

Report No. CDOT-DTD-R-96-6

Evaluation of Slope Stabilization Methods

(US-40 Berthoud Pass)

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Construction Report
March 1996

Prepared in cooperation with the
U.S. Department of Transportation
Federal Highway Administration

96-6

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SH-40 west of Berthoud Pass as seen in 1995 was built in the early 60's. Standard practices for erosion control (in effect during the 60's) were applied to the cut and fill slopes. The slopes consist of highly erodible and unstable sandy soils mixed with a large quantity of rocks, which vary in size to over two meters in diameter. The snowmelt runoff combined with the severe rain storms of spring and summer wash away the top layer of soil and thereby prevent vegetation establishing itself.

Enhancement funds became available for the 1995 construction season to rehabilitate some of the eroded slopes. The purpose of this project is to test various cost effective erosion control materials and installation techniques to provide data for the application on future projects in this and similar areas.

Sixteen materials from erosion mats and mulches to different tackifiers are being used within three work zones. The three zones will be evaluated for constructability and overall performance on the better 1 to 1 slopes that are normal for Berthoud Pass.

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Slope Stabilization
Erosion Mats

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I. INTRODUCTION

State highway 40 west of Berthoud Pass as is seen in 1995 was built in the early 60's. Standard practices for erosion control (in effect during the 60's) were applied to the cut and fill slopes. The disturbed areas were not seeded. The erosion of the cut slopes started almost immediately after construction was completed. The slopes consist of highly erodible and unstable sandy soils mixed with a large quantity of rocks, which vary in size to more than two meters in diameter. This area experiences heavy snow accumulations during the winter months. The snow melt runoff combined with the severe thunderstorms of spring and summer wash away the top layer of soil and thereby prevent vegetation from establishing itself.

Due to continuing erosion, rocks previously deeply embedded into the slopes have become exposed. These rocks roll down onto the road, creating a major safety hazard in this area. It also requires extensive and expensive maintenance operations of rock removal and cleaning sand from the ditches.

Enhancement funds became available for the 1995 construction season to rehabilitate some of the eroded slopes. The purpose of this project is to test various cost effective erosion control materials and installation techniques to provide data for the application on future projects in this and similar areas. The specifics of the work completed are listed below:

1. Restricted access to the top of cut slopes to prevent any additional disturbance of natural terrain.
2. Limited amount of clearing allowed at the top of the cut slopes.
3. Specific test sites were assigned to various products to provide the best comparison of the results.
4. Small retaining wall and concrete paved ditch were placed to help reduce undermining and allow for more efficient cleaning of the ditches and reduce the amount of sand being washed into the river.
5. New cross culvert inlets and outlets to improve drainage and help to reduce the erosion of the fill slopes.

II. SITE LOCATION AND PREPARATION

The Berthoud Pass erosion control project STE 0403-019 starts at m.p. 239.4 (sta. 6+111.5) and continues to m.p. 238.05 (sta.8+140). This project is a metric project, meaning all station measurements and work were completed in metric units. Three work zones were specified for study into the effectiveness of various erosion control methods. Work zone 1 located on the east end of the project was placed at sta. 6+400 and continued to sta. 6+540, a total of 140 linear meters. Photo 1 shows the slope at work zone 1. Work zone 2 began at station 6+910 and continued to station 7+150, a total of 240 linear meters. Photo 2 shows work zone 2 after erosion control materials were in place. Work zone 3 was located at station 7+410 and continued to station 7+680, a total of 270 linear meters. All three slopes were approaching a 1 to 1 slope with a large quantity of rocks varying in size to more than two meters in diameter. Photo 3 demonstrates what types of rocks were typically removed from the slope during the scaling operation. Photo 4 shows a slope before the scaling operation, photo 5 shows a complete typical slope before any work had been performed.

A. Scaling Operation

All three work zones were scaled at night for safety purposes. Scaling was only performed when the roadway was closed to the public. A type 4 concrete barrier was placed at the bottom of the slope between the slope and the roadway to catch rocks and prevent them from passing down to a lower section of roadway.

Scaling work consisted of the following according to project specifications. Scaling shall consist of removing all rocks larger than 0.1 meters from the slopes as directed by the Engineer. Overhanging material considered undesirable shall be removed as directed and will be classified as "scaling." The contractor will be responsible to protect the existing road during the scaling and unclassified excavation operations. The contractor will also build a containment system to control the rocks and other debris at the ditch line.

The type 4 concrete barrier was the containment system used by the contractor between the roadway and the slope to stop any rocks from passing down to a lower section of roadway. These

barriers appeared to work very well as a safety item in preventing the rocks and boulders from rolling wildly down the slope.

The contractor originally attempted the scaling operation with a piece of equipment called a walking excavator. The walking excavator uses legs on its back end to push its way up the slope as shown in photo 6. Tires are located on the front of the excavator. This equipment was experimented with during the day to get a feel for how well it would function at night. However, due to the steepness of the slope the walking excavator had a tendency to slide and be very unstable. It was decided after the first daytime attempt that this piece of equipment would not be used for scaling the slope.

After the failure of the walking excavator to maneuver on the slopes, a crane with a 60 meter (190 ft.) boom was brought in to perform the scaling process. Photo 7 shows the night operation using the crane to perform the machine scaling within work zone 3. While the machine scaling was being completed, lighter hand scaling was also being performed from the top of the slope. This operation required that the worker be strapped into a safety harness, due to the steepness of the slope.

After all rock scaling was complete, it was time to groom and perform the final smoothing of the slope. This was accomplished by using the crane to drag an old dump truck bed across the slope. This method appeared to work very well for final grooming of the slope.



Photo 1 - Work Zone 1



Photo 2 - Work Zone 2



Photo 3 - Typical rocks removed from work zones during scaling operation.



Photo 4 - Typical slope requiring scaling.

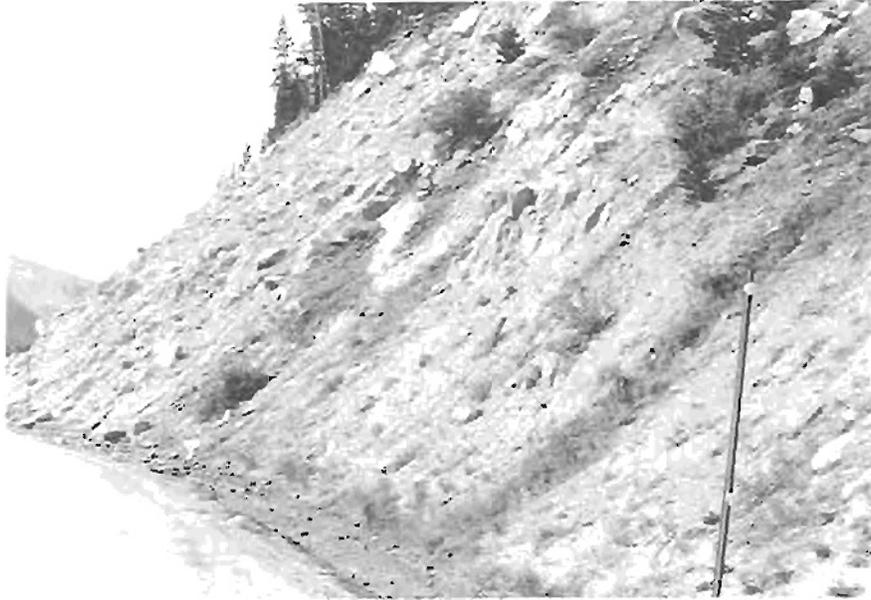


Photo 5 - Same as photo 4

III. MATERIAL PLACEMENT

A. Erosion Control Materials

Figure 1, 2, and 3 show the locations of the erosion control materials according to work zone. Five tackifiers, five erosion mats, two fertilizers, and 2 types of mulch were experimented with. Table 1 shows all material used on the Berthoud Pass project. Table 2 shows the application rates used for these materials on this project. Rates were specified by the material manufacturers or distributors.

