A.G. Wassenaar Inc.
Geotechnical and Environmental Consultants
2180 South Ivanhoe Street, Suite 5
Denver, Colorado 80222-5710
303-759-8100 Fax 303-756-2920
www.agwassenaar.com

May 27, 2011

Denver, Colorado 80237

Subject: ***Soil and Foundation Study***
Proposed Residential Structure
Lot 15, Block 2
Reata North, Filing 7
Parker, Colorado
Project Number 110897

Purpose

As requested, we have performed a soil and foundation study at the subject site. The purpose of our study was to observe subsurface conditions encountered and to recommend geotechnical design criteria for the design and construction of the foundation for the proposed residence. For purposes of this study, we understand and assume the overexcavation recommendations provided in our report, "Geotechnical Due Diligence Study", for the subject site, A. G. Wassenaar, Inc. Project Number 101965, dated November 15, 2011, have been followed. This letter presents a summary of our findings and recommendations.

Subsurface Conditions

The field exploration included drilling a 4-inch diameter auger boring near the center of the lot in the upper level to a depth of approximately 29½ feet. The subsurface materials encountered consisted of:

0′	to	19′	Fill (moisture treated), processed sandstone and claystone, medium dense to very stiff, moist, mottled brown and gray
19′	to	27½′	Claystone (bedrock), hard to very hard, silty, moist, rust brown to olive
27½′	to	29½′	Sandstone (bedrock), very hard, poorly cemented, silty, moist, gray

Date of drilling: April 28, 2011

Depth to water: Dry at the time of drilling
26 feet 12 days after drilling

Laboratory Testing

Samples obtained during drilling were returned to the laboratory. They were visually classified and testing was assigned to selected samples in an effort to evaluate the engineering properties of the subsurface materials encountered. Site specific laboratory swell/consolidation tests exhibited low to moderate measured swell (0.7% at a depth of 19 feet and 2.1% at a depth of 24 feet) upon an increase

in moisture content under a load of 1,000 pounds per square foot (psf). Based upon visual observation of the subsurface conditions encountered and laboratory testing for this and/or adjacent lots, it is our opinion that the subsurface materials generally exhibit no to low potential for expansion. Refer to the Colorado Geological Survey Special Publication 43 for a description of expansive soils and their impact on structure performance.

Foundation Recommendations

Based on our evaluation of the subsurface conditions, the proposed residence may be founded upon spread or pad-type footings bearing on properly placed and compacted fill. The footings should be designed for a maximum bearing pressure of 2,500 psf with a minimum dead load pressure of 800 psf. Four-inch void material should be installed in areas where the minimum dead load cannot be attained. Footing dimensions and foundation structural elements should be determined by a structural engineer. Concrete in contact with the subsurface materials should be designed for moderate sulfate exposure as defined by ACI 318.4.3. Bearing materials loosened by machine excavation should be removed prior to placing footing concrete. Occasionally, pockets of dry, hard fill or very moist, soft fill may be encountered in the foundation excavation. If this condition occurs, the footings should extend to properly moisture treated fill. Exterior footings should bear at least 3 feet below exterior grade for frost protection. The bearing materials beneath footings should be protected from freezing during construction. All footing excavations should be observed prior to placement of concrete to confirm the footings are bearing on suitable materials as anticipated for design purposes.

The foundation walls backfilled with on-site materials should be designed for a lateral earth pressure based upon an equivalent fluid density of 65 pounds per cubic foot (pcf) for the "at rest" condition or 50 pcf for the "active" condition. The "active" condition should only be used where wall movements of at least 0.5% of the wall height are allowed. These values have been provided without considerations for sloping backfill, surcharge loading or hydrostatic pressures. Construction of a drain system and proper surface drainage as discussed later in this report may lower the potential of developing hydrostatic pressure in the backfill materials. Minor cracking of concrete foundation walls should be expected.

Potential Heave

Based upon the data gathered for this and adjacent sites, our understanding of recent research, and our experience in working with the subsurface conditions in the area, we have performed an analysis of the potential heave of the soils underlying this site. This analysis assumes a potential depth of moisture change beneath the lot surface inducing heave in the soil encountered. We have calculated a potential basement slab heave of less than 1 inch. The potential garage slab heave was calculated to be less than 2 inches. Using the foundation bearing pressures presented above, it is our opinion that total and differential foundation movements of more than 1 inch are not likely unless the moisture treated fill is allowed to dry prior to foundation construction or the fills are allowed to saturate after foundation construction.

