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May 24, 2010

Mr. Frank Filas, Environmental Manager
Energy Fuels Resources Corporation
44 Union Blvd., Suite 600
Lakewood, Colorado 80228

RE: BUILDING FOUNDATION SELECTION AND SETTLEMENT ANALYSIS
PIÑON RIDGE PROJECT, MONTROSE COUNTY, COLORADO

Dear Frank:

SM&RC Structural Engineers Inc. has prepared this Building Foundation Selection and Settlement Analysis for Energy Fuels Resources Corporation (EFRC) for the Piñon Ridge Project located in Montrose County, Colorado.

1.0 SCOPE OF THIS REPORT

This report provides responses to the Colorado Department of Public Health and Environment's (CDPHE) request for additional information relating to the Division's review of the Piñon Ridge Mill license application. The following comment received from CDPHE is addressed in this report:

"A revised Geotechnical Design Recommendations Mill and Infrastructure Piñon Ridge Project Montrose County Colorado or a new supplemental report to this document should first provide the foundation type (of the three proposed) selected for each major structure. Next, the report should rigorously support their selection(s) with engineering rationales. The Division wants to understand why the foundation type for each major structure was selected. A decision matrix is an excellent tool for this purpose. Criteria for the selection should include all the elements typically considered, such as but not limited to, calculated loadings (break out all live, static, and temporary loads to arrive at maximal design loadings) geology, geotechnical test results, geohydrology, etc. Energy Fuels should consider limiting movement of all slabs in terms of vertical and lateral displacement as part of the selection criteria for each foundation type. The Division's goal is to have a design that minimizes movement of the foundations and the concrete support slabs to achieve isolation from the environment to the extent possible as well as provide adequate structural support."

2.0 APPROACH

The key criteria for the project foundations is to provide foundations that have minimal settlement and that are designed and detailed to provide secondary containment structures for the mill processing fluids.

The type of foundation considered for the project structures were based on those recommended in the Kleinfelder Project Geotechnical Design Recommendation document. These foundation types included Spread Footing on compacted fill, Mat Foundation on compacted fill, Mat Foundation on Augered Pressure Grouted (APG) Piles and Mat Foundation on Rammed Aggregate Piers. In general these foundation types or combinations of the recommended types were used or considered for the project foundations.

The Rammed Aggregate Pier option was not used in selecting the foundation types for the project. Rammed Aggregate Piers were initially considered but they provided no advantage over the other proposed foundation types and did present some concerns. There was some concern over possible down-drag forces on their performance; the foundation system is also unique and construction materials would be costly as they are not readily available in the project area.

In order to determine which foundation type is best suited to provide containment, building column, equipment and tank foundation loads for the critical mill structure areas were calculated. Loads were calculated using the project design criteria and proposed building, equipment and tank information provided in the general arrangement drawings and documents prepared by CH2MHill. Calculated foundation loads and settlements were then used to select and size the foundations. The settlement potential for each foundation was determined using standard geotechnical methods and reported soil parameters provided in the project geotechnical report. The Boussinesq method was used to determine settlements for mat and thickened footing type foundations. To reduce settlements and provide an added safety factor, several foundation areas were preloaded to induce settlement prior to construction of selected building structures.

3.0 FOUNDATION SELECTION

3.1 Rationale

The following design considerations were evaluated when selecting the appropriate foundation types.

- The selected foundation must meet the project design criteria for allowable settlement. Allowable total settlement for the project structures is 1 inch and allowable differential settlement is 3/4 inch.
- Total and differential settlement must not adversely impact the containment function of materials used to seal the concrete foundation settlement control and construction joints.
- The foundation system selected must limit joints in the system that could provide a path for leakage of mill processing fluids.
- Foundation systems selected for the structures must be compatible. For example, for areas of high loading where APG piles are appropriate, areas outside the high load area must also be designed to prevent excessive differential settlement, which could include preloading, designing with settlement control joints or designing with support on piles.
- The foundation system must meet the recommendations of the geotechnical investigation.
- The foundation system must have sufficient strength to resist the applied loads from the structure.
- Groundwater is well below the on-site collapsible soils.
- Site grading will be developed to collect and drain precipitation away from the building and the top ten ft of finished grade will be compacted fill. The compacted fill will provide for a barrier against infiltration of surface runoff water.
- Building roof drainage will be collected within downspouts and then drained to the process water tank.

