utilized to control roof drainage. Downspouts, or drainage devices, should outlet a minimum of 5 feet from structures or into a subsurface drainage system. Areas of seepage may develop due to irrigation or heavy rainfall, and should be anticipated. Minimizing irrigation will lessen this potential. If areas of seepage develop, recommendations for minimizing this effect could be provided upon request.

Erosion Control

Cut and fill slopes will be subject to surficial erosion during and after grading. Onsite earth materials have a moderate to high erosion potential. Consideration should be given to providing hay bales and silt fences for the temporary control of surface water, from a geotechnical viewpoint.

Landscape Maintenance

Only the amount of irrigation necessary to sustain plant life should be provided. Over-watering the landscape areas will adversely affect proposed site improvements. We would recommend that any proposed open-bottom planters adjacent to proposed structures be eliminated for a minimum distance of 10 feet. As an alternative, closed-bottom type planters could be utilized. An outlet placed in the bottom of the planter could be installed to direct drainage away from structures or any exterior concrete flatwork. If planters are constructed adjacent to structures, the sides and bottom of the planter should be provided with a moisture barrier to prevent penetration of irrigation water into the subgrade. Provisions should be made to drain the excess irrigation water from the planters without saturating the subgrade below or adjacent to the planters. Graded slope areas should be planted with drought resistant vegetation. Consideration should be given to the type of vegetation chosen and their potential effect upon surface improvements (i.e., some trees will have an effect on concrete flatwork with their extensive root systems). From a geotechnical standpoint leaching is not recommended for establishing landscaping. If the surface soils are processed for the purpose of adding amendments, they should be recompacted to 90 percent minimum relative compaction.

Gutters and Downspouts

As previously discussed in the drainage section, the installation of gutters and downspouts should be considered to collect roof water that may otherwise infiltrate the soils adjacent to the structures. If utilized, the downspouts should be drained into PVC collector pipes or non-erosive devices that will carry the water away from the house. Downspouts and gutters are not a requirement; however, from a geotechnical viewpoint, provided that positive drainage is incorporated into project design (as discussed previously).

Subsurface and Surface Water

Subsurface and surface water are not anticipated to affect site development, provided that the recommendations contained in this report are incorporated into final design and construction and that prudent surface and subsurface drainage practices are incorporated into the construction plans. Perched groundwater conditions along zones of contrasting permeabilities may not be precluded from occurring in the future due to site irrigation, poor drainage conditions, or damaged utilities, and should be anticipated. Should perched groundwater conditions develop, this office could assess the affected area(s) and provide the appropriate recommendations to mitigate the observed groundwater conditions. Groundwater conditions may change with the introduction of irrigation, rainfall, or other factors.

Site Improvements

Recommendations for exterior concrete flatwork design and construction can be provided upon request. If in the future, any additional improvements (e.g., pools, spas, etc.) are planned for the site, recommendations concerning the geological or geotechnical aspects of design and construction of said improvements could be provided upon request. This office should be notified in advance of any fill placement, grading of the site, or trench backfilling after rough grading has been completed. This includes any grading, utility trench, and retaining wall backfills.

Tile Flooring

Tile flooring can crack, reflecting cracks in the concrete slab below the tile, although small cracks in a conventional slab may not be significant. Therefore, the designer should consider additional steel reinforcement for concrete slabs-on-grade where tile will be placed. The tile installer should consider installation methods that reduce possible cracking of the tile such as slipsheets. Slipsheets or a vinyl crack isolation membrane (approved by the Tile Council of America/Ceramic Tile Institute) are recommended between tile and concrete slabs-on-grade.

Additional Grading

This office should be notified in advance of any fill placement, supplemental regrading of the site, or trench backfilling after rough grading has been completed. This includes completion of grading in the street and parking areas and utility trench and retaining wall backfills.

Footing Trench Excavation

All footing excavations should be observed by a representative of this firm subsequent to trenching and prior to concrete form and reinforcement placement. The purpose of the observations is to verify that the excavations are made into the recommended bearing

material and to the minimum widths and depths recommended for construction. If loose or compressible materials are exposed within the footing excavation, a deeper footing or removal and recompaction of the subgrade materials would be recommended at that time. Footing trench spoil and any excess soils generated from utility trench excavations should be compacted to a minimum relative compaction of 90 percent, if not removed from the site.

Trenching

Considering the nature of the onsite soils, it should be anticipated that caving or sloughing could be a factor in subsurface excavations and trenching. Shoring or excavating the trench walls at the angle of repose (typically 25 to 45 degrees) may be necessary and should be anticipated. All excavations should be observed by one of our representatives and minimally conform to CAL-OSHA and local safety codes.

Utility Trench Backfill

1. All interior utility trench backfill should be brought to at least 2 percent above optimum moisture content and then compacted to obtain a minimum relative compaction of 90 percent of the laboratory standard. As an alternative for shallow (12-inch to 18-inch) under-slab trenches, sand having a sand equivalent value of 30 or greater may be utilized and jetted or flooded into place. Observation, probing and testing should be provided to verify the desired results.

2. Exterior trenches adjacent to, and within areas extending below a 1:1 plane projected from the outside bottom edge of the footing, and all trenches beneath hardscape features and in slopes, should be compacted to at least 90 percent of the laboratory standard. Sand backfill, unless excavated from the trench, should not be used in these backfill areas. Compaction testing and observations, along with probing, should be accomplished to verify the desired results.

3. All trench excavations should conform to CAL-OSHA and local safety codes.

4. Utilities crossing grade beams, perimeter beams, or footings should either pass below the footing or grade beam utilizing a hardened collar or foam spacer, or pass through the footing or grade beam in accordance with the recommendations of the structural engineer.

SUMMARY OF RECOMMENDATIONS REGARDING GEOTECHNICAL OBSERVATION AND TESTING

We recommend that observation and/or testing be performed by GSI at each of the following construction stages:

- During grading/recertification.
- During significant excavation (i.e., higher than 4 feet).
- During placement of subdrains, toe drains, or other subdrainage devices, prior to placing fill and/or backfill.
- After excavation of building footings, retaining wall footings, and free standing walls footings, prior to the placement of reinforcing steel or concrete.
- Prior to pouring any slabs or flatwork, after presoaking/presaturation of building pads and other flatwork subgrade, before the placement of concrete, reinforcing steel, capillary break (i.e., sand, pea-gravel, etc.), or vapor barriers (i.e., visqueen, etc.).
- During retaining wall subdrain installation, prior to backfill placement.
- During placement of backfill for area drain, interior plumbing, utility line trenches, and retaining wall backfill.
- During slope construction/repair.
- When any unusual soil conditions are encountered during any construction operations, subsequent to the issuance of this report.
- When any developer or homeowner improvements, such as flatwork, spas, pools, walls, etc., are constructed.
- A report of geotechnical observation and testing should be provided at the conclusion of each of the above stages, in order to provide concise and clear documentation of site work, and/or to comply with code requirements.
- GSI should review project sales documents to homeowners/homeowners associations for geotechnical aspects, including irrigation practices, the conditions outlined above, etc., prior to any sales. At that stage, GSI will provide homeowners maintenance guidelines which should be incorporated into such documents.

OTHER DESIGN PROFESSIONALS/CONSULTANTS

The design civil engineer, structural engineer, post-tension designer, architect, landscape architect, wall designer, etc., should review the recommendations provided herein, incorporate those recommendations into all their respective plans, and by explicit reference, make this report part of their project plans. This report presents minimum design criteria for the design of slabs, foundations and other elements possibly applicable

to the project. These criteria should not be considered as substitutes for actual designs by the structural engineer/designer. The structural engineer/designer should analyze actual soil-structure interaction and consider, as needed, bearing, expansive soil influence, and strength, stiffness and deflections in the various slab, foundation, and other elements in order to develop appropriate, design-specific details. As conditions dictate, it is possible that other influences will also have to be considered. The structural engineer/designer should consider all applicable codes and authoritative sources where needed. If analyses by the structural engineer/designer result in less critical details than are provided herein as minimums, the minimums presented herein should be adopted. It is considered likely that some, more restrictive details will be required. If the structural engineer/designer has any questions or requires further assistance, they should not hesitate to call or otherwise transmit their requests to GSI. In order to mitigate potential distress, the foundation and/or improvement's designer should confirm to GSI and the governing agency, in writing, that the proposed foundations and/or improvements can tolerate the amount of differential settlement and/or expansion characteristics and design criteria specified herein.

PLAN REVIEW

Final project plans should be reviewed by this office prior to construction, so that construction is in accordance with the conclusions and recommendations of this report. Based on our review, supplemental recommendations and/or further geotechnical studies may be warranted.

LIMITATIONS

The materials encountered on the project site and utilized for our analysis are believed representative of the area; however, soil and bedrock materials vary in character between excavations and natural outcrops or conditions exposed during mass grading. Site conditions may vary due to seasonal changes or other factors.

Inasmuch as our study is based upon our review and engineering analyses and laboratory data, the conclusions and recommendations are professional opinions. These opinions have been derived in accordance with current standards of practice, and no warranty is expressed or implied. Standards of practice are subject to change with time. GSI assumes no responsibility or liability for work or testing performed by others, or their inaction; or work performed when GSI is not requested to be onsite, to evaluate if our recommendations have been properly implemented. Use of this report constitutes an agreement and consent by the user to all the limitations outlined above, notwithstanding any other agreements that may be in place. In addition, this report may be subject to review by the controlling authorities. Thus, this report brings to completion our scope of services for this portion of the project.

APPENDIX A

REFERENCES

Appendix A

REFERENCES

Blake, Thomas F., 2000a, FRISKSP, Version 4.00, A computer program for the probabilistic estimation of peak accelerations and uniform hazard spectra using 3-D faults as earthquake sources.

_____, Updated 2000b, EQSEARCH, A computer program for the research of historic earthquakes in California from using DMG files.

_____, 2000c, Eqfault, Eqsearch, and Frisk89, Computer programs for the deterministic, historic, and probabilistic prediction of peak horizontal acceleration for digitized California faults.

_____, 2000d, UBCSEIS Version 1.03, A computer program to determine UBC seismic factors.

Boore, et. al, 1997, Equations for estimating horizontal response spectra and peak acceleration from Western North American Earthquakes: A Summary of Recent Work, Seismological Research Letters, Vol. 68, No. 1, pp. 128-153.

CDMG, 1974, Geology of the south half of the El Toro Quadrangle, special report 110.

CDMG, 2000, seismic hazard zone map, El Toro Quadrangle, dated June 30, 1:24,000 scale.

Jennings, C.W., 1994, fault activity map of California and adjacent areas, scale 1:750,000, CDMG Geologic Data Map No. 6.

APPENDIX B

LOGS OF EXPLORATORY BORINGS

UNIFIED SOIL CLASSIFICATION SYSTEM					CONSISTENCY OR RELATIVE DENSITY	
Major Divisions			Group Symbols	Typical Names	CRITERIA	
Coarse-Grained Soils More than 50% retained on No. 200 sieve	Gravels 50% or more of coarse fraction retained on No. 4 sieve	Clean Gravels	GW	Well-graded gravels and gravel-sand mixtures, little or no fines	Standard Penetration Test	
			GP	Poorly graded gravels and gravel-sand mixtures, little or no fines		
		Gravels With Fines	GM	Silty gravels, gravel-sand-silt mixtures	Penetration Resistance N (blows/ft)	Relative Density
			GC	Clayey gravels, gravel-sand-clay mixtures	0-4	Very Loose
	Sands More than 50% of coarse fraction passes No. 4 sieve	Clean Sands	SW	Well-graded sands and gravelly sands, little or no fines	4-10	Loose
			SP	Poorly graded sands and gravelly sands, little or no fines	10-30	Medium
		Sands With Fines	SM	Silty sands, sand-silt mixtures	30-50	Dense
			SC	Clayey sands, sand-clay mixtures	>50	Very Dense
Fine-Grained Soils 50% or more passes No. 200 sieve	Silts and Clays Liquid Limit 50% or less		ML	Inorganic silts, very fine sands, rock flour, silty or clayey fine sands	Standard Penetration Test	
			CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays	Penetration Resistance N (blows/ft)	Consistency / Unconfined Compressive Strength (tons/ft²)
			OL	Organic silts and organic silty clays of low plasticity	<2	Very Soft / <0.25
	Silts and Clays Liquid Limit greater than 50%		MH	Inorganic silts, micaceous or diatomaceous fine sands or silts, elastic silts	2-4	Soft / 0.25-.050
			CH	Inorganic clays of high plasticity, fat clays	4-8	Medium / 0.50-1.00
			OH	Organic clays of medium to high plasticity	8-15	Stiff / 1.00-2.00
					15-30	Very Stiff / 2.00-4.00
Highly Organic Soils			PT	Peat, mucic, and other highly organic soils	>30	Hard / >4.00

3" 3/4" #4 #10 #40 #200 U.S. Standard Sieve

Unified Soil Classification	Cobbles	Gravel		Sand			Silt or Clay
		coarse	fine	coarse	medium	fine	

MOISTURE CONDITIONS

Dry	Absence of moist; dusty, dry to the touch
Slightly Moist	Below optimum moisture content for compaction
Moist	Near optimum moisture content
Very Moist	Above optimum moisture content
Wet	Visible free water; below water table

MATERIAL QUANTITY

trace	0 - 5 %
few	5 - 10 %
little	10 - 25 %
some	25 - 45 %

OTHER SYMBOLS

C	Core Sample
S	SPT Sample
B	Bulk Sample
▼	Groundwater
Qp	Pocket Penetrometer

BASIC LOG FORMAT:
Group name, Group symbol, (grain size), color, moisture, consistency or relative density. Additional comments: odor, presence of roots, mica, gypsum, coarse grained particles, etc.

EXAMPLE:
Sand (SP), fine to medium grained, brown, moist, loose, trace silt, little fine gravel, few cobbles up to 4" in size, some hair roots and rootlets.

PLATE A

LOG OF BORING B-1

Sheet 1 of 1

Date Drilled: 8/30/04 Logged by: SRB

Equipment: HOLLOW-STEM AUGER Driving Weight and Drop: ____

Surface Elevation(ft): ____ Depth to Water(ft): ____

☒ SPT ⧓ Modified California ▽ Water Level ADT

▣ Grab Sample ■ Shelby Tube ▼ Static Water Table

DEPTH (ft)	GRAPHIC LOG	SUMMARY OF SUBSURFACE CONDITIONS	SAMPLES: Sample Type	SAMPLES: Bulk	BLOWS/FOOT	MOISTURE (%)	DRY DENSITY (pcf)	USCS SYMB.
5		**COLLUVIUM (Qc):** Silty fine SAND (SM), medium brown to medium brownish-gray, dry loose, trace amount of rootlets; silty fine to medium SAND (SM) with trace of fine gravel, medium to dark brown to dark grayish-brown, dry to slightly moist, loose to medium dense, fine gravel (<5%)	⧓		24	12.4	100.7	
10		**CAPISTRANO FORMATION, OSO MEMBER (Tco):** Silty fine SANDSTONE (SANDSTONE), brownish-yellow mottled with light gray to white near top grading to strictly light gray to white near base, slightly moist to moist, medium dense, density increases with depth grading from medium dense near top to very dense near base, massive	☒		64			
15			▬		50/4"			
20		TOTAL DEPTH = 15.8 FEET GROUNDWATER NOT ENCOUNTERED BACKFILLED AND TAMPED						
25								
30								
35								
40								
45								

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Plate
B-1

LOG OF BORING B-2

Date Drilled: 8/30/04 Logged by: SRB

Equipment: HOLLOW-STEM AUGER Driving Weight and Drop: _____

Surface Elevation(ft): _____ Depth to Water(ft): _____

SPT | Modified California | Water Level ADT

Grab Sample | Shelby Tube | Static Water Table

DEPTH (ft)	GRAPHIC LOG	SUMMARY OF SUBSURFACE CONDITIONS	SAMPLES: Sample Type	SAMPLES: Bulk	BLOWS/FOOT	MOISTURE (%)	DRY DENSITY (pcf)	USCS SYMB.
		COLLUVIUM (Qc): Silty fine SAND (SM), medium brown to medium brownish-gray, dry, loose, trace amount of rootlets						
		Silty fine to medium SAND (SM) with some coarse sand and fine gravel, medium to dark brown slightly moist, loose to medium dense, coarse sand/ fine gravel (<7%)						
5		**CAPISTRANO FORMATION, OSO MEMBER (Tco):** Silty fine to medium SANDSTONE (SANDSTONE) with trace of fine gravel, light brownish-yellow to cream color, slightly moist to moist, dense to very dense, massive, fine gravel (<2%)			81			
10					50/3"			
		TOTAL DEPTH = 10.8 FEET GROUNDWATER NOT ENCOUNTERED BACKFILLED AND TAMPED						
15								

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Plate
B-2

LOG OF BORING B-3

Date Drilled: 8/30/04 Logged by: SRB

Equipment: HOLLOW-STEM AUGER Driving Weight and Drop: _____

Surface Elevation(ft): _____ Depth to Water(ft): _____

SPT | Modified California | Water Level ADT

Grab Sample | Shelby Tube | Static Water Table

DEPTH (ft)	GRAPHIC LOG	SUMMARY OF SUBSURFACE CONDITIONS	SAMPLES: Sample Type	SAMPLES: Bulk	BLOWS/FOOT	MOISTURE (%)	DRY DENSITY (pcf)	USCS SYMB.
		COLLUVIUM (Qc): Silty fine SAND (SM), medium brown to medium brownish-gray, dry, loose, trace amount of rootlets						
		Silty fine to medium SAND (SM) with trace amount of fine gravel, medium to dark brown to dark grayish-brown, dry to slightly moist, loose to medium dense, fine gravel (<5%)						
5		**CAPISTRANO FORMATION, OSO MEMBER (Tco):** Silty fine to medium SANDSTONE (SANDSTONE) with some coarse sand and fine gravel, light brownish-yellow mottled with light gray to white, slightly moist, dense to very dense, fine gravel (<15%), massive, coarser grained than 1.0-3.0' interval grading to fine grained sandstone near base.			61	5.4	122.2	
10					84			
		TOTAL DEPTH = 11.5 FEET GROUNDWATER NOT ENCOUNTERED BACKFILLED AND TAMPED						
15								

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Plate
B-3

LOG OF BORING B-4

Sheet 1 of 1

Date Drilled: 8/30/04 Logged by: SRB

Equipment: HOLLOW-STEM AUGER Driving Weight and Drop: _____

Surface Elevation(ft): _____ Depth to Water(ft): _____

SPT | Modified California | Water Level ADT

Grab Sample | Shelby Tube | Static Water Table

DEPTH (ft)	GRAPHIC LOG	SUMMARY OF SUBSURFACE CONDITIONS	SAMPLES: Sample Type	SAMPLES: Bulk	BLOWS/FOOT	MOISTURE (%)	DRY DENSITY (pcf)	USCS SYMB.
		ALLUVIUM (Qal): Silty fine SAND (SM) with trace of coarse sand/ fine gravel, medium brown to medium brownish-gray, dry, loose, coarse sand/ fine gravel (<5%)						
5			⊠		26			
		Silty fine SAND (SM), medium brownish-gray, slightly moist, medium dense						
10			⧓		23	6.2	110.4	
15			⊠		23			
20		@ 20.0' Silty fine SND (SM) with trace of coarse sand, dark brownish-gray, moist, medium dense, trace amount of coarse sand (<3%)	⧓		28	12.2	119.4	
25			⊠		17			
30		@ 30.0' Silty fine to medium SAND (SM) with trace of coarse sand, dark grayish-brown, moist, dense, coarse sand (<2%)	⧓		33	11.7	96.3	
35		**CAPISTRANO FORMATION, OSO MEMBER (Tco):** Silty fine SANDSTONE (SANDSTONE), light tan to cream with small localized pockets of orangish-brown, moist, medium dense to dense becoming more dense with depth, massive	⊠		23			
40			⧓		50/5"			
		TOTAL DEPTH = 40.9 FEET GROUNDWATER NOT ENCOUNTERED BACKFILLED AND TAMPED						
45								

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Plate
B-4

LOG OF BORING B-5

Sheet 1 of 1

Date Drilled: 8/30/04 Logged by: SRB

Equipment: HOLLOW-STEM AUGER Driving Weight and Drop: _____

Surface Elevation(ft): _____ Depth to Water(ft): _____

SPT | Modified California | Water Level ADT

Grab Sample | Shelby Tube | Static Water Table

DEPTH (ft)	GRAPHIC LOG	SUMMARY OF SUBSURFACE CONDITIONS	SAMPLES: Sample Type	SAMPLES: Bulk	BLOWS/FOOT	MOISTURE (%)	DRY DENSITY (pcf)	USCS SYMB.
		ALLUVIUM (Qal): Silty fine SAND (SM) with trace amount of coarse sand/ fine gravel, medium brown to medium brownish-gray, dry, loose, coarse sand/ fine gravel (<3%)						
5		Silty fine SAND (SM) with trace amount of coarse sand, medium to dark brownish-gray, slightly moist, medium dense, coarse sand (<5%)	⧓		34	4.1	115.2	
10			⊠		9			
15		@ 15.0' Silty fine SAND (SM), medium brownish-gray, slightly moist, medium dense, no coarse sand apparent	⧓		23	4.5	108.8	
20			⊠		19			
25		@ 25.0' Silty fine to medium SAND (SM) with trace amount of coarse sand, dark brownish-gray, moist, dense, coarse sand (<3%)	⧓		43	12.2	118.0	
30			⊠		13			
35		**CAPISTRANO FORMATION, OSO MEMBER (Tco):** Silty fine SANDSTONE (SANDSTONE), light to medium gray mottled with medium tan, moist, dense to very dense, massive	⧓		50	10.5	113.2	
40		TOTAL DEPTH = 36.5 FEET GROUNDWATER NOT ENCOUNTERED BACKFILLED AND TAMPED						
45								

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Plate
B-5

LOG OF BORING B-6

Date Drilled: 8/30/04 Logged by: SRB

Equipment: HOLLOW-STEM AUGER Driving Weight and Drop: _____

Surface Elevation(ft): _____ Depth to Water(ft): _____

SPT | Modified California | Water Level ADT

Grab Sample | Shelby Tube | Static Water Table

DEPTH (ft)	GRAPHIC LOG	SUMMARY OF SUBSURFACE CONDITIONS	SAMPLES: Sample Type	SAMPLES: Bulk	BLOWS/FOOT	MOISTURE (%)	DRY DENSITY (pcf)	USCS SYMB.
5		**ALLUVIUM (Qal):** Silty fine SAND (SM) with trace amount of coarse sand/ fine gravel, medium brown to medium brownish-gray, dry, loose, coarse sand/ fine gravel (<5%)	☒		17			
10		Silty fine SAND (SM) with trace of medium to coarse sand, medium to dark brownish-gray, slightly moist, dense, small amount of pin-hole-size pore void space (<5%), medium to coarse sand (<3%)	⧓		48	5.7	115.0	
15			☒		16			
20		@ 20.0' pore voids are no longer present	⧓		63	6.5	120.4	
25			☒		18			
30		@ 30.0' - Silty fine to medium SAND (SM) with trace amount of coarse sand, dark brownish-gray with a few orangish-yellow mottled streaks, moist, medium dense, small amount of pin-hole-size pore void space (<7%), coarse sand (<5%)	⧓		19	21.7	102.6	
35		**CAPISTRANO FORMATION, OSO MEMBER (Tco):** Silty fine to medium SANDSTONE (SANDSTONE) with trace of fine gravel, light tan mottled with orangish-yellow, moist, dense to very dense, massive, fine gravel is well rounded (<2%)	☒		25			
40			⧓		50			
45		TOTAL DEPTH = 41.5 FEET GROUNDWATER NOT ENCOUNTERED BACKFILLED AND TAMPED						

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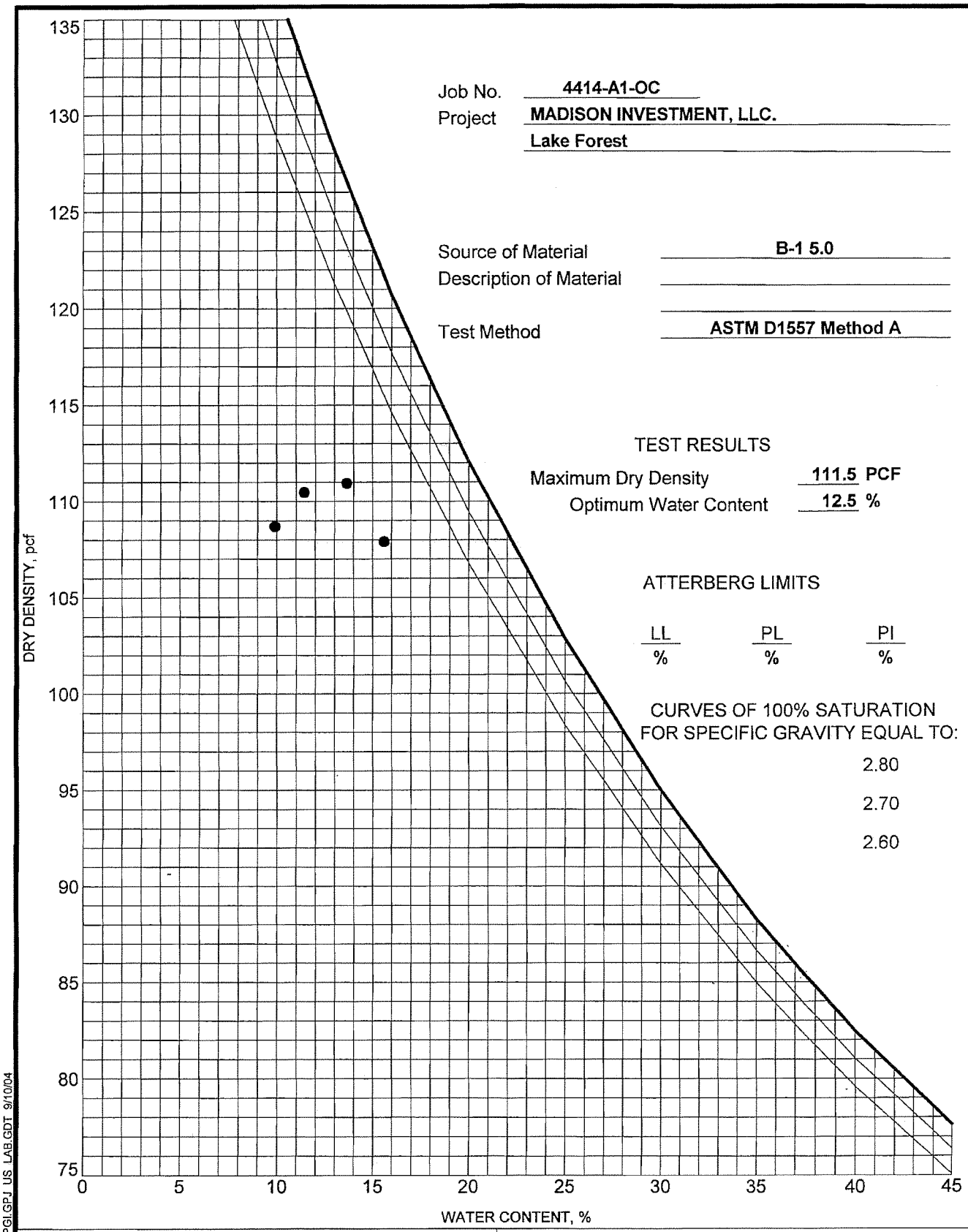
Plate
B-6

APPENDIX C

LABORATORY TESTING



Job No. 4414-A1-OC
Project MADISON INVESTMENT, LLC.
Lake Forest

Source of Material B-1 5.0
Description of Material

Test Method ASTM D1557 Method A

TEST RESULTS

Maximum Dry Density 111.5 PCF
Optimum Water Content 12.5 %

ATTERBERG LIMITS

LL	PL	PI
%	%	%

CURVES OF 100% SATURATION FOR SPECIFIC GRAVITY EQUAL TO:

2.80

2.70

2.60

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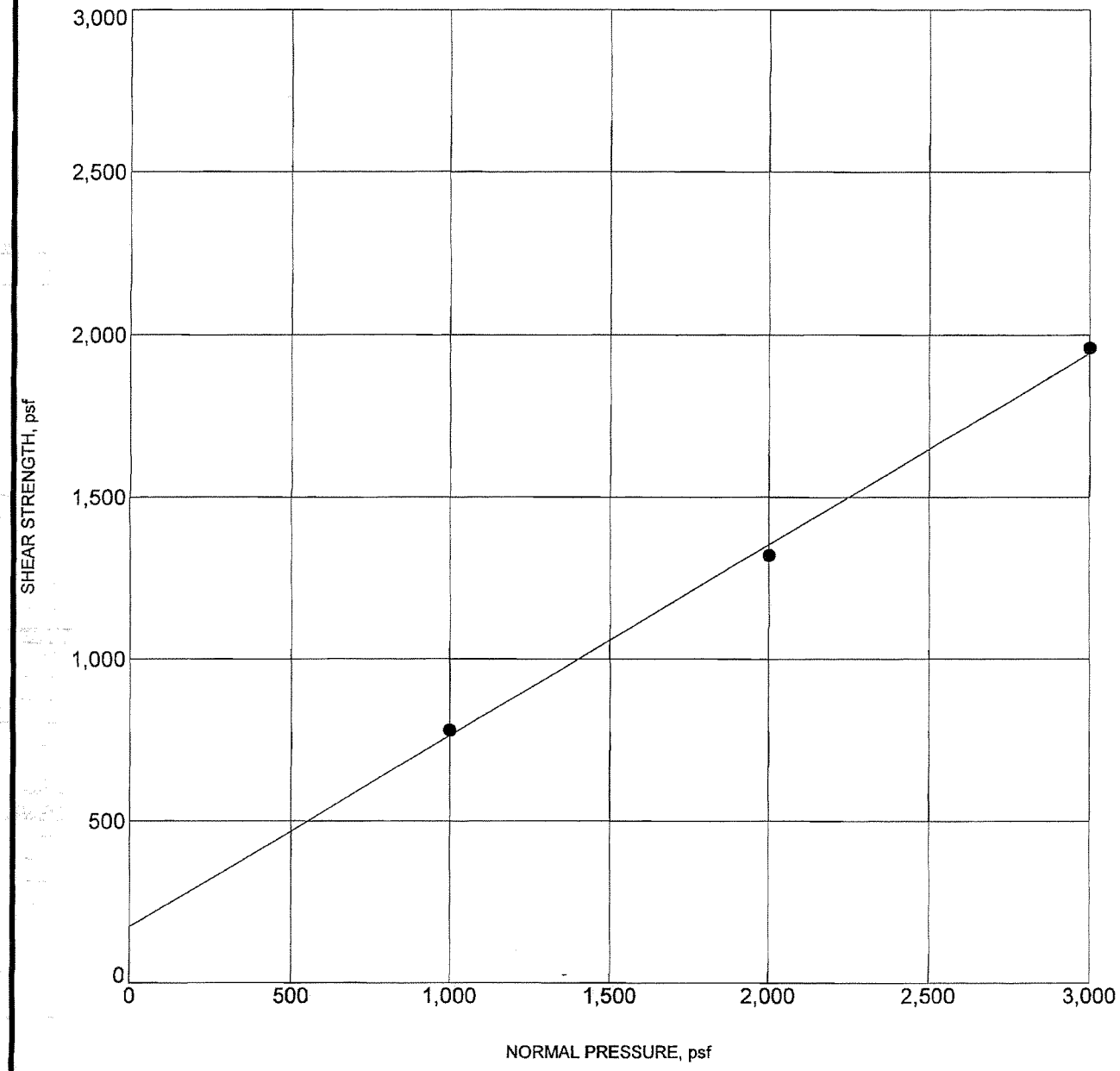
MOISTURE-DENSITY RELATIONSHIP

Project:
Location: Lake Forest
Number: 4414-A1-OC

PLATE
C-1



Specimen Identification		Classification	γ_d	MC%	c	ϕ
● B-1	5.0	**REMOLDED**	93	21	173	31

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DIRECT SHEAR TEST

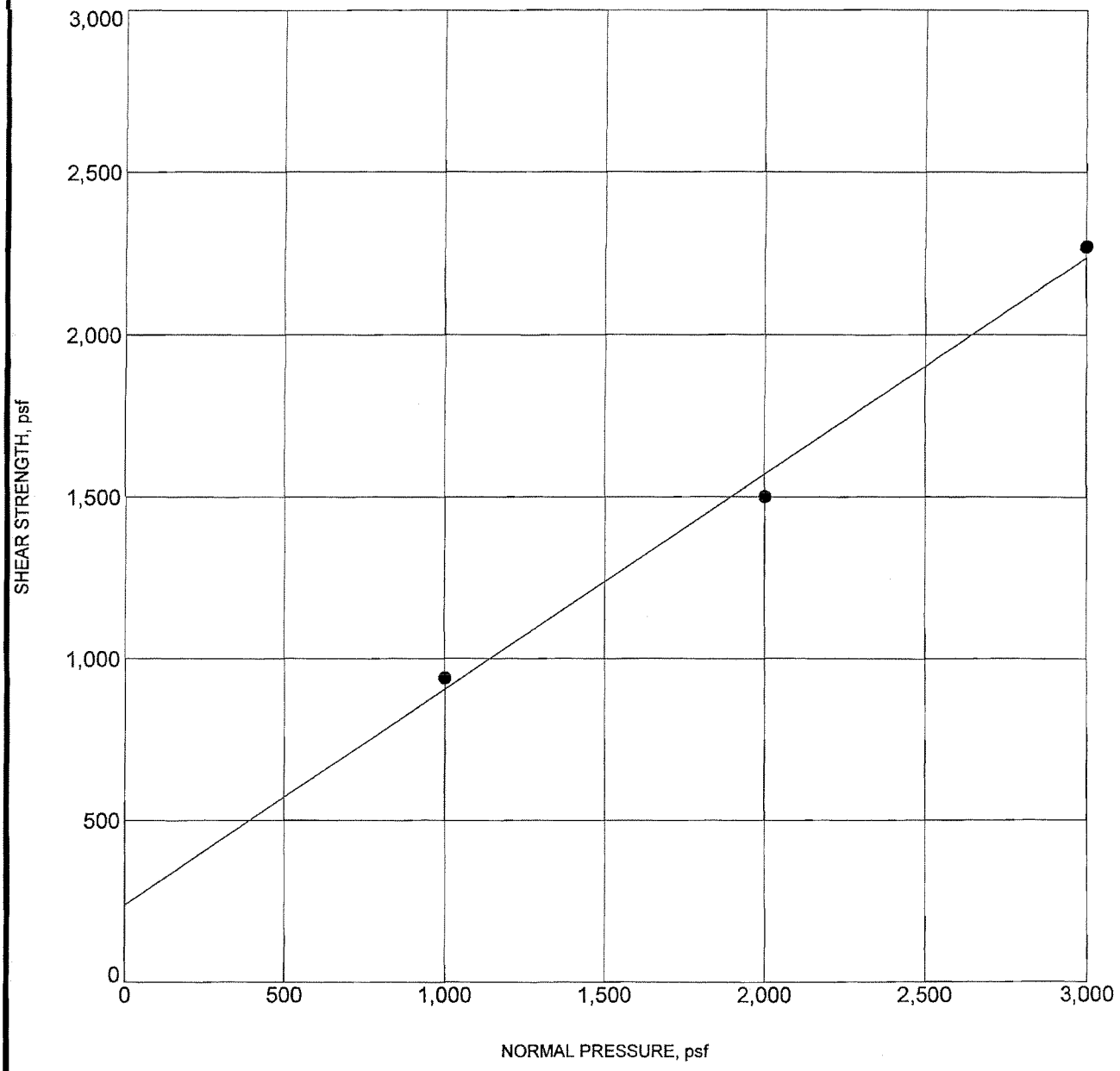
Project:

Location: Lake Forest

Number: 4414-A1-OC

PLATE

C-2



Specimen Identification		Classification	γ_d	MC%	c	ϕ
● B-2	10.0		109	16	240	34

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DIRECT SHEAR TEST

Project:

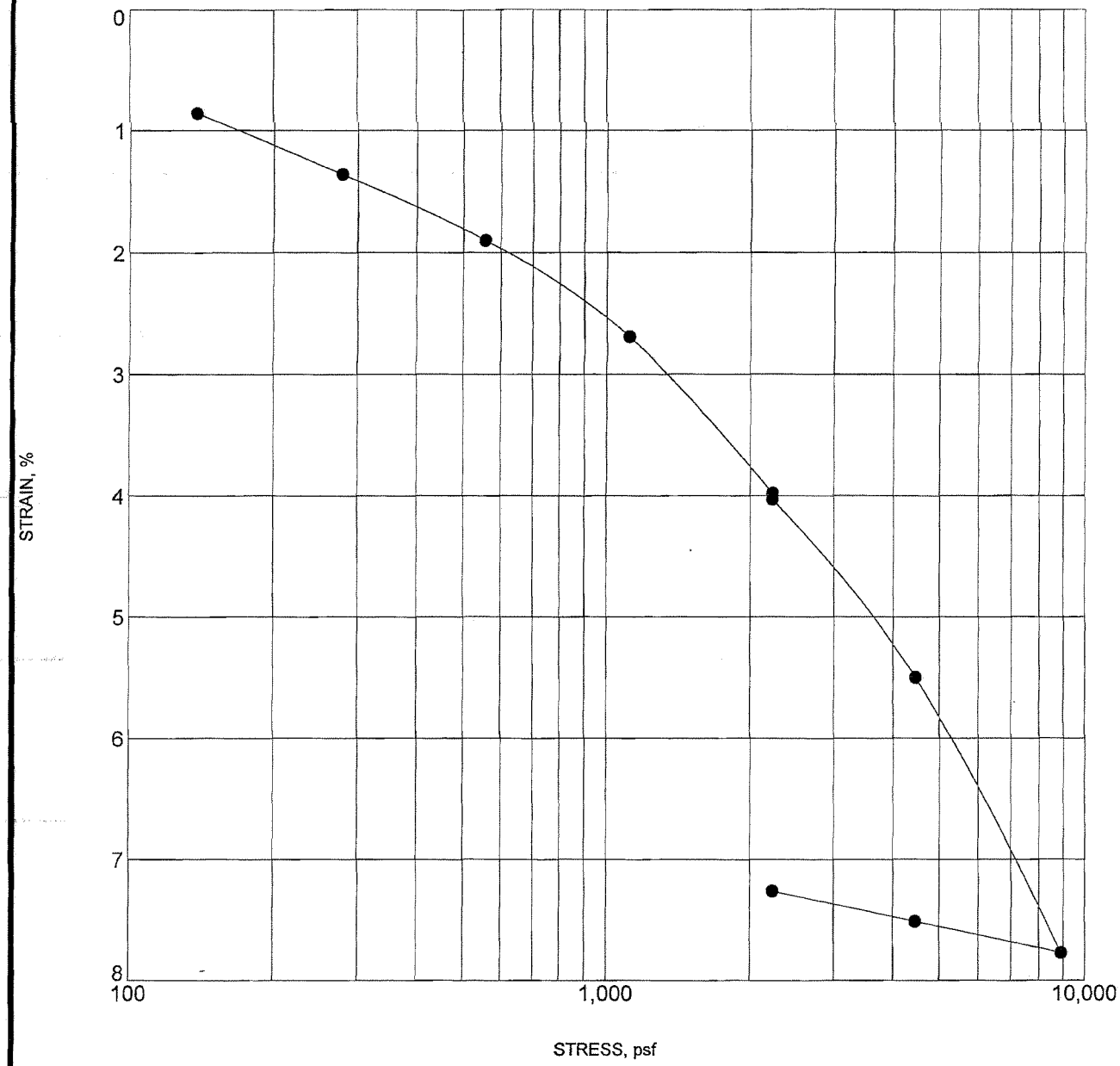
Location: Lake Forest

Number: 4414-A1-OC

PLATE

C-3

US DIRECT SHEAR 4414PGI.GPJ US LAB.GDT 9/10/04



Specimen Identification			Classification	γ_d	MC%
●	B-6	30.0		98	20

US CONSOL STRAIN 4414PGI.GPJ US_LAB.GDT 9/13/04

GSI

GEOSOILS, INC.
1446 East Chestnut Avenue
Santa Ana, California
Telephone: 714-647-0277
Fax: 714-647-0745

CONSOLIDATION TEST

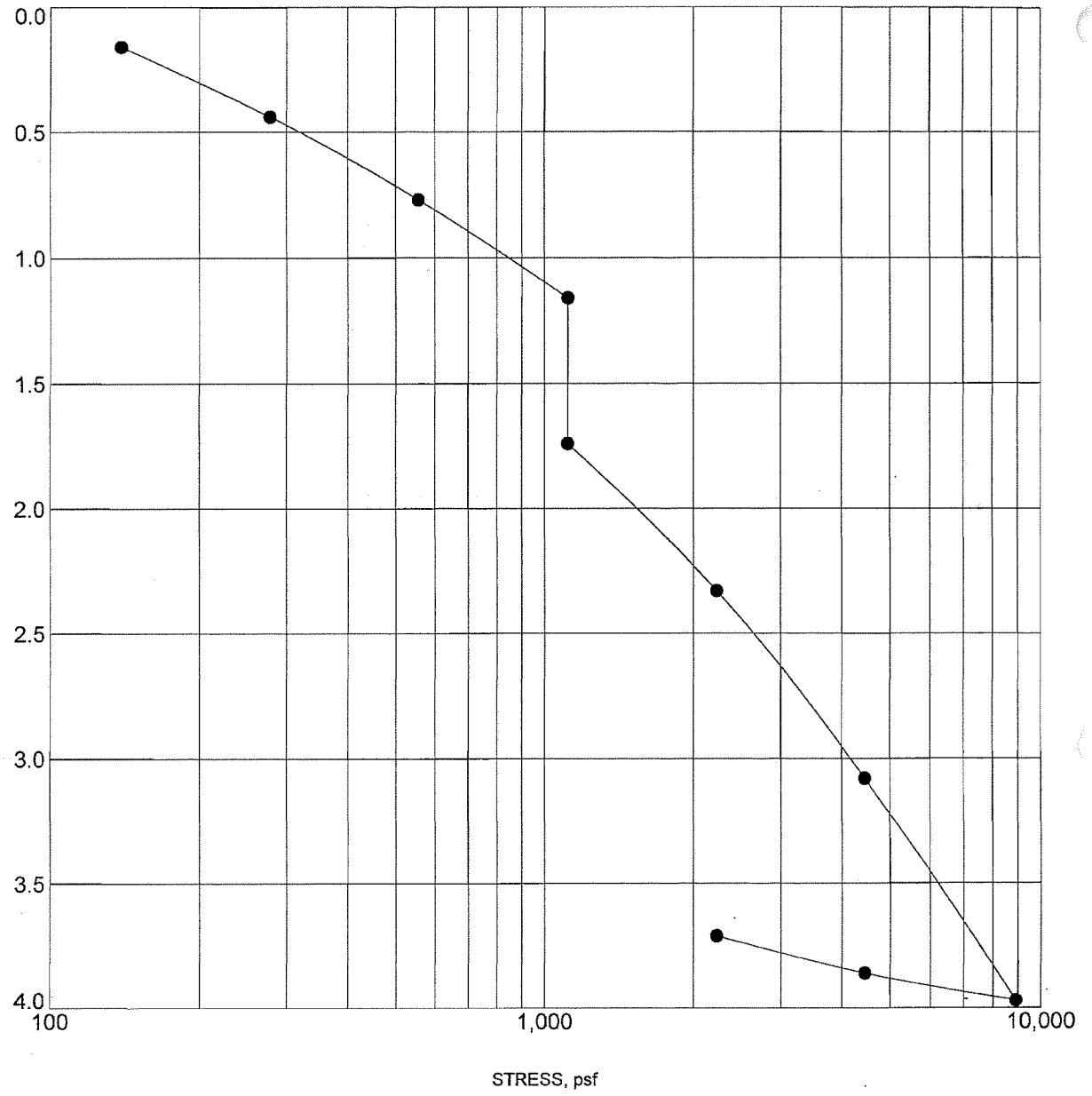
Project:

Location: Lake Forest

Number: 4414-A1-OC

PLATE

C-4



Specimen Identification		Classification	γ_d	MC%
● B-6	20.0		119	12

GSI
GEOSOILS, INC.
1446 East Chestnut Avenue
Santa Ana, California
Telephone: 714-647-0277
Fax: 714-647-0745

CONSOLIDATION TEST

Project:

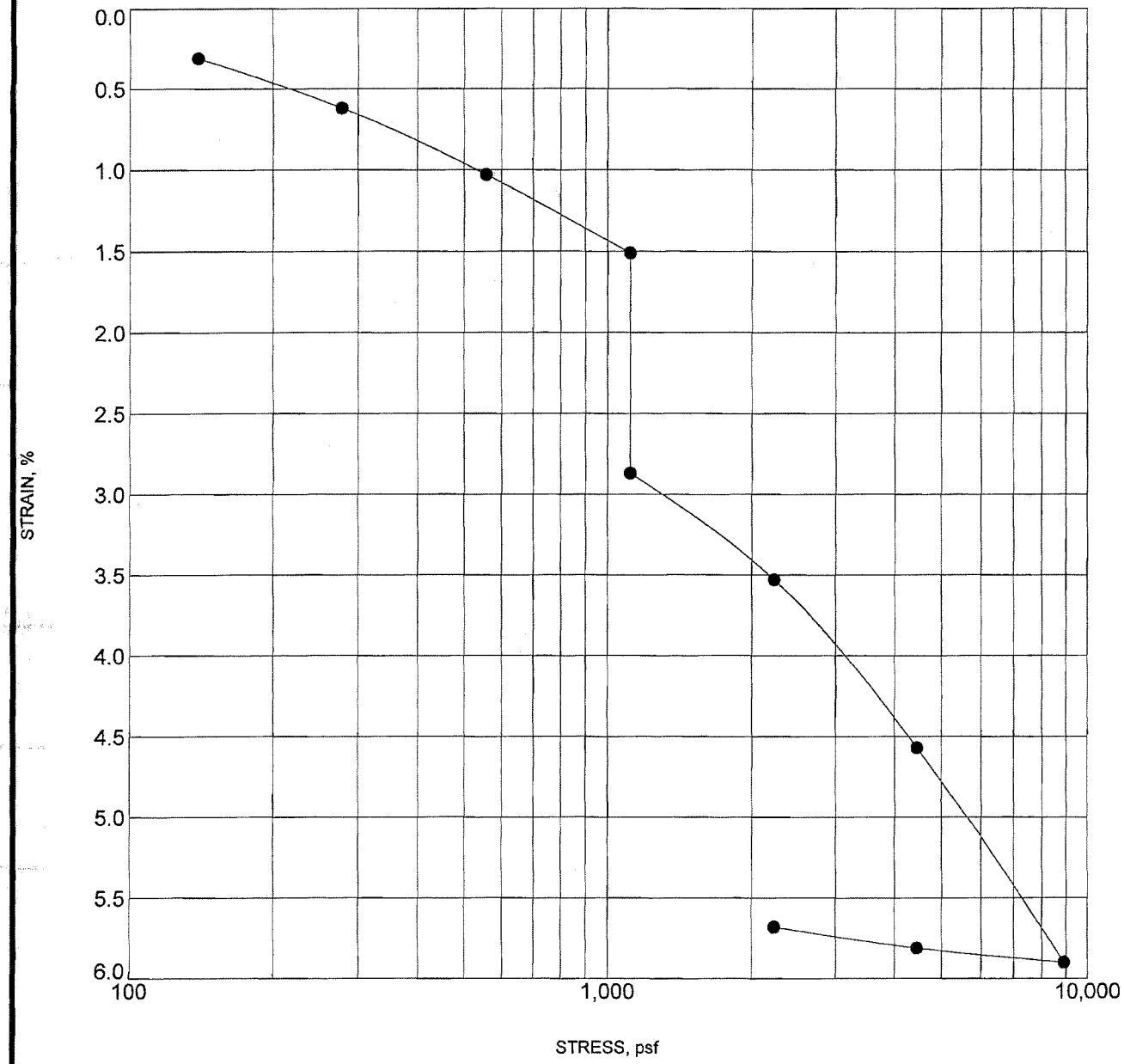
Location: Lake Forest

Number: 4414-A1-OC

PLATE

C-5

US CONSOL STRAIN 4414PGI.GPJ US_LAB.GDT 9/10/04



Specimen Identification		Classification	γ_d	MC%
● B-5 15.0			102	18

US CONSOL STRAIN 4414PGI.GPJ US_LAB.GDT 9/10/04

GSI
GEOSOILS, INC.
1446 East Chestnut Avenue
Santa Ana, California
Telephone: 714-647-0277
Fax: 714-647-0745

CONSOLIDATION TEST

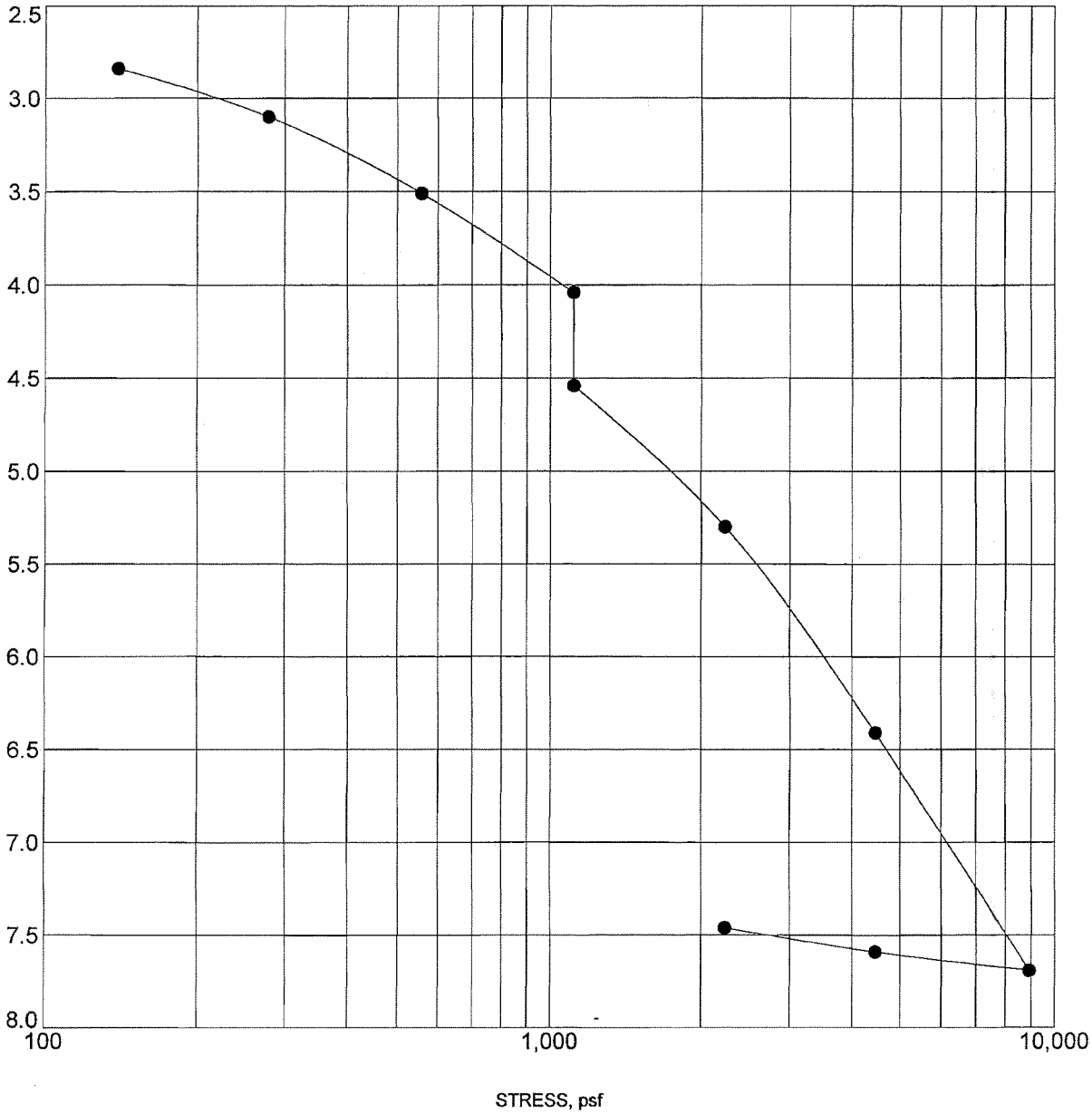
Project:

Location: Lake Forest

Number: 4414-A1-OC

PLATE

C-6



Specimen Identification		Classification	γ_d	MC%
● B-4	20.0		114	13

GSI
GEOSOILS, INC.
1446 East Chestnut Avenue
Santa Ana, California
Telephone: 714-647-0277
Fax: 714-647-0745

CONSOLIDATION TEST

Project:

Location: Lake Forest

Number: 4414-A1-OC

PLATE
C-7

US CONSOL STRAIN 4414PGI.GPJ US_LAB.GDT 9/10/04

Corrosivity

One corrosivity test was performed and collected from the site. The test was performed in accordance with the CalTrans Test Methods 422 and 532.

