Colorado Department
of Public Health
and Environment

March 11, 2004

Mr. Joe Legare
Assistant Administrator for Environment and Infrastructure
U.S. Department of Energy-RFFO
10808 Highway 93, Unit A
Golden CO 80401-8200

RE: 95% Conceptual Design & Quality Assurance/Quality Control Plan for the Present Landfill Closure Cover

Dear Mr. Legare:

The Colorado Department of Public Health and Environment and the Environmental Protection Agency have reviewed the reports referenced above. We have identified deficiencies, which are enclosed for your inclusion into the final design document. As you can see by the comments, this design document requires significant revision and improvement. Also enclosed are EPA's comments on the Interim Measure/Interim Remedial Action Wetland Mitigation Plan. Please see the enclosures for additional details and specific comments on these documents.

If you have any questions concerning these comments, please contact Carl Spreng (CDPHE) at 303-692-3358 or Jean MacKenzie (EPA) at 303-312-6258.

Sincerely,

Steven H. Gunderson
RFCA Project Coordinator
Colorado Department of Public
Health and Environment

Mark Aguilar
Rocky Flats Project Manager
Environmental Protection Agency

Enclosures (3)

ADMIN RECORD

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NOV 23 2006

cc: Bob Davis, K-H
Carl Spreng, CDPHE
Jean MacKenzie, EPA

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**CDPHE COMMENTS**
**ACCELERATED ACTION DESIGN FOR THE**
**PRESENT LANDFILL**
**ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE**
**95% DESIGN SUBMITTAL**
**JANUARY 2004**

## General Comments

1. This Design Analysis attempts to justify the use of a geosynthetic clay liner (GCL) above the frost depth. CDPHE does not agree that a GCL placed above frost depth for closing a Subtitle C facility is appropriate, as detailed below.

   CDPHE has not seen independent research that would conclusively validate either laboratory or long-term field tests similar to the Bentofix study, as provided in Appendix B. We are not convinced that, for long-term considerations, GCLs are not negatively impacted by multiple cycles of freeze/thaw, as demonstrated through research, regulatory guidance, or use on similar projects. The EPA Fact Sheet on GCLs, also provided in Appendix B states: "Full-scale field tests still must be conducted, however, to corroborate the laboratory data [under the heading 'Freeze and Thaw Cycles'], **especially for GCL technology used as an infiltration barrier in landfill caps**." *(emphasis added)*

   CDPHE does not consider the number of freeze/thaw cycles performed for the Bentofix study to constitute long-term conditions. According to Table 1 of the Bentofix study (Appendix B), there were 20 cycles of freeze/thaw. Other studies, including those by Krause et al. (1997) (also provided in Appendix B) likewise tested GCLs with about 20 freeze/thaw cycles. Although the results were encouraging, one of the conclusions by Kraus was: "Only long-term field tests, where GCLs and sand-bentonite mixtures are monitored for an **extended number of years***(emphasis added)*, will provide the definitive information regarding the long-term performance of GCLs and sand-bentonite mixtures subjected to freezing conditions."

   It has previously been demonstrated that an increase in hydraulic conductivity can be caused through ion exchange of sodium bentonite to calcium bentonite. Research has shown that this transformation can increase the saturated hydraulic conductivity by tenfold within a matter of months. GCL exposure to freeze/thaw cycles must be avoided because the freeze/thaw processes compounds the ion-exchange transformation, thereby challenging the long-term hydraulic performance of the material.

   Due to the uncertainty associated with long-term hydraulic performance of GCLs subjected to cycles of freeze/thaw, CDPHE will not consider a design for any Subtitle C facility, including the Present Landfill final cover, if the GCL is located above the frost depth. Therefore, any reference to installing GCLs above the frost depth for this project should be removed from the document.

2. With respect to utilizing a GCL for this project, CDPHE has not seen the information we have requested in past working group meetings, or an adequate justification that the information is not necessary. Specifically, since the concept of this cover design was presented to us, we have requested that appropriate laboratory testing be performed on the actual soils and geosynthetics so that the material properties can be properly evaluated. We have always been concerned with using a geomembrane and GCL on a relatively steep (4:1) slope at a relatively long distance (over 100-feet) for long-term stability issues. We were told that, instead of actual soil and geosynthetic material testing, representative material properties from past studies or vendor testing would be used to demonstrate the effectiveness of the design. From the information provided in the design submittal, we do not agree that an adequate justification has been made.

   Using a GCL for the long-term requires very careful consideration. Some researchers believe that the geonet/geomembrane is the critical interface, while the draft EPA guidance suggests that the weakest interface may be between the GCL and a textured geomembrane. Some regulatory agencies, such as the Nuclear Regulatory Commission, would not allow GCLs to be used in final covers for long-term design considerations, such as at UMTRA disposal cells. CDPHE, along with the EPA, approved a design incorporating a GCL for the original remedy for the Denver Radium OU 8 (Shattuck) site. The design consisted of a GCL on the top slope (~ 3%) that transitioned to a compacted clay liner (CCL) on the 5:1 side slope. A GCL was not approved for the side slope for that design due to the potential long-term stability issues. The major point is that not all researchers or regulatory agencies agree that GCLs are appropriate for long-term design considerations, especially for relatively steep slopes. They all agree, however, that laboratory testing using project-specific materials, coupled with testing procedures and conditions representative of the anticipated field application, be performed to establish material parameters on a project by project basis. Therefore, in order to be consistent with other facilities that have designed final covers for Subtitle C and other similar sites, as well as follow standard industry practice, CDPHE must require that specific material testing be performed, with actual geosynthetics and soils selected for this project, prior to our design approval.

3. The Design Analysis should clearly state the specific product or material that is planned for use. For example, Section 3.3.2 of the Design Analysis discusses products such as Bentomat and Claymax, however, the actual product selected for use in the cover is not explicitly discussed. Appendix G contains a manufacturer's product data sheet for "Bentofix Thermal Lock CNSL", which we assume to be the selected product, but this is not clearly stated. All materials proposed for the cover, including both geosynthetics as well as soils, should be clearly identified in the Design Analysis.

4. Material quantity calculations and summaries for either the proposed geosynthetics or soils to be used for the cover have not been provided. The estimated quantity of soils for the cover is particularly critical in order to determine that an adequate supply exists for project use. This information cannot be deferred until construction, but must be contained in the design in order to allow adequate review of the material's acceptability.

In addition, material quantity calculations are necessary in order to determine if minimal testing frequencies, as shown in Table 2.3 of accepted EPA guidance, have been achieved.

5. There are portions of the design that appear to have been selected out of convenience, rather than through careful thought and attention to details. For instance, the soil selected for the GCL cushion (bedding) layer does not appear to meet the industry requirements with respect to particle size. CDPHE believes that the borrow source for this material was selected because it was available, rather than because it was the correct material to use. Other examples are the improper selection of the horizontal acceleration coefficient for the seismic slope stability analysis, and the use of published data from vendors and textbooks for final design rather than generating actual material parameters through laboratory testing. This approach is not amenable to producing a quality product. The details of our concerns are contained in the specific comments below.

**Specific Comments**

**Design Analysis**

6. Section 1.1, page 1-1, 2nd bullet – This bullet states that the "key" components of the landfill cover will be described. The word "key" should be replaced with "all", as every component in a landfill cover is critical to success.

7. Section 3.4.2, page 3-5 – The title of this section is "FML Recommendation", yet the FML proposed for this project is not stated. Please cite the specific product proposed for use in this section, even if it is discussed in Appendix L. See Comment 3.

8. Section 3.5, page 3-5 – The title of this section is "Soil Evaluation", yet no discussion of the soil planned for use is provided. The minimal information provided in this section refers the reader to two tables and Appendix D. One table (Table 3-1) provides grain size analysis and results of Proctor compaction tests, while the other table (Table 3-2) lists the testing methods. Appendix D provides some lab data, but there is no explanation as to how this relates to the current design. Are the tests results shown for the proposed cushion soil, the infiltration (vegetation growth) soil layer, both, or something else? This section should clearly state the design criteria that the various soil layers must achieve, and demonstrate that the material is acceptable for that purpose. This must include quantity and quality evaluations, through meeting specific laboratory and field testing frequencies, as provided in EPA guidance[4].

9. Section 3.7, page 3-6 – It is stated that model simulations were conducted using preliminary data from borrow soil characteristics. Will additional model runs be performed using actual data from soils planned for use in the cover? If not, please justify in detail that the preliminary modeling runs are appropriate for this project.

