GOODRICH ENGINEERING LLC

Geotechnical Engineering, Soil, Rock, Concrete, Walls, Foundations, Tiebacks, Geology, Hydrology, Drilling-Consultant, Asphalt

Rex Goodrich, President
2297 Tall Grass Road, #B
Grand Junction CO 81505

970-250-3358
rex.goodrich48@gmail.com

Brent Smith
Moving Forward Homes
2507 Greystone Drive
Grand Junction CO 81505

Project 77-1
September 26, 2022

RE: Soil Report, 183 River Ridge Court, (Lot 194) Grand Junction CO 81503

Brent,

Per your request, Goodrich Engineering personnel completed a geotechnical exploration study of the planned residence at Lot #194 at 183 River Ridge Court in the Spyglass Ridge Subdivision, Grand Junction CO. The location map is shown in Figure 1. Assessor information is summarized in Figure 2. Figures 3 and 4 are areal and satellite images of the site from the Mesa County GIS and Google Earth respectively

The following laboratory tests were performed on representative samples to determine their relative engineering properties. Samples were taken in an undisturbed manner using NQ wireline core on August 10, 2022, by Cleveco Drilling and Steve Kissner Drilling. Other samples and testing were conducted during the Filing III subdivision report for the Spyglass Ridge Subdivision in 2004 by Lincoln Devore Inc. Results from that previous study have been incorporated into the recommendations contained in this report.

ASTM D-2487 Soil Classification
ASTM D-422 Soil Particle Analysis
ASTM D-4318 Plastic and Liquid Limits
ASTM D-2216 Moisture Content of Soil
ASTM D-4546 Soil Swell or Settlement – Method C
FHA PVC Meter Testing, Character, and Identification of Expansive Soils

Tests were performed in accordance with test methods of the American Society for Testing and Materials or other accepted standards. The results of our laboratory tests are included in this report. The in-place soil density, moisture content, and the field observations are presented on the attached exploration drill log and accompanying descriptions.

This letter contains general recommendations for construction of a residential foundation but is not a foundation design and cannot be used as such. The conclusions and recommendations for this site are presented below.

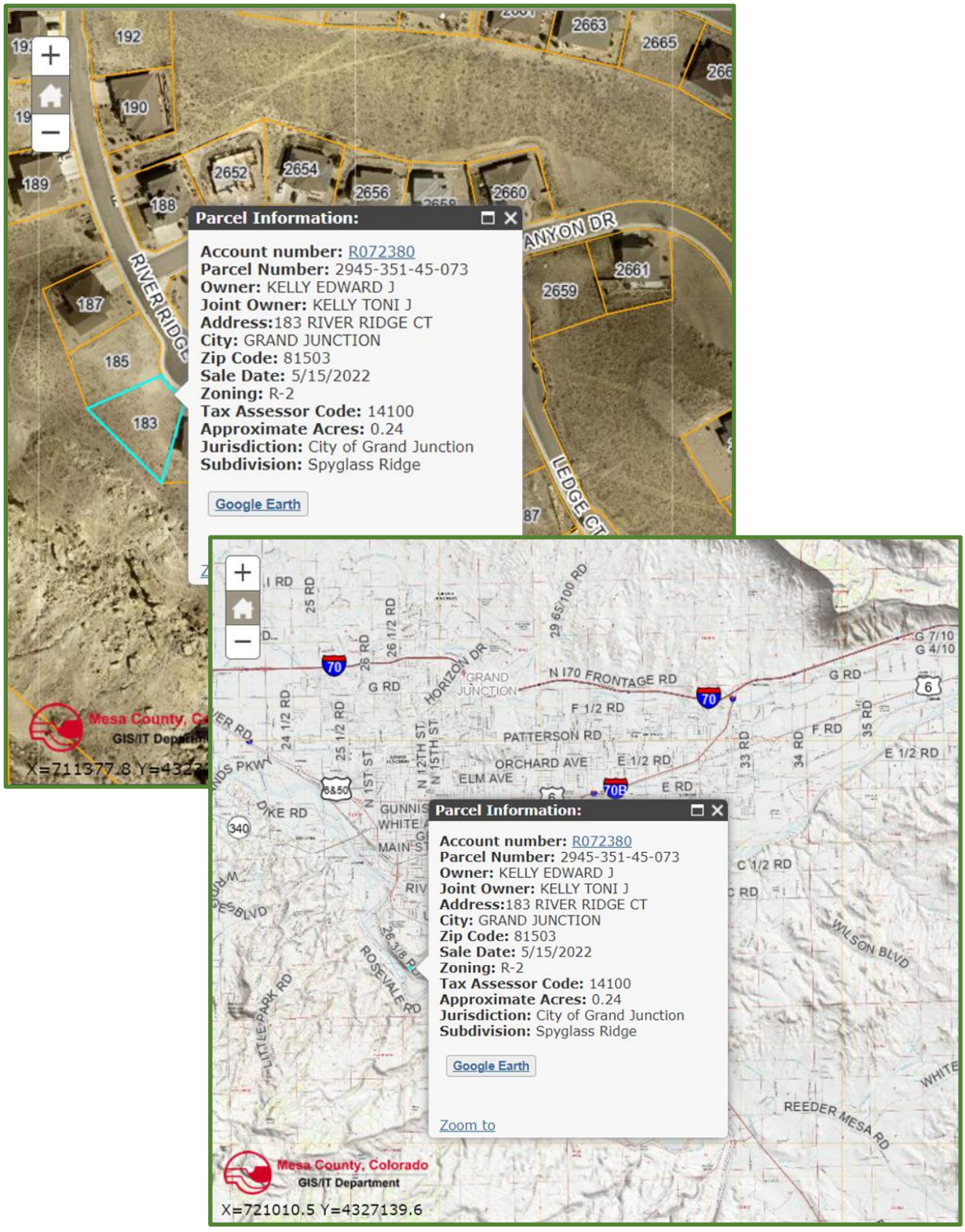


Figure 1. Location Map of 183 River Ridge Court, Grand Junction, CO.

Figure 2. Assessor Summary of 183 River Ridge Court, Lot 194.

Soil/Rock Moisture Conditions: No free water was encountered during the drilling or in the pits excavated on this Lot. A walkout basement is planned for this site.

At this site little natural water is anticipated, however, with the development of the cull-de-sac of homes groundwater occurrences will probably increase from the watering of lawns and shrubbery, excess water from homes or water line breaks. Water, therefore, in the context of its possible negative consequences to long-term stability in an area containing unstable soils/rock must be considered as "present". More water may be introduced as the subdivision becomes more developed.

Robust drainage systems should be installed for mitigation of future water intrusion and to keep subsurface expansive soils dry. Surface water runoff should be planned for, controlled, and disposed of into proper drains. All drains should be designed and constructed in the context of minimizing water intrusion into the subsurface.

