TECHNICAL SPECIFICATIONS
FOR THE CONSTRUCTION OF
GAS MONITORING AND CONTROL SYSTEM
BRITANNIA EAST GRAND DEVELOPMENT
PHASE II

SOUTH SAN FRANCISCO, CALIFORNIA

Prepared for:

Slough Estates USA Inc.
444 North Michigan Avenue, Suite 3230
Chicago, Illinois 60611

Prepared by:

GeoSyntec Consultants
10875 Rancho Bernardo Road, Suite 200
San Diego, California 92127
(858) 674-6559

16 March 2006

CERTIFICATION PAGE

TECHNICAL SPECIFICATIONS
GAS MONITORING AND CONTROL SYSTEM
BRITANNIA EAST GRAND DEVELOPMENT – PHASE II
SOUTH SAN FRANCISCO, CALIFORNIA

The Engineering material and data contained in these Technical Specifications were prepared under the supervision and direction of the undersigned, whose seal as a registered Professional Engineer is affixed below.

// Original Signed By //

Steven M. Fitzwilliam, P.E.
Engineer of Record

TABLE OF CONTENTS

SECTION 02616
POLYVINYL CHLORIDE (PVC) PIPE

PART 1 — GENERAL

1.01 DESCRIPTION OF WORK

A. The Contractor shall furnish all labor, materials, tools, supervision, transportation, and equipment necessary to install perforated and solid wall polyvinyl chloride (PVC) Schedule 40 pipe and fittings, gas extraction aggregate, and pipe hangers as shown on the Drawings.

1.02 RELATED SECTIONS

Section 02771 — Geotextile

1.03 REFERENCES

A. Drawings.

B. Site CQA Plan.

C. Latest version of the American Society for Testing and Materials (ASTM) standards:

ASTM C 33 Standard Specification for Concrete Aggregates

ASTM D 1784 Standard Specification for Rigid Poly (Vinyl Chloride) (PVC) Compounds and chlorinated Poly (Vinyl Chloride) (CPVC) Compounds.

ASTM D 1785 Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80 and 120.

ASTM D 2466 Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40.

ASTM D 2564 Standard Specification for Solvent Cements for Poly (Vinyl Chloride) (PVC) Plastic Pipe and Fittings.

ASTM D 2774 Practice for Underground Installation of Thermoplastic Pressure Piping.

ASTM D 2855 Standard Practice for Making Solvent-Cemented Joints with Poly (Vinyl Chloride) (PVC) Pipe and Fittings.

ASTM F 656 Standard Specification for Primers for Use in Solvent Cement Joints of Poly (Vinyl Chloride) (PVC) Plastic Pipe and Fittings.

D. Latest Edition of the Standard Specifications for Public Works Construction ("Greenbook").

1.04 SUBMITTALS

A. The Contractor shall submit to the Engineer for approval, at least 7 days prior to installation of this material, Certificates of Compliance for the pipe, fittings, and pipe hanger materials to be furnished. Certificates of Compliance shall consist of a properties sheet, including specified properties measured using test methods indicated herein.

B. The Contractor shall submit to the Engineer, record drawings of the installed piping and appurtenant fittings, including both horizontal and vertical. Record drawings shall be submitted within 7 days of completion of the record survey.

1.05 QUALITY ASSURANCE

A. The Contractor shall ensure that the materials and methods used for PVC pipe, fittings, and pipe hanger installation meet the requirements of the Drawings and this Section. Any material or method that does not conform to these documents, or to alternatives approved in writing by the Engineer will be rejected and shall be repaired or replaced by the Contractor.

PART 2 — MATERIALS

2.01 PVC PIPE & FITTINGS

A. PVC pipe and fittings shall be manufactured from a PVC compound which meets the requirements of Cell Classification 12454-B polyvinyl chloride as outlined in ASTM D 1784.

B. PVC pipe shall meet the requirements of ASTM D 1784 and ASTM D 1785 for Schedule 40 PVC pipe.

C. PVC fittings shall meet the requirements of ASTM D 2466.

D. Clean rework or recycle material generated by the manufacturer's own production may be used so long as the pipe or fittings produced meet all the requirements of this Section.

E. Pipe and fittings shall be homogenous throughout and free of visible cracks, holes, foreign inclusions, or other injurious defects. Being uniform in color, capacity, density, and other physical properties.

F. PVC pipe and fitting primer shall meet the requirements of ASTM F 656 and solvent cements shall meet the requirements of ASTM D 2564.

2.02 PVC PERFORATED PIPE

A. PVC perforated pipe shall meet the requirements listed above for solid wall pipe, unless otherwise approved by the Engineer. PVC pipe perforations shall be as shown on the Drawings.

2.03 PIPE HANGERS

A. Pipe hangers shall be the standard clevice type, in accordance with Manufacturers' Standardization Society SP-69 (Type 1) specifications.

B. Pipe hangers shall be able to fit the outside diameter of the PVC pipe, be constructed of stainless steel, zinc-plated steel, or other corrosion resistant materials, and be able to support a minimum workload of 78 pounds.

C. Threaded rod and other appurtenant components shall be constructed of stainless steel, or other corrosion resistant materials.

2.04 GAS EXTRACTION AGGREGATE/SAND

A. Gas extraction aggregate shall meet the requirements specified in ASTM C-33 for #8 fine aggregate and shall have a maximum particle size of ½-inch unless otherwise noted in the geotechnical report for the project.

B. Sand for the gas extraction layer shall meet the requirements for Portland cement concrete (Greenbook 200-1.5.5), or medium fine or fine screenings (Greenbook 200-1.2.1)

PART 3 EXECUTION

3.01 PVC PIPE HANDLING

A. When shipping, delivering, and installing pipe, fittings, and accessories, do so to ensure a sound, undamaged installation. Provide adequate storage for all materials and equipment delivered to the job site. PVC pipe and pipefittings shall be handled carefully in loading and unloading so as not to damage the pipe, fittings, or underlying materials.

3.02 PVC PIPE INSTALLATION

A. PVC pipe installation shall conform to these Specifications, the Manufacturer's recommendations, and as outlined in ASTM D 2774.

B. PVC perforated and solid wall pipe shall be installed, in a horizontal condition, as shown on the Drawings.

C. PVC pipe shall be inspected for cuts, scratches, or other damages prior to installation. Any pipe showing damage, which in the opinion of the Engineer will affect performance of the pipe, must be removed from the site. Replace any material found to be defective.

D. Where PVC solid wall pipe is installed within concrete without a sleeve, the pipe shall be wrapped with closed cell expanded polyethylene (CCPE) foam, or equivalent approved by the Engineer, such that no part of the pipe be exposed to concrete. The minimum thickness of the expansion wrap shall be ¼ inch.

E. As indicated on the Drawings, where the PVC pipe enters the interior of the building or enclosed areas of the parking structure, silicone-based sealant as approved by the Engineer, shall be used to provide an airtight seal between the PVC pipe and concrete.

3.03 JOINING OF PVC PIPES

A. PVC pipe and fittings shall be joined by primer and solvent-cements in accordance with ASTM D 2855; except when installed for the gas monitoring piping, where the

PVC pipe shall be joined only through the use of threaded connections and/or stainless-steel self-tapping screws.

B. All burrs, chips, etc., shall be removed from pipe interior and exterior.

C. All loose dirt and moisture shall be wiped from the interior and exterior of the pipe end and the interior of fittings.

D. All pipe cuts shall be square and perpendicular to the centerline of the pipe.

E. Pipe and fittings shall be selected so that there will be as small a deviation as possible at the joints, and so inverts present a smooth surface. Pipe and fittings that do not fit together to form a tight fit will be rejected.

3.04 PIPE HANGER INSTALLATION

A. Pipe hanger installation shall conform to the Drawings, these Specifications, and the Manufacturer's recommendations.

B. Pipe hangers shall be spaced at 7 feet along solid-wall pipe and 10 feet along perforated pipe and at all pipe crossings.

C. Pipe hangers shall be installed in accordance with the Drawings and in such a manner that the pipe is maintained in a horizontal condition and remains undamaged.

3.05 PROTECTION OF WORK

A. The Contractor shall use all means necessary to protect all work of this Section.

B. In the event of damage, the Contractor shall make all repairs and replacements necessary, to the satisfaction of the Engineer.

[END OF SECTION]

SECTION 02770
GEOMEMBRANE GAS BARRIER

PART 1 — GENERAL

1.01 DESCRIPTION OF WORK

A. The Contractor shall furnish all labor, materials, tools, supervision, transportation, equipment, and incidentals necessary for the installation of geomembrane gas barrier (Liquid Boot manufactured by LBI Technologies or EPRO Waterproofing Systems, Inc.) as shown on the Drawings. The work shall be carried out as specified herein and in accordance with Drawings.

B. The work shall include, but not be limited to, delivery, storage, placement, anchorage, and seaming of the geomembrane gas barrier.

1.02 RELATED SECTIONS

Section 02771 — Geotextile

1.03 REFERENCES

A. Drawings

B. Site Construction Quality Assurance (CQA) Plan

C. Latest version of the American Society for Testing and Materials (ASTM) standards:

ASTM D 412 Standard Test Method for Vulcanized Rubber and Thermoplastic Rubbers and Thermoplastic Elastomers - Tension.
ASTM D 413 Standard Test Methods for Rubber Property – Adhesion to Flexible Substrate.
ASTM D 543 Standard Test Method for Resistance of Plastics to Chemical Reagents.
ASTM D 751 Standard Test Methods for Coated Fabrics.

ASTM D 1434 Standard Test Method for Determining Gas Permeability Characteristics of Plastic Film and Sheeting.

ASTM D 4068 Specification for Chlorinated Polyethylene (CPE) Sheeting for Concealed Water Containment Membrane.

ASTM D 4833 Test Method for Index Puncture Resistance of Geotextiles, Geomembranes, and Related Products.

ASTM D 5199 Standard Test Method for Measuring Nominal Thickness of Geotextile and Geomembranes.

ASTM E 96 Standard Test Method for Water Vapor Transmission of Materials.

1.04 QUALIFICATIONS

A. Geomembrane Gas Barrier Manufacturer (Manufacturer):

1. The Manufacturer shall be responsible for the production of the components of the geomembrane gas barrier materials and shall provide material meeting the requirements of this Section and the construction schedule for this project.
2. The Prequalified Manufacturers are:
   b. LBI Technologies, Inc.; 3873 East Eagle Drive; Anaheim, California 92087; (714) 575-9200.
   c. EPRO Waterproofing Systems, 1328 E. Kellogg Dr., Wichita, KS 67223, 800-882-1896 or 316-262-2513.

B. Geosynthetics Installer:

1. The Geosynthetics Installer, which is subcontracted to the Contractor, shall be responsible and shall provide sufficient resources for field handling, deploying, seaming, temporarily restraining (against wind), and other aspects of the deployment and installation of the geomembrane gas barrier materials and other geosynthetic components of the project.
2. The Geosynthetics Installer shall have successfully completed a training course provided by LBI Technologies, Inc. or EPRO Waterproofing Systems, Inc. and shall have installed a minimum of 2,000,000 ft^2 of spray-applied geomembrane gas barrier (Liquid Boot or similar) on previous projects.
   a. The Superintendent shall have supervised the installation of a minimum of 1,000,000 ft^2 of geomembrane gas barrier on at least five (5) different projects.

b. The Installer may be one of the following, or as otherwise approved by the Engineer:

- Sealtech Caulking and Waterproofing, contact Rich Ceraola (408) 287-9681;
- Best Roofing and Waterproofing, contact Mohommad H. Beigi (510) 886-7240;
- Pioneer Contractors, contact Herbert Li (415) 671-1070.

1.05 WARRANTY

A. The Geosynthetic Installer shall furnish the Engineer a written 30-year warranty against defects in materials.

B. The Geosynthetic Installer shall furnish the Engineer with a 1-year written warranty against defects in workmanship.

1.06 SUBMITTALS

A. The Geosynthetic Installer shall submit the following documentation on the Manufacturer for approval.
   1. List of material properties, including test method, to which are attached geomembrane gas barrier samples.

B. The Geosynthetic Installer shall submit certificates of compliance certifying that the geomembrane gas barrier materials meet the requirements outlined herein.

C. The Geosynthetic Installer shall submit the following information to the Engineer for approval 14 days prior to mobilization.
   1. Installation schedule.
   2. Copy of Geosynthetic Installer's letter of approval or license by the Manufacturer.
   3. Installation capabilities, including:
      a. information on equipment proposed for this project;
      b. average daily production anticipated for this project; and
      c. quality control procedures.

