Robert D. Coney
DIRECTOR

ADAMS COUNTY
COLORADO

Planning and
Development Department
12200 Pecos Street
Westminster, CO 80234
PHONE 303.453.8800
FAX 303.453.8829
www.co.adams.co.us

June 11, 2007

Alan Scheere
Environmental Specialist
Waste Management
7780 East 96th Ave.
Henderson, CO 80640

Re: Modification to the Design and Operations Plan to allow an Alternative Final Cover
Case Number 86-88-CD(A)

This Department has completed its review of your application, titled Updated Alternative Final Cover Demonstration Plan, updated April 23, 2007. This application revises the Design and Operations Plan to allow an Alternative Final Cover for Conservation Services Inc. Alternative Covers use evaporation and plant transpiration to prevent water infiltration through the cover.

Colorado Department of Public Health and Environment (CDPH&E) approved the plan on May 21, 2007. CDPH&E considered the design change to be "not significant."

Based upon our review and the CDPH&E approval, this Department approves the design as an administrative amendment to the Design and Operations Plan to allow an alternative cover, constructed as specified in the Updated Alternative Final Cover Demonstration Plan updated April 23, 2007.

Should you have any questions regarding this administrative approval, please contact me at 303-453-8813.

Sincerely,

Craig Tessmer
Environmental Analyst

cc: Director, Planning and Development
CDPH&E
TCHD

STATE OF COLORADO

Bill Ritter, Jr., Governor
James B. Martin, Executive Director

Dedicated to protecting and improving the health and environment of the people of Colorado

4300 Cherry Creek Dr. S.
Denver, Colorado 80246-1530
Phone (303) 692-2000
TDD Line (303) 691-7700
Located in Glendale, Colorado

Laboratory Services Division
8100 Lowry Blvd.
Denver, Colorado 80230-6928
(303) 692-3090

http://www.cdphe.state.co.us

Colorado Department
of Public Health
and Environment

May 21, 2007

Mr. Alan Scheere
Waste Management of Colorado, Inc.
7780 E. 96th Avenue
Henderson, Colorado 80640

Re: CSI Facility, Approval-Updated Alternative Final Cover Demonstration, Conservation Services, Inc.

Dear Mr. Scheere:

The Hazardous Materials and Waste Management Division of the Department of Public Health and Environment (the Division) has reviewed the Updated Alternative Final Cover Demonstration, Conservation Services, Inc., Adams County, Colorado, dated April 25, 2007, prepared by American Environmental Consulting, LLC, for Waste Management of Colorado, Inc. The proposal for the landfill final cover is to construct an evapotranspiration (ET) cover consisting of 18-inches (20-inches on the side slopes) of a "moisture storage layer", overlain by 6-inches of "topsoil".

In a letter dated September 8, 2005 the Division requested additional information and clarification for the submitted alternative final cover demonstration. This information was provided in a letter to the Division dated December 5, 2006. Subsequently two meetings were conducted on July 20, 2006 and September 21, 2006 between Waste Management and the Division to discuss the issues associated with designing and demonstrating the adequacy of Alternant Final Cover's in Colorado. The agreements made during these meetings are provided in detail in the April 25, 2007 updated demonstration.

It is the assessment of the Division that the above-proposed changes would not decrease the environmental protective features of the landfill if the alternative final cover is constructed as detailed in this plan. Based on this assessment, the Division approves these design changes for the Conservation Services, Inc. Landfill.

Sincerely,

Darrell Dearborn, Geologist
Solid Waste Unit, Hazardous Materials and Waste Management Division

Cc: Deanne Kelly, Tri-County Health Department
Craig Tessmer, Adams County Planning Department
Mark McMullen, American Environmental Consulting

File: SW/ADM/CSI - 2.3

April 25, 2007

Mr. Darrell Dearborn
Colorado Department of
Public Health and Environment
4300 Cherry Creek Drive South
Denver, Colorado 80246-1530

Mr. Craig Tessmer
Adams County Planning Department
12200 N. Pecos St. 3rd Floor
Westminster, Colorado 80234

Ms. Deanne Kelly
Tri-County Health Department
4201 East 72nd Avenue, Suite D
Commerce City, Colorado 80022

Re: Updated Alternative Final Cover Demonstration
Conservation Services, Inc.
Adams County, Colorado

Dear Mr. Dearborn, Mr. Tessmer, and Ms. Kelly;

On behalf of Conservation Services, Inc. (CSI), American Environmental Consulting, LLC (AEC) is pleased to submit this Updated Alternative Final Cover Demonstration pursuant to the Colorado Department of Public Health and Environment (CDPHE) letter dated February 6, 2007. This demonstration, which was updated by AEC with technical assistance from Golder Associates Inc. (Golder) incorporates the results of design review meetings previously conducted on July 20, 2006 and September 21, 2006 between CSI, CDPHE, Golder and AEC. The purpose of these meetings was to discuss and agree on issues associated with designing and demonstrating adequacy of the proposed Alternative Final Cover (AFC) at CSI. As a result of those meetings, Golder submitted a letter dated November 8, 2006, which summarized all issues discussed during the design review meetings. Subsequently, the CDPHE provided review comments in their letter dated February 6, 2007. Specifically, CDPHE requested that the results of the design review meetings be incorporated into the original Alternative Cover Demonstration prepared by AEC dated February 5, 2005 including the following information:

- A proposed window of soil compaction specifications;
- Methods that CSI intends to use to demonstrate appropriate cover thickness and performance monitoring for the cover after construction; and

- A plan that CSI will use to evaluate various soil parameters for suitable geotechnical properties prior to seeding.

Accordingly, the information requested by CDPHE has been consolidated and incorporated into the enclosed Updated Alternative Final Cover Demonstration.

Included with this submittal as separate items are updated pages to the Design and Operations Plan, including a revised Plate 10, and an updated Construction Quality Assurance and Specifications Plan (AEC, May 2003) incorporating the changes necessary to implement the AFC final cover.

In summary, we believe the proposed AFC design will improve final cover performance and provides a greater level of environmental protection when compared to the existing final cover design at CSI. This is based on considerable research that clearly demonstrates that alternate final covers (monolithic soil type) can be very effective systems in semi-arid climates. Moreover, a recent study states that "All soil covers have significant benefits including enhanced methane oxidation/greenhouse gas reductions, ability to allow controlled infiltration, improved slope stability, reduction of gas to groundwater effects, wildlife habitat and other favorable end use alternatives that promote community involvement and optimal end use options" (Dwyer et al., 2006)*. This is further supported by the results of design review meetings including site-specific technical information provided by AEC and Golder Associates.

Accordingly, we request CDPHE approval of the Updated Alternative Final Cover Demonstration for CSI.

In addition, by copy of this submittal we are hereby filing with the Adams County Planning Department a request for minor change to the existing Design and Operations Plan (D&O Plan) for the AFC design at CSI. This minor change filing is consistent with the CDPHE determination as stated in their February 6, 2007 letter, which states "The Division will not consider this design change to be a significant change to the existing Design and Operations Plan for the facility". The filing is also consistent with protocol previously followed by CSI for a minor change to Cell #1 cover system (allowed a PBBT cover design), which was approved by Adams County On July 5, 1995.

Should you have any questions about this request for approval of the AFC design at CSI or related information, please contact Alan Scheere at 720-977-2107 or us at 303.948.7733

Respectively Submitted,

American Environmental Consulting, LLC

Mark A. McMullen, P.G.
Principal

Michael H. Stewart, P.E.
Principal

Cc: Mark McClain, Golder Associates (Updated AFC Demonstration Only)
Leonard Butler, WMC/CSI
Alan Scheere, WMC/CSI
Bill Hedberg, WMC/CSI
Ron Chacon, WMC/CSI

* Dwyer, S.F., Bull L., Johnson T., and Obereiner, J. 2006. Evaluating The Vadose/W Model for Deployment of Evaporation (ET) Covers in Cold and Wet Climates: Proceedings, Waste Tech Landfill Conference, Final Covers Session, March 12, 2006.

Updated Alternative Final Cover Demonstration
Conservation Services, Inc.
Adams County Colorado

Prepared for:

Waste Management of Colorado, Inc.
Conservation Services Inc.

Prepared by:

American Environmental Consulting, LLC
6885 S. Marshall St. Suite 3
Littleton, Colorado 80128

February 2, 2005
Updated April 23, 2007

ERRATA – FOR INTERIM UPDATES
CONSERVATION SERVICES, INC.

DATE	DESCRIPTION OF REVISION	BY
February 2, 2005	Original	AEC, CSI
April 23, 2007	Updated Demonstration per CDPHE letter dated March 6, 2007	AEC, Golder, CSI

BACKGROUND

Standard Subtitle D final cover systems rely on a compacted low-permeability soil cap or synthetic materials as a barrier layer to limit infiltration of moisture through the final cover and into the underlying waste mass. The currently approved final cover system at CSI consists, from the bottom up, of a two-foot thick barrier layer of compacted cohesive soils, an 18-inch thick layer of miscellaneous protective soils, and a six-inch thick layer of topsoil. The proposed AFC is an evapotranspiration (ET) type monolithic final cover system that uses the natural moisture storage properties of the soil, evaporation, and transpiration of vegetation to minimize the infiltration of moisture. ET covers have been shown to be very effective in semi-arid climates such as exists in many areas of Colorado. ET covers have been approved at a number of Colorado landfills, particularly along the Front Range and Eastern Plains. In addition to the ability to minimize infiltration of moisture through the final cover, a major benefit to an ET cover is that its performance is substantially less affected by freeze/thaw action and desiccation than a standard cover system that incorporates a barrier layer.

PRIOR DEMONSTRATIONS AND PROJECT APPROACH FOR CSI

Among the Colorado Landfills that have successfully demonstrated the adequacy of an ET cover are the Midway Landfill (MLF) located between Pueblo and Colorado Springs, the Denver-Arapahoe Disposal Site (DADS) located in the eastern Denver Metro area, the North Weld Landfill (NWLF) north of Greeley, the Colorado Springs Landfill (CSLF), the Buffalo Ridge Landfill (BRLF) near Keenesburg, Denver Regional Landfill (South) near Erie and the Tower Road Landfill (TRLF) in Commerce City. The results of the demonstrations show that a 24-inch to 36-inch ET cover system using a soil with specified characteristics was equally, if not more, effective than the standard Subtitle D "barrier" type cover system previously permitted for each site. The demonstration conducted for the NWLF, BRLF and TRLF used a streamlined approach that was approved by the Colorado Department of Public Health and Environment (CDPHE) for permitting an ET final cover system, and that built on the results of the demonstrations conducted for other landfills as well as the Rocky Mountain Arsenal. For each of the landfills for which the model demonstration indicated acceptable results, site-specific soil testing was conducted to input to empirical methods to estimate the soil moisture characteristic curves or the soil moisture characteristics were measured in the laboratory. Once the soils and the corresponding minimum soil characteristics were found to yield acceptable levels of infiltration, indicator tests, primarily the percentage of fine-grain particles, were used during CQA testing to show that the soils modeled were being used in full-scale construction

The climate for each of the landfills sites for which a successful modeling demonstration was conducted is very similar in terms of quantity, intensity, and patterns of precipitation and potential ET. The NWLF and BRLF are within this region of similar climate and it was concluded that any differences in climate would not be discernable in subsequent modeling efforts. The remaining variables that can influence the infiltration of moisture are the soil and vegetation characteristics. Soils at the BRLF and the TRLF were tested and compared to the soils for the other landfills, and if comparable moisture storage characteristics were available, the demonstration was deemed acceptable. A comparable seed mix of both warm and cool season native grasses were specified to promote year-round transpiration at each site. Because of these similarities, it was also reasoned that other model input parameters such as Leaf Area Index (LAI) and root density function (RDF) would also be comparable and would not change appreciably from site to site.

Since the CSI facility is located within the region outlined by the other Waste Management landfills, and in accordance with the approach taken for the NWLF and BRFL, the approach used and approved for the NWLF and BRLF was used to evaluate the potential for an ET cover at the CSI facility. Additionally, issues discussed during design meetings with CDPHE were incorporated into the AFC design and updated demonstration at CSI.

SOIL SAMPLING PROGRAM AND LABORATORY ANALYSIS AT CSI

Like the other landfills for which modeling results using site-specific soil evaluation indicated favorable results for an ET cover, samples of potential final cover soils and topsoil were collected from CSI. Samples were collected from existing stockpiles and native ground in areas of future excavation to characterize the range of materials likely to be used in the final cover system. Figure 1 shows the location where the samples were collected, and Table 1 lists the sample designations, a general sample location, and the analyses conducted on each sample.

The existing topsoil stockpile located northwest of the current excavation for Cell 18/21/22/23 was sampled. Two test pits were excavated vertically into this stockpile (TP-1 and TP-2). The topsoil samples collected from these two test pits were composited into one sample labeled, "Topsoil".

Test pits TP-3, TP-4, and TP-5 were excavated into a stockpile of previously excavated bedrock materials adjacent to, and west of, the southern part of the current excavation for Cell 18/21/22/23. To identify the range of materials present in the stockpile, each test pit was excavated to an approximate three-foot depth into the sideslope of the stockpile from the top to the bottom of the slope. Two samples were collected from TP-3, one representing a fine-medium grain sand that is present in lenses within the predominantly claystone bedrock, and the other representing the claystone bedrock typical across the site. One sample was collected from TP-4, and it is representative of a blend of the bedrock sand and bedrock claystone bedrock materials as they are mixed during mass excavation, transportation, and processing during liner construction. The materials observed in TP-5 were similar to those in TP-3 and TP-4, so no sample was collected.

A stockpile of random materials, consisting of soils previously excavated below the topsoil and above the claystone bedrock, is present on the south side of Cell 18/21/22/23. Both test pits were excavated to an approximate three-foot depth along the sideslope of the stockpile from the top to the base of the slope. This stockpile consists of sandy and silty clays typical of the soils existing above the bedrock across much of the site. Two test pits, TP-6 and TP-7 were excavated in this stockpile. The soils from both test pits were similar, and so a sample was only collected from TP-6.

