APPENDIX A

CALIFORNIA REGIONAL WATER CONTROL BOARD
SAN FRANCISCO BAY REGION
ORDER NO.: R2-2013-0025
ORDER NO.: R2-2013-0021

CALIFORNIA REGIONAL WATER QUALITY CONTROL BOARD
SAN FRANCISCO BAY REGION

ORDER NO. R2-2013-0025

TIME SCHEDULE ORDER PRESCRIBING ADMINISTRATIVE CIVIL LIABILITY for:

ALCOA CONSTRUCTION SYSTEMS, INC., ALCOA PROPERTIES, INC., AP CONSTRUCTION SYSTEMS, INC., CHALLENGE DEVELOPMENTS, INC., DR. COLLIN MBANUGO, F.M. SMITH AND EVELYN ELLIS SMITH, LEONA CHEMICAL COMPANY, OCEAN INDUSTRIES, INC., REALTY SYNDICATE, RIDGEMONT DEVELOPMENT, INC., WATT HOUSING CORPORATION, WATT INDUSTRIES OAKLAND, WATT RESIDENTIAL, INC.

for the property located at

END OF MCDONELL AVENUE
OAKLAND, ALAMEDA COUNTY

The California Regional Water Quality Control Board, San Francisco Bay Region (hereinafter Water Board), finds that:

1. **Purpose of the Order:** This Order prescribes civil liability for non-compliance with the tasks and schedule contained in Cleanup and Abatement Order (CAO) No. 98-004, as amended by Order Nos. R2-2003-0028 and R2-2013-0021. The Water Board adopted these orders pursuant to section 13304 of the Water Code. Order No. R2-2013-0021 established a schedule for the submittal and implementation of plans to address existing and potential water quality impacts at the Leona Heights Sulfur Mine for protection of water quality and human and environmental health. Although the above named dischargers (collectively, the "Dischargers") have worked cooperatively with Water Board staff to complete a portion of tasks required by CAO No. 98-004 (as amended in 2003), they have not initiated cleanup. The Dischargers will be subject to civil liability prescribed in this Order should they fail to complete any task of Order No. R2-2013-0021, as listed below.

2. **Site Location and Description:** As described in CAO No. 98-004, the Leona Heights Sulfur Mine is an inactive pyrite mine located in the Oakland Hills at the end of McDonell Avenue south of the Montclair District (Figure 1). The mine is located in the upper reach of the Leona Creek watershed, and sulfur-bearing mining waste (also referred to as tailings) fills the stream channel. Water flowing over and through these tailings dissolves sulfur, producing acid mine drainage in Leona Creek. In the dry season, the main source of water to the creek is groundwater that daylights on the property. During rain events, runoff from the watershed above the site forms an ephemeral stream that combines with the daylighted groundwater significantly increasing flows, and therefore increasing acid mine drainage in the creek (Figure 2). The creek has the characteristic orange color associated with acid mine drainage, which also dissolves metals (including cadmium, copper, mercury, nickel, lead, and zinc) and metalloids (arsenic) from surrounding soil and bedrock. Runoff from the site impairs water quality in Leona Creek until it flows into Aliso Lake (also known as Mills College Lake), located approximately 1400 feet downstream of the mine property boundary. No remedial work has been performed at this site, and thus water quality has not changed significantly since CAO No. 98-004 was issued.

3. **Parties Responsible for Discharge:** The site is currently owned by Dr. Collin Mbanugo, who is named as a Discharger in this and the R2-2013-0021 Order. As described in Order No. 98-004, the remaining Dischargers "caused or permitted the discharge of waste that has entered Waters of the State and created a condition of pollution or nuisance. The Dischargers have permitted the discharge of acidic water that contains concentrations of dissolved metals above Water Quality Objectives. All of the Dischargers knew of the discharge and have [or had] the ability to control it."

4. **Regulatory History:** Prior Water Board Orders include:

   a. In 1992, the Water Board adopted Order No. 92-105, prescribing Waste Discharge Requirements for the site. Corrective measures to address the mining waste and resultant pollution were required, however none were submitted, and no corrective measures were taken.

   b. In 1998, the Water Board adopted CAO No. 98-004 for the investigation and cleanup of the site. No tasks were completed.

   c. In 2003, the Water Board amended CAO No. 98-004 (CAO Amendment No. R2-2003-0028) to add the current property owner as a Discharger and amend task due dates. The Dischargers submitted a Corrective Action Plan and Implementation Schedule in partial completion of Task 2, however permits for construction of the remedy were not obtained, and cleanup has not been initiated.

   d. In May of 2013, the Water Board amended CAO No. 98-004 (CAO Amendment No. R2-2013-0021) to add Ocean Industries, Inc., as a Discharger, clarify tasks required to comply, and amend due dates.

5. **History of Non-Compliance:** The Dischargers missed deadlines for the following tasks required of CAO Amendment No. R2-2003-0028:

98-004 Task No.	R2-2003-0028 Action	Description	Due Date (per R2-2003-0028)	Status
B.1	Deleted by 2.a			
B.2	Replaced by 2.b	i. Technical Report Submittal, Corrective Action Plan and Implementation Schedule	May 30, 2003	Submitted April 11, 2006
		ii. Implentation of Corrective Action Plan and Implementation Schedule	Immediately Upon Approval (July 5, 2006)	Not Completed
B.3	Replaced by 2.c	i. Post Construction Monitoring	Upon Completion of Construction	Not Completed
		ii. Post Construction Reporting of Monitoring	Semi-Annually on October 31st and April 30th	Not Completed
B.4	Deleted by 2.d			
B.5		Proper Disposal and Prevention of Erosion of Wastes Onsite	N/A	Not Completed
B.6		Submit Monthly Progress Reports During Implementaion of Corrective Action Activities	N/A	Partially Completed

6. **Justification for this Order:**

   a. The Water Board finds there is an ongoing violation of CAO No. 98-004, as amended by Order No. R2-2003-0028, and a threatened violation of Order No. R2-2013-0021, based upon the Dischargers' history of delayed compliance with Order Nos. 98-004 and R2-2003-0028.

   b. Pursuant to section 13308(a) of the Water Code: "If the Board determines there is a threatened or continuing violation of any Cleanup and Abatement Order, Cease and Desist Order, or any Order issued under section 13267 or 13383, the Board may issue an Order establishing a time schedule and prescribing a civil penalty which shall become due if compliance is not achieved with that schedule."

   c. In view of the ongoing violation of Order Nos. 98-004 and R2-2003-0028 and threatened violation of Order No. R2-2013-0021, issuance of a Time Schedule Order under section 13308(a) of the California Water Code, which establishes tasks, a compliance time schedule, and maximum civil liabilities to be assessed in the event of violation, including delayed compliance, is an appropriate action to ensure timely compliance with CAO No. 98-004 (as amended).

   d. According to section 13308(b) of the Water Code: "The amount of the civil penalty [in a section 13308 Order] shall be based upon the amount reasonably necessary to achieve compliance, and may not include any amount intended to punish or redress previous violations. The amount of penalty may not exceed ten thousand dollars ($10,000) for each day in which the violation occurs."

   e. If the Water Board prosecution staff determines the Dischargers have failed to comply with the time schedule of this Order, it may issue a complaint pursuant to Water Code section 13323(a) alleging the violation(s) of the time schedule and setting forth the amount of civil liability due under this Order. The Dischargers may either pay the civil liability or request a hearing before the Water Board. If the Water Board decides to impose the liability, it may impose a liability that is less than the amount prescribed in this Order if it makes express findings setting forth the reasons for its action based on the specific factors to be considered for administrative civil liabilities in Water Code section 13327 which states:

      > *In determining the amount of civil liability, the regional board, and the state board upon review of any order pursuant to Section 13320, shall take into consideration the nature, circumstance, extent, and gravity of the violation or violations, whether the discharge is susceptible to cleanup or abatement, the degree of toxicity of the discharge, and, with respect to the violator, the ability to pay, the effect on ability to continue in business, any voluntary cleanup efforts undertaken, any prior history of violations, the degree of culpability, economic benefit or savings, if any, resulting from the violation, and other matters as justice may require.*

   f. Given the lengthy history of non-compliance and the nature and duration of the ongoing discharge, the maximum penalty is warranted and reasonably necessary to achieve compliance and is not intended to punish or redress previous violations.

7. **CEQA:** Adoption of this Order will not have any direct or reasonably foreseeable indirect physical change on the environment since it merely prescribes liabilities that will become due if there is non-compliance with Order No. 98-004, as amended by Order Nos. R2-2003-0028 and R2-2013-0021. As such, this Order is not subject to the California Environmental Quality Act ("CEQA"). (See Cal. Code Regs., tit. 14, § 15060(c)(2). Adoption of the Order falls within the general rule that CEQA only applies to activities that have the potential for causing a significant effect on the environment. Where it can be seen with certainty, as in the case of this Order, that there is no possibility that the activity in question may have a significant effect on the environment, the activity is not subject to CEQA. (Cal. Code Regs., tit. 14, § 15061(b)(3).)

8. **Notification:** The Water Board has notified the Dischargers and interested agencies and persons of its intent under Water Code section 13308 to adopt a Time Schedule Order for the discharge and has provided them with the opportunity for a public hearing and an opportunity to submit their written comments.

9. **Public Hearing:** The Water Board, at a public meeting, heard and considered all comments pertaining to this discharge.

IT IS HEREBY ORDERED, pursuant to section 13308 of the California Water Code (CWC) that the Dischargers, their assigned agents, successors and assigns, must complete the tasks described in accordance with the task schedule specified in Table 1 of this Order. In the event of non-compliance with a task or task schedule, the respective penalty (or penalties) prescribed by the Order shall become due. Each discharger who fails to achieve compliance in accordance with the schedule established in this Order shall be liable civilly in an amount not to exceed the amount prescribed by the Order. The penalty shall accrue on each day after the due date until the task is completed.

A. TASKS

Each of the following numbered tasks refers to the tasks outlined in Order No. R2-2013-0021.

2.I.a Remedial Design Plan:

COMPLIANCE DATE: October 15, 2013
PENALTY: $10,000 each day the report is late

2.I.b Creek Restoration Design Plan:

COMPLIANCE DATE: October 15, 2013
PENALTY: $10,000 each day the report is late

2.II Application for Permits:

COMPLIANCE DATE: November 15, 2013
PENALTY: $10,000 each day the report is late

2.III Implement Mine Remediation and Creek Restoration Designs:

COMPLIANCE DATE: September 15, 2014
PENALTY: $10,000 each day the remediation and creek restoration is incomplete after compliance date

2.IV Recordation of Deed Restriction:

COMPLIANCE DATE: 180 days after completion of construction
PENALTY: $10,000 each day the report is late

3. Monitoring and Maintenance Plans:

COMPLIANCE DATE: October 30, 2014
PENALTY: $10,000 each day the report is late

I, Bruce H. Wolfe, do hereby certify that the foregoing is a full, true, and correct copy of an order adopted by the California Regional Water Quality Control Board, San Francisco Bay Region, on July 10, 2013.

Digitally signed by Bruce H. Wolfe
Date: 2013.07.10 15:10:52 -07'00'

Bruce H. Wolfe
Executive Officer

Attachments:

- Figure 1. Site Location
- Figure 2. Leona Creek
- Figure 3. Leona Creek, discoloration from acidophilic bacteria and iron oxide

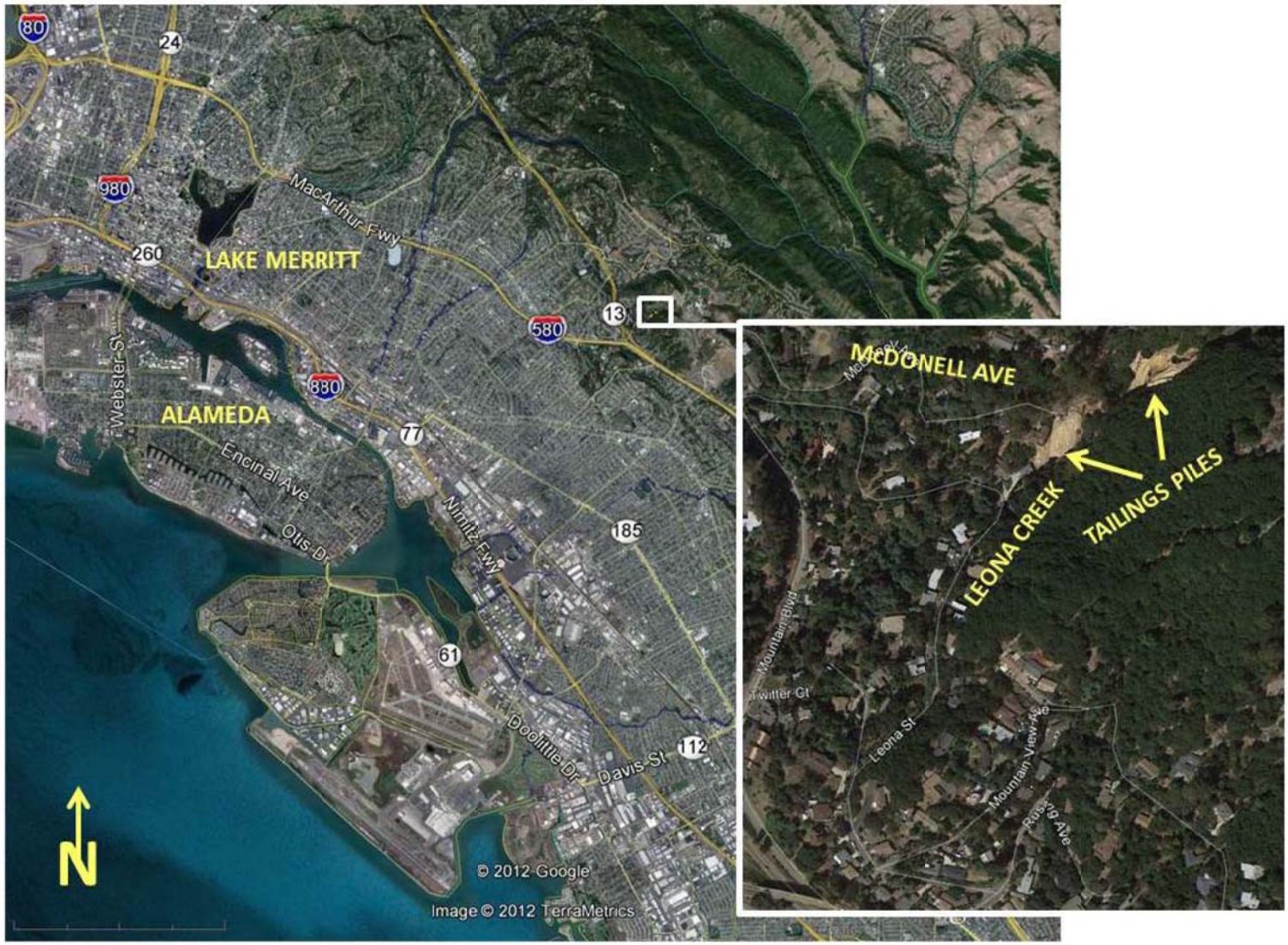

Figure 1. Site location

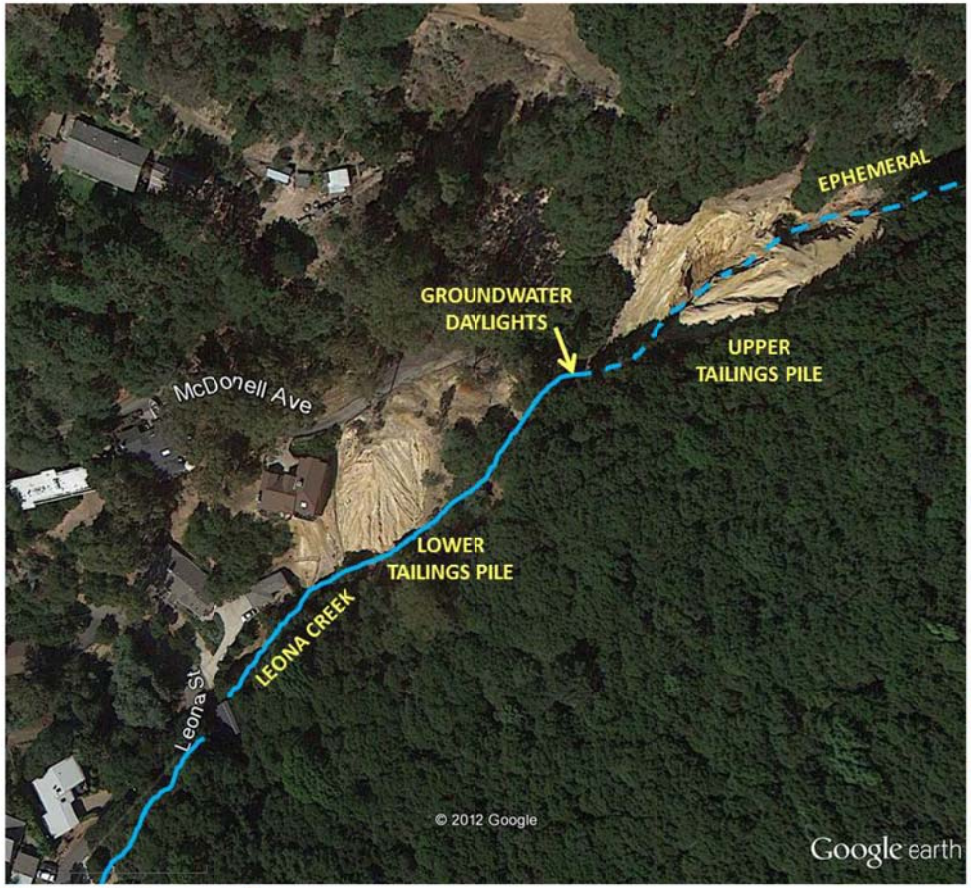

Figure 2. Leona Creek

Figure 3. Leona Creek, discoloration from acidophilic bacteria and iron oxide

CALIFORNIA REGIONAL WATER QUALITY CONTROL BOARD
SAN FRANCISCO BAY REGION

ORDER NO. R2-2013-0021

AMENDMENT OF CLEANUP AND ABATEMENT ORDER NOS. 98-004 AND R2-2003-0028 AND RECISSION OF WASTE DISCHARGE REQUIRMENTS (ORDER NO. 92-105) for:

ALCOA CONSTRUCTION SYSTEMS, INC., ALCOA PROPERTIES, INC., AP CONSTRUCTION SYSTEMS, INC., CHALLENGE DEVELOPMENTS, INC., DR. COLLIN MBANUGO, F.M. SMITH AND EVELYN ELLIS SMITH, LEONA CHEMICAL COMPANY, OCEAN INDUSTRIES, INC., REALTY SYNDICATE, RIDGEMONT DEVELOPMENT, INC., WATT HOUSING CORPORATION, WATT INDUSTRIES OAKLAND, WATT RESIDENTIAL, INC.

for the property located at:

END OF MCDONELL AVENUE
OAKLAND, ALAMEDA COUNTY

The California Regional Water Quality Control Board, San Francisco Bay Region (hereinafter Water Board), finds that:

1. **Prior Water Board Orders:** The Leona Heights Sulfur Mine is an inactive pyrite mine in the Oakland Hills (Figure 1). The Water Board adopted a Cleanup and Abatement Order on January 30, 1998 (CAO Order No. 98-004) requiring remediation of the site, which contains exposed mine waste (also referred to as tailings) that degrade the water quality and impact beneficial uses of Leona Creek (Figures 2 and 3). That order was amended with Order R2-2003-0028 on April 14, 2003 to add a discharger, the current property owner, Dr. Collin Mbanugo, and to modify the compliance schedule. This Order further amends Order Nos. 98-004 and R2-2003-0028 for the reasons listed in Finding 2. This Amendment does not rescind Order No. 98-004 or Order No. R2-2003-0028.

   The Water Board adopted Waste Discharge Requirements (WDRs) in 1992 (Order No. 92-105). Alcoa, Alcoa Construction Systems, Inc. (ACS) and Challenge Developments, Inc. (CDI) filed petitions to the State Water Resources Control Board (State Board) for review. The State Board found insufficient evidence to hold Alcoa liable as the alter ego of CDI or ACS. The State Board upheld the Water Board's inclusion of CDI and ACS as dischargers and found that both should be considered primarily liable. This Amendment rescinds Order No. 92-105. The water quality requirements of the CAO Order No. 98-004 and its amendments, including this Amendment, will supersede the requirements of Order No. 92-105.

2. **Reasons for Amendment:** This Amendment will accomplish the following objectives:

   a) <u>Modify Compliance Dates</u>: This Amendment establishes new compliance dates for corrective actions that were required in Order Nos. 92-105, 98-004, and R2-2003-0028, but which have not been implemented or completed.

b) Clarify Cleanup Requirements: This Amendment clarifies the tasks that are necessary for the Dischargers to successfully implement an approved Corrective Action Plan (CAP). Specifically, before the CAP can be implemented, the Dischargers must submit complete permit applications to regulatory agencies with jurisdiction over various aspects of the project. Because these permits must be obtained in order to implement the CAP, we consider the submittal of complete and acceptable permit application packages to be part of the scope of tasks required by this Amendment and previous Orders. The Dischargers must obtain all permits required to comply with this Amendment.

c) Incorporate Requirements for Creek Restoration: Restoration of the Leona Creek streambed is a necessary element of the mine remediation project. Given the site's steep topography, the long-term stability of corrective actions in and adjacent to the streambed are critical to maintaining the beneficial effects on water quality from the corrective actions. Therefore, this Amendment clarifies the requirements related to creek restoration that are necessary to comply with Order Nos. 98-004 and R2-2003-0028.

d) Name Additional Discharger: Ocean Industries, Inc. is a successor in interest to Watt Industries, a Discharger named in Order 98-004. Ocean Industries, Inc. has participated in the formulation of the remedial action plan that this Amendment requires the Dischargers to execute. Ocean Industries, Inc. is therefore named a Discharger in this Amendment.

e) Rescission of Waste Discharge Requirements: All water quality requirements will be administered via the CAO as amended. WDR Order No. 92-105 is therefore no longer necessary and will be rescinded.

3. **Applicability and Extension of Existing Orders:** Several orders have already been issued by the Water Board to parties legally responsible for environmental remediation at the site. These orders require those responsible parties to perform cleanup actions and to submit technical and monitoring reports. These orders include CAO 98-004 and R2-2003-0028. The obligations contained in this Amendment supersede and replace those contained in prior orders. However, the prior orders remain in effect for enforcement purposes; the Water Board and/or State Board may take enforcement actions (including, but not limited to, issuing administrative civil liability complaints) against responsible parties that have not complied with directives contained in previously issued orders.

4. **CEQA**: This action is an amendment of an order to enforce the laws and regulations administered by the Water Board. As such, this action is categorically exempt from the provisions of the California Environmental Quality Act (CEQA). (Cal. Code Regs., tit. 14, § 15321.) In addition, this CAO contemplates restoration and rehabilitation of an existing facility, activities exempt from CEQA. (*Id.* at § 15301.) The CAO is an action taken by a regulatory agency as authorized by state law to assure the maintenance, restoration, and enhancement of a natural resource and the environment. (*Id.* at §§ 15307 and 15308.) There are no exceptions to these categorical exemptions; there is no reasonable possibility that this

action will have a significant effect on the environment due to unusual circumstances. (Cal. Code Regs., tit. 14, § 15300.2.).

5. **Notification**: The Water Board has notified the Dischargers and all interested agencies and persons of its intent under California Water Code Section 13304 to amend site cleanup requirements for the discharge, and has provided them with an opportunity to submit their written comments.

6. **Public Hearing**: The Water Board, at a public meeting, heard and considered all comments pertaining to this discharge.

IT IS HEREBY ORDERED that Order No. 92-105 is rescinded. It is further ordered, pursuant to Section 13304 of the California Water Code, that Order Nos. 98-004 and R2-2003-0028 shall be amended as follows:

On page 4 of 98-004, to Finding 8.B, add:

8. Ocean Industries, Inc.

On October 7, 1980, Caballo Hills Development Company (the former name of Ridgemont Development Company) acquired the mine site. Caballo Hills Development Company was formed pursuant to a Partnership Agreement involving Watt Industries, Inc., as a 50% general partner. Caballo Hills Development Company changed its name to Ridgemont Development Company on January 20, 1981. Watt Industries Inc., changed its name to Ocean Industries in 1993. Therefore, Ocean Industries, Inc. is added to the list of Dischargers named in this Amendment.

Effective March 2, 1992, Watt Residential, Inc. assigned its entire partnership interest in Ridgemont Development Company to Watt Industries/Oakland, Inc., the sole remaining party in connection with the dissolution of Ridgemont Development Company. By operation of law, as the sole remaining partner, Watt Industries/Oakland, Inc. (now known as Ridgemont Development, Inc.) succeeded to the ownership of the assets of Ridgemont Development Company, including the real property on which the mine is located. Ridgemont Development, Inc. sold the property at issue to Dr. Mbanugo in 2001.

On page 5 of Order No. 98-004 replace B.2 under Remedial Measures; and on page 2 of R2-2003-0028 replace 2.b. under Amended or Deleted Remedial Measures with:

2.

I. **Mine Remediation and Creek Restoration Designs:** The Dischargers shall submit 100% designs for remediation (i.e., isolation and stabilization) of the mine tailings, and 90% designs for the restoration of Leona Creek that are acceptable to the Executive Officer.

a. **Remedial Design Plan:** Submit a 100% design plan for the portions of the project involving stabilization of the mine tailings piles. The proposed plan shall provide for the prevention of further erosion of the mine tailings, and shall encapsulate the mine

tailings in a manner as to best isolate the mining waste from stormwater runoff and contact with groundwater. Previously approved plans may be revised and resubmitted, provided that:

i. The design plans incorporate all requirements of all regulatory permits that are required for project implementation; and
ii. The design plans address requirements listed in the Water Board's July 5, 2006 *Conditional Approval of the Revised Summary Design Report and Construction Documents* (Appendix A).

COMPLIANCE DATE: October 15, 2013

b. **Creek Restoration Design Plan: S**ubmit a 90% design plan for creek restoration that provides details and specifications for field implementation of creek restoration actions. This design plan must also be included in any application for a Section 401 Water Quality Certification. It is understood that certain details of the creek restoration must be designed on-site during construction to address unknowns with respect to bedrock geology.

COMPLIANCE DATE: October 15, 2013

II. **Applications for Permits:** The Dischargers must submit complete and acceptable applications, including all supporting documents and any associated fees, as required for all permits and agency agreements needed to implement the mine remediation and creek restoration projects. These include, *but may not be limited to*:

a. A Creek Protection Permit from the City of Oakland;
b. Encroachment, Grading, and/or Building Permits from the City of Oakland;
c. A Tree Removal/Protection Plan to the City of Oakland;
d. A technical memo in support of a CEQA determination to City of Oakland (the lead agency) and other responsible agencies, including the biological justification;
e. A Section 404 Permit from the US Army Corps of Engineers;
f. Biological information and technical documents to the US Army Corp of Engineers, to support consultation with US Fish and Wildlife Service regarding the Endangered Species Act;
g. A Section 401 Water Quality Certification from the Water Board; and
h. A Lake and Streambed Alteration Agreement from the California Department of Fish and Wildlife (formerly Fish and Game), and if appropriate, an Incidental Take Permit.

If an agency requests additional information or documentation, the Dischargers must fully respond to the request within the time allotted by the agency and inform the Water Board of any such time frames.

COMPLIANCE DATE: November 15, 2013

III. **Implementation of Mine Remediation and Creek Restoration Designs:** Upon receiving permits and authorization from the appropriate agencies, the Dischargers must implement the designs from Remedial Measure B.1 of the CAO. Remediation construction activities must occur and be completed during the 2014 dry season. A professional engineer familiar with the approved creek restoration design must be on site to direct construction.

COMPLIANCE DATE: September 30, 2014

IV. **Recordation of Deed Restriction:** The current landowner must submit a report, acceptable to the Executive Officer, documenting that the deed restriction has been duly signed by all parties and has been recorded with the appropriate county recorder. The report shall include a copy of the recorded deed restriction.

COMPLIANCE DATE: 180 Days after completion of construction

On Page 5 of Order No. 98-004 Replace B.3 under Remedial Measures; and on page 2 of R2-2003-0028 replace 2.c. under Amended or Deleted Remedial Measures with:

3. **Monitoring and Maintenance Plans:** The Dischargers must submit plans, acceptable to the Executive Officer, detailing how the site will be monitored and maintained to ensure water quality improves and the remedial and creek restoration infrastructure is stable. In addition to a water quality monitoring plan, the Dischargers must submit a plan for the Project Designer to examine the site after significant rain events, as it is expected that rocks within and adjacent to the streambed might move in response to high flows, and rocks may need to be repositioned to maintain stability. The plans must include:

   a. A proposed list of monitoring parameters and a plan for monitoring them in the creek;
   b. Periodic inspections of the capped mine tailings piles;
   c. Monitoring of the geomorphic integrity of the restored channel, including bed and banks;
   d. Monitoring the successful establishment of the banks adjacent to the restored creek channel; and
   e. Monitoring of the stability of the capped mine tailings, and hillsides above the banks of the restored channel.

   COMPLIANCE DATE: October 30, 2014

I, Bruce H. Wolfe, Executive Officer, do hereby certify that the foregoing is a full, true, and correct copy of an Order adopted by the California Regional Water Quality Control Board, San Francisco Bay Region, on May 8, 2013.

_____
Bruce H. Wolfe
Executive Officer

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FAILURE TO COMPLY WITH THE REQUIREMENTS OF THIS ORDER MAY SUBJECT YOU TO ENFORCEMENT ACTION, INCLUDING BUT NOT LIMITED TO: IMPOSITION OF ADMINISTRATIVE CIVIL LIABILITY UNDER WATER CODE SECTIONS 13268 OR 13350, OR REFERRAL TO THE ATTORNEY GENERAL FOR INJUNCTIVE RELIEF OR CIVIL OR CRIMINAL LIABILITY

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Attachments:

- Figure 1. Site Location
- Figure 2. Leona Creek, headwaters on mine property
- Figure 3. Leona Creek, discoloration from acidophilic bacteria
- Water Board Letter, *Conditional Approval of the Revised Summary Design Report and Construction Documents* (July 5, 2006)

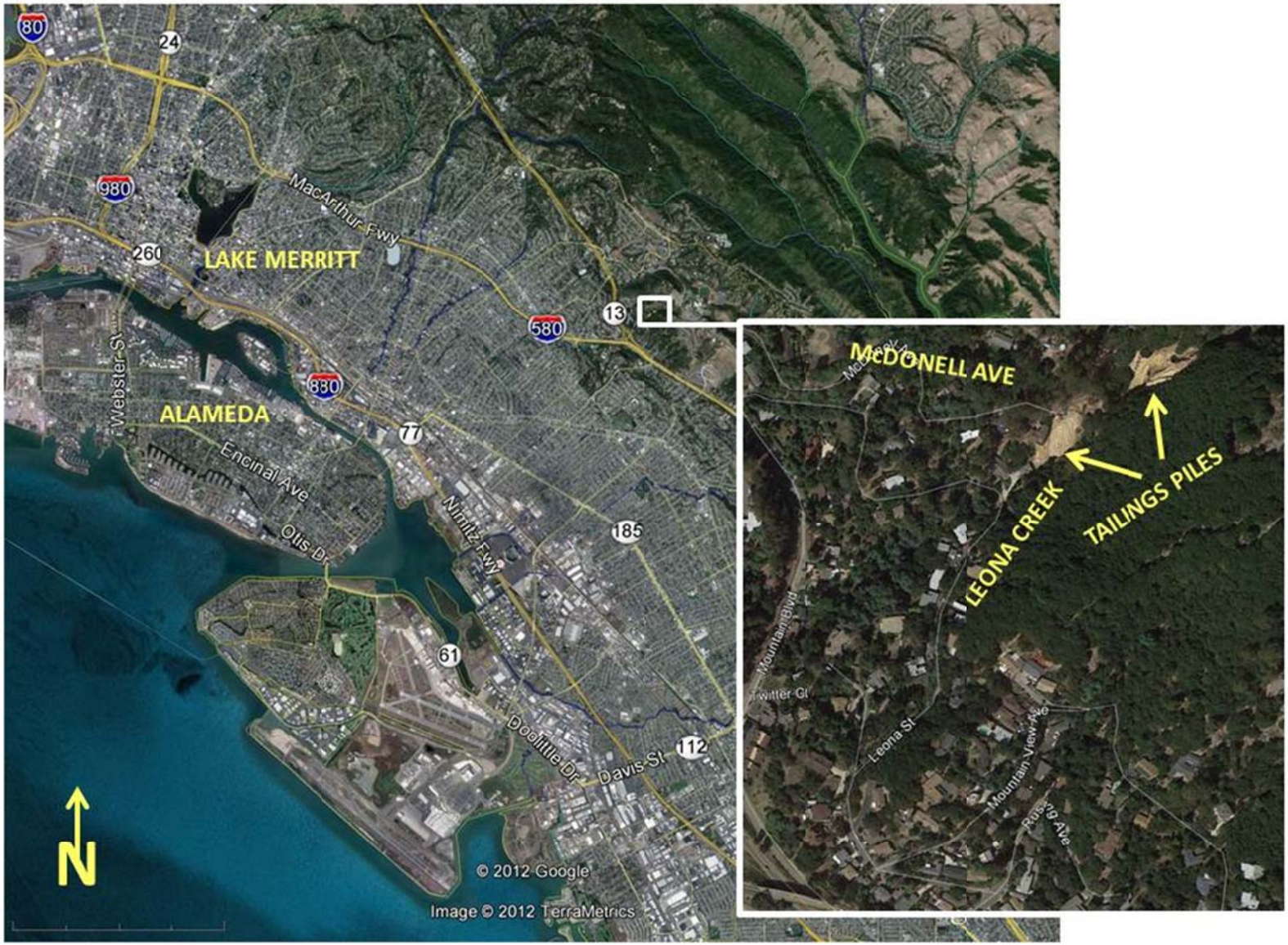

Figure 1. Site location

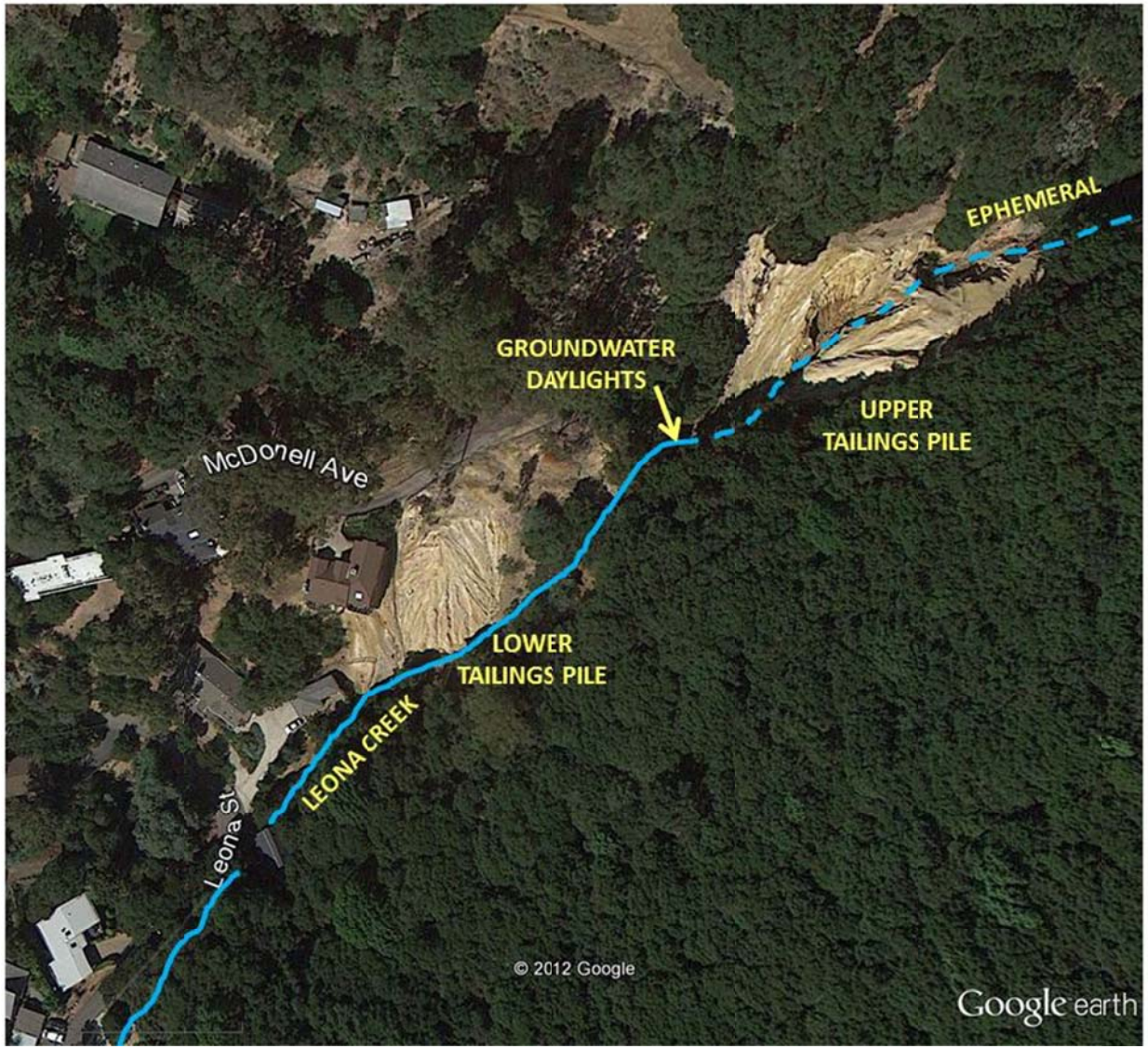

Figure 2. Leona Creek, headwaters on mine property

Figure 3. Leona Creek, discoloration from acidophilic bacteria

APPENDIX B

REVEGETATION PLAN FOR THE LEONA HEIGHTS SULFUR MINE REMEDIATION AND CREEK RESTORATION PROJECT

REVEGETATION PLAN

FOR THE

LEONA HEIGHTS SULFUR MINE REMEDIATION AND CREEK RESTORATION PROJECT

ALAMEDA COUNTY, CALIFORNIA

Prepared for:

DR. COLLIN MBANUGO
3300 Webster Street, Suite 900
Oakland, California 94609

Prepared by:

OLBERDING ENVIRONMENTAL, INC.
3170 Crow Canyon Place, Suite 260
San Ramon, California 94583

Phone: (925) 866-2111 ~ Fax: (925) 866-2126
E-mail: jeff@olberdingenv.com
Contact: Jeff Olberding

MARCH 2014

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Figure 2 Topographic Map
Figure 3 Aerial Map
Figure 4 Construction Access Map
Figure 5 Revegetation Plan

This report should be cited as: Olberding Environmental, Inc. March 2014. *Revegetation Plan for the Leona Heights Sulfur Mine Remediation and Creek Restoration Project, City of Oakland, Alameda County, California*. Prepared for Dr. Collin Mbanugo, Oakland, CA.

1.0 Project Overview

Olberding Environmental, Inc. has prepared this Revegetation Plan (Plan) as part of the work planned to improve environmental quality at the Leona Heights Sulfur Mine site (Site) in Oakland, California.

The Leona Heights Sulfur Mine is a long-abandoned pyrite mine located in the Oakland Hills. The mine was operated from about 1900 through the 1920s to extract pyrite (iron sulfide) crystals from the volcanic bedrock for production of sulfuric acid. Two mine tailings piles, placed in the ravine at the Site during mining operations, remain today. Leona Creek flows through the center of the upper tailings pile and adjacent to the lower tailings pile, with resulting water quality impacts.

The purpose of this Plan is to provide specific recommendations for establishing vegetation on the Site that will be naturally appropriate, feasible, and serve to augment and not undermine the specific water quality goals of the project. Constraints to revegetation are numerous and necessarily eliminate many planting and seeding options that may be feasible in other situations. Two major design parameters of the remediation project pose the most constraints to the revegetation program. First, the planting substrate will be composed of a 12-inch-thick layer of topsoil underlain by an impermeable layer (geomembrane). Thus, no stout tap-rooted plants can be included in the revegetation plan due to the shallow layer of topsoil. This constraint rules out woody plants of any kind and logically leads to revegetation with a mix of native grasses, wildflowers, and herbaceous plants. All planted material will need to be of a xeric nature taking into account the limited soil moisture available with a 12-inch-thick layer of topsoil. In recognition of the absence of a water source for irrigation, restoration efforts will rely on hydroseeding. Hydroseeding immediately prior to the fall rainy season would allow for the germination of ground cover and herbaceous plant establishment during the appropriate growing season while reducing potential for soil erosion.

The second constraint involves keeping non-native invasive vegetation from taking over the Site. A plethora of highly invasive non-native vegetation, such as scotch broom (*Cytisis scoparius*), pampas grass (*Cortideria selloana*), fennel (*Foeniculum vulgare*), and silver wattle acacia (*Acacia dealbata*) can be found in close proximity to the Site. Woody species that can become established quickly and produce a dense canopy can often shade out pest species and would be the best choice to keep these plants at bay with minimal maintenance. Since woody species are excluded due to the topsoil depth, impermeable geomembrane layer, and limited hydrology, only herbaceous species can be planted and may not be able to successfully outcompete the weedy species. This Plan prescribes specific installation techniques to get native herbaceous vegetation established at the site as quickly as possible in order to initially inhibit nuisance vegetation establishment.

Many mature oaks and other trees that may be subject to local tree protection ordinance are located in the proposed grading area for the project and impacts to these will occur. This Plan is specifically associated with the establishment of native ground cover plant species within the disturbed area and does not address plantings associated with local tree protection ordinance or mitigation for impacts thereof.

2.0 Site Characteristics

The Leona Heights Sulfur Mine is located about 0.5 miles northeast from the intersection of Highway 13 and Interstate 580. The Site is located at the east end of McDonell Avenue, at approximately latitude 37.79^{o}N, longitude 122.17^{o}W.

Attachment 1 presents various figures for the site. Figure 1 depicts the regional location of the Project site and the vicinity of the Project site in relationship to surrounding streets. Figure 2 identifies the location of the Project site on a topographic base map. Figure 3 is an aerial photograph of the Project site. Figure 4 is an aerial photograph of the Project site and staging areas.

The Site is positioned at the edge of a larger, undeveloped property and is bordered on the west and southwest by private residences, and open space to the north and southeast. The primary concentration of the waste tailings piles are exposed and bare, while the remaining areas of the Site are covered with dense oak woodland habitat. Oak woodland habitat can be found north and south of the main drainage.

South of the drainage the habitat is very dense with nearly continuous canopy cover provided by the trees. There is little understory vegetation due to a thick layer of oak leaves that covers the surface substrate. The sparse understory vegetation is dominated by maidenhair fern (*Adiantum aleuticum*) and shrubby white alder (*Alnus rhombifolia*). The north facing aspect of this bank is more moist and shaded when compared to the rest of the Site.

North of the drainage the oak woodland habitat is much less dense, and is interspersed with blue gum eucalyptus (*Eucalyptus* sp.) and silver wattle acacia. Toward the fringes and upper elevations of the Site the habitat types transition to coast chaparral dominated by coyote brush (*Baccharis pulularis*) and chamise (*Adenostoma faciculatum*). The south facing aspect of this bank is more dry and sunny when compared to the rest of the Site. Pampas grass can be found as individuals and small patches within the area.

Many of the areas in close proximity to the Site that have been subject to various levels of disturbance are dominated by a mix of scotch broom and fennel which provide an example of what the Site may look like without an appropriate and feasible revegetation plan. These off-site areas which are dominated by several non-native invasive plant species provide a seed source which could hinder restoration efforts of the Site. Without off-site management of the invasive species colonization of the restoration site by these species is inevitable.

3.0 Plant Installation

This section provides information on plant installation directly related to revegetation of the Site after the cap system has been constructed.

All areas that are subject to ground disturbance (i.e. grading) will be revegetated with native plant species found in the local area and in similar habitat types as shown in the revegetation plan sheet (Attachment 1, Figure 5). To the extent practicable, seeds should be obtained from

local native nurseries. All areas subject to ground disturbing activities will be seeded with an appropriate native seed mix (Table 1).

In order to ensure the integrity of the membrane and other liner elements of the remediation design, no vegetation that produces a stout tap-root of more than 10 inches is included in the plant palette.

Once rough and finish grading are complete, revegetation installation will proceed as follows:

- Application of seed with hydroseeder to all disturbed areas;
- Installation of erosion control fabric on the 1:1 slopes as detailed in the Creek Restoration 90% Design Report by E2C and in the locations shown in the Erosion Control Plan; and
- Application of hydrostraw with hydroseeder to all seeded areas.

After the grading operations are complete, a suitable seed bed will be created with harrow rakes to create a friable soil consistency within the top couple of inches of the topsoil layer. This preparation of the soil surface prior to seeding will help ensure good seed to soil contact which is important for germination.

Mycorrhizae in granular form shall be included in the seeding operation at a rate of 60 pounds per acre to ensure newly germinated seedling are able to access available soil nutrients and moisture. Mycorrhizae granules shall be added to the hydroseed mix at the aforementioned per acre rate.

The hydroseeding process will be in layers with a series of applications. The individual mix recipes will be slightly variable depending on which step it is in the process. Seed will be included in the first layer with the goal of achieving good seed to soil contact. Therefore, the first layer will be very light on hydrostraw and tackifier (i.e. binder). Mycorrhizae granules should be included in the first layer to get it as close to the seed as possible. Second, third, and subsequent layers can be applied to reach the desired thickness, crustiness, etc.

The “mulch” product that is chosen for the hydroseeding process shall be appropriate to the area it is being applied. Traditional hydromulch is typically a non-organic product composed of bits of recycled paper. The matrix it produces tends to be thick and papery, like paper mache, which is restrictive to anything trying to grow under it (i.e. native herbs) and breaks down relatively quickly; providing the least erosion control when compared to alternatives. Hydrostraw is typically an organic product composed of ground up straw. The matrix it produces tends to be thinner and more openly spaced allowing native seedlings to poke through and it breaks down slowly providing good erosion control compared to traditional paper hydromulch. We recommend that organic hydrostraw be used at a rate of 2,000 pounds per acre for the hydroseeding process. Organic virgin wood fiber is also available for the hydroseed matrix and provides an excellent establishment environment for native seedlings and good erosion control.

Table 1. Native Seed Mix Plant Palette

Scientific Name	**Common Name**	**Seed Rates (pounds per acre)**
Achillea millefolium	yarrow	1
Acmispon americanus	Pursh's lotus	1
Agrostis pallens	bentgrass	1
Bromus carinatus	California brome	2
Bromus laevipes	woodland brome	2
Deschampsia caespitosa	tufted hairgrass	1
Eschscholtzia californica	California poppy	1
Elymus glaucus	blue wildrye	3
Elymus multisetus	big squirreltail	2
Festuca californica	California fescue	2
Festuca rubra	red fescue	1
Grindelia hirsultula	gumplant	1
Hordeum brachyantherum	meadow barley	1
Koeleria macrantha	junegrass	3
Lupinus bicolor	sky lupine	2
Lupinus albifrons	bush lupine	2
Melica torreyana	Torrey melic	2
Mimulus aurantiacus	sticky monkeyflower	1
Muhlenbergia rigens	deergrass	1
Poa secunda	Sandberg's bluegrass	1
Sisyrinchium bellum	blue-eyed grass	1
Stipa lepida	foothill needlegrass	2
Stipa pulchra	purple needlegrass	2
Symphotrichium chilense	common aster	1
Trifolium wildenovii	tomcat clover	1
Urtica dioica	stinging nettles	1
Wyethia angustifolia	narrowleaf mules-ears	1
	TOTAL POUNDS PER ACRE	**40**

NOTE: Numbers provided for seed rates are in pounds per acre and will need to be extrapolated to meet design and as-built conditions.

The tackifier to be used as a binder in the hydroseed process shall be an organic psyllium fiber based product and applied at a rate of 120 pounds per acre.

In areas where fabric will be used for erosion control, native seed shall be applied directly to the soil surface before the erosion control fabric is installed. A hydrostraw and tackifier mixture will be applied to the fabric after installation to provide additional erosion control in steep areas. The temporary mulch/erosion control fabric must be completely biodegradable and contain no plastic.

Seeding should be scheduled to occur in late summer or early fall (i.e. August to September) in order to occur as close as possible to the onset of the rainy season in October or November. Seeding earlier can result in seed loss to desiccation and wildlife predation and late seeding can result in late germination risking the successful establishment of the native plant species.

4.0 Maintenance Recommendations

We recommend post-construction maintenance to occur due to design constraints such as a restrictive layer at 12 inch depth, moderate to steep slopes, and high potential for non-native invasive plant colonization. The revegetation strategy proposed by this Plan is designed for rapid establishment of the disturbed areas by native grasses, wildflowers, and herbaceous plants. The notion that well-established native vegetation should be able to compete and keep out potential weed invaders is widely vocalized by restoration practitioners but rarely completely observed. More often a balance between native and non-native vegetation occurs and if the dominance is tipped toward the native side of things and the non-native plants are not “invasive”; then we tend to call it a success. The intensity of the post-construction habitat management activities is often directly correlated with the percentage of native dominance on the Site. Therefore, the intensity of the specifically prescribed maintenance program for this project must be related to the desired outcome.

The San Francisco Bay Regional Water Quality Control Board in their November 5, 2013, letter states that, “Staff is concerned that the capped mine waste unit will be seeded by broom bushes, eucalyptus, native oaks, or other plants that are abundant in the area surrounding the Site. These plants must be prevented from taking root on the cap of the mining waste unit because they have deep roots that will likely penetrate the clay layer. Preventing the growth of these plants will require intensive post-construction maintenance….” The City of Oakland’s Standard Conditions of Approval states that, “Any areas disturbed along the riparian corridor shall be replanted with riparian vegetation and be maintained to ensure survival.” We concur with these statements and offer the following recommendations for maintenance of the planting area.

After remediation (stream restoration and capping of the mine tailings), the site will require regular inspections and maintenance to assess the performance of the revegetation plan. Maintenance activities specific to the revegetation effort include regular inspection and nuisance plant removal events for the first year of establishment. To the extent the native grasses and plants have successfully taken hold, maintenance beyond the first year is not recommended because the area around the site is not maintained to eliminate non-native invasive species and is thus providing a continuous seed source.

To assist in herbaceous ground cover establishment, the site will be inspected at least three times during first year for nuisance species that may have colonized the site. Nuisance species will

include all woody species (e.g. tree and shrub seedlings) and herbaceous species rated as “high” by the California Invasive Plant Council (Cal-IPC).

Any nuisance vegetation including scotch broom, pampas grass, fennel, and silver wattle (acacia discovered during the inspection will be cut or dug out and removed from the site. Nuisance vegetation can be removed by hand or cut at the base with hand tools. Ideally, removal will include all root materials to prevent root sprouting and regrowth of the plant.

The land areas directly adjacent to the site are abundant in possible woody colonizers, including French broom, oak species, coyote brush, chamise, etc. Therefore, early and strong establishment of the site with native grasses and wildflowers with proper installation technique and timing will be essential to inhibit nuisance species colonization and establishment.

Nuisance herbaceous species removal requires field maintenance personnel that are adept at identification of native plants (especially those on the plant palette) and non-native plants (especially targeted nuisance species), and experienced with weed control (manual, mechanical, and chemical) in similar situations.

If any corrective measures are taken for the cap system or the surface and subsurface drainage system, then remedial planting will be triggered. Any remedial planting that occurs should include native plant species and installation techniques that are observed to be successful onsite.

The restoration area is private property. Illegal trespass activities could result in a large amount of foot traffic. Human foot traffic can kill native grass plants, compact soils, dislodge surface elements, and result in additional bare ground to be easily colonized by undesirable plant species. Human foot traffic will be prohibited by signs and fences.

A report will be prepared and submitted to San Francisco Bay Regional Water Quality Control Board and City of Oakland at the end of the first year following installation describing the results of site inspections and a summary of maintenance actions.

ATTACHMENT 1

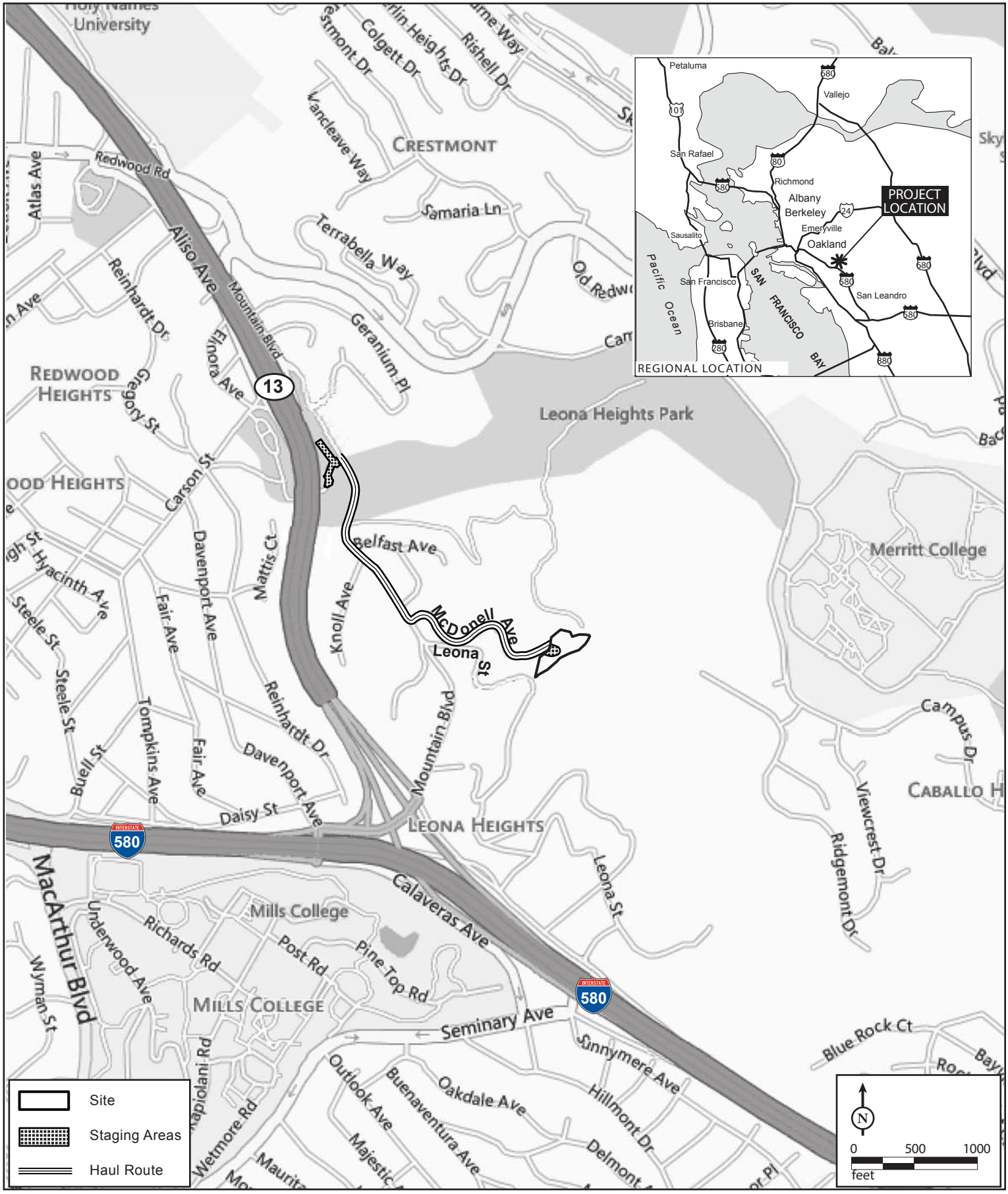
Figure 1 Project Location Map

Figure 2 Topographic Map

Figure 3 Aerial Map

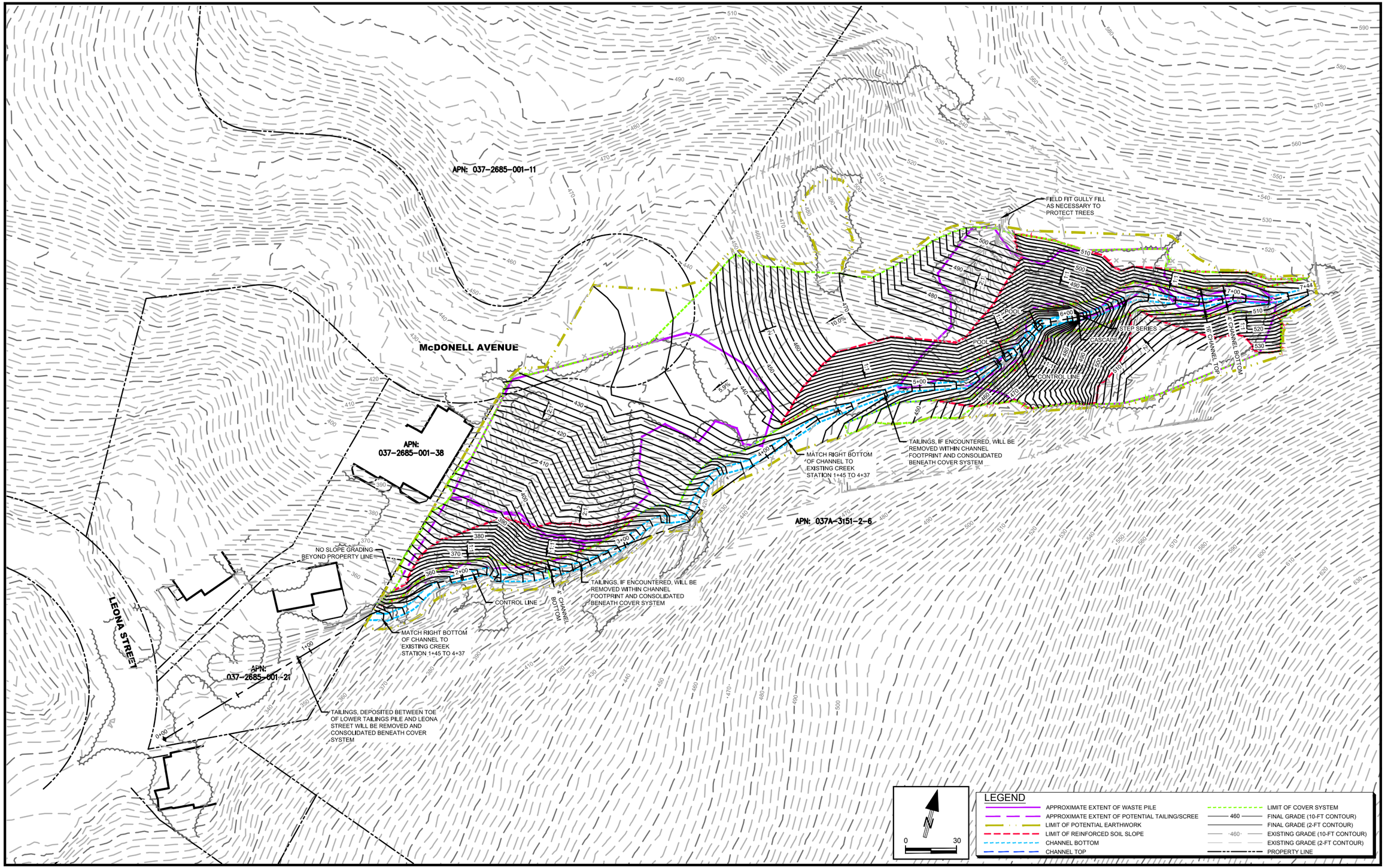
Figure 4 Construction Access Map

Figure 5 Revegetation Plan



193 Blue Ravine Rd. Ste. 165
Folsom, CA 95630
Phone: (916) 985-1188

Figure 1: Project Location Map
Leona Heights
Oakland, California
Source: LSA Associates



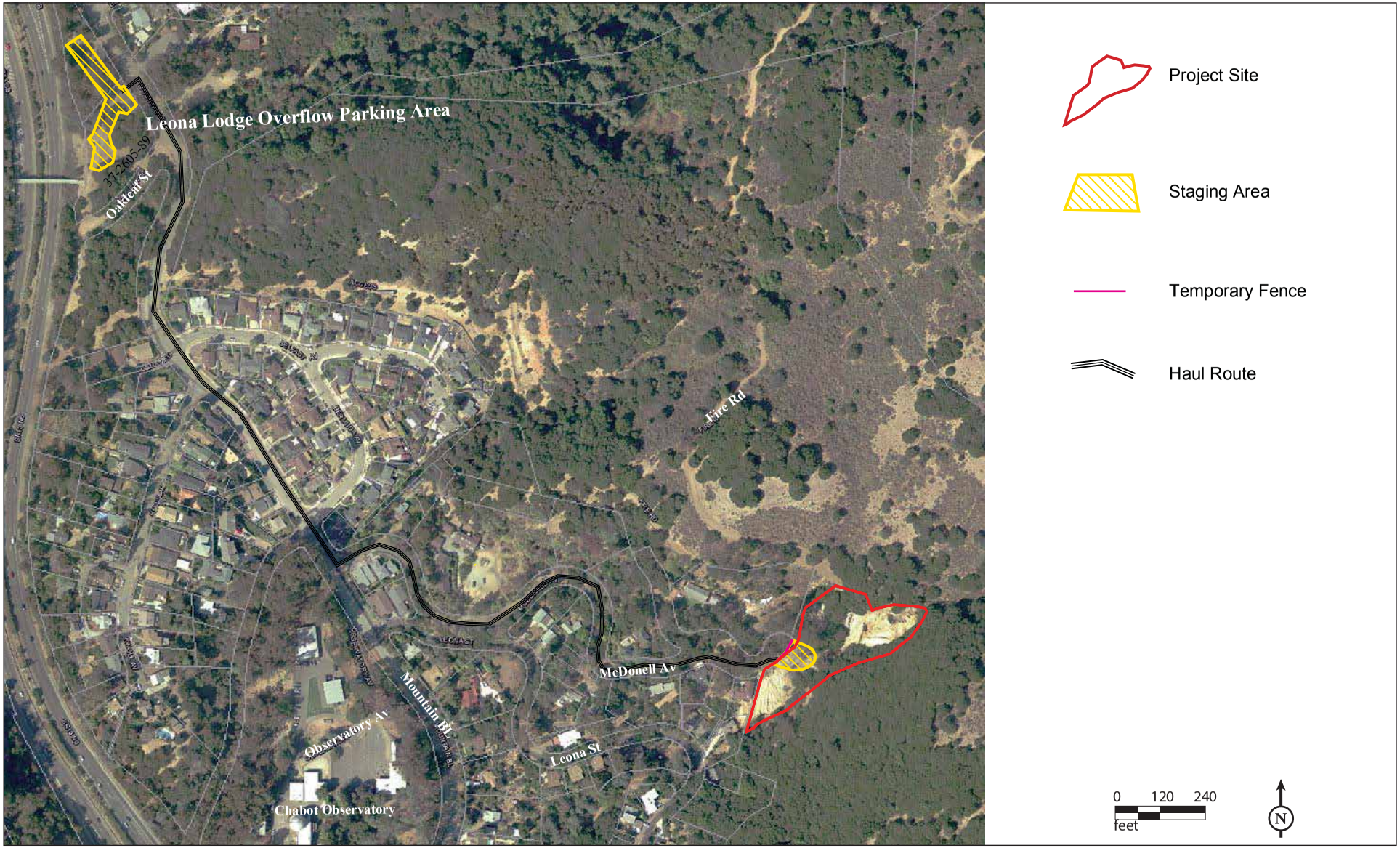
193 Blue Ravine Rd. Ste. 165
Folsom, CA 95630
Phone: (916) 985-1188

Figure 2: Topographic Map
Leona Heights
Oakland, California
Source: LSA Associates

OLBERDING ENVIRONMENTAL INC.
193 Blue Ravine Rd. Ste. 165
Folsom, CA 95630
Phone: (916) 985-1188

Figure 3: Aerial Map
Leona Heights
Oakland, California

Source Image: 10/02/2010



193 Blue Ravine Rd. Ste. 165
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Phone: (916) 985-1188

Figure 1: Project Location Map
Leona Heights
Oakland, California
Source: LSA Associates

NOTES

1. TOPOGRAPHY OUTSIDE THE PROJECT LIMITS WERE BASED ON AERIAL LIDAR PERFORMED IN 2006 AND PROVIDED BY THE ALAMEDA COUNTY DEPARTMENT OF PUBLIC WORKS. COORDINATES BASED ON CALIFORNIA STATE PLANE COORDINATE SYSTEM, ZONE 3, NAD 83 AND VERTICAL DATUM NAVD88.
2. TOPOGRAPHY WITHIN AND ADJACENT TO PROJECT LIMITS BASED ON A COMBINATION OF AERIAL SURVEY IN EXPOSED OPEN AREAS AND GROUND FIELD SURVEY IN TREE-COVERED AREAS. AERIAL SURVEY PERFORMED BY AERIAL PHOTOMAPPING SERVICES OF CLOVIS, CA, ON 5 AUGUST 2013; FIELD SURVEY PERFORMED BY MID COAST ENGINEERS OF WATSONVILLE, CA ON 30 JULY 2013 THROUGH 1 AUGUST 2013.
3. COORDINATES BASED ON CALIFORNIA STATE PLANE COORDINATE SYSTEM, ZONE 3, NAD 83 AS ESTABLISHED BETWEEN NGS HT0281 (M554) AND NGS AA3818 (HPGN D CA 04 GH).
4. BENCHMARK FOR THIS SURVEY IS NGS HT0281 WITH ELEVATION =14.20 FEET (NAVD 88 DATUM).
5. SEEDING SHOULD BE SCHEDULED TO OCCUR IN LATE SUMMER OR EARLY FALL (I.E. AUGUST TO SEPTEMBER) IN ORDER TO OCCUR AS CLOSE AS POSSIBLE TO THE ONSET OF THE RAINY SEASON IN OCTOBER OR NOVEMBER.

Table 1. Leona Heights Native Seed Mix Plant Palette

Scientific Name	Common Name	Seed Rates (pounds per acre)
Achillea millefolium	yarrow	1
Acmispon americanus	Pursh's lotus	1
Agrostis pallens	bentgrass	1
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Bromus laevipes	woodland brome	2
Deschampsia caespitosa	tufted hairgras	1
Eschscholtzia californica	California poppy	1
Elymus glaucus	blue wildrye	3
Elymus multisetus	big squirreltail	2
Festuca californica	California fescue	2
Festuca rubra	red fescue	1
Grindelia hirsultula	gumplant	1
Hordeum brachyantherum	meadow barley	1
Koeleria macrantha	junegrass	3
Lupinus bicolor	sky lupine	2
Lupinus albifrons	bush lupine	2
Melica torreyana	Torrey melic	2
Mimulus aurantiacus	sticky monkeyflower	1
Muhlenbergia rigens	deergrass	1
Poa secunda	Sandberg's bluegrass	1
Sisyrinchium bellum	blue-eyed grass	1
Stipa lepida	foothill needlegrass	2
Stipa pulchra	purple needlegrass	2
Symphotrichium chilense	common aster	1
Trifolium wildenovii	tomcat clover	1
Urtica dioica	stinging nettles	1
Wyethia angustifolia	narrowleaf mules-ears	1
	TOTAL POUNDS PER ACRE	**40**

NOTE: Numbers provided for seed rates are in pounds per acre and will need to be extrapolated to meet design and as-built conditions.

LEGEND

- REVEGETATION AREA
- CHANNEL BOTTOM
- CHANNEL TOP
- 460 FINAL GRADE (10-FT CONTOUR)
- FINAL GRADE (2-FT CONTOUR)
- 460 EXISTING GRADE (10-FT CONTOUR)
- EXISTING GRADE (2-FT CONTOUR)
- PROPERTY LINE
- LIMIT OF POTENTIAL EARTHWORK

N

0 30

193 BLUE RAVINE ROAD,
SUITE 165
FOLSOM, CA 95630 USA
PHONE: 916.985.1188

DATE	DESCRIPTION
03/24/2014	REVISED PERMIT LEVEL

PROJECT NO:
DRAWN BY: N.B.
DESIGNED BY:
CHECKED BY:
APPROVED BY:

PROJECT NAME
Leona Heights Sulfur Mines Remediation

SHEET TITLE
Revegetation Plan

FIGURE NUMBER
5 of 5

APPENDIX C

PRELIMINARY MAINTENANCE AND MONITORING PLAN

PRELIMINARY MAINTENANCE AND MONITORING PLAN

Leona Heights Sulfur Mine Remediation

March 28, 2014

Prepared by

E2C Remediation
Environmental Engineering,
Consulting and Remediation, Inc.

1020 Winding Creek Road, Suite 110
Roseville, CA 95678
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and

OLBERDING ENVIRONMENTAL INC.

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(916) 985.1188

PRELIMINARY MAINTENANCE AND MONITORING PLAN

Leona Heights Sulfur Mine Remediation

This document has been prepared to provide a preliminary maintenance and monitoring plan for the Leona Heights Sulfur Mine Remediation Project in the City of Oakland, California. The Plan was prepared at the request of the City of Oakland for the project permitting review.

INTRODUCTION

The following section describes the project location, site history, existing conditions at the project site and the proposed project.

Project Location

The project area is located in the Oakland Hills region of the City of Oakland, Alameda County, as shown in Figure 1. The site is approximately one-half mile northeast of the intersection of I-580 and State Route 13, and southeast of the eastern terminus of McDonell Avenue which provides roadway access to the site. The project area includes a portion of Leona Creek and adjacent slopes and is referred to as the remediation site, which consists of an approximately 2-acre, irregularly shaped area, located in a small steep ravine.

Site History and Environmental Concerns

The project area is mostly wooded with steep slopes. The Leona Heights Sulfur Mine operated at the project site from about 1900 through the 1920s to extract pyrite (iron sulfide) crystals from the volcanic bedrock for the production of sulfuric acid. The abandoned mine is located in the upper reach of the Leona Creek watershed, and sulfur-bearing mining waste (also referred to as tailings) now fills the creek channel. The site consists of upper and lower mine tailings piles.

The watershed above the site forms an ephemeral stream that flows over and through the tailings creating acid mine drainage in the creek. The elevated acidity, increases the solubility of metals present in the mine tailings, resulting in the leaching of heavy metals into the creek. The creek within the remediation site has the characteristic orange color associated with acid mine drainage, and water samples have demonstrated high levels of cadmium, copper, mercury, nickel, lead, zinc and arsenic.

Proposed Project

In May 2013, the California Regional Water Quality Control Board, San Francisco Bay Region issued a Cleanup and Abatement Order (CAO) for the site. The project consists of remediation efforts for the tailings and Leona Creek. In order to meet the CAO objectives, the proposed project includes the following:

- Remove mine tailings from the creek channel and from surrounding areas;
- Grade and compact tailings and install a subsurface drainage system beneath the compacted tailings to increase stability;
- Cover the consolidated tailings beneath a geomembrane liner, topped with a vegetative layer that will isolate the tailings from water;

- Reroute the groundwater discharge from its current location inside the tailings, to a new discharge point within the creek channel;
- Reinforce steep slopes adjacent to the creek channel to improve stability; and
- Restore the creek channel to accommodate a 100-year, 24-hour design storm, incorporating drop structures reminiscent of natural creek designs on steep slopes that provide for the gradual movement of sediment through the creek, minimizing erosion onsite and downstream.

The proposed consolidation, capping, re-vegetation, and drainage improvements at the site would minimize contact between groundwater runoff and tailings, thereby reducing the metal and sediment load in Leona Creek. Grading and compaction and encasement of the tailings pile would improve slope stability in the vicinity of the creek, and allow for the successful restoration of the channel.

The remedial closure and creek restoration activities are planned for the 2014 dry season beginning in May and will take approximately 5 months to complete.

The following sections present the maintenance and monitoring plan.

MAINTENANCE AND MONITORING PLAN

Maintenance Plan- Stream and Reinforced Slopes

After remediation (stream restoration and capping of the mine tailings), the site will require regular maintenance (at least initially) to preserve the integrity of the cap and to assess the performance of the creek restoration. Maintenance activities include the following:

1) Erosion control BMPs will be inspected and maintained during the first wet season after any major storm events;

Site post-construction BMPs will be inspected within 72 hours after any storm with accumulative rainfall exceeding 2 inches in 24 hours. Any damage or deficiency found during inspection will be repaired and/or corrected.

2) Run-on prevention ditch inspection (once per year and after major storms during the first year after the construction);

The run-on prevention ditches will be inspected once per year for the initial 3 three years. During the first year, the run-on ditches will be inspected within 72 hours of any storm with accumulative rainfall greater than 4 inches in 24 hours. Any damage and deficiency in erosion control features will be repaired and/or corrected.

3) Stream channel bank and bed inspection (once per year and after major[1] storms during the first year after the construction);

The stream channel bank and bed inspection will be performed at the same time the run-on prevention ditches are inspected.

[1] A major storm is defined as any storm that results in rainfall totals of greater than four inches in a twenty-four hour period.

4) Seep drain and sub-drain system inspection (once per year for initial three years); and

The seep drain and sub-drain system inspection will be performed at the same time the run-on prevention ditches are inspected.

5) Cap inspection (prior to annual rainy season or after major storms).

Prior to the annual rainy season for the initial three years, the integrity of the cap system should be inspected. The inspection will be focused on the visual observation of any differential settlement, any severe erosion in the cover vegetative soil layer and any unwanted vegetation which may penetrate the cap layer.

Monitoring of Surface Water

Post-construction surface water monitoring will be conducted to evaluate the performance of the remediation and creek restoration.

Sample Collection

Surface water samples during both dry and wet seasons will be collected above the Leona Street culvert for indicator metal analysis and pH.

Stream flow will be collected by using a small bucket or bailer to take water from the creek. The bucket or bailer will be triple rinsed with distilled water before use. The collected water will then be decanted to sample containers provided by the analytical laboratories. The containers will be capped immediately. Care will be taken to ensure that the containers are full and there is no headspace in the containers. A chain of custody form will be completed immediately after the sample collection. Field measurements will be performed at the site from the water collected in the bucket or bailer. All the field measurement will be recorded on field sampling data sheets with the sampling date, time and location. General weather conditions will be noted on the field data sheets. The sampling technician will perform the field sampling activities and make the recording.

For each sampling event, one (1) set of samples will be collected.

Monitoring Parameters

Field measurements include pH, electrical conductivity, temperature, dissolved oxygen concentration, and oxidation-reduction potential.

These stream water parameters will be monitored in the field with a QED Model MD-20 Flow Cell. The MD-20 Flow Cell measures temperature in degrees Centigrade (^{O}C), dissolved oxygen (DO) in milligrams per liter (mg/L), electrical conductivity in milliSiemens per centimeter (mS/cm), pH (in pH units), and ORP (oxygen reduction potential) in millivolts (mV).

Laboratory analysis consists of dissolved cadmium, copper, mercury, nickel, lead, zinc, arsenic, sulfate and acidity.

- Dissolved metals will be analyzed by ICP-MS using EPA 200.8 method;
- Acidity will be determined by titration using EPA 305.1 method; and
- Sulfate will be analyzed by using EPA 375.2 method or EPA 9038 method.

These chemical analyses will be performed in a California certified laboratory.

Monitoring Frequency

Monitoring sampling will occur twice per year with one event in the wet season (October through March) and one in the dry season (May through August). Wet season samples will be collected immediately after a storm event and dry season samples will be collected at least 72 hours after any precipitation during May through August.

At least four monitoring events will be conducted for the first two years after construction.

Monitoring Reports

A brief letter report will be prepared by a State of California Professional Geologist or Engineer to document the monitoring activities and results.

Post-Earthquake Inspection

Post-earthquake inspection will be performed after any earthquake with a reported magnitude greater than 5.5 (Richter Scale) with an epicenter located within 10 miles of the site. The inspection will be focused on field observations of slope displacement, ground tensional cracks, variation of discharge from groundwater seeps and sub-drain system and creek bank and stream bed conditions as well as run-on prevention ditches.

If any failure or damage degrades the performance of the cap system, the surface and subsurface drainage system, corrective repair measures will be implemented.

Maintenance and Inspection Plan - Revegetation

After remediation (stream restoration and capping of the mine tailings), the site will require regular inspections and maintenance to assess the performance of the revegetation plan. Maintenance activities specific to the revegetation effort include regular inspection and nuisance plant removal events for the first year of establishment. To the extent the native grasses and plants have successfully taken hold, maintenance beyond the first year is not recommended because the area around the site is not maintained to eliminate non-native invasive species and is thus providing a continuous seed source.

To assist in herbaceous ground cover establishment, the site will be inspected at least three times during the first year for nuisance species that may have colonized the site. Nuisance species will include all woody species (e.g. tree and shrub seedlings) and herbaceous species rated as “high” by the California Invasive Plant Council (Cal-IPC).

Any nuisance vegetation including scotch broom, pampas grass, fennel, and silver wattle (acacia) discovered during the inspection will be cut or dug out and removed from the site. Nuisance vegetation can be removed by hand or cut at the base with hand tools. Ideally, removal will include all root materials to prevent root sprouting and regrowth of the plant.

The land areas directly adjacent to the site are abundant in possible woody colonizers, including French broom, oak species, coyote brush, chamise, etc. Therefore, early and strong establishment of

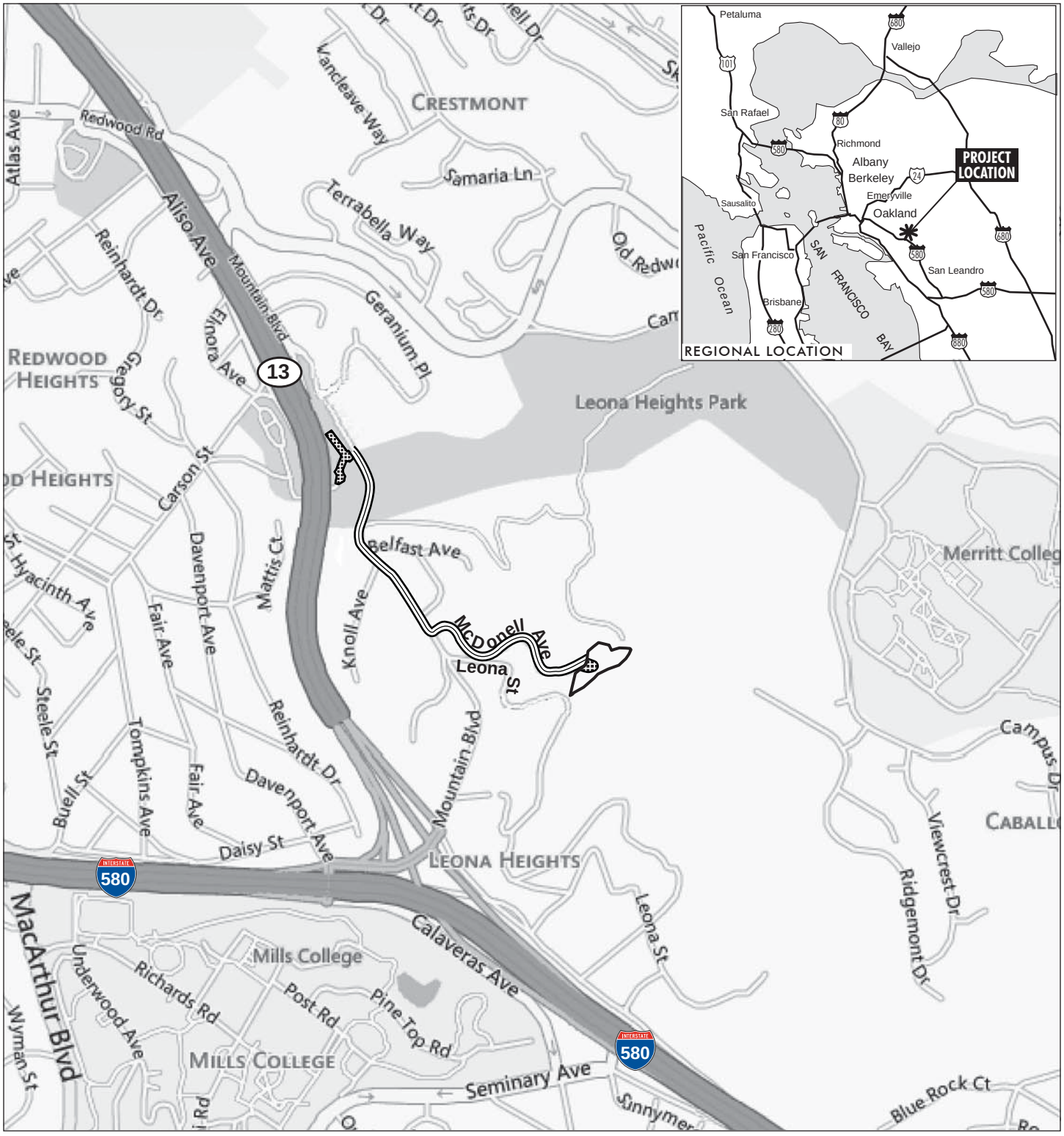
the site with native grasses and wildflowers with proper installation technique and timing will be essential to inhibit nuisance species colonization and establishment.

Nuisance herbaceous species removal requires field maintenance personnel that are adept at identification of native plants (especially those on the plant palette) and non-native plants (especially targeted nuisance species), and experienced with weed control (manual, mechanical, and chemical) in similar situations.

If any corrective measures are taken for the cap system or the surface and subsurface drainage system, then remedial planting will be triggered. Any remedial planting that occurs should include native plant species and installation techniques that are observed to be successful onsite.

The restoration area is private property. Illegal trespass activities could result in a large amount of foot traffic. Human foot traffic can kill native grass plants, compact soils, dislodge surface elements, and result in additional bare ground to be easily colonized by undesirable plant species. Human foot traffic will be prohibited by signs and fences.

A report will be prepared and submitted to San Francisco Bay Regional Water Quality Control Board and City of Oakland at the end of the first year following installation describing the results of site inspections and a summary of maintenance actions.



LSA

FIGURE 1

Leona Creek Restoration and Leona Heights Sulfur Mine Remediation Project IS/MND

Project Location

SOURCES: BING MAPS; LSA ASSOCIATES, INC., 2014.

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APPENDIX D

AIR QUALITY DATA

Air Emission Calculations

Phase Type (Select a drop down list item in Column B; if "Other", please specify in Column C)	Phase Start Date	Phase End Date	Operating Hours Per Day[1]	Work Days Per Week	Equipment Type (Select a drop down list item in Column H; if "Other" please specify in Column I)		Number of Equipment	Horsepower (if known)	Load Factor (if known)	Engine Mfg Year	Engine Tier Rating (Tier 2, Tier 4i)[4]	Diesel Particuate Filter (Level)[5]	Engine Hours	Days (Calculated)	2014
Demolition	05/01/14	05/09/14	8	5	Concrete/Industrial Saws		2			2008				8	8
Demolition	05/01/14	05/09/14	8	5	Crawler Tractors		2			2008				8	8
Demolition	05/01/14	05/09/14	8	5	Excavators		1			2008				8	8
Demolition	05/01/14	05/09/14	8	5	Other General Industrial Equipment	Chipper	1			2008				8	8
Demolition	05/01/14	05/09/14	8	5	Rubber Tired Loaders		1			2008				8	8
Demolition	05/01/14	05/09/14	8	5	Skid Steer Loaders		1			2008				8	8
Demolition	05/01/14	05/09/14	8	5	Tractors/Loaders/Backhoes		1			2008				8	8
Creek Restoration	05/01/14	05/11/14	8	5	Cranes		1			2008				10	10
Creek Restoration	05/01/14	08/04/14	8	5	Crawler Tractors		1			2008				95	95
Creek Restoration	05/01/14	08/04/14	8	5	Tractors/Loaders/Backhoes		1			2008				95	95
Creek Restoration	05/01/14	08/04/14	8	5	Skid Steer Loaders		1			2008				95	95
Creek Restoration	05/01/14	08/04/14	8	5	Excavators		2			2008				95	95
Creek Restoration	05/01/14	08/04/14	8	5	Rollers		1			2008				95	95
Creek Restoration	05/01/14	08/04/14	8	5	Rough Terrain Forklifts		1			2008				95	95
Creek Restoration	05/01/14	08/04/14	8	5	Rubber Tired Loaders		2			2008				95	95
Paving	05/01/14	05/06/14	8	5	Graders		1			2008				5	5
Paving	05/01/14	05/06/14	8	5	Rollers		1			2008				5	5
Paving	05/01/14	05/06/14	8	5	Paving Equipment		1			2008				5	5

Travel

Equipment	Op Days	Trips /Day	Total Trips	Round Trip Length (mi)	Miles per Day	Total Miles	ROG Lb/Day	ROG Tons/ Yr	TOG Lb/Day	TOG Tons/ Yr	CO Lb/Day	CO Tons/ Yr	NOX Lb/Day	NOX Tons/ Yr	CO2 MT/Day	CO2 MT / Yr	CO2 (Pavley I+LCFS) Lb/Day	CO2 (Pavley I+LCFS) MT / Yr	PM10 Lb/Day	PM10 Tons/ Yr	PM2.5 Lb/Day	PM2.5 Tons/ Yr	SOX Lb/Day	SOX Tons/ Yr
G/Mi EFs							2.55		1.06		5.21		20.04		3367.85		3317.33		0.39		0.36		0.03	
					0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Demolition - Haul	8	1	8	1.20	1.20	9.60	0.01	0.00	0.00	0.00	0.01	0.00	0.05	0.00	0.00	0.03	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.00
Demolition - Water Truck- Prim Stage	8	2	16	0.1	0.20	1.60	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.01	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00
						Sum	0.01	0.00	0.00	0.00	0.02	0.00	0.06	0.00	0.00	0.04	0.00	0.04	0.00	0.00	0.00	0.00	0.00	0.00
Creek Restoration																								
Haul Trucks	30	60	1800	1.20	72.00	2160.00	0.40	0.01	0.17	0.00	0.83	0.01	3.18	0.05	0.24	7.27	0.24	7.17	0.06	0.00	0.06	0.00	0.01	0.00
Water Truck	95	2	190	0.6	1.20	114.00	0.01	0.00	0.00	0.00	0.01	0.00	0.05	0.00	0.00	0.38	0.00	0.38	0.00	0.00	0.00	0.00	0.00	0.00
					0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
					0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
					0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
						Sum	0.41	0.01	0.17	0.00	0.84	0.01	3.23	0.05	0.25	7.66	0.24	7.54	0.06	0.00	0.06	0.00	0.01	0.00
Paving																								
Asphalt/Aggregate Trucks	5	6	30	1.2	7.20	36	0.04	0.00	0.02	0.00	0.08	0.00	0.32	0.00	0.02	0.12	0.02	0.12	0.01	0.00	0.01	0.00	0.00	0.00
						0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
						0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
						Sum	0.04	0.00	0.02	0.00	0.08	0.00	0.32	0.00	0.02	0.12	0.02	0.12	0.01	0.00	0.01	0.00	0.00	0.00
						0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
						0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
						0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
						Sum	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
						0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
						0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
						0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
						0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
						0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
						0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
						Sum	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
						Grand Total	0.46	0.007	0.19	0.003	0.94	0.01	3.61	0.05	0.28	7.82	0.27	7.70	0.07	0.00	0.07	0.00	0.01	0.00

Idling Trucks

Equipment	Idle Min/ Hours	Hours /Day	Total # Days		Idle Time / Day (Hours)	Total Idle Time (Hours)	ROG Lb/Day	ROG Tons/ Yr	TOG Lb/Day	TOG Tons/ Yr	CO Lb/Day	CO Tons/ Yr	NOX Lb/Day	NOX Tons/ Yr	CO2 MT/Day	CO2 MT / Yr	CO2 (Pavley I+LCFS) Lb/Day	CO2 (Pavley I+LCFS) MT / Yr	PM10 Lb/Day	PM10 Tons/ Yr	PM2.5 Lb/Day	PM2.5 Tons/ Yr	SOX Lb/Day	SOX Tons/ Yr
G/Mi EFs							6.36		7.24		33.28		72.19		7022.55		6917.22		0.38		0.35		0.07	
Creek Restoration - Hauling	45	10	30		7.50	225.00	0.11	0.00	0.12	0.00	0.55	0.01	1.19	0.02	0.05	1.58	0.05	1.56	0.01	0.00	0.01	0.00	0.00	0.00
Demolition - Hauling	15	2	8		0.50	4.00	0.01	0.00	0.01	0.00	0.04	0.00	0.08	0.00	0.00	0.03	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.00
					0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
					0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
					0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
					0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
					0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
					0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
					0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
					0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
					0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
					0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
					0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
					0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
					0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
						Sum	0.11	0.00	0.13	0.00	0.59	0.01	1.27	0.02	0.06	1.61	0.06	1.58	0.01	0.00	0.01	0.00	0.00	0.00

Idling Cars

Equipment	Idle Min/ Hours	Hours /Day	Total # Days		Idle Time / Day (Hours)	Total Idle Time (Hours)	ROG Lb/Day	ROG Tons/ Yr	TOG Lb/Day	TOG Tons/ Yr	CO Lb/Day	CO Tons/ Yr	NOX Lb/Day	NOX Tons/ Yr	CO2 MT/Day	CO2 MT / Yr	CO2 (Pavley I+LCFS) Lb/Day	CO2 (Pavley I+LCFS) MT / Yr	PM10 Lb/Day	PM10 Tons/ Yr	PM2.5 Lb/Day	PM2.5 Tons/ Yr	SOX Lb/Day	SOX Tons/ Yr
G/Mi EFs							0.31		0.34		2.56		1.76		399.96		393.96		0.05		0.04		0.07	
					0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
					0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
					0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
					0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
					0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
					0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
					0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
					0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
					0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
					0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
					0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
						Sum	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
						Grand Total	0.11	0.00	0.13	0.00	0.59	0.01	1.27	0.02	0.06	1.61	0.06	1.58	0.01	0.00	0.01	0.00	0.00	0.00

Year	ROG Tons/Yr	CO Tons/Yr	NOx Tons/Yr	*PM10 Tons/Yr	CO2 MT/Yr	CH4 MT/Yr	CO2e MT/Yr

Year	ROG Tons/Yr	CO Tons/Yr	NOx Tons/Yr	PM10 Tons/Yr	CO2 MT/Yr	CH4 MT/Yr	CO2e MT/Yr
2014							
Const. Equip	0.11	1.19	1.13	0.081	159.16	0.03	159.70
Const. Mobil Offsite	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Const. Mobil Onsite	0.007	0.013	0.051	0.0010	7.817	0.000	0.000
Const. Mobil Idling	0.002	0.008	0.018	0.0000970	1.608	0.000	0.000
Total 2014	0.12	1.22	1.20	0.08	168.59	0.03	159.70

Year	ROG Lb/Day	CO Lb/Day	NOx Lb/Day	PM10 Lb/Day	CO2 MT/Day	CH4 MT/Day	CO2e MT/Day
2014							
Const. Equip	1.48	15.91	15.12	1.08	1.06	0.00	1.06
Const. Mobil Offsite	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Const. Mobil Onsite	0.09	0.18	0.68	0.01	0.05	0.00	0.00
Const. Mobil Idling	0.02	0.11	0.24	0.00	0.01	0.00	0.00
Total 2014	1.59	16.20	16.05	1.10	1.12	0.00	1.06

ID	Phase Type	Equipment Type	# of Units	BHP	ROG Tons/Yr	CO Tons/Yr	NOx Tons/Yr	*PM10 Tons/Yr	CO2 MT/Yr	CH4 MT/Yr	CO2e MT/Yr
1	Demolition	Concrete/Industrial Saws	2	81	0.01	0.03	0.05	0.00	4.30	0.00	4.32
2	Demolition	Crawler Tractors	2	82	0.00	0.02	0.01	0.00	2.56	0.00	2.57
3	Demolition	Excavators	1	157	0.00	0.01	0.01	0.00	2.18	0.00	2.19
4	Demolition	Other General Industrial Equipment	1	150	0.00	0.01	0.02	0.00	1.85	0.00	1.86
5	Demolition	Rubber Tired Loaders	1	87	0.00	0.01	0.02	0.00	1.14	0.00	1.15
6	Demolition	Skid Steer Loaders	1	37	0.00	0.01	0.00	0.00	0.50	0.00	0.50
7	Demolition	Tractors/Loaders/Backhoes	1	75	0.00	0.01	0.01	0.00	1.01	0.00	1.01
8	Creek Restoration	Cranes	1	208	0.00	0.01	0.01	0.00	2.72	0.00	2.73
9	Creek Restoration	Crawler Tractors	1	82	0.00	0.13	0.09	0.01	15.19	0.00	15.25
10	Creek Restoration	Tractors/Loaders/Backhoes	1	75	0.00	0.09	0.07	0.00	11.94	0.00	11.98
11	Creek Restoration	Skid Steer Loaders	1	37	0.00	0.06	0.05	0.00	5.89	0.00	5.92
12	Creek Restoration	Excavators	2	157	0.02	0.34	0.25	0.02	51.79	0.01	51.92
13	Creek Restoration	Rollers	1	84	0.00	0.11	0.07	0.00	13.61	0.00	13.66
14	Creek Restoration	Rough Terrain Forklifts	1	83	0.00	0.11	0.08	0.00	14.41	0.00	14.46
15	Creek Restoration	Rubber Tired Loaders	2	87	0.06	0.22	0.37	0.03	27.19	0.00	27.29
16	Paving	Graders	1	162	0.00	0.01	0.01	0.00	1.51	0.00	1.51
17	Paving	Rollers	1	84	0.00	0.01	0.00	0.00	0.72	0.00	0.72
18	Paving	Paving Equipment	1	82	0.00	0.01	0.00	0.00	0.66	0.00	0.66
				Totals:	0.11	1.19	1.13	0.08	159.16	0.03	159.70

Equipment Type	Load Factors	Default HP	Equipment Class
Aerial Lifts	0.31	34	Industrial
Air Compressors	0.2	78	Stationary Commercial Engine
Bore/Drill Rigs	0.5025	82	Construction and Mining
Cement and Mortar Mixers	0.56	9	CalEEMOD
Concrete/Industrial Saws	0.73	81	CalEEMOD
Cranes	0.2881	208	Construction and Mining
Crawler Tractors	0.4288	82	Construction and Mining
Crushing/Processing Equipment	0.44	85	Stationary Commercial Engine
Dumpers/Tenders	0.38	16	CalEEMOD
Excavators	0.3819	157	Construction and Mining
Forklifts	0.3	149	Industrial
Generator Sets	0.74	84	Stationary Commercial Engine
Graders	0.4087	162	Construction and Mining
Off-Highway Tractors	0.4355	160	Construction and Mining
Off-Highway Trucks	0.3819	381	Construction and Mining
Other Construction Equipment	0.4154	327	Construction and Mining
Other General Industrial Equipment	0.34	150	Industrial
Other Material Handling Equipment	0.4	196	Industrial
Pavers	0.4154	89	Construction and Mining
Paving Equipment	0.3551	82	Construction and Mining
Plate Compactors	0.43	8	CalEEMOD
Pressure Washers	0.3	13	CalEEMOD
Pumps	0.74	84	Stationary Commercial Engine
Rollers	0.3752	84	Construction and Mining
Rough Terrain Forklifts	0.402	83	Construction and Mining
Rubber Tired Dozers	0.3953	358	Construction and Mining
Rubber Tired Loaders	0.3618	87	Construction and Mining
Scrapers	0.4824	356	Construction and Mining
Signal Boards	0.82	6	CalEEMOD
Skid Steer Loaders	0.3685	37	Construction and Mining
Surfacing Equipment	0.3015	392	Construction and Mining
Sweepers/Scrubbers	0.4556	88	Construction and Mining
Tractors/Loaders/Backhoes	0.3685	75	Construction and Mining
Trenchers	0.5025	69	Construction and Mining
Welders	0.45	46	CalEEMOD
Other	0.42		Stationary Commercial Engine

HRA CONTOURS

Cancer (In a Million)							
Height	CREEK	Roadway	IDLE1	IDLE2	PRIM_STA	LODGE_ST	Total
0 Feet	5.27	0.10	0.0003	0.000003	0.29	0.31	5.97

$PM_{2.5}$							
Height	CREEK	Roadway	IDLE1	IDLE2	PRIM_STA	LODGE_ST	Total
0 Feet	0.140	0.003	0.000	0.000	0.008	0.008	0.159

Chronic HI							
Height	CREEK	Roadway	IDLE1	IDLE2	PRIM_STA	LODGE_ST	Total
0 Feet	0.028	0.001	0.000	0.000	0.002	0.002	0.032

Acute HI							
Height	CREEK	Roadway	IDLE1	IDLE2	PRIM_STA	LODGE_ST	Total
0 Feet	0	0	0	0	0	0	0

Dose = (Cair * DBR * EF * ED * CF) / AT

where:

	Dose = dose through inhalation (mg/kg-day)
1	Cair = air concentration (µg/m3) from air dispersion model (normalizzd air concentration of 1 ug/n3 is used)
581	DBR = daily breathing rate (302 L/kg body weight-day for adult and 581 L/kg-day for child)
150	EF = exposure frequency (350 days/year)
1	ED = exposure duration (70 years)
1.00E-06	CF = conversion factor (10-6 ([mg/µg] * [m3/L])
25,550	AT = averaging time (25,550 days or 70 years)

Dose = 3.41E-06

Cancer Risk = (Dose * Modeled Concentration * Toxic Emissions * CRAF * Cancer Potency Factor)

where:

	Cancer Risk = risk (potential chances per million)
	Modeled Concentraion = ISCST3 Modeled Concentration using a normalizedemissions rate of 1 g/sec
	Toxic Emissions = Sum of all toxic pollutants with a cancer potency value
3.41E-06	Dose = dose through inhalation (mg/kg-day)
10	CRAF = 1.7 for residential receptors 70 years or 10 for child
	Cancer Potency Factor = toxicity factor (mg/kg-day-1)

Cancer Adjustment Factors	
Diesel	TOG
3.75E-05	

							Row	34
Maximum Value		5.27E-06	1.59E-07	2.38E-09	7.71E-10	4.59E-07	4.14E-06	5.97E-06
X	Y	CREEK	ROADWAY	IDLE1	IDLE2	PRIM_STA	LODGE_ST	Total
572674.1	4182680	2.47E-06	6.52E-08	2.91E-10	2.16E-10	4.59E-07	3.68E-07	3.36E-06
572696.3	4182607	5.27E-06	9.85E-08	2.54E-10	3.36E-12	2.89E-07	3.12E-07	5.97E-06
572663.3	4182580	1.40E-06	1.89E-08	3.16E-10	2.55E-13	1.21E-07	3.18E-07	1.86E-06
572675.9	4182539	1.38E-06	1.69E-08	2.25E-10	9.64E-13	1.11E-07	2.90E-07	1.80E-06
572632.6	4182608	1.35E-06	1.25E-07	2.69E-10	1.72E-11	1.11E-07	3.56E-07	1.95E-06
572614	4182650	1.06E-06	1.41E-07	3.07E-10	2.26E-11	1.13E-07	4.01E-07	1.71E-06
572552.9	4182655	2.57E-07	6.22E-08	3.30E-10	3.09E-12	6.34E-08	4.64E-07	8.46E-07
572530.8	4182664	2.12E-07	1.06E-07	3.45E-10	3.35E-12	5.38E-08	4.94E-07	8.66E-07
572560.2	4182568	1.54E-08	2.14E-08	2.89E-10	1.36E-12	4.97E-08	3.44E-07	4.31E-07
572560.6	4182598	1.57E-07	3.38E-08	4.16E-10	2.87E-12	5.54E-08	3.85E-07	6.32E-07
572578.8	4182544	9.67E-09	1.65E-08	2.50E-10	9.79E-13	5.37E-08	3.16E-07	3.96E-07
572562	4182537	3.65E-09	1.14E-08	1.74E-10	7.06E-13	4.77E-08	3.07E-07	3.69E-07
572539.4	4182534	4.97E-09	1.33E-08	1.84E-10	1.05E-12	4.65E-08	3.05E-07	3.70E-07
572624.9	4182519	4.70E-09	1.20E-08	2.25E-10	5.24E-13	6.38E-08	2.90E-07	3.71E-07
572604.1	4182505	2.59E-09	9.15E-09	1.65E-10	5.14E-13	5.03E-08	2.75E-07	3.37E-07
572636.2	4182475	1.40E-07	1.25E-08	3.07E-10	1.86E-12	5.33E-08	2.51E-07	4.57E-07
572600.4	4182470	1.18E-08	1.11E-08	2.06E-10	1.17E-12	4.15E-08	2.46E-07	3.10E-07
572592.8	4182454	7.30E-09	9.88E-09	1.84E-10	1.10E-12	3.68E-08	2.35E-07	2.89E-07
572634.8	4182457	1.33E-07	1.17E-08	2.91E-10	2.04E-12	4.79E-08	2.37E-07	4.30E-07
572535.8	4182647	1.18E-07	5.55E-08	5.35E-10	2.26E-12	5.17E-08	4.65E-07	6.90E-07
572615.4	4182556	9.02E-09	1.57E-08	2.77E-10	4.92E-13	6.72E-08	3.26E-07	4.18E-07
572643.4	4182556	1.44E-08	1.48E-08	2.87E-10	3.07E-13	8.34E-08	3.15E-07	4.28E-07
572660.7	4182626	2.16E-06	1.33E-07	2.74E-10	1.40E-11	1.69E-07	3.47E-07	2.81E-06
573037.4	4182557	1.01E-06	8.51E-09	1.29E-10	7.71E-10	9.13E-08	1.66E-07	1.28E-06
573075.6	4182597	7.98E-07	7.24E-09	1.29E-10	6.14E-10	7.01E-08	1.71E-07	1.05E-06
573090.6	4182592	7.39E-07	6.95E-09	1.26E-10	5.87E-10	6.58E-08	1.67E-07	9.79E-07
573057.4	4182552	9.05E-07	7.95E-09	1.24E-10	7.12E-10	8.19E-08	1.62E-07	1.16E-06
573079.3	4182542	8.03E-07	7.41E-09	1.19E-10	6.54E-10	7.29E-08	1.55E-07	1.04E-06
573110.6	4182581	6.72E-07	6.60E-09	1.22E-10	5.57E-10	6.09E-08	1.61E-07	9.01E-07
573096.2	4182533	7.37E-07	7.03E-09	1.16E-10	6.17E-10	6.69E-08	1.51E-07	9.62E-07
573110.6	4182523	6.84E-07	6.73E-09	1.13E-10	5.79E-10	6.20E-08	1.46E-07	9.00E-07
573129.4	4182565	6.22E-07	6.32E-09	1.16E-10	5.29E-10	5.69E-08	1.54E-07	8.40E-07
573150	4182561	5.67E-07	5.97E-09	1.14E-10	4.94E-10	5.21E-08	1.50E-07	7.76E-07
573128.1	4182513	6.29E-07	6.39E-09	1.09E-10	5.40E-10	5.70E-08	1.42E-07	8.35E-07
573155.1	4182503	5.59E-07	5.92E-09	1.06E-10	4.95E-10	5.06E-08	1.37E-07	7.53E-07
573176.3	4182487	5.08E-07	5.58E-09	1.01E-10	4.61E-10	4.60E-08	1.31E-07	6.91E-07
573285.9	4182733	2.76E-07	3.78E-09	9.61E-11	2.40E-10	2.60E-08	1.30E-07	4.36E-07
573354.8	4182999	1.43E-07	2.68E-09	7.97E-11	1.48E-10	1.36E-08	1.03E-07	2.62E-07
573320.7	4182777	2.29E-07	3.43E-09	9.20E-11	2.21E-10	2.14E-08	1.24E-07	3.78E-07
573409.5	4183138	1.11E-07	2.18E-09	6.74E-11	9.94E-11	1.08E-08	8.91E-08	2.13E-07
572535.2	4183237	1.64E-07	7.10E-09	3.41E-10	1.77E-10	1.67E-08	5.28E-07	7.17E-07
572562.4	4183251	1.59E-07	6.55E-09	3.10E-10	1.72E-10	1.64E-08	4.67E-07	6.50E-07
572598.7	4183278	1.46E-07	5.79E-09	2.69E-10	1.58E-10	1.44E-08	3.88E-07	5.55E-07
572619.1	4183292	1.41E-07	5.45E-09	2.48E-10	1.54E-10	1.38E-08	3.54E-07	5.15E-07
572635.2	4183304	1.38E-07	5.18E-09	2.33E-10	1.48E-10	1.35E-08	3.28E-07	4.85E-07
572579.8	4183261	1.54E-07	6.21E-09	2.90E-10	1.69E-10	1.56E-08	4.31E-07	6.07E-07
572450.9	4182819	1.51E-07	3.65E-08	6.15E-10	1.37E-11	4.67E-08	9.65E-07	1.20E-06
572461.9	4182829	1.62E-07	3.36E-08	6.15E-10	1.85E-11	5.13E-08	9.58E-07	1.21E-06
572472.9	4182850	2.04E-07	3.12E-08	6.44E-10	4.80E-11	5.26E-08	9.90E-07	1.28E-06
572458.9	4182860	1.62E-07	3.01E-08	6.85E-10	3.04E-11	4.85E-08	1.08E-06	1.32E-06
572450.9	4182874	1.66E-07	2.99E-08	7.30E-10	3.97E-11	4.53E-08	1.17E-06	1.41E-06
572432.4	4182892	1.42E-07	2.97E-08	8.03E-10	3.46E-11	4.05E-08	1.35E-06	1.56E-06
572415.5	4182895	1.26E-07	3.14E-08	8.46E-10	2.83E-11	3.82E-08	1.48E-06	1.67E-06
572464.8	4182723	1.68E-07	6.17E-08	4.30E-10	5.42E-12	4.20E-08	6.69E-07	9.41E-07
572448.6	4182734	1.29E-07	5.73E-08	4.54E-10	4.26E-12	3.82E-08	7.15E-07	9.40E-07
572446.4	4182719	1.06E-07	6.33E-08	7.04E-10	3.40E-12	3.74E-08	6.69E-07	8.77E-07
572472.9	4182602	7.20E-09	2.90E-08	2.31E-10	1.48E-12	2.91E-08	3.99E-07	4.65E-07
572408.1	4182798	9.18E-08	4.78E-08	1.03E-09	5.03E-12	3.35E-08	1.02E-06	1.20E-06
572403	4182778	7.81E-08	5.45E-08	1.09E-09	3.72E-12	3.19E-08	9.36E-07	1.10E-06
572389	4182757	5.61E-08	6.91E-08	7.36E-10	2.83E-12	2.81E-08	8.46E-07	1.00E-06
572377.9	4182744	3.81E-08	8.51E-08	5.92E-10	2.26E-12	2.69E-08	7.96E-07	9.47E-07
572393.4	4182899	1.01E-07	3.38E-08	9.37E-10	1.92E-11	3.50E-08	1.67E-06	1.84E-06
573297.2	4183326	1.08E-07	2.07E-09	6.96E-11	8.66E-11	9.91E-09	9.34E-08	2.13E-07
573243.3	4183337	1.13E-07	2.20E-09	7.39E-11	9.30E-11	1.12E-08	9.89E-08	2.25E-07
573230.2	4183355	1.08E-07	2.20E-09	7.39E-11	9.27E-11	1.08E-08	9.93E-08	2.21E-07
573105	4183432	1.11E-07	2.38E-09	8.36E-11	1.07E-10	1.12E-08	1.23E-07	2.47E-07
572951	4183449	1.17E-07	2.79E-09	1.01E-10	1.14E-10	1.23E-08	1.42E-07	2.74E-07
572920.4	4183454	1.09E-07	2.88E-09	1.05E-10	1.10E-10	1.15E-08	1.44E-07	2.68E-07
572895.9	4183462	1.03E-07	2.92E-09	1.07E-10	1.08E-10	1.07E-08	1.45E-07	2.62E-07
572824.6	4183452	9.83E-08	3.20E-09	1.22E-10	1.13E-10	9.80E-09	1.66E-07	2.77E-07
572421.3	4182825	1.12E-07	3.95E-08	7.96E-10	8.96E-12	3.83E-08	1.10E-06	1.29E-06
572413	4182849	1.17E-07	3.76E-08	7.22E-10	1.39E-11	3.85E-08	1.24E-06	1.44E-06
572400.3	4182856	1.04E-07	3.87E-08	7.93E-10	1.25E-11	3.60E-08	1.35E-06	1.53E-06
572375.2	4182855	8.75E-08	4.48E-08	1.35E-09	9.44E-12	3.07E-08	1.48E-06	1.65E-06
572364.3	4182856	8.10E-08	4.75E-08	1.41E-09	8.60E-12	2.89E-08	1.56E-06	1.72E-06
572379.8	4182829	8.28E-08	4.91E-08	1.23E-09	6.45E-12	3.00E-08	1.28E-06	1.44E-06
572392.1	4182813	8.63E-08	4.91E-08	1.13E-09	5.63E-12	3.12E-08	1.14E-06	1.31E-06
572339.6	4182765	3.10E-08	1.18E-07	5.90E-10	2.29E-12	2.28E-08	9.40E-07	1.11E-06
572360.6	4182785	5.37E-08	7.54E-08	8.55E-10	3.25E-12	2.53E-08	1.02E-06	1.18E-06
572327.8	4182784	3.79E-08	1.19E-07	7.48E-10	2.80E-12	2.14E-08	1.06E-06	1.24E-06
572349.2	4182802	5.23E-08	7.45E-08	9.22E-10	3.47E-12	2.49E-08	1.14E-06	1.30E-06
572317.7	4182794	3.90E-08	1.26E-07	8.17E-10	3.01E-12	2.07E-08	1.14E-06	1.33E-06
572340.1	4182820	5.87E-08	7.26E-08	1.13E-09	4.35E-12	2.44E-08	1.30E-06	1.46E-06
572307.3	4182811	4.55E-08	1.24E-07	1.04E-09	3.71E-12	2.06E-08	1.29E-06	1.49E-06
572294.9	4182828	4.89E-08	1.27E-07	1.27E-09	4.37E-12	2.01E-08	1.47E-06	1.67E-06
572283.1	4182840	5.19E-08	1.40E-07	1.54E-09	5.09E-12	1.94E-08	1.63E-06	1.84E-06
572253.4	4182869	5.11E-08	1.47E-07	2.10E-09	6.21E-12	1.75E-08	2.12E-06	2.34E-06
572270.8	4182862	5.58E-08	1.20E-07	1.74E-09	6.39E-12	1.86E-08	1.98E-06	2.17E-06
572283.9	4182861	5.82E-08	9.85E-08	1.69E-09	6.47E-12	1.96E-08	1.95E-06	2.13E-06
572305.9	4182857	6.30E-08	7.85E-08	1.55E-09	6.59E-12	2.14E-08	1.81E-06	1.97E-06
572317.3	4182846	6.31E-08	7.59E-08	1.57E-09	5.97E-12	2.23E-08	1.63E-06	1.80E-06
572328.2	4182831	5.60E-08	7.46E-08	1.20E-09	4.56E-12	2.32E-08	1.44E-06	1.59E-06
572224.7	4182903	5.05E-08	1.51E-07	2.38E-09	7.75E-12	1.60E-08	3.05E-06	3.27E-06
572247	4182908	5.62E-08	1.02E-07	2.31E-09	8.91E-12	1.77E-08	3.22E-06	3.40E-06