Stie Geology: The approximate locations of the exploration core holes, and the exploration pit are shown in Figures 4 and 6. One core hole was drilled by Cleveco Drilling and Steve Kissner Drilling on August 1, 2022. In addition, a test pit was dug on the adjacent lot (Pit #9) and another core hole (Core #3) was drilled in 2004 as part of the original exploration of the subsurface for the Subdivision report by Lincoln Devore, Inc (Spyglass Ridge Subdivision, Filing III, Lincoln Devore, Inc. 2004). Samples of the various soils and rocks were analyzed

and tested for physical properties. The log of the Core #3 hole is included at the end of this report. Photos of the core hole drilled this past August 1 are also included at the end of this report.

Figure 3. Aerial Photo of the Site. The Star Marks the Approximate Drilling Location.

The purpose for the exploration coring was to visually inspect the subsurface and to collect samples of the underlying strata for determination of the geotechnical properties. Also, the new core drilled in August 2022 corresponded lithologically with the previous (2004) investigation permitting inferences to be drawn from that investigation.

The site is underlain by approximately 25 ft of alluvium. It consists of sandy, clay and gravel with come cobble. It is unlithified, dry and presented difficult hole stability problems during drilling. This interval will excavate easily with backhoe type machinery.

Beneath the alluvium was mudstone, shale, and sandstone from 25 to 40 ft. Sandstone was encountered at the bottom of the hole at about 35 ft depth. The description of the interval from 25 ft to about 35 ft strata fit stratigraphically and probably belongs in the Burro Canyon Fm. The mudstones contain expansive clays and slaked upon retrieval and storage in the core boxes. Beneath 35 ft sandstone became more prominent and probably marks the transition into the Dakota Formation. The Burro Canyon and Dakota Fm's are conformable, and the contact is often difficult to discern.

Figure 4. Satellite Image from Google Earth of the Slope to the Southwest of the Lot. The Geologic Strata is Labeled on the Image as are the Locations of the Two Core Holes and Representative Depths.

The 2022 Core Hole Was Drilled to 40 ft Depth. The 2004 Core Hole Was Drilled to a Depth of 160 ft.

Foundation Recommendations:

A deep foundation is recommended for this site. Expansive to highly expansive bentonitic bedrock was encountered at 25 ft during drilling. With the planned basement the concrete foundation may be situated in or near to the swelling strata. The overlying alluvium should be assumed to be highly permeable to water flow and the mudstone and clay immediately beneath will likely become wetted at some time in the future after the residence is constructed. Also, the house will be located at the crest of a steep slope on top of outcrops of ledges of Dakota Fm sandstone. The added weight of a residence may increase soil creep and mobilize shallow bedrock blocks.

To mitigate for the probable differential movement of the foundation strata, micropiles are recommended and should be installed to a minimum depth of 45 ft beneath the elevation of the ground surface at the time of drilling. Also, the bars should have a minimum of 10 ft of grouted bar at the base of the micropile. The remaining 35 ft of the upper portion of the micropile should be sleeved to prevent the bar from bonding to the soil and rock. Figure 5 shows a schematic of the micropile installations. The micropile depth/bar-length will have to be adjusted for the elevation change after excavation of the basement has been conducted.

Since no site-specific bond strength tests were conducted the bond strength should be estimated to be 2000 psf. The bond to sandstone will likely be stronger than 2000 psf but uncertainty in the lateral continuity of the sandstone horizons at depth deserve consideration. Some of the upper strata was highly expansive increasing the potential for heaving should water permeate these strata. We recommend a minimum dead load of 1500 lbs per micropile.

Fractures in the strata above the bond zone could allow blocks to move independently. However, the vertical permeability of the strata is relatively low, and this design will provide a buffer from water intrusion. These bars should be air drilled with an air/rotary system to not introduce water into any swelling strata and to improve the "roughness" of the hole-wall for improved mechanical interlock of the grout to the rock. The hole diameter should be at least 3.5 inches in diameter.

Void form should be installed beneath structural components beneath all components of the building structures (including garages). One foot of void form should be installed. Note that approach concrete slabs to the garage will be susceptible to the ground movements. Several feet of "overdig" and replacement with structural fill will be required with the addition of a robust water collection and drain system to minimize movements of slabs closest to the home. Asphalt concrete (hot mix asphalt) pavement or "block" pavers are better suited in this situation as they will flex with the subsurface movements.

If Portland Cement slabs are placed the overdig and replacement with structural fill becomes even more crucial. Continuous steel reinforcement can be placed to help mitigate "faulting" of the slabs independently of one another. In this case no concrete joints (no control joints) are cut or troweled into the green mix. The concrete structure will crack randomly but cracks are generally thin. A design for continuous reinforced concrete can be provided at your request.

Recommendations pertaining to balancing, reinforcing, drainage, and inspection are considered extremely important and must be followed. Contact stresses beneath all continuous walls should be balanced to within ± 250 psf at all points. Isolated interior column footings should be designed for contact stresses of about 300 psf more than the average used to balance the continuous walls. The criteria for balancing will depend somewhat on the nature of the structure. Single story, slab-on-grade structures may be balanced based on dead load only. Multi-story structures may be balanced based on dead load plus one-half live load for up to three stories.

