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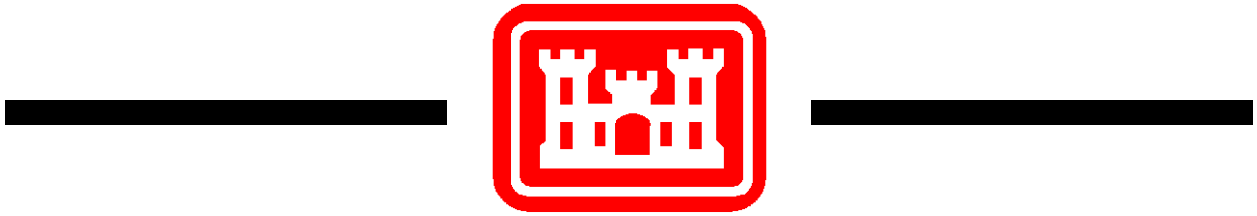
31 JANUARY 2014

ENVIRONMENTAL CONSIDERATIONS OF STABILIZING TREATMENTS FOR TANK TRAILS



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DEPARTMENT OF THE ARMY
US Army Corps of Engineers
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Washington, DC 20314-1000

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No. 200-1-124

Facilities Engineering
Environmental

ENVIRONMENTAL CONSIDERATIONS OF STABILIZING TREATMENTS FOR TANK TRAILS

1. Purpose

a. This Public Works Technical Bulletin (PWTB) evaluates four environmental rehabilitation treatments tested on a military tank trail. The evaluation compares the durability, structural stability, and cost efficiency of treatments which used a varying composite of soil, gravel, riprap, and geosynthetics.

b. This PWTB is written as an aid for mitigating environmental impacts from tank trails. It does not address general trail maintenance or all potential technologies.

c. All PWTBs are available electronically at the National Institute of Building Sciences' Whole Building Design Guide webpage, which is accessible through this link:

http://www.wbdg.org/ccb/browse_cat.php?o=31&c=215

2. Applicability

This PWTB applies to all US Army installations, organizations, and agencies. Applicability includes Active Army, Army National Guard, and Army Reserve units within the United States that are responsible for mitigating environmental impacts from tank trails, secondary roads, and access dirt roads.

3. References.

a. Army Regulation (AR) 200-1, "Environmental Protection and Enhancement," revised 13 December 2007.

b. The Clean Water Act (CWA) as amended (Public Law 95-217, 33 U.S.C. 1251 et seq.), 27 December 1977; 1987 amendments.

4. Discussion.

a. AR 200-1 covers environmental protection and enhancement and provides the framework for the Army Environment Management System. The regulation addresses environmental responsibilities of all Army organizations and provides guidance for preserving, protecting, conserving, and restoring environmental quality.

b. The CWA of 1972 and its subsequent amendments establish the basic structure for regulating discharge of point and nonpoint source pollutants (e.g., erosion, sediment, oil, and grease) into US waters.

c. There currently is no Army policy specifically directed to the subject matter of this PWTB. However, there is Army guidance on or closely related to the subject. This PWTB supports and is specifically in accordance with guidelines specified in TM 5-626 "Unsurfaced Road Maintenance Management", TM 5-822-12 "Design of Aggregate Surfaced Roads and Airfields", and TM 5-822-5 "Pavement Design for Roads, Streets, Walks, and Open Surfaces."

d. Unsurfaced tank trails provide critical access to firing ranges and training areas that support military training missions. Degraded and gullied tank trails present formidable problems with troop safety, vehicle downtime, fugitive dust, surface erosion, and sediment discharge into downstream woodlands and surface waters.

e. Opportunities exist to develop new methods for land restoration that are less costly and more effective than current methods. This evaluation showed that by using improved land restoration methods, an installation can realize more benefit from each land restoration dollar spent. The effectiveness of various environmental treatment methods may vary, however, for installations located in different geographic regions or climates.

f. Appendix A provides background and describes environmental impacts of eroded trails on water quality and

sensitive habitat as well as cost impacts on constrained budgets. It emphasizes that drainage is the most important factor in designing a tank trail. A brief literature review is presented at the end of Appendix A.

g. Appendix B contains an assessment of conditions on the test trail. As Appendix B describes, deeply eroded gullies and surface washouts had nearly rendered the trail impractical for use. This appendix also describes various materials and methods tested and evaluated for environmental restoration of the trail and shows post-construction conditions to substantiate their effectiveness.

h. Appendix C provides "lessons learned" from this project and provides guidance for Army land managers on the environmental methods most effective for tank trails.

i. Supplemental material is given in the remaining appendices. References are listed in Appendix D, and Appendix E provides a list of acronyms and abbreviations. Construction contract design specifications are provided in Appendix F, with details of materials used and methods employed.

5. Points of Contact.

a. Headquarters, US Army Corps of Engineers (HQUSACE) is the proponent for this document. The point of contact (POC) at HQUSACE is Mr. Malcolm E. McLeod, CEMP-CEP, 202-761-5696, or e-mail: Malcolm.E.Mcleod@usace.army.mil.

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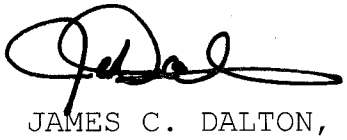

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APPENDIX A:
IMPORTANCE OF ARMY TANK TRAILS

Background

Tank trails provide critical access to ranges and other training areas that support tank maneuvers and troop convoy training. Providing this tactical training access, however, can result in significant negative environmental impacts on the landscape. For example, training activities can be negatively impacted by dust during dry periods and by eroded trails or washed-out shoulders during wet periods. Environmental problems arise with tank trails because, many times, little consideration is given to ensuring adequate drainage to properly control surface water runoff.

There currently is no Army policy specifically directed to the specific subject matter of this PWTB. However, there is Army guidance on or closely related to the subject. The environmental recommendations of this PWTB support and are in accordance with guidelines specified in TM 5-626 "Unsurfaced Road Maintenance Management", TM 5-822-12 "Design of Aggregate Surfaced Roads and Airfields", and TM 5-822-5 "Pavement Design for Roads, Streets, Walks, and Open Surfaces."

When a tank trail fails, excess water and inadequate drainage are often the causes. Then, because tank trails usually pass through sensitive wooded areas, the habitat of various endangered plant and wildlife species can be negatively affected. For example, sometimes drainage problems result in vehicles detouring through these sensitive woodlands or rerouting along shoulders of parallel paved roads. This detouring simply shifts the problem or makes it even worse, because the shoulders are not designed to handle vehicular traffic.

Furthermore, a lack of surface drainage on dirt tank trails reduces their useful life, increases erosion and sediment transport, and results in increased costs that can strain the already-stressed installation budget. For example, Fort Bliss, Texas, was provided funding of $60 million in 2009 just to repair tank trails that had been neglected over several years.

Similar problems arise from fugitive dust, which is known to be responsible for fatal accidents from diminished visibility, and can cause hazards ranging from aggravating respiratory illness to increasing wear and tear on equipment.

Prior Military Research on Tank Trails

Eaton and Beaucham (1992) describe a road system for use on military installations. Chou (1989) provides design criteria characteristics for aggregate-surfaced roads and airfields at military and other Department of Defense (DoD) facilities.

Hinchman et al. (1990) document a long history of training activities by tracked and wheeled vehicles at Fort Carson, Colorado. Those activities have caused extensive erosion and damage to vegetation. The authors developed and demonstrated ecologically effective and economically feasible soil rehabilitation and revegetation techniques designed to increase soil stability and provide a more realistic training environment. Their approach involved excluding traffic from sensitive and damaged areas and managing tank trails to promote healthy ecosystems in adjacent areas.

White (1997) indicated that roadway surface degradation, roadside gully development, deposition of sediments in culverts and ditches, and roadway flooding due to reduced ditch capacity are all common problems encountered by the military land manager.

The ability to identify the geomorphic condition of a road section and its adjacent slopes is mandatory for predicting potentially unstable conditions and significantly enhancing the timeliness, placement, and effectiveness of mitigation measures (White 1997). Use of White’s information should simplify selection, placement, and timing of the most appropriate remediation typically applied to the secondary road or tertiary trail.

It should be noted that understanding the geomorphic condition must happen prior to road design. The second note is that geomorphic conditions are site-specific and thus, a geomorphic evaluation of all road sties/potential road sites is required.

APPENDIX B:
ASSESSMENT OF PREACHERS ROAD TANK TRAIL AT FORT BRAGG, NORTH CAROLINA

Background of Fort Bragg Trails

The condition of hundreds of miles of trails is an important part of Fort Bragg's land restoration program. Drainage and runoff control is a widespread problem for these trails. Trails running through wooded areas often have trees so close to the trail edge that adequate drainage ditches cannot be constructed for surface runoff. Most drainageway crossings are unimproved; frequent grading and reshaping have been the only method of improvement to this point.

This PWTB reports the results from investigations of the durability, structural stability, and relative cost efficiency of four tank trail construction methods installed in 1998 on sections of Preachers Road Tank Trail and subsequently observed (Figure B-1 and Figure B-2).

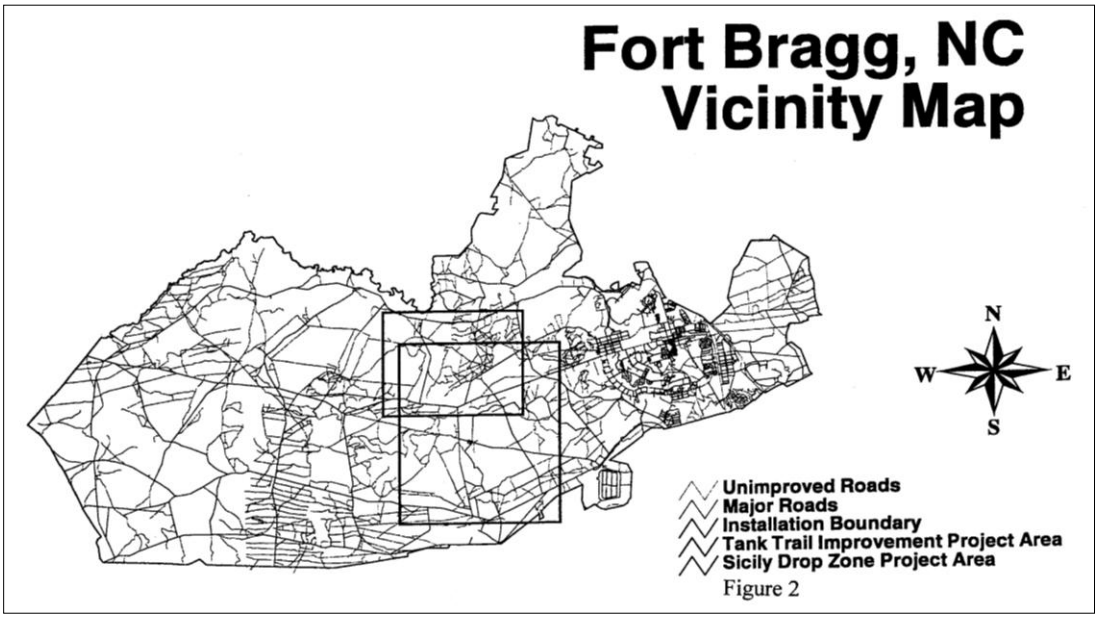

Figure B-1. Vicinity map for Fort Bragg roads. (Figure produced by USACE Savannah District and provided by Fort Bragg DPW-Environment.)

