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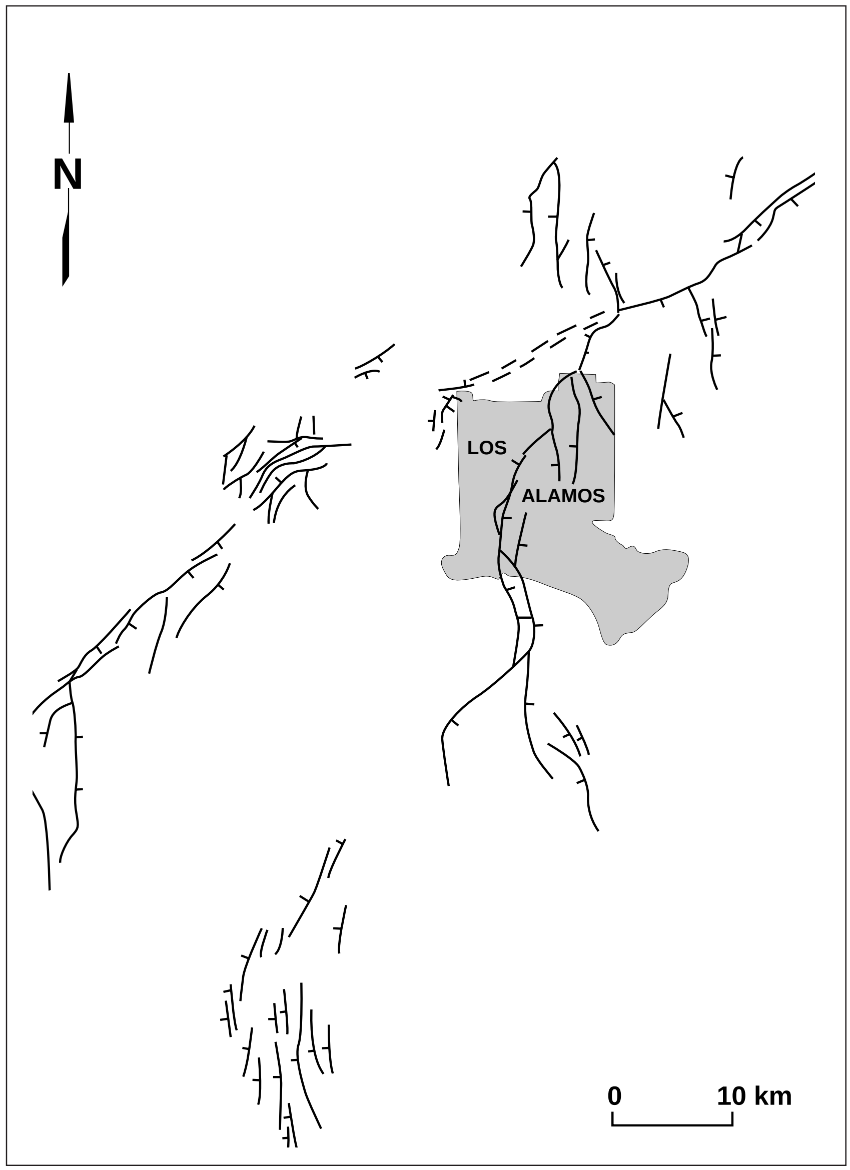
Structural Geology of the Northwestern Portion of Los Alamos National Laboratory, Rio Grande Rift, New Mexico: Implications for Seismic Surface Rupture Potential from TA-3 to TA-55



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Prepared by Lanny Piotrowski, Group EES-1

Cover map: *Quaternary faults in the Los Alamos region.*

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PLATE 1: MAP OF GEOLOGIC FEATURES .... **Rear Cover**

STRUCTURAL GEOLOGY OF THE NORTHWESTERN PORTION OF LOS ALAMOS NATIONAL LABORATORY, RIO GRANDE RIFT, NEW MEXICO: IMPLICATIONS FOR SEISMIC SURFACE RUPTURE POTENTIAL FROM TA-3 TO TA-55

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ABSTRACT

Los Alamos National Laboratory lies at the western boundary of the Rio Grande rift, a major tectonic feature of the North American Continent. Three major faults locally constitute the modern rift boundary, and each of these is potentially seismogenic. In this study we have gathered structural geologic data for the northwestern portion of Los Alamos National Laboratory through high-precision geologic mapping, conventional geologic mapping, stratigraphic studies, drilling, petrologic studies, and stereographic aerial photograph analyses. Our study area encompasses TA-55 and TA-3, where potential for seismic surface rupture is of interest, and is bounded on the north and south by the townsite of Los Alamos and Twomile Canyon, respectively. The study area includes parts of two of the potentially active rift boundary faults—the Pajarito and Rendija Canyon faults—that form a large graben that we name the Diamond Drive graben. The graben embraces the western part of the townsite of Los Alamos, and its southern end is in the TA-3 area where it is defined by east-southeast-trending cross faults. The cross faults are small, but they accommodate interactions between the two major fault zones and gentle tilting of structural blocks to the north into the graben. North of Los Alamos townsite, the Rendija Canyon fault is a large normal fault with about 120 feet of down-to-the-west displacement over the last 1.22 million years. South from Los Alamos townsite, the Rendija Canyon fault splays to the southwest into a broad zone of deformation. The zone of deformation is about 2,000 feet wide where it crosses Los Alamos Canyon and cuts through the Los Alamos County Landfill. Farther southwest, the fault zone is about 3,000 feet wide at the southeastern corner of TA-3 in upper Mortandad Canyon and about 5,000 feet wide in Twomile Canyon. Net down-to-the-west displacement across the entire fault zone over the last 1.22 million years decreases to the south as the fault zone broadens as follows: about 100 feet at Los Alamos Canyon, about 50 feet at upper Mortandad Canyon, and less than 30 feet at Twomile Canyon. These relations lead us to infer that the Rendija Canyon fault probably dies out just south of Twomile Canyon. In detail, the surface deformation expressed within the fault zones can be large, fairly simple normal faults, broad zones of smaller faults, largely unfaulted monoclines, and faulted monoclines. Our study indicates that the seismic surface rupture hazard, associated with the faults in the study area, is localized. South of the county landfill and Los Alamos Canyon, displacements on individual faults become very small, less than about 10 feet in the last 1.22 million years. Such small displacements imply that these little faults do not have much continuity along strike and in a worst-case scenario present a mean probabilistic fault displacement hazard of less than 0.67 inches in 10,000 years (Olig et al., 1998). We encourage, however, site-specific fault investigations for new construction in certain zones of our study area and that facility siting on potentially active faults be avoided.

I. INTRODUCTION, SETTING, AND BACKGROUND

Los Alamos National Laboratory lies at the western boundary of the Rio Grande rift, a major tectonic feature of the North American Continent. The Rio Grande rift is expressed on the surface of the Earth as a series of elongate north-south trending basins that runs from central Colorado, through the central parts of New Mexico, into northern Mexico (Figure 1) (for example, Riecker, 1979; Baldridge et al., 1984; and Keller, 1986). The rift is the site of east-west tectonic extension, which causes the Earth's crust to stretch, thin, and break. From the perspective of seismic hazards, the rift can be considered to be part of the larger Basin and Range tectonic province (for example, Gardner and House, 1987; Wong et al., 1995). The rift and the Basin and Range exhibit remarkably similar major tectonic and magmatic histories that span the last 30 million years, with crustal extension beginning at about 30 Ma, large-volume ignimbrite volcanism from about 30 to 25 Ma, a widespread tectonic and magmatic hiatus from roughly 20 to 15 Ma, and revived tectonism, accompanied by relatively minor volumes of volcanism, since 15 Ma (for example, see discussions in Gardner and House, 1987). Seismicity in the Basin and Range province is characterized by widespread, abundant microseismic events, temporally punctuated by larger earthquakes that range from the limits of human perceptibility to potentially seriously damaging earthquakes of approximately magnitude 7 character. Indeed, the Basin and Range province has experienced at least 11 earthquakes of magnitude 6.5 or larger in relatively recent historic times (dePolo and Slemmons, 1998), and the Rio Grande rift hosted a magnitude 7.2 earthquake in northern Mexico in 1887, numerous magnitude 4 to 6 earthquakes in the Socorro area in the 20th Century, and magnitude 4 to 5+ events in Cerrillos and Dulce in 1918 and 1966, respectively (Gardner and House, 1987; Wong et al., 1995). Additionally, since establishment of the Laboratory during World War II, there have been seven earthquakes felt by the residents of Los Alamos. Apparently the two largest of these felt earthquakes were a magnitude 4 that occurred in 1952 and a magnitude 3.3 in 1971, both of which had reported Modified Mercalli Intensities of V in Los Alamos (Gardner and House, 1987; Gardner and House, 1994; House and Gardner, unpublished data, 1998).

The rift boundary in the vicinity of Los Alamos National Laboratory is locally defined by the Pajarito fault system, which includes the Pajarito, Guaje Mountain, and Rendija Canyon faults (Figure 2). These faults exhibit prominent displacement of the 1.22-million year old Tshirege Member of the Bandelier Tuff (age from Izett and Obradovich, 1994) to the north and to the west of the Laboratory (for example, Smith et al., 1970; Gardner and House, 1987). Each of the three major faults of the Pajarito fault system exhibits evidence of at least one large movement, or, in one case, probable movement, in the Holocene Epoch (last 11,000 years), which indicates that all are potentially seismogenic (Gardner et al., 1990; Wong et al., 1995; Kelson et al., 1996; McCalpin, 1998).

This study addresses the geology of the zone of structural interactions among faults that form the Pajarito fault zone and the southern terminus of the Rendija Canyon fault. This zone of interactions covers roughly the northwestern part of Los Alamos National Laboratory, an area that encompasses TA-55 on the east and TA-3 on the west (Figure 2), where issues of potential seismic surface rupture are of interest. Because most previous studies proved to be inconclusive in determining the location and amount of faulting south of Los Alamos Canyon, we embarked on a program of high-precision geologic mapping to identify even very small faults. Initially, the purpose of this project was to identify faults in the vicinity of TA-55 that cut the Tshirege Member of the Bandelier Tuff (1.22 Ma) with greater than approximately 1 foot of vertical displacement, and results of this initial part of the project were presented by Gardner et al. (1998a). The project was then expanded to include the TA-3 area and some detailed site-specific studies undertaken at the "footprint" of several proposed or existing facilities (Krier et al., 1998a and 1998b).

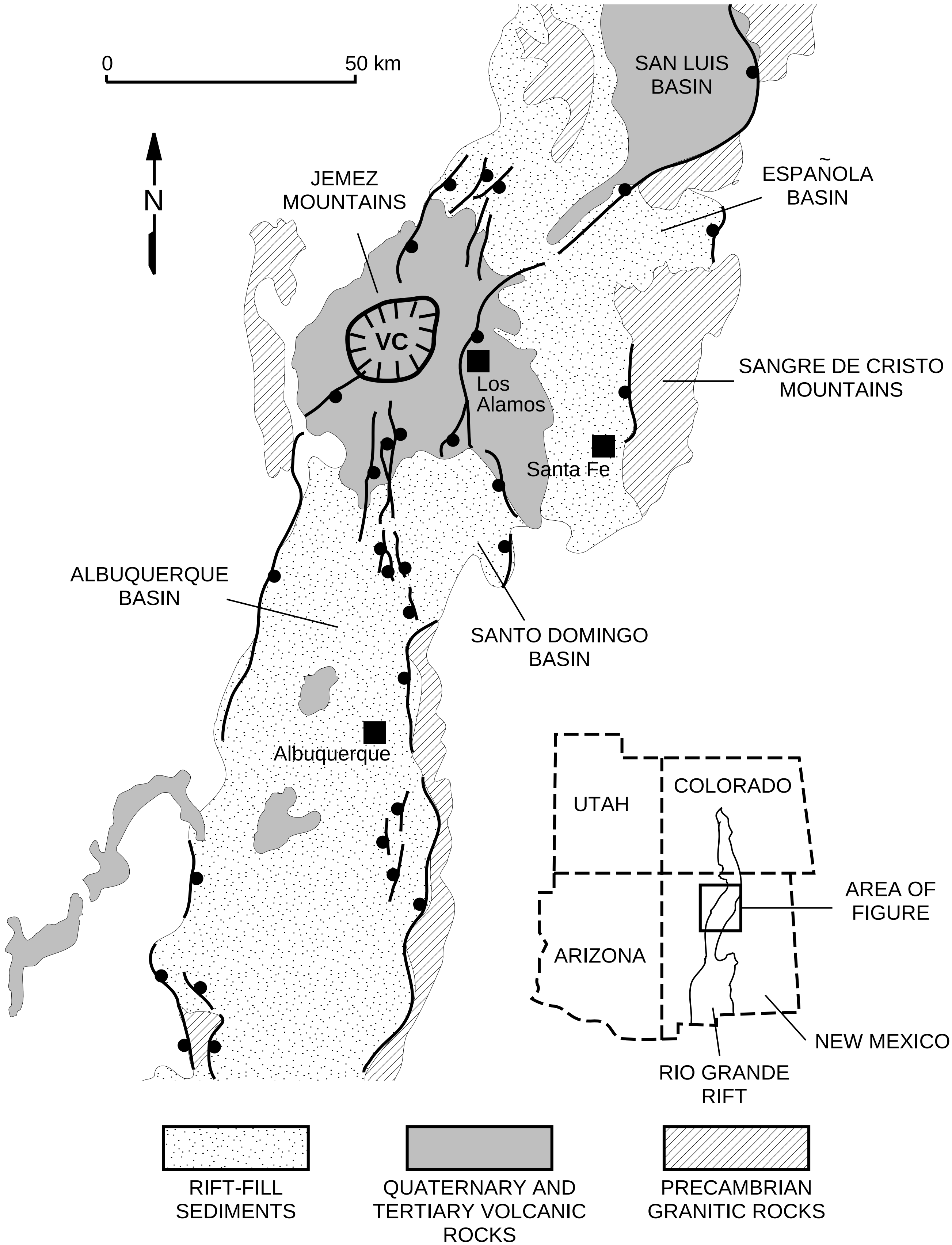


Figure 1: Map of the Rio Grande rift in northern New Mexico. Major fault systems are shown schematically. VC is the Valles caldera, the source of the Bandelier Tuff (modified from Gardner and Goff, 1984).

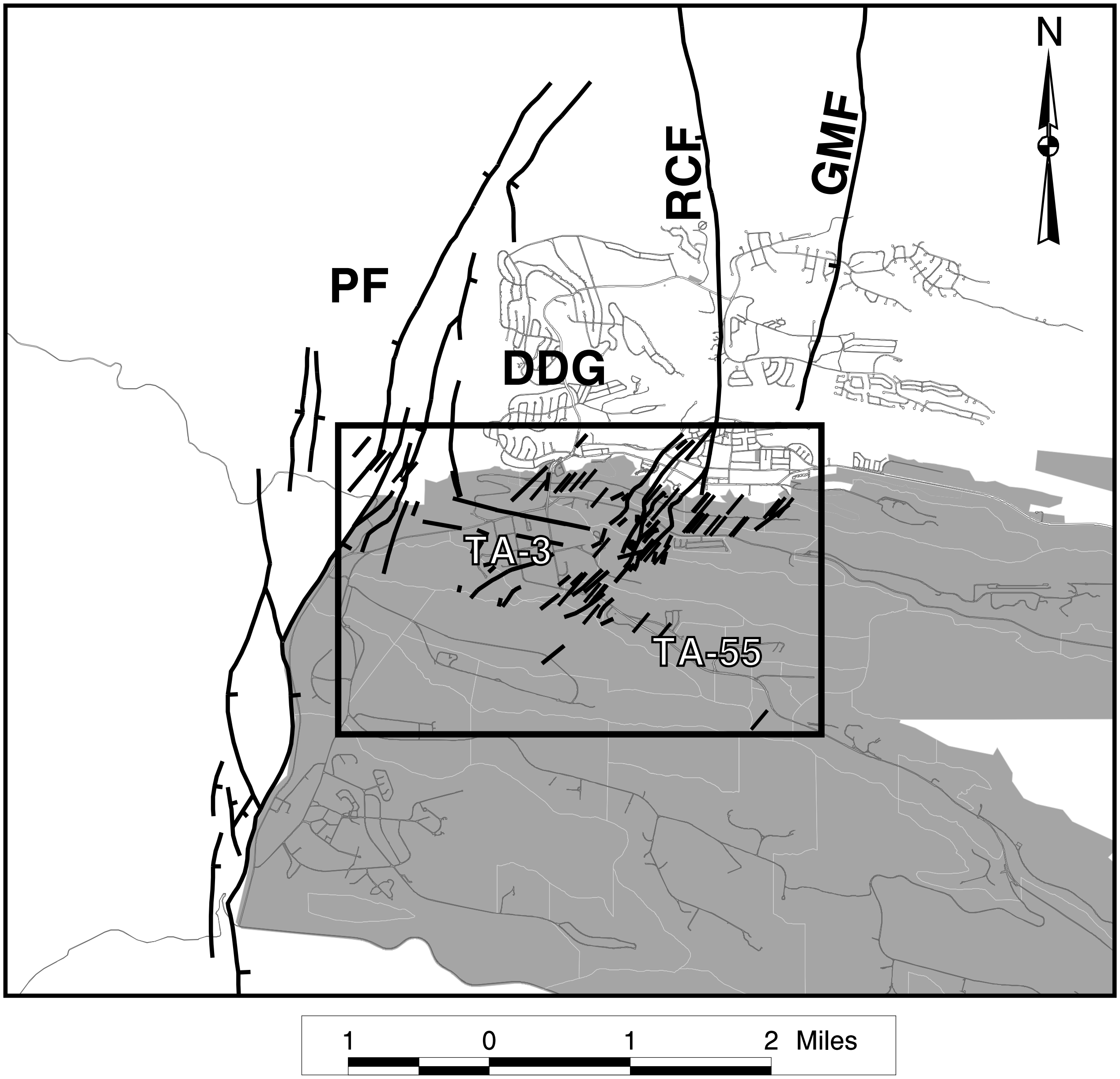


Figure 2: Map showing the study area (outlined in black) and the Pajarito fault system in the vicinity of Los Alamos National Laboratory (shaded gray). Surface faults and related structures are shown as black lines, with some strike lengths exaggerated. Technical Areas are outlined in light gray, with TA-3 and TA-55 labeled, and roads are shown in dark gray. PF = Pajarito fault, RCF = Rendija Canyon fault, GMF = Guaje Mountain fault, DDG = Diamond Drive graben. (fault data from Gardner and House, 1987; Gardner and Reneau, unpublished mapping; and, this study).