Erosion mats were placed over the top of the eyebrow of the slope and extended down the slope with a width of approximately 6 meters for the length of the test section. Specifications stated that the vertical scarp at the top of the cut slope shall be laid back 5 meters maximum to match the rest of the slope prior to placement of the erosion mats. Fill material was then placed over the erosion mats.

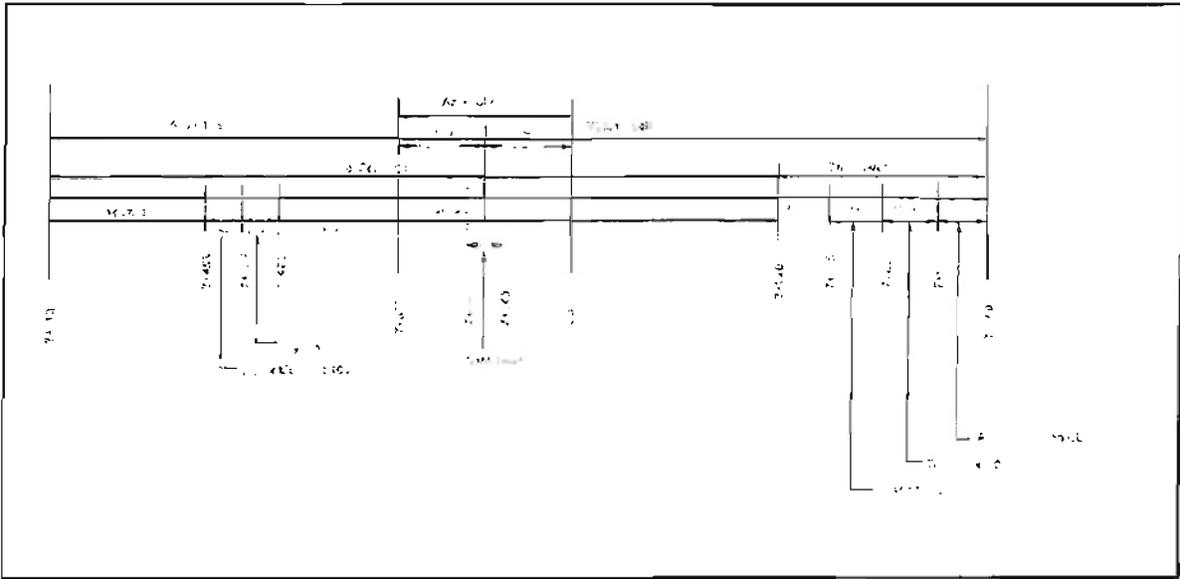


Figure 3 - Work Zone 3 (270 m)

Tackifiers	Fertilizer	Mulch	Erosion Mats
Alpha Plantago CL	Gro Power	Silva-Fiber	Tenax Multimat 100
RMB Plus	Spec. Fertilizer	Spec.	Pyramat
Terra Tack		Soil Guard	Geoweb
Silva Tack			Envirogrid
Airtrol			EC+
			Enkamat S
			Armater

Table 1 - Materials

Soil Prep:	
Humagrow	2250 kg/ha
Biosol	2250 kg/ha
K2O (Potassium)	85 kg/ha
Seeding	64.9 kg/ha
Mulch	4.5 tons/ha
Tack (spec)	510 kg/ha
Silva Fiber	300 kg/ha
Soil Guard	4009 kg/ha
Gro Power	168 kg/ha
Silva Tack	71 kg/ha
RMB Plus	168 kg/ha
Alpha Plantago	168 kg/ha
Tera Tack SC	13.5 kg/ha
Airtrol	6739 kg/ha

Table 2 - Application Rates



Photo 6 - Machine called a walking excavator used for initial experimentation of scaling on slopes. The slopes were found to be too steep to operate this machine safely.



Photo 7 - Nighttime scaling operation being performed in work zone 3 using a crane.



Photo 8 - Concrete wall construction .



Photo 9 - Finished concrete wall after removal of random stone forms.

IV. TRAFFIC CONTROL

Traffic control specifications for this project stated the following: The Contractor shall pay a daily lane rental fee to close US-40 on Berthoud Pass at night between the hours of 9:00 P.M. and 6:00 A.M.. This shall be for the clearing, scaling, unclassified excavation and other work, on the cut slopes, considered dangerous to the public as determined by the Engineer.

The road closure will be permitted on Sunday night through Thursday night only. Once work requiring the road closure is started lane rental will be charged for each night, Sunday through Thursday; work will progress until all work requiring the night closure is completed. This requirement was put in place to eliminate unnecessary time for lane closures.

The Contractor will be required to open the road to allow the general traveling public access through the project up to two times each night as directed by the Engineer. Also, the contractor may be required to allow specific commuting traffic through the site at three additional times each night as directed by the Engineer. Emergency vehicles will be allowed through the project at anytime. Guiding the traffic through the work site shall be the responsibility of the Traffic Control Supervisor and the method for doing this shall be a part of the MHT.

The night closures turned out to be a must for completing the type of work that was performed on this project for safety purposes and speed of construction. For safety reasons, any type of clearing and scaling work during the daytime hours was very slow and inefficient. The actual time of road closures on this project was Sunday thru Thursday 9:00 P.M. to 6:00 A.M.. After the completion of the project the community in the Granby area mentioned that they would prefer a 10:00 P.M. to 6:00 A.M. closure on Berthoud Pass. Traffic was allowed to pass through the construction zone twice per night following a pilot car; all emergency vehicles were allowed through the project immediately with the help of the TCS. The openings for nighttime traffic were at 12:15 A.M. and 3:15 A.M.. The checkpoints where traffic was halted until the opening were located at m.p. 235.5 eastbound and m.p. 239.5 westbound.

V. FUTURE EVALUATIONS

The three work zones will be monitored for plant growth and any problems occurring within each of the individual test sections over a period of three growing seasons. At the end of this period a report will document cost of materials and performance of each within the test sections. This will enable designers to have a better hands on with the selection of erosion materials for severe locations throughout Colorado.

Appendix A

Manufacturer Brochures - Tackifier

RMBplus

From the originators of
TERRA TACK®

THE FIRST TACKIFIER THAT SIMULATES PLANT GROWTH

Finally, after 20 years of research and development, Reinco has produced the singularly most efficient and effective tackifier & binder on the market: **RMBplus**.

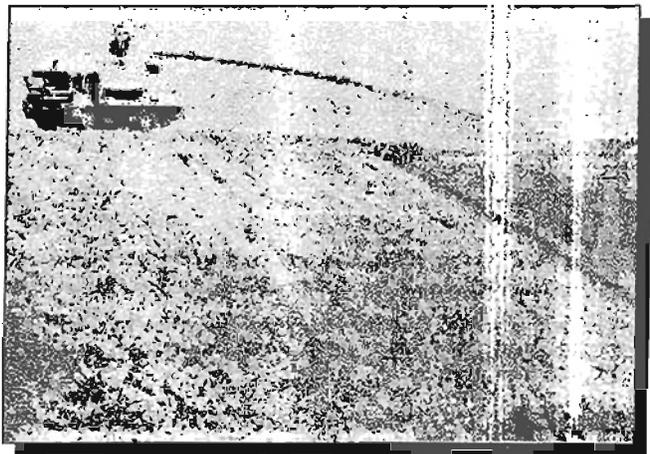
Through its scientifically designed combination of a naturally occurring tack medium with an organic germination promoter and growth stimulant, **RMBplus** provides the best qualities of any competitive product, without the drawbacks. In addition, it has the unique advantage of quicker, denser growth. After all, isn't that why we use a tackifier in the first place?

RMBplus is an inexpensive, non-flammable, non-asphaltic, naturally occurring beige powder blended from a hydrophilic colloidal clay compound mixed with special gelling agents and growth stimulants. It can be used as a tackifier for hay and straw and as a fiber mulch binder. **RMBplus** is also an effective soil stabilizer, germination and growth stimulant, soil moisture retaining agent, and fiber mulch lubricant.

When used in accordance with the instructions herein, this product meets or exceeds specifications and performance characteristics of **TERRA TACK® AR** and **TERRA TACK® MP**.

