BMP INSPECTION & MAINTENANCE RESPONSIBILITY MATRIX			
BMP Applicable? Yes/No	**BMP Name and BMP Implementation, Maintenance and Inspection Procedures**	**Implementation, Maintenance, and Inspection Frequency and Schedule**	**Person or Entity with Operation & Maintenance Responsibility**
No	N9. Hazardous Materials Disclosure Compliance	Not Applicable	
No	N10. Uniform Fire Code Implementation	Not Applicable	
Yes	N11. Common Area Litter Control The HOA will be responsible for performing trash pickup and sweeping of littered common areas on a weekly basis or whenever necessary. Responsibilities will also include noting improper disposal materials by homeowners and reporting such violations to the HOA for investigation.	Litter patrol, violations investigation, reporting and other litter control activities shall be performed weekly and in conjunction with maintenance activities. Frequency: Weekly	Brookfield Residential / HOA
Yes	N12. Employee Training All employees of the HOA and any contractors of the HOA will require training to ensure that employees are aware of maintenance activities that may result in pollutants reaching the storm drain. Materials that may be utilized during training are listed in Section VII.	The Owner shall educate all new employees/managers on storm water pollution prevention, particularly good housekeeping practices prior to the start of the rainy season (October 1). Refresher courses shall be conducted on an as needed basis. Materials that may be utilized on BMP maintenance are attached to this WQMP. Frequency: Annually	Brookfield Residential / HOA
No	N13. Housekeeping of Loading Docks	Not Applicable	
Yes	N14. Common Area Catch Basin Inspection All private catch basins will be maintained and cleaned by the HOA. All public catch basins will be maintained and cleaned by the City of Lake Forest.	On-site catch basin inlets and other drainage facilities shall be inspected after each storm event and once per year. Inlets and other facilities shall be cleaned prior to the storm season by October 1st each year. Frequency: Annually	Brookfield Residential / HOA

BMP INSPECTION & MAINTENANCE RESPONSIBILITY MATRIX			
BMP Applicable? Yes/No	**BMP Name and BMP Implementation, Maintenance and Inspection Procedures**	**Implementation, Maintenance, and Inspection Frequency and Schedule**	**Person or Entity with Operation & Maintenance Responsibility**
Yes	**N15. Street Sweeping Private Streets and Parking Lots** All private streets and parking areas shall be swept by the HOA prior to the rainy season, no later than October 1st each year.	Private streets and parking areas within the project shall be swept at a minimum frequency quarterly as well as once per year prior to the storm season, no later than October 1st each year. Frequency: Quarterly	Brookfield Residential / HOA
No	**N16. Retail Gasoline Outlets**	Not Applicable	
STRUCTURAL SOURCE CONTROL BMPs			
Yes	**S1. Provide storm drain system stenciling and signage** The developer will be responsible for the stenciling of all catch basins to include a legible message such as "No Dumping - Drains to Ocean" or an equally effective phrase.	Storm drain stencils shall be inspected for legibility, at minimum, once prior to the storm season, no later than October 1st each year. Those determined to be illegible will be re-stenciled as soon as possible. Frequency: Annually	Brookfield Residential / HOA
No	**S2. Design and construct outdoor material storage areas to reduce pollution introduction**	Not Applicable	
No	**S3. Design and construct trash and waste storage areas to reduce pollution introduction**	Not Applicable	

BMP INSPECTION & MAINTENANCE RESPONSIBILITY MATRIX			
BMP Applicable? Yes/No	**BMP Name and BMP Implementation, Maintenance and Inspection Procedures**	**Implementation, Maintenance, and Inspection Frequency and Schedule**	**Person or Entity with Operation & Maintenance Responsibility**
Yes	**S4. Use efficient irrigation systems & landscape design, water conservation, smart controllers, and source control** Includes installation and maintenance of all common landscape areas utilizing similar planting materials with similar water requirements to reduce excess irrigation runoff. Also includes implementing all efficient irrigation systems for common area landscaping including but not limited to provisions for water sensors and programmable irrigation cycles in conformance with water use efficiency guidelines.	In conjunction with routine maintenance activities, verify that landscape design continues to function properly by adjusting properly to eliminate overspray to hardscape areas, and to verify that irrigation timing and cycle lengths are adjusted in accordance with water demands, given time of year, weather, and day or nighttime temperatures based on system specifications and local climate patterns. System testing shall occur twice per year. Water from testing/flushing shall be collected and properly disposed to sewer system and shall not discharge to storm drain system. Frequency: Monthly	Brookfield Residential / HOA
Yes	**S5. Protect slopes and channels and provide energy dissipation** All slopes shall be vegetated and stabilized to prevent erosion, in accordance with "Efficient Irrigation and Landscape Design" source control BMP to prevent erosion.	To be performed in conjunction with maintenance activities. Maintain vegetative cover and/or mulch to eliminate exposed soils. Any eroded surfaces to be repaired immediately. Inspections to be performed twice each year (spring and fall) and after major storm events to check for signs of erosion, gullies, and sloughing. Frequency: Monthly	Brookfield Residential / HOA
No	**S6. Dock areas**	Not Applicable	
No	**S7. Maintenance bays**	Not Applicable	
No	**S8. Vehicle wash areas**	Not Applicable	

BMP INSPECTION & MAINTENANCE RESPONSIBILITY MATRIX			
BMP Applicable? Yes/No	BMP Name and BMP Implementation, Maintenance and Inspection Procedures	Implementation, Maintenance, and Inspection Frequency and Schedule	Person or Entity with Operation & Maintenance Responsibility
No	S9. Outdoor processing areas	Not Applicable	
No	S10. Equipment wash areas	Not Applicable	
No	S11. Fueling areas	Not Applicable	
No	S12. Hillside landscaping	Not Applicable	
No	S13. Wash water control for food preparation areas	Not Applicable	
No	S14. Community car wash racks	Not Applicable	

BMP INSPECTION & MAINTENANCE RESPONSIBILITY MATRIX		
BMP Name and BMP Implementation, Maintenance and Inspection Procedures	**Implementation, Maintenance, and Inspection Frequency and Schedule**	**Person or Entity with Operation & Maintenance Responsibility**
LOW IMPACT DEVELOPMENT BMPs		
Biotreatment: Rain Gardens	Inspections should occur semi-annually or after major storm events to check for the following and remove accordingly: standing water, sediment, and trash & debris. Inspections should also look for potential clogging and clean planters or, if necessary, replace the entire filter bed. Inspect for weeds, and prune and/or replace plants in accordance with routine landscape maintenance activities. Replace mulch and prune shrubs as necessary. Frequency: 2x per year	Brookfield Residential / HOA
Biotreatment: Filterra Bioretention Units	Maintenance consists of a minimum of two scheduled visits, one after the rainy season and one before the wet season to inspect and clean the unit. Each visit consists of: Inspection; removal of trash, debris, sediment; filter media and plant health evaluation and replacement if necessary; replacement of mulch. Frequency: 2x per year	Brookfield Residential / HOA

Required Permits

Permits are not required for BMP maintenance.

Forms to Record BMP Implementation, Maintenance, and Inspection

The form that will be used to record implementation, maintenance, and inspection of BMPs is attached.

Recordkeeping

All records must be maintained for at least five (5) years and must be made available for review upon request.

Waste Disposal

Any waste generated from maintenance activities will be disposed of properly. Wash water and other waste from maintenance activities is not to be discharged or disposed of into the storm drain system. Clippings from landscape maintenance (i.e. prunings) will be collected and disposed of properly off-site, and will not be washed into the streets, local area drains/conveyances, or catch basin inlets.

RECORD OF BMP IMPLEMENTATION, MAINTENANCE, AND INSPECTION

Today's Date: _____

Name of Person Performing Activity (Printed): _____

Signature: _____

BMP Name (As Shown in O&M Plan)	Brief Description of Implementation, Maintenance, and Inspection Activity Performed

Filterra® - Americast
11352 Virginia Precast Road
Ashland, VA 23005

Maintenance Services

for

Filterra® Stormwater Bioretention Filtration Systems

- Extended Maintenance Service
- Maintenance Training for your Landscape Contractor or Local DPW

Corporate Headquarters
11352 Virginia Precast Road
Ashland, VA 23005
Toll Free: (866) 349-3458
Fax: (804) 798-8400

E-mail: design@filterra.com
www.filterra.com

Why Main ı?

All stormwater treatment systems require maintenance for effective operation. This necessity is often incorporated in your property's permitting process as a legally binding BMP Maintenance Agreement.

Maintei ce Includes

Filterra maintenance includes:

- Unit inspection
- Debris, trash & mulch removal & disposal
- Filter media evaluation
- Plant health evaluation
- Replacement of mulch
- Updated and stored records of performed maintenance

- **Avoid legal challenges from your jurisdiction's maintenance enforcement program.**
- **Prolong the expected lifespan of your Filterra media.**
- **Avoid more costly media replacement.**
- **Help reduce pollutant loads leaving your property.**

Why use Filterra Services?

- As the manufacturer we have performed 1,000's of maintenance visits.
- Filterra will schedule visits and keep maintenance records for you.
- Cost effective, multi-year plans available.
- Backed by Filterra's technical department.
- Use only Filterra approved materials.

Training Includes

- Site visit by Filterra personnel.
- Full maintenance demonstration on a single unit.
- Instructional DVD.
- *Maintenance Instruction Manual* complete with color photos.
- Maintenance forms for keeping your own records.

Please complete all sections, detach and return to Filterra® or call 866-349-3458

Project Name: _____

Site Address: _____

_____

Contact Information:

Name: _____

Company Name (if applicable): _____

_____

Phone: _____ E-mail: _____

☐ Owner
☐ Owner Representative
☐ Current Occupant
☐ Home Owner Association

I am interested in:

☐ Extended Maintenance
☐ Maintentance Training

Operation & Maintenance (OM) Manual v01

filterra®

Bioretention Systems

A Growing Idea in Stormwater Filtration.

by KRISTAR

A Division of:

AMERICAST

Filterra® Stormwater Bioretention Filtration System

toll free: **800-579-8819** | fax: **707-524-8186** | drainageprotection.com | kristar.com