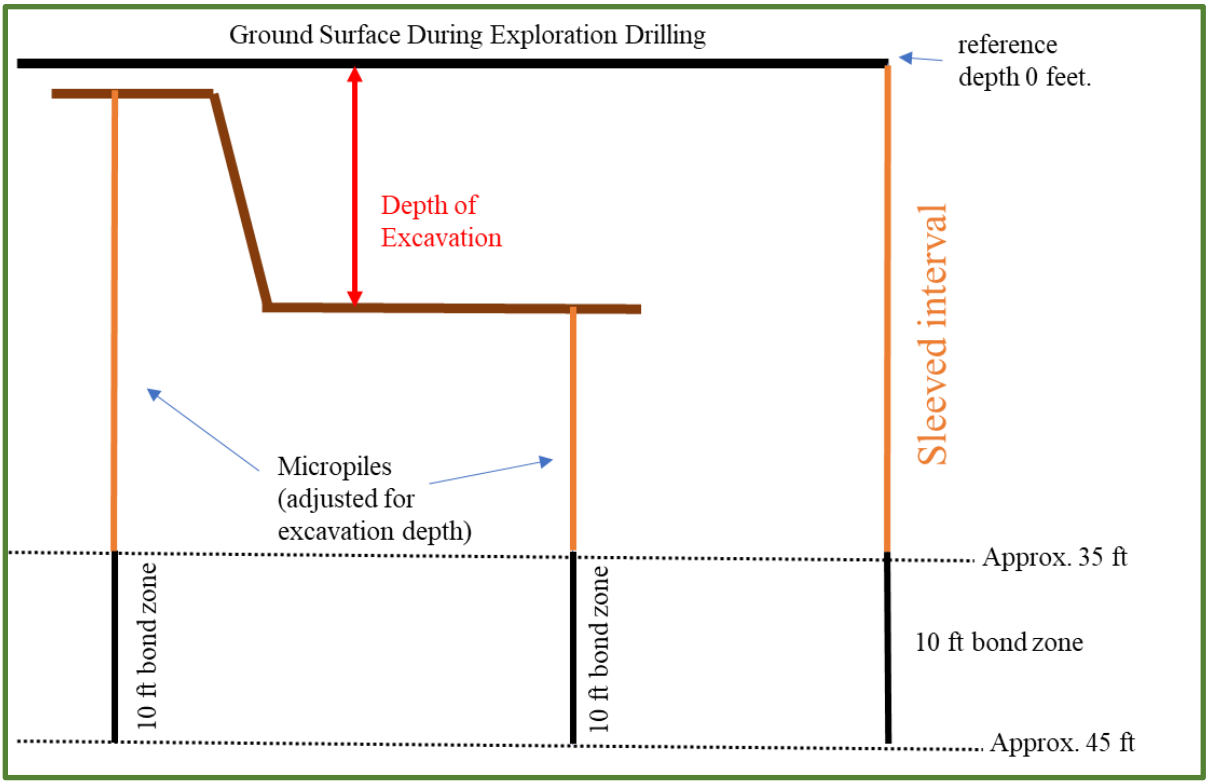


Figure 5. Schematic of Micropile Lengths Adjusted for Depth of Excavation.

Structural Fill/Soil Improvement: Structural fill may be necessary beneath the foundation for the actual construction process for support and to avoid placing the concrete foundation in direct contact with the bedrock. Also, structural fill will be required for leveling beneath flat-work, sidewalks, porches, garage-slab, etc. Imported and insitu materials may be used if properly sized and if they are of satisfactory composition.

The Structural Fill must be brought to the required density by mechanical means to 90% of a Modified Proctor. No soaking, jetting or puddling techniques of any type should be used in placement of fill on this site. To confirm the quality of the compacted fill product, it is recommended that surface density tests be taken at maximum 1-foot vertical intervals.

It is recommended that any required perimeter drain be placed in the exterior portion of the structural fill, at the base of the more permeable portion of the fill, to prevent or at least minimize the collection of water in the soils and fill beneath the structure.

Excavation Observation: Goodrich Engineering personnel should be contacted to observe the foundation soils/rock after the excavation has been completed and prior to placing forms or concrete. The purpose of this is to observe the type and condition of the foundation soils throughout the excavation. If the soils are found to differ from those encountered in our exploration drilling, or if they appear to be unstable, additional recommendations may be required prior to construction of the foundations.

Voids Beneath Foundation Walls: Voids are required to mitigate expansive pressures in conjunction with the deep foundation alternative. One foot of vertical movement should be allowed for uplift beneath the foundation.

Reinforcing: The foundation shall be reinforced as shown on the foundation design. No changes shall be made to this placement of reinforcing without written approval of the design engineer or architect.

All foundation stem walls should be designed as "grade beams" capable of spanning at least 14 feet or from bearing-point to bearing-point. Where the foundation stem walls are relatively shallow in height, vertical reinforcing will not be necessary. However, in walls retaining soil more than 4 feet in height, vertical reinforcing may be necessary to resist the lateral pressures (restrained case) of the soils along the wall exterior. To aid in designing such vertical reinforcing, an equivalent fluid pressure (EFP) on the order of 40 pcf would be appropriate for the native sandy soils. Clayey or silty-clayey soils will require an equivalent fluid pressure of approximately 60 pcf. Highly plastic clays up to 75 pcf.

Floor Slabs: Non-structural floor slabs on grade, if any, should be explicitly separated from all structural portions of this building and allowed to float freely; not tied to the residence stem wall or foundation. Frequent scoring (control joints) of the slabs should be provided to allow for possible shrinkage cracking of the slab. These control joints should be placed to provide maximum slab areas of approximately 200 to 360 square feet. Likewise, any curbing to be placed should be scored every 8 ft and/or to match adjacent flat work.

Alternatively, continuous reinforced concrete may be placed in which case no control joints are placed. A design for continuous reinforced concrete slabs can be provided at the request of the owner or builder.

Any man-made fill placed below floor slabs on grade should be compacted to a minimum of 90% of its maximum modified proctor dry density (ASTM D-1557). These soils should be placed at a moisture content conducive to the required compaction (usually proctor optimum moisture content± 2%).

Drainage and Grading: Adequate site drainage should be provided in the foundation area both during and after construction to prevent the ponding of water and the wetting or

saturation of the subsurface soils. We recommend that the ground surface around the structure be graded so that surface water will be carried quickly away from the building. The minimum gradient within 15 feet of the building will depend on surface landscaping. We recommend that paved areas maintain a minimum gradient of 2% (cross slope) and that landscaped areas maintain a minimum gradient of 8%. It is further recommended that roof drain downspouts be carried at least 5 feet beyond all backfilled areas and discharge a minimum of 10 feet away from the structure. Proper discharge of roof drain downspouts may require the use of subsurface piping in some areas. Examples of roof drain downspouts are shown in Figure 7. Under no circumstances should a "dry well discharge" be used on this site unless specifically designed by a geotechnical engineer. Planters, if any, should be constructed so that moisture is not allowed to seep into foundation areas or beneath slabs or pavements.

The existing drainage on the site must either be maintained carefully or improved. We recommend that water be drained away from structures as rapidly as possible and not be allowed to stand or pond within 15 feet of the building or foundation. We recommend that water removed from one building not be directed onto the backfill areas of adjacent buildings.

Should an automatic lawn irrigation system be used on this site, we recommend that the sprinkler heads, irrigation piping, and valves be installed no less than 10 feet from the building. In addition, these heads should be adjusted so that spray from the system does not fall onto the walls of the building, and that such water does not excessively wet the backfill soils.

It is recommended that lawn and landscaping irrigation be reasonably limited to prevent undesirable saturation of subsurface soils or backfilled areas. Several methods of irrigation water control are possible, to include, but not be limited to:

- Metering the irrigation water.
- Sizing the irrigation distribution service piping to limit onsite water usage.
- Encourage efficient landscaping practices.
- Enforcing reasonable limits on the size of high-water usage landscaping within 5 feet of the building or foundation.
- Incorporating "xeriscaping" landscaping and irrigation techniques.

A plastic membrane placed on any crawlspace ground surfaces may retain/trap excessive amounts of water beneath the membrane. If future moisture problems develop or are anticipated, the foundation design engineer or the geotechnical engineer may require that the membrane be partially or completely removed from the crawlspace area. If membranes associated with radon gas mitigation are present, changes in the soil moisture may adversely affect foundation and concrete slab-on-grade performance. Radon mitigation must be coordinated with the foundation site design and construction.