Location	Chloride (ppm)	Minimum Resistivity (ohm-cm)	Sulfate % by weight	Ph
B-1 @ 5'	53	7800	0.001	7.48

The correlation between electrical resistivity and corrosivity is as follows:

Below 1,000 ohm-cm = Severely Corrosive
1,000 to 2,000 ohm-cm = Corrosive
2,000 to 10,000 ohm-cm = Moderately corrosive
Over 10,000 ohm-cm = Mildly corrosive

APPENDIX D

SEISMIC ANALYSIS

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*                    *
*    U B C S E I S   *
*                    *
*    Version  1.03   *
*                    *
**********************

   COMPUTATION OF 1997
  UNIFORM BUILDING CODE
SEISMIC DESIGN PARAMETERS

JOB NUMBER: 4414-A1                                DATE: 09-21-2004

JOB NAME: MADISON INVESTM

FAULT-DATA-FILE NAME: CDMGUBCR.DAT


SITE COORDINATES:
   SITE LATITUDE:  33.6621
   SITE LONGITUDE:  117.6857

UBC SEISMIC ZONE:  0.4

UBC SOIL PROFILE TYPE:  SD

NEAREST TYPE A FAULT:
   NAME:  ELSINORE-GLEN IVY
   DISTANCE:  19.0  km

NEAREST TYPE B FAULT:
   NAME:  CHINO-CENTRAL AVE. (Elsinore)
   DISTANCE:  17.2  km

NEAREST TYPE C FAULT:
   NAME:
   DISTANCE:  99999.0  km

SELECTED UBC SEISMIC COEFFICIENTS:
   Na:  1.0
   Nv:  1.0
   Ca:  0.44
   Cv:  0.64
   Ts:  0.582
   To:  0.116

   ********************************************************************
   * CAUTION:  The digitized data points used to model faults are     *
   *           limited in number and have been digitized from small-  *
   *           scale maps (e.g., 1:750,000 scale).  Consequently,     *
   *           the estimated fault-site-distances may be in error by  *
   *           several kilometers.  Therefore, it is important that   *
   *           the distances be carefully checked for accuracy and    *
   *           adjusted as needed, before they are used in design.    *
   ********************************************************************
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SUMMARY OF FAULT PARAMETERS

ABBREVIATED FAULT NAME	APPROX. DISTANCE (km)	SOURCE TYPE (A,B,C)	MAX. MAG. (Mw)	SLIP RATE (mm/yr)	FAULT TYPE (SS,DS,BT)
CHINO-CENTRAL AVE. (Elsinore)	17.2	B	6.7	1.00	DS
ELSINORE-GLEN IVY	19.0	A	6.8	5.00	SS
NEWPORT-INGLEWOOD (Offshore)	19.8	B	6.9	1.50	SS
ELSINORE-WHITTIER	21.8	A	6.8	2.50	SS
NEWPORT-INGLEWOOD (L.A.Basin)	22.8	A	6.9	1.00	SS
ELSINORE-TEMECULA	31.3	B	6.8	5.00	SS
PALOS VERDES	41.3	B	7.1	3.00	SS
SAN JOSE	45.6	B	6.5	0.50	DS
CORONADO BANK	49.1	B	7.4	3.00	SS
SIERRA MADRE (Central)	51.5	B	7.0	3.00	DS
CUCAMONGA	51.7	B	7.0	5.00	DS
SAN JACINTO-SAN BERNARDINO	56.4	A	6.7	12.00	SS
SAN JACINTO-SAN JACINTO VALLEY	57.3	A	6.9	12.00	SS
RAYMOND	63.4	B	6.5	0.50	DS
ROSE CANYON	63.9	B	6.9	1.50	SS
CLAMSHELL-SAWPIT	64.2	B	6.5	0.50	DS
VERDUGO	67.8	B	6.7	0.50	DS
SAN ANDREAS - Southern	69.9	A	7.4	24.00	SS
ELSINORE-JULIAN	69.9	A	7.1	5.00	SS
HOLLYWOOD	71.6	B	6.5	1.00	DS
SAN JACINTO-ANZA	71.7	A	7.2	12.00	SS
SAN ANDREAS - 1857 Rupture	73.5	A	7.8	34.00	SS
CLEGHORN	74.6	B	6.5	3.00	SS
NORTH FRONTAL FAULT ZONE (West)	79.8	B	7.0	1.00	DS
SANTA MONICA	81.5	B	6.6	1.00	DS
MALIBU COAST	88.5	B	6.7	0.30	DS
SIERRA MADRE (San Fernando)	88.7	B	6.7	2.00	DS
SAN GABRIEL	91.4	B	7.0	1.00	SS
PINTO MOUNTAIN	99.4	B	7.0	2.50	SS
ANACAPA-DUME	100.0	B	7.3	3.00	DS
NORTH FRONTAL FAULT ZONE (East)	104.1	B	6.7	0.50	DS
SANTA SUSANA	105.0	B	6.6	5.00	DS
HELENDALE - S. LOCKHARDT	109.1	B	7.1	0.60	SS
SAN JACINTO-COYOTE CREEK	111.4	A	6.8	4.00	SS
HOLSER	114.0	B	6.5	0.40	DS
EARTHQUAKE VALLEY	115.3	B	6.5	2.00	SS
OAK RIDGE (Onshore)	123.7	B	6.9	4.00	DS
LENWOOD-LOCKHART-OLD WOMAN SPRGS	124.0	B	7.3	0.60	SS
SIMI-SANTA ROSA	124.4	B	6.7	1.00	DS
BURNT MTN.	125.2	B	6.5	0.60	SS
EUREKA PEAK	129.5	B	6.5	0.60	SS
LANDERS	130.0	B	7.3	0.60	SS
SAN CAYETANO	131.7	B	6.8	6.00	DS
JOHNSON VALLEY (Northern)	133.3	B	6.7	0.60	SS
EMERSON So. - COPPER MTN.	143.7	B	6.9	0.60	SS
ELSINORE-COYOTE MOUNTAIN	145.0	B	6.8	4.00	SS

SUMMARY OF FAULT PARAMETERS

ABBREVIATED FAULT NAME	APPROX. DISTANCE (km)	SOURCE TYPE (A,B,C)	MAX. MAG. (Mw)	SLIP RATE (mm/yr)	FAULT TYPE (SS,DS,BT)
SAN JACINTO - BORREGO	147.3	B	6.6	4.00	SS
SANTA YNEZ (East)	151.2	B	7.0	2.00	SS
GRAVEL HILLS - HARPER LAKE	152.0	B	6.9	0.60	SS
CALICO - HIDALGO	152.7	B	7.1	0.60	SS
VENTURA - PITAS POINT	154.6	B	6.8	1.00	DS
PISGAH-BULLION MTN.-MESQUITE LK	160.3	B	7.1	0.60	SS
BLACKWATER	163.6	B	6.9	0.60	SS
M.RIDGE-ARROYO PARIDA-SANTA ANA	163.8	B	6.7	0.40	DS
GARLOCK (West)	165.4	A	7.1	6.00	SS
RED MOUNTAIN	168.9	B	6.8	2.00	DS
PLEITO THRUST	171.1	B	6.8	2.00	DS
SANTA CRUZ ISLAND	173.2	B	6.8	1.00	DS
BIG PINE	177.7	B	6.7	0.80	SS
SUPERSTITION MTN. (San Jacinto)	179.4	B	6.6	5.00	SS
GARLOCK (East)	183.1	A	7.3	7.00	SS
ELMORE RANCH	183.5	B	6.6	1.00	SS
SUPERSTITION HILLS (San Jacinto)	185.6	B	6.6	4.00	SS
BRAWLEY SEISMIC ZONE	186.5	B	6.5	25.00	SS
WHITE WOLF	191.1	B	7.2	2.00	DS
ELSINORE-LAGUNA SALADA	196.8	B	7.0	3.50	SS
SANTA YNEZ (West)	202.2	B	6.9	2.00	SS
So. SIERRA NEVADA	208.6	B	7.1	0.10	DS
SANTA ROSA ISLAND	209.4	B	6.9	1.00	DS
IMPERIAL	212.7	A	7.0	20.00	SS
LITTLE LAKE	216.6	B	6.7	0.70	SS
TANK CANYON	223.7	B	6.5	1.00	DS
PANAMINT VALLEY	228.6	B	7.2	2.50	SS
OWL LAKE	228.8	B	6.5	2.00	SS
LOS ALAMOS-W. BASELINE	245.1	B	6.8	0.70	DS
DEATH VALLEY (South)	246.5	B	6.9	4.00	SS
LIONS HEAD	262.5	B	6.6	0.02	DS
SAN JUAN	267.6	B	7.0	1.00	SS
SAN LUIS RANGE (S. Margin)	270.6	B	7.0	0.20	DS
DEATH VALLEY (Graben)	278.3	B	6.9	4.00	DS
CASMALIA (Orcutt Frontal Fault)	279.9	B	6.5	0.25	DS
OWENS VALLEY	282.5	B	7.6	1.50	SS
LOS OSOS	300.0	B	6.8	0.50	DS
HOSGRI	308.6	B	7.3	2.50	SS
HUNTER MTN. - SALINE VALLEY	313.8	B	7.0	2.50	SS
INDEPENDENCE	318.0	B	6.9	0.20	DS
RINCONADA	319.0	B	7.3	1.00	SS
DEATH VALLEY (Northern)	329.3	A	7.2	5.00	SS
SAN ANDREAS (Creeping)	372.1	B	5.0	34.00	SS
BIRCH CREEK	373.4	B	6.5	0.70	DS
WHITE MOUNTAINS	378.9	B	7.1	1.00	SS
DEEP SPRINGS	398.3	B	6.6	0.80	DS

SUMMARY OF FAULT PARAMETERS

ABBREVIATED FAULT NAME	APPROX. DISTANCE (km)	SOURCE TYPE (A,B,C)	MAX. MAG. (Mw)	SLIP RATE (mm/yr)	FAULT TYPE (SS,DS,BT)
DEATH VALLEY (N. of Cucamongo)	406.0	A	7.0	5.00	SS
ROUND VALLEY (E. of S.N.Mtns.)	407.5	B	6.8	1.00	DS
FISH SLOUGH	416.4	B	6.6	0.20	DS
HILTON CREEK	433.4	B	6.7	2.50	DS
ORTIGALITA	455.4	B	6.9	1.00	SS
HARTLEY SPRINGS	457.1	B	6.6	0.50	DS
CALAVERAS (So.of Calaveras Res)	461.6	B	6.2	15.00	SS
MONTEREY BAY - TULARCITOS	465.6	B	7.1	0.50	DS
PALO COLORADO - SUR	467.9	B	7.0	3.00	SS
QUIEN SABE .	474.6	B	6.5	1.00	SS
MONO LAKE	492.9	B	6.6	2.50	DS
ZAYANTE-VERGELES	493.4	B	6.8	0.10	SS
SARGENT	498.5	B	6.8	3.00	SS
SAN ANDREAS (1906)	498.6	A	7.9	24.00	SS
ROBINSON CREEK	524.0	B	6.5	0.50	DS
SAN GREGORIO	540.8	A	7.3	5.00	SS
GREENVILLE	547.4	B	6.9	2.00	SS
HAYWARD (SE Extension)	548.3	B	6.5	3.00	SS
MONTE VISTA - SHANNON	548.6	B	6.5	0.40	DS
ANTELOPE VALLEY	564.0	B	6.7	0.80	DS
HAYWARD (Total Length)	567.8	A	7.1	9.00	SS
CALAVERAS (No.of Calaveras Res)	567.8	B	6.8	6.00	SS
GENOA	588.9	B	6.9	1.00	DS
CONCORD - GREEN VALLEY	615.2	B	6.9	6.00	SS
RODGERS CREEK	654.0	A	7.0	9.00	SS
WEST NAPA	654.7	B	6.5	1.00	SS
POINT REYES	673.5	B	6.8	0.30	DS
HUNTING CREEK - BERRYESSA	676.9	B	6.9	6.00	SS
MAACAMA (South)	716.4	B	6.9	9.00	SS
COLLAYOMI	733.1	B	6.5	0.60	SS
BARTLETT SPRINGS	736.5	A	7.1	6.00	SS
MAACAMA (Central)	758.0	A	7.1	9.00	SS
MAACAMA (North)	817.2	A	7.1	9.00	SS
ROUND VALLEY (N. S.F.Bay)	823.2	B	6.8	6.00	SS
BATTLE CREEK	847.0	B	6.5	0.50	DS
LAKE MOUNTAIN	881.5	B	6.7	6.00	SS
GARBERVILLE-BRICELAND	898.7	B	6.9	9.00	SS
MENDOCINO FAULT ZONE	955.0	A	7.4	35.00	DS
LITTLE SALMON (Onshore)	961.4	A	7.0	5.00	DS
MAD RIVER	964.1	B	7.1	0.70	DS
CASCADIA SUBDUCTION ZONE	968.7	A	8.3	35.00	DS
McKINLEYVILLE	974.6	B	7.0	0.60	DS
TRINIDAD	976.1	B	7.3	2.50	DS
FICKLE HILL	976.5	B	6.9	0.60	DS
TABLE BLUFF	982.0	B	7.0	0.60	DS
LITTLE SALMON (Offshore)	995.3	B	7.1	1.00	DS

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*    E Q F A U L T   *
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*    Version 3.00    *
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DETERMINISTIC ESTIMATION OF
PEAK ACCELERATION FROM DIGITIZED FAULTS

JOB NUMBER: 4414-A1

DATE: 09-21-2004

JOB NAME: MADISON

CALCULATION NAME: 4414

FAULT-DATA-FILE NAME: CDMGFLTE.DAT

SITE COORDINATES:
SITE LATITUDE: 33.6621
SITE LONGITUDE: 117.6857

SEARCH RADIUS: 100 mi

ATTENUATION RELATION: 3) Boore et al. (1997) Horiz. - NEHRP D (250)
UNCERTAINTY (M=Median, S=Sigma): S Number of Sigmas: 1.0
DISTANCE MEASURE: cd_2drp
SCOND: 1
Basement Depth: 5.00 km Campbell SSR: Campbell SHR:
COMPUTE PEAK HORIZONTAL ACCELERATION

FAULT-DATA FILE USED: CDMGFLTE.DAT

MINIMUM DEPTH VALUE (km): 0.0

EQFAULT SUMMARY

DETERMINISTIC SITE PARAMETERS

ABBREVIATED FAULT NAME	APPROXIMATE DISTANCE mi (km)	ESTIMATED MAX. EARTHQUAKE EVENT: MAXIMUM EARTHQUAKE MAG. (Mw)	ESTIMATED MAX. EARTHQUAKE EVENT: PEAK SITE ACCEL. g	ESTIMATED MAX. EARTHQUAKE EVENT: EST. SITE INTENSITY MOD.MERC.
CHINO-CENTRAL AVE. (Elsinore)	9.4(15.1)	6.7	0.472	X
ELSINORE-GLEN IVY	11.8(19.0)	6.8	0.348	IX
NEWPORT-INGLEWOOD (Offshore)	12.3(19.8)	6.9	0.356	IX
WHITTIER	13.5(21.8)	6.8	0.315	IX
NEWPORT-INGLEWOOD (L.A.Basin)	14.3(23.0)	6.9	0.319	IX
ELYSIAN PARK THRUST	18.5(29.7)	6.7	0.289	IX
COMPTON THRUST	19.0(30.6)	6.8	0.298	IX
ELSINORE-TEMECULA	19.4(31.3)	6.8	0.241	IX
PALOS VERDES	25.7(41.4)	7.1	0.228	IX
SAN JOSE	28.3(45.6)	6.5	0.188	VIII
CORONADO BANK	30.5(49.1)	7.4	0.234	IX
SIERRA MADRE	32.0(51.5)	7.0	0.222	IX
CUCAMONGA	32.1(51.7)	7.0	0.222	IX
SAN JACINTO-SAN BERNARDINO	35.0(56.4)	6.7	0.146	VIII
SAN JACINTO-SAN JACINTO VALLEY	35.6(57.3)	6.9	0.160	VIII
RAYMOND	39.4(63.4)	6.5	0.146	VIII
ROSE CANYON	39.7(63.9)	6.9	0.147	VIII
CLAMSHELL-SAWPIT	39.9(64.2)	6.5	0.144	VIII
VERDUGO	42.1(67.8)	6.7	0.154	VIII
SAN ANDREAS - Southern	43.4(69.9)	7.4	0.178	VIII
ELSINORE-JULIAN	43.4(69.9)	7.1	0.152	VIII
SAN ANDREAS - San Bernardino	43.4(69.9)	7.3	0.169	VIII
HOLLYWOOD	44.5(71.6)	6.4	0.126	VIII
SAN JACINTO-ANZA	44.6(71.7)	7.2	0.157	VIII
SAN ANDREAS - Mojave	45.7(73.5)	7.1	0.147	VIII
SAN ANDREAS - 1857 Rupture	45.7(73.5)	7.8	0.212	VIII
CLEGHORN	46.4(74.6)	6.5	0.106	VII
NORTH FRONTAL FAULT ZONE (West)	49.5(79.7)	7.0	0.159	VIII
SANTA MONICA	50.6(81.5)	6.6	0.126	VIII
MALIBU COAST	55.0(88.5)	6.7	0.125	VII
SIERRA MADRE (San Fernando)	55.1(88.7)	6.7	0.125	VII
SAN GABRIEL	56.8(91.4)	7.0	0.117	VII
NORTHRIDGE (E. Oak Ridge)	57.1(91.9)	6.9	0.135	VIII
PINTO MOUNTAIN	61.8(99.4)	7.0	0.110	VII
ANACAPA-DUME	62.1(100.0)	7.3	0.156	VIII
NORTH FRONTAL FAULT ZONE (East)	63.6(102.3)	6.7	0.112	VII
SANTA SUSANA	65.2(105.0)	6.6	0.104	VII
HELENDALE - S. LOCKHARDT	67.8(109.1)	7.1	0.108	VII
SAN JACINTO-COYOTE CREEK	69.2(111.4)	6.8	0.091	VII
HOLSER	70.5(113.5)	6.5	0.093	VII

DETERMINISTIC SITE PARAMETERS

ABBREVIATED FAULT NAME	APPROXIMATE DISTANCE mi (km)	ESTIMATED MAX. EARTHQUAKE EVENT: MAXIMUM EARTHQUAKE MAG. (Mw)	ESTIMATED MAX. EARTHQUAKE EVENT: PEAK SITE ACCEL. g	ESTIMATED MAX. EARTHQUAKE EVENT: EST. SITE INTENSITY MOD. MERC.
EARTHQUAKE VALLEY	71.6(115.3)	6.5	0.075	VII
SAN ANDREAS - Coachella	72.2(116.2)	7.1	0.103	VII
OAK RIDGE (Onshore)	76.3(122.8)	6.9	0.108	VII
LENWOOD-LOCKHART-OLD WOMAN SPRGS	77.0(124.0)	7.3	0.109	VII
SIMI-SANTA ROSA	77.3(124.4)	6.7	0.096	VII
BURNT MTN.	77.8(125.2)	6.4	0.067	VI
EUREKA PEAK	80.5(129.5)	6.4	0.065	VI
LANDERS	80.8(130.0)	7.3	0.105	VII
SAN CAYETANO	81.8(131.7)	6.8	0.097	VII
JOHNSON VALLEY (Northern)	82.8(133.3)	6.7	0.075	VII
SAN ANDREAS - Carrizo	85.9(138.3)	7.2	0.095	VII
EMERSON So. - COPPER MTN.	89.3(143.7)	6.9	0.078	VII
ELSINORE-COYOTE MOUNTAIN	90.1(145.0)	6.8	0.074	VII
SAN JACINTO - BORREGO	91.5(147.3)	6.6	0.066	VI
OAK RIDGE(Blind Thrust Offshore)	91.8(147.7)	6.9	0.093	VII
CHANNEL IS. THRUST (Eastern)	93.5(150.4)	7.4	0.120	VII
SANTA YNEZ (East)	93.6(150.7)	7.0	0.080	VII
GRAVEL HILLS - HARPER LAKE	94.4(152.0)	6.9	0.075	VII
CALICO - HIDALGO	94.9(152.7)	7.1	0.083	VII
VENTURA - PITAS POINT	96.1(154.6)	6.8	0.085	VII
PISGAH-BULLION MTN.-MESQUITE LK	99.6 (160.3)	7.1	0.080	VII

-END OF SEARCH- 61 FAULTS FOUND WITHIN THE SPECIFIED SEARCH RADIUS.

THE CHINO-CENTRAL AVE. (Elsinore) FAULT IS CLOSEST TO THE SITE.
IT IS ABOUT 9.4 MILES (15.1 km) AWAY.

LARGEST MAXIMUM-EARTHQUAKE SITE ACCELERATION: 0.4716 g

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*    E Q S E A R C H    *
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*     Version 3.00      *
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     ESTIMATION OF
  PEAK ACCELERATION FROM
CALIFORNIA EARTHQUAKE CATALOGS

JOB NUMBER: 4414-A1
                                                DATE: 09-21-2004

JOB NAME: MADISON

EARTHQUAKE-CATALOG-FILE NAME: ALLQUAKE.DAT


MAGNITUDE RANGE:
   MINIMUM MAGNITUDE:  5.00
   MAXIMUM MAGNITUDE:  9.00

SITE COORDINATES:
   SITE LATITUDE:  33.6621
   SITE LONGITUDE:  117.6857

SEARCH DATES:
           START DATE:   1800
           END DATE:   2000

SEARCH RADIUS:
           100.0 mi
           160.9 km

ATTENUATION RELATION:   3) Boore et al. (1997) Horiz. - NEHRP D (250)
   UNCERTAINTY (M=Median, S=Sigma): S       Number of Sigmas:  1.0
   ASSUMED SOURCE TYPE:  DS [SS=Strike-slip, DS=Reverse-slip, BT=Blind-thrust]
   SCOND:   0  Depth Source:  A
   Basement Depth:  5.00 km     Campbell SSR:        Campbell SHR:
   COMPUTE PEAK HORIZONTAL ACCELERATION

MINIMUM DEPTH VALUE (km):  0.0
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EARTHQUAKE SEARCH RESULTS

Page 1

FILE CODE	LAT. NORTH	LONG. WEST	DATE	TIME (UTC) H M Sec	DEPTH (km)	QUAKE MAG.	SITE ACC. g	SITE MM INT.	APPROX. DISTANCE mi [km]
DMG	33.6990	117.5110	05/31/1938	83455.4	10.0	5.50	0.234	IX	10.4(16.7)
MGI	33.8000	117.6000	04/22/1918	2115 0.0	0.0	5.00	0.176	VIII	10.7(17.2)
DMG	33.6170	117.9670	03/11/1933	154 7.8	0.0	6.30	0.255	IX	16.5(26.5)
DMG	33.7000	117.4000	05/15/1910	1547 0.0	0.0	6.00	0.216	VIII	16.6(26.7)
DMG	33.7000	117.4000	04/11/1910	757 0.0	0.0	5.00	0.128	VIII	16.6(26.7)
DMG	33.7000	117.4000	05/13/1910	620 0.0	0.0	5.00	0.128	VIII	16.6(26.7)
DMG	33.5750	117.9830	03/11/1933	518 4.0	0.0	5.20	0.133	VIII	18.1(29.2)
DMG	33.6170	118.0170	03/14/1933	19 150.0	0.0	5.10	0.120	VII	19.3(31.0)
DMG	33.6830	118.0500	03/11/1933	658 3.0	0.0	5.50	0.139	VIII	21.0(33.8)
DMG	33.7000	118.0670	03/11/1933	85457.0	0.0	5.10	0.109	VII	22.1(35.5)
DMG	33.7000	118.0670	03/11/1933	51022.0	0.0	5.10	0.109	VII	22.1(35.5)
DMG	33.7500	118.0830	03/11/1933	910 0.0	0.0	5.10	0.103	VII	23.6(38.0)
DMG	33.7500	118.0830	03/11/1933	323 0.0	0.0	5.00	0.098	VII	23.6(38.0)
DMG	33.7500	118.0830	03/13/1933	131828.0	0.0	5.30	0.115	VII	23.6(38.0)
DMG	33.7500	118.0830	03/11/1933	230 0.0	0.0	5.10	0.103	VII	23.6(38.0)
DMG	33.7500	118.0830	03/11/1933	2 9 0.0	0.0	5.00	0.098	VII	23.6(38.0)
MGI	34.0000	117.5000	12/16/1858	10 0 0.0	0.0	7.00	0.264	IX	25.6(41.3)
DMG	33.7830	118.1330	10/02/1933	91017.6	0.0	5.40	0.109	VII	27.0(43.5)
MGI	34.0000	118.0000	12/25/1903	1745 0.0	0.0	5.00	0.083	VII	29.5(47.4)
DMG	33.9000	117.2000	12/19/1880	0 0 0.0	0.0	6.00	0.130	VIII	32.3(52.1)
GSP	34.1400	117.7000	02/28/1990	234336.6	5.0	5.20	0.084	VII	33.0(53.1)
DMG	33.7830	118.2500	11/14/1941	84136.3	0.0	5.40	0.093	VII	33.5(53.8)
DMG	34.0000	117.2500	07/23/1923	73026.0	0.0	6.25	0.142	VIII	34.2(55.0)
PAS	34.0610	118.0790	10/01/1987	144220.0	9.5	5.90	0.115	VII	35.6(57.3)
DMG	33.8500	118.2670	03/11/1933	1425 0.0	0.0	5.00	0.071	VI	35.8(57.6)
PAS	34.0730	118.0980	10/04/1987	105938.2	8.2	5.30	0.081	VII	36.9(59.4)
MGI	34.1000	117.3000	07/15/1905	2041 0.0	0.0	5.30	0.080	VII	37.5(60.3)
MGI	34.1000	118.1000	07/11/1855	415 0.0	0.0	6.30	0.134	VIII	38.4(61.9)
DMG	34.2000	117.9000	08/28/1889	215 0.0	0.0	5.50	0.086	VII	39.1(62.9)
DMG	33.7500	117.0000	06/06/1918	2232 0.0	0.0	5.00	0.065	VI	39.8(64.1)
DMG	33.7500	117.0000	04/21/1918	223225.0	0.0	6.80	0.169	VIII	39.8(64.1)
T-A	34.0000	118.2500	09/23/1827	0 0 0.0	0.0	5.00	0.065	VI	39.9(64.2)
T-A	34.0000	118.2500	03/26/1860	0 0 0.0	0.0	5.00	0.065	VI	39.9(64.2)
T-A	34.0000	118.2500	01/10/1856	0 0 0.0	0.0	5.00	0.065	VI	39.9(64.2)
DMG	33.8000	117.0000	12/25/1899	1225 0.0	0.0	6.40	0.135	VIII	40.5(65.2)
DMG	34.2000	117.4000	07/22/1899	046 0.0	0.0	5.50	0.084	VII	40.6(65.3)
MGI	34.0000	118.3000	09/03/1905	540 0.0	0.0	5.30	0.073	VII	42.3(68.0)
DMG	34.2700	117.5400	09/12/1970	143053.0	8.0	5.40	0.077	VII	42.8(68.9)
MGI	34.0800	118.2600	07/16/1920	18 8 0.0	0.0	5.00	0.061	VI	43.8(70.4)
DMG	33.7100	116.9250	09/23/1963	144152.6	16.5	5.00	0.061	VI	43.8(70.5)
DMG	34.3000	117.6000	07/30/1894	512 0.0	0.0	6.00	0.102	VII	44.3(71.3)
GSP	34.2620	118.0020	06/28/1991	144354.5	11.0	5.40	0.073	VII	45.2(72.7)
DMG	34.3000	117.5000	07/22/1899	2032 0.0	0.0	6.50	0.131	VIII	45.3(72.9)
PAS	32.9710	117.8700	07/13/1986	1347 8.2	6.0	5.30	0.065	VI	48.9(78.7)
DMG	34.3700	117.6500	12/08/1812	15 0 0.0	0.0	7.00	0.160	VIII	48.9(78.7)
DMG	34.2000	117.1000	09/20/1907	154 0.0	0.0	6.00	0.093	VII	50.0(80.5)
DMG	33.0000	117.3000	11/22/1800	2130 0.0	0.0	6.50	0.120	VII	50.8(81.8)
DMG	33.9500	116.8500	09/28/1946	719 9.0	0.0	5.00	0.053	VI	51.9(83.5)
MGI	34.0000	118.5000	11/19/1918	2018 0.0	0.0	5.00	0.053	VI	52.2(84.0)
DMG	34.0000	118.5000	08/04/1927	1224 0.0	0.0	5.00	0.053	VI	52.2(84.0)
DMG	34.1800	116.9200	01/16/1930	02433.9	0.0	5.20	0.055	VI	56.6(91.1)
DMG	34.1800	116.9200	01/16/1930	034 3.6	0.0	5.10	0.053	VI	56.6(91.1)
PAS	33.9190	118.6270	01/19/1989	65328.8	11.9	5.00	0.050	VI	56.8(91.5)

EARTHQUAKE SEARCH RESULTS

FILE CODE	LAT. NORTH	LONG. WEST	DATE	TIME (UTC) H M Sec	DEPTH (km)	QUAKE MAG.	SITE ACC. g	SITE MM INT.	APPROX. DISTANCE mi [km]
DMG	33.9500	118.6320	08/31/1930	04036.0	0.0	5.20	0.055	VI	57.8(93.0)
DMG	34.2670	116.9670	08/29/1943	34513.0	0.0	5.50	0.063	VI	58.6(94.4)
GSP	34.1630	116.8550	06/28/1992	144321.0	6.0	5.30	0.057	VI	58.8(94.7)
DMG	34.1000	116.8000	10/24/1935	1448 7.6	0.0	5.10	0.051	VI	59.1(95.1)
DMG	33.9760	116.7210	06/12/1944	104534.7	10.0	5.10	0.051	VI	59.4(95.6)
GSP	34.1950	116.8620	08/17/1992	204152.1	11.0	5.30	0.056	VI	59.8(96.3)
GSP	34.2310	118.4750	03/20/1994	212012.3	13.0	5.30	0.056	VI	59.9(96.4)
PAS	33.9440	118.6810	01/01/1979	231438.9	11.3	5.00	0.048	VI	60.3(97.1)
DMG	33.9940	116.7120	06/12/1944	111636.0	10.0	5.30	0.056	VI	60.4(97.1)
MGI	33.0000	117.0000	09/21/1856	730 0.0	0.0	5.00	0.047	VI	60.4(97.3)
GSN	34.2030	116.8270	06/28/1992	150530.7	5.0	6.70	0.114	VII	61.8(99.4)
GSP	34.2130	118.5370	01/17/1994	123055.4	18.0	6.70	0.114	VII	61.8(99.5)
DMG	34.3080	118.4540	02/09/1971	144346.7	6.2	5.20	0.051	VI	62.6(100.8)
GSP	34.2390	116.8370	07/09/1992	014357.6	0.0	5.30	0.054	VI	62.8(101.1)
DMG	34.1000	116.7000	02/07/1889	520 0.0	0.0	5.30	0.053	VI	64.1(103.1)
GSP	34.3400	116.9000	11/27/1992	160057.5	1.0	5.30	0.053	VI	64.9(104.5)
DMG	33.2000	116.7000	01/01/1920	235 0.0	0.0	5.00	0.045	VI	65.1(104.8)
DMG	34.4110	118.4010	02/09/1971	14 244.0	8.0	5.80	0.068	VI	65.9(106.1)
DMG	34.4110	118.4010	02/09/1971	14 041.8	8.4	6.40	0.093	VII	65.9(106.1)
DMG	34.4110	118.4010	02/09/1971	14 1 8.0	8.0	5.80	0.068	VI	65.9(106.1)
DMG	34.4110	118.4010	02/09/1971	141028.0	8.0	5.30	0.052	VI	65.9(106.1)
DMG	34.5190	118.1980	08/23/1952	10 9 7.1	13.1	5.00	0.044	VI	66.0(106.2)
PAS	33.9980	116.6060	07/08/1986	92044.5	11.7	5.60	0.061	VI	66.1(106.4)
GSP	34.3690	116.8970	12/04/1992	020857.5	3.0	5.30	0.052	VI	66.5(107.0)
GSB	34.3010	118.5650	01/17/1994	204602.4	9.0	5.20	0.049	VI	66.9(107.7)
GSP	34.3050	118.5790	01/29/1994	112036.0	1.0	5.10	0.046	VI	67.7(109.0)
PAS	33.5010	116.5130	02/25/1980	104738.5	13.6	5.50	0.056	VI	68.4(110.0)
DMG	34.3000	118.6000	04/04/1893	1940 0.0	0.0	6.00	0.073	VII	68.4(110.1)
MGI	32.8000	117.1000	05/25/1803	0 0 0.0	0.0	5.00	0.043	VI	68.5(110.2)
DMG	33.5000	116.5000	09/30/1916	211 0.0	0.0	5.00	0.043	VI	69.1(111.2)
DMG	32.8170	118.3500	12/26/1951	04654.0	0.0	5.90	0.068	VI	69.8(112.4)
MGI	33.2000	116.6000	10/12/1920	1748 0.0	0.0	5.30	0.049	VI	70.2(113.0)
DMG	32.7000	117.2000	05/27/1862	20 0 0.0	0.0	5.90	0.066	VI	72.1(116.0)
DMG	34.0170	116.5000	07/25/1947	04631.0	0.0	5.00	0.041	V	72.3(116.3)
DMG	34.0170	116.5000	07/25/1947	61949.0	0.0	5.20	0.046	VI	72.3(116.3)
DMG	34.0170	116.5000	07/26/1947	24941.0	0.0	5.10	0.044	VI	72.3(116.3)
DMG	34.0170	116.5000	07/24/1947	221046.0	0.0	5.50	0.054	VI	72.3(116.3)
GSP	34.3780	118.6180	01/19/1994	211144.9	11.0	5.10	0.043	VI	72.7(117.0)
GSP	34.3260	118.6980	01/17/1994	233330.7	9.0	5.60	0.056	VI	73.9(118.9)
GSP	34.3690	118.6720	04/26/1997	103730.7	16.0	5.10	0.042	VI	74.6(120.1)
T-A	32.6700	117.1700	10/21/1862	0 0 0.0	0.0	5.00	0.040	V	74.7(120.2)
T-A	32.6700	117.1700	12/00/1856	0 0 0.0	0.0	5.00	0.040	V	74.7(120.2)
T-A	32.6700	117.1700	05/24/1865	0 0 0.0	0.0	5.00	0.040	V	74.7(120.2)
GSP	34.3940	118.6690	06/26/1995	084028.9	13.0	5.00	0.040	V	75.6(121.7)
GSP	34.3770	118.6980	01/18/1994	004308.9	11.0	5.20	0.044	VI	76.1(122.5)
GSB	34.3790	118.7110	01/19/1994	210928.6	14.0	5.50	0.051	VI	76.8(123.5)
DMG	33.9330	116.3830	12/04/1948	234317.0	0.0	6.50	0.087	VII	77.0(124.0)
DMG	32.8000	116.8000	10/23/1894	23 3 0.0	0.0	5.70	0.056	VI	78.5(126.3)
MGI	34.0000	119.0000	12/14/1912	0 0 0.0	0.0	5.70	0.056	VI	78.9(127.0)
DMG	34.0000	119.0000	09/24/1827	4 0 0.0	0.0	7.00	0.111	VII	78.9(127.0)
GSP	34.1390	116.4310	06/28/1992	123640.6	10.0	5.10	0.041	V	79.1(127.3)
GSP	34.1080	116.4040	06/29/1992	141338.8	9.0	5.40	0.047	VI	79.7(128.2)
DMG	33.3430	116.3460	04/28/1969	232042.9	20.0	5.80	0.058	VI	80.2(129.1)

EARTHQUAKE SEARCH RESULTS

FILE CODE	LAT. NORTH	LONG. WEST	DATE	TIME (UTC) H M Sec	DEPTH (km)	QUAKE MAG.	SITE ACC. g	SITE MM INT.	APPROX. DISTANCE mi [km]
GSN	34.2010	116.4360	06/28/1992	115734.1	1.0	7.60	0.149	VIII	80.7(129.8)
GSP	34.0640	116.3610	09/15/1992	084711.3	9.0	5.20	0.042	VI	80.9(130.1)
GSP	34.3410	116.5290	06/28/1992	124053.5	6.0	5.20	0.042	VI	81.1(130.5)
GSP	33.9610	116.3180	04/23/1992	045023.0	12.0	6.10	0.067	VI	81.1(130.6)
DMG	33.4000	116.3000	02/09/1890	12 6 0.0	0.0	6.30	0.074	VII	81.8(131.6)
PAS	33.6710	119.1110	09/04/1981	155050.3	5.0	5.30	0.044	VI	81.9(131.8)
GSP	33.9020	116.2840	07/24/1992	181436.2	9.0	5.00	0.037	V	82.1(132.2)
DMG	34.0650	119.0350	02/21/1973	144557.3	8.0	5.90	0.060	VI	82.2(132.3)
GSP	34.0290	116.3210	08/21/1993	014638.4	9.0	5.00	0.037	V	82.3(132.4)
DMG	34.0670	116.3330	05/18/1940	72132.7	0.0	5.00	0.037	V	82.4(132.7)
DMG	34.0670	116.3330	05/18/1940	55120.2	0.0	5.20	0.041	V	82.4(132.7)
GSP	33.8760	116.2670	06/29/1992	160142.8	1.0	5.20	0.041	V	82.8(133.2)
DMG	33.4080	116.2610	03/25/1937	1649 1.8	10.0	6.00	0.062	VI	83.8(134.9)
GSP	34.3320	116.4620	07/01/1992	074029.9	9.0	5.40	0.045	VI	83.9(135.1)
PAS	34.3270	116.4450	03/15/1979	21 716.5	2.5	5.20	0.041	V	84.6(136.1)
GSP	34.2680	116.4020	06/16/1994	162427.5	3.0	5.00	0.037	V	84.6(136.1)
DMG	34.0830	116.3000	05/18/1940	5 358.5	0.0	5.40	0.045	VI	84.6(136.1)
DMG	33.0000	116.4330	06/04/1940	1035 8.3	0.0	5.10	0.038	V	85.5(137.6)
PAS	34.5160	116.4950	06/01/1975	13849.2	4.5	5.20	0.039	V	90.1(144.9)
DMG	33.2830	116.1830	03/23/1954	41450.0	0.0	5.10	0.037	V	90.4(145.5)
DMG	33.2830	116.1830	03/19/1954	102117.0	0.0	5.50	0.045	VI	90.4(145.5)
DMG	33.2830	116.1830	03/19/1954	95429.0	0.0	6.20	0.065	VI	90.4(145.5)
DMG	33.2830	116.1830	03/19/1954	95556.0	0.0	5.00	0.035	V	90.4(145.5)
DMG	33.2910	119.1930	10/24/1969	82912.1	10.0	5.10	0.037	V	90.5(145.6)
DMG	33.2000	116.2000	05/28/1892	1115 0.0	0.0	6.30	0.068	VI	91.4(147.0)
DMG	32.5000	118.5500	02/24/1948	81510.0	0.0	5.30	0.039	V	94.5(152.1)
DMG	33.2170	116.1330	08/15/1945	175624.0	0.0	5.70	0.048	VI	94.6(152.2)
DMG	33.1900	116.1290	04/09/1968	22859.1	11.1	6.40	0.070	VI	95.4(153.6)
DMG	34.2500	116.1670	03/20/1945	2155 7.0	0.0	5.00	0.033	V	96.0(154.5)
T-A	32.2500	117.5000	01/13/1877	20 0 0.0	0.0	5.00	0.033	V	98.1(157.8)
GSP	34.4420	116.2480	10/16/1999	125721.0	1.0	5.70	0.047	VI	98.3(158.2)
DMG	34.7120	116.5030	09/25/1965	174344.1	10.6	5.20	0.036	V	99.1(159.4)
DMG	34.0000	116.0000	09/05/1928	1442 0.0	0.0	5.00	0.032	V	99.5(160.0)
DMG	34.0000	116.0000	04/03/1926	20 8 0.0	0.0	5.50	0.042	VI	99.5(160.0)

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-END OF SEARCH- 140 EARTHQUAKES FOUND WITHIN THE SPECIFIED SEARCH AREA.

TIME PERIOD OF SEARCH: 1800 TO 2000

LENGTH OF SEARCH TIME: 201 years

THE EARTHQUAKE CLOSEST TO THE SITE IS ABOUT 10.4 MILES (16.7 km) AWAY.

