ATTACHMENT D
INFORMATION SHEET IN SUPPORT OF

GENERAL ORDER OF WASTE DISCHARGE REQUIREMENTS FOR TIMBERLAND MANAGEMENT ACTIVITIES ON NON-FEDERAL AND FEDERAL LANDS IN THE CENTRAL VALLEY REGION FOR ORDER NO. R5-2017-0061

This Information Sheet sets forth the background, rationale and references used in the development of certain requirements for Waste Discharge Requirements related to Timberland Management Activities on Non-Federal and Federal Lands, Order No. R5-2017-0061 (hereinafter "Order") within the Central Valley Region. Specifically, the information included herein elaborates on findings in the General Order related to water quality impacts and timberland management activities in the post-fire environment, an evaluation of Significant Existing or Potential Erosion Sites (SEPES), and monitoring and reporting costs associated with Order compliance. The content of this Information Sheet includes: the best available scientific research and information in the area of fire ecology, erosion, forest hydrology and water quality impacts from pesticide[1] use in the post-fire environment; field observations by Central Valley Regional Water Quality Control Board (Central Valley Water Board) staff; clarification on the evaluation of SEPES; and a summary of the existing rules and policies that are currently in place in California that regulate post-fire salvage logging and subsequent post-fire management activities.

WATER QUALITY IMPACTS AND TIMBER HARVEST OPERATIONS IN THE POST-FIRE ENVIRONMENT

In the western United States historic forest management and fire suppression, in conjunction with a changing climate, have led to uncharacteristically large, severe wildfires (Flannigan et al. 2000, Littell et al. 2009, Westerling et al. 2006, Westerling and Bryant 2008). As a result of this general decline in active fuels management on both federal and non-federal lands, exacerbated by nearly a century of intense fire suppression, increased frequency and intensity of stand-replacing fire is occurring throughout the western United States. The remaining forests of central and northern California that have not recently burned at high severity have high fuel loads and are experiencing extended periods of above average seasonal temperatures. These factors are leading to both extended fire seasons as a result of drier fuel conditions, and increased incident of extreme fire behavior

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[1] For the purposes of this Information Sheet and Order (Attachment A) "pesticide" means (1) any substance, or mixture of substances which is intended to be used for defoliating plants, regulating plant growth, or for preventing, destroying, repelling, or mitigating any pest, which may infest or be detrimental to vegetation, man, animals, or households, or be present in any agricultural or nonagricultural environment whatsoever, or (2) any spray adjuvant, or (3) any breakdown products of these material that threaten beneficial uses. This definition excludes aquatic pesticide discharges covered under Order No. 2013-0002-DWQ.

with stand-replacing wildfires. Climatology models and information gathered by leading fire ecologists predict that the future wildfire regime in California will result in increased spatial size, distribution, and occurrence of severe wildfires (Fried et al. 2004, Miller et al. 2009, Westerling and Bryant 2008, Westerling et al. 2011).

Fire is a natural disturbance that directly influences California ecosystems and ecological processes, plant species, animals, and entire watershed ecosystems in California that have evolved to be both tolerant and dependent on fire as a landscape scale physical disturbance. However, as fire regimes in California shift, so has the intensity of the physical disturbance caused by wildfire. Increases in wildfire frequency, magnitude, and severity due to climate change within the western United States may lead to detrimental sediment-related water quality issues within burned mountainous watersheds (Gould et al. 2016). There must be recognition that post-fire land use activities have the potential to exacerbate fire effects, and land owners, land managers, and resource agencies have a responsibility to understand what those potential impacts are and where there is opportunity to minimize those impacts through both adaptive management and strategic regulatory measures.

Water Quality Impacts Following Fire

Following severe wildfire in forested landscapes, increased soil water repellency and other changes to soil properties can reduce infiltration rates and increase the rate and frequency of runoff (Martin and Moody 2001, Robichaud 2000, Robichaud et al. 2016). Additionally, the loss of ground cover following severe wildfires is a dominant factor for increased soil erosion rates (Benavides-Solorio and MacDonald 2001, Delwiche 2009, Larsen et al. 2009, Robichaud et al. 2016). Increased soil erosion rates and sediment delivery to downstream channel networks can pose a significant threat to aquatic resources and beneficial uses, particularly after extensive high severity wildfires (Helvey 1980, Moody et al. 2013, Bladon et al. 2014, Chappel 2014).

Soil erosion at its most basic form involves the detachment, breakdown, transport, and deposition of sediment, which in the context of post-wildfire effects, is dependent on multiple factors, including: fire severity, watershed area, topography, geology, vegetation, and precipitation intensity. The greatest erosion events typically occur before vegetation regrowth and recovery and often coincide with episodic, short-duration, high intensity rain storms immediately after severe wildfire (Moody and Martin 2001). Accelerated erosion, potential hydrophobic soils, reduced water infiltration rates, overland runoff, and mass soil hillslope failures can also produce catastrophic debris flows in some environments (Doerr et al. 2009) which pose a direct threat to water quality, beneficial uses, and human health and safety (Cannon et al. 2010). Accelerated soil loss also affects site class and future tree growth.

On uncompacted, unburned hillslopes and areas with intact overstory canopy and ground cover, overland flow usually occurs only during very intense and short duration storm events. In high severity post-fire environments, where soil properties have been altered and effective ground cover is not present, significantly higher rates of runoff can be expected (e.g., Wagenbrenner et al. 2017). Compared to lower severity fires, high severity fires consume a higher proportion of the vegetation, forest litter, and other organic matter that provide effective ground cover. Reduced ground cover exposes more of the soil to precipitation and often increases erosion by several orders of magnitude. In studies conducted in the Sierra Nevada, rates of post-fire surface erosion have been reported to be 2-239 times greater than pre-burn rates (Ahlgren and Ahlgren 1960). The amount of erosion and sedimentation depends on severity of the fire and post fire storm events (number and intensity), especially the first two winters. The progressive decline in post-fire sediment yields over time is largely controlled by the regeneration of surface cover, primarily vegetation (MacDonald and Larsen 2009, Benavides-Solorio et al. 2001, Larsen et al. 2009). With the return of vegetative growth and stabilization of easily mobilized soil material, hillslope erosion rates generally attenuate with time after the wildfire and return to background rates within 2-3 years (Heede et al. 1988, Wohlgemuth et al. 1998) under natural conditions.

Only limited post-fire sediment monitoring has been undertaken in the Sierra Nevada and Cascade Ranges. Usually erosion and sediment data are not collected following a wildfire. Data collected to date show widely varying impacts, with very high hillslope erosion rates usually requiring one or more major hydrologic event the first two winters. In general, post-wildfire erosion is highly variable and difficult to predict. The risk of elevated sediment yields generally is greatest the first few years after the fire until vegetation is reestablished (Wagenbrenner 2017).

As an extreme example of post fire erosion, the 2012 Bagley Fire (46,011 acres) in Shasta County produced an estimated total hillslope erosion of 5.23 million tons (114 tons per acre) during the first year post-fire. Two intense storms occurred a few months after the fire, with estimated return intervals of 25-50 years. Soil loss was estimated at 0.2 to 2.2 inches on virtually all hillslopes (USFS 2014). Measured sediment delivered to Squaw Creek during the first year post-fire resulted in sustained turbidity and significantly higher water temperatures, exceeding 70 degrees Fahrenheit; a temperature that can be lethal to cold water fish. Sediment produced during the first year post-fire and during subsequent years continue to be transported downstream to Lake Shasta, leading to reduced storage capacity and increased nutrient loads.

