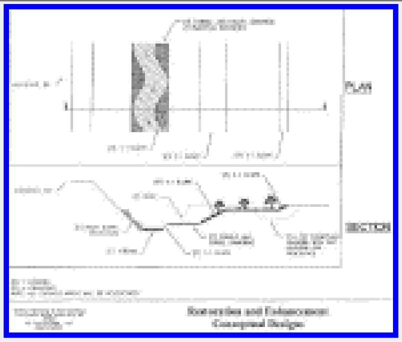


Site 2



Site 3

Project: Headcut Erosion Site 2 Location: Approximately 2000 feet ups tream of confluence with Miner's Ravine. Adjacent to hospital and access road. (See Plate 1) Description: On a weekly basis, fire fighting tests occurring up the hill adjacent to the hospital dump thousands of gallons, in an uncontrolled manner, down into Secret Ravine. This water has begun to erode a section of the access road along Secret Ravine forming a heodcut along the streambank and road where the water enters [he stream. Treatment: Treatment at this site very much depends upon the direction of policy at the hospital. If the practice of allowing uncontrolled releases of water continues, we recommend collecting this water in a rock-lined channel adjacent to the road and moving the water under the road surface to allow the water to be discharged into Secret Ravine without bank erosion or headcutting. Estimated Cost: $5.400. Cost depends on material availability and site accessibility. **Restoration and Enhancement Conceptual Designs** **Site 2**	Project: Channel Restoration Location: Within Management Area A adjacent to hospital. (See Plate 1) Description: This site is indicative of the degraded habitat conditions that occur throughout Management Area A (See ADIP discussion). Channel downcutting, excessive sand, and mobile bars have resulted in pool filling and burial of spawning gravels. Confinement of the channel along Interstate 80 has straightened the channel and reduced the potential for meander development and pool scour. Treatment: Stabilization of existing sand bars to bankfull elevation with cobble and gravel will focus receding flood flows into the main channel. encouraging pool sour and riffle developnent. Cutting back existing high terraces to allow flood flows to inundate the flood plain will expand riparian width and provide flood storage, reducing high flow stresses within the primary channel. Reclaimed flood plain areas will also act to store fine sediment as flows recede, Estimated Cost: $300 per linear too!. Cost depends on material availability and site accessibility **Restoration and Enhancement Conceptual Designs** **Site 3**



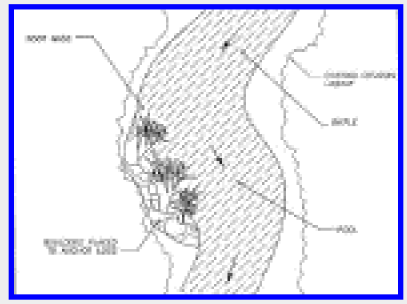
Project: Channel Restoration at Guntert properly.

Location: Within Management Area B. (See Plate 2)

Description: Channel downcutting, excessive sand, and mobile bars have resulted in pool filling and burial of spawning grovels. Confinement of the channel along Interstate 80 has straightened the channel and reduced the potential for meander development and pool scour. Residential development on the Guntert property may provide the opportunity to pursue restoration through this reach.

Treatment: Stabilization of existing sand bars to bankfull elevation with cobble and gravel will focus receding flood flows into the main channel, encouraging pool scour and riffle development. Cutting back existing high terraces to allow flood flows to inundate the flood piain will expand riparian width and provide flood storage, reducing high flow stresses within the primary channel. Reclaimed flood plain areas will also act to store fine sediment, as flows recede. An existing high-flow channel can filled with excess sediment from the terrace cuts. This may provide an opportunity to develop off-channel wetlands.

Estimated Cost: $500 per linear foot. (Cost is higher (due to Site 3 due to more extensive channel reconstruction to develop meander pattern.) Costs depend on material availability and site accessibility.



Project: Habitat Enhancement

Location: Adjacent to Sierra College between Sierra College Boulevard and Rocklin Road - Management Area D (See Plate 2)

Description: This stretch consists of a well-shaded stream with the potential for good spawning and rearing habitat. Good salmonid habitat is limited by the lack of deep pools, escape cover, and hydraulic complexity that generates patches of spawning gravel.

Treatment: Enhancement of these factors can be improved along this reach through placement of channel roughness elements such as large woody debris and root wads, as recommended in the California Department of Fish and Game's Stream Habitat Restoration Manuel (Flosi and Reynolds, 1998). A series of these treatments can be placed at the outside of the low flow channel along the entire reach to induce pool scour and provide places for rearing fish to hide.

Estimated Cost: $2,500 per root wad. Cost depends on material availability and site accessibility.

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115 Limekiln Street Santa Cruz, CA 95060
831.427.0288
fax 831.427-0472

Restoration and Enhancement Conceptual Designs **Site 4**	Restoration and Enhancement Conceptual Designs **Site 5**

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Swanson Hydrology And Geomorphology

October 9, 2001

Dry Creek Conservancy
Attn: Gregg Bates
P.O. Box 1311
Roseville, Ca. 95678

RE: Design Report for Initial Restoration Site on Secret Ravine

Dear Gregg,

Attached is a letter report summarizing the assumptions and methods that went into the preliminary restoration design for the initial site on Secret Ravine. If you need a more detailed description or clarification on certain elements of the design or geomorphic assumptions, feel fee to call me at 831 827-0288. We look forward to implementing this and similar restorations plans on Secret Ravine.

Sincerely,

John Dvorsky

Senior Associate
Swanson Hydrology & Geomorphology

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PRELIMINARY RESTORATION PLAN

SITE #1 OF SECRET RAVINE
PLACER COUNTY, CALIFORNIA

Problem Statement

Historic and modem land use practices within the Secret Ravine watershed have had a long-lasting impact on the geomorphic and biological integrity of the primary stream channels. The impacts from land use practices date back to the period of time when hydraulic mining was occurring throughout the watershed. Hydraulic mining introduced millions of cubic yards of decomposed granite into the active channel system material that had historically been deposited in a series of terraces from large outwash floods following the last glacial period.

Hydrology/ Geomorphology Restoration /Water Resources/ Construction Planning & Supervision

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In the period of time between the last glacial and the 50-year period of intense hydraulic mining, Secret Ravine had developed a static equilibrium between sediment supply, storage and transport. The result was a an active channel that meandered back and forth across a wide floodplain that consisted of an alternating series of stable point bars that were heavily vegetated by common riparian plants of the area such as willow and alder. These stable bars would become inundated during high flows, allowing the water to spread across the floodplain and causing fine sediment to settle out, adding additional nutrients to the riparian forest.

During the receding limb of high flow events, sediment starved water (due to deposition on the floodplain would pour off the floodplain and concentrate in the main channel, scouring out deep pools and cleaning cobble dominated riffles, leaving high quality salmonid spawning gravels in the tail sections of the pools. These scour events would produce a longitudinal series of pools and riffles. Pools would occur on the outside of a bend with a stable point bar on the inside of the bend. Between pools, cobble dominated riffles would occur in the straight sections and act as grade control, limiting excessive downcutting during peak How ever essentially allowing deep scouring of pools on either side of the riffle Due to the presence of a riparian forest on the edge of the active channel, dense root systems would allow bars to persist and banks to be undercut, increasing the habitat value of the system for salmonids.

During the hydraulic mining period, large amounts of sand-sized decomposed granite were introduced into the primary channel from inactive terraces. The introduction of large amounts of material overwhelmed the system and induced a period of channel aggradation Channel aggradation results from the inability of the stream to carry the introduced sediment load. As the sediment load overwhelmed the system, the channel filled up with sediment along its entire length, burying existing channel and floodplain features, such as stable bars, pools, and riffles, smothering riparian vegetation, and causing water to flow across the floodplain, even during low to moderate flow events.

The impacts of channel aggradation can be devastating to the aquatic ecosystem as well as human systems. Aquatic systems are impacted through loss of critical habitat. For salmonids this includes loss of deep pools for rearing, decreased macro invertebrate production through burying of cobble substrate, and loss of potential spawning habitat. Human systems are impacted from increased flooding and reduced bridge capacity, a phenomena that has been well-documented following channel aggradation.

Following the period of hydraulic mining, sediment loads to the channel were reduced and the stream began to adjust to a condition of decreased sediment supply. This consisted of incision of a new channel through the hydraulic mining deposits and establishment of a meandering pattern with a high flow floodplain. Essentially, the channel was attempting to reestablish the static equilibrium that existed prior to the perturbation (i.e. - hydraulic mining).

Unfortunately for the salmonids and other aquatic organism, the process of recover and return to the static equilibrium that existed prior to hydraulic mining, is extremely slow. Sediment supply is still excessive within the active channel due to re-incision of hydraulic mining deposits through undercutting of unstable bank deposits. The reactivated bank deposits are composed primarily of sand that form unstable alternating

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bars. These sand bars do not support stable riparian vegetation because they are mobile and transient during peak flow events. In addition, channel incision into extensive hydraulic mining deposits (6-12 feet in some places) has resulted in reduced access of flows to floodplain surfaces during 2 - to I 0-year recurrence interval floods. Loss of floodplain access can result in higher velocities and shear stresses that can reduce the ability of the bars to support vegetation.

Over time, channel meandering and transport of fine-grained sediment out of the system would allow the system to return to the static equilibrium that existed prior to hydraulic mining. In our proposed restoration design, we plan to accelerate this process through the following treatments:

1) Stabilize existing alternate (sand) bars by armoring them with cobble-sized substrate, altering the bar elevation by matching to the bank full flow (approximately 1.5-2.33- year recurrence interval flow), and revegetation with appropriate riparian plants,

2) Armor existing riffle locations by introducing cobble/gravel substrate and narrowing the channel at these locations to focus flow and energy into downstream pools to accelerate scour and habitat development, and

3) Cutting back existing terraces to provide additional access to floodplain surfaces.

The remainder of this report will discuss the design criteria and assumptions used to develop preliminary plans and specifications for one location within the study area on Secret Ravine.

Geormorphic and Engineering Design

A preliminary geomorphic and engineering design was developed for one site on Secret Ravine within the reach of interest. This site was chosen for initial study because it was an excellent example of problems that exist along the entire reach both geomorphically and biologically. In addition there was good access to the site.

The field investigations that were conducted to develop the design included a detailed topographic survey of the site (see plan sheet) and a geomorphic investigation along approximately 1300 feet of channel. For the geomorphic investigation a longitudinal profile was developed along with a bank full survey and five detailed cross-sections. In addition, notes were made about the depth of scour at certain pools and how those conditions related to riffle slope and width. Data regarding local geomorphic conditions and channel morphology are vital when developing a restoration plan because they provide information about bank full widths and depths, pool-riffle spacing and meander pattern.

Hydrology/ Geomorphology Restoration /Water Resources/ Construction Planning & Supervision

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Swanson Hydrology & Geomorphology

Based on the results from the geomorphic surveys, the following criteria were used in the engineering design phase:

Variable	Value	Notes
Bandfull Depth	2.55 ft	Based on approximately 15 bankfull measurements made along survey reach
Bankfull width	20.1 ft	Based on 4 detailed cross-section measurements made along survey reach

Cross-sectional riffle slope	5% slope	Based on measurements at several properly functioning riffles in study reach
Terrace Elevation	2 feet above bankfull surface	Based on 4 detailed cross-section measurements made along survey

The existing alignment of the low-flow channel at the site of interest will not be significantly altered in the design including the existing meander pattern and locations of pools and riffles The majority of work will focus on the bar features, the lower riffle. and the downstream end of the right bank terrace (looking downstream). Tile three bar features within the project site will be brought to an elevation of 2.5 feet above the low flow channel. This will force water to remain within the low-flow channel area at flows less than bank full, allowing pools to scour and riffles to be cleaned. When flows exceed bank full, water will spread out onto these floodplain surfaces where lower velocities allow for deposition of fine-grained sediment. As flows recede, water will flow back into the channel, focusing flow to further scour pools and generate habitat.

The material required to bring these floodplain surfaces to the appropriate elevation will be excavated from the right bank terrace. Since most of this material consists of sand sized deposits, an additional layer of cobble/gravel substrate will be used to armor file floodplain surfaces and provide a more stable feature for growth of riparian vegetation. Initial estimates suggest a small off-site removal of sand from the right bank terrace would be required to complete the high-flow terrace restoration

Remaining Elements

In order to complete the restoration plan and allow construction to begin, the following elements need to be included.

- Completion of existing design to 100%.
- Revegetation Plan
- Erosion Control Plan
- Temporary diversion, dewatering, and fish relocation plan
- Description of proposed construction sequencing / access to site
- All required permits

Hydrology / Geomorphology / Restoration / Water Resources / Construction Planning & Supervision

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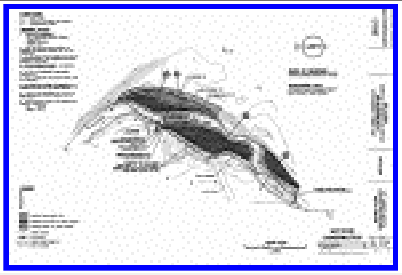
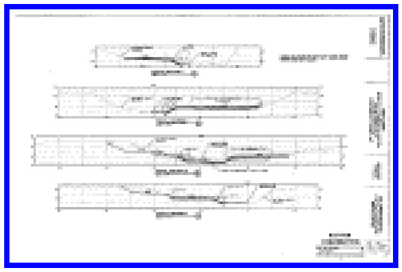
ENGINEER'S ESTIMATE OF PROBABLE CONSTRUCTION COSTS

(NOT TO BE USED FOR BIDDING PURPOSES)

ITEM #	ITEM	UNIT OF MEASURE	ESTIMATED QUANTITY	UNIT PRICE	ITEM TOTAL
1	EARTHWORK CUT	CY	267	10.00	2670
2	EARTHWORK FILL	CY	176	12.00	2112
3	OFFHAUL	CY	91	10.0	910
4	REMOVE/ STOCKPILE EXISTING COBBLE MATERIAL	CY	150	6.00	900
5	PLACE COBBLE MATERIAL	CY	150	10.00	1500
6	TEMPORARY EROSION CONTROL	LS	1	1500.00	1500
7	DEWATERING, DIVERSION, AND FISH REMOVAL	LS	1	5000.00	5000
8	EXTRA WORK (phasing)	LS	1	2000.00	2000
			SUBTOTAL		**$31.592**
			CONTINGENCIES	10.00%	**$3,159**
			TOTAL		**$34,75**1

	
Detailed Plans page 1	**Page 2**

"Where do rivers start?"
in threads hills and gather to here
but the river is all
of it everywhere,
all flowing at once.
all one place"

Gary Synder

916 771- 2013
P.O. BOX 1311 ROSEVILLE, CA 95678-8311

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October 9, 2000

To: Mark Morse

Community Development

City of Roseville

From: Gregg Bates
Executive Director
Dry Creek Conservancy

Subject: Unauthorized vehicle access to Stoneridge Preserve

Dear Mark,

A survey showed that there are four areas of possible access:

1. Sutter Medical Facility and Roseville Parkway
2. Sierra College Blvd.
3. Greenbrae Rd. in Rocklin
4. China Garden Road in Rocklin.