II. PREVIOUS WORK

The different rock types and stratigraphic sequence of the Pajarito Plateau and surrounding areas are known from surface and subsurface geological investigations (for example, Griggs, 1964; Bailey et al., 1969; Smith et al., 1970; Kelly, 1978; Gardner et al., 1986; Goff et al., 1990; Izett and Obradovich, 1994; Broxton and Reneau, 1995; Purtymun, 1995; Rogers, 1995; WoldeGabriel et al., 1996; Dethier, 1997). These works provide general stratigraphic and structural information with broad temporal and spatial constraints on the volcanic, tectonic, and sedimentologic relations of the various lithologic units.

Early workers recognized that faulting and extension are locally accommodated along a fault system that comprises the individual zones now known as the Pajarito, Rendija Canyon, Guaje Mountain, Sawyer Canyon, Embudo, and Puye fault zones (for example, Griggs, 1964; Smith et al., 1970; Kelley, 1978; see Wong et al., 1995, for an index of current name usage). In the vicinity of Los Alamos, the Pajarito fault zone has been interpreted by a number of workers to be the currently active rift boundary (Golombek, 1983; Gardner and Goff, 1984; Aldrich and Dethier, 1990). Gardner and Goff (1984) and Gardner et al. (1998b) presented evidence that active faulting forming the local western boundary of the rift has stepped about 10 kilometers to the east probably twice in the last 17 million years, with the most recent shift to the Pajarito fault system happening at about 4 to 5 Ma. Rift structures commonly appear to have developed on crustal weaknesses that have been inherited from earlier tectonic episodes. Carter and Gardner (1995) speculated, based on limited age constraints and kinematic arguments, that another such eastward step of rift margin faulting could be imminent; however, new paleoseismic constraints and seismic data appear to indicate that the Pajarito fault system continues to be the main focus of the most recent and contemporary activity (McCalpin, 1998; Gardner and House, 1994; House and Gardner, unpublished data, 1998).

In recent years, paleoseismic investigations have been conducted along the Pajarito, Rendija Canyon, and Guaje Mountain fault zones in attempts to characterize their individual earthquake histories (Gardner et al., 1990; Wong et al., 1995, 1996; Kelson et al., 1996; Olig et al., 1996; McCalpin 1998; McCalpin, in prep.). Wong et al. (1995) and Olig et al. (1996) concluded that the Pajarito fault has ruptured during multiple surface faulting events in the past 100,000 to 200,000 years, but their paleoseismic trenches exposed no major fault traces, and the most recent paleoseismic event that they identified in their excavations south of Pajarito Canyon was prior to 50 to 60 ka. McCalpin (1997) studied the Pajarito fault scarp west of Los Alamos National Laboratory through detailed geomorphic mapping and recognized portions of the scarp to be an "articulated monocline." Building on his geomorphic work, McCalpin (1998) employed a transect of seven trenches across identifiable elements of the Pajarito fault zone immediately south of Los Alamos Canyon and found evidence for a faulting event between roughly 1,500 to 2,500 years ago. Wong et al. (1995) and Olig et al. (1996) estimated recurrence intervals for earthquakes on the Pajarito fault to be from 10,000 to 40,000 years, and McCalpin (1998) determined a mean recurrence for the fault of about 21,000 years. Paleoseismic trenching has shown that the Rendija Canyon fault has repeatedly ruptured during the late Quaternary, with the most recent event occurring at about 8 or 23 ka with a coseismic vertical displacement of about 6 feet (Wong et al., 1995; Kelson et al., 1996). These authors also offer estimated recurrence intervals for the Rendija Canyon fault that range from 33,000 to 83,000 years. Similarly, the Guaje Mountain fault exhibits evidence for at least three surface rupturing events during the past approximately 150,000 to 300,000 years, with the most recent event between about 4 to 6 ka (Gardner et al., 1990; Olig et al., 1996). Fault displacements accompanying each paleoseismic event on the Guaje Mountain fault range from about 5 to greater than 7 feet. Estimates of recurrence intervals for the Guaje Mountain fault range from 50,000 to 150,000 years. In all of these studies, the vertical displacements for individual paleoseismic events range from about 1 foot to over 7 feet, with most in the 5- to 7-foot range; these data strongly imply that the paleoearthquakes were in the 6 to 7 magnitude range (Wells and Coppersmith, 1994). Because of missing stratigraphic section or loose constraints on displacement data, all authors concur that the paleoseismic histories that have been developed for the three major, local faults are probably incomplete. Thus, until further paleoseismic studies are accomplished, the various estimates of recurrence intervals are best taken as potential maxima in light of the considerable uncertainties.

Previous studies of faults and fractures within the boundaries of the Laboratory have generally had site-specific, topical focus. Dames and Moore (1972) performed trenching at the footprint of the then-proposed Plutonium Facility at TA-55. The logs for these trenches, however, are inconclusive because no coherent stratigraphic markers could be carried across the trenches. Vaniman and Wohletz (1990) performed reconnaissance geologic mapping and detailed fracture studies around TA-55. Their mapping clearly revealed that there are no large faults around the facility, but they did note zones of abundant fractures in some localities that they inferred to be indicative of faulting. Wohletz (1995; 1996) employed a similar approach to fracture studies in Los Alamos Canyon, at the eastern edge of our study area, and concluded that here, too, zones of abundant fractures are probably indicative of faulting. Ensuing detailed studies, however, have shown no correlations between most of these zones of abundant fractures and faulting (Kolbe et al., 1994; Kolbe et al., 1995; Reneau et al., 1995; Gardner et al., 1998a; this study). One exception is in Los Alamos Canyon near TA-2 (at the eastern edge of our study area) where Wohletz (1996) noted a zone of abundant fractures that appears to correlate with several of our mapped faults. Wong et al. (1991) evaluated the state of knowledge with respect to performing probabilistic surface rupture hazard analyses for specific sites within the Laboratory and concluded that data were insufficient at that time to adequately locate faults south of Los Alamos Canyon. Trenching studies were performed to evaluate the footprints of two proposed facilities at TA-63, immediately east of TA-55, and at TA-67, south of TA-55 (Kolbe et al., 1994; Kolbe et al., 1995; Reneau et al., 1995). No faulting was identified at TA-63, and pre-50 to 60 ka faults were found at TA-67. Some workers (for example, Wong et al., 1995) interpreted the faults identified through trenching and field studies at TA-67 (see Reneau and Raymond, 1995, for summaries), to be the southern end of the Rendija Canyon fault; however, work by Gardner et al. (1998a) shows that this is not the case. Rogers (1995) prepared a relatively detailed geologic map of the Laboratory area and recognized a number of the monoclinal structures we document here to be associated with normal faulting; however, Rogers (1995) inferred many east-trending faults in canyon bottoms for which we find no evidence (see Discussion/Conclusions below). Purtymun et al. (1995) examined excavations near the Chemistry and Metallurgy Research building in the southeast part of TA-3 and concluded that one "fracture" had about 4 inches of displacement along it due to "structural adjustments." Reneau and Vaniman (1998) and Reneau et al. (1998) have done detailed fracture studies and high-precision geologic mapping in the vicinity of TA-54, east of our study area, and Reneau et al. (1998) discovered numerous small-displacement faults. Building on the results of Gardner et al. (1998a) and this study, Olig et al. (1998) developed bounding case, probabilistic estimates for surface ruptures at specific locations in the TA-3 area. Data and results of previous studies by Gardner et al. (1998a) and Krier et al. (1998a and 1998b) are included in this report.

III. METHODS AND QUALITY OF DATA

A. A Note on Units of Measure

In this project we use English units of measure for field data. The State Plane Coordinate System, New Mexico Central Zone, 1983 North American Datum, which provides the three-dimensional reference framework in this area is in feet, as are most of the engineering databases. We retain use of the metric system for petrographic descriptions because we find millimeters far more useful than, for example, fractions of inches for descriptions of small features; furthermore, metric measurements are employed in discussion of analytical methods for geochemistry.

B. Study Area

Initial concerns were raised over the possibility of potential seismic surface rupture at the Plutonium Facility at TA-55. As the project proceeded, it became clear that the Rendija Canyon fault did not pass through TA-55 but must splay to the west as it dies out at its southern terminus (Gardner et al., 1998a). These findings provided impetus to expand the initial project with a renewed focus on the TA-3 area. Geologic mapping requires exposures of stratigraphic units or markers. Thus, in heavily urbanized areas in TA-3, we resorted to core drilling at the footprints of proposed or existing facilities to fix the elevations of unit contacts and evaluate the possibilities of normal or reverse faulting. Consequently, the study area (Figure 2 and Plate 1) is approximately 6 square miles, and includes mapping at or in the Los Alamos County Landfill, TA-55, some construction trenches, sparse bedrock exposures in TA-3, nineteen drill holes in TA-3, and mostly portions of Twomile, Mortandad, Sandia, and Los Alamos Canyons.

C. Geologic Mapping

Issues regarding potential seismic surface ruptures at sensitive facilities at Los Alamos National Laboratory motivated us to develop a unique approach to geologic mapping that enables recognition of vertical fault displacements so small that they would be overlooked and unmapped by conventional geologic mapping techniques (see, for example, Reneau et al., 1995). Our approach, referred to as high-precision geologic mapping, involves actual surveying of points on geologic features in the field, using a Geodimeter Total Station with an on-board computer and detailed computer-aided and field analyses of anomalies in the elevations of the points surveyed on a given geologic surface (Lavine et al. 1997; Gardner et al. 1998a; Lavine et al. 1998). Most of the geologic features shown on Plate 1, particularly those in and around the immediate TA-3 to TA-55 area, were mapped with the high-precision technique and/or identified with data from the detailed drilling work done at a few facility footprints; however, faults depicted on Plate 1 as "previously mapped faults" were mapped by Gardner and Reneau (unpublished data) by conventional geologic mapping techniques at a variety of scales. Additionally, fault mapping at the site of the Los Alamos County Mesa Public Library was done by Reneau and Gardner (unpublished) while they pioneered the high-precision geologic mapping technique. It needs to be stressed that the precision and accuracy of the high-precision mapping technique, discussed below, usually exceed the absolute accuracy of the base map of Plate 1 (i.e., topography, roads, buildings), and use of Plate 1 through any enlargement process, including photographic or photocopy, is inappropriate. If geologic features, such as faults, are shown on Plate 1 to run through or near facilities of concern, then we recommend further, detailed site-specific investigations. The major exceptions to this recommendation are the portions of TA-3 where such detailed site-specific investigations in the drilling part of this project have already been done. Readers must note that Plate 1 is not a complete geologic map. Our objective is mainly to identify faults; as such, the high-precision mapping focused on widespread stratigraphic markers that, at the time of their formation or deposition, approximated planar surfaces. Consequently, geologic features not particularly useful for identification of faults have not been mapped in a systematic fashion to completion. To turn Plate 1 into a complete geologic map would require significant effort beyond this project.

As part of the Environmental Restoration Program, the Facility for Information Management Analysis and Display (FIMAD) was established at the Laboratory in 1991 to serve as a geographic information system (GIS) for environmental data. With the development of an improved digital elevation model for the Laboratory as part of this GIS, FIMAD ran a series of quality assurance checks on established survey monuments, or benchmarks, around the Laboratory. Large inaccuracies were revealed, and in 1992 a new Lab-wide control network of "good" survey monuments was established. Benchmarks of this control network of monuments in the vicinity of TA-55 form the framework for locating our surveyed points in absolute three-dimensional space.

Instrument setups are done by triangulation on benchmarks, which enables location of the Geodimeter Total Station in coordinates of the State

Plane Coordinate System, New Mexico Central Zone, 1983 North American Datum. These data are obtained in real time in the field and allow calculations to evaluate the quality of the setup and instrument location. Typical precision of an instrument setup is better than 0.05 feet in the X and Y directions (easting and northing), and better than 0.02 feet in the Z direction (elevation). Precision of surveyed points is tested at the beginning and end of every instrument setup by shooting points of known coordinates as checks; invariably, the precision of surveyed points is better than the precision of the instrument setup.

Closure on survey monuments at the extremities of our study area suggests a cumulative error in absolute three-dimensional space, assuming the benchmarks are all correct, of less than 3 feet in northing and easting and less than approximately 0.25 feet in elevation over 10,000 surveyed feet. In contrast to procedures of typical surveys, we do not make repeated corrections for cumulative errors; instead, our data form an internally consistent set, with geologic features fixed accurately with respect to each other. While our objectives require greater precision than is provided by conventional geologic mapping, we do not require the precision and accuracy of routine survey work. For the purposes of this project it is sufficient to locate small faults within a few feet in absolute space with reference to established benchmarks. Furthermore, with the integration of our data through FIMAD, it is possible to plot our surveyed points on high-resolution aerial orthophotographs on which one can identify individual rocks, trees, and other detailed features; thus, if needed, each surveyed point can be relocated in the field. Appendix A is a tabulation of the northing, easting, elevation, and unit designation for all points on geologic features surveyed in this project.

Field data are analyzed in profiles, three-dimensional surface diagrams, and maps that are constructed with several software packages (Surfer, Excel, Canvas, and ArcView GIS). The different software packages are capable of generating profiles of the same data at dramatically different scales and perspectives, which enable exaggeration, and therefore identification, of even subtle elevation anomalies. Surveyed points surrounding anomalies are plotted on aerial orthophotographs, and the anomalies are evaluated in the field to determine if, in fact, they indicate faulting. The smallest vertical anomalies that we identified, even in areas of relatively poor exposure, are about 0.5 feet.

D. Aerial Photograph Studies

Commonly in geologic mapping and structural studies, stereographic aerial photograph analyses are performed to supplement fieldwork. However, as with geologic mapping, these studies can sometimes be severely hampered in heavily urbanized areas; human works commonly modify and obscure nature's topographic expressions of geologic structures. We were fortunate to discover a partial set of aerial photographs taken in about 1947, before extensive development of areas occupied by the post-World War II Laboratory, that provided stereo coverage of most of the study area. These photographs provided invaluable information on where some mapped faults may continue through these now-urbanized areas; however, some features identified in the photograph studies could not be verified as geologic structures and consequently appear on Plate 1 simply as "Aerial Photograph Lineaments." Aerial photograph lineaments are features that may deserve further detailed study, but in the absence of other data, cannot be taken as faults. Integration of data from the aerial photographs with the high-precision mapping data through the FIMAD geographic information system introduces some unavoidable uncertainties in the placement of "Aerial Photograph Lineaments" on Plate 1. Optical distortions in the photographs, and their scale (about 1:17,000) contribute to the uncertainties. The locations of "Aerial Photograph Lineaments" on Plate 1 are accurate within about 150 feet.

E. Drilling

The objective of the drilling program was to intercept stratigraphic contacts or marker horizons within the Tshirege Member of the Bandelier Tuff and to evaluate if measurable stratigraphic separation ("offset") of those features was caused by faulting between or among drill sites. This approach was employed around the footprints of two proposed and one existing facility within TA-3 in areas where extensive urbanization precluded high-precision geologic mapping (Krier et al., 1998c). Geologic cores removed from the holes were used to define and correlate the stratigraphic sequence at each drill hole to aid in identifying geologic structures that might impact the buildings' foundations and stability in the future. The borehole locations in TA-3 are shown in detail in Figure 3 and on Plate 1. Borehole locations were selected based on size and shape of the building footprints, with allowances made for the presence of buried electrical utilities, pipelines, and communication lines. Drilling operations took place from March to May, 1998. The holes were continuously cored in 2.5-foot core lengths using a hollow-stem auger with a split-spoon barrel and wireline retrieval system. Core diameter is 3.5 inches. A total of 1,365 feet was cored from nineteen boreholes in 18 days of actual operations.

Careful drilling and the relatively shallow hole depth ensured that each core hole remained at or near its original vertical orientation. The depth intervals from which cores were retrieved during drilling are well known because the number of auger stems in the ground gave an unambiguous measurement of the length of tools in the hole. Detailed lithologic logs were prepared for each hole at the drill sites upon retrieval of the core and supplemented with later detailed examination of key intervals at the Laboratory's Environmental Restoration Project Field Support Facility where the cores are currently archived. Cores were marked and boxed at the drill sites using a procedure designed by Goff (1986) as guidance. The logs include descriptions of lithology, fractures, fracture fill, texture, mineralogy, and the locations of samples taken for chemical analyses; more detailed information on the cores can be found in Krier et al. (1998a and 1998b). The coring operation yielded about 98% core retrieval, which is excellent recovery. The excellent core recovery can be attributed to driller familiarity with the type of rock present, careful drilling with emphasis on core recovery, and the shallow target depth (<100 feet) for each hole. In spite of the excellent recovery, core cohesiveness was poor in intervals where the tuff was poorly welded. The combined effects of drilling, sample rheology, and handling rendered some samples to loose powder when transferred to archive boxes. Consequently, many primary sample textures that were still observable in the drill spoon did not survive the transfer to the core box. There are very few "lost" intervals of core. Lithologic logging of this nearly total record makes the subsurface mapping unusually complete for this type of investigation. Mapping lithologic types and checking and refining contacts against focused geochemical sampling yield contact or marker horizon elevations accurate to less than 1 foot in most cases. Surveying the borehole locations and depth references using the techniques discussed above allows the borehole data to be integrated with the results of the high-precision geologic mapping.

