GEOTECHNICAL FEASIBILITY STUDY
SAGUACHE SOLAR ENERGY PROJECT
SAGAUCHE COUNTY, COLORADO

PREPARED FOR:
SolarReserve
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PREPARED BY:
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May 27, 2011
Project No. 500316001

Mr. Vaughan Johnson
SolarReserve
2425 Olympic Boulevard 500 East
Santa Monica, California 90404

Subject: Geotechnical Feasibility Study
Saguache Solar Energy Project
Saguache County, Colorado

Dear Mr. Johnson:

Transmitted herein are the results of Ninyo & Moore's geotechnical feasibility study for the proposed Saguache Solar Energy Project located near the town of Center in Saguache County, Colorado. The purpose of our study was to review available documents and literature regarding geotechnical and geological conditions at the project site and evaluate the suitability of the site for the proposed development, in accordance with Saguache County 1041 Regulations. The conclusions provided in this report should be considered preliminary and are intended for planning purposes. Once grades are established and structural loads are available, a design-level geotechnical evaluation, including subsurface evaluation and laboratory testing, will need to be performed for the project. We appreciate the opportunity to be of service to you on this project.

Respectfully submitted,
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TABLE OF CONTENTS

Page

1. INTRODUCTION 1
2. SCOPE OF SERVICES 1
3. PROJECT DESCRIPTION 1
4. GENERAL SITE CONDITIONS 3
5. REGIONAL GEOLOGIC SETTING 3
6. NEAR SURFACE SOIL CONDITIONS 4
   6.1. Field Observations 4
   6.2. USDA Soil Data 5
7. SUBSURFACE SOIL CONDITIONS 5
8. GROUNDWATER 6
9. POTENTIAL GEOLOGIC HAZARDS 7
10. GROUND MOTIONS 10
11. LIQUEFACTION 10
12. PRELIMINARY CONCLUSIONS 12
13. LIMITATIONS 14
14. REFERENCES 16

Tables

Table 1 – Faults in Site Vicinity 9
Table 2 – Preliminary Seismic Design Parameters 10

Figures

Figure 1 – Vicinity Map
Figure 2 – Conceptual Site Layout
Figure 3 – Geologic Map

Appendix A

Selected Site Photographs

1. INTRODUCTION

In accordance with your request, Ninyo & Moore has performed a geotechnical feasibility study for the proposed Saguache Solar Energy Project located near the town of Center in Saguache County, Colorado. The purpose of our study was to evaluate the suitability of the site for the proposed development from a geotechnical perspective by performing a geological site reconnaissance and reviewing available documents and literature regarding geotechnical and geological conditions at the project site. The conclusions provided in this report should be considered preliminary and are intended for planning purposes. Once grades are established and structural loads are available, a design-level geotechnical evaluation, including subsurface evaluation and laboratory testing, will need to be performed for the project.

2. SCOPE OF SERVICES

The scope of our geotechnical feasibility study included the following:

- Review of pertinent background data listed in the *References* section of this report. The data reviewed included in-house geotechnical data, aerial photographs, water well data, and published soils and geologic maps and literature.
- Performance of a geologic reconnaissance at the Proposed Site to observe surface conditions and to evaluate possible geologic hazards that may affect design and construction of the project.
- Compilation and analysis of the accumulated data.
- Preparation of this geotechnical feasibility study report presenting our preliminary findings and conclusions.

3. PROJECT DESCRIPTION

Based on our conversations with SolarReserve personnel and our review of referenced project data, we understand that SolarReserve is planning to design and construct the Saguache Solar Energy Project approximately 5-1/2 miles northeast of the town of Center in Saguache County, Colorado (Figure 1). The site is located in the northern San Luis Valley of south-central Colorado.

The project is planned for approximately 3,000 acres of privately owned land located southeast of the intersection of County Road 53 and County Road G in southern Saguache County. The project will consist of two central tower facilities, constructed in two phases, each surrounded by heliostat arrays (*see* Figure 2). The two phases of the solar energy project will utilize concentrating solar thermal technology, including integral thermal storage. Each phase will have a central receiving tower and approximately 17,500 heliostats. The heliostats will be laid-out within an approximately 4,300-foot radius circular pattern around the central receiving tower. A "power block" system will be located in the south-central portion of the heliostat array. Improvements in the power block area will include an approximately 538-foot tall concrete tower to support a 105-foot central receiver and a 13-foot tall maintenance crane (for a total structure height of 656 feet), above-ground hot and cold salt storage tanks, pumps, generators, condensing units, and other appurtenances and structures associated with the project. Paved access roads, transmission lines, evaporation ponds, leach fields, an approximately 80,000 square foot heliostat assembly building/warehouse, an approximately 5,000 square foot administration/maintenance building, an approximately 5,000 square foot control and operations building, and an approximately 11,000 square foot water treatment building will be constructed adjacent to the heliostat field.

The proposed project site includes portions of Sections 3, 4, 8 through 10, 16 and 17 of Township 41 North and Range 8 East. Sections and coordinates indicating approximate locations of the power block and central receiving tower for each site are provided in the following table:

Location	**Section Number (in T41N,R8E)**	**Coordinates of Central Receiving Tower**	
		Latitude	**Longitude**
Central Receiving Tower No. 1	17	37.803000N	-106.009147W
Central Receiving Tower No. 2	3	37.821128N	-106.980647W

4. GENERAL SITE CONDITIONS

The project site is located in the northern portion of the San Luis Valley and approximately 5-1/2 miles northeast of the town of Center, Colorado. Based on the Preliminary Site Layout (Tetra Tech, 2010), the project site is bordered on the north by County Road G, on the south by County Road D, on the west by County Road 53, and on the east by County Road 57.

