

VII. RECOMMENDED ACTIONS

INTRODUCTION

The summary of watershed conditions outlined the opportunities for improvements of the Sausal Creek watershed and the constraints to making improvements. This section outlines recommendations for major erosion sites, watershed stormwater improvements, invasive non-native plants, water quality monitoring and improvement, and stream restoration projects.

The recommendations include some actions to be implemented by FOSC and community and neighborhood groups. However the scale of many of the environmental problems in the Sausal Creek watershed, however, cannot be remedied with volunteers alone. Some of these recommendations will require major engineering and construction and should be carried out by the City of Oakland or other organizations. Larger public works projects are needed to mitigate the hydrologic effects of urbanization and reduce creek erosion so that volunteer efforts to revegetate creek corridors are sustainable.

The Palo Seco Creek sub-basin is an exception in the drainage because it is largely undeveloped and doesn't have the large peak flow problems of the other tributaries. Palo Seco Creek has aquatic and riparian habitat conditions that reflect this difference with a high diversity of aquatic insects and the occurrence of taxa that are sensitive to pollution.

MAJOR EROSION SITES

The watershed assessment identified a number of storm drain outlets with erosion problems. Many of these erosion sites are in public parks. Each one of the erosion sites requires a site-specific repair and the involvement of the City of Oakland Public Works Department. The storm drain system is owned and maintained by the City and repairs are their responsibilities. FOSC, homeowner groups, park advocates, and local elected officials should meet with city staff to determine a schedule for repair implementation.

One of the features documented in the stormdrain assessment were plastic flex pipes attached to downspouts to move stormwater away from houses. Depending on where the flex pipe outlet is placed this practice can cause erosion at the outlet. Homeowners could benefit from workshops on storm water management to reduce erosion and increase slope stability. This workshop could be combined with workshops on rain barrel installation and maintenance.

The erosion sites documented for Joaquin Miller Park (Table 49) point to a need for re-design and maintenance of many of the park trails. When repair projects are designed, a professional with the needed understanding of hydrology and erosion should be involved. The use of ineffective repairs in several locations speaks to the need for improved designs. In addition, several of these erosion sites were caused by urban stormwater runoff released into public lands from residential areas (Castle Drive) and new developments (Chabot Space & Science Center).

The City's approval of a large development like the Chabot Space & Science Center with no provision to reduce the effects of storm water runoff from large parking lots built on top of a slope indicates the need for the City of Oakland to specifically evaluate this impact when permitting new development in the Oakland hills. The degradation and erosion in small hill creeks due to increased urban runoff from additional building can potentially damage existing houses built near tributary creeks (Figure 88).

WATERSHED STORMWATER IMPROVEMENTS

Urban development causes a permanent change in the watershed processes of infiltration of rainfall and runoff of stormwater. These system-wide changes in the drainage basin produce larger volumes of stormwater delivered into creek channels over a short time frame. In response, ephemeral creeks in the steep hills of the watershed erode and can initiate a slide on the hillslope. Larger tributary creeks in the upper watershed are also eroding, particularly in the Cobbledick Creek sub-basin. The main tributary channel of Shephard Creek has already been culverted. In the Sausal Creek sub-basin, the main creek has eroded and deepened, losing riffles, pools and riparian forest due to urban runoff. All of the aquatic insect studies in Sausal Creek show poor aquatic habitat conditions. While urban creeks can be daylighted and enhanced with vegetation, studies of urban creek restoration projects in numerous locations show only small improvements in aquatic habitat conditions (p. 105). This lack of habitat improvement occurs because the urban watershed still produces high velocity flows which scour creeks and greatly reduce aquatic habitat values. Mitigating the effects of urbanization through watershed stormwater improvements can greatly improve aquatic conditions, reduce bank erosion and sustain riparian habitat. The proximity of houses and roads limit the ability of the channel to adjust to the changed urban watershed conditions and regenerate aquatic and riparian habitats.

A broad variety of stormwater facilities were evaluated for their effectiveness in reducing streamflow volumes and velocities in Sausal Creek. These facilities are listed below.

Table 74: Sausal Creek Watershed Stormwater Improvement Sites

Improvement	Scenario 1	Scenario 2	Scenario 3
Rain barrel at each house in the Shephard and Cobbledick Creek sub-basins	✓	✓	✓
Chabot Space & Science Center Parking Lot Detention and Biofiltration Site 1	✓	✓	✓
Chabot Space & Science Center Parking Lot Detention and Biofiltration Site 2	✓	✓	✓
Joaquin Miller Elementary School/Montara Middle School Parking Lot Detention and Biofiltration Site	✓	✓	✓
Montclair Parking Lot Detention and Biofiltration Site	✓	✓	✓
Joaquin Miller Park Parking Lot Detention and Biofiltration Site 1	✓	✓	✓
Joaquin Miller Park Parking Lot Detention and Biofiltration Site 2	✓	✓	✓

Table 74: Sausal Creek Watershed Stormwater Improvement Sites

Improvement	Scenario 1	Scenario 2	Scenario 3
Zion Lutheran Church Parking Lot Detention and Biofiltration Site	✓	✓	✓
Montclair Railroad Trail – Stormwater Detention Basin 1	✓	✓	✓
Montclair Railroad Trail – Stormwater Detention Basin 2	✓	✓	✓
Montclair Railroad Trail – Stormwater Detention Basin 3	✓	✓	✓
Joaquin Miller Park – Upper Meadow Detention Site	✓	✓	✓
Joaquin Miller Park – Middle Meadow Detention Site and Fern Ravine Creek Daylighting	✓	✓	✓
Joaquin Miller Park – Lower Meadow Detention Site	✓	✓	✓
Metropolitan Horseman’s Association Parking Lot Detention and Biofiltration Site	✓	✓	✓
Fruitvale Commercial Area Parking Lot Detention and Biofiltration Site 1	✓	✓	✓
Fruitvale Commercial Area Parking Lot Detention and Biofiltration Site 2	✓	✓	✓
Fruitvale Commercial Area Parking Lot Detention and Biofiltration Site 3	✓	✓	✓
Fruitvale Commercial Area Parking Lot Detention and Biofiltration Site 4	✓	✓	✓
Shepherd Canyon Park – Underground Cistern		✓	✓
Larry Lane On-stream Detention Pond		✓	✓