Other post-fire monitoring efforts in interior California have documented lower sediment yields at the plot or small catchment scales. These include the 2012 Ponderosa Fire - 15.5 t/ac (James 2014); 1999 Pendola Fire - 5 t/ac (MacDonald et al. 2004); 2007 Angora Fire - 0.01 t/ac (Wade and Kocker 2012), 1987 Stanislaus Complex - 20-50 t/ac (J. Frazier and A. Janicki, Stanislaus National Forest, pers. communication, cited in the California Fire Plan, BOF 1995); 1987 Hayfork District -Shasta Trinity National Forest Complex Fires - 10-40 cubic yds/ac (Miles et al. 1989); and the 2001 Star Fire - 1.2 t/ac, second winter (Chase 2004).

Following wildfire, sediment discharge can lead to changes in turbidity, temperature, and stream chemistry. These changes may degrade water quality (i.e., taste, odor, color) and impair drinking-water treatment processes, along with negatively impacting aquatic life. Increases in sediment and turbidity can affect aquatic ecosystems by clogging streambed interstitial voids with fine sediments, reducing stream depth, increasing channel instability, altering stream temperatures, impairing fish feeding, and destabilizing stream channels (Goode et al. 2012). The growth and survival of aquatic plants, invertebrates, and fish are negatively affected by increases in sediment and turbidity (Wagner et al. 2014).

Wildfires such as the 2012 Bagley Fire can liberate accumulated metals, such as arsenic, aluminum, cadmium, iron, lead, and mercury. These metals have a strong affinity for ash and fine sediment, which are subsequently discharged to stream systems via elevated runoff and erosion (Bladon et al. 2014). Mercury's potential to bioaccumulate and biomagnify can result in health problems for consumers of fish. There are several streams, lakes, and reservoirs—including Lake Shasta—in the Central Valley Water Board region that are currently listed as 303(d) impaired by various metals, including mercury. Many of these waterbodies are located in watersheds subject to increased risk of large, severe wildfires.

Nutrients such as nitrogen and phosphorous are often mobilized by fire, which results in increased loading to streams (Bixby et al. 2015). In addition, significant increases in specific conductance and turbidity, along with corresponding decreases in dissolved oxygen are documented (Sherson et al. 2015). Nutrients can contribute to and exacerbate Cyanobacteria (blue-green algae) blooms, such as those experienced during the summer of 2015 throughout much of the Central Valley Water Board region, including Lake Shasta.

Timber Harvesting Policies and Regulations in California

Non-Federal Lands

Timber harvesting on non-federal lands in California is regulated by the Board of Forestry and Fire Protection (BOF) in accordance with the Forest Practice Act (FPA) through implementation of the California Forest Practice Rules (FPRs); a set of regulations that lay out administrative procedures and prescriptive best management practices to protect natural resources. Pursuant to the FPA and through the FPRs, the California Department for Forestry and Fire Protection (CAL FIRE), acting as the lead agency, the applicable Regional Water Board, California Department of Fish and Wildlife (CDFW), and California Geological Survey are responsible agencies for the review of timber harvesting plans (THPs) (Cal. Code of Regs., tit. 14, § 896). As a member of this interdisciplinary Review Team for green tree THPs, the Central Valley Water Board staff reviews proposed THPs, and has the opportunity to participate in pre-harvest inspections, and may provide input and recommendations on water quality-specific components to ensure water quality protection prior to CAL FIRE approval.

This multi-disciplinary review process for green tree THPs is considered to be functionally equivalent to the Environmental Impact Report (EIR) process under California Environmental Quality Act (CEQA) (*see* Cal. Code of Regs., tit. 14, § 896). The average THP consists of more than 120 pages of information related to the site, current conditions, proposed operations, cumulative impacts assessment, operational considerations, and proposed mitigations to address potential impacts to a variety of natural resources supported by forestlands.

Following wildfire, many large industrial forest landowners engage in salvage logging, whereby burned, damaged, and commercially valuable timber is removed through conventional timber harvesting techniques. Generally, the value of the commercial timber burned in a fire degrades within 1-2 years post-fire, resulting in harvesting operations that focus on removing burned timber quickly to recover as much economic value as possible. The FPA and FPRs allow for the rapid removal of trees from areas damaged by fires where such removal meets the definition of an emergency:

> *…those conditions that will cause appreciable financial loss to the timber owner that may be minimized by immediate harvesting of timber" (Pub. Res. Code § 4592; see also Cal. Code of Regs., tit.14, § 895.1).*

The Emergency Notice process requires minimal documentation (generally approximately 3 pages including a map) and does not provide opportunity for the interdisciplinary Review Team to address potential impacts to resources from post-fire salvage operations. As a non-discretionary action taken by CAL FIRE, timber operations associated with Emergency Notices can commence five working days after submittal without first preparing a THP, and are not subject to the interdisciplinary Review Team process or public review/comment. In fact, due to the accelerated timeline for Emergency Notices, it is generally only after a timber/timberland owner has submitted the Emergency Notice to CAL FIRE and then submitted an application for coverage under the Central Valley Water Board's current Waiver of Waste Discharge Requirements (Order No. R5-2014-0144) that staff becomes aware post-fire salvage operations have commenced and receive limited information about the location and timing of those operations.

Non-federal timber/timberland owners are required to retain a Registered Professional Forester (RPF) to prepare and submit an Emergency Notice. Timber operations conducted pursuant to a CAL FIRE-accepted Emergency Notice must comply with the rules and regulations of the BOF and specifically with all operational provisions of the FPRs applicable to plans. The timber/timberland owner has one year to complete timber harvesting under the Emergency Notice from the date of CAL FIRE receipt, unless a discretionary THP is subsequently approved allowing for continued operations in the area.

There are also other differences between an Emergency Notice for post-fire salvage and a typical "green tree" THP. While there are no upper (or lower) limits for the total acreage allowed under a THP, individual even aged harvest unit size in a "green tree" THP is limited to 20 acres for tractor logging and 30 acres for cable/aerial logging with additional controls on the filing of contiguous harvesting plans. Post-fire salvage operations have no upper or lower limits for the total acreage harvested, as long as all operations can be concluded within the one-year time period. Therefore, harvest units under an Emergency Notice can be as large as the timber/timberland owner can operationally accommodate, effectively resulting in the potential for clear-cutting of multiple contiguous square miles (thousands of acres). In burned landscapes, large salvage logged units that exceed hundreds of acres in size can exacerbate runoff and erosion rates through removal of standing dead timber and timber that is damaged by the fire. Increased erosion and runoff can occur due to road and skid trail construction and use, and possible reduction in overstory canopy and removal of biomass that if left unharvested would provide ground cover (i.e., needle cast, tree limbs, and eventually snags and whole trees) to dissipate rainfall energy and concentrated flow along the hillslopes. Often, however, salvage logging increases short-term ground cover due to the logging slash and tree tops left on site (Poff 1989).

Another fundamental difference between an Emergency Notice for post-fire salvage and a typical “green tree” THP applies to the Watercourse and Lake Protection Zone (WLPZ)—also known as riparian buffer zones. WLPZ requirements apply to both standard green tree THPs as well as Emergency Notice operations; however, trees within the WLPZ that have fallen, or are damaged, dead, or dying can be removed under an Emergency Notice, regardless of the standard tree retention or restocking requirements of the FPRs for green tree THPs. This can result in the complete removal of all large timber from within these streamside zones during salvage logging operations, unless the watershed requires additional protection measures for anadromous salmonids.