4. In accordance with Part 1.04, a resume of the Superintendent to be assigned to this project, including dates and duration of employment, shall be submitted at least 7 days prior to beginning geomembrane installation.

D. During installation, the Geosynthetic Installer shall be responsible for the timely submission to the Engineer of:
   1. Quality control documentation; and
   2. Subgrade acceptance certificates, signed by the Geosynthetic Installer, for each area to be covered by geosynthetic materials.

E. Upon completion of the installation, the Geosynthetic Installer shall be responsible for the submission to the Engineer of a warranty from the Geosynthetic Installer as specified in Part 1.05.B of this Section.

1.07 QUALITY ASSURANCE

A. The Geosynthetic Installer shall ensure that the materials and methods used for installation of the geomembrane gas barrier meet the requirements of the Drawings and this Section. Any material or method that does not conform to these documents, or to alternatives approved in writing by the Engineer, will be rejected and shall be repaired or replaced by the Geosynthetic Installer.

B. The Geosynthetic Installer shall be aware of and accommodate all monitoring and conformance testing required by the CQA Plan. The Engineer will perform this monitoring and testing, including random conformance testing of construction materials and completed work. If nonconformances or other deficiencies are found in the Geosynthetic Installer's materials or completed work, the Geosynthetic Installer will be required to repair the deficiency or replace the deficient materials at the geosynthetic installer's expense.

PART 2 — PRODUCTS

2.01 GEOMEMBRANE GAS BARRIER PROPERTIES

A. The Manufacturer shall furnish geomembrane gas barrier materials having properties that comply with the required property values shown in Table 02770-1.

2.02 GEOMEMBRANE CARRIER

A. The Manufacturer shall furnish geomembrane carrier materials having properties that comply with the required property values shown in Table 02770-2 or Section 02771.

2.03 TRANSPORTATION, HANDLING AND STORAGE

A. Handling and care of the geomembrane gas barrier prior to and following installation at the site shall be the responsibility of the Geosynthetic Installer. The Geosynthetic Installer shall be liable for all damage to the materials incurred prior to final acceptance of the liner system by the Engineer.

B. Geosynthetic Installer shall be responsible for storage of the geomembrane gas barrier materials at the site.

PART 3 — GEOMEMBRANE GAS BARRIER INSTALLATION

3.01 FAMILIARIZATION

A. Prior to implementing any of the work described in this Section, the Geosynthetic Installer shall become thoroughly familiar with all portions of the work falling within this Section.

B. Inspection:

1. The Geosynthetic Installer shall carefully inspect the installed work of all other Sections and verify that all work is complete to the point where the work of this Section may properly commence without adverse effect.
2. If the Geosynthetic Installer has any concerns regarding the installed work of other Sections, he shall notify the Engineer in writing prior to the start of the work of this Section. Failure to inform the Engineer in writing or installation of the geomembrane will be construed as the Geosynthetic Installer's acceptance of the related work of all other Sections.

C. A pre-installation meeting shall be held to coordinate the installation of the geomembrane gas barrier with the installation of other components of the gas extraction and foundation systems.

3.02 SURFACE PREPARATION

A. Concrete surfaces shall have a light broom or smoother finish. Concrete surfaces shall be free of dirt, debris, loose materials, release agents, curing agents, and moisture.

B. Voids in concrete surface deeper and/or wider than ¼ inch shall be filled.

C. Provide a ¾ inch minimum bead of Liquid Boot Trowel grade, or other Engineer approved suitable material, at all horizontal to vertical transitions and other inside corners. Allow this material to cure for a minimum of 24 hours prior to spray applying geomembrane gas barrier.

D. All concrete form tie holes must be filled with non-shrink grout.

E. Install Hardcast reinforcing tape over all cold joints, cracks, and grouted holes.

F. Carrier geosynthetic shall be installed with no wrinkles.

3.03 GEOMEMBRANE GAS BARRIER INSTALLATION

A. Geomembrane gas barrier shall not be placed during any precipitation, in the presence of excessive moisture (e.g., fog, dew), in an area of ponded water, or in the presence of excessive winds.

B. Geomembrane gas barrier shall be applied to a minimum dry thickness of 100 mils, not including carrier geosynthetic, in a continuous, uniform layer.

C. The Contractor shall ensure that:
   1. No vehicular traffic is allowed on the geomembrane.
   2. Equipment used does not damage the geomembrane by handling, trafficking, or leakage of hydrocarbons (i.e., fuels).
   3. Personnel working on the geomembrane do not smoke, wear damaging shoes, bring glass onto the geomembrane gas barrier, or engage in other activities that could damage the geomembrane gas barrier.
   4. The geomembrane is protected from damage in heavily trafficked areas.

D. Test apply geomembrane gas barrier to concrete surface in accordance with the Manufacturer's requirements.

E. Geomembrane gas barrier shall be overlapped a minimum of 12 inches when application process is interrupted for more than 8 hours. The overlap area shall be cleaned of dust, dirt and other materials that may affect the quality of the geomembrane gas barrier.

F. Prior to placement of the cushion geotextile, a light coating of geomembrane shall be applied to adhere the cushion geotextile to the cured geomembrane.

3.04 GEOMEMBRANE GAS BARRIER QUALITY CONTROL TESTING

A. Destructive testing shall consist of obtaining one (1) 2-inch square sample of cured geomembrane gas barrier for every 2,000 square feet of geomembrane gas barrier installed. This sample shall be tested for overall thickness (i.e. including the thickness of the carrier geosynthetic). The thickness of the carrier geosynthetic will then be deducted to confirm that the geomembrane gas barrier has been installed to a minimum dry thickness of 100 mils. This testing will be the responsibility of the Contractor.

B. Smoke testing shall consist of making an 8 to 12-inch incision in the cured geomembrane and using a smoke-generating device to inject smoke beneath the geomembrane through a tube. Smoke testing shall be performed after the installation of the steel reinforcing bars for the slab but before the placing of concrete for the slab. A Colt 4 device, manufactured by Concept Engineering Technologies, Inc, or equivalent, should be used to generate a glycerin-based smoke for the test. The smoke shall be passed through an electric blower and beneath the geomembrane through a leaf blower nozzle. Locations of smoke leakage should be observed and marked for subsequent repairs. This testing will be the responsibility of the Contractor.

3.05 GEOMEMBRANE GAS BARRIER REPAIR

A. Voids left by sampling or other damage shall be repaired by patching with carrier geosynthetic overlapped a minimum of 3 inches beyond the edge of the defect. Geomembrane gas barrier material shall then be applied to a minimum of 3 inches beyond the edge of the carrier geosynthetic.

3.06 PENETRATIONS IN THE GEOMEMBRANE GAS BARRIER

A. All penetrations through the geomembrane gas barrier shall be cleaned and etched in accordance with the Manufacturer's requirements. All metal penetrations shall be etched with a 10% muriatic acid solution.

B. Cut carrier geosynthetic around penetration so that the carrier geotextile lies flat on the subgrade.

C. Provide a ¾ inch minimum bead of Trowel Grade geomembrane, or other Engineer approved suitable material, along the base of the penetration.

D. Apply 100 mils, dry thickness, of Trowel Grade geomembrane in a three-inch wide ring around the base of the penetration and three inches up the penetration, except for rebar (2" wide ring) and pipe hangers (1" wide ring). Allow this material to cure prior to applying geomembrane gas barrier.

E. Spray apply 100 mil thick geomembrane gas barrier and allow to cure.

F. Install and tighten cable tie at top of geomembrane gas barrier. Trim excess cable tie after tightening.

3.07 MATERIALS IN CONTACT WITH THE GEOMEMBRANE GAS BARRIER

A. The Contractor shall take all necessary precautions to ensure that the geomembrane gas barrier is not damaged during its installation or during the installation of overlying materials.

B. All attempts shall be made to minimize wrinkles in the geomembrane.

C. Equipment shall not be driven directly on the geomembrane.

3.08 GEOMEMBRANE GAS BARRIER ACCEPTANCE

A. The Contractor shall retain all ownership and responsibility for the geomembrane gas barrier until accepted by the Engineer.

B. The geomembrane shall be accepted by the Engineer when:

1. The installation is completed;
2. All documentation is submitted;
3. The associated testing is complete; and
4. All warranties are submitted.

3.09 PROTECTION OF WORK

A. The Contractor shall use all means necessary to protect all work of this Section.

B. In the event of damage, the Contractor shall make all repairs and replacements necessary, to the satisfaction of the Engineer.

TABLE 02770-1
REQUIRED GEOMEMBRANE GAS BARRIER PROPERTIES

PROPERTIES	QUALIFIERS	UNITS	SPECIFIED VALUES	TEST METHOD
Physical Properties				
Dry Thickness	Minimum	mils	100	ASTM D 5994
Mechanical Properties				
Tensile Strength	Minimum	psi	32	ASTM D 412
Elongation	Minimum	%	1,300	ASTM D 412
Tensile Bond Strength to Concrete	Minimum	ppf	132	ASTM D 413
Environmental Properties				
Methane Gas Permeability	Maximum	N/A	None	ASTM D 1434

TABLE 02770-2
REQUIRED GEOMEMBRANE CARRIER PROPERTIES

PROPERTIES	QUALIFIERS	UNITS	SPECIFIED VALUES	TEST METHOD
Physical Properties				
Thickness	minimum	mils	10	ASTM D 5199
Mechanical Properties				
Tensile Strength	minimum	lbs	19	ASTM D 882
Puncture Resistance	minimum	lbs	150	ASTM D 4883
Environmental Properties				
Water Vapor Permeability	maximum	g/SF/hr	0.0133	ASTM E 96

[END OF SECTION]

SECTION 02771
GEOTEXTILE

PART 1 — GENERAL

1.01 DESCRIPTION OF WORK

A. The Contractor shall furnish all labor, materials, tools, supervision, transportation, equipment, and incidentals necessary for the installation of the geotextile. The work shall be carried out as specified herein and in accordance with the Drawings.

B. The work shall include, but not be limited to, delivery, storage, placement, and seaming of the various geotextile components of the project.

C. Carrier geotextile (nonwoven heat bonded) shall be used as a substrate for the application of the geomembrane gas barrier, as shown on the Drawings.

D. Cushion geotextile (nonwoven needle-punched) shall be used beneath the reinforced concrete structural slab and overlying the geomembrane, as shown on the Drawings.

1.02 RELATED SECTIONS

Section 02616 — Polyvinyl Chloride Pipe
Section 02770 — Geomembrane Gas Barrier

1.03 REFERENCES

A. Drawings

B. Site Construction Quality Assurance (CQA) Plan

C. Latest version of American Society for Testing and Materials (ASTM) standards:

ASTM D 4355 Standard Test Method for Deterioration of Geotextile from Exposure to Ultraviolet Light and Water
ASTM D 4533 Standard Test Method for Trapezoid Tearing Strength of Geotextile
ASTM D 4632 Standard Test Method for Breaking Load and Elongation of Geotextile (Grab Method)

ASTM D 4833 Standard Test Method for Index Puncture Resistance of Geotextile, Geomembranes, and Related Products

ASTM D 5261 Standard Test Method for Measuring Mass Per Unit Area of Geotextile

1.04 SUBMITTALS

A. The Contractor shall submit to the Engineer, at least 7 days prior to geotextile delivery, the following information regarding the proposed geotextile:

1. manufacturer and product name;
2. minimum property values of the proposed geotextile and the corresponding test procedures;
3. projected geotextile delivery dates; and
4. list of geotextile roll numbers for rolls to be delivered to the site.

B. At least 7 days prior to geotextile placement, the Contractor shall submit to the Engineer the manufacturing quality control certificates for each roll of geotextile. The certificates shall be signed by responsible parties employed by the geotextile manufacturer (such as the production manager). The quality control certificates shall include:

1. lot, batch, and/or roll numbers and identification; and
2. results of quality control tests, including a description of the test methods used.

1.05 QUALITY ASSURANCE

A. The Contractor shall ensure that the geotextile and installation methods used meet the requirements of the Drawings and this Section. Any material or method that does not conform to these documents, or to alternatives approved in writing by the Engineer, will be rejected and shall be repaired or replaced by the Contractor.

B. The Contractor shall be aware of all monitoring and conformance testing required by the CQA Plan. The Engineer will perform this monitoring. If nonconformances or other deficiencies are found in the Contractor's materials or completed work, the Contractor will be required to repair the deficiency or replace the deficient materials.