Table 74: Sausal Creek Watershed Stormwater Improvement Sites

Improvement	Scenario 1	Scenario 2	Scenario 3
Montclair Golf Course – Underground Cistern			✓
Dimond Park Meadow – Underground Cistern			✓

Analyses using both a hydrologic and hydraulic model concluded that:

- Stormwater source control practices such as the rain barrels, parking lot detention, and small detention basins simulated in Scenario 1 have a significant effect on reducing flow rates and volumes for the 1-year runoff event. Larger storm events produce larger quantities of runoff, which quickly overflow these facilities producing only minor reductions in flow rates and volumes for the 2- to 100-year events.
- Cisterns and detention basins significantly reduce flow rates in the reaches below the facilities for the 1-year event, and less so for the larger events. However, as additional tributaries join the channel downstream of the detention facility, the flow dampening effect becomes less pronounced. Flow volumes are less affected by the detention facilities.
- The three scenarios evaluated in this analysis would change the configuration and use of different areas in the watershed and have a range of potential benefits for downstream hydrologic and hydraulic conditions in Sausal Creek. Based on the improved hydraulic conditions, Scenario 3 yields the most substantial improvements over the largest extent of the creek system. Scenario 2 also yields significant improvements. Scenario 1 yields small hydraulic improvements, which may not be sufficient to produce noticeable changes in aquatic and riparian habitat in Sausal Creek but could produce improvements in the Palo Seco Creek sub-basin. Therefore, Scenario 3 appears to be the most beneficial with respect to the long-term geomorphic and sediment transport conditions in Sausal Creek.
- In relation to the other sub-basins, Palo Seco Creek is relatively undeveloped. The proposed improvements included in Scenario 1 within the sub-basin reduce flow rates by 14% to 17%, and flow volumes by 15% to 24% compared to existing conditions for the range of storm events. Because the majority of the improvements occur on publicly-owned lands, implementation of these measures may be simpler and less expensive. For these reasons, it is recommended that implementation of watershed stormwater improvements in the Palo Seco Creek sub-basin be considered as a demonstration project.
- The larger program of watershed stormwater improvements in the other sub-basins can be phased over a 10-year period as grant funds become available.
- Installation of biofiltration facilities along roads and in parking lots should be implemented in as many locations as possible as part of the pilot green street projects required by the Regional Board NPDES permit.

These improvements will require leadership from the City of Oakland, the San Francisco Bay Regional Water Quality Control Board, and the Alameda Countywide Clean Water Program, combined with community input and oversight from groups like Friends of Sausal Creek. These watershed improvements are an integral part of creek restoration efforts and should be proposed as part of a watershed restoration approach to aquatic habitat restoration.

INVASIVE NON-NATIVE PLANTS

The abundance and broad distribution of invasive non-native plants in the Sausal Creek watershed is a major threat to native habitat in public parkland and creeks. This problem is further exacerbated by the purchase and planting of many of these invasive species by uninformed homeowners, creating an infinite source of infestation in the watershed.

The main actions recommended to address the invasive plant problem are as follows:

- 1) Eradication of invasives in the Palo Seco Creek sub-basin;
- 2) Homeowner education throughout the watershed on invasive garden plants;
- 3) Work with state and local agencies and organizations to restrict the sale of known invasive non-native plants in the state;
- 4) Maintenance of revegetation sites free of invasive non-native plants;
- 5) Focused eradication of fire hazard invasive plants in the entire watershed.

Eradicating Invasive Non-Native Plants in the Palo Seco Creek Sub-Basin

Palo Seco Creek sub-basin is primarily public land and offers the best opportunity for improvement of both upland and creek habitats. This effort, while involving FOOSC and the Friends of Joaquin Miller Park, will require grant funding and contracts with companies who specialize in invasive plant mapping and eradication projects. This is a major ecological restoration project and requires a larger-scale, more difficult work effort than community volunteers can provide.

The watershed lands outside the park need to be included to evaluate all infested locations on ridge tops and upstream locations. The ridge tops and headwaters are sources of infestation to downhill and downstream areas and should be treated first. Using GPS/GIS, map invasive plants listed in Table 75 and devise an eradication strategy, taking into account the rate of spread, population size, and proximity to at-risk stands of rare plants or intact stands of native vegetation. Using GPS/GIS, also map and identify any rare, unusual or significant plants at risk from invasive plant populations and identify native plant “hotspots” at risk from invasive plant populations. Determine creek and hillside locations most susceptible to bank failure or erosion due to invasive plant infestations.

In Joaquin Miller Park many non-native species are also fire-prone plants. The map of infestations can be used to determine labor hours needed to remove the current infestation. Costs should be compared for removal through mechanical methods only and removal through mechanical methods with herbicide use. The majority of park management agencies including the National Park Service now make careful use of herbicides to eradicate invasive plants. This change has occurred as the result of many years of failing to control invasive plants through using mechanical means only. Since invasive plants are a major threat to native habitats and ecosystem processes, their control outweighs the potential environmental effect of careful use of herbicide. Appendix C provides information on each invasive species.

Given the large number of acres of invasive species in the Palo Seco Creek sub-basin the largest infestations should be cleared from the outside and working toward the center. Areas along trails and roads are priority control areas due to the spread of seed and stem materials by hikers, dogs, and bicyclists.

FOSC, Friends of Joaquin Miller Park, the Oakland Parks and Recreation Department, and the Wildfire Prevention District should form a working group to plan removal of the Eucalyptus, Acacia, broom, and pampas grass as a multi-year effort. The use of herbicide as a cut-and-paint method will be needed to make eradication efforts effective. The use of controlled burns may also be evaluated, especially for Algerian ivy infestations. Work should be done by paid contractors.

The eradication effort needs to be well-publicized to neighboring homeowners and park users. Both fire hazards and ecological issues need to be explained thoroughly. Neighboring homeowners with these species on their property should be encouraged to participate in the eradication effort. For the other invasive species—Cape ivy, Algerian ivy, yellow star thistle, Himalayan blackberry, holly, and various grasses—a broad-based community outreach effort is needed. For each species, the upslope/upstream extent of the plant will need to be determined exactly. Table 77 lists some known locations of invasives. FOSC, in conjunction with weed warriors and other service groups, could be involved along with community members, neighborhood associations, and local landowners in planning and publicizing the program. As with the eradication of fire hazard plants, these efforts should be broadly publicized in Oakland with detailed information about the plants. Work should be done by paid contractors.

