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Presented by Vivian Bridaham Banta & Annie Kreder

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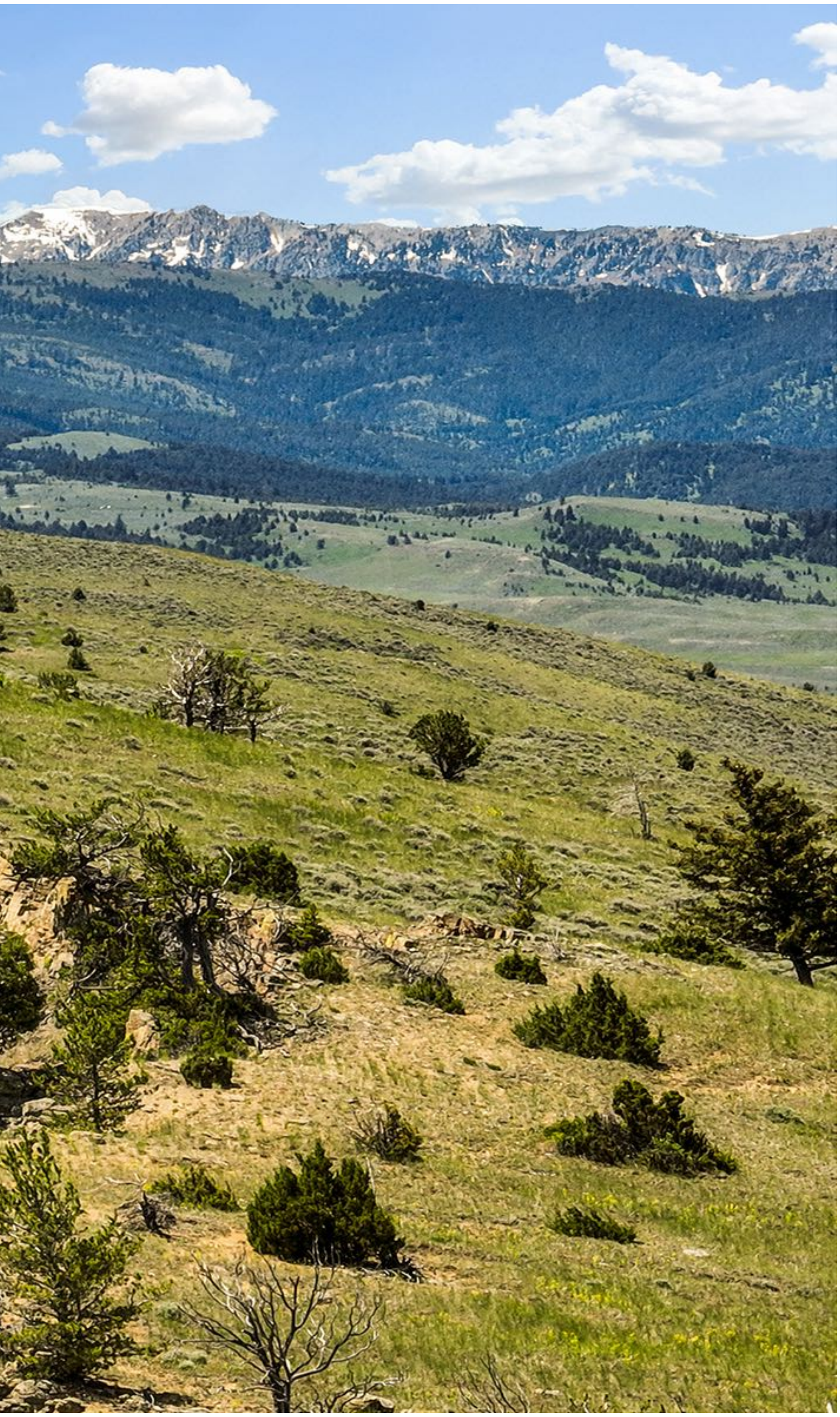

WILD HORSE ROAD | CLYDE PARK

Offered at $1,300,000

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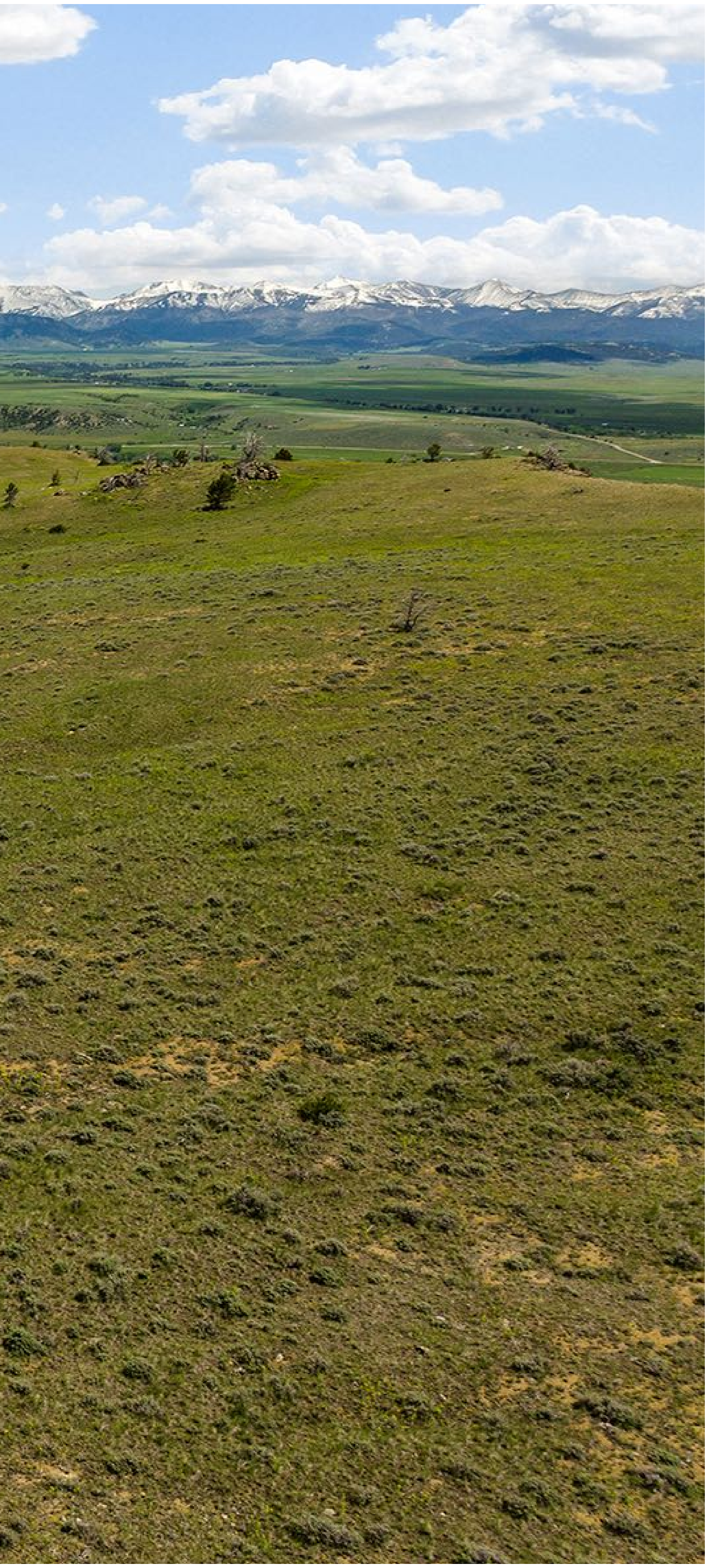
Idyllic 156-acre Property

This is the paradise you've been trying to find. Build a dream home in a valley surrounded by an amphitheater of breath-taking mountains. The Bridgers rise on one side of the land and the Crazies on the other. Seriously, the views look photoshopped. Land of this size and position doesn't change hands often.

Your piece of old Montana awaits. In a fertile wildlife corridor, it hosts abundant numbers of sage grouse, Hungarian partridge and other upland game bird species. A local herd of elk traverses through the property in the fall as they descend out of the nearby Bangtail Mountain Range on their way to their winter range. Just 3 minutes from the Shields River, a 5 minute drive to Clyde Park and 25 minutes to Livingston.

This 156 acres is located in a very desirable and scenic area of Southwest Montana. The land provides a great opportunity to acquire a holding with unparalleled simplicity of ownership and enjoyment. With a short commute to Bozeman and Livingston, the property is ideal for the individual or family looking for privacy and solitude, but also having the amenities and services of larger vibrant communities nearby.



Property Features

- Underground power to parcel
- Buyer to install well and septic
- Neighbors' well is 400' deep at 8 gpm, drilled by Will Hayes
- Neighbors' septic cost about $17,000 - built by Horgenson Construction
- The property consists of varied terrain including gently sloping meadows, gullies, hillsides and dynamic rock formations
- Predominantly covered with sage and native grasses, the property could easily support several saddle horses or a few head of cattle
- Several locations exist to construct a home with outbuildings and a secluded riding arena while retaining the commanding views of the nearby mountain ranges
- This property and adjoining acreages are protected by restrictive covenants further safeguarding the land and owners' investment
- Covenants are in place, but the Home Owner’s Association is not active at this time and there are no HOA dues at the present
- All mineral rights and water rights appurtenant to the property and owned by the Sellers to convey to the Buyer at closing

- Elevation: sits between 5,099' and 5,445'
- Average Annual Precipitation is 16 to 18 inches
- May is the wettest month with an average 3.25 inches of rain
- Winter months bring an average of 8-9 inches of snowfall
- The area's growing season is approximately 90 days
- Average maximum temperatures in June, July, and August are between 68 to 80 degrees
- December, January, and February maximum temperatures are between 32 and 37 degrees
- Summer nights average about 45 degrees with winter evenings around 14 degrees
- Sunshine is abundant in this region of Montana

GEOTECHNICAL INVESTIGATION REPORT

Parcel E
Certificate of Survey 1909
Park County, Montana

Prepared For:

Wright Thompson
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Prepared By:

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October 2017
Project Number: 171051

10/6/17
MICHAEL J. WELCH
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October 6, 2017

Wright Thompson
wrightthompson@gmail.com

RE: Geotechnical Investigation – Parcel E, Certificate of Survey 1909; Park County, MT (171051)

Dear Mr. Thompson,

Thank you for the opportunity to serve your geotechnical engineering needs. Per your request, C&H Engineering and Surveying, Inc. has completed the Geotechnical Investigation Report for the residential improvements to be constructed on the above referenced property in Park County, Montana.

Please find the attached Geotechnical Investigation Report to contain the results of the site investigation, geotechnical evaluation, and recommendations. The recommendations were made for the design and construction of the foundation elements, slabs-on-grade, and pavements for the proposed development.

Please call if you have any questions or if we can assist you during the future phases of your project.

Respectfully Submitted by

MICHAEL J.
WELCH
PEL-PE-LIC-23818

Michael J. Welch, P.E.

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Table of Contents

List of Tables

List of Appendices

1.0 Introduction

C&H Engineering and Surveying Inc., (C&H Engineering) has conducted a geotechnical investigation for residential improvements to be constructed on Parcel E of Certificate of Survey 1909, located in the Northeast Quarter of Section 31, Township 2 North, Range 9 East of P.M.M., in Park County, Montana. The site location is shown on a United States Geological Survey (USGS) topographic quadrangle map in Appendix A, “USGS Topographic Map.”

The scope of services was to conduct a site investigation, evaluate the site, and provide a geotechnical investigation report. The report documents the sites’ soil and groundwater conditions, subsurface soil properties, and provides foundation design and construction recommendations.

2.0 Proposed Structure

A single family residential structure is planned for construction. At the time of this report detailed plans regarding the structure were not available. It has been assumed that a residential structure with a walkout basement will be constructed.

It has also been assumed that the foundation footings will not be subjected to unusual loading conditions such as eccentric loads. A footing is eccentrically loaded if the load transferred to the footing is not directed through the center of the footing. This creates a bending moment in the footing and results in a non-uniform load transfer to the underlying soil. If any of the foundation footings will be eccentrically loaded please contact this office so we can appropriately revise our allowable bearing capacity and settlement estimates if necessary.

3.0 Investigation

The investigation is separated into two parts; the field investigation and the laboratory analysis. While the scope of this project focuses more on the field investigation, we feel it is important to spend time verifying our field observations and conducting tests that will aid in the geotechnical analysis.

3.1 Field Investigation

On September 28, 2017 a site visit was made to the subject property to conduct a subsurface soils investigation and to observe ground features. The subsurface conditions were investigated across the subject property under the direction of Michael J. Welch, P.E., a professional geotechnical engineer with C&H Engineering. The subsurface soils investigation consisted of examining three exploratory test pit excavations. The exploratory test pits were excavated with a John Deere Backhoe provided by Val Mencas Excavation. The test pit locations were chosen based on site topography, accessibility, and the location of the desired building location, as was identified by Vivian Bridaham during a previous site visit. The soil profiles revealed by the excavations were logged and visually classified according to ASTM D 2488, which utilizes the nomenclature of the Unified Soil Classification System (USCS). Representative samples of each soil layer were collected from the trench sidewalls at varying depths for further classification in the lab.