PART 2 — PRODUCTS

2.01 GEOTEXTILE PROPERTIES

A. Geotextile suppliers shall furnish materials in which the "Minimum Average Roll Values", as defined by the Federal Highway Administration (FHWA), meet or exceed the criteria specified in Table 02771-1 for the filtration, cushion, and carrier geotextiles.

B. The cushion geotextile shall be nonwoven materials, suitable for use in cushion applications or a geosynthetic material (such as a 15-mil HDPE) approved by the Engineer. The carrier geotextile shall be Linq Industries Typar 3401 nonwoven heat bonded geotextile or a geosynthetic membrane or geotextile approved by the Engineer.

2.02 MANUFACTURING QUALITY CONTROL

A. The geotextile shall be manufactured with quality control procedures that meet or exceed generally accepted industry standards.

B. The Geotextile Manufacturer shall sample and test the geotextile to demonstrate that the material conforms to the requirements of these Specifications.

C. Any geotextile sample that does not comply with this Section shall result in rejection of the roll from which the sample was obtained. The Contractor shall replace any rejected rolls.

D. If a geotextile sample fails to meet the quality control requirements of this Section the Geotextile Manufacturer shall sample and test, at the expense of the Manufacturer, rolls manufactured in the same lot, or at the same time, as the failing roll. Sampling and testing of rolls shall continue until a pattern of acceptable test results is established to bound the failed roll(s).

E. Additional sample testing may be performed, at the Geotextile Manufacturer's discretion and expense, to identify more closely any non-complying rolls and/or to qualify individual rolls.

F. Sampling shall, in general, be performed on sacrificial portions of the geotextile material such that repair is not required. The Geotextile Manufacturer shall sample and test the geotextile, at a minimum once every 130,000 ft^2, to demonstrate that the geotextile properties conform to the values specified in Table 02771-1. At a minimum, the following manufacturing quality control tests shall be performed on each type of geotextile:

Test	Procedure	Cushion	Carrier
Mass per unit area	ASTM D 5261	Yes	No
Grab strength	ASTM D 4632	Yes	Yes
Tear strength	ASTM D 4533	Yes	Yes
Puncture strength	ASTM D 4833	Yes	Yes

G. The Geotextile Manufacturer shall comply with the certification and submittal requirements of this Section.

2.03 PACKING AND LABELING

A. Geotextile shall be supplied in rolls wrapped in relatively impermeable and opaque protective covers.

B. Geotextile rolls shall be marked or tagged with the following information:
1. manufacturer's name;
2. product identification;
3. lot or batch number;
4. roll number; and
5. roll dimensions.

2.04 TRANSPORTATION, HANDLING, AND STORAGE

A. Handling, unloading, storage, and care of the geotextile prior to and following installation at the site, is the responsibility of the Contractor. The Contractor shall be liable for any damage to the materials incurred prior to final acceptance by the Engineer.

B. The geotextile shall be protected from sunlight, excessive heat or cold, puncture, or other damaging or deleterious conditions. The geotextile shall be protected from mud, dirt, and dust. Any additional storage procedures required by the Geotextile Manufacturer shall be the responsibility of the Contractor.

PART 3 — EXECUTION

3.01 FAMILIARIZATION

A. Prior to implementing any of the work described in this Section, the Contractor shall become thoroughly familiar with the site, the site conditions, and all portions of the work falling within this Section.

B. Inspection:

1. The Contractor shall carefully inspect the installed work of all other Sections and verify that all such work is complete to the point where the installation of this Section may properly commence without adverse effect.
2. If the Contractor has any concerns regarding the installed work of other Sections or the site, the Engineer shall be notified, in writing, prior to commencing the work. Failure to notify the Engineer or installation of the geotextile will be construed as Contractor's acceptance of the related work of all other Sections.

3.02 PLACEMENT

A. The Contractor shall handle all geotextile in such a manner as to ensure they are not damaged in any way.

B. The Contractor shall take any necessary precautions to prevent damage to underlying materials during placement of the geotextile.

C. After unwrapping the geotextile from its opaque cover, the geotextile shall not be left exposed for a period in excess of 15 days unless a longer exposure period is approved in writing by the Geotextile Manufacturer.

D. The Contractor shall take care not to entrap stones, excessive dust, or moisture in the geotextile during placement.

E. The Contractor shall anchor or weight all geotextile with sandbags, or the equivalent, to prevent wind uplift.

F. The Contractor shall examine the entire geotextile surface after installation to ensure that no foreign objects are present that may damage the geotextile or adjacent layers. The Contractor shall remove any such foreign objects and shall replace any damaged geotextile.

G. Prior to placing cushion geotextile over the geomembrane gas barrier, a tack coat of geomembrane gas barrier shall be applied to the surface of the cured geomembrane to provide a bond between the cushion geotextile and the cured geomembrane gas barrier (See Section 02770).

3.03 SEAMS AND OVERLAPS

A. Cushion geotextiles shall be overlapped a minimum of 12 inches.

B. Carrier geotextile shall be overlapped a minimum of 6 inches.

3.04 REPAIR

A. Any holes or tears in the geotextile shall be repaired using a patch made from the same geotextile. Geotextile patches shall be overlapped a minimum of 12 inches. Should any tear exceed 50% of the width of the roll, that roll shall be removed and replaced.

B. Where geosynthetic materials underlie the geotextile being placed, care shall be taken to remove any soil or other material that may have penetrated the torn geotextile.

3.05 PLACEMENT OF OVERLYING MATERIALS

A. The Contractor shall place overlying materials (rebar, rebar chairs, concrete, etc.) on top of the geotextile in such a manner as to ensure that:
   1. the geotextile and the underlying materials are not damaged;
   2. minimum slippage occurs between the geotextile and the underlying layers during placement; and
   3. excess stresses are not produced in the geotextile.

B. Equipment shall not be driven directly on the geotextile.

C. At no time shall stakes or other objects be driven through the geotextile.

3.06 PROTECTION OF WORK

A. The Contractor shall use all means necessary to protect all work of this Section.

B. In the event of damage, the Contractor shall make repairs and replacements to the satisfaction of the Engineer at the expense of the Contractor.

TABLE 02771-1
REQUIRED PROPERTY VALUES FOR GEOTEXTILE

PROPERTIES	QUALIFIERS	UNITS	CUSHION SPECIFIED VALUES	CARRIER SPECIFIED VALUES	TEST METHOD
Type			Nonwoven[1]	Nonwoven, heat bonded[1]	(-)
Mass per unit area	minimum	oz/yd^2	10	-	ASTM D 5261
Mechanical Requirements					
Grab strength	minimum	lb	250	130	ASTM D 4632
Tear strength	minimum	lb	100	60	ASTM D 4533
Puncture strength	minimum	lb	145	41	ASTM D 4833
Durability					
Ultraviolet Resistance @ 500 hours	minimum	%	70	70	ASTM D 4355

Notes: (1) An Engineer approved equivalent may be substituted.
(2) For information purposes only, not a required property.

SECTION 13500
METHANE MONITORING SYSTEM

PART 1 — GENERAL

1.01 DESCRIPTION OF WORK

A. The Contractor shall furnish all labor, materials, tools, supervision, transportation, equipment and incidentals necessary to install a manual gas monitoring system as specified herein and as indicated on the Drawings.

1.02 REFERENCES

A. Drawings.

B. Site Construction Quality Assurance (CQA) Plan

1.03 SUBMITTALS

A. The Contractor shall submit, at least 7 days prior to installation, a written warranty covering defects in materials and workmanship for a period of not less than one year for the methane monitoring system equipment.

B. The Contractor shall submit to the Engineer for approval, at least 7 days prior to installation, Certificates of Compliance on materials furnished and manufacturer's brochures containing complete information and instructions pertaining to the storage, handling, and installation of equipment.

PART 2 — PRODUCTS

2.01 METHANE MONITORING PROBE

A. A labcock valve shall be supplied for each gas monitoring point, which shall be located in the subsurface gas monitoring vault as shown on the Drawings.

B. A subsurface gas monitoring vault shall be constructed for each building structure with a water tight, traffic rated cover.

C. PVC pipe shall meet the requirements outlined in Section 02616 and shall be connected within the subsurface gas monitoring vault by threaded connections or by using stainless steel self-tapping screws, in accordance with Section 02616.

PART 3 — EXECUTION

3.01 FAMILIARIZATION

A. Prior to implementing any of the work described in this Section, the Contractor shall become thoroughly familiar with the site, the site conditions, and all portions of the work falling within this Section.

3.02 PLACEMENT

A. The Contractor shall position the labcock valve such that it will be accessible for gas sampling upon completion of the installation.

[END OF SECTION]

CONSTRUCTION QUALITY ASSURANCE PLAN FOR THE CONSTRUCTION OF GAS MONITORING AND CONTROL SYSTEM BRITANNIA EAST GRAND DEVELOPMENT PHASE II

SOUTH SAN FRANCISCO, CALIFORNIA

Prepared for:

Slough Estates USA Inc.
444 North Michigan Avenue, Suite 3230
Chicago, Illinois 60611

Prepared by:

GeoSyntec Consultants
10875 Rancho Bernardo Road, Suite 200
San Diego, California 82127
(858) 674-6558

16 March 2006

CERTIFICATION PAGE

CONSTRUCTION QUALITY ASSURANCE PLAN
GAS MONITORING AND CONTROL SYSTEM
BRITANNIA EAST GRAND DEVELOPMENT – PHASE II
SOUTH SAN FRANCISCO, CALIFORNIA

The Engineering material and data contained in this Construction Quality Assurance Plan were prepared under the supervision and direction of the undersigned, whose seal as a registered Professional Engineer is affixed below.

// Original Signed By //

Steven M. Fitzwilliam, P.E.
Engineer of Record

TABLE OF CONTENTS

1. INTRODUCTION

1.1 Terms of Reference

This plan describes the gas monitoring and control system construction quality assurance plan (CQA Plan) for the proposed Brittania East Grand – Phase II development in South San Francisco, California (Site). This plan was prepared by GeoSyntec Consultants (GeoSyntec) for Slough Estates USA, Inc. (Slough). This plan was prepared by Mr. Steve Fitzwilliam, G.E., and was reviewed by Mr. Greg Corcoran, P.E., in accordance with the peer review policy of the firm.

1.2 Project Overview and Description

Slough proposes to construct Buildings 2, 7, 8, 9, and Parking Structure B at the Brittania East Grand – Phase II development site (Site). The Site is located on East Grand Avenue east of Haskins Way in South San Francisco, California.

Methane gas was detected in soil gas investigations conducted at the site in the Fall of 2004. Consequently, Slough plans to install a gas monitoring and control system beneath the Phase II structures. The gas monitoring and control system consists of the following components:

- gas barrier beneath the proposed buildings, consisting of a reinforced concrete structural slab, and a cold spray-applied geomembrane (Liquid Boot) applied to a non-woven heat bonded geotextile beneath Parking Structure B and Building 9 only;

- gas extraction system (GES) immediately below the gas barrier, consisting of polyvinyl chloride (PVC) pipe and a sand gas extraction layer beneath Building 2, 7, and 8 and an aggregate gas extraction layer beneath the enclosed areas of Parking Structure B

and Building 9 to collect and remove gas from beneath these structures; and

- manual gas monitoring system (MGMS) beneath the proposed buildings.

The location of the gas monitoring and control systems and associated details are shown on Detail Sheets 3 and 4 in Appendix A.

1.3 Refernces

The CQA Plan includes references to test procedures of the American Society for Testing and Materials (ASTM). Whenever an ASTM test procedure is refernced, it refers to the latest edition of the ASTM standard.

The CQA Plan includes references to the *Construction Documents*, which include:

- Construction Drawings, "Methane Mitigation System, Britannia East Grand Development," prepared by GeoSyntec, November 2005.
- Technical Specifications, "Technical Specifications for the Construction of Gas Monitoring and Control System, Britannia East Grand Development – Phase II," prepared by GeoSyntec, November 2005.
- Technical Addenda, as issued by the Design Engineer.

1.4 Plan Organization

The remainder of this plan is organized as follows:

- Section 2, *Quality Assurance and Quality Control (QA/QC) Overview*, outlines the terminology and the purpose of construction QA/QC.

- Section 3, *Responsible Parties and Definitions*, presents the main parties involved and defines the project terminology.

- Section 4, *CQA Organization*, presents the personnel titles and their responsibilities for this project.

- Section 5, *Meetings*, specifies meetings to be held and the attendees and items addressed at each meeting.