Reinco

REINCO MULCH BINDER CORP
P.O. BOX 584, PLAINFIELD, NJ 07061
REINCO@CNJ.DIGEX.NET • E-MAIL
800-526-7687 • TOLL FREE
908-755-8379 • FAX





SPECIFICATIONS

- **GENERIC DESCRIPTION** **RMBplus** is a naturally occurring beige powder blended from a hydrophilic colloidal clay compound mixed with special gelling agents and growth stimulants. It contains a polymer which prevents breakdown or softening during rain. **RMBplus** will not encourage mold growth.
- **PHYSICAL DATA** Gray white powder as dry product; blue-green to green when moist solid; gray-brown when suspended in water. Insoluble, forms colloidal suspension. Dirt-dust like odor.
- **PACKAGING** **RMBplus** is packaged in 50 pound, environmentally friendly, water resistant paper bags stacked and shrink wrapped at 63 bags per 48"x 52" pallet. Net weight per pallet is 3150 pounds.
- **STORAGE** **RMBplus** has an indefinite shelf life, and will not freeze.

APPLICATION INSTRUCTIONS

- **RATES** Under normal conditions, **RMBplus** should be applied at a rate of 100 pounds per acre. Should slope steepness exceed 2:1 or severe erosion conditions exist or are expected, this rate should be increased to 150 pounds per acre. If erosion potential is low, this rate may be decreased to 80 pounds per acre.
- **MIXING** **RMBplus** should be mixed and applied with a **Hydrograsser, Tack Applicator** or other suitable mixing and spraying equipment. After adding fiber mulch, slowly pour **RMBplus** into a forceful stream of water in the agitating slurry and mix until lump free. Once in suspension, the mixing machine can be shut off and resuspended with ease.
- **FIBER MULCH BINDER** When prepared for use as a fiber mulch binder, **RMBplus** should be mixed with fiber mulch in Hydrograsser and applied at a rate of 80-120 pounds per acre. Fiber mulch application rates may be significantly reduced.
- **HAY OR STRAW TACKIFIER** When prepared for use as a hay or straw tackifier, **RMBplus** should be mixed at a ratio of approximately one 50 pound bag in 150-200 gallons of water. Add 20-50 pounds of fiber mulch to the slurry for each bag of **RMBplus**. Under normal conditions, apply 80-120 pounds **RMBplus** per acre.
- **SOIL STABILIZER** For temporary soil stabilization, **RMBplus** should be mixed at a ratio of one 50 pound bag in 150-300 gallons of water. Apply until soil is fully wetted.
- **PRECAUTIONS** **RMBplus** slurries are extremely slippery before curing. Immediately wash all areas that have been unintentionally sprayed or covered with water until clean. This is especially important when working on or around machinery. **Do not apply immediately prior to, or during rain.** Consult material safety data sheets (MSDS) for more product safety information.
- **WARRANTY** The product represented herein conforms to the description in this specification and is reasonably fit for the purposes stated above when used in accordance with the directions, under normal conditions of use. **All other express warranties and all implied warranties of merchantability and fitness for a particular purpose which exceed the foregoing representation are hereby disclaimed by the seller.** Conditions of use are of critical importance and beyond the control of seller. Buyer assumes all risks for use contrary to label instructions or for use under abnormal conditions. **Seller shall not be liable for consequential damages.**

terra tack SC



SPECIFICATIONS

- **GENERIC DESCRIPTION** **TERRA TACK™ SC** is a soluble granular polymeric electrolyte designed for tacking and binding hay, straw, paper and wood fiber mulches. It provides superior holding properties, reduces soil erosion and water runoff rates.
- **PHYSICAL DATA** White free flowing powder with little or no odor. This product contains no organic material to encourage or support mold growth.
- **PACKAGING** **TERRA TACK™ SC** is packaged in 2 pound (0.9kg), water resistant plastic bags. Unlike the larger packaging, less handling is required and freight is minimized.
- **STORAGE** **TERRA TACK™ SC** has an indefinite shelf life, and will not freeze.

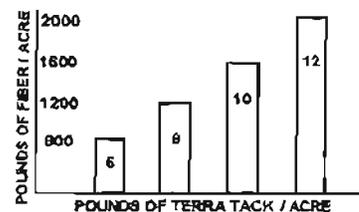
APPLICATION INSTRUCTIONS

- **RATES** Apply **TERRA TACK™ SC** at a rate of 6 pounds per acre (6.7kg/ha). Should slope steepness exceed 2:1 or severe erosion conditions exist or are expected, this rate should be increased to 12 pounds per acre (13.4kg/ha). If erosion potential is low, this rate may be decreased to 4 pounds per acre.
- **MIXING** **TERRA TACK™ SC** should be mixed and applied with a **Hydrograsser, Tack Applicator** or other suitable mixing and spraying equipment. After adding fiber mulch, slowly pour **TERRA TACK™ SC** into a forceful stream of water in the agitating slurry and mix until dissolved. The mixing machine can be shut off and resuspended with ease.

- **FIBER MULCH BINDER**

When use as a fiber mulch binder, **TERRA TACK™ SC** should be mixed with the fiber mulch slurry in Hydrograsser and applied at a rate of 6 pounds per acre (6.7kg/ha). Always mix mulch first. Fiber mulch application rates may be significantly reduced.

This product is water sensitive. Use the following graph as a guide to determine actual application rates required for maximum effectiveness, in less than 2:1 slope applications.



- **HAY OR STRAW TACKIFIER**

When prepared for use as a hay or straw tackifier, **TERRA TACK™ SC** should be mixed in a Hydrograsser at a ratio of 6 pounds in 500 gallons of water with 20-50 pounds of fiber mulch. Be sure to mix the fiber mulch before adding the tackifier. This batch will treat one acre.

If using a Tack Applicator, mix 3 pounds of **TERRA TACK™ SC** and 20-25 pounds of fiber mulch in 150 gallons of water. Mix the fiber mulch before adding the tackifier. This batch will treat ½ acre.

Under normal conditions, apply 6 pounds per acre (6.7kg/ha) **TERRA TACK™ SC** per acre. Double this rate on slopes exceeding 2:1. Optional Hydrograssing dye may be added as desired.

- **SOIL STABILIZER**

For temporary soil stabilization, **TERRA TACK™ SC** should be mixed in a Hydrograsser at a ratio of 12 pounds in 1000 gallons of water with 100 pounds of fiber mulch. Be sure to mix the fiber mulch before adding the tackifier. This batch will treat one acre. Apply until soil is fully wetted. **TERRA TACK™ SC** must be allowed to surface dry.

- **PRECAUTIONS**

TERRA TACK™ SC slurries are extremely slippery before curing. Immediately wash all areas that have been unintentionally sprayed or covered with water until clean. This is especially important when working on or around machinery. **Do not apply immediately prior to, or during rain.** Consult material safety data sheets (MSDS) for more product safety information.

- **WARRANTY**

The product represented herein conforms to the description in this specification and is reasonably fit for the purposes stated above when used in accordance with the directions, under normal conditions of use. **All other express warranties and all implied warranties of merchantability and fitness for a particular purpose which exceed the foregoing representation are hereby disclaimed by the seller.** Conditions of use are of critical importance and beyond the control of seller. Buyer assumes all risks for use contrary to label instructions or for use under abnormal conditions. **Seller shall not be liable for consequential damages.**

Silva-Tack beats the competition

In repeated tests, *Silva-Tack* consistently out performed the next closest competitor:

Up to twice the solubility

Silva-Tack's ability to quickly and completely dissolve in water is important — it means that the binder will be effectively and evenly distributed to the mulch. The result is improved erosion resistance.

More than 200 times the viscosity

You'll notice the difference when you add *Silva-Tack* to the slurry mix. It's thicker and more slippery. The result? On the ground, *Silva-Tack* stays with the mulch. *Silva-Tack* provides a special lubricant that helps machines and mulch products perform better and allows the mixture to be spread more evenly. In spray applications, *Silva-Tack* reduces resistance in hoses, so less pumping energy is required.

Three times the strength

Lab tests show that mulches bonded with *Silva-Tack* have three times the strength to withstand wind and rain. This means lasting protection and less tackifier per acre in all applications.



