mcgehee engineering corp

July 10, 2015

Mr.Stephen Miles, P.E.
Alabama Surface Mining Commission
P. O. Box 2390
Jasper, AL 35502-2390

RE: **Oak Grove Resources, LLC**
Concord Preparation Plant, P-3233

Dear Mr. Miles:

I hereby certify the enclosed detailed design plans for Sediment Basin 050 for the above referenced mine are in accordance with the Regulations of the Alabama Surface Mining Commission as adopted by Act 81-435 of December 18, 1981 and as amended to date and that the information used in the enclosed basin design plans is true and correct to the best of my knowledge and belief.

If you have any questions or need additional information, please do not hesitate to contact our office.

Sincerely,

McGehee Engineering Corp.

ALABAMA LICENSED PROFESSIONAL No. 15917 ENGINEER ROBERT W. USHER

Robert W. Usher, P.E.
Alabama Reg. No. 15917

Post Office Box 3431 • 450 19th Street West • Jasper, Alabama 35502-3431 • 205-221-0686 • Fax 205-221-7721 • staff@mcgehee.org

INTRODUCTION

Sediment Basin 050 is proposed to control runoff from areas currently used and additional areas to be added as coarse refuse disposal facilities. Diversion 1 will be constructed to route runoff from these disturbed areas once the sediment basin is constructed.

To provide adequate sediment and detention storage excavation within the pool area will be conducted. The majority of the material will be used in the construction of the embankment.

There are two (2) 42 inch corrugated metal pipes installed within the railroad spur line that route runoff north of the railroad to the basin. The flood routing of the watersheds addressed these structures.

SEDIMENT BASIN CONSTRUCTION SPECIFICATIONS

Sediment basins (temporary or permanent) will be designed and constructed using the following as minimum specifications:

1. EMBANKMENT REQUIREMENTS

A) The minimum width of the top of the embankment will under no circumstance be less than twelve (12) feet.

B) The embankment will have a minimum front and back slope no steeper than the slopes listed on the detailed design sheet.

C) The foundation area of the embankment will be cleared and grubbed of all organic matter with no surface slope steeper than 1 horizontal to 1 vertical. The entire wet area, as measured from the upstream toe of the embankment to the normal pool level, will be cleared of trees and large brush.

D) A core will be constructed in a cutoff trench along the centerline of the embankment. The cutoff trench will be of suitable depth and width to attain relatively impervious material.

E) The embankment construction material will be free of sod, roots, stumps, rocks, etc., which exceed six (6") inches in diameter. The embankment material will be placed in layers of twelve (12") inches or less and compacted to ninety five (95%) percent of the standard proctor density, as set forth in ASTM.

F) The embankment, foundation and abutments will be designed and constructed to be stable under normal construction and operating conditions, with a minimum static safety factor of 1.3 at normal pool level with steady seepage saturation conditions.

G) The actual constructed height of the embankment will be a minimum of five (5%) percent higher than the design height to allow for settling over the life of the embankment.

H) The design embankment height for temporary impoundments will be a minimum of one (1) foot above the maximum water level anticipated from a 10 Year - 24 Hour or a 25 Year - 6 Hour precipitation event (whichever is greater). The design embankment height for permanent impoundments will be a minimum of one (1) foot above the maximum water level anticipated from a 10 Year - 24 Hour or a 25 Year - 6 Hour precipitation event (whichever is greater).

I) For embankments constructed as point source discharges, the embankment will be constructed and abutments keyed into undisturbed, virgin, ground if at all possible. In the event that this can not be achieved, additional design and construction specifications will be submitted in the detailed design plans.

J) The embankment and all areas disturbed in the construction of the embankment will be seeded with a mixture of perennial and annual grasses, fertilized and mulched to prevent erosion and ensure restabilization. Hay dams, silt fences, rock check dams, etc. will be installed, where deemed necessary, as additional erosion prevention methods.

2. DISCHARGE STRUCTURE REQUIREMENTS

A) The primary spillway will be designed to adequately carry the anticipated peak runoff from a 10 Year - 24 Hour precipitation event. The combination primary and secondary (emergency) spillway system will be designed to safely carry the anticipated peak runoff from a 25 Year - 6 Hour precipitation event. When sediment basins are proposed in the drainage course of a public water supply, the spillway system will be designed and constructed to adequately carry the runoff from a 50 Year - 24 Hour precipitation event.

B) Channel linings, for secondary (emergency) spillways will be a trapezoidal open channel constructed in natural ground and planted with a mixture of both annual and perennial grasses being predominantly fescue and bermuda. In the event that the spillway can not be constructed in natural ground the spillway will be lined with riprap, concrete, asphalt or durable rock (See Detailed Design Plans for Spillway Lining).

C) When consisting of pipe, the primary spillway will be installed according to Class "C" pipe installation for embankment bedding.

D) Sediment basins with a single spillway system, such as a skimmer board, will be a trapezoidal open channel constructed in consolidated, nonerodible material and lined with rip-rap, concrete, asphalt or durable rock (See Detailed Design Plans for Spillway Lining).

E) The primary spillway will be designed and constructed with device to eliminate floating solids from leaving the impoundment. This device will consist of a turned down elbow when using pipe or a skimmer system when using an open channel spillway.

F) When necessary, to prevent erosion of the embankment or discharge area, a splash pad of rip-rap, durable rock, sacrete, etc. will be installed at the discharge end of the primary spillway.

G) The combined spillway systems, for sediment basins constructed in series, will be designed to adequately accommodate the entire drainage area.

3. INSPECTION, MAINTENANCE AND CERTIFICATION REQUIREMENTS

A) Inspections will be conducted regularly during construction of the sediment basin by a qualified registered professional engineer or other qualified person under the direction of a professional engineer. Upon completion of construction, the sediment basin will be certified, by a qualified registered professional engineer, to the Regulatory Authority as having been constructed in accordance with the approved detailed design plans.

B) Sediment basins will be inspected semi-monthly for erosion, instability, etc., with maintenance performed as necessary, until the removal of the structure or until a Phase III Bond Release is granted.

C) Sediment basins will be examined quarterly for structural weakness, instability, erosion, slope failure, or other hazardous conditions with maintenance performed as necessary.

D) Formal inspections will be made annually, by a qualified registered professional engineer or other qualified person under the direction of a professional engineer, including any reports or modifications, in accordance with 880-X- 10C- .20[1(j)] of the Alabama Surface Mining Regulations.

E) Retained sediment will be removed from each sediment basin when the accumulated sediment reaches the maximum allowable sediment volume as set forth in the detailed design plans.

4. BASIN REMOVAL REQUIREMENTS

A) Upon completion of mining, reclamation, restabilization and effluent standards being met, each sediment basin not proposed as a permanent water impoundment will be dewatered in a controlled manner by either pumping or siphoning. Upon successful dewatering, a determination will be made as to the retained sediment level in the basin. After determining the retained sediment level, a channel will be cut into the embankment down to the retained sediment level on the side of the embankment deemed most suitable to reach natural ground without encountering prohibiting rock. The embankment material removed from this newly constructed channel will be spread and compacted over the previous impoundment (wet area) area to prevent erosion and ensure restabilization. The newly constructed channel will be of adequate width (minimum 30 feet) and sloped to a grade (approximately 1% to 3%) which will cause all surface drainage to travel across this area in sheet flow, minimizing the possibility of erosion. Also, where necessary, hay dams will be installed in strategic locations across the width of the channel to retain sediment and slow the water velocity to a favorable rate. Upon removal of the

embankment section, all disturbed areas will be graded in such a manner to ensure slope stability, successful restabilization and to minimize erosion. All disturbed areas will be seeded with a mixture of annual and perennial grasses, fertilized and mulched. No slope, existing or created in the removal of the sediment basin, will be left on a grade that will slip or slough.

5. PERMANENT WATER IMPOUNDMENT REQUIREMENTS

A) Prior to a request for a Phase II Bond Release, all sediment basins being left as permanent water impoundments will have supplemental data submitted to the Regulatory Authority concerning water quality, water quantity, size, depth, configuration, postmining land use, etc.

B) Final grading slopes of the entire permanent water impoundment area will not exceed a slope of 2 Horizontal to 1 Vertical to provide for safety and access for future water users.

DETAILED DESIGN PLANS
SEDIMENT BASIN 050

CONCORD BASIN 050 EXISTING

Elevation-Area-Capacity Table

Elevation (ft)	Area (ac)	Capacity (ac-ft)
512.00	0.000	0.000
512.50	0.002	0.000
513.00	0.010	0.003
513.50	0.022	0.011
514.00	0.040	0.027
514.50	0.049	0.049
515.00	0.058	0.076
515.50	0.069	0.107
516.00	0.080	0.144
516.50	0.093	0.188
517.00	0.108	0.238
517.50	0.123	0.296
518.00	0.140	0.362
518.50	0.160	0.437
519.00	0.182	0.522
519.50	0.205	0.619
520.00	0.230	0.728
520.50	0.253	0.849
521.00	0.278	0.981
521.50	0.303	1.127
522.00	0.330	1.285
522.50	0.358	1.457
523.00	0.388	1.643
523.50	0.418	1.845
524.00	0.450	2.062
524.50	0.492	2.297
525.00	0.536	2.554
525.50	0.582	2.834
526.00	0.630	3.137
526.50	0.677	3.464
527.00	0.727	3.814
527.50	0.777	4.190
528.00	0.830	4.592
528.50	0.898	5.024
529.00	0.970	5.491
529.50	1.043	5.994
530.00	1.120	6.535

Elevation (ft)	Area (ac)	Capacity (ac-ft)
530.50	1.254	7.128
531.00	1.395	7.790
531.50	1.544	8.524
532.00	1.700	9.335
532.50	1.892	10.232
533.00	2.094	11.229
533.50	2.307	12.329
534.00	2.530	13.537
534.50	2.780	14.864
535.00	3.041	16.319
535.50	3.315	17.908
536.00	3.600	19.636