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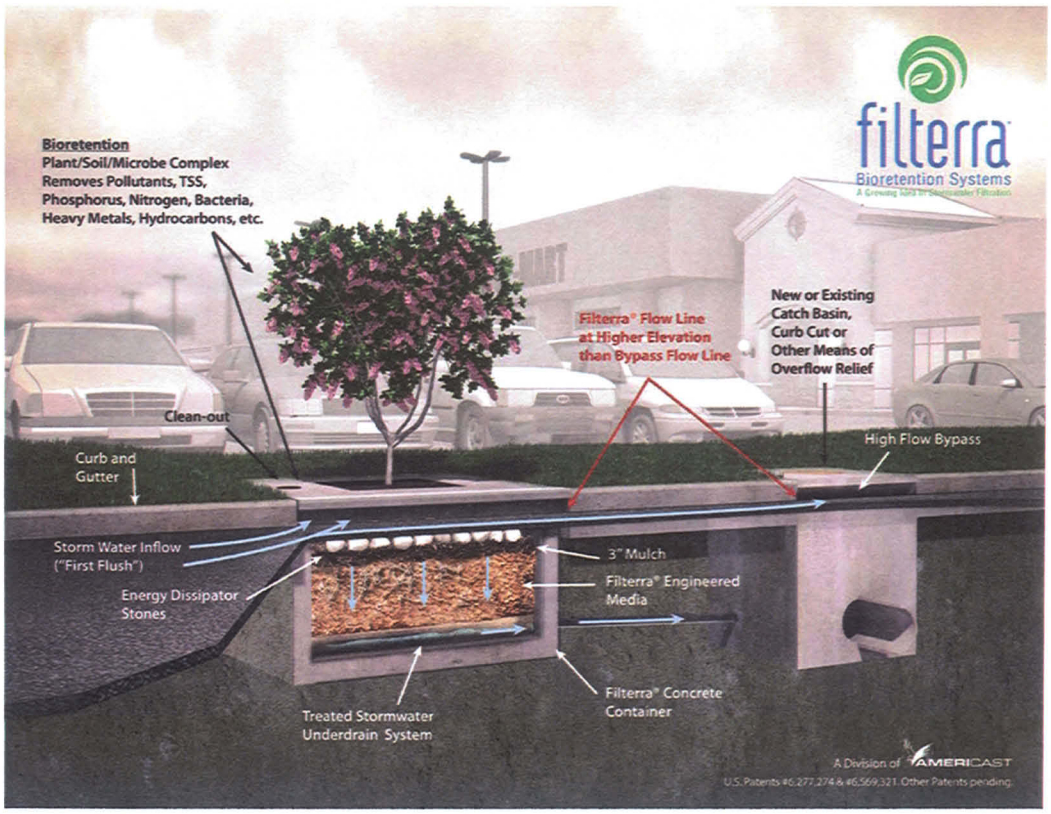
General Description

The following general specifications describe the general operations and maintenance requirements for the Americast stormwater bioretention filtration system, the Filterra®. The system utilizes physical, chemical and biological mechanisms of a soil, plant and microbe complex to remove pollutants typically found in urban stormwater runoff. The treatment system is a fully equipped, pre-constructed drop-in place unit designed for applications in the urban landscape to treat contaminated runoff.



Stormwater flows through a specially designed filter media mixture contained in a landscaped concrete container. The mixture immobilizes pollutants which are then decomposed, volatilized and incorporated into the biomass of the Filterra® system's micro/macro fauna and flora. Stormwater runoff flows through the media and into an underdrain system at the bottom of the container, where the treated water is discharged. Higher flows bypass the Filterra® to a downstream inlet or outfall.

Maintenance is a simple, inexpensive and safe operation that does not require confined space access, pumping or vacuum equipment or specialized tools. Properly trained landscape personnel can effectively maintain Filterra® Stormwater systems by following instructions in this manual.

Basic Operations

Filterra® is a bioretention system in a concrete box. Contaminated stormwater runoff enters the filter box through the curb inlet spreading over the 3-inch layer of mulch on the surface of the filter media. As the water passes through the mulch layer, most of the larger sediment particles and heavy metals are removed through sedimentation and chemical reactions with the organic material in the mulch. Water passes through the soil media where the finer particles are removed and other chemical reactions take place to immobilize and capture pollutants in the soil media. The cleansed water passes into an underdrain and flows to a pipe system or other appropriate discharge point. Once the pollutants are in the soil, the bacteria begin to break down and metabolize the materials and the plants begin to uptake and metabolize the pollutants. Some pollutants such as heavy metals, which are chemically bound to organic particles in the mulch, are released over time as the organic matter decomposes to release the metals to the feeder roots of the plants and the cells of the bacteria in the soil where they remain and are recycled. Other pollutants such as phosphorus are chemically bound to the soil particles and released slowly back to the plants and bacteria and used in their metabolic processes. Nitrogen goes through a very complex variety of biochemical processes where it can ultimately end up in the plant/bacteria biomass, turned to nitrogen gas or dissolves back into the water column as nitrates depending on soil temperature, pH and the availability of oxygen. The pollutants ultimately are retained in the mulch, soil and biomass with some passing out of the system into the air or back into the water.

Design and Installation

Each project presents different scopes for the use of Filterra® systems. To ensure the safe and specified function of the stormwater BMP, Americast reviews each application before supply. Information and help may be provided to the design engineer during the planning process. Correct Filterra® box sizing (by rainfall region) is essential to predict pollutant removal rates for a given area. The engineer shall submit calculations for approval by the local jurisdiction. The contractor is responsible for the correct installation of Filterra units as shown in approved plans. A comprehensive installation manual is available at filterra.com.

Maintenance

Why Maintain?

All stormwater treatment systems require maintenance for effective operation. This necessity is often incorporated in your property's permitting process as a legally binding BMP maintenance agreement.

- Avoid legal challenges from your jurisdiction's maintenance enforcement program.
- Prolong the expected lifespan of your Filterra media.
- Avoid more costly media replacement.
- Help reduce pollutant loads leaving your property.

Simple maintenance of the Filterra® is required to continue effective pollutant removal from stormwater runoff before discharge into downstream waters. This procedure will also extend the longevity of the living biofilter system. The unit will recycle and accumulate pollutants within the biomass, but is also subjected to other materials entering the throat. This may include trash, silt and leaves etc. which will be contained within the void below the top grate and above the mulch layer. Too much silt may inhibit the Filterra's® flow rate, which is the reason for site stabilization before activation. Regular replacement of the mulch stops accumulation of such sediment.

When to Maintain?

Americast includes a 1-year maintenance plan with each system purchase. Annual included maintenance consists of a maximum of two (2) scheduled visits. Additional maintenance may be necessary depending on sediment and trash loading (by Owner or at additional cost). The start of the maintenance plan begins when the system is activated for full operation. Full operation is defined as the unit installed, curb and gutter and transitions in place and activation (by Supplier) when mulch and plant are added and temporary throat protection removed.

Activation cannot be carried out until the site is **fully** stabilized (full landscaping, grass cover, final paving and street sweeping completed). Maintenance visits are scheduled seasonally; the spring visit aims to clean up after winter loads including salts and sands. The fall visit helps the system by removing excessive leaf litter.

A first inspection to determine if maintenance is necessary should be performed at least twice annually after every major storm event of greater than (1) one inch total depth (subject to regional climate). Please refer to the maintenance checklist for specific conditions that indicate if maintenance is necessary.

It has been found that in regions which receive between 30-50 inches of annual rainfall, (2) two visits are generally required. Regions with less rainfall often only require (1) one visit per annum. Varying land uses can affect maintenance frequency; e.g. some fast food restaurants require more frequent trash removal. Contributing drainage areas which are subject to new development wherein the recommended erosion and sediment control measures have not been implemented require additional maintenance visits.

Some sites may be subjected to extreme sediment or trash loads, requiring more frequent maintenance visits. This is the reason for detailed notes of maintenance actions per unit, helping the Supplier and Owner predict future maintenance frequencies, reflecting individual site conditions.

Owners must promptly notify the (maintenance) Supplier of any damage to the plant(s), which constitute(s) an integral part of the bioretention technology. Owners should also advise other landscape or maintenance contractors to leave all maintenance to the Supplier (i.e. no pruning or fertilizing).

Exclusion of Services

It is the responsibility of the owner to provide adequate irrigation when necessary to the plant of the Filterra® system.

Clean up due to major contamination such as oils, chemicals, toxic spills, etc. will result in additional costs and are not covered under the Supplier maintenance contract. Should a major contamination event occur, the Owner must block off the outlet pipe of the Filterra® (where the cleaned runoff drains to, such as drop-inlet) and block off the throat of the Filterra®. The Supplier should be informed immediately.

Maintenance Visit Summary

Each maintenance visit consists of the following simple tasks (detailed instructions below).

1. Inspection of Filterra® and surrounding area
2. Removal of tree grate and erosion control stones
3. Removal of debris, trash and mulch
4. Mulch replacement
5. Plant health evaluation and pruning or replacement as necessary
6. Clean area around Filterra®
7. Complete paperwork

Maintenance Tools, Safety Equipment and Supplies

Ideal tools include: camera, bucket, shovel, broom, pruners, hoe/rake, and tape measure. Appropriate Personal Protective Equipment (PPE) should be used in accordance with local or company procedures. This may include impervious gloves where the type of trash is unknown, high visibility clothing and barricades when working in close proximity to traffic and also safety hats and shoes. A T-Bar or crowbar should be used for moving the tree grates (up to 170 lbs ea.).

Most visits require only replacement mulch. Three bags of double shredded mulch are used per unit (on a standard 6x6' size). Some visits may require additional Filterra® engineered soil media available from the Supplier.

Maintenance Visit Procedure

1. Inspection of Filterra® and surrounding area

- Record individual unit **before** maintenance with photograph (numbered). Record on Maintenance Report (see example in this document) the following:

Record on Maintenance Report the following:

Standing Water	yes | no
Damage to Box Structure Damage	yes | no
to Grate	yes | no
Is Bypass Clear	yes | no

If yes answered to any of these observations, record with close-up photograph (numbered).

2. Removal of tree grate and erosion control stones

- Remove metal grates for access into Filterra® box.
- Dig out silt (if any) and mulch and remove trash & foreign items.

Record on Maintenance Report the following:

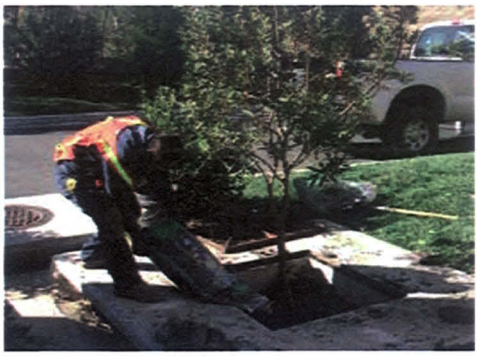
Silt/Clay	yes | no
Cups/ Bags	yes | no
Leaves	yes | no
# of Buckets Removed	

3. Removal of debris, trash and mulch

- After removal of mulch and debris, measure distance from the top of the Filterra® engineered media soil to the bottom of the top slab. If this distance is greater than 12", add Filterra® media (not top soil or other) to recharge to a 9" distance.

Record on Maintenance Report the following:

Distance to Bottom of Top Slab (inches)
# of Buckets of Media Added



4. Mulch replacement

- Please see mulch specifications.
- Add double shredded mulch evenly across the entire unit to a depth of 3".
- Ensure correct repositioning of erosion control stones by the Filterra® inlet to allow for entry of trash during a storm event.
- Replace Filterra® grates correctly using appropriate lifting or moving tools, taking care not to damage the plant.

5. Plant health evaluation and pruning or replacement as necessary

- Examine the plant's health and replace if dead.
- Prune as necessary to encourage growth in the correct directions

Record on Maintenance Report the following:

Height above Grate	(feet)
Width at Widest Point	(feet)
Health	alive | dead
Damage to Plant	yes | no
Plant Replaced	yes | no

6. Clean area around Filterra®

- Clean area around unit and remove all refuse to be disposed of appropriately.

7. Complete paperwork

- Deliver Maintenance Report and photographs to appropriate location (normally Americast during maintenance contract period).
- Some jurisdictions may require submission of maintenance reports in accordance with approvals. It is the responsibility of the Owner to comply with local regulations.