By focusing on invasive plant eradication in Joaquin Miller Park, public funding may be available, particularly if the program can describe this effort in terms of acres of each habitat type improved and number of private landowners involved. The eradication of non-natives in the Palo Seco Creek watershed will need to extend over at least a 5- to 10-year period.

Homeowner Education

Homeowners provide the primary infestation mechanism of invasive non-native plants in the Sausal Creek watershed through their planting, cultivation, and disposal of garden waste in creeks and empty lots. It is likely that most homeowners do not realize the long-term negative effects of their actions.

FOSC in conjunction with the City, Wildfire Prevention District, the local chapter of the California Native Plant Society, the California Invasive Plant Council, and other organizations need to develop a full media approach: brochures, mailers, Internet, hikes, and events to increase homeowner awareness of common invasive plants. Similar to the “green” movement which has changed consumer attitudes about many products, garden decisions involving invasive plants need to be “greened” and made a part of the popular dialogue. Additional actions include:

- Develop training program/materials for training leaders in active homeowner groups: Beaconsfield, Marj Saunders/Piedmont Pines, Shepherd Canyon Homeowners Association, Castle Canyon, Bridgeview, Barry Place, W. D. Wood Park, plus Adopt-a-Spot leaders and crew leaders.
- Purchase copies of *Invasive Plants of the California Wildlands* and *Vegetation Almanac for the East Bay Hills* for project leads for above areas.
- Develop a section of FOSC website to educate homeowners on invasives ID, problems, and best practices for removal.

Ban the Sale of Invasive Non-Native Plants

It is difficult to take on a major plant eradication effort in an urban area knowing that the plants being dug up and removed are available for sale at nurseries and garden centers. The City of Oakland, Friends of Joaquin Miller Park, FOSC, and other groups should discuss involvement in statewide efforts to ban the sale of the worst weeds in California.

Maintain Revegetation Sites Free from Invasive Plants

The locations where FOSC has completed revegetation with native plants need to be maintained to avoid infestation with invasives. This effort can be done with community volunteers and should include broom, Algerian ivy, thornless blackberry, cape ivy and American elm. Development of a system to track treatment of specific areas and invasive species, especially cape ivy, broom, Algerian ivy and blackberry would allow for practices to be evaluated for effectiveness.

Table 75: Some Recommended Invasive Plant Removal Projects in Joaquin Miller Park*

<i>Yellow Star Thistle (YST)</i>
Lookout Point – some control has occurred but additional work and yearly follow-up is needed
Joaquin Miller Road and Skyline Blvd. – just as the Skyline Blvd. right-turn lane onto Joaquin Miller Road starts: patch of YST at roadside, then up the road cut, and some up on top as well. This is an area with some rare natives, including Tiburon Buckwheat.
Sunset Trail – goats graze most of the western portion of the Sunset Trail; YST control needed between the trail and the electric fence and on ungrazed portions near Sinawik Cabin
<i>Broom-all species</i>
Below Lookout Point – starts under Eucalyptus providing fire ladder and is moving downhill toward very good native plant hotspot
Along Sanborn Road-starts near the west end of the one-way loop; scattered plants down to Lookout Point
Joaquin Miller Road and Skyline Blvd. – broom patch up on top of the road cut expanding
Along Chaparral Trail, Sunset Trail, and Sinawik Trail
<i>Cape Ivy</i>
2 patches, each fairly small, along paved road parallel to Skyline; first is at the fire gate; 2 nd is about 250 ft. east of Orchard Trail. Someone removed most above-ground parts sometime in 2008; needs follow-up
Patch along Skyline, from roadside edge down to creek
Large patch near Castle Park Trail in Cinderella Creek headwaters; this patch will take extensive work and many repeat visits to control
Small patch near Sanborn Road and Sinawik Loop Trail
<i>Acacia</i>
Seedling/sapling control is needed to protect native plant and wetland area on Cinderella Creek
Continue to expand clearing efforts below nursery and control re-sprouts
Clear serpentine outcrop near Joaquin Miller House
Continue clearing along Sanborn Road, where zoo harvesting has taken place
Horse Arena area – vast amounts of all 3 kinds of Acacia; priority area is between Castle Park Trail and tributary to Cinderella Creek. Infestation is moving toward good riparian area with significant native plant populations
<i>Holly</i>
Dense patches along Palo Seco Creek need to be removed to protect downstream riparian areas in the park and assure regeneration of shade canopy
<i>Eucalyptus</i>
Dense along Sunset and Castle Park Trails
<i>Veldt Grass</i>
Ranger Station Trail to stone bridge
Sinawik Loop Trail – currently lots of small patches are present, and some larger nearby areas
Sequoia-Bayview Trail – many small patches along trail; it has moved densely downhill from the trail
<i>Himalayan Blackberry</i>
Remove along creeks prior to planting native trees and shrubs
<i>Other Species</i>
As Monterey pines senesce and die they create canopy openings subject to infestation. Remove nearby invasives in the opening area and remove pine seedlings and cut young pines in the area. Replant native trees and shrubs

* This is not a comprehensive list. Mapping and comprehensive control is recommended.

Control of Fire Hazard Plants throughout the Watershed

While it will be nearly impossible to control invasive plants in all areas of the watershed, controlling fire hazard plants throughout the watershed is a necessity. The Wildfire District, working with local groups, is evaluating control of the primary fire hazard plants: Eucalyptus, Acacia, broom, and pampas grass. When these species are removed, some provisions need to be made for erosion on cleared steep sites. The example of the Eucalyptus removal in Joaquin Miller Park next to Castle Drive, which has become a major erosion site (Figures 95-98) should inform current and future eradication efforts. Figure 134 shows a Eucalyptus clearcut on Skyline Blvd. at the headwaters of an ephemeral creek. This figure also shows a small creek cleared of broom with no erosion control installed. Effects on natives plants in these eradication sites also needs to be carefully evaluated.