- Section 6, *PVC Pipe*, describes the CQA activities associated with installation of the PVC pipe system portion of the GES.

- Section 7, *Geomembrane Gas Barrier*, describes the CQA activities involved with installation of the cold spray applied geomembrane (Liquid Boot).

- Section 8, *Gas Monitoring System*, describes the CQA activities involved with the gas monitoring system installation.

- Section 8, *Documentation*, specifies the means and frequency by which information shall be recorded during construction of the gas monitoring and control system.

2. QUALITY ASSURANCE AND QUALITY CONTROL OVERVIEW

Construction Quality Assurance (CQA) and Construction Quality Control (CQC) involve the monitoring and testing of materials and construction to verify that the final product is constructed in accordance with the Construction Documents. While CQA and CQC are similar, and often referenced simultaneously (i.e., CQA/CQC), each is intended to serve a slightly different purpose.

The common thread between CQA and CQC is the monitoring and testing of materials and construction activities used to provide verification that the final product has been constructed in accordance with the Construction Documents. The difference between CQA and CQC is the party who is responsible for performing the duties. A third party, independent of the contractor and hired by the owner, typically performs CQA. CQC is usually performed by the contractor, or a party hired by the contractor, to aid the contractor in constructing a quality product. CQA information may be used to complement the Contractor's CQC function, in correcting work that does not satisfy project requirements.

Materials used to construct the gas monitoring and control system must meet or exceed the criteria indicated in the Construction Drawings and Technical Specifications (Construction Documents). The Gas Monitoring and Control System Design Consultant must approve any deviations from the Construction Drawings and Technical Specifications.

3. RESPONSIBLE PARTIES AND DEFINITIONS

3.1 Responsible Parties

The responsible parties for all Slough construction activities at this site are:

Owner

Slough Estates USA, Inc.
444 North Michigan Avenue, Suite 3230
Chicago, Illinois 60611

Project Manager

Project Management Advisors, Inc..
462 Stevens Avenue, Suite 106
Solana Beach, CA 92075
Contact: Bruce Heimbach, Project Manager
Phone: (858) 362-0483

General Contractor

Hathaway Dinwiddie
275 Battery Street, Suite 300
San Francisco, CA 94111
Contact: David Bowden
Phone: (415) 986-2718

Gas Monitoring and Control System Design Engineer (Engineer) and CQA Consultant

GeoSyntec Consultants
10875 Rancho Bernardo Road; Suite 200
San Diego, CA 82127
Contact: Greg Corcoran, P.E., Project Manager
Phone: (858) 674-6558

3.2 Definitions and Responsibilities

Definitions and responsibilities of the various companies and individuals involved with construction of the gas monitoring and control system are described below.

- Owner - Slough Estates USA., Inc.
- Project Manager - The representative of the owner overseeing and having ultimate responsibility for the project.
- General Contractor - The party responsible for the timely construction and installation of selected aspects of the project as delineated on the Construction Drawings and in the Technical Specifications.
- Subcontractor(s) - The party responsible for installation of components of the project as designated by the General Contractor.
- Gas Monitoring and Control System Design Engineer (Engineer) - The firm responsible for aspects of design of the gas monitoring and control system.

- Construction Documents - Documents pertaining to the construction project, including but not limited to, Final Reports, Construction Drawings, Technical Specifications, Field Logs, and Health and Safety Plans.

- CQA Consultant - The gas monitoring and control system CQA consultant, having overall responsibility for managing, coordinating, and implementing the gas monitoring and control system CQA activities and documenting that the Contractor's CQC activities are performed in accordance with Construction Documents.

- CQA Manager - The individual representative of the CQA consultant, having overall responsibility for managing, coordinating, and implementing the CQA activities and directing CQA field monitors.

- CQA Field Monitors - Representatives of the CQA Consultant, working under the direct supervision of the CQA Manager, responsible for daily implementation of the CQA activities.

- Geosynthetics Installer (Installer) - Particular subcontractor responsible for installation of the geosynthetic components of the project.

4. CQA ORGANIZATION

4.1 General

The personnel listed below will jointly carry out the CQA responsibilities for the construction of the gas monitoring and control system (the project). The responsibility of each individual is described in each section and the relationship of each entity to the others is presented in the Project Organization Chart at the end of this CQA Plan.

4.2 Project Manager

The Project Manager works on behalf of the Owner and has ultimate authority on the project and serves as mediator between the Contractor, CQA Consultant, and the Engineer.

4.3 General Contractor

The General Contractor is contracted to the owner and is responsible for the project construction and coordination with the subcontractors.

4.4 Gas Monitoring and Control System Design Consultant

The Engineer prepares Construction Drawings and Technical Specifications for the gas monitoring and control system. Any deviations or modifications from the Construction Drawings or Technical Specifications must be approved by the Engineer.

4.5 CQA Consultant

Representatives of the gas monitoring and control system CQA Consultant will perform CQA of the gas monitoring and control system. The CQA personnel include a CQA Manager and one or more CQA Field Monitors.

4.5.1 CQA Manager

The CQA Manager will be a representative of the CQA Consultant. Responsibilities of the CQA Manager include:

- reviewing the Construction Drawings, the Technical Specifications, and addenda;
- reviewing other Construction Documents, including proposed material layouts;
- administrating the CQA program (i.e., assign and manage all CQA personnel, review field reports and CQA logs, and provide engineering review of CQA related issues);
- providing quality control of the CQA activities, including site visits;
- reviewing changes to the design, the Construction Drawings, and the Technical Specifications;
- acting as the representative of the CQA Consultant;
- familiarizing CQA Field Monitors with the site, project documents, and project-specific CQA requirements;
- managing of the daily activities of the CQA Field Monitors;

- reviewing test results provided by contractors and making appropriate recommendations to Project Manager;

- reviewing CQA Field Monitors' daily reports and CQA logs;

- reporting to Project Manager and General Contractor, as well as documenting in the daily and weekly reports, any relevant observations reported by the CQA Field Monitors;

- overseeing of the collection, packaging, and shipping of samples recovered for laboratory testing;

- reviewing results of laboratory testing and making appropriate recommendations to Project Manager;

- reporting any unresolved deviations from the CQA Plan, the Construction Drawings, and the Technical Specifications to the Project Manager and General Contractor;

- reviewing submittals from the Contractor and making appropriate recommendations to the Project Manager and General Contractor;

- reviewing the qualifications of the Contractor and Geosynthetics Installer for conformance with the Technical Specifications and making appropriate recommendations to the Project Manager and General Contractor;

- taking note of observed on-site activities that could result in damage to components of the project and reporting them to the Project Manager and Contractor;

- performing duties of the CQA Field Monitors as needed; and
- preparing of the Final CQA Report(s).

4.5.2 CQA Field Monitors

The duties of the CQA Field Monitors, as assigned by the CQA Manager, include monitoring and documenting construction of the gas monitoring and control system. The duties of the CQA Field Monitors include:

- monitoring and testing of geosynthetics prior to and during installation;
- monitoring PVC pipe components and installation;
- monitoring sand or aggregate gas extraction system installation;
- monitoring geomembrane gas barrier installation;
- monitoring gas extraction equipment installation;
- recording CQA activities on field logs;
- preparing daily field reports;
- attending CQA related meetings (e.g., pre-construction, daily, weekly);
- assigning of locations for testing and sampling; and
- reporting to the CQA Manager.

In addition to these specific duties, CQA Field Monitors will take note of any on-site activities that could result in damage to the components of the project. Observations so noted by the CQA Field Monitors will be reported to the CQA Manager.

5. MEETINGS

5.1 Pre-Construction Meeting

A pre-construction meeting will be held prior to the commencement of construction activities at the Site. At a minimum, the meeting shall be attended by the Project Manager, the General Contractor, relevant Subcontractors, the CQA Manager, and the CQA Field Monitors.

Specific topics, pertaining to the CQA of the gas monitoring and control system to be considered for this meeting include:

- the responsibilities and lines of authority of each party;
- the status of submittals;
- establishment of work area security and safety protocols;
- the methods to be used for documenting and reporting;
- changes in the Construction Drawings and Technical Specifications relating to the gas monitoring and control system, if any;
- the establishment of protocols to be used for testing, deficiency identification, repairs, and retesting;
- the proposed equipment and methodology for installation of geosynthetics, aggregate and sand, PVC pipe, gas extraction equipment, and gas monitoring equipment;
- the gas monitoring and control system construction schedule and its relationship to other aspects of the project;

- the establishment of material stockpile, storage, and processing locations;

- a site walk to verify and review: (i) the limits of the construction area; (ii) the locations and routes of the haul roads; (iii) location of storage areas; and (iv) the demarcation of existing underground utilities.

The meeting will be documented in meeting minutes prepared by a person designated by the General Contractor at the beginning of the meeting. Within 2 working days of the meeting, draft minutes will be transmitted to representatives of parties in attendance for review and comment. Corrections and/or comments to the draft minutes shall be made within 2 working days of receipt of the draft minutes to be incorporated in the final meeting minutes.

5.2 Daily Progress Meetings

Daily progress meetings, as required, will be convened by the General Contractor and/or the CQA Manager. The daily progress meetings will be held prior to the start of a construction shift at the site. At a minimum, the Project Manager, the General Contractor, and the CQA Manager (or his representative) shall attend the meeting.

Topics considered for this meeting include:

- the proposed activities scheduled by the General Contractor for the day;

- the problems or deficiencies that have arisen during construction, if any;

- the status of unresolved issues from previous daily meetings;

- the results of test data;
- the Subcontractor's deployment of personnel and equipment; and
- the previous day's activities including the effectiveness of measures taken to alleviate deficiencies.

Topics discussed during meetings will be summarized by the CQA manager (or his representative) in daily field reports.

5.3 Weekly Progress Meetings

A weekly progress meeting will be held between the CQA Manager, the General Contractor and other concerned parties participating in the construction of the project for the duration of the installation of the gas monitoring and control system. This meeting will include discussions on the current progress of the project, planned activities for the next week, and revisions to the work plan and/or schedule. The meeting will be documented in meeting minutes prepared by a person designated by the General Contractor at the beginning of the meeting. Within 2 working days of the meeting, draft minutes will be transmitted to representatives of parties in attendance for review and comment. Corrections and/or comments to the draft minutes shall be made within 2 working days of receipt of the draft minutes to be incorporated in the final meeting minutes.

5.4 Resolution Meeting

A resolution meeting will be held when and if a problem or deficiency is present or likely to occur. At a minimum, the affected Contractor, relevant Subcontractors, Project Manager, CQA Manager, and the appropriate CQA

Field Monitor (s) shall attend the meeting. The purpose of the meeting is to define and resolve the problem or work deficiency as follows:

- define and discuss the problem or deficiency;
- review alternative solutions; and
- implement an action plan to resolve the problem or deficiency.

The meeting will be documented in meeting minutes prepared by a person designated by the General Contractor at the beginning of the meeting. Within 2 working days of the meeting, draft minutes will be transmitted to representatives of parties in attendance for review and comment. Corrections to and/or comments on the draft minutes shall be made within 2 working days of receipt of the draft minutes to be incorporated in the final meeting minutes. If the action plan to resolve the problem or deficiency requires a design change, approval of the design change will be obtained from the Engineer prior to the implementation of the action plan.

5.5 Project Control Visits

The Engineer may periodically visit the construction site. This visit should be coordinated by the CQA Manager and the General Contractor.

6. POLYVINYL CHLORIDE (PVC) PIPE AND FITTINGS

6.1 Material Requirements

PVC pipe and fittings must conform to the requirements of the Technical Specifications Section 02616. The CQA Consultant will document that the PVC pipe and fittings meet those requirements through manufacturer's quality control certificates, conformance testing, and visual examination of materials arriving on site.

6.2 Submittals

Prior to the installation of PVC pipe, the Manufacturer will provide to the CQA Consultant:

- a properties sheet including, at a minimum, all specified properties, measured using test methods indicated in the Technical Specifications, or equivalent; and
- a record drawing of the installed piping.

The CQA Consultant will document that:

- the property values certified by the Manufacturer meet the Technical Specifications;
- the measurement of properties by the Manufacturer are properly documented and that the test methods used are acceptable; and

6.3 Handling and Laying

Care will be taken during transportation of the pipe such that it will not be damaged.

Ropes, fabric, or rubber-protected slings and straps will be used when handling pipes. Chains, cables, or hooks inserted into the pipe ends will not be used. Two slings spread apart will be used for lifting each length of pipe. Pipe or fittings will not be dropped onto rocky or unprepared ground.