Maintenance Checklist

Drainage System Failure	Problem	Conditions to Check For	Conditions That Should Exist	Actions
Inlet	Excessive sediment or trash accumulation	Accumulated sediments or trash impair free flow of water into Filterra	Inlet should be free of obstructions allowing free distributed flow of water into Filterra.	Sediments and/or trash should be removed.
Mulch Cover	Trash and floatable debris accumulation	Excessive trash and/or debris accumulation.	Minimal trash or other debris on mulch cover.	Trash and debris should be removed and mulch cover raked level. Ensure bark nugget mulch is not used.
Mulch Cover	"Ponding" of water on mulch cover.	"Ponding" in unit could be indicative of clogging due to excessive fine sediment accumulation or spill of petroleum oils.	Stormwater should drain freely and evenly through mulch cover.	Recommend contact manufacturer and replace mulch as a minimum.
Vegetation	Plants not growing or in poor condition.	Soil/mulch too wet, evidence of spill. Incorrect plant selection. Pest infestation. Vandalism to plants.	Plants should be healthy and pest free.	Contact manufacturer for advice.
Vegetation	Plant growth excessive	Plants should be appropriate to the species and location of Filterra.		Trim/prune plants in accordance with typical landscaping and safety needs.
Structure	Structure has visible cracks	Cracks wider than ½ inch or evidence of soil particles entering the structure through the cracks.		Vault should be repaired.

Maintenance is ideally to be performed twice annually.
Inspection to be performed after every major storm event >1 inch total depth, subject to climate.

Filterra® Project Maintenance Order

Project	
Address	
Directions	
Project Owner	
Filterra Units on this Order	
Total Units on this Project	
Date of Maintenance	
Arrival Time	
Departure Time	
# of Workers	
Notes on Project	
Maintenance Supervisor	

Note : All maintenance debris, trash and mulch must go to landfill.

03/22/11

Filterra® Structure Maintenance Report

Project		**Structure Number**	
Plant Type		**Structure Size**	
Date		**GPS**	
		Pre Mtce Photo #	

Initial Observations

Standing Water	Y N	Damage to Grate	Y N
IF Yes, STOP NOW & call 888-950-8826		Is Bypass Clear	Y N
		Notes	
Damage to Box Structure	Y N		
If YES to any observation take close up photo			

Waste

Silt / Clay	Y N	Buckets Removed (# of)	
Cups/Bags	Y N	Notes	
Leaves	Y N		
Other			

Media

Distance to Bottom of Top Slab (in.)		Notes	
Buckets of Media Added (# of)			

Mulch

Netting Replaced	Y N	Bags of Mulch Added (# of)	
Stones Replaced	Y N	Notes	

Plant

	#1	(#2)		#1	(#2)
Height above Grate (ft., in.)			Plant Replaced	Y / N	Y / N
Stem diameter/Caliper (in.)					
Width at Widest Point (ft., in.)			Notes		
Health	Alive/Dead	Alive/Dead			
Damage to Plant	Y / N	Y / N			
If YES to plant damage take close up photo					

Other Notes
(use back if necessary)

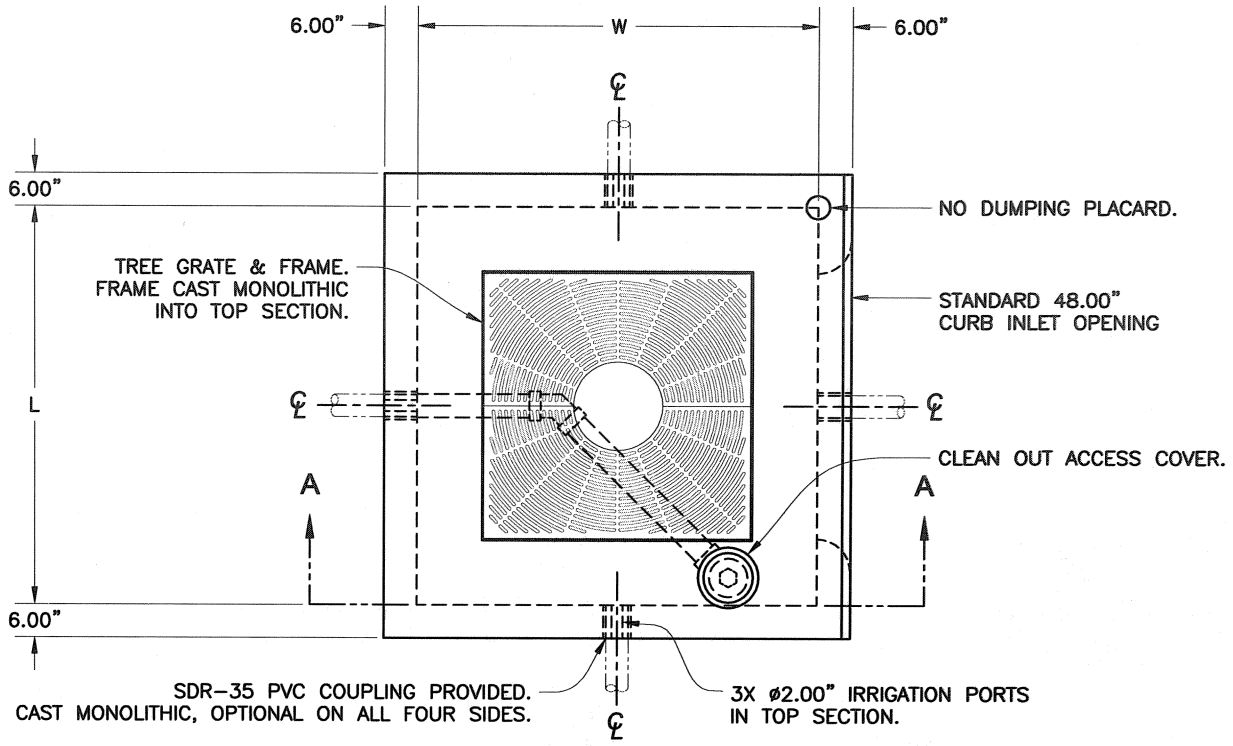
Filterra® Warranty

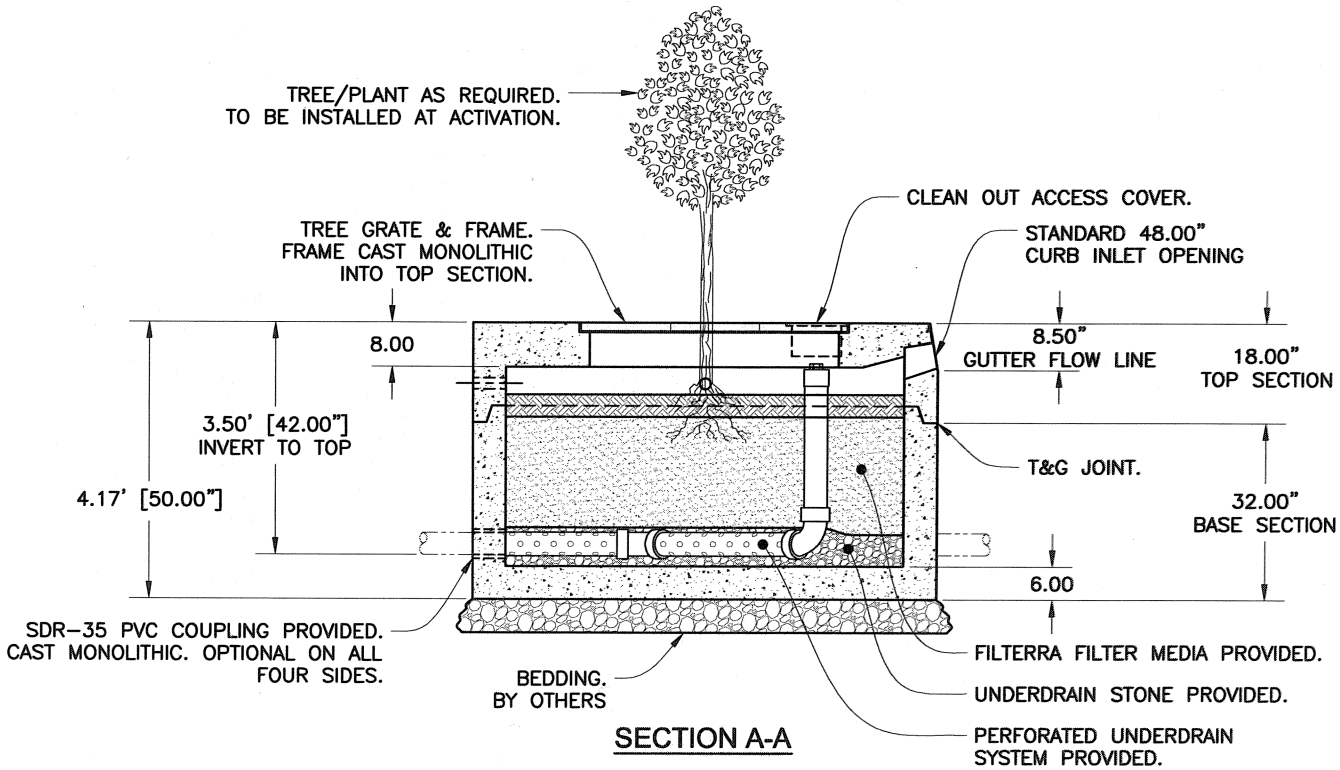
Seller warrants goods sold hereunder against defects in materials and workmanship only, for a period of (1) year from date the Seller activates the system into service. Seller makes no other warranties, expressed or implied.

Seller's liability hereunder shall be conditioned upon the Buyer's installation, maintenance, and service of the goods in strict compliance with the written instructions and specifications provided by the Seller. Any deviation from Seller's instructions and specifications or any abuse or neglect shall void all warranties.

In the event of any claim upon Seller's warranty, the burden shall be upon the buyer to prove strict compliance with all instructions and specifications provided by the Seller.

Seller's liability hereunder shall be limited only to the cost or replacement of the goods. Buyer agrees that Seller shall not be liable for any consequential losses arising from the purchase, installation, and/or use of the goods.