Silva-Tack is made from 100 percent natural, non-toxic materials. It will not harm wildlife, soil or machinery.

Our concentrated formula saves you money

Silva-Tack:

Contains no reducers, fillers, or inert ingredients

That's why you'd need **THREE TIMES** the amount of other better-brand tackifiers, and **FIVE TIMES** the amount of low-end tackifiers, to match the performance of *Silva-Tack*.

Priced to be the best value

Pound for pound it's not the least expensive tackifier on the market, but in terms of quality and effectiveness it simply can't be beat.

Conveniently packaged

Silva-Tack is packaged in plastic bags or in buckets that are reusable, resealable and recyclable — allowing convenient mixing and storage while reducing waste.

For more information, call us.

Silva-Tack is available through your Silva-Fiber distributor. *Silva-Tack* can be part of your regular mulch order — one call, one invoice. For more information, call us at:

1-800-443-9179 (West)

1-800-248-8608 (East)

or fax (202) 888-7504

AIRTROL® Plaster

**U.S. Gypsum Company now offers
the landscaping professional a
new product for erosion control . . .
AIRTRON® Plaster! It's safe, easily
applied with a Hydroseeder® and
low in cost.**



*AIRTRON in combination
with mulch, forms a crust
which resists erosion and
protects seeds until
germination and rooting
take place. AIRTRON is
especially recommended
for use on steep slopes
which always present a
challenge to landscapers
and landfill operators.*



USG

Landscaping/Hydroseeder
Professionals Get These Advantages
From AIRTROL Plaster, it:

- Minimizes surface and gully erosion
- Helps correct poor growth conditions
- Provides dust control
- Reduces labor and equipment costs because it goes on in a single application with conventional hydroseeding equipment
- Eliminates the need to regrade or go back in with a seeder



AIRTROL Plaster Defined

AIRTROL Plaster is a cementitious binder which, when mixed with water and mulch sets in a controlled, predictable way to form a crust. It is produced from high purity gypsum deposits, is safe to use and easy to apply. In addition, AIRTROL Plaster is

nontoxic, noncombustible, and harmless to fish, birds, plants and animals.

Using AIRTROL Plaster to Control Land Erosion and Promote Plant Growth

For landscapers, hydroseeders, and landfill operators, AIRTROL can promote plant growth on inclined surfaces where erosion control products such as netting or blankets might otherwise be required. It can help grass grow in the steeply graded soil found around water retention ponds, on highway embankments and in landfill final covers. It is also ideal for large acreage developments where dust control is critical. AIRTROL Plaster plus mulch coats the soil surface, forming a protective crust-like barrier that:

- Controls water and wind induced erosion
- Reduces the siltation of streams
- Reflects solar radiation
- Lowers soil surface temperatures
- Holds seed and fertilizer in place
- Slowly dissolves supplying calcium and sulfur to the soil
- Retains moisture in the soil
- Buffers soil pH
- Improves the structure of heavy clay soils
- Requires only the normal surface preparation used for seeding



Applying AIRTROL Plaster

For erosion control, first test the site for soil pH. Control any acid soil with an alkaline amendment, then make the proper seed selection. Combine the seed with AIRTROL, fertilizer and mulch in one mix and spray apply it in a single application using conventional hydroseeding equipment. When applied as directed, coverage is reported to be approximately ten acres per day with a 200 foot spraying radius. Hoses can be used to extend the range if necessary. For best results seeding should closely follow soil preparation and should occur during the normal planting season.

Recommended Order of Addition

One Pass:

1. Water
2. Fertilizer
3. Mulch (costly tackified mulch is not needed)
4. Seed
5. Plaster

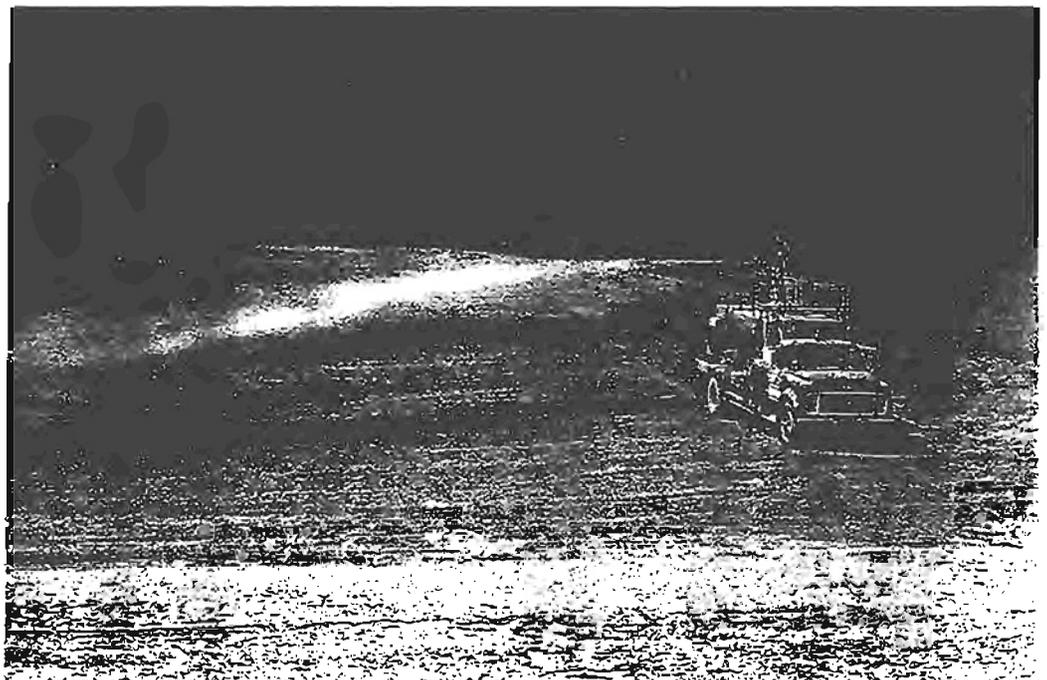
Approximate Mixing Proportions/Coverage

Use the coverages below as general guidelines, but note that the actual coverage achieved may vary with slope, soil type and the extent of the site preparation.

Hydroseeder

Capacity (gal.)	Water (gal.)	Plaster (lb.)	Mulch (lb.)	Coverage (acres)
900	800	1,200	350	0.25
1,500	1,350	2,000	560	>0.33
3,000	2,700	4,000	1,120	0.67 - 0.75

The set time of AIRTROL plaster is controlled to provide ample time, (4 to 6 hours), for application. However, tanks should be emptied and flushed as quickly as possible after use or the material will set up and solidify.



Alpha Plantago CL

(CL - crosslinker)

The high performance tackifier for use under stress conditions.

- unforecasted heavy rains
- daily timed overhead watering

These are stress conditions where *Alpha Plantago* combined with special crosslinker provides greater stability.

Alpha Plantago CL is a soil and mulch tackifier for those hard to control, unusual and potentially destructive erosion problems. It's for areas where extreme weather conditions may bring heavy pounding rains, or in dryer areas where constant daily overhead watering is used to promote seedling growth. *Alpha Plantago CL* helps protect newly laid down seed, fertilizer and mulch from unexpected outside powerful forces. Forces that can easily move newly mulched areas right down and across slopes.



Chemical Definition

Hawley's Condensed Chemical Dictionary

Crosslinker: Attachment of two chains of polymer molecules by bridges composed of either an element, group or a compound which join certain carbon atoms of the chains by primary chemical bonds. Polysaccharide molecules can crosslink by the addition of crosslinking agent. Thus it increases hydrocolloid strength and resistance to solvents and moisture.

Alpha Plantago CL is a combination of highly performance polysaccharides with a selected insolubilizer. When slurried in water the modified tackifier swells and on application cures on the surface, just like normal. But that's it! The tackifier becomes insoluble and thus more resistant to stress conditions during it's active life.

Alpha Plantago is biodegradable and nontoxic to animal and plant life.

