VALUE ENGINEERING IN A LANDFILL CAP DESIGN – A CASE HISTORY

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SUMMARY: Landfill capping systems composed of geosynthetic materials often provide a more cost effective and technically sound solution for refuse facilities at final closure. Designers, however, must evaluate each site on a case by case basis to determine which combination of materials will be most beneficial to a particular site. Often designers use the "it worked on the last job" approach that can lead to over-designed or under-designed projects. On a recent closure project utilizing geosynthetic materials, a value engineering analysis was conducted on the design. Each of the layers of the capping system were evaluated including foundation layer soil, 1-mm HDPE geomembrane, cushion geotextile, and protective soil. Based on a field and laboratory analysis of the natural and synthetic materials, it was determined that the cushion geotextile could be removed at substantial savings to the project.

1. INTRODUCTION

The Chateau Fresno Landfill is a Class III Landfill regulated under Waste Discharge Requirements promulgated by the California Regional Water Quality Control Board. The site is owned and operated by Browning-Ferris Industries and is located approximately 1 kilometer west of Chateau Fresno Avenue between North and Muscat Avenues near the City of Fresno, California. The 32-hectare facility consists of two contiguous waste management units including a 30-hectare unlined unit and a 2-hectare lined unit. The lined unit includes a blanket-type leachate collection and removal system and was constructed in the northwest corner of the facility in 1992. The Chateau Fresno Landfill ceased accepting waste on May 31, 1996.

For years, the standard practice for closing landfills consisted of placing a compacted clay liner (with underlying foundation layer and overlying vegetative/protective layer) over the waste as a barrier to infiltration. As geosynthetic materials such as geomembranes and geosynthetic clay liners became available, engineers began proposing alternative materials from a cost savings standpoint. In addition to saving money, these synthetic materials were also shown to provide superior containment in many instances.

While geosynthetic caps often provide a more cost effective and technically sound solution, designers must also evaluate each site on a case by case basis to determine which combination of materials will be most beneficial to a particular site.

Often designers use the “it worked on the last job” approach that can lead to over-designed or under-designed projects leading to excessive costs being paid by the Owner (over-designed) or technical problems later (under-designed).

On a recent closure project using geosynthetic materials, a value engineering analysis was conducted on the design. The design consisted of a foundation layer, 1-mm HDPE geomembrane, cushion geotextile, and protective soil layer. Based on the analysis of the natural and synthetic materials, it was determined that the cushion geotextile could be removed at substantial cost savings to the project. The following paper describes the engineering analyses and field tests that were conducted to reduce costs while maintaining a high quality containment system.

2. VALUE ENGINEERING ANALYSIS

As part of the closure activities at the site, a final closure plan, construction drawings, specifications, and a construction quality assurance plan were prepared by the design engineer and submitted to the Regional Water Quality Control Board for regulatory approval. The closure design for the Chateau Fresno Landfill specified that a cushion geotextile be placed above the HDPE geomembrane on the top deck. The purpose of the geotextile was to protect the geomembrane from the overlying cover soils that potentially could puncture the liner.

The Owner then selected a Contractor and construction quality assurance (CQA) firm to undertake closure construction at the site. The Contractor began closure construction by placing foundation layer soils over the landfill interim cover and preparing the surface for placement of the HDPE barrier layer. During the grading, the CQA firm conducted tests on the borrow soils. As part of the CQA testing, sieve analyses were conducted on the borrow materials in the CQA firm’s on-site soils laboratory.

The results of the grain size analyses indicated that the borrow materials would not damage the geomembrane by direct contact. All of the borrow materials (100%) passed the 10 mm sieve with a range between 75% and 30% passing the 0.06 mm sieve. Grain size distribution curves were prepared by the CQA firm and used in a value engineering analysis to determine if a cushion geotextile was necessary on the project. Based on the analysis, it was determined that removal of the geotextile layer would result in a significant cost savings. In order to prove that the cushion geotextile could be removed without damage to the geomembrane barrier layer, a geomembrane test pad was proposed.

3. TEST PAD CONSTRUCTION

Construction of the geomembrane test pad was initiated by the Contractor according to specifications developed by the CQA firm. An 18-meter by 12-meter area was prepared by placing and compacting two 15-cm lifts of foundation material. The CQA firm performed nuclear density tests on the foundation layer and found a relative compaction of 94% at a moisture content of 17.4%. The Contractor then graded the foundation surface and the CQA firm walked the surface to determine acceptability for geomembrane placement. After the foundation was found to be acceptable, a 6-meter by 6-meter sheet of 1-mm smooth HDPE liner was placed in the middle of the pad.