There is also an access problem along Taylor Road near the confluence of Secret Ravine and Miners Ravine, but though they can drive down to the creek they can't get across to the Stoneridge Open Space very easily.

There doesn't appear to be any access from Europa in the development along Olympus Drive.

An area to watch is the comer of Lead Hill Road and Roseville Parkway, though it doesn't look like anyone is going through there since the street was finished and the open space access parking lot installed.

The most common entry points seem to be the Sutter Hospital area and the Greenbrae Road area. I think closing these off would eliminate most of the traffic. A long time resident near Greenbrae Road told me that traffic had increased greatly since City of Roseville removed gates associated with the water tanks about five years ago. A motorcycle rider I spoke to told me he had been told by other riders it was all right to come in by the hospital and ride on the Guntert property. A list of possible access points follows, a map of them, and photos are attached.

Stnrdgaccess October 9, 2000 Page I

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Sutter-Medical Facility/Stoneridge

- People drive over the fence along the hospital walking path that runs parallel to the entry road
- The most common access in this area appears to be on a road behind the hospital by the last parking lot where a barricade has been knocked down. This road connects the back of the hospital to Secret Ravine Parkway
- At this time anyone can drive up the incomplete portion of Roseville Parkway and turn left on Secret Ravine Parkway and make their way over to the open space

Sierra College Blvd.

- Though the abandoned sewer pond area could be an access, it doesn't appear to be used.
- The Rocklin subdivisions have numerous dead end streets with barricades that have been broken or are open. Some of these are Scarborough Dr., Echo Ridge, and both ends of Longview

Greenbrae Road

Undeveloped property along this road (thought to be the Fisher property) is prominently posted but appears to be a major entry point. Heavy steel gates have been pulled out of the ground. The Placer County Water Agency maintenance road for the Boardman Canal begins here. Though developments (Granite Lakes Estates) behind the Fisher property will close off some access, this road will remain a potential access, I observed several makeshift barricades erected on some of the roads and was told that a resident of Rustic Hills Estates put them up But they don't seem to be effective since there are many roads and they can be driven around.

China Garden Road

It looks like this entry has been effectively blocked by the owner with boulders, fence, and a steel gate. This is also a future entry to Granite Lakes Estates

Recommendations:

- Closing off the Sutter Hospital and Greenbrae Road entry points would probably stop most of the traffic
    - A better fence could be put along the hospital's boundary with the open spare.
    - The road by the rear parking lot could be gated.
    - Some thought should be given to closing off the back road from the hospital to Secret Ravine Park-way
    - Access all along Secret Parkway wll be a problem until the parcels arc developed The area should be posted
    - The property owner, the City of Rocklin, and PCWA should be contacted to arrange to close access along Greenbrae Rd
- Posting signs on hospital property might help. The motorcycle rider I spoke to thought most people would respect signs and said he came in because there were no signs. On the other hand the signs on Greenbrae don't seem to be a good deterrent. However, signs could educate people about the open space as well as being necessary for enforcement.
- The ends of dead end roads in the developments off Siera a College Blvd should be closed

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June 6, 2001

Glenda Marsh
Fishery Biologist
Department of Water Resources
Fish Passage Improvement Program
020 9th street<
Sacramento, CA 95925

Dear Ms Marsh:

Thank you for the opportunity to inspect potential fish passage barriers in the Roseville area on May 24. Although the timing of the inspection was not ideal for evaluating the full extent to which Marsh obstacle may prevent or delay upstream passage of adult salmonids, I can make preliminary, general comments about each site I saw. No physical measurements were taken at the sites, thus my as assessment is my best professional opinion based on observations.

The extent that each obstacle visited acts as a barrier to fish passage is somewhat difficult to ascertain from simple observations at low flow conditions. To satisfactorily evaluate the obstacles. a study of the hydrology of the areas must be performed, timing of upstream and downstream migration periods must be determined and design in-stream flow ranges for those times must be chosen. Waiter surface profiles for the design flow rate&, whether determined through a HEC analysis or other means. along with fish performance data. will allow the degree of passage delay to be estimated It is important to remember salmonids often move upstream shortly after peak flows of storm events. so passage must be allowable at those times. Predicted water surface profiles may be confirmed by site visits during winter high-flow events. Fish behavior at the sites should be observed as well when possible.

Central Valley steelhead are listed as threatened under the federal Endangered Species Act (ESA). and am likely to be present in ft Dry Creek watershed Any barrier that may result in passage delay, or that may cause injury or otherwise harm a listed species should be modified in cooperation with the National Marine Fisheries Service, to avoid a "take" violation. as defined in the ESA.

Below are some site-specific comments on each site we visited.

Site #I - Cottonwood Dam on Miner's Ravine

Cottenwood dam poses a certain barrier to fish pass* under all imaginable now conditions, in in opinion. The sheer face, - rising 10 15 vertical feet presents a substantial barrier to overcome for up-migrating salmonids. My preliminary inspection of the site leads me to conclude that under 'no foreseeable hdraulic conditions will this obstacle not cause substantial delay, and will most likely completely block passage for most salmonids. Additionally, the dam prevents sediments from moving downstream, filling the pond with sediment, and will most likely result in scour problerns further downstream. I highly recommend options for dam removal be investigated.

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Site #2 Buried pipes crossing Secret Ravine

An unknown number of pipes cross Secrete Ravine at a near 90 degree angle to the creek, Secrete Ravine is split into two forks at the pipe crossing, forming an island through which the pipes are buried. At the time of the site visit, the function of the pipes was unknown, and the ownership was uncertain. I was unable to inspect the pipe crossing on the right channel (as looking downstream). The crossing on the left channel was covered by a concrete apron, effectively paving approximately 20 feet of the creek, The apron was relatively level across the channel, and deflected downward on its downstream edge. The upstream edge of the apron was nearly flush with the creek invert, but the downstream creek channel had been down cut several feet. Under the existing conditions at the time of the site visit, a water surface differential across the apron was approximately three feet. Water passing over the apron was in a thin sheet.

The pipes are an obstacle migrating fish must negotiate. Under flow conditions at the time of inspection, some passage would be possible, but would result in injury do to the abrasive surface of the apron. At higher flows, the pipes may present less of a passage barrier, but my expect modifications are necessary to avoid substantial delays and possible injuries to migrating fish.

Options for improving fish passage include, 1) removing the pipes crossing the waterway; or 2) building up the downstream channel invert to historical elevations, and incorporating grade control structures to prevent recurrence of the existing problem. If the pipes are removed and the channel grade is evened out, one channel may be groomed to take the majority of the water, and the second would be watered up only in higher flows, If the pipes remain in place, water depth over the apron should be a minimum of one foot during periods of adult salmonid migration. This may be accomplished by constricting flow through a notched weir at the downstream edge of the apron. Elevating the upstream water surface may have negative impacts on downstream channel features, and must be anticipated.

Site #3 - Exposed sewer pipe crossing Dry Creek at grad

The pipe appears to be- flush to grade on the upstream side with some scour on the downstream side. Change in water surface elevations appears to be less than one foot. Rubble was placed along the downstream edge of the pipe, presumably to reduce under cutting of the pipe. The pipe is nearly level with a thin, uniform sheet of water spilling over to the downstream pool. Passage is possible under existing conditions, and would be enhanced at river flows greater than that at the time of inspection. Witness reports indicate a constriction point downstream of the site backs up water to flood the surrounding area on a regular basis, The City of Roseville is considering altering the constriction point which could have the affect of lowering the water surface elevation in the pool downstream of the sewer pipe, thus increasing the head differential across the pipe, and negatively affecting fish passage.

Under conditions existing at the time of inspection, the sewer pipe presents a minor barrier to fish passage. Most healthy salmonids could pass, although the possibility of them being abraded by the rubble on the downstream side of the pipe, and scraping over the pipe, makes the obstacle less than ideal. Passage could be improved by concentrating flows to the center of the creek channel, creating a deeper notch through which fish could swim. A deeper plunge pool downstream of the notch, reinforced to prevent scouring under the pipe, would also benefit fish passage. These modifications may not be needed under flows normally seen when salmonids are actively migrating upstream A study of the area's hydrology and fish timing is needed to better assess the situation. Modifications to the constriction downstream of the size could negatively affect fish passage at the sewer pipe, and must be considered when designing that modification.

This concludes my comments on the potential fish barriers we inspected- Because each of these sites will potentially take salmon and steelhead by delaying fish passage and injuring fish attempting to pass, and may increase incidences of poaching, i higher recommendations a "Tudy it) identify the true barriers. Appropriate alternatives for solving the passage problem, and implementation of those solutions should also be expedited to assist in restoring health), salmonid populations to these urbanized waterways. If I may be of further assistance, or if you have any questions regarding my comments, please call me at (707) 575-6079.

Sincerely,

Steven L. Thomas
Hydraulic Engineer

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State of California

Memorandum

To : Files Date: November 5, 2001

From : Department of Fish and Game - Dr. Rob Titus, NAFWB, Stream Evaluation Program

Subject: Perennial Rearing Habitat for Juvenile Steelhead in the Dry Creek Drainage (Placer County)

Native Anadromous Fish and Watershed Branchs Stream Evaluation Program (Program) conducted reconnaissance level assessment of steelhead distribution and , abundance relative to stream habitat conditions in the Dry Creek drainage (Sacramento and Placer counties) during1998-1999. The Program also monitored juvenile salmonid emigration from the upper drainage during 1999 and 2000. Following is a very brief summary of the results of these surveys, in particular as related to the distribution of perennial rearing habitat for steelhead.

Methods

The approximate distribution of juvenile steelhead rearing was determined primarily by backpack electro fishing at various points in the upper Dry Creek drainage from November 5, 1998 through June 8,1999. Areas sampled included Secret Ravine and Miners Ravine. The Department of Fish and Game (DFG) recognizes Secret and Miners ravines as the primary production areas in the Dry Creek drainage for chinook salmon and steelhead trout.

Emigration of juvenile salmon and steelhead was monitored by use of a 5-ft rotary screw trap situated about 100 in downstream from the confluence of Secret and Miners ravines. The trap was run from November 6, 1998 through June 2, 1999, and from January 9, 2000 through June 8, 2000

Secret Ravine

Sampling in Secret Ravine extended from the lower creek area near its confluence with Miners Ravine in Roseville to the upper creek area at Gilardi Road near Penryn. Juvenile steelhead were found in sample sections from the Brace Road crossing near Loomis to the Gilardi Road crossing, and at each of four intermediate sites: Loomis Basin Park near the King Road crossing, the L.D.S. Recreation Park upstream from the Penryn Road crossing, and at one site on each of two forks of the upper creek accessed from Penryn Rock Springs Road. Observed steelhead ranged in fork length (FL) from 21 to 3 10 mm, FL and averaged 117 mm FL (n = 58). While this characterization is based on limited sampling, the presence of young-of-the-year steelhead (<80 mm FL) demonstrates that this stream area supports natural reproduction of steelhead, as well as perennial rearing with the presence of yearling and older steelhead (117-310 mm FL).

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Juvenile steelhead were not found in Secret Ravine sample sections from the confluence with Miners Ravine to Sierra College, including two intermediate sections just downstream and upstream of the East Roseville Parkway crossing. However, juvenile fall-run chinook salmon were sampled at each of these sites. Steel head rearing in Secret Ravine was not accounted for from Sierra College to Brace Road.

Environmental variables that may distinguish creek areas that support steelhead spawning and rearing from those that do not were not investigated in detail. However, some differences were apparent. Lower Secret Ravine (mouth to Sierra College) represents a lower-foothill stream environment with relatively low gradient and which is highly impacted with fine sediment, likely the result of extensive disturbance from urban development along much of this reach. Although used for spawning and early rearing by chinook salmon, year-round resident fishes were dominated by common warm water species including predatory spotted bass and other introduced centrarchids, and Sacramento pikeminnow and Sacramento sucker. In addition, daily mean water temperature in lowermost Secret Ravine peaked above 90' F in summer 1999, which is a temperature level typically regarded as unsuitable for over-summering juvenile steelhead.

In contrast, upper Secret Ravine (Brace Road to Gilardi Road) represents the foothill and "headwater" environment of the creek with higher gradient by virtue of the associated climb in elevation. Although not pristine, upper Secret Ravine appeared relatively less impacted by fine sediment and included intact riparian and upslope attributes in many sections that were conducive to a healthy foothill stream environment. The fish fauna in upper Secret Ravine was dominated by native fishes including Sacramento pikeminnow, Sacramento sucker, steelhead, and lamprey although local abundances of introduced centrarchids were observed. Daily mean water temperature at Gilardi Road never reached 70' Fin summer 1999, which is a temperature level typically regarded as tolerable for over-summering juvenile steelhead in California.