3.2 Foundation Decision Matrix

The project design Geotechnical report recommends the consideration of three types of foundations to support the mill structures. The report recommends two deep foundation types, both involve the installation of deep shaft elements to limit settlement and one shallow foundation type which involves the use of shallow spread footings to support the structures. Of the deep foundation recommendations, the Auger Cast Pile type was selected as the most suitable for the project. The Rammed Aggregate Piers option was not selected as previously stated, as this type of pile is unique, materials for construction are not readily available at the site and they did not provide any advantage over the more common Auger Cast Pile. The Geotechnical report recommendations have been developed further in this report to address the calculated structure loads and resulting stress distribution for the foundation soils beneath each of the foundations.

The design of the project foundations are a function of the distribution of loading as well as the magnitude of loading. The depth of a foundation's influence on a supporting soil profile is proportional to the width and length of the loaded foundation area. The larger the foundation, the deeper the load influence will penetrate the soil. The cumulative settlement in a soil profile resulting from increased loads is a function of the magnitude of the applied loads and the area that the load is applied to. The combination of the above area load parameters, loading magnitudes and physical soil parameters are used in the Boussinesq method of settlement analysis to determine the amount of settlement.

The foundation soils underlying the mill structures consist of a compressible layer of soil approximately 40 ft thick and below this compressible layer is a maximum 40 ft thick dense soil layer down to bedrock. There are some soft layers in the lower 40 ft layer and also some harder cemented layers in the soft upper 40 ft layer. To address settlement concerns for the project, it was assumed that all foundation soils below the compacted fill layer was formed of a soft compressible soil. This is the most conservative assumption and leads to a design which has redundancy.

The combination of large areas of moderate to high loads and soft soil profiles can create the potential for excessive settlement if appropriate foundation design and or construction methods are not used. There are several available options to eliminate excessive settlement for the mill structure foundations. The first option is to preload the existing foundation soil to a value that will cause the majority of settlement in the soft underlying soil to occur prior to the construction of the foundation. Preloading reduces settlement by 80 % and is very reliable. Preloading involves loading the footprint area of the foundation with a load equal to the design load and then removing it prior to installing the structure. For this project, preloading will be obtained by constructing temporary 15-ft-thick soil embankments above the finished grade in specified areas. The design preload of 15 ft of fill is conservative and has been selected to provide an additional measure for reducing settlement.

The second option for controlling settlement for this project is to install piles to a depth where the foundation sub-soil is strong enough that it will support the foundations without allowing significant settlement to occur. This approach is used for the mill foundations where the applied loads are high and the required preloading fill heights would be excessive.

The evaluation of foundation loadings for this project shows that two general loading ranges occur for the project's mat foundations. The mat design load ranges are those with a uniform bearing load less than 1200 psf and mats with a uniform bearing load above 1200 psf. Settlement calculations for preloaded foundation mats which have a calculated bearing stress less the 1200 psf indicates that settlements will meet the design criteria values of less than 1 inch total settlement and 3/4 inch differential settlement. For the mats with bearing loads that exceed

1200 psf, the use of piles is required to maintain settlement in the allowable range. Foundation settlement analysis also shows that spread footings with a size less then 10 ft by 10 ft can be used to support building columns that cause a bearing stress of 3000 psf or less on the footing.

Using the project allowable design settlement criteria and calculated settlements for the proposed foundations, the following decision matrix was developed to select which foundation was suitable for each of the project foundations. Mat type foundations on compacted fill, with or without piles, were used for all foundations to prevent leakage of process solutions. Mats with calculated loads less than 1200 psf did not require piles, mats with bearing loads which exceeded 1200 psf were designed with piles. Mat foundations with loads less than 1200 psf will be preloaded to reduce settlements to a minimum.

Matrix Decision Summary Table

Process Area & Structure	Mat Foundation Acceptable		Mat Foundation on APG Piles Required		Decision	
	FDN Size Greater Than 10 ft by 10 ft and Bearing Load Less than 1200 PSF	FDN Size Less then 10 ft by 10 ft and Bearing Load Less than 3000 PSF	FDN Size Greater than 10 ft x 10 ft and Bearing Load Greater than 1200 PSF	Building Structure or Equipment Sensitive to Vibrating Loads	Design Mat Foundation	Design Mat Foundation on APG Piles
Area 100 – Ore Feed Bldg.	X				X	
Area 100/200 – Pulp Storage and Pre-Leach Area.			X			X
Area 100/200- Grinding and Leach Bldg.			X	X		X
Area 300-CCD Thickener Area	X	X			X	
Area 400/600-Solvent Extraction Bldg.	X	X			X	
Area 400/600-Solvent Extraction Tanks.			X			X
Area 500/700 Precipitation & Packaging Bldg.	X	X			X	
Area 500/700 Precipitation & Packaging Tanks.			X			X
Area 800 – Sulphuric Acid Storage Tank			X			X
Area 800 – Sulphuric Acid Storage Containment Slab	X				X	

3.3 Summary of Foundation Types Selected

The following is a summary of the foundation types proposed for the critical project structures in the mill area and detailed reasoning for selecting the foundation type for each structure.

