# MONTICELLO FIRE

# WATERSHED EROSION POTENTIAL ANALYSIS

# REPORT

**Prepared by Michael Hogan**

**Integrated Environmental Restoration Services**

**For the Solano County Water Agency**

**May 27th, 2015**

# EXECUTIVE SUMMARY

The summary findings of the post fire watershed erosion assessment conducted by IERS in September and October of 2014 of Thompson Canyon, Bray Canyon, Proctor Draw and unnamed intermediate watersheds of areas that were affected by the Monticello Fire (July 2014) are briefly summarized as follows:

-The overall condition of the fire-affected watersheds is one of relatively high geologic instability as exhibited by any number of mass movements or 'failures' that can be seen through all of the studied watersheds.

-In most areas that have been grazed (nearly all of the watershed areas), high levels of soil density/compaction and low levels of soil organic matter exist. This condition results in high probability of surface runoff during medium to high precipitation events.

-Main watercourses are generally downcut below original flood plain surfaces suggesting increased volumes and velocities of water flow during moderate to high rainfall/runoff events and continued sediment export from the watersheds.

-The steep nature of parts of the watersheds suggests high rates of runoff and erosion during high precipitation events in those areas, further exacerbating previously mentioned erosion issues.

-In well over 90% of the watershed area, soil was not severely affected by the Monticello fire as shown by the presence of slightly to moderately burned surface mulch and presence of fine roots within ½ to 1 inch of the soil surface.

-An obvious seed bank exists at least in parts of the watersheds as indicated by resprouting of grasses and other vegetation following light rains that occurred in October.

-Most of the mature trees, particularly oaks and cottonwoods, withstood the fire with partial or full die back of the canopy followed by resprouting of leaves.

-Many of the shrubs and some forbs showed light to vigorous root crown resprouting, further suggesting a relatively low intensity burn in most areas and indicating positive vegetation response to the fire.

-A number of unstable areas exist within the Bobcat Ranch that are likely to affect water quality in Putah Creek during moderate to high runoff events. However, it is unlikely that the fire will, in most cases, accelerate these problems.

-If severe and sustained rainstorms occur during the fall or early winter of 2014, increased nitrogen, phosphorus and sediment movement is likely to occur due to the excess of easily erodible surface material (loose ash, burned mulch, loose surface sediment). However, other mitigating site conditions may tend to minimize that runoff. Those conditions include extreme ***surface roughness*** caused by rodent activity, frost heave and cattle hooves and soil cracking due to silt and clay content.

-Most eroding areas are situated at a fairly great distance from Putah Creek making sediment transport and delivery more difficult than areas in close proximity.

-If light rains occur during the first part of the winter, re-sprouting of additional grasses and forbs will occur which will help deflect raindrop impact. Further, soil hydrophobicity will tend to be eliminated with wetting, thus increasing infiltration.

-In general, the Monticello Fire appears to be a low intensity fire of the type considered to be typical of these watersheds prior to European settlement[1] [2] [3] [4]

-Based on extensive field survey information including direct observation, many of the most immediate erosion threats to Putah Creek in the fire affected area are along Highway 128 where an upslope access road combined with the highway road cut create a critical gradient differential. During times of high runoff, these areas represent a high slope failure probability and thus present obvious and relatively easy repair opportunities.

-This assessment provides information on potential treatments for erosion 'hot spots'. Hot spots are those areas that have been identified as having a high probability of erosion. This report suggests (and partially defines) actions that can be taken to minimize erosion from those hot spots and lists a number of priority sites.

-The Monticello Fire itself does not seem to have created a major increase in potential erosion (except for a small number of specific areas). However, actions taken in the near future while the active erosion areas are clearly visible, will reduce future potential erosion from reaching Putah Creek. This assessment has clearly indicated that there are a number of areas that are ongoing sources of erosion and will most likely continue to be into the future.

-Repair of the main problem areas can be done relatively quickly and at a low cost. Most 'Priority Sites' listed in this repair will require less than 12 hours each and under 50 yards of soil amendments and mulch to complete. This estimate suggests that water quality can be improved at a low cost in the Bobcat Ranch property.

-The main erosion threat in Thompson Canyon (as compared to the other areas) is the main road up the canyon. Heavy rain-caused landslides will likely clog culverts and create massive flows and sediment delivery to Putah Creek.

-The Monticello Fire watersheds provide a potentially powerful and useful learning opportunity on a number of levels. While this assessment has been primarily aimed at determining the *probability* of increased fire related erosion and erosion in general in the affected watersheds, we strongly recommend on-site assessment of hotspots during rain/runoff events, particularly those listed as 'watch' spots.

-A number of other larger watershed learning, research and educational opportunities present themselves within the affected watersheds and particularly on the Audubon-owned Bobcat Ranch. While these components of watershed work are not a specific goal of the assessment that is reported here, some of these opportunities are briefly discussed as part of an overall approach to watershed improvement that can occur post fire.

In summary, the Monticello Fire is expected to exert little additional influence on erosion in fire-affected watersheds. However, insidious erosion is occurring throughout the watershed and during large runoff events, these watersheds can be expected to produce a high amount of erosion, particularly from clay to fine silt soil particles. However, relatively simple repairs and management can be implemented to reduce erosion potential throughout the fire-affected watersheds.

[1] http://www.coastal.ca.gov/fire/ucsbfire.html
[2] http://www.fs.fed.us/land/pubs/ecoregions/ch33.html
[3] http://www.fs.fed.us/land/pubs/ecoregions/ch34.html
[4] http://nature.berkeley.edu/stephens-lab/Publications/Stuart%20Stephens%20North%20Bioregion%20AFE%209-06.pdf

**TABLE OF CONTENTS**

## LIST OF FIGURES



## LIST OF TABLES

# SECTION ONE

## 1.0 ASSESSMENT AND WATERSHED OVERVIEW

## 1.1 INTRODUCTION

This report presents the results to date of an erosion-focused watershed assessment that has been conducted on areas affected by the Monticello Fire, which occurred near Lake Berryessa in July of 2014. Essentially, this assessment attempts to 1) predict whether the Monticello Fire created conditions in watersheds that drain into Putah Creek which will negatively affect water quality in the creek, 2) identify specific areas of concern and 3) suggest cost effective treatments for those areas of concern. Specifically, this watershed erosion assessment was conducted in order to determine if the fire area presents a high probability of fire-caused erosion into Putah Creek and ultimately into one of the main water supplies for Solano County and if so what actions might be taken to minimize that erosion.

One of the fortunate byproducts of the fire was the ability to clearly identify erosion issues in general due to the clearing of ground vegetation that previously masked much of that erosion. We used this opportunity to observe erosion sites and to develop a number of treatments as well as a 'watch list' of areas that are likely to be ongoing erosion issues. In this way, we offer solutions to long-term insidious erosion issues in the fire-affected watersheds.

As in all prescriptive and predictive processes, the information presented here does not guarantee an outcome since watersheds and weather contain innumerable variables and interactions between those variables. However, we present findings based on a broad background of erosional research and field experience. We also have based this assessment on actual observed field conditions rather than on a modeling exercise and thus have been able to pinpoint current and/or potential erosion issue areas or 'hot spots'. This information is designed to be used to directly address those areas if desired.

## 1.2 BACKGROUND

### THE FIRE

The Monticello Fire started on July 4, 2014 at approximately 9:32 P.M. according to the California Department of Forestry and fire Protection (CalFire), and ultimately covered an area of over 6400 acres in several watersheds. Much of the fire occurred on The Audubon-managed Bobcat Ranch. The fire was fully contained by July 12, 2014. This type of fire is historically unusual given the time of year that it took place, according to CalFire staff. However, given two seasons of drought, high

***FIGURE BOBCAT RANCH DURING THE MONTICELLO FIRE***

temperatures and unpredictable winds, the fire was more of the norm in 2014 where a great number of early season fires took place.

## Contributions to Erosion- Fire Impact as one of Many Variables

A number of variables contribute to potential erosion in the Monticello Fire area in addition to the fire itself. In an effort to provide a larger context to erosion in this area, and to support the finding that the fire is unlikely to have a major *additional* impact on erosion, we offer the following brief discussion of erosion variables beyond Monticello fire impacts.

### Fire History

Inner coastal watersheds have a history of frequent fires are that are thought to have occurred for at least the past 10,000 years[5] [6] [7] and in fact, much of the vegetation is considered 'fire adapted'. That is, the dominant vegetation (trees and shrubs) is adapted to largely withstand fire using a number of strategies including root resprouting. Many of the native and some adapted species have also developed strategies for responding to fire and in fact, some species actually need fire to encourage growth. However, since the early part of the 20th century when fire suppression became a dominant watershed management strategy in the United States, landscapes have often become 'overcrowded' with brush, shrubs and trees such that when a fire occurs, the intensity can be extreme and regrowth becomes difficult. In these cases, erosion can become accelerated as well due to the removal of organic matter, roots, and ultimately soil structure. Further, large amounts of ash on the surface can become mobilized during rain and wind events and find its way into nearby waterways, sometimes resulting in various forms of water pollution.

### Geology

The Coast and Inner Coast ranges are well known for their inherent geologic instability[8]. Thus, the general nature of the mixed geology of the area combined with steep terrain creates generally unstable conditions. These signs of instability, including landslides, small to medium size rotational failures and general erosion patterns in the Monticello Fire area reflect this reality.

### Grazing

Cattle grazing has been a primary component of land use on the Bobcat Ranch for many years and has likely affected the soil as well as vegetation composition[9]. As cattle graze the silt and clay rich soils of the Bobcat Ranch area, surface disruption and compaction tends to occur, particularly when grazing occurs during the wet winter and spring months. The thin layer of organic matter that makes up much of the native topsoil is disturbed by cattle hooves and is eroded away during runoff periods in the steep watersheds in the inner coastal range. Thus, after many years, the Bobcat Ranch and other surrounding ranch lands that have seen many years of grazing exhibit a relatively firm, compacted soil surface, which is prone to high rates of runoff. This accelerated runoff results in higher amounts and rates of runoff to streams, which results in downcutting and additional erosion within the stream channels. While this description is conceptual in nature, these conditions are precisely what were encountered in much of  Bobcat Ranch and nearby Thompson Canyon.

---

5 http://www.fs.fed.us/psw/publications/skinner/psw_2009_skinner003.pdf
6 http://www.fs.fed.us/database/feis/plants/tree/quelob/all.html
7 http://www.fs.fed.us/database/feis/plants/tree/quekel/all.html
8 http://nrs.ucdavis.edu/mcl/natural/geology/
9 http://www.sciencedirect.com/science/article/pii/0169555X95000284

### Roads

Bobcat Ranch and Thompson Canyon both contain a relatively large number of roads, either formal or informal (fire breaks, etc.). Roads tend to be a primary conveyor of water during runoff and are in many cases a primary contributor to sediment in watercourses. As will be seen in the body of this report, roads in both Thompson Canyon and on the Bobcat Ranch are likely primary contributors to sediment delivery.

***FIGURE : BOBCAT RANCH PRE-FIRE. NOTE THE ROAD THROUGH THE MIDDLE-LEFT OF THE PHOTO AS WELL AS A ROAD ALONG THE CREEK. MOST OF THE GRASSES IN THIS PHOTO ARE ANNUALS.***

Highway 128 also plays a major role in erosion due to the fact that the road itself cuts through upland areas and thus creates a grade differential between the areas above Highway 128 and those below it. This differential creates a situation whereby drainageways that bisect the Highway 128 corridor are cutting upwards into the native soils above the highway. The highway hot spot map shows the location of these areas.

### Fire Fighting

Fire fighting itself can and in the case of the Monticello Fire, almost certainly will add additional sediment to watercourses during runoff events. The multiple uncontrolled access points, required by the fire fighting process and a large number of bulldozers (29)[10] on the Monticello fire, cutting fire lines along ridges and along the sides of canyons, as can be seen in the videos and photos, all tend to capture and concentrate water. Thus, while the fire itself was found to have little probable affect on most of the soils in the Bobcat Ranch or in Thompson Canyon, the roads, fire breaks, roads and other activities associated with the fire do present some additional probability of sediment movement.

***FIGURE : A BULLDOZER CUTTING A FIRE LINE DURING THE MONTICELLO FIRE.***

[10] http://abc7news.com/news/1-hurt-while-fighting-monticello-fire-near-lake-berryessa/160756/

# SECTION TWO

## 2.0 THE ASSESSMENT

### 2.1 ASSESSMENT BACKGROUND

#### GOALS AND PROCESS

The primary goal of this watershed erosion assessment is to determine as accurately as possible, whether the Monticello fire created a significant increase in erosion potential and if so, whether

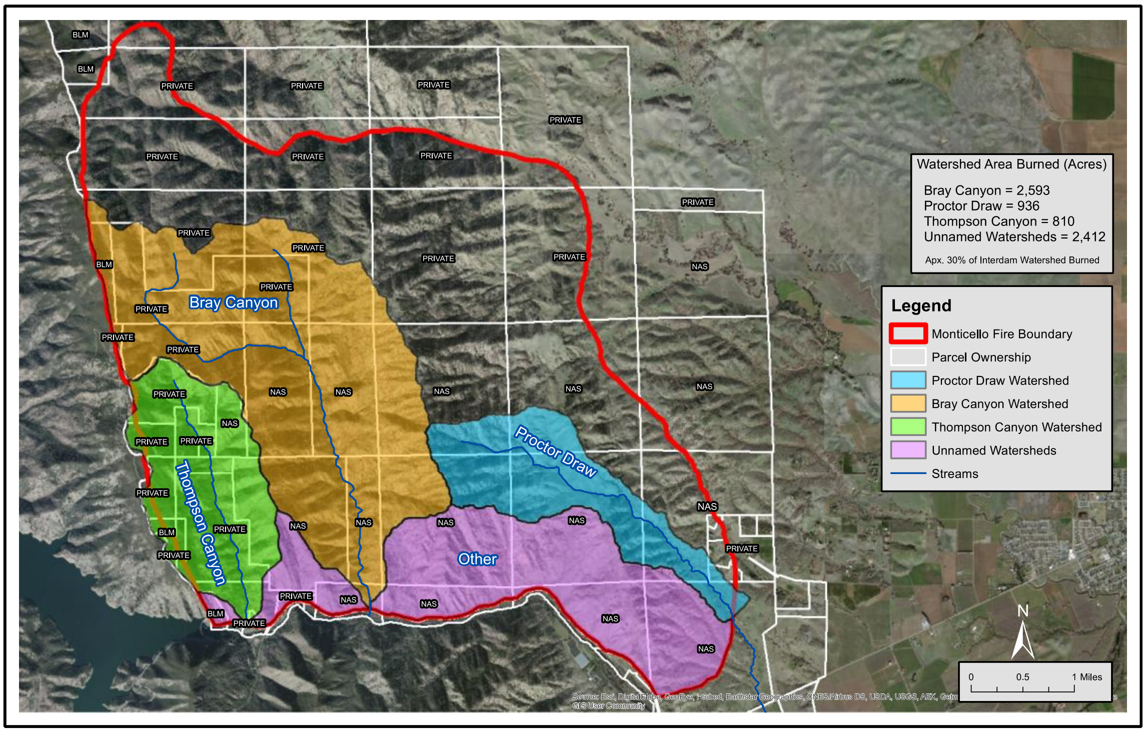


***FIGURE : MAP SHOWING WATERSHEDS AND MONTICELLO FIRE BOUNDARY.***

sediment presents a significant potential impact to water quality in Putah Creek. This question has been addressed though the use of a combination of tools.

First, we employed the process of watershed erosion-focused rapid assessment (EfRA) described in the Watershed Management Guidebook[11]. This process is based on determining where water is likely to flow during periods of moderate to high runoff, the pattern and connectivity of watercourses, the presence of roads, particularly near watercourses, slope steepness (all done from maps and GIS data) and then using that and other information (such as personal communication and historical data if available) as a starting point to field assessment. From the previously listed information, maps are produced that show areas of high potential for erosion problems (for instance where a road and watercourse intersect). Those maps are then taken into the field and used as a starting point for an in-depth field assessment. Problem areas are defined by using specific site parameters, listed below in

[11] www.ierstahoe.com/pdf/research/watershed_management_guidebook.pd

Table 1. The field assessment consists of traveling through the watershed(s) of concern using a low impact all-terrain vehicle, by foot and by unmanned aerial vehicle, and searching for problem areas. In the Monticello Fire assessment, a number of extremely steep areas existed making direct assessment by machine or on foot difficult and potentially dangerous. In those areas, an unmanned aerial vehicle (UAV) was used in order to catalogue and assess inaccessible areas.