WATER QUALITY

The most serious water quality problem identified from the monitoring data is high *E. coli* levels in Sausal Creek and raw sewage spills and overflows from the sanitary sewer system. In the short-term when sewage spills occur in open creek areas where children have access to the water, the City of Oakland must post closure signs. *E. coli* measured at high levels by the water quality monitoring indicates a potential health hazard for water contact recreation. A watershed-wide program of bacterial monitoring and monitoring of the location of sewage spills and overflows need to be implemented by the City in conjunction with the San Francisco Bay Regional Water Quality Control Board and the Environmental Protection Agency. Identifying the locations of sewage spills will assist in implementing a control program.

In the long-term, the sewer system needs to be upgraded so that stormwater infiltration into the sewer pipes, a major cause of overflows, is eliminated. Dry season leaks indicated by the monitoring results also need to be identified and repaired.

In addition to bacteria monitoring, monitoring of aquatic insects in creeks in the watershed can provide a long-term basis for comparison of conditions and improvements. As discussed on page 105, aquatic insects are an excellent indicator of the condition of aquatic habitats. Sausal and Palo Seco Creeks have had aquatic insect monitoring from 1999-2004/2005 to set a baseline for current watershed conditions. As watershed stormwater improvements are implemented, continued aquatic insect monitoring can document the change in aquatic habitat conditions resulting from reduced scour and lower flow velocities. Aquatic insect monitoring should be done using the SWAMP protocols and a professional lab. A spring and fall sampling at all the SWAMP stations with an additional station in the upstream area of Palo Seco Creek would provide adequate review of changes and improvements.

The implementation of biofiltration improvements, if completed in enough locations, can effectively remove nutrients and persistent pollutants typical of urban runoff. These facilities also collect floatable trash. Biofiltration facilities, however, require maintenance annually or they are not effective.

Reducing pollutants at the source is by far the most cost effective solution, but also the most difficult as it involves changing human behavior. Homeowners in the watershed can play a major role in improving the water quality and habitats in Sausal creek and its tributaries. As part of the series of workshops for homeowners a workshop on recommended measures for the home and garden to reduce pollutants should be included. Subjects that should be included are: revising the location of car washing to avoid

soap pollution (nutrients) into creeks, proper locations and methods for cleaning paint brushes and accessories, cleaning up the oil and grease on driveways and streets, low chemical pest control and reduced fertilizer use in gardens, transforming water hungry lawns into low water landscaping with less runoff, and other topics.

Trash as a pollutant also can be reduced through the work of volunteers, neighborhood groups, and businesses. It can also be controlled through enforcement of littering and dumping laws. The City of Oakland has tried using citations to reduce littering.

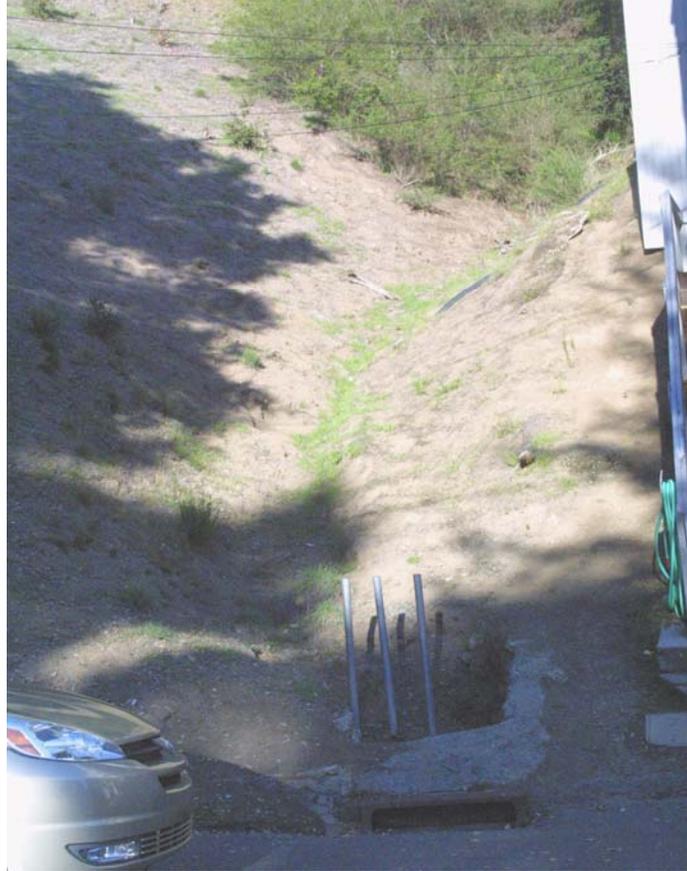


Figure 134: Removal of fire-prone invasive plants in ephemeral creek swales can cause erosion.

AQUATIC AND RIPARIAN HABITATS

Except for Palo Seco Creek, the aquatic and riparian habitats of the Sausal Creek watershed have been significantly degraded by urbanization of the watershed and the increase in storm flow volumes and velocities, and the resulting scour of the channel. The first and most important step in restoring aquatic habitats in the Sausal Creek watershed is implementation of watershed stormwater improvements to reduce the scouring high velocity flows caused by urbanization of the watershed.

By focusing on creek restoration, invasive plant removal, and watershed stormwater improvements in Palo Seco Creek, the greatest degree of habitat enhancement can be achieved. This approach could create high quality aquatic habitat in Palo Seco Creek and provide a genuine refuge for a resident population of rainbow trout. This same goal cannot be met on Sausal Creek. With implementation of all of the watershed stormwater improvements in Scenario 3, flow velocities and channel scour in Sausal Creek still exceed thresholds needed to support high quality aquatic habitat conditions under most flood levels. Implementation of Scenario 3, however, does represent a major improvement in creek conditions under the most frequent 1-year flow event.

Table 76 outlines recommended actions in the creek reaches available for revegetation and improvement. Most of the restoration recommendations will require designs by qualified professionals: civil engineers, geomorphologists, hydrologists, and riparian ecologists. They will also require implementation by contractors with experience in stream restoration. Community groups like FOOSC and Friends of Joaquin Miller Park can supply assistance to grant efforts, grow native plants in the Joaquin Miller nursery, coordinate volunteer assistance with planting native plants, and maintain creek areas after restoration.

