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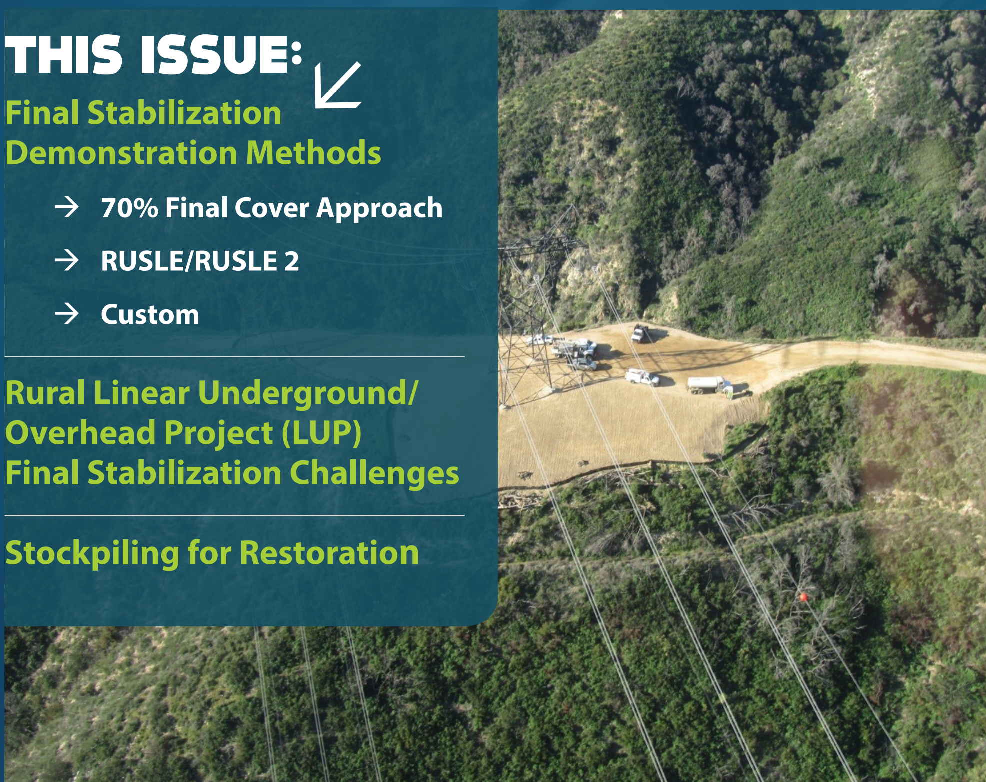
CGP REVIEW

Issue #3

For QSD and QSP Registration and Renewal

Insights for Better Stabilization



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Rural Linear Underground/ Overhead Project (LUP) Final Stabilization Challenges

Stockpiling for Restoration

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Introduction

Compliance with the CGP during the course of a long-term project requires careful planning, a detailed bid process, a well-written Storm Water Pollution Prevention Plan (SWPPP), and knowledgeable Qualified Stormwater Practitioners (QSPs). It also requires an established and routine communication schedule among engineering, construction, stormwater, biologist, restoration, and contractor teams. The Qualified Stormwater Developer (QSD) should be actively involved throughout the life of the project and interact with the QSP regularly. Communication early and often with the Regional Water Quality Control Board (Regional Water Board) is also important because they are ultimately responsible for accepting the final Notice of Termination (NOT) for permit coverage.

Successful communication, schedules, and routines will assist in preparing for and establishing final stabilization, an important component of the final NOT. A site has achieved final stabilization when there is no additional sediment discharge risk when compared to the commencement of construction activity, according to Order Section II.D.1.a of the 2009 CGP. This includes elimination of the potential for discharge of construction-related pollutants as well as removal of construction materials and wastes and construction-related equipment. Final stabilization conditions must be demonstrated using the 70% final cover method, Revised Universal Soil Loss Equation (RUSLE) or RUSLE2 computation proof, or a custom method defined by the permit enrollee and accepted by the Regional Water Board. This CGP Review, Issue #3 outlines these demonstration methods and discusses the challenges in achieving final stabilization on rural linear underground/overhead projects (LUPs) and the benefits of using proper stockpiling techniques.