The primary purpose of this approach is to clearly identify *actual* erosion sites rather than predicting watershed erosion potential based on modeling. In this manner, actual sites are identified and prioritized for restorative *action* if that action is warranted. While models produce generalized and estimated erosion quantities, modeling approaches are not capable of pinpointing problem areas and thus are not useful in addressing specific erosion issues. Further, models have been shown to be highly inaccurate and thus of limited use for directing actions.

## A Note About Soil and Vegetation

***FIGURE : THIS PHOTO CAPTURES A NUMBER OF ELEMENTS DESCRIBED IN THIS REPORT: 1) THE BLACK RESIDUE IS LIGHTLY BURNED SURFACE MULCH AND PLANT MATERIAL, SUGGESTING A LOW INTENSITY BURN; 2) THE VERY ROUGH SURFACE CAN BE SEEN THROUGHOUT THE PHOTO; 3) THE TREES IN THE BACKGROUND ARE ALL ALIVE, SOME RETAINING MOST OF THEIR GREEN LEAVES AND THE OTHERS CONTAINING RE-SPROUTING; 4) THE POND ITSELF WAS NOT BURNED AS IS INDICATED BY THE VEGETATION RING AROUND THE POND BOTTOM; 5) THERE ARE SEVERAL AREAS OF SURFACE VEGETATION RESPROUTING AND 6) THE POND ITSELF PROVIDES A CATCHMENT AREA IF HIGH AMOUNTS OF OVERLAND FLOW DO OCCUR IN THIS AREA.***

For the purposes of this assessment, ***soil condition*** and related components have been used as a primary indicator of a change in runoff and erosion potential post fire. Many post fire assessments use vegetation as a primary indicator of runoff and erosion potential. However, IERS has been involved in leading research that shows that soil conditions (compaction/density, infiltration, surface roughness, surface mulch and in the case of the Monticello Fire area, soil cracking) are the primary limiting variables that determine erosion rates. Vegetation does play an important role in ecosystem function. However, vegetation can be completely absent and an area can still maintain a low erosion rate if soil conditions are optimized. Further, if plant roots remain in the soil after a fire, they continue to provide reinforcement to the soil.

Thus, a key question asked during the assessment was: Has the soil been severely altered from the fire and does that alteration indicate an increase in erosion potential? Additionally, other key questions posed during the assessment were:

-What are the specific erosion issues in the watersheds of concern, regardless of fire impacts?

-Where those erosion issues exist, what can be done to repair them such that sediment delivery into Putah Creek is reduced?

## Primary Erosion Variables

### Weather

Weather, particularly rainfall, is perhaps the most important variable influencing the erosion potential of the Monticello Fire area. As we have mentioned, and as some photos demonstrate, the affected watersheds show clear signs of past instability and accelerated runoff. Downcut creeks, rotational failures (small to large landslides and other types of soil movement) and numerous gullies are present throughout the watersheds inspected. The evidence suggests that when significant amounts of rainfall are delivered to saturated or near saturated slopes, soil movement and increased erosion occur. We have mentioned some of the historical variables that contribute to this erosion in the watersheds of concern. This assessment addressed site conditions that suggest a high rate of possible erosion during medium to extreme runoff events. While it is difficult to define these terms exactly, we assume that a moderate runoff event occurs when between 0.5 and 1" of rain falls within a 24-hour period and particularly if that rainfall occurs during saturated or nearly saturated soil conditions.

```
FLOOD WATCH
NATIONAL WEATHER SERVICE SACRAMENTO CA
330 AM PST TUE DEC 9 2014

...URBAN AND SMALL STREAM FLOODING AND DEBRIS FLOW OVER BURN
AREAS POSSIBLE WEDNESDAY NIGHT INTO FRIDAY...

.A WET AND WINDY STORM IS EXPECTED TO BRING SIGNIFICANT RAIN AND
SNOW TO INTERIOR NORTHERN CALIFORNIA WEDNESDAY NIGHT INTO FRIDAY.
THE SIGNIFICANT RAINFALL ALONG WITH THE RAINS EARLIER THIS MONTH
WILL LEAD TO RISES ON THE SMALL STREAMS AND FLOODING IN POORLY
DRAINED AREAS. DEBRIS FLOWS OVER BURN AREAS ARE POSSIBLE WITH
SATURATED SOIL AND PERIODS OF MODERATE TO HEAVY RAIN.
```

***FIGURE : NATIONAL WEATHER SERVICE FLOOD WATCH, ISSUED DECEMBER 9, 2014. FLOOD WATCHES SUCH AS THIS ONE SHOW THE IMPORTANCE OF WEATHER IN EROSION AND SEDIMENT OUTPUT. WEATHER SUCH AS OCCURRED DURING 1997, 2005 AND 2010 CAN PRODUCE MOST OF THE SEDIMENT IN INNER COASTAL WATERSHEDS***

## Soil Conditions

We have previously discussed that the overall impacts that the Monticello Fire area has received over the past 150 years or so have determined most of the soil and biologic current conditions of the affected watersheds. It is important to re-iterate that the pre-fire soil conditions reflect those impacts. For instance, there was little organic matter buildup in the soil and the soil was generally highly compacted prior to the Monticello Fire. These two conditions are closely related since high levels of organic matter generally help reduce compaction or soil density over time. However, where organic matter levels are low, compaction tends to persist. As previously mentioned, most of the organic matter that would have been present in pre-intensive human use has been extracted and eroded from these watersheds many years ago. Given grazing pressure, which tends to export carbon, organic matter is unlikely to be replaced without targeted grazing and overall watershed management practices. Thus, pre-fire soil conditions were not 'ideal'. Post fire conditions in most areas were not observed to be significantly different from pre-fire conditions with the exception of a layer of charred surface material.

Many other soil factors will play a role in how and how much soil erodes from these hillslopes. Factors such as surface soil roughness, soil cracking, and level of hydrophobicity will all come into play in determining how the landscape responds to rainfall. In much of the moderately steep areas of the watersheds, soil surface was very rough and contained a great deal of cracking, which penetrated to at least eight inches. These variables will help ameliorate runoff and reduce erosion somewhat. However, given the low level of organic matter in the soil, once soils are saturated, they will likely be more highly prone to erosive forces.

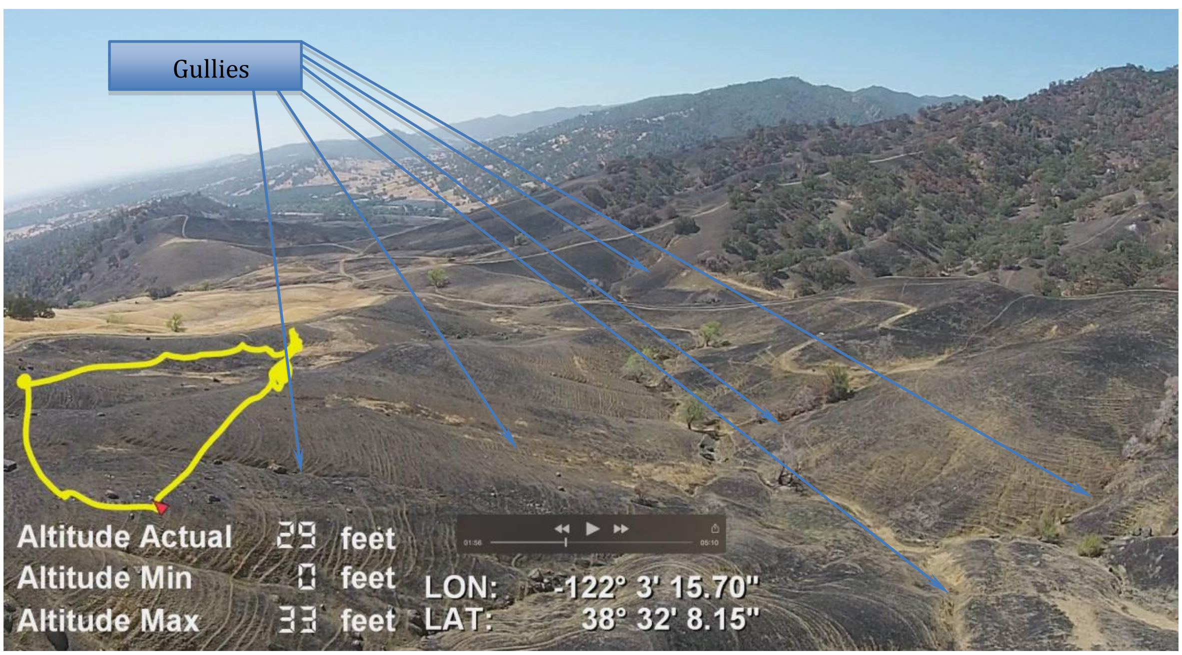


***FIGURE : THIS AERIAL VIEW OF THE FIRE AREA DEMONSTRATES A NUMBER OF FINDINGS FROM THE ASSESSMENT: A GREAT MANY EROSION SIGNATURES EXIST THAT WERE PRESENT PRE-FIRE (MANY RILLS AND GULLIES VISIBLE IN PHOTO); CATTLE TRACKS ARE CLEARLY PRESENT, INDICATING THE EXTENT OF CATTLE INFLUENCE; MOST OF THE TREES IN THIS PHOTO ARE SHOWING ROBUST RE-GROWTH AND THE DRAINAGE ITSELF UNDULATES SUCH THAT WATER TENDS TO BE SLOWED AND SEDIMENT DROPPED FROM THE WATER COLUMN BEFORE IT REACHES PUTAH CREEK. THE AERIAL SURVEY PROVIDES EXACT GPS COORDINATES, ELEVATION OF THE QUADRICOPTER AND A YELLOW TRACK SHOWING THE RELATIVE FLIGHT PATH DURING THIS PARTICULAR FLIGHT.***

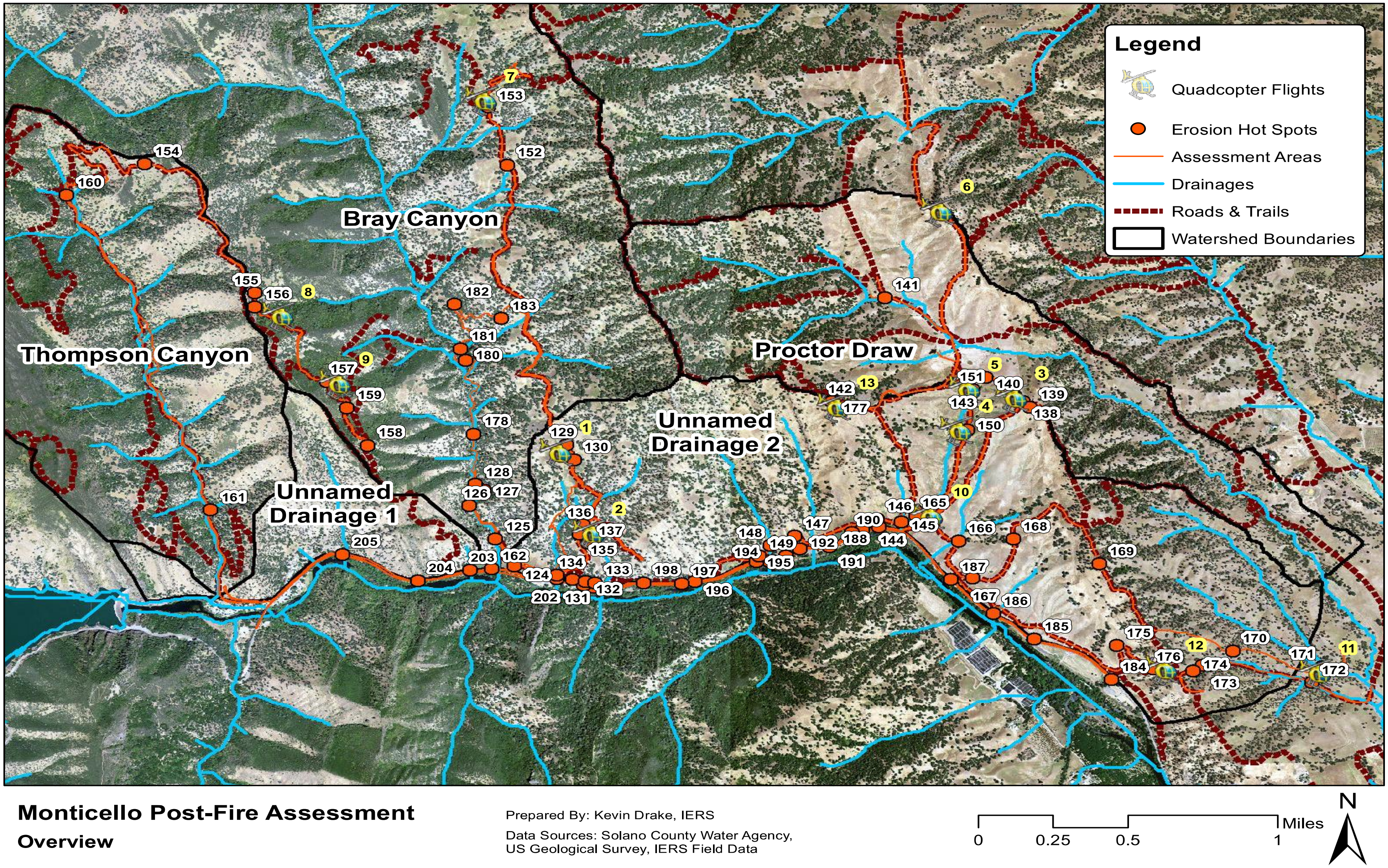


*FIGURE : HOT SPOTS, QUADRICOPTER FLIGHTS, ROADS, WATER FLOW AND DRAINAGES.*

## Site Categorization

The assessment process resulted in three main site categories: 'Hot Spots', Priority Treatment Sites and Watch Sites.

**Hot Spots** are any sites are areas that are currently exhibiting high levels of erosion and/or have clear signs of recent significant erosion. Hot spots are areas that can usually benefit from some sort of treatment. Hot spots are also considered to be the result of anthropogenic alteration of the landscape. Typical alterations are roads, ponds, cut and fill slopes, but can also consist of domesticated animal impacts such as compaction and incised trails caused by grazing cattle and sheep, particularly when impacts occurred during wet periods.

**Priority Treatment Sites** are a subset of Hot Spots that are considered to be immediate threats and/or areas where if treatment is implemented, erosion impacts can be reversed, thus saving time and money that would be required to repair those areas. The Priority Treatment Sites section provides a general description of the steps that can be take on those sites with an approximate time and materials estimate.

**Watch Sites** are sites that appear to be consistently eroding but where the amount of yearly or seasonal erosion is not clear and thus, by watching these sites during and shortly after a significant rainstorm (>0.75 inches in under 8 hours), water quality impacts can be determined. Nearly all of the watch sites are located along Highway 128 and are the result of the road cut lowering the base grade of the lower portion of a drainageway, resulting in a headcutting situation that can produce large amounts of sediment during wet and saturated flow conditions.

### Hot Spots

The assessment process consisted of first locating areas of high potential erosion areas ('Hot Spots') and then rating specific variables in those sites in order to rank the sites numerically. These sites are listed in the Hot Spot list shown later in this section and shown in the map (Figure 8), on the following page.