LARGEST EARTHQUAKE MAGNITUDE FOUND IN THE SEARCH RADIUS: 7.6

LARGEST EARTHQUAKE SITE ACCELERATION FROM THIS SEARCH: 0.264 g

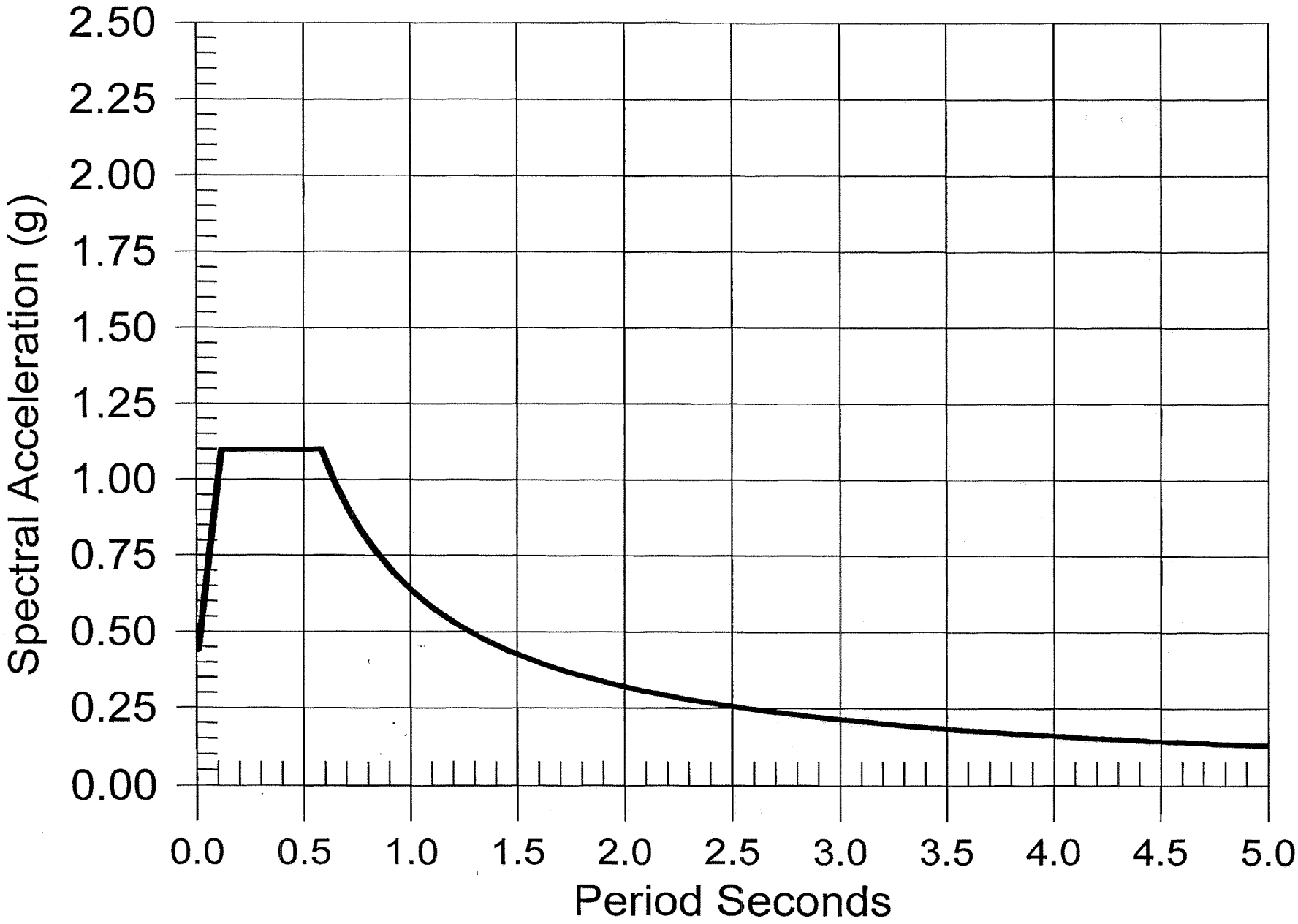
COEFFICIENTS FOR GUTENBERG & RICHTER RECURRENCE RELATION:
a-value= 1.524
b-value= 0.384
beta-value= 0.883

TABLE OF MAGNITUDES AND EXCEEDANCES:

Earthquake Magnitude	Number of Times Exceeded	Cumulative No. / Year
4.0	140	0.69652
4.5	140	0.69652
5.0	140	0.69652
5.5	49	0.24378
6.0	26	0.12935
6.5	10	0.04975
7.0	4	0.01990
7.5	1	0.00498

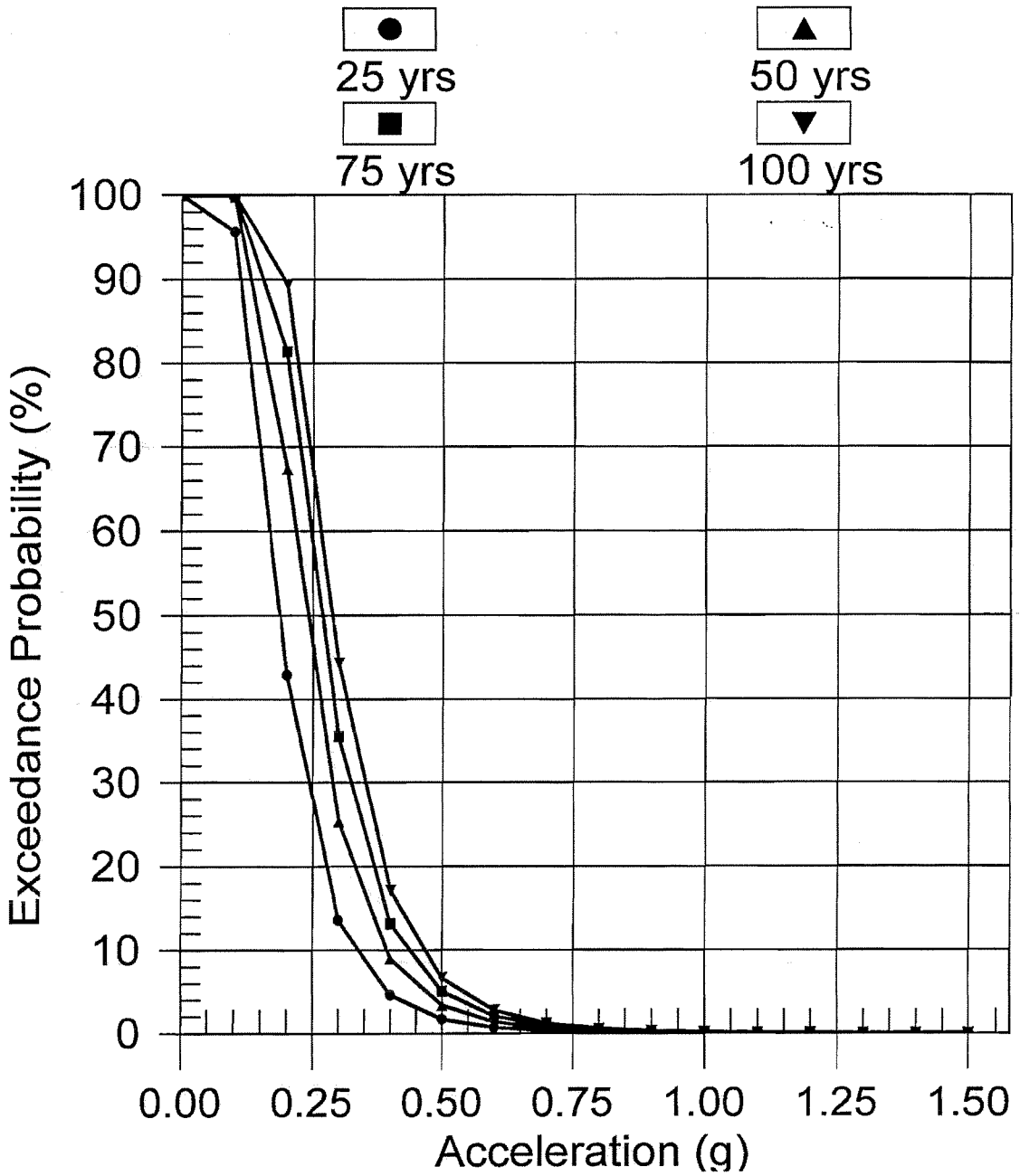
DESIGN RESPONSE SPECTRUM

Seismic Zone: 0.4 Soil Profile: SD



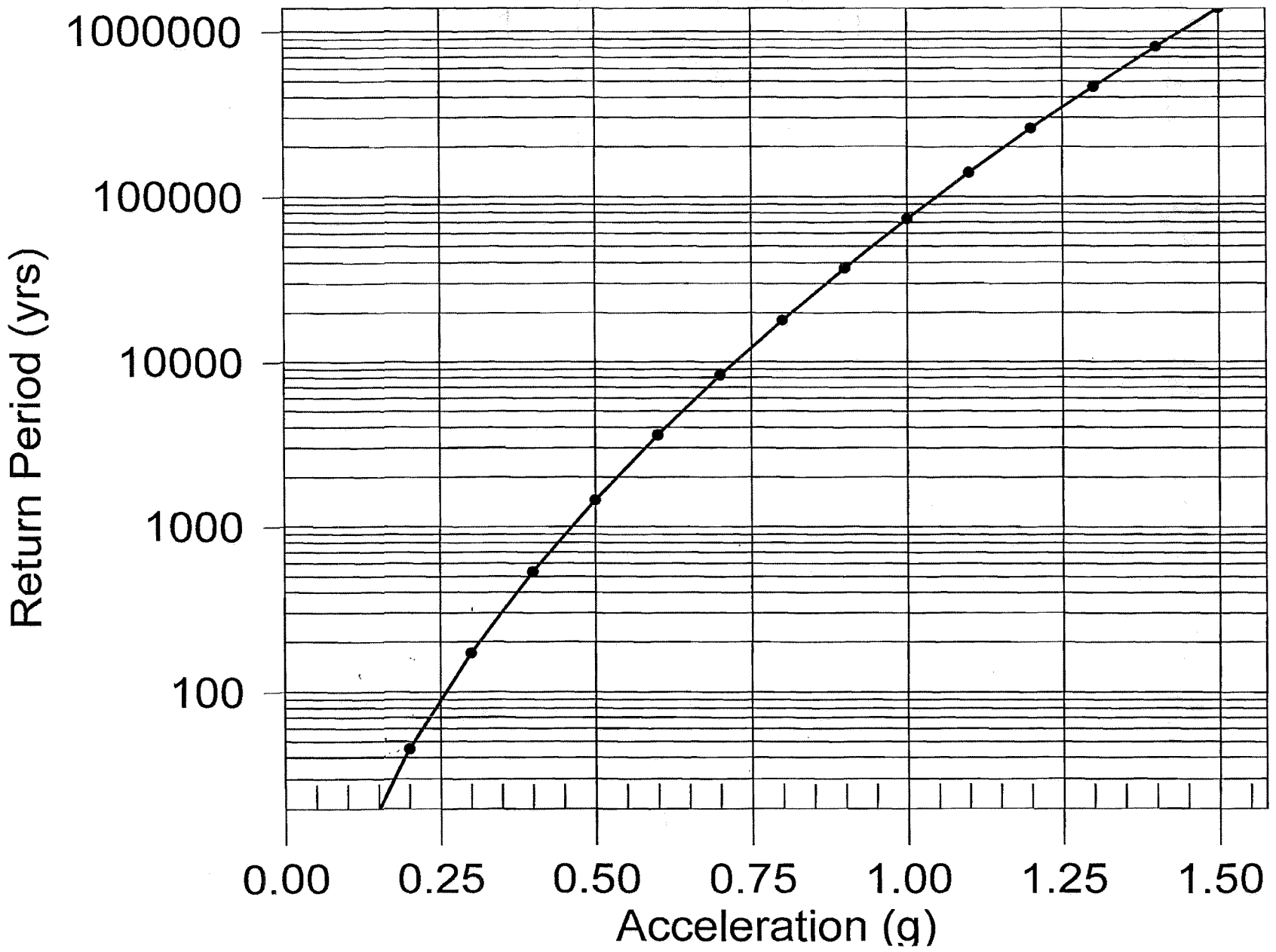
PROBABILITY OF EXCEEDANCE

BOORE ET AL(1997) NEHRP D (250)1



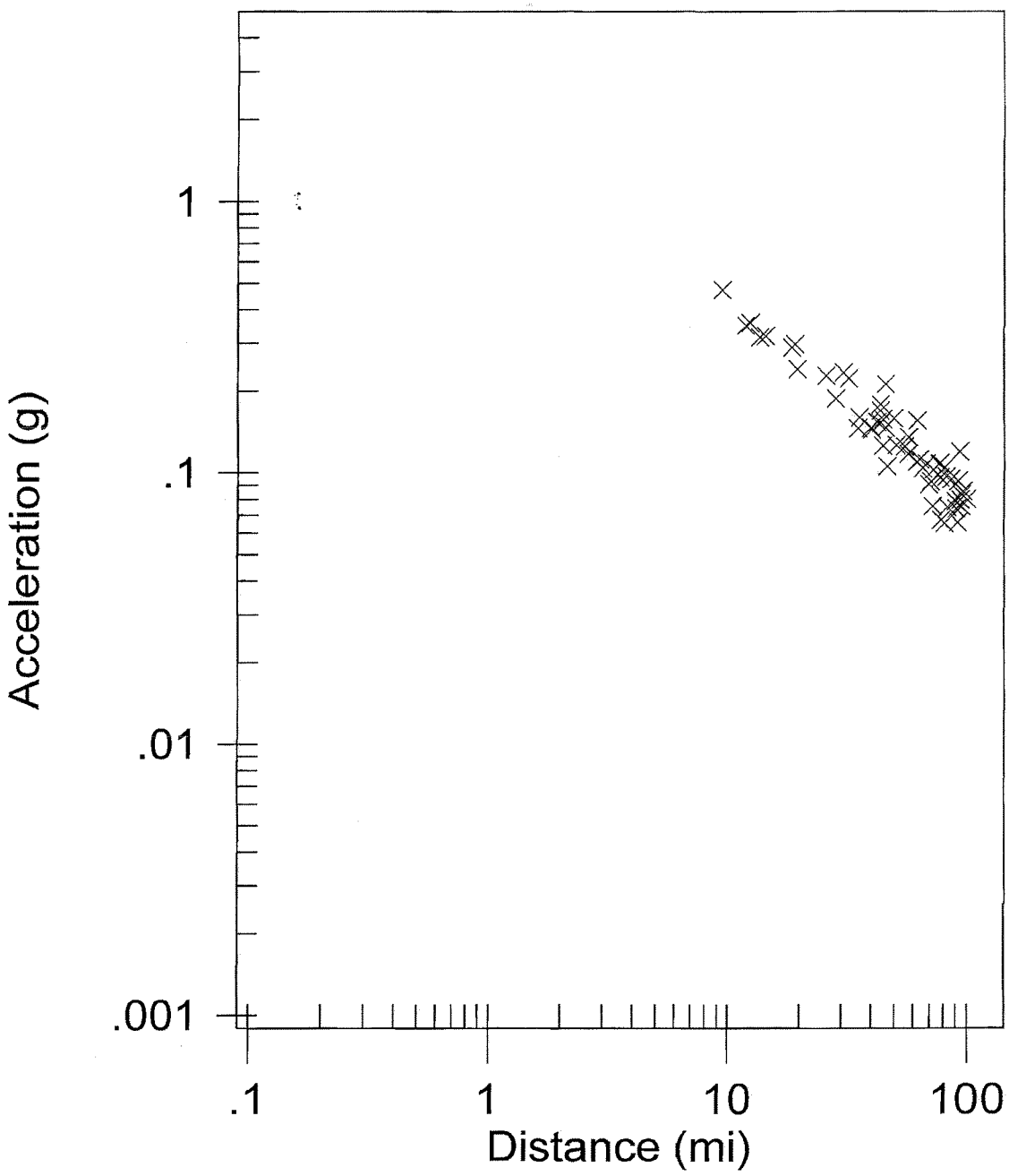
RETURN PERIOD vs. ACCELERATION

BOORE ET AL(1997) NEHRP D (250)1



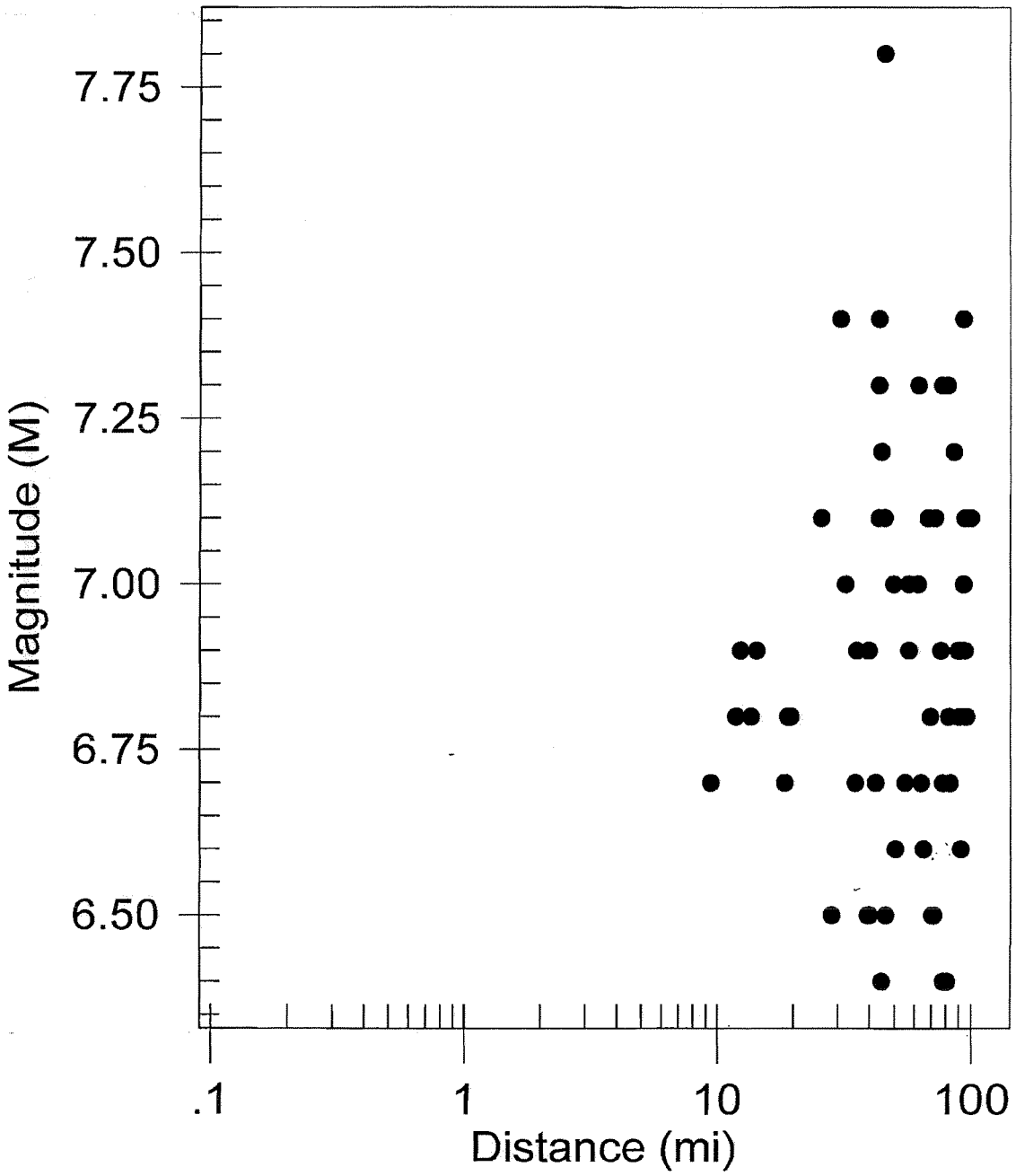
MAXIMUM EARTHQUAKES

MADISON



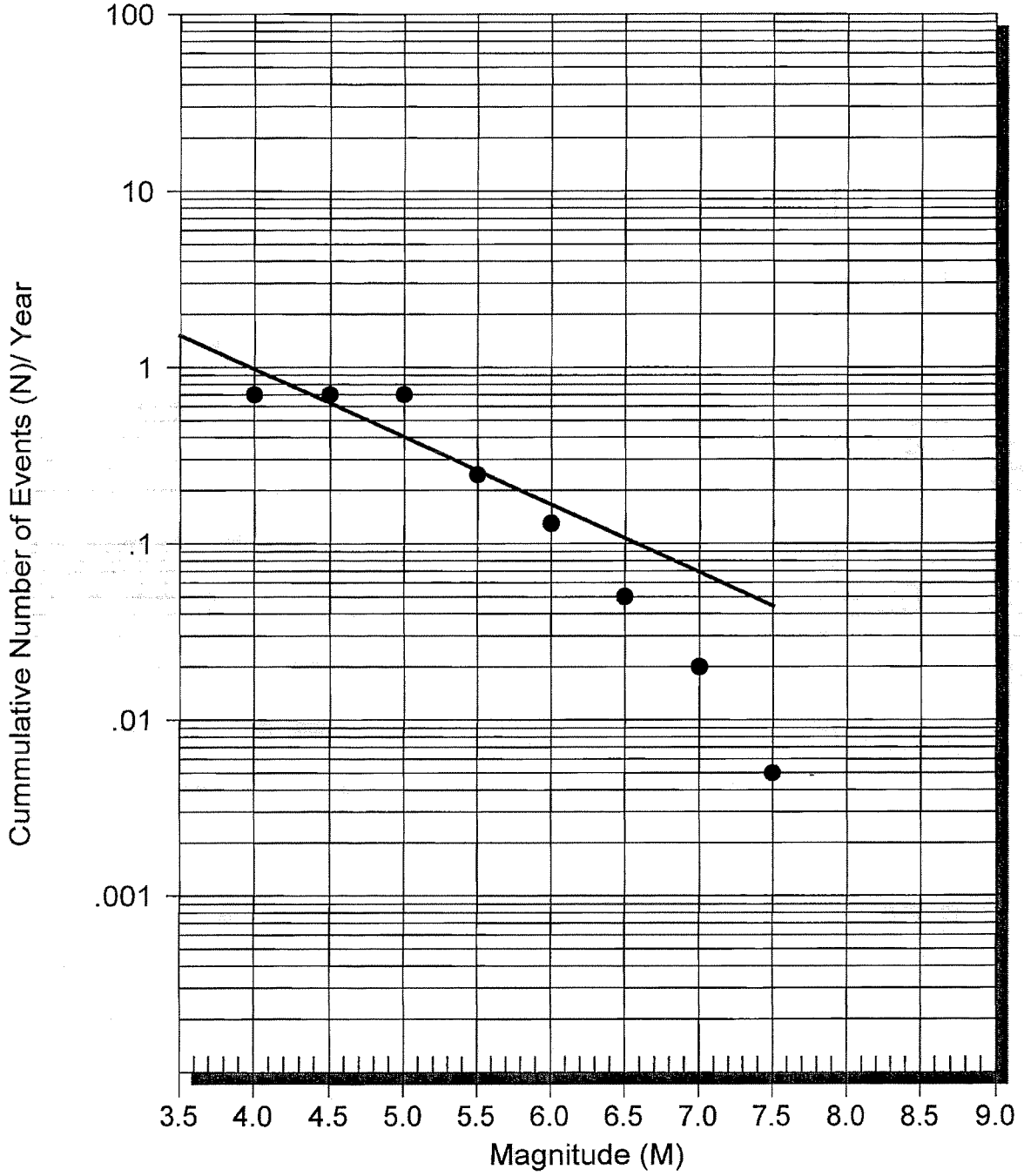
EARTHQUAKE MAGNITUDES & DISTANCES

MADISON



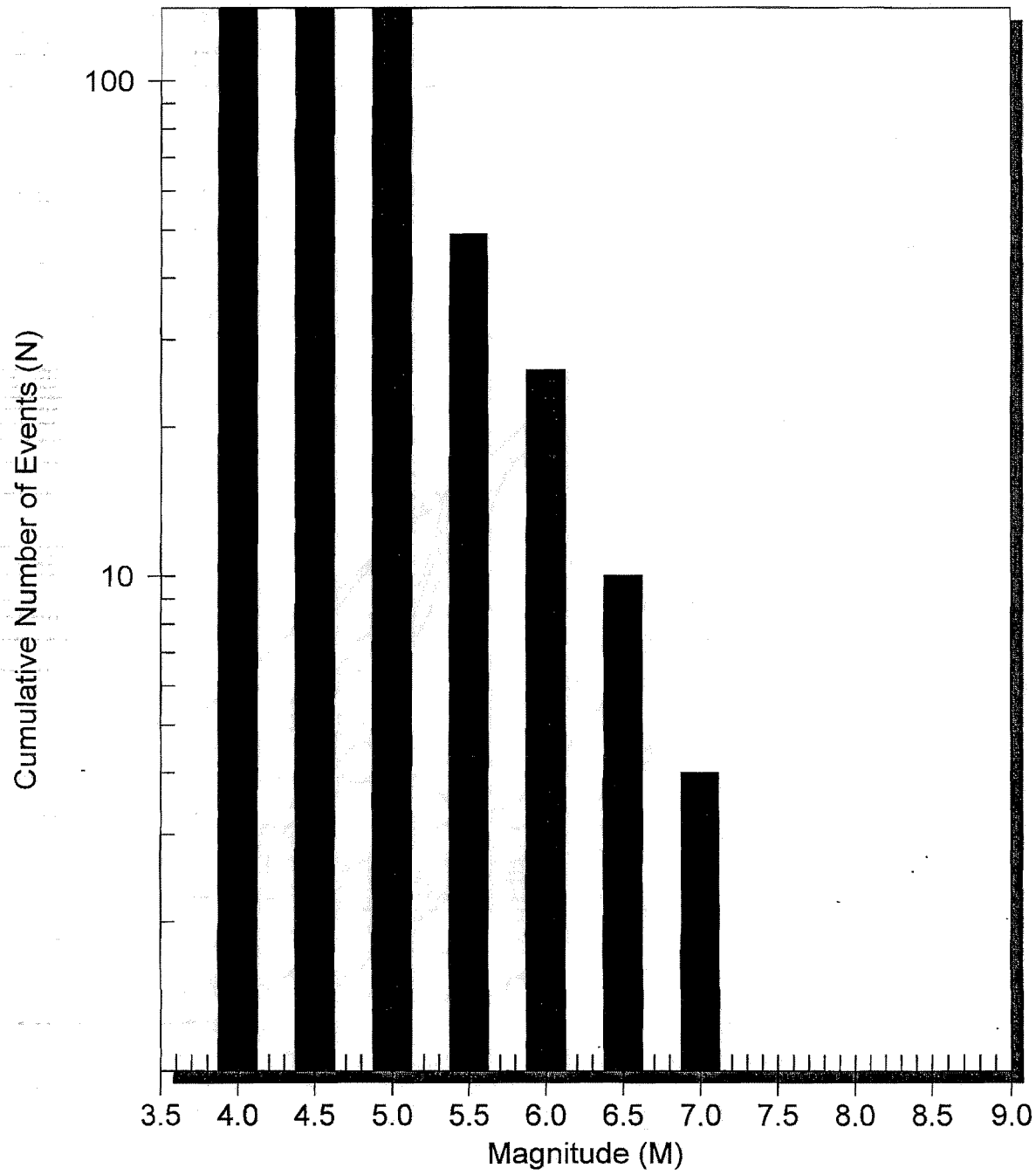
EARTHQUAKE RECURRENCE CURVE

MADISON



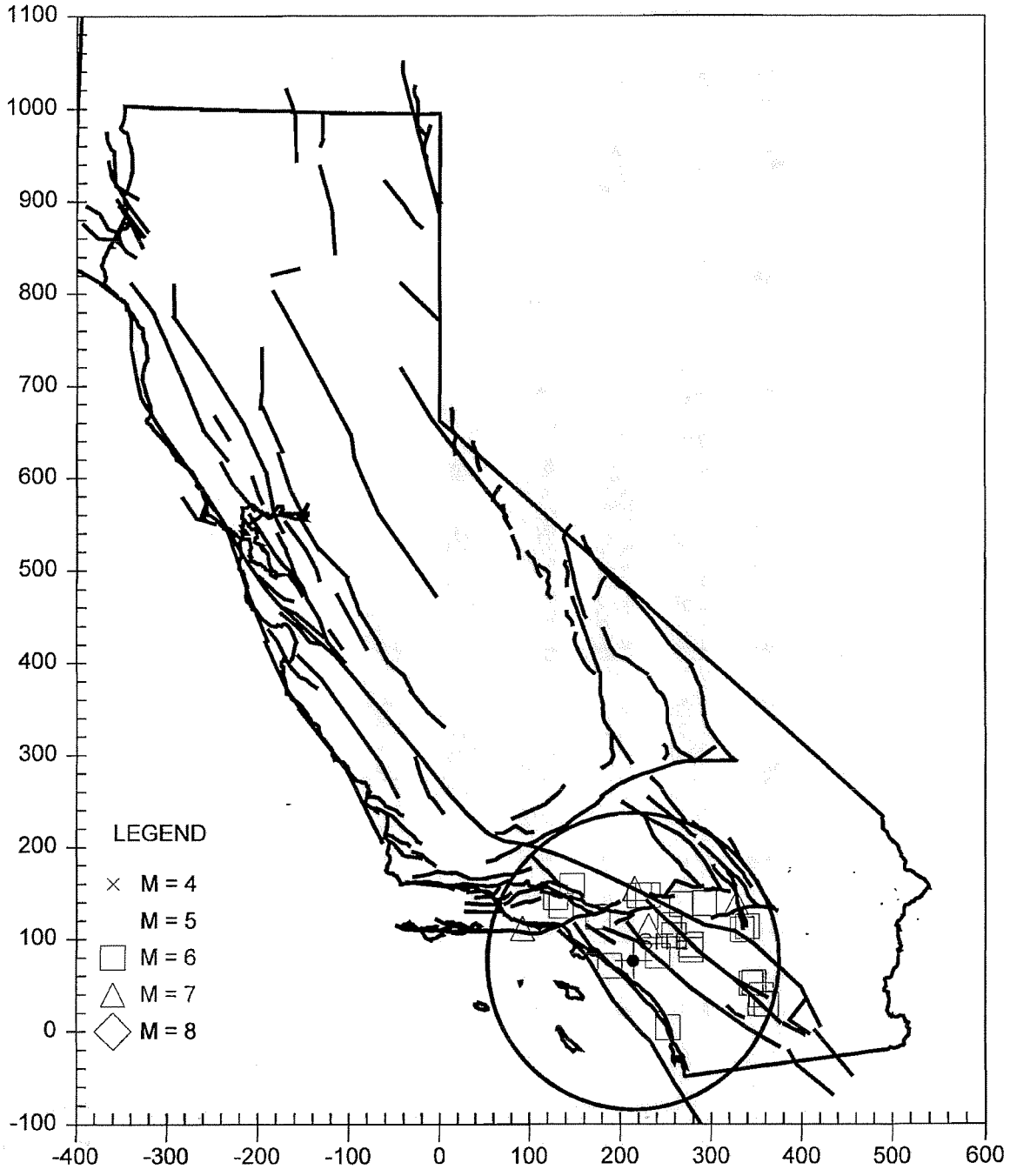
Number of Earthquakes (N) Above Magnitude (M)

MADISON



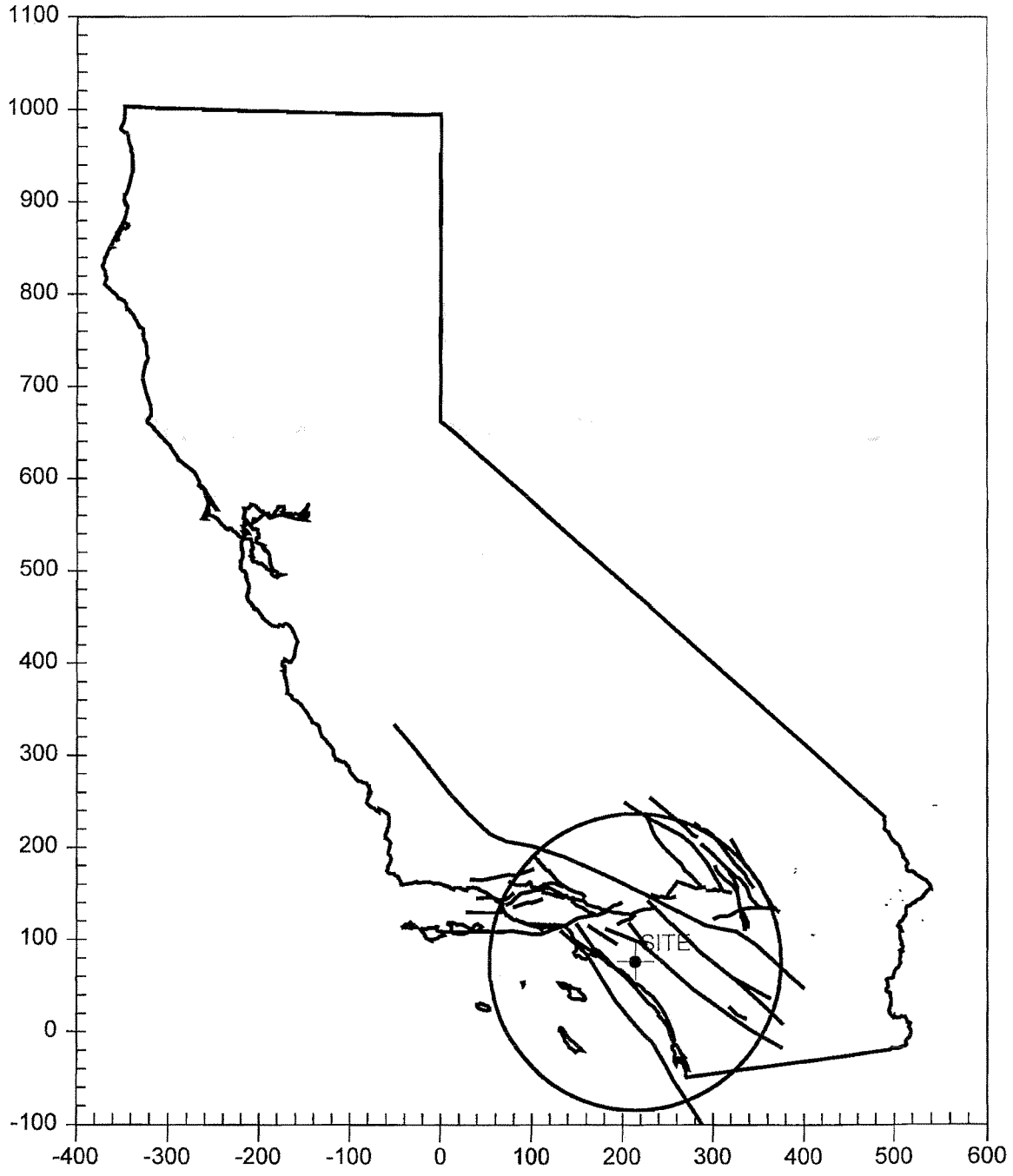
EARTHQUAKE EPICENTER MAP

MADISON



CALIFORNIA FAULT MAP

MADISON



APPENDIX E

GENERAL EARTHWORK AND GRADING GUIDELINES

GENERAL EARTHWORK AND GRADING GUIDELINES

GENERAL

These guidelines present general procedures and requirements for earthwork and grading as shown on the approved grading plans, including preparation of areas to filled, placement of fill, installation of subdrains and excavations. The recommendations contained in the geotechnical report are part of the earthwork and grading guidelines and would supersede the provisions contained hereafter in the case of conflict. Evaluations performed by the consultant during the course of grading may result in new recommendations which could supersede these guidelines or the recommendations contained in the geotechnical report.

The contractor is responsible for the satisfactory completion of all earthwork in accordance with provisions of the project plans and specifications. The project soil engineer and engineering geologist (geotechnical consultant) or their representatives should provide observation and testing services, and geotechnical consultation during the duration of the project.

EARTHWORK OBSERVATIONS AND TESTING

Geotechnical Consultant

Prior to the commencement of grading, a qualified geotechnical consultant (soil engineer and engineering geologist) should be employed for the purpose of observing earthwork procedures and testing the fills for conformance with the recommendations of the geotechnical report, the approved grading plans, and applicable grading codes and ordinances.

The geotechnical consultant should provide testing and observation so that determination may be made that the work is being accomplished as specified. It is the responsibility of the contractor to assist the consultants and keep them apprised of anticipated work schedules and changes, so that they may schedule their personnel accordingly.

All clean-outs, prepared ground to receive fill, key excavations, and subdrains should be observed and documented by the project engineering geologist and/or soil engineer prior to placing and fill. It is the contractors's responsibility to notify the engineering geologist and soil engineer when such areas are ready for observation.

Laboratory and Field Tests

Maximum dry density tests to determine the degree of compaction should be performed in accordance with American Standard Testing Materials test method ASTM designation D-1557-78. Random field compaction tests should be performed in accordance with test method ASTM designation D-1556-82, D-2937 or D-2922 and D-3017, at intervals of approximately 2 feet of fill height or every 100 cubic yards of fill placed. These criteria would vary depending on the soil conditions and the size of the project. The location and frequency of testing would be at the discretion of the geotechnical consultant.

Contractor's Responsibility

All clearing, site preparation, and earthwork performed on the project should be conducted by the contractor, with observation by geotechnical consultants and staged approval by the governing agencies, as applicable. It is the contractor's responsibility to prepare the ground surface to receive the fill, to the satisfaction of the soil engineer, and to place, spread, moisture condition, mix and compact the fill in accordance with the recommendations of the soil engineer. The contractor should also remove all major non-earth material considered unsatisfactory by the soil engineer.

It is the sole responsibility of the contractor to provide adequate equipment and methods to accomplish the earthwork in accordance with applicable grading guidelines, codes or agency ordinances, and approved grading plans. Sufficient watering apparatus and compaction equipment should be provided by the contractor with due consideration for the fill material, rate of placement, and climatic conditions. If, in the opinion of the geotechnical consultant, unsatisfactory conditions such as questionable weather, excessive oversized rock, or deleterious material, insufficient support equipment, etc., are resulting in a quality of work that is not acceptable, the consultant will inform the contractor, and the contractor is expected to rectify the conditions, and if necessary, stop work until conditions are satisfactory.

During construction, the contractor shall properly grade all surfaces to maintain good drainage and prevent ponding of water. The contractor shall take remedial measures to control surface water and to prevent erosion of graded areas until such time as permanent drainage and erosion control measures have been installed.

SITE PREPARATION

All major vegetation, including brush, trees, thick grasses, organic debris, and other deleterious material should be removed and disposed of off-site. These removals must be concluded prior to placing fill. Existing fill, soil, alluvium, colluvium, or rock materials determined by the soil engineer or engineering geologist as being unsuitable in-place should be removed prior to fill placement. Depending upon the soil conditions, these materials may be reused as compacted fills. Any materials incorporated as part of the compacted fills should be approved by the soil engineer.

Any underground structures such as cesspools, cisterns, mining shafts, tunnels, septic tanks, wells, pipelines, or other structures not located prior to grading are to be removed or treated in a manner recommended by the soil engineer. Soft, dry, spongy, highly fractured, or otherwise unsuitable ground extending to such a depth that surface processing cannot adequately improve the condition should be over-excavated down to firm ground and approved by the soil engineer before compaction and filling operations continue. Overexcavated and processed soils which have been properly mixed and moisture conditioned should be re-compacted to the minimum relative compaction as specified in these guidelines.

Existing ground which is determined to be satisfactory for support of the fills should be scarified to a minimum depth of 6 inches or as directed by the soil engineer. After the scarified ground is brought to optimum moisture content or greater and mixed, the materials should be compacted as specified herein. If the scarified zone is grater that 6 inches in depth, it may be necessary to remove the excess and place the material in lifts restricted to about 6 inches in compacted thickness.

Existing ground which is not satisfactory to support compacted fill should be over-excavated as required in the geotechnical report or by the on-site soils engineer and/or engineering geologist. Scarification, disc harrowing, or other acceptable form of mixing should continue until the soils are broken down and free of large lumps or clods, until the working surface is reasonably uniform and free from ruts, hollow, hummocks, or other uneven features which would inhibit compaction as described previously.

Where fills are to be placed on ground with slopes steeper than 5:1 (horizontal to vertical), the ground should be stepped or benched. The lowest bench, which will act as a key, should be a minimum of 15 feet wide and should be at least 2 feet deep into firm material, and approved by the soil engineer and/or engineering geologist. In fill over cut slope conditions, the recommended minimum width of the lowest bench or key is also 15 feet with the key founded on firm material, as designated by the Geotechnical Consultant. As a general rule, unless specifically recommended otherwise by the Soil Engineer, the minimum width of fill keys should be approximately equal to ½ the height of the slope.

Standard benching is generally 4 feet (minimum) vertically, exposing firm, acceptable material. Benching may be used to remove unsuitable materials, although it is understood that the vertical height of the bench may exceed 4 feet. Pre-stripping may be considered for unsuitable materials in excess of 4 feet in thickness.

All areas to receive fill, including processed areas, removal areas, and the toe of fill benches should be observed and approved by the soil engineer and/or engineering geologist prior to placement of fill. Fills may then be properly placed and compacted until design grades (elevations) are attained.

COMPACTED FILLS

Any earth materials imported or excavated on the property may be utilized in the fill provided that each material has been determined to be suitable by the soil engineer. These materials should be free of roots, tree branches, other organic matter or other deleterious materials. All unsuitable materials should be removed from the fill as directed by the soil engineer. Soils of poor gradation, undesirable expansion potential, or substandard strength characteristics may be designated by the consultant as unsuitable and may require blending with other soils to serve as a satisfactory fill material.

Fill materials derived from benching operations should be dispersed throughout the fill area and blended with other bedrock derived material. Benching operations should not result in the benched material being placed only within a single equipment width away from the fill/bedrock contact.

Oversized materials defined as rock or other irreducible materials with a maximum dimension greater than 12 inches should not be buried or placed in fills unless the location of materials and disposal methods are specifically approved by the soil engineer. Oversized material should be taken off-site or placed in accordance with recommendations of the soil engineer in areas designated as suitable for rock disposal. Oversized material should not be placed within 10 feet vertically of finish grade (elevation) or within 20 feet horizontally of slope faces. To facilitate future trenching, rock should not be placed within the range of foundation excavations, future utilities, or underground construction unless specifically approved by the soil engineer and/or the developers representative.

If import material is required for grading, representative samples of the materials to be utilized as compacted fill should be analyzed in the laboratory by the soil engineer to determine its physical properties. If any material other than that previously tested is encountered during grading, an appropriate analysis of this material should be conducted by the soil engineer as soon as possible.

Approved fill material should be placed in areas prepared to receive fill in near horizontal layers that when compacted should not exceed 6 inches in thickness. The soil engineer may approve thick lifts if testing indicates the grading procedures are such that adequate compaction is being achieved with lifts of greater thickness. Each layer should be spread evenly and blended to attain uniformity of material and moisture suitable for compaction.

Fill layers at a moisture content less than optimum should be watered and mixed, and wet fill layers should be aerated by scarification or should be blended with drier material. Moisture condition, blending, and mixing of the fill layer should continue until the fill materials have a uniform moisture content at or above optimum moisture.

After each layer has been evenly spread, moisture conditioned and mixed, it should be uniformly compacted to a minimum of 90 percent of maximum density as determined by ASTM test designation, D-1557-78, or as otherwise recommended by the soil engineer. Compaction equipment should be adequately sized and should be specifically designed for soil compaction or of proven reliability to efficiently achieve the specified degree of compaction.

Where tests indicate that the density of any layer of fill, or portion thereof, is below the required relative compaction, or improper moisture is in evidence, the particular layer or portion shall be re-worked until the required density and/or moisture content has been attained. No additional fill shall be placed in an area until the last placed lift of fill has been tested and found to meet the density and moisture requirements, and is approved by the soil engineer.

Compaction of slopes should be accomplished by over-building a minimum of 3 feet horizontally, and subsequently trimming back to the design slope configuration. Testing shall be performed as the fill is elevated to evaluate compaction as the fill core is being developed. Special efforts may be necessary to attain the specified compaction in the fill slope zone. Final slope shaping should be performed by trimming and removing loose materials with appropriate equipment. A final determination of fill slope compaction should be based on observation and/or testing of the finished slope face. Where compacted fill slopes are designed steeper than 2:1 (horizontal to vertical), specific material types, a higher minimum relative compaction, and special grading procedures, may be recommended.

If an alternative to over-building and cutting back the compacted fill slopes is selected, then special effort should be made to achieve the required compaction in the outer 10 feet of each lift of fill by undertaking the following:

1. An extra piece of equipment consisting of a heavy short shanked sheepsfoot should be used to roll (horizontal) parallel to the slopes continuously as fill is placed. The sheepsfoot roller should also be used to roll perpendicular to the slopes, and extend out over the slope to provide adequate compaction to the face of the slope.

2. Loose fill should not be spilled out over the face of the slope as each lift is compacted. Any loose fill spilled over a previously completed slope face should be trimmed off or be subject to re-rolling.

3. Field compaction tests will be made in the outer (horizontal) 2 to 8 feet of the slope at appropriate vertical intervals, subsequent to compaction operations.

4. After completion of the slope, the slope face should be shaped with a small tractor and then re-rolled with a sheepsfoot to achieve compaction to near the slope face. Subsequent to testing to verify compaction, the slopes should be grid-rolled to achieve compaction to the slope face. Final testing should be used to confirm compaction after grid rolling.

5. Where testing indicates less than adequate compaction, the contractor will be responsible to rip, water, mix and re-compact the slope material as necessary to achieve compaction. Additional testing should be performed to verify compaction.

6. Erosion control and drainage devices should be designed by the project civil engineer in compliance with ordinances of the controlling governmental agencies, and/or in accordance with the recommendation of the soil engineer or engineering geologist.

SUBDRAIN INSTALLATION

Subdrains should be installed in approved ground in accordance with the approximate alignment and details indicated by the geotechnical consultant. Subdrain locations or materials should not be changed or modified without approval of the geotechnical consultant. The soil engineer and/or engineering geologist may recommend and direct changes in subdrain line, grade and drain material in the field, pending exposed conditions. The location of constructed subdrains should be recorded by the project civil engineer.

EXCAVATIONS

Excavations and cut slopes should be examined during grading by the engineering geologist. If directed by the engineering geologist, further excavations or overexcavation and re-filling of cut areas should be performed and/or remedial grading of cut slopes should be performed. When fill over cut slopes are to be graded, unless otherwise approved, the cut portion of the slope should be observed by the engineering geologist prior to placement of materials for construction of the fill portion of the slope.

The engineering geologist should observe all cut slopes and should be notified by the contractor when cut slopes are started.