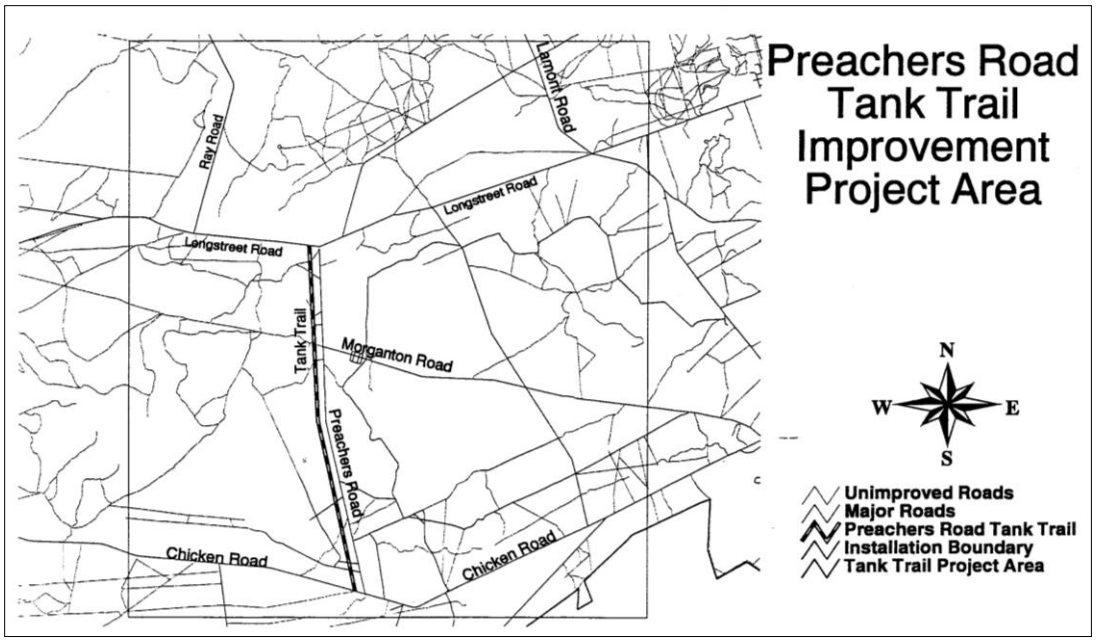

Figure B-2. Close-up area from previous figure of Preachers Road Tank Trail Improvement Project Area. (Figure produced by USACE Savannah District and provided by Fort Bragg DPW-Environment.)

In summer 1994, the Preachers Road Tank Trail running parallel to the Preachers Road was treated by the Fort Bragg Department of Public Works, (DPW) personnel, using locally available "crusher run" stabilizer to a 30-ft width and a 6-in. minimum depth. Soil testing reports classified the surface to be treated mainly as moderately expansive clay or clay loam. Prior to placement of this crusher run treatment, the eroded trail was graded to fill low spots and potholes. The trucked-in crusher run stabilizer was then spread and further compacted by using a vibratory smooth-drum roller. Heavy rains fell the day after construction, but the stabilized section was already able to support tracked-vehicle traffic while, by contrast, tanks rutted an adjacent control section to a 6-in. depth. However, this temporary fix did not last long, and the crusher run treated trail condition deteriorated during the first year after treatment.

Thus, Fort Bragg was interested in finding a more durable and cost-effective solution to protect the usefulness and improve the ecological impact of its tank trails. Fort Bragg was especially interested in reducing wet-weather rutting and erosion, dry-weather dust problems, and reducing frequency of needed mitigation for improved cost efficiency.

The efforts at Fort Bragg will be useful to other Army installations that seek to meet range sustainability and

environmental compliance goals (especially in minimizing soil erosion). Improved tank trail operation also will reduce labor and material costs, as existing mitigation designs have been assessed for cost and impact on range downtime that would negatively affect the military mission.

Observations on Preachers Road Tank Trail

A series of pre- and post-construction pictures were taken by the project contractor (Phillips and Jordan, Inc. of Raleigh, North Carolina) and ERDC-CERL's principal investigator (Muhammad Sharif) to document trail conditions (Figure B-3 — Figure B-11). Windshield surveys were performed by the author on two occasions: one year after construction (1999) and another in March 2011. Both surveys found that, in general, the tank trail has remained in good shape since its 1998 upgrade.[1] Rills and small gullies were present in some locations, found to be nearly always a result of improper construction or mitigation of portions of the trail.

Per Fort Bragg DPW personnel, routine repair work had been done periodically to the tank trail since its construction. It should be noted, however, that some of this work had merely created additional erosion problems. For example, ridges of soil that had formed along the road were a result of grading the trail (e.g., Figure B-3), and they prevented water from running off the trail. In flat sections of the trail (e.g., Figure B-4), these ridges did not result in erosion problems since the slope is small and the concentrated water along the ridges has a velocity slow enough to safely enter the forest. However, in areas in which the slope is greater, the water that concentrates along these ridges has a velocity that is high enough to erode the soil and create rills or small gullies (Figure B-5 — Figure B-8). Finally, when enough water accumulates and cannot escape, very wet areas occur that can impede traffic (Figure B-9) and/or deep gullies form that transport sediment (Figure B-10 and Figure B-11).

To prevent drainage issues, the following steps should be taken: (1) the road should be crowned in the center to drain to either side of the road; (2) there should be a drainage pathway on

[1] In addition, agricultural engineering professor from Purdue University independently observed the trails to be in good condition.

either side of the road with a grade sufficient for water to drain, but not so great as to encourage erosion; and (3) material for the crown in the road should come from material excavated from the drainage paths. Note, too, that optimum use of geomorphic condition is the key to draining the left and right sides of the roadway to any adjoining swales and valleys.

The sections of the trail in which rip rap was installed to stabilize drainage ditches generally have exhibited only small amounts of erosion (Figure B-12). In some instances, concentrated flow areas along the trail and in ditches along the road resulted in some gully formation. Erosion in those areas could be greatly reduced with the use of rip rap. However, it should be noted that, in general, drainage ditches with rip rap installed will tend to "silt up" and become less effective. To help the drainage path remain open, rip rap can be wrapped in a nonwoven synthetic geofabric and lightly covered with stone.

The section of the road and ditches in which crushed concrete had been applied generally had only small amounts of erosion. Some sections of trail had ditches in which gullies were forming. The water in these ditches or concentrating along the sides of the road should be diverted into the surrounding forest so that runoff can be safely infiltrated. Additional crushed concrete in those ditches would help stabilize the ditches and greatly reduce gully formation (Figure B-13 to Figure B-15).

The areas with erosion mat beneath the trail were in good shape and did not exhibit signs of significant erosion (Figure B-16 to Figure B-18). The use of mats provided the intended erosion control and proved particularly useful in sections of trails with high slopes.

Roads being built could be chemically stabilized using a mechanical injection of lime slurry or the addition of lime to the road bed as the crown in the road is being established. In the case of Fort Bragg's moderately expansive clay and clay loam soil types, a limestone/carbonate-based aggregate could serve to chemically stabilize the soil. While lime stabilization is not a permanent fix, it should last 5–20 yr.

Figure B-3. Note ridges of soil along each side of the road that prevent water from running into forest. Ridges were formed as a result of grading (Phillips and Jordan, Inc.).

Figure B-4. Another place where ridges of soil along the side of the road prevent water from running into forest; however, the road's flatness means little damage is done (Phillips and Jordan, Inc.).

Figure B-5. Rills and small gullies forming along and in the road (Phillips and Jordan, Inc.).

Figure B-6. Close-up of a rill in the road, which is deepening as water continues to be unable to get off the road (Phillips and Jordan, Inc.).

Figure B-7. Larger gully on side of road, formed as a result of water running down the road at higher velocity (Phillips and Jordan, Inc.).

Figure B-8. Close-up of gully from previous picture. Note that headcut in gully is moving up the hill (Phillips and Jordan, Inc.).

Figure B-9. Wet area on road develops when water accumulates in larger rills and gullies from being unable to run off the road (Phillips and Jordan).

Figure B-10. Deposition of sediment along road, carried by gullies (Phillips and Jordan, Inc.).

Figure B-11. Gully along road due to runoff from area adjacent to the road (Phillips and Jordan, Inc.).

Figure B-12. Riprap in ditch along road is being used for erosion control (Phillips and Jordan, Inc.).

Figure B-13. Sediment basin along roadside to carry runoff away from roadway (Phillips and Jordan, Inc.).

Figure B-14. Stabilized channel to convey water away from road (Phillips and Jordan, Inc.).

Figure B-15. Riprap along trail for erosion control (Phillips and Jordan, Inc.).

Figure B-16. Erosion control mat (Geoweb®) visible in road surface (Phillips and Jordan, Inc.).

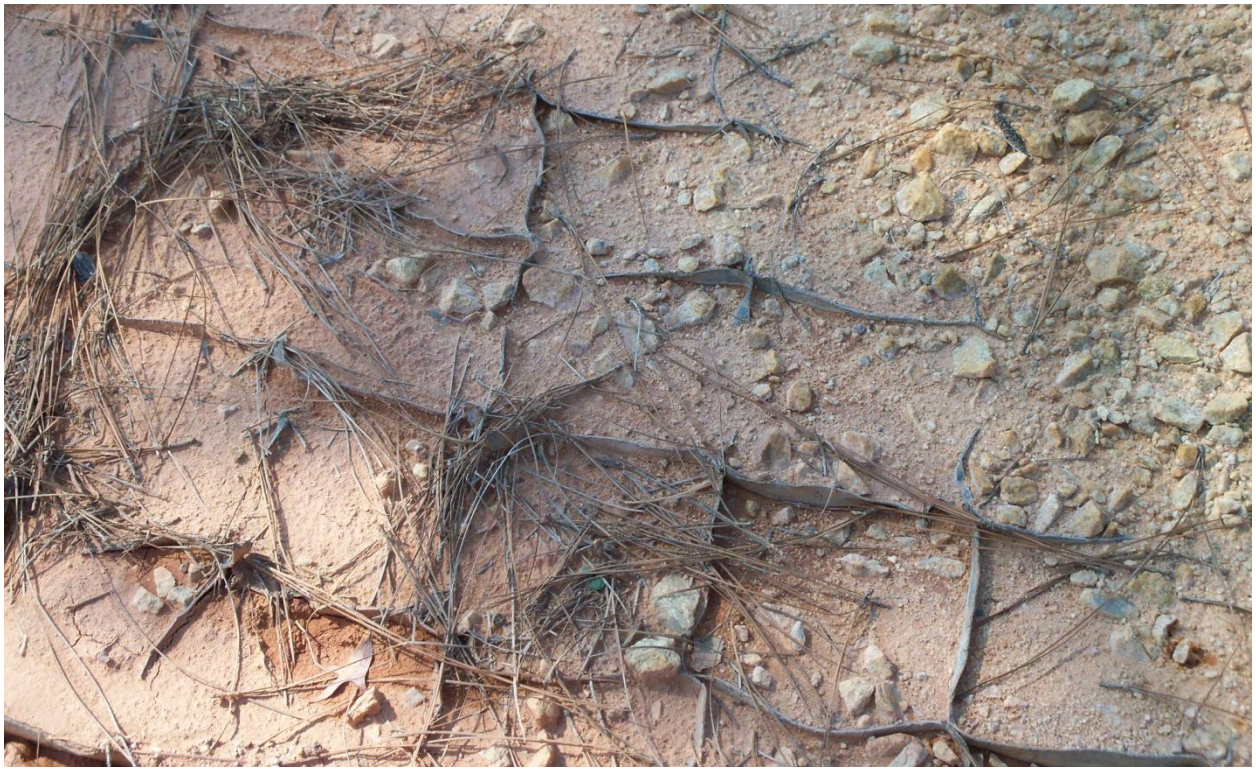

Figure B-17. Close-up of erosion control mat (Geoweb) in road surface (Phillips and Jordan, Inc.).

Figure B-18. Erosion control mat visible along road, showing there is little erosion except some fines leaving (Phillips and Jordan, Inc.).

Test Requirements and Objectives

ERDC-CERL developed designs for selected sections of the total 4-mile length of Preachers Road Tank Trail to be used as test areas. The designs were implemented through the USACE Savannah District, which awarded Contract #DACA21-97-B-0066 in 1997 to Phillips & Jordan, Inc. of Raleigh, North Carolina. Work was started and completed during 1998.

As stated previously, the objective of this work was to examine the durability, structural stability, and cost-efficiency of four tank trail materials and methods that were specified in the design. An ancillary objective was to provide planning considerations for rehabilitation of tank trails at other Army installations.

In order to fulfill the objectives, the contractor first performed on-site surveys in 1998 and collected data to document the present condition of the Preachers Road Tank Trail, including surveys of the alternate materials and methods in use. Based on these on-site inspections and surveys, the contractor provided detailed findings on effectiveness, durability, and cost-efficiency of the practices implemented. The contractor further recommended weaknesses and strengths of the materials and methods used and "dos and don'ts" for future rehabilitation at Army installations (see Appendix C). The recommendations were also designed to incorporate surface drainage considerations in future designs.