During our field geotechnical site reconnaissance, the proposed site was undeveloped agricultural land. The ground surface was covered with irrigated crop land, paved and gravel roads, and irrigation ditches. The topography was relatively flat to slightly undulatory. The ground surface at the site generally slopes downward toward the northeast. The USGS topographic map indicates that the relatively higher elevations are located in the western portions of the site. These relatively higher elevations are on the order of approximately 7,595 feet above mean sea level (MSL). The relatively lower elevations (approximately 7,560 feet above MSL) are located in the eastern portions of the site. Generalized surface and subsurface conditions at the Proposed Site are provided in the following sections.

5. REGIONAL GEOLOGIC SETTING

The project site is located within the north-central portion of the San Luis Valley of south-central Colorado. The San Luis Valley is a large intermontaine valley that is approximately 100 miles in length. The valley has an approximate area of 3,200 square miles and an average elevation of 7,700 feet above mean sea level (MSL). The San Luis Valley is bounded to the west by the San Juan mountain range and to the east by the Sangre de Cristo mountain range. Some peaks in the Sangre de Cristo Mountains exceed 14,000 feet above MSL. The majority of the valley floor is bordered by coalesced alluvial fans and is a nearly level, featureless plain.

The San Luis Valley is a north-trending structural rift basin that is down-faulted on the eastern border and hinged on the west side. The resulting basin is a major physiographic and structural element of the Rio Grande rift. The rift valley is filled with unconsolidated Quaternary-age sedi-

mentary deposits and Tertiary-age sedimentary and volcanic deposits overlying Paleoproterozoic metamorphic, igneous, and sedimentary rocks.

The structural geology of Saguache County is divided into three main provinces. The westernmost structural province is the block-faulted terrain and overlying San Juan volcanic field bounding the west of the San Juan Valley. The Sangre de Cristo range forms the easternmost structural province and is characterized by a thrust-faulted terrain that consists of isoclinal folds between thrust blocks. Between these two provinces lies the San Luis Valley, which bounds the Sangre de Cristo province on the west, with the Sangre de Cristo fault separating the two provinces.

The Rio Grande rift began subsiding during Eocene and Oligocene time and the earliest deposits are composed of ash flow tuffs, which erupted from calderas of the San Juan volcanic field. The bulk of the basin fill is composed of Quaternary-age sand, silt, and clay, and Miocene-age conglomerate, sandstone, and shale. The unit has been mapped by Bister and Gris (1994) as the Santa Fe Group. The Santa Fe Group varies in thickness with its location within the San Luis Valley graben, with thicknesses ranging between 820 feet to more than 10,000 feet. The Quaternary-age deposits consist of glacial till, outwash, lacustrine deposits, alluvial fans, and extensive eolian (wind-blown) deposits.

6. NEAR SURFACE SOIL CONDITIONS

Near surface soil conditions were observed during our recent preliminary site reconnaissance and we reviewed geologic and soil information listed in the *References* section. Observations and summarized research findings regarding near surface soil features are provided in the following sections:

6.1. Field Observations

Our field observations indicated that the near surface soils are composed primarily of loose to medium dense, silty sand and sandy clay with varying amounts of gravel. We expect that

the thickness of the topsoil layer will typically be approximately 2 feet. Scattered gravels were noted on the ground surface at the project sites. The near surface soils were generally damp to wet at the time of our field observations. We expect that the soil moisture contents will increase in the spring months and during the irrigation season. The agricultural areas were observed to have been plowed to a depth of a few feet and were generally in a loose condition.

6.2. USDA Soil Data

As part of our study, we reviewed referenced United States Department of Agriculture (USDA), Natural Resources Conservation Service data available for the project site. This data describes soil properties of near-surface native soil units, typically to an approximate depth of 5 feet below the ground surface. A summary of soil units that were mapped, named, and described by the USDA in the Proposed Site is provided in the following table:

Mapped Soil Unit Name	USDA Soil Description
Arena Loam	Moderately deep, poorly drained, loamy clay (alluvium)
Gunbarrel Loamy Sand	Deep, somewhat poorly to poorly drained, loamy sand (eolium)
Gunbarrel Loamy Sand, Saline	Deep, somewhat poorly to poorly drained, loamy sand (eolium)
Hagga Loam, Dry	Very deep, poorly drained, loamy sand and clay (alluvium)
Hooper Loamy Sand	Deep, well to moderately well drained, sand and sandy loam (alluvium)
Hooper Clay Loam	Deep, well to moderately well drained, clay and clayey loam (alluvium)
Kerber Loamy Sand	Very deep, poorly drained or somewhat poorly drained, sand and sandy loam (alluvium)
Laney Loam, 0 to 3 Percent Slopes	Well-drained, saline-affected, silty sand (alluvium)
Mosca Loamy Sand, 0 to 3 Percent Slopes	Deep, well drained, silty sand (alluvium)
San Luis Sandy Loam	Deep, poorly to well drained, poorly graded sand with silt and gravel (alluvium)
San Luis Sandy Loam, Drained	Deep, well drained, poorly graded sand with silt and gravel (alluvium)

7. SUBSURFACE SOIL CONDITIONS

The site vicinity is mapped by the USGS as being underlain by alluvium, terrace gravels and alluvial fan deposits (Map Unit Qa - Alluvial Deposits (Quaternary)) [Tweto and others, 1976 and

Steven and others, 1974]. The location of the site in relation to the mapped geologic units is depicted on Figure 3. This unit is also mapped by Bister and Gris (1994) as the Santa Fe Group composed of Quaternary-age eolian and alluvial sand consisting of fine to medium, subrounded, grains of quartz and feldspar. The Santa Fe Group is underlain by unconsolidated, upper Tertiary-age deposits consisting of volcanic clastic material deposited in the rift basin that forms the San Luis Valley. Based on our review of water well records from the vicinity of the proposed site from the Colorado Division of Water Resources, the upper 127 to 130 feet are composed of intermittent layers of sand, gravel and clay (CDWR, 1956). The soil below 127 to 130 feet is composed of "hard dry blue clay" (CDWR, 1960). Bedrock was not encountered in the subsurface excavation logs we reviewed and is expected to be on the order of thousands of feet below the ground surface.

8. GROUNDWATER

Groundwater in the San Luis Valley occurs in both confined and unconfined aquifers. Artesian or confined conditions are created by the existence of localized clay layers. Unconfined groundwater occurs across the valley. The average depth to unconfined groundwater across the valley is generally 12 feet, or less. Due to the abundant recharge from surface water, little long-term fluctuation in the groundwater table has occurred. The unconfined aquifer is the principal source of groundwater for irrigation, accounting for the majority of groundwater for large capacity wells. Recharge to the aquifers occurs by infiltration of applied irrigation water, canal leakage, seepage from mountain streams that flow across the permeable alluvial fans, and infiltration of precipitation.

As part of our study, we also reviewed records available from the referenced Colorado Division of Water Resources Well Water Database (2009). Our search of water well data was performed for Township 41 North, Range 8 East, which includes the proposed site and adjacent areas. Water well data indicated static water table depths ranging between 5 and 6 feet below the ground surface in the water well borings at the dates drilled (between 1956 and 1999). According to Mr. Ernest Myers, a representative of the landowner, he estimates the current groundwater depth at

the subject site to range between 18 and 22 feet below the ground surface. Additional subsurface exploration will be necessary to evaluate the depth to groundwater at the site during a design level geotechnical evaluation.

Seasonal fluctuations in groundwater levels and surface water flow may occur. These fluctuations may be due to variations in ground surface topography, subsurface geologic conditions, rainfall, irrigation, and other factors. Evaluation of factors associated with groundwater fluctuations was beyond the scope of this study.

9. POTENTIAL GEOLOGIC HAZARDS

Ninyo & Moore's geotechnical study included an evaluation of the possible presence of geologic hazards, such as faults and landslides in the area of the site, in accordance with Saguache County 1041 Regulations. This evaluation included visual observation of the site for indications of adverse geologic features and review of published geologic and soils maps and literature, and other data listed in the *References* section of this report. Referenced geologic data were also reviewed to evaluate seismic activity levels, and associated potential earthquake hazards, for faults in the vicinity of the site. It should be noted that the ages of faulting provided in this section were obtained/interpreted primarily from the Colorado Geological Survey (CGS) and/or USGS databases.

Based on our field observations and review of referenced data (CGS, 2010), no faults traverse the project site. Review of referenced geologic data indicates that the nearest active fault (i.e., a fault that has experienced ground surface rupture within the past 11,000 years) to the site is the Sangre de Cristo fault zone, located within 30 miles east of the project site.

Several simple Quaternary faults have been mapped within 30 miles of the proposed site. The CGS defines a simple fault as a fault that consists of a single section which ruptured during the last paleoevent. The term "simple fault" also serves as a default category for faults that have not been studied in enough detail to warrant a designation as a sectional or segmented fault. The Lucky Boy Fault (structure number Q62) lies approximately 25 miles to the northwest of the pro-

posed site. The fault is a branch of the Western Boundary Fault which forms the western rim of the Bonanza Caldera. The most recent movement on the Lucky Boy Fault is considered to have occurred during the late Quaternary (<130,000 years before present [<130 ka]). The Lucky Boy Fault has been assigned a Maximum Credible Earthquake magnitude 6.75 by Widmann et al. (1998).

The Mineral Hot Springs Fault (structure number Q68) lies approximately 24 miles to the north-east of the proposed site. The Mineral Hot Springs Fault is a north-northwest trending fault along the western margin of the Rio Grande Rift at the northern end of the San Luis Valley, at the point where the valley narrows abruptly in width. The most recent activity on the Mineral Hot Springs Fault is considered to have occurred during the late Quaternary (<130,000 years before present [<130 ka]).

One sectioned Quaternary fault structure has been mapped within 30 miles of the proposed site. The CGS defines a sectional fault as a fault that consists of two or more sections that have ruptured independently, but each section has not been carefully evaluated in detail to accurately characterize the rupture history of each section. The Northern Sangre de Cristo Fault, Crestone Section, is a major west-dipping (60 degrees) normal fault within the Rio Grande Rift. It forms the structural boundary between the Sangre de Cristo Range on the east, and the San Luis Valley on the west. The most recent movement on the Northern Sangre de Cristo Fault, Crestone Section, is considered to have occurred during the post glacial Holocene (<15,000 years before present [<15 ka]), with a recurrence interval of 5.0 to 11.7 thousand years, and a slip rate of less than 0.2 mm/yr. The Sangre de Cristo Fault has been assigned a Maximum Credible Earthquake magnitude 7.5 by Widmann et al. (1998).

The distances from the site to these faults and fault zones and the ages of faulting are provided in Table 1.

Table 1 – Faults in Site Vicinity

Fault Name	Approximate Distance From Project Sites to Fault (miles)	Age of Faulting
Alamosa Horst Fault Zone West	5	Late Cenozoic (<23.7 Million Years Before Present [Ma])
Alamosa Horst Fault Zone East	13	Late Cenozoic (<23.7 Ma)
Lucky Boy Fault	25	Late Quaternary (<130 ka)
Mineral Hot Springs Fault	24	Late Quaternary (<130 ka)
Northern Sangre de Cristo Fault, Crestone Section	27	Latest Quaternary (<15 ka)
Northern Sangre de Cristo Fault, Zapata Section	32	Latest Quaternary (<15 ka)
Villa Grove Fault Zone	30	Latest Quaternary (<15 ka)
Western Boundary Fault	30	Quaternary (<1.6 Ma)

We have reviewed boring logs, test pit logs, previous water well data, and laboratory test data for projects in the vicinity of the proposed development. Based on our site reconnaissance and review, no evidence of expansive soil or shallow bedrock exists at the proposed site.

Ground fissures, generally believed to be caused by erosion and differential stress resulting from regional subsidence due primarily to withdrawal of groundwater, are known to occur near faults in Colorado. Review of referenced geologic data does not indicate the presence of ground fissures at the project site and no ground fissures were observed during our field activities.

The site is nearly level. No steep slopes exist that may cause a hazard to development. Rockfall, slope instability, mud flow, or debris fan hazards were not observed. The potential for earthquake induced rockfall is considered negligible at the site.

The site is not within a 100-year flood zone and it is not located in the flood plain of any river or stream. Therefore the potential for river or stream flooding is considered negligible.

No evidence of underground mining or exploitable mineral resources was observed at the site.

Radon concentrations in the United States are reported in picocuries per liter of air (pCi/L). At present the Environmental Protection Agency (EPA) classifies concentrations above 4 pCi/L “action level” concentrations, and recommends remedial action when long-term radon content is

above that level. In areas that contain glacial deposits, such as the proposed site, bedrock-derived clasts that comprise the glacial deposits are the principal source of radioactivity.

Data regarding the estimation of potential for radon in Saguache County was obtained from the Colorado Geological Survey Open File Report 91-4, "Results of the 1987-88 EPA Supported Radon Study in Colorado". The study concluded that the 1,911 locations sampled throughout Colorado had an average radon concentration of 5.6 pCi/L, and that 42.9 percent of the locations had radon concentrations greater than 4 pCi/L. Seventeen samples were taken from Saguache County, and results from these tests show an average of 1.89 pCi/L. Based on the results contained in the Colorado Geological Survey study, the site geology, and the intended use of the site, it is our opinion that the site has a low potential for radon exposures above 4 pCi/L. Radiation hazards due to radon is not expected to be a hazard for the proposed use of the site.

10. GROUND MOTIONS

Estimated maximum considered earthquake spectral response accelerations for short (0.2 second) and long (1.0 second) periods were obtained for the subject site tower locations using the United States Geological Survey database (USGS, 2010a). Based on the referenced International Code Council (ICC, 2006) and site information, a Site Class "D" (stiff soil profile) is appropriate for preliminary design considerations. Provided in the following table are preliminary seismic design parameters characteristic at the subject central receiving tower locations.

Table 2 – Preliminary Seismic Design Parameters

Parameters	Tower No. 1 Site		Tower No. 2 Site		Reference (ICC, 2006)
	Short Period	Long Period	Short Period	Long Period	
Mapped Maximum Considered Earthquake Spectral Response Acceleration, S_S and S_1	0.336	0.107	0.379	0.102	Figure 1613 and referenced database (USGS, 2010a)
Site Coefficient, F_a and F_v	1.532	2.374	1.497	2.393	Table 1613.5.3
Maximum Considered Earthquake Spectral Response Acceleration Adjusted for Site Class Effects, S_{MS} and S_{M1}	0.514	0.253	0.567	0.243	Equation 16-37 and 16-38
Design Spectral Response Acceleration, S_{DS} and S_{D1}	0.343	0.169	0.378	0.162	Equation 16-39 and 16-40

To evaluate the site-specific ground motion for the planned tower structures, a seismic refraction survey of the site should be performed to further evaluate the response characteristics of the site soils. There is a potential that the seismic site classification could be indicated as Site Class "E" or "F", based on information gathered during a design-level investigation. A change in site class would affect the seismic design parameters for the site and could result in increased construction costs.

11. LIQUEFACTION

Liquefaction is a phenomenon in which loose, saturated soils lose shear strength under short-term (dynamic) loading conditions. Ground shaking of sufficient duration results in the loss of grain-to-grain contact in potentially liquefiable soils due to a rapid increase in pore water pressure, causing the soil to behave as a fluid for a short period of time. To be potentially liquefiable, a soil is typically cohesionless with a grain-size distribution generally consisting of sand and silt. It is generally loose to medium dense, saturated, and subjected to sufficient magnitude and duration of ground shaking.

Subsurface soils encountered in the previous water well borings drilled near the subject site consisted primarily of unconsolidated, saturated, poorly graded, fine-grained eolian and alluvial soil. Groundwater is expected at depths less than 10 feet below the ground surface. The existence of a shallow groundwater table and the unconsolidated, saturated, poorly graded, fine-grained nature of the on-site soils could tend to increase the potential for liquefaction associated with earthquake induced ground motion. There is a potential risk for seismic shaking from Latest Quaternary-age, sectioned faults within 30 miles of the subject site. Therefore, liquefaction may be a design concern. The potential for earthquake-induced liquefaction should be studied in detail during subsequent, design-level geotechnical investigations.

12. PRELIMINARY CONCLUSIONS

Based on our preliminary field observations, review of referenced geology and soil data, and previous subsurface explorations, it is our opinion that there are no known geotechnical or geologic conditions that would preclude development of the solar energy project at the proposed site, provided a future design-level geotechnical evaluation is performed. The conclusions provided in this report should be considered preliminary and are intended for planning purposes. Once grades are established and structural loads are available, a design-level geotechnical evaluation, including subsurface evaluation and laboratory testing, will need to be performed for the project. Preliminary findings of this geotechnical feasibility evaluation include the following:

- The subject site is considered suitable for the construction of the proposed solar energy project, from a geotechnical perspective.
- Geologic hazards such as on-site faults, ground fissures, flood-prone areas, landslides or unstable slope hazards were not observed during our site reconnaissance and were not indicated in the referenced publications.
- The site is underlain by sediments to depths on the order of thousands of feet. The sediments in the upper approximately 130 feet consist of intermittent layers of sand, gravel, and clay underlain by a substantial layer of blue clay that may be on the order of several hundred feet thick. The bearing capacity provided by these unconsolidated settlements is expected to be relatively low. Foundation designs incorporating low end-bearing capacities and relying mainly on side friction should be evaluated for their constructability and economic suitability.
    - Based on the very limited subsurface data and the potential wind, seismic, and structural loads provided by SolarReserve, our preliminary foundation recommendations for the central receiving towers include the use of deep foundations to support the towers. Deep foundations could consist of cast-in-drilled-hole (CIDH) piles, screw piles, or driven piles supporting pile caps. We performed a preliminary analysis using the L-Pile computer program using values for dead load, live load, wind moment, and wind shear provided by SolarReserve. The soil parameters used in our analysis were estimated from stratigraphic information obtained from logs of water wells from nearby sites. For preliminary budgeting purposes, we have estimated that each tower could be supported on 72-inch diameter, steel-reinforced, drilled concrete piles with lengths on the order of 50 to 75 feet per pile. Given the expected loads and geometry of the towers, we estimate that the number of piles would be on the order of 50 piles per tower. Please note that Ninyo & Moore has not performed subsurface exploration, geophysical testing, laboratory analysis, or engineering analysis using on-site data. We will need to perform a

design-level geotechnical evaluation in order to provide site-specific geotechnical design recommendations.

- Preliminary foundation recommendations for the heliostat structures could include the use of shallow reinforced concrete mat foundations, driven pile, screw pile, or drilled pier foundations.

- Preliminary foundation recommendations for the proposed support buildings and appurtenance structures could include the use of shallow spread footings or reinforced concrete mat foundations. Lightly loaded structures could be supported on conventional shallow spread foundations bearing on compacted fill. The more heavily loaded structures, such as the proposed tanks, could be supported on shallow mat foundations. However, ground improvement techniques such as stone columns, wick drains, rammed aggregate piers, surcharge fills, etc. may be necessary to mitigate expected settlements. An evaluation for the design of ground improvement would be included in a design-level geotechnical evaluation.

- Bedrock units were not encountered in the previous water well borings, which were drilled to a maximum depth of 130 feet. In addition, review of published geology maps and cross-sections does not indicate the presence of bedrock exposures or shallow bedrock conditions at the project site. The depth to bedrock is expected to be on the order of thousands of feet below the ground surface.

- Some of the near-surface native soils are very loose and likely have relatively low in-place dry densities and are potentially moisture-sensitive. These soils are prone to settlement and will likely not be suitable for support of structures and improvements in their existing condition. Shallow foundations, slabs-on-grade, exterior concrete flatwork, pavement sections, and other improvements will likely need to be founded on a zone of adequately placed and compacted engineered fill. The depth, lateral extent, and compaction levels will need to be specified in a design-level geotechnical evaluation.

- Adequate surface drainage should be provided to reduce ponding and infiltration of water into the subsurface soils. Surface runoff from surrounding areas should be intercepted, collected, and not permitted to flow or infiltrate into subsurface soils. Consideration should be given to utilization of swales, edge drains, building roof drains, tightlined downspouts, curbs and gutters, or combination of these drainage devices, to reduce the adverse effects of surface water runoff.

- Although chemical tests have not been performed, the native on-site soils may be potentially deleterious to concrete and corrosive to metal, based on the current use as agricultural land. Soil blending or replacement, and/or utilization of materials that are resistant to corrosion should be anticipated for the project.

- Static groundwater levels were measured in the referenced previous water well borings at approximate depths ranging between approximately 5 and 6 feet below the ground surface at the time of drilling (1956 to 1999). However, according to information from the landowner, current groundwater levels may be as deep as 18 to 22 feet below the ground surface. It is our preliminary opinion that shallow groundwater could be a significant design and construction issue. Due to the extensive size of the proposed site and the variability of water table data, additional borings will be needed to further evaluate the depth to groundwater. We preliminarily recommend establishing finished floor elevations for structures as high as feasible above current grades.

- Due to the anticipated, relatively shallow depth of groundwater at the project site and the unconsolidated, saturated, poorly graded, fine-grained nature of the on-site soils, it is our opinion that liquefaction will be a design concern and should be studied in detail during design-level evaluations.

- The preliminary seismic site classification was assumed to be Site Class “D”. Further seismic studies may change the final site classification to Site Class “E” or “F”, depending on the results of subsurface exploration.

- Ground elevations at the proposed site range from approximately 7,595 to 7,560 feet MSL. An appropriate frost depth will need to be established for the design of site structures.

13. LIMITATIONS

The field evaluation and geotechnical analyses presented in this geotechnical report have been conducted in general accordance with current practice and the standard of care exercised by geotechnical consultants performing similar tasks in the project area. No warranty, expressed or implied, is made regarding the conclusions, recommendations, and opinions presented in this report. There is no evaluation detailed enough to reveal every subsurface condition. Variations may exist and conditions not observed or described in this report may be encountered during the design geotechnical evaluation and/or construction. Uncertainties relative to subsurface conditions can be reduced through additional subsurface exploration. Please also note that our evaluation was limited to preliminary assessment of the geotechnical aspects of the project, and did not include performance of a design-level geotechnical evaluation or evaluation of structural issues, environmental concerns, or the presence of hazardous materials.

This document is intended to be used only in its entirety. No portion of the document, by itself, is designed to completely represent any aspect of the project described herein. Ninyo & Moore

should be contacted if the reader requires additional information or has questions regarding the content, interpretations presented, or completeness of this document.

This report is intended for preliminary evaluation purposes only. It does not provide sufficient data for design purposes.

This report is intended exclusively for use by the client. Any use or reuse of the findings, conclusions, and/or recommendations of this report by parties other than the client is undertaken at said parties' sole risk.

14. REFERENCES

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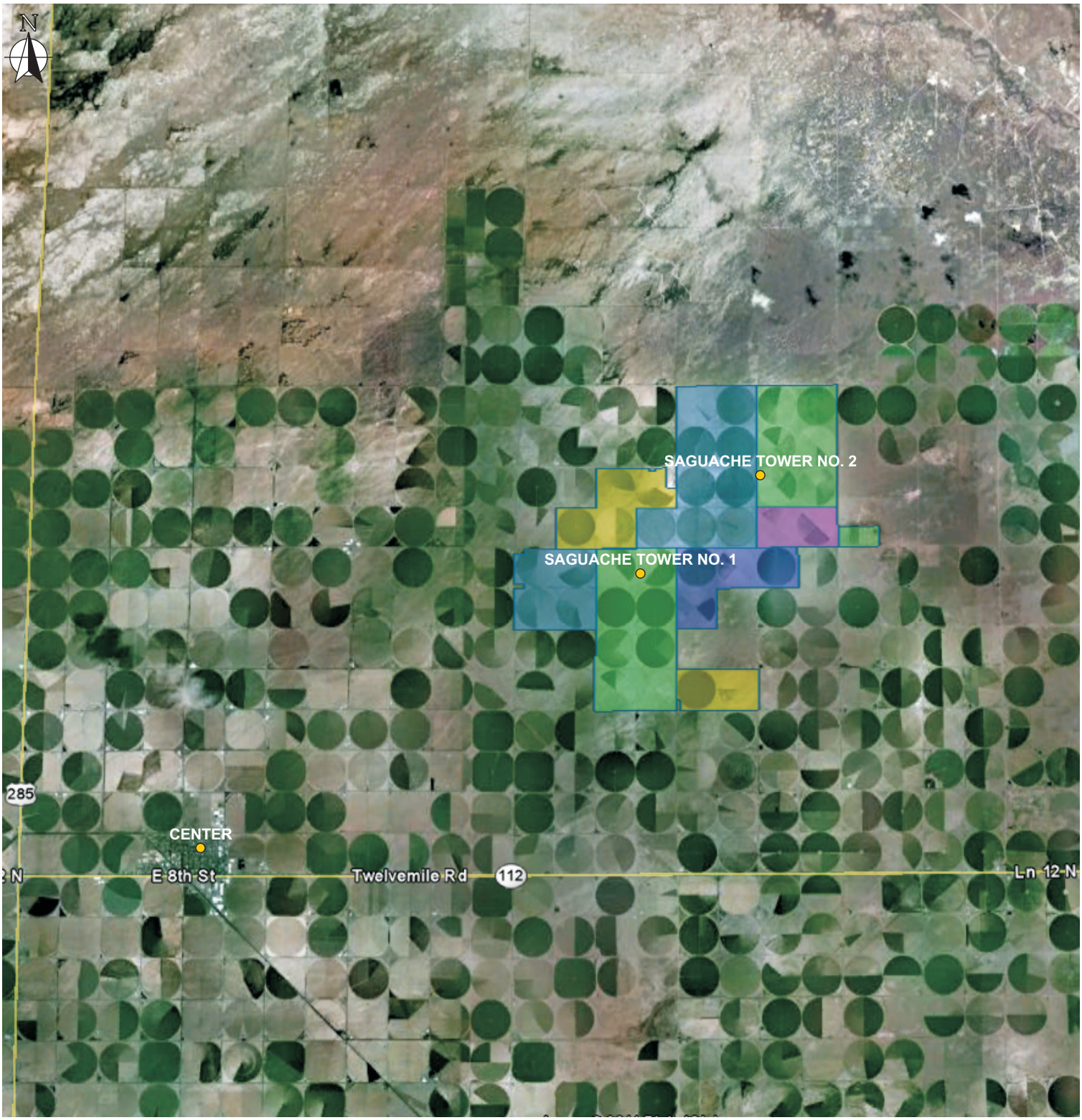


Source: USDA Farm Service Angency, DigitalGlobe, 2011.