If, during the course of grading, unforeseen adverse or potential adverse geologic conditions are encountered, the engineering geologist and soil engineer should investigate, evaluate and make recommendations to treat these problems. The need for cut slope buttressing or stabilizing should be based on in-grading evaluation by the engineering geologist, whether anticipated or not.

Unless otherwise specified in soil and geological reports, no cut slopes should be excavated higher or steeper than that allowed by the ordinances of controlling governmental agencies. Additionally, short-term stability of temporary cut slopes is the contractors responsibility.

Erosion control and drainage devices should be designed by the project civil engineer and should be constructed in compliance with the ordinances of the controlling governmental agencies, and/or in accordance with the recommendations of the soil engineer or engineering geologist.

COMPLETION

Observation, testing and consultation by the geotechnical consultant should be conducted during the grading operations in order to state an opinion that all cut and filled areas are graded in accordance with the approved project specifications.

After completion of grading and after the soil engineer and engineering geologist have finished their observations of the work, final reports should be submitted subject to review by the controlling governmental agencies. No further excavation or filling should be undertaken without prior notification of the soil engineer and/or engineering geologist.

All finished cut and fill slopes should be protected from erosion and/or be planted in accordance with the project specifications and/or as recommended by a landscape architect. Such protection and/or planning should be undertaken as soon as practical after completion of grading.

JOB SAFETY

General

At GeoSoils, Inc. (GSI) getting the job done safely is of primary concern. The following is the company's safety considerations for use by all employees on multi-employer construction sites. On ground personnel are at highest risk of injury and possible fatality on grading and construction projects. GSI recognizes that construction activities will vary on each site and that site safety is the prime responsibility of the contractor; however, everyone must be safety conscious and responsible at all times. To achieve our goal of avoiding accidents, cooperation between the client, the contractor and GSI personnel must be maintained.

In an effort to minimize risks associated with geotechnical testing and observation, the following precautions are to be implemented for the safety of field personnel on grading and construction projects:

Safety Meetings: GSI field personnel are directed to attend contractors regularly scheduled and documented safety meetings.

Safety Vests: Safety vests are provided for and are to be worn by GSI personnel at all times when they are working in the field.

Safety Flags: Two safety flags are provided to GSI field technicians; one is to be affixed to the vehicle when on site, the other is to be placed atop the spoil pile on all test pits.

Flashing Lights: All vehicles stationary in the grading area shall use rotating or flashing amber beacon, or strobe lights, on the vehicle during all field testing. While operating a vehicle in the grading area, the emergency flasher on the vehicle shall be activated.

In the event that the contractor's representative observes any of our personnel not following the above, we request that it be brought to the attention of our office.

Test Pits Location, Orientation and Clearance

The technician is responsible for selecting test pit locations. A primary concern should be the technicians's safety. Efforts will be made to coordinate locations with the grading contractors authorized representative, and to select locations following or behind the established traffic pattern, preferably outside of current traffic. The contractors authorized representative (dump man, operator, supervisor, grade checker, etc.) should direct excavation of the pit and safety during the test period. Of paramount concern should be the soil technicians safety and obtaining enough tests to represent the fill.

Test pits should be excavated so that the spoil pile is placed away form oncoming traffic, whenever possible. The technician's vehicle is to be placed next to the test pit, opposite the spoil pile. This necessitates the fill be maintained in a driveable condition. Alternatively, the contractor may wish to park a piece of equipment in front of the test holes, particularly in small fill areas or those with limited access.

A zone of non-encroachment should be established for all test pits. No grading equipment should enter this zone during the testing procedure. The zone should extend approximately 50 feet outward from the center of the test pit. This zone is established for safety and to avoid excessive ground vibration which typically decreased test results.

When taking slope tests the technician should park the vehicle directly above or below the test location. If this is not possible, a prominent flag should be placed at the top of the slope. The contractor's representative should effectively keep all equipment at a safe operation distance (e.g. 50 feet) away from the slope during this testing.

The technician is directed to withdraw from the active portion of the fill as soon as possible following testing. The technician's vehicle should be parked at the perimeter of the fill in a highly visible location, well away from the equipment traffic pattern.

The contractor should inform our personnel of all changes to haul roads, cut and fill areas or other factors that may affect site access and site safety.

In the event that the technicians safety is jeopardized or compromised as a result of the contractors failure to comply with any of the above, the technician is required, by company policy, to immediately withdraw and notify his/her supervisor. The grading contractors representative will eventually be contacted in an effort to effect a solution. However, in the interim, no further testing will be performed until the situation is rectified. Any fill place can be considered unacceptable and subject to reprocessing, recompaction or removal.

In the event that the soil technician does not comply with the above or other established safety guidelines, we request that the contractor brings this to his/her attention and notify this office. Effective communication and coordination between the contractors representative and the soils technician is strongly encouraged in order to implement the above safety plan.

Trench and Vertical Excavation

It is the contractor's responsibility to provide safe access into trenches where compaction testing is needed.

Our personnel are directed not to enter any excavation or vertical cut which 1) is 5 feet or deeper unless shored or laid back, 2) displays any evidence of instability, has any loose rock or other debris which could fall into the trench, or 3) displays any other evidence of any unsafe conditions regardless of depth.

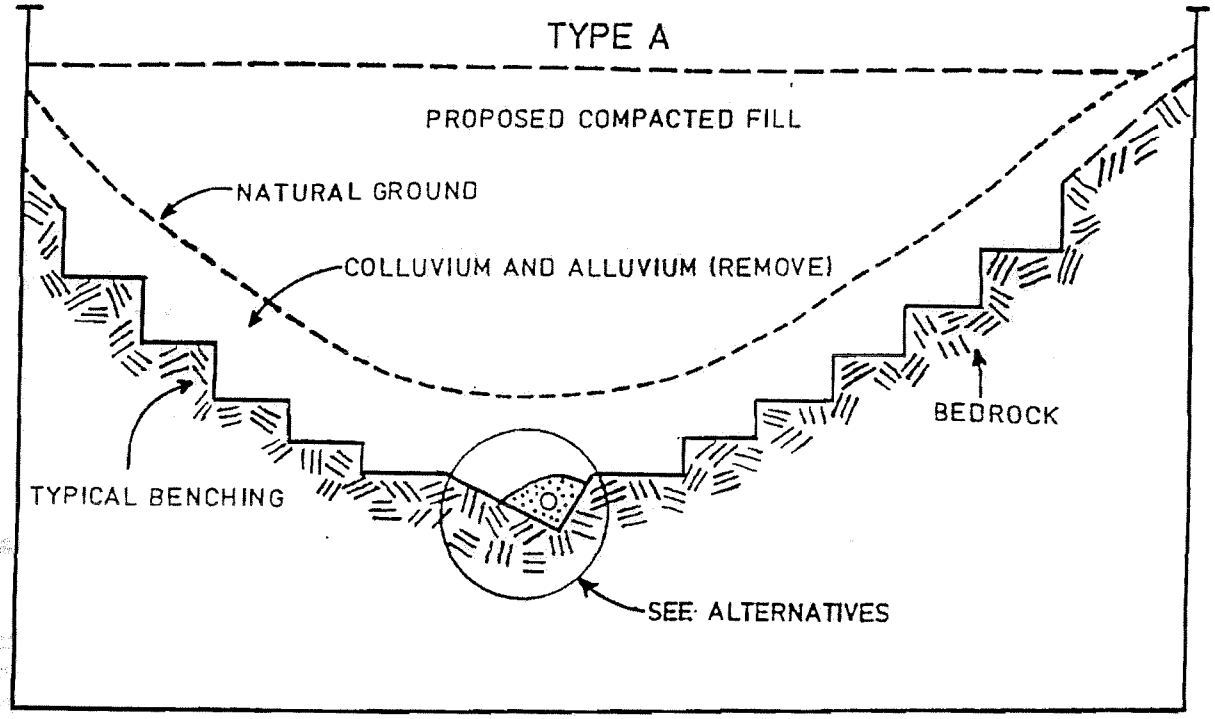
All trench excavations or vertical cuts in excess of 5 feet deep, which any person enters, should be shored or laid back.

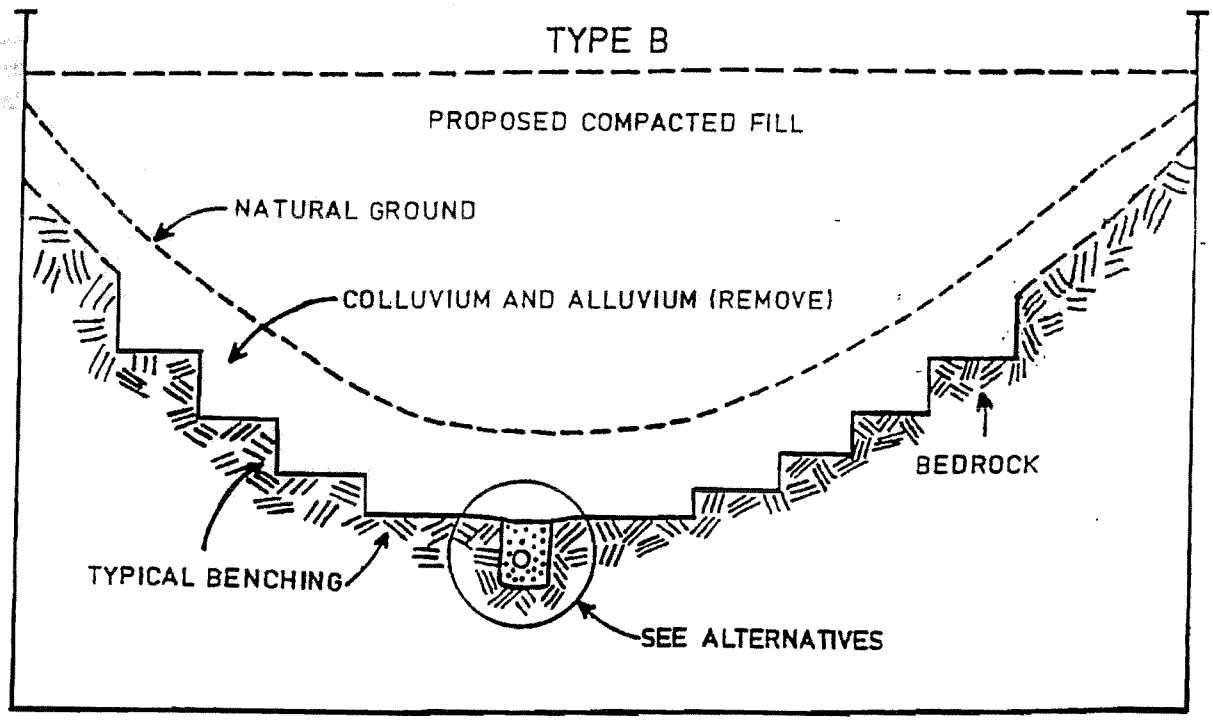
Trench access should be provided in accordance with CAL-OSHA and/or state and local standards. Our personnel are directed not to enter any trench by being lowered or "riding down" on the equipment.

If the contractor fails to provide safe access to trenches for compaction testing, our company policy requires that the soil technician withdraw and notify his/her supervisor. The contractors representative will eventually be contacted in an effort to effect a solution. All backfill not tested due to safety concerns or other reasons could be subject to reprocessing and/or removal.

If GSI personnel become aware of anyone working beneath an unsafe trench wall or vertical excavation, we have a legal obligation to put the contractor and owner/developer on notice to immediately correct the situation. If corrective steps are not taken, GSI then has an obligation to notify CAL-OSHA and/or the proper authorities.

CANYON SUBDRAIN DETAIL



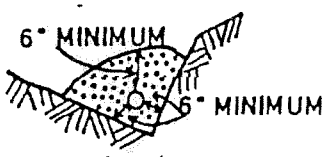


NOTE: ALTERNATIVES, LOCATION AND EXTENT OF SUBDRAINS SHOULD BE DETERMINED BY THE SOILS ENGINEER AND/OR ENGINEERING GEOLOGIST DURING GRADING.

PLATE EG—1

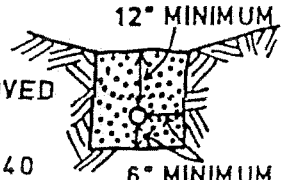
CANYON SUBDRAIN ALTERNATE DETAILS

ALTERNATE 1: PERFORATED PIPE AND FILTER MATERIAL



A—1

FILTER MATERIAL: MINIMUM VOLUME OF 9 FT.³ /LINEAR FT. 6" ø ABS OR PVC PIPE OR APPROVED SUBSTITUTE WITH MINIMUM 8 (1/4" ø) PERFS. LINEAR FT. IN BOTTOM HALF OF PIPE.
ASTM D2751, SDR 35 OR ASTM D1527, SCHD. 40
ASTM D3034, SDR 35 OR ASTM D1785, SCHD. 40
FOR CONTINUOUS RUN IN EXCESS OF 500 FT. USE 8" ø PIPE

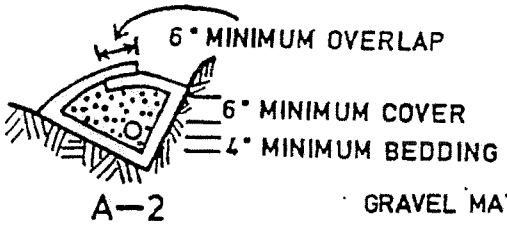


B—1

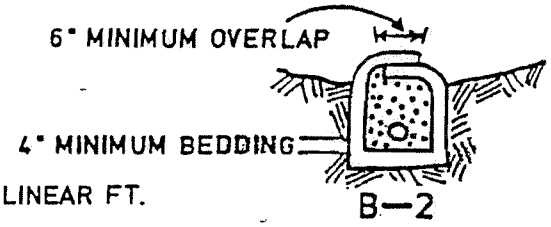
FILTER MATERIAL

SIEVE SIZE	PERCENT PASSING
1 INCH	100
3/4 INCH	90—100
3/8 INCH	40—100
NO. 4	25—40
NO. 8	18—33
NO. 30	5—15
NO. 50	0—7
NO. 200	0—3

ALTERNATE 2: PERFORATED PIPE, GRAVEL AND FILTER FABRIC



A—2

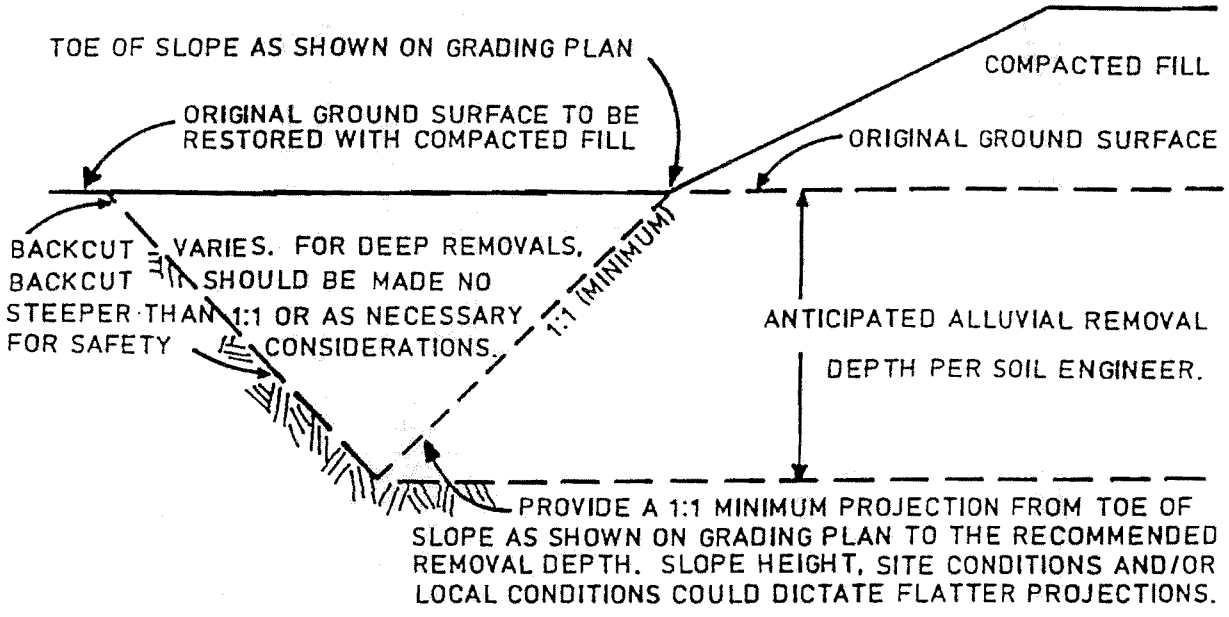


B—2

GRAVEL MATERIAL 9 FT³/LINEAR FT.
PERFORATED PIPE: SEE ALTERNATE 1
GRAVEL: CLEAN 3/4 INCH ROCK OR APPROVED SUBSTITUTE
FILTER FABRIC: MIRAFI 140 OR APPROVED SUBSTITUTE

PLATE EG—2

DETAIL FOR FILL SLOPE TOEING OUT ON FLAT ALLUVIATED CANYON



REMOVAL ADJACENT TO EXISTING FILL

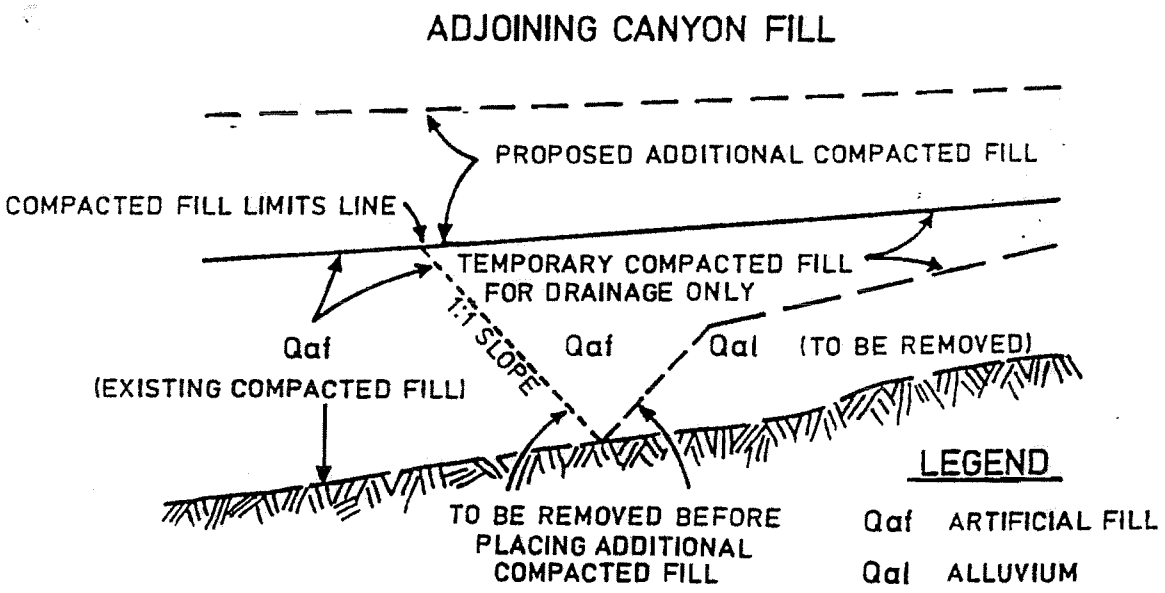


PLATE EG—3

TYPICAL STABILIZATION / BUTTRESS FILL DETAIL

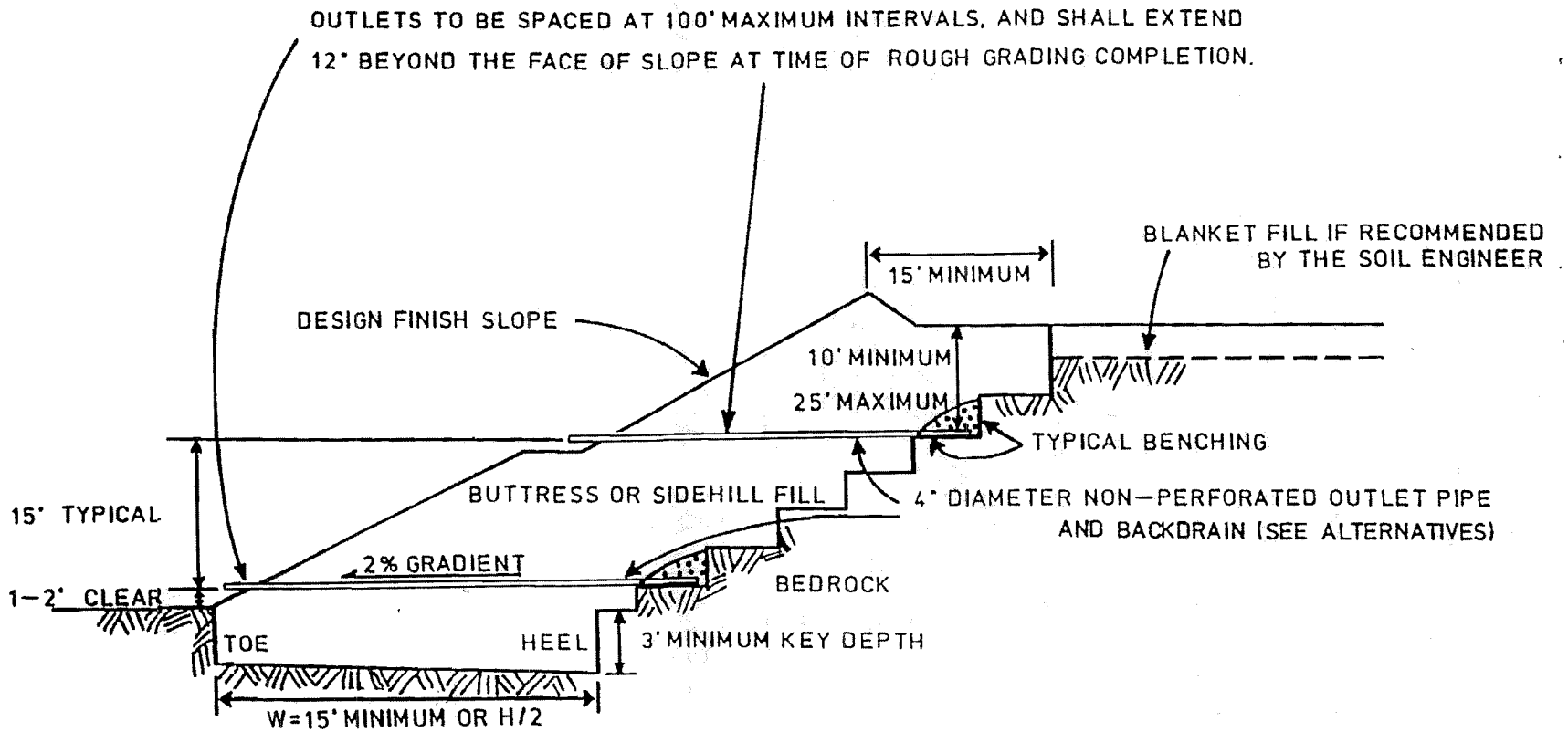
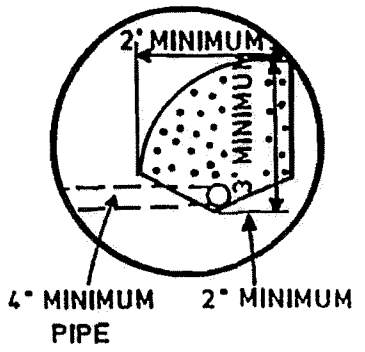
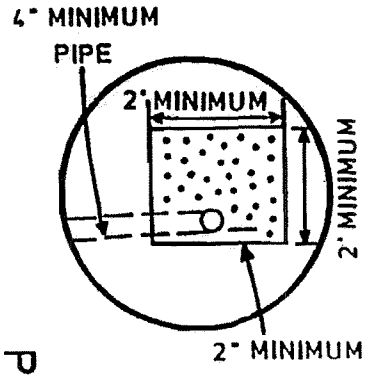


PLATE EG-4

TYPICAL STABILIZATION / BUTTRESS SUBDRAIN DETAIL





FILTER MATERIAL: MINIMUM OF FIVE Ft^3/LINEAR Ft OF PIPE OR FOUR Ft^3/LINEAR Ft OF PIPE WHEN PLACED IN SQUARE CUT TRENCH.

ALTERNATIVE IN LIEU OF FILTER MATERIAL: GRAVEL MAY BE ENCASED IN APPROVED FILTER FABRIC. FILTER FABRIC SHALL BE MIRAFI 140 OR EQUIVALENT. FILTER FABRIC SHALL BE LAPPED A MINIMUM OF 12" ON ALL JOINTS.

MINIMUM 4" DIAMETER PIPE: ABS—ASTM D—2751, SDR 35 OR ASTM D—1527 SCHEDULE 40 PVC—ASTM D—3034, SDR 35 OR ASTM D—1785 SCHEDULE 40 WITH A CRUSHING STRENGTH OF 1,000 POUNDS MINIMUM, AND A MINIMUM OF 8 UNIFORMLY SPACED PERFORATIONS PER FOOT OF PIPE INSTALLED WITH PERFORATIONS OF BOTTOM OF PIPE. PROVIDE CAP AT UPSTREAM END OF PIPE. SLOPE AT 2% TO OUTLET PIPE. OUTLET PIPE TO BE CONNECTED TO SUBDRAIN PIPE WITH TEE OR ELBOW.

NOTE: 1. TRENCH FOR OUTLET PIPES TO BE BACKFILLED WITH ON—SITE SOIL.

2. BACKDRAINS AND LATERAL DRAINS SHALL BE LOCATED AT ELEVATION OF EVERY BENCH DRAIN. FIRST DRAIN LOCATED AT ELEVATION JUST ABOVE LOWER LOT GRADE. ADDITIONAL DRAINS MAY BE REQUIRED AT THE DISCRETION OF THE SOILS ENGINEER AND/OR ENGINEERING GEOLOGIST.

FILTER MATERIAL SHALL BE OF THE FOLLOWING SPECIFICATION OR AN APPROVED EQUIVALENT:

SIEVE SIZE	PERCENT PASSING
1 INCH	100
3/4 INCH	90—100
3/8 INCH	40—100
NO. 4	25—40
NO. 8	18—33
NO. 30	5—15
NO. 50	0—7
NO. 200	0—3

GRAVEL SHALL BE OF THE FOLLOWING SPECIFICATION OR AN APPROVED EQUIVALENT:

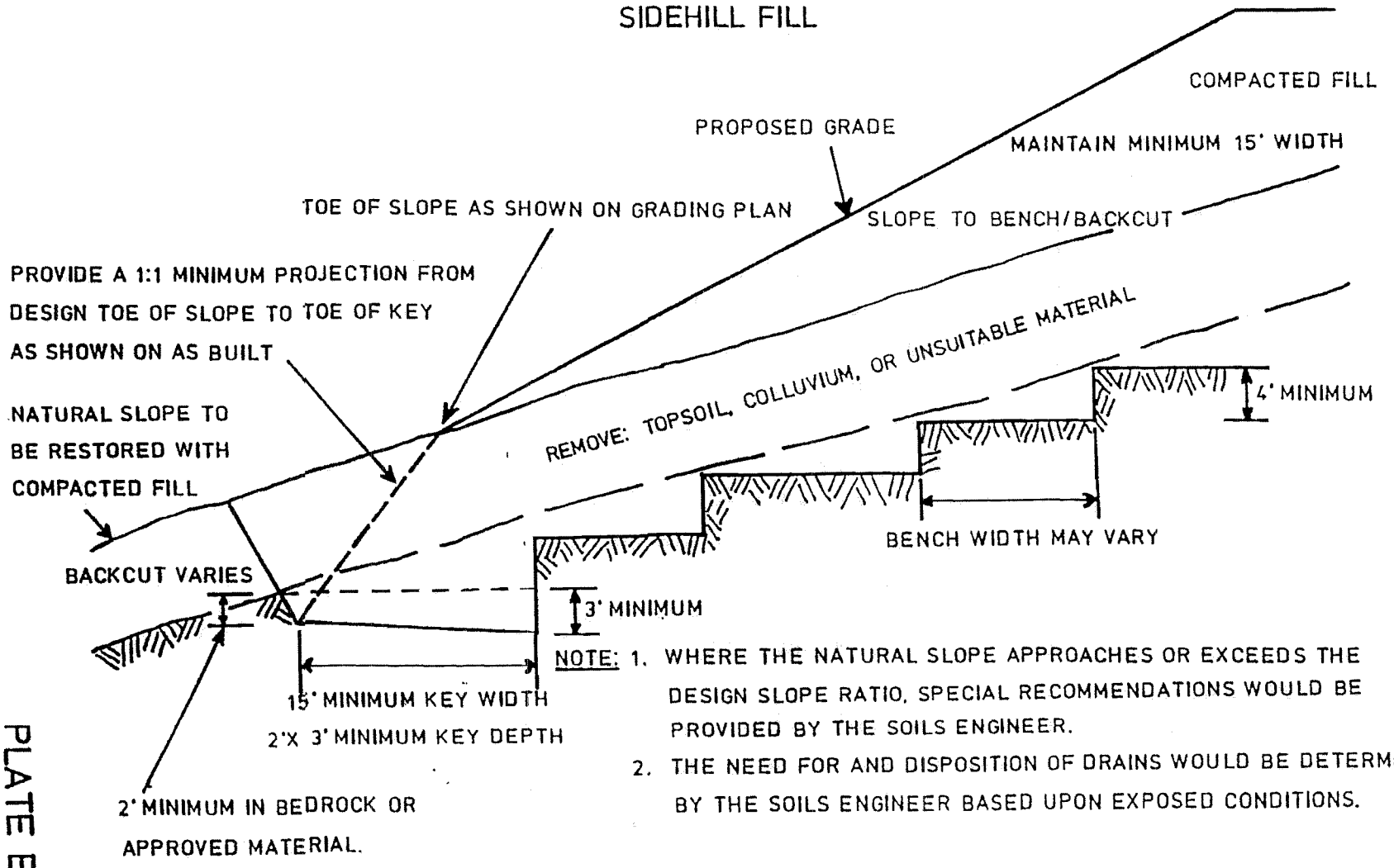
SIEVE SIZE	PERCENT PASSING
1 1/2 INCH	100
NO. 4	50
NO. 200	8

SAND EQUIVALENT: MINIMUM OF 50

PLATE EG—5

FILL OVER NATURAL DETAIL

SIDEHILL FILL

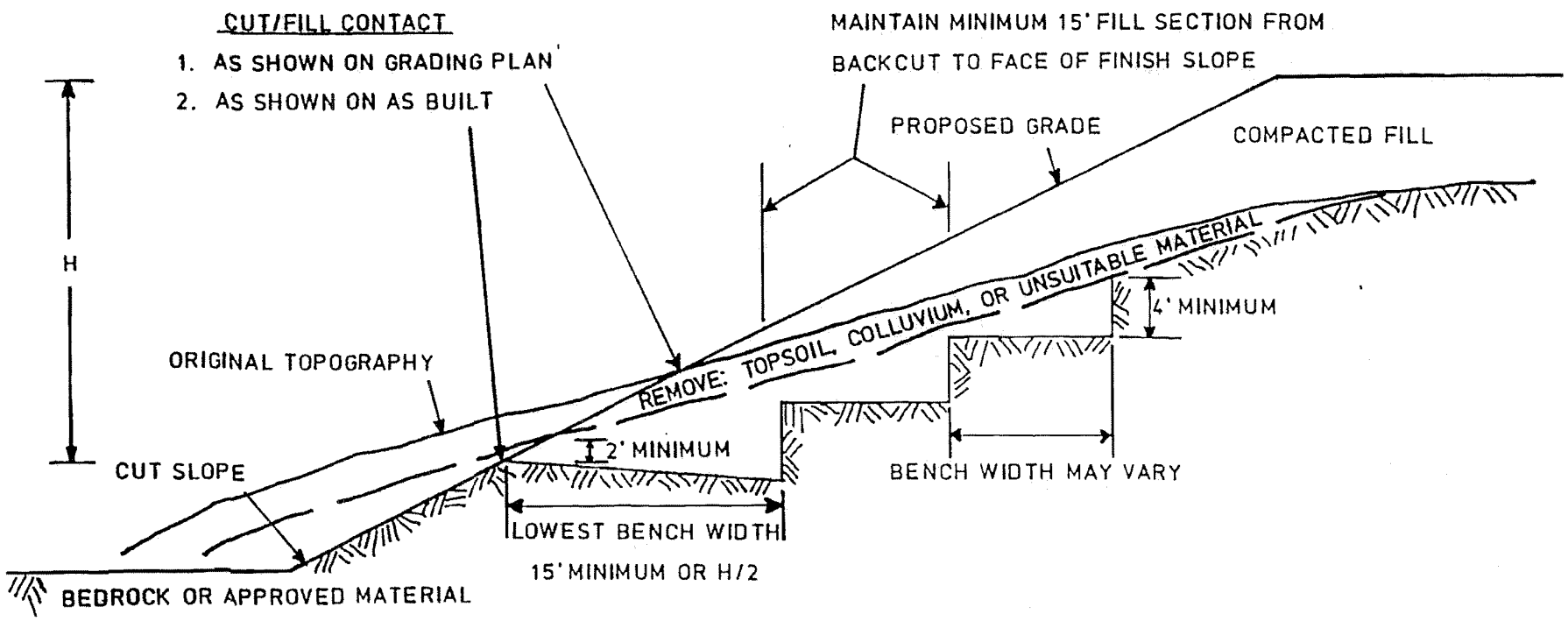


NOTE: 1. WHERE THE NATURAL SLOPE APPROACHES OR EXCEEDS THE DESIGN SLOPE RATIO, SPECIAL RECOMMENDATIONS WOULD BE PROVIDED BY THE SOILS ENGINEER.

2. THE NEED FOR AND DISPOSITION OF DRAINS WOULD BE DETERMINED BY THE SOILS ENGINEER BASED UPON EXPOSED CONDITIONS.

PLATE EG-6

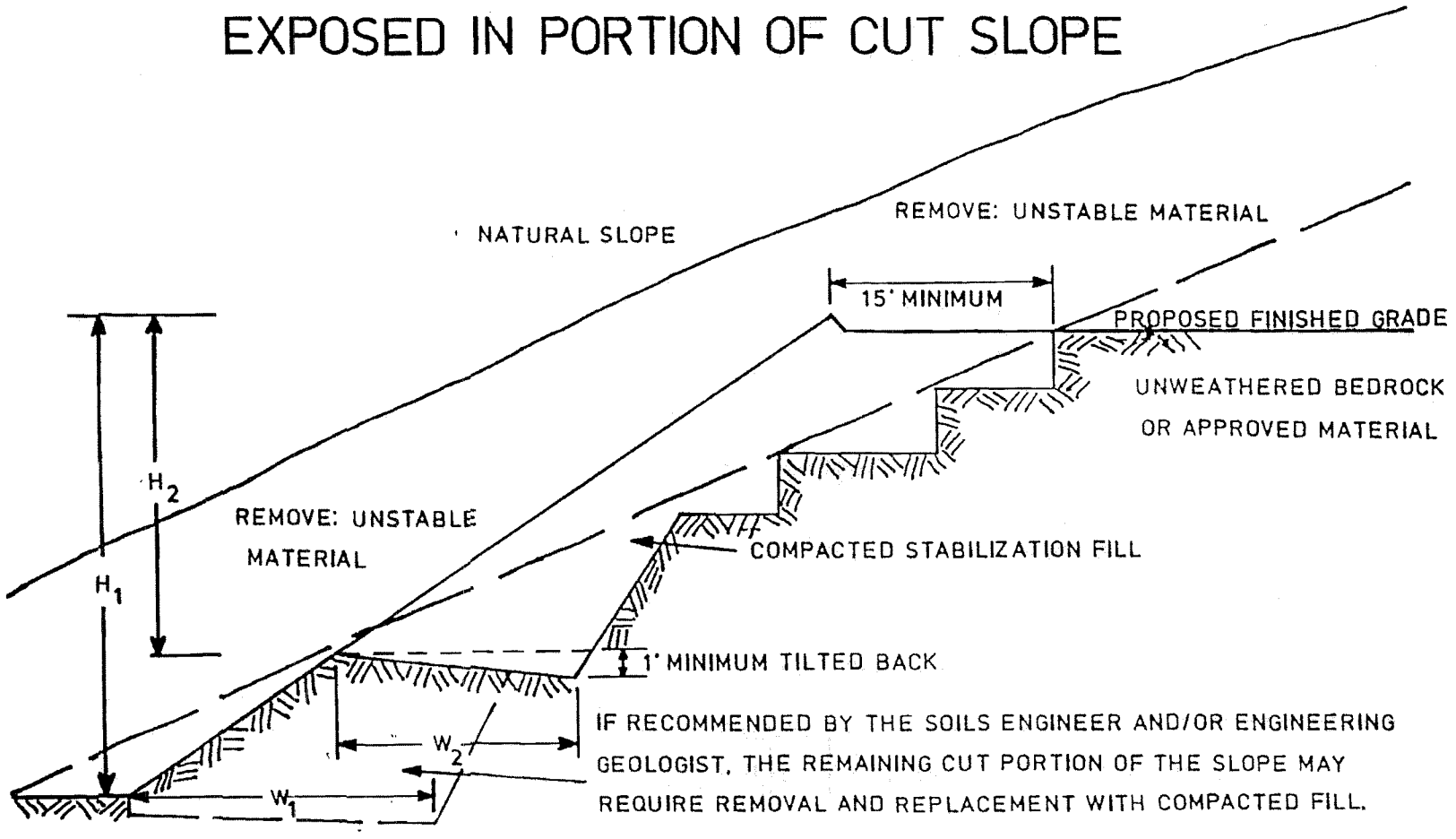
FILL OVER CUT DETAIL



NOTE: THE CUT PORTION OF THE SLOPE SHOULD BE EXCAVATED AND EVALUATED BY THE SOILS ENGINEER AND/OR ENGINEERING GEOLOGIST PRIOR TO CONSTRUCTING THE FILL PORTION.

PLATE EG-7

STABILIZATION FILL FOR UNSTABLE MATERIAL EXPOSED IN PORTION OF CUT SLOPE

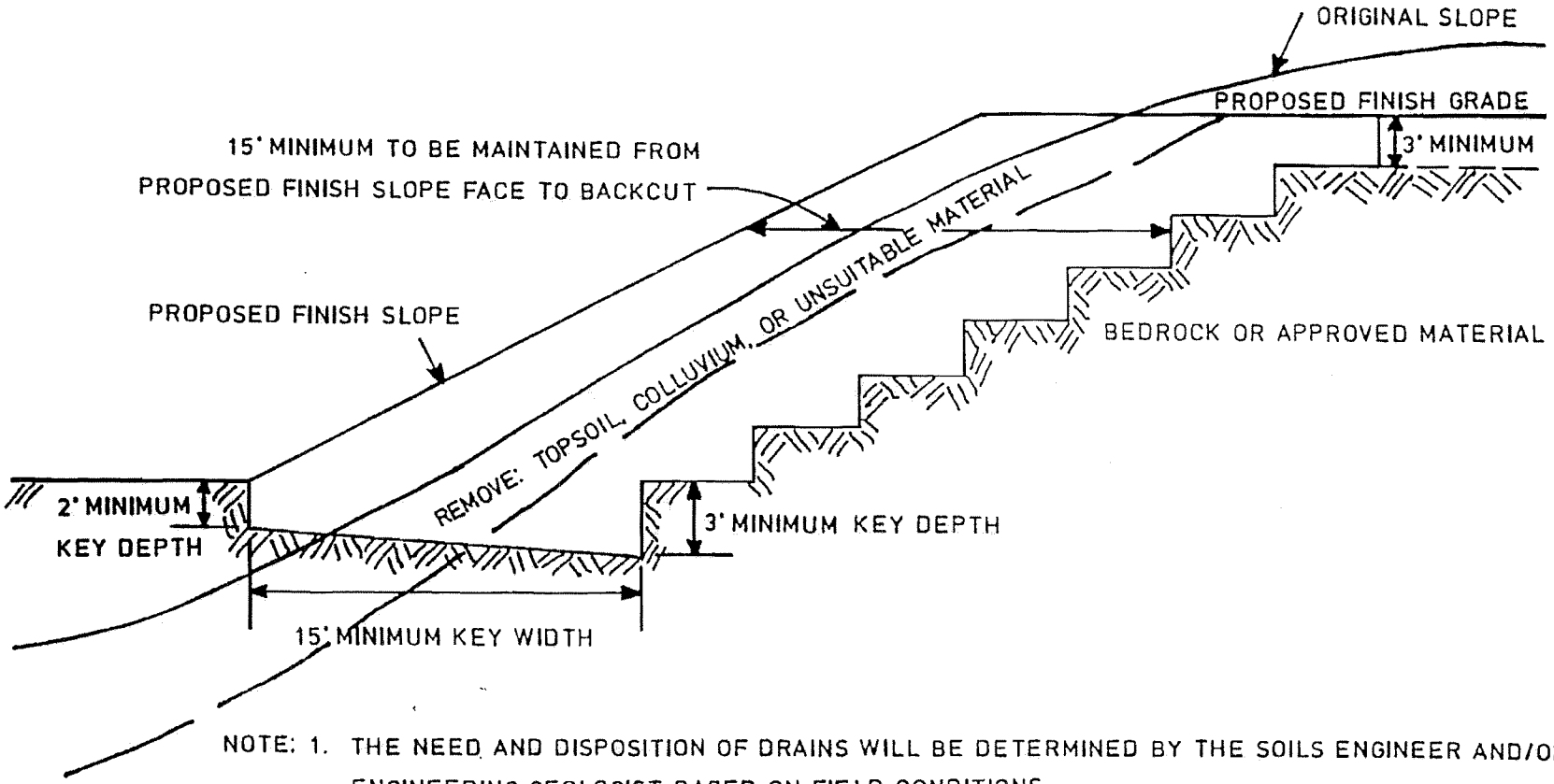


NOTE: 1. SUBDRAINS ARE NOT REQUIRED UNLESS SPECIFIED BY SOILS ENGINEER AND/OR ENGINEERING GEOLOGIST,

2. "W" SHALL BE EQUIPMENT WIDTH (15') FOR SLOPE HEIGHTS LESS THAN 25 FEET. FOR SLOPES GREATER THAN 25 FEET "W" SHALL BE DETERMINED BY THE PROJECT SOILS ENGINEER AND /OR ENGINEERING GEOLOGIST. AT NO TIME SHALL "W" BE LESS THAN H/2.

PLATE EG—8

SKIN FILL OF NATURAL GROUND

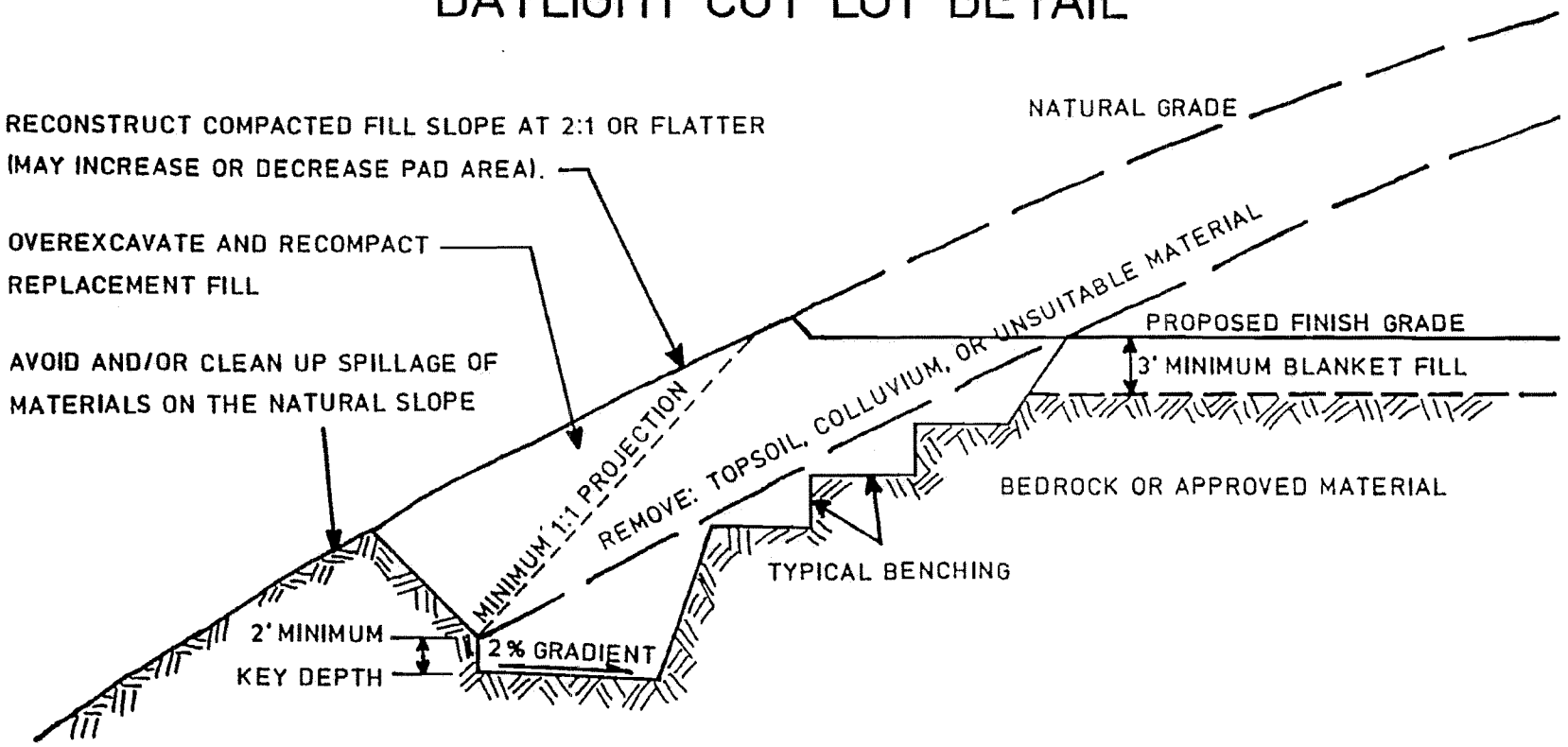


NOTE: 1. THE NEED AND DISPOSITION OF DRAINS WILL BE DETERMINED BY THE SOILS ENGINEER AND/OR ENGINEERING GEOLOGIST BASED ON FIELD CONDITIONS.

2. PAD OVEREXCAVATION AND RECOMPACTION SHOULD BE PERFORMED IF DETERMINED TO BE NECESSARY BY THE SOILS ENGINEER AND/OR ENGINEERING GEOLOGIST.