The contractor also met with Fort Bragg personnel to collect information on the comparative condition of this tank trail with other trails using conventional materials and methods at Fort Bragg. The contractor then incorporated Fort Bragg personnel's recommendations on "lessons learned" about the effectiveness and cost efficiency of Preachers Road Tank Trail conditions and treatments (see Appendix C).

Technology Tested

The following four treatments were tested in 1998 on Preachers Trail.

1. *Treatment #1 (borrow only)*. Fill, compact, and grade the eroded, rutted, and washout sections with sandy borrow material Figure B-19).

2. *Treatment #2 (borrow layer, Geoweb, 2 layers of borrow fill)*. Fill, compact, and grade the eroded, rutted, and

washout sections with sandy borrow material. Install 8-in. deep cellular confinement systems (Geoweb) and fill in the cells with on-site borrow material, followed by 4-6-in. layer of another borrow (refer to Figure B-16).

3. *Treatment #3 (borrow layer, Geoweb, 2 layers crusher run fill).* Fill, compact, and grade the eroded, rutted, and washout sections with sandy borrow material. Install 8-in. deep cellular confinement systems (Geoweb) and fill in the cells with crusher run gravel, followed by 4-6-in. layer of another crusher run gravel (refer to Figure B-17).

4. *Treatment #4 (fabric, 2-ft. rip rap cover, 12-in. crusher run cover).* Install geosynthetic fabric and place riprap (d50 = 6 in.) 2-ft deep, then cover with 12-in. crusher run gravel (Figure B-20). This treatment was used to stabilize sections with unstable subgrade.

As stated above, the comments and lessons learned from the treatments can be found in Appendix C. In addition, see Appendix F for supporting documentation provided by the contractor, based on design specifications by ERDC-CERL. This documentation may be useful to other Army land managers addressing similar issues.

Figure B-19. Treatment #1 – layer of sandy borrow material only (ERDC-CERL).

Figure B-20. Treatment #4 – fabric, 2-ft riprap cover, and 12-in. crusher run cover (ERDC-CERL).

APPENDIX C:
LESSONS LEARNED

Modern-day military maneuvers of wheeled and tracked vehicles can have significant environmental impacts on the landscape.

As previously stated, the tank trail paralleling Preachers Road at Fort Bragg was improved and upgraded in 1998. Four different methods and materials (described in Appendix B) were used during this process and included geosynthetics, soil, rock, and gravel.

The goal was to provide land managers with an understanding of how patterns of environmental damage to trails evolve, and how that damage can affect primary access. The related goal was to investigate or develop new materials that would effectively control dust and erosion, while also reducing equipment and labor requirements to mitigate the negative environmental impacts to trails and surrounding environments.

Lessons Learned - General

- Water and dust are the main enemies of all tank trail networks at Army installations. Especially in wet weather conditions, any vehicular traffic on uncrowned roads that cause water to be channeled down the roadbed will create a need for constant grading. On the opposite end of the weather spectrum, the presence of fine-particle silty-clay soil creates a dust-control problem in dry weather.

- Mitigation activities can be divided into five basic categories: drainage (critical), surface maintenance, cut and fill slopes, erosion control, and vegetation control.

- The most important aspect of trail condition is good drainage. Properly vegetated or riprap-filled shoulders and ditches are important to maintaining the flow required to remove surface water runoff (Figure C-1 — Figure C-3).

- All trail sections must be constructed, crowned, and compacted with a minimum 1 ft of fill above the surrounding contour of the ground, to shed all runoff immediately and keep the surface dry (Figure C-4). The drier the trail surface can be kept, the more durable it will be.

- Remedy the cause before repairing the problem. For example, surface repairs made on a defective subgrade are wasted; it will cost less in the long run to install proper drainage

structures and rock surfacing on a road that gets mudded and rutted every winter than to regrade the road surface every spring.

- Adequate-sized culverts, free-flowing ditches, and properly drained road surfaces and stream crossings (Figure C-5) are essential elements of a reliable road drainage network. Without these elements in place, even a moderate storm can render a road impassable.

Figure C-1. Stabilize road shoulder with riprap (Phillips and Jordan).

Figure C-2. Stabilize road shoulder with vegetation (ERDC-CERL).

Figure C-3. Use hydroseeding for difficult shoulder areas (Phillips and Jordan).

Figure C-4. Road surface should be raised 1 ft above contour (Phillips and Jordan).

Figure C-5.Concrete stream crossing without adequate drainage (Phillips and Jordan).

Observations at Fort Bragg (before new treatments)

Observations of the condition of Preachers Road Tank Trail before treatment yielded the lessons outlined below.

- Rills and small gullies observed in some locations were nearly always the result of improper maintenance and/or improper construction of portions of the trail.

- Ridges of soil can form along the road as a result of grading the trail and will prevent water from running off the trail. In flat sections of the trail, these ridges do not result in erosion problems, since the slope is small and the concentrated water along these ridges has slow velocities. However, in areas in which the slope is greater, the water that concentrates along these ridges has a velocity high enough to erode the soil and create rills or small gullies.

- The road should be crowned to force water to run off to the edges. Water concentrating along the edge of the road should periodically be diverted away from the edge of the road with turnouts or by other means, to reduce the amount of water concentrating and flowing down the slope.

- The section of the road and ditches in which riprap and/or crushed concrete was applied generally had only small amounts of erosion.

- Some sections of trail with riprap or crushed concrete had ditches in which gullies were forming. Additional riprap or crushed concrete in these ditches would help to stabilize the ditches and greatly reduce gully formation.

Lessons Learned from Fort Bragg (after new treatments)

A windshield survey of Preachers Road Tank Trail was done again in March 2011. It was observed that both tank and armored troop transport equipment had utilized the treated sections. Fort Bragg personnel reported that the tank trail was in extremely good condition and had performed without maintenance since treatment. In fact, its condition was reported superior to that of adjacent sections which had not been treated.

The performance of Treatment #3 (Geoweb with two layers of crusher run) was impressive, considering the area had been subjected to record rainfall in months prior to the first inspection in 1999. The engineering firm additionally noted that tanks were clearly turning on top of the treated material and then creating ruts as deep as two feet in the untreated shoulder areas as they maneuvered off the tank trail. Fort Bragg personnel confirmed that this low-cost treatment has continued to support all forms of heavy traffic without damage to the road structure.

Before summarizing the observations after treatment, the four treatment options are repeated below.

1. *Treatment #1*: fill, compact, and grade the eroded, rutted, and washout sections with sandy borrow material.

2. *Treatment #2*: fill, compact, and grade the eroded, rutted, and washout sections with sandy borrow material. Install 8-in. deep cellular confinement systems (Geoweb) and fill in the cells with borrow, followed by 4-6-in. layer of another borrow.

3. *Treatment #3*: fill, compact, and grade the eroded, rutted, and washout sections with sandy borrow material. Install 8-in. deep cellular confinement systems (Geoweb) and fill in the cells with crusher run gravel, followed by another 4—6-in. layer of crusher run gravel.

4. *Treatment #4*: install geosynthetic fabric and place riprap (d50 = 6 in.) 2-ft deep, then cover with 12-in. crusher run gravel.

The following is a summary of observations made after improvements were made to Preachers Road Tank Trail.

- Investigations show that Treatment #4 is the most effective solution for trails with no drainage outlets and/or those having unstable subgrade, where the water has the tendency to pond because it has nowhere to go. Treatment #4 also is particularly effective for trail sections with deep ruts.

- If subsurface drainage can be provided, then Treatment #3 is the more cost-effective and preferred choice over the long term. In this treatment, Geoweb is placed and then filled with borrow material or gravel. Crusher run gravel is then added as the surface layer. Note that over time, low spots could develop; these should be filled as soon as possible to maintain the proper grade.

- One section of the trail with Treatment #1 is holding well. This is the section where tracked traffic is very light and infrequent. Treatment #1 is the least expensive method of refurbishing the trail under these circumstances.

- A trail section where unsatisfactory borrow material (containing excess clay) was tested seems to be performing poorly. The trail stays wet, and vehicular traffic that occurs (when rain is falling or soon thereafter) will lead to ruts and depression areas. It is shown that Treatment #3 will be cost-effective in the long run where low sections of the trail are filled in with borrow and the upper 1 ft of road surface is repaired with Geoweb followed by crusher run.

- The areas of the road with erosion mat beneath the trail were in good shape and did not exhibit signs of significant erosion. This practice provided the intended erosion control and is particularly useful in trail sections with high slopes.

- The sections in which vegetation was used to stabilize drainage ditches generally exhibited small amounts of erosion. Areas with concentrated flow ditches that are exhibiting some gully formation could greatly benefit from stabilizing with riprap instead of vegetation.

- A cost-saving lesson about specification of vegetation planting requirements also was learned during the investigations. Most turf and grass seeding contracts

specify that contractors must guarantee a certain percentage of seed emergence and plant establishment success. Because of this, contractors may increase their cost estimates up to three times the actual costs of planting. If installation land managers are willing and able to fix any bare spots using in-house resources, then substantial savings can be realized in total project cost.

Summary

Opportunities exist to utilize new methods for environmental restoration of tank trails that are less costly and more effective than current methods. By using improved methods, Fort Bragg has realized more benefit from each dollar spent. The effectiveness of various treatment methods may vary, however, for Army installations that are located in different geographic and climatic regions.

APPENDIX D

REFERENCES

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APPENDIX E:
ACRONYMS AND ABBREVIATIONS

Term	Spellout
AR	Army Regulation
CECW	Directorate of Civil Works, United States Army Corps of Engineers
CEMP-CEP	Directorate of Military Programs, United States Army Corps of Engineers
CERL	Construction Engineering Research Laboratory
CWA	Clean Water Act
DPW	Directorate of Public Works
DoD	Department of Defense
ERDC	Engineer Research and Development Center
HQUSACE	Headquarters, United States Army Corps of Engineers
POC	point of contact
PWTB	Public Works Technical Bulletin
USACE	United States Army Corps of Engineers

APPENDIX F:
CONTRACT DESIGN SPECIFICATIONS FOR PREACHERS ROAD TANK TRAIL IMPROVEMENT AT FORT BRAGG, NORTH CAROLINA

The following pages reproduce sections of useful design specifications and data that accompanied Contract DACA21-97-B-006 as awarded by the USACE Savannah District to Phillips and Jordan, Inc.

DESCRIPTION & SPECIFICATIONS

TABLE OF CONTENTS

DIVISIONS 1 AND 2

Appendix

Table F-1. Cumulative quantities of fill requirements

along Tank Trail -- Preachers Road

Figure F-1. Cumulative quantities of fill requirements

along Tank Trail -- Preachers Road

End of Section

SECTION 01000

SUMMARY OF SPECIFICATIONS FOR CONSTRUCTION

PART A

1. Borrow

Approximately 40,050 tons (26,700 cu yards) of borrow, unless otherwise specified, will be hauled from Ft. Bragg designated borrow pits to the project area and compacted to specifications for tank trail improvement. See Appendix Figure 1 and Appendix Table 1.

2. Project Area

The project area is 20,990 lineal feet (3.98 mile) long tank trail that runs almost parallel to the Preachers Road (Appendix Figure 3). The width of the design tank trail will vary from a minimum of 15 ft. to a maximum of 30 ft. See Plans and Drawings.

The tank trailway consists of the trail surface, shoulders, drainage ditches, and adjacent slopes. In the following text, unless otherwise specified, words like trail, road, roadway, and embankment are used interchangeably to mean the tank trail project area.

3. Earth Work

Earth work will consist of all operations required for the improvement of the tank trail to specifications. Earth work operations include, but are not limited to, the following tasks:

a) Erosion Control -Silt Fence --- Section 01110, Paragraph 1.2; Section 02210

b) Clearing and Grubbing --- Section 02210

c) Subgrade/Roadbed Preparation --- Section 02225

d) Borrow Excavation and Hauling --- Section 02215

e) Compaction And Testing --- Section 02225; Section 02240

f) Geosysthetics --- Section 02272

g) Storm Drainage System --- Section 02720

4. Geosynthetics

Installation of approximately 7,225 sq yd of Government-furnished Geoweb/geogrid (also known as cellular confinement systems or geocells) materials on the tank trail as shown in Drawing 2530 and/or as directed by the Contracting Officer's Representative (hereinafter COR).