Planning

Planning should include consideration of how much disturbance is necessary. All projects should minimize disturbed areas. In some cases, there are areas in the work zone where work can progress with only vegetation removal. Mowing or string-trimming vegetation and leaving cuttings in place can protect soil and keep a native seedbank available to the project. Vegetation often returns with minimal extra effort. When trimming vegetation, it is important to remove trimmings from areas where they can easily wash into storm drains or receiving waters.

Final Stabilization Demonstration Methods

There are many acceptable methods to demonstrate final stabilization, even for challenging projects built in steep, rocky, or arid areas. Photos demonstrating 70% final stabilization and RUSLE2 are the best tools for demonstrating the condition; however, the photos and RUSLE2 can only be employed if the responsible parties carefully plan and coordinate the management of the disturbed project areas.

In the trenches: Outside influences can change your CGP compliance strategy!

Factors outside of the CGP compliance realm can impact selection, implementation, longevity, and maintenance of final stabilization Best Management Practices (BMPs). These factors can include protected species habitat within the project site, bird nesting activities, availability of water, Clean Water Act 401/404, section 1600 permit requirements, and even restoration requirements.

Explaining final stabilization in writing will never be as effective as providing photographic proof. Regardless of the demonstration method (70% final cover, RUSLE, RUSLE2, or custom), thoroughly photo documenting pre- and postconstruction conditions will assist Regional Water Board staff in processing the NOT. Photos of the work area before clearing and grubbing are important components of demonstrating final stabilization. For the 70% final cover method, if the background condition of percent coverage is not adequately documented with photographs, Regional Water Board staff may ask that all disturbed areas achieve 70% coverage rather than 70% of pre-project coverage. If you are using RUSLE or RUSLE2, pre-project photos are used to show vegetation type, slope, and even soil type. It is also important to submit photos representative of the entire site. Photos should be keyed to a site map to help Regional Water Board staff determine where the photos were taken. The photos of the completed project are submitted in lieu of a final site inspection and should therefore provide an accurate depiction of the site as a whole.

70% Final Cover Approach

Ideally, upon reaching final grade, the crew applies hydroseed or plants a combination of native ground covers and other plants, waits for rain, watches the vegetation grow, and takes photos showing vegetative coverage at 70% of pre-project coverage for submittal of the NOT within 90 days, having met the needs of all compliance requirements. In the real world, this timeline and success rate is rarely achieved. Planning ahead for likely conditions can mitigate the effects of complications such as those due to weather, drought, time of year, restoration requirements, bird nest buffers, safety, and contractor scheduling.

To improve the likelihood of success in achieving 70% of pre-project coverage, include these factors in your planning:

1. **Time of Year:** Reestablishment of vegetation can be difficult due to natural growing periods. In arid areas, vegetation growth can generally be successful from November through February. Application of seed outside of this timeframe reduces the chance of seed germination due to lack of rainfall and ambient temperatures that can kill young plants. Figures 1 and 2 show successful applications of hyrdoseed on a linear utility project in a rural area.

Figure 1: Slope recently hydroseeded with native seeds

Figure 2: Area recently hydroseeded with native seeds

Climate change

Changing climactic conditions affect construction site stabilization in California. Recent climate trends include rising ambient air temperatures, increased frequency of extreme weather such as heavy precipitation events, increased intensity of droughts, and reductions in snow and ice, all of which are expected to continue in the coming years and decades (Global Climate Change Impacts in the United States, Karl et al., 2009). Other changes have been or are projected to be limited to certain regions, such as a projected decrease in winter and spring precipitation in the southwestern United States (2014 Climate Change Report, Melillo et al., 2014). Project planners need to account for this change by planning for the best conditions for final stabilization.