PLATE EG-9

DAYLIGHT CUT LOT DETAIL



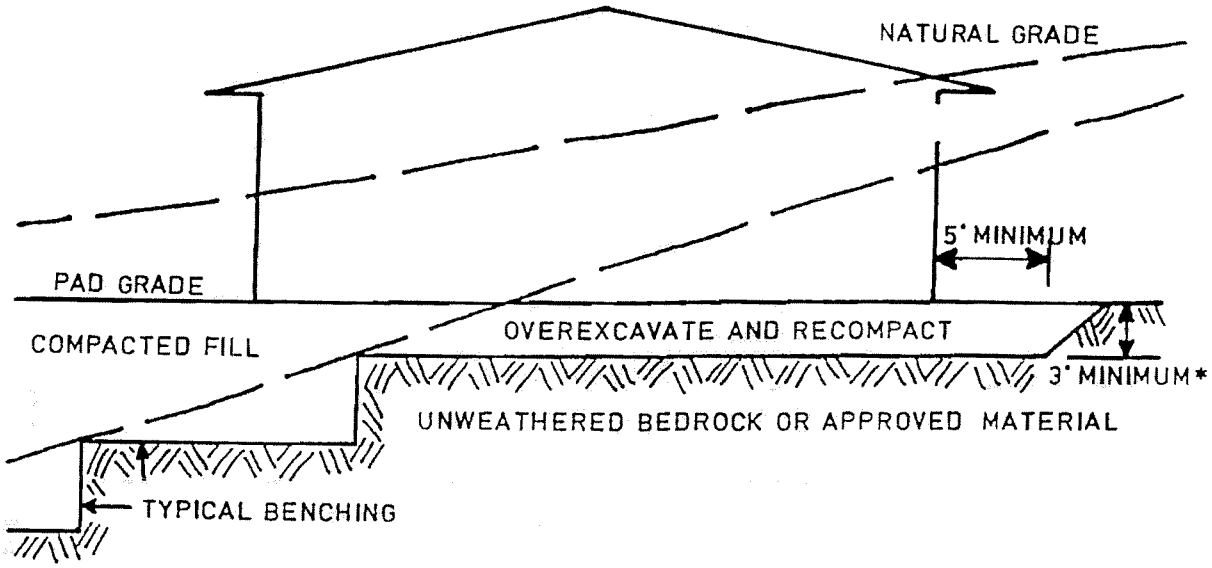
NOTE: 1. SUBDRAIN AND KEY WIDTH REQUIREMENTS WILL BE DETERMINED BASED ON EXPOSED SUBSURFACE CONDITIONS AND THICKNESS OF OVERBURDEN.

2. PAD OVER EXCAVATION AND RECOMPACTION SHOULD BE PERFORMED IF DETERMINED NECESSARY BY THE SOILS ENGINEER AND/OR THE ENGINEERING GEOLOGIST.

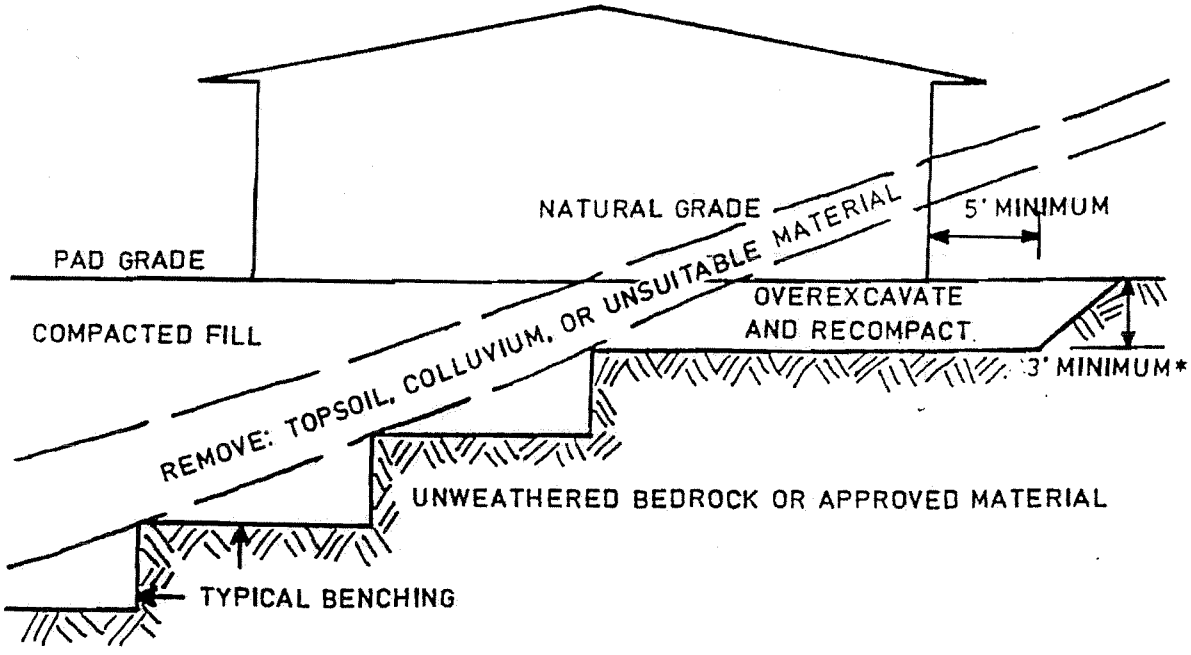
PLATE EG—10

TRANSITION LOT DETAIL

CUT LOT (MATERIAL TYPE TRANSITION)



CUT—FILL LOT (DAYLIGHT TRANSITION)



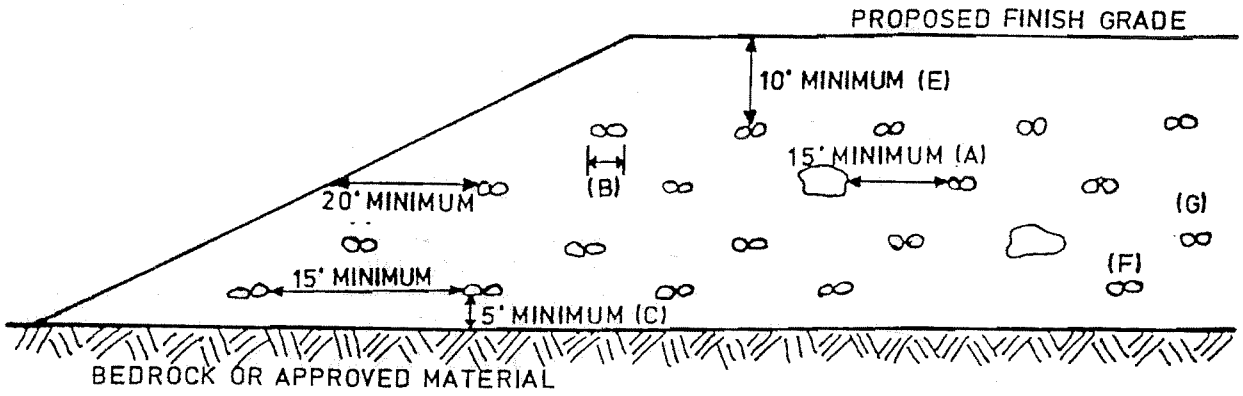
NOTE: * DEEPER OVEREXCAVATION MAY BE RECOMMENDED BY THE SOILS ENGINEER AND/OR ENGINEERING GEOLOGIST IN STEEP CUT—FILL TRANSITION AREAS.

PLATE EG—11

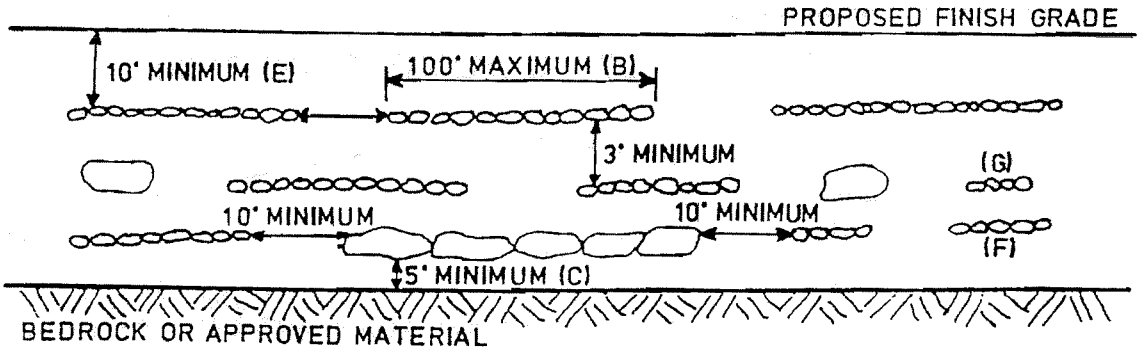
OVERSIZE ROCK DISPOSAL

VIEWS ARE DIAGRAMMATIC ONLY. ROCK SHOULD NOT TOUCH AND VOIDS SHOULD BE COMPLETELY FILLED IN.

VEIW NORMAL TO SLOPE FACE



VIEW PARALLEL TO SLOPE FACE



NOTE: (A) ONE EQUIPMENT WIDTH OR A MINIMUM OF 15 FEET.

(B) HEIGHT AND WIDTH MAY VARY DEPENDING ON ROCK SIZE AND TYPE OF EQUIPMENT USED. LENGTH OF WINDROW SHALL BE NO GREATER THAN 100' MAXIMUM.

(C) IF APPROVED BY THE SOILS ENGINEER AND/OR ENGINEERNG GEOLOGIST, WINDROWS MAY BE PLACED DIRECTLY ON COMPETENT MATERIALS OR BEDROCK PROVIDED ADEQUATE SPACE IS AVAILABLE FOR COMPACTION.

(D) ORIENTATION OF WINDROWS MAY VARY BUT SHALL BE AS RECOMMENDED BY THE SOILS ENGINEER AND/OR ENGINEERING GEOLOGIST. STAGGERING OF WINDROWS IS NOT NECESSARY UNLESS RECOMMENDED.

(E) CLEAR AREA FOR UTILITY TRENCHES, FOUNDATIONS AND SWIMMING POOLS.

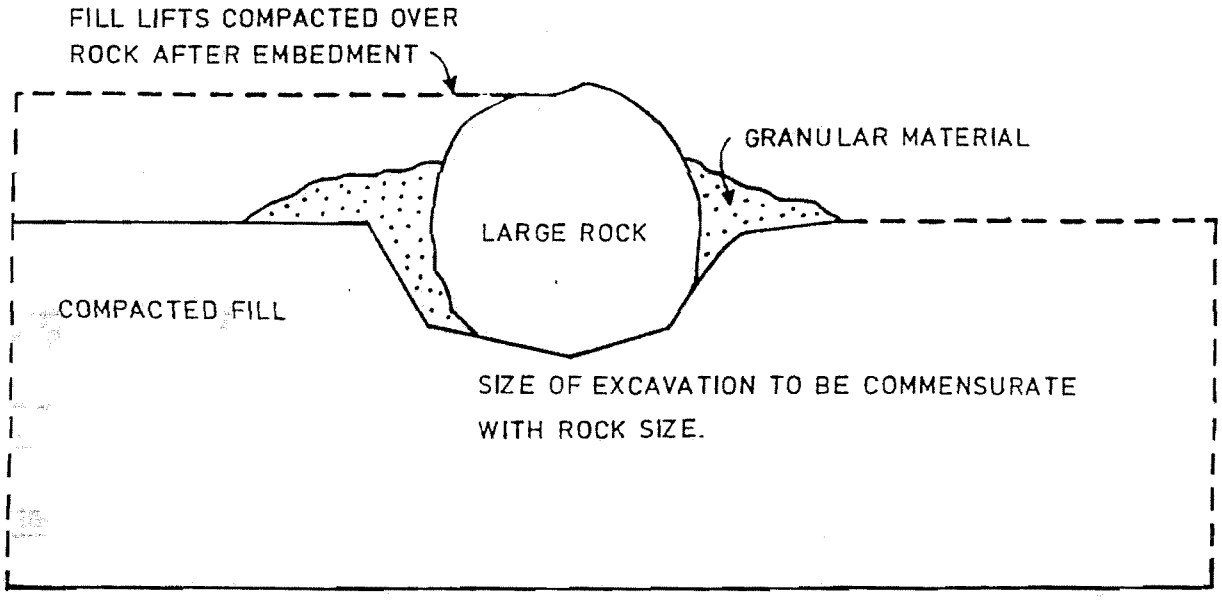
(F) VOIDS IN WINDROW SHALL BE FILLED BY FLOODING GRANULAR SOIL INTO PLACE. GRANULAR SOIL SHALL BE ANY SOIL WHICH HAS A UNIFIED SOIL CLASSIFICATION SYSTEM (UBC 29—1) DESIGNATION OF SM, SP, SW, GP, OR GW. ALL FILL OVER AND AROUND ROCK WINDROW SHALL BE COMPACTED TO 90% RELATIVE COMPACTION.

(G) AFTER FILL BETWEEN WINDROWS IS PLACED AND COMPACTED WITH THE LIFT OF FILL COVERING WINDROW, WINDROW SHALL BE PROOF ROLLED WITH A D—9 DOZER OR EQUIVALENT.

(H) OVERSIZED ROCK IS DEFINED AS LARGER THAN 12", AND LESS THAN 4 FEET IN SIZE.

PLATE EG—12

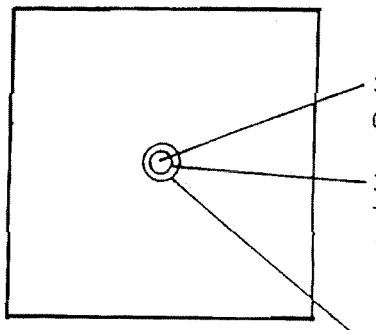
ROCK DISPOSAL PITS



NOTE:
1. LARGE ROCK IS DEFINED AS ROCK LARGER THAN 4 FEET IN MAXIMUM SIZE.
2. PIT IS EXCAVATED INTO COMPACTED FILL TO A DEPTH EQUAL TO 1/2 OF ROCK SIZE.
3. GRANULAR SOIL SHOULD BE PUSHED INTO PIT AND DENSIFIED BY FLOODING. USE A SHEEPSFOOT AROUND ROCK TO AID IN COMPACTION.
4. A MINIMUM OF 4 FEET OF REGULAR COMPACTED FILL SHOULD OVERLIE EACH PIT.
5. PITS SHOULD BE SEPARATED BY AT LEAST 15 FEET HORIZONTALLY.
6. PITS SHOULD NOT BE PLACED WITHIN 20 FEET OF ANY FILL SLOPE.
7. PITS SHOULD ONLY BE USED IN DEEP FILL AREAS.

PLATE EG—13

SETTLEMENT PLATE AND RISER DETAIL

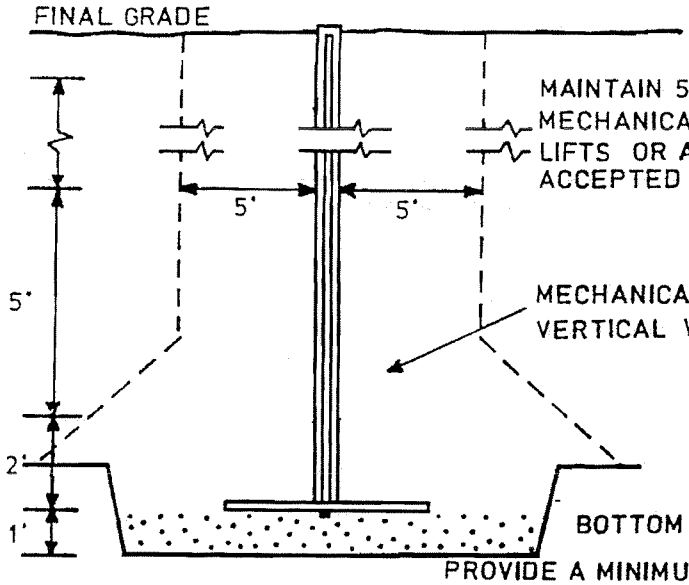


2'X 2'X 1/4" STEEL PLATE

STANDARD 3/4" PIPE NIPPLE WELDED TO TOP OF PLATE.

3/4" X 5' GALVANIZED PIPE, STANDARD PIPE THREADS TOP AND BOTTOM. EXTENSIONS THREADED ON BOTH ENDS AND ADDED IN 5' INCREMENTS.

3 INCH SCHEDULE 40 PVC PIPE SLEEVE, ADD IN 5' INCREMENTS WITH GLUE JOINTS.



MAINTAIN 5' CLEARANCE OF HEAVY EQUIPMENT. MECHANICALLY HAND COMPACT IN 2' VERTICAL LIFTS OR ALTERNATIVE SUITABLE TO AND ACCEPTED BY THE SOILS ENGINEER.

MECHANICALLY HAND COMPACT THE INITIAL 5' VERTICAL WITHIN A 5' RADIUS OF PLATE BASE.

BOTTOM OF CLEANOUT

PROVIDE A MINIMUM 1' BEDDING OF COMPACTED SAND

NOTE:

1. LOCATIONS OF SETTLEMENT PLATES SHOULD BE CLEARLY MARKED AND READILY VISIBLE (RED FLAGGED) TO EQUIPMENT OPERATORS.
2. CONTRACTOR SHOULD MAINTAIN CLEARANCE OF A 5' RADIUS OF PLATE BASE AND WITHIN 5' (VERTICAL) FOR HEAVY EQUIPMENT. FILL WITHIN CLEARANCE AREA SHOULD BE HAND COMPACTED TO PROJECT SPECIFICATIONS OR COMPACTED BY ALTERNATIVE APPROVED BY THE SOILS ENGINEER.
3. AFTER 5' (VERTICAL) OF FILL IS IN PLACE, CONTRACTOR SHOULD MAINTAIN A 5' RADIUS EQUIPMENT CLEARANCE FROM RISER.
4. PLACE AND MECHANICALLY HAND COMPACT INITIAL 2' OF FILL PRIOR TO ESTABLISHING THE INITIAL READING.
5. IN THE EVENT OF DAMAGE TO THE SETTLEMENT PLATE OR EXTENSION RESULTING FROM EQUIPMENT OPERATING WITHIN THE SPECIFIED CLEARANCE AREA, CONTRACTOR SHOULD IMMEDIATELY NOTIFY THE SOILS ENGINEER AND SHOULD BE RESPONSIBLE FOR RESTORING THE SETTLEMENT PLATES TO WORKING ORDER.
6. AN ALTERNATE DESIGN AND METHOD OF INSTALLATION MAY BE PROVIDED AT THE DISCRETION OF THE SOILS ENGINEER.

PLATE EG—14

TYPICAL SURFACE SETTLEMENT MONUMENT

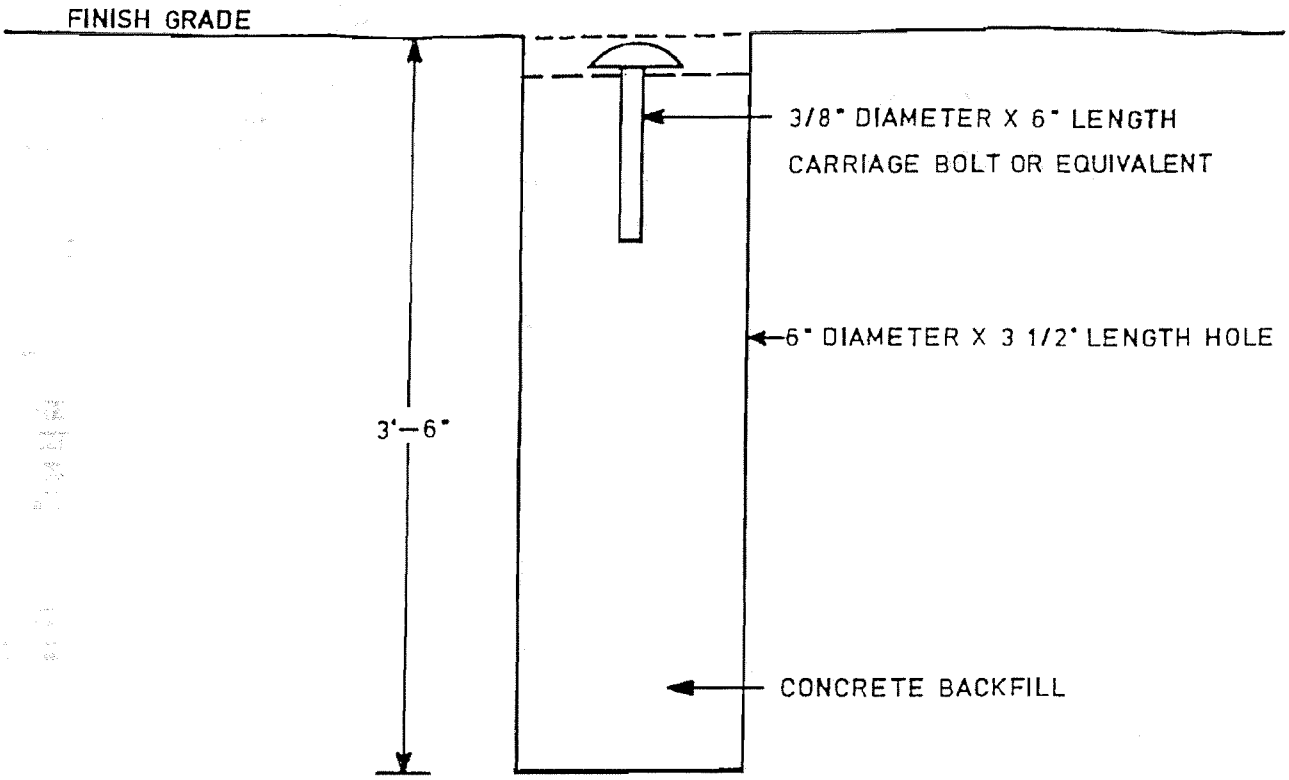
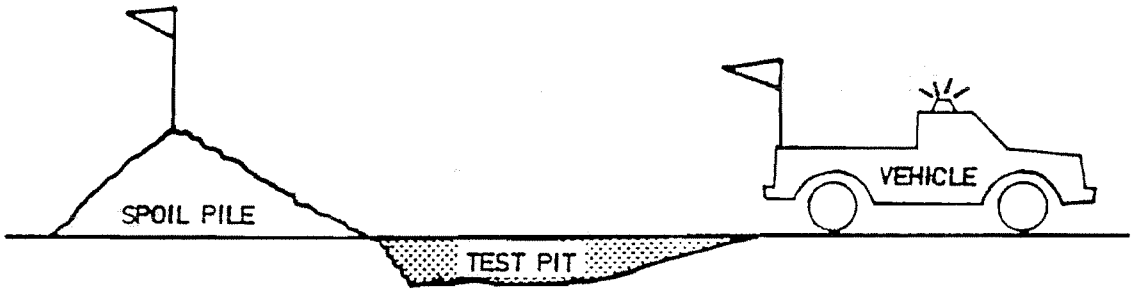


PLATE EG-15

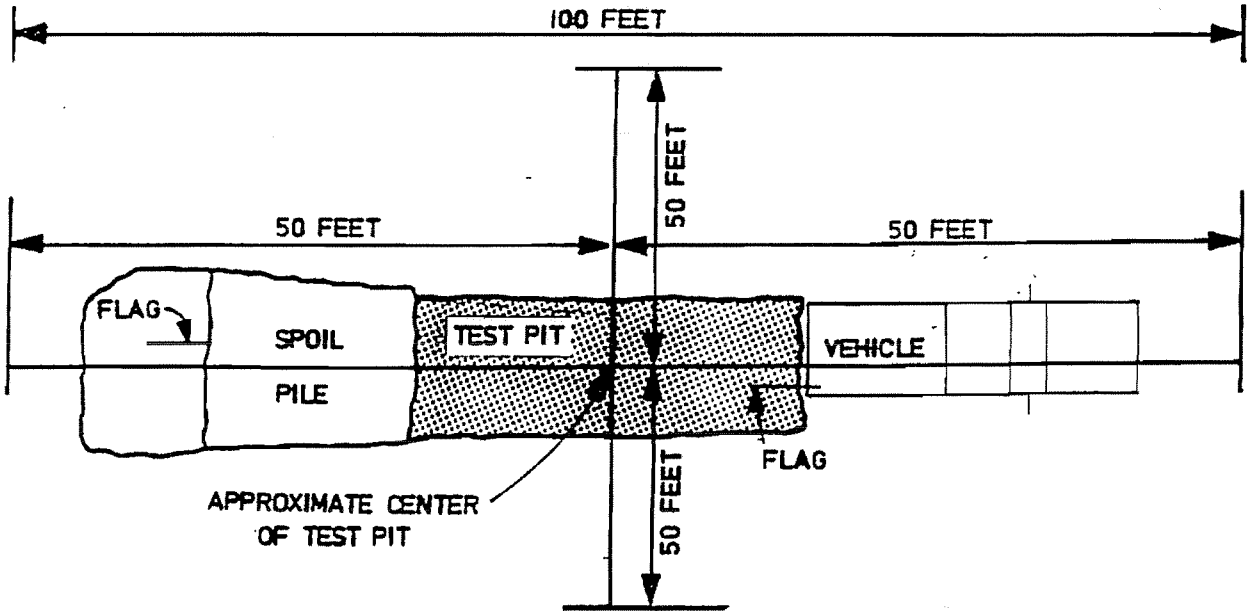
TEST PIT SAFETY DIAGRAM

SIDE VIEW



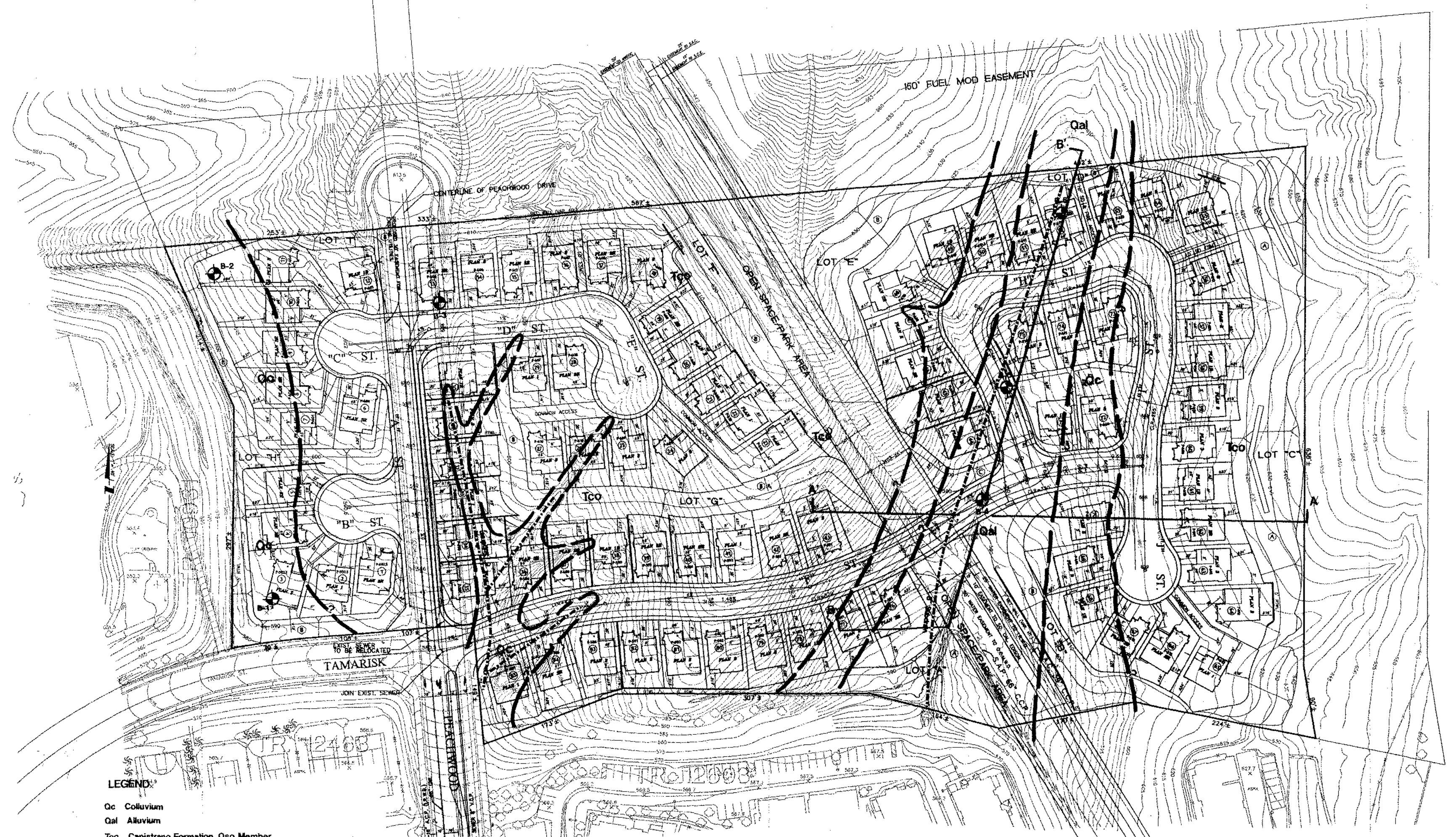
(NOT TO SCALE)

TOP VIEW



(NOT TO SCALE)

PLATE EG—16



LEGEND:

Qc Colluvium

Qal Alluvium

Tco Capistrano Formation, Oso Member

Geologic Contact, Approximately Location

B-6 Approximate Location of GSI's Exploratory Boring

A A' Geologic Cross-Section

Subdrain

LOT AREA SUMMARY

LOT No.	LOT AREA (SQ.FT.)	LOT No.	LOT AREA (SQ.FT.)
1	4,502	49	4,568
2	4,602	50	4,808
3	5,489	51	5,329
4	4,177	52	4,512
5	4,641	53	3,865
6	4,392	54	4,881
7	5,598	55	6,381
8	4,945	56	5,076
9	5,187	57	4,689
10	6,802	58	4,282
11	7,868	59	4,261
12	4,898	60	4,304
13	4,052	61	4,384
14	4,117	62	4,727
15	4,194	63	4,743
16	4,316	64	5,692
17	4,102	65	8,429
18	5,704	66	5,240
19	4,120	67	4,650
20	4,275	68	4,936
21	4,199	69	5,343
22	4,049	70	6,274
23	7,965	71	6,280
24	7,052	72	6,456
25	4,228	73	5,471
26	4,200	74	4,052
27	4,219	75	5,180
28	4,525	76	8,923
29	4,101	77	4,784
30	5,271	78	4,352
31	4,085	79	4,476
32	3,877	80	4,201
33	4,065	81	4,135
34	3,981	82	4,187
35	5,922	83	4,550
36	4,490	84	4,949
37	4,087	85	5,734
38	4,053	A	16,858
39	4,155	B	19,090
40	4,134	C	55,318
41	4,375	D	1,980
42	4,459	E	27,678
43	4,447	F	19,634
44	4,838	G	23,656
45	5,426	H	22,853
46	4,623	I	7,385
47	4,370		
48	7,096		
		TOTAL	604,925
		AVERAGE	4,922

MAP DATE IDENTIFIER
DATE OF LATEST CHANGE TO THIS MAP
08/15/03 BY: LMM
DATE OF THIS PLOT
07/30/04

DESIGNED BY: D.H.
DRAFTED BY: L.A.S.
PROCESSED BY:

DATE	REVISION	BY

NORTH

0 25' 50' 100'

SCALE 1" = 50'
DATE 08-05-03
W.O. 1914-7X
GROSS AREA 18.5 AC±
CONTOUR INTERVAL 10'
TOTAL LOTS 85 NUMBERED
9 LETTERED

NOTES

1. PROPOSED GENERAL DESIGNATION: 7-15 DU/ACRE
2. EXISTING LAND USE: VACANT.
3. PROPOSED LAND USE: SINGLE FAMILY RESIDENTIAL.
4. EXISTING ZONING: SERRANO HIGHLANDS PLANNED COMMUNITY, HIGH DENSITY AND OPEN SPACE.

5. ON SITE DRAINAGE WILL BE COLLECTED IN AN APPROVED ON-SITE DRAINAGE STRUCTURE AND CONVEYED OFF SITE TO EXISTING STORM DRAIN.
6. GRADED SLOPES SHALL BE 2:1, UNLESS OTHERWISE SHOWN.
7. ALL GRADING, SLOPE TERRACE DRAINS AND DOWN DRAINS SHALL CONFORM TO THE CITY OF LAKE FOREST GRADING MANUAL AND EXCAVATION CODE.
8. APPLICANT INTENDS TO PHASE THIS PROJECT WITH MULTIPLE FINAL MAPS.

SLOPE DESIGNATIONS

(A) MAINTAINED BY PUBLIC AGENCY OR HOME OWNERS ASSOCIATION
(B) MAINTAINED BY HOME OWNERS ASSOCIATION
(C) MAINTAINED BY PRIVATE OWNERS

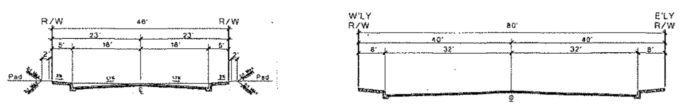
GSI RIVERSIDE CO. ORANGE CO. SAN DIEGO CO.

GEOLOGICAL MAP

W.O. 4414-A1-OC DATE 9-30-04 SCALE 1"=40'

PLATE 1

TYPICAL SECTIONS



"A"-"J" STREETS
PRIVATE

PEACHWOOD
EXISTING
PRIVATE

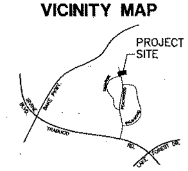
LEGAL DESCRIPTION

A SUBDIVISION OF LOTS 5 AND 6 OF TRACT NO. 10931, IN THE CITY OF LAKE FOREST, COUNTY OF ORANGE, STATE OF CALIFORNIA, AS PER MAP FILED IN BOOK 511, PAGES 1 THROUGH 5, INCLUSIVE, OF MISCELLANEOUS MAPS IN THE OFFICE OF THE COUNTY RECORDER OF SAID COUNTY.

LOT SUMMARY TABLE

1 - 85 SINGLE FAMILY RESIDENTIAL
A - I LANDSCAPE LOTS

VICINITY MAP



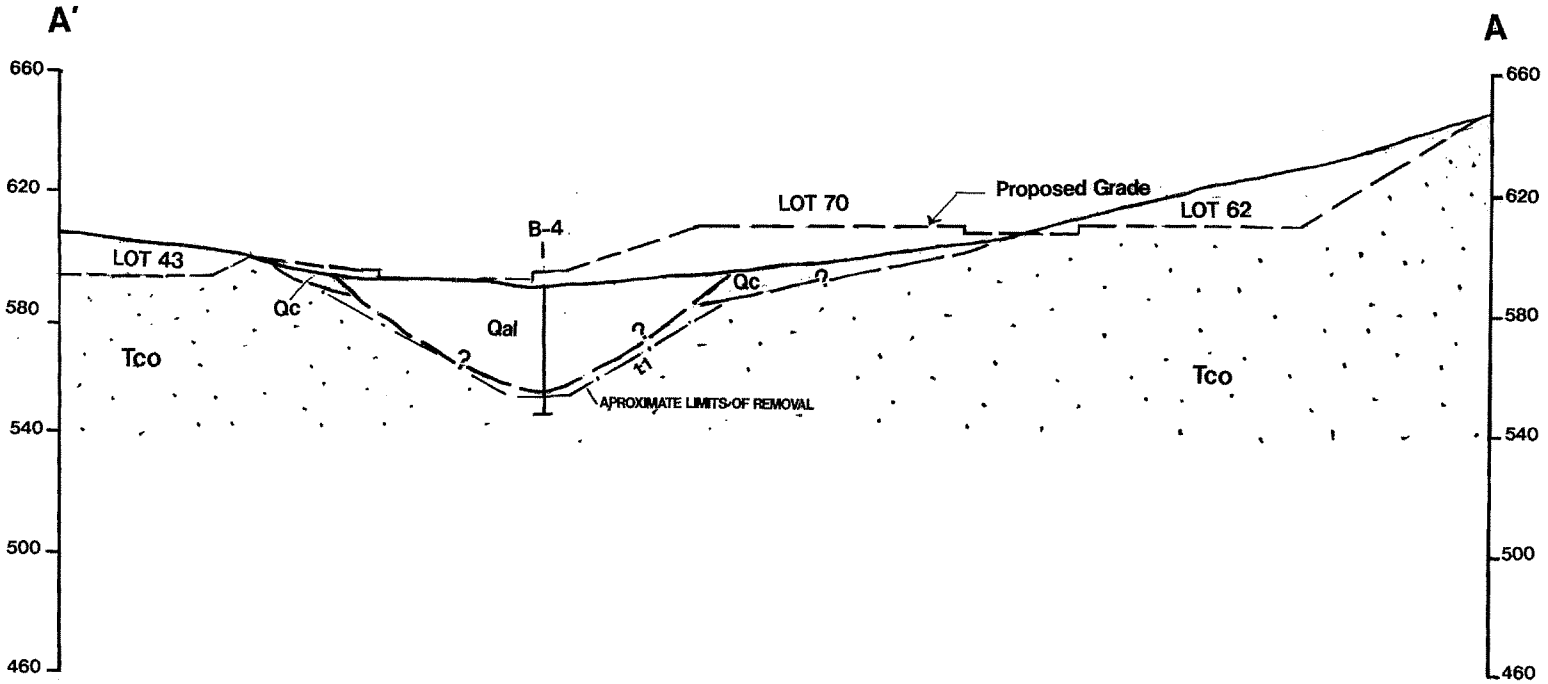
PREPARED FOR:
PACIFIC HERITAGE DEVELOPMENT
23201 MILL CREEK DRIVE
SUITE 130
LAGUNA HILLS, CA 92653
Tel (949) 472-6884
Fax (949) 462-9044

PREPARED BY:
H&A
HUNSAKER & ASSOCIATES

CONCEPT PLAN
TENTATIVE TRACT NO. 15594

W.O. 245-9 TM# 15594 BIN:316-G DOC. 49425

O:\15594\SITE PLAN\SITE.DWG



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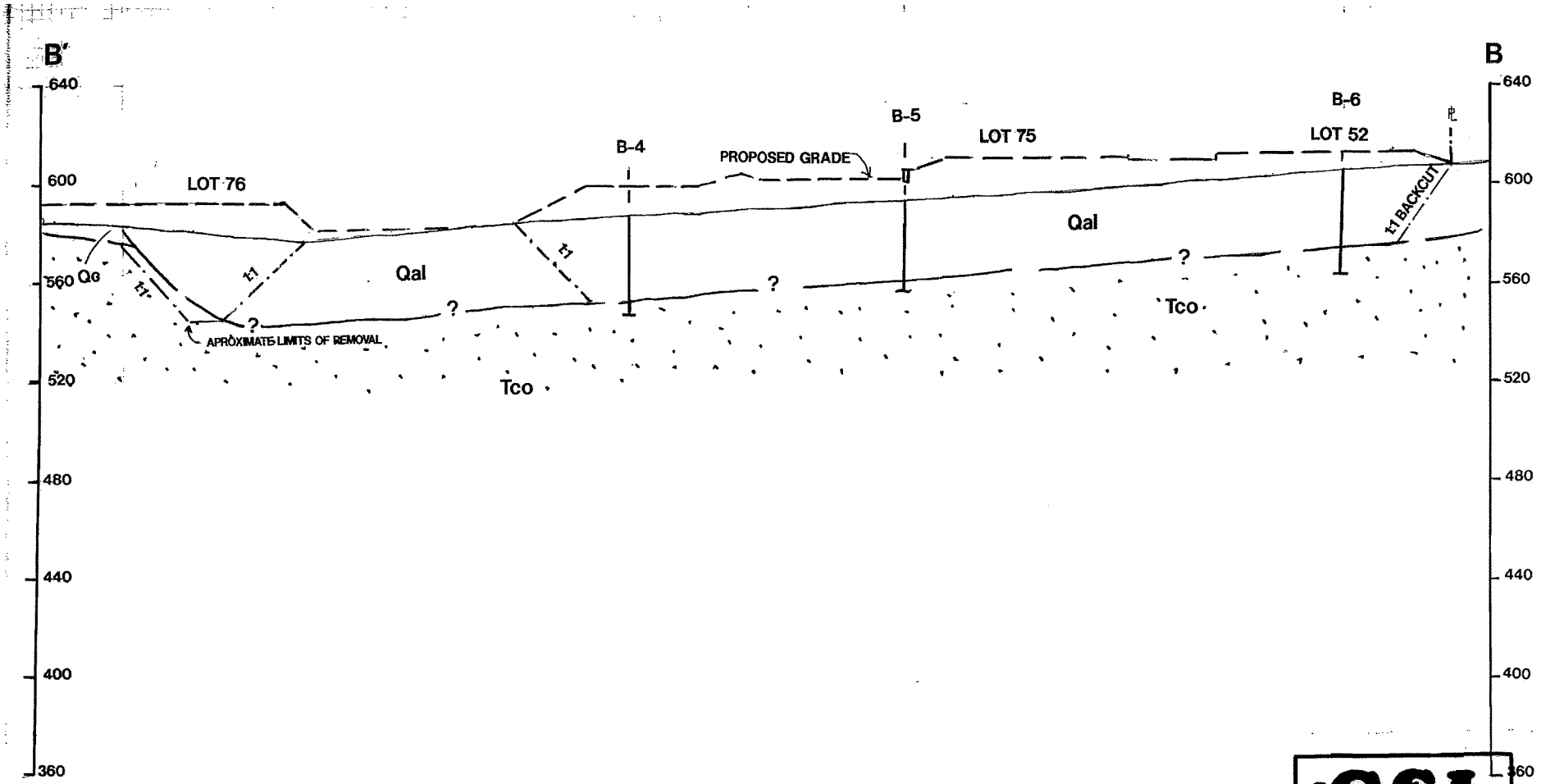
Foundation Engineering
W.O. 4414-A1-OC
DATE 9-30-04

PLATE 2



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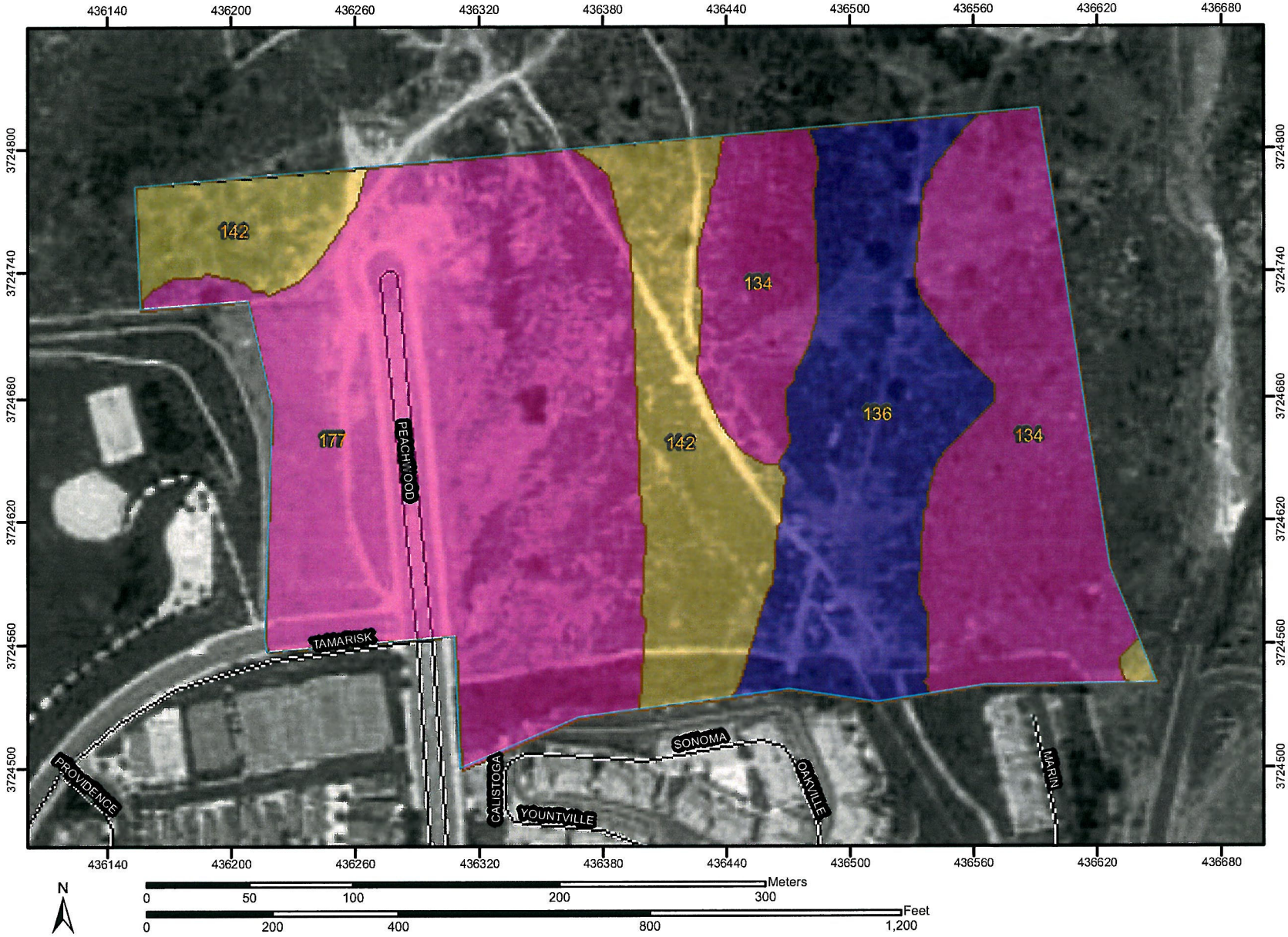
Foundation Engineering

W.O. 4414-A1-OC

DATE 9-30-04

PLATE 3


436140
436200
436260
436320
436380
436440
436500
436560
436620
436680
3724800
3724740
3724680
3724620
3724560
3724500
142
134
177
142
136
134
PEACHWOOD
TAMARISK
PROVIDENCE
CALISTOGA
YOUNTVILLE
SONOMA
OAKVILLE
MARIN
N
0
50
100
200
300
Meters
0
200
400
800
1,200
Feet

MAP LEGEND

Area of Interest (AOI)
- Area of Interest (AOI)

Soils
- Soil Map Units

Soil Ratings
- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Political Features

Municipalities
- Cities
- Urban Areas

Water Features
- Oceans
- Streams and Canals

Transportation
- Rails

Roads
- Interstate Highways
- US Routes
- State Highways
- Local Roads
- Other Roads

MAP INFORMATION

Original soil survey map sheets were prepared at publication scale. Viewing scale and printing scale, however, may vary from the original. Please rely on the bar scale on each map sheet for proper map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL: http://websoilsurvey.nrcs.usda.gov
Coordinate System: UTM Zone 11N

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Orange County and Part of Riverside County, California
Survey Area Data: Version 4, Jan 3, 2008

Date(s) aerial images were photographed: 6/1/1994

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Hydrologic Soil Group

Hydrologic Soil Group— Summary by Map Unit — Orange County and Part of Riverside County, California				
Map unit symbol	**Map unit name**	**Rating**	**Acres in AOI**	**Percent of AOI**
134	CALLEGUAS CLAY LOAM, 50 TO 75 PERCENT SLOPES, ERODED	D	6.8	25.2%
136	CAPISTRANO SANDY LOAM, 9 TO 15 PERCENT SLOPES	B	4.9	18.0%
142	CIENEBA SANDY LOAM, 30 TO 75 PERCENT SLOPES, ERODED	C	4.5	16.7%
177	MYFORD SANDY LOAM, 9 TO 30 PERCENT SLOPES, ERODED	D	10.9	40.1%
Totals for Area of Interest (AOI)			27.2	100.0%

Description

Hydrologic soil groups are based on estimates of runoff potential. Soils are assigned to one of four groups according to the rate of water infiltration when the soils are not protected by vegetation, are thoroughly wet, and receive precipitation from long-duration storms.