The relative density of each soil layer was estimated based on the amount of effort required to excavate the material, probing of the excavation sidewalls with a rock hammer, pocket penetrometer readings, and the overall stability of the excavation. Any evidence of seepage or other groundwater conditions were also noted. The locations of the test pits (TP) are shown on the Test Pit Location Map included in Appendix B. The subsurface soil conditions encountered in the test pits are described briefly in Section 4.2 and in more detail in Appendix E, "Test Pit Logs."

3.2 Laboratory Analysis

The representative soil samples collected from the excavation sidewalls during the field investigation were labeled, stored in a sealed container, and transported to the C&H Engineering soils laboratory. While each soil interval was visually classified during the field investigation, the classifications were verified and further refined in the laboratory using the following procedures:

Table 1. Laboratory Testing Methods and Purpose

Laboratory Test	Purpose of Test
Moisture Content (ASTM D2216)	Used to determine the natural (in-situ) moisture content of the soil
Amount of Material in Soils Finer than the No. 200 Sieve (ASTM D1140)	Used to determine the amount of fine grained soil present

4.0 Site Evaluation

The site evaluation is based on both the field investigation and research of the sites' surface geology, soil survey information, and seismic history.

4.1 Site Description

The subject property has a total area of 156.78 Acres and is located northwest of Clyde Park, Montana. The desired building site is located on the north side of a northeast-southwest trending ridgeline. This ridgeline is a prominent feature in the general area. The slope across the desired building area was estimated to be approximately 15 to 20 percent, downhill to the north-northeast. A drainage channel is located to the north of the desired building site and will need to be traversed to gain access to the building site. No other significant topographical or geological features were observed in the direct vicinity of the desired building site.

4.2 Subsurface Soils and Conditions

The three exploratory test pits (TP) excavated for the field investigation exhibited similar soil profiles. The following paragraphs briefly summarize the subsurface soils and conditions observed in the exploratory test pits excavated for the field investigation. The soil horizons are described as they were encountered in the exploratory excavations, starting with the horizon nearest the surface and proceeding with each additional horizon encountered with depth. Please refer to Appendix E, "Test Pit Logs" for more detailed descriptions.

The first soil horizon encountered in each exploratory excavation was a Organic Soil of low plasticity (OL). This material was black in color, moist, and soft. This material was encountered to depths varying from of 0.25 to 0.7 feet below grounds surface (bgs) in each test pit. Organic soils are highly compressible and are not suitable for foundation support. This material must also be removed from beneath all interior and exterior concrete slabs as well as beneath all asphalt paving. This material may be stockpiled onsite and used for final site grading purposes.

The second soil horizon encountered in TP-1 was a Weathered Sandstone Rock. This material was moderately weathered and broke up into large channery blocks of sandstone. A rock hammer was required to break apart the fragments in the spoils pile. This material was only encountered in TP-1 and was present to a depth of approximately 1.5 feet bgs.

The second horizon encountered in TP-2 and TP-3, and the third horizon encountered in TP-1 was Weathered Mudstone Rock. This material was moderately weathered and broke up into small to medium sized blocks of mudstone. A rock hammer was required to break apart the fragments in the spoils pile. Oxidation stains were observed along the fractures in the rock. This material was observed to become more intact with depth and resulted in the end of excavation due to bucket refusal at depths varying from 6.5 to 8.5 feet bgs. Although we encountered bucket refusals with a backhoe, it is expected that a large tracked excavator can dig down further through this weathered rock, especially once a larger area of excavation is opened up, such as that for a foundation.

Based on the subsurface conditions observed within the three exploratory excavations, it is expected that the excavation for the foundation will end in weathered mudstone rock. This material is suitable as a bearing material, however, the rock was found to begin to decompose when exposed to water. Because of this, it is recommended that a minimum of 12 inches of structural fill be placed and compacted beneath all foundation footings. The structural fill will function to create a level and uniform bearing material for the foundation footings and also to provide a buffer between the moisture sensitive rock and the foundation footings.

It will also be important to implement proper site grading and drainage practices in the vicinity of the homesite. Site grading and drainage are discussed in further detail in Section 6.8. It is also recommended that a foundation drain be installed around the perimeter of the foundation. The foundation drain is discussed in more detail in Section 6.9.

4.3 Natural Resources Conservation Service Soil Survey

The Natural Resources Conservation Service (NRCS) Web Soil Survey (WSS) provides soil data and information produced by the National Cooperative Soil Survey. The NRCS has determined the physical characteristics and engineering properties, among other data, of near surface soils across the United States. These data are reviewed against our observations and analysis of the subsurface soils encountered during the field investigation to determine if a correlation is present. If a strong correlation is determined, it is very likely that other engineering properties or characteristics described by the NRCS regarding the soils present on the subject property are accurate as well. It should be noted that the NRCS typically only describes the soils located within 5 feet of the surface.

NRCS Soil Survey information of the area was taken from the NRCS WSS, Version 2.0. For more information please visit the NRCS Web Soil Survey on the World Wide Web, at http://websoilsurvey.nrcs.usda.gov/app/. The NRCS Soils Survey identifies one soil type in the vicinity of the desired building location. The soil type is **53E** – Tolbert-Vershal-Gnojek Complex. The NRCS describes this soil types as residuum weathered from igneous and sedimentary rock.

The soils encountered in the three exploratory test pit excavations correlate well with the NRCS mapping of the subject property. Moderately weathered to unweathered bedrock was encountered in all three exploratory excavations at shallow depth.

4.4 Geologic Setting

The following paragraphs discuss the geologic setting in the direct vicinity of the subject property. The geologic setting is determined from a review of surface geology maps and reports published by the United States Geological Survey and others that contain the subject property. This information is especially helpful in determining any geologic hazards that may be present in the immediate area (such as landslide deposits) and what types of soil and rock may be present in the area. Additional information regarding the parent material and depositional environment of a given soil type can also sometimes be obtained or inferred from these maps and reports.

The local surface geology in the direct vicinity of the subject property was determined from the USGS Geologic Map of the Livingston 30' x 60' Quadrangle. Please refer to Appendix D, “USGS Geologic Map” for a complete geologic description and map. The USGS Geologic Map identifies one geologic formation mapped across the desired building area. This geological formation is named **TKfu –** Fort Union Formation. For a narrative description of this formation see the USGS Geologic Map in Appendix D.

The weathered rock encountered within each of the exploratory excavations correlates well with the USGS description of the Fort Union Formation.

4.5 Seismicity

The Park County area is located in an earthquake zone known as the intermountain seismic belt, which is a zone of earthquake activity that extends from northwest Montana to southern Arizona. In general, this zone is expected to experience moderately frequent, potentially damaging earthquakes. With that in mind, it is important that the structure be designed to withstand horizontal seismic accelerations that may be induced by such an earthquake, as is required by the International Building Code.

The USGS provides seismic design parameters for the design of buildings and bridges across the United States. These parameters are based on the National Earthquake Hazards Reduction Program (NEHRP) Recommended Seismic Provisions. The primary intent of the NEHRP Recommended Seismic Provisions is to prevent, for typical buildings and structures, serious injury and life loss caused by damage from earthquake ground shaking.

The following seismic design parameters were determined for the subject property using the USGS Seismic Design Application:

Approximate site Location:
Latitude = 45.883° N
Longitude = 110.653° W

Maximum Considered Earthquake (MCE) Spectral Response Acceleration Parameters:
Short Period (S_S) = 0.480g
1-Second Period (S_1) = 0.157g

Site Coefficients and Adjusted MCE Spectral Response Acceleration Parameters:
S_{MS} = 0.680g
S_{M1} = 0.359g

Design Spectral Response Acceleration Parameters:
S_{DS} = 0.453g
S_{D1} = 0.240g

Based on the criteria in Section 1613.3.2 of the 2012 IBC, the Site Class is D.

4.5.1 Regional Faults

The USGS and Montana Bureau of Mines and Geology (MBMG) have compiled a map of Quaternary Class A faults and earthquake epicenters in western Montana; a Class A fault is one that is associated with at least one large magnitude earthquake within the last 1.6 million years. The earthquake epicenters shown on the map (yellow circles) are associated with earthquakes of magnitude 2.5 or greater, with stars indicating epicenters of earthquakes with a magnitude greater than 5.5. A review of this map indicated that there is 1 Class A fault and 12 earthquake epicenters located within 20 miles of the subject property. The fault mapped near the subject property is the Bridger Fault.

The Bridger Fault is located approximately 16 miles west of the subject property and runs along the western side of the Bridger Mountains. See the Quaternary Fault and Seismicity Map of Western Montana in Appendix D for more information regarding the location of these faults and nearby earthquake epicenters.

4.5.2 Liquefaction

In general terms, liquefaction is defined as the condition when saturated, loose, silty sandy soils lose their support capabilities due to the development of excessive pore water pressure, which can develop during a seismic event. Loose silty sandy soils, if located below the groundwater table, have the potential to liquefy during a major seismic event.

Our subsurface investigation did not encounter any loose silty sandy soils that are or will potentially be located below the groundwater table. It is our opinion that the potential for differential settlement resulting from liquefaction during a moderate seismic event is low.

4.6 Groundwater

Groundwater or seepage was not observed within any of the test pits excavated during the site visit. Groundwater is not anticipated to be problematic for construction. However, please understand that groundwater conditions may change dramatically due to conditions that are out of our control and our assessment of the groundwater conditions is based on the conditions observed within the test pits on the day of the excavation, our general experience in the project area, and any available literature regarding groundwater conditions in the vicinity of the subject property.

The Montana Bureau of Mines and Geology maintains a Groundwater Information Center database. This database contains information on the groundwater resources of Montana. The data include well-completion reports from well drillers, measurements of well performance and water quality based on site visits, water-level measurements at various wells for periods of up to 60 years, and water-quality reports for thousands of samples.

This database was searched for well completion reports (referred to as well logs) from water wells drilled near the subject property. The nearest well with a well completion report found was for a well drilled approximately 0.38 miles southwest of the subject property (GWIC ID# 196876). A static water level of 430 feet was recorded within this well on April 8, 2002. This well has a total depth of 600 feet and is perforated from a depth of 580 to 600 feet bgs. This well is located approximately 200 feet higher in elevation than the subject property.

5.0 Geotechnical Analysis

The geotechnical analysis takes into account the field investigation and site evaluation to make engineering recommendations pertaining to bearing capacity, lateral pressures, settlement, and slope stability.

5.1 Allowable Bearing Capacity

The allowable bearing capacity of a soil is defined as the maximum pressure that can be permitted on a foundation soil, giving consideration to all pertinent factors (such as settlement and seismic considerations), with adequate safety against rupture of the soil mass or movement of the foundation of such magnitude that the structure is impaired. The allowable bearing capacity is determined from the geotechnical analysis, the field investigation, available soil and geology information, and our experience in the project area.

The allowable bearing capacity was determined utilizing the bearing capacity equation suggested by Meyerhof (1963). Based on our analysis, it is recommended that all foundation footings be dimensioned for an allowable bearing capacity of **2,500 pounds per square foot (psf)**.

The allowable bearing capacity may be increased by 1/3 for short term loading conditions such as those from wind or seismic forces.

5.2 Settlement

While the soil at the site may be able to physically support the footings, it is also important to analyze the possible settlement of the structure. In many cases, settlement determines the allowable bearing capacity.

When a soil deposit is loaded by a structure, deformations within the soil deposit will occur. The total vertical deformation of the soil at the surface is called total settlement. Total settlement is made up of two components: elastic settlement and consolidation settlement. Elastic settlement is the result of soil particles rearranging themselves into a denser configuration due to a load being imposed on them and usually occurs during the construction process and shortly after. Consolidation settlement occurs more slowly and over time as water within the pore spaces of a soil are forced out and the soil compresses as the stress from the load is transferred from the water molecules to the soil particles. Consolidation settlement is more of a concern with fine-grained soils with low permeability and high in-situ moisture contents. The degree of settlement is a function of the type of bearing material, the bearing pressure of the foundation elements, local groundwater conditions, and in some cases determines the allowable bearing capacity for a structures' footings.

In addition to analyzing total settlement, the potential for differential settlement must also be considered. Differential settlement occurs in soils that are not homogeneous over the length of the foundation or in situations where the foundation rests on cut and fill surfaces. If the foundation rests on structural fill overlaying properly prepared soils with rock, differential settlement is expected to be well within tolerable limits. Areas that have significantly more fill under the foundation footings (four feet of more) create greater potential for differential settlement. In these cases the structural fill must be installed properly and tested frequently. Compaction efforts and structural fill consistence are vital in minimizing differential settlement. For this project it is not anticipated that significant quantities of structural fill will be required.