10. Section 3.10.1, page 3-8, 3rd par. – 1) This paragraph states that subgrade of the landfill will be compacted to a minimum of 90% standard Proctor compaction. According to accepted design guidance, as well as standard geotechnical engineering practice, subgrade compaction for support of structures should be a minimum of 95% of the maximum standard Proctor density (ASTM D 698). Please change this criterion accordingly. 2) It is stated that the method to achieve the subgrade compaction standard will be evaluated using a test fill prior to actual construction in order to test equipment and required number of passes. This sounds like a "method" rather than a "performance" requirement. While CDPHE does not object to a method specification, we would like to be able to formally concur with the proposed subcontractor method prior to its approval. Please clarify that the regulatory agencies will have the opportunity to formally evaluate and sign-off on this procedure prior to its approval for use by the Subcontractor. 3) This paragraph states that soft areas of the subgrade, as defined by 3-inches of deflection or greater, will be reworked. This is too much deflection, particularly with respect to a GCL in the cover system, as well as standard practice in the construction of a Subtitle C landfill final cover. Please change the subgrade deflection criterion to a maximum of 1-inch.

11. Section 3.10.2, page 3-9, 1st par. – A technical memorandum, written in 1994, is referenced with respect to settlement. Please provide this memo for our review.

12. Section 3.10.2, page 3-9, 2nd par. – The first sentence of this paragraph states that there is no site-specific geotechnical data related to the claystone bedrock beneath the landfill. It continues that the compressive strength was evaluated from published design charts and borings conducted "at the site". This is not acceptable for final design purposes. CDPHE is unaware of any guidance that allows non-site-specific data to be used for design purposes, including settlement analysis. Please explain how site-specific data will be obtained and incorporated into the final design so that the assumptions made related to foundation material properties can be verified.

13. Section 3.10.2, page 3-9, 3rd par. – This paragraph states that sludges are part of the waste in the Present Landfill. Please provide additional details related to the sludge, particularly as to quantity, location, and potential impacts to settlement of the landfill.

14. Section 3.10.2, page 3-10, 2nd par. – Please change the subgrade compaction requirement to 95% standard Proctor density. See Comment 10. Also, add the word "density" after "Proctor".

15. Section 3.10.3, page 3-12, 2nd par. – It is stated that a bedrock coefficient of 0.05g was used for seismic evaluations for this project, which was obtained from Attachment 7 of Appendix G. Attachment 7 of Appendix G is a map of part of the western U.S. with peak acceleration contours. Other than the title, which indicates that this is a USGS map, the map is not referenced. The title, however, also states that there is a 10% probability of exceedance in 50 years. Reading the acceleration contours from this map is not

adequate or appropriate for this project's seismic evaluation, as detailed below.

According to Kirkham and Rogers (1981), the Golden fault (fault No. 166) is considered "potentially active". The Golden fault has been mapped to within a mile or so of the Present Landfill. Kirkham and Rogers suggest that for the evaluation of projects located in known fault zones, detailed site investigations, with respect to selecting an appropriate horizontal acceleration coefficient, should be required. Furthermore, even if a project is relatively remote from a known fault, but within a seismotectonic province that has potentially active faults, a minimum of 0.1 g horizontal acceleration should be used in a design analysis. The use of a minimum 0.1 g horizontal acceleration is also required for seismic evaluations for all UMTRA disposal sites, as described in the UMTRA Technical Approach Document.

Considering this project's long-term design requirement, its extremely close proximity to a potentially active fault, and the regulatory requirements for similar projects that have been recently performed by the DOE and others, CDPHE must require a site-specific seismic hazard evaluation in order to determine the appropriate peak horizontal acceleration for use in the stability calculation. Guidance for this evaluation can be found in the UMTRA Technical Approach Document[7], the draft EPA guidance[2], or other recognized sources. Please revise this analysis and associated calculations.

**Tables**

16. Table 3-1 – This Table, which is referenced in section 3.5 of the Design Analysis, is deficient in several aspects. 1) The "Classification System" is shown, but the actual classification is not. Please include columns with both the USCS soil classification and USDA soil classification, where appropriate. 2) The cover component being summarized is not stated. Does this table show material planned for use as the cushion soil above the waste, cushion soil above the drainage net, infiltration soil, or something else? Please clarify. 3) The results of all soil lab testing should be shown. For example, Attachment 1 of Appendix C has results from shear testing performed by Construction Technical Services, Inc. with a cover letter of October 9, 2002. These results, along with any others, should also be included in this table. 4) Sample locations should be shown on a drawing and the drawing referenced in this table. 5) It is not clear whether the sizes shown are relative to the USCS or USDA classification system. For example, is the 6$^{th}$ column "clay" according to USCS, where the material passing a number 200 sieve (0.075 mm) is clay, or is it material finer than 0.002 mm, as measured by hydrometer, and classified clay according to USDA? Please check and clarify.

**Appendices**

**Appendix A – Evaluation of Landfill Gas Generation**

17. Attachment 4, pp A22 through A25 – 1) The calculation shown on pages A22 and A23

appear to be the same as the calculation on pages A24 and A25. Is there any technical difference between the two separate calculations? 2) The only difference between the two calculations that we have found is that the conversion from cubic meters to cubic feet appears to be incorrect in the calculation on page A24 (shown as 27 $ft^3/m^3$), while the conversion on page A22 correctly shows 35.3 $ft^3/m^3$. Please check and clarify.

18. Attachment 4, pp A26 – The graph on this page shows estimated methane emissions by mass, listed in Mega grams (Mg). However, the calculations on pages A22 through A25 show methane emissions as a rate and flux. For consistency and ease of comparison, the graph should also be shown as a rate or flux.

19. Attachment 5, page A29 – The soil moisture input for the cover attenuation factor is shown as 17%. This may be too high for the actual material. According to Table 3-1 of the Design Analysis, the average optimum moisture content (OMC) is about 10.5% (the highest OMC shown is 11.5%). In addition, the infiltration soil layer will probably be placed at moisture contents significantly less than optimum, considering that this will be the zone where vegetation will be established. Please recalculate the cover attenuation factor using a soil moisture content that better represents the actual moisture of soils planned for use in the cover system.

**Appendix B – Applicability of a GCL for Installation Above Frost Depth, and Frost Depth Analysis at the Present Landfill**

20. General – CDPHE strongly disagrees with the concept that a GCL may be located above the frost depth for a landfill cover being closed according to Subtitle C requirements. See Comment 1. There are, however, some portions of this calculation that may be appropriate for the design, provided it is not used to justify the placement of a GCL above the frost depth. With that caveat, the comments below relating to Appendix B should be addressed.

21. Technical Memorandum, page 4 – The examples of projects in Colorado where GCLs have been placed above the frost depth is not appropriate for this project, in that none of those sites are Subtitle C facilities with long-term design criteria requirements. Please eliminate these references from the memo.

22. First Color Divider – The title states "Appendix A", but should be "Appendix B". Please correct this typo.

23. Frost Depth Calculation for Rock Layer – The moisture content used for this calculation is shown as 7%. This moisture content is too high for the biota barrier material. The biota barrier will be 10-inch minus material, with minimal fines. This gradation is considered a free-draining material, with a moisture content approaching zero. The calculation should be revised using more realistic moisture content for this material, namely 0%.

**Appendix C – Flexible Membrane Liner Option Analysis**

24. General – 1) For superior performance, CDPHE recommends that any geomembrane selected for use in the cover system have a minimum thickness of 60-mil, rather than the 40-mil recommended in this Appendix.

**Appendix D – Bluestone Quarry Pit Fines Rocky Flats Alluvial Geotechnical Data**

25. General – The information provided in this Appendix is not clearly presented. We are unsure as to whether this material will comprise the soil cushion layer(s), the infiltration soil layer, or something else. There are no cross-references or drawings provided to indicate where the samples came from. All available data should be clearly summarized in a table or other means.

    Some of the specific questions we have concerning the data are the following. Were these samples taken from stockpiles existing when the samples were analyzed or from borings? If the samples were from stockpiles, do these still exist about two years later? What is the significance of the testing? Has any other geotechnical testing on this material been performed? Did the testing performed meet the minimum testing frequencies for borrow source investigations, as recommended in EPA guidance[2]? These are the types of information that are needed in order to properly evaluate the material proposed for use in the final cover. This Appendix must be reworked and clearly presented.

26. Attachment 2 – On the lab data sheets, reference is made to the following report: Draft RFETS Geotechnical Investigation Report for OU 5, September 1995. This report should be submitted as part of the design if it contains pertinent information regarding soils proposed for use in the cover.