It must be understood that the amounts of calculated potential heave presented above are theoretical numbers. There is currently no type of testing or correlation of factors that will definitively predict the amount of heave that will be experienced at a site.

Basement Floor Construction

A basement slab performance risk evaluation was conducted in general conformance with industry guidelines for the local area. The risk assessment of a site for potential movement is not absolute; rather, it represents a judgment based upon the data available and our experience in the area. Movement of foundations and concrete flat work will occur with time in low to very high risk areas as the soil moisture content increases. On low and moderate rated sites, slab movements of up to 3 inches across the slab with slab cracking of up to ¼ inch in width and/or differential are considered normal. The damage generally increases as the risk assessment increases and as the depth of wetting increases. It must be understood, however, that assessing risk is an opinion. There is currently no type of testing or correlation of factors that will definitively predict the amount of heave that a floor slab will exhibit. Therefore, it may be possible that heaves less than or in excess of what is considered "normal" may be experienced.

For sites with a risk assessment of high or very high, we recommend an interior floor system engineered for expansive soils be constructed. An alternative to the use of an engineered floor system, such as soil modification to reduce the risk assessment, may also be considered. In addition, an engineered interior floor system is recommended for all finished areas or any other areas where floor movements cannot be tolerated.

Based upon our evaluation of the subsurface conditions at this site, it is our opinion that the slab performance risk for this site is low. If this risk of movement is not acceptable, engineered interior floors should be constructed or an alternative such as soil modification should be considered.

If the Builder and/or Owner desires to construct a concrete slab-on-grade and accepts the risk of slab movement, slabs supported by the expansive subsurface materials should be constructed using the following criteria:

1. Slabs should be separated from exterior walls and interior bearing members with a joint which allows free vertical movement of the slab.

2. Slab bearing partitions should be constructed with a minimum 2-inch void space. Stairways bearing upon the slab should be constructed in such a way as to allow at least 2 inches of slab heave. In the event of slab heave, the movement should not be transmitted directly through the partitions to the remainder of the residence.

3. Plumbing and utilities should be isolated from the slab.

4. Where a forced-air heating system is used and the furnace is located on the slab, we recommend provision for a collapsible connection between the furnace and the duct work to allow for at least 3 inches of slab heave. Utility connections should also be provided with flexible connections capable of accommodating the same magnitude of movement as specified above.

5. Provide frequent control joints in the slab.

Following these recommendations will reduce immediate damage caused by movement of the floor slab; however, the void spaces recommended are not intended to predict total slab movement. Care should be taken to monitor and reestablish partition voids and flexible connections when necessary. We are available to provide further consultation regarding basement slab performance risk assessments.

Crawl Space Construction

The crawl space ground surface should be sloped to the perimeter drain system. Trenching or dishing out of the crawl space is not recommended unless a drain system is placed in these areas in such a manner to facilitate drainage. The recommended clearance from the crawl space ground surface to the engineered floor system should meet applicable codes as well as be increased by the recommended foundation void height. In addition, all plumbing lines should be isolated from the ground surface or foundation walls by at least the height of the previously recommended void thickness.

During construction, the crawl space area should be checked for standing water or very moist conditions, construction debris, and other deleterious materials. If these conditions exist, the area should be evaluated and mitigated, as necessary.

Crawl space areas should be constructed with consideration given to proper ventilation and moisture management. Provisions such as the installation of a vapor retarder should be utilized to reduce the amount of moisture (humidity) in the crawl space air. The Client and any future Owner should be aware that crawl space areas are subject to various air quality issues. A consultant specializing in ventilation and air quality control should be contacted to provide any additional recommendations. Such recommendations are beyond the geotechnical scope of this study. The environmental division of A. G. Wassenaar, Inc. is capable of providing such services. Refer to "Homeowner's Guide To Moisture Management" by Tri-County Health Department (Brochure Number S-323) for additional information.

Subsurface Drainage

As a minimum, we recommend providing a subsurface drainage system around the lowest below grade area. The purpose of the drain is to collect water which may become trapped on the surface of the excavation and enter the basement or crawl space areas. A drain should be constructed similar to the attached drain details (Figures 1 or 2) and should be uniformly sloped to a positive gravity discharge or sump.