The remaining test pits, TP-8 through TP-13 were excavated into native (farmed) ground where excavation for future disposal cells will occur as shown on Figure 1. The soil materials observed in these test pits were very similar to each other, differing mainly in sand and silt content, and appeared to be representative of the brown silty, sandy clay and loam soils above the bedrock over most of the CSI site, with the exception of soils in TP-9. The soils from TP-9 between three feet and 15 feet below ground surface (bgs) were dark brown to black, more blocky than the other soils, with a moderate amount of gypsum precipitate and an organic appearance. No samples were collected from TP-10 or TP-12. One sample was collected from TP-8, and it consisted of soils that were composited from the ground surface to 12-feet bgs. Two samples were collected from TP-9; one representing soils from approximately 3 feet bgs to 7-feet bgs, and the other representing soils from 7-feet bgs to 15-feet bgs. Two samples were collected from TP-11; one representing topsoil from the upper two feet and the other representing deeper soils from 5 to 15-feet deep. One composite soil sample was collected from TP-13 representing soils from the ground surface to 20-feet bgs.

All of the soil samples collected, with the exception of the topsoil from TP-11, were tested in the laboratory to determine the percentage of fine grain material passing the standard #200 sieve for purposes of identifying the range of soil textures for potential ET cover soils and topsoil. Table 1 shows the tests conducted for each sample. The fines content ranged from a low of 39% in the sample of bedrock sandstone to 96% for the sample of bedrock claystone, both collected from the stockpile of potential cohesive liner materials. Additional laboratory testing of selected samples, including hydrometer analysis, Atterberg Limit Analysis, and moisture density relationships (Standard Proctor Analysis) for purposes of classifying the soil, were conducted to determine the specific gravity and to establish a compaction and moisture content relationship for permeability testing and construction. These results are summarized on Tables 1, 2, and 3 in Appendix A, which also includes the laboratory test data sheets. The samples selected for this testing included the topsoil sample, "TP-3 brsd" representing the coarsest grain material sampled, "TP-6 Random" representing soils with a relatively large percentage of coarsest grain materials existing above the bedrock, TP-9, 7-15 representing materials with the greatest percentage of fines materials above the bedrock, TP-11 representing an average fines content of soils existing above the bedrock, and TP-13 representing soils with the largest percentage of coarse materials existing above the bedrock.

The bedrock materials stockpile and bedrock materials excavated in the future will be used in cohesive liner construction and not for final cover construction, so no further testing of these materials was conducted. Samples TP-13 and TP-9 represent the low and high range, respectively, of the percent fines-grain material in the soils above the bedrock, and TP-11 would be typical of the soil texture expected during mass excavation of surficial soils over a large area.

FIGURE 1
SOIL SAMPLE LOCATIONS

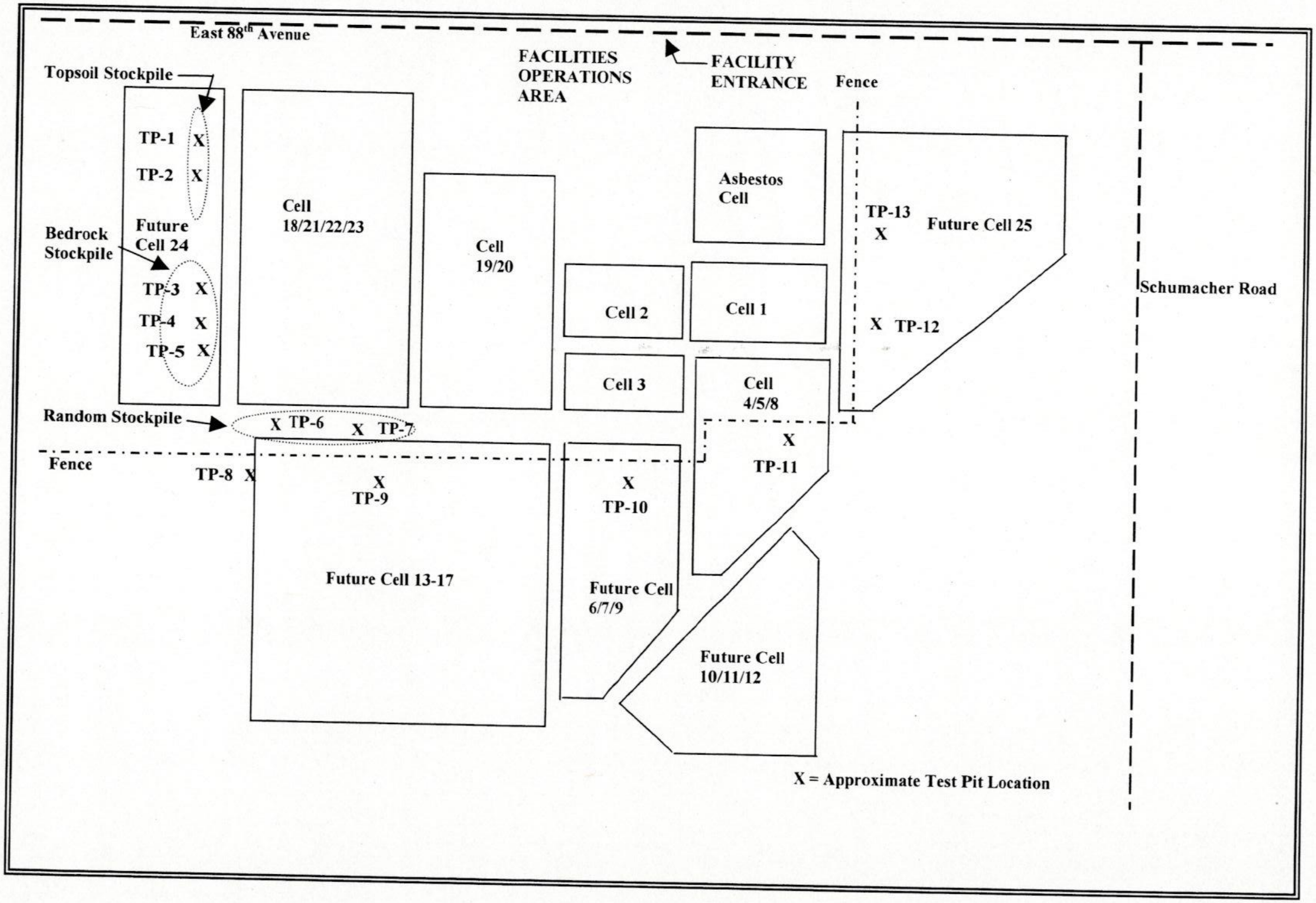


TABLE 1
SOILS ANALYSES

Sample Designation	U.S.C.S Class.	#200 wash	Hydrometer Analysis	Standard Proctor	Atterberg Limits	Organic Content	Remolded Permeability	Location
Topsoil	X	X	X	X	X	X		Topsoil stockpile, west of Cell 18
TP-3 bdrsd [1]	X	X	X	X	X			Bedrock materials stockpile, west of Cell 18
TP-3 bdrclyst [2]		X						Same as above
TP-4 bdrsdclyst [3]		X						Same as above
TP-5-no sample								Same as above
TP-6 random	X	X	X	X	X	X		Random material stockpile, south of Cell 18
TP-7-no sample								Same as above
TP-8 0'-12'		X						Undisturbed area, south of fence, south of Cell 18
TP-9 3'-7'		X						Undisturbed area, south of fence, south of Cell 18
TP-9 7'-15'	X	X	X	X	X			Same as above
TP-10-no sample								Undisturbed area, south of fence, south of Cell 3
TP-11 5'-15'	X	X	X	X	X	X	X	Undisturbed area, south of fence, south of Cell 4
TP-11 topsoil						X		Same as above
TP-12-no sample								Undisturbed area, east of fence, east of Cell 1
TP-13 0'-20'	X	X	X	X	X	X	X	Undisturbed area, east of fence, east of Asbestos Cell

(1) Sample from stockpile of claystone bedrock soils for use in cohesive liner. Sample represents typical sand lense within the bedrock claystone

(2) Sample from stockpile of claystone bedrock soils for use in cohesive liner. Sample represents claystone bedrock.

(3) Sample from stockpile of claystone bedrock soil for use in cohesive liner. Sample is a composite of the claystone bedrock and sand lenses within the bedrock. Is typical of soils mixed during mass excavation.

In order to evaluate the materials under conditions anticipated during construction, remolded permeability testing was conducted on samples TP-11 and TP-13 after compaction to approximately 85% of maximum Standard Proctor density, at moisture contents of 74 percent and 70 percent respectively. The permeability results are shown on Table 2 in Appendix A. The soil grain size analysis and Atterberg Limit analysis of TP-11 are very similar to those of the topsoil collected from the topsoil stockpile, so the permeability of the topsoil should be very similar to that of TP-11 given the uniform nature of the topsoil encountered. Samples "Topsoil", "TP-6 Random", "TP-11 5-15", "TP-13 0-20", and "TP-11 Topsoil" were tested for organic content to evaluate their potential use as topsoil, and the results are shown on Table 3 in Appendix A.

EVALUATION FOR USE IN ET FINAL COVER SYSTEM

The characteristics of the soils collected and tested from CSI were compared to the soil characteristics from DADS, MLF, NWLF, BRLF, and the TRLF, each of which have been shown suitable for use in an ET cover system. This comparison was conducted to determine which landfill soils were most similar to those from CSI.

The laboratory test data from the CSI soils was used to estimate the moisture characteristic curves for the samples using the Arya and Paris (1981) method. The moisture characteristic curve(s) generated from the grain-size distribution at 85% of the maximum density as defined by the Standard Proctor test for sample(s) were compared to the moisture characteristic curves for the other landfills that have approved ET final cover systems.

The available water storage capacity of a soil is the numerical difference between the soils field capacity, often reported as a moisture content at a matric potential of –0.03 MPa (-3.3 m), and wilting point, and often reported as the moisture content at a matric potential of –1.5 MPa (-150) m).

The particle size distributions for the CSI samples were compared to the distributions from the DADS landfill because it is the closest landfill to the site where the detailed modeling was completed. The distributions were also compared to the sample collected from the Tower Road landfill (TRLF) because it is the closest location where a similar type of comparative analysis was completed.

The particle-distribution curves for the CSI samples are shown on Figure 1 in Appendix B. Examination of these curves indicates that samples TP-6, TP-11 and the topsoil sample all exhibit similar grading. The other three samples have differing textures so they were not considered further.

The particle-distribution curves for DADS samples ACTS2, ACS4, ACS6 and TRLF sample PTS-2 are shown on Figure 2 in Appendix B. The ACTS2 and PTS-2 samples in Figure 2 (Appendix B) most closely resemble the distributions of TP-6, TP-11 and the topsoil sample in Figure 1 (Appendix B).

Table 1 in Appendix B compares the material properties used in the evaluation below for the selected samples from the CSI, DADS and TRLF. Examination of Table 1 (Appendix B) indicates that the material properties are also similar, again indicating that the materials from CSI that are proposed to construct the alternative cover are similar to the construction materials from the DADS and the TRLF facilities.

The particle distribution curves for samples TP-6, TP-11 (CSI), ACTS2 (DADS) and PTS2 (TRLF) were used to generate points on a moisture characteristic graph using the method presented by Ayra and Paris[1]. These points were then input into the program RETC to generate continuous curves using the van Genuchten equation. RETC is public domain software that is available through the US Department of Agriculture Salinity Laboratory. The Ayra and Paris points and the fitted van Genuchten curves are plotted on Figure 3 in Appendix B for the CSI data and Figure 4 in Appendix B for the DADS/TRLF data. The figures indicate that the points generated using the Ayra and Paris method produce a good fit when evaluated using an accepted computer model.

The van Genuchten curves for TP-6 and TP-11 from the CSI data and from ACTS2 from the DADS data are plotted on Figure 5 in Appendix B. Two horizontal lines are also shown on Figure 5. The line at –330 cm represents the field capacity. The line at -15,000 cm represents the wilting point. The difference in the moisture content between these two points provides an indication of the material's soil water capacity. Extrapolation of the differences between these points for the three samples shown on Figure 5 indicates that samples TP-6 and TP-11 have similar soil water capacity as ACTS2 from the DADS Landfill.

Table 1 in Appendix B also includes the saturated hydraulic conductivity values for TP-11 and ACTS2. The hydraulic conductivity for ACTS2 was raised from $1.6x10^{-6}$ to $1.6x10^{-5}$ during the original modeling effort with no effect on potential net infiltration though the alternative cap into the refuse. The hydraulic conductivity value for TP-11 of $2.6x10^{-6}$ lies closer to the original value of ACTS2. Additional modeling completed for the Midway Landfill south of Colorado Springs indicated that the hydraulic conductivity in the topsoil layer could be as high as $1.4x10^{-4}$ cm/sec without affecting the performance of the cover system.

[1] Arya, Lalit M. and Paris, Jack F. (1981) A Physicoempirical Model to Predict the Soil Moisture Characteristic for Particle-Size Distribution and Bulk Density Data. Soil Science Society of America Journal, Volume 45, pp 1023-1030.

Samples ACS4 and ACS6 were evaluated in the DADS modeling effort, and the modeling results showed that both samples would be suitable for alternative cover materials. The hydraulic conductivity value of 4.3×10^{-5} for sample TP-13 from CSI lies between the measurements for the two DADS samples of 1.2×10^{-4} for ACS4 and 3.2×10^{-5} for ACS6. The particle-size distribution curve for TP-13, the CSI sample with the least percentage of fine-grain material, lies between ACS4 and ACS6 as shown on Figure 6 in Appendix B so its calculated moisture characteristics curve should also be intermediate between them. The intermediate hydraulic conductivity and soil texture of TP-13 relative to the two DADS samples indicates that this material would be suitable for the construction of the moisture storage layer.

Per agreement with CDPHE, CSI agreed to enter its site-specific soil data into the DADS UNSAT-H Model because the climatic data, derived from Denver International Airport, would be the same for the two sites (CSI and DADS). These modeling results were used to supplement the comparisons outlined above that substantiate the use of the AFC at CSI. Research has shown that the model results do not appear very sensitive to the magnitude of changes in LAI and root zone depth that might occur between the two sites. Thus, the primary factor that might influence a difference in the model output between the DADS and CSI sites would be the soil-moisture characteristics of the soils. A summary of this work, conducted by Golder Associates, is included in Appendix C.