In 2009, after the 2008 June lightning fire siege that occurred across the state, a proposal to extend Emergency Notices from 120 to 365 days was proposed by the timber industry to the BOF. The proposal included modification of California Code of Regulations, title14, section 1052(e) language that:

> *…intended to lengthen the effective period of an Emergency Notice such that preparation and approval of a succeeding THP may be assured prior to expiration of an Emergency Notice.*

At the time, Central Valley Regional Water Board staff argued that if the BOF’s intent was to ensure harvesting operations in the post-fire environment would be started under an Emergency Notice and then analyzed with the THP Review Team process, then the rule language would need to clearly require a THP be submitted prior to the expiration of the applicable Emergency Notice.

In response to questions about possible significant adverse environmental effects, the BOF found that:

> *…[this] proposed regulation would not result in significant adverse environmental effects. The existing Forest Practice Rules for Emergency Notices and Timber Harvesting Plans already provide for comprehensive assessment and mitigation of potential adverse effects. This proposed regulation does not alter these existing provisions.*

Additional response was provided by Central Valley Water Board staff:

> *While Regional Water Board staff agrees that the FPRs provide for assessment and mitigation of potential adverse effects through the THP process, the information required in a THP is significantly more complex than that required by the Emergency Notice. It is inaccurate to state that the FPRs provide for a comprehensive assessment and mitigation of potential adverse effects through the Emergency Notice process. While there is a list of operational limitations that must be complied with for Emergency Notices in the FPRs, there are numerous concerns that are not addressed. And in fact, an argument could be made that allowing operations on lands that have been burned (and thus been made more sensitive than those normally reviewed under the THP process) through a non-discretionary process is not an environmentally responsible or defensible position.*
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> *If a burned area has unmaintained legacy roads and [watercourse] crossings that are undersized, the Emergency Notice allows for those roads to be used and does not require assessment and mitigation of any erosion problems from those roads and crossings. [Central Valley] Water Board staff acknowledges that there may not be a simple answer for the problem this rule is trying to address, but a simple extension of the time limits is only addressing a small portion of the problem.*
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> *The FPRs provide minimum operational standards, and those requirements are frequently supplemented with additional mitigations to address potential impacts to the resources through the interdisciplinary review team process [for THPs]. Due to the nature of the Emergency Notice process those same minimum operational standards [additional mitigations] provided in the FPRs are not applied. If Emergency Notices are allowed to proceed for 365 days, the likelihood of a succeeding THP ever being submitted and those additional environmental mitigation measures being developed declines dramatically.*
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> *There must be acknowledgement that fire is a natural process by which waters of the state (as well as other resources) are impacted, but it is critical to accept that it is our responsibility to ensure that the impacts from the fire are not further aggravated by anthropogenic activities.*

Since the lightning fire siege that occurred throughout the state in 2008, Central Valley Water Board Forest Activities Program staff has focused more effort on these post-fire salvage operations and have not observed THPs being prepared to continue salvage operations subsequent to the first year of harvesting conducted under Emergency Notices (on non-federal lands). Instead, staff has observed multiple Emergency Notices being submitted for 1-3 years after the fire.

Over the last several years CAL FIRE has processed, on average, approximately 175 Emergency Notices covering roughly 45,000 acres annually. This number is heavily dependent on annual fire season activity, but it provides a general idea of the recent scope of the issue.

During this time, Central Valley Water Board staff has observed extensive soil erosion and sediment discharge to receiving waters extending for several years following many large wildfire events. These large fires include: the Bagley, Bully, Ponderosa, King, Chips, Moonlight, Valley, and Rim Fires. Post-fire salvage operations following these fires has resulted in direct impacts to water quality through accelerated erosion and sediment delivery from skid trails, roads, landings, and episodic events such as landslides and debris flows. Many of these sources of sediment discharge are largely attributed to and associated with post-fire salvage operations. Direct in-stream measurements of turbidity that exceeded Basin Plan objectives have been documented downstream of several fires (e.g., Ponderosa, Bagley, and Bully Fires). There are data to suggest that changes in turbidity in streams draining the 2012 Ponderosa Fire were caused by the fire, salvage harvesting, and associated road use (Lewis 2014). In addition, dozens of herbicide (pesticide) detections have been recorded in the post-fire environment that will be discussed in later sections of this document.

There is recognition among Central Valley Water Board staff that identifying cause and effect between post-fire salvage operations and water quality impacts is challenging. Non-point source water quality pollution can be complex and evaluating sediment discharge from post-fire salvage operations against natural or background delivery rates to watercourses is no different. However, the Central Valley Water Board has a responsibility and mandate under the Clean Water Act, California Water Code, Basin Plan, and Non-Point Source policy to identify potential non-point source discharges to waters of the state and address those discharges through prohibitions; or Waste Discharge Requirements (WDRs); conditional waivers of WDRs; or until a determination has been made that the threat of discharge and impact to water quality no longer exists.

Federal Lands

As the largest public land management agency in the Central Valley Region's forested zones, the U.S. Forest Service (USFS) experiences large catastrophic wildland fires, predominantly along the west slope of the Sierra Nevada and southern Cascade Ranges on National Forest System lands (NFS).

Immediately following a fire on federal lands, there is a rapid assessment by a Burned Area Emergency Resource (BAER) team staffed by specially trained professionals for fires greater than 300 acres, generally including hydrologists, soil scientists, engineers, biologists, vegetation specialists, archeologists, GIS specialists, and others, who rapidly evaluate the burned area and prescribe emergency stabilization treatments for Forest Service lands. The BAER program is designed to address these emergency situations through its key goals of protecting values at risk (VARs), including life, property, and critical natural and cultural resources. Water quality and aquatic habitat are not specifically included in the list of VARs evaluated through the BAER process. In most cases, only a small portion of the burned area is treated based on the outcome of the BAER process, due to the high cost of effective treatments (e.g., mulching; hydro-mulching). Some of the information that is gathered during these assessments, however, can be utilized for development of future project proposals and in support of environmental documents for those projects.

The percent of federal lands salvage logged is much lower than that which occurs on private industrial timberland in California. Post-fire salvage logging on federal lands seldom occurs in the first year of the fire due to the time involved in preparing environmental documents in conformance with the National Environmental Policy Act (NEPA). Depending on the scope of proposed actions and the level of impact on the environment, the USFS may choose to prepare a Categorical Exclusion (CE), Environmental Assessment (EA), or Environmental Impact Statement (EIS). In general, the USFS will only utilize a CE for very small proposed post-fire salvage operations or roadside hazard tree removal through areas that have experienced wildfire. The preparation of this document and final decision can be relatively fast and a final decision can be made within a few months. The scope of an EA is generally broader and incorporates multiple resource objectives (e.g., reduce public safety hazard along NFS roads, recover economic value of fire-killed trees, reduce fuel loading, implement reforestation, and manage road infrastructure). These documents take longer to develop utilizing a multi-disciplinary team of specialists, and there is a much more involved public scoping process which can often lead to delays and litigation. The most robust NEPA document is the EIS. These documents can be very broad in scope and include evaluation of a multitude of resource objectives and goals. Preparation of these documents can be lengthy and if post-fire salvage operations are a component of the proposed actions, it is often unlikely that the decision approving the NEPA document will be prepared before the fire-killed commercial species of trees have lost all economic value.

There is a growing trend within the federal agency to prepare larger environmental documents (i.e., EA and EIS) in an effort to conduct multi-phased and longer term watershed-scale projects with multiple resource goals and objectives. There are many reasons why the USFS pursues this type of approach to their land management; however, a consequence of this approach is that post-fire salvage projects can take much longer to receive approval, and as a result, the trees quickly lose economic value before they can be harvested. This can lead to the timber sale/salvage component of these projects being removed from the project or Timber Sales are not purchased by private contractors and the trees are left unharvested. Either way, standing dead and dying trees are often left behind on the landscape. Reforestation efforts are greatly compromised, leading to reduced long term carbon storage in California forestlands (CARB 2017). Despite broad agreement on reforesting lands burned, lack of funding and staff have made reforestation very difficult.