We recommend that perimeter drains (see attached drain sketches in Figures 7 and 8) be incorporated into the home construction. It is recommended that the foundation drain (Figure 8)

be placed in the lower portion of any foundation structural fill (at the base of the permeable portion of the Structural Fill) and be placed several feet away from and somewhat below the building foundation. A drain of this type includes a perforated pipe and an adequate gravel collector, the whole being wrapped in a geotextile filter fabric. We recommend that the discharge pipe for this drain be given a free gravity outlet to exit at ground surface. If "daylight" cannot be obtained, we recommend that a sealed sump and pump be used to discharge the seepage. Under no circumstances should a "dry well discharge" be used on this site unless specifically designed by a geotechnical engineer.

Assuming backfill will be placed against the foundation on the outside of the home a drain should be placed within the filled areas to provide drainage away from the foundation should water penetrate there.

Backfill: To reduce settlement and aid in keeping water from reaching beneath this building, all backfill around this building should be mechanically compacted to a minimum of 90% of its maximum modified proctor dry density (ASTM D-1557). The only exception to this would be the components of the perimeter foundation drain, if any. All backfill should be composed of the native soils and should not be placed by soaking, jetting, or puddling. All backfill placed in utility trenches around this structure or below foundation walls should be mechanically compacted to a minimum of 90% of its maximum modified proctor dry density (ASTM D-1557). These soils should be placed at a moisture content conducive to the required compaction (usually proctor optimum content± 2%).

Cement Type: Type IT, Type I-II, or Type IT-V cement is recommended for all concrete in contact with the soils on this site. Calcium chloride should not be added to a Type II, Type I-IT, or Type II-V cement under any circumstances.

Remarks: We recommend that the bottoms of all foundation components rest a minimum of 1.5 feet below finished grade or as required by the local building codes. Foundation components must not be placed on frozen soils.

Senate Bill 13 (CRS 6-6.5-101) Discussion: This residence is being constructed on or over foundation soils which possess a "significant potential for expansion." We recommend that the owner receive a copy of this summary report of our soil analysis and site recommendations.

Limitations: *This report is issued with the understanding that it is the responsibility of the owner or his representative to ensure that the information and recommendations contained herein are brought to the attention of the architect and engineer for the project and are incorporated into the plans. In addition, it is his responsibility that the necessary steps are taken to see that the contractor and his subcontractors carry out these recommendations during construction. The findings of this report are valid as of the present date. However, changes in the conditions of a property can occur with the passage of time, whether they be due to natural processes or the works of man on this or adjacent properties. In addition, changes in acceptable or appropriate standards may occur or may result from legislation or the broadening of engineering knowledge. Accordingly, the findings of this report may be invalid, wholly, or*

partially, by changes outside our control. Therefore, this report is subject to review and should not be relied upon after a period of 2 years.

The recommendations of this report pertain only to the site investigated and assume that the soil conditions do not deviate from those described in this report. If any variations or undesirable conditions are encountered during construction or the proposed construction will differ from that planned on the day of this report, Goodrich Engineering LLC should be notified so that supplemental recommendations can be provided, if appropriate.

Goodrich Engineering LLC makes no warranty, either expressed or implied, as to the findings, recommendations, specifications, or professional advice, except that they were prepared in accordance with generally accepted professional engineering practices in the field of geotechnical engineering.

Please contact me if you have any concerns or questions.

Respectfully,

Rex Goodrich PE Geologist
Goodrich Engineering LLC
970-250-3358

Alluvium (clayey, sandy gravel and cobble) on the Slope at 183 River Ridge Court.

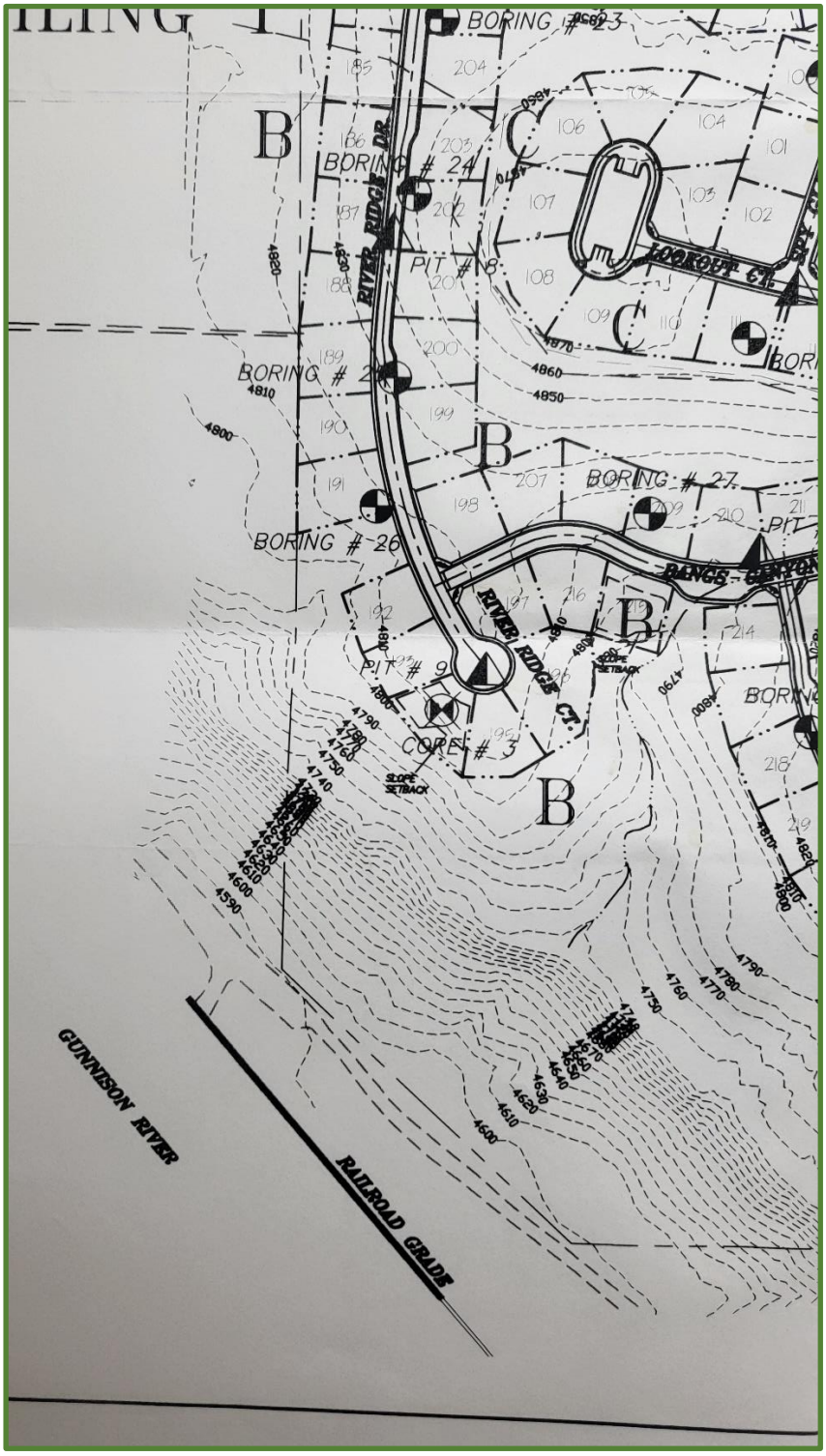


Figure 6. Portion of Map from the Spyglass Ridge Subdivision Filing III Report Showing the Locations of the Surface Pit #9 and Core Hole #3. The Excavation and Drilling Occurred in 2004. The Core Hole Extended to a Depth of 160 ft (Lincoln Devore, Inc. 2004).