If a sump pit is installed, it should be monitored for water accumulation and proper operation. The water level in the sump pit should not be allowed to rise above the foundation drain inlet pipe(s). If water rises above the inlet pipe(s), a pump should be installed (if not originally equipped) or maintenance should be performed on the existing pump.

Surface Drainage

The wetting of foundation soils and/or bedrock materials which causes heave may be reduced by carefully planned and maintained surface drainage. The following recommendations should be implemented during construction and maintained by the Homeowner after the residence is completed:

1. Excessive wetting or drying of the open foundation excavation should be avoided as much as practical during construction.

2. The ground surface surrounding the exterior of the foundation should be maintained in such a manner as to provide for positive surface drainage away from the foundation. At completion of construction, we recommend a minimum fall away from the foundation of 6 inches in the first 5 feet. This slope should be continuous across the backfill zone.

3. Backfill around the foundation should be moistened and compacted in such a manner as to reduce future settlement. Areas which settle should be filled as soon as possible in order to maintain positive drainage away from the foundation.

4. If lawn edging is used around the exterior of the foundation, it should be constructed in a manner to prevent ponding of surface water in the vicinity of the backfill soils.

5. All drainage swales should be constructed and maintained a minimum of 5 feet away from the foundation on side yards and 15 feet away from the foundation on back and front yards. Drainage swales should maintain a slope of at least 2% off of the lot. Swales must not be blocked by fences, landscaping, paths or other Homeowner installed items.

6. Roof downspouts and drains should discharge well beyond the limits of foundation backfill.

7. Watering adjacent to the foundation should be reduced as much as practical. Landscaping which requires excessive watering should not be located within 5 feet of foundation walls. Main sprinkler lines, zone control boxes and drains should be located outside the limits of the foundation backfill. Sprinkler heads should be positioned such that the spray does not fall within 5 feet of foundation walls.

8. Plastic membranes should not be used to cover the ground surface immediately surrounding the foundation. These membranes tend to trap moisture and prevent normal evaporation from occurring. We recommend the use of a weed suppressant geotextile fabric.

Limitations

We believe the professional judgments expressed in this report are consistent with that degree of skill and care ordinarily exercised by practicing design professionals performing similar design services in the same locality, at the same time, at the same site and under the same or similar circumstances and conditions. No other warranty, express or implied, is made. The location of the test boring drilled and the laboratory testing performed for this study were designed to obtain a reasonably accurate picture of subsurface conditions for design purposes. Variations in subsurface conditions not indicated by the boring are possible and expected. Therefore, we should be retained to observe the foundation excavation and construction in order to verify or revise our recommendations. If unexpected subsurface conditions are observed by others during construction, we should be called to review our recommendations.

This report was prepared for the exclusive use of our Client for the sole purpose of providing geotechnical design criteria for the subject structure based upon the existing site conditions as encountered. The conclusions and recommendations contained in this report shall not be considered valid for use by Others without written authorization from A. G. Wassenaar, Inc. In addition, the state of practice in geotechnical engineering is constantly evolving. Therefore, findings presented in this report should be reviewed and revised, if necessary, prior to actual construction.

The recommendations provided in this report are based upon the specified extents of the overexcavation for the original building footprint. The future Homeowner(s) should not construct any additions to the residence utilizing the recommendations given in this report. Additional studies must be provided if any additions are to be constructed.

If we can be of further service in discussing the contents of this letter or in analysis of the proposed structure from the soil and foundation viewpoint, please call our office.

Sincerely,

A. G. WASSENAAR, INC.

COLORADO REGISTERED MICHAEL R. CONNER P.E. 30731 PROFESSIONAL ENGINEER

Michael R. Conner, P.E. 6-2-11
Senior Engineer

Reviewed by:

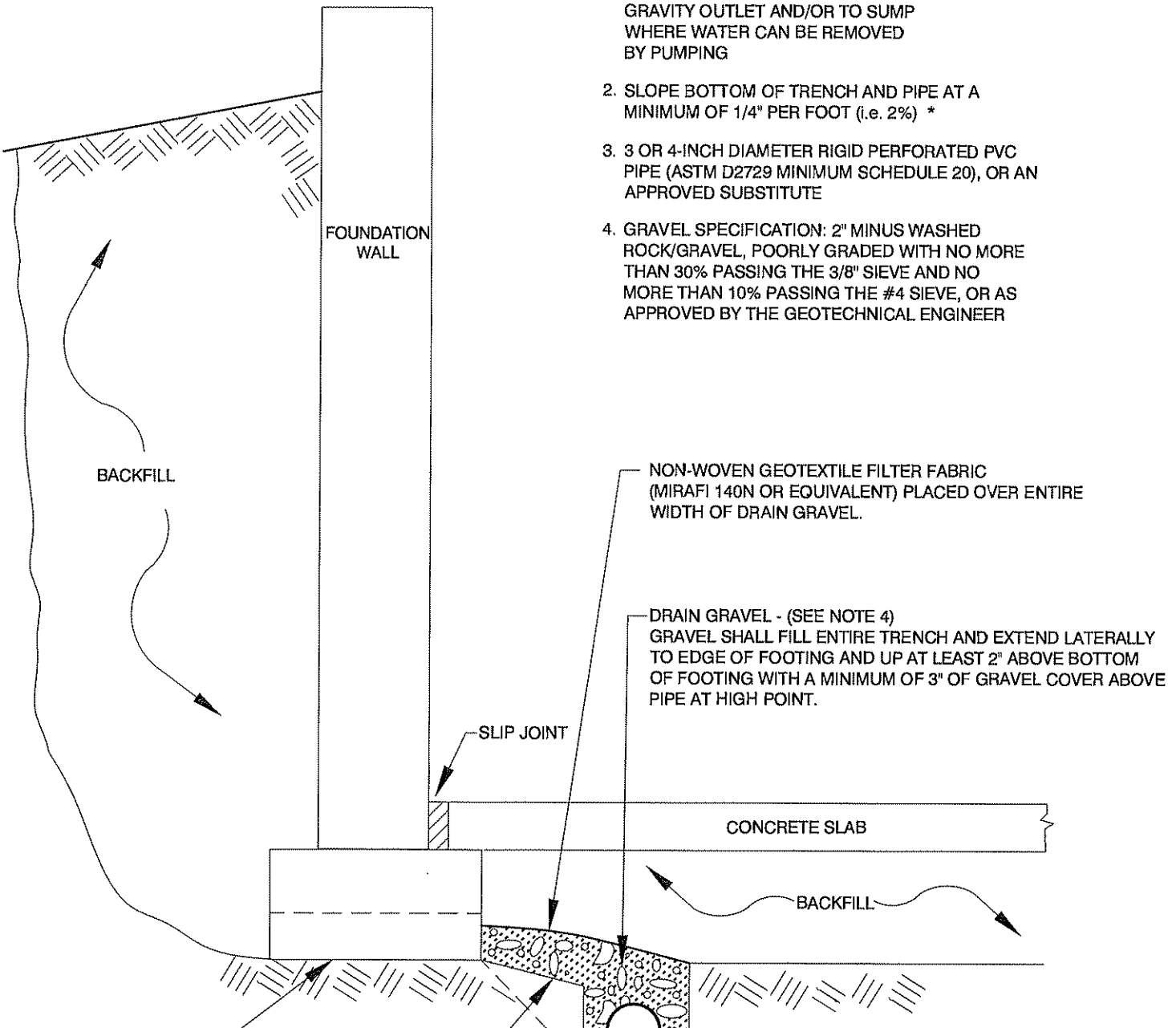
Keith D. Seaton, P.E.
Senior Engineer

MRC/KDS/lia
Attachments: Figures 1 and 2
Statement of Services

A.G. Wassenaar Inc.
Geotechnical and Environmental Consultants

NOTES:

1. DRAIN MUST SLOPE TO A POSITIVE GRAVITY OUTLET AND/OR TO SUMP WHERE WATER CAN BE REMOVED BY PUMPING
2. SLOPE BOTTOM OF TRENCH AND PIPE AT A MINIMUM OF 1/4" PER FOOT (i.e. 2%) *
3. 3 OR 4-INCH DIAMETER RIGID PERFORATED PVC PIPE (ASTM D2729 MINIMUM SCHEDULE 20), OR AN APPROVED SUBSTITUTE
4. GRAVEL SPECIFICATION: 2" MINUS WASHED ROCK/GRAVEL, POORLY GRADED WITH NO MORE THAN 30% PASSING THE 3/8" SIEVE AND NO MORE THAN 10% PASSING THE #4 SIEVE, OR AS APPROVED BY THE GEOTECHNICAL ENGINEER