SECTION A-A

TABULATION				
Size / Designation	L (Feet)	W (Feet)	Tree Grate Quantity / Size	Outlet Pipe PVC SDR-35
4' x 4'	4.00'	4.00'	1Ea. / 3' x 3'	Ø4.00"
6' x 6'	6.00'	6.00'	1Ea. / 3' x 3'	Ø4.00"

Precast Filterra® Unit

Standard Configuration (Square)

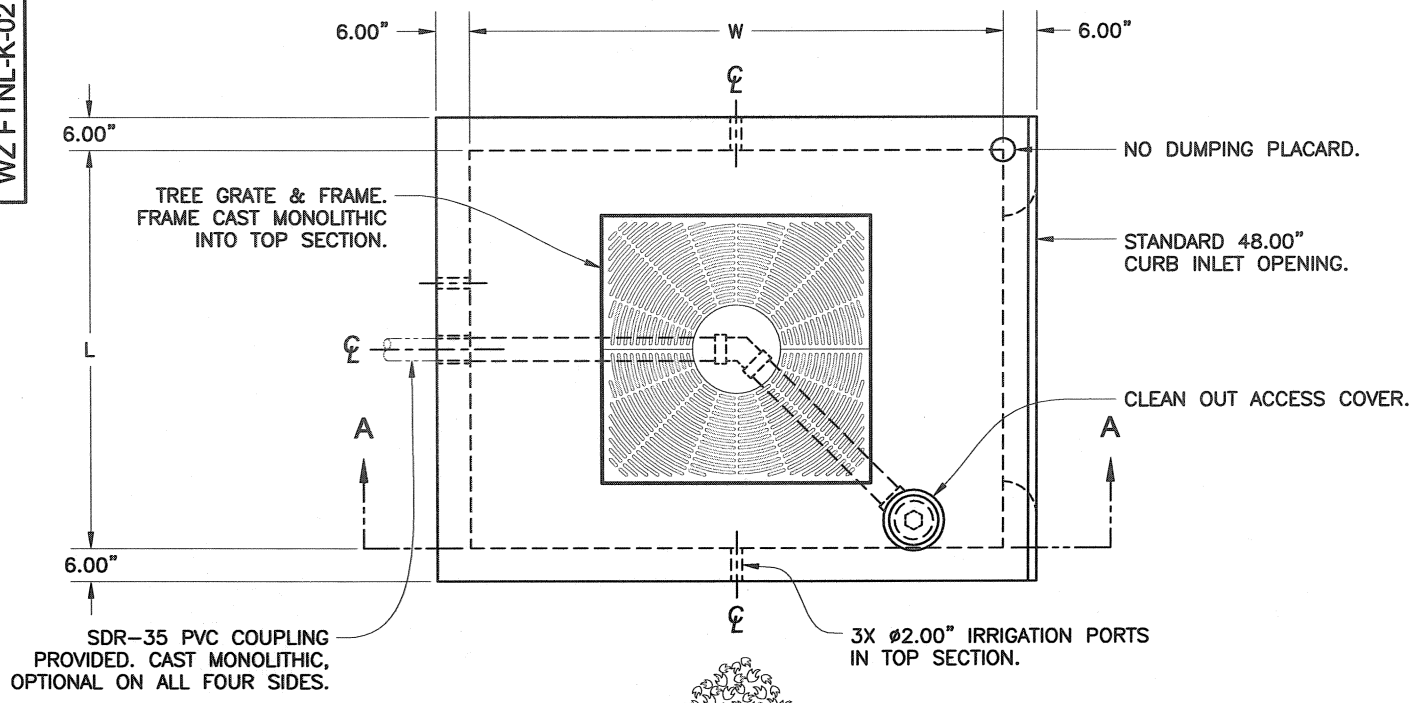
Western Zone

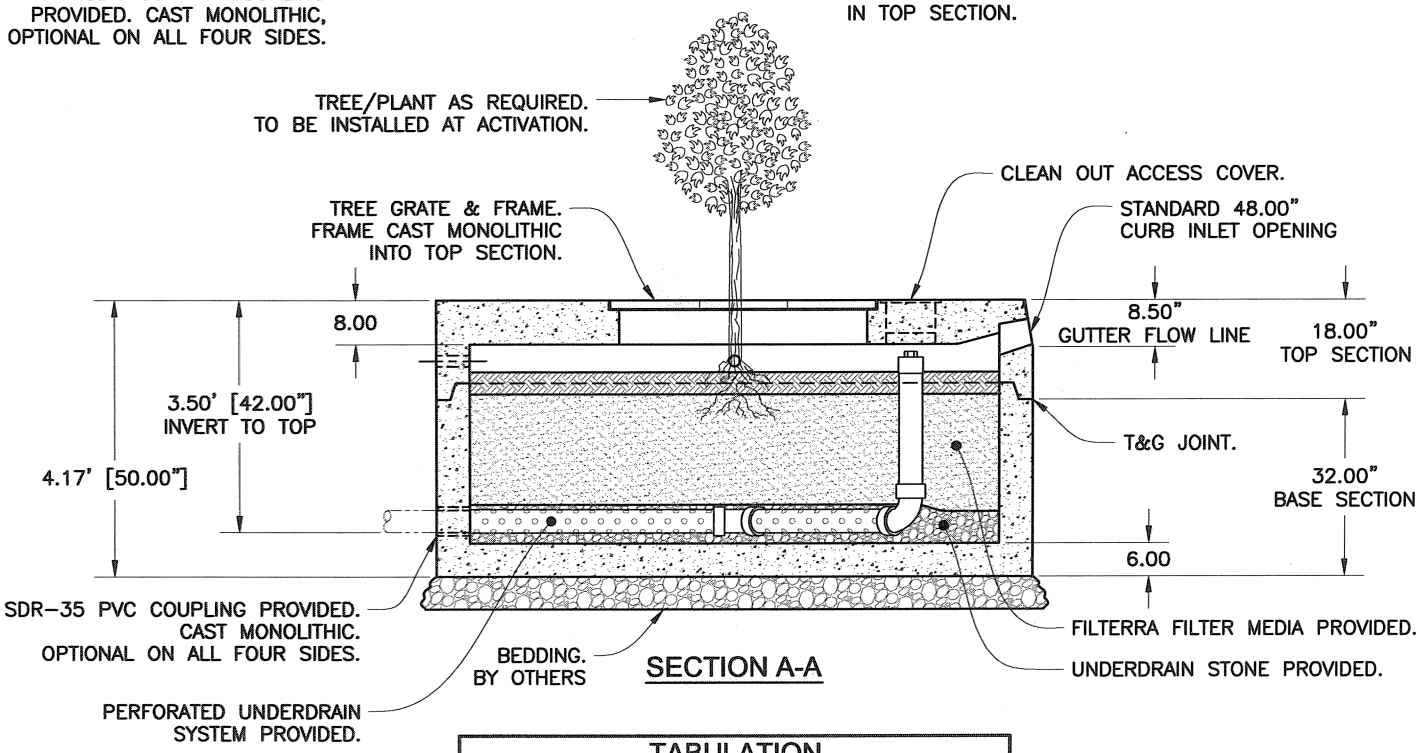
KriStar Enterprises, Inc.
360 Sutton Place, Santa Rosa, CA 95407
Ph: 800.579.8819, Fax: 707.524.8186, www.kristar.com

filterra®
US PAT 6,277,274
AND 6,569,321

DRAWING NO.	REV	F-ECO	DATE
WZ FTST-K-01	02	0004 JPR 3/28/11	JPR 1/7/11

WZ FTNL-K-02





TABULATION

Size / Designation	L (Feet)	W (Feet)	Tree Grate Quantity / Size	Outlet Pipe PVC SDR-35
4' X 6'	4.00'	6.00'	1ea. / 3' x 3'	Ø4.00"
4' x 6.5'	4.00'	6.50'	1ea. / 3' x 3'	Ø4.00"
4' x 8'	4.00'	8.00'	1ea. / 3' x 3'	Ø4.00"
4' x 16'	4.00'	16.00'	2ea. / 3' x 3'	Ø4.00"
6' x 8'	6.00'	8.00'	1ea. / 4' x 4'	Ø4.00"
6' x 10'	6.00'	10.00'	1ea. / 4' x 4'	Ø6.00"
6' x 12'	6.00'	12.00'	2ea. / 4' x 4'	Ø6.00"
8' x 16'	8.00'	16.00'	2ea. / 4' x 4'	Ø6.00"
8' x 18'	8.00'	18.00'	3ea. / 4' x 4'	Ø6.00"
8' x 20'	8.00'	20.00'	3ea. / 4' x 4'	Ø6.00"

TITLE

Precast Filterra® Unit

Narrow Length Configuration

Western Zone

KriStar Enterprises, Inc.
360 Sutton Place, Santa Rosa, CA 95407
Ph: 800.579.8819, Fax: 707.524.8186, www.kristar.com

filterra®
US PAT 6,277,274
AND 6,569,321

DRAWING NO.	REV	F–ECO	DATE
WZ FTNL-K-02	02	0004 JPR 3/28/11	JPR 1/7/11

Appendix E

APPENDIX E
CONDITIONS OF APPROVAL

Placeholder – pending issuance by the City of Lake Forest

Appendix F

APPENDIX F

INFILTRATION TEST RESULTS

LGC Geotechnical, Inc.

PROJECT MEMORANDUM

REGISTERED PROFESSIONAL ENGINEER
DENNIS BORATYNEC
No. 2770
Exp. 12/31/12
GEOTECHNICAL
STATE OF CALIFORNIA

To: Brookfield Homes
3090 Bristol Street, Ste. 200
Costa Mesa, CA 92626

Date: April 5, 2012
Project No.: 11142-01

Attention: Mr. Craig Cristina

From: Dennis Boratynec DJB

Subject: Infiltration Design Rate, Tentative Tract 17446, "Town Centre", Lake Forest, California

---

LGC Geotechnical, Inc. has prepared this memorandum to summarize our data collected during field infiltration testing and to provide a design infiltration rate based on the procedures outlined in Appendix VII of the Orange County Technical Guidance Document. Based on using this methodology, we recommend an average design infiltration rate of 0.014 inches per hour, based on a factor of safety of 3.

Should you have any questions regarding this memorandum, please do not hesitate to contact our office.

Attachments: Boring Logs H-2, H-3 and H-3
Field Infiltration Rates for H-2, H-3 and H-4

cc: Winnie Tham, Fuscoe Engineering

Geotechnical Boring Log Borehole HS-2

Date: 9/22/2011 | **Drilling Company:** Martini Drilling

Project Name: Brookfield - Lake Forest | **Type of Rig:** HSA

Project Number: 11142-01 | **Drop:** 30" | **Hole Diameter:** 8"

Elevation of Top of Hole: ~791' MSL | **Drive Weight:** 140 pounds

Hole Location: See Geotechnical Map

Logged By KTM
Sampled By KTM
Checked By BJE

Elevation (ft)	Depth (ft)	Graphic Log	Sample Number	Blow Count	Dry Density (pcf)	Moisture (%)	USCS Symbol	DESCRIPTION	Type of Test
755	0	B-1						3" Asphalt over 4" base **Tertiary Capistrano Formation, Oso Member (Tso)**	
750	5		R-1	6 15 20	121.3	7.9	[SM]	Silty SANDSTONE with trace Clay: mottled light gray and brown, moist, dense, very fine to coarse subangular grains	
745	10		R-2	30 50/3"	122.7	7.7	[SM]	Silty SANDSTONE with trace Clay: light gray, moist, very dense, fine to coarse subangular grains, well indurated, lacks cementation	#200
740	15		R-3	19 50/4"	111.3	7.8	[SM]	same as above	S&H, Perm
735	20							Total Depth = 16' Groundwater Not Encountered Backfilled with 2" Diameter Slotted PVC Pipe and Pea Gravel on 9/22/2011; Pipe Pulled and Cuttings Placed in Void on 9/23/11	
730	25								
	30								

LGC Geotechnical, Inc.

THIS SUMMARY APPLIES ONLY AT THE LOCATION OF THIS BORING AND AT THE TIME OF DRILLING. SUBSURFACE CONDITIONS MAY DIFFER AT OTHER LOCATIONS AND MAY CHANGE AT THIS LOCATION WITH THE PASSAGE OF TIME. THE DATA PRESENTED IS A SIMPLIFICATION OF THE ACTUAL CONDITIONS ENCOUNTERED. THE DESCRIPTIONS PROVIDED ARE QUALITATIVE FIELD DESCRIPTIONS AND ARE NOT BASED ON QUANTITATIVE ENGINEERING ANALYSIS.