**Appendix F – Landfill Engineering 95% Design Settlement Analysis**

27. General – The assumptions on page F2 indicate that the geotechnical properties used in this settlement analysis are based on previous work. This is acceptable, provided that the material that was tested, whether in stockpiles or in-situ, will actually be used to construct the cover. It is our understanding that this is not necessarily the case. Lab testing on representative samples should be performed in order to obtain critical soil parameters, such as the compressibility indices. For this settlement analysis, consolidation testing such as ASTM D 4546 or ASTM D 2435 for each of the various soil layers comprising the cover is warranted.

    Table B-1 of Attachment 2 of Appendix D (assumed to be the source of the data referenced in first bullet, although this is not explicitly stated) shows a wide range of dry

densities, from about 90 pcf to 119 pcf. The table does not indicate if the dry densities are maximum dry densities, based on laboratory testing, or whether they were densities measured in the field. In fact, the title of this table includes the words "Natural Water Content", which we assume would be based on in-situ samples. However, we surmise that the title is incorrect and the data is actually from laboratory testing. Please clarify.

It is stated that the Present Landfill is about 20 acres in size. It would take over 32,000 $yd^3$ of material for each foot of soil thickness to cover the landfill footprint. With 2 feet of infiltration soil, this is over 64,000 $yd^3$ of material. According to EPA guidance[4], compaction curve testing for borrow source investigations should be at a frequency of about 1 test per 5,000 $m^3$ (~ 6,500 $yd^3$). This would convert to a minimum of about 10 tests for the quantity of material needed. Therefore, the 6 tests previously generated that were used in this calculation, do not meet the minimum frequency requirements. This is even more critical considering the wide range (~ 25% spread) in (assumed) maximum dry densities shown in Table B-1. Even more of a concern to CDPHE, however, is the uncertainty as to the availability for cover use of the soils that were tested in 1995, over 8 years ago.

CDPHE wants to be very clear on the following point. Non-borrow-specific geotechnical testing of a mapped geologic unit, such as the Rocky Flats Alluvium, does <u>not</u> represent testing of a specific borrow source where the material is actually planned for use in the cover system. Therefore, prior to CDPHE approval of a final design, additional borrow-specific source testing, that satisfies minimum guidance frequencies, must be performed.

28. <u>Table F-1, page F3</u> – 1) The columns labeled as "Depth" should actually be labeled as "Thickness". 2) The unit weight of Alluvial (sic) is incorrect. Neglecting the problems with using the data in table B-1 as discussed in Comment 25, it appears that the dry unit weight was used in the calculation, which is not correct. The total unit weight must be considered when evaluating consolidation pressure. Using this data for the Rocky Flats Alluvium, (which CDPHE does not currently accept as meeting minimum frequency requirements), the unit weight should be 108.7 pcf, (90% of 120.8 pcf) rather than the 93.5 pcf shown. Similarly, the dry, rather than total unit weight was used for the cushion soils. However, the cushion soils should be placed at a minimum of 95% maximum standard Proctor density (ASTM D 698), and not the 90% shown.

29. <u>Sheet F4, Section 5.2</u> – Please specifically reference the location in Chapter 6, Appendix 3 where the estimates for porosity and void ratio were obtained. In addition, please explain how the value 1.08 for the void ratio was derived. According to Section 4.2.1.3 of Attachment 2 of Appendix F, the porosity (n) associated with landfill waste is in the range of 30%. By definition, the void ratio $e = n/(1 - n)$. Therefore, $e = 0.3/(1 - 0.3)$, which equals 0.43. Please revise this calculation.

**Appendix G – Landfill Engineering, 95% Design, Slope Stability Analysis**

30. General, Static Slope Stability – It is interesting to note that the design has referenced Table 6-3 (not Attachment 1 as indicated in Reference 3) of the draft EPA guidance[6] for selecting the Factors of Safety. CDPHE requests that the project designers read and comprehend the remainder of Chapter 6. In particular, we are concerned that actual materials selected for use in the cover system have not been tested in the laboratory, as this guidance suggests. Section 6.2.4, page 6-13 of the draft EPA guidance[2] states: "It is recommended that laboratory testing using project-specific materials, coupled with testing procedures and conditions representative of the anticipated field application, be performed to establish design shear strength parameters on a project by project basis."

Lacking material-specific testing, the draft EPA guidance for static slope stability recommends increasing the factor of safety beyond what was selected for this project, 1.5. Table 6.5, page 6-22 recommends a minimum factor of safety of 1.6 for "Hazardous Waste Landfills" with a "high" ranking. The draft guidance goes on to state: "A minimum acceptable factor of safety ($FS_{min}$) for static stability analysis of 1.5 will often be appropriate for permanent cover system applications where the design is based on peak internal and interface shear strengths conservatively established **using project-specific interface direct shear tests**..." *(emphasis added)*

The quote above implies that for this project, where actual lab testing has not been performed, a factor of safety greater than 1.5 for static slope stability must be used. In addition, the statement on sheet G2, which concludes that the consequence of slope failure will not cause a major environmental impact, is not correct. This is a hazardous waste landfill, and failure of the facility, by definition, will cause environmental harm. Therefore, please modify the wording of this statement.

31. Section 7.0. Sheet G3 – This section states that all of the model runs except three met the required factor of safeties. According to Table G-1 on this sheet, the seismic stability of the east slope was 1.33, while the requirement is 1.5. This should be discussed in the Conclusions section of the calculation.

32. Attachment 1 – This attachment contains three pages with selected material parameters that were used for the slope stability calculations. The third page of this attachment references the values used in previous reports or studies. Please provide all data that went into selecting the parameters for each of the materials. This data should include, at a minimum, all lab testing performed, including a summary of the material properties, and the location of the samples that were tested with respect to the actual borrow material proposed for use.

33. Attachment 2 – CDPHE is troubled by this attachment, which attempts to justify the use of published data instead of generating material properties through actual lab testing. The second page of this calculation (labeled "Source 1") is from Koerner (1994). The Note below Table 2.6 supports CDPHE's position, and clearly states: "Values such as the above **should never be used in final design.***(emphasis added)* Site-specific geotextiles and soils must be individually tested and evaluated in accordance with the

particular project conditions."

Even the GCL and geomembrane manufacturers recommend specific testing. Section 4 of the Bentofix (GCL vendor) slope design procedure states: "For a first assumption, the relationship for interface friction angles of geotextiles can be assumed... **but cannot replace shear tests with site soils**." *(emphasis added)*

Page 2 of the Poly-Flex, Inc. (geomembrane vendor) information contained in this attachment states: "Site specific tests should be performed... **The following interface friction data should be used for general information purposes only and should NOT be used for design or certification purposes.**" *(emphasis as-written, not added)*

The quotes above are compelling. They are contained in the information provided in the design, and not from some obscure reference. CDPHE is not aware of any guidance, research, or regulatory protocol that suggests that material-specific testing of geosynthetics should not be performed. The final design for this project must include actual, rather than assumed values for material inputs.

**Appendix H – Landfill Engineering Surface Water Management System Assessment**

34. Section 6.0, Sheet H4 – It is stated that SC150 using staple pattern D was selected for temporary erosion control. Please provide additional details concerning the SC150 product, as well as staple pattern "D". There is no further information in this Appendix.

**Appendix I – Rainfall Soil Erosion and Wind Erosion Calculations**

35. Section 4.0, Point 6 – This point states that the design life for erosion protection is assumed to be 30 years. This is not correct. The 30 years is assumed to be the post-closure care period, but erosion protection must be considered in perpetuity.

36. Sheet I4, Specifics – The soil in this section is classified as sandy loam. However, it is not known how this determination was made. Please provide results of all classification testing for this material to verify this assumption.

37. Section 5.1.2.2, Sheet I4 – This section evaluates the cover for erosion loss assuming a dense grass coverage of about 75% to 95%. In the past, the USF&WS requested that the thickness of the infiltration layer (vegetative growth layer) be increased from the current design of 2-feet to about 4-feet so that adequate vegetation can be established for the long-term. The response from K-H was that vegetation is not necessary for the cover to function properly, and that any vegetation would be an added benefit. The implication was that the vegetation would not approach a "dense" vegetation state, as assumed in this calculation. Please delete this portion of the calculation unless dense vegetation, as defined by 75% to 95% ground coverage, has a realistic chance of succeeding.

38. Section 5.2.1, Sheet I8 – The Wind Erosion Equation has a number of input values that are described, but not referenced or justified. If design charts or some other method was utilized to determine these inputs, it should be provided in the calculation. Simply stating that the climatic factor C was determined to be 80 to 100 is not adequate. Each of the variables should be specifically addressed.

