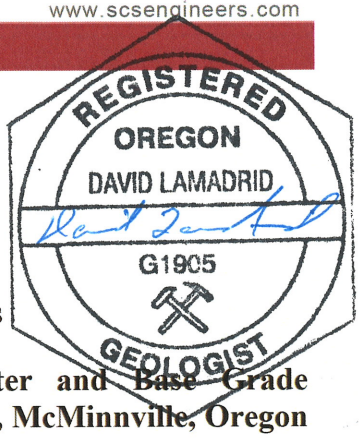
Environmental Consultants
and Contractors

14945 SW Sequoia Parkway
Suite 180
Portland, OR 97224

(503) 639-9201
FAX (503) 684-6948
www.scsengineers.com

SCS ENGINEERS

TECHNICAL MEMORANDUM



DATE: November 28, 2012 Expires 1/31/13

TO: Frank Willmann; Waste Management

FROM: Louis Caruso and David Lamadrid, RG; SCS Engineers

SUBJECT: **Evaluation of Relationship between Groundwater and Base Grade Elevations of Landfill Modules: Riverbend Landfill, McMinnville, Oregon (SCS Project No. 04211010.03)**

This memorandum, prepared by SCS Engineers (SCS), in Portland, Oregon, at the request of Riverbend Landfill Company, Inc. (RLC), responds to a request for information by the Oregon Department of Environmental Quality (DEQ) regarding the elevation of bottom of waste relative to high groundwater conditions at the Riverbend Landfill (RLF) in McMinnville, Oregon. The memorandum presents results of an evaluation/comparison of available base grade information of the landfill modules at RLF with interpretative seasonally high and low water levels in the upper (silt-clay) water-bearing zone (WBZ). The memorandum also provides as reference information the design of the engineered liner systems for landfill Modules 4 through 8D.

EVALUTION METHOD AND RESULTS

Groundwater Elevations

SCS reviewed site-wide water-level data collected as part of routine quarterly (prior to 2004) and semiannual (since 2004) groundwater monitoring events performed at RLF since 2001.[1] SCS reviewed groundwater potentiometric surface contour maps interpreted from water levels measured in the site monitoring wells screened in the shallow (silt-clay) WBZ. The review focused on identifying the specific monitoring events conducted since 2001 when the interpretative shallow groundwater surface was highest and lowest in the vicinity of the landfill modules. Based on this review, SCS established that seasonal high and low level events occurred in April 2011 and October 2006, respectively. Copies of the groundwater potentiometric surface contour maps for these two monitoring periods are provided in Attachment 1.

Base Grade Elevations for Landfill Modules

Base grade elevations that were used for comparison with high and low interpretative groundwater levels were based on the top of operations layer elevations for landfill Modules 4 through 8D. The operations layer consists of a 12- to 18-inch-thick layer of soil over the liner system. A thorough record search of RLF's project files did not locate base grade information for the older landfill modules, including Modules 1, 2, and 3A. As such, these older landfills modules were not included in this evaluation.

[1] The time-window for reviewing historical water-level data began in 2001 because SCS had access to electronic versions of the groundwater potentiometric surface contour maps beginning with the 2001 monitoring events.

Evaluation Method and Results

To evaluate the relationship between groundwater elevations and the base grades of the landfill modules, the groundwater potentiometric surfaces (Attachment 1) were imported into an AutoCAD drawing of the RLF that included the base grade elevation data for the landfill modules. Using a utility in AutoCAD, differences in the elevations between the potentiometric surface elevations for the high and low groundwater conditions and landfill module base grades were calculated (in feet) at grid points spaced 20 feet apart. These data were then contoured using the Surfer® software contouring program and plotted on the RLF site plan that included the landfill modules. Site maps showing the results of this analysis for both the high and low interpretative groundwater condition are provided in Attachment 2 and discussed below. It should be noted that contour lines denoted with positive or negative values in the figures provided in Attachment 2 represent the number of feet the groundwater surface is above or below the base grade elevations, respectively.