Installation of approximately 1,110 sq yd of Government-furnished geotextile fabric under the gravel/rock at designated stream crossings at locations shown in Drawing 2530 or as directed.

5. Storm Drain System

Installation of approximately 14 stream crossings (culverts and at-grade rock and gravel crossings) in accordance with specifications (Drawing 2530) or as directed by the COR. In accordance with the requirements of Part B1, #1.2.1 of this Section (see below), the Government will furnish all needed materials such as gravel/rock, geosynthetics, and corrugated metal pipe for the culverts and at-grade crossings.

PART B1 -- GOVERNMENT-FURNISHED MATERIALS

1. At no cost to the Contractor, the Government will furnish all materials in quantities as needed for the installation of Geoweb/geogrid, geotextile fabric, and rock and gravel for stream crossings, and turf materials. Silt fence material will not be furnished by the Government.

1.2 Material furnished by the Government will be delivered or made available to the Contractor at the locations specified below in Paragraph 1.2.1. The cost of handling and placing all materials after they are delivered or made available to the Contractor will be included in the contract price per ton of Borrow.

1.2.1 At no cost to the Contractor, the Government will furnish the following materials:

1 Geoweb: Currently located at Section 53+00 - 55+00 Tank Trail, Preachers Road.

2. Gravel/rock, culvert pipe and fittings, geotextile fabric: To be delivered to the project site or stored at the Natural Resources Office, Ft. Bragg.

3. Turf materials (lime, fertilizer, seed, and straw mulch). To be delivered to the project site or stored at the Natural Resources Office, Ft. Bragg.

2.1 Testing for fill compaction will be handled through Government-contracted materials testing laboratory. Costs will be assumed for compaction testing by the Government.

PART B2 — CONTRACTOR-FURNISHED MATERIALS

2.1.1. The Contractor will furnish all materials required to complete the work, except those specified by the Government in accordance with Paragraph B1, #1.2.1 above.

1.1 Silt fence material (fabric and posts) will be provided by the Contractor at his expense.

End of Section

SECTION 01100

SCOPE OF WORK

1 Scope

1.1 The work covered by the specifications consists of furnishing all plant, labor, equipment, appliances, and materials, except as specified in Section 01000 Part B1, for performing all operations in connection with TANK TRAIL IMPROVEMENT. The work will be completed in strict accordance with project design drawings and/or field stakes and/or flags, these specifications, and special provisions that are subject to the terms and conditions of this contract.

2 Intent of the Plans and Specifications

2.1 The intent of the Plans and Specifications is to prescribe a complete outline of work that the Contractor undertakes to do in full compliance with the contract.

3. Earth Work

3 The Contractor will perform all earthwork, construct all base and surface courses, structures, and such additional, extra, and incidental construction as may be necessary to complete the work to the finished lines, grades and cross sections in a substantial and acceptable manner. He will furnish all required materials, equipment, tools, labor and incidentals, unless otherwise provided in the contract, and will include the cost of these items in one unit price per ton of Borrow Excavation.

4 Work to be Performed

4.1 Work to be performed is specified in the following SECTIONS of this contract.

End of Section

SECTION 01110

SPECIAL PROVISIONS

PART 1- GENERAL

1.1 Interpretation of quantities in the Bid Schedule.

1.1.1 The Borrow quantities appearing in the bid schedule are approximate and are prepared for the comparison of bids. Payment to the Contractor will be made only for the actual quantities of work performed and accepted in accordance with the contract unit price per ton of Borrow Excavation. The scheduled quantities of work to be done and materials to be furnished may each be increased, decreased or omitted as hereinafter provided.

1.1.2 All increases in borrow will be paid for at the contract unit price per ton. Decreases in quantities included in the contract will be deducted from the contract at the unit bid price. No allowance will be made for delays or anticipated profits.

1.2 Erosion Control Plan

1.2.1 The Contractor is responsible for knowledge of and compliance with all environmental laws, regulations, and programs of this installation, the County, State and Federal agencies that relate to or may arise under the performance of this contract. Included, but not limited to this is compliance with erosion control plans, applicable standards for the prevention, control, and abatement of environmental pollution in full cooperation with the Installation and Federal, State, and local Governments.

1.2.2 Silt Fence Installation

1.2.2.1 The Contractor will not start any work unless erosion control measures, including but not limited to the installation of silt fences, have been implemented. Silt fence will be installed along the entire length of the tank trail as well as on its both sides. If so directed by the Contracting Officer’s Representative (hereinafter COR), the Contractor may remove the fence material from the completed and accepted sections of the

road for later use at other sections of the road to be constructed.

1.3 Penalty charges resulting from citations against the Department of Defense, Department of the Army or Fort Bragg or its agents, officers, or employees due to the Contractor's failure to comply with environmental laws, regulations and programs, that relate to or may arise under the performance of this contract, may be deducted or offset by the Government from any moneys due the Contractor, and with respect to such citations, the Contractor will further take any corrective or remedial actions as directed by the regulatory agencies.

1.4 Endangered Species Act

1.4.1 The project area runs through a forested land occupied by endangered species. It is important that the Contractor will make every effort not to damage, in any way, the trees, shrubs, and other vegetation in and around the limits of project area. The Contractor will be responsible for all damage or injury to trees during the prosecution of the work resulting from any act, omission, neglect, or misconduct in the Contractor's manner or method of executing the work, or due to his non-execution of the work.

1.4.2 Cutting or other damage of any kind to the stand of trees, shrubs, or ground cover outside the boundaries of the clearing limits will not be permitted.

1.4.3 The COR will designate all trees, shrubs, plants, and other items to remain. Paint required for cut or scarred surfaces of trees or shrubs selected for retention will be an approved, asphalt-based paint, specifically prepared for tree surgery.

1.5 Alterations of Plans or Character of Work

1.5.1 At any time during the progress of the work, the Government reserves the right to make such increases or decreases in quantities and such alterations in the details of construction, including alterations in the grade or alignment of the road or structure, or both, as may be found to be necessary or desirable. Such increases or decreases and alterations will not invalidate the contract and the Contractor agrees to accept

the work as altered, the same as if it had been a part of the original contract.

1.5.2 The Contractor will perform such work as may be altered in character or by increased or decreased quantities, and payment will be made on the actual quantities of work done in accordance with the requirements of contract unit price per ton Borrow Excavation. No claim will be made by the Contractor for any loss in anticipated profits because of any such reiterations, or by reason of any variation between the actual quantities and the original contract quantities of the work.

1.6. Maintenance of Traffic

1.6.1 The Contractor will have no authority to close any part of the project, unless otherwise specified, or limit traffic thereon without written permission from the COR.

1.6.2 The Contractor will furnish, erect, and maintain barricades, warning signs, delineators, and other traffic control devices in accordance with Ft. Bragg Traffic Control office, and State and local laws and regulations. The Contractor will provide and maintain in a safe condition temporary approaches or crossings and intersections with tank trail roadway. The Contractor will bear all expense of maintaining the traffic and of constructing and maintaining such approaches, crossings, intersections, and other features as may be necessary, without direct compensation.

1.6.3 Temporary roadways or structures that will not be incorporated into the finished work will be removed or obliterated after their usefulness has ended.

1.6.4 Road Closed to Local Traffic. The Contractor may close the road section upon which construction is in progress. However, he will limit his operations so that he will not have unnecessarily large sections of the roadway under construction at any time and not unduly inconvenience the military vehicular traffic.

1.7 Final Cleaning Up. The work will not be considered as complete, and final payment will not be made, until the right-of-way, borrow pits, and all ground occupied by the Contractor in connection with the work, has been cleared of all rubbish, equipment, excess materials, temporary structures, and weeds.

1.8 Conformity with Plans and Specifications. All work performed will be in reasonably close conformity with the lines, grades, cross sections, dimensions, and material requirements shown on the plans or indicated in the specifications or as directed by the COR.

1.9 Coordination of Contract Documents

1.9.1 The Contractor will take no advantage of any apparent error or omission on the plans or in the specifications. When the Contractor discovers such an error or omission, he will immediately notify the COR. The COR will then make such corrections and interpretations as may be deemed necessary for fulfilling the intent of the plans and specifications.

1.9.2 When separate contracts are let for adjacent or similar projects, each Contractor will conduct his work so as not to interfere with or hinder the progress or completion of the work being performed by other Contractors. Contractors working on such projects will cooperate with each other and in case of dispute the COR will be the referee and his decision will be final and binding.

1.9.3 Each Contractor will assume all liability, financial or otherwise, in connection with his contract and will protect and save harmless the Government from any and all damages or claims that may arise because of inconvenience, delay, or loss experienced by him because of the presence and the operations of other Contractors working on adjacent projects. Each Contractor will assume all responsibility for any work not completed or accepted on his contract because of the presence and operations of the other Contractors.

1.10 Borrow Hauling

1.10.1 The hauling of borrow and all other hauling in conjunction with the construction of this project will be performed so as not to violate any of the truck size, gross weight, or tire width limitations provided by law or regulation.

1.10.2 Hauling Over Structures. It will be the responsibility of the Contractor to inspect and examine all structures to determine if any structure has been damaged before hauling is begun. When damage to a structure is in evidence, the Contractor will request the Government to appraise the evidence of existing

damage by on-site inspection and to grant a release, in writing, from liability for the damage disclosed or otherwise the Contractor will stand liable. Any damage to the structure, including joints, that may be incurred as a result of the Contractor's hauling operations will be repaired by the Contractor at his expense.

1.11 Failure to Complete on Time

As the technical supervision and administration of the project will be performed by the USACERL COR, it is important that all work be pressed to completion in time. Also, the cost to the Government for the administration of the contract including inspection, engineering, supervision, and TDY expenses will increase as the time occupied in the work is lengthened. Therefore, for each calendar day that any work will remain incomplete during the time after the final contract time allowed for the completion of the contract, an $895 daily charge specified herein will be deducted from any money due the Contractor, not as a penalty but as agreed liquidated damages. Daily charges as agreed liquidated damages will be deducted for each calendar day without regard to inclement weather.

1.11.1 Permitting the Contractor to continue and to finish the project after the expiration of the total contract time allowed will in no way operate as a waiver by the Government of any of its rights under the contract.

1.12 Measurement of Quantities

1.12.1 Weight Tickets. Each weight ticket, unless otherwise specified, will be prepared and signed by the weigher or plant manager at Ft. Bragg Borrow pits.

1.12.2 Daily Summary. The daily summary will be prepared by the Contractor. The plant manager or material weigher at Ft. Bragg’s borrow pits will sign the summary certifying that the day's total net weight is correct.

1.12.3 The completed and signed daily summary will be provided to the COR within three working days.

1.12.4 The Contractor will not submit an invoice for payment for borrow quantities for which daily summary has not already been provided to the COR in advance.

1.12.5 Borrow excavation will not include material taken from widened roadbed, widened cuts, ditches, enlarged ditches, subgrade preparation, or from other sources within the right-of-way and will not be measured for payment.

1.13 Basis of Payment. The accepted ton excavated from borrow pits and weighed at scales will be paid for at the contract unit price per ton for Borrow Excavation which payment will be full compensation for all work required to complete the project.

1.14 Compensation for Work Stoppage. It is anticipated that the project area will not be closed to construction due to military operations. However, if the project area upon which construction work is in progress and the Contractor is asked to stop work to accommodate military training activities, the Contractor will accept damages for such stoppage at rates determined and/or established by the Government.

1.15 Broken Stone and Concrete. If so directed by the COR, the Contractor will haul the broken stone and concrete material from Ft. Bragg for use as fill at the project site. All such materials will be weighed at the Ft. Bragg scales. Additional payment will be made for hauling to and placing /compacting the material at the project site at contract unit price per ton. The materials under this item (broken concrete etc.) are otherwise waste and obtained from previous excavation of foundations of buildings and roads, but will be considered for payment as if they were Borrow. periodically

1.16 The tank trail location is such that it is surrounded by trees up to the shoulders on both sides of the trail at many places. To achieve uniform compaction across the entire width of the road, it is mandatory that, unless otherwise APPROVED IN WRITING BY THE COR, the Contractor shall use only vibratory sheepsfoot compactors or vibratory self-propelled steel drum rollers to obtain specified level of compaction.

