PUTTING TOGETHER THE PIECES FOR SUSTAINABLE LAND MANAGEMENT ON SOLAR SITES

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TRM is being hydraulically infilled to address concentrated sheet and channelized flow.

Eroded site prior to installation of hydraulically filled TRM.

Introduction

Establishment of sustainable vegetation is integral to stormwater management and compliance with provisions of the US Environmental Protection Agency (EPA) Clean Water Act (NPDES) in addition to other state and local environmental regulations. Development of solar sites often involves clearing and denudation of large tracks of land. Moreover, placement of access roads, buildings, electrical equipment, arrays, and panels create impervious surfaces and accelerated stormwater runoff.

Vegetation holds soil in place which reduces and filters sediment discharges and ultimately sedimentation into receiving water bodies. Successful establishment on solar sites can be problematic when proper measures and methods are not implemented. Even after initial establishment during construction, sites can still encounter washouts and erosion issues. This increases the risk of stormwater violations and can also have significant implications for the integrity of the underlying utility infrastructure.

In this study the "hydraulic seeding" method was explored to address these issues in the solar industry. "Hydroseeding" is an installation technique that utilizes a liquid slurry of seed, fiber mulch, and soil amendments that are applied to the soil surface. It is widely used in the construction industry for seed establishment and with more advanced formulations, as an alternative to Rolled Erosion Control Products (RECP's). Examples where the hydraulic method can be cost-effectively employed to address specific erosion control or soil health issues in a single application include:

- Application of complex native seed and pollinator mixes while protecting them and the underlying soil from erosion during establishment.
- Rejuvenation of denuded soils and elimination of costly topsoil to create an ideal platform for seed germination and growth.
- Replacement of RECPs in areas with higher erosion risk with no introduction of hazardous plastic netting.
- Working in concert with Turf Reinforcement Mats (TRMs) as an environmentally preferable alternative to unsightly rip rap.

Restoration Challenges

Typical Restoration challenges include:

- How, when, and where to soil test for soil pH, organic matter and other agronomic attributes to help ensure successful site reclamation.
- Examination of when to seed, seed selection choices, when and where to install specific erosion control materials, and "tradeoffs" from these decisions including long-term vegetation management.
- Establishing vegetation in rocky soils or on areas of the project with steep slopes.
- Establishing vegetation in and around solar arrays where shadowing and panel driplines are encountered.
- Establishing native and pollinator species versus faster growing turf type species.
- Deficencies in specification development or lack of contingency options before projects begin.
- Getting solutions installed quickly, especially under tight project deadlines or shrinking application windows.

Technology & Techniques

This study combines observations from the field for common issues encountered, controlled experiments with native vegetation installations, and a focus on the hydraulic method to explore groundbreaking techniques for solar site restoration. Hydraulic methods of site remediation were utilized due to favorable economies of scale, typical ease of access to water, and the ability to address multiple unique site issues from this single application technique.

Soil testing, in combination with the hydraulic mulching method to address underlying soil issues and erosion control is a proven technique for utility scale site restoration. The following examples and pictures from the field represent previous successful installations to address the above challenges listed on solar sites. By utilizing the hydraulic method with a prescriptive approach to address underlying soil and site issues, significant time and expense can be saved in comparison to traditional restoration techniques that are more expensive and less efficient.

A key advantage of the hydraulic method is the ability to combine solutions for soil deficiencies and erosion control in a single application. This can be a combination of solutions such as adjusting soil pH with fast acting and time release products, increasing soil organic matter and increasing biological activity, while providing erosion protection on slopes. Another option is to create robust erosion control in areas of channelized flow when used in combination with TRMs as opposed to rip rap and other forms of hard armor.

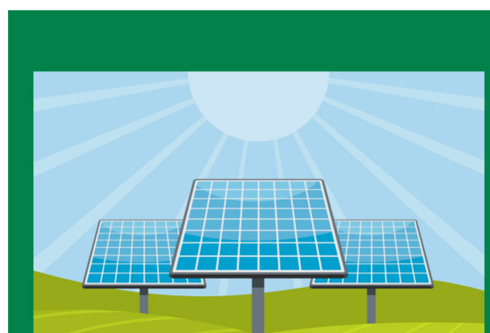
These technologies and techniques include:

Biotic Soil Media (BSM) — a spray-on application of concentrated organic matter with a complement of biological and soil remediation ingredients as an alternative to imported topsoil, compost or other soil improvement measures that are cost prohibitive on solar sites at scale.