The Central Valley Water Board's review process for post-fire salvage projects on federal lands is significantly different compared to non-federal projects. Following a wildfire on NFS lands, Central Valley Water Board staff review the Schedule of Proposed Actions (SOPA) list for each National Forest to see what projects and associated environmental documents will be proposed. Staff review and respond to the proposed action during the regular public scoping period. Once a USFS decision has been made on the NEPA document, the USFS submits a NOI for the proposed project, and Central Valley Water Board staff review the submitted project documents, enrolling the project under the appropriate permit category. Staff often conducts inspections of the post-fire salvage operations and provides recommendations for additional erosion mitigations where necessary to protect water quality. However, unlike the THP process for non-federal lands, it is sometimes difficult to incorporate substantial recommendations (e.g., new or reconstructed watercourse crossings or significant modification to road shape and drainage) without modifying the original environmental documents (i.e., CE, EA, or EIS). These documents are often written in very general, non-prescriptive terms that make evaluations for potential water quality impacts prior to commencement of project activities challenging. The lack of site specificity in the project documents provided by the USFS has been an on-going issue for Central Valley Water Board staff, not only for post-fire salvage projects, but for all non-point source projects enrolled under Water Board permits.

Post-Fire Timber Harvest

Numerous studies have been conducted on post-fire erosion response to logging (Ice and Beschta 1999). Some studies indicate that there are potential benefits to logging after wildfire—increasing ground cover through logging slash, removing sources of high intensity water droplets from standing dead trees, reduction of fuel loading and risk of high intensity fires, and by breaking up hydrophobic soil layers (Poff 1989, James 2014). The application of these ground-based treatments, however, are often limited to slopes that are less than 35 percent where erosion rates are generally lower due to lower erosive energy and runoff velocity. Conversely, there is documentation from other studies reporting that salvage logging increases the risk of sedimentation and that specific best management practices are needed to mitigate the hydrologic impacts of post-fire logging (Beschta et al. 1995, Peterson et al. 2009, Wagenbrenner et al. 2015, Wagenbrenner et al. 2016b, Lewis 2014).

At the small catchment scale, impacts of salvage logging on sediment yields are variable. One recent study has shown a net decrease in sediment yields after salvage logging and subsequent herbicide (pesticide) applications (James 2014), two studies have shown no detectable change in sediment yields because of salvage logging (Wagenbrenner et al. 2015)—Hayman and Kraft Springs Fires; Olsen, 2016), and one study has documented an increase in sediment yields because of salvage logging (Wagenbrenner et al. 2015—Red Eagle Fire) (Wagenbrenner 2017).

Non-Federal Lands
Large non-federal industrial landowners generally remove all the trees within an Emergency Notice harvest unit, including those only partially burned or scorched. This can result in post-fire harvest units which have no size limitations and are almost completely devoid of trees. Based on the fact that burned areas produce additional stormwater runoff and sediment, both the existing road network and any new logging road construction should be designed, utilized for heavy equipment and log hauling, and maintained to minimize delivery of sediment to streams. Post-fire logging generally requires the installation and use of numerous skid trails, used when heavy equipment transports the cut logs within the logging unit to a landing, where the tree is then processed and loaded onto log trucks for transport to the mill. As with new logging road construction, post-fire skid trails present a heightened potential for erosion and sediment transport. With the urgency to remove burned trees and maximize the economic value of the rapidly degrading wood product, there are usually compressed timelines within which to evaluate, design, and implement logging operations, including road construction, before the first winter period following the fire. Central Valley Water Board staff has observed that standard coefficients and input values (e.g., runoff coefficients, time of concentration calculations, headwater/depth ratios for culverts, etc.) used in technical guidance documents for design of stream crossing structures (as noted in Cafferata et al. 2004) may be inadequate in the post-fire environment.

Federal Lands
Unlike non-federal landowners, USFS salvage operations remove only a fraction of the burned trees and generally leave most partially burned and scorched trees for wildlife values and possible recovery. This limited and selective harvesting, by its very nature, may provide immediate ground cover in the form of needle cast, as well as dead trees, green trees (foliage), and some logging slash.

Riparian buffers mandated by various USFS BMPs, regulations and policies, are wider than those required of non-federal landowners in the FPRs, providing extra protection for aquatic resources and water quality.

Post-Fire Pesticide Use

Non-Federal Lands
While post-fire salvage operations conducted under an Emergency Notice are not required to restock (i.e., replant conifers), most non-federal industrial timberland owners in California choose to reforest their lands. Replanting conifers is frequently accompanied by pesticide applications to ensure seedling survival and establish conifer plantations as quickly as possible (DiTornaso et al. 1997, Webster and Fredrickson 2005, Zhang et al. 2008). In some cases, pre-emergent pesticides are applied in the late fall or early spring

immediately after the fire to prevent competing vegetation from germinating. In other cases, post-emergent pesticides are used to kill newly sprouting vegetation before and/or after planting new conifers. There are two common methods in which pesticides are applied within the forested landscape to facilitate regeneration of conifer seedlings: spot applications, where an applicator uses a hand-sprayer to apply pesticides in a small circle around an individual conifer seedling; and aerial applications, where pesticides are sprayed from an aircraft over larger areas. In many cases, especially with the size and extent of recent spatially extensive wildfires, applications of pesticides by non-federal landowners are accomplished via aerial spraying (e.g., helicopters).

Pre-emergents [pesticides] are very effective at preventing new ground cover establishment for several years in the post-fire landscape, which reduces competition for nutrients, light, and water, increasing the success rate of conifer seedling survival (Webster and Fredrickson 2005). From a reforestation perspective, the use of pre-emergents [pesticides] achieves the objective of reducing competition between recently established commercial tree species seedlings and non-desirable species such as hardwoods, brush, and grasses. This practice, however, can come at a cost by delaying natural recovery of the burned landscape and the establishment of effective ground cover to reduce surface erosion (DiTornaso et al. 1997).

Very little information is available regarding the impacts of post-fire management on runoff and erosion (Wagenbrenner 2017). Most post fire research has focused attention on the physical effects of ground-based salvage logging on runoff and erosion, while little attention has focused on post-logging vegetation management. It is currently unknown whether post-fire vegetation management using pesticide treatments has a larger effect on post-fire hydrogeomorphic processes than salvage logging due to alterations in post-fire recovery processes (i.e., revegetation and associated ground cover increases). Clearly there are trade-offs associated with limited pesticide application (e.g., poorer seedling survival, slower establishment of tree cover).

Numerous studies have shown that the percent of ground cover is the primary and dominant control of erosion and sediment yield in the post-fire environment (Benavides-Solorio and Macdonald 2001, Benavides-Solorio et al. 2005, Goldman et al. 1986, Larsen et al. 2009, Lavee et al. 1995, Robichaud et al. 2010, Wagenbrenner et al. 2015, Slesak et al. 2015, Delwiche 2009).

Federal Lands

The USFS typically utilizes pesticides on a very limited basis in post-fire environments. In most cases where pesticides are used on NFS lands, spot spraying is used to control invasive weeds and to help re-establish conifers. Unlike non-federal industrial landowners, these limited applications generally occur a year or more after the fire when vegetative recovery and ground cover has been significantly re-established, thereby, providing the cover necessary to reduce erosion and limit offsite movement of sediment.