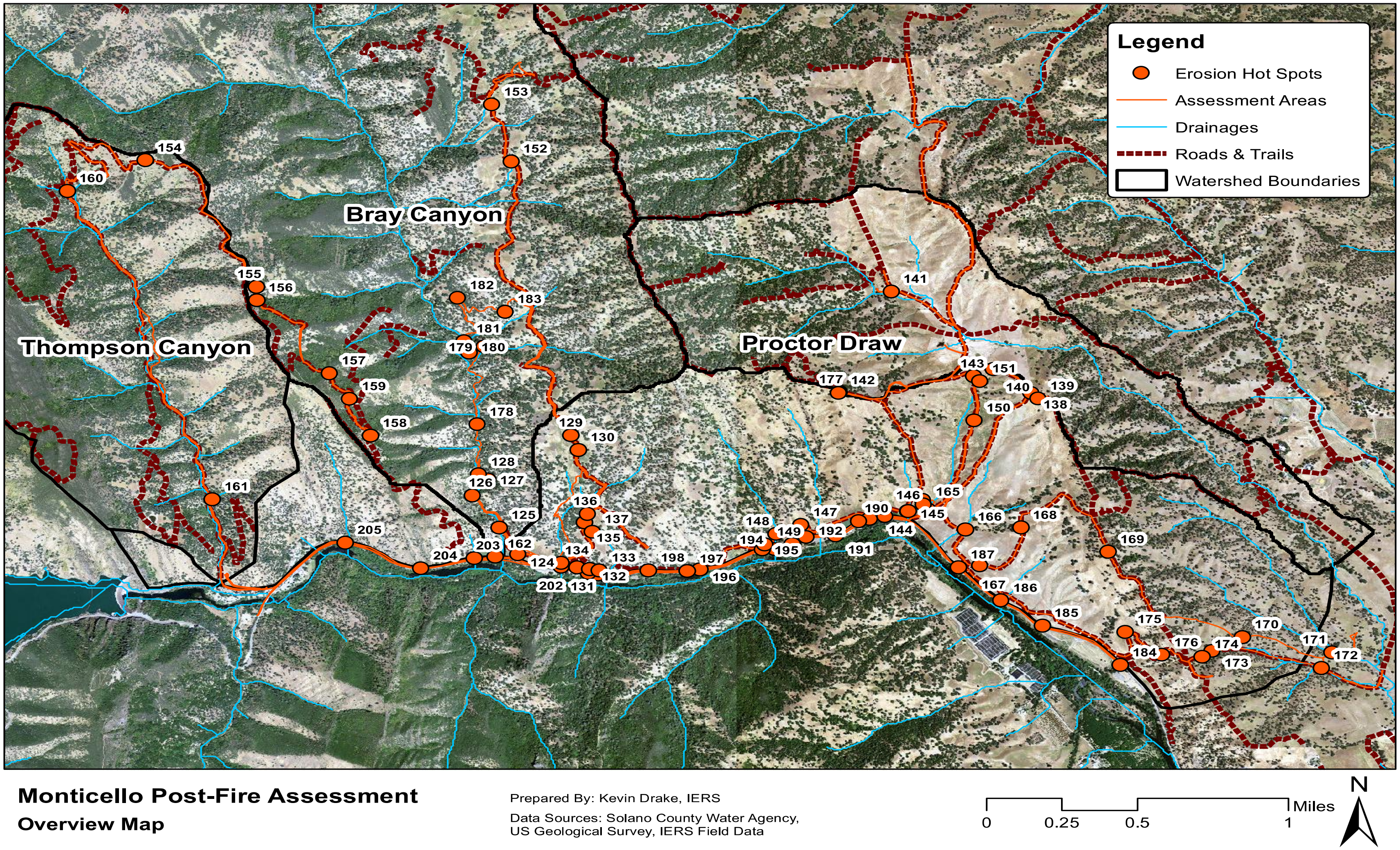


*FIGURE : ALL HOT SPOTS IDENTIFIED DURING THE FIELD ASSESSMENT*

***FIGURE : EROSION HOT SPOT. THIS PHOTO SHOWS TWO CONTRIBUTING ELEMENTS: 1) THE ROAD IN THE FOREGROUND WHICH CONCENTRATES WATER IN LOW SPOTS AND 2) HIGHWAY 128 IN THE BACKGROUND WHICH CUTS INTO THE UPSLOPE AREA CREATING A STEEP GRADIENT AND RESULTING HEADCUT WHICH HAS MIGRATED UPSLOPE TO THE DIRT ROAD.***

## Priority Treatment Sites and Watch Sites

Two other site rankings are presented: Priority Treatments Sites and Watch Sites. Some sites were seen as having very high potential for erosion that might not rank at the top of the list numerically but due to the obvious severity of the erosion threat and/or the large amount of benefit for relatively small amount of repair effort, specific sites were chosen as 'Priority Treatment Sites'. These sites are suggested for immediate treatment if funding and interest exists. 'Watch Sites' were chosen due to their apparent propensity for erosion, uncertainty of when that erosion occurs, difficulty of dealing with erosion on a Caltrans-bordered site and proximity to Putah Creek. Watch Sites should be checked during moderate to severe storms and if erosion is occurring, those sites should be moved up to the Priority Treatment Site list and treated if possible.

The following list briefly describes the variables that were assessed and used to produce the baseline rating system.

***TABLE : JUSTIFICATION OF ASSESSMENT PARAMETERS***

| Variable | Description |
|---|---|
| Mulch[12] | *Critical to surface protection, reducing overland flow velocity and a source of nutrients for soil biology (microbes and plants)* |
| Organic Matter (OM) Layer[13] | *Indicator of overall nutrient levels in soil and resilience (ability to respond to disturbance as well as whether the site is a net accumulator of organic matter or a net exporter.* |
| Depth of Fire Influence | *Indicator of change in soil conditions due to fire and indicator of soil seed bank condition; shallow depth of influence=higher probability of positive soil and vegetation response post fire.* |
| Slope Angle | *A clear relationship exists between slope angle and erosion potential (higher angle=higher erosion potential, all other things being equal)* |
| Compaction/soil density | *Compaction is an indicator of the infiltration rate of a soil as well as general soil condition. Higher density/compaction= lower infiltration rate; lower infiltration rate=higher runoff rate; higher runoff rate=higher erosion energy available.* |
| Active Erosion | *Active or obvious erosion is a clear sign of instability and an extreme probability of continued erosion.* |
| Re-growth (soil) | *Regrowth of soil-based vegetation is a strong indicator of a low level fire influence.* |
| Re-growth (tree/shrub) | *Regrowth of shrubs and trees indicates that the fire is within tolerance levels of native fire-adapted vegetation. Regrowth can occur from sites of burned leaves (leaf buds) and/or from root sprouts.* |
| Distance to Drainage[14] | *The shorter the distance to a drainage, the higher probability of runoff in that drainage of reaching a live water body.* |
| Connectivity to Drainage | *Ease of flow or connection from the feature in question to a drainage. For instance, if a drainage exists nearby (distance to drainage) but that drainage flows onto an alluvial plain, connectivity is low whereas if it flows to a very active drainage that then flows to Putah Creek, connectivity is high.* |
| Distance to Putah Creek | *This metric is an indicator of the ability of runoff to reach Putah Creek and thus negatively influence water quality. The previous metric (distance to drainage) is a measure of distance to any drainage. If that drainage is a long distance to Putah Creek, sediment laden water is less likely to be conveyed to Putah Creek[15].* |
| Condition of Drainage | *Where a drainage exists, is it stable or unstable? Stability is indicated by bank stability, sediment deposition in the drainage channel, and presence of bedrock or other grade-defining substrate.* |

[12] Mulch is the surface layer of dead plant material. Annual grasslands such as is encountered at the Bobcat Ranch tend to have very sparse mulch, even in the best conditions. Areas under trees and shrubs tend to have a more robust layer of mulch.

[13] Organic matter or 'soil organic matter' consists of a range of decomposing plant material (including mulch) that is present in the soil and provides nutrients and additional water holding capacity to the soil.

[14] Most of the drainages in the Monticello Fire-affected area are ephemeral. Some main drainages flow each season and others may only flow during years of high runoff.

[15] While this is generally true in watersheds, the ability for water to be conveyed long distances depends upon a number of variables. In the Monticello Fire-affected watersheds, major grade changes within the drainages themselves creates significant velocity changes in water flows and thus reduces the probability of delivery to Putah Creek with greater distance from Putah Creek.

### Aerial (Quadricopter) Survey

This watershed assessment used an unmanned aerial vehicle (UAV) to capture images and video of fire-affected areas that would otherwise be difficult and/or dangerous to access. This process decreased the time required to complete the field assessment and provides a permanent visual record of those areas surveyed. The UAV that was used is a Phantom 2+ equipped with a high definition (HD) camera and is capable of flight into steep canyons and other inaccessible areas. The UAV video footage is included in the digital version of this report.

***FIGURE 11: PHANTOM QUADRICOPTER SIMILAR TO ONE USED FOR PARTS OF THIS SURVEY.***

## 2.2 Findings Summary

### Observations and Data

***FIGURE : BURNED AREAS SHOWING RESPROUTING***

***FIGURE : EVEN WHERE AN OAK WAS COMPLETELY KILLED, A RE-SPROUT WAS PRESENT.***

Watersheds and watershed processes tend to be chaotic and unpredictable as a whole. That is, the large number of variables at work in watersheds makes generalized and numerical assessment imperfect at best. And while this assessment began with a GIS-based modeling exercise, the most useful analysis is done in the field through direct observation. This report presents a numerical ranking based on the specified parameters. But just as the NRCS modeling exercises always suggest that field 'verification' is needed (see Appendix B), our numerical ranking can be used as a starting point and/or a justification for treatment. However, it is those direct observations of areas that are or have recently been eroding that is most useful since those observations can also offer the context and potential impact from erosion. Direct observation can also lead to repair strategies when done by experienced watershed restoration and erosion control practitioners. Thus, the bulk of this assessment report is based on those direct observations.

The field portion of this assessment provided the following observations:

### Fire Intensity

- The Monticello Fire was apparently low intensity and fast moving in most areas.
- Ground surface cover was lightly burned and in most areas the type of surface cover could still be identified.
- Carissa Rivers (Bobcat Ranch Manager) observed the fire and was able to confirm its fast moving nature.

### Vegetation Response

- Most of the trees and many of the shrubs that were observed showed re-growth. Many oaks for instance had most or all of their leaves killed from heat but were re-sprouting and in those cases there were a large number of small leaves and leaf shoots present.
- A small number of trees were completely disintegrated, as can be seen from the photographs and videos as well as from recent Google Earth imagery. Those disintegrated trees show up as white ash in photos and satellite imagery.
- Most areas showed a distinct presence of fine roots within ½" of the soil surface. This suggests that the fire did not penetrate deeply.
- On the second visit in October, many areas were showing signs of grass and forb re-sprouting. This suggests that at least some of the seed bank was maintained.
- Some areas were devoid of any sign of vegetation; specifically steep areas. It was apparent that these areas were eroding prior to the fire and did not have well established, deep rooted vegetation and thus, what little vegetation (if any) was present was removed by the fire.

### Pre-existing Conditions vs Fire Effects

A large number of pre-fire erosion issues existed in the various watersheds assessed. Some of these issues are briefly described here:

### Bobcat Ranch/Bray Canyon, Proctor Draw and other unnamed watersheds

- Bray Canyon, Proctor Draw and the unnamed watersheds in the fire area exhibited similar attributes: large scale compaction and cattle impacts were present, frequent small to large mass failures were present.
- The main drainages showed signs of downcutting and/or of sediment deposition, depending on landscape position and slope angle.
- The large number of roads in this area and the lack of any functional erosion reduction elements on those roads[16] contribute to ongoing erosion.
- The highly cohesive, dense soil suggests that these watersheds will appear stable until the point of failure at which time large amounts of fine sediment is released into the watershed.
- There are clear signs of large, catastrophic failures in the mid sections of these watersheds. The nature of those failures is not clear nor is the timeframe. All of those failure areas contain at least one or more hot spots.

[16] One exception is the road installed by PG&E up a ridge adjoining Proctor Draw. However, this road, while installing textbook waterbars, outflows, drop inlets, etc., was completely unprotected by those components since they were improperly or inadequately installed. At the same time, those installations, particularly the outflow pipes that exit onto unprotected slopes, are actually sources of erosion. Also, priority site 140 is a direct result of one of these ill-planned 'road BMPs'.

### Thompson Canyon

- Thompson Canyon is a narrow constrained canyon. It was only burned on the east (west facing) side of the canyon, the fire apparently being stopped by the road and creek.
- The road along the bottom of Thompson Canyon is a potential large liability and will undoubtedly become a major source of sediment in the future, as it has been in the past (according to the Thompson Canyon Landowners Assn. representative and as can be seen by the recently installed culverts…installed within the last 5-8 years following a road wash-out).
- Thompson Canyon did not contain a large number of hot spots. However, the nature of the main road itself suggests that when a problem does occur, it has the potential to be very significant. The nature of the problem is that: a) this area is highly prone to landslides, b) when landslides do occur they are likely to be associated with tree and shrub movement down the watershed, c) when the soil and vegetation runs through this highly constrained watershed, it will almost certainly block the culverts which will then create a damming effect, d) when that dam or those dams breach, large amounts of constrained water will flow down the canyon conveying large amounts of sediment into Putah Creek and additional cutting into the creek banks.
- While there are a small number of issues that the Thompson Canyon landowners could address, the larger issue is that the road would need to be re-engineered and then rebuilt to withstand the type of failures that are likely to occur. However, given the uncertainty as to when those failures will occur and the lack of apparent appetite to absorb the high cost associated with rebuilding the road, Thompson Canyon issues were not addressed in any significant manner in this report due to the fact that these problems are not directly associated with the Monticello Fire.


***FIGURE : SITE IN PROCTOR DRAW PRIOR TO MONTICELLO FIRE (GOOGLE EARTH IMAGE)***

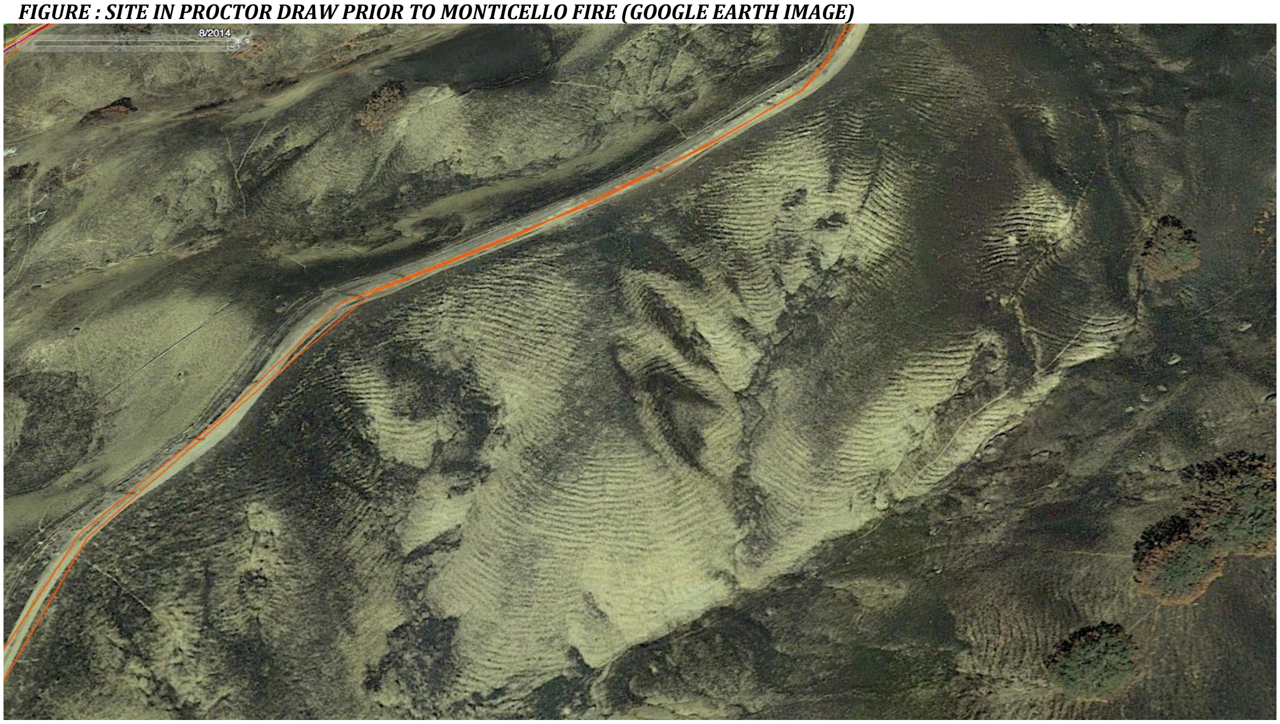


***FIGURE : SAME SITE IN PROCTOR DRAW FOLLOWING MONTICELLO FIRE (GOOGLE EARTH IMAGE)***
***THESE IMAGES SHOW HOW AREAS THAT WERE LIGHTLY VEGETATED BEFORE THE FIRE SHOWED LITTLE IMPACT FROM THE FIRE. AREAS THAT WERE MORE DENSLY VEGETATED SHOWED MORE CHARRED MATERIAL. NOTE THE LIGHTLY SINGED TREES IN THE BOTTOM RIGHT OF THE IMAGE AS WELL AS THE GREENING OF SOME AREAS.***

THIS PAGE LEFT INTENTIONALLY BLANK

# SECTION THREE

## 3.0 RECOMMENDED ACTIONS

### 3.1 PRIORITY TREATMENT SITES

Priority treatments sites were selected based on their high probability of producing significant and/or ongoing erosion and the cost effectiveness of implementing the recommended treatments. With a small to moderate amount of effort, most of these sites can be stabilized and improved, thus reducing the threat of accelerated erosion into Putah Creek. In many cases, the nature of the threat is such that doing nothing will result in needing to do heavy equipment work to make a specific road segment passable following large rain/runoff events.