As shown in Figure A2-1 (Attachment 2), interpretative groundwater elevations for the high groundwater condition in April 2011 are above the base grade elevations in Modules 4 through 7. Groundwater elevations above base grades are highest in the southern portion of Module 4 (up to 16 feet above the base grade elevations) and become progressive lower towards the northeast in Module 6 (between 8 to 12 feet above the base grade elevations) and Module 7 (between 4 to 8 feet above the base grade elevations). For the low groundwater condition in October 2006 (Attachment 2, Figure A2-2), interpretative groundwater elevations are only above the base grade elevations (by up to 4 feet) along the southwestern edge of Module 4.

It is important to note that this evaluation used interpretative groundwater elevations below the landfill modules based on water levels measured in monitoring wells screened in the shallow WBZ located outside the perimeter of the landfill cells.

BASE CONTAINMENT (LINER) SYSTEMS AT RIVERBEND LANDFILL

When considering the depth of shallow groundwater in relation to landfill base grades, it is important to consider that the landfill modules are constructed with double liner systems. The liner systems for Modules 4 through 7 include a low permeability (less than or equal to 1×10^{-7} centimeters per second) soil layer that is at least 24-inches thick and two 60 mil geomembrane liners (see Attachment 3). These liner systems are effective (low permeability) barriers for preventing potential seepage of groundwater through them. Additionally, the liner systems are designed with (1) primary leachate collection systems which collect and remove leachate generated in the waste material and (2) secondary collection and control systems below the primary liner systems (see Attachment 3).

Attachments: Attachment 1: Groundwater Potentiometric Surface Contour Maps Shallow (Silt-Clay) WBZ (October 2006 and April 2011)

Attachment 2: Contour Maps Showing Difference between Shallow Groundwater and Landfill Modules Base Grade Elevations (October 2006 and April 2011)

Attachment 3: Design Drawing of Module-Specific Engineered Liner Systems

Attachment 1
Groundwater Potentiometric Surface Contour Maps
Shallow (Silt-Clay) WBZ
(October 2006 and April 2011)

EXPLANATION

- 10 FOOT TOPOGRAPHIC CONTOUR
- FENCE
- AGRICULTURAL DRAINAGE DITCH
- POPLAR TREE FARM
- LANDFILL MODULE BOUNDARY
- POTENTIOMETRIC SURFACE CONTOUR (FEET MSL) CONTOUR INTERVAL=5 FEET
- MW-9 MONITORING WELL
- P-02 PIEZOMETER
- (131.78) GROUNDWATER ELEVATION IN FEET MSL MEASURED ON (OCTOBER 16, 2006)

OFFICE

MW-1B (131.78)

MW-2 (123.18)

MW-10A (130.66)

130

MW-9A (114.45)

NORTH POPLAR TREE FARM

FORMER POPLAR TREE FARM

MODULE 8

MODULE 6

MODULE 7

MODULE 5

MW-7A (125.64)

P-05A (124.50)

MW-18A (127.37)

HWY 18

P-06A (120.48)

MW-20A (120.78)

P-04A (122.09)

MODULE 2

MODULE 3

MODULE 4

MODULE

MW-3A (120.86)

MW-6A (116.28)

MW-16A (108.08)

MW-4A (113.23)

P-01 (110.68)

MW-5A (111.11)

MW-15A (109.17)

SOUTH POPLAR TREE FARM

125

120

115

110

LEACHATE POND

MW-21A (105.28)

P-02 (109.98)

P-03 (106.23)

MW-14A (99.28)

MW-12A (105.06)

105

100

130

MW-19A (128.52)

MW-17A (132.51)

SOUTH YAMHILL RIVER

0 400 800

SCALE (FEET)

N

Shaw® ENVIRONMENTAL, Inc.