Pipes will be handled and stored in general accordance with the Manufacturer's recommendation. The handling of joined pipe will be in such a manner that the pipe is not damaged by dragging it over sharp and cutting objects. Slings for handling the pipe will not be positioned at joints. Sections of the pipes with deep cuts and gouges will be removed and the ends of the pipe rejoined.

6.4 Joints

Lengths of pipe will be assembled into suitable installation lengths by a manufacturer-recommended method. When installed for gas monitoring pipe, the pipe will be joined by the use of threaded connectors or stainless-steel self-tapping screws.

6.5 Pipe Hangers

Pipe hangers will be assembled and installed at a maximum spacing as specified in Section 02616 of the Technical Specification along the length of the gas extraction system piping and as shown on the Construction Drawings.

7. GEOMEMBRANE GAS BARRIER

7.1 Introduction

This section discusses the CQA of the geomembrane gas barrier component of the gas control system. Information presented in this section corresponds to Section 02770 of the Technical Specifications.

7.2 Design Familiarization

CQA personnel will review the Construction Drawings and Technical Specifications for familiarity. This review should not be considered as a peer review of the design.

7.3 Geomembrane Gas Barrier Material Conformance

CQA personnel shall verify that the geomembrane gas barrier delivered to the site meets the requirements of the Technical Specifications prior to installation. CQA personnel will:

- review the manufacturer's quality control (MQC) submittals for compliance with the Technical Specifications; and
- document the delivery and storage of geomembrane gas barrier component drums.

The following sections describe the CQA activities required to verify the conformance of the geomembrane gas barrier.

7.3.1 Review of Manufacturer Quality Control

7.3.1.1 Material Properties Certification

The Geomembrane Manufacturer will provide the General Contractor and the CQA Manager with the following:

- a properties sheet including, at a minimum, all specified properties, measured using test methods indicated in the Technical Specifications, or approved equivalent; and

- a certification that property values given in the properties sheet are guaranteed by the Geomembrane Manufacturer.

The CQA Manager will document that:

- the property values certified by the Geomembrane Manufacturer satisfy the requirements of the Technical Specifications as summarized in Table 7-1; and

- document that the test methods used are acceptable.

7.4 Storage

The General Contractor will provide storage space in a location (or several locations) such that on-site transportation and handling are optimized, if possible. Storage space should be protected from theft, vandalism, etc.

7.5 Geomembrane Gas Barrier Installation

CQA personnel will document that the geomembrane gas barrier installation is carried out in accordance with the Construction Documents, and manufacturer's recommendations.

7.5.1 Surface Preparation

CQA personnel will verify that the surface of the carrier geotextile does not contain stones or other debris that may damage the geomembrane gas barrier.

The Installer will certify in writing that the surface on which the geomembrane gas barrier will be installed (subgrade) is acceptable. The certificate of subgrade acceptance will be given to the General Contractor prior to commencement of geomembrane gas barrier installation in the area under consideration. The CQA Manager will be given a copy of this certificate by the General Contractor.

After the subgrade has been accepted by the Geosynthetic Installer, it will be the Installer's responsibility to indicate to the General Contractor any change in the subgrade condition that may require repair work. The General Contractor will ensure that the subgrade is repaired.

At any time before and during the geomembrane gas barrier installation, CQA personnel will indicate to the General Contractor locations that may not provide adequate support for the geomembrane gas barrier.

7.5.2 Geomembrane Gas Barrier Installation

The CQA Manager will evaluate changes in the schedule proposed by the Installer and advise the General Contractor on the acceptability of that change. The CQA Manager will verify that the condition of the subgrade has not changed detrimentally during installation.

Weather Conditions

Geomembrane will not be placed during precipitation, in the presence of excessive moisture (e.g., fog, dew), in an area of ponded water, or in the presence of excessive winds (i.e., wind gusts in excess of 20 mph (32 km/h)).

CQA personnel will verify that the above conditions are satisfied. Additionally, CQA personnel will verify that the subgrade has not been damaged by weather conditions. The Installer will inform the General Contractor if the above conditions are not satisfied.

Method of Placement

CQA personnel will verify the following:

- equipment used does not damage the geomembrane gas barrier by handling, trafficking, excessive heat, leakage of hydrocarbons or other means;

- the prepared subgrade surface underlying the geomembrane gas barrier has not deteriorated since previous acceptance, and is still acceptable immediately prior to geomembrane gas barrier installation;

- geosynthetic elements immediately underlying the geomembrane gas barrier are clean and free of debris;

- personnel working on the geomembrane gas barrier do not smoke, wear damaging shoes, or engage in other activities which could damage the geomembrane gas barrier; and

- direct contact with the geomembrane gas barrier is minimized (i.e., the geomembrane gas barrier is protected by geotextiles, or other suitable materials), in areas where excessive traffic may be expected.

The CQA Manager will inform the General Contractor if the above conditions are not satisfied.

7.5.2.1 Requirements of Personnel

All personnel shall have successfully completed a training course for installation of the geomembrane. The superintendent will have experience installing a minimum of 1,000,000 ft^2 of geomembrane gas barrier on at least five (5) different projects, using the same type of spray apparatus to be used on this project.

The Installer will provide the General Contractor and the CQA Manager with a resume for the proposed superintendent. This document will be reviewed by the General Contractor and the Geosynthetics CQA Manager.

Field Testing

Field testing will be performed by the Installer. One (1) 2-inch square sample of cured geomembrane gas barrier will be tested for every 2,000 square feet of geomembrane gas barrier installed. The sample will be tested for overall thickness (i.e. including the thickness of the carrier geotextile). The thickness of the carrier geotextile will then be deducted to confirm that the geomembrane gas barrier has been installed to a minimum thickness dry of 100 mils.

Smoke Testing

Smoke testing of the geomembrane gas barrier shall be performed to detect geomembrane leaks due to installation defects (i.e. improper seaming, insufficient material thickness, accidental puncture, mechanical penetrations, etc.). Smoke testing shall be performed at the end of each day of geomembrane installation by the Installer.

Smoke testing involves making an 8 to 12-inch incision in the cured geomembrane and using a smoke-generating device to inject smoke beneath the geomembrane through a tube. A Colt 4 device, manufactured by Concept Engineering Technologies, Inc, or equivalent, should be used to generate a glycerin-based smoke for the test. The smoke shall be passed through an electric blower and beneath the geomembrane through a leaf blower nozzle. Locations of smoke leakage should be observed and marked for subsequent repairs.

Procedures for Test Failure

The following procedures will apply whenever a sample fails a thickness test:

- The Geosynthetic Installer will check four (4) other samples in a 10' radius from the failed sample;
- If these samples are acceptable, the area will be resprayed such that the original sample area is at the minimum thickness; or
- If the four other samples are not acceptable, the procedure will be repeated until a radius of geomembrane gas barrier has the required minimum thickness.

CQA personnel will document all actions taken in conjunction with sample test failures.

7.5.3 Defects and Repairs

This section describes CQA activities to ensure that all defects, tears, punctures, damage, or voids will be repaired.

7.5.3.1 Repair Procedures

Portions of the geomembrane gas barrier exhibiting a flaw, or failing a destructive test, will be repaired. The repair will be made overlapping a patch of carrier geotextile a minimum of 3" beyond the edge of the defect. Geomembrane gas barrier will then be applied a minimum of 3" beyond the edge of the carrier geotextile.

7.5.4 Geomembrane Gas Barrier Acceptance

The Contractor will retain all ownership and responsibility for the geomembrane gas barrier until accepted by the Engineer.

The geomembrane gas barrier will be accepted by the Engineer when:

- the installation is finished;
- all documentation of installation is completed; and
- verification of the adequacy of all repairs, including associated testing, is complete.

TABLE 7-1

REQUIRED GEOMEMBRANE GAS BARRIER PROPERTIES

Properties	**Qualifiers**	**Units**	**Specified Values**	**Test Method**
Physical Properties				
Dry Thickness	minimum	mils	100	ASTM D 5994
Mechanical Properties				
Tensile Strength	minimum	psi	32	ASTM D 412
Elongation	minimum	%	1,300	ASTM D 412
Tensile Bond Strength to Concrete	minimum	ppf	132	ASTM D 413
Environmental Properties				
Methane Gas Permeability	maximum	N/A	None	ASTM D 1434

8. GEOTEXTILE

8.1 Introduction

This section discusses the CQA of the geotextile components of the gas monitoring and control system. Information presented in this section corresponds to Section 02771 of the Technical Specifications.

8.2 Manufacturing

The Geotextile Manufacturer will provide the General Contractor with a list of guaranteed "minimum average roll value" properties (defined as the mean less two standard deviations), for the type of geotextile to be delivered. The Geotextile Manufacturer will also provide the General Contractor with a written quality control certification signed by a responsible party employed by the Manufacturer that the materials actually delivered have property "minimum average roll values" which meet or exceed all property values guaranteed for that type of geotextile.

The quality control certificates will include:

- roll identification numbers;
- sampling procedures; and
- results of quality control testing.

Quality control tests must be performed in accordance with the test methods specified in Specification Section 02771. The test methods and required property values are repeated herein as Table 8-1.

The CQA Manager will examine Manufacturer certifications to verify that the property values listed on the certifications meet or exceed those specified for the geotextile. The CQA Manager will also verify that the test methods are acceptable and

the certificates have been provided at the specified frequency properly identifying the rolls related to testing. Any deviations will be reported to the General Contractor.

8.3 Labeling

The Geotextile Manufacturer will identify all rolls of geotextile with the following:

- manufacturer's name;
- product identification;
- lot number;
- roll number; and
- roll dimensions.

The CQA Manager will examine rolls upon delivery and any deviation from the above requirements will be reported to the General Contractor.

8.4 Shipment and Storage

During shipment and storage, the geotextile will be protected from ultraviolet light exposure, precipitation or other inundation, mud, dirt, dust, puncture, cutting or any other damaging conditions. To that effect, geotextile rolls will be shipped and stored in relatively opaque and watertight wrappings.

Geotextiles will not be exposed to ultraviolet light prior to being installed. Protective wrappings will be removed less than one hour prior to unrolling the geotextile. After the wrapping has been removed, a geotextile will not be exposed to sunlight for more than 15 days, unless otherwise specified and guaranteed by the Geotextile Manufacturer.

CQA personnel will observe rolls upon delivery at the site and any deviation from the above requirements will be reported to the General Contractor. Any damaged rolls will be rejected.

8.5 Installation

8.5.1 Handling and Placement

The Geosynthetic Installer will handle all geotextiles in such a manner as to ensure they are not damaged, and the following will be complied with:

- In the presence of wind, all geotextiles will be weighted with sandbags or the equivalent. Such sandbags will be installed during placement and will remain until replaced with overlying materials.

- A visual examination of the geotextile will be carried out over the entire surface after installation to ensure that no potentially harmful foreign objects are present.

CQA personnel will note any non-compliance and report it to the General Contractor.

8.6 Seams and Overlaps

Cushion geotextiles will be overlapped a minimum of 12 inches. Carrier geotextile will be overlapped a minimum of 6 inches.

8.7 Repair

Any holes or tears in the geotextile will be repaired with a patch. The patch will be made from the same geotextile and will be overlapped a minimum of 12 inches.

CQA personnel will observe any repair, note any non-compliance with the above requirements and report them to the General Contractor.

8.8 Placement of Overlying Materials

The Contractor will place reinforced concrete materials such that the underlying geotextile is not damaged.

Non-compliance will be noted by CQA personnel and reported to the General Contractor.

TABLE 8-1
REQUIRED PROPERTY VALUES FOR GEOTEXTILE

PROPERTIES	QUALIFIERS	UNITS	CUSHION SPECIFIED VALUES	CARRIER SPECIFIED VALUES	TEST METHOD
Type			Nonwoven	Nonwoven, heat bonded	(-)
Mass per unit area	minimum	oz/yd[1]	10	-	ASTM D 5261
Mechanical Requirements					
Grab strength	minimum	Lb	250	130	ASTM D 4632
Tear strength	minimum	Lb	100	60	ASTM D 4533
Puncture strength	minimum	Lb	145	41	ASTM D 4833
Durability					
Ultraviolet Resistance @ 500 hours	minimum	%	70	70	ASTM D 4355

Notes: (1) All values represent minimum average roll values (i.e., any roll in a lot should meet or exceed these values).
(2) For information purposes only, not a required property.

9. METHANE MONITORING SYSTEM

9.1 Introduction

This section outlines the CQA activities to be performed for the gas monitoring system. Information given in this section corresponds to Section 13500 of the Technical Specifications.