Each treatment description is general. However, the treatment description can be used to implement treatments by a knowledgeable crew who has engaged in this type of work before or by an experienced crew with input and oversight from an individual who has engaged in this type of erosion work. More complex construction drawings can also be created for each site if needed.

Each Priority site description matrix contains one or more photographs or digital images of the site, a description of the threat and a description of the suggested treatment. Figure 15 below shows the location of all priority sites. Notice that all of the Priority sites are located within the Intermediate Watersheds and Proctors Draw. This is primarily a result of high erosion potential and close proximity to Putah Creek.

***Table : Priority Treatment Site matrix***

| Site | Video or Photo link | Description |
|---|---|---|
| 130 | Video 1 | Complex of road and head cut drainages on what appears to be an old massive land failure |
| 140 | Video 5 | Road and road ditch capturing and concentrating water |
| 143 | Video 5 | Complex of road drainages, enhanced 'natural' drainages and large mass failures. |
| 147 | Photos | Headcutting above and below road and road drainage capture |
| 149 | Photos | Typical highway 128 Drainage, dirt road water capture and headcutting |
| 166 | Google Earth | Drainage intersecting and capturing drainage |
| 172 | Video 11 | Road and stream interaction |
| 174 | Video 12 | Stock pond failure |

Table 2 shows the list of priority sites. The digital version of this report can be used to access specific videos by clicking on the active link.

Figure 16 below, shows a typical hot spot that is partially the result of a lack of a road management strategy. That is, roads are bulldozed throughout the Bobcat Ranch and in Thompson Canyon with little to no regard for impact on water quality. With a small amount of effort and an effective management plan, this situation can be addressed and vastly improved. However, Bobcat Ranch and Thompson Canyon are used and impacted by a number of users beyond the landowners and managers including PG&E and fire crews who are likely creating the bulk of the issues. Thus, any solution will require cooperation by the various impacting entities.

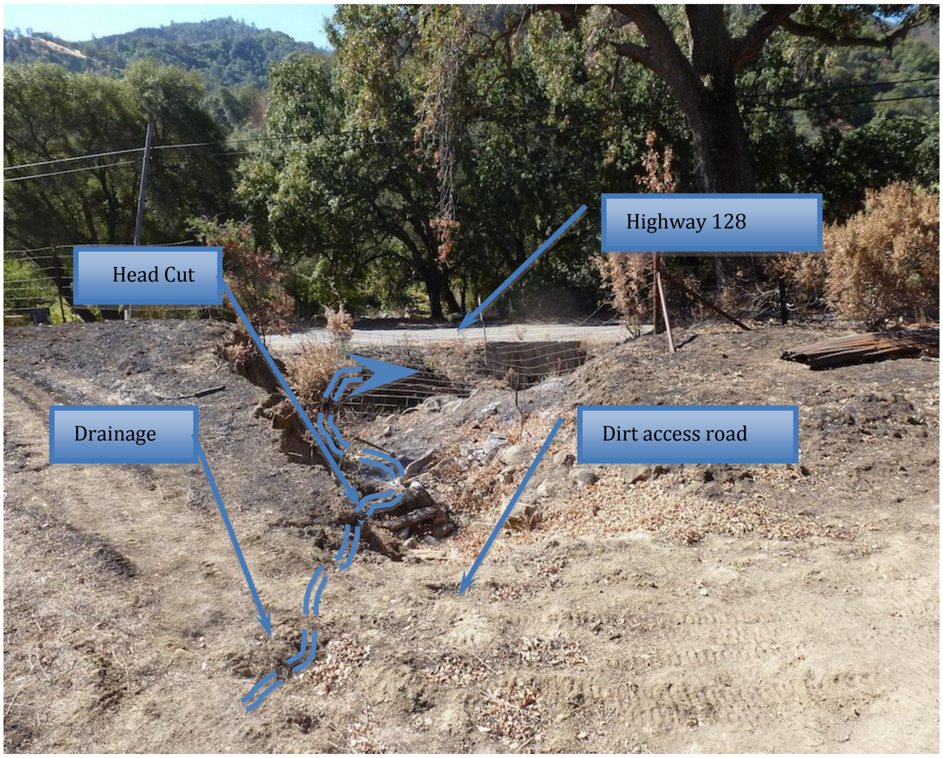


***FIGURE : HEADCUT DUE TO THE GRADIENT DIFFERENTIAL CAUSED BY THE HIGHWAY 128 ROADCUT. THIS CONDITION, AS WITH THE MAJORITY OF EROSION ISSUES, EXISTED PRE-FIRE. THESE AREAS POSE A VERY HIGH RISK OF WATER QUALITY DEGRADATION IN PUTAH CREEK DUE TO THE INSTABILITY OF THE SITE AND ITS PROXIMITY TO PUTAH CREEK. WHICH IS JUST BEYOND THE OAKS IN THE MIDDLE OF THE PHOTO.***

## Site List and Actions

In the Site List and Action pages below, each figure is labeled as 'T-XXX.x" which denotes a 'treatment' site. These areas are suggested for priority treatment based on their immediate threat to water quality.

## Site List and Actions

### Priority Site 130

*Figure T-130.1 looking upslope*

*Figure T-130.2 looking downslope*

### Nature of the Problem to be Treated

1) Massive land movement in this area has created a chaotic drainage pattern. The road bisects the jumble and captures drainage, requiring re-grading on a regular basis.

### Proposed Treatment

1) Simple treatment is to construct large rolling dips to divert water off of road and into drainages, which are cut through the grading berm in order to get the water off of the road.
2) A more complete and long-term solution can be developed and would consist of soil restoration/infiltration treatment and a coordinated drainage plan in this area.
3) An equipment operator training would allow equipment operators who are grading the road to create appropriate waterbars and other features during the grading operations.

### Time-Cost[17]

- 4 hours.
- Crawler tractor or mini or midi excavator with blade.
- No materials needed.
- Work to be done while soil is moist, ideally in the spring.

[17] All time, material and equipment costs are approximations. When work area and scope are more clearly defined, more specific time and materials costs can be developed.

## Priority Site 140

*Figure T-140.1: looking upslope along roadside ditch*

*Figure T-140.2: roadside ditch into drainage diversion.*

*Figure T-140.3: downslope ditch*

## Nature of the Problem to be treated

This site consists of a road, roadside drainage, roadside drainage diversion and the continuation of that diversion onto site 143. This site can be considered part of the overall complex of problems that exist on site 143 and can be dealt with such that part of the input into site 143 is significantly reduced.

1) The roadside drainage ditch, a standard engineered approach to road construction, is non-functional but does concentrate water along the hillslope, sending it downslope.
2) The drainage diversion sends water into a downslope ditch, which contributes, to issues at site 143.

## Proposed Treatment

1) Convert roadside ditch into an infiltration swale by implementing full soil treatment, seed, mulch.
2) Repeat treatment on downslope ditch, add rock energy dissipaters.

## Time-Cost

- 8 Hours
- Mini to midi excavator
- Seed (50#)
- Soil amendment (50 yds. aged or composted wood chips[18])
- Mulch (25 yds. wood chip or pine needles)

[18] Other types of mulch such as locally sources walnut waste material may be used. Trials on walnut waste as a soil amendment and/or mulch will be implemented during the 2015 season.

- Rock for downslope ditch (20 yds. 18-24" angular)

## Priority Site 143

*Figure T-143.1: downslope side of site 140.*

*Figure T-143.2: ongoing erosion area.*

*Figure T-143.3: eroding cutslope just downslope from Figure T-143.2.*

*Figure T-143.4: deep cut just to west of Figure T-143.3 caused by confluence of drainages.*

*Figure T-143.5: area downslope from previous photos showing sediment accumulation in low area.*

*Figure T-143.6: photo taken downslope from Figure T-143-3 showing gullies from road, just out of sight on left, leading into highly eroding drainageway.*

### NATURE OF THE PROBLEM TO BE TREATED

This is a complex and highly eroding area. It consists of a number of issues which interrelate, making repair of this site more complicated than many others. It also requires a carefully sequenced approach. Essentially, this site is typical of ranch roads in steep fire prone watersheds that are not engineered or well planned. The section of road that runs through this area was closed prior to 2014 for an unspecified time[19] and was re-opened shortly before the fire. Given the nature of the sidecast material, it is apparent that the roadwork was done in the spring of 2014 while the soil was still moist.

Without a well-planned effort in this area, it is likely to continue to erode in a way that closes the road during large runoff events. The risk is that each erosion event adds more sediment to the drainages which eventually make their way into Putah Creek.

The suggested treatments are considered interim or precursor to a larger treatment effort for this area. If Bobcat Ranch managers decide that this road is not necessary, we suggest a restoration plan be developed to remove the road.

The following initial treatments are recommended. Refer to the figures above to relate treatment to issue.

### PROPOSED TREATMENTS

1) Figure T-143.1: Assuming site 140 is treated, create an infiltration basin at the bottom of the drainage just upslope of the road. Install an ***Arizona*** type (low water armored or shallow stream ford-see Figure T-143.7, below) crossing at the outflow of the basin.
2) Figure T-143.2: The eroding area upslope of the road to receive full soil treatment including removal of head scarp and slight laying back of top, place head scarp material onto slope to slightly lower slope angle, scalloped tilling, seeding, mulch. Treatment should be done in the late fall just before rain or in the spring while soil still holds moisture.
3) Figure T-143.2: Install water bar across road to divert water off of road and construct armored drainage channel down slope to bottom of adjacent drainage.
4) Figure T-143.3: Slightly lay back cut slope, removing head cut; apply full soil treatment, seed, mulch. Cut material can be placed on road to raise roadbed creating a large rolling dip to divert water from roadbed. This treatment should be used on the entire section of road cuts to eliminate ongoing erosion.
5) Figure T-143.5: this area can be revegetated (full soil treatment) to create a water slowing area and to stabilize existing sediment.
6) Figure T143.6: This photo shows rills, gullies and a severely downcutting drainage that are the result of uncontrolled road runoff and highly compacted soils which increase drainage volume and velocity during peak runoff events. This area can be restored but no specific recommendations are being made here since a comprehensive site plan will be required to address these issues in a sustainable manner.

### TIME-COST

- 2 days
- Mini ex
- Soil amendment (75 yds. wood chips)
- Seed (15#)
- Mulch (30 yds. wood chips or pine needles)
- Rock (25 yds. 6-18” angular)

---

[19] Personal communication with Carissa Rivers, Bobcat Ranch Manager.

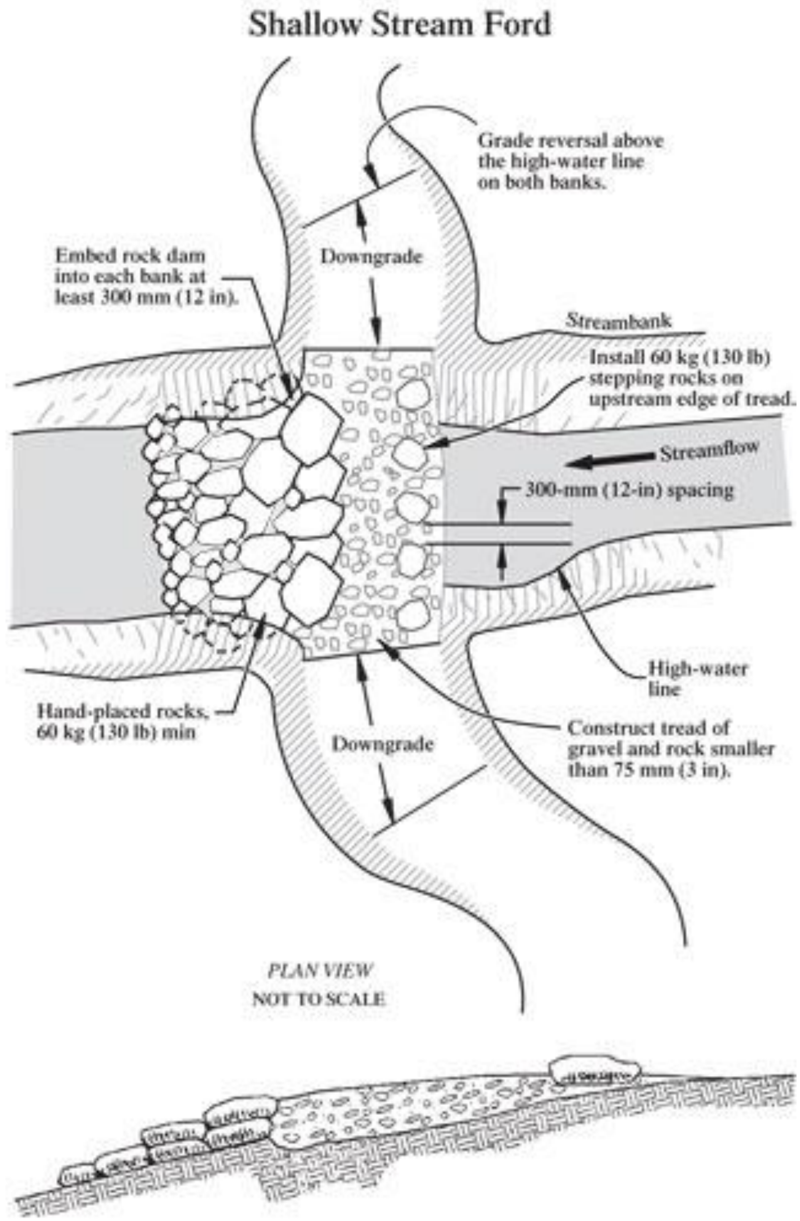


*Figure T-143.7: Arizona-type crossing (courtesy of USFS T&D Publications)*

## Priority Site 147

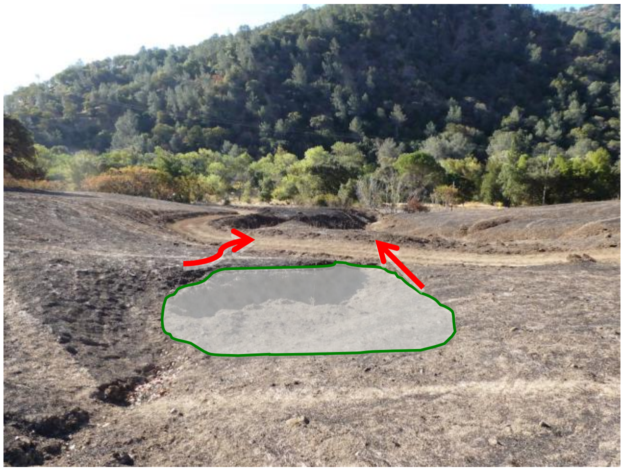

*Figure T-147.1*

*Figure T-147.2*

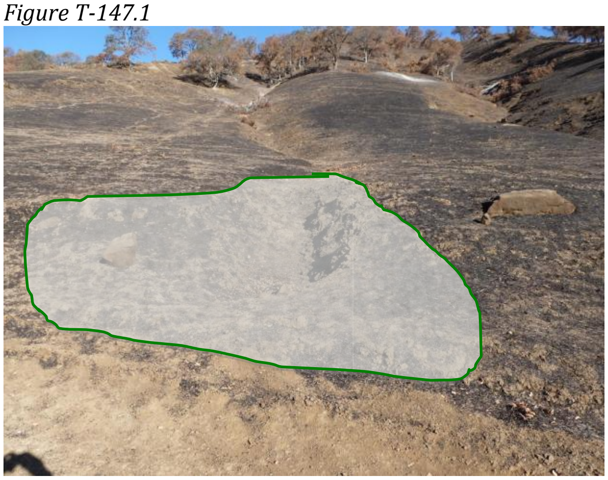

*Figure T-147.3*

*Figure T-147.4*

### Nature of the Problem to be treated

1) The area above the road is headcutting into the hillslope and is cutting into the road. Apparently when this road was treated, a dozer filled in the cut that was created by the eroding drainage. Thus, blockage was created by the re-graded road itself. When high runoff occurs, the road will likely wash out again, taking with it a great deal of sediment.
2) The road grader or dozer operator created a berm on the downslope side of the road, thus creating a restriction to water flowing off of the road. This 'road capture' of the runoff will create a downcutting and concentrating of runoff water which will eventually cut its way through the berm and create a situation of head cutting into the road.

### Proposed Treatment

1) Smooth edges and implement full soil treatment/revegetation/mulch in areas shown in Figures T-147.1 and T-147.3 (same spot, different perspective, above road) and T-147.4 (below road).
2) Install waterbars and outflow dissipaters at locations shown in T-147.1 and T-147.2.