End of Section

SECTION 02210

GRADING AND GRUBBING

PART 1. GENERAL

1.1 Description. These items will be performed wherever they occur within the right of way, within the limits of project area at entrance approaches, and within the areas of borrow pits furnished by the Government.

1.2 Endangered Species Act.

1.2.1 The project area runs through a forested land occupied by endangered species. It is important that the Contractor will make every effort not to damage, in any way, the trees, shrubs, and other vegetation in and around the limits of project area. The Contractor will be responsible for all damage or injury to trees during the prosecution of the work resulting from any act, omission, neglect, or misconduct in the Contractor's manner or method of executing the work, or due to his non-execution of the work.

1.2.1.1 Cutting or other damage of any kind to the stand of trees, shrubs, or ground cover outside the boundaries of the clearing limits will not be permitted.

1.2.1.2 The COR will designate all trees, shrubs, plants, and other items to remain. Paint required for cut or scarred surfaces of trees or shrubs selected for retention will be an approved, asphalt-based paint, specifically prepared for tree surgery.

(a) Tree Removal: Tree Removal will consist of the cutting, grubbing, removal and disposal of all trees and stumps, as directed by the COR, except those designated to be saved. All trees, except those designated to be saved, and all stumps, will be cut and disposed of as provide herein. All other trees and stumps within the project area limits (trailway) will be removed to a depth of not less than 12 inches below the elevation of the subgrade, the finished earth surface, or the ground line.

(b) Protection of Trees and Shrubs: All trees and shrubs designated to be saved will be protected prior to clearing and throughout subsequent construction operations. The COR will designate all trees, shrubs, plants, and other items to remain. Paint required for cut or scarred surfaces of trees or shrubs selected for retention will be an approved, asphalt-based paint specially prepared for tree surgery.

(c) Clearing: This work will consist of clearing, grubbing, removing and disposing of all vegetation and debris within designated limits inside the project area. This work will also include the preservation from injury or defacement of all vegetation and tress designated to remain.

(d) Staking: Construction stakes, tape, flags or a combination thereof, will be set by the COR to mark the general location, alignment, elevation, and grade of work prior to the start of clearing, grubbing, and other construction operations at the project site.

End of Section

SECTION 02215

BORROW, BORROW EXCAVATION

PART 1. GENERAL

PART 2. PRODUCTS

2.1 Borrow

Approximately 40,050 tons (26,700 cu yards) of borrow will be hauled unless otherwise specified from designated borrow pits to the project area and compacted to specifications.

2.1.1 Broken Stone and Concrete. If so directed by the COR, the Contractor will haul the broken stone and concrete material from Ft. Bragg for use as fill at the project site. All such materials will be weighed at the Ft. Bragg scales. The materials under this item (broken concrete etc.) are otherwise waste and obtained from previous excavation of foundations of buildings and roads, but will be considered as Borrow under this section.

PART 3. EXECUTION

3.1 Borrow, Borrow Excavation.

3.1.1 Borrow excavation will consist of excavating, transporting, and placing of materials obtained from borrow pits necessary for the construction of tank trail roadway, embankments, subgrade, shoulders, sub-base intersections, approaches, entrances and other parts of the work. The excavation of materials outside designated borrow pits is not included in this item and will not measured for payment. Tree and hedge removal within borrow pit sites, and their appropriate disposal is considered incidental to borrow operations and work completion.

3.2 Basis of Measurement and Payment

3.2.1 Measurement.

The unit of measurement for Borrow, Borrow Excavation will be short ton consisting of 2,000 pounds. The quantity of total borrow to be paid for at the contract unit price per ton will be the tonnage of borrow excavated and satisfactorily placed and/or compacted at the tank trail project. The tonnage of overburden stripped from borrow pits and the tonnage of excavated material from ditches to drain borrow pits will be considered incidental to work completion. The excavation of materials outside designated borrow pits is not included in this item and will not be measured for payment.

3.2.2 The accepted ton excavated from borrow pits and weighed at Ft. Bragg scales will be paid for at contract unit price per ton for Borrow, Borrow Excavation which payment will be full compensation for all work required to complete the project in this contract.This payment will constitute full compensation for all labor, equipment, tools, supplies, materials, roadway excavation, and incidentals to complete the work.

3.3 Broken Stone and Concrete. If so directed by the COR, the Contractor will haul the broken stone and concrete material from Ft. Bragg for use as fill at the project site. All such materials will be weighed at the Ft. Bragg scales. Additional payment will be made for hauling to and placing /compacting the material at the project site at contract unit price per ton. The materials under this item (broken concrete etc.) are otherwise waste and obtained from previous excavation of foundations of buildings and roads, but will be considered for payment as if they were Borrow.

3.4 Stripping of Topsoil

3.4.1 Where indicated or directed, topsoil will be stripped to a depth of 6 inches. This will include full width under the tank trail alignment as well as at borrow pits. Topsoil will be spread on areas already graded and prepared for topsoil, or transported and deposited in stockpiles convenient to areas that are to receive application of the topsoil later, or at locations indicated or specified. Topsoil will be kept separate from other excavated materials, brush, litter, objectionable weeds, roots, stones larger than 2 inches in diameter, and other materials that would interfere with planting and maintenance operations. Any surplus of topsoil from borrow pit excavations and grading will be stockpiled in locations indicated for reuse.

End of Section

SECTION 02225

EARTHWORK - - TANK TRAIL IMPROVEMENT

PART 1 GENERAL

1.1 References: The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM C 136 (1995a) Sieve Analysis of Fine and Coarse Aggregates

ASTM D 422 (1963; R 1990) Particle-Size Analysis of Soils

ASTM D 1556 (1990) Density and Unit Weight of Soil in Place by the Sand-Cone Method

ASTM D 1557 (1991) Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft.lb./cu.ft.)

ASTM D 2167 (1994) Density and Unit Weight of Soil in Place by the Rubber Balloon Method

ASTM D 2487 (1993) Classification of Soils for Engineering Purposes (Unified Soil Classification System)

ASTM D 2922 (1991) Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Willow Depth)

ASTM D 3017 (1988; R 1993) Water Content of Soil and Rock in Place by Nuclear Methods (Willow Depth)

ASTM D 4318 (1993) Liquid Limit, Plastic Limit, and Plasticity Index of Soils

1.2 Definitions

1.2.1 Earthwork: The work to be performed by the Contractor in this project is to 1) prepare roadbed subgrade by grading, leveling, and compaction; 2) raise the degraded and washout sections of the tank trail to its original contours; 3) install geosynthetics at locations shown on the Drawings or as directed for increased road surface stabilization; 4) install approximately 14 stream crossisngs at designated road crossings; and 5) lime, fertilize, mulch and reseed all disturbed areas at the project site.

1.2.2 Satisfactory Materials: Satisfactory materials will comprise any materials classified by, ASTM D 2487 as GW, GP, SW, SP, SM, SC, and CL. Satisfactory materials for grading will be free from roots and other organic matter, trash, debris, and frozen materials.

1.2.3 Unsatisfactory Materials: Materials that do not comply with the requirements for satisfactory materials are unsatisfactory. Materials classified in ASTM D 2487 as Pt, OH, and OL are unsatisfactory.

1.2.4 Degree of compaction required is expressed as a percentage of the laboratory maximum density obtained by the test procedure presented in ASTM D 1557, abbreviated as a percent of laboratory maximum density.

1.2.5 Tank trail roadway, roadway, roadbed, road surface, tank trail road, tank trail, trail all refer to the project improvement of the tank trail by the placement of borrow fill and compaction as hereinafter specified.

PART 2. PRODUCTS.

PART 3 EXECUTION

3.1 Trailway Excavation

3.1.1 Roadway excavation will consist of the excavation, removal and satisfactory disposal of all materials taken from within the right of way for the construction of roadbed, embankment subgrade, sub-base, shoulders, intersections, ditches, waterways, entrances, approaches and incidental work; and the removal and satisfactory disposal of unstable and unsuitable materials, and their replacement with satisfactory materials where required. Roadway excavation will not be interpreted to include excavation from borrow pits, and it will not be measured for payment but considered incidental to work completion.

3.1.2 The Contractor will perform excavation of every type of material encountered within the limits of the project to the lines, grades, and elevations indicated on Plans and Drawings and/or as directed by the COR. Grading will be in conformity with the typical cross sections shown in Drawings, or as staked, and the tolerances specified in Paragraph 3.10 Finishing, Section 02225. Satisfactory excavated materials will be transported to and placed in fill or embankments within the limits of the work. Unsatisfactory materials encountered within the limits of the work will be excavated below grade and

replaced with satisfactory materials. Unsatisfactory excavated materials, and the satisfactory excavated materials used as replacement at the project site will not be included in excavation for payment, and all on-site excavation will be considered incidental to work completion.

During construction, excavation and fill will be performed in a manner and sequence that will provide proper drainage at all times. The materials required for tank trail or embankment fill in excess of that produced by excavation within the grading limits will be excavated from designated borrow pits, and transported to the project site in accordance with the requirements of Section 02215, Borrow Excavation.

3.1.3 Included in this work will be excavation for widened cuts for roadbeds, subgrades, shoulders, slopes, ditches, waterways, intersections, approaches, balance excavation, inlet and outlet ditches, and channel changes, and as indicated on the Plans and Drawings or as directed.

3.1.4 Roadway and drainage excavation will also include removal and satisfactory disposal of miscellaneous structures removed from within the limits of the roadway and drainage cross sections such as, but not limited to, all types of stone or concrete, and all conduits that have no salvage value, such as unserviceable drainage pipe.

3.1.5 All suitable material removed from excavation will be used, insofar as practicable, in the formation of embankments, subgrade, or shoulders; as backfill for structures; or for other purposes shown on the plans or as directed. No payment will be made for any on-site excavated materials used for any purpose, and all on-site excavation will be considered incidental to work completion.

3.1.6 All sod and soft or spongy material will be removed and disposed of as directed. Such materials will not be used in the construction of the tank trail.

3.1.7 In cut sections the roadbed, whether it consists of existing material or refill material, will be compacted in accordance with the requirements of SECTION 02240, COMPACTION AND TESTING. When the material in place does not contain sufficient moisture to obtain proper compaction, the roadbed will be thoroughly scarified and broken to a minimum depth of 6 inches, the moisture content increased as directed, and the roadbed compacted. Material unsuitable for the roadbed, when encountered at subgrade elevation, will be removed and disposed

of as directed. Material that is unstable due to excessive moisture but that is otherwise suitable for the roadbed will either be scarified, allowed to dry, and compacted; or removed, dried, and used for refill or embankment. No additional payment will be made for scarifying or manipulation necessary to increase or decrease the moisture content as this is considered incidental to the work.

3.2 Subgrade Preparation and Construction

3.2.1 Description. Preparation of the subgrade will include compacting to the required density and shaping to conform to the required lines, grades, and cross sections, all in accordance with the applicable provisions of these specifications.

3.2.2 The subgrade will be shaped to conform to the lines, grades, and cross sections indicated on the plans or as staked by the COR. All high areas of the roadbed will be removed, by scarifying when necessary, and all low areas will be filled with approved material and compacted. The roadbed will not be disturbed below subgrade elevation, except when necessary to comply with requirements herein specified.

3.2.3 The subgrade will be compacted, as nearly as practicable, to a uniform density throughout. Except when otherwise provided, the compaction and moisture control requirements will be in accordance with the requirements of Section 02240, COMPACTION AND TESTING. Should the subgrade subsequently lose its density due to exposure to severe weather, after having been previously compacted to the required density during the construction of the grade, it will be recompacted to the required density.

3.2.4 Subgrade construction and repair will consist of shaping the existing roadbed for placement of the borrow fill and compacted as specified. The subgrade surface on which fill is to be placed will be stripped of live, dead, or decayed vegetation, rubbish, debris, and other unsatisfactory material; plowed, disked, or otherwise broken up to a depth of 6 inches; pulverized; moistened or aerated as necessary; thoroughly mixed; and compacted to at least 95 percent laboratory maximum density for cohesionless materials. This operation will include plowing, disking, and any moistening or aerating required to obtain specified compaction.

3.2.5 Soft or otherwise unsatisfactory material will be removed and replaced with satisfactory excavated material or other approved material as directed. Rock encountered in the cut

section will be excavated to a depth of 6 inches below finished grade for the subgrade.