572266.2	4182907	6.42E-C8	8.18E-08	2.05E-09	1.06E-11	1.92E-08	3.11E-06	3.27E-06
572280.8	4182906	6.96E-C8	7.16E-08	2.02E-09	1.18E-11	2.05E-08	2.93E-06	3.10E-06
572299.4	4182906	7.46E-C8	6.09E-08	1.78E-09	1.31E-11	2.24E-08	2.74E-06	2.90E-06
572319.1	4182901	8.12E-C8	5.35E-08	1.03E-09	1.45E-11	2.46E-08	2.45E-06	2.61E-06
572336.9	4182895	7.88E-C8	4.82E-08	1.75E-09	1.28E-11	2.68E-08	2.18E-06	2.33E-06
572357.4	4182897	8.41E-C8	4.18E-08	1.58E-09	1.44E-11	3.00E-08	2.00E-06	2.15E-06
572377.9	4182898	9.38E-C8	3.69E-08	1.15E-09	1.71E-11	3.29E-08	1.80E-06	1.97E-06
572194.1	4182872	3.57E-C8	4.76E-08	1.27E-09	4.91E-12	1.42E-08	1.93E-06	2.03E-06
572211	4182846	3.73E-C8	5.10E-08	1.30E-09	4.71E-12	1.44E-08	1.62E-06	1.72E-06
572253.9	4182814	4.36E-C8	7.92E-08	1.34E-09	4.58E-12	1.62E-08	1.32E-06	1.46E-06
572273.5	4182788	4.25E-C8	7.86E-08	1.02E-09	3.97E-12	1.76E-08	1.11E-06	1.25E-06
572285.3	4182777	3.67E-C8	8.29E-08	8.40E-10	3.21E-12	1.85E-08	1.03E-06	1.17E-06
572294	4182758	3.06E-C8	7.05E-08	6.54E-10	2.61E-12	1.85E-08	9.22E-07	1.04E-06
572300.4	4182749	2.72E-C8	6.91E-08	5.70E-10	2.34E-12	1.83E-08	8.80E-07	9.95E-07
572313.1	4182735	2.39E-C8	7.48E-08	4.93E-10	2.07E-12	1.81E-08	8.17E-07	9.35E-07
572247.5	4182806	4.23E-C8	6.00E-08	1.22E-09	4.52E-12	1.59E-08	1.23E-06	1.35E-06
572218.3	4182828	3.68E-C8	4.58E-08	1.16E-09	4.42E-12	1.43E-08	1.40E-06	1.50E-06
572187.3	4182822	3.04E-C8	2.59E-08	8.08E-10	3.99E-12	1.31E-08	1.19E-06	1.26E-06
572197.3	4182789	3.52E-C8	2.41E-08	1.05E-09	4.36E-12	1.34E-08	9.79E-07	1.05E-06
572248.8	4182789	4.18E-C8	4.92E-08	1.06E-09	4.37E-12	1.62E-08	1.09E-06	1.20E-06
572243.8	4182776	5.19E-C8	3.98E-08	4.36E-10	5.98E-12	1.56E-08	9.90E-07	1.10E-06
572246.1	4182764	5.28E-C8	3.63E-08	3.97E-10	5.96E-12	1.50E-08	9.16E-07	1.02E-06
572195.5	4182774	3.47E-C8	2.12E-08	9.37E-10	4.22E-12	1.26E-08	8.76E-07	9.45E-07
572177.3	4182764	2.83E-C8	1.64E-08	5.70E-10	3.50E-12	1.11E-08	7.34E-07	7.90E-07
572172.7	4182747	2.50E-C8	1.39E-08	4.62E-10	3.03E-12	1.03E-08	6.47E-07	6.97E-07
572178.2	4182735	2.75E-C8	1.40E-08	5.01E-10	3.18E-12	1.04E-08	6.17E-07	6.70E-07
572225.1	4182740	4.05E-C8	2.24E-08	8.06E-10	4.28E-12	1.23E-08	7.90E-07	8.66E-07
572242.4	4182754	4.89E-C8	3.14E-08	4.62E-10	5.29E-12	1.40E-08	8.62E-07	9.57E-07
572361.5	4182735	2.89E-C8	1.21E-07	5.14E-10	2.04E-12	2.37E-08	7.80E-07	9.54E-07
572371.1	4182743	3.35E-C8	9.31E-08	5.57E-10	2.15E-12	2.60E-08	8.01E-07	9.54E-07
572397.5	4182668	2.14E-C8	1.59E-07	3.83E-10	1.88E-12	2.44E-08	5.60E-07	7.65E-07
572382.2	4182695	2.88E-C8	1.41E-07	4.70E-10	2.01E-12	2.25E-08	6.35E-07	8.28E-07
572270.5	4182711	3.22E-C8	2.85E-08	5.78E-10	2.76E-12	1.44E-08	6.79E-07	7.54E-07
572270.9	4182732	3.75E-C8	3.58E-08	6.89E-10	3.25E-12	1.45E-08	7.64E-07	8.52E-07
572225.3	4182720	3.86E-C8	1.94E-08	7.40E-10	3.88E-12	1.22E-08	7.11E-07	7.82E-07
572218.9	4182703	3.55E-C8	1.61E-08	6.65E-10	3.58E-12	1.24E-08	6.35E-07	6.99E-07
572214.8	4182688	2.78E-C8	1.39E-08	5.50E-10	2.91E-12	1.21E-08	5.77E-07	6.32E-07
572208.9	4182673	2.67E-C8	1.23E-08	5.09E-10	2.96E-12	1.12E-08	5.20E-07	5.70E-07
572174.3	4182685	2.19E-C8	1.03E-08	3.71E-10	2.68E-12	1.04E-08	4.65E-07	5.08E-07
572172.9	4182704	2.49E-C8	1.14E-08	4.28E-10	2.92E-12	1.07E-08	5.09E-07	5.56E-07
572137.3	4182716	9.02E-C9	4.39E-09	8.75E-11	1.53E-12	9.66E-09	5.17E-07	5.40E-07
572130	4182697	5.84E-C9	2.47E-09	5.10E-11	1.27E-12	9.35E-09	4.69E-07	4.86E-07
572166.5	4182667	1.84E-C8	8.73E-09	3.07E-10	2.43E-12	9.38E-09	4.19E-07	4.56E-07
572173.3	4182652	2.03E-C8	8.63E-09	3.19E-10	2.60E-12	8.81E-09	3.96E-07	4.35E-07
572145.5	4182651	9.33E-C9	4.89E-09	1.24E-10	1.68E-12	8.06E-09	3.82E-07	4.05E-07
572137.3	4182677	6.67E-C9	3.24E-09	7.13E-11	1.38E-12	8.96E-09	4.27E-07	4.46E-07
572175.6	4182631	2.08E-C8	8.10E-09	3.04E-10	2.70E-12	8.42E-09	3.64E-07	4.02E-07
572177.9	4182616	2.05E-C8	7.81E-09	2.93E-10	2.80E-12	8.41E-09	3.45E-07	3.82E-07
572207.6	4182636	2.28E-C8	9.90E-09	3.94E-10	2.73E-12	9.36E-09	4.32E-07	4.75E-07
572208.9	4182652	2.34E-C8	1.07E-08	4.31E-10	2.72E-12	9.92E-09	4.68E-07	5.13E-07
572219.4	4182603	2.03E-C8	9.07E-09	3.51E-10	2.83E-12	9.47E-09	3.94E-07	4.33E-07
572212.1	4182621	2.32E-C8	9.59E-09	3.86E-10	2.86E-12	9.38E-09	4.12E-07	4.54E-07
572191	4183185	7.07E-C8	1.36E-08	6.44E-10	5.14E-11	1.31E-08	2.67E-06	2.77E-06
572213	4183202	9.02E-C8	1.25E-08	6.69E-10	9.33E-11	1.37E-08	2.35E-06	2.47E-06
572235.1	4183173	9.66E-C8	1.56E-08	7.06E-10	9.83E-11	1.48E-08	2.97E-06	3.09E-06
572227.1	4183158	7.83E-C8	1.75E-08	7.15E-10	5.65E-11	1.47E-08	3.59E-06	3.70E-06
572207.4	4183157	6.89E-C8	1.74E-08	6.91E-10	4.45E-11	1.39E-08	3.86E-06	3.96E-06
572187.3	4183150	5.51E-C8	1.80E-08	1.62E-09	3.00E-11	1.34E-08	4.14E-06	4.23E-06
572162.9	4183173	5.70E-C8	1.46E-08	5.84E-10	3.43E-11	1.24E-08	2.87E-06	2.96E-06
572176.5	4183186	6.60E-C8	1.34E-08	6.05E-10	4.57E-11	1.26E-08	2.52E-06	2.61E-06

5 Row

0.159

X	Y	CREEK	ROADWAY	IDLE1	IDLE2	PRIM_STA	LODGE_ST	Total
572674.1	4182680	6.58E-02	1.74E-03	7.74E-06	5.75E-06	1.22E-02	9.80E-03	8.95E-02
572696.3	4182607	1.40E-01	2.63E-03	6.77E-06	8.96E-08	7.71E-03	8.30E-03	1.59E-01
572663.3	4182580	3.73E-02	5.04E-04	8.41E-06	6.79E-09	3.21E-03	8.48E-03	4.95E-02
572675.9	4182539	3.68E-02	4.51E-04	5.99E-06	2.57E-08	2.95E-03	7.72E-03	4.79E-02
572632.6	4182608	3.61E-02	3.34E-03	7.18E-06	4.59E-07	2.95E-03	9.49E-03	5.18E-02
572614	4182650	2.82E-02	3.76E-03	8.17E-06	6.04E-07	3.01E-03	1.07E-02	4.56E-02
572552.9	4182655	6.84E-03	1.66E-03	8.81E-06	8.23E-08	1.69E-03	1.24E-02	2.26E-02
572530.8	4182664	5.64E-03	2.83E-03	9.20E-06	8.94E-08	1.43E-03	1.32E-02	2.31E-02
572560.2	4182568	4.11E-04	5.72E-04	7.70E-06	3.62E-08	1.32E-03	9.17E-03	1.15E-02
572560.6	4182598	4.18E-03	9.01E-04	1.11E-05	7.65E-08	1.48E-03	1.03E-02	1.68E-02
572578.8	4182544	2.58E-04	4.40E-04	6.67E-06	2.61E-08	1.43E-03	8.42E-03	1.06E-02
572562	4182537	9.72E-05	3.04E-04	4.63E-06	1.88E-08	1.27E-03	8.17E-03	9.85E-03
572539.4	4182534	1.33E-04	3.55E-04	4.91E-06	2.79E-08	1.24E-03	8.13E-03	9.86E-03
572624.9	4182519	1.25E-04	3.19E-04	6.01E-06	1.40E-08	1.70E-03	7.74E-03	9.89E-03
572604.1	4182505	6.91E-05	2.44E-04	4.40E-06	1.37E-08	1.34E-03	7.34E-03	8.99E-03
572636.2	4182475	3.73E-03	3.34E-04	8.18E-06	4.96E-08	1.42E-03	6.70E-03	1.22E-02
572600.4	4182470	3.15E-04	2.95E-04	5.50E-06	3.13E-08	1.11E-03	6.55E-03	8.27E-03
572592.8	4182454	1.95E-04	2.63E-04	4.91E-06	2.94E-08	9.80E-04	6.27E-03	7.72E-03
572634.8	4182457	3.55E-03	3.11E-04	7.74E-06	5.44E-08	1.28E-03	6.30E-03	1.15E-02
572535.8	4182647	3.15E-03	1.48E-03	1.43E-05	6.04E-08	1.38E-03	1.24E-02	1.84E-02
572615.4	4182556	2.40E-04	4.17E-04	7.37E-06	1.31E-08	1.79E-03	8.69E-03	1.11E-02
572643.4	4182556	3.85E-04	3.95E-04	7.64E-06	8.18E-09	2.22E-03	8.40E-03	1.14E-02
572660.7	4182626	5.76E-02	3.55E-03	7.31E-06	3.73E-07	4.51E-03	9.24E-03	7.49E-02
573037.4	4182557	2.70E-02	2.27E-04	3.43E-06	2.05E-05	2.43E-03	4.44E-03	3.41E-02
573075.6	4182597	2.13E-02	1.93E-04	3.45E-06	1.64E-05	1.87E-03	4.56E-03	2.79E-02
573090.6	4182592	1.97E-02	1.85E-04	3.36E-06	1.56E-05	1.75E-03	4.45E-03	2.61E-02
573057.4	4182552	2.41E-02	2.12E-04	3.30E-06	1.90E-05	2.18E-03	4.31E-03	3.08E-02
573079.3	4182542	2.14E-02	1.98E-04	3.17E-06	1.74E-05	1.94E-03	4.14E-03	2.77E-02
573110.6	4182581	1.79E-02	1.76E-04	3.26E-06	1.48E-05	1.62E-03	4.29E-03	2.40E-02
573096.2	4182533	1.96E-02	1.87E-04	3.10E-06	1.64E-05	1.78E-03	4.02E-03	2.56E-02
573110.6	4182523	1.82E-02	1.79E-04	3.01E-06	1.54E-05	1.65E-03	3.90E-03	2.40E-02
573129.4	4182565	1.66E-02	1.68E-04	3.10E-06	1.41E-05	1.52E-03	4.11E-03	2.24E-02
573150	4182561	1.51E-02	1.59E-04	3.03E-06	1.32E-05	1.39E-03	4.01E-03	2.07E-02
573128.1	4182513	1.68E-02	1.70E-04	2.91E-06	1.44E-05	1.52E-03	3.79E-03	2.23E-02
573155.1	4182503	1.49E-02	1.58E-04	2.82E-06	1.32E-05	1.35E-03	3.64E-03	2.01E-02
573176.3	4182487	1.35E-02	1.49E-04	2.69E-06	1.23E-05	1.23E-03	3.49E-03	1.84E-02
573285.9	4182733	7.35E-03	1.01E-04	2.56E-06	6.39E-06	6.93E-04	3.46E-03	1.16E-02
573354.8	4182999	3.80E-03	7.15E-05	2.13E-06	3.95E-06	3.61E-04	2.74E-03	6.98E-03
573320.7	4182777	6.11E-03	9.14E-05	2.45E-06	5.89E-06	5.70E-04	3.30E-03	1.01E-02
573409.5	4183138	2.96E-03	5.80E-05	1.80E-06	2.65E-06	2.88E-04	2.37E-03	5.69E-03
572535.2	4183237	4.37E-03	1.89E-04	9.08E-06	4.70E-06	4.44E-04	1.41E-02	1.91E-02
572562.4	4183251	4.25E-03	1.75E-04	8.25E-06	4.59E-06	4.36E-04	1.24E-02	1.73E-02
572598.7	4183278	3.90E-03	1.54E-04	7.17E-06	4.21E-06	3.84E-04	1.03E-02	1.48E-02
572619.1	4183292	3.77E-03	1.45E-04	6.62E-06	4.10E-06	3.68E-04	9.43E-03	1.37E-02
572635.2	4183304	3.67E-03	1.38E-04	6.21E-06	3.94E-06	3.60E-04	8.74E-03	1.29E-02
572579.8	4183261	4.11E-03	1.65E-04	7.72E-06	4.50E-06	4.15E-04	1.15E-02	1.62E-02
572450.9	4182819	4.02E-03	9.74E-04	1.64E-05	3.65E-07	1.24E-03	2.57E-02	3.20E-02
572461.9	4182829	4.31E-03	8.97E-04	1.64E-05	4.92E-07	1.37E-03	2.55E-02	3.21E-02
572472.9	4182850	5.44E-03	8.31E-04	1.72E-05	1.28E-06	1.40E-03	2.64E-02	3.41E-02
572458.9	4182860	4.32E-03	8.03E-04	1.83E-05	8.11E-07	1.29E-03	2.88E-02	3.52E-02

572450.9	4182874	4.41E-03	7.96E-04	1.95E-05	1.06E-06	1.21E-03	3.12E-02	3.77E-02
572432.4	4182892	3.77E-03	7.92E-04	2.14E-05	9.23E-07	1.08E-03	3.60E-02	4.17E-02
572415.5	4182895	3.34E-03	8.37E-04	2.26E-05	7.53E-07	1.02E-03	3.94E-02	4.46E-02
572464.8	4182723	4.47E-03	1.65E-03	1.15E-05	1.44E-07	1.12E-03	1.78E-02	2.51E-02
572448.6	4182734	3.44E-03	1.53E-03	1.21E-05	1.13E-07	1.02E-03	1.91E-02	2.50E-02
572446.4	4182719	2.83E-03	1.69E-03	1.88E-05	9.05E-08	9.96E-04	1.78E-02	2.34E-02
572472.9	4182602	1.92E-04	7.72E-04	6.17E-06	3.96E-08	7.74E-04	1.06E-02	1.24E-02
572408.1	4182798	2.45E-03	1.27E-03	2.74E-05	1.34E-07	8.93E-04	2.73E-02	3.19E-02
572403	4182778	2.08E-03	1.45E-03	2.91E-05	9.91E-08	8.49E-04	2.49E-02	2.94E-02
572389	4182757	1.50E-03	1.84E-03	1.96E-05	7.54E-08	7.48E-04	2.25E-02	2.66E-02
572377.9	4182744	1.01E-03	2.27E-03	1.58E-05	6.02E-08	7.17E-04	2.12E-02	2.52E-02
572393.4	4182899	2.68E-03	9.02E-04	2.50E-05	5.13E-07	9.33E-04	4.46E-02	4.91E-02
573297.2	4183326	2.87E-03	5.51E-05	1.86E-06	2.31E-06	2.64E-04	2.49E-03	5.69E-03
573243.3	4183337	3.00E-03	5.87E-05	1.97E-06	2.48E-06	2.98E-04	2.64E-03	6.00E-03
573230.2	4183355	2.88E-03	5.87E-05	1.97E-06	2.47E-06	2.89E-04	2.65E-03	5.88E-03
573105	4183432	2.95E-03	6.34E-05	2.23E-06	2.86E-06	2.97E-04	3.28E-03	6.60E-03
572951	4183449	3.11E-03	7.44E-05	2.70E-06	3.03E-06	3.28E-04	3.78E-03	7.29E-03
572920.4	4183454	2.92E-03	7.67E-05	2.80E-06	2.93E-06	3.06E-04	3.83E-03	7.14E-03
572895.9	4183462	2.74E-03	7.79E-05	2.86E-06	2.88E-06	2.85E-04	3.86E-03	6.98E-03
572824.6	4183452	2.62E-03	8.53E-05	3.25E-06	3.00E-06	2.61E-04	4.41E-03	7.39E-03
572421.3	4182825	2.97E-03	1.05E-03	2.12E-05	2.39E-07	1.02E-03	2.93E-02	3.44E-02
572413	4182849	3.12E-03	1.00E-03	1.92E-05	3.71E-07	1.03E-03	3.31E-02	3.83E-02
572400.3	4182856	2.78E-03	1.03E-03	2.11E-05	3.33E-07	9.59E-04	3.59E-02	4.07E-02
572375.2	4182855	2.33E-03	1.19E-03	3.59E-05	2.52E-07	8.17E-04	3.96E-02	4.39E-02
572364.3	4182856	2.16E-03	1.27E-03	3.76E-05	2.29E-07	7.69E-04	4.15E-02	4.57E-02
572379.8	4182829	2.21E-03	1.31E-03	3.28E-05	1.72E-07	7.99E-04	3.41E-02	3.85E-02
572392.1	4182813	2.30E-03	1.31E-03	3.01E-05	1.50E-07	8.32E-04	3.05E-02	3.50E-02
572339.6	4182765	8.28E-04	3.16E-03	1.57E-05	6.10E-08	6.07E-04	2.51E-02	2.97E-02
572360.6	4182785	1.43E-03	2.01E-03	2.28E-05	8.66E-08	6.75E-04	2.72E-02	3.13E-02
572327.8	4182784	1.01E-03	3.16E-03	1.99E-05	7.45E-08	5.71E-04	2.83E-02	3.31E-02
572349.2	4182802	1.39E-03	1.98E-03	2.46E-05	9.25E-08	6.64E-04	3.05E-02	3.45E-02
572317.7	4182794	1.04E-03	3.36E-03	2.18E-05	8.01E-08	5.51E-04	3.04E-02	3.54E-02
572340.1	4182820	1.56E-03	1.93E-03	3.02E-05	1.16E-07	6.49E-04	3.48E-02	3.89E-02
572307.3	4182811	1.21E-03	3.31E-03	2.78E-05	9.89E-08	5.48E-04	3.45E-02	3.96E-02
572294.9	4182828	1.30E-03	3.40E-03	3.38E-05	1.17E-07	5.36E-04	3.92E-02	4.45E-02
572283.1	4182840	1.38E-03	3.74E-03	4.10E-05	1.36E-07	5.17E-04	4.34E-02	4.91E-02
572253.4	4182869	1.36E-03	3.92E-03	5.61E-05	1.66E-07	4.65E-04	5.64E-02	6.22E-02
572270.8	4182862	1.49E-03	3.20E-03	4.65E-05	1.70E-07	4.95E-04	5.27E-02	5.79E-02
572283.9	4182861	1.55E-03	2.63E-03	4.51E-05	1.72E-07	5.21E-04	5.19E-02	5.67E-02
572305.9	4182857	1.68E-03	2.09E-03	4.14E-05	1.76E-07	5.71E-04	4.82E-02	5.26E-02
572317.3	4182846	1.68E-03	2.02E-03	4.18E-05	1.59E-07	5.94E-04	4.36E-02	4.79E-02
572328.2	4182831	1.49E-03	1.99E-03	3.21E-05	1.22E-07	6.19E-04	3.83E-02	4.25E-02
572224.7	4182903	1.35E-03	4.03E-03	6.34E-05	2.07E-07	4.27E-04	8.13E-02	8.71E-02
572247	4182908	1.50E-03	2.71E-03	6.15E-05	2.37E-07	4.72E-04	8.57E-02	9.05E-02
572266.2	4182907	1.71E-03	2.18E-03	5.46E-05	2.83E-07	5.12E-04	8.28E-02	8.72E-02
572280.8	4182906	1.85E-03	1.91E-03	5.40E-05	3.14E-07	5.45E-04	7.82E-02	8.25E-02
572299.4	4182906	1.99E-03	1.62E-03	4.74E-05	3.50E-07	5.96E-04	7.30E-02	7.72E-02
572319.1	4182901	2.16E-03	1.42E-03	2.74E-05	3.86E-07	6.55E-04	6.52E-02	6.95E-02
572336.9	4182895	2.10E-03	1.28E-03	4.66E-05	3.40E-07	7.13E-04	5.80E-02	6.21E-02
572357.4	4182897	2.24E-03	1.11E-03	4.20E-05	3.83E-07	7.99E-04	5.32E-02	5.74E-02
572377.9	4182898	2.50E-03	9.85E-04	3.06E-05	4.56E-07	8.77E-04	4.80E-02	5.24E-02
572194.1	4182872	9.51E-04	1.27E-03	3.38E-05	1.31E-07	3.79E-04	5.14E-02	5.40E-02
572211	4182846	9.95E-04	1.36E-03	3.46E-05	1.26E-07	3.84E-04	4.31E-02	4.59E-02

572253.9	4182814	1.16E-03	2.11E-03	3.56E-05	1.22E-07	4.31E-04	3.52E-02	3.89E-02
572273.5	4182788	1.13E-03	2.09E-03	2.73E-05	1.06E-07	4.69E-04	2.95E-02	3.32E-02
572285.3	4182777	9.78E-04	2.21E-03	2.24E-05	8.56E-08	4.93E-04	2.76E-02	3.13E-02
572294	4182758	8.15E-04	1.88E-03	1.74E-05	6.97E-08	4.92E-04	2.46E-02	2.78E-02
572300.4	4182749	7.25E-04	1.84E-03	1.52E-05	6.22E-08	4.87E-04	2.35E-02	2.65E-02
572313.1	4182735	6.36E-04	1.99E-03	1.31E-05	5.51E-08	4.81E-04	2.18E-02	2.49E-02
572247.5	4182806	1.13E-03	1.60E-03	3.26E-05	1.20E-07	4.23E-04	3.28E-02	3.60E-02
572218.3	4182828	9.81E-04	1.22E-03	3.10E-05	1.18E-07	3.82E-04	3.74E-02	4.00E-02
572187.3	4182822	8.11E-04	6.89E-04	2.15E-05	1.06E-07	3.49E-04	3.16E-02	3.35E-02
572197.3	4182789	9.38E-04	6.42E-04	2.79E-05	1.16E-07	3.58E-04	2.61E-02	2.81E-02
572248.8	4182789	1.11E-03	1.31E-03	2.84E-05	1.16E-07	4.33E-04	2.90E-02	3.19E-02
572243.8	4182776	1.38E-03	1.06E-03	1.16E-05	1.59E-07	4.17E-04	2.64E-02	2.93E-02
572246.1	4182764	1.41E-03	9.68E-04	1.06E-05	1.59E-07	4.01E-04	2.44E-02	2.72E-02
572195.5	4182774	9.24E-04	5.65E-04	2.50E-05	1.12E-07	3.35E-04	2.33E-02	2.52E-02
572177.3	4182764	7.53E-04	4.36E-04	1.52E-05	9.33E-08	2.95E-04	1.96E-02	2.11E-02
572172.7	4182747	6.67E-04	3.71E-04	1.23E-05	8.07E-08	2.75E-04	1.72E-02	1.86E-02
572178.2	4182735	7.32E-04	3.73E-04	1.33E-05	8.47E-08	2.78E-04	1.64E-02	1.78E-02
572225.1	4182740	1.08E-03	5.97E-04	2.15E-05	1.14E-07	3.27E-04	2.11E-02	2.31E-02
572242.4	4182754	1.30E-03	8.36E-04	1.23E-05	1.41E-07	3.74E-04	2.30E-02	2.55E-02
572361.5	4182735	7.69E-04	3.23E-03	1.37E-05	5.43E-08	6.32E-04	2.08E-02	2.54E-02
572371.1	4182743	8.94E-04	2.48E-03	1.48E-05	5.72E-08	6.92E-04	2.13E-02	2.54E-02
572397.5	4182668	5.71E-04	4.24E-03	1.02E-05	5.00E-08	6.50E-04	1.49E-02	2.04E-02
572382.2	4182695	7.67E-04	3.76E-03	1.25E-05	5.36E-08	6.00E-04	1.69E-02	2.21E-02
572270.5	4182711	8.58E-04	7.58E-04	1.54E-05	7.35E-08	3.83E-04	1.81E-02	2.01E-02
572270.9	4182732	1.00E-03	9.54E-04	1.84E-05	8.66E-08	3.86E-04	2.03E-02	2.27E-02
572225.3	4182720	1.03E-03	5.17E-04	1.97E-05	1.03E-07	3.26E-04	1.89E-02	2.08E-02
572218.9	4182703	9.47E-04	4.29E-04	1.77E-05	9.55E-08	3.30E-04	1.69E-02	1.86E-02
572214.8	4182688	7.41E-04	3.72E-04	1.47E-05	7.75E-08	3.21E-04	1.54E-02	1.68E-02
572208.9	4182673	7.11E-04	3.27E-04	1.36E-05	7.88E-08	2.98E-04	1.38E-02	1.52E-02
572174.3	4182685	5.83E-04	2.75E-04	9.90E-06	7.14E-08	2.78E-04	1.24E-02	1.35E-02
572172.9	4182704	6.63E-04	3.03E-04	1.14E-05	7.79E-08	2.86E-04	1.36E-02	1.48E-02
572137.3	4182716	2.40E-04	1.17E-04	2.33E-06	4.07E-08	2.57E-04	1.38E-02	1.44E-02
572130	4182697	1.56E-04	6.59E-05	1.36E-06	3.38E-08	2.49E-04	1.25E-02	1.30E-02
572166.5	4182667	4.90E-04	2.33E-04	8.18E-06	6.46E-08	2.50E-04	1.12E-02	1.21E-02
572173.3	4182652	5.41E-04	2.30E-04	8.51E-06	6.94E-08	2.35E-04	1.06E-02	1.16E-02
572145.5	4182651	2.49E-04	1.30E-04	3.31E-06	4.47E-08	2.15E-04	1.02E-02	1.08E-02
572137.3	4182677	1.78E-04	8.64E-05	1.90E-06	3.69E-08	2.39E-04	1.14E-02	1.19E-02
572175.6	4182631	5.54E-04	2.16E-04	8.09E-06	7.20E-08	2.24E-04	9.71E-03	1.07E-02
572177.9	4182616	5.46E-04	2.08E-04	7.80E-06	7.47E-08	2.24E-04	9.19E-03	1.02E-02
572207.6	4182636	6.08E-04	2.64E-04	1.05E-05	7.28E-08	2.50E-04	1.15E-02	1.26E-02
572208.9	4182652	6.22E-04	2.86E-04	1.15E-05	7.26E-08	2.64E-04	1.25E-02	1.37E-02
572219.4	4182603	5.42E-04	2.42E-04	9.34E-06	7.54E-08	2.52E-04	1.05E-02	1.15E-02
572212.1	4182621	6.19E-04	2.56E-04	1.03E-05	7.63E-08	2.50E-04	1.10E-02	1.21E-02
572191	4183185	1.89E-03	3.63E-04	1.72E-05	1.37E-06	3.50E-04	7.12E-02	7.38E-02
572213	4183202	2.40E-03	3.34E-04	1.78E-05	2.49E-06	3.64E-04	6.28E-02	6.59E-02
572235.1	4183173	2.58E-03	4.15E-04	1.88E-05	2.62E-06	3.94E-04	7.90E-02	8.24E-02
572227.1	4183158	2.09E-03	4.66E-04	1.91E-05	1.50E-06	3.91E-04	9.56E-02	9.86E-02
572207.4	4183157	1.84E-03	4.65E-04	1.84E-05	1.19E-06	3.70E-04	1.03E-01	1.05E-01
572187.3	4183150	1.47E-03	4.80E-04	4.31E-05	8.00E-07	3.56E-04	1.10E-01	1.13E-01
572162.9	4183173	1.52E-03	3.89E-04	1.56E-05	9.14E-07	3.30E-04	7.66E-02	7.88E-02
572176.5	4183186	1.76E-03	3.56E-04	1.61E-05	1.22E-06	3.36E-04	6.71E-02	6.96E-02

								Row	5
Maximum Value		2.81E-02	8.48E-04	1.27E-05					3.18E-02
X	Y	CREEK	ROADWAY	IDLE1	IDLE2	PRIM_STA	LODGE_ST		Total
572674.1	4182680	1.32E-02	3.48E-04	1.55E-06	1.15E-06	2.45E-03	1.96E-03		1.79E-02
572696.3	4182607	2.81E-02	5.25E-04	1.35E-06	1.79E-08	1.54E-03	1.66E-03		3.18E-02
572663.3	4182580	7.47E-03	1.01E-04	1.68E-06	1.36E-09	6.43E-04	1.70E-03		9.91E-03
572675.9	4182539	7.35E-03	9.02E-05	1.20E-06	5.14E-09	5.91E-04	1.54E-03		9.58E-03
572632.6	4182608	7.21E-03	6.68E-04	1.44E-06	9.17E-08	5.90E-04	1.90E-03		1.04E-02
572614	4182650	5.63E-03	7.52E-04	1.63E-06	1.21E-07	6.01E-04	2.14E-03		9.13E-03
572552.9	4182655	1.37E-03	3.31E-04	1.76E-06	1.65E-08	3.38E-04	2.47E-03		4.51E-03
572530.8	4182664	1.13E-03	5.66E-04	1.84E-06	1.79E-08	2.87E-04	2.63E-03		4.61E-03
572560.2	4182568	8.23E-05	1.14E-04	1.54E-06	7.23E-09	2.65E-04	1.83E-03		2.30E-03
572560.6	4182598	8.37E-04	1.80E-04	2.22E-06	1.53E-08	2.95E-04	2.05E-03		3.37E-03
572578.8	4182544	5.16E-05	8.80E-05	1.33E-06	5.22E-09	2.87E-04	1.68E-03		2.11E-03
572562	4182537	1.94E-05	6.09E-05	9.27E-07	3.77E-09	2.54E-04	1.63E-03		1.97E-03
572539.4	4182534	2.65E-05	7.10E-05	9.83E-07	5.58E-09	2.48E-04	1.63E-03		1.97E-03
572624.9	4182519	2.50E-05	6.38E-05	1.20E-06	2.79E-09	3.40E-04	1.55E-03		1.98E-03
572604.1	4182505	1.38E-05	4.88E-05	8.81E-07	2.74E-09	2.68E-04	1.47E-03		1.80E-03
572636.2	4182475	7.45E-04	6.67E-05	1.64E-06	9.91E-09	2.84E-04	1.34E-03		2.44E-03
572600.4	4182470	6.29E-05	5.91E-05	1.10E-06	6.26E-09	2.21E-04	1.31E-03		1.65E-03
572592.8	4182454	3.89E-05	5.27E-05	9.82E-07	5.87E-09	1.96E-04	1.25E-03		1.54E-03
572634.8	4182457	7.10E-04	6.21E-05	1.55E-06	1.09E-08	2.55E-04	1.26E-03		2.29E-03
572535.8	4182647	6.29E-04	2.96E-04	2.85E-06	1.21E-08	2.76E-04	2.48E-03		3.68E-03
572615.4	4182556	4.81E-05	8.34E-05	1.47E-06	2.62E-09	3.58E-04	1.74E-03		2.23E-03
572643.4	4182556	7.70E-05	7.90E-05	1.53E-06	1.64E-09	4.45E-04	1.68E-03		2.28E-03
572660.7	4182626	1.15E-02	7.10E-04	1.46E-06	7.47E-08	9.01E-04	1.85E-03		1.50E-02
573037.4	4182557	5.40E-03	4.54E-05	6.86E-07	4.11E-06	4.87E-04	8.87E-04		6.83E-03
573075.6	4182597	4.25E-03	3.86E-05	6.89E-07	3.27E-06	3.74E-04	9.12E-04		5.58E-03
573090.6	4182592	3.94E-03	3.70E-05	6.72E-07	3.13E-06	3.51E-04	8.90E-04		5.22E-03
573057.4	4182552	4.82E-03	4.24E-05	6.61E-07	3.79E-06	4.36E-04	8.61E-04		6.17E-03
573079.3	4182542	4.28E-03	3.95E-05	6.34E-07	3.49E-06	3.89E-04	8.28E-04		5.54E-03
573110.6	4182581	3.58E-03	3.52E-05	6.52E-07	2.97E-06	3.24E-04	8.58E-04		4.80E-03
573096.2	4182533	3.93E-03	3.75E-05	6.20E-07	3.29E-06	3.57E-04	8.04E-04		5.13E-03
573110.6	4182523	3.65E-03	3.59E-05	6.01E-07	3.09E-06	3.31E-04	7.81E-04		4.80E-03
573129.4	4182565	3.31E-03	3.37E-05	6.20E-07	2.82E-06	3.03E-04	8.23E-04		4.48E-03
573150	4182561	3.02E-03	3.18E-05	6.07E-07	2.63E-06	2.78E-04	8.01E-04		4.14E-03
573128.1	4182513	3.35E-03	3.41E-05	5.82E-07	2.88E-06	3.04E-04	7.57E-04		4.45E-03
573155.1	4182503	2.98E-03	3.16E-05	5.64E-07	2.64E-06	2.70E-04	7.28E-04		4.01E-03
573176.3	4182487	2.71E-03	2.97E-05	5.38E-07	2.46E-06	2.45E-04	6.98E-04		3.68E-03
573285.9	4182733	1.47E-03	2.01E-05	5.12E-07	1.28E-06	1.39E-04	6.92E-04		2.32E-03
573354.8	4182999	7.61E-04	1.43E-05	4.25E-07	7.90E-07	7.22E-05	5.48E-04		1.40E-03
573320.7	4182777	1.22E-03	1.83E-05	4.90E-07	1.18E-06	1.14E-04	6.61E-04		2.02E-03
573409.5	4183138	5.93E-04	1.16E-05	3.59E-07	5.30E-07	5.76E-05	4.75E-04		1.14E-03
572535.2	4183237	8.75E-04	3.78E-05	1.82E-06	9.41E-07	8.88E-05	2.82E-03		3.82E-03
572562.4	4183251	8.50E-04	3.49E-05	1.65E-06	9.18E-07	8.73E-05	2.49E-03		3.46E-03
572598.7	4183278	7.81E-04	3.08E-05	1.43E-06	8.42E-07	7.67E-05	2.07E-03		2.96E-03
572619.1	4183292	7.54E-04	2.90E-05	1.32E-06	8.21E-07	7.36E-05	1.89E-03		2.74E-03
572635.2	4183304	7.33E-04	2.76E-05	1.24E-06	7.89E-07	7.19E-05	1.75E-03		2.58E-03
572579.8	4183261	8.22E-04	3.31E-05	1.54E-06	8.99E-07	8.31E-05	2.30E-03		3.24E-03
572450.9	4182819	8.03E-04	1.95E-04	3.28E-06	7.31E-08	2.49E-04	5.14E-03		6.40E-03
572461.9	4182829	8.62E-04	1.79E-04	3.28E-06	9.84E-08	2.74E-04	5.11E-03		6.43E-03
572472.9	4182850	1.09E-03	1.66E-04	3.43E-06	2.56E-07	2.81E-04	5.28E-03		6.81E-03
572458.9	4182860	8.65E-04	1.61E-04	3.65E-06	1.62E-07	2.59E-04	5.76E-03		7.05E-03
572450.9	4182874	8.82E-04	1.59E-04	3.89E-06	2.12E-07	2.41E-04	6.25E-03		7.53E-03
572432.4	4182892	7.55E-04	1.58E-04	4.28E-06	1.85E-07	2.16E-04	7.20E-03		8.34E-03
572415.5	4182895	6.69E-04	1.67E-04	4.51E-06	1.51E-07	2.04E-04	7.88E-03		8.92E-03
572464.8	4182723	8.95E-04	3.29E-04	2.29E-06	2.89E-08	2.24E-04	3.56E-03		5.02E-03
572448.6	4182734	6.88E-04	3.05E-04	2.42E-06	2.27E-08	2.04E-04	3.81E-03		5.01E-03
572446.4	4182719	5.66E-04	3.37E-04	3.75E-06	1.81E-08	1.99E-04	3.57E-03		4.67E-03
572472.9	4182602	3.84E-05	1.54E-04	1.23E-06	7.91E-09	1.55E-04	2.13E-03		2.48E-03
572408.1	4182798	4.89E-04	2.55E-04	5.49E-06	2.68E-08	1.79E-04	5.46E-03		6.39E-03
572403	4182778	4.16E-04	2.91E-04	5.82E-06	1.98E-08	1.70E-04	4.99E-03		5.87E-03
572389	4182757	2.99E-04	3.68E-04	3.92E-06	1.51E-08	1.50E-04	4.51E-03		5.33E-03
572377.9	4182744	2.03E-04	4.54E-04	3.15E-06	1.20E-08	1.43E-04	4.24E-03		5.05E-03
572393.4	4182899	5.36E-04	1.80E-04	4.99E-06	1.03E-07	1.87E-04	8.91E-03		9.82E-03
573297.2	4183326	5.75E-04	1.10E-05	3.71E-07	4.62E-07	5.28E-05	4.98E-04		1.14E-03
573243.3	4183337	6.00E-04	1.17E-05	3.94E-07	4.95E-07	5.97E-05	5.27E-04		1.20E-03
573230.2	4183355	5.76E-04	1.17E-05	3.94E-07	4.94E-07	5.78E-05	5.29E-04		1.18E-03
573105	4183432	5.91E-04	1.27E-05	4.46E-07	5.72E-07	5.95E-05	6.55E-04		1.32E-03
572951	4183449	6.21E-04	1.49E-05	5.40E-07	6.05E-07	6.57E-05	7.56E-04		1.46E-03
572920.4	4183454	5.83E-04	1.53E-05	5.60E-07	5.85E-07	6.12E-05	7.67E-04		1.43E-03
572895.9	4183462	5.49E-04	1.56E-05	5.73E-07	5.75E-07	5.70E-05	7.73E-04		1.40E-03
572824.6	4183452	5.24E-04	1.71E-05	6.51E-07	6.00E-07	5.22E-05	8.83E-04		1.48E-03
572421.3	4182825	5.94E-04	2.11E-04	4.24E-06	4.77E-08	2.04E-04	5.86E-03		6.88E-03
572413	4182849	6.24E-04	2.01E-04	3.85E-06	7.41E-08	2.05E-04	6.62E-03		7.65E-03
572400.3	4182856	5.57E-04	2.06E-04	4.22E-06	6.66E-08	1.92E-04	7.18E-03		8.14E-03
572375.2	4182855	4.66E-04	2.39E-04	7.18E-06	5.03E-08	1.63E-04	7.91E-03		8.79E-03
572364.3	4182856	4.32E-04	2.53E-04	7.52E-06	4.59E-08	1.54E-04	8.30E-03		9.14E-03
572379.8	4182829	4.41E-04	2.62E-04	6.57E-06	3.44E-08	1.60E-04	6.83E-03		7.70E-03
572392.1	4182813	4.60E-04	2.61E-04	6.03E-06	3.00E-08	1.66E-04	6.10E-03		6.99E-03

572339.6	4182765	1.66E-04	6.31E-04	3.14E-06	1.22E-08	1.21E-04	5.01E-03	5.93E-03
572360.6	4182785	2.86E-04	4.02E-04	4.56E-06	1.73E-08	1.35E-04	5.44E-03	6.26E-03
572327.8	4182784	2.02E-04	6.32E-04	3.99E-06	1.49E-08	1.14E-04	5.67E-03	6.62E-03
572349.2	4182802	2.79E-04	3.97E-04	4.91E-06	1.85E-08	1.33E-04	6.09E-03	6.91E-03
572317.7	4182794	2.08E-04	6.72E-04	4.35E-06	1.60E-08	1.10E-04	6.09E-03	7.08E-03
572340.1	4182820	3.13E-04	3.87E-04	6.05E-06	2.32E-08	1.30E-04	6.95E-03	7.79E-03
572307.3	4182811	2.43E-04	6.63E-04	5.55E-06	1.98E-08	1.10E-04	6.90E-03	7.92E-03
572294.9	4182828	2.61E-04	6.80E-04	6.75E-06	2.33E-08	1.07E-04	7.84E-03	8.90E-03
572283.1	4182840	2.77E-04	7.47E-04	8.20E-06	2.71E-08	1.03E-04	8.68E-03	9.81E-03
572253.4	4182869	2.73E-04	7.83E-04	1.12E-05	3.31E-08	9.31E-05	1.13E-02	1.24E-02
572270.8	4182862	2.97E-04	6.39E-04	9.30E-06	3.41E-08	9.91E-05	1.05E-02	1.16E-02
572283.9	4182861	3.10E-04	5.25E-04	9.03E-06	3.45E-08	1.04E-04	1.04E-02	1.13E-02
572305.9	4182857	3.36E-04	4.19E-04	8.28E-06	3.51E-08	1.14E-04	9.65E-03	1.05E-02
572317.3	4182846	3.37E-04	4.04E-04	8.35E-06	3.18E-08	1.19E-04	8.71E-03	9.58E-03
572328.2	4182831	2.99E-04	3.97E-04	6.42E-06	2.43E-08	1.24E-04	7.67E-03	8.40E-03
572224.7	4182903	2.65E-04	8.06E-04	1.27E-05	4.13E-08	8.54E-05	1.63E-02	1.74E-02
572247	4182908	2.99E-04	5.42E-04	1.23E-05	4.75E-08	9.44E-05	1.71E-02	1.81E-02
572266.2	4182907	3.42E-04	4.36E-04	1.09E-05	5.66E-08	1.02E-04	1.66E-02	1.74E-02
572280.8	4182906	3.71E-04	3.82E-04	1.08E-05	6.28E-08	1.09E-04	1.56E-02	1.65E-02
572299.4	4182906	3.98E-04	3.25E-04	9.49E-06	7.00E-08	1.19E-04	1.46E-02	1.54E-02
572319.1	4182901	4.33E-04	2.85E-04	5.49E-06	7.72E-08	1.31E-04	1.30E-02	1.39E-02
572336.9	4182895	4.20E-04	2.57E-04	9.33E-06	6.80E-08	1.43E-04	1.16E-02	1.24E-02
572357.4	4182897	4.49E-04	2.23E-04	8.40E-06	7.66E-08	1.60E-04	1.06E-02	1.15E-02
572377.9	4182898	5.00E-04	1.97E-04	6.13E-06	9.11E-08	1.75E-04	9.60E-03	1.05E-02
572194.1	4182872	1.90E-04	2.54E-04	6.75E-06	2.62E-08	7.58E-05	1.03E-02	1.08E-02
572211	4182846	1.99E-04	2.72E-04	6.91E-06	2.51E-08	7.68E-05	8.62E-03	9.17E-03
572253.9	4182814	2.32E-04	4.22E-04	7.13E-06	2.44E-08	8.63E-05	7.04E-03	7.79E-03
572273.5	4182788	2.27E-04	4.19E-04	5.46E-06	2.12E-08	9.39E-05	5.90E-03	6.65E-03
572285.3	4182777	1.96E-04	4.42E-04	4.48E-06	1.71E-08	9.86E-05	5.51E-03	6.25E-03
572294	4182758	1.63E-04	3.76E-04	3.49E-06	1.39E-08	9.84E-05	4.92E-03	5.56E-03
572300.4	4182749	1.45E-04	3.68E-04	3.04E-06	1.24E-08	9.75E-05	4.69E-03	5.31E-03
572313.1	4182735	1.27E-04	3.99E-04	2.63E-06	1.10E-08	9.62E-05	4.36E-03	4.98E-03
572247.5	4182806	2.26E-04	3.20E-04	6.51E-06	2.41E-08	8.46E-05	6.56E-03	7.20E-03
572218.3	4182828	1.96E-04	2.44E-04	6.19E-06	2.36E-08	7.64E-05	7.48E-03	8.01E-03
572187.3	4182822	1.62E-04	1.38E-04	4.31E-06	2.13E-08	6.99E-05	6.32E-03	6.70E-03
572197.3	4182789	1.88E-04	1.28E-04	5.58E-06	2.33E-08	7.15E-05	5.22E-03	5.61E-03
572248.8	4182789	2.23E-04	2.62E-04	5.67E-06	2.33E-08	8.66E-05	5.81E-03	6.39E-03
572243.8	4182776	2.77E-04	2.12E-04	2.33E-06	3.19E-08	8.34E-05	5.28E-03	5.85E-03
572246.1	4182764	2.82E-04	1.94E-04	2.12E-06	3.18E-08	8.01E-05	4.88E-03	5.44E-03
572195.5	4182774	1.85E-04	1.13E-04	5.00E-06	2.25E-08	6.69E-05	4.67E-03	5.04E-03
572177.3	4182764	1.51E-04	8.72E-05	3.04E-06	1.87E-08	5.90E-05	3.91E-03	4.21E-03
572172.7	4182747	1.33E-04	7.41E-05	2.46E-06	1.61E-08	5.49E-05	3.45E-03	3.71E-03
572178.2	4182735	1.46E-04	7.46E-05	2.67E-06	1.69E-08	5.56E-05	3.29E-03	3.57E-03
572225.1	4182740	2.16E-04	1.19E-04	4.30E-06	2.28E-08	6.54E-05	4.21E-03	4.62E-03
572242.4	4182754	2.61E-04	1.67E-04	2.46E-06	2.82E-08	7.48E-05	4.60E-03	5.10E-03
572361.5	4182735	1.54E-04	6.46E-04	2.74E-06	1.09E-08	1.26E-04	4.16E-03	5.09E-03
572371.1	4182743	1.79E-04	4.96E-04	2.97E-06	1.14E-08	1.38E-04	4.27E-03	5.08E-03
572397.5	4182668	1.14E-04	8.48E-04	2.04E-06	1.00E-08	1.30E-04	2.98E-03	4.08E-03
572382.2	4182695	1.53E-04	7.52E-04	2.50E-06	1.07E-08	1.20E-04	3.38E-03	4.41E-03
572270.5	4182711	1.72E-04	1.52E-04	3.08E-06	1.47E-08	7.65E-05	3.62E-03	4.02E-03
572270.9	4182732	2.00E-04	1.91E-04	3.67E-06	1.73E-08	7.72E-05	4.07E-03	4.54E-03
572225.3	4182720	2.06E-04	1.03E-04	3.95E-06	2.07E-08	6.52E-05	3.79E-03	4.17E-03
572218.9	4182703	1.89E-04	8.57E-05	3.55E-06	1.91E-08	6.60E-05	3.38E-03	3.73E-03
572214.8	4182688	1.48E-04	7.44E-05	2.93E-06	1.55E-08	6.42E-05	3.08E-03	3.37E-03
572208.9	4182673	1.42E-04	6.55E-05	2.72E-06	1.58E-08	5.95E-05	2.77E-03	3.04E-03
572174.3	4182685	1.17E-04	5.49E-05	1.98E-06	1.43E-08	5.55E-05	2.48E-03	2.71E-03
572172.9	4182704	1.33E-04	6.07E-05	2.28E-06	1.56E-08	5.72E-05	2.71E-03	2.97E-03
572137.3	4182716	4.81E-05	2.34E-05	4.67E-07	8.13E-09	5.15E-05	2.76E-03	2.88E-03
572130	4182697	3.12E-05	1.32E-05	2.72E-07	6.75E-09	4.98E-05	2.50E-03	2.59E-03
572166.5	4182667	9.81E-05	4.65E-05	1.64E-06	1.29E-08	5.00E-05	2.23E-03	2.43E-03
572173.3	4182652	1.08E-04	4.60E-05	1.70E-06	1.39E-08	4.70E-05	2.11E-03	2.32E-03
572145.5	4182651	4.97E-05	2.61E-05	6.62E-07	8.94E-09	4.30E-05	2.04E-03	2.16E-03
572137.3	4182677	3.56E-05	1.73E-05	3.80E-07	7.38E-09	4.78E-05	2.28E-03	2.38E-03
572175.6	4182631	1.11E-04	4.32E-05	1.62E-06	1.44E-08	4.49E-05	1.94E-03	2.14E-03
572177.9	4182616	1.09E-04	4.16E-05	1.56E-06	1.49E-08	4.49E-05	1.84E-03	2.03E-03
572207.6	4182636	1.22E-04	5.28E-05	2.10E-06	1.46E-08	4.99E-05	2.30E-03	2.53E-03
572208.9	4182652	1.24E-04	5.73E-05	2.30E-06	1.45E-08	5.29E-05	2.50E-03	2.73E-03
572219.4	4182603	1.08E-04	4.84E-05	1.87E-06	1.51E-08	5.05E-05	2.10E-03	2.31E-03
572212.1	4182621	1.24E-04	5.11E-05	2.06E-06	1.53E-08	5.00E-05	2.20E-03	2.42E-03
572191	4183185	3.77E-04	7.27E-05	3.43E-06	2.74E-07	6.99E-05	1.42E-02	1.48E-02
572213	4183202	4.81E-04	6.68E-05	3.56E-06	4.98E-07	7.28E-05	1.26E-02	1.32E-02
572235.1	4183173	5.15E-04	8.31E-05	3.76E-06	5.24E-07	7.88E-05	1.58E-02	1.65E-02
572227.1	4183158	4.17E-04	9.33E-05	3.81E-06	3.01E-07	7.82E-05	1.91E-02	1.97E-02
572207.4	4183157	3.68E-04	9.30E-05	3.69E-06	2.37E-07	7.40E-05	2.06E-02	2.11E-02
572187.3	4183150	2.94E-04	9.60E-05	8.62E-06	1.60E-07	7.12E-05	2.21E-02	2.26E-02
572162.9	4183173	3.04E-04	7.79E-05	3.11E-06	1.83E-07	6.61E-05	1.53E-02	1.58E-02
572176.5	4183186	3.52E-04	7.12E-05	3.22E-06	2.44E-07	6.72E-05	1.34E-02	1.39E-02

								4	Row
Maximum Value		0.00E+00	0.00E+00	0.00E+00				0.00E+00	
X	Y	CREEK	ROADWAY	IDLE1	IDLE2	PRIM_STA	LODGE_ST	Total	
572674.1	4182680	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
572696.3	4182607	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
572663.3	4182580	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
572675.9	4182539	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
572632.6	4182608	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
572614	4182650	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
572552.9	4182655	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
572530.8	4182664	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
572560.2	4182568	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
572560.6	4182598	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
572578.8	4182544	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
572562	4182537	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
572539.4	4182534	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
572624.9	4182519	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
572604.1	4182505	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
572636.2	4182475	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
572600.4	4182470	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
572592.8	4182454	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
572634.8	4182457	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
572535.8	4182647	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
572615.4	4182556	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
572643.4	4182556	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
572660.7	4182626	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
573037.4	4182557	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
573075.6	4182597	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
573090.6	4182592	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
573057.4	4182552	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
573079.3	4182542	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
573110.6	4182581	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
573096.2	4182533	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
573110.6	4182523	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
573129.4	4182565	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
573150	4182561	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
573128.1	4182513	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
573155.1	4182503	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
573176.3	4182487	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
573285.9	4182733	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
573354.8	4182999	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
573320.7	4182777	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
573409.5	4183138	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
572535.2	4183237	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
572562.4	4183251	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
572598.7	4183278	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
572619.1	4183292	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
572635.2	4183304	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
572579.8	4183261	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
572450.9	4182819	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
572461.9	4182829	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
572472.9	4182850	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
572458.9	4182860	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
572450.9	4182874	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
572432.4	4182892	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
572415.5	4182895	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
572464.8	4182723	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
572448.6	4182734	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
572446.4	4182719	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
572472.9	4182602	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
572408.1	4182798	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
572403	4182778	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
572389	4182757	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
572377.9	4182744	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
572393.4	4182899	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
573297.2	4183326	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
573243.3	4183337	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
573230.2	4183355	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
573105	4183432	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
572951	4183449	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
572920.4	4183454	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
572895.9	4183462	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
572824.6	4183452	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
572421.3	4182825	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
572413	4182849	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
572400.3	4182856	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
572375.2	4182855	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
572364.3	4182856	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
572379.8	4182829	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
572392.1	4182813	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
572339.6	4182765	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
572360.6	4182785	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
572327.8	4182784	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
572349.2	4182802	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
572317.7	4182794	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
572340.1	4182820	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
572307.3	4182811	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
572294.9	4182828	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
572283.1	4182840	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
572253.4	4182869	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
572270.8	4182862	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
572283.9	4182861	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
572305.9	4182857	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
572317.3	4182846	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
572328.2	4182831	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
572224.7	4182903	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
572247	4182908	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
572266.2	4182907	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
572280.8	4182906	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
572299.4	4182906	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
572319.1	4182901	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
572336.9	4182895	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
572357.4	4182897	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
572377.9	4182898	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
572194.1	4182872	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
572211	4182846	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
572253.9	4182814	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
572273.5	4182788	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
572285.3	4182777	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
572294	4182758	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
572300.4	4182749	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
572313.1	4182735	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
572247.5	4182806	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
572218.3	4182828	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
572187.3	4182822	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
572197.3	4182789	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
572248.8	4182789	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
572243.8	4182776	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
572246.1	4182764	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
572195.5	4182774	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
572177.3	4182764	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
572172.7	4182747	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
572178.2	4182735	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
572225.1	4182740	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
572242.4	4182754	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
572361.5	4182735	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
572371.1	4182743	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
572397.5	4182668	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
572382.2	4182695	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
572270.5	4182711	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
572270.9	4182732	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
572225.3	4182720	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
572218.9	4182703	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
572214.8	4182688	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
572208.9	4182673	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
572174.3	4182685	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
572172.9	4182704	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
572137.3	4182716	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
572130	4182697	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
572166.5	4182667	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
572173.3	4182652	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
572145.5	4182651	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
572137.3	4182677	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
572175.6	4182631	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
572177.9	4182616	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
572207.6	4182636	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
572208.9	4182652	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
572219.4	4182603	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
572212.1	4182621	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
572191	4183185	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
572213	4183202	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
572235.1	4183173	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
572227.1	4183158	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
572207.4	4183157	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
572187.3	4183150	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
572162.9	4183173	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
572176.5	4183186	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	

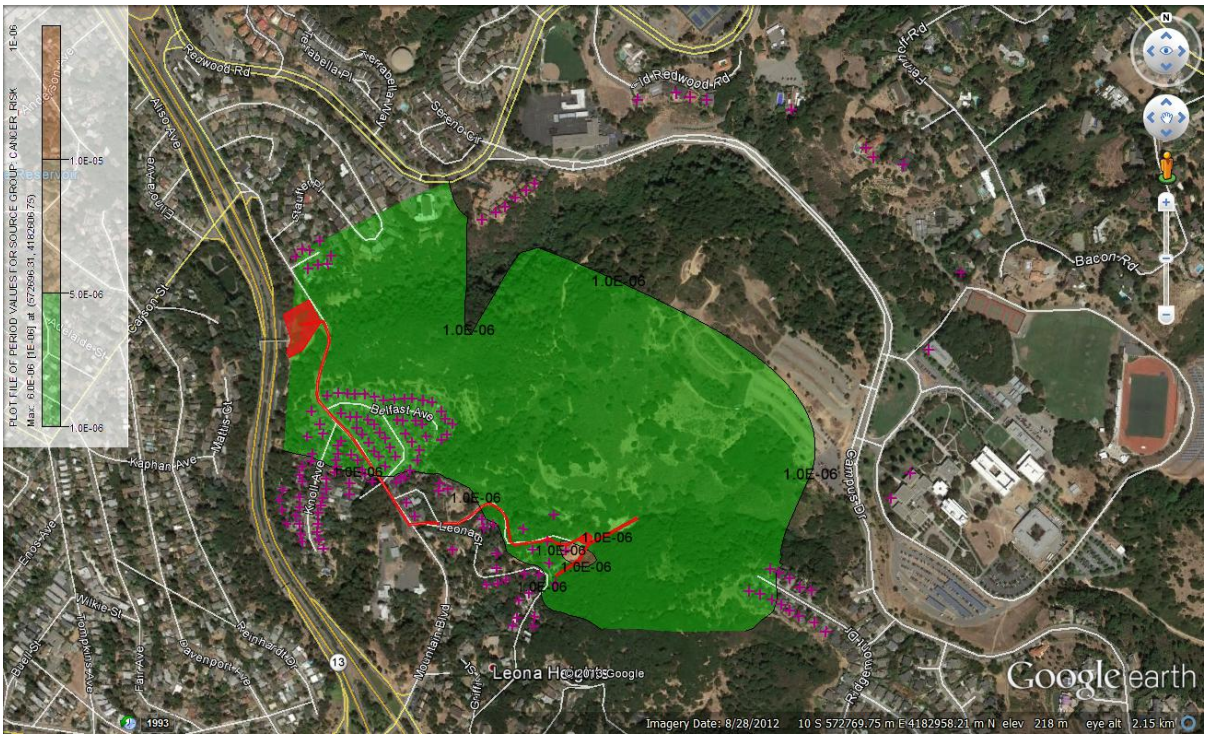
Order	X	Y	CREEK	ROADWAY	IDLE1	IDLE2	PRIM_STA	LODGE_ST
1	572674.125	4182680	62.6894	60.16372	5.64729	4.05249	67.77802	8.86705
2	572696.313	4182606.75	133.8377	90.88994	4.93676	0.06309	42.72609	7.5119
3	572663.312	4182579.5	35.58805	17.45045	6.13498	0.00478	17.80987	7.67384
4	572675.938	4182539	35.03589	15.61272	4.37131	0.01809	16.37655	6.98606
5	572632.562	4182607.75	34.37493	115.56319	5.23369	0.32309	16.36322	8.58905
6	572614	4182649.75	26.84887	130.09573	5.96152	0.42509	16.66141	9.68053
7	572552.938	4182654.75	6.5176	57.36736	6.42364	0.05799	9.3675	11.18261
8	572530.812	4182663.75	5.37785	97.96214	6.71297	0.06295	7.94531	11.90423
9	572560.188	4182567.75	0.39216	19.7927	5.61834	0.02547	7.33984	8.29442
10	572560.625	4182598.25	3.98855	31.18381	8.08498	0.05391	8.18066	9.29204
11	572578.75	4182544.25	0.24582	15.22955	4.86628	0.01837	7.94155	7.61549
12	572562	4182536.75	0.0927	10.53858	3.37876	0.01326	7.04171	7.39024
13	572539.375	4182534.25	0.1264	12.29846	3.58347	0.01966	6.87788	7.35394
14	572624.875	4182519	0.11936	11.04386	4.38185	0.00984	9.43027	6.99794
15	572604.062	4182504.5	0.06583	8.43988	3.21123	0.00964	7.43214	6.63635
16	572636.188	4182475	3.55222	11.54763	5.96318	0.0349	7.87004	6.05719
17	572600.438	4182470.25	0.29989	10.22354	4.01063	0.02205	6.13548	5.92332
18	572592.75	4182454.25	0.18561	9.1205	3.58202	0.02068	5.43052	5.67469
19	572634.812	4182457	3.38539	10.75241	5.64678	0.03828	7.08174	5.70382
20	572535.75	4182647	3.0002	51.19158	10.40637	0.04251	7.64616	11.1999
21	572615.375	4182556	0.22922	14.4431	5.37771	0.00924	9.93071	7.86395
22	572643.375	4182555.5	0.36699	13.67572	5.57516	0.00576	12.32109	7.60081
23	572660.688	4182626	54.86517	122.97768	5.33269	0.26302	24.98733	8.35959
24	573037.375	4182557.25	25.75824	7.85598	2.50165	14.46552	13.49537	4.01368
25	573075.562	4182597.25	20.27493	6.68379	2.51278	11.52964	10.36155	4.12656
26	573090.562	4182591.5	18.76761	6.41228	2.45192	11.01327	9.72568	4.02432
27	573057.375	4182552.25	22.99492	7.33983	2.40907	13.36142	12.09903	3.89574
28	573079.312	4182541.5	20.40993	6.83987	2.3137	12.27941	10.77802	3.74626
29	573110.625	4182581	17.07782	6.09074	2.37733	10.45025	8.99373	3.88081
30	573096.188	4182533.25	18.71496	6.49042	2.26194	11.58372	9.89048	3.63856
31	573110.625	4182522.75	17.38733	6.20917	2.1927	10.8638	9.16649	3.53156
32	573129.375	4182565.25	15.79545	5.83111	2.26171	9.93078	8.4086	3.72214
33	573150	4182561	14.40118	5.51218	2.21265	9.27884	7.7013	3.62525
34	573128.125	4182513.25	15.99076	5.89466	2.12282	10.1426	8.4189	3.42501
35	573155.062	4182503.25	14.20394	5.46542	2.05613	9.28855	7.48175	3.29345
36	573176.313	4182487	12.90907	5.14475	1.96264	8.66244	6.79556	3.15629
37	573285.875	4182733	7.00988	3.48776	1.86871	4.49732	3.84067	3.13004
38	573354.75	4182999	3.62545	2.47532	1.5501	2.78193	2.00235	2.47872
39	573320.688	4182776.75	5.82844	3.16462	1.78859	4.15126	3.15933	2.98913
40	573409.5	4183138.25	2.82519	2.00763	1.31014	1.86661	1.59772	2.14794
41	572535.188	4183237	4.1706	6.54892	6.62415	3.31333	2.46189	12.73576
42	572562.438	4183250.75	4.05022	6.04236	6.01714	3.23122	2.41882	11.25714
43	572598.688	4183277.5	3.72221	5.33909	5.23043	2.96346	2.12718	9.35995
44	572619.125	4183291.5	3.59239	5.02462	4.82581	2.88978	2.04056	8.53081
45	572635.188	4183304.25	3.49486	4.78346	4.52786	2.77809	1.99372	7.91053
46	572579.75	4183261	3.91796	5.72607	5.63231	3.16672	2.30273	10.38845
47	572450.875	4182818.5	3.82906	33.70932	11.95143	0.25724	6.90182	23.2718
48	572461.875	4182828.75	4.10912	31.04941	11.95794	0.3466	7.58429	23.1101
49	572472.938	4182850	5.18238	28.75504	12.50941	0.90077	7.77764	23.86057
50	572458.938	4182860.25	4.12141	27.78671	13.3172	0.57115	7.16873	26.04726
51	572450.875	4182874.25	4.20645	27.57277	14.18846	0.74601	6.68706	28.24872
52	572432.438	4182892	3.59746	27.43696	15.61083	0.64971	5.98437	32.58412
53	572415.5	4182895	3.18891	28.96928	16.44944	0.53063	5.64234	35.63186
54	572464.813	4182722.75	4.2661	56.96923	8.35706	0.10168	6.20875	16.12428
55	572448.625	4182733.75	3.27863	52.83445	8.82454	0.07987	5.64397	17.23559
56	572446.438	4182719	2.69768	58.42023	13.68532	0.06377	5.52235	16.1313
57	572472.938	4182602	0.18305	26.72012	4.498	0.02787	4.29257	9.62229
58	572408.125	4182797.75	2.33308	44.07093	20.011	0.09443	4.9484	24.7047
59	572403	4182778	1.98351	50.31589	21.23092	0.06976	4.70597	22.56658
60	572389	4182757.25	1.42618	63.78666	14.31213	0.05309	4.14843	20.39296
61	572377.938	4182744	0.96725	78.51272	11.50044	0.04241	3.97553	19.19516
62	572393.438	4182898.75	2.55616	31.22193	18.21447	0.36097	5.17408	40.30302
63	573297.188	4183326	2.74057	1.90894	1.35313	1.62582	1.46449	2.25279
64	573243.313	4183337.25	2.8612	2.03154	1.43582	1.74477	1.65413	2.38542
65	573230.188	4183354.75	2.74617	2.03387	1.43591	1.74096	1.60151	2.39332
66	573105	4183432.25	2.81568	2.19656	1.62583	2.01273	1.64798	2.96457
67	572951	4183449.25	2.96161	2.57459	1.96812	2.13184	1.82078	3.41739
68	572920.375	4183454.25	2.77954	2.65378	2.04135	2.06016	1.69697	3.4678
69	572895.938	4183462.25	2.61667	2.69817	2.08819	2.02553	1.57886	3.49588
70	572824.562	4183451.75	2.49894	2.95357	2.37377	2.11345	1.44803	3.9926
71	572421.25	4182824.5	2.83315	36.48803	15.46434	0.1681	5.66567	26.51215
72	572413	4182848.5	2.97654	34.71948	14.03675	0.26105	5.68676	29.92835
73	572400.25	4182855.5	2.65283	35.73462	15.40651	0.23446	5.31551	32.46363
74	572375.188	4182854.5	2.22305	41.30715	26.17031	0.17716	4.52924	35.79308
75	572364.25	4182856.25	2.05705	43.85343	27.41476	0.16152	4.26549	37.52638
76	572379.75	4182829	2.1042	45.27114	23.94314	0.12101	4.42819	30.89203
77	572392.062	4182813	2.19395	45.26288	21.9793	0.10576	4.6146	27.5832
78	572339.625	4182765.25	0.7889	109.23893	11.46449	0.04294	3.36385	22.66415
79	572360.562	4182785.25	1.36333	69.58396	16.6258	0.06098	3.74268	24.59469
80	572327.75	4182784.25	0.96351	109.39333	14.54024	0.05249	3.16477	25.64456
81	572349.188	4182801.5	1.32912	68.71028	17.91718	0.06513	3.68164	27.56405
82	572317.688	4182793.75	0.99024	116.26443	15.88066	0.05641	3.05684	27.52588
83	572340.063	4182819.75	1.49059	66.38717	22.04861	0.08158	3.59797	31.43999
84	572307.25	4182811.25	1.15714	114.70032	20.2457	0.06967	3.03665	31.21801
85	572294.875	4182827.5	1.24371	117.54155	24.63003	0.08206	2.9719	35.47665
86	572283.062	4182839.5	1.31805	129.34348	29.9086	0.0956	2.86529	39.2423
87	572253.375	4182868.75	1.29908	135.59567	40.91538	0.11659	2.5801	51.05373
88	572270.75	4182861.75	1.41693	110.67877	33.90327	0.12	2.74643	47.68029
89	572283.938	4182861.25	1.47884	90.32593	32.91565	0.12145	2.89075	46.95714
90	572305.875	4182856.75	1.60095	72.46954	30.1891	0.1237	3.16529	43.64414
91	572317.25	4182846.25	1.60413	70.31225	30.46597	0.11202	3.29564	39.40111
92	572328.188	4182831.25	1.42395	68.8037	23.39433	0.08561	3.42908	34.67559
93	572224.688	4182902.75	1.28331	139.45831	46.23252	0.1455	2.36784	73.50629
94	572247	4182907.75	1.42757	93.83234	44.88284	0.16725	2.61586	77.56899
95	572266.188	4182907	1.6322	75.48911	39.79885	0.19932	2.83725	74.87833
96	572280.75	4182905.5	1.76801	66.10471	39.35043	0.22119	3.022	70.72012
97	572299.438	4182905.5	1.89657	56.21843	34.60266	0.2465	3.30669	66.01099
98	572319.062	4182901	2.0624	49.32119	20.01729	0.27173	3.63301	59.00564
99	572336.875	4182894.75	2.00235	44.44865	34.01686	0.23946	3.95538	52.46812
100	572357.375	4182897	2.13795	38.57174	30.63651	0.26958	4.42912	48.1449
101	572377.875	4182897.75	2.38272	34.39199	22.34861	0.32086	4.86414	43.43868
102	572194.125	4182871.75	0.90652	43.34261	24.62332	0.09225	2.10093	46.49356
103	572211	4182846.25	0.94896	47.32222	25.20133	0.08842	2.12912	38.97163
104	572253.875	4182814	1.10821	73.39231	25.99288	0.0859	2.39155	31.83889
105	572273.5	4182788	1.07968	72.50487	19.89763	0.07448	2.60162	26.69731
106	572285.312	4182776.5	0.93211	76.50735	16.32995	0.06032	2.73255	24.93092
107	572294	4182757.75	0.77669	65.32708	12.70971	0.04907	2.72625	22.23822
108	572300.375	4182749.25	0.69082	63.78907	11.07717	0.04384	2.70253	21.22101
109	572313.125	4182735	0.60674	66.9998	9.57477	0.03878	2.66727	19.70615
110	572247.5	4182805.75	1.07506	55.3787	23.75303	0.08485	2.34494	29.6757
111	572218.312	4182827.5	0.93539	42.26162	22.58645	0.08296	2.11814	33.85183
112	572187.25	4182821.75	0.77354	23.85913	15.70733	0.0749	1.93729	28.6069
113	572197.312	4182788.75	0.89448	22.21305	20.34787	0.08192	1.98193	23.60167
114	572248.813	4182789.25	1.06239	45.41964	20.67744	0.08199	2.39984	26.27928
115	572243.812	4182776	1.31989	36.69407	8.48028	0.11232	2.31167	23.88145
116	572246.125	4182763.75	1.34224	33.49689	7.72358	0.11195	2.22042	22.09572
117	572195.5	4182774.25	0.88095	19.56714	18.21909	0.0792	1.85472	21.12181
118	572177.25	4182763.75	0.71783	15.39516	11.08631	0.06573	1.63663	17.69279
119	572172.688	4182747.25	0.63616	12.82739	8.97724	0.05687	1.52304	15.59981
120	572178.188	4182734.5	0.69788	12.91105	9.73429	0.05964	1.54129	14.88026
121	572225.125	4182739.5	1.0285	20.68025	15.66949	0.08042	1.81265	19.04957
122	572242.438	4182753.75	1.24277	28.93716	8.9736	0.09922	2.07438	20.79515
123	572361.5	4182734.5	0.73313	111.86382	9.99206	0.03823	3.50267	18.80137
124	572371.063	4182743.25	0.85229	85.88319	10.82413	0.04031	3.83578	19.30857
125	572397.5	4182668	0.54401	146.76927	7.44366	0.03521	3.60609	13.49438
126	572382.188	4182694.5	0.73135	130.14995	9.12631	0.03777	3.32438	15.30696
127	572270.5	4182710.75	0.81782	26.25416	11.23914	0.05178	2.12059	16.36363
128	572270.938	4182731.75	0.95384	33.33076	13.38758	0.06101	2.13865	18.4097
129	572225.312	4182720.25	0.98159	17.91572	14.38879	0.07275	1.80706	17.13837
130	572218.938	4182702.5	0.90325	14.83566	12.92923	0.06728	1.83023	15.30497
131	572214.812	4182687.75	0.70662	12.87129	10.68948	0.05459	1.78059	13.92292
132	572208.938	4182672.75	0.67799	11.33764	9.903 24	0.05552	1.65019	12.52802
133	572174.25	4182684.75	0.55535	9.50809	7.21908	0.05026	1.53883	11.20779
134	572172.875	4182703.75	0.63251	10.49903	8.31475	0.05489	1.5867	12.27135
135	572137.313	4182716.25	0.22913	4.35253	1.70141	0.02864	1.42698	12.4658
136	572130	4182697	0.1485	2.28282	0.99198	0.02377	1.38179	11.3002
137	572166.5	4182667.25	0.46749	8.35713	5.96635	0.04553	1.38538	10.10025
138	572173.312	4182651.5	0.51609	7.96121	6.20702	0.04885	1.30183	9.55902
139	572145.5	4182651	0.23714	4.50975	2.41265	0.03147	1.19147	9.21568
140	572137.313	4182677	0.16955	2.991	1.38526	0.02598	1.32399	10.2995
141	572175.625	4182630.75	0.52804	7.47342	5.90307	0.05074	1.24381	8.7827
142	572177.875	4182616.25	0.52093	7.20562	5.68798	0.05264	1.24325	8.31182
143	572207.562	4182636.25	0.57978	9.13642	7.66262	0.05125	1.38362	10.41931
144	572208.938	4182651.75	0.59344	9.91224	8.37921	0.05113	1.46586	11.29185
145	572219.375	4182603	0.51629	8.37125	6.81366	0.0531	1.39937	9.49771
146	572212.125	4182620.75	0.5904	8.84748	7.50577	0.05376	1.38646	9.9299
147	572191	4183184.5	1.79728	12.5839	12.51299	0.96518	1.93838	64.43545
148	572213	4183202	2.2921	11.56216	12.99812	1.75212	2.01857	56.77461
149	572235.062	4183173.25	2.45516	14.3788	13.72856	1.84505	2.18453	71.49083
150	572227.062	4183158.25	1.98886	16.14778	13.90241	1.05971	2.16809	86.51919
151	572207.438	4183157	1.75187	16.39196	13.43871	0.83566	2.05211	93.00206
152	572187.25	4183149.5	1.39935	16.6198	31.43839	0.56361	1.97439	99.92208
153	572162.875	4183172.75	1.44732	13.48262	11.34553	0.64385	1.83192	69.25434
154	572176.5	4183186	1.67762	12.32984	11.75341	0.85823	1.86331	60.69666

Order	X	Y	CREEK	ROADWAY	IDLE1	IDLE2	PRIM_STA	LODGE_ST
1	572674.1	4182680	1265.452	1118.654	180.0277	6494.842	4869.336	1079.591
2	572696.3	4182607	1940.675	1617.065	171.2216	139.1019	6601.809	985.5706
3	572663.3	4182580	1011.542	591.2131	1156.214	15.66095	5871.308	1002.555
4	572675.9	4182539	2957.619	520.3839	169.9216	76.44535	5045.661	953.2833
5	572632.6	4182608	1316.589	1583.792	185.9425	235.7496	5807.904	1074.585
6	572614	4182650	981.0411	1409.154	197.4901	345.8376	4975.909	1147.735
7	572552.9	4182655	735.7806	1598.094	222.7042	101.8212	3635.93	1253.985
8	572530.8	4182664	676.2274	2147.682	230.0339	100.5337	3214.251	1315.476
9	572560.2	4182568	139.1973	764.1879	933.0225	37.91549	3709.867	1102.236
10	572560.6	4182598	744.4912	767.5243	1380.143	73.35616	3882.433	1147.708
11	572578.8	4182544	81.10822	683.4529	771.574	27.57829	3824.339	1046.187
12	572562	4182537	53.90366	402.635	393.0779	22.02115	3462.07	1098.959
13	572539.4	4182534	53.39809	580.929	478.88	28.19911	3114.127	1128.501
14	572624.9	4182519	123.8969	550.8771	626.6275	36.92994	4126.26	974.481
15	572604.1	4182505	80.51024	385.2521	382.5428	34.62152	3654.017	983.6408
16	572636.2	4182475	985.2885	632.8355	974.1412	97.00294	3494.439	904.8106
17	572600.4	4182470	117.4679	719.8912	806.4982	58.72544	3137.215	975.3344
18	572592.8	4182454	94.23062	725.8273	675.1436	55.48815	2873.642	964.8151
19	572634.8	4182457	883.4903	656.3675	998.5784	93.12288	3208.323	924.8066
20	572535.8	4182647	400.6084	1586.234	1674.789	72.43552	3363.042	1283.27
21	572615.4	4182556	110.0981	606.7069	866.0087	19.58407	4645.125	1045.981
22	572643.4	4182556	147.5346	569.0106	970.8001	21.38042	5101.337	1007.974
23	572660.7	4182626	1215.592	2029.514	182.5231	339.9858	6678.309	1024.435
24	573037.4	4182557	821.9819	699.6068	75.78598	375.058	1965.744	619.2578
25	573075.6	4182597	908.1639	618.3024	73.76216	331.4903	1572.369	610.1613
26	573090.6	4182592	867.6279	589.4471	72.19901	311.8413	1598.873	597.9345
27	573057.4	4182552	787.6384	665.3088	72.89567	344.8305	1808.162	606.6434
28	573079.3	4182542	740.8832	633.2081	69.95216	313.6483	1645.878	593.6708
29	573110.6	4182581	811.4482	576.7996	70.94334	287.4931	1517.422	583.5243
30	573096.2	4182533	709.5693	608.746	68.60113	292.1917	1496.418	583.8782
31	573110.6	4182523	677.2374	568.1577	66.49696	274.4195	1443.257	566.1467
32	573129.4	4182565	751.8167	572.4116	66.96062	265.9876	1405.169	568.7752
33	573150	4182561	723.4031	546.7105	65.68227	246.6552	1301.607	556.3468
34	573128.1	4182513	650.0974	560.4014	64.55167	255.6322	1311.682	554.2907
35	573155.1	4182503	618.0341	531.9279	62.50364	231.1852	1155.717	547.7713
36	573176.3	4182487	583.3075	504.3406	60.14117	212.4012	1117.941	523.2787
37	573285.9	4182733	898.1736	269.1691	48.57986	142.3089	863.1617	521.6882
38	573354.8	4182999	955.9667	176.4871	56.24886	121.7065	583.238	495.5338
39	573320.7	4182777	897.5613	243.529	49.75784	131.3173	769.148	495.6273
40	573409.5	4183138	790.721	142.6771	50.35412	97.01662	452.822	489.4619
41	572535.2	4183237	406.2604	172.6242	238.9544	175.7242	681.9829	1675.4
42	572562.4	4183251	414.7692	161.8554	219.0321	173.7249	678.1396	1579.981
43	572598.7	4183278	419.8367	148.8235	192.7525	166.2053	650.0637	1464.988
44	572619.1	4183292	420.3512	142.6037	185.6502	163.1133	642.1793	1396.217
45	572635.2	4183304	425.6312	138.0644	177.2481	158.1178	627.4901	1328.146
46	572579.8	4183261	418.6848	155.124	203.7918	169.4133	675.3395	1525.548
47	572450.9	4182819	408.4149	295.2896	340.5885	85.68993	1719.288	1757.422
48	572461.9	4182829	418.6533	289.3716	337.4411	85.67722	1738.122	1743.211
49	572472.9	4182850	483.4998	560.9999	335.7586	160.202	1700.781	1729.628
50	572458.9	4182860	411.1626	330.2161	355.8796	97.89232	1584.849	1800.697
51	572450.9	4182874	421.197	392.2094	368.7697	129.1878	1510.511	1865.047
52	572432.4	4182892	377.7445	342.6992	396.1308	111.4013	1381.263	1952.614
53	572415.5	4182895	348.6884	364.3312	420.3109	96.2955	1292.52	2039.509
54	572464.8	4182723	522.6722	451.3186	275.3635	105.4822	2189.768	1551.018
55	572448.6	4182734	435.6426	476.7413	292.4286	88.85217	2016.337	1611.61
56	572446.4	4182719	398.0051	526.3255	2365.206	71.03339	2045.792	1590.897
57	572472.9	4182602	71.90652	730.2767	564.9943	42.06193	2488.996	1336.48
58	572408.1	4182798	285.9014	399.0519	3239.324	70.6115	1533.261	1852.136
59	572403	4182778	255.5595	492.9989	3055.052	64.00674	1586.844	1818.308
60	572389	4182757	199.8724	653.7042	2593.148	63.14191	1568.876	1832.425
61	572377.9	4182744	137.9149	669.207	1789.894	49.33843	1526.204	1840.305
62	572393.4	4182899	291.7396	398.496	2205.442	64.36225	1215.421	2126.148
63	573297.2	4183326	652.2965	118.2542	47.92147	79.99336	410.5453	537.5802
64	573243.3	4183337	646.1707	116.7444	50.53522	82.41458	438.7087	561.4443
65	573230.2	4183355	618.0607	114.7178	50.51494	80.93451	427.2602	564.6151
66	573105	4183432	541.5154	103.403	69.44555	95.68179	412.9593	653.269
67	572951	4183449	477.9318	98.00737	85.70079	103.4742	455.8544	781.6896
68	572920.4	4183454	462.2186	97.51457	88.8101	103.8528	457.3284	815.3953
69	572895.9	4183462	442.8509	96.20451	91.75076	104.0789	454.7366	833.2094
70	572824.6	4183452	433.0687	102.6053	104.9071	110.6435	455.0455	927.0017
71	572421.3	4182825	326.8621	325.0925	3340.288	80.32917	1551.195	1863.586
72	572413	4182849	342.6795	345.6662	390.951	69.74778	1423.829	1941.99
73	572400.3	4182856	311.8906	357.6385	1783.314	66.14885	1355.681	2003.541
74	572375.2	4182855	272.8016	394.1433	4224.689	71.73824	1280.859	2083.313
75	572364.3	4182856	247.523	407.8065	4481.122	71.0759	1238.013	2145.6
76	572379.8	4182829	260.792	371.9919	3908.579	74.63553	1358.154	2017.471
77	572392.1	4182813	271.7834	389.4223	3582.75	73.47696	1448.12	1939.824
78	572339.6	4182765	116.6805	948.1458	1454.64	51.36073	1319.271	2031.404
79	572360.6	4182785	187.3002	658.6267	2848.446	63.1216	1373.762	1995.983
80	572327.8	4182784	142.5626	1001.122	2093.045	59.26725	1230.739	2131.899
81	572349.2	4182802	176.4047	590.6141	2884.179	57.2141	1289.385	2080.35
82	572317.7	4182794	148.331	1166.676	2208.218	60.01659	1191.313	2204.699
83	572340.1	4182820	199.612	548.3564	3742.45	54.83747	1192.366	2164.783
84	572307.3	4182811	174.3479	1168.458	3143.144	60.51091	1094.942	2304.893
85	572294.9	4182828	188.3016	1262.165	4029.369	56.80863	1056.746	2422.02
86	572283.1	4182840	201.0497	1464.821	5161.514	54.07129	1018.297	2512.719
87	572253.4	4182869	198.7893	2131.784	6463.888	55.17766	905.3959	2855.015
88	572270.8	4182862	210.9857	1369.955	5985.247	58.35931	958.2175	2683.28
89	572283.9	4182861	213.7598	964.3171	5843.37	61.57602	962.6502	2584.403
90	572305.9	4182857	220.4404	666.6998	5264.386	65.71883	1057.26	2434.714
91	572317.3	4182846	219.3078	609.4799	5026.846	64.55783	1095.042	2345.037
92	572328.2	4182831	188.2876	580.2866	3783.133	56.8687	1157.067	2248.5
93	572224.7	4182903	193.2586	2086.776	7951.708	60.67112	805.4355	3274.537

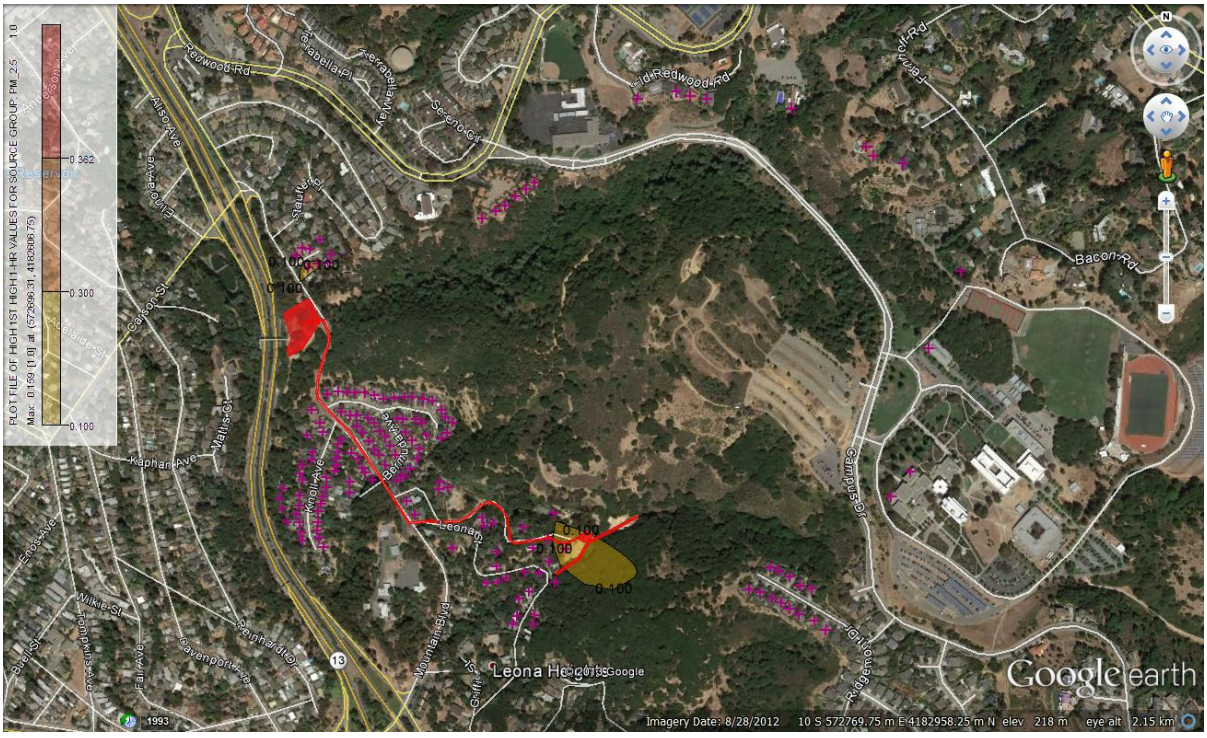
94	572247	4182908	199.8052	1140.833	7786.495	70.69328	849.1412	3023.342
95	572266.2	4182907	226.5523	785.2084	7496.121	78.8426	863.4071	2850.188
96	572280.8	4182906	238.0658	676.402	6915.309	80.84184	923.3522	2733.628
97	572299.4	4182906	251.7633	601.5527	6753.105	76.7199	963.0369	2607.705
98	572319.1	4182901	260.8347	533.4601	3038.015	83.14758	996.3033	2478.124
99	572336.9	4182895	252.0603	492.0026	5639.336	69.65088	1077.329	2371.416
100	572357.4	4182897	259.5893	449.9009	5168.378	67.115	1110.714	2278.144
101	572377.9	4182898	279.7576	421.7711	4825.648	67.77488	1188.185	2186.462
102	572194.1	4182872	156.0211	2063.865	3760.795	49.93039	773.4753	3515.619
103	572211	4182846	172.725	1868.367	4657.653	58.94053	839.7944	3179.04
104	572253.9	4182814	205.0027	1339.482	5092.968	65.40014	949.6186	2643.428
105	572273.5	4182788	205.0158	1315.456	4141.14	63.42419	1052.91	2421.547
106	572285.3	4182777	172.5599	1442.027	2847.13	56.77975	1102.051	2322.098
107	572294	4182758	141.058	1259.148	1970.084	44.35775	1100.643	2217.655
108	572300.4	4182749	120.3636	1265.365	1607.846	39.27275	1185.023	2159.321
109	572313.1	4182735	110.1204	1341.293	1275.953	37.66031	1250.835	2062.007
110	572247.5	4182806	204.6722	1235.703	4915.583	64.56198	960.3095	2667.205
111	572218.3	4182828	176.2523	1520.475	4486.68	59.95412	853.2669	3002.874
112	572187.3	4182822	154.9621	1450.92	3294.081	55.54386	809.8854	3255.412
113	572197.3	4182789	198.8436	1308.124	4826.252	65.0148	846.3719	2952.145
114	572248.8	4182789	215.5067	1130.338	4586.792	60.5659	979.7804	2589.378
115	572243.8	4182776	288.261	1073.467	2026.076	88.07561	974.5595	2565.541
116	572246.1	4182764	301.9128	1018.871	1580.637	91.78401	996.5018	2491.611
117	572195.5	4182774	205.3911	1195.25	4512.935	67.15559	857.7425	2879.969
118	572177.3	4182764	172.9234	1025.915	3422.656	57.12795	827.8371	2934.383
119	572172.7	4182747	158.0988	913.4324	2564.509	52.54049	739.2838	2766.898
120	572178.2	4182735	180.4668	912.0301	3170.138	58.73196	844.0502	2734.965
121	572225.1	4182740	257.0882	982.0489	3751.866	72.53694	910.001	2509.613
122	572242.4	4182754	290.3779	995.2225	3346.732	85.80831	990.8145	2476.916
123	572361.5	4182735	109.142	872.6966	1392.864	44.51917	1452.979	1877.179
124	572371.1	4182743	125.3031	648.7591	1567.141	47.49359	1502.266	1862.9
125	572397.5	4182668	114.8808	1498.085	1148.635	41.69429	1767.14	1623.874
126	572382.2	4182695	131.9361	1462.296	1512.454	43.26233	1641.66	1722.282
127	572270.5	4182711	195.7619	864.8449	2704.714	44.67283	1112.828	2168.189
128	572270.9	4182732	218.4975	881.8262	3329.831	47.99023	1075.224	2242.46
129	572225.3	4182720	256.1048	913.195	3417.313	70.5106	968.1874	2394.781
130	572218.9	4182703	242.0055	835.5659	3261.39	59.57783	958.7168	2363.952
131	572214.8	4182688	202.9313	792.2634	2870.6	49.11067	950.5183	2307.702
132	572208.9	4182673	213.2516	781.1567	2835.271	46.6542	941.9413	2262.538
133	572174.3	4182685	171.2307	729.8638	2330.331	45.57618	852.7532	2367.792
134	572172.9	4182704	182.1289	783.825	2699.611	50.95586	836.1267	2470.591
135	572137.3	4182716	68.57604	355.5027	427.7342	27.33688	763.8707	2781.108
136	572130	4182697	57.58054	205.8101	310.2485	23.54793	755.0401	2541.255
137	572166.5	4182667	147.4939	646.4597	1848.799	43.12604	820.7838	2371.721
138	572173.3	4182652	169.0579	656.2366	2002.465	52.35175	832.9631	2172.532
139	572145.5	4182651	77.17551	441.1064	497.6264	27.01924	783.1503	2333.636
140	572137.3	4182677	64.14921	283.4547	340.3912	23.96503	774.5947	2511.615

141	572175.6	4182631	178.5408	651.0806	2012.769	49.27045	863.2307	2082.346
142	572177.9	4182616	184.2581	636.5547	1983.167	53.72121	853.4357	2022.537
143	572207.6	4182636	190.9428	754.1403	2197.675	49.1305	938.6455	2098.413
144	572208.9	4182652	193.3059	778.0064	2348.075	51.64368	933.9657	2163.139
145	572219.4	4182603	183.3494	669.7272	1856.917	44.98647	975.85	1925.975
146	572212.1	4182621	200.6416	740.2265	2156.737	50.24377	954.9835	2016.837
147	572191	4183185	237.9809	940.5216	828.1834	125.9913	506.8395	4304.493
148	572213	4183202	277.5621	947.8293	702.5049	210.7647	519.365	4355.432
149	572235.1	4183173	288.7012	1064.205	833.9346	215.923	555.7369	4472.775
150	572227.1	4183158	256.1464	1148.452	943.2316	141.6391	563.4247	4719.161
151	572207.4	4183157	230.9332	1132.313	971.7119	111.5391	547.4149	5031.846
152	572187.3	4183150	183.6288	1103.214	9275.284	66.64377	536.103	4727.385
153	572162.9	4183173	194.6951	1022.279	838.9949	73.09423	501.9634	3963.213
154	572176.5	4183186	225.1657	932.329	762.0303	109.5877	501.6979	4043.265

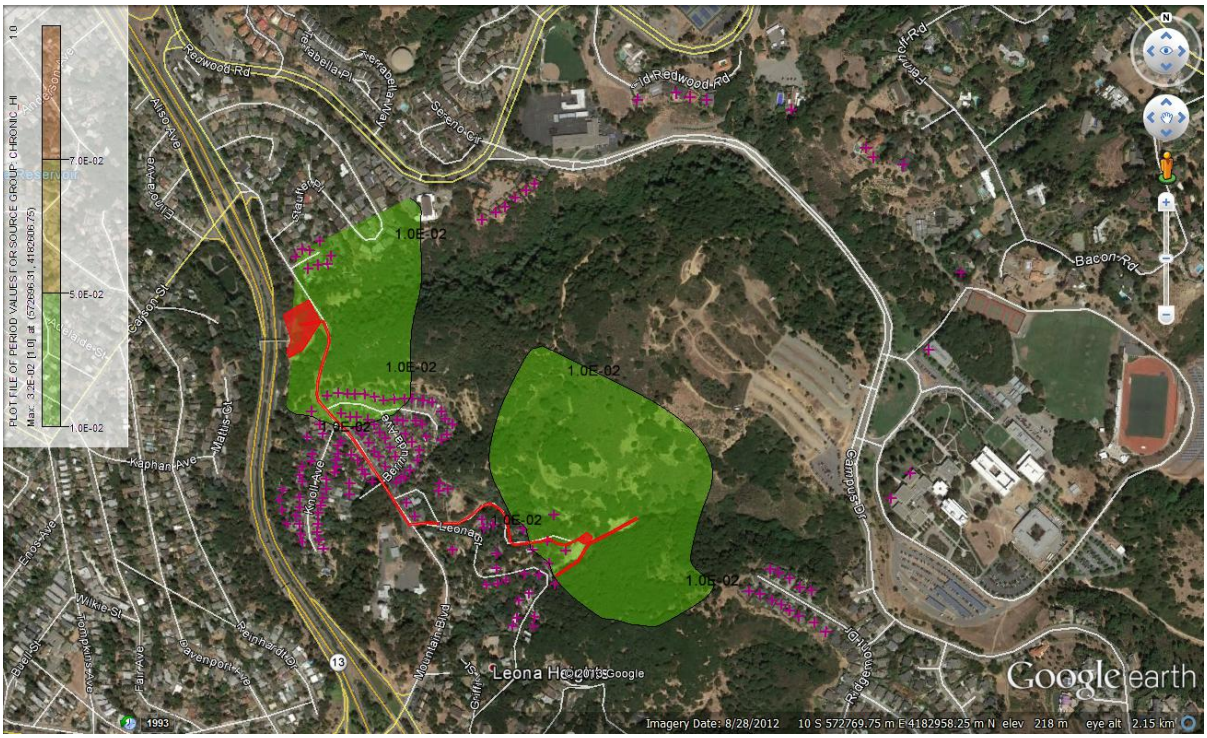
Cancer Risk



PM2.5



Chronic Hazard Index



APPENDIX E

LEONA HEIGHTS SULFUR MINE REMEDIATION PROJECT
TREE SURVEY AND PROTECTION PLAN

LSA ASSOCIATES, INC.
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CARLSBAD
FORT COLLINS
FRESNO
IRVINE
PALM SPRINGS
PT. RICHMOND
RIVERSIDE
ROCKLIN
SAN LUIS OBISPO

MEMORANDUM

DATE: March 21, 2014

TO: Darin Ranelletti, City of Oakland

FROM: Judith Malamut and Tim Milliken, LSA Associates, Inc.

SUBJECT: Leona Heights Sulfur Mine Remediation Project Tree Survey and Protection Plan

This memo provides an update to a previous Tree Survey and Protection Plan memo prepared by LSA Associates Inc., dated November 14, 2014. The purpose of this memo is to describe the results of tree surveys LSA conducted for the Leona Heights Sulfur Mine Remediation project located in Oakland, California (APN 037A-3151-002-06). This update includes revised analysis based on revisions to the project identified in January and February 2014 to protect trees from removal and identify temporary staging areas. The purpose of the tree survey is to identify trees protected by the City of Oakland Protected Trees Ordinance (Chapter 12.36 of the Oakland Municipal Code)[1] occurring within the boundary of the project area which includes the remediation site, two temporary staging areas (overflow parking area for Leona Lodge on Mountain Boulevard and at the southern end of the cul-de-sac on McDonell Avenue adjacent to the remediation site), and the haul route (Mountain Boulevard and McDonell Avenue). The location of the temporary staging areas, as shown in Figure 1, are included as part of the project. No protected (or unprotected) trees would be removed with use of the Leona Lodge staging area. Additionally, this memo is written in support of, and supplementary to, a Tree Removal Permit Application submitted to the City on November 15, 2013. Therefore, this memo also identifies protected trees that will be removed as part of the remediation project and presents a tree protection plan to be implemented during construction to protect retained trees from accidental damage or improper trimming to allow vehicular access.

The proposed project consists of remediation efforts for Leona Creek as required by the Regional Water Quality Control Board's Cleanup and Abatement Order (CAO) as amended in 2013. Criteria set forth in the amended CAO state that the project must prevent further erosion of the mine tailings, encapsulate the mine tailings in a manner which isolates the mining waste from stormwater runoff and contact with groundwater, and provide a design for implementation of creek restoration actions. The former sulfur mine and tailings onsite are proposed to be remediated through relocation of tailings, capping of tailings, and grading of the slopes and creek channel. The proposed project would require the removal of trees within the limits of grading and along the perimeter of the grading area as shown in Figure 2. The limit of disturbance includes a buffer area approximately 5 to 10 feet around the limit of grading. Additionally, the proposed project may require the trimming of some trees along McDonell Avenue and within the temporary staging area located in the overflow parking lot for Leona Lodge on Mountain Boulevard.

[1] Trees protected by Ordinance - OMC Title 12, Chapter 12.36 defines a protected tree as any coast live oak larger than 4 inches in diameter at DBH, or any tree that is larger than 9 inches DBH, except eucalyptus trees or Monterey pines.

METHODS

LSA certified arborist, Timothy Milliken (WE5539A), conducted a tree survey of the remediation site on November 4 and 5, 2013 and March 20, 2014, and a tree survey of the haul route and temporary staging areas on February 5, 2014. Kelly Bray, LSA Planner, also conducted a site visit to the temporary staging area with Mitchell Thomson, City of Oakland Arborist on March 4, 2014.

A total of 186 protected trees were surveyed within and adjacent to the staked boundaries of the work area and eight (8) protected trees were surveyed within the lodge staging area on Mountain Boulevard (194 trees total, see Tables A and B). The survey included and identified all coast live oak trees (Q*uercus agrifolia*, measuring 4 inches in diameter and greater) and all trees with a trunk diameter of 9 inches and greater that occur within the remediation site's work area and within the temporary lodge staging area. Trees within the lodge staging area are identified in Table C (Protected Trees to Remain-Haul Route, Primary Staging and Lodge Staging Area), and have been mapped as shown on Figure 3. Trees along the haul route (Mountain Boulevard and McDonell Avenue) that may need trimming to allow equipment access also are noted in Table C, but have not been specifically mapped or measured. The location of protected trees shown on Figure 3 was approximated on the base topographic survey map in relation to a proposed buffer which was staked in the field at the time of the survey. The location of trees within the work site buffer was analyzed and then categorized as shown on Table A: Protected Trees to Remove - Work Site or as shown on Table B: Protected Trees to Retain – Work Site. A summary of results from the protected tree survey are presented below.

LSA determined that a small grove of approximately 15 eucalyptus trees and acacia trees with a diameter less than 9 inches, which are not protected under the City's Ordinance, will be removed in order to accommodate the primary staging area near the top of the McDonell Avenue cul-de-sac. No protected or non-protected trees will be removed from the Leona Lodge staging area.

RESULTS

A total of 186 protected trees were identified in the project remediation area. The January 2014 revisions to the project made changes to the proposed limit of disturbance (work area) such that 51 trees will be removed and 135 are to remain (see Table 1: Trees in the Survey Area). Within the lodge staging area on Mountain Boulevard eight (8) trees would remain on site and would need to be protected during construction of the project (Table 1). One of these eight protected trees may need minor trimming to allow for equipment access. Protected trees to be removed are identified with a numerical designation in Table A and on Figure 2: Tree Removal and Protection Plan – Work Site. Protected trees to remain after completion of the project are identified with an alphabetical designation in Table B and Table C, and on Figure 2. This analysis identifies a total of 51 protected trees that would be directly impacted (permanently removed) by the mine remediation project.

Table 1: Trees in the Survey Area

Species	Common Name	Remove	Retain
Protected Trees Within the Work Area			
Quercus agrifolia	Coast live oak	51	135
Protected Trees Within the Lodge Staging Area			
Quercus agrifolia	Coast live oak	0	8
	Total	**51**	**143**

Source: E2C, 2014. LSA Associates Inc., 2014.

Tree Protection Measures at the Remediation Site and Staging Area

Protection Measures During Construction. Although a total of 135 trees were mapped outside of the work area, approximately 58 of them are within the 5 to 10 foot buffer line established around the work area. The 58 trees within the 5 to 10 foot buffer line will require protection during construction of the project (by default, all trees behind the 58 trees requiring protection will also be preserved). It is likely that one of the protected trees at the staging area in the overflow parking lot for Leona Lodge on Mountain Boulevard will need trimming of 4 separate limbs (see Table C). All protected trees are coast live oak. The construction contractor must implement best management practices as directed by the Project Arborist (as determined by the project proponent) in compliance with the International Society of Arboriculture (ISA) with regard to protection measures prior to and during construction. Construction activity is not expected to impact these trees as long as the following measures at a minimum are implemented to maintain the health and structural integrity of them. Actual protection measures at the work site may only be adjusted in consultation with the Project Arborist.

A tree protection zone shall be established along the project-facing side of protected tree(s). The tree protection zone is to be installed at a minimum of .75 feet for every inch of diameter of tree trunk, but where possible, at a distance of 1.0 foot for every inch of diameter of tree trunk. No equipment is to operate within the tree protection zone, except when working within the creek bed. The tree protection zone must be delineated with six-foot high chain link fencing and metal posts, and must be installed before construction activities begin. Fencing is not required to extend further than needed to indicate the tree protection zone.

If the contractor encounters roots of protected trees to be retained that extend into the excavation footprint during excavation, these roots shall be cut with a sharp blade (i.e., hand tools or a trenching machine and not a backhoe or excavator) taking care not to rip the roots. Root cutting shall be directly supervised by the Project Arborist.

A preconstruction meeting including the contractor and the Project Arborist shall be conducted to identify subject trees within the lodge staging area on Mountain Boulevard to be pruned ("raised") for equipment access. If pruning is deemed appropriate, then the tree work shall be done by a licensed tree work contractor as directed by the Project Arborist, in compliance with the American National Standards for Tree Care Operations, tree, shrub, and other woody plant maintenance – standard practices (*ANSI a300 [part1]-2001 pruning).* Pruning is only permitted up to 14 feet over roads, and no more than 25 percent of total canopy may be removed unless otherwise approved by the City of Oakland Tree Services Unit.

Monitoring During Construction

Project Compliance. The Project Arborist will be available on an on-call basis during the project construction period. The Project Arborist will be available to answer questions that the project's construction superintendent may have regarding the health of the trees and any modifications proposed within or near the tree protection area. The Project Arborist will be on site during the tree protection and removal period (i.e., when identifying and constructing tree protection zones and pruning) and will undertake periodic inspections to ensure the contractor's compliance with tree protection measures and to evaluate the retained trees for health during construction. Construction personnel are not allowed to prune trees.

During the active construction times, remaining trees will be protected from trunk damage, mounding of soil around trunks, and root damage. The Project Arborist shall be consulted to advise the project's construction superintendent on procedures needed to correct problems.

Post Construction Follow-Up

Removal of Tree Protection Fence and Final Inspection. Clean-up will involve removal of the tree protection fence only after all site development activities have been finalized and risk of tree damage is low.

After completion of the construction period and removal of the tree protection fences, the Project Arborist shall make a final inspection of preserved trees in the sulfur mine remediation area, the temporary staging areas, and the haul route. Any damage to preserved trees shall be reported to the construction contractor and the Tree Services Unit. The Project Arborist shall propose mitigation if any tree damage occurred. The construction contractor shall be responsible for any violation of the Protected Trees Ordinance, Chapter 12.36 of the Oakland Municipal Code.

Removed Trees

In Lieu Fee Payment. As illustrated in Table D, there are 51 protected trees that need to be removed from the project work site. With one exception (tree #117), all trees are healthy. LSA calculated the cumulative trunk area of all trees to be removed, not including hazardous trees, as .002 percent of the total size of the APN 037A-3151-002-06 parcel (as shown in Table D).

Relocation of the trees is not feasible for the following reasons:

- The Water Board would not approve relocation of the trees due to the integration of waste tailings with the root ball of any trees to be relocated resulting in the movement of waste tailings off site.
- Due to the narrow width and tight turns on McDonell Avenue, the types of large equipment needed to relocate the trees likely would be unable to navigate the roadway.
- Steep and hazardous slopes at the site would prohibit the movement of tree removal vehicles in many locations and would not allow for the level of care required to preserve the trees for replanting.
- All of the trees to be removed are coast live oak, which rely on extensive root systems in non-irrigated sites. Substantial changes to mature oaks, such as the ones on site, can weaken or kill the tree.

Replanting oaks on the remediation site is also infeasible. The majority of the project site will be covered with a reinforced impermeable cover system to isolate the tailings from water. The installation of the impermeable liner will prevent trees from establishing root systems, which would deprive them of water. In addition, there are no adjacent areas in which to plant trees due to existing steep slopes and the already heavily-wooded nature of the remainder of the parcel owned by the property owner.

Because relocation and replanting of trees is infeasible for the reasons identified above, the project proponent proposes to provide an in-lieu fee in accordance with section 12.36.060 of the Protected Trees Ordinance for tree removal mitigation at the rate of $475 per tree for the 51 protected trees (for a total of $24,225) to the City of Oakland.