### Time-Cost

- 8 hours
- Mini or midi ex
- Soil amendment (30 yds. aged wood chips)
- Seed (5#)
- Mulch (15 yds. wood chips or pine needles)
- Rock (2 yd 12-18" angular)

## PRIORITY SITE 149

*Figure T-149.1: Site 149 typical of headcutting between Bobcat Ranch and Highway 128. Putah Creek is just beyond the trees in the background.*

*Figure T-149.2: This access road is typical of access roads that are adjacent to Highway 128 that capture and focus water onto the slope between the dirt road and Highway 128. Eventually contributing to the issue seen in Figure T-149.1.*

### NATURE OF THE PROBLEM TO BE TREATED

This site is representative of a number of sites that drain onto/under highway 128 and then into Putah Creek. Apparently these sites are only active during episodic events such as high rainfall events on saturated or nearly saturated soil. Thus, they may remain seemingly stable for long periods of time. However, when they do begin to erode, it's possible that a great deal of sediment is released cumulatively from all of these sites. The erosion signature suggests that erosion is significant when it does take place. Fortunately, many of these sites are accessible and relatively straightforward to repair. Repair consists of a combination of lowering the slope gradient within the drainage by laying back the head cut and side scarps and providing an upslope infiltration area. Road drainage work should also be performed so that drainage is more defined and not a result of road drainage simply breaking through the downslope berm.

1) Steep unplanned drainage differential between Highway 128 and upslope area, combined with highly compacted, high runoff soils and dirt road, which bisects the site.
2) Dirt road and road grading practice which placed dirt berm on the downslope side of the road, which captures water until it can break though.

### PROPOSED TREATMENT

1) Lay back all steep cut areas to create low gradient transition. Perform full soil treatment, add amendment (aged wood chips or composted wood chips), scallop till, seed, mulch. Perform work in spring when soil is wet or irrigate using water truck or water from river. Irrigate 6 times until grass is at least 6" tall.
2) Remove berm from road following initial grading and create rolling dips and/or swales to allow water to exit from road in a planned area. Then provide a settling area and rock armored swale downslope of rolling dip. Make sure rock lined swale extends to an actual drainageway and isn't just daylighted without a connection to drainage.

### TIME-COST

- 8 hours
- Mini or midi ex
- Soil amendment (20 yds. aged wood chips)
- Seed (20#)
- Mulch (10 yds. wood chip or pine needle mulch)

## Priority Site 166


*Figure T-166.1*

### Nature of the Problem to be treated

1) Road cuts through drainage. In heavy runoff events, drainage cuts though road, delivering sediment downslope and requiring road to be rebuilt. Proximity to Putah Creek and steep downslope area creates potential water quality problem.

### Proposed Treatment

1) Construct substantial 'Arizona' (swale and rock lining) crossing that allows water to run across road without cutting through road. Construct inlet and outlet rock lined infiltration areas.

### Time-Cost

- 6 hours
- Midi or mini excavator
- Crossing rock (20 yds. 18" minus graded cobble)

## Priority Site 172


*Figure T-172.1*


*Figure T-172.2*


*Figure T-172.3*


*Figure T-172.4*

## NATURE OF THE PROBLEM TO BE TREATED

Site 172 is a complex of issues that revolves around the interface of a low gradient, ephemeral creek and a series of roads that drain into Proctors Draw. The site is included due to its propensity to produce slugs of sediment that in high runoff years are highly likely to reach Lake Solano and Putah Creek. The site is close to Site 174 and interacts with a number of other potential erosion source sites along Proctors Draw.

1) A series of previously used informal creek crossings produce areas that are continually mined for sediment during moderate to high flows. That sediment is then transported downstream where it either re-settles, is transported to Putah Creek (in high flow events) or both.

### Proposed Treatment

1) A low impact stream restoration plan to be drawn up which includes moderate bank layback and a clear channel definition as well as a clear crossing area.
2) A large Arizona-type (shallow stream ford) crossing should be constructed where the road is designated to cross Proctors Draw.
3) This site can be used as a demonstration site to exhibit the planning and implementation of road-stream interaction plan.

### Time-Cost

- 1-5 days
- Midi excavator
- Seed (amount will vary with overall plan)
- Soil amendment (10-200 yds.)
- Seed (2-50#)
- Mulch (5-100 yds.)
- Rock (40 yds. graded 2” to 12” angular)

Note: Cost can vary a great deal depending on the approach and extent of the overall project. A comprehensive plan and implementation will require more time and resources. However, work can be phased over a season or two as budget and time allows.

## PRIORITY SITE 174


*Figure T-174.1*

### NATURE OF THE PROBLEM TO BE TREATED

This site is representative of a number of stock ponds on the Bobcat Ranch that would benefit from maintenance or removal, depending on need. Failure of the stock pond dam can result in high volumes of water moving through the watershed creating a high erosion and sedimentation rate. Proactive treatment will minimize a great deal of downstream damage if failure were to occur.

1) A stock dam that has been built into a relatively steep ravine that has partially breached. In a particularly heavy precipitation season or series of events, the dam could completely fail sending a potentially large amount of water down Proctors Draw to Lake Solano and Putah Creek.
2) This site is just above site 173, which is a minor hot spot. However, failure at site 174 would affect site 173, taking out the road.

### PROPOSED TREATMENT

1) To keep stock dam: rebuild failed section and install overflow drainageway (rock lined).
2) If stock dam isn't needed: Remove dam and restore dam area.

### TIME-COST

- Mini or midi excavator (16 hrs.)
- Water truck (16 hrs.)
- Vibratory 'whacker' (4 hrs.)
- Imported fill (20 yds.)
- Soil Amendment (20 yds. aged wood chips)
- Seed (10#)
- Mulch (10-15 yds. wood chips or pine needles)
- Spillway rock (10 yds. 6-18" angular rock)

***TABLE : PRIORITY TREATMENT SITES TIME AND MATERIALS***

| Site ID | Feature type | Latitude | Longitude | Immediate damage probability | Site Description, Notes | Time (hrs) | Equip Time | Amend (cu yds) | Seed (#) | Mulch ($yds^3$) | Rock ($yds^3$) | Other (fill) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **130** | Drainage road crossing | 38.521951 | -122.076311 | drainage can erode roadbed, cutting and moving sediment onto road, creating chaotic erosion scenario | Drainage from fire area onto road | 4 | 4 | 0 | 0 | 0 | | |
| **140** | Road drainage | 38.526651 | -122.050839 | capture of road drainage threatens road crossing | Steep road ditch to capture road drainage then dumps water straight downslope to intersect with/go under road below and then into main drainage. | 8 | 8 | 50 | 50 | 25 | 20 | |
| **143** | complex of drainages and road | 38.526226 | -122.052044 | currently sedimenting drainageway; could be chief contributor | this complex of road cuts, road drainage from above (site 140) and general slope erosion, not fire related, are contributing to perhaps the most concentrated erosion and deposition thus far observed. | 16 | 16 | 75 | 15 | 30 | 25 | |
| **147** | Road drainage, head cut | 38.517295 | -122.062744 | drainages onto road will downcut through road | Drainages headcutting onto road. Below road is downcutting but drainage above road will be captured and run down the road. | 8 | 8 | 30 | 5 | 15 | 2 | |
| **149** | drainage road crossing | 38.516138 | -122.064965 | deposition captured by the road topping the road into Putah Creek | water captured by grading berm and downcutting below road from old runoff. | 8 | 8 | 20 | 20 | 10 | 0 | |
| **166** | Drainage crossing | 38.516941 | -122.052664 | ongoing drainage cutting and cutting of road | road crossing drainage that has eroded through previously as seen in old culvert. | 6 | 6 | 0 | 0 | 0 | 20 | |
| **172** | drainage road mess | 38.508371 | -122.030988 | cut through road, major erosion from creek bank/road through creek | Multiple roads and drainages come together here. An accident waiting to happen and one that has happened in the past. | 8 | 8 | 20 | 5 | 10 | 40 | |
| **174** | Stock dam | 38.509104 | -122.038297 | failure would result in large amount of sediment deposition as well as massive flow into downstream drainage | Stock dam that has begun to cut; could be a big issue in certain types of precipitation events. | 16 | 36 | 20 | 10 | 15 | 10 | 20 |
| | | | | | **SUM** | **74** | **94** | **215** | **105** | **105** | **117** | **20** |

## 3.2 Watch Sites

Watch Sites are sites that present potential severe erosion issues in high flow conditions. Rather than suggesting large-scale treatment, we suggest that these sites are watched and monitored, ideally using photo monitoring in order to determine changes over time. When some type of failure begins to occur watching these sites carefully, particularly by an experienced erosion specialist, can help determine if and when they need to be addressed.

Watch Sites should be monitored during or at the very least immediately after a large storm and particularly when large storms occur on saturated or near saturated conditions, such as after a series of back-to-back storms and/or in the late winter. Monitoring of all roadside sites requires approximately 45 minutes to 1 hour for a rapid review of those sites. Rapid review consists of travelling the highway and looking for new, significant cutting of slopes and drainageways. Where a problem is noted, additional and more in depth assessment will need to take place. That secondary in depth assessment consists of determining the cause and extent of the problem. That information should then be linked to one or more of the types of repairs previously described.

Watch Sites have been suggested as an addendum to Priority Treatment Sites in that all watch sites qualify for Priority Status IF they are verified to produce erosion during high runoff events. Watch Sites allow Solano County Water Agency to assess whether efforts should be undertaken to treat sites based on real time observations rather than forensic information. For treatment, see Priority Site 149 above, which describes the type of repair that can be conducted on the various watch sites. Obviously each site is slightly different and each site may require a slightly modified approach. But given that all of the watch sites along Highway 128 are downcutting drainages, the general issue and approach will likely be similar.

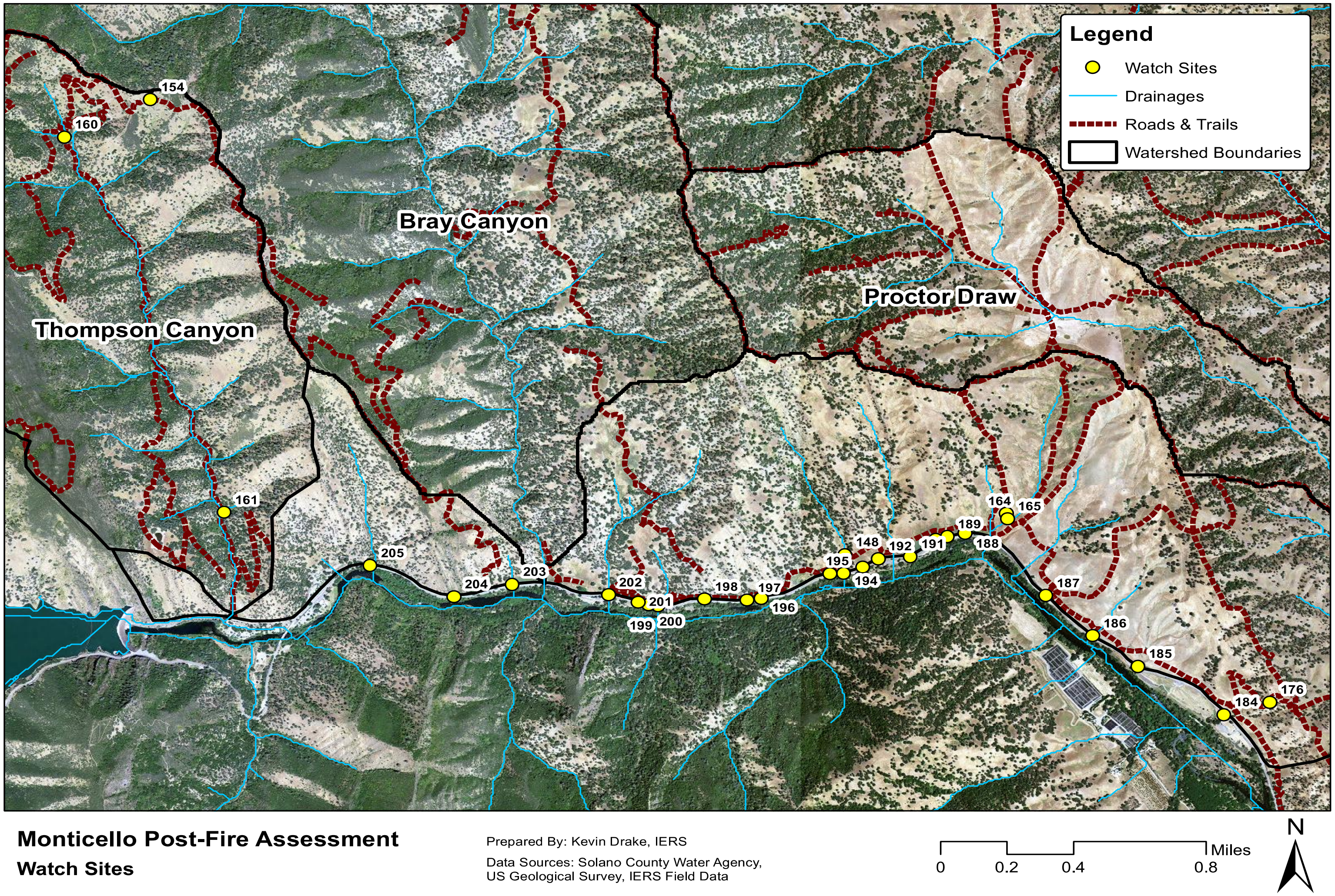


*Figure : Watch Sites. Note that most sites are near or adjacent to Highway 128.*

# WATCH SITE LIST AND ACTIONS

For location of Watch List sites, see Figure 16.

***TABLE : WATCH SITE LIST AND PARTIAL PARAMETER LIST***

| GPS ID | Watch site | Feature type | Dist to drainage 3 close, 1 distant | Connect to drainage 3 connected, 1 poorly connected | Dist to Putah Creek 3 close 1 distant | Condition of drainage 3 poor 1 good | Immediate damage probability | Site Description, Notes | Treatment Recommendations |
|---|---|---|---|---|---|---|---|---|---|
| **148** | x | Drainage road crossing | 3 | 3 | 3 | 3 | Deposition topping the road into Putah Creek | Large steep sided drainage crossing road. There is a culvert, long since clogged, a lot of deposition upslope of road. | Watch; remove material above road or Arizona crossing and protect down road flow |
| **154** | x | Steep canyon hillslopes | 2 | 3 | 1 | 2 | Potential land movement from very hot fire | Steep concave canyon where fire ran VERY hot; shrub dominated | Watch, could be source of sediment in Thomson Canyon |
| **160** | x | road drainage head cut | 3 | 3 | 2 | 2 | | Road put in by fire department- could send sediment to creek | Watch |
| 161 | x | gully drainages coming together at road | 3 | 3 | 2 | 2 | Could clog and take out road | Probably the highest priority watch area in Thompson Canyon, if this area clogs due to upslope erosion, it could cause major failure | Watch |
| 164 | x | head cut | 3 | 3 | 3 | 3 | can continue to head cut | Eroding cut in hillslope adjacent to connected drainage | Watch-if needed, rock head cut and/or full soil treatment |
| 165 | x | Drainage | 3 | 3 | 3 | 3 | Continued downcutting and direct sediment delivery | Drainage that drains many eroding and hot spot areas and is itself eroding | Watch; could create grade control and do near channel soil treatment |
| 176 | x | steep head of drainage and road | 3 | 3 | 3 | 3 | Road and steep slopes may cause large potential issue | Steep canyon head right above Putah creek with road along side of canyon; road capture alone may be a big issue and current colluviation may block flow along road and force it onto slope. If that happens, major head cutting could occur if flows are large | Infiltration treatment on road, roughen road, WATCH |
| 184 | x | 128 road drainage | 3 | 3 | 3 | 3 | HIGH | Photos from across canyon showing typical slump formation, most likely as a result of road capture. This slump has | Road drainages, if severely eroding, require a more complete plan that will need to be coordinated with Caltrans. |