9.2 Equipment Requirements

9.2.1 Labcoack Valve

The labcock valve shall be supplied and installed as shown on the Construction Drawings. There shall be one labcock valve for each subsurface gas monitoring probe.

9.2.2 Subsurface Gas Monitoring Vault

The subsurface gas monitoring vault shall be supplied and installed as shown on the Construction Drawings and shall be large enough to accommodate the number of labcock valves required at each building and accommodate manual sampling. The vaults will be watertight and have a traffic-rated vault cover.

9.3 Manufacturer Submittals

At a minimum the Contractor will provide the General Contractor and the CQA Manager with a record drawing of the installed gas monitoring equipment, including each sampling location (access vault location(s))

9.4 Installation

9.4.1 Labcock Valve

Labcock valves shall be installed in general accordance with the Construction Drawings and Technical Specifications.

9.4.2 Subsurface Gas Monitoring Vault

Subsurface gas monitoring vaults shall be installed in general accordance with the Construction Drawings and Technical Specifications.

10. DOCUMENTATION

10.1 General

The effectiveness of a CQA Plan depends largely on (i) recognition of construction activities that should be monitored and (ii) assigning responsibilities for the monitoring of each activity. This is effectively accomplished and verified by the documentation of quality assurance activities. The CQA Manager will document that quality assurance requirements have been addressed and satisfied.

The CQA Manager will provide the General Contractor with signed descriptive remarks, data sheets, and logs to verify that all CQA monitoring activities have been carried out. The CQA Manager will also maintain, at the job site, a file of the Construction Drawings, Technical Specifications, CQA Plan, checklists, test procedures, daily logs, and other pertinent documents. CQA documentation shall be submitted to the Owner, Project Manager, and General Contractor following completion of the project.

10.2 Daily Record Keeping

10.2.1 General

Standard reporting procedures will include preparation of daily CQA documentation which, at a minimum, will consist of: (i) field notes, including memoranda of meetings and/or discussions with the General Contractor or the Gas Monitoring and Control System Design Consultant; (ii) CQA monitoring logs and testing data sheets; and (iii) construction problem and solution summary sheets. This information will be regularly submitted to and reviewed by the CQA Manager.

10.2.2 Monitoring Logs and Testing Data Sheets

Monitoring logs and testing data sheets will be prepared daily. At a minimum, these logs and data sheets will include the following information:

- date, project name, location, and other identification;
- weather conditions (i.e., temperature, precipitation);
- a site plan showing work areas and test locations;
- descriptions and locations of ongoing construction;
- equipment and personnel in each work area related to the gas monitoring and control system installation;
- a summary of test results;
- delivery of materials;
- decisions made regarding acceptance of units of work and/or corrective actions to be taken in instances of substandard testing results; and
- signature of the CQA Manager and/or the CQA Field Monitor(s).

10.2.3 Construction Problems

The CQA personnel will notify the General Contractor and the Engineer of any significant nonconformance with the Construction Drawings, the Technical Specifications, or the CQA Plan. The cause of the nonconformance will be determined and appropriate changes to the procedures, or the Construction Drawings and Technical

Specifications will be recommended. These changes will be submitted to the Engineer for review and approval. When this type of evaluation is made, the results will be documented, and the Engineer will approve any revision to the procedures, Construction Drawings, and/or Technical Specifications.

A summary of all supporting data sheets, along with final testing results and the CQA Manager's approval of the work, will be required upon completion of construction.

10.3 Photographic Reporting

Photographs will be taken by the CQA personnel and will serve as a pictorial record of work progress, problems, and mitigation activities. The primary project file will contain color prints; negatives or electronic files for digital photographs will be stored in a separate file.

10.4 Design, Technical Specifications, and/or Construction Drawing Changes

Design, Technical Specifications, and/or Construction Drawing changes may be required during construction. In such cases, the CQA Manager will notify the Engineer.

Design, Technical Specifications, and/or Construction Drawing changes will be made only with the written approval of the Engineer, and will take the form of an amendment to the Technical Specifications and/or the Construction Drawings. Documentation of design, Technical Specifications, and/or Construction Drawing changes will be maintained by the Gas Monitoring and Control System CQA Consultant and affected contractors.

10.5 CQA Report

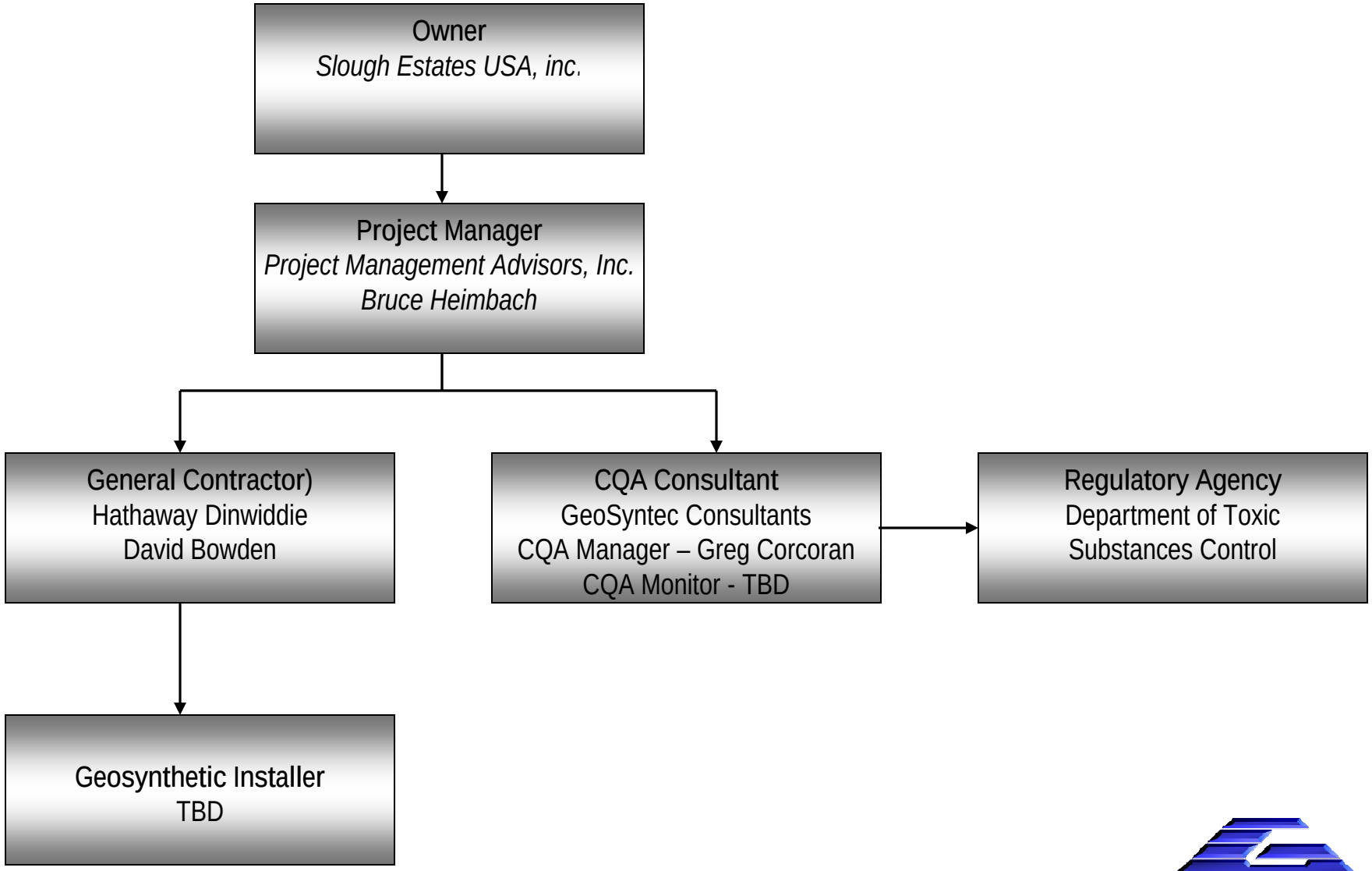
At the completion of the project, the CQA Manager will submit, to the Project Manager, a signed and sealed CQA Report. This report will acknowledge: (i) that the work has been performed in compliance with the Construction Drawings, the Technical Specifications, and approved changes; (ii) physical sampling and testing has been conducted at the appropriate frequencies in accordance with the CQA Plan; and (iii) that the summary document provides the necessary supporting information.

At a minimum, this report will include:

- summaries of construction activities;
- approved contractor submittals;
- monitoring logs and testing data sheets, including sample location plans;
- construction problems and solutions summary sheets;
- approved changes from the design, the Technical Specifications, and/or the Construction Drawings;
- record drawings to be prepared by the contractors as outlined in the Technical Specifications; and
- a summary statement indicating compliance with the Construction Drawings, the Technical Specifications, and approved changes which is signed and sealed by a Civil Engineer currently registered to practice in the State of California.

The CQA report will be submitted to the Department of Toxic Substances Control (DTSC) for comment and approval.

Project Organization Chart
Britannia East Grand – Phase II



GeoSyntec Consultants

OPERATION, MAINTENANCE, & MONITORING PLAN FOR THE CONSTRUCTION OF GAS MONITORING AND CONTROL SYSTEM BRITANNIA EAST GRAND DEVELOPMENT PHASE II

SOUTH SAN FRANCISCO, CALIFORNIA

Prepared for:

Slough Estates USA, Inc.
444 North Michigan Avenue, Suite 3230
Chicago, Illinois 60611

Prepared by:

GeoSyntec Consultants
10875 Rancho Bernardo Road, Suite 200
San Diego, California 92127
(858) 674-6559

16 MARCH 2006

TABLE OF CONTENTS

Page

TABLES

FIGURES

1. INTRODUCTION

1.1 Terms of Reference

This document comprises the Operation, Maintenance and Monitoring (OMM) Plan for the gas monitoring and control system at the Britannia East Grand Development for Slough Estates USA, Inc., (Slough). The project is located on East Grand Avenue east of Haskins Way in South San Francisco, California (Site). This plan was prepared by Mr. Steve Fitzwilliam, P.E. and has been reviewed by Mr. Gregory T. Corcoran, P.E., both of GeoSyntec Consultants (GeoSyntec), in accordance with the peer review policies of the firm.

1.2 Purpose

The purpose of this document is to outline the general operation and maintenance (O&M) procedures and manufacturer information relative to the components of the gas monitoring and control system (the System). This Plan includes procedures for monitoring the integrity of the System, which is comprised of a gas barrier, gas extraction equipment, and gas monitoring equipment.

The purpose of this document is also to outline the gas monitoring and reporting procedures for the System at the Site and identify an appropriate monitoring schedule.

Finally, this document describes the risk management procedures for implementing engineering and institutional controls to acceptably minimize the potential risk to human health and life at the Site.

1.3 Responsible Parties

Slough Estates USA, Inc. (Slough) is ultimately responsible for maintaining the integrity of the System. We understand that Slough will contract with an O&M contractor for the System, who will be responsible for communicating with Slough, managing the operation and maintenance of the System, and preparing reports for Slough. The Slough local representative (Facilities Manager) will be responsible for responding to alarms, operating and maintaining the System, and notifying the O&M contractor of potential problems. This OMM Plan will be amended if conditions and/or responsibilities change.

The following parties are currently involved with the OMM of the System:

Owner Slough Estates USA, Inc. 444 North Michigan Avenue, Suite 3230 Chicago, Illinois 60611 Contact: Jon Bergschneider Phone: (312) 755-0700 Fax: (312) 755-0717	**Facilities Manager** Britannia Management Services 555 12th Street, Suite 1650 Oakland, CA 94607 Contact: Ann Nelson Phone: (510) 834-7116- Fax: (510) 763-6262-
Gas Monitoring & Control System Engineer GeoSyntec Consultants 10875 Rancho Bernardo Road, Ste. 200 San Diego, California 92127 Contact: Gregory T. Corcoran, P.E. Phone: (858) 674-6559 Fax: (858) 674-6586	**Regulatory Oversight** Dept. of Toxic Substances Control 700 Heinz Avenue, Suite 100 Berkeley, CA 94710 Contact: Amber Harmon Phone: (510) 540-3779 Fax: (510) 540-3937

1.4 Health and Safety

The O&M Contractor shall prepare a site-specific Health and Safety Plan (HASP), in accordance with OSHA regulations, for performing the work associated with the gas extraction and gas monitoring system sections of the O&M Plan.