Enclosures: Table A: Protected Trees to Remove – Work Site
Table B: Protected Trees to Retain – Work Site
Table C. Protected Trees to Remain – Haul Route, Primary Staging Area and Lodge Staging Area
Table D: Cumulative Area of Trunks to be Removed from Project Site
Figure 1: Project Location
Figure 2: Tree Removal and Protection Plan- Work Site
Figure 3: Leona Lodge Staging Area Protected Tree Locations

Table A: Protected Trees to Remove – Work Site

Tree #	Common name (*Species name*)	DBH	Status	Notes
1	Coast live oak (*Quercus agrifolia*)	35	Good	3 stem in work area
2	Coast live oak (*Quercus agrifolia*)	13	Good	trailing in work area
3	Coast live oak (*Quercus agrifolia*)	24	Good	3 stem, trailing in work area
4	Coast live oak (*Quercus agrifolia*)	14	Good	5 stem in work area
5	Coast live oak (*Quercus agrifolia*)	9	Good	2 stem in work area
6	Coast live oak (*Quercus agrifolia*)	14	Good	south of waste, east of gate
8	Coast live oak (*Quercus agrifolia*)	8	Good	south of waste, east of gate
9	Coast live oak (*Quercus agrifolia*)	5	Good	south of waste, east of gate
12	Coast live oak (*Quercus agrifolia*)	18	Good	4 stem, south of waste rock
13	Coast live oak (*Quercus agrifolia*)	34	Good	4 stem, south of waste rock
14	Coast live oak (*Quercus agrifolia*)	13	Good	2 stem, south of waste rock
15	Coast live oak (*Quercus agrifolia*)	18	Good	3 stem, south of waste rock
16	Coast live oak (*Quercus agrifolia*)	5	Good	south of waste rock
17	Coast live oak (*Quercus agrifolia*)	11	Good	south of waste rock
21	Coast live oak (*Quercus agrifolia*)	15	Good	south of waste rock
23	Coast live oak (*Quercus agrifolia*)	6	Good	south of waste rock
24	Coast live oak (*Quercus agrifolia*)	14	Good	2 stem, south of waste rock
25	Coast live oak (*Quercus agrifolia*)	10	Good	2 stem, south of waste rock
48	Coast live oak (*Quercus agrifolia*)	15	Good	3 stem, south of waste rock
56	Coast live oak (*Quercus agrifolia*)	5	Good	above influence, top of cliff, south of waste rock
57	Coast live oak (*Quercus agrifolia*)	5	Good	above influence, top of cliff, south of waste rock
58	Coast live oak (*Quercus agrifolia*)	6	Good	above influence, top of cliff, south of waste rock
60	Coast live oak (*Quercus agrifolia*)	38	Good	3 stem, north side upper end
64	Coast live oak (*Quercus agrifolia*)	22	Good	tree in work area
65	Coast live oak (*Quercus agrifolia*)	7	Good	tree in work area
85	Coast live oak (*Quercus agrifolia*)	5	Good	in work area north side
98	Coast live oak (*Quercus agrifolia*)	7	Good	in work area
102	Coast live oak (*Quercus agrifolia*)	28	Good	3 stem in work area
104	Coast live oak (*Quercus agrifolia*)	9	Good	in work area
105	Coast live oak (*Quercus agrifolia*)	23	Good	2 stem in work area
106	Coast live oak (*Quercus agrifolia*)	48	Good	4 stem in work area
107	Coast live oak (*Quercus agrifolia*)	7	Good	in work area
108	Coast live oak (*Quercus agrifolia*)	10	Good	in work area
109	Coast live oak (*Quercus agrifolia*)	34	Good	in work area
110	Coast live oak (*Quercus agrifolia*)	6	Good	in work area
111	Coast live oak (*Quercus agrifolia*)	6	Good	in work area
112	Coast live oak (*Quercus agrifolia*)	51	Good	in work area
113	Coast live oak (*Quercus agrifolia*)	27	Good	2 stem in work area
114	Coast live oak (*Quercus agrifolia*)	18	Good	2 stem in work area
115	Coast live oak (*Quercus agrifolia*)	16	Good	northeast of gate in work area
117	Coast live oak (*Quercus agrifolia*)	50	Poor	north of gate, next to driveway with number sign
118	Coast live oak (*Quercus agrifolia*)	5	Good	south of creek, west of gate, outside of influence
119	Coast live oak (*Quercus agrifolia*)	17	Good	2 stem, southeast of creek, canopy over creek and waste
122	Coast live oak (*Quercus agrifolia*)	9	Good	south of creek, canopy over creek and waste rock
124	Coast live oak (*Quercus agrifolia*)	10	Good	south of creek, canopy over creek and waste rock
126	Coast live oak (*Quercus agrifolia*)	5	Good	south of creek, in slide, large trailing
127	Coast live oak (*Quercus agrifolia*)	6	Good	south of creek, canopy over creek and waste rock
128	Coast live oak (*Quercus agrifolia*)	31	Good	3 stem south of creek, canopy over creek and waste rock
131	Coast live oak (*Quercus agrifolia*)	11	Good	southeast of creek, canopy over creek and waste rock
132	Coast live oak (*Quercus agrifolia*)	20	Good	south of creek, no influence
135	Coast live oak (*Quercus agrifolia*)	15	Good	2 stem tree near bottom of waste rock.
Total Protected Trees to be Removed in Work Area = 51				

Source: LSA Associates, Inc., 2014

Table B: Protected Trees to Retain – Work Site

Tree ID	Common name (*Species name*)	DBH	Status	Notes
A	Coast live oak (*Quercus agrifolia*)	10	Good	south of waste, east of gate
B	Coast live oak (*Quercus agrifolia*)	5	Good	south of waste, east of gate
C	Coast live oak (*Quercus agrifolia*)	19	Good	2 stem, south of waste rock
D	Coast live oak (*Quercus agrifolia*)	8	Good	south of waste rock
E	Coast live oak (*Quercus agrifolia*)	36	Good	trailing, south of waste rock
F	Coast live oak (*Quercus agrifolia*)	18	Good	south of waste rock
G	Coast live oak (*Quercus agrifolia*)	20	Good	south of waste rock
H	Coast live oak (*Quercus agrifolia*)	12	Good	south of waste rock
I	Coast live oak (*Quercus agrifolia*)	36	Good	south of waste rock
J	Coast live oak (*Quercus agrifolia*)	16	Good	south of waste rock
K	Coast live oak (*Quercus agrifolia*)	16	Good	south of waste rock
L	Coast live oak (*Quercus agrifolia*)	8	Good	south of waste rock
M	Coast live oak (*Quercus agrifolia*)	16	Good	south of waste rock
N	Coast live oak (*Quercus agrifolia*)	18	Good	south of waste rock
O	Coast live oak (*Quercus agrifolia*)	30	Good	south of waste rock
P	Coast live oak (*Quercus agrifolia*)	12	Good	south of waste rock
Q	Coast live oak (*Quercus agrifolia*)	24	Good	south of waste rock
R	Coast live oak (*Quercus agrifolia*)	28	Good	south of waste rock
S	Coast live oak (*Quercus agrifolia*)	14	Good	2 stem, above influence, top of cliff, south of waste rock
T	Coast live oak (*Quercus agrifolia*)	9	Good	above influence, top of cliff, south of waste rock
U	Coast live oak (*Quercus agrifolia*)	9	Good	above influence, top of cliff, south of waste rock
V	Coast live oak (*Quercus agrifolia*)	7	Good	above influence, top of cliff, south of waste rock
W	Coast live oak (*Quercus agrifolia*)	14	Good	south of waste rock
X	Coast live oak (*Quercus agrifolia*)	24	Good	top end of survey area, south of waste rock
Y	Coast live oak (*Quercus agrifolia*)	32	Good	north side upper end
Z	Coast live oak (*Quercus agrifolia*)	22	Good	north side out of influence
AA	Coast live oak (*Quercus agrifolia*)	54	Good	tree above staging area will need trim for job site trailer
AB	Coast live oak (*Quercus agrifolia*)	39	Good	2 stem trailing in staging area
AC	Coast live oak (*Quercus agrifolia*)	16	Good	above staging area on cliff
AD	Coast live oak (*Quercus agrifolia*)	5	Good	5 stem in staging area will need trim for job site trailer
AE	Coast live oak (*Quercus agrifolia*)	65	Good	on northern fence line
AF	Coast live oak (*Quercus agrifolia*)	24	Good	in north work area
AG	Coast live oak (*Quercus agrifolia*)	23	Good	3 stem in north work area
AH	Coast live oak (*Quercus agrifolia*)	21	Good	3 stem in work area
AI	Coast live oak (*Quercus agrifolia*)	22	Good	2 stem in north work area
AJ	Coast live oak (*Quercus agrifolia*)	9	Good	in work area north side
AK	Coast live oak (*Quercus agrifolia*)	5	Good	in work area north side
AL	Coast live oak (*Quercus agrifolia*)	5	Good	Landscape of neighboring lot
AM	Coast live oak (*Quercus agrifolia*)	18	Good	southeast of creek, in edge of woods
AN	Coast live oak (*Quercus agrifolia*)	8	Good	southeast of creek, in edge of woods
AO	Coast live oak (*Quercus agrifolia*)	8	Good	southeast of creek, in edge of woods
AP	Coast live oak (*Quercus agrifolia*)	15	Good	south of creek, edge of slide
AQ	Coast live oak (*Quercus agrifolia*)	7	Good	south of creek, edge of slide
AR	Coast live oak (*Quercus agrifolia*)	5	Good	southeast of creek
AS	Coast live oak (*Quercus agrifolia*)	5	Good	southeast of creek
AT	Coast live oak (*Quercus agrifolia*)	9	Good	southeast of creek
AU	Coast live oak (*Quercus agrifolia*)	4	Good	southeast of creek
AV	Coast live oak (*Quercus agrifolia*)	7	Good	southeast of creek
AW	Coast live oak (*Quercus agrifolia*)	7	Good	2 stem south of creek, no waste rock influence
AX	Coast live oak (*Quercus agrifolia*)	20	Good	southeast of creek
AY	Coast live oak (*Quercus agrifolia*)	9	Good	southeast of creek
AZ	Coast live oak (*Quercus agrifolia*)	7	Good	south of creek, no waste rock influence
BA	Coast live oak (*Quercus agrifolia*)	13	Good	south of creek, no waste rock influence
BB	Coast live oak (*Quercus agrifolia*)	15	Good	southeast of creek, in edge of woods, near path

Table B: Protected Trees to Retain – Work Site

Tree ID	Common name (*Species name*)	DBH	Status	Notes
BC	Coast live oak (*Quercus agrifolia*)	6	Good	south of creek, in slide area
BD	Coast live oak (*Quercus agrifolia*)	12	Good	south of creek, in slide area
BE	Coast live oak (*Quercus agrifolia*)	9	Good	south of creek, canopy over creek and waste rock
BF	Coast live oak (*Quercus agrifolia*)	5	Good	south of waste rock
BG	Coast live oak (*Quercus agrifolia*)	14	Good	south of waste rock
BH	Coast live oak (*Quercus agrifolia*)	15	Good	2 stem, south of waste rock
BI	Coast live oak (*Quercus agrifolia*)	31	Good	5 stem, south of waste rock
BJ	Coast live oak (*Quercus agrifolia*)	5	Good	south of waste rock
BK	Coast live oak (*Quercus agrifolia*)	16	Good	2 stem, south of waste rock
BL	Coast live oak (*Quercus agrifolia*)	10	Good	2 stem, south of waste rock
BM	Coast live oak (*Quercus agrifolia*)	15	Good	3 stem, south of waste rock
BN	Coast live oak (*Quercus agrifolia*)	5	Good	south of waste rock
BO	Coast live oak (*Quercus agrifolia*)	12	Good	2 stem, south of waste rock
BP	Coast live oak (*Quercus agrifolia*)	15	Good	3 stem, south of waste rock
BQ	Coast live oak (*Quercus agrifolia*)	11	Good	2 stem, south of waste rock
BR	Coast live oak (*Quercus agrifolia*)	23	Good	3 stem, south of waste rock
BS	Coast live oak (*Quercus agrifolia*)	8	Good	trailing, south of waste rock
BT	Coast live oak (*Quercus agrifolia*)	17	Good	south of waste rock
BU	Coast live oak (*Quercus agrifolia*)	24	Good	south of waste rock
BV	Coast live oak (*Quercus agrifolia*)	4	Good	south of waste rock
BW	Coast live oak (*Quercus agrifolia*)	17	Good	south of waste rock
BX	Coast live oak (*Quercus agrifolia*)	5	Good	outside fence, steep, south of waste rock
BY	Coast live oak (*Quercus agrifolia*)	12	Good	south of waste rock
BZ	Coast live oak (*Quercus agrifolia*)	10	Good	south of waste rock
CA	Coast live oak (*Quercus agrifolia*)	20	Good	south of waste rock
CB	Coast live oak (*Quercus agrifolia*)	9	Good	south of waste rock
CC	Coast live oak (*Quercus agrifolia*)	14	Good	cut roots, south of waste rock
CD	Coast live oak (*Quercus agrifolia*)	18	Good	south of waste rock
CE	Coast live oak (*Quercus agrifolia*)	5	Good	steep bank, lichens, south of waste rock
CF	Coast live oak (*Quercus agrifolia*)	20	Good	south of waste rock
CG	Coast live oak (*Quercus agrifolia*)	4	Good	south of waste rock
CH	Coast live oak (*Quercus agrifolia*)	15	Good	3 stem, close to mine entrance, south of waste rock
CI	Coast live oak (*Quercus agrifolia*)	15	Good	2 stem, close to mine entrance, south of waste rock
CJ	Coast live oak (*Quercus agrifolia*)	24	Good	south of waste rock
CK	Coast live oak (*Quercus agrifolia*)	16	Good	south of waste rock
CL	Coast live oak (*Quercus agrifolia*)	5	Good	Poison oak, south of waste rock
CM	Coast live oak (*Quercus agrifolia*)	12	Good	south of waste rock
CN	Coast live oak (*Quercus agrifolia*)	28	Good	south of waste rock
CO	Coast live oak (*Quercus agrifolia*)	18	Good	south of waste rock
CP	Coast live oak (*Quercus agrifolia*)	24	Good	south of waste rock
CQ	Coast live oak (*Quercus agrifolia*)	12	Good	south of waste rock
CR	Coast live oak (*Quercus agrifolia*)	6	Good	close to mine entrance, south of waste rock
CS	Coast live oak (*Quercus agrifolia*)	16	Good	south of waste rock
CT	Coast live oak (*Quercus agrifolia*)	24	Good	south of waste rock
CU	Coast live oak (*Quercus agrifolia*)	14	Good	above influence, top of cliff, south of waste rock
CV	Coast live oak (*Quercus agrifolia*)	19	Good	close to mine, south of waste rock
CW	Coast live oak (*Quercus agrifolia*)	25	Good	2 stem, above influence, south of waste rock
CX	Coast live oak (*Quercus agrifolia*)	11	Good	top end of survey area, south of waste rock
CY	Coast live oak (*Quercus agrifolia*)	18	Good	south of waste rock
CZ	Coast live oak (*Quercus agrifolia*)	19	Good	2 stem, north side upper end
DA	Coast live oak (*Quercus agrifolia*)	26	Good	north side upper end
DB	Coast live oak (*Quercus agrifolia*)	22	Good	tree in work area
DC	Coast live oak (*Quercus agrifolia*)	26	Good	3 stem south of creek, in edge of woods
DD	Coast live oak (*Quercus agrifolia*)	7	Good	tree in work area

Table B: Protected Trees to Retain – Work Site

Tree ID	Common name (*Species name*)	DBH	Status	Notes
DE	Coast live oak (*Quercus agrifolia*)	30	Good	north side upper end
DF	Coast live oak (*Quercus agrifolia*)	6	Good	canopy over waste rock
DG	Coast live oak (*Quercus agrifolia*)	35	Good	canopy over waste rock
DH	Coast live oak (*Quercus agrifolia*)	33	Good	4 stem in work area
DI	Coast live oak (*Quercus agrifolia*)	18	Good	north side upper end
DJ	Coast live oak (*Quercus agrifolia*)	6	Good	canopy over waste rock
DK	Coast live oak (*Quercus agrifolia*)	54	Good	north side out of influence
DL	Coast live oak (*Quercus agrifolia*)	35	Good	canopy over waste rock
DM	Coast live oak (*Quercus agrifolia*)	15	Good	north side out of influence
DN	Coast live oak (*Quercus agrifolia*)	21	Good	north side out of influence
DO	Coast live oak (*Quercus agrifolia*)	33	Good	4 stem in work area
DP	Coast live oak (*Quercus agrifolia*)	25	Good	north side out of influence
DQ	Coast live oak (*Quercus agrifolia*)	22	Good	4 stem in work area
DR	Coast live oak (*Quercus agrifolia*)	8	Good	5 stem, north side out of influence
DS	Coast live oak (*Quercus agrifolia*)	6	Good	north side out of influence
DT	Coast live oak (*Quercus agrifolia*)	6	Good	in work area north side
DU	Coast live oak (*Quercus agrifolia*)	79	Good	north work area
DV	Coast live oak (*Quercus agrifolia*)	34	Good	in work area
DW	Coast live oak (*Quercus agrifolia*)	6	Good	in work area north side
DX	Coast live oak (*Quercus agrifolia*)	17	Good	2 stem in north work area
DY	Coast live oak (*Quercus agrifolia*)	55	Good	5 stem in north work area
DZ	Coast live oak (*Quercus agrifolia*)	13	Good	north side upper end
EA	Coast live oak (*Quercus agrifolia*)	18	Good	2 stem in work area
EB	Coast live oak (*Quercus agrifolia*)	26	Good	2 stem in north work area
EC	Coast live oak (*Quercus agrifolia*)	31	Good	in work area
ED	Coast live oak (*Quercus agrifolia*)	65	Good	7 stem in work area
EE	Coast live oak (*Quercus agrifolia*)	60	Good	in work area
Total Protected Trees to be Retained in Work Area = 135				

Source: LSA Associates, Inc., 2014

Table C: Protected Trees to Remain –Haul Route, Primary Staging and Lodge Staging Area

Tree ID	Common name (*Species name*)	DBH	Status	Notes
EF	Coast live oak (*Quercus agrifolia*)	8	Good	Leona Lodge Staging area near road on berm, use TPZ[a]
EG	Coast live oak (*Quercus agrifolia*)	8	Good	Staging area near road on berm, use TPZ
EH	Coast live oak (*Quercus agrifolia*)	4	Good	Staging area near road on berm, use TPZ
EI	Coast live oak (*Quercus agrifolia*)	36	Good	Staging area north end past rocks, use TPZ
EJ	Coast live oak (*Quercus agrifolia*)	70	Good	Staging area south side, trim 4 branches, use TPZ
EK	Coast live oak (*Quercus agrifolia*)	10	Good	Leona Lodge staging area south side, use TPZ
EL	Coast live oak (*Quercus agrifolia*)	24	Good	Leona Lodge staging area south side, use TPZ
EM	Coast live oak (*Quercus agrifolia*)	50	Good	Staging area south side, use TPZ
EN	Coast live oak (*Quercus agrifolia*)	N/A[b]	N/A	Haul Route – Trim only
EO	Coast live oak (*Quercus agrifolia*)	N/A	N/A	Haul Route – Trim only
EP	Coast live oak (*Quercus agrifolia*)	N/A	N/A	Haul Route – Trim only
EQ	Coast live oak (*Quercus agrifolia*)	N/A	N/A	Haul Route– Trim only
ER	Coast live oak (*Quercus agrifolia*)	N/A	N/A	Haul Route – Trim only
ES	Coast live oak (*Quercus agrifolia*)	N/A	N/A	Haul Route – Trim only
ET	Coast live oak (*Quercus agrifolia*)	N/A	N/A	Haul Route – Trim only
EU	Coast live oak (*Quercus agrifolia*)	N/A	N/A	Haul Route – Trim only
EV	Coast live oak (*Quercus agrifolia*)	N/A	N/A	Haul Route – Trim only
EW	Coast live oak (*Quercus agrifolia*)	N/A	N/A	Haul Route – Trim only
EX	Coast live oak (*Quercus agrifolia*)	N/A	N/A	Haul Route – Trim only
EY	Coast live oak (*Quercus agrifolia*)	N/A	N/A	Haul Route – Trim only
EZ	Coast live oak (*Quercus agrifolia*)	N/A	N/A	Haul Route– Trim only
FA	Coast live oak (*Quercus agrifolia*)	N/A	N/A	Haul Route – Trim only
FB	Coast live oak (*Quercus agrifolia*)	N/A	N/A	Haul Route – Trim only
FC	Coast live oak (*Quercus agrifolia*)	N/A	N/A	Haul Route– Trim only
FD	Coast live oak (*Quercus agrifolia*)	N/A	N/A	Haul Route – Trim only
FE	Coast live oak (*Quercus agrifolia*)	N/A	N/A	Haul Route – Trim only
FF	Coast live oak (*Quercus agrifolia*)	N/A	N/A	Haul Route – Trim only
FG	Coast live oak (*Quercus agrifolia*)	N/A	N/A	Haul Route – Trim only
FH	Coast live oak (*Quercus agrifolia*)	N/A	N/A	Haul Route– Trim only
FI	Coast live oak (*Quercus agrifolia*)	N/A	N/A	Haul Route – Trim only
FJ	Coast live oak (*Quercus agrifolia*)	N/A	N/A	Haul Route– Trim only
FK	Coast live oak (*Quercus agrifolia*)	N/A	N/A	Haul Route– Trim only
Total Protected Trees to Remain at Haul Road and Staging Area = 32				

[a] TPZ = Tree Protection Zone

[b] N/A = The diameter and condition of these trees were not assessed, yet they all may need minimal trimming to allow for equipment passage.

Source: LSA Associates, Inc., 2014

Table D: Cumulative Area of Trunks to be Removed from Project Site

Tree #	DBH (inches)	Condition	Removed (square feet)
1	35	Good	6.68
2	13	Good	0.92
3	24	Good	3.14
4	14	Good	1.07
5	9	Good	0.44
6	14	Good	1.07
8	8	Good	0.35
9	5	Good	0.14
12	18	Good	1.77
13	34	Good	6.30
14	13	Good	0.92
15	18	Good	1.77
16	5	Good	0.14
17	11	Good	0.66
21	15	Good	1.23
23	6	Good	0.20
24	14	Good	1.07
25	10	Good	0.55
48	15	Good	1.23
56	5	Good	0.14
57	5	Good	0.14
58	6	Good	0.20
60	38	Good	7.87
64	22	Good	2.64
65	7	Good	0.27
85	5	Good	0.14
98	7	Good	0.27
102	28	Good	4.27
104	9	Good	0.44
105	23	Good	2.88
106	48	Good	12.56
107	7	Good	0.27
108	10	Good	0.55
109	34	Good	6.30
110	6	Good	0.20
111	6	Good	0.20
112	51	Good	14.18
113	27	Good	3.97
114	18	Good	1.77
115	16	Good	1.40
117	50	Poor [a]	13.63
118	5	Good	0.14
119	17	Good	1.58
122	9	Good	0.44
124	10	Good	0.55
126	5	Good	0.14
127	6	Good	0.20
128	31	Good	5.24
131	11	Good	0.66
132	20	Good	2.18
135	15	Good	1.23
		Total Removed (square feet)	**102.58**
		Total Parcel (square feet)	**5,880,600**
		Percentage of Parcel	**0.002**

[a] Not eligible for inclusion due to poor health, per OMC 15.158.280 (E.) 2

Source: LSA Associates, Inc., 2014.

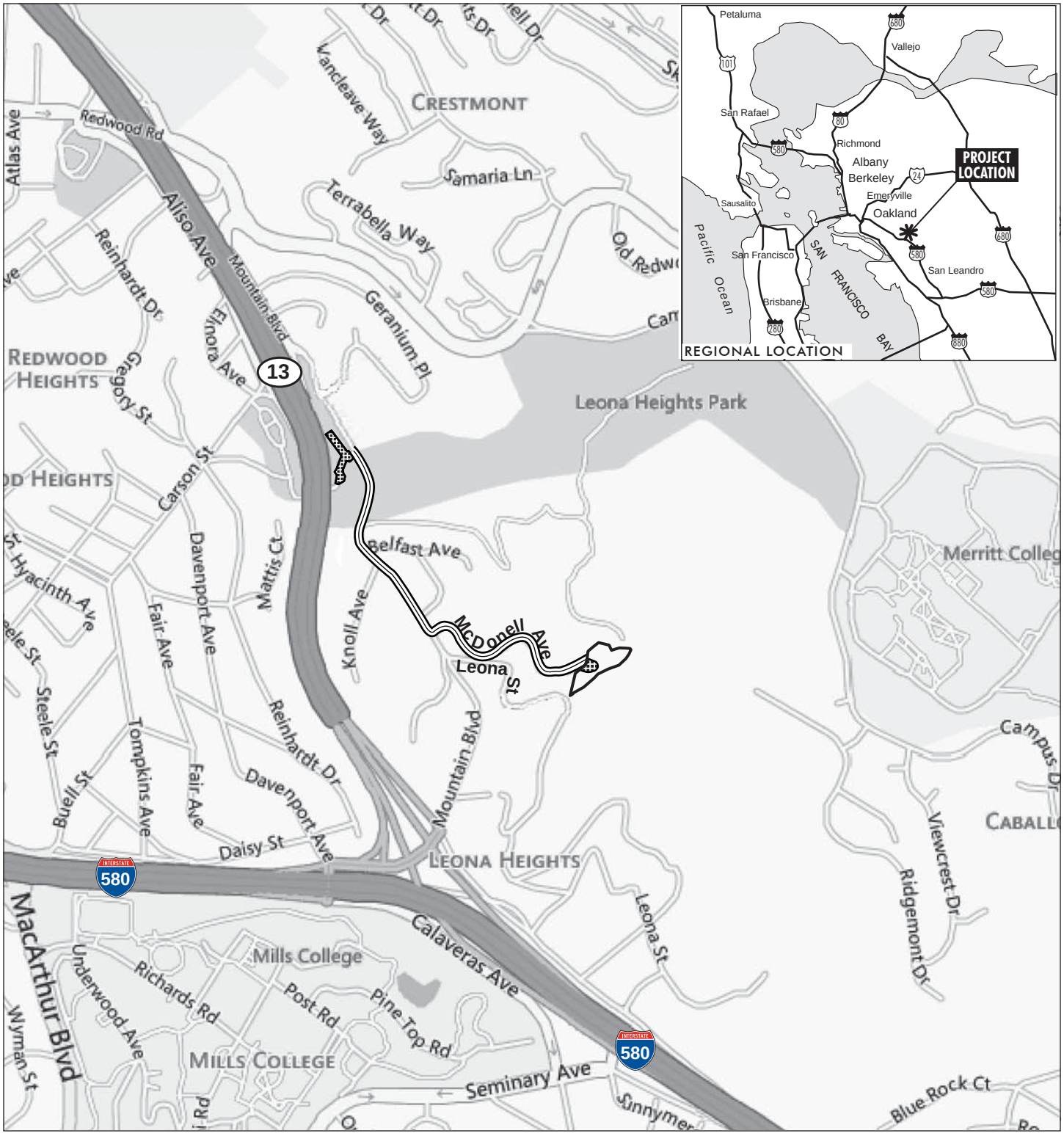

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FIGURE 1

Leona Creek Restoration and Leona Heights Sulfur Mine Remediation Project IS/MND

Project Location

SOURCES: BING MAPS; LSA ASSOCIATES, INC., 2014.

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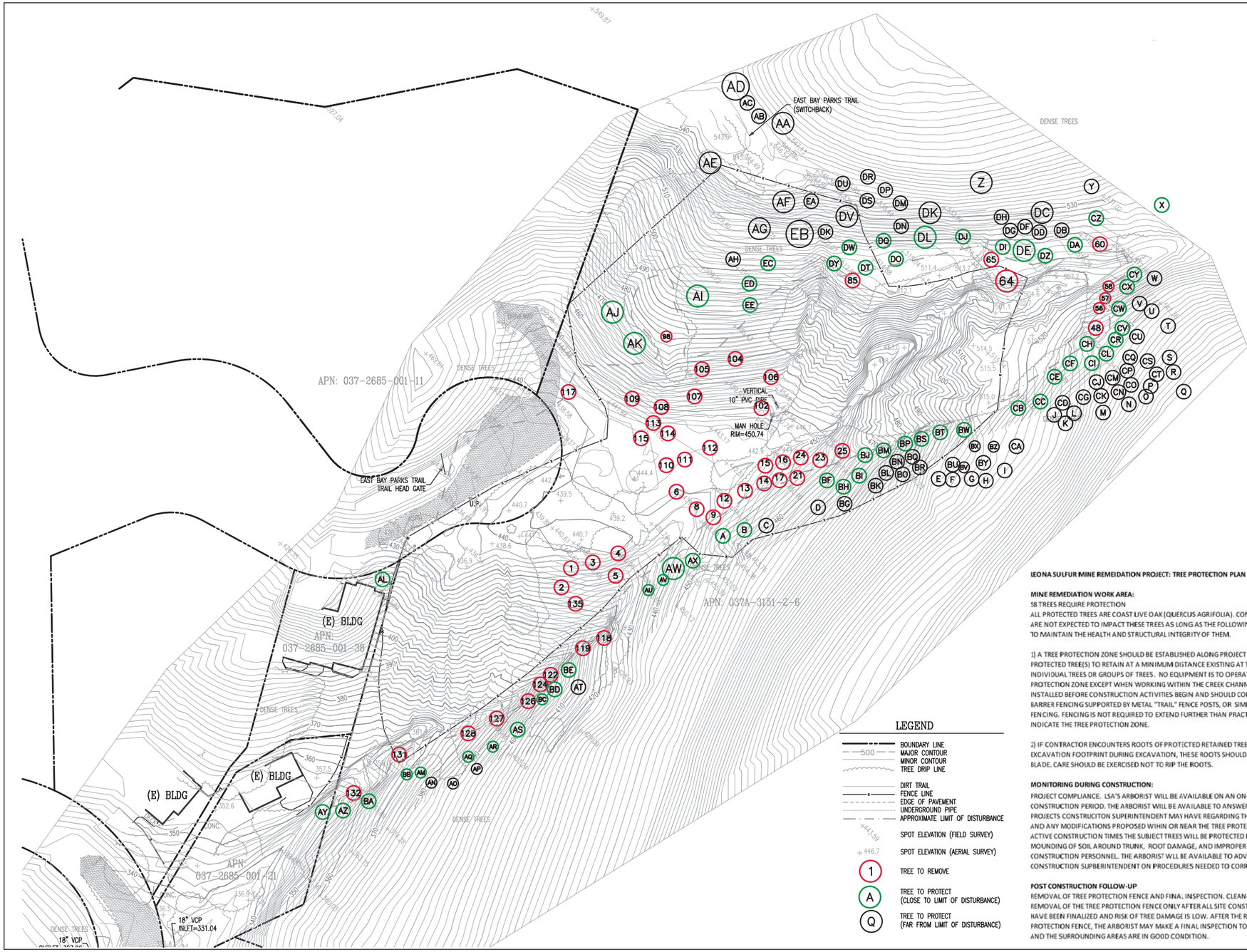

LEGEND

- BOUNDARY LINE
- 500 MAJOR CONTOUR
- MINOR CONTOUR
- TREE DRIP LINE
- DIRT TRAIL
- FENCE LINE
- EDGE OF PAVEMENT
- UNDERGROUND PIPE
- APPROXIMATE LIMIT OF DISTURBANCE
- 1443.59 SPOT ELEVATION (FIELD SURVEY)
- +446.7 SPOT ELEVATION (AERIAL SURVEY)
- (1) TREE TO REMOVE
- (A) TREE TO PROTECT (CLOSE TO LIMIT OF DISTURBANCE)
- (Q) TREE TO PROTECT (FAR FROM LIMIT OF DISTURBANCE)

LEONA SULFUR MINE REMEIDATION PROJECT: TREE PROTECTION PLAN

MINE REMEDIATION WORK AREA:
58 TREES REQUIRE PROTECTION
ALL PROTECTED TREES ARE COAST LIVE OAK (QUERCUS AGRIFOLIA). CONSTRUCITON ACTIVITIES ARE NOT EXPECTED TO IMPACT THESE TREES AS LONG AS THE FOLLOWING MEASURES ARE TAKEN TO MAINTAIN THE HEALTH AND STRUCTURAL INTEGRITY OF THEM.

1) A TREE PROTECTION ZONE SHOULD BE ESTABLISHED ALONG PROJECT FACING SIDE OF PROTECTED TREE(S) TO RETAIN AT A MINIMUM DISTANCE EXISTING AT THE DRIP-LINE OF INDIVIDUAL TREES OR GROUPS OF TREES. NO EQUIPMENT IS TO OPERATE WITHIN THE TREE PROTECTION ZONE EXCEPT WHEN WORKING WITHIN THE CREEK CHANNEL. THE FENCE SHOULD BE INSTALLED BEFORE CONSTRUCTION ACTIVITIES BEGIN AND SHOULD CONSIST OF BLAZE ORANGE BARRER FENCING SUPPORTED BY METAL "TRAIL" FENCE POSTS, OR SIMILAR PROTECTIVE TYPE OF FENCING. FENCING IS NOT REQUIRED TO EXTEND FURTHER THAN PRACTICALLY NEEDED TO INDICATE THE TREE PROTECTION ZONE.

2) IF CONTRACTOR ENCOUNTERS ROOTS OF PROTECTED RETAINED TREES THAT EXTEND INTO THE EXCAVATION FOOTPRINT DURING EXCAVATION, THESE ROOTS SHOULD BE CUT WITH A SHARP BLADE. CARE SHOULD BE EXERCISED NOT TO RIP THE ROOTS.

MONITORING DURING CONSTRUCTION:
PROJECT COMPLIANCE. LSA'S ARBORIST WILL BE AVAILABLE ON AN ON-CALL BASIS DURING THE CONSTRUCTION PERIOD. THE ARBORIST WILL BE AVAILABLE TO ANSWER QUESTIONS THE PROJECTS CONSTRUCITON SUPERINTENDENT MAY HAVE REGARDING THE HEALTH OF THE TREES AND ANY MODIFICATIONS PROPOSED WIHIN OR NEAR THE TREE PROTECTION AREA. DURING THE ACTIVE CONSTRUCTION TIMES THE SUBJECT TREES WILL BE PROTECTED FROM TRUNK DAMAGE, MOUNDING OF SOIL AROUND TRUNK, ROOT DAMAGE, AND IMPROPER PRUNING BY CONSTRUCTION PERSONNEL. THE ARBORIST WLL BE AVAILABLE TO ADVISE THE PROJECT'S CONSTRUCTION SUPBERINTENDENT ON PROCEDURES NEEDED TO CORRECTE PROBLEMS.

POST CONSTRUCTION FOLLOW-UP
REMOVAL OF TREE PROTECTION FENCE AND FINAL INSPECTION. CLEAN-UP WILL INVOLVE REMOVAL OF THE TREE PROTECTION FENCE ONLY AFTER ALL SITE CONSTRUCTION ACTIVITIES HAVE BEEN FINALIZED AND RISK OF TREE DAMAGE IS LOW. AFTER THE REMOVAL OF THE TREE PROTECTION FENCE, THE ARBORIST MAY MAKE A FINAL INSPECTION TO INSURE THAT THE TREES AND THE SURROUNDING AREAS ARE IN GOOD CONDITION.

Table A. Protected Trees to be Removed

Tree#	DBH
1	35
2	13
3	24
4	14
5	9
6	14
8	8
9	5
12	18
13	34
14	12
15	18
16	5
17	11
21	15
23	6
24	14
25	10
48	15
56	5
57	5
58	6
60	38
64	22
65	7
85	5
98	7
102	28
104	9
105	23
106	48
107	7
108	10
109	34
110	6
111	6
112	51
113	27
114	18
115	16
117	50
118	5
119	17
122	9
124	10
126	5
127	6
128	31
131	11
132	20
135	15
Total Removal	51

Table B. Protected Trees to Remain

Tree #	DBH
A	10
B	5
C	19
D	8
E	36
F	18
G	20
H	12
I	36
J	16
K	16
L	8
M	16
N	18
O	30
P	12
Q	24
R	28
S	14
T	9
U	9
V	7
W	14
X	24
Y	32
Z	22
AA	54
AB	39
AC	16
AD	5
AE	65
AF	24
AG	23
AH	21
AI	22
AJ	9
AK	5
AL	5
AM	18
AN	8
AO	8
AP	15
AQ	7
AR	5
AS	5
AT	9
AU	4
AV	7
AW	7
AX	20
AY	9
AZ	7
BA	13
BB	15
BC	6
BD	12
BE	9
BF	5
BG	14
BH	15
BI	31
BJ	5
BK	16
BL	10
BM	15
BN	5
BO	12
Total remaining	

Table B. Protected Trees to Remain (continued)

Tree #	DBH
BP	15
BQ	11
BR	23
BS	8
BT	17
BU	24
BV	4
BW	17
BX	5
BY	12
BZ	10
CA	20
CB	9
CC	14
CD	18
CE	5
CF	20
CG	4
CH	15
CI	15
CJ	24
CK	16
CL	5
CM	12
CN	28
CO	18
CP	24
CQ	12
CR	6
CS	16
CT	24
CU	14
CV	19
CW	25
CX	11
CY	18
CZ	19
DA	26
DB	22
DC	26
DD	7
DE	30
DF	6
DG	35
DH	33
DI	18
DJ	6
DK	54
DL	35
DM	15
DN	21
DO	33
DP	25
DQ	22
DR	8
DS	6
DT	6
DU	79
DV	34
DW	6
DX	17
DY	55
DZ	13
EA	18
EB	26
EC	31
ED	65
EE	60
	135

LSA

FIGURE 2

Leona Creek Restoration and Leona Heights Sulfur Mine Remediation Project
Tree Removal and Protection Plan - Work Site

SOURCE: E2C REMEDIATION, JANUARY 21, 2014.

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LSA

FIGURE 3

N

0 30 60

FEET

Staging Area

Temporary Fence

Haul Route

Trees

Leona Creek Restoration and Leona Heights Sulfur Mine Remediation Project IS/MND

Leona Lodge Staging Area Protected Tree Locations

SOURCE: ESRI WORLD IMAGERY SERVICE (11/2010)

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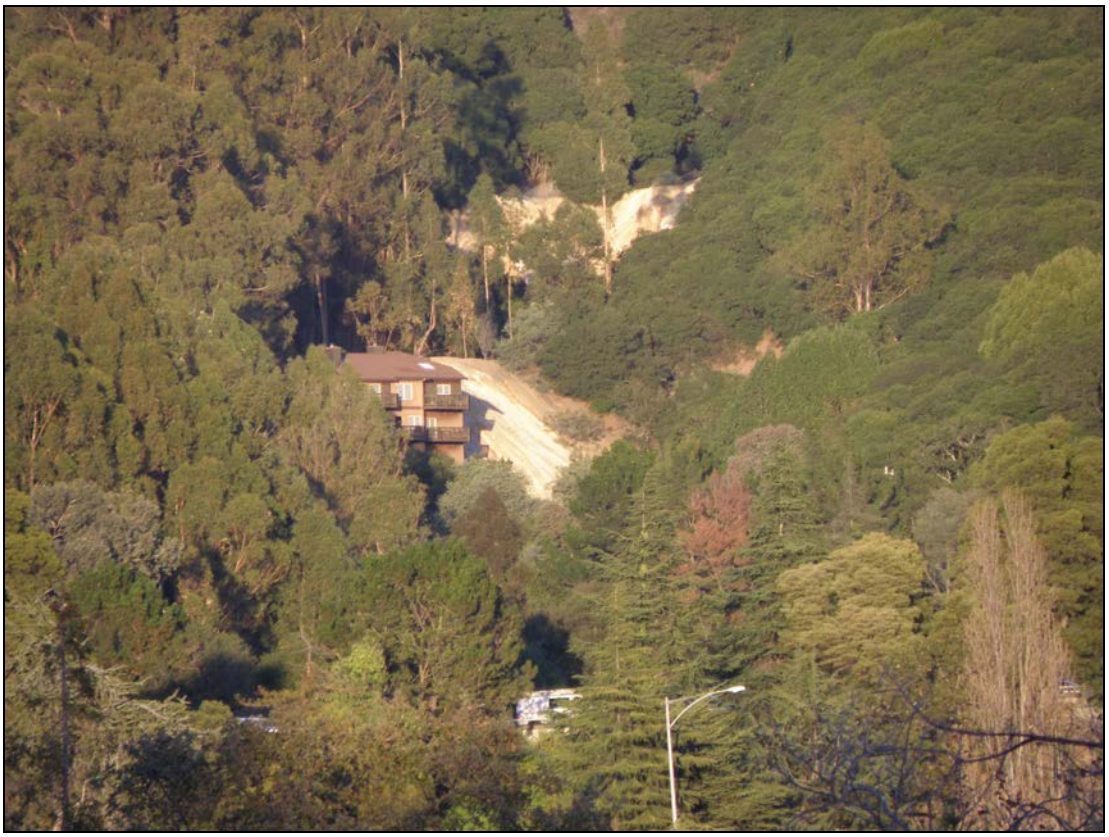
APPENDIX F

AN ELIGIBILITY EVALUATION FOR THE LEONA CREEK RESTORATION AND LEONA HEIGHTS SULFUR MINE REMEDIATION PROJECT

AN ELIGIBILITY EVALUATION FOR THE LEONA CREEK RESTORATION AND LEONA HEIGHTS SULFUR MINE REMEDIATION PROJECT

OAKLAND, ALAMEDA COUNTY, CALIFORNIA



LSA

January 2014

Cover Photograph: View to northeast of a portion of the Leona Sulfur Mine from Mills College showing the upper and lower mine tailings.

AN ELIGIBILITY EVALUATION FOR THE LEONA CREEK RESTORATION AND LEONA HEIGHTS SULFUR MINE REMEDIATION PROJECT

OAKLAND, ALAMEDA COUNTY, CALIFORNIA

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LSA

January 2014

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1.0 INTRODUCTION

The Leona Heights Sulfur Mine consists of built environment remains of an inactive sulfur mine on a 137-acre parcel (Assessor's Parcel Number [APN] #037A-3151-002-06) in the Leona Heights neighborhood of Oakland, California (Figures 1 and 2). Due to stream contamination resulting from toxins such as arsenic employed during the mine's operation, the proposed project will remediate this stretch of Leona Creek as required by a Regional Water Quality Control Board's Cleanup and Abatement Order. The proposed project area is an approximately 0.5-acre portion of the western part of the historical extent of the 5.36-acre Leona Heights Sulfur Mine (mine complex).

The mine complex was active from 1909 to approximately 1929. Evidence of mining activity is present in the project area and vicinity: features within the project area consist of two tailing piles and two collapsed adit entrances; features in the vicinity of the project area consist of mining prospects and a trail leading southwest from the mine. All the above-referenced features constitute a cohesive mine complex that represents the material remains of a range of former mining activities. Fieldwork for this evaluation established a tentative site boundary around the mine complex that includes the project area and nearby mining features (Figure 3), but additional survey or documentation of the mine complex could refine this boundary.

The mining features within the project area are evaluated in this report for eligibility for inclusion in the California Register of Historical Resources (CRHR) as contributors to the larger, potentially eligible, mining complex that extends beyond the project area boundary. The mine complex is an uncommon example of hard rock mining activity in the city of Oakland. The mine complex produced pyrite (sulfide) ore that was transported to a processing plant in Richmond, where it was used in the production of sulfuric acid.

LSA Associates, Inc. (LSA) prepared this cultural CRHR evaluation in support of an Initial Study being prepared for the project pursuant to requirements of the California Environmental Quality Act (CEQA). LSA conducted archival background research and a field survey to evaluate the portion of the mine complex in the project area for eligibility for inclusion in the CRHR. This report includes (1) a description of the regulatory context for the evaluation; (2) a summary of the research and field methods; (3) a description of the mine complex's features; (4) a presentation of the mine complex's historical context; (5) an eligibility evaluation of the portion of the mine complex in the project area; and (6) a summary of the evaluation's findings.

This evaluation addresses only built environment aspects of the mine complex. Potential archaeological features and deposits associated with the mine complex will be addressed through the fulfillment of project conditions of approval and are not considered in this document.

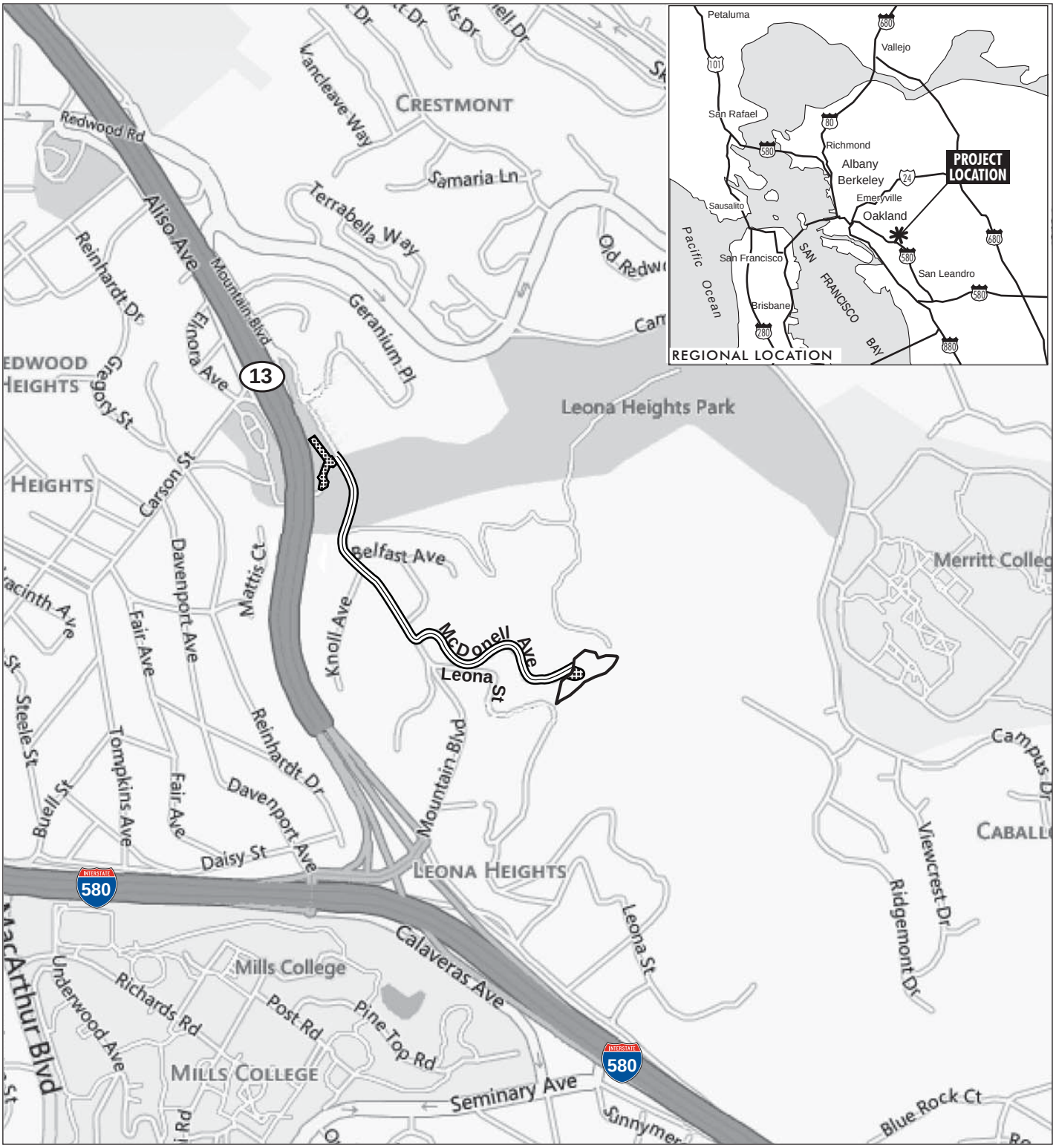

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FIGURE 1

Site

Staging Areas

Haul Route

0 500 1000

FEET

Leona Creek Restoration and Leona Heights Sulfur Mine Remediation Project IS/MND

Project Location

SOURCES: BING MAPS; LSA ASSOCIATES, INC., 2014.

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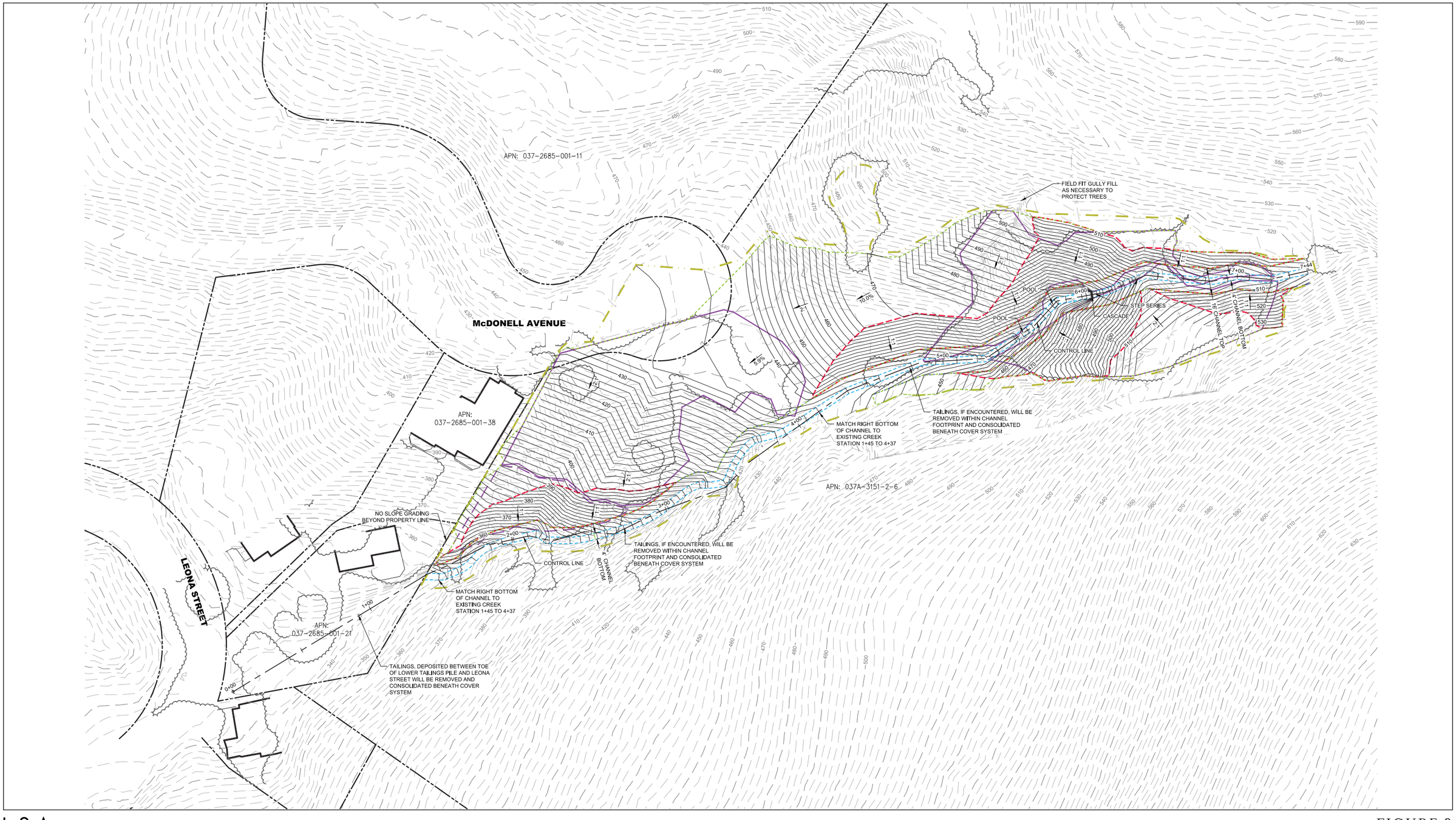

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0 30 60
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N

LEGEND

- APPROXIMATE EXTENT OF WASTE PILE
- APPROXIMATE EXTENT OF POTENTIAL TAILING/SCREE
- LIMIT OF POTENTIAL EARTHWORK
- LIMIT OF REINFORCED SOIL SLOPE
- CHANNEL BOTTOM
- CHANNEL TOP
- LIMIT OF COVER SYSTEM
- 460 FINAL GRADE (10-FT CONTOUR)
- FINAL GRADE (2-FT CONTOUR)
- -460- EXISTING GRADE (10-FT CONTOUR)
- EXISTING GRADE (2-FT CONTOUR)
- PROPERTY LINE

SOURCE: E2C REMEDIATION, JANUARY 21, 2014.

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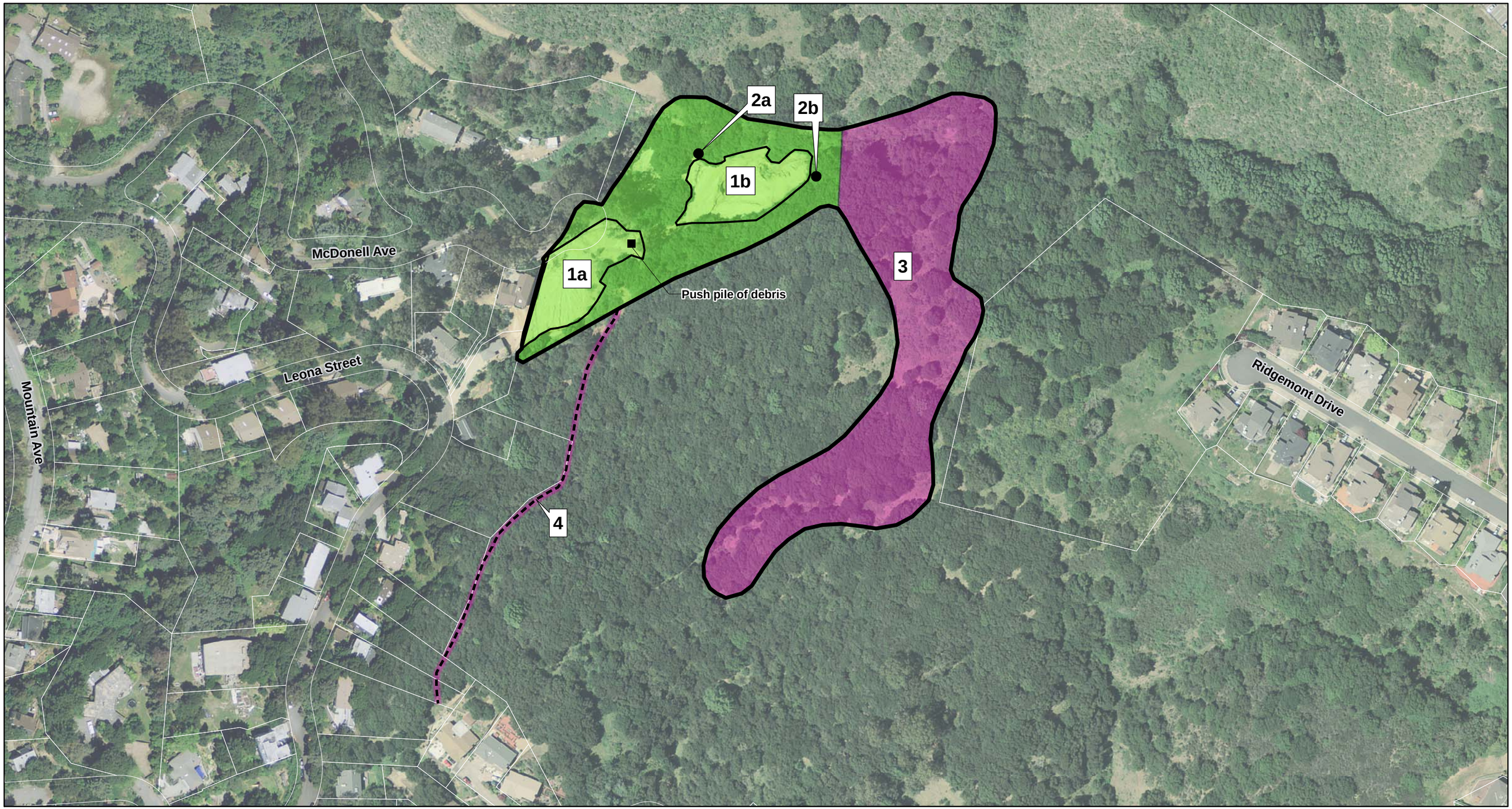
FIGURE 2

Leona Creek Restoration and Leona Heights Sulfur Mine Remediation Project IS/MND

Approximate Limit of Disturbance



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LEGEND

Leona Heights Sulfur Mine Site Boundary

Parcel

1a	Lower tailings pile	(evaluated)
1b	Upper tailings pile	(evaluated)
2a	Lower adit	(evaluated)
2b	Upper adit	(evaluated)
3	Mining Prospects	(not evaluated)
4	Trail	(not evaluated)

N

0 75 150
FEET

SOURCE: Alameda County (2013); USGS Orthoimagery (04/2011).

I:\OCI1301\GIS\Maps\Cultural\CRHR Evaluation\Figure3_Mine Boundary and Major Features.mxd (1/31/2014)

FIGURE 3

Leona Creek Restoration and Leona Heights Sulfur Mine Remediation Project

Leona Heights Sulfur Mine Boundary and Major Features

2.0 LEGISLATIVE AND REGULATORY CONTEXTS

2.1 CALIFORNIA ENVIRONMENTAL QUALITY ACT

CEQA applies to all discretionary projects undertaken or subject to approval by the state's public agencies (California Code of Regulations [CCR] Title 14(3) §15002(i)). Under the provisions of CEQA, "A project with an effect that may cause a substantial adverse change in the significance of a historical resource is a project that may have a significant effect on the environment" (CCR Title 14(3) §15064.5(b)).

CEQA §15064.5(a) defines a "historical resource" as a resource which meets one or more of the following criteria:

- Listed in, or eligible for listing in, the California Register of Historical Resources;
- Listed in a local register of historical resources (as defined at PRC §5020.1(k));
- Identified as significant in a historical resource survey meeting the requirements of §5024.1(g) of the Public Resources Code; or
- Determined to be a historical resource by a project's lead agency (CCR Title 14(3) §15064.5(a)).

A historical resource consists of "Any object, building, structure, site, area, place, record, or manuscript which a lead agency determines to be historically significant or significant in the architectural, engineering, scientific, economic, agricultural, educational, social, political, military, or cultural annals of California…Generally, a resource shall be considered by the lead agency to be 'historically significant' if the resource meets the criteria for listing in the California Register of Historical Resources" (CCR Title 14(3) §15064.5(a)(3)).

CEQA requires that historical resources and unique archaeological resources be taken into consideration during the CEQA planning process (CCR Title 14(3) §15064.5; PRC §21083.2). If feasible, adverse effects to the significance of historical resources must be avoided, or the effects mitigated (CCR Title 14(3) §15064.5(b)(4)). The significance of a historical resource is impaired when a project demolishes or materially alters in an adverse manner those physical characteristics of a historical resource that convey its historical significance and that justify its eligibility for the California Register of Historical Resources. If there is a substantial adverse change in the significance of a historical resource, the preparation of an environmental impact report may be required (CCR Title 14(3) §15065(a)).

If the cultural resource in question is an archaeological site, CEQA (CCR Title 14(3) §15064.5(c)(1)) requires that the lead agency first determine if the site is a historical resource as defined in CCR Title 14(3) §15064.5(a). If the site qualifies as a historical resource, potential adverse impacts must be considered in the same manner as a historical resource (California Office of Historic Preservation 2001a:8). If the archaeological site does not qualify as a historical resource but does qualify as a unique archaeological resource, then the archaeological site is treated in accordance with PRC

§21083.2 (CCR Title 14(3) §15069.5(c)(3)). In practice, most archaeological sites that meet the definition of a unique archaeological resource will also meet the definition of a historical resource (Bass, Herson, and Bogdan 1999:105). CEQA defines a "unique archaeological resource" as an archaeological artifact, object, or site about which it can be clearly demonstrated that, without merely adding to the current body of knowledge, there is a high probability that it meets one or more of the following criteria:

- Contains information needed to answer important scientific research questions and that there is a demonstrable public interest in that information; or
- Has a special and particular quality such as being the oldest of its type or the best available example of its type; or
- Is directly associated with a scientifically recognized important prehistoric or historic event or person (PRC §21083.2(g)).

If an impact to a historical or archaeological resource is significant, CEQA requires feasible measures to minimize the impact (CCR Title 14(3) §15126.4 (a)(1)). Mitigation of significant impacts must lessen or eliminate the physical impact that the project will have on the resource. Generally, the use of drawings, photographs, and/or displays does not mitigate the physical impact on the environment caused by demolition or destruction of a historical resource. However, CEQA requires that all feasible mitigation be undertaken even if it does not mitigate impacts to a less than significant level (California Office of Historic Preservation 2001a:9; see also CCR Title 14(3) §15126.4(a)(1)).

2.1.1 California Register of Historical Resources

Section 5024.1 of the PRC established the California Register of Historical Resources (CRHR). Generally, a resource is considered by the lead agency to be "historically significant" if the resource meets the criteria for listing on the CRHR (CCR Title 14(3) §15064.5(a)(3)). For a cultural resource to qualify for listing in the CRHR it must be significant under one or more of the following criteria:

- Criterion 1: Associated with events that have made a significant contribution to the broad patterns of California's history and cultural heritage;
- Criterion 2: Associated with the lives of persons important in our past;
- Criterion 3: Embodies the distinctive characteristics of a type, period, region, or method of construction, or represents the work of an important creative individual, or possesses high artistic values; or
- Criterion 4: Has yielded, or may be likely to yield, information important in prehistory or history.

In addition to being significant under one or more of these criteria, a resource must retain enough of its historic character and appearance to be recognizable as an historical resource and be able to convey the reasons for its significance (CCR Title 14 Section 4852(c)). Generally, a cultural resource must be 50 years or older to be eligible for the CRHR.

Historical Integrity. In addition to meeting one or more of the significance criteria, a cultural resource must retain its historical integrity to be considered eligible for listing in the CRHR. Historical integrity is defined as "the authenticity of a historical resource's physical identity

evidenced by the survival of characteristics that existed during the resource's period of significance" (California Office of Historic Preservation 2011). The evaluation of integrity must be grounded in an understanding of a resource's physical features and its environment, and how these relate to its significance. There are seven aspects of integrity to consider when evaluating a cultural resource: location, design, setting, materials, workmanship, feeling, and association (National Park Service 1997:44-45).

- Location is the place where the historic property was constructed or the place where the historic event occurred. The actual location of a historic property, complemented by its setting, is particularly important in recapturing the sense of historic events and persons.
- Design is the combination of elements that create the form, plan, space, structure, and style of a property. Design includes such elements as organization of space, proportion, scale, technology, ornamentation, and materials.
- Setting is the physical environment of a historic property. Setting refers to the character of the place in which the property played its historical role. Physical features that constitute the setting of a historic property can be either natural or manmade, including topographic features, vegetation, paths or fences, or relationships between buildings and other features or open space.
- Materials are the physical elements that were combined or deposited during a particular period of time and in a particular pattern or configuration to form a historic property.
- Workmanship is the physical evidence of the crafts of a particular culture or people during any given period in history or prehistory. It is the evidence of the artisan's labor and skill in constructing or altering a building, structure, object, or site.
- Feeling is a property's expression of the aesthetic or historic sense of a particular period of time. It results from the presence of physical features that, taken together, convey the property's historic character.
- Association is the direct link between an important historic event or person and a historic property.

3.0 PROJECT DESCRIPTION

3.1 PROJECT DESCRIPTION

Criteria set forth in the amended Regional Water Quality Control Board's Cleanup and Abatement Order (R2-2013-0021) state that the project must prevent further erosion of the mine tailings, encapsulate them in a manner which isolates the mining waste from stormwater runoff and contact with groundwater, and provide a design for implementation of creek restoration actions. The mine tailings onsite are proposed to be remediated through relocation and capping of the tailings, as well as grading of the slopes and creek channel. The project would require the removal of trees within the limits of grading and along the perimeter of the grading area as defined in the Permit Drawings for the Leona Heights Sulfur Mine Remedial Design, prepared by E2C and dated January 2014. The limit of disturbance is illustrated in Figure 2.

4.0 ENVIRONMENTAL, AND HISTORICAL SETTINGS

4.1 ENVIRONMENTAL SETTING

The approximately 0.5-acre project area is located off Leona Street on a portion of a 137-acre parcel (APN 037A-3151-002-06) in the East Bay hills above Oakland, Alameda County. The project area is in the unsectioned land of Rancho San Antonio (V. and D. Peralta), Township 1 & 2 South/Range 3 West, Mount Diablo Baseline and Meridian. The project area is located in the western portion of APN 037A-3151-002-06 and is bordered on the west by APNs 037-2685-001-11; 037-2685-001-08; 037-2685-001-21, 037-2685-001-27; and 037-2685-001-28. The project area is at an elevation of between 340 and 700 feet above sea level, on a steep hillside approximately 2,000 feet northeast of Mills College and the Highway 13/580 interchange.

Geologically, the project area is situated within the Pliocene Age (5.3-1.8 million years ago) Coast Range Ophiolite[1] (Sloan 2006:233). The geologic formation within the project area consists of Leona Rhyolite. Extraction activities within this formation focused on the removal of iron pyrite which consists of iron sulfide—a key ingredient in the production of sulfuric acid (Archaeological Consulting and Research Services, Inc. n.d.).

4.2 HISTORICAL SETTING

The historical context of the mine complex is presented in the Eligibility Evaluation section of this report.

[1] An ophiolite is a geologic formation consisting of "mantle and ocean crust." (Sloan 2006:54)

5.0 METHODS

Background research was conducted to identify the historical context for the mine complex. The background research consisted of a records search, literature and map review, research at local archives and City of Oakland offices, and consultation with the Oakland Heritage Alliance. The research was geared to the historical theme of mining, particularly extraction and mineral resource distribution.

5.1 RECORDS SEARCH

A record search of the project area was conducted by LSA on November 4, 2013, at the Northwest Information Center (NWIC) of the California Historical Resources Information System. The NWIC, an affiliate of the State of California Office of Historic Preservation (OHP), is the official state repository of cultural resource records and reports for Alameda County.

The records search included a review of the following federal and state inventories:

- California Points of Historical Interest (California Office of Historic Preservation 1992);
- California Historical Landmarks (California Office of Historic Preservation 1996);
- List of National Historic Landmarks by State (National Parks Service 2007);
- Five Views: An Ethnic Historic Site Survey for California (California Office of Historic Preservation 1988); and
- Directory of Properties in the Historic Property Data File updated on March 5, 2012 (California Office of Historic Preservation). The directory includes the listings of the National Register of Historic Places, National Historic Landmarks, the California Register of Historical Resources, California Historical Landmarks, and California Points of Historical Interest.

5.2 LITERATURE REVIEW

The following publications and maps were reviewed by LSA for historical information about the project area and its vicinity:

- Historic Engineering Landmarks of San Francisco and Northern California (American Society of Civil Engineers, San Francisco Section, 1977);
- Historical Atlas of California (Hayes 2007);
- California 1850: A Snapshot in Time (Marschner 2000);
- Oakland: the Story of a City (Bagwell 1982);
- Key System Streetcars: Transit, Real Estate, the Growth of the East Bay (Sappers 2007);
- Historical Spots in California (Hoover et al. 1990);
- California Place Names (Gudde 1998); and

- Oakland East, Calif., 7.5-minute topographic quadrangle (United States Geological Survey (USGS) 1947, 1949, 1959, 1966, 1969, 1975, 1980, 1997).

As part of the records search, LSA also reviewed the following inventories for cultural resources in and adjacent to the project area:

- City of Oakland Designated Landmarks, Heritage Properties, and Preservation Districts. Maintained by the Oakland Cultural Heritage Survey, this is the official list of City-designated cultural resources (Oakland Cultural Heritage Survey 2011);
- Oakland Heritage Alliance List of Oakland City Landmarks. This list of Oakland City Landmarks was compiled by David Nicolai, Director of the Pardee Home Museum (Oakland Heritage Alliance n.d.); and
- Alameda County Landmarks in Oakland. This website lists the Alameda County landmarks within the city of Oakland. It was compiled in 2007 by the former editor of the Alameda Sun newspaper (Oakland California Landmarks 2007).

5.3 ARCHIVAL AND ONLINE RESEARCH

On November 20, 2013, LSA architectural historian Michael Hibma, M.A., conducted archival research to gather information about the Leona Heights Sulfur Mine. The research was done at the Oakland Cultural Heritage Survey (OCHS) and the Oakland History Room in the Main Branch of the Oakland Public Library. The following internet sources were also accessed: Oakland California Landmarks web-blog, the website for the Oakland Heritage Alliance, and the California Geological Survey online database. Documents reviewed at these repositories consisted of newspaper articles, photographs, survey maps, previous environmental and technical documentation, and previous evaluation records.

5.4 HISTORICAL SOCIETY CONSULTATION

On November 18, 2013, LSA sent a letter and maps depicting the project area to Oakland Heritage Alliance (OHA) requesting any information or concerns they may have regarding historical sites in the project area. No response was received within two weeks.

During a December 4, 2013, follow-up telephone conversation, Ms. January Ruck, OHA Executive Director, noted that she had not seen the letter and requested that LSA send her an electronic copy. Following the phone call, LSA provided Ms. Ruck with a scanned version of the letter via email to Ms. Ruck on the same day. Ms. Ruck confirmed receipt of the letter and responded that she would then contact LSA with any question or information about cultural resources in the project area. No response from Ms. Ruck has been received to date.

5.5 FIELD SURVEY

LSA archaeologist Neal Kaptain, M.A., RPA, conducted a complete pedestrian field survey of the project area and a selective field review of the remainder of the mine complex on November 24 and December 2, 2013.

6.0 ELIGIBILITY EVALUATION

This section describes the mine complex, focusing on those features within the project area; presents the historical context of the mine; evaluates the mine's potential eligibility for inclusion in the CRHR; and assesses whether those mining features within the project area contribute to the overall significance of the resource. The mine complex's period of significance is the years between 1906 and approximately 1929 (Mix 1999).

Mining was taking place in the vicinity of the project area in the late 1800s to obtain ingredients for paint products (Franklin n.d.). Evidence of this early mining activity may be represented by the mining prospects on the hillside above the tailings. In 1906, the mine complex was opened by Francis Marion "Borax" Smith and later acquired by the Stauffer Chemical Company. During this early era, the mine complex contained a variety of built environment improvements associated with mineral extraction: ore cart tracks, an adit, a garage, a "shop," and the aerial tramway. (L'Ommedieu and Wilson 1898). Mining activity ceased in 1929 (Mix 1999), and none of these features survived to the present. The only evidence of mining activity now consists of two tailings piles, and two collapsed adits.

6.1 PHYSICAL DESCRIPTION

The 5.36-acre mine complex is situated in a steep, southwest-facing ravine in a forested hillside between 340 and 700 feet above sea level. The following features remain from the mine's period of significance (Figure 3 and Appendix A). Each feature is listed by its map reference number and described further below.

- Lower (1a) and upper (1b) tailing piles (evaluated—inside the project area);
- Lower (2a) and upper (2b) collapsed adits entrances (evaluated—inside the project area);
- A concentration of mining prospects (3) (unevaluated—outside the project area) ; and
- A segment of unimproved trail (4) (unevaluated—outside the project area).

6.1.1 Lower Tailings (1a)

The lower tailings (Appendix A: page 5) are situated between 340 and 440 feet above sea level. The base of the tailings is approximately 100 feet wide at Leona Creek. The top of the tailings is approximately 120 feet wide. Leona Creek descends adjacent to the southerly margin of the tailings. The ends of several scorched, milled heavy timbers measuring approximately 10-inches by 10-inches protrude from the tailings. A level area at the top of the lower tailings extends 60 to 120 feet northeasterly to the base of the upper tailings. The level area has likely been graded, as suggested by a push-pile of dirt, glass fragments, a segment of 5/8-inch-diameter solid cable, and a segment of 1/2-inch-diameter stranded cable.

6.1.2 Upper Tailings (1b)

The upper tailings (Appendix A: page 5) are situated between 440 and 540 above sea level. The base of the tailings is approximately 100 feet wide. The top of the tailings is approximately 120 feet wide. A level bench approximately 40 feet wide is situated at the top of the tailings. Leona Creek dissects the tailings from the east in a deeply eroded channel.

6.1.3 Lower Adit (2a)

The collapsed lower adit entrance (Appendix A: page 5) is in the upper tailings at an elevation of approximately 475 feet above sea level and faces southwest. The entrance now consists of a mostly buried timber structure that resembles a bulkhead. The entrance to the adit has been blocked with ore cart rails placed vertically across the opening. Tailings almost completely cover the structure.

6.1.4 Upper Adit (2b)

The collapsed upper adit entrance (Appendix A: page 6) is in the hillside to the southeast of the upper tailings and faces northwest. A mound of dirt prevents access to the adit; two one-foot- diameter holes in the mound provide the only visible evidence of the entrance.

6.1.5 Mining Prospects (3)

Three mining prospects measuring approximately 30-feet-wide by 20-feet-tall (Appendix A: page 7) are located to the east of the upper tailings, along the southern bank of Leona Creek. Above and to the south of the upper tailings are numerous mining prospects up to 30 feet wide by up to 20 feet deep, as well as an eroded trough or cut approximately 100 feet long with a pit at the west end.

6.1.6 Trail (4)

A 3-foot-wide trail (Appendix A: page 7) contours around a steep hillside to the south from the level area at the top of the lower tailings. The trail extends for approximately 3,000 feet to a subdivision, and appears to have been intentionally excavated into hillside—as opposed to an informal, opportunistic hiking trail—and is likely a feature associated with the mine complex.

6.2 HISTORICAL CONTEXT

6.2.1 Oakland

The mine is within the former Rancho San Antonio land grant, originally granted by Spain on August 3, 1820, to Luis Maria Peralta in appreciation of his 40 years of military service. His 43,000-acre rancho included what are now the cities of Oakland, Berkeley, Alameda, and parts of San Leandro and Piedmont. Peralta's land grant was re-confirmed by the Mexican government in 1822. When the United States annexed California in 1848, the Treaty of Guadalupe-Hidalgo stipulated that existing land grants be reviewed and confirmed to the grantees. Peralta's grant was reviewed and honored by the U.S. Land Commission after California became a state in 1850. Despite his undisputed legal ownership, squatters moved in to use the vast amounts of Peralta's land; cattle were stolen and slaughtered and trees logged by squatters and those traveling to and from the gold mines (Hoover et al. 1990:18-19). When Luis Peralta died in San José in 1851, Rancho San Antonio was divided amongst his sons Ignacio, José Domingo, Antonio María, and José Vicente. The land that was to become Oakland was given to José Vicente.

In 1850, Andrew Moon, Horace W. Carpentier, and Edson Adams illegally built a house on Peralta's property at the foot of Broadway, near the banks of the Oakland-Alameda Estuary and what is now Jack London Square. José Vicente Peralta sought to evict the group, but eventually relented and allowed them to lease the land with the stipulation that they not attempt to plat a town. Moon, Carpentier, and Adams violated this agreement and hired Julius Kellersberger, a Swiss engineer, to survey the land and plat the town that became Oakland. The area is now encompassed by Fallon, Market, First, and 14th streets.

The California legislature, persuaded by Carpentier, incorporated the City of Oakland in 1852. Carpentier promptly ran for Mayor in 1853 and won. The state deeded all waterfront property to the City of Oakland, which in turn passed an ordinance giving control of the land, over 10,000 acres, to Carpentier in exchange for a new school house, a wharf, and $20,000. Carpentier, however, maintained control of the wharf and charged whatever fees he desired for its use (Bagwell 1982:42-47). He went on to serve as an Assemblyman, convincing the Legislature to create Alameda County out of Contra Costa County. Many saw Carpentier's actions as a grab for more land and power, and through his busy law practice, many political connections, vast personal wealth, and property holdings, Carpentier prospered handsomely. His total control of the wharf resulted in a 20-year monopoly on San Francisco ferry service, as well as the railroad service connecting the ferry terminal with downtown. Carpentier died in 1918 with a net worth of approximately $20 million (Bagwell 1982:48-52).

Oakland grew around its waterfront, with development limited only by the available modes of transportation. Carpentier's steam ferry service to San Francisco was established in 1850, and on October 30, 1869, the first horse-car service followed a route from the estuary up Broadway to Telegraph Avenue at 36th Street. Nine days later the transcontinental railroad's inaugural west bound train rolled into Oakland to the Central Pacific Railroad's (CPRR) new 7th Street station. By 1891, Oakland's first electric street car line connected Oakland's waterfront with the city of Berkeley along Telegraph Avenue (Sappers 2007:15-17; Bagwell 1982:152-156).

The selection of Oakland as the CPRR western terminus paved the way for a population explosion. In 1860, only 1,543 people resided in Oakland; ten years later the city was home to over 10,500, a number that tripled by 1880, surpassing Sacramento as California's second largest city after San Francisco. Infrastructure supporting the population boom and transcontinental railroad included vast railroad yards, repair shops, and a wharf extending two miles into San Francisco Bay. During this time, Oakland acquired a reputation as an upright family town–a stark contrast to the rampant hedonism of San Francisco–and soon was known as the "bedroom of San Francisco" as Oakland residents commuted on ferries to San Francisco.

From about 1900 to 1912, industrial growth in Oakland was fueled by several factors, including a general turn-of-the-century economic upswing following the depression of the 1890s. The 1906 San Francisco Earthquake and Fire also had a profound effect, as industries and people moved to Oakland and the East Bay to escape the extensive damage in San Francisco. In the days following the Earthquake and Fire, for example, more than 150,000 San Francisco residents took ferries to Oakland, where many of the displaced lived for months in a tent community set up by the U.S. Army in Lakeside Park on the shores of Lake Merritt (Bagwell 1982:178; Fradkin 2005:181). A large segregated Chinese encampment was set up near Lake Merritt in an area known as "The Willows," roughly located between 15th and 18th streets (Fradkin 2005:181-182). The influx of people prompted the development of new residential areas in Oakland to accommodate many of the displaced San Franciscans. Older neighborhoods grew more densely populated as new apartment buildings and related growth became part of Oakland's residential fabric (Woodbridge 1984:11-12; Bagwell 1982:175). By 1910, Oakland's population reached 150,174, more than doubling its population in 10 years. In 1909, Oakland annexed the neighborhoods of Fruitvale, Melrose, Elmhurst, and the area between Brooklyn (East Oakland) and the City of San Leandro, providing more room for residential and industrial growth.

Commercial enterprises and industrial development, particularly at the Port of Oakland and the Oakland Municipal Airport, played vital roles in Oakland's growth throughout the 20th century. During World War II, the Port provided land and facilities to the Army and Navy. By 1943, Oakland had become the largest shipping center for the Pacific Theater of Operations and within two decades was the largest container terminal on the West Coast. As suburbs grew outward during the 1950s, the inner core of the city began to decline as residents left for the outlying areas made accessible via new freeways. The perception of Oakland, as with many large cities during the 1960s and 1970s, was that of a neglected urban core with high unemployment, cyclical racial and ethnic tension, and reduced economic opportunity (Bagwell 1982). This trend began to reverse in the 1980s as reinvestment and redevelopment helped to reinvigorate the City's image and prospects.

6.2.2 Leona Heights

Leona Heights is a neighborhood in the southern hills of present-day Oakland. Its name comes from El Cañon de los Leones (Canyon of the Lions), as it was originally part of the Rancho San Antonio land grant. In the 1840s, logging of the hills began, eventually exhausting the timber by the 1860s. A major haul road connecting the hills to the estuary is now modern Redwood Road. Much of the milled wood was shipped across the bay to rebuild San Francisco following several of its many early, devastating fires (ESA 2002:IV.C-2, 3). By the 1870s, a commercial laundry, named Laundry Farm, was established to wash the lumberjacks' clothing as well as linens from San Francisco hotels. The laundry was washed in spring water from Leona Creek, bleached, and spread out on the grass to dry.

Following a series of heavy rains in the early 1860s, that destroyed the facility, the laundry moved to a new location in West Oakland at Kirkham Court and 14th Street, which became Contra Costa Laundry (Mix 1999).

Leona Heights was historically part of the Brooklyn Township, which consisted of villages of Clinton and San Antonio, and became part of the city of Oakland in 1872. By this time, the area's laundry business had waned, in large part due to a drastic reduction in logging operations (Mix 1999).

The site of the Laundry Farm later became known as Laundry Farm Canyon, a popular picnicking area with horse-drawn sightseeing tours. By the 1880s, the Laundry Farm Railroad, an electric trolley system, carried picnickers to Laundry Farm Canyon. In 1892, the Leona Heights Hotel was built near the dead end of modern Griffen Street, between Mountain Boulevard and Leona Street, directly across from the Chabot observatory Director's house. The Hotel burned down twice in 15 years and was not rebuilt following the second fire. The hotel and associated railway were removed in 1902, and the rail beds were converted to roadways (Mix 1999; ESA 2002:IV.C-3).

Following the sulfur mining era (described below), the Leona Heights area began to see residential settlement in the 1920s when the Realty Syndicate, a real-estate development group partnered by Francis Marion 'Borax' Smith and attorney and developer Frank Colton Havens, offered ¼-acre lots for $200. The Realty Syndicate sold the parcels as potential small-scale chicken ranches to entice homeowners with supplemental income via eggs and poultry sales (Mailman 2000; Oakland Tribune 1921, 1927). The area continued to develop with residential construction before and after World War II. Building permits and Sanborn maps indicate that most of the modern residential development occurred from the 1940s to 1950s (Oakland Cultural Heritage Survey, Sanborn Perris Map Company 1951).

6.2.3 Leona Mine

Mining and quarrying began in the project area and vicinity during the 1890s. The hills east of Laundry Farm were a source of pyrite (or "fool's gold") used to produce sulfuric acid, a common chemical used in industrial applications such as mineral production, fertilizer manufacturing, oil refining, and wastewater processing. The pyrite at the Leona Mine was assayed as 50% sulfur with some infused copper (Monteagle n.d.:2). The copper was extracted as copper sulfate and used marketable product. The largest mine to produce native sulfur was the Leviathan Mine in Alpine County, but the Leona Mine was one of seven mines in California that produced sulfur from processing pyrite. The principal source of sulfur processed from pyrite was the Iron Mountain Mine in Shasta County (4,500,000 tons of sulfide ore), with the Alma Mine (located approximately one mile north of Leona) (156,600 tons) and the Leona Mine (87,500 tons) producing smaller amounts. Four other mines, the Spencerville Mine in Nevada County, the Dairy Farm Mine in Mono County, the Copper Queen Mine in Inyo County, and the Valley View Mine in Placer County produced 150,000 tons of sulfide ore (California Division of Mines and Geology 1966:411).

The earliest printed references to the Leona Mine in operation date to 1906. It was the project of Francis Marion 'Borax' Smith, who made his fortune mining borax in Nevada. Borax is a soluble mineral used in many detergents, cosmetics, industrial fluxes, glass making, and enamel glazes (Mix 1999; California Division of Mines and Geology 1966:104-111). At the Leona Mine, Smith and his Realty Syndicate financed the construction of a system of aerial tramways to deliver extracted ore to

the railroad, where it was then hauled to the Stauffer Chemical Company facility in Richmond, where it was processed into sulfuric acid (Franklin n.d.). The Stauffer Company was founded by John Stauffer, who came to San Francisco in 1885 as a representative of European chemical producers. Stauffer saw an opportunity to develop a chemical business, and after obtaining financing from European investors, he began producing soda bicarbonate and sulfur. The Stauffer Company grew to eventually absorb other competing firms, and was consolidated as Stauffer Chemical Company in 1895. Following the bankruptcy of Smith in 1913, the Stauffer Chemical Company assumed control of Leona Mine, and Stauffer Chemical Company continued to extract ore until 1929, when diminishing ore quality and safety concerns resulted in the mine's closure (Monteagle n.d). In 1925, the company expanded into the chlor-alkali business by acquiring an interest in New York-based Niagara Smelting Corporation (San Francisco Chronicle 1955).

Following World War II, the demand for chemicals rose steeply in the United States. To raise funds to expand and meet this demand, the Stauffer Chemical Company went public and sold shares of the business in 1953 (following the close of Leona Mine in 1929). During the 1950s, after the capital investment from the public offering, the company prospered and grew. By 1955, the Stauffer Chemical Company operated 44 plants nationwide with facilities in Richmond and in San Francisco (San Francisco Chronicle 1955).

The Leona Mine extracted sulfur ore from the ground similar to a hard rock mining operation would extract gold from quartz veins deep in the earth. Typical resource types associated with this activity include exploratory prospect pits, waste rock piles, shafts, adits, and underground workings. Other facilities associated with this activity can include an office, changing rooms, machine shop, blacksmith, equipment storage, tramways, trails, paths, roads, railroad beds, tanks or cisterns, and a reservoir (California Department of Transportation 2008:92-102).

At its height, the Leona Mine contained two adits, totaling over 3,000 feet, with a daily output of 500 tons (Monteagle n.d.). Mines fires were routine occurrences, and the risk associated with ore extraction eventually prompted the mine's closure. Before the mine closed in about 1929 over 200,000 tons of pyrite valued over a $1,000,000 was extracted (Monteagle n.d.). Around 1950, the adits were blasted shut to prevent accidents (Oakland Tribune 1950).

6.3 SIGNIFICANCE EVALUATION

This section presents an evaluation of the portion of the mine complex in the project area under the four CRHR significance criteria. The evaluation considers whether or not the portion of the mine complex's built environment features inside the project area contributes to the CRHR eligibility of the complex as a whole. As mining archaeologist and historian Donald Hardesty has stated, "All properties must be able to convey their significance" (2000:45). The mine complex was active during the years between 1906 and approximately 1929 (Mix 1999). This approximately 30-year-long period constitutes the mine complex's period of significance.

6.3.1 Application of Significance Criteria

The mine complex appears eligible for inclusion in the CRHR for its historical association with mining activities in Oakland under CRHR significance Criterion 1. The remains of the complex's mining activities fall within three broad categories: (1) extraction, (2) beneficiation, and (3) refining.

Extraction consists of exploration or prospecting for mineral resources. Beneficiation consists of upgrading those resources to improve purity. Refining consists of "converting metal into a state of purity suitable for commercial use, manufacturing, or for commercial exchange" (National Park Service 1997:11-12). The surviving features at the Leona Mine consist of features associated with extraction. Beneficiation and refining took place at a processing plant in Richmond, after the pyrite ore had been hoisted by aerial tramway out of the mining complex and loaded onto rail cars for shipment to Richmond.

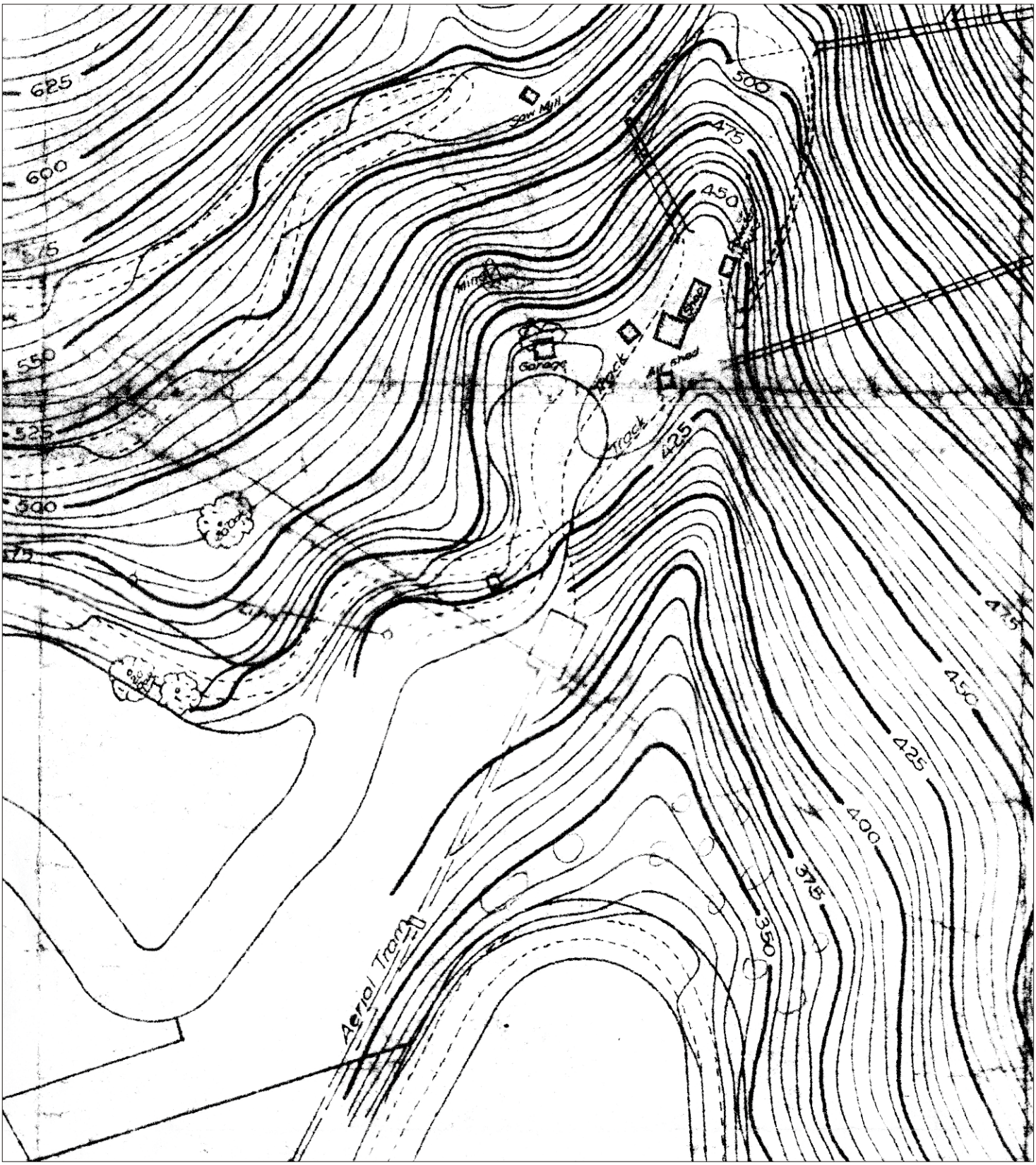
The two phases of mining activity associated with extraction at the Leona Heights Sulfur Mine are (1) exploration and (2) mining development. Exploration is represented by the numerous mining prospects—pits, troughs, and gouges—that are on the hillside above the tailings (outside the project area). Mining development is represented by the two large tailings piles and the collapsed adits (inside the project area). Mining development was once represented at the mine complex by infrastructure such as ore cart tracks, adits, a garage, a "shop," and an aerial tramway (Figure 4). These features are no longer present, leaving only documentary evidence to illustrate and convey the industrial process of historical mining at the Leona Mine.

Criterion 1: Associated with events that have made a significant contribution to the broad patterns of California's history and cultural heritage?

The mine complex is an uncommon example of hard rock mining in Oakland. The mine complex produced iron sulfide ore that was transported to the Stauffer Chemical Company processing plant in Richmond, where it was used in the production of sulfuric acid. Mining activities played a key role in California's historical development, resulting in monumental economic, societal, technological, and ethnic shifts locally and statewide. The mine complex contributed to the development of chemical manufacturing in the San Francisco Bay area as one of the primary extractive operations for the production of sulfur. Due to its role in the development of the San Francisco Bay area economy and industrial history, the portion of the mine complex within the project area appears significant under CRHR Criterion 1.

Criterion 2: Is it associated with the lives of persons important to local, California, or national history?

The mine complex was developed by Francis Marion 'Borax' Smith, a major figure in the mining industry of the western United States. Although Smith was an important proponent of California's mining industry, his wealth and fame were predominantly derived from his borax mines in Southern California's Mojave Desert. The Leona Mine represented a minor holding for Smith and is not an important subsidiary that substantially contributed to his prominence as an successful industrialist. Due to a lack of association with important historical figures, the portion of the mine complex within the project area lacks significance under CRHR Criterion 2.



LSA

FIGURE 4

North

10 ft.

Leona Creek Restoration and Leona Heights Sulfur Mine Remediation Project

Locations of Built Environment Features No Longer Present

P:\GEO1301\g\Cultural\CRHR Evaluation\Figure 4_Locations of Built Environment Features No Longer Present.cdr (1/31/2014)

Criterion 3: Does it embody the distinctive characteristics of a type, period, region, or method of construction, or represent the work of a master, or possess high artistic values?

Due to its lack of the majority of built environment features that were present during the period of significance, the portion of the mine complex within the project area lacks significance under CRHR Criterion 3 and cannot convey its significance.

Criterion 4: Has it yielded, or may it be likely to yield, information important to history?

Research has not identified important information about the mine complex and it is unlikely that such information will be forthcoming as a result of future research. The portion of the mine complex within the project area itself consists of two tailings piles and two collapsed adit entrances. As there are no indications that study of the mine's built environment (non-archaeological) features would identify new information regarding mining activities or techniques, the portion of the mine complex in the project area lacks significance under Criterion 4.

6.4 INTEGRITY ASSESSMENT

This section presents an assessment of the historical integrity of those portions of the mine complex in the project area. In evaluating the integrity of mining properties, one must employ a ". . . holistic outlook that comprehensively considers all the component parts of a mining system." (National Park Service 1997:21). The seven aspects of integrity that convey historical significance are location, design, setting, materials, workmanship, feeling, and association. Each integrity aspect is discussed below:

- **Location**. The portion of the mine complex within the project area—two tailing piles and mining prospects—retains integrity of location. These features have not moved or been otherwise relocated since the historical events that produced them originally occurred.
- **Design.** The infrastructure once originally located within the portion of the mine complex within the project area—adits, buildings, aerial tramway components, adit shoring, and ore cart rails—has not survived. The tailings, isolated as discrete features, do not convey a sense of form, plan, space, and structure of the mine when it began, nor how the configuration of its facilities changed as its operations matured and eventually subsided. The tailings exist as a consequence of the mine complex's operations and infrastructure, but do not in and of themselves convey the process of subterranean extraction, transportation, and refining, all of which contribute to the mining system process. Of particular importance is the lack of any aerial tramway components that would convey the means of multi-modal distribution used to transport the pyrite ore from the mines to rail cars for shipment to Richmond (Franklin n.d.). The aerial tramway was a defining feature of the mine complex; however, none of the tramway's components remain. The portion of the mine complex's features within the project area does not retain integrity of design.
- **Setting.** The portion of the mine complex within the project area is situated in and just below a forested ravine above a residential neighborhood. In spite of the encroachment of urban development below and adjacent to the lower tailings pile, the rugged and densely forested slopes of the ravine provide an immediate setting that still conveys the once rural nature of the mine complex. Although slightly diminished by the construction of nearby houses and freeway, the portion of the mine complex within the project area retains integrity of setting.

- **Materials.** The infrastructure of the mine complex within the project area is no longer present and it cannot convey any information about the materials that were used in its construction. The portion of the mine complex within the project area does not retain integrity of materials.
- **Workmanship.** The infrastructure portion of the mine complex within the project area is no longer present and it cannot convey any information about the labor and skill that went into its construction. The portion of the mine complex within the project area does not retain integrity of workmanship.
- **Feeling.** The mine complex's infrastructure within the project area is no longer present, and the tailings do not, in and of themselves, convey the feel of a mining operation to an uninformed visitor. The portion of the mine complex within the project area does not retain integrity of feeling.
- **Association**. The lack of mining infrastructure makes it difficult for a visitor to understand the specific activities that produced the two tailings piles. Given this lack of key information regarding the mine complex's operations, the complex lacks integrity of association with the complex's mining activities.

The mine complex retains integrity of location and setting, but lacks integrity of design, materials, workmanship, feeling, and association. On balance, the mine complex does not possess the ability to convey the significance of its role in the history of sulfur mining in the East Bay due to the removal of the majority of mining related built-environment features.

Eligibility Conclusion. In evaluating the CRHR eligibility of the portion of the mine complex within the project area, the guiding concept used in the evaluation is the "degree to which the overall mining system remains intact and visible" (U.S. Department of the Interior 1997:21). The movement of ore through the site and the exact nature of the mining activities that took place there cannot be clearly reconstructed or conveyed: the two adits have been blasted shut, no ore cart rails extend from the collapsed adits, and none of the components of the aerial tramway survive. Due to the removal of the majority of the mine's infrastructure, it is difficult to understand how the mine functioned as a system engaged in the extraction of mineral resources. In spite of its significance in Oakland history, the portion of the mine complex within the project area appears ineligible for inclusion in the CRHR due to a lack of integrity.

7.0 CONCLUSION

The portion of the mine complex within the project area has been evaluated here for CRHR eligibility as a built environment cultural resource—not for any potential archaeological significance. While the mine is significant under CRHR Criterion 1, its ability to convey its significance is greatly compromised by its lack of built environment (infrastructure) components. A visitor to the mine complex would observe the remains of some type of ground-disturbing activities, but it is not likely that these landscape modifications would be recognized or perceived as a mining system. While the portion of the mine complex within the project area has an important association with Oakland's historical development, it does not appear eligible for inclusion in the CRHR due to a lack of integrity, and does not appear to qualify as a historical resource as defined by California Public Resources Code §21084.1.

8.0 REFERENCES CONSULTED

American Society of Civil Engineers
1977 *Historic Engineering Landmarks of San Francisco and Northern California*. San Francisco Section, San Francisco California.

Archaeological Consulting and Research Services, Inc.
n.d. *Report of the Archaeological Reconnsiassance of the Proposed Mountain Village Developments, Alameda County, California*. Archaeological Consulting and Research Service, Inc., Mill Valley.

Bagwell, Beth.
1982 *Oakland, Story of a City*. Presidio Press, Novato, California.

Baker, Joseph E.
1914 *Past and Present of Alameda County*. Volume I. S.J. Clarke Publishing Company, Chicago, Illinois.

California Division of Mines and Geology
1966 *Mineral Resources of California, Bulletin 191*. California Division of Mines and Geology, San Francisco, California.

California Historical Society Quarterly
1964 Stauffer Chemical Company. California Historical Society Quarterly December 1964. On file at Oakland History Room Oakland Public Library, Oakland, California.

California Office of Historic Preservation
1988 *Five Views: An Ethnic Historic Site Survey for California*. California Department of Parks and Recreation, Sacramento, California.

1992 *California Points of Historical Interest*. California Department of Parks and Recreation, Sacramento, California.

1996 *California Historical Landmarks*. California Department of Parks and Recreation, Sacramento, California.

2001 *California Environmental Quality Act (CEQA) and Historical Resources*. Technical Assistance Series 1. California Department of Parks and Recreation, Sacramento.

2012 *Directory of Properties in the Historic Property Data File*, April 5, 2012. California Department of Parks and Recreation, Sacramento, California.

California Department of Transportation (Caltrans)
2008 *A Historical Context and Archaeological Research Design for Mining Properties in California.* Division of Environmental Analysis, California Department of Transportation, Sacramento, California.

Calisphere
n.d. *Laundry Farm Cottage.* Electronic document, http://content.cdlib.org/ark:/13030/tf2n39p07n/?query=laundry farm&brand=calisphere, accessed December 9, 2013.

1880 *Laundry Farm, 1880s*. Electronic document, http://content.cdlib.org/ark:/13030/tf0d5nb2rr/?query=laundry farm&brand=calisphere

City of Oakland
1998 *Historic Preservation: An Element of the Oakland General Plan.* Community and Economic Development Agency, City of Oakland, California.

1993 *Oakland Cultural Heritage Survey Evaluation Methods*. Oakland Cultural Heritage Survey, Oakland, California.

ESA
2002 *Leona Quarry Draft Environmental Impact Report*. On file at Oakland History Room, Oakland Public Library, Oakland, California

Fradkin, Phillip L.
2005 *The Great Earthquake and Firestorms of 1906: How San Francisco Nearly Destroyed Itself.* University of California Press, Berkeley.

Franklin, Harold J.
n.d. A Brief History of Leona Canyon (With Emphasis on the Mining and Quarry Operations). No publisher listed.

Gudde, Erwin G.
1998 *California Place Names: The Origin and Etymology of Current Geographical Names*. Fourth edition, revised and enlarged by William Bright. University of California Press, Berkeley.

Hardesty, Donald L., and Barbara J. Little
2000 *Assessing Site Significance: A Guide for Archaeologists and Historians*. AltaMira Press, Walnut Creek, California.

Hayes, Derek
2007 *Historical Atlas of California*. University of California Press, Berkeley.

Hibma, Michael
2008 *Historical Resources Evaluation Report for the 12th Street Reconstruction Project, Oakland, Alameda County California*. LSA Associates, Inc., Point Richmond, California.

Hoover, Mildred Brooke, Hero Eugene Rensch, Ethel Rensch, and William N. Abeloe
1990 *Historic Spots in California*. Fourth edition, revised by Douglas E. Kyle. Stanford University Press, Stanford, California.

L'Hommedieu & Wilson, Inc.
1898 *Topographical Map of Laundry Farm.* L'Hommedieu & Wilson, Inc., Oakland, California.

Mailman, Erika
2000 Leona Heights developed quickly with the help of the Realty Syndicate…and chickens. *Montclarion* 19 September 2000.

Marschner, Janice
2000 *California, 1850: A Snapshot in Time*. Coleman Ranch Press, Sacramento, California.

Mix, Steven Russell
1999 *History of Laundry Farm Canyon*. Electronic document, P:\GEO1301\Cultural\Mix Family History Page - Laundry Farm Canyon, Oakland, CA.mht, accessed November 18, 2013.

Monteagle, Fredrick J.
n.d. Leona Gold. Oakland Districts, Leona Heights. On file at Oakland History Room, Oakland Public Library, Oakland, California.

Mulryan, Henry
1925 *Geology and Ores of the Leona Heights Pyrite Deposit, Oakland, California*. Citation only. Electronic document, http://redirect.conservation.ca.gov/CGS/information/publications/library_catalog.htm, accessed December 9, 2013.

National Park Service
1986 *Guidelines for Completing National Register of Historic Places Forms*. Bulletin 16. U.S. Department of the Interior, Washington, D.C.

1997a *How to Apply the National Register Criteria for Evaluation*. U.S. Department of the Interior, Washington, D.C.

1997b *How to Complete the National Register Registration Form*. U.S. Department of the Interior, Washington, D.C.

1997c *National Register Bulletin 42: Guidelines for Identifying, Evaluating, and Registering Historic Mining Properties*. U.S. Department of the Interior, Washington, D.C.

1998 *Guidelines for Evaluating and Nominating Properties that Have Achieved Significance within the Past Fifty Years*. U.S. Department of the Interior, Washington, D.C.

1999 *Guidelines for Evaluating and Documenting Rural Historic Landscapes*. U.S. Department of the Interior, Washington, D.C.

2000 *Guidelines for Evaluating and Registering Archeological Properties*. U.S. Department of the Interior, Washington, D.C.

Oakland California Landmarks
2007 *Alameda County Landmarks in Oakland*. Electronic document, http://oakcountylandmarks.blogspot.com/, accessed November 18, 2013.

Oakland Community and Economic Development Agency (CEDA)
1994 *Summary of the Historic Preservation Element of the Oakland General Plan*. Electronic document, http://www.oaklandnet.com/government/ceda/revised/planningzoning/historicpreservation/HP-overviewH.html#Survey, accessed on May 8, 2008.

Oakland Cultural Heritage Survey
n.d. OCHS survey maps of Leona Heights with building permits. On file at Oakland Cultural Heritage Survey, Oakland, California.

2011 *City of Oakland Designated Landmarks, Heritage Properties, and Preservation Districts*. Electronic document, http://www2.oaklandnet.com/Government/o/PBN/OurServices/Historic/DOWD009012, accessed November 18, 2013.

Oakland Heritage Alliance
2001 Homepage. Electronic document, http://www.oaklandheritage.org/, accessed November 20, 2013.

n.d. *List of Oakland City Landmarks*. Electronic document, http://oaklandheritage.org/files/42417032.pdf, accessed November 18, 2013.

Oakland Tribune
1921 Leona Heights Addition. Advertisement matter. *Oakland Tribune*, 10 May 1921.

1921 Leona Heights Addition. Advertisement matter. *Oakland Tribune* 4 September 1921.

1950 Cows Come Home To roost; City has Mine Shaft Trouble. *Oakland Tribune* 2 July 1950.

Online Archive of California
n.d. *Laundry Farm Cottage*. Electronic document, http://www.oac.cdlib.org/ark:/13030/tf2n39p07n/?brand=oac4, accessed December 9, 2013.

Sanborn Map Company
1925 *Fire Insurance Maps of Oakland.* Oakland Sheet 736. Sanborn Map and Publishing Company, New York, New York.

1951 *Fire Insurance Maps of Oakland.* Oakland Sheet 736. Sanborn Map and Publishing Company, New York, New York.

San Francisco Chronicle
1955 Free Enterprise in the Bay Area: the Story of Stauffer Chemical Company. San Francisco Chronicle. 16 December 1955. On file at Oakland History Room Oakland Public Library, Oakland, California.

Sappers, Vernon J.
2007 *Key System Streetcars: Transit, Real Estate, and Growth of the East Bay*. Bay Area Electric Railroad Association. Signature Press, Wilton, California.

Sloan, Doris
2006 *Geology of the San Francisco Bay Region*. University of California Press, Berkeley.

U.S. Coast Survey
1856 *San Francisco Bay T-Sheet* #24. U.S. Coast Survey, Washington D.C.

U.S. Department of the Interior
1997 *Guidelines for Identifying, Evaluating, and Registering Historic Mining Properties*. National Register Bulletin 15. U.S. Department of the Interior, National Park Service, Washington, D.C.

U. S. Geological Survey
1947 *Oakland East, Calif.*, 7.5-minute topographic quadrangle. U.S. Geological Survey, Washington, D.C.

1949 *Oakland East, Calif.*, 7.5-minute topographic quadrangle. U.S. Geological Survey, Washington, D.C.

1958 *Oakland East, Calif.*, 7.5-minute topographic quadrangle. U.S. Geological Survey, Washington, D.C.

1966 *Oakland East, Calif.*, 7.5-minute topographic quadrangle. U.S. Geological Survey, Washington, D.C.

1969 *Oakland East, Calif.*, 7.5-minute topographic quadrangle. U.S. Geological Survey, Washington, D.C.

1975 *Oakland East, Calif.*, 7.5-minute topographic quadrangle. U.S. Geological Survey, Washington, D.C.

1980 *Oakland East, Calif.*, 7.5-minute topographic quadrangle. U.S. Geological Survey, Washington, D.C.

1997 *Oakland East, Calif.*, 7.5-minute topographic quadrangle. U.S. Geological Survey, Washington, D.C.

Wikipedia
2013 Mills College. Electronic document, http://en.wikipedia.org/wiki/Mills_College, accessed November 18, 2013.

Francis Marion Smith. Electronic document, http://en.wikipedia.org/wiki/Borax_Smith, accessed December 3, 2013.

APPENDIX A

CALIFORNIA DEPARTMENT OF PARKS AND RECREATION FORM 523 SERIES RECORDS

LEONA HEIGHTS SULFUR MINE

State of California — The Resources Agency **Primary #**
DEPARTMENT OF PARKS AND RECREATION **HRI #**
PRIMARY RECORD
Trinomial
NRHP Status Code
Other Listings
Review Code _____ Reviewer _____Date

 Resource Name: Leona Heights Sulfur Mine

P1. **Other Identifier:** Known to some local residents as the "McDonell Sulfur Mine."

P2. **Location:** Unrestricted

a. **County:** Alameda

b. **USGS 7.5' Quad: 1997** *Oakland East, Calif.* **Date: 1997 T 1 & 2S ; R 3W;** unsectioned lands of the Rancho San Antonio land grant; Mount Diablo Baseline & Meridian

c. **Address:** McDonell Avenue **City:** Oakland **Zip**

d. **UTMs:** NAD 83 **Zone** 10**;** 572,697 **mE** 4,182,574 **mN;** 572,780 **mE** 4,182,704 **mN;** 572,928 **mE** 4,182,704 **mN;** 572,803 **mE** 4,182,460

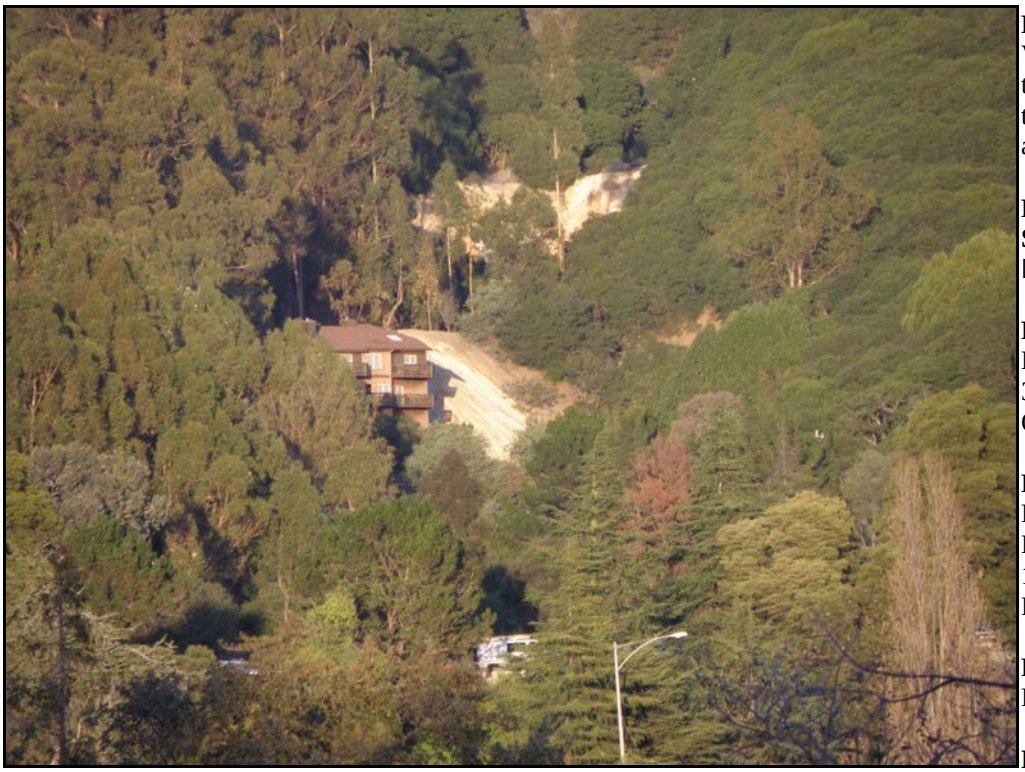
e. **Other Locational Data:** At the eastern terminous of McDonell Avenue.

P3a. **Description:** The Leona Heights Sulfur Mine complex consists of two tailings piles, two collapsed adits, mining prospects, and a trail. (See Sketch Maps 1a and 2b on pages 9-10.) These features are the remains of a sulfur mining operation that was active from 1906 to approximately 1929. The adits were closed in 1950. The only constructed mining remains visible are heavy timbers and narrow-gauge rail road segments partially buried in the tailings at the presumed entrance to the lower adit. Few artifacts are visible in the complex. A push-pile near McDonell Avenue has glass fragments, an automobile wheel, and segments of stranded and solid steel cable. The level area on which the push pile is situated was the likely landing for an aerial tramway that carried ore to the vicinity of what is now the Warren Freeway. Burned, heavy timbers are present in the tailings. This record contains a California Register of Historical Resources evaluation of the portion of the mining complex within the Leona Creek Restoration and Leona Heights Sulfur Mine Remediation Project limits. The evaluation focuses on the mine as a built environment resource. It is unknown if archaeological deposits are present.

P3b. **Resource Attributes:**AH9

P4. **Resources Present:** ☐ Building ☐ Structure ☐ Object ☒ Site ☐ District ☐ Element of District ☐ Other (Isolates, etc.)

P5a.



P5b. Description of Photo: View to northeast. The lower tailings are visible to the right of the house; the upper tailings are above and right.

P6. Date Constructed/Age and Source: 1906 to about 1929
☒ **Historic**

P7. Owner and Address:
Dr. Collin Mbanugo
3300 Webster Street #900
Oakland, CA 94619

P8. Recorded by:
Neal Kaptain, M.A., RPA
LSA Associates, Inc.
157 Park Place
Pt. Richmond, CA 94801

P9. Date recorded:
November 24, 2013

P10. Survey Type: Intensive

P11. Report citation:
Kaptain, Neal (2013) *Eligibility Evaluation for the Leona Creek Restoration and Leona Heights Sulfur Mine Remediation Project, Oakland, Alameda County, California.* LSA Associates, Inc., Point Richmond, California.

Attachments: ☒Location Map ☒Sketch Map ☒Continuation Sheet

DPR 523A (1/95)

Description of Leona Heights Sulfur Mine complex:
(See Sketch Maps 1a and 1b on pages 9-10.)

The mine complex is situated in a steep, southwest-facing ravine in a forested hillside between 340 and 700 feet above sea level. The following features remain from the mine's period of significance (Figure 4 and Appendix). Each feature is listed by its map reference number and described further below.

- Lower (1a) and upper (1b) tailing piles (evaluated—inside the project area);
- Lower (2a) and upper (2b) collapsed adits entrances (evaluated—inside the project area);
- A concentration of mining prospects (3) (unevaluated—outside the project area) ; and
- A segment of unimproved trail (4) (unevaluated—outside the project area).

Lower Tailings (1a)
The lower tailings are situated between 340 and 440 feet above sea level. The base of the tailings is approximately 100 feet wide at Leona Creek. The top of the tailings is approximately 120 feet wide. Leona Creek descends adjacent to the southerly margin of the tailings. The ends of several scorched, milled heavy timbers measuring approximately 10-inches by 10-inches protrude from the tailings. A level area at the top of the lower tailings extends 60 to 120 feet northeasterly to the base of the upper tailings. The level area has likely been graded, as suggested by a push-pile of dirt, glass fragments, a segment of 5/8-inch-diameter solid cable, and a segment of 1/2-inch-diameter stranded cable.

Upper Tailings (1b)
The upper tailings are situated between 440 and 540 above sea level. The base of the tailings is approximately 100 feet wide. The top of the tailings is approximately 120 feet wide. A level bench approximately 40 feet wide is situated at the top of the tailings. Leona Creek dissects the tailings from the east in a deeply eroded channel.