| GPS ID | Watch site | Feature type | Dist to drainage 3 close, 1 distant | Connect to drainage 3 connected, 1 poorly connected | Dist to Putah Creek 3 close 1 distant | Condition of drainage 3 poor 1 good | Immediate damage probability | Site Description, Notes | Treatment Recommendations |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | affected the drainage below | |
| 185 | x | 128 road drainage | 3 | 3 | 3 | 3 | HIGH | Drainage onto/into cutslope, under Highway 128 and into Putah Creek | |
| 186 | x | 128 road drainage | 3 | 3 | 3 | 3 | HIGH | Drainage onto/into cutslope, under Highway 128 and into Putah Creek | |
| 187 | x | 128 road drainage | 3 | 3 | 3 | 3 | HIGH | Drainage onto/into cutslope, under Highway 128 and into Putah Creek | |
| 188 | x | 128 road drainage | 3 | 3 | 3 | 3 | HIGH | Drainage onto/into cutslope, under Highway 128 and into Putah Creek | |
| 189 | x | 128 road drainage | 3 | 3 | 3 | 3 | HIGH | Drainage onto/into cutslope, under Highway 128 and into Putah Creek | |
| 190 | x | 128 road drainage | 3 | 3 | 3 | 3 | HIGH | Drainage onto/into cutslope, under Highway 128 and into Putah Creek | |
| 191 | x | 128 road drainage | 3 | 3 | 3 | 3 | HIGH | Drainage onto/into cutslope, under Highway 128 and into Putah Creek | |
| 192 | x | 128 road drainage | 3 | 3 | 3 | 3 | HIGH | Drainage onto/into cutslope, under Highway 128 and into Putah Creek | |
| 193 | x | 128 road drainage | 3 | 3 | 3 | 3 | HIGH | Drainage onto/into cutslope, under Highway 128 and into Putah Creek | |
| 194 | x | 128 road drainage | 3 | 3 | 3 | 3 | HIGH | Drainage onto/into cutslope, under Highway 128 and into Putah Creek | |
| 195 | x | 128 road drainage | 3 | 3 | 3 | 3 | HIGH | Drainage onto/into cutslope, under Highway 128 and into Putah Creek | |
| 196 | x | 128 road drainage | 3 | 3 | 3 | 3 | HIGH | Drainage onto/into cutslope, under Highway 128 and into Putah Creek | |

| GPS ID | Watch site | Feature type | Dist to drainage<br>3 close,<br>1 distant | Connect to drainage<br>3 connected,<br>1 poorly connected | Dist to Putah Creek<br>3 close<br>1 distant | Condition of drainage<br>3 poor<br>1 good | Immediate damage probability | Site Description, Notes | Treatment Recommendations |
|---|---|---|---|---|---|---|---|---|---|
| 197 | **x** | 128 road drainage | 3 | 3 | 3 | 3 | HIGH | Drainage onto/into cutslope, under Highway 128 and into Putah Creek | |
| 198 | **x** | 128 road drainage | 3 | 3 | 3 | 3 | HIGH | Drainage onto/into cutslope, under Highway 128 and into Putah Creek | |
| 199 | **x** | 128 road drainage | 3 | 3 | 3 | 3 | HIGH | Drainage onto/into cutslope, under Highway 128 and into Putah Creek | |
| 200 | **x** | 128 road drainage | 3 | 3 | 3 | 3 | HIGH | Drainage onto/into cutslope, under Highway 128 and into Putah Creek | |
| 201 | **x** | 128 road drainage | 3 | 3 | 3 | 3 | HIGH | Drainage onto/into cutslope, under Highway 128 and into Putah Creek | |
| 202 | **x** | 128 road drainage | 3 | 3 | 3 | 3 | HIGH | Drainage onto/into cutslope, under Highway 128 and into Putah Creek | |
| 203 | **x** | 128 road drainage | 3 | 3 | 3 | 3 | HIGH | Drainage onto/into cutslope, under Highway 128 and into Putah Creek | |
| 204 | **x** | 128 road drainage | 3 | 3 | 3 | 3 | HIGH | Drainage onto/into cutslope, under Highway 128 and into Putah Creek | |
| 205 | **x** | 128 road drainage | 3 | 3 | 3 | 3 | HIGH | Drainage onto/into cutslope, under Highway 128 and into Putah Creek | |

## 3.3 Summary

Based on the watershed assessment presented in this report, the Monticello Fire had a relatively minor effect on erosion potential in the fire affected watersheds. Some increase in carbon-related compounds may be experienced from charred surface material as that material finds its way into watercourses and ultimately into Putah Creek. However, it is uncertain from field observations and modeling exercises how readily that charred organic matter may make its way to the creek. Direct observations during storm periods are critical to understand transport mechanisms linked to specific rainfall rates and flow regimes. However, insidious erosion is occurring throughout most of the observed watersheds due to historic impacts and inherent geological instability. Erosion is likely to occur into Putah Creek during periodic high rainfall rate events and subsequent runoff.

Repair of many of the erosion areas can be done relatively easily and cost effectively, depending on interest and perceived importance. An overall strategic plan that includes prioritizing, treating and assessing areas is suggested. A learning/treatment development process is also suggested in partnership with Audubon and others so that ongoing, cost effective multi-use land management strategies can be developed. Repair of the priority sites is estimated to require less than 100 hours and less than 600 cubic yards of total materials including soil amendment, seed, mulch and rock. Specific amounts of materials and time required are shown in Table 4.

# APPENDIX A: ADDITIONAL ACTIONS

Additional actions are actions that can be taken beyond the scope of recommendations in this watershed assessment that would benefit the watersheds, water quality, grazing forage values and overall management of the areas under consideration. The possibility of additional actions has been discussed with SCWA and staff from Audubon/Bobcat Ranch. These discussions are based on the fact that the Monticello Fire removed ground vegetation in a manner that allows a clear look at some of the landforms and insidious issues that are present but often masked by vegetation.

This assessment has identified a number of potential actions that can be taken to improve watershed conditions immediately. Two other important elements that can drastically improve watershed function include:

1) an overall travel management plan which would include defining roads, removing and in some cases re-aligning poorly placed roads and

2) an overall soil and vegetation management plan based on restoring carbon to soils and improving overall edaphic[20] or soil-related factors.

There are a number of ways to approach this process. We suggest using and building on the process described in the Watershed Management Guidebook which is the foundation of this assessment and also outlines a step-wise adaptive management plan to achieving long term watershed environmental goals. This process, which is likely worthy of pursuing grant funding can develop as follows:

## LONG TERM (SUSTAINABLE) STRATEGY

Development of a soil, erosion and water flow management plan based on this assessment. This assessment would provide the following benefits:

-Understanding of how to create reduced probability of sediment delivery into Putah Creek.

-Lower maintenance costs on Bobcat Ranch (roads, landslides, surface area losses).

-Potential higher water infiltration and retention in treated areas.

-Reduced WQ issues associated with unplanned travelways.

-Potential for increased forage in highly compacted areas (would be combined with grazing management plan).

-Increased understanding of the requirements of managing ranch landscapes for maximum yield and water quality benefits.

-Water quality and quantity issues are becoming increasingly important land management considerations.

[20] http://en.wikipedia.org/wiki/Edaphic

### Water Quality

The State of California State Water Quality Control Board is currently engaged in developing regulations for agriculture and specifically for ranchland and specifically for grazing (http://www.waterboards.ca.gov/water_issues/programs/nps/grap.shtml). The Bobcat Ranch offers a prime opportunity to develop a process to address water quality issues that puts control into the hands of the land managers rather than in the hands of the regulatory staff. That is, where a proactive response to water quality issues is taken by land managers, the Water Quality Control Board can be included as a partner in the process rather than as 'Big Brother', and the land manager/rancher will be able to exercise much more latitude in addressing their own issues. While this 'model' has not been clearly defined yet for grazing and water quality yet, it is being used for ski resorts and forestry practices in the Lake Tahoe region by the Lahontan Regional Water Quality Control Board and offers a promising solution for grazing. The actual process is outlined in the Watershed Management Guidebook[21] . This approach has been shown to be a viable alternative to the standard command and control approach currently practiced and can also be highly cost effective when implemented appropriately.

Therefore, based on the assessment outlined in this document and the current and future water quality considerations, we recommend the following actions:

### Test and Demonstration Sites: Improving Watershed Conditions

Many of the components of addressing both water quality, water supply and grazing are not well understood. The ability to implement test and demonstration plots on Bobcat Ranch and other nearby sites offers an important opportunity to increase understanding of various types of treatments and can do so very cost effectively. The components of those plots include:

#### Soil

Soil amendments and physical soil treatments can be applied in small areas (<1ac) in order to compare treatments for infiltration, erosion, vegetation response and overall site resilience.

#### Vegetation

Various types of vegetation treatments (native and adapted grasses, forbs, shrubs) can be applied across different soil treatments as described above to help improve forage and habitat value (habitat for birds, pollinators, and others).

#### Forage

Forage values can be measured across soil and vegetation treatments, as described above in order to determine which treatments both increase infiltration and specific forage species.

#### Infiltration/ Erosion

Infiltration, runoff and erosion can be measured directly using a runoff and/or rainfall simulator to quantify the treatment benefits to erosion rather than to assume benefits.

#### Carbon Sequestration

High carbon soil treatments and vegetation establishment in denuded or low production areas can be quantified in order to better understand how we can sequester carbon in specific landscape treatments on grazing land.

#### Pollinator Value

[21] http://www.ierstahoe.com/pdf/research/watershed_management_guidebook.pdf

Grasses and flowering can likely be increased and/or their season extended on Bobcat Ranch and elsewhere using specific soil and vegetation treatment. These grasses and plants provide important forage value and habitat for many pollinators.

These and other aspects of watershed function and ecosystem services can be addressed though a testing and demonstration program that would be ideal to implement at Bobcat Ranch as the process and results provide a firm foundation for science and education, two key components of the Audubon commitment. Findings can be presented as examples of how these types of watersheds (steep, low organic matter, poor response to heavy and winter grazing) can be brought back to full function and thus create a model for other grazing land management sites.

# Appendix B: Planning Maps

## IERS Planning Maps

The planning maps below were used to determine the most probable areas of erosion hot spots prior to field assessment. These maps are similar to the NRCS maps showing erosion potential.

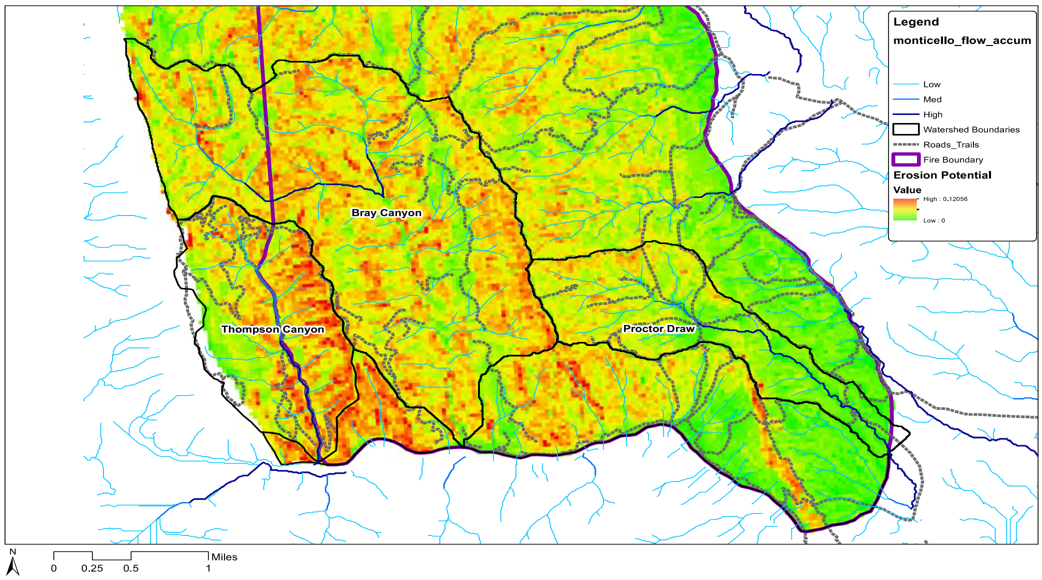


***FIGURE B1: EROSION POTENTIAL MODEL OUTPUT BASED ON SLOPE. AREAS WITH HIGH SLOPE, ROADS AND WATERCOURSES WERE ASSESSED. HOWEVER, DESPITE STEEP SLOPES MANY AREAS WERE NOT AFFECTED BY THE FIRE, PERHAPS DUE TO THE VERY RAPID MOVEMENT OF THE FIRE THROUGH THOSE AREAS.***

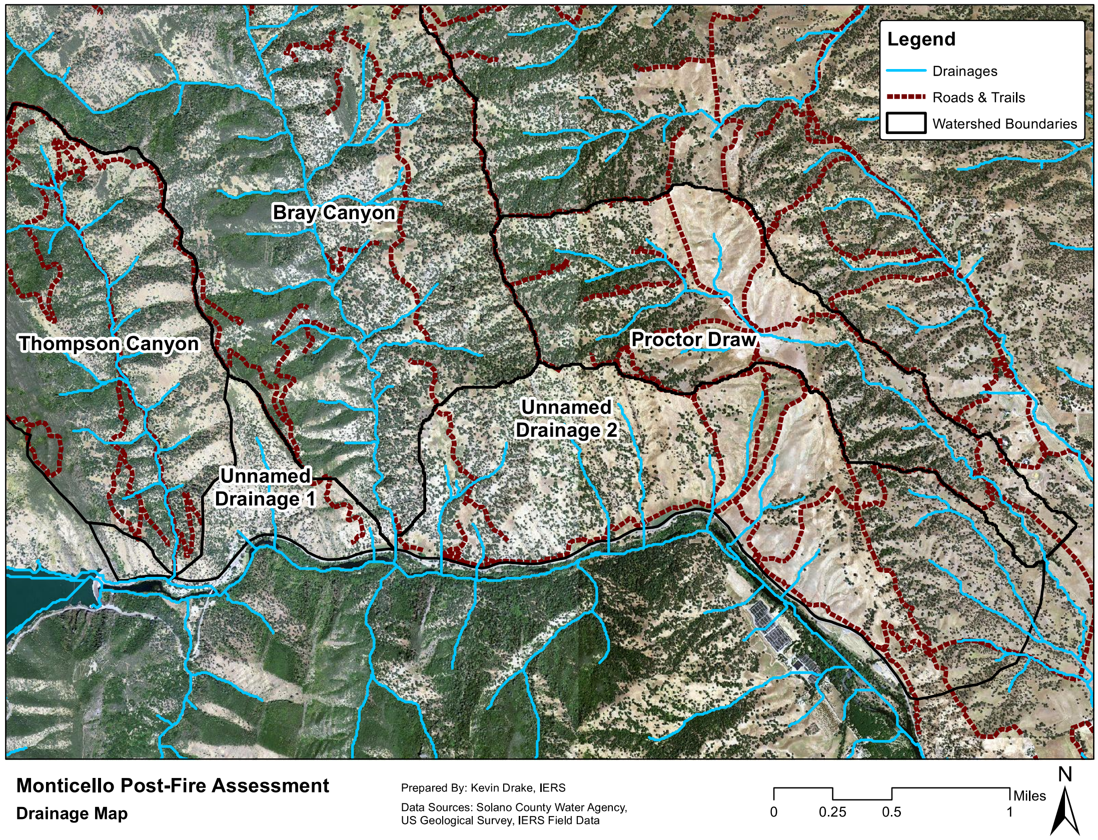


***FIGURE B2: IERS FLOW ACCUMULATION MODEL RUN. THIS MAP IS USED TO LOCATE DRAINAGEWAY AND ROAD CROSSINGS AS PRIMARY EROSION POTENTIAL AREAS PRIOR TO VISITING THE FIELD.***