1.5 Report Organization

The remainder of this plan is organized as follows:

- Section 2, "*Site Background*," contains background information regarding the site, including site history, configuration, and constituents of concern.

- Section 3, "*Gas Extraction System*," contains information regarding the description, location, operation, and maintenance of the gas extraction system components.

- Section 4, "*Gas Barrier*," contains information regarding the description, location, operation, and maintenance of the gas barrier at the Site.

- Section 5, "*Gas Monitoring System*," contains information regarding the description, location, operation, and maintenance of the gas monitoring system components.

- Section 6, "*Monitoring and Reporting*," contains information about gas monitoring frequency and reporting of the results.

- Section 7, "*Management of Potential Risks*," describes precautions that need to be taken during subsurface work, such as utility repair and installation of Site improvements with subsurface components.

- Section 8, "*Summary*," summarizes the OMM Plan.

- Section 9, "*References*," provides a list of resources utilized for the compilation of this document.

Tables and figures are presented at the end of this document.

2. SITE BACKGROUND

2.1 Site Information

The Site is located on East Grand Avenue east of Haskins Way in South San Francisco, California. Methane gas was detected during two 2004 soil gas investigations. Consequently, Slough installed a gas monitoring and control system beneath the enclosed structures at the site. As shown on Figure 1, the site is separated into Phase I and Phase II. Phase II is again separated into Phase II North and Phase II South. Phase I and Phase II North can be grouped together from a Methane monitoring stand point. Phase II South (Building 9 and Parking Structure B) will require reporting to the California Department of Toxic Substances Control (DTSC). This OMM Plan was prepared for Phase II.

2.2 Constituents of Concern

Methane gas concentrations greater than 20 percent have been encountered in the subsurface near the Site [GeoSyntec, 2004]. Concentrations of methane exceeding the lower explosive limit (LEL) (5% by volume); pose significant risk of fire hazard and/or explosion. The constituent of concern at the Site is methane.

2.3 Site Construction

Phase II for this project includes Buildings 2, 7, 8, and 9 and Parking Structure B. GeoSyntec designed the System, which will be installed beneath the building structures at the site.

The System is designed to mitigate the migration of explosive gas into the development at the Site. The System is comprised of two main subsystems, the gas control system, which includes the gas barrier and the gas extraction system, and the gas monitoring system, which includes manual monitoring of explosive gas concentrations. The gas barrier, which minimizes gas migration pathways into the development, consists of a geomembrane and/or a reinforced concrete structural slab and utility trench cut-offs. The gas extraction system is comprised of horizontal air inlet and gas extraction piping laid within sand beneath the building slabs or within aggregate beneath the geomembrane beneath the building slabs. The gas barrier consists of the reinforced concrete structural slab, which is supplemented with a geomembrane in Phase II south. The horizontal air inlet piping is connected to vertical

pipes, which terminate above the roofline.

Included in the gas monitoring system are gas monitoring, which are used to manually monitor the concentrations of explosive gases beneath the gas barriers.

Structure	No. of Gas Monitor Probes
Building 2	5
Building 7	5
Building 8	5
Building 9	5
Parking Structure B	2

3. GAS EXTRACTION SYSTEM

3.1 General

The gas extraction system is designed to collect and remove gases that may accumulate beneath the reinforced concrete structural slab or geomembrane gas barrier at the Site. The gas extraction system is integrated with the gas monitoring system, as discussed in Section 5.

The gas extraction system (GES) is generally divided into two distinct areas: Phase II North (Buildings 2, 7, and 8) and Phase II South (Parking Structure B and Building 9). The primary component of the GES is a system of 2-inch diameter polyvinyl chloride (PVC) that functions as a porous layer in which gases may accumulate and be extracted from beneath the gas barrier. The system of PVC pipes include alternating air and gas extraction pipes which serve to introduce air from the atmosphere and flush gases from the subsurface. The PVC piping is supported from the overlying reinforced concrete structural slab by means of stainless steel pipe hangers in areas where settlement is expected. The PVC piping is supported on the subgrade soils elsewhere. The gas extraction system details are shown on Figure 2.

Extracted gases are vented to the atmosphere through a vent pipe located on the roof of the building structures or within the adjacent mechanical yard. The air inlet piping includes a single cap at the roofline to minimize infiltration of foreign objects into the piping.

3.2 Piping

The horizontal gas extraction and air inlet piping is comprised of both solid wall and perforated 2-inch Schedule 40 PVC pipe. In general, solvents will be used in the joining of the PVC pipes. The gas monitoring probe piping consists of ½-inch Schedule 40 PVC pipe. PVC piping used as components of the gas monitoring probes will be joined using threaded connections or self-tapping stainless steel screws. Pipe hangers will be used to support the 2-inch PVC piping from the overhead slab where needed. The piping locations are shown on Figures 3A through 3E. The vertical air inlet pipes are comprised of 2-inch piping.

Exposed and/or accessible PVC piping will be monitored after the completion of any subsurface work at the site to determine if any damage has occurred

to the piping. Repairs made to the PVC piping or pipe hangers shall be as directed in the Technical Specifications, Section 02616. The use of solvents and adhesives is acceptable, except as a method of repairing the components of the gas monitoring probes. In addition, the portions of the pipes located on the roof shall be inspected annually for any breaks, cracks, or otherwise deleterious conditions. The sealant surrounding pipe penetrations through concrete shall be visually inspected for cracks and deterioration. If necessary, additional sealant shall be applied, in accordance with the Specifications, to maintain an airtight seal and to minimize gas migration.

3.3 Air Inlet

The air inlet allows air to flow into the gas extraction system. The air inlet is attached to the vertical air inlet pipes located on the roof of the buildings (Figures 3A – 3E). The vertical air inlet piping, which is comprised of PVC inside the building structure and ductile iron as it penetrates the roof and is exposed outside the building structure, has a rain shield on the opening to minimize water or foreign debris from entering the System.

Maintenance of the air inlet requires checking the rain shield annually for debris and monitoring exposed piping for breaks or cracks. Damage to the rain shield and/or piping may allow the intrusion of water or refuse into the air inlet, which could affect the performance of the System.

4. GAS BARRIER

The purpose of the gas barrier is to minimize the migration of gases from the subsurface into the building and parking structure areas of the Site. Beneath the enclosed areas of Parking Structure B and Building 9, the gas barrier includes a reinforced concrete structural slab and a geomembrane. Beneath Buildings 2, 7, and 8, the gas barrier consists of a reinforced concrete structural slab.

4.1 Geomembrane Gas Barrier

The geomembrane gas barrier is comprised of a cold spray-applied geomembrane. This geomembrane is sprayed onto a nonwoven heat bonded carrier geotextile that is installed overlying the gas extraction piping. A nonwoven cushion geotextile is placed overlying the geomembrane gas barrier to cushion the geomembrane during the installation of the overlying reinforced concrete structural slab components.

In the event of subsurface work at the Site that requires penetration of the gas barrier, the geomembrane and any damaged underlying components shall be repaired immediately. All repairs to the geomembrane shall be made in accordance with the Technical Specifications. Appropriate measures shall be taken to seal all possible gas migration pathways. The integrity of the geomembrane gas barrier is crucial to the overall performance of the System and must be preserved in all cases.

4.2 Concrete Gas Barrier

The concrete gas barrier consists of a 10-inch thick, steel reinforced concrete slab. The concrete gas barrier is an integral part of the System; however there are no operating mechanisms.

In the event of subsurface work at the Site, the concrete gas barrier and any damaged underlying components shall be repaired immediately. Furthermore, should any alterations to the slab require penetrations to the full depth of the reinforced concrete, appropriate measures shall be taken to seal all possible gas migration pathways.

5. GAS MONITORING SYSTEM

The purpose of the gas monitoring system is to determine the concentrations of explosive gases in the subsurface beneath buildings at the site. The gas monitoring system for Buildings 2, 7, 8, and 9 consists of five strategically placed subsurface gas monitoring probes beneath the Site for each building and two subsurface gas monitoring probes beneath Parking Structure B. The gas monitoring probes will be manually sampled on a regular basis. Monitoring should commence once the building framing and shell of the building have been completed (i.e. an enclosed structure has been created). Based on the concentration of explosive gases detected, if any, appropriate individuals may be notified.

5.1 Manual Monitoring (Subsurface)

5.1.1 Gas Monitoring Probe

Each gas monitoring probe is comprised of solid wall and perforated ½" PVC pipe and connectors. The gas monitoring probe is a 3-foot length of horizontally placed, perforated PVC pipe, capped at both ends, beneath the reinforced concrete barrier. Various lengths of solid-wall PVC pipe connect the monitor point with the labcock valve in the vault located outside the perimeter of each building. Each monitoring probe is housed in an airtight, traffic rated vault cast within concrete.

A small portion of the PVC pipe and connected labcock valve are visible within the monitoring vault. Maintenance of the gas monitoring probe includes checking for cracks, weathering, or other damage to the PVC riser pipe or sampling labcock valve that may inhibit routine monitoring.

5.1.2 Monitoring Probe Labcock Valves

Each gas monitoring probe includes a labcock valve for collecting gas samples. The labcock valves used at the Site are ¼" PVC threaded Asahi labcock valves. After being wrapped in Teflon tape, the labcock valves are threaded into a PVC couple. When the monitoring vaults are opened for sampling, each labcock valve shall be visually inspected for excessive damage, wear, and/or clogging. In addition, if a closed labcock valve is determined to allow gas to escape, it shall be replaced. Replacement valves can be obtained from the following: Consolidated Plastics Company, Inc., 8181 Darrow Road, Twinsburg, OH, 44087, (800) 362-1000.

5.1.3 Gas Monitoring Vaults

Each of the valve vaults at the Site contains a watertight lid sealed with a neoprene gasket. The monitoring vaults can be opened using a hexagonal head socket wrench.

When the monitoring vaults are opened for sampling, the condition of the neoprene gasket seal shall be visually inspected. If the neoprene gasket has been damaged, it must be replaced.

In addition to visually inspecting the neoprene gasket seals, each monitoring vault shall be inspected for excessive amounts of water. Water in the monitoring vault may indicate a leaking seal that needs replacement. The water in the vault must be removed promptly upon discovery. A wet-dry vacuum may be suitable for this purpose.

6. MONITORING AND REPORTING

6.1 Gas Monitoring

In addition to operations and maintenance (O&M) of System components, gas monitoring at the Site is also necessary. The purpose of gas monitoring is to develop an understanding of explosive gas conditions and alter the monitoring frequency, if warranted. Manual gas monitoring is incorporated in the design for Phase II at the Site.

The maintenance frequency and procedures for System components are summarized in Table 1. A gas monitoring procedural checklist for the gas monitoring system is included as Table 2. In addition, gases may accumulate in subsurface utility vaults, such as manholes and catch basins. Therefore, a gas monitoring procedural checklist for the subsurface features is included as Tables 3A and 3B.

6.1.1 Manual Monitoring (Subsurface)

The gas monitoring probes integral to the manual system will be sampled on a routine basis to determine subsurface explosive gas concentrations and identify gas concentration trends, if any. Gas samples are drawn from the gas monitoring probes using a sample pump and analyzed using a portable combustible gas indicator (CGI or Landtech CEM 2000). Each gas monitoring probe is purged of four volumes of the gas monitoring probe prior to sampling. Proper sampling documentation forms and the gas monitoring checklist (Table 2) shall be filled out for each monitoring event.

The O&M Contractor is responsible for maintaining and updating the manual gas monitoring database files. Consistent and regular updating of the gas monitoring database allows trends to be identified and for the O&M Contractor to anticipate and correct potential problems before they become serious. On a regular basis, gas monitoring data will be evaluated by the O&M Contractor. Figures and tables representing current gas monitoring data will be included in the periodic letters, as discussed in Section 6.2.

In order to establish a baseline of gas monitoring data, manual monitoring will be performed on a weekly basis for the first month, on a monthly basis for the remainder of the first quarter, and continue on a quarterly basis for the first year.

Upon completion of 4 consecutive quarterly sampling events, the data will be assessed for each individual building. If the data from the most recent 4 quarterly sampling events for an individual building indicate that explosive gas concentrations are consistently lower than 25% of the LEL, sampling will be reduced to annually for the specific building only. If data indicates that concentrations in any single monitoring probe exceed 25% of the LEL, continue quarterly sampling in each monitoring probe associated with the building until the above criteria can be met and the monitoring frequency lowered.