Lower Adit (2a)
The collapsed lower adit entrance is in the upper tailings at an elevation of approximately 475 feet above sea level and faces southwest. The entrance now consists of a mostly buried timber structure that resembles a bulkhead. The entrance to the adit has been blocked with ore cart rails placed vertically across the opening. Tailings almost completely cover the structure.

Upper Adit (2b)
The collapsed upper adit entrance is in the hillside to the southeast of the upper tailings and faces northwest. A mound of dirt prevents access to the adit; two one-foot- diameter holes in the mound provide the only visible evidence of the entrance.

Mining Prospects (3)
Three mining prospects measuring approximately 30-feet-wide by 20-feet-tall are located to the east of the upper tailings, along the southern bank of Leona Creek. Above and to the south of the upper tailings are numerous mining prospects up to 30 feet wide by up to 20 feet deep, as well as an eroded trough or cut approximately 100 feet long with a pit at the west end.

Trail (4)
A 3-foot-wide trail contours around a steep hillside to the south from the level area at the top of the lower tailings. The trail extends for approximately 3,000 feet to a subdivision, and appears to have been intentionally excavated into hillside—as opposed to an informal, opportunistic hiking trail—and is likely a feature associated with the mine complex.

Signficance assessment of Leona Heights Sulfur Mine Complex:

This section presents an evaluation of the portion of the mine complex in the project area under the four CRHR significance criteria. The evaluation considers whether or not the portion of the mine complex's built environment features inside the project area contributes to the CRHR eligibility of the complex as a whole. The mine complex was active during the years between 1906 and approximately 1929. This approximately 30-year-long period constitutes the mine complex's period of significance.

6.3.1 Application of Significance Criteria

Criterion 1: Associated with events that have made a significant contribution to the broad patterns of California's history and cultural heritage?

The mine complex is an uncommon example of hard rock mining in Oakland. The mine complex produced iron sulfide ore that was transported to the Stauffer Chemical Company processing plant in Richmond, where it was used in the production of sulfuric acid. Mining activities played a key role in California's historical development, resulting in monumental economic, societal, technological, and ethnic shifts locally and statewide. The mine complex contributed to the development of chemical manufacturing in the San Francisco Bay area as one of the primary extractive operations for the production of sulfur. Due to its role in the development of the San Francisco Bay area economy and industrial history, the portion of the mine complex within the project area appears significant under CRHR Criterion 1.

Criterion 2: Is it associated with the lives of persons important to local, California, or national history?

The mine complex was developed by Francis Marion 'Borax' Smith, a major figure in the mining industry of the western United States. Although Smith was an important proponent of California's mining industry, his wealth and fame were predominantly derived from his borax mines in Southern California's Mojave Desert. The Leona Mine represented a minor holding for Smith and is not an important subsidiary that substantially contributed to his prominence as an successful industrialist. Due to a lack of association with important historical figures, the portion of the mine complex within the project area lacks significance under CRHR Criterion 2.

Criterion 3: Does it embody the distinctive characteristics of a type, period, region, or method of construction, or represent the work of a master, or possess high artistic values?

Due to its lack of the majority of built environment features that were present during the period of significance, the portion of the mine complex within the project area lacks significance under CRHR Criterion 3 and cannot convey its significance.

Criterion 4: Has it yielded, or may it be likely to yield, information important to history?

REearch has not identified important information about the mine complex and it is unlikely that such information will be forthcoming as a result of future research. The portion of the mine complex within the project area itself consists of two tailings piles and two collapsed adit entrances. As there are no indications that study of the mine's built environment (non-archaeological) features would identify new information regarding mining activities or techniques, the portion of the mine complex in the project area lacks significance under Criterion 4.

Integrity assessment of Leona Heights Sulfur Mine complex: This section presents an assessment of the historical integrity of those portions of the mine complex in the project area.

- **Location**. The portion of the mine complex within the project area—two tailing piles and mining prospects—retains integrity of location. These features have not moved or been otherwise relocated since the historical events that produced them originally occurred.
- **Design.** The infrastructure once originally located within the portion of the mine complex within the project area—adits, buildings, aerial tramway components, adit shoring, and ore cart rails—has not survived. The tailings, isolated as discrete features, do not convey a sense of form, plan, space, and structure of the mine when it began, nor how the configuration of its facilities changed as its operations matured and eventually subsided. The tailings exist as a consequence of the mine complex's operations and infrastructure, but do not in and of themselves convey the process of subterranean extraction, transportation, and refining, all of which contribute to the mining system process. Of particular importance is the lack of any aerial tramway components that would convey the means of multi-modal distribution used to transport the pyrite ore from the mines to rail cars for shipment to Richmond (Franklin n.d.). The aerial tramway was a defining feature of the mine complex; however, none of the tramway's components remain. The portion of the mine complex's features within the project area does not retain integrity of design.
- **Setting.** The portion of the mine complex within the project area is situated in and just below a forested ravine above a residential neighborhood. In spite of the encroachment of urban development below and adjacent to the lower tailings pile, the rugged and densely forested slopes of the ravine provide an immediate setting that still conveys the once rural nature of the mine complex. Although slightly diminished by the construction of nearby houses and freeway, the portion of the mine complex within the project area retains integrity of setting.
- **Materials.** The infrastructure of the mine complex within the project area is no longer present and it cannot convey any information about the materials that were used in its construction. The portion of the mine complex within the project area does not retain integrity of materials.
- **Workmanship.** The infrastructure portion of the mine complex within the project area is no longer present and it cannot convey any information about the labor and skill that went into its construction. The portion of the mine complex within the project area does not retain integrity of workmanship.
- **Feeling.** The mine complex's infrastructure within the project area is no longer present, and the tailings do not, in and of themselves, convey the feel of a mining operation to an uninformed visitor. The portion of the mine complex within the project area does not retain integrity of feeling.
- **Association**. The lack of mining infrastructure makes it difficult for a visitor to understand the specific activities that produced the two tailings piles. Given this lack of key information regarding the mine complex's operations, the complex lacks integrity of association with the complex's mining activities.

Eligibility Conclusion. In evaluating the CRHR eligibility of the portion of the mine complex within the project area, the guiding concept used in the evaluation is the "degree to which the overall mining system remains intact and visible" (U.S. Department of the Interior 1997:21). The movement of ore through the site and the exact nature of the mining activities that took place there cannot be clearly reconstructed or conveyed: the two adits have been blasted shut, no ore cart rails extend from the collapsed adits, and none of the components of the aerial tramway survive. Due to the removal of the majority of the mine's infrastructure, it is difficult to understand how the mine functioned as a system engaged in the extraction of mineral resources. In spite of its significance in Oakland history, the portion of the mine complex within the project area appears ineligible for inclusion in the CRHR due to a lack of integrity.

Photographs of the Leona Heights Sulfur Mine:

Lower tailings. View to Northwest.

Upper tailings (above) with push pile of debris in foreground. View to East.

Photographs of Leona Heights Sulfur Mine:

Lower adit (collapsed). View to northwest.

Upper adit (collapsed). View to southeast.

Photographs of Leona Heights Sulfur Mine:

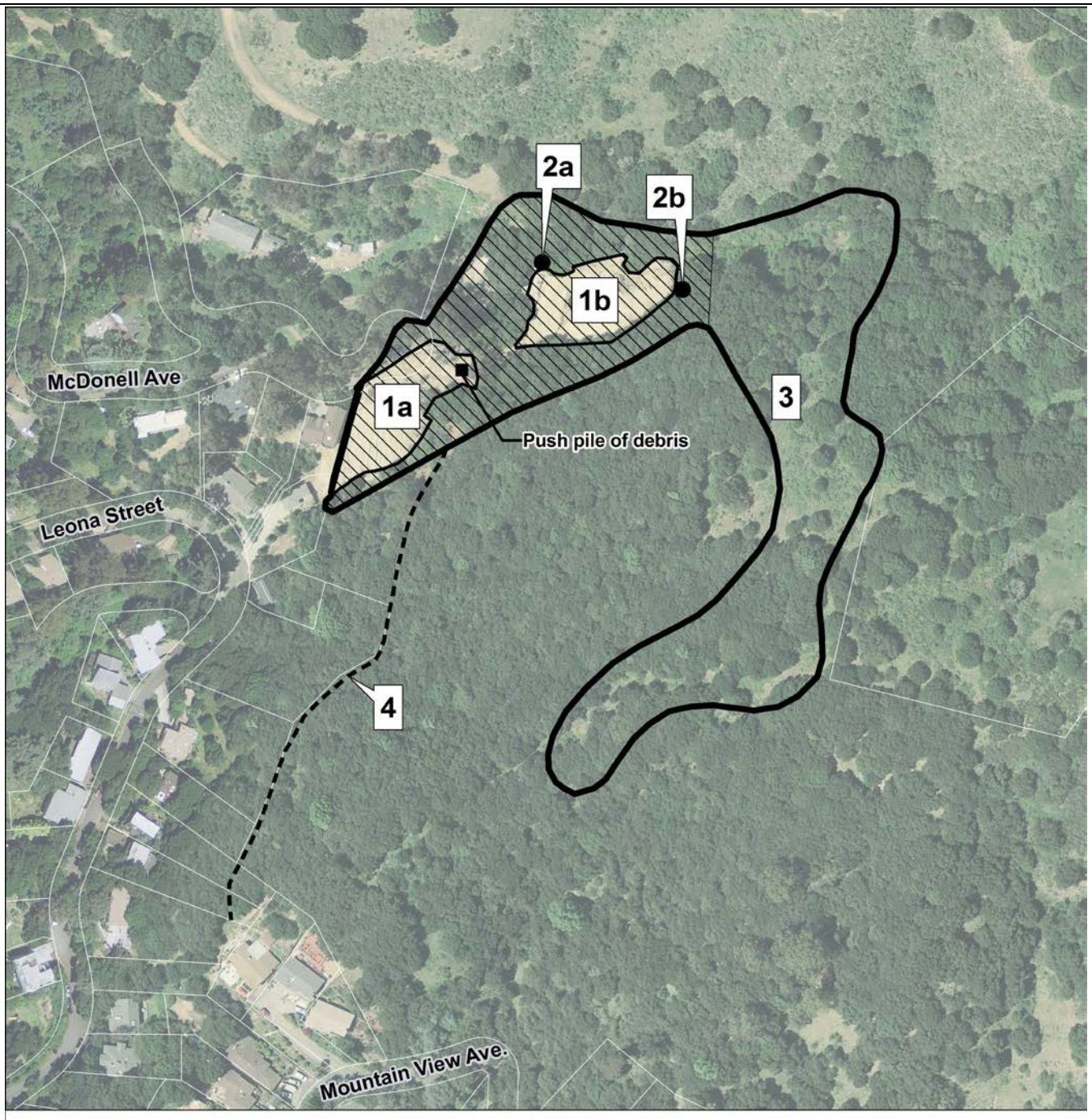
Mining prospect. View to north.

Trail. View to north.

Photographs of Leona Heights Sulfur Mine:

Push pile. View to east.

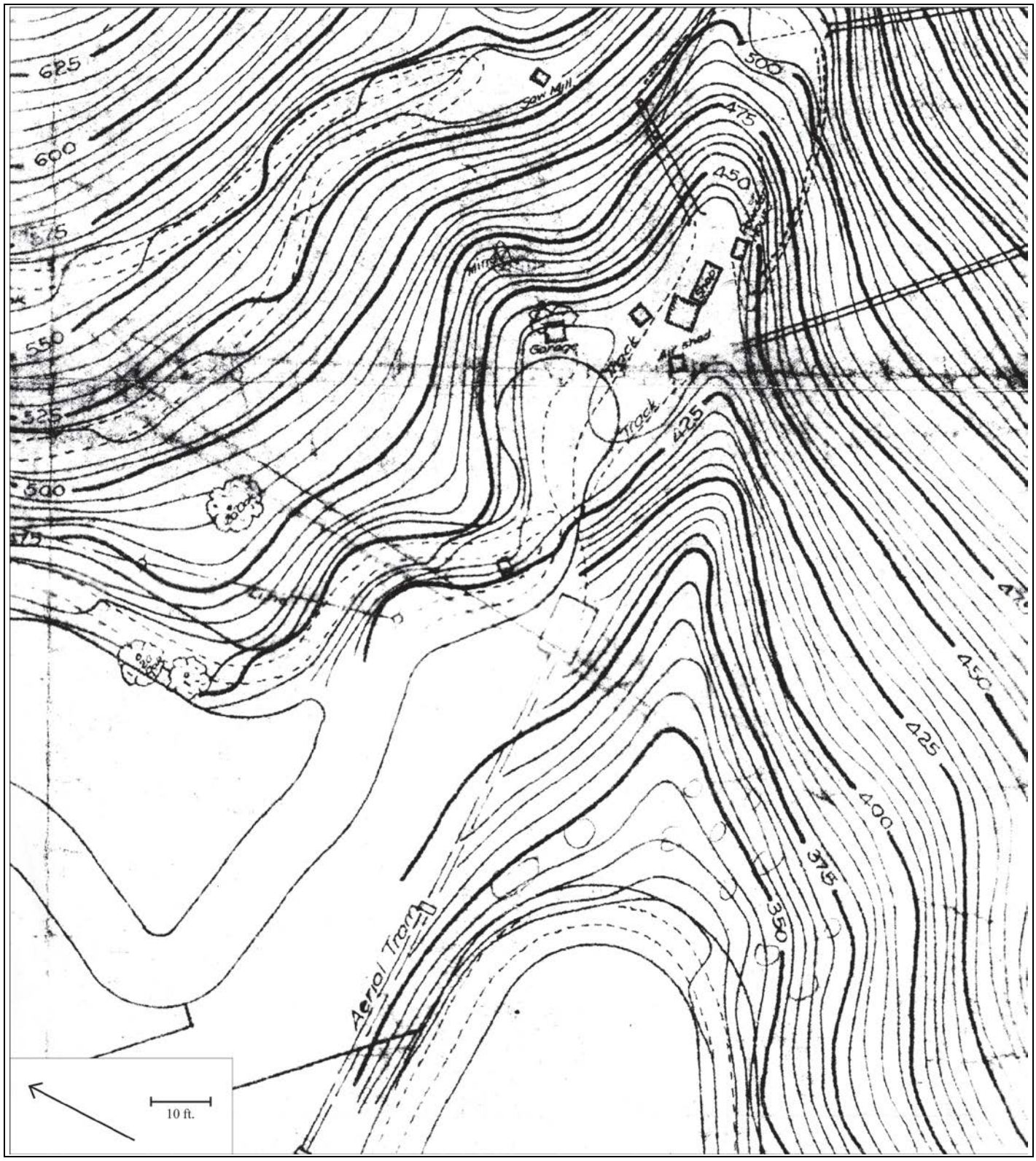
View of Oakland from upper tailings pile. View to southwest.


2a
2b
1b
1a
3
4
Push pile of debris
McDonell Ave
Leona Street
Mountain View Ave.
N
0
100
200
FEET
SOURCE: Alameda County (2013);
USGS Orthoimagery (04/2011).
Legend
Leona Heights Sulfur Mine Site Boundary
Evaluated Portion
Parcel
1a Lower tailings pile (evaluated)
1b Upper tailings pile (evaluated)
2a Lower adit (evaluated)
2b Upper adit (evaluated)
3 Mining Prospects (not evaluated)
4 Trail (not evaluated)

State of California — The Resources Agency	Primary #
DEPARTMENT OF PARKS AND RECREATION	HRI#
SKETCH MAP 1b	Trinomial

Page 10 **of** 11 **Resource Name:** Leona Heights Sulfur Mine

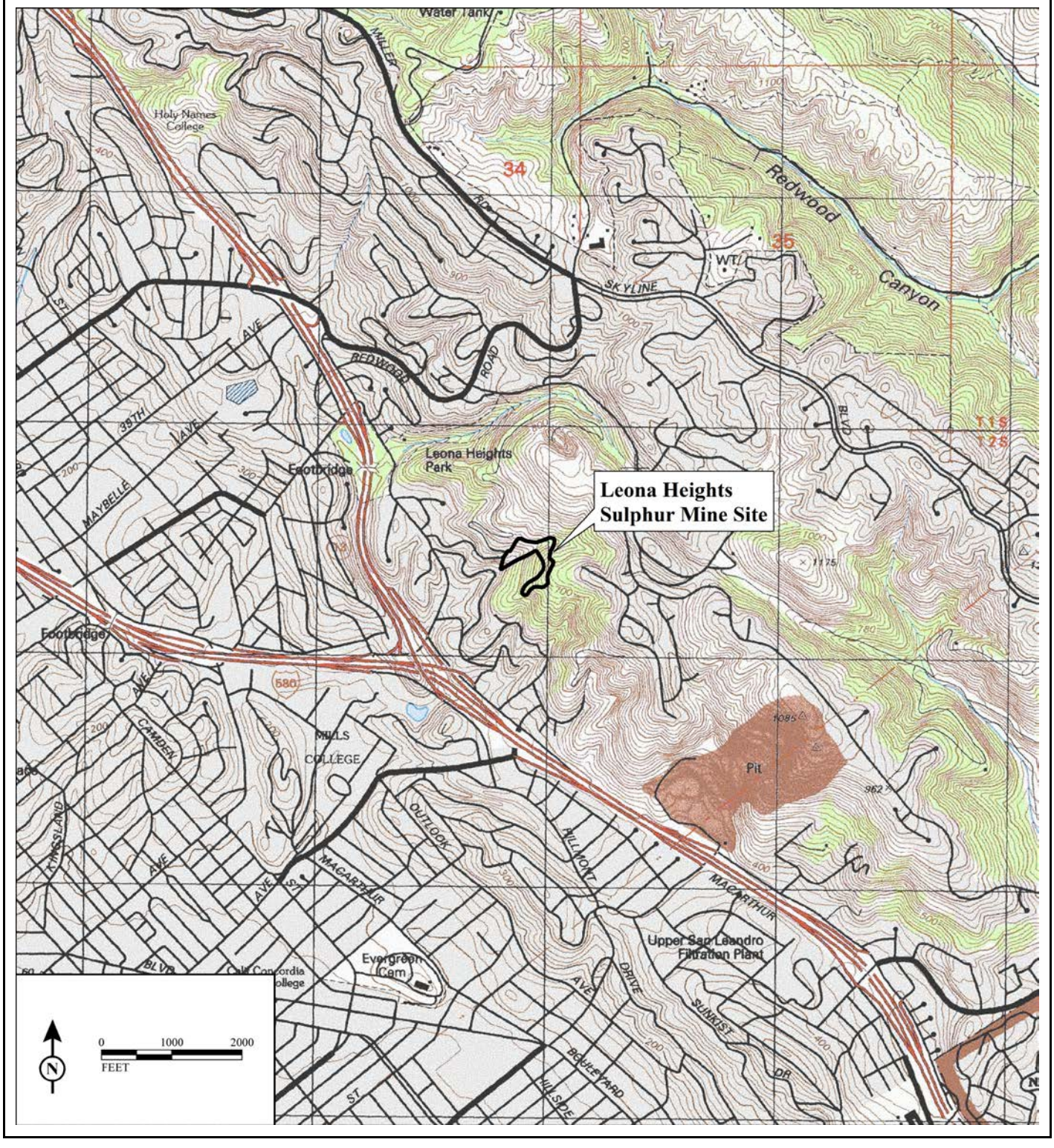
Drawn By: Neal Kaptain **Date:** November 24, 2013



State of California — The Resources Agency **Primary #**
DEPARTMENT OF PARKS AND RECREATION **HRI#**
LOCATION MAP **Trinomial**

 Resource Name: Leona Heights Sulfur Mine

Map Name: USGS *Oakland, East* **Scale:** 7.5-minute **Date of Map: 1959** (PR 1980)



DPR 523J (1/95)

APPENDIX G

LEONA HEIGHTS SULFUR MINE
REMEDIATION CREEK RESTORATION
CONSTRUCTION WORKPLAN

E2C Remediation
Environmental Engineering,
Consulting and Remediation, Inc.

LEONA HEIGHTS SULFUR MINE REMEDIATION
CREEK RESTORATION

CONSTRUCTION WORKPLAN
(Revised January 2014)

End of McDonell Avenue
Oakland, California

January 28, 2014

Project Number 2028BK48

PREPARED BY:

E_2C Remediation
Environmental Engineering Consulting & Remediation, Inc.
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Roseville, California 95678

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Appendix C: San Francisco Bay Regional Water Quality Control Board Concurrence Letter, dated November 5, 2013

LIST OF ACRONYMS

ASTM	American Society for Testing and Materials
BMPs	Best Management Practices
CASQA	California Stormwater Quality Association
CDFW	California Department of Fish and Wildlife
CEQA	California Environmental Quality Act
CQA	Construction Quality Assurance
FHWA	Federal Highway Administration
ft bgs	Feet Below Ground Surface
LLDPE	Linear Low Density Polyethylene
k_y	Yield acceleration
MCE	Maximum Capable Earthquake
MND	Mitigated Negative Declaration
MPE	Maximum Probable Earthquake
M_w	Moment magnitude
NAVD88	1988 North American Vertical Datum
NGA	Next Generation Attenuation
OSHA	Occupational Safety and Health Administration
R	Source-to-site distance
SWPPP	Stormwater Pollution Prevention Plan
USACE	U.S. Army Corps of Engineers
USFWS	United States Fish and Wildlife Service
Water Board	Regional Water Quality Control Board

1. INTRODUCTION

E2C Remediation (E2C) has prepared this Construction Work Plan for the closure of the Leona Heights Sulfur Mine site (Site) in Oakland, California at the request of Alcoa Properties, Inc. (Alcoa) and Ocean Industries, Inc. (Ocean). This work plan describes the proposed construction procedures and protocols to implement the remedial design and creek restoration at the Site, and was prepared to satisfy permit requirements by the City of Oakland.

1.1 Background

The Leona Heights Sulfur Mine (Site) is an approximately two-acre abandoned pyrite mine site located at east end of McDonell Avenue in Oakland, California, about 0.5 miles northeast from the intersection of Highway 13 and Interstate 580 (Figure 1). The Leona Chemical Company operated the mine in the early 1900s to extract pyrite (iron sulfide) from the volcanic bedrock for production of sulfuric acid. There have been no active mining operations since the 1920's but two mine tailings piles, placed in the ravine at the Site during mining operations, remain today. Leona Creek flows through the center of the upper tailings pile and adjacent to the lower tailings pile, with resulting water quality impacts. A site plan is shown on Figures 2A and 2B.

The initial remediation and creek restoration designs for the Site were prepared by Geosyntec Consultants, Inc. (Geosyntec) and E2C, respectively, for the closure of the mine site. The Remedial Design Plan [Geosyntec, 2013a] and the Creek Restoration Design Report [E_2C, 2013] were prepared to satisfy requirements of the amended Cleanup and Abatement Order (CAO) (Order R2-2013-0021) issued on 9 May 2013 by the California Regional Water Quality Control Board, San Francisco Bay Region (Water Board). The remediation design has been revised by E2C to address the concerns of the permitting agencies. This revised construction workplan was prepared to describe construction activities in accordance with the revised remediation design.

1.1.1 Environmental Concerns

Previous site investigations performed by Levine-Fricke (LFR) (1989, 1991, and 1992) identified environmental concerns at the site. Based on analytical testing of dry and wet weather onsite surface water samples, rock samples, and downstream storm water samples, LFR [2004] noted the following:

- Elevated concentrations of arsenic, copper, and lead, relative to typical background concentrations, were detected in waste rock samples.

- Storm water runoff from the Site has low pH (about 3), although the pH may increase slightly during periods of very high storm-water runoff due to the effects of dilution.
- Samples of storm water flowing onto the Site show slightly elevated metals concentrations that may be attributed to naturally occurring (or non-mine activity related) sources in the area, including exposed outcrops of rhyolite.
- Shallow groundwater flow direction was assessed to be generally toward the southwest
- Groundwater from the upgradient and downgradient wells are in the normal pH range, but groundwater from the on-site well has a pH of 4.0.
- Shallow groundwater upgradient and downgradient from the tailings does not appear to be affected by acid or metals. However, the on-site shallow groundwater appears to be locally affected by the tailings.

1.2 Permit Requirements

Amended CAO No. R2-2013-0021 listed the following permits required for the project:

- Section 401 Water Quality Certification from the Water Board;
- Creek Protection Permit from the City of Oakland;
- Tree Removal and/or Protection Permit from the City of Oakland;
- Encroachment, Grading and/or Building permits from the City of Oakland;
- Section 404 Permit from the US Army Corp of Engineers (USACE);
- Lake and Streambed Alteration Agreement from the California Department of Fish and Wildlife (CDFW); and
- Incidental Take Permit from the CDFW.

A Section 7 Consultation with supporting biological information will also be required with the USACE and US Fish and Wildlife Service (USFWS).

The City of Oakland also requires various plans be submitted with the Creek Protection Permit, including but not limited to:

- Creek Protection Plan;

- Landscape Plan;
- Erosion Control Plan;
- Construction Work Plan;
- Hydrology report; and
- Drainage plan.

The last two items have already been prepared as part of the Creek Restoration Design Report [E2C, 2013]. Additionally, an Initial Study/ Mitigated Negative Declaration (IS/MND#1) [LSA, 2013] has been prepared to comply with the California Environmental Quality Act (CEQA) with the City of Oakland acting as lead agency. An IS/MND#2 is currently in preparation.

1.3 Report Organization

The remainder of this report is organized as follows:

- Section 2 describes the existing conditions at the Site;
- Section 3 presents the project description;
- Section 4 outlines the proposed construction activities;
- Section 5 briefly describes the proposed dust control for the project
- Section 6 summarizes the proposed erosion control measures
- Section 7 describes the demobilization activities
- Section 8 includes the list of references cited in the report; and
- Section 9 contains the workplan limitations.

Figures and appendices are provided after the work plan text.

2. SITE CONDITIONS

This section presents an overview of the site conditions, including subsurface and current surface conditions, based on historical information, previous investigations, and more recent site investigations and geologic reconnaissance [E_2C, 2013].

2.1 Subsurface Conditions

The Site is underlain by greenstone and Leona Rhyolite. The Leona Rhyolite is a silica-rich, volcanic rock that is predominantly dark yellowish-orange; however, some less weathered portions of the rhyolite are light gray. At the Site, the rhyolite exhibits abundant fractures that are predominantly blocky and with occasional fractures on a smaller scale [LFR, 1992]. The more weathered portions of the rhyolite are relatively weak, consisting of fragments held together in a clayey matrix. The less weathered portions of rhyolite are very hard. The Leona Rhyolite is the unit from which the ore was mined at the Site.

Materials encountered during previous drilling activities consisted primarily of consolidated Leona Rhyolite, greenstone, and unconsolidated sediments [LFR, 1992]. The more recent geologic investigation by E_2C observed stratigraphic layering of the Rhyolitic tuff that exhibited varying degrees of fracture [E_2C, 2013]. In general, the unconsolidated sediments were light yellow, light gray, and/or reddish-brown, dry to moist, and poorly sorted. The fine-grained sediments ranged in consistency from soft to very stiff and exhibited low to high plasticity. The coarse-grained sediments were loose to very dense medium sand to coarse gravel. Rock fragments in the unconsolidated sediments were rhyolitic or andesitic.

Shallow materials encountered during LFR's previous investigations [1992 and 2004] consisted of predominantly clayey materials with occasional sands and gravels. Rhyolite, mine tailings, and engineered fill were encountered at or near surface, while unconsolidated sediments were encountered at depths ranging from approximately 7 to 32 feet below ground surface (ft. bgs). Beneath the unconsolidated sediments, rhyolite or greenstone was encountered in most of the borings.

Groundwater beneath the Site was measured by LFR in September 1992 during an investigation of the site hydrogeologic conditions. Water level measurements, collected on 10 September 1992, indicated that groundwater flows approximately from north to southwest, generally following the topography at the Site, and ranges from approximately 25 to 65 ft bgs [LFR, 1992].

2.2 Existing Site Conditions

The Site sits at the edge of a larger, undeveloped property (Figure 1). The Site is bordered on the west and northwest by private residences and open space to the northeast, east and south. The primary portions of the waste tailings piles are exposed and bare, while the remaining areas of the Site are covered with mainly oak and eucalyptus trees. The horizontal extent of the tailings is shown on Figures 2A and 2B.

The upper portion of Leona Creek has been observed to be dry during various site visits in the summer and fall of 2013. However, flows from the perennial spring (associated with a groundwater seep near the top of the lower waste pile) and from an overflow pipe from an offsite water tank were discharging over the waste piles and introducing water to the lower portion of the creek at the Site. It appears that portions of the upper pile have eroded from concentrated surface water runoff flowing over the pile. Some of this eroded sediment has been deposited behind a metal trash rack immediately upstream of the culvert at Leona Street, down gradient of the tailings piles. Shallow slope failures were also noted in the steeper slopes of the upper pile.

3. PROJECT DESCRIPTION

The initial remedial closure and creek restoration designs for the Leona Heights Sulfur Mine were described by Geosyntec [2013a] and E2C [2013], respectively. The remedial closure design portion of the initial submittal has been revised to reduce project impact to the environment by reducing the project foot print, adjusting the grading plan, revising the project haul route and revising the remedial cap design. The project will include the following key components:

- Re-grading the tailings slopes;
- Removing of isolated tailings on the northeastern slope and within the creek channel, and consolidating within the mass tailings beneath the cover;
- Constructing reinforced soil slopes (RSS) adjacent to portions of the restored channel;
- Covering the consolidated tailings with a geomembrane liner, including a vegetative layer that will isolate the tailings from water;
- Installing subsurface drainage systems beneath the cover and behind the RSS to route subsurface flows into the channel;
- Constructing storm water channels and diversion structures;
- Re-Vegetating the cover and areas of soil disturbance; and
- Restoring the creek channel to accommodate a 100-year design storm, incorporating drop structures reminiscent of natural creek designs on steep slopes that provide for the natural transport of sediment through the creek, minimizing erosion onsite and downstream.

Section 4 discusses the construction activities related to each of the above.

4. PROPOSED CONSTRUCTION ACTIVITIES

This section describes the main construction activities anticipated for the project.

4.1 Construction Preparation

Prior to mobilization of construction equipment, materials and supplies, construction plans will be developed, construction signage will be posted, haul roads and staging areas will be prepared, site security features will be installed, tree protection and removal will be implemented and noise reduction features will be installed. These pre-construction preparations are discussed below.

4.1.1 Contractor's Construction Plans

Prior to construction, the contractor will prepare, at minimum, the following plans:

- Health and Safety Plan
- Storm Water Pollution Prevention Plan (SWPPP)
- Construction Work Plan
- Clearing and Grubbing Plan
- Construction Sequencing Plan
- Dust Control Plan
- Traffic Control Plan

4.1.2 Trail Closures and Signage

The fire road is currently used as a trail by the public for hiking, jogging, biking and dog-walking. Visitors to the trail park either at the end of the McDonell Avenue cul-de-sac or in the Merritt College Parking Lot. During staging and construction activities, the McDonell Avenue entrance and parking to the fire road trail may need to be closed to the public, for limited time frames (Monday-Friday for up to 5 non-consecutive weeks) and no parking during these limited time frames will be allowed on McDonell Avenue to reduce circulation conflicts. The trail itself will remain open and could still be accessed from Merritt College. The McDonell Avenue cul-de-sac entrance to the fire trail closure would be posted at least one month prior to construction and throughout the 5-month construction period. Signs would be placed at all entrance locations and on the trail to notify users of the closure of the McDonell Avenue access. Barricades and signage would be erected at the end of McDonell Avenue and signage would be placed at the Merritt College campus parking lot prior to and throughout construction.

Access to the site and the primary staging area for the remediation project would be located at the southeast side of the McDonell Avenue cul-de-sac and is approximately a 0.13-acre which includes a portion of the total cul-de-sac area right-of-way. The project area also includes the temporary use of an approximately 1-acre portion of the overflow parking lot for Leona Lodge. The Leona Lodge is owned by City of Oakland and will be used for the staging of materials and equipment. This lower staging area is located about 0.6 miles from the project site. In addition a private lot (Parcel #37-2605-16-2) on the north side of McDonell Avenue, with an area of approximately 3,500 square feet, can be used for staging of personnel.

A traffic control plan will be submitted to City of Oakland for approval. The traffic control plan will show the locations of traffic control, control device placement, and sign type and locations.

Temporary fencing will be installed around the primary staging area and the materials staging area. Additional fencing may be installed based on permit requirements.

4.1.3 Haul Road Preparation

McDonell Avenue is a paved, local road which terminates at the base of the upper tailings pile in a cul-de-sac where access to the project site is direct The road is in good condition, and is wide enough to allow trucks of sufficient size to access the primary staging area. Limited preparation including trimming low-hanging tree limbs may be necessary. The existing fence at the southern edge of the cul-de-sac will be relocated and replaced with a temporary gated fence. The roadway permits one-way access but contains turnout areas that could be utilized in an emergency. To maintain one-way traffic, the construction manager will utilize traffic controls such as traffic monitors, GPS units and radio communications.

4.1.4 Staging Area Preparation

Security fencing and access gate will be installed in the Staging areas to form a compound. In the compounds, there will be the primary mobile office/trailer, vehicle and equipment staging areas, construction material stockpile and storage area, and decontamination facilities for personnel and outbound vehicles.

It is anticipated that truck and heavy equipment staging will be located in the primary staging area at the cul-de-sac of McDonell Avenue. Figure 3 presents the primary

staging area location. The primary staging area is located on the southeast side of the McDonell Avenue cul-de-sac. This area is currently fenced off and partially covered by a small grove (approximately10-12) six-to-twelve-inch diameter eucalyptus trees, brush and sloughed tailings, but is partially within the limits of the mapped cul-de-sac right-of-way. The primary staging area is located within several feet of the upper tailings pile and the remediation site is easily accessible.

The contractor will prepare and maintain staging facilities for stockpiling of construction materials, including import soils, boulders, and geosynthetics. Delivered materials (in stages) will be initially placed in the materials staging area located at the overflow parking lot of Leona Lodge. These materials will be ferried up to the primary staging area using smaller 10-wheel trucks, in phases, as needed for construction. Material processing may occur at the materials staging area, or hauled up to primary staging area at the Site for processing and placement depending on the contractor's sequencing plan.

4.1.5 Site Security

The existing perimeter fence around the project active work area will be repaired, relocated, and supplemented and temporary fence will be installed around the staging areas prior to the start of construction. Fencing locations and limits for the staging areas are shown on Figure 3, and the fencing for active working area will be adjusted during construction based on field conditions.

4.1.6 Tree Protection and Removal

Tree trimming and/or tree removal will be required to allow material and equipment access. To the extent practical and possible, tree removal, particularly oaks, will be kept to an absolute minimum and will be in accordance with the City of Oakland's approved tree removal permit. Trees will be removed from the project area to facilitate site access and to allow excavation, placement of fill, compaction, installation of soil reinforcement, installation of run-on prevention ditches and installation of the geomembrane cap system. Some tree pruning may be required to allow vehicles to travel along the haul road as they carry soil/material to the primary staging area and the restoration project area.

An arborist's Tree Survey Protection Plan has been developed and updated in support of the restoration project by LSA Associates, Inc. The summary of trees potentially to be removed and/or retained/protected is tabulated in that plan (Tables A, B, and C of the Tree Survey Protection Plan). The majority of the trees to be removed are located

within the identified boundaries of the waste rock piles. With this revised grading plan, the number of trees to be removed and protected would be reduced by approximately 84 oak trees.

Trees with trunk diameters greater than 8 inches (not included in Tables A, B, and C of the Tree Survey Protection Plan will not be removed without prior approval from the City of Oakland. Vegetation will be cleared as necessary to perform the work and as directed by site construction manager. Grubbed material will be placed in a designated waste material pile prior to chipping and recycling.

4.1.7 Noise Control

To construct the project, various types of equipment will be operated at or near the site. Although actual equipment to be used will depend on the conditions encountered and the selected contractor, it is anticipated the equipment as listed in Table 1 will likely be used during the project construction.

Table 1 Major Equipment List

EQUIPMENT	PEAK QUANTITY
Concrete/Industrial Saw	2
Crawler Tractor (dozer, backhoe, skidsteer, winch cat)	5
Excavator	2
Rubber Tired Loader	2
Grader	1
Crane	1
Rollers	1
Rough Terrain Forklift	1
Off Highway Truck	6
Other Equipment (Water Truck, Chipper, ATV)	4

When equipment is to be operated adjacent to homes abutting the site, noise reduction blankets will be installed over perimeter fences or temporary fences with the noise reduction blankets placed between the equipment and the homes.

4.1.8 Temporary Diversion of Leona Creek

The planned restoration activities are going to take place during the dry season. The current channel alignment will not be significantly modified. Therefore, flows are anticipated to be low, but in an abundance of caution, temporary diversion of Leona Creek is planned. Collected flow from the seep near the adit will be temporarily piped along the channel during channel restoration for the segments downstream of the seep discharge location.

4.2 Construction

After construction preparation, on-site construction will begin. The following subsections describe the construction activities. These activities may not necessarily occur in the order described below, as many of the activities will occur simultaneously.

4.2.1 Clearing and Grubbing

It is anticipated that the contractor will clear brush from the active work and staging areas. The contractor will prepare detailed clearing plans prior to construction that will conform with requirements contained in the relevant permits (e.g., tree removal). The contractor will also be required to identify and clearly delineate areas that are not to be disturbed or specifically protected during construction.

4.2.2 Creek Channel Restoration

The first task in the creek restoration will be to clean the existing channel by removing any mine tailings in the channel. The removed tailings will be stockpiled in the on-site staging area and then added to the re-graded mine tailings for eventual compaction and cover. Once all tailings materials have been removed from the existing channel, the portion of the creek channel within the Site boundaries will be restored in accordance with the design drawings (Appendix A). Steps and drops will be constructed utilizing existing competent bedrock, where encountered, or by placing and embedding cobbles and/or large boulders. The large boulders will be individually stabilized and interlocked with one another. Cobbles, gravels and coarse sands will fill the gaps among the large boulders (key particles).

4.2.3 Mine Adits and Shafts

Two former mine adits and three former mine airshafts have been described previously by LFR [2004]. The entrance of the identified adit located near the toe of the upper pile will be exposed and sealed prior to earthfill in the area. The groundwater seep

associated with this adit will be collected and discharged in the restored creek channel. If other adits or mine shafts are encountered during construction, they will be sealed or disposed with approval from on-site engineer.

4.2.4 Reinforced Soil Slope (RSS) Construction

The 1H:1V RSS will be stabilized using horizontal geogrid elements embedded in a zone of compacted waste rock and a specially-designed slope facing. The extent and grading of the RSS are shown on the permit level design drawings (Appendix A).

The mine tailings will be excavated horizontally from the slope face up to a maximum of 70% of the reinforced soil slope heights or excavated to competent bedrock, whichever occurs first. The excavated slope will be assessed, by the on-site Engineering Geologist/Geotechnical Engineer, during construction to achieve safe working conditions. At the same time, excess excavation will be kept to a minimum to reduce unnecessary impact to the environment. Initially, excavated soil will be stockpiled in one of the staging areas. When the native soil or rock is exposed after excavation, its strength properties will be tested and evaluated to serve as a foundation for the RSS. If weak soil is found or the elevation of the native soil is below the creek design water surface, a foundation will be constructed to support the RSS. The foundation will be constructed with compacted base gravel or concrete with compressive strength up to 3,500 pounds per square inch. The RSS construction will be divided into segments to minimize the hauling of mine tailings, or as required for constructability. The excavated mine tailings from the next segments will be placed at the segment immediately adjacent to it as backfill and compacted in horizontal lifts on top of the geogrid reinforcements to construct the RSS.

During excavation, representative soil samples will be collected for geotechnical testing for soil strength properties and to verify optimal compaction condition and design parameters used for the reinforced soil slope design.

4.2.5 Subsurface Drainage System

The subsurface drainage system for the RSS consists of two components: (1) a drainage system behind the RSS to alleviate potential water pressure build-up behind the reinforced zone; and (2) a drainage collection and conveyance system to route the groundwater seep (located near the identified adit) towards the restored creek channel. Layouts of the drainage systems are shown on the design drawings (Appendix A).

The sub-drain filter fabric wrapped well screen behind the RSS will be placed along the back slope and bottom of the RSS zone with collection and conveyance pipe near the RSS toe. Waste mine tailings will be placed as fill for the reinforced slope. The mine tailings will be compacted to 95% compaction or the optimal compaction determined based on soil testing during the reinforced soil slope construction with mechanical compaction in layers from the bottom up.

4.2.6 Grading and Waste Rock Consolidation

The final grading plan, shown on the permit level design drawings (Appendix A), includes 2H:1V slopes for the re-graded tailings piles, 1H:1V RSS adjacent to portions of the channel, and a flatter bench area in the middle area of the site. There are also limited areas outside the grading footprint, such as within the existing channel, that may contain tailings materials. All tailings material within the project footprint that is identified outside of the final grading footprint will be removed and consolidated within the waste mass or disposed of off-site.

4.2.7 Final Cover Construction

The final cover will consist, from top to bottom, of the following:

On slopes with gradient less than 2H:1V

- 12-inch thick vegetative soil layer;
- 12 ounces per square yard (oz/sy) nonwoven filter geotextile;
- 60-mil double-sided textured linear low density polyethylene (LLDPE) Agru Super Gripnet® geomembrane (with spikes facing down and studs up); and
- Compacted foundation (compacted tailings).

On the reinforced 1H:1V slopes the cover system (see Figure 12 of design drawings in Appendix A) is comprised of the following:

- 12-inch thick vegetative soil layer (both below and above face erosion control mat);
- well-graded clean sand fill;
- 12 ounces per square yard (oz/sy) nonwoven filter geotextile;
- 60-mil double-sided textured high-density polyethylene (HDPE) geomembrane; and
- Compacted mine tailings with geogrid reinforcement.

Note: In accordance with the RWQCB's conditional acceptance of the design and restoration plans (Item #6) consideration will be given to either altering the vegetative soil layer to accommodate deep-rooted plant species or revising the re-vegetation plan to include species which will prevent and/or preclude the growth of undesirable plant species.

4.2.8 Storm Water Conveyance Structures

Storm water conveyance structures will be constructed on the edges of the cover and around the Site perimeter to divert and manage storm water flows over the capped and vegetated waste tailings towards the restored creek channel. The storm water drainage plan is shown on the design drawings (Appendix A).

Note: In accordance with the RWQCB's conditional acceptance of the design and restoration plans (Item #3), consideration was given to using alternative materials (geocomposites lined with rip-rap armoring) for construction of the conveyance v-ditches . It was determined that, due to the increased size and depth of these conveyance v-ditches requiring additional oak tree removal, concrete-lined conveyance v-ditches were a better solution to the short-term need to prevent run-on water from washing away the newly re-vegetated slopes. The useful life of concrete in the environment is approximately 10 years and the newly re-vegetated slopes need significantly less than 10 years to establish root systems and stabilize the slopes.

4.2.9 Re-vegetation

The Site will be re-vegetated once the cover construction and overall site grading are completed. Re-vegetation will occur on the cover, on the RSS, and in areas of soil disturbance. The re-vegetation will be implemented in accordance with the re-vegetation plan prepared by Olberding [2013]. As noted above in Section 4.2.7, the re-vegetation plan will be reviewed and/or revised as necessary to accommodate the concerns regarding undesirable plant species.

4.2.10 Repaving McDonell Avenue Cul-De-Sac

McDonell road will be used as the main hauling route. It will be used for personnel access, equipment access and material deliveries. A portion of The Cul-De-Sac area will be used heavily for material and equipment staging. At the end of project, the Cul-De-Sac will be repaved with base and asphalt surface layers in accordance with the design plans prepared by E2C 2014. The cap portion adjacent to the Cul-De-Sac has been designed to allow future completion of cul-de-sac paving.

5. DUST CONTROL

Grading activities at the Site will result in the generation of dust in the form of particulate matter (PM). To mitigate the potential fugitive emissions of PM and maintain acceptable concentrations of PM in air at the perimeter of the Site during grading activities, the following dust control techniques (individually or in combination) will be implemented during construction:

- Apply water to areas to be graded before starting soil excavation and fill;
- Control grading activities and grading rates to minimize the generation of dust;
- Apply water using a water truck in areas adjacent to and within cut and fill areas;
- Spray exposed areas with water to prevent formation of dust while grading, transferring material onsite, or loading transportation vehicles;
- Cover soil stockpiles with weighted plastic sheeting;
- Keep the drop heights to a minimum while loading and unloading transport vehicles;
- Keep vehicle speeds on the Site below five miles per hour;
- Place aggregate base on the fire road, if needed;
- Placement of a stabilized construction entrance;
- Spray water along loading, unloading, and the haul route regularly; and
- Increase frequency of dust control measures during windy conditions.

Note: The City of Oakland in their Standard Conditions of Permit Approval and Supplemental Conditions thereof, establish specific guidelines for dust control. These guidelines will be followed specifically and in their entirety throughout the construction phase of this project. A copy of these guidelines are attached as Appendices C and D.

6. EROSION CONTROL

Site drainage patterns for pre- and post- construction conditions are shown in the design drawings (Appendix A). Erosion control measures will be implemented to prevent the initial mobilization of soil particles during a storm event. On-site runoff generally starts as sheet flow and is later concentrated in the Leona Creek. Due to the steep site slope (on average ranging from 12% to 64%) the erosion potential is very high at the site.

Erosion control measures will be focused on (1) the down gradient portions of activity areas (active construction areas, staging, and traffic areas), around the boundary of the project area and where concentrated flow enters or exits the project area; (2) drainage paths to intercept potential sediments carried by storm water into streets; and (3) drain inlet locations.

Erosion control measures will consist of fiber wattles, silt fabric and plastic sheeting covers. Erosion control will also be enhanced by preserving existing vegetative land cover and avoiding the disruption, wherever possible, of native ground. Fiber rolls, in conjunction with the measures above, will be used to provide additional erosion and sediment control measure. Grading and compacting in non-remediation areas will be performed with erosion resistant soil. Disturbed creek channel in incompetent material will be immediately reinforced with cobbles and large boulders.

Sedimentation control BMPs will consist of filtration and barrier devices along the down gradient site perimeter and at all inlets to any storm water drain system. Sedimentation control assumes that the initial mobilization of soil particles has occurred during a storm event, therefore, appropriate BMPs are necessary to trap and prevent an adverse discharge into a protected body of water.

Prior to construction, a SWPPP will be drafted to comply with the California General Permit for Stormwater Discharges Associated with Construction and Land Disturbance Activities (Construction General Permit), Order No. 2009-0009-DWQ, National Pollutant Discharge Elimination System (NPDES) Order No. CAS000002, issued by the State Water Resources Control Board (SWRCB, 2010).

In accordance with the Construction General Permit, this SWPPP will be designed to address the following:

- All pollutants and their sources, including sources of sediment associated with construction, construction site erosion, and all other activities associated with construction activity, are controlled;

- All non-stormwater discharges are identified and either eliminated, controlled, or treated as required;
- Site Best Management Practices (BMPs) are effective and result in the reduction or elimination of pollutants in stormwater discharges and authorized non-stormwater discharges from construction activity to the Best Available Technology Economically Achievable/Best Conventional Pollutant Control Technology (BAT/BCT) standard;
- Site run-on is addressed and controlled;
- Stabilization BMPs are installed to reduce or eliminate pollutants after construction is completed; and
- Methods for implementation of BMP inspections, visual monitoring, and the Construction Site Monitoring Program (CSMP) are identified and provided.

The SWPPP will be drafted to follow the annotated outline of the California Construction BMP Handbook from the California Stormwater Quality Association (CASQA, 2009).

During construction, all components of the SWPPP will be implemented to ensure that no non-stormwater discharges occur, which are defined as the release of any water that has not originated from a rain event from the site (e.g., decontamination water, wash water, fire suppression water). Site run-on will also be addressed and controlled during construction activities. The following structural and non-structural soil and erosion control measures will be implemented during construction:

- Schedule of major earthwork, such as excavation, grading, or other activities that disturb soil will be clearly communicated and documented.
- The area of soil disturbing activities will be controlled such that soil and erosion control BMPs can be implemented quickly and effectively.
- Existing vegetation will be preserved where no construction activities are intended to occur, or where existing trees, shrubs, or other vegetation creates favorable erosion control.
- Stabilize non-active areas as soon as possible.
- A combination of perimeter controls (i.e., silt fences, fiber rolls, gravel bag berms, etc.) will be installed around the construction work limit..
- Perimeter controls (i.e., fiber rolls or gravel bag berms) will be installed around the staging area to contain any spills and prevent mobilization from any

temporary stockpiles. In the event of a forecasted rain event, establish secondary containment around the following areas:

  - Material storage area;
  - Vehicle maintenance and fueling area;
  - Water storage area for dust control, unless water trucks are used; and
  - Sanitary/septic and solid waste management areas, if present.

- Install gravel bags or equivalent for drainage inlet protection, at the culvert at Leona Street inside the construction work limit.
- All construction-related stockpiles will be covered with plastic sheets or tarps that are securely weighed down by sand bags and bermed with gravel bags to prevent runoff, unless actively being used.
- Control erosion in concentrated flow paths by applying erosion control blankets, check dams, erosion control seeding, or alternate methods.
- All construction equipment will be maintained to control leaks and spills and fueling will only be conducted within the contained staging areas. Any contaminated soils resulting from spills will be excavated promptly, and segregated for off-site disposal.
- Sanitation facilities will be located and maintained at the staging areas for the duration of the Project. Regular maintenance will be provided by licensed personnel and wastes will be disposed off-site. The toilets will be located away from concentrated flow paths and traffic flow. Secondary containment will be implemented on all portable toilets.

A more detailed erosion control plan, in the form of a draft SWPPP, has been prepared by E2C and Insight Environmental for the project.

7. DEMOBILIZATION

7.1 Site Winterization

Following completion of the construction, the Site will be winterized to provide erosion control and stormwater management during the winter rainy season. Post-construction BMPs will be installed and maintained according to the draft SWPPP. Erosion control BMPs will be inspected and repaired, if necessary, before the first winter raining season and after a major storm event during the monitoring phase of the project..

7.2 Site Restoration

At the end of construction, the haul roads and staging areas will be restored to pre-construction conditions. Temporary roads and temporary retaining structures will be removed and the areas re-graded to match the existing grade. Any improvements to the existing fire road will also be removed, including road surfacing and road widening.

7.3 Demobilization

Any site equipment will be transported off site. Staging area compounds will be removed. Any extra materials will be removed and any wastes will be disposed properly. All of the signage will be removed and staging areas will be restored to their pre-construction condition.

8. PROJECT SCHEDULE

The anticipated construction start date is May 2014, with an expected duration of approximately 5 months. The proposed project schedule is included in Appendix B.

9. REFERENCES

California Stormwater Quality Association (CASQA), 2009. Stormwater Best Management Practice Handbook Portal: Construction.

E_2C Remeditation, 2013. *Leona Heights Sulfur Mines Remediation, Creek Restoration 90% Design* Report*, End of McDonell Avenue, Oakland, California*, 14 October.

Geosyntec Consultants, Inc., 2013a. *Remedial Design Plan, Leona Heights Sulfur Mine, Oakland, California*, 15 October.

Geosyntec Consultants, Inc., 2013b. *Erosion Control Plan, Leona Heights Sulfur Mine, Oakland, California*, November, 2013.Insight Environmental, Engineering and Construction, Inc., 2010, *Draft Final Leona Heights Restoration Project Workplan*, Prepared for Dr. Collin Mbanugo, 23 September.

Levine-Fricke, 2004. *Summary Design Report and Construction Documents, Leona Heights Mine, Oakland, California*, Prepared for Dr. Collin Mbanugo, 1 March.

Levine-Fricke, 1992. *Hydrogeology Report, Leona Heights Sulfur Mine, Oakland, California*, Prepared for Ridgemont Development, Inc., 15 October.

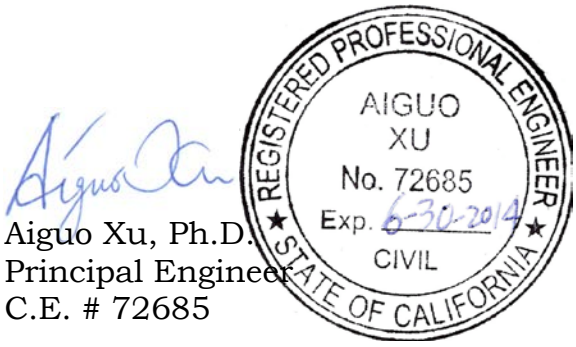
Levine-Fricke, 1991. *Mine Closure Plan, Leona Heights Sulfur Mine, Oakland, California*, Prepared for Ridgemont Development, 19 July.

Levine-Fricke, 1989. *Sulfur Mine Tailings Site Investigation, McDonell Avenue, Oakland, California*, Prepared for Hane and Hunt, c/o Watt Industries, Inc., 21 June.

10. LIMITATIONS

This workplan was prepared in general accordance with the accepted standard of practice existing in California at the time the project was performed. It should be recognized that definition and evaluation of environmental conditions is a difficult and inexact art. The subsurface conditions (e.g., soil, rock, and groundwater) only represent the location and type(s) of evaluations or tests performed. Judgments leading to conclusions and recommendations are generally made with a limited knowledge of the conditions present. E_2C Remediation has prepared this workplan for the exclusive use by Ocean Industries, Inc. and Alcoa Properties, Inc. to comply with the amended CAO for Site remediation and restoration for this particular project and in accordance with generally accepted engineering practices within the area at the time of our investigation and evaluation. No other representations, expressed or implied, and no warranty or guarantee is included or intended. This workplan may be used only by Ocean Industries, Inc. and Alcoa Properties, Inc. and only for the purposes stated, within a reasonable time from its issuance. Land use, site conditions (both on site and off-site) or other factors may change over time, and additional work may be required with the passage of time. Any party other than by Ocean Industries, Inc. and Alcoa Properties, Inc. who wishes to use this workplan shall notify E_2C Remediation of such intended use. Based on the intended use of the workplan, E_2C Remediation may require that additional work be performed and that an updated workplan be issued. Non-compliance with any of these requirements by Ocean Industries, Inc. and Alcoa Properties, Inc. or anyone else will release E_2C Remediation from any liability resulting from the use of this workplan by any unauthorized party.

Prepared by:



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Principal Engineer
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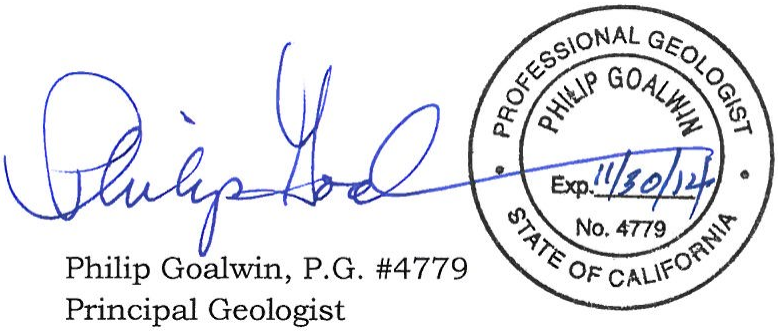


Philip Goalwin, P.G. #4779
Principal Geologist

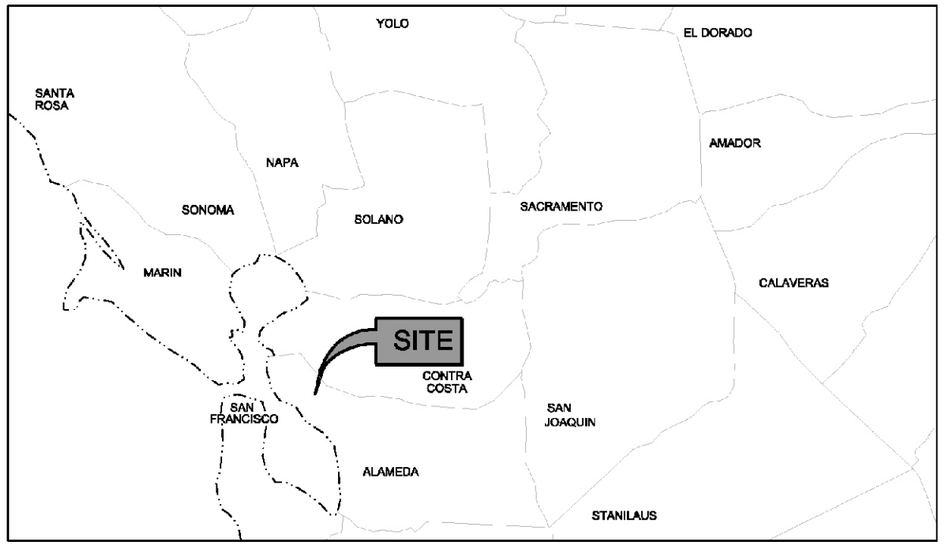
FIGURES

Figure 1: Site Vicinity Map

Figure 2A: Site Plan (Southwest)

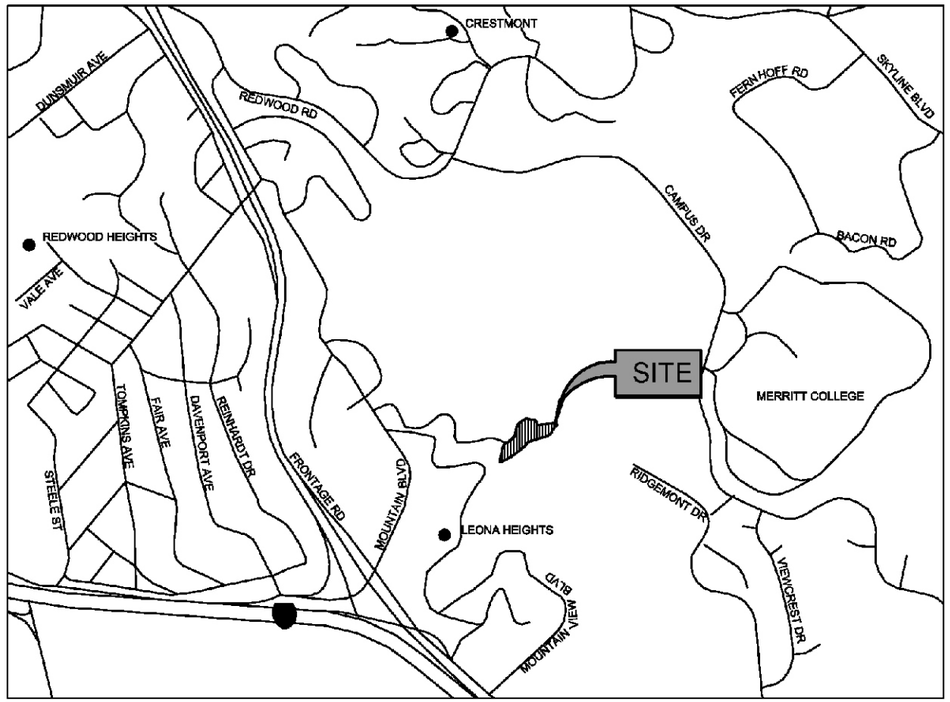
Figure 2B: Site Plan (Northeast)

Figure 3: Haul Routes and Staging Areas



SITE VICINITY MAP

N.T.S.



SITE LOCATION MAP

N.T.S.

E²C Remediation
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Fax: (661) 831-6234

N

DATE	DESCRIPTION
11/14/13	Const. Work Plan

PROJECT NAME

LEONA HEIGHTS SULFUR MINES REMEDIATION

PROJECT NO: 2028BK

DRAWN BY: A.X.

DESIGNED BY:

CHECKED BY:

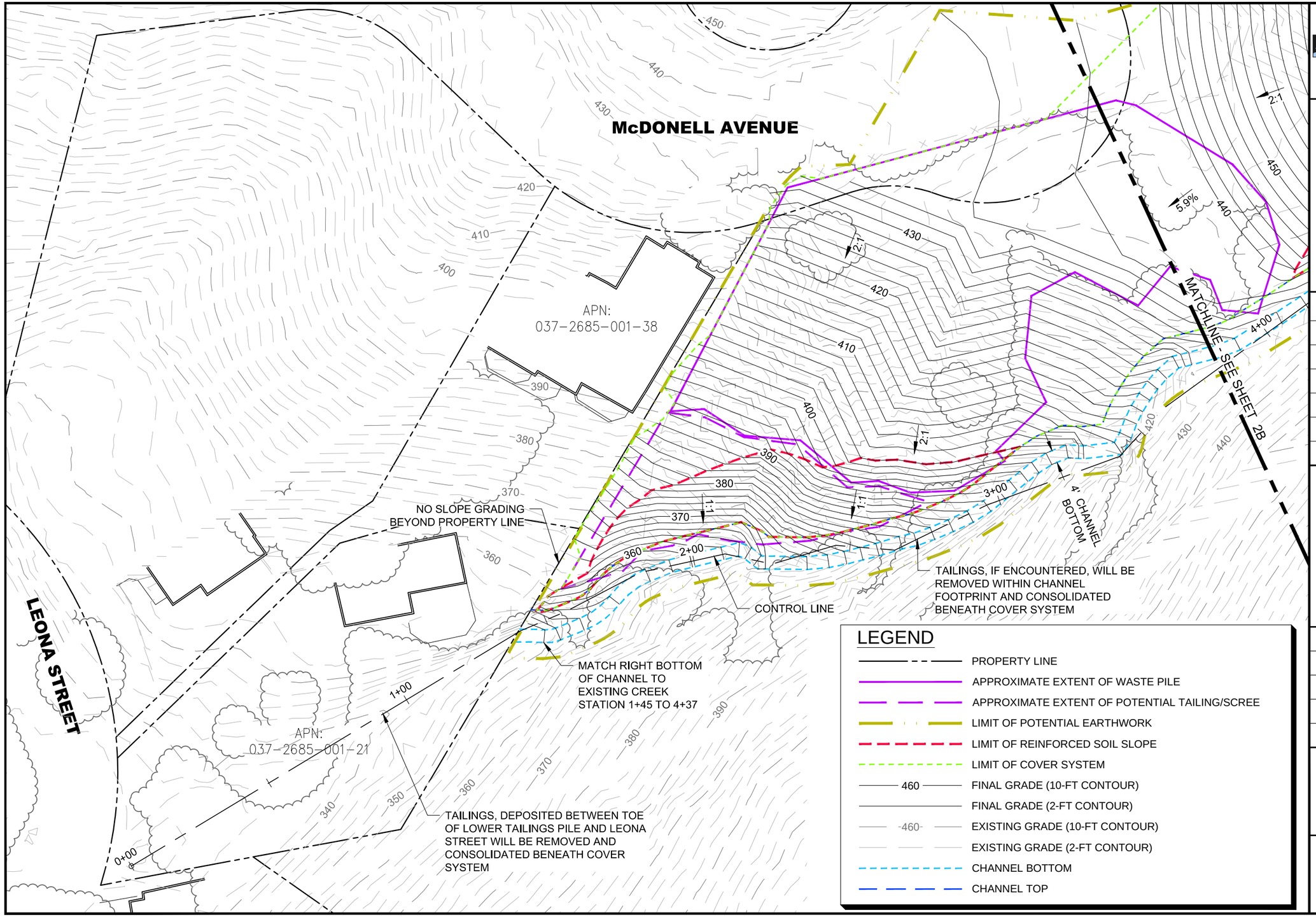
APPROVED BY:

SHEET TITLE

Site Vicinity Map

DRAWING NUMBER

FIGURE 1



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DATE	DESCRIPTION
01/21/2014	REVISED PERMIT LEVEL

PROJECT NAME

Leona Heights Sulfur Mines Remediation

PROJECT NO: 2028BK

DRAWN BY: N.B.

DESIGNED BY: A.X.

CHECKED BY:

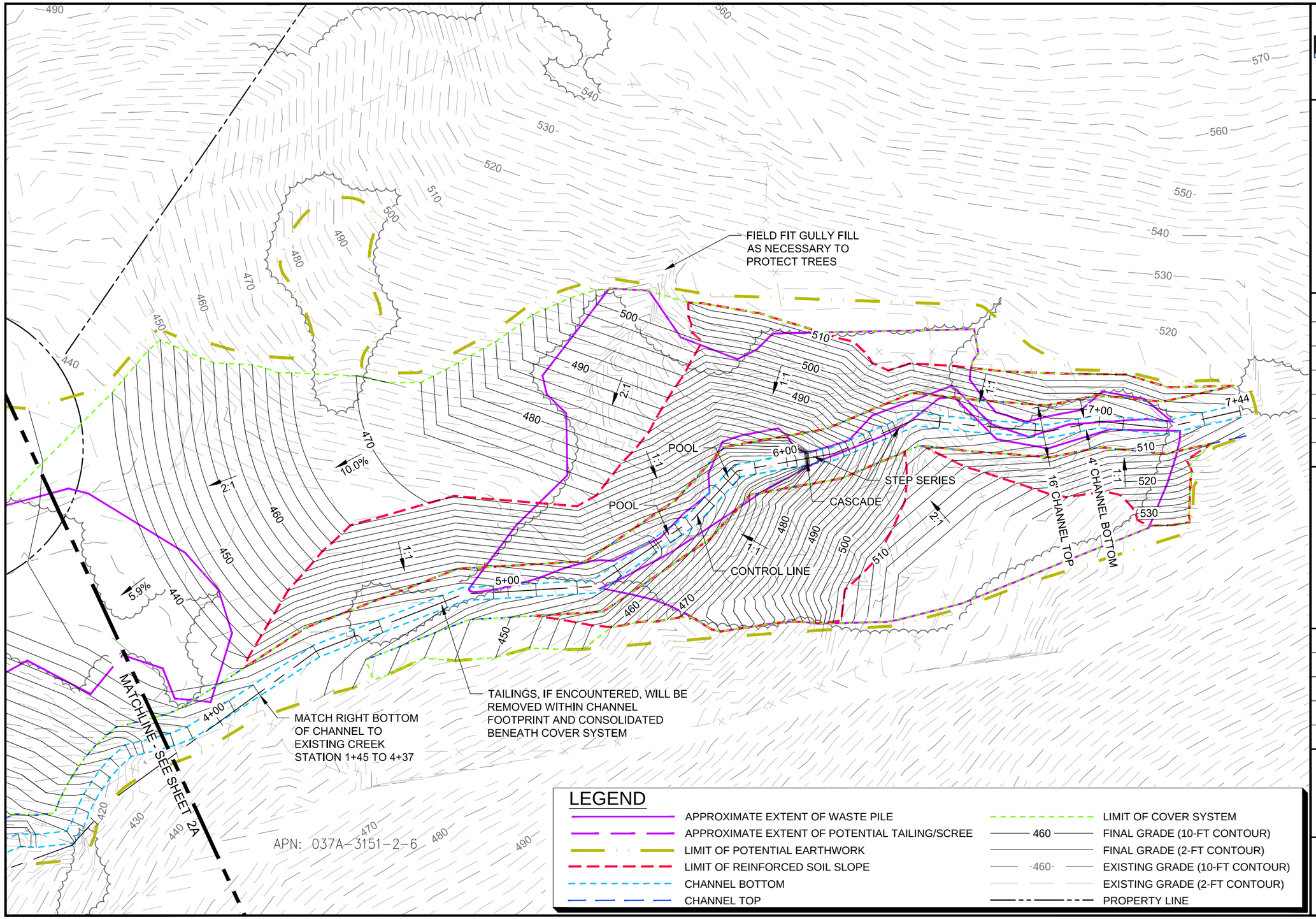
APPROVED BY:

SHEET TITLE

Proposed Final Grading Plan (Southwest)

DRAWING NUMBER

Figure 2A



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01/21/2014	REVISED PERMIT LEVEL

PROJECT NAME

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PROJECT NO: 2028BK

DRAWN BY: N.B.

DESIGNED BY: A.X.

CHECKED BY:

APPROVED BY:

SHEET TITLE

Proposed Final Grading Plan (Northeast)

DRAWING NUMBER

Figure 2B

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FIGURE 3

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Leona Creek Restoration and Leona Heights Sulfur Mine Remediation Project IS/MND

Project Haul Route and Staging Areas

SOURCE: ALAMEDA COUNTY ASSESSOR'S OFFICE, 2014.

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APPENDICES

Appendix A: Permit Level Design Drawings

Appendix B: Proposed Construction Schedule

Appendix C: San Francisco Bay Regional Water Quality Control Board Concurrence Letter, dated November 5, 2013

Appendix A
Permit Level Design Drawings

PERMIT DESIGN DRAWINGS FOR
LEONA HEIGHTS SULFUR MINES REMEDIATION
(LEONA CREEK RESTORATION)
Oakland, California

Prepared By:
E2C Remediation

DRAWING INDEX

C	Title Sheet
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Figure 2	Proposed Final Grading Plan
Figure 2A	Proposed Final Grading Plan (Southwest)
Figure 2B	Proposed Final Grading Plan (Northeast)
Figure 2C	Reinforced Soil Slope (RSS) Areas
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Figure 4	Proposed Longitudinal Streambed Profile
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Figure 6	Typiecal Cross Section Details
Figure 7A	Site Drainage Management Plan (Southwest)
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Figure 8A	V-Ditch Details
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Figure 12	Cover Details
Figure 13	McDonell Avenue Improvement
Figure 14	Subbase/Foundation Detail

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REGISTERED PROFESSIONAL ENGINEER
AIGUO XU
No. 72685
Exp. 6/30/2014
CIVIL
STATE OF CALIFORNIA
2/14/2014

DATE	DESCRIPTION
2/12/2014	REVISED
	PERMIT LEVEL

PROJECT NAME
Leona Heights Sulfur Mines Remediation

PROJECT NO: 2028BK
DRAWN BY: A.X.
DESIGNED BY: A. X.
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APPROVED BY:

SHEET TITLE
Title Sheet

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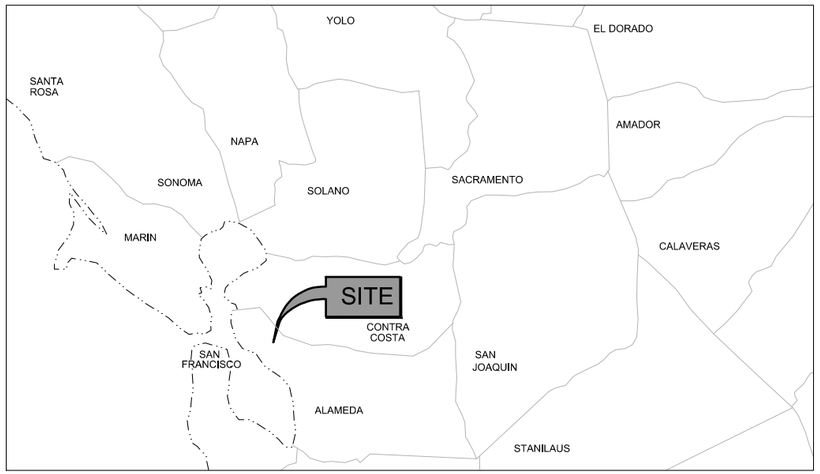

SITE VICINITY MAP

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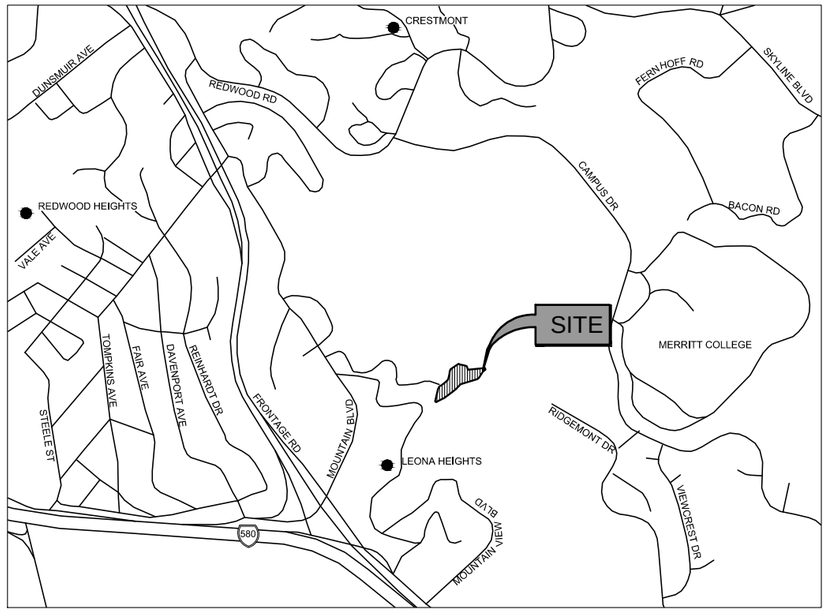

SITE LOCATION MAP

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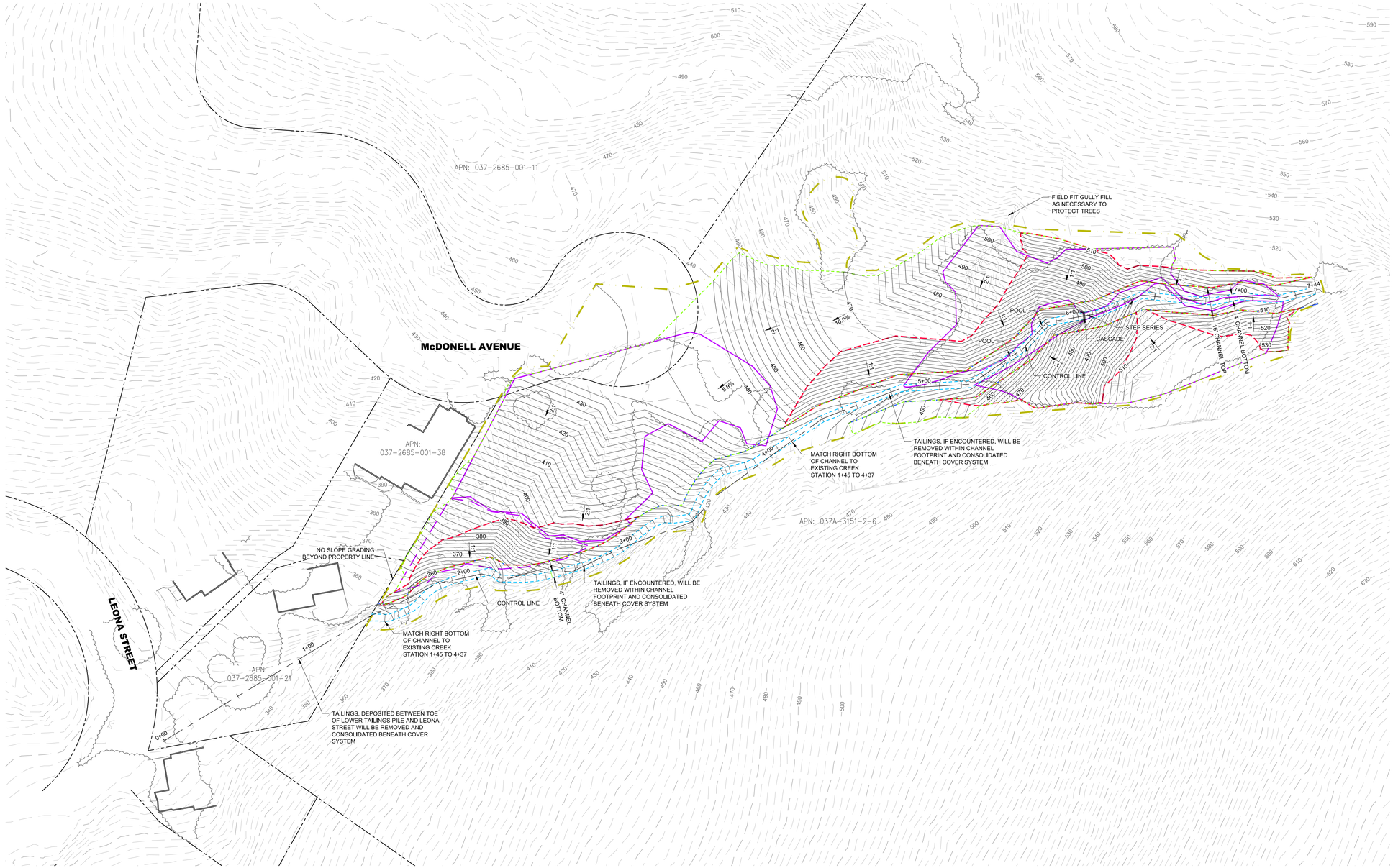
SHEET TITLE

Site Vicinity Map

DRAWING NUMBER

Figure 1



LEGEND

- APPROXIMATE EXTENT OF WASTE PILE
- APPROXIMATE EXTENT OF POTENTIAL TAILING/SCREE
- LIMIT OF POTENTIAL EARTHWORK
- LIMIT OF REINFORCED SOIL SLOPE
- CHANNEL BOTTOM
- CHANNEL TOP
- LIMIT OF COVER SYSTEM
- 460 FINAL GRADE (10-FT CONTOUR)
- FINAL GRADE (2-FT CONTOUR)
- 460 EXISTING GRADE (10-FT CONTOUR)
- EXISTING GRADE (2-FT CONTOUR)
- PROPERTY LINE

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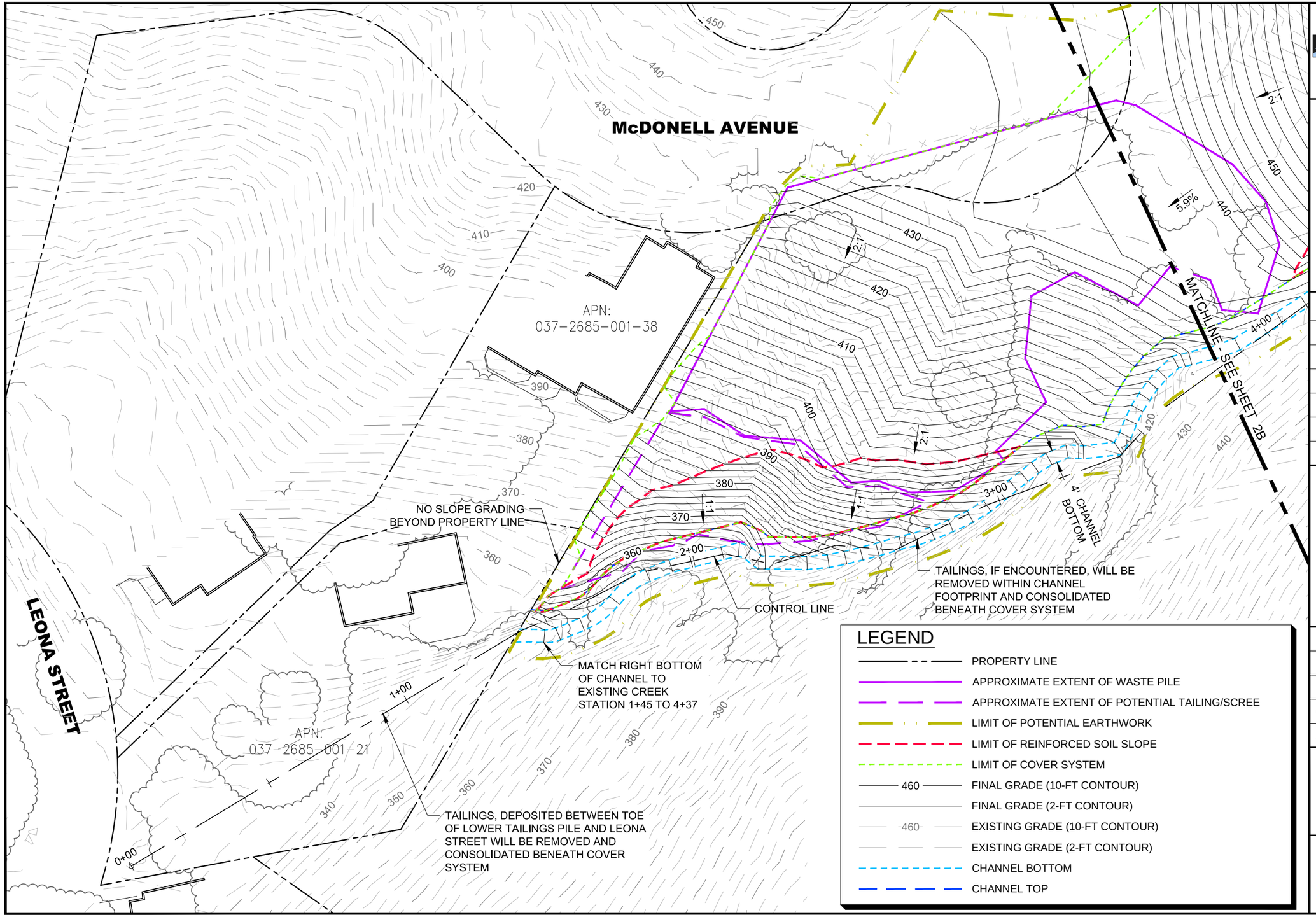
APPROVED BY:

PROJECT NAME
Leona Heights Sulfur Mines Remediation

SHEET TITLE
Proposed Final Grading Plan

DRAWING NUMBER
Figure 2



E2C Remediation
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Phone: (661) 831-6906
Fax: (661) 831-6234

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DATE	DESCRIPTION
01/21/2014	REVISED PERMIT LEVEL

PROJECT NAME

Leona Heights Sulfur Mines Remediation

PROJECT NO: 2028BK

DRAWN BY: N.B.

DESIGNED BY: A.X.

CHECKED BY:

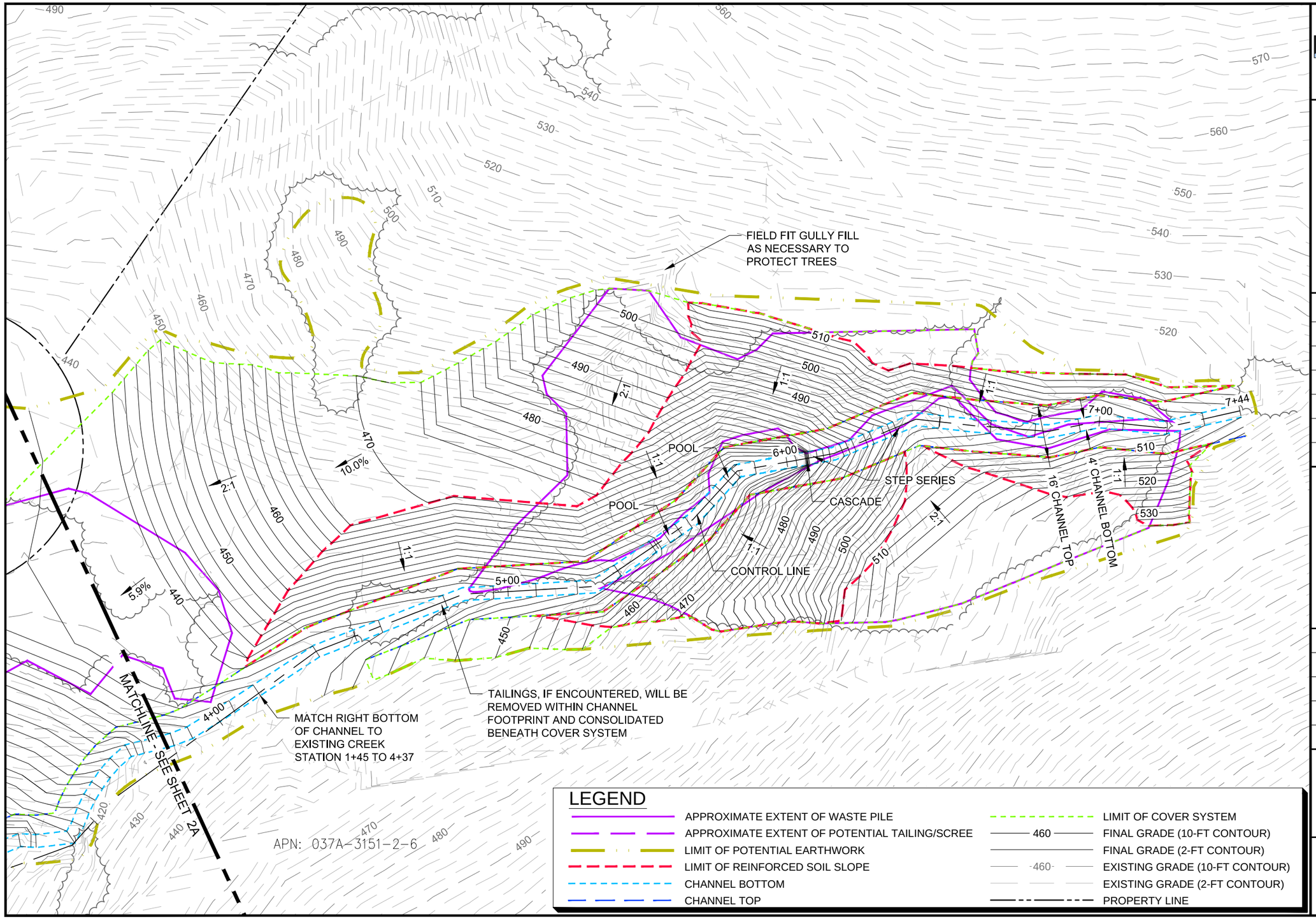
APPROVED BY:

SHEET TITLE

Proposed Final Grading Plan (Southwest)

DRAWING NUMBER

Figure 2A



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PROJECT NO: 2028BK

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DESIGNED BY: A.X.

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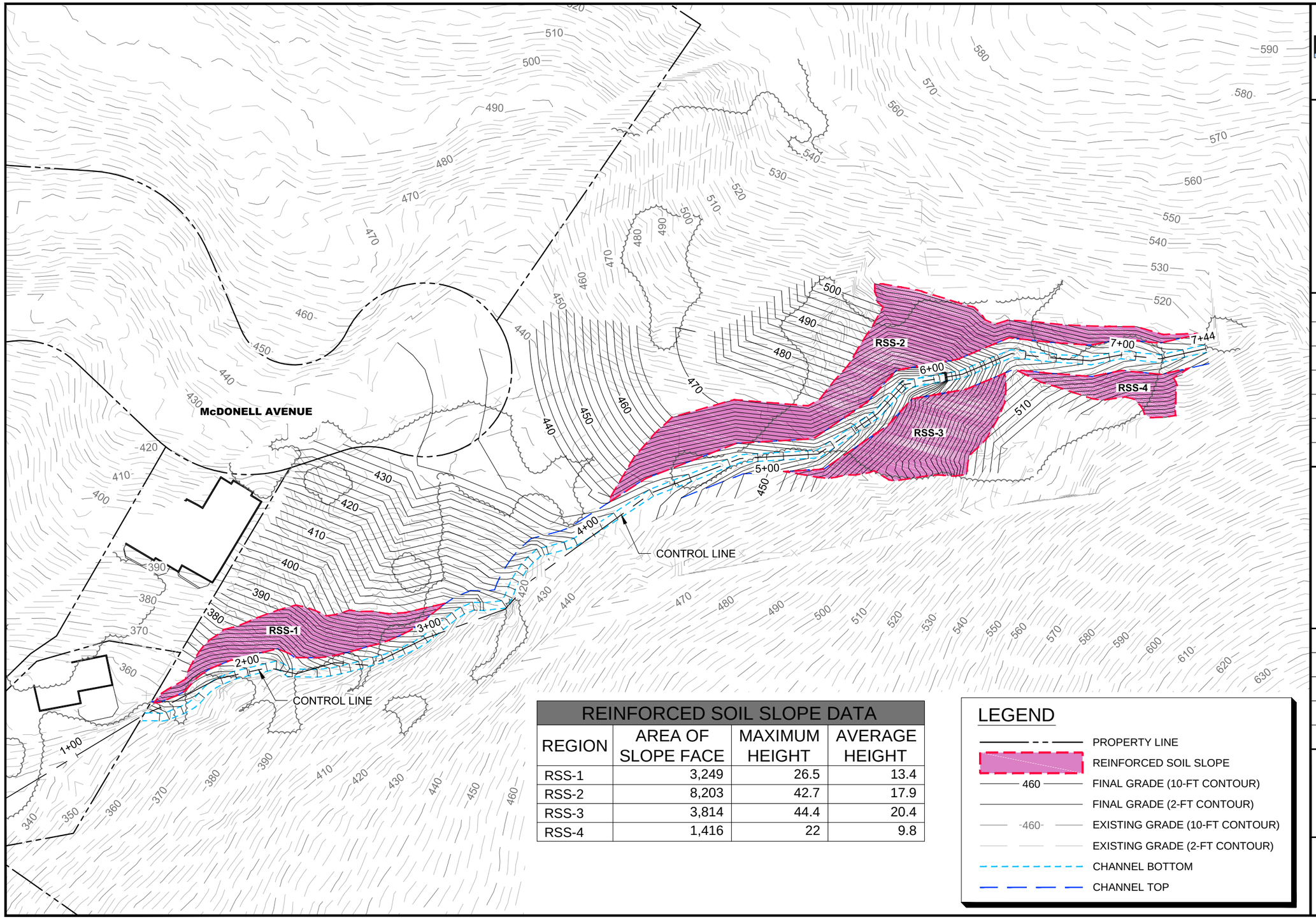
SHEET TITLE

Proposed Final Grading Plan (Northeast)

DRAWING NUMBER

Figure 2B



REINFORCED SOIL SLOPE DATA

REGION	AREA OF SLOPE FACE	MAXIMUM HEIGHT	AVERAGE HEIGHT
RSS-1	3,249	26.5	13.4
RSS-2	8,203	42.7	17.9
RSS-3	3,814	44.4	20.4
RSS-4	1,416	22	9.8

LEGEND

- PROPERTY LINE
- REINFORCED SOIL SLOPE
- 460 — FINAL GRADE (10-FT CONTOUR)
- FINAL GRADE (2-FT CONTOUR)
- -460- EXISTING GRADE (10-FT CONTOUR)
- EXISTING GRADE (2-FT CONTOUR)
- CHANNEL BOTTOM
- CHANNEL TOP

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DATE	DESCRIPTION
01/21/2014	REVISED PERMIT LEVEL

PROJECT NAME

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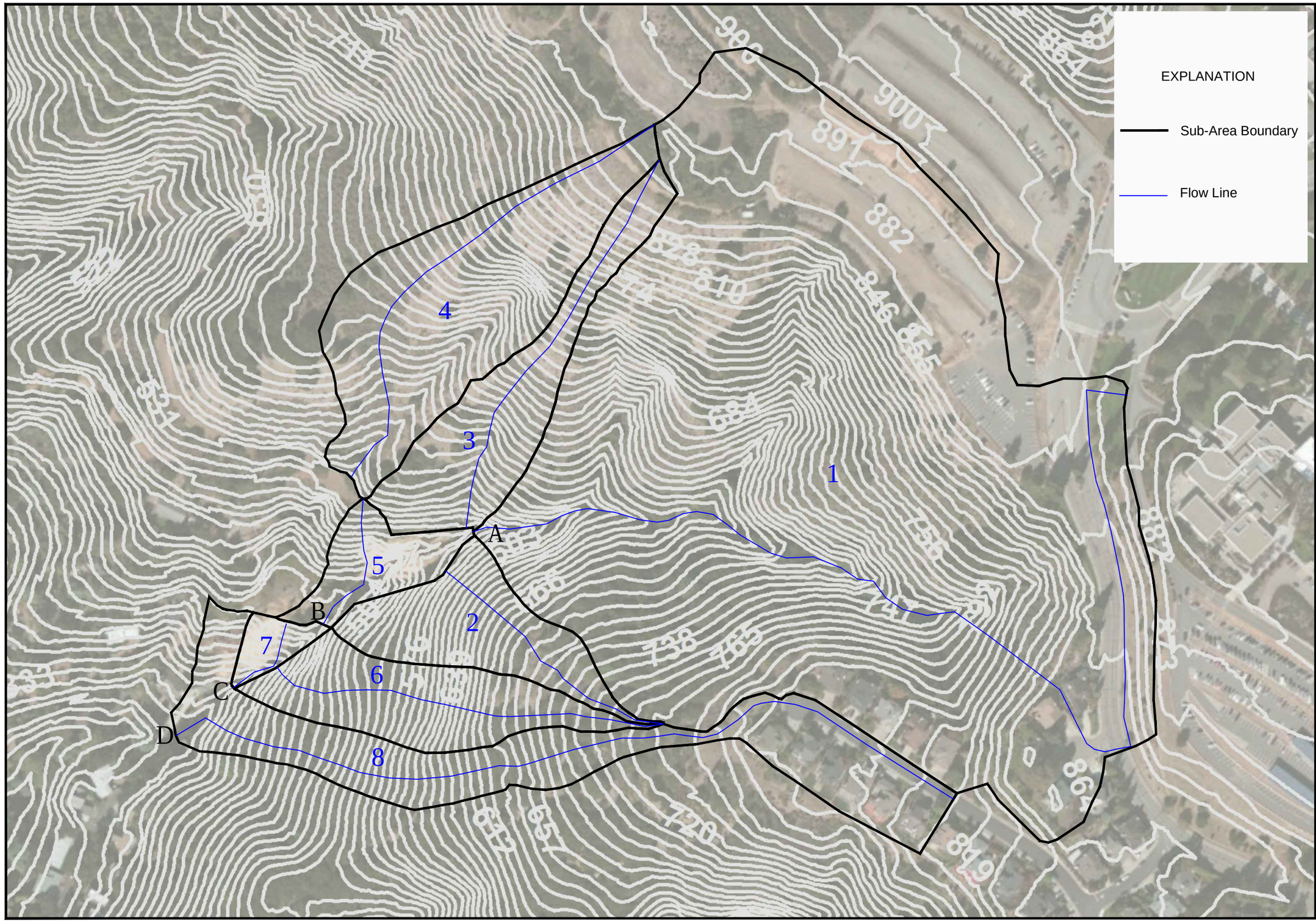
RSS Areas

DRAWING NUMBER

Figure 2c



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DATE	DESCRIPTION
10/09/2013	90% Design

PROJECT NAME

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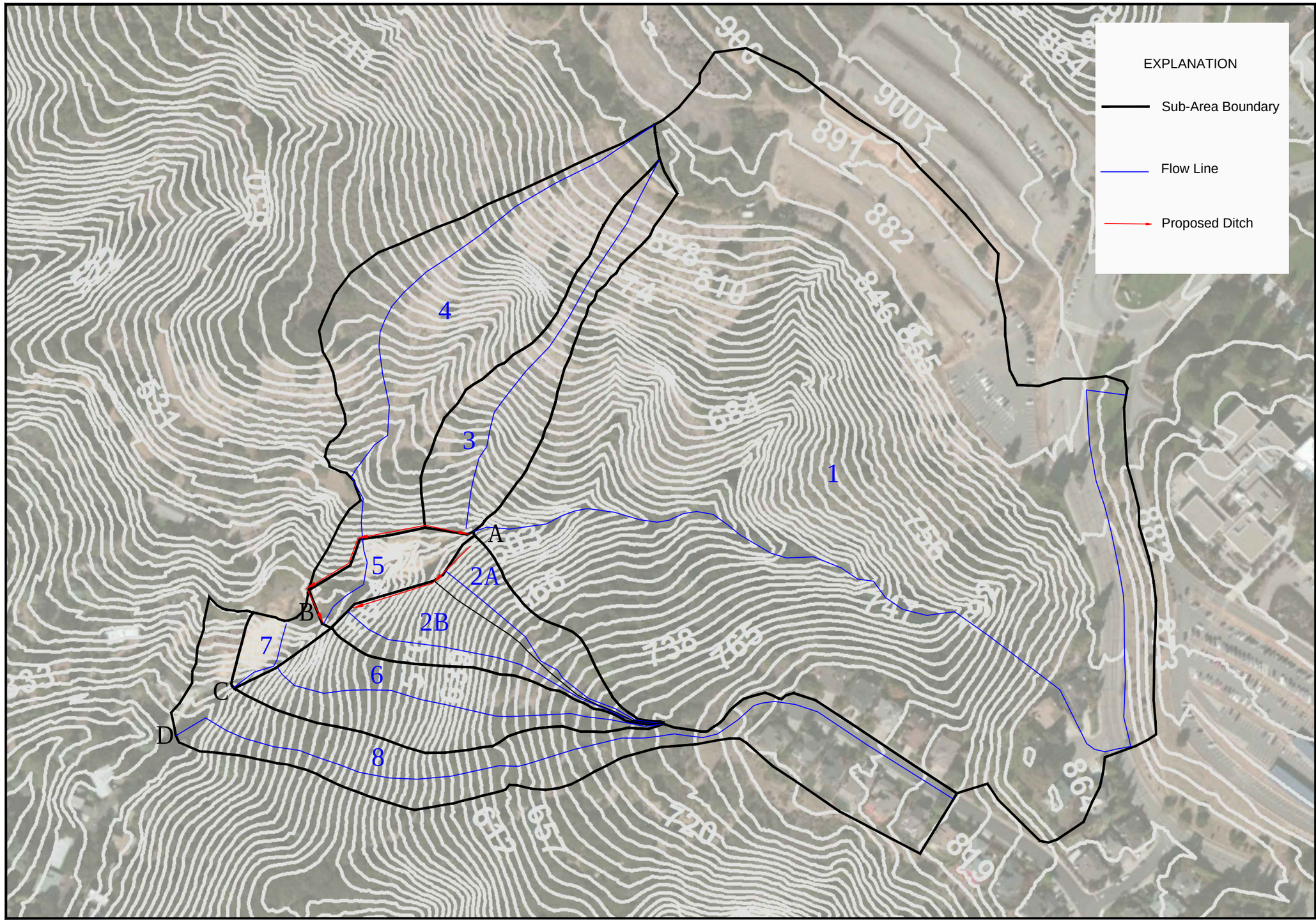
SHEET TITLE

Drainage Area Delineation (Existing Condition)

DRAWING NUMBER

Figure 3A



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2/12/2014	REVISED
	PERMIT LEVEL

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APPROVED BY:

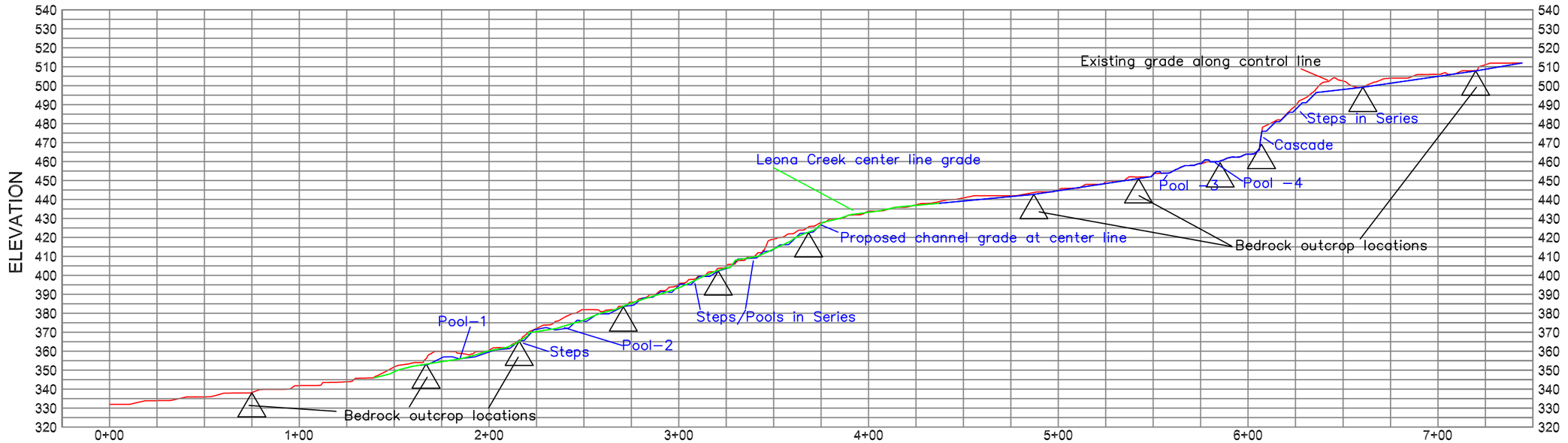
SHEET TITLE

Drainage Area Delineation (Proposed Condition)

DRAWING NUMBER

Figure 3B

PROPOSED LONGITUDINAL STEAMBED PROFILE



DISTANCE (FT)

NOTEs:
Elevations are based on survey performed by Mid Coast Engineers in August 2013
Dimensions of streambed features may be adjusted upon engineer's approval

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CHECKED BY:

APPROVED BY:

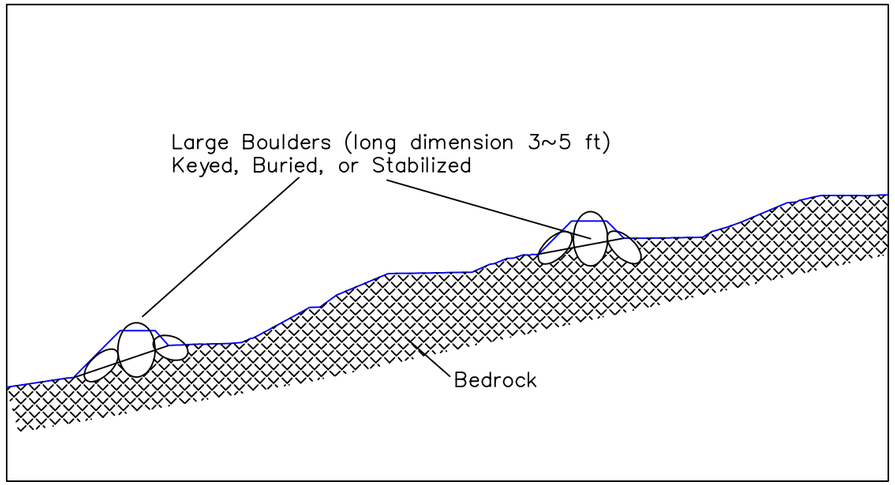
SHEET TITLE

Proposed Longitudinal Streambed Profile

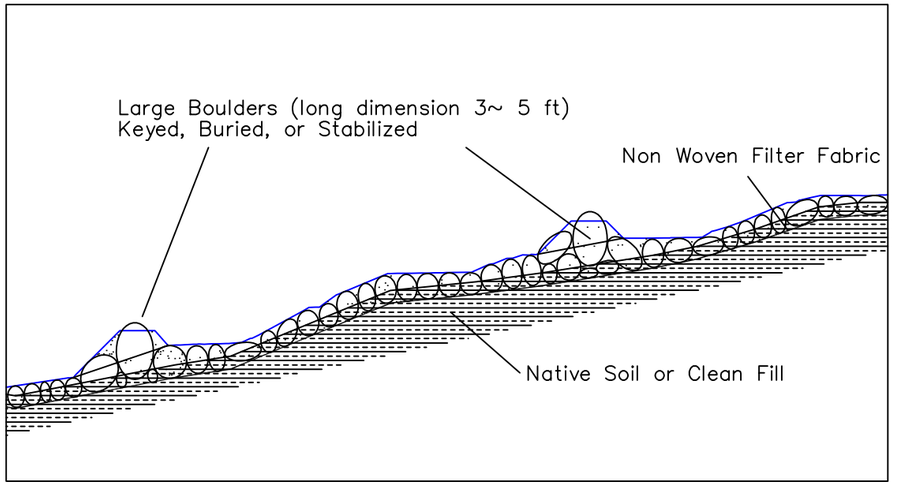
DRAWING NUMBER

Figure 4

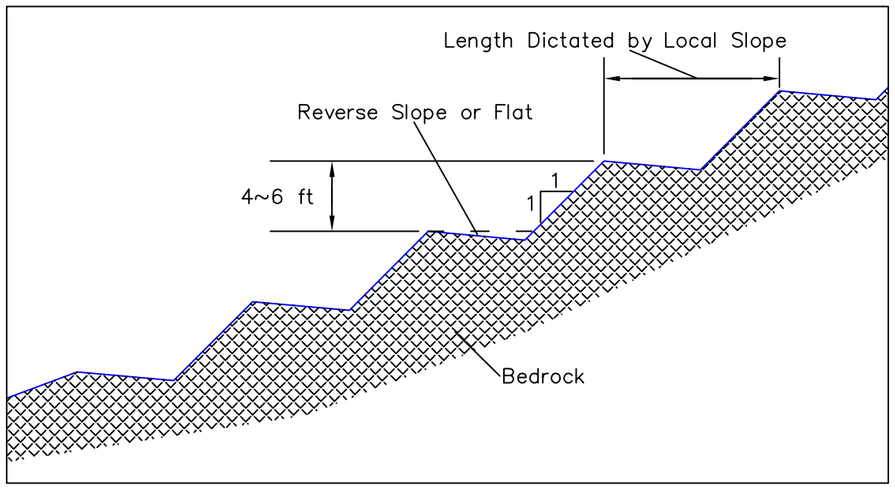
TYPICAL STEP/POOL PROFILE DETAILS FOR CREEK CHANNEL RESTORATION



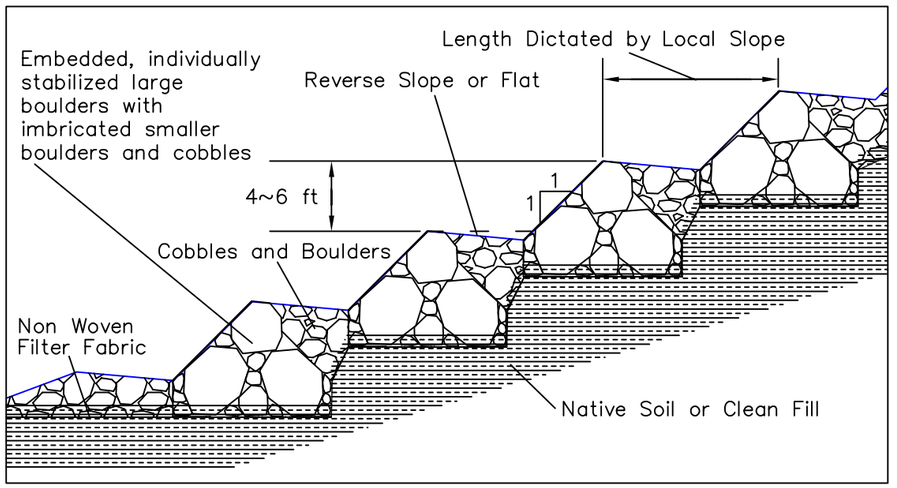
A. Typical Step Pool Profile in Competent Bedrock



B. Typical Step Pool Profile in Native Soil or Clean Fill



C. Typical Step (Pool) Profile in Competent Bedrock



D. Typical Step (Pool) Profile in Native Soil or Clean Fill

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Not to Scale

DATE	DESCRIPTION
10/09/2013	90% Design

PROJECT NAME

Leona Heights Sulfur Mines Remediation

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DESIGNED BY:

CHECKED BY:

APPROVED BY:

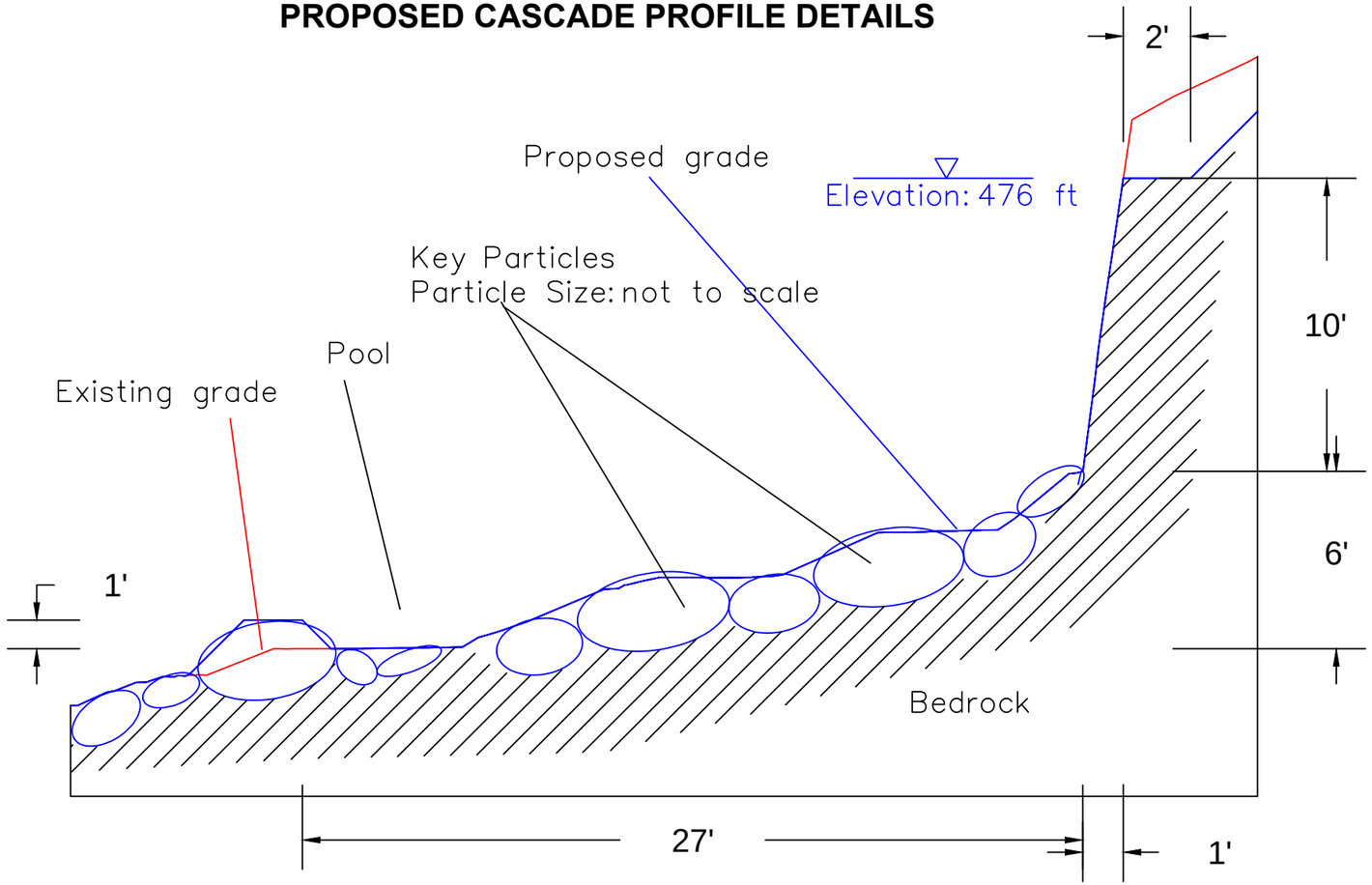
SHEET TITLE

Typical Step/Pool Profile Details

DRAWING NUMBER

Figure 5

PROPOSED CASCADE PROFILE DETAILS



NOTES:

1. **Elevations are based on survey performed by Mid Coast Engineers in August 2013.**
2. **Dimensions of streambed features may be adjusted upon engineer's approval.**
3. **Minimum long dimension of key particles need to be greater than 5 ft.**
4. **Key particles are to be keyed into bedrock with minimum embedded depth greater than 1/3 of shortest dimension of key particles.**
5. **Key particles need to be individually stablized and kept in contact laterally.**
6. **Fill the voids among key particles with gravels to approximate the proposed grade.**
7. **Key particles need to be angular, fresh, and competent (not visually fractured or weathered).**

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DATE	DESCRIPTION
10/29/2013	90% Design
10/29/2013	Amended

PROJECT NAME

Leona Heights Sulfur Mines Remediation

PROJECT NO: 2028BK

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DESIGNED BY:

CHECKED BY:

APPROVED BY:

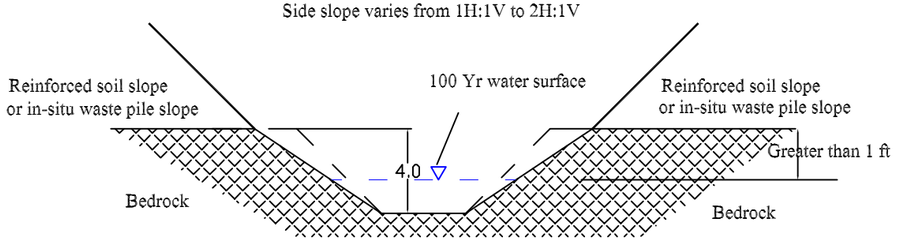
SHEET TITLE

Proposed Cascade Profile Details

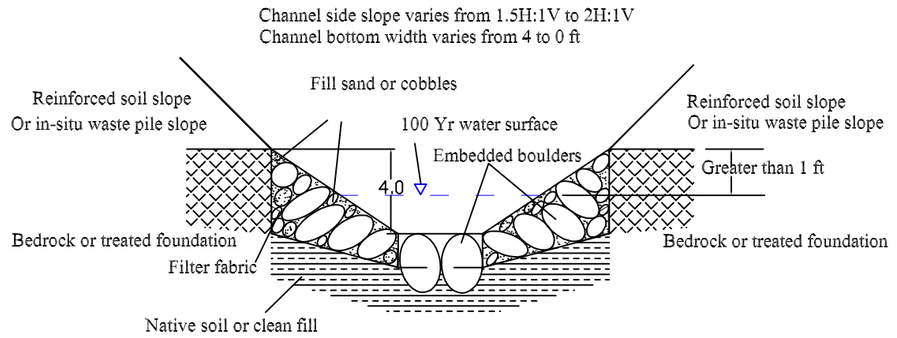
DRAWING NUMBER

Figure 5A

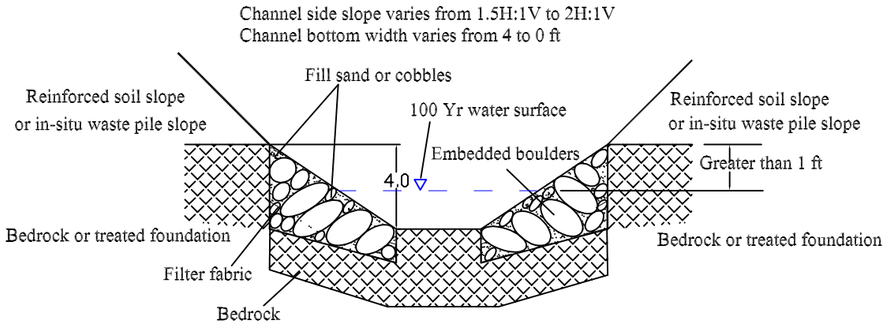
TYPICAL CROSS-SECTION DETAILS FOR CREEK CHANNEL RESTORATION



A. Typical Cross-Section in Competent Bedrock



C. Typical Cross-Section with Embedded Boulders
For Segments with Incompetent Bedrock or Clean Fill



B. Typical Cross-Section with Embedded Boulders
For Segments with Competent Streambed and Incompetent Stream Banks

Notes:

Boulders sized to resist 100-yr design flow
Fill Cobbles sized to resist 5-yr design flow

For segments with high scour potential, large boulders will be embedded, individually stabilized, with imbricated smaller boulders and cobbles.