Miners Ravine

Sampling in Miners Ravine extended from the lower creek area near its confluence with Secret Ravine to the upper creek area at the King Road crossing. Juvenile steelhead were only found in a sample section upstream from the Dick Cook Road crossing. steelhead were observed at this site on both occasions it was sampled: in mid-December 1998 and in late March 1999. These fish ranged in length from 72 to 400 mm. FL and averaged 211 mm. FT (n - 12). Again, while this characterization is based on a very limited sample. The presence of young-of-the-year-sized steelhead (<80 mm FL) in late March demonstrates that this stream area supports natural reproduction of steelhead. as well as perennial rearing with the presence of yearling and older steelhead (tip to 400 mm FL).

Juvenile steelhead were not found in Miners Ravine sample section,, upstream or downstream from the Dick- Cook Road site. Upstream sites included the first bridge crossing, on Auburn-Folsom

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Road just north of Horseshoe Bar Road, and the King Road crossing. However, juvenile fall-run chinook salmon were sampled in lower Miners Ravine in each of six sections from the creek mouth to above the fourth bicycle-trail bridge upstream during late March early April 1999. No salmon or steelhead were found at the Barton Road crossing or in two sample sections just downstream from the dam at Cottonwood Lake in Hidden Valley during the same period. The dam at Cottonwood Lake is recognized as a full barrier to upstream migration of adult chinook salmon because of relatively low flow conditions during the salmon migration period, and as a partial barrier to steelhead because passage around the dam is possible wider high flow conditions. That steelhead do migrate past the dam at least in some years was evidenced by the presence of juvenile steelhead above the dam.

Miners Ravine, from Kings Road to its confluence with Secret Ravine, transitions from relatively high to low gradient as a function of elevation, in much the same manner as Secret Ravine. Water temperature was monitored only as far upstream as Dick Cook Road where daily mean temperature spiked at 77' F on three occasions during July 1999, but averaged 70' F (+/- 3 SD) from June 1, 1999 through August 31, 1999. Stream temperature may have been cooler farther upstream in the system as on Secret Ravine, but was not monitored there.

One notable difference between Secret and Miners ravines that may serve as an overall index of habitat quality for juvenile steelhead rearing was the composition of the fish fauna in each creek. Fishes in Secret Ravine transitioned from a spotted bass/Sacramento pikeminnow/Sacramento sucker dominated fauna in Its lowermost reaches to a predominantly native fish fauna including steelhead and lamprey in its upper reaches. In contrast, there was no longitudinal trend in catch composition on Miners Ravine. With the exception of juvenile steelhead at the Dick Cook Road site, fishes were typically dominated by one or a combination of introduced warm water species including cyprinids(namely golden shiners) and centrarchids (largemouth bass, bluegill. and other species) and portionately very few observations of Sacramento pikeminnow and Sacramento sucker. That the fish fauna was so variable from site to site and consisted primarily of introduced warm water fishes when juvenile chinook salmon were presenting the creek below Cottonwood Dam) suggests that localized habitat conditions in the creek may also be highly variable, possibly as a function of water quality and pond development within the system. Localized dominance of especially golden shiner may be indicative of high temperature and low dissolved oxygen conditions that are unsuitable for the native fishes in the system, especially steelhead.

Steelhead Smolt Emigration

Three steelhead smolts (177-212 mm FL) were captured in the rotary screw trap from March 14 1999 through April 7, 1999, and 10 smolts (160-23 8 min FL) were captured from March 1, 2000 through April 28, 2000. Because the rotary screw trap was located below the confluence of Secret and Miners ravines, the trap catches may have included smolt production from either or both creeks. Trap efficiency for steelhead smolts was not determinable because of small catches.

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Conclusions and Management Implications

Our surveys demonstrated that the upper Dry Creek drainage continues to support production of steelhead as recognized historically but-presumably at lower levels due to habitat impacts from urban development. The upper creek areas appear to be especially important for spawning and rearing, given the stream gradient and temperature conditions there. Any actions which protect or improve access to and the quality of these areas will benefit steelhead production in the system.

The lower creek areas, including mainstem Dry Creek, need to be protected and improved for chinook salmon spawning, juvenile rearing and emigration and for seasonal rearing and migration of steelhead. The most conspicuous needs are to identify, control, and prevent sources of sediment pollution, and to discourage land-use and waterway practices that favor production of introduced warm water fishes, especially as related to pond development and stocking of these species within the system.

Two factors may be especially limiting to steelhead production on Miners Ravine. The first factor is the darn at Cottonwood Lake, the most conspicuous migration barrier in the system. We suggest that improving passage of adult steelhead to upstream areas that contain favorable gradient and temperature conditions for spawning and juvenile rearing will increase steelhead production in Miners Ravine. The second factor may be variable water quality within the system as evidenced by the highly variable localized composition of the fish fauna. mostly introduced warm water species including golden shiner. We recommend that localized water quality and associated biota be assessed in Miners Ravine to identify potential water quality problems that may be limiting to steelhead production.

Robert G. Titus, Ph.D.
Environmental Scientist
Stream Evaluation Program

Ms. Kelly Finn, National Marine Fisheries Service. Sacramento. California

Department of Fish and Game, Sacramento, California

Mr. Rich Dixon, Dr. Larry Eng, Mr. John Nelson. Ms. Katie Perry

Mr. Chris Lee, Department of Water Resources, Sacramento, California

Mr. Mark Morse, City of Roseville

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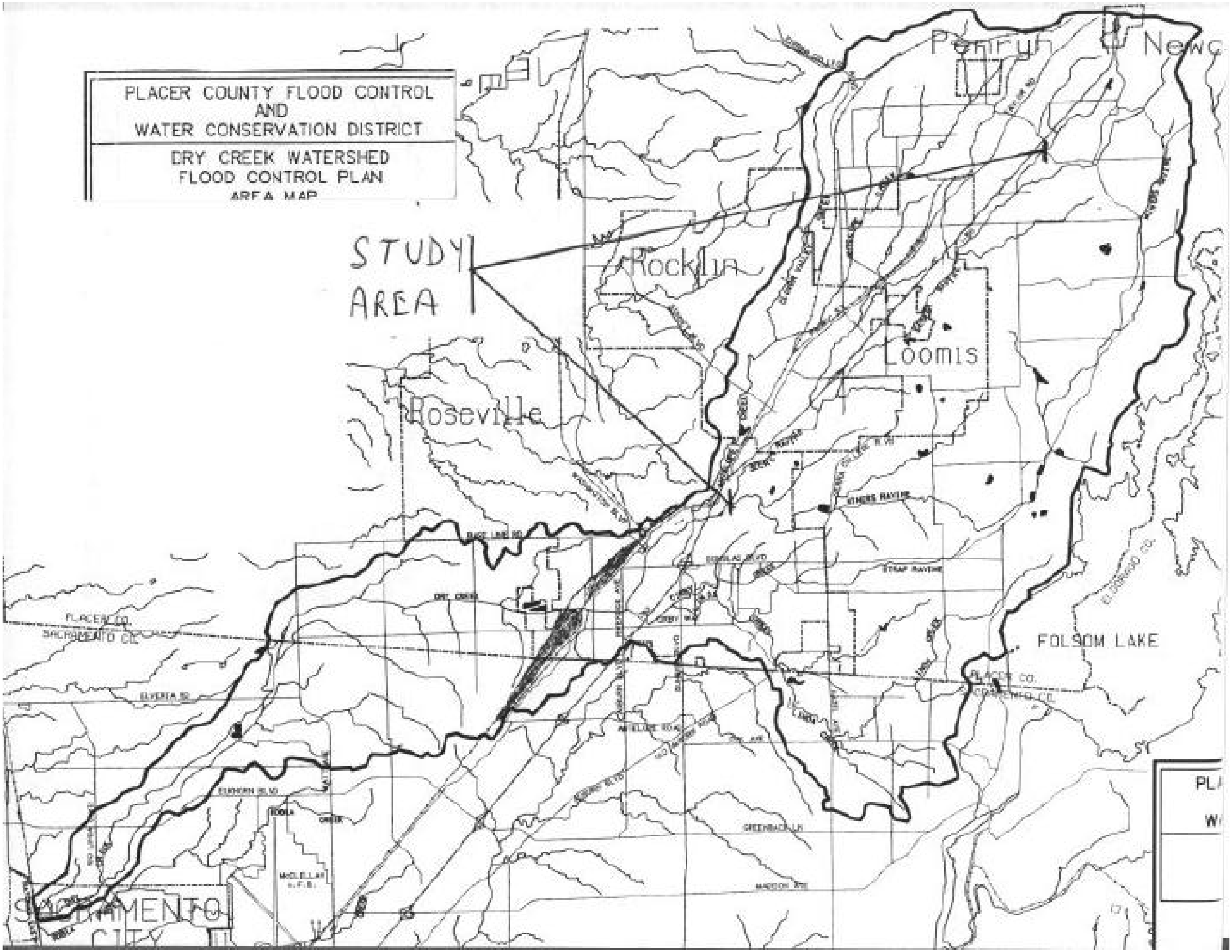

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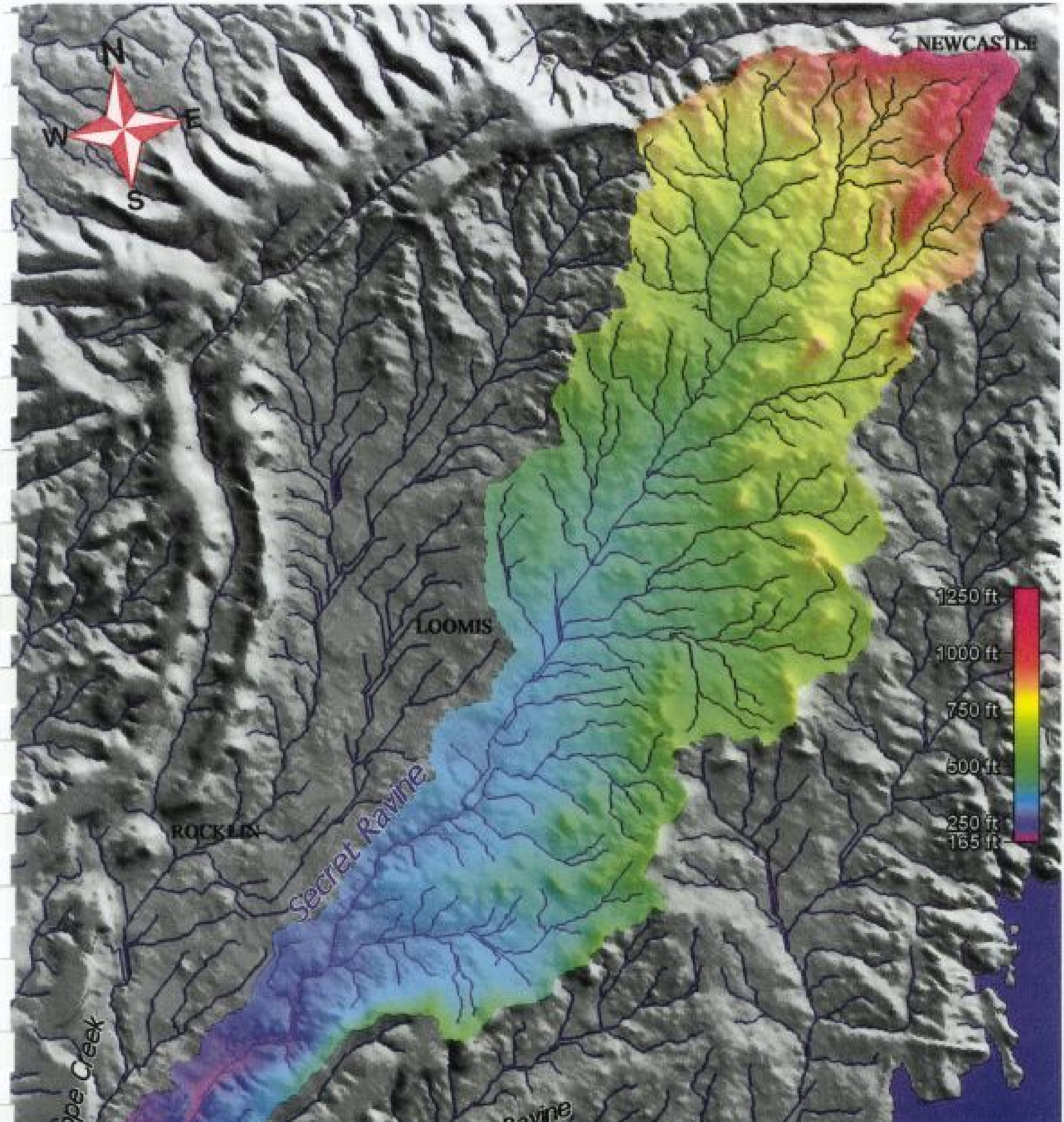

FIGURE 1: WATERSHED MAP FOR SECRET RAVINE
Derived From USGS Digital Elevation Model
SCALE = 1:63,360 or 1 inch = 1 mile