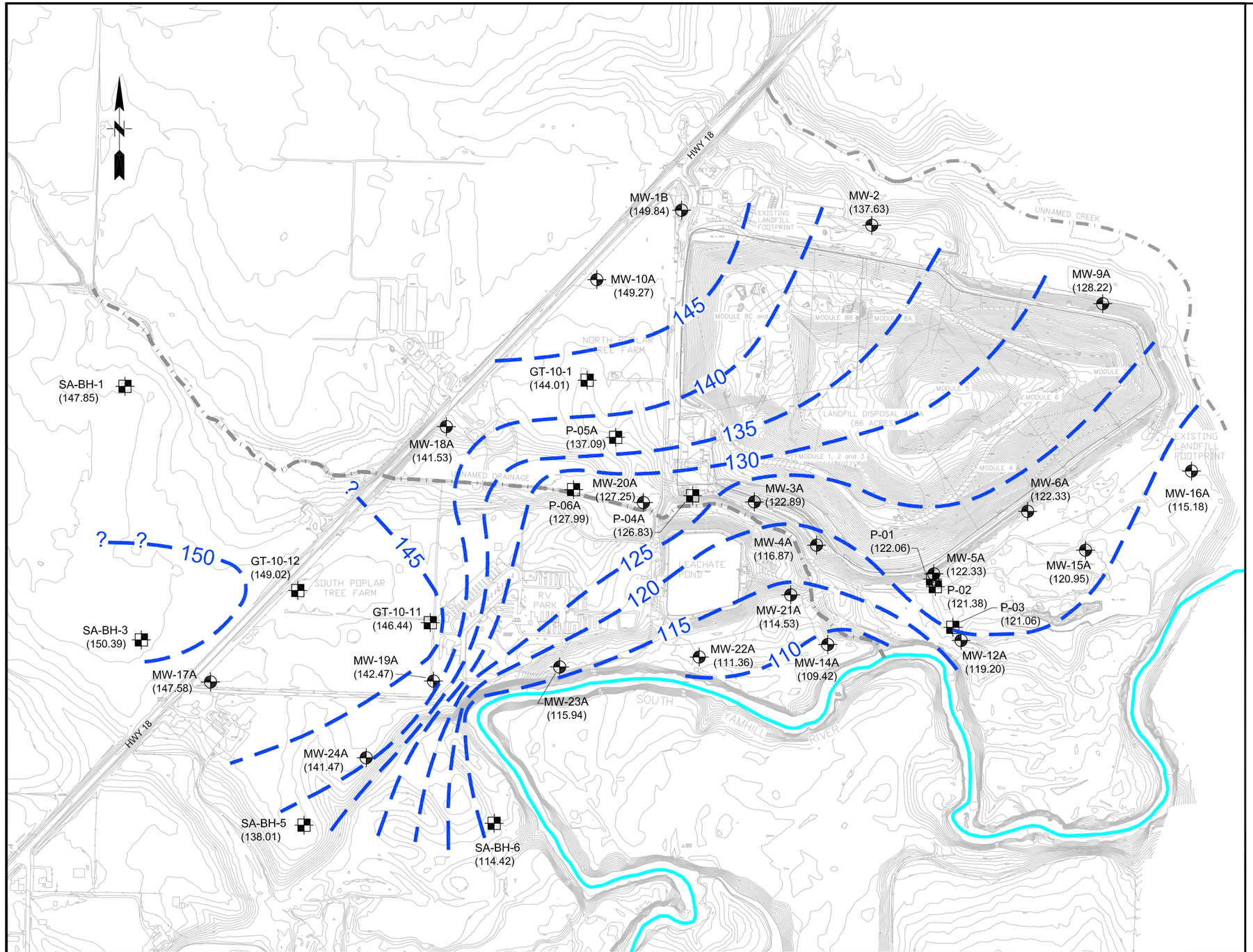
WASTE MANAGEMENT

DATE 01/19/07
DWN JDT
APP
REV
PROJECT NO. 119896

FIGURE 6-3
RIVERBEND LANDFILL
McMINNVILLE, OREGON
SHALLOW WATER-BEARING ZONE
POTENTIOMETRIC SURFACE CONTOURS
(OCTOBER 16, 2006)

File: N:\Cad\Drawings\Waste Management\Landfills\Riverbend LF\Hydrogeology\2006 AEMR\RBLF 10-06 Shallow.dwg Layout: Layout1 User: jeremy.totten Jan 19, 2007 - 8:08am

1" 1/2" 0" 1"



LEGEND:

- Topographic Contours (Surveyed)
- Topographic Contours (USGS)
- Flow Line - Yamhill River
- Flow Line - Tributary Stream
- 100 — Potentiometric Surface Contours for shallow water - bearing zone (Feet MSL) Contour Interval = 5 Feet (Quieried where uncertain)
- MW-19A — Groundwater Monitoring Well
- P-05A — Piezometer
- (128.22) — Groundwater Elevation in Feet Above Mean Sea Level on April 12, 2011

SOURCE:

1) Existing contours based on aerial topography provided by Aero-Metric, flown on April 22, 2011. Contours are based on NAVD 88.