F. Geochemical Analyses

Major and trace elements were analyzed for 192 bulk-rock samples using an automated Rigaku wavelength-dispersive x-ray fluorescence (XRF) spectrometer in the EES-1 analytical facility at Los Alamos National Laboratory. Individual samples were first crushed and homogenized in 15- to 20-gram portions in a tungsten-carbide shatterbox in accordance with Yucca Mountain Project procedure LANL-EES-DP-130—Geologic Sample Preparation. Sample splits were heated at 110°C for 4 hours and then allowed to equilibrate with ambient atmosphere for 12 hours. One gram splits were fused at 1,100°C with 9 grams of lithium tetraborate flux to obtain fusion disks. Additional one-gram splits were heated at 1,000°C to obtain the loss-on-ignition (LOI) measurements. Elemental concentrations were calculated by quantitative comparisons of x-ray intensities for the samples to those for 21 standards of known composition. The EES-1 XRF laboratory routinely analyzes the concentrations of ten major element compounds (SiO_2, TiO_2, Al_2O_3, Fe_2O_3, MnO, MgO,

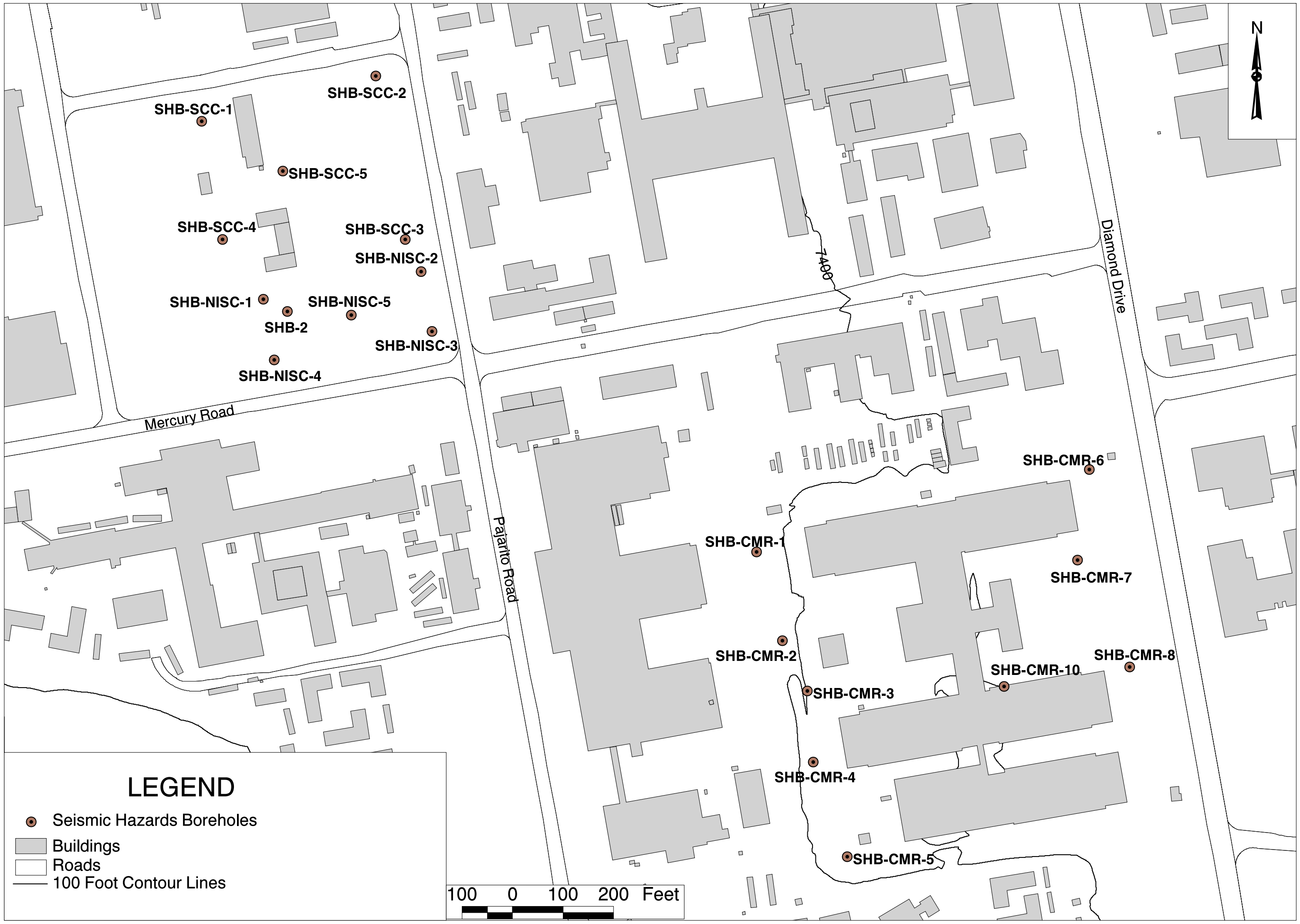


Figure 3: Detailed map of a portion of TA-3 showing the locations of boreholes drilled as part of the seismic hazards project. Seismic hazards borehole (SHB) locations are shown at the Chemical and Metallurgy Research (CMR) building and at the sites for the proposed Strategic Computing Center (SCC) and Nonproliferation and International Security Center (NISC) (see Krier et al., 1998a and 1998b for more information). Also shown, surrounded by the NISC boreholes, is SHB-2, which was drilled in 1991 as part of the Wong et al. (1995) study (see also Gardner et al., 1993). The grid is in the State Plane Coordinate System (in feet), New Mexico Central Zone, 1983 North American Datum; 100-foot contours are shown in black. Borehole locations are also shown on Plate 1.

CaO, Na_2O, K_2O, P_2O_5), ten trace elements (V, Cr, Ni, Zn, Rb, Sr, Y, Zr, Nb, Ba), and LOI. Appendix B is a tabulation of all geochemical data, including analytical uncertainties for each analyte, generated for this study. Concentrations for the elements V, Cr, and Ni in the Bandelier Tuff are at or below detection limits for the XRF method, and are not tabulated in the Appendix. Appendix B also contains maps that show field sample locations. Geochemical samples from the boreholes are related to specific hole by sample number (see also Figure 3) and depth.

IV. GEOLOGY

A. Stratigraphy

Temporal and lithologic relations for formalized stratigraphic units of the Jemez Mountains region are discussed by Bailey et al. (1969) and Gardner et al. (1986), and these units form the broad stratigraphic framework for the area. The stratigraphy exposed in the study area includes, from oldest to youngest: the Otowi Member of the Bandelier Tuff; the Cerro Toledo Rhyolite; the Tshirege Member of the Bandelier Tuff; mesa-top alluvial deposits; mesa-top soils; fluvial terraces and associated gravels; colluvium on slopes and canyon walls; and recent alluvium in canyon bottoms. The most widespread unit in the study area is the Tshirege Member of the Bandelier Tuff, which forms the mesas in the northwestern part of Los Alamos National Laboratory. Because the main objective of our project is to identify faults and gain understanding of the structural geology of the study area, we emphasized mapping units with lateral continuity that were originally deposited as gently dipping layers with nearly planar contacts. Thus, because of their lack of lateral continuity in the study area, and, for some units their erosional or nonplanar basal contacts, we did not systematically map the alluvial, colluvial, soil, terrace, Cerro Toledo Rhyolite, and Otowi Member deposits. However, patches of alluvial sands and gravels commonly overlie the Tshirege Member on mesa tops. Locally, these mesa-top alluvial deposits are capped with fairly well-developed, orange, clay-rich soils. In a few localities where we thought it may provide additional faulting constraints, we did map the tuff-alluvium contact, and these data are shown on Plate 1. In Twomile and Los Alamos canyons we also note flights of Quaternary terraces, overlain with coarse, subrounded alluvial gravels. Additionally, at the eastern margin of the study area, the Cerro Toledo Rhyolite and Otowi Member of the Bandelier Tuff are well exposed beneath the Tshirege Member in Los Alamos Canyon but were not mapped. If, however, the high-precision mapping begun in this project were to be extended farther east for purposes of fault identification, the Otowi and Cerro Toledo horizons would probably be worth mapping.

Most of the units and stratigraphic markers (Figure 4) we have mapped are cooling unit contacts or individual pyroclastic surges within the Tshirege Member of the Bandelier Tuff. The Tshirege Member was erupted at 1.22 Ma (Izett and Obradovich, 1994) from the Valles caldera (Figure 1), to the west of Los Alamos, as a series of hot pyroclastic flows. Although the pyroclastic flows were erupted in fairly rapid succession, sufficient time passed between major eruptive pulses so that packages of the resultant ignimbrite deposits cooled as discrete units. Additionally, the volume of the Tshirege Member tuffs in the study area was sufficient to flood and completely bury a rugged, preexisting topography (Broxton and Reneau, 1996). Consequently, the higher cooling unit contacts and pyroclastic surges were essentially planar and nearly horizontal on deposition.

Below we briefly describe salient field characteristics of the features we have mapped.

1. Tshirege Member of the Bandelier Tuff

The stratigraphy for the Tshirege Member of the Bandelier Tuff that we employ is based on Broxton and Reneau (1995). Building on the earlier work of Vaniman and Wohletz (1990) around TA-55, Broxton and Reneau (1995) developed a stratigraphy of cooling units within the Tshirege

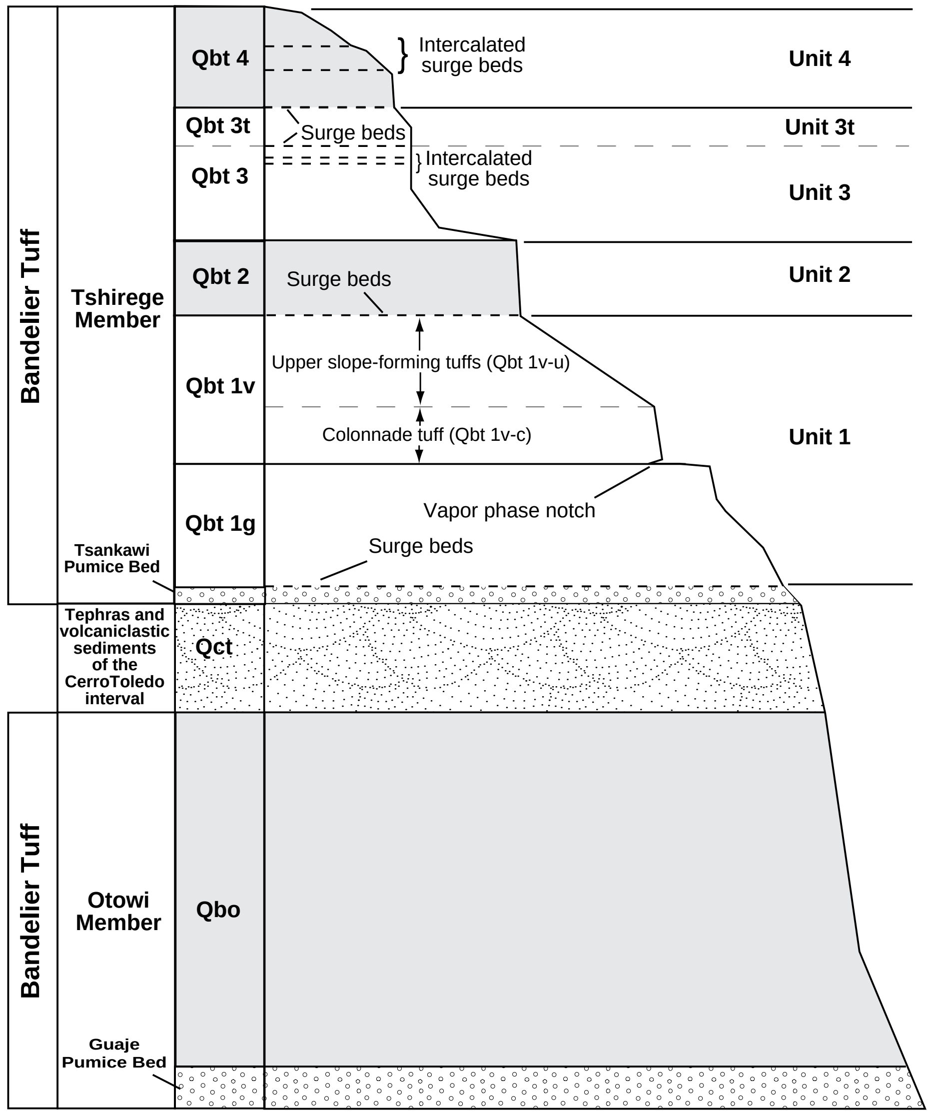


Figure 4: Composite stratigraphy of the Bandelier Tuff (modified from Broxton and Reneau, 1995). At any given locality, units may pinch out or swell in thickness.

Member. As we have mapped from central to more western portions of the Laboratory, we have discovered that although the Tshirege units defined by Broxton and Reneau (1995) are laterally continuous, there are a number of other mappable Tshirege units not included in their definitions. These other mappable units are thickest on the western part of our study area and pinch out to the east. This is not geologically surprising, because as one moves west across the Pajarito Plateau, one moves closer to the Valles caldera (Figure 1), the source of the Bandelier Tuff. Thus, farther west the tuff stratigraphy will record a more complete record of eruptions because not all pyroclastic flows ran out the same distance to the east. In the immediate vicinity of TA-55, there are three main features mapped: the contact of cooling Units 2 and 3, the contact of Units 3 and 4, and a pyroclastic surge deposit that commonly lies between cooling Units 3 and 4. All of these features are noted and described by Broxton and Reneau (1995) and are lithologically and geochemically distinctive from each other. In contrast, in the western part of the map area the stratigraphy becomes much more complicated, and petrographic and geochemical variations are more subtle from one unit to its stratigraphic neighbors. In the western part of the study area the mapped Tshirege units are as follows: Unit 3, lower and upper Unit 3T ("T" for transitional petrographic and geochemical characteristics between over- and underlying units), and lower and upper Unit 4. Pyroclastic surges can be found in places at every unit boundary horizon, within Unit 3, within Unit 3T, and throughout the sequence of Unit 4. The most widespread surge unit throughout the map area appears to be at the base of Unit 4, either overlying Unit 3 or Unit 3T. Up to two-thirds of the exposed stratigraphic sequence in the western part of the map area are not described by Broxton and Reneau (1995).

Unit 2: greater than 50 feet thick, but base, exposed only at the eastern margin of the study area in Los Alamos Canyon, is not mapped in this study. Unit 2 is recognized in the field as a prominent cliff-forming unit and the most strongly welded unit of the Tshirege Member in the central and eastern parts of the Laboratory. In fact, the unit is so densely welded that it forms impassable cliffs near the bottoms of some canyons around TA-55 (for example, Twomile Canyon). Well exposed in the canyon bottoms in the eastern half of the map area, the unit disappears, as one moves west, beneath topography around the eastern edge of TA-3 and Omega Bridge in Los Alamos Canyon. Unit 2 is exposed at the western edge of the study area in the upthrown block of the Pajarito fault in Los Alamos Canyon, but it was not mapped at this location. Accidental lithic fragments are rare (<1%), and the welded tuff is moderately porphyritic (15% to 20% phenocrysts of subequal amounts of sanidine and quartz). Pumices tend to be relatively sparse (5% to 10%), but can be difficult to distinguish because of the densely welded nature of the unit.

Unit 3: 110 to 140 feet thick. The boundary between Unit 2 and the overlying Unit 3 is marked by an abrupt change in welding characteristics. The transition from the densely welded tuffs of Unit 2 to the completely nonwelded tuffs of lower Unit 3 occurs over a stratigraphic interval of less than 3 feet, and Broxton and Reneau (1995) define the base of Unit 3 as the base of these nonwelded tuffs. In most of the western half of the map area, the base of Unit 3 is not exposed, and the higher portions of the unit achieve a moderate degree of welding. The top of Unit 3 is commonly marked by a crystal-rich surge deposit, where it is overlain by Unit 4, and less commonly a surge deposit separates Unit 3 and Unit 3T. However, everywhere in the map area, the top of Unit 3 is marked by a sharp increase in the degree of welding in the overlying Units 3T or 4. Unit 3 is more pumice rich (about 30%) than Unit 2, and contains relatively abundant (locally up to 5%) accidental lithic fragments. In contrast to other units, Unit 3 is more porphyritic, with at least 30% phenocrysts. Again, quartz and sanidine occur in subequal amounts, but fairly distinctive of the phenocryst population of Unit 3 is the relatively coarse crystal size, with most phenocrysts 4 to 6 mm across. Phenocrysts are most commonly euhedra of single crystals or single crystal fragments. Boreholes in TA-3 revealed three surge beds that range from 0.1 feet to 1.1 feet thick within the top 5 feet of Unit 3 (SHB-CMR-10), a surge-like deposit about 2 feet thick at the top of Unit 3 (SHB-CMR-2), and one thin surge bed (about 0.1 feet thick) within the top one foot of Unit 3 (SHB-CMR-6) (Krier et al., 1998b). Most pyroclastic surge deposits in the Tshirege sequence are petrographically difficult, if not impossible, to distinguish from each other macroscopically, although some limited data suggest that they might be distinguished geochemically. The surge deposits are commonly crystal rich (up to 90%), ash poor, and composed of sand-sized grains of crystals and both cognate and accidental lithic fragments. In outcrop, and even in core, these deposits can exhibit sedimentary structures that include plane beds and low-angle crossbeds.