2. **Soil Quality:** Healthy soils maintain stormwater quality and control erosion because the open pore structures facilitate infiltration of runoff and provide the nutrients and soil biota necessary to support long-term sustainable vegetative cover (Caltrans Erosion Control Toolbox: **http://www.dot.ca.gov/hq/LandArch/16_la_design/guidance/ec_toolbox/index.htm**). Soils that are low in organic material or are overly compacted result in poor plant health, limited plant growth, and non-sustainable vegetative cover.

Soils are composed of solids, liquids, and void spaces. The solid portion of soils is further divided into sands, silts, and clays. A healthy balance of the three will aid in moisture storage, and increase water availability for vegetation growth. Geotechnical engineering techniques often change the weight to volume relationship of the soil by reducing the void spaces to increase its strength characteristics. Although this decrease in void spaces increases the strength characteristics of the soil, it also effectively reduces the soil's ability to transmit and store the water required by vegetation. Restoration of the disturbed area often requires the soil to be decompacted and amended to re-establish conditions that allow for moisture storage capacity through an extended dry period.

Most areas within California experience extended dry periods every summer. A soil water balance typical of most areas within California is illustrated in Figure 3 below.

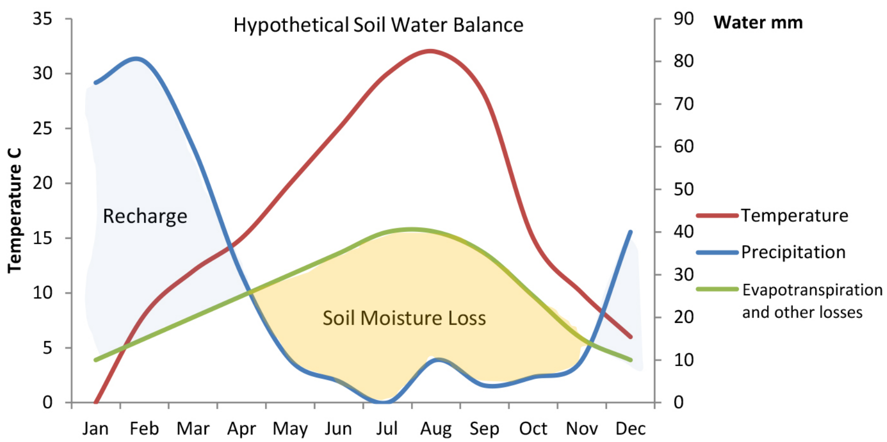

Figure 3: Soil Water Balance

Evapotranspiration rates will change across a typical construction site influencing the water supply capacity of the landscape. The area's slope and aspect to the sun (e.g., the north face of a slope) changes the types and concentrations of sustainable vegetation species. Understanding the various soil types and their capacity to store water on a construction site is fundamental to ensuring the water needs of specific plant species are met when reestablishing vegetation. Correctly interpreting these needs and capacities can save the project time and money as well as reduce frustration when revegetating and filing your NOT for termination of regulatory coverage.

Soil ecology surveys help define characteristics necessary to successfully establish plant growth. These characteristics are listed in Table 1. Using soil additives, such as compost teas[1] with an abundance of beneficial soil biology, may improve vegetation establishment if the soil is deficient for a given parameter.

1. Compost tea is a liquid application of live beneficial soil biology and organic plant-available nutrients (e.g., worm castings and kelp). Compost tea is commonly applied by spraying plant foliage, directly injecting into the plant's root zone, or applying on top of the soil.