For the pesticides commonly used by the USFS in its management activities, Human Health and Ecological Risk Assessments (HERAs) are prepared. In these documents, the process of risk assessment is used to quantitatively evaluate the probability that pesticide use might pose harm to humans or other species in the environment. When evaluating risks from the use of pesticides proposed in a NEPA planning document, the USFS has determined that reliance on the U.S. Environmental Protection Agency's (U.S. EPA) pesticide registration process as the sole demonstration of safety is insufficient. The USFS and Bureau of Land Management (BLM) were involved in court cases in the early 1980's that specifically addressed this question (principally Save Our Ecosystems v. Clark, 747 F.2d 1240, 1248 (9th Circuit, 1984) and Southern Oregon Citizens v. Clark, 720 F. 2d 1475, 1480 (9th Cir. 1983)). These court decisions and others affirmed that although the USFS can use U.S. EPA toxicology data, it is still required to do an independent assessment of the safety of pesticides rather than relying on the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) registration alone. The Courts have also found that FIFRA does not require the same examination of impacts that the USFS is required to undertake under NEPA. Further, USFS assessments consider data collected from both published scientific literature and data submitted to U.S. EPA to support FIFRA product registration, whereas U.S. EPA utilizes the latter data only. The U.S. EPA also considers many forestry pesticides uses to be minor. Thus, the project-specific application rates, spectrum of target and non-target organisms, and specialized exposure scenarios evaluated by the USFS are frequently not evaluated by U.S. EPA in its generalized registration assessments.

Post-Fire Pesticide Application and Regulations

Post-fire applications of pesticides follow the same pesticide labeling rules as used in 'green tree' forestry pesticide applications (as shown on the individual pesticide label), regardless of the severity of the fire and the amount of vegetation cover removed by the fire or the risk of erosion.

All pesticide label requirements, including those related to aquatic buffers are initially approved by the U.S. EPA based on evaluation of pesticide registrant submitted data used to support proposed label uses. In order for pesticide products to be used in California, the Department of Pesticide Regulation (DPR) reviews all U.S. EPA pesticide label components. State specific modifications to address necessary additional restrictions may be incorporated in coordination with registrant and EPA. Each pesticide label has general use instructions with specific state requirements. A Pest Control Advisor (PCA) is a trained, licensed individual that provides site specific pesticide recommendations. Most commonly used forestry pesticides have no aquatic buffers listed on the label, as indicated in Table 1 below.

Table 1 - Pesticide aquatic buffer widths as provided in current labels*

Active Ingredient	Formulation Name	Aquatic Buffer (feet)	Label Toxicity Warnings	Additional Labeling
Aminopyralid	Milestone	0	N/A	N/A
Clopyralid	Transline	0	N/A	N/A
Glyphosate	Accord XRT II	0	N/A	N/A
Hexazinone	Velpar L	0	N/A	N/A
Imazapyr	Polaris	0	N/A	N/A
Imazapyr	Arsenal	0	N/A	N/A
Imazapyr	Chopper	0	N/A	N/A
Imazapyr	Stalker	0	N/A	N/A
Imazapyr	Rotary 2 SL	0	N/A	N/A
Oxfluorfen	Pindar GT	25 ***Vegetated* buffer strip	This product is toxic to aquatic invertebrates and wildlife	Runoff from treated areas may be hazardous to aquatic organisms in neighboring areas
Oxfluorfen	Cleantraxx	25 ***Vegetated* buffer strip	This product is toxic to aquatic invertebrates and wildlife	Runoff from treated areas may be hazardous to aquatic organisms in neighboring areas.
Sulfometuron methyl	Oust XP	0	N/A	N/A
Triclopyr	Garlon 4	0	This pesticide is toxic to fish.	The use of this chemical in areas where soils are permeable, particularly where the water table is shallow, may result in groundwater contamination.
Triclopyr	Element 4	0	This pesticide is toxic to fish.	The use of this chemical in areas where soils are permeable, particularly where the water table is shallow, may result in groundwater contamination.

Active Ingredient	Formulation Name	Aquatic Buffer (feet)	Label Toxicity Warnings	Additional Labeling
Triclopyr	Forestry Garlon XRT	0	This pesticide is toxic to fish.	The use of this chemical in areas where soils are permeable, particularly where the water table is shallow, may result in groundwater contamination.
*** 2,4-D	Weedone LV6 EC	0	This pesticide is toxic to fish.	The use of this chemical in areas where soils are permeable, particularly where the water table is shallow, may result in groundwater contamination.
*** 2,4-D	Weedone LV4	0	This pesticide is toxic to fish.	The use of this chemical in areas where soils are permeable, particularly where the water table is shallow, may result in groundwater contamination.

* This table provides a summary of current label requirements and is subject to change. The most up to date requirements for individual pesticides are listed on the label and should take precedent.

** Vegetated buffer: Note that in many wildfires with high burn severity there is no vegetation remaining to provide an aquatic buffer.

*** 2,4-D is a Restricted Material: Restricted Materials are designated by DPR, based on hazards to public health, applicators, farm workers, domestic animals, honeybees, the environment, wildlife, or crops other than those being treated.

Pesticide Application Monitoring (DPR/County Ag)

For non-restricted materials, licensed pesticide applicators are required to report pesticide use to the respective county agricultural commissioner (CAC) within seven days of the completion of the application. Restricted material pesticides (e.g., 2,4-D and strychnine) have to report to the CAC 24 hours in advance of application. Restricted Materials are designated by DPR, based on hazards to public health, applicators, farm workers, domestic animals, honeybees, the environment, wildlife, or crops other than those being treated. There is no evidence that any monitoring of forestry pesticide applications is conducted by CAC staff (Central Valley Water Board staff personal communication with CAC staff and RPFs, May 2016).

Post-Fire Pesticide Detections
Following the 2012 Ponderosa Fire in the Battle Creek watershed located in Shasta and Tehama counties, salvage operations were conducted throughout the watershed on non-federal lands. During 2013 and early 2014, approximately 12,000 pounds of Hexazinone (Active Ingredient – A.I.) 1395 pounds of Imazapyr, 115 pounds of Triclopyr, and 30 pounds of 2,4-D were applied in the Battle Creek watershed, most of it associated with post-fire conifer plantation establishment.

Through a contract agreement with the Central Valley Water Board, a water sampling and analysis pilot study was conducted by the California Department of Fish and Wildlife (CDFW) between November 2013 and March 2014. Hexazinone, 2, 4-D, Triclopyr, and Imazapyr were detected. Hexazinone was detected in all 26 samples. The primary purpose of the pilot study was to test the utility of the Continuous Low Level Aquatic Monitoring (CLAM) collection devices for detecting pesticides downstream of forestry operations. This study did not quantify concentrations of specific chemicals; however, pesticide chemicals were present and detectable. While detections were indicated, significant issues with regard to the equipment reliability of the CLAM sampling devices, testing protocols, and verification standards indicate that further study is needed. Until further study can be conducted, the General Order establishes specific requirements in Parts III.C.3.b.ii. and III.F.3.c.ii. to provide reasonable protection measures to address potential threat to water quality from pesticides in forestry application.

Post-Fire Mitigations for Protecting Water Quality

The previous sections have summarized the naturally occurring and anthropogenic sources of accelerated erosion and sediment delivery that can occur following a major wildfire, including: the mechanics of increased runoff rates, hydrophobicity, surface soil erosion, and the inability of burned landscapes to buffer increased erosion. In unmanaged landscapes where no salvage logging operations will occur, these processes will occur naturally and play a vital role in ecosystem dynamics and landscape scale erosional processes. In managed landscapes where salvage logging will occur, BMPs and mitigations are needed to reduce management-related sediment sources to watercourses within the burned area. The most widely used and most cost-effective management measures and BMPs used to mitigate erosion and sediment delivery are erosion barrier treatments, mulch treatments, chemical soil surface treatments, and natural reestablishment of vegetative cover.