All structures will be designed with secondary containment walls and double containment sumps. Double containment sumps will consist of a heavily reinforced secondary concrete sump attached to the under side of the main foundation slab. The sump below the main foundation slab will be fitted with rubber water-stops at all construction joints. Within this sump, a smaller primary precast reinforced concrete sump will be placed. This primary sump will be placed on gravel bedding and will be detailed to form a space all around relative to the walls of the sump attached to the main slab. The space between the two sumps will be fitted with an embedded liner to direct all leakage within the building to the primary precast sump. Any leakage into the secondary sump will be pumped out thru a standpipe which will be installed during construction. This type of double containment sump system will be used in all floor sumps located within secondary containment areas.

- **Area 100 - Ore Feed Building**
  The Ore Feed Building receives raw ore and distributes it to the Grinding and Leach Building via an underground conveyor. The building foundation has a plan dimension of approximately 50 ft x 20 ft and extends 25 ft below finished grade. The building superstructure consists of a 20 ft high pre-engineered steel building.

  The soils in the vicinity of the proposed building consist of silty sands. The upper 14 ft of the soils exhibit a low Standard Penetration (STP) blow count and are porous in the upper 10 ft. Below this layer, the soils transition to silty sands with cemented layers that have higher STP blow counts. The bearing elevation of the building will be 18 ft below existing grade in the soils with the higher blow counts. Approximately 9 ft of fill will be required to bring the existing subgrade up to final finished grade.

  Loads for the foundation consist of the steel building, the below grade concrete structure, equipment and deposited ore. The foundation for the building will be in silty sands with a medium dense to dense relative density that exhibit higher blow counts. The fill required to bring existing grade up to final grade will be placed prior to construction of the foundation and steel building. Foundation loads applied to the subgrade will be similar to the weight of the soil removed for excavation of the structure. Therefore, the structure will not impose loads on the subgrade that are significantly greater than the conditions present before the foundation and building are constructed. Because of the soil conditions present at the foundation bearing elevation and the low potential for settlement, a mat foundation was selected. A deep foundation consisting of APG piles is not required for this application since the mat foundation will meet the settlement criteria. Spread footings are not practical for construction of the sub-structure for this building. The calculated total and differential settlement will be less than 3/4 inch. All below grade concrete joints will be sealed with waterstops to provide water tight joints.

- **Area 100/200 - Pulp Storage and Pre-Leach Area**
  The pulp storage and pre-leach area consists of various above grade tanks surrounded by a secondary containment area. The tanks consist of two 39 ft diameter x 39 ft high pulp storage tanks, a 60 ft diameter thickener with a side water depth of 12 ft, a 50 ft diameter clarifier with a side water depth of 14 ft and two 21 ft diameter x 24 ft high pre-leach tanks. The containment area consists of a concrete floor and a 4.5 ft high concrete perimeter wall.

The upper 18 to 26 ft of the soil in the pulp storage area is a variable combination of silty sands and clayey sands. The sands have a loose to medium dense relative density and exhibit low STP blow counts. Below this layer are silty sands with a medium dense to dense relative density. Fill will be required to bring the existing subgrade up to final finished grade. The estimated amount of fill is 3.5 ft in the southwest corner of the containment area and 8 ft in the northeast corner. A minimum 10 ft layer of fill will be placed beneath the foundation which means some excavation of existing soils will be needed.

Area bearing loads for the tanks spread over the footprint of the tank are as follows:

- Pulp storage tanks – 4800 psf
- Thickener – 1100 psf
- Clarifier – 1300 psf
- Pre-Leach storage tanks – 3000 psf

The bearing loads for the footprint of the pulp storage and pre-leach tanks are higher than the maximum allowable bearing load of 3000 psf recommended for spread footings in the geotechnical report. Therefore, the only foundation type that will provide the required strength is a deep foundation consisting of APG piles. The entire structure will be placed on a mat foundation supported by APG piles. A pile foundation will produce significantly less settlement than other foundation types available. The estimated total settlement of the foundation will be less than 1 inch and the differential settlement will be less than 3/4 inch.