SWANSON HYDROLOGY & GEOMORPHOLOGY
115 Limekiln Street
Santa Cruz, CA 95060

SCALE = 1:63,360 or 1 inch = 1 mile 0 1 2 miles Santa Cruz, CA 95060

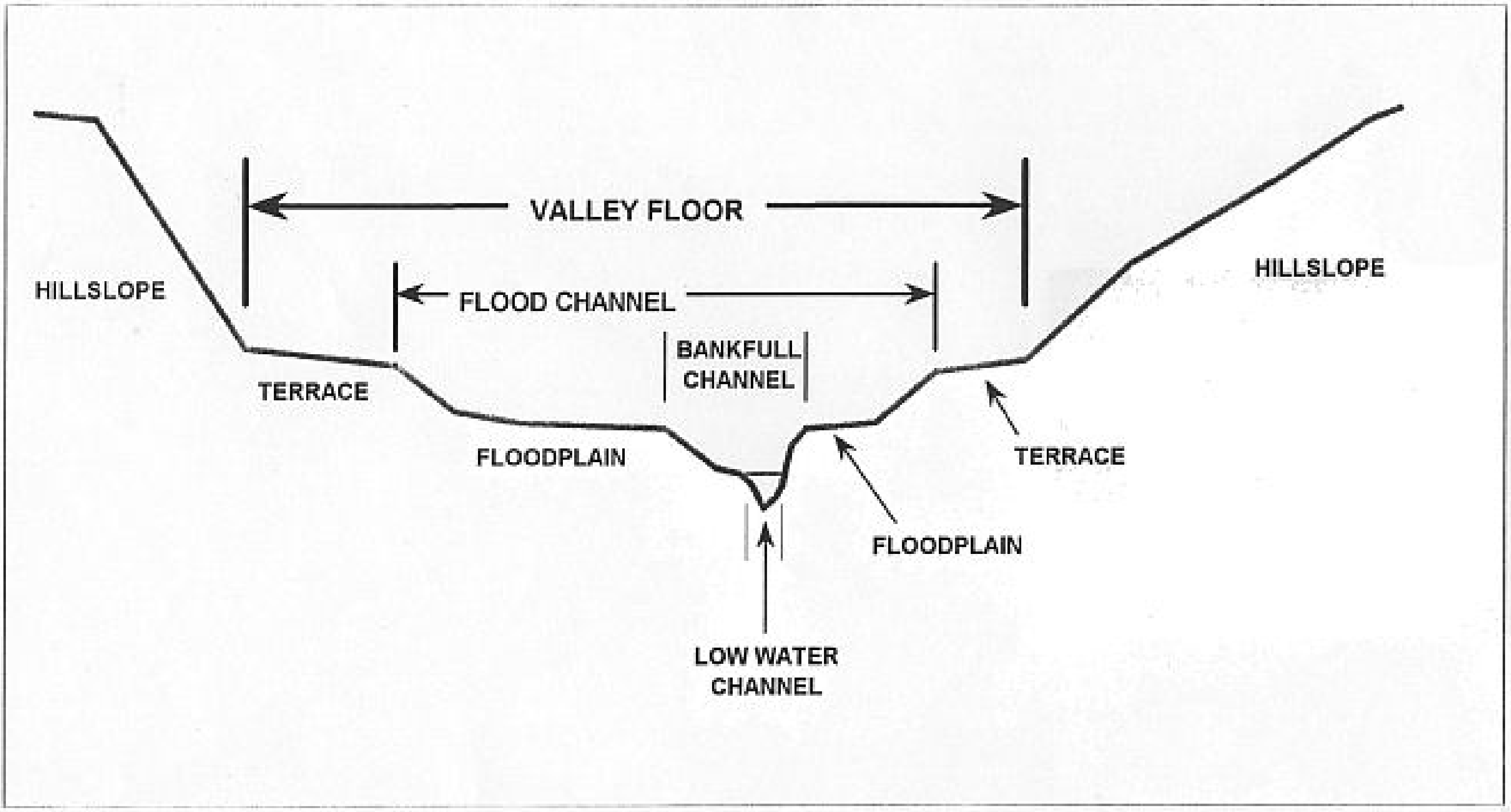

FIGURE 4: IDEALIZED VALLEY FLOOR CROSS-SECTION SHOWING TYPICAL GEOMORPHOLOGIC FEATURES.

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Santa Cruz, CA 95060

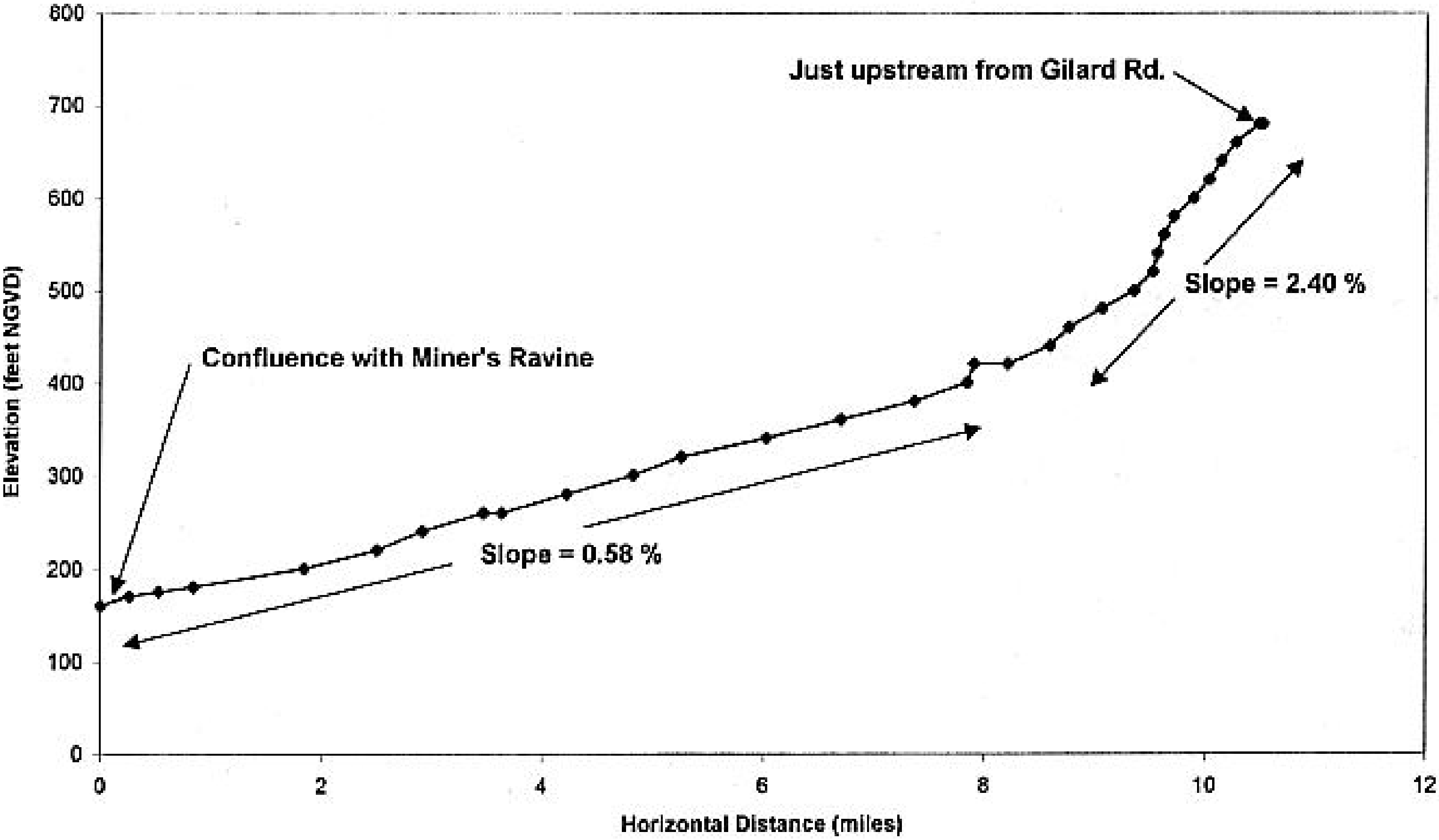


FIGURE 3: LONGITUDINAL PROFILE OF SECRET RAVINE MEASURED UPSTREAM FROM CONFLUENCE WITH MINER'S RAVINE.

SWANSON HYDROLOGY
115 Limekiln Street
Santa Cruz, CA 95060

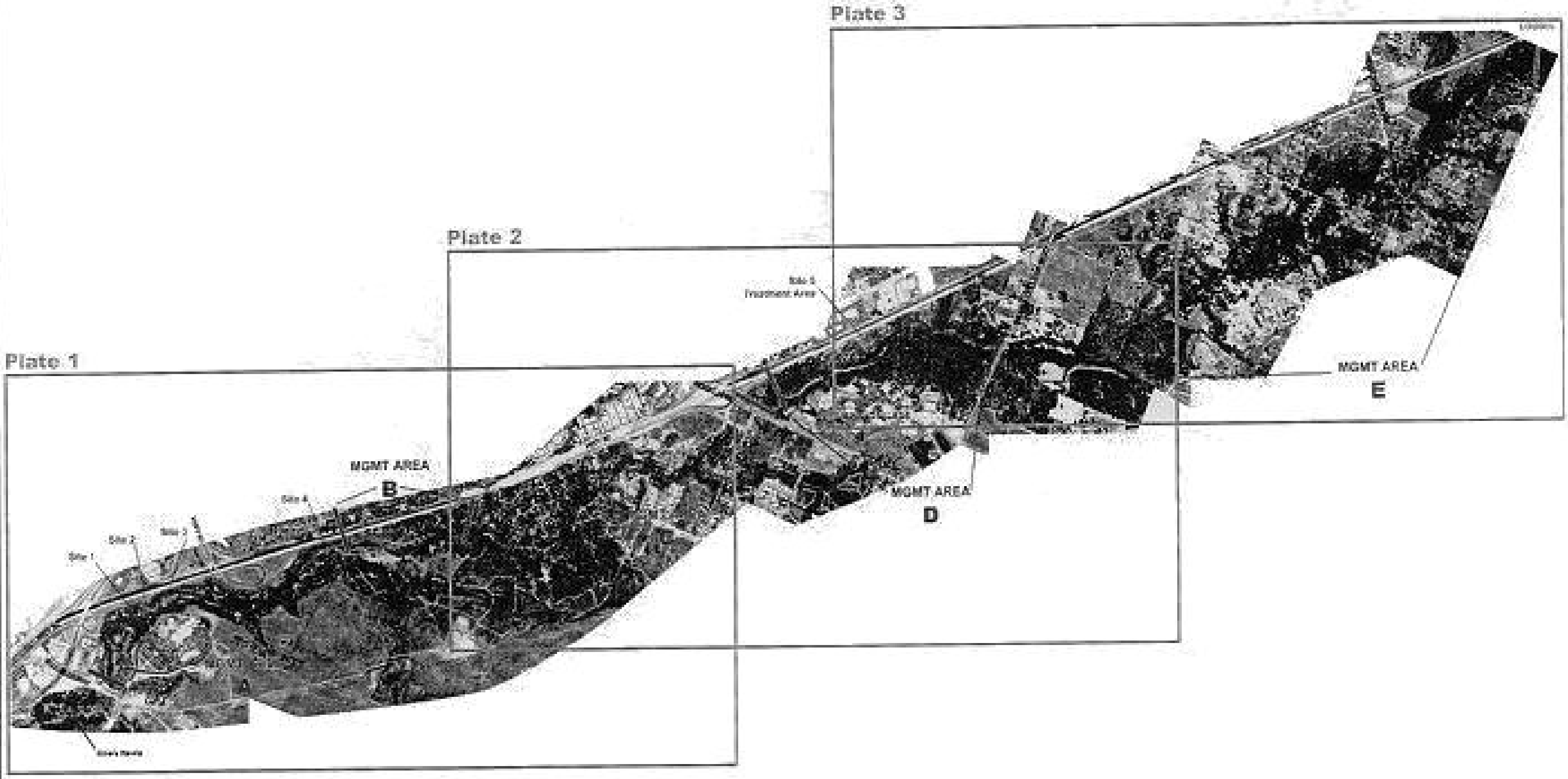
Table 3

Summary of Suggested Remedial Actions for Stressors

Functional requirement	Stressors		Suggested actions		Priority
sufficient flow	1	depressed groundwater	1	educate decision makers	low
	2	lack of flow from effluent sources	2	participate in discharge permitting	med
	3	change in PCWA flows	3	work to satisfy mutual interests	med
no migration barriers	4	utility crossings, bridge sills, diversion dams, unscreened diversions	4a	work with DWR Fish Passage Improvement Program	high
			4b	educate decision makers	high
			4c	educate landowners	high
	5	excessive sediment	5	streambank stabilization, revegetation	high
Channel Complexity-instream-cobble, boulders, undercut banks, pools riparian-large woody debris, streamside vegetation, good channel morphology	6	sedimentation from in channel and upland erosion	6	streambank stabilization, revegetation, instream complexity projects, recreate three stage channel	high
	7	flood control maintenance	7	educate decision makers	med

	8	poor stormwater management	8	design retrofit for drainage from developed areas to mimic natural hydrology	med
	9	homeowner maintenance, grazing	9	educate landowners	high
appropriate temperature	10	inadequate vegetation, lack of substrate complexity, inadequate flow, impoundments, effluent	10	report results of temperature assessments	high
			10a	institute actions 1,2,3	med
			10b	institute action 6	high
good water quality	11	cumulative contamination from watershed sources	11	report results of water quality assessments	med
	12	poor stormwater management	12	retrofit stormwater quality systems	med
	13	homeowner maintenance	13	educate homeowners	med
	14	industrial discharge	14	report polluted discharge	low

Adaptive Management Plan for Secret Ravine
prepared for **Dry Creek Conservancy**