Erosion barrier treatments are designed to slow runoff, and trap and store eroded sediment. Common post-fire hillslope erosion barriers include contour-felled logs, straw wattles, contour trenches or ‘contour ripping’ (hand or machine dug), and straw bales (Napper 2006). Erosion barriers, and contour-felled logs in particular, may reduce runoff and sediment yields for low intensity rain events, but they are unlikely to have a significant effect for high intensity rain events and can concentrate flow, creating erosion if implemented incorrectly (Robichaud et al. 2010). Contour ripping has been used by some landowners and land managers as cost-effective erosion mitigation in post-fire environments (James 2014). Contour ripping can be implemented generally on slopes 35% or less, where erosion is lower than on steeper slopes, and is not restricted by natural barriers, such as rocky terrain. The contours created by this practice must be deep enough to penetrate the hydrophobic layer created by high intensity fire and be constructed “on-contour”, perpendicular to slope, to reduce flow pathways and concentration of runoff that could result in rilling and gullying. A study conducted by a large industrial landowner in the Ponderosa Fire footprint indicates that contour ripping reduces post-fire surface erosion (James 2014).

Mulch treatments can be an effective post-fire mitigation for reducing surface erosion and involves the spread of material over the exposed soil surface to protect it from rain drop impact, overland flow, and erosion. Mulching is a quick way to immediately increase ground cover in areas that are at high risk of erosion and can be an effective post-fire mitigation. Mulches include wet mulches, such as hydromulches, which are mixed with water and sprayed over the soil surface. Dry mulches include straw, wood chips, wood shreds, and wood strands. Large wood chippers and masticators have proven to be very effective at generating wood chips and wood sheds using on-site fuels and logging slash. A limiting factor with dry mulches is that they are generally applied only on slopes from 20 to 60 percent, or where chippers can broadcast chipped materials on to the hillslope. “Straw bombing” or heli-mulching is another technique that has been utilized most frequently on federal post-fire landscapes by dropping cut hay bales from helicopters. This method can be effective, however, the operational cost of helicopters to “bomb” the hillside is often cost prohibitive (usually over $1500 per acre), and can result in less than two percent of the landscape being successfully treated.

Tackifiers—also known as soil binding agents—are another form of erosion treatment that is applied directly to the soil surface, forming a thin web of polymer designed to hold soil particles together. The soil binder polyacrylamide (PAM), a soil particle flocculant, is designed to connect small particles, thus increasing their size and mass. PAM is the only soil binder that has been used as a post-fire hillslope stabilization treatment. Post-fire treatment effectiveness studies that include PAM have generally been inconclusive or have shown no treatment effect.

For landscape-scale fires, many of the mitigations mentioned above are costly, with varying degrees of effectiveness (Robichaud et al. 2010, Wagenbrenner et al. 2006). The natural re-establishment of ground cover has shown to be the most feasible and cost-effective method to reduce erosion and sediment production (MacDonald and Larsen 2009, Benavides-Solorio et al. 2001). For many non-federal industrial timberland owners, however, allowing burned forestlands to regenerate naturally is not a viable economic option for maximizing commercial tree species production. For these landowners, herbicide (pesticide) use has been proven to be an effective measure for delaying the re-establishment of natural vegetative cover and increasing the rate of survival for replanted conifer seedlings. As discussed in previous sections of this document, the application of pesticides in the post-fire environment can have both a direct and indirect effect on rates of soil erosion, and the potential discharge of residual chemicals directly into surface waters.

Ground cover and riparian buffers can reduce pesticide discharge into streams by providing dissipation, filtration, chemical sequestration, and chemical degradation/biodegradation (Wenger 1999, Larson et al. 1997). Ground cover has been shown through numerous studies to be effective at reducing erosion and sediment transport. Research consistently indicates that 50% ground cover functions as the threshold where erosion and sediment production is significantly reduced (Benavides-Solorio et al. 2005, Foltz and Wagenbrenner 2010, Golman et al. 1986, Harrison et al. 2016, MacDonald and Robichaud 2008, Prats et al. 2012, Robichaud et al. 2012, Wagenbrenner et al. 2006, Yanosek et al. 2006).

Riparian buffers are shown to protect water quality, habitat, and biota in non-burned landscapes (Sweeney and Newbold 2014, Wenger 1999, U. S. Army Corps of Engineers 1991). Unburned or stream buffers burned with low severity are critical to protect water quality and other beneficial uses in post-fire environments because of the increased sediment production due to runoff after wildfires. Appropriate sized stream buffers (generally ≥30 meters or 100 feet) have been shown to mitigate stream impacts from green tree logging activities, while small buffers (≤10 meters) do not significantly protect a stream from logging impacts (Davies and Nelson 1994). Areas with high resource value—such as wetlands and fish bearings streams—benefit from buffers that are a minimum of 15 meters, or approximately 50 feet (Castelle et al. 1994).

Studies on herbicide fate and transport show that average buffer widths of 38 m and 50 m, in restored and managed riparian forests respectively, reduced herbicide concentrations to at or below detection limits (Lowrance et al. 1997, Vellidis et al. 2002). A review of pesticide buffers found that cases of high pesticide concentrations only occurred when no buffer was used and that generally, bufferstrips of 15 m or larger are effective in minimizing pesticide contamination in streams (Neary et al. 1993).

This General Order requires the implementation of buffers based upon the information provided above. While slightly larger than research indicates necessary, required buffers are the same as those required in the FPRs to address large variations in soil, topography, resource sensitivity, etc. This General Order also allows the discharger to propose an optional plan (Attachment C) should they wish to test out emerging or alternate methods, technology, or pesticide use within the buffer(s) or on the slopes above.

Development of effective post-fire mitigations and BMPs to reduce impacts from erosion and sediment delivery to streams is an area of research and development that is being explored by many leading fire scientists, soil scientists, watershed scientists, foresters, and many state and federal resource agencies throughout the western U.S., including California. In an effort to provide more site-specific research into the effects of post-fire salvage logging in California, and to support an adaptive management framework where new science and research is used to support or promulgate existing and new rules and regulations, the Central Valley Water Board is funding a study through the AB 1492 Timber Regulation and Forest Restoration Fund (TRFRF) on Boggs Mountain Demonstration Forest (BMDSF), managed by CAL FIRE. BMDSF burned in 2015 during the Valley Fire and has provided a valuable opportunity to explore the effects of post-fire management on water quality by assessing the responses of runoff and sediment to logging and reforestation activities, and to demonstrate effective logging BMPs to landowners and land managers that are well suited for post-fire landscapes to mitigate potential water quality impacts. The project has three primary purposes: (1) to quantify the effects of post-fire salvage logging and common post-salvage site preparation techniques including mechanical and herbicide (pesticide)-assisted reforestation on soil properties controlling runoff, hillslope erosion rates, and vegetative recovery; (2) to understand processes occurring at small-catchment scales so that small-plot results can be extrapolated to sizes of specific interest to land managers and watershed stakeholders; and (3) to develop and demonstrate alternative BMPs used to reduce runoff and erosion from post-fire salvage logging. This study is currently underway and is expected to be completed by 2019. Initial study results are presented in Wagenbrenner et al. (2016a) and Olsen (2016).