SAMPLE TYPES:

B	BULK SAMPLE
R	RING SAMPLE (CA Modified Sampler)
G	GRAB SAMPLE
SPT	STANDARD PENETRATION TEST SAMPLE
▽	GROUNDWATER TABLE

TEST TYPES:

DS	DIRECT SHEAR
MD	MAXIMUM DENSITY
SA	SIEVE ANALYSIS
S&H	SIEVE AND HYDROMETER
EI	EXPANSION INDEX
CN	CONSOLIDATION
CR	CORROSION
AL	ATTERBERG LIMITS
CO	COLLAPSE/SWELL
RV	R-VALUE
#200	% PASSING # 200 SIEVE

Last Edited: 10/6/2011

Geotechnical Boring Log Borehole HS-3

Date: 9/22/2011 | **Drilling Company:** Martini Drilling

Project Name: Brookfield - Lake Forest | **Type of Rig:** HSA

Project Number: 11142-01 | **Drop:** 30" | **Hole Diameter:** 8"

Elevation of Top of Hole: ~787' MSL | **Drive Weight:** 140 pounds

Hole Location: See Geotechnical Map

Logged By KTM
Sampled By KTM
Checked By BJE

Elevation (ft)	Depth (ft)	Graphic Log	Sample Number	Blow Count	Dry Density (pcf)	Moisture (%)	USCS Symbol	DESCRIPTION	Type of Test
755	0							Grass covered topsoil; dark brown, dry, dense **Older Artificial Fill (Afo)**	
								Tertary Capistrano Formation, Oso Member (Tso)	
	5		R-1	10 22 26	124.2	7.6	[SM]	Silty SANDSTONE: light gray and brown, moist, dense, very fine to coarse subangular grains, well indurated, lacks cementation	
750									
	10		R-2	12 21 34	123.3	8.4	[SM]	same as above	
745									
	15		R-3	12 18 31	125.3	7.5	[SM]	same as above	S&H, Perm
740									
								Total Depth = 16' Groundwater Not Encountered Backfilled with 2" Diameter Slotted PVC Pipe and Pea Gravel on 9/22/2011; Pipe Pulled and Cuttings Placed in Void on 9/23/11	
	20								
735									
	25								
730									
	30								

LGC Geotechnical, Inc.

THIS SUMMARY APPLIES ONLY AT THE LOCATION OF THIS BORING AND AT THE TIME OF DRILLING. SUBSURFACE CONDITIONS MAY DIFFER AT OTHER LOCATIONS AND MAY CHANGE AT THIS LOCATION WITH THE PASSAGE OF TIME. THE DATA PRESENTED IS A SIMPLIFICATION OF THE ACTUAL CONDITIONS ENCOUNTERED. THE DESCRIPTIONS PROVIDED ARE QUALITATIVE FIELD DESCRIPTIONS AND ARE NOT BASED ON QUANTITATIVE ENGINEERING ANALYSIS.

SAMPLE TYPES:

B	BULK SAMPLE
R	RING SAMPLE (CA Modified Sampler)
G	GRAB SAMPLE
SPT	STANDARD PENETRATION TEST SAMPLE
▽	GROUNDWATER TABLE

TEST TYPES:

DS	DIRECT SHEAR
MD	MAXIMUM DENSITY
SA	SIEVE ANALYSIS
S&H	SIEVE AND HYDROMETER
EI	EXPANSION INDEX
CN	CONSOLIDATION
CR	CORROSION
AL	ATTERBERG LIMITS
CO	COLLAPSE/SWELL
RV	R-VALUE
-#200	% PASSING # 200 SIEVE

Last Edited: 10/6/2011

Geotechnical Boring Log Borehole HS-4

Date: 9/22/2011 | **Drilling Company:** Martini Drilling

Project Name: Brookfield - Lake Forest | **Type of Rig:** HSA

Project Number: 11142-01 | **Drop:** 30" | **Hole Diameter:** 8"

Elevation of Top of Hole: ~786' MSL | **Drive Weight:** 140 pounds

Hole Location: See Geotechnical Map

Logged By KTM
Sampled By KTM
Checked By BJE

Elevation (ft)	Depth (ft)	Graphic Log	Sample Number	Blow Count	Dry Density (pcf)	Moisture (%)	USCS Symbol	DESCRIPTION	Type of Test
755	0							Grass covered topsoil; dark brown, dry, dense **Older Artificial Fill (Afo)**	
	5	B-1	R-1	10 15 16	119.2	9.8	SC-CL	Clayey SAND - Sandy CLAY: brown, moist, dense, sand is very fine to medium with few coarse grains	EI CR
750									
	10		R-2	7 12 18	119.2	12.1	SC	Clayey SAND: brown, moist, dense, sand is very fine to medium with few coarse grains	
745									
	15		R-3	8 14 28	120.5	12.1	SC	Clayey SAND: brown, moist, dense, sand is fine to coarse	#200
740									
	20							Total Depth = 16' Groundwater Not Encountered Backfilled with 2" Diameter Slotted PVC Pipe and Pea Gravel on 9/22/2011; Pipe Pulled and Cuttings Placed in Void on 9/23/11	
735									
	25								
730									
	30								

LGC Geotechnical, Inc.

THIS SUMMARY APPLIES ONLY AT THE LOCATION OF THIS BORING AND AT THE TIME OF DRILLING. SUBSURFACE CONDITIONS MAY DIFFER AT OTHER LOCATIONS AND MAY CHANGE AT THIS LOCATION WITH THE PASSAGE OF TIME. THE DATA PRESENTED IS A SIMPLIFICATION OF THE ACTUAL CONDITIONS ENCOUNTERED. THE DESCRIPTIONS PROVIDED ARE QUALITATIVE FIELD DESCRIPTIONS AND ARE NOT BASED ON QUANTITATIVE ENGINEERING ANALYSIS.

SAMPLE TYPES:

B	BULK SAMPLE
R	RING SAMPLE (CA Modified Sampler)
G	GRAB SAMPLE
SPT	STANDARD PENETRATION TEST SAMPLE
▽	GROUNDWATER TABLE

TEST TYPES:

DS	DIRECT SHEAR
MD	MAXIMUM DENSITY
SA	SIEVE ANALYSIS
S&H	SIEVE AND HYDROMETER
EI	EXPANSION INDEX
CN	CONSOLIDATION
CR	CORROSION
AL	ATTERBERG LIMITS
CO	COLLAPSE/SWELL
RV	R-VALUE
-#200	% PASSING # 200 SIEVE

Last Edited: 10/6/2011

Infiltration Test Data Sheet

LGC Geotechnical, Inc
120 Calle Iglesia Suite A, San Clemente, CA 92672 tel. (949) 369-6141

Project Name: Brookfield Lake Forest
Project Number: 11142-01
Date:
Boring Number: LGC -2
USCS Soil Classification:

Test hole dimensions (if circular)	
Boring Depth (feet)*:	16
Boring Diameter (inches):	8
Pipe Diameter (inches):	4

*measured at time of test

Test pit dimensions (if rectangular)	
Pit Depth (feet):	
Pit Length (feet):	
Pit Breadth (feet):	

*Pre-Test (Sandy Soil Criteria)**

Trial No.	Start Time (24:HR)	Stop Time (24:HR)	Time Interval (min)	Initial Depth to Water (feet)	Final Depth to Water (feet)	Total Change in Water Level (feet)	Greater Than or Equal to 0.5 feet (yes/no)
1							
2							

*If two consecutive measurements show that six inches of water seeps away in less than 25 minutes, the test shall be run for an additional hour with measurements taken every 10 minutes. Otherwise, pre-soak (fill) overnight, and then obtain at least twelve measurements per hole over at least six hours (approximately 30 minute intervals) with a precision of at least 0.25 inches

Main Test Data

Trial No.	Start Time (24:HR)	Stop Time (24:HR)	Time Interval, Δt (min)	Initial Depth to Water, D_o (feet)	Final Depth to Water, D_f (feet)	Change in Water Level, ΔD (feet)	Raw Infiltration Rate (in/hr)	Design Infiltration Rate (in/hr)
1			30.0	9.95	10.09	0.14	0.091	0.030
2			30.0	10.09	10.16	0.07	0.046	0.015
3			30.0	10.16	10.26	0.1	0.067	0.022
4			30.0	10.26	10.35	0.09	0.061	0.020
5			30.0	10.35	10.45	0.1	0.069	0.023
6			30.0	10.45	10.49	0.04	0.028	0.009
7			30.0	10.49	10.61	0.12	0.085	0.028
8			30.0	10.61	10.69	0.08	0.058	0.019
9			30.0	10.69	10.76	0.07	0.051	0.017
10			30.0	10.76	10.85	0.09	0.067	0.022
11			30.0	10.85	10.92	0.07	0.053	0.018
12								
						Recommended Design Infiltration Rate (Including Factor of Safety of 3)		**0.019**

Sketch:

Notes:

LGC Geotechnical, Inc.

Infiltration Test Data Sheet

LGC Geotechnical, Inc
120 Calle Iglesia Suite A, San Clemente, CA 92672 tel. (949) 369-6141

Project Name: Brookfield Lake Forest
Project Number: 11142-01
Date:
Boring Number: LGC -3
USCS Soil Classification:

Test hole dimensions (if circular)	
Boring Depth (feet)*:	16
Boring Diameter (inches):	8
Pipe Diameter (inches):	4

*measured at time of test

Test pit dimensions (if rectangular)	
Pit Depth (feet):	
Pit Length (feet):	
Pit Breadth (feet):	

*Pre-Test (Sandy Soil Criteria)**

Trial No.	Start Time (24:HR)	Stop Time (24:HR)	Time Interval (min)	Initial Depth to Water (feet)	Final Depth to Water (feet)	Total Change in Water Level (feet)	Greater Than or Equal to 0.5 feet (yes/no)
1							
2							

*If two consecutive measurements show that six inches of water seeps away in less than 25 minutes, the test shall be run for an additional hour with measurements taken every 10 minutes. Otherwise, pre-soak (fill) overnight, and then obtain at least twelve measurements per hole over at least six hours (approximately 30 minute intervals) with a precision of at least 0.25 inches

Main Test Data

Trial No.	Start Time (24:HR)	Stop Time (24:HR)	Time Interval, Δt (min)	Initial Depth to Water, D_o (feet)	Final Depth to Water, D_f (feet)	Change in Water Level, ΔD (feet)	Raw Infiltration Rate (in/hr)	Design Infiltration Rate (in/hr)
1			30.0	10.4	10.58	0.18	0.127	0.042
2			30.0	10.58	10.68	0.1	0.072	0.024
3			30.0	10.05	10.11	0.06	0.039	0.013
4			30.0	10.17	10.24	0.07	0.047	0.016
5			30.0	10.24	10.32	0.08	0.054	0.018
6			30.0	10.32	10.41	0.09	0.062	0.021
7			30.0	10.41	10.45	0.04	0.028	0.009
8			30.0	10.45	10.51	0.06	0.042	0.014
9			30.0	10.51	10.58	0.07	0.050	0.017
10			30.0	10.58	10.65	0.07	0.050	0.017
11			30.0	10.65	10.74	0.09	0.066	0.022
12			30.0	10.74	10.8	0.06	0.044	0.015
						Recommended Design Infiltration Rate (Including Factor of Safety of 3)		**0.018**

Sketch:

Notes:

LGC Geotechnical, Inc.