THIS PAGE LEFT INTENTIONALLY BLANK

# APPENDIX C: DATA SHEETS

***TABLE C-1: COMPLETE UNSORTED DATA SHEET***

| GPS ID | High Priority | Watch site | Feature type | Mulch | OM layer | Depth of fire influence | Slope angle | Compaction | Active Erosion | Re-growth (soil) | Re-growth (tree/shrub) | Dist to drainage | Connect to drainage | Dist to Putah Crk | Condition of drainage | Immediate damage probability | Site Description, Notes | Treatment Recommendations | Photo #s, Video? | Flight Video | ID | Latitude | Longitude | y_proj | x_proj |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1, 2, 3 | | | 1,2,3 | 1,2,3 | 1,2,3 | 1,2,3 | 1,2,3 | 1,2,3 | 1,2,3 | 1,2,3 | 1,2,3 | 1,2,3 | 1,2,3 | 1,2,3 | | | | | | | | | | |
| | 3=highest | | | H:1 | H:1 | H:3 | H:3 | H=3 | H=3 | H=1 | H=1 | Close=3 | High=3 | Close=3 | Active=3 | | | | | | | | | | |
| **124** | **1** | | Flat staging area | 3 | 3 | 1 | 1 | 3 | 2 | 3 | 2 | 3 | 3 | 3 | 3 | runoff directly to road and into Putah Creek | staging area at bottom of fire area adjacent to highway 128 and Putah Creek | build buffer strips; ideal spot for demonstration plots | 368 | | 124 | 38.515665 | -122.080079 | 4263432.59 | 580198.56 |
| **125** | **2** | | creek- ephemaral drainage into Putah Creek | 3 | 3 | 1 | 2 | 3 | 3 | 3 | 2 | 3 | 3 | 3 | 3 | drainage breakthrough will deliver sediment to Putah Creek | two arms of ephemeral drainage… one arm will break through to the other, causing downcutting and sediment movment | define one side or the other, using excavator to remove material instead of having creek do it. More detailed plan needs to be created | 369, 370 | | 125 | 38.517281 | -122.0812 | 4263610.93 | 580099.04 |
| **126** | | | steep slope | 3 | 3 | 1 | 2 | 3 | 3 | 3 | 2 | 3 | 3 | 2 | 3 | steep hillslope with road that is representative of many hillslopes throughout the watersheds. Active erosion from animals | surface roughness will slow runoff. However, these types of areas should be watched to see if they reach a tipping point post fire. The road could be removed if not needed in order to minimize runoff concentration | None or remove road | 372 (371 was deleted) | | 126 | 38.519254 | -122.082803 | 4263828.47 | 579957.11 |
| **127** | | | steep concave slope | 3 | 3 | 1 | 3 | 2 | 3 | 3 | 1 | 3 | 3 | 2 | 3 | | very steep concave slope that was eroding pre fire but may increase post fire. | no practical treatment | 373 | | 127 | 38.520207 | -122.081863 | 4263935.04 | 580038.00 |
| **128** | | | drainage-representative general drainage condition | 3 | 2 | 1 | | | | | | 3 | 3 | 2 | 3 | | This site is representative of generial drainage conditions in this area. * main drainage is downcut. Creek bottom is exposed with large rock and boulders present. * rouchness of slope from wet season grazing, while overall not positive, may be an overall advantage in some rainfall scenarios; * road/trail running along creek is problematic due to chanellization of water; * drainage bottom is supporting green vegetation suggesting shallow water; * 1st flush will likley move charcol into Putah Creek but may not perisist | drainage is likley equilibrated to compacted upslopes and may not need treatment; road/trail could be removed | 374, 375 | | 128 | 38.520517 | -122.08241 | 4263968.96 | 579989.97 |
| **129** | | | Phantom flight | | | | | | | | | | | | | | | | | | 129 | 38.522836 | -122.076745 | 4264231.23 | 580481.24 |
| **130** | **3** | | Drainage road crossing | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 2 | 3 | drainage can erode roadbed, cutting and moving sediment onto road, creating chaotic erosion scenario | Drainge from fire area onto road | large rolling dip will keep water in more contolled area | 376, 377, 378v | F1 0:30-0:36 | 130 | 38.521951 | -122.076311 | 4264133.41 | 580520.06 |
| **131** | | | Upland drainage | 2 | 2 | 1 | 3 | 3 | 3 | 2 | 1 | 3 | 3 | 3 | 3 | Continued headcutting | Upland drainageway from upslope trail which is eroding and headcutting into fenceline trail and onto road. Typical of other areas | | 379-380 | | 131 | 38.514839 | -122.076478 | 4263344.07 | 580513.42 |
| **132** | **2** | | Culvert headcut | 2 | 2 | 1 | 2 | 3 | 3 | 2 | 3 | 3 | 3 | 3 | 3 | clog culvert, threaten higway 128 | Drainage into culvert-drop creates big headcut with probability of clogging culvert | rock fall area; also, infiltration area above fenceline road with rock velocity dissipators | 381; 382 | | 132 | 38.514721 | -122.075687 | 4263331.67 | 580582.51 |
| **133** | **2** | | Upland drainage | 2 | 2 | 1 | 3 | 3 | 3 | 3 | 2 | 3 | 3 | 3 | 3 | clog culvert; threaten hiwgway 128 | Small drainage over upland area, with head cuts, redistribution of water and then into deeply headcut drainage into culvert; | | 383; 384 | | 133 | 38.514648 | -122.075101 | 4263324.09 | 580633.68 |
| **134** | **2** | | Culvert headcut | 3 | 3 | 1 | 2 | 3 | 3 | 3 | 1 | 3 | 3 | 3 | 3 | clog culvert,; close acess road across drainage | downcutting drainage across road onto and into culvert; this area captures at least 3 drainages, which converge right above this area. | Open up mouth of drainage before it comes onto road, create large wood chip-till infiltration area; broaden headcutting area below road, treat soil, rock protect flow area | 385-386 | | 134 | 38.515113 | -122.077431 | 4263373.65 | 580430.03 |
| **135** | | | Settling pond | 3 | 3 | 1 | 1 | 3 | 3 | 3 | 2 | 2 | 2 | 2 | 2 | Captures some runoff | not a problem; an example of capture potential | | 387 | F2 1:10-1:19 | 135 | 38.517559 | -122.075994 | 4263646.32 | 580552.59 |
| **136** | | | Source infiltration area | 3 | 3 | 1 | 2 | 3 | 2 | 3 | 2 | 2 | 2 | 2 | 2 | Source of runoff | this source area is a good potential for demo site/natuve or pasture grass soil restoration demo and would minimize runon to surrounding areas | | 388 | | 136 | 38.51807 | -122.075798 | 4263703.20 | 580569.10 |
| **137** | **and P2+ flight** | | Upland drainage | 2 | 3 | 1 | 2 | 3 | 3 | 2 | 3 | 3 | 3 | 3 | 3 | ongoing down/head cutting, sediment delivery | Several drainages downcutting into upland areas due to compaction | Upland soil (source) treatment and in-drainage soil treatment including undulating flow path bottoms; also open up/broaden sides | 389 | | 137 | 38.516978 | -122.075503 | 4263582.28 | 580596.04 |
| **138** | **P2+ flight** | | Top of ridge | 1 | 2 | 1 | 1 | 3 | 1 | 2 | 1 | | 1 | 1 | 2 | Road drainage to this point should be watched | Phantom flight for overview of Proctor Draw | | | | 138 | 38.525185 | -122.048555 | 4264516.93 | 582935.95 |
| **139** | | | regrowth | 1 | 2 | 1 | 2 | 3 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | | Photo showing forb regrowth w catarpiller as example of spontenous regeneration; Road up to this point is associated with fiber optic cable. Drainage network including AC swale and water bars are present as well as at least 1 DI, not apparantly working. | | 390, 391 | | 139 | 38.524845 | -122.048121 | 4264479.59 | 582974.17 |
| **140** | 3 | | **Road drainage** | 1 | 2 | 1 | 2 | 2 | 3 | 1 | 3 | 3 | 3 | 2 | 2 | capture of road drainage threatens road crossing | Steep road ditch to capture road drainage then dumps water straight downslope to intersect with/go under road below and then into main drainage | Infiltration treatment inside of swale in less steep area, treat roadside with soil infiltration berm, wood chip wrapped berms in steep drainage; ultimately, this swale should be eliminated or rendered non-functional by upslope treatments. | 392, 393, 401 | F5 1:58-2:03 | 140 | 38.526651 | -122.050839 | 4264677.55 | 582735.17 |

| GPS ID | High Priority | Watch site | Feature type | Mulch | OM layer | Depth of fire influence | Slope angle | Compaction | Active Erosion | Re-growth (soil) | Re-growth (tree/ shrub) | Dist to drainage | Connect to drainage | Dist to Putah Crk | Condition of drainage | Immediate damage probability | Site Description, Notes | Treatment Recommendations | Photo #s, Video? | Flight Video | ID | Latitude | Longitude | y_proj | x_proj |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1, 2, 3 | | | 1,2,3 | 1,2,3 | 1,2,3 | 1,2,3 | 1,2,3 | 1,2,3 | 1,2,3 | 1,2,3 | 1,2,3 | 1,2,3 | 1,2,3 | 1,2,3 | | | | | | | | | | |
| | 3=highest | | | H:1 | H:1 | H:3 | H:3 | H=3 | H=3 | H=1 | H=1 | Close=3 | High=3 | Close=3 | Active=3 | | | | | | | | | | |
| 143 | 3 | | complex of drainages and road | 2 | 3 | 1 | 3 | 3 | 3 | 3 | 1 | 3 | 3 | 2 | 3 | currently sedimenting drainageway; could be chief contributor | this complex of road cuts, road drainage from above (site 140) and general slope erosion, not fire related, are contributing to perhaps the most concentrated erosion and deposition thius far observed | Treatement 140, road cut treatment; create full plan | 402, 403, 404, 405, 406, 407 | F5 1:31-1:36 | 143 | 38.526226 | -122.052044 | 4264629.30 | 582630.62 |
| | | | | | | | | | | | | | | | | | | | | | 144 | 38.518096 | -122.05618 | 4263723.45 | 582279.35 |
| 145 | 2 | | road drainage/crossing | 3 | 3 | 1 | 2 | 3 | 3 | 1 | 1 | 3 | 3 | 3 | 2 | headcutting across road | road crossing from active drainage | arizona crossing, widen crossing | 411 | | 145 | 38.518094 | -122.056175 | 4263723.23 | 582279.78 |
| 146 | 2 | | road drainages, head cutting | 2 | 2 | 1 | 2 | 3 | 3 | 3 | 1 | 3 | 3 | 3 | 3 | road drainage and head cutting right to Putah Creek | Road and upland drainage leading to distributed head and down cutting | push high spots into lower area, full soil treatment throughout, create flow paths | 412, 413, 414, 415 | | 146 | 38.518288 | -122.057652 | 4263743.44 | 582150.80 |
| 147 | 3 | | Road drainage, head cut | 2 | 3 | 1 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | drainages onto road will downcut thorugh road | Drainages headcutting onto road. Below road is downcutting but drainaged above road will be captured and run down the road | three rollling dips to keep water into drainages | 416, 417, 418, 419, 420, 421 mvy | No flight | 147 | 38.517295 | -122.062744 | 4263628.71 | 581708.01 |
| 148 | 2 | x | Drainage road crossing | 2 | 3 | 1 | 2 | 3 | 3 | 2 | 3 | 3 | 3 | 3 | 3 | deposition topping the road into Putah Creek | Large steep sided drainage crossing road. There is a culvert, long since clogged, a lot of depostion uplsope of road. | Watch; remove material above road or arizona crossing and protect down road flow | 422, 423, 424 | | 148 | 38.516771 | -122.064258 | 4263569.22 | 581576.61 |
| 149 | 3 | | drainage road crossing | 2 | 3 | 1 | 2 | 3 | 3 | 2 | 1 | 3 | 3 | 3 | 3 | deposition captured by the road topping the road into Putah Creek | water captured by grading berm and downcutting below road from old runoff | Create low spot and define outflow area and rock protect that area | 425, 426, 427 | No flight | 149 | 38.516138 | -122.064965 | 4263498.36 | 581515.69 |
| 150- | | | flight into drainage | | | | | | | | | | | | | | | | | | 150 | 38.523542 | -122.052042 | 4264331.47 | 582633.86 |
| 151 | | | flight into drainage shoinw | | | | | | | | | | | | | | showing drainage from 140 and 143 | | | | 151 | 38.525924 | -122.05168 | 4264596.12 | 582662.70 |
| 152 | | | drainage across road | 1 | 2 | 1 | 1 | 3 | 3 | 2 | 3 | 3 | 3 | 1 | 2 | **potential to cut road out** | shallow downcut drainage that is cutting across road | widen drainage, soil treatment, drop sturctures | 428, 429 | | 152 | 38.53946 | -122.080186 | 4266072.91 | 580162.83 |
| flight? | | | | | | | | | | | | | | | | | | | /' | | 153 | 38.542917 | -122.081334 | 4266455.52 | 580058.94 |
| 154 | | x | Steep canyon hillslopes | 3 | 3 | 2 | 3 | 3 | 2 | 3 | 3 | 2 | 3 | 1 | 2 | potentail land movement from very hot fire | Steep concave canyon where fire ran VERY hot; shrub dominated | watch, could be source of sediment in Thomsen Canyon | 430v, 431,432, 433 | | 154 | 38.539705 | -122.102576 | 4266080.82 | 578211.21 |
| | | | | | | | | | | | | | | | | | | | | | | | | | |
| 155 | | | road drainage head cut | 3 | 2 | 2 | 3 | 3 | 3 | 3 | 1 | 2 | 2 | 1 | 1 | head cutting into road | rock protect head cut | | 434, 435, 436, 437 | | 155 | 38.531986 | -122.095869 | 4265230.00 | 578804.16 |
| 156 | | | photo-regrowth | 3 | 3 | 2 | 3 | 3 | 2 | 3 | 1 | | | | | | | | | | 156 | 38.531165 | -122.095875 | 4265138.89 | 578804.54 |
| 157 | | | flight | | | | | | | | | | | | | | | | | | 157 | 38.52672 | -122.091472 | 4264649.44 | 579193.19 |
| 158 | | | road and pond | 1 | 2 | 1 | 2 | 2 | 3 | 2 | 1 | 3 | 2 | 1 | 3 | head cut into road, onto pond, pond failure | old pond failure fed by road drainage failure | rock protect road outflow, fix drainageway with infiltration treatment, remove dam | 439, 440, 441, 442, 443 | | 158 | 38.522917 | -122.089012 | 4264229.56 | 579411.80 |
| 159 | | | unstable hillslope | 2 | 3 | 1 | 3 | 3 | 3 | 2 | 1 | 3 | 2 | 1 | 2 | eroding hillsope (prior to fire) | Hillslope eroding prior to fire, bisected by road. This is an area to watch… fire may tip it over to cause erosion if there is high precip | | 444, 445, 446v | | 159 | 38.525147 | -122.090259 | 4264475.93 | 579300.65 |
| 160 | | x | road drainage head cut | 2 | 2 | 1 | 3 | 3 | 3 | 2 | 3 | 3 | 3 | 2 | 2 | | road put in by fire department- could send sediment to creek | watch | 448 | | 160 | 38.537878 | -122.107383 | 4265874.01 | 577794.24 |
| 161 | | x | gully drainages coming together at road | 2 | 2 | 1 | 3 | 3 | 3 | 2 | 3 | 3 | 3 | 2 | 2 | could clog and take out road | Probably the highest priority watch area in Thomson Canyon, if this area clogs due to upslope erosion, it could cause major failure | watch | 449, 450, 451 | | 161 | 38.519145 | -122.098737 | 4263802.64 | 578568.15 |
| | | | | | | | | | | | | | | | | | | | | | 162 | 38.515535 | -122.08147 | 4263416.95 | 580077.43 |
| 163 | | | flight | | | | | | | | | | | | | | shows a potential watch site and vegetation | | | | 163 | 38.518183 | -122.054993 | 4263734.16 | 582382.73 |
| 164 | | x | head cut | 2 | 2 | 1 | 3 | 3 | 3 | 2 | | 3 | 3 | 3 | 3 | can continue to head cut | eroding cut in hillslope adjacent to connected drainage | watch-if needed, rock head cut and/or full soil treatment | 483, 484 | | 164 | 38.518752 | -122.055266 | 4263797.06 | 582358.28 |
| 165 | 2 | x | Drainage | 2 | 3 | 1 | 1 | 3 | 3 | 2 | 3 | 3 | 3 | 3 | 3 | continued downcutting and direct sediment delivery | Drainage that drains many eroding and hot spot areas and is iteslf eroding | Watch; could create grade control and do near channel soil treatment | 485, 486, 487, 488, | | 165 | 38.518483 | -122.055216 | 4263767.25 | 582362.95 |
| 166 | 3 | | Drainage crossing | 3 | 3 | 1 | 2 | 3 | 3 | 1 | 1 | 3 | 3 | 3 | 3 | ongiong drainage cutting and cutting of road | road crossing drainage that has eroded through previously as seen in old culvert | arizona crossing | 490, 491, 492 | | 166 | 38.516941 | -122.052664 | 4263598.43 | 582587.19 |
| 167 | | | Drainage crossing | 2 | 3 | 2 | 3 | 3 | 3 | 2 | 3 | 3 | 3 | 3 | 3 | could cut through road if culvert clogs | draingage that is culverted under road with clear signs of recent side slope erosion and head cutting in drainage. It appears that what is eroding from the side slope may be spoils from installing culvert. | full soil treatment on side slope and drainage bottoem | 493, 494 | | 167 | 38.514745 | -122.051815 | 4263355.52 | 582663.71 |
| 168 | 2 | | Drainage crossing | 2 | 3 | 1 | 2 | 3 | 3 | 2 | 1 | 3 | 3 | 2 | 3 | could cut through road if culvert clogs; also road is delivering sediment into drainage | road crossing drainage. Updrainage areas are headcutting and road is putting water into drainage alongside culvert. Clear signs of large amounts of deposition below culvert in flat area. | full treatment in areas above and below culvert in drainages. | 495, 496 | | 168 | 38.517033 | -122.049285 | 4263611.68 | 582881.66 |
| 169 | | | overview video | | | | | | | | | | | | | | video from hilltop overlooking Putah Creek | | 497 | | 169 | 38.51552 | -122.043975 | 4263448.59 | 583346.33 |
| 170 | | | photo and video | | | | | | | | | | | | | | photos and video showing example of 'healthy' burn with nearly all trees responding | | 498, 499, 500v | | 170 | 38.510292 | -122.035828 | 4262875.87 | 584062.68 |