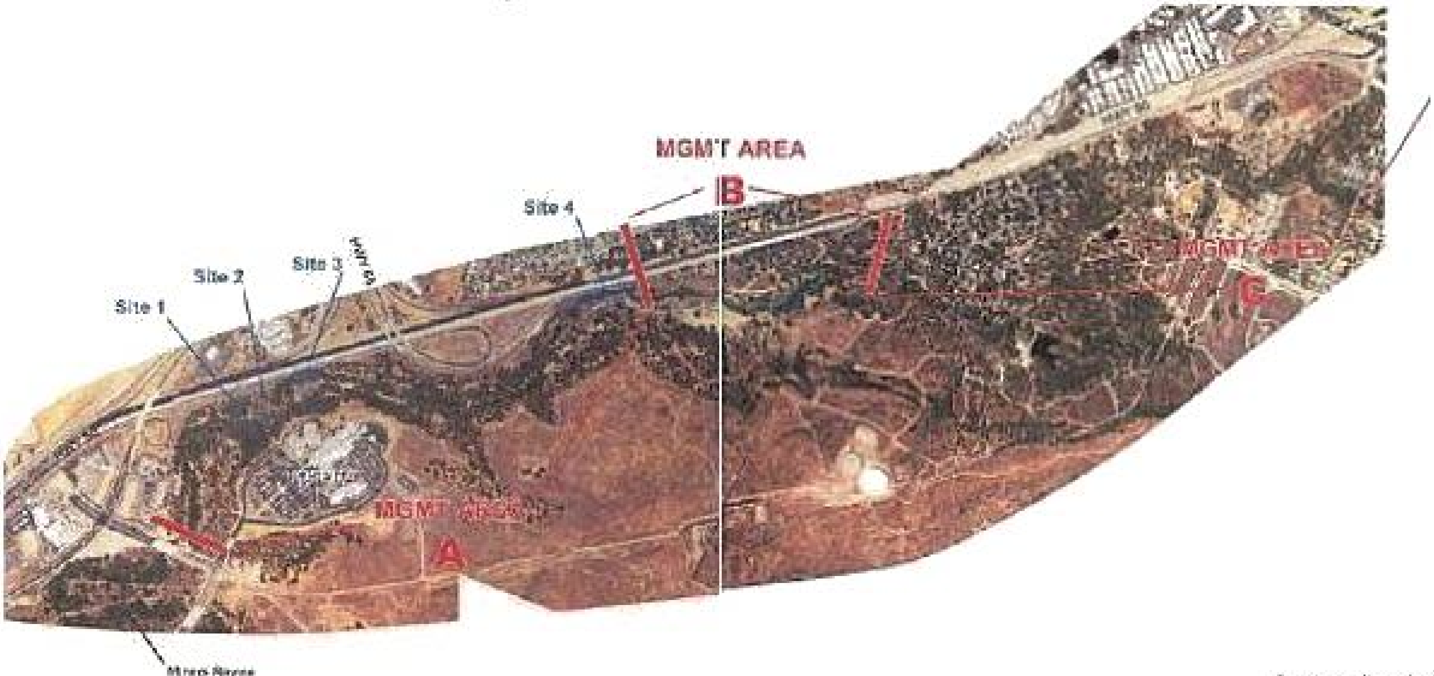
Approximate Scale
1 inch = 2,000 feet

Swanson Hydrology & Geomorphology
115 Limekiln Street Santa Cruz, CA 95060
tel: 831.427.0288 fax: 831.427.0472

Restoration & Enhancement Plan Areas and Locations of Conceptual Design Projects

Plate Index

Adaptive Management Plan for Secret Ravine prepared for Dry Creek Conservancy



Approximate scale
1 inch = 1,000 feet

Restoration & Enhancement Plan Areas and Locations of Conceptual Design Projects

Swanson Hydrology & Geomorphology
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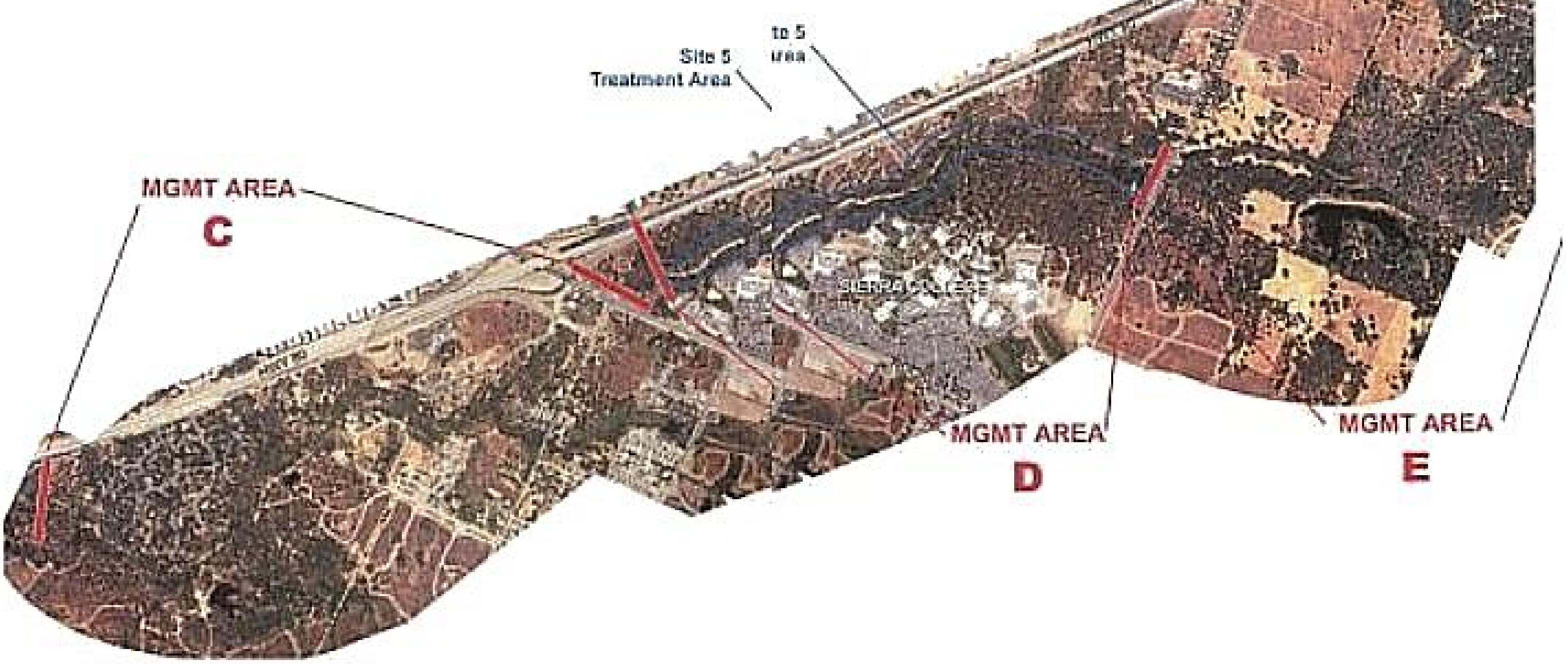
tel: 831-427-0288 fax: 831 427 0472

Plate I

Adaptive Management Plan for Secret Ravine
prepared for Dry Creek Conservancy



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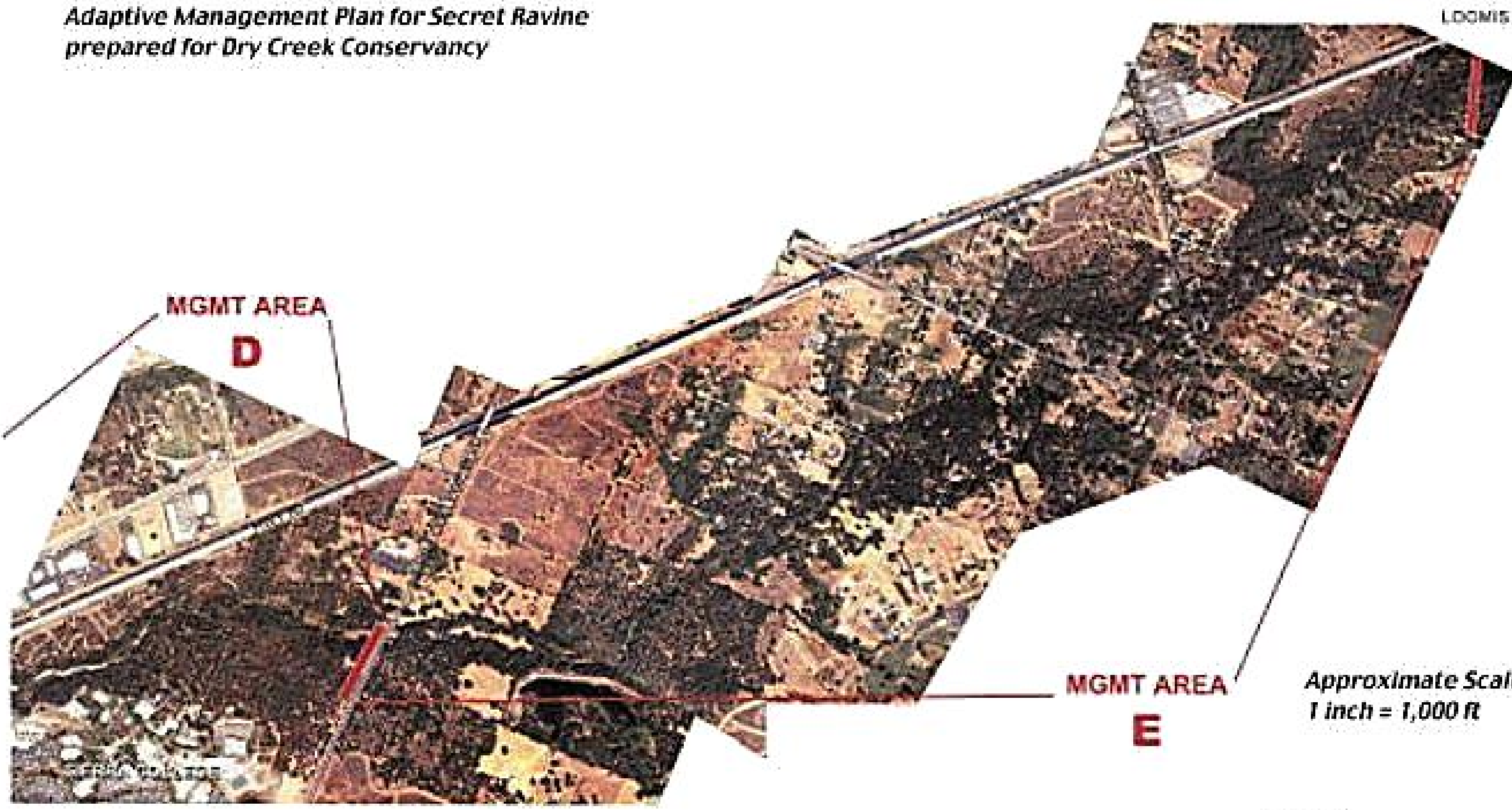
Restoration & Enhancement Plan Areas and Locations of Conceptual Design Projects