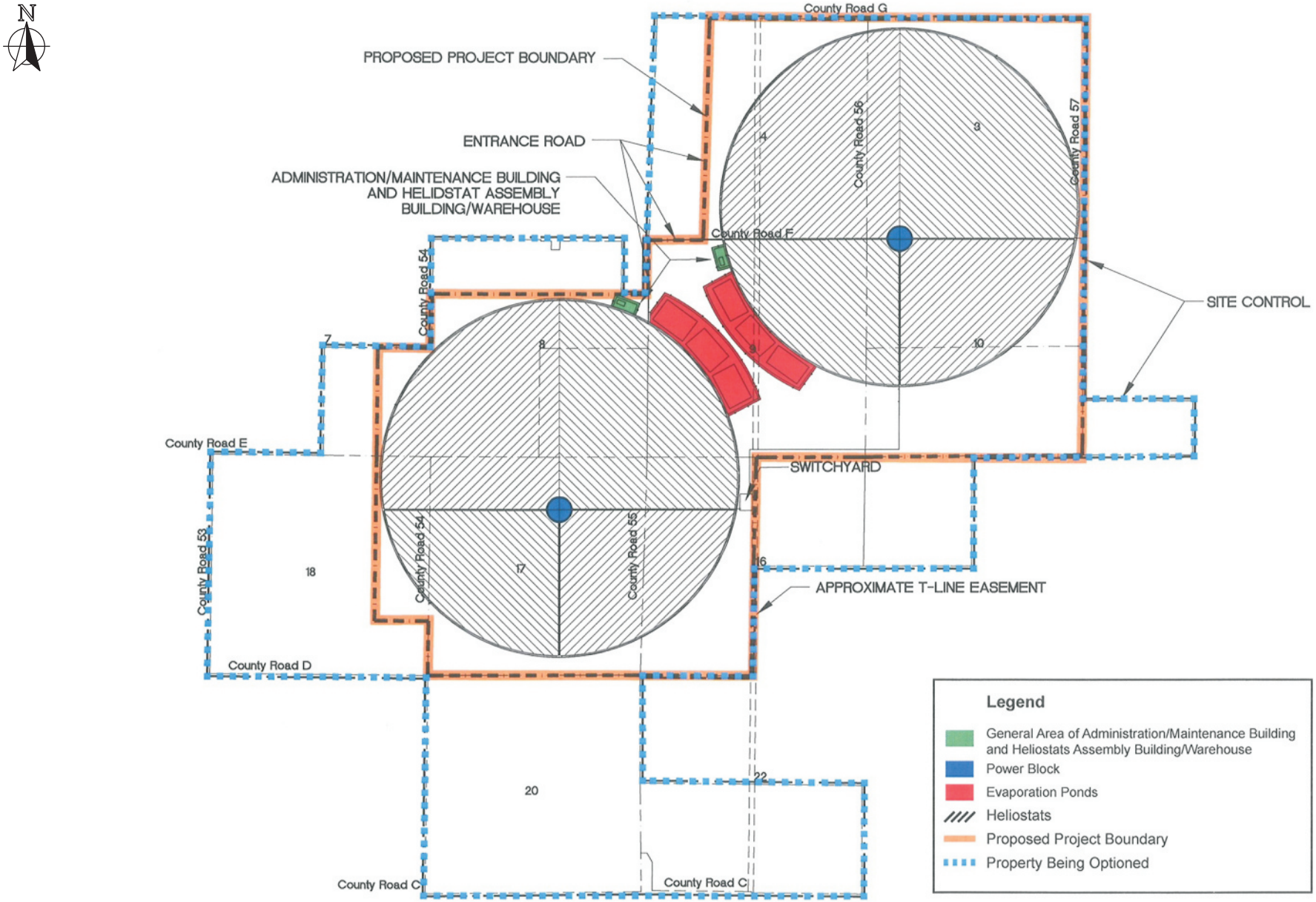
0 2 miles

Approximate Scale:
1 inch = 2 miles

Note: All dimensions, directions, and locations are approximate.

Ninyo & Moore	VICINITY MAP	FIGURE
PROJECT NO: 500316001 / DATE: 5/11	SAGUACHE SOLAR ENERGY PROJECT SAGUACHE COUNTY, COLORADO	1

file no: 0316vmap0111



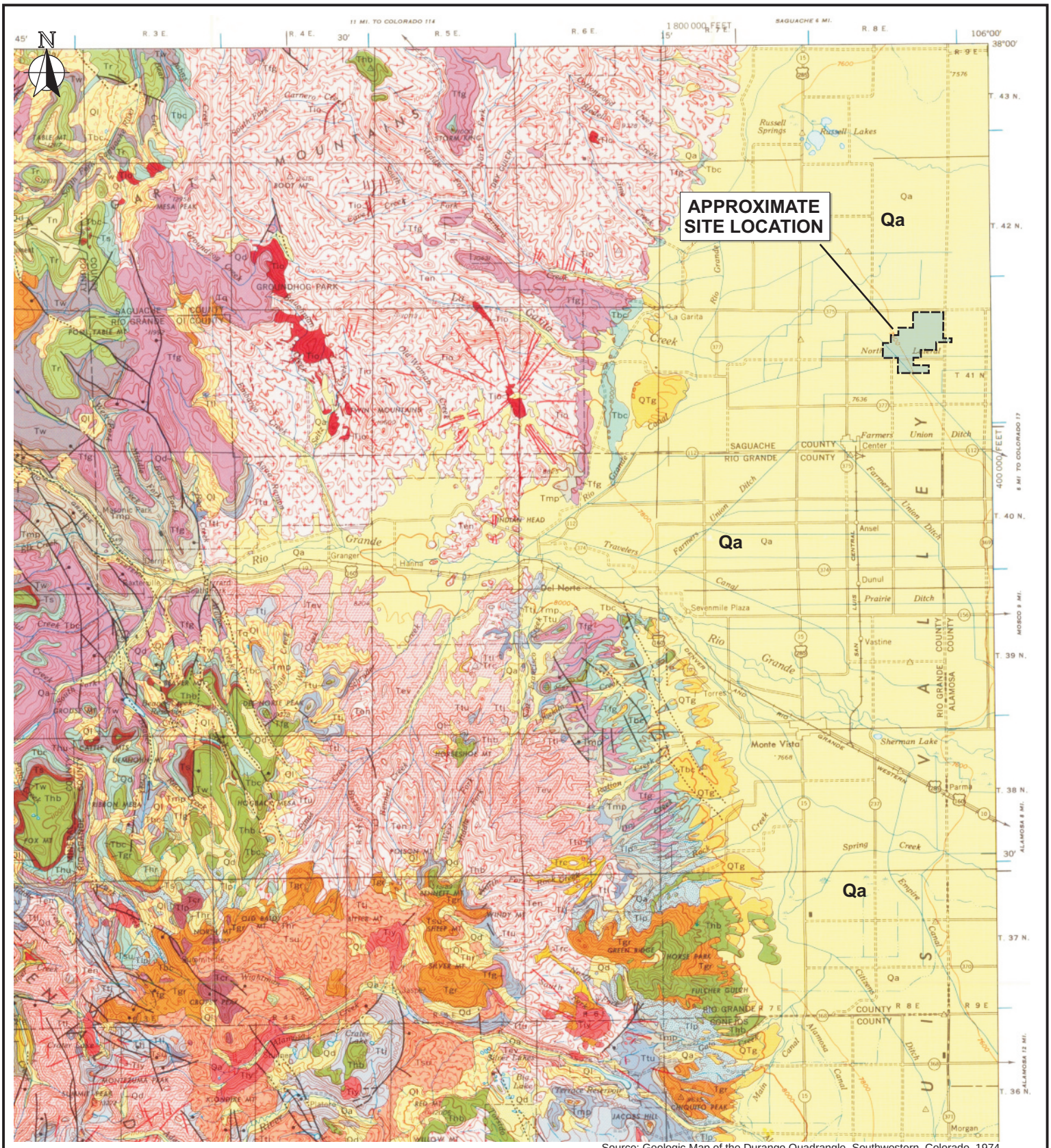
Source: Supplied by SOLAR RESERVE.