Minimum thickness of boulders or cobbles: 2 ft or the shortest dimension of key particles, which ever is larger.

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Not to Scale

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PROJECT NAME

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PROJECT NO: 2028BK

DRAWN BY: A.X.

DESIGNED BY: A.Xu

CHECKED BY:

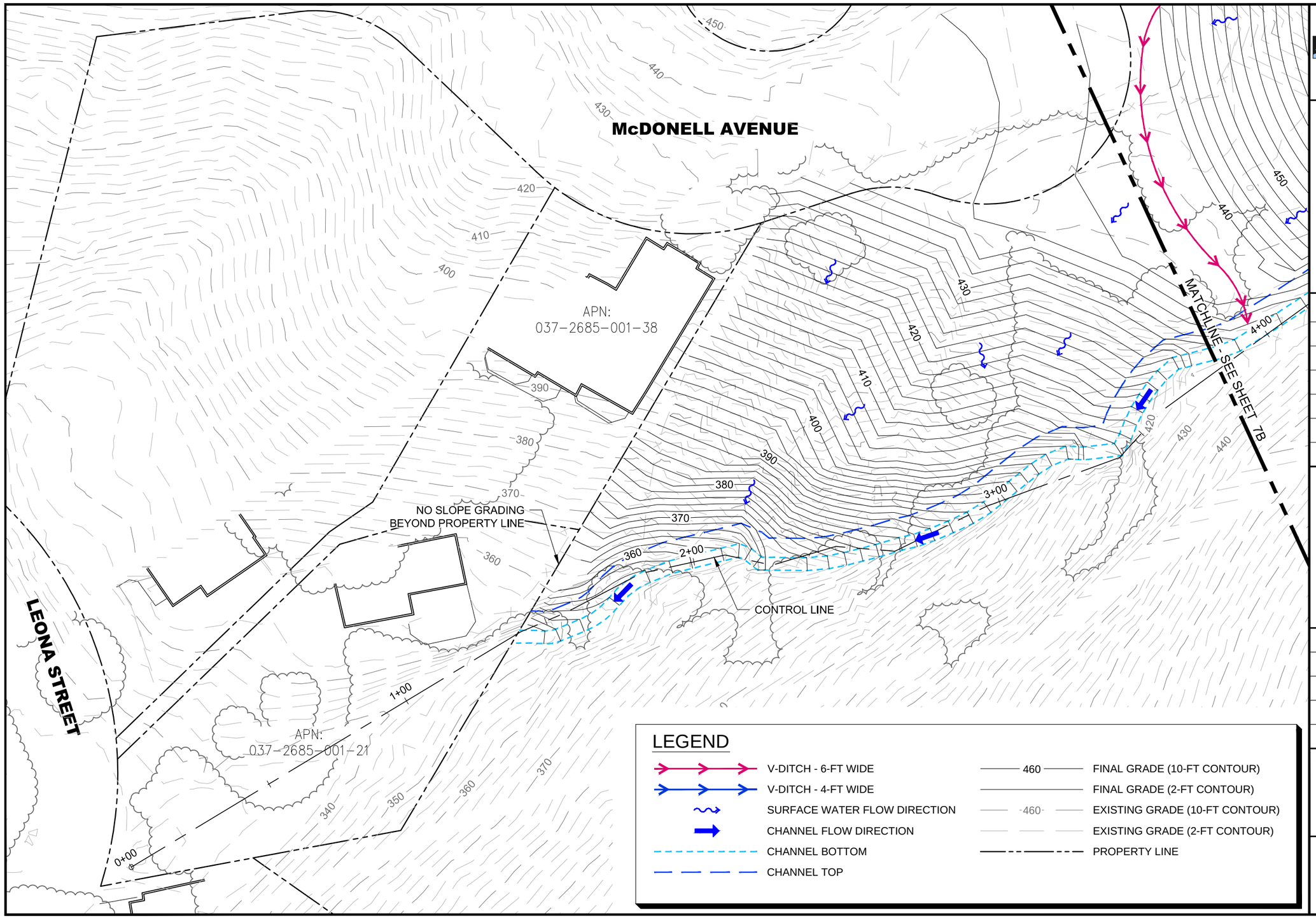
APPROVED BY:

SHEET TITLE

Typical Cross-Sections

DRAWING NUMBER

Figure 6



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Fax: (661) 831-6234

N

0 30

DATE	DESCRIPTION
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DESIGNED BY: A.X.

CHECKED BY:

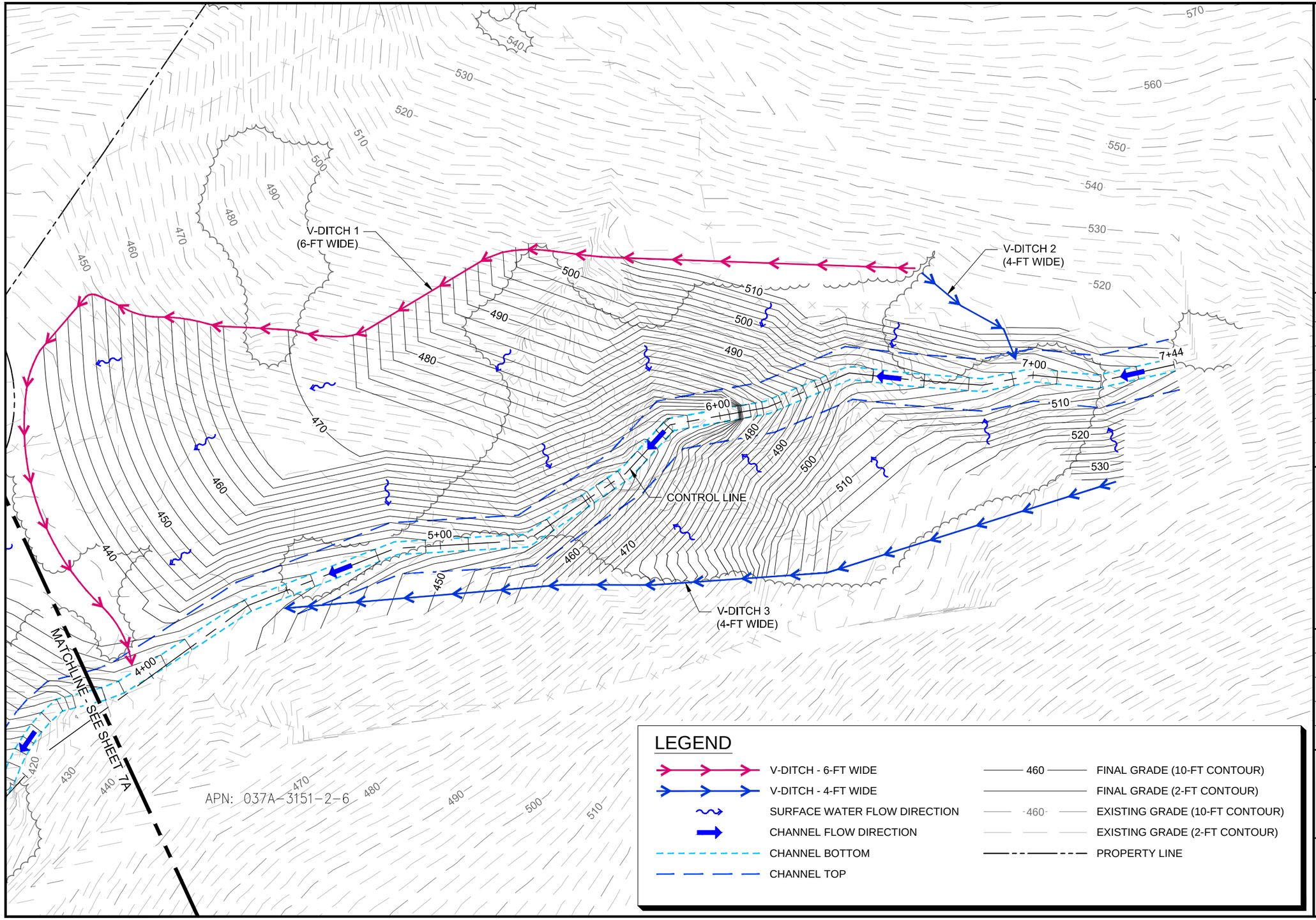
APPROVED BY:

SHEET TITLE

Site Drainage Management Plan (Southwest)

DRAWING NUMBER

Figure 7A



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PROJECT NAME

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PROJECT NO: 2028BK

DRAWN BY: N.B.

DESIGNED BY: A.X.

CHECKED BY:

APPROVED BY:

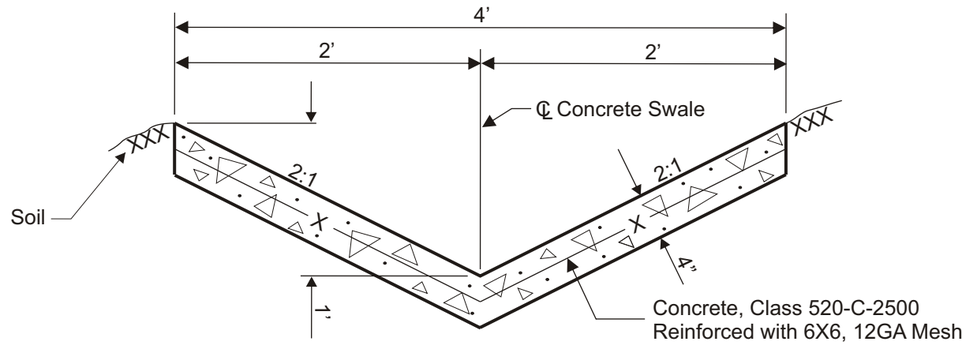
SHEET TITLE

Site Drainage Management Plan (Northeast)

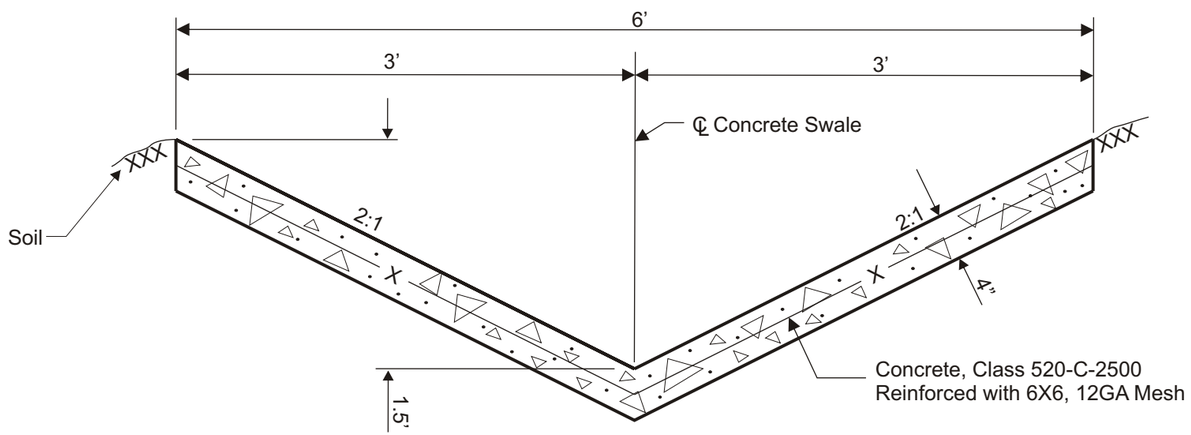
DRAWING NUMBER

Figure 7B

4' V-Ditch



6' V-Ditch



E2C Remediation
1020 Winding Creek Road, Suite 110
Roseville, CA 95678
Phone: (916) 782-8700
Fax: (916) 782-8750

0 1 ft.

Scale

1 inch = 1 ft.

DATE	DESCRIPTION
1/27/14	REVISED PERMIT LEVEL

PROJECT NAME

LEONA HEIGHTS SULFUR MINES REMEDIATION

PROJECT NO: 2028BK

DRAWN BY: Tim Hasler

DESIGNED BY: A.X.

CHECKED BY:

APPROVED BY:

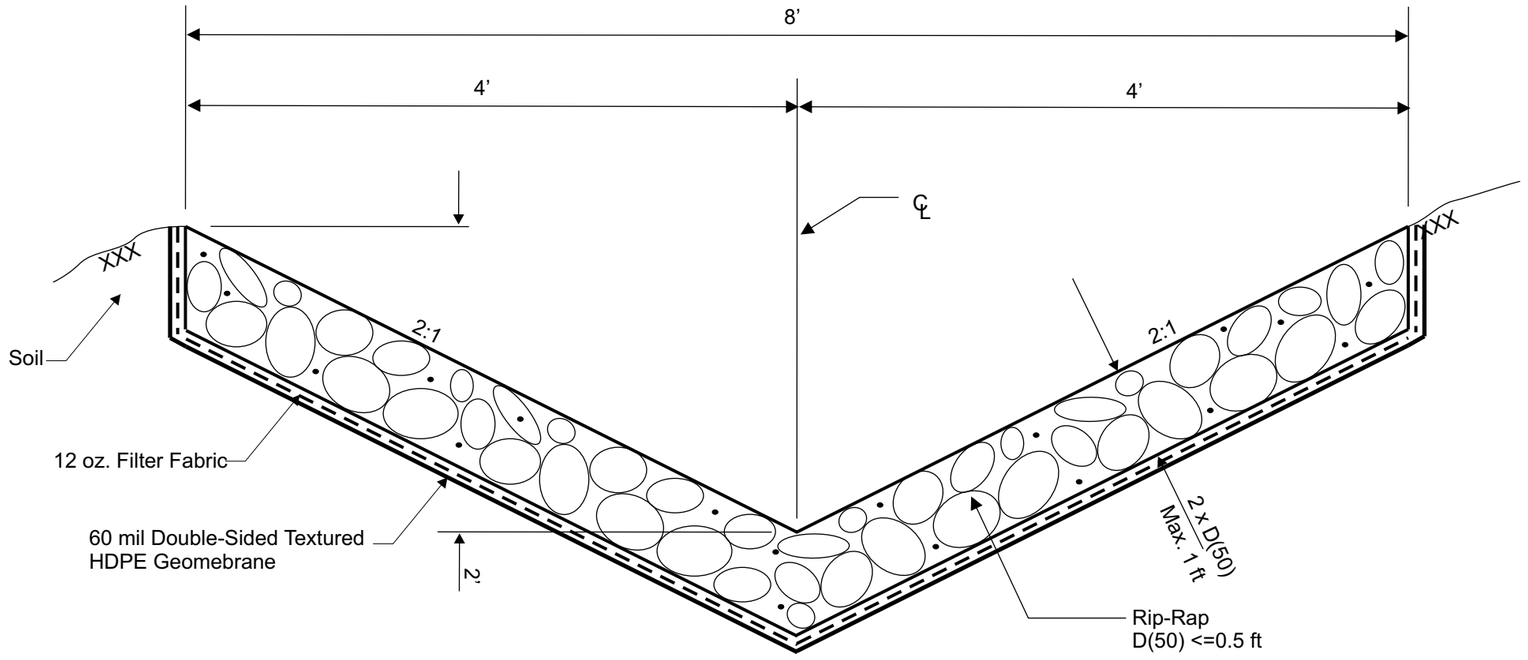
SHEET TITLE

V-Ditch Details

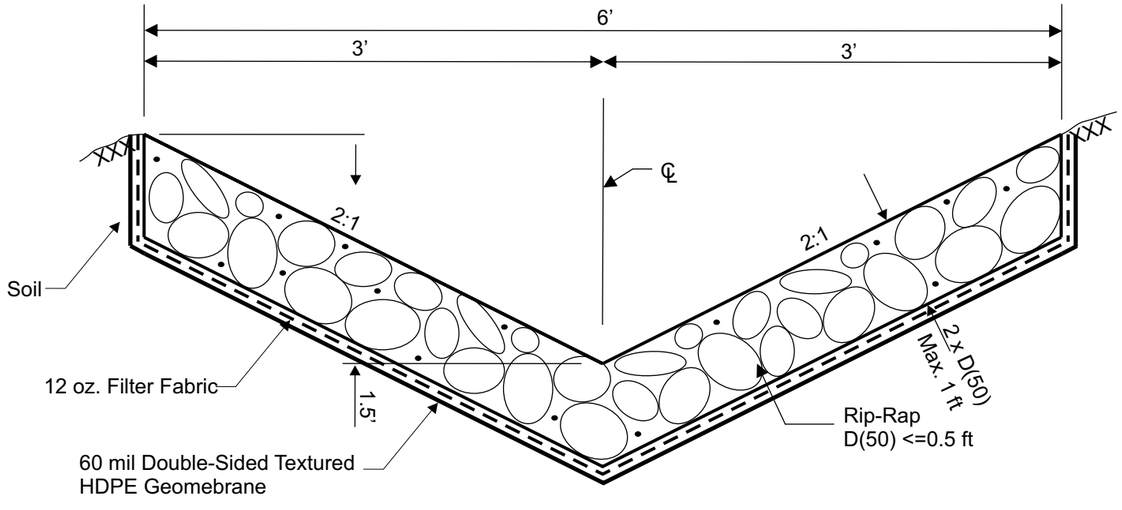
DRAWING NUMBER

FIGURE 8A

8' V-Ditch



6' V-Ditch



Notes:
The 8' Rip-Rap ditch is an alternative to the 6' concrete ditch and the 6' rip-rap ditch is an alternative to the 4' concrete ditch.

The use of these alternatives are subject to field conditions (space and slope as well as tree protection limitations). Where they are feasible, these alternative ditches will be preferred.

EC Remediation
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Phone: (916) 782-8700
Fax: (916) 782-8750

0 1 ft.

Scale

1 inch = 1 ft.

DATE	DESCRIPTION
1/27/14	REVISED PERMIT LEVEL

PROJECT NAME

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PROJECT NO: 2028BK

DRAWN BY: A.X.

DESIGNED BY: A.X.

CHECKED BY:

APPROVED BY:

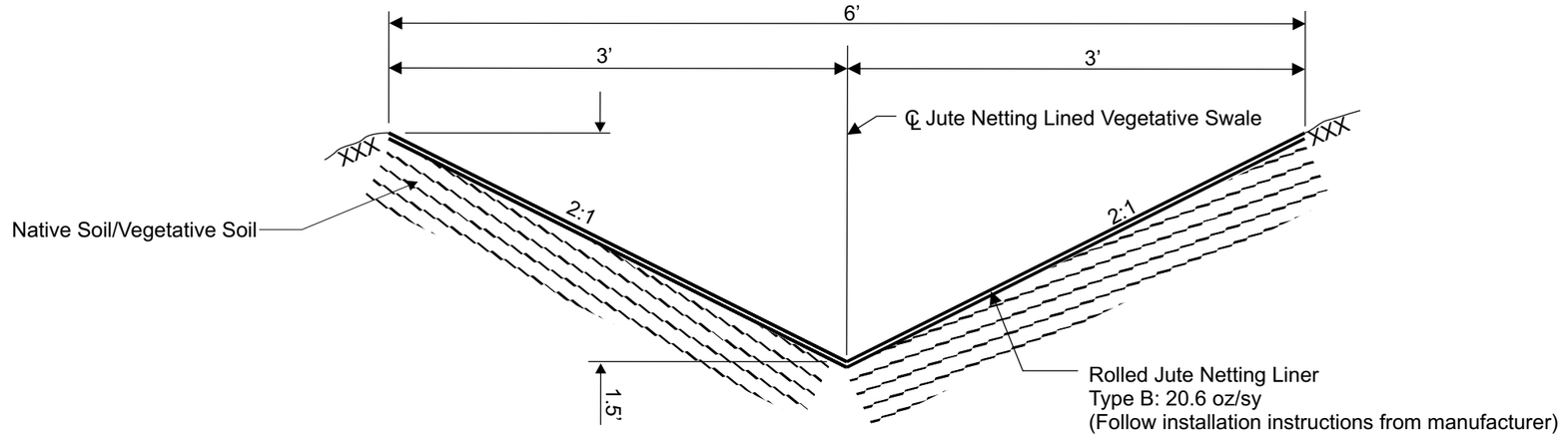
SHEET TITLE

V-Ditch Details (Alternative I)

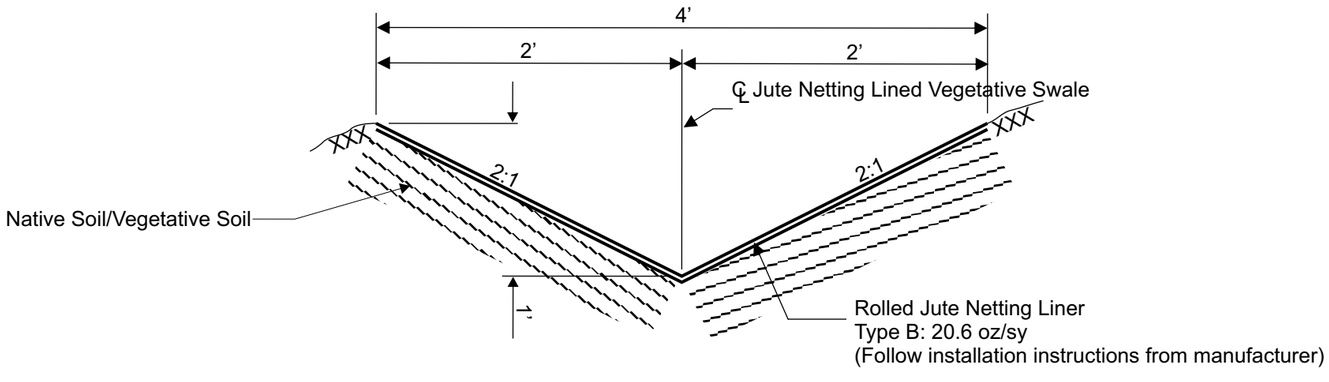
DRAWING NUMBER

FIGURE 8B

6' V-Ditch



4' V-Ditch



Notes:

1. The 6' jute netting vegetative swale is an alternative to the 6' concrete ditch and the 4' Jute netting vegetative swale is an alternative to the 4' concrete ditch.

2. The use of these alternatives are subject to field conditions (for longitudinal slope <50%). Where they are feasible, these alternative ditches will be preferred.

3. For turns, do not use these alternatives.

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0 1 ft.

Scale

1 inch = 1 ft.

DATE	DESCRIPTION
2/11/14	REVISED PERMIT LEVEL

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DESIGNED BY: A.X.

CHECKED BY:

APPROVED BY:

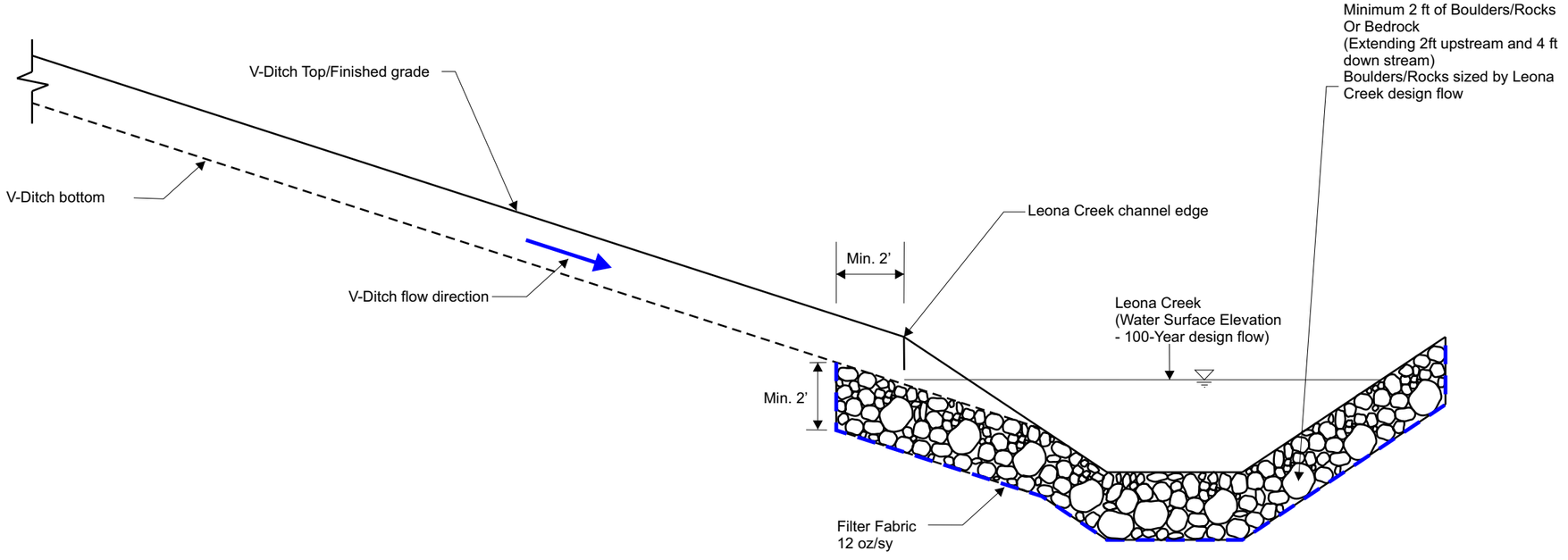
SHEET TITLE

V-Ditch Details (Alternative II)

DRAWING NUMBER

FIGURE 8C

V-Ditch Outfall



Note: Not drawn to scale

Note:
If the V-Ditch longitudinal slope immediately prior to the outfall is greater than 20%, rock check dams with a height of 6 inches or less shall be formed at the confluence with Leona Creek and every 20 ft apart upstream from the confluence to enhance energy dissipation and minimize loss of ditch capacity..

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02/12/14	Revised Permit Level

PROJECT NAME

LEONA HEIGHTS SULFUR MINES REMEDIATION

PROJECT NO: 2028BK

DRAWN BY: A.X.

DESIGNED BY: A.X.

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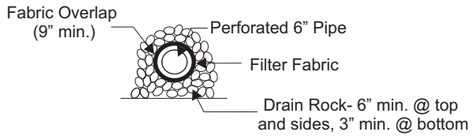
APPROVED BY:

SHEET TITLE

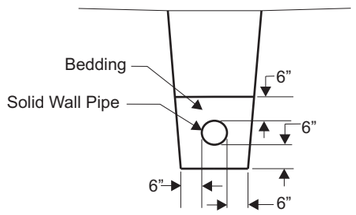
V-Ditch Outfall Details

DRAWING NUMBER

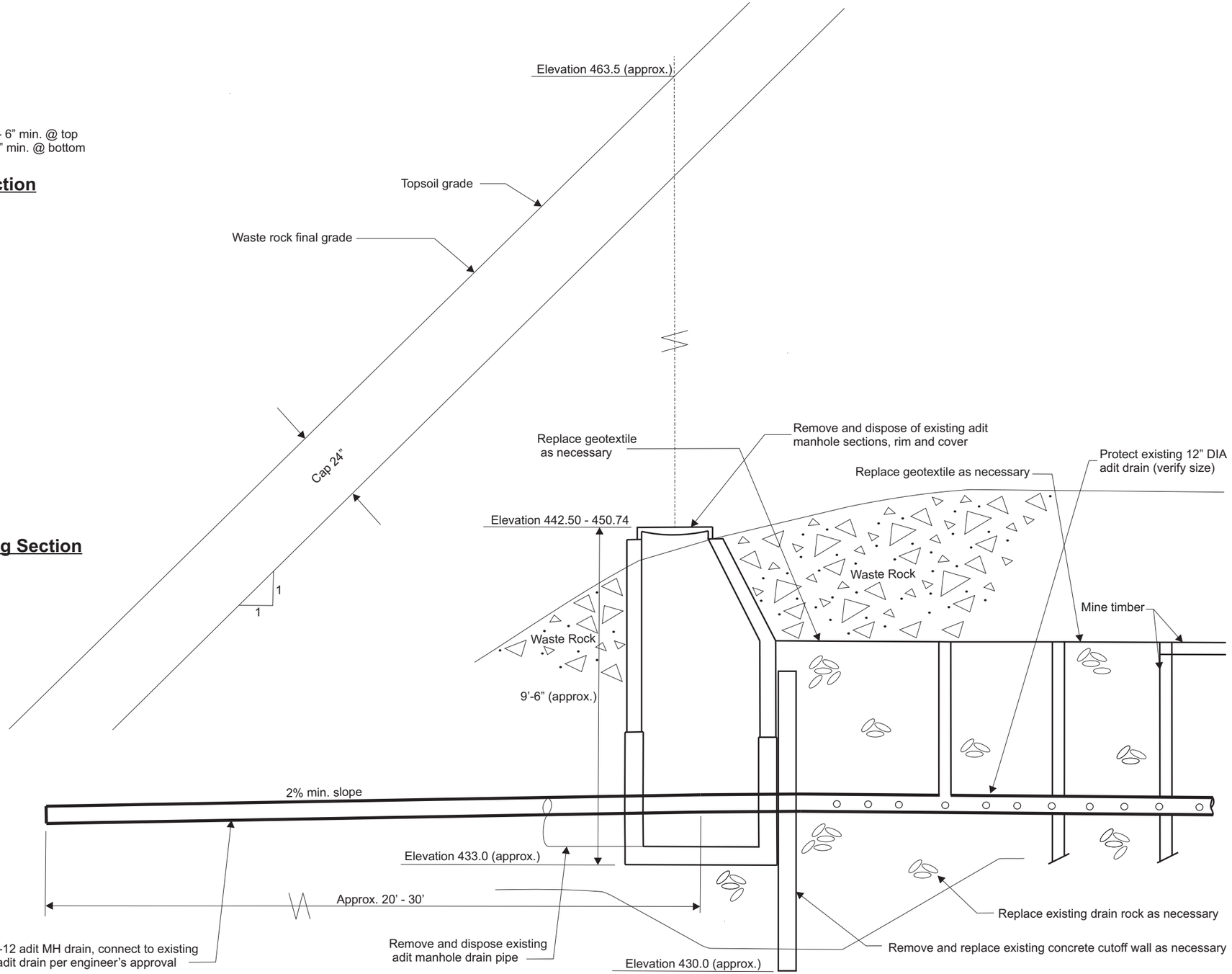
FIGURE 8D



Perforated Pipe Typical Section



Solid Wall Pipe Typical Bedding Section



Seep Remediation Cross Section

NOTE: MODIFIED FROM LFR (March 2004)

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Fax: (661) 831-6234

0 3 ft.
Scale

1 inch = 3 ft.

DATE	DESCRIPTION
10/8/13	90% design

PROJECT NAME

LEONA HEIGHTS SULFUR MINES REMEDIATION

PROJECT NO: 2028BK

DRAWN BY: Tim Hasler

DESIGNED BY: A.X.

CHECKED BY:

APPROVED BY:

SHEET TITLE

Seep Remediation Cross Section Details

DRAWING NUMBER

FIGURE 9

NOTE:
SUBDRAIN LENGTH WILL BE ADJUSTED IN THE FIELD BASED ON EXCAVATION EXTENT FOR REINFORCED SOIL SLOPE.

2" SCHEDULE 80 PVC WELL SCREEN

4" SOLID SCHEDULE 80 PVC COLLECTION PIPE

6" SEEP REMEDIATION PIPE (N12 SEWER, WATER TIGHT)

McDONELL AVENUE

2" SCHEDULE 80 PVC WELL SCREEN

4" SOLID SCHEDULE 80 PVC COLLECTION PIPE

CONTROL LINE

2" SCHEDULE 80 PVC WELL SCREEN

4" SOLID SCHEDULE 80 PVC COLLECTION PIPE

CONTROL LINE

0:0.000,0.000,1.000,0.000

LEGEND

- 2" PRE-PACKED WELL SCREEN SUBDRAIN
- 4" SOLID SCH 80 PVC COLLECTION SUBDRAIN
- 6" N12 SEWER, WATER TIGHT, SEEP REMEDIATION PIPE
- CHANNEL BOTTOM
- CHANNEL TOP
- 460 FINAL GRADE (10-FT CONTOUR)
- FINAL GRADE (2-FT CONTOUR)
- -460- EXISTING GRADE (10-FT CONTOUR)
- EXISTING GRADE (2-FT CONTOUR)
- PROPERTY LINE

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PROJECT NAME

Leona Heights Sulfur Mines Remediation

PROJECT NO: 2028BK

DRAWN BY: N.B.

DESIGNED BY: A.X.

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APPROVED BY:

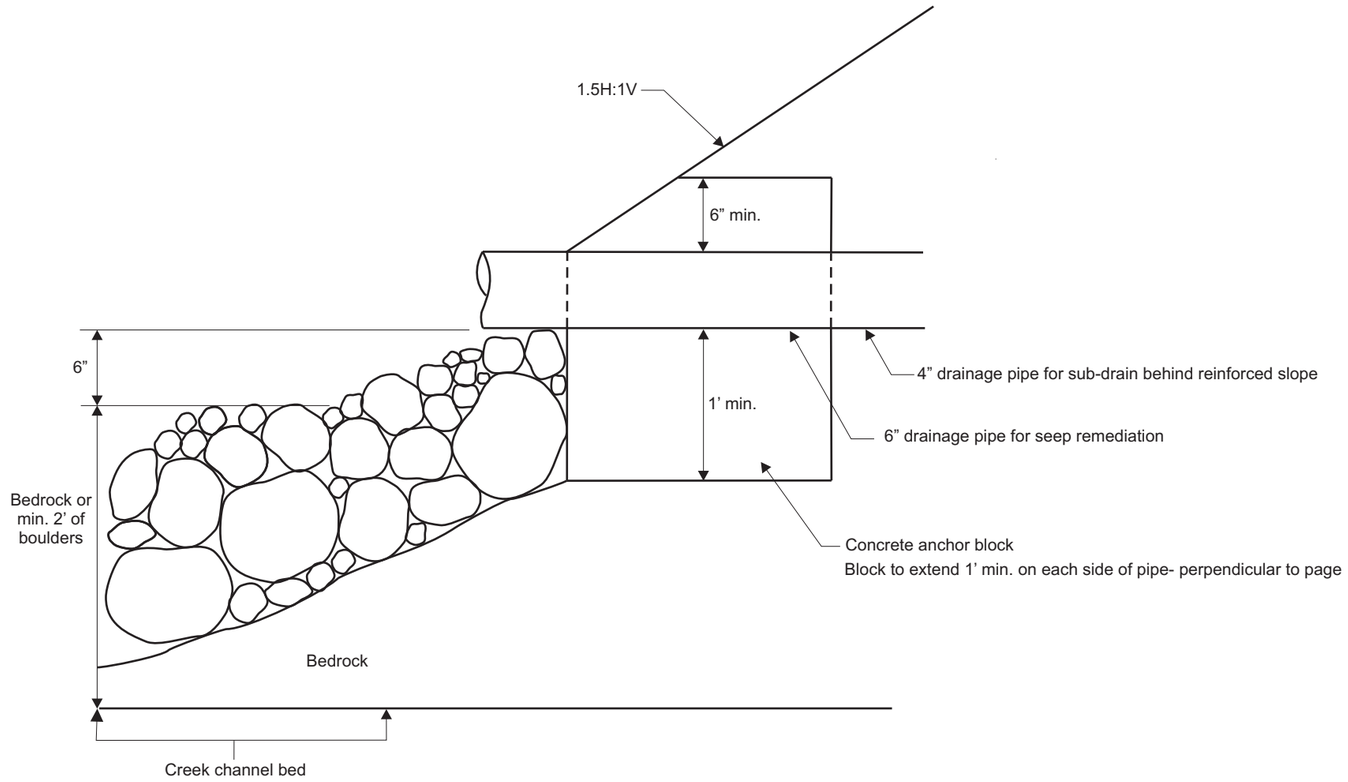
SHEET TITLE

Sub-Surface Drainage Plan

DRAWING NUMBER

Figure 10

Drainage Pipe Outlet



Note: Not drawn to scale

E2C Remediation
5300 Woodmere Dr., Suite 105
Bakersfield, CA 93313
Phone: (661) 831-6906
Fax: (661) 831-6234

DATE	DESCRIPTION
10/8/13	90% design

PROJECT NAME

LEONA HEIGHTS SULFUR MINES REMEDIATION

PROJECT NO: 2028BK

DRAWN BY: Tim Hasler

DESIGNED BY: A.X.

CHECKED BY:

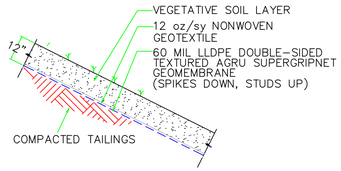
APPROVED BY:

SHEET TITLE

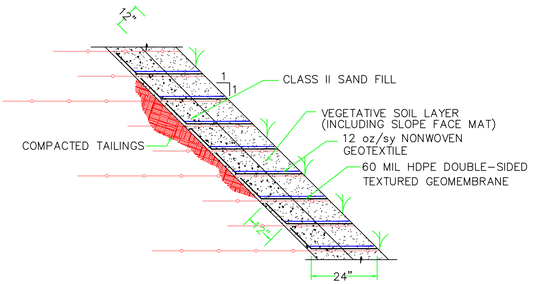
Drainage Pipe Outlet Details

DRAWING NUMBER

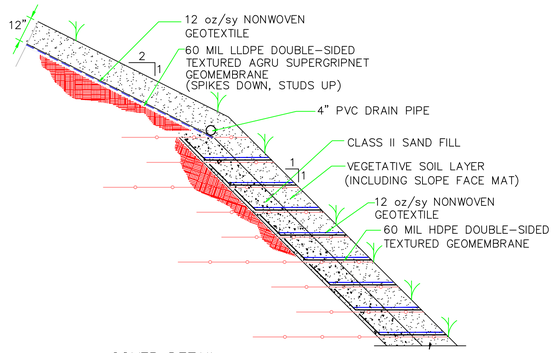
FIGURE 11



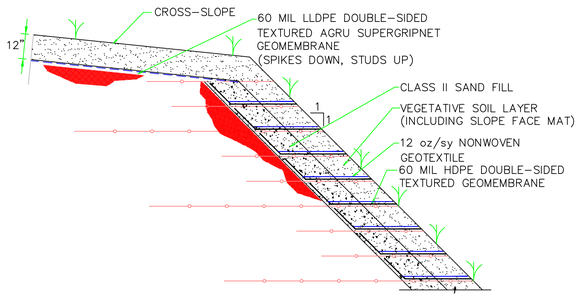
D-1 COVER DETAIL
GEOMEMBRAINE ON SLOPE 2H:1V OR GENTLER
SCALE: N.T.S.



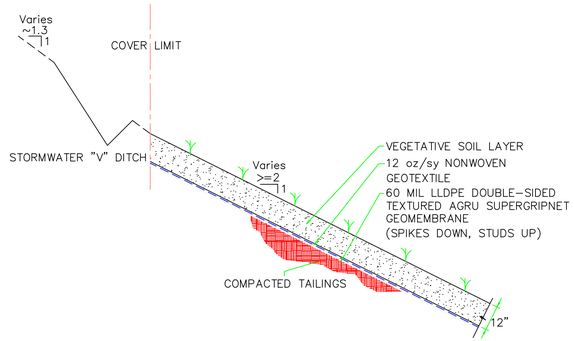
D-2 COVER DETAIL
GEOMEMBRAINE ON SLOPE 1H:1V
SCALE: N.T.S.



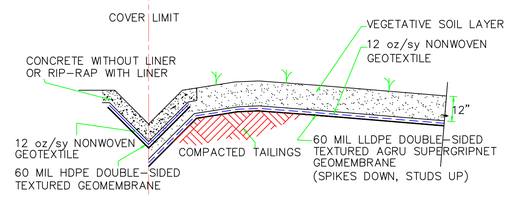
D-3 COVER DETAIL
TRANSITION FROM 2H:1V SLOPE TO 1H:1V SLOPE
SCALE: N.T.S.



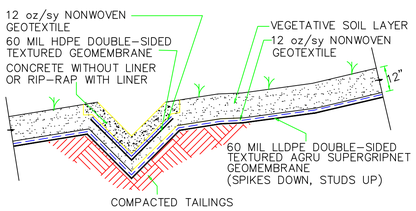
D-4 COVER DETAIL
TRANSITION FROM CROSS SLOPE TO 1H:1V SLOPE
SCALE: N.T.S.



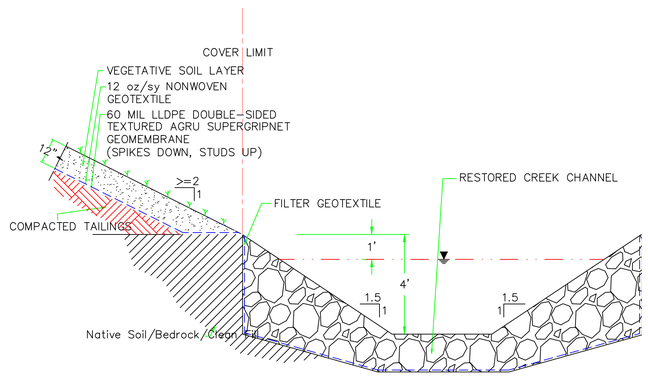
D-5 COVER DETAIL
UPPER BOUNDARY TO "V" DITCH
SCALE: N.T.S.



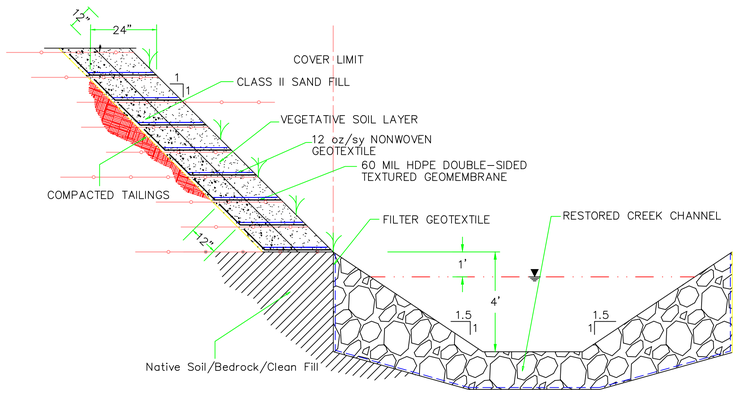
D-6 COVER DETAIL
SIDE BOUNDARY TO "V" DITCHES
SCALE: N.T.S.



D-7 COVER DETAIL
COVER WITH "V" DITCHES ON TOP
SCALE: N.T.S.



D-8 COVER DETAIL
TRANSITION FROM 2H:1V OR GENTLER SLOPE TO CREEK
SCALE: N.T.S.



D-9 COVER DETAIL
TRANSITION FROM 1H:1V SLOPE TO CREEK
SCALE: N.T.S.

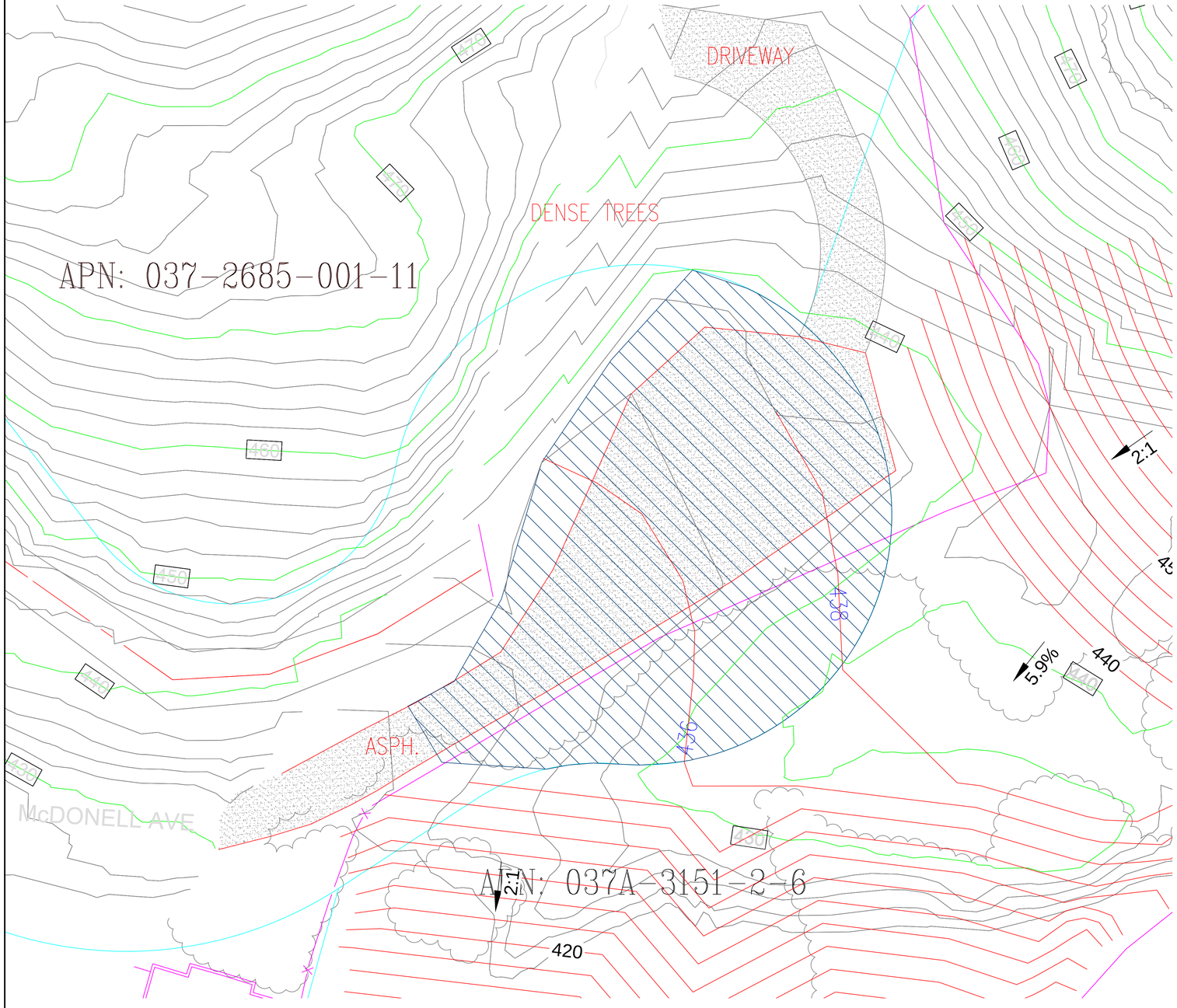
EC Remediation
1020 Winding Creek Road, Suite 110
Roseville, CA 95678
Phone: (916) 782-8700
Fax: (916) 782-8750

DATE	DESCRIPTION
1/24/2014	REVISED PERMIT LEVEL

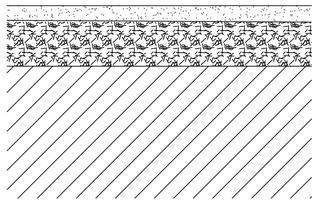
PROJECT NAME
Leona Heights Sulfur Mine Remediation

PROJECT NO: 2028BK
DRAWN BY: A.X.
DESIGNED BY: A.X.
CHECKED BY:
APPROVED BY:
SHEET TITLE
Cover Details

DRAWING NUMBER
Figure 12

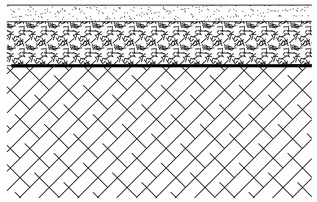


PAVEMENT CROSS SECTIONS



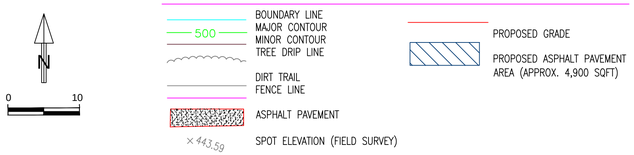
HOT MIXED ASPHALT (3 INCHES THICK)
CLASS 2 AGGREGATE (8 INCHES THICK)

NATIVE SOIL, CONGLOMERATE, WEATHERED BEDROCK



HOT MIXED ASPHALT (3 INCHES THICK)
CLASS 2 AGGREGATE (8 INCHES THICK)
LLDPE GEOMEMBRANE (60 mil)

COMPACTED MINE WASTE ROCKS



FIELD SURVEY PERFORMED BY MID COAST ENGINEERS.

COORDINATES BASED ON CALIFORNIA STATE PLANE COORDINATE SYSTEM, ZONE 3, NAD 83 AS ESTABLISHED BETWEEN NGS HT0281 (M554) AND NGS AA3818 (HPGN D CA 04 GH)

BENCHMARK FOR THIS SURVEY IS NGS HT0281 WITH ELEVATION =14.20 FEET (NAVD 88 DATUM).

AERIAL TOPOGRAPHIC SURVEY PERFORMED AND MAPPED BY AERIAL PHOTOMAPPING SERVICES 2929 LARKIN AVE., CLOVIS, CA 93612

DATE OF FLIGHT: 08/05/2013

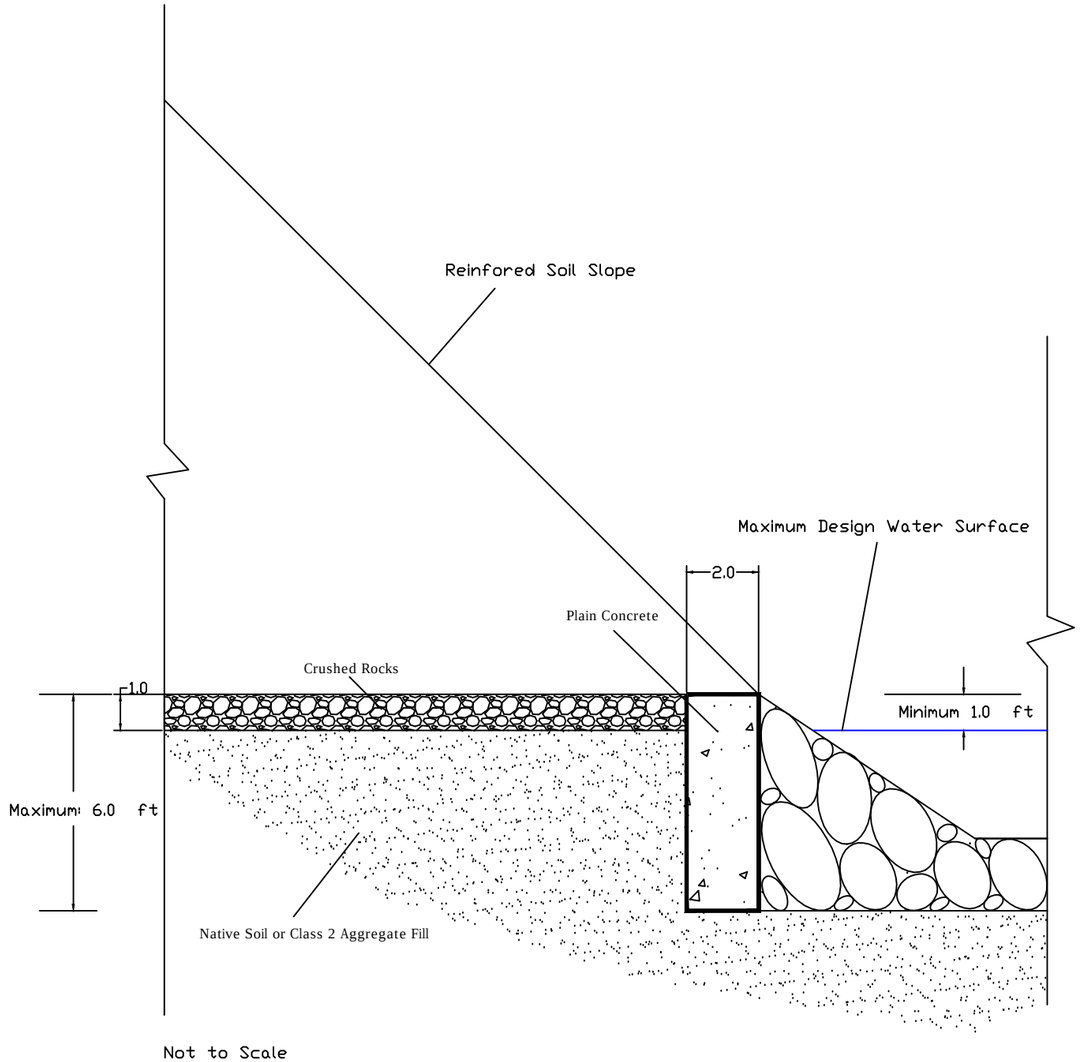
EC Remediation
1020 Winding Creek Road, Suite 110
Roseville, CA 95678
Phone: (916) 782-8700
Fax: (916) 782-8750

DATE	DESCRIPTION
1/28/2014	PERMIT LEVEL

PROJECT NAME
Leona Heights Sulfur Mine Remediation

PROJECT NO: 2028BK
DRAWN BY: A.X.
DESIGNED BY: A.X.
CHECKED BY:
APPROVED BY:
SHEET TITLE
McDonell Avenue Improvement

DRAWING NUMBER
Figure 13



Reinforced Soil Slope Subbase/Foundation Detail

Notes:

1. This subbase/foundation detail only applies to locations where competent native soil/bedrock is absent at the designed base elevation of the Reinforced Soil Slope (which is at least 1 ft above the maximum design water surface of the creek).

2. For the determination of competent native soil/bedrock for the subbase/foundation, the minimum angle of repose of the native material is 40 degrees or equivalent.

3. The crushed rocks should meet Caltrans pervious back fill requirements (2010 Standard Specifications Section 19).

4. The minimum angle of repose for the crushed rocks is 40 degrees.

5. The layer of cruched rocks should be flat or stepped and extends into the slope to competent soil/bedrock.

6. The concrete block should be corrosion resistent under acidic condition. The design compressive strength is 5000 psi without reinforcement. The maximum length is 15 ft per section to avoid cracking.

7. The concrete block height is the shorter of 6 ft or the depth of comptent native soil or bedrock from the design base elevation of the Reinforced Soil Slope

8. If Class 2 aggregate base (Section 26 of Caltrans 2010 Standard Specifications) fill is used to achieve the designed base elevation of the reinforced soil slope, the aggregate fill should be compacted to 95% relative compaction.

E2C Remediation
1020 Winding Creek Road, Suite 110
Roseville, CA 95678
Phone: (916) 782-8700
Fax: (916) 782-8750

DATE	DESCRIPTION
1/28/2014	PERMIT LEVEL

PROJECT NAME

Leona Heights Sulfur Mine Remediation

PROJECT NO: 2028BK

DRAWN BY: A.X.

DESIGNED BY: A.X.

CHECKED BY:

APPROVED BY:

SHEET TITLE

Subbase/Foundation Detail

DRAWING NUMBER

Figure 14

MSE STRUCTURE DRAFT PERMIT DRAWINGS
Prepared For

OCEAN/ALCOA PROPERTIES TEAM MEMBERS

LEONA HEIGHTS SULFUR MINE REMEDIATION

OAKLAND, CALIFORNIA

INDEX

SHEETS	DESCRIPTION
1	Title Sheet
2	Construction Requirements
3	Typical Cross-Section
4	Typical Details
5	Typical Details

REGISTERED PROFESSIONAL ENGINEER
JONG H. LEE
No. 71009
CIVIL
STATE OF CALIFORNIA

JONG H. LEE
P.E. NO. 71009

S1310301.DWG

THIS DESIGN IS BASED UPON SPECIFIC PROPERTIES OF THOSE SPECIFIC TENSAR PRODUCTS INCORPORATED THEREIN WHICH ARE PROPRIETARY TO TENSAR. ANY SUBSTITUTION OF THE SPECIFIED PRODUCTS WILL INVALIDATE THIS DESIGN. THIS DRAWING IS BEING FURNISHED FOR USE ON THIS SPECIFIC PROJECT ONLY. ANY PARTY ACCEPTING THIS DOCUMENT DOES SO IN CONFIDENCE AND AGREES THAT IT SHALL NOT BE DUPLICATED WHOLE OR IN PART, NOR DISCLOSED TO OTHERS, WITHOUT THE CONSENT OF TENSAR INTERNATIONAL CORPORATION.

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REVISIONS

NO.	DATE	DESCRIPTION	BY	NO.	DATE	DESCRIPTION	BY
0	10/8/13	ISSUED FOR REVIEW	JHL				

CLIENT
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ROSEVILLE, CA 95678
(916) 782-8700

ENGINEER OF RECORD:
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2500 Northwinds Parkway | Suite 500
Alpharetta, Georgia 30009 | 770-344-2090
C.O.A. # P-0955
JONG H. LEE P.E. NO. 71009

PROJECT NAME
LEONA HEIGHTS SULFUR MINE REMEDIATION

PROJECT LOCATION
OAKLAND, CALIFORNIA
STATE OR FEDERAL AID PROJECT No.

SHEET TITLE
TITLE SHEET

	NAME	DATE
DRAWN BY	RR	10/8/13
DESIGNED BY	JHL	10/8/13
CHECKED BY	JHL	10/8/13

TIC PROJECT NO. A13103
SCALE AS SHOWN
SHEET 1 OF 5

CONSTRUCTION REQUIREMENTS FOR TENSAR SIERRA SLOPE SYSTEM

1.0 PROJECT INTRODUCTION

1.1 THE SIERRA SLOPE SYSTEM FOR THE LEONA HEIGHTS SURFUR MINE REMEDIATION PROJECT IS A MECHANICALLY STABILIZED EARTH (MSE) STRUCTURE (REINFORCED SLOPE). THE DRAFT PERMIT DRAWINGS AND ASSOCIATED ANALYSES ARE PRESENTED BY TENSAR INTERNATIONAL CORPORATION (TIC) TO E2C REMEDIATION (CLIENT) UNDER CONTRACT.

2.0 MATERIALS

2.1 BACKFILL

2.1.1 BACKFILL (REINFORCED AND RETAINED ZONES) SHALL BE FREE OF EXCESS MOISTURE, ROOTS, MUCK, SOD, SNOW, FROZEN LUMPS, ORGANIC MATTER OR OTHER DELETERIOUS MATERIALS. ALL ROCK PARTICLES AND HARD EARTH CLODS SHALL BE LESS THAN 4 INCHES IN THE LONGEST DIMENSION. BACKFILL WHICH DOES NOT MEET THESE CRITERIA SHALL BE CONSIDERED UNSUITABLE AND SHALL BE REMOVED.

2.1.2 REINFORCED BACKFILL SHALL BE ONSITE MATERIAL OR IMPORT SOILS THAT MEET THE STRENGTH REQUIREMENTS DEFINED IN SECTION 4.0.

2.2 SOIL REINFORCEMENT
GEOGRID REINFORCEMENT SHALL BE TENSAR UNIAXIAL AND BIAXIAL GEOGRIDS MANUFACTURED BY THE TENSAR INTERNATIONAL CORPORATION, MORROW, GEORGIA, USA.

2.3 FACING MATERIAL

2.3.1 EROSION CONTROL MAT SHALL BE MANUFACTURED BY NORTH AMERICAN GREEN, EVANSVILLE, INDIANA, USA.

3.0 DESIGN RESPONSIBILITY

3.1 TIC RESPONSIBILITY
TIC HAS DESIGNED THE SIERRA SLOPE SYSTEM TO MEET FACTORS OF SAFETY FOR THE MSE CHARACTERISTICS LISTED BELOW

	STATIC	SEISMIC
3.1.1 INTERNAL STABILITY		
GEOGRID TENSILE STRENGTH, MINIMUM	1.5	1.1
GEOGRID PULLOUT CAPACITY, MINIMUM	1.5	1.1
COMPOUND STABILITY	1.5	1.1
SURFICIAL STABILITY, MINIMUM	1.5	1.1
3.1.2 GLOBAL STABILITY	1.5	1.1

3.2 RESPONSIBILITY OF OTHERS
THE SITE CHARACTERISTICS LISTED BELOW AFFECT THE PERFORMANCE OF THE SIERRA SLOPE SYSTEM. TIC IS NOT RESPONSIBLE FOR EVALUATING OR VERIFYING SITE CHARACTERISTICS, THEREFORE TIC ASSUMES NO LIABILITY FOR THE POTENTIAL NEGATIVE EFFECTS OF THE SITE CHARACTERISTICS. THE CLIENT IS RESPONSIBLE FOR ENSURING THAT THE FOLLOWING SITE CHARACTERISTICS ARE PROPERLY ADDRESSED BY A QUALIFIED ENGINEER.

3.2.1 TIC REPORTS PHYSICAL AND STRENGTH REQUIREMENTS OF THE BACKFILL. THE CLIENT IS RESPONSIBLE FOR VERIFICATION OF BACKFILL SPECIFICATIONS AND APPROPRIATE BACKFILL TESTING METHODS AND FREQUENCY.

3.2.2 ALLOWABLE BEARING CAPACITY
THE CLIENT IS RESPONSIBLE FOR ENSURING THAT A QUALIFIED GEOTECHNICAL ENGINEER PERFORMS AN EVALUATION OF THE FOUNDATION AND ITS ALLOWABLE BEARING CAPACITY.

3.2.3 HYDROSTATIC CONDITIONS
TIC REPORTS MAXIMUM DESIGN WATER LEVELS (SURFACE AND SUBSURFACE) IN SECTION 4.6. TIC REQUIRES THAT THE REINFORCED ZONE OF THE MSE STRUCTURE REMAINS FREE OF WATER AND ALL UNBALANCED HYDROSTATIC FORCES. THE CLIENT IS RESPONSIBLE FOR ENSURING THAT THE DESIGN, ANALYSIS, DETAILING, AND MITIGATION OF SURFACE WATER AND SUBSURFACE WATER, INCLUDING BUT NOT LIMITED TO COLLECTION, DIVERSION, AND EROSION/SCOUR PROTECTION ARE PROPERLY ADDRESSED BY A QUALIFIED ENGINEER.

3.2.4 SETTLEMENT
TOTAL SETTLEMENT AND DIFFERENTIAL SETTLEMENT OF THE REINFORCED SLOPE EXCEEDING 1/50 SHALL BE THE RESPONSIBILITY OF THE CLIENT. THE CLIENT IS RESPONSIBLE TO NOTIFY TIC IF IT IS DETERMINED THAT THE POTENTIAL FOR DIFFERENTIAL SETTLEMENT EXCEEDS THIS VALUE. TIC ACCEPTS NO LIABILITY OR RESPONSIBILITY FOR THE EVALUATION OF SETTLEMENT.

4.0 DESIGN PARAMETERS

4.1 DESIGN OF THE SIERRA SLOPE IS BASED ON THE METHODS AND GUIDELINES STATED IN FHWA NHI-00-043 "MECHANICALLY STABILIZED EARTH WALLS AND REINFORCED SOIL SLOPES DESIGN AND CONSTRUCTION GUIDELINES". THE FOLLOWING PARAMETERS CONTROL THE DESIGN

4.2 SOIL PARAMETERS

SOIL ZONE	MOIST UNIT WEIGHT (PCF)	EFFECTIVE FRICTION (DEGREES)	EFFECTIVE COHESION (PSF)
REINFORCED FILL	140	40	0
TOP SLOPE	140	35	40
RETAINED & FOUNDATION SOILS (WEATHERED BEDROCK)	140	40	150

NOTE: ALL SOIL PARAMETERS DESCRIBED ABOVE WERE PROVIDED BY THE CLIENT (E2C REMEDIATION). ALL OF THE ASSUMED SOIL PARAMETERS MUST BE REVIEWED AND VERIFIED BY THE PROJECT ENGINEER PRIOR CONSTRUCTION. IF ACTUAL CONDITIONS ARE FOUND TO BE OTHER THAN AS SET FORTH IN THESE PARAMETERS, THEN CONSTRUCTION SHALL NOT PROCEED AND THE RELEVANT DATA SHALL BE PROVIDED TO TIC FOR PURPOSE OF MODIFYING THE DESIGN.

4.3 GEOGRID
GEOGRID TENSILE PROPERTIES AND REDUCTION FACTORS ARE REPORTED IN THE TIC DESIGN REPORT DATED OCTOBER 8, 2013.

4.4 DESIGN LIFE = 100 YEARS

4.5 LOADINGS

4.5.1 2H:1V TOP SLOPE

4.5.2 SEISMIC ACCELERATION COEFFICIENT = 0.20g

4.6 HYDROSTATIC PARAMETERS
PHREATIC SURFACES ARE NOT CONSIDERED IN DESIGN OF THE MSE STRUCTURE. WATER LEVELS (SURFACE AND SUBSURFACE) SHALL REMAIN SUFFICIENTLY BELOW THE BOTTOM OF THE STRUCTURE FOR THE LIFE OF THE STRUCTURE TO PRECULDE NEGATIVE EFFECTS ON THE INTERNAL AND GLOBAL STABILITY OF THE STURCURE.

5.0 CONSTRUCTION REQUIREMENTS

5.1 A COMPLETE SET OF APPROVED CONSTRUCTION DRAWINGS AND CONTRACT SPECIFICATIONS SHALL BE ON SITE AT ALL TIMES DURING CONSTRUCTION OF THE SIERRA SLOPE SYSTEM. THE CONTRACTOR IS RESPONSIBLE TO FOLLOW THE DRAWINGS AND THE INSTRUCTIONS PROVIDED IN THE CONSTRUCTION AND QUALITY CONTROL MANUAL PROVIDED BY TIC.

5.2 THE FOUNDATION SHALL BE PREPARED IN ACCORDANCE WITH THE CONTRACT DOCUMENTS. THE CONTRACTOR IS RESPONSIBLE TO HAVE THE PROJECT GEOTECHNICAL ENGINEER CONFIRM THAT THE SITE HAS BEEN PROPERLY PREPARED AND MEETS THE DESIGN PARAMETERS STATED IN SECTION 4.0.

5.3 GEOGRID PLACEMENT

5.3.1 THE CONTRACTOR IS RESPONSIBLE TO SURVEY AND LAYOUT THE SIERRA SLOPE FACING AS SHOWN ON THE OWNER'S CONTRACT DRAWINGS.

5.3.2 GEOGRIDS SHALL BE INSTALLED AT THE LENGTHS, ELEVATIONS, AND LOCATIONS SHOWN ON THE DRAWINGS HEREIN. CHANGES TO GEOGRID LAYOUT ARE NOT PERMISSIBLE WITHOUT THE EXPRESS WRITTEN CONSENT OF TIC.

5.3.3 UNIAXIAL (UX) GEOGRID SHALL BE ROLLED OUT PERPENDICULAR TO THE SLOPE FACE. THE TRANSVERSE BAR OF THE UX GEOGRID (ACROSS THE ROLL WIDTH) SHALL BE POSITIONED AT THE SLOPE FACE.

5.3.4 BIAXIAL (BX) GEOGRID SHALL BE ROLLED OUT PARALLEL TO THE SLOPE FACE.

5.3.5 GEOGRID REINFORCEMENTS SHALL BE CONTINUOUS THROUGHOUT THEIR EMBEDMENT LENGTH. GEOGRID-TO-GEOGRID CONNECTION IS NOT ALLOWED.

5.3.6 TRACKED CONSTRUCTION EQUIPMENT SHALL NOT BE OPERATED DIRECTLY ON THE GEOGRID REINFORCEMENT. A MINIMUM BACKFILL THICKNESS OF 6 INCHES IS REQUIRED FOR OPERATION OF TRACKED VEHICLES OVER THE GEOGRID REINFORCEMENT. TURNING OF TRACKED VEHICLES SHOULD BE KEPT TO A MINIMUM TO PREVENT TRACKS FROM DISPLACING THE FILL AND/OR GEOGRID REINFORCEMENT. RUBBER-TIRED VEHICLES MAY PASS OVER THE GEOGRID REINFORCEMENT AT SPEEDS LESS THAN 10 MPH. SUDDEN BRAKING AND SHARP TURNING SHALL BE AVOIDED.

5.3.7 A MINIMUM OF 3 INCHES OF REINFORCED BACKFILL SHALL BE PLACED BETWEEN OVERLAPPING LAYERS OF GEOGRID REINFORCEMENT.

5.4 BACKFILL PLACEMENT

5.4.1 THE GEOGRID SHALL BE TENSIONED BY HAND TO ELIMINATE SLACK AND ANCHORED BY PINNING OR PLACING SOIL ON THE GEOGRID AT THE BACK OF THE REINFORCED ZONE. ONLY LIGHTWEIGHT EQUIPMENT SHALL BE ALLOWED WITHIN 3 FEET OF THE BACK FACE OF THE MSE STRUCTURE.

5.4.2 BACKFILL SHALL BE PLACED FROM THE BACK OF THE REINFORCED SLOPE FACING TOWARDS THE ENDS OF THE GEOGRID TO PROMOTE PROPER TENSIONING.

5.4.3 BACKFILL SHALL BE PLACED AT A MOISTURE CONTENT NO GREATER THAN TWO PERCENT WET AND NO LESS THAN ONE PERCENT DRY OF OPTIMUM MOISTURE CONTENT AND COMPACTED TO A MINIMUM OF 90% OF MAXIMUM MODIFIED PROCTOR DRY DENSITY AS DETERMINED IN ACCORDANCE WITH AASHTO T-180 OR AS SPECIFIED BY THE PROJECT SPECIFICATIONS.

5.4.4 AT THE END OF EACH WORKDAY, BACKFILL SURFACE SHALL BE GRADED AWAY FROM THE WALL FACE A MINIMUM OF TWO PERCENT SLOPE. THE BACKFILL SURFACE SHALL BE COMPACTED WITH A SMOOTH DRUM ROLLER TO MINIMIZE PONDING OF WATER AND SATURATION OF THE BACKFILL. A TEMPORARY SOIL BERM SHALL BE CONSTRUCTED NEAR THE CREST OF THE MSE STRUCTURE TO PREVENT SURFACE WATER RUNOFF FROM OVERTOPPONG THE MSE STRUCTURE.

6.0 SPECIAL PROVISIONS

6.1 THE DESIGN PRESENTED HEREIN IS ONLY VALID FOR THE SIERRA SLOPE SYSTEM FOR THE LEONA HEIGHTS SURFUR MINE REMEDIATION PROJECT. THE DESIGN IS BASED ON SOIL PARAMETERS, FOUNDATION CONDITIONS, GROUNDWATER CONDITIONS, AND LOADINGS STATED IN SECTION 4.0. TIC ASSUMES NO LIABILITY FOR INTERPRETATION OR VERIFICATION OF SUBSURFACE CONDITIONS, FOR SUITABILITY OF SOIL DESIGN PARAMETERS OR FOR INTERPRETATION OF SUBSURFACE GROUNDWATER CONDITIONS. THE ENGINEER IS RESPONSIBLE TO VERIFY THAT ACTUAL SITE CONDITIONS, PARAMETERS, AND STRUCTURE GEOMETRIES ARE AS DESCRIBED HEREIN PRIOR TO AND DURING CONSTRUCTION. PROCEEDING WITH CONSTRUCTION WITHOUT FIRST VERIFYING CONDITIONS AND PARAMETERS DISCUSSED ABOVE SHALL ABSOLVE TIC FROM ALL LIABILITY FOR THE DESIGN AND CONSTRUCTION OF THIS STRUCTURE AND THE CONTRACTOR SHALL INDEMNIFY AND HOLD HARMLESS TIC FROM ALL RESULTING CLAIMS, DAMAGES, LOSSES AND EXPENSES.

6.2 THE ENGINEER IS RESPONSIBLE FOR PROVIDING QUALITY ASSURANCE AND QUALITY CONTROL PROGRAMS THAT ENSURE CONSTRUCTION OF THE REINFORCED SLOPEIS PERFORMED IN ACCORDANCE WITH THE TIC NOTES AND DRAWINGS, AND THE OWNER'S CONTRACT PLANS AND SPECIFICATIONS.

6.3 THE CLIENT SHALL IMMEDIATELY REPORT ANY CHANGES TO TIC (770-344-2090) PRIOR TO PROCEEDING WITH CONSTRUCTION. THE CLIENT SHALL IMMEDIATELY REPORT TO TIC THE DISCOVERY OF ANY ROCK FORMATIONS AND/OR GROUNDWATER DURING CONSTRUCTION.

6.4 TIC IS NOT RESPONSIBLE FOR HAVING PERSONNEL ON-SITE UNLESS SPECIFICALLY PROVIDED FOR IN A WRITTEN CONTRACT SIGNED BY TIC. ANY TIC REPRESENTATIVE ON SITE DOES NOT HAVE THE AUTHORITY TO STOP OR START CONSTRUCTION OF THE REINFORCED SLOPE OR ANY OTHER WORK.

7.0 REFERENCE DOCUMENTS

7.1 THE DESIGN CALCULATIONS AND CONSTRUCTION DRAWINGS PREPARED BY TIC ARE BASED UPON THE DOCUMENTS REFERENCED IN THE TIC DESIGN REPORT DATED OCTOBER 8, 2013.

REGISTERED PROFESSIONAL ENGINEER
JONG H. LEE
No. 71009
CIVIL
STATE OF CALIFORNIA

JONG H. LEE
P.E. NO. 71009

S1310302.DWG

THIS DESIGN IS BASED UPON SPECIFIC PROPERTIES OF THOSE SPECIFIC TENSAR PRODUCTS INCORPORATED THEREIN WHICH ARE PROPRIETARY TO TENSAR. ANY SUBSTITUTION OF THE SPECIFIED PRODUCTS WILL INVALIDATE THIS DESIGN. THIS DRAWING IS BEING FURNISHED FOR USE ON THIS SPECIFIC PROJECT ONLY, ANY PARTY ACCEPTING THIS DOCUMENT DOES SO IN CONFIDENCE AND AGREES THAT IT SHALL NOT BE DUPLICATED WHOLE OR IN PART, NOR DISCLOSED TO OTHERS, WITHOUT THE CONSENT OF TENSAR INTERNATIONAL CORPORATION.

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SIERRA SLOPE RETENTION SYSTEM

REVISIONS

NO.	DATE	DESCRIPTION	BY	NO.	DATE	DESCRIPTION	BY
0	10/8/13	ISSUED FOR REVIEW	JHL				

CLIENT
E2C REMEDIATION
1020 WINDING CREEK ROAD, SUITE 110
ROSEVILLE, CA 95678
(916) 782-8700

ENGINEER OF RECORD:
Tensar.
Tensar International Corporation
2500 Northwinds Parkway | Suite 500
Alpharetta, Georgia 30009 | 770-344-2090
C.O.A. # P-0955
JONG H. LEE P.E. NO. 71009

PROJECT NAME
LEONA HEIGHTS SULFUR MINE REMEDIATION

PROJECT LOCATION
OAKLAND, CALIFORNIA

STATE OR FEDERAL AID PROJECT No.

SHEET TITLE
CONSTRUCTION REQUIREMENTS

	NAME	DATE
DRAWN BY	RR	10/8/13
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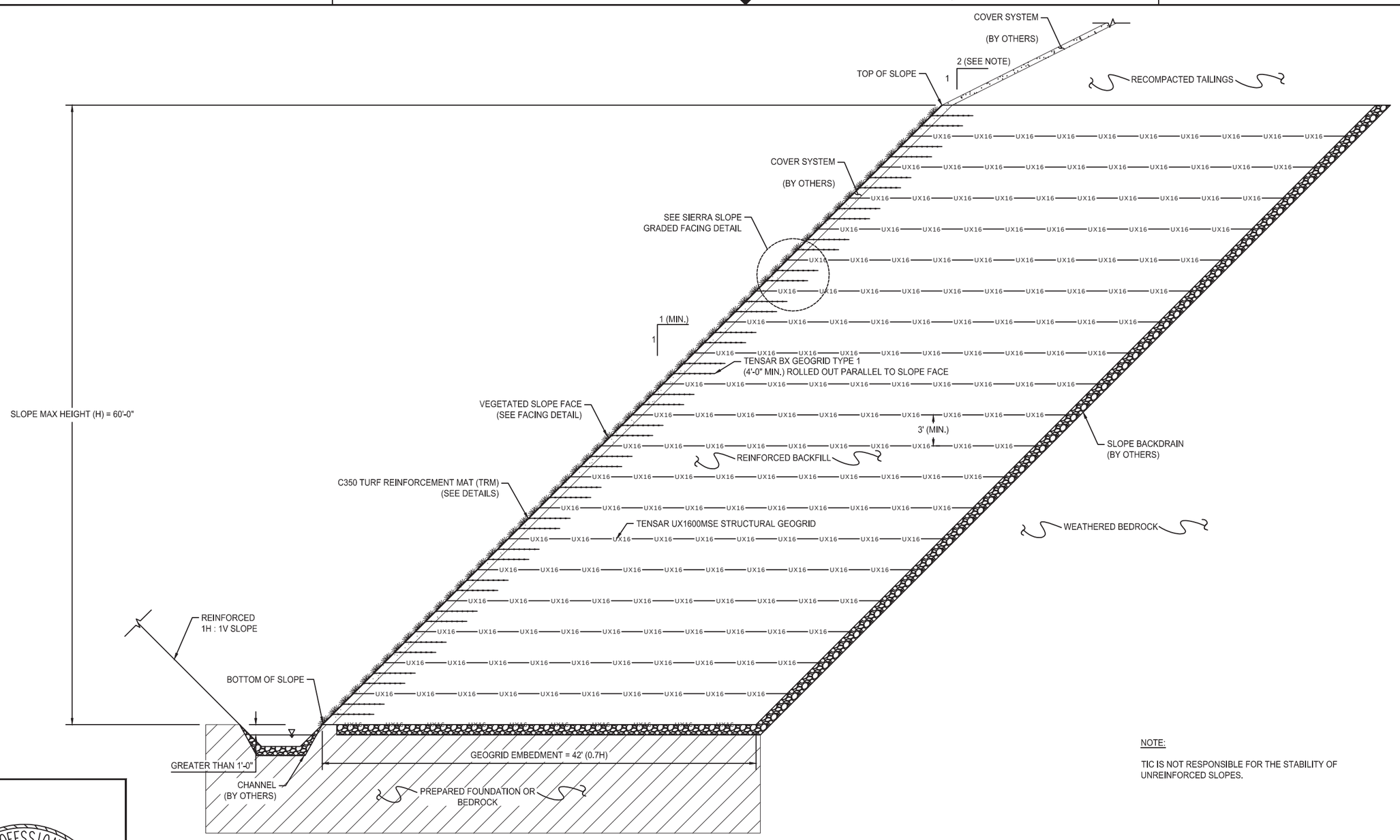
SHEET 2 OF 5



NOTE:

TIC IS NOT RESPONSIBLE FOR THE STABILITY OF UNREINFORCED SLOPES.

TYPICAL CROSS-SECTION REINFORCED SOIL SLOPE

SCALE FEET
5 2.5 0 5 10

S1310303.DWG

REGISTERED PROFESSIONAL ENGINEER
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PROJECT NAME
LEONA HEIGHTS SULFUR MINE REMEDIATION

PROJECT LOCATION
OAKLAND, CALIFORNIA

STATE OR FEDERAL AID PROJECT No.

SHEET TITLE
TYPICAL CROSS-SECTION

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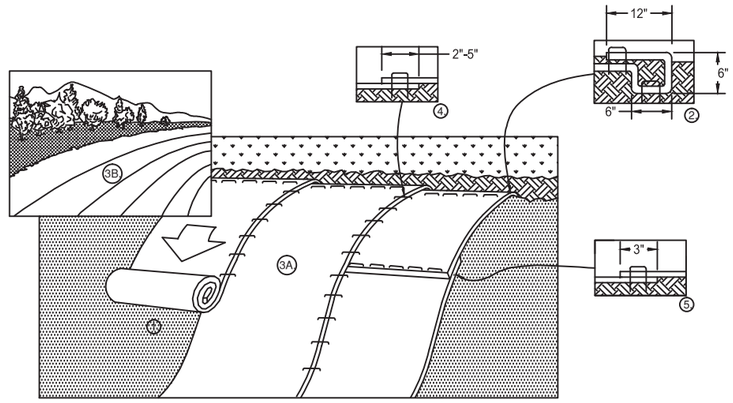
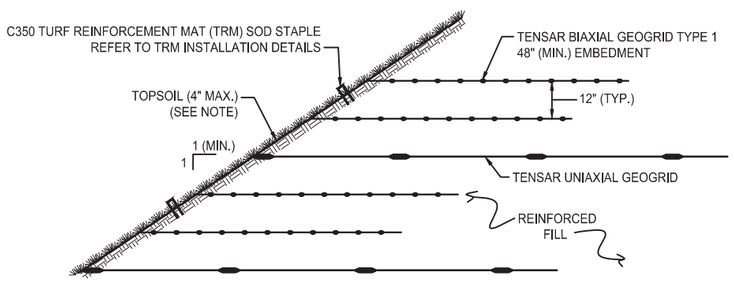


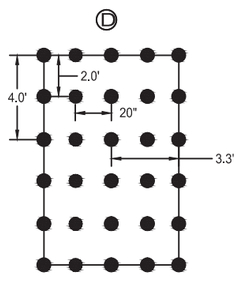


NOTE:

TOPSOIL SHALL BE LOAMY SAND OR FINER GRADATION WITH 10% - 15% ORGANIC CONTENT OR MATERIAL APPROVED BY A QUALIFIED LANDSCAPE ARCHITECT. VEGETATION TYPE SHALL BE SPECIFIED BY A QUALIFIED LANDSCAPE ARCHITECT.

GRADED SIERRA SLOPE DETAIL

NOT TO SCALE



3.4 STAPLES PER SQ. YD.

1. PREPARE SOIL BEFORE INSTALLING ROLLED EROSION CONTROL PRODUCTS (RECP'S), INCLUDING ANY NECESSARY APPLICATION OF LIME, FERTILIZER, AND SEED. NOTE: WHEN USING CELL-O-SEED DO NOT SEED PREPARED AREA. CELL-O-SEED MUST BE INSTALLED WITH PAPER SIDE DOWN.
2. BEGIN AT THE TOP OF THE SLOPE BY ANCHORING THE RECP'S IN A 6" (15 CM) DEEP X 6" (15 CM) WIDE TRENCH WITH APPROXIMATELY 12" (30CM) OF RECP'S EXTENDED BEYOND THE UP-SLOPE PORTION OF THE TRENCH. ANCHOR THE RECP'S WITH A ROW OF STAPLES/STAKES APPROXIMATELY 12" (30 CM) APART IN THE BOTTOM OF THE TRENCH. BACKFILL AND COMPACT THE TRENCH AFTER STAPLING. APPLY SEED TO COMPACTED SOIL AND FOLD REMAINING 12" (30 CM) PORTION OF RECP'S BACK OVER SEED AND COMPACTED SOIL. SECURE RECP'S OVER COMPACTED SOIL WITH A ROW OF STAPLES/STAKES SPACED APPROXIMATELY 12" (30 CM) APART ACROSS THE WIDTH OF THE RECP'S.
3. ROLL THE RECP'S (A.) DOWN OR (B.) HORIZONTALLY ACROSS THE SLOPE. RECP'S WILL UNROLL WITH APPROPRIATE SIDE AGAINST THE SOIL SURFACE. ALL RECP'S MUST BE SECURELY FASTENED TO SOIL SURFACE BY PLACING STAPLES/STAKES IN APPROPRIATE LOCATIONS AS SHOWN IN THE STAPLE PATTERN GUIDE. WHEN USING THE DOT SYSTE™, STAPLES/STAKES SHOULD BE PLACED THROUGH EACH OF THE COLORED DOTS CORRESPONDING TO THE APPROPRIATE STAPLE PATTERN.
4. THE EDGES OF PARALLEL RECP'S MUST BE STAPLED WITH APPROXIMATELY 2" - 5" (5 CM - 12.5 CM) OVERLAP DEPENDING ON RECP'S TYPE.
5. CONSECUTIVE RECP'S SPLICED DOWN THE SLOPE MUST BE PLACED END OVER END (SHINGLE STYLE) WITH AN APPROXIMATE 3" (7.5 CM) OVERLAP. STAPLE THROUGH OVERLAPPED AREA, APPROXIMATELY 12" (30 CM) APART ACROSS ENTIRE RECP'S WIDTH.

NOTE:*IN LOOSE SOIL CONDITIONS, THE USE OF STAPLE OR STAKE LENGTHS GREATER THAN 6" (15 CM) MAY BE NECESSARY TO PROPERLY SECURE THE RECP'S.

1:1 TURF REINFORCEMENT INSTALLATION

NOT TO SCALE

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JONG H. LEE P.E. NO. 71009

PROJECT NAME
LEONA HEIGHTS SULFUR MINE REMEDIATION

PROJECT LOCATION
OAKLAND, CALIFORNIA
STATE OR FEDERAL AID PROJECT No.

SHEET TITLE
TYPICAL DETAILS

	NAME	DATE
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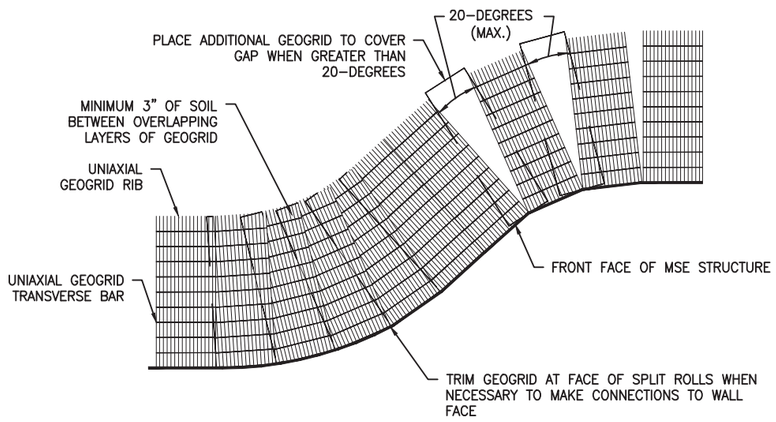
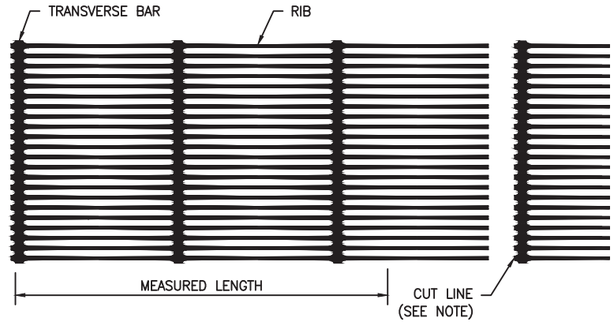


GEOGRID PLACEMENT ON CURVES DETAIL-PLAN VIEW

NOT TO SCALE



NOTE:

CUT TENSAR GEOGRID AT NEAREST TRANSVERSE BAR BEYOND THE MEASURED LENGTH.

GEOGRID MEASURED LENGTH CUTTING DETAIL

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CIVIL
STATE OF CALIFORNIA

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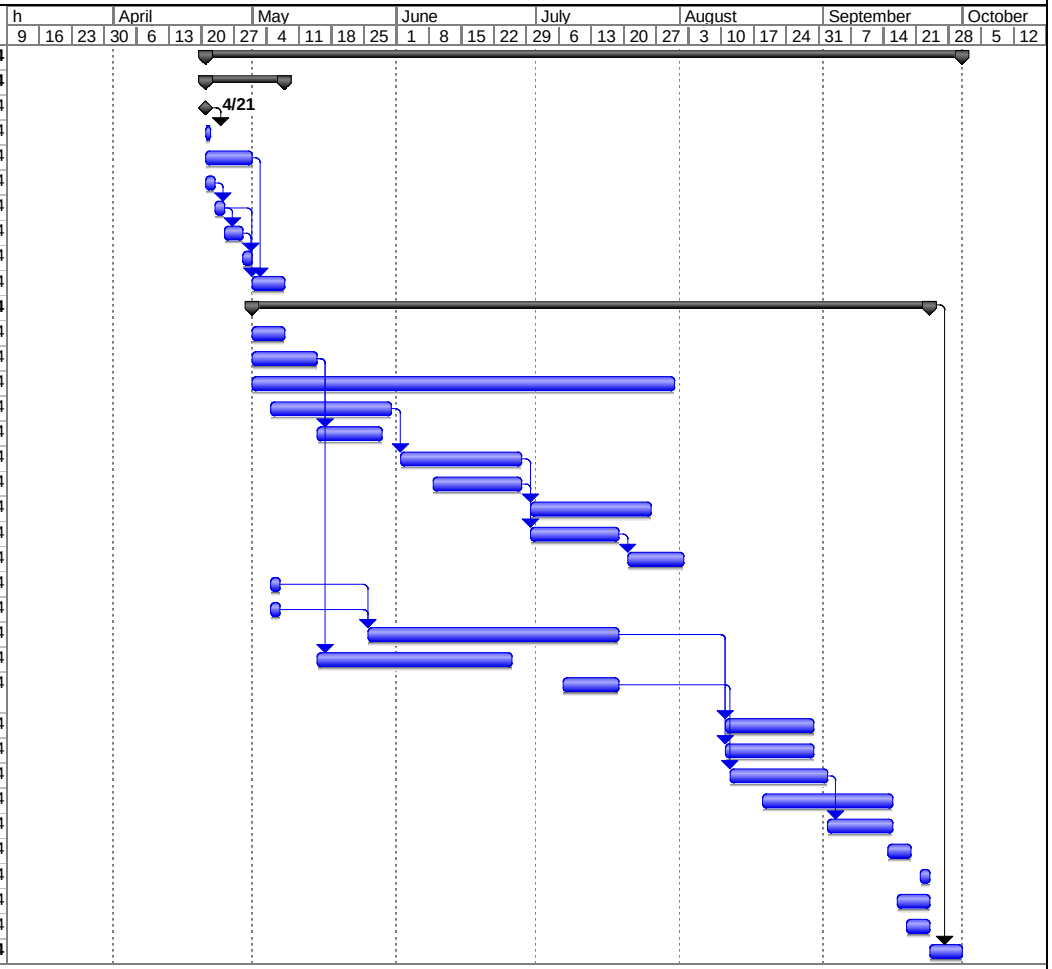
Appendix B
Proposed Construction Schedule

Leona Heights Sulfur Mines Remediation Proposed Construction Sechedule

ID	Task Name	Duration	Start	Finish
1	**Total Estimated Duration**	**117 days**	**Mon 4/21/14**	**Tue 9/30/14**
2	**1.0 Mobilization**	**13 days**	**Mon 4/21/14**	**Wed 5/7/14**
3	Workplan Approval	0 days	Mon 4/21/14	Mon 4/21/14
4	Kickoff Meeting	1 day	Mon 4/21/14	Mon 4/21/14
5	Permitting and USA Notification	8 days	Mon 4/21/14	Wed 4/30/14
6	Signage, Fencing, and Traffic Control	2 days	Mon 4/21/14	Tue 4/22/14
7	Haul Road and Staging Area Preparation	2 days	Wed 4/23/14	Thu 4/24/14
8	Noise Reduction Barrier Installation	2 days	Fri 4/25/14	Mon 4/28/14
9	Pre-Construction BMP Implementation	2 days	Tue 4/29/14	Wed 4/30/14
10	Tree Protection and Removal	5 days	Thu 5/1/14	Wed 5/7/14
11	**2.0 Construction**	**104 days**	**Thu 5/1/14**	**Tue 9/23/14**
12	Clearing and Grubbing	5 days	Thu 5/1/14	Wed 5/7/14
13	Creek Excavation	10 days	Thu 5/1/14	Wed 5/14/14
14	Excavation for RSS	65 days	Thu 5/1/14	Wed 7/30/14
15	Geotechnical Testing on in-situ soil	20 days	Mon 5/5/14	Fri 5/30/14
16	Creek Bed and Bank Stabilization for RSS	10 days	Thu 5/15/14	Wed 5/28/14
17	RSS Foundation Construction	20 days	Mon 6/2/14	Fri 6/27/14
18	Subsurface Drainage Installation	15 days	Mon 6/9/14	Fri 6/27/14
19	RSS Geogrid Installation	20 days	Mon 6/30/14	Fri 7/25/14
20	RSS Compaction	15 days	Mon 6/30/14	Fri 7/18/14
21	RSS Surface Layers Installation	10 days	Mon 7/21/14	Fri 8/1/14
22	Adit Closure	2 days	Mon 5/5/14	Tue 5/6/14
23	Seep Remediation	2 days	Mon 5/5/14	Tue 5/6/14
24	Mine Tailings Grading	40 days	Mon 5/26/14	Fri 7/18/14
25	Creek Bed and Bank Stabilization	30 days	Thu 5/15/14	Wed 6/25/14
26	Chemical and Geophysical Testing on Imported Soils	10 days	Mon 7/7/14	Fri 7/18/14
27	Geomembrane Cover Installation	15 days	Mon 8/11/14	Fri 8/29/14
28	Geotextile Installation	15 days	Mon 8/11/14	Fri 8/29/14
29	Vegetative Soil Installation	15 days	Tue 8/12/14	Mon 9/1/14
30	Surface Drainage Ditch Construction	20 days	Tue 8/19/14	Mon 9/15/14
31	Revegetation	10 days	Tue 9/2/14	Mon 9/15/14
32	McDonell Ave. End Repaving	5 days	Mon 9/15/14	Fri 9/19/14
33	Staging Area Restoration	2 days	Mon 9/22/14	Tue 9/23/14
34	Winterization	5 days	Wed 9/17/14	Tue 9/23/14
35	Waste Handling and Disposal	3 days	Fri 9/19/14	Tue 9/23/14
36	**3.0 Demobilization**	**5 days**	**Wed 9/24/14**	**Tue 9/30/14**



Project: Leona_Heights_Construction-
Date: Thu 1/30/14

Task
Progress
Milestone
Summary
Rolled Up Task
Rolled Up Milestone
Rolled Up Progress
Split
External Tasks
Project Summary
Group By Summary
Deadline

November 5, 2013
CIWQS Place ID: 645714 (LW)

Dr. Collin Mbanugo
(sent via e-mail to DrMbanugo@yahoo.com)

Alcoa Inc.
Attn: Richard Dworek and Ron Morosky
(sent via e-mail to Richard.Dworek@alcoa.com and Ronald.Morosky@alcoa.com)

Ocean industries Inc.
Attn: Chris Chase and Mark S. Humphreys
(sent via e-mail to CChase@wattcompanies.com and Mhumphreys@wattcompanies.com)

SUBJECT: Concurrence on the Remedial Design Plan, Creek Restoration Design Report, and Addendum to Stream Restoration Design for the Leona Heights Sulfur Mine, Oakland, Alameda County

Dear Messrs:

This letter provides Water Board staff (Staff) concurrence for the *Remedial Design Plan, Creek Restoration Design Report,* and *Addendum to Stream Restoration Design* submitted in response to Remedial Measures 1.I. a and b of Cleanup and Abatement Order Amendment No. R2-2013-0021. The Order required the submittal of reports detailing proposed designs for the remediation of the Leona Heights Sulfur Mine and restoration of Leona Creek, which runs through the site.

The submittal details plans to:

- Remove mining waste from the creek channel and from isolated deposits outside of the current footprint of the mining waste piles;
- Grade and compact slopes of mining waste and install a subsurface drainage system beneath the waste to increase stability;
- Cover the consolidated mining waste beneath a low-permeability cap, including a vegetative layer, to create a single mining waste unit that will isolate the mining waste from water;
- Reroute the groundwater discharge point from its current location inside the mine tailings to discharge to the creek without coming into contact with mining waste;
- Reinforce steep slopes adjacent to the creek channel to improve stability; and
- Restore the creek channel to accommodate a 100-year, 24-hour design storm, incorporating drop structures reminiscent of natural creek designs on steep slopes that provide for the gradual movement of sediment through the creek, minimizing erosion onsite and downstream.

Staff concurs with these designs. Below are specific comments and recommendations for their implementation.

1. The plan proposes to use a vacant parking lot on Merritt College property as a staging area for construction, and a fire road that leads from the college at Campus Drive to the cul-de-sac at the end of McDonell Avenue as the access route to the project area. Please keep Staff informed regarding your efforts to obtain access agreements from Merritt College, and other parties as needed.

2. The Geologic Site Reconnaissance Report referenced in the submittal report indicates that a thin veneer of mining waste is present on properties located at 5251 Leona Street and 5171 McDonell Avenue, which are immediately adjacent to the site. It is likely that this mining waste discharged offsite to these locations. It is our understanding that these materials will be removed from these properties and placed within the mining waste unit. Please keep Staff informed of progress on this issue.

3. The plan proposes concrete lined v-ditches to direct run-on around the upper perimeter of the capped mining waste unit, in order to minimize the erosional impact of storm water to the slopes (page 27). It is Staff's professional experience that concrete used in storm conveyance structures deteriorates, requiring significant maintenance. An alternative material might be considered to minimize post construction maintenance. For instance, a rock lined or geocomposite conveyance system might be preferable, so long as infiltration can be minimized.

4. Please ensure the materials used in the mining waste subdrain system and the piping for the groundwater conveyance system are constructed of materials that will tolerate acidic liquids (groundwater has been measured at a pH of 5).

5. Staff concur with the recommendation on page 30 that a qualified Engineering Geologist/Geotechnical Engineer be present on-site during construction to evaluate or test the native slope stability of the bedrock. Similarly, Staff concurs with recommendations on page 4-4 that short term stability of slopes be evaluated to determine if interim stabilization measures are necessary during construction. Finally, Staff concur with recommendations in the report, including on page 4-5, for additional stabilization measures should tailings be deeper than the current estimate.

6. Staff is concerned that the capped mining waste unit will be seeded by broom bushes, eucalyptus, native Oaks, or other plants that are abundant in the area surrounding the site. These plants must be prevented from taking root on the cap of the mining waste unit because they have deep roots that will likely penetrate the clay layer. Preventing the growth of these plants will require intensive post-construction maintenance, potentially into perpetuity, or an adjustment to the capping and planting design to account for deeper rooted vegetation. For instance, increasing the depth of the vegetative layer to account for deeper roots and planting species, like coyote brush, that can outcompete these undesirable plants.

7. The plan requires the removal of a significant number of trees, including mature Oaks, to obtain stable slope grades of the mining waste unit. The City of Oakland must issue a tree removal permit for this work and may request adjustments to the design or construction plans to avoid or minimize impacts to trees, especially Oaks, which are a protected species. While Staff support and concur with the proposed design, adjustments that will not compromise the stability of the remedy, but minimize the removal of trees or other impacts to the surrounding habitat, may need to be considered to satisfy the City of Oakland's requirements. We are available to discuss and review any necessary changes to meet these objectives.

Should you have any questions, please contact Lindsay Whalin at (510) 622-2363 or at lwhalin@waterboards.ca.gov.

Sincerely,

Dyan C. Whyte
Assistant Executive Officer

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E2C Remediation - Phil Goalwin
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APPENDIX H

EROSION CONTROL PLAN
LEONA HEIGHTS SULFUR MINE
OAKLAND, CALIFORNIA

E2C Remediation
Environmental Engineering,
Consulting and Remediation, Inc.

LEONA HEIGHTS SULFUR MINES REMEDIATION
CREEK RESTORATION

EROSION CONTROL PLAN

(Revised January 2014)

End of McDonell Avenue
Oakland, California

January 31, 2014

Project Number 2028BK48

PREPARED BY:

E2C Remediation
Environmental Engineering Consulting & Remediation, Inc.
1020 Winding Creek Rd., Suite 110
Roseville, California 95678

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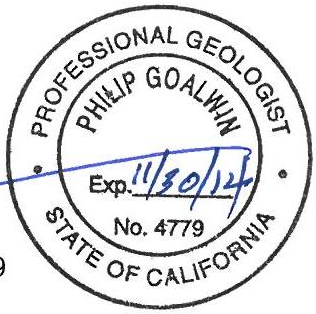
CERTIFICATION

Hydrogeologic, geologic and engineering information and findings presented in this document have been prepared under the supervision of and reviewed by California registered Professionals.

Aiguo Xu, Ph.D.
Principal Engineer
C.E. # 72685



Philip Goalwin, P.G. #4779
Principal Geologist

1. INTRODUCTION

E2C Remediation c. (E2C) has prepared this revised Erosion Control Plan (ECP) for the closure of the Leona Heights Sulfur Mine site (Site) in Oakland, California on behalf of Alcoa Properties, Inc. (Alcoa) and Ocean Industries, Inc. (Ocean). The first version of this ECP was prepared by Geosyntec Consultants, Inc. in November 2013. The closure of the former mine and restoration of the portion of Leona Creek flowing through the Site (the Project) is being performed to satisfy requirements of the Amended Cleanup and Abatement Order (CAO) Number R2-2013-0021, issued on 9 May 2013 by the Regional Water Quality Control Board, San Francisco Bay Region (Regional Water Board). The ECP is being prepared as part of the Category IV Creek Protection Permit application to the City of Oakland.

This ECP describes measures to mitigate soil erosion and potential discharges off-site during Project activities through the use of standard Best Management Practices (BMPs). The Project will comply with local, state, and federal regulatory requirements associated with the protection of water quality and soil resources.

1.1 Erosion Control Plan Elements

This ECP details the site management activities to be implemented during site mobilization, grading, slope stabilization, installation of the cover system, and stream restoration activities. Key elements of the ECP include a project-specific description of the BMPs, description of the on-site remediation activities, and a schedule of proposed remediation activities.

This ECP includes the following elements:

- **Site Location Map** – This map shows the general Site location and significant geographic features including residential streets and topography (See Figure 1).

- **Grading and Slope Stabilization** – The ECP describes the various construction activities associated with the Project. Figure 2 shows the main Project area and various Project elements including the construction work limit, staging areas, tailings locations, and access road. Figure 3 shows the primary staging area, materials staging area, and access road that leads to the main Project area.

- **Best Management Practices –** This ECP describes the location, timing, and extent of the BMPs to be used in preparation of and during construction activities. Also included are California Stormwater Quality Association

(CASQA) BMP Fact Sheets, which reference the appropriate installation and operation and maintenance (O&M) procedures. Figure 2 and 3 identify the types and locations of the proposed BMPs to be installed during construction activities. Figure 4 identifies the post-construction BMPs.

- **Project Schedule** – This ECP provides a general outline of the construction schedule.

1.2 Project Overview

The Leona Heights Sulfur Mine is a two-acre abandoned pyrite mine located in the Oakland Hills about 0.5 miles northeast from the intersection of Highway 13 and Interstate 580 (See Figure 1). The Site is located at the east end of McDonell Avenue, at an approximately latitude of 37.79^{o}N and longitude of 122.17^{o}W. Access to the Site is from the terminus of McDonell Avenue.

The main Project area consists of two mine tailings areas, a creek restoration area, and a primary staging area (See Figure 2). The closure design includes the following four key elements:

- Re-grade and stabilize steep slopes for increased stability;
- Place a cover system over the waste tailings;
- Restore the creek channel; and
- Provide surface water drainage management.

Each key element of the remediation and restoration activities will be discussed in detail below. BMPs will be installed to manage stormwater entering the Project area and prevent sediment mobilization offsite.

1.3 Existing Site Conditions

The Site is bounded by residential communities to the west and the south, and undeveloped areas to the north and east. The closest residence is adjacent to the west side of the lower tailings pile. A fence surrounding the property line limits public access to the Site.

1.4 Existing Stormwater Drainage

The Site is located in a steep ravine where several ephemeral surface water channels drain the approximately 50-acre watershed (E2C, 2013b). The upper mine tailings deposit is cut by an ephemeral stream channel that flows through the upper tailings pile and meanders along the margin of the lower tailings pile. Water from Leona Creek flows through a culvert under Leona Street and along a natural channel for several hundred feet, before entering a storm sewer near Mountain Boulevard and Griffin Street. The storm sewer discharges to Lake Aliso, which feeds into Seminary Creek and ultimately to San Leandro Bay (Levine Fricke 1990).

1.5 Geology and Groundwater

The soils at the Site are primarily silty, sandy, and gravely clays, with gravelly sand, clayey gravel, and sandy gravel encountered in unconsolidated sediments (Levine Fricke 1992). The unconsolidated sediments are underlain by fractured rhyolite and greenstone encountered between 7 and 32 feet below ground surface. Groundwater measured in 1992 was first encountered in three wells at depths between 25and 64.5 feet below ground surface (Levine Fricke, 1992). In addition, a groundwater seep associated with a former mine adit was identified near the toe of the upper tailings pile.

2. CONSTRUCTION ACTIVITIES

The total Project footprint covered by this ECP is approximately 2.26 acres. The main Project area is 1.26 acres, the material staging area is approximately 1.0 acres of parking lot with angular aggregate surface, and the access road is an existing paved road. The Project is expected to be completed in one phase that includes the following construction activities: (1) Site mobilization; (2) establishment of staging areas and preparing access road; (3) clearing and grubbing; (4) re-grading and stabilizing channel slopes; (5) re-grading, consolidating, compacting, and covering the waste tailings piles; (6) restoring the creek channel including incorporating drop structures (steps, step pools and cascade features) within the channel and placing rip rap along the channel bottom and banks; (7) installing permanent surface water drainage management; and (8) installing post-construction stormwater management measures. Assuming agency approvals, the anticipated start date of ground-disturbing activities is 1 May 2014, pending permit approvals, with an expected completion date of 30 September 2014 (E2C, 2014).

2.1 Site Mobilization Activities

Prior to any ground disturbing activities, the boundaries of the Project area will be delineated with stakes and flagging to define the Construction Work Limit (CWL). Primary access to the Site will be along McDonell Avenue that will connect to the material staging area at the Leona Lodge overflow parking area, located approximately 0.6 miles from the site on Mountain Boulevard northwest of the site. The entrance will be monitored and maintained to limit sediment tracking and creation of dust.

Construction activities during Site mobilization will be contained within the CWL and may include the following (See Figures 2 and 3):

1. Survey and flag the CWL, remediation work area, staging areas, and stockpile areas.
2. Survey and flag any underground utilities through both a private utility survey for the remediation work area and contact USA to inspect the entire Site.
3. Install a stabilized construction entrance/exit at the entrance of the primary staging area at the end of McDonnell Avenue.
4. Install a combination of perimeter controls (i.e. silt fences, fiber rolls, gravel bag berms, etc.) where appropriate, to be field-verified.
5. Install gravel bags, or equivalent, for drainage inlet protection, at the base of the culvert at Leona Street outside of the Project footprint.
6. Install check dams (i.e. sand bags barriers, gravel bag berms, etc.) both upstream and downstream of the tailing piles.

The following BMPs that may be used for Site mobilization (See Appendix A for CASQA BMP Fact Sheets):

1. Scheduling (EC-1)
2. Preservation of Existing Vegetation (EC-2)
3. Silt Fence (SE-1)
4. Fiber Rolls (SE-5)
5. Gravel Bag Berms (SE-6)
6. Street Sweeping and Vacuuming (SE-7)
7. Sand Bag Barrier (SE-9)
8. Stabilized Construction Entrance/Exit (TC-1)
9. Storm Drain Inlet Protection (SE-10)
10. Wind Erosion Control (WE-1)
11. Water Conservation Practices (NS-1)

See ECP Section 4 below, for a further description of the BMPs implemented in the Project area.

2.2 Establish Staging and Stockpile Areas and Prepare Access Road

Once the Project area is delineated and the construction entrances/exits are stabilized, the staging and stockpile areas will be established and the access road will be prepared for use.