CONCORD BASIN 050 EXCAVATED

Elevation-Area-Capacity Table

Elevation (ft)	Area (ac)	Capacity (ac-ft)
512.00	0.030	0.000
512.50	0.040	0.017
513.00	0.052	0.040
513.50	0.065	0.070
514.00	0.080	0.106
514.50	0.093	0.149
515.00	0.108	0.200
515.50	0.123	0.257
516.00	0.140	0.323
516.50	0.158	0.398
517.00	0.178	0.482
517.50	0.198	0.576
518.00	0.220	0.680
518.50	0.243	0.796
519.00	0.268	0.924
519.50	0.293	1.064
520.00	0.320	1.217
520.50	0.348	1.384
521.00	0.378	1.566
521.50	0.408	1.762
522.00	0.440	1.974
522.50	0.480	2.204
523.00	0.522	2.454
523.50	0.565	2.726
524.00	0.610	3.019
524.50	0.660	3.337
525.00	0.711	3.679
525.50	0.765	4.048
526.00	0.820	4.444
526.50	0.886	4.871
527.00	0.955	5.331
527.50	1.026	5.826
528.00	1.100	6.357
528.50	1.234	6.940
529.00	1.375	7.592
529.50	1.524	8.316
530.00	1.680	9.117

Elevation (ft)	Area (ac)	Capacity (ac-ft)
530.50	1.870	10.004
531.00	2.070	10.988
531.50	2.280	12.075
532.00	2.500	13.270
532.50	2.621	14.550
533.00	2.744	15.891
533.50	2.871	17.295
534.00	3.000	18.762
534.50	3.131	20.295
535.00	3.264	21.894
535.50	3.401	23.560
536.00	3.540	25.295

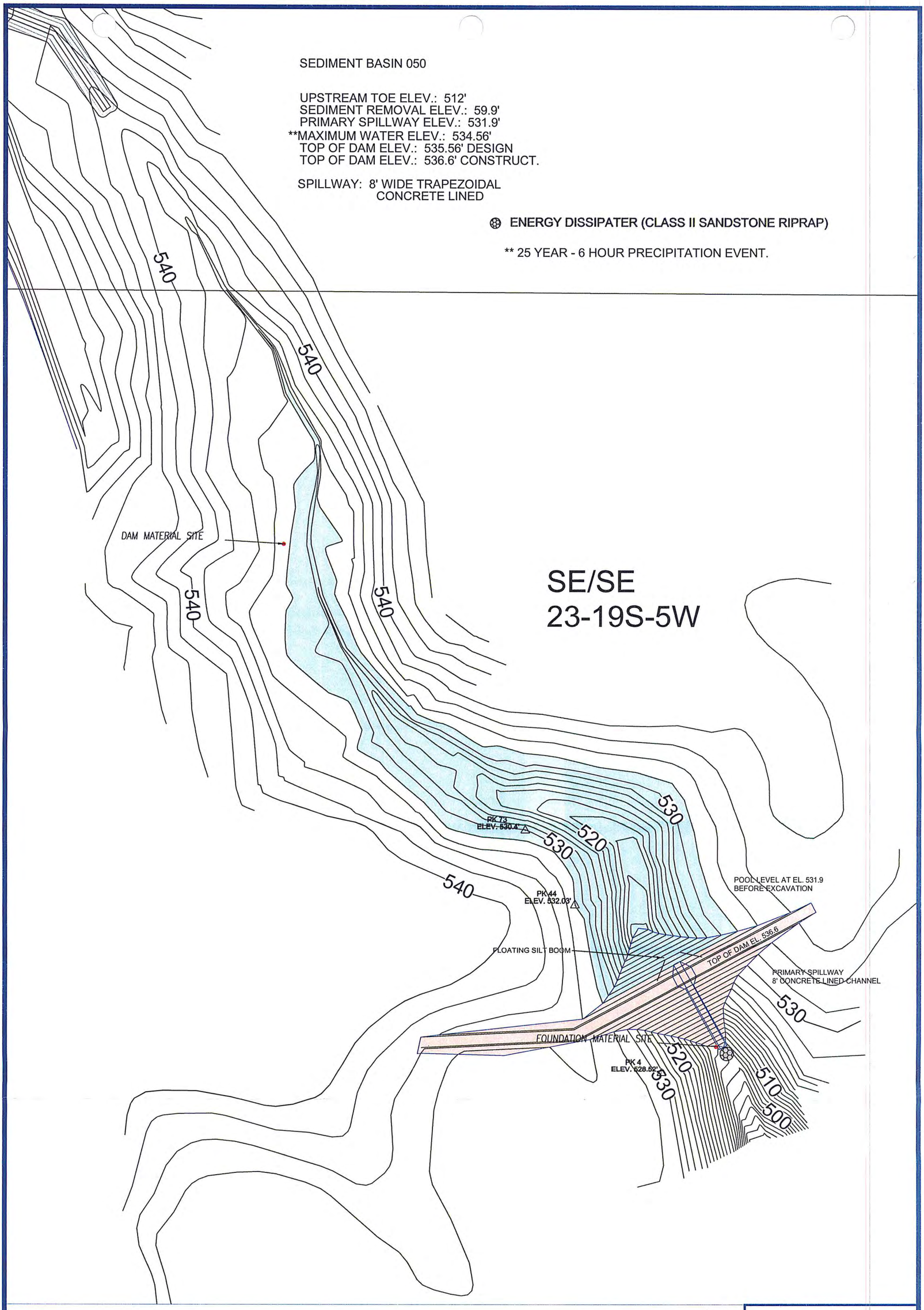
SEDIMENT BASIN 050

UPSTREAM TOE ELEV.: 512'
SEDIMENT REMOVAL ELEV.: 59.9'
PRIMARY SPILLWAY ELEV.: 531.9'
**MAXIMUM WATER ELEV.: 534.56'
TOP OF DAM ELEV.: 535.56' DESIGN
TOP OF DAM ELEV.: 536.6' CONSTRUCT.

SPILLWAY: 8' WIDE TRAPEZOIDAL
CONCRETE LINED

ENERGY DISSIPATER (CLASS II SANDSTONE RIPRAP)

** 25 YEAR - 6 HOUR PRECIPITATION EVENT.



EMBANKMENT

POOL AREA BEFORE EXCAVATION

2 FOOT CONTOUR INTERVAL

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Bobby Usher-Z:\Mining\BASEMAPS\Cleveland Cliffs\Concord\BASIN DESIGN\POND 050 PLAN VIEW.dwg – Jul 10, 2015 – 9:18am

CLIFFS

CONCORD PREP PLANT
REFUSE PILE

SEDIMENT BASIN 050
PLAN VIEW BEFORE EXCAVATION

FILE:	SCALE: 1"=100'	JOB NO.:
APPROVED BY: R.W.U.	DATE: 7/09/15	SHEET NO.: 1 OF 1

SEDIMENT BASIN 050

UPSTREAM TOE ELEV.: 512'
SEDIMENT REMOVAL ELEV.: 59.9'
PRIMARY SPILLWAY ELEV.: 531.9'
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SPILLWAY: 8' WIDE TRAPEZOIDAL
CONCRETE LINED

⊗ ENERGY DISSIPATER (CLASS II SANDSTONE RIPRAP)

** 25 YEAR - 6 HOUR PRECIPITATION EVENT.

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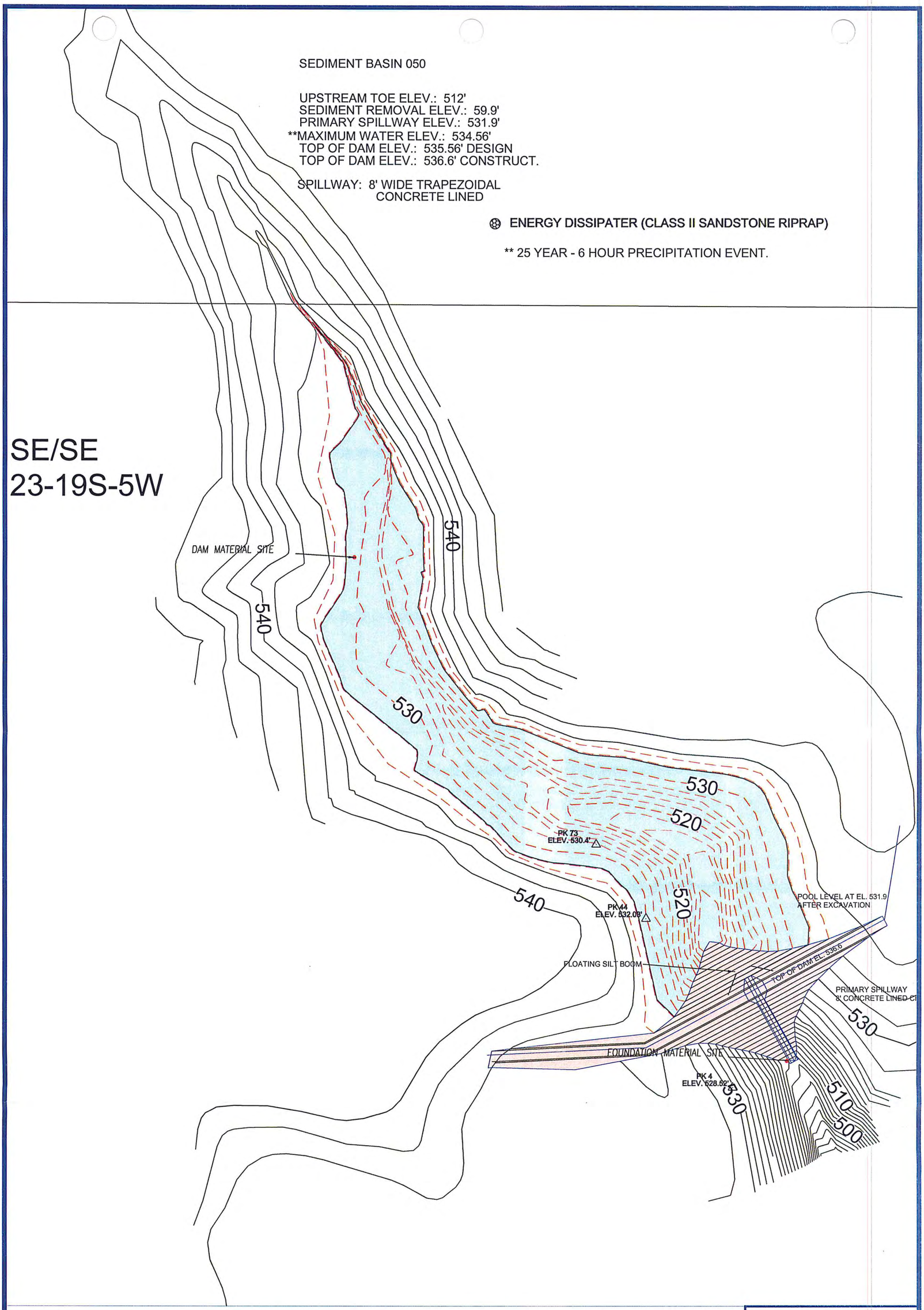