A settlement analysis based on conservative soil parameter estimates, the allowable bearing capacity recommended in Section 5.1, and the assumption that all recommendations made in this report are properly adhered to, indicates the total and differential settlement are expected to be 1/2-inch or less. Structures of the type assumed can generally tolerate this amount of movement, however, these values should be checked by a licensed structural engineer to verify that they are acceptable.

Please note that the settlement estimates are based on loads originating from the proposed structure. If additional loads are introduced, such as those from the placement of large quantities of fill, our office should be contacted to re-evaluate the settlement estimates.

5.2.1 Collapse Potential

Collapsible soils are soils that compact and collapse after wetting. The soil particles are originally loosely packed and barely touch each other before moisture infiltrates into the soil. As water infiltrates into the soil it reduces the friction between the soil particles and allows them to slip past each other and become more tightly packed, often resulting in a radical reduction in volume; this radical reduction in volume can occur without any additional loading of the soil. Another term for collapsible soils is "hydrocompactive soils" because they compact after water is added. The amount of collapse depends on how loosely the particles are packed originally and the thickness of the soil layer susceptible to collapse.

Soils with dry densities of less than 80 pounds per cubic foot (pcf), generally silts deposited by the wind, are considered to be susceptible to collapse. Soils with dry unit weights greater than 90 pcf are not considered susceptible to collapse. Using this correlation it is our opinion that the proposed structure is not at risk of sustaining damage due to collapsible soils.

5.3 Lateral Pressures

It is recommended that all foundation and retaining walls be backfilled with well-draining granular material. Well-draining granular backfill has a more predictable behavior in terms of the lateral earth pressure exerted on the foundation or retaining wall and will not generate expansive related forces. If backfill containing significant quantities of clayey material is used, the seepage of water into the backfill could potentially generate horizontal swelling pressures well above at-rest values. Additionally, seepage into a clayey backfill material will also cause significant hydrostatic pressures to build up against the foundation wall due to the low permeability of clay soils and will make the backfill susceptible to frost action.

Lateral pressures imposed upon foundation and retaining walls due to wind, seismic forces, and earth pressures may be resisted by the development of passive earth pressures and/or frictional resistance between the base of the footings and the supporting soils. If a foundation or retaining wall is restrained from moving, the lateral earth pressure exerted on the wall is called the at-rest earth pressure. If a foundation or retaining wall is allowed to tilt away from the retained soil, the lateral earth pressure exerted on the wall is called the active earth pressure. Passive earth pressure is the resistance pressure the foundation or retaining wall develops due to the wall being pushed laterally into the earth on the opposite side of the retained soil. Each of these pressures is proportional to the distance below the earth surface, the unit weight of the soil, and the shear strength properties of the soil.

Subsurface walls that are restrained from moving at the top, such as basement walls, are recommended to be designed for an equivalent fluid pressure of 60 pounds per cubic foot (at-rest pressure); the equivalent fluid pressure is the product of the retained soils unit weight and its coefficient of active or at-rest earth pressure. Any subsurface walls that are allowed to move away from the restrained soil, such as cantilevered retaining walls, are recommended to be designed for an equivalent fluid pressure of 30 pounds per cubic foot (active pressure). For passive pressures, an equivalent fluid pressure of 350 pcf is recommended, and the coefficient of friction between cast-in-place concrete and the weathered mudstone is estimated to be 0.3.

These recommended values were calculated assuming a near horizontal backfill and that a well-draining granular material will be imported for use a foundation wall backfill. It is also assumed that the backfill will be compacted as recommended in this report.

Also, please note that these design pressures do not include a factor of safety and are for static conditions, they do not account for additional forces that may be induced by seismic loading.

6.0 Recommendations

The following recommendations are given as guidance to assure for a safe and effective foundation for the proposed structure. These recommendations are determined by the geotechnical analysis, code requirements, our experience, and local construction practices.

6.1 Foundation

Based on the site evaluation and geotechnical analysis it will be acceptable for the foundation elements to consist of typical strip and column footings. Please find the following as general recommendations:

- In order to keep the footing out of the active frost zone it is recommended that the bottom of all footing elevations be a minimum of 48 inches below finished grade.

- The foundation footings are to bear on a minimum of 12 inches of compacted structural fill overlying weathered sandstone and/or mudstone rock.

- It is recommended that typical strip footings for this structure have a minimum width of 16 inches and column footings should have a minimum width of 24 inches, provided the allowable soil bearing capacity is not exceeded.

- A foundation drain shall be installed around the perimeter of the foundation.

6.2 Foundation Excavation

In general, the excavation must be level and uniform and continue down to 12 inches below the desired bottom of footing elevation or to the weathered sandstone or mudstone rock, whichever is deeper. If any soft spots, saturated soils or boulders are encountered, they will need to be removed and backfilled with structural fill. The excavation width must extend a minimum of one footing width from the outer edges of the footings.

Once the excavation is complete the subgrade must be cleaned of all debris before placing and compacting the required structural fill.

The subgrade must be kept dry throughout construction. At no time should surface water runoff be allowed to flow into and accumulate within the excavation for the foundation elements. If necessary, a swale or berm should be temporarily constructed to reroute all surface water runoff away from the excavation. Excavation should not proceed during large precipitation events. If the subgrade does become excessively moist or saturated, construction should not proceed until C&H Engineering has inspected the subgrade and determined it has sufficiently dried.

If any of the foundation footings are found to be located on a test pit, the area will need to be excavated down to the full depth of the test pit and structural fill be placed and compacted in lifts to bring the area back up to the desired grade.

It is also recommended that spoils from the foundation excavation **NOT** be stockpiled along the uphill sides of the excavation. The surcharge load from the spoils pile can potentially destabilize the excavation sidewalls and cause them to slough into the excavation.

6.3 Structural Fill

Structural fill is defined as all fill that will ultimately be subjected to structural loadings, such as those imposed by footings, floor slabs, pavements, etc.. None of the soils encountered in the three exploratory excavations are suitable for use as structural fill. Structural fill will need to be imported for this project. Imported structural fill is recommended to be a well graded gravel with sand that contains less than 15 percent of material that will pass a No. 200 sieve and that has a maximum particle size of 3 inches. Also, the fraction of material passing the No. 40 sieve shall have a liquid limit not exceeding 25 and a plasticity index not exceeding 6, and the gravel and sand particles need to be made up of durable rock materials that will not degrade due to moisture or the compaction effort; no shale or mudstone fragments should be present.

Structural fill must be placed in lifts no greater than 12 inches (uncompacted thickness) and be uniformly compacted to a minimum of 97 percent of its maximum dry density, as determined by ASTM D698. Typically the structural fill must be moisture conditioned to within ± 2 percent of the materials optimum moisture content to achieve the required density. It is recommended that the structural fill be compacted with a large vibrating smooth drum roller.

Please note that if a moisture-density relationship test (commonly referred to as a proctor) needs to be performed for a proposed structural fill material to determine its maximum dry density in accordance with ASTM D698, a sample of the material must be delivered to this office a minimum of three full business days prior to beginning placement of the structural fill.

Achieving proper compaction is imperative, as it will insure no additional settlement of the structure occurs. Therefore, it is required that C&H Engineering verifies proper compaction of all structural fill lifts.

6.4 Foundation Wall Backfill

Approved backfill material should be placed and compacted between the foundation wall and the edge of the excavation. None of the onsite material encountered within the three exploratory excavations is suitable for reuse as foundation wall backfill. It is recommended that a well-draining granular material be imported for use as foundation wall backfill. It is also recommended that backfill meeting the structural fill requirements of Section 6.3 be used as foundation wall backfill along the interior of the foundation wall because this material will help support the interior slab-on-grade. It is also recommended that structural fill be used as foundation wall backfill in all areas that will support exterior slabs-on-grade or paving improvements.

The backfill shall be placed in uniform lifts and be compacted to a minimum of 95 percent of its maximum dry density, as determined by ASTM D698. The foundation wall backfill will need to be compacted with either walk behind compaction equipment or hand operated compaction equipment in order to avoid damaging the foundation walls. If walk behind compaction equipment is used lifts should not exceed 8-inches (loose thickness) and if hand operated compaction equipment is used lifts should not exceed 4-inches (loose thickness).

A 6 to 12 inch cap of low permeability topsoil should be placed, compacted, and appropriately graded above the approved foundation wall backfill on the outside of the foundation wall in all areas that will not be paved with concrete or asphalt. This will effectively cap the backfill and redirect surface water away from the structure. Please note, if the foundation wall backfill is not compacted properly it will settle and positive drainage away from the foundation will not be maintained. See Appendix F, "Typical Foundation Details" for more information.

6.5 Interior Slabs-on-Grade

In preparation for any interior slabs-on-grade, the excavation must continue down through any organic soil to a minimum depth of 6 inches below the desired bottom of slab elevation. If required, structural fill can then be placed and compacted to 6 inches below the bottom of slab elevation.

For all interior concrete slabs-on-grade, preventative measures must be taken to stop moisture from migrating upwards through the slab. Moisture that migrates upwards through the concrete slab can damage floor coverings such as carpet, hardwood and vinyl, in addition to causing musty odors and mildew growth. Moisture barriers will need to be installed to prevent water vapor migration and capillary rise through the concrete slab.

Capillarity is the result of the liquid property known as surface tension, which arises from an imbalance of cohesive and adhesive forces near the interface between different materials. With regards to soils, surface tension arises at the interface between groundwater and the mineral grains and air of a soil. The height of capillary rise within a given soil is controlled by the size of the pores between the soil particles and not the size of the soil particles directly. Soils that have small pore spaces experience a higher magnitude of capillary rise than soils with large pore spaces. Typically soils composed of smaller particles (such as silt and clay) have smaller pore spaces.

In order to prevent capillary rise through the concrete slab-on-grade it is recommended that 6 inches of ¾-inch washed rock (containing less than 10 percent fines) be placed and compacted once the excavation for the slab is complete. The washed rock has large pore spaces between soil particles and will act as a capillary break, preventing groundwater from migrating upwards towards the bottom of the slab.

Water vapor is currently understood to act in accordance with the observed physical laws of gases, which state that the water vapor will travel from an area of higher concentration to that of a lower concentration until equilibrium is achieved. Because Earth contains large quantities of liquid water, water vapor is ubiquitous in Earth's atmosphere, and, as a result, also in soils located above the water table (referred to as the vadose zone). Typically the concentration of water vapor in the vadose zone is greater than that inside the residence. This concentration difference results in an upward migration of water vapor from the vadose zone through the concrete slab-on-grade and into the building.

In order to prevent this upward migration of water vapor through the slab, it is recommended that a vapor barrier (such as a 15-mil visqueen moisture barrier) be installed. The vapor barrier should be pulled up at the sides and secured to the foundation wall or footing. Care must be taken during and after the installation of the vapor barrier to avoid puncturing the material, and all joints are to be sealed per the manufactures recommendations.

Once the excavation for the interior slab-on-grade is completed as described in the first paragraph of this section, the washed rock is placed according to paragraph 4, and the moisture barriers have been properly installed, it will be acceptable to form and cast the steel reinforced concrete slab. It is recommended that interior concrete slabs-on-grade have a minimum thickness of 4 inches, except garage slabs have a recommended minimum thickness of 6 inches, unless directed otherwise by a licensed structural engineer.

6.6 Exterior Slabs-on-Grade

For exterior areas to be paved with concrete slabs, it is recommended that, at a minimum, the topsoil, any organics, and any undocumented fill be removed. The subgrade soils then need to be compacted to an unyielding condition. Then for non-vehicular traffic areas, a minimum of 6 inches of ¾-inch minus rock needs to be placed, and 4 inches of 4000 pounds per square inch concrete placed over the ¾-inch minus rock. For areas with vehicular traffic, a minimum of 9 inches of ¾-inch minus rock should be placed, followed by 6 inches of 4000 pounds per square inch concrete.

Exterior slabs that will be located adjacent to the foundation walls need to slope away from the structure at a minimum grade of 2 percent and should not be physically connected to the foundation walls. If they are connected, any movement of the exterior slab will be transmitted to the foundation wall, which may result in damage to the structure.

6.7 Asphalt Paving Improvements

For areas to be paved with asphalt, it is recommended that, as a minimum, the topsoil and any organics be removed. The native subgrade then needs to be rolled at ± 2 percent of its optimum moisture content to 95 percent of its maximum dry density, as determined by ASTM D698. Following compaction of the native subgrade a woven geotextile (such as a Mirafi 500X) shall be place across the compacted subgrade. Next a 12-inch layer of compacted 6-inch minus gravel needs to be placed (sub-base layer), followed by a 3-inch layer of compacted 1-inch minus road mix (base layer). Both gravel courses must be compacted at ± 3 percent of their optimum moisture content to 95 percent of their maximum dry density. A 3-inch thick layer of asphalt pavement can then be placed and compacted over this cross-section.

