Appendix B
Initial Geologic and Geotechnical Evaluation

INITIAL GEOLOGIC AND GEOTECHNICAL EVALUATION ARIZONA EASTERN RAILWAY GRAHAM COUNTY, ARIZONA

PREPARED FOR:
Circlepoint
135 Main Street, Suite 1600
San Francisco, California 94105

PREPARED BY:
Ninyo & Moore
Geotechnical and Environmental Sciences Consultants
3001 South 35th Street, Suite 6
Phoenix, Arizona 85040

October 20, 2006
Project No. 601605001

Ninyo & Moore
Geotechnical and Environmental Sciences Consultants

October 20, 2006
Project No. 601605001

Ms. Katrina Hardt, AICP
Circlepoint
135 Main Street, Suite 1600
San Francisco, California 94105

Subject: Initial Geologic and Geotechnical Evaluation
Arizona Eastern Railway
Graham County, Arizona

Dear Ms. Hardt:

In accordance with our proposal dated July 3, 2006, and your authorization, Ninyo & Moore has performed an initial geologic and geotechnical evaluation for the above-referenced site. The attached report describes our evaluation methodology, and presents our findings, and conclusions regarding the geological and geotechnical conditions at the project site.

We appreciate the opportunity to be of service to Circlepoint during this phase of the project.

Sincerely,
NINYO & MOORE

Jeffrey S. Rodgers, G.I.T.
Staff Geologist

Steven D. Nowaczyk, P.E.
Principal Engineer

JSR/SDN/SAH/pjs

Distribution: (3) Addressee

TABLE OF CONTENTS

1. INTRODUCTION

In accordance with our proposal dated July 3, 2006, and your authorization, Ninyo & Moore has performed an initial geologic and geotechnical evaluation for the proposed Arizona Eastern Railway project in Graham County, Arizona. Our services generally included the evaluation of the geologic and geotechnical conditions along the proposed railway corridor. This report presents the results of our services.

2. SCOPE OF SERVICES

The scope of our services for the project generally included:

- Reviewing readily available aerial photographs and published geologic literature, including maps and reports pertaining to the project site and vicinity.
- Providing a preliminary evaluation of potential geologic and geotechnical constraints.
- Evaluating geologic hazards along the project corridor.
- Preparing this report presenting the results of our geotechnical evaluation, and addressing the geologic hazards underlying and adjacent to the project corridor.

3. SITE AND PROJECT DESCRIPTION

The project consists of the design and construction of a new railway segment that will extend from the existing Arizona Eastern Railroad northwest to the proposed Phelps Dodge San Juan Mine, in Graham County, Arizona (see Figure 1). The proposed railway corridor is to be approximately 10 miles in length, and is being designed for the purpose of servicing the proposed San Juan Mine. The proposed project alignment is to be located within Sections 5, 6, 8 , 9, 10, 15, 22, 23, 26, 34, and 35 in Township 6 South, Range 26 East, and Sections 2, 3, 11, 14, 23, 24, and 25 in Township 7 South, Range 26 East. Based on the railway alignment maps provided by your office, the proposed railway corridor is shown on Figure 2.

According to the *Safford, Graham County, Arizona 7.5 minute United States Geological Survey Topographic Map (1985)* ,and the *Weber Peak, Graham County, Arizona 7.5 minute USGS Topographic Map (1985),*the elevation along the proposed railway corridor is approximately 3,480 feet relative to mean sea level (MSL) at the northwestern limits, and approximately 2,970 feet MSL at the southern limits. The central and northern sections of the project site generally slopes from the northeast down to the southwest toward the Gila River, while the southern section generally slopes from the south to the north, also towards the Gila River.

At the time of our evaluation, the project corridor situated north of the Gila River generally consisted of undeveloped desert land with Lone Star Road, San Juan Road, and Phelps Dodge Road traversing northeast through the corridor. The undeveloped desert land was dissected by multiple natural drainages that are typically oriented in a northeast-southwest direction. These natural drainages are generally attributed to the Lone Star Wash, Wilson Wash, Peterson Wash, Cottonwood Wash, Watson Wash, Tulley Wash, and the Coyote Wash. An east-west trending unnamed aqueduct dissects the land north of the Gila River. The Safford Municipal Airport is situated approximately 2.5 miles north of US Highway 70 (US-70), and east of the corridor. The Gila River dissects the project corridor approximately 1 mile north of US-70. The area south of the Gila River generally consists of agricultural land with an unnamed aqueduct, Montezuma Canal, and the San Simon River cross-cutting the landscape. The existing Arizona Eastern Railroad bounds the southern limits of the project corridor.

4. AERIAL PHOTOGRAPH REVIEW

Five aerial photographs were reviewed for this project to evaluate historical changes and potential geologic hazards along the proposed railway corridor. A 1935 aerial photograph obtained from Fairchild, and a set of 1964 aerial photographs obtained from Arizona Department of Transportation depicted the project corridor as agricultural land south of the Gila River, and undeveloped desert land north of the river. A 1980 Rupp's aerial photograph, a 1998 United States Department of Agriculture aerial photograph, and a 2005 GlobeXplorer aerial photograph depicted increased development of the Town of Safford, and agricultural land south of the Gila River along the project corridor. Furthermore, the aerial photographs depicted the Montezuma Canal traversing northeast-southwest and intersecting the San Simon River north of the Arizona Eastern Railway, which traversed northwest-southeast. The Union Canal was depicted as traversing east-west approximately 0.4 miles south of the Gila River. North of the Gila River, these aerial photographs depicted the project site as undeveloped desert land dissected by multiple natural drainages and washes. The Safford Municipal Airport was depicted north of the Gila River and the graded roadways, Airport Road, Lone Star Road, San Juan Road, and the Phelps Dodge Road, were depicted in the photographs traversing northeast-southwest. The aerial photographs reviewed depicted the proposed railway corridor as being similar to its current condition. The review of the aerial photographs did not indicate any past development and/or large-scale cutting or filling, other than the airport, roadways, and aqueducts.

5. GEOLOGIC SETTING

The project site is located within the Mexican Highlands Section of the Basin and Range physiographic province, also known as the Arizona Transition Zone, which is typified by broad, hydrologically closed, alluvial valleys or basins separated by steep, northwest trending mountain ranges (United States Department of the Interior Geological Survey, 1985).

The basins and surrounding mountains were formed approximately 10 to 13 million years ago during the mid- to late-Tertiary. Extensional tectonics resulted in the formation of horsts (mountains) and grabens (basins) with vertical displacement along high-angle normal faults. Intermittent volcanic activity also occurred during this time. The surrounding basins filled with alluvium from the erosion of the surrounding mountains as well as from deposition from rivers. Coarser-grained alluvial material was deposited at the margins of the basins near the mountains and near rivers.