EMBANKMENT

POOL AREA BEFORE EXCAVATION

EXCAVATED CONTOURS

2 FOOT CONTOUR INTERVAL

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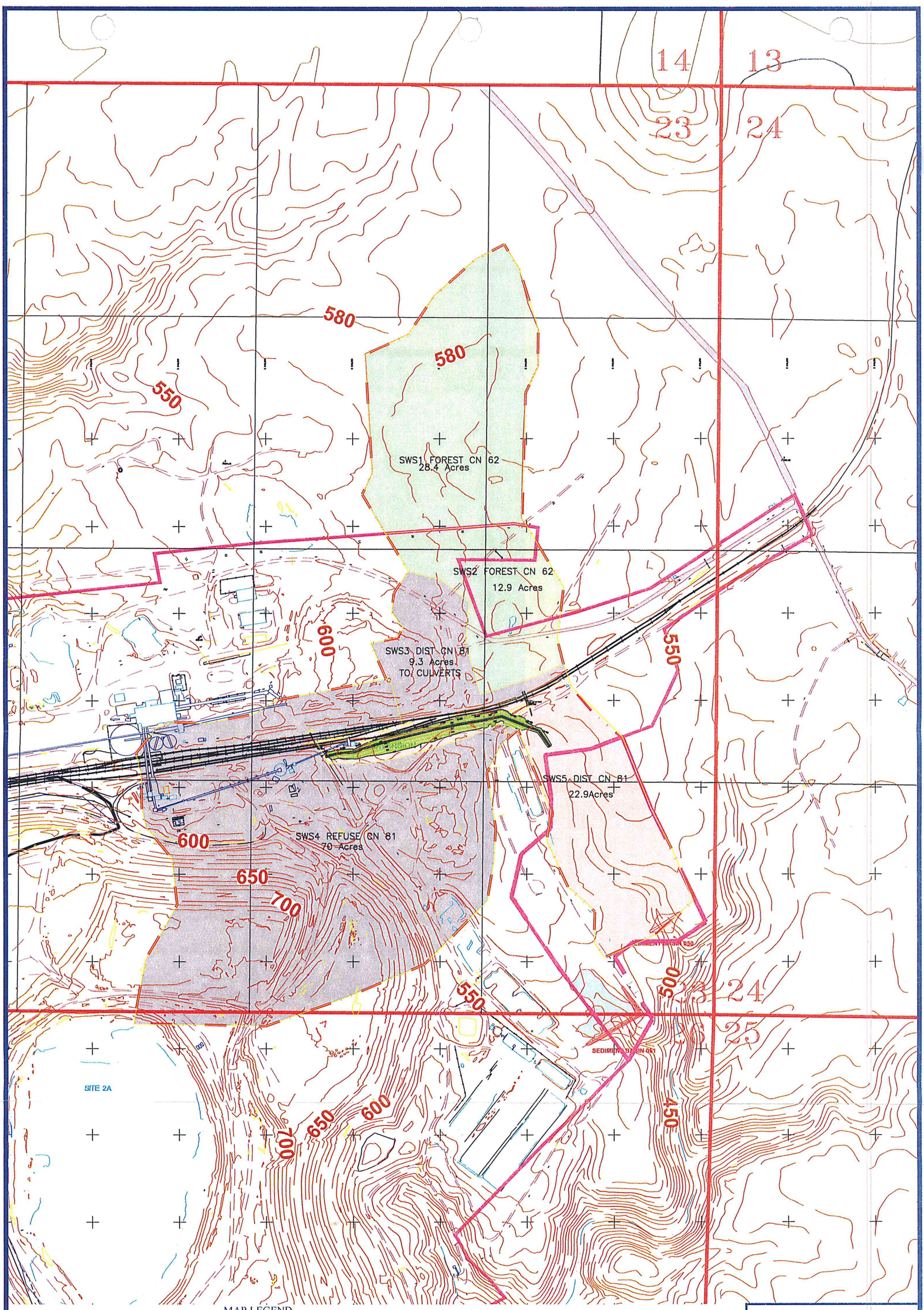
CLIFFS

CONCORD PREP PLANT
REFUSE PILE

SEDIMENT BASIN 050
PLAN VIEW AFTER EXCAVATION

FILE:	SCALE: 1"=100'	JOB NO.:
APPROVED BY: R.W.U.	DATE: 7/09/15	SHEET NO.: 1 OF 1



MAP LEGEND

ASMC PERMIT BOUNDARY

WATERSHED BOUNDARY

SWS1 & 2 FOREST CN 62

SWS3 COAL PILES & COARSE REFUSE CN 81

SWS4 COARSE REFUSE CN 81

SWS5 NATURAL GROUND CN 81

B SEDIMENT BASIN, C.N. 100

N W E S

10 FOOT CONTOUR INTERVAL

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Bobby Usher-Z: \Mining\BASEMAPS\Cleveland Cliffs\Concord\Proposed expansion\REVISED EXPANSION FILES ADDING 3A 4-16-15\REVISED Concord Refuse expansion SITE 3A ONLY 4-14-15.dwg – Jul 09, 2015 – 4:26pm