It is recommended that following compaction of the native subgrade, a loaded dump truck or other heavy piece of equipment be driven over it to determine the stability of the subgrade. If any isolated soft spots are found, these areas should be sub-excavated and replaced with compacted fill. If widespread unstable conditions are present (i.e. significant rutting or pumping is observed) the sub-base component of the road section will need to be increased and a woven geotextile may also be required, especially if moisture related issues are the cause of the instability. In severe cases geogrid may also be necessary.

If asphalt paving is to be placed on foundation wall backfill, it is imperative that the backfill be compacted to 95 percent of its maximum dry density, as determined by ASTM D698. It is recommended the backfill be placed in uniform lifts and compacted as described in Section 6.4.

6.8 Site Grading

Surface water should not be allowed to accumulate and infiltrate the soil near the foundation. Proper site grading will ensure surface water runoff is directed away from the foundation elements and will aid in the mitigation of excessive settlement. Please find the following as general site grading recommendations:

- Finished grade must slope away from the building a minimum of 5 percent within the first 10 feet, in order to quickly drain ground surface and roof runoff away from the foundation walls. Please note that in order to maintain this slope; it is imperative that any backfill placed against the foundation walls be compacted properly. If the backfill is not compacted properly, it will settle and positive drainage away from the structure will not be maintained.

- Permanent sprinkler heads for lawn care should be located a sufficient distance from the structure to prevent water from draining toward the foundation or saturating the soils adjacent to the foundation.

- Rain gutter down spouts are to be placed in such a manner that surface water runoff drains away from the structure.

- All roads, walkways, and architectural land features must properly drain away from all structures.

6.9 Foundation Drainage

It is recommended that a foundation drain be installed around the perimeter of the structure's foundation. The drain will aid in reducing the risk of moisture damage to lower levels of the structure, prevent the soils near the foundation footings from becoming saturated due to seasonal groundwater flow, and prevent the buildup of hydrostatic water pressure on the foundation wall. A gravel drain is recommended for this application.

The foundation drain system should consist of 4 inch diameter perforated PVC pipe encased in a minimum of 6 inches of ¾-inch minus washed rock. The drainpipe must be placed with the perforations facing down and the invert of the pipe must be located at an elevation that is below the lowest adjacent floor elevation in order to function properly. The drain pipe should be located adjacent to the foundation footings and should be sloped in such a manner to provide sufficient hydraulic head to gravity drain to daylight or a sump. Non-woven filter fabric should be installed around the perimeter washed rock to effectively stop the migration of fine-grained soils into the pipe, which could eventually lead to clogging.

The pipe must drain either to daylight or a sump. If the pipe is drained to daylight, the drain should daylight down slope and well away from the foundation. The drainpipe must be protected from the entry of small animals and/or debris by a screen or gate and the location marked so it can be easily located for inspection. It is also recommended that cleanouts be installed at all 90 degree bends to help facilitate future maintenance of the foundation drain and for inspection. Care must also be taken not to crush the drain pipe during backfilling of the foundation walls.

A geo-composite drain system would also be acceptable. If used, the drain should be installed per the manufacturer's instructions. If there are any questions about these prefabricated drainage systems our office should be contacted.

6.10 Underground Utilities

We recommended specifying non corrosive materials or providing corrosion protection unless additional tests are performed to verify the onsite soils are not corrosive.

It is recommended that ¾-inch minus gravel be used as a bedding material. The bedding material should be thoroughly compacted around all utility pipes. Trench backfill shall be compacted to a minimum of 95 percent of its maximum dry density in landscaped areas and a minimum of 97 percents of its maximum dry density beneath foundation footings. Backfilling around and above utilities should meet the requirements of Montana Public Works Standard Specifications.

6.11 Construction Administration

The foundation is a vital element of a structure; it transfers all of the structures dead and live loads to the native soil. It is imperative that the recommendations made in this report are properly adhered to. A representative from C&H Engineering should observe the construction of any foundation or drainage elements recommended in this report and should verify proper compaction has been achieved in all structural fill lifts. The recommendations made in this report are contingent upon our involvement. If the soils encountered during the excavation differ than those described in this report or any unusual conditions are encountered, our office should be contacted immediately to examine the conditions and re-evaluate our recommendations.

If construction and site grading take place during cold weather, it is recommended that approved winter construction practices be observed. All snow and ice shall be removed from cut and fill areas prior to site grading taking place. No fill should be placed on soils that are frozen or contain frozen material. No frozen soils can be used as fill under any circumstances. Please note that not following the preceding recommendations may potentially result in foundation settlement issues in the spring when the frost thaws and the snow melts.

Additionally, concrete should not be placed on frozen soils and should meet the temperature requirements of ASTM C 94. Any concrete placed during cold weather conditions shall be protected from freezing until the necessary compressive strength has been attained. Once the footings are placed, frost shall not be permitted to extend below the foundation footings, as this could heave and crack the foundation footings and/or foundation walls.

It is the responsibility of the contractor to provide a safe working environment with regards to excavations on the site. All excavations should be sloped or shored in the interest of safety and in accordance with local and federal regulations, including the excavation and trench safety standards provided by the Occupational Safety and Health Administration (OSHA). According to OSHA regulations (29 CFR 1926 Subpart P Appendix A) the subsurface soils encountered in the test pit excavations can be generally classified as Type A. For Type A soils, OSHA regulations state that cut slopes shall be no steeper than 0.75:1V for excavations less than 20 feet deep. A trench box may also be used, provided the system extends at least 18 inches above the top of the trench walls. Please understand the preceding OSHA soil classification is provided for planning purposes only and the actual classification of the onsite soils will need to be determined by the contractor onsite during excavation.

7.0 Conclusions

The soils present at the site will be adequate to support the proposed structure, provided the recommendations made in this report are properly implemented. Please find the following recommendations as particularly crucial:

- The foundation footings are to bear on a minimum of 12 inches of compacted structural fill overlying weathered sandstone and/or mudstone rock.
- It is recommended that typical strip footings for this structure have a minimum width of 16 inches and column footings should have a minimum width of 24 inches, provided the allowable soil bearing capacity is not exceeded.
- All site grading and drainage recommendations must be properly implemented.
- The subgrade must be kept dry throughout construction.
- A foundation drain shall be installed

8.0 Report Limitations

This report is for the exclusive use of Wrights Thompson and his authorized agents. In the absence of our written approval, we make no representation and assume no responsibility to other parties regarding the use of this report. The recommendations made in this report are based upon data obtained from test pits excavated at the locations indicated on the attached Test Pit Location Map. It is not uncommon that variations will occur between these locations, the nature and extent of which will not become evident until additional exploration or construction is conducted. These variations may result in additional construction costs, and it is suggested that a contingency be provided for this purpose. If the soils encountered during the excavation differ than those described in this report or any unusual conditions are encountered, our office should be contacted immediately to examine the conditions and re-evaluate our recommendations if necessary.

This report is applicable to the subject property only and is not applicable to other construction sites. Under no circumstances shall a portion of this report be removed or be used independently of the rest of the document, this report is applicable as a full document only. The preparation of this report has been performed in a manner that is consistent with the level and care currently practiced by professionals in this area under similar budget and time restraints. No warranty, expressed or implied, is made. Please review Appendix G, "Report Limitations." This Appendix has been prepared to relay the risks associated with this report.

9.0 References

Das, Braja M., "Principles of Foundation Engineering" 5th ed., Pacific Grove, CA, Brooks/Cole-Thompson Learning, 2004.

Day, Robert W., "Foundation Engineering Handbook," McGraw-Hill, 2006.

International Code Council, Inc., "2012 International Building Code (IBC)," International Code Council, Inc., 2012.

Kehew, Alan, "Geology for Engineers and Environmental Scientists," 3rd ed., Prentice Hall, 2006.

Das, Braja M., "Principles of Geotechnical Engineering," 3rd ed., Boston, MA, PWS Publishing Company, 1994.

Natural Resources Conservation Service, "Web Soil Survey - Version 2.0," 2014, United States Department of Agriculture, <http://websoilsurvey.nrcs.usda.gov/app/>.

Berg, R.B., Lopez, David A., and Lonn, Jeffrey D., 2000, Geologic map of the Livingston 30' x 60' quadrangle, south-central Montana: Montana Bureau of Mines and Geology Open-File Report 387, 12 p., 1 sheet, scale 1:100,000.

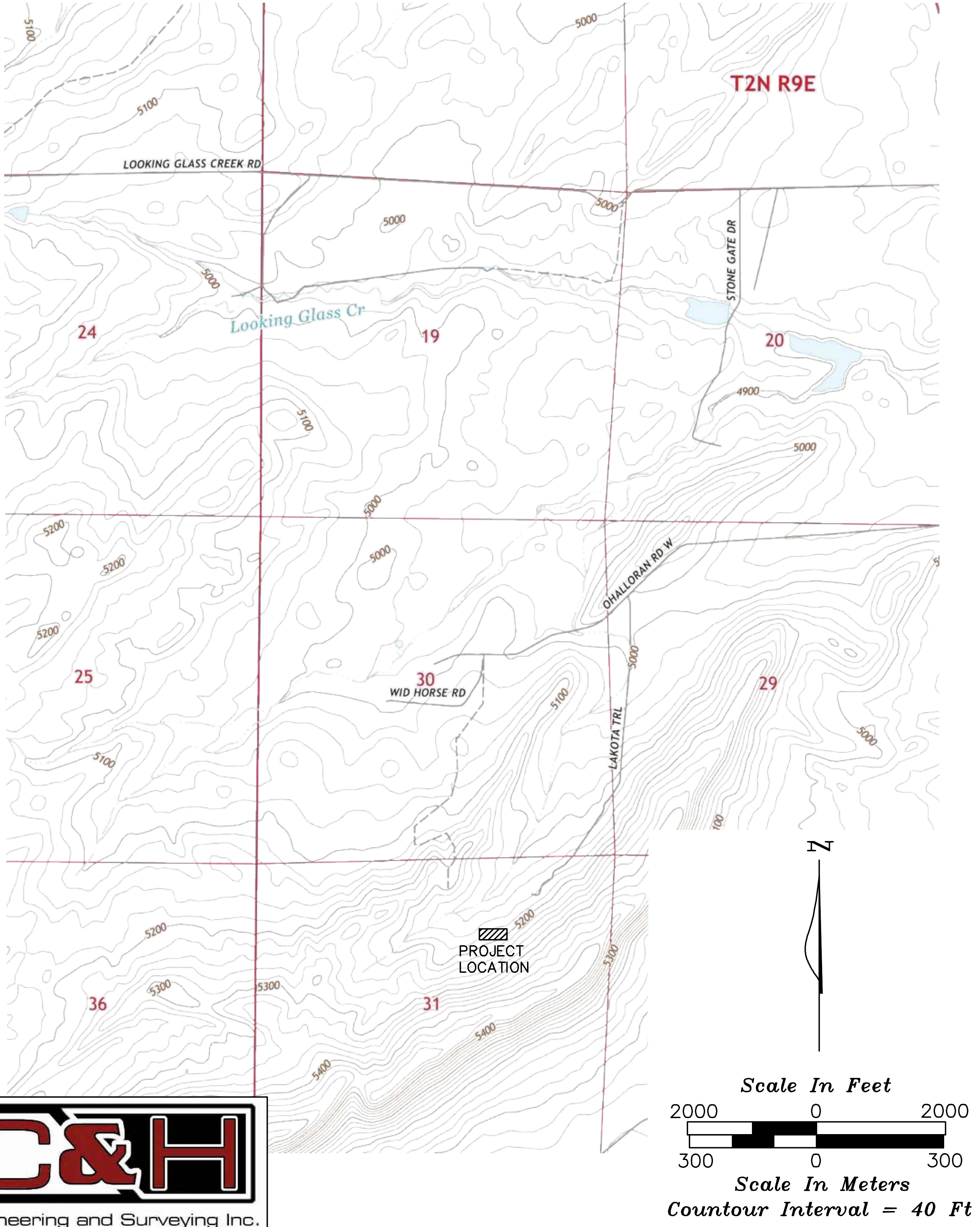
National Earthquake Hazards Reduction Program Recommended Seismic Provisions for New Buildings and Other Structures, FEMA P-1050-2, 2015.

Appendix A

USGS Topographic Map

U.S.G.S TOPOGRAPHIC MAP

NE 1/4, SECTION 31, TOWNSHIP 2 NORTH, RANGE 9 EAST, P.M.M.