**Appendix J – Geotextile Clogging Evaluation**

39. Section 6.0, Sheet J3 – Similar to many previous comments, CDPHE is unaware how the soil parameters were selected, such as the diameters for $D_{85}$, $D_{60}$, and $D_{10}$. The reference for this calculation is the information provided in Appendix D. As previously discussed, the data in Appendix D is inadequate to select representative soil parameters for use in this calculation.

**Attachment 1 – Construction Specifications**

40. Section 01050, General – Reference is made to the Construction Quality Control Work Plan Document (CQCWPD), yet it was not included with the design package. This document apparently contains specific work requirements related to project surveying. Please provide this document for CDPHE review.

    Unless the CQCWPD contains the information requested, please include the following additional details in this section:

    1) Allowable tolerances, both horizontal and vertical, for each cover component, including the subgrade and each specific soil layer. Note that the soil layers comprising the cover shall not have a "negative" thickness vertical tolerance (in other words, the vertical tolerance should be –0.0 to +0.1, or similar).
    2) The type of survey equipment allowed to be used, such as total station, GPS, etc. If GPS is used, list any special QA requirements.
    3) The features of the landfill cover to be surveyed. This should include, at a minimum, all soil layer thicknesses based on surveys at prescribed grid locations and at all grade breaks and other pertinent locations. Thickness verifications must not be based on interpolation between surveyed points or contour mapping. The location of the treatment system, associated piping, and any other feature must also be surveyed.
    4) The location of temporary and permanent drainage channels, haul roads and access roads. Survey cross-sections of temporary and permanent drainage channels or haul roads at maximum 100-foot intervals.
    5) All CQC and CQAE test samples for both soils and geosynthetics.
    6) All geomembrane panels, panel intersections, destructive seam sample locations, repair locations, extrusion welds, break lines and caps.
    7) The responsible Professional Land Surveyor (PLS) shall stamp all record

drawings. Show all survey points (e.g., survey grid points, break line points) on applicable record drawings. Drawing scale shall be 1 inch = 50 feet, with a 1-foot contour interval.

41. Section 01110, Part 1.01.A.1.e – Please clarify that the subject trailer, or other appropriate facility, will allow space for the Construction Quality Assurance Engineer (CQAE) and their staff.

42. Section 01110, Part 1.01.A.6 – As previously discussed (Comment 10), change the subgrade deflection criterion to a 1-inch maximum, rather than the 3-inches shown.

43. Section 01110, Part 1.01.A.7 – Also previously discussed (Comment 10), please clarify that the regulatory agencies will have an opportunity to review and approve the constructability assessment (i.e., test fill) prior to its implementation for this project.

44. Section 01110, Part 1.01.A.9.a. – Please clarify the second sentence. It currently implies that all soils for the cover will consist of the Rocky Flats Alluvium. Is this correct, or is just the infiltration layer composed of Rocky Flats Alluvium? Also, if the intent of the infiltration layer composed of Rocky Flats Alluvium is to grow vegetation, then lift thicknesses greater than 6-inches should be specified. Studies have shown that soils compacted to greater than their growth limiting bulk density (GBLD), as described by Goldsmith et al. (2001) will inhibit vegetative root development, thereby limiting potential plant growth on the landfill cover. Since thinner lift thickness (as well as wetter soils) typically promotes compaction, thicker lifts should be considered for this project.

45. Section 01110, Part 1.01.A.9.b.,c., and d. – Geosynthetics are not placed in "layers", as described in these sections. Please revise the terminology for these sections.

46. Section 01110, Part 1.01.A.9.g. – Two 12-inch "loose" lifts of soils will not comprise a 24-inch soil thickness when subjected to compaction, even lightly compacted as expected for a vegetative growth soil. Please clarify that the minimum finished thickness of the infiltration soil layer will be 24-inches.

47. Section 01190, Part 1.03 – The attendance roster for the progress meetings do not include the independent Construction Quality Assurance Engineer (CQAE). Please add the CQAE to this list.

48. Section 01900, Part 2 – It is stated that the decontamination pad will drain to a point where rinsate and solids/sediment can be collected. Please explain what will happen with both the contaminated liquid and solid materials after they are collected.

49. Section 01900, Part 3.01, 2nd par. – The decontamination pad is to be checked for leaks through marking the water level and checking the level again after 3 hours. Please provide further detail. Will the mark be surveyed using an instrument (i.e., total station, GPS, hand level, etc.)? Will any lowering of the water level be considered leakage?

Will the test be repeated if the results are suspect? Who will make the decision whether it passes the leak test? Will repairs be made if it does not pass? Please expand this section for clarity.

50. Section 01900, Part 3.02, last sentence – It is stated that the decon pad will also be used to clean the tires of vehicles leaving the site, if needed. The sentence sounds like it will be based on visual identification only. The phrase "if needed" should be clarified. All vehicles that have accessed areas of the site where contaminated materials exist (i.e., exclusion zone) must be decontaminated, including the tires, even if contaminated materials are not visible on the vehicle.

51. Section 01900, Part 3.03 – Although it is stated that the pad shall be removed at the end of the project, there is no direction as to what happens with the pad after removal. Please discuss the appropriate disposition of the decon pad after its removal.

52. Section 02221, Part 1.02.D – This unit of the cover is called "6-inch Cushion Soil" in the construction drawings (drawing number 12), but is called "Foundation Layer Soil" in the specifications. The names must be consistent throughout the project documents. Please check and correct.

53. Section 02221, Part 1.03.B. – This item states that one of the submittals expected from the Subcontractor is the geotechnical test results demonstrating that the soil source is in compliance with the specifications and CQC WCD. CDPHE must approve any material to be used in the final cover, including all soils. While CDPHE does not object to reviewing a subcontractor submittal, please be advised that this review must be considered in the project schedule. It may be more efficient for the Contractor or Engineer to demonstrate that the geotechnical testing criteria have been satisfied prior to subcontractor mobilization, then direct the Subcontractor to obtain the approved borrow material.

54. Section 02221, Part 3.01.A.4. – As previously discussed, please change the maximum subgrade deflection requirement from 3-inches to 1-inch.

55. Section 02221, Part 3.02.A.2. – The minimum compaction performance requirement should be 95% of standard Proctor dry density, ASTM D 698. Also, the deflection criterion should be 1-inch. Please change accordingly.

56. Section 02221, part 3.04.7. – In order to eliminate confusion, please provide a definition of "frozen material", similar to the following: Frozen material is defined as soil with a temperature less than 32°F (+/– the accuracy of the thermometer) or containing visible ice crystals or clods of frozen soil larger than 4-inches in any dimension.

57. Section 02221, Part 3.05.3. – 1) It is stated that the foundation layer will be "approximately" 6-inches in thickness. The foundation layer must be a minimum of 6-inches. Please change the wording accordingly. 2) Also, the table showing the

gradation of this material is referred to as "typical". The word "typical" should be removed and the table should be referenced as a specification. 3) The table shows a gradation that is not suitable for GCL placement. According to one GCL manufacturer, CETCO, subgrade soils (supporting the GCL) should have a particle size distribution such that at least 80% of the soil is finer than a #60 sieve (0.2 mm). This gradation shows that only 30.5% of the soils would be finer than a #60 sieve. This material will not be approved for bedding a GCL. In addition, the specification apparently allows cobbles less than 3-inches (i.e., 2.5 inches) to remain. This is certainly not appropriate for GCL bedding.

58. Section 02221, Part 3.05.4. – The foundation layer must be compacted to a minimum 95% standard Proctor dry density (ASTM D 698). Please change the specification currently shown. Also, a moisture requirement is not stated for this material. Please add a moisture requirement, such as +/– 2% of the optimum moisture content (OMC) as measured by standard Proctor density (ASTM D 698).

59. Section 02221, Part 3.06, General – A specification for density or moisture requirements have not been provided for this material. Please add a minimum dry density of 95% standard Proctor density (ASTM D 698) with a moisture content +/– 2% of OMC.

60. Section 02221, Part 3.06.3. – 1) It is stated that the cushion layer will be "approximately" 10-inches in thickness. The cushion layer must be a minimum of 10-inches. Please change the wording accordingly. 2) The table showing the gradation of this material is referred to as "typical". The word "typical" should be removed and the table should be referenced as a specification. 3) The gradation table shows that 100% of the material must pass a 0.5-inch sieve, yet this part of the specification requires the removal of cobbles over 3-inches. This is not consistent. If an occasional cobble is anticipated, then a suitable specification should be provided specifically for that allowance. Otherwise, all material greater than 0.5-inches must be removed from the cushion layer.

61. Section 02221, Part 3.07.2 – This specification states that the borrow source is assumed to be reasonably uniform in texture and gradation throughout its full depth of the vertical profile. Until adequate borrow sampling and testing has been performed, we are not sure how this statement can be justified.

62. Section 02221, Part 3.07.4. – Similar to other comments, the word "approximate" should be removed and replaced with "minimum", such that the thickness of the Rocky Flats Alluvium (infiltration soil layer) is a minimum of 2-feet.

63. Section 02221, Part 3.07.6. – 1) The first sentence needs to be clarified. 2) Since this layer will act as the vegetative growth medium, compaction must be reduced from typical construction practice for optimum plant growth. Please change the specification to indicate that the maximum dry density shall be no greater than 90% of standard Proctor density (ASTM D 698).

64. Section 2222, Part 1.01, 2nd par. – Although meaningless to the Subcontractor, the biota barrier will also act as a barrier to vegetation. For accuracy, please include the vegetation deterrent capabilities of the biota barrier in this paragraph.

65. Section 02222, Part 1.02 – The reference listed for the gradation testing is incorrect. ASTM D 422 is for finer grained material, where the material for testing passes a #4 sieve (4.75 mm). The correct gradation testing procedure for the biota barrier material should be ASTM C 136, Sieve Analysis for Fine and Coarse Aggregates. Please change.

66. Section 02222, Part 2.01.A.3. – This specification lists a requirement for compressive strength, yet no ASTM or other standard is referenced. Please include ASTM C 39, Compressive Strength of Cylindrical Concrete Specimens, or other recognized procedures for strength testing.

67. Section 02222, Part 2.01.A.4. – This section "assumes" that local rock sources should be within the specification requirements. This is not appropriate. All materials must be tested to demonstrate that the approved specifications will be achieved.

68. Section 02222, Part 2.01.A., last par. – This paragraph states that the material should not be placed until the material delivered to the site has passed a "visual field gradation test". We are not clear as to how this will work. If the material is not placed, it will be stockpiled. How can a visual field gradation test be performed on a random stockpile? Please provide specific details. The actual field placement will look different than the stockpile. Will a visual field gradation test also be performed for the in-pace material? Although the visual field gradation test, if meaningful, may be used as part of the QC or QA, material testing according to ASTM or other recognized sources must be still be performed and shown to meet the approved specifications, including gradation.

69. Section 02222, Part 3.02.B. – At past working group meetings, the regulatory agencies expressed a concern about the technique to be used for placement of the biota barrier. Our basic concern was that dropping the biota barrier materials from a dump truck directly onto the surface would damage the underlying geosynthetics. We suggested that an actual test fill or other means be planned in the project schedule in order to evaluate the proposed method by the subcontractor. This test fill would be performed outside of the cover footprint, so that the technique to be used can be optimized without concern for underlying material damage. The K-H design team assured us that the specification would provide enough direction to the subcontractor that the underlying material would not be damaged, and a test fill would not be necessary. From the information contained in this part of the specifications, we still have concerns. Please rework this specification and include more details and information such as maximum drop height allowed or other means (i.e., construct a soil "pad" where the rocks are be unloaded) in order to reduce the impact of dropping 12-inch rocks.

70. Section 02224, General – 1) Conformance testing of representative field samples have not been specified. Sampling should be at a minimum frequency of one per 100,000 $ft^2$

of material produced and supplied to this project, with a minimum of one sample per production lot. The material may be obtained either directly at the GDN manufacturing facility by a representative of the Engineer/Contractor/CQAE, or at the project site upon delivery. At a minimum, the tests contained in Table 02621-1 should be performed.

71. Section 02224, Part 1.03.A. – This party appears to be the same as the Construction Quality Assurance Engineer (CQAE). Is that correct? If so, then for consistency with this document and the QA/QC Plan, please change the name to CQAE.

72. Section 02224, Part 1.06.A. – In addition to the information shown, the lot number should also be provided from the manufacturer.

73. Section 02224, Part 3.02.B. – The project does contain a long, steep slope. Therefore, this part should be re-written as such.

74. Section 02224, Part 3.02.C. – Sandbags or other ballast should be required at all times, not just in the "presence of wind". Once a wind gust begins (they do occur at RFETS), it will not be possible to place the ballast, and the material could be damaged.

75. Section 02224, Part 3.02.D. – An anchor trench for the GDN is not shown on the project drawings (Drawing 012). Therefore, this specification should be eliminated.

76. Section 02224, Part 3.03.B. – Our experience with GDNs at other sites was that a minimum overlap of 6-inches side to side and 12-inches end to end was required. Please provide the manufacturer's recommendations that justify the minimum overlap requirements specified for this project. Also, the language in the overlap specifications should be an absolute minimum, and not a range of minimums, as currently shown.

77. Section 02225, General – 1) There are no specifications for the extrudate rod or bead, to be used for extrusion seaming for patches or tight areas where thermal fusion welding is not possible. 2) Conformance testing of actual material delivered to the site should be specified. 3) In order to assure intimate contact, please provide requirements for geomembrane wrinkles. A maximum wrinkle height of 3-inches is normally specified. 4) Procedures for liner protection, particularly during seaming, should be provided. For example, items such as placing a piece of protective fabric beneath the hot welding apparatus and locating the electric generators off the geomembrane should be required.

78. Section 02225, Part 1.03.B. – For consistency, please change the word "consultant" to "engineer", so that the term is Construction Quality Assurance Engineer (CQAE).

79. Section 02225, Part 1.04.A. – A time prior to installation (i.e., 14 days) should be specified in order for a proper review of the product data prior to installation.

80. Section 02225, Part 1.04.A.2. – In addition to the stated information, a copy of the manufacturer's Quality Control Program, the results of all quality control tests, as well as

the test methods used, should also be submitted.

81. Section 02225, Part 1.04.B. – In addition to the information requested from the installer, the following should also be submitted: 1) installation schedule; 2) copy of the Installer's letter of approval or license from the geomembrane manufacturer; 3) a list of all equipment proposed for work by make and model for the seaming work; and 4) average daily production anticipated for this project.

82. Section 02225, Part 1.04.C. – The submittal after completion should also include the locations of destructive seam tests.

83. Section 02225, Part 1.05.A. – Rather than the subcontractor contracting a geosynthetic quality assurance consultant, the independent CQAE hired for the project should also act as the CQAE for the geosynthetics as well.

84. Section 02225, Part 1.07.A. – Include the lot number as part of the label information.

85. Section 02225, Part 1.09.D.1. – Reference is made to Table 1.1 for the geomembrane property requirements. In addition to the requirements shown, Table 1.1 should also include the following: 1) asperity height (GRI GM 12); 2) tensile properties, including yield stress, break stress, and yield elongation; 3) stress crack resistance (ASTM D 5397); 4) oven aging at 85° C (ASTM D 5721, 3895, and 5885); and UV Resistance (GRI GM 11 and ASTM D 5885).

86. Section 1.09.E.1. – Similar to the comment for the smooth geomembrane, the textured material should also be tested for the properties shown in the preceding comment.

87. Section 02225, Part 1.11.A. – Clarify that the identifying code will be clearly marked on each panel.

88. Section 02225, Part 1.12.E.3. – Trial welds should also be performed whenever there is a change in seaming personnel or seaming equipment or whenever the ambient temperature changes more than 20° F within a seaming period.

89. Section 02225, Part 1.12.E.6. – Reference is made to Table 3.1 for minimum values of trial welds. The values on this table appear low. The shear strength should be a minimum of 120 lb/in., and the peel strength should be a minimum of 88 lb/in. for fusion weld and 75 lb/in. for extrusion weld. Also, the value column (third column) in Table 3.1 should show the proper units.

90. Section 02225, Part 1.12.F. – Specific temperature criteria should be provided for seaming. Seam geomembrane in ambient temperatures less than 104° F and greater than 32° F, measured 6-inches above the geomembrane surface.

91. Section 02225, Part 1.13.C.1. – Non-destructive testing (vacuum and air testing) should

be performed concurrently with seaming as the work progresses, and not at the completion of all seaming. Please change this specification. Also, has electrical resistivity or electrical leak detection methods been considered for this project?

92. Section 02225, Part 1.13.C.2.a.1. – The frequency for destructive testing is stated as one per every 1,500 lineal feet of seam length. This is too great a frequency. According to EPA guidance[4] (Section 3.5.2.1, page 151), fixed incremental sampling for destructive testing of geomembrane range from 75 to 225 m (250 to 750 ft) with a commonly specified value being one destructive test sample every 150 m (500 ft). Please increase the frequency to match the guidance.