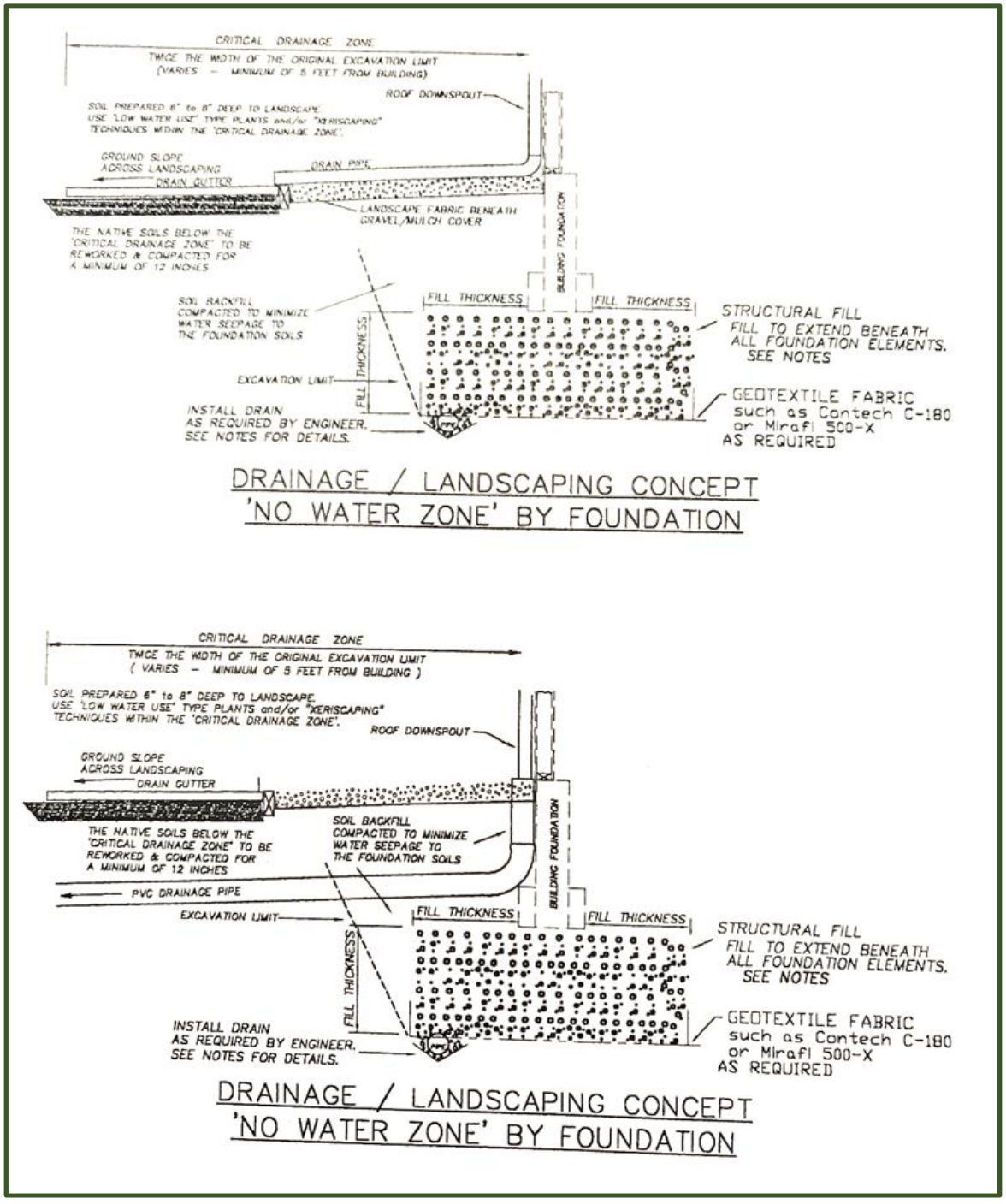


Figure 7. Example Downspout Drain.

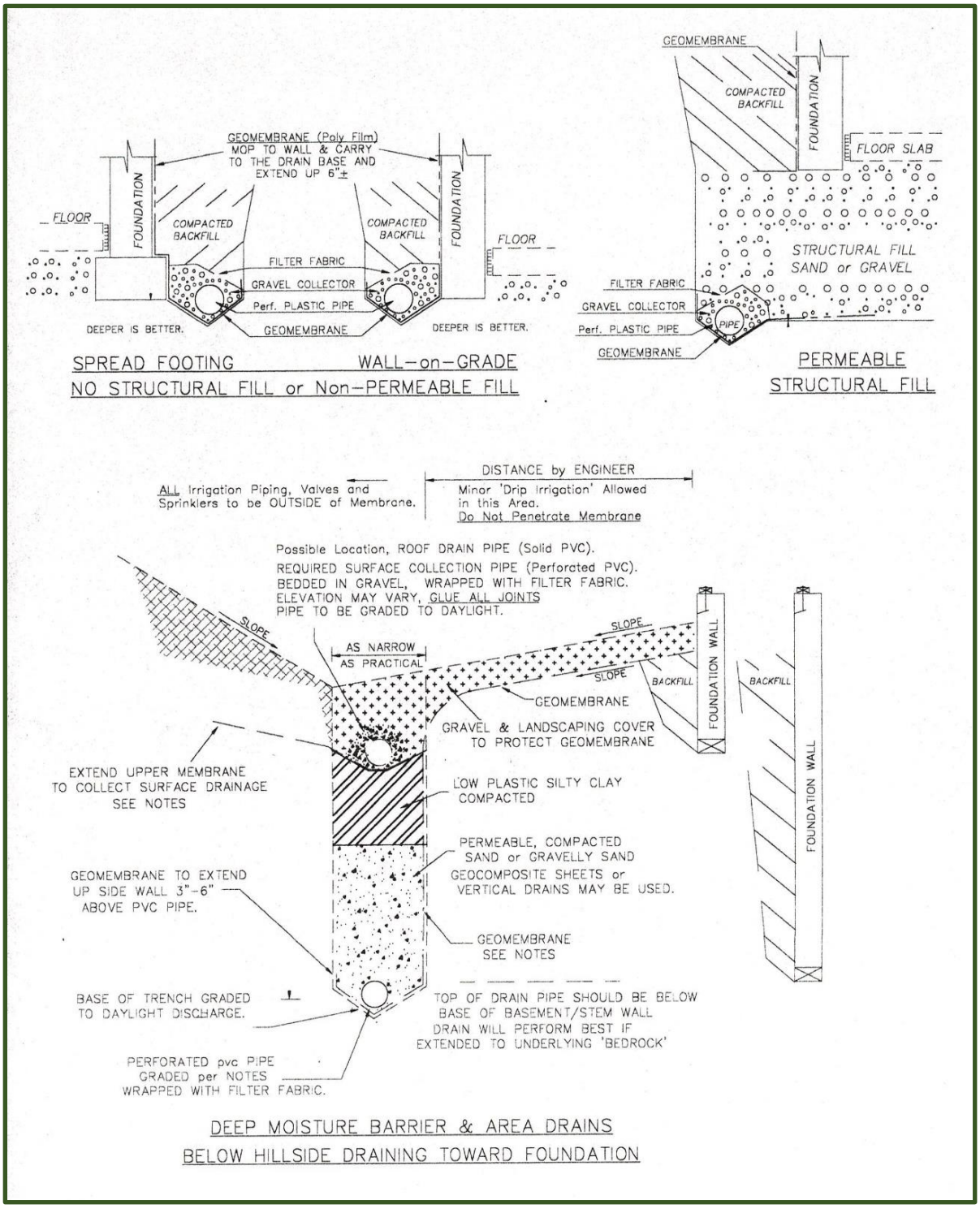
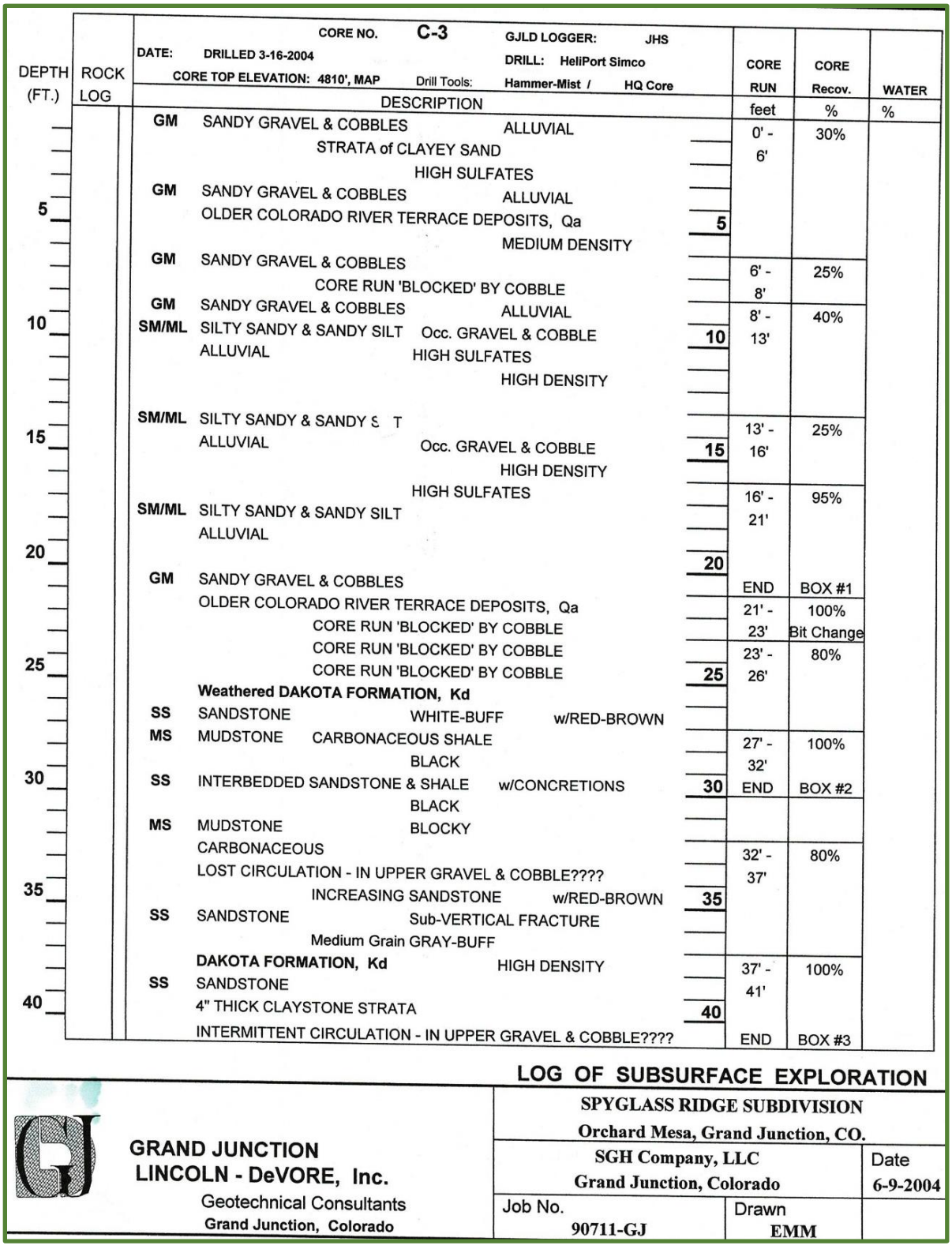
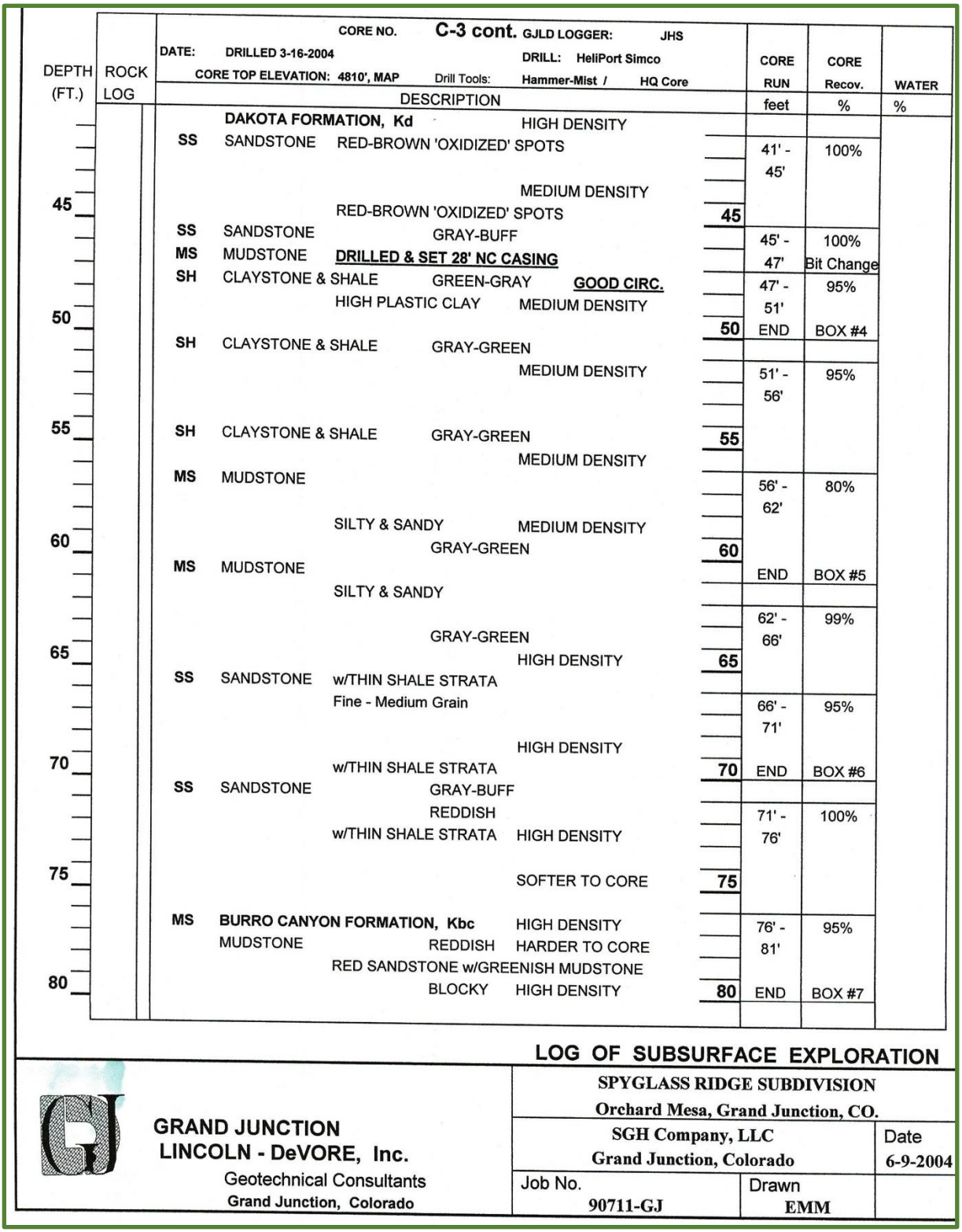


Figure 8. Example Foundation Drain.



Core Hole #3, 2004 (Lincoln Devore, Spyglass Ridge Subdivision Filing III, 2004).



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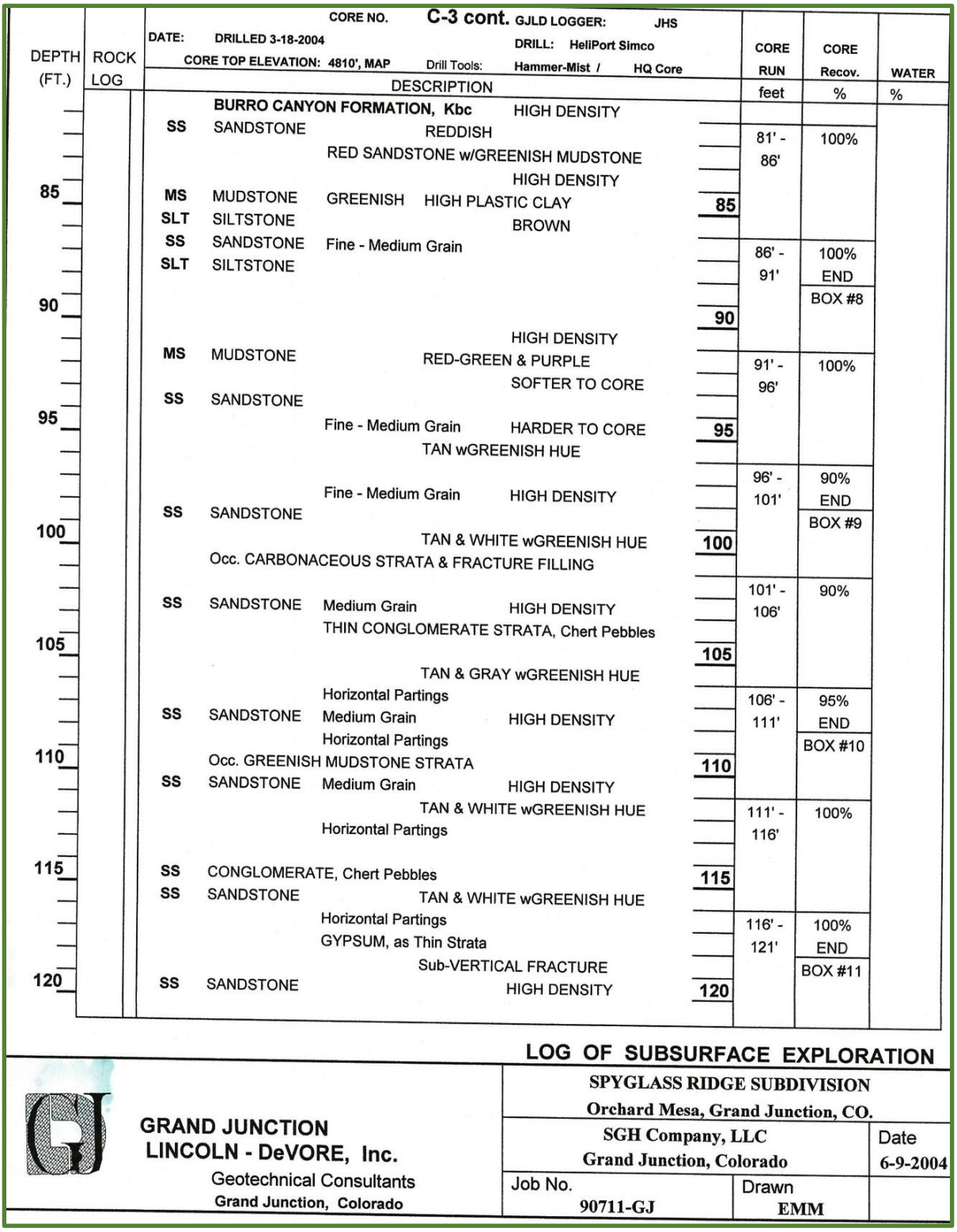
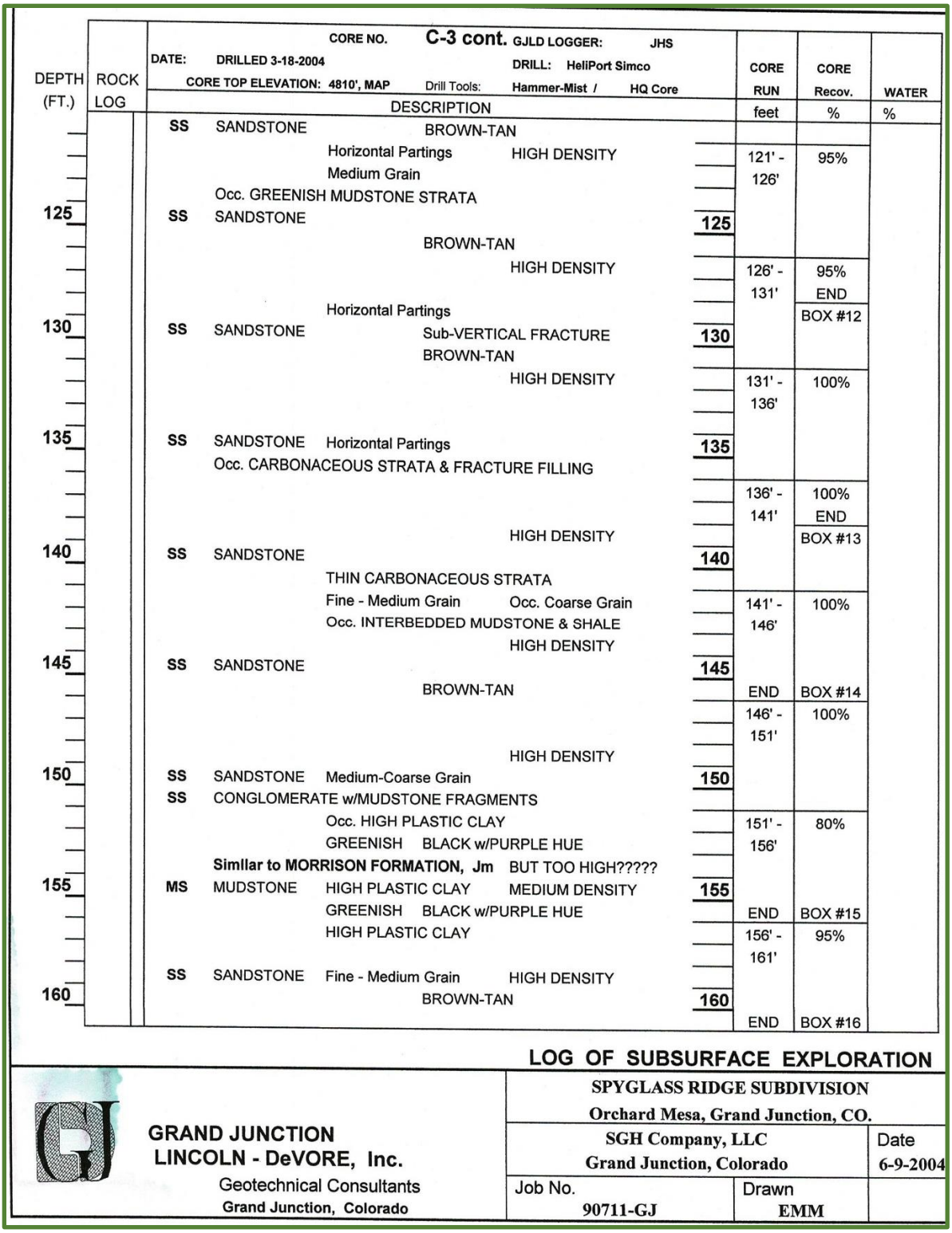