The approach agreed to with CDPHE for the modeling was to conduct supplemental work that would use CSI empirically generated soil-moisture characteristic curves and curves obtained from the Soil Vision database to simulate infiltration. Adopting this approach acknowledges that approximately equivalent climatic conditions exist at CSI and DADS and therefore it is appropriate to use DADS climatic data.

Also included in Appendix C are the ranges of soil-moisture characteristic curves (Golder Associates) obtained from Soil Vision for TP-6/TP-11 and for TP-13 along with the grain-size distribution curves for each soil. The search for TP-6 and TP-11 was done together since the soils were so similar. Also provided on these graphs are the van Genuchten values used for input to UNSAT-H for the lower range, mean range and upper range of soil-moisture characteristic curves for TP-6/TP-11 and for TP-13. These van Genuchnten values were input to the DADS UNSAT-H model along with the measured saturated hydraulic conductivity values for the 2- foot cover.

The entire range of soil-moisture characteristic curves for TP-6/TP-11 indicates that a 2-foot cover comprised of these soils will yield essentially no infiltration as shown in Table 1 in Appendix C. Likewise, Table 2 (Appendix C) shows that a 2-foot cover consisting of TP-13 material will yield very low infiltration rates varying between 0.0 mm/yr to 4.2 mm/yr. These values are less than those associated with measured infiltration rates through composite caps at Subtitle D sites near Omaha, Nebraska and Cedar Rapids, Iowa that that are part of the Alternative Cover Assessment Program (ACAP). The two sites showed average annual infiltration values of 6.0 mm/yr and 12.2 mm/yr, respectively. The modeling results show that even the worse-case soil-moisture characteristic curves for the coarsest soil (TP-13) yield infiltration rates less than these measured values, providing additional substantiation that the proposed AFC design will provide good hydraulic performance.

REVEGETATION SPECIFICATIONS

The Natural Resource Conservation Service (NRCS) was consulted for a seeding specification consisting of native warm and cool season vegetation with the goal to maximize year-round transpiration of soil moisture. The NRCS recommendations are in Appendix D, including specifications for a cover crop if needed to stabilize the soil until permanent vegetation is established.

The vegetation specification included in Appendix D is similar to that adopted at the previously-approved sites, and uses a blend of cool and warm season native grass species to maximize ET throughout the growing season as well as during winter months.

The organic content measured in the select CSI samples are also summarized in Table 3 in Appendix B. The measured values are all at least 2.5 times higher than the 1 percent threshold that is typically used as the minimum organic content. Organic material content will not be a limiting factor for any of these materials. Nevertheless, soil agronomic characterization will be completed and analysis of the topsoil shall be conducted after topsoil placement but before adding amendments. A revegetation contractor will evaluate the results of topsoil analyses and recommend treatments of any soil deficiencies (e.g., high pH, low nutrients, high carbonates, etc.), which will be addressed with mixing and/or soil amendments. Accordingly, a soil-testing plan will be developed specifically for CSI based on the results of top soil analyses. Additionally, annual vegetation performance surveys will be conducted to ensure successful revegetation of the AFC.

EROSION ANALYSIS

Erosion analysis was conducted to estimate the amount of erosion that could occur in these areas over time. The evaluation was completed using the Revised Universal Soil Loss Equation (RUSLE) public-domain software. The analysis was completed on the longest (240 foot) side slope with a 4:1 (25 percent) design grade. These calculations are provided in Appendix E. These calculations show that an erosion loss of about .0007 inches per year or about 1 inch every 1,400 years, could occur on the slope areas. Even though this number is very small AEC proposes that the AFC thickness on the side slopes be conservatively increased by 2 inches to provide appropriately conservative erosion allowance.

SUMMARY OF FINAL DESIGN AND CQA REQUIREMENTS

Based on the comparison to the DADS Landfill and TRLF, the proposed AFC will consist of 6 inches of topsoil and 18 inches of lightly compacted soil (20 inches on the side slopes) as a moisture storage layer from on-site sources of material above the bedrock materials. The model

UNSAT-H results (Appendix C) indicate that the net infiltration from the bottom of the proposed alternative covers for a cover constructed of soil similar to samples TP-6 and TP-11 or sample TP13 will yield very low infiltration (the highest estimate being 4.2 mm/year) that is comparable to or less than that measured at other Subtitle D sites.

CSI has an approved Construction Quality Assurance Plan (CQAP) that establishes testing protocol and standards for construction of the final cover system at CSI. Revisions to the CQA requirements for construction of the final cover are required as a result of this AFC demonstration, and the proposed revisions are outlined below. Following approval of this demonstration and the proposed revisions, the CQAP will be revised appropriately.

The final cover system at CSI will consist of an 18-inch thick (on slopes <4H:1V) or 20-inch thick (on slopes 4H:1V or greater) moisture storage layer of soils with a minimum fines content of 58%, and a minimum six-inch topsoil layer with a minimum fines content of 58%. Soils intended for use in the moisture storage layer and topsoil must meet the following specifications and will be tested in accordance with the following proposed schedule:

Test	ASTM Designation	Construction Frequency	Preconstruction Frequency	Requirement
Grain Size Analysis	ASTM D 422 (excluding hydrometer)	Min. 1 per 5,000 cy constructed	1 per 20,000 cy	Min. 58% passing #200 sieve – Moisture storage layer. Min. 58% passing #200 sieve - Topsoil
Standard Proctor	ASTM D 698	Min. 1 per 10,000 cy constructed	Min 1 per 20,000	No requirement
Moisture Content	ASTM D 3017	Min. 1 per 1,000 cy constructed	None	Dry of optimum
Compacted Density	ASTM D 2922	Min. 1 per 1,000 cy constructed	None	80%-90%, inclusive, of maximum Proctor density

A compacted soil barrier layer is generally constructed in six-inch thick lifts to ensure continuity of compaction and permeability throughout the layer; however, excessive compaction and low permeability are to be avoided in an ET cover. Therefore, the moisture storage layer will be placed in lifts between 12 and 20-inches if possible, to a density of between 80 percent and 90 percent of the maximum density as defined by Standard Proctor (ASTM D-698), and it will be placed dry of optimum. Density and moisture content will be verified by nuclear methods at a frequency of one test per 1,000 cubic yards constructed, and the moisture storage layer and topsoil layer shall be considered as separate units for calculating the volume and test frequency (i.e., each component will require testing at the frequency shown in the table above).

Verification of the thickness of the moisture storage layer and topsoil layer will be verified by surveying, hand measurements, or visual verification of grade staking, at the frequency currently specified in the CQAP for the compacted cap portion of the final cover.

It may be necessary to scarify or otherwise decrease the density of the soils prior to placing the overlying topsoil layer, and before seeding. Seeding will be conducted in accordance with the recommendations from the NRCS included in Appendix D. Following completion of construction of the final cover, a construction certification report will be submitted in compliance with the approved CQAP.

LONG-TERM PERFORMANCE MONITORING

The monitoring of long-term performance of the AFC will involve monitoring leachate collection volumes and inspection and repair, as necessary, of AFC areas where excessive erosion is noted and or reseeding is required. Leachate volumes will be evaluated for significant changes that might be an indication of poor cover performance. Leachate trends will be evaluated every five years as a performance monitoring method along with annual vegetation performance surveys. If, after the first 5-year period, it is clear that leachate volumes are continuing to decline, CSI may request that further 5-year reviews are unnecessary and may be discontinued. Vegetation surveys will be completed annually and locations of surveys will change over a period of years in an effort to obtain better measurements over a larger area of the cover. This monitoring and inspection program will be conducted in conjunction with the Closure Post-Closure Plan in the Design and Operations Plan (DOP). Documentation of areas requiring repair for excessive erosion or reseeding will be documented and kept in the Facility Operation Record.

CONCLUSIONS

A proposed AFC design, consisting of 6 inches topsoil and a minimum of 18 inches of lightly-compacted soil, has been recommended for CSI based on comparisons to other sites and UNSAT-H modeling using the model developed for the nearby DADS Landfill. The results of this work provide confidence that an AFC designed and constructed as outlined above will provide a cover that will yield minimal infiltration at levels at or below AFCs approved for other Subtitle D sites

An erosion allowance of 2 inches has been recommended for the AFC to be placed on the side slopes to provide additional assurance that the minimum cover thickness is maintained in these areas. Also, a CQA program in accordance with the procedures outlined above will be implemented to ensure that the AFC is constructed as designed, and long-term monitoring plans have been proposed to ensure that the design functions well in the future, both hydraulically and in controlling erosion in the future.

Based on the analysis presented herein, we conclude that the proposed alternative final cover for the CSI facility meets the requirements of Section 2.1.15 of the Colorado Regulations Pertaining to Solid Waste Disposal Sites and Facilities (6 CCR 1007-2), and request final approval of this design and CQA requirements. After approval, the approved CQAP will be revised as necessary to incorporate these CQA requirements and submitted to Adams County, the TCHD, and CDPHE for their records.

APPENDIX A

LABORATORY GEOTECHNICAL RESULTS

TABLE 1
AEC/LAB TESTING/CO
(AMERICAN ENVIRONMENTAL CONSULTING, LLC PROJECT - CSI)
SUMMARY OF SOIL DATA

Sample Type	Sample Number	Sample Depth (ft)	U.S.C.S. Soil Classi-fication	Delivered Moisture (%)	Atterberg Limits			Grain Size Distribution			Specific Gravity	Moist/Den Relationship Standard Proctor		Additional Tests Comments (See Notes)
					LL	PL	PI	% Finer 3/4"	% Finer #4	% Finer #200		PCF (Dry)	Moist (%)	
Bulk	Topsoil	--	--	--	--	--	--	--	--	68	--	--	--	
Bulk	Topsoil	--	CL	--	33	14	19	100	100	68	2.65	111.0	15.0	
Bulk	TP-3	bdrsd	--	--	--	--	--	--	--	41	--	--	--	
Bulk	TP-3	bdrsd	SC	10.3	26	13	13	100	100	39	2.68	120.4	12.4	
Bulk	TP-3	bdrclyst	--	--	--	--	--	--	--	96	--	--	--	
Bulk	TP-4	bdrsdclct	--	--	--	--	--	--	--	84	--	--	--	
Bulk	TP-6	Random	--	--	--	--	--	--	--	64	--	--	--	
Bulk	TP-6	Random	CL	--	35	14	21	100	100	63	2.68	104.9	17.5	
Bulk	TP-9	3-7	--	--	--	--	--	--	--	85	--	--	--	
Bulk	TP-9	7-15	--	--	--	--	--	--	--	95	--	--	--	
Bulk	TP-9	7-15	CH	--	59	20	39	100	100	93	2.67	92.3	25.0	
Bulk	TP-11	5-15	--	--	--	--	--	--	--	63	--	--	--	
Bulk	TP-11	5-15	CL	--	33	16	17	100	100	68	2.70	107.6	18.9	PERM
Bulk	TP-13	0-20	--	--	--	--	--	--	--	59	--	--	--	
Bulk	TP-13	0-20	ML	--	NP	NP	NP	100	100	58	2.67	107.5	17.5	PERM
Bulk	TP-8	0-12	--	--	--	--	--	--	--	70	--	--	--	
Bulk	TP-11	Topsoil	--	--	--	--	--	--	--	--	--	--	--	Hold

NOTES:

LL = LIQUID LIMIT
PL = PLASTIC LIMIT
PI = PLASTIC INDEX
SL = SHRINKAGE LIMIT

T = TRIAXIAL TEST
U = UNCONFINED COMPRESSION TEST
C = CONSOLIDATION TEST
DS = DIRECT SHEAR TEST
PERM = PERMEABILITY

TABLE 2
AEC/LAB TESTING/CO
(AMERICAN ENVIRONMENTAL CONSULTING, LLC PROJECT - CSI)
SUMMARY OF FLEXIBLE-WALL PERMEABILITY TEST RESULTS

Sample Number	Sample Length (cm)	Sample Diameter (cm)	Sample Dry Density (pcf)	Maximum Dry Density (pcf)	Compaction (%)	Initial Moisture (%)	Optimum Moisture (%)	Effective Stress (psi)	Back Pressure (psi)	Gradient	Average Permeability (cm/sec)
TP-11	9.46	7.26	90.9	107.6	84.5	14	18.9	5	95	3	2.6 X 10-6
TP-13	9.51	7.26	91.2	107.5	84.8	12.4	17.5	5	95	2	4.3 X 10-5

TABLE 3
AEC/LAB TESTING/CO
(AMERICAN ENVIRONMENTAL CONSULTING, LLC PROJECT - CSI)
SUMMARY OF ORGANIC MATERIAL DATA

Boring Number	Sample Number	Sample Depth (ft)	Bulk Density			Organic Content			Additional Tests Comments (See Notes)
			Moisture (%)	Wet Unit Weight (pcf)	Dry Unit Weight (pcf)	Moisture (%)	Ash (%)	Organics (%)	
--	Topsoil	--	--	--	--	11.9	96.97	3.03	
--	TP-6	Random	--	--	--	17.0	96.90	3.10	
--	TP-11	5-15	--	--	--	13.9	97.39	2.61	
--	TP-13	0-20	--	--	--	13.9	97.49	2.51	
--	TP-11	Topsoil	--	--	--	11.4	97.14	2.86	