- **Area 100/200 – Grinding and Leach Building**

The Grinding and Leach Building contains a 14 ft diameter SAG mill to grind the ore and an elevated leach train consisting of eight 21 ft by 24 ft high steel tanks. The building has a plan dimension of approximately 80 ft x 225 ft. The superstructure of the building consists of a metal building with a gabled roof that is 100 ft tall. The building will contain a 25 ton-bridge crane.

The upper 14 ft of the soil in the vicinity of the building consist of silty and clayey sands. The silty sands have a loose to medium dense relative density and exhibit a low STP blow count. Progressing downward, the soils are silty sands with a medium dense to dense relative density and high STP blow counts. Fill will be required to bring the existing subgrade up to final finished grade. The estimated amount of fill required is 5.5 ft in the southwest corner of the building and 12 ft in the northeast corner. A minimum 12 ft layer of fill will be placed beneath the foundation which means some excavation of existing soils will be needed.

Area loads for the building include the building columns, the SAG mill and leach tanks. The building columns will have a maximum column load of 160 kips (1kip = 1000lbs). The SAG mill will have a total load of 745 kips. The leach tanks have a load of 1040 kips or 3000 psf spread over the footprint of the tank or a column load of 295 kips.

The building structure consists of building columns that support the superstructure, overhead crane, and platform columns that support the leach train. The building also contains the SAG mill. Each area of the building was reviewed and an appropriate foundation type was selected.

The building columns will support a 25-ton bridge crane. Since even a very small amount of differential settlement could affect the operation of the crane system, a deep foundation consisting of APG piles was selected for this component of the building.

The SAG mill is a heavy piece of equipment that is costly and vibrates when in operation. The equipment's performance could be affected by settlement and vibration magnitude. Therefore, a deep foundation consisting of a 5 ft thick concrete mat supported on APG piles was selected for the SAG mill.

The leach tanks are a heavily loaded area. Calculated loads are 3000 psf spread over the area of the tank footprint which is above the recommendations for the allowable loads of spread footings. The only foundation system that will provide the strength to support the tanks is an APG pile system.

Since an APG pile foundation is required for all of the major components of the building, it was decided to use a mat foundation supported by APG piles for the entire building. A pile foundation will produce less settlement than other foundation types available. The anticipated total settlement will be less than 1 inch and the differential settlement will be less than 3/4 inch.

- **Area 300 – CCD Thickener Area**

  The CCD Thickener area consists of eight 40 ft diameter epoxy coated steel thickeners with a side water depth of 10 ft. The thickeners will have a conical bottom and will be supported on steel columns. A pre-engineered steel building for housing pumps runs the entire length of the CCD area between the thickeners. A containment area consisting of a concrete floor and a 1.5 ft high concrete curb will provide secondary containment for the tanks.

  The soils in the vicinity of the CCD thickeners consist of silty and clayey sands. The upper 15 ft of the soils are silty sands that have a loose to medium dense relative density and exhibit low STP blow counts. Below this layer, the soils transition to silty sands with a medium dense to dense relative density. Fill will be required to bring the existing subgrade up to final finished grade. The estimated amount of fill required is 10 ft in the southwest corner of the building and 18 ft in the northeast corner.

  Area loads for the thickeners will be 1200 psf spread over the footprint of the tank. Maximum loads for the building columns will be 15 kips.

  Since the loads to the foundation are moderate, a mat foundation for the building columns and thickeners was selected. The mat foundation will function as a large unit that will distribute loads to the subgrade and reduce differential settlement. As an added precaution, the thickener area will be pre-loaded with approximately 15 ft of fill or an area load of 1500 psf. Pre-loading of the building area will be accomplished by placing 15 ft of fill above the finished grade of the footprint of the building for a minimum period of 1 month prior to construction of the foundation. The pre-loading is approximately equivalent to the calculated loads of the new thickeners and will significantly reduce the potential for settlement during the startup filling of the thickeners. Preloading will induce settlement to occur in the foundation soils prior to construction. The anticipated settlement will be less than 1 inch and the differential settlement will be less than 3/4 inch. Since the calculated settlement is low, an APG pile foundation is not required for this area. A spread footing foundation would result in larger settlements and more joints that can leak; therefore, spread footings are not recommended.

- **Area 400/600 – Solvent Extraction Building**
  The Solvent Extraction Building has a plan dimension of approximately 140 ft x 370 ft. The superstructure of the building consists of a pre-engineered steel building with a gabled roof that is 30 to 60 ft tall. The building will contain multiple mixers and several above grade storage tanks. A containment curb around the perimeter of the building will be provided.