5.1. Surficial Geology

According to the *Geologic Map of Graham and Greenlee Counties (1958)*, the surficial geology along the proposed railway corridor consists of three separate alluvial deposits aging from Late Tertiary (<2,000,000 years) to Holocene (recent to 10,000 years). These deposits are generally composed of gravel, sand, silt, cobbles, and boulders. The younger alluvial deposits are situated along the Gila River (Qal), and along the southern base of the Natanes

Mountains (Qs). Depth to bedrock (Qtb) may be shallow within the alluvial unit denoted as Qs, due to the adjacent mountain range. Late Tertiary to Early Quaternary (<1,800,000 years) alluvial deposits are generally found in the middle of the slope between the Natanese Mountains and the Gila River (Qts). A detailed map of the geologic units can be found on Figure 3. A detailed description of these geologic units can be found in Appendix A.

According to the *National Resources Conservation Service Web Soil Survey*, the alluvial material along the proposed railway corridor may have a natural of slope that ranges from 0 to 90 percent. Units with a flatter slope are generally encountered away from the Natanes Mountains, while the steeper sloping soils are generally encountered adjacent to the mountains. Slower excavation rates within these soils are possible, and can generally be attributed to sidewall cave-in, underlying restrictive clay layers, and encounters with cobbles and boulders. These soils are generally well-drained (water is removed from soil rapidly, generally medium-grained material), exhibit a high corrosion potential to ferrous materials, and a low corrosion potential to concrete. A detailed map of the surficial soils along the proposed railway corridor can be found on Figures 4A through 4C. A detailed description of the surficial soils can be found in Appendix A.

A common characteristic of these types of desert soils include the development of calcium carbonate and caliche horizons. Soils containing carbonate horizons, including caliche horizons, are generally more difficult to excavate, may have more difficult rippability characteristics, and may necessitate a more aggressive excavation techniques.

Stages of calcium carbonate and caliche cementation range from Stage I (partial grain coating of cementation) to Stage VI (complete cementation of former soil) (Lerner et. al, 2003). In general, soils with Stage II or higher number carbonate development or calcification can mean increasingly higher potential for encountering difficult excavation and rippability conditions as the Stage number increases. Calcium carbonate cemented soils and caliche horizons were not described in the geologic map or the soil survey; however, such soils should be expected to be encountered during excavation within these types of desert soils.

5.2. Groundwater

Based on well data from the Arizona Department of Water Resources (ADWR, 2002), the depth to the regional groundwater has been estimated to be as shallow as a few feet bgs in land adjacent to the Gila River. Regional groundwater levels not adjacent to the Gila River have been estimated to be as shallow as 126 feet bgs.

Groundwater levels should be anticipated to be shallow within, and adjacent to, ephemeral streams and the Gila River. Groundwater is generally not expected to be a constraint to this project, except in the general vicinity of the Gila River; however, depending on the time of year the construction is implemented, it is possible that perched groundwater could be encountered at some locations, especially near heavily cemented alluvial fan units, alluvial units with clay layers, existing natural and man-made drainages, and ephemeral streams, especially following seasonal precipitation events. Groundwater levels can fluctuate due to seasonal variations, irrigation, groundwater withdrawal or injection, and other factors. Shallow groundwater may be an important factor for design and construction of foundations for a bridge over the Gila River, and possibly for bridges or culverts near canals and/or wash crossings in or near the Gila River flood plain.

6. GEOLOGIC HAZARDS

The following sections describe potential geologic hazards at the site, including land subsidence and earth fissures, giant desiccation cracks, landslides, faulting and seismicity, and liquefaction.

6.1. Land Subsidence and Earth Fissures

Groundwater depletion, due to groundwater pumping, has caused land subsidence and earth fissures in numerous alluvial basins in southern Arizona. It has been estimated that subsidence has affected more than 3,000 square miles and has caused damage to a variety of engineered structures and agricultural land (Schumann and Genualdi, 1986). From 1948 to 1983, excessive groundwater withdrawal has been documented in several alluvial valleys where groundwater levels have been reportedly lowered by up to 500 feet. With such large depletions of groundwater, the alluvium has undergone consolidation resulting in large areas of land subsidence.

In Arizona, earth fissures are generally associated with land subsidence and pose an on-going geologic hazard. Earth fissures generally associated with land subsidence form near the margins of geomorphic basins where significant amounts of groundwater depletion have occurred. Reportedly, earth fissures have also formed due to tensional stress caused by differential subsidence of the unconsolidated alluvial materials over buried bedrock ridges and irregular bedrock surfaces. Facies changes within the unconsolidated alluvial materials may also cause differential subsidence resulting in tensional stress (Schumann and Genualdi, 1986).

Based on our review of the referenced material, there are no known earth fissures present at the surface of the subject site. The closest documented earth fissure to this site is located approximately 33 miles southeast of the project site, where groundwater levels have declined approximately 100 to 300 feet bgs (Schumann, 1986). Continued groundwater withdrawal within the area may result in subsidence of the valley and the formation of new fissures or the extension of existing fissures.

6.2. Giant Desiccation Cracks

Giant desiccation cracks are common in the southwestern United States where clayey soils have become desiccated. Several of these large-scale cracks have been reported in playas in Arizona. Desiccation cracks are soil or mud cracks, formed in a polygonal-type shape, that range in size from less than a millimeter up to several feet wide and several feet deep, and can extend to 1,000 feet in length. These cracks generally form beneath the surface and commonly extend up toward the surface by the collapse of the roof cavity. Large desiccation cracks are commonly mistaken for earth fissures (Harris, 2004).

Giant desiccation cracks generally form in clay-rich layers deposited in lakes or playas within drained basins. In Arizona, these clay-rich layers generally undergo shrink-swell cycles due to fluctuations in moisture content (Harris, 2004).

Based on our review of the referenced material, there are currently no known giant desiccation cracks underlying the subject corridor. Based on our research, the closest giant desiccation crack to the site is located approximately 8.3 miles to the southeast of the project site (Harris, 2004).

6.3. Landslides

Landslides are downslope movements of soil and rock driven by gravity. Landslides generally occur along steep slopes, and rates of movement can range from rapidly, to a slow creep. Landslides and other mass movements can occur in every state, and on average result in 1 to 2 billion dollars in damage across the United States each year (Harris, 2002).

Landslides in Arizona generally occur during heavy rainfall events, and in colder regions of the state, in response to freezing of water in fractures and soils. Other factors that can contribute to landslides are lack of vegetation, orientation of rock fractures, thickness of underlying soil, steepness of slopes, and sources of vibrations (i.e. earthquakes, construction, etc.) (Harris, 2002).

In Arizona, landslides generally occur where coherent rocks or soil overlie clay-rich units. Once saturated, the clay-rich units lose their cohesion resulting in the overlying material to move downslope. Landslides are not expected to be a constraint to the design of this project; however, where the proposed railway alignment is adjacent to mountains where steeper slopes are encountered, landslides may occur.

6.4. Faulting and Seismicity

The site lies within the Mexican Highland Zone, which is a relatively stable tectonic region in the desert southwest (Euge et al., 1992). This zone is characterized by sparse seismicity and few Quaternary faults.