Alpha Plantago CL Benefits

- improves mulch stability
- helps stabilize seed & fertilizer
- biodegradable
- nontoxic - no growth inhibitors
- forms organic network on drying
- easy clean up
- hydrates quickly
- consistent quality bag to bag
- non-reemulsifiable after curing

Typical slurry mix with fiber mulch

Water gals	Alpha Plantago CL	Mulch lbs	Coverage	
			acres	sq feet
800	16	320	0.16	6,970
1500	30	600	0.30	13,000
2500	50	1000	0.50	21,800

Increase Alpha Plantago CL to 120 pounds per acre on critical sites.

Typical slurry mix with spray overspray

Water gals	Alpha Plantago CL	Mulch lbs	Coverage	
			acres	sq feet
800	80	106	0.53	23,086
1500	150	200	1.00	43,560
2500	250	333	1.60	69,696

For Straw Blower machine application reduce amount of Plantago and mulch by one quarter.

Suggested Specification

.....shall consist of.....

.....dry powder hydrocolloid Plantago from natural plant source which has been combined with a crosslinker, all of which will hydrate in water and blend with other slurry materials.....and marketed under the trade name *Alpha Plantago CL* or previously proven equal. After application and drying shall tack together the slurry ingredients and shall be nontoxic and exhibit no growth inhibiting factors.....

Application Rates

The recommended use rate for Alpha Plantago CL is 100 pounds per acre. On steeper slopes, light ravelling soils or straw use heavier rates as indicated on charts.

Mixing Instructions

Fill empty tank with water approximately ¼ full. Turn on agitation and continue filling with water. Add dry powder Alpha Plantago CL to the area with greatest agitation. Pour slowly for best mixing. Add other slurry ingredients after tackifier.

Alpha Plantago CL meets or exceeds performance specifications as a dry powder tackifier for dust and erosion control, and revegetation, when used at the recommended application rates.

Reclamare believes the information and recommendations contained here in, to be accurate and reliable. However, we cannot anticipate all conditions under which this information and our product, or the products of other manufacturers in combination with our product, may be used. We accept no responsibility for results obtained by the application of this information or the safety and suitability of our product, either alone or in combination with other products. Users are advised to make their own tests to determine the safety and suitability of each such product or product combination for their own purposes. Unless otherwise agreed in writing, we sell the product without warranty, and buyers and users assume all responsibility and liability for loss or damage arising from the handling and use of our products, whether used alone or in combination with other products.



Reclamare Company

Appendix B

Manufacturer Brochures - Fertilizer

The distinctive difference with all Gro-Power Products is that they work. Gro-Power Products are registered and our base is a true humus, composted beyond the fibrous state, that does not contain any animal matter. The humic acids in our products help increase the cation exchange capacity. Additionally, all Gro-Power Products are designed to enhance the nutrient availability of the soil. Completing the products with nitrogen, phosphorus, potassium, micro-nutrients, and soil enhancers. The following is a brief product description. Extensive individual product information is available from your distributor.

ALL PURPOSE SOIL CONDITIONER/FERTILIZER



GRO-POWER: For soil preparation, backfill, hydroseeding, maintenance, and for all purpose use. 5-3-1 NPK analysis, 70% Humus, 15% Humic Acids, Micronutrients, and Soil Enhancers.
50 lb. bag.
SOIL PREP: 150-200 lbs. per 1,000 sq. ft.
MAINTENANCE: 20-25 lb. per 1,000 sq. feet.



GRO-POWER PLUS: Used for the same purposes as Gro-Power, however it has a Soil Penetrant blended in for use in soil conditions such as clay, adobe soils, or areas with high salt, sodium, boron, or pH problems. 50 lb. bag.
ALSO AVAILABLE WITH 4% OR 12% SULFUR ADDED.
Rates are the same as Gro-Power. Analysis the same with the addition of 1% Soil Penetrant.

TURF FERTILIZERS/SOIL CONDITIONERS

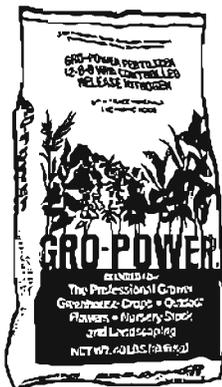


GRO-POWER PREMIUM HI NITROGEN: A maintenance product designed to maximize results, with a goal of slow long-term feeding, instead of a quick green and excessive top growth. 18-3-7 NPK analysis. with 40% of the nitrogen a slow release SCU. 20% Humus, 4% Humic Acids, 4% Sulfur, 1% Iron, 0.50% Soil Penetrant, and Soil Enhancers.
50 lb. bag.
APPLICATION RATE: 8 1/2 lbs. per 1,000 sq. ft.



GRO-POWER HI NITROGEN: A maintenance product designed to feed all types of turf. A specially formulated high nitrogen fertilizer with phosphorus, potash, and sulfur. Two types of nitrogen for quick green-up and longer term feeding. 14-4-9 (S) NPK analysis, 30% Humus, 6% Humic Acids, 3% Sulfur, and Soil Enhancers.
50 lb. bag.
APPLICATION RATE: 7 1/4 lbs. per 1,000 sq. ft.

CONTROLLED RELEASE FERTILIZER



GRO-POWER CONTROLLED RELEASE: For color areas and sensitive plants. Will release slowly under normal conditions, with availability in three analysis depending on your horticultural/landscape needs.
40 lb. bag.
12-8-8 NPK analysis. 25% Humus, 5% Humic Acids. Trace Minerals.

3-4 MONTH RELEASE:
Nitrogen sources 100% sulfur coated urea.

4-6 MONTH RELEASE:
Nitrogen source is 33.5% sulfur coated urea and 66.5% ureaform.

6-8 MONTH RELEASE:
Nitrogen source is 100% ureaform.
APPLICATION RATE: Per product information sheet.

Appendix C

Manufacturer Brochures - Mulch

Silva-Fiber®

Wood Fiber Mulch



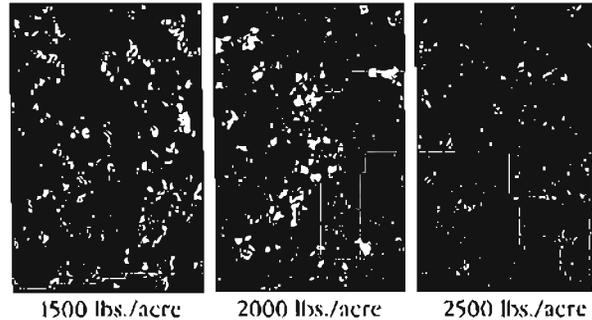
If you're planting grass without Weyerhaeuser Silva-Fiber®, you might as well be throwing your seeds to the wind.

Wind, rain and dryness can destroy or carry away unprotected grass seeds before they have a chance to take root. Silva-Fiber® mulch helps you beat the elements by giving your seeds the best protection available for growing a solid, healthy lawn or ground cover.



How does Silva-Fiber® work?

Designed for use with hydraulic planting equipment, Silva-Fiber® is made from virgin wood fibers, mixed in a large tank with water, seed and fertilizer and sprayed through a nozzle onto the soil. Its long fibers interlock and cling to the soil, forming a web-like network that holds the seeds in place. The network then acts as a second layer of soil that deflects wind and rain and insulates the seeds. It retains moisture to sustain the seeds during dry spells. Silva-Fiber® decomposes and contributes nutrients to the soil, but only after the grass has grown enough to act as a soil stabilizer.



1500 lbs./acre

2000 lbs./acre

2500 lbs./acre

Where can you use Silva-Fiber®?

Use Silva-Fiber® wherever erosion control, soil protection or revegetation is desired:

- Residential lawns
- Highway construction
- Roadside stabilization
- As a tackifier over straw for a two-part mulching application
- Commercial lawns and landscape development
- Golf courses, athletic fields, parks, cemeteries
- Mining reclamation sites, pipeline right-of-ways, and alongside power lines, etc.



Silva-Fiber® Application

Application rates for Silva-Fiber® are as individual as each job. Climate, soil, slope and desired coverage change with every job and affect how much Silva-Fiber® you need.

As a guideline, use 1,500 to 2,400 lbs. per acre for erosion control and 2,000 to 2,500 lbs. per acre for lawns.