Infiltration Test Data Sheet

LGC Geotechnical, Inc
120 Calle Iglesia Suite A, San Clemente, CA 92672 tel. (949) 369-6141

Project Name: Brookfield Lake Forest
Project Number: 11142-01
Date:
Boring Number: LGC -4
USCS Soil Classification:

Test hole dimensions (if circular)	
Boring Depth (feet)*:	15
Boring Diameter (inches):	8
Pipe Diameter (inches):	4

*measured at time of test

Test pit dimensions (if rectangular)	
Pit Depth (feet):	
Pit Length (feet):	
Pit Breadth (feet):	

*Pre-Test (Sandy Soil Criteria)**

Trial No.	Start Time (24:HR)	Stop Time (24:HR)	Time Interval (min)	Initial Depth to Water (feet)	Final Depth to Water (feet)	Total Change in Water Level (feet)	Greater Than or Equal to 0.5 feet (yes/no)
1							
2							

*If two consecutive measurements show that six inches of water seeps away in less than 25 minutes, the test shall be run for an additional hour with measurements taken every 10 minutes. Otherwise, pre-soak (fill) overnight, and then obtain at least twelve measurements per hole over at least six hours (approximately 30 minute intervals) with a precision of at least 0.25 inches

Main Test Data

Trial No.	Start Time (24:HR)	Stop Time (24:HR)	Time Interval, Δt (min)	Initial Depth to Water, D_o (feet)	Final Depth to Water, D_f (feet)	Change in Water Level, ΔD (feet)	Raw Infiltration Rate (in/hr)	Design Infiltration Rate (in/hr)
1			30.0	3.6	3.62	0.02	0.007	0.002
2			30.0	3.62	3.67	0.05	0.017	0.006
3			30.0	3.67	3.71	0.04	0.014	0.005
4			30.0	3.71	3.75	0.04	0.014	0.005
5			30.0	3.75	3.81	0.06	0.021	0.007
6			30.0	3.81	3.84	0.03	0.011	0.004
7			30.0	3.84	3.88	0.04	0.014	0.005
8			30.0	3.88	3.92	0.04	0.014	0.005
9			30.0	3.92	3.96	0.04	0.014	0.005
10			30.0	3.96	4	0.04	0.014	0.005
11			30.0	4	4.05	0.05	0.018	0.006
12			30.0	4.05	4.1	0.05	0.018	0.006
						Recommended Design Infiltration Rate (Including Factor of Safety of 3)		**0.006**

Sketch:

Notes:

LGC Geotechnical, Inc.

LGC Geotechnical, Inc.

November 18, 2011 Project No. 11142-01

Mr. Craig Cristina
Brookfield Homes
3090 Bristol St., Ste. 200
Costa Mesa, CA 92626

Subject: ***Geotechnical Evaluation of the Proposed Residential Development of The Village at Foothill Ranch, City of Lake Forest, California***

In accordance with your request, LGC Geotechnical, Inc. has performed a geotechnical evaluation for the proposed residential development of The Village at Foothill Ranch, City of Lake Forest, California. The purpose of our work was to evaluate the existing subsurface geotechnical conditions and review the readily available geotechnical and geologic reports and maps pertinent to the site. This report presents the results of our subsurface exploration and geotechnical analysis and provides a summary of our conclusions and preliminary recommendations relative to the proposed development of the site.

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

Respectfully,

LGC Geotechnical, Inc.

Katie Maes, CEG 2216
Project Geologist

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STATE OF CALIFORNIA

BJE/KTM/DJB/abs

Distribution: (4) Addressee (3 wet-signed copies)

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Appendix B – Boring Logs
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1.0 INTRODUCTION

1.1 Purpose and Scope of Services

This report presents the results of our geotechnical evaluation for the proposed residential development of The Village at Foothill Ranch in the City of Lake Forest, California (see Figure 1 - Site Location Map). The purpose of our work was to evaluate the geotechnical conditions at the site and to provide preliminary geotechnical recommendations relative to the proposed development of the site.

Our scope of services included:

- Review of pertinent readily available geotechnical reports and geologic maps (Appendix A);
- Subsurface evaluation consisting of four hollow stem-auger borings (HS-1 through HS-4) to depths of up to approximately 50.5 feet below existing grade. A representative of LGC Geotechnical was onsite to coordinate the subsurface work, collect samples, and log the borings (Appendix B). The borings were backfilled with the excavated materials;
- Perform three in-situ field infiltration test to assess the onsite infiltration characteristics;
- Laboratory testing on relatively undisturbed and bulk samples obtained during our subsurface evaluation (Appendix C);
- Geotechnical analysis of the data reviewed/obtained; and
- Preparation of this report presenting our findings, conclusions, and preliminary recommendations with respect to the proposed site development.

1.2 Existing Site Conditions and Proposed Project

The site consists of an irregular piece of land located south of the intersection of Bake Parkway and Portola Parkway in the City of Lake Forest. The northern portion of the site is currently developed with a former car dealership while the southern portion is currently vacant land with minor vegetation and a few isolated piles of soil. Existing topography at the site is generally sheet graded to drain to the southwest corner of the area. A small descending slope with a toe-of-slope retaining wall adjacent to an existing commercial site defines the southern boundary of the site, and another descending, slightly variable slope to the adjacent Bake Parkway defines the western boundary of the site. At the northern boundary of the site, an east-west trending berm currently exists, with a gentle gradient down to Portola Parkway at the north side and a steeper gradient down to the south side that has a small retaining wall at the toe.

Existing improvements at the site will be demolished, removed, and replaced with slab-on-grade multi-family residential buildings and associated interior streets and utilities as depicted on the base map dated October 18, 2011, utilized for the Geotechnical Map, Figure 2 (Rear of Text). Additionally, along the northern and western boundaries of the site, retaining walls are proposed.

1.3 *Subsurface Evaluation*

Our subsurface evaluation consisted of the excavation of four small-diameter hollow stem auger borings. One boring (HS-1) was advanced to a depth of approximately 50.5 feet below existing ground surface, and the remaining borings (HS-2 through HS-4) were drilled to depths of approximately 16.5 feet below existing ground surface. During drilling, the borings were sampled and logged from the surface by field personnel from our firm to evaluate the geotechnical characteristics of the subsurface materials. The hollow stem borings were geotechnically logged and sampled using California Ring Samplers (Ring) at selected intervals. The Ring samplers were driven using a 140-pound hammer falling freely for 30 inches until a total penetration of 18 inches was achieved; the number of blow counts required for each 6 inches of sampler penetration was recorded. In addition, bulk samples were collected at various depths from selected borings.

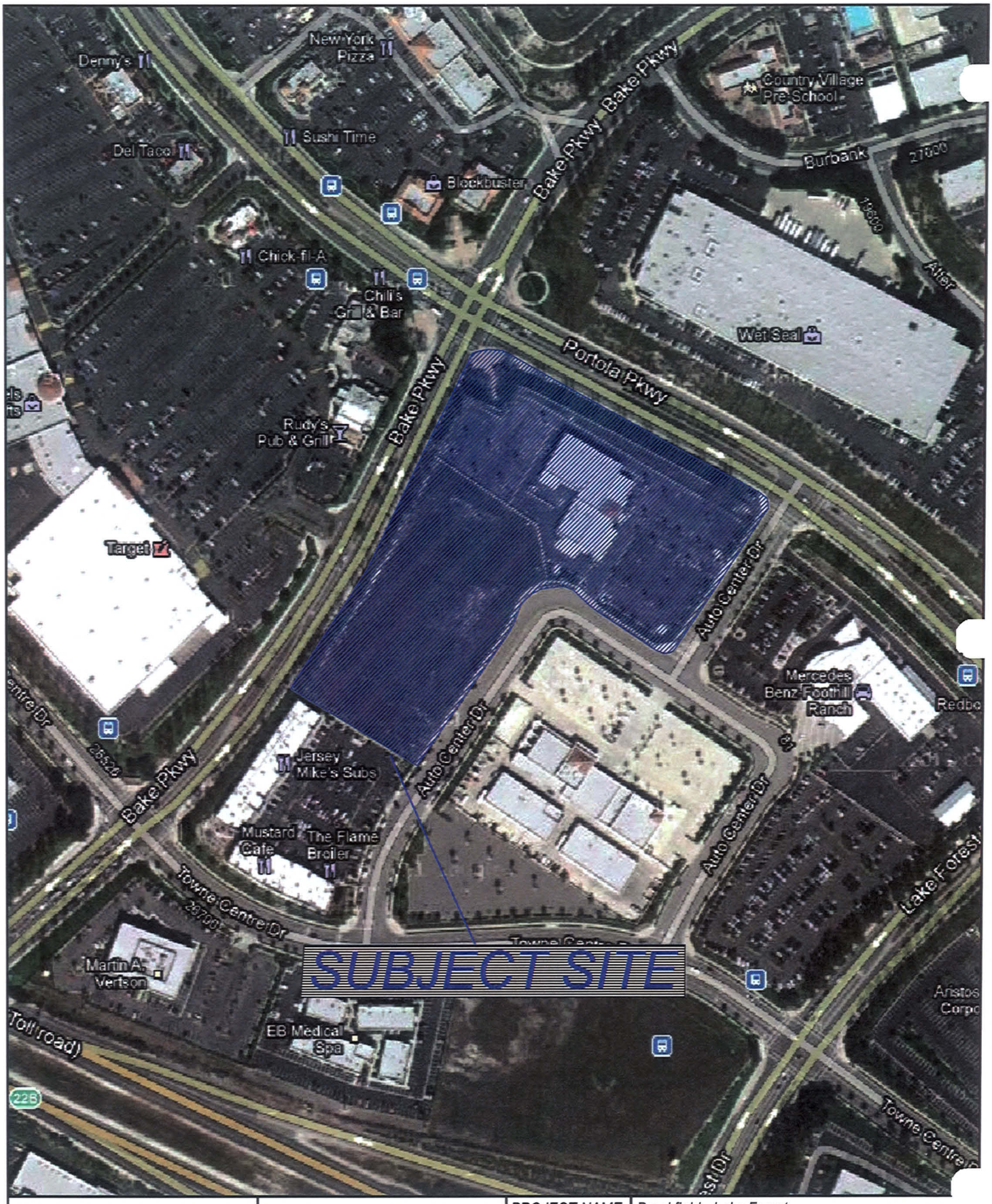
Three of the borings were utilized to assess infiltration characteristics of the onsite materials. Infiltration testing was performed in boreholes with the installation of perforated PVC pipe, backfilled with pea gravel. Upon completion of the tests, the PVC pipe was removed and the remaining voids were backfilled with cuttings.

Descriptions of the materials encountered during our subsurface exploration are further discussed in Section 2.2 of this report and are also presented in the boring logs in Appendix B. The approximate locations of the borings are indicated on our Geotechnical Map, Figure 2.

1.4 *Laboratory Testing*

Representative bulk and driven (relatively undisturbed) samples were obtained during our subsurface exploration for laboratory testing. Laboratory testing included in-situ moisture content and in-situ density, laboratory hydraulic conductivity, sieve and hydrometer, expansion potential, direct shear, and corrosion potential.