3.2.6 Low areas resulting from removal of unsatisfactory material or excavation of rock will be brought up to required grade with satisfactory materials, and the entire subgrade will be shaped to line, grade, and cross section and compacted as specified.

3.2.7 Subgrade and all subsequent fill for tank trail and embankments will be compacted to at least 95 percent of laboratory maximum density. Compaction will be accomplished by vibratory sheepsfoot compactors or vibratory self-propelled steel drum rollers.

3.3 Tank Trailway Construction

3.3.1 This work will consist of the construction of tank trail by raising its existing roadbed to the original surface contours by depositing, placing and compacting earth, stone, gravel or other materials of acceptable quality above the natural ground or other surface.

3.3.2 The entire depths of borrow fill placed at the road for improvement will be compacted to a density of at least 95 percent of maximum density as determined by ASTM D 1557. The in-place density will be determined by using nuclear gages and/or in accordance with ASTM D 1556 and/or ASTM D 2167] [ASTM D 2922]. When ASTM D 2922 is used, the calibration curves will be checked and adjusted using only the sand cone method as described in ASTM D 1556.

In addition of the above, the Contractor shall place and compact the Borrow in accordance with the following requirements:

3.3.3 Tank trail will be constructed of materials that will compact and develop a satisfactory fill stability. Tank trail will be constructed to the height and width deemed necessary to provide for shrinkage during compaction. Upon completion, the finished road surface will conform to the lines, grades and cross sections shown on the Plans and Drawings or as directed, with proper provision for shrinkage.

3.3.4 The density of the compacted road-fill will be determined by the Government-contracted materials testing laboratory at regular intervals in accordance with the requirements of Section 02240, COMPACTION AND TESTING.

3.3.5 Should the moisture content of the borrow be insufficient to obtain proper compaction, the fill material will be sprinkled with water and then compacted. When the moisture content of the borrow fill is in excess of that required to obtain proper compaction, it will be permitted to dry to the required moisture content, by scarifying when necessary, before being compacted

3.3.6 Compaction will be accomplished by vibratory sheepsfoot compactors or vibratory self-propelled steel drum rollers. Each layer of the fill material will be compacted to at least 95 percent of laboratory maximum density

3.3.7 Compacting equipment (vibratory sheepsfoot compactors or vibratory self-propelled steel drum rollers) and compacting operations will be coordinated with the rate of placing fill so that the required density is obtained.

3.4 Broken Stone and Concrete. If so directed by the COR, the Contractor will haul the broken stone and concrete material from Ft. Bragg for use as fill at the project site. All such materials will be weighed at the Ft. Bragg scales. Additional payment will be made for hauling to and placing /compacting the material at the project site at contract unit price per ton. The materials under this item (broken concrete etc.) are otherwise waste and obtained from previous excavation of foundations of buildings and roads, but will be considered for payment as if they were Borrow.

3.5 Special care will be exercised in placing and compacting borrow fill adjacent to trees.

3.6 Moisture Content

3.6.1 During compaction, the moisture content of borrow fill or subgrade material will not vary from the optimum moisture content as determined in accordance with ASTM D 2922 and ASTM D 3017 by more than plus 2 percent or minus 4 percent. (ASTM D 2922 results in a wet unit weight of soil, and when using this method, ASTM D 3017 will be used to determine the moisture content of the soil.) This moisture content requirement will have equal weight with the density requirement when determining the acceptability of tank trail construction work. Borrow fill material that does not contain sufficient moisture to obtain proper compaction will be wetted as needed, and thoroughly mixed as deemed necessary. Borrow fill material containing an excess of moisture will be allowed to dry before being compacted.

3.7 Construction Operations

3.7.1 Construction operations will be performed in such a manner that simultaneous rolling and placing of material in the same lane or section will be prevented. To avoid uneven compaction, the hauling equipment will traverse, as much as possible, the full width of the cross section. Each layer will be compacted as required before material for the next layer is deposited. Equipment will be such as will satisfy the density requirements at all times.

3.8 Equipment

3.8.1 The tank trail location is such that it is surrounded by trees to the shoulders on both sides of the trail at many places. To achieve uniform compaction across the entire width of the road, it is mandatory that, unless otherwise APPROVED IN WRITING BY THE COR, the Contractor shall use only vibratory sheepsfoot compactors or vibratory self-propelled steel drum rollers to obtain desired level of compaction such that each layer of the fill material will be compacted to at least 95 percent of laboratory maximum density. This is also important to satisfy density requirements at all times.

3.9 Ditches

3.9.1 Ditch fills where required will be shaped to meet the grades as shown on the Drawings as directed by the COR. Embankment fill for side slopes will be compacted to at least 95 percent laboratory maximum density for the full depth of the ditch section.

3.10 Finishing

3.10.1 The surface of the tank trail and drainage ditches will be finished to a smooth and compact surface in accordance with the lines, grades, and cross sections or elevations shown on the Drawings or as directed by the COR. The degree of finish for graded areas and completed tank trail surface will be within 0.1 foot of the grades and elevations shown on the Drawings or as directed. Ditches will be finished in a manner that will result in effective drainage. The surface of areas to be turfed will be finished to a smoothness suitable for the application of turfing materials.

End of Section

SECTION 02240

COMPACTION AND TESTING

PART 1. GENERAL

1.1 References: The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM C 136 (1995a) Sieve Analysis of Fine and Coarse Aggregates

ASTM D 422 (1963; R 1990) Particle-Size Analysis of Soils

ASTM D 1556 (1990) Density and Unit Weight of Soil in Place by the Sand-Cone Method

ASTM D 1557 (1991) Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft.lb./cu.ft.)

ASTM D 2167 (1994) Density and Unit Weight of Soil in Place by the Rubber Balloon Method

ASTM D 2487 (1993) Classification of Soils for Engineering Purposes (Unified Soil Classification System)

ASTM D 2922 (1991) Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Willow Depth)

ASTM D 3017 (1988; R 1993) Water Content of Soil and Rock in Place by Nuclear Methods (Willow Depth)

ASTM D 4318 (1993) Liquid Limit, Plastic Limit, and Plasticity Index of Soils

1.2. Definitions

1.2.1 Degree of compaction required is expressed as a percentage of the laboratory maximum density obtained by the test procedure presented in ASTM D 1557, abbreviated as a percent of laboratory maximum density.

PART 2. PRODUCTS

PART 3. EXECUTION

3.1 Compaction

3.1.1 In accordance with the requirements of Section 02225 EARTH WORK, Paragraph 3.8 EQUIPMENT, compaction will be accomplished by vibratory sheepsfoot compactors or vibratory self-propelled steel drum rollers. Each layer of the fill material will be compacted to at least 95 percent of laboratory maximum density.

3.1.2 In cut sections the roadbed, whether it consists of existing material or refill material, will be compacted in accordance with the requirements and specifications of this Section 02240 as well as those of Section 02225, Earth Work. When the material in place does not contain sufficient moisture to obtain proper compaction, the roadbed will be thoroughly scarified and broken to a minimum depth of 6 inches, the moisture content increased as directed, and the roadbed compacted. Material unsuitable for the roadbed, when encountered at subgrade elevation, will be removed to such depths as directed, and disposed of as directed. Material that is unstable due to excessive moisture but that is otherwise suitable for the roadbed will either be scarified, allowed to dry, and compacted; or removed, dried, and used for refill or embankment. No additional payment will be made for scarifying or manipulation necessary to increase or decrease the moisture content as this is considered incidental to the work

3.1.3 RESERVED

3.1.4 Should the moisture content of the borrow be insufficient to obtain proper compaction, the fill material will be sprinkled with water and then compacted. When the moisture content of the borrow fill is in excess of that required to obtain proper compaction, it will be permitted to dry to the required moisture content, by scarifying when necessary, before being compacted.

3.1.5 During compaction, the moisture content of borrow fill or subgrade material will not vary from the optimum moisture content as determined in accordance with ASTM D 2922 and ASTM D 3017 more than plus 2 percent or minus 4 percent. (ASTM D 2922 results in a wet unit weight of soil and when using this method, ASTM D 3017 will be used to determine the moisture content of the soil.) This moisture content requirement will have equal weight with the density requirement when determining the acceptability of tank trail construction work. Borrow fill

material that does not contain sufficient moisture to obtain proper compaction will be wetted as needed, and thoroughly mixed as deemed necessary. Borrow fill material containing an excess of moisture will be allowed to dry before being compacted.

3.1.6 Construction operations will be performed in such a manner that simultaneous rolling and placing of material in the same lane or section will be prevented. To avoid uneven compaction, the hauling equipment will traverse, as much as possible, the full width of the cross section. Each layer will be compacted as required before material for the next layer is deposited. Equipment will be such as will satisfy the density requirements at all times.

3.2 Testing -- Determination of Density

3.2.1 At no cost to the Contractor, the government is responsible for retaining a materials testing laboratory. The Contractor may, at his option, retain his own testing laboratory at no cost to the Government. The Contractor is responsible for informing the Government, in writing, at least 24 hours in advance, of the time an area will be ready for testing.

3.2.2 Tests will be performed in sufficient number to ensure that specified density is being obtained. Laboratory tests for moisture-density relations will be made in accordance with ASTM D 1557 except that mechanical tampers may be used provided the results are correlated with those obtained with the specified hand tamper. Field in-place density tests will be determined in accordance with ASTM 1556 or ASTM D 2167 or ASTM D 2922 or by nuclear testing methods. When ASTM D 2922 is used, the calibration curves will be checked and adjusted, if necessary, using only the sand cone method as described in ASTM D 1556. ASTM D 2922 results in a wet unit weight of soil and when using this method ASTM D 3017 will be used to determine the moisture content of the soil. The calibration curves furnished with the moisture gauges will be checked along with density calibration checks as described in ASTM D 3017 or ASTM D 2922.

3.2.3 When test results indicate that compaction is not as specified, the material will be removed, replaced and recompacted to meet specification requirements. Tests on recompacted areas will be performed to determine conformance with specification requirements. Inspections and test results will be certified by a registered professional engineer. These certifications will state that the tests and observations were performed by or under the direct supervision of the engineer and that the results are representative of the materials or

conditions being certified by the tests. The following number of tests will be the minimum acceptable for each type of operation.

3.2.3.1 Subgrade Preparation: One test per 500 linear foot of prepared subgrade. Gradation of subgrade material will be determined in accordance with ASTM C 136 and or ASTM D 422.

3.2.3.2 Fill and Backfill Material Gradation: One test per 500 cubic yard stockpiled or in-place source material. Gradation of fill and backfill material will be determined in accordance with ASTM C 136 and/or ASTM D 422 and/or other approved methods.

3.2.3.3 RESERVED

3.2.3.4 Moisture Content: In the stockpile, excavation, or borrow areas, if performed at the appropriate time, a minimum of two tests per day per type of material or source of material being placed during stable weather will be performed. During unstable weather, tests will be made as dictated by local conditions.

3.2.3.5 Optimum Moisture and Laboratory Maximum Density: Tests will be made for each type material or source of material including borrow material to determine the optimum moisture and laboratory maximum density values. One representative test per 500 cubic yard of fill and backfill, or when any change in material occurs which may affect the optimum moisture content or laboratory maximum density.

3.2.4 Field In-Place Density

3.2.4.1 Filed in-place density will be determined in accordance with ASTM D 1556 and/or ASTM D 2167] [ASTM D 2922] or other pproved methods. When ASTM D 2922 is used, the calibration curves will be checked and adjusted using only the sand cone method as described in ASTM D 1556.

End of Section

SECTION 02272

GEOSYNTHETICS

Geoweb® and Geotextile Fabrics

PART 1 GENERAL

1.1 References

1.1.1 The publications listed below form a part of the specification to the extent referenced. The publications are referred to in the text by basic designation only.