Silva-Fiber® is also suitable for use with stolons, at a usual application rate of about 500 lbs. of Silva-Fiber® to 30-40 bushels of stolons per acre. After the sprigs are in place, a second layer of Silva-Fiber® should be applied at the rate of 1,400 lbs. per acre.

Appendix D

Manufacturer Brochures - Erosion Mats

TENAX MULTIMAT 100

PERMANENT EROSION CONTROL MAT

TENAX MULTIMAT 100 is a three dimensional high strength mesh structure specifically designed for turf reinforcement on slopes subject to erosion. TENAX MULTIMAT 100 is manufactured by interweaving and stitching three distinct, high strength polypropylene grids. The mesh structure holds seeds and reinforces new vegetation to protect from erosion. TENAX MULTIMAT 100 is inert to most chemical environments and is stabilized to resist ultraviolet degradation.

Typical applications:

- steep slope protection - turf reinforcement - channel lining systems

MATERIAL CHARACTERISTICS	TEST METHOD	DATA
STRUCTURE		3 BI-ORIENTED GRIDS SEWN
POLYMER TYPE		POLYPROPYLENE
CARBON BLACK CONTENT	ASTM D4218	0.50%

TECHNICAL CHARACTERISTICS	TEST METHOD	UNIT	MULTIMAT 100	Note
PEAK TENSILE STRENGTH	ASTM D1682	lb/ft	540	a,b
MAXIMUM ELONGATION	ASTM D1682	%	8	a,b
POROSITY		%	90	a,d
MASS PER UNIT AREA	ASTM D5261	oz/sy	9.4	a

DIMENSIONAL CHARACTERISTICS	TEST METHOD	UNIT	MULTIMAT 100	Note
THICKNESS	ASTM D5199	mils	700	a,c
ROLL WIDTH		ft	7.2	a
ROLL LENGTH		ft	98	a
ROLL AREA		sf	705	a
GROSS ROLL WEIGHT		lb	53	a

NOTES:

- a) Typical value
- b) Machine direction
- c) At 2 kPa pressure
- d) Calculated value

TENAX Corporation

4800 East Monument Street
 Baltimore, Maryland 21205
 (410) 522-7000
 fax (410) 522-7015

mult 040194



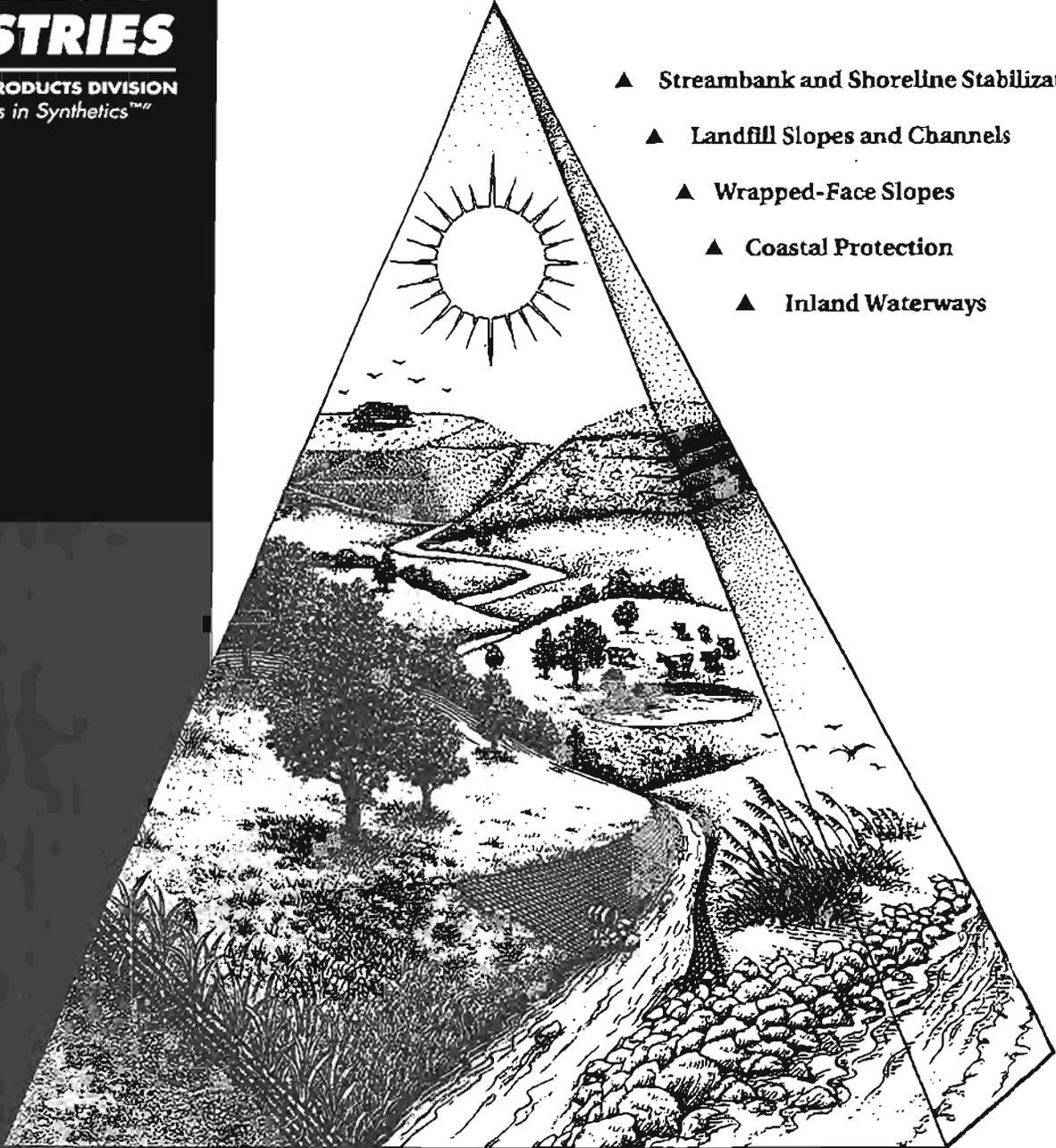
**SYNTHETIC
INDUSTRIES**

CONSTRUCTION PRODUCTS DIVISION
"Smart Solutions in Synthetics™"

PYRAMAT™

Permanent Erosion and Reinforcement Matrix

"The Fourth Dimension in Soft Armor"



- ▲ Streambank and Shoreline Stabilization
- ▲ Landfill Slopes and Channels
- ▲ Wrapped-Face Slopes
- ▲ Coastal Protection
- ▲ Inland Waterways



Engineering Specifications

The PERMANENT EROSION AND REINFORCEMENT MATRIX (PERM) shall be a three-dimensional, lofty, woven polypropylene geotextile specially designed for erosion control applications on steep slopes, water containment structures and vegetated waterways. The matrix shall be composed of polypropylene mono-filament yarns woven into a uniform, dimen-

sionally stable configuration of resilient pyramid-like projections. The material shall exhibit very high interlock and reinforcement capacity with both soil and root systems and demonstrate high tensile modulus. The PERM shall conform to the property values listed below under dry or saturated conditions.