Hydraulically-applied Erosion Control Products (HECPs) – Spray-on erosion control that is comprised of product categories that address seeding and erosion control needs for low risk areas of mild terrain, to areas of significant erosion risk such as retention pond slopes, areas of sheet flow from roadways, previously forested areas and/or cleared areas of disturbance. Categories range from Hydraulic Mulches (HM's) to Bonded Fiber Matrices (BFM's), Flexible Growth Media (FGM) or Biotic Erosion Control Matrices (BECM's).

Infilling TRMs — An EPA endorsed, economical, and permanent green solution that allows for substantial erosion control performance with greater installation efficiency and a dramatically reduced carbon footprint versus hard armoring techniques.

The Five Fundamentals For SOLAR Vegetation



Soil Analysis and Amendment Planning
Optimize vegetation mixes that meet site goals
Limit soil loss - Select adequate Erosion and Sediment Control
Apply materials according to plan
Review vegetation development and execute maintenance needs

Experiment

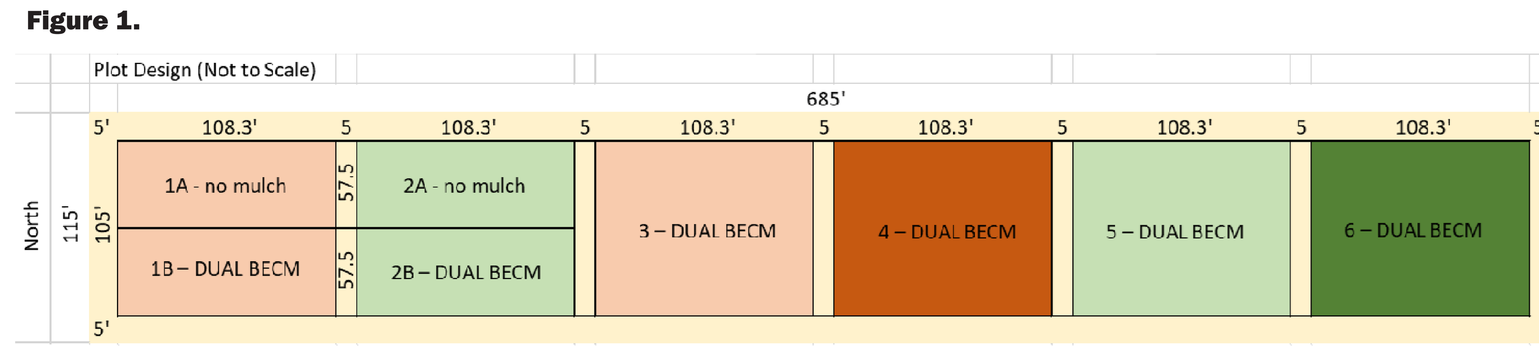
Purpose – to evaluate the use of native seed applications in combination with the hydraulic method. Is the perception correct that broadcast or hydraulic seeding needs to be placed at double the drill seeding rate? How will a biotic erosion control matrix affect seed establishment and soil health?

A variety of technologies were utilized in a collaborative effort with the Stantec Nursery (formerly Cardno) near South Bend, Indiana. Eight test plots were installed with two separate seed mixes (a native mix and a native/hybrid blend). These mixes were applied at two different seeding rates, with certain plots also installed with a fixed rate BECM mulch technology as described in Figure 1."

Cardno/Stantec solar field pollinator habitat mix
5 native grasses/sedges
13 native forbs
Temp nurse crop of seed oats
Std application rate of 41.4 lbs/ac

"Hybrid" fescue/native mix
Three fescue species Kentucky blue grass
White clover
5 native grasses/sedges
11 native forbs
Std application rate of 61.8 lbs/ac

Figure 1.



Plots 1A, 1B, 2A, 2B - hand broadcasted and cultipacked at "standard" seeding rate to simulate drill seeding

Plots 1B & 2B - covered with a dual-purpose biotic erosion control product (BECM) known as DUAL.