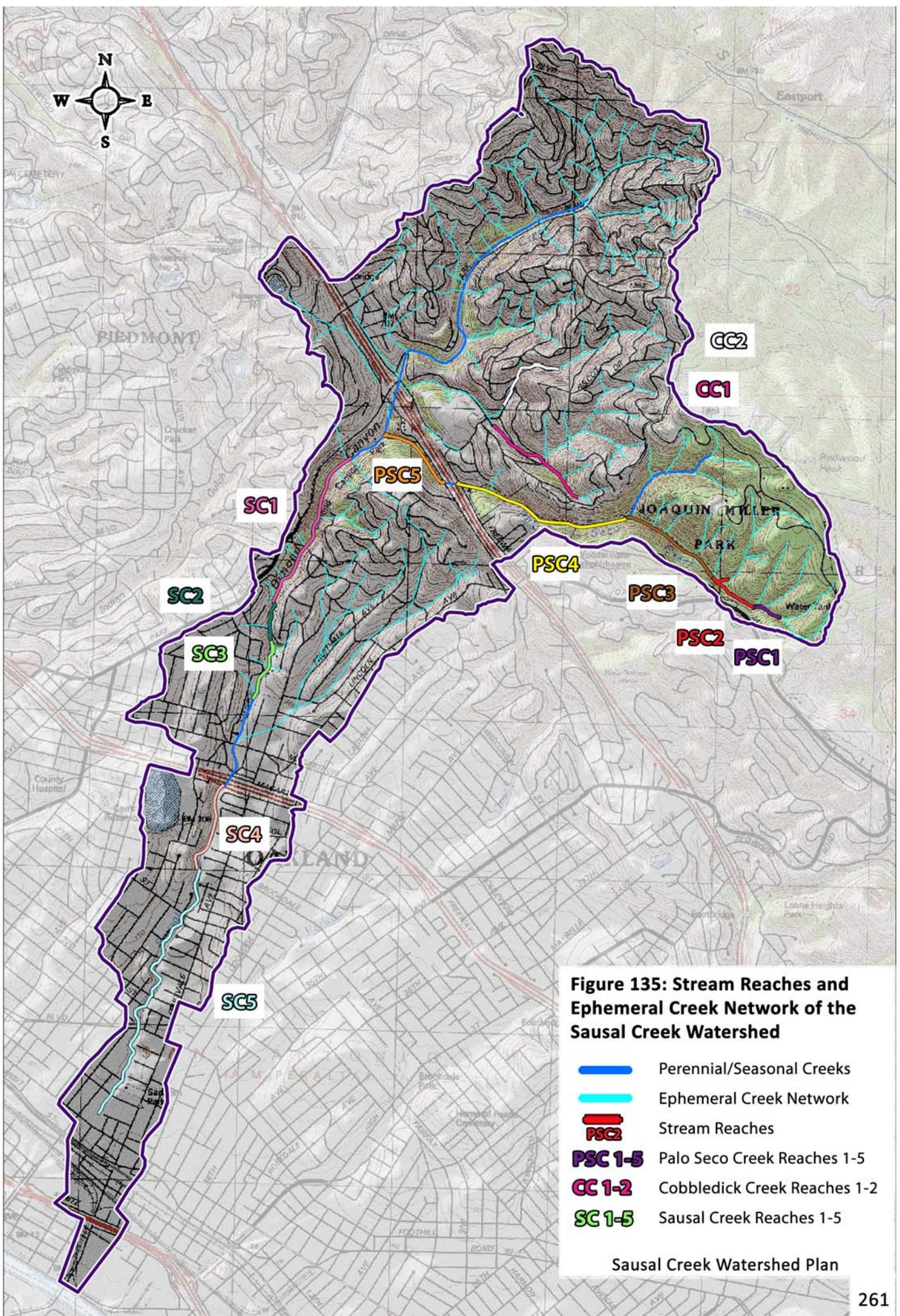


Figure 135: Stream Reaches and Ephemeral Creek Network of the Sausal Creek Watershed

-  Perennial/Seasonal Creeks
-  Ephemeral Creek Network
-  Stream Reaches
-  Palo Seco Creek Reaches 1-5
-  Cobbledick Creek Reaches 1-2
-  Sausal Creek Reaches 1-5

Table76: Restoration Recommendations for Stream Reaches

Reach	Priority	Recommendations
PSC1	High	<ul style="list-style-type: none"> • Repair Erosion Site 1 by installing culvert where the trail crosses an ephemeral creek. Culvert must be set in the channel at the slope of the stream to minimize erosion at the culvert outlet and have a minimum of 18 inches of trail fill on top to avoid damage to culvert. Fine sediment from this erosion site is filling the creek. • Relocate trail out of meadow and direct traffic onto Sunset Trail. Restrict bikes and hikers to allow stream restoration. • Install berm at downstream end of Upper Meadow with standpipe connected to culvert under trail. Eradicate Himalayan blackberry and revegetate the floodplain with native trees. • This reach offers one of the only locations for a floodplain riparian restoration with a detention and sediment basin. This site is part of the overall watershed improvements to reduce velocity and volume of stormwater and improve Palo Seco Creek aquatic habitat.
PSC2	High	<ul style="list-style-type: none"> • The creek is culverted through a meadow likely created during the WPA era when recreational areas were created at the expense of environmental protection. • This reach is a major candidate for daylighting and restoration, especially as the culverts are old and will require replacement in the near future. • Install berm at downstream end to detain stormwater during peak runoff events. • The downstream portion of Fern Ravine Creek now runs overland during nearly every rainfall event as the culvert outlet clogs. The creek should be daylighted and directed into the proposed stormwater detention area and eventually integrated with a daylighted and restored Palo Seco Creek.
PSC3	High	<ul style="list-style-type: none"> • Improved grade control structures need to be installed at the two knickpoints (Erosion Sites 3 and 4) to avoid the migration of the knickpoints upstream and the undercutting of large trees. Downstream of the bridge a number of trees along the banks have been eroded. The banks should be set back and revegetated once the Himalayan blackberry is removed.
PSC4	High	<ul style="list-style-type: none"> • Invasive non-native plants are degrading the redwood/California bay laurel forest riparian habitat and weakening the trees. Holly trees are the only species regenerating in the corridor. The holly and ivy need to be eradicated to restore the health of the forest. Ivy should be cut around the base of each tree, and the stumps immediately painted with herbicide to kill the ivy quickly and effectively. If the trees along the steep-sided gorge become weakened by the parasitic ivy and fall, the slopes may fail due to the ground disturbance. The holly needs to be cut and the stumps painted with herbicide to quickly remove this invader before it becomes established and dominates the corridor.
PSC5	Moderate	<ul style="list-style-type: none"> • FOSC has completed an erosion control project and an invasive plant removal/native plant revegetation project here. Continued maintenance will be needed. • Replace bridge at stream level or re-route trail.