NOTE: Moisture Contents Determined at 110° C

APPENDIX B

SOIL TEXTURE AND MOISTURE CHARACTERISTIC CURVE COMPARISON

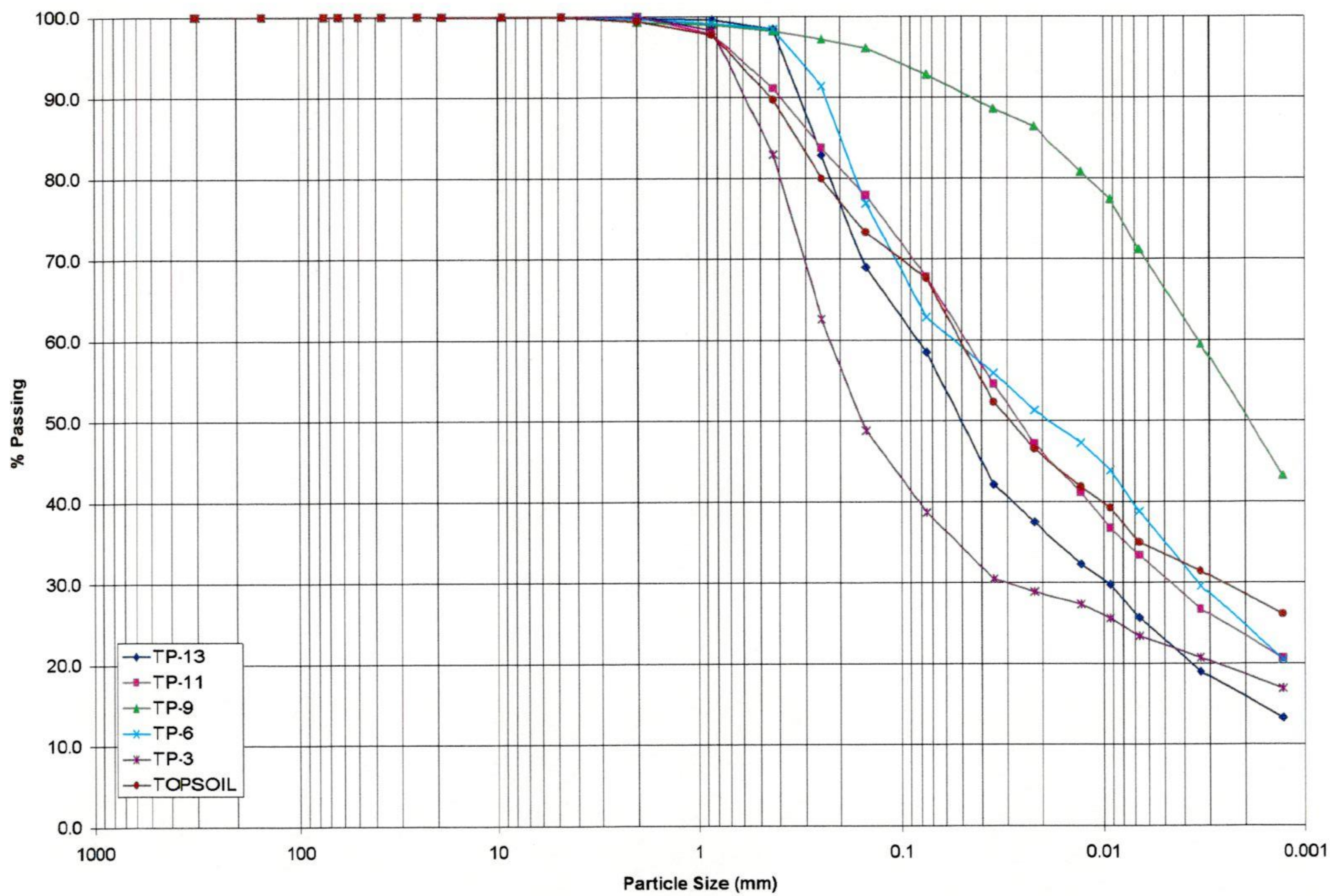


FIGURE 1 – PARTICLE SIZE DISTRIBUTION CURVES FOR SAMPLES COLLECTED AT CSI

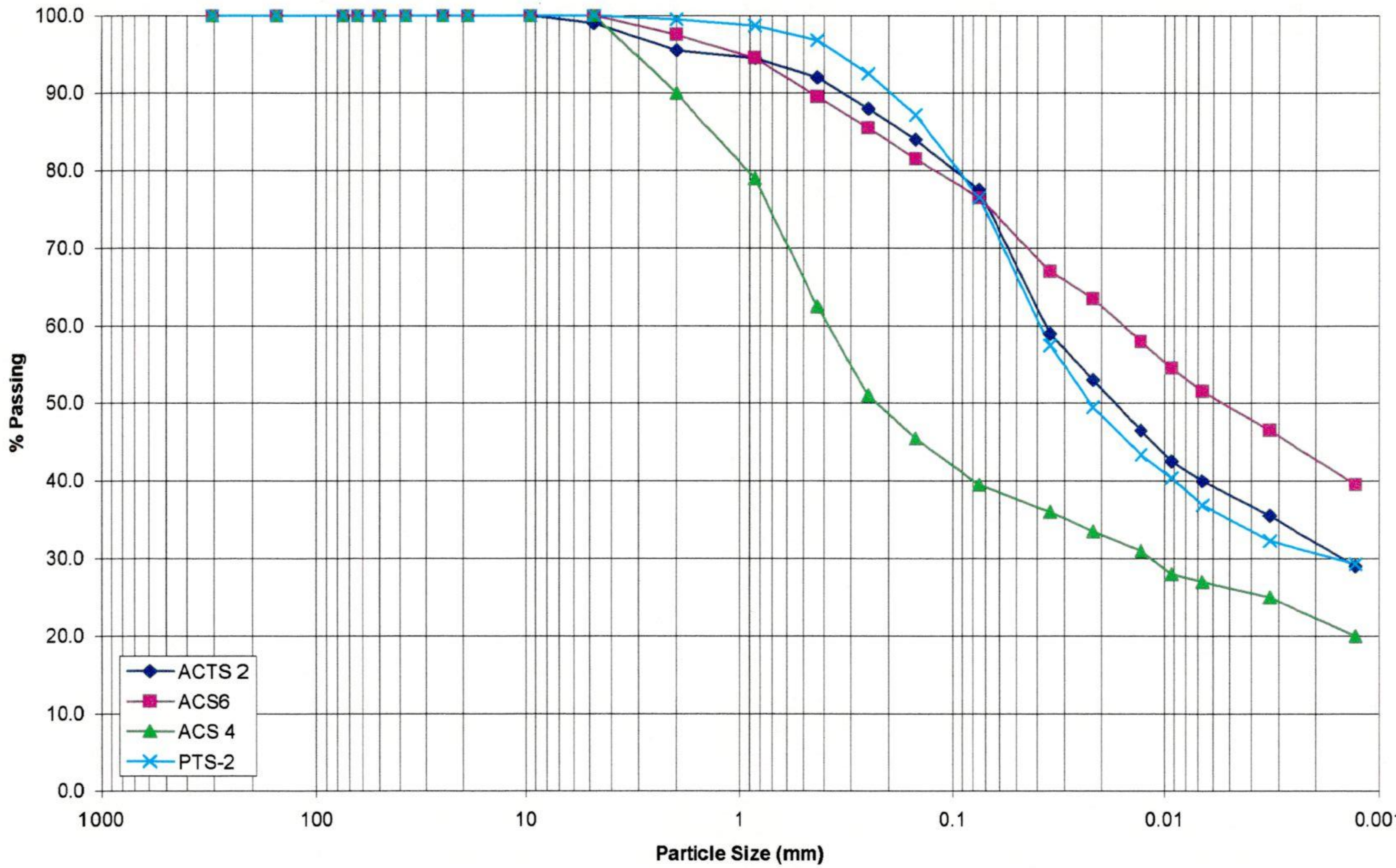


FIGURE 2 – PARTICLE SIZE DISTRIBUTION CURVES FOR SAMPLES COLLECTED AT DADS AND TRLF

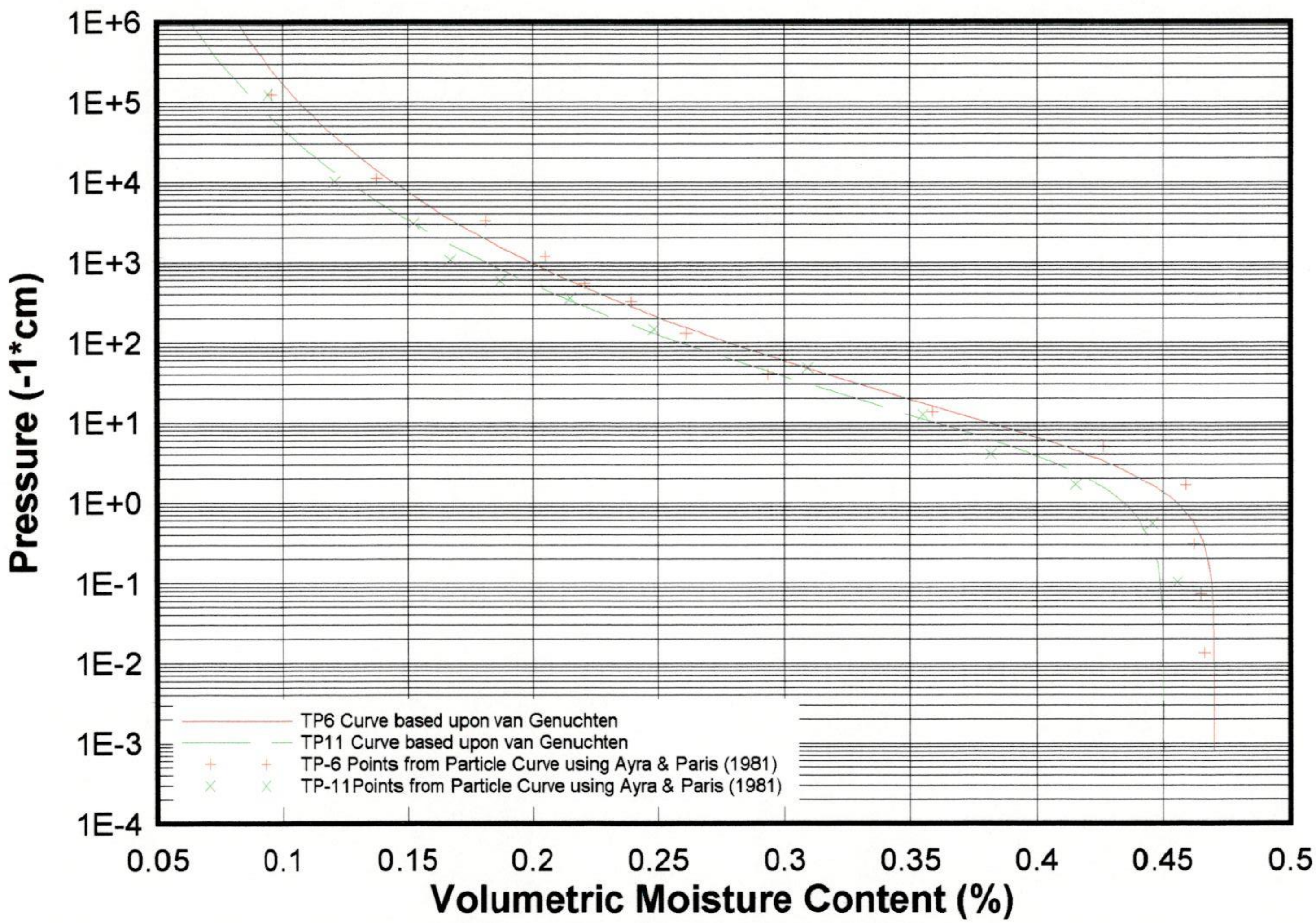


FIGURE 3 – MOISTURE-PRESSURE DATA AS GENERATED BY THE AYRA-PARIS METHOD AND THE RESULTING CALCULATED VAN GENUCHTEN PLOTS FOR CSI SAMPLES

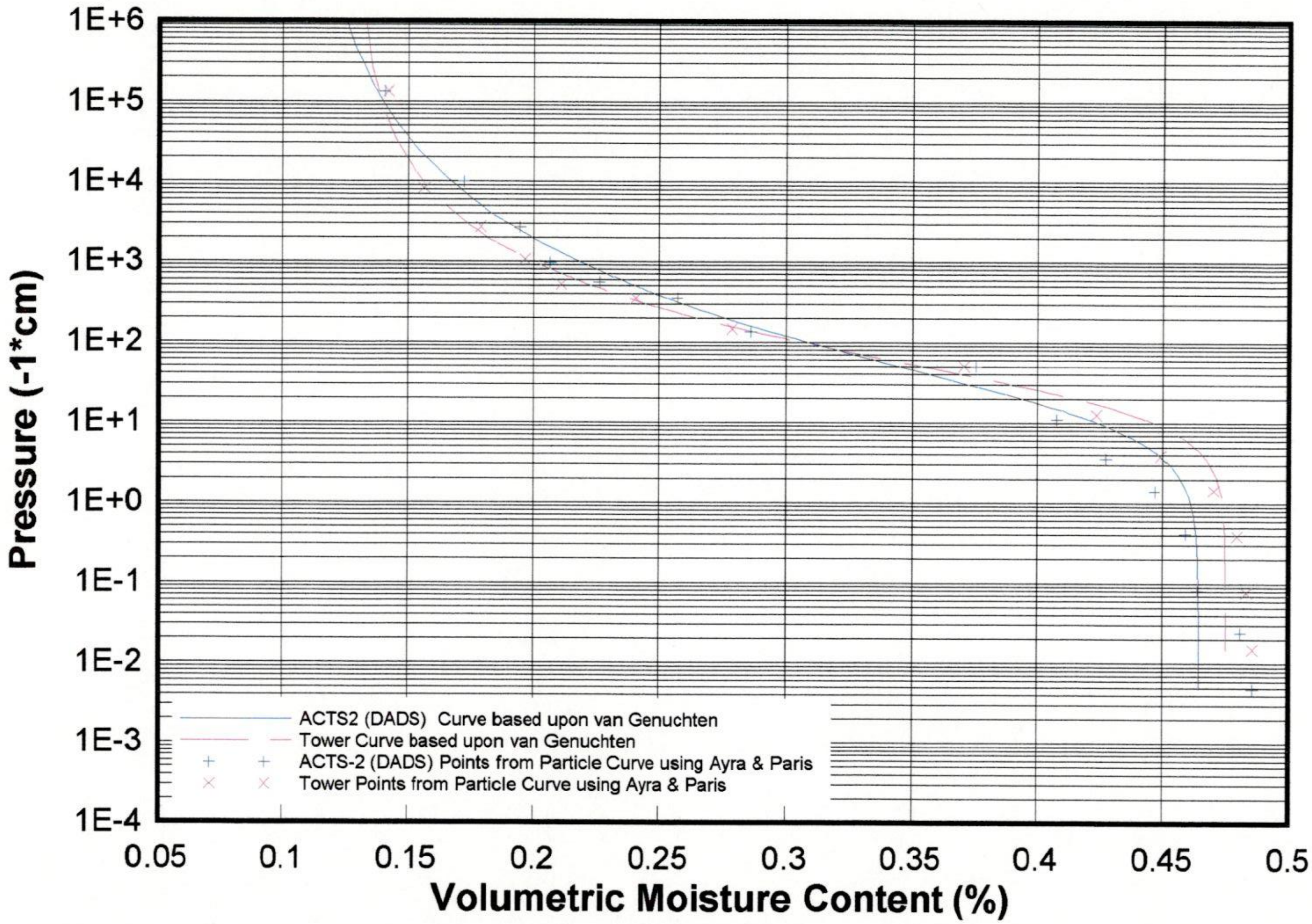


FIGURE 4 – MOISTURE-PRESSURE DATA AS GENERATED BY THE ARYA-PARIS METHOD AND THE RESULTING CALCULATED VAN GENUCHTEN PLOTS FOR DADS AND TRLF