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Phone (406) 587-1115 • Fax (406) 587-9768
www.chengineers.com • info@chengineers.com

SOURCE: USGS TOPOGRAPHIC QUADRANGLE MAP

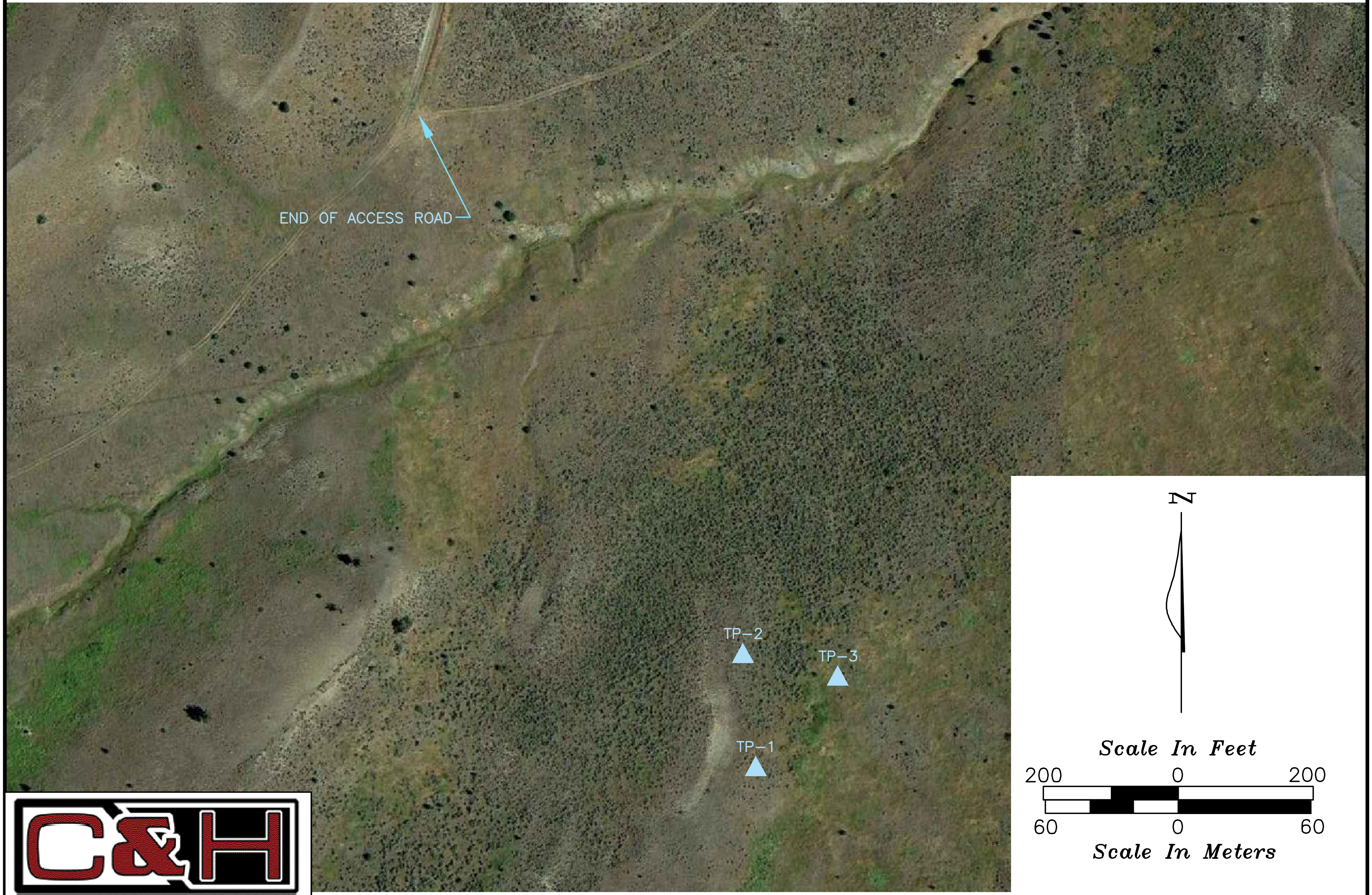
#171051

Appendix B

Test Pit Location Map

TEST PIT LOCATION MAP

NE 1/4, SECTION 31 TOWNSHIP 2 NORTH, RANGE 9 EAST, P.M.M.



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NOTE: TEST PIT LOCATIONS ARE APPROXIMATE

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Appendix C

NRCS Web Soil Survey Map

NRCS SOILS MAP

NE 1/4, SECTION 31 TOWNSHIP 2 NORTH, RANGE 9 EAST, P.M.M.

LEGEND

● Approx. Site Location

53E Tolbert-Vershal-Gnojek Complex

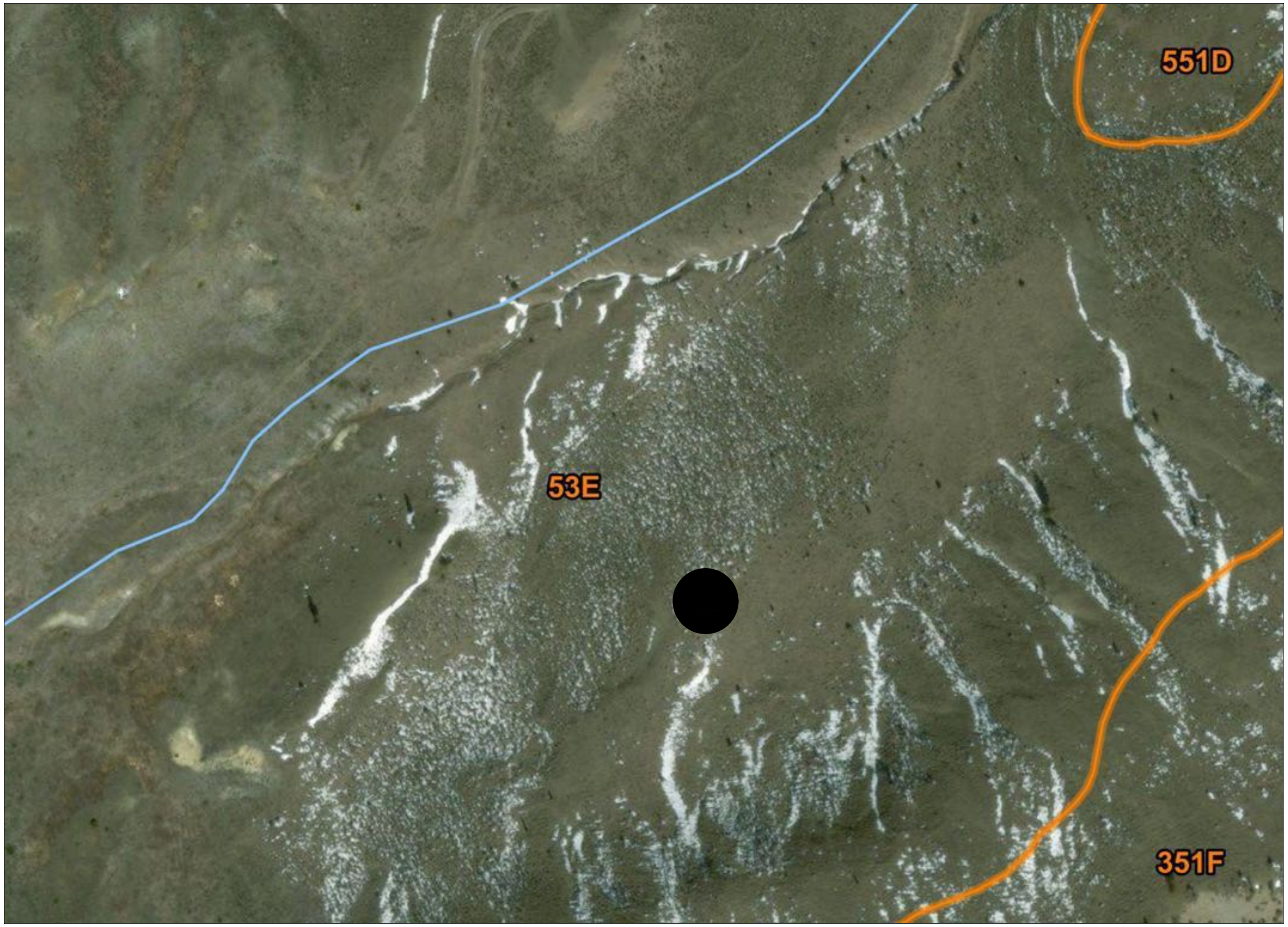
N

Scale In Feet

400 0 400

120 0 120

Scale In Kilometers



Tolbert-Vershal-Gnojek Complex described as residuum weathered from igneous and sedimentary with a typical profile of channery sandy loam (0-7 Inches), very flaggy clay loam (7-12 Inches) and unweathered bedrock (12-22 Inches). Depth to groundwater listed as greater than 80 inches.

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Aerial Photo Date = August 3, 2009 - September 1, 2016

Source: *Natural Resources Conservation Service, "Web Soil Survey - Version 8," September 24, 2014, United States Department of Agriculture, <http://websoilsurvey.nrcs.usda.gov/app/>*

#171051

Appendix D

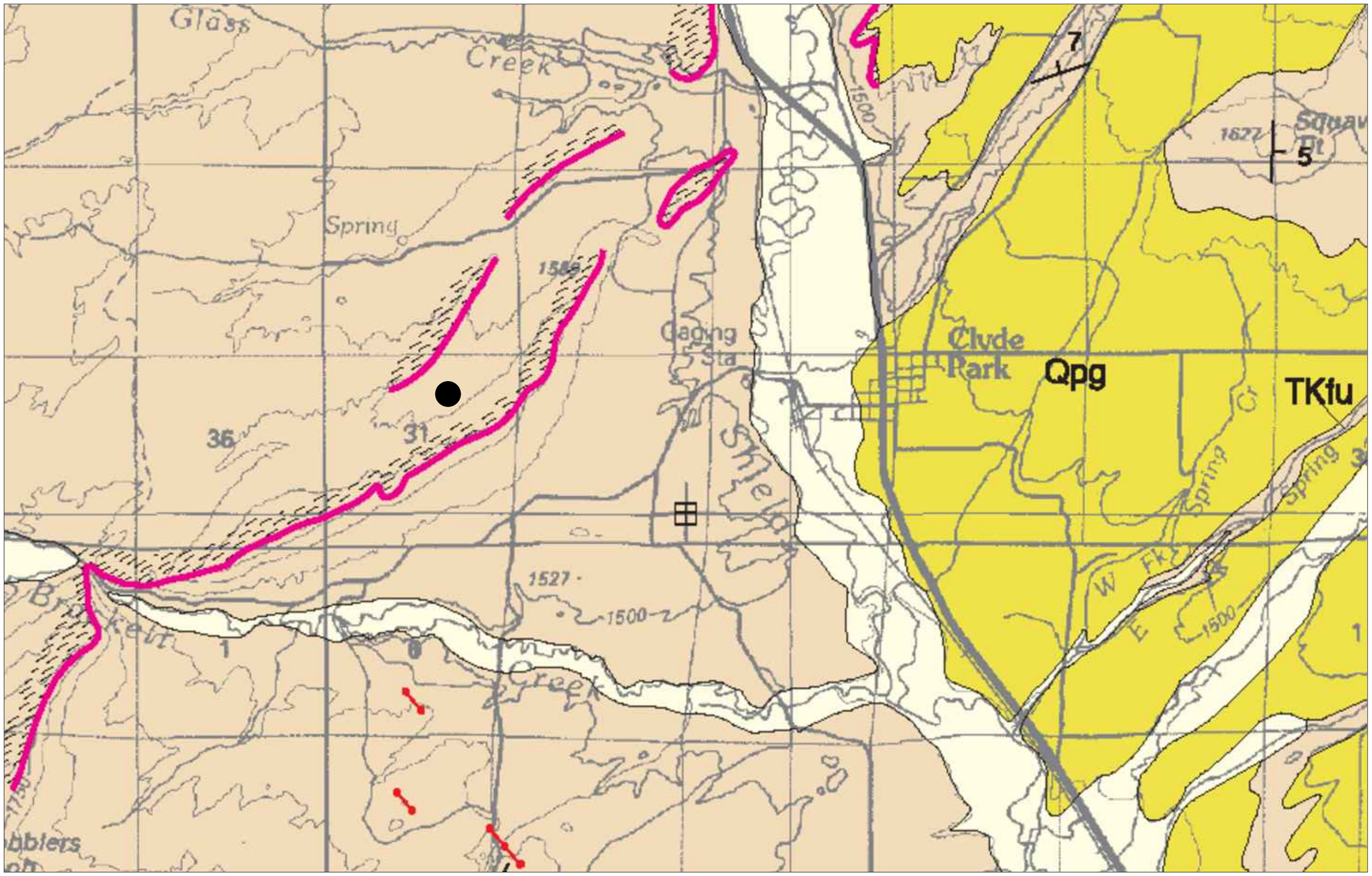
Geology Maps

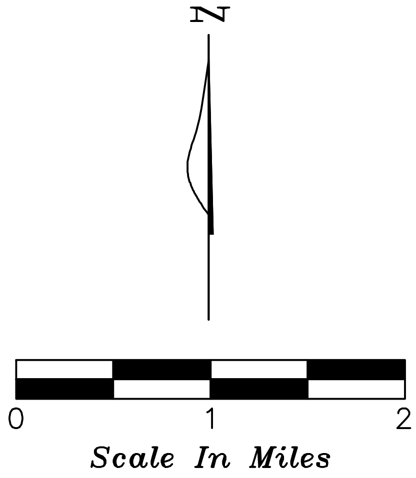
GEOLOGIC MAP OF THE LIVINGSTON 30' X 60' QUADRANGLE

NE 1/4, SECTION 31 TOWNSHIP 2 NORTH, RANGE 9 EAST, P.M.M.