- In-situ dry density values ranged from approximately 96 pounds per cubic foot (pcf) to 127 pcf, with an average of approximately 118 pcf. Field moisture contents ranged from approximately 6 percent to 12 percent, with an average of approximately 9 percent.
- Hydraulic conductivity values were determined to range between 1.7×10^{-5} cm/sec and 3.6×10^{-7} cm/sec based on laboratory test results.
- Sieve and hydrometer testing indicated the fines content ranges between 17 to 26 percent.
- The results of an expansion potential test indicated an expansion index ranging from 8 to 24, which corresponds to the "Very Low" category (per Chapter 18 of the 2007 C.B.C.; ASTM D 4829 Section 5.3).
- Direct shear testing was performed on one sample. The results indicate peak friction angle of 39 degrees and cohesion of 1089 psf.
- Corrosion testing performed on a representative bulk sample from an approximate depth of 4 to 7 feet resulted in a pH of 7.3, chloride content of 31 ppm, a sulfate content of 55 ppm, and a minimum resistivity value of 1,350 ohm-cm.
- A summary of the results are presented in Appendix C. The moisture and density test results are presented on the boring logs in Appendix B.



PROJECT NAME	Brookfield - Lake Forest
PROJECT NO.	11142-01
ENG. / GEOL.	DJB / KTM
SCALE	Not to Scale
DATE	November 2011

LGC Geotechnical, Inc.

FIGURE 1
Site Location Map

2.0 GEOTECHNICAL CONDITIONS

2.1 Regional Geology

The site is located within the foothills of the Santa Ana Mountains, part of the Peninsular Ranges Geomorphic Province. The region consists of dissected foothills bordering the Los Angeles Basin to the northwest and the granite-core Santa Ana Mountains to the east. The Southern California Batholith forms the core of the Santa Ana Mountains, which is overlain by a thick sequence of sedimentary units, which comprise the foothills. The foothills have been tilted, folded, and faulted since deposition as a result of regional uplift. Drainage from the nearby mountains has dissected the subject area and alluvial deposits in a previously existing (prior to grading) southwest-trending finger canyon underlie the site at depth; ultimately those alluvial deposits are connected to alluvium of the Tustin Plain to the southwest of the site. Late Miocene to Early Pliocene bedrock materials that underlie a portion of the subject site are primarily composed of sandstone and silty sandstone.

2.2 Site-Specific Geology

Prior to grading of the subject site, a southwest-trending canyon with alluvial deposits existed at the western portion of the site, some of which remains in place. The flank of the canyon rising to the eastern portion of the site exposed the bedrock geologic unit mapped as the Oso Member of the Tertiary-aged Capistrano Formation. Grading activities for the nearby Bake Parkway resulted in placement of engineered fill at depth along the western portion of the site, followed by additional grading activities that resulted in engineered fill placement to the current grades at the western portion of the site. The eastern/northeastern portion of the site was left as cut bedrock at the surface, with the exception of the placement of engineered fill for overexcavation of a cut to fill transition in support of the existing car dealership structure at the northeast portion of the site (Coleman, 2005). The three phases of fill placement are undifferentiated on the Geotechnical Map (Figure 2, rear of text). Limited zones of undocumented stockpiled materials were observed in piles during the recent site work, reportedly from nearby building excavations.

Based on our review of the State of California Seismic Hazard Zones El Toro 7.5 Minute Quadrangle (CDMG, 2001), no zones of potential earthquake induced landslide or potential liquefaction are depicted within the limits of the site.

The following material types are anticipated to underlie the subject area. Approximate limits of the materials are depicted on the Geotechnical Map, Figure 2, and described in the boring logs, Appendix B, where observed during the recent subsurface evaluation.

2.2.1 Quaternary Alluvium/Colluvium (Map Symbol – Qac)

Alluvium was not encountered during our subsurface field work. However, descriptions by others indicate up to 7 feet of alluvium, consisting of clayey sand, moist, dense, was left in place below the engineered fill. The alluvium was tested for hydro collapse potential by others and was evaluated to posses approximately 0.5 inch of potential collapse if fully saturated (PSE, 2007).

2.2.2 *Artificial Fill - Older (Map Symbol – Afo)*

As described in Section 2.2, three phases of older engineered fill materials were identified on the site associated with the grading of Bake Parkway on the western side of the site, construction of the current graded superpad configuration, and construction of the car dealership structure at the northeast portion of the site (References). In general, the existing fill materials should be considered suitable to receive additional fill placement and/or for support of the proposed improvements, with the exception of the near surface materials which are anticipated to be desiccated and contain some organics.

2.2.3 *Capistrano Formation – Oso Member (Map Symbol - Tco)*

The Oso Member of the Tertiary Capistrano Formation is exposed within the western portion of the site and underlies the majority of the site at depth. As encountered, this material generally consists of medium to coarse, weakly cemented, dense to very dense silty sandstone. The material is generally light gray to off-white in color.

2.3 *Ground Water*

During our subsurface evaluation, ground water was not encountered. Seasonal fluctuations of ground water elevations should be expected over time. In general, ground water levels fluctuate with the seasons and local zones of perched ground water may be present within the near-surface deposits due to local seepage or during rainy seasons. Local perched ground water conditions or surface seepage may develop once site development is completed and landscape irrigation commences.

2.4 *Assessment of Infiltration Characteristics*

Field infiltration testing consisted of utilizing three hollow-stem auger borings (HS-2, HS-3 and HS-4) that were each drilled to the depth of approximately 16 feet below existing grade. Boring HS-2 was excavated into bedrock, Boring HS-3 was excavated into a thin layer of fill over bedrock, and Boring HS-4 was excavated into existing engineered fill materials that were previously placed by others. Three-inch-diameter perforated PVC pipe was placed in each hole and the annulus filled with pea gravel. Prior to conducting the infiltration tests, each location was presoaked overnight with water. Results of infiltration testing indicate the site to posses a relatively low infiltration rate as discussed in Section 4.6 of this report.

2.5 *Faulting*

California is located on the boundary between the Pacific and North American Lithospheric Plates. The average motion along this boundary is on the order of 50-mm/yr in a right-lateral sense. The majority of the motion is expressed at the surface along the northwest trending San Andreas Fault Zone with lesser amounts of motion accommodated by sub-parallel faults located predominantly west of the San Andreas including the Elsinore, Newport-Inglewood, Rose Canyon, and Coronado Bank Faults. Within Southern California, a large bend in the San Andreas Fault north of the San Gabriel Mountains has resulted in a transfer of a portion of the right-lateral motion between the plates into left-lateral displacement and vertical uplift. Compression south and west of the bend has resulted in folding, left-lateral reverse thrust faulting, and regional uplift creating the east-west trending Transverse Ranges and several east-west trending faults. Further south within the Los Angeles Basin, "blind thrust" faults are believed to have developed below the surface also as a result of this compression, which have resulted in earthquakes such as the 1994 Northridge event along faults with little to no surface expression.

Prompted by damaging earthquakes in Northern and Southern California, State legislation and policies concerning the classification and land-use criteria associated with faults have been developed. Their purpose was to prevent the construction of urban developments across the trace of active faults. The result is the Alquist-Priolo Earthquake Fault Zoning Act, which was most recently revised in 1997. According to the State Geologist, an active fault is defined as one, which has had surface displacement within the Holocene Epoch (roughly the last 11,000 years). A potentially active fault is defined as any fault, which has had surface displacement during Quaternary time (last 1,600,000 years), but not within the Holocene. Earthquake Fault Zones have been delineated along the traces of active faults within California. Where developments for human occupation are proposed within these zones, the state requires detailed fault evaluations be performed so that engineering geologists can mitigate the hazards associated with active faulting by identifying the location of active faults and allowing for a setback from the zone of previous ground rupture.

The subject site is not located within an Alquist-Priolo Earthquake Fault Zone and no faults were identified on the site during our site evaluation or previous site evaluations by others during grading. The possibility of damage due to ground rupture is considered low since no active faults are known to transect the site.

Secondary effects of seismic shaking resulting from large earthquakes on the major faults in the Southern California region, which may affect the site, include ground lurching and shallow ground rupture, soil liquefaction, and dynamic settlement. These secondary effects of seismic shaking are a possibility throughout the Southern California region and are dependant on the distance between the site and causative fault and the onsite geology. Seiches and tsunamis are potential hazards for sites near bodies of water and the ocean, respectively. The closest major active faults that could produce these secondary effects include the Elsinore, Whittier, Chino-Central and Newport Inglewood Fault Systems. A discussion of these secondary effects is provided in the following sections.

2.5.1 *Lurching and Shallow Ground Rupture*

Soil lurching refers to the rolling motion on the ground surface by the passage of seismic surface waves. Effects of this nature are not likely to be significant where the thickness of soft sediments does not vary appreciably under structures.

Ground rupture, due to active faulting, is not likely to occur on site due to the absence of known active fault traces. Minor cracking of near-surface soils, due to shaking from distant seismic events, is not considered a significant hazard, although it is a possibility at any site in the region.

2.5.2 Liquefaction and Dynamic Settlement

Liquefaction and liquefaction-induced dynamic settlement of soils can be caused by strong vibratory motion due to earthquakes. Liquefaction is typified by a build-up of pore-water pressure in the affected soil layer to a point where a total loss of shear strength occurs, causing the soil to behave as a liquid. Liquefaction primarily occurs in loose, saturated, granular soils while cohesive soils such as silty clays and clays are generally not considered susceptible to soil liquefaction. The effect of liquefaction may be manifested at the ground surface by rapid settlement and/or sand boils. Based on our review of the State of California Seismic Hazard Zones El Toro 7.5 Minute Quadrangle (CDMG, 2001), no zones having a potential for liquefaction have been depicted within the proposed site. Based on the proposed finish grades, depth of compacted fill, and lack of a shallow groundwater table, the potential for post construction liquefaction and liquefaction-induced settlement is considered very low.

2.5.3 Lateral Spreading

Lateral spreading is a type of liquefaction induced ground failure associated with the lateral displacement of surficial blocks of sediment resulting from liquefaction in a subsurface layer. Once liquefaction transforms the subsurface layer into a fluid mass, gravity plus the earthquake inertial forces may cause the mass to move downslope towards a free face (such as a river channel or an embankment). Lateral spreading may cause large horizontal displacements and such movement typically damages pipelines, utilities, bridges, and structures.

Due to the low potential for liquefaction, the potential for lateral spreading is also considered very low.

2.6 Seismic Design Parameters

The site seismic characteristics were evaluated per the guidelines set forth in Chapter 16, Section 1613 of the 2010 C.B.C. Site coordinates of latitude 33.6767 degrees north and longitude -117.6615 degrees west, which are representative of the site, were utilized in our analyses. The initial results of our analyses for the maximum considered earthquake spectral response accelerations (S_S and S_1) are presented in Table 1.

TABLE 1

Seismic Design Values

Selected Parameters from the 2010 C.B.C. Section 1613 - Earthquake Loads	Seismic Design Values
Site Class per Table 1613.5.2	D
Spectral Acceleration for Short Periods (S_S)*	1.397 g
Spectral Accelerations for 1-Second Periods (S_1)*	0.501 g
Site Coefficient F_a per Table 1613.5.3(1)	1.0
Site Coefficient F_v per Table 1613.5.3(2)	1.5

* Calculated from the USGS computer program "Seismic Hazard Curves, Response Parameters and Design Parameters" v5.1.0 (02/20/11)

The spectral response accelerations (S_{MS} and S_{M1}) and design spectral response acceleration parameters (S_{DS} and S_{D1}), adjusted for Site Class D, were evaluated for the site in general accordance with section 1613 of the 2010 C.B.C. These site class adjusted parameters are presented in Table 2.