93. Section 02225, Part 1.13.C.2.b.3. – Clarify that the minimal length for the seam sample will be 42-inches long.

94. Section 02226, General – This specification describing the details necessary for utilizing a GCL requires additional information. Major items such as surface preparation, placement of GCL on side slopes, seaming requirements, protection of GCL after placement, repairs, and covering the GCL need to be added or expanded. There appears to be considerable more information contained in the specification for the temporary erosion control material (Section 02227) than for the GCL.

95. Section 02226, Part 1.03.A.1. – Please clarify the intent of this specification. The bentonite we are aware of used in GCLs is sodium montmorillonite.

96. Section 02226, Part 1.03.A.2. – The required GCL manufacturer's quality testing along with the minimum values should be shown in the specifications. For bentonite, this should include swell index (ASTM D 5890) and fluid loss (ASTM D 5891). For the GCL, the tests should include peel strength (ASTM D 4632), bentonite mass per unit area (ASTM D 5993) and flux (ASTM D 5887). Clarify that any test results not meeting the requirements shall result in rejection of applicable rolls.

97. Section 02226, Part 1.04.B. – In addition to the conformance tests shown, the GCL should also be tested for bentonite mass per unit area (ASTM D 5993) and index flux (ASTM D 5887).

98. Section 02226, Part 1.05.C. – The GCL rolls should also be labeled with the lot number and date it was manufactured.

99. Section 02226, Part 2.01.B.2. – There is no acceptable "or equal" GCL once the material is selected. Bentomat ST must be utilized for this project if selected and approved. Please remove this specification.

100. Section 02226, Part 3.02.A. – According to the CETCO sample specifications, the GCL should be overlapped a minimum of 24-inches for end of roll seams. Please check.

**QA/QC Plan**

101. General – This QA/QC Plan did not include discussion on several important items that we expected to see. Topics such as document etiquette, qualifications for QC or QA inspectors, QA/QC staffing requirements, and quality audits and surveillances should be included. Proposed documentation, through the inclusion of sample field/lab forms planned for use during the project, should also be included. In addition, please consider the use of a formal hold point/release, whereby written documentation of the completed item is required prior to releasing the area for further work.

102. Section 1.1, 1st par. – This paragraph states that QC will be the complete responsibility of the designated subcontractor. The next sentence states that one of the duties of QC is to review and approve subcontractor submittals. Please clarify that the subcontractor will not be reviewing his own submittals.

103. Section 1.2, 1st par. – All changes, not just major changes, after approval of the design documents should require CDPHE concurrence. Please change.

104. Section 1.2, 2nd par. – We disagree that documentation of a change can be as simple as inclusion in a contractor report. A formal process must be utilized for all changes to the specifications, drawings, QC/QA Plan, or other work products that have been approved by CDPHE.

105. Section 1.2, 3rd par. – CDPHE requests that we receive a copy of the Request for Information log in a timely manner at regular intervals, such as every week or another agreed upon time.

106. Section 2.1, page 2-2, 1st par. – 1) It is stated that the CQAE will document his responsibilities through review and acknowledgement of the Daily Contractor QC Report. The CQAE is independent of QC, and should write his own specific CQAE report. 2) It is stated that the CQAE will be on-site during critical construction operations. Clarify whether the term "CQAE" refers to the person or the organization. Also, please define what are the critical activities that require the CQAE.

107. Section 2.2, page 2-3 – It appears that the group DECAM is from another project. Please check and change. Also, the same comment for section 2.2.1, 1st paragraph.

108. Section 2.2.2, page 2-5, 2nd bullet – This bullet states that protocols for handling construction deficiencies, repairs and retesting will be established at the QA/QC meeting. This should actually be established prior to the meeting, during the design phase, and specifically detailed in the QA/QC Plan. Items such as lines of communication and retesting requirements must be planned and written into the plan prior to subcontractor mobilization.

109. Section 3.0, General – There is no discussion of required "hold point/release" in the QA/QC Plan. A hold point/release is defined as a mandatory inspection point beyond which work specific to a certain activity shall not proceed until such time as an inspection and documentation determines that the work is acceptable. Hold point/release is critical for each of the cover components (subgrade, cushion layer, GCL, FML, GDN, cushion soil, biota barrier, and infiltration layer). Each layer must be qualitatively inspected, surveyed, and appropriately documented, typically on a hold point form generated for this project. Drawings showing areas where hold points have been approved should be continuously updated and provided in the final Certification Report.

110. Section 3.1, page 3-2 – An example is given concerning demolition in different areas. A different example should be provided, as no demolition is planned for this project.

111. Section 4.0, page 4-1, 3rd par. – Clarify that the QC lab/firm selected will be approved by the CQAE and/or regulatory agencies.

112. Section 4.1.1, page 4-1, 3rd bullet – Include cobbles/rocks over 1-inch as material that would be unacceptable in the top 6-inches of subgrade.

113. Section 4.1.1, page 4-2, 1st bullet – Please clarify that lift thickness will be documented by some physical means (i.e., survey, hand level, direct measure, etc.) rather than just a visual observation.

114. Section 4.1.3, page 4-2 – Please state specifically where the specifications require correlation testing of density and moisture. Also, remove the term "if applicable" in the parenthesis. Lab moisture correlation is a requirement.

115. Section 4.2.4, page 4-5, 2nd par. – In addition to the conformance testing listed in this paragraph, please also include moisture content (ASTM D 2216 or D 4643) and index flux (ASTM D 5887).

116. Section 4.2.4, page 4-5, 2nd bullet – Change the word "geogrid" to GCL.

117. Section 4.2.5, page 4-6 – The CQAE must also be involved in accepting the subgrade for GCL placement. Please modify this section to include the CQAE.

118. Section 4.2.5, page 4-6, 2nd bullet – Ballast (sandbags) must be required at all times. "Excessive" wind is difficult to define and impossible to address once it begins.

119. Section 4.2.6, page 4-7 – Please state the specific minimum overlap required for the product selected.

120. Section 4.2.7, page 4-7 – Clarify that the location of the repair will be documented through instrument surveying.

121. Section 4.3.1.1, page 4-7 – It is stated that the QCSM will review the documents submitted by the geomembrane subcontractor. Section 2.1 of this plan requires the CQAE to review and approve subcontractor submittals. Please include the CQAE in the review and approve process discussed in this section of the plan. Same comment for Section 4.3.1.2.

122. Section 4.3.1.6, page 4-10 – In addition to the properties listed for conformance testing, please also include the following: asperity (GRI GM 12), density (ASTM D 1505 or ASTM D 792), carbon black content (ASTM D 1603) and carbon black dispersion (ASTM D 5596).

123. Section 4.3.2.2.2, page 4-12 – Include repair of identified defects and areas of destructive seam testing where extrusion welding is also allowed.

124. Section 4.3.2.2.6, page 4-14 – 1) Performing work under reduced light conditions may be a health and safety concern. This should be addressed in the appropriate H&S Plan. 2) Clarify what is meant by weld testing prior to final installation and cap stripping.

125. Section 4.3.2.3.3, page 4-16 – A specific height of wrinkles requiring repair, such as 3-inches, should be specified.

126. Section 4.4.1, page 4-17 – The CQAE should also evaluate the GDN submittals.

127. Section 4.4.4, page 4-18, 2nd par. – 1) In addition to the thickness test (ASTM D 5199), conformance testing should also include bond adhesion (ASTM D 413, GRI GC 7 or F904) for the geocomposite. For the geonet comprising the geocomposite, include the following testing: carbon black content (ASTM D 4218 or ASTM D 1603), density (ASTM D 1505 or ASTM D 792), tensile strength (ASTM D 5035) and transmissivity (ASTM D 4716). 2) The paragraph also references Section 4.6 for geotextile requirements. Section 4.6 is titled Soils. Please check and change.

128. Section 4.5.2, page 4-20 – The tests discussed for the biota barrier are not appropriate. The modified Proctor (ASTM D 1557) and sieve analysis shown (ASTM D 422) cannot be performed on 12-inch minus material. While there is really no need to measure density or moisture content for this material, a gradation should be performed according to ASTM C 136 or ASTM D 5519.

129. Section 4.6.1, page 4-21 – Include the CQAE for review of the submittals.

130. Section 4.6.3, page 4-22 – Remove the reference to verifying soil layer thickness by using test holes. This is a low permeability cover system, and purposely providing preferential water pathways is undesirable. Verification must be by actual instrument survey or other non-destructive means.

131. Section 4.8.5.2, page 4-25 – The QCSM should provide full time monitoring of joints and

connections, rather than the spot-monitoring stated.

132. Section 4.10.3, page 4-27 – Eliminate reference to the test hole method of the sand gas vent layer thickness. See Comment 130.