Plate 2

Adaptive Management Plan for Secret Ravine
prepared for Dry Creek Conservancy



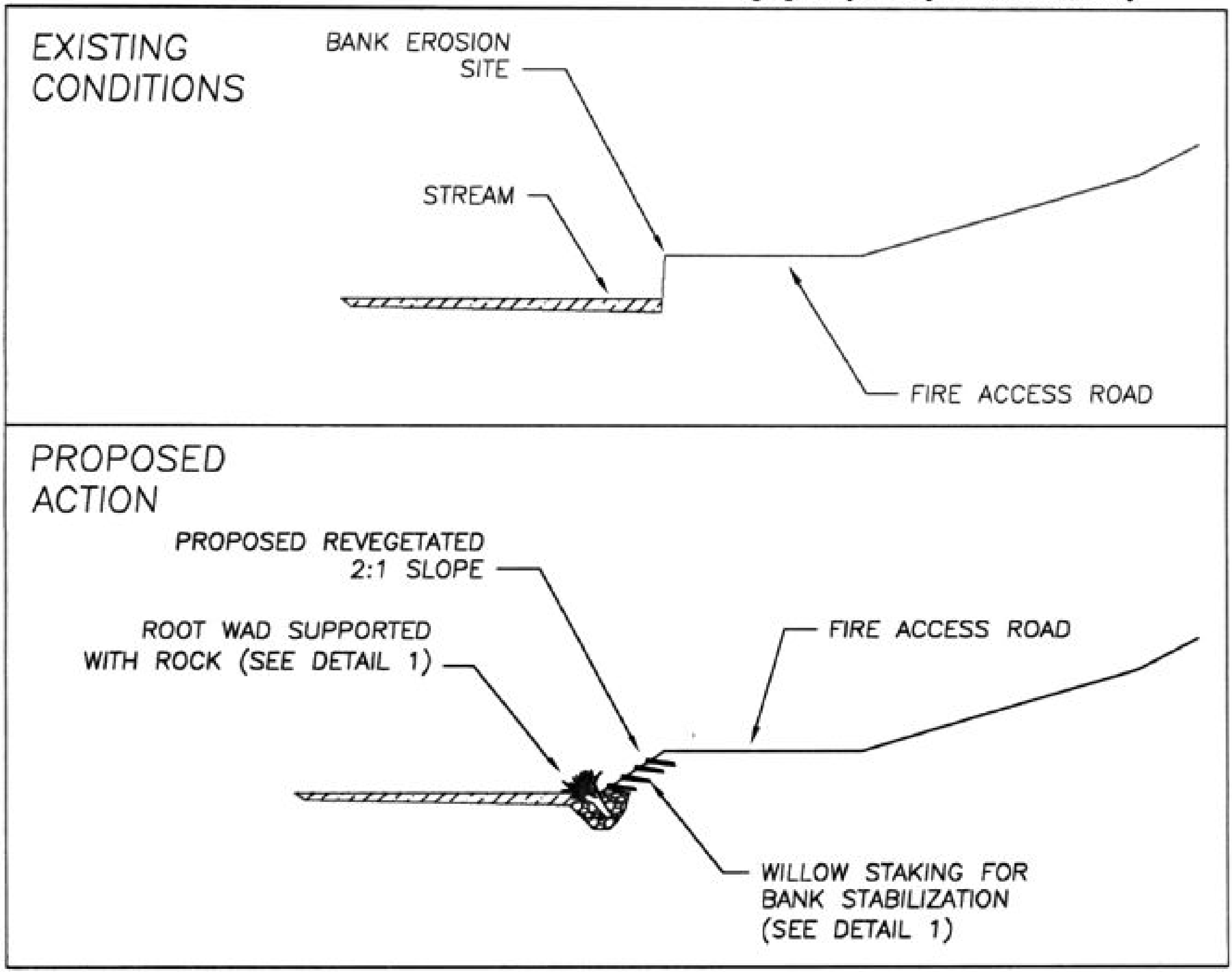
Approximate Scale
1 inch = 1,000 ft

Plate 3

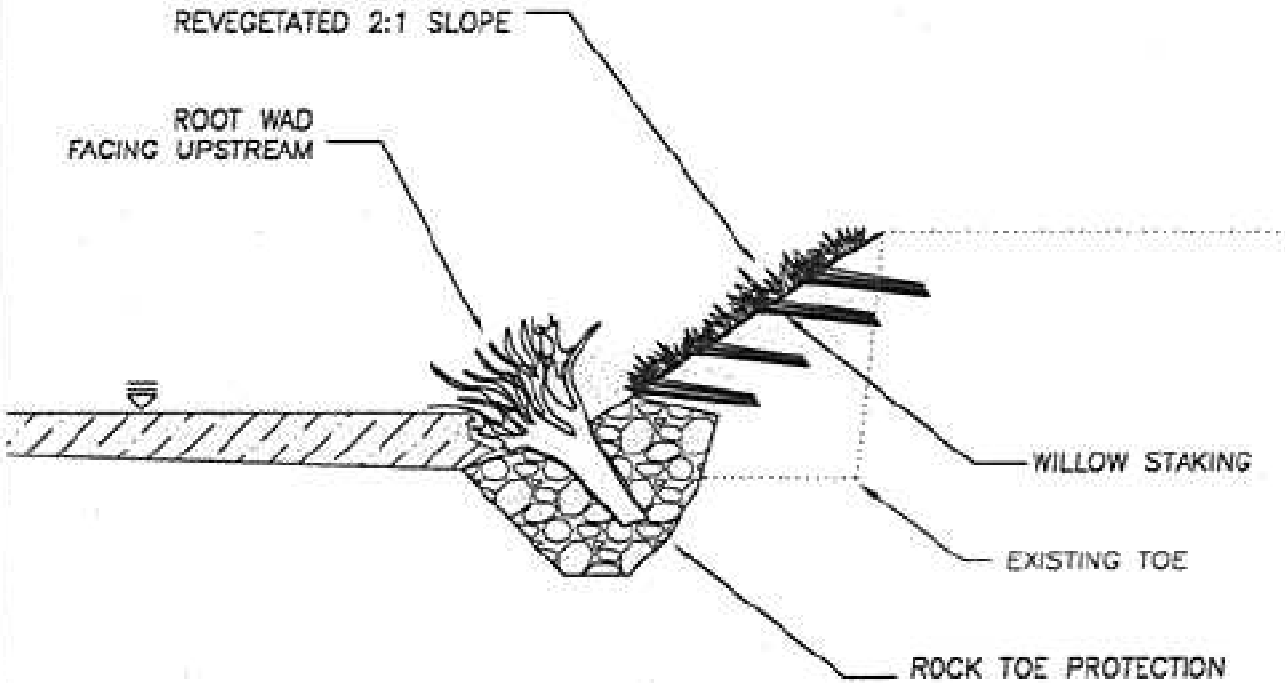
Restoration and Enhancement Plan Areas and Locations of Conceptual Design Projects

Swanson Hydrology and Gemomorphology
1151 Limekiln Street Santa Cruz, Ca 95060

Adaptive Management Plan for Secret Ravine
prepared for ***Dry Creek Consevancy***



Project: Bank Erosion Site 1



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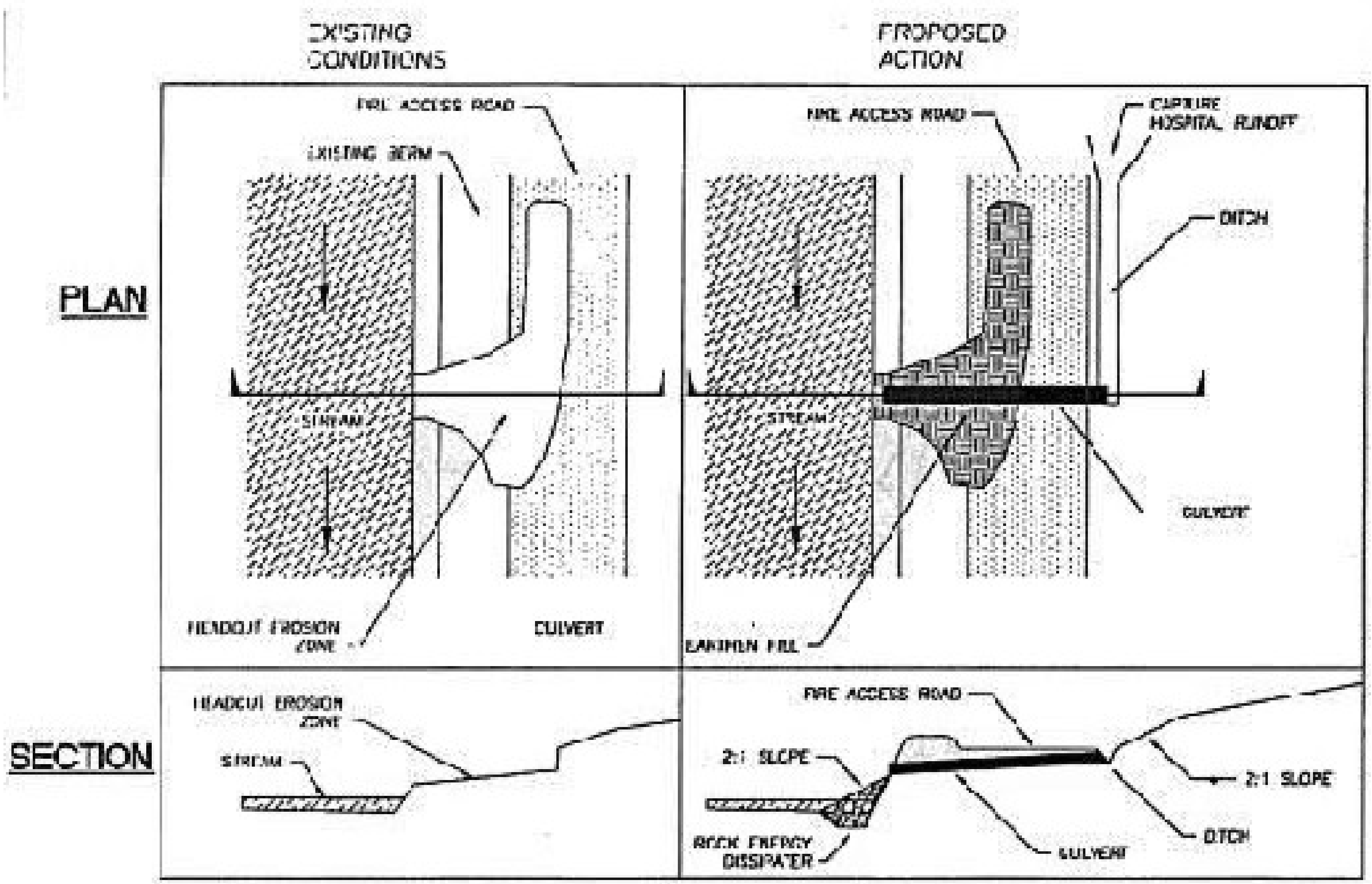
Restoration and Enhancement Conceptual Designs

Site 1 Detail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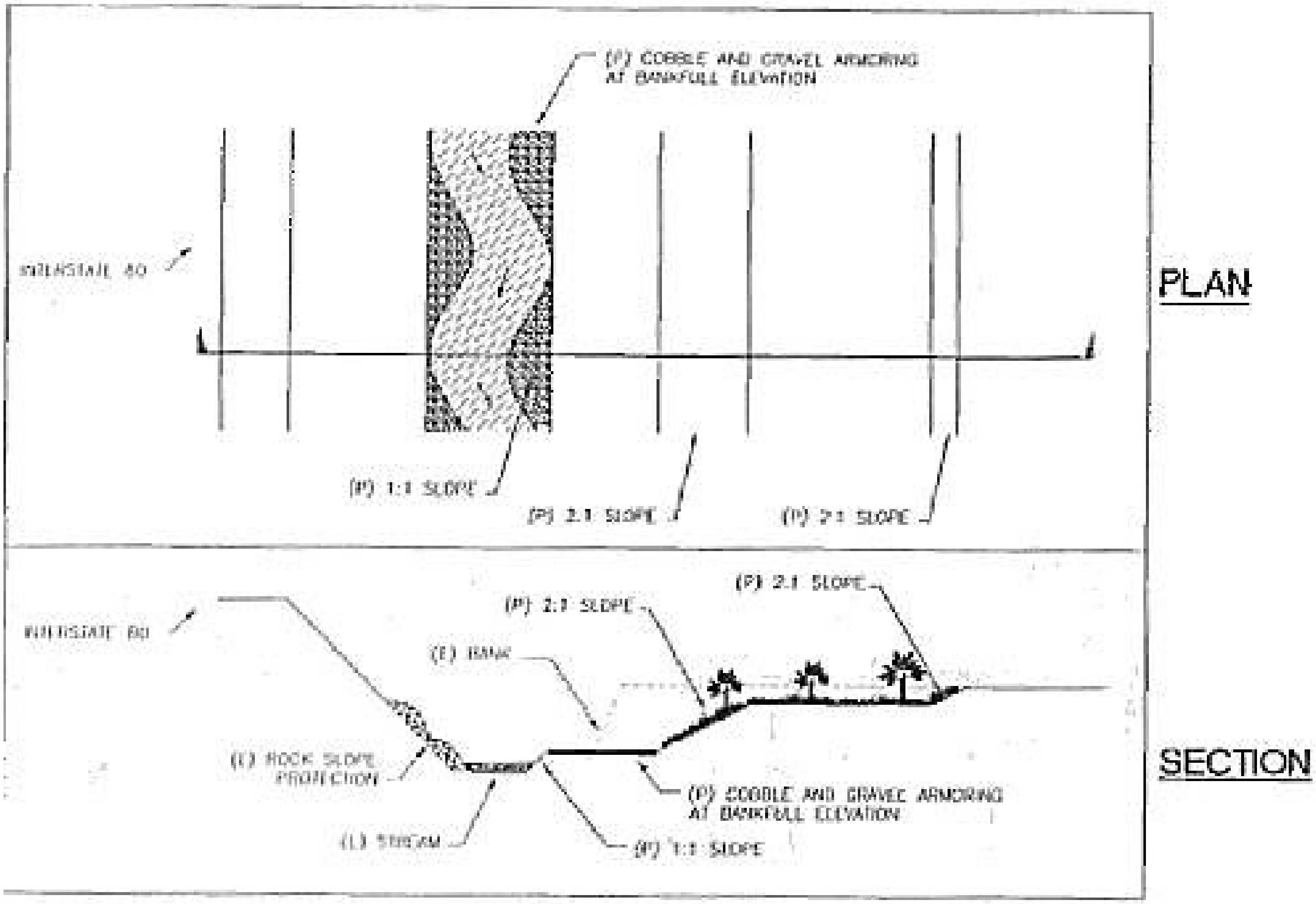
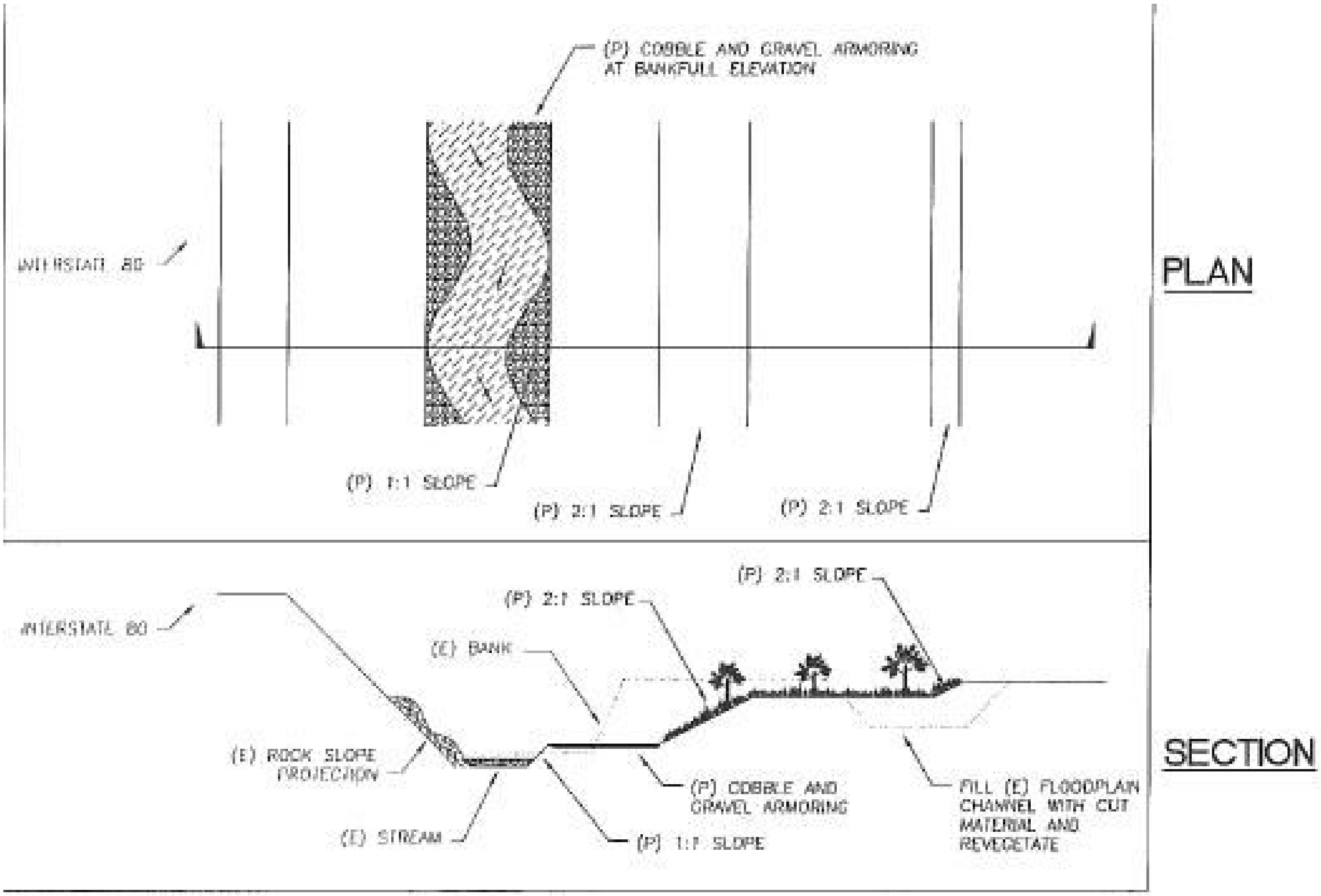
CONDITIONS
PROPOSED
ACTION
PLAN
SECTION
FIRE ACCESS ROAD
EXISTING BERM
STREAM
HEADCUT EROSION
ZONE
CULVERT
CAPTURE
HOSPITAL RUNOFF
DITCH
EARTHEN FILL
2:1 SLOPE
ROCK ENERGY
DISSIPATER