TABLE 2

Seismic Design Values Modified for Site Class D

Selected Parameters from the 2010 C.B.C. Section 1613 - Earthquake Loads	Seismic Design Values Modified for Site Class D
Site Modified Spectral Acceleration for Short Periods (S_{MS}) for Site Class D [Note: $S_{MS} = F_aS_S$]	1.397 g
Site Modified Spectral Acceleration for 1-Second Periods (S_{M1}) for Site Class D [Note: $S_{M1} = F_vS_1$]	0.751 g
Design Spectral Acceleration for Short Periods (S_{DS}) for Site Class D [Note: $S_{DS} = (^2/_3)S_{MS}$]	0.931 g
Design Spectral Acceleration for 1-Second Periods (S_{D1}) for Site Class D [Note: $S_{D1} = (^2/_3)S_{M1}$]	0.501 g

In accordance with Tables 1613.5.6 (1 & 2), the seismic design category for the subject site is Category D, where $S_{DS} \geq 0.50$g and $S_{D1} \geq 0.20$g.

Section 1803.5.12 of the 2010 C.B.C. states that the PGA for a site may be defined as $S_{DS}/2.5$. The S_{DS} for the subject site has been calculated as 0.931 g. Therefore, PGA = 0.931 /2.5 = **0.37 g**

2.7 *Corrosivity to Concrete and Metal*

Based on our laboratory test results of representative site soil samples, onsite soils should be considered as having a severity categorization of "not applicable" and are designated class "S0" per ACI 318, Table 4.2.1, sulfate. As a result, the minimum compressive strength of the concrete shall be 2,500 psi.

Due to the low minimum resistivity, the onsite soils may be corrosive to buried metal. However, LGC Geotechnical is not a corrosion consultant and does not provide recommendations related to corrosion. Laboratory testing may need to be performed at the completion of grading by the project corrosion engineer to further evaluate the as-graded soil corrosivity characteristics. Accordingly, revision of the corrosion potential may be needed, should future test results differ substantially from the conditions reported herein. The client and/or other members of the development team should consider this during the design and planning phase of the project, and formulate an appropriate course of action.

3.0 CONCLUSIONS

Our geotechnical evaluation has included a review of previous geotechnical reports, limited subsurface exploration, laboratory testing, and geotechnical analyses of the data collected. Based on geotechnical data gathered/reviewed and the results of our analyses, it is our opinion that the subject site is located within a geotechnically favorable area, and that development of the subject site for residential construction is considered feasible from a geotechnical standpoint. The major geotechnical items to be considered in the design, and ultimately construction of the proposed project, are discussed in greater detail below.

- Near-surface fill materials have been exposed to the elements over the years and will need to be reworked to provide support of future site development. Additionally, structures that are planned in areas of cut-fill transitions or that are underlain by fill less than 5 feet thick with a transition to deep fill under the same structure, should be overexcavated followed by replacement with engineered compacted fill. Recommendations for near surface improvement and site preparation are presented in Section 4.1 of this report.
- Excavations into the existing site materials (engineered fill and bedrock) should be achievable with heavy construction equipment in good working order. We anticipate that the earth materials generated from the recommended earthwork will be generally suitable for re-use as compacted fill, provided they are relatively free of rocks larger than 6 inches in dimension, demolition debris, and organic material.
- Future compacted fill materials derived from site excavations are anticipated to have a very low to low expansion potential. However, future testing and analysis needs to be performed after grading has been completed.
- Future compacted fill materials derived from onsite materials are anticipated to have sulfate severity categorization of "not applicable" and are designated class "S0" with regards to potential sulfate attack on concrete. However, further testing will be needed to confirm this upon completion of grading.
- Ground water was not encountered within the upper 50.5 feet of the site during our subsurface evaluation. Laboratory test results from moisture and density testing indicate that the average degree of saturation of the subsurface materials is also relatively low.
- The subject study area is not located within a mapped Earthquake Fault-Rupture Zone and based upon our review of published geologic mapping, no known active or potentially active faults cross the site. The nearest mapped active fault, the Elsinore Fault, is located more than approximately 16 kilometers away from the site. Therefore, the potential for ground rupture as a result of faulting is considered remote.
- The subject site is not located within an area considered susceptible to liquefaction.
- Laboratory testing by others indicates that a deep, thin layer of alluvial material left in place during grading of the site, has the potential to collapse up to approximately 0.5 inch when inundated with water (PSE, 2007).
- Seismic hazards associated with a significant earthquake generated from one of the active regional faults include ground shaking. The estimated peak horizontal ground acceleration is 0.37g. **New improvements will need to be designed for seismic forces in accordance with current building codes and regulations.** However, there is still a risk that the proposed structures and associated improvements could be damaged as a result of an earthquake. Repair of the planned residential structures may be needed after a seismic event.

4.0 RECOMMENDATIONS

The following recommendations are to be considered preliminary and should be confirmed upon completion of final development plans, grading, and earthwork operations. In addition, they should be considered minimal from a geotechnical viewpoint, as there may be more restrictive requirements from the architect, structural engineer, building codes, governing agencies, or the owner. A grading plan review should also be performed by LGC Geotechnical prior to the start of earthwork activities. Additional and/or revised recommendations may be provided at the conclusion of plan review, including recommendations for additional subsurface evaluation and laboratory testing.

It should be noted that the following geotechnical recommendations are intended to provide the owner with sufficient information to develop the site in general accordance with the 2010 C.B.C. requirements. With regard to the potential occurrence of potentially catastrophic geotechnical hazards such as fault rupture, earthquake-induced landslides, liquefaction, etc., the following geotechnical recommendations should provide adequate protection for the proposed development to the extent required to reduce seismic risk to an "acceptable level". The "acceptable level" of risk is defined by the California Code of Regulations as "that level that provides reasonable protection of the public safety, though it does not necessarily ensure continued structural integrity and functionality of the project" [Section 3721(a)]. Therefore, repair and remedial work of the proposed structures may be required after a significant seismic event. With regards to the potential for less significant geologic hazards to the proposed development, the recommendations contained herein are intended as a reasonable protection against the potential damaging effects of geotechnical phenomena such as expansive soils, soil settlement, groundwater seepage, etc. It should be understood, however, that our recommendations are intended to maintain the structural integrity of the proposed development and structures given the site geotechnical conditions, but cannot preclude the potential for some cosmetic distress or nuisance issues to develop as a result of the site geotechnical conditions.

4.1 Site Earthwork

We anticipate that after demolition of existing improvements and asphalt parking lots at the northern portion of the site is complete, rough grading earthwork at the site will then generally consist of clearing and grubbing of demolition debris and organic materials, earthwork cuts and overexcavations below structures in accordance with project specifications, remedial removals for areas of fill and shallow cuts, and placement of engineered compacted fill to design grades. Precise grading earthwork will include shallow trenching for construction of slab-on-grade type foundations and utilities. Site earthwork operations should be performed in accordance with the following recommendations, in addition to those contained in the 2010 C.B.C., and the General Earthwork and Grading Specifications for Rough Grading included in Appendix D of this report. In case of conflict, the following recommendations shall supersede those included as a part of Appendix D.

4.1.1 Site Preparation

Prior to grading, the proposed construction areas should be stripped of all vegetation and any remaining construction debris; these materials should be removed and properly disposed of offsite. Holes resulting from the removal of buried obstructions should be replaced with suitable compacted fill material (refer to Section 4.1.4). Soft or yielding subgrade materials encountered within bottom excavations should also be removed to a depth that exposes firm materials. The

actual depth of removals in these areas will be determined by the geotechnical consultant in the field based on the observed conditions.

4.1.2 Remedial Measures

The subject site has been previously graded to the current existing superpad grades, and the southern portion has been left vacant for several years. The northern portion of the site has been improved with a structure, a parking lot and associated utilities and landscaping. Approximate limits of recommended remedial earthwork are presented on the Remedial Measures Map, Figure 3 (Rear of Text).

Actual limits of over-excavation below structures may vary significantly depending on the actual thickness of fill encountered during grading. Limits of the recommended 10 feet over-excavation area, shown on Figure 3, are based on limited subsurface information. Actual limits of the western boundary of the 10 feet overexcavation area shall be determined based on field observations during grading.

Removal bottom areas and over-excavated bottom areas to receive compacted fill should be scarified to a minimum depth of 6 inches, brought to a near-optimum moisture condition, and recompacted to at least 90 percent relative compaction (based on American Standard of Testing and Materials, ASTM, Test Method D1557).

Local conditions, such as deeper than anticipated weathered or unsuitable fill or excessively loose and yielding native materials, may be encountered during excavation. These conditions could require additional removals beyond the above noted minimum in order to obtain an acceptable subgrade. The actual depths and lateral extents of remedial grading will be determined by the geotechnical consultant in the field, based on subsurface conditions encountered during grading.

4.1.3 Earthwork Shrinkage and Bulking

Based upon the results of our subsurface evaluation and laboratory testing, it is our opinion that the existing fill material will shrink less than approximately 5 percent. We estimate that the surface bedrock materials will bulk on the order of 5 to 10 percent. The actual amount of shrinkage depends on many factors including type of equipment used, contractor's technique, homogeneity of onsite soils, etc.

4.1.4 *Fill Placement and Compaction*

The onsite engineered fill and bedrock are considered generally suitable for use as compacted fill provided they are screened of rocks greater than 6 inches in dimension, excessive organic materials, and demolition debris. Fill materials should be moisture conditioned or dried (as needed) to near optimum-moisture content and recompacted to at least 90 percent relative compaction (based on ASTM Test Method D1557). The optimum lift thickness to produce a uniformly compacted fill will depend on the type and size of compaction equipment used. In general, fill should be placed in uniform lifts not exceeding 8 inches in thickness. Placement and compaction of fill should be performed in accordance with local grading ordinances under the observation and testing of LGC Geotechnical.

Import soils (if required) should consist of granular soils of low expansion potential (expansion index 50 or less based on ASTM D4829 Section 5.3 Classification), and should be free of organic debris and hard materials over 6 inches in dimension. Prior to import, LGC should be provided with the location of the import source for geotechnical evaluation.

Aggregate base or crushed miscellaneous base material should be placed at a minimum relative compaction of 95 percent based on ASTM Test Method D1557 and conform to the specifications of the current edition of the Standard Specifications for Public Works Construction ("Greenbook").

4.1.5 *Trench Backfill and Compaction*

Utility trench backfills should be compacted to a minimum relative compaction of 90 percent. Trench backfill materials should be placed in loose lifts no greater than approximately 8 inches in thickness, moisture-conditioned to optimum-moisture content or greater, and compacted with conventional compaction equipment. If trenches are shallow and conventional equipment may result in damage to the utilities, clean sand, having sand equivalent (SE) of 30 or greater, may be imported to bed and shade the utilities. Sand backfill should be densified. Densification by jetting or flooding may be considered, but tamping of the sand with relatively light, hand-operated equipment should be employed to ensure adequate compaction. A representative from LGC Geotechnical should observe, probe, and test the bedding sand and compacted backfill to verify compliance with the project specifications.

4.2 *Preliminary Foundation Recommendations*

Given that the expansion index exceeds 20, the foundation system shall be designed for effects of expansive soil. The foundation designer/client may elect to design the foundation in accordance with either the WRI or post-tensioned methodology. Due to potential for hydro-consolidation, either foundation system should be designed to accommodate an anticipated differential settlement of approximately ½ inch in 40 feet.