Additional tools for landscape design

Caltrans Soil Rehabilitation: http://www.dot.ca.gov/hq/LandArch/16_la_design/guidance/ec_toolbox/earthwork/soil_rehab_testing.htm

Eco-Landscape California: http://www.ecolandscape.org/

Table 1 Soil Ecology Survey Elements	
Climate	Precipitation, Temperature, Wind
Soil Physical Properties	Soil Type (% sand, silt, and clay), Dry-weight Bulk Density (compaction), Porosity, pH
Soil Fertility	Macronutrients (N, P, K, Ca, Mg, S), Micronutrients (Mn, Fe, Zn, Cu, Mo, Cl, B)
Toxins	Herbicides, Agricultural or Industrial Pollutants (toxicity to plants)
Organic Content	Amount (% by volume), Fresh or Humus, C:N Ratio, Microbiology

Soil quality may have the most profound effect in establishing vegetation, so follow guidelines for stockpiling and preserving topsoil (see page 14). In addition, after construction, slopes may require decompaction; this is generally a restoration requirement. Prior to hydroseeding, slopes should be track walked to keep seeds and mulch from sliding down the slope. Figure 4 shows a smooth slope that is not ideal for hydroseeding, while Figure 5 shows a decompacted and track walked slope that is well prepared for hydroseed application. Final stabilization should include healthy soil, a surface mulch layer of duff/mulch, and regionally appropriate plant material that mimics the functionality of the natural environment.

Figure 4: Perfectly smooth slope is not an ideal surface for hydroseeding

Figure 5: Decompacted and track walked slope is well prepared for hydroseed application

Soil Quality Quick Tips

→ Minimizing disturbance to soil and vegetation is an excellent BMP.

→ Soil density (bulk density) is the dry weight of soil divided by its volume. Grading and compacting will increase the density. Mixing in organic compost will reduce the bulk density and help restore the disturbed soil. Specify mature compost that contains less than 2% dry weight of nitrogen (0.5–1.5% is typical).

→ Consider using equipment to break the stratification between the top soil, compacted construction layer, and the native soil to increase infiltration of water to the root zone of vegetation as vegetation matures. Be sure the decompacted soil depth can support adequate water storage for your selected plant species. A shallow water zone encourages shallow and weak plant roots susceptible to disease and failure in drought conditions. This simple rip and flip technique results in a decompacted and homogeneous soil without clear layers.

Vegetation sets the standard

Poor climate conditions are often used as justification for being unable to successfully vegetate a developed area. However, this justification is invalid if the same climate conditions succesfully support vegetation on the adjacent undeveloped landscape. If the developed landscape does not sustain vegetation, it is the result of poor planning for climate site conditions. More information on working with arid soils can be found at:

https://www.youtube.com/watch?v=ZoVis1Ov8dw

- → Use caution when amending soil. Mix compost, not raw or unfinished organic matter, into the top layer of soil when an amendment is required. Finished compost or humus compost is the result of the breakdown of organic constituents (such as vegetation) by microbes, hemic acids, and lindens. If a soil does not have a proper nutrient balance, adding raw or unfinished compost can decrease the available nutrients to the plants as soil biota eat up available nitrogen. New compost that is unfinished can consume available nitrogen because the soil biota are finishing the breakdown of material and greatly outnumber the plants. Soil preparation specifications list organic matter as a percentage of the dry weight, whereas soil amendment application rates specify compost (or other amendments such as kelp) as a volume per area of measurement (e.g., pounds per square foot). Amendment instructions also provide information on how often to apply the nutrient.

- → Before adding high nitrogen fertilizer, consider the increase in water requirements to accommodate the growth spurt of the vegetation.

- → Adding mulch and compost on an overly compacted soil will help the soil retain moisture, lower the soil temperature, and increase infiltration. Applying mulch 4–6 inches thick will also assist in controlling weeds which can out-compete the desired plant community.

- → It is not necessary for the type of vegetation to match the type at the site before the project began. The 70% coverage requirement is a physical measurement that does not refer to specific plant types. Quick-growing plants are sufficient and desirable for stabilizing your site. Hydroseed mixes can be modified to promote fast-growing vegetation. However, consider native vegetation to reduce weeds and long-term water use.