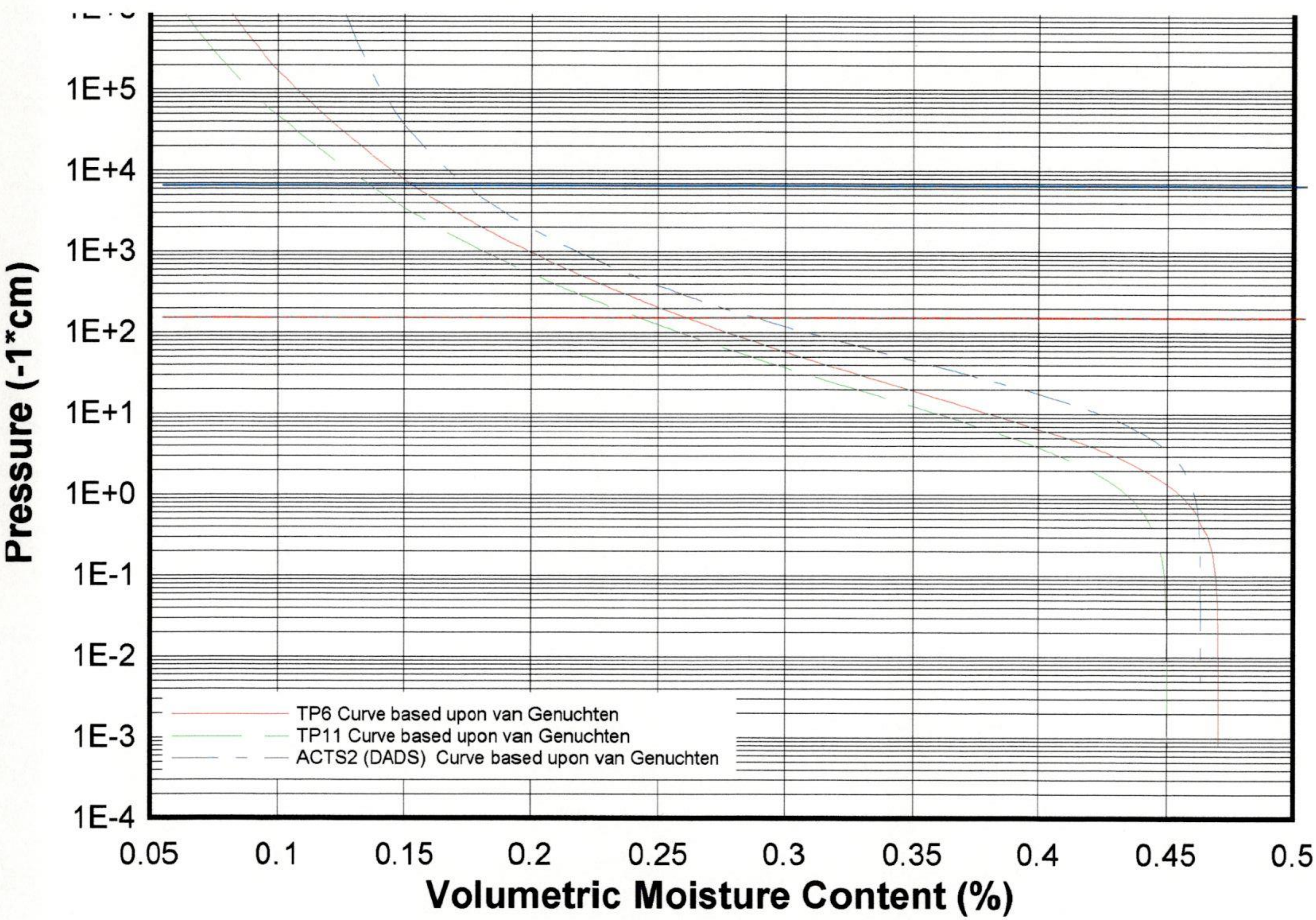


FIGURE 5 – CALCULATED VAN GENUCHTEN PLOTS FOR THE SELECTED CSI SAMPLES AND THE DADS ACTS2 SAMPLE

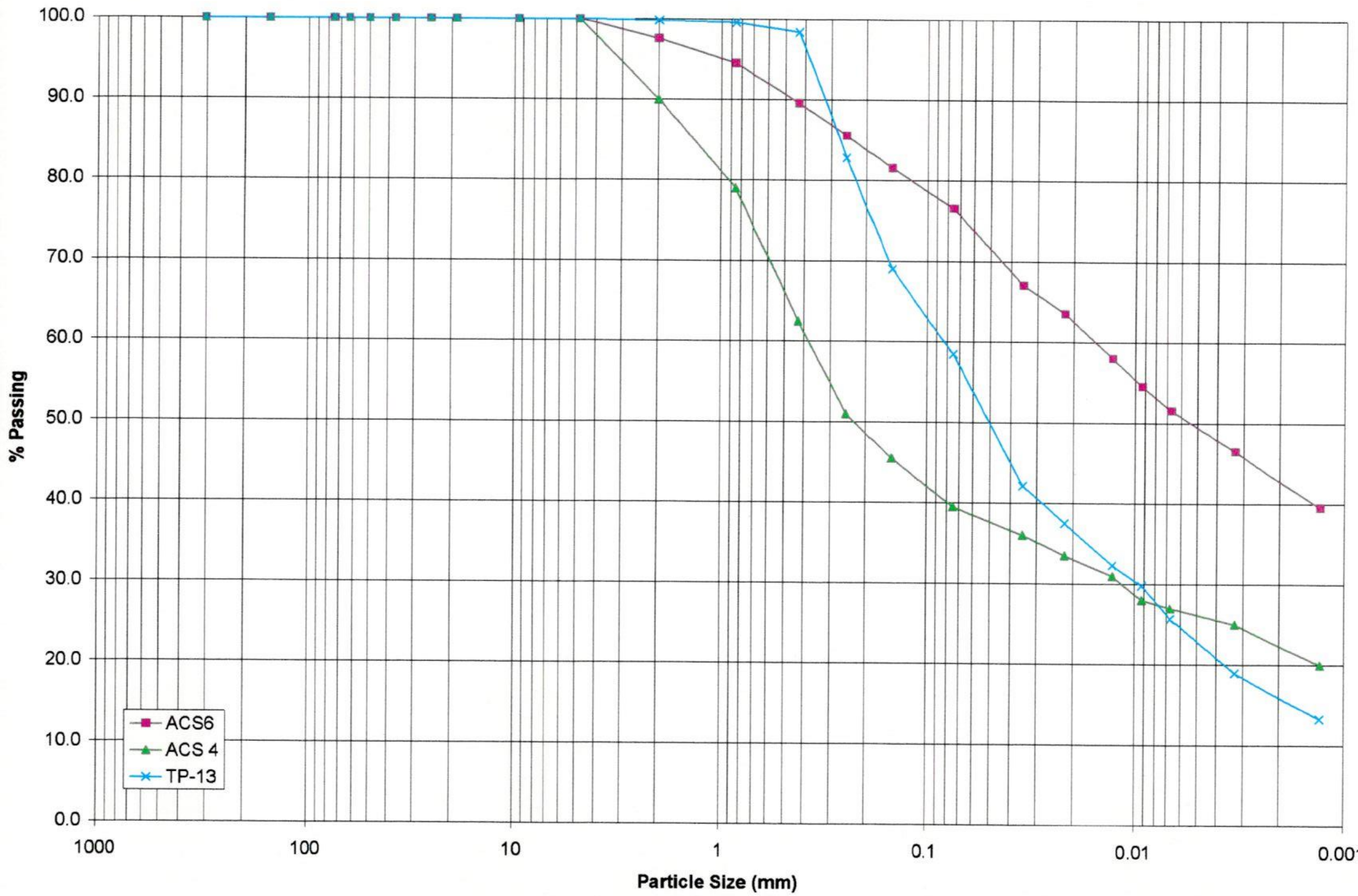


FIGURE 6 – PARTICLE SIZE DISTRIBUTION CURVES FOR ACS4 AND ACS6 FROM DADSVERSUS TP-13 FROM CSI

Table 1 – Summary of Comparative Parameters

Sample Location and Identifier	Standard Proctor Results	Organics (wt %)	Hydraulic Conductivity @ 85% Standard Proctor (cm/sec)
CSI TP-6	104.9 pcf @17.5 %	3.10	NM
CSI TP-11	107.6 pcf @ 18.9 %	2.61	$2.6x10^{-6}$
CSI TP-13	107.5 pcf @ 17.5 %	2.67	$4.3x10^{-5}$
CSI Topsoil	111.0 pcf @ 15.0 %	3.03	NM
DADS ACTS-2	102.1pcf @ 18.5 %	NM	$1.6x10^{-6*}$
DADS ACS4	113.2 pcf @ 14.7 %		$1.2x10^{-4}$
DADS ACS6	103.9 pcf @ 20.4%		$3.2x10^{-5}$
Tower PTS-2	103.6 pcf @ 19.9 %	4.83	$1.0x10^{-5}$

Notes: NM, not measured
Densities are dry densities for the
Moisture content by weight for the Proctor test results
* the hydraulic conductivity in ACTS-2 was raised by an order of magnitude to $1.6x10^{-5}$ as part of the original DADS modeling effort. The increase did not change the simulation results.

APPENDIX C

GOLDER ASSOCIATES
UNSAT-H MODELING EFFORT SUMMARY
SOIL MOISTURE CHARACTERISTIC CURVES-SOIL VISION

APPENDIX C
UNSAT-H MODELING

The following is a discussion of the supplemental modeling conducted by Golder Associates Inc. (Golder) for the alternative final cover (AFC) at CSI. During working meetings with the Colorado Department of Public Health and Environment (CDPHE) it was agreed that simulations of the proposed cover at CSI using the UNSAT-H model developed for the nearby Denver Arapahoe Disposal Site (DADS) would be performed. This was documented in our November 8, 2006 letter that captured the content of the working meetings and the resulting agreements made with CDPHE.

It was agreed that full grain-size curves (including hydrometer) performed on representative samples from CSI borrow areas would be used in conjunction with a data base (Soil Vision) that correlates grain-size to soil water characteristic curves. This data base was then used to provide a range of soil water characteristic curves that bracket the soil types at CSI based on grain-size distribution. In utilizing this approach, it was agreed that the climate for DADS and CSI are very similar as would be expected from their close proximity to one another. Hence, the climatic inputs from DADS were used for the CSI simulations. Likewise, it was agreed that the vegetation (seeding mix) proposed for CSI is essentially the same as for DADS and that, given the limitations in predicting vegetation parameters such as Leaf Area Index (LAI) and Root Density Function (RDF), it was appropriate to use the DADS vegetation parameters for CSI.

The search for moisture characteristic curves for TP-6 and TP-11 was done together since the grain-size distributions for the soils were so similar (Figure 1). Attached is the range of soil moisture characteristic curves obtained from Soil Vision for TP-6/TP-11 and for TP-13 (Figure 2 and Figure 3). Also provided on these graphs are the Van Genuchten values used for input to UNSAT-H for the lower range, mean range and upper range of soil moisture characteristic curves for TP-6/TP-11 and for TP-13. These Van Genuchnten values were input to the DADS UNSAT-H model along with the measured saturated hydraulic conductivity values for the 2-foot cover.

The entire range of soil moisture characteristic curves for TP-6/TP-11 indicate that a 2-foot cover comprised of these soils will yield essentially no infiltration as shown in the attached Table 1. Likewise, Table 2 shows that a 2-foot cover consisting of TP-13 material will yield very low infiltration rates varying between 0.0 mm to 4.2 mm. These values are less than those associated with measured infiltration rates through composite caps at Subtitle D sites near Omaha, Nebraska and Cedar Rapids, Iowa that that are part of the Alternative Cover Assessment Program (ACAP). These two sites showed average annual infiltration values of 5.5 mm/yr and 6.1 mm/yr, respectively. The modeling results show that even the worse-case soil-moisture characteristic curves for the coarsest soil (TP-13) yield infiltration rates less than these measured values at other Subtitle D sites providing additional substantiation that proposed AFC design for CSI will provide good hydraulic performance.