Evaluation of Significant Existing or Potential Erosion Sites (SEPES)

The BOF, through a lengthy stakeholder process, developed and adopted a section in the FPRs referred to as the Road Rules, 2013, Rule Package. This rule package was intended to clarify, streamline and organize all of the FPRs where roads were included. The development process resulted in some additions as well, including the new definition of "Significant Existing or Potential Erosion Site (SEPES)" (Cal. Code of Regs., title 14, § 895.1) based upon a need to address such sites for water quality protection. The FPRs now include the following definition:

> *"Significant Existing or Potential Erosion Site means a location where soil is currently, or there are visible physical conditions to indicate soil erosion may be in the future, discharged to watercourses or lakes in quantities that violate Water Quality Requirements or result in significant individual or cumulative adverse impacts to the beneficial uses of water."*

The Road Rules, 2013, Rule Package became effective on January 1, 2015. Central Valley Water Board staff has been reviewing and commenting on the application of this definition for the past two years through the THP process and noting inconsistent interpretations. In Attachment A of the Order, an expanded definition has been provided that embeds the definition of Water Quality Requirements (also provided California Code of Regulations, title 14, section 895.1):

> *"Significant Existing or Potential Erosion Sites (SEPES)" means a location where soil erosion is currently, or there are visible physical conditions to indicate soil erosion may be in the future, discharged to watercourses or lakes in quantities that violate a* ***water quality objective (narrative or numeric), prohibition, Total Maximum Daily Load (TMDL) implementation plan, policy, or other requirement contained in a water quality control plan adopted by the Central Valley Water Board and approved by the State Water Central Valley Water Board, or a location where soil erosion may*** *result in significant individual or cumulative adverse impacts to the beneficial uses of water" (emphasis added).*

The intent in combining the two definitions in Attachment A of the Order is to emphasize that level of significance relative to existing and potential erosion sites is ultimately determined by, and is the responsibility of the Central Valley Water Board, who have a legal mandate and the authority to determine the significance of any discharge to waters of the state, and to ensure permitted discharges are in conformance with the appropriate Basin Plan, permit, policy, or other requirement (see Finding 18 of the Order).

Indicators of SEPES on the Existing Road Network

As noted in California Code of Regulations, title 14, Technical Rule Addendum No. 5: Guidance on Hydrologic Disconnection, Road Drainage, Minimization of Diversion Potential, and High Risk Crossings (1^{st} Edition), section B, indicators of SEPES with the existing road drainage systems include:

- *Evidence of direct sediment entry into a watercourse or a flood prone area from road surfaces or drainage structures and facilities (e.g., ponded sediment, sediment deposits, delivery of turbid runoff from drainage structures during rainfall events).*
- *Ditch scour or downcutting resulting from excessively long undrained ditches with infrequent ditch drain (relief) culverts or other outlet structures or facilities. This condition can also result from design inadequacies (e.g., spacing not altered for steep ditch gradient), inadequate erosion prevention practices (e.g., lack of armoring), or ditches located in areas of erodible soils.*
- *Gullies or other evidence of erosion on road surfaces or below the outlets of road drainage facilities or structures, including ditch drain (relief) culverts, with transport or a high likelihood of transport to a watercourse.*

Additionally, if a road and/or ditch runoff is hydrologically connected to a watercourse, the following factors elevate the risk of sediment delivery to a watercourse:

- *Existing or high potential for cutbank sloughing or erosion into inside ditches.*

- *Native-surfaced road exhibiting erosion.*
- *Native-surfaced road composed of erodible soil types (e.g., granitic soils).*
- *Rilled, gullied, or rutted road approaches to crossings.*
- *Existing ditch drain (relief) culverts or other road drainage structures with significant plugging from sediment and/or small woody debris.*
- *Existing ditch drain (relief) culverts or other road drainage structures with decreased capacity due to damage or impairment (e.g., crushed or bent inlets, flattened dips due to road grading).*
- *Decreased structural integrity of ditch drain (relief) culverts, waterbreaks, or other road drainage structures (e.g., excessive culvert corrosion, breached waterbreaks, or rutted road segments).*

Under the FPRs, a standard 'green tree' THP must include an analysis of all SEPES and a schedule for addressing such sites within the project area as a part of the CEQA EIR equivalent process. However, post-fire salvage operations conducted under an Emergency Notice are exempt from the requirement to disclose and address SEPES. Previous sections of this Information Sheet have described the concerns that Central Valley Water Board staff have with salvage logging operations conducted under an Emergency Notice, and to address these concerns, the Order contains requirements for SEPES disclosure as a condition for enrollment of post-fire salvage operations.

SEPES in the Post-Fire Environment

For post-fire salvage areas (Category 2A and 5A), and areas not salvage logged but proposed for reforestation with pesticide applications, the Discharger shall evaluate SEPES considering the factors listed below that elevate the risk of sediment delivery to watercourses. The intent of this expanded SEPES evaluation is to identify existing or the potential for upslope erosional features (e.g., landslides, debris flows, significant gully networks, channel initiation and other mass wasting features) within the burned/logged area that have the potential to significantly influence the downslope road network. Documentation of hillslope level SEPES is only required where there is, or there is the potential for, an interaction of that feature with the below road network that will result in significant erosion and sediment delivery to a watercourse.

- Increased runoff and associated sediment/debris in high/moderate burn severity areas originating at mid to upper, convergent slope within the fire salvage area; or in areas outside the salvage area that contribute increased runoff to watercourse crossings and drainage structures within the fire salvage area or to appurtenant roads.
- Rilling and gullying along existing or proposed skid trails and water bars within the fire salvage area that have potential for sediment delivery to a watercourse;

- Existing watercourse crossings, particularly those with a structure (i.e. culvert, bridge), that are now undersized and at an elevated risk of failure due to any of the bulleted items listed above.

How Information is Used in the General Order

This Information Sheet sets forth the background and rationale used in the development of certain requirements in Order No. R5-2017-0061. Many of these requirements are new and represent significant changes between Order No. R5-2014-0144 (Timber “Waiver”) and Order R5-2017-0061, specifically creation of Category 2A and Category 5A for post-fire salvage operations on non-federal and federal lands, respectively. The following requirements and the rationale for these requirements will be summarized in this section: 50% Effective Ground Cover and Minimum Watercourse Pesticide Buffers (Parts III.C.3.b.ii. and III.F.3.c.ii. of the General Order); Table 1. Erosion Site Table for Significant Existing or Potential Erosion Sites (SEPES) and New Watercourse Crossings (Category 2A and 5A NOI); and the Post-Fire Management and Reforestation Plan (Attachment C).

50% Effective Ground Cover

Based on thorough research and review of dozens of peer reviewed studies, technical guidance documents, and handbooks on post-fire effects, and the mechanisms that are driving both increased rates of erosion and sediment delivery on managed and un-managed post-fire landscapes, the rationale for selecting 50% effective ground cover as a requirement for Category 2A and 5A in the Order (see Parts III.C.3.b.ii. and III.F.3.c.ii.) is based four primary factors:

- The dominant factor for controlling soil erosion rates post-fire is ground cover;
- Fifty-percent effective ground cover is the value most often referred to the reviewed literature (e.g., U.S. Forest Service 2012, Benavides-Solorio et al. 2001, 2005, Berg and Azuma 2010, Doerr et al. 2009, Goldman et al. 1986, Harrison et al. 2016, Hyde et al. 2007, 2014, and 2015, Johansen et al. 2001, Stubblefield et al. 2016);
- Fifty-percent effective ground cover is a value that is most easily assessed and verified from visual estimations; and
- Ground cover is shown to be the most feasible and cost-effective method to reduce erosion and sediment production.