The Soil Science Society of America provides more information on healthy soil at:
https://www.youtube.com/watch?v=LXUnGntFahE&index=1&list=LLTqootiUJRsH6Ksa6KG8DA

3. **Seed Availability and Seed Mix:** Restoration is a special circumstance typically dictated by an Environmental Impact Report, Environmental Impact Statement (EIR/EIS) or other regulatory requirements from agencies such as the Army Corps of Engineers (ACOE), Bureau of Land Management (BLM), Fish and Wildlife Services (FWS), and California Department of Fish and Wildlife (CDFW). Restoration may require a strict recipe of native seed mixtures.
   Where seed collection options are limited, the project biologist must plan for long lead times and early coordination between biologist teams and the site staff implementing the construction SWPPP. The QSD and the project biologist will need to work together closely to ensure first that the site is stabilized in the period between construction and restoration, and second that the interim stabilization BMPs are conducive to future restoration activities. When revegetating an area, it can also be helpful to use a mix of non-competitive annuals. The annuals will be dominant in their first year, helping to quickly cover and hold the soil while the perennials become established for long term coverage.

4. **Selection of BMPs:** Successfully establishing vegetation requires a combination of linear controls along with either hydroseed and hydromulch (Figure 6) or rolled erosion control products (Figure 7). The always-evolving BMP market offers excellent choices for final stabilization that are easy to apply, long lasting, effective, and provide both growth medium and erosion control. These include burlap-wrapped fiber rolls (100% biodegradable), compost-filled socks (100% biodegradable), coconut or straw matting (100% biodegradable and without fixed aperature nets), and numerous hydraulically-applied products. Any temporary BMPs used for final stabilization need to be 100% biodegradable and wildlife friendly. Figure 8 displays the installation of hydromulch at 5,000 lbs/acre for a 2:1 slope, rather than the typical application rate for standard hydraulic mulch of 2,000 lb/acre (California Stormwater BMP Handbook: http://www.lakeforestca.gov/DocumentCenter/Home/View/892), to further reduce sediment loss and increase BMP performance[2].

Figure 6 : Hydromulch application

Figure 7: Rolled erosion control product installation

Figure 8: Application of hydromulch at 5,000 lb/acre, with burlap wrapped fiber rolls installed using the Caltrans Type 2 method

RUSLE or RUSLE2 Approach

In some cases, establishing vegetation to reach 70% final cover within a reasonable time following completion of the construction project is not feasible due to lack of water, unseasonable temperatures that damage seed application, or construction completion outside of acceptable seeding windows. Often, however, the BMPs installed to stabilize the site are sufficient to meet the final stabilization criteria. For instance, when water is scarce, top dressing soil with erosion resistant material is an effective way to meet final stabilization requirements.

2. Utilizing higher hydromulch application rates will increase BMP performance; however, these rates may also adversely affect seed germination.

In cases like this, the Revised Universal Soil Loss Equation (RUSLE or RUSLE2), a computational modeling tool, can demonstrate that final stabilization has been achieved.

The inputs to the RUSLE account for project location, time, soil types, site topography, soil cover practices, and BMPs. The output of the RUSLE predicts average annual sediment delivery in tons per acre per year. To use the RUSLE to demonstrate final stabilization, two scenarios must be modeled: preconstruction conditions and postconstruction conditions. Preconstruction conditions must reflect the project topography and soil cover before the project started; postconstruction conditions must reflect the site at the time construction is complete and all final stabilization BMPs are installed. Soil loss during construction is not considered, so use the annual erosivity factor (R). To meet the final stabilization demonstration criteria, the postconstruction sediment delivery must not exceed the preconstruction sediment delivery. Successful demonstration of this condition is required for NOT approval by the Regional Water Board.

In addition to RUSLE, the RUSLE2 modeling program can be used to demonstrate final stabilization. RUSLE2 was developed based on further research and several versions have been adapted specifically for use at construction sites. Increasingly, QSDs are using RUSLE2 during SWPPP development to determine the necessary BMPs to reach final stabilization. A RUSLE2 program user can easily model pre- and postconstruction scenarios.

Figure 9 summarizes the inputs and shows the postconstruction sediment loss using gravel in comparison to the preconstruction sediment soil loss. Figure 10 shows a screenshot of a RUSLE2 postconstruction model implementing gravel as a BMP to demonstrate final stabilization. In this example, postconstruction soil loss was estimated at 7.2 tons/acre/year compared to the preconstruction condition estimate of 12 tons/acre/year. In addition to demonstrating final stabilization requirements, this valuable project planning tool can be used to fine-tune bid documents and assist with more precise project scheduling and BMP purchases.

RUSLE2 Inputs	Pre-Project Analysis	Post Project Analysis
R	Los Angeles County R25-28	Los Angeles County R25-28
K	Gravely Sandy Clay Loam (Subsoil, substratum 15-60% coarse fragments)	Gravely Sandy Clay Loam (Subsoil, substratum 15-60% coarse fragments)
L	50 ft	50 ft
S	100%	100%
Management	Shrub vegetation, existing, greater than 40% canopy cover	Gravel
Soil Loss (tons/acre/year)	12	7.2
Sediment Delivery (tons/acre/year)	12	7.2
Result	Postconstruction sediment delivery is less than preconstruction. RUSLE2 analysis supports termination of CGP coverage.	

Figure 9: Summary of pre- and postconstruction RUSLE2 model runs

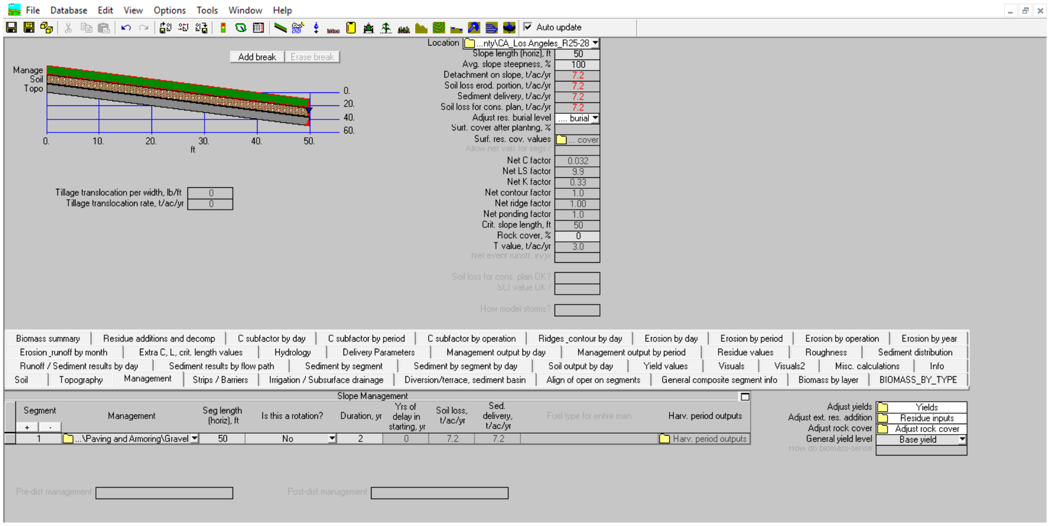

Figure 10: Screen shot of a RUSLE2 model run

RUSLE2 can be used to demonstrate post project sediment delivery for many types of BMPs. For example, RUSLE2 can model specific hydromulch application rates. However, hydromulch can fail, particularly on steep and rocky slopes, leaving exposed soil vulnerable to erosion as seen in Figure 11. Figures 12 and 13 compare project sites that meet the RUSLE2 final stabilization condition. The site in Figure 12 contains rocky terrain and partial vegetation as a justification for final stabilization, whereas the site in Figure 13 uses hydromulch, fiber rolls, and perimeter controls as justification for final stabilization. This demonstrates the flexibility of the RUSLE2 program.

Figure 11: Project site that demonstrates failed hydromulch application. This site does not qualify for final stabilization.

Figure 12: Project site that meets the final stabilization condition. Demonstrated using RUSLE2 with rocky terrain and partial vegetation as justification.

The U.S. Department of Agriculture (USDA) developed the RUSLE2 program, which can be downloaded from http://fargo.nserl.purdue.edu/rusle2_dataweb/RUSLE2_Index.htm.
In addition, Caltrans and other large construction project owners such as Southern California Edison developed customized versions. Numerous tutorials and trainings are available to assist in learning the RUSLE2 program.

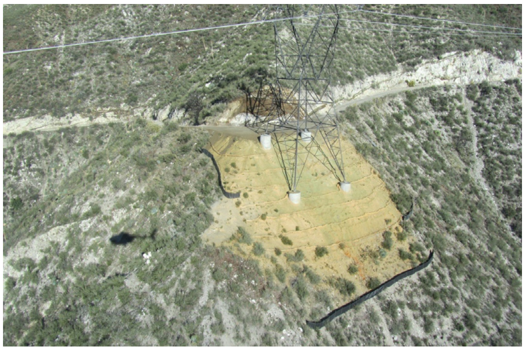

Figure 13: Steep slope that meets the final stabilization condition. Demonstrated using RUSLE2 with hydromulch, fiber rolls, and perimeter controls as justification.

Figure 14: This site does not qualify for final stabilization. The surrounding vegetation indicates very dense pre-project vegetation coverage. The postconstruction sediment delivery is substantially higher than the pre-project condition due primarily to the lack of postconstruction vegetation relative to preconstruction.

In contrast, Figure 14 displays a project site that does not qualify for final stabilization. The surrounding vegetation indicates very dense pre-project vegetation coverage. In this case, RUSLE 2 will calculate the postconstruction sediment delivery as substantially higher than the pre-project condition.

Custom Approach

Custom approaches acceptable to quantitatively demonstrate final stabilization use alternative numeric models to quantify pre- and postconstruction sediment delivery. The custom approach is listed in the permit to allow the option of an analytic solution for final stabilization other than RUSLE or RUSLE2. Coordinate with your Regional Water Board on selection of an appropriate alternative numeric model for your construction site.

Rural LUP Final Stabilization Challenges

Linear underground/overhead projects (LUPs) include high voltage electrical transmission lines, gas pipelines, water pipelines, and electrical undergrounding projects. (Roads are not considered LUPs.) LUPs can be categorized into two general groups: urban and rural. Urban LUPs are built within streets or urban rights-of-way. For these projects, final stabilization is a simple matter of repaving the street, replacing the original cover material, or providing temporary irrigation to establish vegetation using readily available water sources.

Rural LUPs, however, may be hundreds of miles long and extend through remote areas that include steep terrain and varying climates (Figures 15–18), drastically increasing the difficulty in complying with routine CGP requirements such as daily inspections, 72-hour BMP repair, and final stabilization. For example, an electrical transmission line built to

Figure 15: Helicopter photograph of a linear construction in arid conditions through steep terrain.

Figure 16: Long linear pipeline construction project.

connect the solar electricity generation fields in eastern California to the population centers on the California coast necessitates hundreds of miles of transmission line through the dry eastern California deserts. These projects require many of the same construction activities and support staff as urban projects, including access roads, grading, drilling, dust control, erosion and sediment control, trailers and equipment yards (Figure 18), environmental monitors, and associated ancillary facilities. Even though the final stabilization requirements are the same as for urban projects, conditions often limit the types of erosion control that are feasible to meet final stabilization requirements within a reasonable timeframe. For instance, hydroseed and mulch should not be used on excessively steep slopes because it will slide off. Certain rolled erosion control products such as stapled erosion blankets may be appropriate but can be prohibitively expensive in the quantities needed for long power line or water pipeline projects.