Table 1 Infiltration Through AFC (TP-6 and TP-11)
(% annual precipitation, mm/year)

	Infiltration	
SWCC	%	mm
Lower Bound	0.00%	0.0
Average	0.00%	0.0
Upper Bound	0.00%	0.0

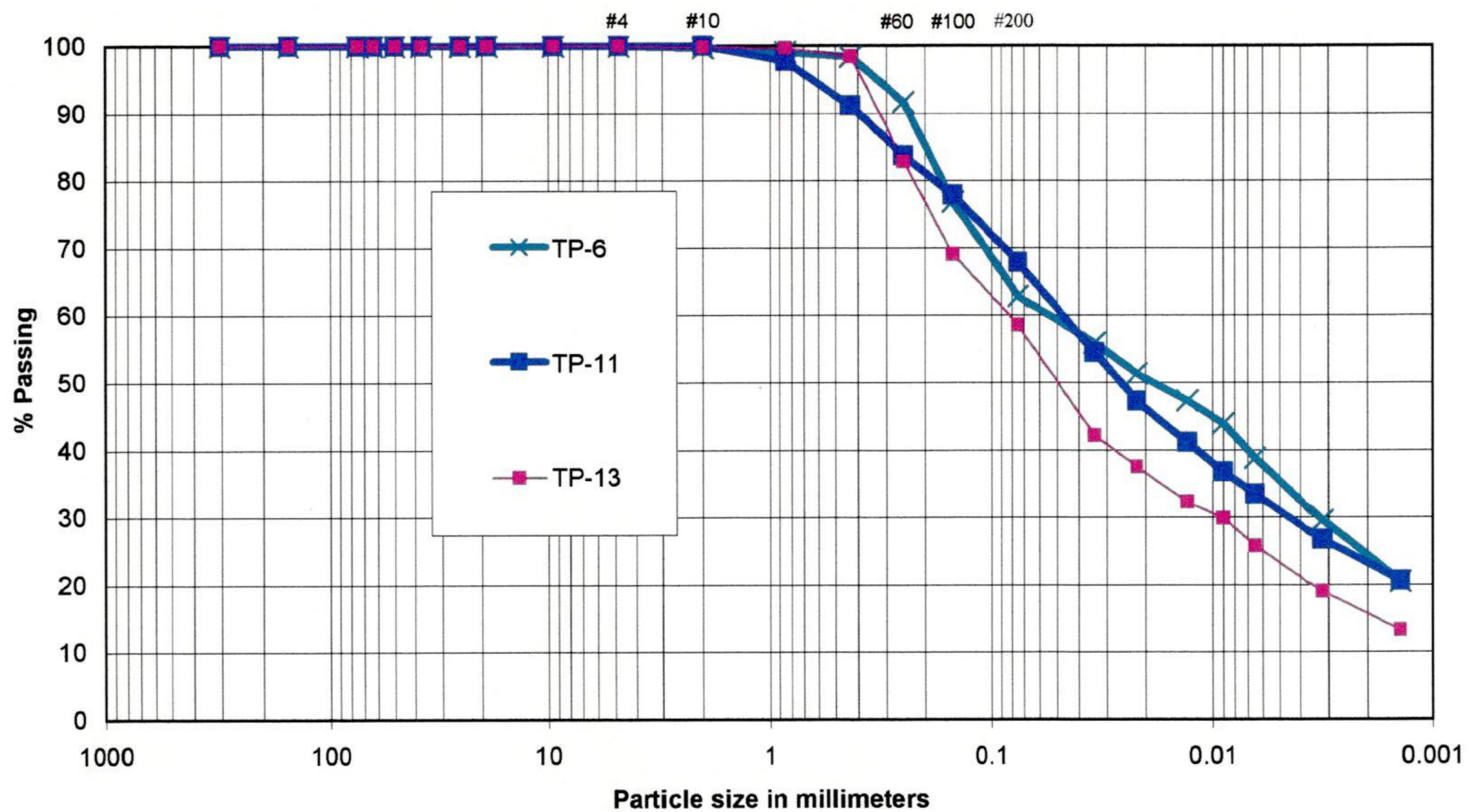
Long term AFC performance, TP-6 and TP-11, thickness=2 ft, grass seeded, K=2.6E-06

Table 2 Infiltration Through AFC (TP-13)

(% annual precipitation and mm/year)

SWCC	Infiltration	Infiltration (mm)
Lower Bound	0.00%	0.0
Average	0.63%	2.5
Upper Bound	1.07%	4.2

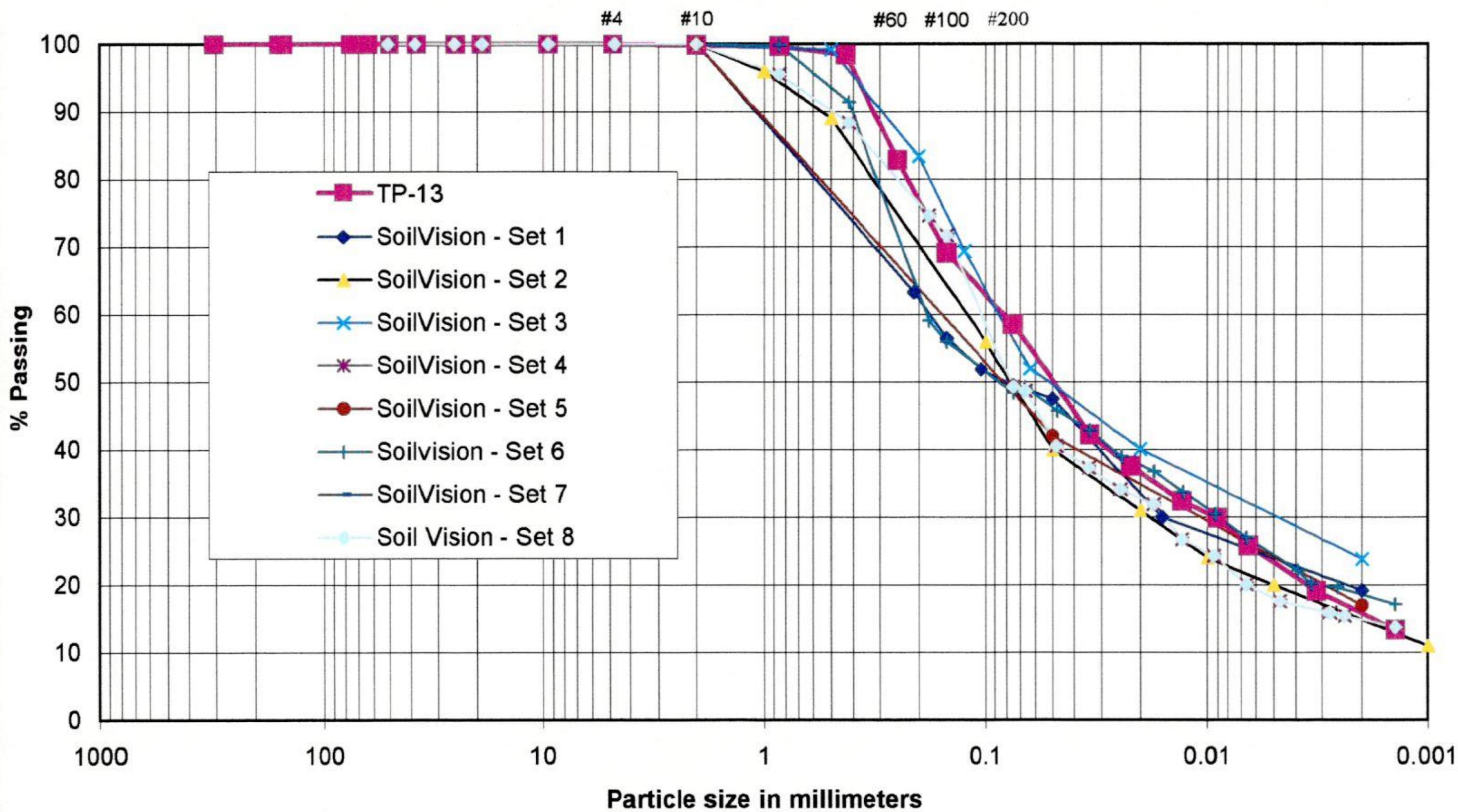
Long term AFC performance, TP-13 cover material, grass seeded, 2 foot cover, K=4.3E-05 cm/sec



Golder Associates

Denver, Colorado

CLIENT/PROJECT	TITLE				
WM/CSI AFC	Grain Size Distributions forTP-6, TP-11 and TP-13				
DRAWN	GG	DATE	Apr-07	JOB NO.	063-2224
CHECKED		SCALE	AS SHOWN	DWG. NO.	
REVIEWED		FILE NO.		FIGURE NO.	FIGURE 1



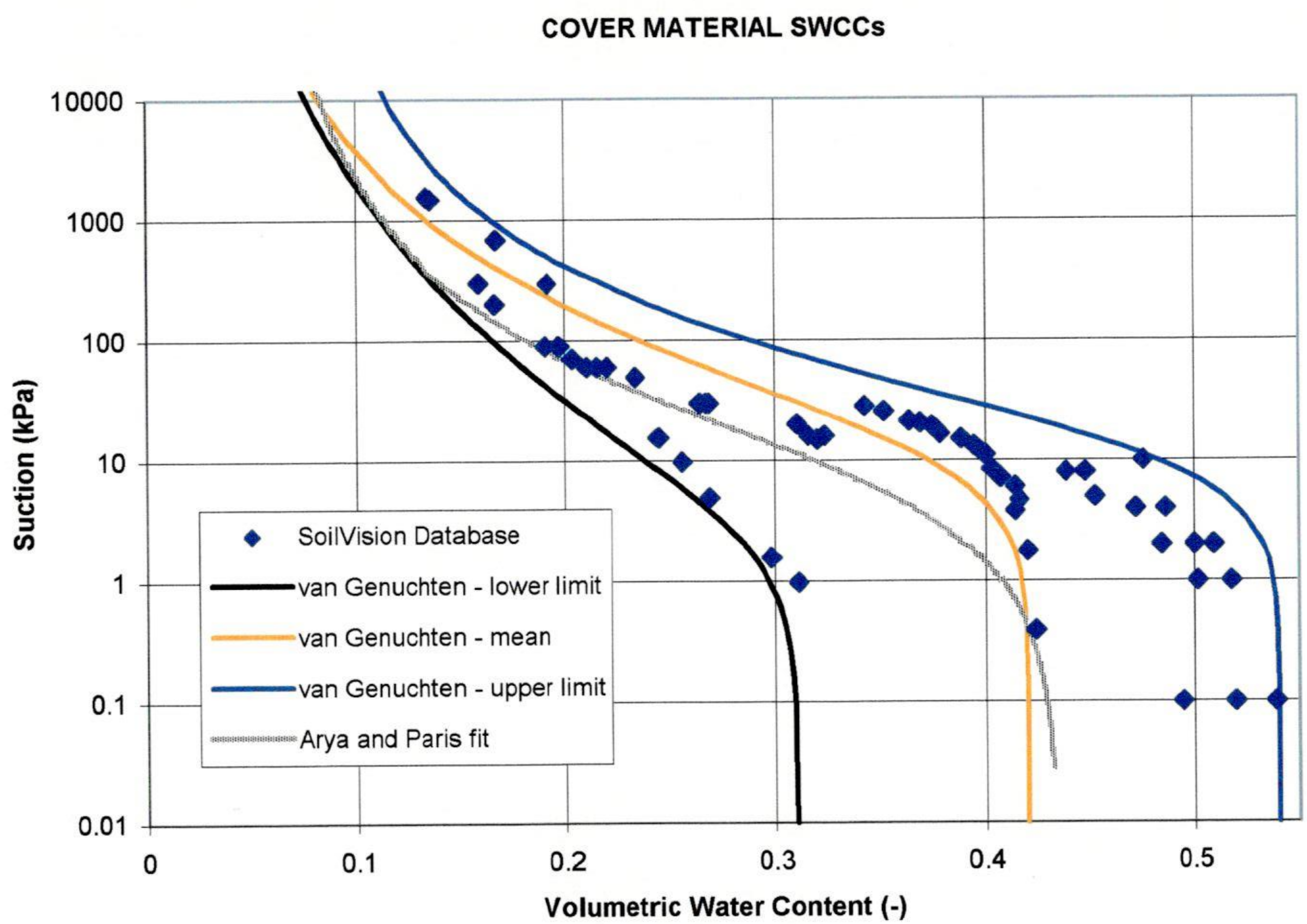
Golder Associates

Denver, Colorado

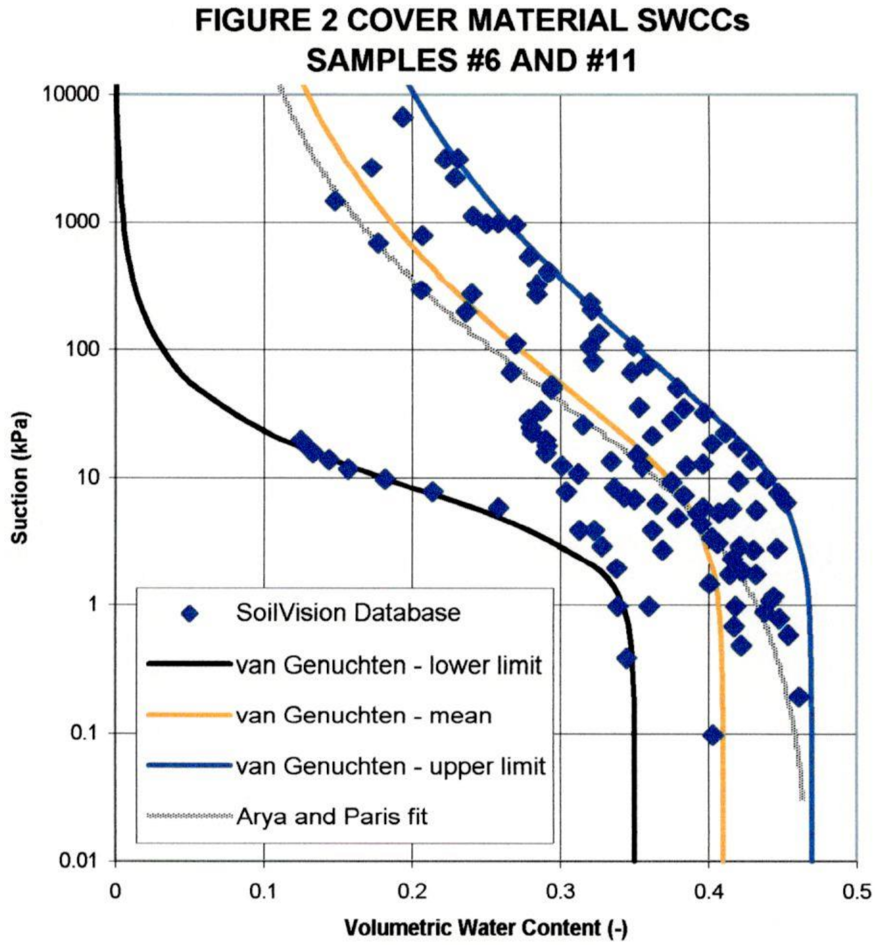
TITLE	**Matching Grain-Size Distributions for TP-13 SoilVision Database**				
DRAWN	GG	DATE	Apr-07	JOB NO.	063-2224
CHECKED		SCALE	AS SHOWN	DWG. NO.	
REVIEWED		FILE NO.		FIGURE NO.	FIGURE 2

CLIENT/PROJECT

WM/CSI AFC



Golder Associates	Denver, Colorado	TITLE	Matching SWCCs for TP-13 SoilVision Database		
CLIENT/PROJECT WM/CSI AFC		DRAWN GG	DATE Apr-07	JOB NO. 063-2224	
		CHECKED	SCALE AS SHOWN	DWG. NO.	
		REVIEWED	FILE NO.	FIGURE NO. FIGURE 3	