American Society For Testing and Materials (ASTM)

ASTM D 3786 (1987) Hydraulic Bursting Strength of Knitted Goods and Nonwoven Fabrics-Diaphragm Bursting Strength Tester Method

ASTM D 4354 (1989; R 1994) Sampling of Geosynthetics for Testing

ASTM D 4355 (1992) Deterioration of Geotextiles from Exposure to Ultraviolet Light and Water (Xenon-Arc Type Apparatus)

ASTM D 4491 (1992) Water Permeability of Geotextiles by Permitivity

ASTM D 4533 (1991) Trapezoid Tearing Strength of Geotextiles

ASTM D 4632 (1991) Grab Breaking Load and Elongation of Geotextiles

ASTM D 4751 (1993) Determining Apparent Opening Size of a Geotextile

ASTM D 4759 (1988; R 1992) Determining the Specification Conformance of Geosynthetics

ASTM D 4833 (1988) Index Puncture Resistance of Geotextiles, Geomembranes, and Related Products

ASTM D 4873 (1995) Identification, Storage, and Handling of Geotextiles

ASTM D 638 Test Method for Tensile Properties of Plastic.

ASTM D 1248 Specification for Polyethylene Plastics Molding and Extrusion Materials

ASTM D 4218 Test Method for Carbon Black Content in Polyethylene Compounds by the Muffle Furnace Technique

ASTM D 1785 Specification for Poly Vinyl Chloride (PVC) Plastic Pipe, Schedules 20,40, 80 and 120

ASTM D 1338 Flexural Rigidity of Geogrids

Geosynthetic Research Institute (GRI)

GG1-87 Standard Test Method for Geogrid Rib Tensile Strength

GG2-87 Standard Test Method for Geogrid Junction Strength

GG3-91 Standard Test Method for Tension Creep Testing of Geogrids

GG4-91 Standard Practice for Determination of the Long Term Design Strength of Geogrids

1.2 Description.

1.2.1 This Section covers requirements for increased road surface stabilization, subgrade restraint construction, and surface and subsurface drainage using geosynthetics.

1.3 Measurement and Payment: The installation and placement of geosynthetics in this contract is considered incidental to work completion, the cost of which will be included in the contract unit price per ton, Borrow.

1.4 Qualifications

1.4.1 The geotextile fabric and Geoweb will meet the requirements stated within and be supported by the manufacturer with standard literature describing strength, qualities and project experience

1.5 Definitions

1.5.1.1 Geotextile fabric is a nonwoven pervious sheet of polymeric material

1.5.1.2 Geoweb is articulating web of polymeric material oriented such as to create pockets with the structure when it is unfolded. When properly installed and backfilled, it provides enhanced soil enforcement and subgrade stabilization.

1.5.1.3 Geosynthetics will be considered to refer to individual products listed in this section in total.

1.6 Delivery, Storage, and Handling

1.6.1 Geoweb: Is currently located at Section 53+00 - 55+00 Tank Trail, Preachers Road.

1.6.2 Geotextile Fabric for Stream Crossings: To be delivered to the project site or stored at the Natural Resources Office, Ft. Bragg.

PART 2 PRODUCTS

2.1 It is estimated that 7,225 sq.yd. of Geoweb and/or geogrid and 1,110 sq.yd of geotextile fabric will be installed at approximately fourteen stream crossings and critical (steep-sloped) sections of the road surface.

2.2 Materials. Geosynthetics will be furnished by the Government in accordance with the requirements of Section 01000, Part B1 Government Furnished Materials. It will be the Contractor's responsibility for the hauling and installing of these materials, the cost of which will be included in the contract unit price per ton, Borrow Excavation.

PART 3 EXECUTION

3.1 Surface Preparation

3.1.1 The surface underlying the geosynthetics will be smooth and free of rocks or protrusions that could damage the material. Subgrade materials and compaction requirements will be in accordance with Section 02225, Earth Work.

3.2 Construction Requirements

3.2.1 Geosynthetics (geotextile fabric and web/geogrid) will be placed in accordance with the manufacturer's specifications and recommendations, and at the locations as shown in Plans and Drawings or as staked by the COR.

3.2.2 Geotextile rolls that are damaged or contain imperfections will be repaired or replaced as directed. The geotextile will be

laid smooth so as to be free of tensile stresses, folds, and wrinkles. Overlap seams will be a minimum of 3 ft. in width and will be overlapped in the direction of flow. That is fabric will overlap sections placed downhill.

3.2.3 Geotextile panels will be continuously overlapped a minimum of 36 inches. Where it is required that seams be oriented across the trail, the upper sheet will be lapped over the lower sheet.

3.2.4 Geoweb/geogrid will be backfilled with a layer of the specified material such as gravel and/or earth fill as directed in the field.

3.2.5 Geoweb/geogrid will be placed in a manner to eliminate any gaps between adjacent sections. Installation joints will be installed perpendicular to the direction of travel.

3.2.6 Geoweb will be replaced in its entire section when damage exceeds more than 1 sq.ft. of surface area.

3.2.7 The Geoweb soil reinforcement will be laid horizontally on compacted rock fill, pull grid taut, and anchor geogrid prior to placing the backfill. Slack in the geogrid will be removed in a manner, and to such a degree, as approved by the COR. Location and placement of the Geoweb are as shown on the Drawing 2530 or as staked in the field.

3.2.8 The Geoweb will be installed following the manufacturers' recommendations insuring that all voids within the web have been fully expanded to receive rock fill. Rock fill placed in the Geoweb will be level and compacted.

3.3 Protection

3.3.1 Geosynthetics will be protected during installation from clogging, tears, and other damage. Damaged geotextile will be repaired or replaced as directed. Adequate ballast (i.e., sand bags) will be used to prevent uplift. by wind. Staples or pins will not be used to hold the geotextile in place. Geosynthetics will not be left. uncovered for more than 2 days during installation. The initial loose soil lift height over the geotextile will be between 6 inches and 12 inches. Fill will be placed with small equipment so as to not introduce rutting or overstressing of the underlying fabric until sufficient fill has been placed. Overlying materials will be deployed such that the geosynthetic layers are not shifted, damaged, or placed in tension. Cover soil will be placed from the bottom of the slope

upward. Cover soil placed from a bucket will be dropped from a height no greater than 2 feet.

3.4 Repairs

3.4.1 Geotextile damaged during installation will be repaired by placing a patch of the same type of geotextile that extends a minimum of 36 inches beyond the edge of the damage or defect in each direction or replaced at the option of the contractor. A maximum of 1 patched area within a given placement area will be allowed.

- End of Section --

SECTION 02720

STORM DRAINAGE SYSTEM

PART 1 GENERAL

1.1 References: The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

American Association Of State Highway Transportation Officials (AASHTO)

AASHTO-01 (1992; Interim specs 1993, 1994,1995) Standard Specifications for Highway Bridges

AASHTO M 167 (1994) Corrugated Steel Structural Plate, Zinc Coated, for Field Bolted Pipe

American Society For Testing And Materials (ASTM)

ASTM A 444 (1989) Steel Sheet, Zinc-Coated (Galvanized) by the Hot Dip Process for Storm Sewer and Drainage Pipe

ASTM A 798 (1994) Installing Factory-Made Corrugated Steel Pipe for Sewers and other Applications

ASTM A 807 Installing Corrugated Steel and Other Structural Plate Pipe for sewer Applications

ASTM D 1557 (1991) Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft.lb./cu.ft.)

ASTM D 2167 (1994) Density and Unit Weight of Soil in Place by the Rubber Balloon Method

ASTM D 2922 (1991) Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Willow Depth)

ASTM D 3017 (1988; R 1993) Water Content of Soil and Rock in Place by Nuclear Methods (Willow Depth)

Federal Specifications

WW-P-405 2 Pipe, corrugated (iron or steel, zinc coated)

1.2 Measurement and Payment

1.2.1 Materials for all storm drain structures will be furnished in accordance with the requirements of Section 01000, Paragraph B1Government-Furnished Materials.

1.3 Delivery, Storage, and Handling

1.3.1 Delivery

1.3.1.1 Required quantities of material for storm drain structures will be delivered to the project site and/or stored at the Resources Office, Fort Bragg.

1.3.2 Handling

1.3.2.1 Materials will be handled in such a manner as to ensure delivery to the site in sound, undamaged condition. Pipe will be carried to the site, not dragged.

1.4 Scheduling

1.4.1 Unless otherwise specified, under construction road sections may be closed during construction.

PART 2 PRODUCTS

2.1 Corrugated Metal Pipe

2.1.1 Corrugated metal pipe for each stream crossing will be 24-36 inches in diameter, 60 feet long, and conform to the requirements of Federal Specification WW-P-405 2. The pipe will have bituminous coating inside and outside.

2.2 Flared End Sections

2.2.1 The flared end sections for the corrugated metal pipe conduit outlet will be fabricated from zinc coated steel sheets meeting requirements of ASTM A 444 or as furnished.

PART 3 EXECUTION

3.1 Excavation For Pipe Culverts, Storm Drains, And Drainage Structures

3.1.1 Excavation of trenches and for appurtenances and backfilling for culverts and storm drains will be in accordance with the applicable portions of Section 02225 EARTH WORK, and the requirements specified below.

3.1.1.1 Trenching: The width of trenches at any point below the top of the pipe will be not greater than the outside diameter of the pipe plus 14 inches to permit satisfactory jointing and thorough tamping of the bedding material under and around the pipe. All conduits will be laid to line and grade in such a way that the side walls are continuously and uniformly supported. All will be properly placed and compacted to provide lateral restraint against deflection and to protect the conduit against collapse during backfill. Care will be taken not to over-excavate.

3.1.1.2 Trench Bottom: The trench bottom will be smooth and free of clods and loose or exposed rock. The bottom of the trench may not be shaped to conform to the pipe.

3.1.1.3 Removal of Unstable Material: All trench installations will be made when the soil profile is in its driest possible condition in order to minimize problems of trench stability, and conduit alignment. The conduit should be blinded with selected material containing no hard objects larger than 1.5 inches in diameter. Blinder will be carried to a minimum of 3 inches above the conduit. Where wet or otherwise unstable soil incapable of properly supporting the pipe, as determined by the COR, is unexpectedly encountered in the bottom of a trench, such material will be removed to the depth required and replaced to the proper grade with select granular material, compacted as provided in this Section 02720, Paragraph BACKFILLING.

3.2 Bedding

3.2.1 The bedding surface for the pipe will provide a firm foundation of uniform density throughout the entire length of the pipe. All conduits will be laid to line and grade in such a way that the side walls are continuously and uniformly supported with bedding materials.

3.2.1.1 Corrugated Metal Pipe: Bedding for corrugated metal pipe will be in accordance with ASTM A 798. It is not required to shape the bedding to the pipe geometry.

3.3 Placing and Installing Corrugated Metal Pipe (CMP)

3.3.1 Each pipe will be carefully examined before being laid, and defective or damaged pipe will not be used. Pipelines will be laid to the grades and alignment directed by the COR. Proper facilities will be provided for lowering sections of pipe into trenches. Lifting lugs in vertically elongated metal pipe will be placed in the same vertical plane as the major axis of the pipe. Under no circumstances will pipe be laid in water, and no pipe will be laid when trench conditions or weather are unsuitable for such work. Diversion of drainage or dewatering of trenches during construction will be provided as necessary. All pipe in place will be inspected before backfilling, and those pipes damaged during placement will be removed and replaced.

3.3.1.1 CMP Installation: Install CMP conduit culverts underneath the tank trail roadway at locations shown in the Drawings or as directed in the field. The culverts will be 60 feet long each, and will be installed on a one (1) percent slope, with a flared outlet section that projects onto the outlet stabilization structure. Build the outlet stabilization structures as directed in the field. The structures will be constructed of rock riprap and installed at the end of the flared outlet. They will be 12 feet long by 3 feet wide where the flared outlet section exits and 15 feet wide at the 12-foot length. Depth of riprap will be 18 inches in this section

3.4 Rock Blanket Crossings (Also known as Texas Crossings or At-Grade Crossings)

3.4.1 Rock

3.4.1.1 Rock that will be used to install rock blanket crossings will be placed to the lines and grades indicated on the drawings. The rock will be washed gravel obtained from approved sources with a minimum size of 2 in. and maximum size of 3 inches. Rock will be kept free of dirt or debris prior to placement in the blanket. Rock removed from stockpiles will not be placed where moving operations contaminate the pile.

3.4.2 Installation

3.4.2.1 The contractor may opt to place the culverts pipes and rock blankets during or after completion of the tank trail alignment. Protection of the uncompleted crossing is the contractor's responsibility and materials will be replaced at no cost to the Government if the crossing is damaged.