133. Section 5.0, page 5-1, 2nd par. – The CQAE or a representative of his organization should perform full-time oversight of all construction operations affecting the final cover. Therefore, change the word "may" to "shall" in the last sentence.

134. Section 5.0, page 5-1, bullets 2 and 3 – In addition to CDPHE, EPA also approves the project plans. Please make this change.

135. Section 6.0, General – Clarify that the following will be included in the Construction Completion Report: 1) summary of all QA field and laboratory soil and geosynthetic material test results; 2) quantities of all material used for each final cover component, including both soils and geosynthetics; and 3) locations of all field tests and samples through instrument surveying shown on an appropriate drawing.

136. Tables, General – 1) The tables included with the QA/QC Plan needs to be revised to reflect the changes requested in previous comments. 2) We have previously discussed with K-H and Earth Tech that specific material testing frequencies, from accepted guidance, be utilized for minimum testing requirements rather than the subjective phrase "at the discretion of the CQAE". K-H and Earth Tech acknowledge that point, and have committed to make the changes.

**Drawings**

137. Sheet 004 – For accuracy and consistency, the slurry "trench" should be changed to slurry "wall". It is also called "wall" on Note 4.

138. Sheet 008 – Please explain the intent of the diversion berm on the top slope of the cover. Will this lead to concentrated flow and excessive erosion? The diversion berm does not appear in the cover cross-sections on Sheet 011.

**EPA COMMENTS ON**
**ACCELERATED ACTION DESIGN FOR THE PRESENT LANDFILL**
**95% DESIGN SUBMITTAL**

## GENERAL COMMENT

1. In the final submittal, all calculations must be checked, dated, and approved.

## COMMENTS ON THE DESIGN ANALYSIS

1. **Section 1.1.1, Page 1-2.** This section discusses the basis for the design. The third bullet indicates that the design storm was the 100-year storm event. In accordance with a Colorado state landfill siting criterion, the design should be protective of human health and the environment for 1,000 years. Therefore, the hydraulic design should demonstrate that the surface water collection and conveyance systems can handle the 1,000-year 24-hour storm event. This bullet should be revised to include the 1,000-year storm event as a design basis.

2. **Section 2.0, Page 2-1.** This section discusses the general setting of the site. The last paragraph mentions future missions for the site. The paragraph should state that a future mission for the site is "a wildlife refuge."

3. **Section 2.1, Page 2-1.** This section describes the use of the site and does not state that hazardous materials were routinely placed in the landfill. This important item of information should be added to the section.

4. **Section 2.2, Page 2-1.** This section lists previous reports. The "Design Basis" document should be listed in this section.

5. **Section 3.3.1, Page 3-3, and Appendix B.** This section discusses the evaluation of depth of frost penetration. Frost penetration of 24 inches and 18 inches were calculated for a cobble layer and a soil layer, respectively.

   In Appendix B, the 24-inch frost depth appears to be calculated incorrectly. In the calculations, the average thermal conductivity (k-value) of 1.05 for silt and clay soil was used instead of the corresponding value of 1.7 for granular material. Using the more appropriate average k-value for cobble of 1.7 yields a frost depth of 30 inches. The calculations should be checked and the section revised as appropriate.

   The calculation for the 18-inch frost depth in soil was not included in Appendix B and should be provided.

6. **Section 3.3.3, Page 3-4.** This section should be revised in accordance with Comment 6, Section 3.3.1.

7. **Section 3.10.1, Page 3-8.** This section discusses the grading plan. The third paragraph indicates that a test fill program will be implemented to determine the relationship among 90 percent standard Proctor density, number of passes and equipment. Details of the test fill program including requirements should be provide for review.

This section also refers to passes with a "piece of equipment." The type of equipment should be identified.

The last paragraph of this section indicates that "soft areas" are defined as areas where deflection exceeds 3 inches. This section should identify the equipment to be used to perform the tests.

8. **Section 3.10.2, Page 3-11.** This section discusses settlement of the proposed cover. The second paragraph on this page indicates that the cover soils are expected to be placed in one lift. Prior experience indicates that placement in one 2-foot thick lift leads to the formation of layer with excessive voids and variable density, which can lead to the formation of potholes and subsequent increase in the permeability of the cover soils. Therefore, lift thickness should be reduced so that the constructed cover will have a uniform bulk density. This section should be revised to be more consistent with specification Section 01110, Article 1.01, 9.g, page 01110-3 which indicates that the Rocky Flats alluvium will be placed in two lifts.

9. **Section 3.10.3, Page 3-12, Appendix D, and Appendix G.** This section discusses stability of the proposed cover system and eastern side-slope. The first paragraph indicates that stability is controlled by several factors including, but not limited to, properties of foundation soils and interface friction between the geosynthetics.

   Appendix D provides test results for pit fines, Rocky Flats alluvium, waste fill, and claystone. The results confirm that the characteristics of the waste fill and alluvium are highly variable. For example, as shown in Table B-2, the percent of alluvium passing the No. 200 sieve varies from 20 to 58 percent. Appendix G contains several quotes urging that design parameters should be determined from tests using site-specific soils and project-specific materials. Given the inherent variability of materials and repeated cautions cited in references in the document, it is not clear why, at the 95 percent design, site-specific tests for interface friction parameters, which are critical for analyzing slope stability, are not included in the design report.

   Appendix G provides results of slope stability analyses. Because no interface friction test results are available using site-specific soils and other potential project-specific materials, such as GCL and FML, the analyses in this appendix are somewhat academic and are not necessarily representative of the project at this time. A design analysis will not be final until parameters developed from site-specific soils and project-specific materials are included in the analyses and the results presented in the design analysis report.

   The tables in Appendix G, Attachment 1 show the selected parameters. It is not clear why the saturated and unsaturated unit weights are the same for several materials. For example, for the waste, 125 pcf is the saturated and unsaturated unit weight. A discussion of the parameter values should be provided.

   In Appendix G, Attachment 1, the profile selected for analysis indicates isotropic subsurface conditions. However, Appendix F, Attachment 2 indicates that the

subsurface is layered and the layers are dipping in various directions. Also, the northern section of the east slope was reported to be in an active landslide zone. Because local subsurface conditions and dipping layers can adversely impact slope stability, Appendix G, Attachment 1 should contain the necessary information, including profiles with appropriate geotechnical data, that provides the basis for the subsurface model used in the stability analyses.

In addition, if it is intended that the subcontractor provide all the necessary testing to support stability analyses, then specifications should be provided in this document for materials, methods, and test conditions. The schedule should also provide for review of test results by the Agencies.

10. **Section 3.10.4, Page 3-13, and Appendix H.** This section discusses surface water management. The first paragraph indicates that the system will collect and convey run-on and runoff from a 100-year 24-hour event. Because the siting requirements state that the surface water management program must be protective of human health and the environment for 1,000 years, the surface water collection and conveyance systems should be designed to handle the 1,000-year 24-hour event without exceeding their capacity.

    Appendix H should be revised to show that the surface water collection and conveyance systems have adequate hydraulic capacity and erosion resistance to handle the 1,000-year storm event of 6.4 inches.

11. **Section 3.10.5, Page 3-15, and Appendix I.** This section discusses the erosion losses due to precipitation and wind. Appendix I contains the supporting calculations. However, the basis for selecting the values of the parameters that were used in the equations for erosion loss was not provided. For example, it is not clear why there is an expectation that a cover with dense grass, with 75 to 90 percent coverage, will develop and be sustainable on a 2-foot thick layer of Rocky Flats alluvium. Also, the unit weight of 120 pounds per cubic foot (pcf) seems high and may exceed the growth limiting bulk density compatible with Rocky Flats alluvium. Actual parameters and documentation supporting the basis for their selection should be provided with the calculations.

    The design life for erosion protection used in the calculation is 30 years. Calculations should also be provided for a design life of 1,000 years.

**Appendix I Rainfall Soil Erosion and Wind Erosion Loss Calculations:**

**Sheet I-4**
Indicates that soil detached is 3.9 tons/acre/year. This erosion rate is nearly twice EPA's recommended rate and cannot be accepted. EPA guidance is less than 2 tons/acre/year. The assumed unit weight of the soil is 120 lb/ft3. Is this the soil that will be used? These calculations need to be run with parameters specific to the soils that will be used.

**Section 5.1.2.2 Dense Grass cover**
Although the title of this section indicates "Dense Grass," the text appears to be in error as it talks about erosion estimate for bare cover. Please correct.

**Sheet I-5**
These calculations appear to be in error, please revise or clarify. The important point in these comments is that these calculations need to be run only for the specific soils that will be used on the cover. Therefore, we recommend that the borrow pits be identified, such that soil analysis can be performed and appropriate parameters determined.