Unit 3T: 0 to greater than 35 feet thick. Unit 3T is not present in the eastern half of the map area, but first appears, on moving west, immediately south of TA-3 in Twomile Canyon and west of Omega Bridge in Los Alamos Canyon. Some of the boreholes in TA-3 appear to have penetrated the feather edge of the Unit 3T flow lobe as it pinches out to the east (Krier et al., 1998a). Unit 3T thickens progressively to the west, but its maximum thickness is unknown because its base is not mapped in the western part of the map area. Unit 3T must have been erupted as a relatively small volume of very high temperature pyroclastic flows because even where it is as thin as 5 to 10 feet, the unit is commonly very densely welded to its top and bottom contacts. The best examples of non- to moderately welded Unit 3T encountered in this project are in TA-3 boreholes where its thickness is less than 5 feet (Krier et al., 1998a and 1998b). In the western part of the map area, Unit 3T has been locally divided into upper and lower subunits that are separated by a prominent surge deposit. There are, however, no appreciable differences in welding or petrography between the upper and lower subunits. Unit 3T is moderately porphyritic with about 20% to 25% phenocrysts, but the phenocryst population includes both large (4 to 6 mm) and small (2 to 3 mm) crystals. Thus, Unit 3T has a phenocryst population that is transitional between Unit 3 (greater than 30% with most 4 to 6 mm) and Unit 4 (10% to 15% with most 2 to 3 mm). Very commonly, Unit 3T is separated from overlying Unit 4 by a crystal-rich surge deposit that can be greater than 2 feet thick.

Unit 4: 0 to 80 feet thick. In the eastern part of the map area, Unit 4 is a thin ignimbrite that pinches out eastward at TA-55. The unit thickens to the west, and is locally subdivided into upper and lower cooling units in Twomile Canyon where it exhibits a welding break. The ignimbrite is relatively pumice and crystal poor with 10% to 15% phenocrysts and less than 5% pumice. Accidental lithic fragments are rare. Near TA-55 the unit is nonwelded to partly welded, but around TA-3 the interior of the unit is typically densely welded. At the base of Unit 4 is the most widespread pyroclastic surge deposit in the study area, but multiple surges occur within all stratigraphic levels of Unit 4. The basal surge is a crystal-rich deposit, which ranges in thickness from 0.3 to 0.5 feet in the eastern part of the map area to greater than 2 feet on the west. The surge is greater than 90% sand-sized crystal and lithic fragments, and exhibits low-angle cross beds and plane beds.

2. Mesa-Top Alluvial Deposits

At many mesa-top localities, such as the Los Alamos County Landfill, silts, sands, gravels, soils, and reworked pyroclastic deposits overlie the Bandelier Tuff. These deposits lie on the erosional surface that cuts either Unit 3 or Unit 4 of the Tshirege Member but are locally useful as a stratigraphic marker. Alluvial gravels contain abundant pumice and dacite clasts and were deposited by a fluvial system that preceded incision of Los Alamos Canyon (Reneau, 1995). Wong et al. (1995) interpreted these deposits as being at least several hundred thousand years old. Analyses of pumices contained in these deposits provide a maximum age of 1.16 to 1.21 Ma (Reneau and McDonald, 1996).

3. Quaternary Terrace Deposits

In a few localities in Twomile and Los Alamos Canyons we surveyed some points on fluvial terraces. The terraces are commonly capped with subrounded gravels that are mostly cobbles of dacitic lithologies. In Los Alamos Canyon, we noted at least two flights of terraces carved into the canyon walls. Although beyond the scope of this project, systematic mapping and dating of these terraces could yield additional age constraints on faulting.

B. Geochemistry

Systematic variations in geochemistry and petrography with respect to stratigraphic position in the Bandelier Tuff have long been recognized (Smith and Bailey, 1966). Smith and Bailey (1966) and Smith (1979) envisioned the Bandelier Tuff as the result of successive eruptions from a large, chemically and mineralogically zoned magma chamber. The petrologic stratigraphy of the outflow sheets reflects an inverted picture of the magma chamber zonations, with the stratigraphically lowest ignimbrites having been derived from the top of the magma chamber in the earliest eruptions and higher deposits in the outflow sequence representing later eruptions from deeper within the zoned magma body. With increasing interest in environmental issues, studies have been done that have begun to document these petrologic variations in the Bandelier Tuff sequence on the Pajarito Plateau (Crowe et al., 1978; Broxton et al., 1995; Rogers, 1995; Stimac et al., in prep.; Warren et al., 1998), and petrographic and geochemical data can be used to "fingerprint" many subdivisions of the Bandelier Tuff stratigraphy.

Geochemical analyses of whole-rock samples from units of the Tshirege Member of the Bandelier Tuff were used in this study to support unit identifications and correlations in the field and in drill holes. Although some units are geochemically distinctive, the geochemistry of an individual sample is not necessarily diagnostic for unit identification. The data for all samples analyzed in this study display a spectrum of chemical variation for many elements (Figures 5, 6, and 7; Appendix B), and portions of some units appear to exhibit overlapping chemical signatures. Thus, geochemical data must be combined with field observations to provide unit identification.

Figures 5 and 6 show the variation of SiO_2 and TiO_2 for all samples and for four geographic groupings of the samples. Samples from the eastern part of the study area around TA-55 (Figure 5a) are from Units 2, 3, and 4. Note that in the vicinity of TA-55 there is a distinct gap between the Unit 4 samples (top left of Figure 5a) and the Unit 2 and 3 samples (lower right of Figure 5a). In contrast, samples from the other three geographical groups in the western part of the study area (Figures 5b and 6) include Unit 3T as well as Units 3 and 4 and have compositions that span this gap. These data illustrate the transitional character of the geochemistry of Unit 3T. It is additionally interesting to note that the compositions of samples from the boreholes (Figures 5b and 6b), taken at more closely spaced stratigraphic intervals than the field samples, span a similar range as the field samples. Thus, in spite of differing sampling intervals, each geographic grouping includes samples from multiple units of the Tshirege Member, and nearly the entire range of SiO_2 and TiO_2 contents is represented in each subgroup.

Figure 7 is a plot of zirconium *versus* barium, which is one of several variation diagrams that are useful for distinguishing among the different units within the Tshirege Member (Krier et al., 1998b). There is a clear chemical zonation with respect to the stratigraphic sequence of units, but Figure 7 shows that the geochemistry of some individual samples does not provide unique unit identification.

C. Structure

1. General

The structural geology of the study area is dominated by normal faulting within the Rendija Canyon (including RCF, F1, F2, F7, and F8 on Plate 1) and Pajarito fault zones (including PF, F3, and F4 on Plate1). These fault zones form a north-trending graben that is bisected by the north-trending section of Diamond Drive (thus, the name Diamond Drive graben; DDG on Figure 2 and Plate 1). The most structurally complex part of the study area is the southern boundary of the Diamond Drive graben around the TA-3 and Los Alamos Canyon areas. Here, the Rendija Canyon

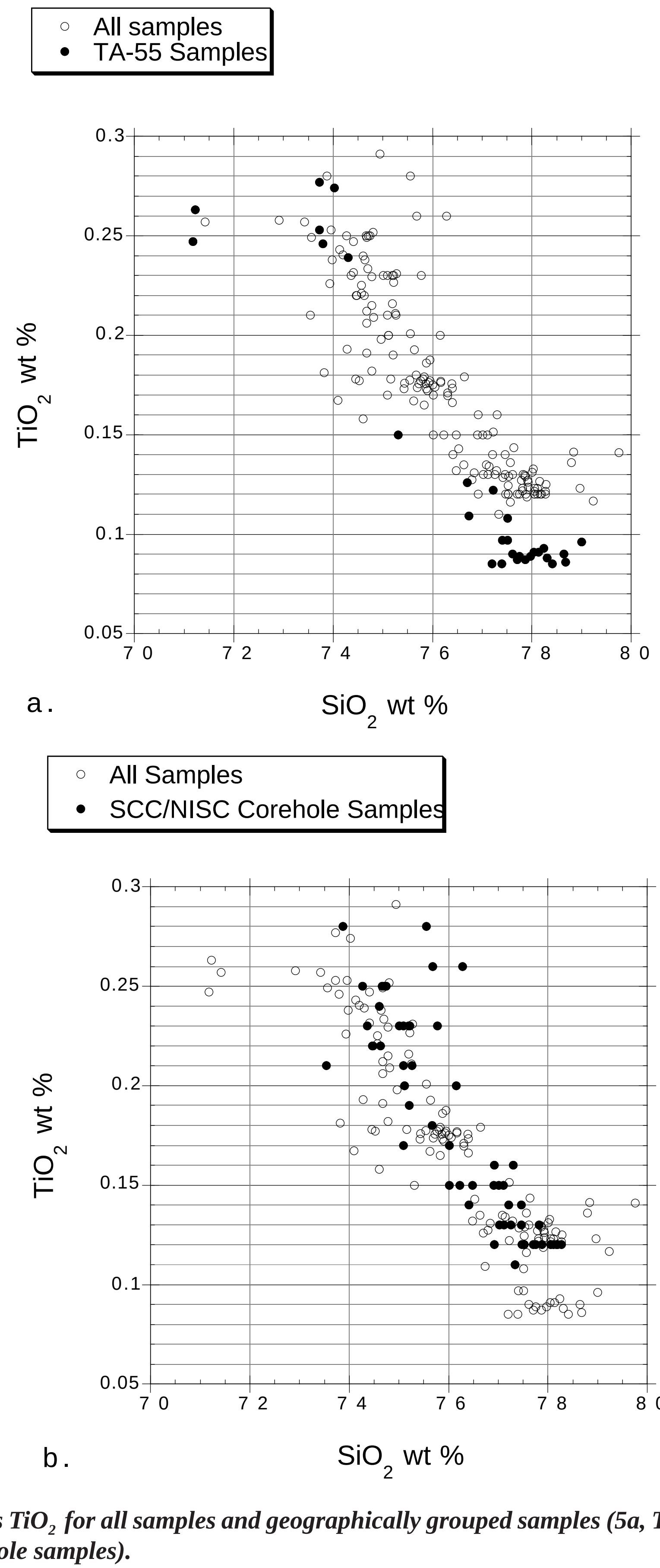
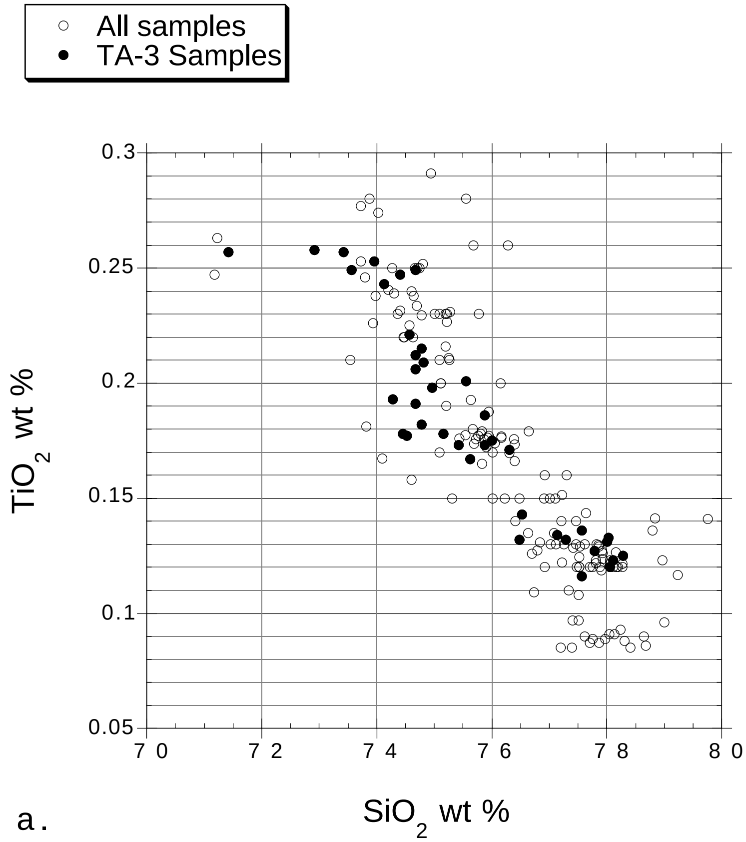
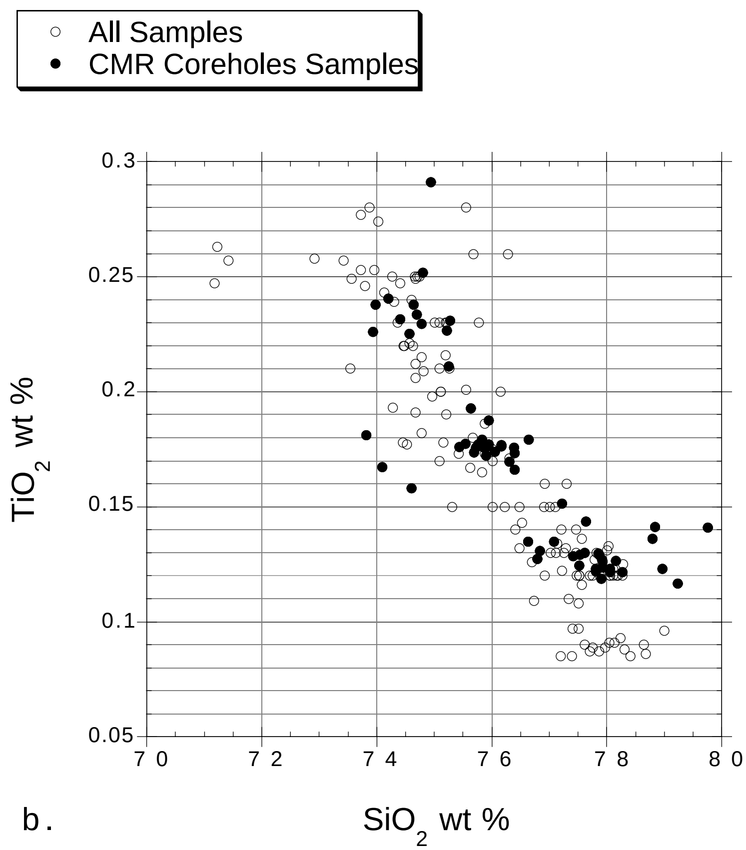


Figure 5: SiO_2 versus TiO_2 for all samples and geographically grouped samples (5a, TA-55 vicinity samples; 5b, SSC/NISC core hole samples).



a.



b.

Figure 6: SiO_2 versus TiO_2 for all samples and geographically grouped samples (6a, TA-3 vicinity samples; 6b, CMR core hole samples).

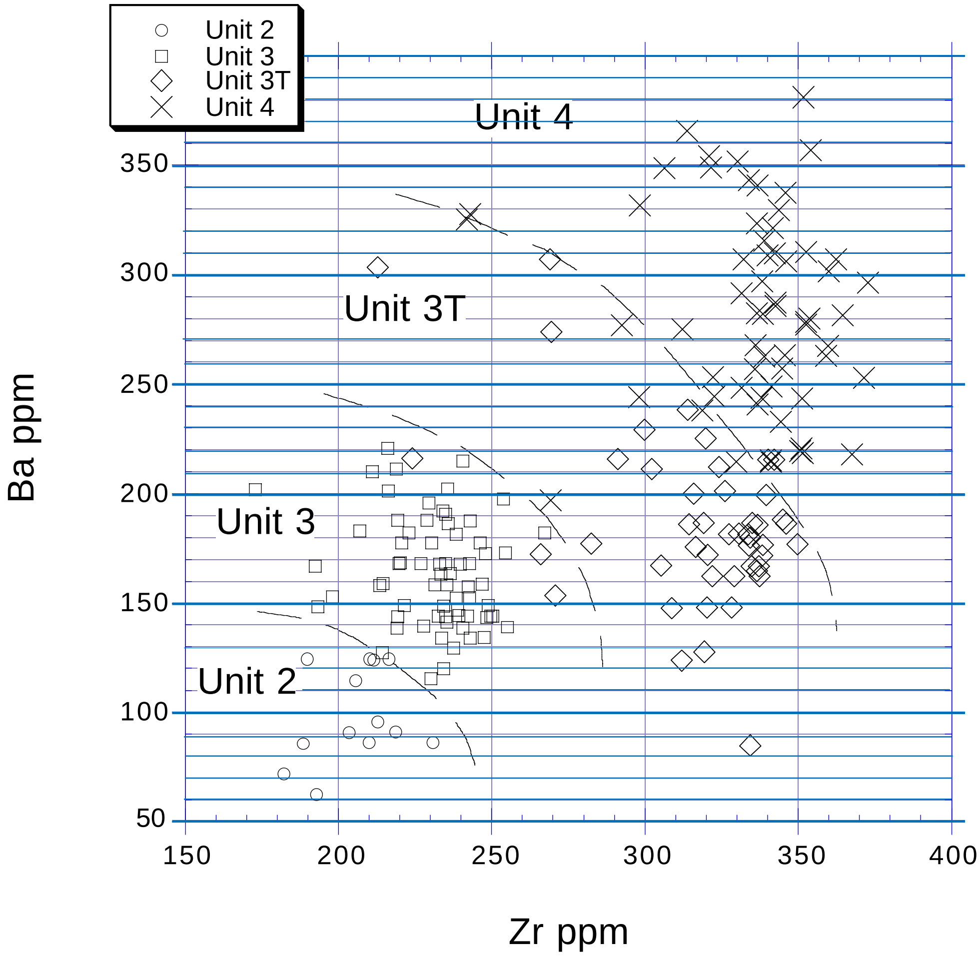


Figure 7: Barium versus zirconium variation diagram, showing compositional fields for Tshirege Member units for all samples from this study. Several variation diagrams of different analytes can be used in combination to "fingerprint" many individual Tshirege Member units.

fault splays into a broad zone of deformation on numerous southwest-trending structures (including F1, F2, F7, and F8 on Plate 1), and east-southeast-trending cross structures (F5 and F6 on Plate 1) accommodate the tilting of large blocks at 1 to 2 degrees to the north-northeast into the large graben. This area marks the zone of structural interactions between the southern end of the Rendija Canyon fault zone, and the master Pajarito fault zone farther west. We infer that the southern end of the Rendija Canyon fault must be near Twomile Canyon because as the southwestern portion of the fault zone broadens, the net displacement across the zone decreases (see "Styles of Deformation," below).

Structure F6 is shown on Plate 1 as an Aerial Photograph Lineament because complete urbanization over the feature prevented our finding any direct evidence for its nature. However, on the 1947 aerial photographs this feature is defined by a 10-foot-high, south-facing scarp, and 1950's engineering drawings for building SM-43 (the Laboratory's Administration Building) show part of this feature as a "fault line." For these reasons, and because the topographic linear that defines F6 is parallel to fault F5, we treat structure F6 as a fault. Feature F6 is not shown on the diagrams of Figure 8 because these figures are general enough to allow its absence. However, in the more detailed cross sections of Figure 9, F6 is shown as a fault, and in the Discussions and Conclusions section we consider it to be a fault.

East of the Diamond Drive graben and its bounding structures, the structural geology of the study area is quite simple. There are few faults south of Los

Alamos Canyon in the eastern part of the study area, and Bandelier Tuff units exhibit a regional strike and dip of about N33E, 5 degrees SE. Within individual canyons, local strikes and dips range from N30E to N70E, 1 to 1.5 degrees SE. The only faults identified in the eastern part of the map area have only 2 and 3 feet of vertical displacement on the Unit 3-Unit 4 contact and could neither be traced along strike nor identified in the Unit 2-Unit 3 contact in that area. Our data regarding these small faults are consistent with the general, empirical relations, observed worldwide, that faults with small displacements also have very short strike lengths (for example Slemmons, 1977; Wells and Coppersmith, 1994).

Figure 8 is a series of diagrams that illustrates the general structure of the area. Figure 8a shows the approximate map locations of Figures 8b, 8c, and 8d, which are three-dimensional models of the surfaces defined by the mapped unit contacts. Figure 8b is mostly the eastern part of the study area with surveyed control points on the top of Unit 2 that were used for the three-dimensional surface construction shown as dots (refer also to Plate 1). Figure 8b illustrates the largely unfaulted surface of Unit 2, between Sandia Canyon and the southern edge of the diagram, dipping gently to the southeast. In contrast, the northwestern corner of Figure 8b includes the southeastern edge of the Diamond Drive graben (DDG on Figure 8 and Plate 1), which appears as part of a bowl-shaped structural depression on the Unit 2 surface. Figure 8b shows that the east and southeastern edges of the Diamond Drive graben are defined by down-to-the-west structural displacements across Rendija Canyon fault zone structures (F1, F2, and F8 on Figure 8b). Gardner et al. (1998a) observed that the regional southeastern dip begins to flatten to the west of TA-48 in Twomile Canyon. The cause of the flattening of the regional dip is a broad zone of small down-to-the-west faults (Zone F8, Figure 8b and Plate 1) near the southern end of the Rendija Canyon fault zone at the southeastern edge of TA-3 and the Diamond Drive graben. Farther west, Figure 8c shows the surface defined by the top of Unit 3, with the southern end of the Diamond Drive graben as the southern part of the bowl-shaped structural depression. The Diamond Drive graben lies between structures of the Rendija Canyon fault zone (F2 and F8 on Figure 8c and Plate 1) and the abrupt uplift along the Pajarito fault zone at the northwestern corner of the diagram (F3 on Figure 8c). Figure 8c also illustrates the importance of the east-southeast-trending cross structures (F5 on Figure 8c, and F5 and F6 on Plate 1) between the Pajarito and Rendija Canyon fault zones. These cross structures appear to represent small faults that resulted from the flexing of the Bandelier Tuff as blocks were gently tilted north into the Diamond Drive graben. In the western portion of the study area, Figure 8d shows the major uplift of the surface of Unit 3T, very similar to the underlying Unit 3 surface (Figure 8c), across the Pajarito fault zone (F3 and F4). Figure 8d also shows that the Unit 3T surface dips gently to the northeast from Twomile Canyon into the southern end of the graben.

It must be noted that the three-dimensional diagrams of Figure 8 have a great deal of vertical exaggeration (ten times) for illustrative and visualization purposes, and structural features, such as the southern end of the Diamond Drive graben beneath TA-3, appear greatly enlarged. In fact, structural blocks dip at less than 2 degrees to the north beneath TA-3, and we have noted significantly thick sequences of sediment—presumably in part graben fill—only at the south edge of Los Alamos Canyon. Additional insights into the general structural relations at the southern end of the Diamond Drive graben in the TA-3 area can be gained from examination of cross sections of Figure 9 (see Plate 1 for cross section locations). Cross section A-A’ (Figure 9a) is nearly parallel to most structures of the southern end of the Rendija Canyon fault, but cuts the east-southeast-trending cross structures at nearly right angles. The section shows that displacements on the cross structures (F5 and F6, Figure 9a and Plate 1) are quite small, and structural blocks dip to the north into the Diamond Drive graben. Cross section B-B’ (Figure 9b) is also nearly parallel to most structures of the southern end of the Rendija Canyon fault

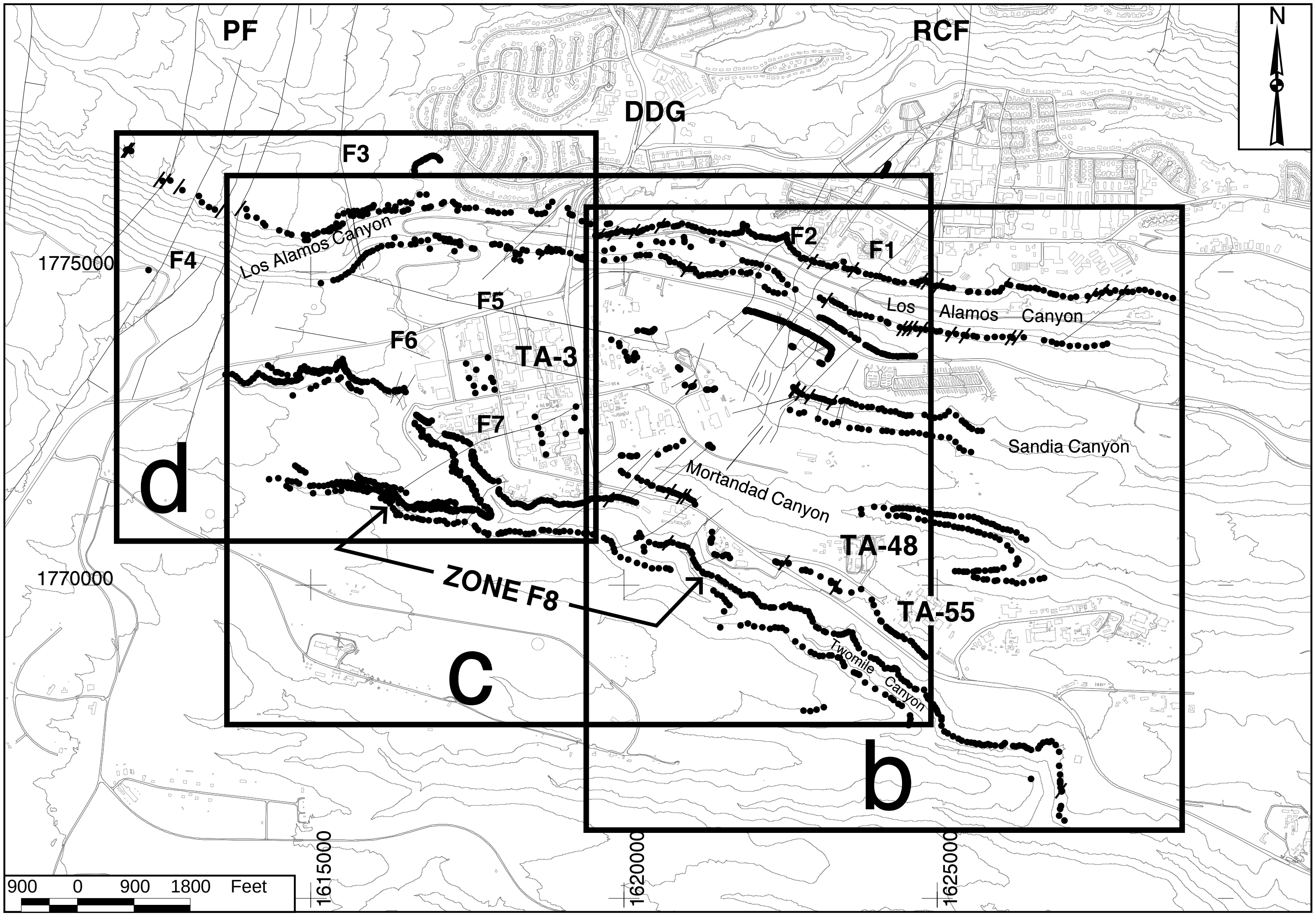


Figure 8a: Reduced-scale map of Plate 1, showing the location of surface diagrams for the top of Unit 2 (Figure 8b), the top of Unit 3 (Figure 8c), and the top of Unit 3T (Figure 8d). Also shown are surveyed points on geologic features and boreholes. Other labels are the same as Plate 1. For each Figure 8 diagram, the surface was interpolated using kriging of data points. The surface grid was modified in areas of no data to approximate the orientation of the surface based on the closest mapped control points. Mapped faults have been superimposed on each modeled surface, but these figures are not structure contour diagrams. Northing and Easting are in the State Plane Coordinate System (in feet), New Mexico Central Zone, 1983 North American Datum.

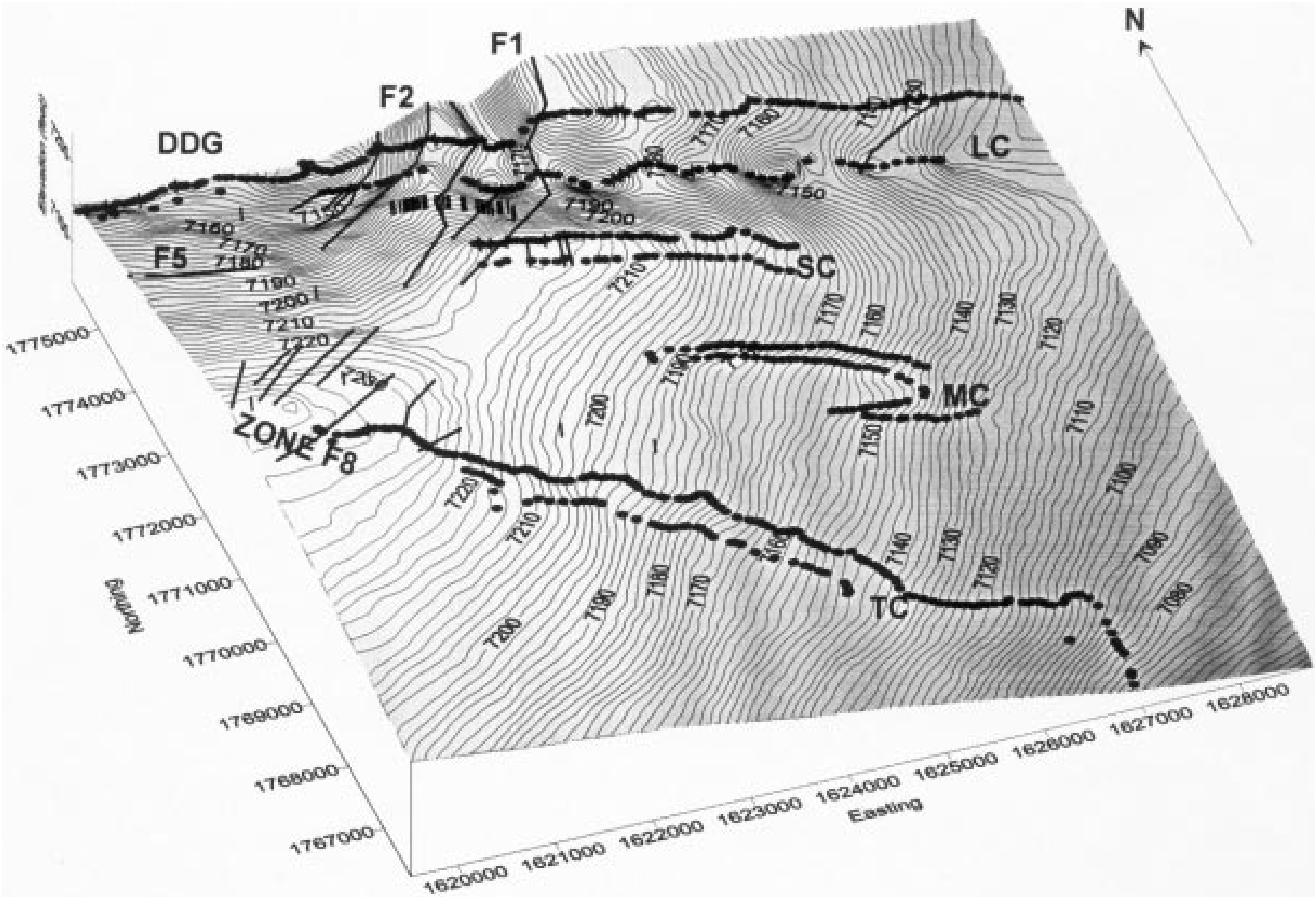


Figure 8b: Oblique aerial view, looking north-northeast, of a three-dimensional surface diagram showing the top of Unit 2 of the Tshirege Member of the Bandelier Tuff. Surveyed points at the Unit 2-Unit 3 contact, used as controls for construction of the figure, are shown, and mapped faults are superimposed on the modeled surface. It should be noted that this is not a structure contour diagram. Vertical exaggeration is 10x, and contour interval is 2 feet. TC = Twomile Canyon, MC = Mortandad Canyon, SC = Sandia Canyon, and LC = Los Alamos Canyon. (See Figure 8a caption for more information).

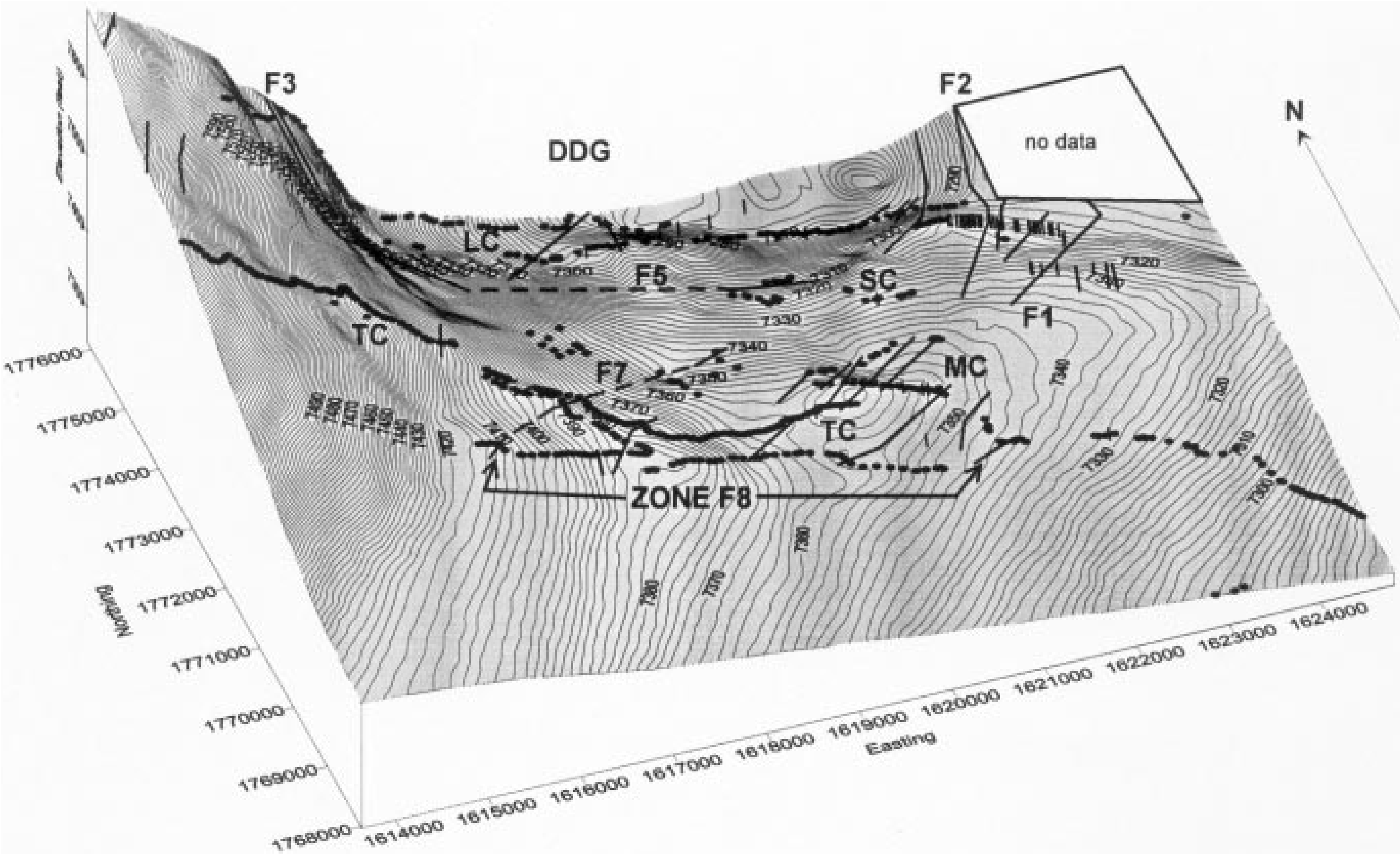


Figure 8c: Oblique aerial view, looking north-northeast, of a three-dimensional surface diagram showing the top of Unit 3 of the Tshirege Member of the Bandelier Tuff. Surveyed points at the Unit 3-Unit 4 and the Unit 3-Unit 3T contacts and locations of these contacts in boreholes, used as controls for construction of the figure, are shown. Mapped faults are superimposed on the surface. Vertical exaggeration is 10x, and contour interval is 2 feet. White polygon in the northeast corner is an area with no data on the top of Unit 3. (See Figure 8a and 8b captions for more information).

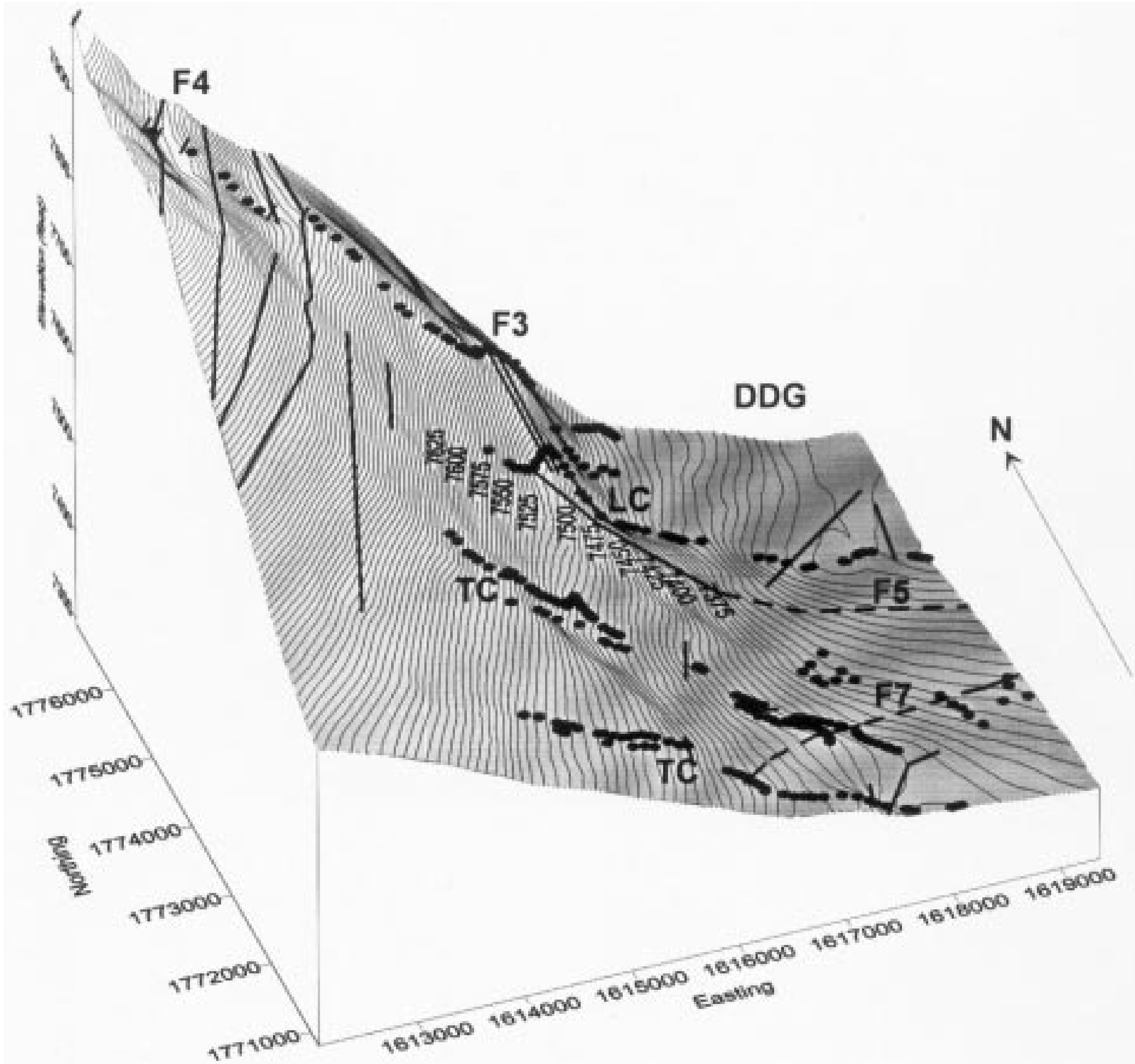


Figure 8d: Oblique aerial view, looking north-northeast, of a three-dimensional surface diagram showing the top of Unit 3T of the Tshirege Member of the Bandelier Tuff. Surveyed points at the Unit 3T-Unit 4 contact and locations of this contact in boreholes are shown, and mapped faults are superimposed on the surface. Vertical exaggeration is 10x, and contour interval is 5 feet. (See Figure 8a and 8b captions for more information).

zone, but the section line obliquely cuts one of the northwesternmost faults of the zone in this area that we have identified (F7, Plate 1). Fault F7 is coincident with some very strongly expressed topographic lineaments on the 1947 aerial photographs and was identified in borehole SHB-CMR-6 (Krier et al., 1998b) and in the north fork of Twomile Canyon (Plate 1). Cross section B-B' (Figure 9b) also intersects the east-southeast-trending cross faults (F5 and F6) and illustrates how these cross structures accommodate the northward tilting of structural blocks into the large Diamond Drive graben. Cross section C-C' (Figure 9c) runs normal to the faults that constitute the Rendija Canyon fault (Zone F8) in upper Mortandad Canyon at the southeastern end of the section line. Cross section C-C' shows that northwest of fault F7 no faults are necessary to explain the contact elevations encountered in the TA-3 boreholes

2. Styles of Deformation

In detail, the styles of deformation within the fault zones are quite complex. Figure 10 is a series of schematic sketches, modified from Powell (1873), that shows the contrasting styles of deformation that we have mapped along strike in the major fault zones. Along the strike of a given structure, deep-seated normal faulting can be expressed at the surface as a spectrum of styles that range from large, but simple, normal faults, to broad zones of smaller faults, to faulted monoclines, to largely unfaulted monoclines (Figure 10). It should be stressed that Figure 10 is meant only to be illustrative of deformational styles, and does not represent actual cross sections in the study area. Because we can document all of these contrasting styles along strike within a given fault zone, we are confident that, in spite of the surface expression of the deformation, all are related to deeper-seated normal faulting.

In the northern part of Los Alamos townsite, the Rendija Canyon fault is a fairly simple, albeit large, normal fault. The fault may include up to several subparallel strands, but for the most part, the style of deformation that forms the scarps at the west ends of Barranca and North Mesas, caused by about 120 feet of displacement in the last 1.22 million years (Kelson et al., 1996), is very similar to what is shown in Figure 10a. Farther south along the strike of the Rendija Canyon fault, around Pueblo Canyon, the fault begins to splay to the southwest into a broader zone of smaller faults similar to Figure 10b. As the fault passes farther southwest beneath downtown Los Alamos and into Los Alamos Canyon, the surface expression of the deformation is dominated by monoclines, or faulted monoclines (Figures 10c and 10d, respectively). Figure 11 is a profile of our surveyed data along the north wall of Los Alamos Canyon, with the points projected into an east-west plane, that shows some of the monoclinal folds associated with the major fault zones. Two monoclines (F1 and F2, Figure 11 and Plate 1) of the Rendija Canyon fault zone display hinge zones and steep western dips on the Unit 2-Unit 3 contact. Structural displacements on these monoclines are about 40 and 50 feet for the eastern and western folds, respectively. It should be noted that faulting of the eastern flanks of monoclines F1 and F2, combined with the regional eastward dip, makes the folds appear to be asymmetrical anticlines in east-west profiles. To the west, two monoclines of the Pajarito fault zone (F3 and F4, Figure 11 and Plate 1) exhibit hinge zones and steep eastern dips on the tops of Units 3 and 3T. Because of the complexity of the structure at this edge of our map area, it is difficult to estimate structural displacements across the Pajarito fault zone, but from the profile, displacements must conservatively exceed 200 feet. In addition to the monoclines, numerous faults cut through the profile of Figure 11 (see also Plate 1). For comparison, Figure 12 is a similar profile of surveyed data from a long stretch of Twomile Canyon on the southern boundary of the study area. At the west end (left side) of Figure 12, unit contacts have steep eastern dips, apparently on the limb of a Pajarito fault zone monoclinal structure to the west of the study area. Figure 12 also shows Unit 3T pinching out eastwards, but the structural character evident in this profile is the down-to-the-west faulting and

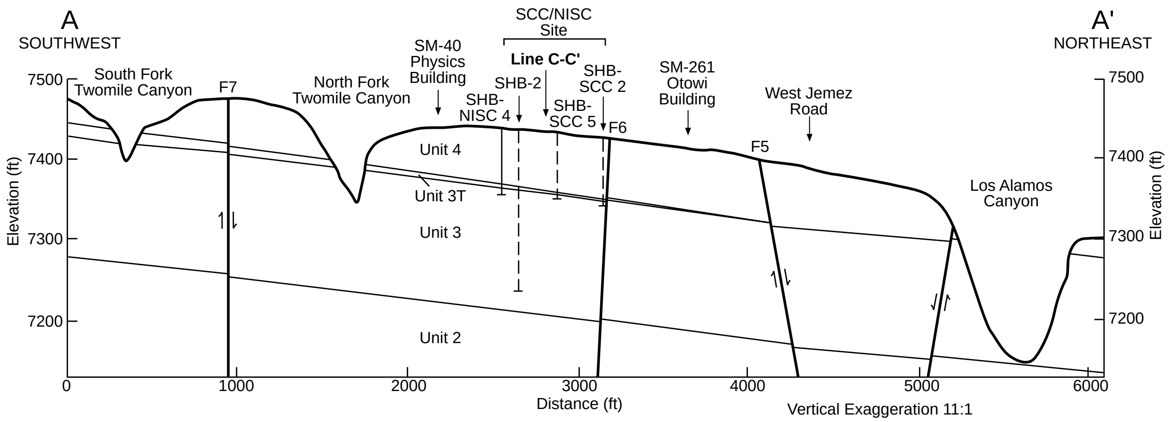


Figure 9a: Cross section in TA-3 area along line A-A' on Plate 1. This section is parallel to most structures of the Rendija Canyon fault and normal to east-southeast-trending cross structures.

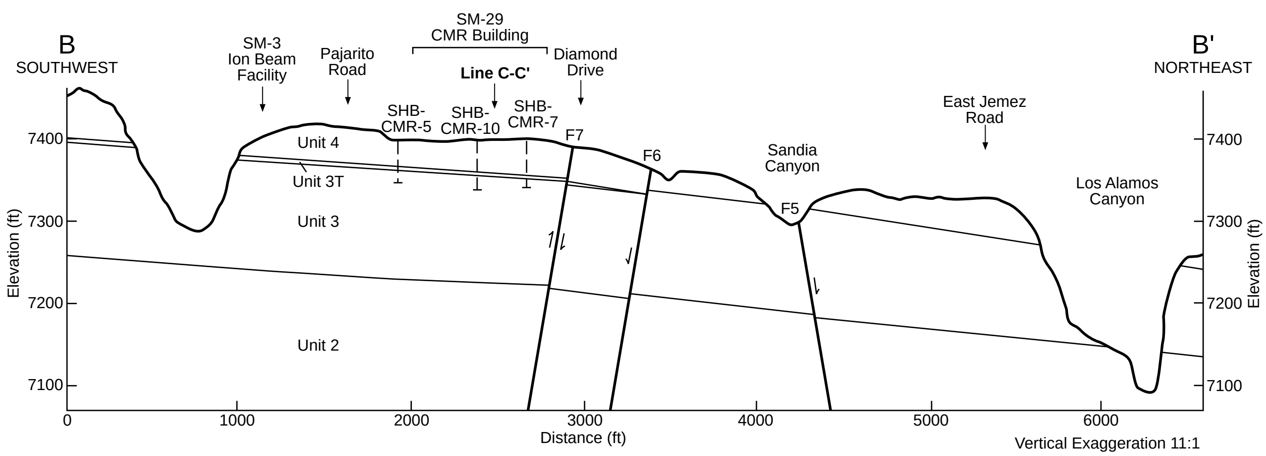


Figure 9b: Cross section in TA-3 area along line B-B' on Plate 1. This section is parallel to most structures of the Rendija Canyon fault and normal to east-southeast-trending cross structures.

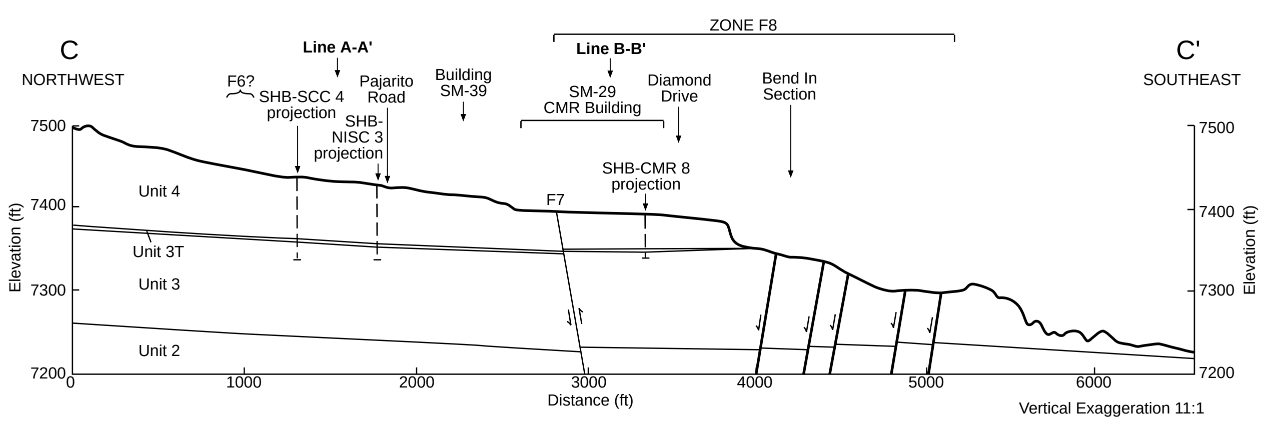


Figure 9c: Cross section in TA-3 area along line C-C' on Plate 1. This section is normal to structures near the southwestern end of the Rendija Canyon fault, but roughly parallel to the east-southeast-trending cross structures.

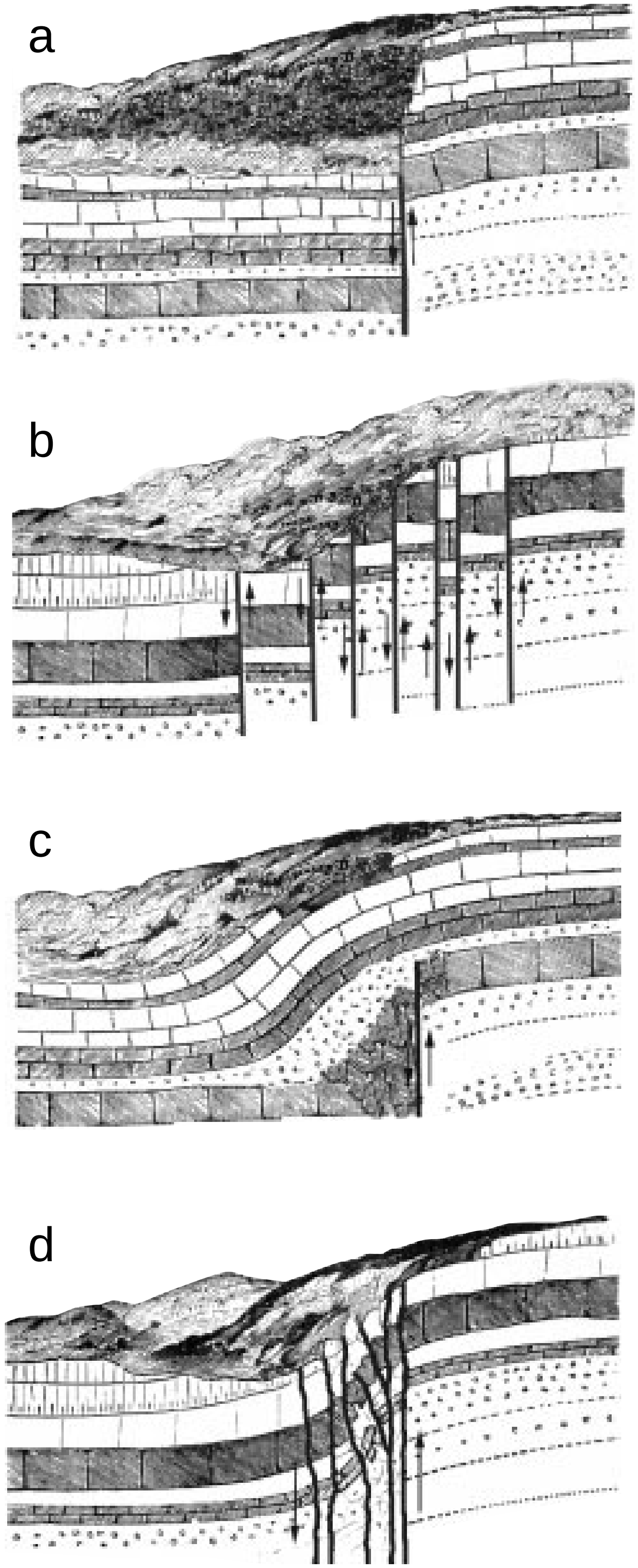


Figure 10: Schematic sketches showing contrasting styles of surface expression of deformation within normal fault zones (modified from Powell, 1873). Figure 10a: simple normal fault with prominent scarp; Figure 10b: broad zone of small normal faults; Figure 10c: monocline with normal fault at depth; Figure 10d: faulted monocline.

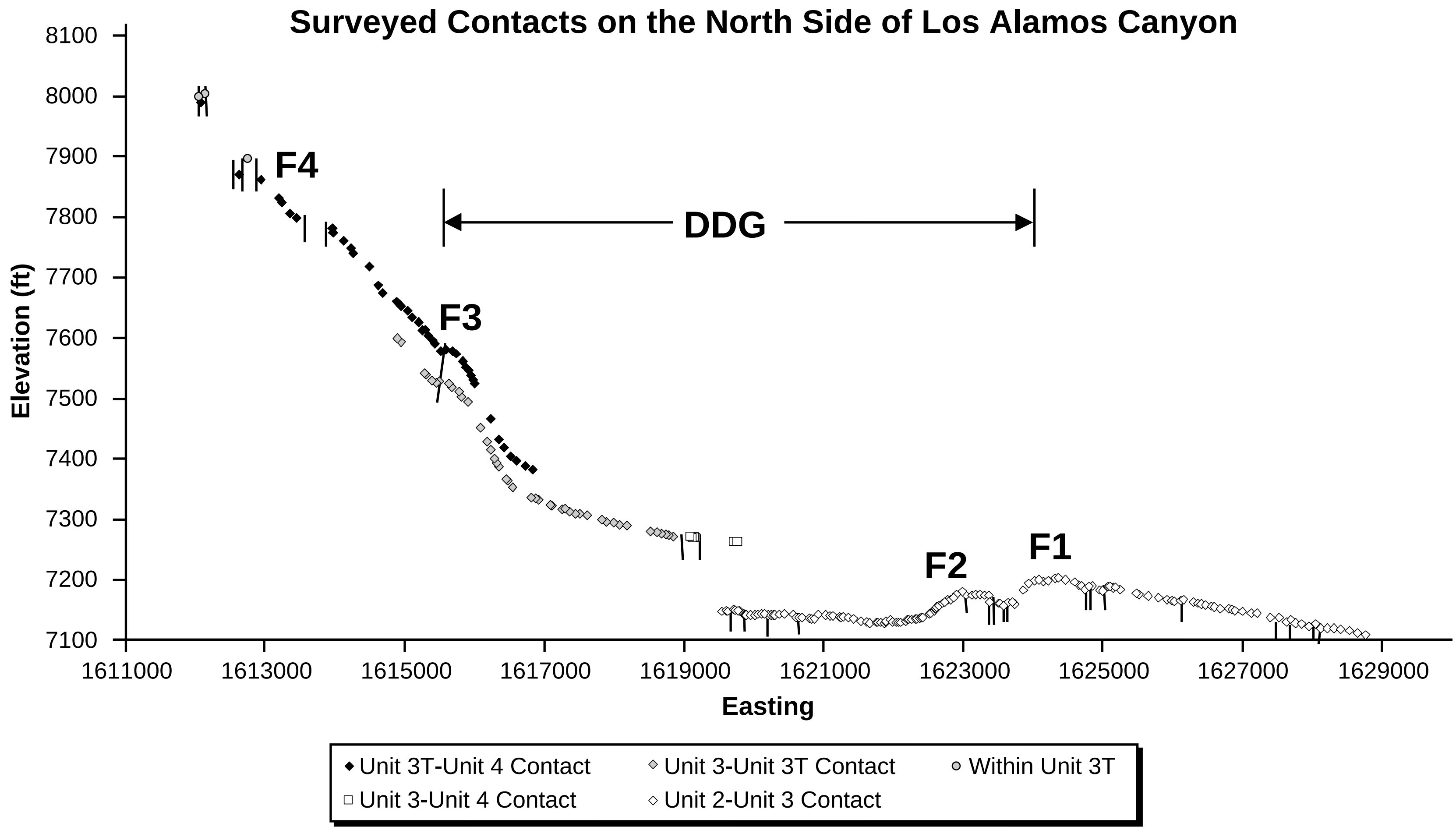


Figure 11: East-west profile of surveyed points on the north side of Los Alamos Canyon. All data are projected into the east-west plane. Mapped faults are shown as black lines. Labels are the same as Plate 1. Easting values are in the State Plane Coordinate System (in feet), New Mexico Central Zone, 1983 North American Datum.

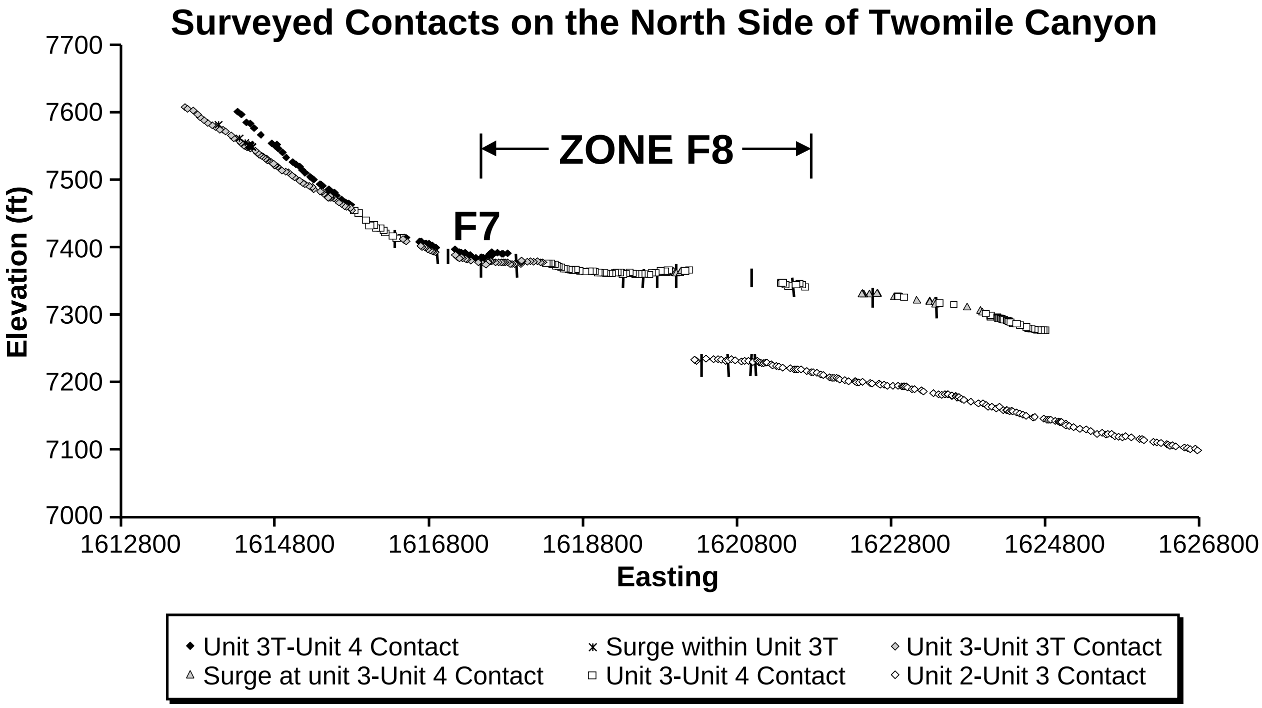


Figure 12: East-west profile of surveyed points on the north side of Twomile Canyon. All data are projected into the east-west plane. Mapped faults are shown as black lines. Labels are the same as Plate 1. Easting values are in the State Plane Coordinate System (in feet), New Mexico Central Zone, 1983 North American Datum.

the resultant flattening of the dip of the contacts (F7 and Zone F8) near the southern end of the Rendija Canyon fault zone (see also Plate 1). The net displacement across this 5,000-foot-wide zone is less than 30 feet, with no displacement on an individual structure greater than about 8 feet. To the east of these features, as discussed above, unit contacts exhibit a gentle southeastern dip and very few, very small faults (Figure 12; see also Plate 1 and Figure 8b).

The Pajarito fault zone at the western margin of the study area is large and complex, and our mapping reveals no signs of it dying out north or south of Los Alamos Canyon. In contrast, moving south along strike on the Rendija Canyon fault, there are significant changes in the style and amount of deformation. Figure 13 is a series of profiles of surveyed data that shows the main zone of deformation around monoclines F1 and F2 of the Rendija Canyon fault zone, from the north side of Los Alamos Canyon, to the south side of Los Alamos Canyon, to the county landfill. The profile at the county landfill in Figure 13 cannot be used for direct comparison of displacements across the fault zone because most of the points surveyed there are on a datum of different age (ie., the Bandelier Tuff–alluvium contact); however, the landfill profile is instructive in that it shows both structure continuity and changing deformational styles along strike. Comparing the Los Alamos Canyon north and south side data on Figure 13, one can readily see that, although major structures have continuity, the amplitude of displacement across the main zone of deformation is significantly reduced in only about 500 feet of distance southwest along strike. In fact, at Los Alamos Canyon the entire Rendija Canyon fault zone is about 2,000 feet wide, at upper Mortandad Canyon it is about 3,000 feet wide, and at Twomile Canyon the fault zone is about 5,000 feet wide. At Los Alamos Canyon there is about 100 feet; at upper Mortandand Canyon there is about 50 feet; and at Twomile Canyon there is less than 30 feet of net down-to-the-west displacement. Thus, we infer that Twomile Canyon, at the southern limit of our mapping, must be very close to the southern terminus of the Rendija Canyon fault zone.

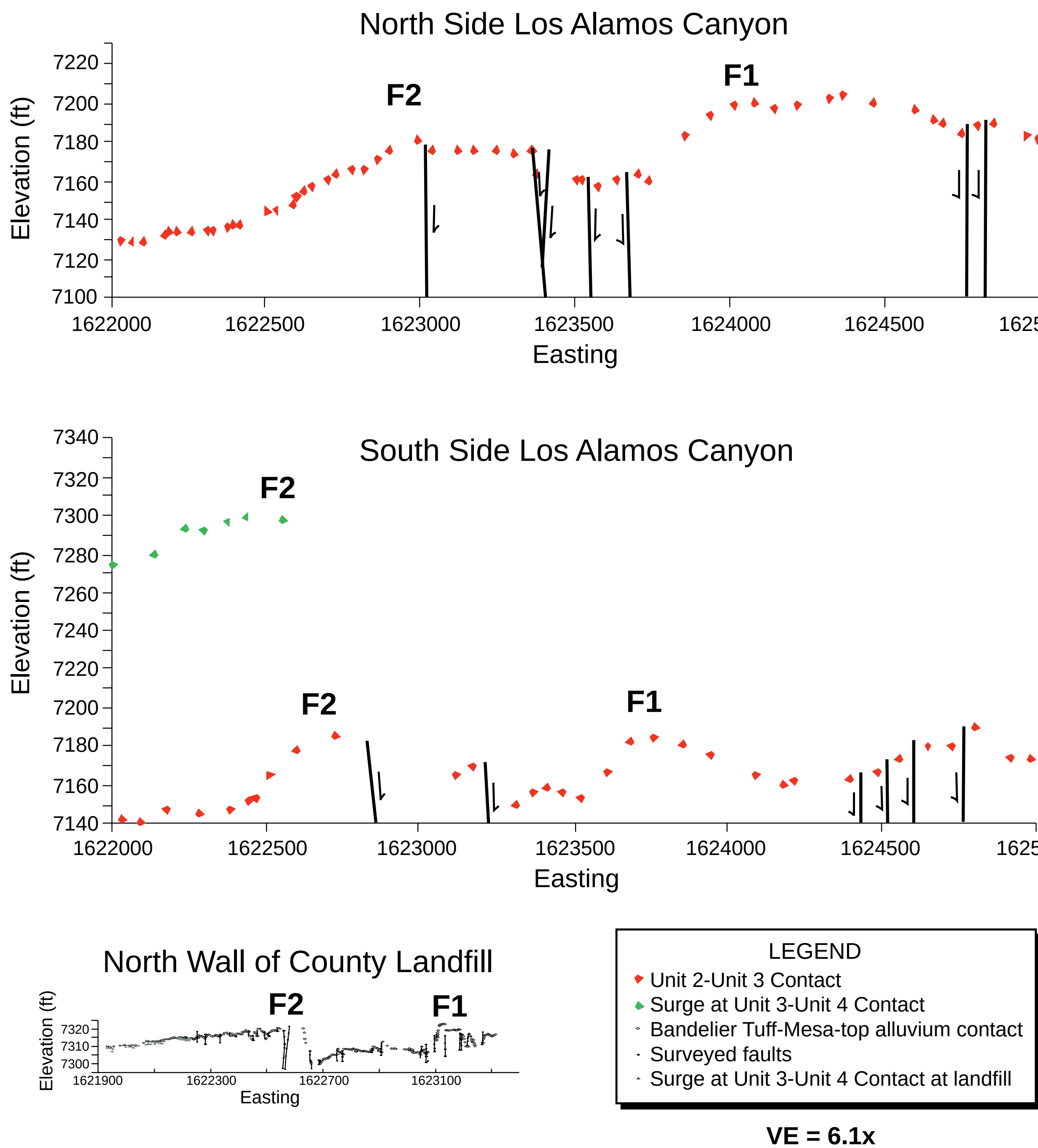


Figure 13: East-west profiles of surveyed contacts showing continuity of structures and changing styles of deformation of part of the Rendija Canyon fault zone from Los Alamos canyon on the north (at top) to the county landfill on the south (at bottom). F1 and F2 mark the top hinge zones of monoclines. Surveyed contacts shown include the Unit 2-Unit 3 contact, and the Unit 3-Unit 4 contact; in the bottom diagram for the county landfill, the Bandelier Tuff–mesa-top alluvium contact and surveyed faults are also shown.

3. The Los Alamos County Landfill Exposure

The exposures of the zone of deformation of the Rendija Canyon fault in the active pit of the Los Alamos County Landfill are important because, not only are exposures excellent, the landfill is the last locality moving southwest along strike where we find displacements greater than 10 feet on individual faults. Furthermore, our displacement datum at this locality is younger than elsewhere in the study area; therefore, the relations at the landfill support our inference that the Rendija Canyon fault is dying out to the southwest. Figure 14 is a series of diagrams that illustrates some of the detailed structural data from the landfill. The primary contact mapped at the landfill was the upper erosional contact of the Bandelier Tuff with mesa-top alluvial deposits. In most places, alluvium overlies Unit 3, but toward the west end of the pit, alluvium overlies Unit 4. Post-Bandelier Tuff sediments were not mapped in detail, but the sedimentary sequence is similar to that logged by Wong et al. (1995), who found the sequence incomplete and not of much use for dating paleoseismic events. The Unit 3-Unit 4 contact was mapped on the north wall of the landfill toward the west end of the pit and on the south wall of the landfill toward the middle of the pit.

Over 40 faults were mapped at the landfill (Figures 14a and 14b) with vertical offsets ranging from less than 1 foot to greater than 15 feet on the Bandelier Tuff–mesa-top alluvium contact. Most common orientations of faults in the landfill are N-S, N20W, or N45E. Net down-to-the-west displacement on the Bandelier Tuff–mesa-top alluvium contact across a deformation zone about 1,200 feet wide is approximately 15 feet. Many of the mapped structures in the landfill can be correlated with those mapped in Los Alamos Canyon and Sandia Canyon (see Figure 13 and Plate 1). Perhaps notable about the fault zone exposures in the landfill is the presence of high-angle reverse faults (Figure 14c; see also Wong et al., 1995). Reverse faulting in the southern part of the Diamond Drive graben is probably not unique to the landfill; in fact, Krier et al. (1998b) present evidence that borehole SHB-CMR-6 penetrated two small reverse faults (F7 on Plate 1).

V. DISCUSSION AND CONCLUSIONS

A. Seismic Surface Rupture Hazard

For commercial nuclear facilities, the Code of Federal Regulations defines a potentially active, or “capable,” fault as a fault with either one movement in the last 35,000 years, more than one movement in the last 500,000 years, or associated micro- or historical macroseismicity. Previous paleoseismic work and recent seismicity have shown that the geomorphically prominent portions of the Pajarito, Rendija Canyon, and Guaje Mountain faults are capable (Gardner et al., 1990; Kelson et al., 1996; McCalpin, 1998; Gardner and House, 1994; House and Gardner, unpublished data, 1998). In addition, the Code of Federal Regulations states that faults that can be shown to be integral parts of, or connected to, other potentially active faults also need to be considered capable. It must be stressed that just because a fault is identified in this study to cut the 1.22-million-year-old Bandelier Tuff, it is not necessarily capable, nor does it necessarily pose hazards.