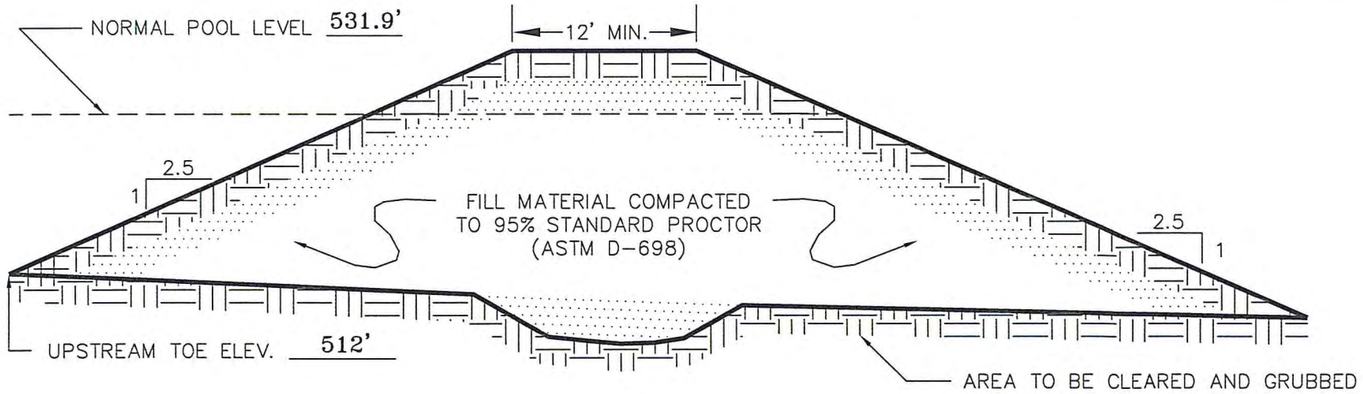
CLIFFS

CONCORD PREP PLANT
REFUSE PILE

SEDIMENT BASIN 050
WATERSHED MAP

FILE:	SCALE: 1"=500'	JOB NO.:
APPROVED BY: R.W.U.	DATE: 7/9/15	SHEET NO.: 1 OF 1

EMBANKMENT CROSS-SECTION



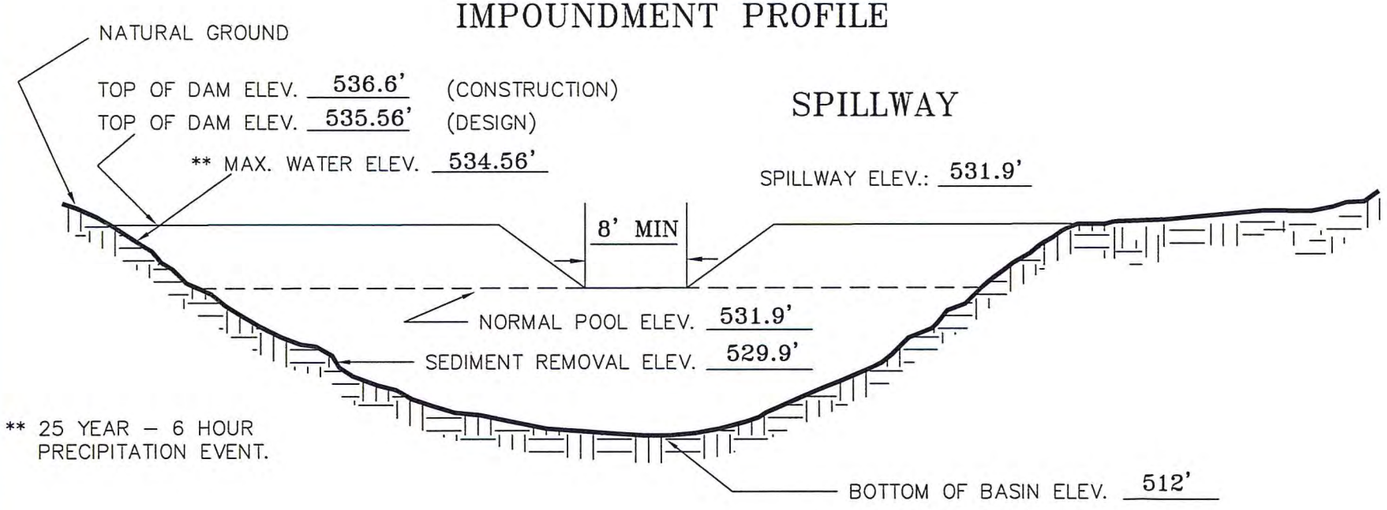
COMPANY: OAK GROVE RESOURCES, LLC

MINE NAME: CONCORD PREPARATION PLANT

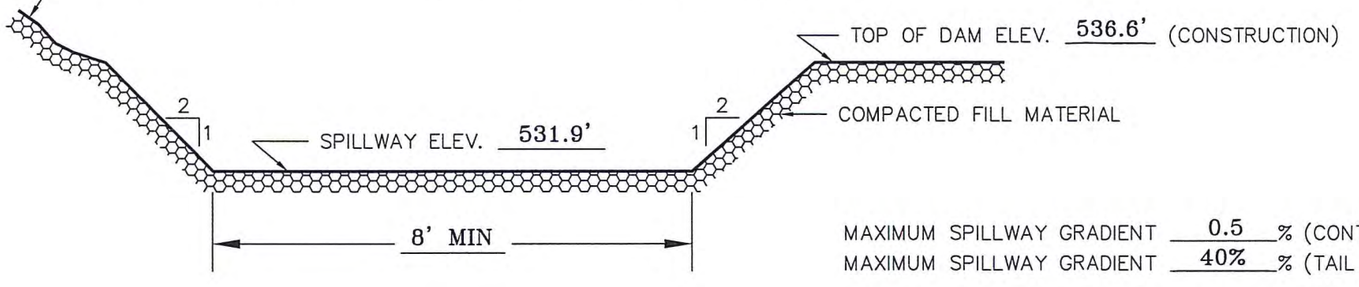
PERMIT #: P-3233

BASIN I.D. #: SEDIMENT BASIN 050

IMPOUNDMENT PROFILE



EMERGENCY SPILLWAY



MAXIMUM SPILLWAY GRADIENT 0.5 % (CONTROL SECTION)

MAXIMUM SPILLWAY GRADIENT 40% % (TAIL DITCH SECTION)

KEY BASIN PARAMETERS

DRAINAGE AREA	143.5	ACRES
DISTURBED AREA	102.2	ACRES
SEDIMENT STORAGE	9	AC.FT.
DETENTION STORAGE	4.3	AC.FT.
PERMANENT POOL CAPACITY	13.3	AC.FT.
* TOTAL BASIN STORAGE CAPACITY	19.54	AC.FT.
** PEAK INFLOW	245.98	C.F.S.
** PEAK OUTFLOW	136.61	C.F.S.

NOTE: ALL ELEVATIONS ASSUMED.

* 10 YEAR - 24 HOUR PRECIPITATION EVENT.

** 25 YEAR - 6 HOUR PRECIPITATION EVENT.

SEE SPILLWAY CONTROL SECTION AND TAIL DITCH DESIGN FOR CHANNEL LINING REQUIREMENTS.

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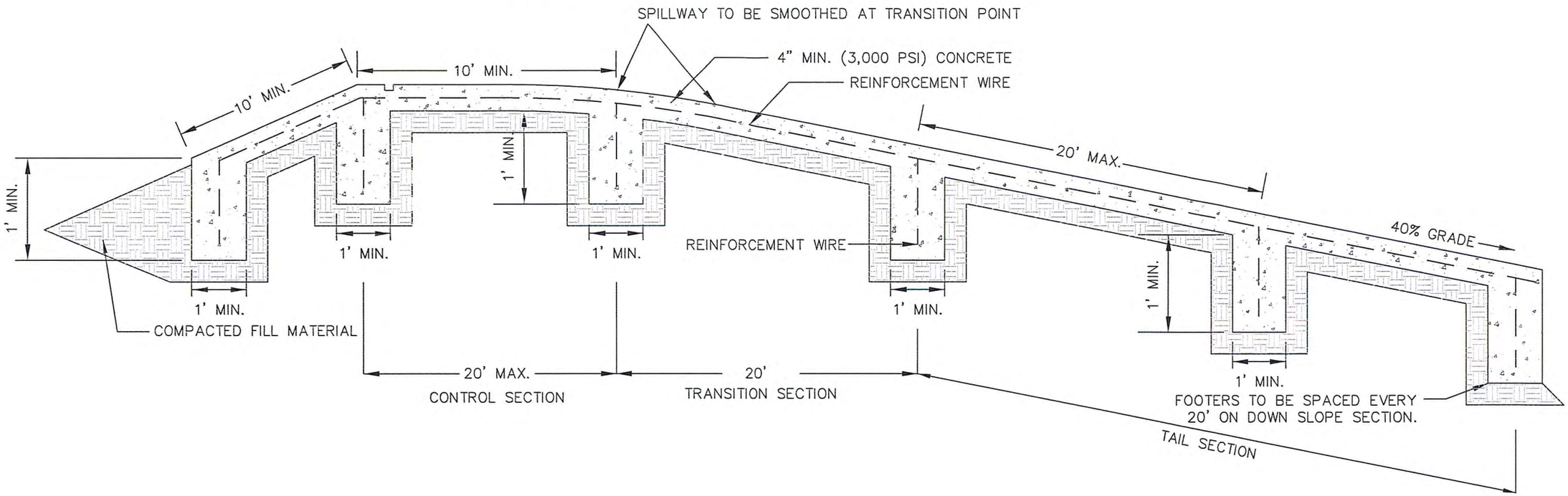
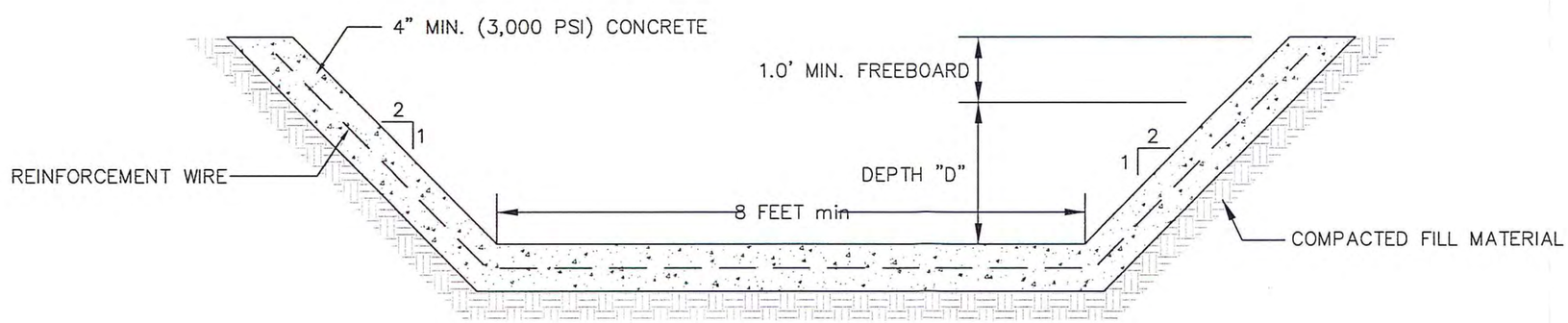
SEDIMENT BASIN 050 SPILLWAY PROFILE



TYPICAL SPILLWAY CROSS-SECTION



SPILLWAY FLOW DEPTH "D" = 2.66 FEET (CONTROL SECTION)

SPILLWAY FLOW DEPTH "D" = 0.56 FEET (TAIL DITCH SECTION)

TOTAL SPILLWAY DEPTH "D+1" = 3.66 FEET (CONTROL SECTION)

TOTAL SPILLWAY DEPTH "D+1" = 1.56 FEET (TAIL DITCH SECTION)

NOTE: TOTAL SPILLWAY DEPTH IN TRANSITION SECTION VARIES FROM 3.66 FEET TO 1.56 FEET

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SPILLWAY CHANNEL SPECIFICATIONS
SEDIMENT BASIN 050

The entire control section and tail ditch section of the emergency spillway will be cut into the compacted fill of the embankment and lined with a minimum of 4 inches of reinforced concrete. All concrete will be reinforced with 10 gauge, 6" x 6" welded wire mesh. Fibermesh may be added to the concrete for additional strength, however, the addition of fibermesh shall not be used in place of the required 6" x 6" welded wire.

The gradient of the control section of the emergency spillway will not exceed two (2%) percent. The gradient of the tail ditch section of the emergency spillway will not exceed forty (40%) percent.

The control section and tail ditch section of the emergency spillway will extend from the inner face of the embankment, past the centerline of the embankment and be carried out beyond the downstream slope of the embankment.

The concrete liner of the control section of the emergency spillway will be a minimum of 3.66 as measured vertically, allowing 2.66 feet for the maximum anticipated flow and 1.0 feet of dry freeboard. The concrete liner of the tail ditch section of the emergency spillway will be a minimum of 1.56 feet as measured vertically, allowing 0.56 feet for the maximum anticipated flow and 1.0 foot of dry freeboard. There will be a transition zone of at least 20 feet in length between the control section and the tail section. The minimum depth at the beginning of the transition will be 3.66 feet and 1.66 feet at the end of the transition. The flow line of the spillway will be smoothed at the transition to avoid abrupt changes in the flow line slope.

See enclosed SEDCAD 4.0 spillway tail ditch section design and attached Plan Sheet cross-section for the minimum and maximum emergency spillway construction requirements.

A floating silt fence (lightweight turbidity curtain) will be installed near the entrance to the spillway to accomplish sub-surface withdrawal. The floating silt fence (lightweight turbidity curtain) will be set at normal pool and will be anchored at the 10 Year – 24 Hour Event peak stage with steel fence posts.

Concord Sediment Basin 050 Spillway Control Section

Material: Concrete, Rubble

Trapezoidal Channel

Bottom Width (ft)	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Manning's n	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)
8.00	2.0:1	2.0:1	2.0	0.0220	1.00		

	w/o Freeboard	w/ Freeboard
Design Discharge:	136.61 cfs	
Depth:	1.33 ft	2.33 ft
Top Width:	13.31 ft	17.31 ft
Velocity:	9.67 fps	
X-Section Area:	14.13 sq ft	
Hydraulic Radius:	1.014 ft	
Froude Number:	1.65	

Concord Sediment Basin 050 Spillway Tail Ditch Section

Material: Concrete, Rubble

Trapezoidal Channel

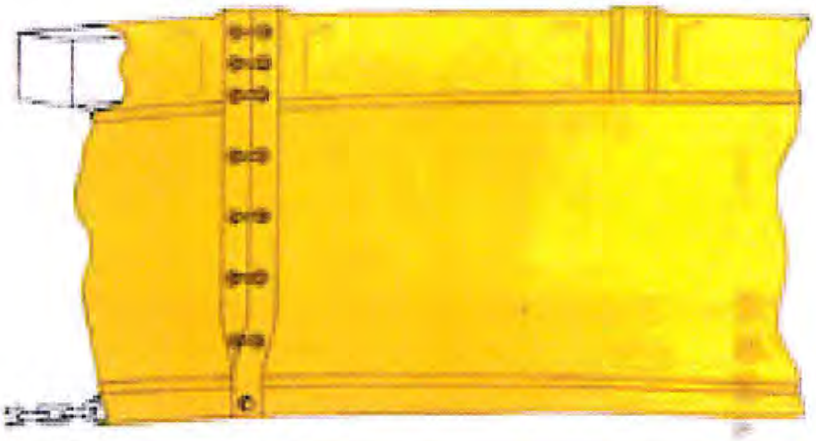
Bottom Width (ft)	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Manning's n	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)
8.00	2.0:1	2.0:1	40.0	0.0220	1.00		

	w/o Freeboard	w/ Freeboard
Design Discharge:	136.61 cfs	
Depth:	0.56 ft	1.56 ft
Top Width:	10.25 ft	14.25 ft
Velocity:	26.58 fps	
X-Section Area:	5.14 sq ft	
Hydraulic Radius:	0.489 ft	
Froude Number:	6.61	

SUBSURFACE WITHDRAWAL DEVICE AND FLOATING SILT BOOM

Lightweight Turbidity Curtain

Application: Calm waters with little current, such as lakes, ponds, canals and shoreline areas.



Specifications

- Curtain to be anchored at the maximum anticipated peak stage elevation (10 Year – 24 Hour Precipitation Event).
- PVC coated floatations - ultraviolet resistant
- Geotextile fabric screens
- Chain ballast with connectors
- Double sewn seams with grommets
- Depths per requirements ' 50' sections = Minimum 24" deep
- Fabric - Polyester reinforced vinyl high visibility yellow
- Connector - Sections are laced together through grommets and load lines are bolted together.
- Flotation - 6" expanded polystyrene over 9 lbs./ft. buoyancy.
- Ballast - 1/4" galvanized chain (.7 lbs/ft).

HYDROLOGY AND SEDIMENTOLOGY PREDICTION
10 YEAR - 24 HOUR PRECIPITATION EVENT
SEDIMENT BASIN 050

Copyright 1998 -2010 Pamela J. Schwab

Oak Grove Resources, LLC
Concord Preparation Plant
Sediment Basin 050

10 year - 24 hour event

Robert W. Usher, P.E.

General Information

Storm Information:

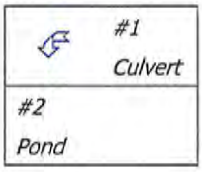
Storm Type:	DRN 58
Design Storm:	10 yr - 24 hr
Rainfall Depth:	6.000 inches

Particle Size Distribution:

Size (mm)	cover soil	refuse
4.7500	100.000%	100.000%
3.0000	78.000%	47.870%
2.0000	63.000%	29.130%
1.0000	47.000%	12.170%
0.5000	30.500%	5.300%
0.3000	19.900%	3.300%
0.2000	14.300%	1.800%
0.1000	7.400%	0.830%
0.0500	5.000%	0.300%
0.0300	3.700%	0.200%
0.0200	1.900%	0.100%
0.0100	0.800%	0.050%
0.0050	0.350%	0.000%
0.0030	0.270%	0.000%
0.0010	0.190%	0.000%
0.0000	0.000%	0.000%

Structure Networking:

Type	Stru #	(flows into)	Stru #	Musk. K (hrs)	Musk. X	Description
Culvert	#1	==>	#2	0.000	0.000	42" culverts
Pond	#2	==>	End	0.000	0.000	Basin 050



Structure Summary:

		Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)	Sediment (tons)	Peak Sediment Conc. (mg/l)	Peak Settleable Conc. (ml/l)	24VW (ml/l)
#1		50.600	50.600	22.17	7.64	235.9	67,300	53.22	17.72
#2	In	92.900	143.500	131.60	35.89	7,274.7	252,038	199.32	112.87
	Out			107.78	35.89	58.5	2,815	0.13	0.06

Particle Size Distribution(s) at Each Structure

Structure #1 (42" culverts):

Size (mm)	In/Out
4.7500	100.000%
3.0000	81.703%
2.0000	66.035%
1.0000	49.288%
0.5000	31.985%
0.3000	20.869%
0.2000	14.996%
0.1000	7.760%
0.0500	5.243%
0.0300	3.880%
0.0200	1.992%
0.0100	0.839%
0.0050	0.367%
0.0030	0.283%
0.0010	0.199%
0.0000	0.000%

Structure #2:

Size (mm)	In	Out
4.7500	100.000%	100.000%
3.0000	82.057%	100.000%
2.0000	66.278%	100.000%
1.0000	49.446%	100.000%
0.5000	32.088%	100.000%
0.3000	20.936%	100.000%
0.2000	15.044%	100.000%
0.1000	7.785%	100.000%
0.0500	5.260%	100.000%
0.0300	3.893%	100.000%
0.0200	1.999%	100.000%
0.0100	0.842%	100.000%

Size (mm)	In	Out
0.0050	0.368%	45.803%
0.0030	0.284%	35.334%
0.0010	0.200%	24.865%
0.0000	0.000%	0.000%

Structure Detail:

Structure #1 (Culvert)

42" culverts

Culvert Inputs:

Length (ft)	Slope (%)	Manning's n	Max. Headwater (ft)	Tailwater (ft)	Entrance Loss Coef. (Ke)
100.00	0.30	0.0240	2.50	0.00	0.90

Culvert Results:

Design Discharge = 22.17 cfs

Minimum pipe diameter: 1 - 42 inch pipe(s) required

Structure #2 (Pond)

Basin 050

Pond Inputs:

Initial Pool Elev:	531.90 ft
Initial Pool:	4.05 ac-ft
*Sediment Storage:	9.00 ac-ft
Dead Space:	20.00 %

**Sediment capacity was entered by user*

Emergency Spillway

Spillway Elev	Crest Length (ft)	Left Sideslope	Right Sideslope	Bottom Width (ft)
531.90	20.00	2.00:1	2.00:1	8.00

Pond Results:

Peak Elevation:	534.25 ft
H'graph Detention Time:	1.32 hrs
Pond Model:	CSTRS
Dewater Time:	1.22 days
Trap Efficiency:	99.20 %

Dewatering time is calculated from peak stage to lowest spillway

Elevation-Capacity-Discharge Table

Elevation	Area (ac)	Capacity (ac-ft)	Discharge (cfs)	Dewater Time (hrs)	
529.92	1.665	0.000	0.000		Top of Sed. Storage
530.00	1.690	0.132	0.000		
530.50	1.878	1.023	0.000		
531.00	2.076	2.011	0.000		
531.50	2.284	3.101	0.000		
531.90	2.457	4.049	0.000		Spillway #1
532.00	2.500	4.297	1.337	12.70	
532.50	2.621	5.577	8.025	4.50	
533.00	2.744	6.918	25.040	8.55	
533.50	2.871	8.321	50.766	2.35	
534.00	3.000	9.789	85.964	0.80	
534.25	3.065	10.545	107.783	0.40	Peak Stage
534.50	3.131	11.322	130.207		
535.00	3.264	12.920	183.872		
535.50	3.401	14.586	247.368		
536.00	3.540	16.322	321.111		

Detailed Discharge Table

Elevation (ft)	Emergency Spillway (cfs)	Combined Total Discharge (cfs)
529.92	0.000	0.000
530.00	0.000	0.000
530.50	0.000	0.000
531.00	0.000	0.000
531.50	0.000	0.000
531.90	0.000	0.000
532.00	1.337	1.337
532.50	8.025	8.025
533.00	25.040	25.040
533.50	50.766	50.766
534.00	85.964	85.964
534.50	130.207	130.207
535.00	183.872	183.872
535.50	247.368	247.368
536.00	321.111	321.111

Subwatershed Hydrology Detail:

Stru #	SWS #	SWS Area (ac)	Time of Conc (hrs)	Musk K (hrs)	Musk X	Curve Number	UHS	Peak Discharge (cfs)	Runoff Volume (ac-ft)
#1	1	28.400	0.850	0.012	0.374	62.000	S	8.05	3.306
	2	12.900	0.510	0.000	0.000	62.000	S	4.54	1.503
	3	9.300	0.210	0.000	0.000	81.000	F	11.12	2.828
	Σ	**50.600**						**22.17**	**7.638**
#2	1	35.000	0.290	0.000	0.000	81.000	F	41.50	10.643
	2	35.000	0.290	0.000	0.000	81.000	F	41.50	10.643
	3	22.900	0.300	0.000	0.000	81.000	F	27.10	6.970
	Σ	**143.500**						**131.60**	**35.894**

Subwatershed Sedimentology Detail:

Stru #	SWS #	Soil K	L (ft)	S (%)	C	P	PS #	Sediment (tons)	Peak Sediment Conc. (mg/l)	Peak Settleable Conc (ml/l)	24VW (ml/l)
#1	1	0.320	200.00	3.00	0.0030	1.0000	1	0.3	109	0.09	0.06
	2	0.320	200.00	5.00	0.0030	1.0000	1	0.3	235	0.18	0.11
	3	0.320	200.00	7.00	0.9000	1.0000	1	235.3	103,725	82.03	46.96
	Σ							**235.9**	**67,300**	**53.22**	**17.72**
#2	1	0.320	200.00	15.00	0.9000	1.0000	1	3,154.8	334,265	264.35	155.87
	2	0.320	200.00	15.00	0.9000	1.0000	1	3,154.8	334,265	264.35	155.87
	3	0.320	200.00	8.00	0.9000	1.0000	1	729.3	129,044	102.05	58.63
	Σ							**7,274.7**	**252,038**	**199.32**	**112.87**

HYDROLOGY AND SEDIMENTOLOGY PREDICTION
25 YEAR - 6 HOUR PRECIPITATION EVENT
SEDIMENT BASIN 050

Copyright 1998 -2010 Pamela J. Schwab

Oak Grove Resources, LLC
Concord Preparation Plant
Sediment Basin 050

25 year - 6 hour event

Robert W. Usher, P.E.

General Information

Storm Information:

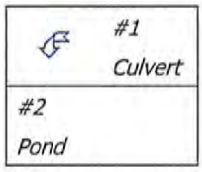
Storm Type:	SCS 6 HOUR
Design Storm:	25 yr - 6 hr
Rainfall Depth:	5.000 inches

Particle Size Distribution:

Size (mm)	cover soil	refuse
4.7500	100.000%	100.000%
3.0000	78.000%	47.870%
2.0000	63.000%	29.130%
1.0000	47.000%	12.170%
0.5000	30.500%	5.300%
0.3000	19.900%	3.300%
0.2000	14.300%	1.800%
0.1000	7.400%	0.830%
0.0500	5.000%	0.300%
0.0300	3.700%	0.200%
0.0200	1.900%	0.100%
0.0100	0.800%	0.050%
0.0050	0.350%	0.000%
0.0030	0.270%	0.000%
0.0010	0.190%	0.000%
0.0000	0.000%	0.000%

Structure Networking:

Type	Stru #	(flows into)	Stru #	Musk. K (hrs)	Musk. X	Description
Culvert	#1	==>	#2	0.000	0.000	42" culverts
Pond	#2	==>	End	0.000	0.000	Basin 050



Structure Summary:

		Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)	Sediment (tons)	Peak Sediment Conc. (mg/l)	Peak Settleable Conc. (ml/l)	24VW (ml/l)
#1		50.600	50.600	29.63	5.48	308.8	126,640	100.10	31.72
#2	In	92.900	143.500	245.98	27.20	9,194.7	364,530	287.98	178.37
	Out			136.61	27.20	101.7	5,608	0.91	0.45

Particle Size Distribution(s) at Each Structure

Structure #1 (42" culverts):

Size (mm)	In/Out
4.7500	100.000%
3.0000	85.781%
2.0000	69.312%
1.0000	51.745%
0.5000	33.605%
0.3000	21.927%
0.2000	15.757%
0.1000	8.154%
0.0500	5.509%
0.0300	4.077%
0.0200	2.094%
0.0100	0.881%
0.0050	0.386%
0.0030	0.298%
0.0010	0.209%
0.0000	0.000%

Structure #2:

Size (mm)	In	Out
4.7500	100.000%	100.000%
3.0000	89.359%	100.000%
2.0000	72.175%	100.000%
1.0000	53.846%	100.000%
0.5000	34.944%	100.000%
0.3000	22.799%	100.000%
0.2000	16.383%	100.000%
0.1000	8.478%	100.000%
0.0500	5.728%	100.000%
0.0300	4.239%	100.000%
0.0200	2.177%	100.000%
0.0100	0.917%	82.895%

Size (mm)	In	Out
0.0050	0.401%	36.266%
0.0030	0.309%	27.977%
0.0010	0.218%	19.687%
0.0000	0.000%	0.000%

Structure Detail:

Structure #1 (Culvert)

42" culverts

Culvert Inputs:

Length (ft)	Slope (%)	Manning's n	Max. Headwater (ft)	Tailwater (ft)	Entrance Loss Coef. (Ke)
100.00	0.30	0.0240	2.50	0.00	0.90

Culvert Results:

Design Discharge = 29.63 cfs

Minimum pipe diameter: 1 - 54 inch pipe(s) required

Structure #2 (Pond)

Basin 050

Pond Inputs:

Initial Pool Elev:	531.90 ft
Initial Pool:	4.05 ac-ft
*Sediment Storage:	9.00 ac-ft
Dead Space:	20.00 %

**Sediment capacity was entered by user*

Emergency Spillway

Spillway Elev	Crest Length (ft)	Left Sideslope	Right Sideslope	Bottom Width (ft)
531.90	20.00	2.00:1	2.00:1	8.00

Pond Results:

Peak Elevation:	534.56 ft
H'graph Detention Time:	1.00 hrs
Pond Model:	CSTRS
Dewater Time:	0.92 days
Trap Efficiency:	98.89 %

Dewatering time is calculated from peak stage to lowest spillway

Elevation-Capacity-Discharge Table

Elevation	Area (ac)	Capacity (ac-ft)	Discharge (cfs)	Dewater Time (hrs)	
529.92	1.665	0.000	0.000		Top of Sed. Storage
530.00	1.690	0.132	0.000		
530.50	1.878	1.023	0.000		
531.00	2.076	2.011	0.000		
531.50	2.284	3.101	0.000		
531.90	2.457	4.049	0.000		Spillway #1
532.00	2.500	4.297	1.337	12.65	
532.50	2.621	5.577	8.025	4.80	
533.00	2.744	6.918	25.040	1.25	
533.50	2.871	8.321	50.766	1.10	
534.00	3.000	9.789	85.964	1.35	
534.50	3.131	11.322	130.207	0.80	
534.56	3.148	11.512	136.607	0.15	Peak Stage
535.00	3.264	12.920	183.872		
535.50	3.401	14.586	247.368		
536.00	3.540	16.322	321.111		

Detailed Discharge Table

Elevation (ft)	Emergency Spillway (cfs)	Combined Total Discharge (cfs)
529.92	0.000	0.000
530.00	0.000	0.000
530.50	0.000	0.000
531.00	0.000	0.000
531.50	0.000	0.000
531.90	0.000	0.000
532.00	1.337	1.337
532.50	8.025	8.025
533.00	25.040	25.040
533.50	50.766	50.766
534.00	85.964	85.964
534.50	130.207	130.207
535.00	183.872	183.872
535.50	247.368	247.368
536.00	321.111	321.111

Subwatershed Hydrology Detail:

Stru #	SWS #	SWS Area (ac)	Time of Conc (hrs)	Musk K (hrs)	Musk X	Curve Number	UHS	Peak Discharge (cfs)	Runoff Volume (ac-ft)
#1	1	28.400	0.850	0.012	0.374	62.000	S	8.39	2.275
	2	12.900	0.510	0.000	0.000	62.000	S	4.74	1.034
	3	9.300	0.210	0.000	0.000	81.000	F	23.46	2.174
	Σ	**50.600**						**29.63**	**5.483**
#2	1	35.000	0.290	0.000	0.000	81.000	F	81.91	8.181
	2	35.000	0.290	0.000	0.000	81.000	F	81.91	8.181
	3	22.900	0.300	0.000	0.000	81.000	F	53.17	5.358
	Σ	**143.500**						**245.98**	**27.203**

Subwatershed Sedimentology Detail:

Stru #	SWS #	Soil K	L (ft)	S (%)	C	P	PS #	Sediment (tons)	Peak Sediment Conc. (mg/l)	Peak Settleable Conc (ml/l)	24VW (ml/l)
#1	1	0.320	200.00	3.00	0.0030	1.0000	1	0.3	108	0.08	0.07
	2	0.320	200.00	5.00	0.0030	1.0000	1	0.2	222	0.17	0.13
	3	0.320	200.00	7.00	0.9000	1.0000	1	308.4	153,889	121.64	78.70
	Σ							**308.8**	**126,640**	**100.10**	**31.72**
#2	1	0.320	200.00	15.00	0.9000	1.0000	1	3,983.9	451,663	356.82	243.94
	2	0.320	200.00	15.00	0.9000	1.0000	1	3,983.9	451,663	356.82	243.94
	3	0.320	200.00	8.00	0.9000	1.0000	1	918.0	179,552	141.84	94.20
	Σ							**9,194.7**	**364,530**	**287.98**	**178.37**

STABILITY ANALYSIS - COMPUTER OUTPUT
SEDIMENT BASIN 050 - STATIC

STABILITY ANALYSIS PROCEDURE

The computer program used to analyze the slope stability was the REAME Slope Stability Program as developed by Dr. Yang H. Huang, P.E. of the University of Kentucky.

The soil type of the foundation material beneath the proposed embankment structure of Sediment Basin 050 was sampled, analyzed and classified by personnel of McGehee Engineering Corp. The depth to the stiff base of Sediment Basin 050 (3') was measured by personnel of McGehee Engineering Corp.

The soil type to be used in the construction of the proposed embankment structure of Sediment Basins 050 was sampled, analyzed and classified by personnel of McGehee Engineering Corp. This sample of material was taken upstream within the adjacent pool area. From laboratory testing either material types are satisfactory for construction of the embankment. The analysis used the material with the lesser strength values.

SOIL PROPERTIES

USAGE	TYPE	COHESION (psf)	INTERNAL ANGLE OF FRICTION	EFFECTIVE DENSITY (pcf)
050 FOUND.	SM	270.00	33.02	132.14
050 DAM	SM-SC	180.00	30.54	135.96

ANALYSIS RESULTS

BASIN	STATIC SAFETY FACTOR
050	1.66

SIEVE ANALYSIS

(ASTM C136-96a)

Company Name: Cliffs Natural Resources
Location: Concord
Sample I.D.: Basin 050 UPSTREAM
Description: Dam Material

Sample Date: 5/12/11
Analyzed By: JW
Date Analyzed: 5/16/11
Requested By: R. Usher

Weight of Oven Dry Sample (W): **1014.0 Grams**

Sieve No.	Sieve + Sample Weight	Sieve Weight	Sample Weight Retained	Percent of Total Retained	Cumulative Weight Percent	Percent Retained	Percent Finer
1"	0.0	0.0	0.0	0.0	0.0	0.0	100.0
3/4"	0.0	0.0	0.0	0.0	0.0	0.0	100.0
1/2"	566.0	540.0	26.0	2.6	2.6	2.6	97.4
4	644.0	513.0	131.0	12.9	15.5	15.5	84.5
10	638.0	462.0	176.0	17.4	32.8	32.8	67.2
40	694.0	383.0	311.0	30.7	63.5	63.5	36.5
200	504.2	333.0	171.2	16.9	80.4	80.4	19.6
Pan	578.8	380.0	198.8	19.6	100.0	100.0	0.0
		Total Weight (W1):	1014.0				

SOIL CLASSIFICATION

Unified System (ASTM D-2487)

Liquid Limit: 22.3
Plastic Limit: 17.4
Plasticity Index: 4.9

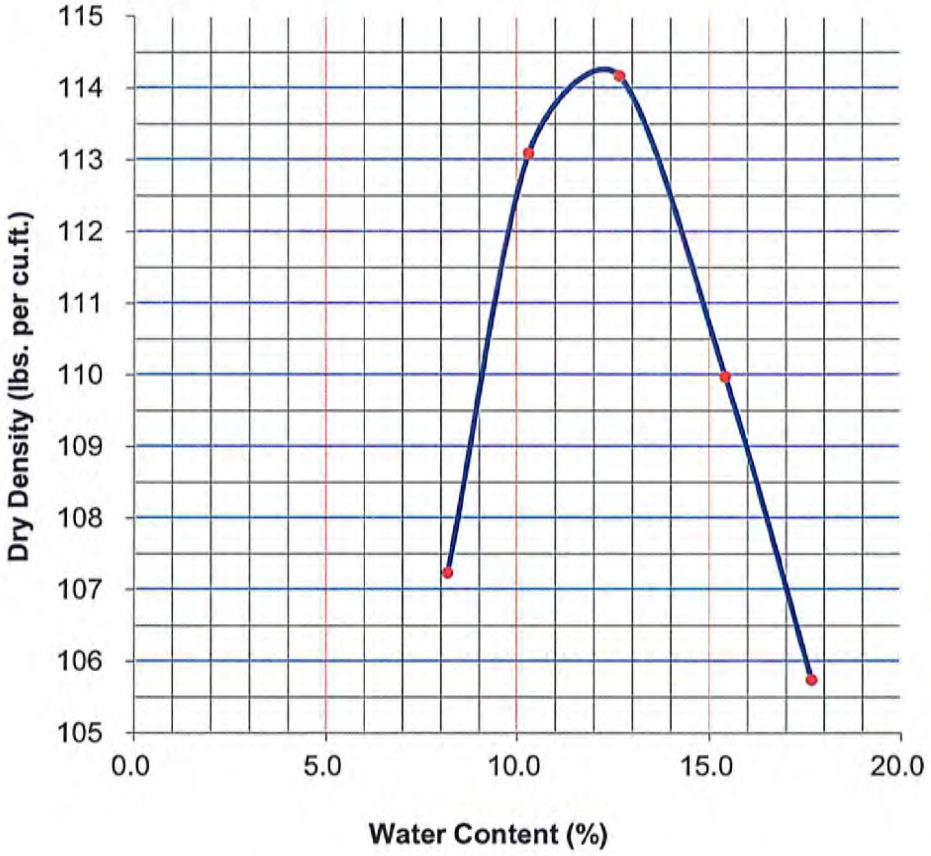
Soil Classification: **SM-SC**

Coarse Grained
Silty, Clayey Sand

Effective Cohesion: 1.2500 psi
Total Cohesion: 1.940 psi
Permeability: 1.40 ft/yr
Maximum Dry Density: 120.0 pcf
Optimum Moisture: 13.3 %
Effective Cohesion: 180.0 psf
Angle of Internal Friction: 30.54 degrees
Mass Unit Weight: 135.96 pcf

mcgehee engineering corp

Cliffs Natural Resources
Concord, Basin 050 UPSTREAM, Dam Material
Moisture Density Relationship
(Proctor Method)



ASTM D-698 Method C	Water Content %	Specific Gravity	%> No. 4	%< No. 200	LL %	PL %	PI %
			15.50	19.60	22.3	17.4	4.9

Sample Description, Classification and Location	Sample No.:	Basin 050 UPSTREAM Dam Material
Coarse Grained Silty Clayey Sand	Optimum Moisture Content=	12.3
	Maximum Dry Density =	114.3

mcgehee engineering corp

SIEVE ANALYSIS

(ASTM C136-96a and C117)

Company Name: Cliffs
Location: Concord Prep Plant
Sample I.D.: Basin 050
Description: Foundation

Sample Date: 4/22/15
Analyzed By: JWW
Date Analyzed: 4/27/15
Requested By: B Usher

Weight of Oven Dry Sample (W): **1012.0 Grams**

Sieve No.	Sieve + Sample Weight	Sieve Weight	Sample Weight Retained	Percent of Total Retained	Cumulative Weight Percent	Percent Retained	Percent Finer
1"	0.0	0.0	0.0	0.0	0.0	0.0	100.0
3/4"	0.0	0.0	0.0	0.0	0.0	0.0	100.0
1/2"	583.6	537.9	45.7	4.5	4.5	4.5	95.5
4	609.8	512.4	97.4	9.5	14.0	14.0	86.0
10	516.9	460.5	56.4	5.5	19.5	19.5	80.5
40	517.3	382.0	135.3	13.2	32.8	32.8	67.2
200	676.1	332.2	343.9	33.6	66.4	66.4	33.6
Pan	718.6	375.2	343.4	33.6	100.0	100.0	0.0
		Total Weight (W1):	1022.1				

SOIL CLASSIFICATION

Unified System (ASTM D-2487)

Liquid Limit: 15.7
Plastic Limit: 13.9
Plasticity Index: 1.8

Soil Classification: **SM**

Coarse Grained
Silty sand

Effective Cohesion: 1.8750 psi
Total Cohesion: 6.528 psi
Permeability: 12.30 ft/yr
Maximum Dry Density: 115.0 pcf
Optimum Moisture: 14.9 %
Effective Cohesion: 270.0 psf
Angle of Internal Friction: 33.02 degrees
Mass Unit Weight: 132.14 pcf

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REAME
(Rotational Equilibrium Analysis of Multilayered Embankments)

Oak Grove Resources, LLC
Concord Preparation Plant, P-3233
Sediment Basin 050
Static Case

Oak Grove Resources, LLC Concord Prep Plant Sediment Basin 050

Number of cases to be analyzed 1

Case Number 1

Number of boundary lines= 4
Number of points on boundary lines are: 2 2 3 7

On boundary line no. 1 Point no. and coordinates are:
1 .000 25.000 2 500.000 .000

On boundary line no. 2 Point no. and coordinates are:
1 200.000 18.000 2 354.286 10.286

On boundary line no. 3 Point no. and coordinates are:
1 .000 28.000 2 200.000 18.000 3 249.750 37.900

On boundary line no. 4 Point no. and coordinates are:
1 .000 37.900 2 249.750 37.900 3 261.500 42.600 4 273.500 42.600 5 338.407 16.637
6 354.286 10.286 7 500.000 3.000

Line no. and slope of each segment are:
1 -.050
2 -.050
3 -.050 .400
4 .000 .400 .000 -.400 -.400 -.050

No. of radius control zones= 1 Plot or no plot= 1 No. of seepage cases= 1

Total no. of lines at bottom of radius control zones is: 1

For rad. cont. zone no. 1 Radius decrement= .000 No. of Circles= 5 Id no. for first circle=, 1
Line no.= 1 Begin pt. no.= 1 End pt. no.= 2

Soil no.	Cohesion	F. angle	Unit wt.
1	270.000	33.020	132.140
2	180.000	30.540	135.960
3	.000	.000	62.400

Seismic coefficient= .000 Min. depth of tallest slice= .000 Unit weight of water= 62.400

The factors of safety are determined by the SIMPLIFIED BISHOP method

NSPG= 1 NSRCH= 0 No. of slices= 10 No. of add. radii= 2

No. of points on water table for each case= 6

Under seepage condition 1point no. and coordinates of water table are:
1 .000 37.900 2 249.750 37.900 3 286.616 30.444 4 338.407 16.637 5 354.286 10.286
6 500.000 3.000

point1=(274.000, 64.000) point2=(274.000, 44.000) point3=(355.000, 44.000) NJ= 2 NI= 2
Automatic search will follow after grid with XINC= 10.000 and YINC= 10.000

At point (274.000, 64.000) under seepage 1,the radius and the corresponding factor of safety are:
52.634 9.109 46.389 8.495 40.143 8.579 33.897 8.562 27.652 8.467
50.552 8.870 48.470 8.514 44.307 8.570 42.225 8.612 25.570 9.404
23.488 15.125
Lowest factor of safety= 8.467 and occurs at radius = 27.652

At point (274.000, 54.000) under seepage 1,the radius and the corresponding factor of safety are:
42.647 9.251 36.400 8.544 30.152 8.176 23.905 7.673 17.658 7.575
15.576 8.742 13.493 13.161
Lowest factor of safety= 7.575 and occurs at radius = 17.658

At point (274.000, 44.000) under seepage 1,the radius and the corresponding factor of safety are:
32.659 10.028 26.425 9.080 20.190 8.188 13.956 8.281 7.721 9.179
24.347 8.603 22.268 8.370 18.112 8.122 16.034 8.024
Lowest factor of safety= 8.024 and occurs at radius = 16.034

At point (314.500, 64.000) under seepage 1,the radius and the corresponding factor of safety are:
54.657 1.959 50.745 1.846 46.833 1.976 42.921 2.290 39.009 3.092
53.353 1.936 52.049 1.886 49.441 1.876 48.137 1.917
Lowest factor of safety= 1.846 and occurs at radius = 50.745

At point (314.500, 54.000) under seepage 1,the radius and the corresponding factor of safety are:
44.669 2.046 40.898 1.936 37.126 2.076 33.355 2.392 29.583 3.224
43.412 2.032 42.155 1.985 39.641 1.970 38.383 2.015
Lowest factor of safety= 1.936 and occurs at radius = 40.898

At point (314.500, 44.000) under seepage 1,the radius and the corresponding factor of safety are:
34.682 2.264 31.051 2.151 27.420 2.280 23.789 2.590 20.158 3.443
33.471 2.255 32.261 2.220 29.840 2.183 28.630 2.224
Lowest factor of safety= 2.151 and occurs at radius = 31.051

At point (355.000, 64.000) under seepage 1,the radius and the corresponding factor of safety are:
56.679 2.558 55.371 2.676 54.063 2.759 52.754 3.063 51.446 5.146
Lowest factor of safety= 2.558 and occurs at radius = 56.679

At point (355.000, 54.000) under seepage 1,the radius and the corresponding factor of safety are:
46.692 2.802 45.524 2.955 44.356 3.144 43.189 3.244 42.021 5.523
Lowest factor of safety= 2.802 and occurs at radius = 46.692

At point (355.000, 44.000) under seepage 1,the radius and the corresponding factor of safety are:

36.704	3.146	35.677	3.363	34.650	3.677	33.623	3.514	32.595	6.065
34.307	3.789	33.965	3.834	33.280	4.021	32.938	4.784		

Lowest factor of safety= 3.146 and occurs at radius = 36.704

For piezometric line No. 1

At point (314.500, 64.000) ,RADIUS 50.745
the minimum factor of safety is 1.846

At point (314.500, 64.000) under seepage 1,the radius and the corresponding factor of safety are:

54.657	1.959	50.745	1.846	46.833	1.976	42.921	2.290	39.009	3.092
53.353	1.936	52.049	1.886	49.441	1.876	48.137	1.917		

Lowest factor of safety= 1.846 and occurs at radius = 50.745

At point (324.500, 64.000) under seepage 1,the radius and the corresponding factor of safety are:

55.156	1.840	51.887	1.759	48.618	1.938	45.349	2.311	42.080	3.316
54.066	1.838	52.977	1.824	50.797	1.804	49.708	1.863		

Lowest factor of safety= 1.759 and occurs at radius = 51.887

At point (334.500, 64.000) under seepage 1,the radius and the corresponding factor of safety are:

55.655	1.830	53.029	1.833	50.403	1.948	47.777	2.368	45.151	3.634

Lowest factor of safety= 1.830 and occurs at radius = 55.655

At point (324.500, 74.000) under seepage 1,the radius and the corresponding factor of safety are:

65.144	1.793	61.734	1.713	58.324	1.890	54.915	2.263	51.505	3.213
64.007	1.790	62.871	1.769	60.597	1.756	59.461	1.816		

Lowest factor of safety= 1.713 and occurs at radius = 61.734

At point (324.500, 84.000) under seepage 1,the radius and the corresponding factor of safety are:

75.131	1.795	71.581	1.702	68.031	1.860	64.480	2.227	60.930	3.126
73.948	1.785	72.764	1.756	70.397	1.741	69.214	1.794		

Lowest factor of safety= 1.702 and occurs at radius = 71.581

At point (324.500, 94.000) under seepage 1,the radius and the corresponding factor of safety are:

85.119	1.823	81.428	1.728	77.737	1.869	74.046	2.196	70.355	3.051
83.888	1.814	82.658	1.777	80.198	1.763	78.967	1.807		

Lowest factor of safety= 1.728 and occurs at radius = 81.428

At point (334.500, 84.000) under seepage 1,the radius and the corresponding factor of safety are:

75.631	1.730	72.723	1.713	69.816	1.876	66.909	2.300	64.001	3.435
74.661	1.738	73.692	1.745	71.754	1.732	70.785	1.799		

Lowest factor of safety= 1.713 and occurs at radius = 72.723

At point (314.500, 84.000) under seepage 1,the radius and the corresponding factor of safety are:

74.632	1.993	70.439	1.869	66.245	1.972	62.052	2.225	57.859	2.921
73.234	1.962	71.836	1.895	69.041	1.890	67.643	1.924		

Lowest factor of safety= 1.869 and occurs at radius = 70.439

At point (327.000, 84.000) under seepage 1,the radius and the corresponding factor of safety are:

75.256	1.762	71.866	1.686	68.477	1.855	65.087	2.242	61.698	3.191
74.126	1.758	72.996	1.741	70.737	1.728	69.607	1.785		

Lowest factor of safety= 1.686 and occurs at radius = 71.866

At point (329.500, 84.000) under seepage 1,the radius and the corresponding factor of safety are:

75.381	1.742	72.152	1.678	68.923	1.857	65.694	2.258	62.466	3.264
74.305	1.743	73.228	1.735	71.076	1.723	70.000	1.783		

Lowest factor of safety= 1.678 and occurs at radius = 72.152

At point (332.000, 84.000) under seepage 1,the radius and the corresponding factor of safety are:

75.506	1.732	72.438	1.674	69.370	1.864	66.302	2.277	63.233	3.344
74.483	1.736	73.460	1.737	71.415	1.728	70.392	1.789		

Lowest factor of safety= 1.674 and occurs at radius = 72.438

At point (334.500, 84.000) under seepage 1,the radius and the corresponding factor of safety are:

75.631	1.730	72.723	1.713	69.816	1.876	66.909	2.300	64.001	3.435
74.661	1.738	73.692	1.745	71.754	1.732	70.785	1.799		

Lowest factor of safety= 1.713 and occurs at radius = 72.723

At point (332.000, 86.500) under seepage 1,the radius and the corresponding factor of safety are:

78.003	1.729	74.899	1.670	71.796	1.857	68.693	2.269	65.590	3.321
76.968	1.732	75.934	1.731	73.865	1.721	72.831	1.782		

Lowest factor of safety= 1.670 and occurs at radius = 74.899

At point (332.000, 89.000) under seepage 1,the radius and the corresponding factor of safety are:

80.499	1.727	77.361	1.667	74.223	1.851	71.084	2.262	67.946	3.297
79.453	1.729	78.407	1.727	76.315	1.716	75.269	1.775		

Lowest factor of safety= 1.667 and occurs at radius = 77.361

At point (332.000, 91.500) under seepage 1,the radius and the corresponding factor of safety are:

82.996	1.726	79.823	1.665	76.649	1.845	73.476	2.255	70.302	3.275
81.938	1.728	80.881	1.724	78.765	1.713	77.707	1.771		

Lowest factor of safety= 1.665 and occurs at radius = 79.823

At point (332.000, 94.000) under seepage 1,the radius and the corresponding factor of safety are:

85.493	1.730	82.285	1.665	79.076	1.839	75.867	2.248	72.659	3.253
84.424	1.728	83.354	1.723	81.215	1.712	80.146	1.768		

Lowest factor of safety= 1.665 and occurs at radius = 82.285

At point (334.500, 91.500) under seepage 1,the radius and the corresponding factor of safety are:

83.121	1.719	80.108	1.663	77.096	1.856	74.083	2.277	71.070	3.360
82.117	1.723	81.113	1.725	79.104	1.717	78.100	1.778		

Lowest factor of safety= 1.663 and occurs at radius = 80.108

At point (337.000, 91.500) under seepage 1,the radius and the corresponding factor of safety are:

83.246	1.720	80.394	1.714	77.542	1.872	74.690	2.303	71.838	3.455
82.295	1.727	81.345	1.734	79.443	1.725	78.493	1.790		

Lowest factor of safety= 1.714 and occurs at radius = 80.394

At point (334.500, 94.000) under seepage 1,the radius and the corresponding factor of safety are:

85.618	1.718	82.570	1.661	79.522	1.851	76.474	2.270	73.427	3.336
84.602	1.721	83.586	1.722	81.554	1.713	80.538	1.772		

Lowest factor of safety= 1.661 and occurs at radius = 82.570

At point (334.500, 96.500) under seepage 1,the radius and the corresponding factor of safety are:

88.115	1.718	85.032	1.660	81.949	1.844	78.866	2.264	75.783	3.313
87.087	1.721	86.060	1.719	84.004	1.711	82.977	1.768		

Lowest factor of safety= 1.660 and occurs at radius = 85.032

At point (334.500, 99.000) under seepage 1,the radius and the corresponding factor of safety are:

90.612	1.722	87.494	1.660	84.375	1.839	81.257	2.257	78.139	3.291
89.572	1.721	88.533	1.719	86.454	1.710	85.415	1.766		

Lowest factor of safety= 1.660 and occurs at radius = 87.494

At point (337.000, 96.500) under seepage 1,the radius and the corresponding factor of safety are:

88.240	1.716	85.317	1.691	82.395	1.860	79.473	2.289	76.551	3.404
87.266	1.720	86.292	1.723	84.343	1.714	83.369	1.779		

Lowest factor of safety= 1.691 and occurs at radius = 85.317

At point (332.000, 96.500) under seepage 1,the radius and the corresponding factor of safety are:

87.990	1.736	84.746	1.667	81.503	1.837	78.259	2.241	75.015	3.232
86.909	1.732	85.828	1.723	83.665	1.712	82.584	1.768		

Lowest factor of safety= 1.667 and occurs at radius = 84.746

For piezometric line No. 1

At point (334.500, 96.500) ,RADIUS 85.032
the minimum factor of safety is 1.660

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Cross section in distorted scale. Numerals indicate boundary line no.
If there area more than 10 bound. lines, alphabets will then be used. P indicates
Piezometric line. If a portion of Piezometric line coincides with
the ground or another boundary line, only the ground or boundary
line will be shown. X indicates intersection of two boundary
lines. * indicates failure surface.
The minimum factor of safety is     1.660
5.000E+01 X+++++++++X+++++++++X+++++++++X+++++++++X+++++++++X
     +  +                      +
     +  +                      +
     +  +                      +
     +  +                      +
4.500E+01 X   X  +     +     +     +     X
     +  +                      +
     +  +        44             +
     +  +                      +
     +  +                      +
4.000E+01 X   X  +     +     +     +     X
     +  +                      +
     +  4444444444444444X              +
     +  +         4             +
     +  +                      +
3.500E+01 X   X  +     +     +     +     X
     +  +         P             +
     +  +                      +
     +  +                      +
     +  +       3 *             +
3.000E+01 X   X  +     + P4  +     +     X
     +  +                      +
     +  33                     +
     +  +3                     +
     +  + 3        P            +
2.500E+01 X   X1 33     +     +     +     X
     +  +1  3    3   4            +
     +  + 1  3                    +
     +  +  1  33      P            +
     +  +  11  3     *             +
2.000E+01 X   X  +1  3  +     +     +     X
     +  +    1  3                 +
     +  +     1  X2                +
     +  +     11  2   4            +
     +  +      1  2                +
1.500E+01 X   X  +    1+2    +     +     X
     +  +       1  2 *            +
     +  +       11 2              +
     +  +        1  2*            +
     +  +        1  2             +
1.000E+01 X   X  +     +  1  X4 +     +     X
     +  +          11 4           +
     +  +           1 4           +
     +  +           1 44          +
     +  +           1  4          +
5.000E+00 X   X  +     +     11 4   +     X
     +  +             1 4         +
     +  +              1 4        +
     +  +               1         +
     +  +               1         +
 .000E+00 X+++++++++X+++++++++X+++++++++X+++++1+++X+++++++++X
0       -8.00E+01  8.00E+01  2.40E+02  4.00E+02  5.60E+02  7.20E+02
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