The soils in the United States are assigned to four groups (A, B, C, and D) and three dual classes (A/D, B/D, and C/D). The groups are defined as follows:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

If a soil is assigned to a dual hydrologic group (A/D, B/D, or C/D), the first letter is for drained areas and the second is for undrained areas. Only the soils that in their natural condition are in group D are assigned to dual classes.

Rating Options

Aggregation Method: Dominant Condition

Component Percent Cutoff: *None Specified*

Tie-break Rule: Lower

GeoSoils, Inc.

Geotechnical • Geologic • Coastal • Environmental

3812 E. La Palma Avenue • Anaheim, CA 92807 • (714) 632-0151 • FAX (714) 632-0745 • www.geosoilsinc.com

July 19, 2011

W.O. 6283-A-OC

Madison Investors, LLP
25108 Marguerite Parkway, Suite A-132
Mission Viejo, California 92691

Attention: Mr. Gary Emsiek

Subject: Ponding and Infiltration of Water Potential, Serrano Highlands - VTTM 15594, City of Lake Forest, California

Reference: "Limited Preliminary Geotechnical Investigation, Serrano Highlands, Tentative Tract 15594, City of Lake Forest, California," W.O. 4414-A1-OC, dated September 30, 2004, by GeoSoils, Inc.

Dear Mr. Emsiek,

As discussed, this letter is provided to reiterate our recommendations regarding the potential for adverse performance of proposed improvements, should water be allowed to pond and/or infiltrate into site subsoils. The scope of our services has included a review of the referenced report, conversations with you and representatives of Hunsaker & Associates, and preparation of this summary letter. Unless specifically superceded herein, the conclusions and recommendations contained in the referenced report remain pertinent and applicable, and should be appropriately implemented during planning, design, and construction.

We understand that consideration is being given to installing detention/infiltration devices on the lots at the subject site. Please note our report specifically provides recommendations against this practice (page 23). Furthermore, allowing soils to become saturated is not good engineering practice, as such conditions typically lead to adverse performance of improvements, and contribute to un-planned soil settlement, exacerbating the potential for distress.

We appreciate the opportunity to be of service. Should you have any questions, please do not hesitate to contact this office.

Respectfully submitted,

GeoSoils, Inc.

John P. Franklin
Engineering Geologist, CEG 1340

David W. Skelly
Civil Engineer, RCE 47857

JPF/DWS/jh

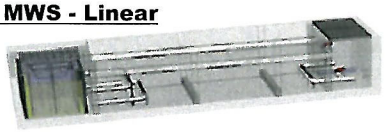
Distribution: (2) Addressee

Appendix D

Treatment BMP Design Calculations

MWS - LINEAR FLOW BASED SIZING SHEET

The MWS - Linear



Hybrid Stormwater Treatment System

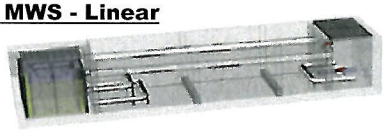
Project Location

Project Name	Serrano Highlands - Area A
City/Town	Lake Forest
State	CA
Zip Code	

SIZING CALCULATIONS	Inputs	Units	Notes/References
Impervious Area			
BMP Drainage Area (not required)	20.5	Acres	
Watershed Impervious Ratio (not required)			
Runoff Coefficient "C" (not required)	0.27		
WATER QUALITY FLOW	1.107	cfs (cubic feet per second)	
Or	497	gpm (gallons per minute)	
MWS - Linear Sizing			
# of 14' MWS - Linear Systems Required	0	quantity	
# of 22' MWS - Linear Systems Required	4	quantity	
14' MWS Discharge Rate (per system)	60	gpm	60 gpm per system reccomended for High Level Treatment
22' MWS Discharge Rate (per system)	126	gpm	126 gpm per system reccomended for High Level Treatment
Flow Treated During Event			
MWS - Linear System(s) Peak Treatment Flow	1.123	cfs	Should be equal to or greater than Water Quality Flow
or	504.00	gpm	
Sizing Approved? 1 = YES / 2 = NO	1		Approved means the amount of Modular Wetland Systems Specified Will Properly Treat the Water Quality Flow Rate. Not Approved Means More Systems Need to Be Added.

MWS - LINEAR FLOW BASED SIZING SHEET

The MWS - Linear



Hybrid Stormwater Treatment System

Project Location

Project Name	Serrano Highlands - Area B
City/Town	Lake Forest
State	CA
Zip Code	

SIZING CALCULATIONS	Inputs	Units	Notes/References
Impervious Area			
BMP Drainage Area (not required)	12.3	Acres	
Watershed Impervious Ratio (not required)			
Runoff Coefficient "C" (not required)	0.50		
WATER QUALITY FLOW	1.230	cfs (cubic feet per second)	
Or	552	gpm (gallons per minute)	
MWS - Linear Sizing			
# of 14' MWS - Linear Systems Required	1	quantity	
# of 22' MWS - Linear Systems Required	4	quantity	
14' MWS Discharge Rate (per system)	60	gpm	60 gpm per system recomended for High Level Treatment
22' MWS Discharge Rate (per system)	126	gpm	126 gpm per system reccomended for High Level Treatment
Flow Treated During Event			
MWS - Linear System(s) Peak Treatment Flow	1.257	cfs	Should be equal to or greater than Water Quality Flow
or	564.00	gpm	
Sizing Approved? 1 = YES / 2 = NO	1		Approved means the amount of Modular Wetland Systems Specified Will Properly Treat the Water Quality Flow Rate. Not Approved Means More Systems Need to Be Added.

CONCEPTUAL DRAWINGS

MWS – Linear

Hybrid Stormwater Filtration System

PROJECT:

Serrano Highlands, Lake Forest, CA

MODULAR WETLANDS™

PREPARED FOR:

Madison Investors / Hunsaker & Associates

DISTRIBUTED BY:

BIO CLEAN ENVIRONMENTAL SERVICES, INC

Modular Wetland Systems, Inc.
P.O. Box 869
Oceanside, CA 92049

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P 760-433-7640
F 760-433-3179

CONCEPTUAL DRAWINGS

SERRANO HIGHLANDS - LOT "A"

MWS - LINEAR FLOW BASED SIZING SHEET

The MWS - Linear

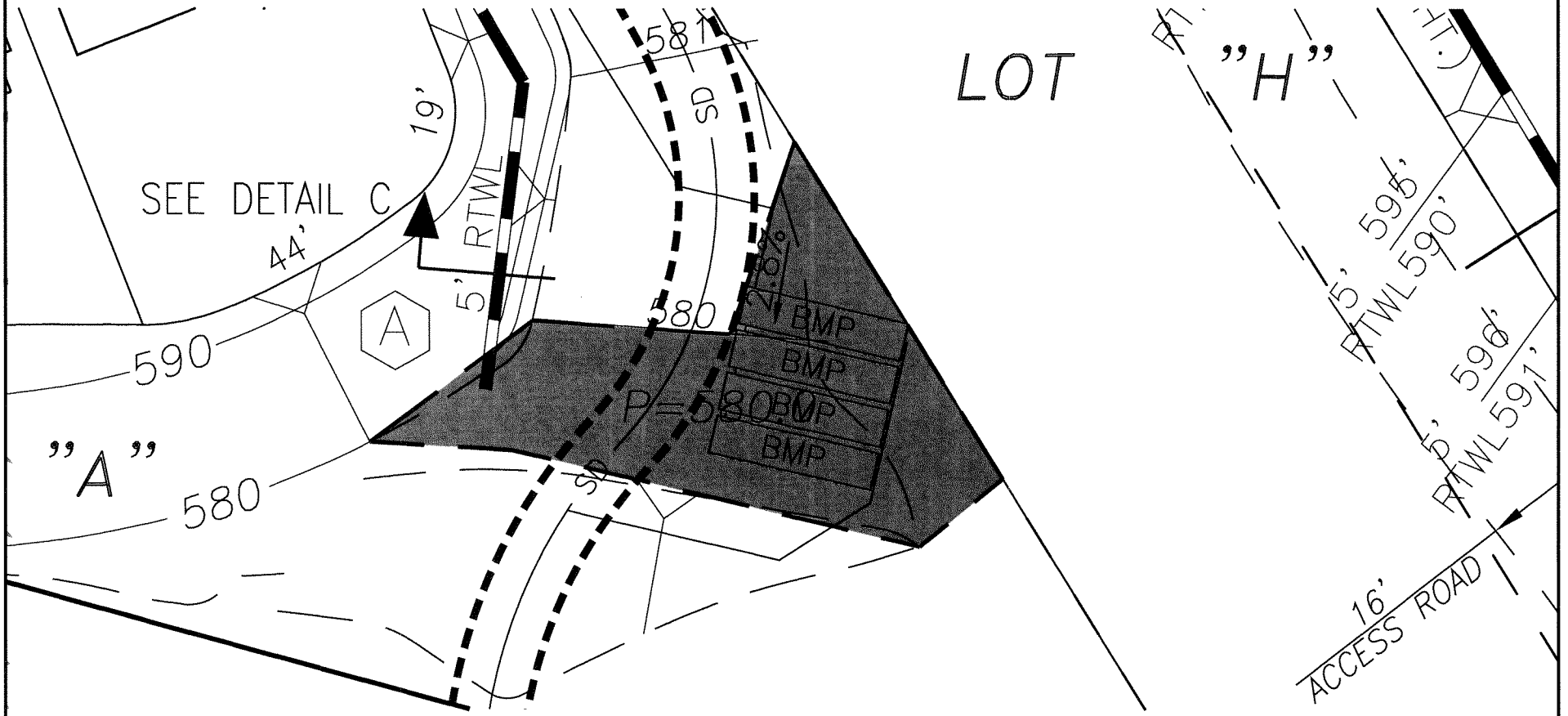
Hybrid Stormwater Treatment System

Project Location

Project Name	Serrano Highlands - Area A
City/Town	Lake Forest
State	CA
Zip Code	

SIZING CALCULATIONS	Inputs	Units	Notes/References
Impervious Area			
BMP Drainage Area (not required)	20.5	Acres	
Watershed Impervious Ratio (not required)			
Runoff Coefficient "C" (not required)	0.27		
WATER QUALITY FLOW	1.107	cfs (cubic feet per second)	
Or	497	gpm (gallons per minute)	
MWS - Linear Sizing			
# of 14' MWS - Linear Systems Required	0	quantity	
# of 22' MWS - Linear Systems Required	4	quantity	
14' MWS Discharge Rate (per system)	60	gpm	60 gpm per system reccomended for High Level Treatment
22' MWS Discharge Rate (per system)	126	gpm	126 gpm per system reccomended for High Level Treatment
Flow Treated During Event			
MWS - Linear System(s) Peak Treatment Flow	1.123	cfs	Should be equal to or greater than Water Quality Flow
or	504.00	gpm	
Sizing Approved? 1 = YES / 2 = NO	1		Approved means the amount of Modular Wetland Systems Specified Will Properly Treat the Water Quality Flow Rate. Not Approved Means More Systems Need to Be Added.

MODULAR WETLAND SYSTEMS – LINEAR VAULT TYPE



SCALE 1" = 20'

20 0 20 40

Patent No. 7,425,262

MODULAR WETLAND SYSTEMS INC.
P.O. BOX 869
OCEANSIDE, CA 92049
www.ModularWetlands.com

	NAME	DATE
DRAWN	JJC	7/15/09
EDITED		

COMMENTS:
MWS UNIT LOT "A" OVERLAY
SORRANO HIGHLANDS
LAKE FOREST, CA

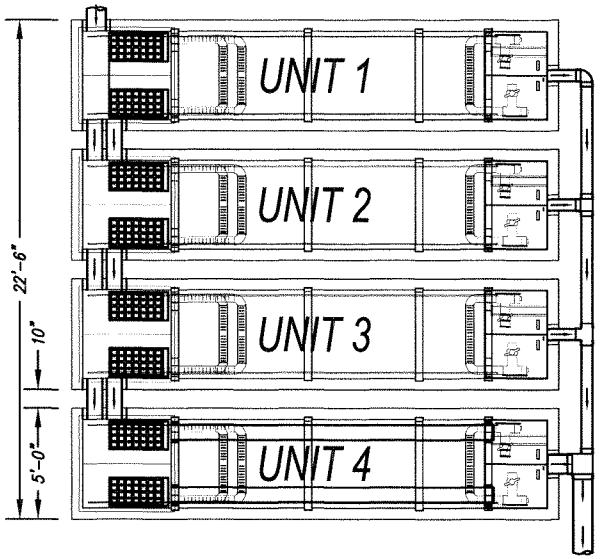
TITLE: MWS LINEAR – VAULT TYPE

SIZE	DWG. NO.	REV
A	MWS-L-V	

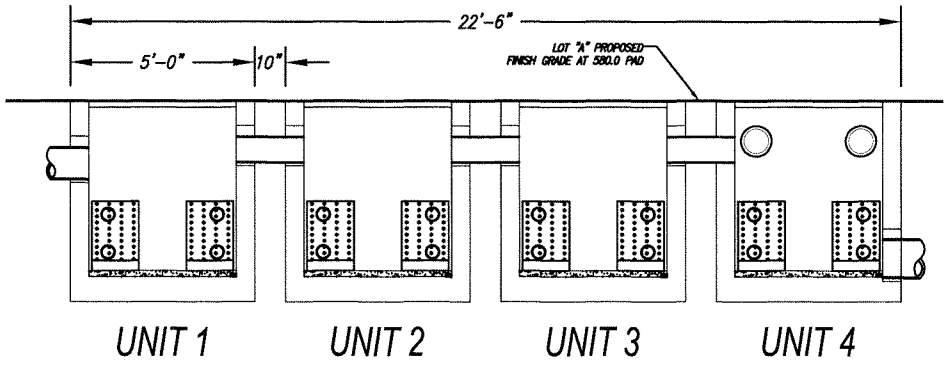
SCALE 1:50 | UNITS = INCHES | SHEET 1 OF 1

MODULAR WETLAND SYSTEMS – LINEAR VAULT TYPE

CONCEPTUAL LAYOUT FOR LOT "A"



PLAN VIEW



END VIEW - ALL MWS UNITS AT SAME ELEVATION

Patent No. 7,425,262

MODULAR WETLAND SYSTEMS INC.
P.O. BOX 869
OCEANSIDE, CA 92049
www.ModularWetlands.com

	NAME	DATE
DRAWN	JJC	7/15/09
EDITED		

COMMENTS: *MWS UNIT CONCEPT LAYOUT FOR LOT "A" SORRANO HIGHLANDS LAKE FOREST, CA*

TITLE: MWS LINEAR – VAULT TYPE

SIZE	DWG NO.	REV
A	MWS-L-V	

SCALE 1:50 | UNITS - INCHES | SHEET 1 OF 1

MODULAR WETLAND SYSTEMS – LINEAR VAULT TYPE

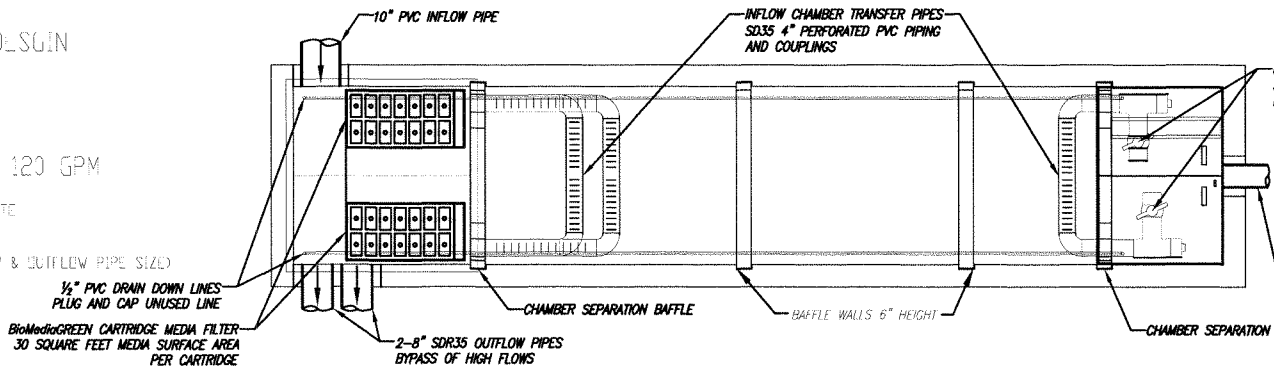
MODULAR WETLANDS™

*FLOW BASED DESIGN

FLOW RATES

TREATMENT FLOW RATE
= 27 CFS OR 120 GPM

PEAK BYPASS FLOW RATE
= 4.28 C.F.S
(DEPENDENT ON INFLOW & OUTFLOW PIPE SIZE)



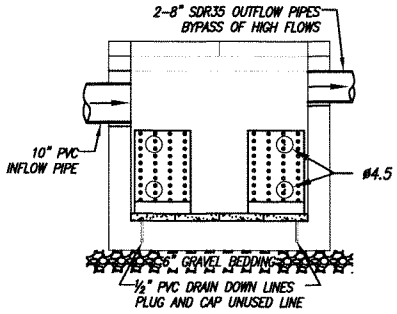
PLAN VIEW

SPECIFICATIONS

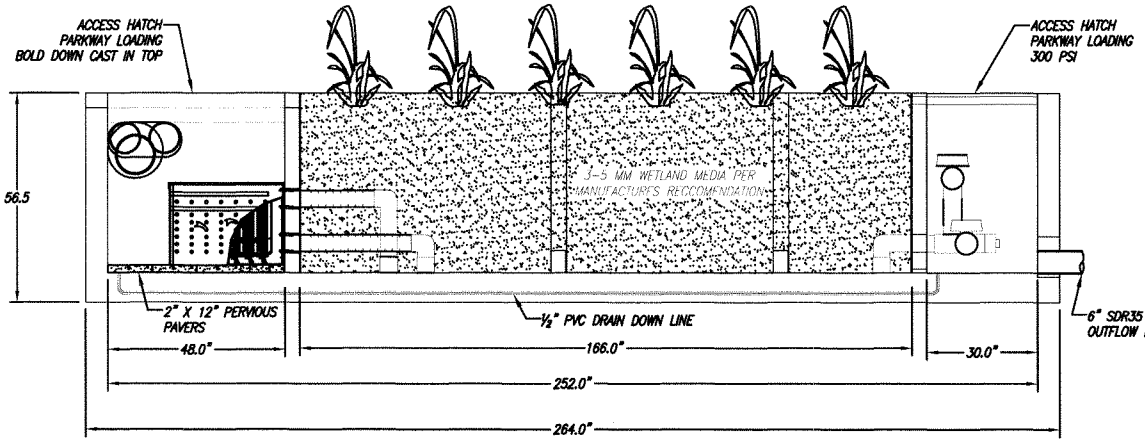
INSTALL AT GRADE

O.D. DIMENSIONS
= 22' X 5' X 4.7'

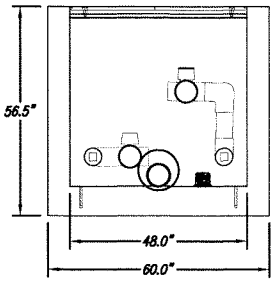
STORAGE CAPACITY
= 1000 LBS OR 23.5 CF



LEFT END VIEW



ELEVATION VIEW



RIGHT END VIEW

INSTALLATION NOTES:

1. INSTALL UNIT ON LEVEL BED OF GRAVEL OF AT LEAST 6" IN DEPTH.
2. CONCRETE 28 DAY COMPRESSIVE STRENGTH fc=5,000 PSI.
3. REINFORCING:ASTM A-615, GRADE 60.
4. SUPPORTS AN H20 LOADING AS INDICATED BY AASHTO.
5. ALL WALLS ARE 6" THICK, BAFFLES ARE 4" THICK BOTTOM 8" THICK, TOP 10" THICK.
6. JOINT SEALANT: BUTYL RUBBER SS-S-00210
7. MUST BE ADA COMPLIANT

Patent No. 7,425,262

MODULAR WETLAND SYSTEMS INC.
P.O. BOX 869
OCEANSIDE, CA 92049
www.ModularWetlands.com

	NAME	DATE
DRAWN	JJC	7/15/09
EDITED		

COMMENTS:
MWS UNIT #1
SORRANO HIGHLANDS
LAKE FOREST, CA

TITLE: MWS LINEAR – VAULT TYPE

SIZE	DWG. NO.	REV
A	MWS-L-V	

SCALE 150 | UNITS = INCHES | SHEET 1 OF 1

MODULAR WETLAND SYSTEMS – LINEAR VAULT TYPE

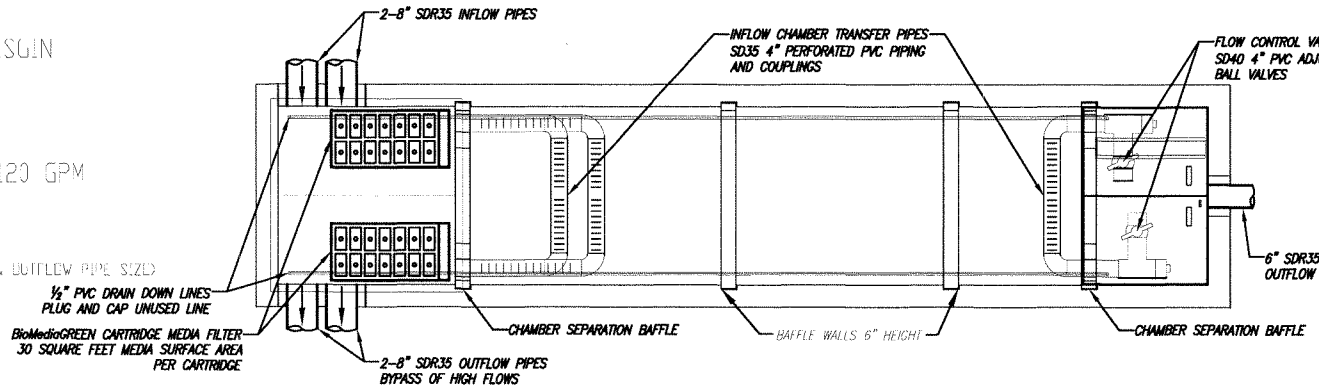
MODULAR WETLANDS™

XFLOW BASED DESIGN

FLOW RATES

TREATMENT FLOW RATE
= 27 CFS OR 120 GPM

PEAK BYPASS FLOW RATE
= 4.28 C-S
(DEPENDENT ON INFLOW & OUTFLOW PIPE SIZE)



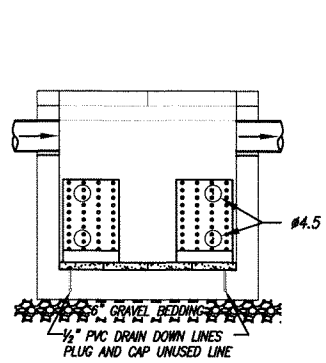
PLAN VIEW

SPECIFICATIONS

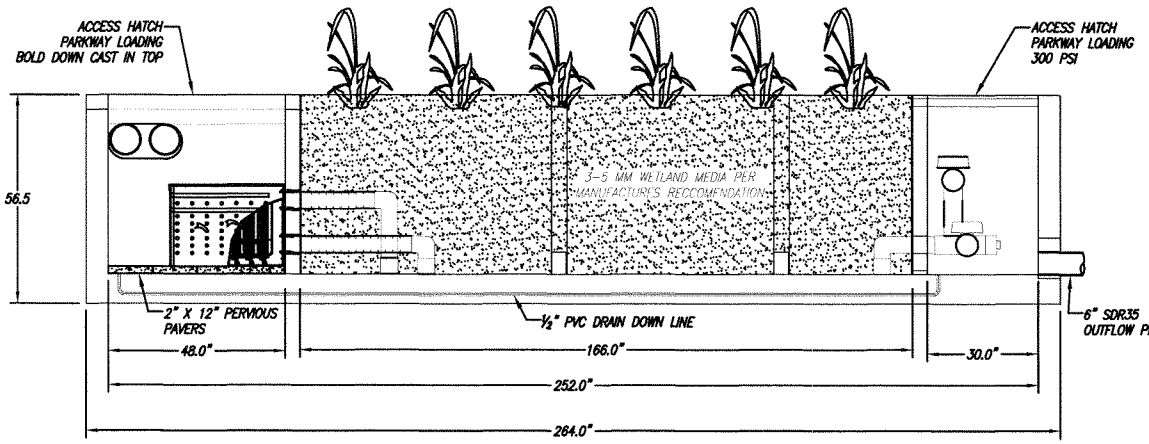
INSTALL AT GRADE

O.D. DIMENSIONS
= 22' X 5' X 4.7'

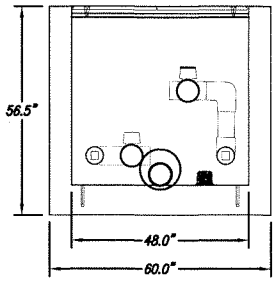
STORAGE CAPACITY
= 1000 LBS OR 23.5 CF



LEFT END VIEW



ELEVATION VIEW



RIGHT END VIEW

INSTALLATION NOTES:

1. INSTALL UNIT ON LEVEL BED OF GRAVEL OF AT LEAST 6" IN DEPTH.
2. CONCRETE 28 DAY COMPRESSIVE STRENGTH fc=5,000 PSI.
3. REINFORCING:ASTM A-615, GRADE 60.
4. SUPPORTS AN H20 LOADING AS INDICATED BY AASHTO.
5. ALL WALLS ARE 6" THICK, BAFFLES ARE 4" THICK BOTTOM 8" THICK, TOP 10" THICK.
6. JOINT SEALANT: BUTYL RUBBER SS-S-00210
7. MUST BE ADA COMPLIANT

Patent No. 7,425,262

MODULAR WETLAND SYSTEMS INC.
P.O. BOX 869
OCEANSIDE, CA 92049
www.ModularWetlands.com

	NAME	DATE
DRAWN	JJC	7/15/09
EDITED		

COMMENTS:
MWS UNITS 2-3
SORRANO HIGHLANDS
LAKE FOREST, CA

TITLE: MWS LINEAR – VAULT TYPE

SIZE	DWG. NO.	REV
A	MWS-L-V	

SCALE 1:50 | UNITS = INCHES | SHEET 1 OF 1

MODULAR WETLAND SYSTEMS – LINEAR VAULT TYPE

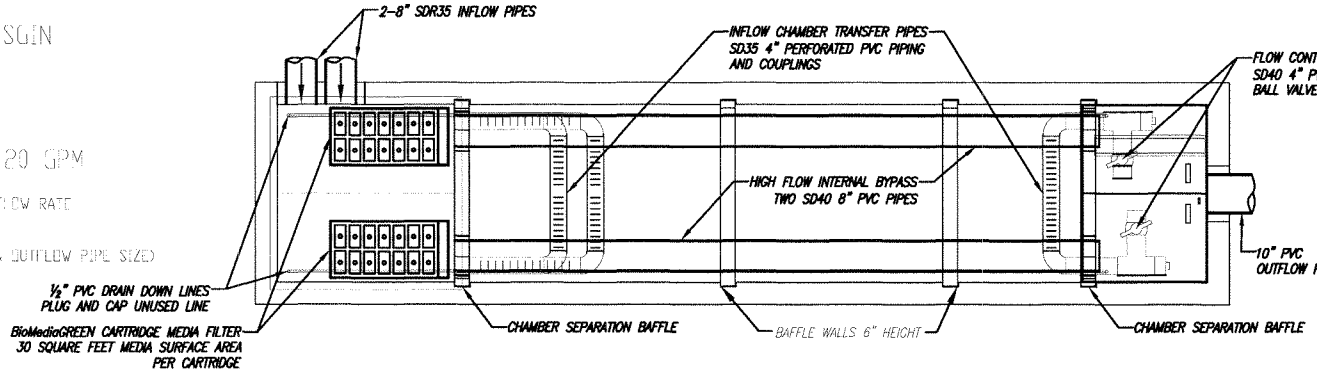
MODULAR WETLANDS™

X FLOW BASED DESIGN

FLOW RATES

TREATMENT FLOW RATE
= .27 CFS OR 120 GPM

PEAK INTERNAL BYPASS FLOW RATE
= 4.28 CFS
(DEPENDENT ON INFLOW & OUTFLOW PIPE SIZE)



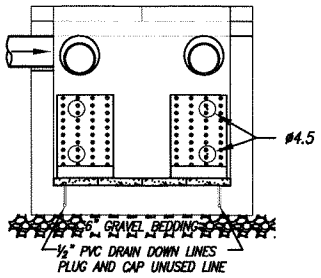
PLAN VIEW

SPECIFICATIONS

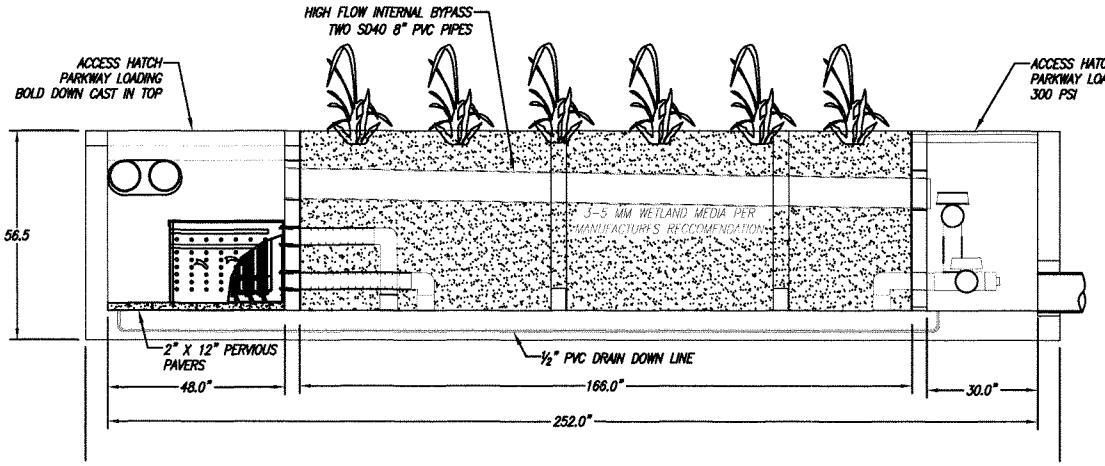
INSTALL AT GRADE

O.D. DIMENSIONS
= 22' X 5' X 4.7'

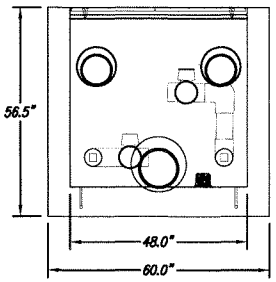
STORAGE CAPACITY
= 1000 LBS OR 23.5 CF



LEFT END VIEW



ELEVATION VIEW



RIGHT END VIEW

INSTALLATION NOTES:

1. INSTALL UNIT ON LEVEL BED OF GRAVEL OF AT LEAST 6" IN DEPTH.
2. CONCRETE 28 DAY COMPRESSIVE STRENGTH fc=5,000 PSI.
3. REINFORCING:ASTM A-615, GRADE 60.
4. SUPPORTS AN H20 LOADING AS INDICATED BY AASHTO.
5. ALL WALLS ARE 6" THICK, BAFFLES ARE 4" THICK BOTTOM 8" THICK, TOP 10" THICK.
6. JOINT SEALANT: BUTYL RUBBER SS-S-00210
7. MUST BE ADA COMPLIANT

Patent No. 7,425,262

MODULAR WETLAND SYSTEMS INC.
P.O. BOX 869
OCEANSIDE, CA 92049
www.ModularWetlands.com

	NAME	DATE
DRAWN	JJC	7/15/09
EDITED		

COMMENTS:
MWS UNIT #4
SORRANO HIGHLANDS
LAKE FOREST, CA

TITLE: MWS LINEAR – VAULT TYPE

SIZE	DWG. NO.	REV
A	MWS-L-V	

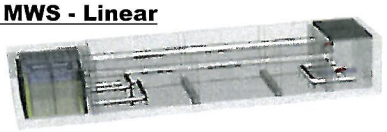
SCALE 1:50 | UNITS = INCHES | SHEET 1 OF 1

CONCEPTUAL DRAWINGS

SERRANO HIGHLANDS - LOT "I"

MWS - LINEAR FLOW BASED SIZING SHEET

The MWS - Linear



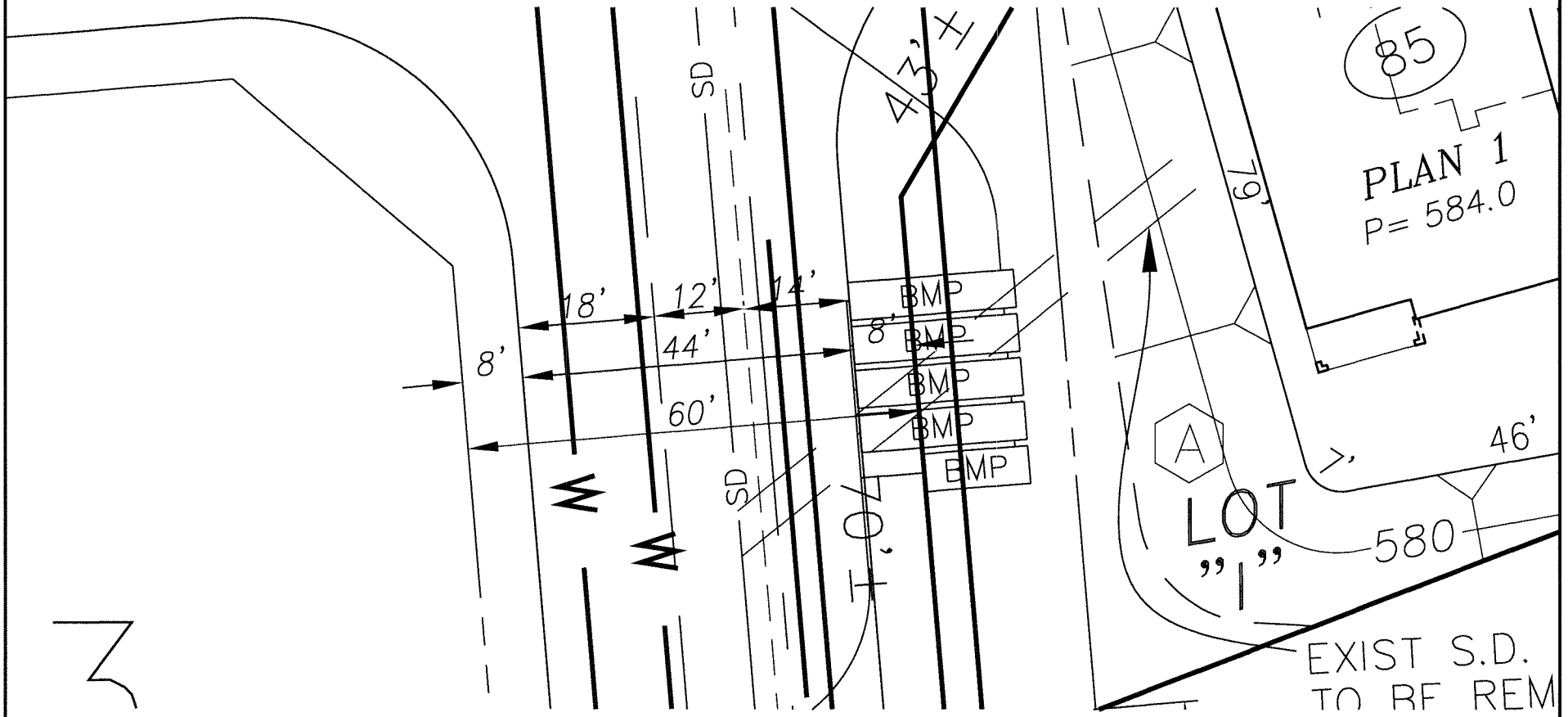
Hybrid Stormwater Treatment System

Project Location

Project Name	Serrano Highlands - Area B
City/Town	Lake Forest
State	CA
Zip Code	

SIZING CALCULATIONS	Inputs	Units	Notes/References
Impervious Area			
BMP Drainage Area (not required)	12.3	Acres	
Watershed Impervious Ratio (not required)			
Runoff Coefficient "C" (not required)	0.50		
WATER QUALITY FLOW	1.230	cfs (cubic feet per second)	
Or	552	gpm (gallons per minute)	
MWS - Linear Sizing			
# of 14' MWS - Linear Systems Required	1	quantity	
# of 22' MWS - Linear Systems Required	4	quantity	
14' MWS Discharge Rate (per system)	60	gpm	60 gpm per system reccomended for High Level Treatment
22' MWS Discharge Rate (per system)	126	gpm	126 gpm per system reccomended for High Level Treatment
Flow Treated During Event			
MWS - Linear System(s) Peak Treatment Flow	1.257	cfs	Should be equal to or greater than Water Quality Flow
or	564.00	gpm	
Sizing Approved? 1 = YES / 2 = NO	1		Approved means the amount of Modular Wetland Systems Specified Will Properly Treat the Water Quality Flow Rate. Not Approved Means More Systems Need to Be Added.

MODULAR WETLAND SYSTEMS – LINEAR VAULT TYPE



SCALE 1" = 20'

20 0 20 40

Patent No. 7,425,262

MODULAR WETLAND SYSTEMS INC.
P.O. BOX 869
OCEANSIDE, CA 92049
www.ModularWetlands.com

	NAME	DATE
DRAWN	JJC	7/15/09
EDITED		

COMMENTS:
MWS UNIT LOT "I" OVERLAY
SORRANO HIGHLANDS
LAKE FOREST, CA

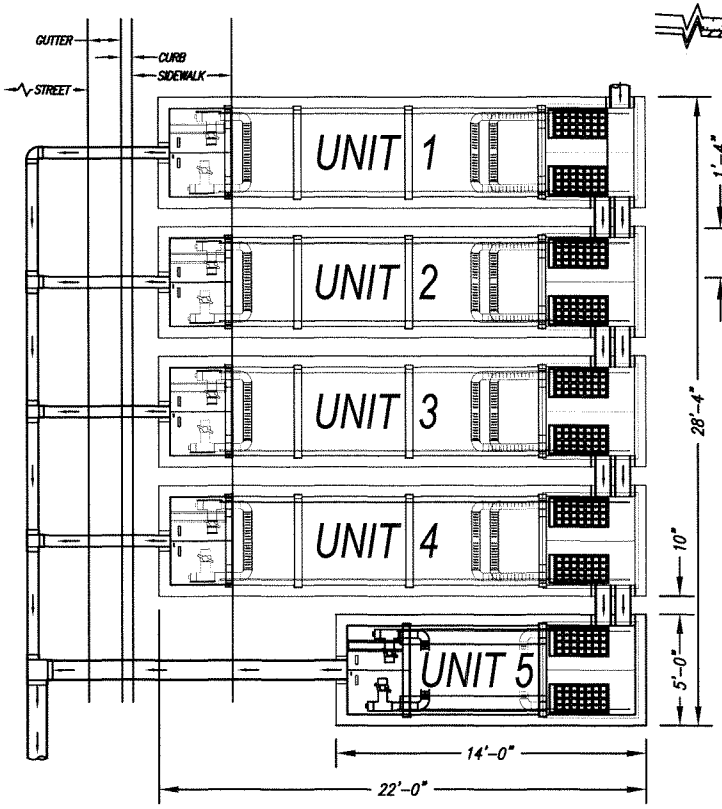
TITLE: MWS LINEAR – VAULT TYPE

SIZE	DWG. NO.	REV
A	MWS-L-V	

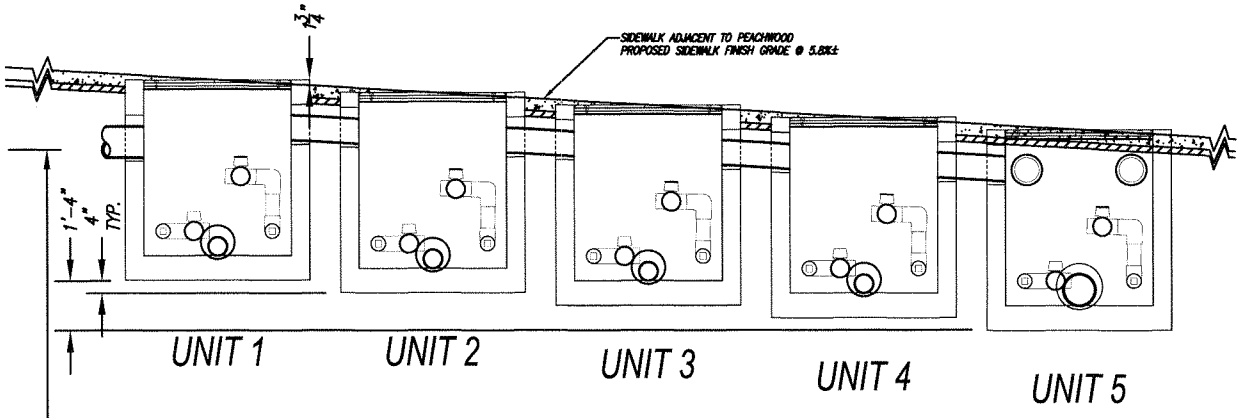
SCALE 1:50	UNITS = INCHES	SHEET 1 OF 1

MODULAR WETLAND SYSTEMS – LINEAR VAULT TYPE

CONCEPTUAL LAYOUT FOR LOT "I"



PLAN VIEW



END VIEW - MWS UNITS ON SLOPE

Patent No. 7,425,262

MODULAR WETLAND SYSTEMS INC. P.O. BOX 869 OCEANSIDE, CA 92049 www.ModularWetlands.com		NAME	DATE
	DRAWN	JJC	7/15/09
	EDITED		
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TITLE: MWS LINEAR – VAULT TYPE		
SIZE: A	DWG. NO.: MWS-L-V	REV:
SCALE: 1:50	UNITS = INCHES	SHEET 1 OF 1

MODULAR WETLAND SYSTEMS - LINEAR VAULT TYPE

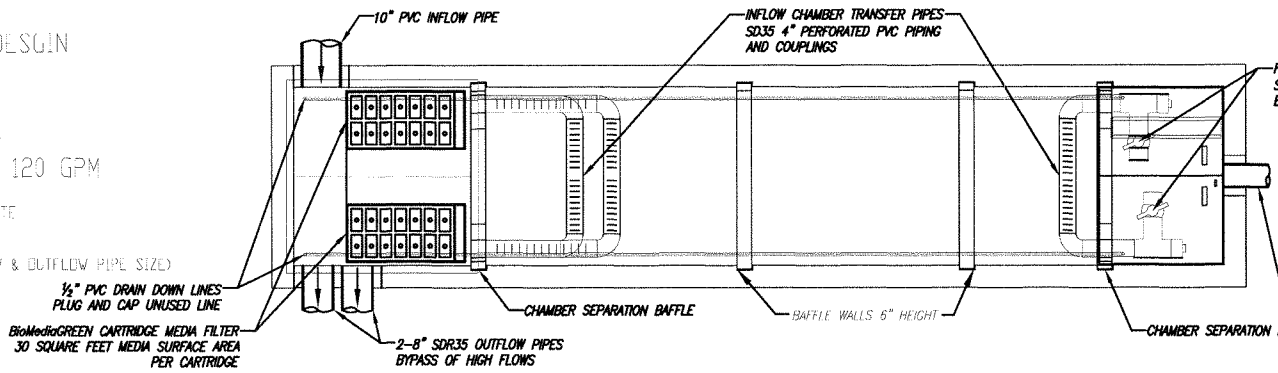
MODULAR WETLANDS™

×FLOW BASED DESIGN

FLOW RATES

TREATMENT FLOW RATE
= 27 CFS OR 120 GPM

PEAK BYPASS FLOW RATE
= 4.28 CFS
(DEPENDENT ON INFLOW & OUTFLOW PIPE SIZE)



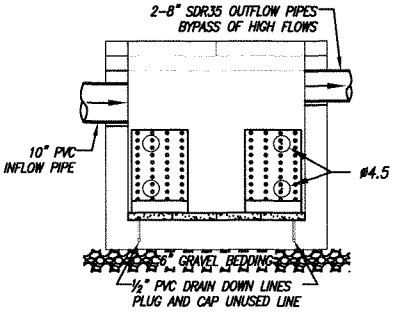
PLAN VIEW

SPECIFICATIONS

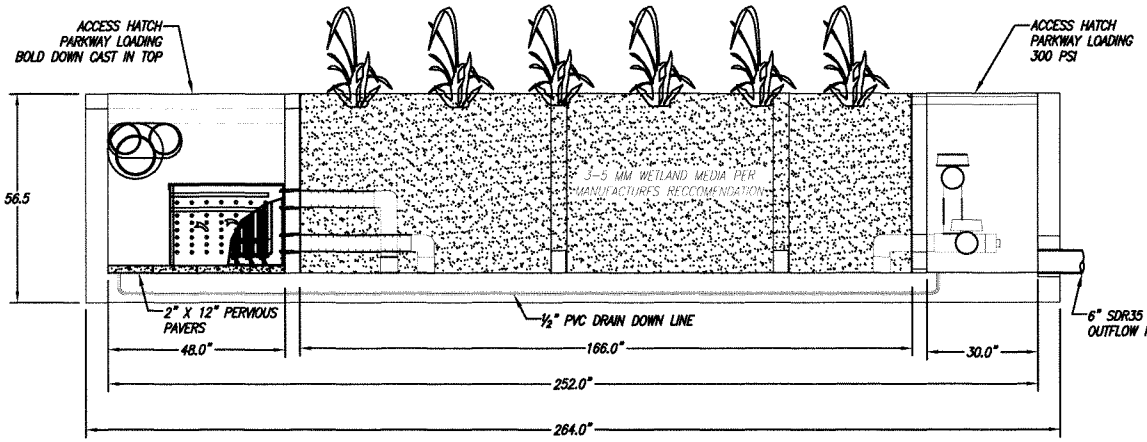
INSTALL AT GRADE

O.D. DIMENSIONS
= 22' X 5' X 4.7'