The primary staging area will be located at the end of McDonell Avenue, which includes a portion of the cul-de-sac right of way and the adjacent relatively flat area of the project site and is approximately 0.13 acres. Security fencing and an access gate will be installed in the primary staging area to form a secured enclosure. In the enclosure, the primary mobile office/trailer, truck and heavy equipment staging area, temporary construction material stockpile and storage area, and decontamination facilities for personnel and outbound vehicles will be located.

The primary staging area will also contain stockpiles of construction materials, including import soils, boulders, and geosynthetics. Delivered materials will be initially placed in materials staging area at the overflow parking lot of Leona Lodge and will be transferred to the primary staging area for immediate placement and utilization. Material processing may occur at the materials staging area, or hauled up to the Site for processing and placement depending on the contractor's sequencing plan. Figure 3 shows the primary staging area and the materials staging locations. In addition a private lot (Parcel #37-2605-16-2) on the north side of McDonell Avenue, with an area of approximately 3,500 square feet, can be used for staging of personnel. Within the Site, the stockpile areas will be dynamic in nature and located within the upper tailings and lower tailings area (See Figure 2).

All surfaces will be sprayed with water as needed to reduce generation of dust. Excessive application of water will be avoided so as to not contribute to runoff. Fiber rolls may be used at the edges of the staging areas, as necessary to minimize sediment dispersion.

All construction equipment will be maintained to control leaks and spills and fueling will only be conducted within contained areas. Any contaminated soils resulting from spills will be excavated promptly, and segregated for off-site disposal.

McDonell Avenue to the Site will be prepared for Site access before it is used for hauling equipment and materials. McDonell Avenue is a paved, local road which terminates at the base of the upper tailings pile in a cul-de-sac where access to the project site is direct. The road is in good condition, and is wide enough to allow trucks of sufficient size to access the primary staging area. Limited preparation including trimming low-hanging tree limbs may be necessary. The existing fence at the southern edge of the cul-de-sac will be

relocated and replaced with a temporary gated fence. The roadway permits one-way access but contains turnout areas that could be utilized in an emergency. To maintain one-way traffic, the construction manager will utilize traffic controls such as traffic monitors, GPS units and radio communications. Limited installation of BMPs may be necessary for drainage inlets along the road. Specific BMPs will be field-determined by the Contractor's SWPPP. This may involve the use of BMPs such as silt fence and fiber roles to prevent sediment entering storm drain system and prevent sediment mobilization.

Construction activities will be contained within the CWL and will include the following:

1. Install temporary security fencing and an access gate at the primary staging area and the materials staging area to form secure enclosures.
2. Prepare the primary staging area at the east end of McDonell Avenue. Install fiber rolls on the down-gradient side of the staging area to contain any spills. In the event of a forecasted rain event, establish secondary containment at the following areas:
    a. Material storage area;
    b. Vehicle maintenance and fueling area;
    c. Water storage area for dust control, unless water trucks are used; and
    d. Sanitary/septic and solid waste management areas, if present.
    e. Cover inactive stockpiles with plastic tarp and install gravel bag berms around its perimeter.
3. Prepare the materials staging area, which will be located at the overflow parking lot of Leona Lodge at Mountain Boulevard. Install fiber rolls on the down-gradient side of the staging area to contain any spills. In the event of a forecasted rain event, establish secondary containment at the following areas:
    a. Material storage area; and
    b. Sanitary/septic and solid waste management areas, if present; and
4. Install perimeter controls of the stockpile areas, in the event of a forecasted rain event. Cover inactive stockpiles with plastic tarp and install gravel bag berms or equivalent, around its perimeter.

BMPs that may be used for establishing the staging and stockpile areas and preparing the access road include:

1. Fiber Rolls (SE-5)
2. Gravel Bag Berms (SE-6)

3. Vehicle and Equipment Fueling (NS-9)
4. Vehicle and Equipment Maintenance (NS-10)
5. Water Storage for Dust Control (WE-1)
6. Material Delivery and Storage (WM-1)
7. Material Use (WM-2)
8. Stockpile Management (WM-3)
9. Spill Prevention and Control (WM-4)
10. Solid Waste Management (WM-5)
11. Contaminated Soil Management (WM-7)
12. Sanitary/Septic Waste Management (WM-9)
13. Water Conservation Practices (NS-1)

The stockpile areas are dynamic in nature and may change during the duration of the Project. See ECP Section 4 below, for a further description of the BMPs for the Project area.

2.3 Clearing and Grubbing

Tree trimming and/or tree removal will be performed to facilitate Site access and to allow grading, placement of fill, compaction, installation of soil reinforcement, installation of run-on prevention ditches and installation of the geomembrane cap system. Some tree pruning will be required to allow vehicles to travel along the access road as they carry construction material to the primary staging area and the remediation work area. Vegetation will be cleared as necessary to perform the work and as directed by the site construction manager. Grubbed material will be placed in a designated waste material pile prior to chipping and disposal.

Figures 2 and 3 show the CWL, which encompasses the upper and lower tailings areas and the Leona Creek alignment, with the McDonell Avenue cul-de-sac to the west and Leona Street to the southwest. Vegetation will be cleared within the CWL. Existing vegetation beyond the boundaries of the CWL will be preserved.

BMPs that may be used during clearing and grubbing include:

1. Preservation of Existing Vegetation (EC-2)

2.4 Re-grading and Stabilizing of Slopes

The steep slopes at the Site (ranging from about 1H:1V to near vertical) will be graded to flatter 2H:1V slopes where possible to increase the overall mass stability of the

tailing piles (Geosyntec, 2013). Figure 2 presents the proposed final grading plan. In some areas, steeper 1H:1V slopes will be constructed adjacent to the creek channel due to space constraints imposed by the low channel elevation relative to the surrounding topography. A majority of those 1H:1V slopes occur in the upper tailings pile.

The 1H:1V slopes will be stabilized by excavating existing materials and rebuilding the slopes using geogrid reinforcement. Key components include layers of closely spaced geogrid reinforcement extending horizontally into the slope, a drainage system behind the reinforced zone to prevent buildup of water pressure, and incorporation of the cover system at the slope face, including both a layered geomembrane and vegetative soils.

Installation of temporary sheet piling or equivalent to support the remediation operations may take place.

The following BMPs may be used during slope grading and stabilization activities:

1. Non-Vegetated Stabilization (EC-16)
2. Stockpile Management (WM-3)
3. Contaminated Soil Management (WM-7)

See ECP Section 4 below, for a further description of the BMPs for the Project area.

2.5 Covering of Waste Tailing Piles

A cover system will be placed over the waste tailings piles. Limited areas of isolated waste tailings on the northwest slope of the Site, possibly at the toe of the lower pile, and wherever encountered within the channel alignment, will be removed and consolidated within the existing piles. The cover system will consist of a combination of the following:

On slopes with gradient less than 2H:1V

- 12-inch thick vegetative soil layer;
- 12 ounces per square yard (oz/sy) nonwoven filter geotextile;
- 60-mil double-sided textured linear low density polyethylene (LLDPE) Agru Super Gripnet® geomembrane (with spikes facing down and studs up); and
- Compacted foundation (compacted tailings).

On the reinforced 1H:1V slopes the cover system is comprised of the following:

- 12-inch thick vegetative soil layer (both below and above face erosion control mat);
- well-graded clean sand fill;
- 12 ounces per square yard (oz/sy) nonwoven filter geotextile;
- 60-mil double-sided textured high-density polyethylene (HDPE) geomembrane; and
- Compacted mine tailings with geogrid reinforcement.

The cover and other disturbed areas onsite will be vegetated to provide erosion protection. A Re-vegetation Plan has been developed by Olberding Environmental, Inc.

The following BMPs may be used during cover of the waste tailing pile activities:

1. Stockpile Management (WM-3)
2. Contaminated Soil Management (WM-7)
3. Solid Waste Management (WM-5)
4. Wind Erosion Control (WE-1)

See ECP Section 4 below, for a further description of the BMPs for the Project area.

2.6 Creek Channel Restoration

The planned restoration activities are going to take place during the dry season. The current channel alignment will not be significantly modified. The restoration work will be maintained in such a fashion so as not to block any flow in the channel during construction. However, temporary diversion of the adit water is planned. Additionally, there is illegal discharge from a private storage tank that will have to cease per the City of Oakland's directive.

The creek channel will be cleaned by removing any mine tailings in the channel. The removed tailings may be stockpiled within the remediation work area or temporarily stockpiled in the primary staging area. The removed tailings will then be added to the stockpiled mine tailings for eventual compaction and cover.

Once all tailings materials have been removed from the existing channel, the portion of the creek channel within the Site boundaries will be restored in accordance with design drawings prepared by E2C (2013b). Steps and drops will be constructed utilizing existing competent bedrock, where encountered, or by placing and embedding cobbles and/or large boulders. The large boulders will be individually stabilized and interlocked with one another. Cobbles, gravels and coarse sands will fill the gaps among the large boulders (key particles) (E2C, 2013a).

The creek channel will be restored to allow continued flow of Leona Creek through the

Site and to provide natural sediment transport along the creek. The channel restoration will include the following:

- Restoration of the channel elevation to approximate existing grade;
- Removal of waste tailings within the channel, if encountered, and backfilled with clean soil to achieve the desired grade elevation;
- Incorporation of drop structures within the channel where possible to provide energy dissipation without the use of stilling basins; and
- Placement of rocks and boulders along the channel bottom and banks to provide stability and scour protection.

The following BMPs may be used during creek channel restoration activities:

1. Stream Bank Stabilization (EC-12)
2. Clear Water Diversion (NS-5)
3. Illicit Connection/Discharge (NS-6)

See ECP Section 4 below, for a further description of the BMPs for the Project area.

2.7 Surface Water Drainage Management

Stormwater conveyance structures will be constructed on the edges of the cover and around the Site perimeter to divert and manage stormwater flows over the capped and vegetated waste tailings towards the restored creek channel.

The overall site drainage management will include a series of surface water conveyance features to (i) divert run-on flows from up-gradient areas away from the cover system and (ii) route flows to the creek channel. Drainage from the northern portion of the Site will be conveyed through a concrete "V" ditch with a side slope of 2H:1, a depth of 1.5 ft, and a minimum longitudinal slope of 3%. For all the other run-on prevention ditches, the concrete "V" ditch is 1.0 ft deep with a minimum longitudinal slope of 2%.

The following BMPs may be used for surface water drainage management:

1. Stockpile Management (WM-3)
2. Solid Waste Management (WM-5)
3. Concrete Waste Management (WM-08)
4. Wind Erosion Control (WE-1)
5. Material and Equipment Use Over Water (NS-14)

See ECP Section 4 below, for a further description of the BMPs implemented in the Project area.

2.8 Post-Construction Stormwater Management

Post-Construction BMPs include permanent measures installed at the end of construction, designed to reduce or eliminate pollutant discharges from the Site after final grading activities are complete. Post-construction activities include the tasks required to finalize the remedial action, restore the Site to stable conditions, and prepare the Site for long-term operation and monitoring of the remedial action and restoration activities following construction. These activities include the Contractor's demobilization of construction equipment, facilities, and Site controls; restoration of vegetation and installation of post-construction BMPs; and operation and management of the Re-vegetation Plan developed by Olberding Environmental, Inc.

2.8.1 Winterization

Following completion of the Project, the Site will be winterized to provide erosion control and stormwater management during the rainy season. The following BMPs will be installed and remain on-site as post-construction BMPs into the wet season, as shown on Figure 4:

- Erosion control fabric will be installed on the 1H:1V slopes, in accordance with BMP Factsheet EC-7, within the limits of the final cover. C350 Turf Reinforcement Mat (TRM), a matting structure incorporated with a coconut fiber matrix, may be used as detailed in the Creek Restoration 90% Design Report (E2C, 2013b), or an equivalent product to be determined by the SWPPP Contractor.

- The fiber rolls will be installed, in accordance with BMP Factsheet SE-5, within the limits of the final cover:

    - Fiber rolls placed approximately every 7 vertical feet to reduce erosion of the finished clean fill (Per Construction General Permit requirements, for slopes from 25-50%, sheet flow length shall not exceed 15 feet; for slopes over 50%, sheet flow length shall not exceed 10 feet); or

- Fiber rolls with underlying soil and erosion control blanket placed approximately every 15 vertical feet over the final graded area, or equivalent.

- The following inlet protection will remain, installed in accordance with BMP Factsheet SE-10, at the base of the culvert at Leona Street outside of the Project footprint.

- Disturbed areas of the Site will be hydro-mulched/hydro-seeded, as detailed in the Re-vegetation Plan (Olberding Environmental Inc., 2013), and as determined by the SWPPP Contractor.

2.8.2 Demobilization

The Contractor will demobilize from the Site in the following sequence of operations:

- Clean the Project limits and potentially impacted areas beyond the Project limits of debris that may have been left behind or deposited during the remedial activities;
- Remove temporary gates, construction entrances and exits, fences, and barricades;
- Remove trail closure signs;
- Remove temporary facilities, including staging areas, etc.; and
- Repair roadways (i.e. McDonnell Avenue cul-de-sac) or objects damaged by remediation activities.

Prior to the Contractor's demobilization activities, the Owner will perform a final walk through of the Site with the Regional Water Board and the Contractor. A punch list of remaining activities will be prepared for the Contractor to implement during the demobilization phase of the Project.

The following BMPs may be used during post-construction stormwater management:

1. Fiber Rolls (SE-5)
2. Hydraulic Mulch (EC-3)
3. Hydro-seed (EC-5)
4. Geotextiles and Mats (EC-7)
5. Storm Drain Inlet Protection (SE-10)

See ECP Section 4 below, for a further description of the BMPs implemented in the Project area.

3. PROJECT SCHEDULE

Assuming agency approval, construction work will begin by May 1 2014 and is anticipated to be completed by 30 September 2014.

4. BEST MANAGEMENT PRACTICES

The Project has been designed to minimize disturbance to the Site and limit the amount of exposed soil. The following sections present standard construction BMPs recommended by the California Stormwater Quality Association's Stormwater Best Management Practice Handbook Portal: Construction (2009).

The Handbook provides comprehensive details on BMP implementation and will be obtained and reviewed by managers for all construction contractors that may have an impact on implementation of the ECP. Appendix A contains the BMP Fact Sheets with detailed descriptions of the BMPs discussed in the following sections. The Fact Sheets also include the operations and maintenance practices for each BMP. Figures 2 and 3 show the locations of all BMPs to be used during construction activities.

The following sections present the recommended construction BMPs for erosion and sediment controls for the Project area. Each section provides information on BMP implementation as it relates to the activity being performed. BMPs that may have an impact on implementation of the ECP will be reviewed by managers and construction contractors. While performing the work, the contractors may implement additional control measures if necessary.

4.1 Erosion and Sediment Control

Erosion and sediment controls reduce or eliminate sediment related pollutants in stormwater discharges from the Site. Applicable BMPs are identified in this Section for erosion control, sediment control, tracking control, and wind erosion control.

4.1.1 Erosion Control

Erosion control, also referred to as soil stabilization, consists of source control measures that are designed to prevent soil particles from detaching and becoming transported in stormwater runoff. Erosion control BMPs protect the soil surface by covering and binding soil particles.

The Project Contractor will implement the following practices to provide effective temporary and final erosion control during construction:

1. Preserve existing vegetation where applicable and feasible.

2. The area of soil disturbing activities will be controlled such that the Contractor is able to implement erosion control BMPs quickly and effectively.
3. Stabilize non-active areas as soon as possible.
4. Control erosion in concentrated flow paths by applying erosion control blankets, check dams, erosion control hydro-seeding or alternate methods.

The following temporary erosion control BMP selection table lists potential and selected BMPs for erosion control at the Site. Fact Sheets for temporary erosion control BMPs are provided in Appendix A.

Table 4.1 Temporary Erosion Control BMPs

CASQA Fact Sheet	BMP Name	During Construction
EC-1	Scheduling	X
EC-2	Preservation of Existing Vegetation	X
EC-3	Hydraulic Mulch	X
EC-4	Hydroseed	X
EC-5	Soil Binders	
EC-6	Straw Mulch	
EC-7	Geotextiles and Mats	X
EC-8	Wood Mulching	
EC-9	Earth Dike and Drainage Swales	
EC-10	Velocity Dissipation Devices	
EC-11	Slope Drains	
EC-12	Stream Bank Stabilization	X
EC-14	Compost Blankets	
EC-15	Soil Preparation-Roughening	
EC-16	Non-Vegetated Stabilization	X

The temporary erosion control BMPs will be implemented in conformance with the following guidelines:

1. Schedule of major earthwork, such as excavation, demolition or other activities that disturb soil will be clearly marked on Figures 2 and 3.
2. The area of soil disturbing operations will be controlled such that the Contractor is able to implement erosion control BMPs quickly and effectively.

3. Existing vegetation will be preserved where no construction activities are intended to occur, or where existing trees, shrubs, or other vegetation creates favorable erosion control.

4.1.2 Sediment Controls

Sediment controls are temporary or permanent structural measures that are intended to complement the selected erosion control measures and reduce sediment discharges from active construction areas. Sediment controls are designed to intercept and settle out soil particles that have been detached and transported by the force of water.

The following table lists potential and selected BMPs to control sediment on-site. Fact Sheets for temporary sediment control BMPs are provided in Appendix A.

Table 4.2 Temporary Sediment Control BMPs

CASQA Fact Sheet	BMP Name	During Construction
SE-1	Silt Fence	X
SE-2	Sediment Basin	
SE-3	Sediment Trap	
SE-4	Check Dams	X
SE-5	Fiber Rolls	X
SE-6	Gravel Bag Berm	X
SE-7	Street Sweeping	X
SE-8	Sandbag Barrier	X
SE-9	Straw Bale Barrier	
SE-10	Storm Drain Inlet Protection	X
SE-11	ATS	
SE-12	Temporary Silt Dike	
SE-13	Compost Sock and Berm	
SE-14	Biofilter Bags	

Temporary sediment control BMPs will be deployed according to the schedule shown in ESCP Section 4.4. These will be implemented prior to the start of construction and maintained throughout the duration of construction activities.

4.1.3 Tracking Control

Table 4.3 below lists potential and selected BMPs to reduce sediment tracking from the Site onto public roads. A tire wash will be installed at the construction entrance/exit, if needed based on field conditions.

Table 4.3 Tracking Control BMPs

CASQA Fact Sheet	BMP Name	During Construction
SE-7	Street Sweeping	X
TC-1	Stabilized Construction Entrance/Exit	X
TC-2	Stabilized Construction Roadway	X
TC-3	Entrance/Outlet Tire Wash, if Needed	X

4.1.4 Wind Control

Table 4.4 below, lists potential and selected BMPs to control dust from the Site.

Table 4.4 Wind Control BMPs

CASQA Fact Sheet	BMP Name	During Construction
WE-1	Wind Erosion Control	X
EC-5	Soil Binders	
NS-1	Water Conservation Practices	X

4.2 Non-Storm Water Controls and Waste and Materials Management

4.2.1 Non-Storm Water Controls

Non-storm water discharges consist of all discharges which do not originate from precipitation events (i.e., all discharges other than stormwater to a conveyance system). Table 4.5 lists potential and selected BMPs to control non-stormwater pollution on the Site. Implementation and locations of all non-stormwater control BMPs are shown on Figure 3.

Table 4.5 Non-Stormwater Control BMPs

CASQA Fact Sheet	BMP Name	During Construction
NS-1	Water Conservation Practices	X
NS-2	Dewatering Operation	
NS-3	Paving and Grinding Operation	X
NS-4	Temporary Stream Crossing	
NS-5	Clear Water Diversion	X
NS-6	Illicit Connection- Illegal Discharge Connection	X
NS-7	Potable Water Irrigation Discharge Detection	
NS-8	Vehicle and Equipment Cleaning	
NS-9	Vehicle and Equipment Fueling	X
NS-10	Vehicle and Equipment Maintenance	X
NS-11	Pile Driving Operation	X
NS-12	Concrete Curing	
NS-13	Concrete Finishing	
NS-14	Material and Equipment Use Over Water	X
NS-15	Demolition Removal Adjacent to Water	
NS-16	Temporary Batch Plants	

Non-stormwater BMPs will be implemented in conformance with the following guidelines:

1. Water Conservation Practices:
    a. Water Conservation BMPs are essential to ensure that water used for dust control (NS-1) is managed to avoid soil erosion and transport of pollutants off-site. These practices can help reduce or eliminate non-stormwater discharges.
2. Vehicle and Equipment Operations:
    a. Several types of vehicles and equipment maybe used in the Project area, including graders, scrapers, excavators, loaders, rollers, trucks and trailers, backhoes and forklifts. NS-9, Vehicle and Equipment Fueling, and NS-10, Vehicle and Equipment Maintenance, will be utilized to prevent

discharges of fuel and other vehicle fluids.

b. Drip pans or absorbent pads will be used in a designated area for all vehicle and equipment maintenance activities that involve grease, oil, solvents, or other vehicle fluids.

c. All vehicle maintenance and mobile fueling operations will be conducted at least 50 feet away from operational inlets and drainage facilities and on a level graded area.

d. Vehicle fueling and maintenance will be conducted within a designated area on-site.

e. Regular maintenance of construction equipment will be performed to prevent unwarranted leaks of petroleum products from the equipment onto the Site. Equipment servicing and storage will be in a designated area on-site away from stormwater conveyance and will be performed in a clean and professional manner. Bulk storage of fuels and oils will be placed within the allocated area on-site and stored in accordance with BMP WM-1 below. If any significant spills of petroleum products occur during the Project, the Owner or his/her designated representative will be notified and appropriate cleanup and disposal will occur.

f. Vehicles and equipment will be washed off (if necessary) within a containment structure.

4.2.2 Materials Management and Waste Management

Materials management control practices consist of implementing procedural and structural BMPs for handling, storing and using construction materials to prevent the release of those materials into stormwater discharges. The amount and type of construction materials to be used at the Site will depend upon the type of construction and the length of the construction period. The materials may be used continuously, such as fuel for vehicles and equipment, or the materials may be used for a discrete period, such as for temporary water diversions.

Waste management consists of implementing procedural and structural BMPs for handling, storing and ensuring proper disposal of wastes to prevent the release of those wastes into stormwater discharges.

Materials and waste management pollution control BMPs will be implemented to minimize stormwater contact with construction materials, wastes and service areas; and to prevent materials and wastes from being discharged off-site. The primary mechanisms for stormwater contact that will be addressed include:

1. Direct contact with precipitation;
2. Contact with stormwater run-on and runoff;
3. Wind dispersion of loose materials;
4. Direct discharge to the storm drain system through spills or dumping; and
5. Extended contact with some materials and wastes, such as asphalt cold mix and treated wood products, which can leach pollutants into stormwater.

Table 4.6 below lists potential and selected BMPs for Materials and Waste Management for the Site wastes associated with these construction activities. Fact Sheets for Materials and Waste Management BMPs are provided in Appendix A.

Table 4.6 Material and Waste Management BMPs

CASQA Fact Sheet	BMP Name	During Construction
WM-01	Material Delivery and Storage	X
WM-02	Material Use	X
WM-03	Stockpile Management	X
WM-04	Spill Preservation and Control	X
WM-05	Solid Waste Management	X
WM-06	Hazardous Waste Management	X
WM-07	Contaminated Soil Management	X
WM-08	Concrete Waste Management	X
WM-09	Sanitary-Septic Waste Management	X
WM-10	Liquid Waste Management	X

Material management BMPs will be implemented in conformance with the following guidelines.

1. Material Delivery, Storage, and Use:

    a. All construction materials will be delivered to and stored in the designated construction staging areas (See Figures 2 and 3). The main loading, unloading, and access areas will be located away from storm drain inlets. Enclosures (e.g. gravel bag berms, fiber rolls, sand bags) will be

placed around the staging areas to prevent stormwater from coming into contact with these materials or entering storm drains or receiving waters.

b. Materials being stored which could release pollutants by wind or water to stormwater systems or receiving waters will additionally be protected by overhead cover, secondary containment, tarpaulins, or other methods. Chemicals on the Site will be stored in watertight containers or in the storage shed.

c. In general, WM-1 and WM-2 will be implemented to help prevent discharges of construction materials during delivery, storage, and use.

d. Spill clean-up materials, material safety data sheets, a material inventory, and emergency contact numbers will be maintained and stored in a labeled container or in the office trailer.

2. Stockpile Management:

a. WM-3, Stockpile Management, and WM-7, Contaminated Soil Management, will be implemented to reduce or eliminate pollution of stormwater from construction-related stockpiles of soil and paving materials such as PCC rubble, asphalt concrete (AC), AC rubble, aggregate base, aggregate sub-base, pre-mixed aggregate, and asphalt minder (so called "cold mix" asphalt). All construction-related stockpiles will be contained and securely protected from wind and rain at all times unless actively being used (plastic covers or suppressants, for example). Construction-related stockpiles will be located within the designated stockpile areas.

3. Spill Prevention and Control:

a. Fuel products, lubricating fluids, grease or other products and/or waste released by the Contractor's vehicles, equipment, or construction methods will be collected and disposed of in accordance with state, federal, and local laws.

b. Materials used on the Site will be used in accordance with the manufacturer's directions. Methods for cleanup and stormwater pollution prevention will be in place for all activities with the potential to impact water quality.

c. WM-4, Spill Prevention and Control, will be implemented to contain and clean-up spills and prevent material discharges to the storm drain system. Spill prevention is also discussed above in Material Delivery, Storage, and Use, as well as below in the following Waste Management and

Equipment Maintenance sections.

d. Equipment and materials for cleanup of spills will be available on-site. Specific spill response personnel will be trained to clean up spills and leaks immediately and dispose of waste properly.

4. Waste Management:

   a. Litter will be collected from the Site each day.

   b. Temporary non-hazardous waste-storage areas will be located within the staging areas and maintained in a manner that prevents direct contact of waste with stormwater run-off or run-on (See Figure 3). All generated waste materials will be removed from the storage areas by the Contractor or a licensed subcontractor and transported to an off-site landfill or to the appropriate recycling facility. The disposal of excess material off-site will comply with all federal, state, and local regulations.

   c. Municipal wastes will be stored in covered dumpsters. Dumpsters must be covered at the end of every business day and before rain events. Waste will be removed by the Contractor or a licensed subcontractor and transported to an off-site landfill or to the appropriate recycling facility. The disposal of excess material off-site will comply with all federal, state, and local regulations.

   d. All sanitary wastes will be collected and managed through the use of portable toilet facilities. Portable toilets will be transported to and from the Site by a licensed contractor. No sanitary wastes will be disposed of on-site. Sanitation facilities will be cleaned and inspected regularly.

   e. WM-3, Stockpile Management, WM-5, Solid Waste Management, and WM-7, Contaminated Soil Management, will be implemented to minimize stormwater contact with waste materials and prevent waste discharges. Solid wastes will be loaded directly into trucks for off-site disposal, to the extent feasible. When on-site storage is necessary, solid wastes will be segregated into temporary stockpiles for future loading and transport to an off-site disposal facility. Rubble will be stockpiled in the general storage area and will be contained by sediment controls and covered when necessary. Generated solid waste will be removed and disposed off-site in compliance with the applicable regulations.

5. Contaminated Soil Management:

   a. Employees will be instructed to recognize evidence of contaminated soil, such as buried debris, discolored soil, and unusual odors. If potentially

contaminated soil is identified during construction activities, the Project Geologist and Construction Manager will be notified to inspect the contaminated soils to determine the appropriate course of action. If remedial action is required, contaminated soils will be disposed of following WM-7, Contaminated Soil Management or in accordance with the methods directed by a qualified professional. Contaminated soils will be covered and/or contained or otherwise prevented from coming in contact with stormwater runoff until disposal.

6. Sanitary and Septic Wastes:

    a. The Contractor will implement WM-9, Sanitary and Septic Waste Management, and portable toilets will be located and maintained at the Shared Facilities area for the duration of the Project. Regular maintenance will be provided by licensed personnel and wastes will be disposed off-site. The toilets will be located away from concentrated flow paths and traffic flow. Secondary containment will be implemented on all portable toilets.

4.3 Schedule of BMP Implementation

Unless otherwise noted, the BMPs described in this ECP will be implemented throughout the entirety of the Project. Table 4-7 below lists the start and end date for applicable BMPs.

Table 4-7 BMP Implementation Schedule

	BMP	Implementation	Duration
Erosion Control	EC-1, Scheduling	Prior to Construction	Entirety of Project
	EC-2, Preservation of Existing Vegetation	Prior to Construction	Entirety of Project
	EC-3, Hydraulic Mulch	After Final Grading and Slope Stabilizing is Complete	Post-Construction Phase
	EC-4, Hydroseed	After Final Grading and Slope Stabilizing is Complete	Post-Construction Phase
	EC-7 Geotextiles and Mats	After Final Grading and Slope Stabilizing is Complete	Post-Construction Phase
	EC-12, Stream Bank Stabilization	Start of Construction	Entirety of Project
	EC-16, Non-Vegetated Stabilization	Start of Construction	Entirety of Project
Sediment Control	SE-1, Silt Fence	Prior to Construction	Entirety of Project
	SE-4, Check Dams	Prior to Construction	Entirety of Project
	SE-5, Fiber Rolls	Prior to Construction, during site mobilization and preparation of staging areas, and as Needed	Entirety of Project
	SE-6, Gravel Bag Berms	Prior to Construction	Entirety of Project
	SE-8, Sand Bag Barriers	Prior to Construction	Entirety of Project
	SE-10, Storm Drain Inlet Protection	Prior to Construction and as constructed.	Entirety of Project
Tracking Control	SE-7, Street Sweeping and Vacuuming	Start of Construction	As Needed
	TC-1, Stabilized Construction Entrance/Exit	Prior to Construction	Entirety of Project
	TC-2, Stabilized Construction Roadway	Start of Construction	As Needed
	TC-3, Entrance/Outlet Tire Wash,	Prior to Construction, as needed	As Needed
Wind Control	WE-1, Wind Erosion Control	Start of Construction	As Needed
	NS-1, Water Conservation Practices	Start of Construction	As Needed

5. BMP INSPECTION AND MAINTENANCE

5.1 BMP Inspection and Maintenance

Routine daily inspections of the construction activities and BMPs during construction are recommended. A BMP inspection checklist will be filled out for inspections and maintained on-site with the ECP. A blank sample inspection checklist can be found in Appendix B.

If necessary, corrective actions will be implemented within 72 hours of identified deficiencies. Specific details for maintenance, inspection, and repair of Site BMPs can be found in the BMP Fact Sheets in Appendix A.

6. REFERENCES

California Stormwater Quality Association (CASQA), 2009. Stormwater Best Management Practice Handbook Portal: Construction.

E2C Remediation, 2013a. *Leona Heights Sulfur Mines Remediation Creek Restoration Construction Work Plan, End of McDonell Avenue, Oakland, California*, Prepared for Ocean/Alcoa Properties, 2013.

E2C Remediation, 2013b. *Leona Heights Sulfur Mines Remediation, Creek Restoration 90% Design* Report, *End of McDonell Avenue, Oakland, California*, Prepared for Ocean/Alcoa Properties, 15 October.

E2C Remediation, 2014. *Leona Heights Sulfur Mines Remediation Creek Restoration Construction Work Plan (Revised 2014), End of McDonell Avenue, Oakland, California*, Prepared for Ocean/Alcoa Properties, 28 January.

Geosyntec Consultants, Inc., 2013a. *Remedial Design Plan, Leona Heights Sulfur Mine, Oakland, California*, 15 October.

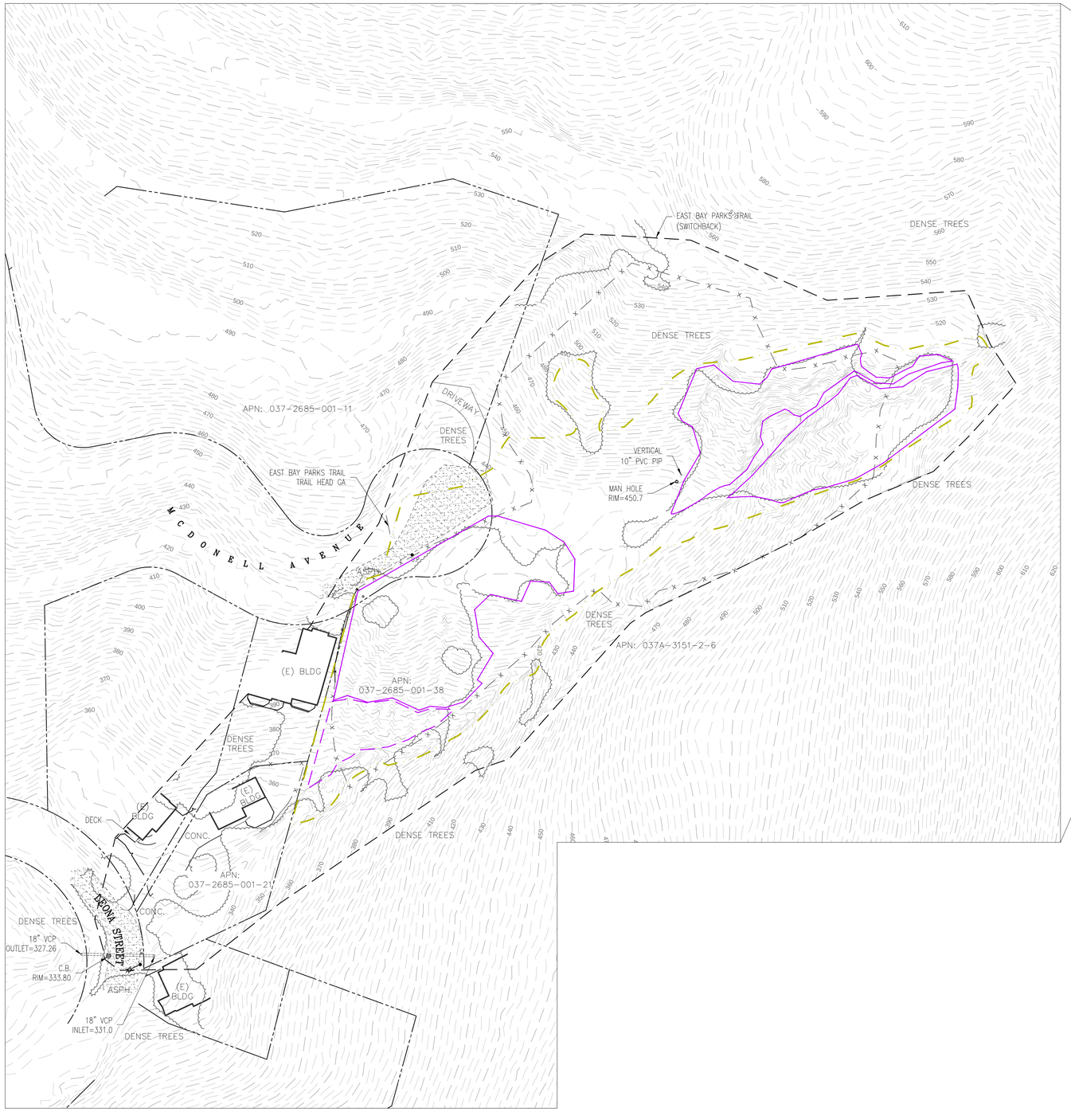
Geosyntec Consultants, Inc., 2013b. *Erosion Control Plan, Leona Heights Sulfur Mine, Oakland, California*, 14 November.

Levine-Fricke, 1992b. *Hydrogeology Report, Leona Heights Sulfur Mine, Oakland, California*, Prepared for Ridgemont Development, Inc., 15 October. LF 2622.04.

Levine Fricke, 1990. *Evaluation of Remediation Alternatives for the Leona Heights Mine Tailings Site at the End of McDonell Avenue, Oakland, California*. 2 August 1990. LF2031.

Olberding Environmental, Inc. 2013. *Revegetation Plan for the Leona Heights Sulfur Mine Remediation and Creek Restoration Project, City of Oakland, Alameda County, California*. Prepared for Dr. Collin Mbanugo, Oakland, CA. 13 November.

FIGURES



EXISTING TOPOGRAPHY
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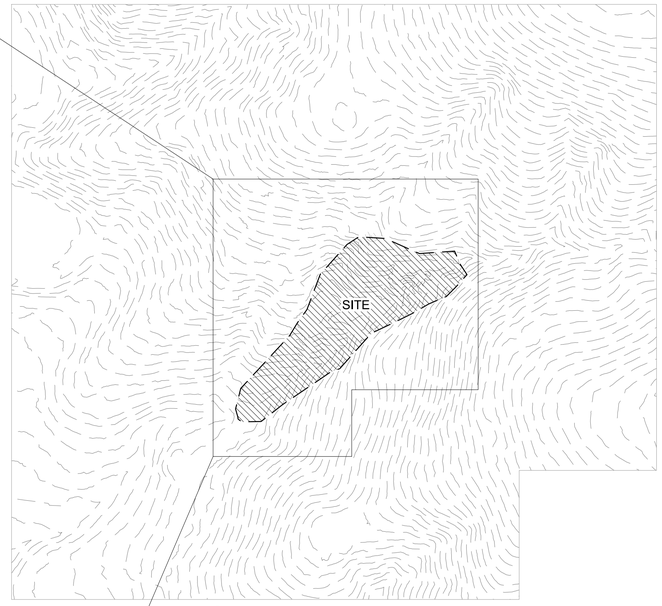

SITE PLAN
SCALE: 1"=200'

NOTES

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4. BENCHMARK FOR THIS SURVEY IS NGS HT0281 WITH ELEVATION =14.20 FEET (NAVD 88 DATUM).
5. REVISED FROM PREVIOUS VERSION PREPARED BY GEOSYNTEC (10/15/2013)

LEGEND

- 460 — EXISTING GRADE (10-FT CONTOUR)
- EXISTING GRADE (2-FT CONTOUR)
- PROPERTY LINE
- x x EXISTING FENCE
- EXISTING CREEK CENTERLINE
- APPROXIMATE EXTENT OF WASTE PILE
- APPROXIMATE EXTENT OF POTENTIAL TAILING/SCREE
- LIMIT OF POTENTIAL EARTHWORK

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DATE	DESCRIPTION
01/21/2014	REVISED PERMIT LEVEL

PROJECT NO: 2028BK
DRAWN BY: N.B.
DESIGNED BY: A.X.
CHECKED BY:
APPROVED BY:

PROJECT NAME
Leona Heights Sulfur Mines Remediation

SHEET TITLE
Site Plan & Existing Topography

DRAWING NUMBER
Figure 1

GENERAL NOTES

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5. DOCUMENT AREAS OF ACTIVE CONSTRUCTION AND SOIL DISTURBANCE (TEMPORARY OR PERMANENT) ON SITE MAPS KEPT ON-SITE (PROGRESS MAPS).
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11. THE FIBER ROLLS WILL BE INSTALLED, IN ACCORDANCE WITH BMP SE-5, WITHIN THE LIMITS OF THE FINAL COVER: FIBER ROLLS PLACED APPROXIMATELY EVERY 7 VERTICAL FEET TO REDUCE EROSION OF THE FINISHED CLEAN FILL (PER CONSTRUCTION GENERAL PERMIT REQUIREMENTS, FOR SLOPES FROM 25-50%, SHEET FLOW LENGTH SHALL NOT EXCEED 15 FEET; FOR SLOPES OVER 50%, SHEET FLOW LENGTH SHALL NOT EXCEED 10 FEET); OR FIBER ROLLS WITH UNDERLYING EROSION CONTROL BLANKET PLACED APPROXIMATELY EVERY 15 VERTICAL FEET OVER THE FINAL GRADED AREA, OR EQUIVALENT.
12. DISTURBED AREAS OF THE SITE WILL BE HYDROMULCHED/HYDROSEEDED, AS DETAILED IN THE REVEGETATION PLAN (OLBERDING ENVIRONMENTAL INC., 2013), AND AS DETERMINED BY THE SWPPP CONTRACTOR.
13. REVISED FROM PREVIOUS VERSION PREPARED BY GEOSYNTEC (10/152/2013).

LEGEND

- HIGH VISIBILITY FENCING
- SF — SILT FENCE (SE-1)
- CHECK DAM
- CONSTRUCTION ENTRANCE
- CHANNEL BOTTOM
- CHANNEL TOP
- 460 — FINAL GRADE (10-FT CONTOUR)
- FINAL GRADE (2-FT CONTOUR)
- 460 — EXISTING GRADE (10-FT CONTOUR)
- EXISTING GRADE (2-FT CONTOUR)
- PROPERTY LINE
- IP — INLET PROTECTION (SE-10)
- SF — SANITATION FACILITIES (WM-9)
- CS — CONTAMINATED SOIL MANAGEMENT AREA (MW-7)
- MS — MATERIAL STORAGE (WM-1, WM-2)
- VM — VEHICLE FUELING AND MAINTENANCE AREA (NS-9, NS-10)
- SP — STOCKPILE AREA (WM-3)
- WS — WASTE STORAGE (WM-5)
- H_2O — WATER STORAGE FOR DUST CONTROL (WE-1)

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DATE	DESCRIPTION
01/21/2014	REVISED PERMIT LEVEL

PROJECT NO: 2028BK
DRAWN BY: N.B.
DESIGNED BY: A.X.
CHECKED BY:
APPROVED BY:

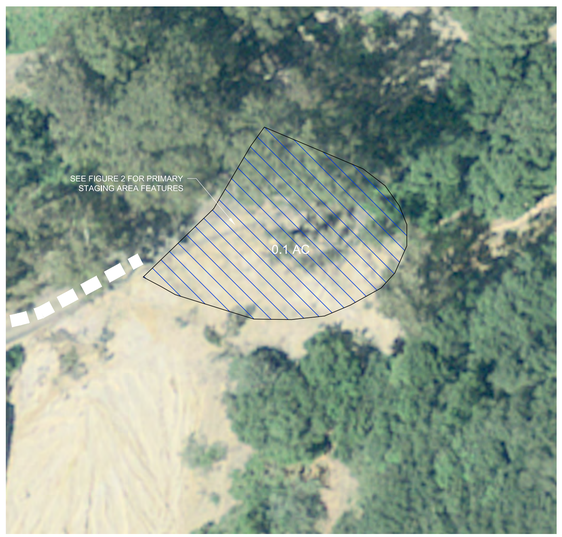
PROJECT NAME
Leona Heights Sulfur Mines Remediation

SHEET TITLE
Erosion Control Plan (Main Project Area)

DRAWING NUMBER
Figure 2

LOCATION MAP
SCALE: 1"=250'

MATERIAL STORAGE AREA
SCALE: 1"=30'



PRIMARY STAGING AREA
SCALE: 1"=30'

SECONDARY STAGING AREA
SCALE: 1"=30'

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LEGEND

- TEMPORARY FENCING
- FIBER ROLL
- STAGING/STORAGE AREA
- HAUL ROUTE
- MS — MATERIAL STORAGE (WM-1, WM-2)
- VP — VEHICLE PARKING

AERIAL PHOTO PROVIDED BY USDA GEOSPATIAL DATA GATEWAY

N

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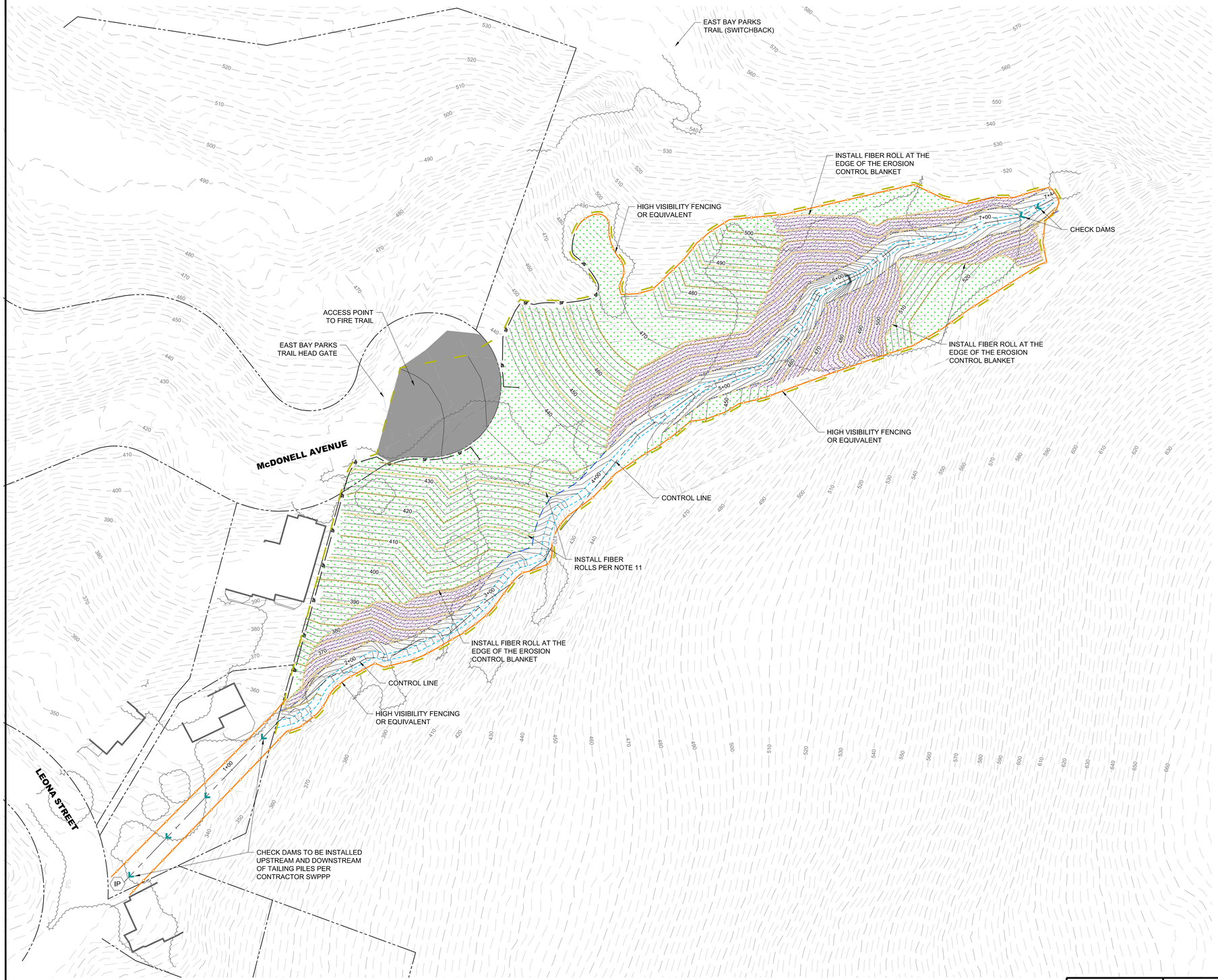
PROJECT NO: 2028BK	
DRAWN BY: N.B.	
DESIGNED BY: A.X.	
CHECKED BY:	
APPROVED BY:	

PROJECT NAME
Leona Heights Sulfur Mines Remediation

SHEET TITLE
Erosion Control Plan (Staging Areas)

DRAWING NUMBER
Figure 3



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7. INLET PROTECTION SUPPLIES SHALL BE STORED IN THE PRIMARY STAGING AREA AND SHALL BE INSPECTED 72 HOURS PRIOR TO A PREDICTED RAIN EVENT TO ALLOW ADEQUATE TIME FOR REPAIRS. INLET PROTECTION SHALL BE CHECKED REGULARLY AND MAINTAINED AS APPROPRIATE.
8. CHECK DAMS (I.E. SAND BAGS BARRIERS, GRAVEL BAG BERMS, ETC.) SHALL BE INSTALLED BOTH UPSTREAM AND DOWNSTREAM OF THE TAILING PILES, PER CONTRACTOR'S SWPPP.
9. WITHIN THE MAIN REMEDIATION WORK AREA, THE STOCKPILE AREAS ARE DYNAMIC IN NATURE AND WILL BE LOCATED WITHIN THE UPPER TAILINGS AND LOWER TAILINGS AREA.
10. EROSION CONTROL FABRIC WILL BE INSTALLED ON THE 1:1 SLOPES, IN ACCORDANCE WITH BMP FACTSHEET EC-7, WITHIN THE LIMITS OF THE FINAL COVER. C350 TURF REINFORCEMENT MAT (TRM), A MATTING STRUCTURE INCORPORATED WITH A COCONUT FIBER MATRIX, MAY BE USED AS DETAILED IN THE CREEK RESTORATION 90% DESIGN REPORT (E2C, 2013B), OR AN EQUIVALENT PRODUCT TO BE DETERMINED BY THE SWPPP CONTRACTOR.
11. THE FIBER ROLLS WILL BE INSTALLED, IN ACCORDANCE WITH BMP SE-5, WITHIN THE LIMITS OF THE FINAL COVER: FIBER ROLLS PLACED APPROXIMATELY EVERY 7 VERTICAL FEET TO REDUCE EROSION OF THE FINISHED CLEAN FILL (PER CONSTRUCTION GENERAL PERMIT REQUIREMENTS, FOR SLOPES FROM 25-50%, SHEET FLOW LENGTH SHALL NOT EXCEED 15 FEET; FOR SLOPES OVER 50%, SHEET FLOW LENGTH SHALL NOT EXCEED 10 FEET); OR FIBER ROLLS WITH UNDERLYING EROSION CONTROL BLANKET PLACED APPROXIMATELY EVERY 15 VERTICAL FEET OVER THE FINAL GRADED AREA, OR EQUIVALENT.
12. DISTURBED AREAS OF THE SITE WILL BE HYDROMULCHED/HYDROSEEDED, AS DETAILED IN THE REVEGETATION PLAN (OLBERDING ENVIRONMENTAL INC., 2013), AND AS DETERMINED BY THE SWPPP CONTRACTOR.
13. REVISED FROM PREVIOUS VERSION PREPARED BY GEOSYNTEC (10/152/2013).

LEGEND

- FIBER ROLL
- HIGH VISIBILITY FENCING
- SILT FENCE (SE-1)
- CHECK DAM
- EROSION CONTROL BLANKET (ON 1:1 SLOPES)
- HYDROMULCH/HYDROSEED (ON 2:1 SLOPES)
- CONSTRUCTION ENTRANCE
- ASPHALT
- CHANNEL BOTTOM
- CHANNEL TOP
- 460 FINAL GRADE (10-FT CONTOUR)
- FINAL GRADE (2-FT CONTOUR)
- 460 EXISTING GRADE (10-FT CONTOUR)
- EXISTING GRADE (2-FT CONTOUR)
- PROPERTY LINE
- IP INLET PROTECTION (SE-10)

N

0 30

E2C Remediation
5300 Woodmere Dr., Suite 105
Bakersfield, CA 93313
Phone: (661) 831-6906
Fax: (661) 831-8234

DATE	DESCRIPTION
01/21/2014	REVISED PERMIT LEVEL

PROJECT NO:	2028BK
DRAWN BY:	N.B.
DESIGNED BY:	A.X.
CHECKED BY:	
APPROVED BY:	

PROJECT NAME
Leona Heights Sulfur Mines Remediation

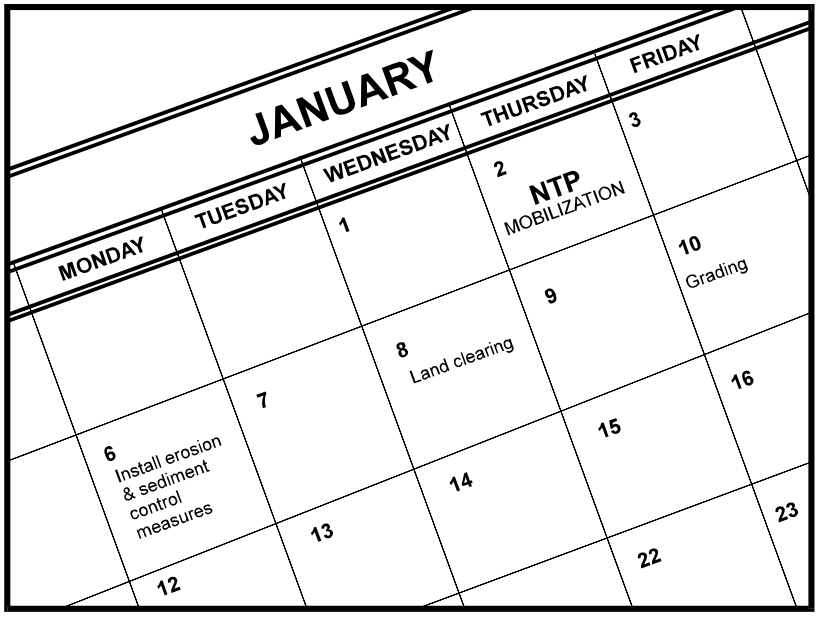
SHEET TITLE
Erosion Control Plan (Post-Construction Area)

DRAWING NUMBER
Figure 4

APPENDIX A

CASQA BMP Fact Sheets

Scheduling EC-1



Categories

EC	Erosion Control	☑
SE	Sediment Control	☒
TC	Tracking Control	☒
WE	Wind Erosion Control	☒
NS	Non-Stormwater Management Control	
WM	Waste Management and Materials Pollution Control	

Legend:
☑ **Primary Objective**
☒ **Secondary Objective**

Targeted Constituents

Sediment	☑
Nutrients	
Trash	
Metals	
Bacteria	
Oil and Grease	
Organics	

Potential Alternatives

None

Description and Purpose

Scheduling is the development of a written plan that includes sequencing of construction activities and the implementation of BMPs such as erosion control and sediment control while taking local climate (rainfall, wind, etc.) into consideration. The purpose is to reduce the amount and duration of soil exposed to erosion by wind, rain, runoff, and vehicle tracking, and to perform the construction activities and control practices in accordance with the planned schedule.

Suitable Applications

Proper sequencing of construction activities to reduce erosion potential should be incorporated into the schedule of every construction project especially during rainy season. Use of other, more costly yet less effective, erosion and sediment control BMPs may often be reduced through proper construction sequencing.

Limitations

- Environmental constraints such as nesting season prohibitions reduce the full capabilities of this BMP.

Implementation

- Avoid rainy periods. Schedule major grading operations during dry months when practical. Allow enough time before rainfall begins to stabilize the soil with vegetation or physical means or to install sediment trapping devices.
- Plan the project and develop a schedule showing each phase

of construction. Clearly show how the rainy season relates to soil disturbing and re-stabilization activities. Incorporate the construction schedule into the SWPPP.

- Include on the schedule, details on the rainy season implementation and deployment of:
  - Erosion control BMPs
  - Sediment control BMPs
  - Tracking control BMPs
  - Wind erosion control BMPs
  - Non-stormwater BMPs
  - Waste management and materials pollution control BMPs
- Include dates for activities that may require non-stormwater discharges such as dewatering, sawcutting, grinding, drilling, boring, crushing, blasting, painting, hydro-demolition, mortar mixing, pavement cleaning, etc.
- Work out the sequencing and timetable for the start and completion of each item such as site clearing and grubbing, grading, excavation, paving, foundation pouring utilities installation, etc., to minimize the active construction area during the rainy season.
  - Sequence trenching activities so that most open portions are closed before new trenching begins.
  - Incorporate staged seeding and re-vegetation of graded slopes as work progresses.
  - Schedule establishment of permanent vegetation during appropriate planting time for specified vegetation.
- Non-active areas should be stabilized as soon as practical after the cessation of soil disturbing activities or one day prior to the onset of precipitation.
- Monitor the weather forecast for rainfall.
- When rainfall is predicted, adjust the construction schedule to allow the implementation of soil stabilization and sediment treatment controls on all disturbed areas prior to the onset of rain.
- Be prepared year round to deploy erosion control and sediment control BMPs. Erosion may be caused during dry seasons by un-seasonal rainfall, wind, and vehicle tracking. Keep the site stabilized year round, and retain and maintain rainy season sediment trapping devices in operational condition.
- Apply permanent erosion control to areas deemed substantially complete during the project's defined seeding window.

Costs

Construction scheduling to reduce erosion may increase other construction costs due to reduced economies of scale in performing site grading. The cost effectiveness of scheduling techniques should be compared with the other less effective erosion and sedimentation controls to achieve a cost effective balance.

Inspection and Maintenance

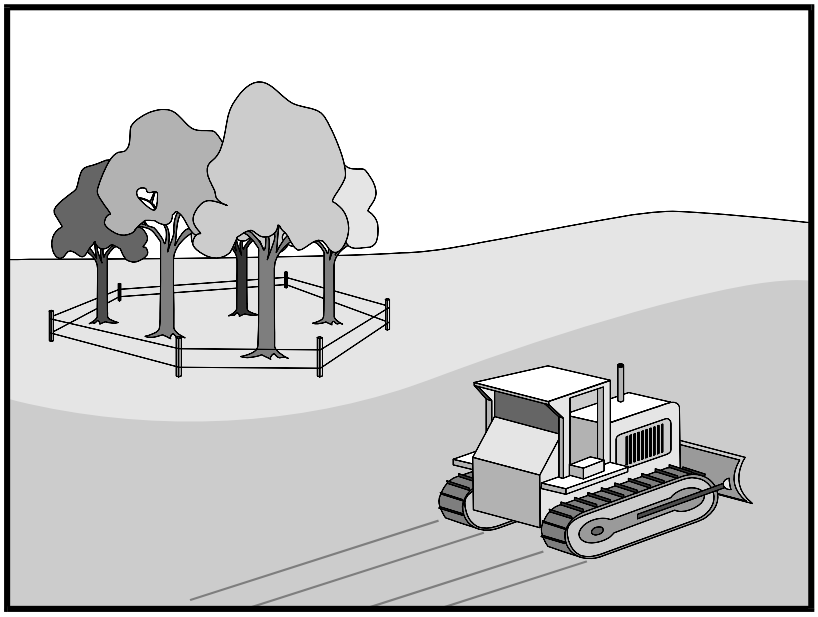
- Verify that work is progressing in accordance with the schedule. If progress deviates, take corrective actions.
- Amend the schedule when changes are warranted.
- Amend the schedule prior to the rainy season to show updated information on the deployment and implementation of construction site BMPs.

References

Stormwater Quality Handbooks Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), November 2000.

Stormwater Management for Construction Activities Developing Pollution Prevention Plans and Best Management Practices (EPA 832-R-92-005), U.S. Environmental Protection Agency, Office of Water, September 1992.

Preservation Of Existing Vegetation EC-2



Categories

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Legend:

☑ **Primary Objective**

☒ **Secondary Objective**

Targeted Constituents

Sediment	☑
Nutrients	
Trash	
Metals	
Bacteria	
Oil and Grease	
Organics	

Potential Alternatives

None

Description and Purpose

Carefully planned preservation of existing vegetation minimizes the potential of removing or injuring existing trees, vines, shrubs, and grasses that protect soil from erosion.

Suitable Applications

Preservation of existing vegetation is suitable for use on most projects. Large project sites often provide the greatest opportunity for use of this BMP. Suitable applications include the following:

- Areas within the site where no construction activity occurs, or occurs at a later date. This BMP is especially suitable to multi year projects where grading can be phased.
- Areas where natural vegetation exists and is designated for preservation. Such areas often include steep slopes, watercourse, and building sites in wooded areas.
- Areas where local, state, and federal government require preservation, such as vernal pools, wetlands, marshes, certain oak trees, etc. These areas are usually designated on the plans, or in the specifications, permits, or environmental documents.
- Where vegetation designated for ultimate removal can be temporarily preserved and be utilized for erosion control and sediment control.

Limitations

- Requires forward planning by the owner/developer,

contractor, and design staff.

- Limited opportunities for use when project plans do not incorporate existing vegetation into the site design.

- For sites with diverse topography, it is often difficult and expensive to save existing trees while grading the site satisfactory for the planned development.

Implementation

The best way to prevent erosion is to not disturb the land. In order to reduce the impacts of new development and redevelopment, projects may be designed to avoid disturbing land in sensitive areas of the site (e.g., natural watercourses, steep slopes), and to incorporate unique or desirable existing vegetation into the site's landscaping plan. Clearly marking and leaving a buffer area around these unique areas during construction will help to preserve these areas as well as take advantage of natural erosion prevention and sediment trapping.

Existing vegetation to be preserved on the site must be protected from mechanical and other injury while the land is being developed. The purpose of protecting existing vegetation is to ensure the survival of desirable vegetation for shade, beautification, and erosion control. Mature vegetation has extensive root systems that help to hold soil in place, thus reducing erosion. In addition, vegetation helps keep soil from drying rapidly and becoming susceptible to erosion. To effectively save existing vegetation, no disturbances of any kind should be allowed within a defined area around the vegetation. For trees, no construction activity should occur within the drip line of the tree.

Timing

- Provide for preservation of existing vegetation prior to the commencement of clearing and grubbing operations or other soil disturbing activities in areas where no construction activity is planned or will occur at a later date.

Design and Layout

- Mark areas to be preserved with temporary fencing. Include sufficient setback to protect roots.
  - Orange colored plastic mesh fencing works well.
  - Use appropriate fence posts and adequate post spacing and depth to completely support the fence in an upright position.
- Locate temporary roadways, stockpiles, and layout areas to avoid stands of trees, shrubs, and grass.
- Consider the impact of grade changes to existing vegetation and the root zone.
- Maintain existing irrigation systems where feasible. Temporary irrigation may be required.
- Instruct employees and subcontractors to honor protective devices. Prohibit heavy equipment, vehicular traffic, or storage of construction materials within the protected area.

Costs

There is little cost associated with preserving existing vegetation if properly planned during the project design, and these costs may be offset by aesthetic benefits that enhance property values. During construction, the cost for preserving existing vegetation will likely be less than the cost of applying erosion and sediment controls to the disturbed area. Replacing vegetation inadvertently destroyed during construction can be extremely expensive, sometimes in excess of $10,000 per tree.

Inspection and Maintenance

During construction, the limits of disturbance should remain clearly marked at all times. Irrigation or maintenance of existing vegetation should be described in the landscaping plan. If damage to protected trees still occurs, maintenance guidelines described below should be followed:

- Verify that protective measures remain in place. Restore damaged protection measures immediately.
- Serious tree injuries shall be attended to by an arborist.
- Damage to the crown, trunk, or root system of a retained tree shall be repaired immediately.
- Trench as far from tree trunks as possible, usually outside of the tree drip line or canopy. Curve trenches around trees to avoid large roots or root concentrations. If roots are encountered, consider tunneling under them. When trenching or tunneling near or under trees to be retained, place tunnels at least 18 in. below the ground surface, and not below the tree center to minimize impact on the roots.
- Do not leave tree roots exposed to air. Cover exposed roots with soil as soon as possible. If soil covering is not practical, protect exposed roots with wet burlap or peat moss until the tunnel or trench is ready for backfill.
- Cleanly remove the ends of damaged roots with a smooth cut.
- Fill trenches and tunnels as soon as possible. Careful filling and tamping will eliminate air spaces in the soil, which can damage roots.
- If bark damage occurs, cut back all loosened bark into the undamaged area, with the cut tapered at the top and bottom and drainage provided at the base of the wood. Limit cutting the undamaged area as much as possible.
- Aerate soil that has been compacted over a trees root zone by punching holes 12 in. deep with an iron bar, and moving the bar back and forth until the soil is loosened. Place holes 18 in. apart throughout the area of compacted soil under the tree crown.
- Fertilization
  - Fertilize stressed or damaged broadleaf trees to aid recovery.
  - Fertilize trees in the late fall or early spring.

- Apply fertilizer to the soil over the feeder roots and in accordance with label instructions, but never closer than 3 ft to the trunk. Increase the fertilized area by one-fourth of the crown area for conifers that have extended root systems.

- Retain protective measures until all other construction activity is complete to avoid damage during site cleanup and stabilization.

References

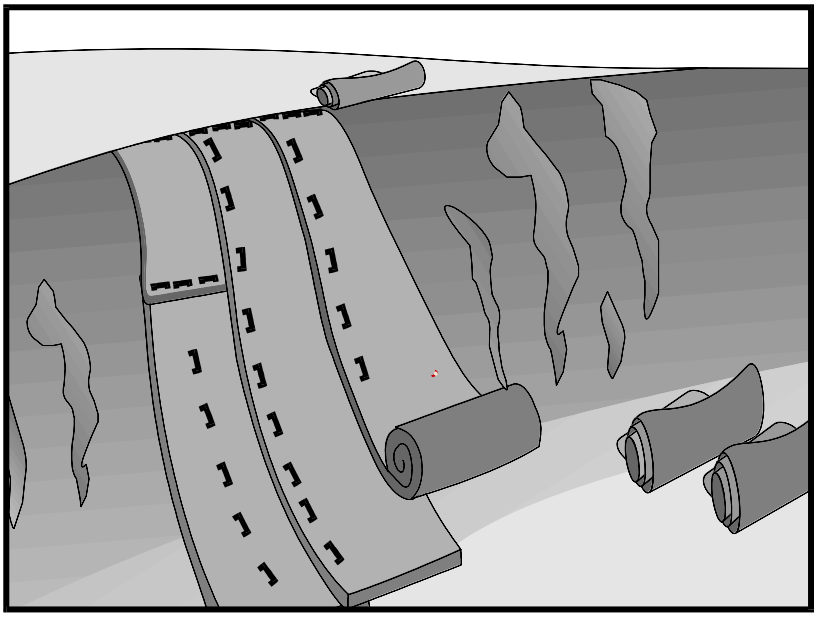
County of Sacramento Tree Preservation Ordinance, September 1981.

Stormwater Quality Handbooks Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), November 2000.

Stormwater Management of the Puget Sound Basin, Technical Manual, Publication #91-75, Washington State Department of Ecology, February 1992.

Water Quality Management Plan for The Lake Tahoe Region, Volume II, Handbook of Management Practices, Tahoe Regional Planning Agency, November 1988.

Geotextiles and Mats EC-7



Categories		
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WE	Wind Erosion Control	☒
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WM	Waste Management and Materials Pollution Control	

Legend:
☑ **Primary Category**
☒ **Secondary Category**

Targeted Constituents	
Sediment	☑
Nutrients	
Trash	
Metals	
Bacteria	
Oil and Grease	
Organics	

Potential Alternatives

EC-3 Hydraulic Mulch

EC-4 Hydroseeding

If User/Subscriber modifies this fact sheet in any way, the CASQA name/logo and footer below must be removed from each page and not appear on the modified version.

Description and Purpose

Mattings, or Rolled Erosion Control Products (RECPs), can be made of natural or synthetic materials or a combination of the two. RECPs are used to cover the soil surface to reduce erosion from rainfall impact, hold soil in place, and absorb and hold moisture near the soil surface. Additionally, RECPs may be used to stabilize soils until vegetation is established or to reinforce non-woody surface vegetation.

Suitable Applications

RECPs are typically applied on slopes where erosion hazard is high and vegetation will be slow to establish. Mattings are also used on stream banks, swales and other drainage channels where moving water at velocities between 3 ft/s and 6 ft/s are likely to cause scour and wash out new vegetation, and in areas where the soil surface is disturbed and where existing vegetation has been removed. RECPs may also be used when seeding cannot occur (e.g., late season construction and/or the arrival of an early rain season). RECPs should be considered when the soils are fine grained and potentially erosive. RECPs should be considered in the following situations.

- Steep slopes, generally steeper than 3:1 (H:V)
- Slopes where the erosion potential is high
- Slopes and disturbed soils where mulch must be anchored
- Disturbed areas where plants are slow to develop

- Channels with flows exceeding 3.3 ft/s
- Channels to be vegetated
- Stockpiles
- Slopes adjacent to water bodies

Limitations

- RECP installed costs are generally higher than other erosion control BMPs, limiting their use to areas where other BMPs are ineffective (e.g. channels, steep slopes).
- RECPs may delay seed germination, due to reduction in soil temperature.
- RECPs are generally not suitable for excessively rocky sites or areas where the final vegetation will be mowed (since staples and netting can catch in mowers). If a staple or pin cannot be driven into the soil because the underlying soil is too hard or rocky, then an alternative BMP should be selected.
- If used for temporary erosion control, RECPs should be removed and disposed of prior to application of permanent soil stabilization measures.
- The use of plastic should be limited to covering stockpiles or very small graded areas for short periods of time (such as through one imminent storm event) until more environmentally friendly measures, such as seeding and mulching, may be installed.
    - Plastic sheeting is easily vandalized, easily torn, photodegradable, and must be disposed of at a landfill.
    - Plastic sheeting results in 100% runoff, which may cause serious erosion problems in the areas receiving the increased flow.
- RECPs may have limitations based on soil type, slope gradient, or channel flow rate; consult the manufacturer for proper selection.
- Not suitable for areas that have foot traffic (tripping hazard) – e.g., pad areas around buildings under construction.
- RECPs that incorporate a plastic netting (e.g. straw blanket typically uses a plastic netting to hold the straw in place) may not be suitable near known wildlife habitat. Wildlife can become trapped in the plastic netting.
- RECPs may have limitations in extremely windy climates. However, when RECPs are properly trenched at the top and bottom and stapled in accordance with the manufacturer's recommendations, problems with wind can be minimized.

Implementation

Material Selection

- Natural RECPs have been found to be effective where re-vegetation will be provided by re-seeding. The choice of material should be based on the size of area, side slopes, surface conditions such as hardness, moisture, weed growth, and availability of materials.

- Additional guidance on the comparison and selection of temporary slope stabilization methods is provided in Appendix F of the Handbook.

- The following natural and synthetic RECPs are commonly used:

Geotextiles

- Material can be a woven or a non-woven polypropylene fabric with minimum thickness of 0.06 in., minimum width of 12 ft and should have minimum tensile strength of 150 lbs (warp), 80 lbs (fill) in conformance with the requirements in ASTM Designation: D 4632. The permittivity of the fabric should be approximately 0.07 sec^{-1} in conformance with the requirements in ASTM Designation: D4491. The fabric should have an ultraviolet (UV) stability of 70 percent in conformance with the requirements in ASTM designation: D4355. Geotextile blankets must be secured in place with wire staples or sandbags and by keying into tops of slopes to prevent infiltration of surface waters under geotextile. Staples should be made of minimum 11 gauge steel wire and should be U-shaped with 8 in. legs and 2 in. crown.

- Geotextiles may be reused if they are suitable for the use intended.

Plastic Covers

- Generally plastic sheeting should only be used as stockpile covering or for very small graded areas for short periods of time (such as through one imminent storm event). If plastic sheeting must be used, choose a plastic that will withstand photo degradation.

- Plastic sheeting should have a minimum thickness of 6 mils, and must be keyed in at the top of slope (when used as a temporary slope protection) and firmly held in place with sandbags or other weights placed no more than 10 ft apart. Seams are typically taped or weighted down their entire length, and there should be at least a 12 in. to 24 in. overlap of all seams. Edges should be embedded a minimum of 6 in. in soil (when used as a temporary slope protection).

- All sheeting must be inspected periodically after installation and after significant rainstorms to check for erosion, undermining, and anchorage failure. Any failures must be repaired immediately. If washout or breakages occur, the material should be re-installed after repairing the damage to the slope.

Erosion Control Blankets/Mats

- Biodegradable RECPs are typically composed of jute fibers, curled wood fibers, straw, coconut fiber, or a combination of these materials. In order for an RECP to be considered 100% biodegradable, the netting, sewing or adhesive system that holds the biodegradable mulch fibers together must also be biodegradable. See typical installation details at the end of this fact sheet.

- **Jute** is a natural fiber that is made into a yarn that is loosely woven into a biodegradable mesh. The performance of jute as a stand-alone RECP is low. Most other RECPs outperform jute as a temporary erosion control product and therefore jute is not commonly used. It is designed to be used in conjunction with vegetation. The material is supplied in rolled strips, which should be secured to the soil with U-shaped staples or stakes in accordance with manufacturers' recommendations.

- **Excelsior** (curled wood fiber) blanket material should consist of machine produced mats of curled wood excelsior with 80 percent of the fiber 6 in. or longer. The excelsior blanket should be of consistent thickness. The wood fiber must be evenly distributed over the entire area of the blanket. The top surface of the blanket should be covered with a photodegradable extruded plastic mesh. The blanket should be smolder resistant without the use of chemical additives and should be non-toxic and non-injurious to plant and animal life. Excelsior blankets should be furnished in rolled strips, a minimum of 48 in. wide, and should have an average weight of 0.8 lb/yd^2, ±10 percent, at the time of manufacture. Excelsior blankets must be secured in place with wire staples. Staples should be made of minimum 11 gauge steel wire and should be U-shaped with 8 in. legs and 2 in. crown.

- **Straw blanket** should be machine produced mats of straw with a lightweight biodegradable netting top layer. The straw should be attached to the netting with biodegradable thread or glue strips. The straw blanket should be of consistent thickness. The straw should be evenly distributed over the entire area of the blanket. Straw blanket should be furnished in rolled strips a minimum of 6.5 ft wide, a minimum of 80 ft long and a minimum of 0.5 lb/yd^2. Straw blankets must be secured in place with wire staples. Staples should be made of minimum 11 gauge steel wire and should be U-shaped with 8 in. legs and 2 in. crown.

- **Wood fiber blanket** is composed of biodegradable fiber mulch with extruded plastic netting held together with adhesives. The material is designed to enhance re-vegetation. The material is furnished in rolled strips, which must be secured to the ground with U-shaped staples or stakes in accordance with manufacturers' recommendations.

- **Coconut fiber blanket** should be a machine produced mat of 100 percent coconut fiber with biodegradable netting on the top and bottom. The coconut fiber should be attached to the netting with biodegradable thread or glue strips. The coconut fiber blanket should be of consistent thickness. The coconut fiber should be evenly distributed over the entire area of the blanket. Coconut fiber blanket should be furnished in rolled strips with a minimum of 6.5 ft wide, a minimum of 80 ft. long and a minimum of 0.5 lb/yd^2. Coconut fiber blankets must be secured in place with wire staples. Staples should be made of minimum 11 gauge steel wire and should be U-shaped with 8 in. legs and 2 in. crown.

- **Coconut fiber mesh** is a thin permeable membrane made from coconut or corn fiber that is spun into a yarn and woven into a biodegradable mat. It is designed to be used in conjunction with vegetation and typically has longevity of several years. The material is supplied in rolled strips, which must be secured to the soil with U-shaped staples or stakes in accordance with manufacturers' recommendations.

- **Straw coconut fiber blanket** should be machine produced mats of 70 percent straw and 30 percent coconut fiber with a biodegradable netting top layer and a biodegradable bottom net. The straw and coconut fiber should be attached to the netting with biodegradable thread or glue strips. The straw coconut fiber blanket should be of consistent thickness. The straw and coconut fiber should be evenly distributed over the entire area of the blanket. Straw coconut fiber blanket should be furnished in rolled strips a minimum of 6.5 ft wide, a minimum of 80 ft long and a minimum of 0.5 lb/yd^2. Straw coconut fiber blankets must be secured in place with wire staples. Staples should be made of minimum 11 gauge steel wire and should be U-shaped with 8 in. legs and 2 in. crown.

- Non-biodegradable RECPs are typically composed of polypropylene, polyethylene, nylon or other synthetic fibers. In some cases, a combination of biodegradable and synthetic fibers is used to construct the RECP. Netting used to hold these fibers together is typically non-biodegradable as well.

  - **Plastic netting** is a lightweight biaxially oriented netting designed for securing loose mulches like straw or paper to soil surfaces to establish vegetation. The netting is photodegradable. The netting is supplied in rolled strips, which must be secured with U-shaped staples or stakes in accordance with manufacturers' recommendations.

  - **Plastic mesh** is an open weave geotextile that is composed of an extruded synthetic fiber woven into a mesh with an opening size of less than ¼ in. It is used with re-vegetation or may be used to secure loose fiber such as straw to the ground. The material is supplied in rolled strips, which must be secured to the soil with U-shaped staples or stakes in accordance with manufacturers' recommendations.

  - **Synthetic fiber with netting** is a mat that is composed of durable synthetic fibers treated to resist chemicals and ultraviolet light. The mat is a dense, three dimensional mesh of synthetic (typically polyolefin) fibers stitched between two polypropylene nets. The mats are designed to be re-vegetated and provide a permanent composite system of soil, roots, and geomatrix. The material is furnished in rolled strips, which must be secured with U-shaped staples or stakes in accordance with manufacturers' recommendations.

  - **Bonded synthetic fibers** consist of a three dimensional geomatrix nylon (or other synthetic) matting. Typically it has more than 90 percent open area, which facilitates root growth. It's tough root reinforcing system anchors vegetation and protects against hydraulic lift and shear forces created by high volume discharges. It can be installed over prepared soil, followed by seeding into the mat. Once vegetated, it becomes an invisible composite system of soil, roots, and geomatrix. The material is furnished in rolled strips that must be secured with U-shaped staples or stakes in accordance with manufacturers' recommendations.

  - **Combination synthetic and biodegradable RECPs** consist of biodegradable fibers, such as wood fiber or coconut fiber, with a heavy polypropylene net stitched to the top and a high strength continuous filament geomatrix or net stitched to the bottom. The material is designed to enhance re-vegetation. The material is furnished in rolled strips,

which must be secured with U-shaped staples or stakes in accordance with manufacturers' recommendations.

Site Preparation

- Proper soil preparation is essential to ensure complete contact of the RECP with the soil. Soil Roughening is not recommended in areas where RECPs will be installed.
- Grade and shape the area of installation.
- Remove all rocks, clods, vegetation or other obstructions so that the installed blankets or mats will have complete, direct contact with the soil.
- Prepare seedbed by loosening 2 to 3 in. of topsoil.

Seeding/Planting

Seed the area before blanket installation for erosion control and re-vegetation. Seeding after mat installation is often specified for turf reinforcement application. When seeding prior to blanket installation, all areas disturbed during blanket installation must be re-seeded. Where soil filling is specified for turf reinforcement mats (TRMs), seed the matting and the entire disturbed area after installation and prior to filling the mat with soil.

Fertilize and seed in accordance with seeding specifications or other types of landscaping plans. The protective matting can be laid over areas where grass has been planted and the seedlings have emerged. Where vines or other ground covers are to be planted, lay the protective matting first and then plant through matting according to design of planting.

Check Slots

Check slots shall be installed as required by the manufacturer.

Laying and Securing Matting

- Before laying the matting, all check slots should be installed and the seedbed should be friable, made free from clods, rocks, and roots. The surface should be compacted and finished according to the requirements of the manufacturer's recommendations.
- Mechanical or manual lay down equipment should be capable of handling full rolls of fabric and laying the fabric smoothly without wrinkles or folds. The equipment should meet the fabric manufacturer's recommendations or equivalent standards.

Anchoring

- U-shaped wire staples, metal geotextile stake pins, or triangular wooden stakes can be used to anchor mats and blankets to the ground surface.
- Wire staples should be made of minimum 11 gauge steel wire and should be U-shaped with 8 in. legs and 2 in. crown.
- Metal stake pins should be 0.188 in. diameter steel with a 1.5 in. steel washer at the head of the pin, and 8 in. in length.
- Wire staples and metal stakes should be driven flush to the soil surface.

- Fold and secure all rolls of matting snugly into all transverse check slots. Lay mat in the bottom of the slot then fold back against itself. Anchor through both layers of mat at 12 in. intervals, then backfill and compact soil. Continue rolling all mat widths upstream to the next check slot or terminal anchor trench.
- Alternate method for non-critical installations: Place two rows of anchors on 6 in. centers at 25 to 30 ft. intervals in lieu of excavated check slots.
- Staple shingled lap spliced ends a minimum of 12 in. apart on 12 in. intervals.
- Place edges of outside mats in previously excavated longitudinal slots; anchor using prescribed staple pattern, backfill, and compact soil.
- Anchor, fill, and compact upstream end of mat in a 12 in. by 6 in. terminal trench.
- Secure mat to ground surface using U-shaped wire staples, geotextile pins, or wooden stakes.
- Seed and fill turf reinforcement matting with soil, if specified.

Soil Filling (if specified for turf reinforcement mat (TRM))

Installation should be in accordance with the manufacturer's recommendations. Typical installation guidelines are as follows:

- After seeding, spread and lightly rake ½-3/4 inches of fine topsoil into the TRM apertures to completely fill TRM thickness. Use backside of rake or other flat implement.
- Alternatively, if allowed by product specifications, spread topsoil using lightweight loader, backhoe, or other power equipment. Avoid sharp turns with equipment.
- Always consult the manufacturer's recommendations for installation.
- Do not drive tracked or heavy equipment over mat.
- Avoid any traffic over matting if loose or wet soil conditions exist.
- Use shovels, rakes, or brooms for fine grading and touch up.
- Smooth out soil filling just exposing top netting of mat.

Temporary Soil Stabilization Removal

- Temporary soil stabilization removed from the site of the work must be disposed of if necessary.

Costs

Installed costs can be relatively high compared to other BMPs. Approximate costs for installed materials are shown below:

Installation on Slopes

Installation should be in accordance with the manufacturer's recommendations. In general, these will be as follows:

- Begin at the top of the slope and anchor the blanket in a 6 in. deep by 6 in. wide trench. Backfill trench and tamp earth firmly.
- Unroll blanket down slope in the direction of water flow.
- Overlap the edges of adjacent parallel rolls 2 to 3 in. and staple every 3 ft (or greater, per manufacturer's specifications).
- When blankets must be spliced, place blankets end over end (shingle style) with 6 in. overlap. Staple through overlapped area, approximately 12 in. apart.
- Lay blankets loosely and maintain direct contact with the soil. Do not stretch.
- Staple blankets sufficiently to anchor blanket and maintain contact with the soil. Staples should be placed down the center and staggered with the staples placed along the edges. Steep slopes, 1:1 (H:V) to 2:1 (H:V), require a minimum of 2 staples/yd^2. Moderate slopes, 2:1 (H:V) to 3:1 (H:V), require a minimum of 1 ½ staples/yd^2. Check manufacturer's specifications to determine if a higher density staple pattern is required.

Installation in Channels

Installation should be in accordance with the manufacturer's recommendations. In general, these will be as follows:

- Dig initial anchor trench 12 in. deep and 6 in. wide across the channel at the lower end of the project area.
- Excavate intermittent check slots, 6 in. deep and 6 in. wide across the channel at 25 to 30 ft intervals along the channels.
- Cut longitudinal channel anchor trenches 4 in. deep and 4 in. wide along each side of the installation to bury edges of matting, whenever possible extend matting 2 to 3 in. above the crest of the channel side slopes.
- Beginning at the downstream end and in the center of the channel, place the initial end of the first roll in the anchor trench and secure with fastening devices at 12 in. intervals. Note: matting will initially be upside down in anchor trench.
- In the same manner, position adjacent rolls in anchor trench, overlapping the preceding roll a minimum of 3 in.
- Secure these initial ends of mats with anchors at 12 in. intervals, backfill and compact soil.
- Unroll center strip of matting upstream. Stop at next check slot or terminal anchor trench. Unroll adjacent mats upstream in similar fashion, maintaining a 3 in. overlap.

Rolled Erosion Control Products		Installed Cost per Acre (2004)[1]	Estimated Cost per Acre (2009)[2]
Biodegradable	Jute Mesh	$6,000-$7,000	$6,600-$7,700
	Curled Wood Fiber	$8,000-$10,500	$8,800-$11,050
	Straw	$8,000-$10,500	$8,800-$11,050
	Wood Fiber	$8,000-$10,500	$8,800-$11,050
	Coconut Fiber	$13,000-$14,000	$14,300-$15,400
	Coconut Fiber Mesh	$30,000-$33,000	$33,000-$36,300
	Straw Coconut Fiber	$10,000-$12,000	$11,000-$13,200
Non-Biodegradable	Plastic Netting	$2,000-$2,200	$2,200-$2,220
	Plastic Mesh	$3,000-$3,500	$3,300-$3,850
	Synthetic Fiber with Netting	$34,000-$40,000	$37,400-$44,000
	Bonded Synthetic Fibers	$45,000-$55,000	$49,500-$60,500
	Combination with Biodegradable	$30,000-$36,000	$33,000-$39,600

1. Source: Cost information received from individual product manufacturers solicited by Geosyntec Consultants (2004).

2. 2009 costs reflect a 10% escalation over year 2004 costs. Escalation based on informal survey of industry trends. Note: Expected cost increase is offset by competitive economic conditions.

Inspection and Maintenance

- RECPs must be inspected in accordance with General Permit requirements for the associated project type and risk level. It is recommended that at a minimum, BMPs be inspected weekly, prior to forecasted rain events, daily during extended rain events, and after the conclusion of rain events.
- Areas where erosion is evident shall be repaired and BMPs reapplied as soon as possible. Care should be exercised to minimize the damage to protected areas while making repairs, as any area damaged will require reapplication of BMPs.
- If washout or breakage occurs, re-install the material after repairing the damage to the slope or channel.
- Make sure matting is uniformly in contact with the soil.
- Check that all the lap joints are secure.
- Check that staples are flush with the ground.

References

Erosion and Sediment Control Manual, Oregon Department of Environmental Quality, February 2005

Erosion Control Pilot Study Report, State of California Department of Transportation (Caltrans), June 2000.

Guides for Erosion and Sediment Controls in California, USDA Soils Conservation Service, January 1991.

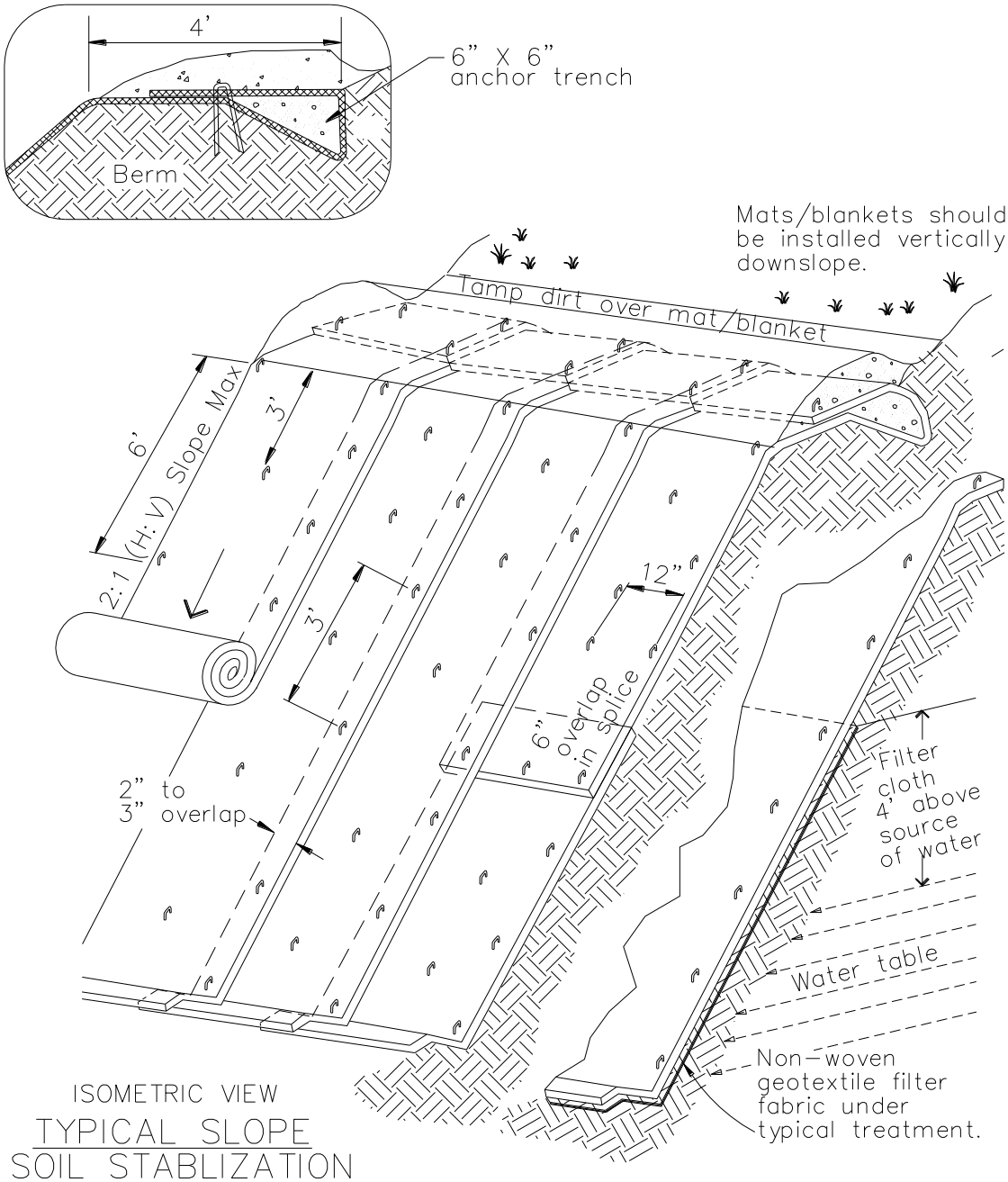
National Management Measures to Control Nonpoint Source Pollution from Urban Areas, United States Environmental Protection Agency, 2002.

Stormwater Quality Handbooks Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), March 2003.

Guidance Document: Soil Stabilization for Temporary Slopes, State of California Department of Transportation (Caltrans), November 1999.

Stormwater Management of the Puget Sound Basin, Technical Manual, Publication #91-75, Washington State Department of Ecology, February 1992.

Water Quality Management Plan for The Lake Tahoe Region, Volume II, Handbook of Management Practices, Tahoe Regional Planning Agency, November 1988.



ISOMETRIC VIEW

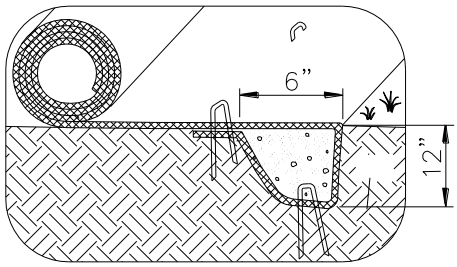
TYPICAL SLOPE
SOIL STABLIZATION
NTS

WET SLOPE LINING
NTS

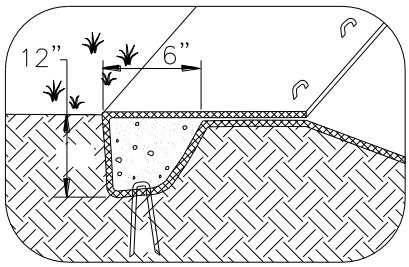
NOTES:

1. Slope surface shall be free of rocks, clods, sticks and grass. Mats/blankets shall have good soil contact.
2. Lay blankets loosely and stake or staple to maintain direct contact with the soil. Do not stretch.
3. Install per manufacturer's recommendations

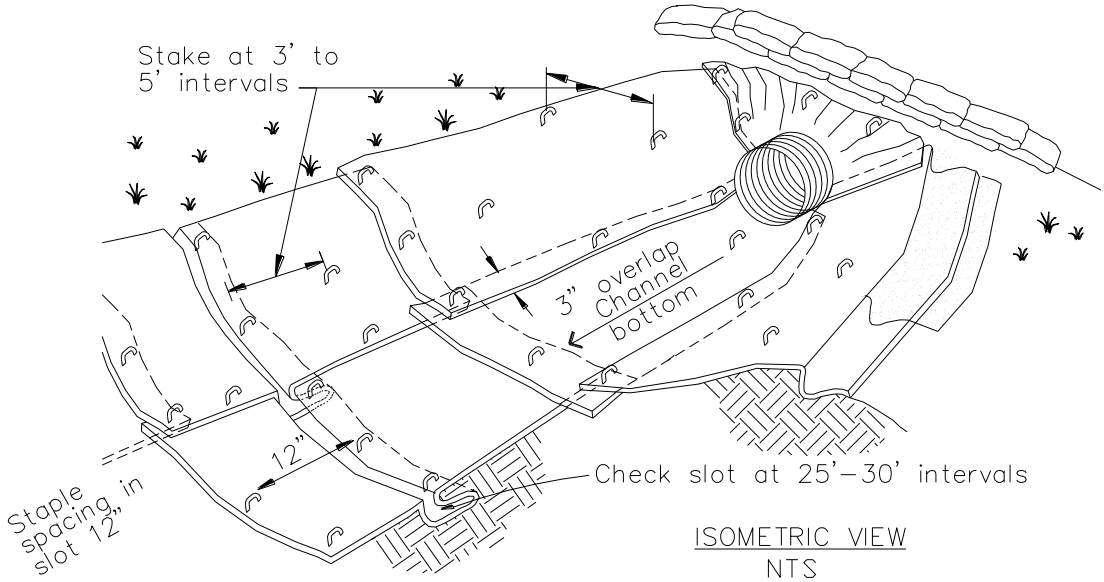
TYPICAL INSTALLATION DETAIL



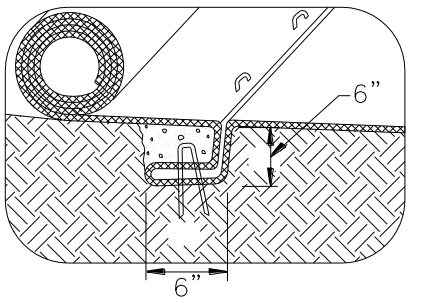
INITIAL CHANNEL ANCHOR TRENCH
NTS



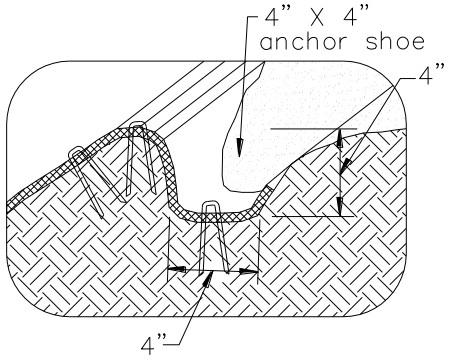
TERMINAL SLOPE AND CHANNEL ANCHOR TRENCH
NTS



ISOMETRIC VIEW
NTS



INTERMITTENT CHECK SLOT
NTS

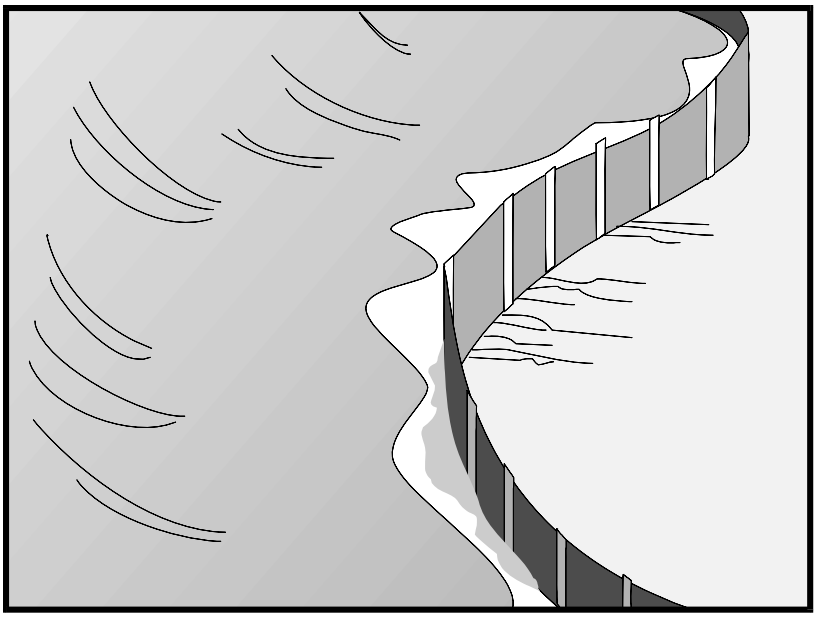


LONGITUDINAL ANCHOR TRENCH
NTS

NOTES:
1. Check slots to be constructed per manufacturers specifications.
2. Staking or stapling layout per manufacturers specifications.
3. Install per manufacturer's recommendations

TYPICAL INSTALLATION DETAIL

Silt Fence SE-1



Categories

EC	Erosion Control	
SE	Sediment Control	☑
TC	Tracking Control	
WE	Wind Erosion Control	
NS	Non-Stormwater Management Control	
WM	Waste Management and Materials Pollution Control	

Legend:
☑ **Primary Category**
☒ **Secondary Category**

Targeted Constituents

Sediment	☑
Nutrients	
Trash	
Metals	
Bacteria	
Oil and Grease	
Organics	

Potential Alternatives

SE-5 Fiber Rolls
SE-6 Gravel Bag Berm
SE-8 Sandbag Barrier
SE-10 Storm Drain Inlet Protection
SE-14 Biofilter Bags

Description and Purpose

A silt fence is made of a woven geotextile that has been entrenched, attached to supporting poles, and sometimes backed by a plastic or wire mesh for support. The silt fence detains sediment-laden water, promoting sedimentation behind the fence.

Suitable Applications

Silt fences are suitable for perimeter control, placed below areas where sheet flows discharge from the site. They could also be used as interior controls below disturbed areas where runoff may occur in the form of sheet and rill erosion and around inlets within disturbed areas (SE-10). Silt fences are generally ineffective in locations where the flow is concentrated and are only applicable for sheet or overland flows. Silt fences are most effective when used in combination with erosion controls. Suitable applications include:

- Along the perimeter of a project.
- Below the toe or down slope of exposed and erodible slopes.
- Along streams and channels.
- Around temporary spoil areas and stockpiles.
- Around inlets.
- Below other small cleared areas.

Limitations

- Do not use in streams, channels, drain inlets, or anywhere flow is concentrated.
- Do not use in locations where ponded water may cause a flooding hazard. Runoff typically ponds temporarily on the upstream side of silt fence.
- Do not use silt fence to divert water flows or place across any contour line. Fences not constructed on a level contour, or fences used to divert flow will concentrate flows resulting in additional erosion and possibly overtopping or failure of the silt fence.
- Improperly installed fences are subject to failure from undercutting, overtopping, or collapsing.
- Not effective unless trenched and keyed in.
- Not intended for use as mid-slope protection on slopes greater than 4:1 (H:V).
- Do not use on slopes subject to creeping, slumping, or landslides.

Implementation

General

A silt fence is a temporary sediment barrier consisting of woven geotextile stretched across and attached to supporting posts, trenched-in, and, depending upon the strength of fabric used, supported with plastic or wire mesh fence. Silt fences trap sediment by intercepting and detaining small amounts of sediment-laden runoff from disturbed areas in order to promote sedimentation behind the fence.

The following layout and installation guidance can improve performance and should be followed:

- Use principally in areas where sheet flow occurs.
- Install along a level contour, so water does not pond more than 1.5 ft at any point along the silt fence.
- The maximum length of slope draining to any point along the silt fence should be 200 ft or less.
- The maximum slope perpendicular to the fence line should be 1:1.
- Provide sufficient room for runoff to pond behind the fence and to allow sediment removal equipment to pass between the silt fence and toes of slopes or other obstructions. About 1200 ft^2 of ponding area should be provided for every acre draining to the fence.
- Turn the ends of the filter fence uphill to prevent stormwater from flowing around the fence.
- Leave an undisturbed or stabilized area immediately down slope from the fence where feasible.

- Silt fences should remain in place until the disturbed area is permanently stabilized, after which, the silt fence should be removed and properly disposed.
- Silt fence should be used in combination with erosion source controls up slope in order to provide the most effective sediment control.
- Be aware of local regulations regarding the type and installation requirements of silt fence, which may differ from those presented in this fact sheet.

Design and Layout

The fence should be supported by a plastic or wire mesh if the fabric selected does not have sufficient strength and bursting strength characteristics for the planned application (as recommended by the fabric manufacturer). Woven geotextile material should contain ultraviolet inhibitors and stabilizers to provide a minimum of six months of expected usable construction life at a temperature range of 0 °F to 120 °F.

- Layout in accordance with attached figures.
- For slopes steeper than 2:1 (H:V) and that contain a high number of rocks or large dirt clods that tend to dislodge, it may be necessary to install additional protection immediately adjacent to the bottom of the slope, prior to installing silt fence. Additional protection may be a chain link fence or a cable fence.
- For slopes adjacent to sensitive receiving waters or Environmentally Sensitive Areas (ESAs), silt fence should be used in conjunction with erosion control BMPs.

Standard vs. Heavy Duty Silt Fence

Standard Silt Fence

- Generally applicable in cases where the slope of area draining to the silt fence is 4:1 (H:V) or less.
- Used for shorter durations, typically 5 months or less
- Area draining to fence produces moderate sediment loads.

Heavy Duty Silt Fence

- Use is generally limited to 8 months or less.
- Area draining to fence produces moderate sediment loads.
- Heavy duty silt fence usually has 1 or more of the following characteristics, not possessed by standard silt fence.
  - Fence fabric has higher tensile strength.
  - Fabric is reinforced with wire backing or additional support.
  - Posts are spaced closer than pre-manufactured, standard silt fence products.
  - Posts are metal (steel or aluminum)

Materials

Standard Silt Fence

- Silt fence material should be woven geotextile with a minimum width of 36 in. and a minimum tensile strength of 100 lb force. The fabric should conform to the requirements in ASTM designation D4632 and should have an integral reinforcement layer. The

reinforcement layer should be a polypropylene, or equivalent, net provided by the manufacturer. The permittivity of the fabric should be between 0.1 sec^{-1} and 0.15 sec^{-1} in conformance with the requirements in ASTM designation D4491.

- Wood stakes should be commercial quality lumber of the size and shape shown on the plans. Each stake should be free from decay, splits or cracks longer than the thickness of the stake or other defects that would weaken the stakes and cause the stakes to be structurally unsuitable.

- Staples used to fasten the fence fabric to the stakes should be not less than 1.75 in. long and should be fabricated from 15 gauge or heavier wire. The wire used to fasten the tops of the stakes together when joining two sections of fence should be 9 gauge or heavier wire. Galvanizing of the fastening wire will not be required.

Heavy-Duty Silt Fence

- Some silt fence has a wire backing to provide additional support, and there are products that may use prefabricated plastic holders for the silt fence and use metal posts or bar reinforcement instead of wood stakes. If bar reinforcement is used in lieu of wood stakes, use number four or greater bar. Provide end protection for any exposed bar reinforcement for health and safety purposes.

Installation Guidelines – Traditional Method

Silt fences are to be constructed on a level contour. Sufficient area should exist behind the fence for ponding to occur without flooding or overtopping the fence.

- A trench should be excavated approximately 6 in. wide and 6 in. deep along the line of the proposed silt fence (trenches should not be excavated wider or deeper than necessary for proper silt fence installation).

- Bottom of the silt fence should be keyed-in a minimum of 12 in.

- Posts should be spaced a maximum of 6 ft apart and driven securely into the ground a minimum of 18 in. or 12 in. below the bottom of the trench.

- When standard strength geotextile is used, a plastic or wire mesh support fence should be fastened securely to the upslope side of posts using heavy–duty wire staples at least 1 in. long. The mesh should extend into the trench.

- When extra-strength geotextile and closer post spacing are used, the mesh support fence may be eliminated.

- Woven geotextile should be purchased in a long roll, then cut to the length of the barrier. When joints are necessary, geotextile should be spliced together only at a support post, with a minimum 6 in. overlap and both ends securely fastened to the post.

- The trench should be backfilled with native material and compacted.

- Construct silt fences with a setback of at least 3 ft from the toe of a slope. Where, due to specific site conditions, a 3 ft setback is not available, the silt fence may be constructed at the

toe of the slope, but should be constructed as far from the toe of the slope as practicable. Silt fences close to the toe of the slope will be less effective and more difficult to maintain.

- Construct the length of each reach so that the change in base elevation along the reach does not exceed 1/3 the height of the barrier; in no case should the reach exceed 500 ft.
- Cross barriers should be a minimum of $^1/_3$ and a maximum of ½ the height of the linear barrier.
- See typical installation details at the end of this fact sheet.

Installation Guidelines - Static Slicing Method

- Static Slicing is defined as insertion of a narrow blade pulled behind a tractor, similar to a plow blade, at least 10 inches into the soil while at the same time pulling silt geotextile fabric into the ground through the opening created by the blade to the depth of the blade. Once the gerotextile is installed, the soil is compacted using tractor tires.
- This method will not work with pre-fabricated, wire backed silt fence.
- Benefits:
    - Ease of installation (most often done with a 2 person crew). In addition, installation using static slicing has been found to be more efficient on slopes, in rocky soils, and in saturated soils.
    - Minimal soil disturbance.
    - Greater level of compaction along fence, leading to higher performance (i.e. greater sediment retention).
    - Uniform installation.
    - Less susceptible to undercutting/undermining.

Costs

- It should be noted that costs vary greatly across regions due to available supplies and labor costs.
- Average annual cost for installation using the traditional silt fence installation method (assumes 6 month useful life) is $7 per linear foot based on vendor research. Range of cost is $3.50 - $9.10 per linear foot.
- In tests, the slicing method required 0.33 man hours per 100 linear feet, while the trenched based systems required as much as 1.01 man hours per linear foot.

Inspection and Maintenance

- BMPs must be inspected in accordance with General Permit requirements for the associated project type and risk level. It is recommended that at a minimum, BMPs be inspected weekly, prior to forecasted rain events, daily during extended rain events, and after the conclusion of rain events.
- Repair undercut silt fences.

- Repair or replace split, torn, slumping, or weathered fabric. The lifespan of silt fence fabric is generally 5 to 8 months.
- Silt fences that are damaged and become unsuitable for the intended purpose should be removed from the site of work, disposed, and replaced with new silt fence barriers.
- Sediment that accumulates in the BMP should be periodically removed in order to maintain BMP effectiveness. Sediment should be removed when the sediment accumulation reaches one-third of the barrier height.
- Silt fences should be left in place until the upstream area is permanently stabilized. Until then, the silt fence should be inspected and maintained regularly.
- Remove silt fence when upgradient areas are stabilized. Fill and compact post holes and anchor trench, remove sediment accumulation, grade fence alignment to blend with adjacent ground, and stabilize disturbed area.

References

Manual of Standards of Erosion and Sediment Control Measures, Association of Bay Area Governments, May 1995.

National Management Measures to Control Nonpoint Source Pollution from Urban Areas, United States Environmental Protection Agency, 2002.

Proposed Guidance Specifying Management Measures for Sources of Nonpoint Pollution in Coastal Waters, Work Group-Working Paper, USEPA, April 1992.

Sedimentation and Erosion Control Practices, and Inventory of Current Practices (Draft), UESPA, 1990.

Southeastern Wisconsin Regional Planning Commission (SWRPC). Costs of Urban Nonpoint Source Water Pollution Control Measures. Technical Report No. 31. Southeastern Wisconsin Regional Planning Commission, Waukesha, WI. 1991

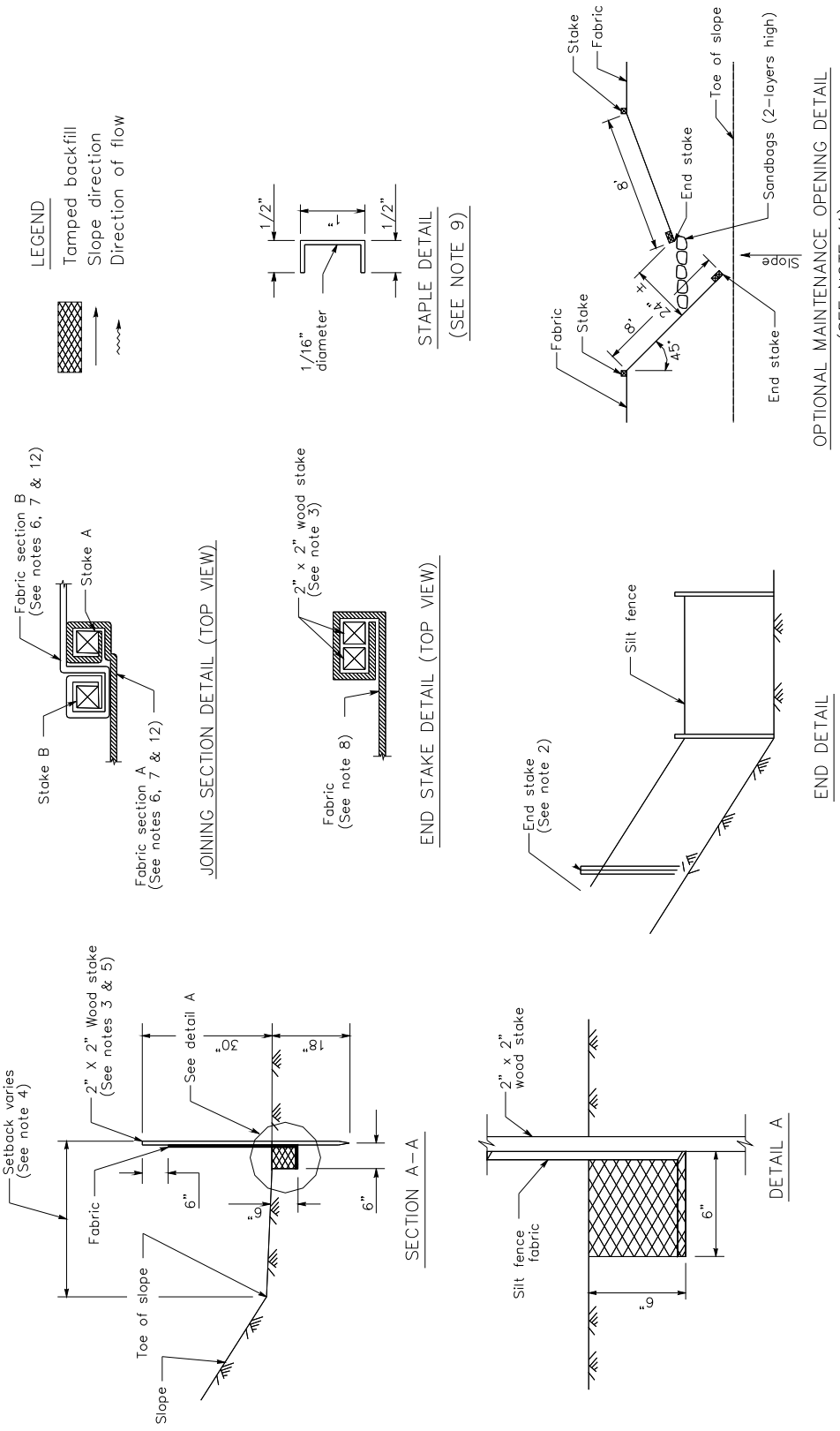
Stormwater Quality Handbooks - Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), March 2003.

Stormwater Management Manual for The Puget Sound Basin, Washington State Department of Ecology, Public Review Draft, 1991.