3.4.2.2 Rock will be placed in 12" lifts on top of the geotextile fabric. Where Geoweb/geogrid is to be installed the contractor will place the appropriate thickness of rock fill and compact with hand operated equipment only. Geogrid is to be laid out as specified in Section 02272 Geosynthetics. Continue rock placement to the extent of lines and grades shown on the Drawings and/or in accordance with manufacturer's specifications.

3.4.3 Rock Handling

3.4.3.1 Rock placement will be by methods that limit the drop height to 2 ft. Only hand operated equipment will be used to compact the rock. Three passes with hand compactor is required per lift.

3.4.4 Geotextile Fabric

3.4.4.1 Geotextile fabric ends will be protected from damage. The ends will be sufficiently anchored into the surrounding embankment fill so as to insure that fabric will not be disturbed by future construction activities. Compaction on top of the geotextile fabric will be by hand operated equipment for the first 12 inches of backfill.

3.4.5 Geoweb/Geogrid

3.4.5.1 Where Geoweb/geogrid is to be installed upon the final lift, the Contractor will place the Geoweb/geogrid as specified in Section 02272, GEOSYNTHETICS. Rock fill to be placed in the Geoweb/geogrid will be as specified for the blanket fill and will be compacted using hand operated equipment after the voids have been completely filled. Follow the manufacturer's specifications for installation techniques.

3.5 Backfilling

3.5.1 Backfill Pipe in Fill Sections

For pipe placed in fill sections, backfill material and the placement and compaction procedures will be as specified below in Paragraph 3.5.1. The fill material will be uniformly spread in layers longitudinally on both sides of the pipe, not exceeding 6 inches in compacted depth, and will be compacted by rolling parallel with pipe or by mechanical tamping or ramming. Prior to commencing normal filling operations, the crown width of the fill at a height of 12 inches above the top of the pipe will extend a distance of not less than twice the outside pipe

diameter on each side of the pipe or 12 feet, whichever is less. After the backfill has reached at least 12 inches above the top of the pipe, the remainder of the fill will be placed and thoroughly compacted in layers not exceeding 12 inches.

3.6 Backfilling Pipe in Trenches

3.6.1 After the pipe has been properly bedded, selected material from excavation or borrow, at a moisture content that will facilitate compaction, will be placed along both sides of pipe layers not exceeding 6 inches in compaction depth. The backfill will be brought up evenly on both sides of pipe for full length of pipe. Care will be taken to ensure thorough compaction of the fill under the haunches of the pipe. Each layer will be thoroughly compacted with mechanical tampers or rammers. This method of filling and compacting will continue until the fill has reached an elevation of at least 12 inches above the top of the pipe. The remainder of the trench will be backfilled and compacted by spreading and rolling or compacted by mechanical rammers. Place backfill material so that displacement of deflection of the conduit will not occur. This is preferably on an angle, so the material flows down the front slope. Avoid large stones, and dry clods that cause concentrated point loads installing the tubing on a hot day, backfilling should be delayed until tubing temperature cools to the soil temperature. The minimum depth of cover over the underground conduits will be 2 feet. The maximum depth of cover will be 10 feet.

3.7 Movement of Construction Machinery

3.7.1 In compacting by rolling or operating heavy equipment parallel with the pipe, displacement of or injury to the pipe will be avoided. Movement of construction machinery over a culvert or storm drain at any stage of construction will be at the Contractor's risk. Any damaged pipe will be repaired or replaced. Where rock blanket crossings are to be installed contractor will not run heavy equipment over the area until rock section is completed.

End of Section

SECTION 02935

TURF

PART 1. GENERAL

1.1 References: The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation.

Practice Standards and Specifications of the North Carolina Erosion and Sedimentation Control Planning and Design Manual.

PART 2. PRODUCTS

2. 1 Seed

2.1.1 Seed Classification

2.1.1.1 State-certified seed of the latest season's crop will be provided in original sealed packages bearing the producers guaranteed analysis for percentages of mixture, purity, germination, hard seed, weed seed content, and inert material. Labels will be in conformance with applicable state seed laws.

2.1.2 Seed Mixtures

2.1.2.1 Seed mixtures will be proportioned by weight as follows:

Seed Mixture	Fall Seeding PLS Rate (lb./acre)	Spring Seeding PLS Rate (lb./acre)
Bahiagrass	50	50
Bermuda Bermudagrass	10 (unhulled)	10
Apallow Lespedeza	30	30

Seed Mixture	Fall Seeding PLS Rate (lb./acre)	Spring Seeding PLS Rate (lb./acre)
Kobe Lespedeza	05	05
Millet	20	--
Grain Rye	--	50
Total	115	145

2.1.3 Quality

2.1.3.1 Weed seed will not exceed 1 percent by weight of the total mixture. Wet, moldy, or otherwise damaged seed will be rejected. All seed will be 88 percent pure and viable seed.

2.1.4 Seed Mixing

2.1.4.1 Seed supplier will provide the seed mixture obtained by machine mixing to provide better and uniform seed mix.

2.2 Soil Amendments

2.2.1 Soil Amendments will consist of lime and fertilizer, and soil conditioners meeting the following requirements.

2.2.1.1 Lime: Lime will be agricultural limestone or lime slurry. It will have a minimum calcium carbonate equivalent of 90 percent and will be ground to such a fineness that at least 90 percent will pass a 10-mesh sieve and at least 50 percent will a 60-mesh sieve.

2.2.1.2 Fertilizer: Fertilizer will be commercial grade, free flowing, uniform in composition. Granular fertilizer consisting of nitrogen, phosphorus, and potassium in the following rates will be used:

Nitrogen ---------- 80 lb../acre

P_2O_5 ---------- 160 lb../acre

K_2O ---------- 160 lb../acre

2.3 Mulch

2.3.1 Mulch will be free from weeds, mold, and other deleterious materials. Anchor mulch by tacking with asphalt, roving, or netting or by crimping with a mulch anchoring tool. A disk with blades set nearly straight can be used as a mulch anchoring tool.

PART 3. EXECUTION

3.1 Lime, fertilizer, and seed will be applied to all project areas, **including the entire surface area (xxx acres) of the newly constructed road.**

3.2 Site Preparation

3.2.1 Grading

3.2.1.1 The COR will verify that finished grades are as indicated on drawings and in the specification, before soil amendments or seeds are spread.

3.2.2 Application of Soil Amendments

3.2.2.1 Lime: Lime will be applied at the rate of 1 Ton per acre in project areas, and 1/2 ton per acre in non-traffic areas. Lime will be incorporated into the soil to a minimum depth of 4 inches or may be incorporated as part of the tillage operation.

3.2.3 Tillage

3.2.3.1 Minimum Depth: Soil on slopes gentler than 3-horizontal-to 1 vertical (3:1) will be tilled to a minimum depth of 4 inches. On slopes between 3-horizontal-to-1-vertical and 1-horizontal-to-1-vertical (3:1 to 1:1), the soil will be tilled to a minimum depth of 2 inches by scarifying with heavy rakes, or other method. Rototillers will be used where soil conditions and length of slope permit. On slopes l-horizontal-to-l vertical (1:1) and steeper, no tillage is required.

3.3 Seeding

3.3.1 General

3.3.1.1 Prior to seeding, any previously prepared seedbedareas compacted or damaged by interim rain, traffic or other cause, will be reworked to restore the ground condition previously specified. Seeding operations will not take place when the wind velocity will prevent uniform seed distribution.

3.3.2 Seeding Time

3.3.2.1 Seed will be sown immediately following completion of construction activities.

3.3.3 Seeding Rate

3.3.3.1 Seed all project areas with the seed mixture and rate shown in 2.1.2.

3.3.4 Mulch

3.3.4.1 Grain straw mulch will be spread uniformly at the rate of 4,000 pounds per acre in project areas only. Mulch will be spread by hand, blow-type mulch spreader or other approved method. Mulching will be started on the windward side of relatively flat areas or on the upper part of a steep slope and continued uniformly until the area is covered. The mulch will not be bunched. All seeded areas will be mulched on the same day as the seeding.

3.3.4.2 Mechanically Anchoring: Immediately following spreading, the mulch will be anchored to the soil by a V-type-wheel land packer, a scalloped-disk land packer designed to force mulch into the soil surface, or other suitable equipment.

3.3.5 Asphalt Adhesive Tackifier

When asphalt adhesive is applied to the in-place mulch, spraying will be at a rate of between 10 to 13 gallons per 1000 sq.ft.

3.3.6 Non-Asphaltic Tackifier

Hydrophilic colloid will be applied at a rate recommended by manufacturer. Apply with hydraulic equipment suitable for mixing and applying uniform mixture of tackifier.

3.4 Spreading Asphalt Adhesive Coated Mulch

Straw mulch will be spread simultaneously with asphalt adhesive at the pate of 4,000 pounds per acre by using power mulch equipment that will be equipped with suitable asphalt pump and nozzle. The adhesive-coated mulch will be applied evenly over the surface. Sunlight will not be completely excluded from penetration to the ground surface.

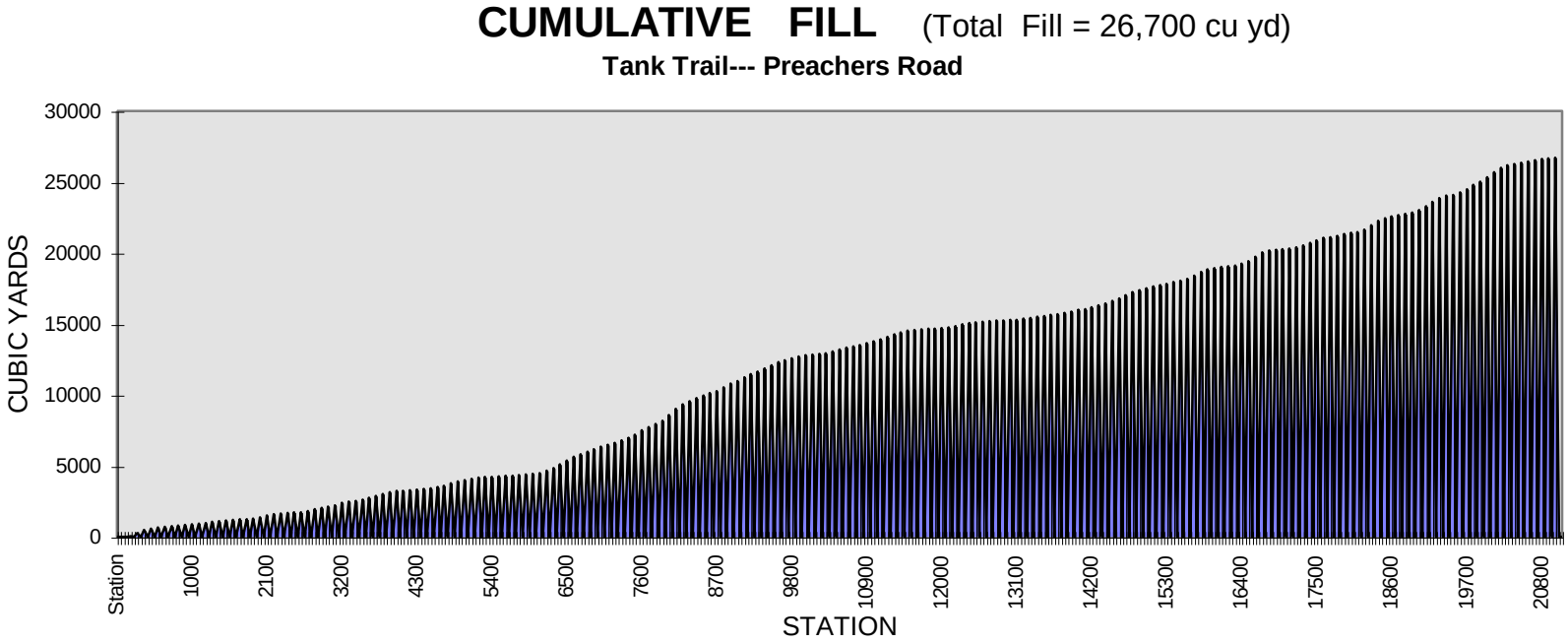

Figure 1:Cumulative Borrow Fill required along Tank Trail--Starting from Chicken Road

Figure F-1. Cumulative borrow fill required along Tank Trail – Starting from Chicken Road.