LEGEND

●	Approximate Site Location
TKfu	Fort Union Formation





Fort Union Formation, undivided (Paleocene and Upper Cretaceous)

Cliff-forming massive sandstone, siltstone, mudstone, and lesser amounts of conglomerate. Conglomerate contains clasts of reworked Cretaceous and older rocks; contains fossil spores, plants, wood, freshwater mollusks, and vertebrates (Roberts, 1964d). Thickness increases toward axis of Crazy Mountain Basin and is probably at least 10,000 ft. Skipp and others (1999) show the Fort Union about 8000 ft thick in a cross-section on the west side of the Crazy Mountains. The lower part of the Fort Union formation near Livingston was assigned to the uppermost part of the Late Cretaceous by Roberts (1963, p. B89; 1965, p. B60).

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Source: Berg, & Richard B., Lopez, David A., & Lonn, Jeffrey D., "Geologic Map of the Livingston 30' x 60' Quadrangle, South-Central Montana" MBMG, Open File Report 406, 2000.

#171051

QUATERNARY FAULT & SEISMICITY MAP OF WESTERN MONTANA

NE 1/4, SECTION 31 TOWNSHIP 2 NORTH, RANGE 9 EAST, P.M.M.

LEGEND

▲	Approximate Site Location
●	Approximate Location of Earthquake Epicenter. (Scaled to Magnitude)
⋯⋯	Class A Fault
691	Bridger Fault
670	Central Park Fault
692	Gallatin Range Fault
694	Elk Creek Fault
642a	Emigrant Fault, Unamed Section

N

0 10 20

Scale In Miles

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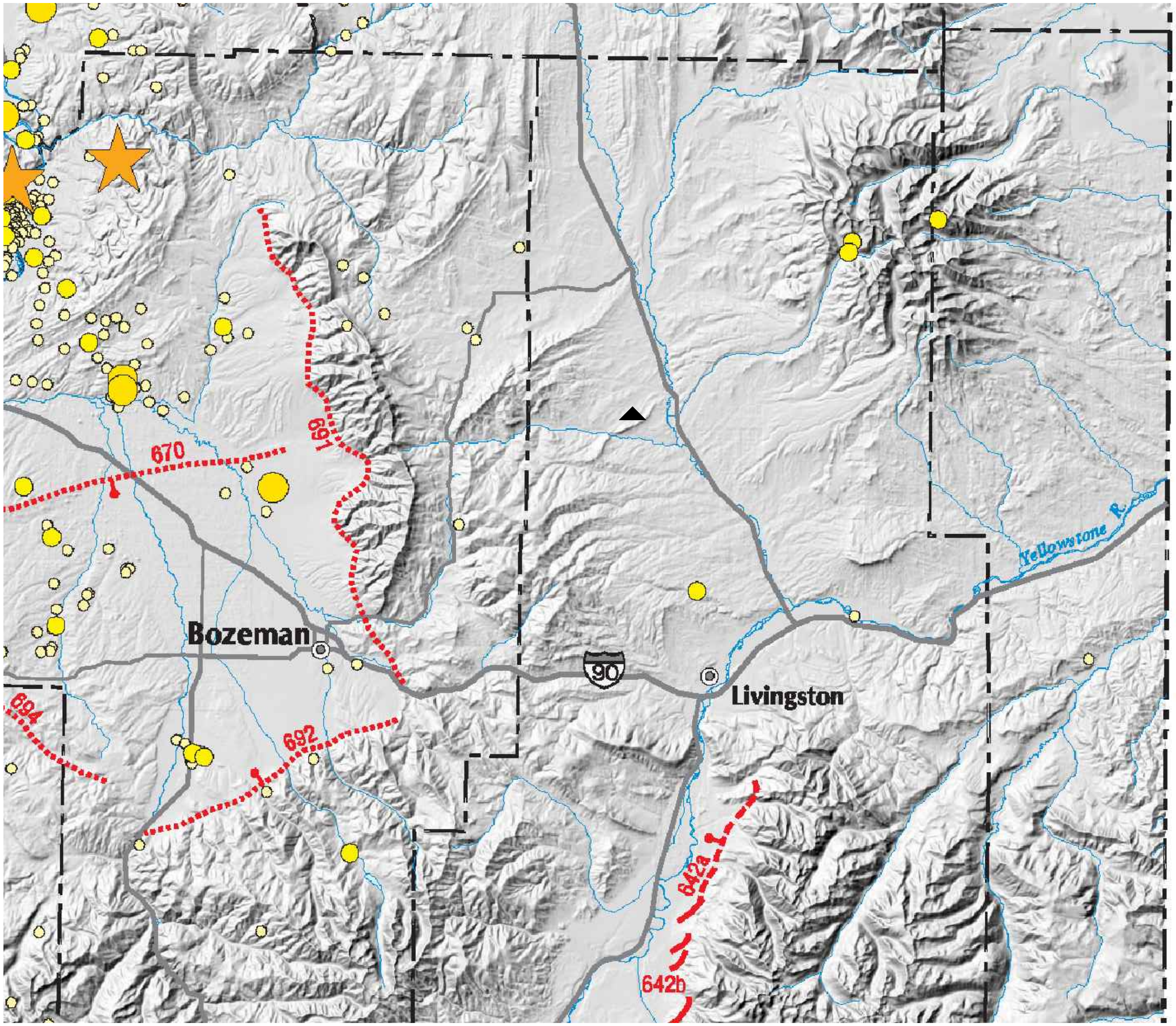

Class A Faults are associated with at least 1 large magnitude earthquake within the last 1.6 million years.

Source: Stickney, Michael C., Holler, Kathleen M., Machette Michael N., "Quaternary Faults and Seismicity in Western Montana ," MBMG, Special Publication No. 114, 2000.

#171051

Appendix E

Test Pit Logs

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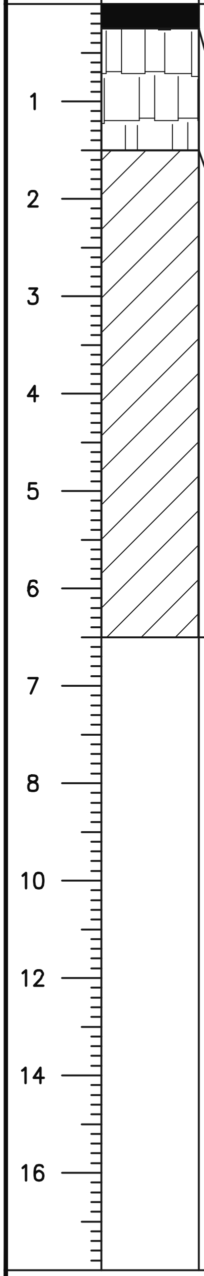
TEST PIT LOG

PAGE 1 OF 1

PROJECT: **WRIGHT THOMPSON – GEOTECHNICAL INVESTIGATION**	PROJECT #: **171051**
PROJECT LOCATION: **PARCEL E, C.O.S. 1909; PARK COUNTY, MT**	DATE: **9.28.2017**
TEST PIT LOCATION: **REFER TO THE TEST PIT LOCATION MAP**	START: FINISH:

DRILL TYPE: **JOHN DEERE BACKHOE**
DRILLER: **VME EXCAVATION, LLC**
LOGGED BY: **MICHAEL J. WELCH, P.E.**

TEST PIT ID: **TP-1**
ELEVATION: **N/A**
TOTAL DEPTH: **6.5'**
DEPTH TO GW: **N/E**



DEPTH (ft)	GRAPHIC LOG	SOIL DESCRIPTION	GROUP SYMBOL	SAMPLE ID	MOISTURE CONTENT (%)	LIQUID/PLASTIC LIMITS
		(0.0'–0.25') Organic Soil of Low Plasticity – low plasticity, root mass; trace shale fragments. In–place conditions – black; moist; soft.	OL			
		(0.25'–1.5') Moderately Weathered Sandstone – breaking up into large channry blocks of sandstone, rock hammer required to break apart rock fragments.				
		(1.5'–6.5') Moderately Weathered Mudstone – breaking up into medium sized blocks of mudstone, oxidation stains along fractures; rock hammer required to break apart rock fragments.				
		End of Excavation due to Bucket Refusal on Hard Intact Rock.				

REMARKS:

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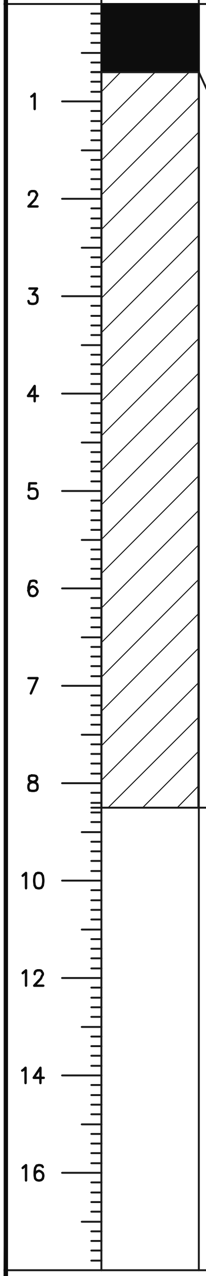
TEST PIT LOG

PAGE 1 OF 1

PROJECT: **WRIGHT THOMPSON – GEOTECHNICAL INVESTIGATION**
PROJECT #: **171051**
PROJECT LOCATION: **PARCEL E, C.O.S. 1909; PARK COUNTY, MT**
DATE: **9.28.2017**
TEST PIT LOCATION: **REFER TO THE TEST PIT LOCATION MAP**
START:
FINISH:
DRILL TYPE: **JOHN DEERE BACKHOE**
DRILLER: **VME EXCAVATION, LLC**
LOGGED BY: **MICHAEL J. WELCH, P.E.**
TEST PIT ID: **TP–2**
ELEVATION: **N/A**
TOTAL DEPTH: **8.5'**
DEPTH TO GW: **N/E**



DEPTH (ft)	GRAPHIC LOG	SOIL DESCRIPTION	GROUP SYMBOL	SAMPLE ID	MOISTURE CONTENT (%)	LIQUID/PLASTIC LIMITS
		(0.0'–0.7') Organic Soil of Low Plasticity – low plasticity, root mass; trace shale fragments. In–place conditions – black; moist; soft.	OL			
		(0.7'–8.5') Moderately Weathered Mudstone – breaking up into medium sized blocks of mudstone, oxidation stains along fractures; rock hammer required to break apart rock fragments.				
		End of Excavation due to Bucket Refusal on Hard Intact Rock.				

REMARKS:

Engineering and Surveying Inc.

TEST PIT LOG

PAGE 1 OF 1

PROJECT: **WRIGHT THOMPSON – GEOTECHNICAL INVESTIGATION**
PROJECT #: **171051**
PROJECT LOCATION: **PARCEL E, C.O.S. 1909; PARK COUNTY, MT**
DATE: **9.28.2017**
TEST PIT LOCATION: **REFER TO THE TEST PIT LOCATION MAP**
START:
FINISH:
DRILL TYPE: **JOHN DEERE BACKHOE**
DRILLER: **VME EXCAVATION, LLC**
LOGGED BY: **MICHAEL J. WELCH, P.E.**
TEST PIT ID: **TP–3**
ELEVATION: **N/A**
TOTAL DEPTH: **8.5'**
DEPTH TO GW: **N/E**

DEPTH (ft)	GRAPHIC LOG	SOIL DESCRIPTION	GROUP SYMBOL	SAMPLE ID	MOISTURE CONTENT (%)	LIQUID/PLASTIC LIMITS
1	■ ▨	(0.0'–0.7') Organic Soil of Low Plasticity – low plasticity, root mass; trace shale fragments. In–place conditions – black; moist; soft.	OL			
2 3 4 5 6	▨	(0.7'–6.7') Moderately Weathered Mudstone – breaking up into medium sized blocks of mudstone, oxidation stains along fractures; rock hammer required to break apart rock fragments.				
7 8 10 12 14 16		End of Excavation due to Bucket Refusal on Hard Intact Rock.				