  The soils in the vicinity of the Solvent Extraction Building consist of silty and clayey sands. The upper 20 ft of the soils are silty sands that have a loose to medium dense relative density with a STP blow count of less than 15. Below this soil layer, the soils transition to silty sands with a medium dense to dense relative density. Fill will be required to bring the existing subgrade up to final finished grade. The estimated amount of fill required is 9 ft in the southwest corner of the building and 14 ft in the northwest corner.

  Area loads for the building tanks consist of a load of 1500 psf spread over the footprint of the tanks. Loads for the mixers and column foundation loads are 1000 psf.

  Since the loads to the building and interior area of the foundation are moderate, a mat foundation with thickened areas for the building columns was selected. The heavier tanks will be placed on a deep foundation formed with a mat supported on APG piles. The mat foundation will distribute loads to the subgrade and reduce differential settlement. The heavy tank foundations will be isolated and moved away from the building columns to reduce the potential for differential settlement. As an added precaution, the building area will be pre-loaded with approximately 15 ft of fill to induce an area load of 1500 psf similar to the CCD thickener area. The pre-loading is more than the calculated loads of the building columns and equipment. Pre-loading will significantly reduce the potential for settlement. The calculated total settlement will be less than 1 inch and the differential settlement will be less than 3/4 inch. Since the estimated settlement for the mat foundation is low, an APG pile foundation is not required for the lightly loaded building portion of the structure. Isolated spread footing foundations would result in larger differential settlements and more joints that can leak; therefore, spread footings are not recommended.

- **Area 500/700 – Precipitation and Packaging Building**
  The Precipitation and Packaging Building has a plan dimension of approximately 150 ft x 200 ft. The superstructure of the building consists of a pre-engineered steel building with a gabled roof that is 40 to 100 ft tall. The precipitation area contains filters, pumps and several above grade storage tanks. The packaging area is split into uranium and vanadium areas and will contain an area for drum storage. A containment curb around the perimeter of the building will be provided.

  The soils in the vicinity of the proposed building consist of silty sands with a medium dense to dense relative density. The upper 18 ft of the soils exhibit low STP blow counts while the soils below this layer have higher blow counts with several cemented layers at 19 ft, 39 ft and 44 to 46 ft depths. At 30 ft below existing grade there is a layer of soil that has lower STP blow counts. The sands in this area have a loose to medium dense relative density and have blow counts of less than 15. Below 14 ft, the soils transition to silty sands with a medium dense to dense relative density. The estimated amount of fill required to bring the existing grade up to final grade is 1 ft in the southwest corner of the building and 9 ft in the northeast corner.

Area loads for the building tanks consist of a load of 3000 psf spread over the footprint of each tank. The main building column foundation loads are 3000 psf and the storage area loads have been conservatively estimated to be 1000 psf.

Since the building foundation loads are localized in the higher bearing stress areas and are moderate elsewhere, a mat foundation with thickened areas for the building columns was selected. The heavier tanks will be placed on a deep foundation formed with a mat supported on APG piles. The building mat foundation will distribute loads to the sub-grade and reduce differential settlement. The heavy tank foundations are outside the footprint of the building in containment areas adjacent to the building. These foundations will be separated from the foundations of the building to eliminate development of stresses from differential settlement between the foundations.

The boring in the vicinity of the building showed layers of fill 15 ft from the surface that exhibited low STP blow counts. Therefore, it is recommended that an additional 10 ft of the existing sub-grade be removed and replaced with compacted fill in addition to the minimum 10 ft of fill recommended in the project geotechnical report. Finally, as an added precaution, the building area will be pre-loaded with approximately 15 ft of fill or an area load of 1500 psf similar to the CCD thickener area. The pre-loading is more than the calculated loads induced by the building columns and equipment. Pre-loading will reduce the potential for settlement. The anticipated total settlement will be less than 1 inch and the differential settlement should be less than 3/4 inch.

- **Area 800 - Sulphuric Acid Storage**

  The sulfuric acid storage area consists of three 28 ft diameter x 28 ft high steel tanks surrounded by a secondary containment area. The containment area consists of a concrete floor and a 5 ft high concrete containment wall.

  The soils in the vicinity of the proposed storage area consist of silty and clayey sands. The upper 14 ft of the soils are silty sands that have a loose to medium dense relative density with STP blow counts of less than 15. Below this layer the soils transition to silty sands with a medium dense to dense relative density. Boring TB-20 did have a 4 ft layer of material at 24 ft below grade that had low blow counts.

  Area loads for the tanks consist of a load of 3200 psf spread over the footprint of each tank.