After the sheet of HDPE was secured, the Contractor used a Cat D7H dozer to push a 30-cm thick layer of cover soil over the geomembrane. A Cat 815 sheepsfoot compactor made approximately 12 passes over the lift. A second 15-cm lift of material was then placed and compacted in a similar fashion. The CQA firm performed nuclear density tests on the protective cover soil layer and measured a relative density of 93% with a moisture content of 10.6%.

After the cover layer placement was completed using the same equipment proposed for the production cover installation, a Cat 140 road grader was used to remove the soil to within 15-cm of the geomembrane. The remaining 15-cm of cover soil was then removed by hand to expose the HDPE barrier layer. The CQA firm visually examined the geomembrane sheet for punctures or other defects caused by the cover soil placement. No damage to the geomembrane was observed within the boundaries of the test area (a small area on the outside edge of the test pad was damaged but was not representative of the test procedures).

4. CONFORMANCE TESTING

In order to ensure that the properties of the 1-mm HDPE geomembrane were not affected by the cover placement, two conformance samples were cut out of the sheet within the test pad area. These conformance samples were cut by the CQA firm and shipped to a third party geosynthetics testing laboratory in Orange, California. The two samples were tested for thickness, tensile properties, tear resistance, puncture resistance, density, carbon black content, and carbon black dispersion. The results of the conformance testing by the third party laboratory have been included in Table 1.

Table 1 – Geomembrane Conformance Test Results

MQA Specifications	Test Method	Sample #1 Results	Sample #2 Results	MQA Specifications
Thickness	ASTM D5199	1.02 mm	1.02 mm	1.0 mm
Density	ASTM D1505	0.9447 gm/cm^3	0.9447 gm/cm^3	0.934 to 0.94 gm/cm^3
Carbon Content	ASTM D1603	2.40%	2.34%	2.0 – 3.0%
Carbon Dispersion	ASTM D3015	A-1	A-1	A-1, A-2, or B-1
Tensile Properties	ASTM D638			
Yield Strength		17.9 kg/cm	16.8 kg/cm	15 kg/cm
Break Strength		31.9 kg/cm	32.6 kg/cm	27 kg/cm
Yield Elongation		22.3%	22.2%	12%
Break Elongation		584%	625%	560%
Tear Resistance	ASTM D1004	13.6 kg	13.2 kg	11.8 kg
Puncture Resistance	FTMS 101c	28.6 kg	28.2 kg	21.8 kg

5. RESULTS

The CQA firm's personnel observed all segments of the test pad installation. The Contractor conducted the installation in general conformance with the test pad and project specifications. The foundation and cover materials were placed with heavy equipment that was proposed for the closure construction. The size of the dozer used by the Contractor even had a higher ground pressure rating than the originally specified dozer. By proving that the higher ground pressure equipment would not damage the HDPE geomembrane on the test pad, the Contractor was allowed to use the heavier equipment on the production cover.

Following receipt of the conformance test results from the third party geosynthetics laboratory, the CQA firm compared the two test pad geomembrane samples with the values listed in the specifications. In all instances, the values of the test pad samples exceeded the specified values. In addition to the laboratory test results, the CQA firm conducted a visual inspection of the HDPE geomembrane after the protective cover soil was removed. This inspection found no damage, holes, cracks, blemishes, significant scratches, or imperfections in the sheet. The CQA firm conducted photographic documentation of all components of the test pad construction.

Following the successful completion of the geomembrane test pad, the CQA firm prepared a letter to the Regional Water Quality Control Board. This letter discussed the test pad construction procedures, the results of the grain size analyses, the visual observations, and the outcome of the HDPE conformance testing. The letter also recommended that the cushion geotextile be removed from the design and that the cover soil be placed directly on the geomembrane following the procedures established during the test pad installation.

6. CONCLUSION

The Regional Water Quality Control Board sent a representative to the Chateau Fresno Landfill during the construction of the test pad to observe the proposed installation procedures. This same representative reviewed the report submitted by the CQA firm. After an extensive review of the procedures, observations, and conformance test results, the Regional Water Quality Control Board issued a letter approving the recommendation to remove the cushion geotextile from the design configuration.

Following receipt of the approval letter from the regulatory agency, the Owner authorized the Contractor to delete the geotextile component of the capping system design. The Contractor then finalized the foundation layer placement and the geomembrane barrier layer was installed. Using the procedures determined during the test pad construction, the Contractor then placed the final cover material over the geomembrane.

Based on the unit cost of the cushion geotextile in the Contractor's bid, removing the material over the top deck of the landfill resulted in a value engineering savings for the Owner in excess of US $240,000. While cushion geotextiles are often necessary to protect geomembrane, the designer should take site specific conditions and materials into account prior to final design.