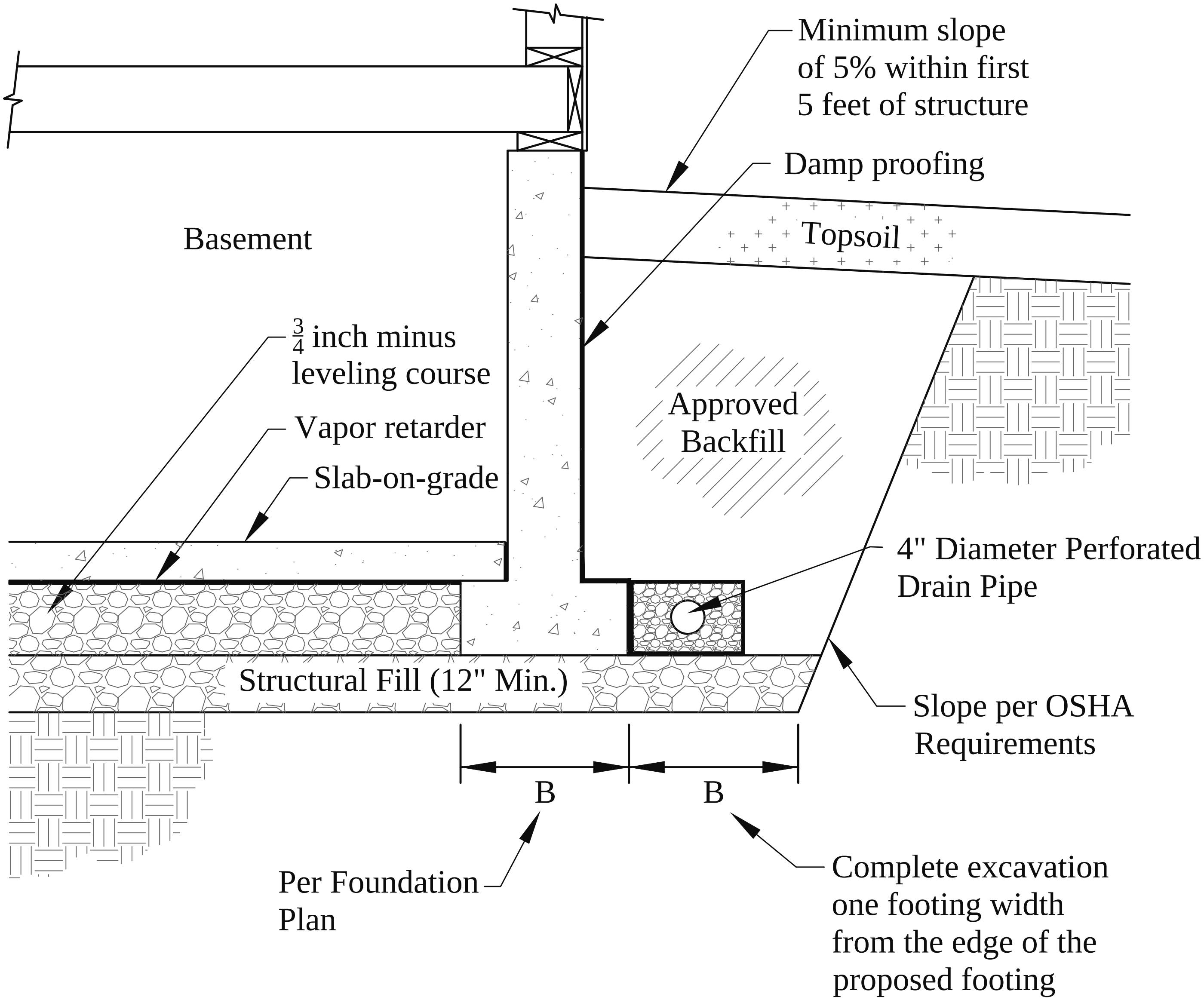
REMARKS:

Appendix F

Typical Foundation Details

TYPICAL FOUNDATION DETAIL

NE 1/4, SECTION 31, TOWNSHIP 2 NORTH, RANGE 9 EAST, P.M.M.



BASEMENT CROSS SECTION

SCALE: NTS

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#171051

Appendix G

Report Limitations

Report Limitations and Guidelines for Use

This appendix has been prepared to help the client understand the risks associated with the use of this report and provide guidelines on the proper use of this report.

This report was prepared to be used exclusively by Wright Thompson and his authorized agents for residential improvements to be constructed on Parcel E of Certificate of Survey 1909, located in the Northeast Quarter of Section 31, Township 2 North, Range 9 East, P.M.M. in Park County, Montana. All of the work was performed in accordance with generally accepted principles and practices used by geotechnical engineers and geologists practicing in this or similar localities. This report should not be used by anyone it was not prepared for, or for uses it was not intended for. Field investigations and preparation of this report was conducted in accordance with a specific set of requirements set out by the client, which may not satisfy the requirements of others. This report should not be used for nearby sites or for structures on the same site that differ from the structures that were proposed at the time this report was prepared. Any changes in the structures (type, orientation, size, elevation, etc.) proposed for this site must be discussed with our company for this report to be valid.

Our services consist of professional opinions based on subsurface exploration at specific points, surface observation of the site, and the review of available published data. These data are then extrapolated by geologists and geotechnical engineers to give an opinion of the overall subsurface conditions. Based on the subsurface conditions that are thought to occur at the site, we evaluate how those conditions would respond to the construction that is proposed, and give recommendations on foundation design and subgrade improvement.

Our subsurface exploration is limited to visual observation of the materials uncovered in an open test pit dug by an excavator. Soil testing was minimal in this investigation so conservative soil parameters have been estimated for bearing capacity and potential settlement from visual observation of the soil. Sampling and testing necessary for a local and global slope stability analysis have also not been completed for this site. Catastrophic events and other structures can contribute to the global stability of a slope, and have not been analyzed. If a more in depth subsurface investigation is desired, please contact our office to discuss your options.

It is important to note that subsurface exploration identifies actual subsurface conditions only at specific points under the conditions present at the time of exploration. Because of this, actual conditions may differ from those inferred to exist. The transitions between materials observed may be much more gradual or abrupt than inferred and subsurface materials may be uncovered during construction that were not thought to occur when the initial subsurface investigation was carried out. Conditions at the site can also change with time due to natural processes and construction practices on the site or on adjacent sites. With these limitations in mind, it is recommended that our services be retained for observation of the materials encountered during construction and that we are informed of any changes that occur on the site and any unexpected conditions that are encountered.

This report is only a preliminary recommendation, which may change if unexpected conditions are encountered during construction. We cannot be held responsible for damages due to constructing on a site with conditions that are different from conditions thought to occur from our investigation. The only way to verify if the conditions encountered during construction are the same as expected in our report is to have us inspect the subgrade materials during construction. We cannot be held responsible for constructing on materials that we have not seen in person.

The scope of our investigation did not include an environmental assessment for determining the presence or absence of hazardous or toxic materials on the site. If information regarding the potential presence of hazardous materials on the site is desired, please contact us to discuss your options for obtaining this information.

This report is valid as a complete document only. No portion of this report should be transmitted to other parties as an incomplete document. Misinterpretation of portions of this report (i.e. test pit logs) is possible when this information is transmitted to others without the supporting information presented in other portions of the report.

If any questions arise with regards to any aspects of this report, please contact us at your convenience to avoid misinterpretation. Costly mistakes due to misinterpretation of geotechnical reports can usually be avoided by a quick phone call.

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October 9, 2017

Wright Thompson
wrightthompson@gmail.com

RE: Septic System Feasibility – Parcel E, Certificate of Survey 1909; Park County, MT (171051)

Dear Mr. Thompson,

On September 28, 2017 a site visit was made to the above referenced property. The scope of services was to make a site visit and determine if there are any potentially suitable locations to install a subsurface wastewater treatment system, typically referred to as a septic system. The scope of our investigation included completing all the necessary work to provide our professional opinion on the feasibility of obtaining a permit to install a subsurface wastewater treatment system on the subject property from the Park County Department of Environmental Health.

The subject property consists of a single tract of land with a total area of 156.78 acres. The subject property is located in the Northeast Quarter of Section 31, Township 2 North, Range 9 East, in Park County Montana. The desired building site is located on the north facing side of a prominent northeast-southwest trending ridgeline.

A visual inspection of the area directly surrounding the desired building site indicates that locations for a subsurface watstewater treatment system are somewhat limited. The main limiting factors are a drainage channel that cuts through the approximate center of the subject property and steep slopes (>35%) located adjacent to the prominent ridgeline mentioned above. At a minimum, the drainfield component of the subsurface wastewater treatment system must be located 100 feet from the drainage channel and must be located in an area that has a slope of less than 35 percent and that also has a minimum of 5.5 feet of soil overlying bedrock. Typically a landform such as a ridgeline indicates that bedrock is relatively shallow. This was confirmed when three test pits were excavated for a geotechnical investigation at the desired building site. The three test pits excavated for the geotechnical investigation encountered shallow bedrock and this area was determined to be not suitable for a septic system.

Following the excavation of the geotechnical test pits, a relatively flat area downslope of the desired building site was identified as a potential drainfield area. A total of two test pits were excavated in the potential drainfield area to determine if enough soil was present to allow for the installation of a drainfield. The test pits revealed that this area is suitable for the installation of a drainfield as bedrock was not encountered within the depth of exploration, 10.0 feet below grounds surface in each test pit; see the attached test pits logs for more detailed subsurface information. These two test pits revealed that a clay loam soil is present in this area. Based on the subsurface soils present, an application rate of 0.3 gpd/ft^2 should be used to size the drainfield in this location.

In addition to having suitable soils and meeting all applicable offsets, the state of Montana requires that all subsurface wastewater treatment systems go through a nondegradation analysis to verify that the wastewater discharged into the subsurface will not pollute the local groundwater and any nearby surface water. Specifically it must be shown that the septic system will not cause the nitrate concentration in the local groundwater to rise above 5 mg/L and that the phosphorous plume generated from the wastewater discharged into the subsurface will not reach the nearest non-ephemeral surface water in less than a 50 year time period. For this project, there are no non-ephemeral surface waters located within 0.5 miles of the subject property and nitrate impacts to surface water do not need to be addressed in addition to the nitrate impacts to groundwater.

C&H Engineering has performed a nondegradation analysis and determined that a subsurface wastewater treatment system installed in the vicinity of the desired building location will pass the nondegradation analysis for nitrate impacts to groundwater and also phosphorous impacts to surface water; please note that this analysis was run for up to a 5-bedroom home.

In order to determine the background nitrate concentration in the underlying groundwater, a water sample was collected from a potable water well drilled north of the subject property. The water sample was analyzed for total nitrates and yielded a background nitrate concentration of 2.79 mg/L. Using this number, it was found that the wastewater from the residence will raise the nitrate concentration to 4.89 mg/L in the vicinity of the subsurface wastewater treatment system. As stated previously, in order to comply with state regulations it must be demonstrated that the wastewater will not raise the nitrate concentration in the underlying groundwater to above 5 mg/L.

The nondegradation analysis also indicated that it will take significantly greater than 50 years for the phosphorous plume to reach the nearest non-ephemeral surface water. As stated previously, in order to comply with state regulations it must be demonstrated that the phosphorous plume will take 50 years or more to reach the nearest non-ephemeral surface water.

Please note that any well installed on the subject property will have to be located a minimum of 100 feet from the drainfield component of the subsurface wastewater treatment system. This offset can range from 200 to 600 feet if the well is installed downgradient in the direction of groundwater flow from the drainfield. At this site the direction of groundwater flow is estimated to the north 40 degrees west, based on the regional slope method.

Another item to consider is that in Montana if a drainfield requires more than 1000 square feet of absorption area, the drainfield must be pressure dosed. This requires adding an additional tank to subsurface wastewater treatment system, referred to as a dose tank, to house an effluent pump. The effluent pump sends the wastewater to the drainfield under pressure and more evenly distributes the effluent across the drainfield. With an application rate of 0.3 gpd/ft^2, a subsurface wastewater treatment system designed for more than 3-bedrooms will require pressure distribution, even if the drainfield is located downslope of the homesite.

Based on our analysis it is our professional opinion that a permit for a subsurface wastewater treatment can be obtained for the subject property under the regulations in effect at the time of this report.

If you have any questions or comments, please contact the undersigned. This letter is not meant to be a guarantee or warranty of any kind.

Sincerely

M.J. Welch

Michael J. Welch, P.E.

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Enc: Test Pit Logs
Test Pit Location Map

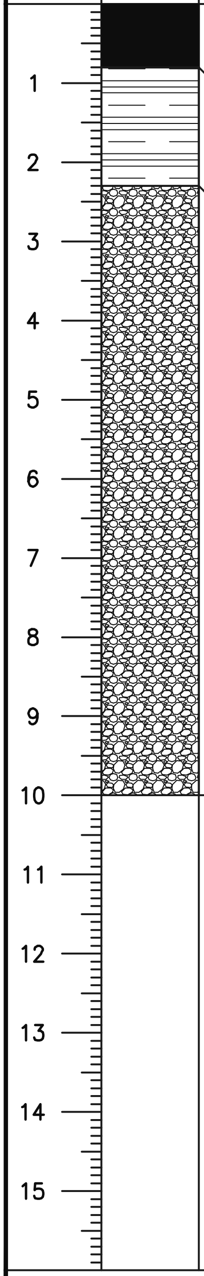
C&H
Engineering and Surveying Inc.

