COMPOSITE LINER PERFORMANCE IN A FLY ASH POND

A utility client in Minnesota recently constructed a 45-acre pond to contain scrubber solids generated at their nearby power plant. Since the geology in the area consists of sandy soils, the pond design required a low-permeability bottom liner. A composite liner, including a GCL (Bentomat ST [flat areas] and Bentomat DN [side slopes]), overlain by a 60-mil HDPE geomembrane, was selected.

As part of the construction permitting process, the Minnesota Pollution Control Agency required that, when the pond was 1/5th full, the measured leakage through the pond bottom could not exceed 100 gallons per acre per day (gpad). To demonstrate the pond liner's performance, a water balance study was conducted using barrels placed at the north, northwest, southeast, and southwest edges of the pond. To limit movement, the barrels were mounted on steel frames fastened to the riprap.

Water levels in each barrel were measured over a 36-day period. After correcting for rainfall and evaporative losses, the barrel measurements showed a leakage rate (loss) through the pond bottom of only 35 gpad (0.0013 inches/day), approximately one-third of the state's leakage limit.

Theoretical flux calculations performed by CETCO predict that, for 10 feet of hydraulic head (the approximate head on the liner during the water balance study), and reasonable assumptions of the number of geomembrane installation and manufacturing defects and placement quality, the predicted flow through the composite liner would be between 15 and 70 gpad, on the same order of magnitude as the actual volumes measured in the field.

800.527.9948 Fax 847.577.5566

Water Balance Test Report
for
Scrubber Solids Pond 3 North

Xcel Energy
Sherco Generating Plant
Becker, MN

June 2005

BMI Project No. M21.35870

Prepared by:

Bolton & Menk, Inc.
Consulting Engineers & Land Surveyors

WATER BALANCE TEST REPORT

FOR

SCRUBBER SOLIDS POND 3 NORTH

XCEL ENERGY
SHERCO GENERATING PLANT
BECKER, MN

JUNE 2005
BMI Project No. M21.35870

I hereby certify that this plan, specification or report was prepared by me or under my direct supervision, and that I am a duly Licensed Professional Engineer under the laws of the State of Minnesota.

Signature: _____ Typed or Printed Name: Seth A. Peterson

Date 14 June 2005 Reg. No. 26468

BOLTON & MENK, INC.
CONSULTING ENGINEERS AND LAND SURVEYORS

SUMMARY

Purpose

The purpose of our work is to perform the water balance test and seepage calculations for the Xcel Energy Sherco Plant Scrubber Solids Pond 3 North as specified by the Minnesota Pollution Control Agency (MPCA) based upon the water balance test data collected.

Scope of Services

To determine the seepage rates in the pond, our firm conducted the barrel tests, reviewed the data, and performed a least squares analysis of the slope data in general accordance with the MPCA "Report on Evaluation of Minnesota Water Balance Test", dated July, 1989.

Findings

Readings were taken over a thirty-six (36) day period from April 29, 2005 to June 3, 2005. Eleven (11) rainfall events were recorded over this period.

The MPCA criteria for water balance test results requires three items: the mean seepage rate in gallons/acre/day (gpad); the confidence interval for the mean seepage rate also in gpad; and the correlation coefficient for the least squares analysis which measures the linear relationship between the data. A passing test will meet the required seepage rate and have a high correlation of 0.8 or better.

The combined analysis used eighty (80) data points from four, barrel sets NW, N, SE, and SW. The combined analysis is presented below:

Mean Seepage Rate ..... 35 gpad (loss)
Seepage Rate Range (95% confidence) ..... 234 to –164 gpad
Statistical Correlation Coefficient (R^2)
Pond Levels 0.97
Evaporation Barrel Levels 0.96

The individual barrel set analysis is as follows:

Station 1- NW Set
Mean Seepage Rate ..... 387 gpad (loss)
Seepage Rate Range (95% confidence) ..... 700 to 75 gpad
Statistical Correlation Coefficient (R^2)
Pond Levels 0.99
Evaporation Barrel Levels 0.97