Watercourse Pesticide Buffers

The rationale behind the requirement for standard watercourse riparian buffers (see Parts III.C.3.b.ii. and III.F.3.c.ii. of the Order) in Category 2A and 5A in the Order is based on four primary factors:

- Extensive literature review indicates that ground cover and aquatic buffers can reduce pesticide discharge into streams by providing dissipation, filtration, chemical sequestration, chemical degradation/biodegradation (Brosofske et al. 1997, Reeves et al. 2006, Davies and Nelson 1994, Sweeney and Newbold 2014, Richardson et

al. 2012, Wenger 1999, ACOE 1991, MacDonald 2011, Lindenmayer and Noss 2006, Minshall 2003);
- Studies on herbicide fate and transport show that average buffer widths of 38 m and 50 m, in restored and managed riparian forests respectively, reduced herbicide concentrations to at or below detection limits (Lowrance et al. 1997, Vellidis et al. 2002).
- A review of pesticide buffers found that cases of high pesticide concentrations only occurred when no buffer was used and that generally, bufferstrips of 15 m or larger are effective in minimizing pesticide contamination in streams (Neary et al. 1993).
- Buffers widths for pesticide applied in the post-fire landscape are limited or non-existent (see Table 1);
- Post-fire pesticide sampling by CDFW in 2014 indicates that label instructions and applications were ineffective at preventing discharge of specific chemicals (Hexazinone, 2, 4-D, Triclopyr, and Imazapyr) to surface waters; and
- The buffer requirements that are in the Order (see Parts III.C.3.b.ii. and III.F.3.c.ii.) are existing buffer widths for WLPZs as specified in California Code of Regulations, title 14, section 936.5 for 'green tree' timber harvesting activities, have been proven to be effective at reducing transport of waste to surface waters, and are widths that are familiar to RPFs. For federal projects, these same buffer widths are specified around perennial, intermittent, and ephemeral streams.

Erosion Site Table for Significant Existing or Potential Erosion Sites (SEPES) and New Watercourse Crossings

The rationale behind the requirement to disclose road and crossing-related SEPES within project areas enrolling in Category 2A and 5A NOI is based on five primary factors:

- Decades of research in post-fire hydrologic response and erosional processes indicate that roads and associated watercourse crossings are particularly susceptible to accelerated rates of erosion due to increased runoff rates and transport of associated sediment and debris;
- SEPES and new/reconstructed watercourse crossings in the post-fire environmental necessitate additional evaluation and review, as normal input values for calculating stream flow to determine the appropriate size and capacity of stream crossing structures (e.g., culverts) may need modification (Cafferata et al. 2017);
- Emergency Notices pursuant to California Code of Regulations, title 14, §§ 1052.1 et seq., for fire salvage do not provide adequate information to properly assess whether a project has SEPES and whether those sites will be mitigated to a level that is less than significant (for enrollment in Category 2A);
- Following wildfires on federal lands, values at risk assessed through BAER teams do not directly consider or prioritize water quality and aquatic habitat for immediate resource protection; and
- Requirement of an Erosion Site Table for Category 2A and 5A allows for better treatment prioritization and implementation tracking.

Post-fire Management and Reforestation Plan (PFP)
The rationale behind the Order requirement for Category 2A and 5A to provide a PFP (Attachment C) in-lieu of complying with the watercourse buffers and ground cover standards, is based on four primary factors:

- A PFP provides the Discharger flexibility in applying specific management practices across the fire salvage area that consider all aspects of the timing of the fire salvage, site-preparation, and other activities associated with reforestation; provides for site specificity in terms of topography, soils, climate, hydrology, and soil burn severity; and consider all sources of potential negative water quality impacts from those activities (i.e., sediment and pesticide applications);
- Allows the Discharger the option to address multiple Emergency Notice areas (non-federal), and fire salvage areas (federal projects), under one comprehensive post-fire plan;
- Provides the Discharger the option and flexibility in applying post-fire management practices and mitigations other than those identified in Parts III.C.3.b.ii. and III.F.3.c.ii. of the Order, including experimental practices; and
- Ensures an appropriate monitoring plan will be developed for a PFP.

COST OF MONITORING FOR NON-FEDERAL PROJECTS

Water Code section 13267(b)(1) states that "the burden, including costs, of these [required monitoring and] reports shall bear a reasonable relationship to the need for the report and the benefits to be obtained from the reports." Based upon information provided by timber industry representatives, staff estimates an annual cost of required visual monitoring and reporting, depending on project type and enrollment category, to range from $100 to $2,800 per enrolled project once operations have been initiated. Table 2 provides an estimate for a 'green-tree' THP on non-federal lands with a maximum operational lifespan of 7 years enrolled under Category 3A and for a post-fire salvage Emergency Notice project with a maximum operational lifespan of 1 year enrolled in Category 2A. Projects can remain enrolled in the General Order beyond the maximum operational lifespan if risks to water quality are identified and additional management measures, monitoring and reporting are necessary to protect the beneficial uses.

Table 2 - Example Monitoring Cost Estimate for 7 Year THP and 1 Year Post-Fire Salvage Emergency Notice (EM).

MRP Activity	THP (3A) Cost Range	EM (2A) Cost Range
Inspection Plan Development (1 time cost per project)	$200-$500	$200-$500
Erosion Site Inventory Table	N/A	$500-$700
Implementation Monitoring**	$500-$700	$500-$700
Forensic Monitoring**	$500-$700	$500-$700
Effectiveness Monitoring	$500-$700	$500-$700
Reporting (annual and NOV)	$100-$200	$100-$200
1st Year Cost Estimate*	$1,800-$2,800	$2,300-$3,500
Total Cost Estimate for 7 years of enrollment	$11,200-$16,100	N/A
Total Cost Estimate for 2 years of enrollment	N/A	$4,200-$6,000

* Mileage not included, extreme variability in distance to monitored sites exists.
** Implementation and forensic monitoring required by the FPRs for THPs.

The visual monitoring required for 'green tree' projects (THPs) on non-federal lands has, since 2005 under the Timber Waiver, included two rounds of forensic monitoring during the winter period once operations have commenced. Eleven years of enrolled project monitoring has resulted in staff proposing to reduce this type of monitoring from twice per winter to once per winter under the General Order, comprising a modest annual cost savings to the timber/timberland owner of these projects.

It must also be noted that implementation monitoring is a requirement of the FPRs, as is forensic monitoring. The FPRs specify that the Regional Water Board's monitoring and reporting requirements may be used in the evaluation of the road rule requirements. California Code of Regulations, title 14, section 943.7(k)(2) under Maintenance and Monitoring of Logging Roads and Landings specifies: "Inspections conducted pursuant to

California Regional Water Quality Control Board requirements may be used to satisfy the inspection requirement of this section." While the FPRs require visual implementation inspections prior to the winter period, and inspections during the winter period (essentially "forensic" monitoring), no formal reporting is required. So, even should the Central Valley Water Board determine that no additional monitoring or reporting will be required of projects enrolled in the Order, implementation and forensic inspections are still required by the FPRs (even for projects eligible to file an Notice of Non-Applicability under the General Order), though no reporting occurs. Thus, requiring development of an inspection plan, effectiveness monitoring, Notice of Violation (NOV) reporting and annual reporting are additional costs to non-federal Dischargers not required by the Forest Practice Rules.

The Central Valley Water Board concludes that the cost of monitoring and reporting required by the General Order represent a reasonable cost of conducting permitted operations that pose a threat to water quality. Benefits inherent in the proposed monitoring and reporting are many and include: increased awareness on the part of the landowner/land manager of sensitive water quality resources; potential impacts and effectiveness of management measures; increased potential for identifying threats before they impact water quality and the beneficial uses; increased data available to aid in future risk analyses; lessons learned regarding specific threats and effective mitigations that can be presented to the BOF for consideration in developing rule revisions or used in the furtherance of best management practice development.

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