(E) = EXISTING
(P) = PROPOSED
NOTE: ALL EXPOSED AREAS WILL BE REVEGETATED

Restoration and Enhancement
Conceptual Designs



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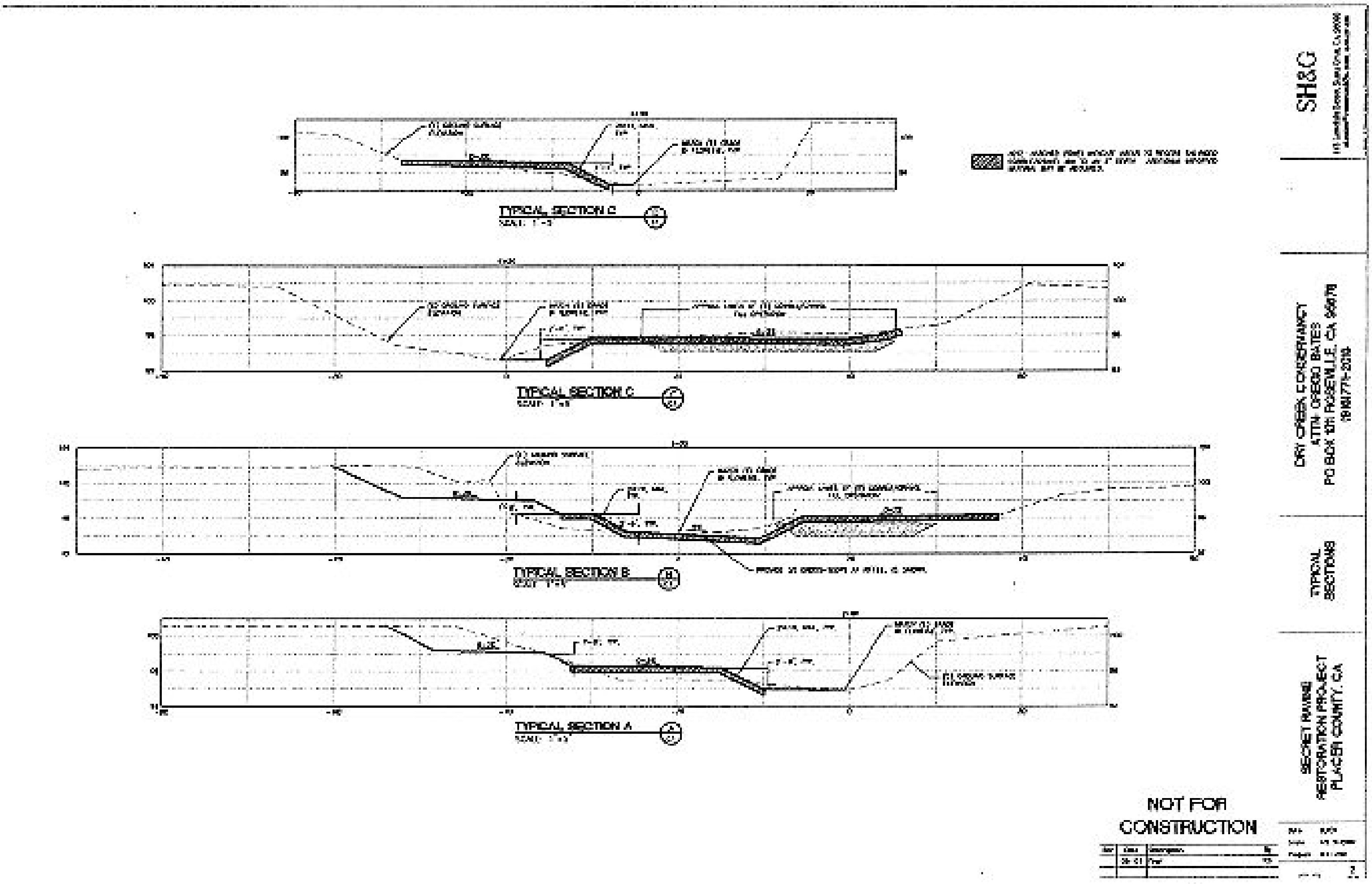
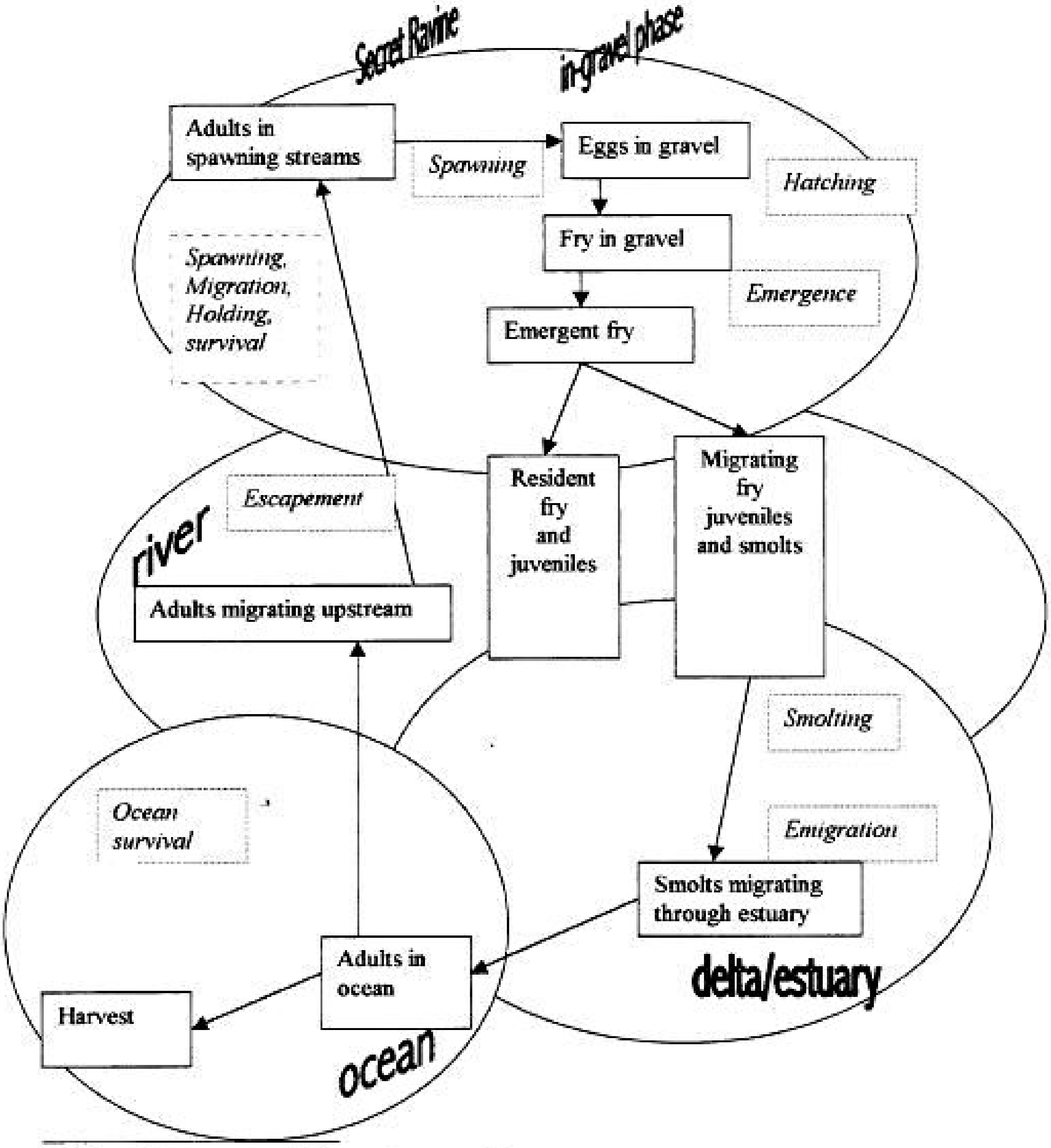

TYPICAL SECTION C
TYPICAL SECTION B
TYPICAL SECTION A
NOT FOR CONSTRUCTION
SH&G
TYPICAL SECTIONS
SECRET RAVINE
RESTORATION PROJECT
PLACER COUNTY, CA

Figure 1 – Landscape Level Conceptual Model of Chinook Salmon[2]



The four oval areas represent the four major geographic Regions. Arrows indicate a change of state of surviving salmon. Terms in italics indicate the major transformation occurring in each phase.

From 1998 draft of Strategic Plan for the Ecosystem Restoration Program.

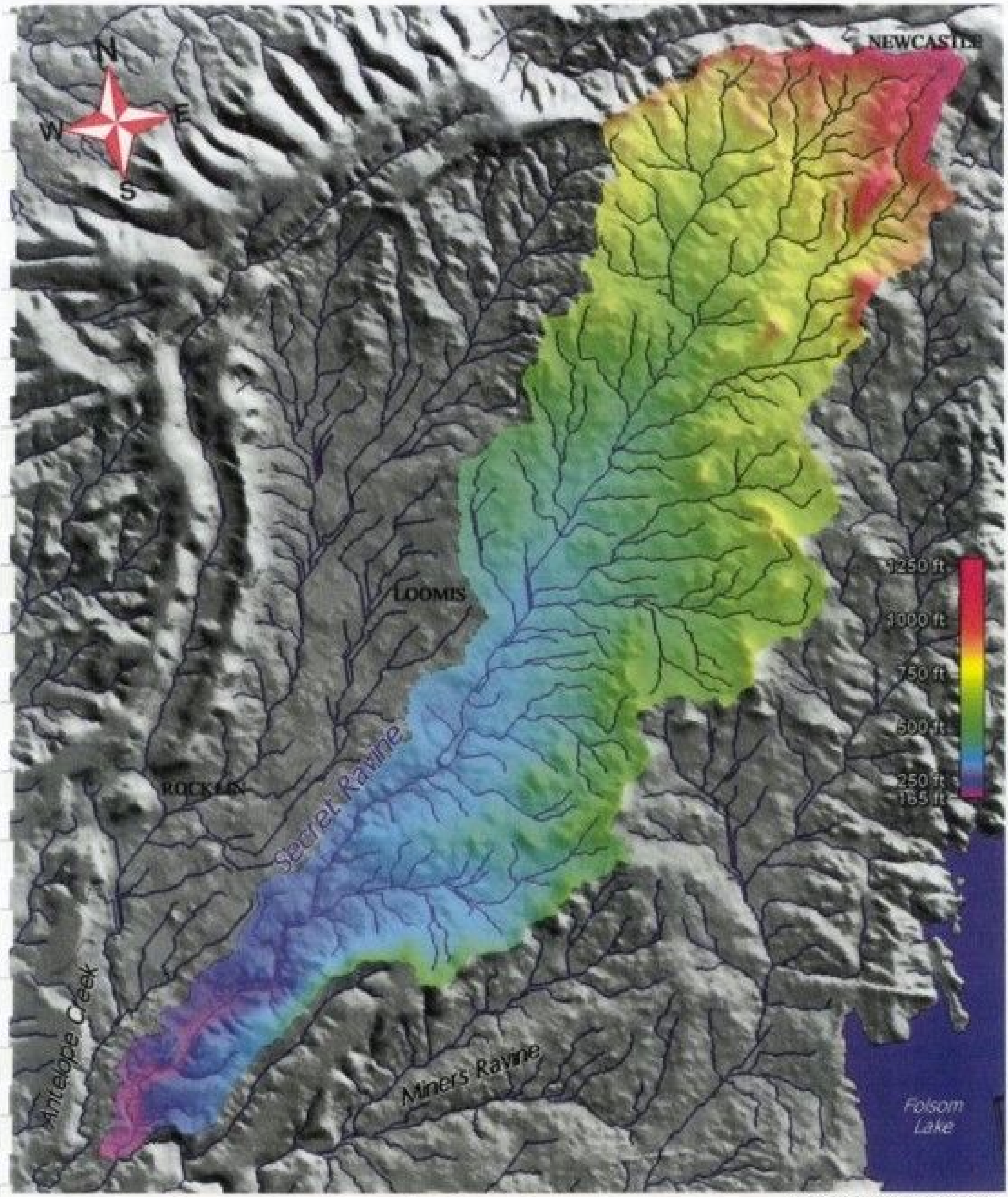


FIGURE 1: WATERSHED MAP FOR SECRET RAVINE
Derived From USGS Digital Elevation Model
SCALE = 1:63,360 or 1 inch = 1 mile