NOTES:

1) Monitoring wells and piezometers with "A" designation are screened in the shallow (Silt-Clay) water-bearing zone, and monitoring wells and piezometers with "B" designation are screened in the deeper (Sand-Gravel) water-bearing zone.

2) Piezometers with "GT" and "SA-BH" designations are screened in the shallow (Silt-Clay) water-bearing zone.

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14945 SW Sequoia Parkway, Suite 180
Portland, Oregon 97224
(503) 639-9201 FAX: (503) 684-6948

0 600 1200
SCALE IN FEET

PROJECT NO. 04208022.12	DES BY D.L.
SCALE AS SHOWN	CHK BY D.L
CAD FILE FIGURE 6-1	APP BY L.C.

SHALLOW WATER - BEARING ZONE
POTENTIOMETRIC SURFACE CONTOURS
(APRIL 12, 2011)
RIVERBEND LANDFILL
McMINNVILLE, OREGON

DATE MARCH 2012
FIGURE 6-1

Attachment 2
Contour Maps Showing Difference between Shallow Groundwater and Landfill Modules Base Grade Elevations
(October 2006 and April 2011)

Figure A2-2: Contour Map Showing Difference between Shallow Groundwater and Landfill Modules Base Grade Elevations (Low Groundwater Condition in October 2006)

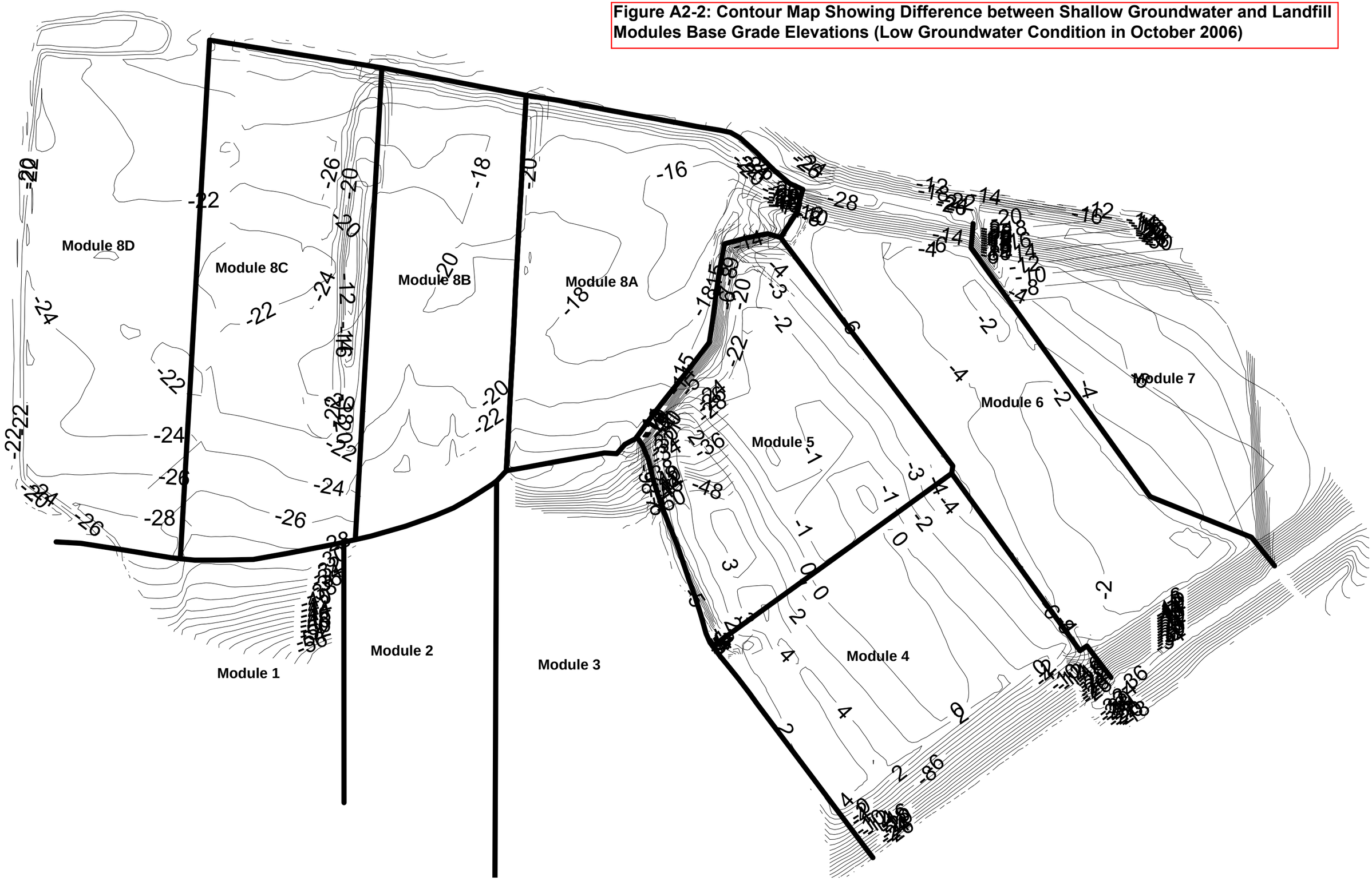
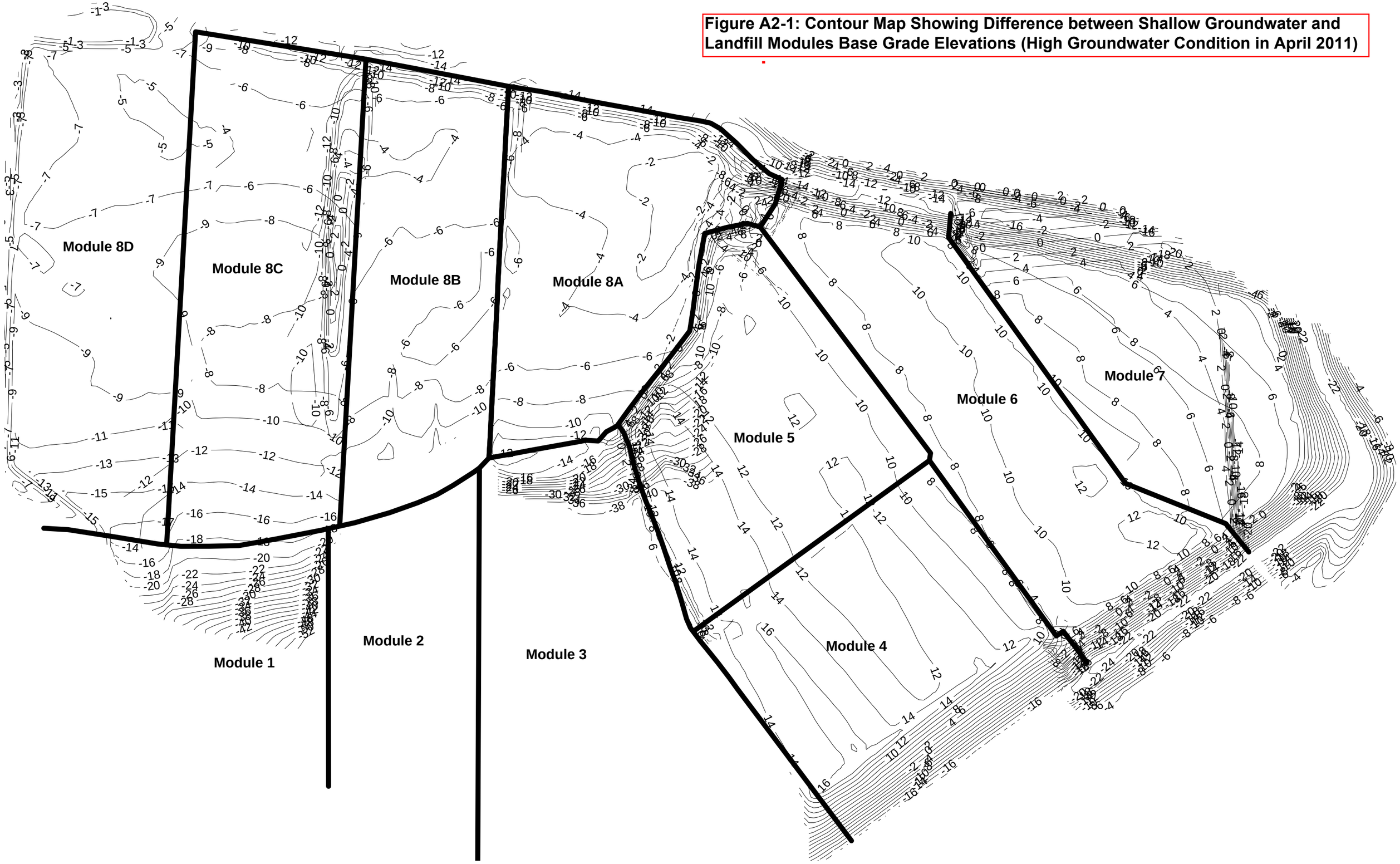
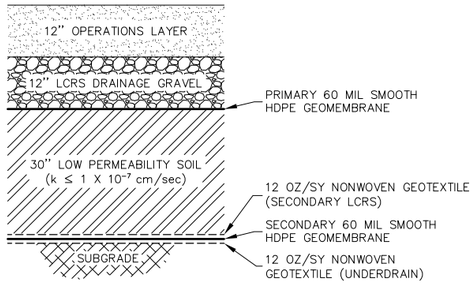


Figure A2-1: Contour Map Showing Difference between Shallow Groundwater and Landfill Modules Base Grade Elevations (High Groundwater Condition in April 2011)

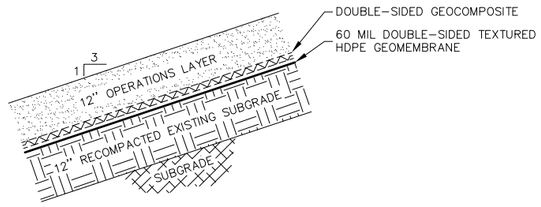


Attachment 3
Design Drawing of Module-Specific Engineered Liner Systems

MODULE 4



FLOOR LINER

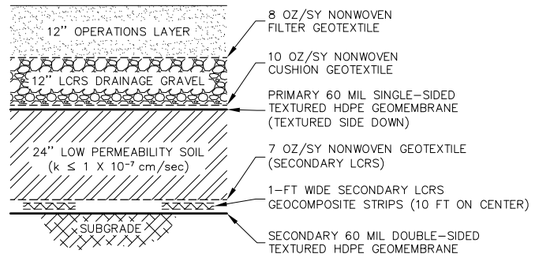


SIDESLOPE LINER

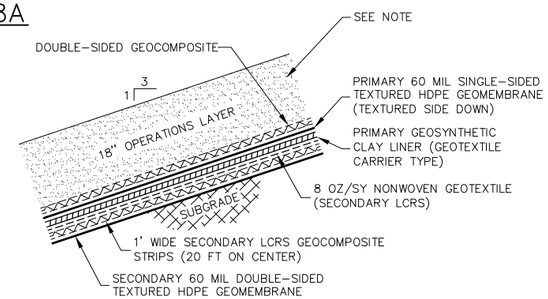
NOTE: MODULE 4 ALSO INCLUDES AN UNDERDRAIN SYSTEM.

SOURCES: "*RIVERBEND LANDFILL, MODULE 4 LINER AND MODULE 5 EXCAVATION, ENGINEERING DESIGN REPORT*," BY EMCON NORTHWEST, INC., JULY 1993; "*CONTRACT DOCUMENTS FOR THE CONSTRUCTION OF MODULE 4 LINER AND MODULE 5 EXCAVATION PLANS, RIVERBEND SANITARY LANDFILL*," BY EMCON NORTHWEST, INC., MAY 1993; LETTER FROM MARK SADLER OF EMCON NORTHWEST, INC. TO MONTY MORSHED OF OREGON DEPARTMENT OF ENVIRONMENTAL QUALITY "*RIVERBEND LANDFILL MODULE 4 CONSTRUCTION: DESIGN CLARIFICATIONS*," 9 AUGUST 1993; AND "*MODULE 4 LINING AND MODULE 5 EXCAVATION CONSTRUCTION REPORT*," BY EMCON NORTHWEST, INC., 8 NOVEMBER 1993.

MODULE 8A



FLOOR LINER

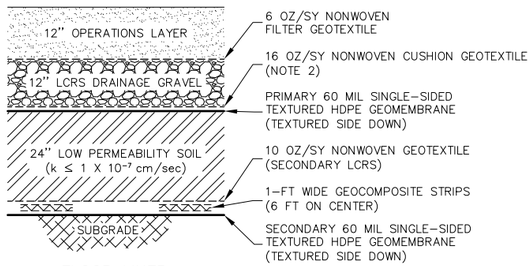


SIDESLOPE LINER

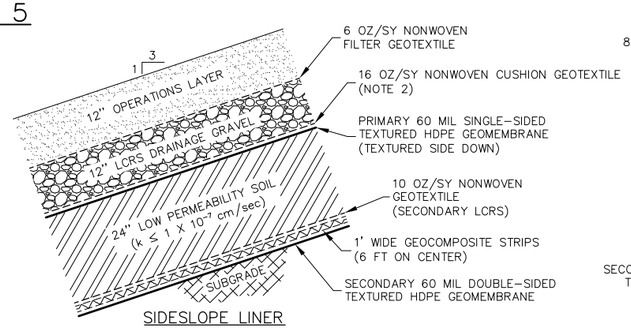
NOTE:
DESIGN DOCUMENTS STATE THICKNESS OF OPERATIONS LAYER IS 12 INCHES; HOWEVER, CQA DOCUMENTS AND REDLINE DRAWINGS SHOW 18 INCHES.

SOURCES: "*MODULE 8A DESIGN REPORT, RIVERBEND LANDFILL, McMINNVILLE, OREGON*," BY EMCON/OWT SOLID WASTE SERVICES, APRIL 2002; "*CONSTRUCTION CERTIFICATION REPORT, MODULE 8A CONSTRUCTION, RIVERBEND LANDFILL, McMINNVILLE, OREGON*," BY EMCON/OWT, INC., NOVEMBER 2002.

MODULE 5



FLOOR LINER

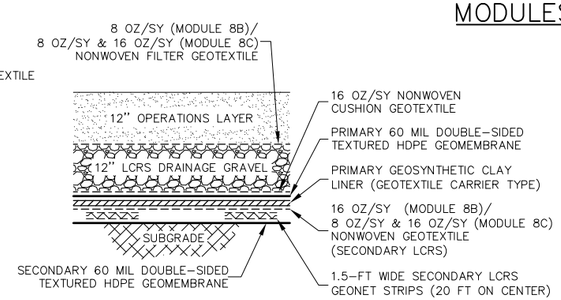


SIDESLOPE LINER

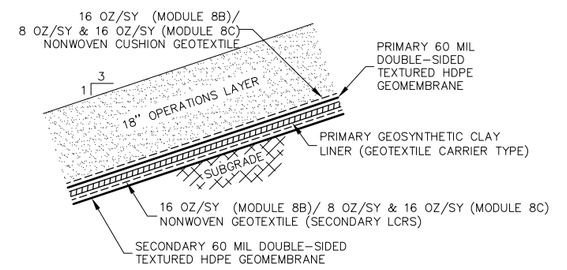
NOTES:
1. MODULE 5 ALSO INCLUDES AN UNDERDRAIN SYSTEM.
2. 16 OZ/SY NONWOVEN GEOTEXTILE SHOWN IN DESIGN DOCUMENTS BUT NOT IN CQA DOCUMENTS.

SOURCES: "*ENGINEERING DESIGN REPORT, RIVERBEND LANDFILL: MODULE 5, McMINNVILLE, OREGON*," BY DAMES & MOORE, 22 FEBRUARY 1995; "*SPECIFICATIONS, RIVERBEND LANDFILL MODULE 5, McMINNVILLE, OREGON*," BY DAMES & MOORE, 6 APRIL 1995, REVISION 1 – 30 MAY 1995; AND "*REPORT ON CONSTRUCTION QUALITY ASSURANCE, RIVERBEND LANDFILL, MODULE 5 CONSTRUCTION, McMINNVILLE, OREGON*," BY GOLDER CONSTRUCTION SERVICES, INC., 8 SEPTEMBER 1995.

MODULES 8B & 8C



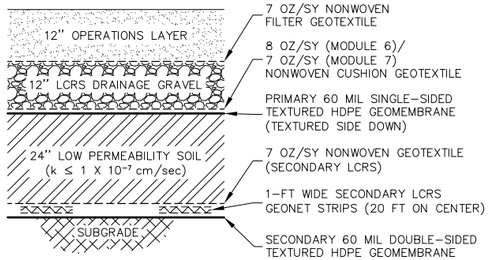
FLOOR LINER



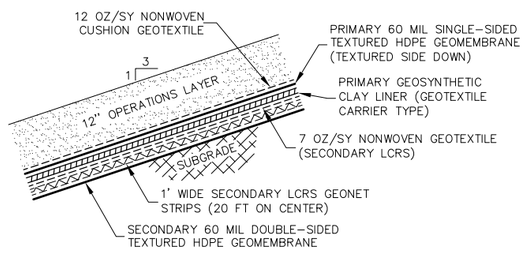
SIDESLOPE LINER

SOURCES: "*CONSTRUCTION REPORT, MODULE 8B COMPOSITE LINER AND PHASE 2 OVERLINER CONSTRUCTION, RIVERBEND LANDFILL, McMINNVILLE, OREGON*," BY SHAW ENVIRONMENTAL, INC., SEPTEMBER 2005; "*CONSTRUCTION REPORT, MODULE 8C AND PHASE 3 CONSTRUCTION, RIVERBEND LANDFILL, McMINNVILLE, OREGON*," BY KENNEC, INC., 4 OCTOBER 2007..

MODULES 6 & 7



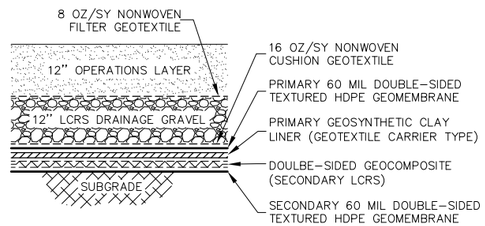
FLOOR LINER



SIDESLOPE LINER

SOURCES: "*DESIGN REPORT, MODULES 6 AND 7 EXPANSION, RIVERBEND LANDFILL, McMINNVILLE, OREGON*," BY GEOSYNTEC CONSULTANTS, INC, 26 MARCH 1997; "*REPORT OF CONSTRUCTION QUALITY ASSURANCE (CQA), MODULE 6 CONSTRUCTION, RIVERBEND LANDFILL, McMINNVILLE, OREGON*," BY GEOSYNTEC CONSULTANTS, INC., 30 SEPTEMBER 1997; "*FINAL REPORT, CONSTRUCTION QUALITY ASSURANCE, MODULE 7 CONSTRUCTION, RIVERBEND LANDFILL, McMINNVILLE, OREGON*," BY GEOSYNTEC CONSULTANTS, INC., 7 OCTOBER 1998.

MODULE 8D



FLOOR & SIDESLOPE LINERS

SOURCES: "*DESIGN REPORT, MODULE 8D AND PHASE 4 OVERLINER DESIGN REPORT, RIVERBEND LANDFILL, McMINNVILLE, OREGON*," BY ENVIRONMENTAL INFORMATION LOGISTICS, LLC AND VISTA CONSULTANTS, LLC, MAY 2009; "*CONSTRUCTION REPORT, MODULE 8D AND PHASE 4 OVERLINER, RIVERBEND LANDFILL, McMINNVILLE, OREGON*," BY VISTA CONSULTANTS, LLC, OCTOBER 2009.

NOTES:

1. BASE CONTAINMENT SYSTEM INFORMATION FOR MODULES 1 AND 2 ARE NOT AVAILABLE.

2. MODULE 3 IS NOTED TO HAVE A 1 X 10^{-9} CM/SEC SOIL LINER OVERLAIN WITH A GEOTEXTILE, OVERLAIN WITH A 1-FT THICK GRAVEL LAYER, OVERLAIN WITH A GEOTEXTILE (SOURCE: 10 AUGUST 1993 FILE MEMO BY MARK SADLER OF EMCON, INCLUDED AS PART OF THE "RIVERBEND LANDFILL MODULE 4 CONSTRUCTION: DESIGN CLARIFICATIONS" LETTER FROM MARK SADLER OF EMCON NORTHWEST, INC. TO MONTY MORSHED OF THE OREGON DEPARTMENT OF ENVIRONMENTAL QUALITY.

Geosyntec consultants

BASE CONTAINMENT SYSTEM DETAILS

RIVERBEND LANDFILL
McMINNVILLE, OREGON

FIGURE NO.

PROJECT NO.

DATE: 9 JULY 2012