*NOTE: PER CLIENTS DIRECTION

RICHMOND HOMES
FTG 1 INT-SOG
MARCH 2010

FOOTING FOUNDATION
RICHMOND INTERIOR DRAIN DETAIL
FIGURE 1

A.G. Wassenaar Inc.
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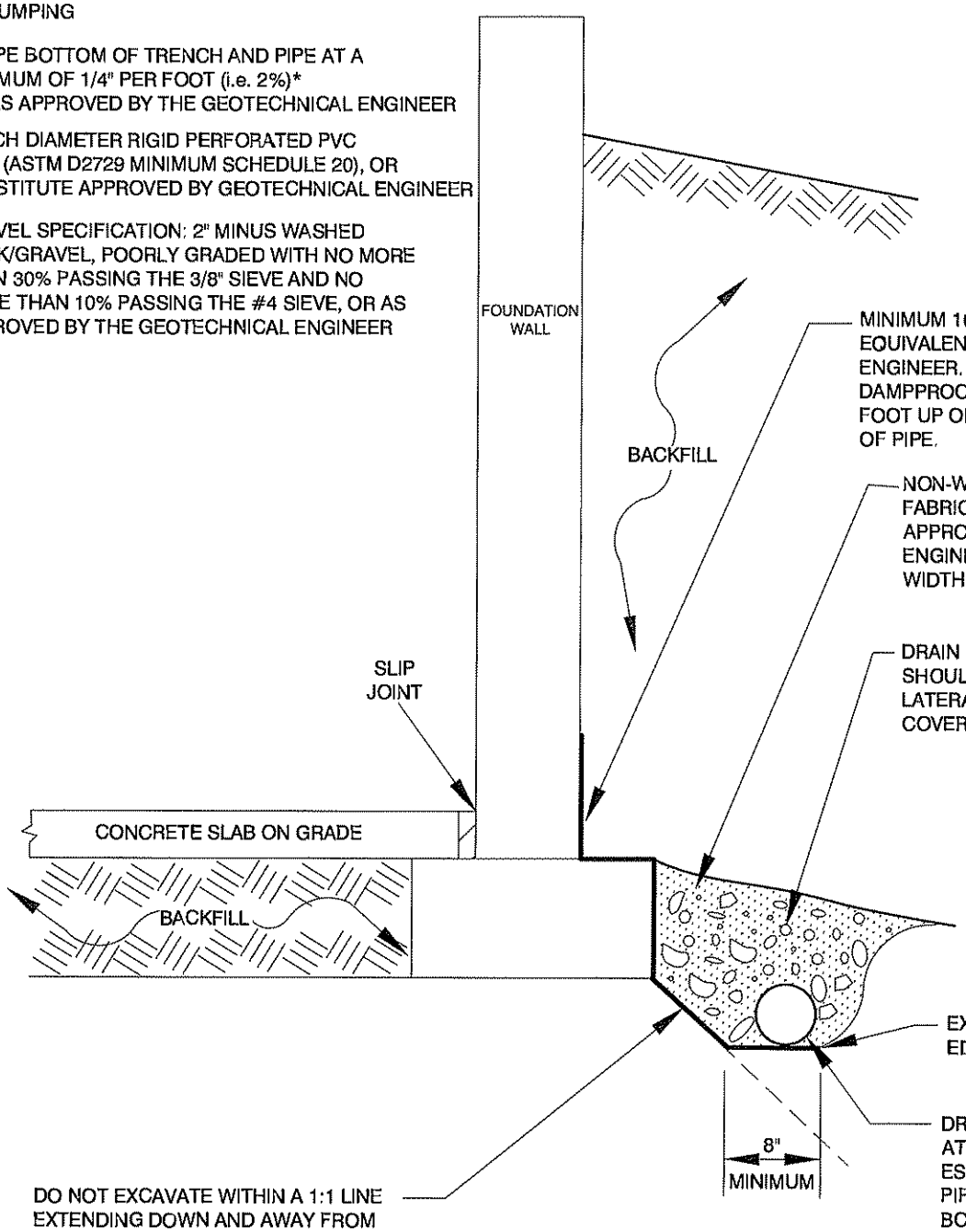

FOOTING FOUNDATION
RICHMOND EXTERIOR DRAIN DETAIL
FIGURE 2

RICHMOND HOMES
FTG 3 EXT-SOG
JUNE 2010

*NOTE: PER CLIENTS DIRECTION