Long Meadow Soil Investigation

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On Wednesday August 2nd, 2012, I visited the planned Long Meadow Restoration site on the Sequoia National Forest to examine the soil properties of the area around the site. Joe Loehner was there for assistance. The primary goal of the soil assessment was to evaluate the soil types and properties of those areas to be used for material in the construction of plugs in a plug and pond restoration effort.

The restoration site is at the downstream end of Long Meadow. Figure 1 illustrates the general location of the gully and the two soil pits that were dug and described. The gully is approximately 8 feet deep and the headwall of the gully is actively slumping due to weakly consolidated soil material inadequately supporting the hydraulic force of saturated water in an 8 foot water column. There are no evident barriers in place to prevent the headcuts from migrating up the length of the meadow.

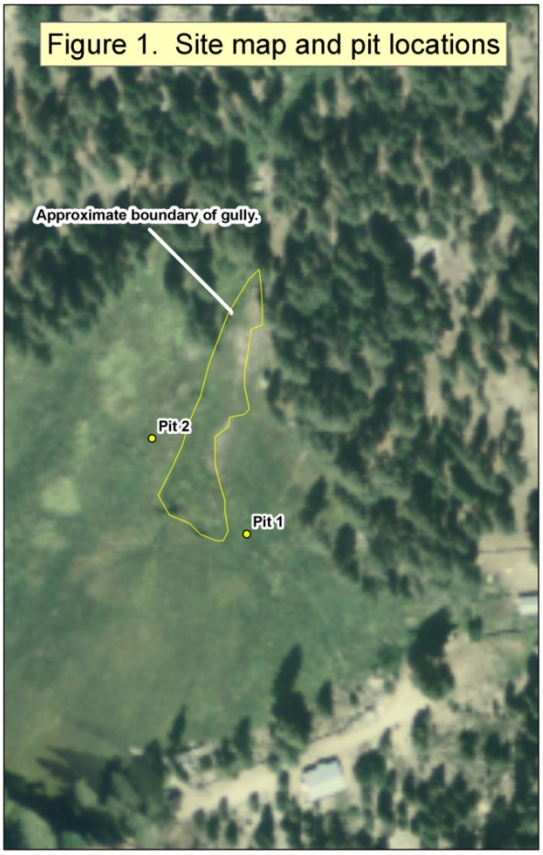


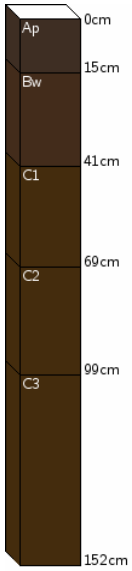
Figure 1. Site map and pit locations

Long Meadow is situated in the Cretaceous age granitic rock on the Sequoia National Forest. The soil derived from the material in the project area is dominated by the Chaix and Dome soil series. Both soil series are weakly developed soils formed in granitic residuum. Because of the young age of these soils and the mineralogy of the parent rock, little clay accumulates within the soil matrix and the soils have a characteristic coarse-texture (sand dominated) with little soil strength and water-holding capacity.

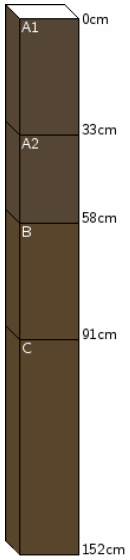
The soils mapped by the NRCS are the Wind River-Monache Variant complex. Both soils are derived from alluvium originating from the Chaix and Dome soil series environment. Figure 2 illustrates the typical soils profile representing the Wind River and Monache soil series. In general, the "A" and "B" horizons have a high proportion of silt in the matrix and the "C" horizons are dominated by sandy textures.

Figure 2. Typical soil profiles of the meadow soils as mapped by the NRCS

Wind River soil profile



Monache Variant soil profile



For the evaluation, two soil pits were dug to a depth of 165 cm and described. The two pits were located primarily on the upstream portion of the proposed activity. This area is where the greatest soil movement is expected. Pits were examined both east and west of the gully to capture the different possible deposition surfaces that formed the meadow.

Soil Interpretations:

For both excavated pits, samples were collected in a soil pedon collection box and photos are included below. Soil Pit 1 is represented by Figure 3 and Pit 2 is represented by Figure 4. Soil Pit 1 was excavated southeast of the gully and Soil Pit 2 was excavated west of the gully.

Both soil pits were similar in their horizonation, however, Soil Pit 1 does contain more silt-sized material throughout the profile than Soil Pit 2. This is likely due to the most active depositional area is represented by Soil Pit 2 which would lead

to coarser, water transported material. Perhaps the most significant character of the soils in the project area is a very recent deposition of coarse grained material overlying an older, more stable meadow surface. The deposit is most pronounced and deepest for Pit 2 at 152 cm compared to 75 cm for Pit 1. That deposit is also cleaner, less developed and the soil texture coarser at Pit 2 compared to Pit 1. This recent deposit is likely due to a historical disturbance that allowed for excessive erosion and sedimentation in the watersheds above the meadow. The differences in thickness and development is likely due to the watershed supplying sediment to Pit 2 is several orders magnitude larger than the watershed supplying sediment to Pit 1.

Soil Pit 1 is most closely associated to the Monarche Variant soil and Soil Pit 2 is most associated with the Wind River soil. The observed soils both differ from the typical soils mapped by NRCS in that they both have a buried A horizon. The buried A horizon (or meadow soil) has a substantially finer soil texture than the overlying recent deposits. The textures change from loamy sands and loams in the upper horizons to silt loams in the buried horizons. What soil horizons occur under the buried A horizon is not known and will not be known until the time of excavation associated with the project. It is this soil scientist's expectation that there is a post-glacial period accumulation of clean sand and gravel. **Both the known and potential coarse-textured material is significant** when considering the design and construction of the plugs. The two primary concerns are:

Seepage: A soil texture of loamy coarse sand or loamy sand is likely to have high permeability. As described, theses porous surface layers range in depth from 75 to 152 cm. Even though it is expected that the plugs would hold water with some engineering, the *in situ* soils surrounding the plugs are likely to drain rapidly as the water table in the ponds drop. When this site was visited, there was very little water input from upstream, but it was a particularly dry year when sampled. In normal years, input may be more rapid than the rate of seepage. Currently there is a fairly robust sedge community, but it is the root mat water holding capacity that is providing the longer term plant available water. Colonization and development of root mat forming vegetation will likely reduce the porosity of the soils. Despite the risk of seepage, it is expected that plant available moisture would be higher after development of root mats on the plugs.

Inadequate construction material using excavated material: There are obvious concerns constructing plugs using infill material with loamy sand sandy loam textures such as that of the sub surface horizons. Loamy sands have little ability to consolidate once disturbed from the natural setting. If the core of the plugs is constructed with this material, hydrostatic pressure could cause piping and sloughing of the sands which would compromise the integrity of the plugs. If this sandy material is used as the rooting medium for the top of the plugs, the soil moisture is likely to deplete rapidly and hinder vigorous establishment of sod forming vegetation. The moisture depletion would be due to the excessively well-drained characteristics of a sandy soil. As the water table drops, the soil matrix does not have adequate pore space to store water for anything other than very short-term.

Recommendation: The use of imported soil with the textural qualities ideal to construct the plugs for Long Meadow seems impractical. This is particularly true given that most soils within a reasonable range of transportation are similarly coarse-textured. The bulk of the excavated volume appears to be coarse textured soil. I would recommend that the surface horizons and buried A-horizons be mixed thoroughly with the coarse-textured material be used for the base of the plugs.

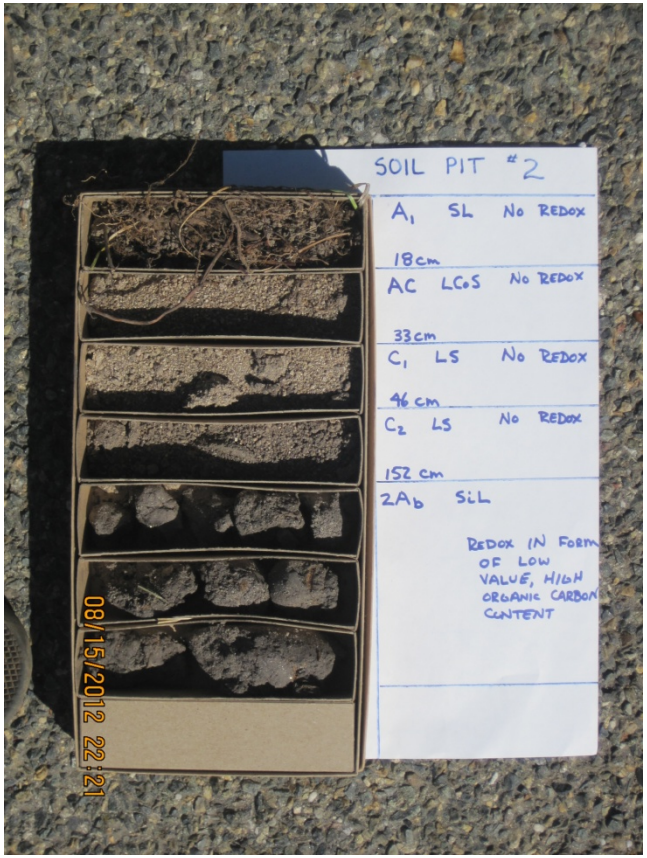
I would also recommend that the material from the east side of the gully represented by Pit 1 be used as much as practical for the deepest part of the plugs. The surface and buried A layers have the most silt and clay and are likely to compact better than the material on the west side of the meadow (Pit 2). If it is found that after a season or two of monitoring there are structural and permeability issues with the plugs, the forest may want to consider placing filter cloth on the upstream portion of the plugs and place low permeability soil material to reduce permeability.

Also, the integrity of the plugs is strengthened by the success of established vegetation of the plug surface; this also should be monitored. If it is found that the summer and fall elevation of the pond level is too low to support robust perennial vegetation, the forest may want to consider amending the surface of the plug with a soil with enough silt and clay to increase the water holding capacity of the soil enough to provide moisture longer in the growing season. I do believe with two wet seasons occurring consecutively after construction, root penetration will be deep enough to access deeper moisture found during dry seasons.

Joshua Courter did inform me that Jim Wilcox of Plumas River Corporation did review an initial draft of this report and believed there is enough of the fine-textured material available to be mixed with the coarse-textured material which would provide soil material with enough strength to maintain the plugs. By using fine-textured material in the plug does diminish the potential plant available water during dry years for the transplanted vegetation. The success of the vegetation should be monitored until the root mass penetrates deep enough to access the perennial moisture.

Figure 2. Soil Pit 1 excavated from east side of the meadow.

Figure 3. Soil Pit 2 excavated from the west side of the meadow.


SOIL PIT #2
A1 SL No REDOX
18cm
AC LCoS No REDOX
33cm
C1 LS No REDOX
46 cm
C2 LS No REDOX
152 cm
2Ab SiL
REDOX IN FORM OF LOW VALUE, HIGH ORGANIC CARBON CONTENT
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