SAMPLE # 6,11

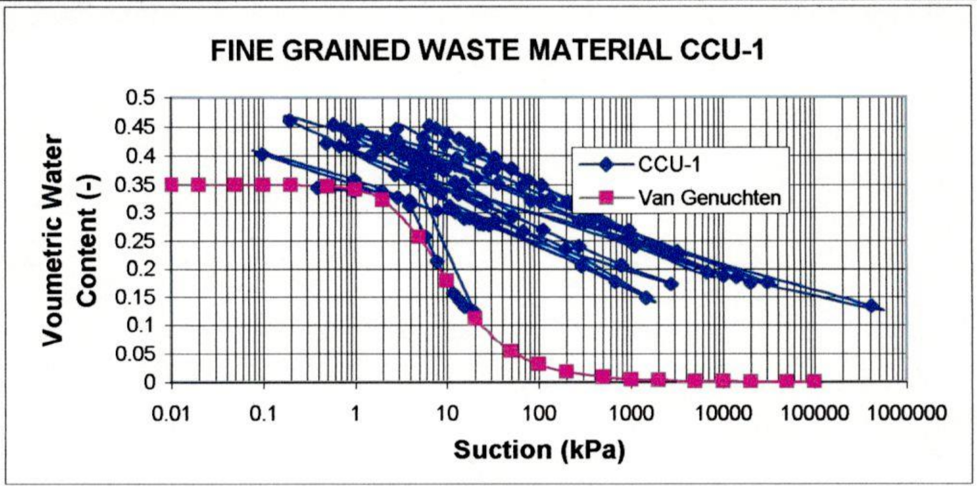
NOTES:

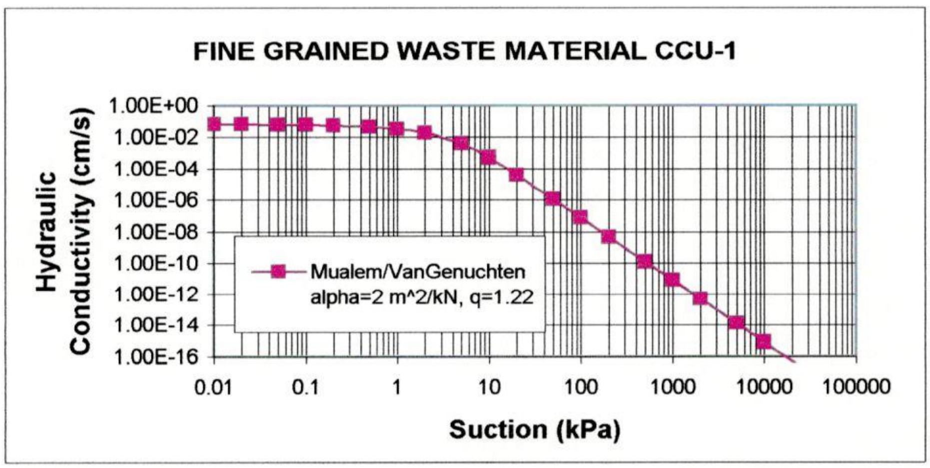
SoilVision Van Genuchten fit			
	lower	**mean**	**upper**
alpha=	**0.20**	**0.09**	**0.07**
n=	**1.80**	**1.20**	**1.17**
Sr=	**0.00**	**0.08**	**0.15**
θsat=	**0.35**	**0.41**	**0.47**

DATE	4/26/2007
CALC	GG
REVIEW	GG

WM/CSI AFC
062-2224

GOLDER ASSOCIATES INC.
LAKEWOOD, COLORADO





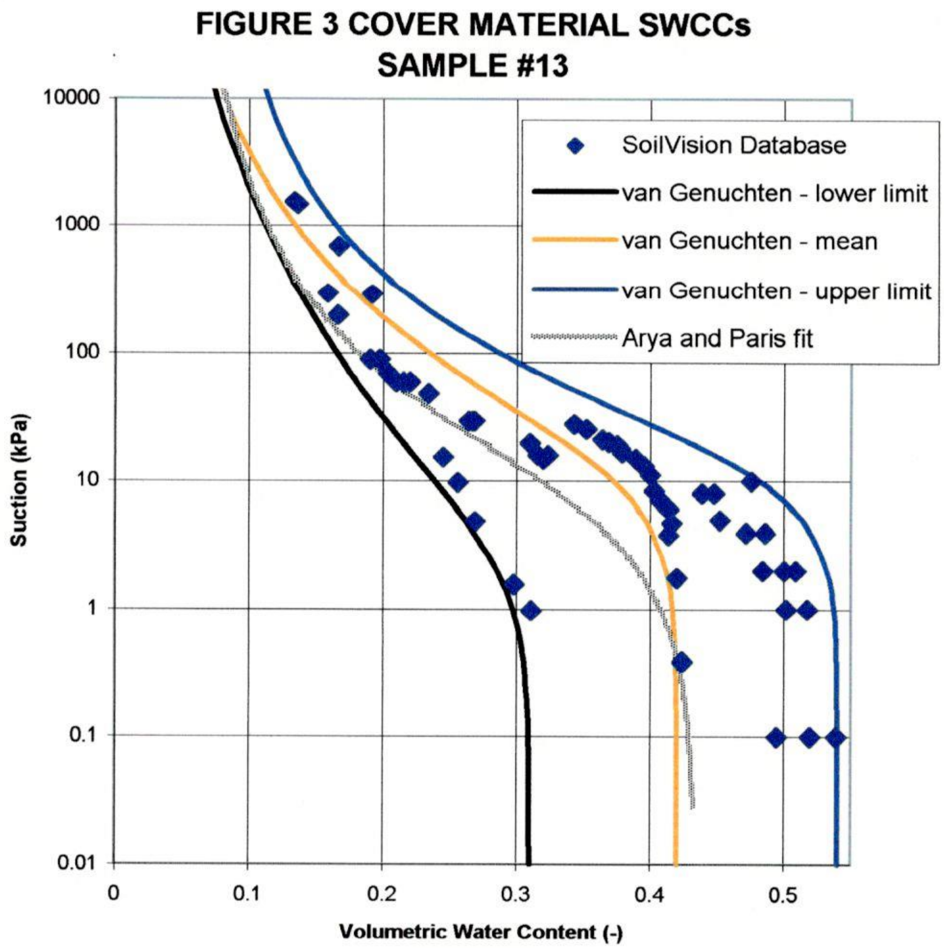
SAMPLE #: **SoilVision Van Genuchten fit**

NOTES:

DATE	4/26/2007
CALC	GG
REVIEW	GG

WM/CSI AFC
062-2224

GOLDER ASSOCIATES INC.
LAKEWOOD, COLORADO



SAMPLE # 13

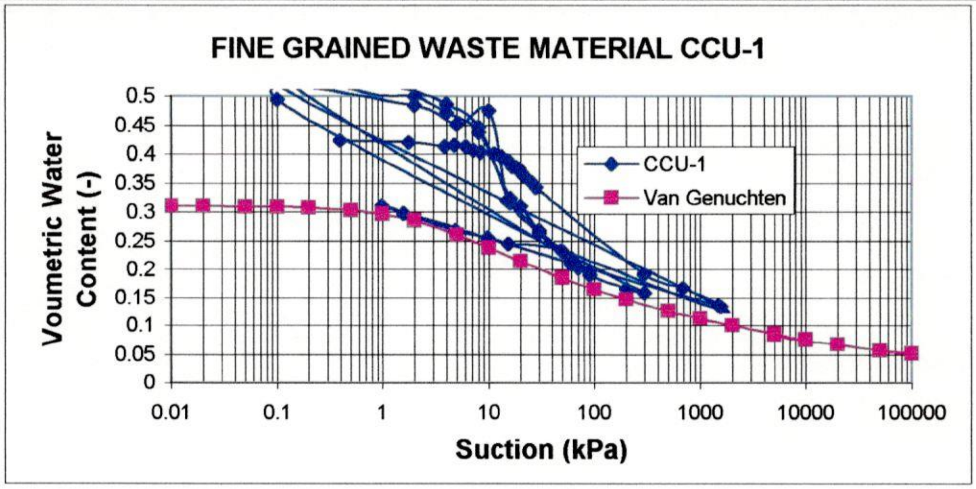
NOTES:

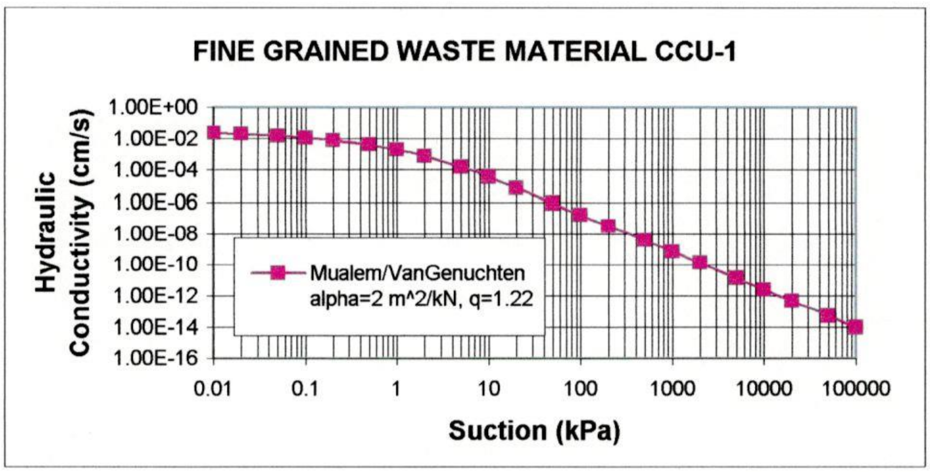
SoilVision Van Genuchten fit			
	lower	mean	upper
alpha=	0.40	0.08	0.07
n=	1.17	1.30	1.40
Sr=	0.00	0.07	0.15
θsat=	0.31	0.42	0.54

DATE	4/26/2007
CALC	GG
REVIEW	GG

WM/CSI AFC
062-2224

GOLDER ASSOCIATES INC.
LAKEWOOD, COLORADO





SAMPLE #:	**SoilVision Van Genuchten fit**
NOTES:	

DATE	4/26/2007
CALC	GG
REVIEW	GG

WM/CSI AFC
062-2224

GOLDER ASSOCIATES INC.
LAKEWOOD, COLORADO

APPENDIX D

NRCS REVEGETATION RECOMMENDATIONS AND PLAN

Grass Seeding: Part I - Planned

Natural Resources Conservation Service

Planner:	Deric Clemons			**Date:**	27-Jan-05
Producer:	American Environmental Consulting				
MLRA:	67	**Contract/Agreement #:**	N/A	**Item Num:**	N/A
Seeding Operation:	**Acres to be seeded:**	320			
	Seedbed Prep:	Intensive: more than 3 tillage operations		**Cropland:**	non-irrigated
	Planting Dates:	Nov. 1-A;pril 30			
	Planting Depth (in.):	1/4 - 1/2			
	Drill Type:	grass		**Range Site:**	Sandy Plains
	Drill Spacing (in.):	7-10"			
Fertilizer:	**Pounds per acre recommended-N/A**			(planned and applied requires practice standard 590)	
	Nitrogen (N)	**Phosphorus (P)**	**Potassium (K)**		
Weed Control:	**Dates:**			(planned and applied requires practice standard 595)	
	Description:	mechanical			
Cover:	**Amount:**				
	Description:				
	Application Method:				

Seed Recommendations:

Species	Variety (table 6: PMTN 59)	PLS Rates Irr/Non-Irr	PLS/Ac to use (100%)	% in mix	Rate (PLS lb/ac)	Acres to be seeded	Total PLS
Green needlegrass	Lordorm	10.0 / 5.0	5.0	20	1.0	320.0	320.0
Western wheatgrass	Arriba	16.0 / 8.0	8.0	20	1.6	320.0	512.0
Needleandthread	any	11.0 / 5.5	5.5	20	1.1	320.0	352.0
Little Bluestem	Pasture	7.0 / 3.5	3.5	10	0.4	320.0	112.0
Prairie sandreed	Goshen	6.5 / 3.5	3.5	20	0.7	320.0	224.0
Switchgrass	Grenville	4.0 / 2.0	2.0	10	0.2	320.0	64.0
Totals			27.5	100.0	5.0	320.0	1584.0

Notes: Use adapted improved varieties and cultivars in the following order of preference, when available:

1. certified name varieties, 2. named varieties, 3. common seed

PLS = Pure Live Seed

Double drilled seeding rate to obtain broadcast seeding rate.

For critical area seedings use the irrigated rate.

Certified Planner: ______________________ **Date:** ________

2 pages only

BYERS FIELD OFFICE COVER CROP WORK SHEET

Eligible crops that can be planted for a cover crop include the following: forage ai grain sorghum, broomcorn, or Sudan grass. Oats can be used South of County Road 34 in Arapahoe County. Wheat or millet is not to be used because of the allelopathic effect, grass seed depth placement, and volunteer pressure from the previous wheat crop. All of the above listed crops must be sterile and must have 120 growing days to maturity. Use seed that has a minimum germination of 85% greater to get the desired plant population to produce enough residue to qualify foi an adequate cover crop.

The cover crop will be planted between May 15th through June 15th. Cover Crop can be planted up to two weeks earlier on sandy soils. Any cover crop that is planted later then June 15th will not be cost shared until the fall. A field inspection will be needed to see if there are enough residues to qualify for a cover to seed the grass into.

The cover crop will be drilled and not row cropped. The maximum width will be 20 inches. The desirable width will be 12 inches.

The seeding rate will depend on the soils.

For sandy soils drill early and apply between 10 to 15 lbs. per acre for Sudan grass For broomcorn, forage and grain sorghum drill between 8 to 12 lbs. per acre.

For clay and loam soils drill later and drill between 8 to 12 lbs. for Sudan grasses. For Broomcorn, forage and grain sorghum use 6 to 8 lbs. to the acre.

Planting depth will be 1 inch.

The cover crop should be drilled from West to East to provide protection from the predominant winds out of the Northwest.

Minimum stubble height of cover crop to drill into sandy soil is 18 inches tall.