NOT TO SCALE

Map supplied by SolarReserve, 2011.

Ninyo & Moore	PRELIMINARY SITE LAYOUT	FIGURE
PROJECT NO: 500316001 / DATE: 5/11	SAGUACHE SOLAR ENERGY PROJECT SAGUACHE COUNTY, COLORADO	2

file no: 0316psl0111



Source: Geologic Map of the Durango Quadrangle, Southwestern, Colorado, 1974.

0 5000

Approximate Scale:
1 inch = 5,000 feet

Qa Quaternary Alluvial deposits: Alluvium, terrace gravels, and alluvial fan deposits.

Note: All dimensions, directions, and locations are approximate.

Ninyo & Moore	GEOLOGIC MAP	FIGURE
PROJECT NO: 500316001 / DATE: 5/11	SAGUACHE SOLAR ENERGY PROJECT SAGUACHE COUNTY, COLORADO	3

file no: 0316vmap0111

APPENDIX A

SELECTED SITE PHOTOGRAPHS

Project Name: Saguache Solar Energy Project **Project No.: 500316001**

Photo No. 1 **Location: Heliostat Field No. 1** **Date: 12/17/2010**

View of Heliostat Field No. 1 Location Looking East

Photo No. 2 **Location: Heliostat Field No. 1** **Date: 12/17/2010**

View of Heliostat Field No. 1 Location Looking Northeast

Photo No. 3 **Location: Central Receiving Tower No. 1** **Date: 12/17/2010**

View of Central Receiving Tower No. 1 Location Looking East

Photo No. 4 **Location: Heliostat Field No. 1** **Date: 12/17/2010**

View of Heliostat Field No. 1 Location Looking West

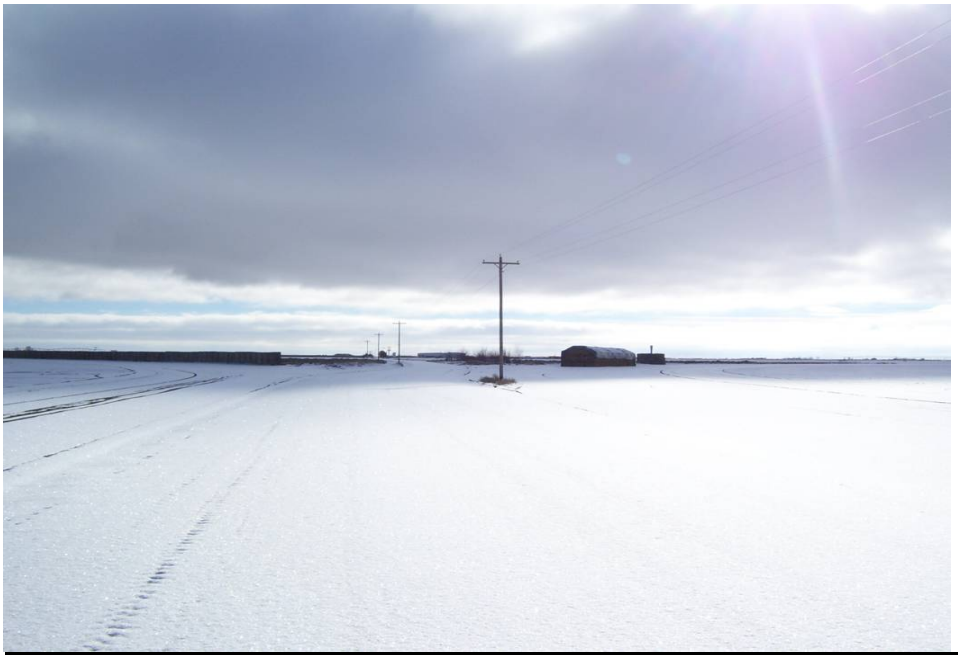


Photo No. 5 **Location: Heliostat Field No. 1** **Date: 12/17/2010**

View of Heliostat Field No. 1 Location Looking South

Photo No. 6 **Location: Heliostat Field No. 1** **Date: 12/17/2010**

View of Heliostat Field No. 1 Location Looking North

Photo No. 7 **Location: Central Receiving Tower No. 1** **Date: 12/17/2010**

Approximate Location of Central Receiving Tower No. 1

Photo No. 8 **Location: Central Receiving Tower No. 2** **Date: 12/17/2010**

View of Central Receiving Tower No. 2 Location Looking South

Photo No. 9 **Location: Heliostat Field No. 2** **Date: 12/17/2010**

View of Heliostat Field No. 2 Location Looking East

Photo No. 10 **Location: Heliostat Field No. 2** **Date: 12/17/2010**

View of Heliostat Field No. 2 Location Looking West

Photo No. 11 **Location: Heliostat Field No. 2** **Date: 12/17/2010**

View of Heliostat Field No. 2 Location Looking North

Photo No. 12 **Location: Central Receiving Tower No. 2** **Date: 12/17/2010**

Approximate Location of Central Receiving Tower No. 2

Photo No. 13 **Location: Heliostat Field No. 2** **Date: 12/17/2010**

View of Heliostat Field No. 2 Location Looking West from East Property Boundary

Photo No. 14 **Location: East Property Boundary** **Date: 12/17/2010**

View of East Property Boundary Looking South

Project Name: Saguache Solar Energy Project **Project No.: 500316001**

Photo No. 15 **Location: East Property Boundary** **Date: 12/17/2010**

View of East Property Boundary Looking North