LUP vs. Traditional Final Stabilization

Though Attachment A of the 2009 Construction General Permit (CGP) provides specific requirements for linear underground/overhead projects (LUPs) during active phases of construction, the methods used to demonstrate final stabilization are the same as traditional construction projects. In particular, some have questioned the use of the RUSLE or RUSLE2 for demonstration of final stabilization because demonstration methods are not explicit in Attachment A of the CGP. However, RUSLE and RUSLE2 demonstration methods are defined in section II.D.3.b in the CGP Order and have been accepted by Regional Water Boards for LUPs.

Figure 17: Postconstruction BMPs on a linear pipeline project.

Figure 18: Linear construction support yard.

Safety and available water supplies are important factors for achieving final stabilization at these rural projects, particularly in steep or remote areas where fire danger is the controlling factor for site access or where helicopters may be the only way to access the construction site. Workers may need additional equipment such as harnesses to safely rappel down extremely steep slopes. Additional factors to consider include habitat restoration, nesting restrictions, endangered species, and seed collection.

From The Trenches: Restoration Planting

In some cases, short-term needs and long-term goals conflict, but effective solutions are often found through cooperation between the contractor and the QSD/QSP. For example, on an actual project in an arid region, the contractor proposed spraying a disturbed area that would receive restoration planting in the near future with hydromulch to achieve interim stabilization. The project biologist expressed concerns that the hydromulch layer would inhibit the restoration seed application in later phases of the project. Ultimately, they selected a solution of linear controls and soil binder that met the goals of interim stability and long-term restoration planting.

Proper Stockpiling for Restoration

Stockpiling in this section refers to the accumulation of excavated topsoil within a construction site. Stockpiles must be used to store and preserve topsoil on site before it is respread for the reestablishment of vegetation. Properly stockpiling topsoil can reduce costs by eliminating seed purchases, special equipment required to spread the seed, and transportation costs associated with moving topsoil to and from a construction site.

Restoration ecology is an important part of stabilizing and restoring a damaged landscape, including the soil, to support its historic ecological function. Soil quality is an important factor in watershed health. Pre-construction soil structure is destroyed with disturbance, and native seed banks and soil biota are often destroyed by poor stockpiling practices.

Common consequences of poor stockpiling practices include reduced infiltration, increased erosion, and pollutant entrainment from increased surface flows. Reduced soil quality also changes the vegetation community, adding to unnatural levels of soil loss. Maintaining healthy soil and proper stockpiling protocol supports the natural ecology of the area, which can also be more cost-effective because natural systems are more self-maintaining than revegetation on poor soil that requires repeated applications of nutrients and water.
For more information see:

http://www.watershedmanagement.vt.gov/stormwater/docs/sw_gi_1.3_minimize_total_disturbance.pdf

Proper stockpiling practices preserve soil biota and the native seed bank and can reduce the need for fertilizer, seed, and water. Improper stockpiling can sterilize and consolidate soil. The American Association of State Highway Officials (AASHTO) includes best practices on stockpiling, including Section 4.11.1 on specific guidelines for preserving stockpiles, in its online Environmental Stewardship Practices in Construction and Maintenance Compendium. AASHTO recommends stockpiling for up to 6 months, but no longer than a year, and a maximum stockpile height of 4 feet.

AASHTO's Online Compendium:
http://environment.transportation.org/environmental_issues/construct_maint_prac/compendium/manual/4_11.aspx

The CGP requires cover for inactive areas and stockpiles. Inactive areas, including stockpiles, are areas that have been disturbed and are not scheduled to be disturbed again for at least 14 days. Rolled erosion control products (RECPs) or temporary vegetation cover is better than impervious covers because impervious covers can kill native seed stock that is already in the ground by increasing soil temperatures and can reduce soil quality by preventing exposure to rainfall which is necessary to maintain healthy soil biota. If an impervious cover is used, raise the cover off of the soil by a few inches to allow air exchange into the soil. This will prevent anaerobic organisms (pests) from dominating. Also, when the stockpile soil is returned to the site, add compost amendments that contains an abundance of beneficial soil biota to aid in revegetation efforts.

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