Similarly, upon completion of 4 consecutive annual sampling events, the data will be assessed from each individual building. If the data from the most recent 4 annual sampling events for an individual building indicate that explosive gas concentrations are consistently lower than 5% of the LEL, perform an evaluation, by a qualified registered professional engineer or geologist licensed in the State of California, of the data to assess the ability to cease monitoring. If data indicates that concentrations in any single monitoring probe exceed 5% of the LEL, continue annual sampling in each monitoring probe associated with the building until the above criteria can be met and the monitoring frequency lowered.

A diagram summarizing the monitoring procedure described above for the Britannia East Grand project is presented on Figure 4.

6.2 System Reporting

The results of the gas monitoring for the Site shall be reported at the end of the first month, the end of the first quarter, and at the end of the first year of monitoring. The reports shall be issued to the Site Owner. The results of the monitoring for Phase II South shall also be reported to DTSC (Department of Toxic Substances Control, c/o Ms. Amber Harmon, 700 Heinz Avenue, suite 200, Berkeley, California 94710). Included in the monitoring reports shall be:

- Presentation of gas monitoring data, including tables and figure;
- The completed sampling documentation form;
- Discussion of any changes to the System; and
- Conclusions and recommendations regarding the results of the gas monitoring program.

7. CONTINGENCY ITEMS

This section contains a description of the contingency items to be addressed following an exceedence of methane gas action levels.

7.1 Manual Gas Monitoring System Data Evaluation

Upon completion of the subsurface manual gas monitoring, the O&M Contractor shall evaluate the data for methane gas concentrations. If one or more data points are greater than 100% of the LEL for methane (5% by volume) and after verification that the gas monitoring equipment is functioning properly, blower(s) for the affected building may need to be added to the gas extraction system at the discretion of the Engineer.

7.2 Equipment Malfunction

In the event of equipment malfunction, equipment should be repaired to meet the project specifications.

8. MANAGEMENT OF POTENTIAL RISKS

Risk management is the process of implementing engineering and institutional controls to acceptably minimize the potential risk. The management of potential risks to human beings at the site should consist of two primary elements: 1) education/communication, and 2) implementation of risk management measures. Britannia East Grand site maintenance employees need to be aware of the potential risks present at the Site. These employees also need to have an understanding of what activities could increase their potential risk and procedures to adopt which will acceptably minimize potential exposure to contaminants.

8.1 Employee Education/Communication

Britannia East Grand maintenance employees should be educated as to the Site conditions and potential risks associated with methane gas in the subsurface at the Site. Employees should confirm that they agree to comply with the relevant procedures specified herein, in the event they are involved in or required to perform subsurface work at the Site. Employees should be informed that, with the corrective measures implemented at the Site, there is an insignificant risk to employees. Although the potential risks may be considered insignificant, activities that may expose employees and site visitors to unnecessary risks associated with explosive gas in the subsurface need to be communicated to the employees.

The information to be communicated to the employees includes the Site background and corrective measures described in this section. This information could be posted in a place where employees could review the documentation. Alternatively, the information could be communicated to the employees as a part of the routine employee orientation and continued health and safety training for Site maintenance employees.

Employees should be required to confirm, in writing, that they have been briefed about the Site conditions, the current risks, and the types of activities that may increase their personal risk. The Human Resources Department should maintain the documentation regarding employee notification and training in each employee's personnel file.

8.2 Implementation of Risk Management Measures

The risk management measures that will be implemented at the Site will consist of health and safety plans, subsurface work requirements, inspections of the System, and the responsibilities of the O&M contractor.

8.2.1 Health and Safety Plans

A site specific Health and Safety Plan (HASP) should be prepared by the firm or subcontractor performing subsurface work, in accordance with OSHA regulations, for the specific work to be prepared.

Slough will notify subcontractors of potential hazards prior to commencing subsurface work. Slough should require the contractor to prepare and submit a HASP prior to commencing subsurface work. The contractor's HASP should not only be designed to protect their workers, but should also include measures to protect Site employees and visitors.

8.2.2 Subsurface Work Checklist

This section contains procedures to be followed in the event that subsurface work is needed at the Site. Typical subsurface work may include, but is not limited to:

- Utility installation/repair;
- Repair of gas monitoring or control systems;
- Improvements to Site structures with subsurface components; or
- Response to natural disasters.

Slough shall perform the following prior to and during subsurface work at the Site:

1) Locate proposed area of work on site map (Figures 3A – 3E);

2) Locate gas monitoring and control system components and evaluate whether the work may affect the gas monitoring and control system;

3) Locate existing utilities and evaluate whether the work may affect them;

4) Be prepared to repair and/or replace gas monitoring and control system components that may have to be removed or are damaged during the work. Should any damage be done to these systems, the gas monitoring and control system design engineer (GeoSyntec Consultants) must be notified;

5) Obtain appropriate air monitoring equipment and personal protective equipment. While work is being performed, air monitoring is to be conducted in accordance with the HASP;

6) Perform work in accordance with HASP. It is the responsibility of the Contractor performing the work that the health and safety of Site employees, customers, and surrounding industries be protected;

8) Protect work area from unauthorized personnel;

9) Repair and/or replace damaged gas monitoring and control system components; and

10) Repair concrete and asphalt pavements as soon as subsurface work is complete. The concrete layer and asphalt pavement is part of the gas monitoring and control system at the Site and must be repaired.

In addition to the above checklist, there are some other considerations that must be taken into account with subsurface work. Appropriate caution must be taken with the use of heavy equipment for excavation purposes. Due to the potential presence of methane, the possibility for fires and explosions exists; therefore, employees should confirm that they agree to comply with the relevant procedures specified herein, in the event they are involved in or required to perform subsurface work at the Site.

8.2.3 System Inspections

In order to maintain their integrity, the System components must be visually inspected on a periodic basis to check for signs of wear, distress, or damage. Those components specific to the gas monitoring system shall be inspected during regularly scheduled monitoring events. Other components, including those incidental to the gas extraction system, shall be inspected on at least an annual basis. The maintenance frequency and procedures for System components are summarized in Table 1.

9. SUMMARY

The gas monitoring and control system at the Site has been designed to minimize the migration of subsurface gases into the site developments. Proper O&M of gas monitoring and control system components is necessary to ensure the system functions as designed.

Sections 3 through 5 describe standard O&M procedures for components of the gas extraction system, gas barrier, and the gas monitoring system, respectively. A comprehensive list of maintenance procedures and frequencies for system components is located in Table 1. Routine maintenance of the System is crucial to maintaining the performance of the gas monitoring and control system at an optimal level. Benefits of routine maintenance are:

- Aid in smooth operation of the gas monitoring and control system;
- Detection of potential problems;
- Minimize the need for major maintenance; and
- Minimize gas monitoring and control system malfunction due to O&M related problems.

In addition to operating and maintaining the System, explosive gas concentrations beneath the buildings at the Site will be monitored and the results will be reported. Section 6 describes the O&M procedures for monitoring and reporting of the analytical results of the gas monitoring program. Explosive concentrations shall be monitored and reported on a periodic basis. Should gas concentrations decrease significantly, a reduction in the duration and frequency of monitoring may be warranted. Alternatively, if gas concentrations across the Site increase, additional monitoring may be prudent.

Section 7 describes the procedures of implementing engineering and institutional controls to acceptably minimize the potential risk to employees and visitors to the Site. The primary objectives of the risk management process are education/communication and implementation of control measures.

10. REFERENCES

GeoSyntec Consultants. 2004a. *Evaluation of Methane in Soil Gas, 450 E. Grand Avenue, South San Francisco, California*. November 19.

GeoSyntec Consultants. 2004b. *Methane Mitigation Plan, Britannia East Grand Development, South San Francisco, California*. November 23.

GeoSyntec Consultants. 2005. *Memorandum, Gas Monitoring and Control System, Britannia East Grand – Phase II*. September 7.

Iris Environmental. 2004a. *Draft Soil Gas Investigation Report, 450 East Grand Avenue, South San Francisco, California*. September 10.

Iris Environmental. 2004b. *Draft Methane Investigation Report, 450 East Grand Avenue, South San Francisco, California*. October 20.

Los Angeles RWQCB and the Department of Toxic Substances Control (LARWQCB-DTSC). 2003. *Advisory – Active Soil Gas Investigations*. January 28.

TABLE 1
MAINTENANCE PROCEDURES
BRITANNIA EAST GRAND - PHASE II DEVELOPMENT
SOUTH SAN FRANCISCO, CALIFORNIA

Component	Location	System	Maintenance Frequency	Maintenance Notes	Supplier
PVC Piping	subsurface	Gas Extraction System	As needed	check during and after subsequent subsurface work	
Ductile Iron Piping	roof	Gas Extraction System	As needed	check for breaks, cracks, and corrosion	
Air Inlet	roof	Gas Extraction System	As needed	check for debris buildup, breaks, cracks, and corrosion	
Concrete slab	Buildings 2, 7, 8, and 9, Parking Structure B	Gas Barrier System	As needed	repair if full slab-depth cracking is evident	
Geomembrane	Building 9 Parking Structure B	Gas Barrier System	As needed	repairs need to be in accordance with the Technical Specifications	To be determined Address Phone
Vapor Monitoring Probes	subsurface	Gas Monitoring System	During monitoring	check visible PVC pipes for cracks, weathering	
Labcock valves	monitoring vaults	Gas Monitoring System	During monitoring	check for damage, wear, clogging	To be determined Address Phone
Monitoring Vaults	Buildings 2, 7, 8, and 9, Parking Structure B	Gas Monitoring System	During monitoring	check neoprene gasket seal, remove any water present in vault	To be determined Address Phone

TABLE 2
ANNUAL MAINTENANCE CHECKLIST
BRITANNIA EAST GRAND - PHASE II
SOUTH SAN FRANCISCO, CALIFORNIA

Date	Time On-Site	Name
	Time Off-Site	Company

☐ Check visible piping for breaks, cracks, corrosion
Yes/No Repair Required? If yes, describe:

☐ Check Air inlet on the roof for debris buildup, breaks, cracks, corrosion
Yes/No Repair Required? If yes, describe:

☐ Maintenance perfomed on the subsurface PVC piping during past year?
Yes/No Repair Required? If yes, describe:

☐ Maintenance perfomed on the valves/valve vaults during past year?
Yes/No Repair Required? If yes, describe:

☐ Maintenance perfomed on the gas monitoring probes/vaults during past year?
Yes/No Repair Required? If yes, describe:

☐ Maintenance performed on the concrete slab during the past year?
Yes/No Repair Required? If yes, describe:

☐ Maintenance performed on the geomembrane during the past year?
Yes/No Repair Required? If yes, describe:

Notes:

TABLE 3A - Gas Monitoring Probes
GAS MONITORING CHECKLIST
BRITANNIA EAST GRAND - PHASE II
SOUTH SAN FRANCISCO, CALIFORNIA

Date	Time On-Site	Name
	Time Off-Site	Company

Sample Pump Model / ID	Flow Rate _____ L/min

Monitor Model / ID	Calibrated

	Equipment Readings					Maintenance Procedures / Notes		
Monitoring Location	Purge Time (sec)	% CH4	% LEL	% CO2	% O2	Check GMP / valve?	Check seal on vault?	Water in vault?
Building 2								
SG - 1								
SG - 2								
SG - 3								
SG - 4								
SG - 5								
Building 7								
SG - 1								
SG - 2								
SG - 3								
SG - 4								
SG - 5								
Building 8								
SG - 1								
SG - 2								
SG - 3								
SG - 4								
SG - 5								
Building 9								
SG - 1								
SG - 2								
SG - 3								
SG - 4								
SG - 5								
Parking Structure B								
SG - 1								
SG - 2								

Notes:

TABLE 3B - Subsurface Utility Enclosures
GAS MONITORING CHECKLIST
BRITANNIA EAST GRAND - PHASE II
SOUTH SAN FRANCISCO, CALIFORNIA

Date	Time On-Site	Name
	Time Off-Site	Company

Sample Pump Model / ID	Flow Rate _____ L/min

Monitor Model / ID	Calibrated

	Equipment Readings						Equipment Readings				
GML#	Purge Time (sec)	% CH4	% LEL	% CO2	% O2	**GML#**	Purge Time (sec)	% CH4	% LEL	% CO2	% O2
1						25					
2						26					
3						27					
4						28					
5						29					
6						30					
7						31					
8						32					
9						33					
10						34					
11						35					
12						36					
13						37					
14						38					
15						39					
16						40					
17						41					
18						42					
19						43					
20						44					
21						45					
22						46					
23						47					
24						48					

GML - Gas Monitoring Location

Notes: