INTERSTATE 11- BOULDER CITY BYPASS
PHASE 2 DESIGN BUILD PROJECT
GEOLOGIC EVALUATION, SAMPLING, AND TESTING FOR NATURALLY-OCCURRING ASBESTOS
BOULDER CITY, CLARK COUNTY, NEVADA

Kleinfelder Project No.: 137120
August 29, 2014

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EXECUTIVE SUMMARY

The following report presents the results of geologic evaluation, sampling and testing for Naturally Occurring Asbestos (NOA) completed by Kleinfelder, Incorporated (Kleinfelder) for Phase 2 of the Boulder City Bypass (BCB) Project, Clark County, Nevada. The purpose of this evaluation was to provide to the Clark County Regional Transportation Commission (RTC) information regarding the potential presence and concentration of NOA in surface and subsurface materials within the Phase 2 right-of-way alignment. This Executive Summary provides an overview of the results of this evaluation; the following report should be consulted for a complete description of the work performed and our findings.

A total of 311 soil and rock samples were initially collected for NOA analyses. Two hundred sixty four of these samples were collected from rock core and other samples obtained as part of the geotechnical exploration. Chain of custody forms were prepared for the analytical lab submission. Quality Assurance/Quality Control (QA/QC) methods were employed to obtain usable and accurate field and laboratory data. The samples were tested using Transmission Electron Microscopy (TEM) and Polarizing Light Microscopy (PLM). Rock materials were dried, crushed and ground using a disk pulverizer calibrated to achieve a nominal 200 mesh particle size for the TEM analyses. This method, as prescribed by the CARB 435 Method, was selected for these materials because mechanical pulverization liberates asbestos fibers similar to processes during construction. The TEM samples were analyzed following a two-tiered counting level approach using a modified EPA/600/R-93/116 counting protocol as described in the following report. The target analytical sensitivity for weight percent was 0.0002%. A total of 80 TEM samples representing the range of geologic units and TEM weight percent results were reanalyzed using PLM. The PLM analyses were performed for Quality Control to measure asbestos concentration for coarser particle fractions than were evaluated by TEM, and assess differences in concentrations that might result from analysis by different preparation and test methods. The quantitation protocol for PLM was point counting per the CARB 435 Method (400 points; limit of detection 0.25%).

Following the initial Phase 2 sampling and testing, an additional 150 samples were collected between the depths of 0 and 6 inches and tested for NOA at the request of Volpe Transportation Center (Volpe), Federal Highway Administration (FHWA), and Nevada Department of Transportation (NDOT). Sampling and testing protocol established for the adjacent BCB

Phase 1 NOA evaluation were observed. PLM analyses were performed on all 150 additional samples; TEM testing was performed on 20% of the PLM samples.

A tabulated summary of NOA weight percent and structures per gram for the initial 311 samples using both) protocol and Phase Contrast Microscopy Equivalent (PCMe) counting rules are presented on the NOA Sample and Test Summary tables in Appendix A. It is emphasized that no documentation exists where these values measured in soil may be directly correlated with the potential emissions resulting from the disturbance of these materials. The test results for the additional 150 samples taken between the depths of 0 and 6 inches are presented in Attachment 1.

Asbestiform actinolite is present in the Tertiary intrusive rocks that comprise the basement, or older, underlying and surrounding rocks, at the site. Alluvial materials and sediments that were derived from the intrusive source rocks also contain asbestos deposited through the alluvial and fluvial transport and depositional process. The average concentration in each unit, as reported by weight percent, is below 1%, a value that EPA and OSHA define as Asbestos Containing Material (ACM). However, 14 of the 311 samples that contributed to these averages were above 1%. This would be a consideration when establishing certain OSHA protection requirements that are triggered by the classification of a material as ACM.

Although there are not currently specific EPA and OSHA target levels other than 1% in Nevada NOA practice, OSHA regulates asbestos in any amount. A potential to be exposed above the OSHA PEL exists for site workers if dust control measures are not implemented. Controls and procedures will be necessary to assure that contractors are compliant with OSHA regulations and other standards designed to protect workers and provide a safe work environment, including, but not limited to, wet methods and other dust suppression methods, and personal air monitoring (initial assessments and periodic or daily personal monitoring) to assure that the controls are working and asbestos exposures remain below regulatory thresholds. Because this project may be the first large project in Nevada that involves NOA, consultation with OSHA will clarify the appropriate controls and other requirements necessary to achieve compliance with their standards.

If generated from excavation, excess materials may require stockpiling or special handling prior to offsite disposal or other forms of disposition. It is our understanding a plan for excess material handling and management will be prepared by others that specifies procedures for safe handling, transportation, stockpiling, additional testing, and reuse or disposal requirements for soil that is considered excess and not incorporated into the design of the project.

Although there is no current method to predict airborne asbestos concentrations directly from solid media concentration data, the concentrations measured in terms of structures per gram combined with our understanding of the anticipated construction activities suggests that there is a potential for offsite emissions to occur if appropriate dust control measures are not implemented. A plan for asbestos dust mitigation and monitoring will be developed by others, designed to control airborne emissions and monitor the effectiveness of dust control practices, and accounting for the findings and limitations as presented in this report. Consultation with the Clark County Department of Air Quality (DAQ) will assure that dust control measures are in conformance with local and state requirements, and any additional controls or procedures such as perimeter and ambient air monitoring as required are identified and implemented.

1 INTRODUCTION

1.1 GENERAL

This report presents the results of geologic evaluation, sampling and testing for Naturally Occurring Asbestos (NOA) completed by Kleinfelder for Phase 2 of the Boulder City Bypass (BCB) Project, Clark County, Nevada. A Site Location Map is presented on Figure 1. The purpose of this evaluation is to provide information regarding the potential presence and concentration of NOA within surface and subsurface materials within the Phase 2 right-of-way alignment. A scope of services is presented in our revised proposal of February 12, 2014 (Kleinfelder Project No. 137120, Task 12). This work was authorized by Amendment No. 2 to the Boulder City Bypass Subcontract Agreement between The Louis Berger Group, Incorporated (LBG) and Kleinfelder, Incorporated, effective February 2, 2014.

The information contained in this report is subject to the limitations presented in the 'Limitations' section of this report.

1.2 PROJECT DESCRIPTION

The BCB project consists of planned new construction of interstate roadway between the existing Hoover Dam Bypass and US 95 north of Railroad Pass, in Boulder City, Clark County, Nevada (Figure 1). The project is divided into two phases; extending from a western boundary at the south end of Interstate 515 on US 93/US 95 in Henderson, approximately 1 mile north of the Railroad Pass Hotel and Casino and an eastern boundary on US 93, approximately 0.75 miles east of the Hacienda Hotel and Casino. Phase 1 of this project begins at the western boundary and continues east to Silver Line Road, approximately one-half mile west of the US 95 crossing. Phase 2 begins at Silver Line Road and extends approximately 12½ miles east across the northern portion of Eldorado Valley and northeast through the Eldorado Mountains to the proposed tie-in near the Hoover Dam Bypass – Nevada Interchange. The work will take place in a right-of-way (ROW) corridor ranging from 500 to 700 feet in width. Nevada Department of Transportation (NDOT) has performed the design of Phase 1. This evaluation addresses only Phase 2 of the Boulder City Bypass project.

The western approximately three-quarters of the Phase 2 alignment crosses over a mostly undeveloped alluvial fan area south of Boulder City with relatively shallow grades and comparatively good access along local tracks, trails and transmission line maintenance roads.

Based on preliminary plans, construction in this portion of the alignment will require fills ranging from approximately 10 to 45 feet in height, with the majority of embankments 20 feet or less in height. The easternmost quarter of the alignment passes through the rugged Eldorado Mountains, with steeper grades and limited access. Construction of this portion of the alignment will require fills which range from approximately 10 to 70 feet, and approximately 12,000 totals linear feet of cuts up to approximately 250 feet in depth. The project also includes a total of nine bridges. Stationing has been added to Figures 2 through 17 for reference. Archeological sensitive areas were identified along the alignment in the general vicinity of Sta P 599+50 and between approximate Sta P1 779 and Sta P1 802. Only limited access to these areas was possible during this evaluation.

1.3 GEOTECHNICAL EXPLORATION

Kleinfelder was contracted on October 10, 2013 to provide geotechnical data in support of the Interstate 11 - Boulder City Bypass Phase 2 Design-Build Project. Our scope of work included geologic review; reconnaissance geologic mapping; surface geophysical surveys; subsurface exploration consisting of 101 hollow stem auger (HSA) soil borings, both with and without coring (2,540 lineal feet, including HSA locations cored); as well as 49 rock core borings (4,660 lineal feet). The explorations began in mid-October and the final boring was completed on January 22, 2014. The results of this geotechnical exploration are presented in Kleinfelder's report of April 9, 2014 (Project No. 137120), referenced in Section 7.

1.4 NOA SCOPE OF SERVICES

While the geotechnical exploration program was in progress, it was reported in the December 26, 2013 edition of the Las Vegas Review Journal (LVRJ) that University of Nevada Las Vegas (UNLV) researchers had identified NOA in the Boulder City area. The Phase 2 project area is underlain by both rock and soil materials within the general area where asbestos was reported in the UNLV study, initially published in a Soil Science Society of America Journal article in October, 2013 (Buck and others, 2013). At the time of the LVRJ article, all of the soil borings and the majority of the rock core borings had been completed.

Only a limited number of the UNLV samples were located on the BCB alignment and there were uncertainties regarding whether or not the limited UNLV data was representative of the large BCB alignment. The UNLV study also did not employ standard National Institute for Occupational Safety and Health (NIOSH) and Environmental Protection Agency (EPA) reference test methodology, no concentration data were presented, and the distribution of rock units that are the source of the asbestos was not documented. The UNLV study was therefore determined to be of limited use in understanding the potential presence of NOA in such a large area. It was not possible using the UNLV data to assess the actual distribution of potential NOA-containing materials at the site or evaluate whether a significant exposure potential to workers or off-site areas may exist during earth moving activities. As a result, Kleinfelder was contracted to conduct an evaluation of the concentration and distribution of NOA in the Phase 2 alignment in conformance with industry and regulatory protocol.

Kleinfelder's scope of services for this evaluation was based on an understanding of the geological materials and knowledge gained by the Phase 2 geotechnical exploration. The State of Nevada does not currently have guidelines for the evaluation of NOA. This evaluation was therefore developed using the California Geological Survey Guidelines for Geologic Investigations of Naturally Occurring Asbestos as a guideline (Special Publication 124, dated 2002). Our scope of services included review of the results of geotechnical explorations; selection of geotechnical samples for NOA testing; field reconnaissance; limited field exploration for additional NOA samples to supplement tests performed on archived geotechnical samples; petrographic analysis; laboratory analytical testing to measure NOA concentration; and preparation of this report.

The term surface materials, as used in this report, is a general geotechnical term and not depth-specific, but typically refers to materials present within the upper 6 inches to one foot of the ground surface. Sampling details, including sample depths, are included as part of the data presented in this report.

This evaluation focused on characterizing the asbestos mineralogy of the major geological units within the site to differentiate rock and other geologic materials that may possess NOA from those that may not, and if present, which rocks may be a significant source of asbestos emissions during their disturbance by blasting, excavation, processing, loading, dumping, spreading, compacting, and other activities common to major excavation and grading projects. The data presented in this report may also be used by others to support interpretation under the National Environmental Policy Act (NEPA); as well as to facilitate informed decisions regarding re-use of materials during construction, the need to implement site specific dust control measures for asbestos emissions, level of OSHA compliance required, and the potential for fence line air monitoring to document that dust mitigation measures are effective and that off-site exposures exceeding baseline have not occurred. Ambient air sampling of the BCB alignment is being conducted by others concurrently with this evaluation.

2 GEOLOGY

2.1 GEOLOGIC SETTING

The site is located in the Basin and Range Province, characterized by elongate, subparallel, north to northeast trending, alternating mountain ranges and valleys. The southwestern approximately half of the alignment traverses the north end of the Eldorado Valley; the north eastern approximately half of the alignment traverses the foothills and rugged, northern end of the Eldorado Mountains. The Boulder City pluton, a Tertiary-aged batholith composed mostly of quartz monzonite (Felger and others, 2014), is the principal geologic unit of the Eldorado Mountains in the site area. Structural features in the area associated with the Tertiary tensional tectonism include large scale normal faulting and strike slip faulting (Beard and others, 2007; Felger and others, 2014).

2.2 SITE GEOLOGY

Published United States Geological Survey (USGS) mapping by Felger and others (2014, 1:48,000) encompasses the BCB Phase 2 alignment area. The USGS mapping in the alignment area, including a key to units along the Phase 2 alignment, is reproduced on Figure 2, Area Geology Map. A description of the principal units present along the alignment, summarized from the previously referenced Phase 2 Geotechnical Data Report, is presented in the following sections. The units are described in order of youngest to oldest.

2.3 QUATERNARY ALLUVIUM – Qa AND Qoa

The Quaternary deposits are the youngest geologic units exposed in the site area and occur along the western portion of the project alignment in the gently sloping floor of Eldorado Valley. The Quaternary deposits as mapped by Felger and others (2014) include an Older (Qoa) and Younger (Qa) Alluvium. These deposits generally comprise the alluvial fan with a ground surface that slopes away from Boulder City area toward the southwest. The older alluvium comprises the majority of the alluvial fan deposit, and the younger alluvium occurs as more local accumulations within the active drainage channels and immediately adjacent areas. Alluvial deposits are mapped (Felger and others, 2014) between approximate Sta P 214 to Sta P 542 with a majority of the area mapped as Qoa. The less extensive Qa is shown in an area just east of US 95 and another strip centered in the vicinity of Sta P 400. Other generally thin accumulations of young alluvium also locally occurs within drainages or as thin veneers overlying rock in other portions of the project; however, due to their inferred local extent, have not been mapped on Felger and others (2014).

In general, where present, the younger alluvium overlies the older alluvium and the older alluvium generally has higher occurrence of cementation. Both units were logged as soil in the BCB Phase 2 geotechnical work. Due to the similar depositional environment and compositional similarity, the Qa and Qoa alluvial units were not differentiated on the Phase 2 geotechnical boring logs.

2.4 TERTIARY VOLCANIC ROCKS - Tdmm

Tertiary volcanic rocks are exposed along the alignment between approximate Sta P1 683 and Sta P1 700. This unit has also been mapped at the right edge of the ROW near Sta P1 710. The volcanic flows, referred to as Mafic lavas in Felger and others (2014), consist of olivine basalt and basaltic andesite, and are collectively referred to as basalt in this report. The basalt encountered in the borings was predominantly black to dark gray, aphanitic to fine-grained, varied from massive to vesicular with filled and unfilled vesicles up to ½-inch in diameter, slightly weathered to highly weathered in zones, and highly to intensely fractured. Talc, gypsum, chlorite, and calcium carbonate were noted as fracture coatings and fillings.

The basalt typically unconformably overlies the Tertiary sedimentary rocks and/or the Boulder City Pluton. The contact between basalt and the underlying sedimentary rocks is mapped in some cases as both a flow contact and others as a fault contact, and the contact is commonly obscured by overlying Quaternary-age sediments. Where not faulted, the contact generally dips shallowly to the northeast. The contact is sharp where exposed at the surface and in the core, with thin zones, typically on the scale of inches, showing heat (i.e. baked) or hydrothermal alteration.

2.5 TERTIARY SEDIMENTARY ROCKS – Tsmo AND Tsmy

Older and younger Tertiary sedimentary rocks (Tsmo and Tsmy, respectively) are mapped along the alignment. Tsmo is extensively exposed along the alignment from approximate Sta P 542 to Sta P1 683 and from Sta P1 700 to Sta P1 715. These sedimentary rocks generally consist of a sequence of mudstone, sandstone, and conglomerate with local tuff and/or tuffaceous sandstone beds and lesser amounts of gypsum. In general, the lithology of the sedimentary rocks is dominated by finer grained deposits to the south and clastic deposits (conglomerate) up-station and to the northeast toward Eldorado Ridge. The compositions include mudstone in the vicinity of Boy Scout Canyon Bridge (approximate Sta P 560); sandstone with interbedded mudstone and transitioning to predominately pebbly sandstone between Boy Scout Canyon Bridge and the Intertie Bridge (approximate Sta P 672); and sandstone, pebbly sandstone, and conglomerate to the Eldorado Ridge foothills (approx. Sta P1 715). Tsmy, consisting of fine to coarse pebbly sandstone, is mapped along approximately 300 feet of the alignment in the vicinity of Sta P 200.

The sedimentary rocks encountered in explorations drilled at the proposed Boy Scout Canyon Bridge site generally consist of reddish yellow to reddish brown claystone. Gypsum beds and veins are locally exposed along the alignment in this area and were encountered in many of the claystone samples. Variably colored sandstone, including dark brown to black, red, reddish brown, and greenish-grey, was dominantly present in the remainder of the borings south of Sta P1 682. North of approximately Sta P1 682, Tsmo occurs primarily as light to medium reddish brown conglomerate with interbedded sandstone composed of clasts of both volcanic and intrusive rock. The conglomerate and coarse sandstones are likely basin edge deposits, interpreted to have been shed from the adjacent plutonic highlands during Tertiary extension and uplift, and the mudstone likely represents lacustrine deposits from more central basin regions.

A relatively thin layer of alluvial/colluvial or residual soil was encountered overlying the weak Tsmo sedimentary rock in borings drilled south of Sta P1 683. The overburden encountered ranged from 2 to 10 feet thick and was less dense and more heterogeneous than the underlying Tsmo.

2.6 BOULDER CITY PLUTON – Tib, Tibu, Tibb, AND Tid

The Boulder City pluton underlies the alignment north and east of approximate Sta P1 715. The pluton extends several miles both southwest and southeast of the northern alignment area. The Boulder City Pluton is described in the literature as having a range of compositions (Felger and others, 2014); the units of the Boulder City pluton are generalized as quartz monzonite in the Kleinfelder BCB Phase 2 Geotechnical Data Report mapping and logging.

The pluton exposed most predominantly along the alignment is divided into two units by Felger and others (2014): Tib, an upper, predominantly unmineralized, fractured to brecciated, gray quartz monzonite and Tibu, an undifferentiated assemblage of fractured, brecciated, intruded, and mineralized quartz monzonite with variable pervasive red staining and alteration. The red mineralization and staining is attributed to hematite; other mineralization, including barite and manganese oxides also occur. Exposures of the pluton exhibit near horizontal, resistant bands formed by strong concentrations of hematite (Felger and others, 2014), generally associated with the transition from the lower, red Tibu to the upper, gray Tib.

Mapped Tibb, identified as a separate border facies within the Boulder City Pluton consisting predominantly of brecciated intrusive rocks in Felger and others (2014), is present within the Phase 2 right-of-way in a single, isolated location right of centerline between approximate Sta P 631 and Sta P 634. Tid refers to dikes that intrude the Boulder City Pluton near the northern edge (Felger and others, 2014), mapped in one location along the alignment near Sta P1 760. The composition of the dikes range from quartz monzonite to basalt. The mapped dike at Sta P1 760 was not distinguished from the surrounding rock during geological reconnaissance mapping performed as part of the geotechnical field exploration program and was therefore judged to be similar in composition to the surrounding Tibu.

The Tib and Tibu designations of Felger and others (2014) have been used in Kleinfelder's Phase 2 exploration. The character and textures of the Boulder City Pluton and particularly Tibu along the alignment have been strongly influenced by numerous episodes of faulting, brecciation, alteration, and mineralization. Additional observations of Tib and Tibu, based on the core logging and field reconnaissance, are presented in the following sections 2.6.1 and 2.6.2.

2.6.1 Unmineralized Quartz Monzonite - Tib

Tib is the principal rock unit of the Boulder City Pluton exposed in the Eldorado Ridge area and is present along the alignment between approximate Sta P1 713 and Sta P1 730. The transition between the conglomerates and pebbly sandstones of the Tsmo unit to the south and the Boulder City Pluton to the north is in the lower south slope of Eldorado Ridge near approximate Sta P1 715. Colluvium and clayey soils were encountered to depths of approximately 5 feet to greater than 10 feet at these locations. The Tib encountered in these borings occurs predominantly as angular to subangular fragments of moderately strong to strong quartz monzonite ranging in size from less than 3 inches to approximately 2 feet, contained within a matrix of weak to friable, red-brown silty to clayey sand. The Tib breccia zones range from moderately to intensely fractured, and break easily at clast matrix boundaries. In addition to the matrix, fracture fillings include calcite, chlorite, and clay.

Alternating zones of highly brecciated, clayey, and sheared, red-brown quartz monzonite occur within the Tib breccia throughout the borings drilled at the edge of the pluton, suggesting the possible presence of high angle faulting in the vicinity of these holes, possibly displacing the underlying Tibu upwards. Evidence of faulting is not apparent at the ground surface in this area but a similar fault relationship between the Tib and Tibu is shown in the USGS mapping approximately one half mile to the west of the alignment (Felger and others, 2014).

In surface exposures and core from the upper portions of the ridge, the Tib is typically fine to medium grained, weak to medium strong, slightly weathered to unweathered, and highly to intensely fractured. Exposures at the ridgeline and down the steep, north facing slope exhibited closely spaced open fractures dominantly striking nearly east-west and dipping nearly vertical to steeply to both the south and north. A prominent east-west trending topographic lineament is present on the north side of the ridge and interpreted to be a fault. Slow drilling progress and poor core recovery were encountered in the borings drilled near this feature. Core recovery refers to the amount of core recovered from a drill run versus the total length of the drill run and is expressed as a percentage. Core that is not recovered often is ground up and entrained in the circulating drilling fluid.

The majority of recovered core in the upper portions of the ridgeline consisted predominantly of angular to rounded, coarse gravel-sized fragments of strong to very strong quartz monzonite. Recovered zones of intact quartz monzonite core were predominantly slightly to unweathered, weak to medium strong, highly to intensely fractured, with areas of clay and calcite filling and iron oxide staining. The poor recovery and nature of the recovered core is attributed to the pervasive, near vertical fractures that were difficult to penetrate with the coring equipment. The rounding of the recovered core clasts is interpreted as the result of abrasion during the coring process.

2.6.2 Undifferentiated Boulder City Pluton- Tibu

The undifferentiated Boulder City Pluton, Tibu, is mapped at the surface along the alignment upstation of approximate Sta P1 730. Topographically, the Tibu forms rugged, steep, irregular cliffs and slopes, compared to overall less rugged and smoother slopes within the Tib. The transition from the Tibu and overlying Tib is associated with the hematite-rich resistant layers described in the literature as relatively flat-lying near elevation 700 m (2,300 feet) (Felger and others, 2014; Anderson, 1977); the contact as observed in the core beneath Eldorado Ridge is transitional in nature but was identified at elevations ranging between approximately 2,310 to and 2,350 feet and is likely locally offset by faulting.

A distinct structural feature interpreted to be a major shear zone was identified near the contact between Tib and Tibu. The shear zone as encountered in the core was generally between 5 to 10 feet thick and consisted of dark brown to dark red, weak, highly brecciated and sheared rock and appeared to be closely associated with less sheared to intact dike materials in the core. Based on correlations between the core and the downhole fracture survey data, it appears this feature dips to the southeast between 30 and 45 degrees.

The Tibu encountered in the core ranged widely in color, texture, strength, and both density and condition of discontinuities. The red color occurs as surficial staining on fracture surfaces, concentrated in mineralized brecciated zones, and as pervasive alteration affecting the entire rock mass. Texturally, Tibu occurs as both brecciated and non-brecciated. In general, the term breccia was used in the logging when the majority of the corehole exhibited a brecciated texture of fragments or clasts in a matrix. The brecciation varies between thin zones of gravel to sand-sized, angular to subrounded fragments contained within a strongly mineralized red-brown matrix resembling a sedimentary rock to variable zones tens of feet thick composed of broken, mineralized and healed rock. The brecciation also occurred in zones a few to several feet thick of weak, decomposed, altered material resembling matrix without clasts.

In addition to the brecciated zones, the majority of the Tibu was highly to intensely fractured, with much of the fracturing healed through hematite mineralization. Mineralized zones also containing barite, manganese, and magnetite were observed in outcrop and in the core. The strength of the brecciated zones within the Tibu is variable but in general, highly mineralized zones were very dense and strong with mostly healed fractures.

2.7 PATSY MINE VOLCANICS – Tpm and Tpma

The undivided middle part of the Patsy Mine Volcanics are mapped at the eastern end of the alignment east of approximate Sta P1 805 as Tpm and Tpma on Figures 2 and 17. Tpm is described in Felger and others (2014) as consisting of dacite, interbedded flow breccias, and volcaniclastic sedimentary rocks while Tpma is described as highly altered and locally mineralized dacite flows.

2.8 STRUCTURAL FEATURES

Structural features identified along the alignment include the local high angle faulting and fracturing in the volcanic flows and Tertiary sediments, Tdmm and Tsmo, and more extensive faulting, brecciation and fracturing in the Boulder City Pluton, Tib and Tibu. Field verification of features included on published mapping was performed within the Tdmm unit to characterize structural features (i.e., faults and fractured zones) and refine their locations. Mappable faults within the Tdmm were defined by apparent and observed offset of the contact between the younger Tdmm and older Tsmo. Surficial deposits obscure fault contacts; measured fault attitudes and the thickness of shear zones were not measurable based on surface exposures. However interpretation of possible faults based on observations within the core suggest moderately to high angle faults and thicknesses on the order of less than feet. Zones of fractures were observed both subparallel and coincident with faulting, as well as at varying orientations, and are pervasive through most of the exposed Tdmm in ravines within this unit. Fracture zones were not typically noted to be healed with secondary mineralization; however, a coating of iron-oxide often stains fracture planes and desert varnish coats exposed surfaces. Faults and fractures mapped within the Tdmm appear to follow northwest–southeast structural trends.

Faults and fractures are apparent from exposed offsets within the Tsmo. Where not obscured by surficial deposits, fault contacts are sharp, sub-parallel, often stepped or en echelon, and sometimes have secondary mineralization of gypsum along the fault plane. Individual fault plane thicknesses are commonly less than 1 inch; however, fault zones with associated sub-parallel fractures were noted to be 5 to 20 feet wide as exposed in bedrock outcrops. Fracture zones are commonly healed with secondary gypsum, clay or siliceous mineralization. Faults and fractures mapped within the Tsmo also appear to follow a northwest–southeast structural trend.

Faults within the upper Tib unit of the Boulder City Pluton in the project area are inferred from map scale fractures and breccia interpreted to be tectonic in origin. Linear, sub-parallel fracture trends combined with topographic breaks were used as a basis to map the location of these fault zones. Fracture zones up to approximately 15 feet thick are assumed to be indicative of faulting, although surficial deposits obscure most inferred faults contacts. Subparallel, high angle fractures were observed throughout the field area; random fracture orientations were apparent and mapped as presented. Fracture zones within the Tib were rarely observed to be healed with secondary mineralization; however, a coating of iron-oxide was observed on fracture planes along with a desert varnish coating on exposed surfaces.

A major, northeast-southwest trending, left-lateral strike slip fault zone forms the north boundary of the Boulder City Pluton north of the project area and serves as the contact between Tibu and adjacent Tertiary volcanic and associated units immediately north of the eastern alignment, as shown on Figure 2 (Felger and others, 2014). Displacement along this fault zone has offset structural features within the Tib; faults and fractures mapped within the Tib appear to only partially follow the regional northeast–southwest structural trends of the strike-slip fault zone.

Faults within the Tibu are apparent from lineament traces, tectonic breccia and the presence of slickensides. Linear sub-parallel fracture trends combined with topographic breaks in slope were used as a basis for the mapped location of these fault zones. Individual fault zones up to approximately 10 feet wide were observed in the mapping, as defined by sheared and brecciated zones. As in the Tib, sub-parallel, high angle fracture sets are common, although random fracture orientations are apparent in some locations that do not appear to be associated with faulting. Between mapped fault and fracture zones there are domains of less-fractured Tibu. Fracture and fault zones are commonly healed with secondary mineralization of hematite with desert varnish coating on exposed surfaces. Faults and fractures mapped within the Tibu generally appear to follow regional northwest–southeast structural trends; however numerous features show trends consistent with later displacements in response to the northeast-southwest left-lateral strike slip faults.

3 SAMPLING AND LABORATORY TESTING METHODOLOGY

3.1 INTRODUCTION

Because the State of Nevada does not currently have guidelines for the evaluation of NOA, sampling and test protocols for this evaluation included guidance, regulations and rules developed by the California Geological Survey for NOA sites, the California Department of Toxic Substances Control who oversees NOA investigations at school sites, the California Air Resources Board (CARB) who implements several Airborne Toxic Control Measures for asbestos, as well as EPA and OSHA regulations.

A total of 461 soil and rock samples were collected for NOA analyses. Three hundred eleven (311) samples were initially collected, consisting of 264 selected from rock core and samples of alluvium, colluvium, and rock obtained during the geotechnical exploration program and 47 collected from additional test pit explorations performed, as well as additional locations using hand, shovel and trowels, selected for the purpose of obtaining samples for NOA testing. Following submittal of the draft version of the report (DRAFT), an additional 150 samples were obtained from the depths of 0 to 6 inches between approximate alignment Sta P 185 and Sta P1 680 at the request of Volpe, FHWA, and NDOT. The purpose of the additional sampling was to provide data that may be directly compared to data collected during the Phase 1 segment of the BCB project.

Except where explicitly stated otherwise, all discussions of sampling, testing, and data in this report refer to the previously-described 311 NOA samples obtained as part of the initial sampling and which also form the basis of the findings and conclusions presented in this report.

A description of soil and rock sample collection methods, as well as laboratory testing analysis activities conducted is presented in this section, including a description of the sampling objectives, locations, and measurement methods.

3.2 SAMPLE COLLECTION

3.2.1 General

The principal objective of the sample collection was to obtain geologic and mineralogic data to assess the presence and concentration of NOA in surface and subsurface materials along the project alignment. Based on the results of our evaluation and published mapping (Felger and others, 2014), seven distinct soil and rock units are present within the Phase 2 alignment ROW. Five additional rock units are also mapped in limited areas along the alignment or within 300 feet of the ROW boundaries.

As shown on Figure 2, the geologic map units occurring prominently within the ROW are:

- Alluvium (Qa),
- Older alluvium (Qoa),
- Tertiary sedimentary units (Tsmy and Tsmo),
- Tertiary volcanic rocks (Tdmm), and
- Tertiary intrusive units (Tib and Tibu).

The five units mapped in limited areas or adjacent but just outside the ROW are:

- Tertiary intrusives (Ti, Tibb, and Tid)
- Tertiary volcanic rocks (Tpm and Tpma).

Because each sedimentary (including alluvial) unit may have a different provenance with different compositions, and each igneous (intrusive and extrusive) unit has different primary compositions and possible alteration histories, this geologic evaluation focused on the asbestos mineralogic composition of each unit to delineate NOA-bearing units and to provide data regarding NOA concentration in the units where NOA is found to be present.

Two hundred sixty four (264) of the total 461 NOA samples, or 55%, were obtained from alluvium, colluvium and rock core samples from the auger and core borings drilled for the Phase 2 geotechnical exploration program. The geotechnical borings were spaced at intervals of 500 to 800 feet along the alignment. NOA samples in the initial sampling program were taken at typical spacing in the range of 500 to 800 feet, with an average centerline to centerline spacing of approximately 600 feet along the alignment. The NOA samples were obtained at regular intervals so that the numbers of tests for each unit would be approximately proportional to the relative prominence of each geologic unit along the alignment. An Index Map and NOA Sample Summary for the initial 311 samples is presented as Figure 3. Alignment stationing is also included on Figure 3 for reference. Enlarged maps of all NOA sample locations and results, including alignment stationing and right-of-way boundaries, are presented on Figures 4 through 17, NOA Sampling Results. A tabulated summary of all sample locations, including Station and

Offset, sample type and geologic unit, is presented on the NOA Sample and Test Summary sheets in Appendix A. Samples 1 through 294 are organized generally west to east along the alignment; Samples 295 through 311 were added to address data gaps and are out of Stationing sequence.

Following completion of the 311 initial Phase 2 samples and submittal of the DRAFT report, an additional 150 samples were collected between the depths of 0 and 6 inches and tested for NOA at the request of Volpe, FHWA, and NDOT. The purpose of the sampling was to provide additional NOA data within the upper 6 inches of the existing ground surface. These samples were taken between approximate Sta P 185 and Sta P1 680 at typical intervals of 300 to 350 feet. Sampling and testing protocol established for the adjacent BCB Phase 1 NOA evaluation concurrently being performed by Tetra Tech for NDOT were observed to support correlation of the two studies. PLM analyses were performed on all 150 additional samples; TEM testing was performed on 20% of the PLM samples. An addendum to the Phase 1 Sampling Analysis Plan prepared by Tetra Tech with a description of the sampling and test methods, a tabulated summary of the PLM and TEM test results on the 150 additional samples, and maps showing the sample locations, are presented in Attachment 1. A discussion of the results of these 150 additional samples is presented in Section 5.2.

3.2.2 Project Grading

Consideration was given to anticipated grading in the selection of samples for NOA testing. The planned source of Phase 2 embankment fill is the Phase 2 excavations. Approximately 60% of the geotechnical explorations were located along the centerline in the flat portion of the alignment west of approximate Sta P 540. With the exception of a few hundred feet near Sta P 200, this portion of the alignment is underlain by the Quaternary alluvial units, Qa and Qoa. Site grading in this area is assumed to consist primarily of embankment fill placement to a typical preliminary height of 20 feet, with possible disturbance of up to approximately 5 feet for reworking of surficial loose soils and installation of storm drains. The sampling was performed under the assumption that on a laterally extensive alluvial fan encompassing tens of square miles, variations present in samples on centerline will be representative of variations transverse to centerline within the relatively small area of the right-of-way. In this portion of the alignment, 51 of 70 NOA tests were on bulk samples from auger cuttings between the depths of 0 to 5 feet; 10 of 70 NOA tests were on samples obtained with a shovel between the depths of approximately 0 and 1/2 foot; and 9 of 70 NOA tests were on bulk samples from test pits.

In the foothills area between approximate Sta P 540 and Sta P1 675, underlain by the Tertiary sedimentary unit Tsmo except for a localized area of Tibb right of centerline between Sta P 631 and Sta P 634, more than three-quarters of the explorations were drilled left or right of centerline or at the edge of right-of-way in areas of low cuts. This portion of the alignment is undulating and incised, characterized by low hills separated by steep-walled drainages typically up to a few tens of feet deep. Grading in this portion of the alignment is anticipated to consist of localized fill in the low areas alternating with localized low cuts which generally increase in depth up station to a maximum depth of approximately 30 feet. In the foothill areas of fills and low cuts, discrete and composite samples were obtained to represent the range of materials observed in both core samples and in outcrop.

In the mountainous areas between approximate Sta P1 675 and Sta P1 815, fewer than 20% of the explorations were drilled along centerline and the remaining approximately 80% of the borings were drilled left or right of centerline within the limits and at the edges of the proposed major cuts. The area between Sta P1 675 and approximate Sta P1 715 are underlain by the Tertiary sedimentary and volcanic units, Tsmo and Tdmm. The mountainous areas north and east of approximate Sta P1 715 are underlain by the Tertiary intrusive units, Tib and Tibu. Grading in this portion of the alignment is characterized by fills up to 70 feet thick and cuts up to 250 feet deep. A tabulated summary of stationing and maximum depths for major cuts is presented in Table 3.2.2-1.

Table 3.2.2-1: Proposed Major Cuts

Cut Number	P1 Stationing		Side	Max Depth (feet)
	Start	End		
1	679+00	696+00	Left	90
2	701+00	713+00	Both	70
3	713+00	730+00	Both	240
4	736+00	743+00	Right	145
5	748+00	754+00	Right	125
6	757+00	764+00	Both	150
7	765+00	779+00	Right	190
8	779+00	788+00	Left	120

3.2.3 Sample Location Control

Surveyed staking of the Phase 2 alignment centerline was placed at approximate intervals of 500 feet prior to the exploration program. Geotechnical soil and rock core borings were located in advance of drilling by survey. Boring locations that were moved in the field due to access constraints were surveyed again after drilling. Geotechnical surface samples were located in the field by tape measurements from centerline staking. Where supplemental NOA samples were collected after the Phase 2 geotechnical exploration was completed, coordinates were obtained using a hand held GPS unit and locations double checked against the alignment staking.

3.3 BCB PHASE 2 GEOTECHNICAL SOIL SAMPLING

Gradation data was obtained on each soil sample recovered from the geotechnical explorations. The boring logs and laboratory test results indicate the grain size distribution of the near surface soils are relatively homogeneous in the alluvial areas underlying proposed fill and typically consist of sand and gravel with 5% to 20% silt. Samples from geotechnical hollow stem auger borings were collected for NOA testing at 80 locations (identified in Appendix A between approximate Sta P 214 and Sta P1 682 by Auger Cuttings in the Sample Type column). The NOA sample locations were selected to provide data at regular intervals along the alignment.

The soil borings were drilled with a track-mounted drill rig equipped with hollow stem auger 6 inches in diameter and drill string connected to a center bit. The samples were collected from bulk, composite samples obtained from the auger cuttings between the depths of 0 and approximately 5 feet below grade with the exception of one location, where the bulk sample was collected to a depth of approximately 10 feet (Sample 91). Samples were also collected from materials obtained between the depths of 0 and 6 inches at 6 locations during geotechnical exploration (Samples 22, 26, 59, 62, 66, and 70 in Appendix A). These sample locations are in active drainage channels at or near proposed roadway drainage structures. The samples were obtained using a shovel. Because NOA had not been reported in these rocks until after the samples were collected, decontamination of drill or hand-sampling equipment was not performed as part of the geotechnical soil sampling program. Potential impacts on NOA data resulting from the lack of decontamination are discussed in Section 5.3.3.

All bulk samples collected as part of the geotechnical exploration program were approximately 60 to 80 pounds each, transported to Kleinfelder's Las Vegas office using 20- by 30-inch 6 Mil plastic bags, and transferred to 5 gallon buckets labeled with the Kleinfelder project number, boring designation, depth, and date sampled, and sealed until testing was assigned.

Geotechnical samples selected for NOA testing were split using a Gilson Sample Splitter Model SP-1. The samples were not homogenized prior to splitting. Portions of each sample were submitted with a chain of custody form to Asbestos TEM Laboratories Incorporated (ATEM) in

Berkeley, California for NOA analysis. The typical sample size shipped to ATEM was two, one-gallon bags approximately three-quarters full, or approximately 10 to 15 pounds. The balance of the sample was retained, unaltered, for future analysis.

3.4 NOA SOIL SAMPLING

The portion of the Phase 2 alignment west of US 95 was formerly Package 4 of Phase 1 and was added into the Phase 2 construction scope after the completion of the Phase 2 exploration. This area was explored by NDOT as part of the Phase 1 geotechnical work but it was Kleinfelder's understanding only limited geotechnical samples remained from this work. Twelve samples for NOA testing were therefore obtained from test pit excavations at intervals of 200 to 500 feet along this portion of the alignment (Samples 1 through 13 in Appendix A). The test pits were located based on geologic map review and field reconnaissance and were located to represent each of the units mapped in this portion of the alignment. The test pit locations were recorded using a hand held GPS unit and are shown on Figure 4.

The test pit excavations extended to a maximum depth of 5 feet or practical backhoe refusal and were typically approximately 8 feet long and 2 to 3 feet wide. The materials excavated from the test pit were segregated into piles by depth interval, typically intervals of 1 to 3 feet, dumped directly from the backhoe bucket. A 5 gallon bucket approximately half-full was collected from each test pit. A portion of each depth interval was obtained from the corresponding stockpile with a shovel. Two shovel samples were obtained from each stock pile at alternate locations, extending from the exterior to the approximate center of each stockpile. The portion of segregated zone was estimated as a fraction of the bucket volume e.g., if three segregated zones were obtained from the test pit, each portion was approximately 1/6 of the bucket. A Key to Soil Symbols and terms used in the logging are presented on Plates B-1 and B-2 in Appendix B. Test pit logs are presented on Plates B-3 through B-11.

The test pit samples were using a Gilson Sample Splitter Model SP-1. The entire sample was split and typically two splits were performed. The samples were not homogenized prior to splitting. The split portions of each sample were submitted with a chain of custody form to ATEM. The typical sample size shipped to ATEM was two, one-gallon bags approximately three-quarters full, approximately 10 to 15 pounds. The balance of the sample was retained in the Kleinfelder laboratory, unaltered, for future analysis.

In addition to the test pit samples, NOA samples were obtained at discrete locations with a shovel or hand trowel to an approximate depth of 6 inches at 14 locations. Four locations were in an area mapped as Qoa (Samples 10, 11, 12, and 13), west of US 95, originally explored by NDOT as part of the Phase 1 geotechnical work. Two locations were in an isolated area mapped as Qa within the Tsmo (Samples 78 and 79) for which geotechnical samples were not available. Four locations were in Tsmo near the former helicopter staging area near Sta P1 708 during the Phase 2 exploration (Samples 142, 143, 146, and 153). A shovel sample of approximately 10 pounds was obtained between the approximate depths of 0 and 6 inches at these locations. Three trowel samples were located in surficial sediments in areas mapped as Tibu (Samples 305, 308, and 309), and one trowel sample was located in surficial sediments overlaying Tpma (Sample 310). Samples were submitted in entirety to ATEM for NOA analysis.

Samples collected for NOA analysis not originally geotechnical samples were designated with a unique name that includes alignment station, offset and depth.

The NOA sampling crew consisted of either 2 to 3 personnel, depending on the activity. Two (2) people were fitted with air monitoring equipment consisting of a pump and 25 millimeter (mm) filter cassettes during the field work. A water truck was on-site during backhoe operations to pre-soak the excavation area and spray water during excavation to reduce dust levels. The water truck was also used to wet travel areas between test pit excavation locations. The personal air monitoring data from the referenced field activities are being analyzed by TEM concurrently with this report and will be presented in a summary letter for future reference.

NOA soil sampling equipment was decontaminated with water immediately after use by rinsing with water applied from a hose from a tank on the back of a truck or from the water truck. The washing was performed between sample locations and the equipment allowed to air dry. The laboratory soil splitting equipment was not decontaminated.

3.5 NOA ROCK SAMPLING

Rock sampling was conducted following two methods, developed based on the site geology and topography, proposed grading activities, and availability and type of samples obtained from the geotechnical exploration program. A description of the geotechnical exploration program and work methods are presented in the Geotechnical Data Report, referenced in Section 7.

Preliminary grading plans in the foothills area between approximate Sta P 540 and Sta P1 675 indicate a combination of fills and cuts are proposed, which increase in thickness and depth, respectively, up station toward the mountains. This portion of the alignment is underlain by the Tertiary sedimentary unit, Tsmo. The geotechnical borings conducted in this portion of the alignment consisted of a combination of auger methods in the soil and weathered rock, with conversion to coring methods where less weathered, more competent rock materials were encountered. Sampling of soil materials was described in Sections 3.4. Core recovery was poor to variable in the weathered and weak rock layers. A discussion of core recovery and potential impacts to the NOA data is presented in Section 5.3.4.

NOA sampling on rock materials between approximate Sta P 540 and P1 675 was performed on intervals from rock core recovered from the geotechnical borings. Seven discrete core samples (Samples 94, 96, 99, 102, 104, 111, and 114) were selected by breaking off a 4 to 6 inch section of core. The samples were selected to represent the range of materials present, based on color, prevalence of amphiboles in clasts, and evidence of discoloration or alteration. The sampling depths were recorded. Lab equipment (a rock hammer) was decontaminated by rinsing with fresh water and drying with a paper towel or air drying.

A field reconnaissance and sampling of rock materials were also performed. A review of the boring logs, core and maps was performed to assess the materials available for sampling from the explorations. The boring logs and recovered core provided information on the range of materials encountered in the explorations for comparison to materials observed in the field reconnaissance. The mapping provided information on the distribution of geologic units and helped identify places along the alignment where mapped units were present which were not represented in the explorations.

Following the map and boring log review, reconnaissance of the alignment by a team of two geologists was performed. Six samples of Tsmo and one sample of Tdmm (Samples 84, 89, 90, 100, 115, 122, and 139), typically 1 to 2 kg in size, were obtained from the foothills area. The Tsmo samples were interpreted as different than the Tsmo represented in the core based on observations of clast mineralogy, sample color, and evidence of discoloration and or alteration. The samples were selected to represent the range of materials observed within Tsmo. Decontamination of sampling equipment (rock hammers) was not performed at these locations.

Four composite samples were also obtained from exposures in drainage sidewalls over an approximate stratigraphic thickness of 5 to 10 feet (Samples 97, 105, 106, and 107). These samples were taken in areas of the proposed WAPA transmission tower relocations. The composites were typically collected as five samples each of approximately 1000 grams (g) at intervals of 1 to 2 feet on wash sidewall exposures for a total sample size of 10 to 15 pounds. Washing of sampling equipment (rock hammers) with fresh water was performed, followed by air drying. All sample locations were recorded in the field using a hand held GPS unit.

Units Tibb, Tpm, and Tpma are present within isolated areas of the alignment but were not explored with core borings because they either underlie areas of proposed fill or are in areas of shallow disturbance such as in areas of proposed slope trimming. Hand specimens approximately 2,000 g to 3,000 g in size of Tibb (Samples 295 through 297), Tpm (Samples 299 through 302), and Tpma (Sample 298) were obtained as part of field reconnaissance activities and submitted for TEM testing. Decontamination of field equipment (rock hammers) was not performed. Following completion of the core borings, limited access to the archeological sensitive area between approximate Sta P1 779 and Sta P1 802 was granted. Four samples of Tibu (Samples 303, 304, 306, and 307) and one sample of Tpm (Sample 311), each approximately 2,000 g, were obtained from outcrop exposures using a rock hammer decontaminated by washing with water between each sample. These sample locations were recorded in the field using a hand held GPS unit.

In the mountainous areas between approximate Sta P1 675 and Sta P1 780, helicopter-assisted, geotechnical core borings were drilled at intervals of approximately 500 to 800 feet along the alignment. The area between Sta P1 675 and approximate Sta P1 715 are underlain by the Tertiary sedimentary and volcanic units, Tsmo and Tdmm. The mountainous area north and east of approximate Sta P1 715 is underlain by the Tertiary intrusive units, Tib and Tibu. Core borings were located in the areas of proposed major cuts and were drilled to a depth of 10 or 15 feet below the base of cut, depending on total cut depth. Because full depth, continuous core borings were performed at regular intervals along the alignment, composite samples of the recovered core were selected to reduce sample bias and to obtain data to support evaluation of average NOA concentration for the rock materials to be excavated. Composite samples were taken for every core boring drilled through the area of major cuts between approximate Sta P1 675 up station to approximate Sta P1 780.

The majority of the composite samples (122 of 132 rock composites total) represent a single geologic unit i.e. the transition or contact with the underlying unit was not crossed in the sample.

Eight of the 132 samples included the contact from Tib to Tibu (Samples 160, 170, 178, 180, 192, 198, 206, and 213). The contact between these two units is transitional. Sample 133 and Sample 137 included the transition between Tdmm basalt and Tsmo conglomerate, with the total sample consisting of approximately 60% to 70% Tdmm and 30% to 40% Tsmo in both cases.

Composite samples of core were collected by removing approximately 100 +/- 10 grams of recovered core at intervals of approximately 2 feet, with up to approximately 30 composites, or approximately 60 feet of core, per test. To limit the amount of core disturbance, an effort was made to obtain samples of the desired size of approximately 100 grams from small pieces of intact core. Where a core piece of suitable size was not available in the 2 foot sample interval, a sample was obtained by breaking the core. Prior to breakage, the core was sprayed with water from a spray bottle. The samples were removed with a rock hammer, chisel, or sledge hammer. Breaking of the core was performed in an outdoor work space with a clean, unused, heavy gauge plastic bag which was discarded after completion of each composite sample. The core pieces were placed into a container for weighing which was rinsed with water after completion of each composite sample. The containers were dried with a paper towel, which was then discarded. The composite sampling crew consisted of 2 to 3 personnel. Two (2) people were fitted with air monitoring equipment consisting of a pump and 25 mm filter cassettes during the work.

Core sampling for NOA was first conducted in core intervals selected by the Design Build (DB) proposers for aggregate suitability testing following the described core sampling method. After these samples were obtained, sampling of the remaining core was performed. The recovered core from all borings was sampled following the above-described method. Samples were composited from single borings to represent only that location. The number of NOA tests per boring varied depending on the depth of the boring, the core recovery, and whether or not aggregate test samples were requested by the DB proposers in the boring. All core was tested independent of DB team input. The samples identified by the DB teams for later aggregate testing were sampled separately so information on asbestos concentration can be provided for the individual samples when the aggregate testing is performed. The NOA samples of the core varied in sample size depending on the interval sampled.

As previously described, up to approximately 30 samples, or 60 feet of recovered core, was obtained per test. Core recovery refers to the length of core recovered divided by the total interval cored and is typically reported as a percent. Recovery is recorded every core run and can also be computed as a total for each boring. Where core recovery was low, the depth interval represented would be larger than 60 feet. A rock core composite summary for each of the intervals sampled, including total boring depth and recovery, is presented in Appendix C. Additional discussion of core recovery and impact on the results of this evaluation is presented in Section 5.3.4.

3.6 CHAIN OF CUSTODY AND SAMPLE DELIVERY

Chain of custody forms were first prepared when samples were selected/collected for NOA testing and were prepared specifically for the ATEM lab submission. Samples were shipped to ATEM via United Parcel Service (UPS). Each sample was accompanied by a chain of custody form that included the sample identification, description, type of analysis requested, turnaround time, and other information required to prevent sample identification error and document the integrity of the sample delivery process. Each chain of custody was signed by the originator at Kleinfelder and the receiving office of ATEM. The samples were handled only by Kleinfelder, the commercial parcel delivery service, and the lab. Because the samples were shipped by UPS, it is assumed that the package was not opened or otherwise compromised by the carrier. The integrity of the packaging and samples within the containers were verified by ATEM on receipt. Any potential problems with the chain of custody or sample integrity were communicated to the Kleinfelder Project Manager for special instructions.

3.7 LABORATORY TESTING

3.7.1 General

Laboratory testing procedures were selected to meet standard regulatory protocol (EPA and OSHA) for asbestos identification in bulk materials, modified as required for soil and rock samples. For the initial Phase 2 work, a total of 311 soil and rock samples were tested using Transmission Electron Microscopy (TEM), with approximately 20% (60 total) of these reanalyzed by Polarizing Light Microscopy (PLM). A complete description of the analytical protocol and laboratory Standard Operating Procedures for Asbestos TEM Laboratories, including QA/QC protocol is provided as Appendix D. In addition to TEM and PLM testing, petrographic analyses of rock thin sections from the project area were performed. Additional details regarding the TEM and PLM analyses are presented in Sections 3.7.2 and 3.7.3. A discussion of petrographic analyses performed to date, including a preliminary discussion of amphibole mineralogy and source is presented in Section 3.7.4. The laboratory test data for the initial 311 samples is discussed in Section 5.1.

PLM and TEM testing were also performed on the 150 additional samples completed following submission of the DRAFT report observing NOA sampling protocols established for Phase 1. Additional information on the test methods for the 150 additional samples is included with the results in Attachment 1. A discussion of the test results for the 150 additional samples is presented in Section 5.2.

3.7.2 TEM Analyses

A total of 113 TEM tests were performed on samples obtained from a shovel, trowel, auger cuttings or backhoe bucket and 198 TEM tests were performed on rock core or hand samples of rock obtained from outcrop. Soil materials were dried and sieved by the analytical lab to obtain a minus No. 200 sieve (minus 0.074 mm) particle size so that the analysis would be biased toward the material with the highest potential to become airborne during disturbance by vehicular traffic, scraping, blading, excavation and loading, dumping, and spreading and compacting. Rock materials were dried, crushed and ground at the analytical lab using a disk pulverizer calibrated to achieve a nominal 200 mesh particle size. This method, as prescribed by the CARB 435 Method, was selected for these materials because the mechanical pulverization liberates asbestos fibers similar to processes during construction, including blasting. The samples were analyzed following a two-tiered counting level approach using a modified EPA/600/R-93/116 counting protocol with modifications as described in Appendix D. The target analytical sensitivity for total weight percent was 0.0002%. A tabulated summary of weight percent and structures per gram using both California Air Resource Board/Asbestos Hazard Emergency Response Act (CARB/AHERA) protocol and Phase Contrast Microscopy Equivalent (PCMe) counting rules are included on the NOA Sample and Test Summary tables in Appendix A. It is noted that no documentation exists where these values measured in soil may be directly correlated with the potential emissions resulting from the disturbance of these materials. The ATEM TEM test reports are provided as Appendix E.

3.7.3 PLM Analyses

A total of 80 PLM analyses were performed on 60 samples previously tested by TEM. The PLM analyses were performed for Quality Control to measure asbestos concentration for coarser particle fractions than were evaluated by TEM, and assess differences in concentrations that might result from analysis by different preparation and test methods. Thirty of the PLM tests were selected for samples where TEM non-detection were reported and 30 samples were selected randomly from samples where asbestos was reported in the TEM analyses. The PLM tests on soil materials were performed on material screened over the 2 mm sieve and milled to 250 microns (No. 60 sieve). The PLM tests on rock were performed on material milled to 250 microns. The quantitation protocol for PLM was point counting per the CARB 435 method (400 points; limit of detection 0.25%).

Two additional preparation methods were utilized on 10 of the PLM soil samples, resulting in a total of 30 tests on 10 samples (and the above-referenced 80 total PLM tests on 60 samples). This subset of 10 was prepared by passing the material over a No. 60 sieve (0.25 mm) with no milling for one set of analyses and by sieving over a No. 200 mesh material with no milling for the second preparation method.

The TEM non-detection samples selected for PLM were a mixture of alluvium (Qa and Qoa), sedimentary (Tsmo), basalt (Tdmm), and intrusive (Tib and Tibu) rock samples. The alluvium samples selected were adjacent to samples where asbestos had been detected. Non-detection Tsmo samples were selected for PLM testing because non-detection was considered an atypical result for this unit. PLM samples from the non-detection Tib and Tibu samples included composite rock samples where discrete samples within that interval had detected asbestos. The 30 PLM test samples where asbestos was detected were randomly selected and reviewed to affirm the range of geologic units and concentrations were represented.

The PLM test samples are identified as shaded entries in the tabulated NOA Sample and Test Summary sheets in Appendix A. A summary of the PLM test results is presented at the end of the tabulated NOA Sample and Test Summary sheets in Appendix A. The ATEM PLM test reports are presented in Appendix F.

3.7.4 Petrographic Analyses and Amphibole Source

Amphiboles are inosilicates, where the basic structural unit is defined by a double-chain linked by a variety of cations, giving the general chemical formula as:

$$A_{0\text{-}1}B_2C_5T_8O_{22}(OH,F,Cl)_2$$

Where:

A = Na, K

B = Na, Li, Ca, Mn, Fe^{2+} 20, Mg

C = Mg, Fe^{2+}, Mn, Al, Fe^{3+} 21, Ti

T = Si, Al

The specific cations between the two double-chain plates define the elemental composition of the mineral, and the ratio of these cations in each location is used to classify amphiboles. Actinolite and hornblende, for example, belong to the calcic amphibole class, with end member compositions $Ca_2(Mg,Fe)_5Si_8O_{22}(OH)_2$ and $Ca_2(Mg, Fe, Al)_5(Al, Si)_8O_{22}(OH)_2$, respectively.

Amphiboles form naturally in two habits, non-fibrous (most common) where the crystal grain possesses a coherent crystallographic structure and may fracture along its two (110) cleavages resulting in elongate particles that may be defined as asbestos due to the counting rules prescribed in EPA, NIOSH, and OSHA methods. Plate 1 shows an example of the non-fibrous habit of an amphibole in a rock similar to unaltered quartz monzonite at the site. Amphiboles may also be present in the asbestiform habit where long fibrils crystallize parallel to the <001> double chains by nucleation and growth, Plate 2, or result from dislocation glide along the (100) and (010) crystallographic plane during plastic deformation. Plate 3 shows an example of a strongly deformed glaucophane amphibolite ("blueschist") mylonite where brittle deformation of the parent rock (greenstone) within the glaucophane matrix led to a porphyroclastic texture and strong preferred orientation of the glaucophane fibrils.

Asbestiform amphiboles in the Boulder City Pluton have been reported to be a result of hydrothermal alteration of unspecified primary magmatic amphibole to fibrous actinolite (Buck and others, 2013). Plates 4a, 4b, 5a, and 5b show actinolite altering from hornblende, exhibiting a fine lamellar structure that appears to reflect the fibrous habit of this mineral, consistent with the findings of Buck and others (2013).

Asbestos in clastic rocks and sediments derived from the exhumed host rocks are released through chemical weathering in the soil profile and mechanical weathering, primarily by abrasion, during sediment transport in alluvial and fluvial systems. Due to their fine grain size, many, if not most, of the released fibrils are removed and transported far from the source. However, the larger grains act as a continuous source of fibers during transport and deposition, and larger grains of amphiboles along with numerous fine fibers would be expected within the finer component of sedimentary rocks near their source material. In general, the percentage of amphiboles relative to the more resistant quartz and feldspars would decrease with increasing distance from the source. Because the clastic alluvial material in the project area is near the quartz monzonite source, measurable concentrations of fibrous amphiboles would be expected in the source rocks and the sediments derived from them.

4 QA/QC PROCEDURES

The objective of the geologic evaluation, sampling and testing for NOA is to provide to information regarding the distribution and concentration of NOA across the surface and subsurface within the BCB Phase 2 alignment. Quality Assurance/Quality Control (QA/QC) methods were employed to obtain usable and accurate field and laboratory data. Specific laboratory QA/QC methods are described in this section, with a discussion of general protocols in Appendix D. A description of the QA/QC procedures observed as part of the geotechnical exploration program is presented in the Kleinfelder Geotechnical QA/QC Plan documented as part of the Boulder City Bypass project record.

QA/QC methods specific to the NOA sample collection consist of observing chain of custody procedures; routine checking that sample identification information and sample compositing information have been transferred correctly from the hand-written forms to the sample logs maintained in the project data base; and sample tracking through reconciliation of chain of custody forms, shipping records and as-received laboratory test results. Throughout the sampling and testing and as part of the summary process, the results of the field sampling and laboratory testing program were reviewed to establish that the results are consistent, reasonable and valid.

Laboratory QA/QC tests, including recount same, recount different, repreparations and laboratory blanks, were performed on a minimum of 10% of the PLM analyses. QA/QC tests were also performed on a minimum of 10% of the TEM samples using the above methods, and included verified analyses on a minimum of 1% of the TEM samples. Additionally, interlaboratory analyses were performed on 4 TEM samples and 3 PLM samples, representing a minimum of 1% of samples. The interlaboratory tests were performed by Lab/Cor, Incorporated in Portland, Oregon and are presented in the beginning of Appendix E.

5 RESULTS OF EVALUATION

5.1 DISCUSSION OF ANALYTICAL RESULTS

5.1.1 General

A qualitative, simplified summary of the asbestos concentrations by the TEM analyses for the 311 samples presented in Appendix A is presented on Figure 3. Graphs 1 through 17, presented following the Figures and Plates, show NOA concentration by weight versus percentage of samples tested for the principal geologic units along the BCB Phase 2 alignment. Binned results using threshold values of 1% and 0.25% are presented on the graphs. These values were chosen as reference points but it is emphasized these values are not represented as risk or exposure thresholds. One percent is considered Asbestos Containing Material (ACM) by OSHA and EPA. CARB requires capping or roadway surfacing material placed over NOA be <0.25%. Additionally, 0.25% is the limit of detection for the PLM per CARB 435. Graphs 1 through 11 present all data for the geologic unit indicated; Graphs 12 through 15 present the results of rock core composite tests only. The NOA data presented was summarized from the tabulated TEM data in Appendix A.

As described in Section 3.5, ten of the rock composite samples extend across contacts between geologic units: eight of these cross the Tib/Tibu contact and two cross the Tdmm/Tsmo contact. NOA was not detected in four of the samples crossing the Tib/Tibu contact. The composite data from each of the ten Tib/Tibu and Tdmm/Tsmo samples was included in Graphs 1 through 15 and assumed to be representative of both respective units in each boring, i.e. the measured TEM result was used twice as a graphing data point, once for each of the two geologic units at the ten locations. This resulted in ten more graph data points (321) than TEM test results (311). Table 5.1.1 is a summary of the information presented on Graphs 1 through 11 and includes the maximum concentration detected for each unit.

Table 5.1.1 Summary of Graphs 1 through 11

Unit	Total Number of TEM Test Results	None Detected		<0.25%		0.25% - 1%		>1%		Detections		Maximum Weight Percent Detected
		Percent of Total Test Results	Number of Samples	Percent of Total Test Results	Number of Samples	Percent of Total Test Results	Number of Samples	Percent of Total Test Results	Number of Samples	Percent of Total Test Results	Number of Samples	
Qa	25	56%	14	44%	11	0%	0	0%	0	44%	11	0.204
Qoa	45	89%	40	11%	5	0%	0	0%	0	11%	5	0.014
Tsmy	3	33%	1	67%	2	0%	0	0%	0	67%	2	0.244
Tsmo	68	22%	15	47%	32	25%	17	6%	4	78%	53	2.295
Tdmm	15	80%	12	20%	3	0%	0	0%	0	20%	3	0.077
Tibu	106	59%	63	22%	23	10%	11	8%	9	41%	43	6.380
Tib	49	49%	24	33%	16	16%	8	2%	1	51%	25	1.912
Tibb	3	67%	2	0%	0	33%	1	0%	0	33%	1	0.273
Tpm	5	80%	4	20%	1	0%	0	0%	0	20%	1	0.048
Tpma	2	100%	2	0%	0	0%	0	0%	0	0%	0	ND
All	321	55%	177	29%	93	12%	37	4%	14	45%	144	6.380

ND = Below laboratory detection limits

Appendix G presents tabulated weighted average asbestos concentrations calculated for each core boring drilled in the portion of the alignment where major cuts are proposed (R-81 through P-5). The weighted average is a sum of the asbestos content for each cored interval divided by the total recovered cored footage for each boring. The asbestos content for each cored interval was calculated as the product of the asbestos weight percent obtained from the composite sample for that cored interval multiplied by the corresponding recovered cored footage. Details of the rock core composite sampling were provided in Section 3.5; a tabulated summary of the TEM test data is presented in Appendix A; and a summary of the rock core composite samples for each boring are presented in Appendix C. A value of zero was used as a concentration for the samples where results were below laboratory detection limits in the calculation of weighted average asbestos concentrations for each core boring. A sample weighted average calculation for a core boring is included in Appendix G.

Weighted average and mean asbestos concentrations for each geologic unit as both CARB/AHERA weight percent and PCMe weight percent are provided in Table 5.1.2. Discussions of CARB/AHERA and PCMe data are presented in Sections 5.1.2 and 5.1.3, respectively. The weighted average concentrations were calculated for the four units underlying the portion of the alignment where major cuts are proposed (Tsmo, Tdmm, Tib and Tibu) and were calculated from the data in Appendix G. The weighted average for each geologic unit within the cut areas was obtained by summing the product of the weighted average concentration and the recovered core footage for each boring within each unit and dividing by the total recovered core footage within that unit. Data from the ten samples crossing the Tdmm/Tsmo and Tib/Tibu contacts were used following the same method as for Graphs 1 through 17, described previously. The Mean NOA Weight percent values presented in Table 5.1.2 were calculated based on all TEM data in Appendix A. A sample weighted average and mean asbestos concentration calculation for a geologic unit is also included in Appendix G.

Table 5.1.2 Weighted Average and Mean NOA Concentration by Geologic Unit

Unit	Weighted Average NOA Weight Percent (rock core composite samples)			Mean NOA Weight Percent (all samples except rock core composite)			Maximum Weight Percent Detected	Approximate Recovered Core Footage
	Number of TEM Tests	CARB / AHERA	PCMe	Number of TEM Tests	CARB / AHERA	PCMe		
Qa	*None	*Not calculated	*Not calculated	25	0.01	0.001	0.204	*None
Qoa	*None	*Not calculated	*Not calculated	45	0.0007	0	0.014	*None
Tsmy	*None	*Not calculated	*Not calculated	3	0.1	0.04	0.244	*None
Tsmo	11	0.18	0.11	57	0.26	0.17	2.295	360
Tdmm	10	0.01	0.01	5	**Not Calculated	**Not Calculated	0.077	220
Tibu	90	0.27	0.20	16	**Not Calculated	**Not Calculated	6.380	3190
Tib	31	0.08	0.05	18	**Not Calculated	**Not Calculated	1.912	950
Tibb	*None	*Not calculated	*Not calculated	3	0.09	0.09	0.273	*None
Tpm	*None	*Not calculated	*Not calculated	5	0.01	0.01	0.048	*None
Tpma	*None	*Not calculated	*Not calculated	2	***ND	***ND	--	*None

**Core borings not performed in the indicated units*

*** Available samples judged to be insufficient for unit representation - test results included in Graphs 1-17 and Table 5.1.1*

**** ND = Below laboratory detection limits*

In many NOA studies, and particularly in building material surveys, results often include only the chrysotile and the five "regulated" amphiboles that are specifically named in OSHA and EPA regulations (tremolite, actinolite, fibrous grunerite ("amosite"), anthophyllite, and fibrous riebeckite ("crocidolite"). Amphiboles such as hornblende, winchite, and glaucophane, which are nominally present in the materials tested, are generally excluded or not reported by the laboratory. However, petrographic analysis discussed in Section 3.7.4 shows that hornblende in the source rocks (Tertiary intrusive units) is not present as a dual phase system (rocks that include two independent amphibole phases, each with a distinct composition). Rather, the actinolite in these rocks appears to be intimately associated with the hornblende resulting from replacement and/or alteration of the primary mineral, hornblende.

Although the hornblende and actinolite appear to be distinct and independent minerals in thin section, and individual fibers of each are detected during TEM analysis, it is likely that they coexist as exsolution lamella and/or adjacent but independent fibrils on the sub microscopic scale (with widths measured on the angstrom scale), distinguished only by the partitioning of aluminum in the coexisting actinolite ($Ca_2(Mg,Fe)_5Si_8O_{22}(OH)_2$) and hornblende ($Ca_2(Mg, Fe, Al)_5 (Al, Si)_8O_{22}(OH)_2$) phases. In igneous and metamorphic systems, hornblende coexisting with actinolite, glaucophane, and winchite in solid solution within an individual amphibole crystal is not an uncommon occurrence. Recent studies at the Libby Asbestos Superfund Site (Montana) indicate that several regulated and non-regulated amphiboles coexist in solid solution, and these amphiboles may have similar toxicities. Therefore, in this particular geologic setting and for the purpose of this evaluation, all amphiboles, regardless of composition and crystallographic habit, are included in the concentrations.

5.1.2 CARB/AHERA Structures

The weight percent (WP) plotted against fibers per gram (F/gr) of each sample within each unit is presented on Graph 16. Additional data, including numbers of samples tested for each geologic unit and maximum binned concentrations, are summarized in Table 5.1.1. The purpose of Graph 16 is to characterize each unit in terms of WP and (F/gr), and provide evidence that the geologic units sampled in this study are distinct units and may be interpreted independently. It is emphasized that no documentation exists where these values measured in soil may be directly correlated with the potential emissions resulting from the disturbance of these materials.

5.1.2.1 Plutonic Rocks: Tib, Tibu, and Tibb

The plots for Tib and Tibb occupy similar fields and are considered to be similar geologic materials. However, Tib/Tibb and Tibu occupy different fields in Graph 16, suggesting they might be considered different units for the purposes of this evaluation. There does not appear to be a correlation between WP and F/gr in unit Tib. This lack of correlation is interpreted as follows: amphiboles in this unit are bound within the rock matrix and released during the grinding process in the preparation phase of the analysis. WP in amphiboles is highly dependent on the size of the fiber, which in turn is dependent of the morphology of the amphibole that was pulverized by the grinding process. Amphiboles that are less fibrous and retained their original crystalline habit will tend to form fibers (as per the counting rules) through fracture along the (110) cleavage planes, giving rise to relatively large and broader particles. The result in this case is a high WP relative to the number of fibers produced. The fibrous portion of the amphibole crystals, or those which are entirely fibrous, will disperse into numerous thin and shorter fibrils, resulting in a low WP to fiber ratio. Because both forms, crystalline and fibrous, are present in the rock, and even within the same crystal, the two types of resulting structures ("cleaved" fragments and asbestiform fibers) will be mixed during pulverization, and no relationship should be expected.

The distribution for unit Tibu on Graph 16 is different than that of unit Tib. Not only is the weight percent higher than Tib, the F/gr increases dramatically with increasing WP. Because Tibu is highly altered as compared to Tib, and veins of alteration are present, there may be a higher concentration of amphiboles in the Tibu resulting from nucleation and growth during the tectonic process that created the highly brecciated rock. For example, mineralization within breccia zones along detachment faults is observed in the western Cordillera and Basin and Range Province. In one documented case, the Asbestos Mountain fault beneath Asbestos Mountain in the Santa Rosa Mountains of southern California, syn-tectonic mineralization produced tremolite asbestos. In addition to a higher relative asbestos content compared to Tib, mineralization by fibril nucleation and growth would produce a higher proportion of thin fibrils, giving rise to relatively low WP to (F/gr) ratios.

5.1.2.2 Older and Younger Sedimentary Rocks: Tsmo and Tsmy

Values for the Tsmo and Tsmy units, collectively, have a distribution that is similar to the brecciated unit Tibu on Graph 16. Samples with low WP have a corresponding low F/gr, and the F/gr increase greatly with increasing WP. This trend is consistent with that expected for the fine component of sedimentary rocks derived from asbestos-bearing units. Amphiboles within the source rocks are fully disarticulated during the weathering and transport process, and a general relationship between content (WP) and fiber count (F/gr) could be anticipated. The analytical results for these units, considering both relatively low WP and the relationship between WP and F/gr, is consistent with that expected for this type of rock derived from Tib and Tibu.

5.1.2.3 Quaternary Deposits: Qa and Qoa

The younger and older alluvial materials that overlie the basement rocks, or older igneous rocks, and the sediments derived from them are characterized by their low asbestos content, relative to other units in the area. There does not appear to be a significant relationship between WP and (F/gr) for these units on Graph 16, which is a trend expected from rocks with low amphibole contents. At low concentrations, the WP is highly influenced by particle size. A small number of large countable fibers in a sample can greatly increase the apparent asbestos content (higher overall WP) without significantly increasing the fiber count.

5.1.2.4 Volcanic Rocks: Tdmm

The volcanic unit Tdmm is characterized by relatively low WP and no apparent correlation with (F/gr) on Graph 16. This is the anticipated signature of unaltered volcanic rocks: amphiboles are generally present in low amounts and not fibrous. Countable fibers will tend to be cleaved particles, and the weight percent is greatly influenced on the particle size in the sample, particularly when few structures are counted.

5.1.2.5 Volcanic Rocks: Tpm and Tpma

Primary amphiboles in extruded, or extended flow, rocks are most often prismatic crystals of hornblende. Kleinfelder's experience with extrusive rocks is that the hornblende does not readily fracture into elongate particles that meet the counting criteria prescribed in the asbestos test methods. When a particle is cleaved along (110) and observed during the analysis, it tends to be relatively large (generally in width) and can account for a large weight percent even though it is found in low fiber concentrations. It is possible that the hornblende in these rocks has not been significantly affected by the alteration that is pervasive in the intrusive rocks, and this is why low levels of asbestos was reported in these rocks and in only one sample. It is noted, however, that these units are present in isolated areas of the alignment and only limited sampling of these units was therefore performed.

5.1.3 PCMe Structures

OSHA regulations under CFR 1926.1101 require an initial exposure assessment be conducted to assure workers will not be exposed above the Permissible Exposure Limit (PEL) for asbestos. The exposure assessment is based on monitoring of employees by sampling of the breathing zone, and asbestos is measured using the NIOSH 7400 method by Phase Contrast Microscopy (PCM). This method measures all fibers that meet counting rule criteria, and is not specific for asbestos. The sample may also be reanalyzed by the NIOSH 7402 method that uses Transmission Electron Microscopy, a method that is asbestos specific. The counting rules under this method count fibers that are longer than 5 microns, thereby producing an equivalent result (PCMe). The ratio of asbestos to non-asbestos fibers is applied to the original result to obtain a corrected asbestos exposure.

In addition to counting structures by the CARB/AHERA (AHERA) counting rules, asbestos structures in samples analyzed by TEM were counted following the rules specified under the NIOSH 7402 method, reported herein as PCMe. The purpose of this analysis is to assess whether emissions by disturbance of asbestos in the soil or rock may potentially include fibers that would be counted in a personal breathing zone sample, and potentially cause exposure above the PEL. Note that there is no method to show a correlation between concentrations or structure types in soil and what will become airborne, or what may appear in the breathing zone samples. One key difference between the AHERA counting rules and NIOSH 7400/7402 (PCMe) is that the latter methods count fibers that are greater than or equal 5 microns in length, whereas the AHERA rules count fibers and other structures down to 0.5 microns in length.

Table 5.1.2 shows the average of PCMe fibers as compared to the AHERA structures, summarized from the TEM data in Appendix E. In the younger alluvial materials (Qa) with relatively low levels of asbestos, the long fibers represent less than 15% of the total structure count. However, in the most important materials in terms of volume of disturbance (Tsmo, Tib Tibu), the long fibers represent between 60% and nearly 100%, respectively, of the total structure count. This indicates that disturbance of the actinolite bound within the rock matrix in the intrusive units may produce significant emissions of PCMe fibers. The high proportion of PCMe fibers in the older sediments (Tsmo) indicate that actinolite and hornblende fibers greater than 5 microns survived the alluvial transport processes and were retained in the sediments.

Graph 17 plots the weight percent (WP) against fibers per gram (F/gr) for the PCMe fibers in each geologic unit. In general, the data points within each unit are scattered and do not appear to show a correlation between these parameters. This lack of a relationship is not unusual because the WP of asbestos in a sample is very size dependent, particularly with the amphibole class, and relatively few large fibers counted in a sample can have a great influence on the result.

5.2 RESULTS OF 150 ADDITIONAL SAMPLES

A summary of the results of the 150 additional samples obtained between the depths of 0 and 6 inches is presented in Table A1-1 in Attachment 1. These tests were requested by Volpe, FWHA, and NDOT and were performed using sampling protocols established for the adjacent, concurrent NOA evaluation for BCB Phase 1 (Attachment 1, Addendum 2). The PLM results were non-detection except for BC-S2-0026 at Sta 235+10, 60’ LT, where asbestos was identified but not present on a counting point. TEM analyses were performed on 20% of the PLM samples. A summary of the PLM analyses is presented in Table 5.2.1 and a summary of the TEM analysis is presented in Table 5.2.2.

Table 5.2.1 - PLM Results for Additional 150 Samples Taken from 0 to 6 inches Depth

Units	Total Number of Test Results	None Detected		<0.25%		0.25% - 1%		>1%		Detections	
		Percent of Total Test Results	Number of Samples	Percent of Total Test Results	Number of Samples	Percent of Total Test Results	Number of Samples	Percent of Total Test Results	Number of Samples	Percent of Total Test Results	Number of Samples
Qa	70	100%	70	0%	0	0%	0	0%	0	0%	0
Qoa	33	97%	32	3%	1	0%	0	0%	0	3%	1
Tsmy	1	100%	1	0%	0	0%	0	0%	0	0%	0
Tsmo	45	100%	45	0%	0	0%	0	0%	0	0%	0
Tibb	1	100%	1	0%	0	0%	0	0%	0	0%	0
All	150	>99%	149	1%	1	0%	0	0%	0	<1%	1

Table 5.2.2 - TEM Results for Additional 150 Samples Taken from 0 to 6 inches Depth

Units	Total Number of Test Results	None Detected		<0.25%		0.25% - 1%		>1%		Detections	
		Percent of Total Test Results	Number of Samples	Percent of Total Test Results	Number of Samples	Percent of Total Test Results	Number of Samples	Percent of Total Test Results	Number of Samples	Percent of Total Test Results	Number of Samples
Qa	2	0%	0	100%	2	0%	0	0%	0	100%	2
Qoa	18	50%	9	50%	9	0%	0	0%	0	50%	9
Tsmy	1	0%	0	100%	1	0%	0	0%	0	100%	1
Tsmo	10	20%	2	70%	7	10%	1	0%	0	80%	8
All	31	35%	11	61%	19	3%	1	0%	0	65%	20

5.3 NOA DATA ASSESSMENT

5.3.1 General

An assessment of the NOA data obtained as part of the initial sampling program has been performed as part of this evaluation. Limitations of this study are presented in Section 6. Specific questions addressed as part of the NOA data assessment are the following:

- What is the impact of the selection of TEM versus PLM as the principal method of analysis?
- What are potential impacts associated with the absence of equipment decontamination procedures during sampling?
- What are potential impacts of variable core recovery on the results of this evaluation?
- What data gaps have been identified and what is the planned resolution?

A discussion of these items is presented in the following paragraphs.

5.3.2 TEM Results versus PLM Results

The PLM analyses were performed for Quality Control to assess the potential for variations in asbestos concentration for coarser particle fractions than were evaluated by TEM. The PLM results are presented at the end of the NOA Sampling and Test Summary sheets on Plate A-6. As shown, the PLM preparation method using sieving over the No. 200 sieve (minus 74 microns) correlated equally or better with the TEM results than from the PLM results prepared by the other two methods. Although the TEM and PLM methods of analysis are not directly comparable, the value of analytical sensitivity of the TEM method is several orders of magnitude lower than the limit of detection for the PLM. The Phase 2 TEM concentrations are consistently higher than the PLM, except in two cases (Samples 254 and 282) where the results are correlatable.

5.3.3 Sample Contamination

A total of 264 of the NOA samples were obtained from soil and rock materials as part of the BCB Phase 2 geotechnical exploration. This work was performed following geotechnical protocols where cleaning of equipment between sample or exploration locations is not typically performed. Sample contamination could impact the test results in the following two ways; Case One: Higher asbestos contents than are actually present are measured. Case Two: Lower asbestos contents than are actually present are measured. Each of these cases are discussed in the following paragraphs.

<u>Case One: Higher asbestos contents than are actually present are measured.</u> Core borings from R-81 and up station were drilled with both helicopter supported, component rigs and track mounted drills. All rock core was obtained using circulating drill fluids which were disposed following completion of each hole with the exception of a few locations during freezing weather when drill fluid was flown between holes to maintain drill production until frozen water supply lines thawed. As standard procedure, drill fluid residue was cleaned from the core with a brush and clean water in the core tray in the field and again in the core box at the core warehouse in preparation for photography. Because reuse of drill fluids between boreholes was limited to a few instances and the drill fluid residue cleaned from the core, we judge the potential for sample contamination of rock core to be low. As an example to support this judgment, Boring R-106 had the highest concentration of asbestos measured on the project (greater than 6% by weight on

the composite sample taken from the bottom half of the boring). Boring R-107 was started following completion of R-106 with the same drill rig. Asbestos was not detected in either of the composite samples from R-107. We therefore conclude that sample contamination has not significantly impacted the rock core samples, the principal sample type from R-81 and up station.

The borings from R-80 and down station were drilled with two, track-mounted drill rigs. One rig performed hollow stem auger drilling only and the second performed both hollow stem auger and core drilling. The drill rigs were never operating simultaneously; the second rig arrived after the first rig completed their holes. We judge the highest likelihood of sample contamination would occur where drilling and sampling of a higher NOA content location preceded a lower to non-NOA bearing location. To further assess the potential impacts of sample contamination, a tabulated summary of date, boring number, station and offset, and TEM weight percent is presented in the Soil Boring Drilling Date Summary in Appendix H. The break in the table represents the transition between the two drilling subcontractors.

As indicated in Appendix H, between October 7, 2013, through November 5, 2013, the on-site drilling company generally drilled from west to east across the alignment from the west end of the alignment through R-55 (approximate Sta P 540). This area was characterized by intervals where asbestos was not detected above laboratory detection limits with intermittent zones where asbestos was detected. The prevalence of non-detection in this portion of the alignment documents that measurable contamination did not occur in this portion of the alignment.

Two areas where sample contamination cannot be ruled out are the samples from BSC-1A and BSC-2A (drilled 11/13/13) and the samples between R-75 through R-63 (drilled 11/25/13 to 12/12/13). BSCB-1A and 2A were added to the Boy Scout Canyon Bridge location after BSCB-1 and 2 were already drilled. Asbestos was not detected in BSCB-1 and -2. BSCB-1A and -2A were preceded by R-66 and R-65. An asbestos content of 0.022 was measured in R-66. No asbestos was detected in R-65, drilled after R-66 and before BSCB-1A and -2A. It is possible that the measured asbestos at these locations is higher than BSCB-1 and -2 as the result of sample contamination. This is also a possibility for the samples from R-75 through R-63. These holes were drilled, as shown in Appendix H, through areas of generally decreasing NOA concentration. In both these cases, we judge that Case One sample contamination, if it occurred, is small, a conservative error, and of low impact to the results of this evaluation.

<u>Case Two: Lower asbestos contents than are actually present are measured.</u> This case would occur if non-NOA bearing materials were incorporated into NOA-bearing materials in quantities sufficient to significantly lower the results. The “contamination,” or the reduction in measured asbestos, would be proportional to the amount of “contaminated” non-NOA bearing materials present in the sample e.g., for a reduction of 10%, the sample would have to include 10% “contaminated” sample. Based on the volumes of samples obtained and sampling methods described in Section 3.3, and noting that dry, granular soil material remaining on the drilling auger would be nominal, we judge Case Two sample contamination, if it occurred, to be very small and of low impact to the results of this evaluation.

5.3.4 Core Recovery

The core recovery for each boring is included with the Rock Core Composite Summary in Appendix C. Core recovery in the BCB Phase 2 borings varied by area and rock type during the exploration as a result of a combination of general rock strengths, amount of natural fracturing, faulting or shearing present, degree of weathering, and nature of the weak matrix in breccia zones. Faulted, sheared, or brecciated zones are preferred paths for intrusions such as dikes, circulating fluids and mineralization, including asbestos mineralization. Because variable core recovery may be associated with these zones, it is possible that intervals with asbestos mineralization are not fully represented in the recovered core. Accordingly, it is possible that asbestos concentrations are under-represented in the borings where poor recovery occurred. Table 5.3.4.1 is a summary of number of core borings, total footage cored, and the range of core recovery in borings for each unit where a composited core weighted average was calculated and presented in Section 5.1.

Table 5.3.4.1: Borehole Recoveries for Geologic Units

Geologic Unit	Number of Core Borings	Approximate Cored Footage	Core Recovery (%)
Tsmo	7	390	90 - 95
Tdmm	4	230	95 - 100
Tib	11	1330	70 - 75
Tibu	45	3670	85 - 90

A quantitative assessment of the impact of core recovery is not possible.

5.3.5 Data Gaps

The following discussion addresses data gaps specific to the sampling for the Phase 2 NOA evaluation which were identified after completion of the initial sampling as part of the DRAFT reporting. Limitations of this study are addressed in Section 6.

Data gaps identified following the initial sampling were the archeological sensitive area and the easternmost end of the alignment. The archeological sensitive area between approximate Sta P1 779 and Sta P1 802 was excluded from all activities during BCB Phase 2 geotechnical exploration. However, a previous exploration, P-5, was located at the west end of this area (Sta P1 779+10) and tested as part of this evaluation. Three TEM tests on composite core samples from this location were all non-detections. This area is within the Tibu where asbestos has been detected in core from numerous borings. Sampling of alluvium and from rock outcrops has been performed in this area since the time of the DRAFT report and are discussed in Sections 3.4 and 3.5 and the results are included as Samples 303 through 310 in Appendix A.

The volcanic units Tpm and Tpma are mapped within and adjacent to the eastern end of the Phase 2 alignment as shown on Figure 17. These units were not encountered in any of the BCB Phase 2 borings; however, portions of the easternmost end of the alignment were not explored because geotechnical data from the Hoover Dam Bypass project included this area and was available for DB team reference. Grading in this area is expected to consist primarily of fill, however, areas of shallow cut associated with slope grooming are present on the north side of right-of-way between approximate Sta “93” 37+00 and Sta “93” 41+00, as well as approximate Sta “NV” 29+00 and Sta “NV” 30+50. Five hand samples, i.e. manually obtained with a rock hammer, of Tpm samples (299 through 302 and 311) and one hand sample of Tpma (sample 298) were obtained for TEM testing from outcrops of these units on the north side of Highway 93 adjacent to the project area. These samples are included in the Section 3.5 discussion.

An additional area of consideration is the westernmost end of the BCB Phase 2 alignment. Ti, a Tertiary intrusive unit, is mapped at the westernmost end of the Phase 2 alignment. Preliminary grading indicated this to be near-grade or an area of proposed fill. Two test pits were performed in this area to a depth of 5 feet but Ti was not encountered in either location. Asbestos was not detected in TEM tests on composite samples from both locations (Samples 1 and 2 in Appendix A). Phase 1 includes major cuts in Ti; data from Ti will be obtained as part of the BCB Phase 1 NOA evaluation. Although we do not judge this area to be a Phase 2 data gap, due to proximity, we anticipate that the westernmost end of Phase 2 could be impacted by the Phase 1 findings.

5.4 FINDINGS

Kleinfelder conducted an evaluation of Naturally Occurring Asbestos (NOA) within rocks and soil materials that will be disturbed during construction of Phase 2 of the Boulder City Bypass (BCB) Project, Clark County, Nevada. The purpose of this evaluation was to provide to the Regional Transportation Commission information regarding the potential presence and concentration of NOA in surface and subsurface materials within the Phase 2 right-of-way alignment. The data presented may be used by others to support interpretation under the National Environmental Policy Act (NEPA); as well as facilitating informed decisions regarding re-use of materials during construction, the need to implement site specific dust control measures for asbestos emissions, level of OSHA compliance required, and the potential for fence line air monitoring to document that dust mitigation measures are effective and that off-site exposures exceeding baseline have not occurred.

The evaluation employed practices and techniques that have become routine in California for well over a decade. California, of all states, has the most comprehensive protocols for NOA investigations, and it is judged these standards provide the baseline for evaluation on a project of this complexity and magnitude. For example, we drew from exploration, sampling and test protocols that include guidance, regulations and rules developed by the California Geological Survey for NOA sites, the California Department of Toxic Substances Control who oversees NOA investigations at school sites, the California Air Resources Board who implements several Airborne Toxic Control Measures for asbestos, as well as EPA and OSHA regulations. The evaluation was undertaken, overseen and directed by a Nevada Professional Geological Engineer, Professional Civil Engineer, Professional Geologist (CA), Certified Engineering Geologist (California), with the support of additional geologists and technical staff, including two Nevada Certified Environmental Managers, with extensive experience in the geology of the site. During the evaluation we consulted with geologists at the University of Nevada, Las Vegas who have both led studies and been participants in geologic research in the site region, and knowledgeable staff of the Regional Transportation Commission, Nevada Department of Transportation, EPA, the Volpe National Transportation Systems Center, and Tetra Tech consultants who are currently performing an evaluation of NOA for BCB Phase 1.

The evaluation focused on characterizing the asbestos mineralogy of the major geological units within the site to differentiate rock and other geologic materials that may possess NOA from those that may not, and if present, which rocks may be a significant source of asbestos emissions during their disturbance by blasting, excavation, processing, loading, dumping, spreading, compacting, and other activities common to major excavation and grading projects. Once the major units were identified, a variety of standard and additional test methods were employed to characterize the mineralogy and morphology of the asbestos. These included petrographic analysis to understand the petrogenesis of the asbestos in the rocks and its character before disturbance, Polarized Light Microscopy (PLM) to identify potential asbestos that may reside in the larger size fraction of sieved samples, and Transmission Electron Microscopy (TEM)- a very sensitive method- to characterize and quantify asbestos in the small size fraction that cannot be detected by PLM.

The analysis was not restricted to only chrysotile and the five “regulated” amphibole forms. Techniques were employed to identify all fibrous amphiboles, which were conservatively included in the asbestos count. We considered not only where asbestos is present and in what quantities, but why the asbestos is present and the processes by which it arrived at its present disposition. This approach facilitated the understanding of NOA at the site, and assists project designers and contractors anticipate the potential impacts of asbestos during construction, and proactively monitor and mitigate those impacts in advance of and during disturbance.

The test data in this study reported the asbestos content as a weight percent, which allows the classification of materials in terms of OSHA work class or determination of whether materials may be used for specific purposes such as road surfacing and capping. Conversion of test data to fibers/gram helps anticipate whether there are sufficient fiber concentrations for potential on-site and off-site exposures. Reporting using different asbestos test methods and counting rules supports an assessment of potential NOA emissions that may be transmitted off-site and received by workers on site.

Based on the results and considering the many variables and complexities of the geologic environment that constitutes the site, it is concluded that this evaluation met the stated goals and appropriately characterizes NOA for the purposes of the Phase 2 Bypass Project. As a result, we provide the following principal conclusions regarding potential exposure of asbestos during construction:

- As a result of alteration (from geologic processes) of primary hornblende amphibole, asbestiform actinolite is present in the Tertiary intrusive rocks that comprise the basement, or older, underlying and surrounding igneous materials, at the site. Alluvial materials and sediments that were derived from the intrusive source rocks also contain asbestos deposited through the alluvial and fluvial transport and depositional process.

The average concentration in each unit, as reported by weight percent, is below 1%, a value that EPA and OSHA define as Asbestos Containing Material (ACM). However, 14 of the 311 samples that contributed to these averages were above 1%. This would be a consideration when establishing certain OSHA protection requirements that are triggered by the classification of a material as ACM.

- Although there are not currently specific EPA and OSHA target levels other than 1% in Nevada NOA practice, OSHA regulates asbestos in any amount. A potential to be exposed above the OHSA PEL exists for site workers if dust control measures are not implemented. Controls and procedures will be necessary to assure that contractors are compliant with OSHA regulations and other standards designed to protect workers and provide a safe work environment, including, but not limited to, wet methods and other dust suppression methods, and personal air monitoring (initial assessments and periodic or daily personal monitoring) to assure that the controls are working and asbestos exposures remain below regulatory thresholds. Because this project may be the first large project in Nevada that involves NOA, early consultation with OSHA will clarify the appropriate controls and other requirements necessary to achieve compliance with their standards.
- If generated from excavation, excess materials may require stockpiling or special handling prior to offsite disposal or other forms of disposition. It is our understanding a plan will be prepared by others that specifies procedures for safe handling, transportation, stockpiling, additional testing, and reuse or disposal requirements for excavated materials that is considered excess and not incorporated into the design of the project.
- Although there is no current method to predict airborne asbestos concentrations directly from solid media concentration data, the concentrations measured in terms of structures per gram combined with our understanding of the anticipated construction activities suggests that there is a potential for offsite emissions to occur if appropriate dust control measures are not implemented. A plan for asbestos dust mitigation and monitoring will be developed by others, designed to control airborne emissions and monitor the effectiveness of dust control practices, accounting for the findings and limitations as presented in this report. Early consultation with the Clark County Department of Air Quality (DAQ) will assure that dust control measures are in conformance with local and state requirements, and any additional controls or procedures such as perimeter and ambient air monitoring as required are identified and implemented.

6 LIMITATIONS

This data report was performed in a manner consistent with that level of care and skill ordinarily exercised by other members of our profession practicing in the same locality, under similar conditions and at the date the services are provided. The information presented in this report is based on a limited number of observations and data. Conditions, including the concentrations and distribution of asbestos, will vary between locations of data collection or beyond the defined project boundaries. There is no accepted method to relate asbestos concentrations in soil and rock matrices to concentrations in air. Kleinfelder makes no other representation, guarantee or warranty, express or implied, regarding the services, communication (oral or written), report, opinion, or instrument of service provided.

This report may be used only by the Louis Berger Group, the Regional Transportation Commission and their designated representatives for presentation of factual interpretations of data and observations made in the field exploration, and remains valid for a reasonable time from its issuance, but in no event later than two (2) years from the date of the final report.

The work performed was based on project information provided by Client. Kleinfelder assumes no responsibility for the applicability of the data collected to any proposed design other than the one referenced herein.

This report was prepared in general accordance with accepted standards of care that exist in the area of work at the time the evaluation was performed. Conclusions are based on information obtained from analytical results provided by Asbestos TEM Laboratories, Inc.

Kleinfelder offers various levels of investigative and engineering services to suit the varying needs of different clients. It should be recognized that definition and evaluation of geologic and environmental conditions are a difficult and inexact science. Judgments leading to conclusions are generally made with incomplete knowledge of the subsurface conditions present due to the limitations of data from field studies. Although risk can never be eliminated, more-detailed and extensive studies yield more information, which may help understand and manage the level of risk. Since detailed study and analysis involves greater expense, our clients participate in determining levels of service that provide adequate information for their purposes at acceptable levels of risk. More extensive studies, including subsurface studies or field tests, should be performed to reduce uncertainties. Acceptance of this report will indicate that Louis Berger

Group has reviewed the document and determined that it does not need or want a greater level of service than provided.

During the course of the performance of Kleinfelder's services, hazardous materials or substances may have been discovered. Kleinfelder assumes no responsibility or liability whatsoever for any claim, loss of property value, damage, or injury that results from pre-existing hazardous materials or substances being encountered or present on the project site, or from the discovery of such hazardous materials or substances. Nothing contained in this report should be construed or interpreted as requiring Kleinfelder to assume the status of an owner, operator, or generator, or person who arranges for disposal, transport, storage or treatment of hazardous materials or substances within the meaning of any governmental statute, regulation or order. Louis Berger Group is solely responsible for directing notification of all governmental agencies, and the public at large, of the existence, release, treatment or disposal of any hazardous materials or substances observed at the project site, either before or during performance of Kleinfelder's services. Louis Berger Group is responsible for directing all arrangements to lawfully store, treat, recycle, dispose, or otherwise handle hazardous materials or substances, including cuttings and samples resulting from Kleinfelder's services.

Kleinfelder appreciates the opportunity to be of service to Louis Berger Group. Please feel free to contact us if you have any questions.

7 REFERENCES CITED

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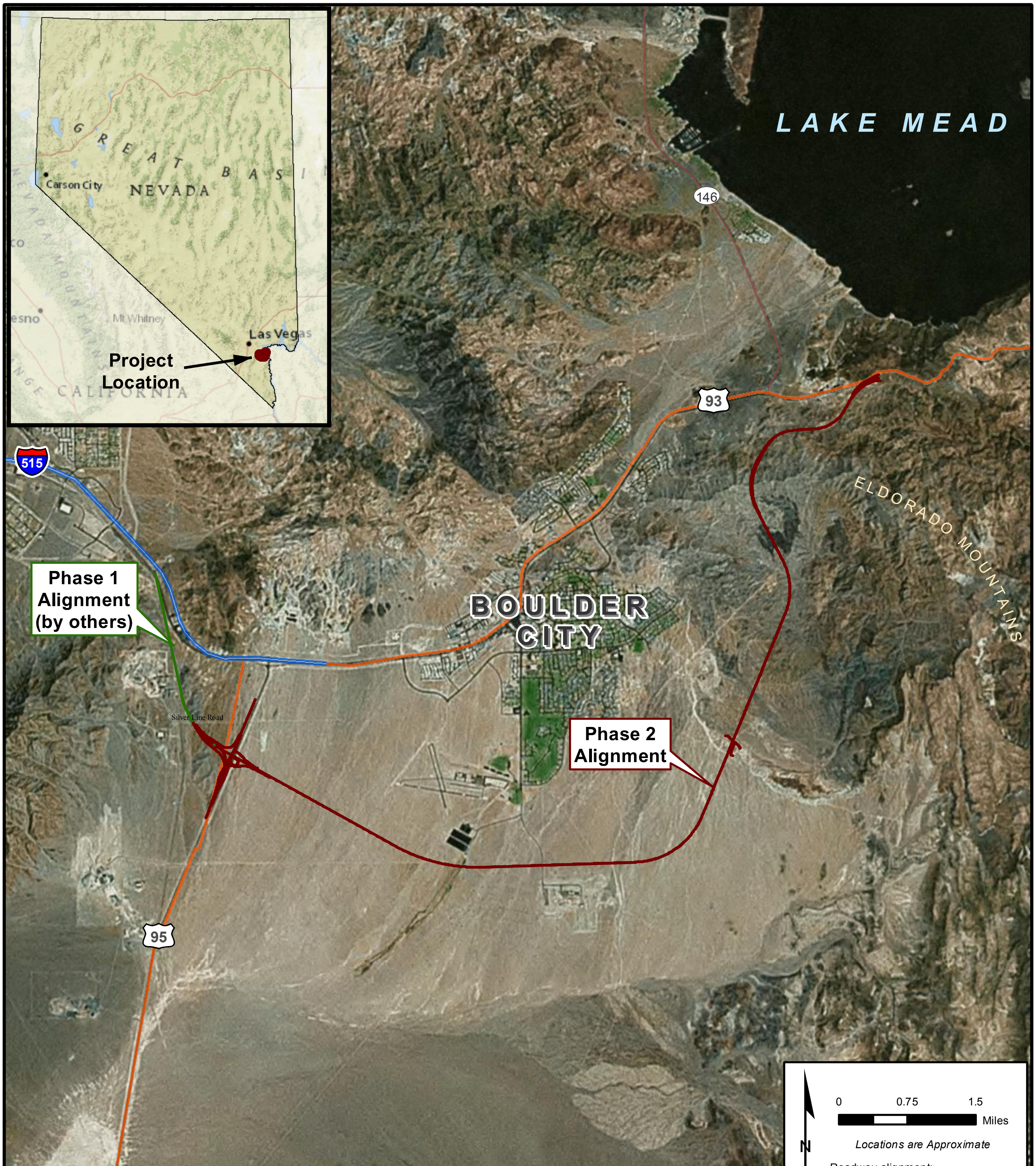
Kleinfelder, 2014, Interstate 11- Boulder City Bypass, Phase 2 Design Build Project, Geotechnical Data Report, Boulder City, Clark County, Nevada dated April 9, 2014 (Kleinfelder Project No. 137120)

FIGURES



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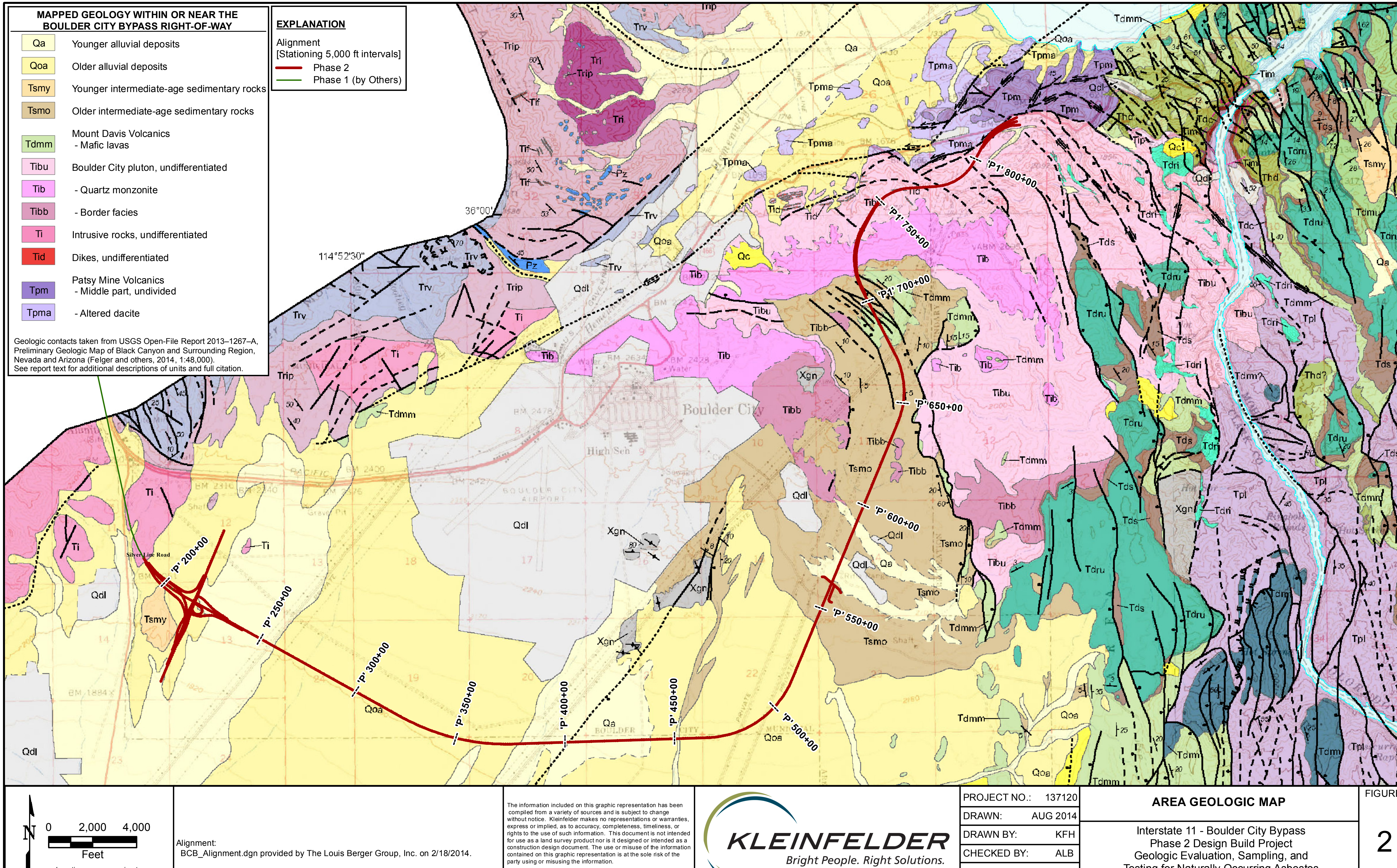
PROJECT NO.: 137120	**SITE LOCATION MAP**		FIGURE
DRAWN: AUG 2014			
DRAWN BY: KFH	Interstate 11 - Boulder City Bypass Phase 2 Design Build Project Geologic Evaluation, Sampling, and Testing for Naturally Occurring Asbestos Boulder City, Clark County, Nevada		**1**
CHECKED BY: JLS			
FILE NAME: Figure1.mxd			



Alignment:
BCB_Alignment.dgn provided by The Louis Berger Group, Inc. on 2/18/2014.

Geology Reference:
Felger and others, 2014, USGS OFR 2013-1267-A, published scale 1:48,000.

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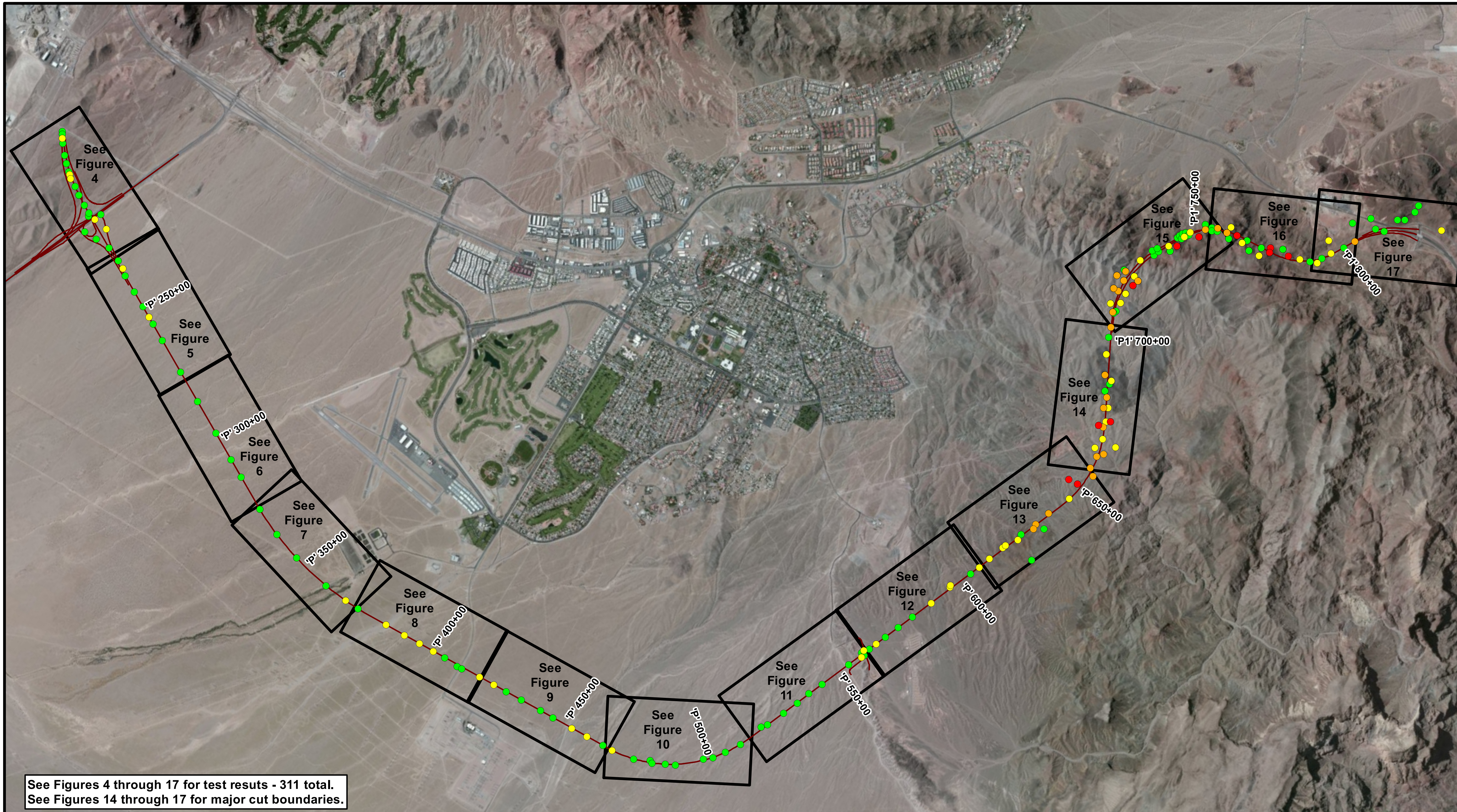
DRAWN BY:	KFH
CHECKED BY:	ALB
FILE NAME:	Figure2_Geology.mxd

AREA GEOLOGIC MAP

Interstate 11 - Boulder City Bypass
Phase 2 Design Build Project
Geologic Evaluation, Sampling, and
Testing for Naturally Occurring Asbestos
Boulder City, Clark County, Nevada

FIGURE
2



N

0 1,500 3,000

Feet

Locations are approximate

Sources: BCB_Alignment.dgn provided 2/18/14 by The Louis Berger Group, Inc. Aerial image: ESRI World Imagery, 5/7/2011.

EXPLANATION

Calculated Asbestos Concentration by Weight

- Below Detection Limit < 0.0002 %
- Asbestos Detected >= 0.0002 % to < 0.25 %
- Asbestos Detected >= 0.25 % to <= 1.0 %
- Asbestos Detected > 1.0 %
- Alignment with Stationing at 5,000-ft Intervals

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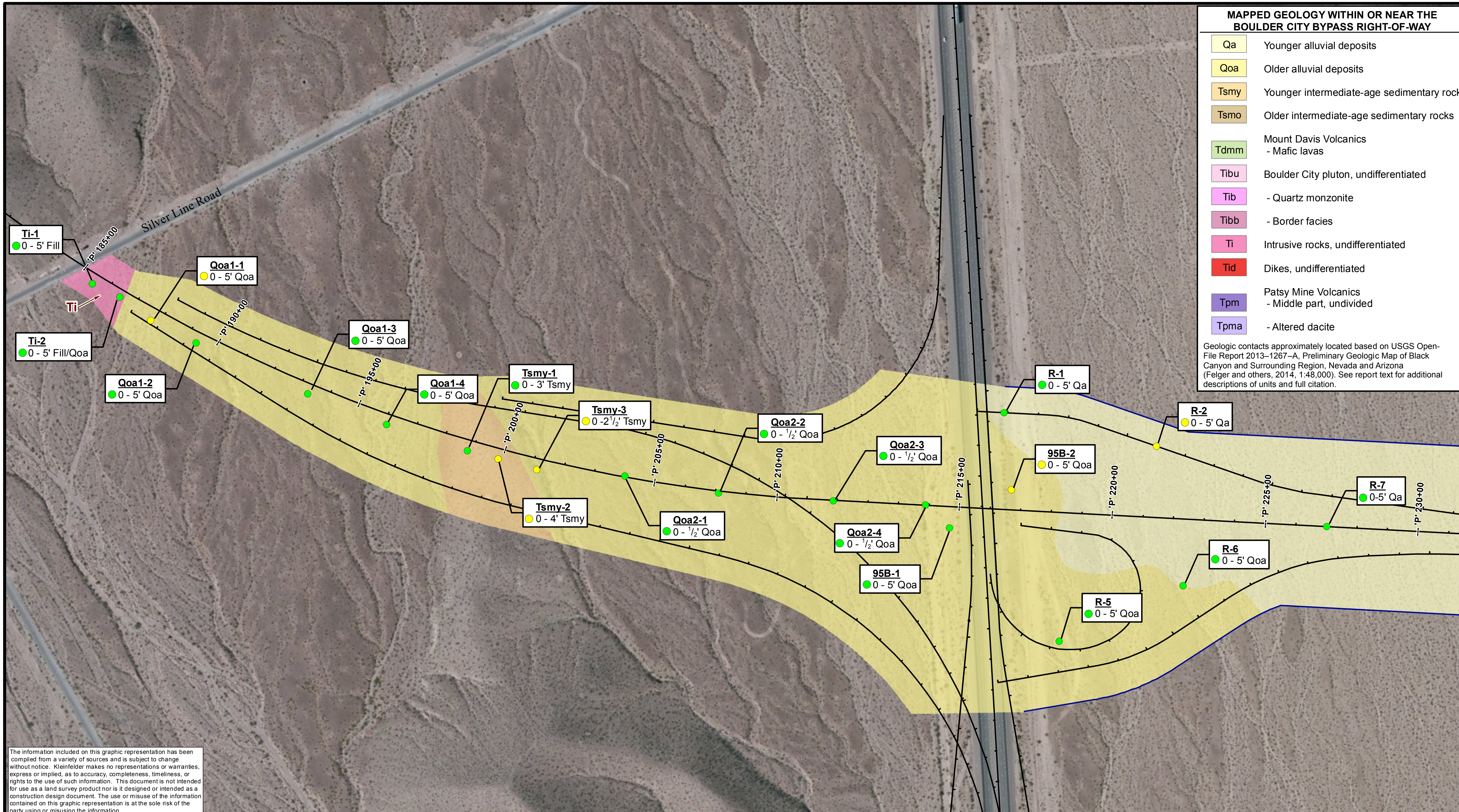
PROJECT NO.:	137120
DRAWN:	AUG 2014
DRAWN BY:	KFH
CHECKED BY:	JLS
FILE NAME:	Figure3.mxd

INDEX MAP AND NOA SAMPLE SUMMARY

Interstate 11 - Boulder City Bypass
Phase 2 Design Build Project
Geologic Evaluation, Sampling, and
Testing for Naturally Occurring Asbestos
Boulder City, Clark County, Nevada

FIGURE
3



N

0 150 300
Feet

Locations are approximate

EXPLANATION

Calculated Asbestos Concentration by Weight

- Below Detection Limit < 0.0002 %
- Asbestos Detected >= 0.0002 % to < 0.25 %
- Asbestos Detected >= 0.25 % to <= 1.0 %
- Asbestos Detected > 1.0 %

- Right-of-Way
- Alignment, 500-ft Stationing

Sources: BCB_Alignment.dgn provided 2/18/14 by The Louis Berger Group, Inc. Aerial: ESRI World Imagery, 5/7/11.

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PROJECT NO.:	137120
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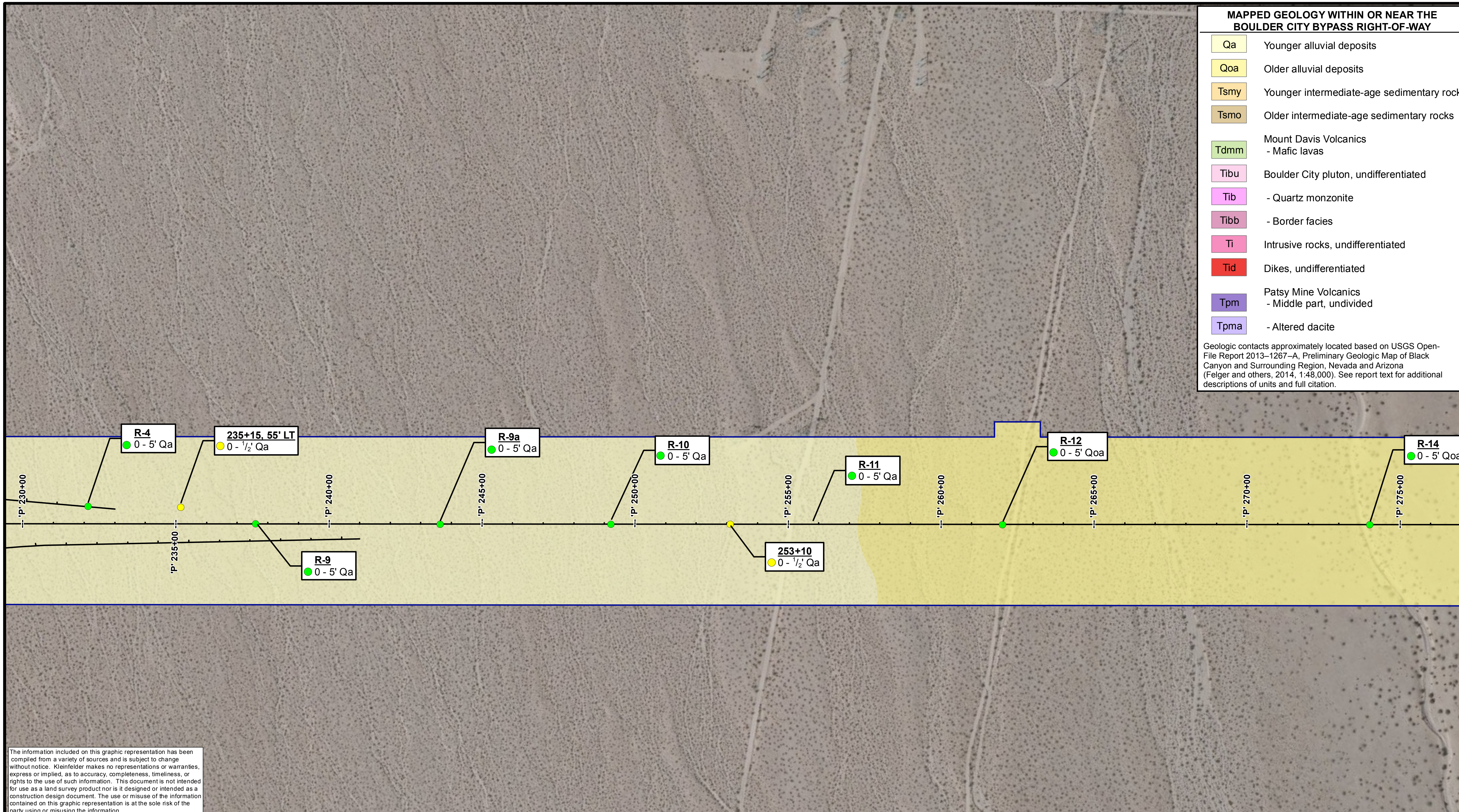
CHECKED BY:	JLS
FILE NAME:	Figure4.mxd

NOA SAMPLING RESULTS

Interstate 11 - Boulder City Bypass
Phase 2 Design Build Project
Geologic Evaluation, Sampling, and
Testing for Naturally Occurring Asbestos
Boulder City, Clark County, Nevada

FIGURE
4



N
0 150 300
Feet
Locations are approximate

EXPLANATION

Calculated Asbestos Concentration by Weight
- Below Detection Limit < 0.0002 %
- Asbestos Detected >= 0.0002 % to < 0.25 %
- Asbestos Detected >= 0.25 % to <= 1.0 %
- Asbestos Detected > 1.0 %

Right-of-Way
Alignment, 500-ft Stationing

Sources: BCB_Alignment.dgn provided 2/18/14 by The Louis Berger Group, Inc. Aerial: ESRI World Imagery, 5/7/11.

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PROJECT NO.:	137120
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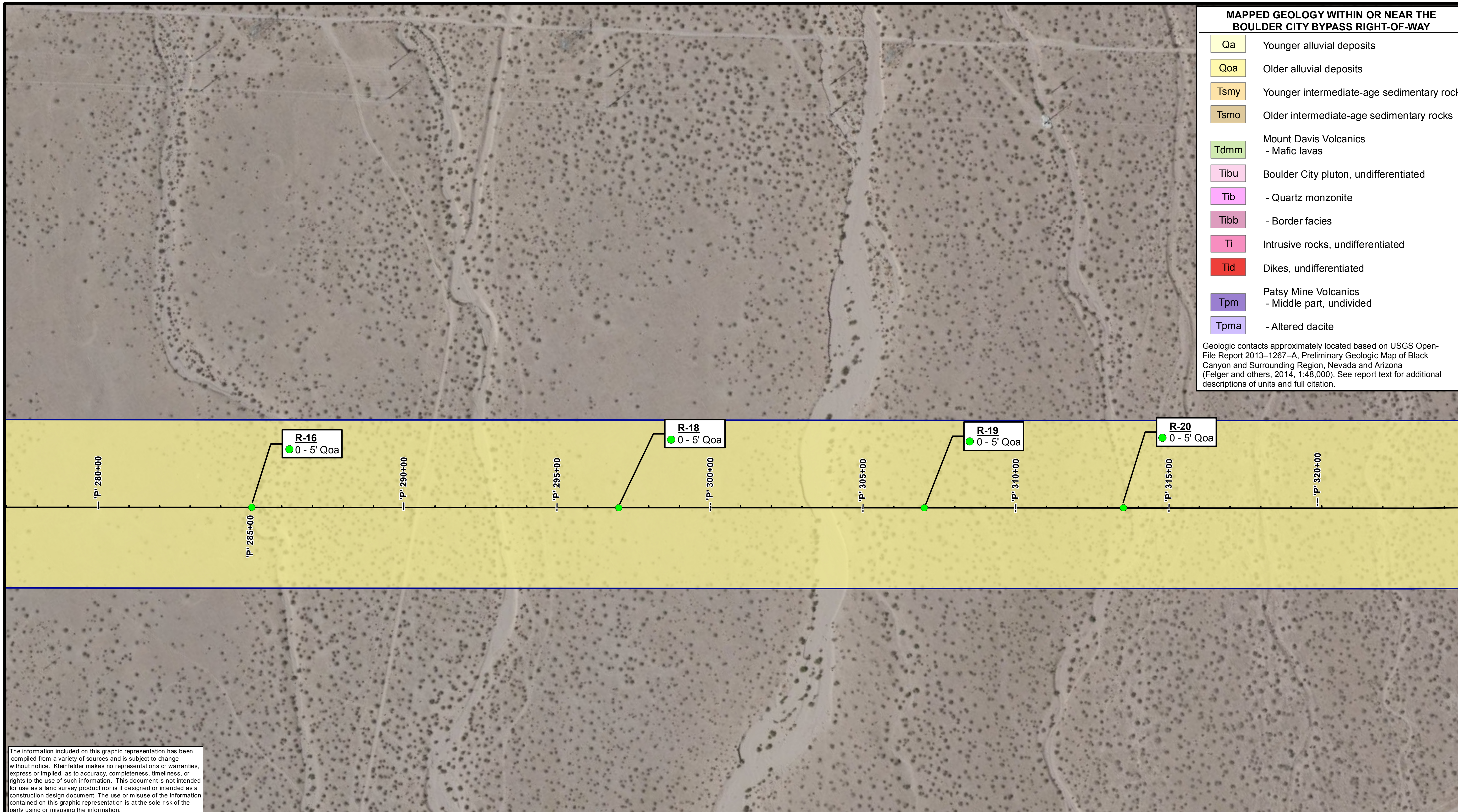
DRAWN BY:	KFH
CHECKED BY:	JLS
FILE NAME:	Figure5.mxd

NOA SAMPLING RESULTS

Interstate 11 - Boulder City Bypass
Phase 2 Design Build Project
Geologic Evaluation, Sampling, and
Testing for Naturally Occurring Asbestos
Boulder City, Clark County, Nevada

FIGURE
5



Locations are approximate

EXPLANATION

Calculated Asbestos Concentration by Weight
- Below Detection Limit < 0.0002 %
- Asbestos Detected >= 0.0002 % to < 0.25 %
- Asbestos Detected >= 0.25 % to <= 1.0 %
- Asbestos Detected > 1.0 %

- Right-of-Way
- Alignment, 500-ft Stationing

Sources: BCB_Alignment.dgn provided 2/18/14 by The Louis Berger Group, Inc. Aerial: ESRI World Imagery, 5/7/11.

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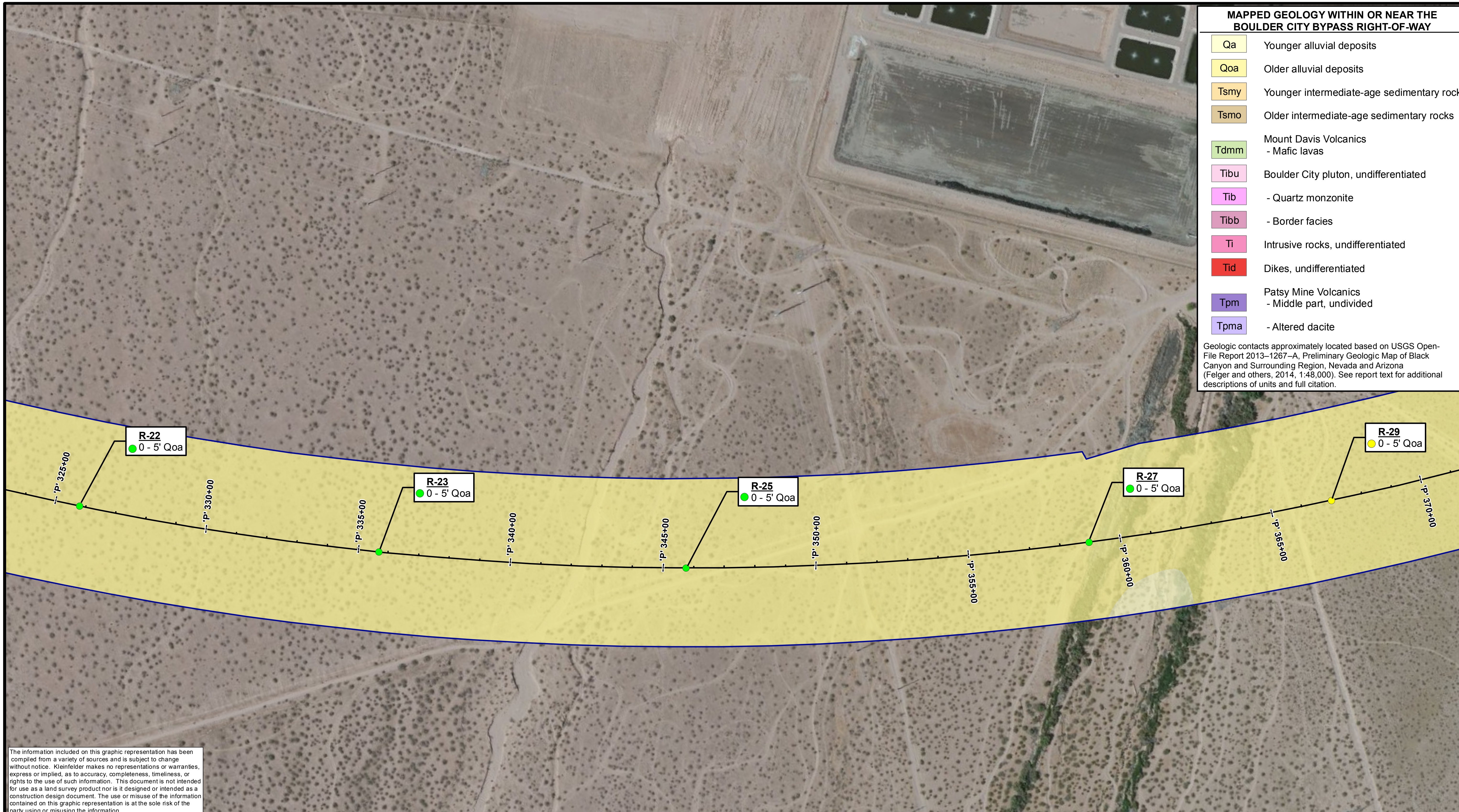
DRAWN BY:	KFH
CHECKED BY:	JLS
FILE NAME:	Figure6.mxd

NOA SAMPLING RESULTS

Interstate 11 - Boulder City Bypass
Phase 2 Design Build Project
Geologic Evaluation, Sampling, and
Testing for Naturally Occurring Asbestos
Boulder City, Clark County, Nevada

FIGURE 6



N

0 150 300

Feet

Locations are approximate

EXPLANATION

Calculated Asbestos Concentration by Weight
- Below Detection Limit < 0.0002 %
- Asbestos Detected >= 0.0002 % to < 0.25 %
- Asbestos Detected >= 0.25 % to <= 1.0 %
- Asbestos Detected > 1.0 %

Right-of-Way
Alignment, 500-ft Stationing

Sources: BCB_Alignment.dgn provided 2/18/14 by The Louis Berger Group, Inc. Aerial: ESRI World Imagery, 5/7/11.

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PROJECT NO.:	137120
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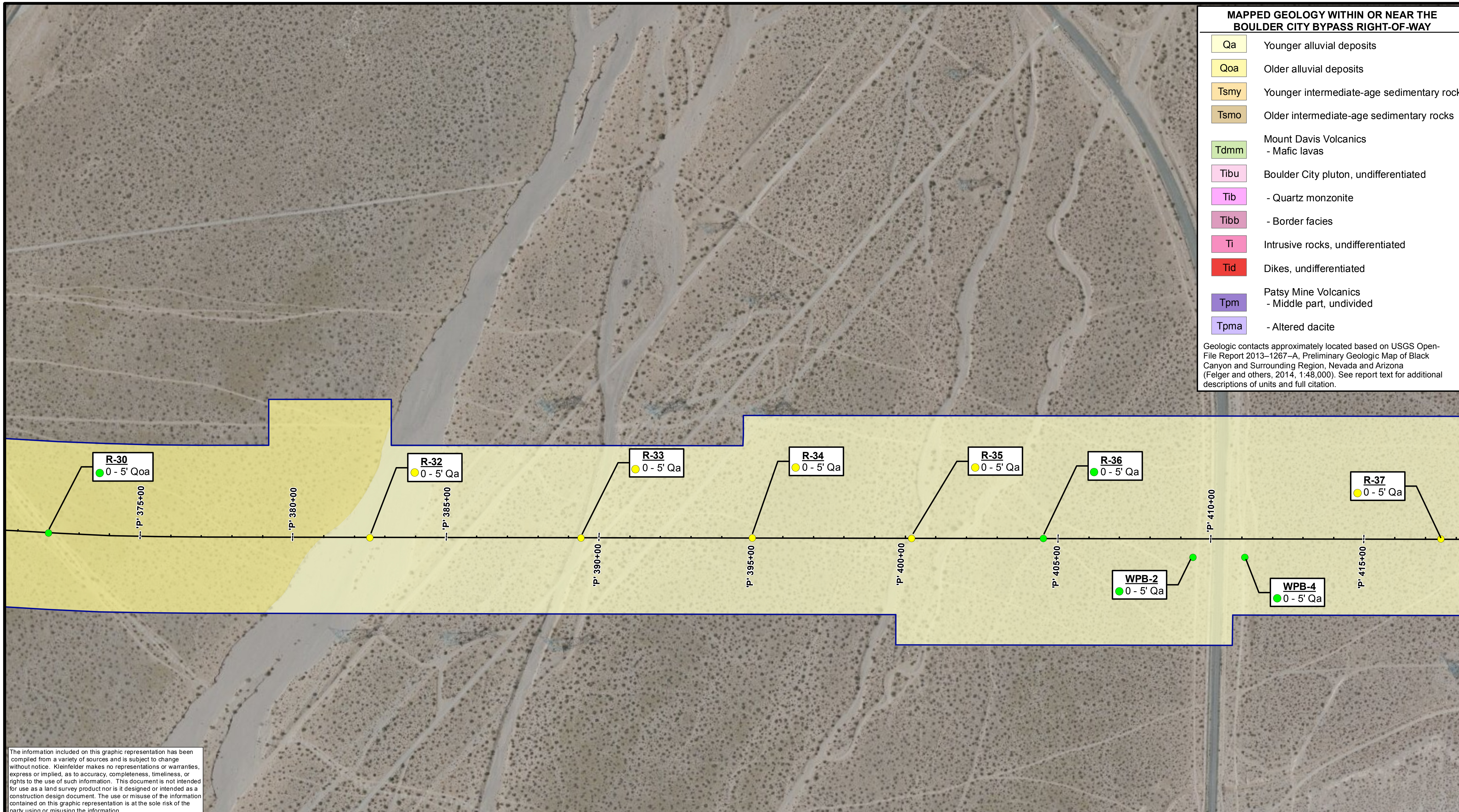
CHECKED BY:	JLS
FILE NAME:	Figure7.mxd

NOA SAMPLING RESULTS

Interstate 11 - Boulder City Bypass
Phase 2 Design Build Project
Geologic Evaluation, Sampling, and
Testing for Naturally Occurring Asbestos
Boulder City, Clark County, Nevada

FIGURE

7



N

0 150 300
Feet

Locations are approximate

EXPLANATION

Calculated Asbestos Concentration by Weight
- Below Detection Limit < 0.0002 %
- Asbestos Detected >= 0.0002 % to < 0.25 %
- Asbestos Detected >= 0.25 % to <= 1.0 %
- Asbestos Detected > 1.0 %

Right-of-Way
Alignment, 500-ft Stationing

Sources: BCB_Alignment.dgn provided 2/18/14 by The Louis Berger Group, Inc. Aerial: ESRI World Imagery, 5/7/11.

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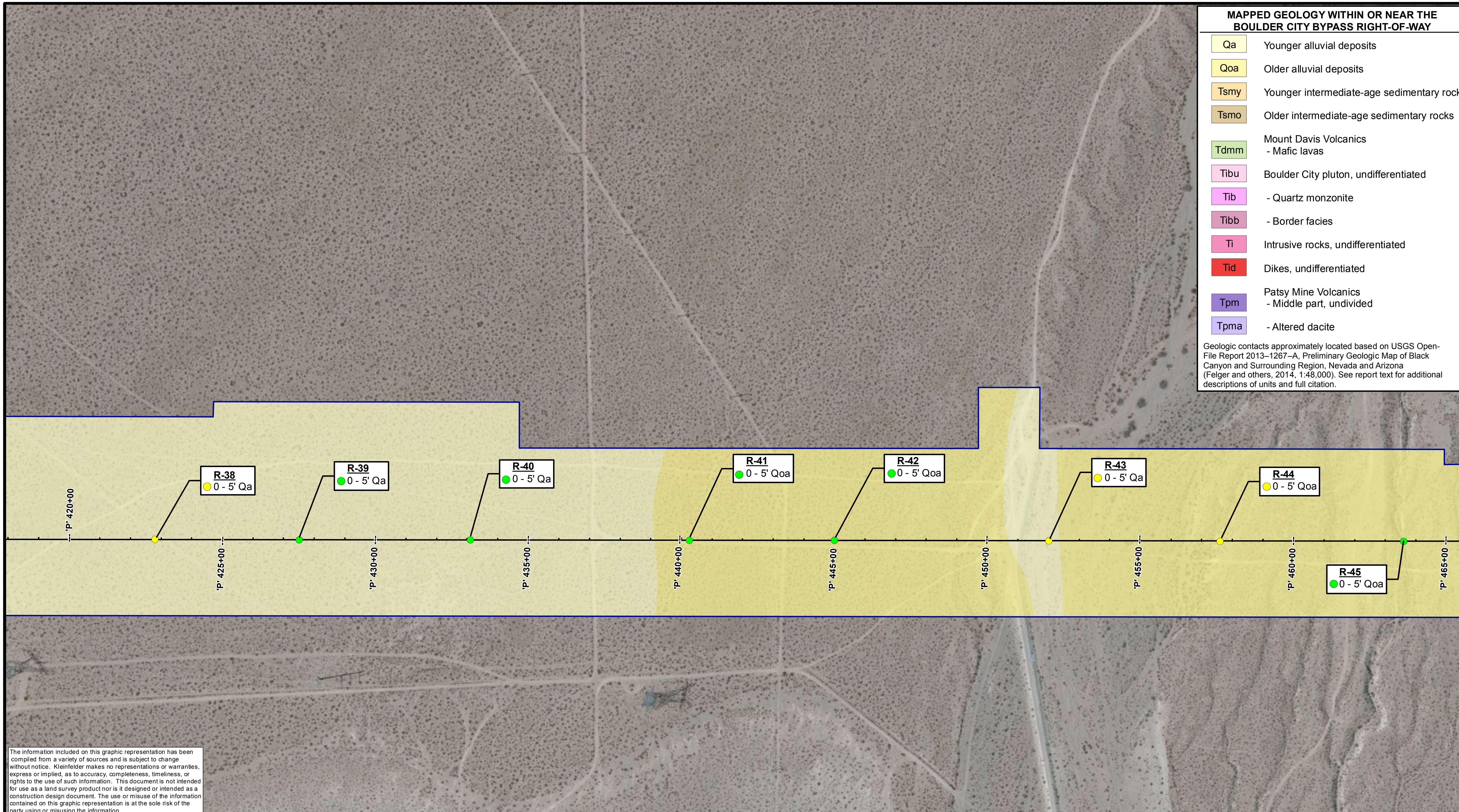
DRAWN BY:	KFH
CHECKED BY:	JLS
FILE NAME: Figure8.mxd	

NOA SAMPLING RESULTS

Interstate 11 - Boulder City Bypass
Phase 2 Design Build Project
Geologic Evaluation, Sampling, and
Testing for Naturally Occurring Asbestos
Boulder City, Clark County, Nevada

FIGURE
8



N

0 150 300

Feet

Locations are approximate

EXPLANATION

Calculated Asbestos Concentration by Weight
- Below Detection Limit < 0.0002 %
- Asbestos Detected >= 0.0002 % to < 0.25 %
- Asbestos Detected >= 0.25 % to <= 1.0 %
- Asbestos Detected > 1.0 %

Right-of-Way
Alignment, 500-ft Stationing

Sources: BCB_Alignment.dgn provided 2/18/14 by The Louis Berger Group, Inc. Aerial: ESRI World Imagery, 5/7/11.

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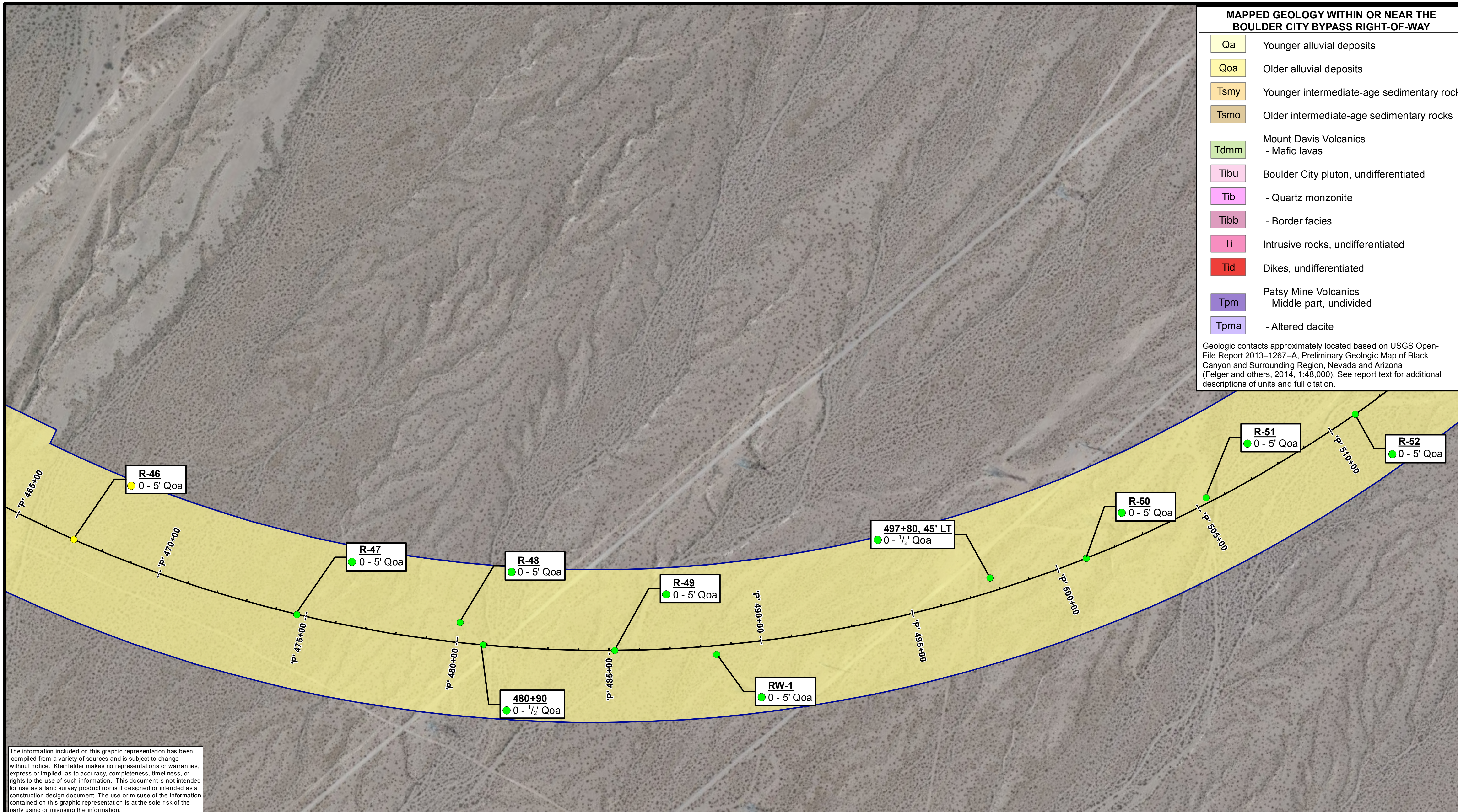
FILE NAME:	Figure9.mxd

NOA SAMPLING RESULTS

Interstate 11 - Boulder City Bypass
Phase 2 Design Build Project
Geologic Evaluation, Sampling, and
Testing for Naturally Occurring Asbestos
Boulder City, Clark County, Nevada

FIGURE
9



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N
0 150 300
Feet
Locations are approximate

EXPLANATION

Calculated Asbestos Concentration by Weight
- Below Detection Limit < 0.0002 %
- Asbestos Detected >= 0.0002 % to < 0.25 %
- Asbestos Detected >= 0.25 % to <= 1.0 %
- Asbestos Detected > 1.0 %

- Right-of-Way
- Alignment, 500-ft Stationing

Sources: BCB_Alignment.dgn provided 2/18/14 by The Louis Berger Group, Inc. Aerial: ESRI World Imagery, 5/7/11.

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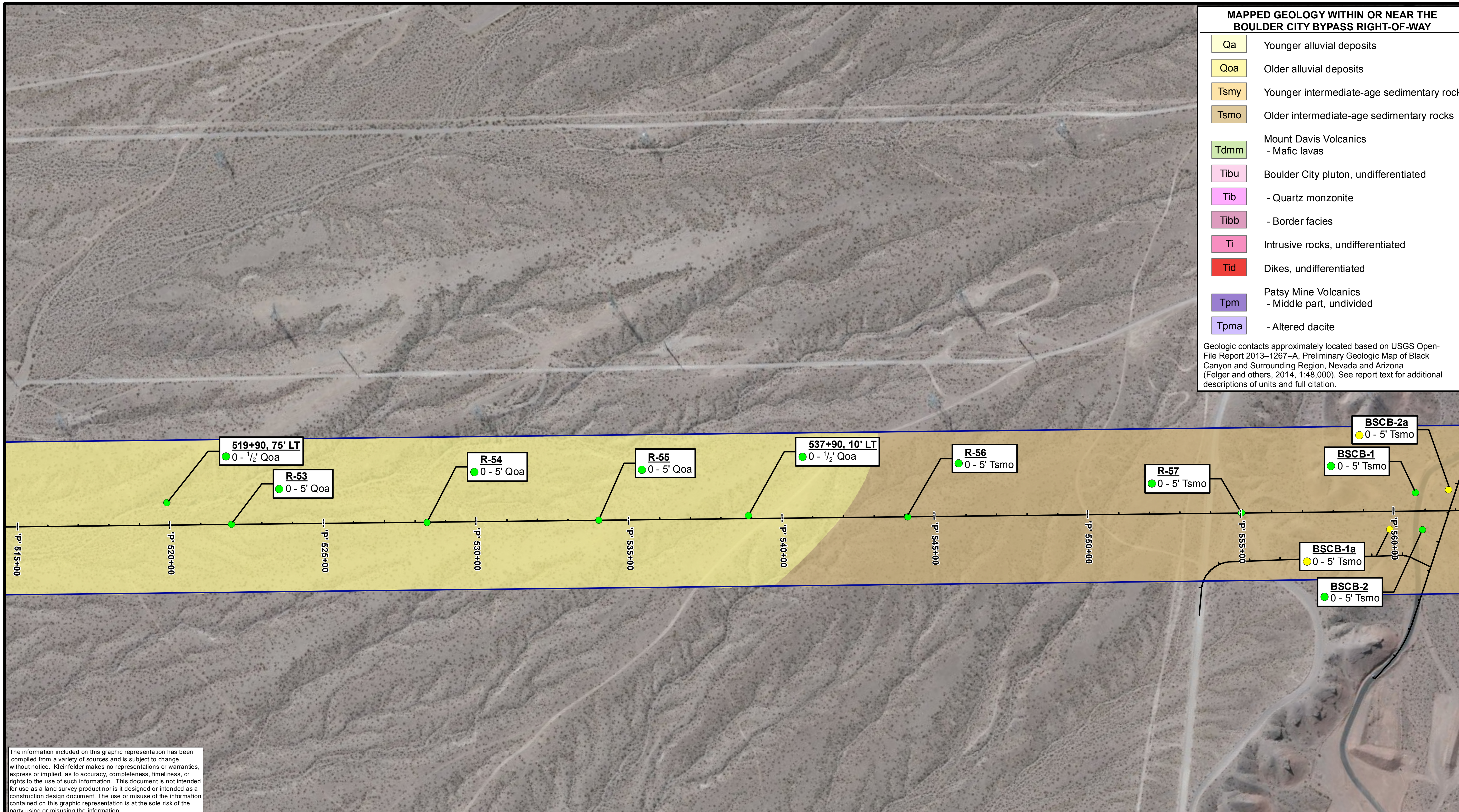
FILE NAME:	Figure10.mxd

NOA SAMPLING RESULTS

Interstate 11 - Boulder City Bypass
Phase 2 Design Build Project
Geologic Evaluation, Sampling, and
Testing for Naturally Occurring Asbestos
Boulder City, Clark County, Nevada

FIGURE
10



0 150 300
Feet

Locations are approximate

EXPLANATION

Calculated Asbestos Concentration by Weight
- Below Detection Limit < 0.0002 %
- Asbestos Detected >= 0.0002 % to < 0.25 %
- Asbestos Detected >= 0.25 % to <= 1.0 %
- Asbestos Detected > 1.0 %

- Right-of-Way
- Alignment, 500-ft Stationing

Sources: BCB_Alignment.dgn provided 2/18/14 by The Louis Berger Group, Inc. Aerial: ESRI World Imagery, 5/7/11.

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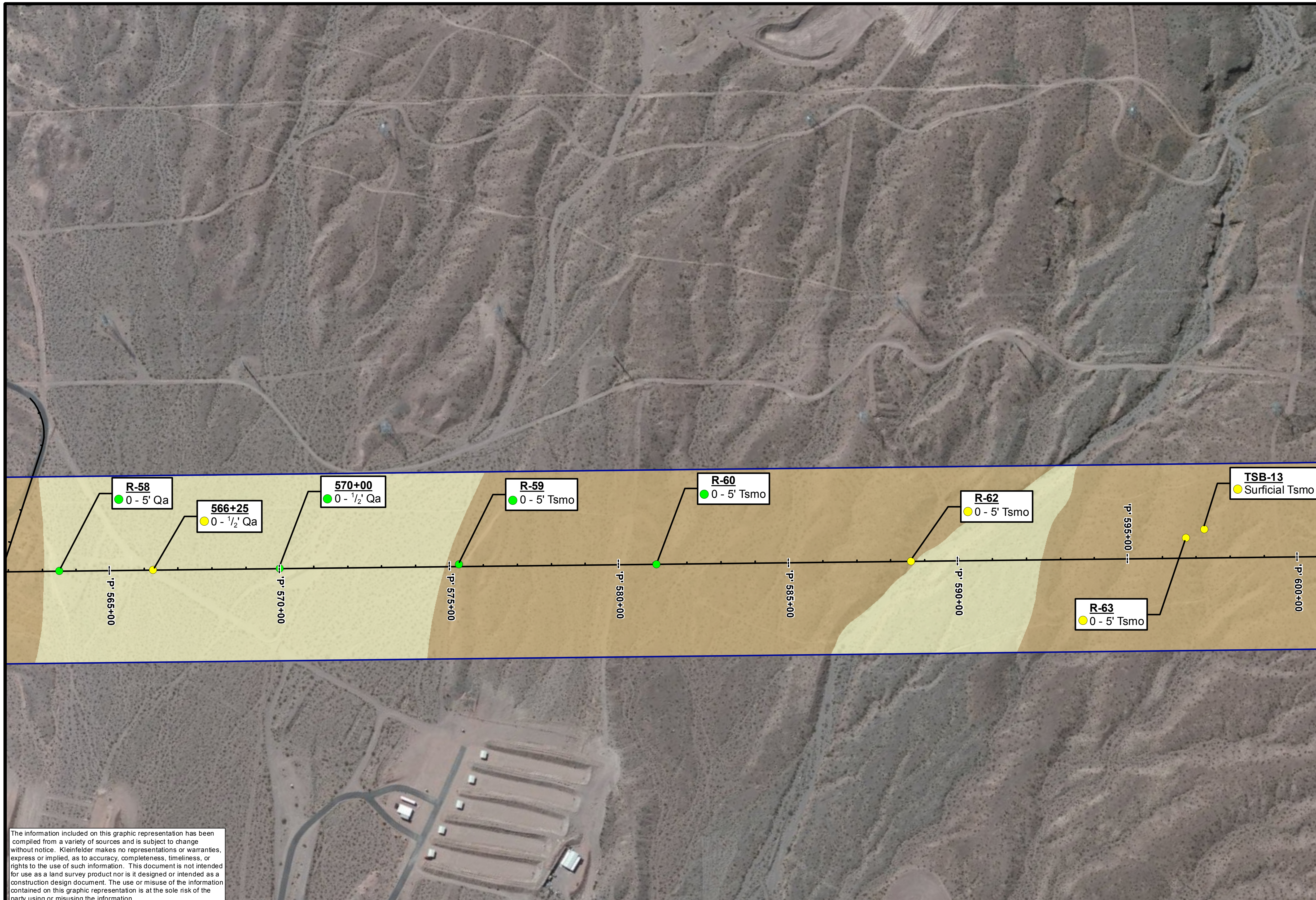
FILE NAME:	Figure11.mxd

NOA SAMPLING RESULTS

Interstate 11 - Boulder City Bypass
Phase 2 Design Build Project
Geologic Evaluation, Sampling, and
Testing for Naturally Occurring Asbestos
Boulder City, Clark County, Nevada

FIGURE
11



MAPPED GEOLOGY WITHIN OR NEAR THE BOULDER CITY BYPASS RIGHT-OF-WAY

Qa	Younger alluvial deposits
Qoa	Older alluvial deposits
Tsmy	Younger intermediate-age sedimentary rocks
Tsmo	Older intermediate-age sedimentary rocks
Tdmm	Mount Davis Volcanics - Mafic lavas
Tibu	Boulder City pluton, undifferentiated
Tib	- Quartz monzonite
Tibb	- Border facies
Ti	Intrusive rocks, undifferentiated
Tid	Dikes, undifferentiated
Tpm	Patsy Mine Volcanics - Middle part, undivided
Tpma	- Altered dacite

Geologic contacts approximately located based on USGS Open-File Report 2013–1267–A, Preliminary Geologic Map of Black Canyon and Surrounding Region, Nevada and Arizona (Felger and others, 2014, 1:48,000). See report text for additional descriptions of units and full citation.

0 150 300
Feet
Locations are approximate

EXPLANATION

Calculated Asbestos Concentration by Weight
- Below Detection Limit < 0.0002 %
- Asbestos Detected >= 0.0002 % to < 0.25 %
- Asbestos Detected >= 0.25 % to <= 1.0 %
- Asbestos Detected > 1.0 %

- Right-of-Way
- Alignment, 500-ft Stationing

Sources: BCB_Alignment.dgn provided 2/18/14 by The Louis Berger Group, Inc. Aerial: ESRI World Imagery, 5/7/11.

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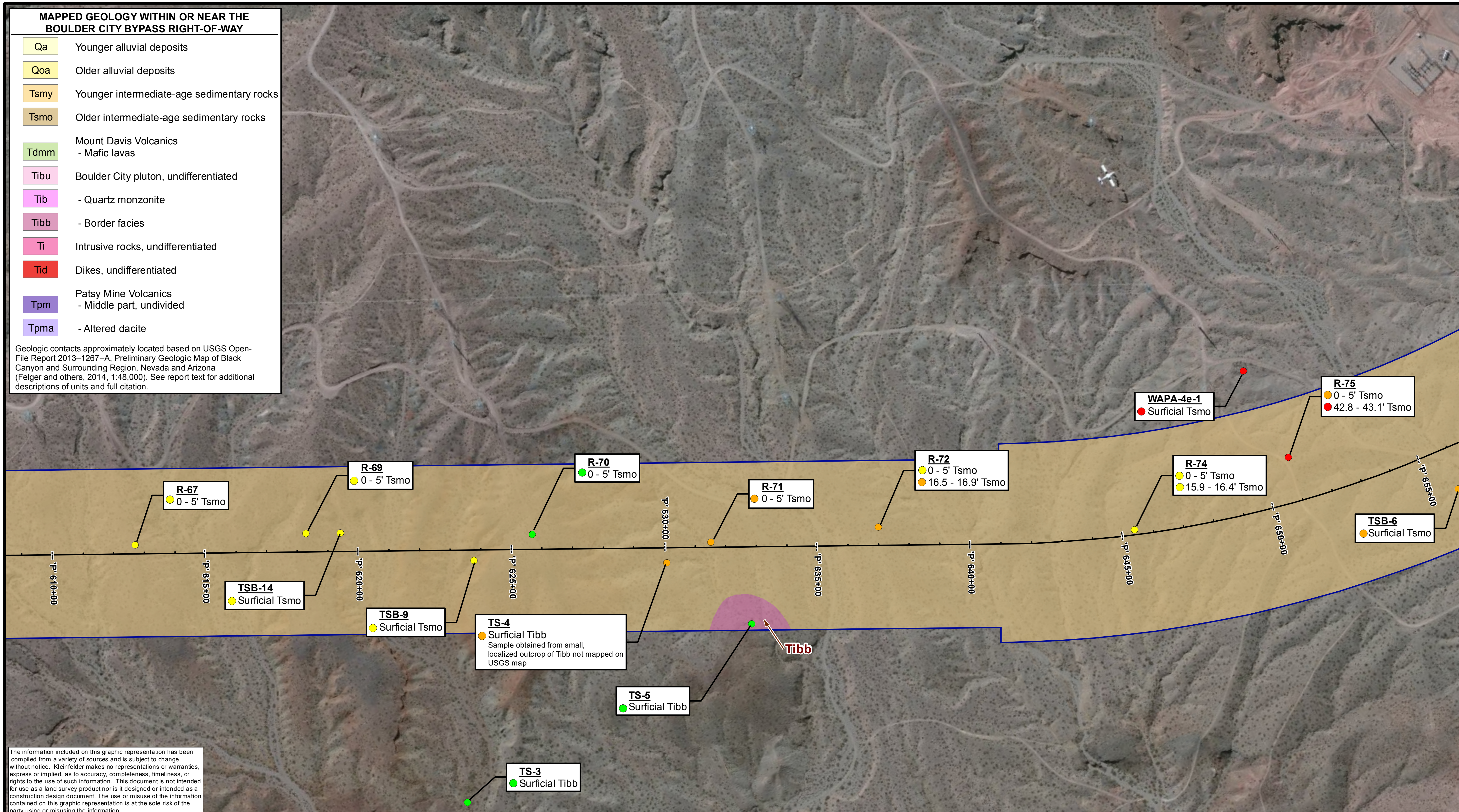
FILE NAME:	Figure12.mxd

NOA SAMPLING RESULTS

Interstate 11 - Boulder City Bypass
Phase 2 Design Build Project
Geologic Evaluation, Sampling, and
Testing for Naturally Occurring Asbestos
Boulder City, Clark County, Nevada

FIGURE
12



0 150 300
Feet
Locations are approximate

EXPLANATION

Calculated Asbestos Concentration by Weight
- Below Detection Limit < 0.0002 %
- Asbestos Detected >= 0.0002 % to < 0.25 %
- Asbestos Detected >= 0.25 % to <= 1.0 %
- Asbestos Detected > 1.0 %

- Right-of-Way
- Alignment, 500-ft Stationing

Sources: BCB_Alignment.dgn provided 2/18/14 by The Louis Berger Group, Inc. Aerial: ESRI World Imagery, 5/7/11.

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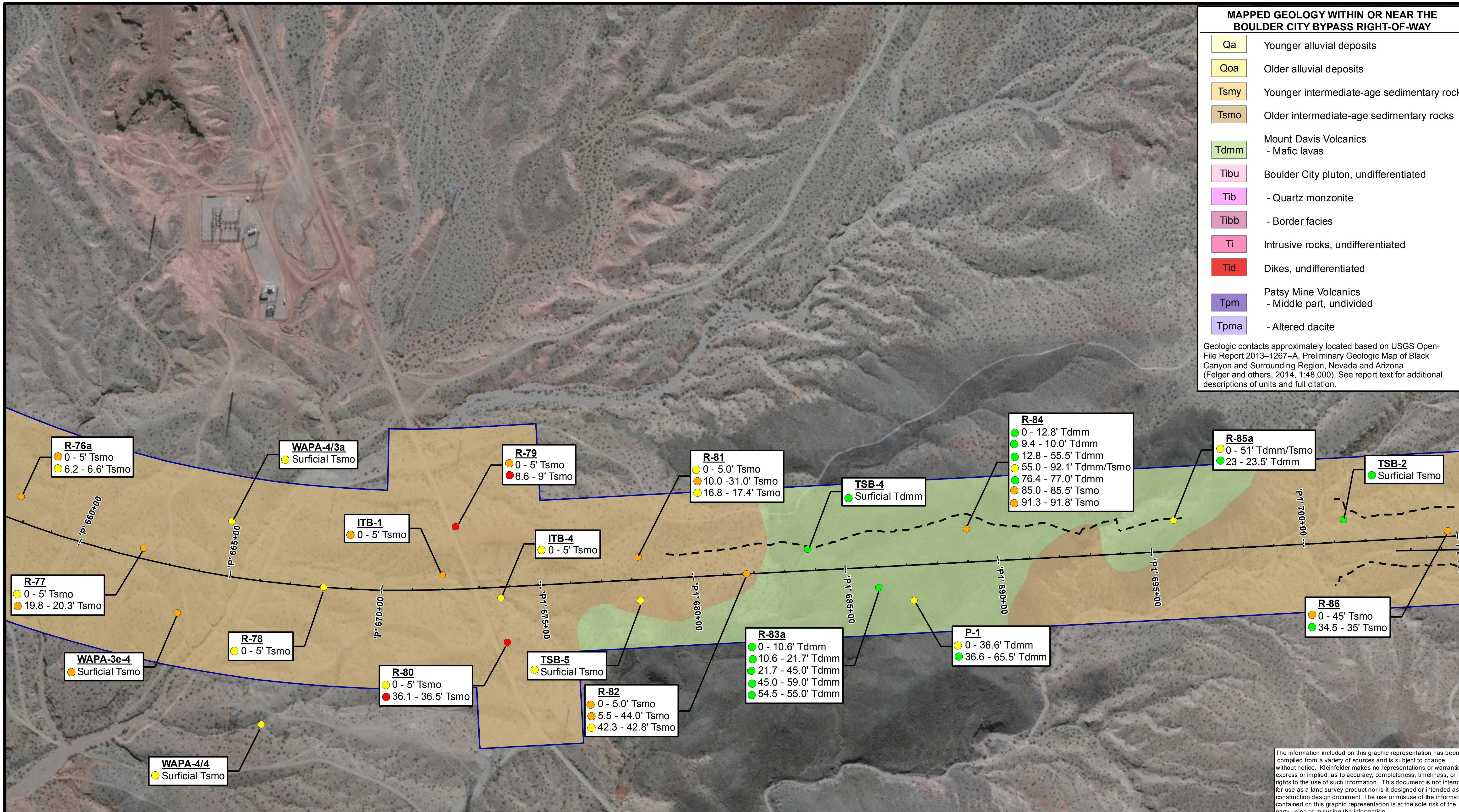
FILE NAME:	Figure13.mxd

NOA SAMPLING RESULTS

Interstate 11 - Boulder City Bypass
Phase 2 Design Build Project
Geologic Evaluation, Sampling, and
Testing for Naturally Occurring Asbestos
Boulder City, Clark County, Nevada

FIGURE
13



0 150 300
Feet

Locations are approximate

EXPLANATION

Calculated Asbestos Concentration by Weight
- Below Detection Limit < 0.0002 %
- Asbestos Detected >= 0.0002 % to < 0.25 %
- Asbestos Detected >= 0.25 % to <= 1.0 %
- Asbestos Detected > 1.0 %

- Proposed Major Cut (See Table 3.2.2-1 for more information)
- Right-of-Way
- Alignment, 500-ft Stationing

Sources: BCB_Alignment.dgn provided 2/18/14 by The Louis Berger Group, Inc. Aerial: ESRI World Imagery, 5/7/11.

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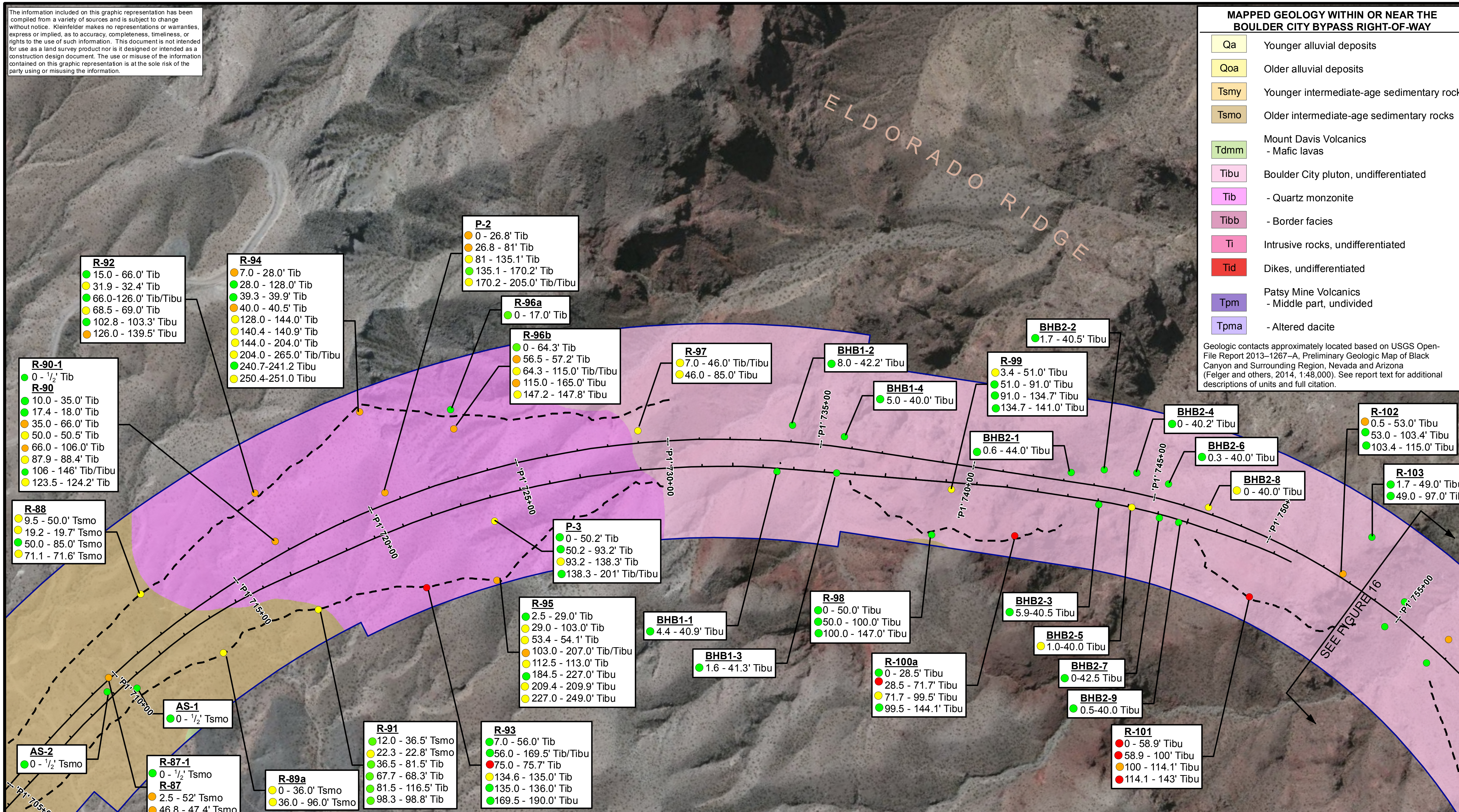
FILE NAME:	Figure14.mxd

NOA SAMPLING RESULTS

Interstate 11 - Boulder City Bypass
Phase 2 Design Build Project
Geologic Evaluation, Sampling, and
Testing for Naturally Occurring Asbestos
Boulder City, Clark County, Nevada

FIGURE
14



0 150 300
Feet
Locations are approximate

EXPLANATION

Calculated Asbestos Concentration by Weight
- Below Detection Limit < 0.0002 %
- Asbestos Detected >= 0.0002 % to < 0.25 %
- Asbestos Detected >= 0.25 % to <= 1.0 %
- Asbestos Detected > 1.0 %

- Proposed Major Cut (See Table 3.2.2-1 for more information)
- Right-of-Way
- Alignment, 500-ft Stationing

Sources: BCB_Alignment.dgn provided 2/18/14 by The Louis Berger Group, Inc. Aerial: ESRI World Imagery, 5/7/11.

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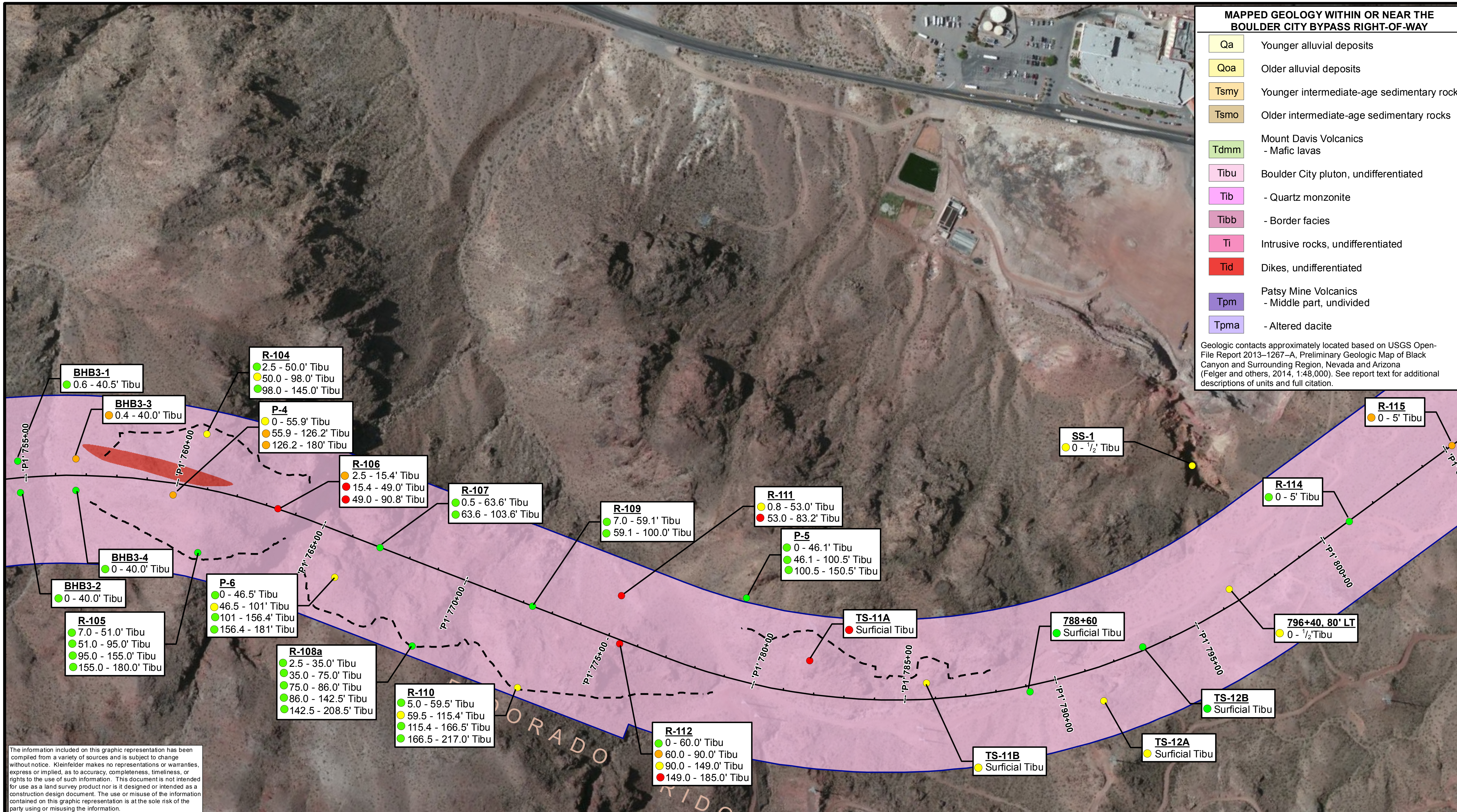
PROJECT NO.:	137120
DRAWN:	AUG 2014
DRAWN BY:	KFH
CHECKED BY:	JLS
FILE NAME:	Figure15.mxd

NOA SAMPLING RESULTS

Interstate 11 - Boulder City Bypass
Phase 2 Design Build Project
Geologic Evaluation, Sampling, and
Testing for Naturally Occurring Asbestos
Boulder City, Clark County, Nevada

FIGURE
15



N
0 150 300
Feet
Locations are approximate

EXPLANATION

Calculated Asbestos Concentration by Weight
- Below Detection Limit < 0.0002 %
- Asbestos Detected >= 0.0002 % to < 0.25 %
- Asbestos Detected >= 0.25 % to <= 1.0 %
- Asbestos Detected > 1.0 %

- Proposed Major Cut (See Table 3.2.2-1 for more information)
- Right-of-Way
- Alignment, 500-ft Stationing

Sources: BCB_Alignment.dgn provided 2/18/14 by The Louis Berger Group, Inc. Aerial: ESRI World Imagery, 5/7/11.

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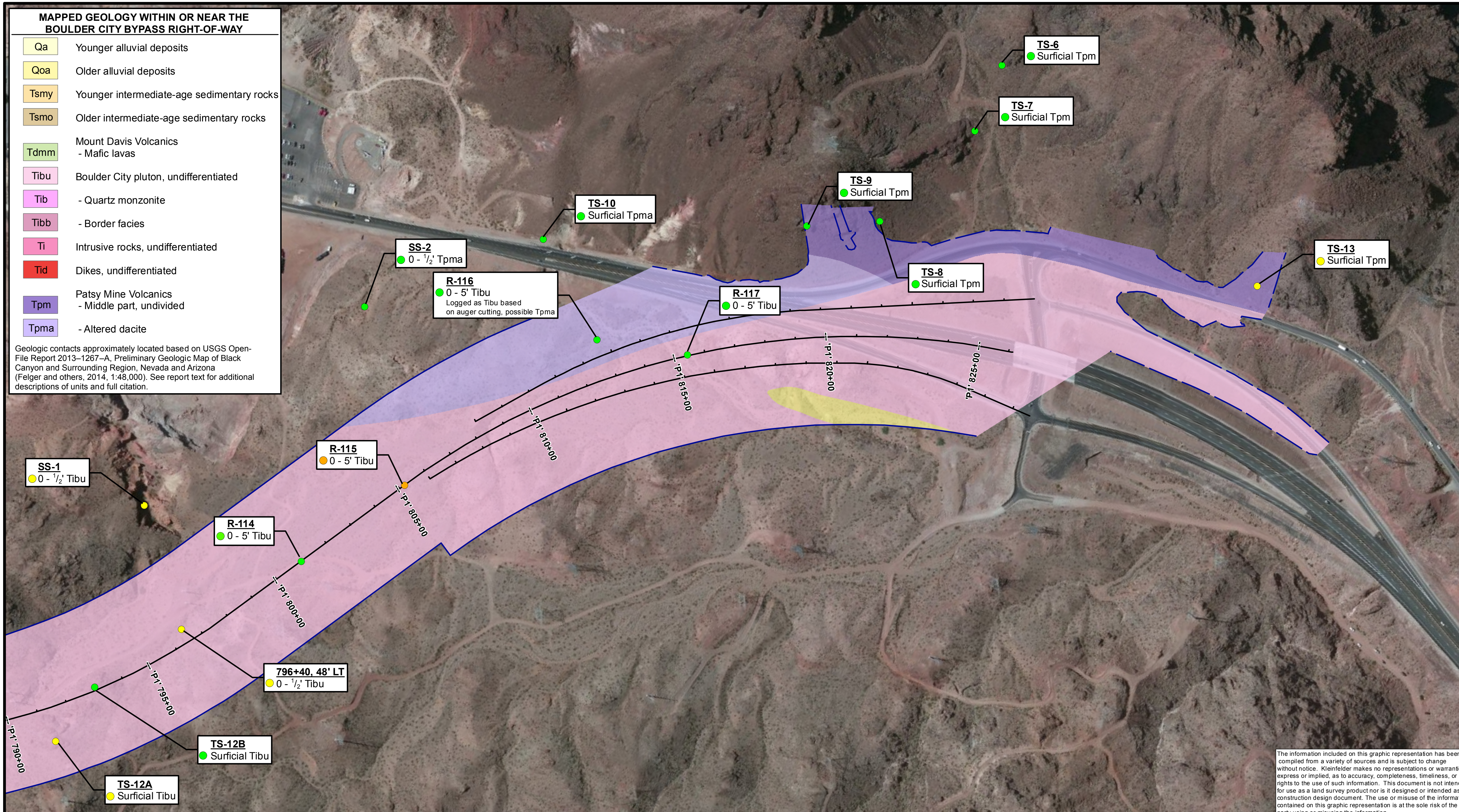
PROJECT NO.:	137120
DRAWN:	AUG 2014
DRAWN BY:	KFH
CHECKED BY:	JLS
FILE NAME:	Figure16.mxd

NOA SAMPLING RESULTS

Interstate 11 - Boulder City Bypass
Phase 2 Design Build Project
Geologic Evaluation, Sampling, and
Testing for Naturally Occurring Asbestos
Boulder City, Clark County, Nevada

FIGURE
16



N

0 150 300

Feet

Locations are approximate

EXPLANATION

Calculated Asbestos Concentration by Weight
- Below Detection Limit < 0.0002 %
- Asbestos Detected >= 0.0002 % to < 0.25 %
- Asbestos Detected >= 0.25 % to <= 1.0 %
- Asbestos Detected > 1.0 %

- Right-of-Way
- Approximate Extent of Disturbance from 30% Plans
- Alignment, 500-ft Stationing

Sources: BCB_Alignment.dgn provided 2/18/14 by The Louis Berger Group, Inc. Aerial: ESRI World Imagery, 5/7/11.

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PROJECT NO.:	137120
DRAWN:	AUG 2014
DRAWN BY:	KFH
CHECKED BY:	JLS
FILE NAME:	Figure17.mxd

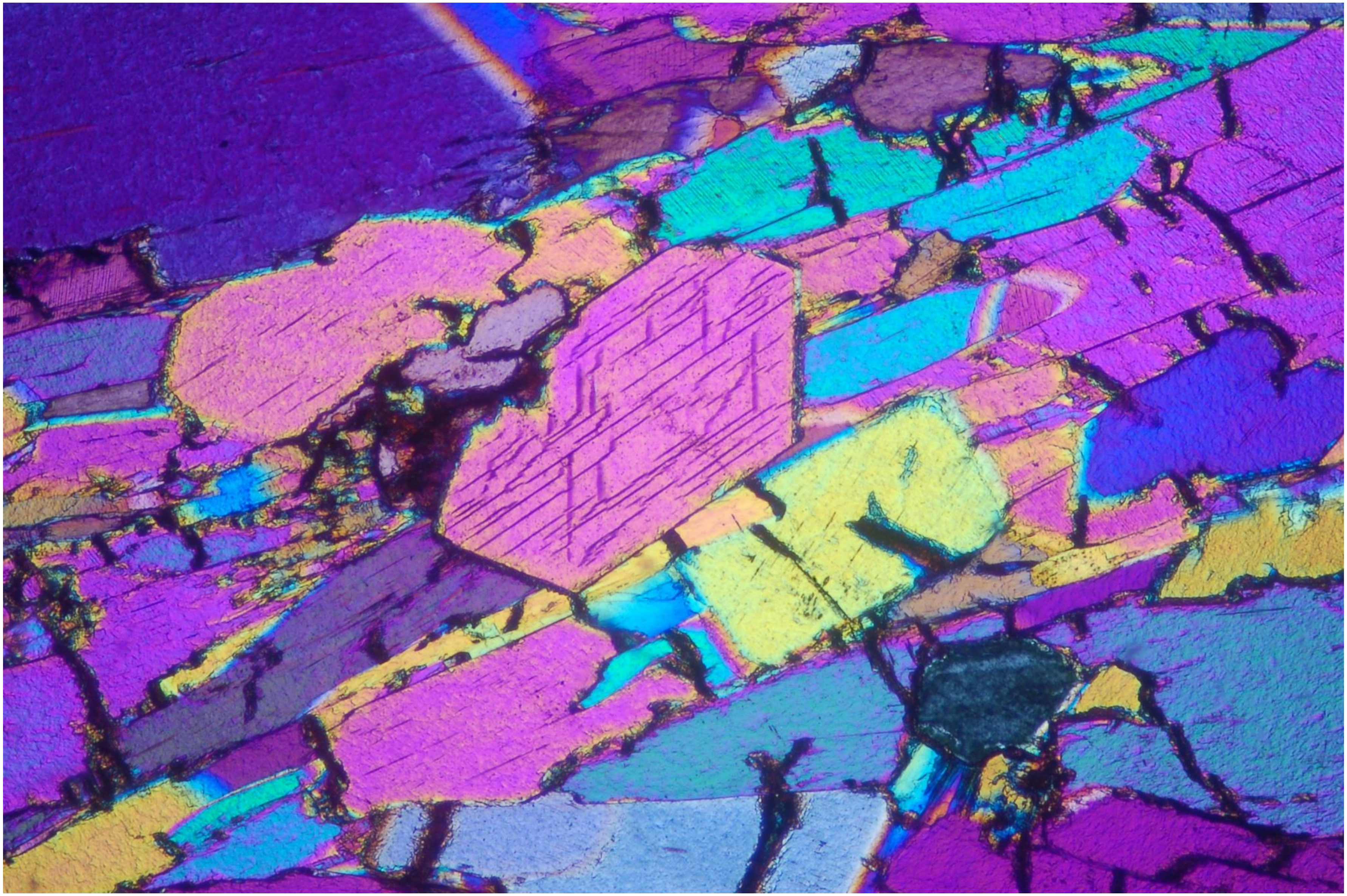
NOA SAMPLING RESULTS

Interstate 11 - Boulder City Bypass
Phase 2 Design Build Project
Geologic Evaluation, Sampling, and
Testing for Naturally Occurring Asbestos
Boulder City, Clark County, Nevada

FIGURE

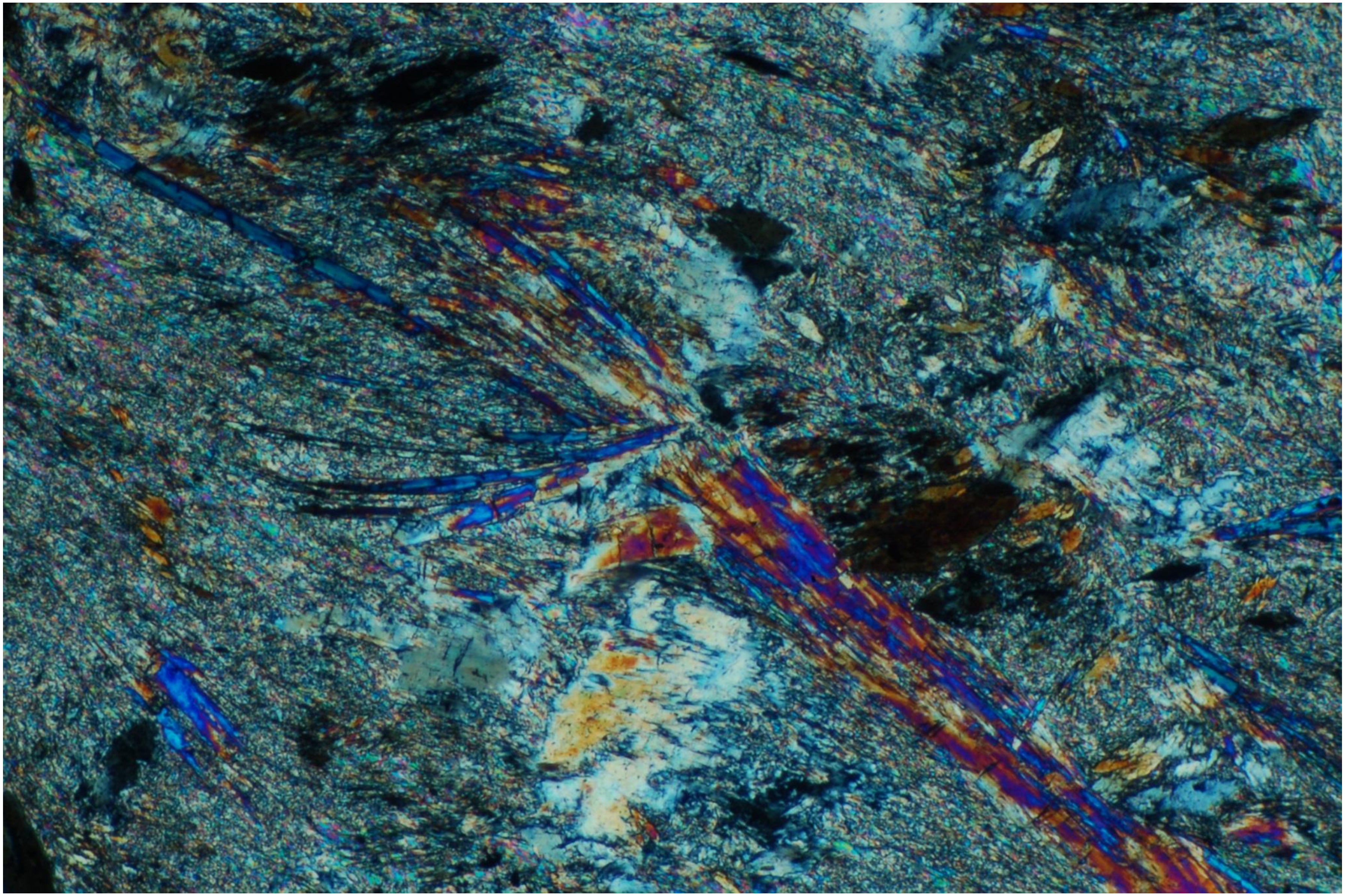
17

PLATES



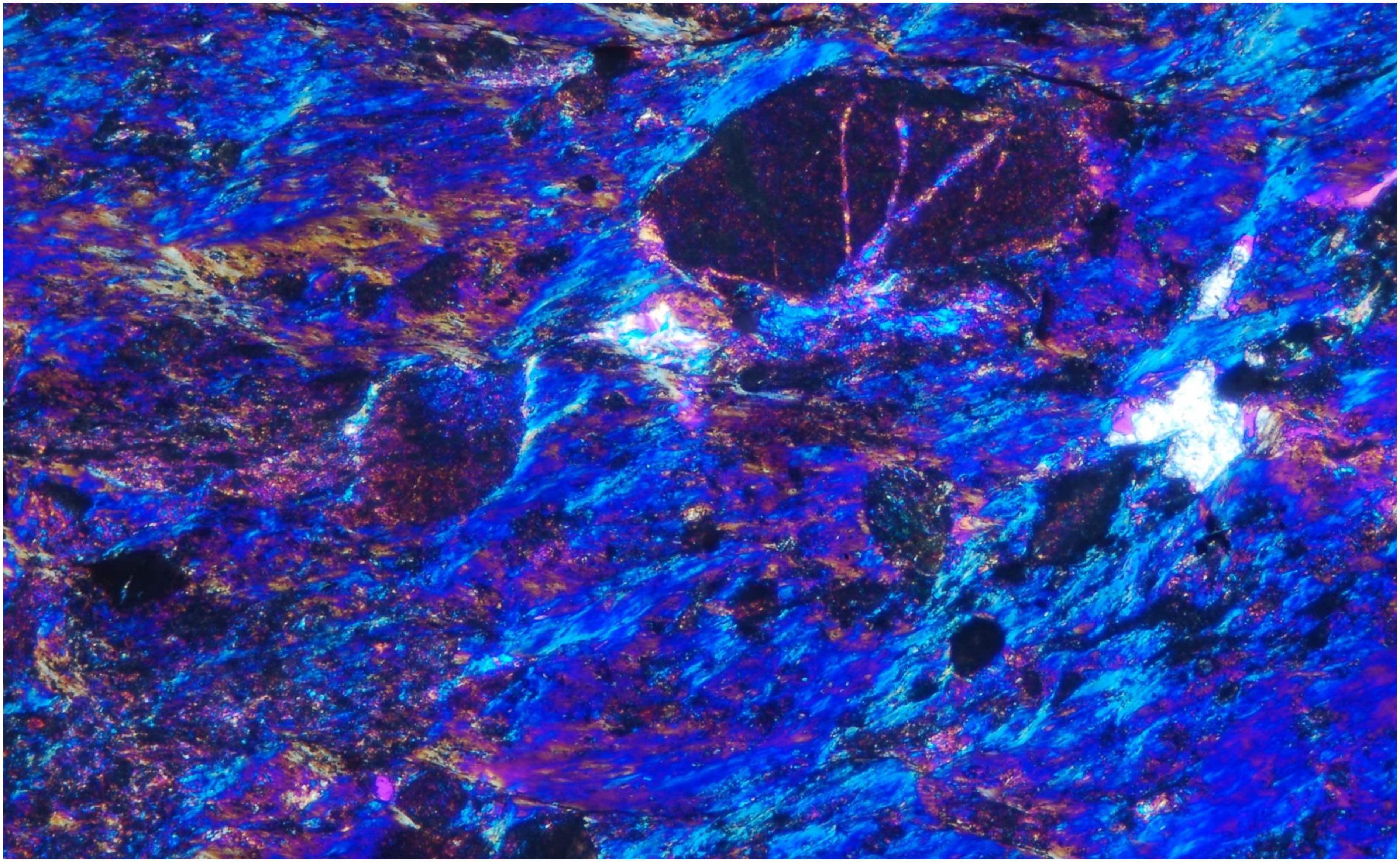
Thin section photomicrograph of euhedral hornblende in plutonic rock illustrating the well developed (110) cleavages
(Hetch Hetchy granodiorite, CA)

KLEINFELDER Bright People. Right Solutions.	PROJECT NO: 137120.12 DRAWN BY: MAP CHECKED BY: JLS DATE: 5/20/2014 REVISED: --	Petrographic Analysis Interstate 11 – Boulder City Bypass Phase 2 Design Build Project Geologic Evaluation, Sampling, and Testing for Naturally Occurring Asbestos Boulder City, Clark County, Nevada	PLATE **1**



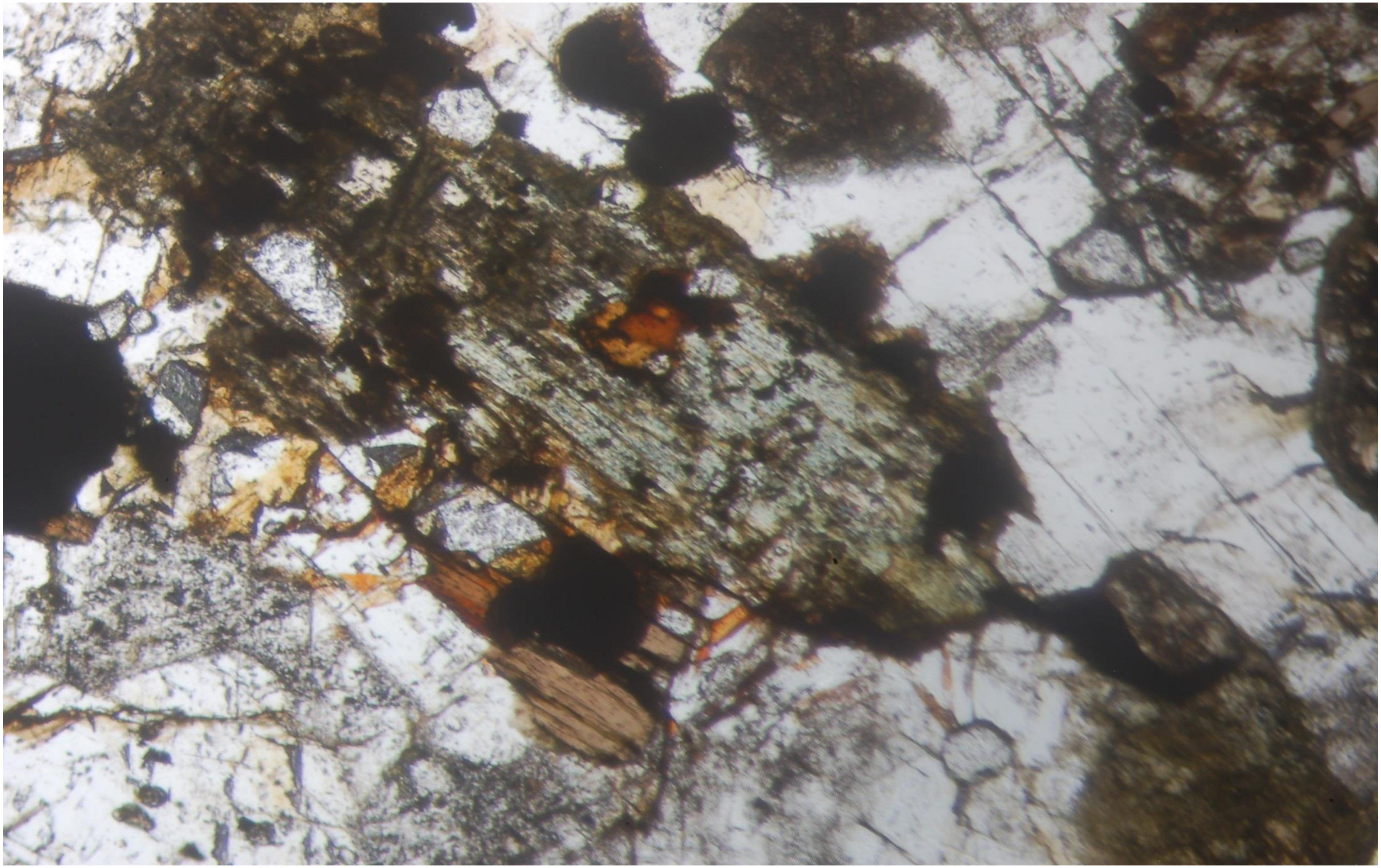
Thin section photomicrograph of long crystals of tremolite illustrating formation by nucleation and growth
(Talc schist, Porterville, CA)

KLEINFELDER Bright People. Right Solutions.	PROJECT NO: 137120.12 DRAWN BY: MAP CHECKED BY: JLS DATE: 5/20/2014 REVISED: --	Petrographic Analysis Interstate 11 – Boulder City Bypass Phase 2 Design Build Project Geologic Evaluation, Sampling, and Testing for Naturally Occurring Asbestos Boulder City, Clark County, Nevada	PLATE **2**



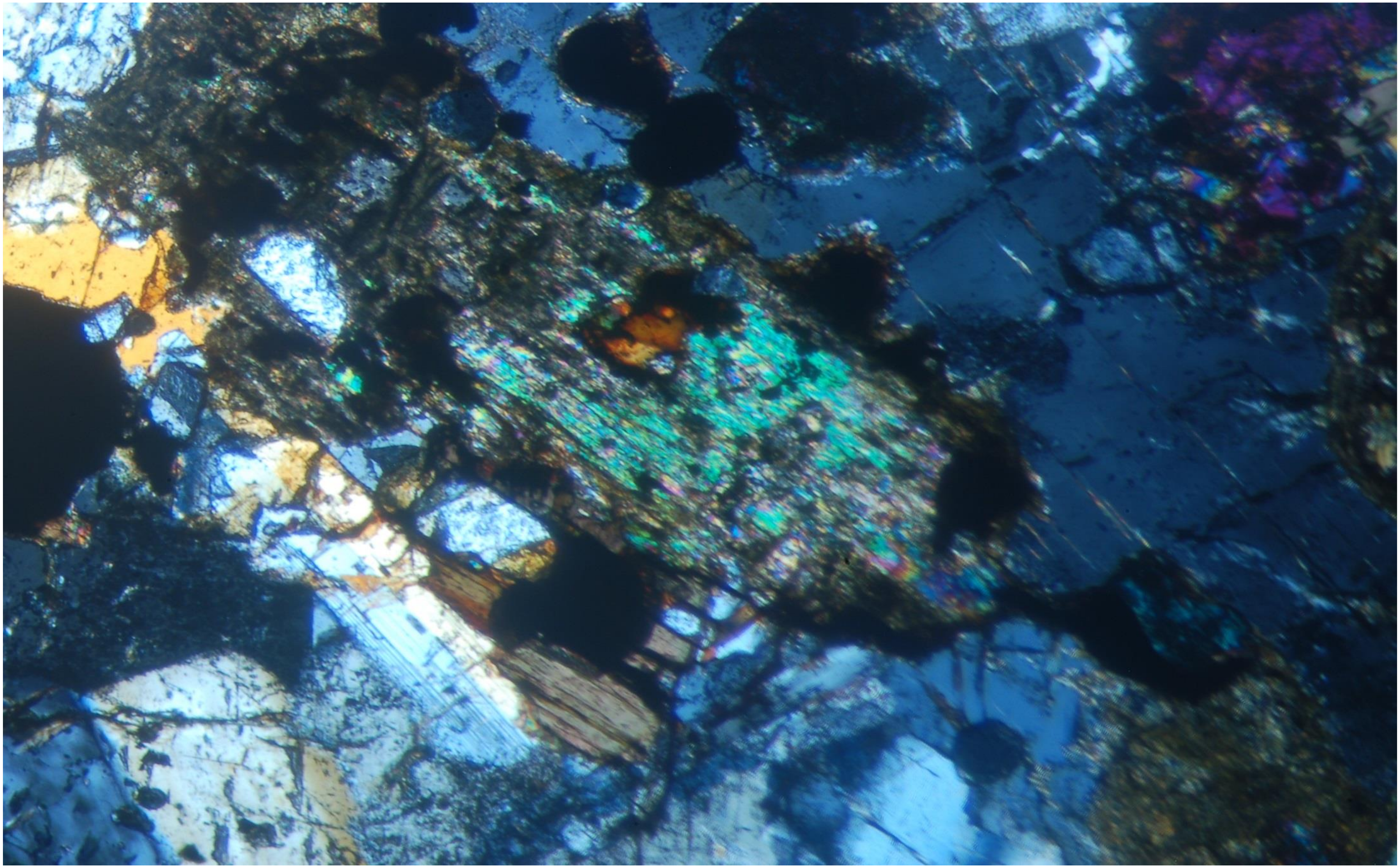
Thin section photomicrograph of fibrous glaucophane showing asbestiform habit within a deformed mylonite
(Blueschist, Calaveras dam, Sunol, CA)

KLEINFELDER Bright People. Right Solutions.	PROJECT NO: 137120.12 DRAWN BY: MAP CHECKED BY: JLS DATE: 5/20/2014 REVISED: --	Petrographic Analysis Interstate 11 – Boulder City Bypass Phase 2 Design Build Project Geologic Evaluation, Sampling, and Testing for Naturally Occurring Asbestos Boulder City, Clark County, Nevada	PLATE **3**



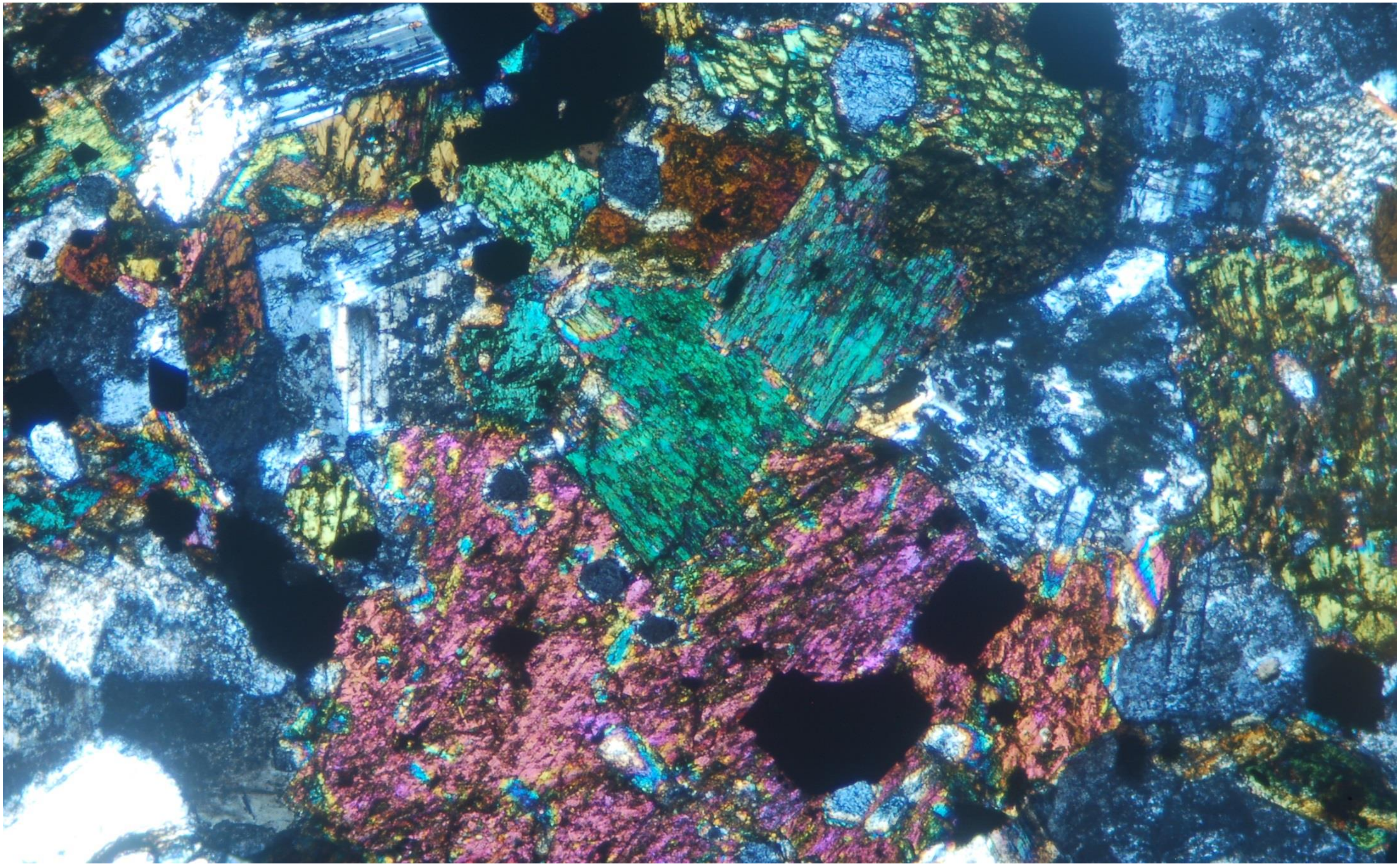
Thin section of actinolite in Tibu, plane polarized light

KLEINFELDER *Bright People. Right Solutions.*	PROJECT NO: 137120.12 DRAWN BY: MAP CHECKED BY: JLS DATE: 5/20/2014 REVISED: --	Petrographic Analysis Interstate 11 – Boulder City Bypass Phase 2 Design Build Project Geologic Evaluation, Sampling, and Testing for Naturally Occurring Asbestos Boulder City, Clark County, Nevada	PLATE **4a**



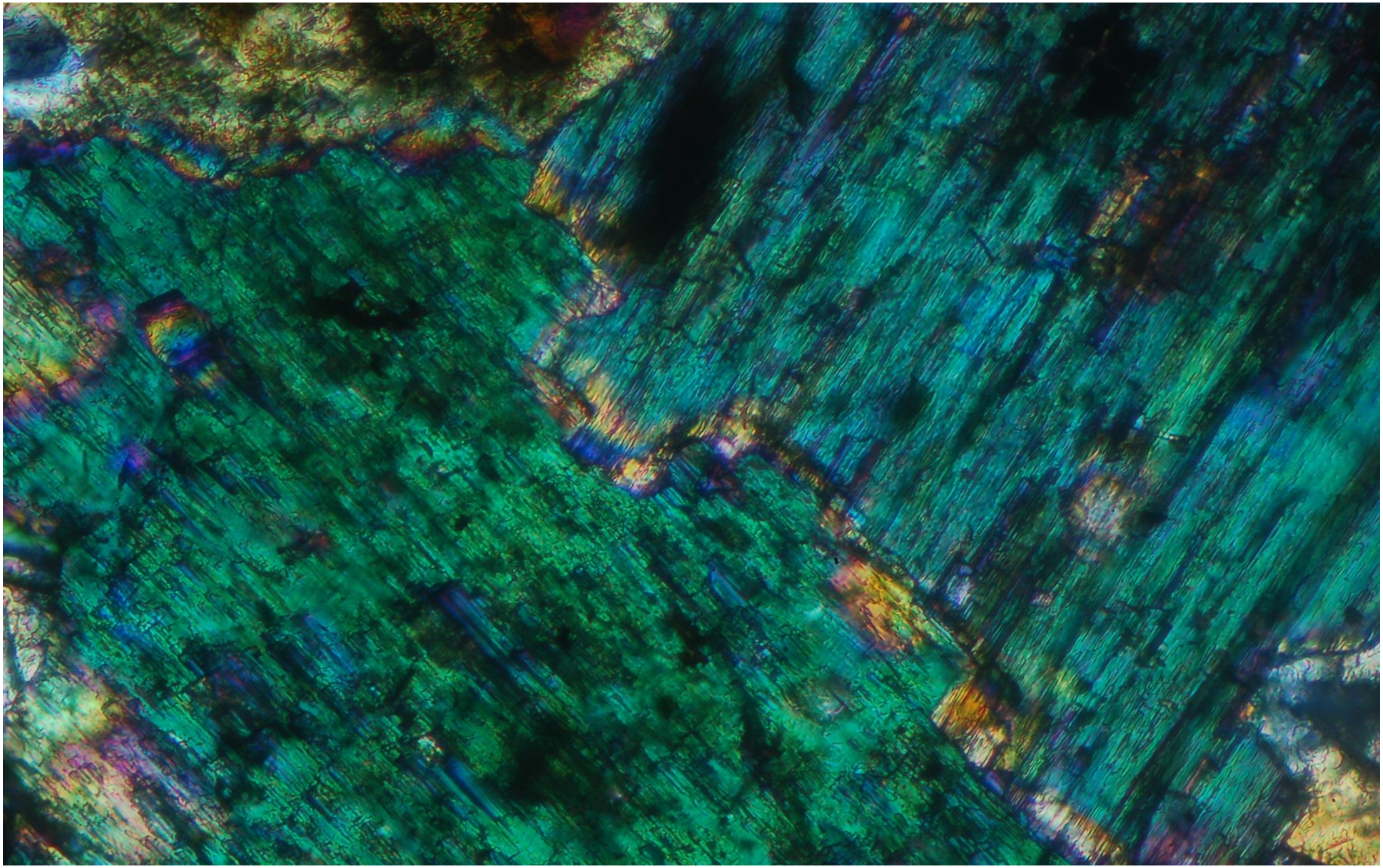
Thin section of actinolite in Tibu, crossed polarizers

KLEINFELDER Bright People. Right Solutions.	PROJECT NO: 137120.12 DRAWN BY: MAP CHECKED BY: JLS DATE: 5/20/2014 REVISED: --	Petrographic Analysis Interstate 11 – Boulder City Bypass Phase 2 Design Build Project Geologic Evaluation, Sampling, and Testing for Naturally Occurring Asbestos Boulder City, Clark County, Nevada	PLATE **4b**



Thin section of actinolite in Tibu, crossed polarizers

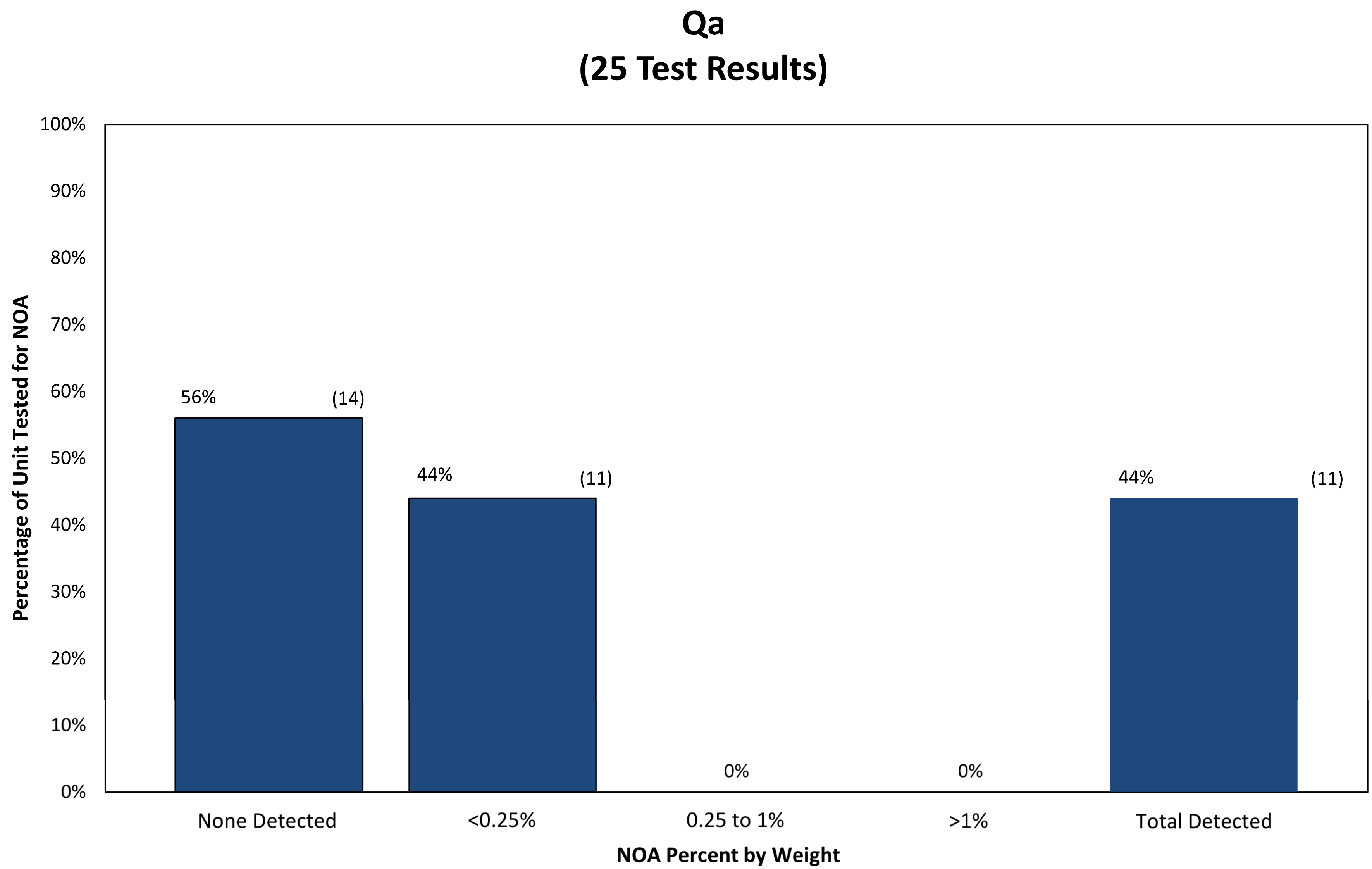
KLEINFELDER Bright People. Right Solutions.	PROJECT NO: 137120.12 DRAWN BY: MAP CHECKED BY: JLS DATE: 5/20/2014 REVISED: --	Petrographic Analysis Interstate 11 – Boulder City Bypass Phase 2 Design Build Project Geologic Evaluation, Sampling, and Testing for Naturally Occurring Asbestos Boulder City, Clark County, Nevada	PLATE 5a



Detail of Plate 5a

KLEINFELDER Bright People. Right Solutions.	PROJECT NO: 137120.12 DRAWN BY: MAP CHECKED BY: JLS DATE: 5/20/2014 REVISED: --	Petrographic Analysis Interstate 11 – Boulder City Bypass Phase 2 Design Build Project Geologic Evaluation, Sampling, and Testing for Naturally Occurring Asbestos Boulder City, Clark County, Nevada	PLATE **5b**

GRAPHS



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REVISED:	7/28/2014

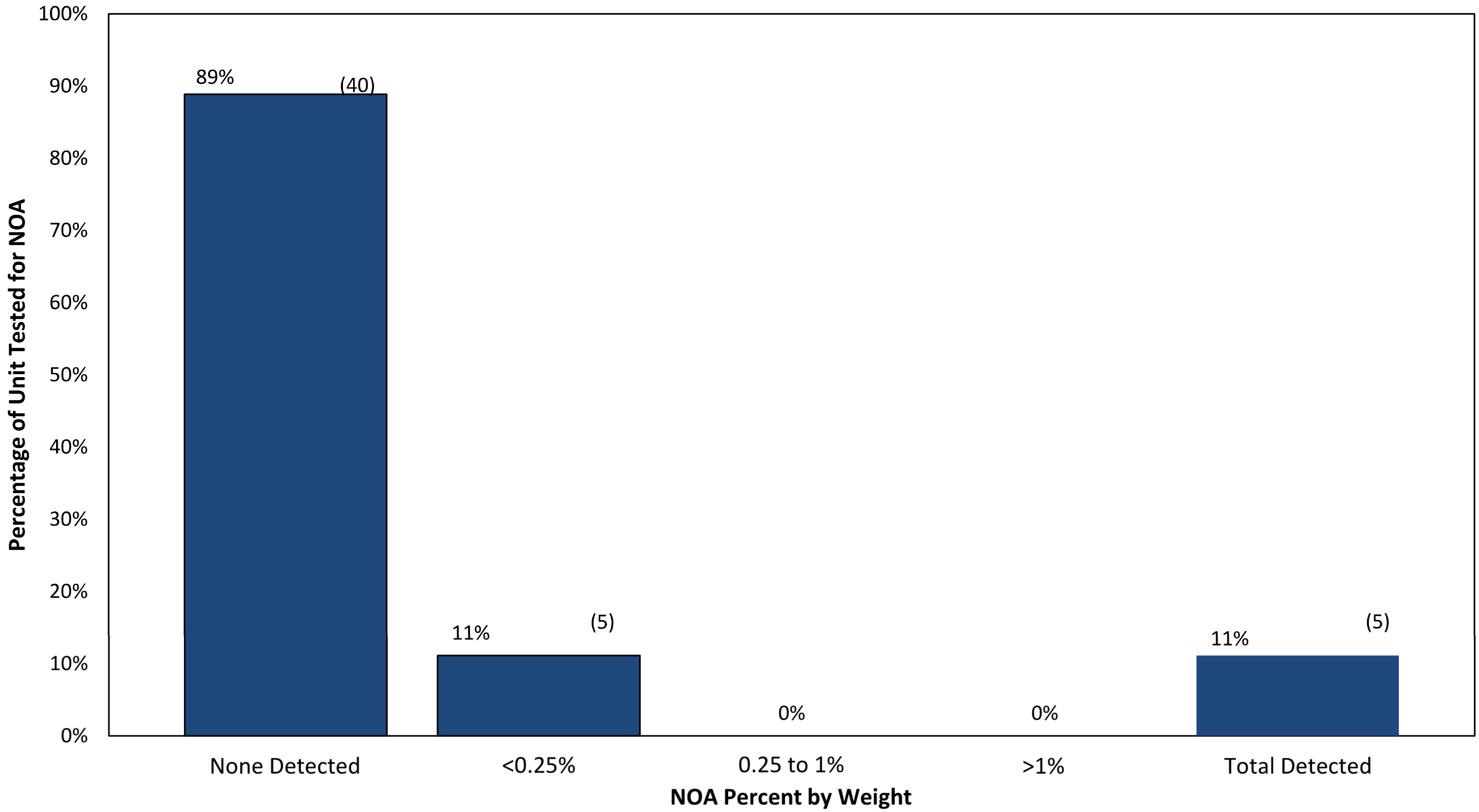
NOA Content for Geologic Units Combined

Interstate 11 – Boulder City Bypass Phase 2 Design Build Project
Geologic Evaluation, Sampling, and Testing for Naturally Occurring Asbestos
Boulder City, Clark County, Nevada

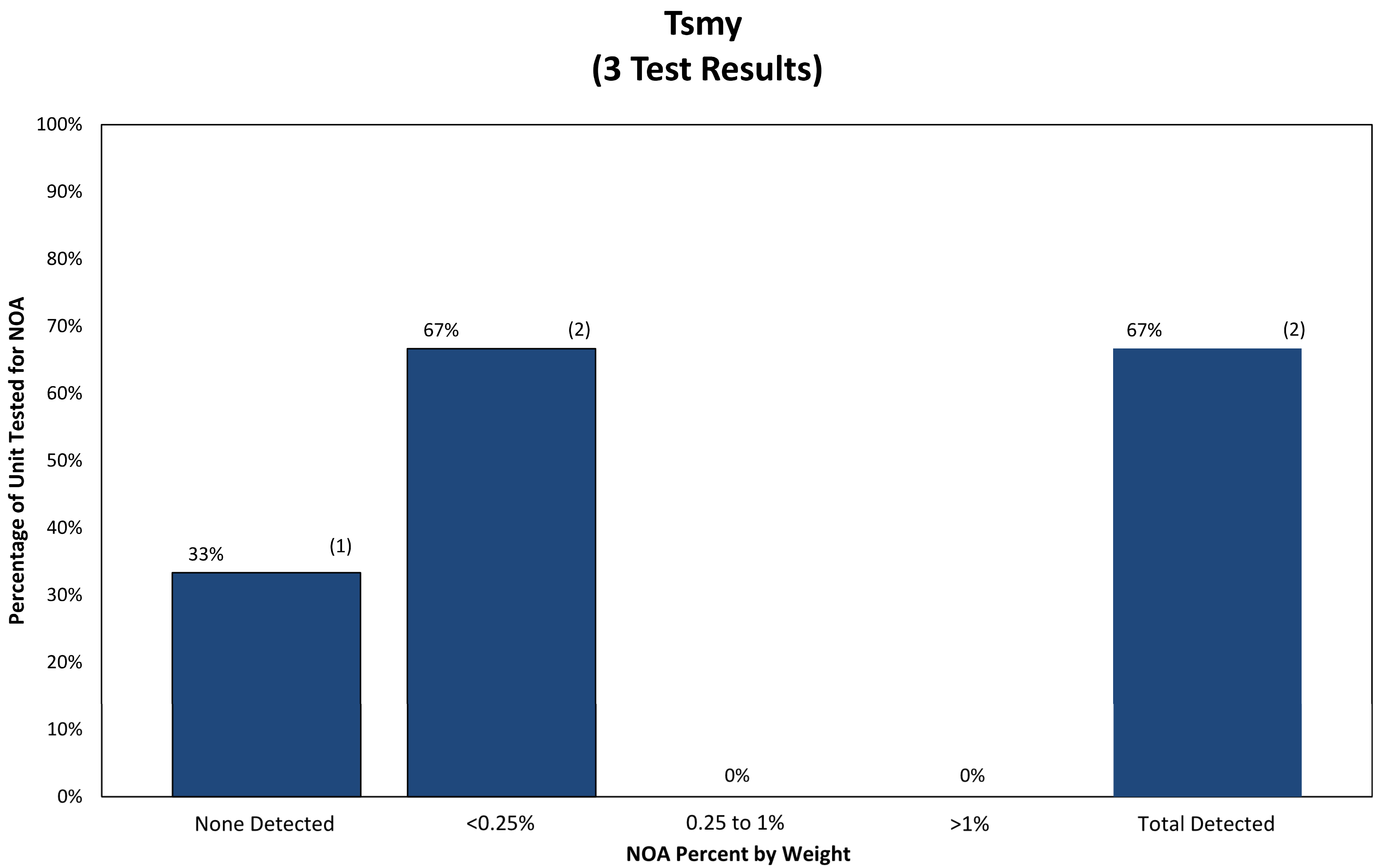
GRAPH

1

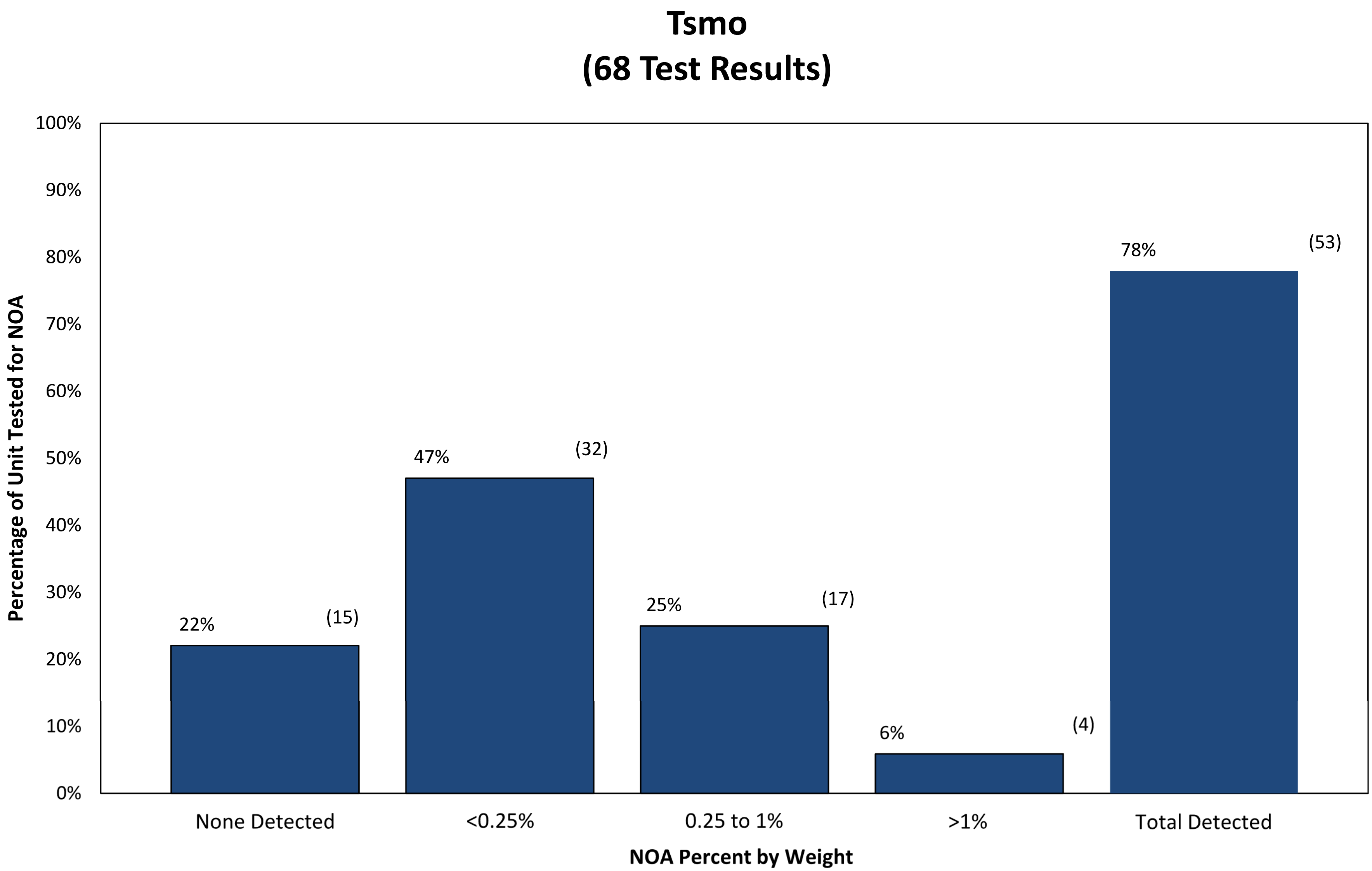
Qoa
(45 Test Results)



KLEINFELDER Bright People. Right Solutions.	PROJECT NO: 137120 DRAWN BY: MB CHECKED BY: JLS DATE: 7/15/2014 REVISED: 7/28/2014	NOA Content for Geologic Units Combined Interstate 11 – Boulder City Bypass Phase 2 Design Build Project Geologic Evaluation, Sampling, and Testing for Naturally Occurring Asbestos Boulder City, Clark County, Nevada	GRAPH 2



KLEINFELDER Bright People. Right Solutions.	PROJECT NO: 137120 DRAWN BY: MB CHECKED BY: JLS DATE: 7/15/2014 REVISED: 7/28/2014	NOA Content for Geologic Units Combined Interstate 11 – Boulder City Bypass Phase 2 Design Build Project Geologic Evaluation, Sampling, and Testing for Naturally Occurring Asbestos Boulder City, Clark County, Nevada	GRAPH 3



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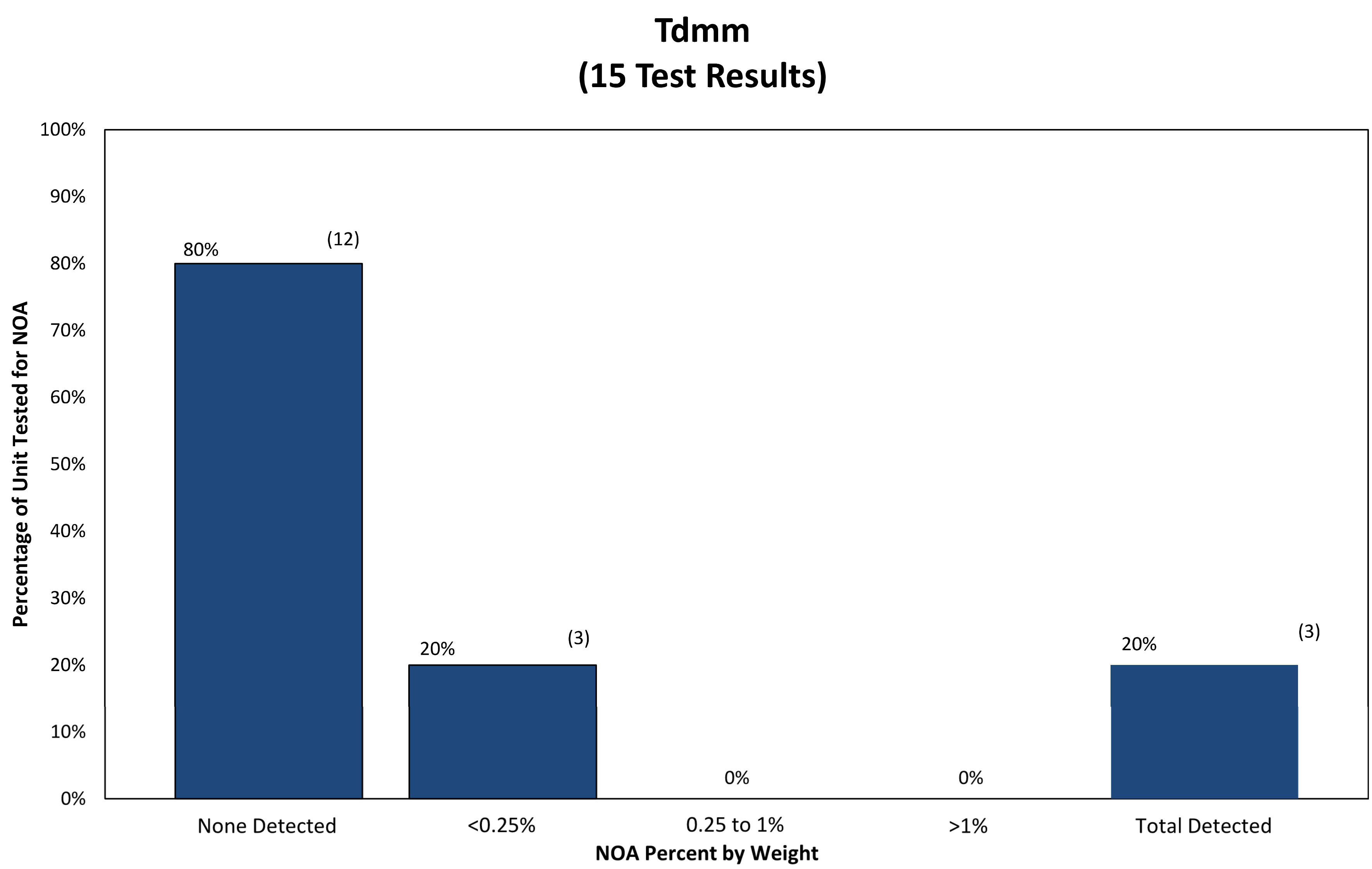
REVISED:	7/28/2014

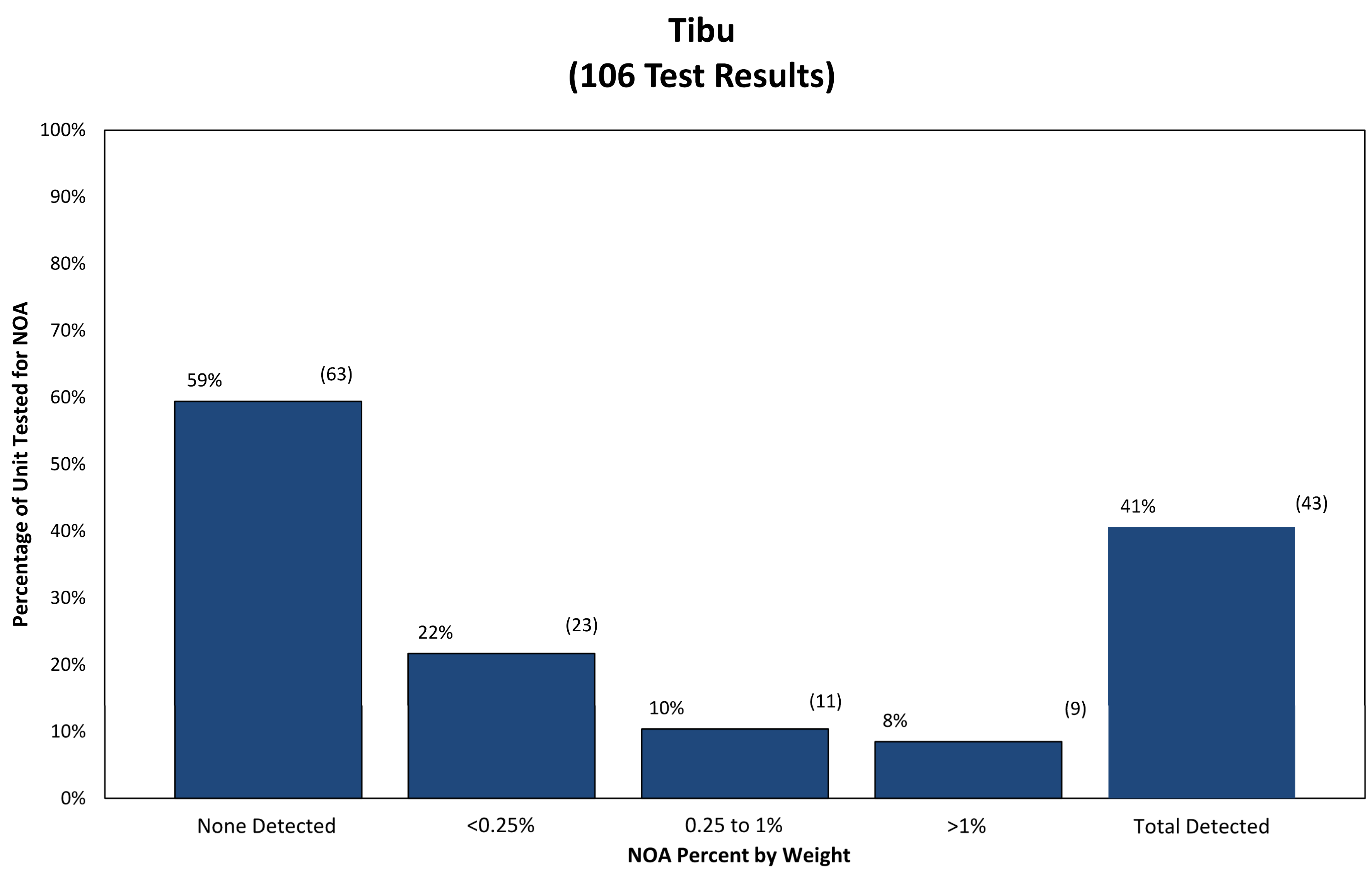
NOA Content for Geologic Units Combined

Interstate 11 – Boulder City Bypass Phase 2 Design Build Project
Geologic Evaluation, Sampling, and Testing for Naturally Occurring Asbestos
Boulder City, Clark County, Nevada

GRAPH
4



KLEINFELDER Bright People. Right Solutions.	PROJECT NO: 137120 DRAWN BY: MB CHECKED BY: JLS DATE: 7/15/2014 REVISED: 7/28/2014	NOA Content for Geologic Units Combined Interstate 11 – Boulder City Bypass Phase 2 Design Build Project Geologic Evaluation, Sampling, and Testing for Naturally Occurring Asbestos Boulder City, Clark County, Nevada	GRAPH 5



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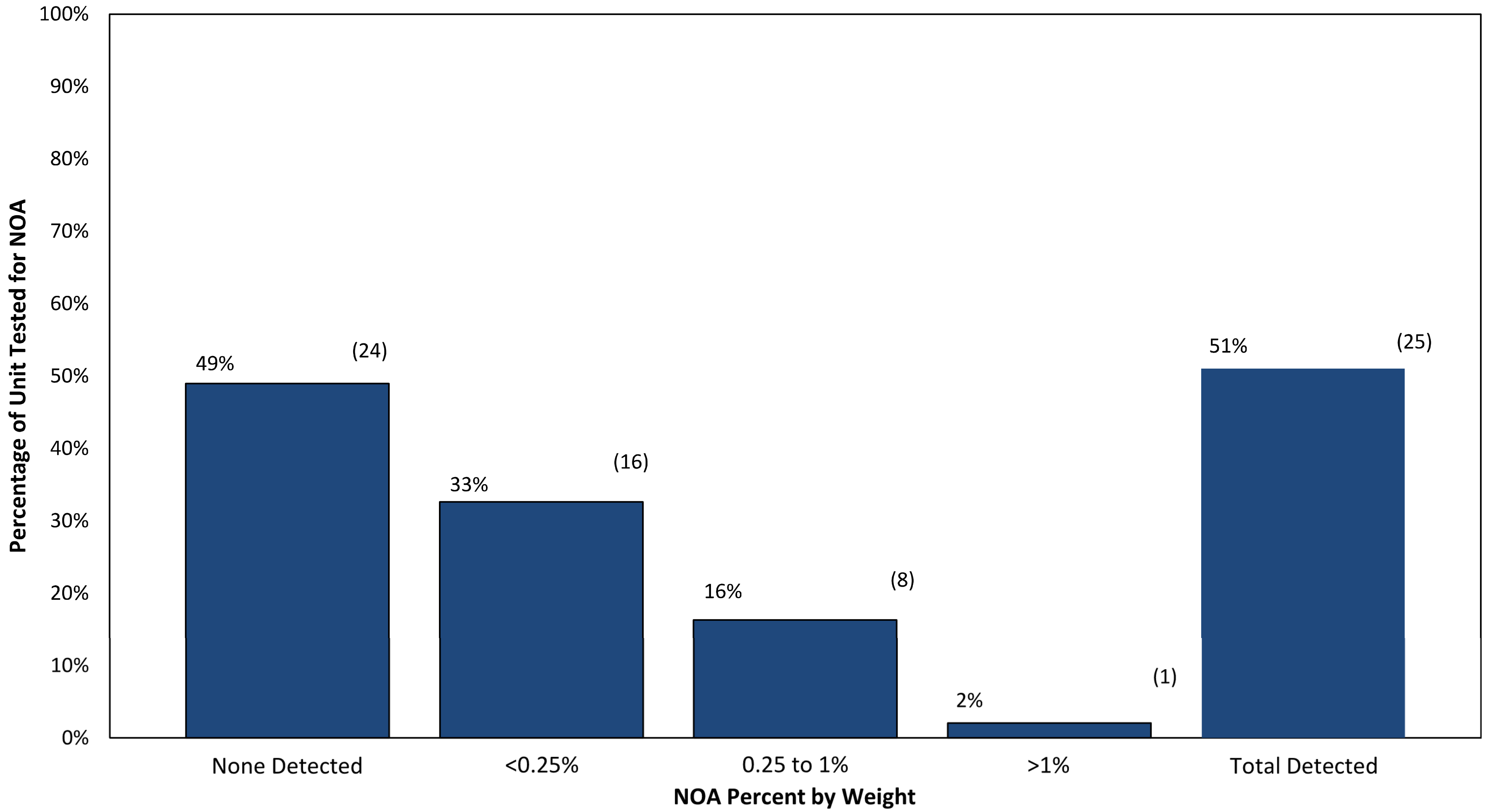
NOA Content for Geologic Units Combined

Interstate 11 – Boulder City Bypass Phase 2 Design Build Project
Geologic Evaluation, Sampling, and Testing for Naturally Occurring Asbestos
Boulder City, Clark County, Nevada

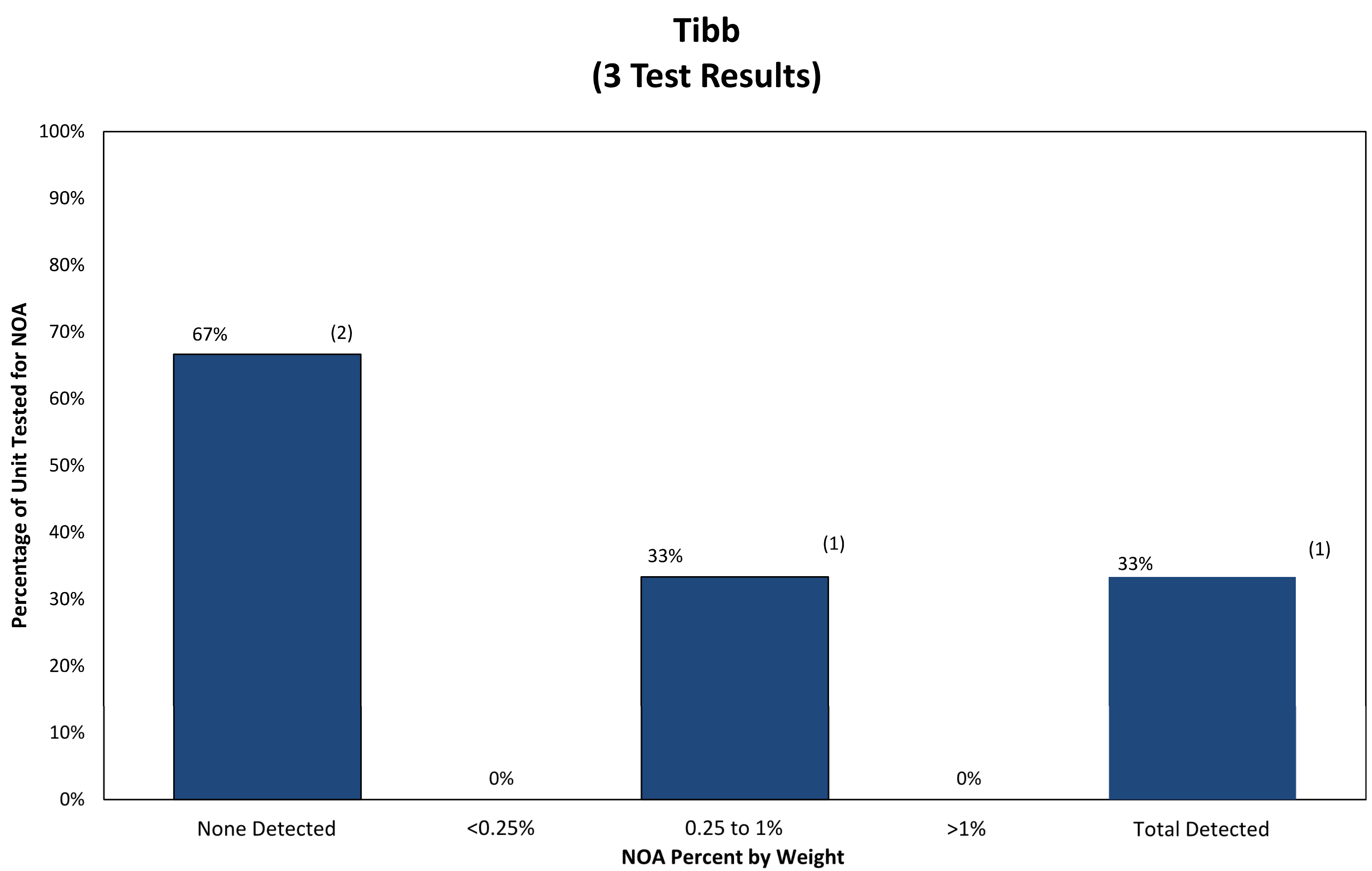
GRAPH

6

Tib
(49 Test Results)



KLEINFELDER Bright People. Right Solutions.	PROJECT NO: 137120 DRAWN BY: MB CHECKED BY: JLS DATE: 7/15/2014 REVISED: 7/28/2014	NOA Content for Geologic Units Combined Interstate 11 – Boulder City Bypass Phase 2 Design Build Project Geologic Evaluation, Sampling, and Testing for Naturally Occurring Asbestos Boulder City, Clark County, Nevada	GRAPH 7



PROJECT NO: 137120	NOA Content for Geologic Units Combined	GRAPH
DRAWN BY: MB CHECKED BY: JLS DATE: 7/15/2014 REVISED: 7/28/2014	Interstate 11 – Boulder City Bypass Phase 2 Design Build Project Geologic Evaluation, Sampling, and Testing for Naturally Occurring Asbestos Boulder City, Clark County, Nevada	8

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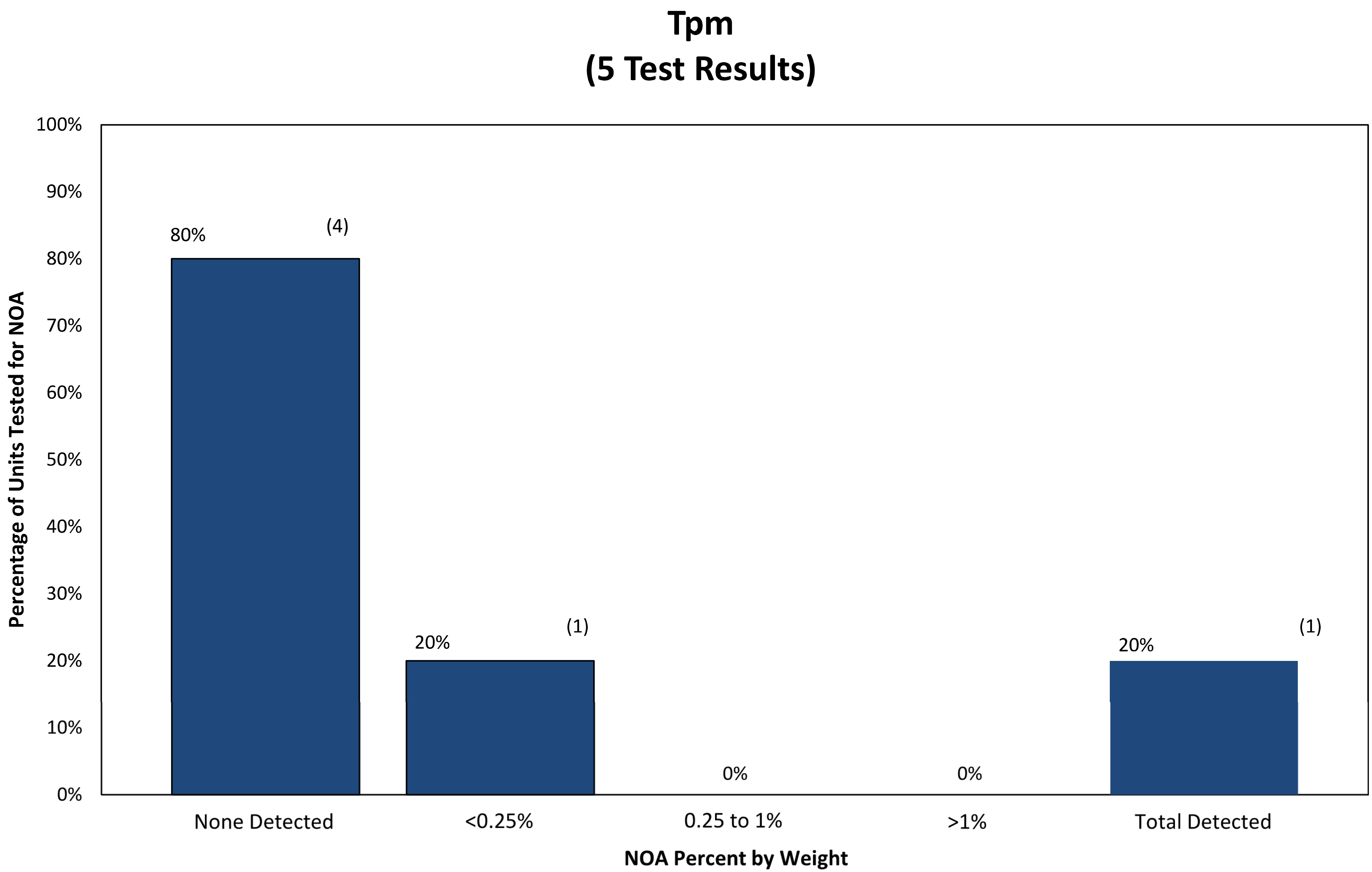
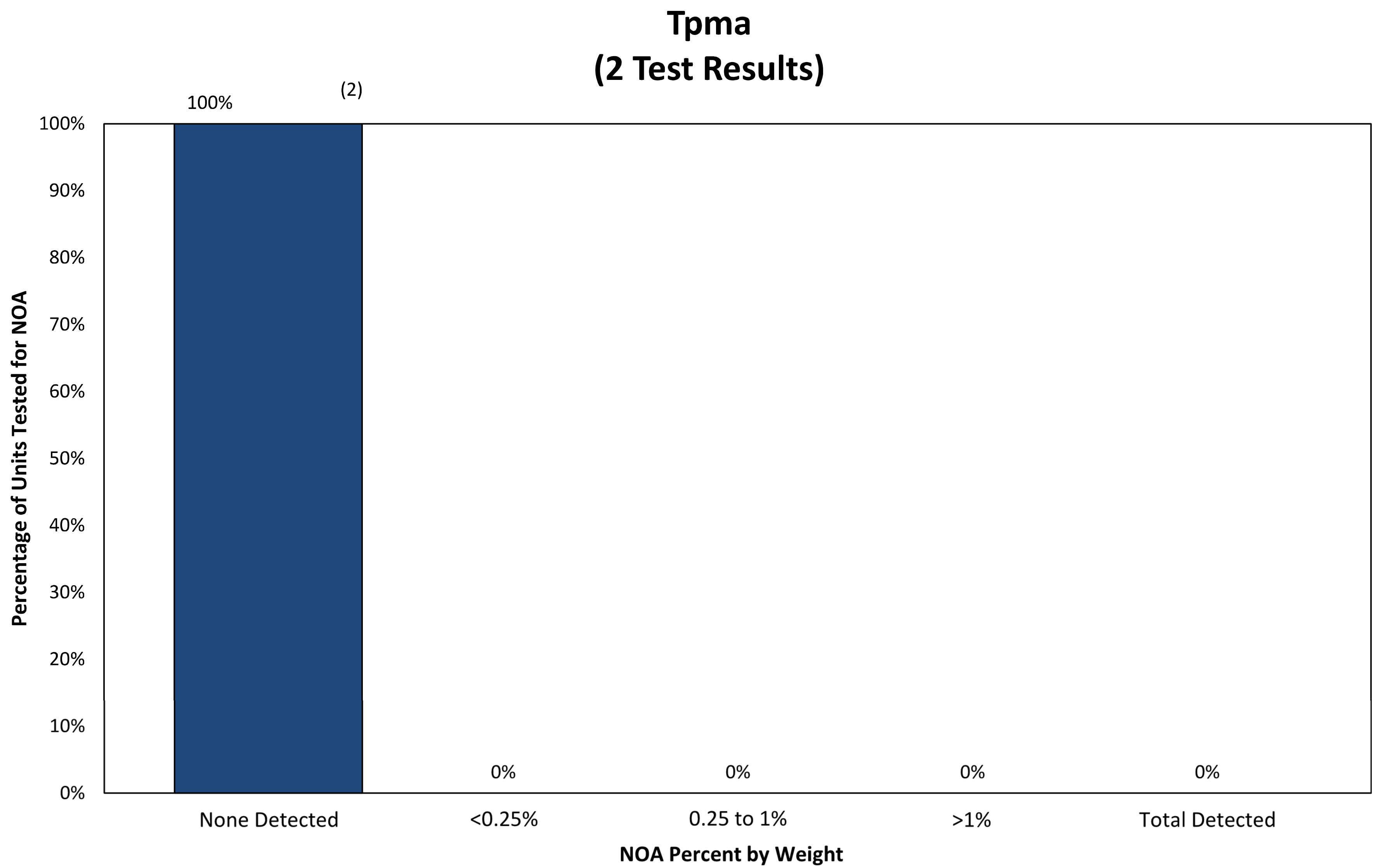
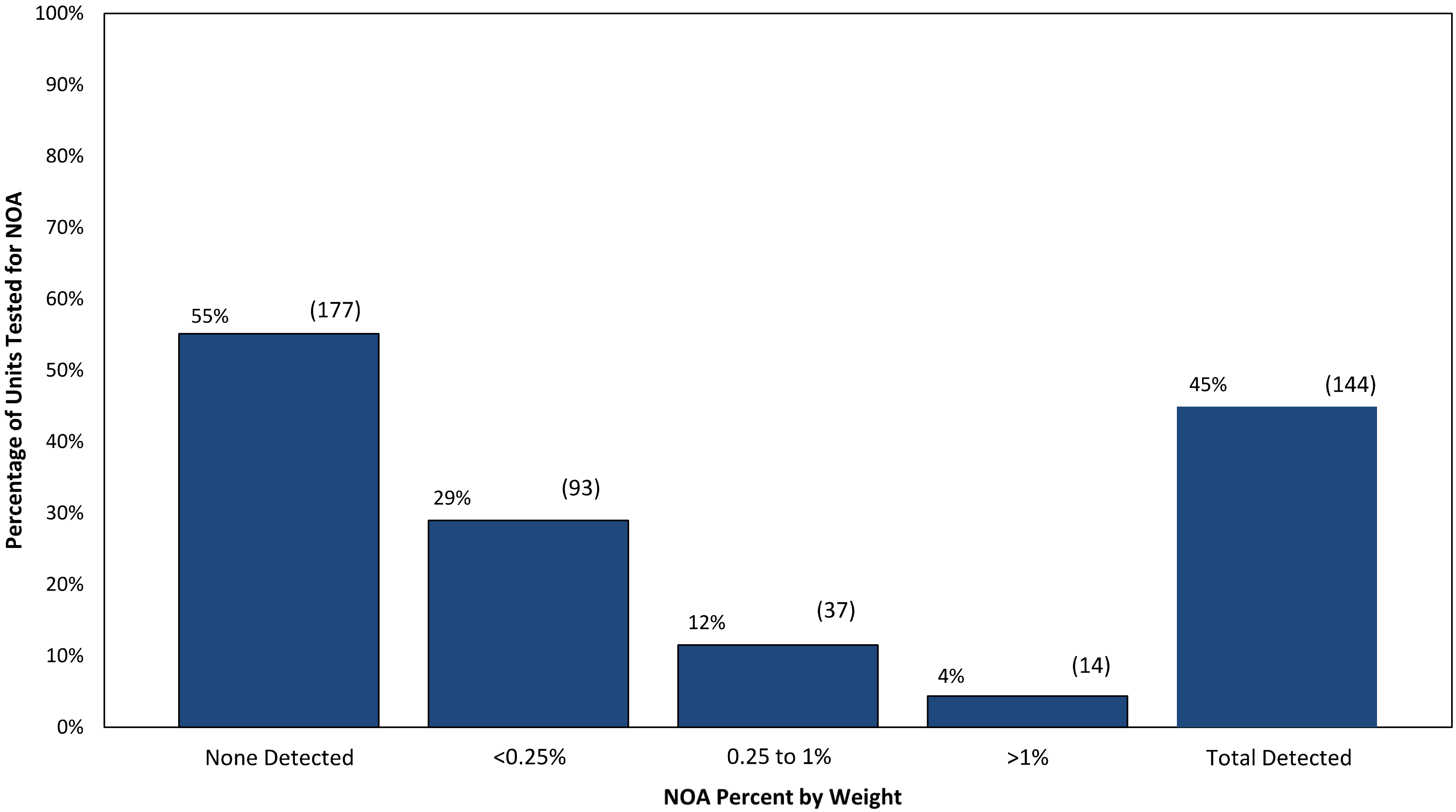


KLEINFELDER Bright People. Right Solutions.	PROJECT NO: 137120 DRAWN BY: MB CHECKED BY: JLS DATE: 7/15/2014 REVISED: 7/28/2014	NOA Content for Geologic Units Combined Interstate 11 – Boulder City Bypass Phase 2 Design Build Project Geologic Evaluation, Sampling, and Testing for Naturally Occurring Asbestos Boulder City, Clark County, Nevada	GRAPH 9



KLEINFELDER Bright People. Right Solutions.	PROJECT NO: 137120 DRAWN BY: MB CHECKED BY: JLS DATE: 7/15/2014 REVISED: 7/28/2014	NOA Content for Geologic Units Combined Interstate 11 – Boulder City Bypass Phase 2 Design Build Project Geologic Evaluation, Sampling, and Testing for Naturally Occurring Asbestos Boulder City, Clark County, Nevada	GRAPH 10

TEM Data Set Geologic Units Combined
(321 Test Results)



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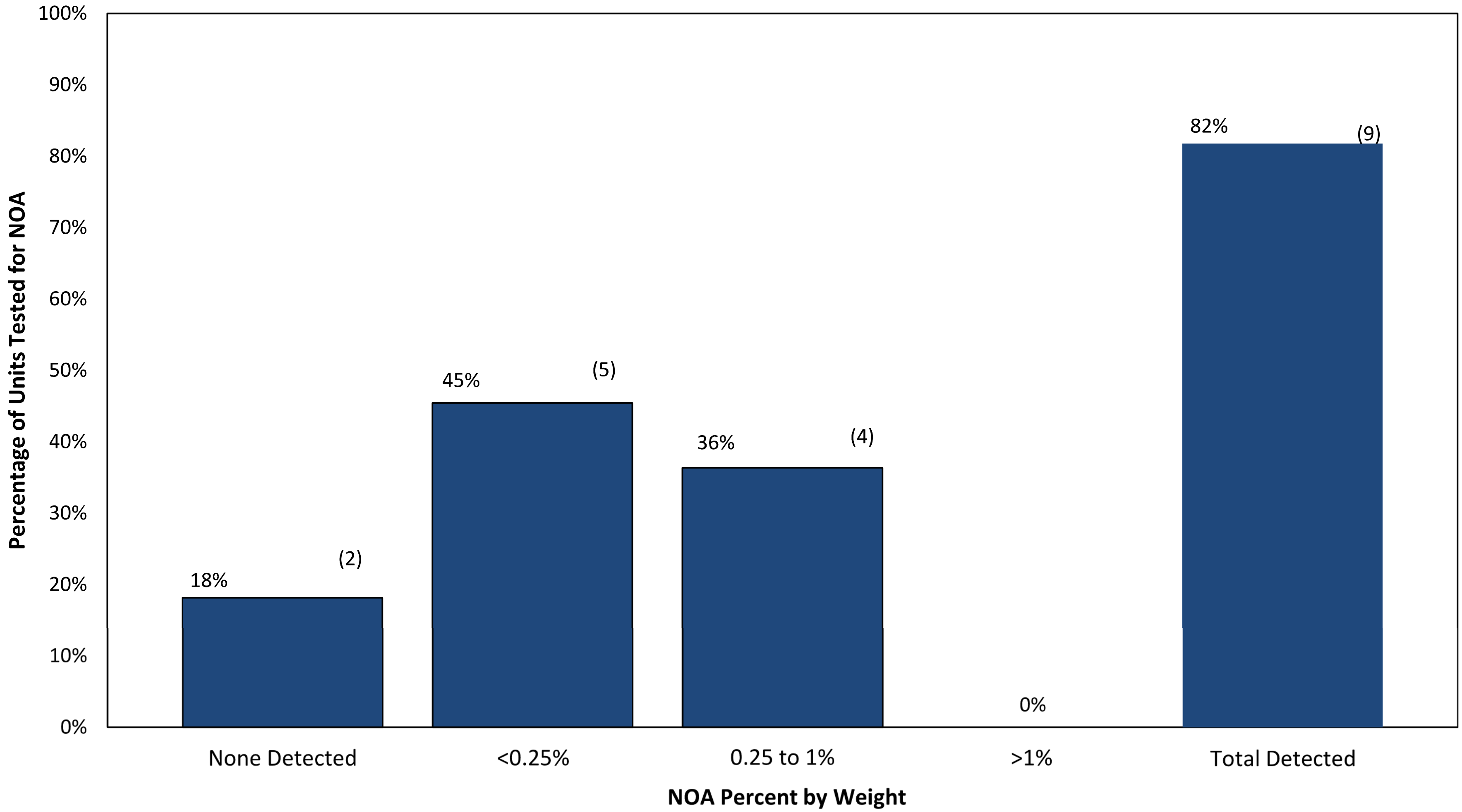
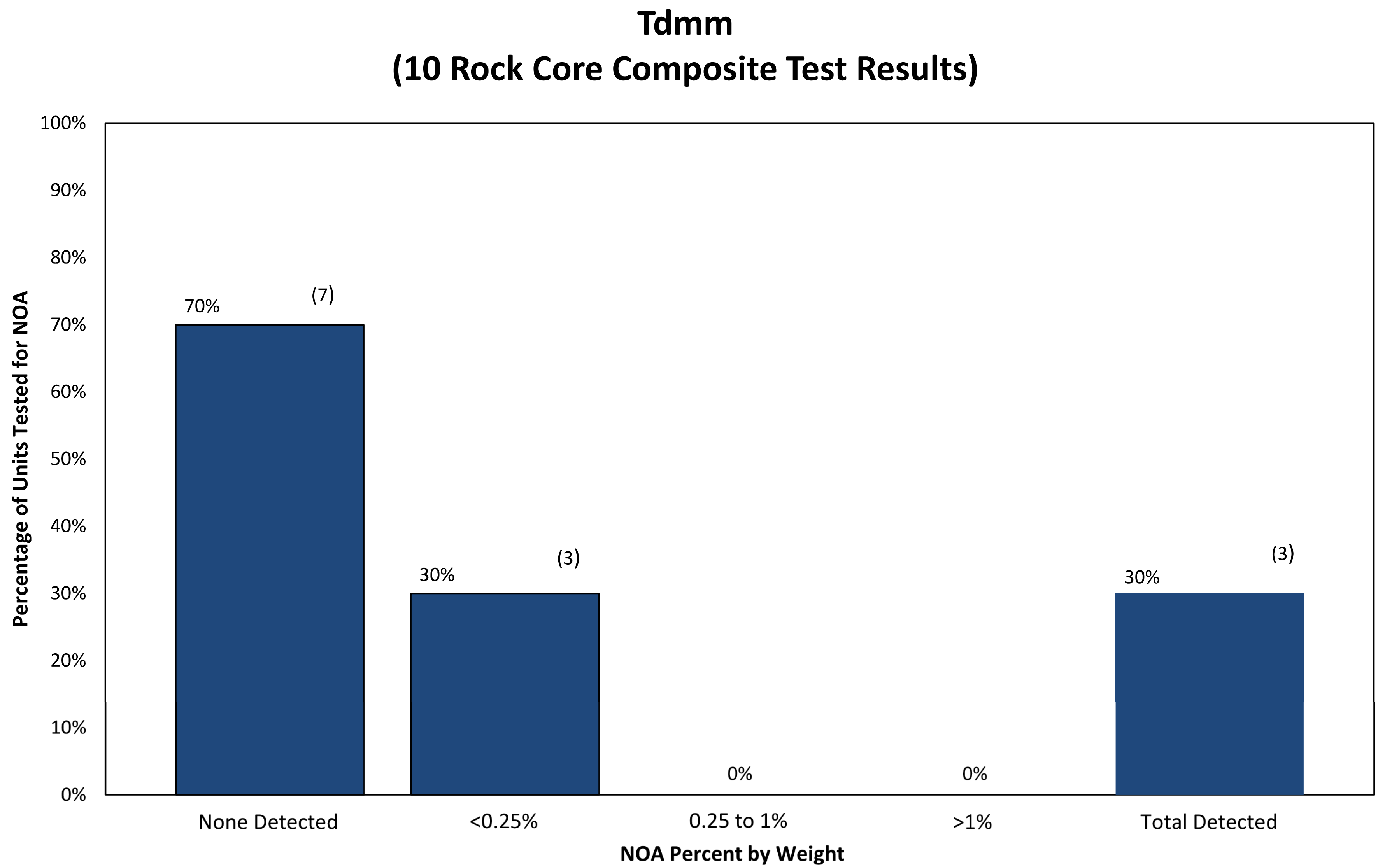
PROJECT NO:	137120	NOA Content for Geologic Units Combined	GRAPH
DRAWN BY:	MB	Interstate 11 – Boulder City Bypass Phase 2 Design Build Project Geologic Evaluation, Sampling, and Testing for Naturally Occurring Asbestos Boulder City, Clark County, Nevada	**11**
CHECKED BY:	JLS		
DATE:	7/15/2014		
REVISED:	7/28/2014		

Tsmo
(11 Rock Core Composite Test Results)

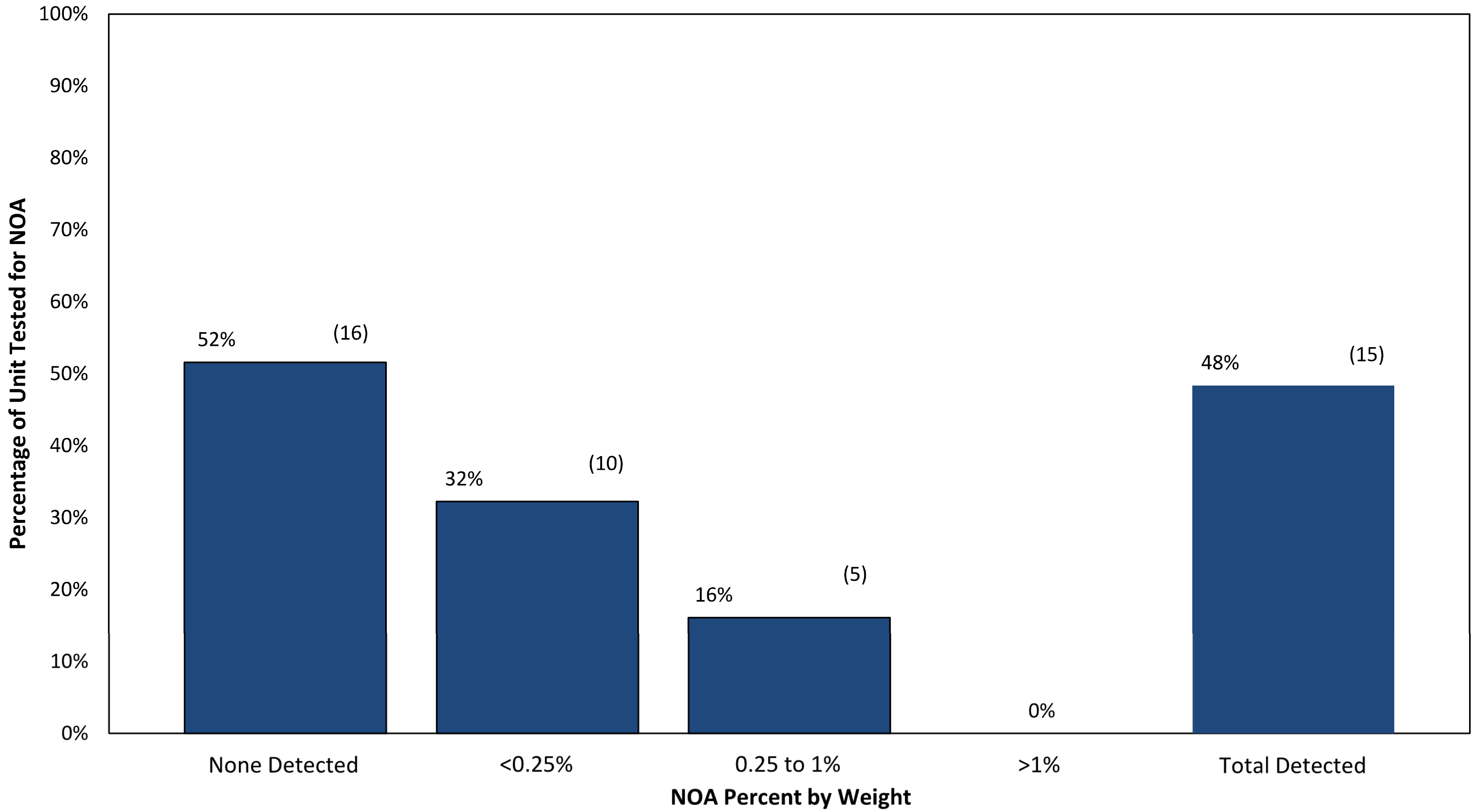


KLEINFELDER *Bright People. Right Solutions.*	PROJECT NO: 137120 DRAWN BY: MB CHECKED BY: JLS DATE: 7/15/2014 REVISED: 7/28/2014	NOA Content for Geologic Units Combined Interstate 11 – Boulder City Bypass Phase 2 Design Build Project Geologic Evaluation, Sampling, and Testing for Naturally Occurring Asbestos Boulder City, Clark County, Nevada	GRAPH **12**

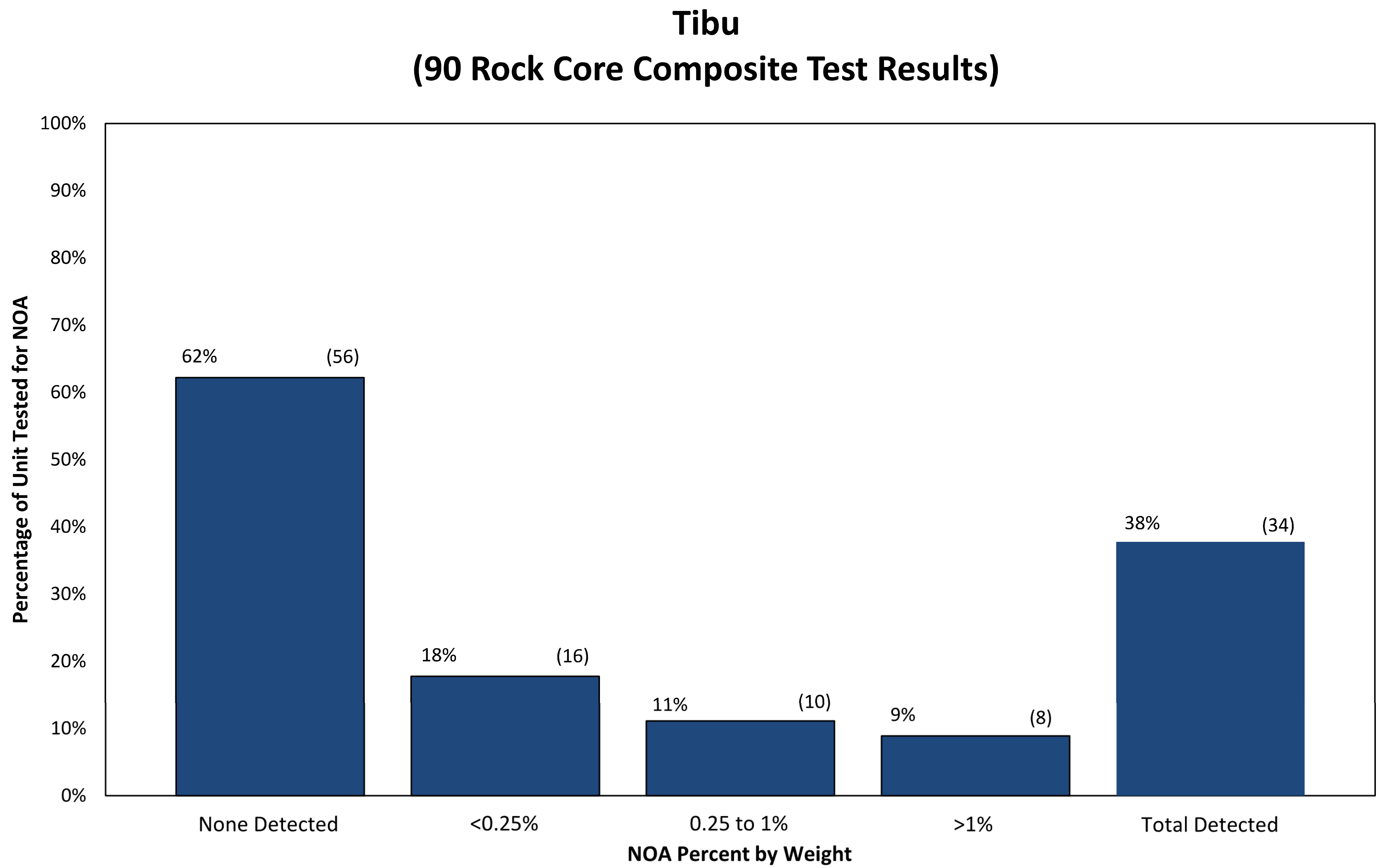


KLEINFELDER Bright People. Right Solutions.	PROJECT NO: 137120 DRAWN BY: MB CHECKED BY: JLS DATE: 7/15/2014 REVISED: 7/28/2014	NOA Content for Geologic Units Combined Interstate 11 – Boulder City Bypass Phase 2 Design Build Project Geologic Evaluation, Sampling, and Testing for Naturally Occurring Asbestos Boulder City, Clark County, Nevada	GRAPH **13**

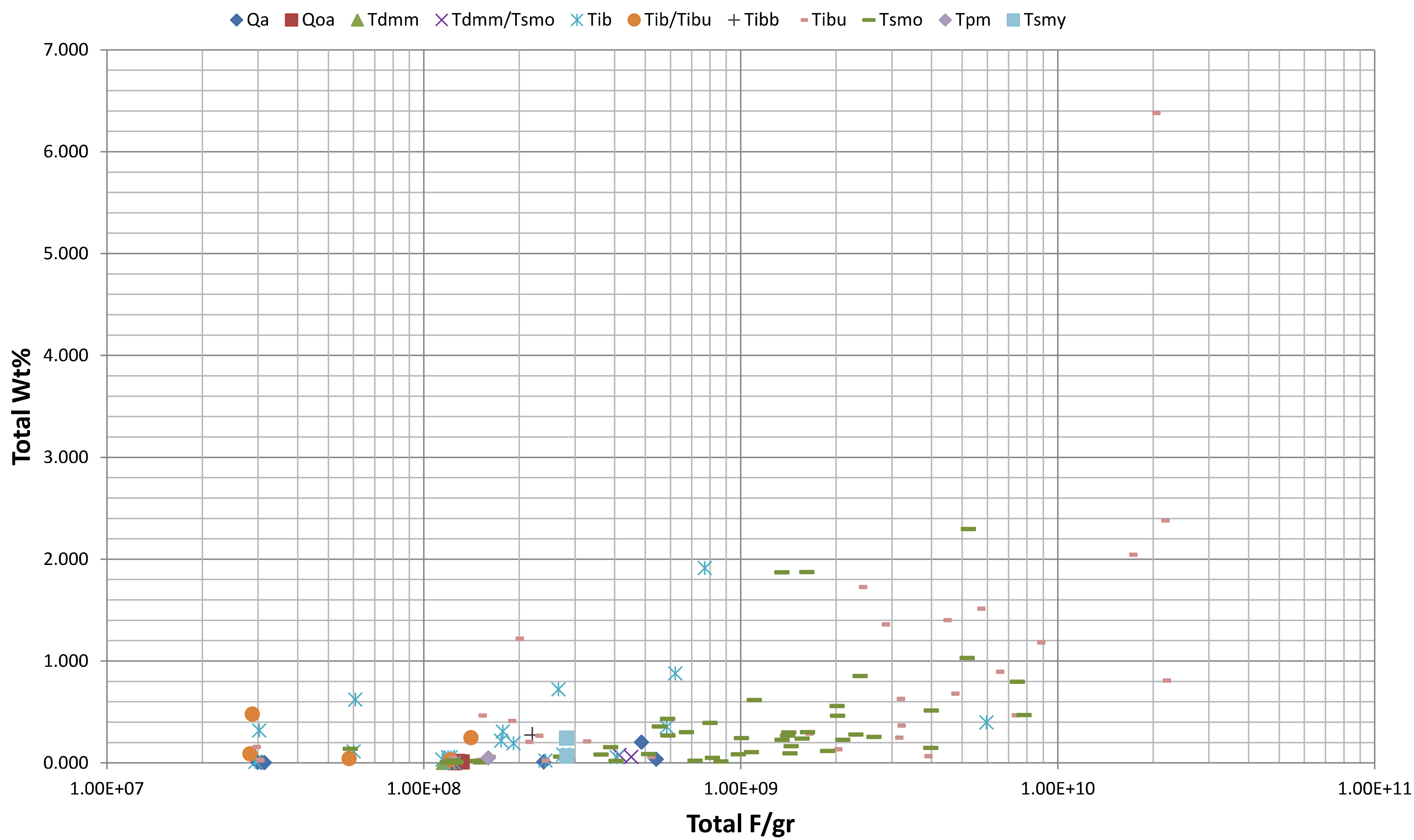
Tib
(31 Rock Core Composite Test Results)



KLEINFELDER Bright People. Right Solutions.	PROJECT NO: 137120 DRAWN BY: MB CHECKED BY: JLS DATE: 7/15/2014 REVISED: 7/28/2014	NOA Content for Geologic Units Combined Interstate 11 – Boulder City Bypass Phase 2 Design Build Project Geologic Evaluation, Sampling, and Testing for Naturally Occurring Asbestos Boulder City, Clark County, Nevada	GRAPH **14**



KLEINFELDER Bright People. Right Solutions.	PROJECT NO: 137120 DRAWN BY: MB CHECKED BY: JLS DATE: 7/15/2014 REVISED: 7/28/2014	NOA Content for Geologic Units Combined Interstate 11 – Boulder City Bypass Phase 2 Design Build Project Geologic Evaluation, Sampling, and Testing for Naturally Occurring Asbestos Boulder City, Clark County, Nevada	GRAPH **15**



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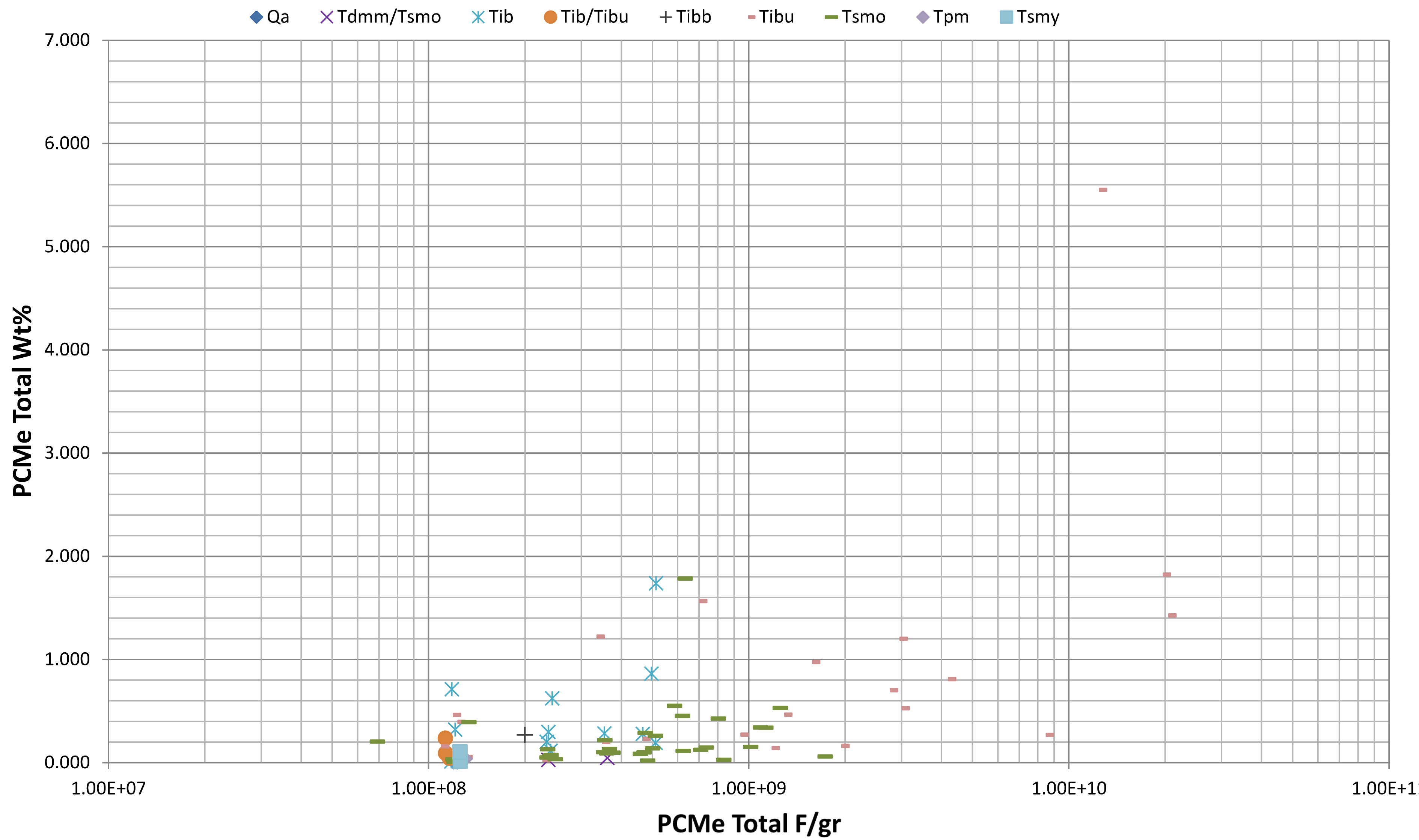
CARB / AHERA - Weight Percent versus Fibers/Grams

Interstate 11 – Boulder City Bypass Phase 2 Design Build Project
Geologic Evaluation, Sampling, and Testing for Naturally Occurring Asbestos
Boulder City, Clark County, Nevada

GRAPH

16



KLEINFELDER Bright People. Right Solutions.	PROJECT NO: 137120 DRAWN BY: MB CHECKED BY: JLS DATE: 7/15/2014 REVISED: 7/28/2014	PCMe - Weight Percent versus Fibers/Grams Interstate 11 – Boulder City Bypass Phase 2 Design Build Project Geologic Evaluation, Sampling, and Testing for Naturally Occurring Asbestos Boulder City, Clark County, Nevada	GRAPH 17

APPENDIX A

NOA SAMPLE AND TEST SUMMARY - TEM TEST RESULTS
INTERSTATE 11 - DESIGN BUILD
BOULDER CITY BYPASS PHASE 2
BOULDER CITY, NEVADA

Sample No.	Station	Offset	Sample Name	Depth (feet)	Geologic Unit	Sample Type	Total Wt (percent)	PCMe Total Wt (percent)	Total F/gr	PCMe Total F/gr
1	P 185+45	30' RT	TI-1	0-5	Fill	Composite from Test Pit, Water Decon	--	--	--	--
2	P 186+40	20' RT	TI-2	0-5	Fill/Qoa	Composite from Test Pit, Water Decon	--	--	--	--
3	P 187+65	40' RT	Qoa1-1	0-5	Qoa	Composite from Test Pit, Water Decon	0.014	--	1.28E+08	--
4	P 189+30	30' RT	Qoa1-2	0-5	Qoa	Composite from Test Pit, Water Decon	--	--	--	--
5	P 193+25	30' RT	Qoa1-3	0-5	Qoa	Composite from Test Pit, Water Decon	--	--	--	--
6	P 196+10	35' RT	Qoa1-4	0-5	Qoa	Composite from Test Pit, Water Decon	--	--	--	--
7	P 198+80	35' RT	TSMY-1	0-3	Tsmy	Composite from Test Pit, Water Decon	--	--	--	--
8	P 199+80	30' RT	TSMY-2	0-4	Tsmy	Composite from Test Pit, Water Decon	0.244	0.100	2.82E+08	1.25E+08
9	P 201+15	35' RT	TSMY-3	0-2 1/2	Tsmy	Composite from Test Pit, Water Decon	0.066	0.013	2.83E+08	1.26E+08
10	P 202+00	0	Qoa2-1	0-1/2	Qoa	Surficial Obtained With Shovel, Water Decon	--	--	--	--
11	P 207+10	10' RT	Qoa2-2	0-1/2	Qoa	Surficial Obtained With Shovel, Water Decon	--	--	--	--
12	P 210+85	0	Qoa2-3	0-1/2	Qoa	Surficial Obtained With Shovel, Water Decon	--	--	--	--
13	P 213+85	0	Qoa2-4	0-1/2	Qoa	Surficial Obtained With Shovel, Water Decon	--	--	--	--
14	P 214+65	69' RT	95B-1	0-5	Qoa	Auger Cuttings	--	--	--	--
15	P 216+43	315' LT	R- 1	0-5	Qa	Auger Cuttings	--	--	--	--
16	P 216+65	65' LT	95B-2	0-5	Qoa	Auger Cuttings	0.002	--	1.25E+08	--
17	P 218+48	420' RT	R- 5	0-5	Qoa	Auger Cuttings	--	--	--	--
18	P 221+30	234' LT	R- 2	0-5	Qa	Auger Cuttings	0.012	--	1.22E+08	--
19	P 222+41	218' RT	R- 6	0-5	Qoa	Auger Cuttings	--	--	--	--
20	P 227+00	0	R- 7	0-5	Qa	Auger Cuttings	--	N/A	--	N/A
21	P 232+11	57' LT	R- 4	0-5	Qa	Auger Cuttings	--	--	--	--
22	P 235+15	55'LT	235+15, 55'LT	0-1/2	Qa	Surficial Obtained With Shovel	0.204	--	4.87E+08	--
23	P 237+60	0	R- 9	0-5	Qa	Auger Cuttings	--	--	--	--
24	P 243+61	0	R- 9A	0-5	Qa	Auger Cuttings	--	--	--	--
25	P 249+20	0	R- 10	0-5	Qa	Auger Cuttings	--	--	--	--
26	P 253+10	0	253+10	0-1/2	Qa	Surficial Obtained With Shovel	0.005	0.005	3.00E+07	1.20E+08
27	P 255+80	0	R- 11	0-5	Qa	Auger Cuttings	--	--	--	--
28	P 262+00	0	R- 12	0-5	Qoa	Auger Cuttings	--	--	--	--
29	P 274+00	0	R- 14	0-5	Qoa	Auger Cuttings	--	--	--	--
30	P 285+00	0	R- 16	0-5	Qoa	Auger Cuttings	--	--	--	--
31	P 297+00	0	R- 18	0-5	Qoa	Auger Cuttings	--	--	--	--
32	P 307+00	0	R- 19	0-5	Qoa	Auger Cuttings	--	N/A	--	N/A
33	P 313+50	0	R- 20	0-5	Qoa	Auger Cuttings	--	--	--	--
34	P 325+80	0	R- 22	0-5	Qoa	Auger Cuttings	--	--	--	--
35	P 335+70	0	R- 23	0-5	Qoa	Auger Cuttings	--	--	--	--
36	P 345+75	0	R- 25	0-5	Qoa	Auger Cuttings	--	--	--	--
37	P 358+95	0	R- 27	0-5	Qoa	Auger Cuttings	--	--	--	--
38	P 367+00	0	R- 29	0-5	Qoa	Auger Cuttings	0.010	N/A	1.32E+08	N/A
39	P 367+00	0	R- 30	0-5	Qoa	Auger Cuttings	--	--	--	--
40	P 382+50	0	R- 32	0-5	Qa	Auger Cuttings	0.035	0.018	5.41E+08	1.27E+08
41	P 389+40	0	R- 33	0-5	Qa	Auger Cuttings	0.008	--	2.39E+08	--
42	P 395+00	0	R- 34	0-5	Qa	Auger Cuttings	0.004	--	1.23E+08	--
43	P 400+20	0	R- 35	0-5	Qa	Auger Cuttings	0.004	--	1.23E+08	--
44	P 404+50	0	R- 36	0-5	Qa	Auger Cuttings	--	--	--	--
45	P 409+40	60' RT	WPB-2	0-5	Qa	Auger Cuttings	--	N/A	--	N/A
46	P 411+10	60' RT	WPB-4	0-5	Qa	Auger Cuttings	--	--	--	--
47	P 417+50	0	R- 37	0-5	Qa	Auger Cuttings	0.005	--	1.29E+08	--
48	P 422+80	0	R- 38	0-5	Qa	Auger Cuttings	0.005	0.005	3.07E+07	1.23E+08
49	P 427+50	0	R- 39	0-5	Qa	Auger Cuttings	--	--	--	--
50	P 433+10	0	R- 40	0-5	Qa	Auger Cuttings	--	--	--	--
51	P 440+25	0	R- 41	0-5	Qoa	Auger Cuttings	--	--	--	--
52	P 445+00	0	R- 42	0-5	Qoa	Auger Cuttings	--	--	--	--
53	P 452+00	0	R- 43	0-5	Qa	Auger Cuttings	0.005	0.005	3.08E+07	1.23E+08
54	P 457+60	0	R- 44	0-5	Qoa	Auger Cuttings	0.002	--	1.25E+08	--
55	P 463+60	0	R- 45	0-5	Qoa	Auger Cuttings	--	N/A	--	N/A
56	P 467+00	0	R- 46	0-5	Qoa	Auger Cuttings	0.006	--	1.21E+08	--
57	P 474+70	0	R- 47	0-5	Qoa	Auger Cuttings	--	--	--	--
58	P 480+08	7' LT	R- 48	0-5	Qoa	Auger Cuttings	--	--	--	--
59	P 480+90	0	480 + 90	0-1/2	Qoa	Surficial Obtained With Shovel	--	--	--	--
60	P 485+20	0	R- 49	0-5	Qoa	Auger Cuttings	--	--	--	--
61	P 488+51	27' RT	RW-1	0-5	Qoa	Auger Cuttings	--	--	--	--
62a	P 497+80	45' LT	497+80, 45' LT	0-1/2	Qoa	Surficial Obtained With Shovel	--	--	--	--
62b	P 497+80	45' LT	497+80, 45' LT	0-1/2	Qoa	Surficial Obtained With Shovel	--	--	--	--
63	P 501+00	0	R- 50	0-5	Qoa	Auger Cuttings	--	--	--	--
64	P 505+39	18' LT	R- 51	0-5	Qoa	Auger Cuttings	--	--	--	--
65	P 511+00	0	R- 52	0-5	Qoa	Auger Cuttings	--	--	--	--
66	P 519+90	75' LT	519+90, 75' LT	0-1/2	Qoa	Surficial Obtained With Shovel	--	--	--	--

- PLM testing also performed following 3 sample preparation techniques

- PLM testing also performed following Phase 1 sample preparation techniques

"--" - Asbestos not detected to level of analytical sensitivity

N/A PCMe calculation cannot be performed with available data

NOA SAMPLE AND TEST SUMMARY - TEM TEST RESULTS
INTERSTATE 11 - DESIGN BUILD
BOULDER CITY BYPASS PHASE 2
BOULDER CITY, NEVADA

Sample No.	Station	Offset	Sample Name	Depth (feet)	Geologic Unit	Sample Type	Total Wt (percent)	PCMe Total Wt (percent)	Total F/gr	PCMe Total F/gr
67	P 522+00	0	R- 53	0-5	Qoa	Auger Cuttings	--	--	--	--
68	P 528+40	0	R- 54	0-5	Qoa	Auger Cuttings	--	N/A	--	N/A
69	P 534+00	0	R- 55	0-5	Qoa	Auger Cuttings	--	--	--	--
70	P 537+90	10' LT	537+90, 10' LT	0-1/2	Qoa	Surficial Obtained With Shovel	--	--	--	--
71	P 544+10	0	R- 56	0-5	Tsmo	Auger Cuttings	--	--	--	--
72	P 555+00	0	R- 57	0-5	Tsmo	Auger Cuttings	--	--	--	--
73	P 559+90	60' RT	BSCB-1A	0-5	Tsmo	Auger Cuttings	0.020	--	1.24E+08	--
74	P 560+70	60' LT	BSCB-1	0-5	Tsmo	Auger Cuttings	--	--	--	--
75	P 560+91	61' RT	BSCB-2	0-5	Tsmo	Auger Cuttings	--	--	--	--
76	P 561+74	71' LT	BSCB-2A	0-5	Tsmo	Auger Cuttings	0.008	--	1.53E+08	--
77	P 563+50	0	R- 58	0-5	Qa	Auger Cuttings	--	--	--	--
78	P 566+25	0	566+25	0-1/2	Qa	Surficial Obtained With Shovel, Water Decon	0.002	--	3.15E+07	--
79	P 570+00	0	570+00	0-1/2	Qa	Surficial Obtained With Shovel, Water Decon	--	--	--	--
80	P 575+26	7' LT	R- 59	0-5	Tsmo	Auger Cuttings	--	--	--	--
81	P 581+10	0	R- 60	0-5	Tsmo	Auger Cuttings	--	N/A	--	N/A
82	P 588+60	0	R- 62	0-5	Tsmo	Auger Cuttings	0.023	--	1.23E+08	--
83	P 596+70	60' LT	R- 63	0-5	Tsmo	Auger Cuttings	0.004	--	1.19E+08	--
84	P 597+10	110' LT	TSB-13	Surficial	Tsmo	Surficial Rock	0.001	--	1.26E+08	--
85	P 608+22	0	R- 65	0-5	Tsmo	Auger Cuttings	--	--	--	--
86	P 612+70	30' LT	R- 66	0-5	Tsmo	Auger Cuttings	0.022	--	7.18E+08	--
87	P 616+00	0	R- 67	0-5	Tsmo	Auger Cuttings	0.005	--	1.25E+08	--
88	P 618+25	60' LT	R- 69	0-5	Tsmo	Auger Cuttings	0.001	--	1.20E+08	--
89	P 619+25	90' LT	TSB-14	Surficial	Tsmo	Surficial Rock	0.009	--	1.27E+08	--
90	P 623+70	10' RT	TSB-9	Surficial	Tsmo	Surficial Rock	0.092	0.046	1.43E+09	2.49E+08
91	P 625+68	50' LT	R- 70	0-10	Tsmo	Auger Cuttings	--	--	--	--
92	P 631+54	17' LT	R- 71	0-5	Tsmo	Auger Cuttings	0.358	N/A	5.54E+08	N/A
93	P 637+00	60' LT	R- 72	0-5	Tsmo	Auger Cuttings	0.004	0.003	1.51E+08	1.21E+08
94	P 637+00	60' LT	R- 72	16.5-16.9	Tsmo	Rock Core	0.461	0.339	2.02E+09	4.76E+08
95	P 645+39	17' LT	R- 74	0-5	Tsmo	Auger Cuttings	0.001	--	1.20E+08	--
96	P 645+39	17' LT	R- 74	15.9-16.4	Tsmo	Rock Core	0.117	0.025	1.88E+09	2.39E+08
97	P 650+00	440' LT	WAPA-4e-1	Surficial	Tsmo	Surficial Rock Composite, Water Decon	1.871	1.780	1.35E+09	5.87E+08
98	P 650+92	148' LT	R- 75	0-5	Tsmo	Auger Cuttings	0.278	--	2.31E+09	--
99	P 650+92	148' LT	R- 75	42.8-43.1	Tsmo	Rock Core	1.029	0.450	5.18E+09	1.26E+09
100	P 655+80	135' RT	TSB-6	Surficial	Tsmo	Surficial Rock	0.302	0.214	6.75E+08	3.52E+08
101	P 657+70	80' LT	R- 76A	0-5	Tsmo	Auger Cuttings	0.432	0.335	5.89E+08	4.71E+08
102	P 657+70	80' LT	R- 76A	6.2-6.6	Tsmo	Rock Core	0.153	0.143	3.88E+08	8.37E+08
103	P 662+09	35' LT	R- 77	0-5	Tsmo	Auger Cuttings	0.227	0.093	2.10E+09	3.60E+08
104	P 662+09	35' LT	R- 77	19.8-20.3	Tsmo	Rock Core	0.514	0.389	4.00E+09	1.09E+09
105	P 663+50	145' RT	WAPA-3e-4	Surficial	Tsmo	Surficial Rock Composite, Water Decon	0.298	0.098	1.42E+09	7.09E+08
106	P 664+70	170' LT	WAPA-4/3a	Surficial	Tsmo	Surficial Rock Composite, Water Decon	0.225	0.128	1.35E+09	7.37E+08
107	P 666+65	450' RT	WAPA-4/4	Surficial	Tsmo	Surficial Rock Composite, Water Decon	0.084	0.031	9.83E+08	1.19E+08
108	P 668+10	24' LT	R- 78	0-5	Tsmo	Auger Cuttings	0.164	0.086	1.44E+09	5.02E+08
109	P 672+00	50' LT	ITB-1	0-5	Tsmo	Auger Cuttings	0.557	0.055	2.01E+09	5.11E+08
110	P 672+61	204' LT	R- 79	0-5	Tsmo	Auger Cuttings	0.615	0.425	1.10E+09	1.34E+08
111	P 672+61	204' LT	R- 79	8.6-9.0	Tsmo	Rock Core	2.295	N/A	5.23E+09	N/A
112	P1 673+72	36' RT	ITB-4	0-5	Tsmo	Auger Cuttings	0.049	--	8.15E+08	--
113	P1 673+79	182' RT	R- 80	0-5	Tsmo	Auger Cuttings	0.243	0.082	1.01E+09	3.77E+08
114	P1 673+79	182' RT	R- 80	36.1-36.5	Tsmo	Rock Core	1.873	1.670	1.62E+09	6.22E+08
115	P1 678+20	60' RT	TSB-5	Surficial	Tsmo	Surficial Rock	0.147	--	3.98E+09	--
116	P1 678+24	74' LT	R- 81	0-5	Tsmo	Auger Cuttings	0.238	0.150	1.56E+09	3.67E+08
117	P1 678+24	74' LT	R- 81	10.0-31.0	Tsmo	Rock Core Composite	0.853	0.547	2.38E+09	8.04E+08
118	P1 678+24	74' LT	R- 81	16.8-17.4	Tsmo	Rock Core	0.082	0.070	3.63E+08	4.84E+08
119	P1 681+75	0	R- 82	0-5	Tsmo	Auger Cuttings	0.391	0.285	8.00E+08	3.56E+08
120	P1 681+75	0	R- 82	5.5-44	Tsmo	Rock Core Composite	0.300	0.201	1.62E+09	6.25E+08
121	P1 681+75	0	R- 82	42.3-42.8	Tsmo	Rock Core	0.105	--	1.08E+09	--
122	P1 683+75	70' LT	TSB-4	Surficial	Tdmm	Surficial Rock	--	--	--	--
123	P1 686+05	67' RT	R- 83A	0-10.6	Tdmm	Rock Core Composite	--	--	--	--
124	P1 686+05	67' RT	R- 83A	10.6-21.7	Tdmm	Rock Core Composite	--	--	--	--
125	P1 686+05	67' RT	R- 83A	21.7-45.0	Tdmm	Rock Core Composite	--	--	--	--
126	P1 686+05	67' RT	R- 83A	45.0-59.0	Tdmm	Rock Core Composite	--	--	--	--
127	P1 686+05	67' RT	R- 83A	54.5-55.0	Tdmm	Rock Core	--	--	--	--
128	P1 687+18	117' RT	P- 1	0.0-36.6	Tdmm	Rock Core Composite	0.004	--	1.16E+08	--
129	P1 687+18	117' RT	P- 1	36.6-65.5	Tdmm	Rock Core Composite	--	--	--	--
130	P1 689+00	110' LT	R- 84	0.0-12.8	Tdmm	Rock Core Composite	--	--	--	--
131	P1 689+00	110' LT	R- 84	9.4-10.0	Tdmm	Rock Core	--	--	--	--
132	P1 689+00	110' LT	R- 84	12.8-55.5	Tdmm	Rock Core Composite	--	--	--	--

(grey) - PLM testing also performed following 3 sample preparation techniques

(olive) - PLM testing also performed following Phase 1 sample preparation techniques

"--" - Asbestos not detected to level of analytical sensitivity

N/A PCMe calculation cannot be performed with available data

NOA SAMPLE AND TEST SUMMARY - TEM TEST RESULTS
INTERSTATE 11 - DESIGN BUILD
BOULDER CITY BYPASS PHASE 2
BOULDER CITY, NEVADA

Sample No.	Station	Offset	Sample Name	Depth (feet)	Geologic Unit	Sample Type	Total Wt (percent)	PCMe Total Wt (percent)	Total F/gr	PCMe Total F/gr
133	P1 689+00	110' LT	R- 84	55.0-92.1	*Tdmm/Tsmo	Rock Core Composite	0.077	0.024	4.15E+08	2.37E+08
134	P1 689+00	110' LT	R- 84	76.4-77.0	Tdmm	Rock Core	--	--	--	--
135	P1 689+00	110' LT	R- 84	85.0-85.5	Tsmo	Rock Core	0.795	0.526	7.47E+09	1.74E+09
136	P1 689+00	110' LT	R- 84	91.3-91.8	Tsmo	Rock Core	0.468	0.257	7.83E+09	1.13E+09
137	P1 695+82	99' LT	R- 85A	0.0-51.0	*Tdmm/Tsmo	Rock Core Composite	0.057	0.042	4.52E+08	3.61E+08
138	P1 695+82	99' LT	R- 85A	23.0-23.5	Tdmm	Rock Core	--	--	--	--
139	P1 701+30	75' LT	TSB-2	Surficial	Tsmo	Surficial Rock	--	--	--	--
140	P1 704+70	20' LT	R- 86	0.0-45.0	Tsmo	Rock Core Composite	0.268	0.110	5.89E+08	2.36E+08
141	P1 704+70	20' LT	R- 86	34.5-35.0	Tsmo	Rock Core	--	--	--	--
142	P1 709+35	35' RT	AS-2	0-1/2	Tsmo	Surficial Obtained With Shovel, Water Decon	--	--	--	--
143	P1 709+75	6' LT	R- 87-1	0-1/2	Tsmo	Surficial Obtained With Shovel, Water Decon	--	--	--	--
144	P1 709+75	6' LT	R- 87	2.5-52.0	Tsmo	Rock Core Composite	0.268	0.120	1.41E+09	4.59E+08
145	P1 709+75	6' LT	R- 87	46.8-47.4	Tsmo	Rock Core	0.254	0.126	2.63E+09	1.02E+09
146	P1 710+15	35' RT	AS-1	0-1/2	Tsmo	Surficial Obtained With Shovel, Water Decon	--	--	--	--
147	P1 712+24	145' LT	R- 88	9.5-50.0	Tsmo	Rock Core Composite	0.018	0.016	1.48E+08	1.18E+08
148	P1 712+24	145' LT	R- 88	19.2-19.7'	Tsmo	Rock Core	0.087	0.061	5.13E+08	2.41E+08
149	P1 712+24	145' LT	R- 88	50.0-85.0	Tsmo	Rock Core Composite	--	--	--	--
150	P1 712+24	145' LT	R- 88	71.1-71.6	Tsmo	Rock Core	0.013	--	8.68E+08	--
151	P1 713+26	171' RT	R- 89A	0.0-36.0	Tsmo	Rock Core Composite	0.059	0.028	2.70E+08	1.20E+08
152	P1 713+26	171' RT	R- 89A	36.0-96.0	Tsmo	Rock Core Composite	0.136	0.136	5.86E+07	2.35E+08
153	P1 716+75	46' LT	R- 90-1	0-1/2	Tib	Surficial Obtained With Shovel, Water Decon	--	--	--	--
154	P1 716+75	46' LT	R- 90	10.0-35.0	Tib	Rock Core Composite	--	--	--	--
155	P1 716+75	46' LT	R- 90	17.4-18.0	Tib	Rock Core	--	--	--	--
156	P1 716+75	46' LT	R- 90	35.0-66.0	Tib	Rock Core Composite	0.620	0.620	6.08E+07	2.43E+08
157	P1 716+75	46' LT	R- 90	50.0-50.5	Tib	Rock Core	0.055	0.009	4.07E+08	1.25E+08
158	P1 716+75	46' LT	R- 90	66.0-106.0	Tib	Rock Core Composite	0.217	0.199	1.76E+08	2.34E+08
159	P1 716+75	46' LT	R- 90	87.9-88.4	Tib	Rock Core	--	--	--	--
160	P1 716+75	46' LT	R- 90	106.0-146.0	**Tib/Tibu	Rock Core Composite	--	--	--	--
161	P1 716+75	46' LT	R- 90	123.5-124.2	Tib	Rock Core	0.082	--	2.76E+08	--
162	P1 716+93	218' RT	R- 91	12.0-36.5	Tsmo	Rock Core Composite	--	--	--	--
163	P1 716+93	218' RT	R- 91	22.3-22.8	Tsmo	Rock Core	0.019	--	4.05E+08	--
164	P1 716+93	218' RT	R- 91	36.5-81.5	Tib	Rock Core Composite	--	--	--	--
165	P1 716+93	218' RT	R- 91	67.7-68.3	Tib	Rock Core	--	--	--	--
166	P1 716+93	218' RT	R- 91	81.5-116.5	Tib	Rock Core Composite	--	--	--	--
167	P1 716+93	218' RT	R- 91	98.3-98.8	Tib	Rock Core	--	--	--	--
168	P1 716+93	213' LT	R- 92	15.0-66.0	Tib	Rock Core Composite	--	--	--	--
169	P1 716+93	213' LT	R- 92	31.9-32.4	Tib	Rock Core	0.192	0.188	1.92E+08	5.12E+08
170	P1 716+93	213' LT	R- 92	66.0-126.0	**Tib/Tibu	Rock Core Composite	--	--	0.00E+00	0.00E+00
171	P1 716+93	213' LT	R- 92	68.5-69.0	Tib	Rock Core	0.877	0.860	6.22E+08	4.97E+08
172	P1 716+93	213' LT	R- 92	102.8-103.3	Tibu	Rock Core	--	--	--	--
173	P1 716+93	213' LT	R- 92	126-139.5	Tibu	Rock Core Composite	0.464	0.460	1.50E+08	1.20E+08
174	P1 720+59	39' LT	P- 2	0-26.8	Tib	Rock Core Composite	0.309	0.295	1.78E+08	2.37E+08
175	P1 720+59	39' LT	P- 2	26.8-81.0	Tib	Rock Core Composite	0.318	0.318	3.03E+07	1.21E+08
176	P1 720+59	39' LT	P- 2	81.0-135.1	Tib	Rock Core Composite	0.003	--	1.21E+08	--
177	P1 720+59	39' LT	P- 2	135.1-170.2	Tib	Rock Core Composite	--	--	--	--
178	P1 720+59	39' LT	P- 2	170.2-205.3	**Tib/Tibu	Rock Core Composite	0.031	--	1.22E+08	--
179	P1 720+74	303' RT	R- 93	7.0-56.0	Tib	Rock Core Composite	--	--	--	--
180	P1 720+74	303' RT	R- 93	56.0-169.5	**Tib/Tibu	Rock Core Composite	--	--	--	--
181	P1 720+74	303' RT	R- 93	75.0-75.7	Tib	Rock Core	1.912	1.734	7.71E+08	5.14E+08
182	P1 720+74	303' RT	R- 93	134.6-135.0	Tib	Rock Core	--	--	--	--
183	P1 720+74	303' RT	R- 93	135.0-136.0	Tib	Rock Core	--	--	--	--
184	P1 720+74	303' RT	R- 93	169.5-190.0	Tibu	Rock Core Composite	--	--	--	--
185	P1 720+91	310' LT	R- 94	7.0-28.0	Tib	Rock Core Composite	0.722	0.709	2.66E+08	1.18E+08
186	P1 720+91	310' LT	R- 94	28.0-128.0	Tib	Rock Core Composite	--	--	--	--
187	P1 720+91	310' LT	R- 94	39.3-39.9	Tib	Rock Core	--	--	--	--
188	P1 720+91	310' LT	R- 94	40.0-40.5	Tib	Rock Core	0.397	0.281	5.96E+09	3.54E+08
189	P1 720+91	310' LT	R- 94	128.0-144.0	Tib	Rock Core Composite	0.022	--	2.42E+08	--
190	P1 720+91	310' LT	R- 94	140.4-140.9	Tib	Rock Core	0.053	--	1.22E+08	--
191	P1 720+91	310' LT	R- 94	144.0-204.0	Tib	Rock Core Composite	0.033	--	1.15E+08	--
192	P1 720+91	310' LT	R- 94	204.0-265.0	**Tib/Tibu	Rock Core Composite	0.041	0.039	5.82E+07	1.16E+08
193	P1 720+91	310' LT	R- 94	240.7-241.2	Tibu	Rock Core	--	--	--	--
194	P1 720+91	310' LT	R- 94	250.4-251.0	Tibu	Rock Core	0.050	--	1.20E+08	--
195	P1 723+22	354' RT	R- 95	2.5-29.0	Tib	Rock Core Composite	--	--	--	--
196	P1 723+22	354' RT	R- 95	29.0-103.0	Tib	Rock Core Composite	0.002	--	1.25E+08	--
197	P1 723+22	354' RT	R- 95	53.4-54.1	Tib	Rock Core	0.112	0.112	6.01E+07	2.41E+08
198	P1 723+22	354' RT	R- 95	103.0-207.0	**Tib/Tibu	Rock Core Composite	0.478	--	2.88E+07	--

- PLM testing also performed following 3 sample preparation techniques
- PLM testing also performed following Phase 1 sample preparation techniques

"--" - Asbestos not detected to level of analytical sensitivity

* Each Tdmm/Tsmo composite result was used twice, once to represent Tdmm and once to represent Tsmo.

** Each Tib/Tibu composite result was used twice, once to represent Tib and once to represent Tibu.

NOA SAMPLE AND TEST SUMMARY - TEM TEST RESULTS
INTERSTATE 11 - DESIGN BUILD
BOULDER CITY BYPASS PHASE 2
BOULDER CITY, NEVADA

Sample No.	Station	Offset	Sample Name	Depth (feet)	Geologic Unit	Sample Type	Total Wt (percent)	PCMe Total Wt (percent)	Total F/gr	PCMe Total F/gr
199	P1 723+22	354' RT	R- 95	112.5-113.0	Tib	Rock Core	0.055	--	1.19E+08	--
200	P1 723+22	354' RT	R- 95	184.5-227.0	Tibu	Rock Core Composite	--	--	--	--
201	P1 723+22	354' RT	R- 95	209.4-209.9	Tibu	Rock Core	0.024	0.024	2.98E+07	1.19E+08
202	P1 723+22	354' RT	R -95	227.0-249.0	Tibu	Rock Core Composite	0.006	0.005	1.50E+08	1.20E+08
203	P1 723+28	225' LT	R- 96A	0.0-17.0	Tib	Rock Core Composite	--	--	--	--
204	P1 723+23	161' LT	R- 96B	* 0.0-64.3	Tib	Rock Core Composite	--	--	--	--
205	P1 723+23	161' LT	R- 96B	56.5-57.2	Tib	Rock Core	0.352	0.276	5.84E+08	4.67E+08
206	P1 723+23	161' LT	R- 96B	64.3-115.0	**Tib/Tibu	Rock Core Composite	0.247	0.233	1.41E+08	1.13E+08
207	P1 723+23	161' LT	R- 96B	115.0-165.0	Tibu	Rock Core Composite	0.265	--	2.26E+08	--
208	P1 723+23	161' LT	R- 96B	147.2-147.8	Tibu	Rock Core	0.030	0.030	2.97E+07	1.19E+08
209	P1 723+86	167' RT	P- 3	0-50.2	Tib	Rock Core Composite	--	--	--	--
210	P1 723+86	167' RT	P- 3	50.2-93.2	Tib	Rock Core Composite	--	--	--	--
211	P1 723+86	167' RT	P- 3	93.2-138.3	Tib	Rock Core Composite	0.008	0.008	2.95E+07	1.18E+08
212	P1 723+86	167' RT	P- 3	138.3-201.0	Tib	Rock Core Composite	--	--	--	--
213	P1 729+03	39' LT	R- 97	7.0-46.0	**Tib/Tibu	Rock Core Composite	0.088	0.088	2.83E+07	1.13E+08
214	P1 729+03	39' LT	R- 97	46.0-85.0	Tibu	Rock Core Composite	0.003	--	1.15E+08	--
215	P1 733+60	100' RT	BHB1-1	4.4-40.9	Tibu	Rock Core Composite	--	--	--	--
216	P1 734+00	55' LT	BHB1-2	8.0-42.2	Tibu	Rock Core Composite	--	--	--	--
217	P1 735+60	85' RT	BHB1-3	1.6-41.3	Tibu	Rock Core Composite	--	--	--	--
218	P1 735+75	36' LT	BHB1-4	5.0-40.0	Tibu	Rock Core Composite	--	--	--	--
219	P1 739+00	240' RT	R- 98	0.0-50.0	Tibu	Rock Core Composite	--	--	--	--
220	P1 739+00	240' RT	R- 98	50.0-100.0	Tibu	Rock Core Composite	--	--	--	--
221	P1 739+00	240' RT	R- 98	100.0-147.0	Tibu	Rock Core Composite	--	--	--	--
222	P1 739+45	81' RT	R- 99	3.4-51.0	Tibu	Rock Core Composite	0.022	0.016	1.45E+08	1.16E+08
223	P1 739+45	81' RT	R- 99	51.0-91.0	Tibu	Rock Core Composite	--	--	--	--
224	P1 739+45	81' RT	R- 99	91.0-134.7	Tibu	Rock Core Composite	--	--	--	--
225	P1 739+45	81' RT	R- 99	134.7-141.0	Tibu	Rock Core Composite	--	--	--	--
226	P1 741+58	204' RT	R- 100A	0.0-28.5	Tibu	Rock Core Composite	--	--	--	--
227	P1 741+58	204' RT	R- 100A	28.5-71.7	Tibu	Rock Core Composite	1.219	1.217	1.96E+08	3.36E+08
228	P1 741+58	204' RT	R- 100A	71.7-99.5	Tibu	Rock Core Composite	0.204	0.070	2.10E+08	2.40E+08
229	P1 741+58	204' RT	R- 100A	99.5-144.1	Tibu	Rock Core Composite	--	--	--	--
230	P1 743+20	30' LT	BHB2-1	0.6-44.0	Tibu	Rock Core Composite	--	--	--	--
231	P1 744+25	55' LT	BHB2-2	1.7-40.5	Tibu	Rock Core Composite	--	--	--	--
232	P1 744+25	60' RT	BHB2-3	5.9-40.5	Tibu	Rock Core Composite	--	--	--	--
233	P1 745+26	65' LT	BHB2-4	0.0-40.2	Tibu	Rock Core Composite	--	--	--	--
234	P1 745+31	49' RT	BHB2-5	1.0-40.0	Tibu	Rock Core Composite	0.058	0.040	5.10E+08	1.20E+08
235	P1 746+35	55' LT	BHB2-6	0.3-40.0	Tibu	Rock Core Composite	--	--	--	--
236	P1 746+35	60' RT	BHB2-7	0.0-42.5	Tibu	Rock Core Composite	--	--	--	--
237	P1 747+81	20' LT	BHB2-8	0-40.0	Tibu	Rock Core Composite	0.030	--	1.48E+08	--
238	P1 746+99	57' RT	BHB2-9	0.5-40.0	Tibu	Rock Core Composite	--	--	--	--
239	P1 750+25	200' RT	R- 101	0-58.9	Tibu	Rock Core Composite	1.360	0.970	2.80E+09	1.59E+09
240	P1 750+25	200' RT	R- 101	58.9-100.0	Tibu	Rock Core Composite	1.402	1.197	4.39E+09	2.97E+09
241	P1 750+25	200' RT	R- 101	100.0-114.1	Tibu	Rock Core Composite	0.680	0.525	4.65E+09	3.02E+09
242	P1 750+25	200' RT	R- 101	114.1-143.0	Tibu	Rock Core Composite	1.181	0.806	8.66E+09	4.22E+09
243	P1 752+71	14' LT	R- 102	0.5-53.0	Tibu	Rock Core Composite	0.808	0.266	2.16E+10	8.51E+09
244	P1 752+71	14' LT	R- 102	53.0-103.4	Tibu	Rock Core Composite	--	--	--	--
245	P1 752+71	14' LT	R- 102	103.4-115.0	Tibu	Rock Core Composite	--	--	--	--
246	P1 752+87	165' LT	R- 103	1.7-49.0	Tibu	Rock Core Composite	--	--	--	--
247	P1 752+87	165' LT	R- 103	49.0-97.0	Tibu	Rock Core Composite	--	--	--	--
248	P1 754+80	55' LT	BHB3-1	0.6-40.5	Tibu	Rock Core Composite	--	--	--	--
249	P1 754+80	49' RT	BHB3-2	*** 0-40.0	Tibu	Rock Core Composite	--	--	--	--
250	P1 756+65	55' LT	BHB3-3	0.4-40.0	Tibu	Rock Core Composite	0.286	0.226	1.61E+09	4.68E+08
251	P1 756+65	49' RT	BHB3-4	0-40.0	Tibu	Rock Core Composite	--	--	--	--
252	P1 759+89	39' RT	P- 4	0-55.9	Tibu	Rock Core Composite	0.023	--	2.37E+08	--
253	P1 759+89	39' RT	P- 4	55.9-126.2	Tibu	Rock Core Composite	0.627	0.461	3.12E+09	1.30E+09
254	P1 759+89	39' RT	P- 4	126.2-180.0	Tibu	Rock Core Composite	0.366	0.268	3.14E+09	9.48E+08
255	P1 760+63	180' LT	R- 104	2.5-50.0	Tibu	Rock Core Composite	--	--	--	--
256	P1 760+63	180' LT	R- 104	50.0-98.0	Tibu	Rock Core Composite	0.023	0.021	2.85E+08	2.28E+08
257	P1 760+63	180' LT	R- 104	98.0-145.0	Tibu	Rock Core Composite	--	--	--	--
258	P1 761+06	207' RT	R- 105	7.0-51.0	Tibu	Rock Core Composite	--	--	--	--
259	P1 761+06	207' RT	R- 105	51.0-95.0	Tibu	Rock Core Composite	--	--	--	--
260	P1 761+06	207' RT	R- 105	95.0-155.0	Tibu	Rock Core Composite	--	--	--	--
261	P1 761+06	207' RT	R- 105	155.0-180.0	Tibu	Rock Core Composite	--	--	--	--
262	P1 763+41	0	R- 106	2.5-15.4	Tibu	Rock Core Composite	0.893	0.698	6.43E+09	2.77E+09
263	P1 763+41	0	R- 106	15.4-49.0	Tibu	Rock Core Composite	2.042	1.422	1.69E+10	2.06E+10

- PLM testing also performed following 3 sample preparation techniques
- PLM testing also performed following Phase 1 sample preparation techniques

"--" - Asbestos not detected to level of analytical sensitivity

* Actual sample depth begins at 7 feet

** Each Tib/Tibu composite result was used twice, once to represent Tib and once to represent Tibu.

*** Actual sample depth begins at a 8 feet

NOA SAMPLE AND TEST SUMMARY - TEM TEST RESULTS
INTERSTATE 11 - DESIGN BUILD
BOULDER CITY BYPASS PHASE 2
BOULDER CITY, NEVADA

Sample No.	Station	Offset	Sample Name	Depth (feet)	Geologic Unit	Sample Type	Total Wt (percent)	PCMe Total Wt (percent)	Total F/gr	PCMe Total F/gr
264	P1 763+41	0	R- 106	49.0-90.8	Tibu	Rock Core Composite	6.380	5.548	2.00E+10	1.25E+10
265	P1 766+00	144' RT	P- 6	0-46.5	Tibu	Rock Core Composite	--	--	--	--
266	P1 766+00	144' RT	P- 6	46.5-101.0	Tibu	Rock Core Composite	0.133	0.094	1.98E+09	3.55E+08
267	P1 766+00	144' RT	P- 6	101.0-156.4	Tibu	Rock Core Composite	--	--	--	--
268	P1 766+00	144' RT	P- 6	156.4-181.0	Tibu	Rock Core Composite	--	--	--	--
269	P1 766+97	0	R- 107	0.5-63.6	Tibu	Rock Core Composite	--	--	--	--
270	P1 766+97	0	R- 107	63.6-103.6	Tibu	Rock Core Composite	--	--	--	--
271	P1 769+04	266' RT	R- 108A	2.5-35.0	Tibu	Rock Core Composite	--	--	--	--
272	P1 769+04	266' RT	R- 108A	35.0-75.0	Tibu	Rock Core Composite	--	--	--	--
273	P1 769+04	266' RT	R- 108A	75.0-86.0	Tibu	Rock Core Composite	--	--	--	--
274	P1 769+04	266' RT	R- 108A	86.0-142.5	Tibu	Rock Core Composite	--	--	--	--
275	P1 769+04	266' RT	R- 108A	142.5-208.5	Tibu	Rock Core Composite	--	--	0.00E+00	0.00E+00
276	P1 772+32	0	R- 109	7.0-59.1	Tibu	Rock Core Composite	--	--	--	--
277	P1 772+32	0	R- 109	59.1-100.0	Tibu	Rock Core Composite	--	--	--	--
278	P1 772+82	265' RT	R- 110	5.0-59.5	Tibu	Rock Core Composite	--	--	--	--
279	P1 772+82	265' RT	R- 110	59.5-115.4	Tibu	Rock Core Composite	0.002	--	1.20E+08	--
280	P1 772+82	265' RT	R- 110	115.4-166.5	Tibu	Rock Core Composite	--	--	--	--
281	P1 772+82	265' RT	R- 110	166.5-217.0	Tibu	Rock Core Composite	--	--	--	--
282	P1 774+95	137' LT	R- 111	0.8-53.0	Tibu	Rock Core Composite	0.248	0.137	3.09E+09	1.19E+09
283	P1 774+95	137' LT	R- 111	53.0-83.2	Tibu	Rock Core Composite	1.726	1.563	2.38E+09	7.04E+08
284	P1 775+40	11' RT	R- 112	0-60.0	Tibu	Rock Core Composite	--	--	--	--
285	P1 775+40	11' RT	R- 112	60.0-90.0	Tibu	Rock Core Composite	0.466	0.159	7.21E+09	1.96E+09
286	P1 775+40	11' RT	R- 112	90.0-149.0	Tibu	Rock Core Composite	0.065	--	3.82E+09	--
287	P1 775+40	11' RT	R- 112	149.0-185.0	Tibu	Rock Core Composite	2.380	1.819	2.14E+10	1.97E+10
288	P1 779+10	270' LT	P- 5	0-46.1'	Tibu	Rock Core Composite	--	--	--	--
289	P1 779+10	270' LT	P- 5	46.1-100.5	Tibu	Rock Core Composite	--	--	--	--
290	P1 779+10	270' LT	P- 5	100.5-150.5	Tibu	Rock Core Composite	--	--	--	--
291	P1 801+00	0	R- 114	0-5	Tibu	Auger Cuttings	--	--	--	--
292	P1 805+18	4' RT	R- 115	0-5	Tibu	Auger Cuttings	0.410	0.391	1.86E+08	1.24E+08
293	P1 812+74	132' LT	R- 116	0-5	Tibu	Auger Cuttings	--	--	--	--
294	P1 815+43	3' LT	R- 117	0-5	Tibu	Auger Cuttings	--	N/A	--	N/A
295	P 623+40	50' RT	TS- 3	Surficial	Tibb	Surficial Rock	--	--	--	--
296	P 630+05	250' RT	TS- 4	Surficial	Tibb	Surficial Rock	0.273	0.266	2.20E+08	2.00E+08
297	P 632+80	235' LT	TS- 5	Surficial	Tibb	Surficial Rock	--	--	--	--
298	P1 813+00	365' LT	TS- 10	Surficial	Tpma	Surficial Rock	--	--	--	--
299	P1 819+50	380' LT	TS- 9	Surficial	Tpm	Surficial Rock	--	--	--	--
300	P1 821+40	695' LT	TS- 8	Surficial	Tpm	Surficial Rock	--	--	--	--
301	P1 824+00	694' LT	TS- 7	Surficial	Tpm	Surficial Rock	--	--	--	--
302	P1 824+50	919' LT	TS- 6	Surficial	Tpm	Surficial Rock	--	--	--	--
303	P1 781+65	110' LT	TS-11A	Surficial	Tibu	Surficial Rock, Water Decon	1.512	1.24	5.60E+09	5.70E-09
304	P1 785+75	54' LT	TS-11B	Surficial	Tibu	Surficial Rock, Water Decon	0.155	0.155	2.90E+07	1.10E+08
305	P1 789+08	19' RT	788+60	0-1/2	Tibu	Surficial Obtained With Shovel, Water Decon	--	--	--	--
306	P1 791+24	111' RT	TS-12A	Surficial	Tibu	Surficial Rock, Water Decon	0.018	0.008	1.20E+08	1.20E+08
307	P1 793+04	10' LT	TS-12B	Surficial	Tibu	Surficial Rock, Water Decon	--	--	--	--
308	P1 796+40	48' LT	796+40	0-1/2	Tibu	Surficial Obtained With Shovel, Water Decon	0.058	0.052	1.60E+08	1.30E+08
309	P1 797+62	277' LT	SS-1	0-1/2	Tibu	Surficial Obtained With Shovel, Water Decon	0.209	0.195	3.20E+08	3.50E+08
310	P1 807+00	557' LT	SS-2	0-1/2	Tpma	Surficial Obtained With Shovel, Water Decon	--	--	--	--
311	NV 29+96	72' LT	TS-13	Surficial	Tpm	Surficial Rock, Water Decon	0.048	0.034	1.60E+08	1.30E+08

- PLM testing also performed following 3 sample preparation techniques
- PLM testing also performed following Phase 1 sample preparation techniques

"--" - Asbestos not detected to level of analytical sensitivity

N/A PCMe calculation cannot be performed with available data

NOA SAMPLE AND TEST SUMMARY - PLM WITH TEM TEST RESULTS
INTERSTATE 11 - DESIGN BUILD
BOULDER CITY BYPASS PHASE 2
BOULDER CITY, NEVADA

Sample Name	Depth (feet)	Geologic Unit	Sample Description	TEM Results (weight percent)	Soil Samples - 400 Count PLM Test Results for Various Prep Methods								
					Minus No. 10 Sieve, then crushed			Minus No. 60 Sieve			Minus No. 200 Sieve		
					Pts. Counted	Percent	Type	Pts. Counted	Percent	Type	Pts. Counted	Percent	Type
T1-1	0-5	Fill	Composite from Test Pit, Water Decon	ND	None	<0.25	ND	None	<0.25	ND	None	<0.25	ND
TSMY-2	0-4	Tsmy	Composite from Test Pit, Water Decon	0.244	None	<0.25	*Actinolite	None	<0.25	*Actinolite	None	<0.25	*Actinolite
R-11	0-5	Qa	Auger cuttings	ND	None	<0.25	ND	None	<0.25	ND	None	<0.25	ND
R-32	0-5	Qa	Auger cuttings	0.035	None	<0.25	ND	None	<0.25	ND	None	<0.25	ND
R- 45	0-5	Qoa	Auger cuttings	ND	None	<0.25	ND	None	<0.25	ND	None	<0.25	ND
BSCB-1	0-5	Tsmo	Auger cuttings	ND	None	<0.25	ND	None	<0.25	ND	None	<0.25	ND
R- 66	0-5	Tsmo	Auger cuttings	0.022	None	<0.25	ND	None	<0.25	ND	None	<0.25	ND
R- 75	0-5	Tsmo	Auger cuttings	0.278	None	<0.25	ND	None	<0.25	*Actinolite	None	<0.25	*Actinolite
ITB-1	0-5	Tsmo	Auger cuttings	0.557	None	<0.25	*Actinolite	None	<0.25	*Actinolite	2	0.50	Actinolite
R- 82	0-5	Tsmo	Auger cuttings	0.391	None	<0.25	*Actinolite	None	<0.25	*Actinolite	1	0.25	Actinolite
TSMY-1	0-3	Tsmy	Composite from Test Pit, Water Decon	ND	None	<0.25	ND						
R- 2	0-5	Qa	Auger Cuttings	0.012	None	<0.25	ND						
WPB-4	0-5	Qa	Auger Cuttings	ND	None	<0.25	ND						
R- 43	0-5	Qa	Auger Cuttings	0.005	None	<0.25	ND						
R- 46	0-5	Qoa	Auger Cuttings	0.006	None	<0.25	ND						
519+90, 75' LT	0-1/2	Qoa	Surficial Obtained With Shovel	ND	None	<0.25	ND						
570+00	0-1/2	Qa	Surficial Obtained With Shovel, Water Decon	ND	None	<0.25	ND	Not Performed					
R- 65	0-5	Tsmo	Auger Cuttings	ND	None	<0.25	ND						
R- 70	0-10	Tsmo	Auger Cuttings	ND	None	<0.25	ND						
R- 74	0-5	Tsmo	Auger Cuttings	0.001	None	<0.25	ND						
R- 77	0-5	Tsmo	Auger Cuttings	0.227	None	<0.25	*Actinolite						
R- 80	0-5	Tsmo	Auger Cuttings	0.243	None	<0.25	*Actinolite						
R- 87-1	0-1/2	Tsmo	Surficial Obtained With Shovel, Water Decon	ND	None	<0.25	ND						
R- 114	0-5	Tibu	Auger Cuttings	ND	None	<0.25	ND						

ND - None Detected
**** Asbestos detected in non counted portion of sample.***

Sample Name	Depth (ft.)	Geologic Unit	Sample Description	TEM Results (weight %)	Rock Samples - 400 Count PLM Test Results		
					Pts. Counted	Percent	Type
TSB-14	Surficial	Tsmo	Surficial Rock	0.009	None	<.25	ND
R- 74	15.9-16.4	Tsmo	Rock Core	0.117	None	<.25	*Actinolite
WAPA-4/3a	Surficial	Tsmo	Surficial Rock Composite, Water Decon	0.225	None	<.25	*Actinolite
R- 83A	45.0-59.0	Tdmm	Rock Core Composite	ND	None	<.25	ND
R- 84	55.0-92.1	Tdmm/Tsmo	Rock Core Composite	0.077	None	<.25	ND
TSB-2	Surficial	Tsmo	Surficial Rock	ND	None	<.25	ND
R- 90	35.0-66.0	Tib	Rock Core Composite	0.620	1	0.25	Actinolite
R- 91	12.0-36.5	Tsmo	Rock Core Composite	ND	None	<.25	ND
P- 2	170.2-205.3	Tib/Tibu	Rock Core Composite	0.031	None	<.25	ND
R- 93	56.0-169.5	Tib/Tibu	Rock Core Composite	ND	None	<.25	ND
R- 94	28.0-128.0	Tib	Rock Core Composite	ND	None	<.25	ND
R- 94	128.0-144.0	Tib	Rock Core Composite	0.022	None	<.25	ND
R- 94	140.4-140.9	Tib	Rock Core	0.053	None	<.25	ND
R- 94	240.7-241.2	Tibu	Rock Core	ND	None	<.25	ND
R- 95	184.5-227.0	Tibu	Rock Core Composite	ND	None	<.25	ND
R- 95	209.4-209.9	Tibu	Rock Core	0.024	None	<.25	ND
R- 96B	** 0.0-64.3	Tib	Rock Core Composite	ND	None	<.25	ND
R- 96B	115.0-165.0	Tibu	Rock Core Composite	0.265	None	<.25	ND
P- 3	50.2-93.2	Tib	Rock Core Composite	ND	None	<.25	ND
R- 98	50.0-100.0	Tibu	Rock Core Composite	ND	None	<.25	ND
R-100A	28.5-71.7	Tibu	Rock Core Composite	1.219	3	0.75	Actinolite
R-100A	99.5-144.1	Tibu	Rock Core Composite	ND	None	<.25	ND
BHB2-5	1.0-40.0	Tibu	Rock Core Composite	0.058	None	<.25	ND
BHB2-7	0.0-42.5	Tibu	Rock Core Composite	ND	None	<.25	ND
R-101	100.0-114.1	Tibu	Rock Core Composite	0.680	2	0.50	Actinolite
R-102	53.0-103.4	Tibu	Rock Core Composite	ND	None	<.25	ND
P- 4	0-55.9	Tibu	Rock Core Composite	0.023	None	<.25	ND
P- 4	126.2-180.0	Tibu	Rock Core Composite	0.366	2	0.50	Actinolite
R-104	50.0-98.0	Tibu	Rock Core Composite	0.023	None	<.25	ND
R-105	51.0-95.0	Tibu	Rock Core Composite	ND	None	<.25	ND
R-106	49.0-90.8	Tibu	Rock Core Composite	6.380	8	2.00	Actinolite
P- 6	101.0-156.4	Tibu	Rock Core Composite	ND	None	<.25	ND
R-108A	35.0-75.0	Tibu	Rock Core Composite	ND	None	<.25	ND
R-110	5.0-59.5	Tibu	Rock Core Composite	ND	None	<.25	ND
R-111	0.8-53.0	Tibu	Rock Core Composite	0.248	2	0.50	Actinolite
P- 5	0-46.1	Tibu	Rock Core Composite	ND	None	<.25	ND

ND - None Detected
**** Asbestos detected in non counted portion of sample.***
**** * Actual sample depth begins at 7 feet.***