Based on our field observations and on our review of readily available published geological maps and literature, there are no known active faults underlying the subject site or adjacent areas. Nearby Quaternary faults to the site are the Cactus Flats Faults, Buena Vista Faults, and the Safford Fault Zone (Figure 5). The Cactus Flats Faults are located approximately 4.2 miles south of Safford along the US-191. This normal fault trends northeast and crosses the US-191. The surface displacement along the middle Pleistocene (<750,000 years) units along the fault is approximately 2 meters. Late Pleistocene (<250,000 years) to Holocene (<10,000 years) deposits have not been displaced. The Buena Vista Fault is located approximately 3 miles east of the project corridor near the Town of Solomon. This normal fault trends northeast. The surface displacement along the middle Pleistocene units along the fault is approximately 2 meters. Late Pleistocene to Holocene deposits have not been displaced. The Safford Fault Zone consists of a series of northwest trending normal faults located approximately 16 miles south of the Town of Safford, crossing the US-191. Latest Pleistocene (<15,000 years) have been displaced along the fault; however Holocene deposits have not been displaced (Pearthree, 1998).

Based on a Probabilistic Seismic Hazard Assessment for the Western United States, issued by the USGS (2002), the site is located in a zone where the peak ground accelerations that have a 10 percent and 2 percent probability of being exceeded in 50 years are 0.05g and 0.12g, respectively. These ground motion values are calculated for "firm rock" sites, which correspond to a shear-wave velocity of approximately 2,500 feet per second in approximately the top 100 feet bgs. Different soil sites may amplify or de-amplify these values. Seismic design parameters according to the 1994 Uniform Building Code (UBC) are presented in Table 1.

Table 1 – Seismic Design Parameters

Parameter	Value	1994 UBC Reference
Seismic Zone Factor, Z	0.15	Table 16 – I
Soil Profile Type	S_C	Table 16 – J
Seismic Coefficient C_a	0.18	Table 16 – Q
Seismic Coefficient C_v	0.25	Table 16 – R
Near-Source Factor, N_a	1.0	Table 16 – S
Near-Source Factor, N_v	1.0	Table 16 – T
Seismic Source Type	C	Table 16 – U

6.5. Liquefaction Potential

Based on the lack of near-surface groundwater along the majority of the alignment, assumed relative density of subsurface materials, and the low ground-motion hazard (relatively low ground accelerations), the likelihood or potential for liquefaction is not expected to be a factor in the design of the railway.

7. RIPPABILITY

Based on our review of available geologic maps and soil surveys, the alluvial materials along the corridor are expected to be generally rippable to the anticipated depths (±5 feet) with conventional earthmoving equipment in good operating condition. Some of the alluvial materials along the project corridor may be difficult to excavate due to cobbles, possible boulders, and/or layers of moderate to heavy calcium carbonate or caliche cementation. Accordingly, these materials may necessitate more aggressive excavation techniques, and could slow the excavation rate. Bedrock should be expected to be encountered below alluvial deposits at shallow depths in areas along the northern alignments of the corridor. Evaluation of the approximate depths to bedrock in these areas could be developed by conducting seismic refraction surveying along specific portions of the proposed railway alignment.

8. TRENCHING

Our evaluation of the trenching characteristics of the on-site materials is based on the review of the *USDA National Resources Conservation Service Soil Survey*. The on-site soils are prone to caving; therefore, some soils within the proposed alignments may be problematic for slope stability in trenches. This limitation is a result of the soil exhibiting cohesionless characteristics (i.e., too sandy and/or gravelly). Other limitations include the soils being weakly to non-cemented by calcium carbonate, and may have sensitivity to moisture conditions (i.e., high shrink/swell potential) during wetting and drying cycles.

During trenching activities, the contractor should provide safely sloped excavations or an adequately constructed and braced shoring system, in compliance with Occupational Safety and

Health Administration regulations for employees working in an excavation that may expose employees to the danger of moving ground. If material is stored or equipment is operated near an excavation, stronger shoring should be used to resist the extra pressure due to superimposed loads.

It may be desirable to recognize utilities, underground structures, or other features that are near the planned construction and to survey or document (e.g., photographs, video, official documentation, etc.) their pre-construction condition. The findings of the survey could be used to differentiate between pre-existing damage and new damage that might result from this project.

9. RAILWAY CROSSINGS

Several natural drainages that are tributary to the Lone Star Wash, Wilson Wash, Peterson Wash, Cottonwood Wash, Watson Wash, Tulley Wash, and the Coyote Wash, dissect the study corridor. These drainages may necessitate the use of concrete box culverts for the railway to cross. Where the railway alignment crosses the Montezuma Canal, Union Canal south of the Gila River, and an unnamed aqueduct north of the Gila River, bridges supported on conventional spread footings may be needed.

Where the railway corridor crosses the Gila River, we recommend a bridge supported on deep foundations be utilized due to potential scour erosion from the river. The depths of the foundations will be established based upon bridge loading, scour predictions, and other factors. It should, however, be anticipated that this scour erosion could extend to significant depths. A scour expert should be consulted regarding these crossings. Because deposits of sand, gravel, and cobbles, as well as potential for groundwater, are typically expected in this area, difficult excavation and/or caving conditions may also be encountered. Deep foundations could include driven piles or cast-in-place drilled shafts. In recent years, bridge crossings of the Gila River in the general site vicinity have been supported by deep drilled shaft foundations.

10. LIMITATIONS

The field evaluation, laboratory testing, 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 construction. Uncertainties relative to subsurface conditions can be reduced through additional subsurface exploration. Additional subsurface evaluation will be performed upon request. Please also note that our evaluation was limited to assessment of the geotechnical aspects of the project, and did not include 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 design purposes only. It does not provide sufficient data to prepare an accurate bid by contractors. It is suggested that the bidders and their geotechnical consultant perform an independent evaluation of the subsurface conditions in the project areas. The independent evaluations may include, but not be limited to, review of other geotechnical reports prepared for the adjacent areas, site reconnaissance, and additional exploration and laboratory testing.

Our conclusions, recommendations, and opinions are based on an analysis of the observed site conditions. If geotechnical conditions different from those described in this report are encountered, our office should be notified and additional recommendations, if warranted, will be provided upon request. It should be understood that the conditions of a site could change with time as a result of natural processes or the activities of man at the subject site or nearby sites. In addition, changes to the applicable laws, regulations, codes, and standards of practice may occur due to government action or the broadening of knowledge. The findings of this report may, therefore, be invalidated over time, in part or in whole, by changes over which Ninyo & Moore has no control.

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.

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.

11. REFERENCES

Arizona Department of Water Resources (ADWR), 2002, ADWR 55- Well Database on CD-ROM.

"Caliche." World of Earth Science. Ed. K. Lee Lerner and Brenda Wilmoth Lerner. Thomson Gale, 2003. eNotes.com. 2006. 10 Oct, 2006 http://science.enotes.com/earth-science/caliche.

Harris, R.C., 2004, Giant Dessication Cracks in Arizona, Arizona Geological Survey OFR 04-01.

Harris, R.C., Pearthree, P.A., 2002, A Home Buyer's Guide to Geologic Hazards in Arizona, Arizona Geological Survey Down-to-Earth Series 13.

International Conference of Building Officials, 1994, Uniform Building Code: Whittier California.

Moores, Eldridge, Twiss, Robert, 1995, Tectonics: W.H. Freeman and Company.

Moore et al. Geologic Map of Graham and Greenlee Counties, Arizona, 1958, Arizona Bureau of Mines University of Arizona, Tucson, Arizona. Scale: 1:375,000.

Ninyo & Moore, In-house proprietary information.

Pearthree, P.A., 1998, Quaternary Fault Data and Map for Arizona: Arizona Geological Survey, Open-File Report 98-24, 122 p.

Schumann, H.H. and Genualdi, R., 1986, Land Subsidence, Earth Fissures, and Water-level Changes in Southern Arizona: Arizona Geological Survey OFR 86-14, Scale 1:500,000.

United States Department of Agriculture Web Soil Survey, 2006, World Wide Web, http://websoilsurvey.nrcs.usda.gov/app/.

United States Geological Survey, 1985, Safford-7.5 Minute Topographical Map, Scale: 1:24,000.

United States Geological Survey, 1985, Weber Peak-7.5 Minute Topographical Map, Scale: 1:24,000.

United States Geological Survey, 2002, National Seismic Hazard Mapping Project, World Wide Web,http://geohazards.cr.usgs.gov/eq.

United States Department of the Interior Geological Survey, 1985, United States Government Printing Office, Washington.

Aerial Photographs Reviewed	
Source	Date
Arizona Department of Transportation	1964
Fairchild	1935
GlobeXplorer	2005
Rupp's Photography	1980
United States Department of Agriculture	1998

FIGURES

SOURCE: Microsoft Streets and Trips, 2006.

Ninyo & Moore

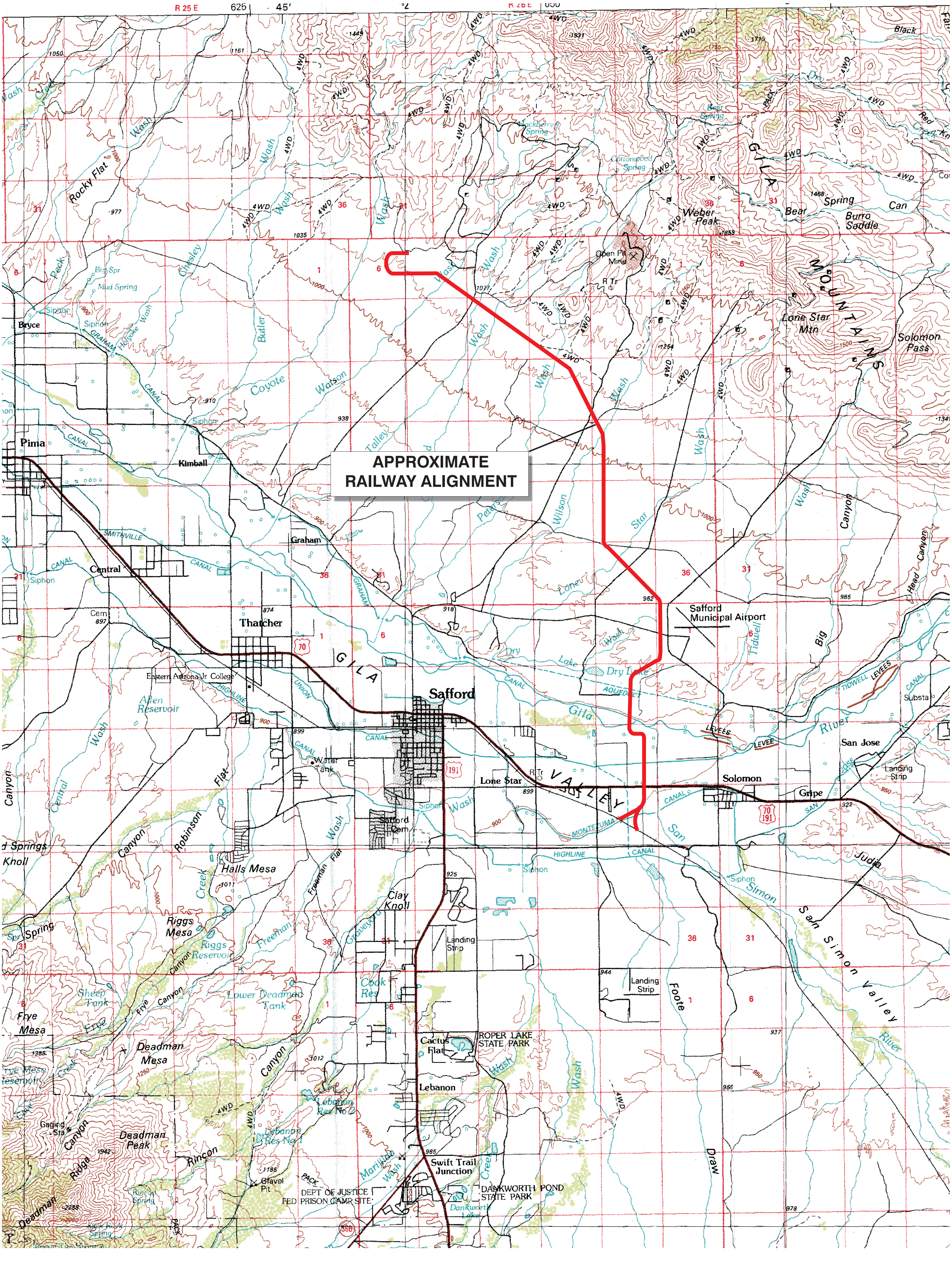
SITE LOCATION MAP

FIGURE 1

PROJECT NO:	DATE:
601605001	10/06

ARIZONA EASTERN RAILWAY
GRAHAM COUNTY, ARIZONA

file no: 1605vmap1006



Source: USGS 1985 Safford Topographic Map

NOTE: ALL BOUNDARIES AND LOCATIONS ARE APPROXIMATE.

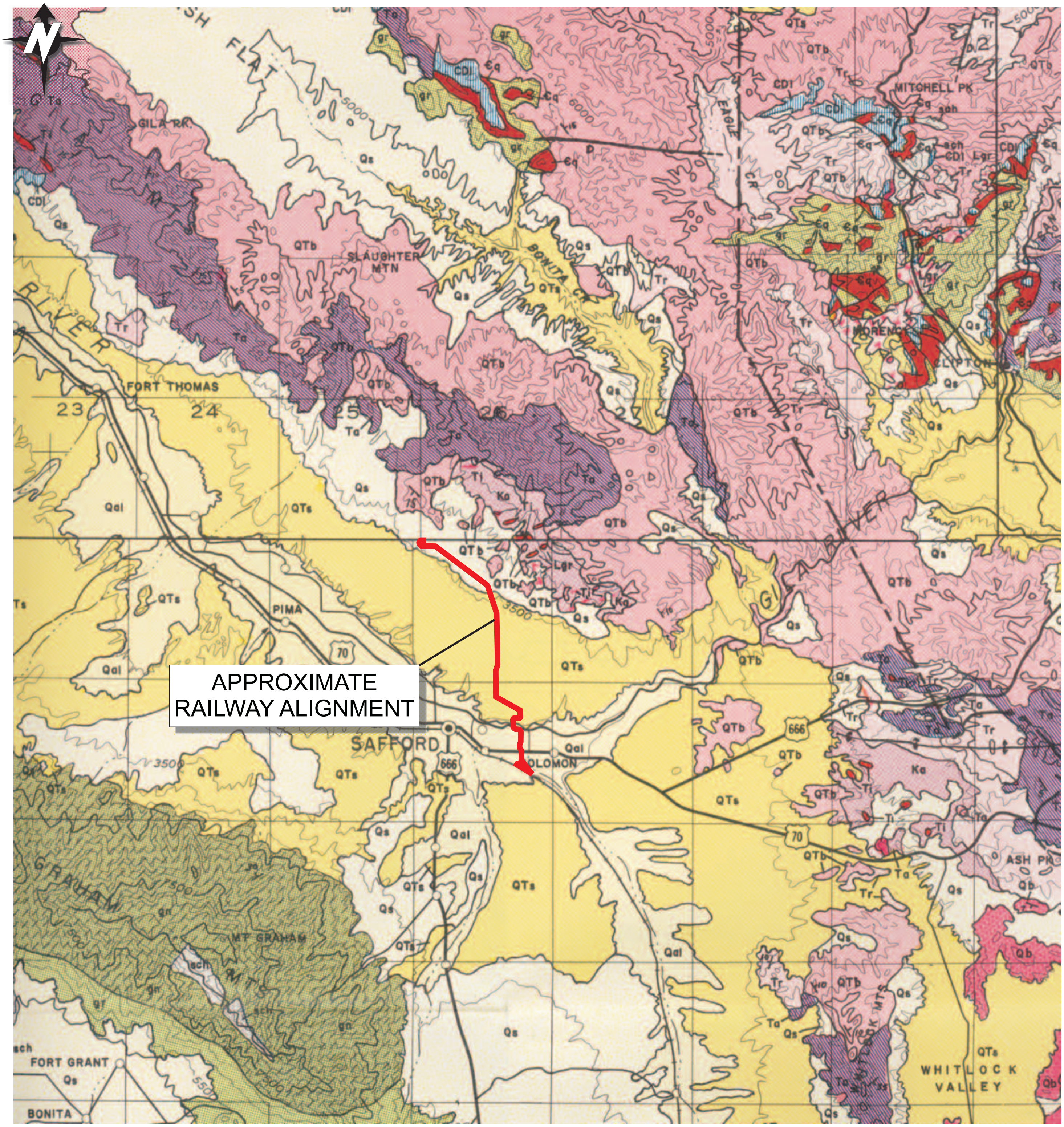
FILE NO. 1605ALIGN1006

APPROXIMATE RAILWAY ALIGNMENT MAP

ARIZONA EASTERN RAILWAY
GRAHAM COUNTY, ARIZONA

Ninyo & Moore

PROJECT NO:	DATE:	FIGURE
601605001	10/06	2



0 6 miles

Approximate Scale:
1 inch = 6 miles

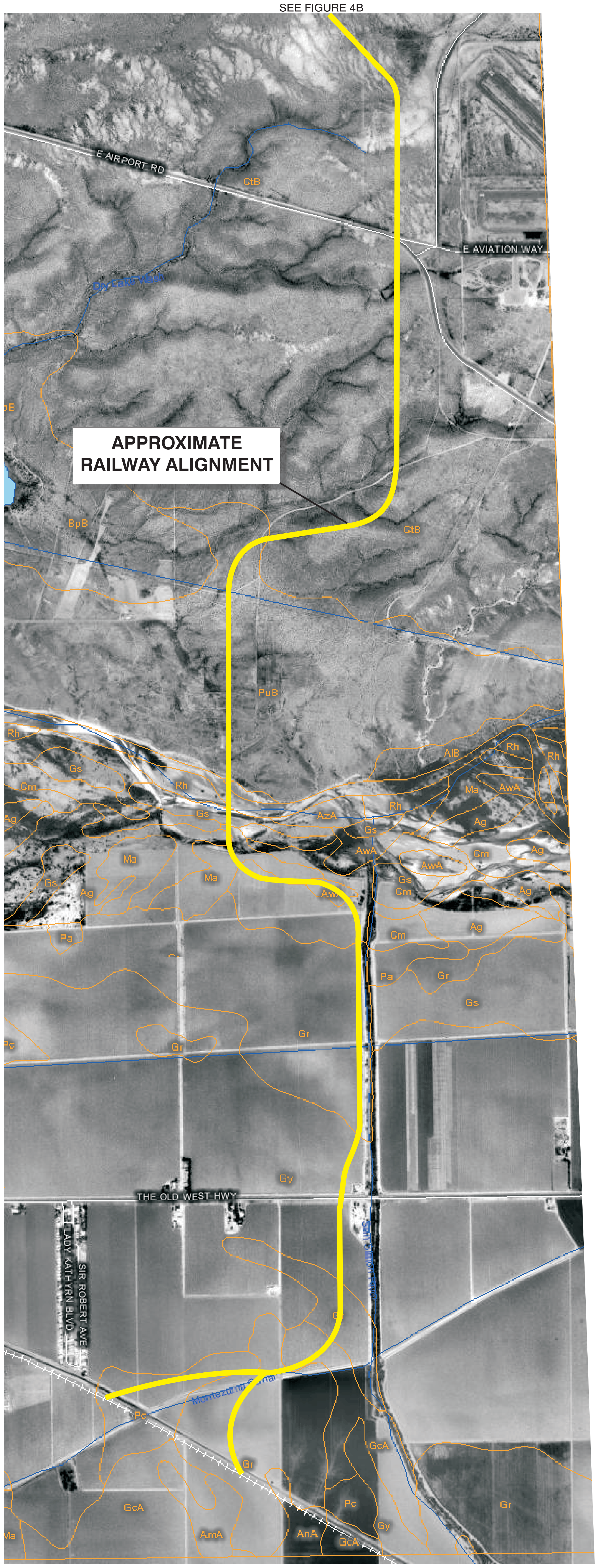
SOURCE: Geologic Map of Graham and Greenlee Counties, Arizona

NOTE: Applicable abbreviations presented in Appendix A of report.

Ninyo & Moore		SURFICIAL GEOLOGIC MAP	FIGURE 3
PROJECT NO: 601605001	DATE: 10/06	ARIZONA EASTERN RAILWAY GRAHAM COUNTY, ARIZONA	

file no: 1605geo1006

MATCH LINE
SEE FIGURE 4B



NOTE: Applicable abbreviations presented in Appendix A of report.

0 1440 feet

APPROXIMATE SCALE:
1 INCH = 1440 feet

SOURCE: USDA NRCS WEB SOIL SURVEY, 2006.
NOTE: ALL BOUNDARIES AND LOCATIONS ARE APPROXIMATE.

FILE NO. 1605arl1006c

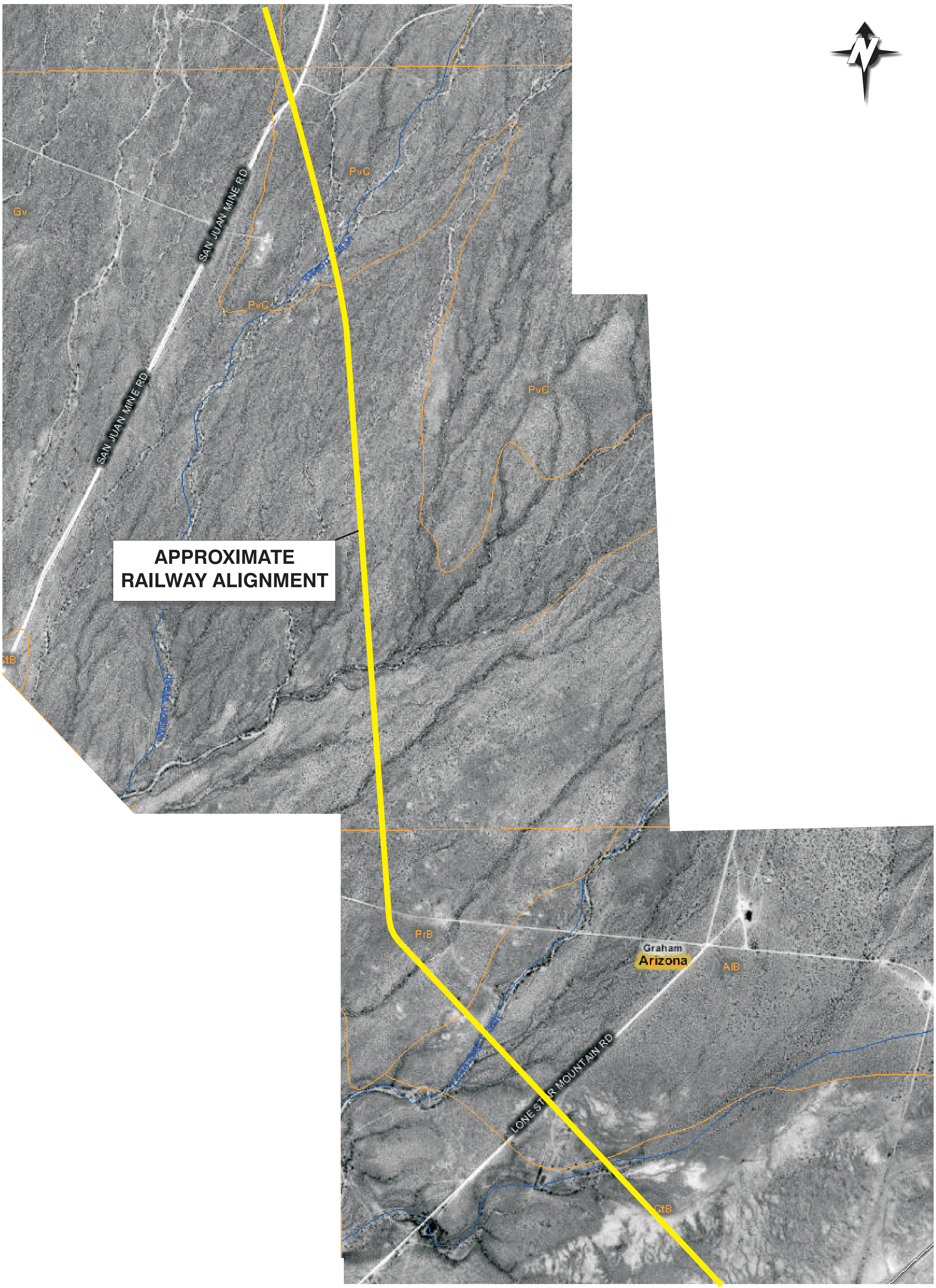
SURFICIAL SOILS MAP(SOUTHERN SEGMENT)

ARIZONA EASTERN RAILWAY
GRAHAM COUNTY, ARIZONA

Ninyo & Moore

PROJECT NO:	DATE:	FIGURE
601605001	10/06	4A

MATCH LINE
SEE FIGURE 4C



MATCH LINE
SEE FIGURE 4A

NOTE: Applicable abbreviations presented in Appendix A of report.

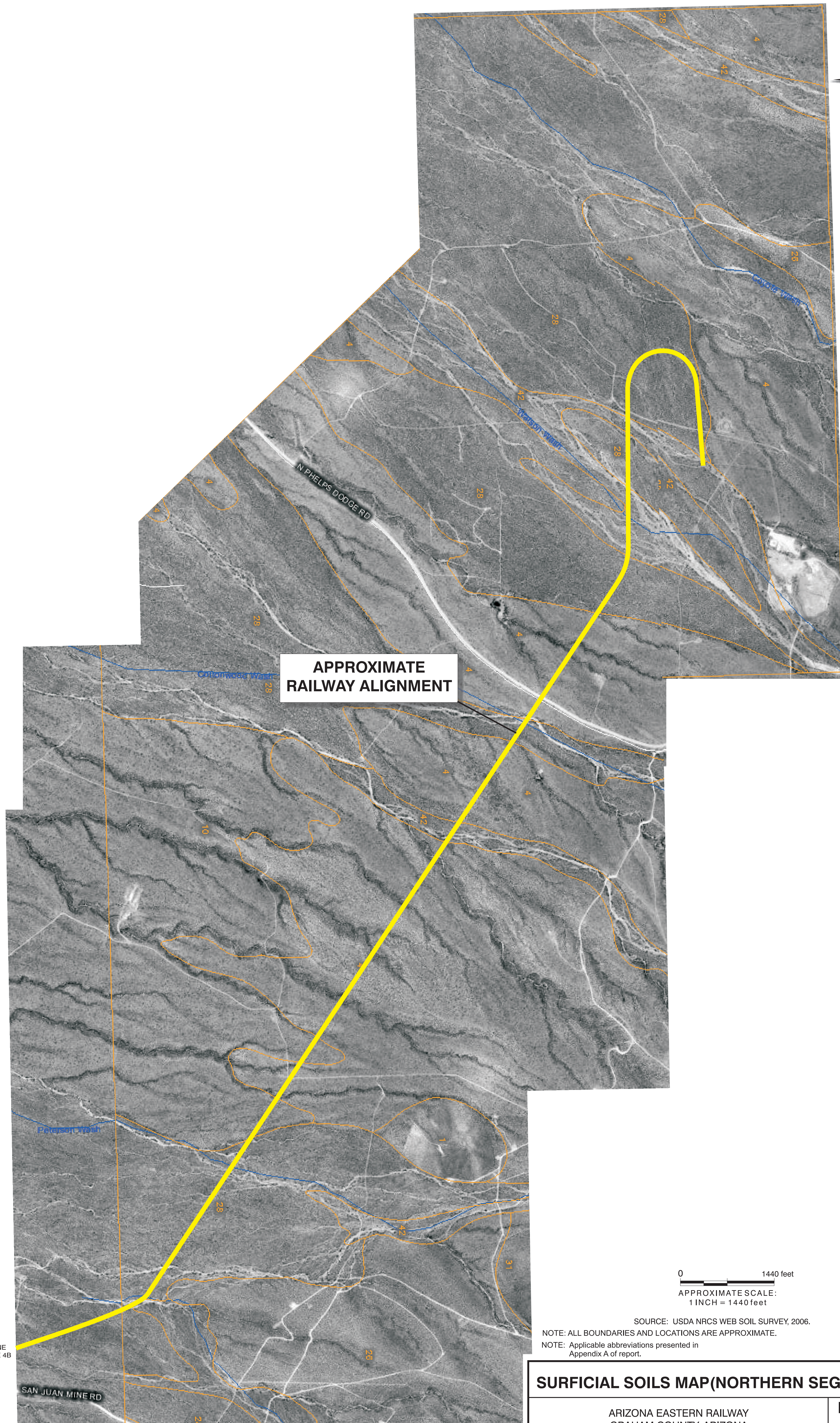
0 1440 feet
APPROXIMATE SCALE:
1 INCH = 1440 feet

SOURCE: USDA NRCS WEB SOIL SURVEY, 2006.
NOTE: ALL BOUNDARIES AND LOCATIONS ARE APPROXIMATE.

SURFICIAL SOILS MAP(CENTRAL SEGMENT)

ARIZONA EASTERN RAILWAY GRAHAM COUNTY, ARIZONA			FIGURE 4B
Ninyo & Moore	PROJECT NO: 601605001	DATE: 10/06	

FILE NO. 1605ar1006b



0 1440 feet

APPROXIMATE SCALE: 1 INCH = 1440 feet

SOURCE: USDA NRCS WEB SOIL SURVEY, 2006.

NOTE: ALL BOUNDARIES AND LOCATIONS ARE APPROXIMATE.

NOTE: Applicable abbreviations presented in Appendix A of report.

SURFICIAL SOILS MAP(NORTHERN SEGMENT)

ARIZONA EASTERN RAILWAY
GRAHAM COUNTY, ARIZONA

Ninyo & Moore	PROJECT NO: 601605001	DATE: 10/06	FIGURE 4C

FILE NO. 1605arl1006a

SOURCE: USGS EHP QUATERNARY FAULT AND FOLD DATABASE.

Ninyo & Moore		QUATERNARY FAULT MAP	FIGURE
PROJECT NO: 601605001	DATE: 10/06	ARIZONA EASTERN RAILWAY GRAHAM COUNTY, ARIZONA	5

file no: 1605fault1006

APPENDIX A

SURFICIAL GEOLOGIC MAP AND SURFICIAL SOILS MAP UNIT DESCRIPTIONS

GEOLOGIC MAP OF GRAHAM AND GREENLEE COUNTIES UNITS

Unit Symbol	Approximate Unit Age	Unit Description
Qs	**Late Quaternary**	Late Quaternary (<250,000 years) alluvial deposits of gravel, sand and silt. Generally deposited at the base of the Natanes Mountains. Bedrock should be expected at shallow depths.
Qal	**Late Quaternary**	Late Quaternary alluvial deposits of gravel, sand, silt, clay, cobbles and boulders. These deposits are generally encountered along the Gila River.
QTs	**Late Tertiary to Early Quaternary**	Late Tertiary to Early Quaternary (2,000,000 years to 750,000 years) alluvial deposits of gravel, sand and silt. These deposits are generally encountered in the middle of the alluvial slope from the Natanes Mountains toward the Gila River.
QTb	**Late Tertiary to Early Quaternary**	Late Tertiary to Early Quaternary basalt, that including tuff and agglomerate. This unit is located near the northern limits of the project site. This unit may underlie the Qs at shallow depths.

NATIONAL RESOURCES CONSERVATION SERVICE SURFICIAL SOILS MAP UNITS

Unit Symbol	Unit Name	Unit Description
4	**Artesia Extremely Cobbly Sandy Clay Loam**	A well-drained soil with approximately 0 to 8 percent slopes, exhibits a slow water permeability rate, generally does not cause water ponding, and has a flooding probability of 1 time in 500 years. Cobbles and possible boulders in the subsurface as well as sidewall cave-in may cause difficulty excavating these soils. Generally, these soils exhibit a high corrosive potential for ferrous materials, and a low potential for concrete.
10	**Pinalneo Complex**	A well-drained soil with approximately 2 to 4 percent slopes, exhibits a slow water permeability rate, generally does not cause water ponding, and has a flooding probability of 1 time in 500 years. Cobbles and possible boulders in the subsurface, sidewall cave-in, and restrictive clay layers may cause difficulty excavating these soils. Generally, these soils exhibit a high corrosive potential for ferrous materials, and a low potential for concrete.

**NATIONAL RESOURCES CONSERVATION SERVICE
SURFICIAL SOILS MAP UNITS**

26	**Peloncillo-Orthents-Pinaleno Complex**	A well-drained soil with approximately 20 to 90 percent slopes, exhibits a slow water permeability rate, generally does not cause water ponding, and has a flooding probability of 1 time in 500 years. Relatively steep slopes as well as sidewall cave-in may cause difficulty excavating these soils. Generally, these soils exhibit a high corrosive potential for ferrous materials, and a low potential for concrete.
28	**Pinaleno Very Cobbly Loam**	A well-drained soil with approximately 5 to 30 percent slopes, exhibits a moderate water permeability rate, generally does not cause water ponding, and has a flooding probability of 1 time in 500 years. Relatively steep slopes as well as sidewall cave-in may cause difficulty excavating these soils. Generally, these soils exhibit a high corrosive potential for ferrous materials, and a low potential for concrete.
42	**Torrifluvents-Riverwash Complex**	An excessively-drained soil with approximately 2 to 15 percent slopes that generally does not cause water ponding, and generally has a 50 percent chance of flooding in any year. Generally, these soils exhibit a high corrosive potential for ferrous materials, and a low potential for concrete. Excavation and water-permeability rates were not rated for this unit.
Ag	**Agua Loam**	A well-drained soil with approximately 1 percent slopes, exhibits a moderate water permeability rate, generally does not cause water ponding, and has a flooding probability of 1 to 5 percent in any year. Side-wall cave-in may cause difficulty excavating these soils. Generally, these soils exhibit a high corrosion potential for ferrous materials, and a low corrosion potential for concrete.
AlB	**Anthony Gravelly Sandy Loam**	A well-drained soil with approximately 0 to 5 percent slopes, exhibits a moderate water permeability rate, generally does not cause water ponding and has a flooding probability of 1 to 5 percent in any year. Side-wall cave-in may cause difficulty excavating these soils. Generally, these soils exhibit a high corrosion potential for ferrous materials, and a low corrosion potential for concrete.

**NATIONAL RESOURCES CONSERVATION SERVICE
SURFICIAL SOILS MAP UNITS**

AmA	**Anthony Loam**	A well-drained soil with approximately 0 to 2 percent slopes, exhibits a moderate water permeability rate, generally does not cause water ponding and has a flooding probability of 1 to 5 percent in any year. Side-wall cave-in may cause difficulty excavating these soils. Generally, these soils exhibit a high corrosion potential for ferrous materials, and a low corrosion potential for concrete.
AnA	**Anthony Sandy Loam**	A well-drained soil with approximately 0 to 2 percent slopes, exhibits a moderate water permeability rate, generally does not cause water ponding and has a flooding probability of 1 to 5 percent in any year. Side-wall cave-in may cause difficulty excavating these soils. Generally, these soils exhibit a high corrosion potential for ferrous materials, and a low corrosion potential for concrete.
AwA	**Arizo Loam**	An excessively-drained soil with approximately 0 to 2 percent slopes, exhibits a high water permeability rate, generally does not cause water ponding and has a flooding probability of 5 to 50 percent in any year. Sidewall cave-in and water flooding trenches may cause difficulty excavating these soils. Generally, these soils exhibit a moderate corrosion potential for ferrous materials, and a low corrosion potential for concrete.
AzA	**Arizo Gravelly Loam**	An excessively-drained soil with approximately 0 to 2 percent slopes, exhibits a high water permeability rate, generally does not cause water ponding and has a flooding probability of 5 to 50 percent in any year. Sidewall cave-in and water flooding trenches may cause difficulty excavating these soils. Generally, these soils exhibit a high corrosion potential for ferrous materials, and a low corrosion potential for concrete.
BpB	**Bitter Spring-Pinaleno Complex**	A well-drained soil with approximately 0 to 5 percent slopes, exhibits a moderate water permeability rate, generally does not cause water ponding, and has a flooding probability of 1 time in 500 years. Sidewall cave-in may cause difficulty excavating these soils. Generally, these soils exhibit a high corrosion potential for ferrous materials, and a low corrosion potential for concrete.

**NATIONAL RESOURCES CONSERVATION SERVICE
SURFICIAL SOILS MAP UNITS**

Cm	**Comoro Loam**	A well-drained soil with approximately 1 percent slopes, exhibits a moderate water permeability rate, generally does not cause water ponding, and has a flooding probability of 1 to 5 percent in any year. Sidewall cave-in may cause difficulty excavating these soils. Generally, these soils exhibit a high corrosion potential for ferrous materials, and a low corrosion potential for concrete.
CtB	**Continental Pinaleno Complex**	A well-drained soil with approximately 0 to 5 percent slopes, exhibits a slow water permeability rate, generally does not cause water ponding, and has a flooding probability of 1 time in 500 years. Sidewall cave-in and restrictive clayey layers may cause difficulty excavating these soils. Generally, these soils exhibit a high corrosion potential for ferrous materials, and a low corrosion potential for concrete.
GcA	**Gila Loam**	A well-drained soil with approximately 0 to 2 percent slopes, exhibits a moderate water permeability rate, generally does not cause water ponding and has a flooding probability of 1 to 5 percent in any year. Sidewall cave-in may cause difficulty excavating these soils. Generally, these soils exhibit a high corrosion potential for ferrous materials, and a low corrosion potential for concrete.
Gr	**Grabe Clay Loam**	A well-drained soil with approximately 1 percent slopes, exhibits a moderate water permeability rate, generally does not cause water ponding and has a flooding probability of 1 to 5 percent in any year. Sidewall cave-in may cause difficulty excavating these soils. Generally, these soils exhibit a high corrosion potential for ferrous materials, and a low corrosion potential for concrete.
Gs	**Grabe Loam**	A well-drained soil with approximately 1 percent slopes, exhibits a moderate water permeability rate, generally does not cause water ponding and has a flooding probability of 1 to 5 percent in any year. Sidewall cave-in may cause difficulty excavating these soils. Generally, these soils exhibit a high corrosion potential for ferrous materials, and a low corrosion potential for concrete.

**NATIONAL RESOURCES CONSERVATION SERVICE
SURFICIAL SOILS MAP UNITS**

Gv	**Gravelly Alluvial Land**	An excessively-drained soil with approximately 4 percent slopes, generally does not cause water ponding and has a flooding probability of 5 to 50 percent in any year. Sidewall cave-in, cobbles, and possible boulders may cause difficulty excavating these soils. Water permeability rates and corrosivity were not rated within this unit.
Gy	**Guest Clay**	A well-drained soil with approximately 1 percent slopes, exhibits a very slow water permeability rate, generally does not cause water ponding and has a flooding probability of 1 to 5 percent in any year. Sidewall cave-in may cause difficulty excavating these soils. Generally, these soils exhibit a high corrosion potential for ferrous materials, and a low corrosion potential for concrete. This unit may also exhibit a high shrink/swell potential.
Ma	**Maricopa Loam**	A well-drained soil with approximately 1 percent slopes, exhibits a moderate water permeability rate, generally does not cause water ponding and has a flooding probability of 1 to 5 percent in any year. Sidewall cave-in may cause difficulty excavating these soils. Generally, these soils exhibit a high corrosion potential for ferrous materials, and a low corrosion potential for concrete.
Pa	**Pima Clay**	A well-drained soil with approximately 1 percent slopes, exhibits a moderate water permeability rate, generally does not cause water ponding and has a flooding probability of 1 to 5 percent in any year. Sidewall cave-in may cause difficulty excavating these soils. Generally, these soils exhibit a high corrosion potential for ferrous materials, and a low corrosion potential for concrete.
Pc	**Pima Clay Loam**	A well-drained soil with approximately 1 percent slopes, exhibits a moderate water permeability rate, generally does not cause water ponding and has a flooding probability of 1 to 5 percent in any year. Sidewall cave-in may cause difficulty excavating these soils. Generally, these soils exhibit a high corrosion potential for ferrous materials, and a low corrosion potential for concrete.

NATIONAL RESOURCES CONSERVATION SERVICE SURFICIAL SOILS MAP UNITS

PrB	**Pinaleno Gravelly Loam**	A well-drained soil with approximately 0 to 5 percent slopes, exhibits a moderate water permeability rate, generally does not cause water ponding and has a flooding probability 1 time in 500 years. Sidewall cave-in may cause difficulty excavating these soils. Generally, these soils exhibit a high corrosion potential for ferrous materials, and a low corrosion potential for concrete.
PuB	**Pinaleno-Cave Complex**	A well-drained soil with approximately 0 to 5 percent slopes, exhibits a moderate water permeability rate, generally does not cause water ponding and has a flooding probability 1 time in 500 years. Sidewall cave-in may cause difficulty excavating these soils. Generally, these soils exhibit a high corrosion potential for ferrous materials, and a low corrosion potential for concrete.
PvC	**Pinaleno-Continental Gravelly Sandy Loam**	A well-drained soil with approximately 0 to 10 percent slopes, exhibits a moderate water permeability rate, generally does not cause water ponding and has a flooding probability 1 time in 500 years. Sidewall cave-in and restrictive clay layers may cause difficulty excavating these soils. Generally, these soils exhibit a high corrosion potential for ferrous materials, and a low corrosion potential for concrete.
Rh	**Riverwash**	An excessively-drained soil with approximately 2 percent slopes that generally does not cause water ponding, and generally has a 50 percent chance of flooding in any year. Excavation, water-permeability rates, and corrosion potential for ferrous materials and concrete were not rated for this unit.