TEST PIT LOG

PAGE 1 OF 1

PROJECT: **WRIGHT THOMPSON – SEPTIC SYSTEM FEASIBILITY**
PROJECT #: **171051**
PROJECT LOCATION: **PARCEL E, C.O.S. 1909; PARK COUNTY, MT**
DATE: **9.28.2017**
TEST PIT LOCATION: **SEE TEST PIT LOCATION MAP**
START:
FINISH:
DRILL TYPE: **JOHN DEERE BACKHOE**
DRILLER: **VAL MENCAS EXCAVATION, LLC**
LOGGED BY: **MICHAEL J. WELCH, P.E.**
TEST PIT ID: **TP-1**
ELEVATION:
TOTAL DEPTH: **120"**
DEPTH TO GW: **N/E**

DEPTH (ft) | GRAPHIC LOG



SOIL DESCRIPTION	USDA SOIL DESCRIPTION	MUNSELL SOIL COLOR
(0"–9") Very Dark Brown; no structure; no reaction with dilute hydrochloric acid; organics present, low density.	SANDY LOAM	10YR 2/2
(9"–28") Grayish Brown; fine strong blocky structure; trace gravels; organics present; strong reaction with dilute hydrochloric acid.	CLAY LOAM	10YR 5/2
(28"–120") Grayish Brown; medium strong blocky structure, approximately 15 to 30 percent gravels; organics present to a depth of approximately 3.0 feet; strong reaction with dilute hydrochloric acid.	GRAVELLY CLAY LOAM	10YR 5/2
End of Excavation		

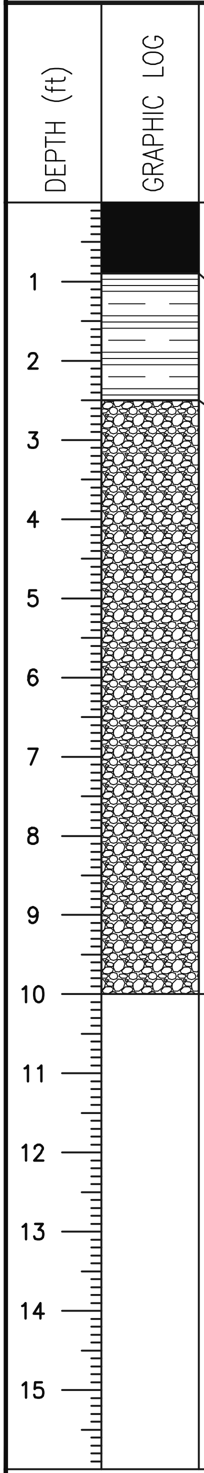
REMARKS: Munsell soil color determined from dry soil samples.
No evidence of seasonally high groundwater observed.

C&H
Engineering and Surveying Inc.

TEST PIT LOG

PAGE 1 OF 1

PROJECT: **WRIGHT THOMPSON – SEPTIC SYSTEM FEASIBILITY**
PROJECT #: **171051**
PROJECT LOCATION: **PARCEL E, C.O.S. 1909; PARK COUNTY, MT**
DATE: **9.28.2017**
TEST PIT LOCATION: **SEE TEST PIT LOCATION MAP**
START:
FINISH:
DRILL TYPE: **JOHN DEERE BACKHOE**
DRILLER: **VAL MENCAS EXCAVATION, LLC**
LOGGED BY: **MICHAEL J. WELCH, P.E.**
TEST PIT ID: **TP-2**
ELEVATION:
TOTAL DEPTH: **120"**
DEPTH TO GW: **N/E**

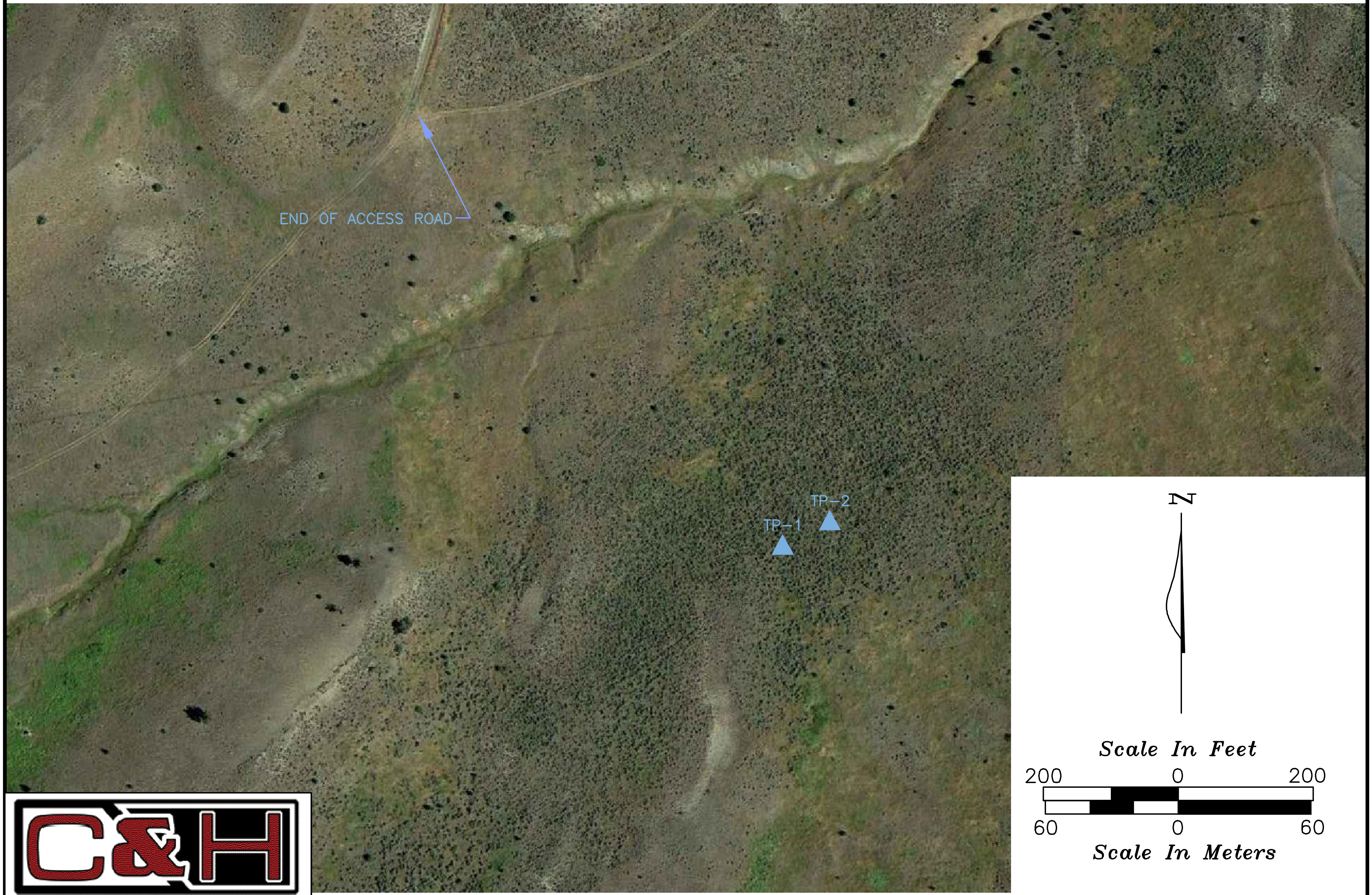


SOIL DESCRIPTION	USDA SOIL DESCRIPTION	MUNSELL SOIL COLOR
(0"–10") Very Dark Brown; no structure; no reaction with dilute hydrochloric acid; organics present, low density.	**SANDY LOAM**	**10YR 2/2**
(10"–30") Grayish Brown; fine strong blocky structure; trace gravels; organics present; strong reaction with dilute hydrochloric acid.	**CLAY LOAM**	**10YR 5/2**
(30"–120") Grayish Brown; medium strong blocky structure, approximately 15 to 30 percent gravels; organics present to a depth of approximately 3.0 feet; strong reaction with dilute hydrochloric acid.	**GRAVELLY CLAY LOAM**	**10YR 5/2**
End of Excavation		

REMARKS: Munsell soil color determined from dry soil samples.
No evidence of seasonally high groundwater observed.

TEST PIT LOCATION MAP

NE 1/4, SECTION 31 TOWNSHIP 2 NORTH, RANGE 9 EAST, P.M.M.



C&H Engineering and Surveying Inc.

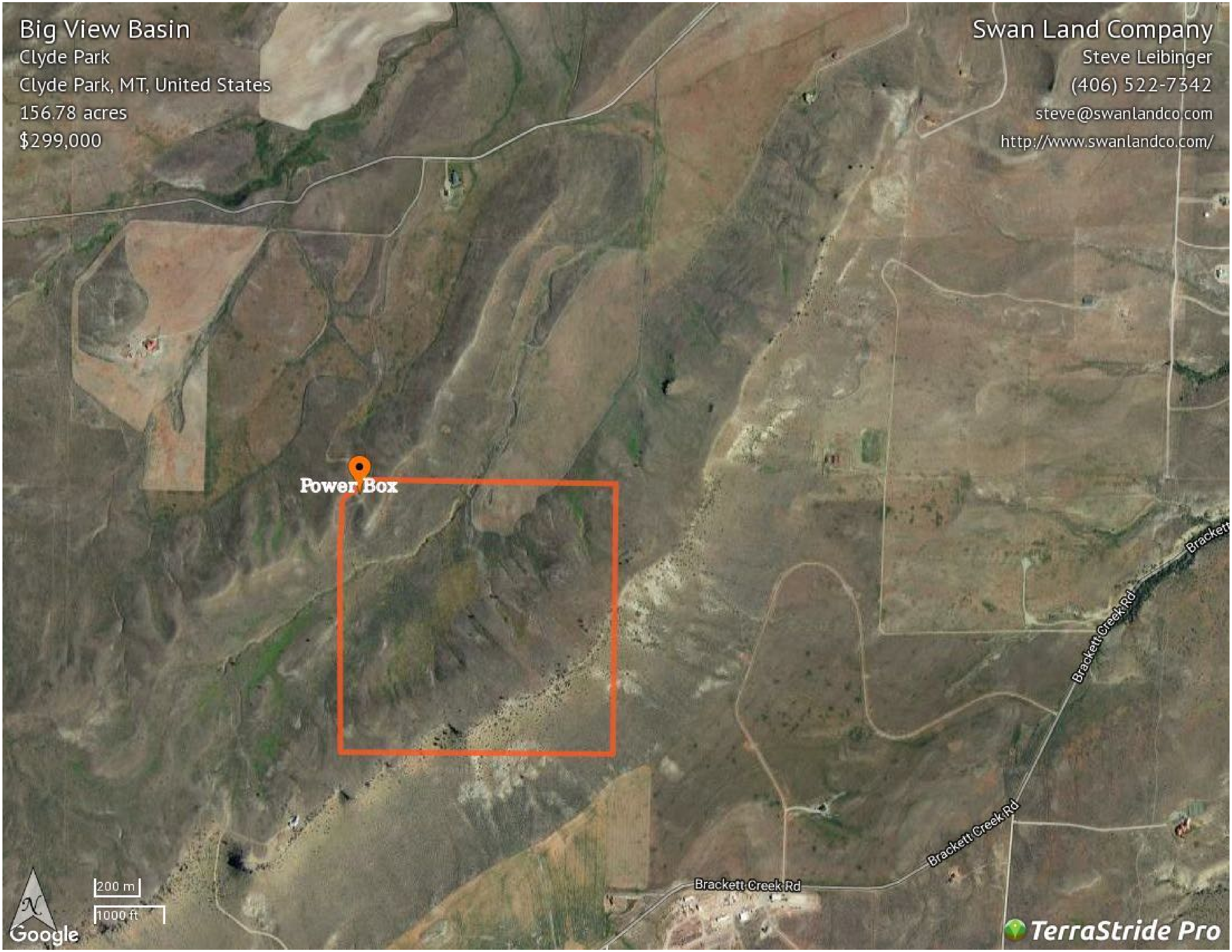
NOTE: TEST PIT LOCATIONS ARE APPROXIMATE

#171051.1

Big View Basin

Clyde Park
Clyde Park, MT, United States
156.78 acres
$299,000

Swan Land Company
Steve Leibinger
(406) 522-7342
steve@swanlandco.com
http://www.swanlandco.com/



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