Plots 3 & 4 – Native mix applied hydraulically with BECM

Plot 4 - hydroseeded at double the normal rate

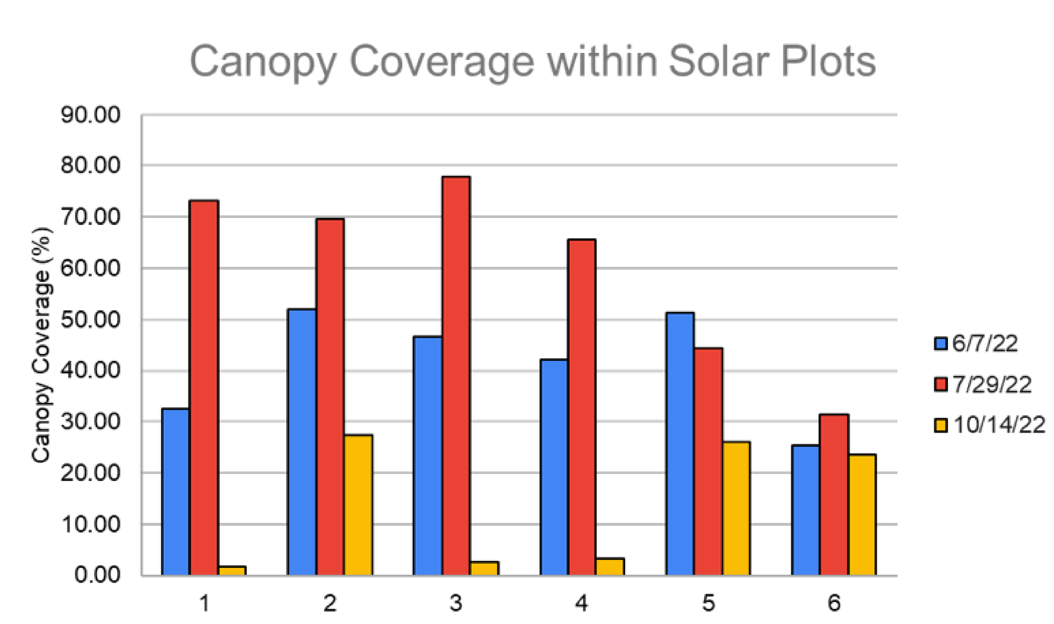
Plots 5 & 6 – Hybrid fescue/native mix applied hydraulically with BECM

Plot 6 - hydroseeded at double the normal rate

Notes:

- Calibration of complicated seed mixes using a seed drill was unattainable due small plot sizes
- BECM applied at 5,363 lb/ac (1,400 lb/plot)

Results



Key findings:

Fescues (*Festuca sp.*) dominate the hybrid mix areas. Very few native forbs have been observed in Year One of study. The most prevalent native species is partridge pea (*Chamaecrista fasciculata*). Green foxtail (*Setaria viridis*) is present in most of the native plots. Preliminary soil test data shows an increase in CO_2 respiration, indicating increasing biological activity.

- All plots eventually achieved 70% aerial coverage after these measurements
- "Double rate" plots have less coverage than "single rate" plots
- These are Year One results of a Three-Year Study

Conclusions

The results of the experiment confirm the compatibility of complex native seeding applications via the hydraulic installation method. Furthermore, the results of this experiment also confirm that a requirement to double the hydraulic seeding rate in order to achieve greater vegetation establishment vs. drill seeding methods is not necessary.

A notable learning from this experiment was that permanent turf grass as part of a hybrid mix should be examined closely. It is likely that the early establishment and over abundance of fescue in this seed mix likely shaded and reduced some of the native vegetation, reducing the native blend's germination rate and establishment. This reinforces the need for careful scrutiny of cover crop species selection and rate when designing a staged seeding mix.

The results of this native seeding experiment and those seen in large scale field applications confirm the viability of hydraulic methods for utility scale solar projects. Compatible with industry best practices for site reclamation, this platform provides more options to solve complex site challenges. With proactive soil testing, proper planning of seed mixes and erosion control methods, and comprehensive specifications with products properly installed and inspected, excellent results in site restoration can be achieved.

To simplify, an acronym was developed to the left that the authors describe as "The 5 Fundamentals for Site Restoration" using the techniques summarized.

Hydraulic Application of multi-tiered treatment on a Solar Site.

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