  The bearing loads over the footprint of the tanks are greater than 3000 psf or the allowable load for spread footings given in the Kleinfelder 2008 Geotechnical report. Therefore, an APG pile foundation was selected for the foundation. The containment area of the storage area will be lightly loaded. It will have a maximum load of 700 psf should a tank rupture. Since the containment area is lightly loaded, providing a slab on grade foundation will not result in significant differential settlement between the tanks and the containment area. The structure and materials used to make the concrete joints watertight will be designed to withstand the differential settlement between the APG piles and the containment area. As an added precaution the storage area will be pre-loaded with approximately 10 ft of fill or an area load of 1000 psf. The pre-loading is more than the calculated loads of the lightly loaded containment area and will significantly reduce the potential for differential settlement between the tank area and the slab containment area.

4.0 Foundation Design and Detailing

In addition to selecting appropriate foundation types for the structures, the foundations will be designed and detailed in such a manner that provides for a fluid tight structure with a low potential for cracking. The following design, detailing and construction criteria shall be used.

- The design of the concrete floors and containment walls shall be in accordance with the report, ACI 350.2R, "Concrete Structures for Containment of Hazardous Materials" and the standard, "ACI 350 Code Requirements for Environmental Engineering Concrete Structures". The use of ACI 350 is specifically applicable to providing a structure that will contain fluids as it uses an additional load factor during the design to reduce working stresses which result in a more durable structure.
- The concrete mix used in the construction of the floor slabs and containment walls shall have a low permeability and reduced amount of shrinkage. The concrete mix design shall be durable with a minimum strength of 4500 psi and a maximum water to cement ratio of 0.40. Maximum specified shrinkage of the mix design will not exceed 0.040 percent after 28-days in accordance with ASTM C157. The concrete mix design will be designed to be acid resistant.
- Concrete joints in containment walls, sumps and slab construction joints will be fluid tight joints to prevent leakage of product solution and hazardous chemicals. Joints shall be sealed with chemically resistant sealants and waterstops to form a continuous seal. Water stops shall have a center bulb and be capable of resisting a hydraulic head of 50 ft of water and differential settlements of 3/4 inch. Splices shall be made by using shop manufactured sections and welding to provide a cross-section that is dense and free of porosity.
- Double containment will be provided for all building sumps with leakage monitoring provisions.
- Containment slabs will be sloped between 1 and 2 percent to provide effective drainage of process fluids towards sumps for each containment zone.
- Compaction of the existing subgrade and engineered fill shall be to 100% of ASTM D698. Compaction testing shall be performed for each lift of fill and for every 500 square ft of each lift to ensure good compaction.
- Piping and equipment in buildings and structures shall be detailed to accommodate anticipated foundation movement.
- During construction of concrete, water curing methods will be specified to reduce drying shrinkage.
- Construction joints will be placed at appropriate places in accordance with the ACI 350 code to reduce tensile stresses in the mat foundation slabs.
- Construction joints will be detailed with dowels and shear keys to prevent differential settlement at the joint.
- Final foundation design analysis methods used will make use of finite elements structural analysis methods to account for the foundation-soil structure interaction.

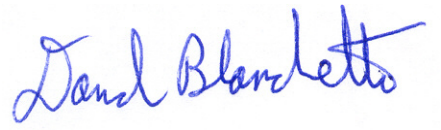
5.0 CONCLUSIONS

This evaluation shows that the foundations types selected will provide containment of process fluids and hazardous chemicals. In general, the foundations recommended will either be formed using a mat foundation on APG piles, or a mat foundation with thickened footings supported on compacted fill and preloaded sub-soils. Both these foundation types will result in minimal settlement for the loadings calculated. The use of the mat foundations with building columns and containment walls supported on top of the mat eliminates penetrating the mat and the potential for leakage.

6.0 CLOSING

SM&RC appreciates Energy Fuels Resources for allowing us to provide this report. If you have any questions or comments, please feel free to contact us.

Respectfully submitted,



David Blanchette, P.E.

cc: Bob Monok
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ATTACHMENTS

Attachment A – Foundation Selection Summary Tables

REFERENCES

ACI 350, “Code Requirements for Environmental Engineering Concrete Structures”

ACI 350.2R, “Concrete Structures for Containment of Hazardous Materials”

Bowles, Joseph E., 1982, *Foundation Analysis and Design* (3rd Edition), McGraw-Hill.

Kleinfelder, 2008, “Geotechnical Design Recommendations Mill and Infrastructure, Piñon Ridge Project, Montrose County, Colorado,” October 31, 2008.

SAP2000 Version 10, Computer Software

Golder Associates, September 2008, “Project# 073-81694 Phase 2 Geotechnical Investigation and Laboratory Program

CH2MHill Process Flow Diagrams

CH2MHill General Arrangement Drawings

ATTACHMENT A
FOUNDATION SELECTION SUMMARY TABLES

Energy Fuels Resources - Piñon Ridge Uranium Mill Foundation Summary			
Area 100 - Ore Feed Building			
Geotechnical Considerations			
Applicable Borings	TB-9, TB-10, TB-14 and TB-15		
Building Finished Floor	El 5546.00		
Finished Grade	El. 5545.00		
Existing Grade	El. 5536.00	9 ft of fill required	
Approximate Foundation Bearing Elevation	El. 5518.00	Structure bears 18 ft below existing grade	
Bearing Material	Silty Sand: medium dense to dense		
Foundation Type			
Location	**Type**	**Approximate Size**	
Building	Mat Foundation	50 ft x 20 ft	
Load Summary		**Loads**	**Foundation Loads**
Building Mat Foundation	Dead Load	1600 Kips	1600 psf
	Live Load	600 Kips	600 psf
	Total Load	2200 Kips	2200 psf
Estimated Settlement			
Building	Differential Settlement	less than 3/4"	
	Total Settlement	less than 1”	

Energy Fuels Resources - Piñon Ridge Uranium Mill Foundation Summary			
Area 100/200- Pulp Storage and Pre-Leach Tanks			
Geotechnical Considerations			
Applicable Borings	TB-8 and TB-13		
Building Finished Floor	El 5546.00		
Finished Grade	El. 5546.00		
Existing Grade	El. 5541.00	5 ft of fill required	
Approximate Foundation Bearing Elevation	El 5544.50		
Bearing Material	10 ft Compacted Fill		
Foundation Types			
Location	Type	Minimum Pile Depth	
Pulp Storage Tanks	Mat with APG Piles	40 ft	
Pre-Leach Tanks	Mat with APG Piles	40 ft	
Pre-Leach Clarifier	Mat with APG Piles	40 ft	
Load Summary		**Load**	**Foundation Loads**
Pulp Storage Tank Foundation	Dead Load	95 kips	15 kips/pile
(other tank loads are less)	Live Load	5600 kips	165 kips/pile
	Seismic/Lateral Load	320 kips	25 kips/pile
	Maximum Vertical Load		205 kips/pile
Estimated Settlement			
Tank Foundation	Differential Settlement	less than 3/4"	
	Total Settlement	less than 1"	

Energy Fuels Resources - Piñon Ridge Uranium Mill Foundation Summary			
Area 100/200 - Grinding and Leach Building			
Geotechnical Considerations			
Applicable Borings	TB-8, TB-9, TB-13 and TB-14		
Building Finished Floor	El 5547.00		
Finished Grade	El. 5546.00		
Existing Grade	El. 5539.00	7 ft of fill required	
Bearing Material	10 ft Compacted Fill		
Foundation Types			
Location	Type	Minimum Pile Depth	
SAG Mill	Mat with APG Piles	40 ft	
Building Column	Mat with APG Piles	40 ft	
Leach Tanks	Mat with APG Piles	40 ft	
Load Summary		**Loads**	**Foundation Loads**
SAG Mill	Equipment Load	743 kips total	124 kips/pile
	Pile Cap Dead Load	457 kips total	76 kips/pile
	Seismic/Lateral Load	100 kips total	
	Seismic/Vertical Load		40 kips/pile
	Total Load	1200 kips	240 kips/pile
Building Column	Dead Load	50 kips/column	25 kips/pile
	Live Load	130 kips/column	65 kips/pile
	Total Load	180 kips/column	90 kips/pile
	Wind/Lateral Load	25 kips/column	13 kips/pile
Leach Tanks	Dead Load	15 kips/column	15 kips/pile
	Live Load	250 kips/column	250 kips/pile
	Seismic/Lateral Load	30 kips/column	30 kips/pile
	Total Load	295 kips/column	295 kips/pile
Estimated Settlement			
SAG Mill	Differential Settlement	less than 3/4"	
	Total Settlement	less than 1"	
Building Column	Differential Settlement	less than 3/4"	
	Total Settlement	less than 1"	
Leach Tanks	Differential Settlement	less than 3/4"	
	Total Settlement	less than 1"	