Station 2 – N Set
Mean Seepage Rate ..... -174 gpad (gain)
Seepage Rate Range (95% confidence) ..... 171 to -520 gpad

Statistical Correlation Coefficient (R^2)
Pond Levels 0.99
Evaporation Barrel Levels 0.98

Station 3-SE Set
Mean Seepage Rate ..... -19 gpad (gain)
Seepage Rate Range (95% confidence) ..... 354 to –393 gpad
Statistical Correlation Coefficient (R^2)
Pond Levels 0.97
Evaporation Barrel Levels 0.97

Station 4-SW Set
Mean Seepage Rate ..... -53 gpad (gain)
Seepage Rate Range (95% confidence) ..... 318 to –424 gpad
Statistical Correlation Coefficient (R^2)
Pond Levels 0.98
Evaporation Barrel Levels 0.97

Conclusions

Based on the data obtained during the monitoring period and the statistical evaluation specified by the MPCA, it is our opinion that the mean seepage rate is less than 100 gallons/acre/day (gpad) with a confidence limit of +/- 200 gpad. As previously mentioned, the correlation coefficient is applied to each data set (pond and evaporation barrel readings) for an indicator of that data set's correlation with a linear regression. The correlation coefficients are very high, ranging from 0.96 to 0.99, which is well above the MPCA requirement of 0.80 and indicates very liner data.

Discussion

Four-barrel sets were placed in the new Sherco Generating Facility Scrubber Solids Pond 3 North similar to MPCA guidance documents and as shown in the attached Figure No. 1. The barrels were mounted on steel frames that were mounted in the riprap to prevent movement and were located on the pond dikes at an approximate water elevation of 958. The evaporation barrels were slightly modified to include an extension piece that was removable. The extension piece was attached to the top of the barrel and extended approximately 6-inches above the baffle. The purpose of the extension pieces was to eliminate waves from entering the evaporation barrel. Due to the large size of the pond (roughly 40 acres, ¼-mile by ¼-mile), waves could be substantial and could possibly enter the evaporation barrels and greatly impact the readings. The barrel sets were surveyed before and after the test to ensure that the barrels did not move during the test period. Pictures of the barrels are located in Appendix A.

The water elevation of 958 is roughly one-fifth of the ultimate high water elevation of the pond. Because of this, the MPCA determined that the allowable seepage rate would be $1/5^{th}$ of the typical seepage rate of 500 gpad. Therefore, the allowable mean seepage rate for this water

balance test at elevation 958 is 100 gpad.

Readings began on April 29, 2005 and continued for thirty-six (36) days until June 3, 2005. Eleven rainfall events were recorded over the thirty-three day period and the data was adjusted for the rainfall events as shown in the "raw data" sheet included in Appendix B. No ice or freeze-up conditions were encountered during the testing period. Twenty-six (26) readings were taken over the thirty-three (33) days, resulting in twenty (20) data points for the water balance test. All readings were adjusted to a common original reading of 650 to allow analysis of the combined barrels. Additionally, the readings were corrected for rainfall events by throwing out the data for the rain day and then setting the barrel elevations to the previous "corrected" elevation prior to the rain event. This is shown in the "raw data" sheet included in Appendix B of this report. In calculating the least squares analysis of the data for all barrel sets and the combined analysis, the column for "Adjustment Due to Runoff" was not used since the data was already corrected for on the "raw data" sheet.

The data was analyzed using the MPCA required least squares method. As mentioned above, twenty (20) data points were used for the single barrel analysis, and eighty (80) data points for the combined analysis. Seepage loss/gain computations are included in Appendix B. The barrel readings data is included in Appendix C.

The analysis showed a seepage loss for the pond in the NW barrel set and the other stations (N, SE, and SW) show a seepage gain. The correlation coefficient of the readings is very good with correlations of 96 to 99 percent. The correlation coefficient is applied to each data set for an indicator of that data set's correlation with a linear regression. Since the correlation coefficient of the four barrel sets is very high and the seepage rates are below 100 gpad for the combined analysis, the results show that the pond and liner meets the required MPCA leakage criteria.