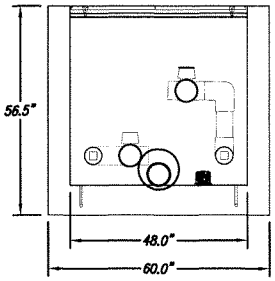
STORAGE CAPACITY
= 1000 LBS OR 23.5 CF



LEFT END VIEW



ELEVATION VIEW



RIGHT END VIEW

INSTALLATION NOTES:

1. INSTALL UNIT ON LEVEL BED OF GRAVEL OF AT LEAST 6" IN DEPTH.
2. CONCRETE 28 DAY COMPRESSIVE STRENGTH fc=5,000 PSI.
3. REINFORCING: ASTM A-615, GRADE 60.
4. SUPPORTS AN H20 LOADING AS INDICATED BY AASHTO.
5. ALL WALLS ARE 6" THICK, BAFFLES ARE 4" THICK BOTTOM 8" THICK, TOP 10" THICK.
6. JOINT SEALANT: BUTYL RUBBER SS-S-00210
7. MUST BE ADA COMPLIANT

Patent No. 7,425,262

MODULAR WETLAND SYSTEMS INC.
P.O. BOX 859
OCEANSIDE, CA 92049
www.ModularWetlands.com

	NAME	DATE
DRAWN	JJC	7/15/09
EDITED		

COMMENTS:
MWS UNIT #1
SORRANO HIGHLANDS
LAKE FOREST, CA

TITLE: MWS LINEAR - VAULT TYPE

SIZE	DWG. NO.	REV
A	MWS-L-V	

SCALE 1:50 | UNITS = INCHES | SHEET 1 OF 1

MODULAR WETLAND SYSTEMS – LINEAR VAULT TYPE

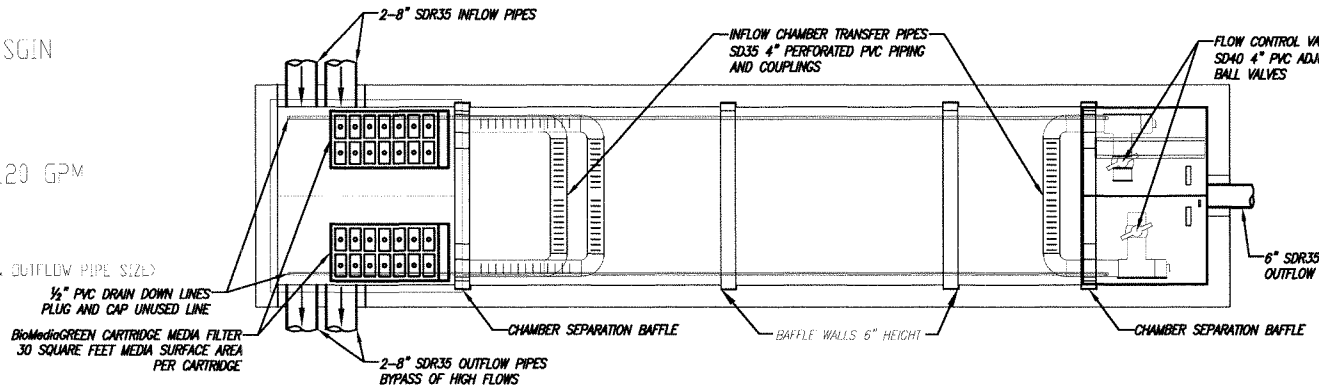
MODULAR WETLANDS™

×FLOW BASED DESIGN

FLOW RATES

TREATMENT FLOW RATE
= .27 CFS OR 120 GPM

PEAK BYPASS FLOW RATE
= 4.28 CFS
(DEPENDENT ON INFLOW & OUTFLOW PIPE SIZE)



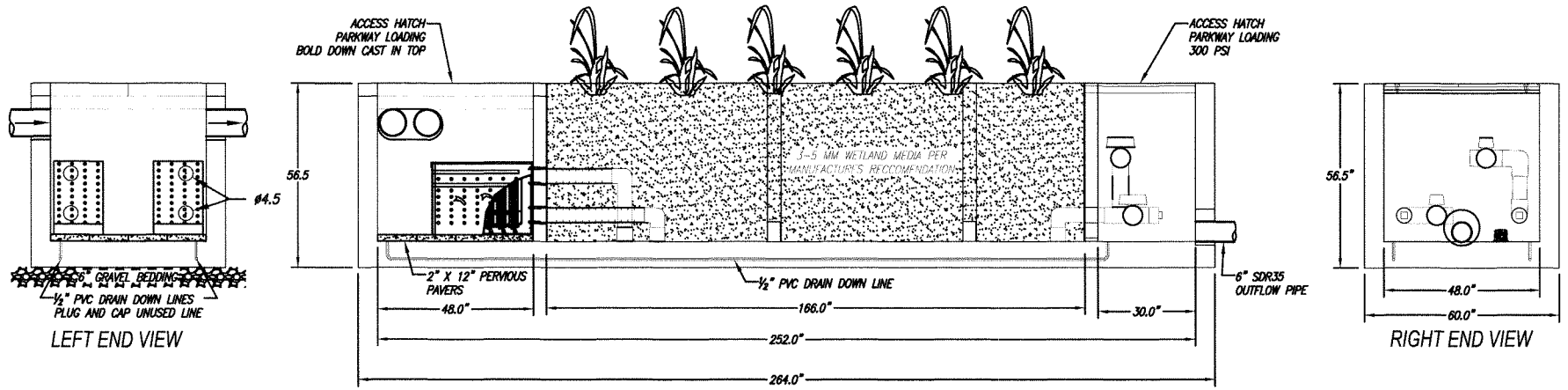
PLAN VIEW

SPECIFICATIONS

INSTALL AT GRADE

O.D. DIMENSIONS
= 22' X 5' X 4.7'

STORAGE CAPACITY
= 1000 LBS OR 23.5 CF



LEFT END VIEW

ELEVATION VIEW

RIGHT END VIEW

INSTALLATION NOTES:

1. INSTALL UNIT ON LEVEL BED OF GRAVEL OF AT LEAST 6" IN DEPTH.
2. CONCRETE 28 DAY COMPRESSIVE STRENGTH fc=5,000 PSI.
3. REINFORCING:ASTM A-615, GRADE 60.
4. SUPPORTS AN H20 LOADING AS INDICATED BY AASHTO.
5. ALL WALLS ARE 6" THICK, BAFFLES ARE 4" THICK BOTTOM 8" THICK, TOP 10" THICK.
6. JOINT SEALANT: BUTYL RUBBER SS-S-00210
7. MUST BE ADA COMPLIANT

Patent No. 7,425,262

MODULAR WETLAND SYSTEMS INC.
P.O. BOX 869
OCEANSIDE, CA 92049
www.ModularWetlands.com

	NAME	DATE
DRAWN	JJC	7/15/09
EDITED		

COMMENTS:
MWS UNITS 2-4
SORRANO HIGHLANDS
LAKE FOREST, CA

TITLE: MWS LINEAR – VAULT TYPE

SIZE	DWG. NO.	REV
A	MWS-L-V	

SCALE 1:50 | UNITS = INCHES | SHEET 1 OF 1

MODULAR WETLAND SYSTEMS – LINEAR VAULT TYPE

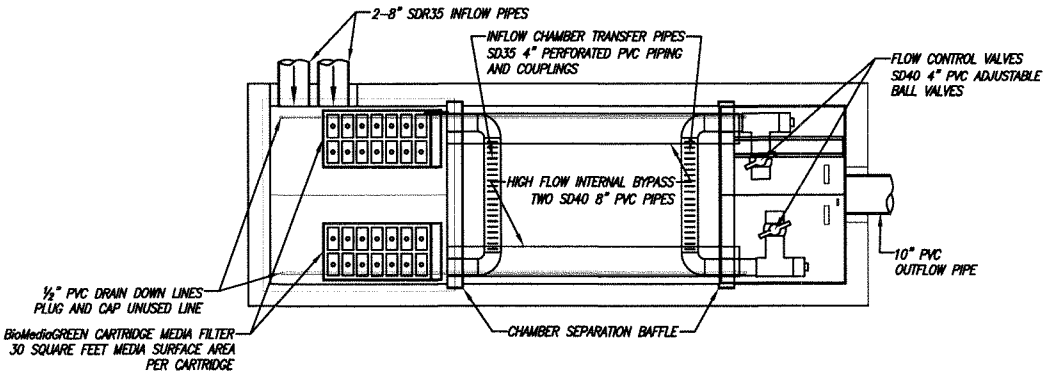
MODULAR WETLANDS™

×FLOW BASED DESGIN

FLOW RATES

TREATMENT FLOW RATE
= .27 CFS OR 120 GPM

PEAK INTERNAL BYPASS FLOW RATE
= 4.28 CFS
(DEPENDENT ON INFLOW & OUTFLOW PIPE SIZE)



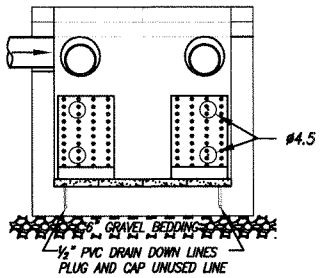
PLAN VIEW

SPECIFICATIONS

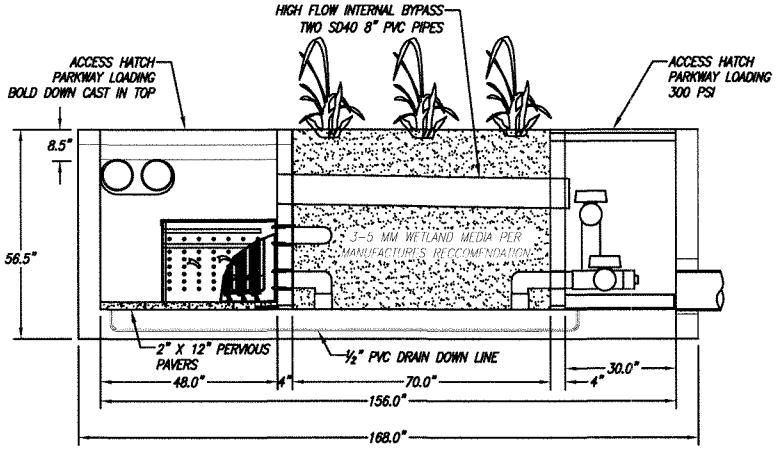
INSTALL AT GRADE

O.D. DIMENSIONS
= 22' X 5' X 4.7'

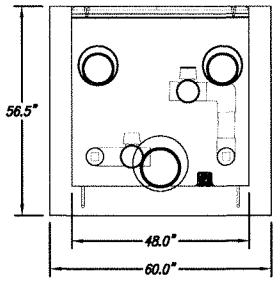
STORAGE CAPACITY
= 1000 LBS OR 23.5 CF



LEFT END VIEW



ELEVATION VIEW



RIGHT END VIEW

INSTALLATION NOTES:

1. INSTALL UNIT ON LEVEL BED OF GRAVEL OF AT LEAST 6" IN DEPTH.
2. CONCRETE 28 DAY COMPRESSIVE STRENGTH fc=5,000 PSI.
3. REINFORCING:ASTM A-615, GRADE 60.
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7. MUST BE ADA COMPLIANT

Patent No. 7,425,262

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OCEANSIDE, CA 92049
www.ModularWetlands.com

	NAME	DATE
DRAWN	JJC	7/15/09
EDITED		

COMMENTS:
MWS UNIT #5
SORRANO HIGHLANDS
LAKE FOREST, CA

TITLE: MWS LINEAR – VAULT TYPE

SIZE	DWG. NO.	REV
A	MWS-L-V	

SCALE: 1:50 | UNITS = INCHES | SHEET 1 OF 1

INTRODUCING

MWS-LINEAR STORMWATER FILTRATION SYSTEM

NATURE AND TECHNOLOGY WORKING TOGETHER IN PERFECT HARMONY.

The need for a new stormwater treatment system is evident. Federal and state requirements on cities and industry to reduce stormwater runoff increase every year as our population explodes. The EPA is now reporting that stormwater runoff represents the nation s number one water quality problem, and is the reason why nearly half of our rivers and lakes are not even clean enough to support fishing or swimming. ***Nearly half.***

MODULAR WETLANDS™

To combat this catastrophe, we turned to the expert in this field: **Nature.** By developing technology that imitates the processes found in nature, we ve created the most advanced stormwater filtration system available. Years ahead of current EPA requirements, our clients understand that when they invest in our new technology, they are investing in the future. For all of us.

CONFIGURATION 1: GRATE TYPE

CONFIGURATION 2: CURB TYPE

MWS-LINEAR TESTED REMOVAL EFFICIENCIES*

TSS "Sil-Co-Sil 106"	Dissolved Cadmium	Dissolved Copper	Dissolved Lead	Dissolved Zinc	Dissolved Mercury	Bacteria E. Coli
98%	74%	93%	81%	80%	89%	60%

*Laboratory Testing of Quarter Scale Model. Average Removal Efficiencies. Tested at Scaled Flow Rate Equal To 120 GPM For Full Size System.

BioMediaGREEN TESTED REMOVAL EFFICIENCIES*

TSS "Sil-Co-Sil 106"	Total Phosphorus	Dissolved Copper	Dissolved Lead	Dissolved Zinc	TPH	Turbidity
85%	69%	79%	98%	78%	99%	99%

*Laboratory Testing - Average Removal Efficiencies. Tested at Flow Rate of 3 GPM Per Square Foot Media Surface Area & Minimum Head.

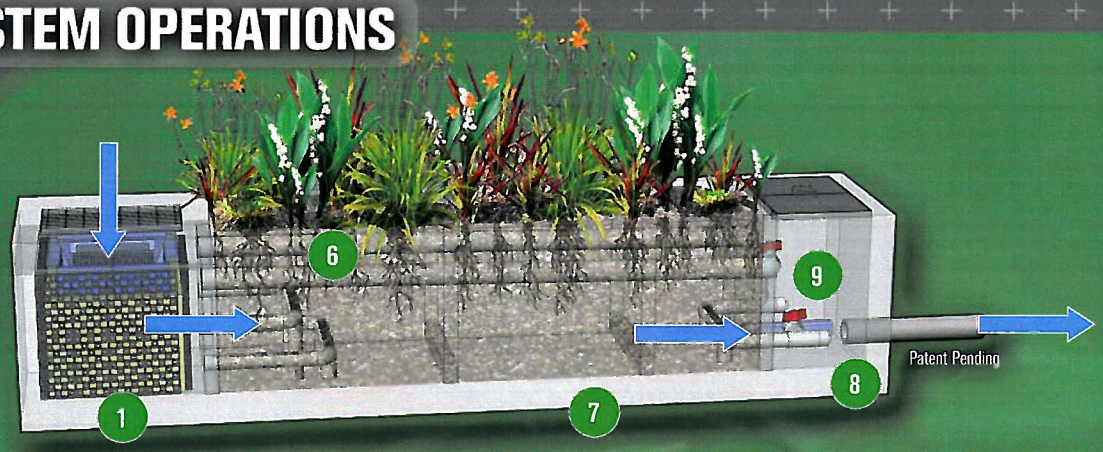
CURB & GRATE TYPE FLOW BASED DESIGN

- **Primary Treatment Peak Flow Rate** = 120 GPM or .27 CFS
- **Internal Bypass Peak Flow Rate** = 4.28 CFS "Grate Type"
- **Internal Bypass Peak Flow Rate** = 2.01 CFS "Curb Type"
- **O.D Dimensions** = 22' x 5' x 4.8'
- **Curb Type Minimum Fall Required** = 3.57' "Flow Line to Invert Out"
- **Grate Type Minimum Fall Required** = 4.13' "Top of Grate to Invert Out"
- **Storage Capacity** = 1000 LBS "Settling Chamber Storage"

VAULT TYPE VOLUME BASED DESIGN (Configuration not shown)

- **Peak Treatment Volume** = 4000 Cubic Feet "10 GPM Discharge Rate & 48 Hour Drain Down Time" "Pre-Storage Required"
- **Install External Bypass Prior To Pre-Storage**
- **O.D Dimensions (at grade)** = 22' x 5' x 4.8'
- **O.D Dimensions (below grade)** = 22' x 5' x 5.6'
- **Vault Type Minimum Fall Required** = 4.13' "Finish Grade to Invert Out"
- **Storage Capacity** = 1000 LBS "Settling Chamber Storage"

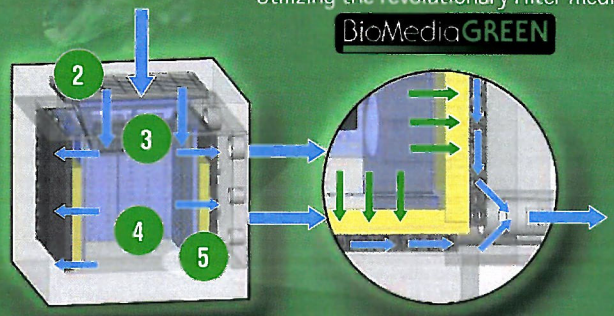
SYSTEM OPERATIONS



MWS-LINEAR IS DESIGNED TO MEET THE MOST STRINGENT STORMWATER REGULATIONS.

The system utilizes multi-stage treatment processes including the revolutionary filter media (BioMediaGreen) for primary filtration followed by a 4th generation sub-surface flow wetland for biological remediation .

Utilizing the revolutionary filter media:
BioMediaGREEN



THIS SYSTEM PROVIDES THE MOST EFFECTIVE TREATMENT IN THE INDUSTRY.

FEATURES

1. **CATCH BASIN CHAMBER - Capture, Screen, Separate, Filter**
   Directs Incoming Stormwater Through The First Three Stages of Treatment.
2. **GRATE TYPE CATCH BASIN INLET**
   A standard 41" x 24" grate type traffic rated catch basin opening directs stormwater into the system.
3. **CATCH BASIN INSERT FILTER UTILIZING BIO CLEAN - CATCH BASIN FILTERS**
   Provides the first stage of treatment by capturing trash & litter, gross solids, and sediment.
4. **SETTLING CHAMBER**
   Provides the second stage of treatment by separating out larger suspended solids.
5. **PERIMETER FILTER UTILIZING BioMediaGREEN SEE TESTED REMOVAL EFFICIENCIES**
   Provides the third stage of treatment by physically and chemically capturing fine TSS, metals, nutrients, and bacteria.
6. **HIGH FLOW INTERNAL BYPASS**
   Flow rates greater than the systems treatment capacity are bypassed directly to the discharge chamber.
7. **WETLAND CHAMBER SUB-SURFACE FLOW - Biological Remediation**
   Provides the final stage of treatment through a combination of physical, chemical, and biological processes.
8. **DISCHARGE CHAMBER - Flow Control, Drain Down, Discharge**
   Controls flow rates with adjustable valves and contains a drain down filter that eliminates any standing water.
9. **MULTI-LEVEL FLOW CONTROL VALVES**
   Two 4" adjustable ball valves allows various flow rates to be set for primary and secondary treatment levels.

FSC
Mixed Sources
Product group from well-managed forests, controlled sources and recycled wood or fiber
Cert no. XXX-XXX-000
www.fsc.org
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MODULAR WETLANDS

RAINFOREST ALLIANCE CERTIFIED

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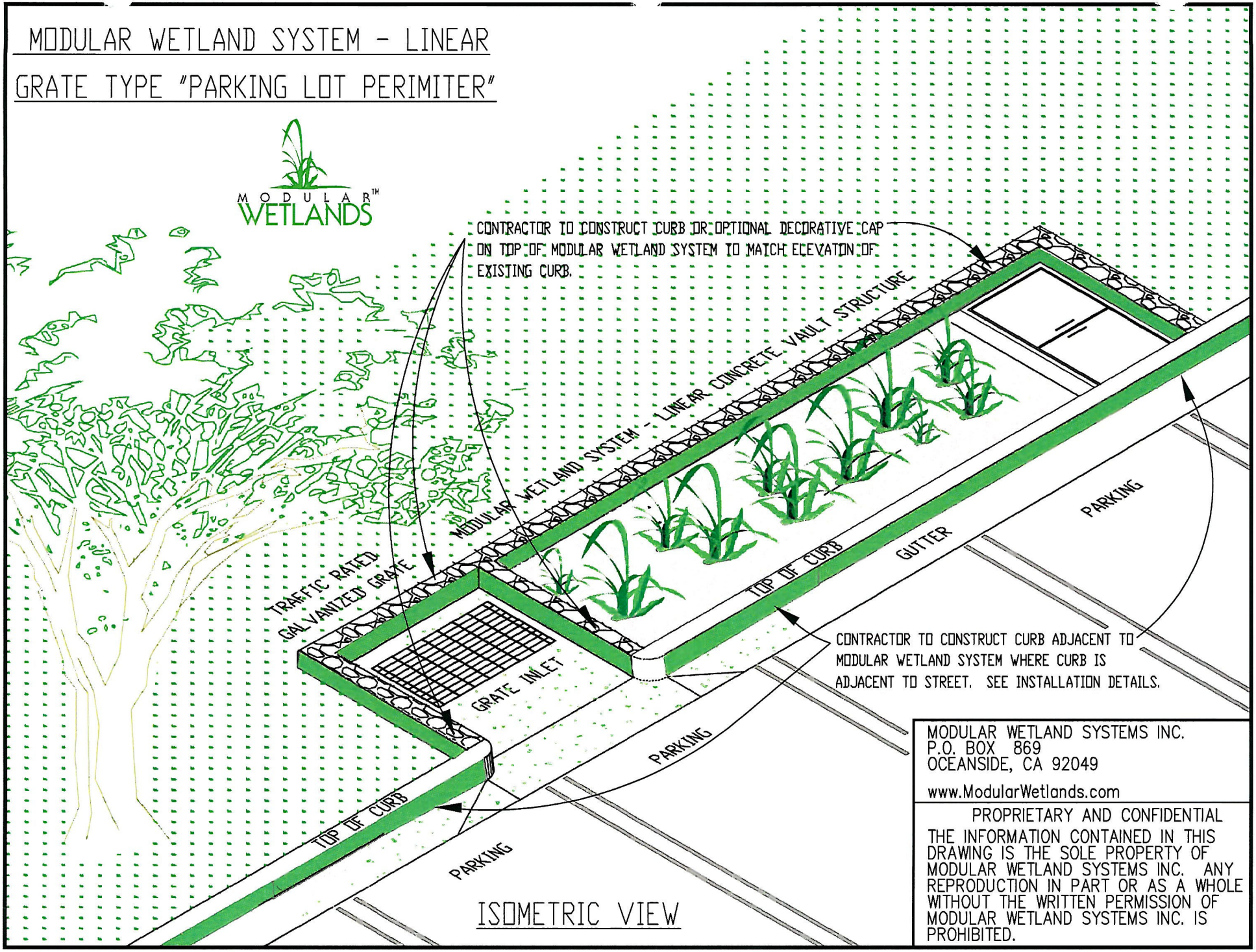
MODULAR WETLAND SYSTEM - LINEAR

GRATE TYPE "PARKING LOT PERIMITER"



ISOMETRIC VIEW

MODULAR WETLAND SYSTEMS INC.
P.O. BOX 869
OCEANSIDE, CA 92049

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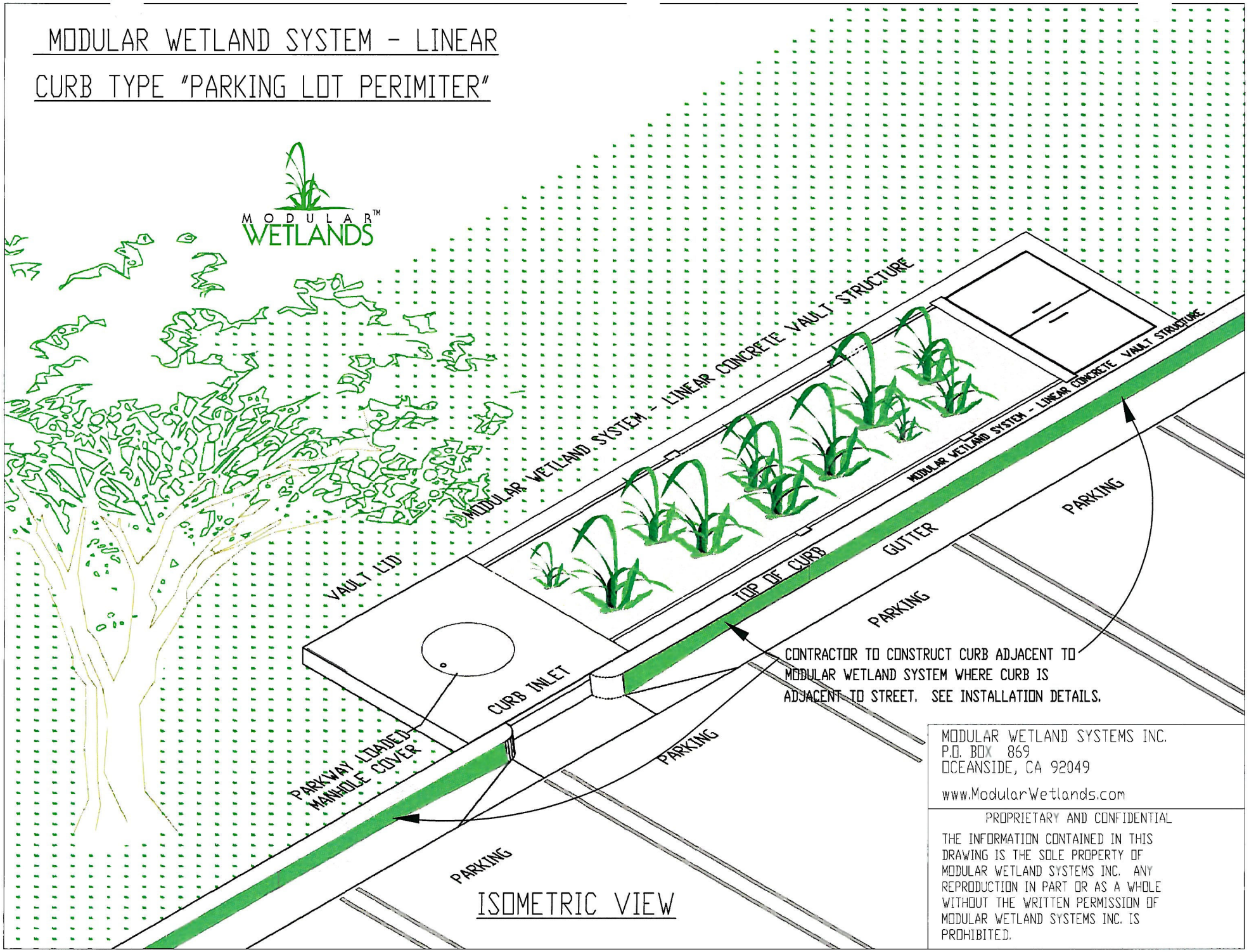
MODULAR WETLAND SYSTEM - LINEAR
CURB TYPE "PARKING LOT PERIMITER"



ISOMETRIC VIEW

MODULAR WETLAND SYSTEMS INC.
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OCEANSIDE, CA 92049

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SPECIFICATIONS

MWS – Linear

Hybrid Stormwater Filtration System

MODULAR WETLANDS™

Modular Wetland Systems, Inc.
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- Pollution
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- Contact

- Design
- Sizing
- Drawings
- Hydraulics
- Performance
- Installation
- Maintenance
- Project Profiles
- Plant Selection

Performance & Reports

The Modular Wetland System - Linear is the industry's first hybrid treatment system. It is a self-contained treatment train that incorporates the following treatment processes: screening, hydrodynamic separation, media filtration, and a bioretention filter. The bioretention filter is an enhanced sub surface flow vegetated wetland with a special blend of sorptive media. This treatment train approach makes this system very effective at removing a wide range of stormwater pollutants.

Pollutant Removal Performance

(bench scale testing)

Pollutant	Efficiency %
TSS (Sil-Co-Sil 106) (mean particle size 20 microns)	98%
Dissolved Phosphorus	22%
Dissolved Copper	93%
Dissolved Lead	81%
Dissolved Zinc	80%
Oils & Grease	84%
Total Petroleum Hydrocarbons	100%
Turbidity	93%
Fecal Coliform	66%
E. Coli	60%

Download Performance Summary

(full scale field testing)

Pollutant	Efficiency %
TSS (Sil-Co-Sil 106) (less than 15 microns)	82%
Nitrate-N	76%
Copper	53%
Lead (not present)	N/A
Zinc	79%
TPH - diesel	100%
TPH - motor oil	100%
Enterococci	70%
Fecal Coliform	84%
E. Coli	79%

More Information

For more information on performance please email us at assistance@modularwetlands.com or call 760-433-7640.

Learn More About ...

BioMediaGREEN

The revolutionary filter media

MWS - LINEAR

Pollutant Removal Performance Summary

Test Run	pH		TSS (mg/L)		Dissolved Phosphorus (mg/L)		Dissolved Cadmium (mg/L)		Dissolved Copper (mg/L)		Dissolved Lead (mg/L)		Dissolved Mercury (mg/L)	
	Influent	Effluent	Influent	Effluent	Influent	Effluent	Influent	Effluent	Influent	Effluent	Influent	Effluent	Influent	Effluent
1	7.26	7.68	270	6	0.68	0.12	0.61	0.02	0.757	0.028	0.543	0.1	0.018	0.002
2	7.26	7.43	270	3	0.68	0.65	0.61	0.07	0.757	0.055	0.543	0.1	0.018	0.002
3	7.26	7.35	270	2	0.68	0.77	0.61	0.2	0.757	0.066	0.543	0.1	0.018	0.002
4	7.26	7.36	270	1	0.68	0.58	0.61	0.33	0.757	0.072	0.543	0.1	0.018	0.002
5														
6														
7														
8														
Averages	7.26	7.455	270	3	0.68	0.53	0.61	0.155	0.757	0.05525	0.543	0.1	0.018	0.002
Average Removal Efficiency (%)			**98.89%**		**22.06%**		**74.59%**		**92.70%**		**81.58%**		**88.89%**	

Using Sil-Co-Sil 106

Mean particle size = 19 microns

Test Run	Dissolved Nickel (mg/L)		Dissolved Zinc (mg/L)		Oil & Grease (mg/L)		TPH (mg/L)		Turbidity (NTU)		Fecal Coliform (MPN/100 mL)		E.Coli (MPN/100 mL)	
	Influent	Effluent	Influent	Effluent	Influent	Effluent	Influent	Effluent	Influent	Effluent	Influent	Effluent	Influent	Effluent
1	0.37	0.01	0.95	0.05	10	1	19	0	21	0.5				
2	0.37	0.25	0.95	0.05	10	1	19	0	21	1.5				
3	0.37	0.3	0.95	0.21	10	2.5	19	0	21	1.5				
4	0.37	0.34	0.95	0.43	10	2	19	0	21	2.8				
5														
6											1600	170	1600	110
7														
8											1600	900	1600	900
													1600	900
Averages	0.37	0.225	0.95	0.185	10	1.625	19	0	21	1.575	1600	535	1600	636.66667
Average Removal Efficiency (%)	**39.19%**		**80.53%**		**83.75%**		**100.00%**		**92.50%**		**66.56%**		**60.21%**	

Red text indicates concentrations are greater than testing limits of 1600 MPN/100mL

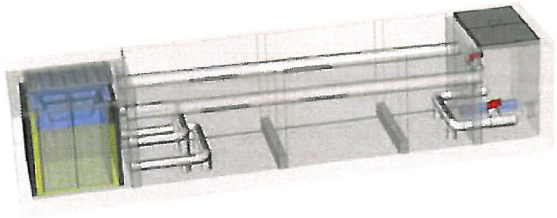
Testing of Quarter Scale Model - at Flow Rate of 1.9 GPM. This flow rate is equal to 121.6 GPM for full size system.

Modular Wetland System - Linear is manufactured by Modular Wetland Sytems, Inc. 760-433-7640 www.modularwetlands.com

MWS – Linear

Hybrid Stormwater Filtration System

MODULAR WETLANDS



Save valuable space with small footprint for urban sites.

Improve BMP aesthetics with attractive native and tropical landscape plants.

Reduce lifetime costs with safer and less expensive maintenance

"The MWS – Linear hybrid stormwater treatment system is described as a self contained treatment train. This system utilizes an innovative combination of I treatment processes. Stormwater runoff flows into the system via pipe or curb/grate type catch basin opening. Polluted runoff first encounters a screening device to remove larger pollutants and then enters a hydrodynamic separation chamber which settles out the sediments and larger suspended solids. Next the runoff is treated by a revolutionary filter media, BioMediaGREEN that removes fines and associated pollutants, including bacteria. From there runoff enters of bioretention filter in the form of a subsurface flow vegetated gravel wetland. Within the wetland physical, chemical, and biological mechanisms remove the remaining particulate and dissolved pollutants. The purified runoff leaves the system via the discharge chamber. In the discharge chamber the rate of discharge is controlled by valves set to a desired rate".

Tested Pollutant Removal Efficiencies:

TSS Removal	Dissolved Lead Removal	Dissolved Copper Removal	TPH	E. coli Removal	Turbidity Removal
98%	81%	92%	99%	60.2%	92%

"Nature and Harmony Working Together in Perfect Harmony"

SPECIFICATIONS – MWS- LINEAR

Track Record: The MWS- Linear Hybrid Stormwater Treatment System is manufactured by a company whom is regularly engaged in the engineering design and production of treatment systems for stormwater.

Coverage: The MWS- Linear is designed to treat the water quality volume or water quality flow. For flow based design, high flow bypass is internal, for volume based design, high flow bypass is external and prior to pre-detention system. For offline volume based designs the MWS - Linear has the ability to treat the entire water quality volume when used with pre-storage and properly sized.

Non-Corrosive Materials: The MWS – Linear is designed with non-corrosive materials. All internal piping is SD35 PVC. Catch basin filter components, including mounting hardware, fasteners, support brackets, filtration material, and support frame are constructed of non-corrosive materials (316 stainless steel, and UV protected/marine grade fiberglass). Fasteners are stainless steel. Primary filter mesh is 316 stainless steel welded screens. Filtration basket screens for coarse, medium and fine filtration is ¾" x 1 ¾"expanded, 10 x 10 mesh, and 35 x 35 mesh, respectively. No polypropylene, monofilament netting or fabrics shall be used in this system. Media Protective Panels are constructed of UV protected/marine grade fiberglass. Mounts are constructed of stainless steel. BioMediaGREEN is an inert rock substrate and is non-corrosive. Perimeter filter structure is constructed of lightweight injection molded plastic. Mounting brackets are constructed of SD40 PVC and are mounted with 3/8" diameter stainless steel redheads. Drain down filter cover is constructed of UV protected/marine grade fiberglass and stainless steel hinge and mount.

Weight: Each complete unit weighs approximately 29,000 to 40,000 pounds and requires a boom crane to install. Details of this are provided in the installation section of the MWS-Linear Design Kit.

Transportation: The Modular Wetland System – Linear is designed to be transported on a standard flat bed truck. The unit easily fits on a flat bed truck without the need of special permitting.

Alternative Technology Configurations: The Modular Wetland System – Linear is modular is design. Each module will be up to 22 feet long and 5 feet wide. The system can be made in lengths varying from 13 to 100s of feet long. For lengths longer than 22 feet the system will shipped in modules and assembled on site. The Modular Wetland System – Linear has many alternative configurations. This allows the system to be adapted to many site conditions. Runoff can enter the system through a pipe, and/or a built in curb or grate type opening.

Energy Requirements: The Modular Wetland System – Linear is completely passive and requires no external energy sources.

Buoyancy Issues: Buoyancy is only a an issue when ground water levels rise above the bottom of the Modular Wetland System – Linear's concrete structure. With 8.5 cubic yards of wetland media there is no concern of floatation. As a precaution a footing can also be built into the systems concrete structure.

Durability: The structure of the box will be precast concrete. The concrete will be 28 day compressive strength fc = 5,000 psi. Steel reinforcing will be ASTM A – C857. Structure will support an H20 loading as indicted by AASHTO. The joint between the concrete sections will ship lap and joint sealed with ram-nek. Filter (excluding oil absorbent media) and support structures are of proven durability. The filter and mounting structures are of sufficient strength to support water, sediment, and debris loads when the filter is full, with no slippage, breaking, or tearing. All filters are warranted for a minimum of five (5) years.

Oil Absorbent Media: The MWS – Linear utilizes both physical and biological mechanisms to capture and filter oil and grease. A skimmer and boom system will be positioned on the internal perimeter of the catch basin insert. The primary filtration media, BioMediaGreen, utilized in the perimeter and drain down filters, has excellent hydrocarbon removal abilities. Within the wetland filter biological processes capture and

break down oil and grease. Much of the breakdown and transformation of oil and grease is performed by natural occurring bacteria.

Overflow Protection: The grate and curb type MWS – Linear are designed with an internal bypass consisting of two SD PVC pipes which direct high flows around the perimeter and wetland filter, directly into the discharge chamber. For the volume based vault type configuration, bypass should be located prior to the pre-detention system. For peak flows that exceed internal bypass capacity, external bypass is use.

Filter Bypass: Runoff will bypass filtration (BioMediaGREEN and wetland filter) components of the MWS - Linear. The system will still provide screening and settling during higher flow rates for internally bypassed flows. External bypass will bypass of treatment processes.

Pollutant Removal Efficiency: The MWS - Linear is capable of removing over 90% of the net annual total suspended solids (TSS) load based on a 20-micron particle size. Annual TSS removal efficiency models are based on documented removal efficiency performance from full-scale laboratory tests on BioMediaGreen and quarter-scale laboratory tests on the MWS – Linear flow based system.

POLLUTANT	REMOVAL EFFICIENCY
Trash & Litter	99%
TPH (mg/L)	99%
TSS (mg/L)	98%
E. Coli (MPN/100ml)	60%
Turbidity (NTU)	92%
Dissolved Metals (mg/L)	76%

Sil-Co-Sil 106. Mean particle diameter = 19 microns

Non-Scouring: During heavy storm events the runoff bypasses perimeter and wetland filter components. The system will not re-suspend solids at design flows.

Uniqueness: The Modular Wetland System – Linear is a complete self contained treatment train that incorporates capture, screening, sedimentation, filtration, bioretention, high flow bypass, and flow control into a single modular structure. This system provides four stages of treatment making it the only 4 stage treatment train stormwater filtration system, therefore making it unique to the industry. Other systems do not incorporate all the necessary attributes to make it a complete stormwater management device as with the Modular Wetland System – Linear. Therefore, no equal exists for this system.

Pretreatment & Preconditioning: Since the Modular Wetland System – Linear is a complete capture and treatment train stormwater management system no external pretreatment of preconditioning is necessary.

SPECIFICATIONS – BioMediaGREEN

BioMediaGREEN is a proprietary engineered filter media. Made of a unique combination of the inert naturally occurring material this product is non-combustible and do not pose a fire hazard, stable and non-reactive, and is also biodegradable. It is stable with no known adverse environmental effects.

This product has been tested in long-term carcinogenicity studies [inhalation and intraperitoneal injection (i.p.)] with no significant increase in lung tumors or abdominal tumors. Short-term biopersistent (inhalation and intra-tracheal injection) studies have shown that the products disappear very rapidly from the lung.

In October 2001, IARC classified this product as Group 3, "not classifiable as to its carcinogenicity to humans". The 2001 decision was based on the latest epidemiological studies and animal inhalation studies that show no relation between inhalation exposure and the development of tumors.

The product can typically be disposed of in an ordinary landfill (local regulations may apply). If you are unsure of the regulations, contact your local Public Health Department or the local office of the Environmental Protection Agency (EPA).

Coverage: When properly installed BioMediaGREEN Filter Blocks provide sufficient contact time, at rated flows, of passing contaminate water. The BioMediaGREEN material will capture and retain most pollutants that pass through it. The BioMediaGREEN material is made of a proprietary blend of inert substances. The BioMediaGREEN Filter Blocks can be used in different treatment devices, including but not limited to flume filters, trench drain filters, downspout filters, catch basin inserts, water polishing units, and hydrodynamic separators.

Non-Corrosive Materials: The BioMediaGreen material is made of non-corrosive materials.

Durability: The BioMediaGREEN material has been chosen for its proven durability, with an expected life of 2 plus years. The BioMediaGREEN material is of sufficient strength to support water, sediment, and debris loads when the media is at maximum flow; with no slippage, breaking, or tearing. The BioMediaGREEN material has been tested through rigorous flow and loading conditions.

Oil Absorbent Media: The BioMediaGREEN material has been proven to capture and retain hydrocarbons.

Pollutant Removal Efficiency: The BioMediaGREEN Filter Blocks are designed to capture high levels of Hydrocarbons including but not limited to oils & grease, gasoline, diesel, and PAHs. BioMediaGREEN Filter Blocks have the physical ability to block and filter trash and litter, grass and foliage, sediments, TSS, particulate and dissolved metals, nutrients, and bacteria.

BioMediaGREEN technology is based on a proprietary blend of synthetic inert natural substances aimed at removal of various stormwater pollutants. BioMediaGREEN was created to have a very porous structure capable of selectively removing pollutants while

allowing high flow through rates for water. As pollutants are captured by its structure, BioMediaGREEN captures most pollutants and maintains porosity and filtering capabilities.

Field and laboratory tests have confirmed the BioMediaGREEN capability to capture large percentage of TSS, hydrocarbons, nutrients, and heavy metals. Microbial reduction efficiency will vary depending on colony size, flow rates and site specific conditions.

POLLUTANT	REMOVAL EFFICIENCY
Oil & Grease (mg/L)	90%
TPH (mg/L)	99%
TSS (mg/L)	85%
Turbidity (NTU)	99%
Total Phosphorus (mg/L)	69.6%
Dissolved Metals (mg/L)	75.6%

Sil-Co-Sil 106. Mean particle diameter = 19 microns

Replacement: Removal and replacement of the blocks is simple. Remove blocks from filtration system. Replace with new block of equal size.

DESIGN

MWS – Linear

Hybrid Stormwater Filtration System

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Design

The MWS – Linear is a state of the art structural/LID hybrid stormwater treatment system. It contains a bio-retention filter component in the form of a 4th generation subsurface flow enhanced gravel wetland. MWS – Linear system can work with existing drainage and landscaping design to become a major design element of a site plan. The MWS – Linear can capture runoff, detain or retain surface water, attenuate peak runoff rates, improve water quality and convey stormwater. Site plans that apply the MWS – Linear maintain existing drainage design while using the existing landscape areas to filter and attenuate runoff while generating an aesthetically pleasing urban form integrated with the natural features of the site.

The MWS – Linear Hybrid Stormwater Treatment System is modular in design. In the last section volume or flow based design was determined, and the associated calculations were completed to determine the water quality volume and/or water quality flow. This information was entered into the MWS – Linear Flow and Volume Based Sizing Template to determine the number of units needed. The next step is to determine the appropriate configuration. The curb and grate configurations are designed for flow based sizing. Each unit can treat, at high levels, flow rates between 90 to 120 gpm. This equates to approximately one unit per acre. Each unit also has an internal bypass of 2.01 CFS for the curb type and 4.28 CFS for the grate type and therefore can be installed as an online system. Configurations allowing for higher internal bypass flow rates are available upon request.

The grate type configuration can be installed at or below grade. The curb type configuration can only be installed at grade. Installing units at grade along the perimeter of a project's impervious area or as part of a vegetated island of a parking lot is the preferable setup. This allows the system's enhanced sub-surface flow wetland to be vegetated with various plants and integrated into the landscape area. In this configuration the system's natural filtration component is utilized to its full potential, and

is a true natural type treatment system. The plants will also provide an aesthetic enhancement to the project's landscaping.

MWS Linear – Grate Type Architectural Rendering

MWS Linear - Curb Type Architectural Rendering

If the above configurations are deemed impractical considering site constraints, the unit can be installed under sidewalks, landscaping and paved areas. For this configuration three risers or a concrete lid will be needed to provide access to the inflow, wetland and discharge chambers. The risers will usually consist of a manhole access over the inflow and discharge chambers and a set of larger hatch doors over the wetland chamber. This will ensure simple and easy access to the system. Units installed below grade will lose the vegetation, which may have a minor effect on the removal efficiencies of some pollutants. Following are visuals of these different configurations.

A general rule of thumb is the MWS – Linear can be utilized in a similar fashion as traditional catch basins and therefore has little impact on the drainage system design. Design the elevations of the MWS – Linear curb or grate openings in the fashion as traditional curb or grate inlets.

The vault type configuration MWS - Linear is slightly modified for volume based design. In this configuration runoff is not conveyed directly to the system. Volume based design requires a pre-storage/detention of the water quality volume. The storage of this volume is usually accomplished with above ground detention basins or underground detention facilities. The MWS – Linear vault type system will be located on the effluent end of the detention facility. In this configuration the MWS – Linear will provide both treatment and flow control of the water quality volume. The vault type configuration can also be installed at or below grade. As explained on the previous page, systems installed below grade will lose the vegetative component of the enhanced sub-surface flow wetland.

The MWS – Linear can be used as space saving alternative to grass/vegetated swales, turf block paving areas, and bio-retention areas. The bio-treatment component to this system makes use of the project's existing landscape area and utilizes that area to provide natural treatment of stormwater. These areas therefore act as a BMP, and no additional BMPs to treat the quality of runoff should be required. Site drainage designs must only direct runoff to the MWS - Linear from other areas of the site that require treatment of runoff.

Configuration

In regard to appropriate elevation, the MWS Linear should be installed in the same manner as standard catch basins. For the Grate Type, the top of the grate should be at an elevation equal to that of the flow line, which in most designs is the elevation of the bottom of the gutter, channel, flume or culvert. For the Curb Type the bottom of the curb opening should be at an elevation equal to that of the flow line, which in most designs is the elevation of the bottom of the gutter and curb or culvert.

The MWS –Linear Grate Type should be installed in the landscape (including islands) or perimeter area of the project. Curb and gutter should be built around the exterior of the system. At minimum, the backside of the curb can set within an inch of the outside perimeter of the top of the MWS –Linear's concrete structure. An architectural cap will be installed on top of the MWS –Linear's outer perimeter concrete structure. This will bring the top of the MWS – Linear's outer perimeter up to the height of the top of the curb. This architectural cap will provide a barrier between the MWS – Linear's vegetated wetland chamber and the surrounding landscape and vegetation. The grate opening can be positioned to receive water from drain channels or gutters. Curbs can be built around on top of the catch basin chamber surrounding the grate opening on sides that are not receiving runoff.

The MWS – Linear Curb Type should also be installed in the landscape (including islands) or perimeter area of the project. Curb and gutter should be built against the exterior of the system. At minimum, the backside of the curb can butt up to the outside perimeter wall of the MWS –Linear's concrete structure. No architectural cap will be needed since the top of the MWS –Linear's outer perimeter will already be at an elevation equal to the top of the curb. The curb opening can be positioned to receive water from gutters along the curb. The curb will be built to convey water to the MWS – Linear's curb opening.