Energy Fuels Resources - Piñon Ridge Uranium Mill Foundation Summary			
Area 300- CCD Thickener			
Geotechnical Considerations			
Applicable Borings	TB-3, TB-4, TB-8 and TB-9		
Building Finished Floor	El 5547.00		
Finished Grade	El. 5546.00		
Existing Grade	El. 5533.00	13 ft of fill required	
Bearing Material	13 ft Compacted Fill		
Foundation Types			
Location	Type	Approximate Size	
Building Column	Mat Foundation	78 ft x 199 ft	
Thickener Tanks	Mat Foundation	78 ft x 199 ft	
Load Summary		**Loads**	**Foundation Loads**
Building Column	Dead Load	8 kips/column	550 psf
	Live Load	7 kips/column	250 psf
	Total Load	15 kips/column	800 psf
	Wind/Lateral Load	4 kips/column	
Tank Foundation	Dead Load	35 kips	250 psf
	Live Load	1470 kips	1000 psf
	Total Load	1505 kips	1250 psf
	Seismic/Lateral Load	85 kips	250 psf
Estimated Settlement			
Building Column	Differential Settlement	less than 3/4"	
	Total Settlement	less than 1"	
Tank Foundation	Differential Settlement	less than 3/4"	
	Total Settlement	less than 1"	

Energy Fuels Resources - Piñon Ridge Uranium Mill Foundation Summary			
Area 400 and 600 - Solvent Extraction Building			
Geotechnical Considerations			
Applicable Borings	TB-1, TB-2, TB-3, TB-6, TB-7 and TB-8		
Building Finished Floor	El 5544.00		
Finished Grade	El. 5543.00		
Existing Grade	El. 5533.00	10ft of fill required	
Bearing Material	10 ft Compacted Fill		
Foundation Types			
Location	Type		
Building Column	Mat Foundation with Thickened Areas		
Tank Foundation	Mat Foundation with APG Piles		
Load Summary		**Loads**	**Foundation Loads**
Building Column	Dead Load	30 kips/column	400 psf
	Live Load	45 kips/column	600 psf
	Total Load	75 kips/column	1000 psf
	Wind/Lateral Load	10 kips/column	
Tank Foundation	Operating Weight	596 kips	
Estimated Settlement			
Building Column	Differential Settlement	Less than 3/4"	
	Total Settlement	Less than 1"	
Tank Foundation	Differential Settlement	Less than 3/4”	
	Total Settlement	Less than 1"	

Energy Fuels Resources - Piñon Ridge Uranium Mill Foundation Summary			
Area 500/700- Precipitation and Packaging Building			
Geotechnical Considerations			
Applicable Borings	TB-12		
Building Finished Floor	El 5546.00		
Finished Grade	El. 5545.00		
Existing Grade	El. 5541.00	4ft of fill required	
Bearing Material	20 ft Compacted Fill		
Foundation Types			
Location	Type		
Building Column	Mat Foundation with Thickened Areas		
Tank Foundation	Mat Foundation with APG Piles		
Load Summary		**Loads**	**Foundation Loads**
Building Column	Dead Load	55 kips/column	700 psf
	Live Load	45 kips/column	560 psf
	Wind/Vertical Load	48 kips/Column	600 psf
	Wind/Lateral Load	25 kips/column	
	Total Vertical Load	148 kips/column	1860 psf
Tank Foundation	Dead Load	90 kips	10 kips/pile
	Live Load	1416 Kips	157 kips/pile
	Total Load	1506 kips	167 kips/pile
Estimated Settlement			
Building Column	Differential Settlement	Less than 3/4"	
	Total Settlement	Less than 1"	
Tank Foundation	Differential Settlement	Less than 3/4"	
	Total Settlement	Less than 1"	

Energy Fuels Resources - Piñon Ridge Uranium Mill Foundation Summary			
Area 800- Sulfuric Acid Storage			
Geotechnical Considerations			
Applicable Borings	TB-14, TB-15, TB-19 and TB-20		
Building Finished Floor	El 5546.00		
Finished Grade	El. 5545.00		
Existing Grade	El. 5540.00	5 ft of fill required	
Bearing Material	10 ft Compacted Fill		
Foundation Types			
Location	Type	Minimum Pile Depth	
Tank Foundation	Mat with APG Piles	40 ft	
Load Summary		**Load**	**Foundation Loads**
Tank Foundation	Dead Load	240 kips	15 kips/pile
	Live Load	2160 kips	130 kips/pile
	Seismic/Lateral Load	125 kips	
	Seismic/Vertical Load		10 kips/pile
	Maximum Load		155 kips/pile
Estimated Settlement			
Tank Foundation	Differential Settlement	Less than 3/4"	
	Total Settlement	less than 1"	