Soil texture and gradation are very important factors for the establishment of cover vegetation. Note that, for establishment of vegetation, the suitable soil texture for the upper layer would be loamy sand sandy loam or loam, and this should be taken into account for the erosion calculations.

**Sheet I-6**
Indicates design for the Eastern Slope, with 25% slope. The Bare Soil option has an erosion loss of 33 tons/acre/year. Again, this rate far exceeds the EPA accepted rate of 2 tons/acre/year, and cannot be approved.

**Sheet I-9 Section 5.2.2**
Indicates that cover vegetation will be established/maintained with irrigation and assumes a high vegetation cover factor (V). However, the Spec document does not include construction of an irrigation system. Either the specs for construction of an irrigation system need to be submitted, or the entire wind erosion loss calculations need to be recalculated, using the site specific conditions. As submitted, it is not acceptable.

12. **Section 3.12, Page 3-18, and Drawings Number 51781-015 to -018.** This section discusses the seep treatment system. The drawings illustrate the proposed layout and design of the seep treatment system. The drawings indicate that an excavation about 8 feet deep will be required at the toe of the slope which probably is soft because of the presence of the seep. It is not clear how the excavation and construction will proceed safely without triggering a slide. Slope stability calculations should be provided to indicate that construction will be within allowable safety factors and constructability issues should be discussed.

**COMMENTS ON THE DRAWINGS**

13. **Drawing Number 51781-009.** This drawing illustrates the surface water management plan. It shows the downslope channel, segment 5 to 6, crossing the road without a culvert. This channel flow will probably cause unnecessary erosion. A culvert, similar to the existing culvert west of the beginning of segment 5 to 6, should be designed and constructed at the location where this channel crosses the road.

14. **Drawings Number 51781-012 and -013.** Detail 2 on these drawings illustrate the section of the anchor trench and references Drawing Number 009. However, the location of the anchor trench is not depicted in Drawing 009. This drawing should indicate the location of the anchor trench.

15. **Drawing Number 51781-014.** This drawing illustrates details of the gas management system. The details indicate that the trench excavations may

extend into the waste. The drawing and specifications should indicate how this waste will be handled when it is encountered.

## COMMENTS ON THE SPECIFICATIONS

17. **Specifications Section 01110 and Section 11100.** These sections describe the summary of work and equipment. In both of these sections the detail design and construction of the multi-step aeration tank are not discussed. Detail drawings and specifications should be provided for this aeration tank.

18. **Specification Section 02221, Article 3.07, 4, Page 02221-8.** This section addresses placement of Rocky Flats alluvium and indicates that the 2-foot thick soil layer will be placed in a single lift. This section should be revised to state that this layer should be placed in at least two lift as indicated in specification Section 01110, Article 1.01, A. 7, Page 01110-2.

19. **Specification Section 02222, Article 2.01.** This section describes the properties of the biota barrier material.

    The first sentence in Paragraph 1. is misleading and should be deleted. The paragraph should simply present the required gradation.

    In Paragraph 3, the required unconfined compressive strength should be 4000 pounds per square inch (psi) and not 2000 psi as stated.

    Paragraph 4 implies that all local sources comply with the requirements. This is not necessarily the case. The paragraph should be revised to indicate that rock materials shall consist of clean sound rock, consisting of silica-based material containing durable particles of crushed stone meeting the durability requirements stated in specification Section 02245, Article 2.01, B. Carbonate based materials shall not be used.

20. **Specification Section 02222, Article 3.02.** This section describes the placement of biota barrier material.

    Paragraph A. describes the limits and thickness. This paragraph should be revised to state that the completed surface of the biota barrier shall have a thickness tolerance of + 0.0 to +0.2 ft. as determined by construction surveying.

    Paragraph C. describes field gradation testing. This section should be revised to indicate that all testing will be performed in accordance with the approved Quality Assurance/Quality Control (QA/QC) plan.

21. **Specification Section 02225.** This specification discusses linear low density polyethylene (LLDPE) geomembrane.

    If it the responsibility of the subcontractor to perform testing to verify that site-specific soils, project-specific materials, and placement methodology will combine to provide stable slopes, this specification section should include specific requirements. This should include, but not be limited to, types of tests, test methodology, test samples, test conditions, and a schedule. The

subcontractor should be required to provide a Work Plan for this program as a formal submittal for review by the Contractor and Agencies.

22. **Specification Section 02226.** This specification discusses the geosynthetic clay liner (GCL). The comment is the same as Comment 21.

23. **Section 02900 -Seeding, page 02900-2**. Reference is made to the Construction Quality Control Work Plan Document (CQCWPD), Vegetation Plan Work Control Document and the Field Implementation Plan Work Control Documents, but these were not included with the design package. These document contain specific work requirements related to seeding, monitoring and testing requirements. Please provide the documents to the agencies for review. Information in this specification will be reserved until the additional documentation has been provided.

    Standard agronomic test results should be presented and discussed to verify that the depth of soil proposed will be suitable to establish and sustain the proposed seed mix and resulting vegetative cover. Specifications for the placement and compaction of the cover soils should also account for limiting bulk density requirements.

# EPA COMMENTS ON THE ACCELERATED ACTION DESIGN 95 PERCENT DESIGN SUBMITTAL QA/QC PLAN

## GENERAL COMMENTS

1. In several sections of the document the text indicates that the documents will be submitted to CDPHE for approval. For example, the forth paragraph, page 6-1 states that the Construction Completion Report will be prepared and submitted to CDPHE and DOE, and not to EPA. Because this is an EPA-lead project, these sections should be revised to state that all documents for information, review and approval will be submitted to EPA.

2. Their document does not discuss record keeping. A section should be included to describe document handling, document security, and retention during construction and after completion of the project.

3. The document does not address training requirements for personnel involved with implementing the QA/QC program. A section should be added to listed required training for those involved in implementing the QA/QC program.

## SPECIFIC COMMENTS

1. **Section 4.2.3, Page 4-4.** This section is intended to discuss shipment and storage of GCL. However, "storage" is not discussed. This section should be revised to include a discussion of storage requirements for GCL.

2. **Section 4.5.1, Page 4-20.** This section discusses conformance testing for biota barrier material. The paragraph indicates that modified Proctor tests and sieve analyses will be performed. This is not correct. Proctor tests are not required for biota barrier material. The paragraph should be revised to state the frequency of gradation tests to be performed on biota barrier material.

3. **Table 4.2.** This table summarizes the QA/QC plan for natural materials. Page 2-5 indicates that "as-required visual inspection" is the only test for biota barrier material. This is sufficient. Biota barrier placement should be continuously inspected during placement for quality control. The CQAE should also conduct visual inspections at a specified frequency. In addition QC acceptance samples should be taken at a specified frequency, such as, 1 per 5,000 tons. 5 percent of QC samples should be tested independently in accordance with the QA requirements currently in the QA/QC Plan.

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# EPA Comments on IM/IRA APPENDIX F Wetland Mitigation Plan

1. The plan does not include or refer to corresponding scale drawings with proposed construction cross sections of the site. The drawings are needed in order to demonstrate compliance with the proposed mitigation.

2. Appendix F, Page 6: Performance Objectives, Success Criteria. The document indicates that the objective is to establish an area of emergent wetland with 40% native species. This presumes that 60% will be non-native species. This is federal property and the performance goal should be to achieve a much higher percentage of native species. It is recommended that the performance goal be to establish the areas using container plantings on one-foot centers using of native species only. We recommend that you strive for 100% native species.

3. In addition, the plan should state that weeds will be managed as a success criteria for the five year period and should be less than 5%.

4. Appendix F, Page 6: Rationale for Choice. The plan indicates that off-site mitigation is preferred since on-site mitigation in the form of widening the pond is not possible. Although it is not readily apparent as to why widening the pond is not possible, it is also noted that the East Landfill Pond has not been characterized and the ecological risk assessment associated with the pond is to be completed at a later date. Therefore, it is not known whether it would be appropriate to expand habitat in the immediate area. However, on site wetland mitigation would be preferable with other on site areas, such as No Name Gulch, considered as possible alternatives.

5. Appendix F, Page 9: Wetland in-situ Mitigation Site Plan. The wetland vegetative community in the area of permanent impact should be specifically described (i.e., dominant plant community) and the same or better quality plant community should be replanted as mitigation (i.e., similar species in similar numbers). The same is true for the temporary wetland impacts. For example, EPA does not want typha to repopulate the site when more diversity is possible (see Appendix F, Comment No. 2 above).

6. Appendix F, Page 10: Contingency Measures. The plan must state a commitment to contingency plantings within the next year of any reported problems (i.e., new plantings within the year).

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