MINIMUM AVERAGE ROLL VALUES (MARV)

PROPERTY	TEST METHOD	ENGLISH	METRIC	
MECHANICAL				
Tensile Strength ²	ASTM D-4595	3,000 X 2,200 lbs/ft	43.8 X 32.1 kN/m	
	ASTM D-5035	4,000 X 3,500 lbs/ft	58.4 X 51.1 kN/m	
Tensile Elongation ²	ASTM D-4595	45% (max)	45% (max)	
	ASTM D-5035	50% (max)	50% (max)	
Tensile Strength ² @ 10% Elongation	ASTM D-4595	1,850 X 1,600 lbs/ft (typ)	27.0 X 23.4 kN/m (typ)	
ENDURANCE				
UV Resistance @ 1000 hours	ASTM D-4355	80%	80%	
PHYSICAL				
Thickness	ASTM D-1777	0.5 in	12.7 mm	
Resiliency ³	ASTM D-1777	80%	80%	
Mass Per Unit Area	ASTM D-5261	14 oz/yd ²	475 g/m ²	
Ground Cover Factor ⁴	Light Projection Analysis	75%	75%	
PERFORMANCE		MAXIMUM PERMISSIBLE VALUE⁵		
Velocity	<u>Short Term (1/2 hr)</u>		<u>Long Term (50 hrs)</u>	
	Vegetated	25 ft/sec	7.6 m/sec	14 ft/sec
Unvegetated	20 ft/sec	6.1 m/sec	10 ft/sec	3.0 m/sec
Shear Stress	Vegetated		6 lbs/ft ²	
	Unvegetated		3 lbs/ft ²	
	10 lbs/ft ²	48.9 kg/m ²	29.3 kg/m ²	
	8 lbs/ft ²	39.2 kg/m ²	14.7 kg/m ²	

NOTES:

- All published values are Minimum Average Roll Values (MARV) unless otherwise indicated, yielding a 95% confidence level. Additional property values available upon request.
- Values for both machine and cross machine directions under dry or saturated conditions.
- Resiliency defined as percent of original thickness retained after 3 cycles of a 100 psi load (690 kPa) for 60 seconds followed by 60 seconds without load...thickness measured 30 minutes after load removed in accordance with ASTM D-1777.
- Ground Cover Factor represents "% shade" from Lumite Light Projection Test.
- Values obtained at an independent hydraulics testing laboratory.

STANDARD ROLL SIZE INFORMATION = 6 ft x 90 ft = 540 ft² = 60 yd²
1.83 m x 27.4 m = 50 m²

FABRICATED DOUBLE WIDE ROLLS = 12 ft x 90 ft = 1080 ft² = 120 yd²
3.66 m x 27.4 m = 100 m²





CELLULAR CONFINEMENT SYSTEM

MATERIAL

EnviroGrid™ standard sections are manufactured from High Density Polyethylene Plastic ("HDPE") of the following minimum standards:

Sheet Thickness:	50 mil ± 4 mils
Density:	.941 - .960 gr/cm ³ in accordance with ASTM D762
Carbon Black Content:	1½% - 2½% in accordance with ASTM D1603
ESCR: (Environmental Stress Crack Resistance)	2,000 hour minimum in accordance with ASTM D1693

DIMENSIONS

EnviroGrid™ in standard section configuration has nominal expanded dimensions of 2", 3", 4", 6", and 8" (56mm, 76.2mm, 102mm, 152mm, and 203mm) cell depths, with a width of 8' (2.44m) and length of 20' (6.1m). Unexpanded spacing of weld joints is 13" (330mm), ± 0.10" (2.5mm), with melt pool width not exceeding 0.500" (12.5mm). The cells are uniform in shape and size. Nominal dimensional tolerances are within ± 0.250" (6mm).

FABRICATION

EnviroGrid™ standard size sections are manufactured from 60 strips of HDPE; each of appropriate width and 11 feet (3.35m) in length.

Cell joints are ultrasonically spot welded with 3 spot welds per inch (3 welds per 25.4mm) uniformly spaced across the width of each strip. Seam strengths are uniform across the entire width of the cell joint.

A 4" (101.6mm) wide weld joint creep test sample will support a load of 160 pounds (72.5kg) for a minimum of 30 days; or support a load of 160 pounds (72.5kg) for a minimum of 7 days in a temperature controlled environment undergoing temperature change from ambient room temperature 74° ± 4°F to 130° ± 4°F (23° ± 2°C to 54° ± 2°C) on a 1 hour cycle.

SPECIALTY ITEMS

EnviroGrid™ can be manufactured to nonstandard configurations. Contact an EnviroGrid™ distributor for information.

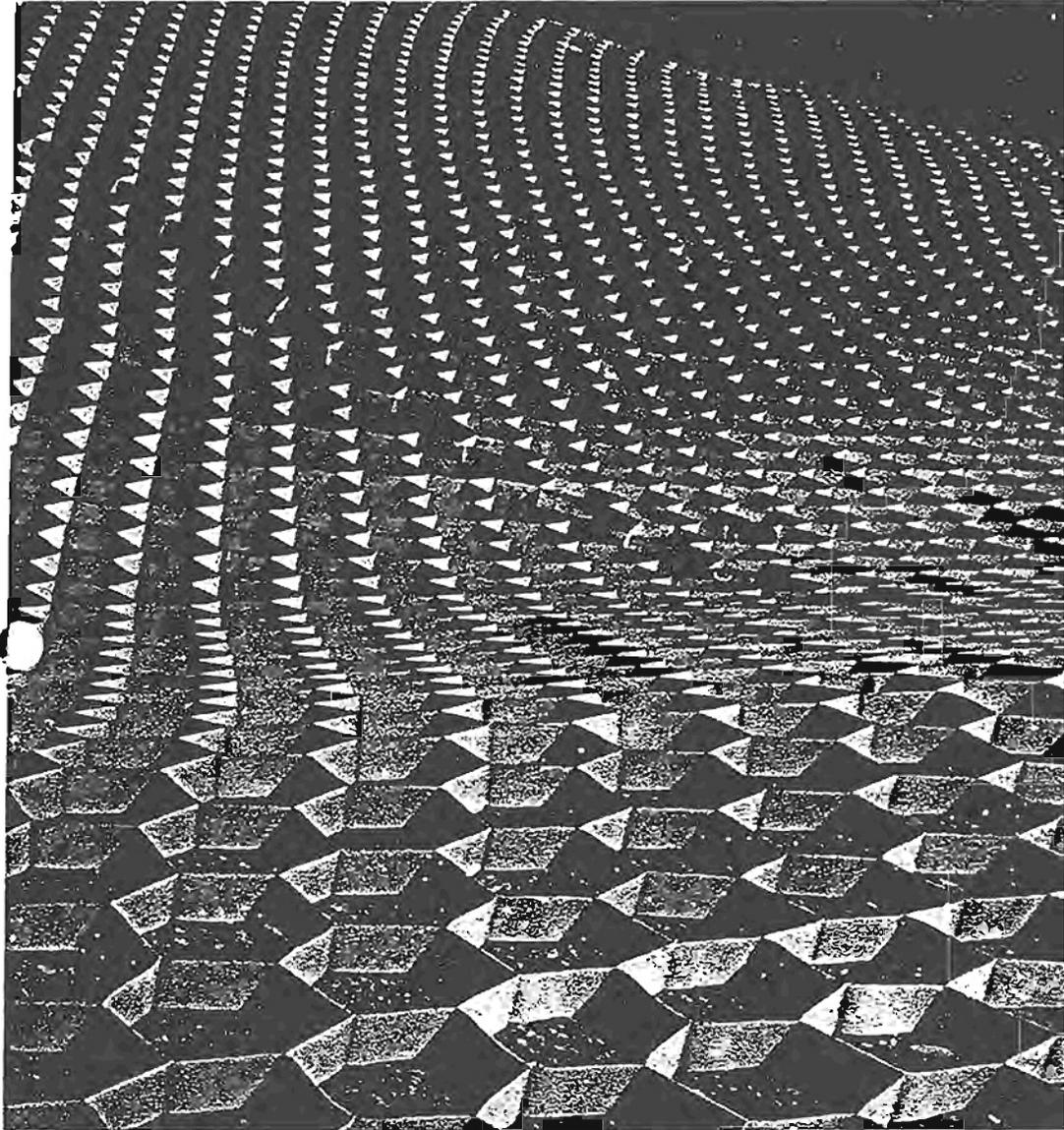
ENVIROGRID™ SIZE	NOMINAL CELL DEPTH	CELL JOINT STRENGTH*	NOMINAL WEIGHT	NUMBER OF WELDS
EnviroGrid™ 8"	8" (203mm)	525 lb (2,333 N)	111 lb (50.35kg)	23
EnviroGrid™ 6"	6" (152mm)	393 lb (1,746 N)	84 lb (38.10kg)	18
EnviroGrid™ 4"	4" (102mm)	262 lb (1,164 N)	56 lb (25.40kg)	11
EnviroGrid™ 3"	3" (76.2mm)	196 lb (871 N)	32 lb (14.51kg)	9
EnviroGrid™ 2"	2" (56mm)	131 lb (582 N)	28 lb (12.70kg)	6