Table76: Restoration Recommendations for Stream Reaches

Reach	Priority	Recommendations
CC1	Low	<ul style="list-style-type: none"> Houses line the upstream portion of this reach, leaving few opportunities for restoration. The sediment/stormwater detention basin on this reach needs to be cleaned out and retrofitted in order to function better. A large gully in this sub-basin requires repair.
CC2	Moderate	<ul style="list-style-type: none"> The Beaconsfield Canyon reach needs to have the rusted culvert removed and a geomorphic /revegetation restoration plan that includes a riparian floodplain area completed. Downstream drop inlet to storm drain needs to be repaired/replaced.
SC1	Low	<ul style="list-style-type: none"> This reach presents a real challenge for restoration. There are two major culverts and numerous concrete structures including a cement wall protecting the sanitary sewer pipe. California bay laurel trees have eroded off the canyon wall and into the creek. Replanting these trees will maintain shade cover for the creek. Eradicate ivy and other invasives to retain health of native trees. Work with the City of Oakland to repair erosion from storm drains, especially the major erosion sites along Park Blvd. Sanitary sewer overflows into Sausal Creek occur during major storms and need to be alleviated to avoid both contamination of the creek and a public health problem.
SC2	Low	<ul style="list-style-type: none"> This reach is a restoration project completed in 2001. Control of invasive plants and revegetation are necessary both along the channel and along side channels. The channel does not provide adequate room for regeneration of riparian species, and replanting will be required. Installing white alder along the channel could diversify the vegetation and provide some stability to the undercut bank areas, which provide refuge to wildlife in floods.
SC3	Moderate	<ul style="list-style-type: none"> Replanting of white alder and removal of waste cement and asphalt is needed along this reach. Riparian shade cover over the El Centro pool is also needed to maintain cool water temperatures. Recreation uses preclude the option of daylighting the creek through Dimond Canyon Park. Future City of Oakland project to stabilize private property and revegetate stream banks.
SC4	Low	<ul style="list-style-type: none"> Creek is entrenched with steep banks and fill from the McKillop slide. With this slide affecting the creek it is difficult to implement revegetation. Houses are very close to the channel, further restricting restoration options. Community-based invasive plant removal and native plant installations would provide local educational opportunities.
SC5	Low	<ul style="list-style-type: none"> Creek is entrenched with steep banks and numerous houses. Channel is hardpan clay and revegetation will be difficult in most locations. Community-based invasive plant removal and native plant installations would provide local educational opportunities.

IMPLEMENTING THE WATERSHED PLAN

There are recommended actions in this plan that are suitable for community groups such as Friends of Sausal Creek (FOSC), Friends of Joaquin Miller Park, Shepherd Canyon Homeowners' Association, and others. Many of the actions needed to restore productive aquatic habitat to Sausal Creek and its tributaries, however, require a significant change to storm drain and sanitary sewer infrastructure, including construction of both stormwater detention facilities and creek restoration. This change requires the involvement of the owner of the infrastructure: the City of Oakland. Many areas of Oakland have old and deteriorating infrastructure such as storm drain and sewer systems. The construction of stormwater detention and biofiltration facilities may be able to attract grant funds and allow for the upgrade of storm pipes as part of water quality and creek improvements. The recent municipal stormwater permit from the San Francisco Bay Regional Water Quality Control Board to Alameda County requires implementation of LID (low impact development) practices. This permit also requires the construction of two pilot green street projects. The recommended focus on Palo Seco Creek sub-basin as a demonstration project includes a number of stormwater detention facilities on City property. Table 77 outlines lead and supporting agencies and organizations for each of the recommended actions in the watershed plan.

Table 77: Implementation of Recommended Actions in the Sausal Creek Watershed

Recommendations	Lead Entity	Supporting Entities	Comments
Major Erosion Sites			
Repair extreme and eroded sites at outlets of City storm drain system	City of Oakland	San Francisco Bay Regional Water Quality Control Board FOSC and neighborhood groups	Adopt-a-Stormdrain program could be used to maintain repaired outlets and repaired erosion sites.
Homeowner workshops on stormwater management	Alameda Countywide Clean Water Program	FOSC and neighborhood groups	
Repair erosion sites in City parks, including relocation and re-grading of trail	City of Oakland	FOSC, Friends of Joaquin Miller Park, Friends of Beaconsfield Canyon, Piedmont Pines Neighborhood Association, and other neighborhood groups	Volunteer groups can play a major role in implementing improvements in parks but designs need to be done by professionals.
Watershed Stormwater Improvements			
<i>High Priority</i>			
Implement Scenario 1 improvements in Palo Seco Creek sub-basin including: <ul style="list-style-type: none"> • Retrofit Chabot Space & Science Center parking lots 1 and 2 to detain stormwater and install biofiltration units • Retrofit Joaquin Miller Park parking lots to detain stormwater and install biofiltration units 	Chabot Space and Science Center Joint Powers Agency City of Oakland	FOSC San Francisco Bay Regional Water Quality Control Board Alameda Countywide Clean Water Program Friends of Joaquin Miller Park	Due to the low level of development in this sub-basin, the greatest level of creek habitat improvement can be achieved by installing stormwater facilities. Detention facilities can also reduce the need for replacement of undersized storm drains. The ridgetop parking lots near the Joaquin Miller Community Center drain toward Joaquin Miller Park. The stormwater runoff from the Chabot Space and Science Center is actively eroding areas of the park.