| GPS ID | High Priority | Watch site | Feature type | Mulch | OM layer | Depth of fire influence | Slope angle | Compaction | Active Erosion | Re-growth (soil) | Re-growth (tree/shrub) | Dist to drainage | Connect to drainage | Dist to Putah Crk | Condition of drainage | Immediate damage probability | Site Description, Notes | Treatment Recommendations | Photo #s, Video? | Flight Video | ID | Latitude | Longitude | y_proj | x_proj |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1, 2, 3 | | | 1,2,3 | 1,2,3 | 1,2,3 | 1,2,3 | 1,2,3 | 1,2,3 | 1,2,3 | 1,2,3 | 1,2,3 | 1,2,3 | 1,2,3 | 1,2,3 | | | | | | | | | | |
| | 3=highest | | | H:1 | H:1 | H:3 | H:3 | H=3 | H=3 | H=1 | H=1 | Close=3 | High=3 | Close=3 | Active=3 | | | | | | | | | | |
| 173 | | | road drainage crossing | 2 | 2 | 1 | 2 | 3 | 2 | 2 | 1 | 3 | 3 | 1 | 2 | could take out road | Drainage crossing road | arizona crossing | 509, 510 | | 173 | 38.509453 | -122.037686 | 4262781.08 | 583901.66 |
| 174 | 3 | | Stock dam | 2 | 2 | 1 | 2 | 3 | 3 | 2 | 1 | 3 | 3 | 1 | 2 | failure would result in large amount of sediment deposition as well as HUGE flow into downstream drainage | Stock dam that has begun to cut; could be a big issue in certain types of precip events | create spillway, revegetate dam downstream face | 511, 512 | | 174 | 38.509104 | -122.038297 | 4262741.79 | 583848.79 |
| 176 | 2 | x | steep head of drainage and road | 3 | 3 | 2 | 3 | 3 | 3 | 3 | 2 | 3 | 3 | 3 | 3 | road and steep slopes may cause large potential issue | steep canyon head right above putah creek with road along side of canyon; road capture alone may be a big issue and current colluviation may block flow along road and force it onto slope. If that happens, major head cutting could occur if flows are large | infiltation treatment on road, roughen road, WATCH | 513, 514quad copter flight | | 176 | 38.509248 | -122.040747 | 4262755.54 | 583635.01 |
| 175 | 2 | | road drainage crossing | 2 | 3 | 1 | 2 | 3 | 2 | 3 | 2 | 3 | 3 | 3 | 3 | drainge can take out road | Drainage across road; stock pond below can catch sediment | | 515,516 | | 175 | 38.51067 | -122.042997 | 4262911.29 | 583437.20 |
| 177 | | | flight | | | | | | | | | | | | | | | | | | 177 | 38.525342 | -122.060288 | 4264523.84 | 581913.00 |
| 178 | | | drainage bottom photo | | | | | | | | | | | | | | photos showing regrowth in stream bottom as example of regeneration | | 517, 518, 519, 520, 521 | | 178 | 38.523543 | -122.082457 | 4264304.70 | 579982.52 |
| 179 | | | steep slope colluviation | 2 | 3 | 2 | 3 | 2 | 3 | 2 | 1 | 3 | 3 | 1 | 3 | large sediment deposit could clog and then release drainage, impacting main drainage channel | Very steep, actively colluviating slope which is feeding directly to a steep secondary drainage. This drainage shows clear signs of previous blockage (photo 523); threre is standing water and a very steep escarpment just upslope of this spot | Organic matter surface addiions, hand mixing, seeding, irrigation (probably impractical); open up drainage to reduce blockage potential | 522, 523 | | 179 | 38.52825 | -122.081972 | 4264827.44 | 580019.59 |
| 180 | | | Large drainage complex | 1 | 1 | 1 | 1 | 3 | 3 | 2 | 1 | 3 | 3 | 1 | 3 | blockage and release could result in large amount of sediment into main channel | This large flat area is a complex of erosion issues. Two drainages come together here, the main one and the one from the previous site. A road disects the site, which has been washed out. This seems to be an obvious gathering place for cattle. | Define drainage, remove road, set some grade control in main creek, lay back bank in main creek where constrainted | 527, 528, 529, 530 | | 180 | 38.52788 | -122.082927 | 4264785.55 | 579936.75 |
| 181 | | | road drainage crossing | 2 | 2 | 1 | 1 | 3 | 3 | 2 | 1 | 3 | 3 | 1 | 3 | potential blockage and release could increase sidecutting in main drainage | large side drainage channel that is cutting through road immediately adjacent to main channel | remove road, smooth headcut, add rock protection to head cut | 531, 532 | | 181 | 38.528586 | -122.083207 | 4264863.65 | 579911.57 |
| 182 | | | photos | | | | | | | | | | | | | | photos from large plateu showing regrowth and long view across canyon | | 533, 534, 535, 536, 537 | | 182 | 38.531222 | -122.083564 | 4265155.84 | 579877.53 |
| | | | | | | | | | | | | | | | | | photos showing regrowth on hillslope | | 538, 539, 540 | | 183 | 38.530358 | -122.08066 | 4265062.49 | 580131.61 |
| 184 | | x | 128 road drainage | 3 | 3 | 2 | 3 | 3 | 3 | 2 | 2 | 3 | 3 | 3 | 3 | | photos from across canyon showing typical slump formation, most likley as a result of road caputre. This slump has affected the drainge below | | 541, 542 | | 184 | 38.508656 | -122.043313 | 4262687.52 | 583411.97 |
| 185 | | x | 128 road drainage | 3 | 3 | 2 | 3 | 3 | 3 | 2 | 2 | 3 | 3 | 3 | 3 | | | | | | 185 | 38.511086 | -122.048054 | 4262952.88 | 582995.81 |
| 186 | | x | 128 road drainage | 3 | 3 | 2 | 3 | 3 | 3 | 2 | 2 | 3 | 3 | 3 | 3 | | | | | | 186 | 38.51263 | -122.050554 | 4263121.96 | 582776.07 |
| 187 | | x | 128 road drainage | 3 | 3 | 2 | 3 | 3 | 3 | 2 | 2 | 3 | 3 | 3 | 3 | | | | | | 187 | 38.514654 | -122.053132 | 4263344.24 | 582549.00 |
| 188 | | x | 128 road drainage | 3 | 3 | 2 | 3 | 3 | 3 | 2 | 2 | 3 | 3 | 3 | 3 | | | | | | 188 | 38.517792 | -122.057576 | 4263688.47 | 582157.99 |
| 189 | | x | 128 road drainage | 3 | 3 | 2 | 3 | 3 | 3 | 2 | 2 | 3 | 3 | 3 | 3 | | | | | | 189 | 38.517632 | -122.058562 | 4263669.83 | 582072.21 |
| 190 | | x | 128 road drainage | 3 | 3 | 2 | 3 | 3 | 3 | 2 | 2 | 3 | 3 | 3 | 3 | | | | | | 190 | 38.517496 | -122.059198 | 4263654.17 | 582016.92 |
| 191 | | x | 128 road drainage | 3 | 3 | 2 | 3 | 3 | 3 | 2 | 2 | 3 | 3 | 3 | 3 | | | | | | 191 | 38.516655 | -122.060629 | 4263559.58 | 581893.12 |
| 192 | | x | 128 road drainage | 3 | 3 | 2 | 3 | 3 | 3 | 2 | 2 | 3 | 3 | 3 | 3 | | | | | | 192 | 38.516559 | -122.062424 | 4263547.33 | 581736.74 |
| 193 | | x | 128 road drainage | 3 | 3 | 2 | 3 | 3 | 3 | 2 | 2 | 3 | 3 | 3 | 3 | | | | | | 193 | 38.516147 | -122.063274 | 4263500.86 | 581663.10 |
| 194 | | x | 128 road drainage | 3 | 3 | 2 | 3 | 3 | 3 | 2 | 2 | 3 | 3 | 3 | 3 | | | | | | 194 | 38.515841 | -122.064349 | 4263465.95 | 581569.73 |
| 195 | | x | 128 road drainage | 3 | 3 | 2 | 3 | 3 | 3 | 2 | 2 | 3 | 3 | 3 | 3 | | | | | | 195 | 38.515829 | -122.065122 | 4263463.93 | 581502.35 |
| 196 | | x | 128 road drainage | 3 | 3 | 2 | 3 | 3 | 3 | 2 | 2 | 3 | 3 | 3 | 3 | | | | | | 196 | 38.514651 | -122.06895 | 4263329.83 | 581169.94 |
| 197 | | x | 128 road drainage | 3 | 3 | 2 | 3 | 3 | 3 | 2 | 2 | 3 | 3 | 3 | 3 | | | | | | 197 | 38.51455 | -122.069739 | 4263317.92 | 581101.27 |
| 198 | | x | 128 road drainage | 3 | 3 | 2 | 3 | 3 | 3 | 2 | 2 | 3 | 3 | 3 | 3 | | | | | | 198 | 38.514624 | -122.072111 | 4263324.05 | 580894.39 |
| 199 | | x | 128 road drainage | 3 | 3 | 2 | 3 | 3 | 3 | 2 | 2 | 3 | 3 | 3 | 3 | | | | | | 199 | 38.514302 | -122.074666 | 4263286.07 | 580672.00 |
| 200 | | x | 128 road drainage | 3 | 3 | 2 | 3 | 3 | 3 | 2 | 2 | 3 | 3 | 3 | 3 | | | | | | 200 | 38.514388 | -122.075202 | 4263295.15 | 580625.17 |
| 201 | | x | 128 road drainage | 3 | 3 | 2 | 3 | 3 | 3 | 2 | 2 | 3 | 3 | 3 | 3 | | | | | | 201 | 38.5145 | -122.075775 | 4263307.07 | 580575.09 |
| 202 | | x | 128 road drainage | 3 | 3 | 2 | 3 | 3 | 3 | 2 | 2 | 3 | 3 | 3 | 3 | | | | | | 202 | 38.514888 | -122.077433 | 4263348.68 | 580430.11 |
| 203 | | x | 128 road drainage | 3 | 3 | 2 | 3 | 3 | 3 | 2 | 2 | 3 | 3 | 3 | 3 | | | | | | 203 | 38.515447 | -122.082767 | 4263406.06 | 579964.46 |
| 204 | | x | 128 road drainage | 3 | 3 | 2 | 3 | 3 | 3 | 2 | 2 | 3 | 3 | 3 | 3 | | | | | | 204 | 38.514854 | -122.08602 | 4263337.43 | 579681.51 |
| 205 | | x | 128 road drainage | 3 | 3 | 2 | 3 | 3 | 3 | 2 | 2 | 3 | 3 | 3 | 3 | | | | | | 205 | 38.516447 | -122.090647 | 4263510.20 | 579276.37 |
| | | | | | | | | | | | | | | | | | | | | | | | | | |
| 206 | | | slide off road | 3 | 3 | 2 | 3 | 2 | 3 | 2 | 2 | 1 | 2 | 1 | 2 | Sloughing of the hillside | Site is located at the top of a road switch back, where water is coming off the hillside and eroding it, going across the roadway, and then eroding away on the downstream part of the road. | Improve the side slopes to the road, and convey roadway drainage water to large mulched area where the water can infiltrate into the ground. | 39-43 | | 206 | 38.52811 | -122.08784 | | |
| 207 | | | Head cut | 3 | 3 | 2 | 3 | 2 | 3 | 2 | 2 | 1 | 2 | 1 | 2 | Sloughing of the hillside | Site is located along road switch back, where water from the uphill part of the road is conveyed to the hillside causing active erosion to the downhill part of the road. | Improve the side slopes to the road, and convey roadway drainage water to large mulched area where the water can infiltrate into the ground. | 44, 45 | | 207 | 38.5281 | -122.08764 | | |
| 208 | | | Massive head cut at road crossing | 2 | 2 | 2 | 3 | 2 | 3 | 3 | 2 | 3 | 3 | 1 | 3 | Poorly designed road cut, with no drainage for the stream crossing and a fairly large upstream watershed. | Site is located along a road cut and tributary to Bray Canyon (where a spring was present). The road and bank materials were loose and highly suspectible to erosion, and the road did not have any proper drainage crossing, culverts, etc. | Install appropriate drainage along the road cut and along the stream channel that bisects the road. An Arizona crossing, appropriately sized culvert with downstream rip rap control, or other improvement would need to be done. | 46-52 | | 208 | 38.52936 | -122.08833 | | |
| 209 | | | Incised steep bank and flood plain | 2 | 2 | 1 | 1 | 3 | 3 | 2 | 1 | 3 | 3 | 3 | 2 | Most significant issue would be associated with bank erosion along the right bank of the channel. | Site is located in the bottom valley of Bray Canyon about 0.1 miles upstream of Hwy. 128. There is significant erosion along the right channel bank, which is most likely from this being along a scour bend. The bottom of the channel is filled with large rocks and boulders and appears stable. | Install a rock weir in the channel to deflect flows away from the right bank | 53-58 | | 209 | 38.51707 | -122.08103 | | |

## Scoring Matrix

The following matrix was used as guidance for scoring each hot spot site. In some cases, scoring was altered. For instance, if a site was 2000' from Putah Creek but ran through a large flat catchment area, it would be given a 3 score in order to reflect the low probability of sediment reaching Putah Creek. The main context of and logic behind the parameters and score are to reflect whether a specific site posed a high probability of water pollution in Putah Creek.

***TABLE C-2: SCORING MATRIX USED FOR THE MONTICELLO FIRE WATERSHED EROSION ASSESSMENT***

| | **Score** | | |
|---|---|---|---|
| **Parameter** | **1** | **2** | **3** |
| mulch | 1"+ | trace to 1" | none |
| OM Layer | developed to 1", distinct soil color | poorly developed but visible | none |
| Depth of Fire influence | surface only | <1" but visible to depth | 1"+, roots burned, fire-darkened soil |
| slope angle | 0-15 deg | 15-30 deg | > 30 deg |
| compaction | 6" plus, dry soil | 3-6" | 0-3" |
| active erosion | none or small, older rills | rills to 3" | rills and gullies, fresh evidence |
| re-growth soil | 5% surface cover with new growth | 1-5% surface cover | none |
| re-growth- tree/shrub | >50% of trees or shrubs resprouting | 10-50% of trees or shrubs resprouting | little to no resprouting |
| distance to drainage | >100' | 15-100' | within 15' |
| connect to drainage | no obvious connection | interrupted or meandering connection | direct connection |
| distance to Putah Creek | 1000' | 1000-3000' | >3000 |
| condition of drainage | Stable | some instability, limited down and or headcutting | highly unstable, fresh bank failure, downcutting and/or headcutting |
| Immediate damage probability | Description of potential problem | | |

# Appendix D

## Post Fire Photos March 12th, 2015

The following photos were taken on March 12th , 2015 at Bobcat Ranch. The photos support findings from the assessment in two ways: First, the robust presence of grasses and wildflowers support the finding that the fire did minimal deep soil damage and left the seed bank in tact and second, the grasses begin to mask the ongoing erosion issues, which have become almost invisible under the green blanket of vegetation.

*FIGURE D-1. LUPINES RESPONDING FAVORABLY TO POST FIRE CONDITIONS.*

*FIGURE D-2. ALL FIRE AFFECTED AREAS HAVE RESPONDED POSITIVELY POST FIRE.*

*FIGURE D-3. ABUNDANT LUPINE AND MIXED FORBS AND GRASSES POST FIRE.*

*FIGURE D-4. WILDFLOWERS, FORBS AND GRASSES COVERING AN ABANDONED ROAD NEAR HIGHWAY 128.*

***FIGURE D-5 GRASSES ALMOST COMPLETELY COVER AN ERODING DRAINAGEWAY, ONE OF THE WATCH/PRIORITY SITES ABOVE HIGHWAY 128.***