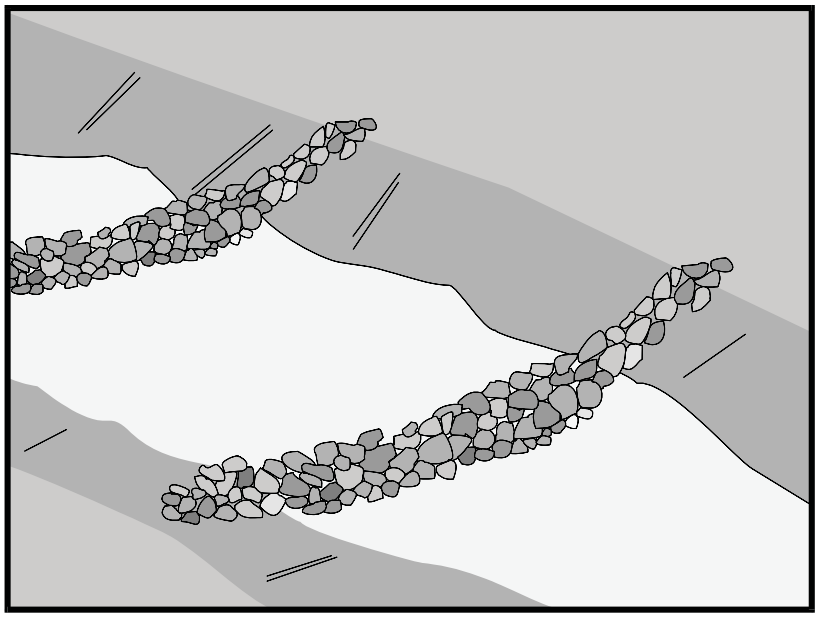
U.S. Environmental Protection Agency (USEPA). Stormwater Management for Industrial Activities: Developing Pollution Prevention Plans and Best Management Practices. U.S. Environmental Protection Agency, Office of Water, Washington, DC, 1992.

Water Quality Management Plan for the Lake Tahoe Region, Volume II, Handbook of Management Practices, Tahoe Regional Planning Agency, November 1988.Soil Stabilization BMP Research for Erosion and Sediment Controls: Cost Survey Technical Memorandum, State of California Department of Transportation (Caltrans), July 2007.

Erosion and Sediment Control Manual, Oregon Department of Environmental Quality, February 2005.


LEGEND
Tamped backfill
Slope direction
Direction of flow
1/2"
1"
1/2"
1/16" diameter
STAPLE DETAIL
(SEE NOTE 9)
Stake
Fabric
Toe of slope
8'
End stake
Sandbags (2-layers high)
4"
8'
45°
Fabric
Stake
End stake
OPTIONAL MAINTENANCE OPENING DETAIL
(SEE NOTE 11)
Fabric section B
(See notes 6, 7 & 12)
Stake A
Stake B
Fabric section A
(See notes 6, 7 & 12)
JOINING SECTION DETAIL (TOP VIEW)
2" x 2" wood stake
(See note 3)
Fabric
(See note 8)
END STAKE DETAIL (TOP VIEW)
Silt fence
End stake
(See note 2)
END DETAIL
Setback varies
(See note 4)
2" X 2" Wood stake
(See notes 3 & 5)
See detail A
30"
18"
Fabric
6"
6"
6"
Toe of slope
Slope
SECTION A-A
2" x 2"
wood stake
Silt fence
fabric
6"
6"
DETAIL A

Check Dams SE-4



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TC	Tracking Control	
WE	Wind Erosion Control	
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WM	Waste Management and Materials Pollution Control	

Legend:
☑ **Primary Category**
☒ **Secondary Category**

Targeted Constituents

Sediment	☑
Nutrients	
Trash	
Metals	
Bacteria	
Oil and Grease	
Organics	

Potential Alternatives

SE-5 Fiber Rolls
SE-6 Gravel Bag Berm
SE-8 Sandbag Barrier
SE-14 Biofilter Bags

Description and Purpose

A check dam is a small barrier constructed of rock, gravel bags, sandbags, fiber rolls, or other proprietary products, placed across a constructed swale or drainage ditch. Check dams reduce the effective slope of the channel, thereby reducing scour and channel erosion by reducing flow velocity and increasing residence time within the channel, allowing sediment to settle.

Suitable Applications

Check dams may be appropriate in the following situations:

- To promote sedimentation behind the dam.
- To prevent erosion by reducing the velocity of channel flow in small intermittent channels and temporary swales.
- In small open channels that drain 10 acres or less.
- In steep channels where stormwater runoff velocities exceed 5 ft/s.
- During the establishment of grass linings in drainage ditches or channels.
- In temporary ditches where the short length of service does not warrant establishment of erosion-resistant linings.
- To act as a grade control structure.

Limitations

- Not to be used in live streams or in channels with extended base flows.
- Not appropriate in channels that drain areas greater than 10 acres.
- Not appropriate in channels that are already grass-lined unless erosion potential or sediment-laden flow is expected, as installation may damage vegetation.
- Require extensive maintenance following high velocity flows.
- Promotes sediment trapping which can be re-suspended during subsequent storms or removal of the check dam.
- Do not construct check dams with straw bales or silt fence.
- Water suitable for mosquito production may stand behind check dams, particularly if subjected to daily non-stormwater discharges.

Implementation

General

Check dams reduce the effective slope and create small pools in swales and ditches that drain 10 acres or less. Using check dams to reduce channel slope reduces the velocity of stormwater flows, thus reducing erosion of the swale or ditch and promoting sedimentation. Thus, check dams are dual-purpose and serve an important role as erosion controls as well as as sediment controls. Note that use of 1-2 isolated check dams for sedimentation will likely result in little net removal of sediment because of the small detention time and probable scour during longer storms. Using a series of check dams will generally increase their effectiveness. A sediment trap (SE-3) may be placed immediately upstream of the check dam to increase sediment removal efficiency.

Design and Layout

Check dams work by decreasing the effective slope in ditches and swales. An important consequence of the reduced slope is a reduction in capacity of the ditch or swale. This reduction in capacity should be considered when using this BMP, as reduced capacity can result in overtopping of the ditch or swale and resultant consequences. In some cases, such as a "permanent" ditch or swale being constructed early and used as a "temporary" conveyance for construction flows, the ditch or swale may have sufficient capacity such that the temporary reduction in capacity due to check dams is acceptable. When check dams reduce capacities beyond acceptable limits, either:

- Don't use check dams. Consider alternative BMPs, or.
- Increase the size of the ditch or swale to restore capacity.

Maximum slope and velocity reduction is achieved when the toe of the upstream dam is at the same elevation as the top of the downstream dam (see "Spacing Between Check Dams" detail at the end of this fact sheet). The center section of the dam should be lower than the edge sections (at least 6 inches), acting as a spillway, so that the check dam will direct flows to the center of

the ditch or swale (see "Typical Rock Check Dam" detail at the end of this fact sheet). Bypass or side-cutting can occur if a sufficient spillway is not provided in the center of the dam.

Check dams are usually constructed of rock, gravel bags, sandbags, and fiber rolls. A number of products can also be used as check dams (e.g. HDPE check dams, temporary silt dikes (SE-12)), and some of these products can be removed and reused. Check dams can also be constructed of logs or lumber, and have the advantage of a longer lifespan when compared to gravel bags, sandbags, and fiber rolls. Check dams should not be constructed from straw bales or silt fences, since concentrated flows quickly wash out these materials.

Rock check dams are usually constructed of 8 to 12 in. rock. The rock is placed either by hand or mechanically, but never just dumped into the channel. The dam should completely span the ditch or swale to prevent washout. The rock used should be large enough to stay in place given the expected design flow through the channel. It is recommended that abutments be extended 18 in. into the channel bank. Rock can be graded such that smaller diameter rock (e.g. 2-4 in) is located on the upstream side of larger rock (holding the smaller rock in place); increasing residence time.

Log check dams are usually constructed of 4 to 6 in. diameter logs, installed vertically. The logs should be embedded into the soil at least 18 in. Logs can be bolted or wired to vertical support logs that have been driven or buried into the soil.

See fiber rolls, SE-5, for installation of fiber roll check dams.

Gravel bag and sand bag check dams are constructed by stacking bags across the ditch or swale, shaped as shown in the drawings at the end of this fact sheet (see "Gravel Bag Check Dam" detail at the end of this fact sheet).

Manufactured products, such as temporary silt dikes (SE-12), should be installed in accordance with the manufacturer's instructions. Installation typically requires anchoring or trenching of products, as well as regular maintenance to remove accumulated sediment and debris.

If grass is planted to stabilize the ditch or swale, the check dam should be removed when the grass has matured (unless the slope of the swales is greater than 4%).

The following guidance should be followed for the design and layout of check dams:

- Install the first check dam approximately 16 ft from the outfall device and at regular intervals based on slope gradient and soil type.
- Check dams should be placed at a distance and height to allow small pools to form between each check dam.
- For multiple check dam installation, backwater from a downstream check dam should reach the toes of the upstream check dam.
- A sediment trap provided immediately upstream of the check dam will help capture sediment. Due to the potential for this sediment to be resuspended in subsequent storms, the sediment trap should be cleaned following each storm event.

- High flows (typically a 2-year storm or larger) should safely flow over the check dam without an increase in upstream flooding or damage to the check dam.
- Where grass is used to line ditches, check dams should be removed when grass has matured sufficiently to protect the ditch or swale.

Materials

- Rock used for check dams should typically be 8-12 in rock and be sufficiently sized to stay in place given expected design flows in the channel. Smaller diameter rock (e.g. 2 to 4 in) can be placed on the upstream side of larger rock to increase residence time.
- Gravel bags used for check dams should conform to the requirements of SE-6, Gravel Bag Berms.
- Sandbags used for check dams should conform to SE-8, Sandbag Barrier.
- Fiber rolls used for check dams should conform to SE-5, Fiber Rolls.
- Temporary silt dikes used for check dams should conform to SE-12, Temporary Silt Dikes.

Installation

- Rock should be placed individually by hand or by mechanical methods (no dumping of rock) to achieve complete ditch or swale coverage.
- Tightly abut bags and stack according to detail shown in the figure at the end of this section (pyramid approach). Gravel bags and sandbags should not be stacked any higher than 3 ft.
- Upper rows or gravel and sand bags shall overlap joints in lower rows.
- Fiber rolls should be trenched in, backfilled, and firmly staked in place.
- Install along a level contour.
- HDPE check dams, temporary silt dikes, and other manufactured products should be used and installed per manufacturer specifications.

Costs

Cost consists of labor costs if materials are readily available (such as gravel on-site). If material must be imported, costs will increase. For other material and installation costs, see SE-5, SE-6, SE-8, SE-12, and SE-14.

Inspection and Maintenance

- BMPs must be inspected in accordance with General Permit requirements for the associated project type and risk level. It is recommended that at a minimum, BMPs be inspected weekly, prior to forecasted rain events, daily during extended rain events, and after the conclusion of rain events.
- Replace missing rock, bags, rolls, etc. Replace bags or rolls that have degraded or have become damaged.

- If the check dam is used as a sediment capture device, sediment that accumulates behind the BMP should be periodically removed in order to maintain BMP effectiveness. Sediment should be removed when the sediment accumulation reaches one-third of the barrier height.
- If the check dam is used as a grade control structure, sediment removal is not required as long as the system continues to control the grade.
- Inspect areas behind check dams for pools of standing water, especially if subjected to daily non-stormwater discharges.
- Remove accumulated sediment prior to permanent seeding or soil stabilization.
- Remove check dam and accumulated sediment when check dams are no longer needed.

References

Draft – Sedimentation and Erosion Control, and Inventory of Current Practices, USEPA, April 1990.

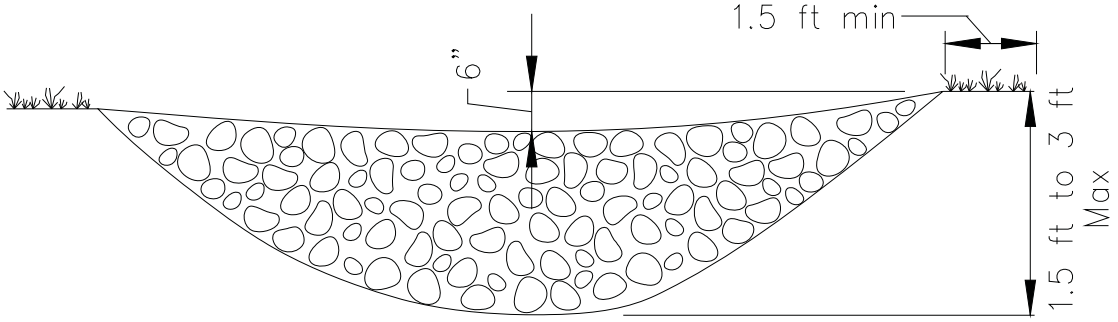
Manual of Standards of Erosion and Sediment Control Measures, Association of Bay Area Governments, May 1995.

Stormwater Quality Handbooks - Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), March 2003.

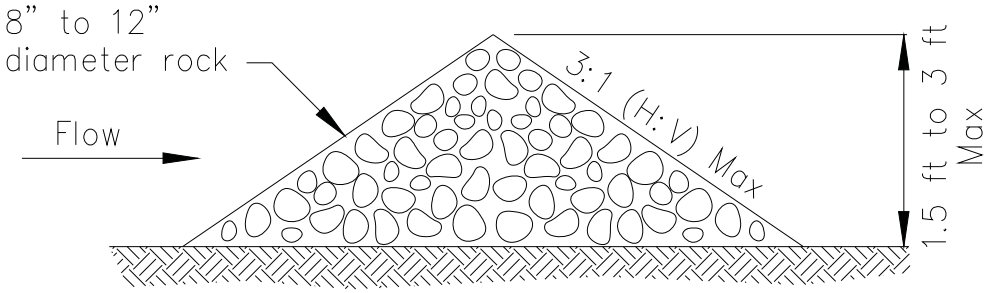
Stormwater Management of the Puget Sound Basin, Technical Manual, Publication #91-75, Washington State Department of Ecology, February 1992.

Erosion and Sediment Control Manual, Oregon Department of Environmental Quality, February 2005.

Metzger, M.E. 2004. Managing mosquitoes in stormwater treatment devices. University of California Division of Agriculture and Natural Resources, Publication 8125. On-line: http://anrcatalog.ucdavis.edu/pdf/8125.pdf

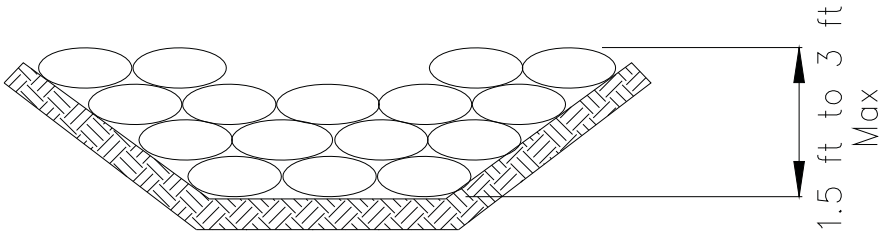


ELEVATION

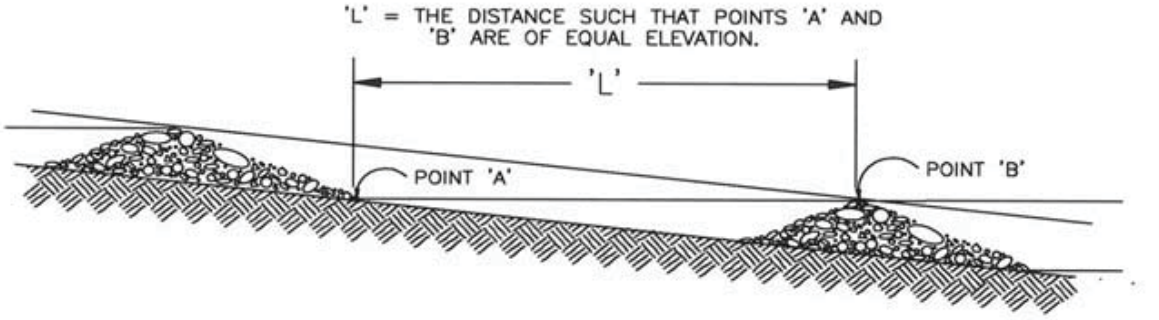


TYPICAL ROCK CHECK DAM SECTION

ROCK CHECK DAM
NOT TO SCALE

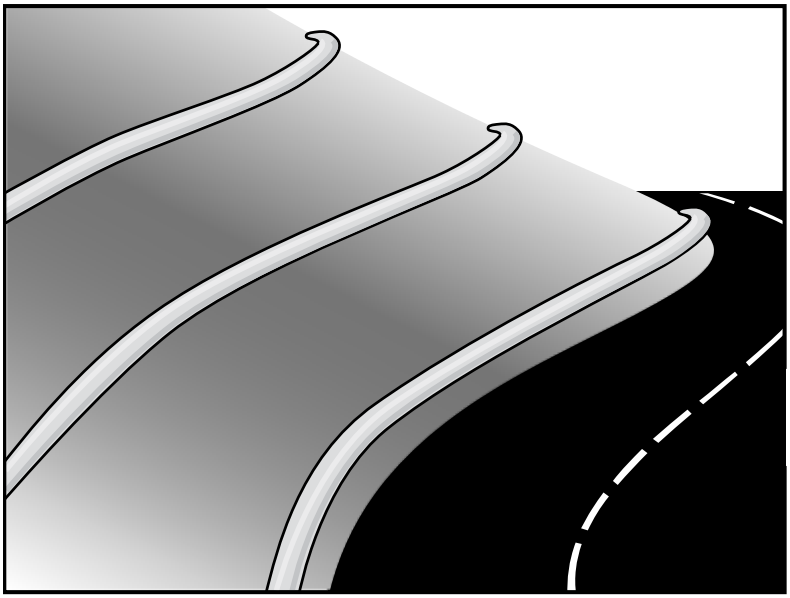


GRAVEL BAG CHECK DAM ELEVATION
NOT TO SCALE



SPACING BETWEEN CHECK DAMS

Fiber Rolls SE-5



Categories

EC	Erosion Control	☒
SE	Sediment Control	☑
TC	Tracking Control	
WE	Wind Erosion Control	
NS	Non-Stormwater Management Control	
WM	Waste Management and Materials Pollution Control	

Legend:
☑ **Primary Category**
☒ **Secondary Category**

Description and Purpose

A fiber roll consists of straw, coir, or other biodegradable materials bound into a tight tubular roll wrapped by netting, which can be photodegradable or natural. Additionally, gravel core fiber rolls are available, which contain an imbedded ballast material such as gravel or sand for additional weight when staking the rolls are not feasible (such as use as inlet protection). When fiber rolls are placed at the toe and on the face of slopes along the contours, they intercept runoff, reduce its flow velocity, release the runoff as sheet flow, and provide removal of sediment from the runoff (through sedimentation). By interrupting the length of a slope, fiber rolls can also reduce sheet and rill erosion until vegetation is established.

Targeted Constituents

Sediment	☑
Nutrients	
Trash	
Metals	
Bacteria	
Oil and Grease	
Organics	

Potential Alternatives

SE-1 Silt Fence

SE-6 Gravel Bag Berm

SE-8 Sandbag Barrier

SE-14 Biofilter Bags

Suitable Applications

Fiber rolls may be suitable:

- Along the toe, top, face, and at grade breaks of exposed and erodible slopes to shorten slope length and spread runoff as sheet flow.
- At the end of a downward slope where it transitions to a steeper slope.
- Along the perimeter of a project.
- As check dams in unlined ditches with minimal grade.
- Down-slope of exposed soil areas.
- At operational storm drains as a form of inlet protection.

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- Around temporary stockpiles.

Limitations

- Fiber rolls are not effective unless trenched in and staked.
- Not intended for use in high flow situations.
- Difficult to move once saturated.
- If not properly staked and trenched in, fiber rolls could be transported by high flows.
- Fiber rolls have a very limited sediment capture zone.
- Fiber rolls should not be used on slopes subject to creep, slumping, or landslide.
- Rolls typically function for 12-24 months depending upon local conditions.

Implementation

Fiber Roll Materials

- Fiber rolls should be prefabricated.
- Fiber rolls may come manufactured containing polyacrylamide (PAM), a flocculating agent within the roll. Fiber rolls impregnated with PAM provide additional sediment removal capabilities and should be used in areas with fine, clayey or silty soils to provide additional sediment removal capabilities. Monitoring may be required for these installations.
- Fiber rolls are made from weed free rice straw, flax, or a similar agricultural material bound into a tight tubular roll by netting.
- Typical fiber rolls vary in diameter from 9 in. to 20 in. Larger diameter rolls are available as well.

Installation

- Locate fiber rolls on level contours spaced as follows:
  - Slope inclination of 4:1 (H:V) or flatter: Fiber rolls should be placed at a maximum interval of 20 ft.
  - Slope inclination between 4:1 and 2:1 (H:V): Fiber Rolls should be placed at a maximum interval of 15 ft. (a closer spacing is more effective).
  - Slope inclination 2:1 (H:V) or greater: Fiber Rolls should be placed at a maximum interval of 10 ft. (a closer spacing is more effective).
- Prepare the slope before beginning installation.
- Dig small trenches across the slope on the contour. The trench depth should be ¼ to 1/3 of the thickness of the roll, and the width should equal the roll diameter, in order to provide area to backfill the trench.

- It is critical that rolls are installed perpendicular to water movement, and parallel to the slope contour.
- Start building trenches and installing rolls from the bottom of the slope and work up.
- It is recommended that pilot holes be driven through the fiber roll. Use a straight bar to drive holes through the roll and into the soil for the wooden stakes.
- Turn the ends of the fiber roll up slope to prevent runoff from going around the roll.
- Stake fiber rolls into the trench.
  - Drive stakes at the end of each fiber roll and spaced 4 ft maximum on center.
  - Use wood stakes with a nominal classification of 0.75 by 0.75 in. and minimum length of 24 in.
- If more than one fiber roll is placed in a row, the rolls should be overlapped, not abutted.
- See typical fiber roll installation details at the end of this fact sheet.

Removal

- Fiber rolls can be left in place or removed depending on the type of fiber roll and application (temporary vs. permanent installation). Typically, fiber rolls encased with plastic netting are used for a temporary application because the netting does not biodegrade. Fiber rolls used in a permanent application are typically encased with a biodegradeable material and are left in place. Removal of a fiber roll used in a permanent application can result in greater disturbance.
- Temporary installations should only be removed when up gradient areas are stabilized per General Permit requirements, and/or pollutant sources no longer present a hazard. But, they should also be removed before vegetation becomes too mature so that the removal process does not disturb more soil and vegetation than is necessary.

Costs

Material costs for regular fiber rolls range from $20 - $30 per 25 ft roll.

Material costs for PAM impregnated fiber rolls range between 7.00-$9.00 per linear foot, based upon vendor research.

Inspection and Maintenance

- BMPs must be inspected in accordance with General Permit requirements for the associated project type and risk level. It is recommended that at a minimum, BMPs be inspected weekly, prior to forecasted rain events, daily during extended rain events, and after the conclusion of rain events.
- Repair or replace split, torn, unraveling, or slumping fiber rolls.
- If the fiber roll is used as a sediment capture device, or as an erosion control device to maintain sheet flows, sediment that accumulates in the BMP should be periodically removed

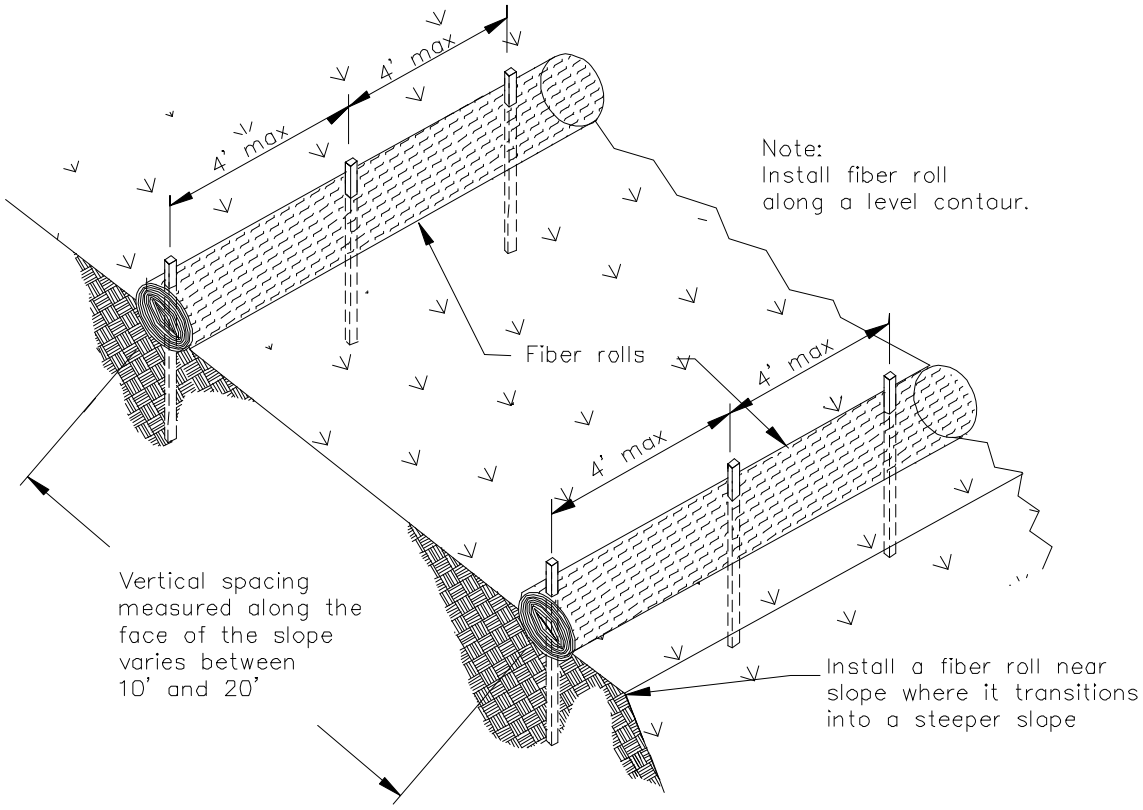
in order to maintain BMP effectiveness. Sediment should be removed when sediment accumulation reaches one-third the designated sediment storage depth.

- If fiber rolls are used for erosion control, such as in a check dam, sediment removal should not be required as long as the system continues to control the grade. Sediment control BMPs will likely be required in conjunction with this type of application.
- Repair any rills or gullies promptly.

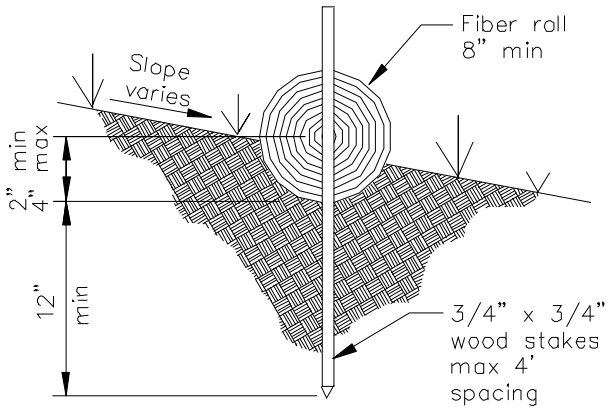
References

Stormwater Quality Handbooks - Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), March 2003.

Erosion and Sediment Control Manual, Oregon Department of Environmental Quality, February 2005.

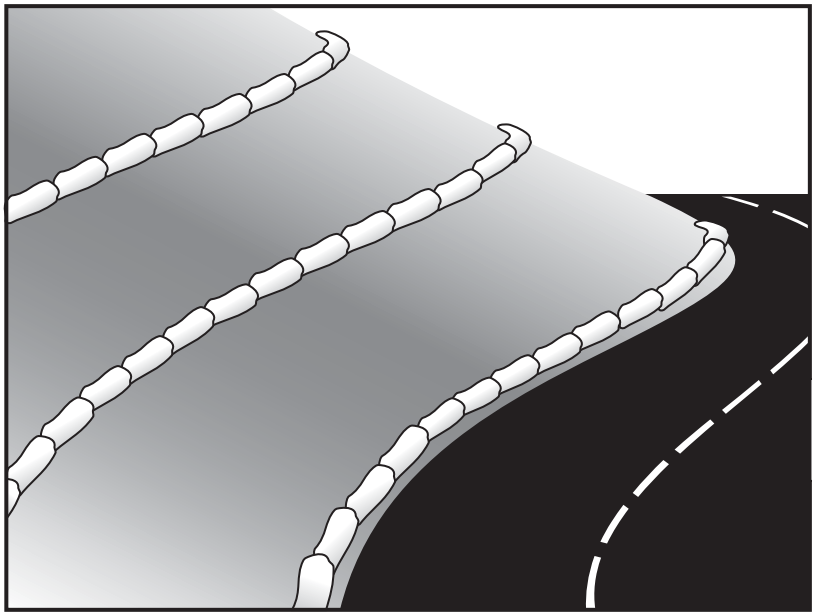


TYPICAL FIBER ROLL INSTALLATION
N.T.S.



ENTRENCHMENT DETAIL
N.T.S.

Gravel Bag Berm SE-6



Description and Purpose

A gravel bag berm is a series of gravel-filled bags placed on a level contour to intercept sheet flows. Gravel bags pond sheet flow runoff, allowing sediment to settle out, and release runoff slowly as sheet flow, preventing erosion.

Suitable Applications

Gravel bag berms may be suitable:

- As a linear sediment control measure:
  - Below the toe of slopes and erodible slopes
  - As sediment traps at culvert/pipe outlets
  - Below other small cleared areas
  - Along the perimeter of a site
  - Down slope of exposed soil areas
  - Around temporary stockpiles and spoil areas
  - Parallel to a roadway to keep sediment off paved areas
  - Along streams and channels
- As a linear erosion control measure:
  - Along the face and at grade breaks of exposed and erodible slopes to shorten slope length and spread runoff as sheet flow.

Categories

EC	Erosion Control	☒
SE	Sediment Control	☑
TC	Tracking Control	
WE	Wind Erosion Control	
NS	Non-Stormwater Management Control	
WM	Waste Management and Materials Pollution Control	

Legend:

☑ **Primary Category**

☒ **Secondary Category**

Targeted Constituents

Sediment	☑
Nutrients	
Trash	
Metals	
Bacteria	
Oil and Grease	
Organics	

Potential Alternatives

SE-1 Silt Fence

SE-5 Fiber Roll

SE-8 Sandbag Barrier

SE-14 Biofilter Bags

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- At the top of slopes to divert runoff away from disturbed slopes.
- As chevrons (small check dams) across mildly sloped construction roads. For use check dam use in channels, see SE-4, Check Dams.

Limitations

- Gravel berms may be difficult to remove.
- Removal problems limit their usefulness in landscaped areas.
- Gravel bag berm may not be appropriate for drainage areas greater than 5 acres.
- Runoff will pond upstream of the berm, possibly causing flooding if sufficient space does not exist.
- Degraded gravel bags may rupture when removed, spilling contents.
- Installation can be labor intensive.
- Durability of gravel bags is somewhat limited and bags may need to be replaced when installation is required for longer than 6 months.
- Easily damaged by construction equipment.
- When used to detain concentrated flows, maintenance requirements increase.

Implementation

General

A gravel bag berm consists of a row of open graded gravel-filled bags placed on a level contour. When appropriately placed, a gravel bag berm intercepts and slows sheet flow runoff, causing temporary ponding. The temporary ponding allows sediment to settle. The open graded gravel in the bags is porous, which allows the ponded runoff to flow slowly through the bags, releasing the runoff as sheet flows. Gravel bag berms also interrupt the slope length and thereby reduce erosion by reducing the tendency of sheet flows to concentrate into rivulets, which erode rills, and ultimately gullies, into disturbed, sloped soils. Gravel bag berms are similar to sand bag barriers, but are more porous. Generally, gravel bag berms should be used in conjunction with temporary soil stabilization controls up slope to provide effective erosion and sediment control.

Design and Layout

- Locate gravel bag berms on level contours.
- When used for slope interruption, the following slope/sheet flow length combinations apply:
  - Slope inclination of 4:1 (H:V) or flatter: Gravel bags should be placed at a maximum interval of 20 ft, with the first row near the slope toe.
  - Slope inclination between 4:1 and 2:1 (H:V): Gravel bags should be placed at a maximum interval of 15 ft. (a closer spacing is more effective), with the first row near the slope toe.

Slope inclination 2:1 (H:V) or greater: Gravel bags should be placed at a maximum interval of 10 ft. (a closer spacing is more effective), with the first row near the slope toe.

- Turn the ends of the gravel bag barriers up slope to prevent runoff from going around the berm.
- Allow sufficient space up slope from the gravel bag berm to allow ponding, and to provide room for sediment storage.
- For installation near the toe of the slope, gravel bag barriers should be set back from the slope toe to facilitate cleaning. Where specific site conditions do not allow for a set-back, the gravel bag barrier may be constructed on the toe of the slope. To prevent flows behind the barrier, bags can be placed perpendicular to a berm to serve as cross barriers.
- Drainage area should not exceed 5 acres.
- In Non-Traffic Areas:
  - Height = 18 in. maximum
  - Top width = 24 in. minimum for three or more layer construction
  - Top width = 12 in. minimum for one or two layer construction
  - Side slopes = 2:1 (H:V) or flatter
- In Construction Traffic Areas:
  - Height = 12 in. maximum
  - Top width = 24 in. minimum for three or more layer construction.
  - Top width = 12 in. minimum for one or two layer construction.
  - Side slopes = 2:1 (H:V) or flatter.
- Butt ends of bags tightly.
- On multiple row, or multiple layer construction, overlap butt joints of adjacent row and row beneath.
- Use a pyramid approach when stacking bags.

Materials

- ***Bag Material:*** Bags should be woven polypropylene, polyethylene or polyamide fabric or burlap, minimum unit weight of 4 ounces/yd^2, Mullen burst strength exceeding 300 lb/in^2 in conformance with the requirements in ASTM designation D3786, and ultraviolet stability exceeding 70% in conformance with the requirements in ASTM designation D4355.

- ***Bag Size:*** Each gravel-filled bag should have a length of 18 in., width of 12 in., thickness of 3 in., and mass of approximately 33 lbs. Bag dimensions are nominal, and may vary based on locally available materials.

- ***Fill Material:*** Fill material should be 0.5 to 1 in. crushed rock, clean and free from clay, organic matter, and other deleterious material, or other suitable open graded, non-cohesive, porous gravel.

Costs

Material costs for gravel bags are average and are dependent upon material availability. $2.50-3.00 per filled gravel bag is standard based upon vendor research.

Inspection and Maintenance

- BMPs must be inspected in accordance with General Permit requirements for the associated project type and risk level. It is recommended that at a minimum, BMPs be inspected weekly, prior to forecasted rain events, daily during extended rain events, and after the conclusion of rain events.

- Gravel bags exposed to sunlight will need to be replaced every two to three months due to degrading of the bags.

- Reshape or replace gravel bags as needed.

- Repair washouts or other damage as needed.

- Sediment that accumulates in the BMP should be periodically removed in order to maintain BMP effectiveness. Sediment should be removed when the sediment accumulation reaches one-third of the barrier height.

- Remove gravel bag berms when no longer needed and recycle gravel fill whenever possible and properly dispose of bag material. Remove sediment accumulation and clean, re-grade, and stabilize the area.

References

Handbook of Steel Drainage and Highway Construction, American Iron and Steel Institute, 1983.

Stormwater Quality Handbooks - Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), March 2003.

Stormwater Pollution Plan Handbook, First Edition, State of California, Department of Transportation Division of New Technology, Materials and Research, October 1992.

Erosion and Sediment Control Manual, Oregon Department of Environmental Quality, February 2005.

Street Sweeping and Vacuuming SE-7

Categories

EC	Erosion Control	
SE	Sediment Control	☒
TC	Tracking Control	☑
WE	Wind Erosion Control	
NS	Non-Stormwater Management Control	
WM	Waste Management and Materials Pollution Control	

Legend:
☑ **Primary Objective**
☒ **Secondary Objective**

Targeted Constituents

Sediment	☑
Nutrients	
Trash	☑
Metals	
Bacteria	
Oil and Grease	☑
Organics	

Potential Alternatives

None

Description and Purpose

Street sweeping and vacuuming includes use of self-propelled and walk-behind equipment to remove sediment from streets and roadways, and to clean paved surfaces in preparation for final paving. Sweeping and vacuuming prevents sediment from the project site from entering storm drains or receiving waters.

Suitable Applications

Sweeping and vacuuming are suitable anywhere sediment is tracked from the project site onto public or private paved streets and roads, typically at points of egress. Sweeping and vacuuming are also applicable during preparation of paved surfaces for final paving.

Limitations

Sweeping and vacuuming may not be effective when sediment is wet or when tracked soil is caked (caked soil may need to be scraped loose).

Implementation

- Controlling the number of points where vehicles can leave the site will allow sweeping and vacuuming efforts to be focused, and perhaps save money.
- Inspect potential sediment tracking locations daily.
- Visible sediment tracking should be swept or vacuumed on a daily basis.
- Do not use kick brooms or sweeper attachments. These tend to spread the dirt rather than remove it.

- If not mixed with debris or trash, consider incorporating the removed sediment back into the project

Costs

Rental rates for self-propelled sweepers vary depending on hopper size and duration of rental. Expect rental rates from $58/hour (3 yd^3 hopper) to $88/hour (9 yd^3 hopper), plus operator costs. Hourly production rates vary with the amount of area to be swept and amount of sediment. Match the hopper size to the area and expect sediment load to minimize time spent dumping.

Inspection and Maintenance

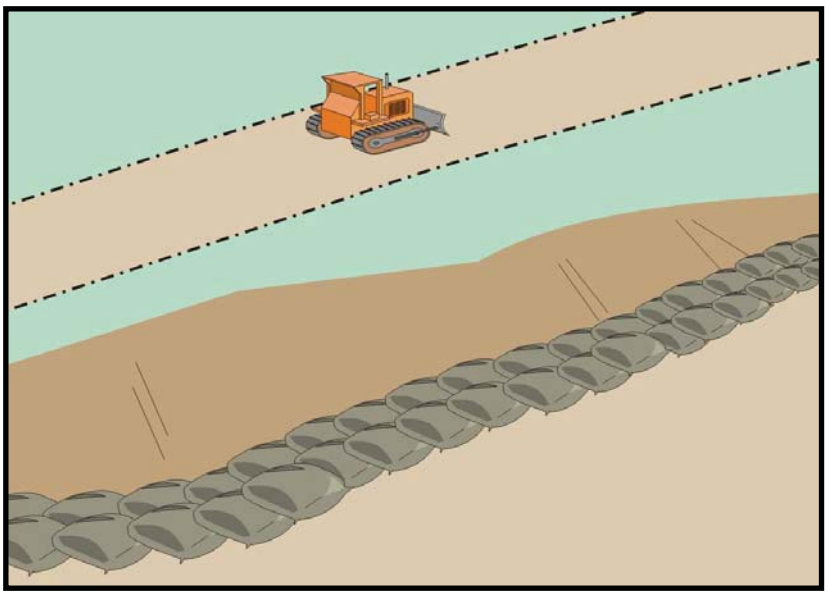
- Inspect BMPs in accordance with General Permit requirements for the associated project type and risk level. It is recommended that at a minimum, BMPs be inspected weekly, prior to forecasted rain events, daily during extended rain events, and after the conclusion of rain events.
- When actively in use, points of ingress and egress must be inspected daily.
- When tracked or spilled sediment is observed outside the construction limits, it must be removed at least daily. More frequent removal, even continuous removal, may be required in some jurisdictions.
- Be careful not to sweep up any unknown substance or any object that may be potentially hazardous.
- Adjust brooms frequently; maximize efficiency of sweeping operations.
- After sweeping is finished, properly dispose of sweeper wastes at an approved dumpsite.

References

Stormwater Quality Handbooks - Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), November 2000.

Labor Surcharge and Equipment Rental Rates, State of California Department of Transportation (Caltrans), April 1, 2002 – March 31, 2003.

Sandbag Barrier SE-8



Categories		
EC	Erosion Control	☒
SE	Sediment Control	☑
TC	Tracking Control	
WE	Wind Erosion Control	
NS	Non-Stormwater Management Control	
WM	Waste Management and Materials Pollution Control	

Legend:
☑ **Primary Category**
☒ **Secondary Category**

Description and Purpose

A sandbag barrier is a series of sand-filled bags placed on a level contour to intercept or to divert sheet flows. Sandbag barriers placed on a level contour pond sheet flow runoff, allowing sediment to settle out.

Suitable Applications

Sandbag barriers may be suitable:

- As a linear sediment control measure:
  - Below the toe of slopes and erodible slopes.
  - As sediment traps at culvert/pipe outlets.
  - Below other small cleared areas.
  - Along the perimeter of a site.
  - Down slope of exposed soil areas.
  - Around temporary stockpiles and spoil areas.
  - Parallel to a roadway to keep sediment off paved areas.
  - Along streams and channels.
- As linear erosion control measure:
  - Along the face and at grade breaks of exposed and erodible slopes to shorten slope length and spread runoff as sheet flow.

Targeted Constituents	
Sediment	☑
Nutrients	
Trash	
Metals	
Bacteria	
Oil and Grease	
Organics	

Potential Alternatives
SE-1 Silt Fence
SE-5 Fiber Rolls
SE-6 Gravel Bag Berm
SE-14 Biofilter Bags

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- At the top of slopes to divert runoff away from disturbed slopes.
- As check dams across mildly sloped construction roads.

Limitations

- It is necessary to limit the drainage area upstream of the barrier to 5 acres.
- Sandbags are not intended to be used as filtration devices.
- Easily damaged by construction equipment.
- Degraded sandbags may rupture when removed, spilling sand.
- Sand is easily transported by runoff if bag is damaged or ruptured.
- Installation can be labor intensive.
- Durability of sandbags is somewhat limited and bags may need to be replaced when installation is required for longer than 6 months. When used to detain concentrated flows, maintenance requirements increase.
- Burlap should not be used for sandbags.

Implementation

General

A sandbag barrier consists of a row of sand-filled bags placed on a level contour. When appropriately placed, a sandbag barrier intercepts and slows sheet flow runoff, causing temporary ponding. The temporary ponding allows sediment to settle. Sand-filled bags have limited porosity, which is further limited as the fine sand tends to quickly plug with sediment, limiting or completely blocking the rate of flow through the barrier. If a porous barrier is desired, consider SE-1, Silt Fence, SE-5, Fiber Rolls, SE-6, Gravel Bag Berms or SE-14, Biofilter Bags. Sandbag barriers also interrupt the slope length and thereby reduce erosion by reducing the tendency of sheet flows to concentrate into rivulets which erode rills, and ultimately gullies, into disturbed, sloped soils. Sandbag barriers are similar to gravel bag berms, but less porous. Generally, sandbag barriers should be used in conjunction with temporary soil stabilization controls up slope to provide effective erosion and sediment control.

Design and Layout

- Locate sandbag barriers on a level contour.
- When used for slope interruption, the following slope/sheet flow length combinations apply:
  - Slope inclination of 4:1 (H:V) or flatter: Sandbags should be placed at a maximum interval of 20 ft, with the first row near the slope toe.
  - Slope inclination between 4:1 and 2:1 (H:V): Sandbags should be placed at a maximum interval of 15 ft. (a closer spacing is more effective), with the first row near the slope toe.

    Slope inclination 2:1 (H:V) or greater: Sandbags should be placed at a maximum interval of 10 ft. (a closer spacing is more effective), with the first row near the slope toe.

- Turn the ends of the sandbag barrier up slope to prevent runoff from going around the barrier.
- Allow sufficient space up slope from the barrier to allow ponding, and to provide room for sediment storage.
- For installation near the toe of the slope, sand bag barriers should be set back from the slope toe to facilitate cleaning. Where specific site conditions do not allow for a set-back, the sand bag barrier may be constructed on the toe of the slope. To prevent flows behind the barrier, bags can be placed perpendicular to a berm to serve as cross barriers.
- Drainage area should not exceed 5 acres.
- Stack sandbags at least three bags high.
- Butt ends of bags tightly.
- Overlap butt joints of row beneath with each successive row.
- Use a pyramid approach when stacking bags.
- In non-traffic areas
  - Height = 18 in. maximum
  - Top width = 24 in. minimum for three or more layer construction
  - Side slope = 2:1 (H:V) or flatter
- In construction traffic areas
  - Height = 12 in. maximum
  - Top width = 24 in. minimum for three or more layer construction.
  - Side slopes = 2:1 (H:V) or flatter.
- See typical sandbag barrier installation details at the end of this fact sheet.

Materials

- ***Sandbag Material:*** Sandbag should be woven polypropylene, polyethylene or polyamide fabric, minimum unit weight of 4 ounces/yd^2, Mullen burst strength exceeding 300 lb/in^2 in conformance with the requirements in ASTM designation D3786, and ultraviolet stability exceeding 70% in conformance with the requirements in ASTM designation D4355. Use of burlap is not an acceptable substitute, as sand can more easily mobilize out of burlap.
- ***Sandbag Size:*** Each sand-filled bag should have a length of 18 in., width of 12 in., thickness of 3 in., and mass of approximately 33 lbs. Bag dimensions are nominal, and may vary based on locally available materials.

- ***Fill Material:*** All sandbag fill material should be non-cohesive, Class 3 (Caltrans Standard Specification, Section 25) permeable material free from clay and deleterious material, such as recycled concrete or asphalt..

Costs

Empty sandbags cost $0.25 - $0.75. Average cost of fill material is $8 per yd^3. Additional labor is required to fill the bags. Pre-filled sandbags are more expensive at $1.50 - $2.00 per bag. These costs are based upon vendor research.

Inspection and Maintenance

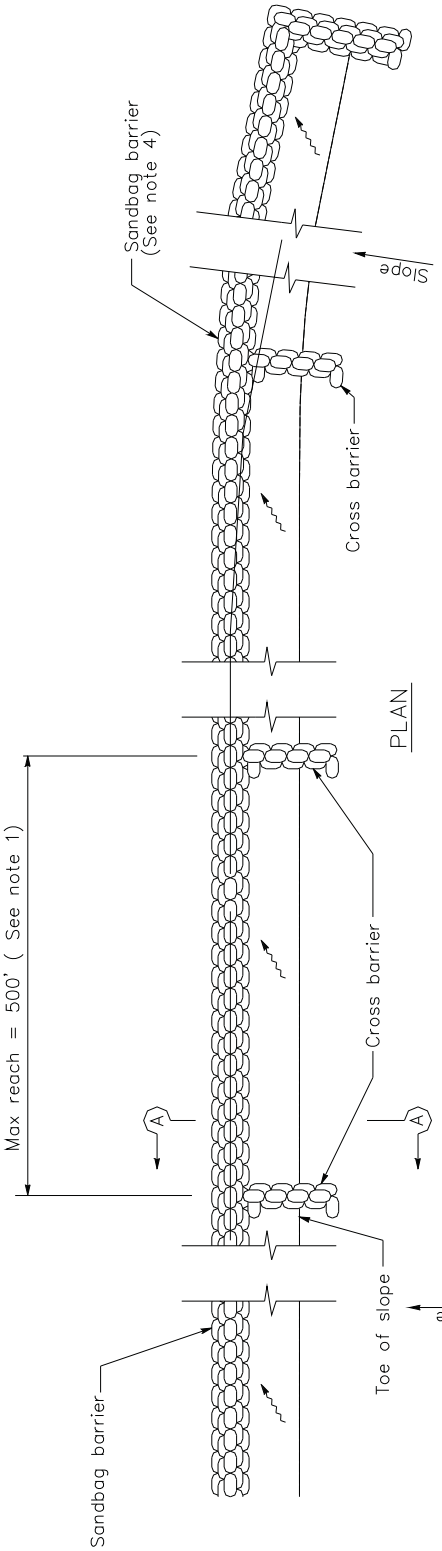
- BMPs must be inspected in accordance with General Permit requirements for the associated project type and risk level. It is recommended that at a minimum, BMPs be inspected weekly, prior to forecasted rain events, daily during extended rain events, and after the conclusion of rain events.
- Sandbags exposed to sunlight will need to be replaced every two to three months due to degradation of the bags.
- Reshape or replace sandbags as needed.
- Repair washouts or other damage as needed.
- Sediment that accumulates behind the BMP should be periodically removed in order to maintain BMP effectiveness. Sediment should be removed when the sediment accumulation reaches one-third of the barrier height.
- Remove sandbags when no longer needed and recycle sand fill whenever possible and properly dispose of bag material. Remove sediment accumulation, and clean, re-grade, and stabilize the area.

References

Standard Specifications for Construction of Local Streets and Roads, California Department of Transportation (Caltrans), July 2002.

Stormwater Quality Handbooks - Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), March 2003.

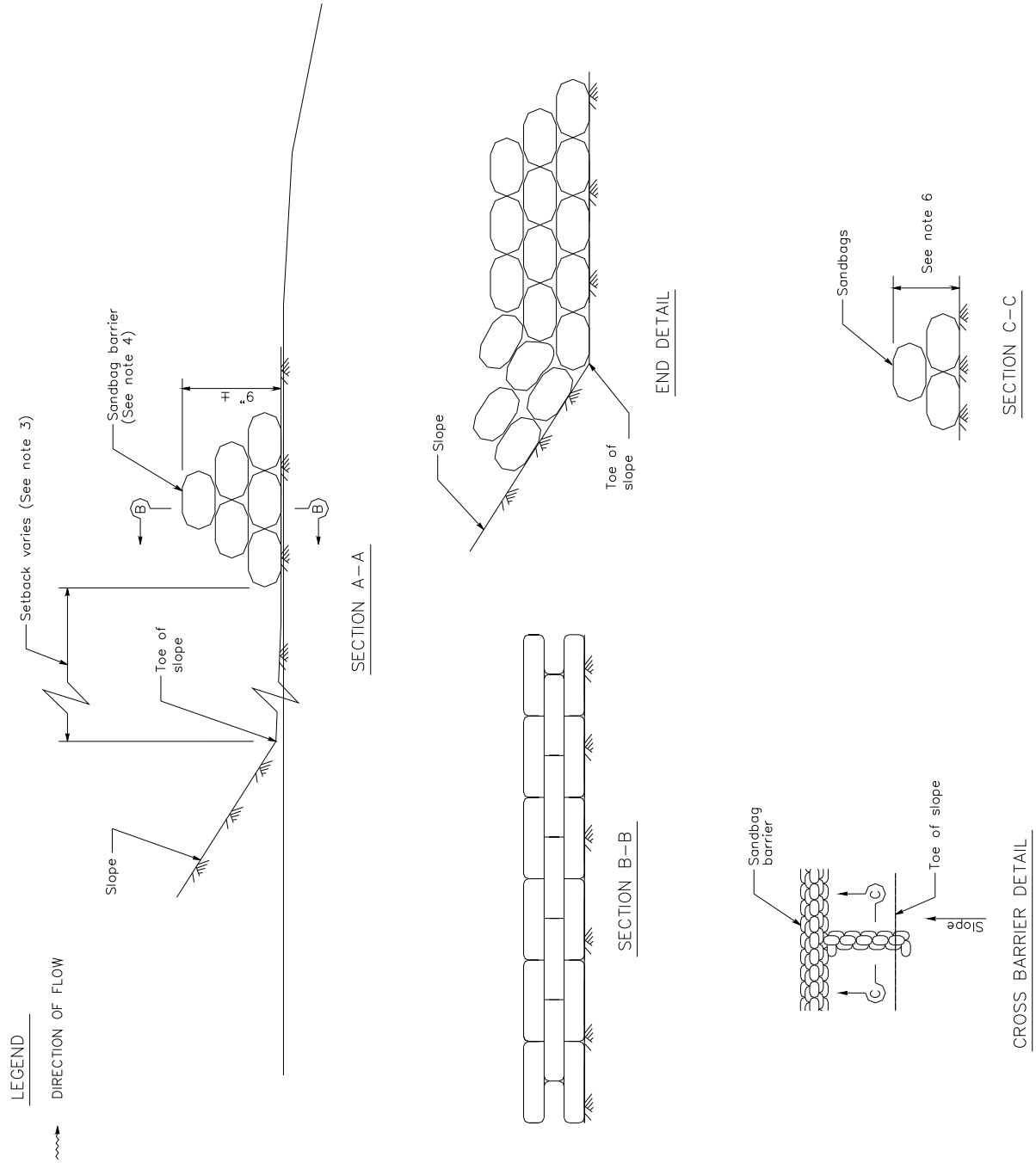
Erosion and Sediment Control Manual, Oregon Department of Environmental Quality, February 2005.



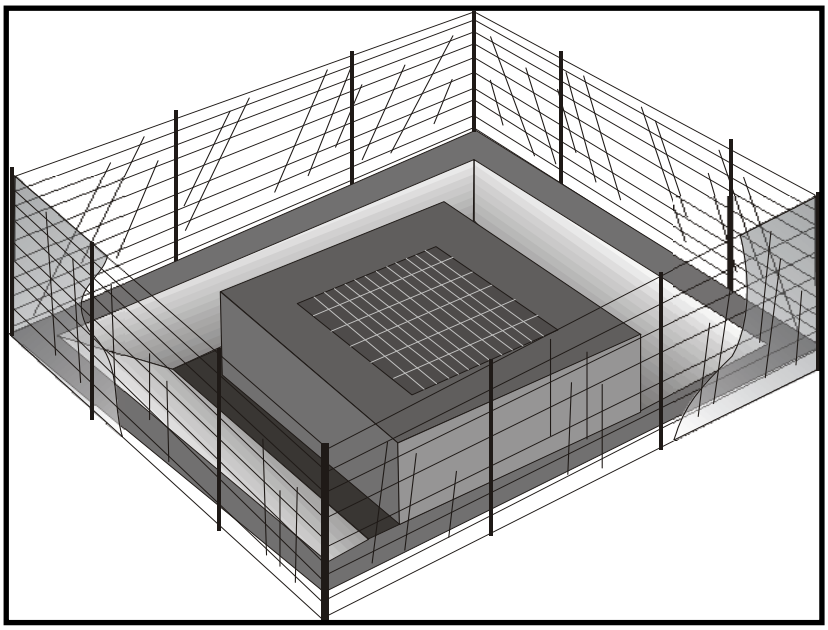
SANDBAG BARRIER

NOTES

1. Construct the length of each reach so that the change in base elevation along the reach does not exceed 1/2 the height of the linear barrier. In no case shall the reach length exceed 500'.
2. Place sandbags tightly.
3. Dimension may vary to fit field condition.
4. Sandbag barrier shall be a minimum of 3 bags high.
5. The end of the barrier shall be turned up slope.
6. Cross barriers shall be a min of 1/2 and a max of 2/3 the height of the linear barrier.
7. Sandbag rows and layers shall be staggered to eliminate gaps.


LEGEND
DIRECTION OF FLOW
Setback varies (See note 3)
Sandbag barrier (See note 4)
H
"a"
B
B
Toe of slope
Slope
SECTION A-A
Slope
Toe of slope
END DETAIL
SECTION B-B
Sandbags
See note 6
SECTION C-C
Sandbag barrier
C
C
Toe of slope
Slope
CROSS BARRIER DETAIL

Storm Drain Inlet Protection SE-10



Categories

EC	Erosion Control	
SE	Sediment Control	☑
TC	Tracking Control	
WE	Wind Erosion Control	
NS	Non-Stormwater Management Control	
WM	Waste Management and Materials Pollution Control	

Legend:

☑ **Primary Category**

☒ **Secondary Category**

Targeted Constituents

Sediment	☑
Nutrients	
Trash	☒
Metals	
Bacteria	
Oil and Grease	
Organics	

Potential Alternatives

SE-1 Silt Fence

SE-5 Fiber Rolls

SE-6 Gravel Bag Berm

SE-8 Sandbag Barrier

SE-14 Biofilter Bags

Description and Purpose

Storm drain inlet protection consists of a sediment filter or an impounding area in, around or upstream of a storm drain, drop inlet, or curb inlet. Storm drain inlet protection measures temporarily pond runoff before it enters the storm drain, allowing sediment to settle. Some filter configurations also remove sediment by filtering, but usually the ponding action results in the greatest sediment reduction. Temporary geotextile storm drain inserts attach underneath storm drain grates to capture and filter storm water.

Suitable Applications

Every storm drain inlet receiving runoff from unstabilized or otherwise active work areas should be protected. Inlet protection should be used in conjunction with other erosion and sediment controls to prevent sediment-laden stormwater and non-stormwater discharges from entering the storm drain system.

Limitations

- Drainage area should not exceed 1 acre.
- In general straw bales should not be used as inlet protection.
- Requires an adequate area for water to pond without encroaching into portions of the roadway subject to traffic.

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- Sediment removal may be inadequate to prevent sediment discharges in high flow conditions or if runoff is heavily sediment laden. If high flow conditions are expected, use other onsite sediment trapping techniques in conjunction with inlet protection.
- Frequent maintenance is required.
- Limit drainage area to 1 acre maximum. For drainage areas larger than 1 acre, runoff should be routed to a sediment-trapping device designed for larger flows. See BMPs SE-2, Sediment Basin, and SE-3, Sediment Traps.
- Excavated drop inlet sediment traps are appropriate where relatively heavy flows are expected, and overflow capability is needed.

Implementation

General

Inlet control measures presented in this handbook should not be used for inlets draining more than one acre. Runoff from larger disturbed areas should be first routed through SE-2, Sediment Basin or SE-3, Sediment Trap and/or used in conjunction with other drainage control, erosion control, and sediment control BMPs to protect the site. Different types of inlet protection are appropriate for different applications depending on site conditions and the type of inlet. Alternative methods are available in addition to the methods described/shown herein such as prefabricated inlet insert devices, or gutter protection devices.

Design and Layout

Identify existing and planned storm drain inlets that have the potential to receive sediment-laden surface runoff. Determine if storm drain inlet protection is needed and which method to use.

- The key to successful and safe use of storm drain inlet protection devices is to know where runoff that is directed toward the inlet to be protected will pond or be diverted as a result of installing the protection device.
  - Determine the acceptable location and extent of ponding in the vicinity of the drain inlet. The acceptable location and extent of ponding will influence the type and design of the storm drain inlet protection device.
  - Determine the extent of potential runoff diversion caused by the storm drain inlet protection device. Runoff ponded by inlet protection devices may flow around the device and towards the next downstream inlet. In some cases, this is acceptable; in other cases, serious erosion or downstream property damage can be caused by these diversions. The possibility of runoff diversions will influence whether or not storm drain inlet protection is suitable; and, if suitable, the type and design of the device.
- The location and extent of ponding, and the extent of diversion, can usually be controlled through appropriate placement of the inlet protection device. In some cases, moving the inlet protection device a short distance upstream of the actual inlet can provide more efficient sediment control, limit ponding to desired areas, and prevent or control diversions.

- Six types of inlet protection are presented below. However, it is recognized that other effective methods and proprietary devices exist and may be selected.

  - Silt Fence: Appropriate for drainage basins with less than a 5% slope, sheet flows, and flows under 0.5 cfs.

  - Excavated Drop Inlet Sediment Trap: An excavated area around the inlet to trap sediment (SE-3).

  - Gravel bag barrier: Used to create a small sediment trap upstream of inlets on sloped, paved streets. Appropriate for sheet flow or when concentrated flow may exceed 0.5 cfs, and where overtopping is required to prevent flooding.

  - Block and Gravel Filter: Appropriate for flows greater than 0.5 cfs.

  - Temporary Geotextile Storm drain Inserts: Different products provide different features. Refer to manufacturer details for targeted pollutants and additional features.

  - Biofilter Bag Barrier: Used to create a small retention area upstream of inlets and can be located on pavement or soil. Biofilter bags slowly filter runoff allowing sediment to settle out. Appropriate for flows under 0.5 cfs.

- Select the appropriate type of inlet protection and design as referred to or as described in this fact sheet.

- Provide area around the inlet for water to pond without flooding structures and property.

- Grates and spaces around all inlets should be sealed to prevent seepage of sediment-laden water.

- Excavate sediment sumps (where needed) 1 to 2 ft with 2:1 side slopes around the inlet.

Installation

- ***DI Protection Type 1 - Silt Fence -*** Similar to constructing a silt fence; see BMP SE-1, Silt Fence. Do not place fabric underneath the inlet grate since the collected sediment may fall into the drain inlet when the fabric is removed or replaced and water flow through the grate will be blocked resulting in flooding. See typical Type 1 installation details at the end of this fact sheet.

  1. Excavate a trench approximately 6 in. wide and 6 in. deep along the line of the silt fence inlet protection device.

  2. Place 2 in. by 2 in. wooden stakes around the perimeter of the inlet a maximum of 3 ft apart and drive them at least 18 in. into the ground or 12 in. below the bottom of the trench. The stakes should be at least 48 in.

  3. Lay fabric along bottom of trench, up side of trench, and then up stakes. See SE-1, Silt Fence, for details. The maximum silt fence height around the inlet is 24 in.

  4. Staple the filter fabric (for materials and specifications, see SE-1, Silt Fence) to wooden stakes. Use heavy-duty wire staples at least 1 in. in length.

5. Backfill the trench with gravel or compacted earth all the way around.

- ***DI Protection Type 2 - Excavated Drop Inlet Sediment Trap -*** Install filter fabric fence in accordance with DI Protection Type 1. Size excavated trap to provide a minimum storage capacity calculated at the rate 67 yd^3/acre of drainage area. See typical Type 2 installation details at the end of this fact sheet.

- ***DI Protection Type 3 - Gravel bag -*** Flow from a severe storm should not overtop the curb. In areas of high clay and silts, use filter fabric and gravel as additional filter media. Construct gravel bags in accordance with SE-6, Gravel Bag Berm. Gravel bags should be used due to their high permeability. See typical Type 3 installation details at the end of this fact sheet.

  1. Construct on gently sloping street.

  2. Leave room upstream of barrier for water to pond and sediment to settle.

  3. Place several layers of gravel bags – overlapping the bags and packing them tightly together.

  4. Leave gap of one bag on the top row to serve as a spillway. Flow from a severe storm (e.g., 10 year storm) should not overtop the curb.

- ***DI Protection Type 4 – Block and Gravel Filter -*** Block and gravel filters are suitable for curb inlets commonly used in residential, commercial, and industrial construction. See typical Type 4 installation details at the end of this fact sheet.

  1. Place hardware cloth or comparable wire mesh with 0.5 in. openings over the drop inlet so that the wire extends a minimum of 1 ft beyond each side of the inlet structure. If more than one strip is necessary, overlap the strips. Place woven geotextile over the wire mesh.

  2. Place concrete blocks lengthwise on their sides in a single row around the perimeter of the inlet, so that the open ends face outward, not upward. The ends of adjacent blocks should abut. The height of the barrier can be varied, depending on design needs, by stacking combinations of blocks that are 4 in., 8 in., and 12 in. wide. The row of blocks should be at least 12 in. but no greater than 24 in. high.

  3. Place wire mesh over the outside vertical face (open end) of the concrete blocks to prevent stone from being washed through the blocks. Use hardware cloth or comparable wire mesh with 0.5 in. opening.

  4. Pile washed stone against the wire mesh to the top of the blocks. Use 0.75 to 3 in.

- ***DI Protection Type 5 – Temporary Geotextile Insert (proprietary) –*** Many types of temporary inserts are available. Most inserts fit underneath the grate of a drop inlet or inside of a curb inlet and are fastened to the outside of the grate or curb. These inserts are removable and many can be cleaned and reused. Installation of these inserts differs between manufacturers. Please refer to manufacturer instruction for installation of proprietary devices.

- ***DI Protection Type 6 - Biofilter bags*** – Biofilter bags may be used as a substitute for gravel bags in low-flow situations. Biofilter bags should conform to specifications detailed in SE-14, Biofilter bags.

    1. Construct in a gently sloping area.
    2. Biofilter bags should be placed around inlets to intercept runoff flows.
    3. All bag joints should overlap by 6 in.
    4. Leave room upstream for water to pond and for sediment to settle out.
    5. Stake bags to the ground as described in the following detail. Stakes may be omitted if bags are placed on a paved surface.

Costs

- Average annual cost for installation and maintenance of DI Type 1-4 and 6 (one year useful life) is $200 per inlet.
- Temporary geotextile inserts are proprietary and cost varies by region. These inserts can often be reused and may have greater than 1 year of use if maintained and kept undamaged. Average cost per insert ranges from $50-75 plus installation, but costs can exceed $100. This cost does not include maintenance.

Inspection and Maintenance

- BMPs must be inspected in accordance with General Permit requirements for the associated project type and risk level. It is recommended that at a minimum, BMPs be inspected weekly, prior to forecasted rain events, daily during extended rain events, and after the conclusion of rain events.
- Silt Fences. If the fabric becomes clogged, torn, or degrades, it should be replaced. Make sure the stakes are securely driven in the ground and are in good shape (i.e., not bent, cracked, or splintered, and are reasonably perpendicular to the ground). Replace damaged stakes. At a minimum, remove the sediment behind the fabric fence when accumulation reaches one-third the height of the fence or barrier height.
- Gravel Filters. If the gravel becomes clogged with sediment, it should be carefully removed from the inlet and either cleaned or replaced. Since cleaning gravel at a construction site may be difficult, consider using the sediment-laden stone as fill material and put fresh stone around the inlet. Inspect bags for holes, gashes, and snags, and replace bags as needed. Check gravel bags for proper arrangement and displacement.
- Sediment that accumulates in the BMP should be periodically removed in order to maintain BMP effectiveness. Sediment should be removed when the sediment accumulation reaches one-third of the barrier height.
- Inspect and maintain temporary geotextile insert devices according to manufacturer's specifications.
- Remove storm drain inlet protection once the drainage area is stabilized.

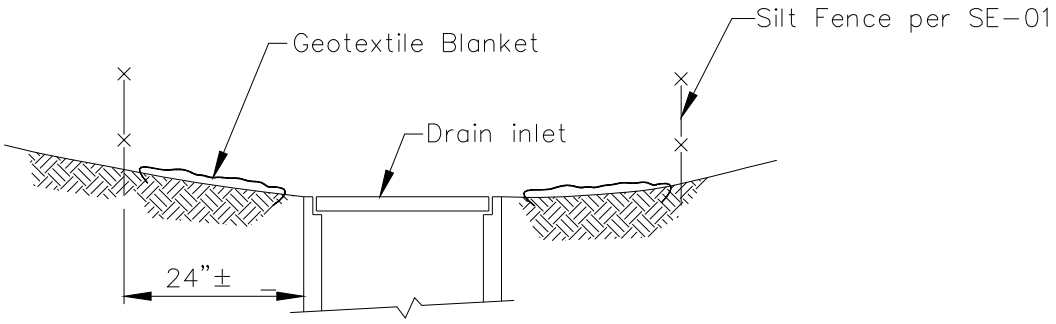
- Clean and regrade area around the inlet and clean the inside of the storm drain inlet, as it should be free of sediment and debris at the time of final inspection.

References

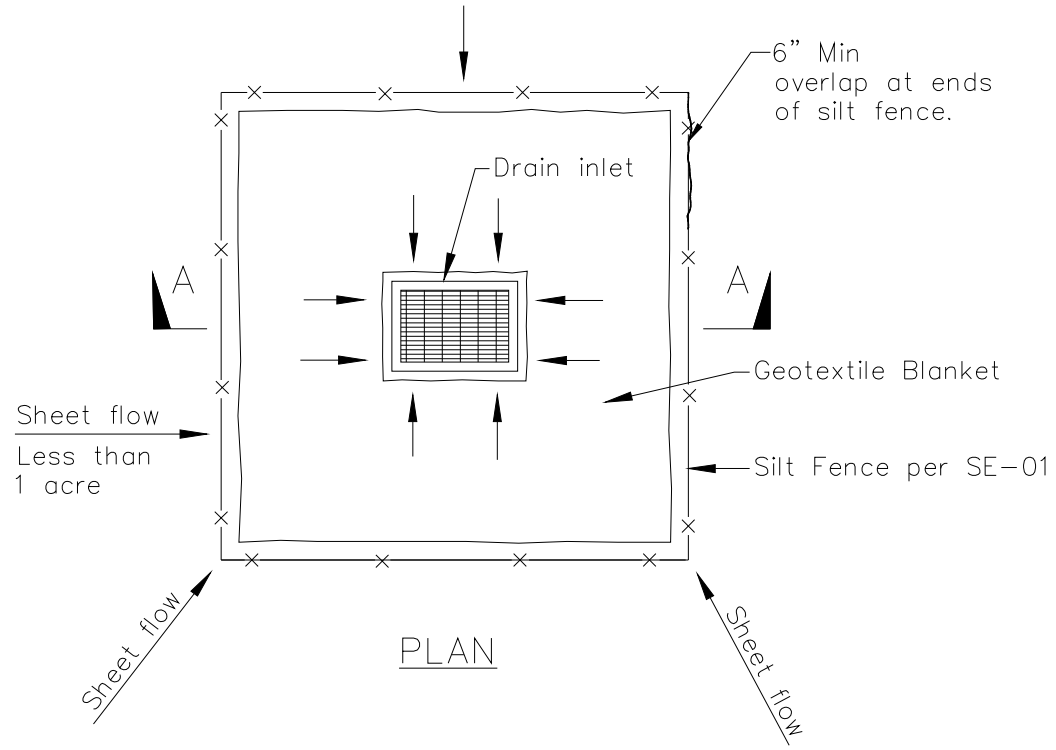
Stormwater Quality Handbooks - Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), March 2003.

Stormwater Management Manual for The Puget Sound Basin, Washington State Department of Ecology, Public Review Draft, 1991.

Erosion and Sediment Control Manual, Oregon Department of Environmental Quality, February 2005.



SECTION A–A

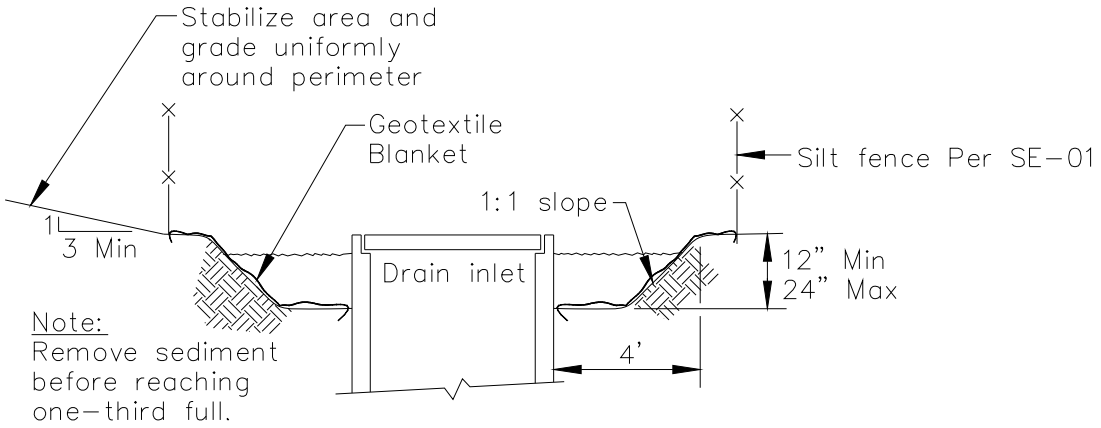


PLAN

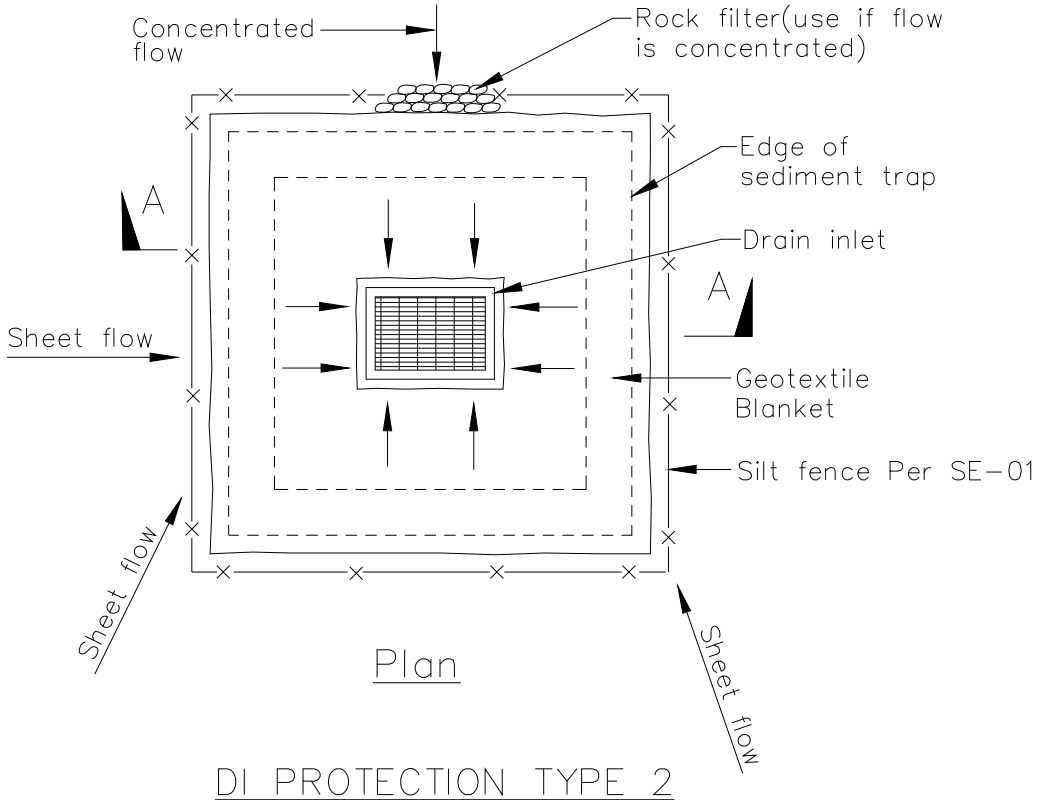
DI PROTECTION TYPE 1
NOT TO SCALE

NOTES:

1. For use in areas where grading has been completed and final soil stabilization and seeding are pending.
2. Not applicable in paved areas.
3. Not applicable with concentrated flows.



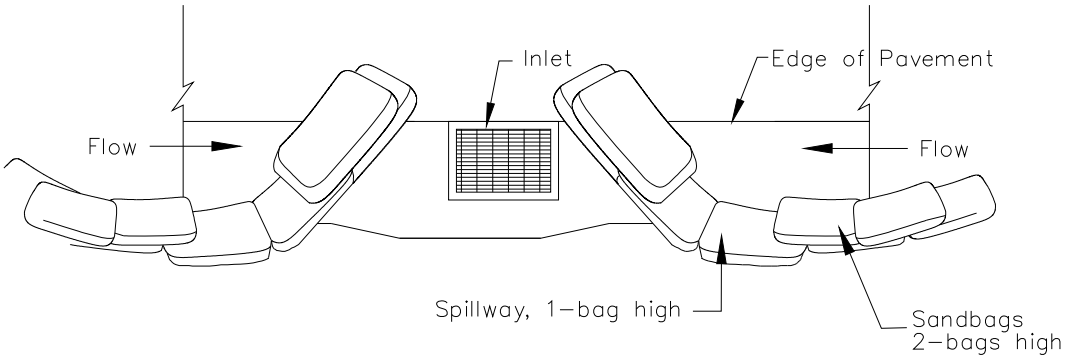
Section A–A



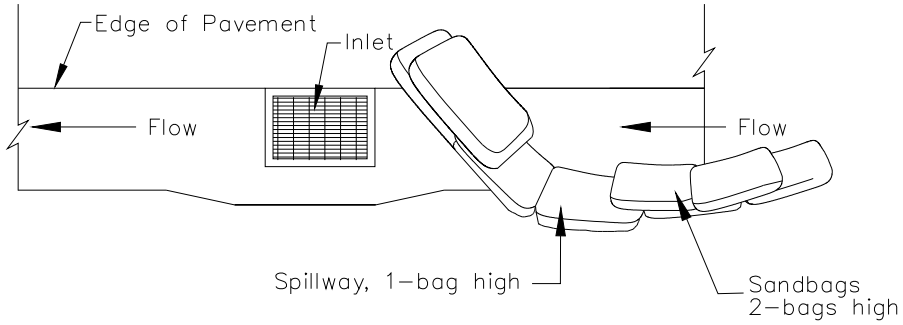
Plan

DI PROTECTION TYPE 2
NOT TO SCALE

Notes
1. For use in cleared and grubbed and in graded areas.
2. Shape basin so that longest inflow area faces longest length of trap.
3. For concentrated flows, shape basin in 2:1 ratio with length oriented towards direction of flow.



TYPICAL PROTECTION FOR INLET ON SUMP

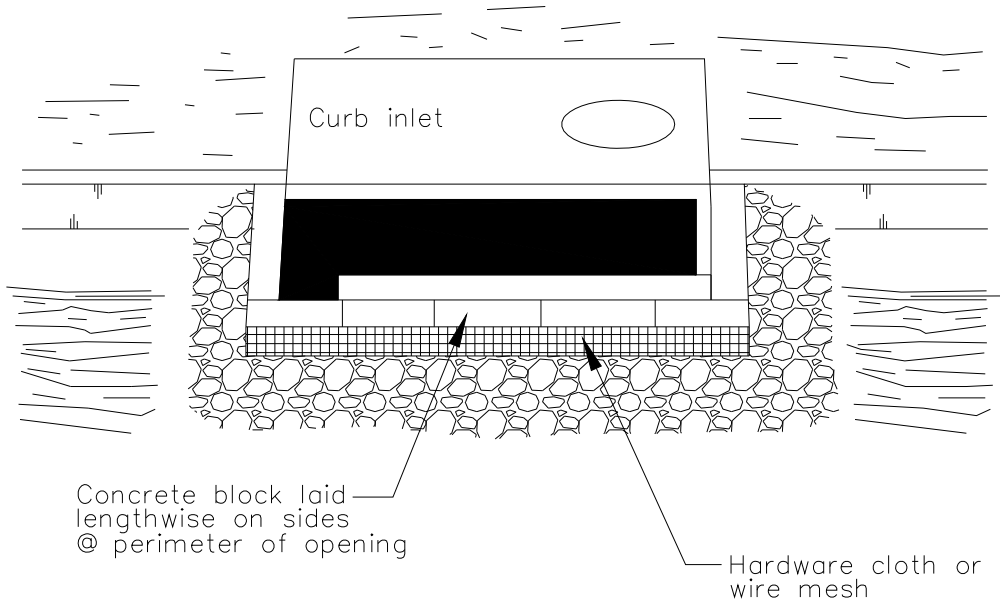


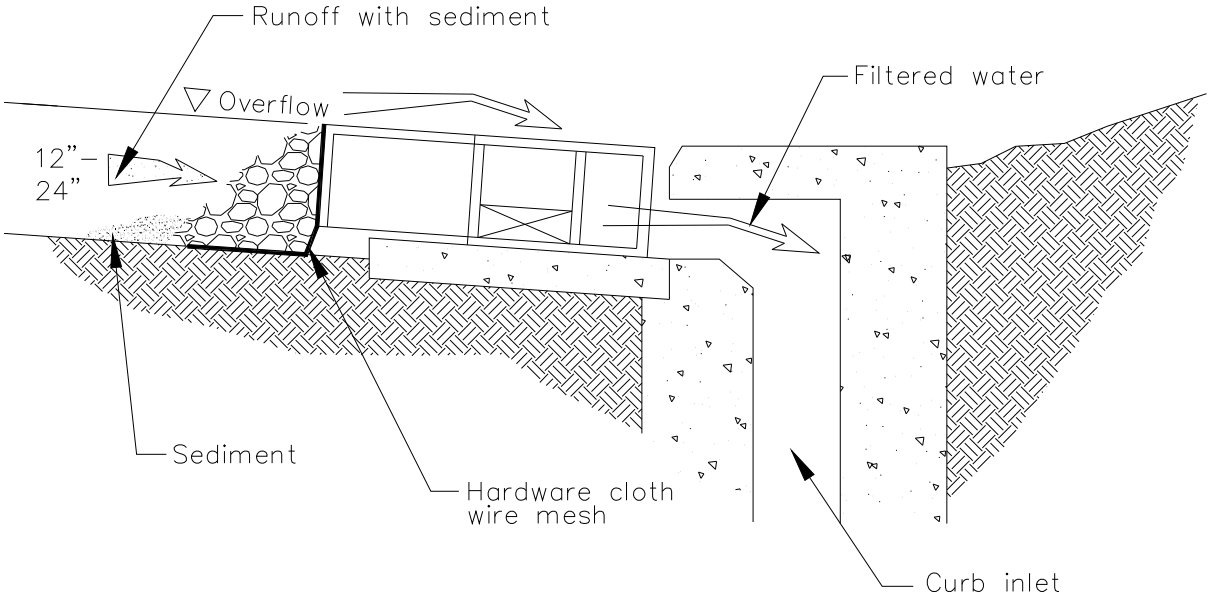
TYPICAL PROTECTION FOR INLET ON GRADE

NOTES:

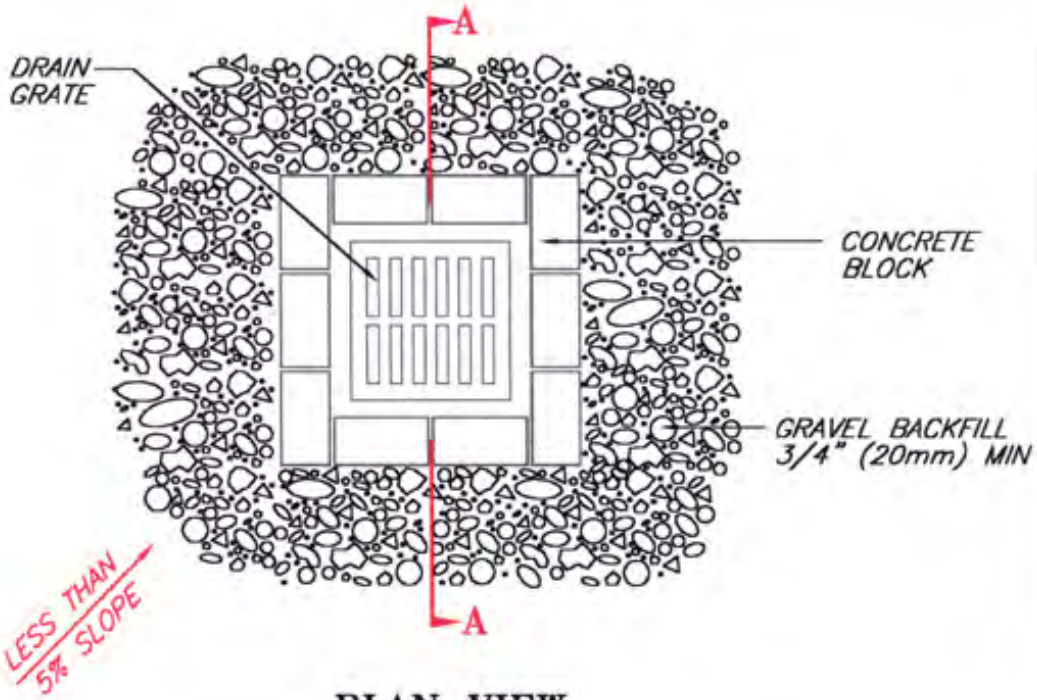
1. Intended for short–term use.
2. Use to inhibit non–storm water flow.
3. Allow for proper maintenance and cleanup.
4. Bags must be removed after adjacent operation is completed
5. Not applicable in areas with high silts and clays without filter fabric.

DI PROTECTION TYPE 3
NOT TO SCALE

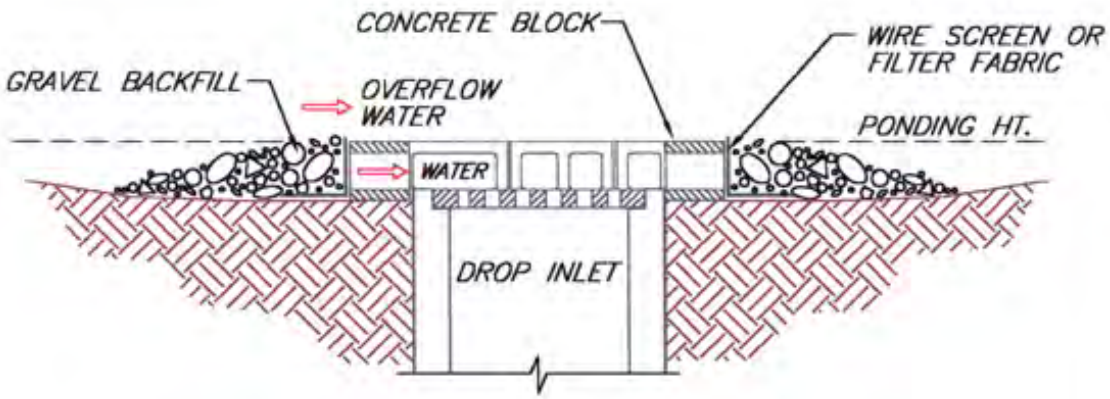




DI PROTECTION – TYPE 4
NOT TO SCALE



PLAN VIEW



SECTION A – A

NOTES:

1. DROP INLET SEDIMENT BARRIERS ARE TO BE USED FOR SMALL, NEARLY LEVEL DRAINAGE AREAS. (LESS THAN 5%)

BLOCK AND GRAVEL DROP INLET SEDIMENT BARRIER

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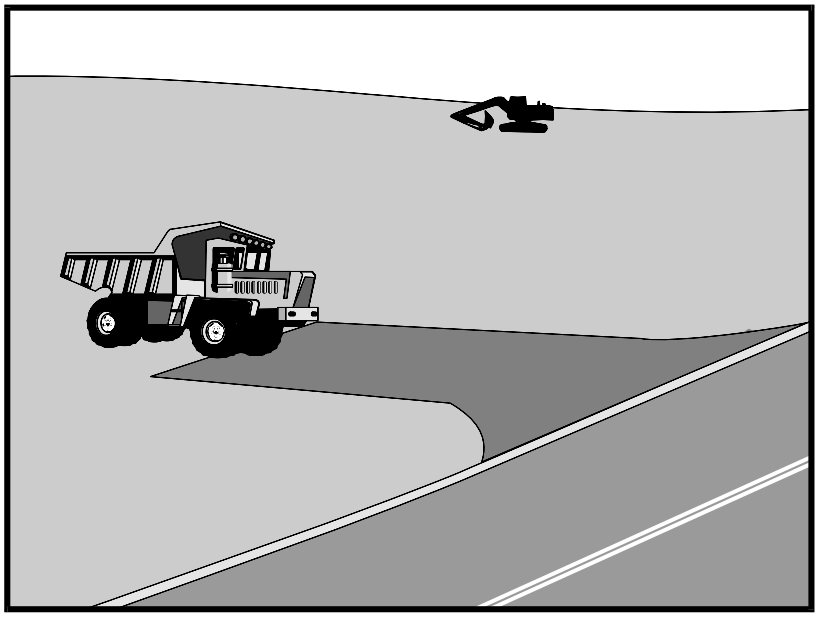
FILE: BGSEDBAR

Stabilized Construction Entrance / Exit TC-1



Categories

EC	Erosion Control	☒
SE	Sediment Control	☒
TC	Tracking Control	☑
WE	Wind Erosion Control	
NS	Non-Stormwater Management Control	
WM	Waste Management and Materials Pollution Control	

Legend:

☑ **Primary Objective**

☒ **Secondary Objective**

Targeted Constituents

Sediment	☑
Nutrients	
Trash	
Metals	
Bacteria	
Oil and Grease	
Organics	

Potential Alternatives

None

Description and Purpose

A stabilized construction access is defined by a point of entrance/exit to a construction site that is stabilized to reduce the tracking of mud and dirt onto public roads by construction vehicles.

Suitable Applications

Use at construction sites:

- Where dirt or mud can be tracked onto public roads.
- Adjacent to water bodies.
- Where poor soils are encountered.
- Where dust is a problem during dry weather conditions.

Limitations

- Entrances and exits require periodic top dressing with additional stones.
- This BMP should be used in conjunction with street sweeping on adjacent public right of way.
- Entrances and exits should be constructed on level ground only.
- Stabilized construction entrances are rather expensive to construct and when a wash rack is included, a sediment trap of some kind must also be provided to collect wash water

runoff.

Implementation

General

A stabilized construction entrance is a pad of aggregate underlain with filter cloth located at any point where traffic will be entering or leaving a construction site to or from a public right of way, street, alley, sidewalk, or parking area. The purpose of a stabilized construction entrance is to reduce or eliminate the tracking of sediment onto public rights of way or streets. Reducing tracking of sediments and other pollutants onto paved roads helps prevent deposition of sediments into local storm drains and production of airborne dust.

Where traffic will be entering or leaving the construction site, a stabilized construction entrance should be used. NPDES permits require that appropriate measures be implemented to prevent tracking of sediments onto paved roadways, where a significant source of sediments is derived from mud and dirt carried out from unpaved roads and construction sites.

Stabilized construction entrances are moderately effective in removing sediment from equipment leaving a construction site. The entrance should be built on level ground. Advantages of the Stabilized Construction Entrance/Exit is that it does remove some sediment from equipment and serves to channel construction traffic in and out of the site at specified locations. Efficiency is greatly increased when a washing rack is included as part of a stabilized construction entrance/exit.

Design and Layout

- Construct on level ground where possible.
- Select 3 to 6 in. diameter stones.
- Use minimum depth of stones of 12 in. or as recommended by soils engineer.
- Construct length of 50 ft minimum, and 30 ft minimum width.
- Rumble racks constructed of steel panels with ridges and installed in the stabilized entrance/exit will help remove additional sediment and to keep adjacent streets clean.
- Provide ample turning radii as part of the entrance.
- Limit the points of entrance/exit to the construction site.
- Limit speed of vehicles to control dust.
- Properly grade each construction entrance/exit to prevent runoff from leaving the construction site.
- Route runoff from stabilized entrances/exits through a sediment trapping device before discharge.
- Design stabilized entrance/exit to support heaviest vehicles and equipment that will use it.

- Select construction access stabilization (aggregate, asphaltic concrete, concrete) based on longevity, required performance, and site conditions. Do not use asphalt concrete (AC) grindings for stabilized construction access/roadway.
- If aggregate is selected, place crushed aggregate over geotextile fabric to at least 12 in. depth, or place aggregate to a depth recommended by a geotechnical engineer. A crushed aggregate greater than 3 in. but smaller than 6 in. should be used.
- Designate combination or single purpose entrances and exits to the construction site.
- Require that all employees, subcontractors, and suppliers utilize the stabilized construction access.
- Implement SE-7, Street Sweeping and Vacuuming, as needed.
- All exit locations intended to be used for more than a two-week period should have stabilized construction entrance/exit BMPs.

Inspection and Maintenance

- Inspect and verify that activity–based BMPs are in place prior to the commencement of associated activities. While activities associated with the BMPs are under way, inspect weekly during the rainy season and of two-week intervals in the non-rainy season to verify continued BMP implementation.
- Inspect local roads adjacent to the site daily. Sweep or vacuum to remove visible accumulated sediment.
- Remove aggregate, separate and dispose of sediment if construction entrance/exit is clogged with sediment.
- Keep all temporary roadway ditches clear.
- Check for damage and repair as needed.
- Replace gravel material when surface voids are visible.
- Remove all sediment deposited on paved roadways within 24 hours.
- Remove gravel and filter fabric at completion of construction

Costs

Average annual cost for installation and maintenance may vary from $1,200 to $4,800 each, averaging $2,400 per entrance. Costs will increase with addition of washing rack, and sediment trap. With wash rack, costs range from $1,200 - $6,000 each, averaging $3,600 per entrance.

References

Manual of Standards of Erosion and Sediment Control Measures, Association of Bay Area Governments, May 1995.

National Management Measures to Control Nonpoint Source Pollution from Urban Areas, USEPA Agency, 2002.

Proposed Guidance Specifying Management Measures for Sources of Nonpoint Pollution in Coastal Waters, Work Group Working Paper, USEPA, April 1992.

Stormwater Quality Handbooks Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), November 2000.

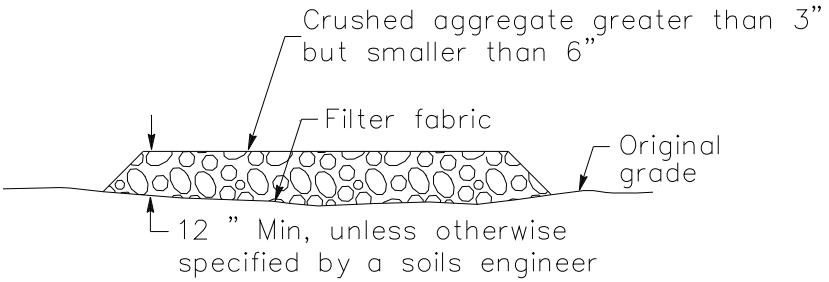
Stormwater Management of the Puget Sound Basin, Technical Manual, Publication #91-75, Washington State Department of Ecology, February 1992.

Virginia Erosion and Sedimentation Control Handbook, Virginia Department of Conservation and Recreation, Division of Soil and Water Conservation, 1991.

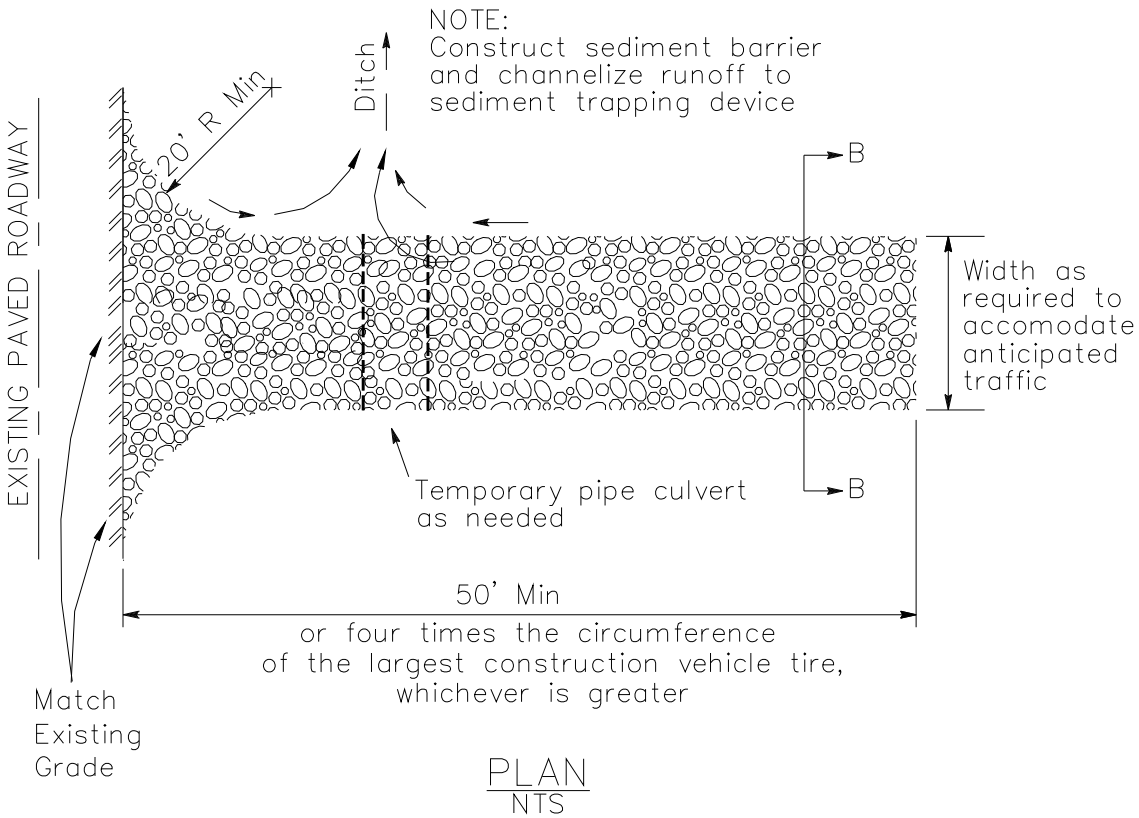
Guidance Specifying Management Measures for Nonpoint Pollution in Coastal Waters, EPA 840-B-9-002, USEPA, Office of Water, Washington, DC, 1993.

Water Quality Management Plan for the Lake Tahoe Region, Volume II, Handbook of Management Practices, Tahoe Regional Planning Agency, November 1988.

Stabilized Construction Entrance / Exit TC-1

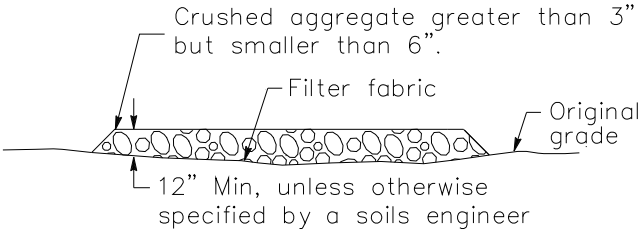


SECTION B–B
NTS

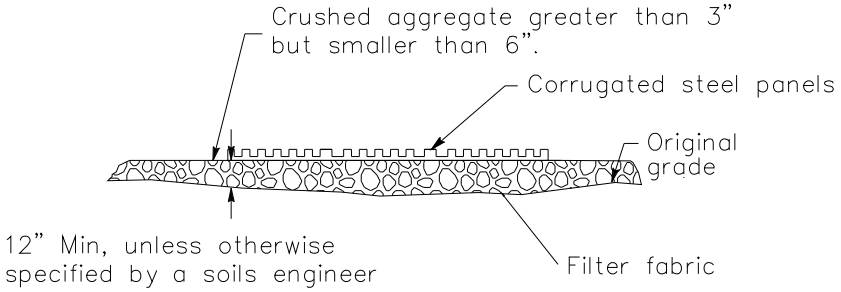


PLAN
NTS

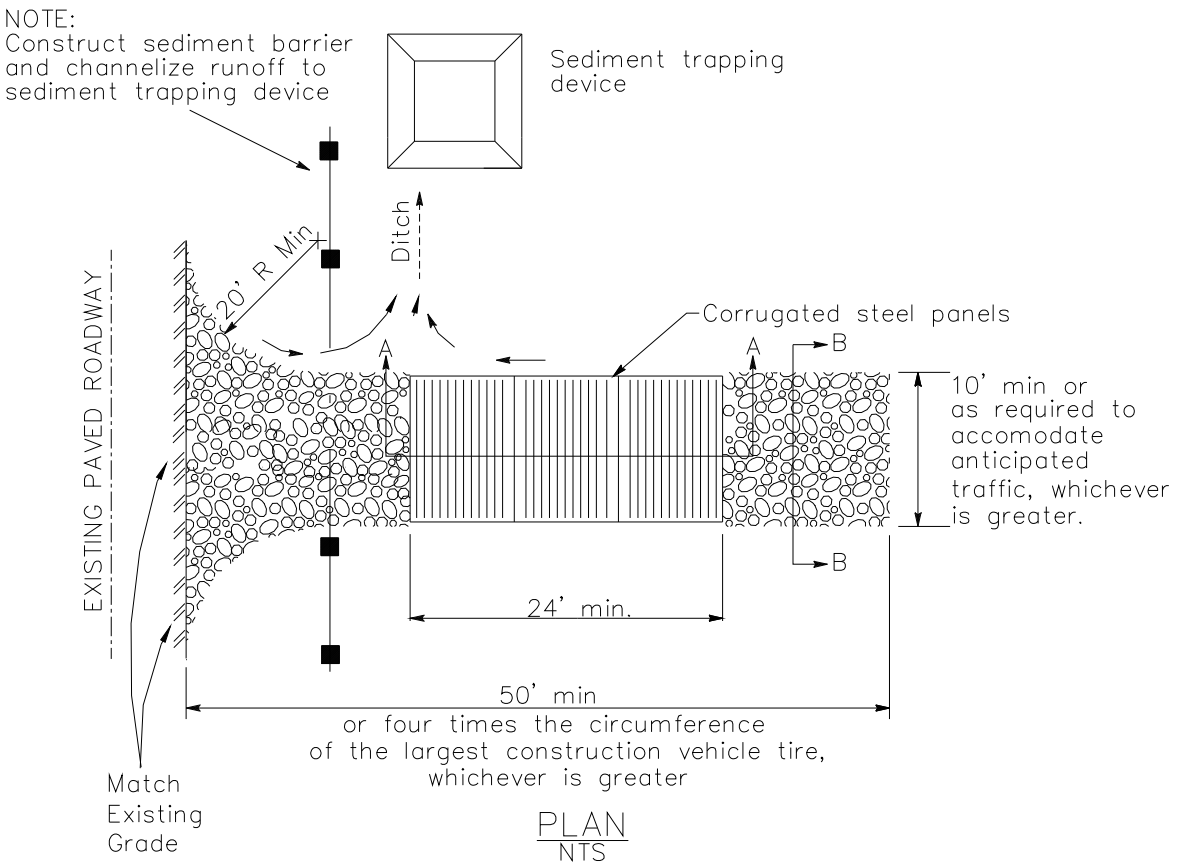
Stabilized Construction Entrance / Exit TC-1



SECTION B–B
NTS

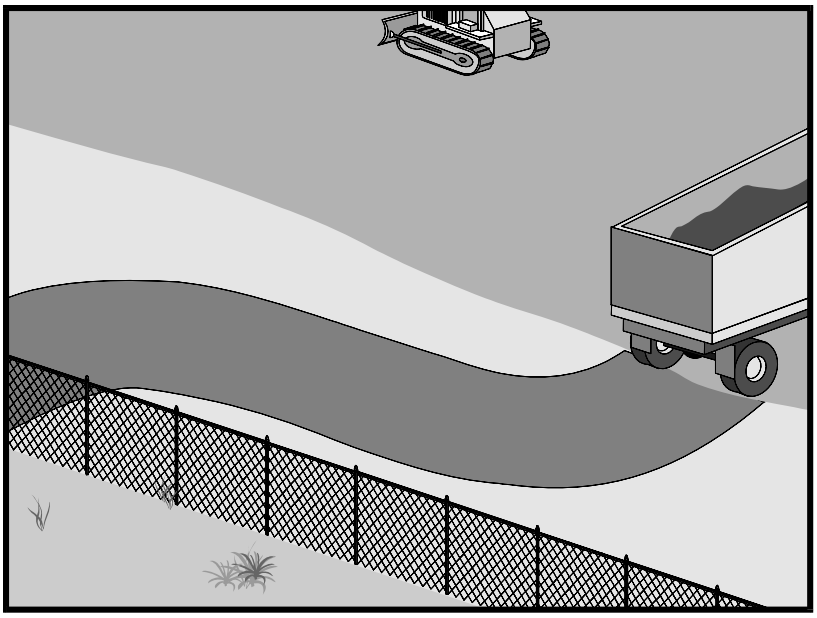


SECTION A–A
NOT TO SCALE



PLAN
NTS

Stabilized Construction Roadway TC-2



Description and Purpose

Access roads, subdivision roads, parking areas, and other onsite vehicle transportation routes should be stabilized immediately after grading, and frequently maintained to prevent erosion and control dust.

Suitable Applications

This BMP should be applied for the following conditions:

- Temporary Construction Traffic:
  - Phased construction projects and offsite road access
  - Construction during wet weather
- Construction roadways and detour roads:
  - Where mud tracking is a problem during wet weather
  - Where dust is a problem during dry weather
  - Adjacent to water bodies
  - Where poor soils are encountered

Limitations

- The roadway must be removed or paved when construction is complete.
- Certain chemical stabilization methods may cause stormwater or soil pollution and should not be used. See WE-1, Wind Erosion Control.

Categories

EC	Erosion Control	☒
SE	Sediment Control	☒
TC	Tracking Control	☑
WE	Wind Erosion Control	
NS	Non-Stormwater Management Control	
WM	Waste Management and Materials Pollution Control	

Legend:

☑ **Primary Objective**

☒ **Secondary Objective**

Targeted Constituents

Sediment	☑
Nutrients	
Trash	
Metals	
Bacteria	
Oil and Grease	
Organics	

Potential Alternatives

None

- Management of construction traffic is subject to air quality control measures. Contact the local air quality management agency.
- Materials will likely need to be removed prior to final project grading and stabilization.
- Use of this BMP may not be applicable to very short duration projects.

Implementation

General

Areas that are graded for construction vehicle transport and parking purposes are especially susceptible to erosion and dust. The exposed soil surface is continually disturbed, leaving no opportunity for vegetative stabilization. Such areas also tend to collect and transport runoff waters along their surfaces. During wet weather, they often become muddy quagmires that generate significant quantities of sediment that may pollute nearby streams or be transported offsite on the wheels of construction vehicles. Dirt roads can become so unstable during wet weather that they are virtually unusable.

Efficient construction road stabilization not only reduces onsite erosion but also can significantly speed onsite work, avoid instances of immobilized machinery and delivery vehicles, and generally improve site efficiency and working conditions during adverse weather

Installation/Application Criteria

Permanent roads and parking areas should be paved as soon as possible after grading. As an alternative where construction will be phased, the early application of gravel or chemical stabilization may solve potential erosion and stability problems. Temporary gravel roadway should be considered during the rainy season and on slopes greater than 5%.

Temporary roads should follow the contour of the natural terrain to the maximum extent possible. Slope should not exceed 15%. Roadways should be carefully graded to drain transversely. Provide drainage swales on each side of the roadway in the case of a crowned section or one side in the case of a super elevated section. Simple gravel berms without a trench can also be used.

Installed inlets should be protected to prevent sediment laden water from entering the storm sewer system (SE-10, Storm Drain Inlet Protection). In addition, the following criteria should be considered.

- Road should follow topographic contours to reduce erosion of the roadway.
- The roadway slope should not exceed 15%.
- Chemical stabilizers or water are usually required on gravel or dirt roads to prevent dust (WE-1, Wind Erosion Control).
- Properly grade roadway to prevent runoff from leaving the construction site.
- Design stabilized access to support heaviest vehicles and equipment that will use it.

- Stabilize roadway using aggregate, asphalt concrete, or concrete based on longevity, required performance, and site conditions. The use of cold mix asphalt or asphalt concrete (AC) grindings for stabilized construction roadway is not allowed.
- Coordinate materials with those used for stabilized construction entrance/exit points.
- If aggregate is selected, place crushed aggregate over geotextile fabric to at least 12 in. depth. A crushed aggregate greater than 3 in. but smaller than 6 in. should be used.

Inspection and Maintenance

- Inspect and verify that activity–based BMPs are in place prior to the commencement of associated activities. While activities associated with the BMP are under way, impact weekly during the rainy season and of two-week intervals in the non-rainy season to verify continued BMP implementation.
- Keep all temporary roadway ditches clear.
- When no longer required, remove stabilized construction roadway and re-grade and repair slopes.
- Periodically apply additional aggregate on gravel roads.
- Active dirt construction roads are commonly watered three or more times per day during the dry season.

Costs

Gravel construction roads are moderately expensive, but cost is often balanced by reductions in construction delay. No additional costs for dust control on construction roads should be required above that needed to meet local air quality requirements.

References

Blueprint for a Clean Bay: Best Management Practices to Prevent Stormwater Pollution from Construction Related Activities; Santa Clara Valley Nonpoint Source Pollution Control Program, 1995.

Coastal Nonpoint Pollution Control Program; Program Development and Approval Guidance, Working Group, Working Paper; USEPA, April 1992.

Manual of Standards of Erosion and Sediment Control Measures, Association of Bay Area Governments, May 1995.

Stormwater Quality Handbooks Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), November 2000.

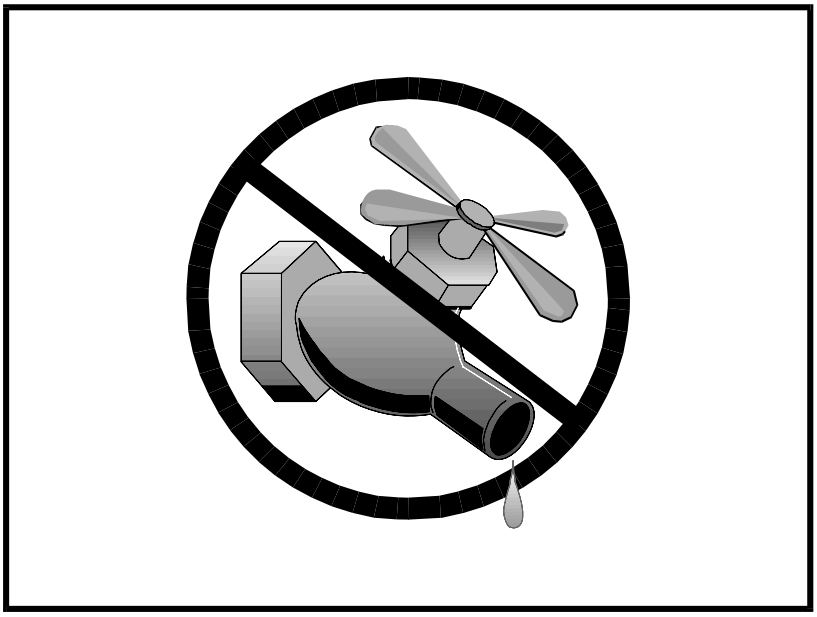
Stormwater Management for Construction Activities, Developing Pollution Prevention Plans and Best Management Practices, EPA 832-R-92005; USEPA, April 1992.

Stormwater Management of the Puget Sound Basin, Technical Manual, Publication #91-75, Washington State Department of Ecology, February 1992.

Virginia Erosion and Sedimentation Control Handbook, Virginia Department of Conservation and Recreation, Division of Soil and Water Conservation, 1991.

Water Quality Management Plan for the Lake Tahoe Region, Volume II, Handbook of Management Practices, Tahoe Regional Planning Agency, November 1988.

Water Conservation Practices NS-1



Categories		
EC	Erosion Control	☒
SE	Sediment Control	☒
TC	Tracking Control	
WE	Wind Erosion Control	
NS	Non-Stormwater Management Control	☑
WM	Waste Management and Materials Pollution Control	

Legend:
☑ **Primary Objective**
☒ **Secondary Objective**

Targeted Constituents	
Sediment	☑
Nutrients	
Trash	
Metals	
Bacteria	
Oil and Grease	
Organics	

Potential Alternatives

None

Description and Purpose

Water conservation practices are activities that use water during the construction of a project in a manner that avoids causing erosion and the transport of pollutants offsite. These practices can reduce or eliminate non-stormwater discharges.

Suitable Applications

Water conservation practices are suitable for all construction sites where water is used, including piped water, metered water, trucked water, and water from a reservoir.

Limitations

- None identified.

Implementation

- Keep water equipment in good working condition.
- Stabilize water truck filling area.
- Repair water leaks promptly.
- Washing of vehicles and equipment on the construction site is discouraged.
- Avoid using water to clean construction areas. If water must be used for cleaning or surface preparation, surface should be swept and vacuumed first to remove dirt. This will minimize amount of water required.
- Direct construction water runoff to areas where it can soak

into the ground or be collected and reused.

- Authorized non-stormwater discharges to the storm drain system, channels, or receiving waters are acceptable with the implementation of appropriate BMPs.
- Lock water tank valves to prevent unauthorized use.

Costs

The cost is small to none compared to the benefits of conserving water.