Table 77: Implementation of Recommended Actions in the Sausal Creek Watershed

Recommendations	Lead Entity	Supporting Entities	Comments
Joaquin Miller Park – Upper, Middle, and Lower Meadow detention sites	City of Oakland FOSC	Friends of Joaquin Miller Park Alameda Countywide Clean Water Program	These facilities include daylighting lower Fern Ravine Creek. Daylighting Palo Seco Creek through the meadow can also be included in the detention design.
Metropolitan Horsemen’s Association parking lot detention and biofiltration site	City of Oakland	Friends of Joaquin Miller Park Alameda Countywide Clean Water Program FOSC	
Implementation of biofiltration facilities along streets and in parking lots	City of Oakland San Francisco Bay Regional Water Quality Control Board	Alameda Countywide Clean Water Program FOSC and other community organizations	
<i>Long-Term Priority</i>			
Implementation of watershed stormwater improvements in Scenario 3 for Sausal Creek	City of Oakland San Francisco Bay Regional Water Quality Control Board	Alameda Countywide Clean Water Program FOSC and other community organizations	The only long-term option for sustainable improvement in Sausal Creek requires the implementation of Scenario 3 of watershed stormwater improvements.

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Recommendations	Lead Entity	Supporting Entities	Comments
Invasive Non-Native Plants			
Implement a comprehensive mapping, invasive plant eradication/native planting program in the Palo Seco Creek sub-basin	FOSC City of Oakland	Wildfire Prevention District	This program should be implemented with grants and contractors skilled in invasive plant eradication (i.e., Shelterbelt Builders, California Conservation Corps). Relying on community volunteers limits the extent and location of invasives removed and cannot accomplish a comprehensive program. Palo Seco Creek sub-basin offers the best opportunity for large-scale restoration of upland and wetland/riparian habitats.
Homeowner education	Wildfire Prevention District FOSC City of Oakland	Homeowner and community groups	Urban gardens are the primary infestation mechanism for invasive non-native plants. Most homeowners are not aware of the problem and could be convinced to avoid planting them.
Ban the sale of invasive plants for gardens	City of Oakland FOSC and Friends of Joaquin Miller Park Wildfire Prevention District	Homeowner and community groups California Native Plant Society California Invasive Plant Council	The continued sale of invasive plants in California is a state-wide issue.
Maintain FOSC revegetation projects	FOSC	Community volunteers	Invasives have affected FOSC revegetation projects in several locations.

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Recommendations	Lead Entity	Supporting Entities	Comments
Control fire hazard plants	Wildfire Prevention District	FOSC, Friends of Joaquin Miller Park, Friends of Beaconsfield Canyon, Piedmont Pines Neighborhood Association, and other neighborhood groups	Eradicating fire hazards and not planting these species are important actions in fire reduction.
Water Quality			
Monitor creeks for <i>E. coli</i>	City of Oakland San Francisco Bay Regional Water Quality Control Board	EPA, FOSC, and community groups	
Monitor location and frequency of sewage spills	City of Oakland San Francisco Bay Regional Water Quality Control Board	EPA, FOSC, and community groups	
Post creek areas in parks when sewage overflows occur	City of Oakland San Francisco Bay Regional Water Quality Control Board	EPA, FOSC, and community groups	
Twice annual monitoring of aquatic insects at a number of stations in the watershed	San Francisco Bay Regional Water Quality Control Board FOSC	City of Oakland	A long-term study of changes in aquatic insect communities as watershed improvements are implemented may attract academic interest.
Implement biofiltration projects to reduce nutrients, trash, and other pollutants	City of Oakland San Francisco Bay Regional Water Quality Control Board	Alameda Countywide Clean Water Program FOSC and other community groups	

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Recommendations	Lead Entity	Supporting Entities	Comments
Aquatic and Riparian Habitats			
<i>High Priority</i>			
<u>Implement Watershed Stormwater Improvements, Scenario 1</u>			
<p>Creek Reach PSC1</p> <ul style="list-style-type: none"> • Repair Erosion Site 1 by installing culvert where the trail crosses an ephemeral creek. Culvert must be set in the channel at the slope of the stream to minimize erosion at the culvert outlet and have a minimum of 18 inches of trail fill on top to avoid damage to culvert. Fine sediment from this erosion site is filling the creek. • Relocate trail out of meadow and direct traffic onto Sunset Trail. Restrict bikers and hikers to allow stream restoration. • Install berm at downstream end of Upper Meadow with standpipe connected to culvert under trail. Eradicate Himalayan blackberry and revegetate the floodplain with native trees. • This reach offers one of the only locations for a floodplain riparian restoration with a detention and sediment basin. This site is part of the overall watershed improvements to reduce velocity and volume of stormwater and improve Palo Seco 	<p>City of Oakland</p> <p>FOSC, Friends of Joaquin Miller Park</p>	<p>San Francisco Bay Regional Water Quality Control Board</p> <p>Community groups</p>	<p>Palo Seco Creek has the greatest potential for major improvement in aquatic habitat conditions through a combined program of watershed stormwater improvements, creek restoration, and invasive plant eradication. This focus would create a sustainable habitat area to provide refuge for resident rainbow trout.</p>

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Recommendations	Lead Entity	Supporting Entities	Comments
Creek aquatic habitat.			
<p>Creek Reach PSC2</p> <ul style="list-style-type: none"> The creek is culverted through a meadow likely created during the WPA era when recreational areas were created at the expense of environmental protection. This reach is a major candidate for daylighting and restoration, especially as the culverts are old and will require replacement in the near future. Install berm at downstream end to detain stormwater during peak runoff events. The downstream portion of Fern Ravine Creek now runs overland during nearly every rainfall event as the culvert outlet clogs. The creek should be daylighted and directed into the proposed stormwater detention area and eventually integrated with a daylighted and restored Palo Seco Creek. 	<p>City of Oakland</p> <p>FOSC, Friends of Joaquin Miller Park</p>	<p>San Francisco Bay Regional Water Quality Control Board</p> <p>Urban Creeks Council and other community groups</p>	<p>Daylighting Palo Seco and Fern Ravine Creeks would be one of the largest habitat improvements in the watershed; however, it would require a major re-design of recreational uses of a part of Joaquin Miller Park</p>
<p>Creek Reach PSC3</p> <ul style="list-style-type: none"> Improved grade control structures need to be installed at the two knickpoints (Erosion Sites 3 and 4) to avoid the migration of the knickpoints upstream and the undercutting of large trees. 	<p>City of Oakland</p> <p>FOSC, Friends of Joaquin Miller Park</p>	<p>San Francisco Bay Regional Water Quality Control Board</p> <p>Community groups</p>	