NOTE: All dimensions are subject to manufacturing tolerances

*Minimum joint tensile peel strength when tested per Figure 1

Armater®

Geocell Containment System



- Earth and slope surface reinforcements
- Highway embankments
- Headwalls and wing-walls
- Pipeline and culvert installations
- Highway bed containment
- Pond embankments
- Landfills
- Railroad ballast containment
- Earthen dams
- Tailings dams



Features

- Lightweight
- Permeable cell walls
- Flexible
- Large expanded panels
- Easy to fabricate on site

Benefits

- Easy to install, low shipping costs
- Drains from cell to cell
- Conforms to terrain
- Covers more area, less labor
- No waste, works around obstacles

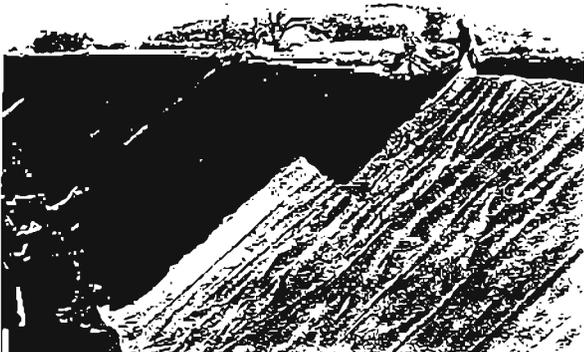
Gaining Ground Thru IngenuitySM



Enkamat® "S"

Friction and Grip Layer

Increase the Friction Angle Between Soil and Liner



Installation of reinforced Enkamat over liner material.



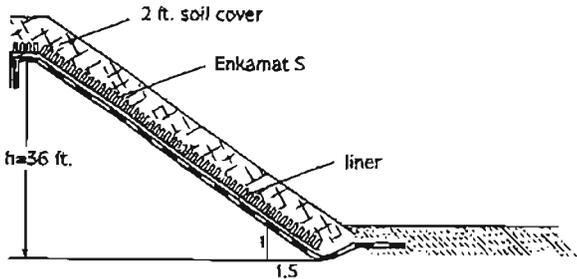
Load is transferred to anchor trench.



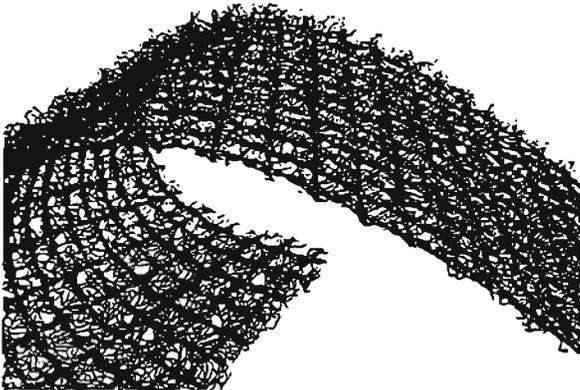
Applying cover soil.



Wild flowers growing on the lined slope.



Enkamat S on a typical liner.



Close up view of Enkamat S.



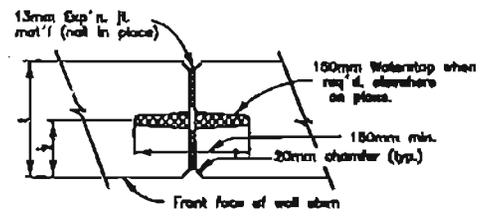
Akzo Industrial
Systems Company
Suite 318, Ridgefield Business Center
Ridgefield Court
P.O. Box 7249
Asheville, NC 28802
Telephone (704) 665-5050
Telefax (704) 665-5009

Appendix E

Concrete Wall Details

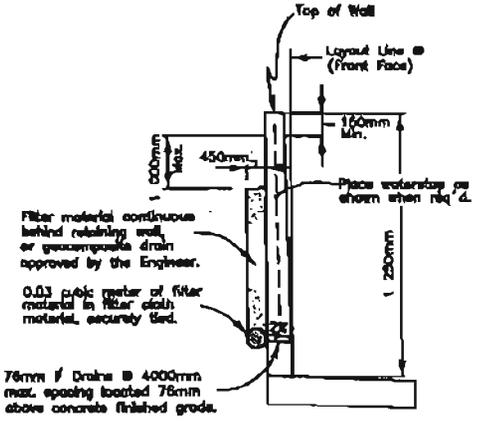
AS CONSTRUCTED		
NO REVISIONS	REVISED	VOID

PROJ. NO.	SECTION	WALL NO.	SHEET NO.
VSI	COLL.	STE 0403-010	10

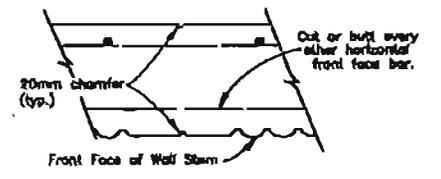


EXPANSTION JOINT

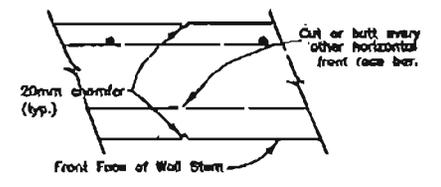
NOTE: 150mm Waterstop shall conform to Section 518 of the Standard Specifications. The cost of the waterstop shall not be paid for separately, but shall be included in the work. Terminate waterstop joint material 150mm from the top of wall.



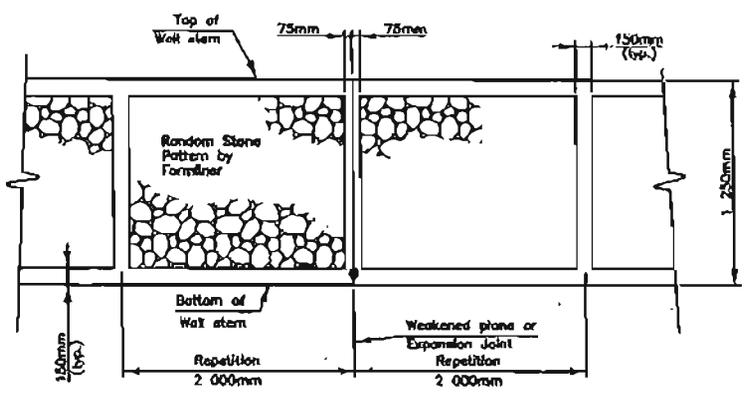
DRAINAGE



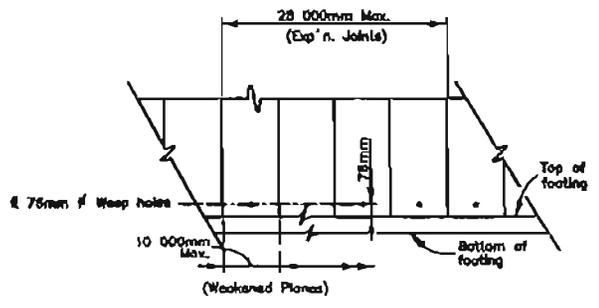
WEAKENED PLANE @ FIELD-STONE PATTERN FACADE
(@ 10 000mm Max.)



WEAKENED PLANE @ WALL CAP
(@ 10 000mm Max.)



WALL FACADE FORMLINER PATTERN



WALL EXPANSION JOINTS AND WEAKENED PLANES

COLORADO DEPARTMENT OF TRANSPORTATION			
WALL DETAILS			
Designer S T Wang	Structure		
Checker T O Edwards	Numbers		
Drawing Number B 3		of 3 Drawings	

NO.	DATE	BY	DESCRIPTION
1	11/17/11	STW	DESIGN
2	11/17/11	STW	REVISED
3	11/17/11	STW	REVISED
4	11/17/11	STW	REVISED
5	11/17/11	STW	REVISED
6	11/17/11	STW	REVISED
7	11/17/11	STW	REVISED
8	11/17/11	STW	REVISED
9	11/17/11	STW	REVISED
10	11/17/11	STW	REVISED

04/17/11 Rev. R 1 2011 Colorado Department of Transportation