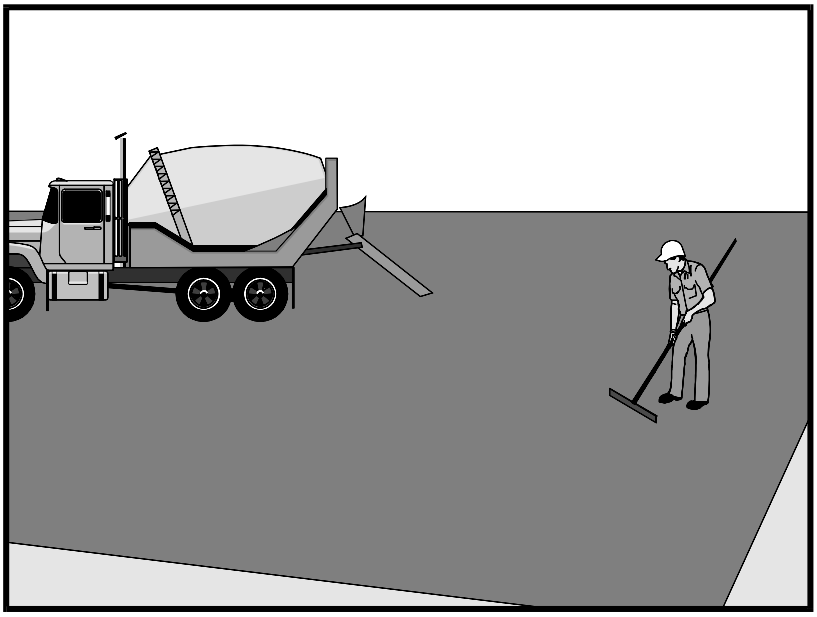
Inspection and Maintenance

- Inspect and verify that activity based BMPs are in place prior to the commencement of authorized non-stormwater discharges.
- Inspect BMPs subject to non-stormwater discharges daily while non-stormwater discharges are occuring.
- Repair water equipment as needed to prevent unintended discharges.
  - Water trucks
  - Water reservoirs (water buffalos)
  - Irrigation systems
  - Hydrant connections

References

Stormwater Quality Handbooks - Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), November 2000.

Paving and Grinding Operations NS-3



Categories

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SE	Sediment Control	
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Legend:

☑ **Primary Category**

☒ **Secondary Category**

Targeted Constituents

Sediment	☑
Nutrients	
Trash	
Metals	
Bacteria	
Oil and Grease	☑
Organics	

Potential Alternatives

None

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Description and Purpose

Prevent or reduce the discharge of pollutants from paving operations, using measures to prevent runon and runoff pollution, properly disposing of wastes, and training employees and subcontractors.

The General Permit incorporates Numeric Action Levels (NAL) for pH and turbidity (see Section 2 of this handbook to determine your project's risk level and if you are subject to these requirements).

Many types of construction materials associated with paving and grinding operations, including mortar, concrete, and cement and their associated wastes have basic chemical properties that can raise pH levels outside of the permitted range. Additional care should be taken when managing these materials to prevent them from coming into contact with stormwater flows, which could lead to exceedances of the General Permit requirements.

Suitable Applications

These procedures are implemented where paving, surfacing, resurfacing, or sawcutting, may pollute stormwater runoff or discharge to the storm drain system or watercourses.

Limitations

- Paving opportunities may be limited during wet weather.

  Discharges of freshly paved surfaces may raise pH to environmentally harmful levels and trigger permit violations.

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Implementation

General

- Avoid paving during the wet season when feasible.
- Reschedule paving and grinding activities if rain is forecasted.
- Train employees and sub-contractors in pollution prevention and reduction.
- Store materials away from drainage courses to prevent stormwater runon (see WM-1, Material Delivery and Storage).
- Protect drainage courses, particularly in areas with a grade, by employing BMPs to divert runoff or to trap and filter sediment.
- Stockpile material removed from roadways away from drain inlets, drainage ditches, and watercourses. These materials should be stored consistent with WM-3, Stockpile Management.
- Disposal of PCC (Portland cement concrete) and AC (asphalt concrete) waste should be in conformance with WM-8, Concrete Waste Management.

Saw Cutting, Grinding, and Pavement Removal

- Shovel or vacuum saw-cut slurry and remove from site. Cover or barricade storm drains during saw cutting to contain slurry.
- When paving involves AC, the following steps should be implemented to prevent the discharge of grinding residue, uncompacted or loose AC, tack coats, equipment cleaners, or unrelated paving materials:
  - AC grindings, pieces, or chunks used in embankments or shoulder backing should not be allowed to enter any storm drains or watercourses. Install inlet protection and perimeter controls until area is stabilized (i.e. cutting, grinding or other removal activities are complete and loose material has been properly removed and disposed of)or permanent controls are in place. Examples of temporary perimeter controls can be found in EC-9, Earth Dikes and Drainage Swales; SE-1, Silt Fence; SE-5, Fiber Rolls, or SE-13 Compost Socks and Berms
  - Collect and remove all broken asphalt and recycle when practical. Old or spilled asphalt should be recycled or disposed of properly.
- Do not allow saw-cut slurry to enter storm drains or watercourses. Residue from grinding operations should be picked up by a vacuum attachment to the grinding machine, or by sweeping, should not be allowed to flow across the pavement, and should not be left on the surface of the pavement. See also WM-8, Concrete Waste Management, and WM-10, Liquid Waste Management.
- Pavement removal activities should not be conducted in the rain.
- Collect removed pavement material by mechanical or manual methods. This material may be recycled for use as shoulder backing or base material.

- If removed pavement material cannot be recycled, transport the material back to an approved storage site.

Asphaltic Concrete Paving

- If paving involves asphaltic cement concrete, follow these steps:

  - Do not allow sand or gravel placed over new asphalt to wash into storm drains, streets, or creeks. Vacuum or sweep loose sand and gravel and properly dispose of this waste by referring to WM-5, Solid Waste Management.

  - Old asphalt should be disposed of properly. Collect and remove all broken asphalt from the site and recycle whenever possible.

Portland Cement Concrete Paving

- Do not wash sweepings from exposed aggregate concrete into a storm drain system. Collect waste materials by dry methods, such as sweeping or shoveling, and return to aggregate base stockpile or dispose of properly. Allow aggregate rinse to settle. Then, either allow rinse water to dry in a temporary pit as described in WM-8, Concrete Waste Management, or pump the water to the sanitary sewer if authorized by the local wastewater authority.

Sealing Operations

- During chip seal application and sweeping operations, petroleum or petroleum covered aggregate should not be allowed to enter any storm drain or water courses. Apply temporary perimeter controls until structure is stabilized (i.e. all sealing operations are complete and cured and loose materials have been properly removed and disposed).

- Inlet protection (SE-10, Storm Drain Inlet Protection) should be used during application of seal coat, tack coat, slurry seal, and fog seal.

- Seal coat, tack coat, slurry seal, or fog seal should not be applied if rainfall is predicted to occur during the application or curing period.

Paving Equipment

- Leaks and spills from paving equipment can contain toxic levels of heavy metals and oil and grease. Place drip pans or absorbent materials under paving equipment when not in use. Clean up spills with absorbent materials and dispose of in accordance with the applicable regulations. See NS-10, Vehicle and Equipment Maintenance, WM-4, Spill Prevention and Control, and WM-10, Liquid Waste Management.

- Substances used to coat asphalt transport trucks and asphalt spreading equipment should not contain soap and should be non-foaming and non-toxic.

- Paving equipment parked onsite should be parked over plastic to prevent soil contamination.

- Clean asphalt coated equipment offsite whenever possible. When cleaning dry, hardened asphalt from equipment, manage hardened asphalt debris as described in WM-5, Solid Waste Management. Any cleaning onsite should follow NS-8, Vehicle and Equipment Cleaning.

Thermoplastic Striping

- Thermoplastic striper and pre-heater equipment shutoff valves should be inspected to ensure that they are working properly to prevent leaking thermoplastic from entering drain inlets, the stormwater drainage system, or watercourses.
- Pre-heaters should be filled carefully to prevent splashing or spilling of hot thermoplastic. Leave six inches of space at the top of the pre-heater container when filling thermoplastic to allow room for material to move.
- Do not pre-heat, transfer, or load thermoplastic near drain inlets or watercourses.
- Clean truck beds daily of loose debris and melted thermoplastic. When possible, recycle thermoplastic material.

Raised/Recessed Pavement Marker Application and Removal

- Do not transfer or load bituminous material near drain inlets, the stormwater drainage system, or watercourses.
- Melting tanks should be loaded with care and not filled to beyond six inches from the top to leave room for splashing.
- When servicing or filling melting tanks, ensure all pressure is released before removing lids to avoid spills.
- On large-scale projects, use mechanical or manual methods to collect excess bituminous material from the roadway after removal of markers.

Costs

- All of the above are low cost measures.

Inspection and Maintenance

- Inspect and verify that activity-based BMPs are in place prior to the commencement of paving and grinding operations.
- BMPs must be inspected in accordance with General Permit requirements for the associated project type and risk level. It is recommended that at a minimum, BMPs be inspected weekly, prior to forecasted rain events, daily during extended rain events, and after the conclusion of rain events.
- Sample stormwater runoff required by the General Permit.
- Keep ample supplies of drip pans or absorbent materials onsite.
- Inspect and maintain machinery regularly to minimize leaks and drips.

References

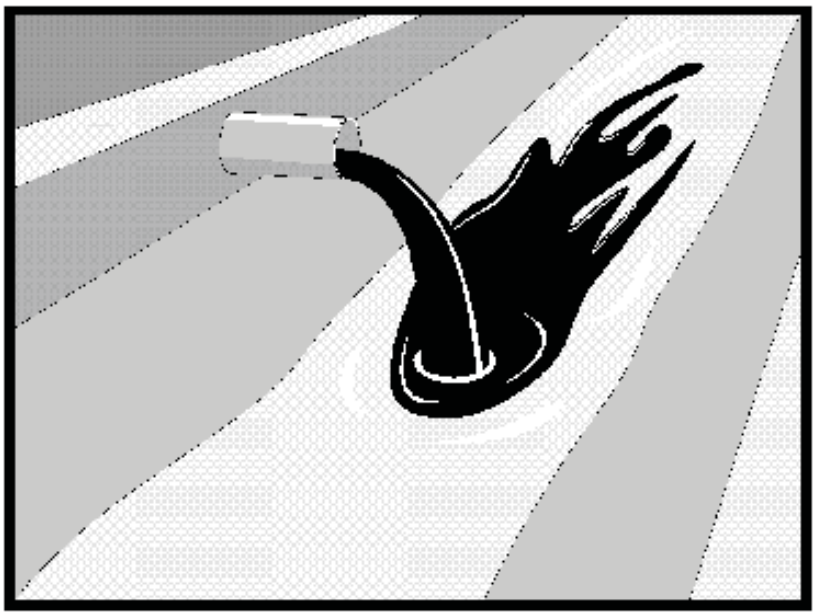
Blueprint for a Clean Bay: Best Management Practices to Prevent Stormwater Pollution from Construction Related Activities; Santa Clara Valley Nonpoint Source Pollution Control Program, 1995.

Hot Mix Asphalt-Paving Handbook AC 150/5370-14, Appendix I, U.S. Army Corps of Engineers, July 1991.

Stormwater Quality Handbooks - Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), March 2003.

Erosion and Sediment Control Manual, Oregon Department of Environmental Quality, February 2005.

Illicit Connection / Discharge NS-6



Description and Purpose

Procedures and practices designed for construction contractors to recognize illicit connections or illegally dumped or discharged materials on a construction site and report incidents.

Suitable Applications

This best management practice (BMP) applies to all construction projects. Illicit connection/discharge and reporting is applicable anytime an illicit connection or discharge is discovered or illegally dumped material is found on the construction site.

Limitations

Illicit connections and illegal discharges or dumping, for the purposes of this BMP, refer to discharges and dumping caused by parties other than the contractor. If pre-existing hazardous materials or wastes are known to exist onsite, they should be identified in the SWPPP and handled as set forth in the SWPPP.

Implementation

Planning

- Review the SWPPP. Pre-existing areas of contamination should be identified and documented in the SWPPP.
- Inspect site before beginning the job for evidence of illicit connections, illegal dumping or discharges. Document any pre-existing conditions and notify the owner.
- Inspect site regularly during project execution for evidence

Categories

EC	Erosion Control	
SE	Sediment Control	
TC	Tracking Control	
WE	Wind Erosion Control	
NS	Non-Stormwater Management Control	☑
WM	Waste Management and Materials Pollution Control	

Legend:

☑ **Primary Objective**

☒ **Secondary Objective**

Targeted Constituents

Sediment	
Nutrients	☑
Trash	☑
Metals	☑
Bacteria	☑
Oil and Grease	☑
Organics	☑

Potential Alternatives

None

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of illicit connections, illegal dumping or discharges.

- Observe site perimeter for evidence for potential of illicitly discharged or illegally dumped material, which may enter the job site.

Identification of Illicit Connections and Illegal Dumping or Discharges

- **General –** unlabeled and unidentifiable material should be treated as hazardous.
- **Solids** - Look for debris, or rubbish piles. Solid waste dumping often occurs on roadways with light traffic loads or in areas not easily visible from the traveled way.
- **Liquids** - signs of illegal liquid dumping or discharge can include:
  - Visible signs of staining or unusual colors to the pavement or surrounding adjacent soils
  - Pungent odors coming from the drainage systems
  - Discoloration or oily substances in the water or stains and residues detained within ditches, channels or drain boxes
  - Abnormal water flow during the dry weather season
- **Urban Areas** - Evidence of illicit connections or illegal discharges is typically detected at storm drain outfall locations or at manholes. Signs of an illicit connection or illegal discharge can include:
  - Abnormal water flow during the dry weather season
  - Unusual flows in sub drain systems used for dewatering
  - Pungent odors coming from the drainage systems
  - Discoloration or oily substances in the water or stains and residues detained within ditches, channels or drain boxes
  - Excessive sediment deposits, particularly adjacent to or near active offsite construction projects
- **Rural Areas** - Illicit connections or illegal discharges involving irrigation drainage ditches are detected by visual inspections. Signs of an illicit discharge can include:
  - Abnormal water flow during the non-irrigation season
  - Non-standard junction structures
  - Broken concrete or other disturbances at or near junction structures

Reporting

Notify the owner of any illicit connections and illegal dumping or discharge incidents at the time of discovery. For illicit connections or discharges to the storm drain system, notify the local stormwater management agency. For illegal dumping, notify the local law enforcement agency.

Cleanup and Removal

The responsibility for cleanup and removal of illicit or illegal dumping or discharges will vary by location. Contact the local stormwater management agency for further information.

Costs

Costs to look for and report illicit connections and illegal discharges and dumping are low. The best way to avoid costs associated with illicit connections and illegal discharges and dumping is to keep the project perimeters secure to prevent access to the site, to observe the site for vehicles that should not be there, and to document any waste or hazardous materials that exist onsite before taking possession of the site.

Inspection and Maintenance

- Inspect and verify that activity-based BMPs are in place prior to the commencement of associated activities. While activities associated with the BMP are under way, inspect BMPs in accordance with General Permit requirements for the associated project type and risk level. It is recommended that at a minimum, BMPs be inspected weekly, prior to forecasted rain events, daily during extended rain events, and after the conclusion of rain events.
- Inspect the site regularly to check for any illegal dumping or discharge.
- Prohibit employees and subcontractors from disposing of non-job related debris or materials at the construction site.
- Notify the owner of any illicit connections and illegal dumping or discharge incidents at the time of discovery.

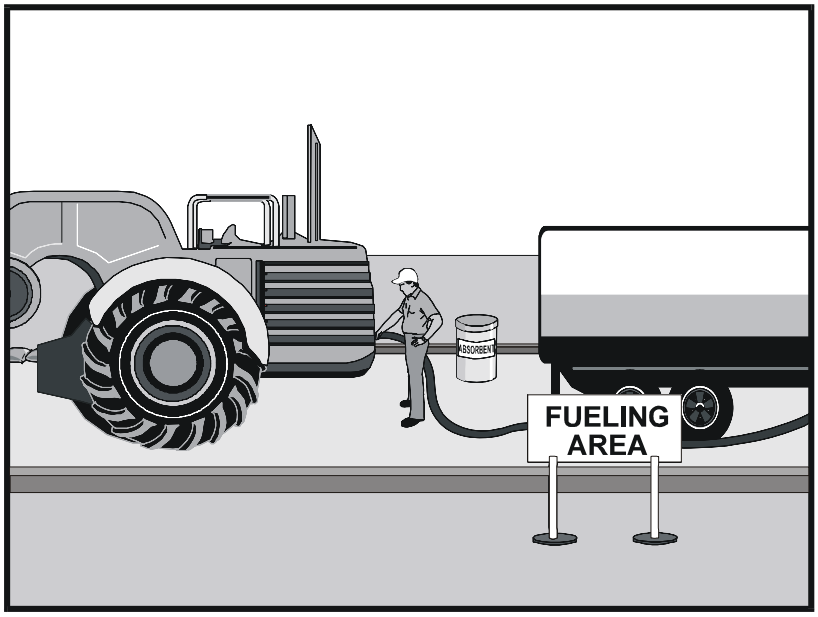
References

Blueprint for a Clean Bay: Best Management Practices to Prevent Stormwater Pollution from Construction Related Activities; Santa Clara Valley Nonpoint Source Pollution Control Program, 1995.

Stormwater Quality Handbooks - Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), November 2000.

Stormwater Management for Construction Activities, Developing Pollution Prevention Plans and Best Management Practices, EPA 832-R-92005; USEPA, April 1992.

Vehicle and Equipment Fueling NS-9



Categories

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Legend:
☑ **Primary Objective**
☒ **Secondary Objective**

Targeted Constituents

Sediment	
Nutrients	
Trash	
Metals	
Bacteria	
Oil and Grease	☑
Organics	

Potential Alternatives

None

Description and Purpose

Vehicle equipment fueling procedures and practices are designed to prevent fuel spills and leaks, and reduce or eliminate contamination of stormwater. This can be accomplished by using offsite facilities, fueling in designated areas only, enclosing or covering stored fuel, implementing spill controls, and training employees and subcontractors in proper fueling procedures.

Suitable Applications

These procedures are suitable on all construction sites where vehicle and equipment fueling takes place.

Limitations

Onsite vehicle and equipment fueling should only be used where it is impractical to send vehicles and equipment offsite for fueling. Sending vehicles and equipment offsite should be done in conjunction with TC-1, Stabilized Construction Entrance/ Exit.

Implementation

- Use offsite fueling stations as much as possible. These businesses are better equipped to handle fuel and spills properly. Performing this work offsite can also be economical by eliminating the need for a separate fueling area at a site.
- Discourage "topping-off" of fuel tanks.
- Absorbent spill cleanup materials and spill kits should be available in fueling areas and on fueling trucks, and should

be disposed of properly after use.

- Drip pans or absorbent pads should be used during vehicle and equipment fueling, unless the fueling is performed over an impermeable surface in a dedicated fueling area.
- Use absorbent materials on small spills. Do not hose down or bury the spill. Remove the adsorbent materials promptly and dispose of properly.
- Avoid mobile fueling of mobile construction equipment around the site; rather, transport the equipment to designated fueling areas. With the exception of tracked equipment such as bulldozers and large excavators, most vehicles should be able to travel to a designated area with little lost time.
- Train employees and subcontractors in proper fueling and cleanup procedures.
- When fueling must take place onsite, designate an area away from drainage courses to be used. Fueling areas should be identified in the SWPPP.
- Dedicated fueling areas should be protected from stormwater runon and runoff, and should be located at least 50 ft away from downstream drainage facilities and watercourses. Fueling must be performed on level-grade areas.
- Protect fueling areas with berms and dikes to prevent runon, runoff, and to contain spills.
- Nozzles used in vehicle and equipment fueling should be equipped with an automatic shutoff to control drips. Fueling operations should not be left unattended.
- Use vapor recovery nozzles to help control drips as well as air pollution where required by Air Quality Management Districts (AQMD).
- Federal, state, and local requirements should be observed for any stationary above ground storage tanks.

Costs

- All of the above measures are low cost except for the capital costs of above ground tanks that meet all local environmental, zoning, and fire codes.

Inspection and Maintenance

- Vehicles and equipment should be inspected each day of use for leaks. Leaks should be repaired immediately or problem vehicles or equipment should be removed from the project site.
- Keep ample supplies of spill cleanup materials onsite.
- Immediately clean up spills and properly dispose of contaminated soil and cleanup materials.

References

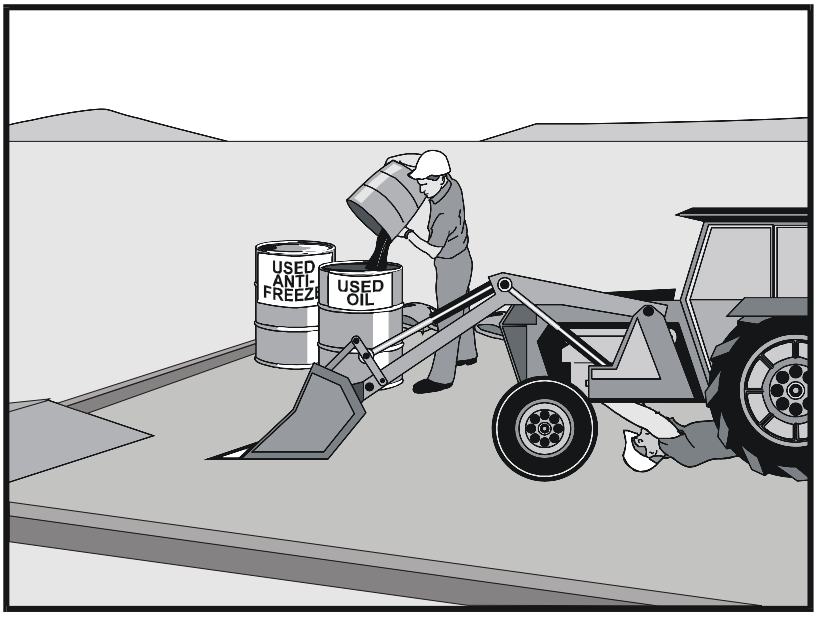
Blueprint for a Clean Bay: Best Management Practices to Prevent Stormwater Pollution from Construction Related Activities; Santa Clara Valley Nonpoint Source Pollution Control Program, 1995.

Coastal Nonpoint Pollution Control Program: Program Development and Approval Guidance, Working Group Working Paper; USEPA, April 1992.

Stormwater Quality Handbooks - Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), November 2000.

Stormwater Management for Construction Activities, Developing Pollution Prevention Plans and Best Management Practices, EPA 832-R-92005; USEPA, April 1992.

Vehicle & Equipment Maintenance NS-10



Description and Purpose

Prevent or reduce the contamination of stormwater resulting from vehicle and equipment maintenance by running a "dry and clean site". The best option would be to perform maintenance activities at an offsite facility. If this option is not available then work should be performed in designated areas only, while providing cover for materials stored outside, checking for leaks and spills, and containing and cleaning up spills immediately. Employees and subcontractors must be trained in proper procedures.

Suitable Applications

These procedures are suitable on all construction projects where an onsite yard area is necessary for storage and maintenance of heavy equipment and vehicles.

Limitations

Onsite vehicle and equipment maintenance should only be used where it is impractical to send vehicles and equipment offsite for maintenance and repair. Sending vehicles/equipment offsite should be done in conjunction with TC-1, Stabilized Construction Entrance/Exit.

Outdoor vehicle or equipment maintenance is a potentially significant source of stormwater pollution. Activities that can contaminate stormwater include engine repair and service, changing or replacement of fluids, and outdoor equipment storage and parking (engine fluid leaks). For further information on vehicle or equipment servicing, see NS-8, Vehicle and Equipment Cleaning, and NS-9, Vehicle and

Categories

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Legend:

☑ **Primary Objective**

☒ **Secondary Objective**

Targeted Constituents

Sediment	
Nutrients	☑
Trash	☑
Metals	
Bacteria	
Oil and Grease	☑
Organics	☑

Potential Alternatives

None

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Equipment Fueling.

Implementation

- Use offsite repair shops as much as possible. These businesses are better equipped to handle vehicle fluids and spills properly. Performing this work offsite can also be economical by eliminating the need for a separate maintenance area.
- If maintenance must occur onsite, use designated areas, located away from drainage courses. Dedicated maintenance areas should be protected from stormwater runon and runoff, and should be located at least 50 ft from downstream drainage facilities and watercourses.
- Drip pans or absorbent pads should be used during vehicle and equipment maintenance work that involves fluids, unless the maintenance work is performed over an impermeable surface in a dedicated maintenance area.
- Place a stockpile of spill cleanup materials where it will be readily accessible.
- All fueling trucks and fueling areas are required to have spill kits and/or use other spill protection devices.
- Use adsorbent materials on small spills. Remove the absorbent materials promptly and dispose of properly.
- Inspect onsite vehicles and equipment daily at startup for leaks, and repair immediately.
- Keep vehicles and equipment clean; do not allow excessive build-up of oil and grease.
- Segregate and recycle wastes, such as greases, used oil or oil filters, antifreeze, cleaning solutions, automotive batteries, hydraulic and transmission fluids. Provide secondary containment and covers for these materials if stored onsite.
- Train employees and subcontractors in proper maintenance and spill cleanup procedures.
- Drip pans or plastic sheeting should be placed under all vehicles and equipment placed on docks, barges, or other structures over water bodies when the vehicle or equipment is planned to be idle for more than 1 hour.
- For long-term projects, consider using portable tents or covers over maintenance areas if maintenance cannot be performed offsite.
- Consider use of new, alternative greases and lubricants, such as adhesive greases, for chassis lubrication and fifth-wheel lubrication.
- Properly dispose of used oils, fluids, lubricants, and spill cleanup materials.
- Do not place used oil in a dumpster or pour into a storm drain or watercourse.
- Properly dispose of or recycle used batteries.
- Do not bury used tires.

- Repair leaks of fluids and oil immediately.

Listed below is further information if you must perform vehicle or equipment maintenance onsite.

Safer Alternative Products

- Consider products that are less toxic or hazardous than regular products. These products are often sold under an "environmentally friendly" label.
- Consider use of grease substitutes for lubrication of truck fifth-wheels. Follow manufacturers label for details on specific uses.
- Consider use of plastic friction plates on truck fifth-wheels in lieu of grease. Follow manufacturers label for details on specific uses.

Waste Reduction

Parts are often cleaned using solvents such as trichloroethylene, trichloroethane, or methylene chloride. Many of these cleaners are listed in California Toxic Rule as priority pollutants. These materials are harmful and must not contaminate stormwater. They must be disposed of as a hazardous waste. Reducing the number of solvents makes recycling easier and reduces hazardous waste management costs. Often, one solvent can perform a job as well as two different solvents. Also, if possible, eliminate or reduce the amount of hazardous materials and waste by substituting non-hazardous or less hazardous materials. For example, replace chlorinated organic solvents with non-chlorinated solvents. Non-chlorinated solvents like kerosene or mineral spirits are less toxic and less expensive to dispose of properly. Check the list of active ingredients to see whether it contains chlorinated solvents. The "chlor" term indicates that the solvent is chlorinated. Also, try substituting a wire brush for solvents to clean parts.

Recycling and Disposal

Separating wastes allows for easier recycling and may reduce disposal costs. Keep hazardous wastes separate, do not mix used oil solvents, and keep chlorinated solvents (like,-trichloroethane) separate from non-chlorinated solvents (like kerosene and mineral spirits). Promptly transfer used fluids to the proper waste or recycling drums. Don't leave full drip pans or other open containers lying around. Provide cover and secondary containment until these materials can be removed from the site.

Oil filters can be recycled. Ask your oil supplier or recycler about recycling oil filters.

Do not dispose of extra paints and coatings by dumping liquid onto the ground or throwing it into dumpsters. Allow coatings to dry or harden before disposal into covered dumpsters.

Store cracked batteries in a non-leaking secondary container. Do this with all cracked batteries, even if you think all the acid has drained out. If you drop a battery, treat it as if it is cracked. Put it into the containment area until you are sure it is not leaking.

Costs

All of the above are low cost measures. Higher costs are incurred to setup and maintain onsite maintenance areas.

Inspection and Maintenance

- Inspect and verify that activity-based BMPs are in place prior to the commencement of associated activities. While activities associated with the BMP are under way, inspect BMPs in accordance with General Permit requirements for the associated project type and risk level. It is recommended that at a minimum, BMPs be inspected weekly, prior to forecasted rain events, daily during extended rain events, and after the conclusion of rain events.
- Inspect BMPs subject to non-stormwater discharges daily while non-stormwater discharges occur.
- Keep ample supplies of spill cleanup materials onsite.
- Maintain waste fluid containers in leak proof condition.
- Vehicles and equipment should be inspected on each day of use. Leaks should be repaired immediately or the problem vehicle(s) or equipment should be removed from the project site.
- Inspect equipment for damaged hoses and leaky gaskets routinely. Repair or replace as needed.

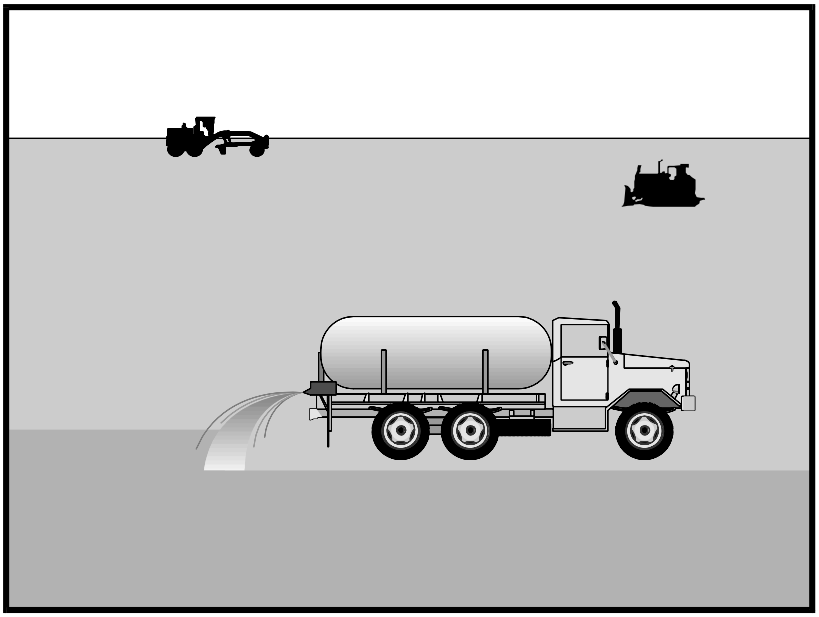
References

Blueprint for a Clean Bay: Best Management Practices to Prevent Stormwater Pollution from Construction Related Activities; Santa Clara Valley Nonpoint Source Pollution Control Program, 1995.

Coastal Nonpoint Pollution Control Program; Program Development and Approval Guidance, Working Group, Working Paper; USEPA, April 1992.

Stormwater Quality Handbooks - Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), November 2000.

Wind Erosion Control WE-1



Categories

EC	Erosion Control	
SE	Sediment Control	☒
TC	Tracking Control	
WE	Wind Erosion Control	☑
NS	Non-Stormwater Management Control	
WM	Waste Management and Materials Pollution Control	

Legend:
☑ **Primary Category**
☒ **Secondary Category**

Targeted Constituents

Sediment	☑
Nutrients	
Trash	
Metals	
Bacteria	
Oil and Grease	
Organics	

Potential Alternatives

EC-5 Soil Binders

Description and Purpose

Wind erosion or dust control consists of applying water or other chemical dust suppressants as necessary to prevent or alleviate dust nuisance generated by construction activities. Covering small stockpiles or areas is an alternative to applying water or other dust palliatives.

California's Mediterranean climate, with a short "wet" season and a typically long, hot "dry" season, allows the soils to thoroughly dry out. During the dry season, construction activities are at their peak, and disturbed and exposed areas are increasingly subject to wind erosion, sediment tracking and dust generated by construction equipment. Site conditions and climate can make dust control more of an erosion problem than water based erosion. Additionally, many local agencies, including Air Quality Management Districts, require dust control and/or dust control permits in order to comply with local nuisance laws, opacity laws (visibility impairment) and the requirements of the Clean Air Act. Wind erosion control is required to be implemented at all construction sites greater than 1 acre by the General Permit.

Suitable Applications

Most BMPs that provide protection against water-based erosion will also protect against wind-based erosion and dust control requirements required by other agencies will generally meet wind erosion control requirements for water quality protection. Wind erosion control BMPs are suitable during the following construction activities:

- Construction vehicle traffic on unpaved roads
- Drilling and blasting activities
- Soils and debris storage piles
- Batch drop from front-end loaders
- Areas with unstabilized soil
- Final grading/site stabilization

Limitations

- Watering prevents dust only for a short period (generally less than a few hours) and should be applied daily (or more often) to be effective.
- Over watering may cause erosion and track-out.
- Oil or oil-treated subgrade should not be used for dust control because the oil may migrate into drainageways and/or seep into the soil.
- Chemical dust suppression agents may have potential environmental impacts. Selected chemical dust control agents should be environmentally benign.
- Effectiveness of controls depends on soil, temperature, humidity, wind velocity and traffic.
- Chemical dust suppression agents should not be used within 100 feet of wetlands or water bodies.
- Chemically treated subgrades may make the soil water repellant, interfering with long-term infiltration and the vegetation/re-vegetation of the site. Some chemical dust suppressants may be subject to freezing and may contain solvents and should be handled properly.
- In compacted areas, watering and other liquid dust control measures may wash sediment or other constituents into the drainage system.
- If the soil surface has minimal natural moisture, the affected area may need to be pre-wetted so that chemical dust control agents can uniformly penetrate the soil surface.

Implementation

Dust Control Practices

Dust control BMPs generally stabilize exposed surfaces and minimize activities that suspend or track dust particles. The following table presents dust control practices that can be applied to varying site conditions that could potentially cause dust. For heavily traveled and disturbed areas, wet suppression (watering), chemical dust suppression, gravel asphalt surfacing, temporary gravel construction entrances, equipment wash-out areas, and haul truck covers can be employed as dust control applications. Permanent or temporary vegetation and mulching can be employed for areas of occasional or no construction traffic. Preventive measures include minimizing surface areas to be disturbed, limiting onsite vehicle traffic to 15 mph or less, and controlling the number and activity of vehicles on a site at any given time.

Chemical dust suppressants include: mulch and fiber based dust palliatives (e.g. paper mulch with gypsum binder), salts and brines (e.g. calcium chloride, magnesium chloride), non-petroleum based organics (e.g. vegetable oil, lignosulfonate), petroleum based organics (e.g. asphalt emulsion, dust oils, petroleum resins), synthetic polymers (e.g. polyvinyl acetate, vinyls, acrylic), clay additives (e.g. bentonite, montimorillonite) and electrochemical products (e.g. enzymes, ionic products).

Site Condition	Dust Control Practices							
	Permanent Vegetation	Mulching	Wet Suppression (Watering)	Chemical Dust Suppression	Gravel or Asphalt	Temporary Gravel Construction Entrances/Equipment Wash Down	Synthetic Covers	Minimize Extent of Disturbed Area
Disturbed Areas not Subject to Traffic	x	x	x	x	x			x
Disturbed Areas Subject to Traffic			x	x	x	x		x
Material Stockpiles		x	x	x			x	x
Demolition			x			x	x	
Clearing/ Excavation			x	x				x
Truck Traffic on Unpaved Roads			x	x	x	x	x	
Tracking					x	x		

Additional preventive measures include:

- Schedule construction activities to minimize exposed area (see EC-1, Scheduling).
- Quickly treat exposed soils using water, mulching, chemical dust suppressants, or stone/gravel layering.
- Identify and stabilize key access points prior to commencement of construction.
- Minimize the impact of dust by anticipating the direction of prevailing winds.
- Restrict construction traffic to stabilized roadways within the project site, as practicable.
- Water should be applied by means of pressure-type distributors or pipelines equipped with a spray system or hoses and nozzles that will ensure even distribution.
- All distribution equipment should be equipped with a positive means of shutoff.
- Unless water is applied by means of pipelines, at least one mobile unit should be available at all times to apply water or dust palliative to the project.
- If reclaimed waste water is used, the sources and discharge must meet California Department of Health Services water reclamation criteria and the Regional Water Quality

Control Board (RWQCB) requirements. Non-potable water should not be conveyed in tanks or drain pipes that will be used to convey potable water and there should be no connection between potable and non-potable supplies. Non-potable tanks, pipes, and other conveyances should be marked, "NON-POTABLE WATER - DO NOT DRINK."

- Pave or chemically stabilize access points where unpaved traffic surfaces adjoin paved roads.
- Provide covers for haul trucks transporting materials that contribute to dust.
- Provide for rapid clean up of sediments deposited on paved roads. Furnish stabilized construction road entrances and wheel wash areas.
- Stabilize inactive areas of construction sites using temporary vegetation or chemical stabilization methods.

For chemical stabilization, there are many products available for chemically stabilizing gravel roadways and stockpiles. If chemical stabilization is used, the chemicals should not create any adverse effects on stormwater, plant life, or groundwater and should meet all applicable regulatory requirements.

Costs

Installation costs for water and chemical dust suppression vary based on the method used and the length of effectiveness. Annual costs may be high since some of these measures are effective for only a few hours to a few days.

Inspection and Maintenance

- Inspect and verify that activity-based BMPs are in place prior to the commencement of associated activities.
- BMPs must be inspected in accordance with General Permit requirements for the associated project type and risk level. It is recommended that at a minimum, BMPs be inspected weekly, prior to forecasted rain events, daily during extended rain events, and after the conclusion of rain events.
- Check areas protected to ensure coverage.
- Most water-based dust control measures require frequent application, often daily or even multiple times per day. Obtain vendor or independent information on longevity of chemical dust suppressants.

References

Best Management Practices and Erosion Control Manual for Construction Sites, Flood Control District of Maricopa County, Arizona, September 1992.

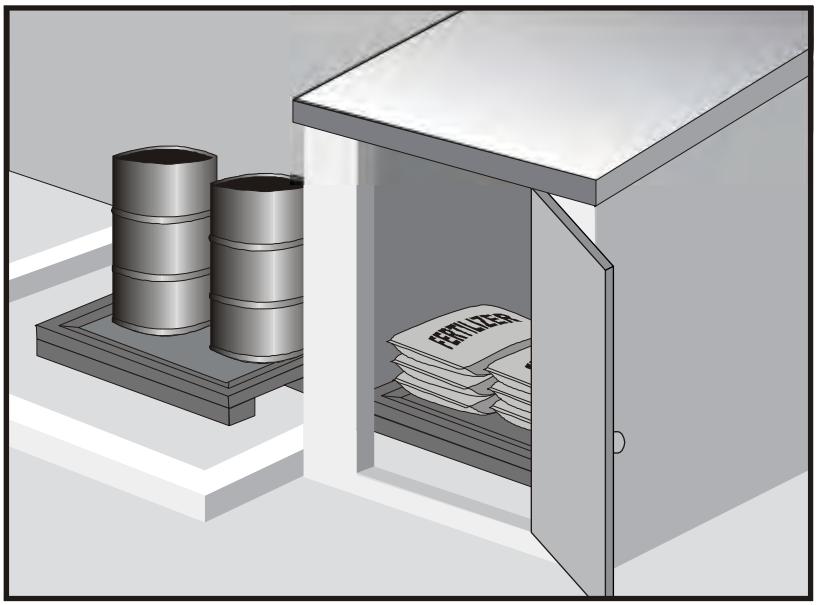
California Air Pollution Control Laws, California Air Resources Board, updated annually.

Construction Manual, Chapter 4, Section 10, "Dust Control"; Section 17, "Watering"; and Section 18, "Dust Palliative", California Department of Transportation (Caltrans), July 2001.

Prospects for Attaining the State Ambient Air Quality Standards for Suspended Particulate Matter (PM10), Visibility Reducing Particles, Sulfates, Lead, and Hydrogen Sulfide, California Air Resources Board, April 1991.

Stormwater Quality Handbooks Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), March 2003.

Material Delivery and Storage WM-1



Categories

EC	Erosion Control	
SE	Sediment Control	
TC	Tracking Control	
WE	Wind Erosion Control	
NS	Non-Stormwater Management Control	
WM	Waste Management and Materials Pollution Control	☑

Legend:

☑ **Primary Category**

☒ **Secondary Category**

Targeted Constituents

Sediment	☑
Nutrients	☑
Trash	☑
Metals	☑
Bacteria	
Oil and Grease	☑
Organics	☑

Potential Alternatives

None

Description and Purpose

Prevent, reduce, or eliminate the discharge of pollutants from material delivery and storage to the stormwater system or watercourses by minimizing the storage of hazardous materials onsite, storing materials in watertight containers and/or a completely enclosed designated area, installing secondary containment, conducting regular inspections, and training employees and subcontractors.

This best management practice covers only material delivery and storage. For other information on materials, see WM-2, Material Use, or WM-4, Spill Prevention and Control. For information on wastes, see the waste management BMPs in this section.

Suitable Applications

These procedures are suitable for use at all construction sites with delivery and storage of the following materials:

- Soil stabilizers and binders
- Pesticides and herbicides
- Fertilizers
- Detergents
- Plaster
- Petroleum products such as fuel, oil, and grease

- Asphalt and concrete components
- Hazardous chemicals such as acids, lime, glues, adhesives, paints, solvents, and curing compounds
- Concrete compounds
- Other materials that may be detrimental if released to the environment

Limitations

- Space limitation may preclude indoor storage.
- Storage sheds often must meet building and fire code requirements.

Implementation

The following steps should be taken to minimize risk:

- Chemicals must be stored in water tight containers with appropriate secondary containment or in a storage shed.
- When a material storage area is located on bare soil, the area should be lined and bermed.
- Use containment pallets or other practical and available solutions, such as storing materials within newly constructed buildings or garages, to meet material storage requirements.
- Stack erodible landscape material on pallets and cover when not in use.
- Contain all fertilizers and other landscape materials when not in use.
- Temporary storage areas should be located away from vehicular traffic.
- Material Safety Data Sheets (MSDS) should be available on-site for all materials stored that have the potential to effect water quality.
- Construction site areas should be designated for material delivery and storage.
- Material delivery and storage areas should be located away from waterways, if possible.
    - Avoid transport near drainage paths or waterways.
    - Surround with earth berms or other appropriate containment BMP. See EC-9, Earth Dikes and Drainage Swales.
    - Place in an area that will be paved.
- Storage of reactive, ignitable, or flammable liquids must comply with the fire codes of your area. Contact the local Fire Marshal to review site materials, quantities, and proposed storage area to determine specific requirements. See the Flammable and Combustible Liquid Code, NFPA30.
- An up to date inventory of materials delivered and stored onsite should be kept.

- Hazardous materials storage onsite should be minimized.
- Hazardous materials should be handled as infrequently as possible.
- Keep ample spill cleanup supplies appropriate for the materials being stored. Ensure that cleanup supplies are in a conspicuous, labeled area.
- Employees and subcontractors should be trained on the proper material delivery and storage practices.
- Employees trained in emergency spill cleanup procedures must be present when dangerous materials or liquid chemicals are unloaded.
- If significant residual materials remain on the ground after construction is complete, properly remove and dispose of materials and any contaminated soil. See WM-7, Contaminated Soil Management. If the area is to be paved, pave as soon as materials are removed to stabilize the soil.

Material Storage Areas and Practices

- Liquids, petroleum products, and substances listed in 40 CFR Parts 110, 117, or 302 should be stored in approved containers and drums and should not be overfilled. Containers and drums should be placed in temporary containment facilities for storage.
- A temporary containment facility should provide for a spill containment volume able to contain precipitation from a 25 year storm event, plus the greater of 10% of the aggregate volume of all containers or 100% of the capacity of the largest container within its boundary, whichever is greater.
- A temporary containment facility should be impervious to the materials stored therein for a minimum contact time of 72 hours.
- A temporary containment facility should be maintained free of accumulated rainwater and spills. In the event of spills or leaks, accumulated rainwater and spills should be collected and placed into drums. These liquids should be handled as a hazardous waste unless testing determines them to be non-hazardous. All collected liquids or non-hazardous liquids should be sent to an approved disposal site.
- Sufficient separation should be provided between stored containers to allow for spill cleanup and emergency response access.
- Incompatible materials, such as chlorine and ammonia, should not be stored in the same temporary containment facility.
- Materials should be covered prior to, and during rain events.
- Materials should be stored in their original containers and the original product labels should be maintained in place in a legible condition. Damaged or otherwise illegible labels should be replaced immediately.

- Bagged and boxed materials should be stored on pallets and should not be allowed to accumulate on the ground. To provide protection from wind and rain throughout the rainy season, bagged and boxed materials should be covered during non-working days and prior to and during rain events.
- Stockpiles should be protected in accordance with WM-3, Stockpile Management.
- Materials should be stored indoors within existing structures or completely enclosed storage sheds when available.
- Proper storage instructions should be posted at all times in an open and conspicuous location.
- An ample supply of appropriate spill clean up material should be kept near storage areas.
- Also see WM-6, Hazardous Waste Management, for storing of hazardous wastes.

Material Delivery Practices

- Keep an accurate, up-to-date inventory of material delivered and stored onsite.
- Arrange for employees trained in emergency spill cleanup procedures to be present when dangerous materials or liquid chemicals are unloaded.

Spill Cleanup

- Contain and clean up any spill immediately.
- Properly remove and dispose of any hazardous materials or contaminated soil if significant residual materials remain on the ground after construction is complete. See WM-7, Contaminated Soil Management.
- See WM-4, Spill Prevention and Control, for spills of chemicals and/or hazardous materials.
- If spills or leaks of materials occur that are not contained and could discharge to surface waters, non-visible sampling of site discharge may be required. Refer to the General Permit or to your project specific Construction Site Monitoring Plan to determine if and where sampling is required.

Cost

- The largest cost of implementation may be in the construction of a materials storage area that is covered and provides secondary containment.

Inspection and Maintenance

- BMPs must be inspected in accordance with General Permit requirements for the associated project type and risk level. It is recommended that at a minimum, BMPs be inspected weekly, prior to forecasted rain events, daily during extended rain events, and after the conclusion of rain events.
- Keep storage areas clean and well organized, including a current list of all materials onsite.
- Inspect labels on containers for legibility and accuracy.

- Repair or replace perimeter controls, containment structures, covers, and liners as needed to maintain proper function.

References

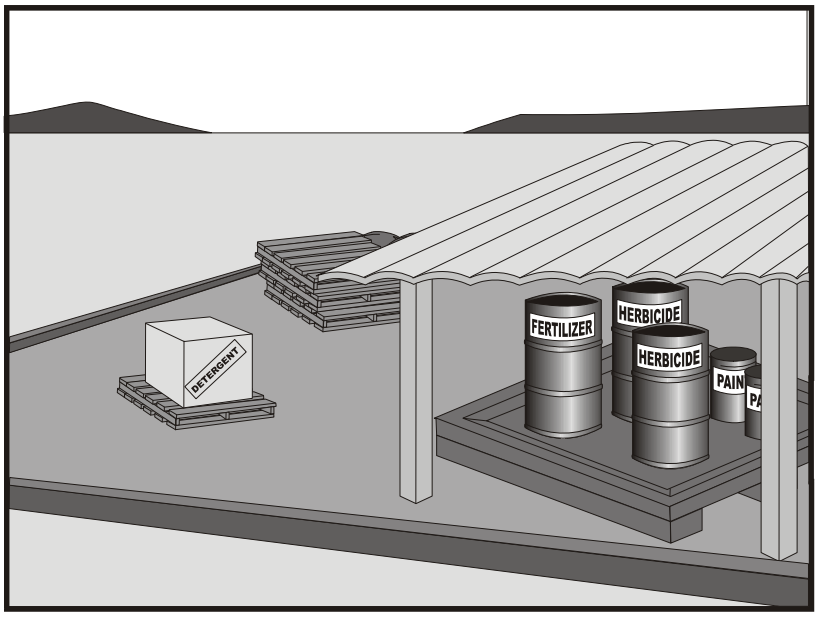
Blueprint for a Clean Bay: Best Management Practices to Prevent Stormwater Pollution from Construction Related Activities; Santa Clara Valley Nonpoint Source Pollution Control Program, 1995.

Coastal Nonpoint Pollution Control Program: Program Development and Approval Guidance, Working Group Working Paper; USEPA, April 1992.

Stormwater Quality Handbooks - Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), March 2003.

Stormwater Management for Construction Activities; Developing Pollution Prevention Plans and Best Management Practice, EPA 832-R-92005; USEPA, April 1992.

Material Use WM-2



Categories

EC	Erosion Control	
SE	Sediment Control	
TC	Tracking Control	
WE	Wind Erosion Control	
NS	Non-Stormwater Management Control	
WM	Waste Management and Materials Pollution Control	☑

Legend:

☑ **Primary Category**

☒ **Secondary Category**

Description and Purpose

Prevent or reduce the discharge of pollutants to the storm drain system or watercourses from material use by using alternative products, minimizing hazardous material use onsite, and training employees and subcontractors.

Suitable Applications

This BMP is suitable for use at all construction projects. These procedures apply when the following materials are used or prepared onsite:

- Pesticides and herbicides
- Fertilizers
- Detergents
- Petroleum products such as fuel, oil, and grease
- Asphalt and other concrete components
- Other hazardous chemicals such as acids, lime, glues, adhesives, paints, solvents, and curing compounds
- Other materials that may be detrimental if released to the environment

Targeted Constituents

Sediment	☑
Nutrients	☑
Trash	☑
Metals	☑
Bacteria	
Oil and Grease	☑
Organics	☑

Potential Alternatives

None

CASQA
CALIFORNIA STORMWATER QUALITY ASSOCIATION

Limitations

Safer alternative building and construction products may not be available or suitable in every instance.

Implementation

The following steps should be taken to minimize risk:

- Minimize use of hazardous materials onsite.
- Follow manufacturer instructions regarding uses, protective equipment, ventilation, flammability, and mixing of chemicals.
- Train personnel who use pesticides. The California Department of Pesticide Regulation and county agricultural commissioners license pesticide dealers, certify pesticide applicators, and conduct onsite inspections.
- The preferred method of termiticide application is soil injection near the existing or proposed structure foundation/slab; however, if not feasible, soil drench application of termiticides should follow EPA label guidelines and the following recommendations (most of which are applicable to most pesticide applications):
  - Do not treat soil that is water-saturated or frozen.
  - Application shall not commence within 24-hours of a predicted precipitation event with a 40% or greater probability. Weather tracking must be performed on a daily basis prior to termiticide application and during the period of termiticide application.
  - Do not allow treatment chemicals to runoff from the target area. Apply proper quantity to prevent excess runoff. Provide containment for and divert stormwater from application areas using berms or diversion ditches during application.
  - Dry season: Do not apply within 10 feet of storm drains. Do not apply within 25 feet of aquatic habitats (such as, but not limited to, lakes; reservoirs; rivers; permanent streams; marshes or ponds; estuaries; and commercial fish farm ponds).
  - Wet season: Do not apply within 50 feet of storm drains or aquatic habitats (such as, but not limited to, lakes; reservoirs; rivers; permanent streams; marshes or ponds; estuaries; and commercial fish farm ponds) unless a vegetative buffer is present (if so, refer to dry season requirements).
  - Do not make on-grade applications when sustained wind speeds are above 10 mph (at application site) at nozzle end height.
  - Cover treatment site prior to a rain event in order to prevent run-off of the pesticide into non-target areas. The treated area should be limited to a size that can be backfilled and/or covered by the end of the work shift. Backfilling or covering of the treated area shall be done by the end of the same work shift in which the application is made.
  - The applicator must either cover the soil him/herself or provide written notification of the above requirement to the contractor on site and to the person commissioning the

application (if different than the contractor). If notice is provided to the contractor or the person commissioning the application, then they are responsible under the Federal Insecticide Fungicide, and Rodenticide Act (FIFRA) to ensure that: 1) if the concrete slab cannot be poured over the treated soil within 24 hours of application, the treated soil is covered with a waterproof covering (such as polyethylene sheeting), and 2) the treated soil is covered if precipitation is predicted to occur before the concrete slab is scheduled to be poured.

- Do not over-apply fertilizers, herbicides, and pesticides. Prepare only the amount needed. Follow the recommended usage instructions. Over-application is expensive and environmentally harmful. Unless on steep slopes, till fertilizers into the soil rather than hydraulic application. Apply surface dressings in several smaller applications, as opposed to one large application, to allow time for infiltration and to avoid excess material being carried offsite by runoff. Do not apply these chemicals before predicted rainfall.
- Train employees and subcontractors in proper material use.
- Supply Material Safety Data Sheets (MSDS) for all materials.
- Dispose of latex paint and paint cans, used brushes, rags, absorbent materials, and drop cloths, when thoroughly dry and are no longer hazardous, with other construction debris.
- Do not remove the original product label; it contains important safety and disposal information. Use the entire product before disposing of the container.
- Mix paint indoors or in a containment area. Never clean paintbrushes or rinse paint containers into a street, gutter, storm drain, or watercourse. Dispose of any paint thinners, residue, and sludge(s) that cannot be recycled, as hazardous waste.
- For water-based paint, clean brushes to the extent practicable, and rinse to a drain leading to a sanitary sewer where permitted, or contain for proper disposal off site. For oil-based paints, clean brushes to the extent practicable, and filter and reuse thinners and solvents.
- Use recycled and less hazardous products when practical. Recycle residual paints, solvents, non-treated lumber, and other materials.
- Use materials only where and when needed to complete the construction activity. Use safer alternative materials as much as possible. Reduce or eliminate use of hazardous materials onsite when practical.
- Document the location, time, chemicals applied, and applicator's name and qualifications.
- Keep an ample supply of spill clean up material near use areas. Train employees in spill clean up procedures.
- Avoid exposing applied materials to rainfall and runoff unless sufficient time has been allowed for them to dry.
- Discontinue use of erodible landscape material within 2 days prior to a forecasted rain event and materials should be covered and/or bermed.

- Provide containment for material use areas such as masons' areas or paint mixing/preparation areas to prevent materials/pollutants from entering stormwater.

Costs

All of the above are low cost measures.

Inspection and Maintenance

- Inspect and verify that activity-based BMPs are in place prior to the commencement of associated activities.
- BMPs must be inspected in accordance with General Permit requirements for the associated project type and risk level. It is recommended that at a minimum, BMPs be inspected weekly, prior to forecasted rain events, daily during extended rain events, and after the conclusion of rain events.
- Ensure employees and subcontractors throughout the job are using appropriate practices.

References

Blueprint for a Clean Bay: Best Management Practices to Prevent Stormwater Pollution from Construction Related Activities; Santa Clara Valley Nonpoint Source Pollution Control Program, 1995.

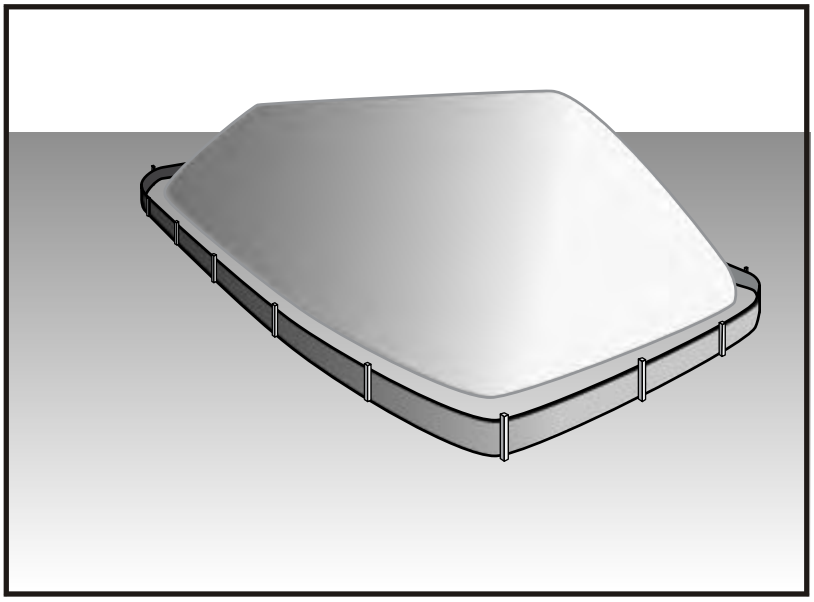
Coastal Nonpoint Pollution Control Program: Program Development and Approval Guidance, Working Group Working Paper; USEPA, April 1992.

Comments on Risk Assessments Risk Reduction Options for Cypermethrin: Docket No. OPP–2005–0293; California Stormwater Quality Association (CASQA) letter to USEPA, 2006.Environmental Hazard and General Labeling for Pyrethroid Non-Agricultural Outdoor Products, EPA-HQ-OPP-2008-0331-0021; USEPA, 2008.

Stormwater Quality Handbooks - Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), March 2003.

Stormwater Management for Construction Activities; Developing Pollution Prevention Plans and Best Management Practice, EPA 832-R-92005; USEPA, April 1992.

Stockpile Management WM-3



Categories		
EC	Erosion Control	
SE	Sediment Control	☒
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Legend:
☑ **Primary Category**
☒ **Secondary Category**

Targeted Constituents	
Sediment	☑
Nutrients	☑
Trash	☑
Metals	☑
Bacteria	
Oil and Grease	☑
Organics	☑

Potential Alternatives

None

Description and Purpose

Stockpile management procedures and practices are designed to reduce or eliminate air and stormwater pollution from stockpiles of soil, soil amendments, sand, paving materials such as portland cement concrete (PCC) rubble, asphalt concrete (AC), asphalt concrete rubble, aggregate base, aggregate sub base or pre-mixed aggregate, asphalt minder (so called "cold mix" asphalt), and pressure treated wood.

Suitable Applications

Implement in all projects that stockpile soil and other loose materials.

Limitations

- Plastic sheeting as a stockpile protection is temporary and hard to manage in windy conditions. Where plastic is used, consider use of plastic tarps with nylon reinforcement which may be more durable than standard sheeting.
- Plastic sheeting can increase runoff volume due to lack of infiltration and potentially cause perimeter control failure.
- Plastic sheeting breaks down faster in sunlight.
- The use of Plastic materials and photodegradable plastics should be avoided.

Implementation

Protection of stockpiles is a year-round requirement. To properly manage stockpiles:

- On larger sites, a minimum of 50 ft separation from concentrated flows of stormwater, drainage courses, and inlets is recommended.
- All stockpiles are required to be protected immediately if they are not scheduled to be used within 14 days.
- Protect all stockpiles from stormwater runon using temporary perimeter sediment barriers such as compost berms (SE-13), temporary silt dikes (SE-12), fiber rolls (SE-5), silt fences (SE-1), sandbags (SE-8), gravel bags (SE-6), or biofilter bags (SE-14). Refer to the individual fact sheet for each of these controls for installation information.
- Implement wind erosion control practices as appropriate on all stockpiled material. For specific information, see WE-1, Wind Erosion Control.
- Manage stockpiles of contaminated soil in accordance with WM-7, Contaminated Soil Management.
- Place bagged materials on pallets and under cover.
- Ensure that stockpile coverings are installed securely to protect from wind and rain.
- Some plastic covers withstand weather and sunlight better than others. Select cover materials or methods based on anticipated duration of use.

Protection of Non-Active Stockpiles

Non-active stockpiles of the identified materials should be protected further as follows:

Soil stockpiles

- Soil stockpiles should be covered or protected with soil stabilization measures and a temporary perimeter sediment barrier at all times.
- Temporary vegetation should be considered for topsoil piles that will be stockpiled for extended periods.

Stockpiles of Portland cement concrete rubble, asphalt concrete, asphalt concrete rubble, aggregate base, or aggregate sub base

- Stockpiles should be covered and protected with a temporary perimeter sediment barrier at all times.

Stockpiles of "cold mix"

- Cold mix stockpiles should be placed on and covered with plastic sheeting or comparable material at all times and surrounded by a berm.

Stockpiles of fly ash, stucco, hydrated lime

- Stockpiles of materials that may raise the pH of runoff (i.e., basic materials) should be covered with plastic and surrounded by a berm.

Stockpiles/Storage of wood (Pressure treated with chromated copper arsenate or ammoniacal copper zinc arsenate

- Treated wood should be covered with plastic sheeting or comparable material at all times and surrounded by a berm.

Protection of Active Stockpiles

Active stockpiles of the identified materials should be protected as follows:

- All stockpiles should be covered and protected with a temporary linear sediment barrier prior to the onset of precipitation.
- Stockpiles of "cold mix" and treated wood, and basic materials should be placed on and covered with plastic sheeting or comparable material and surrounded by a berm prior to the onset of precipitation.
- The downstream perimeter of an active stockpile should be protected with a linear sediment barrier or berm and runoff should be diverted around or away from the stockpile on the upstream perimeter.

Costs

For cost information associated with stockpile protection refer to the individual erosion or sediment control BMP fact sheet considered for implementation (For example, refer to SE-1 Silt Fence for installation of silt fence around the perimeter of a stockpile.)

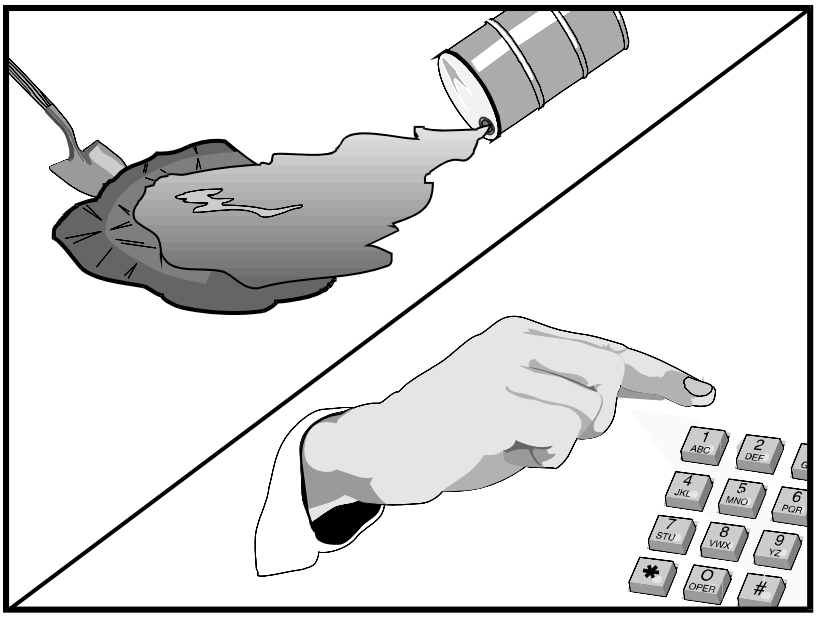
Inspection and Maintenance

- Stockpiles must be inspected in accordance with General Permit requirements for the associated project type and risk level. It is recommended that at a minimum, BMPs be inspected weekly, prior to forecasted rain events, daily during extended rain events, and after the conclusion of rain events.
- It may be necessary to inspect stockpiles covered with plastic sheeting more frequently during certain conditions (for example, high winds or extreme heat).
- Repair and/or replace perimeter controls and covers as needed to keep them functioning properly.
- Sediment shall be removed when it reaches one-third of the barrier height.

References

Stormwater Quality Handbooks - Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), March 2003.

Spill Prevention and Control WM-4



Description and Purpose

Prevent or reduce the discharge of pollutants to drainage systems or watercourses from leaks and spills by reducing the chance for spills, stopping the source of spills, containing and cleaning up spills, properly disposing of spill materials, and training employees.

This best management practice covers only spill prevention and control. However, WM-1, Materials Delivery and Storage, and WM-2, Material Use, also contain useful information, particularly on spill prevention. For information on wastes, see the waste management BMPs in this section.

Suitable Applications

This BMP is suitable for all construction projects. Spill control procedures are implemented anytime chemicals or hazardous substances are stored on the construction site, including the following materials:

- Soil stabilizers/binders
- Dust palliatives
- Herbicides
- Growth inhibitors
- Fertilizers
- Deicing/anti-icing chemicals

Categories

EC	Erosion Control	
SE	Sediment Control	
TC	Tracking Control	
WE	Wind Erosion Control	
NS	Non-Stormwater Management Control	
WM	Waste Management and Materials Pollution Control	☑

Legend:

☑ **Primary Objective**

☒ **Secondary Objective**

Targeted Constituents

Sediment	☑
Nutrients	☑
Trash	☑
Metals	☑
Bacteria	
Oil and Grease	☑
Organics	☑

Potential Alternatives

None

- Fuels
- Lubricants
- Other petroleum distillates

Limitations

- In some cases it may be necessary to use a private spill cleanup company.
- This BMP applies to spills caused by the contractor and subcontractors.
- Procedures and practices presented in this BMP are general. Contractor should identify appropriate practices for the specific materials used or stored onsite

Implementation

The following steps will help reduce the stormwater impacts of leaks and spills:

Education

- Be aware that different materials pollute in different amounts. Make sure that each employee knows what a "significant spill" is for each material they use, and what is the appropriate response for "significant" and "insignificant" spills.
- Educate employees and subcontractors on potential dangers to humans and the environment from spills and leaks.
- Hold regular meetings to discuss and reinforce appropriate disposal procedures (incorporate into regular safety meetings).
- Establish a continuing education program to indoctrinate new employees.
- Have contractor's superintendent or representative oversee and enforce proper spill prevention and control measures.

General Measures

- To the extent that the work can be accomplished safely, spills of oil, petroleum products, substances listed under 40 CFR parts 110,117, and 302, and sanitary and septic wastes should be contained and cleaned up immediately.
- Store hazardous materials and wastes in covered containers and protect from vandalism.
- Place a stockpile of spill cleanup materials where it will be readily accessible.
- Train employees in spill prevention and cleanup.
- Designate responsible individuals to oversee and enforce control measures.
- Spills should be covered and protected from stormwater runon during rainfall to the extent that it doesn't compromise clean up activities.
- Do not bury or wash spills with water.

- Store and dispose of used clean up materials, contaminated materials, and recovered spill material that is no longer suitable for the intended purpose in conformance with the provisions in applicable BMPs.
- Do not allow water used for cleaning and decontamination to enter storm drains or watercourses. Collect and dispose of contaminated water in accordance with WM-10, Liquid Waste Management.
- Contain water overflow or minor water spillage and do not allow it to discharge into drainage facilities or watercourses.
- Place proper storage, cleanup, and spill reporting instructions for hazardous materials stored or used on the project site in an open, conspicuous, and accessible location.
- Keep waste storage areas clean, well organized, and equipped with ample cleanup supplies as appropriate for the materials being stored. Perimeter controls, containment structures, covers, and liners should be repaired or replaced as needed to maintain proper function.

Cleanup

- Clean up leaks and spills immediately.
- Use a rag for small spills on paved surfaces, a damp mop for general cleanup, and absorbent material for larger spills. If the spilled material is hazardous, then the used cleanup materials are also hazardous and must be sent to either a certified laundry (rags) or disposed of as hazardous waste.
- Never hose down or bury dry material spills. Clean up as much of the material as possible and dispose of properly. See the waste management BMPs in this section for specific information.

Minor Spills

- Minor spills typically involve small quantities of oil, gasoline, paint, etc. which can be controlled by the first responder at the discovery of the spill.
- Use absorbent materials on small spills rather than hosing down or burying the spill.
- Absorbent materials should be promptly removed and disposed of properly.
- Follow the practice below for a minor spill:
  - Contain the spread of the spill.
  - Recover spilled materials.
  - Clean the contaminated area and properly dispose of contaminated materials.

Semi-Significant Spills

- Semi-significant spills still can be controlled by the first responder along with the aid of other personnel such as laborers and the foreman, etc. This response may require the cessation of all other activities.

- Spills should be cleaned up immediately:
  - Contain spread of the spill.
  - Notify the project foreman immediately.
  - If the spill occurs on paved or impermeable surfaces, clean up using "dry" methods (absorbent materials, cat litter and/or rags). Contain the spill by encircling with absorbent materials and do not let the spill spread widely.
  - If the spill occurs in dirt areas, immediately contain the spill by constructing an earthen dike. Dig up and properly dispose of contaminated soil.
  - If the spill occurs during rain, cover spill with tarps or other material to prevent contaminating runoff.

Significant/Hazardous Spills

- For significant or hazardous spills that cannot be controlled by personnel in the immediate vicinity, the following steps should be taken:
  - Notify the local emergency response by dialing 911. In addition to 911, the contractor will notify the proper county officials. It is the contractor's responsibility to have all emergency phone numbers at the construction site.
  - Notify the Governor's Office of Emergency Services Warning Center, (916) 845-8911.
  - For spills of federal reportable quantities, in conformance with the requirements in 40 CFR parts 110,119, and 302, the contractor should notify the National Response Center at (800) 424-8802.
  - Notification should first be made by telephone and followed up with a written report.
  - The services of a spills contractor or a Haz-Mat team should be obtained immediately. Construction personnel should not attempt to clean up until the appropriate and qualified staffs have arrived at the job site.
  - Other agencies which may need to be consulted include, but are not limited to, the Fire Department, the Public Works Department, the Coast Guard, the Highway Patrol, the City/County Police Department, Department of Toxic Substances, California Division of Oil and Gas, Cal/OSHA, etc.

Reporting

- Report significant spills to local agencies, such as the Fire Department; they can assist in cleanup.
- Federal regulations require that any significant oil spill into a water body or onto an adjoining shoreline be reported to the National Response Center (NRC) at 800-424-8802 (24 hours).

Use the following measures related to specific activities:

Vehicle and Equipment Maintenance

- If maintenance must occur onsite, use a designated area and a secondary containment, located away from drainage courses, to prevent the runon of stormwater and the runoff of spills.
- Regularly inspect onsite vehicles and equipment for leaks and repair immediately
- Check incoming vehicles and equipment (including delivery trucks, and employee and subcontractor vehicles) for leaking oil and fluids. Do not allow leaking vehicles or equipment onsite.
- Always use secondary containment, such as a drain pan or drop cloth, to catch spills or leaks when removing or changing fluids.
- Place drip pans or absorbent materials under paving equipment when not in use.
- Use absorbent materials on small spills rather than hosing down or burying the spill. Remove the absorbent materials promptly and dispose of properly.
- Promptly transfer used fluids to the proper waste or recycling drums. Don't leave full drip pans or other open containers lying around
- Oil filters disposed of in trashcans or dumpsters can leak oil and pollute stormwater. Place the oil filter in a funnel over a waste oil-recycling drum to drain excess oil before disposal. Oil filters can also be recycled. Ask the oil supplier or recycler about recycling oil filters.
- Store cracked batteries in a non-leaking secondary container. Do this with all cracked batteries even if you think all the acid has drained out. If you drop a battery, treat it as if it is cracked. Put it into the containment area until you are sure it is not leaking.

Vehicle and Equipment Fueling

- If fueling must occur onsite, use designate areas, located away from drainage courses, to prevent the runon of stormwater and the runoff of spills.
- Discourage "topping off" of fuel tanks.
- Always use secondary containment, such as a drain pan, when fueling to catch spills/ leaks.

Costs

Prevention of leaks and spills is inexpensive. Treatment and/ or disposal of contaminated soil or water can be quite expensive.

Inspection and Maintenance

- Inspect and verify that activity–based BMPs are in place prior to the commencement of associated activities. While activities associated with the BMP are under way, inspect weekly during the rainy season and of two-week intervals in the non-rainy season to verify continued BMP implementation.
- Inspect BMPs subject to non-stormwater discharge daily while non-stormwater discharges occur.

- Keep ample supplies of spill control and cleanup materials onsite, near storage, unloading, and maintenance areas.
- Update your spill prevention and control plan and stock cleanup materials as changes occur in the types of chemicals onsite.

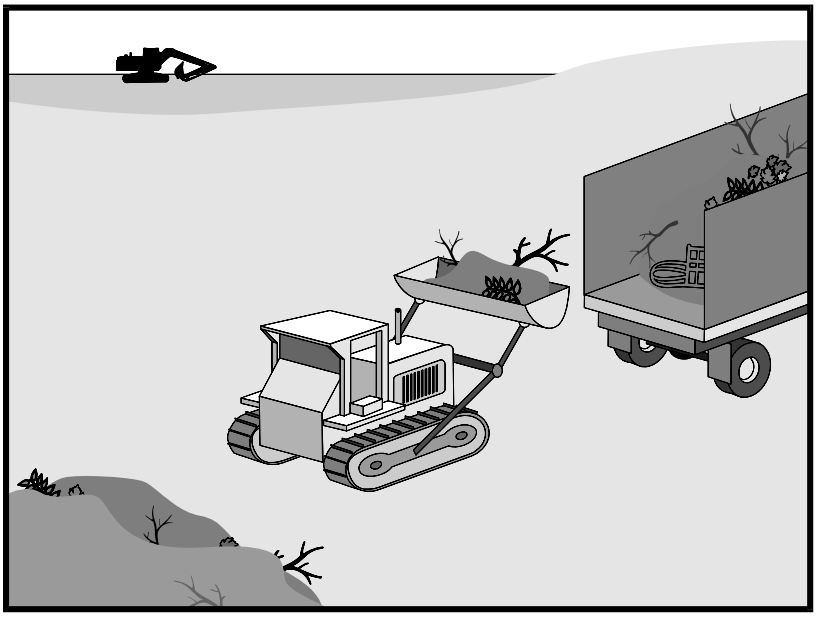
References

Blueprint for a Clean Bay: Best Management Practices to Prevent Stormwater Pollution from Construction Related Activities; Santa Clara Valley Nonpoint Source Pollution Control Program, 1995.

Stormwater Quality Handbooks - Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), November 2000.

Stormwater Management for Construction Activities; Developing Pollution Prevention Plans and Best Management Practice, EPA 832-R-92005; USEPA, April 1992.

Solid Waste Management WM-5



Categories

EC	Erosion Control	
SE	Sediment Control	
TC	Tracking Control	
WE	Wind Erosion Control	
NS	Non-Stormwater Management Control	
WM	Waste Management and Materials Pollution Control	☑

Legend:

☑ **Primary Objective**

☒ **Secondary Objective**

Targeted Constituents

Sediment	☑
Nutrients	☑
Trash	☑
Metals	☑
Bacteria	
Oil and Grease	☑
Organics	☑

Potential Alternatives

None

Description and Purpose

Solid waste management procedures and practices are designed to prevent or reduce the discharge of pollutants to stormwater from solid or construction waste by providing designated waste collection areas and containers, arranging for regular disposal, and training employees and subcontractors.

Suitable Applications

This BMP is suitable for construction sites where the following wastes are generated or stored:

- Solid waste generated from trees and shrubs removed during land clearing, demolition of existing structures (rubble), and building construction
- Packaging materials including wood, paper, and plastic
- Scrap or surplus building materials including scrap metals, rubber, plastic, glass pieces and masonry products
- Domestic wastes including food containers such as beverage cans, coffee cups, paper bags, plastic wrappers, and cigarettes
- Construction wastes including brick, mortar, timber, steel and metal scraps, pipe and electrical cuttings, non-hazardous equipment parts, styrofoam and other materials used to transport and package construction materials
- Highway planting wastes, including vegetative material,

plant containers, and packaging materials

Limitations

Temporary stockpiling of certain construction wastes may not necessitate stringent drainage related controls during the non-rainy season or in desert areas with low rainfall.

Implementation

The following steps will help keep a clean site and reduce stormwater pollution:

- Select designated waste collection areas onsite.
- Inform trash-hauling contractors that you will accept only watertight dumpsters for onsite use. Inspect dumpsters for leaks and repair any dumpster that is not watertight.
- Locate containers in a covered area or in a secondary containment.
- Provide an adequate number of containers with lids or covers that can be placed over the container to keep rain out or to prevent loss of wastes when it is windy.
- Plan for additional containers and more frequent pickup during the demolition phase of construction.
- Collect site trash daily, especially during rainy and windy conditions.
- Remove this solid waste promptly since erosion and sediment control devices tend to collect litter.
- Make sure that toxic liquid wastes (used oils, solvents, and paints) and chemicals (acids, pesticides, additives, curing compounds) are not disposed of in dumpsters designated for construction debris.
- Do not hose out dumpsters on the construction site. Leave dumpster cleaning to the trash hauling contractor.
- Arrange for regular waste collection before containers overflow.
- Clean up immediately if a container does spill.
- Make sure that construction waste is collected, removed, and disposed of only at authorized disposal areas.

Education

- Have the contractor's superintendent or representative oversee and enforce proper solid waste management procedures and practices.
- Instruct employees and subcontractors on identification of solid waste and hazardous waste.
- Educate employees and subcontractors on solid waste storage and disposal procedures.
- Hold regular meetings to discuss and reinforce disposal procedures (incorporate into regular safety meetings).

- Require that employees and subcontractors follow solid waste handling and storage procedures.
- Prohibit littering by employees, subcontractors, and visitors.
- Minimize production of solid waste materials wherever possible.

Collection, Storage, and Disposal

- Littering on the project site should be prohibited.
- To prevent clogging of the storm drainage system, litter and debris removal from drainage grates, trash racks, and ditch lines should be a priority.
- Trash receptacles should be provided in the contractor's yard, field trailer areas, and at locations where workers congregate for lunch and break periods.
- Litter from work areas within the construction limits of the project site should be collected and placed in watertight dumpsters at least weekly, regardless of whether the litter was generated by the contractor, the public, or others. Collected litter and debris should not be placed in or next to drain inlets, stormwater drainage systems, or watercourses.
- Dumpsters of sufficient size and number should be provided to contain the solid waste generated by the project.
- Full dumpsters should be removed from the project site and the contents should be disposed of by the trash hauling contractor.
- Construction debris and waste should be removed from the site biweekly or more frequently as needed.
- Construction material visible to the public should be stored or stacked in an orderly manner.
- Stormwater runon should be prevented from contacting stored solid waste through the use of berms, dikes, or other temporary diversion structures or through the use of measures to elevate waste from site surfaces.
- Solid waste storage areas should be located at least 50 ft from drainage facilities and watercourses and should not be located in areas prone to flooding or ponding.
- Except during fair weather, construction and highway planting waste not stored in watertight dumpsters should be securely covered from wind and rain by covering the waste with tarps or plastic.
- Segregate potentially hazardous waste from non-hazardous construction site waste.
- Make sure that toxic liquid wastes (used oils, solvents, and paints) and chemicals (acids, pesticides, additives, curing compounds) are not disposed of in dumpsters designated for construction debris.
- For disposal of hazardous waste, see WM-6, Hazardous Waste Management. Have hazardous waste hauled to an appropriate disposal and/or recycling facility.

- Salvage or recycle useful vegetation debris, packaging and surplus building materials when practical. For example, trees and shrubs from land clearing can be used as a brush barrier, or converted into wood chips, then used as mulch on graded areas. Wood pallets, cardboard boxes, and construction scraps can also be recycled.

Costs

All of the above are low cost measures.

Inspection and Maintenance

- Inspect and verify that activity–based BMPs are in place prior to the commencement of associated activities. While activities associated with the BMP are under way, inspect weekly during the rainy season and of two-week intervals in the non-rainy season to verify continued BMP implementation.
- Inspect BMPs subject to non-stormwater discharge daily while non-stormwater discharges occur
- Inspect construction waste area regularly.
- Arrange for regular waste collection.

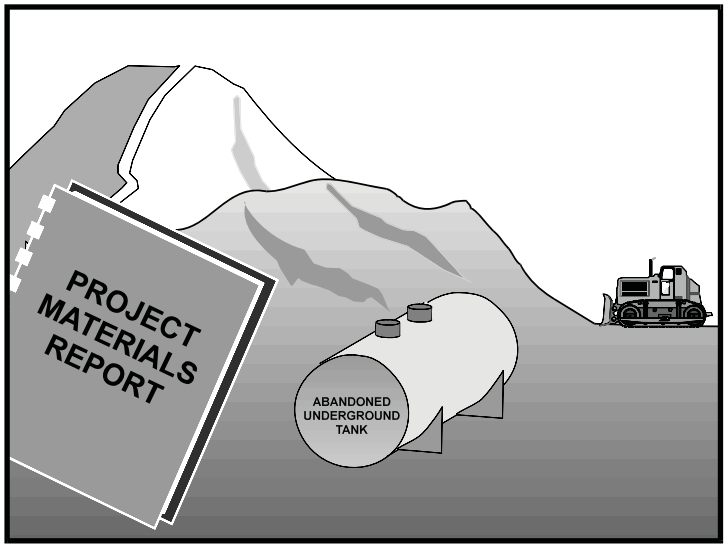
References

Processes, Procedures and Methods to Control Pollution Resulting from All Construction Activity, 430/9-73-007, USEPA, 1973.

Stormwater Quality Handbooks - Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), November 2000.

Stormwater Management for Construction Activities; Developing Pollution Prevention Plans and Best Management Practice, EPA 832-R-92005; USEPA, April 1992.

Contaminated Soil Management WM-7



Categories		
EC	Erosion Control	
SE	Sediment Control	
TC	Tracking Control	
WE	Wind Erosion Control	
NS	Non-Stormwater Management Control	
WM	Waste Management and Materials Pollution Control	☑

Legend:
☑ **Primary Objective**
☒ **Secondary Objective**

Description and Purpose

Prevent or reduce the discharge of pollutants to stormwater from contaminated soil and highly acidic or alkaline soils by conducting pre-construction surveys, inspecting excavations regularly, and remediating contaminated soil promptly.

Suitable Applications

Contaminated soil management is implemented on construction projects in highly urbanized or industrial areas where soil contamination may have occurred due to spills, illicit discharges, aerial deposition, past use and leaks from underground storage tanks.

Limitations

Contaminated soils that cannot be treated onsite must be disposed of offsite by a licensed hazardous waste hauler. The presence of contaminated soil may indicate contaminated water as well. See NS-2, Dewatering Operations, for more information.

The procedures and practices presented in this BMP are general. The contractor should identify appropriate practices and procedures for the specific contaminants known to exist or discovered onsite.

Implementation

Most owners and developers conduct pre-construction environmental assessments as a matter of routine. Contaminated soils are often identified during project planning and development with known locations identified in the plans, specifications and in the SWPPP. The contractor should review applicable reports and investigate appropriate call-outs in the

Targeted Constituents	
Sediment	
Nutrients	☑
Trash	☑
Metals	☑
Bacteria	☑
Oil and Grease	☑
Organics	☑

Potential Alternatives

None

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plans, specifications, and SWPPP. Recent court rulings holding contractors liable for cleanup costs when they unknowingly move contaminated soil highlight the need for contractors to confirm a site assessment is completed before earth moving begins.

The following steps will help reduce stormwater pollution from contaminated soil:

- Conduct thorough, pre-construction inspections of the site and review documents related to the site. If inspection or reviews indicated presence of contaminated soils, develop a plan before starting work.
- Look for contaminated soil as evidenced by discoloration, odors, differences in soil properties, abandoned underground tanks or pipes, or buried debris.
- Prevent leaks and spills. Contaminated soil can be expensive to treat and dispose of properly. However, addressing the problem before construction is much less expensive than after the structures are in place.
- The contractor may further identify contaminated soils by investigating:
  - Past site uses and activities
  - Detected or undetected spills and leaks
  - Acid or alkaline solutions from exposed soil or rock formations high in acid or alkaline forming elements
  - Contaminated soil as evidenced by discoloration, odors, differences in soil properties, abandoned underground tanks or pipes, or buried debris.
  - Suspected soils should be tested at a certified laboratory.

Education

- Have employees and subcontractors complete a safety training program which meets 29 CFR 1910.120 and 8 CCR 5192 covering the potential hazards as identified, prior to performing any excavation work at the locations containing material classified as hazardous.
- Educate employees and subcontractors in identification of contaminated soil and on contaminated soil handling and disposal procedures.
- Hold regular meetings to discuss and reinforce disposal procedures (incorporate into regular safety meetings).

Handling Procedures for Material with Aerially Deposited Lead (ADL)

- Materials from areas designated as containing (ADL) may, if allowed by the contract special provisions, be excavated, transported, and used in the construction of embankments and/or backfill.
- Excavation, transportation, and placement operations should result in no visible dust.
- Caution should be exercised to prevent spillage of lead containing material during transport.

- Quality should be monitored during excavation of soils contaminated with lead.

Handling Procedures for Contaminated Soils

- Minimize onsite storage. Contaminated soil should be disposed of properly in accordance with all applicable regulations. All hazardous waste storage will comply with the requirements in Title 22, CCR, Sections 66265.250 to 66265.260.
- Test suspected soils at an approved certified laboratory.
- Work with the local regulatory agencies to develop options for treatment or disposal if the soil is contaminated.
- Avoid temporary stockpiling of contaminated soils or hazardous material.
- Take the following precautions if temporary stockpiling is necessary:
  - Cover the stockpile with plastic sheeting or tarps.
  - Install a berm around the stockpile to prevent runoff from leaving the area.
  - Do not stockpile in or near storm drains or watercourses.
- Remove contaminated material and hazardous material on exteriors of transport vehicles and place either into the current transport vehicle or into the excavation prior to the vehicle leaving the exclusion zone.
- Monitor the air quality continuously during excavation operations at all locations containing hazardous material.
- Procure all permits and licenses, pay all charges and fees, and give all notices necessary and incident to the due and lawful prosecution of the work, including registration for transporting vehicles carrying the contaminated material and the hazardous material.
- Collect water from decontamination procedures and treat or dispose of it at an appropriate disposal site.
- Collect non-reusable protective equipment, once used by any personnel, and dispose of at an appropriate disposal site.
- Install temporary security fence to surround and secure the exclusion zone. Remove fencing when no longer needed.
- Excavate, transport, and dispose of contaminated material and hazardous material in accordance with the rules and regulations of the following agencies (the specifications of these agencies supersede the procedures outlined in this BMP):
  - United States Department of Transportation (USDOT)
  - United States Environmental Protection Agency (USEPA)
  - California Environmental Protection Agency (CAL-EPA)

- California Division of Occupation Safety and Health Administration (CAL-OSHA)
- Local regulatory agencies

Procedures for Underground Storage Tank Removals

- Prior to commencing tank removal operations, obtain the required underground storage tank removal permits and approval from the federal, state, and local agencies that have jurisdiction over such work.
- To determine if it contains hazardous substances, arrange to have tested, any liquid or sludge found in the underground tank prior to its removal.
- Following the tank removal, take soil samples beneath the excavated tank and perform analysis as required by the local agency representative(s).
- The underground storage tank, any liquid or sludge found within the tank, and all contaminated substances and hazardous substances removed during the tank removal and transported to disposal facilities permitted to accept such waste.

Water Control

- All necessary precautions and preventive measures should be taken to prevent the flow of water, including ground water, from mixing with hazardous substances or underground storage tank excavations. Such preventative measures may consist of, but are not limited to, berms, cofferdams, grout curtains, freeze walls, and seal course concrete or any combination thereof.
- If water does enter an excavation and becomes contaminated, such water, when necessary to proceed with the work, should be discharged to clean, closed top, watertight transportable holding tanks, treated, and disposed of in accordance with federal, state, and local laws.

Costs

Prevention of leaks and spills is inexpensive. Treatment or disposal of contaminated soil can be quite expensive.

Inspection and Maintenance

- Inspect and verify that activity–based BMPs are in place prior to the commencement of associated activities. While activities associated with the BMP are under way, inspect BMPs in accordance with General Permit requirements for the associated project type and risk level. It is recommended that at a minimum, BMPs be inspected weekly, prior to forecasted rain events, daily during extended rain events, and after the conclusion of rain events.
- Arrange for contractor's Water Pollution Control Manager, foreman, and/or construction supervisor to monitor onsite contaminated soil storage and disposal procedures.
- Monitor air quality continuously during excavation operations at all locations containing hazardous material.
- Coordinate contaminated soils and hazardous substances/waste management with the appropriate federal, state, and local agencies.

- Implement WM-4, Spill Prevention and Control, to prevent leaks and spills as much as possible.

References

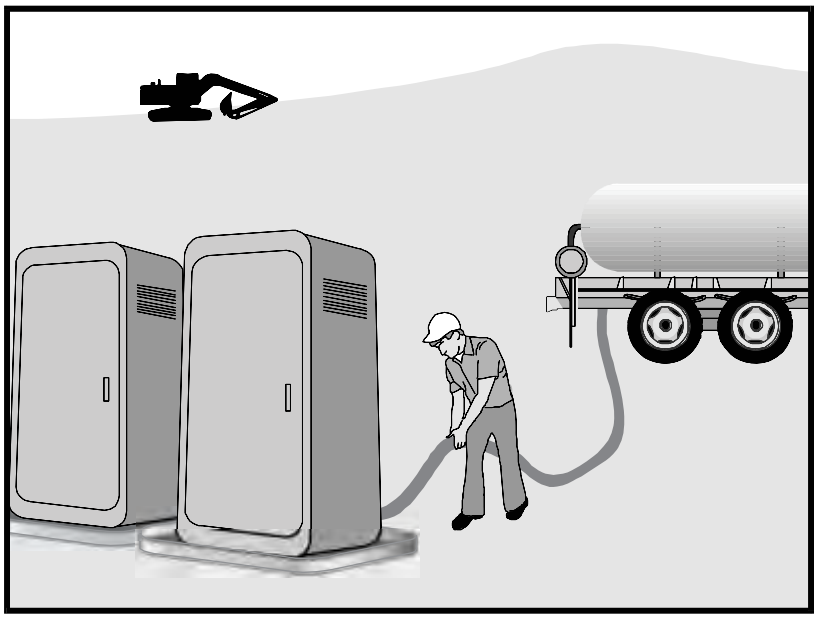
Blueprint for a Clean Bay: Best Management Practices to Prevent Stormwater Pollution from Construction Related Activities; Santa Clara Valley Nonpoint Source Pollution Control Program, 1995.

Processes, Procedures and Methods to Control Pollution Resulting from All Construction Activity, 430/9-73-007, USEPA, 1973.

Stormwater Quality Handbooks - Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), November 2000.

Stormwater Management for Construction Activities; Developing Pollution Prevention Plans and Best Management Practice, EPA 832-R-92005; USEPA, April 1992.

Sanitary/Septic Waste Management WM-9



Categories

EC	Erosion Control	
SE	Sediment Control	
TC	Tracking Control	
WE	Wind Erosion Control	
NS	Non-Stormwater Management Control	
WM	Waste Management and Materials Pollution Control	☑

Legend:

☑ **Primary Category**

☒ **Secondary Category**

Targeted Constituents

Sediment	
Nutrients	☑
Trash	☑
Metals	
Bacteria	☑
Oil and Grease	
Organics	☑

Potential Alternatives

None

Description and Purpose

Proper sanitary and septic waste management prevent the discharge of pollutants to stormwater from sanitary and septic waste by providing convenient, well-maintained facilities, and arranging for regular service and disposal.

Suitable Applications

Sanitary septic waste management practices are suitable for use at all construction sites that use temporary or portable sanitary and septic waste systems.

Limitations

None identified.

Implementation

Sanitary or septic wastes should be treated or disposed of in accordance with state and local requirements. In many cases, one contract with a local facility supplier will be all that it takes to make sure sanitary wastes are properly disposed.

Storage and Disposal Procedures

- Temporary sanitary facilities should be located away from drainage facilities, watercourses, and from traffic circulation. If site conditions allow, place portable facilities a minimum of 50 feet from drainage conveyances and traffic areas. When subjected to high winds or risk of high winds, temporary sanitary facilities should be secured to prevent overturning.

- Temporary sanitary facilities must be equipped with containment to prevent discharge of pollutants to the stormwater drainage system of the receiving water.
- Consider safety as well as environmental implications before placing temporary sanitary facilities.
- Wastewater should not be discharged or buried within the project site.
- Sanitary and septic systems that discharge directly into sanitary sewer systems, where permissible, should comply with the local health agency, city, county, and sewer district requirements.
- Only reputable, licensed sanitary and septic waste haulers should be used.
- Sanitary facilities should be located in a convenient location.
- Temporary septic systems should treat wastes to appropriate levels before discharging.
- If using an onsite disposal system (OSDS), such as a septic system, local health agency requirements must be followed.
- Temporary sanitary facilities that discharge to the sanitary sewer system should be properly connected to avoid illicit discharges.
- Sanitary and septic facilities should be maintained in good working order by a licensed service.
- Regular waste collection by a licensed hauler should be arranged before facilities overflow.
- If a spill does occur from a temporary sanitary facility, follow federal, state and local regulations for containment and clean-up.

Education

- Educate employees, subcontractors, and suppliers on sanitary and septic waste storage and disposal procedures.
- Educate employees, subcontractors, and suppliers of potential dangers to humans and the environment from sanitary and septic wastes.
- Instruct employees, subcontractors, and suppliers in identification of sanitary and septic waste.
- Hold regular meetings to discuss and reinforce the use of sanitary facilities (incorporate into regular safety meetings).
- Establish a continuing education program to indoctrinate new employees.

Costs

All of the above are low cost measures.

Inspection and Maintenance

- BMPs must be inspected in accordance with General Permit requirements for the associated project type and risk level. It is recommended that at a minimum, BMPs be inspected weekly, prior to forecasted rain events, daily during extended rain events, and after the conclusion of rain events.
- Arrange for regular waste collection.
- If high winds are expected, portable sanitary facilities must be secured with spikes or weighed down to prevent over turning.
- If spills or leaks from sanitary or septic facilities occur that are not contained and discharge from the site, non-visible sampling of site discharge may be required. Refer to the General Permit or to your project specific Construction Site Monitoring Plan to determine if and where sampling is required.

References

Stormwater Quality Handbooks - Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), March 2003.

Stormwater Management for Construction Activities; Developing Pollution Prevention Plans and Best Management Practice, EPA 832-R-92005; USEPA, April 1992.

APPENDIX B

Sample Inspection Forms

BMP INSPECTION REPORT

Date and Time of Inspection:			Date Report Written:		
Inspection Type: (Circle one)	Weekly *Complete Parts I,II,III and VII*	Pre-Storm *Complete Parts I,II,III,IV and VII*	During Rain Event *Complete Parts I, II, III, V, and VII*	Post-Storm Complete *Parts I, II, III, VI, and VII*	Quarterly Complete *Parts I,II,III, and VII*

Part I. General Information

Site Information

Construction Site Name:			
Construction stage and completed activities:			Approximate area of site that is exposed:
Photos Taken: (Circle one)	Yes	No	Photo Reference IDs:

Weather

Estimate storm beginning: (date and time)	Estimate storm duration: (hours)
Estimate time since last storm: (days or hours)	Rain gauge reading and location: (in)
Is a "Qualifying Event" predicted or did one occur (i.e., 0.5" rain with 48-hrs or greater between events)? (Y/N) If yes, summarize forecast:	

Exemption Documentation (explanation required if inspection could not be conducted). Visual inspections are not required outside of business hours or during dangerous weather conditions such as flooding or electrical storms.

Inspector Information

Inspector Name:	Inspector Title:
Signature:	Date:

Part II. BMP Observations. Describe any deficiencies in Part III.			
Minimum BMPs for Risk Level 1 Sites	Adequately designed, implemented and effective (yes, no, N/A)	Action Required (yes/no)	Action Implemented (Date)
Good Housekeeping for Construction Materials			
Inventory of products (excluding materials designed to be outdoors)			
Stockpiled construction materials not actively in use (14 days of non-use) are covered and bermed			
All chemicals are stored in watertight containers with appropriate secondary containment, or in a completely enclosed storage shed			
Construction materials are minimally exposed to precipitation			
BMPs preventing the off-site tracking of materials are implemented and properly effective			
Good Housekeeping for Waste Management			
Wash/rinse water and materials are prevented from being disposed into the storm drain system			
Portable toilets are contained to prevent discharges of waste			
Sanitation facilities are clean and inspected regularly for leaks and spills			
Waste disposal containers are covered at the end of each business day and during rain events			
Discharges from waste disposal containers are prevented from discharging to the storm drain system / receiving water			
Stockpiled waste material is securely protected from wind and rain if not actively in use			
Procedures are in place for addressing hazardous and non-hazardous spills			
Appropriate spill response personnel are assigned and trained			
Equipment and materials for cleanup of spills is available on site			
Washout areas (e.g., concrete) are contained appropriately to prevent any discharge or infiltration into the underlying soil			
Good Housekeeping for Vehicle Storage and Maintenance			
Measures are in place to prevent oil, grease, or fuel from leaking into the ground, storm drains, or surface waters			
All equipment or vehicles are fueled, maintained, and stored in a designated area with appropriate BMPs			
Vehicle and equipment leaks are cleaned immediately and disposed of properly			

Part II. BMP Observations Continued. Describe any deficiencies in Part III.			
Minimum BMPs for Risk Level 1 Sites	Adequately designed, implemented and effective (yes, no, N/A)	Action Required (yes/no)	Action Implemented (Date)
Good Housekeeping for Landscape Materials			
Stockpiled landscape materials such as mulches and topsoil are contained and covered when not actively in use			
Erodible landscape material has not been applied 2 days before a forecasted rain event or during an event			
Erodible landscape materials are applied at quantities and rates in accordance with manufacturer recommendations			
Erodible landscape materials are stored on pallets and covered			
Good Housekeeping for Air Deposition of Site Materials			
Good housekeeping measures are implemented on site to control the air deposition of site materials and from site operations			
Non-Stormwater Management			
Non-storm water discharges are properly controlled			
Vehicles are washed in a manner to prevent non-storm water discharges to surface waters or drainage systems			
Streets are cleaned in a manner to prevent unauthorized non-storm water discharges to surface waters or drainage systems. Authorized discharges include fire hydrant flushing, irrigation, pipe flushing, and dust control.			
Erosion Controls			
Wind erosion controls are effectively implemented			
Effective soil cover is provided for disturbed areas inactive (i.e., not scheduled to be disturbed for 14 days) as well as finished slopes, open space, utility backfill, and completed lots			
The use of plastic materials is limited in cases when a more sustainable, environmentally friendly alternative exists.			
Sediment Controls			
Perimeter controls are established and effective at controlling erosion and sediment discharges from the site			
Entrances and exits are stabilized to control erosion and sediment discharges from the site			
Sediment basins are properly maintained			
Run-On and Run-Off Controls			
Run-on to the site is effectively managed and directed away from all disturbed areas.			

Other			
Are the project SWPPP and BMP plan up to date, available on-site and being properly implemented?			
Has the District Environmental Services been notified of any Reportable Quantity Discharges or discharges listed in Table 6?			

Part III. Descriptions of Any BMP Deficiencies

Deficiency	Repairs Implemented: Note - Repairs must begin within 72 hours of identification.	
	Start Date	Action
1.		
2.		
3.		
4.		

Part IV. Additional Pre-Storm Observations. Note the presence or absence of floating and suspended materials, sheen, discoloration, turbidity, odors, and source(s) of pollutants(s).

	Yes, No, N/A
Do storm water storage and containment areas have adequate freeboard? If no, complete Part III.	
Are drainage areas free of spills, leaks, or uncontrolled pollutant sources? If no, complete Part VII and describe below.	
Notes:	
Are storm water storage and containment areas free of leaks? If no, complete Parts III and/or VII and describe below.	
Notes:	

Part V. Additional During-Storm Observations. If BMPs cannot be inspected during inclement weather, list the results of visual inspections at all relevant outfalls, discharge points, and downstream locations. Note odors or visible sheen on the surface of discharges. Complete Part VII (Corrective Actions) as needed.	
Outfall, Discharge Point, or Other Downstream Location	
Location	Description
Location	Description
Location	Description
Location	Description
Location	Description
Location	Description
Location	Description
Location	Description

Part VI. Additional Post-Storm Observations. Visually observe (inspect) storm water discharges at all discharge locations within two business days (48 hours) after each qualifying rain event, and observe (inspect) the discharge of stored or contained storm water that is derived from and discharged subsequent to a qualifying rain event producing precipitation of ½ inch or more at the time of discharge. Complete Part VII (Corrective Actions) as needed.	
Discharge Location, Storage or Containment Area	**Visual Observation**

Part VII. Additional Corrective Actions Required. **Identify any additional corrective actions not included with BMP Deficiencies (Part III) above. Note if SWPPP change is required.**	
Required Actions	**Implementation Date**

APPENDIX I

NOISE MONITORING DATA

Leona Mine Grading-Construction Phase

Receptor: Hypothetical

No.	Equipment Description	Reference (dBA) 50 ft Lmax	Quantity	Usage factor*	Distance to Receptor (ft)	Ground Effect	Shielding (dBA)	Calculated (dBA) Lmax	Calculated (dBA) Leq	Lmax Energy	Leq Energy
1	Concrete/Industrial Saw	90	1	40	50	0.5		90.0	86.0	1000000000	400000000
2	Concrete/Industrial Saw	90	1	40	100	0.5		84.0	78.5	250000000	70710678.12
3	Dozer	85	1	40	50	0.5		85.0	81.0	316227766	126491106.4
4	Dozer	85	1	40	100	0.5		79.0	73.5	79056941.5	22360679.77
5	Excavator	85	1	40	50	0.5		85.0	81.0	316227766	126491106.4
6	Off-Highway Truck	84	2	40	100	0.5		78.0	72.5	62797160.79	17761719.29
7	Water truck	84	1	40	100	0.5		78.0	72.5	62797160.79	17761719.29
8	Chipper	85	1	40	100	0.5		79.0	73.5	79056941.5	22360679.77
9	Rubber Tired Loader	80	1	40	100	0.5		74.0	68.5	25000000	7071067.812
10	Skid Steer Loader	80	1	40	100	0.5		74.0	68.5	25000000	7071067.812
11	Backhoe	80	1	40	100	0.5		74.0	68.5	25000000	7071067.812
									**** Lmax**	**92**	
										Leq dBA	**89**

Notes: * Percentage of time during a construction noise operation that a piece of equipment is operating at full power

** Calculated Lmax is for the 3 loudest pieces of equipment.

Leona Mine Creek Restoration Phase

Receptor: Hypothetical

No.	Equipment Description	Reference (dBA) 50 ft Lmax	Quantity	Usage factor *	Distance to Receptor	Ground Effect	Shielding (dBA)	Calculated (dBA) Lmax	Calculated (dBA) Leq	Lmax Energy	Lmax Energy
1	ATV	85	1	40	100	0.5		79.0	73.5	79056941.5	22360679.77
2	Backhoe	80	2	40	100	0.5		74.0	68.5	25000000	7071067.812
3	Crane	85	1	40	100	0.5		79.0	73.5	79056941.5	22360679.77
4	Dozer	85	1	40	50	0.5		85.0	81.0	316227766	126491106.4
5	Excavator	85	1	40	50	0.5		85.0	81.0	316227766	126491106.4
6	Excavator	85	1	40	100	0.5		79.0	73.5	79056941.5	22360679.77
7	Off Highway Truck	84	6	40	100	0.5		78.0	72.5	62797160.79	17761719.29
8	Roller	85	1	40	50	0.5		85.0	81.0	316227766	126491106.4
9	Rough Terrain Forklift	80	1	40	100	0.5		74.0	68.5	25000000	7071067.812
10	Rubber Tired Loader	80	1	40	100	0.5		74.0	68.5	25000000	7071067.812
11	Skidsteer	80	1	40	100	0.5		74.0	68.5	25000000	7071067.812
12	Water Truck	84	2	40	100	0.5		78.0	72.5	62797160.79	17761719.29
13	Winch Cat	85	1	40	100	0.5		79.0	73.5	79056941.5	22360679.77
									**** Lmax**	**90**	
										Leq	**87**

Notes: * Percentage of time during a construction noise operation that a piece of equipment is operating at full power

** Calculated Lmax is for the 3 loudest pieces of equipment.

Leona Mine Asphalt Restoration Phase

Receptor: Hypothetical

No.	Equipment Description	Reference (dBA) 50 ft Lmax	Quantity	Usage factor *	Distance to Receptor	Ground Effect	Shielding (dBA)	Calculated (dBA) Lmax	Calculated (dBA) Leq	Lmax Energy	Leq Energy
1	Grader	85	1	40	50	0.5		85.0	81.0	316227766	126491106.4
2	Off Highway Truck	84	1	40	50	0.5		84.0	80.0	251188643.2	100475457.3
3	Off Highway Truck	84	4	40	100	0.5		78.0	72.5	62797160.79	17761719.29
4	Water Truck	84	2	40	100	0.5		78.0	72.5	62797160.79	17761719.29
5	Roller	85	1	40	50	0.5		85.0	81.0	316227766	126491106.4
									**** Lmax**	**89**	
										Leq	**86**

Notes: * Percentage of time during a construction noise operation that a piece of equipment is operating at full power

** Calculated Lmax is for the 3 loudest pieces of equipment.

TABLE Existing-01
FHWA ROADWAY NOISE LEVEL ANALYSIS

RUN DATE: 01/28/2014
ROADWAY SEGMENT: Mountain Boulevard - Carson Street to McDonnell Avenue
NOTES: Leona Mine - Existing

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* * ASSUMPTIONS * *

AVERAGE DAILY TRAFFIC: 1000 SPEED (MPH): 25 GRADE: .5

	TRAFFIC DISTRIBUTION PERCENTAGES		
	DAY	EVENING	NIGHT
AUTOS	75.51	12.57	9.34
M-TRUCKS	1.56	0.09	0.19
H-TRUCKS	0.64	0.02	0.08

ACTIVE HALF-WIDTH (FT): 6 SITE CHARACTERISTICS: SOFT

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* * CALCULATED NOISE LEVELS * *

CNEL AT 50 FT FROM NEAR TRAVEL LANE CENTERLINE (dB) = 50.73

DISTANCE (FEET) FROM ROADWAY CENTERLINE TO CNEL			
70 CNEL	65 CNEL	60 CNEL	55 CNEL
0.0	0.0	0.0	0.0

TABLE Existing-02
FHWA ROADWAY NOISE LEVEL ANALYSIS

RUN DATE: 01/28/2014
ROADWAY SEGMENT: McDonnell Avenue - Mountain Boulevard to Parking Lot
NOTES: Leona Mine - Existing

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* * ASSUMPTIONS * *

AVERAGE DAILY TRAFFIC: 100 SPEED (MPH): 25 GRADE: .5

	TRAFFIC DISTRIBUTION PERCENTAGES		
	DAY	EVENING	NIGHT
AUTOS	75.51	12.57	9.34
M-TRUCKS	1.56	0.09	0.19
H-TRUCKS	0.64	0.02	0.08

ACTIVE HALF-WIDTH (FT): 3 SITE CHARACTERISTICS: SOFT

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* * CALCULATED NOISE LEVELS * *

CNEL AT 50 FT FROM NEAR TRAVEL LANE CENTERLINE (dB) = 41.06

DISTANCE (FEET) FROM ROADWAY CENTERLINE TO CNEL			
70 CNEL	65 CNEL	60 CNEL	55 CNEL
0.0	0.0	0.0	0.0

TABLE Existing-03
FHWA ROADWAY NOISE LEVEL ANALYSIS

RUN DATE: 01/28/2014
ROADWAY SEGMENT: McDonnell Avenue - Parking Lot to Site Entrance
NOTES: Leona Mine - Existing

* * ASSUMPTIONS * *

AVERAGE DAILY TRAFFIC: 100 SPEED (MPH): 25 GRADE: .5

TRAFFIC DISTRIBUTION PERCENTAGES

	DAY	EVENING	NIGHT
AUTOS	75.51	12.57	9.34
M-TRUCKS	1.56	0.09	0.19
H-TRUCKS	0.64	0.02	0.08

ACTIVE HALF-WIDTH (FT): 3 SITE CHARACTERISTICS: SOFT

* * CALCULATED NOISE LEVELS * *

CNEL AT 50 FT FROM NEAR TRAVEL LANE CENTERLINE (dB) = 41.06

DISTANCE (FEET) FROM ROADWAY CENTERLINE TO CNEL

70 CNEL	65 CNEL	60 CNEL	55 CNEL
0.0	0.0	0.0	0.0

TABLE Existing + Construction-01
FHWA ROADWAY NOISE LEVEL ANALYSIS

RUN DATE: 01/28/2014
ROADWAY SEGMENT: Mountain Boulevard - Carson Street to McDonnell Avenue
NOTES: Leona Mine - Existing + Construction

* * ASSUMPTIONS * *

AVERAGE DAILY TRAFFIC: 1100 SPEED (MPH): 25 GRADE: .5

TRAFFIC DISTRIBUTION PERCENTAGES

	DAY	EVENING	NIGHT
AUTOS	75.51	12.57	9.34
M-TRUCKS	1.56	0.09	0.19
H-TRUCKS	0.64	0.02	0.08

ACTIVE HALF-WIDTH (FT): 6 SITE CHARACTERISTICS: SOFT

* * CALCULATED NOISE LEVELS * *

CNEL AT 50 FT FROM NEAR TRAVEL LANE CENTERLINE (dB) = 51.14

DISTANCE (FEET) FROM ROADWAY CENTERLINE TO CNEL

70 CNEL	65 CNEL	60 CNEL	55 CNEL
0.0	0.0	0.0	0.0

TABLE Existing + Construction-02
FHWA ROADWAY NOISE LEVEL ANALYSIS

RUN DATE: 01/28/2014
ROADWAY SEGMENT: McDonnell Avenue - Mountain Boulevard to Parking Lot
NOTES: Leona Mine - Existing + Construction

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* * ASSUMPTIONS * *

AVERAGE DAILY TRAFFIC: 200 SPEED (MPH): 25 GRADE: .5

TRAFFIC DISTRIBUTION PERCENTAGES

	DAY	EVENING	NIGHT
AUTOS	75.51	12.57	9.34
M-TRUCKS	1.56	0.09	0.19
H-TRUCKS	0.64	0.02	0.08

ACTIVE HALF-WIDTH (FT): 3 SITE CHARACTERISTICS: SOFT

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* * CALCULATED NOISE LEVELS * *

CNEL AT 50 FT FROM NEAR TRAVEL LANE CENTERLINE (dB) = 44.07

DISTANCE (FEET) FROM ROADWAY CENTERLINE TO CNEL

70 CNEL	65 CNEL	60 CNEL	55 CNEL
0.0	0.0	0.0	0.0

TABLE Existing + Construction-03
FHWA ROADWAY NOISE LEVEL ANALYSIS

RUN DATE: 01/28/2014
ROADWAY SEGMENT: McDonnell Avenue - Parking Lot to Site Entrance
NOTES: Leona Mine - Existing + Construction

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* * ASSUMPTIONS * *

AVERAGE DAILY TRAFFIC: 200 SPEED (MPH): 25 GRADE: .5

TRAFFIC DISTRIBUTION PERCENTAGES

	DAY	EVENING	NIGHT
AUTOS	75.51	12.57	9.34
M-TRUCKS	1.56	0.09	0.19
H-TRUCKS	0.64	0.02	0.08

ACTIVE HALF-WIDTH (FT): 3 SITE CHARACTERISTICS: SOFT

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* * CALCULATED NOISE LEVELS * *

CNEL AT 50 FT FROM NEAR TRAVEL LANE CENTERLINE (dB) = 44.07

DISTANCE (FEET) FROM ROADWAY CENTERLINE TO CNEL

70 CNEL	65 CNEL	60 CNEL	55 CNEL
0.0	0.0	0.0	0.0