0 1 2 miles

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Table 1

Summary of Stressors and impacts for salmon and steelhead in Dry Creek

		Life Stage Function				
		adult migration	spawning	incubation and emergence	Juvenile rearing	juvenile migration
Functional requirement	**Stressors**	**Negative impact**				
sufficient flow	depressed groundwater, lack of flow from effluent sources, change in PCWA flows	inability to reach spawning area	decrease in usable riffle area	drying of redds, insufficient transfer of nutrients and waste, unhealthy temperature	unhealthy temp, increased predation	
no migration barriers	diversion dams, utility crossings, bridge sills, excessive sediment, unscreened diversions	inability to reach spawning area, increased poaching at barriers	prespawning mortality			increased predation at barriers, stranding
Channel Complexity:						
instream-cobble, boulders, undercut banks, pools riparian-large woody debris, streamside vegetation, good channel morphology	sedimentation from in channel and upland erosion, flood control maintenance, homeowner maintenance, grazing, poor stormwater management	lack of optimal velocity through a range of flows, lack of resting pools	lack of clean spawning gravel	poor percolation for nutrients and waste, inability to emerge from gravel, scouring of redds	increased predation, less than optimal food supply from instream and terestrial sources, less than optimal velocity for growth	

appropriate temperature	inadequate vegetation, lack of substrate complexity, inadequate flow, impoundments, effluent			mortality	decreased vigor, size and increased mortalilty
good water quality	poor stormwater management, homeowner maintenance, industrial discharge			poor development, increased mortality	

Table 4

Summary of Adaptive Management Studies

Functional requirement	Stressors		Adaptive management studies		Priority
sufficient flow	1	depressed groundwater	1	flow measurements	high
	2	lack of flow from effluent sources			
	3	change in PCWA flows	2	investigate PCWA operations	high
no migration barriers	4	utility crossings, bridge sills, diversion dams, unscreened diversions	3	run timing	high
			4	steelhead upmigration estimates	high
			5	salmon upmigration estimates	med
			6	survey predators during outmigration period	med
	5	excessive sediment	7	survey stream reaches for habitat type quantity and quality	high
Channel Complexity- instream- cobble, boulders, undercut banks, pools riparian-	6	sedimentation from channel and upland erosion	8	compare habitat parameters with juvenile utilization	low
			7	survey habitat types	high

large woody debris, streamside vegetation, good channel morphology	7	flood control maintenance	9	quantify benefit of stream maintenance	high
	8	poor stormwater management	10	survey riparian quality near outflows	high
	9	homeowner maintenance, grazing	11	estimate erosion due to poor maintenance	high
appropriate temperature	10	inadequate vegetation, lack of substrate complexity, inadequate flow, impoundments, effluent	12	assess temperature in various habitats and reaches	high
good water quality	11	cumulative contaminatioin from watershed sources	13	assess water quality parameters at regular intervals	high
	12	poor stormwater management	14	assess stormwater quality at regular intervals	high
	13	homeowner maintenance	15	analyze water from urban drains	med
	14	industrial discharge	16	locate dischargers and analyze outflow	low
reproductive success	15	various cumulative	17	juvenile outmigration	med
			17a	correlate outmigration with escapement	med
			18	analyze juvenile stomach samples	med

non-natal rearing			19	investigate methods to study the extent of non-natal rearing	med

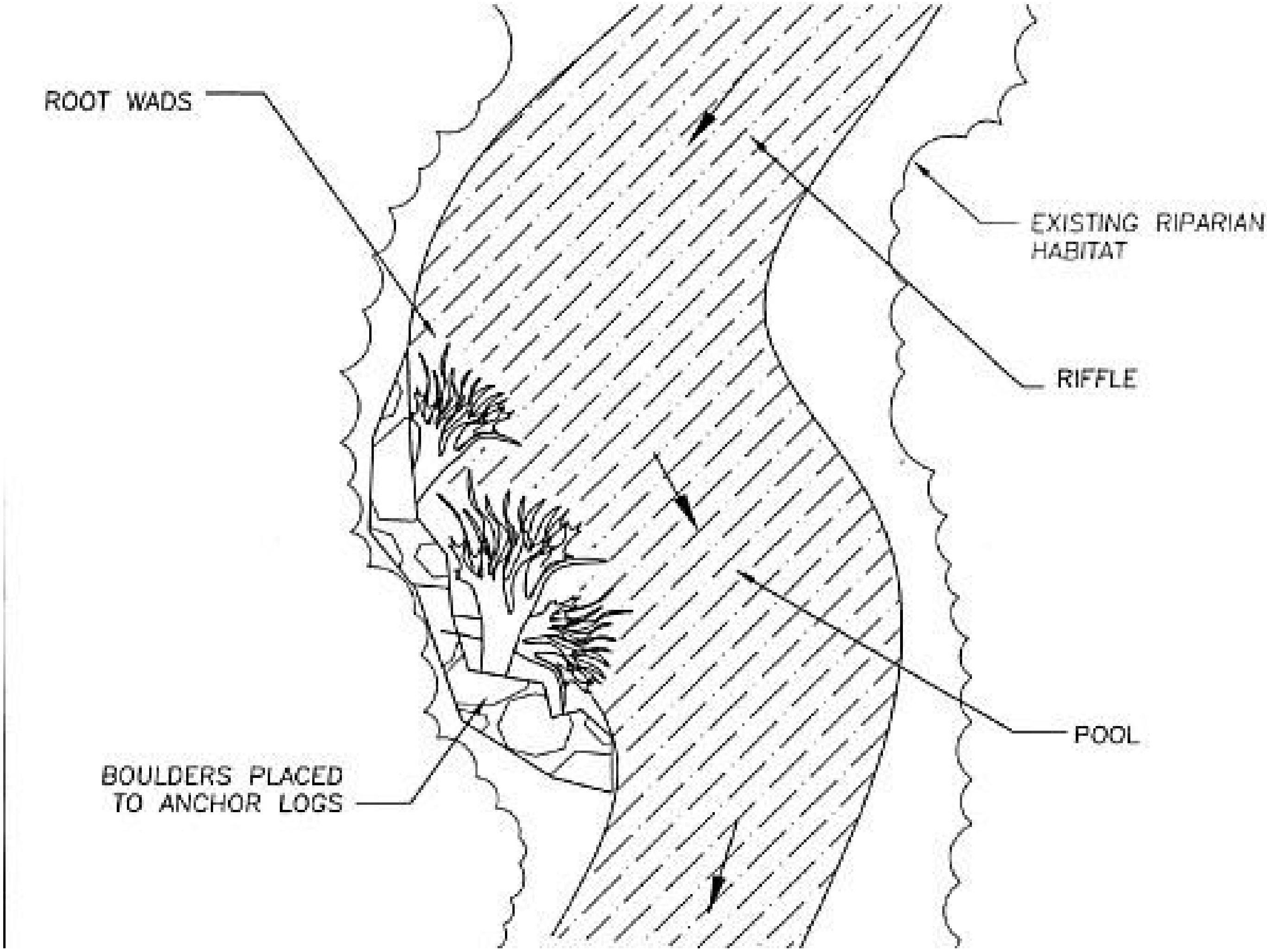
Table 2

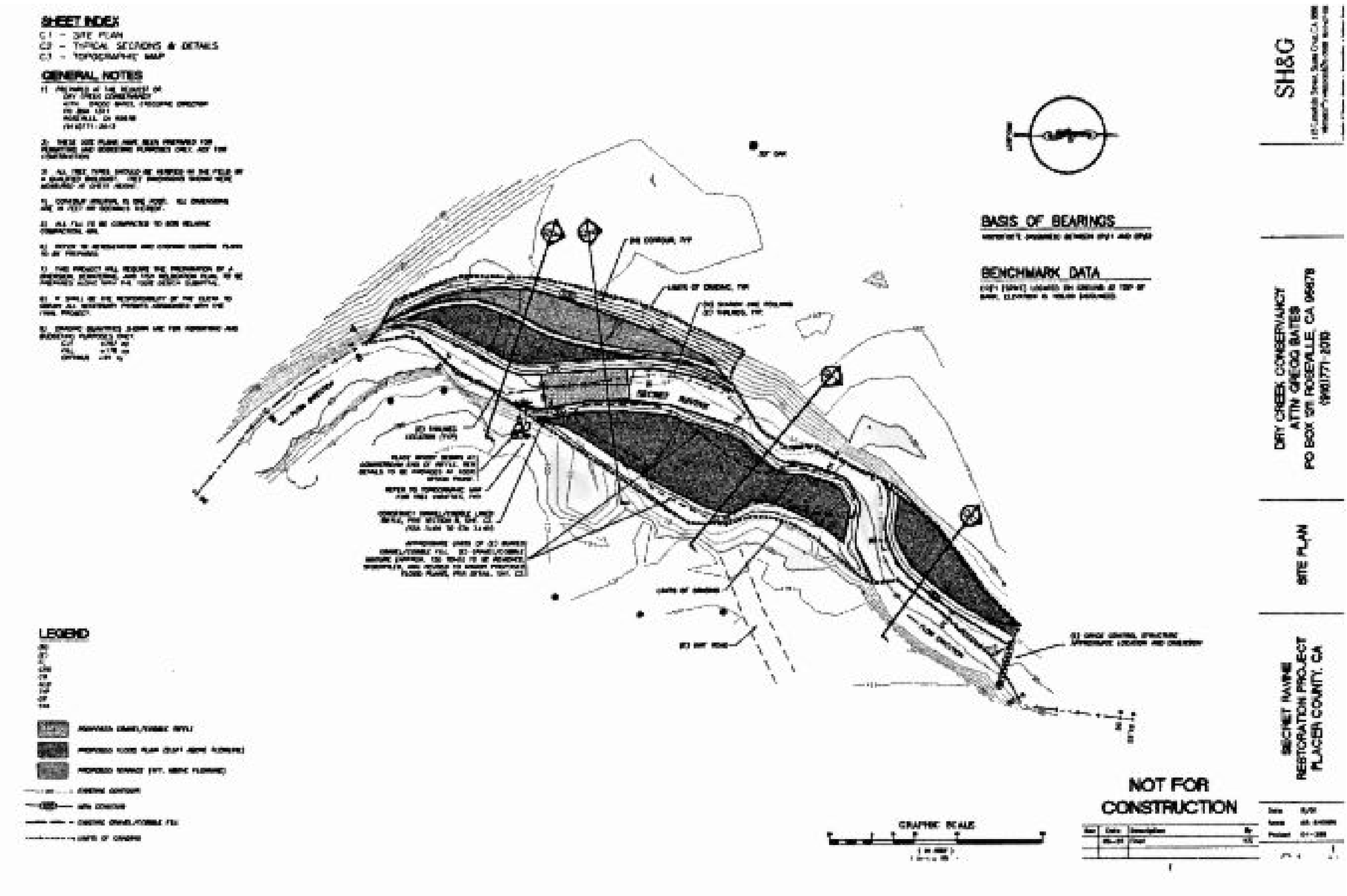
Summary of Hypotheses

Life Stage Function

Functional requirement	Stressors	adult migration	spawning	incubation and emergence	Juvenile rearing	juvenile migration
		Hypotheses				
sufficient flow	depressed groundwater, lack of flow from effluent sources, change in PCWA flows	**1 Dry Creek watershed is dependant upon surface runoff to attract upstream migrating adults**				
		2 Low flows result in unhealthy temperatures for all life stages.				
			6 Low flows cause superimposition of redds	Low flows 9 increase mortality and 10 decrease healthy development		**17 Low flows increase mortality due to predation**
no migration barriers	diversion dams, utility crossings, bridge sills, excessive sediment, unscreened diversions	**3 Partial barriers in combination with rainfall patterns and other sources of flow influence run timing and geographical distribution sending fish to less suitable habitat, and 4 partial barriers cause prespawning mortality due to poaching**				Partial barriers: 18 delay spawning resulting in outmigration during times of unhealthy temperature, 19 provide opportunity for predators. 20 Unscreened diversions increase mortality
Channel Complexity:				Lack of channel complexity		

instream- cobble, boulders, undercut banks, pools riparian- large woody debris, streamside vegetation, good channel morphology	sedimentation from in channel and upland erosion, flood control maintenance, homeowner maintenance, grazing, poor stormwater management	**5 Lack of channel complexity causes prespawning mortality due to excess expenditure of energy**	**7 Lack of channel complexity leads fish to build redds in substrate impacted by sand and 8 to superimposition of redds.**	causes 11 lack of vigor and increased mortality due to poor percolation, 12 scouring of redds due to increased channel velocity	Lack of channel complexity causes 21 increased predation due to lack of cover, 22 decreased food supply due to lack of benthic macroinvertebrate and terrestrial habitat, 23 unfavorable velocities resulting in excess energy expenditure and less that optimal growth.
appropriate temperature	inadequate vegetation, lack of substrate complexity, inadequate flow, impoundments, effluent			**13 Dry Creek and Secret Ravine support a non-natal population of juvenile salmon and steelhead. 14 Lack of riparian and channel complexity cause lack of vigor and mortality due to unhealthy temperature.**	
good water quality	poor stormwater management, homeowner maintenance, industrial discharge			**15 Pollutants from urban sources are introduced into the stream and 16 cause poor development and increased mortality**	


ROOT WADS
EXISTING RIPARIAN HABITAT
RIFFLE
POOL
BOULDERS PLACED TO ANCHOR LOGS


SHEET INDEX
C1 - SITE PLAN
C2 - TYPICAL SECTIONS & DETAILS
C3 - TOPOGRAPHIC MAP
GENERAL NOTES
BASIS OF BEARINGS
BENCHMARK DATA
LEGEND
GRAPHIC SCALE
NOT FOR CONSTRUCTION
SH&G
DRY CREEK CONSERVANCY
ATTN: GREGG BATES
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SITE PLAN
SECRET RAVINE
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