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Recommendations	Lead Entity	Supporting Entities	Comments
<p>Downstream of the bridge a number of trees along the banks have been eroded. The banks should be set back and revegetated once the Himalayan blackberry is removed.</p>			
<p>Creek Reach PSC4</p> <ul style="list-style-type: none"> Invasive non-native plants are degrading the redwood/California bay laurel forest riparian habitat and weakening the trees. Holly trees are the only species regenerating in the corridor. The holly and ivy need to be eradicated to restore the health of the forest. Ivy should be cut around the base of each tree, and the stumps immediately painted with herbicide to kill the ivy quickly and effectively. If the trees along the steep-sided gorge become weakened by the parasitic ivy and fall, the slopes may fail due to the ground disturbance. The holly needs to be cut and the stumps painted with herbicide to quickly remove this invader before it becomes established and dominates the corridor. 	<p>City of Oakland</p> <p>FOSC, Friends of Joaquin Miller Park</p>	<p>San Francisco Bay Regional Water Quality Control Board</p> <p>Community groups</p>	
<i>Moderate Priority</i>			
<p>Creek ReachPSC5</p> <ul style="list-style-type: none"> FOSC has completed an erosion control project and an invasive plant removal/native plant revegetation 	<p>City of Oakland</p> <p>FOSC</p>	<p>San Francisco Bay Regional Water Quality Control Board</p> <p>Other community groups</p>	<p>These projects have a much lower ability to provide sustainable, high quality aquatic and riparian habitats unless Scenario 3 watershed</p>

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Recommendations	Lead Entity	Supporting Entities	Comments
<p>project here. Continued maintenance will be needed.</p> <ul style="list-style-type: none"> • Replace bridge at stream level or re-route trail. 			<p>stormwater improvements are implemented.</p>
<p>Creek Reach CC2</p> <ul style="list-style-type: none"> • The Beaconsfield Canyon reach needs to have the rusted culvert removed and a geomorphic /revegetation restoration plan that includes a riparian floodplain area completed. • Downstream drop inlet to storm drain needs to be repaired/ replaced. 	<p>City of Oakland FOSC</p>	<p>San Francisco Bay Regional Water Quality Control Board Other community groups</p>	<p>These projects have a much lower ability to provide sustainable, high quality aquatic and riparian habitats unless Scenario 3 watershed stormwater improvements are implemented.</p>
<p>Creek Reach SC3</p> <ul style="list-style-type: none"> • Replanting of white alder and removal of waste cement and asphalt is needed along this reach. Riparian shade cover over the El Centro pool is also needed to maintain cool water temperatures. • Recreation uses preclude the option of daylighting the creek through Dimond Canyon Park. • Future City of Oakland project to stabilize private property and revegetate stream banks. 	<p>City of Oakland FOSC</p>	<p>San Francisco Bay Regional Water Quality Control Board Other community groups</p>	<p>These projects have a much lower ability to provide sustainable, high quality aquatic and riparian habitats unless Scenario 3 watershed stormwater improvements are implemented.</p>
<i>Low Priority</i>			
<p>Creek Reach CC1</p> <ul style="list-style-type: none"> • Houses line the upstream portion of this reach, leaving few opportunities for restoration. The sediment/ stormwater detention basin on this 	<p>City of Oakland FOSC</p>	<p>San Francisco Bay Regional Water Quality Control Board Other community groups</p>	<p>These projects have a much lower ability to provide sustainable, high quality aquatic and riparian habitats unless Scenario 3 watershed stormwater improvements are</p>

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Recommendations	Lead Entity	Supporting Entities	Comments
<p>reach needs to be cleaned out and retrofitted in order to function better. A large gully in this sub-basin requires repair.</p>			<p>implemented.</p>
<p>Creek Reach SC1</p> <ul style="list-style-type: none"> • This reach presents a real challenge for restoration. There are two major culverts and numerous concrete structures including a cement wall protecting the sanitary sewer pipe. • California bay laurel trees have eroded off the canyon wall and into the creek. Replanting these trees will maintain shade cover for the creek. • Eradicate ivy and other invasives to retain health of native trees. • Work with the City of Oakland to repair erosion from storm drains, especially the major erosion sites along Park Blvd. • Sanitary sewer overflows into Sausal Creek occur during major storms and need to be alleviated to avoid both contamination of the creek and a public health problem. 	<p>City of Oakland FOSC</p>	<p>San Francisco Bay Regional Water Quality Control Board Other community groups</p>	<p>These projects have a much lower ability to provide sustainable, high quality aquatic and riparian habitats unless Scenario 3 watershed stormwater improvements are implemented.</p>
<p>Creek Reach SC2</p> <ul style="list-style-type: none"> • This reach is a restoration project completed in 2001. Control of invasive plants and revegetation are necessary both along the channel and alongside channels. The channel does 	<p>City of Oakland FOSC</p>	<p>San Francisco Bay Regional Water Quality Control Board Other community groups</p>	<p>These projects have a much lower ability to provide sustainable, high quality aquatic and riparian habitats unless Scenario 3 watershed stormwater improvements are implemented.</p>

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Recommendations	Lead Entity	Supporting Entities	Comments
<p>not provide adequate room for regeneration of riparian species, and replanting will be required. Installing white alder along the channel could diversify the vegetation and provide some stability to the undercut bank areas, which provide refuge to wildlife in floods.</p>			
<p>Creek Reach SC4</p> <ul style="list-style-type: none"> • Creek is entrenched with steep banks and fill from the McKillop slide. With this slide affecting the creek it is difficult to implement revegetation. Houses are very close to the channel, further restricting restoration options. Community-based invasive plant removal and native plant installations would provide local educational opportunities. 	<p>City of Oakland</p> <p>FOSC</p>	<p>San Francisco Bay Regional Water Quality Control Board</p> <p>Other community groups</p>	<p>These projects have a much lower ability to provide sustainable, high quality aquatic and riparian habitats unless Scenario 3 watershed stormwater improvements are implemented.</p>
<p>Creek Reach SC5</p> <p>Creek is entrenched with steep banks and numerous houses. Channel is hardpan clay and revegetation will be difficult in most locations. Community-based invasive plant removal and native plant installations would provide local educational opportunities.</p>	<p>City of Oakland</p> <p>FOSC</p>	<p>San Francisco Bay Regional Water Quality Control Board</p> <p>Other community groups</p>	<p>These projects have a much lower ability to provide sustainable, high quality aquatic and riparian habitats unless Scenario 3 watershed stormwater improvements are implemented.</p>