For heavier soils the minimum cover crop height will be 12 inches.

APPENDIX E

FINAL COVER EROSION ANALYSIS

USLE Soil Loss Estimate Conservation Services Inc. Landfill

RUSLE PROGRAM INPUT AND RESULTS

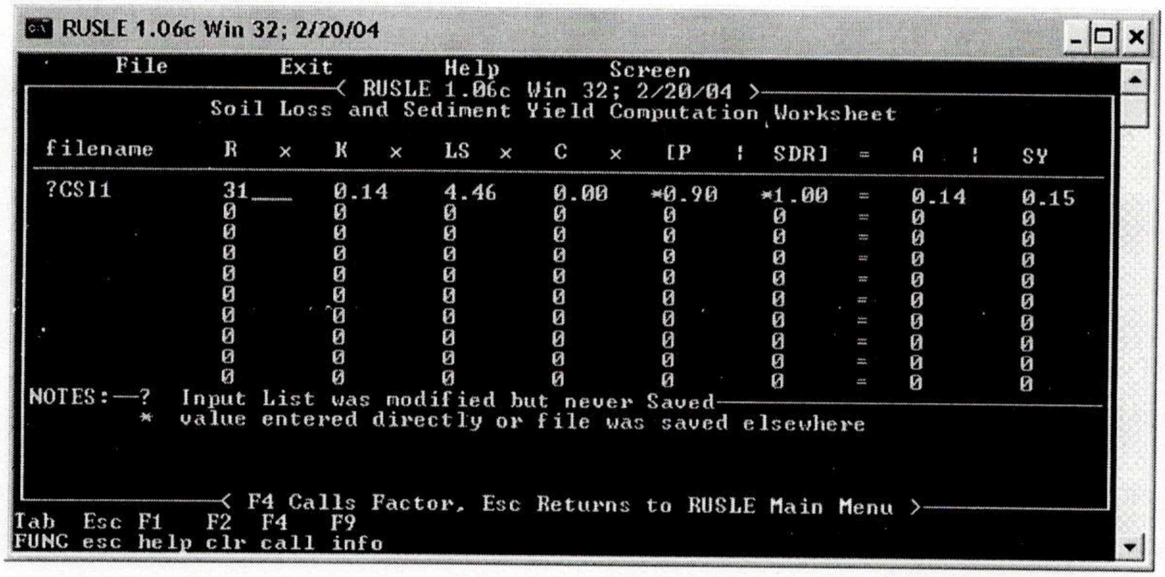
Equation: A = RxKxLxSxCxP, where:

A = Soil loss in tons/acre/year
R = Rainfall and runoff factor
K = Soil erodibility factor
L = Slope length factor
S = Slope steepness factor
C = Cover and management factor
P = Support practice factor

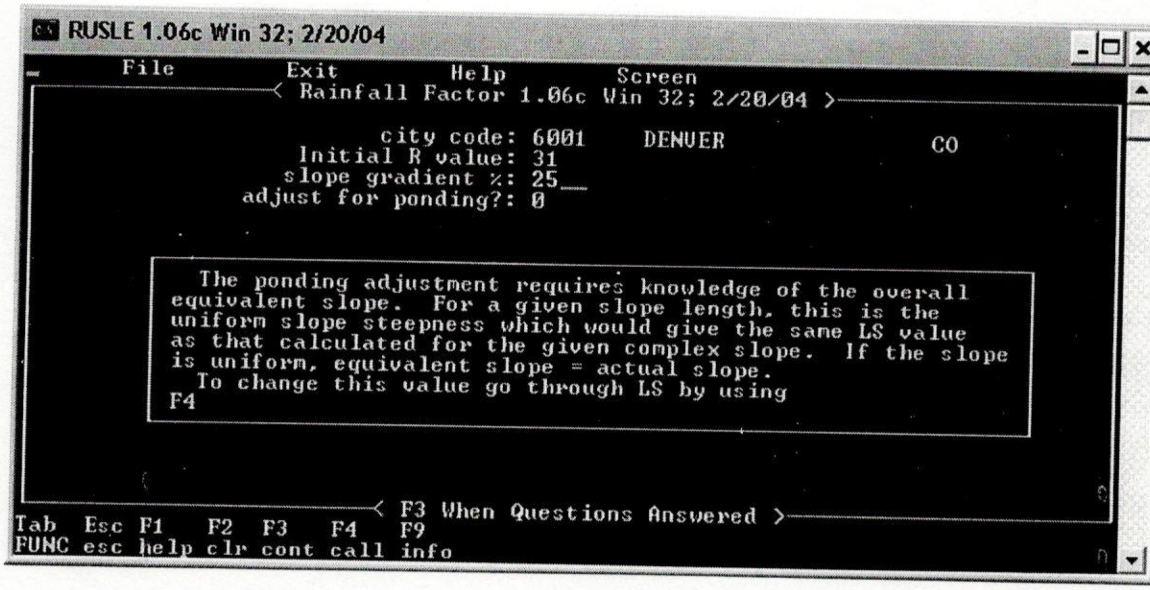
Incorporating the above equation based upon the factors derived in the program as listed on the following two pages and and solving for units:

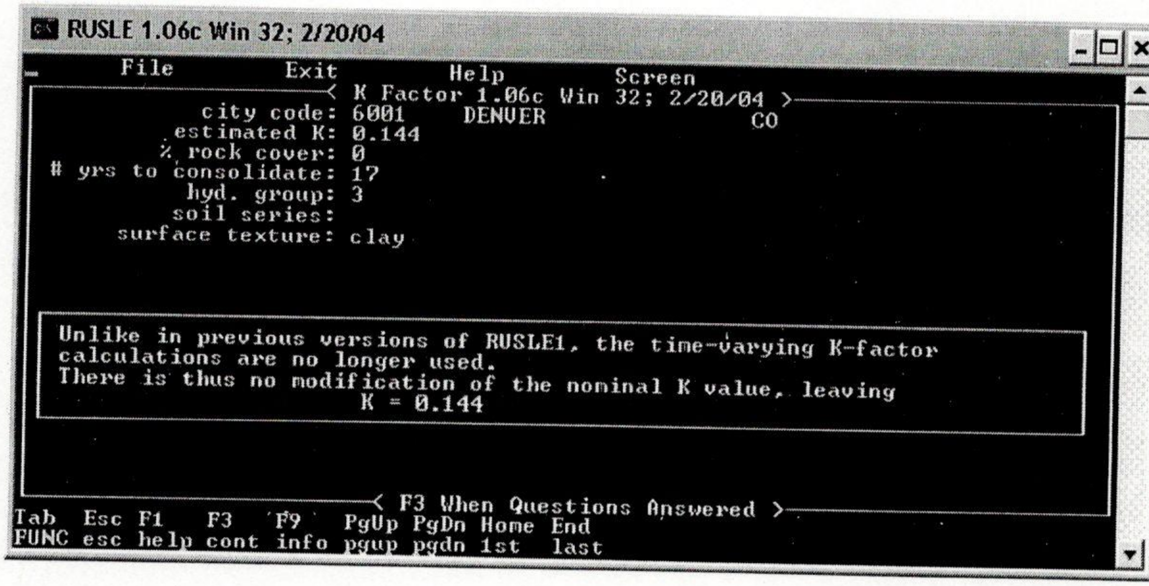
0.14 tons/acre/year*2000 lbs./ton*1cubic foot/104.9 pounds*1 acre/43,560 square feet*12 inches/foot =

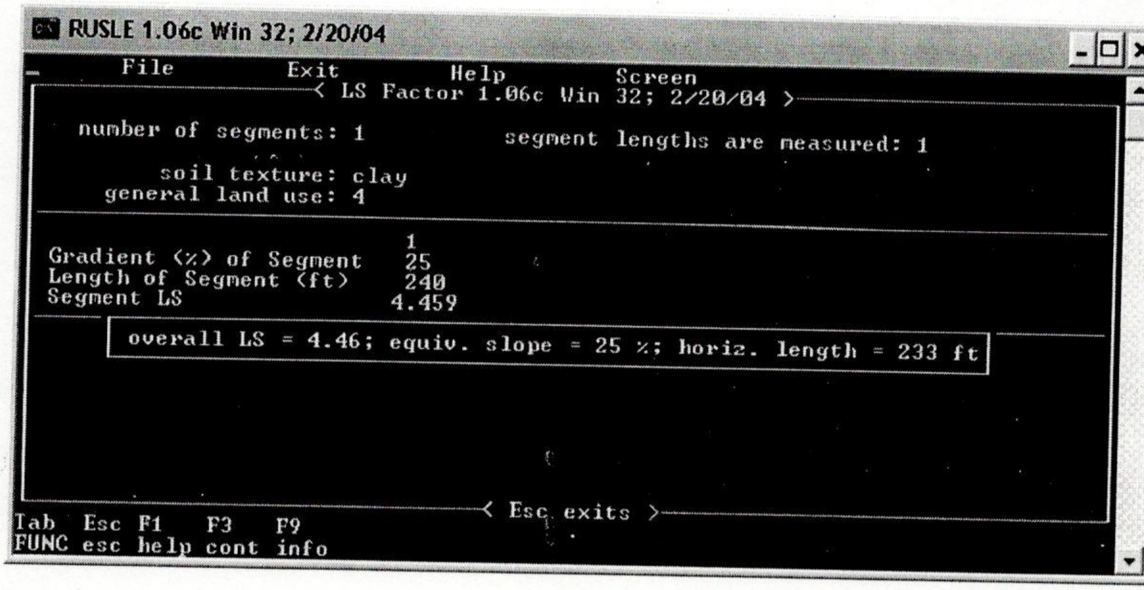
<u>0.0007 inches/year of annual soil loss</u>

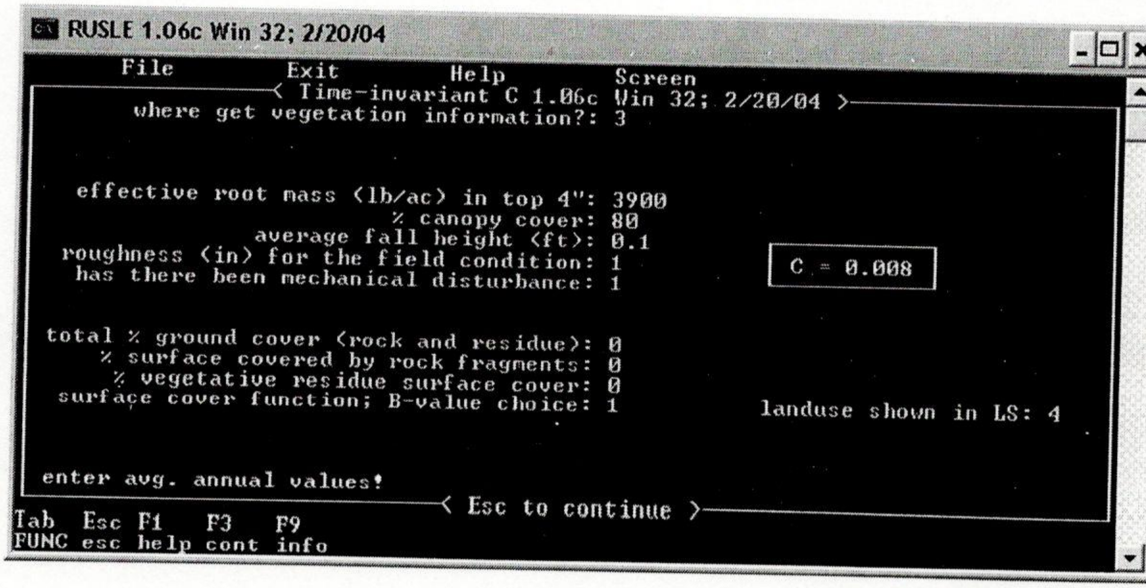


Notes: 1) The value of P (P/SDR) was estimated at 0.9 based upon evaluations for prior Landfills. The screens for the other input values are shown below.


RUSLE 1.06c Win 32; 2/20/04
File Exit Help Screen
< Rainfall Factor 1.06c Win 32; 2/20/04 >
city code: 6001 DENVER CO
Initial R value: 31
slope gradient %: 25
adjust for ponding?: 0
The ponding adjustment requires knowledge of the overall equivalent slope. For a given slope length, this is the uniform slope steepness which would give the same LS value as that calculated for the given complex slope. If the slope is uniform, equivalent slope = actual slope.
To change this value go through LS by using F4
< F3 When Questions Answered >
Tab Esc F1 F2 F3 F4 F9
FUNC esc help clr cont call info


RUSLE 1.06c Win 32; 2/20/04
File Exit Help Screen
< K Factor 1.06c Win 32; 2/20/04 >
city code: 6001 DENVER CO
estimated K: 0.144
% rock cover: 0
# yrs to consolidate: 17
hyd. group: 3
soil series:
surface texture: clay
Unlike in previous versions of RUSLE1, the time-varying K-factor calculations are no longer used.
There is thus no modification of the nominal K value, leaving
K = 0.144
< F3 When Questions Answered >
Tab Esc F1 F3 F9 PgUp PgDn Home End
FUNC esc help cont info pgup pgdn 1st last


RUSLE 1.06c Win 32; 2/20/04
File Exit Help Screen
< LS Factor 1.06c Win 32; 2/20/04 >
number of segments: 1
segment lengths are measured: 1
soil texture: clay
general land use: 4
1
Gradient (%) of Segment 25
Length of Segment (ft) 240
Segment LS 4.459
overall LS = 4.46; equiv. slope = 25 %; horiz. length = 233 ft
< Esc exits >
Tab Esc F1 F3 F9
FUNC esc help cont info


RUSLE 1.06c Win 32; 2/20/04
File Exit Help Screen
< Time-invariant C 1.06c Win 32; 2/20/04 >
where get vegetation information?: 3
effective root mass (lb/ac) in top 4": 3900
% canopy cover: 80
average fall height (ft): 0.1
roughness (in) for the field condition: 1
has there been mechanical disturbance: 1
C = 0.008
total % ground cover (rock and residue): 0
% surface covered by rock fragments: 0
% vegetative residue surface cover: 0
surface cover function; B-value choice: 1
landuse shown in LS: 4
enter avg. annual values!
< Esc to continue >
Tab Esc F1 F3 F9
FUNC esc help cont info