Core Hole #3, 2004 (Lincoln Devore, Spyglass Ridge Subdivision Filing III, 2004).



CORE NO. C-3 cont. GJLD LOGGER: JHS
DATE: DRILLED 3-18-2004 DRILL: HeliPort Simco
CORE TOP ELEVATION: 4810', MAP Drill Tools: Hammer-Mist / HQ Core

DEPTH (FT.)	ROCK LOG	DESCRIPTION	CORE RUN feet	CORE Recov. %	WATER %
	SS	SANDSTONE BROWN-TAN			
		Horizontal Partings HIGH DENSITY	121' - 126'	95%	
		Medium Grain			
		Occ. GREENISH MUDSTONE STRATA			
125	SS	SANDSTONE 125			
		BROWN-TAN			
		HIGH DENSITY	126' - 131'	95% END	
		Horizontal Partings		BOX #12	
130	SS	SANDSTONE Sub-VERTICAL FRACTURE 130			
		BROWN-TAN			
		HIGH DENSITY	131' - 136'	100%	
135	SS	SANDSTONE Horizontal Partings 135			
		Occ. CARBONACEOUS STRATA & FRACTURE FILLING			
			136' - 141'	100% END	
		HIGH DENSITY		BOX #13	
140	SS	SANDSTONE 140			
		THIN CARBONACEOUS STRATA			
		Fine - Medium Grain Occ. Coarse Grain	141' - 146'	100%	
		Occ. INTERBEDDED MUDSTONE & SHALE			
		HIGH DENSITY			
145	SS	SANDSTONE 145			
		BROWN-TAN	END	BOX #14	
			146' - 151'	100%	
		HIGH DENSITY			
150	SS	SANDSTONE Medium-Coarse Grain 150			
	SS	CONGLOMERATE w/MUDSTONE FRAGMENTS			
		Occ. HIGH PLASTIC CLAY	151' - 156'	80%	
		GREENISH BLACK w/PURPLE HUE			
		Similar to MORRISON FORMATION, Jm BUT TOO HIGH?????			
155	MS	MUDSTONE HIGH PLASTIC CLAY MEDIUM DENSITY 155			
		GREENISH BLACK w/PURPLE HUE	END	BOX #15	
		HIGH PLASTIC CLAY	156' - 161'	95%	
	SS	SANDSTONE Fine - Medium Grain HIGH DENSITY			
160		BROWN-TAN 160			
			END	BOX #16	

LOG OF SUBSURFACE EXPLORATION

GRAND JUNCTION
LINCOLN - DeVORE, Inc.
Geotechnical Consultants
Grand Junction, Colorado

SPYGLASS RIDGE SUBDIVISION
Orchard Mesa, Grand Junction, CO.
SGH Company, LLC
Grand Junction, Colorado
Date 6-9-2004
Job No. 90711-GJ
Drawn EMM

Core Hole #3, 2004 (Lincoln Devore, Spyglass Ridge Subdivision Filing III, 2004).

Core Photos from August 1, 2022, Core Drilling. Total Depth of the Core is Approximately 40 ft.