The MWS – Linear requires minimum of 3.57 feet (curb type) or 4.13 feet (grate type) of fall between the surface flow line and the MWS – Linear's discharge pipe invert. This

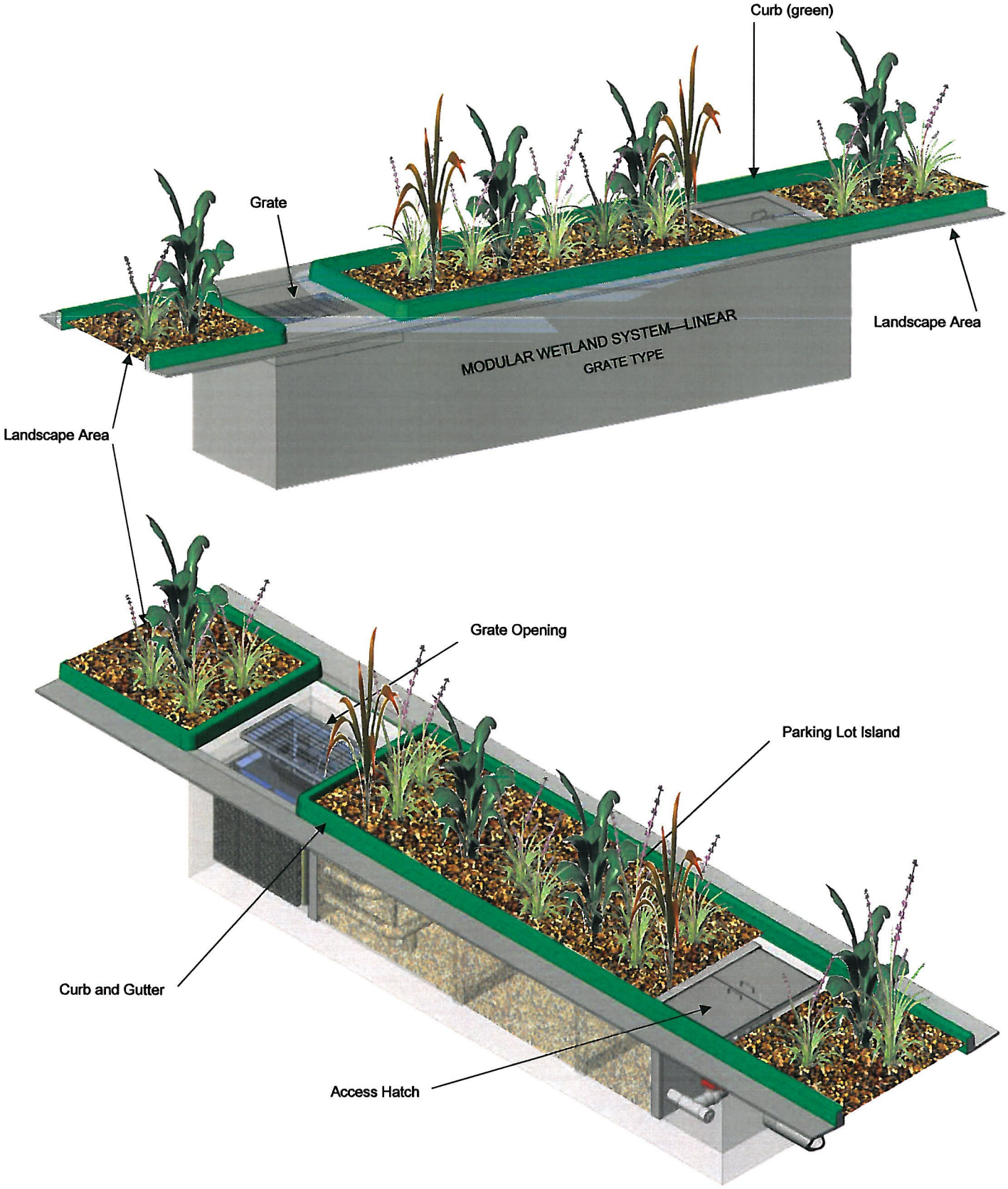
amount of fall will ensure that the MWS – Linear has no standing water. For projects where this amount of fall is not available, an alternate configuration may be possible. Please consultant a Modular Wetland System, Inc. compliance and design specialist for assistance.

The standard pipe size out of the MWS – Linear is 12" diameter. The system can easily be configured to accept larger or smaller pipe size. This standard size has been determined to process a flow rate equal to or greater than the maximum internal bypass flow rate of MWS – Linear (which is equal to 2.01 CFS curb type and 4.28 CFS grate type at peak operating head) plus the sum of the primary and secondary treatment peak flow rates.

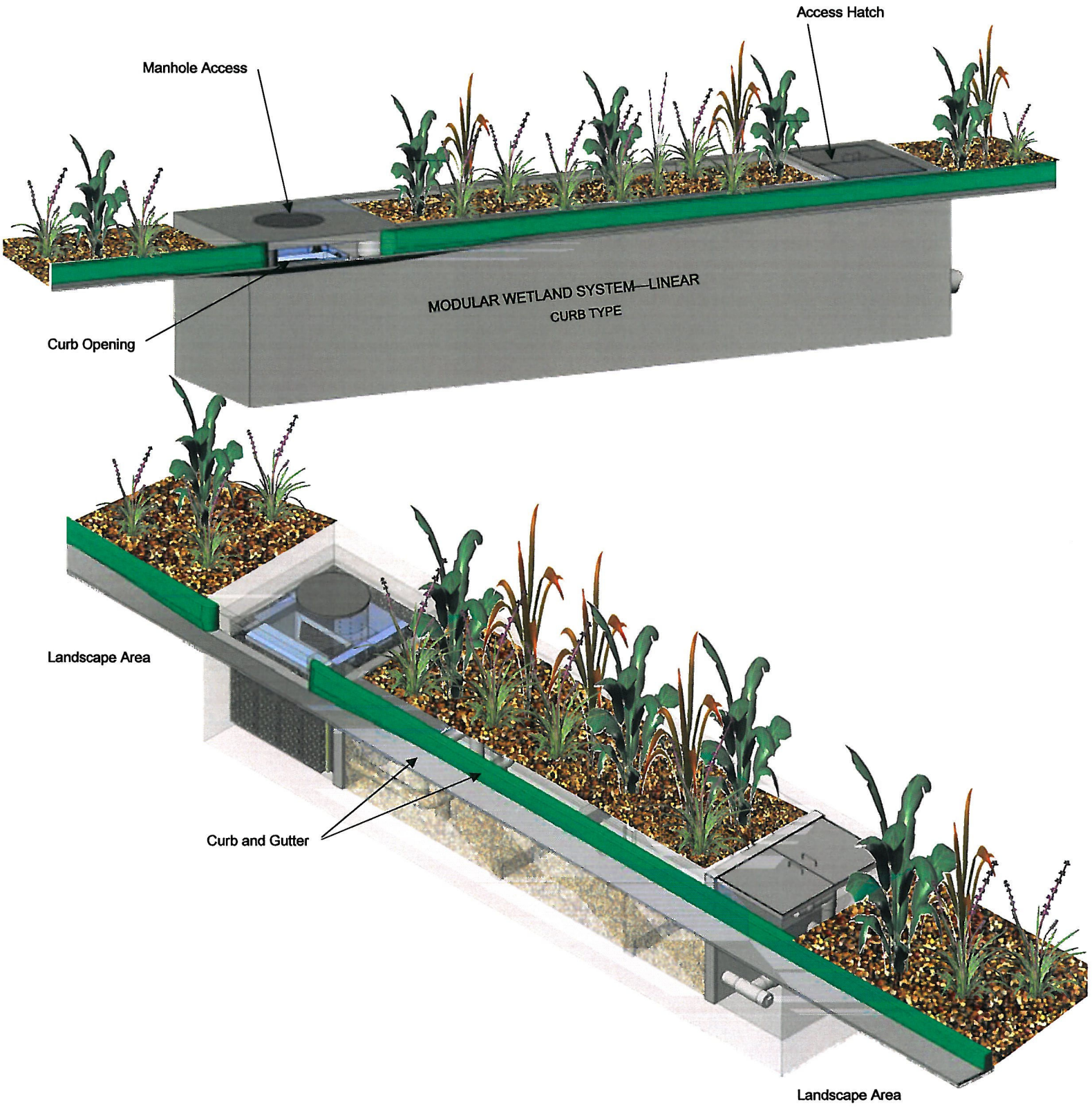
A Modular Wetland System, Inc. compliance and design specialist is always available to provide assistance. Call 760-433-7640 or email info@modularwetlands.com.

Following are illustrations detailing appropriate integration of the MWS – Linear Curb, Grate and Vault Type units. Also included at the end of this section is a design process flow chart and a pollutant of concern land use matrix that can be submitted as part of your water quality management plan to justify what pollutants of concern are expected and anticipated.

Grate Type (Flow Based) –

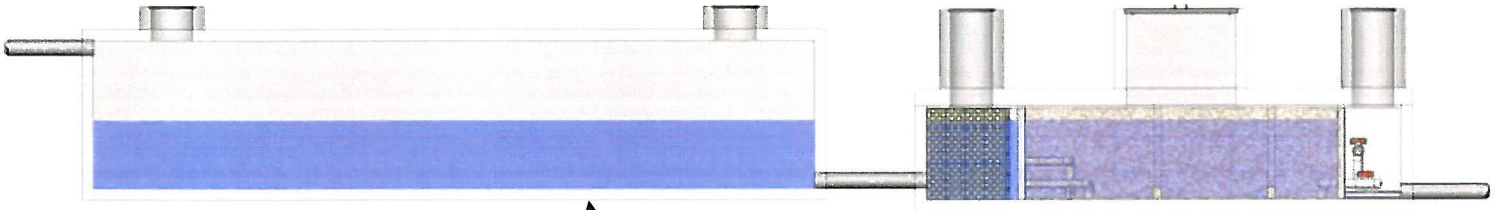


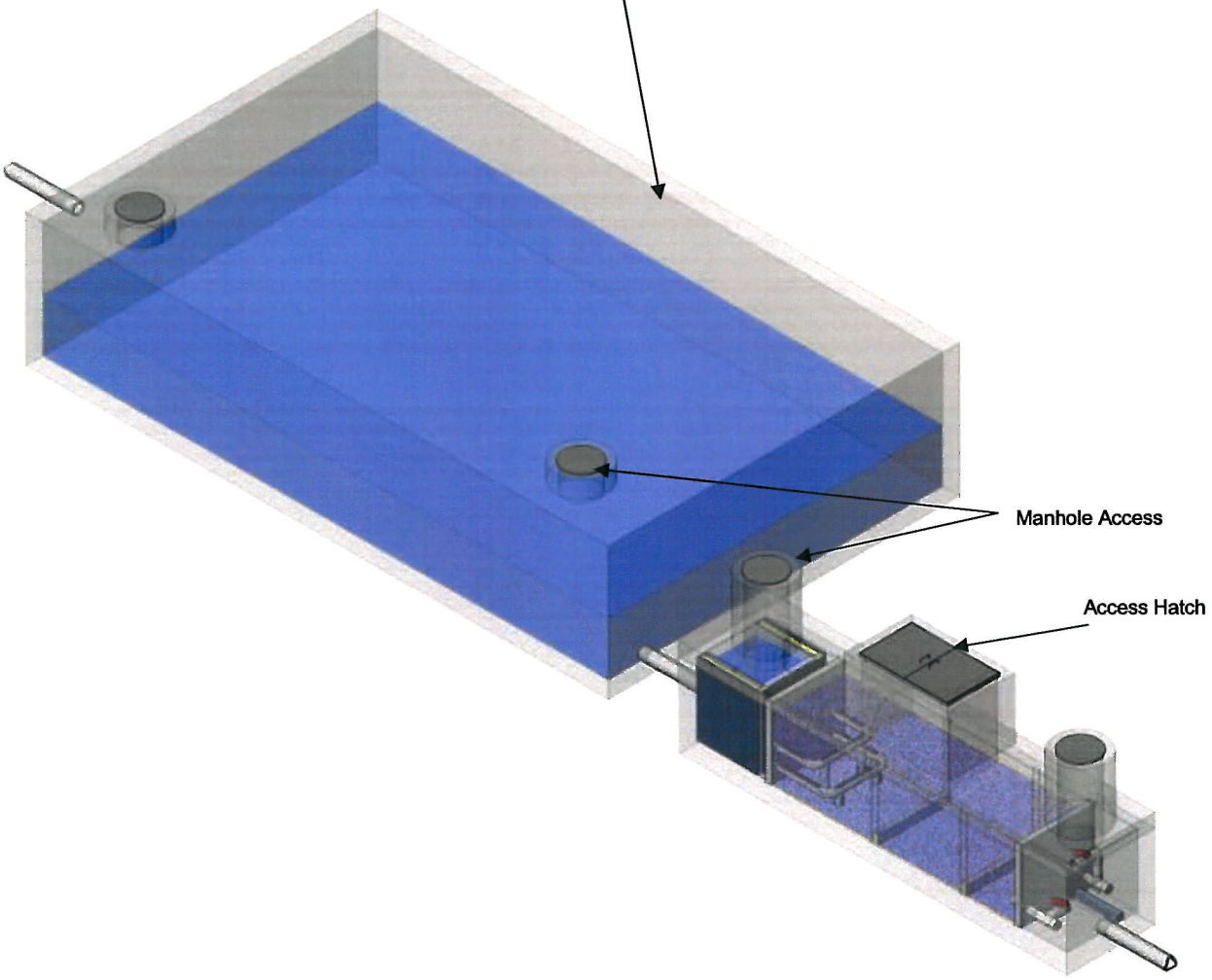
Curb Type (Flow Based) –



Vault Type (Volume Based) –

MWS – Linear Vault Type





DESIGN FLOW CHART

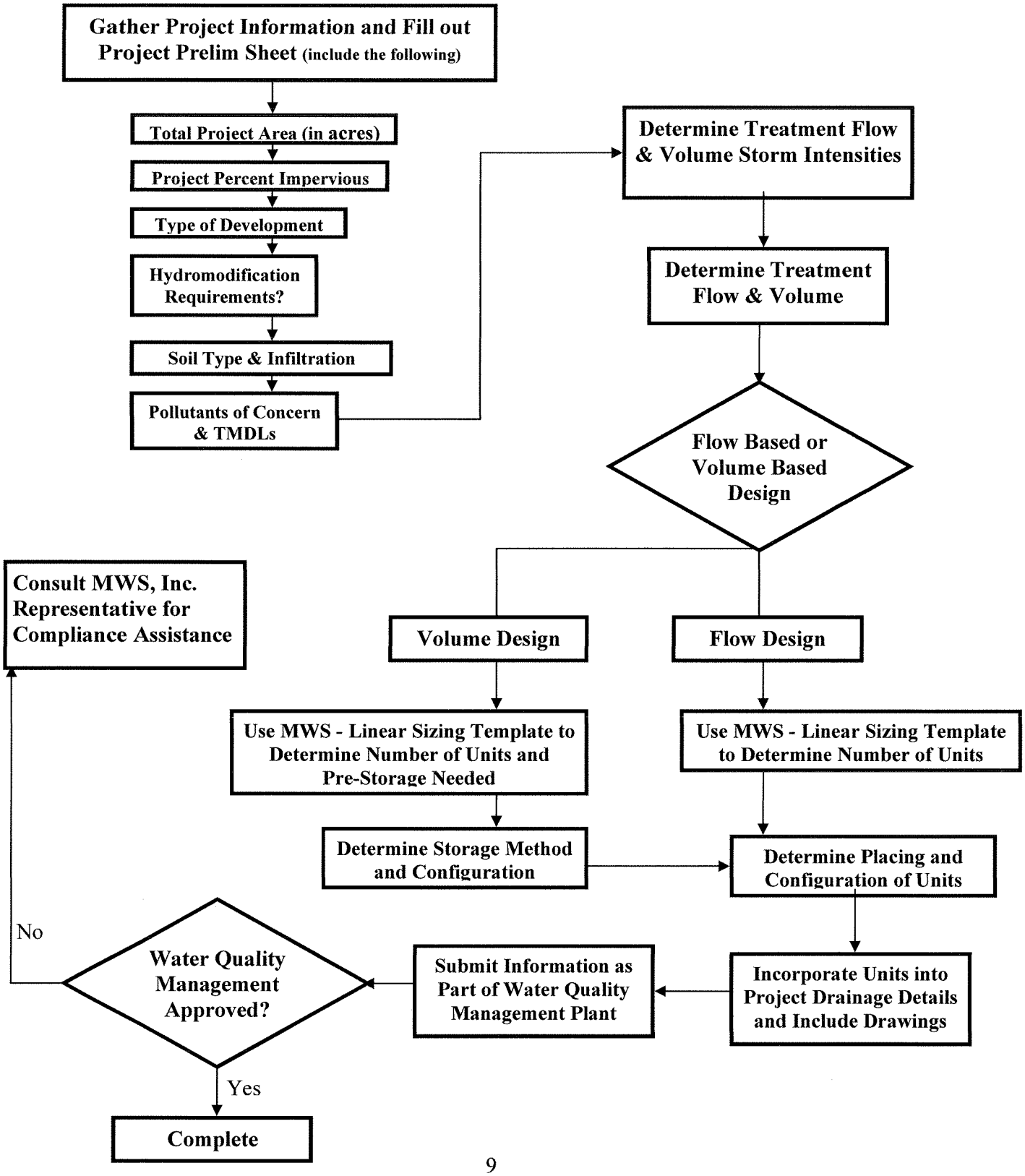


Table 1- Anticipated and Potential Pollutants Generated by Land Use Type									
Priority Project Categories	Pathogens	Heavy Metals	Nutrients	Pesticides	Organic Compounds	Sediment	Trash & Debris	Oxygen Demanding Substances	Oil & Grease
Detached Residential Development	X		X	X		X	X	X	X
Attached Residential Development	P		X	X		X	X	P(1)	P(2)
Commercial/Industiral Development >100,000 ft2	P(3)		P(1)	P(5)	P(2)	P(1)	X	P(5)	X
Automotive Repair Shop		X			X(4)(5)		X		X
Restaurants	X						X	X	X
Hillside Development >5,000 ft2 In SDRWQCB			X	X		X	X	X	X
Hillside Development >100,000 ft2 In SARWQCB			X	X		X	X	X	X
Parking Lots		X	P(1)	P(2)		P(1)	X	P(s)	X
Streets, Highways & Freeways		X	P(1)		X(4)	X	X	P(5)	X

X = anticipated

P = potential

(1) A potential pollutant if landscaping exists on-site

(2) A potential pollutant if the project includes uncovered parking areas

(3) A potential pollutant if land use involves food or animal waste products.

(4) Including petroleum hydrocarbons.

(5) Including solvents.

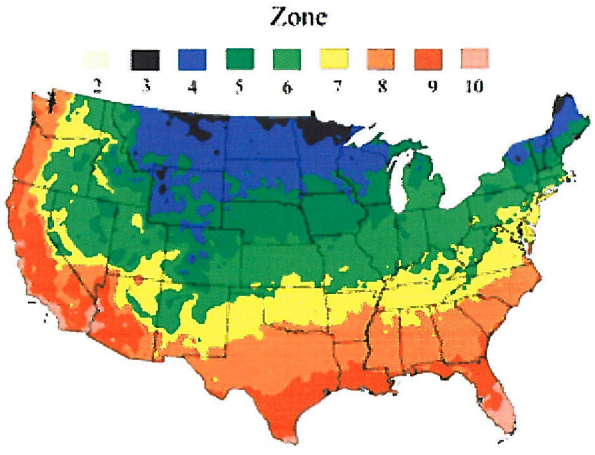
Modular Wetland Systems, Inc.

Plant Selection

The Modular Wetland System - Linear is designed with a specific media blend that is ideal for supporting many types of plants. While we always recommend using native plants, you will find that the lists below contain many common plants used in most landscape themes. If there is a plant not on our list that you would like to use please contact us directly at: assistance@modularwetlands.com or call 760-433-7640.

We recommend plants that have deep roots and are adapted to course soil textures.

Plant Lists By Hardy Zone



Hardy Zone 2

Hardy Zone 3

Hardy Zone 4

Hardy Zone 5

Hardy Zone 6

Hardy Zone 7

Hardy Zone 8

Hardy Zone 9

Hardy Zone 10

Detailed Hardy Zone Map

Provided by American Horticulture Society

Modular Wetland System - Linear® Plants for Hardy Zone 10

Common Name ***Latin Name***	**Light Exposure**	**Hardy Range**	**Height**	**Flower Color**
canna, canna tropicana, canna lilly *Canna X generalis*	full sun to partial shade	USDA Zones 8-11	2.5 to 8 feet	yellow, orange, red
Lily-of-the-Nile, African Lily, African Blue Lily *Agapanthus spp*	full sun to partial shade	USDA Zones 8-11	2 to 4 feet	blue
Vetiveria zizanioides (L.) Nash Vetiver Grass	full sun	USDA Zones 5-11	2 to 8 feet	green
giant wild rye *Leymus condensatus*	full sun	USDA Zones 3-11	4 to 8 feet	brown
society garlic, pink agapanthus *Tulbaghia violacea*	full sun to full shade	USDA Zones 7-10	1.5 to 3 feet	lavender
Gulf muhlygrass, mist grass, hairawn muhly *Muhlenbergia capillaris*	full sun to partial shade	USDA Zones 5-10	2 to 3 feet	pinkish purple
Lindheimer's muhlygrass, blue muhlygrass *Muhlenbergia lindheimeri*	full sun	USDA Zones 7-11	2 to 4 feet	purple to gray
horsetail, scouring rush, E. prealtum *Equisetum hyemale*	full sun to light shade	USDA Zones 3-11	2 to 4 feet	n/a
cattail, reed-mace *Typha latifolia*	full sun	USDA Zones 2-11	3 to 9 feet	brown
papyrus, Egyptian papyrus, bulrushes *Cyperus papyrus*	full sun to partial shade	USDA Zones 9-11	2 to 10 feet	white
lavender *Lavandula L.*	sun	USDA Zones 5-10	1 to 2 feet	purple

palm sedge *Carex phyllocephala*	full sun to full shade	USDA Zones 7-10	1 to 2 feet	green
lemongrass, oil grass *Cymbopogon citratus*	full sun to partial shade	USDA Zones 10-11	4 to 6 feet	n/a
umbrella sedge, umbrella plant *Cyperus involucratus*	full sun to partial shade	USDA Zones 8-11	2 to 6 feet	green/white
feather grass, Mexican needle grass *Nassella tenuissima*	full sun to partial shade	USDA Zones 7-11	2 to 3 feet	green/brown
sea oats, Chasmanthium paniculatum *Uniola paniculata*	full sun to partial shade	USDA Zones 6-10	3 to 6 feet	golden/brown
Cape lily, Powell's crinum lily *Crinum X powellii*	full sun to partial shade	USDA Zones 6-11	3 to 4 feet	white/pink
African iris, fortnight lily, morea iris *Dietes iridioides*	full sun to partial shade	USDA Zones 8-10	2 to 4 feet	white/purple
whirling butterflies, white gaura *Gaura lindheimeri*	full sun to partial shade	USDA Zones 5-10	2 to 4 feet	white/pink
daylily *Hemerocallis hybrids*	full sun to partial shade	USDA Zones 2-10	1 to 3.5 feet	various
Adam's needle, bear grass, weak-leaf yucca *Yucca filamentosa*	full sun	USDA Zones 5-10	3 to 5 feet	white
brome hummock sedge *carex bromoides*	full sun to partial shade	USDA Zones 2-10	1 ft	green

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The Modular Wetland System - Linear® standard 22' long system will require 18 to 20 plants. Different size systems will require different plant quanitities; please contact us for detailed information.

The plants listed are tolerant to drought and have deep roots to allow for ehanced pollutant removal.

These plants are subject to availability in local areas. If you would like to use a different plant please contact us. We will work with you to ensure the chosen plants work with the projects current landscape theme.

The Modular Wetland System - Linear® should be irrigated like any other planter area. The plants in the system must receive adequate irrigation to ensure plant survival during periods of drier weather. As with all landscape areas the plants within the Modular Wetland System - Linear will require more frequent watering during the establishment period.

For more information please contact at: 760-433-7640 or email: info@modularwetlands.com


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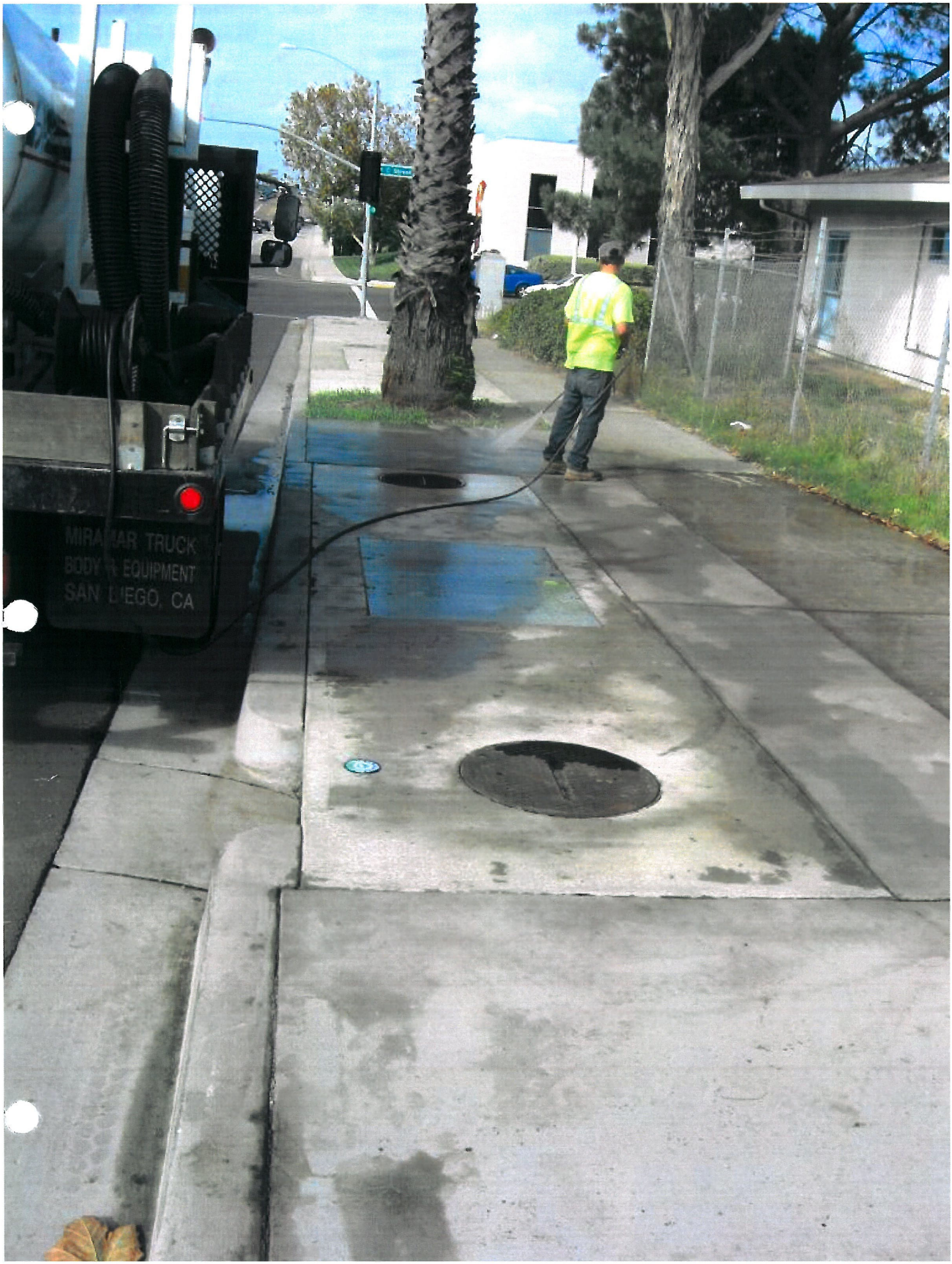
BODY & EQUIPMENT
SAN DIEGO, CA

MAINTENANCE

MWS – Linear

Hybrid Stormwater Filtration System

MODULAR WETLANDS™

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MAINTENANCE

Maintenance Summary –

- **Clean Bio Clean® Catch Basin Filter – average maintenance interval is 3 to 6 months.**
  - ***(15 minute service time).***
- **Clean Separation (sediment) Chamber – average maintenance interval is 6 to 18 months.**
  - ***(30 minute service time).***
- **Replace Cartridge Filter Media (BioMediaGREEN™) – average maintenance interval 6 – 12 months.**
  - ***(45 minute service time).***
- **Replace Drain Down Filter Media (BioMediaGREEN™) – average maintenance interval is 6 to 12 months.**
  - ***(5 minute service time).***
- **Trim Vegetations – average maintenance interval is 3 to 6 months.**
  - ***(15 minute service time).***
- **Evaluate Wetland Media Flow Hydraulic Conductivity – average inspection interval is once per year.**
  - ***(5 minute inspection time).***
- **Wetland Media Replacement – average maintenance interval is 5 to 20 years.**
  - ***(6 hours).***

For more information on maintenance procedures, to order replacement media or find an authorized service company please contact:

Modular Wetland Systems, Inc
2972 San Luis Rey Road
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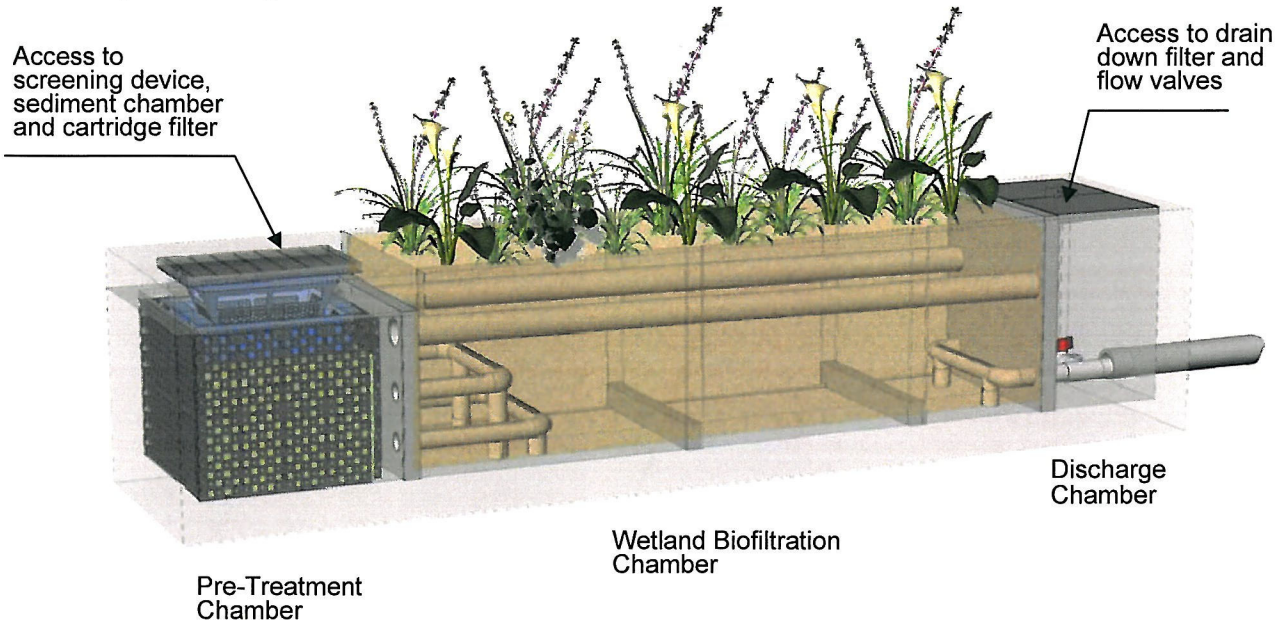
System Diagram –



Maintenance Overview –

A. Every installed MWS – Linear unit is to be maintained by the Supplier, or a Supplier approved contractor. The cost of this service varies among providers.

B. The MWS – Linear is a multi-stage self-contained treatment train for stormwater treatment. Each stage protects subsequent stages from clogging. Stages include: screening, separation, cartridge media filtration, and biofiltration. The biofiltration stage contains various types of vegetation which will require annual evaluation and trimming.

1. **Clean Bio Clean® Catch Basin Filter** – Screening is provided by well proven catch basin filter. The filter has a trash and sediment capacity of 2 (curb type) and 4 (grate type) cubic feet. The filter removes gross solids, including litter, and sediments greater than 200 microns. This procedure is easily done by hand or with a small industrial vacuum device. This filter is located directly under the manhole or grate access cover.

2. **Clean Separation (sediment) Chamber** – separation occurs in the pre-treatment chamber located directly under the curb or grated inlet. This chamber has a capacity of approximately 21 cubic feet for trash, debris and sediments. This chamber targets TSS, and particulate metals and nutrients. This procedure can be performed with a standard vacuum truck. This chamber is located directly under the manhole or grate access cover.

3. **Replace Cartridge Filter Media (BioMediaGREEN™)** – Primary filtration is provided by a horizontal flow cartridge filter utilizing BioMediaGREEN blocks. Each cartridge has a media surface area of 35 square feet. The large surface area will insure long term operation without clogging. The cartridge filter with BioMediaGREEN targets fine TSS, metals, nutrients, hydrocarbons, turbidity and bacteria. Media life depends on local loading conditions and can easily be replaced and disposed of without any equipment. The filters are located in the pre-treatment chamber. Entry into chamber required to replace BioMediaGREEN blocks. Each cartridge contain 14 pieces of 20" tall BioMediaGREEN.

4. **Replace Drain Down Filter Media (BioMediaGREEN™)** – A drain down filter, similar in function to the perimeter filter is located in the discharge chamber. This filter allows standing water to be drained and filtered out of the separation chamber. This addresses any vector issues, by eliminating all standing water within this system. Replacement of media takes approximately 5 minutes and is performed without any equipment.

5. **Trim Vegetations** – The system utilizes multiple plants in the biofiltration chamber to provide enhanced treatment for dissolved pollutants including nutrients and metals. The vegetation will need to be maintained (trimmed) as needed. This can be done as part of the project normal landscape maintenance. **NO FERTILIZER SHALL BE USED IN THIS CHAMBER.**

6. **Evaluate Wetland Media Flow Hydraulic Conductivity** – The systems flow can be assessed from the discharge chamber. This should be done during a rain event. By viewing into the discharge chamber the flow out of the system can be observed. If little to know flow is observed from the lower valve or orifice plate this is a sign of potential wetland media (biofiltration) maintenance needs.

7. **Wetland Media Replacement** – biofiltration is provided by an advance horizontal flow vegetated wetland. This natural filter contains a mix of sorptive media that supports abundant plant life. This biofilter targets the finest TSS, dissolved nutrients, dissolved metals, organics, pesticides, oxygen demanding substances and bacteria. This filter provides the final polishing step of treatment. If prior treatment stages are properly maintained, the life of this media can be up to 20 years. Replacement of the media is simple. Removal of spent media can be done with a shovel of a vacuum truck.

C. The MWS – Linear catch basin filter, separation chamber, cartridge filter media and wetland media are designed to allow for the use of vacuum removal of captured pollutants and spent filter media by centrifugal compressor vacuum units without causing damage to the filter or during normal cleaning and maintenance. Filter and chambers can be cleaned from finish surface through standard manhole or grate access.

Maintenance Procedures –

1. <u>Clean Bio Clean® Catch Basin Filter</u> – Modular Wetland Systems, Inc. recommends the **catch basin filter** be inspected and cleaned a minimum of once every six months and replacement of hydrocarbon booms once a year. The procedure is easily done with the use of any standard vacuum truck. *This procedure takes approximately 15 minutes.*

1. Remove grate or manhole to gain access to catch basin filter insert. Remove the deflector shield (grate type only) with the hydrocarbon boom attached. Where possible the maintenance should be performed from the ground surface. Note: entry into an underground stormwater vault such as an inlet vault requires certification in confined space training.
2. Remove all trash, debris, organics, and sediments collected by the inlet filter insert. Removal of the trash and debris can be done manually or with the use of a vacuum truck. The hose of the vacuum truck will not damage the screen of the filter.
3. Evaluation of the hydrocarbon boom shall be performed at each cleaning. If the boom is filled with hydrocarbons and oils it should be replaced. Attach new boom to basket with plastic ties through pre-drilled holes in basket. Place the deflector shield (grate type only) back into the filter.
4. Transport all debris, trash, organics and sediments to approved facility for disposal in accordance with local and state requirements.
5. The hydrocarbon boom may be classified as hazardous material and will have to be picked up and disposed of as hazardous waste. Hazardous material can only be handled by a certified hazardous waste trained person (minimum 24-hour hazwoper).

2. <u>Clean Separation (sediment) Chamber</u> – Modular Wetland Systems, Inc. recommends the **separation chamber** be inspected and cleaned a minimum of once a year. The procedure is easily done with the use of any standard vacuum truck. *This procedure takes approximately 30 minutes.*

1. Remove grate or manhole to gain access to the catch basin filter.
2. Remove catch basin filter. Where possible the maintenance should be performed from the ground surface. Note: entry into an underground stormwater vault such as an inlet vault requires certification in confined space training.
3. With a pressure washer spray down pollutants accumulated on walls and cartridge filters.
4. Vacuum out separation chamber and remove all accumulated debris and sediments.
5. Replace catch basin filter, replace grate or manhole cover.
6. Transport all debris, trash, organics and sediments to approved facility for disposal in accordance with local and state requirements.

3. <u>Replace Cartridge Filter Media (BioMediaGREEN™)</u> – Modular Wetland Systems, Inc. recommends the **cartridge filters** media be inspected and cleaned a minimum of once a year. The procedure will require prior maintenance of separation chamber. *Replacement of media takes approximately 45 minutes.*

1. Remove grate or manhole to gain access to the catch basin filter.
2. Remove catch basin filter. Where possible the maintenance should be performed from the ground surface. Note: entry into an underground stormwater vault such as an inlet vault requires certification in confined space training.
3. Enter separation chamber.
4. Unscrew the two ½" diameter bolts holding the lid on each cartridge filter and remove lid and place outside of unit.
5. Remove each of the 14 BioMediaGREEN filter blocks in each cartridge and remove from chamber for disposal.
6. Spray down the outside and inside of the cartridge filter to remove any accumulated sediments.
7. Replace with new BioMediaGREEN filter blocks insuring the blocks are properly lined up and seated in the bottom.
8. Replace the lid and tighten down bolts.
9. Replace catch basin filter, replace grate or manhole cover.
10. Transport all debris, trash, organics, spent media and sediments to approved facility for disposal in accordance with local and state requirements.

4. <u>Replace Drain Down Filter Media (BioMediaGREEN™)</u> – Modular Wetland Systems, Inc. recommends the **drain down filter** be inspected and maintained a minimum of once a year. *Replacement of media takes approximately 5 minutes.*

1. Open hatch of discharge chamber
2. Enter chamber, unlatch drain down filter cover.
3. Remove BioMediaGREEN filter block
4. Replace with new block, replace and latch cover.
5. Exit chamber, close and lock down the hatch.
6. Transport spent media to approved facility for disposal in accordance with local and state requirements.

5. <u>Trim Vegetations</u> – Modular Wetland Systems, Inc. recommends the plants/vegetation be inspected and maintained a minimum of once a year. It is also recommended that the plants receive the same care as other landscaped areas. **Note: No fertilizer is to be used on this area.** *Trimming of vegetation takes approximately 15 minutes.*

<u>6. Evaluate Wetland Media Flow Hydraulic Conductivity</u> – Modular Wetland Systems, Inc. recommends system flow be inspected and observed a minimum of once a year. This needs to be done during a rain event. *Inspection and Observation takes approximately 5 minutes.*

1. Open hatch of discharge chamber
2. Observe the level of flow from the bottom valve or orifice plate.
3. If flow is steady and high the system is operating normally.

4. If little or no flow is observed exiting the valve possible maintenance to the biofiltration wetland chamber may be needed. Contact Modular Wetlands for further assistance.
5. Exit chamber, close and lock down the hatch.

7. Wetland Media Replacement – Modular Wetland Systems, Inc. recommends the wetland media be replaced a minimum of one every 20 years. *Inspection takes approximately 15 minutes. Replacement of rock media takes approximately 6 hours and requires a vacuum truck.*

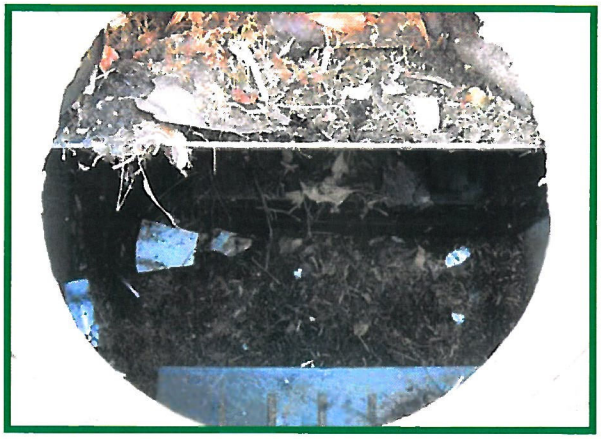
1. Remove plants from the wetland chamber.
2. Use a vacuum truck or shovel to remove all wetland media.
3. Spray down the walls and floor of the chamber and vacuum out any accumulated pollutants.
4. Spray down perforated piping and netting of flow matrix and the inflow and outflow end to remove any accumulated pollutants.
5. Vacuum out any standing water from the media removal and insure the chamber is cleaning.
6. Use a small backhoe to fill chamber with new media. Call Modular Wetland Systems, Inc. for media delivery information.
7. Install BioMediaGREEN filter blocks across over the entire filter bed. Fill with media until 9" from top. The install filter blocks which are 3" thick. Fill the top 6" inches with wetland media.
8. Plant new vegetation in the same configuration and quantity as old vegetation. Dig down until the BioMediaGREEN is exposed. Cut out a small circle of the BioMediaGREEN. Remove plant from container including soil ball and place in the whole cut out of the BioMediaGREEN. Cover up with wetland media.
9. Spray down the plants and media with water to saturate.
10. Continue supplemental irrigation (spray or drip) for at lest 90 days.

7. Other Maintenance Notes –

1. Following maintenance and/or inspection, the maintenance operator shall prepare a maintenance/inspection record. The record shall include any maintenance activities performed, amount and description of debris collected, and condition of the system and its various filter mechanism. .
2. The owner shall retain the maintenance/inspection record for a minimum of five years from the date of maintenance. These records shall be made available to the governing municipality for inspection upon request at any time.
3. Any person performing maintenance activities must have completed a minimum of OSHA 24-hour hazardous waste worker (hazwoper) training.
4. Remove access manhole lid or grate to gain access to filter screens and sediment chambers. Where possible the maintenance should be performed from the ground surface. Note: entry into an underground stormwater vault such as an inlet vault requires certification in confined space training.
5. Transport all debris, trash, organics and sediments to approved facility for disposal in accordance with local and state requirements.
6. The hydrocarbon boom is classified as hazardous material and will have to be picked up and disposed of as hazardous waste. Hazardous material can only be handled by a certified hazardous waste trained person (minimum 24-hour hazwoper).

Maintenance Sequence –

Access Pre-Treatment Chamber by Removing Manhole or Grate Cover

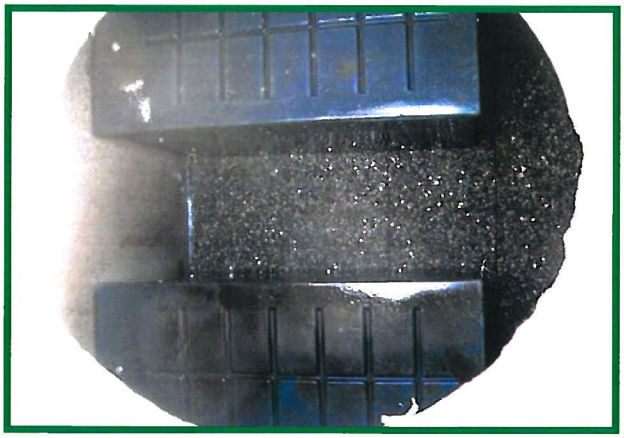


Assess Pollutant Loading in Catch Basin Filter and Sediment Chamber

Vacuum Catch Basin Filter

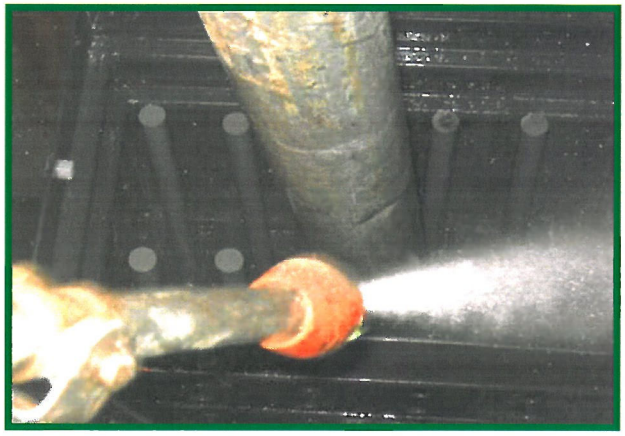
Remove Catch Basin Filter

Vacuum out the Sediment Chamber



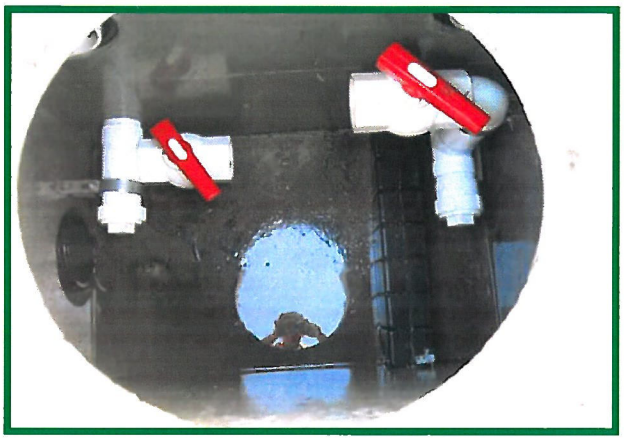
Enter Chamber Remove Lids of Cartridge Filters

Remove Spent BioMediaGREEN Filter Blocks



Spray Down and Clean Cartridge Filter Housing

Replace with New BioMediaGREEN Filter Blocks and Replace Lid, then Catch Basin Filter and Replace Manhole or Grate



Open Discharge Chamber Lid to Asses Wetland Media Flow Rate and Replace Drain Down Filter Near Bottom

Evaluate Vegetation and Trim if Needed. Maintenance Complete.

Please Contact Modular Wetland Systems, Inc. for More Information:

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