Farmington-Thoreau Railroad Study

August 21, 2015 Final Report

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Rail Line Study from Farmington to Thoreau

1 Introduction/Summary

A rail line connecting the Farmington, NM area to the Burlington Northern Santa Fe corridor (BNSF), Interstate 40, and Thoreau, New Mexico across the San Juan and McKinley Counties has been proposed. This report presents the results of a feasibility study of this rail line. Included in the study are cost estimates, a market study, and an analysis of economic impact, with detailed quantitative and qualitative information presented on rail alignments, transportations plans, land ownership, and utilities availability, as well as cultural/environmental impacts. The report uses the most recent rail line study in the region conducted by Freight Services Incorporated that proposed an extension of the Star Lake Line as a starting point for economic data on the region (Freight Services Incorporated, 1998) with adjustments factored in, based on inflation and major developments in the local economy. Key changes in the economic market between 1998 and 2015 are highlighted, including information from Four Corners Economic Development of potential rail shippers in 2009 and 2015.

The first section of this report, Section 1, provides an introduction to the project and a summary of the project background. Within this section major findings and recommendations are also overviewed, pertaining to the political, cultural/historic, environmental, technical, and economic feasibility of the proposed line. More detail, including data and figures, to support these findings and recommendations is included in the latter sections of this report.

1.1 Motivation

Energy resources in the Four Corners region are beginning to drive the demand for a 110 mile railroad spur connection to the BNSF Transcon rail line. In particular, a rail line is needed for shipment of equipment and materials into the Four Corners region and to extract energy resources and shipment of products out of the Four Corners region for further processing or to send to national and international markets.

This short line railroad is being proposed by the Navajo Nation as they currently see an opportunity to derive alternative revenue streams from the economic growth the rail line has the potential to generate. A key difference from previous proposals is that the Navajo Nation is the one proposing to build the rail line primarily on Navajo and BLM lands, where past studies were driven by extraction companies leasing coal mine lands from the Navajo Nation and Southern Utes. The result is the current focus on how the proposed line would benefit the Navajo Nation and Four Corners region as a whole as opposed to an outside mining company. Substantial San Juan Basin oil and gas reserves are also leased from the Navajo Nation as well as BLM and other types of lands.

Environmental concerns related to the mining and burning of coal are threatening Navajo revenue streams from coal mineral resources. The Navajo Nation faces an economic disaster as royalty income from the Navajo mine that feeds the Four Corners Power Plant has been significantly impacted with the shutdown of 3 out of 5 units reducing coal consumption by 1/3 of previous levels. As a result new markets for the Navajo Coal mine need to be found; with rail access such markets could either be international or domestic. The potential exists to ship coal or processed coal to other markets where modern plants have the necessary equipment to meet environmental emissions standards.

The Navajo Nation owns trust lands and fee simple lands; also, individual Navajos own Indian Allotment lands located between Thoreau, NM and Farmington, NM. Previous railroad proposals have never considered what the Navajo Nation's motivation for issuing right of way (ROW) would be. This study, however, is focused around the prospect of the Navajo Nation operating the rail line in order to provide market access for the Navajo Coal Mine, Navajo Agricultural Products Industry (NAPI), and the Four Corners region as a whole.

1.2 Scope of Project

This project's scope included conducting a feasibility study for a potential NM 371 corridor rail alignment. The rail line proposed would follow NM 371 and/or the border of the Navajo Reservation but not be within the existing NM 371 right of way. This study was conducted to determine the cost benefit analysis for the construction and operation of the rail line, to determine any environmental, cultural, or historic concerns that could impede construction of the proposed rail, as well as to evaluate public opinion towards acquiring rail line right of way. **The key question guiding the project is: Would construction of the Thoreau to Farmington Rail Line along NM 371 be feasible and could it function profitably?**

1.3 Summary of Findings and Recommendations

1.3.1 Political Feasibility

The Navajo Nation Division of Economic Development has met with many of the Navajo chapters along the proposed route and advised on location of the line. So far the opinion of the land owners along the route has been generally favorable. Previous studies of rail line connections to the Farmington Area found Navajo land owners to be an obstacle due to the studies' inability to demonstrate the economic benefit to the Navajo Nation and land owners. This study approaches the construction of the rail line from a new standpoint in that the Navajo Nation will be the owner and operator of the rail line which will primarily service Navajo Industries. This new approach has been helpful in securing interest and support for the rail line. **The political feasibility (Section 2) of the rail line will be an ongoing task, as public opinion changes over time and funding does not currently exist to secure land rights. However, this study has found no insurmountable political or social opposition to the rail line itself.**

1.3.2 Cultural and Historic Feasibility

The proposed route has maintained a standoff distance as large as possible from Chaco Canyon National Historic Park. The names and locations of specific sites other than Chaco Canyon are closely held by Navajo Nation Historical Preservation (NNHP) and are not publishable information. NNHP records were compared to the proposed route, and the findings of that comparison are presented in Section 2.4. The entire route will need to be surveyed for historic and archaeologic sites, and it is likely that some sites will be discovered that need to be mitigated or avoided by the rail line. The Navajo Nation is experienced with such surveys and mitigation techniques that are regularly used in areas of large development such as the Navajo Mine and NAPI. **This study does not anticipate cultural or historic sites being an insurmountable obstacle to construction of the proposed rail line.**

1.3.3 Economic Feasibility

To determine economic feasibility of the proposed rail line, this study investigated the amount of traffic required to make the rail line financially sound and researched various scenarios for reaching those traffic levels.

The 1998 FSI study found that a rail line connection to Farmington could cover its operating costs but not pay off its construction debt; consequently the FSI study proposed attempting to secure public funds to cover some of the construction costs. In contrast, with this project the Navajo Nation Division of Economic Development has expressed interest in finding a way to fund the project with private rather than public funds. There have been several major changes to the economic market since the 1998 FSI study, some of which have the potential to make private financing a viable option. The primary change is the recent shutdown of coal- fired power plants in the region. These shutdowns and the subsequent loss of a market for coal mines in the region represent a major blow to the local economy but also represent an economic opportunity for the rail line to ship that same coal to other markets.

The proposed rail line needs to move a minimum of 89,800 car loads a year to cover its operating expenses and construction debt if the rail segments 1, 2, and 3-B are constructed with double track or 50,700 car loads annually if segments 1, 2, and 3-A are constructed as single track. The rail traffic projections compiled in this study predict an initial traffic level of 28,000 car loads annually from NAPI and the Farmington area, growing to 40,600 car loads annually in 4-15 years depending on the rate of economic growth spurred by rail access and detailed in Section 3.8.4. The other major source of rail traffic is the Navajo Mine which could export as much as 58,000 rail cars per year if it exported all the coal it produces. **Thus, if the single track option were selected and a market other than the Four Corners Power Plant is found for the Navajo Mine coal, the rail line could easily cover its costs and be profitable.** The economic impact section of this report details the market prices of coking and steam coal at various international ports (Section 3.8.3). **The findings are that the coal from the Navajo Mine could be exported for a profit at any of the ports studied. Alternatively if no exports are assumed from the Navajo Mine the rail line would need an estimated 10,100 additional car loads annually from a source not identified in this study to be profitable within the initial 4, 10,**

or 15 years of operation depending on the economic growth model outlined in Sections 3.8.2 and 3.8.4.

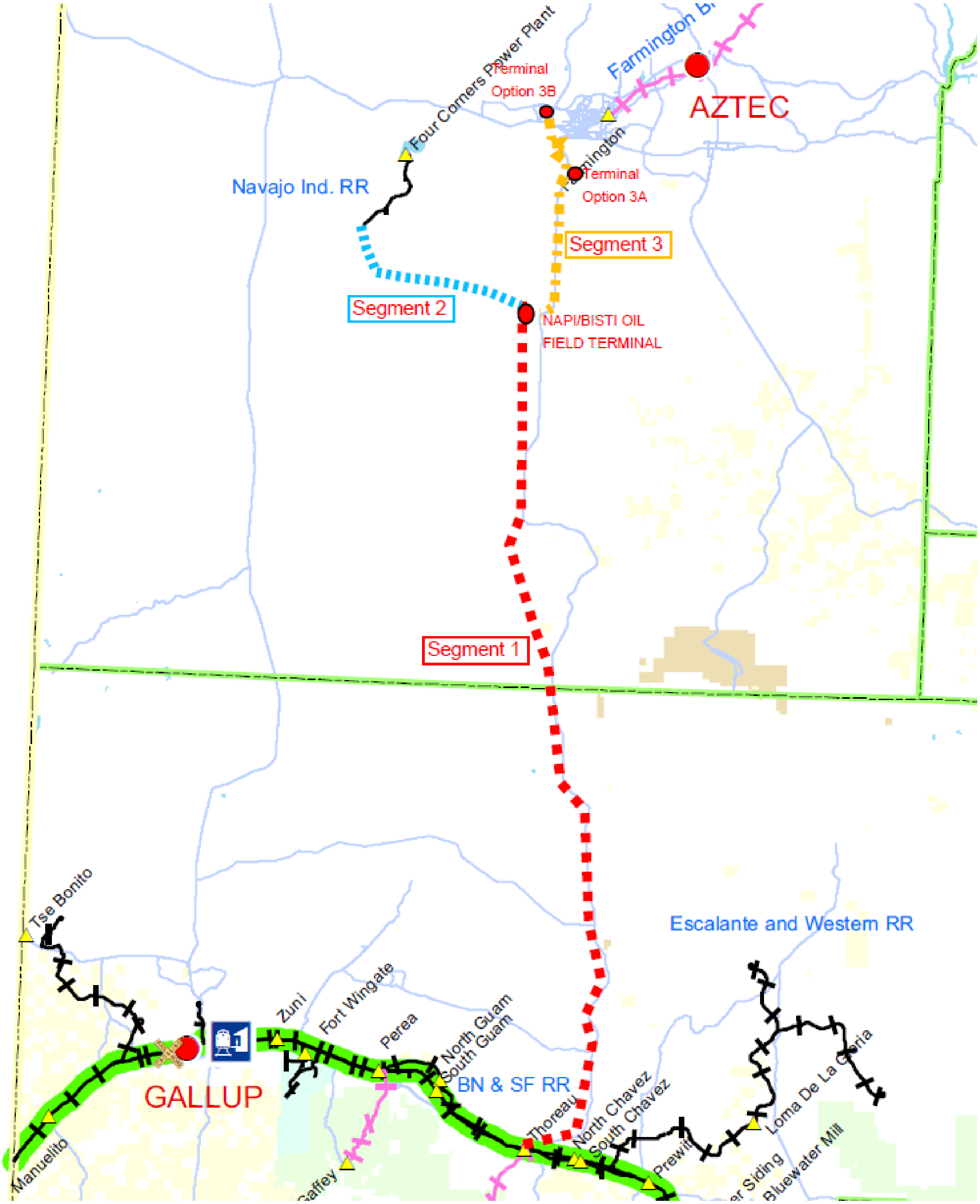


Figure 1-1 Thoreau to Farmington Rail Segments 1, 2, 3-A and 3-B

Other options for the Navajo Mine coal include coal liquefaction, which is used as an environmental cleanup for abandoned stores of coal that are polluting local ecosystems. Other uses for the Navajo Mine coal include conversion to various forms of alcohol or jet fuel. Such conversion would be more environmentally-friendly than burning coal, due to the removal of pollutants in the processing (Bailey, Coal To Liquids - Question and Answer, 2015) (Bailey, Coal to Liquids - An Explanation, 2015) . The conversion of the coal from the Navajo Mine to other substances would decrease the volume of material shipped out of the region; however, that decrease would be offset in part by shipments of materials and supplies into the coal processing center. **The end result would be that if the mine either ships to a new market coal or processes the coal and ships out the alcohol or other product(s), the line would be profitable.**

The US Office of Surface Mining decision from July 2015 authorizes the Navajo Mine to remain operational and continue to supply coal to the Four Corners Power Plant and fulfill the Navajo Mines coal sale obligations through 2041 (Mining, 2015). It is unclear how much coal the Navajo Mine would export on the proposed rail line, so two scenarios are studied in this report. The 1st scenario (section 3.8) is based on the Navajo Mine exporting all of the 5.8 million tons it mines annually. **Under scenario 1 the rail line would be profitable in 2-8 years depending on which construction options were selected.** The second scenario studied in the economic section (3.8) of this report computes the tons of freight shipments needed from either the Navajo Mine or new shippers not yet identified in this report for the line to be profitable. **This second scenario found that if the cheapest construction options are selected then an additional 10 million tons of freight is required from either the Navajo Mine or a new shipper for the line to be profitable in 10 years given moderate economic growth predictions.**

The firm tasked with conducting an economic feasibility analysis for the Thoreau Railport and Industrial Park is Blue Horse Energy, LLC. One of its affiliates, Charlton Associates, LLC, is engaged in identifying companies with a potential interest in locating at that site. Charlton Associates, LLC is a business development; financial consulting and management services firm based in Albuquerque, NM with an extensive background in private equity and venture capital investing as well as real estate and project development. A representative from the firm noted "In connection with efforts to identify companies that may be interested in locating facilities in the Four Corners Area, generally, and the Navajo Nation, more particularly, we have experienced favorable responses from companies that are related to the energy industry, to be sure, but also manufacturing and distribution. Discussions with these companies have been preliminary in nature." According to Charlton Associates, these preliminary discussions "have related to logistics matters, such as rail and highway access, power and water resources, work force issues, project costs and tax characteristics of various site alternatives. Several of the companies that we would list as "possibilities" are interested in light manufacturing and assembly utilizing new technologies. The rest of them represent fairly traditional distribution and supply chain operations. (Arland, 2015)"

The Navajo Agricultural Products Industry (NAPI) is an Enterprise of the Navajo Nation. NAPI produces several agricultural commodities such as Pinto Beans, Potatoes, Popcorn, Alfalfa, Alfalfa Pellets, Flour, Wheat, Corn and other grain products. NAPI currently markets and ships their products via rail to their customers in Mexico, Costa Rica, Dominican Republic, Japan and other counties. **NAPI currently receives approximately 120 railcars of liquid fertilizer at Thoreau, New Mexico and with rail access estimates it would ship out 40% of its products by rail at a rate of approximately 700 railcars per year.**

The King II mine in southern Colorado shipped an estimated 5,600 railcars per year of coal out of Gallup, NM in 2014. **The presence of a rail line near Farmington would significantly decrease their shipping costs** (Slothower, 2014)**. The current 2015 coal mining rate is 1,000,000 tons per year with approximately 80% shipped by rail or 8,000 railcars annually** (Peterson, 2015).

Additional exports/imports include industries such as lumber, chemical, petroleum, and military manufacturing. All such exports are assumed to be on a similar scale to what was reported in the 1998 FSI study of the region. The possible exception is the oil and gas industry; however, any projected increase in oil shipment out of the region or drilling equipment shipments into the region is contingent on a rise in oil prices. As a result this study has conservatively assumed oil and gas related shipments remain unchanged.

This report concludes that if the Navajo Mine ships all or most of its coal on the line, then even the most expensive double track construction option (rail segments 1, 2, and 3-B) is

viable. If the Navajo Mine does not ship out any coal on the line, then alternative shippers will have to be scrutinized in order to reach a total of 50,700 car loads annually to make the least expensive single track construction option viable (rail segments 1, 2 , and 3-A). This study predicts rail traffic from the Farmington area will increase to 40,600 carloads per year within 10 years under the median economic growth projection in Section 3.8.4, which leaves 10,100 car loads needed from a combination of other mines in the area like the San Juan Mine, the oil and gas industry, or new industry partners to be profitable. **It is recommended that the single track option be chosen for the entire route and that option 3-A be chosen in order to reduce the initial construction costs.** If it were determined that the Navajo Mine did not expect to export coal on the rail line, then the cost of construction could be reduced by almost $40 million if rail segment 2 were eliminated.

1.3.4 Technical Feasibility

The study has found that an alignment along NM 371 is technically feasible. The route was broken into 3 segments: 1 Thoreau to NAPI/Bisti, 2 NAPI/Bisti to the Navajo Mine, and 3NAPI/Bisti to Farmington (Figure 1-1). Segment 3 is further broken down into option A and B terminating the line on the mesa south of Farmington (3-A) or in Farmington (3-B). Detailed cost estimate of each segment and option constructed as double or single track are included in Section 4.31 to 4.34 of this report. The most challenging portion of section 1 of the route is a portion that goes through Satan Pass between the towns of Smith Lake and Crown Point. That section will require moving 5 Million Cubic yards of earth to widen the pass at its southern end and bring its grade to 2%. The other large expense associated with construction of section 1 of the proposed line is bridging and excavation where the line crosses the Chaco River. The single largest construction expense is the northern most stretch of the rail line descending the mesa south of Farmington and crossing the San Juan River. This stretch of the rail line is included in rail segment 3-B and represents a substantial technical and economic challenge.

Currently a project is in the planning and design build stages to construct a Rail Transloader Station at Thoreau, NM. This station will initially serve as a truck to train transition point and industrial complex, and when the Farmington line is constructed the station will then also serve as the southern terminus of the proposed line. **As a result, efforts are currently underway by the Navajo Nation to design and construct the entire infrastructure and utilities needed at**

the southern end of the line. Contracts have been awarded to Blue Horse Energy and Texas-based AUI to securing industry partners for the station and finalizing the design. The planned station at Thoreau is one of the main reasons for the location of the rail line along NM 371 and its connection to Thoreau.

Rail segment 2 of the proposed rail line would connect to the Navajo Railroad which currently services the Navajo Mine and Four Corners Power Plant. **Since the proposed line would be connecting to an existing rail line at the Navajo Mine, utilities are already present, and modifications of the existing infrastructure are likely needed.** The proposed transloader station at the northern end of the line would be located along NM 371 at the southern end of NAPI. This location will require the extension of existing utilities from NAPI south and construction of a new transloader transfer station.

1.3.5 Environmental Feasibility

The study has found no known obstacles from an environmental standpoint to constructing the proposed rail line. There are environmental concerns to be addressed such as minimizing disturbing of habitats, minimizing air pollution during construction, and minimizing noise levels in populated areas. **However all the environmental concerns discovered by this study can be reasonably addressed by modern design and construction techniques.**

2 Political Feasibility

2.1 Previous Railroad Proposals

Previous railroad proposals considered two main routes: 1) Tucson Gas & Electric (TG&E) right of way (ROW), 2) Star Lake to NAPI. Each of the previous proposals and the main reason they were unsuccessful is discussed below.

1) TG&E ROW acquisition began with the Chairman of the Navajo Tribe unilaterally signing without grazing “permittee consent,” leading to the ROW permittees suing the Tucson Gas and Electric Co. and prevailing on legality of what is equivalent to “imminent domain.” The TG&E transmission line exists today without ROW fencing; permittees enjoy open grazing of their livestock. However, ROW fencing, which a railroad requires, will minimize grazing access by permittees. On the Navajo Nation this

"permittee consent" is elevated above all land uses, the Navajo Nation's biggest challenge in development of any kind. This eventually gave strength to "Desert Rock Dooda" in protesting the development of Desert Rock Power Plant. (Dennison vs Tucson Gas and Electric Co., 1974)

2) The Star Lake to NAPI route traverses several types of ownership where ROW was close to being secured by BNSF, but Indian Allotment owners did not want the railroad development through their lands. The White Horse Lake Chapter community voted down a Chapter resolution for support, an effort which eventually died. There are two other coal mine leases that did end up in federal court, Thermal Energy and Arch Minerals. Thermal Energy secured a mining lease from the BLM for the Star Lake coal deposit, but ended up in Federal Court to which the Navajo Nation supported the BLM. The site of Star Lake is southeast of White Horse Lake Chapter. The Arch Minerals proposal was for the coal deposit called the Paragon Ranch, which also ended up in Federal Court, but was settled out of court. (Rodgers, 2015)

2.2 Current Railroad Proposal (Thoreau to Farmington NM 371)

Thoreau to Farmington NM 371 alignment is a straight run from Farmington to Thoreau to connect to the BNSF Transcon at the Thoreau Industrial Park Railhead. This route is within and along the 371 ROW which allows for the use of "categorical exclusion" as environmental and archaeological sites have been disturbed and previous clearances have been completed in order to secure the ROW. There are three options on the southern third of the route listed below and pictured in Figure 2-1:

1) Stay within and along the 371 ROW except at the Bisti Badlands to White Rock avoiding the Denazin and Chaco Wash, which present terrain challenges.
2) From White Rock Chapter continue south along the inside of the Navajo reservation trust lands until north of Crownpoint, then turn east to meet up with NM 371.
3) Continue south by Nahodeshgizh Chapter inside the reservation line to Dalton Pass up along the east wall of the canyon, then cut east through Mariano Lake to Smith Lake to 371.

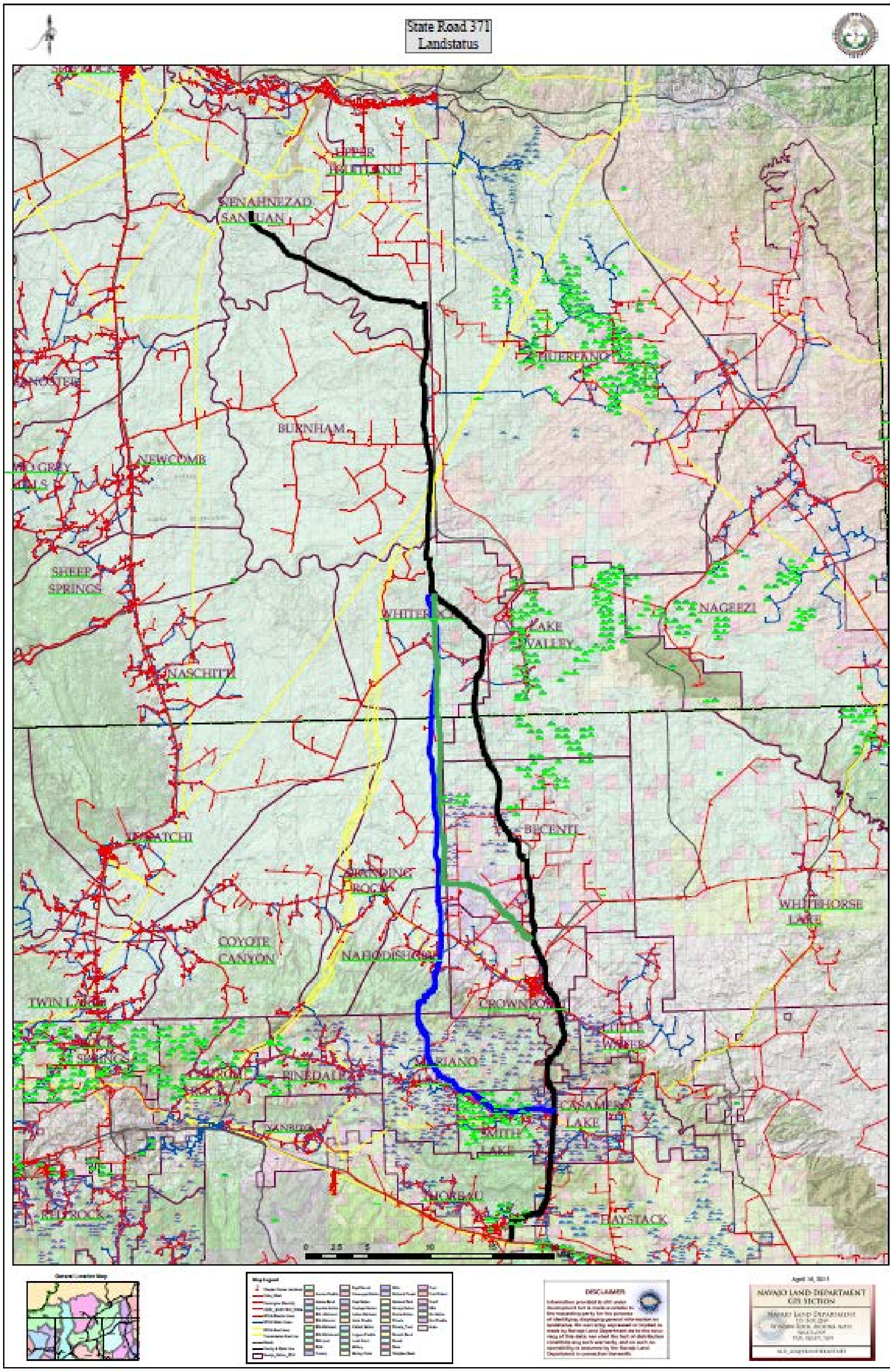


Figure 2-1 Alternate Rail Alignments
(numbered left to right 1-black, 2-green and 3-blue) (Navajo Land Department, 2015)

2.3 Land Owner Evaluation

Generally there are two types of lands in the San Juan Basin region extending south from Farmington, NM to Thoreau, NM: a) Navajo Reservation Trust Lands, and b) "Checkerboard Area." The region is broken down into individual land holder groups in Figure 2-2.

One of the major land owners/users in the region is NAPI. They have provided the following statement in support of the Thoreau-Farmington rail line project. "NAPI is supportive of the rail line and interested in development of the rail to the farm area (Northern Rail Port) as long as it maintains sufficient distance from food grade production facilities (plants including beans, Flour, popcorn, potatoes, storage buildings and granary) to prevent contamination. Any other products such as coal, oil, or other similar products received or shipped at the Northern Rail Port would be considered in the "sufficient distance" consideration." (Benally, 2015)

Land owner data was not readily available for this study. However, the Eastern Agency Realty office expressed their support of the Thoreau – Farmington Railroad, and that when the alignment is determined that they would like a map indicating the selected alignment, they will assist in securing ROW for the project from the Indian Allotment owners, They will also be instrumental on Navajo Nation Trust Lands. With respect to Navajo Nation owned fee simple lands, the Navajo Nation is the authority.

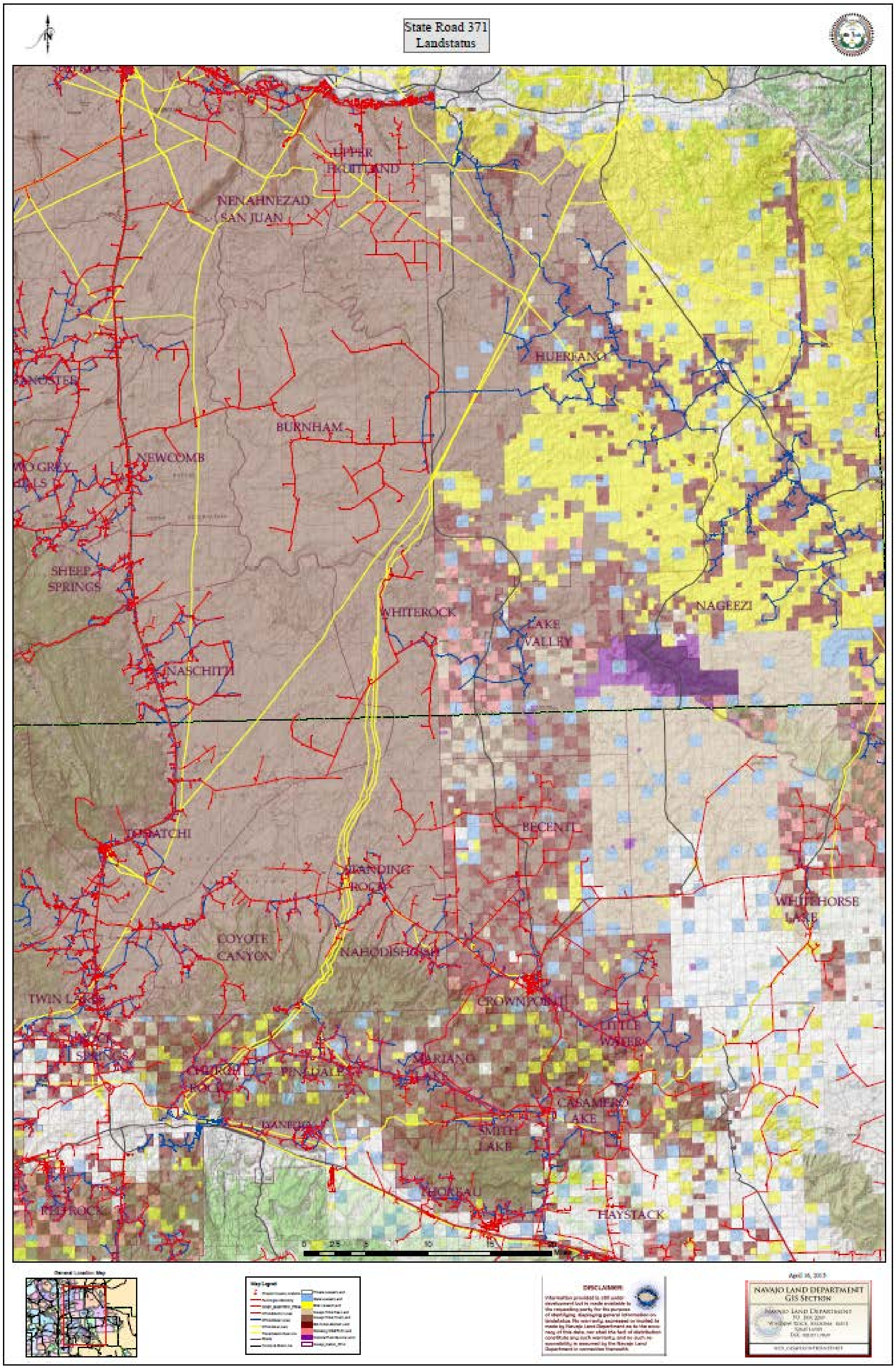


Figure 2-2 Land Owner Status Map (Navajo Land Department, 2015)

2.3.1 Navajo Reservation Trust Land

Navajo Reservation Trust Lands is the reservation proper. It is a land mass that is owned and controlled by the Navajo Nation government for allocation to various uses via leases, ROW and permits, with the BIA exercising trust responsibility. This land mass's eastern boundary begins in the middle of the San Juan River just south of the City of Farmington and runs straight south to just east of Dalton Pass southwest of Crownpoint, NM, then west into Arizona to Flagstaff, AZ. The other boarders of the Navajo Reservation can be seen in Figure 2-3.

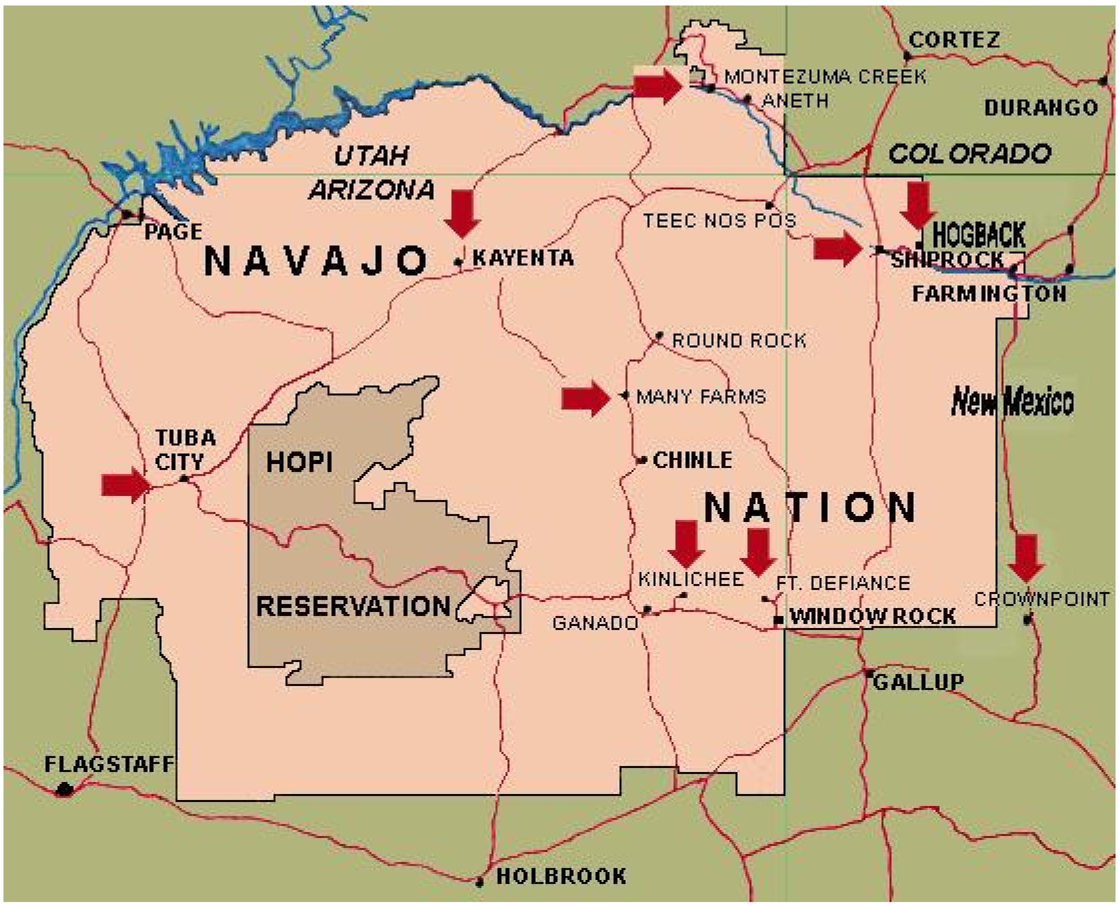


Figure 2-3 Navajo Reservation (Destination 360, 2015)

2.3.2 The Checkerboard Area

"The Checkerboard Area" is situated east of the Navajo Reservation Trust Lands to the west and south of the Jicarilla Indian Reservation, near Cuba, NM; south to the west end of Jemez and Zia Indian Reservations; then generally west to Baca/Prewitt, NM; west to Fort Wingate, NM; south to Ramah, NM; then west to Zuni Indian Reservation; then north to the southern Navajo

Reservation Trust Lands boundary. This area is the multi colored checkerboard region making up the right half of Figure 2-2.

The "checkerboard" area encompasses eight classes of land designed by the federal government to constrain Indians from accessing their lands to undertake economic activity. The "checkerboard" area is a true checkerboard as Indian Allotment lands are laid out with other classes of land isolating the lands' accessibility. The eight classes of lands within the checkerboard area are: 1) Bureau of Land Management (BLM), 2) Indian Allotment, 3) Navajo Tribal Fee Land, 4) Navajo Trust Lands, 5) National Forest Lands, 6) PLO 2198, 7) Private, and 8) State land. Figure 2-2 gives an overview of the land status along NM 371. There is too much detail to include all of it in this report, but this map and similar maps were used to help locate the proposed rail alignment. For example, due to the large number of individual allottees that would need to approve a rail line right of way through each allotment, when possible allottee land is avoided.

2.3.2.1 Bureau of Land Management

Bureau of Land Management (BLM) lands are public lands owned by the U.S. Government and managed by the Bureau of Land Management, Department of Interior who issues leases, ROW, and permits for use of the resources.

2.3.2.2 Indian Allotment

Indian Allotment lands are "merchantable" Indian lands conveyed to individual Indians and held in 'trust' by the Bureau of Indian Affairs (BIA). The BIA having trust responsibility exercises certain authorities on behalf of the Indian allottees. Most have surface and subsurface rights, while some only have surface rights.

2.3.2.3 Navajo Tribal Fee Land

Navajo Tribal Fee Lands are private lands that the Navajo Nation purchased which are subject to State Land Laws and County Zoning Ordinances. The Navajo Nation as owner issues leases, ROW and permits for use.

2.3.2.4 Navajo Tribal Trust Land

Navajo Tribal Trust Lands are lands that Navajo Nation acquired and converted into "Trust Land" similar to the Navajo Indian Reservation Trust Lands with the Navajo Nation Government issuing leases, ROW & permits for uses and the BIA exercising its trust responsibility.

2.3.2.5 National Forest Lands

National Forest Lands are also public lands similar to BLM managed by the U.S. Forest Services in the issuance of leases, ROW, & permits for use.

2.3.2.6 P.L.O. 2198

P.L.O. 2198 are lands that are reserved, withdrawn for use by Navajo Indians with restrictions, and are managed by the BLM.

2.3.2.7 State Land

State Lands are lands owned by the State of New Mexico, and are managed by the State Land Laws in its disposition for use.

2.4 Cultural and Historic Sites

There are numerous known sites along the proposed route. A survey of the map of known sites at the Navajo Historic Preservation Department concluded that for the majority of the route known historic sites can be avoided by the rail line. The one exception is at the base of Satan Pass where there are sites on both sides of NM 371, making completely avoiding known sites not likely possible. Additionally, because most of the route has never been surveyed, it is not possible to state with certainty that there are no significant sites along the route. Due to the nature of the project, a survey of the entire length of the rail line would be required before any construction could begin. It is recommended that such a survey examine a 400ft wide corridor along the proposed rail line so that if sites are found that must be avoided the line could be relocated within the 400ft wide survey. Should sites be found along the route, it is possible to mitigate the impact of the rail line's construction on such sites. The Navajo Nation has extensive experience in such mitigation especially in areas such as the Navajo Mine and NAPI farm land. As a result, as long as the rail line maintains a distance from Chaco Canyon National Historic Park, as is proposed historic sites are not likely to pose an insurmountable obstacle to the proposed rail line.

3 Economic Impact Statement

The northwest region of New Mexico is an economic engine in developing energy markets. The land this study encompasses includes farmland, small towns, a Federal Preserve, Native American Allotted Land, Tribal Held Trust Lands, State of NM Lands, BOR / BLM and the Chaco Canyon National Monument borderlands.

3.1 Regional Economic Background

The average unemployment rate is 45% and it spans across the Navajo Nation. This project has the ability to change that for the Eastern Agency and the Navajo Nation.

Unemployment on the Navajo Nation is estimated as high as 64% with closing down the coal mine. The mine's purchase agreement includes a mandate to invest 10% of its net profits in renewable technologies such as solar and wind. Therefore, renewable energy is developing in the region gradually with coal mine profit, and sustainable development of the region can be expected. Besides the coal mine profit, there are other currently operating businesses and potential businesses such as power plant electrical production, farming – NAPI, ranching/grazing, energy production / oil shale deposits, military hardware, the Navajo Nation, and tourism. The following section of this report will provide a description and background of each sector of the region's economy. The economic impact statement will then be divided into subsequent sections to explain what effect the Farmington-Thoreau Rail line will have on each sector.

3.1.1 Economic Drivers – Coal Mining

This area of the United States is situated on one of the largest coal deposits in North America. The region has over 300 years of coal buried underground. The Navajo Nation currently owns the NTEC Mine that supplies the Four Corners Generating Station to produce electricity to the southwestern United States. There are several other leases in the region to produce coal, but they have yet to be activated by the Nation.

3.1.2 Power Plant Electrical Production

The current speakers report of the 23rd Navajo Nation Council Spring Council Session (Navajo Nation Council, 2015) held on Apr. 20, 2015 concluded the Environmental Impact Statement for the Navajo Mine and Four Corners Power Plant (FCPP), with a Record of Decision released by the US Office of Surface Mining July 2015, which will allow the nation to expand the mine operations enough to continue to supply coal to FCPP through the next 15 years. However, at the end of 2013, Arizona Public Service Co. (APS) permanently closed units 1, 2 and 3 at the Four Corners Power Plant. Closing the three older units has reduced the coal needed from the mine by about 30 percent, which could mean reductions in the staff of 430. Therefore, the Navajo Nation would benefit by creating the opportunity to rail out the coal for future markets worldwide with the high international demand. This opportunity can be realized when the rail line is completed.

3.1.3 Farming – Navajo Agricultural Production Industry (NAPI)

The Navajo Nation owns the second largest farm in the United States consisting of 76,000+ acres currently under cultivation with 30,000+ acres to develop, for a total of 110,630 acres under cultivation when completed, and NAPI farms located seven miles south of Farmington. This farm would benefit from the ability to ship out its products and import products related to their farm activities by rail. Rail access would also facilitate the planned expansion of NAPI farms, and make such expansion more viable due to decreased shipping costs and access to wider markets.

3.1.4 Energy Production / Oil Shale Deposits

Just recently the Mancos Shale Field has spurred oil drilling and subsequent production from these regional wells located in northwest New Mexico. One report by the Bureau of Indian Affairs (BIA) found a new oil exploration play to develop in Sandoval and San Juan Counties, New Mexico. A Calgary-based company (with offices in Denver, CO), Encana Oil and Gas (Encana) has recently horizontally drilled and produced oil from the Cretaceous age Gallup sandstone. These wells offset unleased Navajo allotted lands, and it is anticipated that Encana and other oil and gas companies will be very interested in leasing Navajo allotment tracts as soon as possible. WPX is the other major oil company that has drilled the Mancos Shale oil and is producing crude oil within Nageezi, Counselor and Ojo Encino Chapters. The Navajo Nation's Economic Development Division has noticed increased interest in drilling activities on Native American Allotted Lands and as well as on the Navajo Nation for more Mancos Shale oil explorations. The *Navajo Times* reported in March last year that the Navajo allottees have leased 159,000 acres (Bitsoi, 2015). The Bureau of Indian Affairs-Federal Indian Minerals Office and San Juan College will quicken the process for energy companies to negotiate leases on about

90,000-plus acres of allotments. The agreement could generate more than 1,000 jobs and provide revenue to over 60,000 allottees.

The San Juan Basin is the key in the production of oil from shale deposits and other fuel sources in the region.

3.1.5 Military Hardware

Raytheon Missile Systems Incorporated has one of its facilities located on the Navajo Nation just south of the City of Farmington. The Navajo Facility produces surface to air missiles and other tactical weaponry. In 2013 they obtained a contract to build more missiles. Raytheon's Diné Facility employs 330, and the bulk of the workforce is Navajo. The Diné Facility has earned a stellar reputation for high quality work and tremendous leadership for the 10 missile programs at the site. Raytheon's revenue was 23.7 million in 2013. As a major American defense contractor and industrial corporation with core manufacturing concentrations in weapons and military electronics, it has the potential for positively impacting the Navajo Nation's economy even though there is no data of revenue for Raytheon's Diné Facility.

3.1.6 The Navajo Nation

The Navajo Nation is one of the largest tribal governments of the North American Indian tribes covering 27,425 square miles (71,000 km^2), occupying portions of northeastern Arizona, southeastern Utah and northwestern New Mexico. Its institutions include a judicial system, a legislative house, an executive office, a large law enforcement and social services division and other local educational trusts. The majority of the lands reviewed in this study are Navajo Trust lands and/or Navajo Allotted lands. This region is the Eastern Agency of the Navajo Nation. The Navajo Nation is looking at this study as Phase two of the inland port strategy, the rail buildout to occur in the Eastern Agency. Phase one of the buildout is the Thoreau Transloader Rail Port which is now in preliminary design services with a design build rail contractor with Texas-based contractor AUI and should be opened in June 2017. An illustration of the proposed Thoreau Rail Port is discussed in section 4.1 the need for the rail port is discussed in section 3.6, and a market study for the Rail Port is being conducted by Blue Horse Energy. The rail line study team has met and coordinated with Blue Horse Energy subcontractor Charlton Associates, LLC to obtain information relevant to both studies.

The Navajo Nation foresees the ability to rail out coal and other resources in the region such as food, oil, and gas. The Navajo Nation will move into the transportation markets for shipping produce and commodities across the US and abroad. These activities will likely spawn growth centers and bring needed revenue to the Navajo Nation in gross receipts taxes, lease revenue, and new jobs. The potential revenue in gross receipts taxes, lease and jobs depend on the number of businesses and their sizes; therefore, the projection is not summarized here.

Phase three of the buildout is to build the transloader facility near the City of Farmington to connect to the existing rail that serves the mine and power plant. This will enable the Navajo Nation to keep its mine open and provide revenue back the Nation in coal payments and job retention.

3.1.7 Tourism

This region is in the heart of the Grand Circle, known in the tourism world as an area where one could see a great number of ancient cliff dwellings and cultural attractions. The region boasts the Chaco Canyon National Monument, Mesa Verde National Monument, Navajo National Monument, Monument Valley Tribal Park, Canyon De Chelly National Monument, Glen Canyon National Recreational Area, and Grand Canyon National Park.

The Navajo Nation has been working on great potential for growth in tourism and welcomed resort developers and the hospitality industry. The Navajo Nation can earn approximately 1.36 billion in annual tourism.

3.2 Available Reserves, Current Rate of Mining, and Current Market Prices

The Navajo mine has roughly 300 years of reserves based on the current rate of mining, with an average rate of mining of 7,799,605 short tons of coal between 2009 and 2013. Currently, Wyoming is the domestic competitor with the closest match for price and quality of coal. Market average price for coal from Wyoming was $12.93 per short ton on average over 2009-2013, and the price to ship Wyoming coal to the electric power sector was $32.10 per short ton. Over the same period, Navajo coal had a market average price of $29 per short ton, and price in New Mexico to ship to the electric power sector is $37.17 per short ton (United States Energy Information Administration, 2014). This data provides a rough idea of revenue and cost.

$$\text{Market revenue for Navajo coal } \left(7{,}799{,}605\ \frac{\text{short tons}}{\text{year}}\right) * \frac{\$29}{\text{short ton}} = \frac{\$226{,}188{,}545}{\text{year}}$$

$$\text{Cost to ship Navajo coal to power } \left(7{,}799{,}605\ \frac{\text{short tons}}{\text{year}}\right) * \frac{\$37.17}{\text{short ton}} = \frac{\$289{,}911{,}317.9}{\text{year}}$$

Export prices from the U.S. to other nations varies depending on two factors: type of coal and port of export. The Navajo mine produces both bituminous and sub-bituminous coal, which can be used for coking coal and steam coal exports. The average price across the U.S. between 2013-2009 for exported coal was $73 per short ton for steam coal and $184.62 per short ton for coking coal (United States Energy Information Administration, 2014). However, those prices can change by up to ±$30 per short ton depending on which port it is shipped from. BNSF, the connecting railroad, ships to Los Angeles and Houston ports (BNSF Railway, 2013), and it can ship to Phoenix, Arizona where they can use a connecting line to take the shipments to Guaymas, Mexico. Houston had an average export price between 2013-2009 of $73.63 per short ton for steam coal and $162.45 per short ton for coke coal. Over the same period, Los Angeles had an average export price of $78.82 per short ton for steam coal and $614.50 for coking coal; however, the price for coking coal fluctuated greatly for Los Angeles, ranging between $158 and $1,736. Finally, Mexico had an average export price of $85.26 per short ton for steam coal and $178.61 per short ton for coking coal (United States Energy Information Administration, 2014).

Table 3-1 summarizes the potential revenue and shipping costs for exports through three ports if all coal quantity could be exported as steam coal or coking coal.

Table 3-1 Potential Revenue and Cost for 3 Ports in Two Types of Coal

	Price steam	Price coke	Revenue steam	Revenue coke	Shipping cost
L.A.	$78.82/ ton	$614.5/ ton	$614,76m	$4,792,86m	7.01Q=54.68m
Houston	$73.63/ton	$162.45/ ton	$574,28m	$1,267,05m	9.9Q=77.22m
Guaymas	$85.26/ ton	$178.61/ ton	$664,99m	$1,393,09m	8.2Q=63.96m

Note: m stands for million

From the proposed connection site in Gallup, it is roughly 701 miles to the Los Angeles port, roughly 990 miles to the Houston port, and roughly 820 miles to the Guaymas port if routed through Phoenix (BNSF Engineering Systems GIS, 2014). However, even though Guaymas is closer than the Houston port, there might be extra costs such as across-the-border fee, which is 5% of the price of shipping items.

At the costs presented in Table 3-1, the coal mine can attain a high profit no matter which port is selected to export.

3.3 Agricultural Demand for the Rail Line

The Navajo Nation produces several different agricultural commodities such as pinto beans, potatoes, corn and grain (Navajo Agricultural Products Industry, 2015). The easiest way to export these goods is by rail line. Each of the products that would be shipped fall into one of two categories for shipping: either fresh and frozen, or grains and seed. The shipping rates for these products are not publicly available (only available for customers with a login on the BNSF website). The BNSF ships from Albuquerque, New Mexico so the products would have to be transported to Albuquerque and then shipped out from there.

A 2004-2011 study on rail tariff rates for food products with a focus on shipment size and the distance shipped included a section on the rates for grains and oilseeds as well as “food products; including potatoes, which the Navajo nation would be looking to ship (United States Department of Agriculture, 2014). This study showed that rates dropped as shipment size increased, as well as distance increased. Since the amount of goods being shipped is unknown, the distance shipped was looked at for estimates. In Figure 3-1 and Figure 3-2 the revenue per ton-mile by shipment distance for food products and grains is shown.

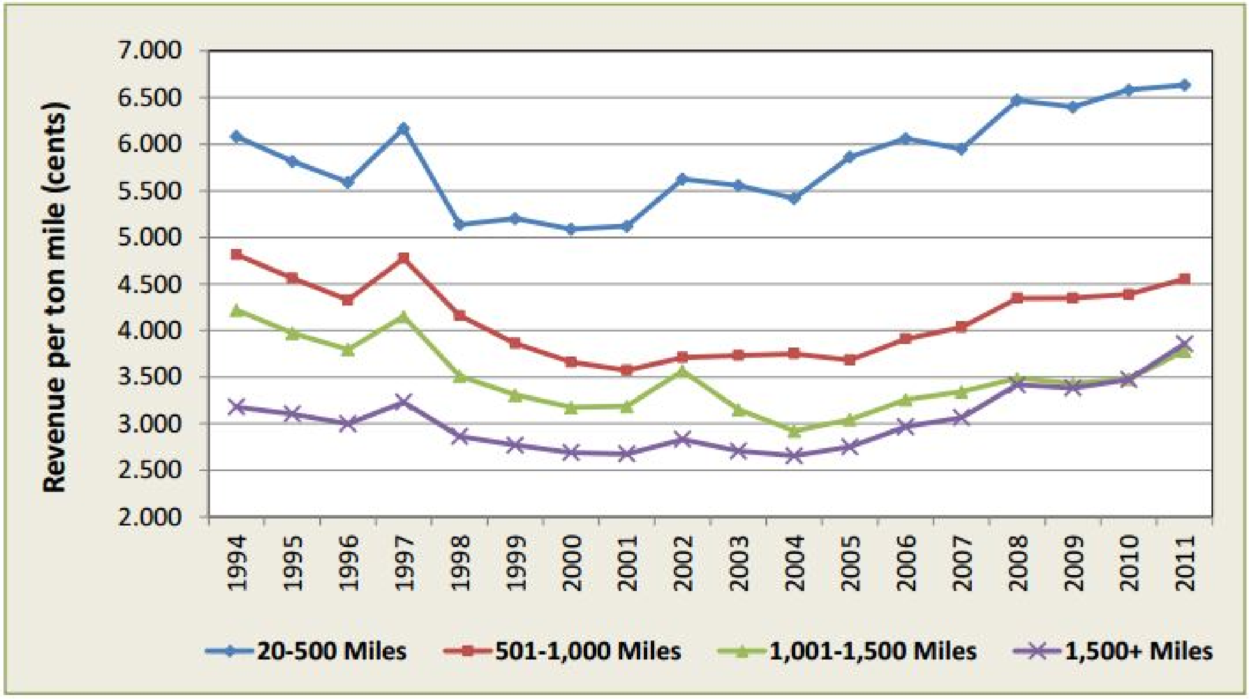


Figure 3-1 Food products inflation-adjusted tariff revenue per ton-mile by shipment distance

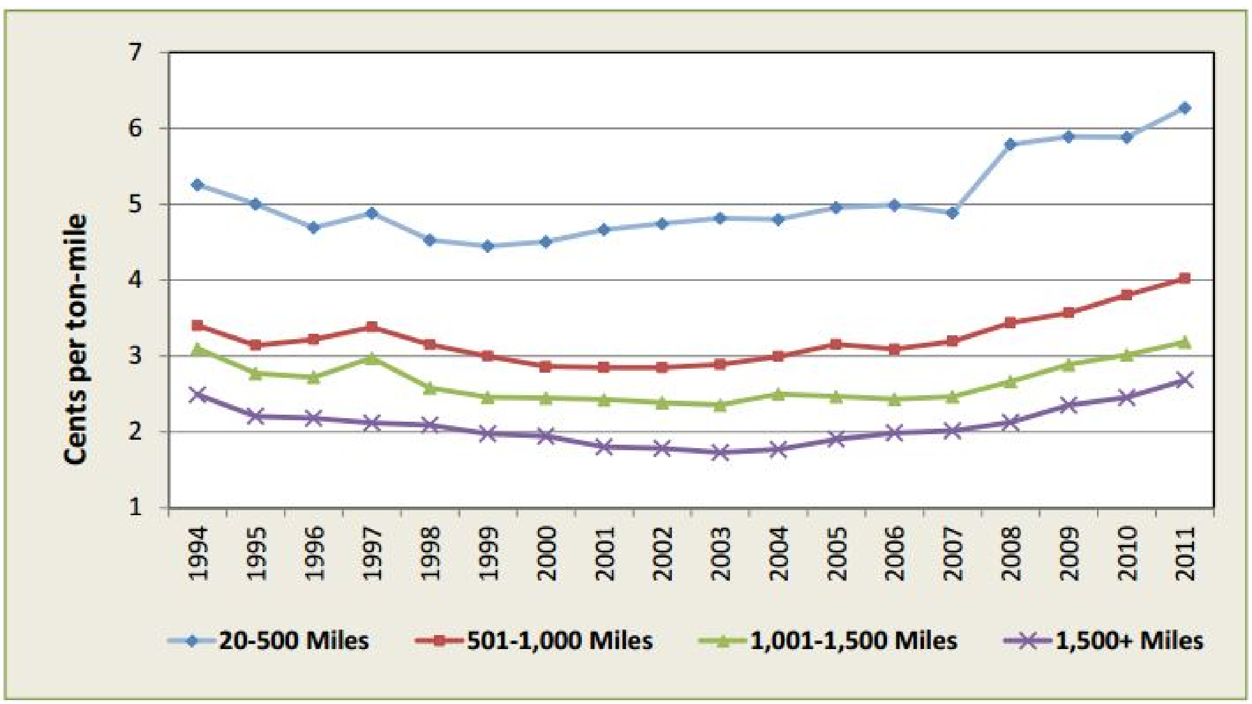


Figure 3-2 Grains and Oil Seeds inflation-adjusted tariff revenue per ton-mile by shipment distance

For an estimate cost, Houston was considered as a potential port to export to by rail. It is 880 miles from Albuquerque and therefore would fall into the 501-1000 mile tariff region. The estimated tariff for grains at this distance is 4.5 cents per ton-mile and 4 cents per ton mile for food products. Estimating two tons for grain and oilseed products and one ton for food products this comes out to a total cost of $11,000.

Many factors go into the purchasing price of agricultural products. These include the consumer base, as well as size of purchase. Bulk products usually sell for far less then smaller portions. In order to give an accurate estimate it would be necessary to know how the Navajo nation is going to sell their agriculture products as well as a rough estimate of the prices at which they are currently sold. This information is not publicly available.

3.4 Navajo Agricultural Products Industry (NAPI)

The Navajo Agricultural Products Industry (NAPI) is an Enterprise of the Navajo Nation. NAPI produces several agricultural commodities such as pinto beans, potatoes, popcorn, alfalfa, alfalfa pellets, flour, wheat, corn and other grain products. NAPI currently markets and ships their products via rail to their customers in Mexico, Costa Rica, Dominican Republic, Japan and other countries. Products include pinto beans, popcorn, alfalfa and popcorn. Other products for future sales include flour, wheat and corn. Should the rail line be closer to the farm, NAPI would be able to expand their customer base by shipping products to the east and west coast including international markets.

NAPI currently receives approximately 120 railcars annually of liquid fertilizer at Thoreau, New Mexico but in smaller lots (5-8 railcars); however, should the Thoreau Industrial Park be developed, a 100,000 gallon (35 rail car capacity) storage tank would be built allowing to order more rail cars at a time to reduce rail freight cost.

NAPI is currently farming approximately 76,000 acres under sprinkler irrigation with plans to complete the growth of the farm’s acreage to 110,630 acres in the future. As the farm size increases, rail shipments received or shipped would increase. **It is estimated should NAPI ship 40 percent of their products by rail they would use approximately 700 railcars per year of agricultural goods and products.** This estimate takes in consideration that the flourmill will be operating at full capacity; wheat may have to be shipped to the farm depending on the quality needed. Other future plans are to build a 45,000 head cattle feed yard on the farm, where grain would have to be shipped to the farm. Information pertaining to NAPI can be found on their website (navajopride.com).

3.5 Demand for Rail Line Based on Oil Products

The project is also based on the assumption that the cost of oil will return to higher values of $80 a barrel (Damon, 2015). The $80 per barrel limit is for new well exploration to be considered profitable and can also be found in Energen Corporation's 2014 third quarter report (Energen Corporation, 2014). Figure 3-3 depicts oil trends, and oil prices could increase to 85 at the end of 2015 from one Bloomberg report. With that assumption, there are several companies looking to begin large scale drilling in the Mancos Shale Oil Field. This oil field would be a major shipper on the new line, exporting crude oil and importing supplies for the oil field. According to the BIA report on oil and gas, the cumulated gas could be 40.8 billion mcf and the cumulated oil could be 335.8 million barrels.

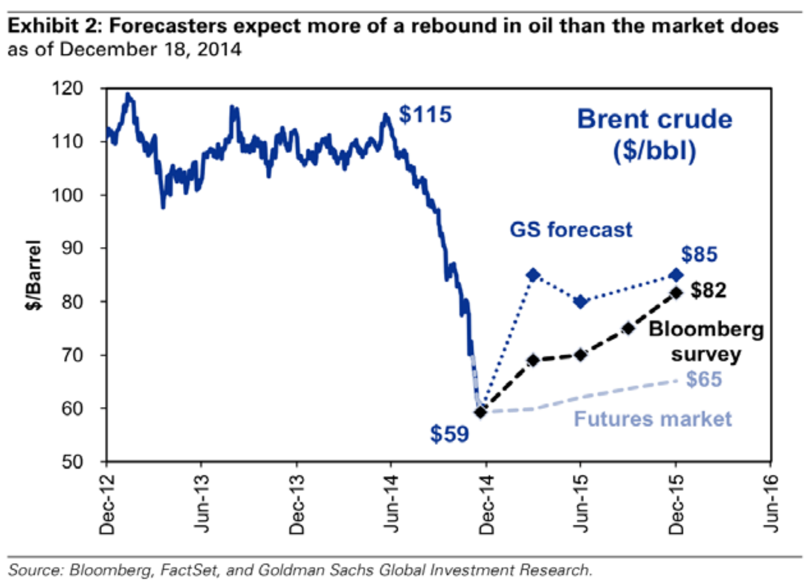


Figure 3-3 Oil price prediction

3.6 Other Demands for the Rail Line

Phase one discussed the rail line's construction of the transloader station at the Thoreau end of the line already under design by AUI (TX) as a design build project. The transloader station would replace the existing spur just west of Thoreau where 10 oil tanker cars are filled and then backed onto the transcontinental rail line by an engine based out of Gallup. Each time this happens the transcontinental rail line has to be shut down because the spur is only long enough for the cars, not for the engine. In addition, the rail line is currently not long enough for the engine to get up to speed before entering the main line. It is important to note that this transloader station is contingent upon finding clean water sources in the nearby area.

An additional demand is from Raytheon, located just across NM 371 from the NAPI farms, who could benefit from a transloader station that could transport their manufactured Tomahawk missiles. Additionally, there is also a long range plan for an international airport to service the region to be built at an unspecified date (Damon, 2015), which will be located just north and west of the NAPI farms. Finally, from the Transloader station at the NAPI farms, there would be an extension of the current rail line at the mine to bring the coal to the transfer station, either as part of this project or a later phase. Additionally, the 800,000 tons of coal currently driven annually to Gallup from the King II mine in Colorado would be re-routed to the Farmington Transloader station (Peterson, 2015), and there is a possibility of shipping coal from the San Juan mine.

3.7 Breakdown of Costs of Rail Line and Infrastructure

Construction unit costs for this project were taken primarily from the 1998 FSI rail study (Freight Services Incorporated, 1998), and are presented in Table 3-2. Unit costs for items 1 through 9 in Table 3-2 are adjusted for inflation between 1998 and 2015 from the FSI report. The siding cost item number 10 is based on the additional track work, excavation, clearing and signaling required for one mile siding. The terminal cost of 5.053 million dollars each is based the cost required for signaling, excavation, and construction of a rail loop. Individual sidings within the terminal would be financed by the industry partners that would utilize them, so are outside the estimate for the terminals basic infrastructure. The last two line items in the table are the bridge over the Chaco River and the bridge over the San Juan River. The Chaco River Bridge would be approximately a mile long and at its highest point 100ft over the river bed. The San Juan River Bridge would be 2 miles long and 200 ft over the valley floor. Section 4.3.4 goes into more detail on the San Juan River bridge cost breakdown but the total cost of the bridge adding in additional excavation, track work; etc is estimated at $160 Million. Detailed construction cost break downs of each segment of the rail line 1, 2, 3-A, and 3-B can be found in sections 4.3.1, 4.3.2, 4.3.3, and 4.3.4 respectively. The detailed costs breakdowns include quantities for each of the line items listed below that pertain to that section of the route.

Table 3-2 Construction Unit Costs

	Construction Cost Breakdown		
#	Item	Units	Unit Price
1	Clearing and Grubbing	AC	$ 1,850.00
2	Excavation and Embankment	CY	$ 4.44
3	Sub-ballast (30 ft)	TN	$ 17.76
4	Bridges	EA	$ 666,000.00
5	Culverts	EA	$ 6,926.40
6	R/W Fencing	MI	$ 23,443.20
7	Track Work	FT	$ 140.60
8	Main Road Crossing	EA	$ 10,656.00
9	Secondary Road Crossings	EA	$ 10,656.00
10	Siding	EA	$ 1,379,004.80
11	Terminal	EA	$ 5,053,000.00
12	Chaco River Bridge	EA	$ 20,000,000.00
13	Bridge over San Juan River	MI	$40,000,000.00

3.8 Economic Analysis on Railroad Project

3.8.1 Business Forecast

Comparing to a previous study in 1998, there are some changes which are listed below:

a. There is a need for a new market for coal currently produced. Approximately 5.8 million tons will be shipped annually at 100 tons per car. This correlates to 58,000 train cars per year.
b. There are 8,000 carloads of coal from the King II mine currently trucked to Gallup annually. Therefore, the total number of coal carloads is 66,000.
c. Options also exist for mine mouth operations to convert the coal to various forms of alcohol. This would result in few car shipments out of the region but more shipments of supplies into the region. The product being shipped out would also be of a higher quality,

so it would yield a higher price, as well as be more environmentally-sound due to reduced pollutants (Bailey, Coal to Liquids - An Explanation, 2015).

d. Farmington area is included in our report. The traffic volume we have is from a 2013 study done by Four Corners Economic Development and the accumulated inflation rate from 2013 to 2015 is 2.4%. Therefore, the volume for Farmington in Table 1 is adjusted traffic volume in 2015.

Chance c above does not have any rail traffic data associated with it so is not incorporated in Table 3-3; however, Table 3-3 does incorporate changes a, b, d and summarizes the commodity groups that are potentially move on a transfer basis, making prospective businesses extremely susceptible to benefiting from the railroad extension. The high, mid and low forecasts start with the same base. The difference among them is the time frame in which the traffic volume is realized.

Table 3-3 Railroad Traffic Forecast

low	year 3		year 6		year 9		year 12		year 15	
mid	year 2		year 4		year 6		year 8		year 10	
high	year 2		year 3		year 4		year 5		year 6	
	IB	OB	IB	OB	IB	OB	IB	OB	IB	OB
Coal		66000		66000		66000		66000		66000
Non-Metallic Mining Products	1675	1200	2500	1300	3700	1500	3850	1700	4000	2000
Agricultural Products		200		250		350		400		550
Manufactured Food Products	165		210	10	280	25	360	250	530	1050
Chemical and Fertilizers	335		345		360		360		360	
Petroleum Products	1290	500	1400	600	1870	750	2150	800	2720	900
Machinery	55		55		55		55		55	
Lumber and Wood Products	150	1200	200	1200	200	1200	250	1200	300	1200
Farmington area										
Oil/gas products and equipment	765	160	830	192	1109	240	1275	256	1613	288
Recycling (metals and paper)	53	426	56	447	59	470	62	493	65	518
Shipping containers	106	106	121	121	141	141	166	166	196	226
Power plant		2560		2810		3110		3460		3860
Oil/gas/asphalt	799	1012	867	1214	1158	1518	1331	1619	1684	1821
Coal-SW Colorado		7987		8044		8101		8158		8216
Retail automotive	374	0	394		419		449		484	
Total carloads by direction	5767	81351	6978	82188	9351	83405	10308	84502	12007	86629
Grand Total all Carloads	87118		89166		92756		94810		98636	

Note: a. IB stands for inbound. b. OB stands for outbound.

To capitalize on the forecast business volumes will require considerable work with shippers and receivers even prior to the beginning of new rail operations. **It is anticipated that prior to revenue operations, three to five years will be required for construction and other development.**

3.8.2 Economic Analysis

This report cites many data from the 1998 study. Therefore, after 17 years, inflation should be considered. According to US inflations from 1999-2015, the accumulated inflation rate is 46%, so all cost will be adjusted by 1.46.

3.8.2.1 Cost

Table 3-4 presents both the projected construction and operating cost of the rail line. The operating costs include: track and equipment maintenance, the transportation cost of the freight, the overhead.

Table 3-4 Construction and Operating Costs

Type of cost	Track Length (Miles)	Cost-double track	Cost-single track
Construction cost			
Segment 1: Thoreau To NAPI/Bisti Oil Fields	97.9	$ 261,603,267.61	$ 184,823,442.81
Segment 2: NAPI/Bisti Oil Fields to Navajo Mine	19.4	$ 53,534,045.60	$ 39,541,544.80
Segment 3-A: NAPI/Bisti Oil Fields to Mesa South of Farmington	15.2	$ 40,816,344.56	$ 28,213,256.56
Segment 3-B: NAPI/Bisti Oil Fields to Farmington	21.3	$ 234,745,018.88	$ 217,679,707.20
Total Cost to Construct 1, 2 and 3-A	132.5	$ 355,953,657.77	$ 252,578,244.17
Total Cost to Construct 1, 2 and 3-B	138.6	$ 549,882,332.09	$ 442,044,694.81
Operating expenses	Cost		
Transportation	$\$3,500,000 \times 1.46 = \$5110,000$ /year		
Maintenance	$\$1,500,000 \times 1.46 = \$2190,000$ /year		
Administration	$\$750,000 \times 1.46 = \$1095,000$ /year		
Total operating	$8,395,000/year		

Assumptions:

a. Maintenance of way. Most of the maintenance in the first 5 to 15 years will be related to inspections and fine-tuning weak areas in sections where there are unique topographical issues that negatively impact railroad maintenance. The track will be maintained at the Federal railroad Administration's Class III safety standard which allows trains to travel at a top speed of 40 miles/hour.

b. Revenue. Suppose all carloads move exactly the same distance between the BNSF to Farmington. To simplify the problem, several averages are considered. The revenue for inbound business is assumed to be $\$400 \times 1.46 = \$584 / car$ and the revenue for outbound shipments is set at $\$300 \times 1.46 = \$438 / car$. In order to ease the problem, for low scenario, we suppose IB volume increase 300/year and OB increases 4500/year, which brings 0.377 million increments. For mid scenario, we suppose the missing cash flow is the average of near two years. For high scenario, we suppose IB increases 1500/year and OB increases 2500/year after year 6, which brings 2 million increments each year.

c. Land usage fee. $7/acre for BLM land up to hundreds of thousands of dollars for certain Navajo lands. The right-of-way alignment chosen generally minimizes the exposure to nonpublic lands. However, further due diligence would be necessary to specifically pinpoint exact costs for any particular alignment. It is estimated that the annual lease rates from pueblo Pintado to Farmington would be $\$300,000 \times 1.46 = \$438,000 / year$. (Other land fees may be added). The length of the line in the 1998 study was roughly half of the current route, so the report will utilize a land use fee of $888,000 annually. Since the proposed line is primarily on Navajo nation land, an estimate could also be based on the average 1998 permittee fee of $400 per acre. Once adjusted for inflation a 120 mile long 100 ft wide right of way would cost approximately $850,000 annually. Right of way leases for pipe lines can be substantially higher, but it is assumed that the Navajo Nation could negotiate more typical rates. The study includes a conservatively estimated total annual land use fee at $1,000,000 per year.

3.8.2.2 Revenue

According to the business forecast in the previous section and assumption for revenue, Table 3-5 summarizes the revenues and cost together per year.

Table 3-5 Railroad Revenue Analysis

low	year 3		year 6		year 9		year 12		year 15	
mid	year 2		year 4		year 6		year 8		year 10	
high	year 2		year 3		year 4		year 5		year 6	
	IB	OB	IB	OB	IB	OB	IB	OB	IB	OB
Total carloads by direction	5767	81351	6978	82188	9351	83405	10308	84502	12007	86629
Revenue/car	$584	$438	$584	$438	$584	$438	$584	$438	$584	$438
Total Revenue/year	3.37m	35.63m	4.08m	36.00m	5.46m	36.53m	6.02m	37.01m	7.01m	37.94m
Grand Total Revenue/year	**39m**		**40.07m**		**41.99m**		**43.03m**		**44.96m**	
Operating Cost/year	**8.395m**		**8.395m**		**8.395m**		**8.395m**		**8.395m**	
Land fee/year	**.438m**		**.438m**		**.438m**		**.438m**		**.438m**	
Cash flow/year	**30.17m**		**31.24m**		**33.16m**		**34.20m**		**36.12m**	

Note: m stands for million.

3.8.2.3 Operating Cash Flow

Table 3-5 estimates the cash flow in three scenarios within 15 years. Therefore, this report uses a 15-year period. In each scenario of traffic volume, rail is under construction the first year; therefore only land fees should be considered year 1. From year 2 onward, the railroad generates the revenue depending on the forecast scenario. Here, suppose that we finance the initial construction cost. According to current finance rates for commercial business, a 30-year fixed rate is 3.9%; therefore we use 3.9% as the mortgage rate. Since the rail construction plan has not been determined at this point, we show the cash flow projection with the highest construction cost (option B: segment 1, 2 and 3-B) in double-track case and single-track case for conservative purposes. Under the double-track plan, the cost that needs to be financed is $549,882,332.09. To finance 549.882 million dollars, the annual payment should be $31,685,844.20 (31.685 million). Table 3-6 and Figure 3-4 show the yearly operating cash flow for the double track construction case, and that after the first year the rail line will be profitable given the assumed traffic levels and costs. Under the single-track plan, if the cheapest options were selected (segments 1, 2, and 3-A) the cost is $252,578,244.17. To finance 252.578 million dollars at 3.9% for 30 years, the annual payment should be $14,295,972 (14.295 million). Table 3-7 and Figure 3-5 show the yearly operating cash flow for the single track construction option and that after the first year the rail line will be profitable given the assumed traffic levels and costs. **This projection indicates that the cash flow/year can cover the financial annual payment.**

Table 3-6 15-Year Operating Cash Flow Projection in Three Scenarios (in Millions)-Double Track

	Low			Mid			High		
Year	Annual operating cash flow	Annual debt	Annual deposit	Annual operating cash flow	Annual debt	Annual deposit	Annual operating cash flow	Annual debt	Annual deposit
1	-0.438	31.685	-32.123	-0.438	31.685	-32.123	-0.438	31.685	-32.123
2	29.24	31.685	-2.445	29.60	31.685	-2.085	29.60	31.685	-2.085
3	29.60	31.685	-2.085	30.14	31.685	-1.545	30.68	31.685	-1.005
4	29.96	31.685	-1.725	30.68	31.685	-1.005	32.6	31.685	0.915
5	30.32	31.685	-1.365	31.64	31.685	-0.045	33.64	31.685	1.955
6	30.68	31.685	-1.005	32.6	31.685	0.915	35.56	31.685	3.875
7	31.32	31.685	-0.365	33.12	31.685	1.435	36.62	31.685	4.935
8	31.96	31.685	0.275	33.64	31.685	1.955	38.54	31.685	6.855
9	32.6	31.685	0.915	34.60	31.685	2.915	39.60	31.685	7.915
10	32.95	31.685	1.265	35.56	31.685	3.875	41.52	31.685	9.835
11	33.29	31.685	1.605	36.09	31.685	4.405	42.58	31.685	10.895
12	33.64	31.685	1.955	37.58	31.685	5.895	44.50	31.685	12.815
13	34.28	31.685	2.595	39.07	31.685	7.385	45.56	31.685	13.875
14	34.92	31.685	3.235	40.56	31.685	8.875	47.48	31.685	15.795
15	35.56	31.685	3.875	42.05	31.685	10.365	48.54	31.685	16.855
Total	449.882	475.275	-25.393	486.492	475.275	11.217	546.582	475.275	71.307
NFV_{15}			-39.320			0.730			67.308

Note: NFV_{15} stands for net future value at the end of 15 years considering 2.31% as the inflation rate, which is the average inflation rate in past 15 years.

Table 3-6 and Figure 3-4 show the annual profit projection in three scenarios for a double track. The increasing trend is observed and the slope increases from low to high scenario. **It takes eight years to get positive profit in the worst case for low scenario, five years to get profit for mid scenario, and three years for high scenario.**

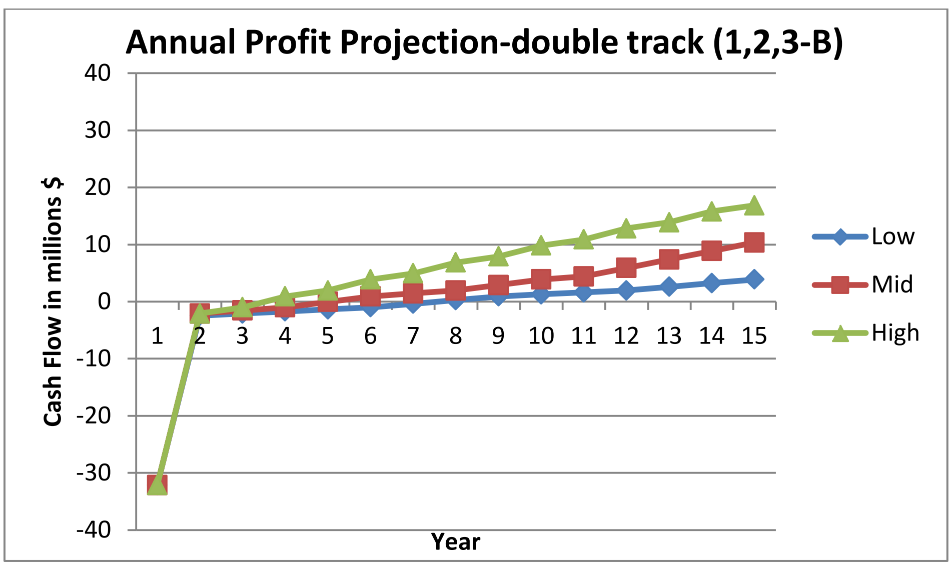


Figure 3-4 Cash Flow Projection in Three Scenarios-Double Track

Table 3-7 15-Year Operating Cash Flow Projection in Three Scenarios (in Millions)-Single Track

	Low			Mid			High		
Year	Annual operating cash flow	Annual debt	Annual deposit	Annual operating cash flow	Annual debt	Annual deposit	Annual operating cash flow	Annual debt	Annual deposit
1	-0.438	14.554	-14.992	-0.438	14.554	-14.992	-0.438	14.554	-14.992
2	29.24	14.554	14.686	29.60	14.554	15.046	29.60	14.554	15.046
3	29.60	14.554	15.046	30.14	14.554	15.586	30.68	14.554	16.126
4	29.96	14.554	15.406	30.68	14.554	16.126	32.6	14.554	18.046
5	30.32	14.554	15.766	31.64	14.554	17.086	33.64	14.554	19.086
6	30.68	14.554	16.126	32.6	14.554	18.046	35.56	14.554	21.006
7	31.32	14.554	16.766	33.12	14.554	18.566	36.62	14.554	22.066
8	31.96	14.554	17.406	33.64	14.554	19.086	38.54	14.554	23.986
9	32.6	14.554	18.046	34.60	14.554	20.046	39.60	14.554	25.046
10	32.95	14.554	18.396	35.56	14.554	21.006	41.52	14.554	26.966
11	33.29	14.554	18.736	36.09	14.554	21.536	42.58	14.554	28.026
12	33.64	14.554	19.086	37.58	14.554	23.026	44.50	14.554	29.946
13	34.28	14.554	19.726	39.07	14.554	24.516	45.56	14.554	31.006
14	34.92	14.554	20.366	40.56	14.554	26.006	47.48	14.554	32.926
15	35.56	14.554	21.006	42.05	14.554	27.496	48.54	14.554	33.986
Total	449.882	218.310	231.572	486.492	218.310	268.182	546.582	218.310	328.772
NFV_{15}			263.659			303.709			370.287

Note: NFV_{15} stands for net future value at the end of 15 years considering 2.31% as the inflation rate, which is the average inflation rate in past 15 years.

Figure 3-5 shows the annual profit projection in three scenarios for cheapest single track. The increasing trend is observed and the slope increases from low to high scenario, and the slope is much higher than the double track plan. **No matter which scenario, the cost will be recovered in year 2 for the single track plan.**

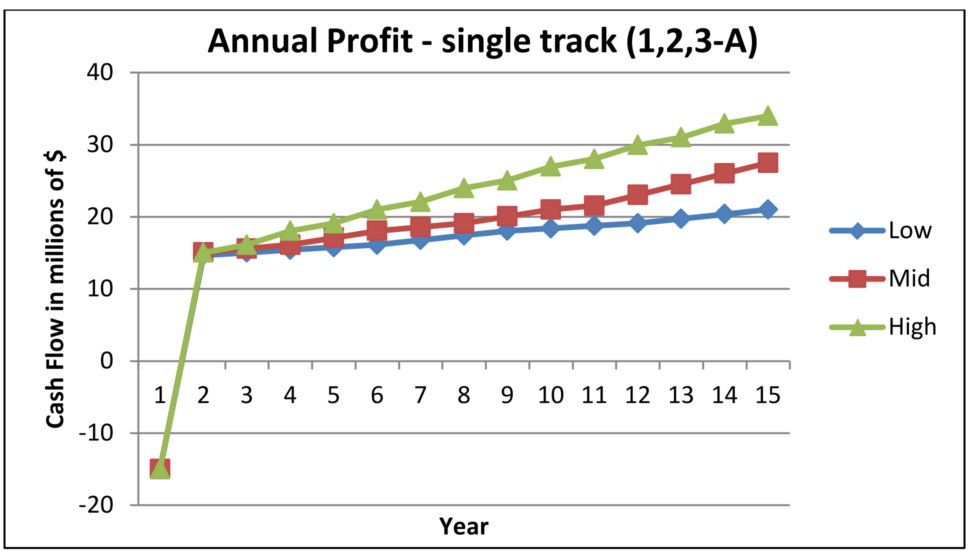


Figure 3-5 Cash Flow Projection in Three Scenarios-Single Track

Figure 3-6 presents the results of breakeven analysis for the double track plan. It confirms the result of Table 3-6 and Figure 3-4. It is clear to see in which years a positive profit can be realized for each of the three scenarios. **The breakeven point is at year 8, year 5 and year 3 which means that the cost will be covered in year 8, year 5 and year 3 respectively for low scenario, mid scenario and high scenario.**

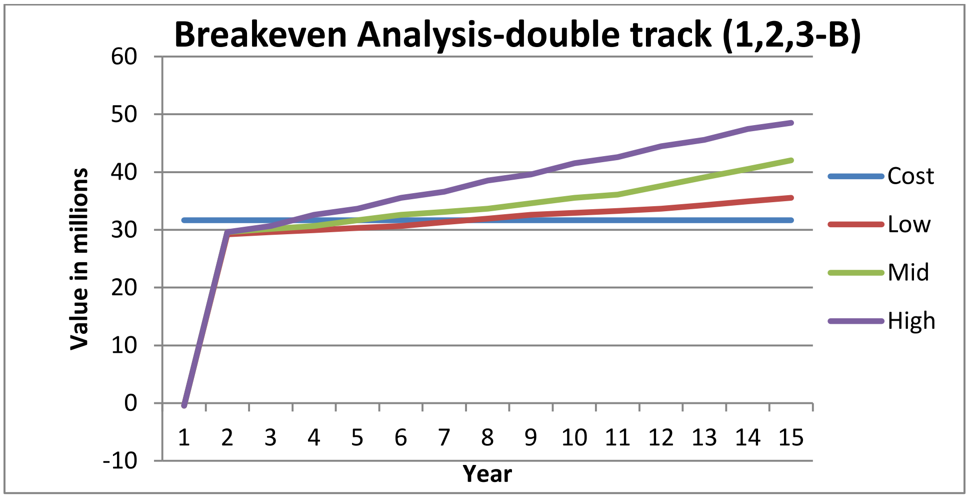


Figure 3-6 Cash Flow Projection in Three Scenarios-Double Track

Figure 3-7 presents the results of the breakeven analysis for the single track plan. **No matter which growth scenario, the breakeven point is at year 2, which means, under the single track construction plan, the annual revenue exceeds annual costs at year 2.**

Considering the increasing trend from Figure 3-6 and Figure 3-7, after the initial 15 years, the railroad will continue to be profitable and benefit the state of New Mexico.

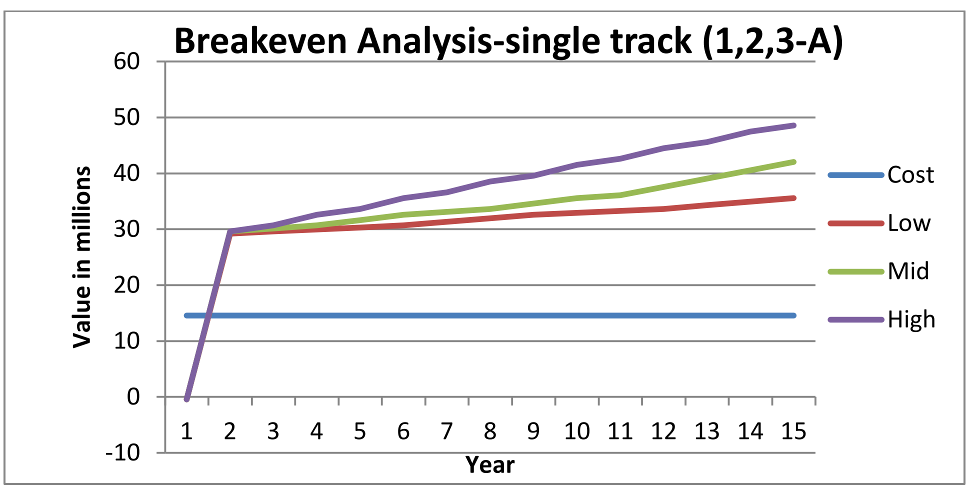


Figure 3-7 Cash Flow Projection in Three Scenarios-Single Track

3.8.3 Potential Export Opportunity

From the proposed connection site in Gallup, the following data are observed (average data between 2009-2013).

a. Los Angeles port: 701 miles. $78.82/short ton for steam coal & $614.5/short ton for coke coal, ranging from $158-$1736.
b. Houston port: 990 miles. $73.63/short ton for steam coal & $162.45/short ton for coke coal.
c. Guaymas port: 820 miles. $85.26/short ton for steam coal & $178.61/short ton for coke coal.

Long distance cost (tariff rate)/ton-mile=1 cent, leading to two assumptions below.

a. The production quantity of coal in the Navajo mine is observed as 5.8 million short tons from the most updated Record of Decision on the Navajo Mine. That is approximately 58,000 carloads. Here we assume the production quantity will maintain this level after 2015.
b. Since the production quantity of steam coal and coke coal of Navajo mine are not known and the export price of steam coal is lower than the price of coke coal, we suppose the coal type to be steam coal for cautious purposes.

Table 3-8 summarizes the extra profit the coal mine could earn exporting its coal. From the last column of Table 3-8, 431.75 million can be earned through LA to export each year if the coal can be exported. Amounts of 401.65 million and 469.1 million can be earned separately through Houston and Guaymas. Therefore, in a 15-year period, the total profit and NFV, including inflation effect, at the end of 15 years are listed in Table 3-9.

Table 3-8 Export Price And Cost Information

	P_s	P_s_export	P_r	ΔP	ΔRev	Cost_ship	Annual ΔRev_export
LA	$78.82/ ton	7882/ carload	438/carload	7444	431.75	7.01Q=40.66m	431.75m
Houston	$73.63/ton	7363/carload	438/carload	6925	401.65	9.9Q=57.42m	401.65m
Guaymams	$85.26/ ton	8526/ carload	438/carload	8088	469.10	8.2Q=47.56m	469.10m

Note: m stands for million, P stands for price. s stands for steam. r stands for regular.

Table 3-9 Profit And NPV Estimate For 15 Year Period (in Millions)

	Profit_steam/year	NFV_steam
LA	5866.41	$6,916.89
Houston	5163.45	$6,088.05
Guaymas, Mexico	6323.16	$7,455.43

3.8.4 Breakeven Analysis for Traffic Volume

In Table 3-3, we use 58,000 carloads as the estimate for the new market of the Navajo coal mine and get all results presented in section 3.8.2. The coal in southwest Colorado is fixed, so it is important to find out the breakeven carloads needed from either the Navajo coal mine or other unidentified sources in order to cover all costs. Here we suppose the production quantity of the new market(s) is x. Under the double-track plan, the total cost including operating costs, land fees and mortgage payment is $8.395+0.438+31.685=40.518$ million. Under the single-track plan, the cost is $8.395+1+14.554=23.949$ million.

Table 3-3 forecasts carloads in five proposed time periods for three scenarios. Here we follow these five time periods to find out the breakeven rail car quantity for each case. Table 3-10 and Table 3-11 summarize the extra quantity needed from new shipper(s) to cover all the costs under the double track plan and single track plan respectively. Five cases are defined for forecasted carloads with increasing trends. **This indicates that for the double track construction of segments 1, 2, and 3-B, the Navajo mine or other new shipper(s) needs to ship 62,750 carloads for the line to be profitable in the 2nd year or needs 49,152 carloads for the rail line to be profitable in 10 years under the mid growth rate scenario. If single track construction of segments 1, 2, and 3-A is selected instead, then 23,638 carloads are needed from either the Navajo Mine or new shipper(s) for the line to be profitable in the second year or only 10,040 additional carloads are needed from the Navajo Mine or new shipper(s) for the rail line to be profitable in 10 years under the mid growth rate scenario.**

Table 3-10 Railroad traffic forecast for breakeven analysis-Double track

	Case 1		Case 2		Case 3		Case 4		Case 5	
low	year 3		year 6		year 9		year 12		year 15	
mid	year 2		year 4		year 6		year 8		year 10	
high	year 2		year 3		year 4		year 5		year 6	
	IB	OB	IB	OB	IB	OB	IB	OB	IB	OB
Total carloads by direction	5,767	23,351+x	6,978	24,188+x	9,351	25,405+x	10,308	26,502+x	12,007	28,629+x
Revenue/car	$584	$438	$584	$438	$584	$438	$584	$438	$584	$438
Total Cost/year	41.08m		41.08m		41.08m		41.08m		41.08m	
x additional carloads needed	**62,750**		**60,298**		**55,917**		**53545**		**49,152**	

Note: m stands for million

Table 3-11 Railroad traffic forecast for breakeven analysis-Single track

	Case 1		Case 2		Case 3		Case 4		Case 5	
low	year 3		year 6		year 9		year 12		year 15	
mid	year 2		year 4		year 6		year 8		year 10	
high	year 2		year 3		year 4		year 5		year 6	
	IB	OB	IB	OB	IB	OB	IB	OB	IB	OB
Total carloads by direction	5,767	23,351+x	6,978	24,188+x	9,351	25,405+x	10,308	26,502+x	12,007	28,629+x
Revenue/car	$584	$438	$584	$438	$584	$438	$584	$438	$584	$438
Total Cost/year	23.949m		23.949m		23.949m		23.949m		23.949m	
x additional carloads needed	**23,638**		**21,186**		**16,805**		**14,432**		**10,040**	

Note: m stands for million

Figure 3-8 and Figure 3-9 visually depict the breakeven carloads in five cases for double track and single track plans separately. The five crossing points of cost function and five revenue functions are breakeven points to cover all cost, in other words, zero profit.

Figure 3-8 Breakeven Carloads Needed in Five Cases-Double track

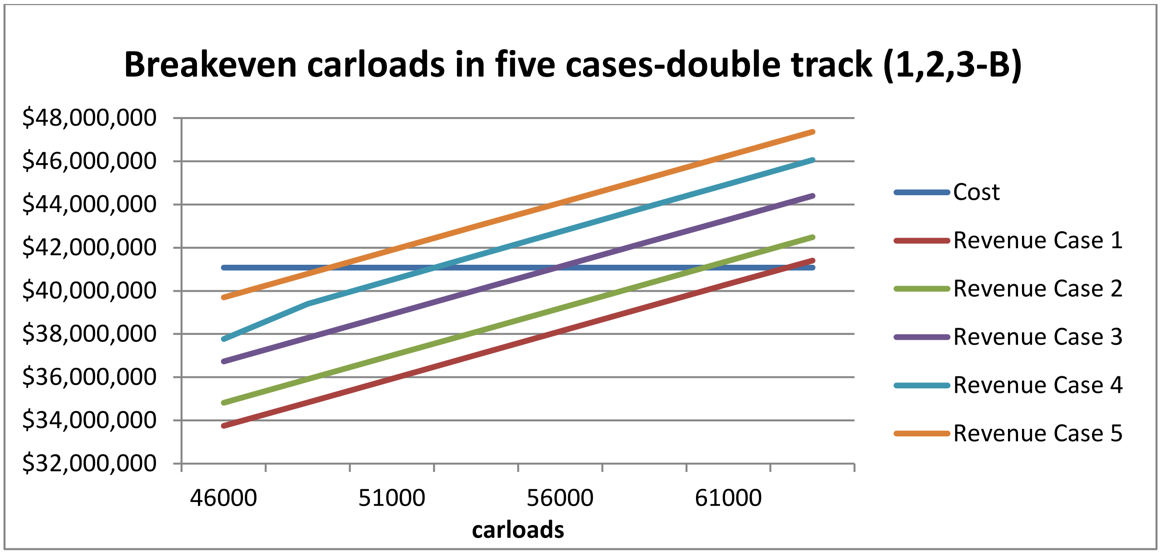
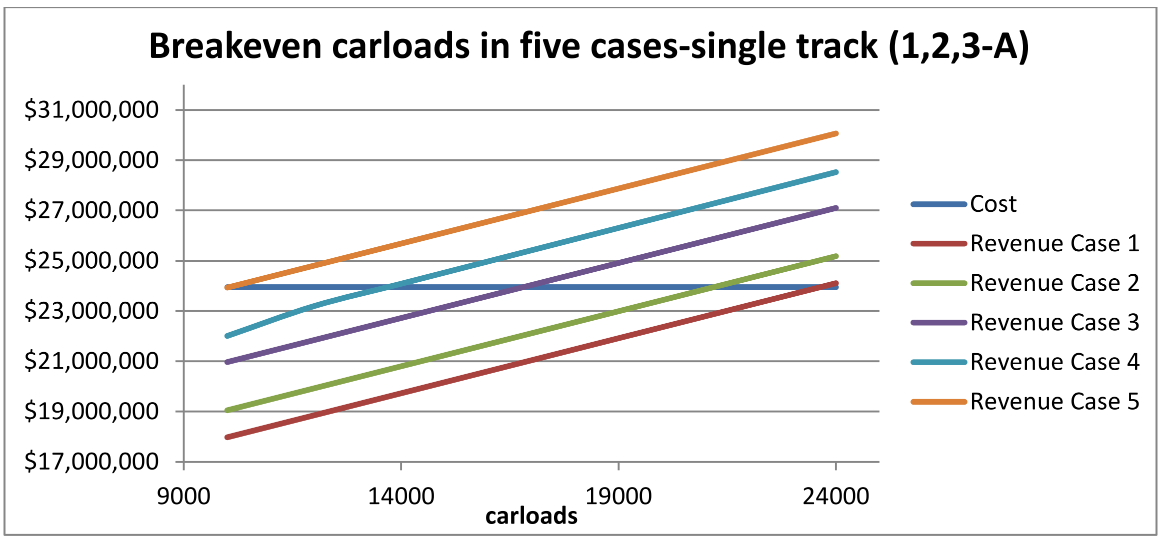


Figure 3-9 Breakeven Carloads Needed in Five Cases-Single Track



3.8.5 Economics Summary

Estimates have been constructed for the profit in the most expensive case- double track with Option B compared to the cheapest case single track with option A. The line has been shown to be profitable in every scenario within 15 years provided the Navajo Mine exports at least 50,000 rail cars per year. Since some uncertainty remains as to the quantity of coal to be exported from the Navajo Mine, the project has also determined the minimum number of rail cars needed to make the cheapest option feasible. To make the single track construction of rail segments 1, 2, and 3-A profitable within 2 years, 23,638 rail cars are needed from either the Navajo Mine or a shipper not identified in this study. **To make the single track construction of rail segments 1, 2, and 3-A profitable within 10-15 years, depending on the rate of economic growth in the region, 10,040 rail cars are needed from either the Navajo Mine or a shipper not identified in this study.**

4 Technical Feasibility

4.1 Engineering Requirements

This project's engineering requirements are that the grade of the rail line shall not exceed 2 percent and the curvature of the line shall not exceed 4 degrees. Exceeding the slope and curvature requirement would result in increased construction and operating costs that would make the project not viable. The reason for the cost increase in terms of construction cost is that the forces on the rails and foundation are higher at larger slopes and curvature. Also, sharper curves require slower speeds to prevent derailment of the trains. In terms of operating cost, steeper grades require additional engines to pull the load and the result is lower efficiency along the whole route, and requires maintenance of additional engines. Operating costs are also increased due to the fact that the more expensive rails and ties used on steep grades have to be replaced more frequently than on level rail lines.

Some engineering concerns that must be addressed along the route include the geology of the regions. Geologic concerns include shallow bedrock in regions where lowering the grade or tunneling is required, as well as deep formations of organic clay with poor compaction and load bearing capacity.

There are also location restraints on the route:

- It must connect to Thoreau and Farmington Area
- It must connect to the Navajo Coal Mine
- It must avoid National Monuments such as the Bisti Badlands
- It should follow NM 371 as much as possible in an effort to minimize political opposition

Based on the location restraints, the route considered and technical feasibility analysis was performed on the rail alignment pictured in Figure 4-1.

Discussions with NMDOT have determined that the current width of the NM 371 right of way varies along the length of the road but is typically 150' (Sanchez, 2015). This width is insufficient to contain both the road and the rail line. As a result the proposed line will parallel NM 371 as much as possible but utilize its own right of way. Additionally NMDOT confirmed that it has no ongoing projects to widen NM 371 that would be impacted by the proposed rail line. The only ongoing projects are resurfacing and installing fencing along portions of NM 371.

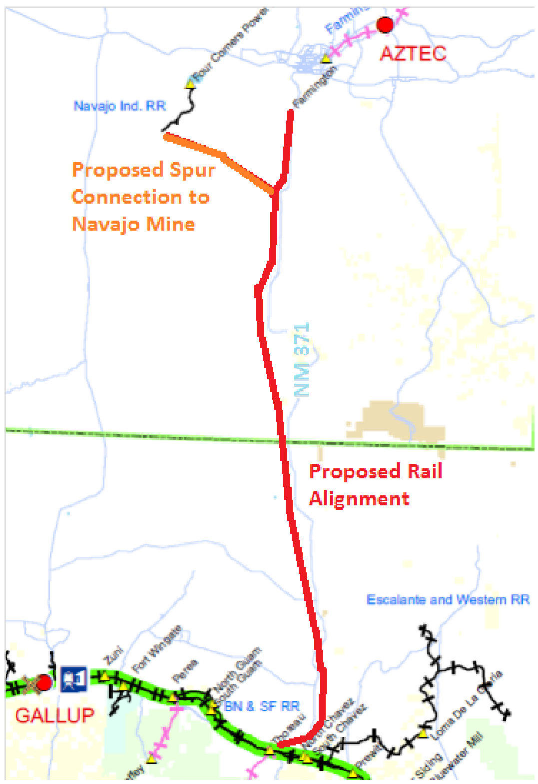


Figure 4-1 Project study area

This report will detail the layout and cost of several options for the northern termination of the rail line. As a result the technical analysis of the route is broken into three segments, with two options as part of the third segment.

1. Connection of Thoreau Railhead to Bisti Oil Fields/NAPI
2. Connection of Bisti Oil Fields/NAPI to Navajo Mine
3. Connection of Bisti Oil Fields/NAPI to Farmington

3-A. Farmington terminal located on the mesa just south of the city limits

3-B. Farmington terminal located in Farmington adjacent to US 64

A map showing all three segments of the route including the termination location associated with options 3-A and 3-B is displayed in Figure 4-2.

The rail line will connect the Transloader Station at Thoreau, NM pictured in Figure 4-3 to the Navajo Coal Mine southwest of Farmington as well as a planned Transloader Station near Bisti Oil Field/NAPI just west of NM 371, and a transloader station in or adjacent to the City of Farmington . The Transloader Station at Thoreau is in the final stages of planning and design and will replace a current rail siding located at the northwest corner of NM 371 and I-40. The existing siding is not safe to operate and too short to service industry needs in the Farmington-Thoreau region. The new station will include a 7,900' siding for merging trains onto the main line as well as an 8,470' loop for loading and unloading trains. The construction of a station to service Bisti Oil Fields and NAPI would allow for shipping equipment directly to the oil field, exporting oil directly from the field as well as agricultural products directly into and out of NAPI. The rail connection to the Navajo Mine would allow the mine to service national and international markets at a competitive cost. The proposed station at Farmington would provide transportation and access to international markets for businesses in the region. Option 3-B would extend the rail line all the way to US 64 which would allow for construction of rail sidings to individual manufactures along US 64 from Aztec to Shiprock. It would also reduce stress on NM highways, resulting in 8 million few miles per year of truck traffic, this reduction of truck traffic come from reducing the travel distance between the King II mine in Colorado and the nearest rail terminal.

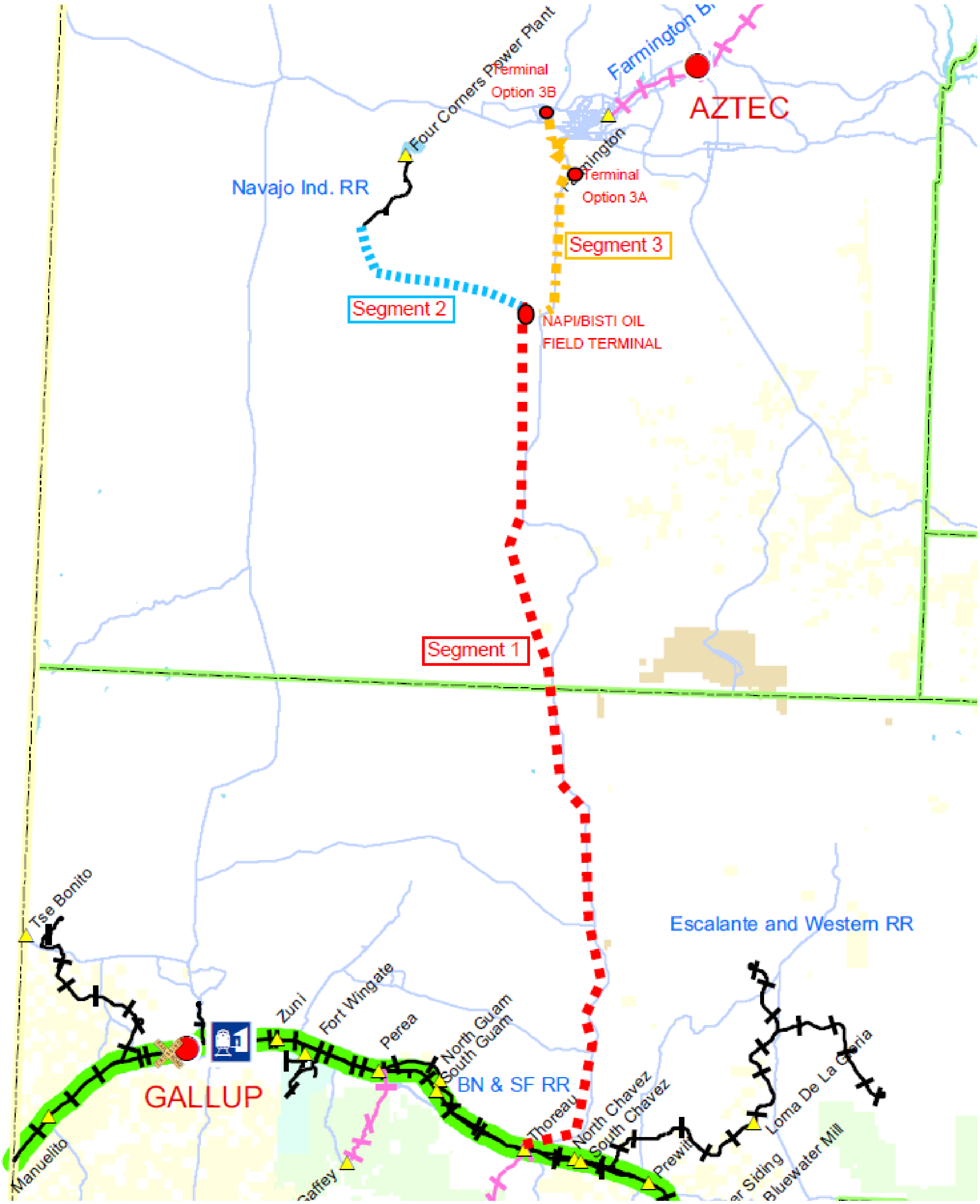


Figure 4-2 Route Segments 1, 2, 3-A and 3-B

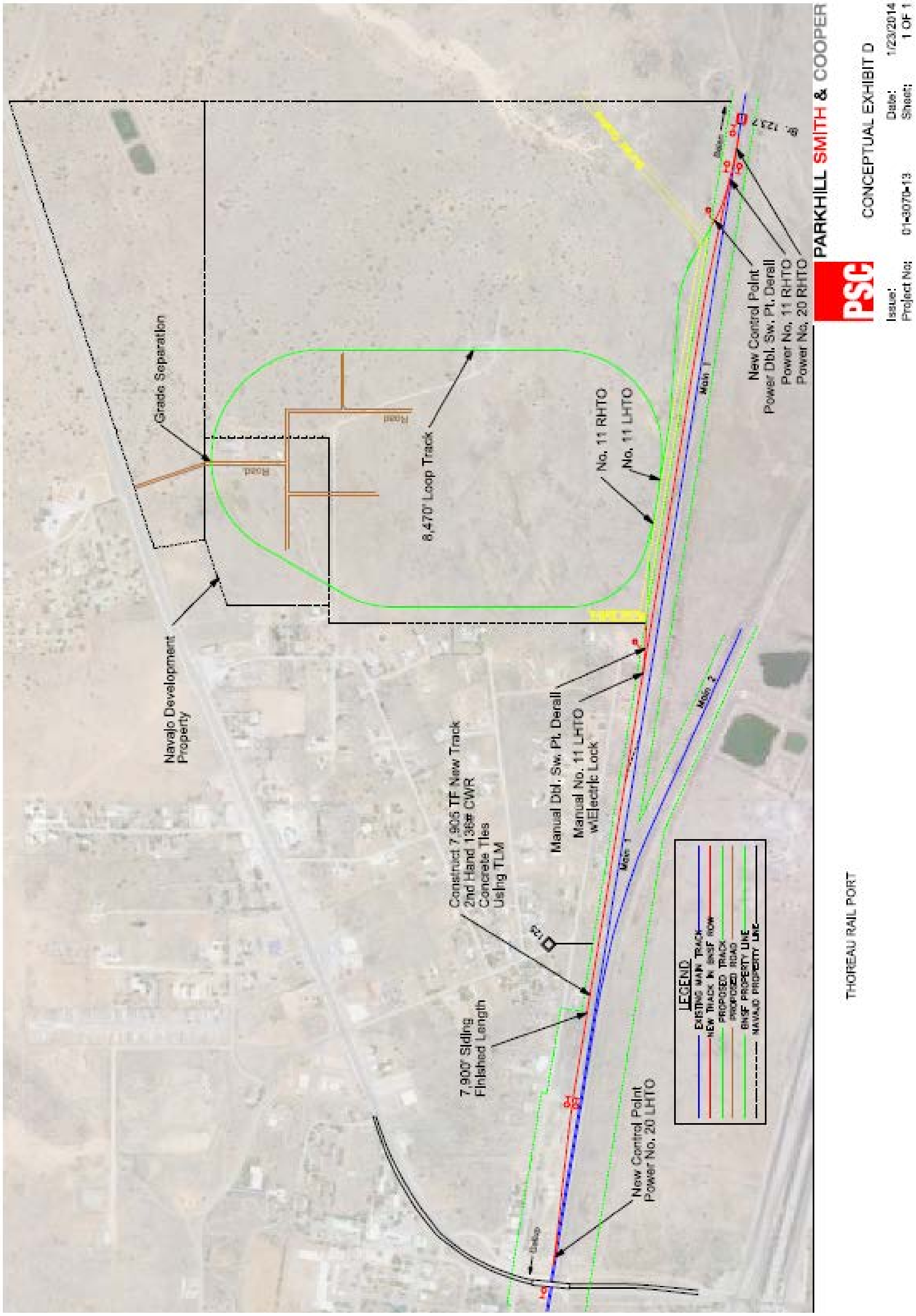


Figure 4-3 Thoreau Transloader Station (Parkhill Smith and Cooper, 2014)

4.2 Existing Infrastructure Available to Support Rail Line

Currently there is one active main rail line and two branch or short line railroads in the project area. The Main line is BNSF's transcontinental rail line that passes through Thoreau (Figure 4-4). The branch lines include the Navajo Indian Railroad and the Escalante and Western Railroad. The Navajo Indian Railroad connects the Navajo Mine to the Four Corners Power Generating Station, and currently has no connection to the wider rail network. Part of this study will include making a connection between this short line and the BNSF main line. The Escalante and Western Railroad connects the Lee Ranch and El Segundo Mines to BNSF's main line. The only abandoned rail line within the study area that of note is the Farmington Branch line of the Denver and Rio Grande Western Railroad (D&RGW). The D&RGW is now defunct; however, the abandoned lines offer the potential for future extension of the proposed rail spur to other natural resource and economic centers north and west of Farmington, NM. Such future expansion is beyond the scope of the current project and as such will not factor into the current analysis.

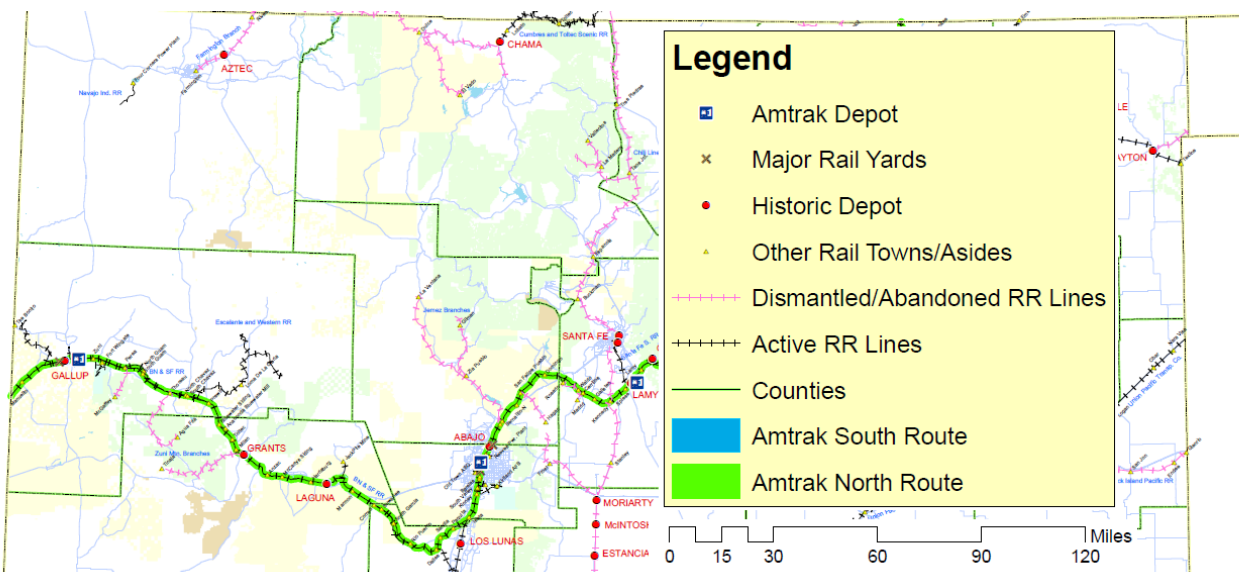


Figure 4-4 Existing Rail Lines in Northeast New Mexico (NM Department of Transportation, 2012)

A map of existing roads and highways in the region is presented in Figure 4-5. Additional roads that could be used as service roads include unpaved Indian Service roads not pictured in Figure

4-5. The existing right of way along NM 371 is an average of 150 feet wide (75 feet either side of the roads center line). This width is insufficient for both the road and the proposed rail line. In addition the rail must maintain a much lower grade change than the road, so a separate right of way will be required. The rail right of way is still preferred to follow NM 371, as this would prevent creating a new disruption to grazing lands.

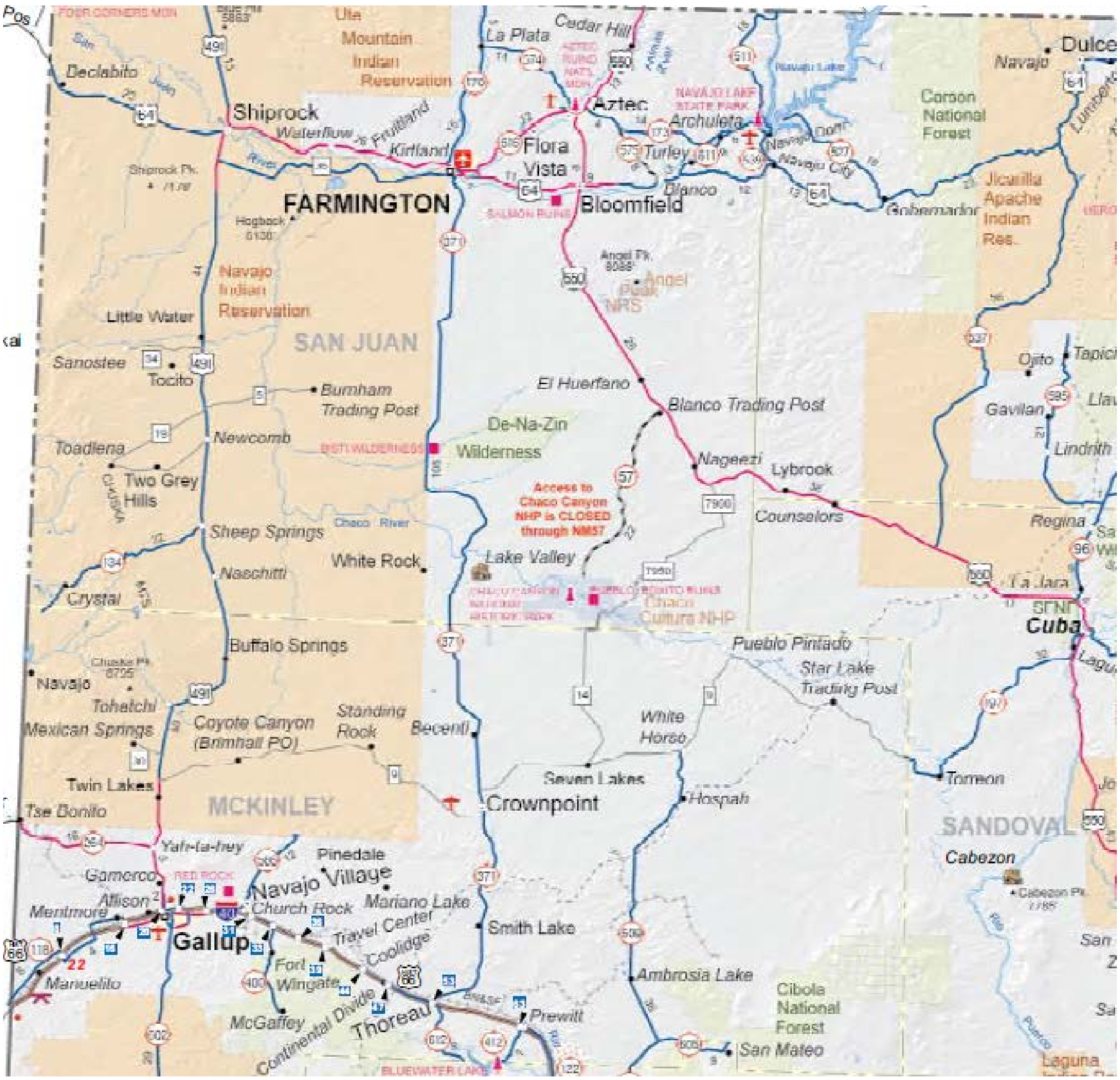


Figure 4-5 NM State Roads Map (NM Department of Transporation, 2012)

4.3 Grade and Curvature Evaluation

The project team has compiled USGS 7.5 minute latitude by 7.5 minute longitude quadrangle topographic maps of the San Juan and McKinley Counties from Farmington to Thoreau. An index from the New Mexico Bureau of Geology of the quadrangle topography maps in the region is presented in Figure 4-6. The quadrangles used to lay out the route from Thoreau to Farmington are outlined in red. This report includes topographic maps and profiles of the route from the Thoreau quadrangle to the proposed transloader station in the Pillar quadrangle at Bisti Oil Fields/NAPI (Segment 1). It also evaluates the route the Pillar quadrangle to the Hogback South quadrangle which is where the line would meet up with the existing Navajo Railroad which services the Navajo Mine (Segment 2). The final segment, which connects to Farmington, is evaluated as two options: 3-A starts at the Pillar quadrangle and ends at Farmington South quadrangle just outside Farmington. Option 3-B starts at the Pillar quadrangle and ends at Kirtland quadrangle inside the Farmington city limits. The reason for the two options for route segment 3 is the large cost associated with descending the mesa south of Farmington. The combination of dropoff in elevation from the mesa to the river valley and subsequent rise in elevation on the north side of the San Juan River in such close proximity present a formidable obstacle. This study evaluated several alternatives for crossing this obstacle including tunneling down off the mesa, using cut and fill to descend to the valley floor with a bridge across the river, and using cut and fill to descend from the mesa to the elevation of hills north of the San Juan river and then crossing both the river and river valley with a 200 ft high and approximately 2 mile long viaduct. Of the three options the viaduct has by far the cheapest construction cost and is the one presented in this report. The viaduct option would also minimize disturbance of the farm land in the river valley.

The maps in the following sections are being used to plot the course of the rail line, compute the amount of cut and fill required to achieve the project’s grade requirement of 2%, and ensure the curvature of the rail line is less than 4%. The initial alignment of the rail line was done to demonstrate that a route along NM 371 is feasible from a technical standpoint.

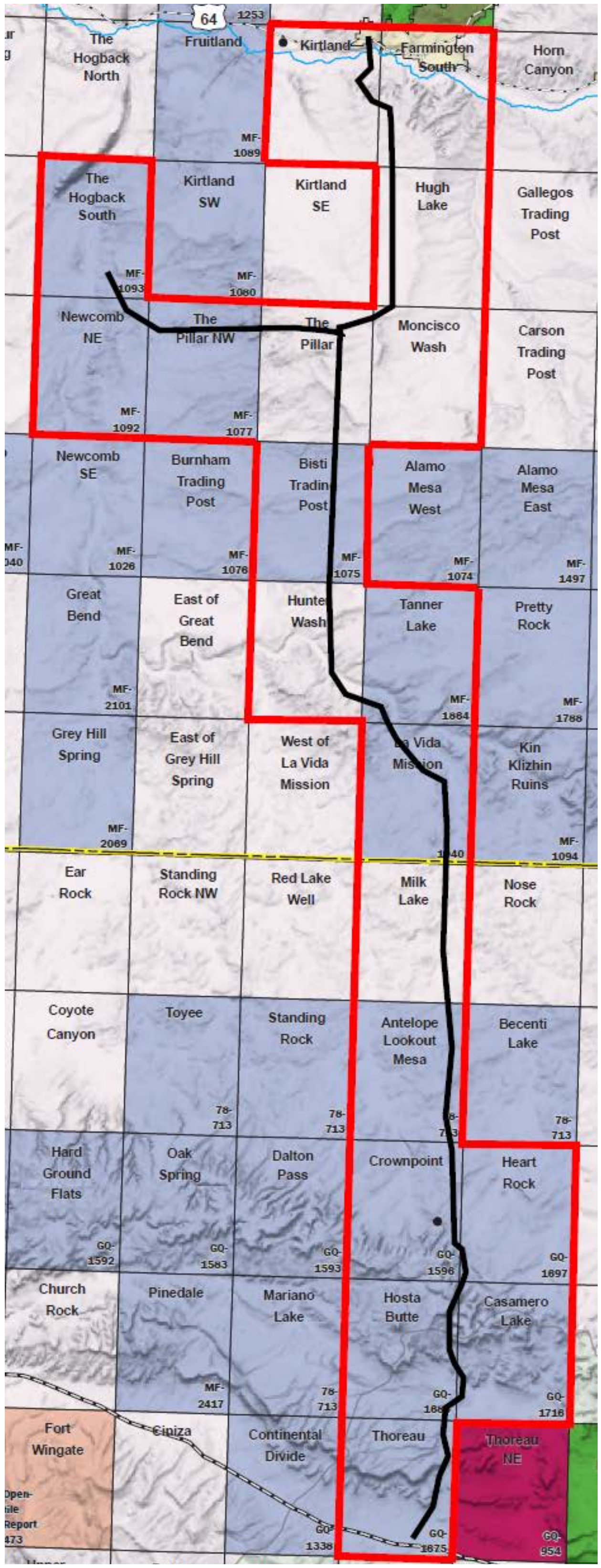


Figure 4-6 Index of Quadrangles Proposed Alignment (NM Bureau of Geology, 2014)

The most challenging grades along the route segment 1 are between Crown Point and Thoreau. The grade changes at San Antonio Hill between Smith Lake and Thoreau, as well as the grade change at the southern end of Satan Pass are too steep to meet the target grade for the rail line of 2%. The three main options for overcoming the steep grade changes at these locations are construction of a tunnel, using S curves to lengthen the approach, or evaluating alternative routes. Due to the limited width of Satan Pass, using S curves to lengthen the rail line's approach to the steep grades is not a viable option. The alternative routes consist of going around the region and the mountain or using Dalton Pass instead of Satan Pass. Going around the mountain offers the promise of a less technically challenging route but presents substantial political obstacles because the route would cross a large number of private, state, federal, and allotment lands. The alternate route through Dalton instead of Satan Pass does not appear to offer a significant grade change, as the elevation drop and length of the passes are similar.

The cross section of the rail line is to consist of two parallel rail lines with ballast dimensions as specified in RailCorp's Engineering Standards ESC 240 Ballasts (RailCorp, April 2013). The minimum required ballast shoulder width is 400mm or 1.312ft; the minimum ballast depth is 350mm or 1.148ft (Figure 4-7). Also a distance of 16 ft between the parallel track center lines has been used.

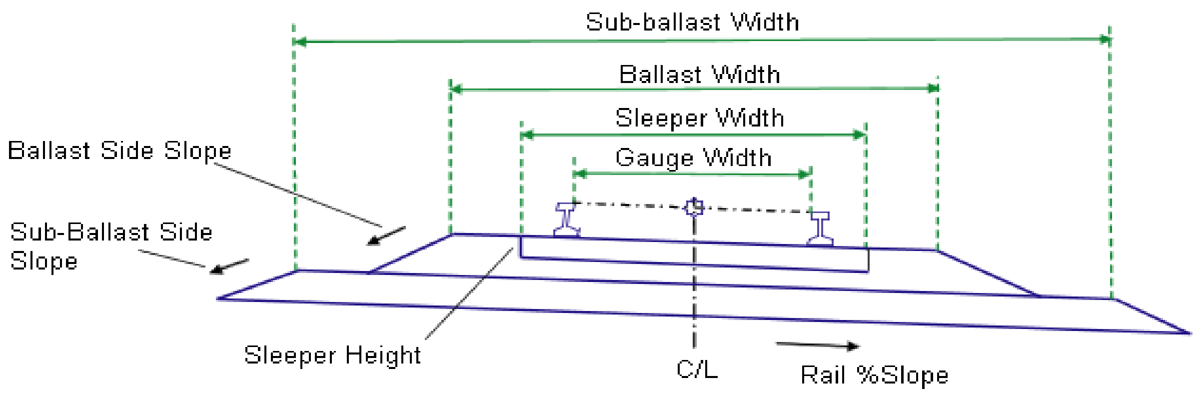


Figure 4-7: Definitions of Civil 3D Rail Parameters (Autodesk, 2015)

4.3.1 Rail Segment 1 Thoreau to Bisti Oil Fields/NAPI

Sections 4.3.1.1 through 4.3.1.10 lay out the route north from Thoreau to the Bisti Oil Fields and are broken down into the ten USGS quadrangles that segment 1 of the proposed the route traverses. The route laid out in these ten sections used quantities needed to develop a construction cost estimate. The unit costs in Table 4-1and Table 4-2 were developed based on costs reported in the 1998 study by FSI (Freight Services Incorporated, 1998) and then updated for inflation and augmented for information. The cost of the Bisti/NAPI station is only the basic infrastructure of the station or terminal. Individual sidings within the loop would be constructed by the industry partners serviced on each siding.

Two alternatives are presented for rail segment 1. The first is to construct a single track line between Thoreau and Bisti/NAPI terminals. The single track option would include two sidings for trains to pass along the route. The most optimistic freight projections would see an average of 4-5, one hundred car trains per day each direction. The single track option cost estimate includes the entire earthwork needed to grade the route for expansion to double track at some later date.

Table 4-1 Construction Cost for Single Track Along Rail Segment 1

Thoreau to NAPI Single Track Cost Estimate				
Item	Quantity	Units	Unit Price	Cost
Clearing and Grubbing	648	AC	$ 1,850.00	$ 1,198,430.00
Excavation and Embankment	13,417,842	CY	$ 4.44	$ 59,575,219.81
Sub-ballast (30 ft)	772,223	TN	$ 17.76	$ 13,714,671.60
Bridges	4	EA	$ 666,000.00	$ 2,664,000.00
Culverts	195	EA	$ 6,926.40	$ 1,350,648.00
R/W Fencing	195	MI	$ 23,443.20	$ 4,571,557.20
Track Work	516,931	FT	$ 140.60	$ 72,680,498.60
Siding	2	EA	$ 1,379,004.80	$ 2,758,009.60
Main Road Crossing	52	EA	$ 10,656.00	$ 554,112.00
Secondary Road Crossings	66	EA	$ 10,656.00	$ 703,296.00
Chaco River Bridge	1	EA	$ 20,000,000.00	$ 20,000,000.00
Bisti/NAPI Terminal	1	EA	$ 5,053,000.00	$ 5,053,000.00
Total Cost				**$ 184,823,442.81**

The second alternative is to build a double track line for the entire route from the start. Since all freight traffic going to and from Farmington, NAPI, Bisti Oil Field and the Navajo Mine will traverse Segment 1 of the rail line it is the segment mostly likely to require double track to operate efficiently.

Table 4-2 Construction Cost for Double Track Along Rail Segment 1

Thoreau to NAPI Double Track Cost Estimate				
Item	Quantity	Units	Unit Price	Cost
Clearing and Grubbing	647.8	AC	$ 1,850.00	$ 1,198,430.00
Excavation and Embankment	13,417,843	CY	$ 4.44	$ 59,575,219.81
Sub-ballast (45 ft)	1,158,334	TN	$ 17.76	$ 20,572,007.40
Bridges	4	EA	$ 666,000.00	$ 2,664,000.00
Culverts	195	EA	$ 6,926.40	$ 1,350,648.00
R/W Fencing	196	MI	$ 23,443.20	$ 4,571,557.20
Track Work	1,033,862	FT	$ 140.60	$ 145,360,997.20
Main Road Crossings	52		$ 10,656.00	$ 554,112.00
Secondary Road Crossings (Signal Only)	66	EA	$ 10,656.00	$ 703,296.00
Chaco River Bridge	1	EA	$ 20,000,000.00	$ 20,000,000.00
Bisti/NAPI Terminal	1	EA	$ 5,053,000.00	$ 5,053,000.00
Totals				**$ 261,603,267.61**

4.3.1.1 Thoreau Quadrangle

The land east of NM 371 slopes up to San Antonio Hill but does so at near the 2% grade required for a rail line. An image of the grade along the eastern edge of NM 371 looking south from San Antonio Hill toward Thoreau is presented in Figure 4-8. The slope where NM 371 crosses San Antonio Hill is much steeper on both the southern and northern approach. The southern approach's slope up to San Antonio Hill Figure 4-9 with the view looking down from the top of the hill is pictured in Figure 4-10.

Figure 4-8 Grade East Of NM 371 From San Antonio Hill To Thoreau

Figure 4-9 Approach To San Antonio Hill From The South

Figure 4-10 San Antonio Hill Looking South

One main route for getting from Thoreau to San Antonio Hill has been evaluated along with several options for crossing the hill itself. Figure 4-11 illustrates the initial route explored which follows closely NM 371. The amount of cut and fill required by the route laid out in Figure 4-11 has been tabulated in Table 4-3.

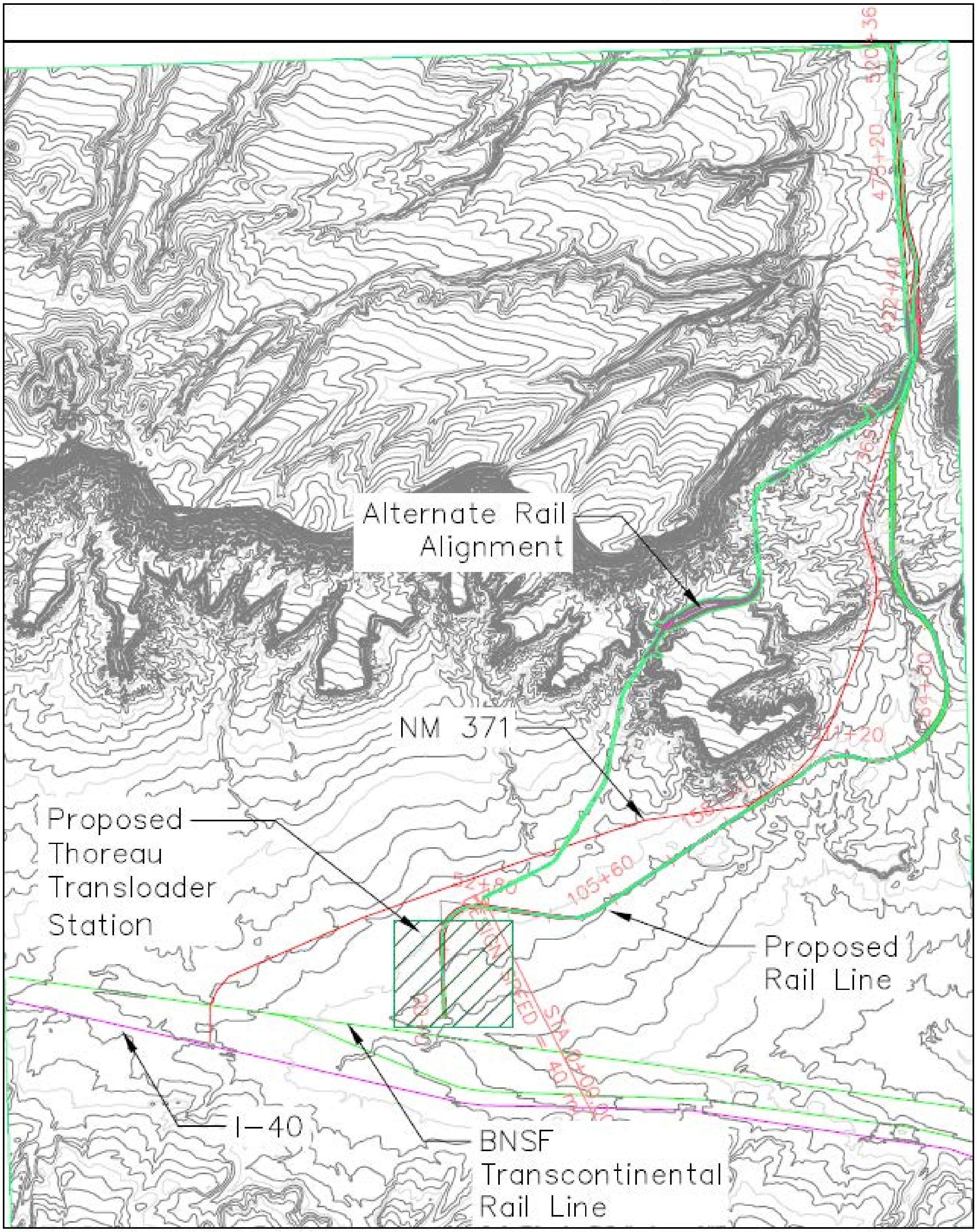


Figure 4-11 Proposed Rail Line Thoreau to San Antonio Hill

Table 4-3 Thoreau to San Antonio Hill Cut and Fill

	Disturbed Area (Sq ft)	Volume of Cut (Cu Yd)	Volume of Fill (Cu Yd)	Net Cut/Fill (Cu Yd)
Thoreau Quadrangle Rail Alignment	833,739	308,477	387,062	78,584 <Fill>
Alternate Rail Alignment	6,150,502	4,748,993	1,119,145	3,629,848 <Cut>

Table 4-3 also includes cut and fill data for an alternative route for crossing San Antonio Hill. The alternative route is laid out in Figure 4-11. Only the profile view of all primary routes is presented in Figure 4-12 because the alternative route requires substantial additional excavation. The bulk of the excavation along the primary route is associated with leveling the ridge at the as the top of the hill. The grade of the rail alignment is shown if Figure 4-12 as a percent and cut is shown in red with areas of fill shown in green. **The profile view shows clearly that the 2% grade requirement can be met on the approach to San Antonio Hill.**

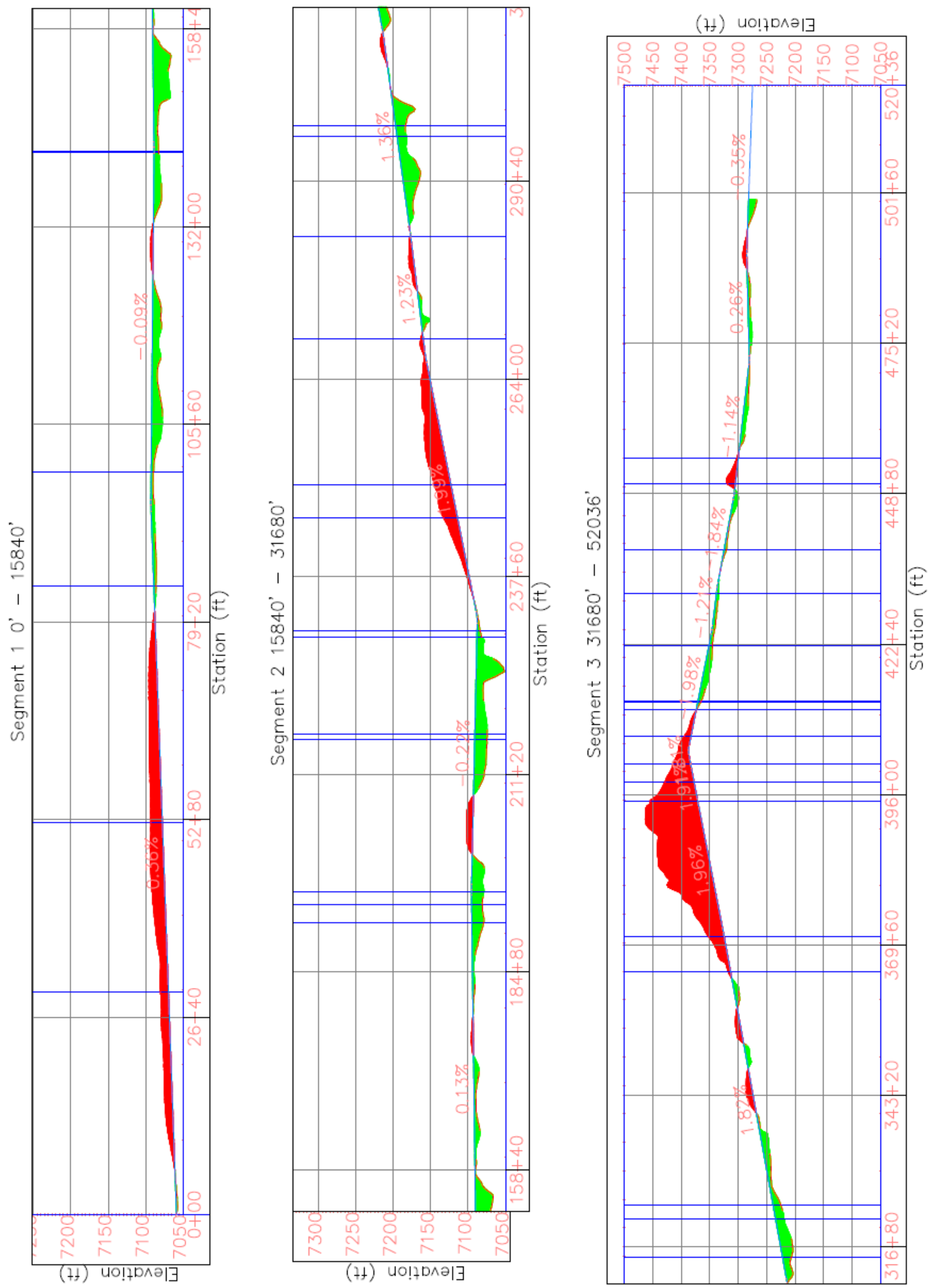


Figure 4-12 Profile of Thoreau to San Antonio Hill

4.3.1.2 Hosta Butte and Casamero Lake Quadrangle

Smith Lake is located along NM 371 on a plateau between San Antonio Hill and Satan Pass. There are two options for the rail line to cross the plateau at Smith Lake. Both options are illustrated in Figure 4-13 and the individual merits of each are discussed here. Option one is to follow NM 371 directly through the town of Smith Lake. The second option is to go along the valley wall east of 371.

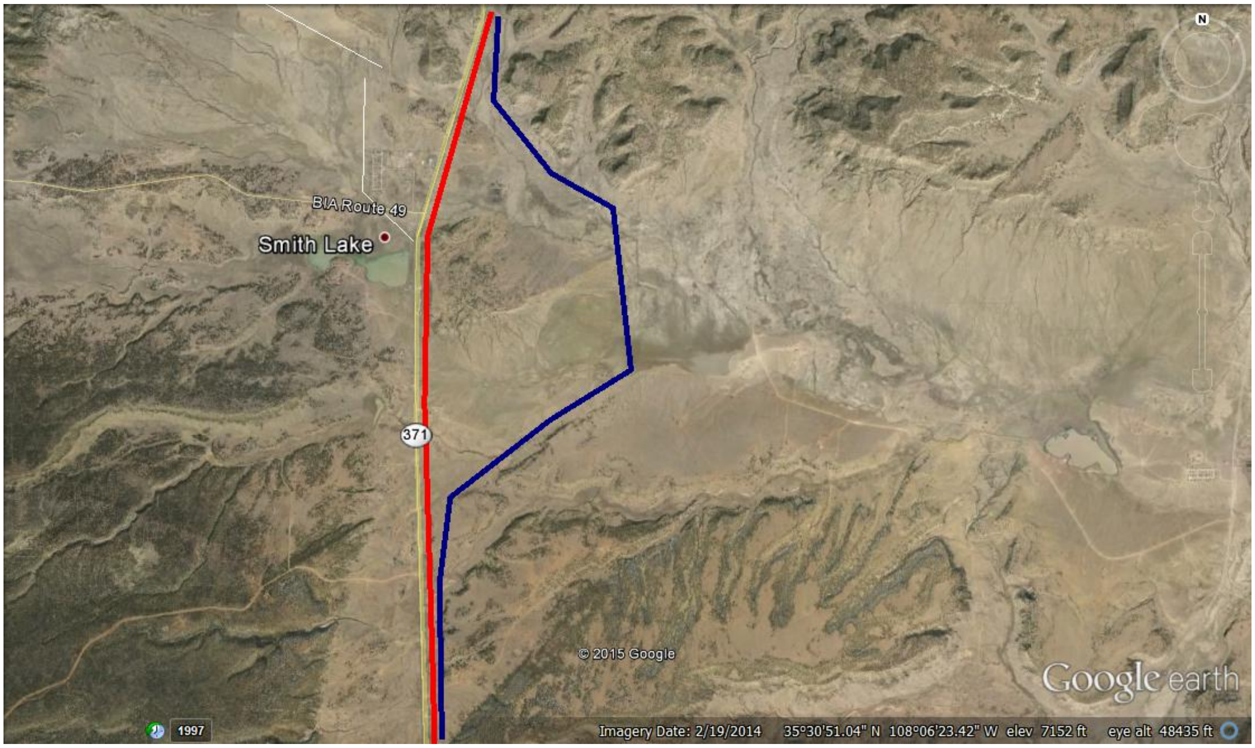


Figure 4-13 Smith Lake Alignment Options (Option 1 Red on Left, Option 2 Blue on Right) (Google Earth)

The first option through Smith Lake has the benefit of not creating a new area disturbance to the natural environment in that it follows the existing road closely and a new service road would not be needed. A disadvantage of this option is that the line would be very close to existing businesses and residences. The rail line would have to pass through a narrow strip of land between Smith Lake and the hill just east of the lake. That narrow corridor is already occupied by NM 371 and several buildings. Due to the narrow passage at the eastern edge of the lake, the 100 foot right of way width cannot be obtained without demolishing structures, and the driveways to some homes and businesses south of the lake would have to cross the rail line.

The second option is staying further east of NM 371 from San Antonio Hill until the line reaches Satan Pass. This option would create a new area of disturbance since it would not follow existing roads. It also may introduce a new dividing line between grazing lands, though it may be possible to follow Indian Service Roads rather than create a completely new disturbance. An advantage of this option is that it would have a reduced liability due to its distance from existing businesses and residences. Thus, it would have reduced noise levels at existing homes, would maintain the desired 100 foot wide right of way, and would be substantially easier and cheaper to construct due to the fact that the existing grade changes are below the required 2%.

Satan Pass is expected to be the most challenging terrain along the proposed line (Figure 4-14). Several options for meeting the grade requirement of no more than 2% have been evaluated. The proposed rail alignment closely follows NM 371 except around the town of Smith Lake where it makes a swing east to avoid the town and lake (Figure 4-15). The proposed alignment is broken into 4 segments labeled HBC 1, 2, 3 and 4. The profile of each segment is presented in a separate figure below due to the total length of track.

Figure 4-14 View From Crest of Satan Pass North

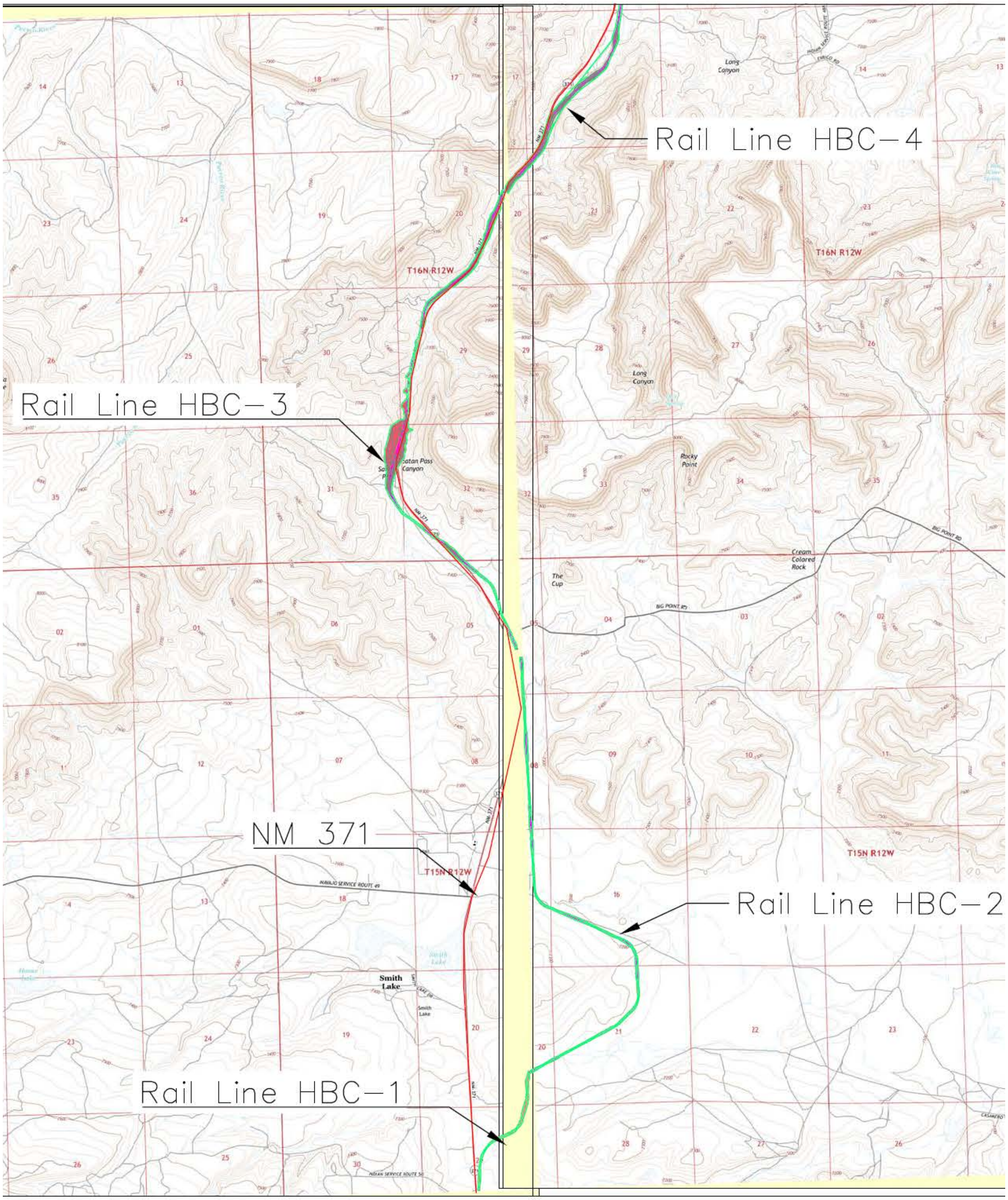


Figure 4-15 Hosta Butte and Casamero Lake Quadrangle

In Figure 4-15 the left half of the image is Hosta Butte Quadrangle and the right half is Casamero Lake Quadrangle. The rail line is shown in green and snakes up the center of the image following NM 371 which is the red line. The amount of excavation required to meet the grade requirement in terms of cubic yards of cut and fill is displayed in Table 4-4. The four segments HBC 1 to 4 are numbered sequentially from south to north. Additionally, profiles of the grade along each of the segments of the route are shown in Figure 4-16 through Figure 4-19. Satan Pass is too steep and narrow at its southern end, so in order to correct this approximately 3 million cubic yards of earth will need to be removed and used to fill and level the northern sections of Satan Pass. As a result of this cut and fill, NM 371 will also need to be rebuilt at the new grade created. This section of the route represents the greatest technical challenge and the single largest construction cost along the route. The main alternative to this proposed cut and fill would be to construct a 1 mile long tunnel through the ridge at the southern end of Satan Pass. Such a tunnel is likely to cost as much or more than the proposed cut and fill, but have a reduced environmental impact. Without a detailed geologic study of the area, a precise estimate of the tunnel's construction is not possible, so the cut and fill option is the one utilized for cost estimating and planning purposes in this study.

The third alternative, presented in Figure 2-1 would use Dalton pass instead of Satan pass. Looking at the topography of both passes, they are roughly equivalent and so Dalton Pass is not seen to represent a significant advantage from a technical standpoint. Furthermore, the transition from following NM 371 to following the reservation line is considered easier and cheaper from a technical standpoint if that transition is made near Crownpoint or White Rock rather than around Hosta Butte. As a result this alternative remains as a backup plan should political obstacles arise at a later date with the primary route but is not evaluated in great detail here.

Table 4-4 Hosta Butte and Casamero Lake Excavation

	Disturbed Area (Sq ft)	Volume of Cut (Cu Yd)	Volume of Fill (Cu Yd)	Net Cut/Fill (Cu Yd)
HBC Seg. 1	409,741	52,846	34,613	18,233<Cut>
HBC Seg. 2	1,340,952	58782	95,428	36,645<Fill>
HBC Seg. 3	3,719,949	2,905,177	915,234	1,989,943<Cut>
HBC Seg. 4	2,216,907	75,854	1,760,266	1,684,411<Fill>
TOTAL	7,687,550	3,092,662	2,805,541	287,120<Cut>

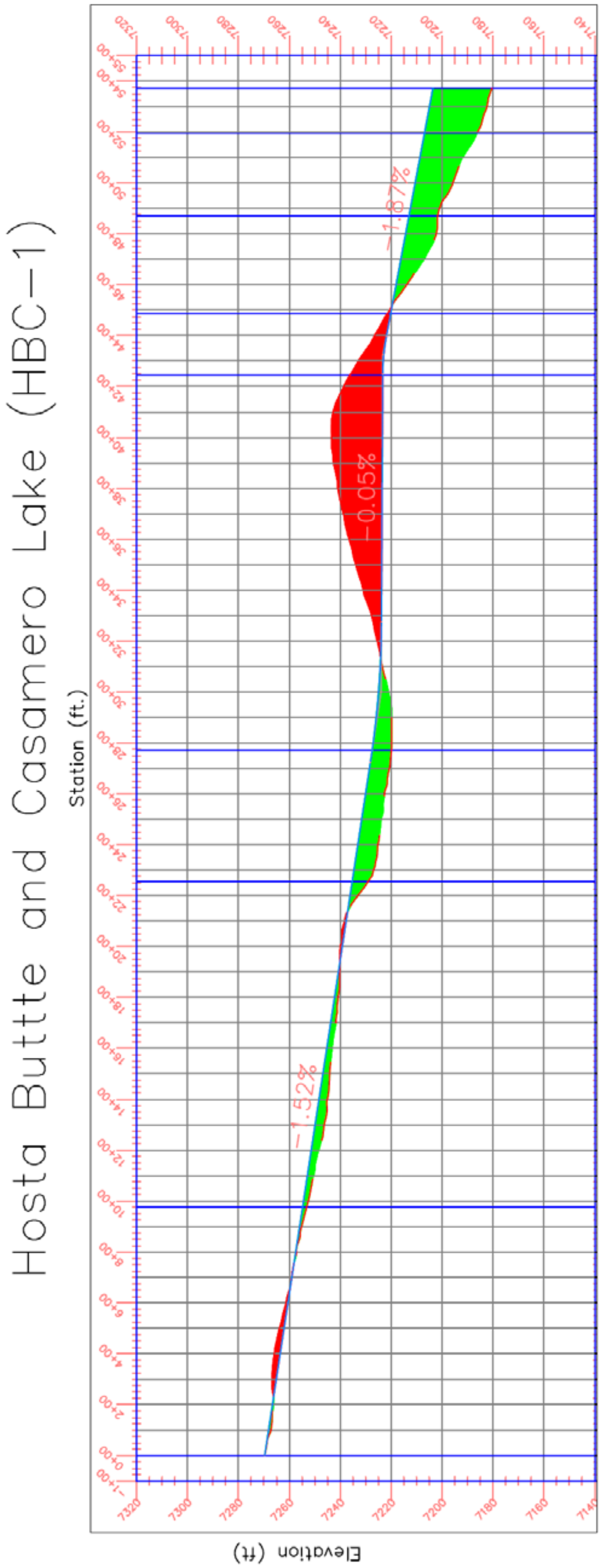


Figure 4-16 Grade Profile HBC Segment 1

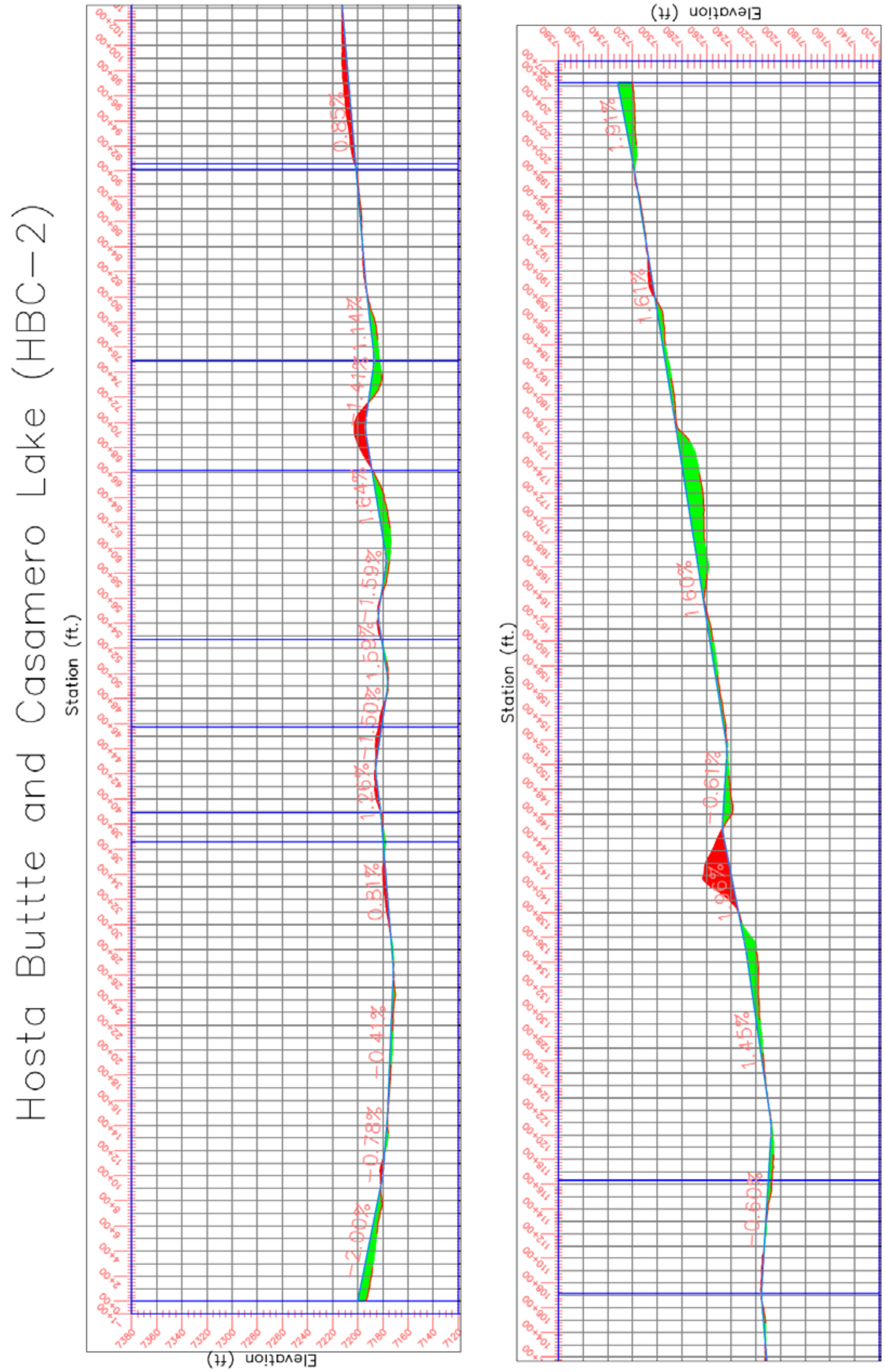


Figure 4-17 Grade Profile HBC Segment 2

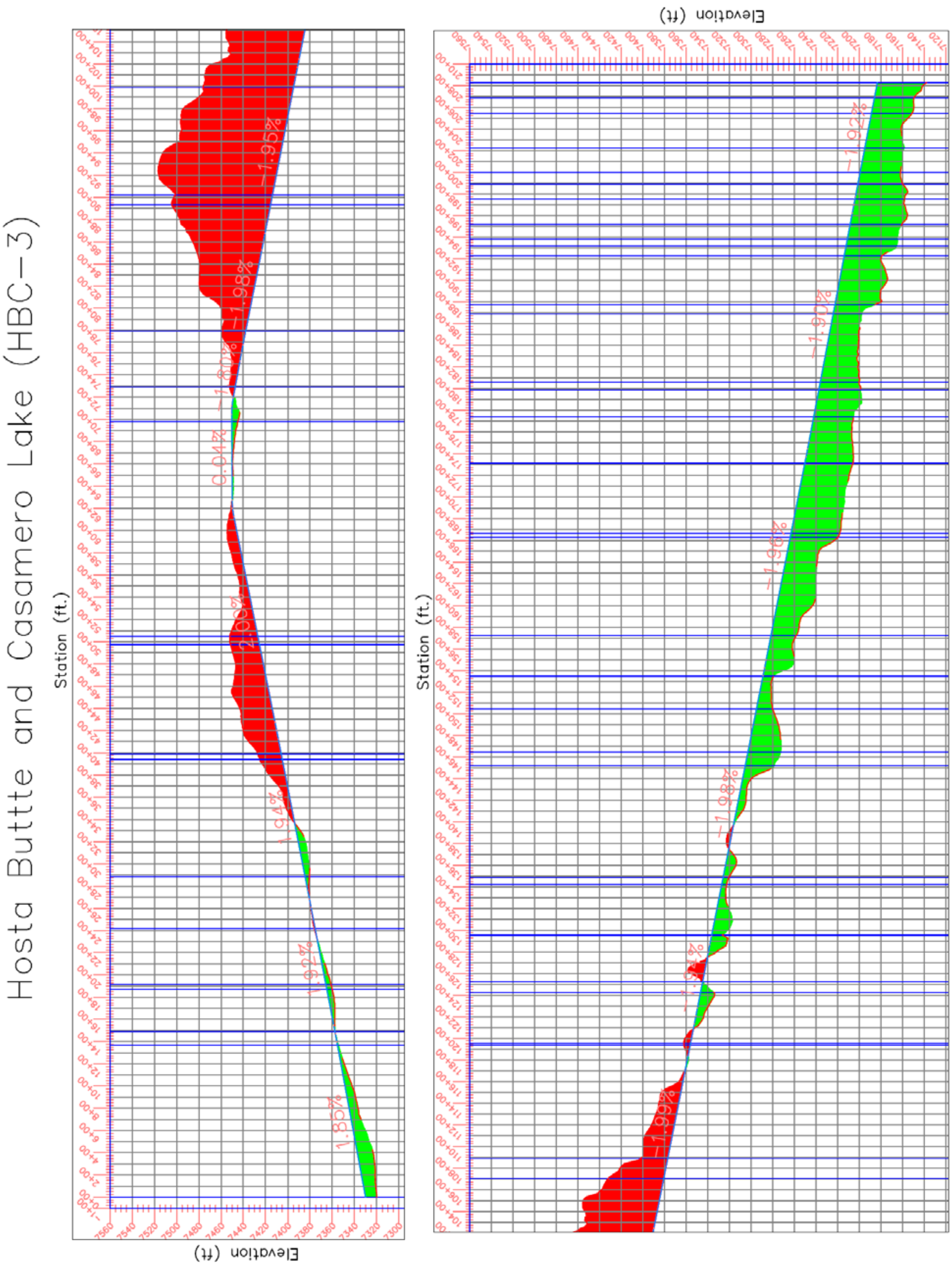


Figure 4-18 Grade Profile HBC Segment 3

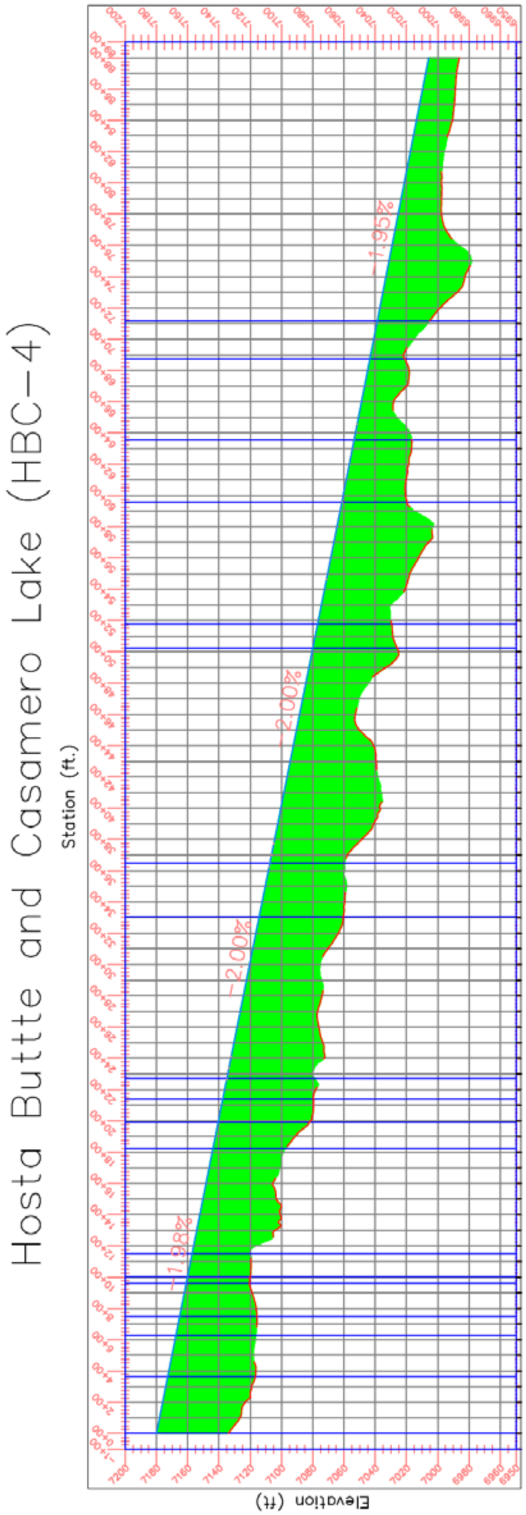


Figure 4-19 Grade Profile HBC Segment 4

4.3.1.3 Satan Pass and San Antonio Hill Tunneling Alternative

In order to properly estimate the cost of tunneling in these two regions more information is needed on the type of rock formations the tunnel would pass through. The following subsections detail what is currently known about the regions' geology and references to tunneling costs from other rail projects. This information details the need for borings and other detailed study of the region.

4.3.1.3.1 Geology of Satan Pass

Figure 4-20 consists of a small portion of a larger USGS survey map from 1972 showing Satan Pass to consist of several different types of geological material. The legend of the larger map indicates the pass to consist of Mancos Shale (Kmm)(Kms), Point Lookout Sandstone (Kpl)(Kph), and the Crevasse Canyon Formation (Kcc). (USGS, 1972)

The Mancos Shale subdivides into two subgroups, the Satan and Mulatto Tongue, which are "considerably sandier than the main body of the Mancos Shale." (USGS, 1972). The Mulatto Tongue is further characterized as "consists principally of dark-gray sandy marine shale and numerous thin beds of fine-grained calcareous sandstone." (USGS, 1972)

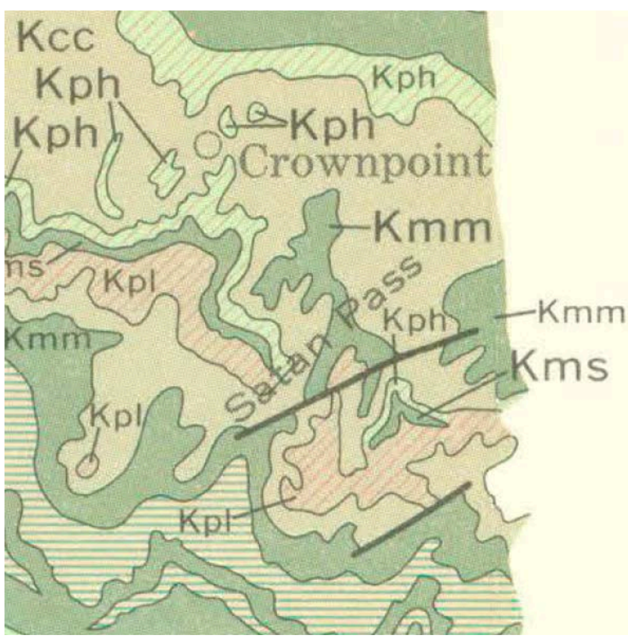


Figure 4-20 Satan Pass (USGS, 1972)

4.3.1.3.2 Geology of San Antonio Hill

The geology of San Antonio Hill (Figure 4-21) consists of three primary materials: Mancos Shale/Dakota Sandstone, (Kmd), Sandstone (Jsr), and Shale (Jm). (NMBGMR, 2015) The peak of the hill is shale and part of the Morrison Formation. (NMBGMR, 2015) Figure 4-21 was generated from the New Mexico Bureau of Geology and Mineral Resources website.

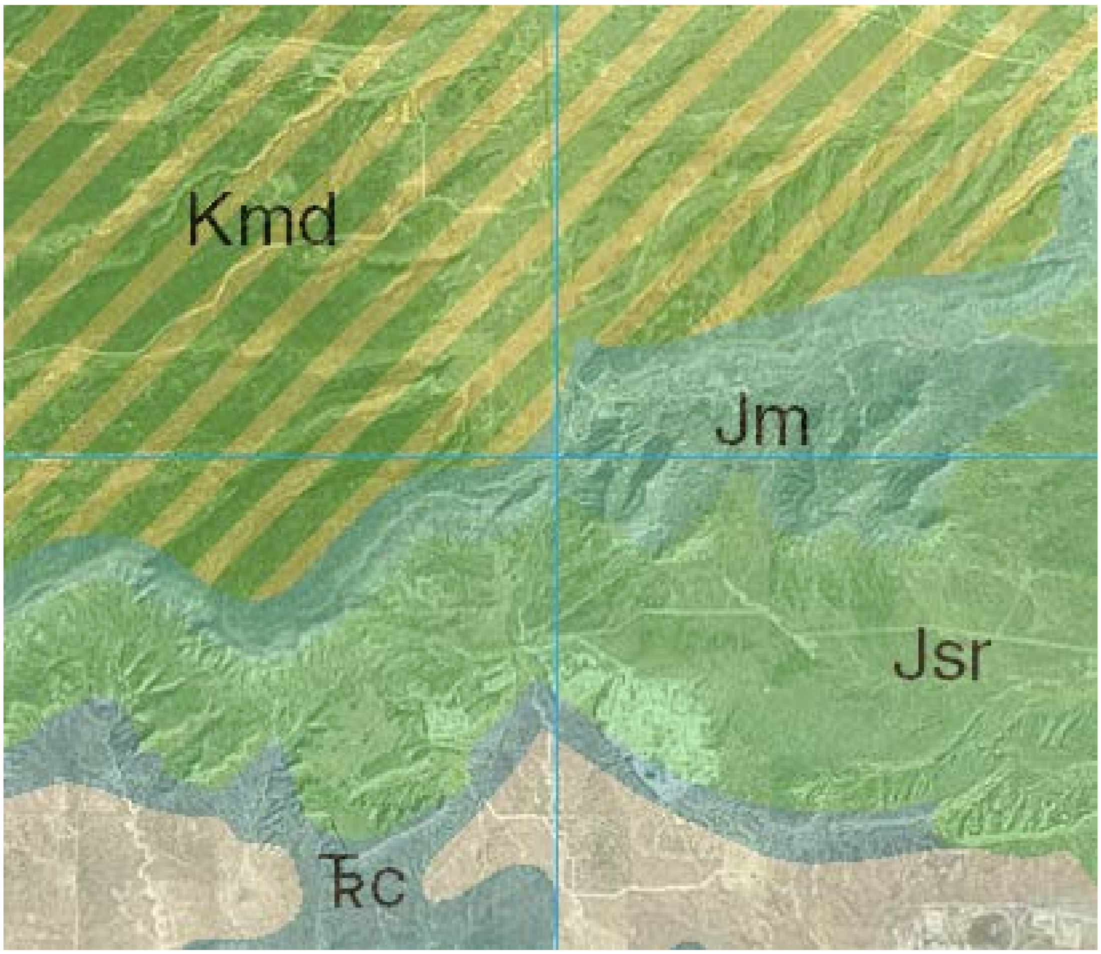


Figure 4-21 San Antonio Hill Geology Map (NMBGMR, 2015)

4.3.1.3.3 Rating Systems

Projecting a tunneling mythology for a given rock or formation requires knowledge of rock or formations through which the tunnel passes. Within the geology and mining community there exists such methods “and it is recommended that at least two methods be used at any site during the early stages of a project.” (Rocscience Inc., 2000) Such methodologies are the Rock Mass Rating (RMS) System developed by Bieniawski, the Q-System developed by Barton, Terzaghi rock mass, Rock Quality Designation Index, and the New Austrian Tunneling Method. (Rocscience Inc., 2000) (Kolymbas, 2008)

Each method will vary slightly due to different parameter considerations. (Rocscience Inc., 2000). The Terzaghi system uses a nomenclature method for describing rocks without a numerical value, whereas RMS is empirically based with RQD and the Q-system yielding qualitative results (Rocscience Inc., 2000). The unfortunate reality of rating systems such as the RMS and Q-system is that they require core sampling of the formation of interest, something that has not yet occured. This means that these quite useful systems are currently unusable until at least an accurate RMS evaluation of the area of interest has been done.

4.3.1.3.4 Standard Rock Characteristics

The prevailing rock types and formations of the areas of interest are shale, sandstone, and Crevasse Canyon Formation. Shale will experience “squeezing and swelling problems, descried by Terzaghi” due to shale being described as “a fine-grained sedimentary rock that forms from the compaction of silt and clay-size mineral particles”. (Rocscience Inc., 2000) (King) Sandstone is a sedimentary rock consisting of larger particulates than shale.

A paper published by rocscience.com on the subject of rock mass properties characterizes the uniaxial compressive strengths of sandstone and shale. (Measurement of Rock Mass Properties for Mine Design, 1993) Sandstone is defined as having ‘strong’ to ‘very strong’ properties which correlate to uniaxial compressive strengths ranging from 50 to 250 MPa. (Measurement of Rock Mass Properties for Mine Design, 1993) Shale is defined as being ‘medium strong’ to ‘strong’ relating to uniaxial compressive strengths of 25 to 100 MPa. (Measurement of Rock Mass Properties for Mine Design, 1993).

4.3.1.3.5 Tunneling and Excavation

Five types of tunnel excavation exist: hammer, excavators, roadheaders, tunnel boring machines and blasting (Kolymbas, 2008). Hammers are effective on rock types with ‘unconfined strength’ properties ranging from 40 to 100 MPa with excavation speeds ranging from 40 to 20 cubic meters per hour (Kolymbas, 2008). If excavators and rippers are to be used the rock cannot have an RMR value higher than 30 for the excavators and 100 for the rippers (Kolymbas, 2008). This emphasizes the need for an accurate RMR value to be known for the desired locations. A tunnel boring machine is applicable to removing rocks of higher strengths than either hammers or excavators. The last method of tunnel construction is drill and blasting which is seen as “advantageous for relatively short tunnels” and “ very hard rock” (Kolymbas, 2008).

Hammer excavation may not be optimal for the locations under investigation due to the possibility of rocks whose strengths exceed the effective range of the hammer. The tunnel boring machine method would get the job done but is likely not cost effective for the relatively short tunnel length needed. **Drill and blasting would likely be the most effective method for tunneling at the desired location(s) with current knowledge, but it is highly recommended that more knowledge of the RMR values of said locations is known before a final decision is made.**

4.3.1.3.6 Tunnel and Excavation Cost

Cost estimates for building a tunnel depend specifically upon the case at hand, but comparisons can be made to other railroad tunnels. The Midwest High Speed Rail Association compiled a study of high speed rail lines in the Midwest from which several tunnel estimations can be gathered. Four railroad projects were found with tunneling expenses reported in 2010 dollars those projects include: a Chicago to Minneapolis/St. Paul rail corridor of 455 miles (Economic Development Research Group, AECOM, 2011), a Chicago to St. Louis route of 311 miles (Economic Development Research Group, AECOM, 2011), a Chicago to Cincinnati route of 284 miles (Economic Development Research Group, AECOM, 2011), and a Chicago to Detroit/Cleveland route of 420 miles (Economic Development Research Group, AECOM, 2011). However, none of these projects detailed the tunneling expense in terms of per mile or in a way that could be extrapolated accurately to the proposed route.

In a presentation on tunneling given at the University of Oxford the cost of tunnels in urban settings was estimated to “cost on average £50 million per kilometer.” (Pickhaver, 2004) **This cost correlates to averages of $122.78 million per mile in an urban setting** (Pickhaver, 2004)**. If a retained cut were made instead of a tunnel, “typical unit costs” for such would be 85 million per route mile** (Economic Development Research Group, AECOM, 2011).

4.3.1.4 Crownpoint and Heart Rock Quadrangles

The rail line alignment through Crownpoint and Heart Rock closely follows the eastern edge of NM 371 except near the town of Crownpoint where it runs farther east away from residential structures and near NM 57 where it runs farther east around a large rock formation. The alignment of the route is shown in Figure 4-22.

Alternative 2 in Figure 2-1 would go due west to the Navajo Reservation line and continue north along the reservation near Crownpoint. However following NM 371 through Crownpoint leaves open the possibility of future passenger rail service to Crownpoint if future development of the line included the addition of passenger service. A shift from following NM 371 to following the reservation line between the northern opening of Satan Pass and the south side of Crownpoint is problematic because existing homes come right up to the edge of the mesas that extend out from the mountains to the south. It is instead recommended that if the line is to make the shift from NM 371 to the Navajo Reservation border it be along Indian Service Route 7101 or 7009, or near where NM 57 meets NM 371. The ground is fairly flat in all three regions, so whichever of the three routes is populated with allottees most willing to grant right of way access when funding is available to purchase such rights of way should be the route chosen.

The grade and profile of the rail alignment through the Heart Rock and Crownpoint quadrangles is presented in Figure 4-23 and Figure 4-24. There is some considerable fill in the Heart Rock quadrangle as the descent continues out of Satan Pass, but the remainder of the alignment through these quadrangles has only moderate levels of cut and fill required to meet grade as seen in Table 4-5.

Table 4-5 Crownpoint and Heart Rock Excavation

	Disturbed Area (Sq ft)	Volume of Cut (Cu Yd)	Volume of Fill (Cu Yd)	Net Cut/Fill (Cu Yd)
Heart Rock Segment	1,420,134	133,710	221,211	87,501 <Fill>
Crownpoint Segment	2,422,377	237,450	125,120	112,330<Cut>
TOTAL	3,842,512	371,161	346,332	24,829<Cut>

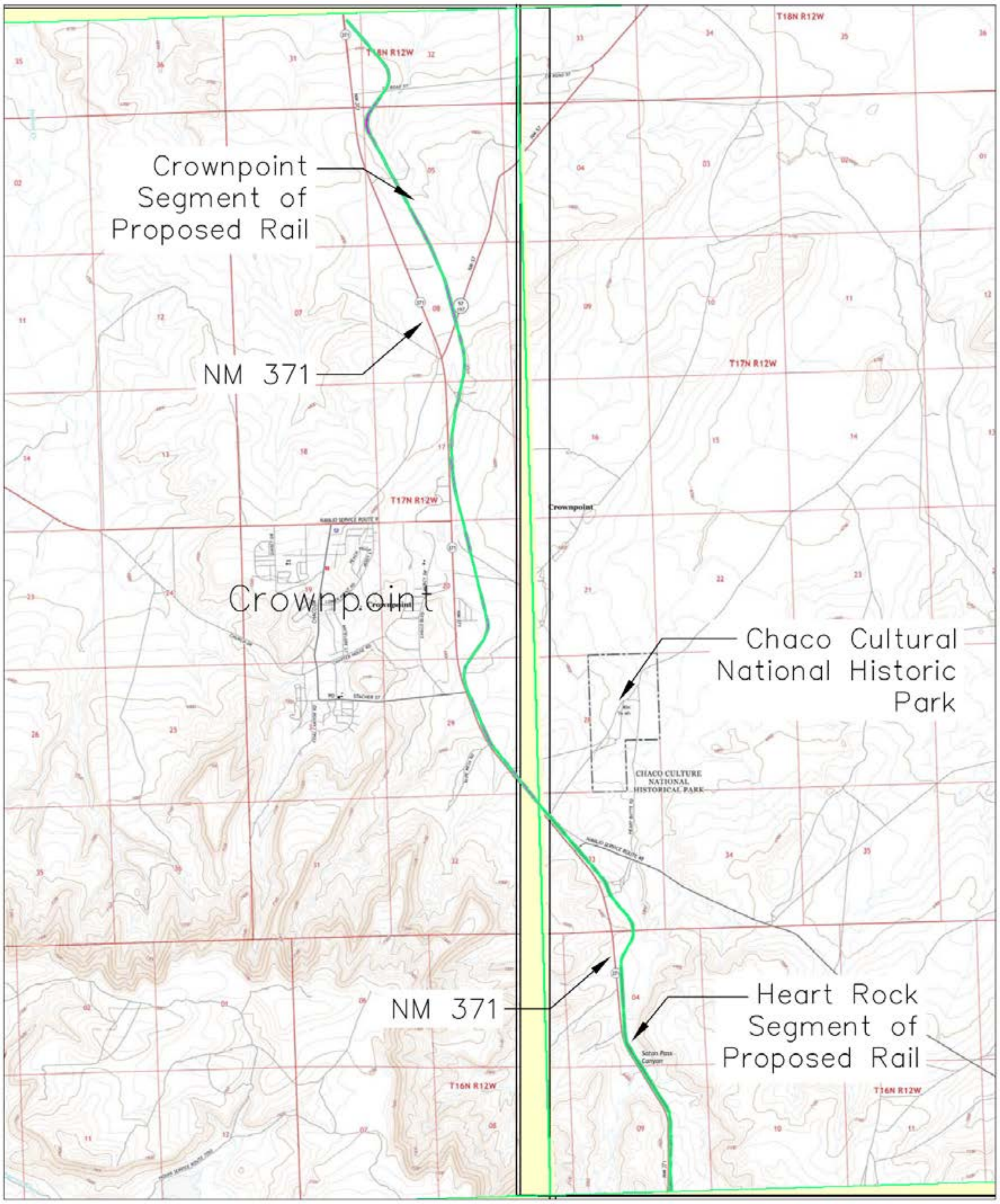


Figure 4-22 Rail Alignment at Crown Point and Heart Rock Quadrangles

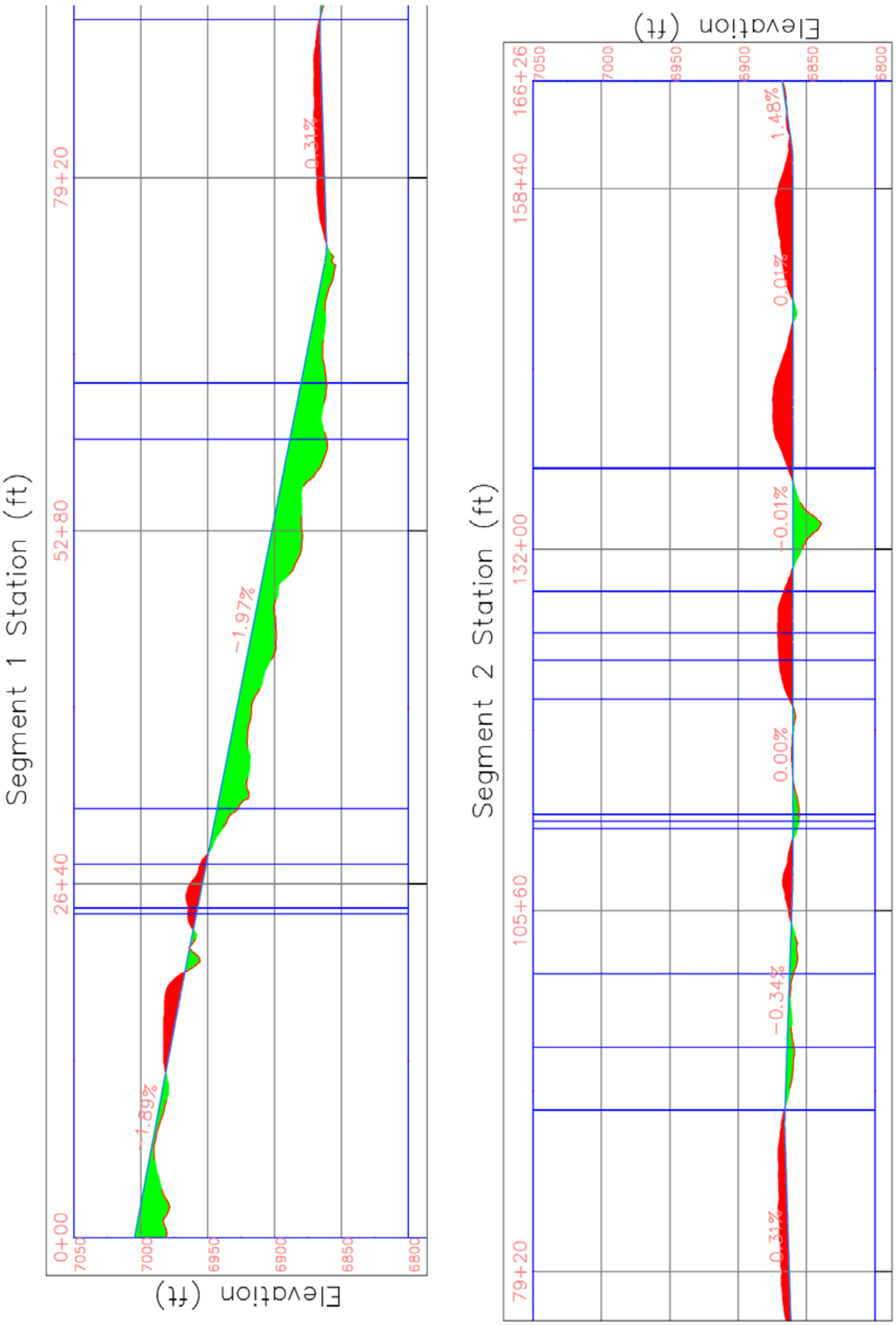


Figure 4-23 Heart Rock Segment Rail Profile

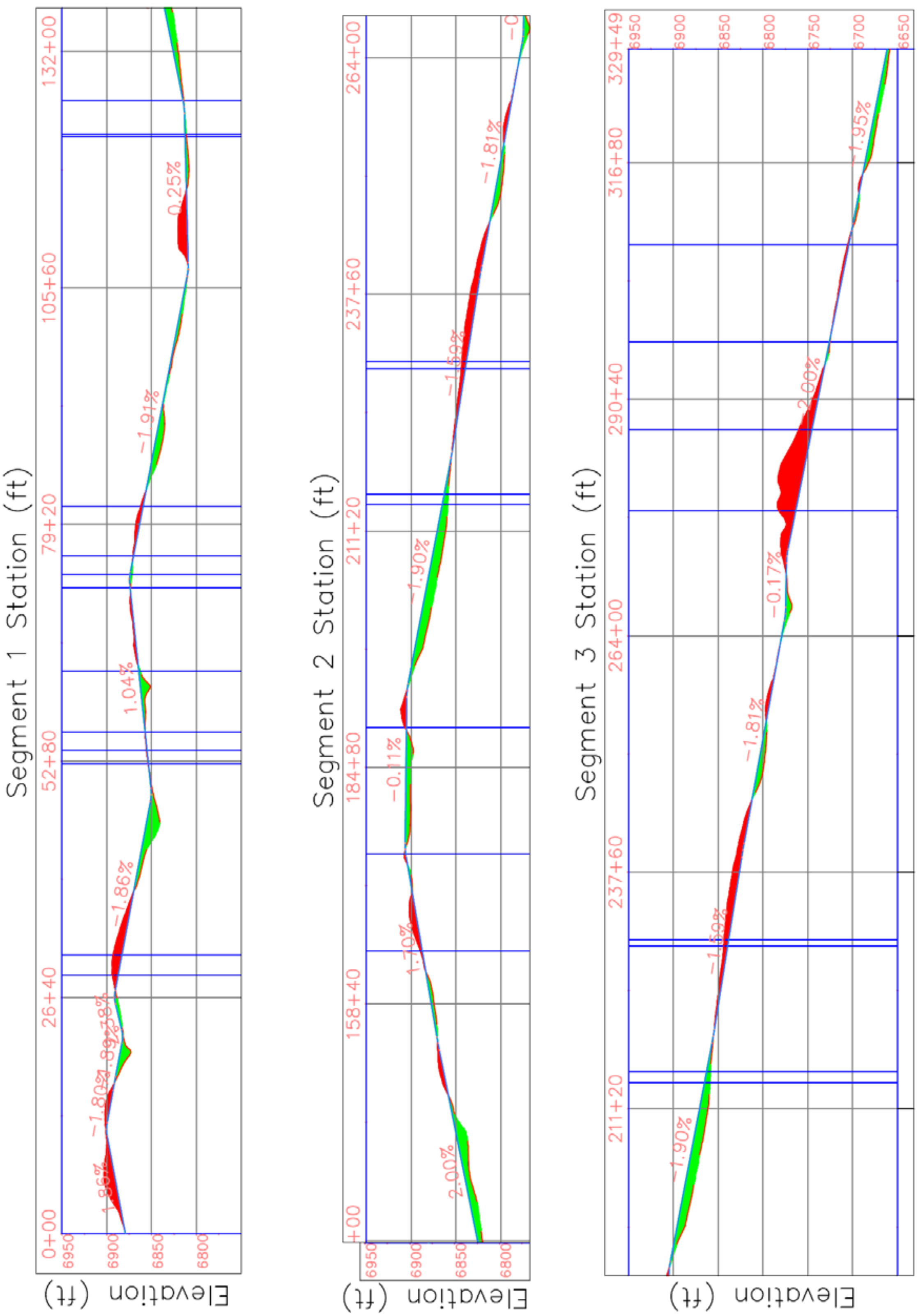


Figure 4-24 Crownpoint Segment Rail Profile

4.3.1.5 Antelope Lookout Mesa Quadrangle

The proposed rail alignment through Antelope Lookout Mesa follows the eastern side of NM 371 closely with small diversions around mesas and rock outcroppings (Figure 4-25). The proposed alignment through Antelope Lookout Mesa easily meets the required 2% grade and 4 degree curvature requirements. A profile of the grade along the proposed alignment can be found in Figure 4-26. Segment three of the Figure 4-26 profiles contains two deep stretches of fill, which would likely be accomplished through bridging rather than fill. The amount of cut and fill is minimal and within what is assumed in the standard 1 million dollar a mile cost estimate.

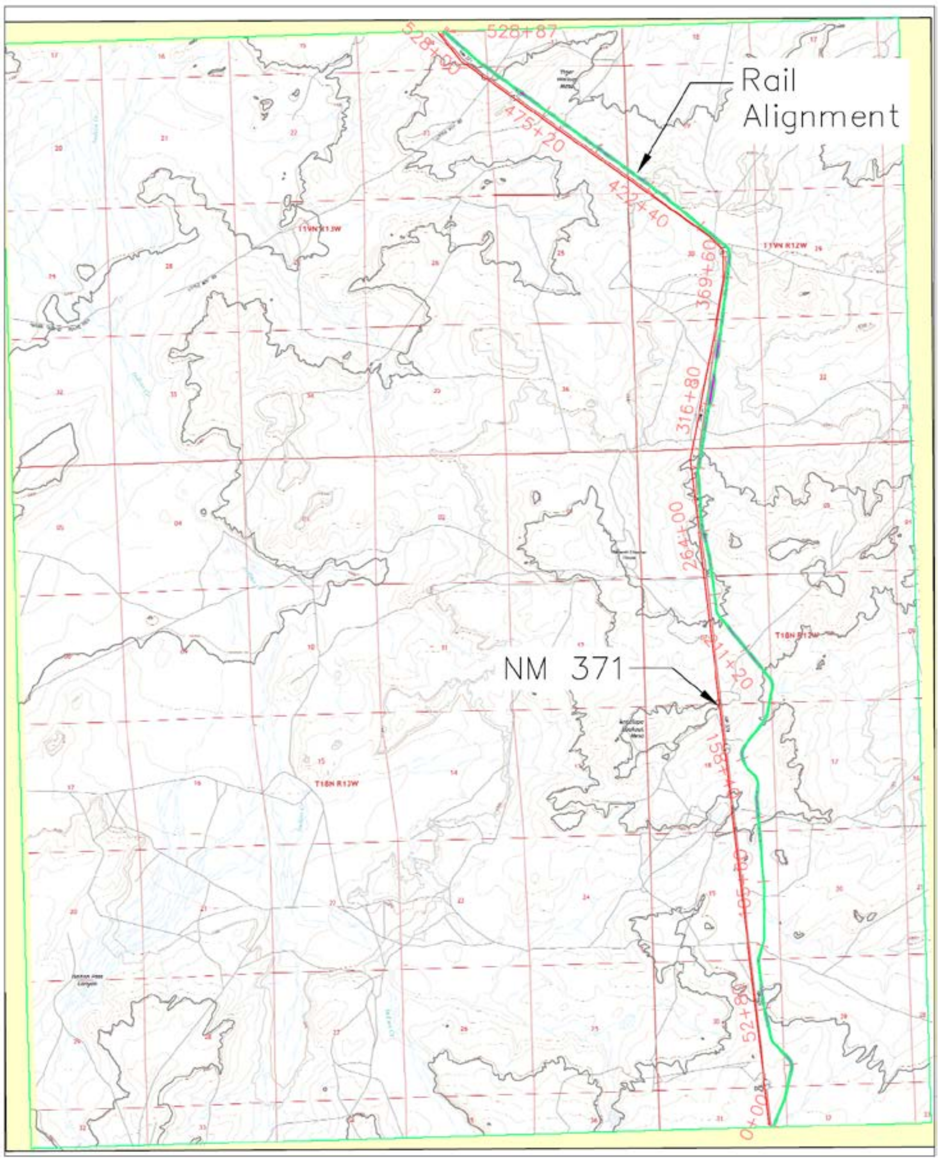


Figure 4-25 Rail Alignment at Antelope Lookout Mesa Quadrangle

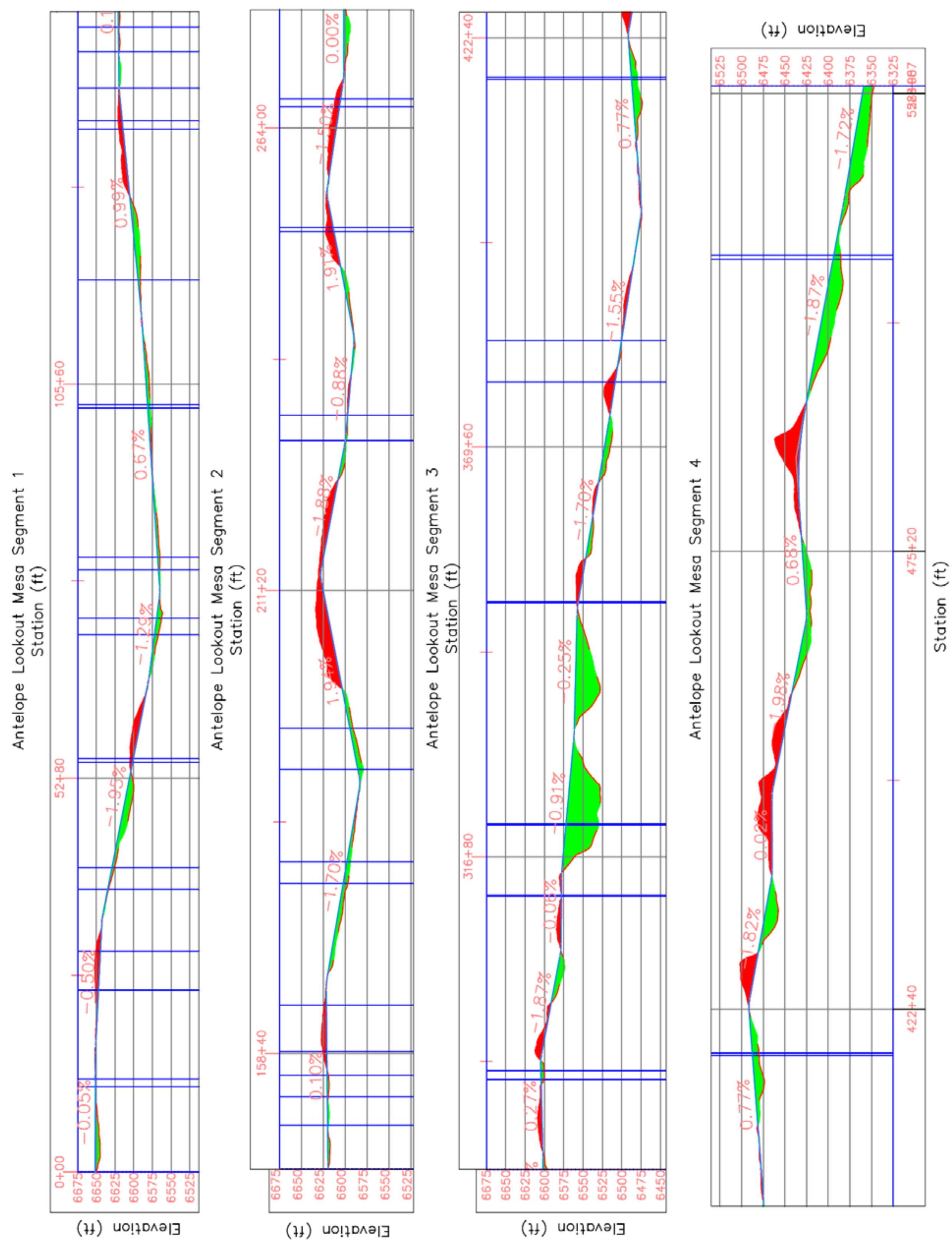


Figure 4-26: Antelope Lookout Mesa Rail Alignment Grade Profile

4.3.1.6 Milk Lake Quadrangle

The proposed rail alignment through Milk Lake continues along NM 371 switching from the east to west side of the road about halfway through the quadrangle (Figure 4-27). As with Antelope Lookout he proposed alignment through Milk Lake easily meets the required 2% grade and 4 degree curvature requirements, and a profile of the proposed grade along can be found in Figure 4-28. The main thing of note in the Milk Lake Quadrangle is the presence of an outlier of the Chaco Cultural National Historic Park in the north east corner. The proposed rail line is located 3.5 to 4 miles west of the parks western edge, and the main park is located 10+ miles from the proposed alignment.

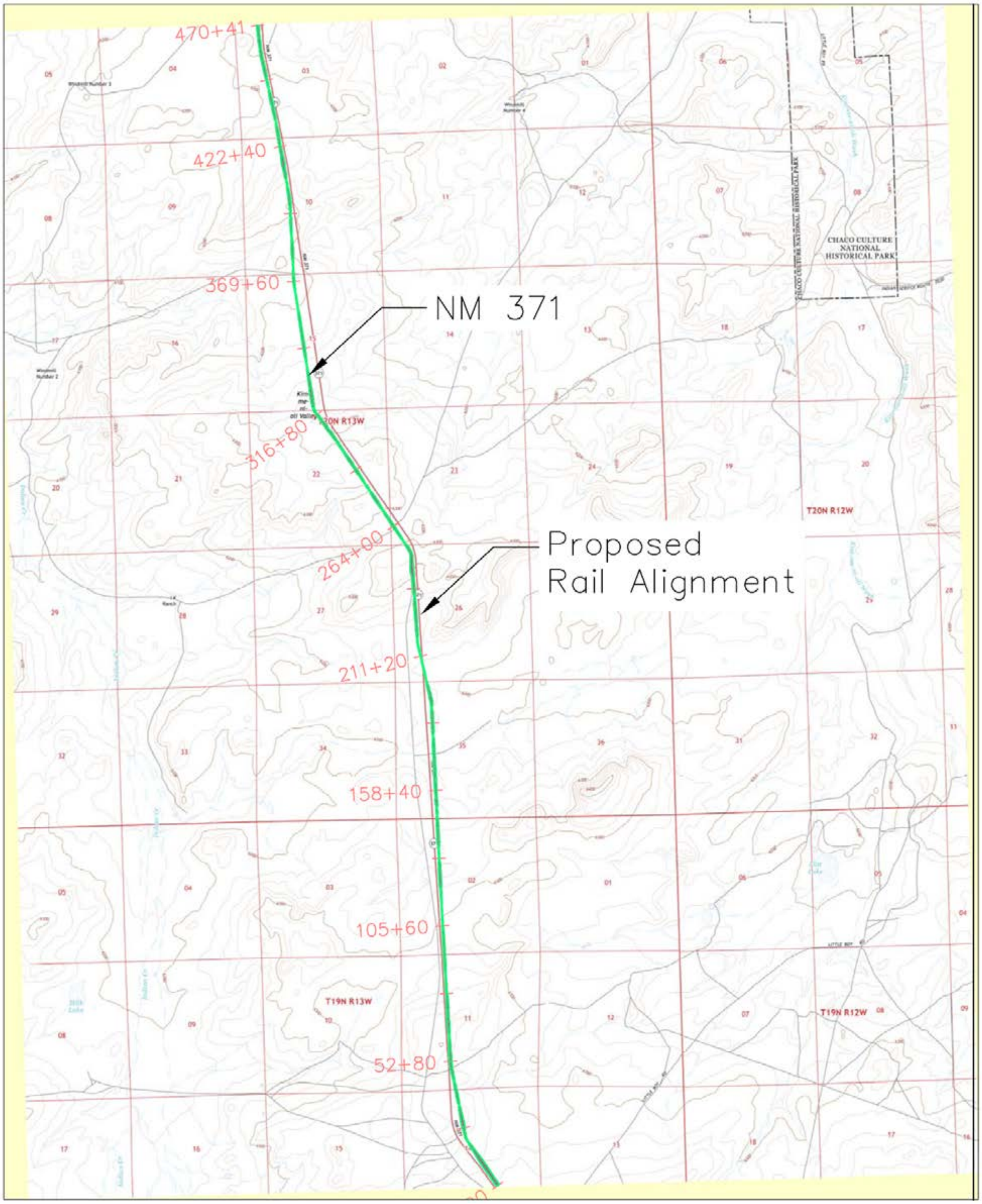


Figure 4-27 Rail Alignment at Milk Mesa Quadrangle

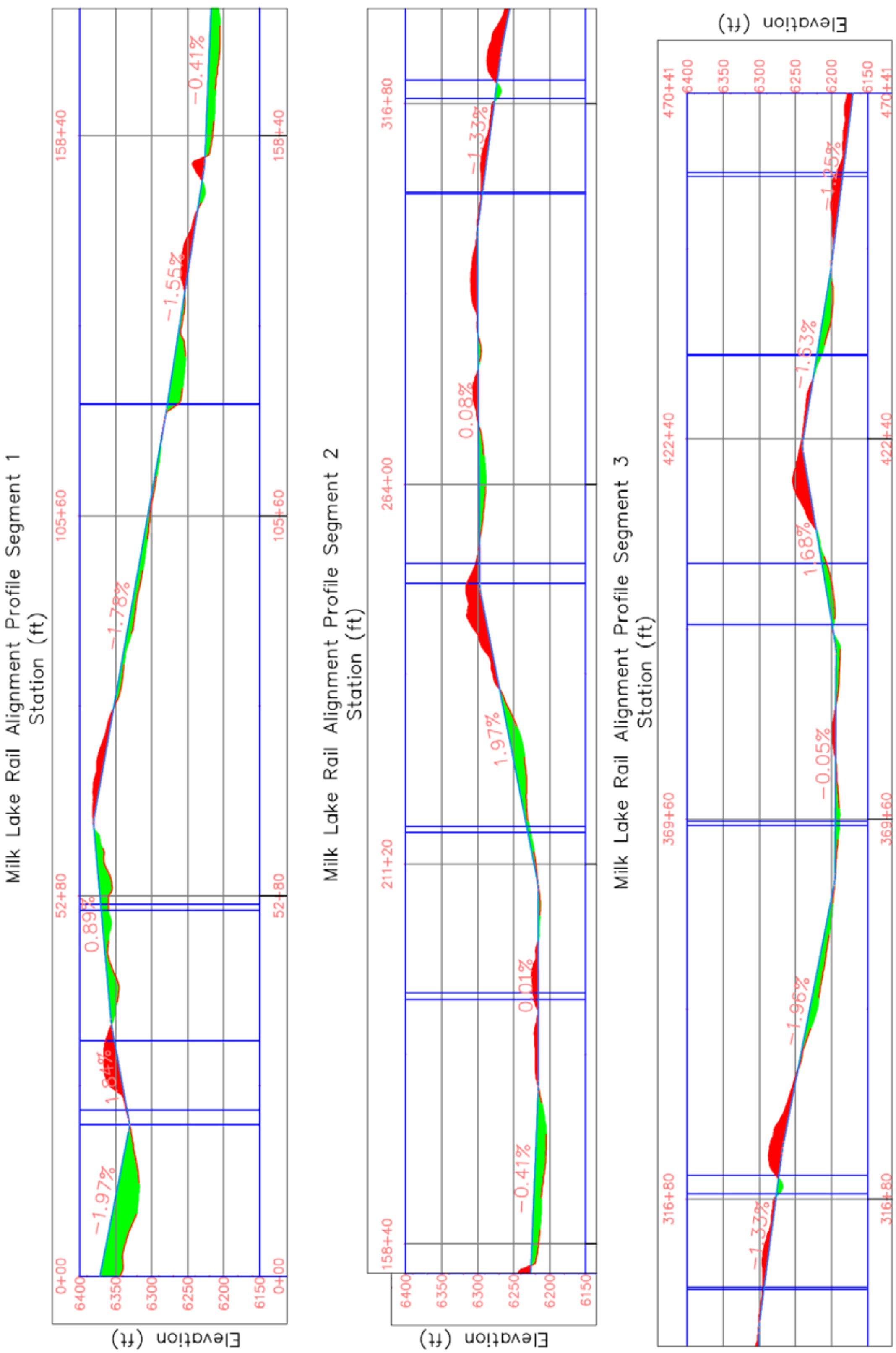


Figure 4-28: Milk Lake Rail Alignment Grade Profile

4.3.1.7 La Vida Mission Quadrangle

The proposed rail alignment through La Vida Mission follows the western side of NM 371 until it reaches County Road 7745 (Figure 4-29). It then follows the western edge of County Road 7745 along the west side of the Chaco River. Grade changes in La Vida Mission Quadrangle are relatively mild and within the required 2% but are harder to maintain than Milk Lake or Antelope Lookout Mesa (Figure 4-30). The grade profile in Figure 4-30 is broken into three sequential segments in order for the scale to be large enough to read. The amount of cut and fill required in the La Vida Mission quadrangle is well within the 1 Million dollars a mile cost estimate. As a result of the steep grades in the region and the need to meet the grade requirements in and around White Rock, the political feasibility assessment is likely to be more complicated than in other areas where the grade is less restrictive.

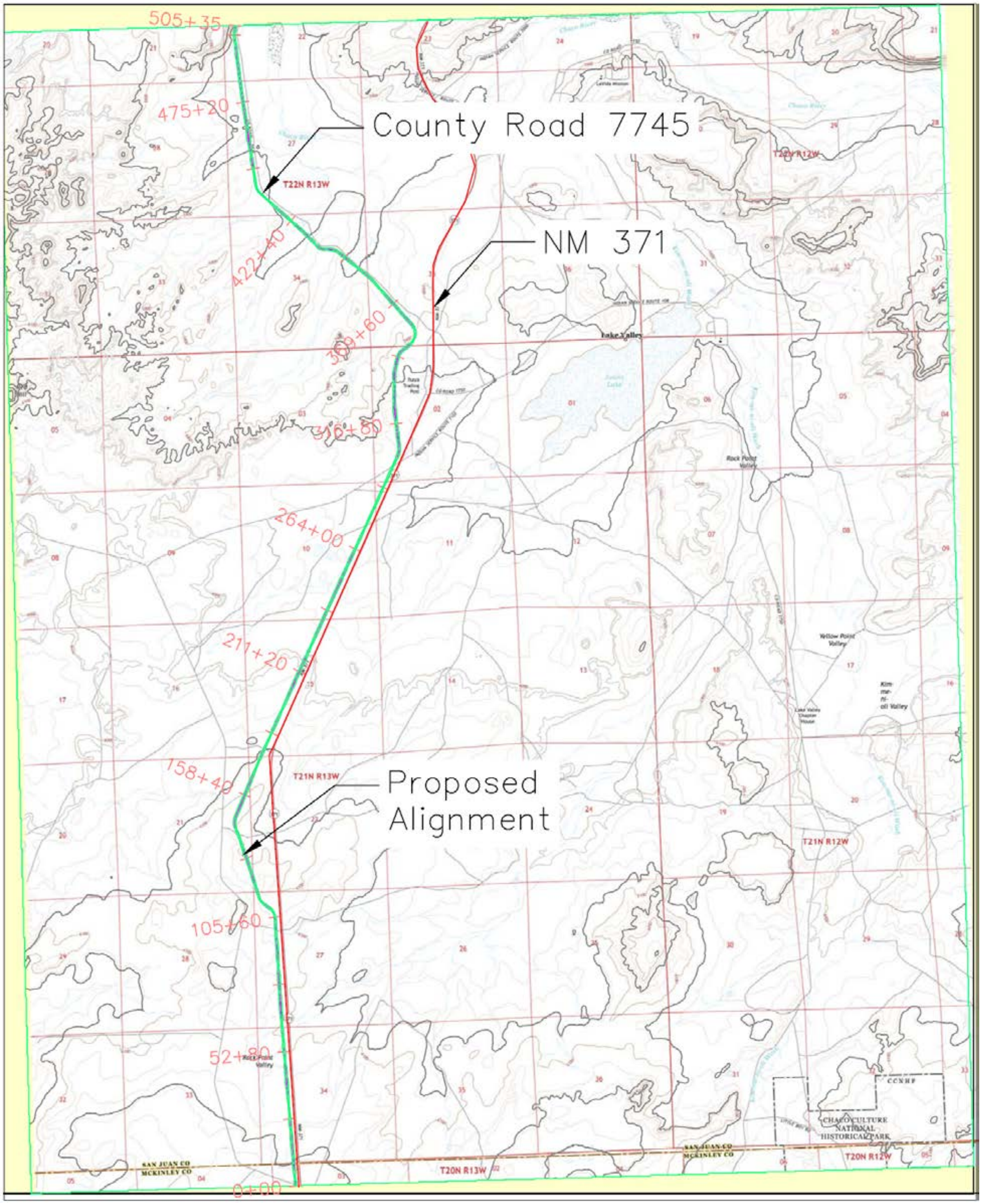


Figure 4-29 Rail Alignment at La Vida Mission Quadrangle

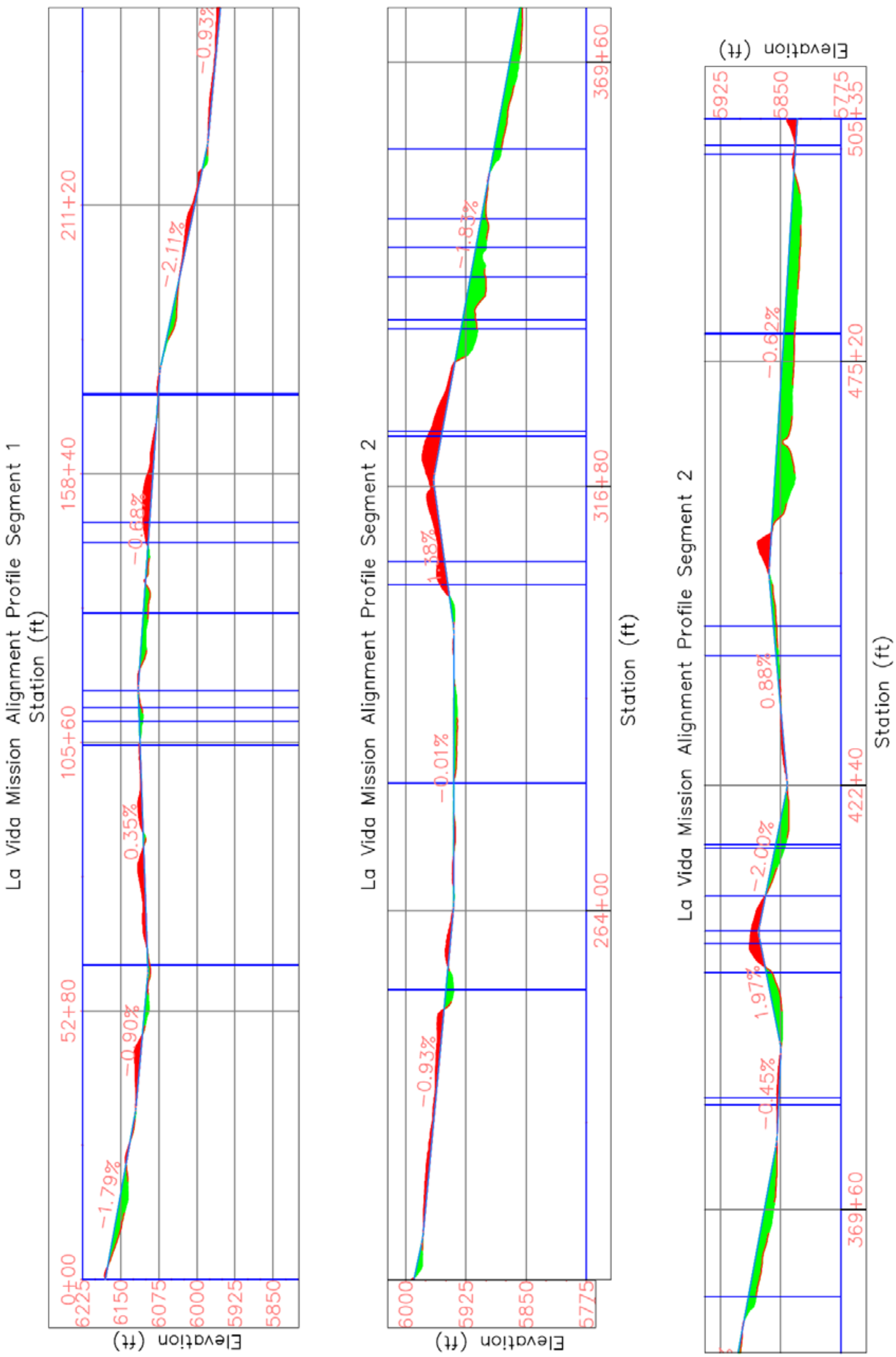


Figure 4-30: La Vida Mission Rail Alignment Grade Profile

4.3.1.8 Tanner Lake and Hunter Wash Quadrangles

The rail alignment through Tanner Lake and Hunter Wash Quadrangles follows the western bank of Chaco River, and cuts west from NM 371 toward the Navajo Reservation line (Figure 4-31). The grade along this section of the proposed alignment continues to fall below the maximum of 2% and is split between three figures: Figure 4-32, Figure 4-33, and Figure 4-34. The most technically challenging portion of the route through these quadrangles is the bridge required to cross the Chaco River. The location of the bridge has the potential to be impacted by factors such as a soil study and an archeologic survey of the river crossing site.

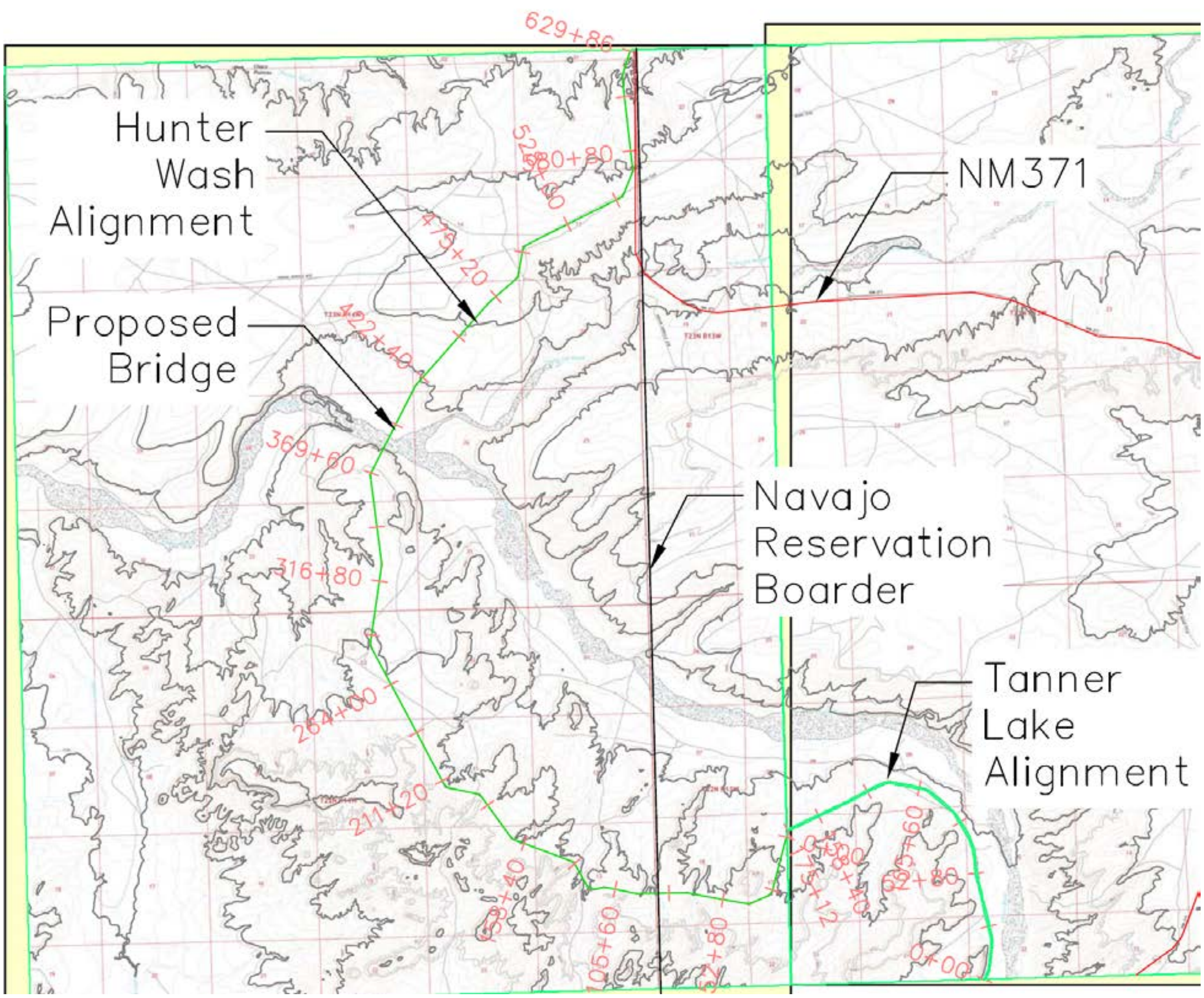


Figure 4-31 Rail Alignment at Hunter Wash (left) and Tanner Lake (right) Quadrangles

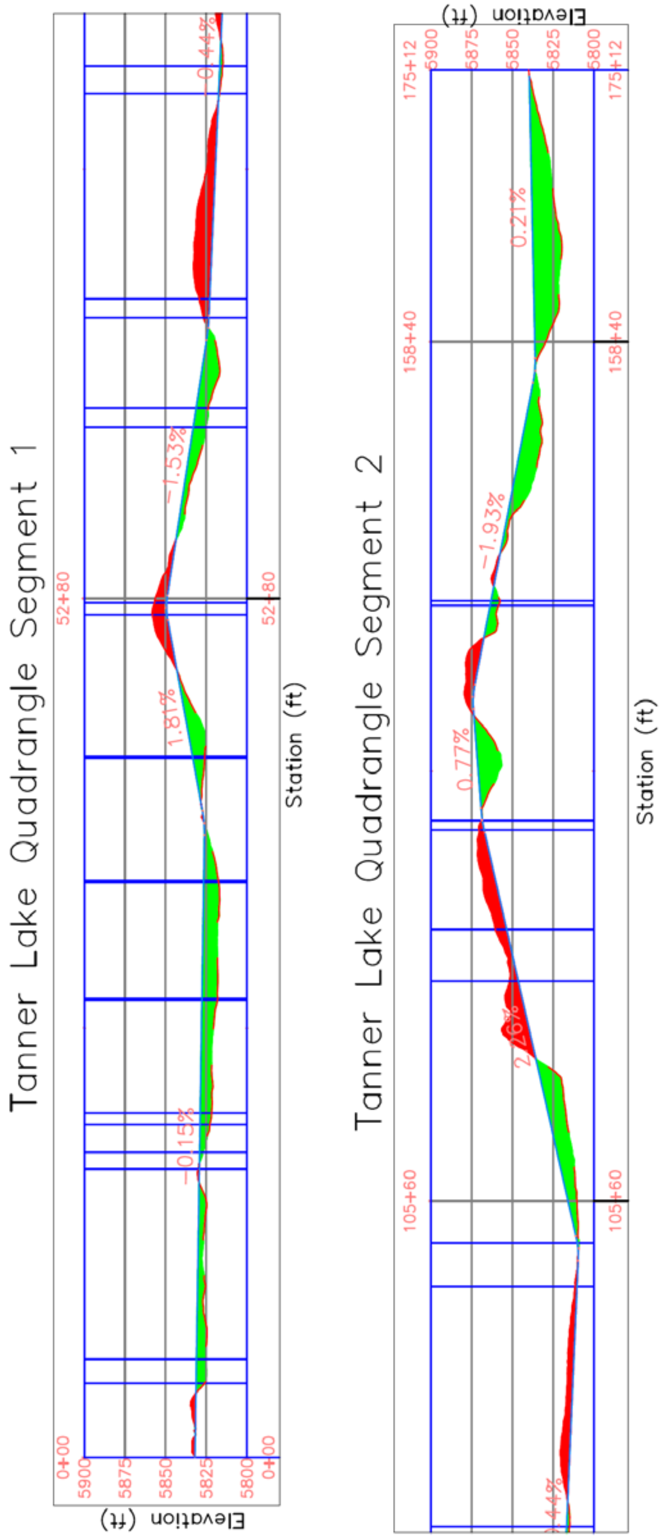


Figure 4-32: Tanner Lake Rail Alignment Grade Profile

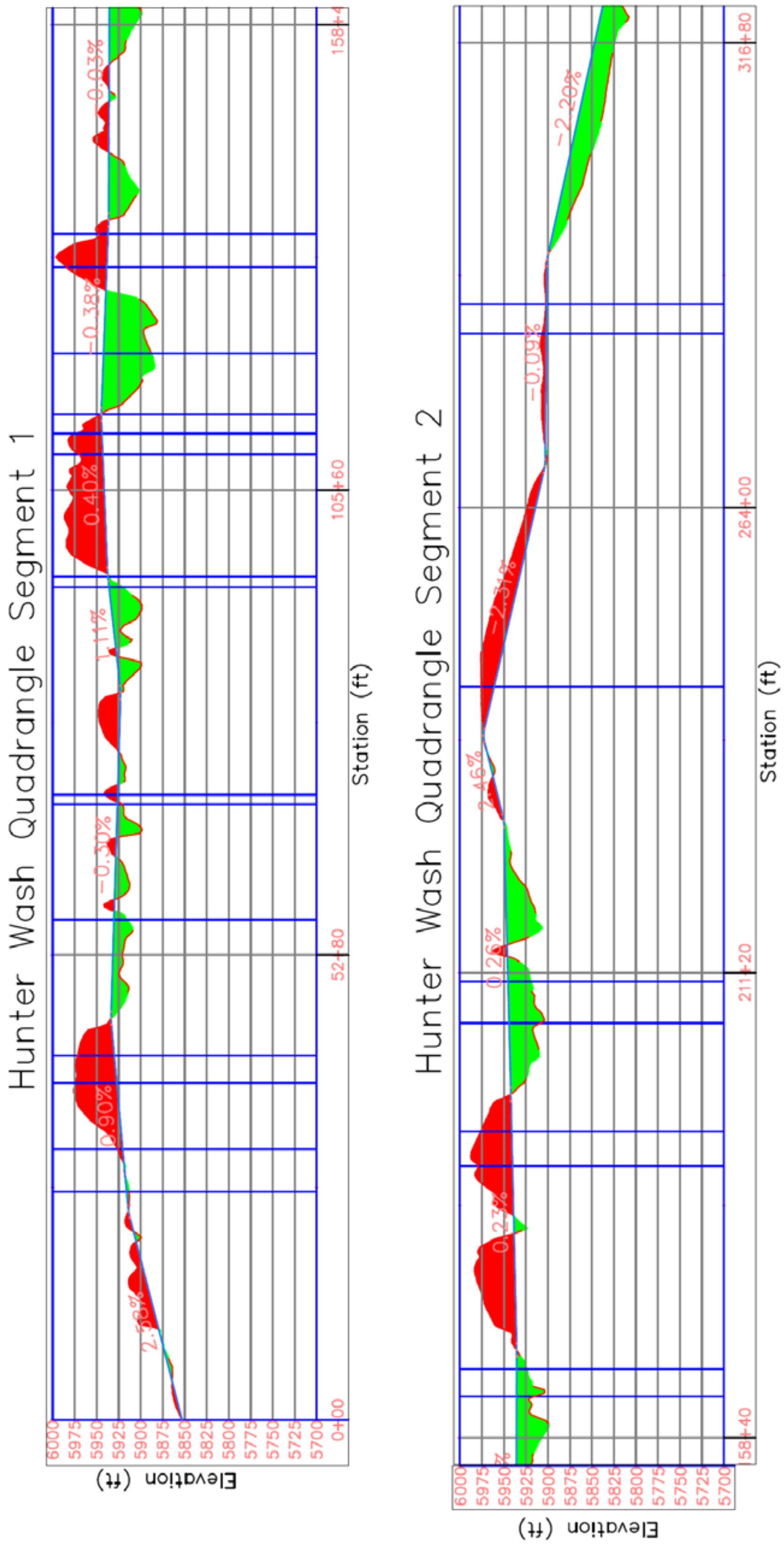


Figure 4-33 Hunter Wash Quadrangle Rail Alignment Grade Profile Segments 1 and 2

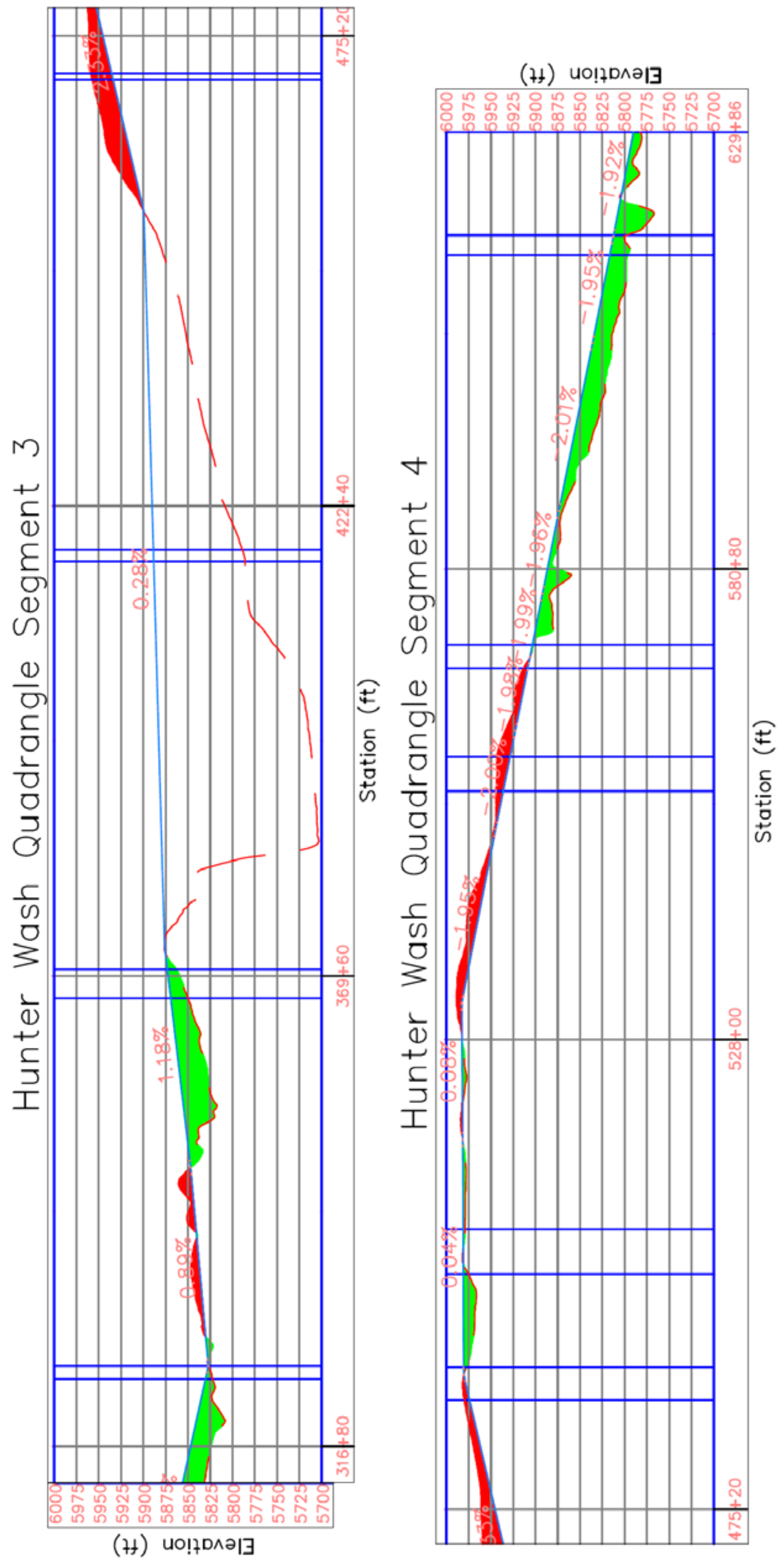


Figure 4-34 Hunter Wash Rail Alignment Grade Profile Segments 3 and 4

4.3.1.9 Bisti Trading Post Quadrangle

The rail alignment though Bisti Trading Post Quadrangle (Figure 4-35) and grade profile of the route (Figure 4-36), show a route through the region that meets the required grade and curvature without significant technical challenges. The route through this region will follow the edge of the Navajo Reservation, and the most technically challenging portion will be crossing three oil/gas pipelines that all run parallel to each other diagonally across the region.

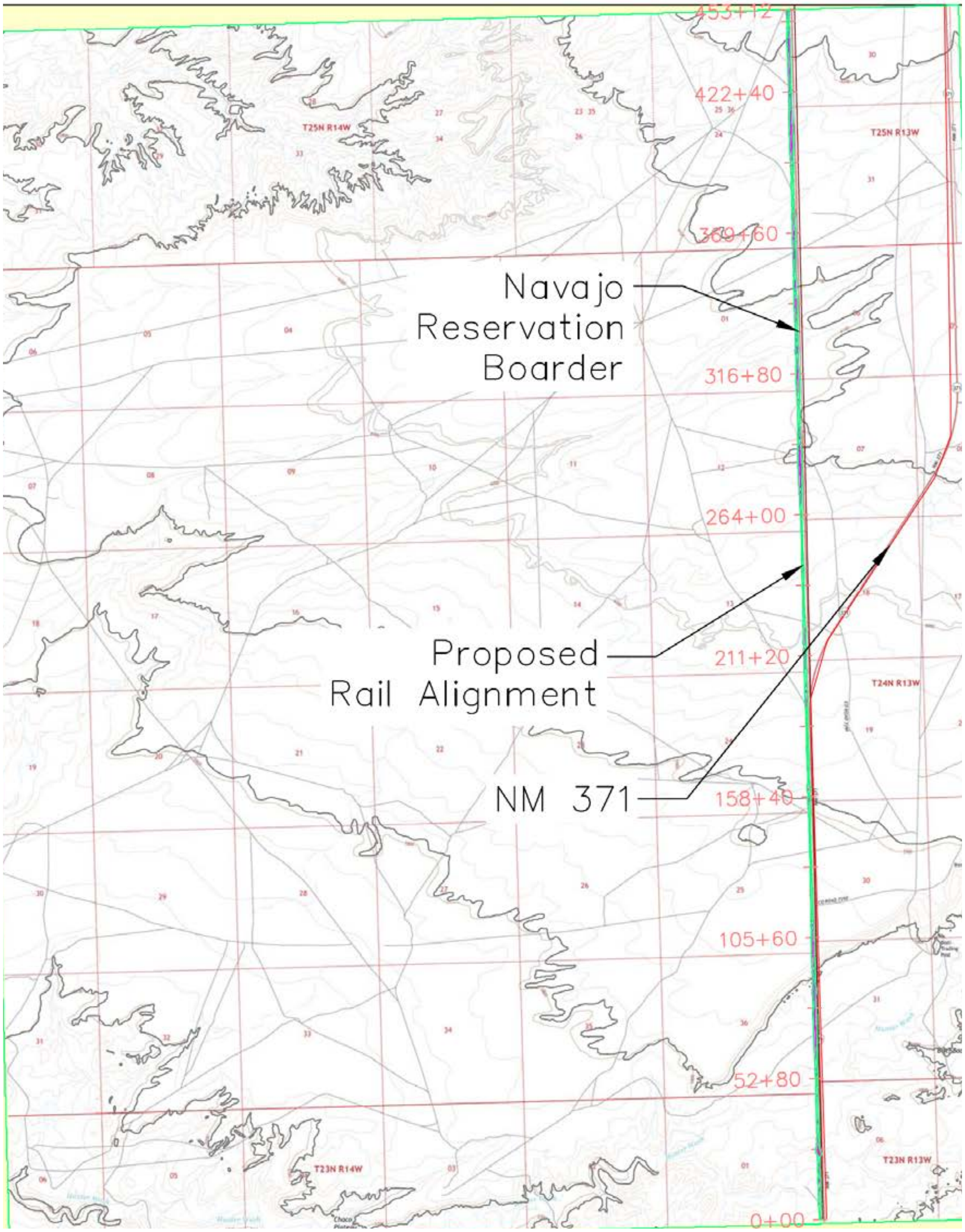


Figure 4-35 Rail Alignment at Bisti Trading Post Quadrangle

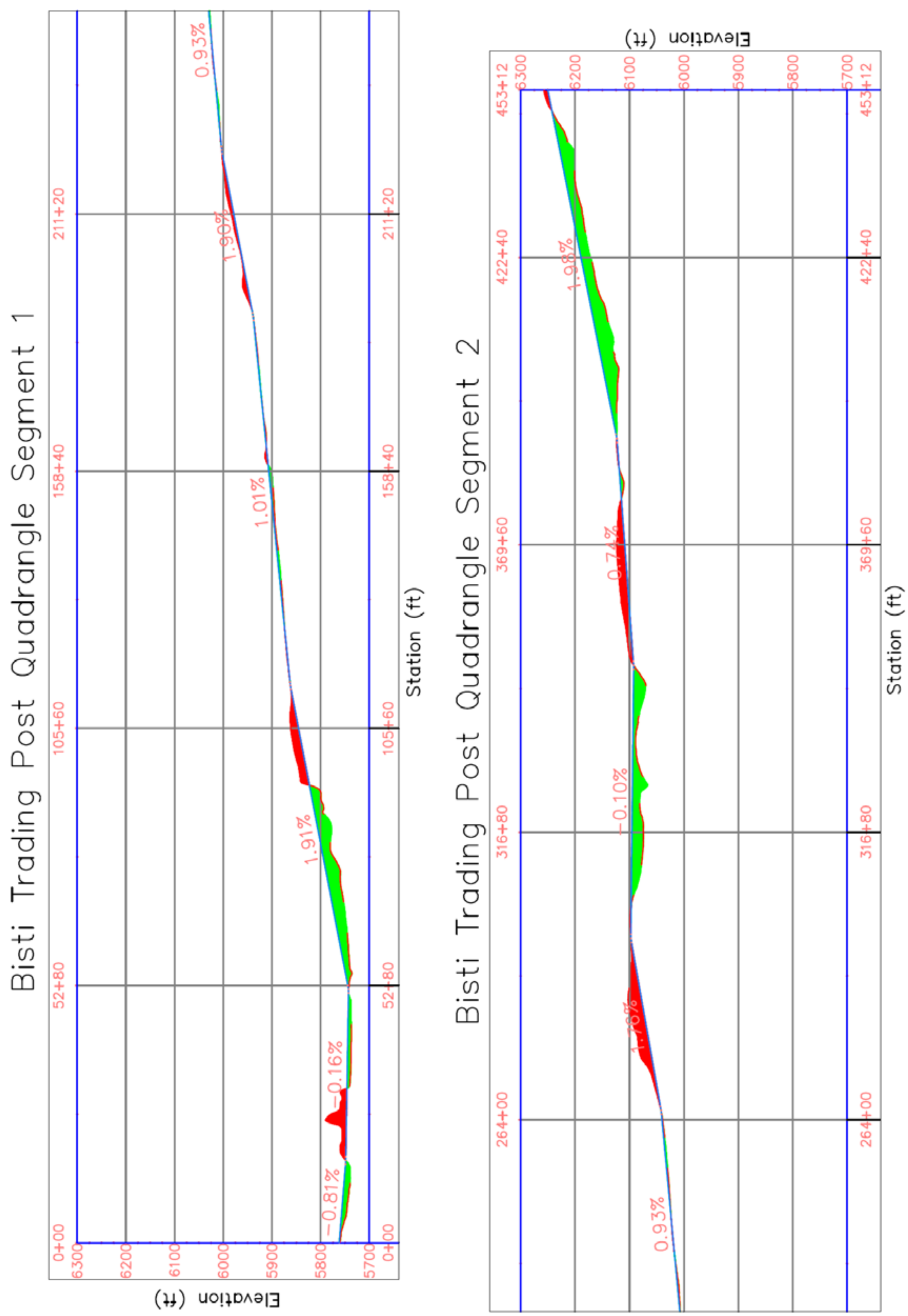


Figure 4-36: Bisti Trading Post Grade Profile of Rail Alignment

4.3.1.10 The Pillar Quadrangle

The proposed rail line continues north through the Pillar Quadrangles (Figure 4-37) and ends at the proposed Bisti Oil Field/NAPI Terminal near the north east corner of the quadrangle. In order to avoid the steep grade near Moncisco Mesa the proposed route swings west around the mesa. The resulting profile of the proposed route is presented in Figure 4-38. The Bisti/NAPI terminal will be at the northern end of the Pillar quadrangle, and from there the line will branch west to the Navajo Mine. The rail alignment west to the Navajo Mine is presented in section 4.3.2.

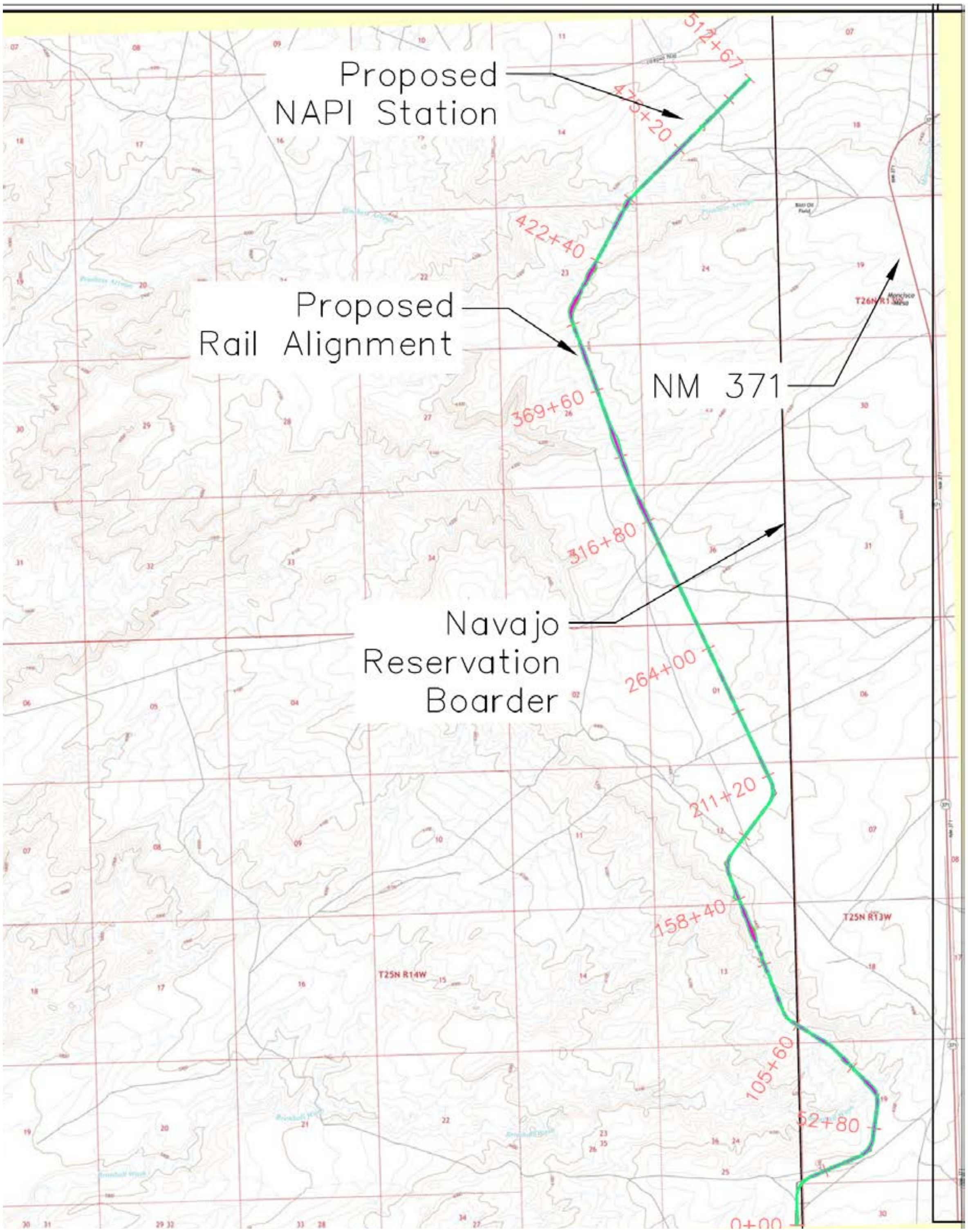


Figure 4-37 Rail Alignment at The Pillar Quadrangles

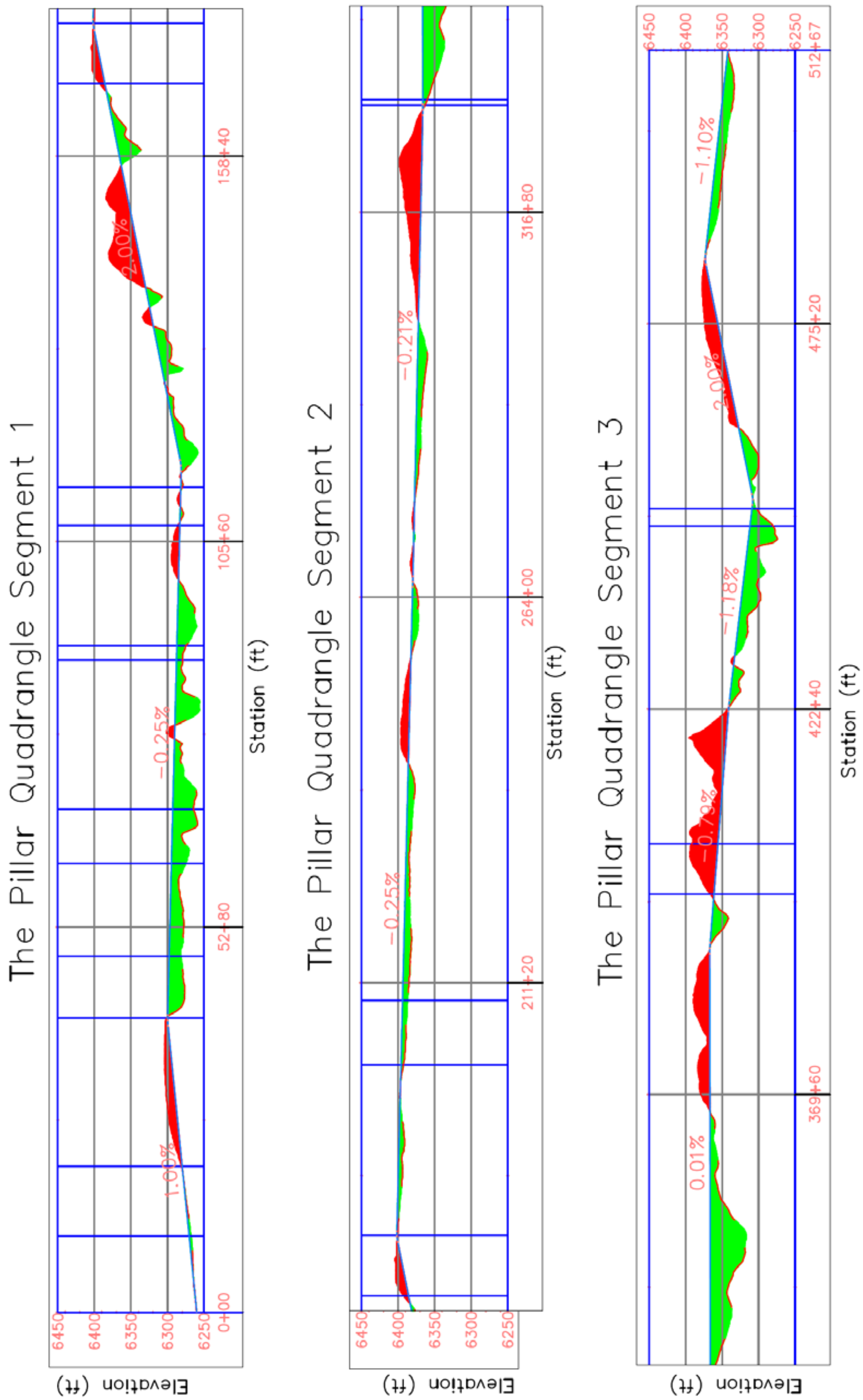


Figure 4-38 The Pillar Grade Profile of Rail Alignment

4.3.2 Rail Segment 2 Bisti Oil Fields/NAPI to Navajo Mine

Rail segment 2 connecting the Navajo Mine to the main Thoreau to Farmington line is just under 20 miles in length and crosses 4 quadrangles: The Pillar, The Pillar NW, Newcomb NE, and the Hogback South. This rail segment would provide direct access from the coal mine to the national rail network and by connecting to the existing Navajo Railroad would provide direct access for the Four Corners Power Plant to import chemicals and export fly ash or other waste products. Again two cost estimates have been prepared the first in Table 4-6 based on a single track and the second in Table 4-7 based on a double track connection to the mine. **If export from the mine totals 3 million tons a year, then one train per day each direction could be expected on the line. Or if exports total 6+ million tons a year, then two trains per day each direction should be expected. In either case single track construction should be sufficient for this segment of the rail line.**

Table 4-6 Construction Cost for Single Track Along Rail Segment 2

NAPI to Navajo Mine Single Track Cost Estimate				
Item	Quantity	Units	Unit Price	Cost
Clearing and Grubbing	221.7	AC	$ 1,850.00	$ 410,145.00
Excavation and Embankment	4273136.8	CY	$ 4.44	$ 18,972,727.44
Sub-ballast (30 ft)	153547.5	TN	$ 17.76	$ 2,727,003.60
Bridges	0	EA	$ 666,000.00	-
Culverts	39	EA	$ 6,926.40	$ 270,129.60
R/W Fencing	38.8	MI	$ 23,443.20	$ 909,596.16
Track Work	102365	FT	$ 140.60	$ 14,392,519.00
Siding	21120	FT	$ 83.50	$ 1,763,520.00
Main Crossing	0	EA	$ 10,656.00	-
Secondary Crossing	9		$ 10,656.00	$ 95,904.00
Totals				**$ 39,541,544.80**

Table 4-7 Construction Cost for Double Track Along Rail Segment 2

NAPI to Navajo Mine Double Track Cost Estimate				
Item	Quantity	Units	Unit Price	Cost
Clearing and Grubbing	221.7	AC	$ 1,850.00	$ 410,145.00
Excavation and Embankment	4,273,136	CY	$ 4.44	$ 18,972,727.44
Sub-ballast (45 ft)	230,321	TN	$ 17.76	$ 4,090,505.40
Bridges	0	EA	$ 666,000.00	-
Culverts	39	EA	$ 6,926.40	$ 270,129.60
R/W Fencing	38.8	MI	$ 23,443.20	$ 909,596.16
Track Work	204,730	FT	$ 140.60	$ 28,785,038.00
Main Crossing	0	EA	$ 10,656.00	-
Secondary Crossing	9	EA	$ 10,656.00	$ 95,904.00
Totals				**$ 53,534,045.60**

Connecting the existing Navajo Indian Railroad to the Thoreau-Farmington line will require cutting across undeveloped land between The Pillar Quadrangle and the Navajo Mine (Figure 4-39). A route that is technically feasible has been identified and the resulting grade is presented in Figure 4-40 and Figure 4-41. Due to the undeveloped and undisturbed nature of this section of the route, the potential exists for substantial modification being required in order to avoid any archeologically significant sites. From an engineering standpoint the train is similar throughout this region and construction costs are not expected to vary significantly if the route must be shifted slightly north or south for political or archeologic reasons.

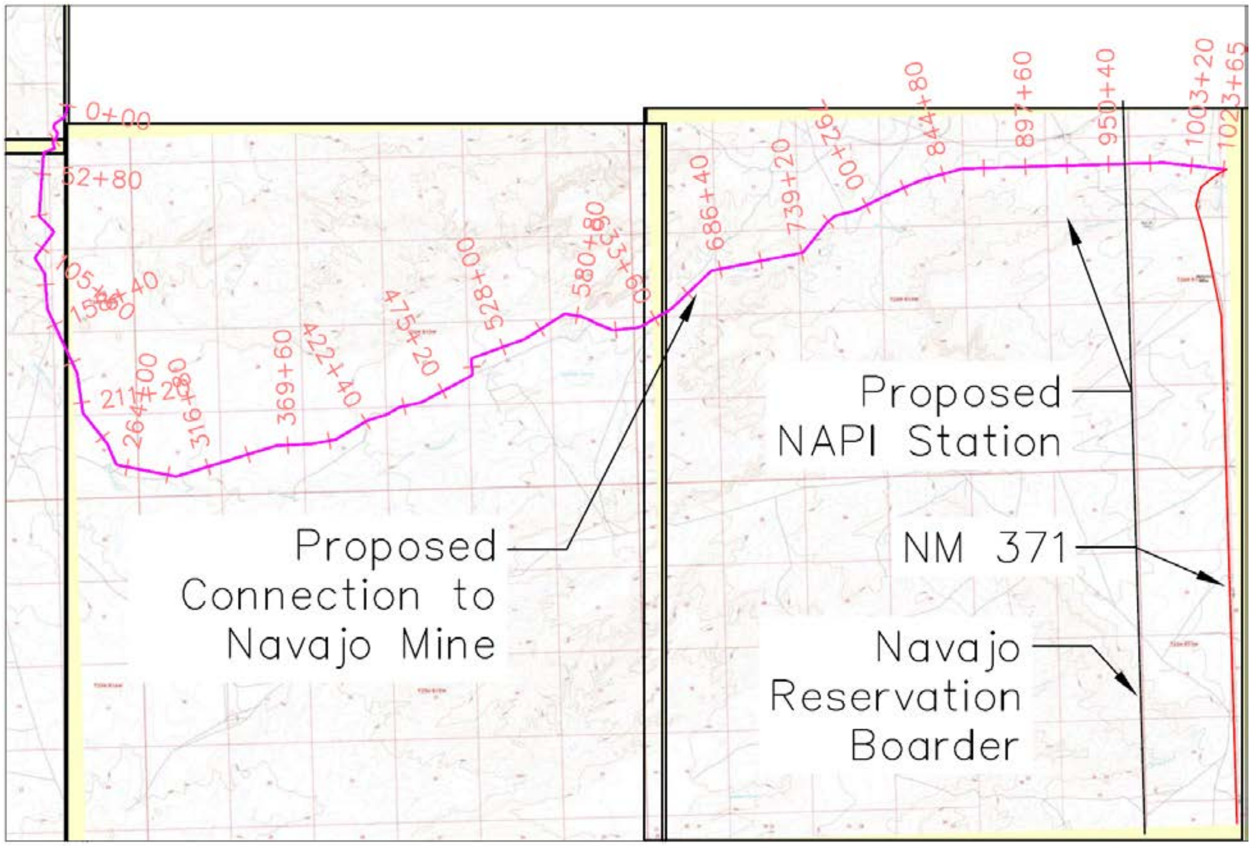


Figure 4-39 Rail Alignment From The Navajo Mine to NAPI Station

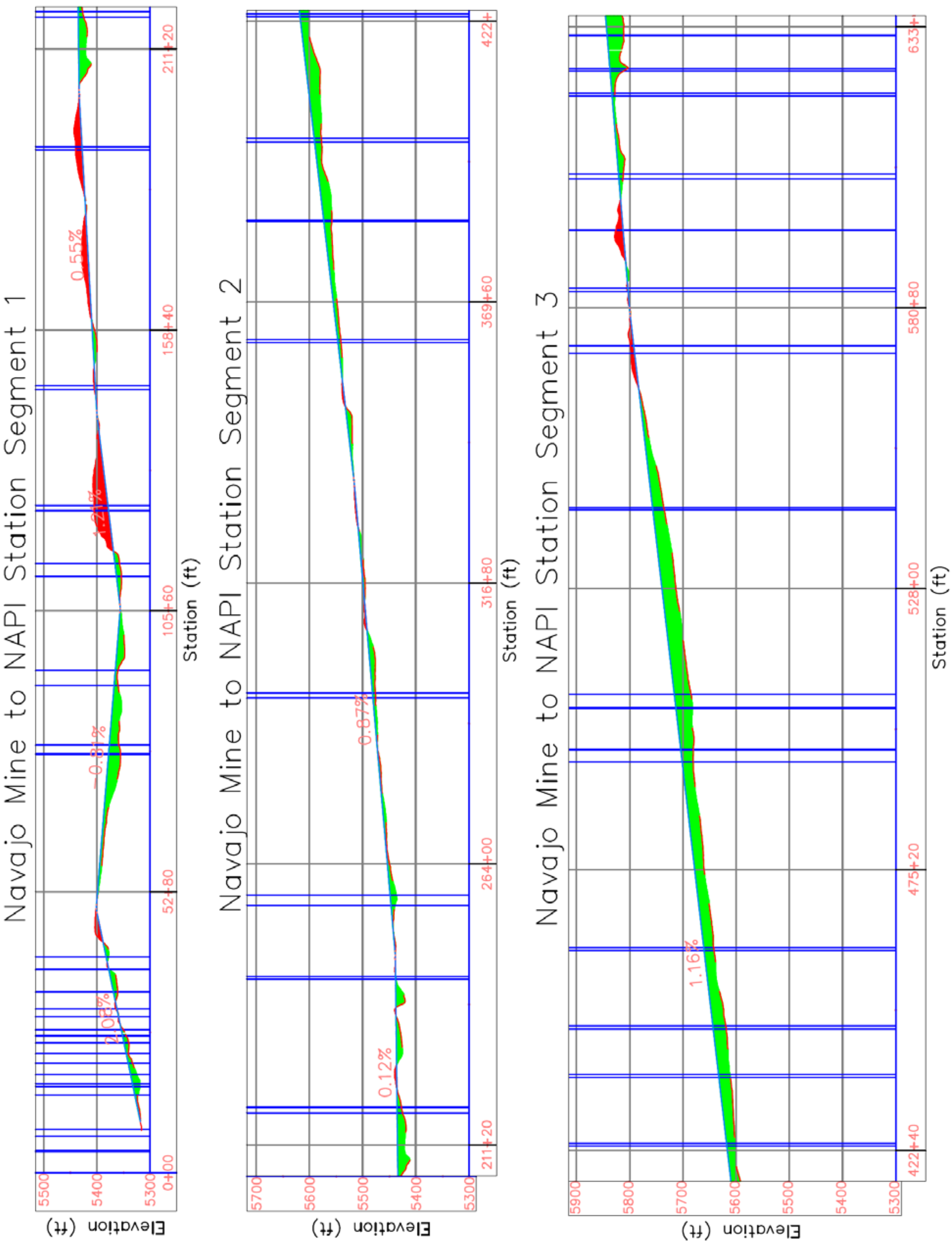


Figure 4-40 Grade Profile From The Navajo Mine to NAPI Station (Segments 1-3)

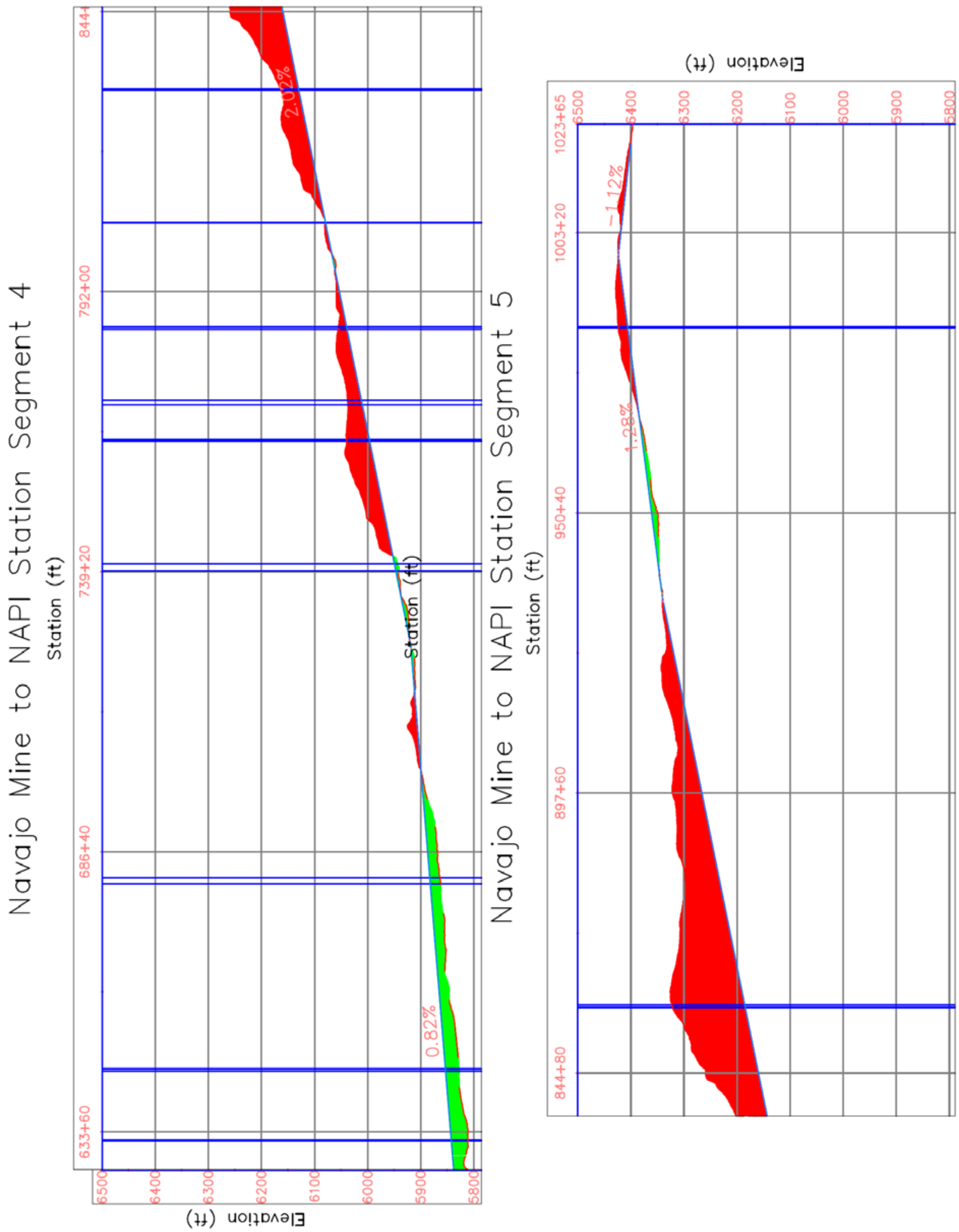


Figure 4-41 Grade Profile From The Navajo Mine to NAPI Station (Segments 4 and 5)

4.3.3 Rail Segment 3-A Bisti Oil Fields/NAPI to Farmington outside city limits

Two options will be presented for linking the rail line to the city of Farmington the first (3-A) would end the line ending the line on top of the mesa overlooking Farmington. This avoids the costs associated with descending the mesa on the south side of the San Juan river, crossing the river and ascending the hills north of the river. The second option 3-B includes descending the mesa south of Farmington near NM 371 and then crossing the San Juan River just west of the intersection of US 64 and The La Plata Highway.

This section presents the technical aspects and construction cost associated with option 3-A and section 4.3.4 presents and discusses option 3-B. Like rail segments 1 and 2 a cost of constructing both single and double track is presented in Table 4-8 and Table 4-9. **With only a portion of the total traffic on the line continuing all the way to Farmington, it is reasonable to construct single track between Farmington and the NAPI/Bisti station.** The single track estimate in Table 4-8 includes the site work to grade the route for the future construction of a parallel track once economic growth in the four corners area warrants the additional shipping capacity of double track.

Table 4-8 Construction Cost for Single Track Along Rail Segment 3-A

Bisti Oil Fields/NAPI To Mesa Station Single				
Item	Quantity	Unit	Unit Price	Costs
Clearing and Grubbing	175.0	AC	$ 1,850.00	$ 323,750.00
Excavation and Embankment	1,288,000.0	CY	$ 4.44	$ 5,718,720.00
Sub-ballast (30 ft)	155,000.0	TN	$ 17.76	$ 2,752,800.00
Bridges	3.0	EA	$ 666,000.00	$ 1,998,000.00
Culverts	39.0	EA	$ 6,926.40	$ 270,129.60
R/W Fencing	30.3	MI	$ 23,443.20	$ 710,328.96
Track Work	80,000.0	FT	$ 140.60	$ 11,248,000.00
Siding	-	FT	$ 83.50	$ -
Main Crossing	3.0	EA	$ 10,656.00	$ 31,968.00
Secondary Crossing	10.0	EA	$ 10,656.00	$ 106,560.00
Mesa Station	1.0	EA	$ 5,053,000.00	$ 5,053,000.00
Totals				**$ 28,213,256.56**

Table 4-9 Construction Cost for Double Track Along Rail Segment 3-A

Bisti Oil Fields/NAPI to Mesa Station Double Track Cost Estimate				
Item	Quantity	Unit	Unit Price	Cost
Clearing and Grubbing	175.00	AC	$ 1,850.00	$ 323,750.00
Excavation and Embankment	1,288,000	CY	$ 4.44	$ 5,718,720.00
Sub-ballast (45 ft)	231,300	TN	$ 17.76	$ 4,107,888.00
Bridges	3.00	EA	$ 666,000.00	$ 1,998,000.00
Culverts	39.00	EA	$ 6,926.40	$ 270,129.60
R/W Fencing	30.30	MI	$ 23,443.20	$ 710,328.96
Track Work	160,000	FT	$ 140.60	$ 22,496,000.00
Main Crossing	3.00	EA	$ 10,656.00	$ 31,968.00
Secondary Crossing	10.00	EA	$ 10,656.00	$ 106,560.00
Mesa Station	1.0	EA	$ 5,053,000.00	$ 5,053,000.00
Totals				**$ 40,816,344.56**

4.3.3.1 Moncisco Wash Quadrangle

The proposed rail alignment through Moncisco Wash is very short just clipping the corner of the quadrangle and follows the eastern side of NM 371 as it curves east from the boarder of the Navajo Reservation and cuts through the center of NAPI (Figure 4-42). Grade changes along this segment of the route are very mild and within the required 2% (Figure 4-43). As the proposed rail line enters existing developed NAPI land space becomes a limiting factor as the distance between the road and irrigated fields is very limited.

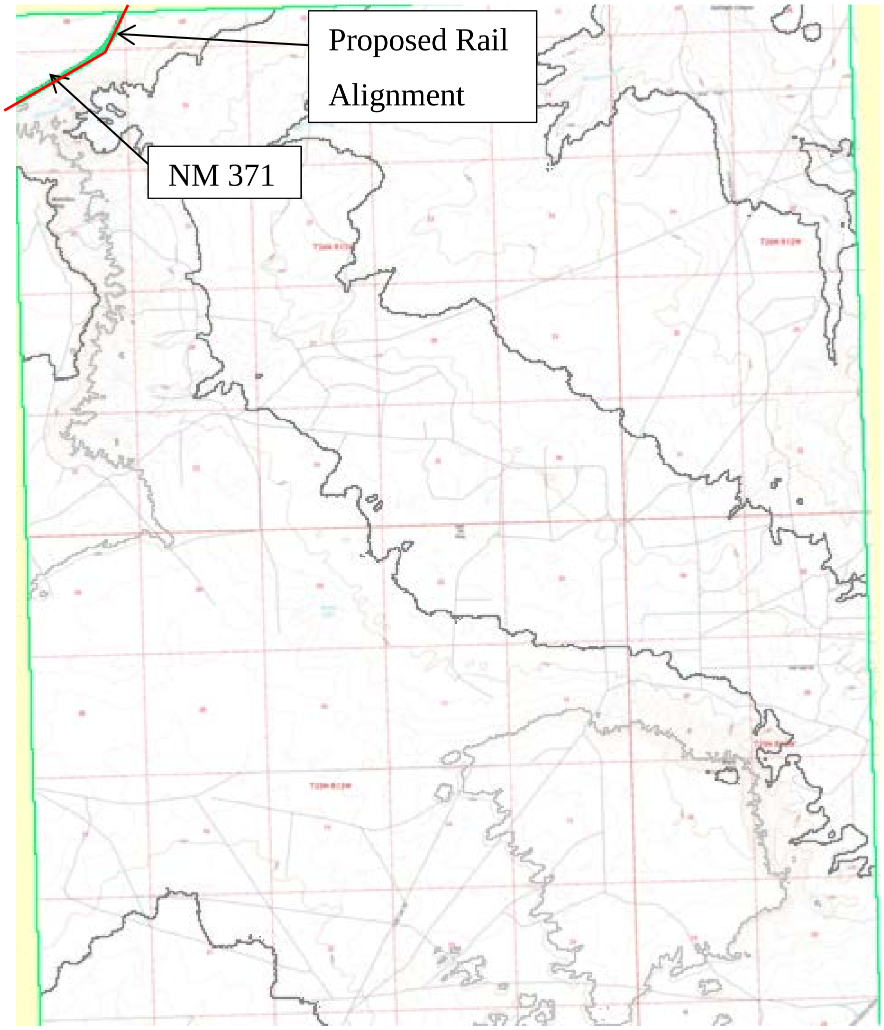


Figure 4-42 Rail Alignment at Moncisco Wash Quadrangle

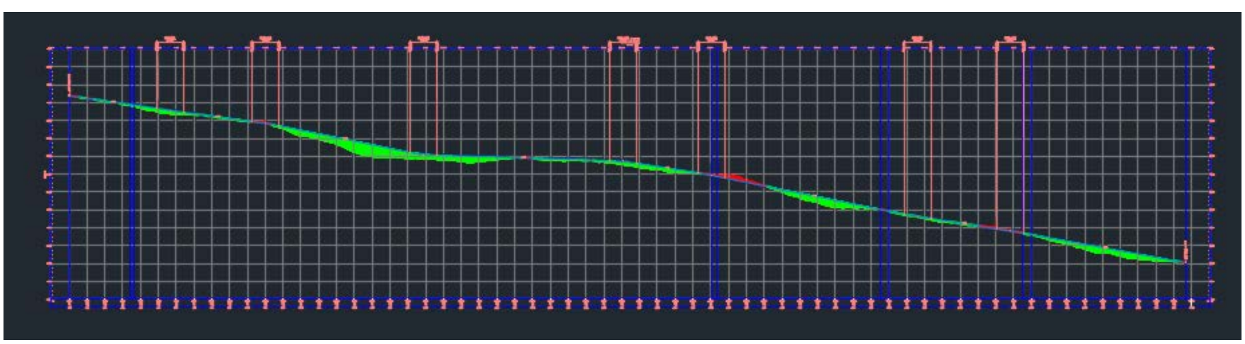


Figure 4-43 Moncisco Wash Rail Alignment Grade Profile

4.3.3.2 Hugh Lake Quadrangle

The proposed rail alignment through Hugh Lake Quadrangle is follows the eastern side of NM 371 as it cuts straight through the center of NAPI (Figure 4-44). Grade changes along this segment of the route are very mild, uniform, and within the required 2% (Figure 4-45). As the proposed rail line passes through developed NAPI land, space is very limited between NM 371 and existing Irrigated fields. There is a sufficient gap along this stretch for the rail line but it may not be feasible to maintain a constant 100 ft rail right of way when passing some of the fields closest to the road.

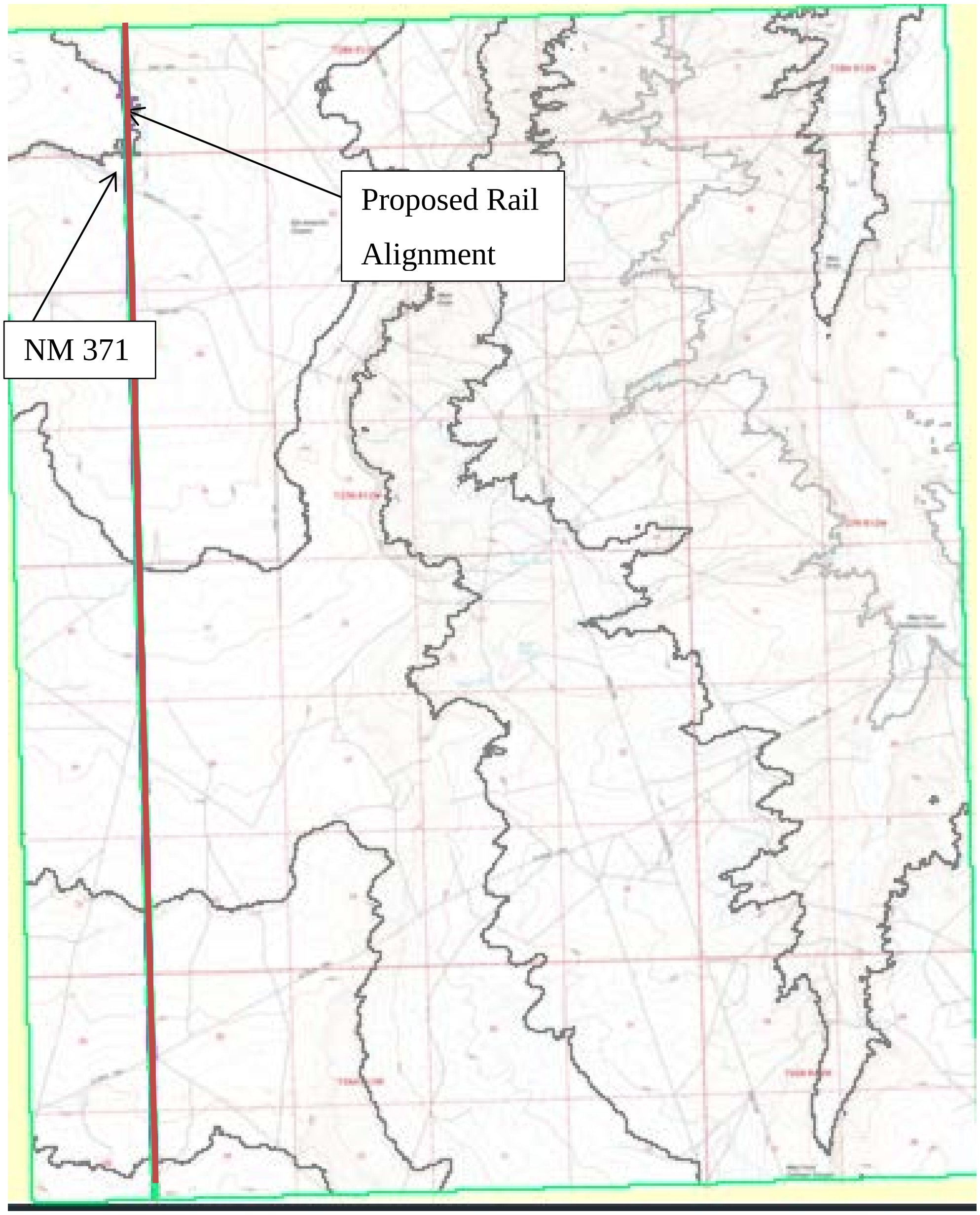


Figure 4-44 Rail Alignment at Hugh Lake Quadrangle

Figure 4-45: Hugh Lake Rail Alignment Grade Profile

4.3.3.3 Farmington South Quadrangle (Route 3-A)

The proposed rail alignment 3-A through Farmington South Quadrangle starts on the eastern side of NM 371, crosses to the western side at NAPI Headquarters and then back to the eastern side of NM 371 at the proposed rail terminal on top of the Mesa overlooking Farmington (Figure 4-46). Grade changes along this segment of the route are more challenging than passing through NAPI lands but still within the required 2% (Figure 4-47). The reason the rail line switches sides of the road several times is the limited space between existing NAPI facilities and NM 371. An alternative would be working with the NMDOT during design of the rail line to shift NM 371 west and eliminate the need for rail crossings.

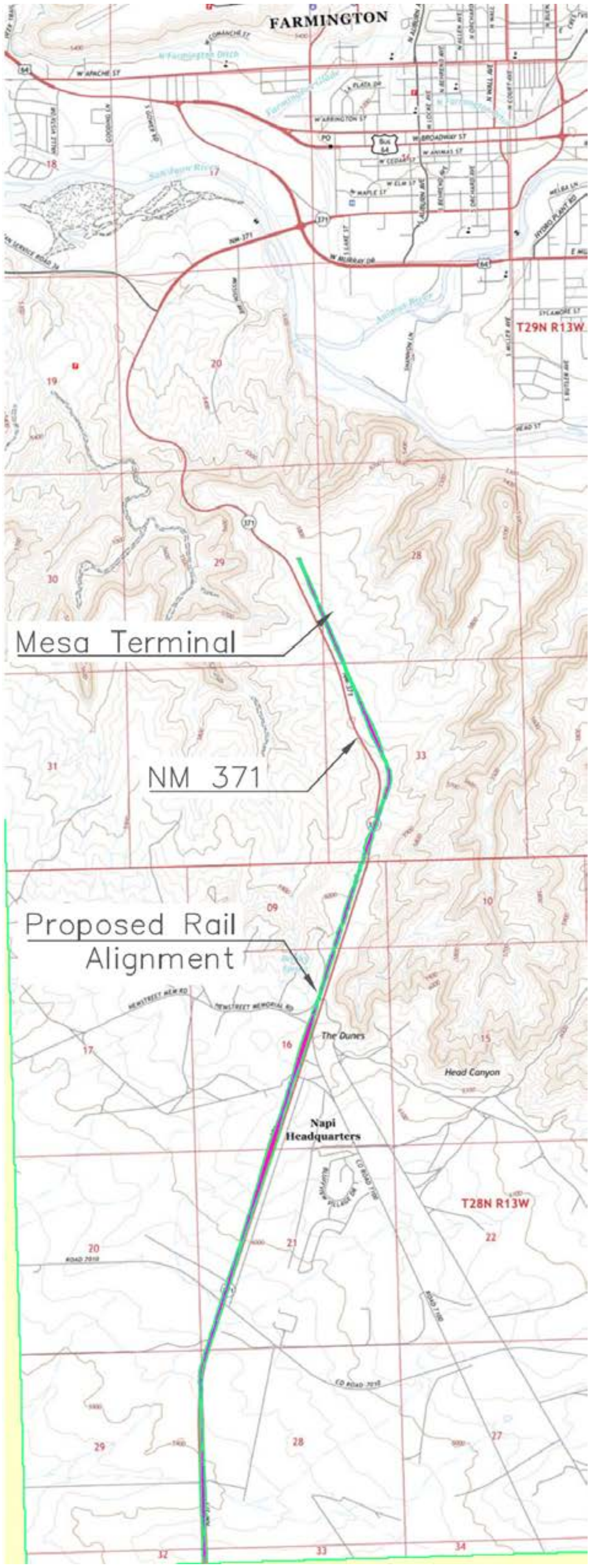


Figure 4-46 Rail Alignment (3-A) at Farmington South Quadrangle

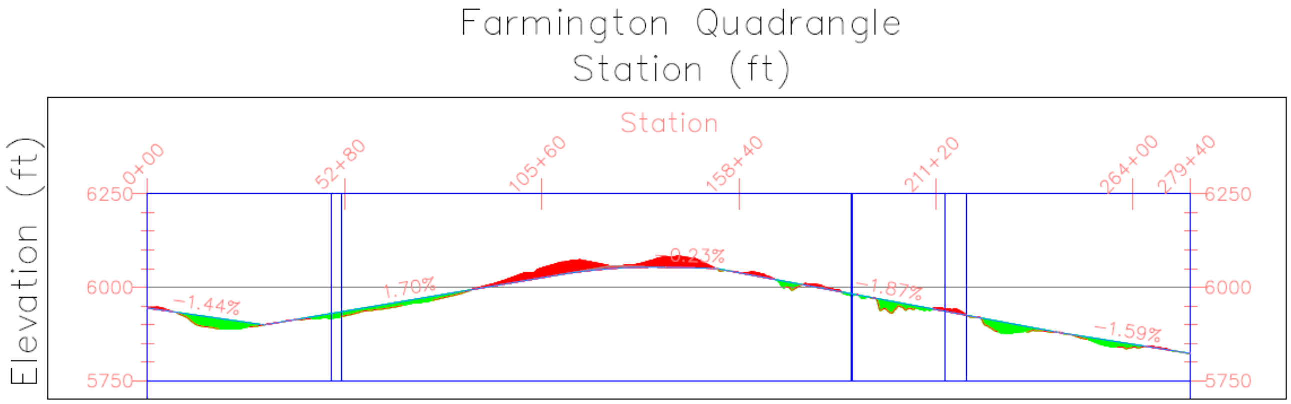


Figure 4-47 Farmington South Rail Alignment (3-A) Grade Profile

4.3.4 Rail Segment 3-B Bisti Oil Fields/NAPI to Farmington inside city limits

Rail segment 3 option B would have the line descend the mesa south of Farmington near NM 371 and then crossing the San Juan River just west of the intersection of US 64 and The La Plata Highway. Option 3-B would leave open the possibility of constructing sidings along US 64 to service individual manufactures and extending the line north to Colorado already having overcome crossing the San Juan River. **This option has the greatest potential for long term economic benefit to the region because of the direct connection to businesses and potential for future extension; however, the cost of this option is high due to the difficulties associated with descending the mesa and crossing the river.**

The full cost of bridging the San Juan River including additional site work on the track is $160 million (approx. 2 mile length). By comparison the bridge over the San Juan River at Shiprock is 1,000 feet long and has an estimated replacement cost of $25 Million for two lane highway with a shoulder. The estimated replacement cost of the Shiprock Bridge comes from (TRIP, 2015) and is given here as the geographically closest example of an independent bridge construction estimate.

Table 4-10 Construction Cost for Single Track Along Rail Segment 3-B

NAPI to Farmington Station Single Track Cost Estimate				
Item	Quantity	Units	Unit Price	Cost
Clearing and Grubbing	432.0	AC	$ 1,850.00	$ 799,200.00
Excavation and Embankment	24,325,000	CY	$ 4.44	$ 108,003,000.00
Subballast (30 ft)	167,700	TN	$ 17.76	$ 2,978,352.00
Bridges	5.0	EA	$ 666,000.00	$ 3,330,000.00
Culverts	43.0	EA	$ 6,926.40	$ 297,835.20
R/W Fencing	42.5	MI	$ 23,443.20	$ 996,336.00
Track Work	112,800	FT	$ 140.60	$ 15,859,680.00
Siding	-	FT	$ 83.50	$ -
Main Crossing	20.0	EA	$ 10,656.00	$ 213,120.00
Secondary Crossing	14.0	EA	$ 10,656.00	$ 149,184.00
Bridge over San Juan River	2.0	MI	$ 40,000,000.00	$ 80,000,000.00
Farmington Station	1.0	EA	$ 5,053,000.00	$ 5,053,000.00
Totals				**$ 217,679,707.20**

Table 4-11 Construction Cost for Single Track Along Rail Segment 3-B

NAPI to Farmington Station Double Track Cost Estimate				
Item	Quantity	Units	Unit Price	Cost
Clearing and Grubbing	432	AC	$ 1,850	$ 799,200.00
Excavation and Embankment	24,325,000	CY	$ 4.44	$ 108,003,000.00
Subballast (45 ft)	251,550	TN	$ 17.76	$ 4,467,528.00
Bridges	5	EA	$ 666,000	$ 3,330,000.00
Culverts	43	EA	$ 6,926.4	$ 297,835.20
R/W Fencing	42.4	MI	$ 23,443.2	$ 993,991.68
Track Work	223,600	FT	$ 140.6	$ 31,438,160.00
Main Crossing	20	EA	$ 10,656	$ 213,120.00
Secondary Crossing	14	EA	$ 10,656	$ 149,184.00
Bridge over San Juan River	2.0	MI	$ 40,000,000.00	$ 80,000,000.00
Farmington Station	1	EA	$ 5,053,000	$ 5,053,000.00
Totals				**$ 234,745,018.88**

4.3.4.1 Farmington South Quadrangle (Route 3-B)

The proposed rail alignment 3-B differs from 3-A discussed in section 4.3.3.3 in that is crosses NM 371 several additional times as it makes a winding decent down off the mesa toward the San Juan river valley and Farmington (Figure 4-48). These additional crossing would be grade separated with NM 371 either bridging over the rail line or the rail line tunneling under NM 371. The sharp descent of the mesa requires this winding path in order to minimize the amount of excavation required to meet the 2% grade requirement (Figure 4-49).

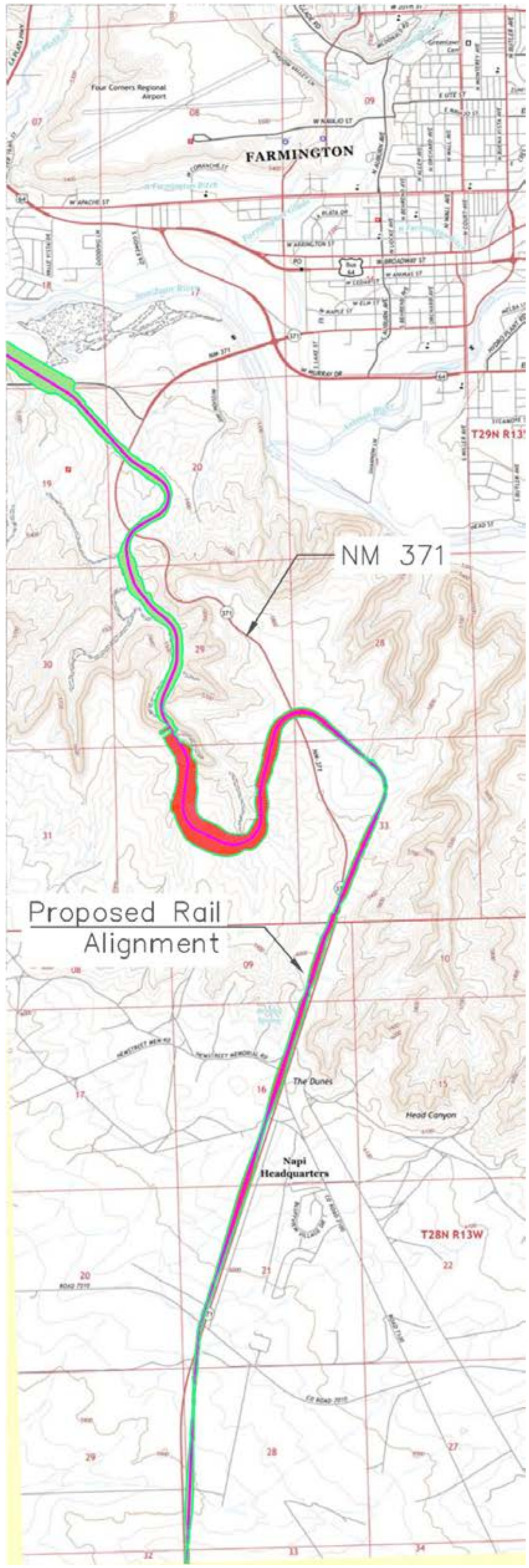


Figure 4-48 Rail Alignment (3-B) at Farmington South Quadrangle

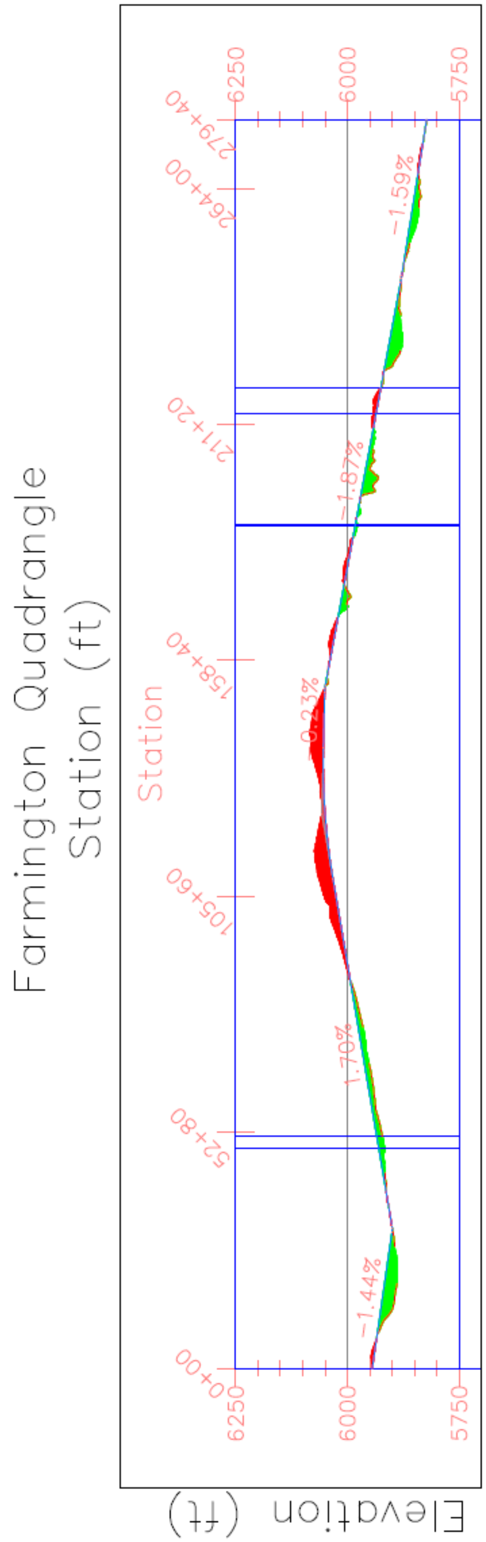


Figure 4-49 Farmington South Rail Alignment (3-B) Grade Profile

4.3.4.2 Kirtland Quadrangle

The rail alignment through Kirtland Quadrangle is the most challenging and costly of any stretch in the proposed routes. Multiple options were explored for descending the mesa on the south side of Farmington and then climbing the hills north of 371. The steep grade changes on both sided of the San Juan River valley, the close proximity of the grade changes, and the limited space due to existing development are among the technical challenges. Tunneling down off the Mesa, crossing the valley floor and then bridging the river was found to be the most expensive option. Slightly less expensive was using cut material from the descent off the mesa to raise the elevation of the valley floor so the rail line would not have to climb back up out of the valley on the northern end. This option would require disturbing the largest amount of developed land in addition to its high cost of construction. The third option explored and the one presented in this report is to build a viaduct 200 feet above the valley floor two miles long stretching from the hills north of US 64 to where the rail line descends the mesa (Figure 4-50).

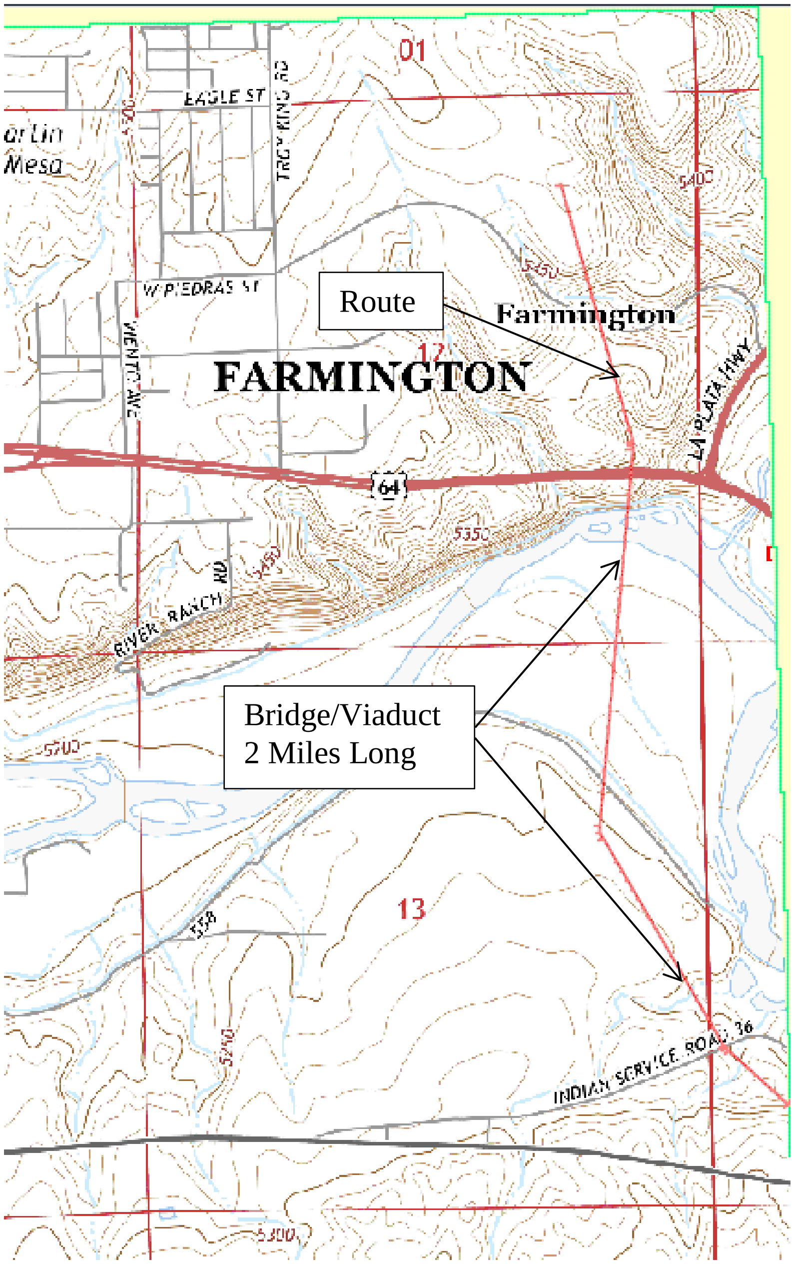


Figure 4-50 Rail Alignment at Kirtland South Quadrangle

4.3.5 Soil-Geologic Evaluation

Maps and information of soil types and problem areas are contained in Appendix A for the route in three segments. The soil maps and corresponding tables present the soil types and highlight known major problem areas within the defined corridor. These problem areas and regions with soil types prone to low bearing strength are avoided whenever possible by the route alignment.

5 Environmental Evaluation

The information collected in the environmental section of this report was essential to assess the current state of the region and to determine the environmental and cultural effects for the construction of a rail line through the proposed corridor.

The following sections are an Environmental Impact Assessment (**EIA**) for the project prepared in accordance to the guidelines dictated by the National Environmental Policy Act (NEPA). This EIA discusses and analyzes the potential impacts that could result from the construction and operation of the proposed Farmington-Thoreau rail line if the alignment under consideration is constructed. Furthermore, reasonable alternatives to the proposed alignment's construction and operation are also discussed.

The analysis and selection of the main route and the alternatives considered in the EIA take into account engineering and marketing considerations because of the critical role these factors play in selecting the most feasible and practical route.

The process of selecting the most critical issues related to the proposed rail alignment was carried out as follows. First, it was necessary to identify alternative routes that could be considerable reasonable alternatives to the proposed railroad. Ease of access, existing corridors, engineering costs, land ownership, environmental assets and concerns, topography of the area and type of soil were among some of the factors considered when selecting the most feasible route. Second, it was necessary to identify those issues and concerns specific to the proposal that should be included for consideration in an analysis of environmental impacts. Two alternative routes were identified as being worthy of detailed analysis in the EIA.

5.1 Rail Access to Coal Deposits

State coal production currently occurs in two areas within the San Juan basin. At the present there is no production in the central part of the basin; however, production from the northwest corner including the San Juan and Navajo Mine is used at mine-mouth power generating stations San Juan and Four Corners power plants. Production from El Segundo, and Lee Ranch Mine located in the southeast part of the region is shipped by rail mostly to Arizona and western markets (BNSF Railway, 2013). Most of these San Juan coal reserves including areas with leased federal coal are not presently served by rail transportation.

The coal reserves present in the northwest portion of New Mexico are illustrated in Figure 5-1, and the active coal mines within the region are identified in Figure 5-2. The central region of the basin is one of the largest untapped strippable coal reserves in the Western United States. Construction and operation of the proposed railroad would provide an economical and environmentally acceptable means of transporting coal from the Farmington area and other potential mines in the region to a connecting point on the BNSF corridor. From this point the coal could be shipped to national and international markets.

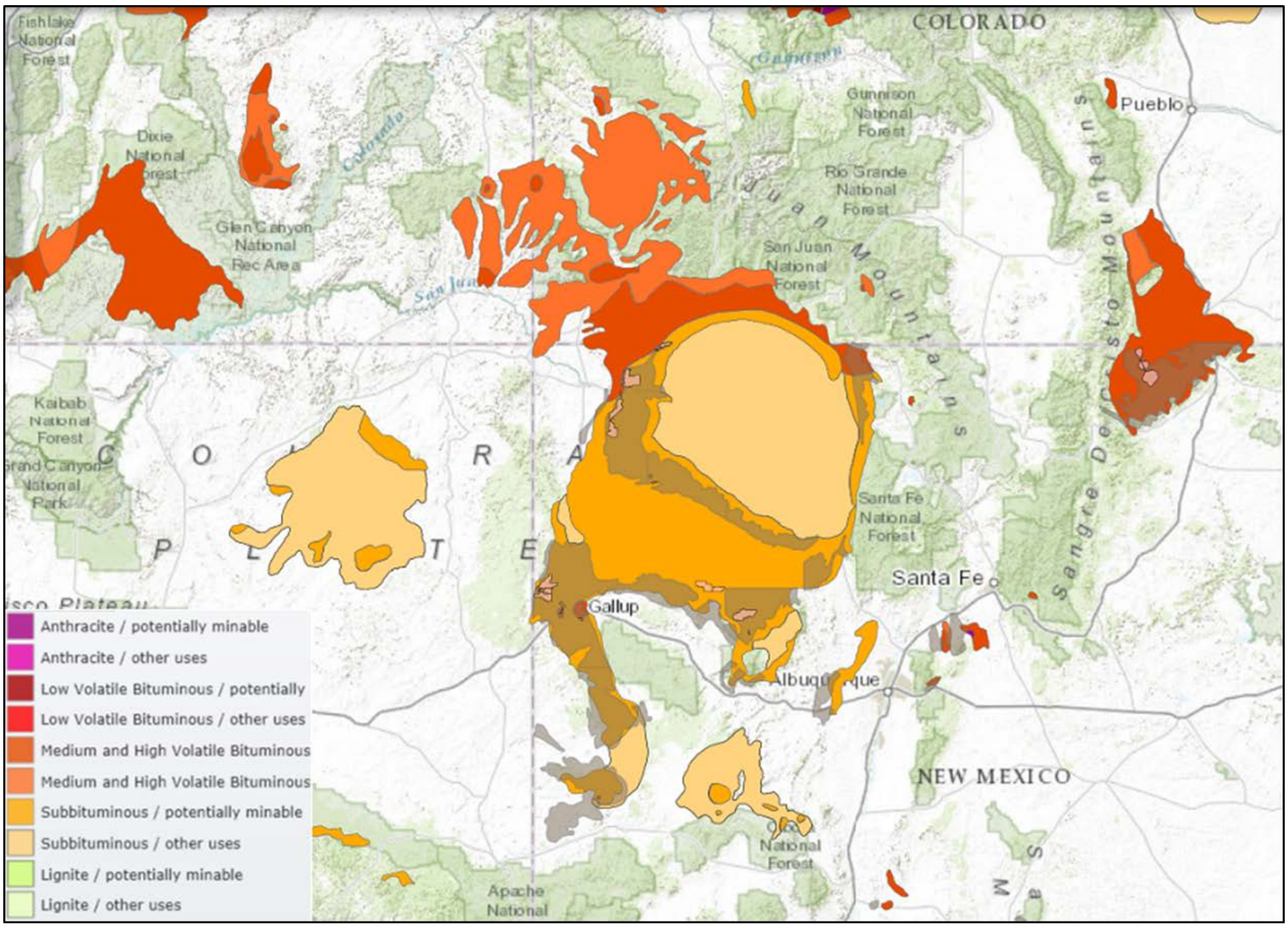


Figure 5-1 US. Coal Fields (San Juan Basin, New Mexico) (EMNRD, 2014)

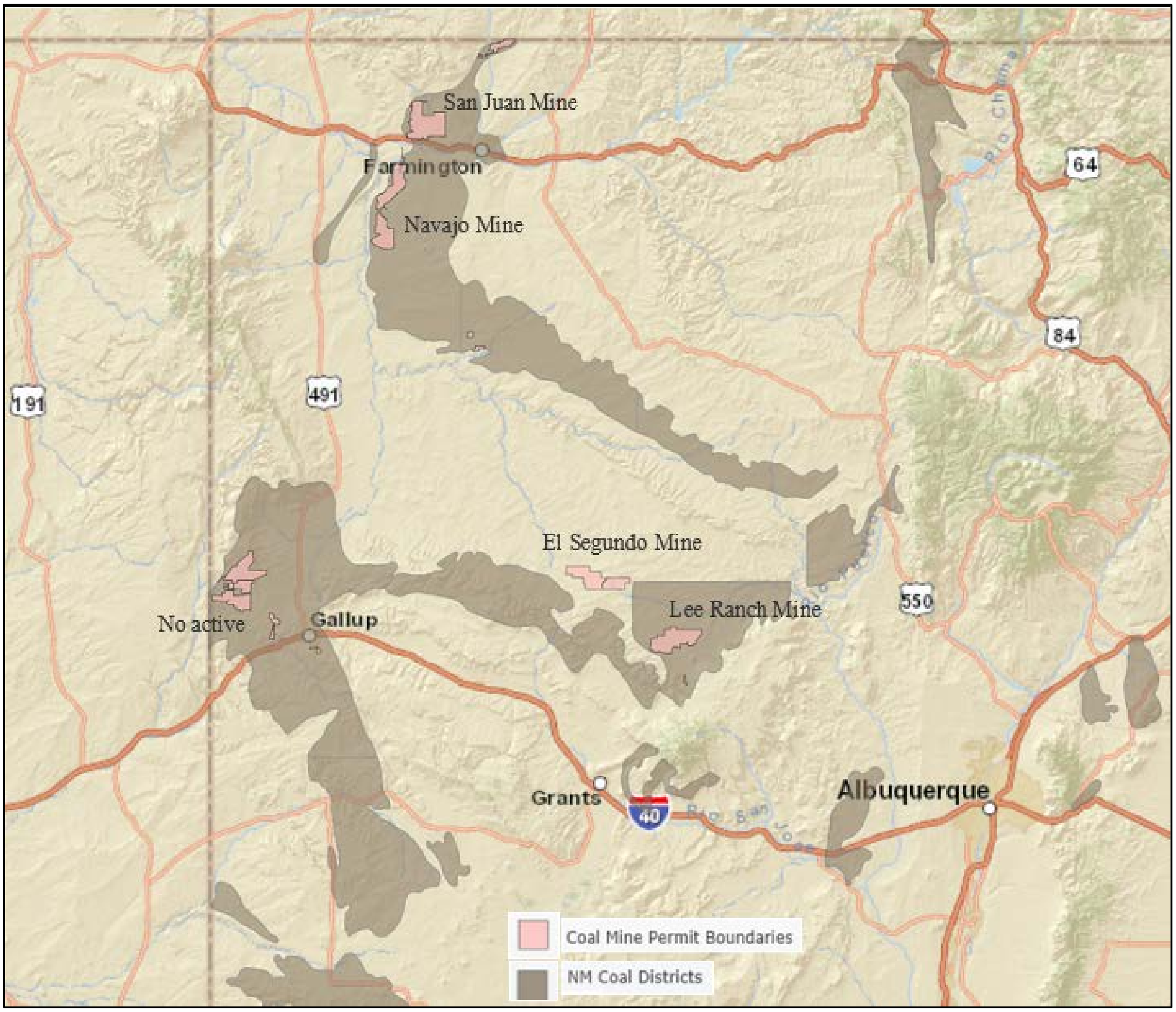


Figure 5-2 Coal Mines and Coal Districts northwestern New Mexico (EMNRD, 2014)

5.2 Area of Study

Environmental effects from the construction and operation of the proposed Farmington-Thoreau railroad would occur primarily within the San Juan basin, in San Juan and McKinley Counties. The environmental study area (referred to hereafter as ES) encompassing over 2.1 million acres, is a portion of the San Juan basin, extending southward from Farmington to Thoreau, New Mexico. The Chaco Culture National Park roughly coincides with the eastern extremity of the impact area, while the Navajo Indian Reservation is encountered along the western boundary. Figure 5-3 illustrates the ES and its location within New Mexico. Portions of the analysis included in the EIA required consideration of the entire ES region, while other portions refer strictly to areas of specific physical disturbance. Communities outside of the ES region that would be affected include Gallup, Grants and Prewitt. The population of the area is centered on the Farmington area to the north; the City and Towns of Gallup, Thoreau, Grants to the south; and Cuba to the east.

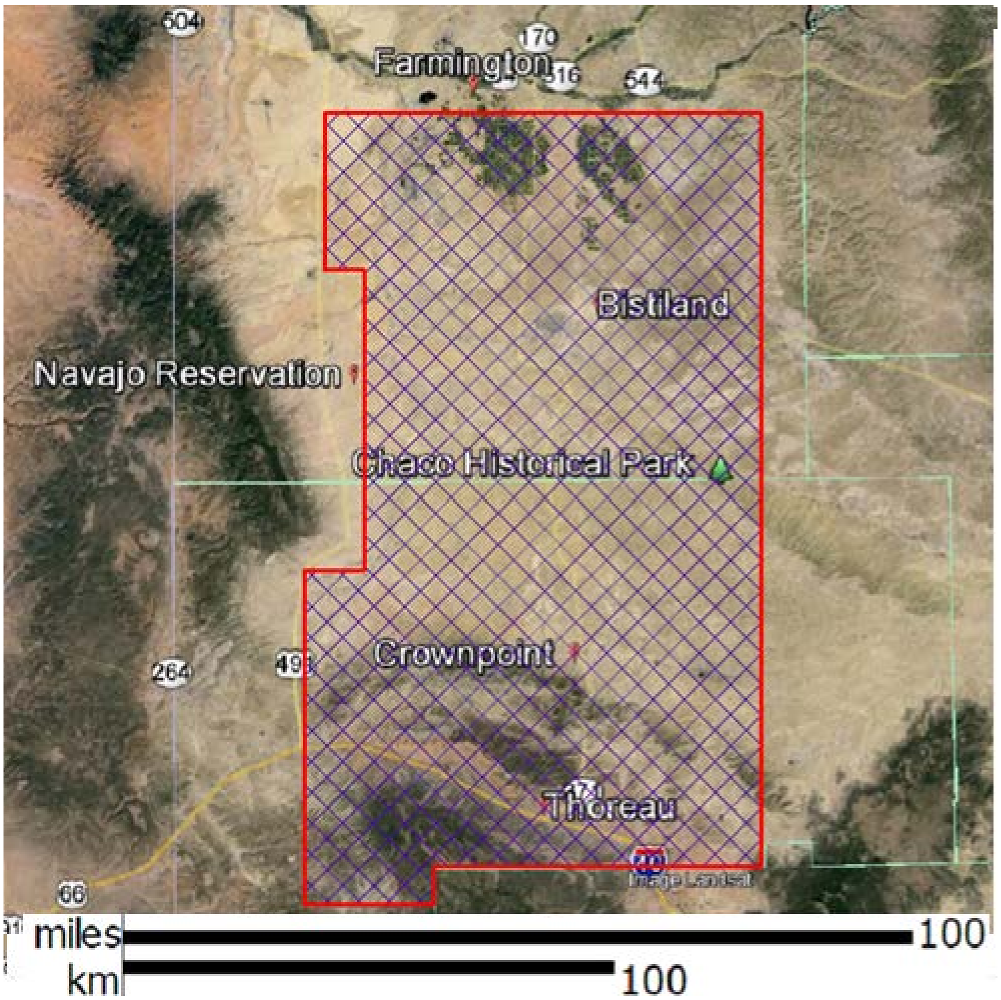


Figure 5-3 Railroad Environmental Study Area (ES) (Google Earth)

5.2.1 Project Description

The proposed Farmington-Thoreau railroad would involve the construction of a 110-mile rail line extending southward from Farmington to a terminal nearby the community of Thoreau N.M., where it would join the main BNSF line with access to the national rail system. The rail line would roughly follow NM 371 from Thoreau to a point 20 miles south of Farmington, avoiding disturbance of White Rock and Bisti Wilderness Area. Figure 4-6 illustrates the location of the initial alignment for the proposed Farmington-Thoreau railroad. Approximately 80 percent of the proposed railroad is on treaty 1868 Reservation Land and Executive Order Reservation Land. The remainder of the route crosses Navajo Tribal, Navajo Allotment, Private and State land (Farmington Field Office, 2003).

5.2.2 Alternative Routes

An alternative route was identified in the process of analysis of other feasible routes. Extension of this route is essentially identical to the proposed alignment, extending from Farmington N.M. and crossing the San Juan basin to connect a terminal point in Thoreau, NM. This alternative track would depart southward from Farmington to a point just north of the community of Crownpoint. There, the rail track would follow 18 miles east, where it would join an active secondary branch (Star Lake) of the BNSF that presently serves El Segundo and Lee Ranch mines in McKinley County. This single rail track continues south until Prewitt where it connects the main BNSF rail system. Figure 5-4 illustrates the location of the alternative route. Coal and other commodities would be transported 9 miles westward from Prewitt to Thoreau via an independent rail track connecting both locations. With a total length of approximately 100 miles, the alternative route is expected to incur less environmental disturbance due to its shorter length. Potential capacity demands would vary significantly by route because of the number of mines served. However, right-of-way (ROW) availability and existing development along the proposed route is expected to make this route impractical.

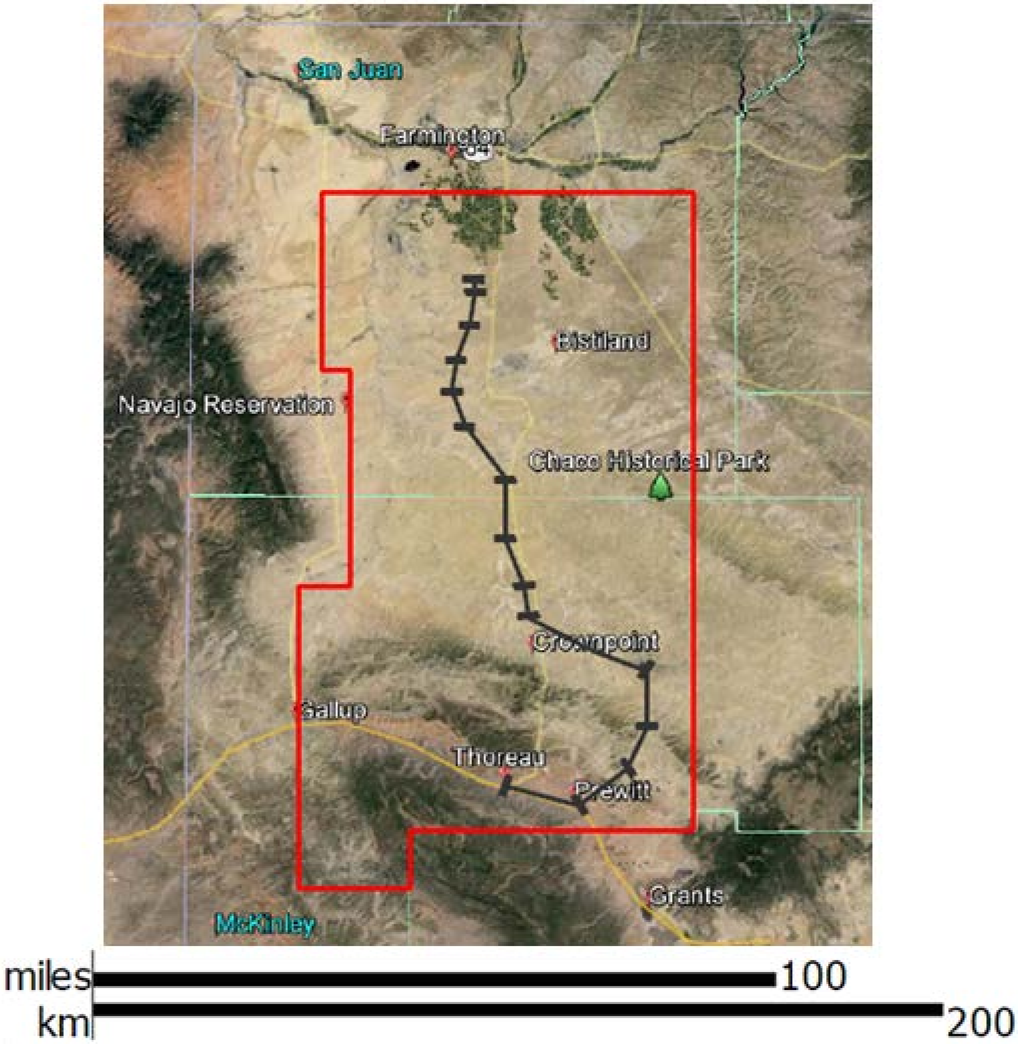


Figure 5-4 Proposed alternative Route Farmington-Thoreau Railroad. (Connecting EL Segundo and Lee Ranch Mine) (Google Earth)

5.3 Identification of the Affected Environment

This section describes briefly the physical, biological and cultural resources of the environment within the project area boundary shown in Figure 5-3. The description focuses on environmental aspects most likely to be affected by the proposed action. Geographic areas included in this analysis represent those areas which may be susceptible to impacts from the construction and operation of the proposed railroad or its alternatives. For resources such as soils and vegetation, the affected area was confined to the physical location and immediate vicinity of the areas to be disturbed by the proposed project. For other resources such as water, air quality, and economical values, the description of the affected environment is more extensive. The information summarized in this chapter was obtained from published and unpublished materials and interviews with local and state agencies. Table 5-1 provides a summary of the preliminary findings for the many resources considered in this EIA.

The proposed alignment or its alternative route would be situated within the south-central portion of the San Juan basin and would serve existing and future coal mines in the vicinity of the route. Therefore, major cultural and environmental impacts from construction and operation of the Farmington-Thoreau railroad would be expected to occur in San Juan and McKinley Counties.

Table 5-1 Affected Environments

Resources	Affected by the Proposed Action	Not Affected by the Proposed Action	Further Analysis Presented in Text	Justification If No Further Analysis is Performed
Topography	X		X	
Climate Resources	X		X	
Air Quality	X		X	
Areas of Critical Environmental Concern (ACEC's)		X		No ACEC's are located within the project area
Wilderness		X		No wilderness areas will be disturbed in the project area
Land Use	X		X	
Water Quality, Surface/Ground	X		X	
Wetlands/Riparian Zones		X		No wetlands or riparian zones occur in the project area

Resources	Affected by the proposed Action	Not Affected by the proposed Action	Further Analysis Presented in Text	Justification If No Further Analysis is Performed
Wilderness		X		No wilderness areas will be disturbed in the project area
Land Use	X		X	
Water Quality, Surface/Ground	X		X	
Wetlands/Riparian Zones		X		No wetlands or riparian zones occur in the project area
Floodplains		X		No floodplains located in the corridor area
Wild and Scenic Rivers		X		There are no wild and scenic rivers in the FFO
Soils	X		X	
Mineral Resources	X		X	
Paleontology		X		No paleontological resources occur in the area
Noise	X		X	
Vegetation/Forestry	X		X	
Wildlife	X		X	
Threatened or Endangered Species	X		X	
Special Status Species	X		X	
Migratory Birds	X		X	
Socioeconomics	X		X	
Visual Resources		X		
Cultural Resources	X	X	X	
Public Health and Safety		X		
Waste, Hazardous or Solids		X		No hazardous materials will be used for construction and operation of proposed action

5.3.1 Topography

The proposed and alternatives rail line routes would be situated along the central and southern portion of the San Juan topographic and structural basin. The San Juan basin is a geologic depression located near the four corners of the states of New Mexico, Colorado, Arizona and Utah (Kelley, 1951). It has an elliptical shape about 120 miles in the north-south dimension and 90 miles in width, extending over an area of 7500 square miles (Fasset, 1971). The main water feature within the plane is the San Juan River. Tributaries that contribute to the broken topography drain the greatest part of the basin towards the westward flowing San Juan River, and some other ephemeral tributaries towards the Rio Grande through the Chaco and Puerco River.

The majority of the ES region consists of rangeland with broad plains, sharply and frequent dissected by mesas, badlands and buttes of relative low relief (United States Department of Interior (USDI) and Bureau of Land Management (BLM), 1979). The central flank of the basin, Bisti Land and White Rock, where badlands are notable, is relatively featureless with elevations ranging from 6000 – 6500 feet. However, in the south, Hosta Butte and Mount Powell with an elevation of 8500 feet stands 2000-2500 feet above White Rock and Bisti land. The lowest elevations are along NAPI near Farmington with the 5,300 foot contour crossing the agricultural field near the Navajo mine.

The proposed transportation corridor would start at an elevation of 7200 feet adjacent to Thoreau and gradually descend to an elevation of 5300 feet in the Farmington area. The southern one-third of the corridor would cross rougher hills with slopes in the region significantly exceeding the technical requirement of 2 percent; in such regions high disruption of terrain is anticipated. The central and northern segment of the proposed corridor would pass terrain that is relatively gently sloping to almost flat. Most of the ES area is between the 5500 to 7000 feet in elevation, with local relief generally of only a few hundred feet. Appendix A contains maps which display contours and major features of the area. The proposed railroad will cross Mount Powell and Hosta Butte through Satan pass along the southern segment, followed by Crownpoint, Bisti Wilderness area and White Rock.

5.3.2 Climate

The climate in the vicinity of the proposed rail line is typical of a semi-arid region. The area is typified by low relative humidity, sparse precipitation, intense solar radiation, and large annual and diurnal temperature fluctuations characteristic of the higher-elevation Colorado Plateau (US Department of Interior, 1984).

Temperature and precipitation across the ES area vary considerably with respect to season and location because of the topography and orthographic lifting. Seasonal annual temperature averages for selected sites near the proposed route are given in Table 5-2. As noted, temperature within the region varies markedly with elevation. Mountainous areas such as Dulce, NM have much cooler temperatures than locations at lower elevations.

Summer daytime temperatures are generally in the 80s to 95s ^{O}F, August being the warmest month with temperatures above 90 ^{O}F. Winter daytime temperatures are usually in the 20's to 30's ^{O}F, with periods below zero. January, the coldest month, registers minimum temperatures of just below 0 ^{O}F at Chaco National Park (New Mexico State University (NMSU). Climate Center, 2015). Growing season in the area ranges from about 120-150 days for places with higher elevation; however, lower elevations such as Farmington may experience 170 days, beginning in mid–to late May and ending in late September to mid-October (Bierei, 1977).

Table 5-2 Average temperatures for selected locations near the ES area (New Mexico State University (NMSU). Climate Center, 2015)

Season	Chaco National Park	Gallup NM	Farmington NM	Aztec NM	Dulce NM	Albuquerque NM
Winter (December-February)	31°F	33°F	35°F	35°F	23°F	41°F
Spring (March-May)	46°F	47°F	53°F	52°F	45°F	56°F
Summer (June-August)	68°F	69°F	80°F	74°F	66°F	78°F
Fall (September-November)	50°F	52°F	58°F	56°F	47°F	60°F

Annual precipitations within the ES region vary according to the topography of the area. The higher elevations in the northeast receive the most rainfall primarily occurring during highly intense thunderstorms (Bierei, 1977). Average annual precipitation at the site is 7.7 inches from the nearest station at Farmington. About 45 percent of the precipitation within the ES region falls during the months of July and October (Western Regional Climate Center (WRCC), 2009). Table 5-3 provides monthly average precipitation values collected from weather stations nearby the proposed route. Snowfall is erratic and usually light with average snowfall at Farmington of only 11.9 inches.

Table 5-3 Average Precipitation 1998-2008, Farmington Airport (Western Regional Climate Center (WRCC), 2009)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Average Monthly	0.61	0.75	0.64	0.61	0.36	0.08	0.66	0.94	0.92	1.07	0.59	0.44	7.67
Maximum Daily	0.41	0.47	0.55	1.2	0.58	0.14	1.75	1.08	0.97	0.63	0.5	0.32	1.75
Snowfall	2.9	3.9	1.2	0	0	0	0	0	0	0.30	0.5	2.9	11.9

Winds in the area of the proposed route are generally moderate, with average annual wind speed of 8 miles per hour. Wind speeds tend to be higher during the spring months, due to a strong pressure gradient associated to low pressure systems. Table 5-4 shows average wind speed values for the Farmington New Mexico Agricultural Science Center Monitoring Station.

Table 5-4 Average Wind Conditions 1998-2008, Farmington Airport (Western Regional Climate Center (WRCC), 2009)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Daily Average mi/h	7	7.9	8.7	9.5	9	9.1	8.1	7.7	7.5	7.5	7.2	7.1	8
Daily Average Max 2-Min	16.6	19.3	22.3	24.3	23.6	23.4	24.3	22.3	20.6	19	17.5	17.6	20.9
Daily Average Peak Gust	19.9	23.6	27.7	30.6	30.2	30	30.5	27.8	25.8	23.4	21	21	26
Direction	E	E	W	W	W	E	E	E	E	E	E	E	E

5.3.3 Air Quality

The USEPA has the primary responsibility for regulating atmospheric emissions. Generally, air quality at the proposed corridor site is excellent within state and federal standards. The ES area is primarily rural except for the towns of Farmington and Thoreau where main industrial and commercial developments exist. The major point sources of air pollutants are the coal mines and coal-fired electrical generation facilities at Farmington and east of Crownpoint. Pollutants of concern regarding the construction and operation of the proposed rail line are Total Suspended Particles (TSP), primarily generated as fugitive dust by construction activities and, Sulfur Dioxide (SO2), Carbon Monoxides (COx) and Nitrogen Oxides (NOx) that would be generated by construction equipment and trains using the corridor. Table 5-5 summarizes the National Ambient Air Quality Standards (NAAQS) and the New Mexico State AAQS for each of the aforementioned pollutants.

Table 5-5 Summary of National Ambient Air Quality Standards (NAQQS) (USEPA, 2010)

National Ambient Air Quality Standards					New Mexico Ambient Air Quality Standards
Pollutant	Primary Standards		Secondary Standards		
	Concentration	Averaging Time	Concentration	Averaging Time	Concentrations
Carbon Monoxide	9 ppm (10 mg/m^3)	8-hour [1]	None		8.7 ppm
	35 ppm (40 mg/m^3)	1-hour [1]			13.1 ppm
Lead	0.15 µg/m^3 [2]	Rolling 3-Month Average	Same as primary		None (11)
	1.5 µg /m^3 [3]	Quarterly Average	Same as primary		None
Nitrogen Dioxide	53 ppb [3]	Annual (Mean)	Same as primary		50 ppb
	100 ppb	1-hour [4]	None		100 ppb
Particulate Matter (PM10)	150 µg /m^3	24-hour [5]	Same as primary		None
Particulate Matter (PM2.5)	15.0 µg /m^3	Annual Mean [6]	Same as primary		None
	35 µg /m^3	24-hour [7]	Same as primary		None
Total Suspended Particulates	None	Annual Mean [6]	None		60.0 µg /m^3 [12]
	None	24-hour [7]	None		90.0 µg /m^3 [12]
Sulfur Dioxide	0.03 ppm	Annual Mean	0.5 ppm	3-hour [1]	0.02 ppm
	0.14 ppm	24-hour [1]			0.10 ppm

An analysis of regional air quality data collected from nearest locations at Farmington and Thoreau indicated that their TSP differs considerably from rural areas. Atmospheric studies conducted by the Bureau Land of Management (United States Department of Interior (USDI) and Bureau of Land Management (BLM), 1979) demonstrate that major impacts in the air quality of the region are the product of mining activities on a local scale. **Most TSP concentrations in the region are well below permissible values.** Data collected at Crownpoint station AQS site ID 35-031-1236 located 14 miles west from EL Segundo Mine indicted that TSP concentrations for this area is about 19.57 micrograms per cubic meter (µg/m^3) (United States Environmental Protection Agency (USEPA), 2015). Conversely, TSP concentrations collected from nearest stations at Farmington indicate concentrations of about 12.58 microgram per cubic meter (United States Environmental Protection Agency (USEPA), 2015). All air quality data for sulfur dioxide, nitrogen dioxide and carbon monoxide for the region was collected in the north area (Farmington) which contains the Four Corners and San Juan generating station, as well as the greatest density population. **These concentrations are well below the applicable standards, and both primary and secondary air quality standards are attained. (**Table 5-6**)**

Table 5-6 Regional Air Quality Data for selected locations near the proposed railroad route (USEPA, 2014)

Station	Pollutants of Concern								
	PM2.5 (µg/m3)		PM10 (µg/m3)	SO2 (ppb)		NO2 (ppb)		COx (ppm)	
	Annual	24-hour	24-hour	Annual	24-hour	Annual	1-hour	1-hour	8-hour
Farmington	3.68	3.68	8.9	0.18	0.167	11.16	23.33	0.4269	0.447
Crownpoint	N/A	N/A	19.57	N/A	N/A	N/A	N/A	N/A	N/A

5.3.4 Soils

The soils in San Juan and McKinley Counties have been surveyed by the U.S. Department of Agriculture's Natural Resources Conservation Service (NRCS) (Natural Resources Conservation Service (NRCS), 2001). An analysis of the soils encountered within the ES region indicated that the proposed transportation corridor would cross a variety of soil types over its 110-mile extent. Therefore, to assess the major soils, units that would be disturbed by construction activities of the proposed action, the length of the railway with a 4 miles-width was divided into three sub segments for purposes of this analysis (north, central and south). In addition, soil association maps for each sub area were prepared from information provided by the Soil Conservation Service. Description and properties of the soils present on the corridor site are derived from NRCS Soil Survey for McKinley and San Juan Counties, New Mexico (Natural Resources Conservation Service (NRCS), 2001).

The total area of disturbance for the proposed transportation corridor would be approximately 1459.36 acres. The surface texture of the area varies from clay to fine sand. Along major stream valleys and broad drainage areas, surficial deposits of alluvium and stream gravel are found (United States Department of Interior (USDI) and Bureau of Land Management (BLM), 1979). Most of the soils within the San Juan basin originated from sedimentary parent materials; sandstone, shale and alluvium (US Department of Interior, 1984).

5.3.4.1 South Segment. Thoreau-Crownpoint

Approximately 60 percent of the soils that occur in the southern segment are shallow to very shallow sandy clay loam or loams with inclusions of some rock outcrop. The remainder percentage of soils ranges from deep fine-and medium-textured soils. The two soil map units most frequently crossed by the south corridor area would be the Flugle-Fragua complex, and the Rock outcrop Westmion-Skyvillage complex. The Flugle-Fragua complex occupies 14.3 percent of the south corridor area and contains soils that range from 0 to 6 feet in thickness and loam to sandy clay loam in surface texture (Natural Resources Conservation Service (NRCS), 2001). These soils occur on hills, mesas and cuestas with slopes varying from 1 to 10 percent. The level of water table generally fluctuates between 6 to 10 feet with moderate to rapid permeability. The native vegetative cover of this soil unit is generally used for wildlife (Natural Resources Conservation Service (NRCS), 2001).

The Rock outcrop Westmion-Skyvillage occupies 17.5 percent of the south corridor and occurs in escarpments on mesas with slopes ranging from 5 to 50 percent. These soils characterize to be relatively shallow and well drained. The Skyvillage soil unit is in the shallow sandstone ecological site, and bedrock is found 5 to 20 inches beneath the soil (Ecological Site Description, 2011). Soils within this map unit are developed in alluvial and eolian deposits derived from sandstone and shale (Natural Resources Conservation Service (NRCS), 2001). Appendix A, contains Figure A-1 which illustrates the boundaries of the different soil types and Table A-1 provides a list of soil types and quantities in the southern segment of the rail alignment.

5.3.4.2 Central Segment. Crownpoint-Bistiland

About 65 percent of the soils that occur in the central segment of the corridor are composed of fine sandy loam and sand clay loam, with inclusions of rock outcrops. The soil map units that would be most frequently crossed through this segment are Razito-Shiprock complex, Fajada Huerfano-Benally complex, Norkiki-Kimnoli complex and Sheppard Huerfano-Notal. These soils occur as broad ridges and dunes on upland mesas and valleys with gently slopes varying from 1 to 10 percent. Natural drainage capacity, as well as depth to restrictive layer for these soil units can vary from well to excessively drained, and from 2 to more than 80 inches in depth respectively. The native vegetative cover of these soil units is generally used for wildlife habitat. Likewise, the ecological site is described as “Loamy Upland’’ (Ecological Site Description, 2011). This soil type is well suited for topdressing. Appendix A contains Figure A-2 which illustrates the boundaries of the different soil types and Table which provides a list of soil types and quantities in the central segment of the rail alignment.

5.3.4.3 North Segment. Bisti Land – Farmington

Soils within the north segment corridor are conformed primarily of shallow to deep layers of sand and clay, with inclusions of surficial rock. Information describing the soil map units encountered in the north segment is given in the Soil Survey of San Juan County, New Mexico (Natural Resources Conservation Service (NRCS), 2001). Sheppard Mayqueen-Shiprock complex (more soils) which represents 27 percent of the north segment area is composed primarily of loamy fine sand with slopes varying from 1 to 8 percent. Badland map units occupying 6.8 percent of the north segment characterizes by steep slope, minimal vegetation and high run off potential as a result of its low permeability. Fruitland Persayo-Sheppard complex occupies 20.2 percent and occurs on hills, mesas and breaks with slopes between 5 to 30 percent. The native vegetation for this type of soil is mainly grass and some pinon and juniper (Natural Resources Conservation Service (NRCS), 2001). Appendix A contains Figure A-3 which illustrates the boundaries of the different soil types and Table which provide a list of soil types and quantities in the central segment of the rail alignment.

5.3.5 Vegetation

Vegetation resources include the plant communities and the diversity of species that comprise them. The characteristics of the vegetation that occur within the project area are exemplary of much of the southern high desert regions, adapted to extremes of winter cold, and severe summer droughts. Studies conducted by the Bureau of Land Management Farmington Office (Bureau of Land Management (BLM), 2014) have identified a variety of plant communities that occur in San Juan and McKinley Counties. For purposes of simplicity only those communities that are extensive in nature within the ES area and characterized by few principle species will be addressed in this document.

Six vegetation types that occur within the area include: desert grassland, sagebrush, saltbush-greasewood, badland, pinon-juniper and desert shrubland. The occurrence of these vegetative communities and its mosaic pattern is a function of several environmental parameters predominately geologic, and topographic (elevation and, aspect), climate, and variable soil conditions (Bierei, 1977). However, in the last century extensive areas of San Juan and McKinley Counties have undergone vegetation treatments to facilitate the growth of grasses for domestic livestock, thus influencing the regional vegetation pattern.

Within the ES area, grasses represent the largest component, predominating on a broad belt extending roughly from the northwestern through the southeastern part of the ES region. Pinon-juniper mixes with grassland in the south where elevation is higher, slopes are steeper, and soils are shallower (United States Department of Interior (USDI) and Bureau of Land Management (BLM), 1979).

In 2012, biological surveys were conducted by El Segundo Mine to identify vegetative species within the central portion of the San Juan Basin. Blue grama, alakali sacaton, fourwing saltbush, broom snakeweed, and galleta were the most common, and dominant species observed during the pedestrian survey within the mine boundaries (Bureau of Land Management (BLM), 2014). Communities of scattered juniper trees were observed in northern portion of the project area.

Appendix B contains a complete list of the plant species observed during the biological survey (Table).

In Addition, in 2014 the BLM utilized satellite imagery acquired from 2000-2001, and digital elevation data to model and classify natural and semi-natural vegetation communities in San Juan, McKinley, Rio Arriba and Sandoval Counties. Vegetation communities for this study were classified according to the National Vegetation Classification Standard. The study demonstrated that over the four-county area exist seven major plant community types represented and its majority by pinon-juniper, shrubland, grassland, rock vegetation and sagebrush shrubland (USDI/BLM Farmington Field Office (FFO), 2014). Table 5-7 provides information of the acres of plant community types encountered in this study. As illustrated in Figure 5-5 large tracts of desert grassland occur on the proposed corridor site.

Each vegetation classification is describe in the following subsection and are then used to determine if endangered plant or animal species are present or likely to be present in the proposed project area.

Table 5-7 Acres of Plant Communities Types in San Juan, McKinley, Sandoval and Rio Arriba Counties (United States Department of the Interior, Bureau of Land Management Geographic Information Systems, 2014)

National Vegetation Classification System Macrogroup	National Vegetation Classification System Code	Acres	Percentage of Area
Rocky Mountain Two-needle Pinyon-Juniper Woodland	M027	874,460	39%
Great Basin and Intermountain Dry Shrubland and Grassland	M171	696,300	31%
Intermountain Basin Cliff, Scree and Rock Vegetation	M118	175,930	7.8%
Great Basin and Intermountain Tall Sagebrush Shrubland and Steppe	M169	171,560	7.6%
Southern Rocky Mountain Lower Montane Forest	M022	141,900	6.3%
Cool Semi-Desert Alkali-Saline Wetland	M082	56,180	2.5%
Great Basin Saltbrush Scrub	M093	40,960	1.8%
Agricultural Vegetation	M330 and M331	38,900	1.7%

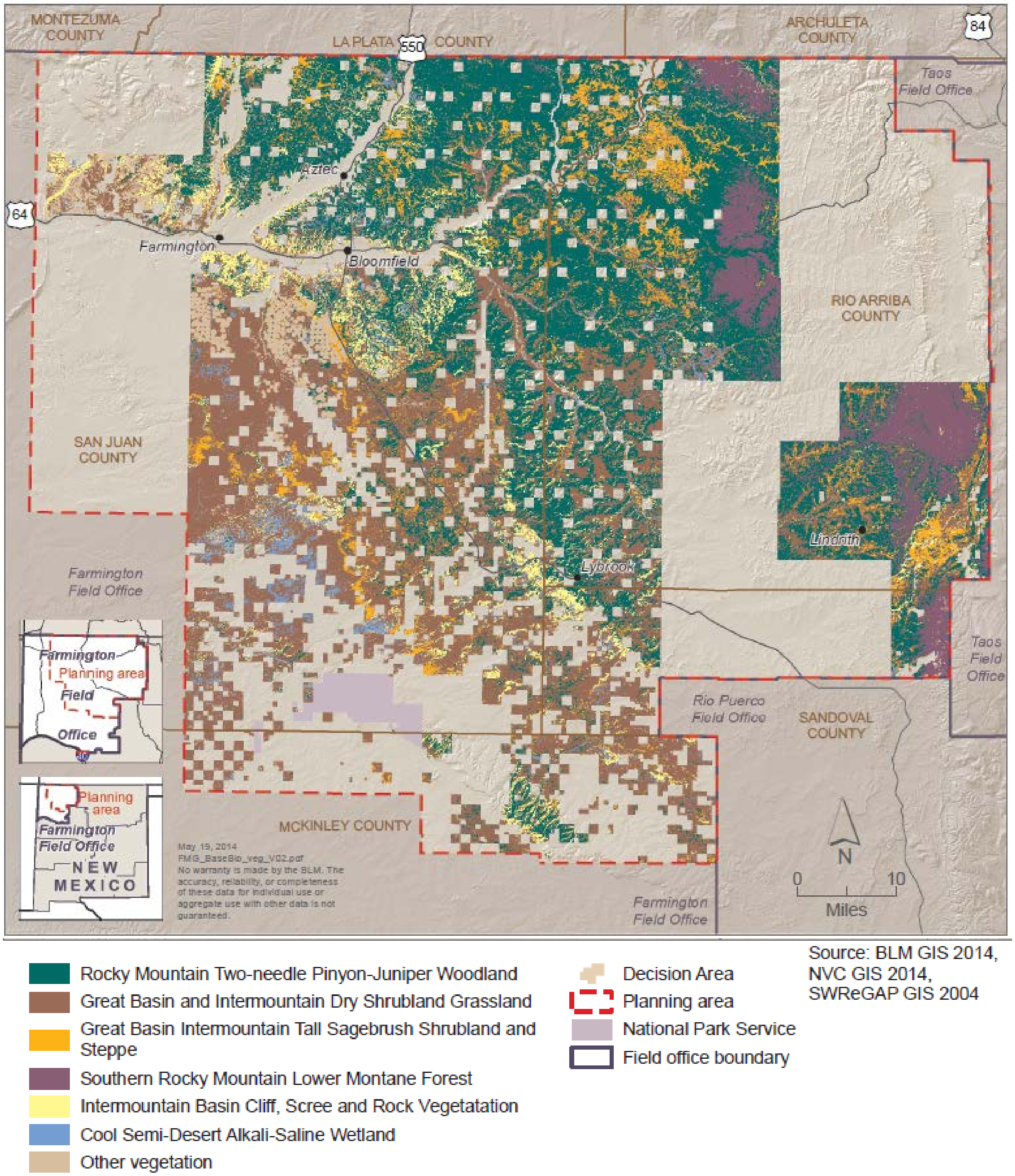


Figure 5-5 Vegetation Communities San Juan, McKinley, Sandoval and Rio Arriba N.M. (USDI/BLM Farmington Field Office (FFO), 2014)

5.3.5.1 Grassland

The grassland within the project area is similar to the short grass plains vegetation because galleta and blue grama are major components of both (United States Department of Interior (USDI) and Bureau of Land Management (BLM), 1979). However, the grasslands in the southern part of the ES area have some similarities of the dessert grassland due to the presence of black grama.

In general sandy or shallow gravels soils encountered at altitudes of 6500 - 7000 feet and where precipitation is sparse exemplify the proper conditions for grassland to exist (Natural Resources Conservation Service (NRCS), 2001). The Fajada-Huerfano Benally complex, Sparanak-San Mateo-Zia complex, Zia sandy loam, Celavar-Atarque complex, Razito-Shiprock complex and Norkiki-Kimnoli complex soils types that occur in the project area are strongly correlated with grasslands (Natural Resources Conservation Service (NRCS), 2001).

5.3.5.2 Sagebrush

The sagebrush/grassland communities exist in fine soils such as deep alluvium where chemical soil characteristics such as moderate alkalinity is not prohibited (Bierei, 1977). Sagebrush occurs in two areas within the ES area. The first area is the central portion of a line extending along the pronounced slopes of Chaco Mesa at Chaco National Park and northerly from Chaco National Park to Farmington (Figure 5-5). Although the growth of sagebrush is not associated with any particular soil association, this specie occurs in areas that receive more than 8 inches of annual precipitation and where moisture holding capacity of the soil is optimum (Bierei, 1977).

5.3.5.3 Saltbush-Greasewood

The third extensive vegetative type consists of saltbush/grassland communities. Within the ES area this specie occurs in bottomlands, in major drainage areas where fine soils accumulate and alkaline sodic conditions are evident (United States Department of Interior (USDI) and Bureau of Land Management (BLM), 1979). According to the NRCS (Ecological Site Description, 2011), this vegetative type is strongly correlated to soil associations such as Sparank-San Mateo soil complex encountered within the corridor area. Species dominating this community are fourwing saltbush, alkali sacaton and galleta (Ecological Site Description, 2011).

5.3.5.4 Pinon Juniper

Pinon-juniper/grassland communities are fairly encountered in vast amounts in the San Juan Basin, especially in the northeast side. This vegetation type occupies dry areas with shallow, coarse texture soils such as ridges, mesas, slopes and rock outcrops of lower elevations (Ecological Site Description, 2011). Principle species observed during the EL Segundo Mine biological survey included one-seed juniper and blue grama. These vegetation types are strongly correlated to soil association such as Marianolake-Skyvillage complex, Marianolake fine sandy loam and Rock outcrop complex soil types (BLM-FFO, 2012), all identified in the soil analysis of the corridor area.

5.3.5.5 Badland

The badland vegetation type normally known as ‘’barren’’ exists mainly in the northern portion of the ES area near the Bisti badlands, 20 miles south of Farmington where sedimentary rock such as shale is exposed to the surface. Soils formed from fine sedimentary material (shale) predominately clay are highly resistant to water infiltration; thus, this vegetative community is found to be particularly sparse in small amounts over the ES area. Where vegetation is found, grasses are the most common and include alkali sacaton, galleta and sand dropseed. (United States Department of Interior (USDI) and Bureau of Land Management (BLM), 1979)

5.3.6 Wildlife

Along the San Juan basin, wildlife is diverse because of the varied vegetation types the region supports. Wildlife species and habitats found within the project area are characteristic of the arid landscape of northwestern New Mexico. The Bureau of Land Management is the organization responsible for the stewardship and habitat for the wildlife in the project area.

The existence of different wildlife species within this ES area has been recorded by a number of researchers. Information provided by the Bureau Land of Management through existing published sources, the (Biota Information System of New Mexico (BISON), 2014), the U.S. Fish and Wildlife Service (USFWS) (Division of Migratory Bird Management, 2008), mining reports, and information collected from site specific surveys conducted in the vicinity of the proposed transportation corridor were used in this section for identification of the major listed, threatened, and endangered species.

In 2012, a wildlife monitoring survey conducted by Peabody Natural Resources Company (PNRC) within the project area recognized 99 bird species, 22 mammal species, and 7 amphibian and reptile species existing in the region (BLM-FFO, 2012). In 1977, Greg Bierei prepared an environmental study of the San Juan basin and reported that over 100 bird species, 30 mammals, and 30 type of reptiles overlapped the basin (Bierei, 1977). The Bureau of Land Management (United States Department of Interior (USDI) and Bureau of Land Management (BLM), 1979), during an environmental assessment of the area prepared for the Star Bisti-Lake railroad reported that 74 mammal species, 283 bird species, and at least 9 amphibian species had been found within the project area, mainly in riparian key habitats such as San Juan, Animas and La Plata river drainages (United States Department of Interior (USDI) and Bureau of Land Management (BLM), 1979).

After an analysis of the information collected, it is concluded that mammal species commonly recorded within the ES area and correlated to their habitat type include; deer mouse (*Peromyscus maniculatus*), northern grasshopper mouse (*Onychomys Leucogaster*), Ord's kangaroo rat (*Dipodomys ordi*i) and plain's pocket mouse (*Perognathus flavescens*). Black-tailed jackrabbits (*Lepus townsendii*) and dessert cottontails (*Sylvilagus auduboni*) also habitat the area. These species represent an important source of food for carnivores such as coyotes and raptors. Mule deer (*Odocoeileus*), pronghorn antelope (*Anticolapra Americana*) and elk (*Cervus elaphus*) have been also documented as migrators on the area (BLM-FFO, 2012).

Bird species commonly recorded include common raven (Corvus corax), horned lark (Eremophilia alpestris), mountain bluebird (Sialia cucurroides), chipping sparrow (Spizella passerine) and loggerhead shrike (Lanius ludovicicanus) (BLM-FFO, 2012). In addition to the species listed above, annual raptor monitoring conducted at El Segundo Mine have identified nesting habitats for common raven, American kestrel (Falco sparverius), ferruginous hawk (Buteo regalis), golden eagle (Aquila chrysaetos), great-horned owl (Bubo virginianus), long-eared owl (Asio otus), prairie falcon (Falco mexicanus) and red-tailed hawk (Buteo jamaicensis). Northern harriers (Circus cyaneus) and merlins (Falco columbarius) have also been observed during monitoring surveys (Bureau of Land Management (BLM), 2014)

Reptiles and amphibians have been also documented during wildlife surveys within the region. Short-horned lizards (Phyrnosoma douglasi), spiny lizards (Sceloporus sp.) and Tiger salamanders (Ambystosoma tigrinum) were the most common species found during these surveys (Bureau of Land Management (BLM), 2014). Appendix C provides a list of the wildlife observed during surveys conducted by Peabody Natural Resources Company at El Segundo Mine area (Table C-1).

5.3.6.1 Migratory Birds.

Data collected through breeding bird surveys coordinated by the U.S. Fish and Wildlife Service (USFWS) as well as other private sector efforts have provided the basis for the New Mexico Partners in Flight (NMPIF) organization to develop a bird watch list and the USFWS's Birds Concern List (Norris, 2007). The NMPIF has identified priority species of birds for the state of New Mexico by habitat type. Birds included in this list are those species, subspecies and population of all migratory non-game birds that, without additional conservation actions are likely to become candidates for listing under the Endangered Species Act. (ESA) of 1973 (Division of Migratory Bird Management, 2008). Within the FFO, some of the birds listed as highest priority species by the NMPIF group and the USFWS Birds of Conservation Concern list for Region 16 (Colorado Plateau) that occur or potentially occur in habitats found in the project area are listed in Table C-2 (Appendix C). Furthermore, the table highlights bird species that have been documented to exist at El Segundo Mine boundaries which lie with the ES area. The open grassland and desert scrubs in and surroundings of the ES area provide foraging habitat for different bird species.

5.3.6.2 Threatened and Endangered Species

Sensitive species are those species for which state or federal agencies afford an additional level of protection by law, regulations or policy (Biota Information System of New Mexico (BISON), 2014). Included in this category are federally listed species that are protected under the ESA of 1973, and species as sensitive by the Bureau Land of Management. In addition the state of New Mexico maintains a list of designated threatened and endangered species. In accordance with the ESA, the BLM in coordination with the USFWS must ensure that any action that they authorize would not adversely affect a federally listed threatened or endangered species. Data used to prepare this section was derived from extensive existing data from the (USFWS, 2010) and Biota

Information System of New Mexico (BISON) (2014). The affected environment considered for federally listed species was delineated based on considerations of all direct and indirect effects of the proposed transportation corridor. For analysis of this section, the affected environment is considered as the two-county region shown in Figure 5-3. According to the (USFWS, 2010) there are nine federally listed and threatened, endangered or candidate animal species with the potential to occur in McKinley and San Juan Counties. **All nine endangered species and their habitat associations are provided in Table 5-8; however, none have habitats along the proposed route or are expected to be impacted. Based on evaluation of data collected, habitat association and field surveys conducted within the ES area by BLM, no federally listed species within the potential to occur in San Juan and McKinley Counties, or potential habitats for listed species, occur within the Farmington-Thoreau ES area.**

Table 5-8 Species Listed by the USWFS as Threatened (T), Endangered (E), or Candidate (C) for McKinley and San Juan Counties, N.M and the potential to occur in the ES area (Bureau of Land Management (BLM), 2014) and (Biota Information System of New Mexico (BISON), 2014)

Species	Status	Habitat Association	Potential Occurrence
		Fish	
Zuni bluehead sucker (*Catostomus discobolus yarrow)*	E	Sedentary sucker found in shady pools in low velocity runs of rivers and creeks containing clean, coarse substrates such as gravel, cobbles, boulder, and bedrock	NP
Colorado Pikeminnow (*Ptychocheilus luciu)*	E	Inhabits sections of the San Juan River and other rivers in the upper Colorado River basin. No wild Colorado pikeminnows have been detected in the ES area.	NP
Razorback Sucker (*Xyrauchen texanus)*	E	Inhabits off-channel backwaters and shallow flooded areas of the San Juan River and other rivers in the upper Colorado River basin. No razorback suckers have been detected in the ES area	NP
		Birds	
Least tern (*Sterna antillarum athalassos)*	E	Breeds locally along Colorado and other southern river systems. Not known to occur in any two-counties area	NP
Mexican spotted owl Strix (*occidentalis lucida')*	T	Found in the southwestern US, principally in New Mexico and Arizona. After extensive surveys, no nesting has been confirmed in the ES area	NP
Sprague's pipit (*Anthus spragueii)*	C	Grassland ground-nesting bird found in pastures and weedy fields, including agricultural fields. Rare visitor to the ES area during migration; winters in southern US including southern New Mexico	NP
Yellow-billed cuckoo (*Coccyzus americanus)*	PT	Breeds in riparian woodlands with dense understory vegetation. Requires habitats patches larger than 5 acres. Rare in the San Juan River valley. Potential habitat on in the planning area was surveyed for this species in 2002.	NP
Southwestern willow flycatcher (*Empidonax trailii extimus)*	E	No breeding southwestern willow flycatchers have ever been detected in the ES area. Critical habitat for this specie is located in riparian corridors close to proximity to surface water or saturated soils.	NP
		Mammals	
Canada lynx (*Lynx canadensis)*	PT	Medium-sized cat found in boreal and montane forests, feeds primarily upon snowshoe hare and other small mammals and birds. Distributed through western and northern US into southern Rocky Mountains; has been observed in along the San Juan River. No documented in the ES area.	NP

NP = Habitat not present and species unlikely to occur.

5.3.6.3 Special Status Species

The BLM manages certain sensitive species not federally listed as threatened or endangered, including species that are candidates or proposed for listing but receive no protection under the ESA, in order to prevent them from being listed as threatened or endangered in the future (Bureau of Land Management (BLM), 2014). Information used to prepare this section is derived from published data in the BISON, BLM/FFO, and data collected from habitat evaluations within the project area. According to (Biota Information System of New Mexico (BISON), 2014) there are 12 BLM special status species that may have the potential to occur in the project area. Special status and their habitat associations are listed in Table 5-9. Ferruginous hawk, golden eagle and prairie falcon have been documented as occurring in the project area (BLM-FFO, 2012).

The only plant with a special status of sensitive known to occur in the proposed area is the San Juan milkweed; however, it typically grown below 5,500 feet of elevation and nearly the entire proposed route is above that elevation so it is not likely to be found along the proposed line.

Three birds, the Ferruginous Hawk, the Golden Eagle and the Prairie Falcon are known to be present in the area of the proposed rail line. **Of these birds the only with potential to nest in the proposed region is the Ferruginous Hawk. The Golden Eagle and Prairie Falcon nest outside of the proposed area of disturbance but could hunt in the project area.**

Table 5-9 BLM and FFO Special Management Status Species and potential to occur in the ES area (Biota Information System of New Mexico (BISON), 2014) and (Bureau of Land Management (BLM), 2014)

Species	Status		Habitat Association	Potential Occurrence
	BLM	State NM		
			Plants	
Aztec gilia *Aliciella formosa*	Sensitive, SMS	E	Salt desert scrub communities. Project area does not contains the adequate geological substrate	NP
Brack's hardwall cactus *Sclerocactus cloveriae var. brackii*	Sensitive, SMS	E	Occurs on sandy-clay hills of the Nacimiento Formation in desert scrub habitat. Project does not contain adequate geological substrate	NP
San Juan milkweed Asclepias sanjuanensis	Sensitive	SOC	Found in sandy loam soils, usually in disturbed sites, in juniper savanna and Great Basin desert scrub; 5,000 to 5,500 feet.	P
			Birds	
American peregrine falcon (*Falco peregrinus anatum)*	SMS	T	The American peregrine falcon nests adjacent to rivers, lakes or streams and rugged terrain with rocky cliffs. No cliffs near perennial water in ES area	NP

Bald eagle *(Haliaeetus leucocephalus)*	Sensitive, SMS	T	Breeding habitat most commonly includes areas close to coastal areas, bays, rivers, lakes, reservoirs, or other bodies of water with available food sources including fish, waterfowl, or seabirds	NP
Burrowing owl *(Athene cunicularia)*	Sensitive, SMS		Species associated to with prairie dog colonies. Will also use kangaroo rats burrows as food source	NO
Ferruginous hawk *(Buteo regalis)*	Sensitive, SMS		Nests in flat or rolling terrain in graslands, shrub-steepes and deserts. Known nest in El Segundo Permit boundary approximately 15 miles from proposed corridor.	P
Golden eagle *(Aquila chrysaetos)*	SMS		In the west, mostly open habitats in mountainous, canyon terrain. Nest primarily on cliffs and trees. Project area contains suitable foraging habitat.	P
Mountain plover *(Charadrius montanus)*	SMS		Found in high plains/shortgrass prairie, desert tablelands and sagebrush habitats. Commonly associated with prairie dog towns. ES area has suitable foraging habitat, however, none have been observed in surveys	NO
Prairie falcon *(Falco mexicanus)*	SMS		Found in arid, open grassland and shrubs. Open grass land provides suitable foraging habitat. Historical nests occur 6.5 miles north of El Segundo Mine	P
Yellow-billed cuckoo *(Coccyzus americanus occidentalis)*	Sensitive, SMS		Breeding habitat is generally deciduous riparian woodland, especially including dense stands of cottonwood and willow. No riparin areas occur in the ES area	NP
Bendire's thrasher *Toxostoma bendirei*	Sensitive		Found in sparse desert habitats from sea level to 5,900 feet. Breeders favor relatively open grassland, shrubland or woodland with scattered shrubs or trees; it is not found in dense vegetation.	NO

Notes: (1) E=Endangered, T=threatened, SMS=BLM Special Species, SOC=State of New Mexico Species of Concern. NP=Not present, NO= No observed, P=Present.

5.3.6.4 Noise

Noise is defined as any loud, discordant or unwanted sound associated with human activities that may cause an undesired effect on people or animals and that may interfere with their behavior and quality of life (Farmington Field Office, 2003).The response of individuals to similar noise events and the level of perceptibility is influence by several environmental factors, characteristics of the sound and the physical and mental sensitivity of the receptors (New York State Department of Environmental Conservation, 2001). The environmental factors include; time of the day, wind direction, relative humidity, temperature gradient and distance from the receptor to the source of sound (Farmington Field Office, 2003). Amplitude (loudness), frequency (pitch) and duration represent characteristic of the sound (New York State Department of Environmental Conservation, 2001). The combination of all these factors determine whether or not sound will be perceived as noise. Table 5-10 contains some definitions of the noise terminology used in this section.

Table 5-10 Definitions of Noise Terminology

Term	Definition
Decibel (dBA)	A unit describing the amplitude or loudness by comparing it to a given reference level on a logarithmic scale. The reference level in air is 20 micropascals (μPa), corresponding to 0 decibels.
A-weighted sound level (dBA)	The sound pressure level in decibels as measured on a sound level meter using the a-weighting filter. The a-weighting filter de-emphasizes the very low and very high frequency components of the sound in a manner similar to the frequency response of the human ear and correlates well with subjective reactions to noise
Equivalent noise level (Leq)	The average a-weighted noise level during a given measurement period. The hourly Leq is denoted as Leq [h].
Day/Night noise level (Ldn)	The average a-weighted noise level during a 24-hour day, obtained after the addition of a 10 dBA penalty for nighttime noise from 10:00 p.m. and 7:00 a.m.

Source: BLM 2014.

Noise levels are quantified using units of decibels (dB) that indicate the relative amplitude or wave intensity of the sound (Burns District Office, 2011). Since the human ear is not equally sensitive to all frequencies, an A-weighted (dBA) scale was derived to relate or approximate noise to human sensitivity (BLM, 2014). A normal speech has for example a sound level of approximately 60 dBA. Sound levels that exceed about 120 dBA begin to be felt inside the human ear as discomfort (Burns District Office, 2011).

Because sensitivity of the noise increases at night, 24 hour descriptors (Ldn and Leq) that incorporate penalties for nighttime use are generally used (Battle Mountain, Elko and Ely Field Offices, Nevada, 2001). Ldn represents a time weighted 24-hour noise level and includes 10 dBA adjustment for noise events occurring at night (Battle Mountain, Elko and Ely Field Offices, Nevada, 2001).

In 1974, the USEPA published existing noise levels for areas with type of noise generating activities. To prevent hearing loss, a 24-equivalent level of 70 dBA was established (USEPA, 1974). Furthermore, noise levels established to prevent annoyance and interference with human activities for outdoor and indoor areas were set to be 55 dBA and 45 dBA respectively (USEPA, 1974). These USEPA noise levels can be used to estimate and assess noise levels in areas where site specific noise measurements have not been taken (Pinedale Field Office Wyoming, 1999) Table D-1 (Appendix D) provides a list of estimated noise levels for typical construction equipment.

The proposed project and alternative would be located in a rural and wilderness environment with limited dispersed noise sources. Sensitive receptors in the area include residences, industrial and recreational areas in the communities of Crownpoint, Thoreau and Farmington. Ambient noise levels expected to occur within the corridor area would include those periodic noises related to the construction of the rail track such as loader trucks, jackhammers, vibratory roller, dirt hauling etc. However, continuous noise would occur as a result of the rail operation.

In 2011, BLM reported different noise levels for typical oil and gas activities recorded at a distance of 50 feet. Approximately 83 dBA was recorded for drilling activities, 71 dBA for produced water injection equipment, and 85 dBA for gas compressor facilities (Burns District Office, 2011). For purposes of analysis, noise levels of operational surface mining activities as well as rail line at El Segundo Mine will be used.

For purposes of analysis, a noise study conducted at El Segundo Mine and Lee Ranch related to the noise produced by mining equipment will be used to represent those noises that would be produced by construction and operation of the proposed action. The study includes sources of continuous and periodic mine-related noise such as shovel excavation, blasting operations, road and rail noise (Table 5-11).

The US Dept. of Transportation's Federal Rail Road administration's site (Federal Railroad Administration) includes projections for noise levels near rail crossings. **These projects show a**

a noise level of 80-90 dBA at the crossings and a 40 dBA drop in noise levels 1,000 feet from the rail line, so whenever possible the proposed route should maintain 1,000 feet from populated areas.

Table 5-11 Maximum Noise Levels (2-minute Leq) measure at 1000 foot intervals from Operational Sources at El Segundo and Lee Ranch Mines

Source	Noise (dBA) at distances from noise sources										
	0	1000	2000	3000	4000	5000	6000	7000	8000	9000	10000
Dragline	50.3	62.9	67.4	36.3	64.7	60.5	63.6	73.5	66.5	66.9	58.3
Crusher	88.4	80.5	84.3	41.7	42.5	49.6	48.3	37	36	42.9	49.8
Rai Line	84.3	80.5	88.4	65.7	44.6	49.6	48.3	37	36	42.9	49.8
Shovel and truck/Haul Road	74.3	59.5	57.3	52.5	53.1	47.6	45.6	52.6	49	59.2	42.7

Source: BLM 2014

The information shown above demonstrates that for most operational sources at El Segundo Mine, noise levels dropped to ambient levels at approximately 7000 feet, therefore causing no negative impact within the mine area. Only the dragline can be heard at 10,000 feet, the greatest distance from the source that sounds levels were sampled.

In order to prevent annoyance or interference with human activities based on Table 5-11 no rail sidings where engines would idle for extended periods of time should be closer than 4000 ft to any populated areas.

5.3.7 Cultural Resources

The proposed and alternative routes would traverse the southern and central portion of the archaeologically rich San Juan Basin. The region represents an important source of the cultural history and heritage of the northwestern New Mexico (United States Department of Interior (USDI) and Bureau of Land Management (BLM), 1979).

Several archaeological surveys and research adjacent to the proposed transportation corridor date back to last century where historic remains were found in what is known as the Chaco Culture National Historical Park (US Department of Interior, 1984). Hewett (Hewett, 1977) divided the prehistory of the San Juan basin into five major periods: Paleo-Indian period (ca. 10000 B.C. to 5500 B.C.), Archaic (ca. 5500 B.C. to A.D. 400), Basketmaker II-III and Pueblo I-IV periods (A.D. 1 to 1540), and the historic (A.D. 1540 to present), which discuss the incursion of Native Americans as well as Hispanic and Euro-American settlers (Hewett, 1977). A description of each of these periods can be found in the Farmington PRMP/FEIS prepared by the Bureau of Land Management, Farmington Field office (BLM-FFO). The proposed corridor and alternative would be located within the San Juan basin watershed. Based on the Farmington (Bureau of Land Management, March 2003) a total of 4329 sites representing the aforementioned historical periods have been recognized within the watershed area (Bureau of Land Management, Sept 2003). The most frequently occurring cultural affiliations of known existence in this area include Anasazi Pueblo I (41 Percent) and Dinetah/Gobernador (15 percent) (Bureau of Land Management, Farmington Field Office, Nov. 2011). **Since site specific locations for each of the 4,329 sites are not published, no illustrative map could be included in this environmental study.**

5.3.7.1 Archaeological Sites

Archaeological sites and historical properties are specific locations and/or tangible remains in which evidence of past human activity is preserved. The Navajo Nation maintains a list and map of known archeological sites in the vicinity of the proposed rail alignment. The final alignment has been coordinated with the Navajo Nation Historic Preservation Department in order to avoid such sites.

5.3.7.2 Traditional Cultural Properties (TCP)

A traditional cultural property can be defined as one that is eligible for incorporation in the National Register List because its association with cultural practices is vital in maintaining the community sense of identity, history and self-respect (Parker & King, 1988). Within the ES area, Native American cultural organizations are the communities most likely to identify TCPs, although TCPs are not restricted to this group. For the proposed action and alternative, efforts to identify Native American Religious and Traditional Cultural Properties (TCPs) included reviewing existing and published literature, personal communication with the BLM staff and Navajo Nation. **No known TCPS exist within the corridor area; therefore, the project would have no impact to Navajo Traditional Cultural Resources** (BLM-FFO, 2012).

5.3.8 Land Use

Land use impacts are measured in terms of how the proposed action would affect present and future land use at the proposed site and its surroundings. The proposed transportation corridor and alternative route would cross federal, state, private, and tribal land inside of McKinley and San Juan Counties; therefore, the two county region would be defined as the affected area for land use. Approximately 7.1 million acres is the total surface of both counties with the majority of land owned by the Navajo Nation (Bureau of Land Management, Sept 2003). The distribution of the land in McKinley and San Juan Counties is outlined in Table 5-12.

Tribal Land governed by the Navajo Nation and Ute Indian Tribe occupies more than 60 percent in each county land area. Generally, the traditional economic land use of the region is for livestock grazing, and to a minor extent for timber and agricultural production (USNRC , 2009).

Table 5-12 Land Ownership in San Juan and McKinley Counties, New Mexico (Bureau of Land Management, Sept 2003)

Cooperating Land Management Agencies	San Juan County	McKinley County
FFO BLM	856,593	204,705
AFO BLM	0	40,035
USFS	0	13
USBR	15982	0
Subtotal: Surface acres by county	872,575	244,753
Other Land Management Agencies		
Department of Defense	0	259
Tribal Lands	2,323,806	2,167,694
National Park Service	31,301	2,904
State	122,326	174,814
Private	234,460	734,218
Subtotal: Surface acres by county	2,711,893	3,079,889
Total Surface Acres	3,584,468	3,324,641

In addition Federal land for oil and natural gas development would be affected by the proposed corridor. Some of these oil and gas leases are located entirely on Federal Land, whereas other fields are located on private and tribal land within San Juan and McKinley counties. **Careful consideration will have to be given to how the proposed rail line crosses existing oil and gas pipelines just south of NAPI farms.**

5.4 Environmental Conclusions

Most of the endangered or special status plant and animal species known to possibly occur in the region are not present in the proposed project area. The primary reason they are not present is the lack of an appropriate habitat, sufficient water, or elevation. **The only known special status species that is likely to potentially nest in the proposed project area is the Ferruginous Hawk, and no endangered status species are known to nest in the project area.**

A complete survey of the proposed alignment will be required prior to construction for historical and archeologic sites regardless of whether existing studies have been performed. **The proposed rail line avoids known sites, and it is anticipated that any new sites found could either be avoided or mitigated.**

Noise levels near populated areas are of concern. The region has a sparse enough population that sufficient distance from populated areas to prevent noise disruptions is possible. However some populated regions such as Crownpoint have expressed interest in the line being located relatively close to the town in order to leave open the prospect of passenger service at a future date.

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APPENDIX A

SOIL DATA

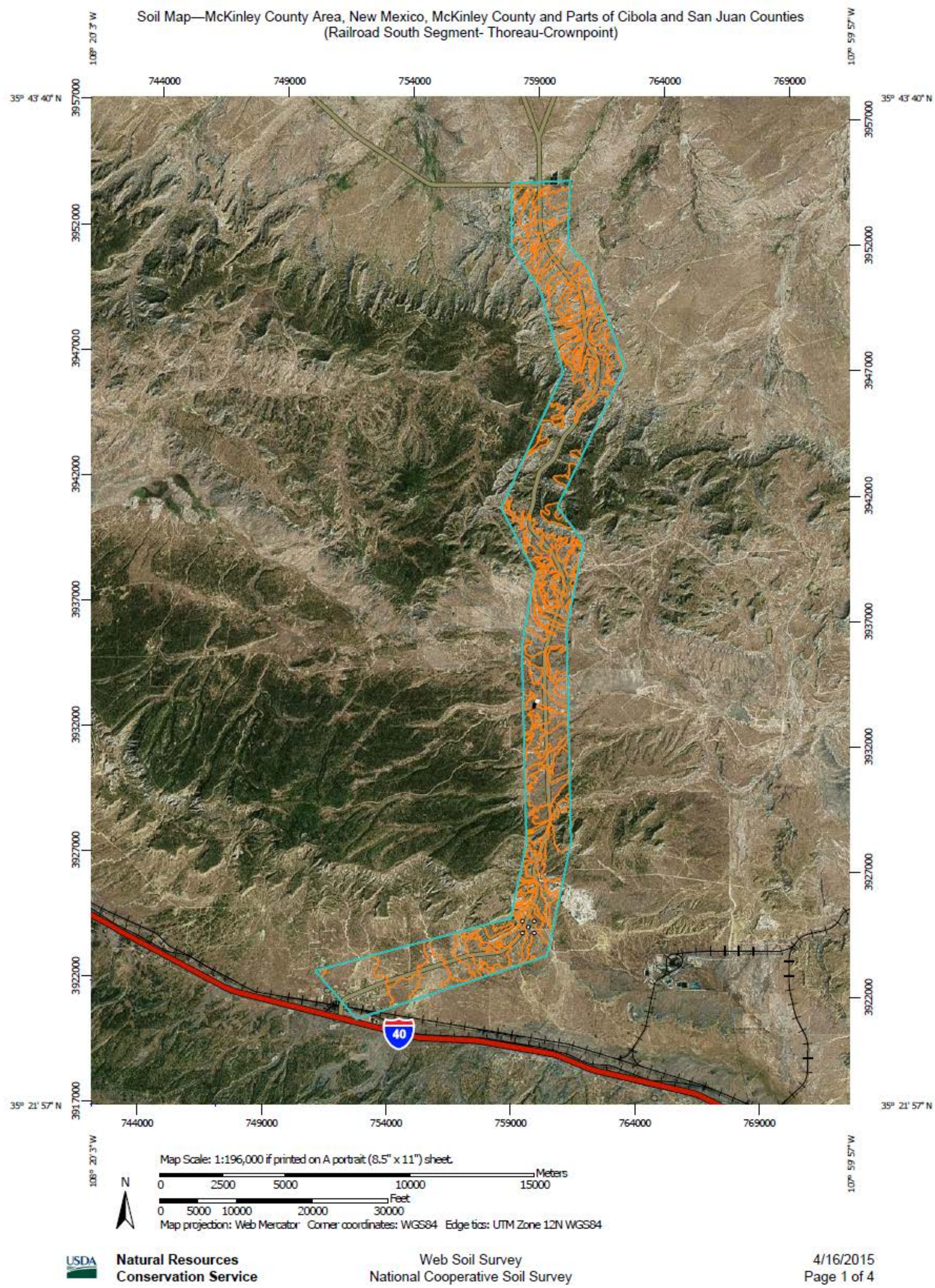

Figure A-1 Soil map of south-segment corridor (US Department of Agriculture, Natural Resources Conservation Service)

Table A-1 Soil Map Units present within south-segment corridor area (US Department of Agriculture, Natural Resources Conservation Service)

Map Unit symbol	**Map Unit Name**	**Acres in project area**	**Percent project area**
100	Norkiki-Kimnoli complex, 1 to 8 percent slopes	281.0	1.4%
116	Fajada-Huerfano-Benally complex, 1 to 5 percent slopes	141.0	0.7%
118	Farb-Chipeta-Rock outcrop complex, 2 to 30 percent slopes	12.5	0.1%
120	Doak-Shiprock complex, 1 to 8 percent slopes	36.5	0.2%
205	Penistaja-Tintero complex, 1 to 10 percent slopes	723.7	3.7%
208	Marianolake fine sandy loam, 1 to 8 percent slopes	490.1	2.5%
210	Marianolake-Skyvillage complex, 1 to 8 percent slopes	801.0	4.1%
220	Hagerwest-Bond fine sandy loam, 1to 8 percent slopes	727.3	3.7%
225	Aquima-Hawaikuh complex, 1 to 5 percent slopes	182.1	0.9%
230	Sparanak-San Mateo-Zia complex, 0 to 30 percent slopes	1733.1	8.8%
235	Notal-Hamburn complex, 0 to 2 percent slopes	227.7	1.2%
250	Hospah-Skyvillage-Rockoutcrop complex, 2 to 35 percent slopes	1443.6	7.3%
260	Quarries and Pits	114.3	0.6%

290	Rock outcrop-Westmion-Skyvillage complex, 30 to 80 percent slopes	3445.2	17.5%
305	Celavar-Atarque complex, 1 to 8 percent slopes	1728.8	8.8%
310	Parkelei sandy loam, 1 to 8 percent slopes	30.0	0.2%
315	Flugle-Fragua complex, 1 to 10 percent slopes	2813.8	14.3%
332	Evpark-Arabrab complex, 2 to 6 percent slopes	269.9	1.3%
338	Zyme-Lockerby association, 5 to 35 percent slopes	119.6	0.6%
350	Toldohn-Vessilla-Rock outcrop complex, 8 to 35 percent slopes	412.0	2.1%
351	Rock outcrop-Vessilla complex, 35 to 70 percent slopes	383.0	1.9%
352	Zia sandy loam, 1 to 5 percent slopes	2458.0	12.5%
355	Rizno-Tekapo-Rock outcrop complex, 2 to 45 percent slopes	76.3	0.4%
368	Simitarq-Celavar sandy loams, 2 to 8 percent slopes	183	0.9%
375	Todest-Shadito complex, 2 to 8 percent slopes	76.7	0.4%
376	Todest fine sandy loam, 2 to 8 percent slopes	49.7	0.3%
380	Berryhill-Casamero clays, 2 to 10 percent slopes	287.4	1.5%
404	Rock outcrop-Techado-Stozuni complex, 5 to 60 percent slopes	53.7	0.3%

565	Pluamasano-Rock outcrop complex, 15 to 40 percent slopes	147.7	0.8%
566	Bamac extremely gravelly sandy loam, 5 to 50 percent slopes	202.1	1.0%
Total for Area of Interest		19650.8	100.0%

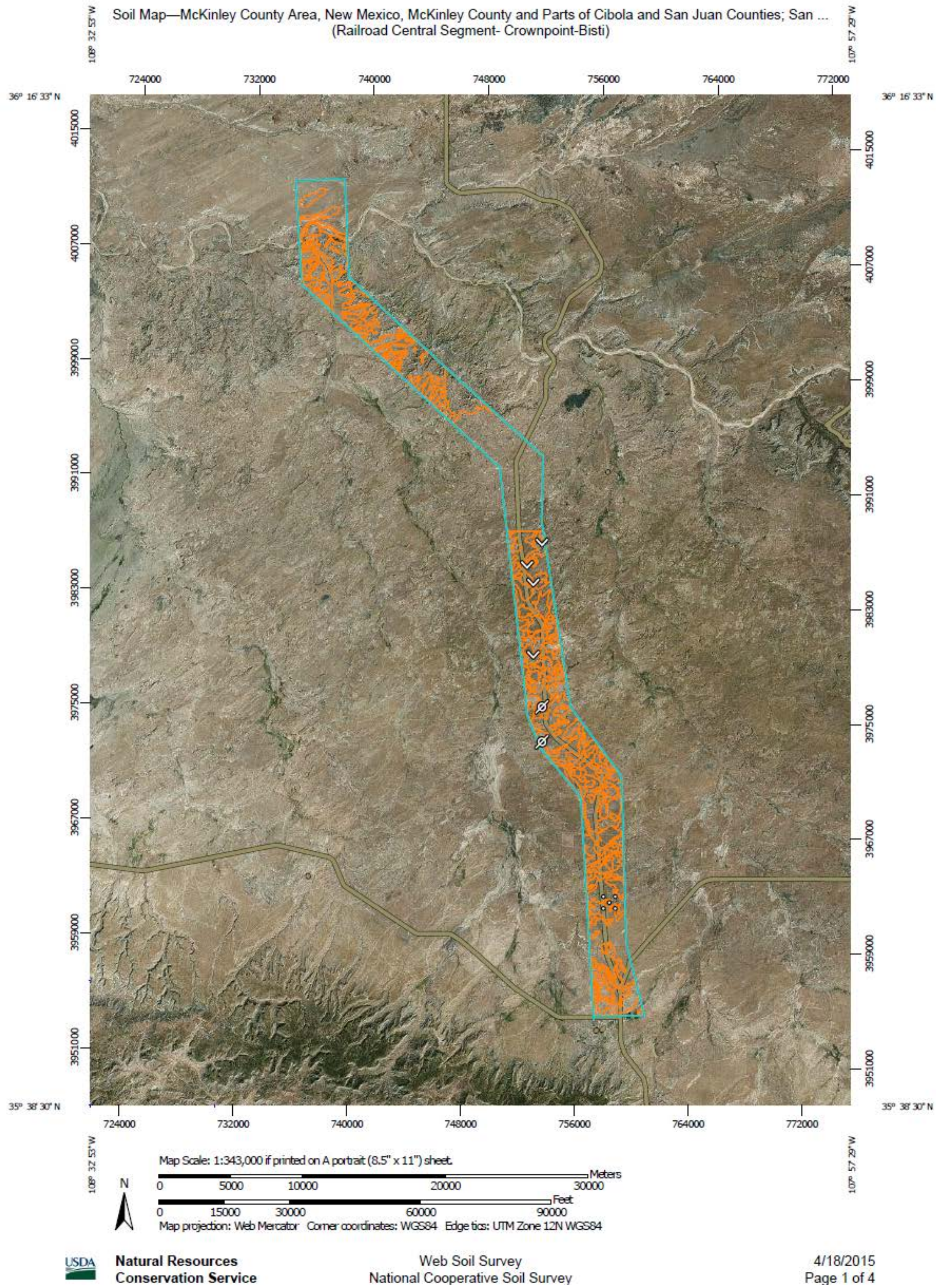

Figure A-2 Soil map of central-segment corridor (US Department of Agriculture, Natural Resources Conservation Service)

Table A-2 Soil Map Units Present Within Central-segment Corridor Area (US Department of Agriculture, Natural Resources Conservation Service)

Map Unit symbol	Map Unit Name	Acres in project area	Percent project area
100	Norkiki-Kimnoli complex, 1 to 8 percent slopes	7060.1	15.2%
110	Benally-Fruitland association, 1 to 5 percent slopes	168.2	0.4%
111	Yelives fine sandy loam, 1 to 3 percent slopes	1574.0	3.4%
115	Razito-Shiprock complex, 3 to 8 percent slopes	8658.0	18.6%
116	Fajada-Huerfano-Benally complex, 1 to 5 percent slopes	7536.0	16.2%
118	Farb-Chipeta-Rock outcrop complex, 2 to 30 percent slopes	2476.1	5.3%
120	Doak-Shiprock complex, 1 to 8 percent slopes	1906.3	4.1%
121	Badland	1322.8	2.8%
130	Chipeta-Badland-Moncisco complex, 2 to 45 percent slopes	3979.7	8.6%
160	Escawetter-Riverwash-Razito association, 0 to 5 percent slopes	211.5	0.5%
220	Hagerwest-Bond fine sandy loams, 1 to 8 percent slopes	0.3	0.0%
235	Notal -Hamburn complex, 0 to 2 percent slopes	2004.9	4.3%
BA	Badland		0.0%
SC	Sheppard-Huerfano-Notal complex, gently sloping	6588.6	14.2%

115	Denazar-Farb fine sands, 0 to 3 percent slopes	2153.0	4.6%
125	Kimbeto loamy fine sand, 0 to 4 percent slopes	453.1	1.0%
135	Farb-Rock outcrop-Badland complex, 0 to 8 percent slopes	183.6	0.4%
145	Razito-Huerfano complex, 0 to 8 percent slopes	0.3	0.0%
160	Notal -Escavada-Riverwash association, 0 to 1 percent slopes	164.7	0.4%
Total for Area of Interest		46441.1	100.0%

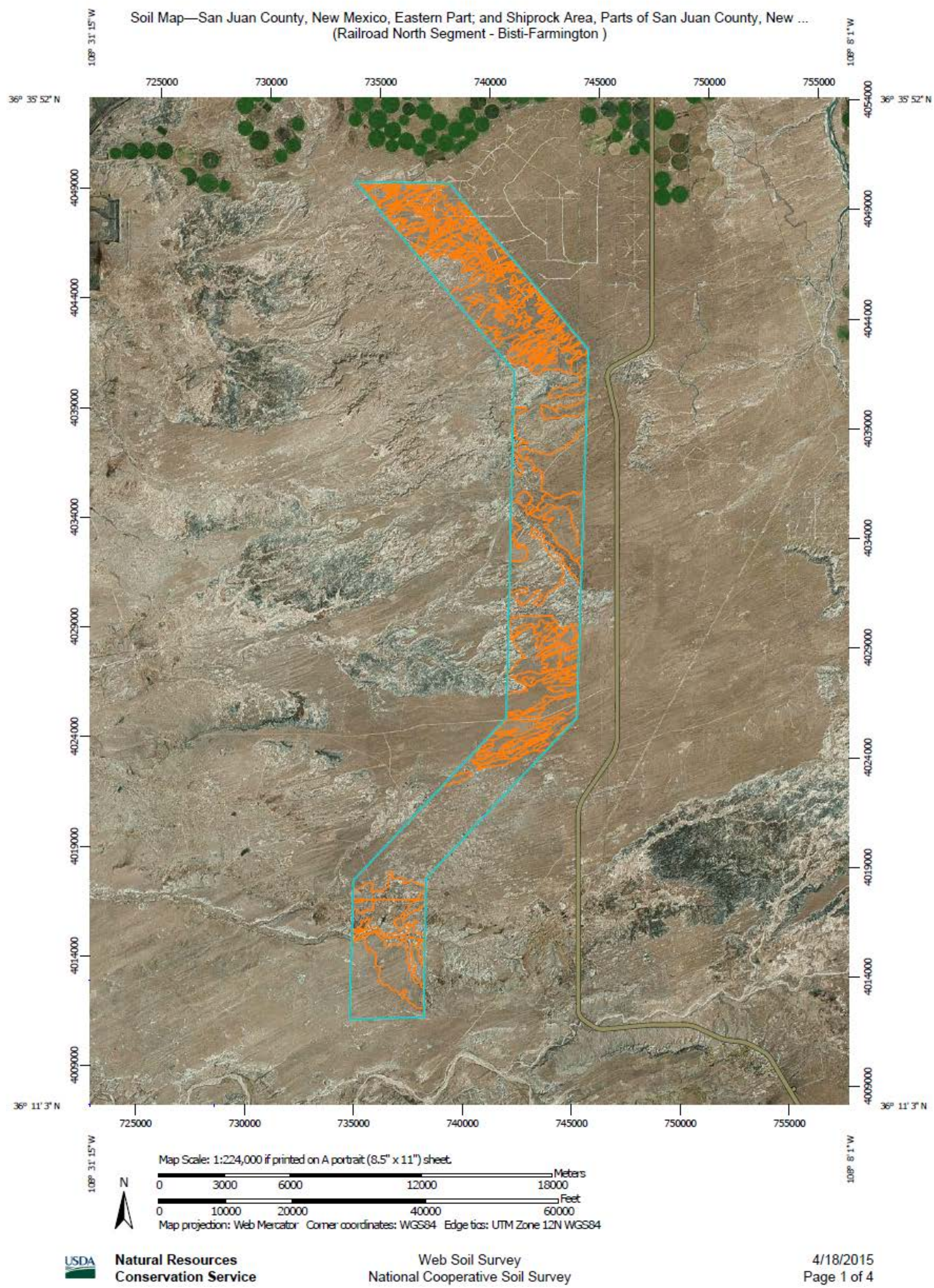

Figure A-3 Soil map of north-segment corridor (US Department of Agriculture, Natural Resources Conservation Service)

Table A-3 Soil Map units present within the north-segment corridor area (US Department of Agriculture, Natural Resources Conservation Service)

Map Unit symbol	Map Unit Name	Acres in project area	Percent project area
Av	Avalon sandy loam, 2 to 5 percent slopes	703.6	2.1%
Ax	Avalon sandy loam, 5 to 8 percent slopes	102.1	0.3%
Ay	Avalon loam, 0 to 3 percent slopes	73.9	0.2%
AZ	Avalon-Sheppard-Shiprock association, getly sloping	778.8	2.4%
BA	Badland	2261.9	6.8%
BP	Blackston-Farb complex, moderately steep	113.8	0.3%
Da	Doak loam, 0 to 1 percent slopes	1485.0	4.5%
Db	Doak loam, 1 to 3 percent slopes	1272.4	3.9%
Dc	Doak loam, 3 to 5 percent slopes	18.1	0.1%
Du	Doak-Uffens complex, 0 to 3 percent slopes	445.2	1.3%
FX	Fruitland-Persayo-Sheppard complex, hilly	6690.2	20.2%
HU	Huerfano-Muff-Uffens complex, gently sloping	1820.7	5.5%
MO	Monierco fine sandy loam, gently sloping	134.6	0.4%

RO	Rock outcrop	14.4	0.0%
SC	Sheppard-Huerfano-Notal complex, 0 to 8 percent slopes	4960.2	15.0%
Sd	Sheppard-Mayqueen-Shiprock complex, 0 to 8 percent slopes	5153.8	15.6%
Sm	Shiprock fine sandy loam, 0 to 2 percent slopes	172.9	0.5%
So	Shiprock fine sandy loam, 2 to 5 percent slopes	1650.4	5.0%
Sr	Shiprock variant fine sandy loam, 0 to 2 percent slopes	647.0	2.0%
115	Denazar-Farb fine sands, 0 to 3 percent slopes	1599.2	4.8%
135	Farb-Rock outcrop-Badland complex, 2 to 25 percent slopes	37.8	0.1%
145	Razito-Huerfano complex, 0 to 8 percent slopes	1514.2	4.6%
150	Chipeta-Badland-Moncisco complex, 2 to 45 percent slopes	1210.9	3.7%
165	Jeddito-Escavada association, 0 to 3 percent slopes	183.5	0.6%
Total for Area of Interest		33044.6	100.0%

APPENDIX B

VEGETATION

Table B-1 Plants Species Observed at El Segundo Mine Area (BLM-FFO, 2012)

GRASSES	
Achnatherum hymenoides	Indian ricegrass
Bouteloua gracilis	blue grama
Bromus tectorum	cheatgrass
Elymus elymoides	squirreltail
Eremopyrum triticeum	annual wheatgrass
Hesterostipa comata	needle and thread
Muhlenbergia torreyi	ring muhly
Pascopyrum smithii	western wheatgrass
Pleuraphis jamesii	James' galleta
Sporobolus airoides	alkali sacaton
Sporobolus cryptandrus	sand dropseed

HERBACEOUS FORBS	
Ambrosia acanthicarpa	flatspine bur ragweed
Asclepias sp.	milkweed
Bassia scoparia	burningbush
Brassica sp.	mustard
Dimorphocarpa wislizeni	touristplant
Eriogonum sp.	buckwheat
Eriogonum leptophyllum	slenderleaf buckwheat
Halogeton glomerotus	saltlover
Helianthus sp.	sunflower
Heterotheca villosa	hairy false goldenaster
Mentzelia albicaulis	whitestem blazingstar
Rumex sp.	dock
Sphaeralcea sp.	scarlet globemallow

SHRUBS	
Artemisia bigelovii	Bigelow sagebrush
Artemisia frigida	prairie sagewort
Atriplex canescens	fourwing saltbush
Chrysothamnus viscidiflorus	yellow rabbitbrush

Ephedra torreyana	Torrey’s jointfir
Ericameria nauseosa	rubber rabbitbrush
Gutierrezia microcephala	threadleaf snakeweed
Gutierrezia sarothrae	broom snakeweed
Krascheninnikovia lanata	winterfat

CACTI	
Coryphantha sp.	beehive cactus
Cylindropuntia whipplei	whipple cholla
Opuntia polyacantha	plains pricklypear

TREES	
Juniperus monosperma	oneseed juniper

APPENDIX C

Wildlife, Threatened and Endangered Species

Table C-1 Wildlife observed during survey at El Segundo Mine (BLM-FFO, 2012)

QUADRUPEDS	
Canis latrans	coyote
Cervus elaphus	elk
Dipodomys ordii	Ord’s kangaroo rat
Lepus californicus	black-tailed jackrabbit
Neotoma sp.	woodrat
Odocoileus hemionus	mule deer
Sylvilagus audubonii	desert cottontail

BIRDS	
Corvus corax	common raven
Eremophila alpestris	horned lark

Table C-2 Migratory Birds including New Mexico NMPIF and USWS Birds of Conservation Concern within the project area. (Division of Migratory Bird Management, 2008), (Norris, 2007), and (USDI/BLM Farmington Field Office (FFO), 2014)

Species	New Mexico Partners in Flight Priority Species	USFWS Birds of Conservation Concern (BCR Region 16)	Birds documented at El Segundo Mine Area
American Bittern	X	X	
Baird's Sparrow	X		
Bald Eagle	X	X	
Band-tailed Pigeon	X		
Bank Swallow	X		
Bell's Vireo	X		
Belted Kingfisher	X		
Bendire's Thrasher	X	X	X
Black Rosy-Finch		X	
Black Swift	X		
Black-chinned Hummingbird	X		

Black-throated Gray Warbler	X		
Black-throated Sparrow	X		X
Brewer's Sparrow		X	X
Broad-tailed Hummingbird	X		
Brown-capped Rosy-Finch	X	X	
Bullock's Oriole	X		
Burrowing Owl		X	X
Cassin's Finch	X	X	
Chestnut-collared Longspur (nb)		X	
Clark's Grebe	X		
Commom Black Hawk	X		
Cordilleran Flycatcher	X		
Dickcissel	X		
Eared Grebe	X		
Ferruginous Hawk	X	X	X
Flammulated Owl	X	X	
Golden Eagle	X	X	X
Grace's Warbler	X	X	
Grasshopper Sparrow	X	X	
Gray Vireo	X	X	
Hooded Oriole	X		
Juniper Titmouse	X	X	X
Lazuli Bunting	X		
Least Bittern	X		
Least Tern	X		
Lewis's Woodpecker	X	X	
Loggerhead Shrike	X		X
Long-billed Curlew	X	X	
Lucy's Warbler	X		
McCown's Longspur	X		
Mississippi Kite	X		
Mountain Bluebird	X		X
Mountain Plover	X	X	
Northern Harrier	X		X
Northern Pygmy-Owl	X		

Olive-sided Flycatcher	X		
Painted Bunting	X		
Peregrine Falcon	X	X	
Pinyon Jay	X	X	X
Plumbeous Vireo	X		
Prairie Falcon	X	X	X
Red-headed Woodpecker	X		
Red-naped Sapsucker	X		
Sage Sparrow	X		
Sage Thrasher	X		
Scaled Quail	X		
Snowy Egret	X		
Snowy Plover	X	X	
Sprague's Pipit	X		
Summer Tanager	X		
Swainson's Hawk	X		
Vesper Sparrow	X		X
Virginia's Warbler	X		
Warbling Vireo	X		
Western Bluebird	X		
Western Grebe	X		
Western Scrub-Jay	X		
Whip-poor-will	X		
White-throated Swift	X		
Williamson's Sapsucker	X		
Willow Flycatcher	X	X	
Wilson's Warbler	X		
Yellow-billed Cuckoo	X	X	

APPENDIX D

Noise Sources

Table D-1 Estimated Noise Levels of Typical Construction Equipment (Burns District Office, 2011)

Construction Equipment	Estimated maximum noise level, dBA at distance, meters							
	15	**50**	**100**	**200**	**500**	**1000**	**2000**	**5000**
Backhoe/Loader	85	74	68	62	52	44	33	10
Tracked Equipment (Bulldozer)	100	89	83	77	67	59	48	25
Drilling / Boring Ring	96	85	79	73	63	55	44	21
Crane	85	74	68	62	52	44	33	10
Pump	70	59	53	47	37	29	18	0
Welding Machine/Generator	72	61	55	49	39	31	20	0
Average for Equipment	**91**	**80**	**74**	**67**	**58**	**49**	**38**	**15**
Dump Truck	91	80	74	68	58	50	39	16
Flatbed Truck	85	74	68	62	52	44	33	10
Pickup Truck	70	59	53	47	37	29	18	0
Tractor Trailer	85	74	68	62	52	44	33	10
City Street Traffic	80	69	63	57	47	39	28	5
Average for Truck Traffic	**85**	**74**	**68**	**61**	**52**	**43**	**32**	**9**