As discussed above, TA-3 lies within a structurally complex zone at the southern end of the Diamond Drive graben, but TA-55 sits in an area of relatively simple structure. For TA-55 and the eastern part of the study area, the potential for seismic surface rupture has to be extremely low because virtually no deformation in the last 1.22 million years can be documented there. Most of the faults that we have identified south of Los Alamos Canyon are quite small; traceable strike lengths are less than a mile, and with few exceptions none shows more than 10 feet of displacement in the last 1.22 million years (Plate 1). These data indicate that these small faults, with such low slip rates and such short strike lengths, cannot be independently seismogenic (for example, Slemmons, 1977; Wells and Coppersmith, 1994). Most of these small faults south of Los Alamos Canyon probably represent ruptures subsidiary to the major faults, and as such their potential rupture hazard is very small. Olig et al. (1998) calculate a probabilistic displacement hazard for a *principal trace* of the Rendija Canyon fault near its southern end as 0.67 inches in 10,000 years. Thus, even if our interpretations of principal versus subsidiary rupture are not correct, the potential seismic surface rupture hazard is extremely low.

It is clear, however, that the zone of deformation that splays to the southwest from the more obvious trace of the Rendija Canyon fault north of Los

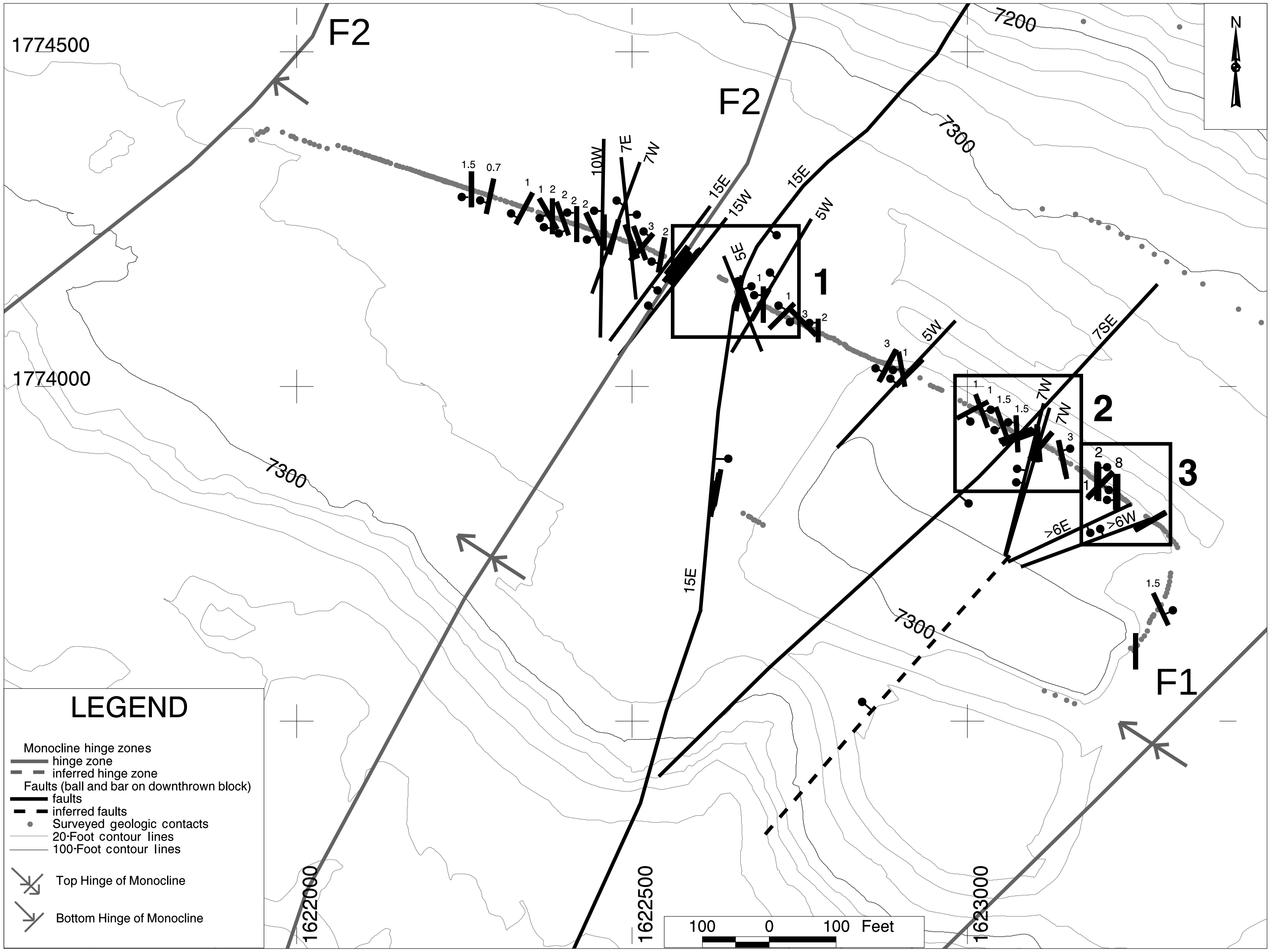


***Figure 14a:** Map of faults and surveyed points along the tuff-alluvium contact at the county landfill. Numbers indicate the amount of vertical offset on the Bandelier Tuff–mesa-top alluvium contact on each mapped fault; on larger faults the sense of offset is also shown (E = down to the east, W = down to the west). For clarity, only faults with greater than 5 feet of vertical offset on the Bandelier Tuff–alluvium contact are also shown in Plate 1 from this locality. Figure 14b is a profile of these data, and boxes labeled 1, 2, and 3 show the locations of photographs 1 to 3 in Figure 14c. Grid is in the State Plane Coordinate System (in feet), New Mexico Central Zone, 1983 North American Datum.*

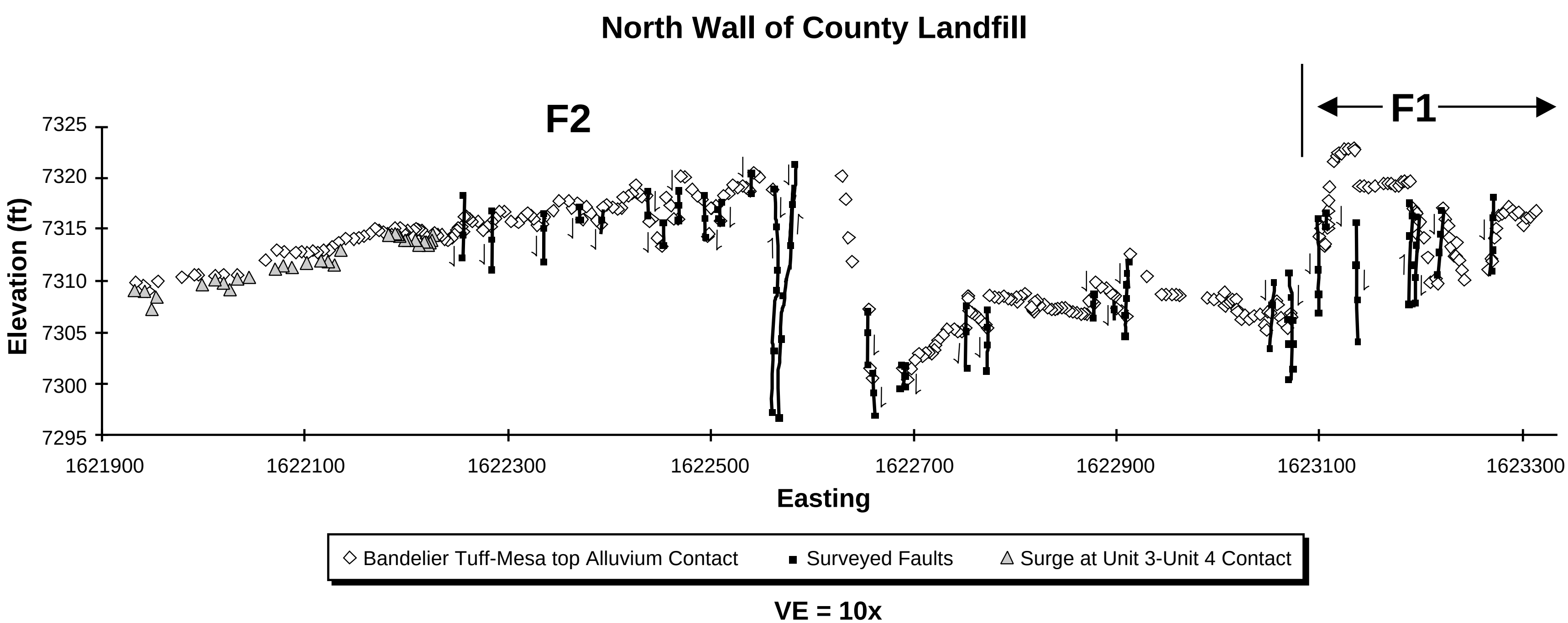


Figure 14b: Profile of surveyed data from the active pit at the Los Alamos County Landfill. Data are projected into an east-west plane. Note that the excellent exposures allowed surveying of points along individual fault planes.

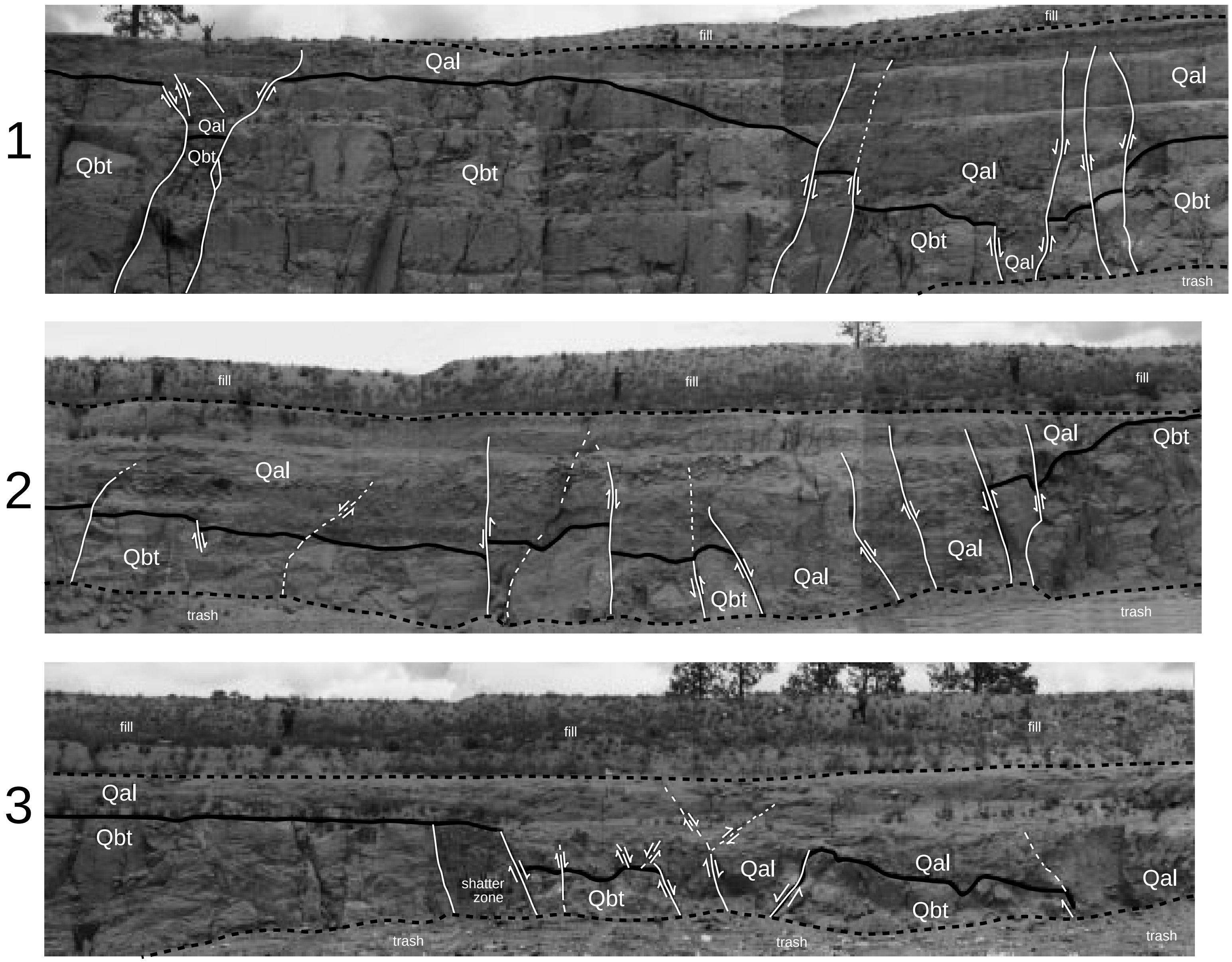


Figure 14c: Photomosaic of portions of the north wall of the county landfill active pit with overlay of data from Figure 14b. See Figure 14a for locations of mosaics. People in the photomosaics serve for scale.

Alamos townsite is part of the potentially active fault zone. From Los Alamos Canyon on the north, structures F1, F2, F7, and F8 (Plate 1) delineate the southern tail of the Rendija Canyon fault zone, and according to the definitions of the Code of Federal Regulations this swath of structures must be considered potentially active, or capable. Similarly, the east-southeast-trending cross faults (F5 and probably F6 on Plate 1) appear to connect the capable Rendija Canyon and Pajarito faults. These cross faults, too, must be considered capable.

The State of California has designated strips of “special study zones” along potentially active faults in that state. For construction in or near these special study zones, legislation mandates detailed site-specific fault investigations to locate the fault(s). Most facilities can be sited with a standoff of at least 50 feet once the exact positions of the faults are known. At Los Alamos, however, the level of detailed geologic studies necessary to designate similar special study zones has not been achieved Laboratory-wide. In our study area, we would recommend that the capable faults and fault zones discussed above be treated as special study zones similar to those of California. Siting of new facilities over potentially active faults should be avoided.

B. Geologic Mapping and Structural Issues

The Rendija Canyon fault zone impinges on the Laboratory and TA-3 from the Los Alamos townsite to the north, where the fault splays to the southwest into a broad zone of deformation. Including monoclinal folds as well as faults, the zone is about 2,000 feet wide where it crosses Los Alamos Canyon and about 5,000 feet wide at Twomile Canyon. It is noteworthy, in this vein, that as the fault zone broadens along strike to the southwest, both displacements on individual faults and net displacements across the whole zone of deformation diminish. These features, the paucity of faults in upper Twomile Canyon, and the lack of any pronounced aerial photograph lineaments to the south and southwest of Twomile Canyon, lead us to conclude that the Rendija Canyon fault dies out to the south of Twomile Canyon.

Vaniman and Wohletz (1990) inferred that the southern end of the Rendija Canyon fault continued south from near TA-48, based largely on zones of greater fracture abundance. In similar studies Wohletz (1995; 1996) discovered zones of abundant fractures in Los Alamos Canyon and concluded that they are probably indicative of faulting. Ensuing detailed studies, however, have shown no correlations between most of these zones of abundant fractures and faulting (Kolbe et al., 1994; Kolbe et al., 1995; Reneau et al., 1995; Gardner et al., 1998a; this study). One exception is in Los Alamos Canyon near TA-2 (at the eastern edge of our study area) where Wohletz (1996) noted a zone of abundant fractures that appears to correlate with several of our mapped faults.

Although results of our high-precision geologic mapping differ in detail from the mapping of Rogers (1995), especially with respect to structures and their placement, we have enjoyed the benefit of the high-precision mapping technique and a high-quality GIS for integration of data. Given that, the general nature of Rogers’ (1995) map is not too inconsistent with what we document. We agree with Rogers (1995) that there is a broad zone of deformation between the landfill and Omega Bridge in Los Alamos Canyon, but we would restrict that zone of greatest deformation to a 2,000-foot-wide swath, centered on the landfill. Additionally, we agree with Rogers (1995) that there is a broad zone of deformation west of TA-3 in Los Alamos Canyon which is part of the Pajarito fault zone. As noted above, Rogers (1995) inferred the presence of faults in many canyon bottoms; we find no evidence for these east-trending canyon bottom faults. Rogers (1995) may have inferred the presence of these canyon bottom faults because of numerous small faults that cut obliquely across the canyon. For example, in upper Mortandad Canyon at the eastern edge of Zone F8 (Plate 1), looking due north across the canyon gives a sense that the north side of the canyon is downdropped relative to the south. While this observation is generally true, the causative faults cut across the canyon with southwest strikes and do not trend east in the canyon bottom.

Our stratigraphic framework for the Tshirege Member of the Bandelier Tuff is based on the work of Broxton and Reneau (1995), which is derived from the earlier work of Vaniman and Wohletz (1990). Thus, most of our units correlate well with those defined by Broxton and Reneau (1995). However, these earlier workers based many unit contacts on topographic features that, while useful at some scales, are not sufficiently precise for the purposes of our study. Consequently, placement of our unit contacts differs from earlier workers in detail, and our contacts are placed at lithologic changes in the stratigraphic sequence that can be consistently recognized in the field. Additionally, we have mapped a number of previously unrecognized units in the Tshirege Member. In a similar fashion, part of our stratigraphy generally correlates with that employed by Rogers (1995). We have found that Rogers' (1995) Units C and D are much the same as our Units 2 and 3. Stratigraphically above our Unit 3 and Rogers' (1995) Unit D, however, there are no consistent correlations of units. Part of the problem with correlation of our units is that Rogers (1995) did not recognize many of the local units we have identified in the western part of the Laboratory (for example, Unit 3T). We have found that Rogers (1995) included Unit 3T in her Unit D in some places and in her Unit E elsewhere. The higher portions of the Bandelier Tuff stratigraphy are complicated and deserve further detailed study.

C. Summary

1) The Pajarito and Rendija Canyon fault zones define the Diamond Drive graben. The graben trends north and lies beneath the western part of the Los Alamos townsite, with its southern end in the TA-3 area. East-southeast-trending cross structures define the southern end of the graben and connect the Rendija Canyon and Pajarito fault zones.

2) The Rendija Canyon fault changes from a fairly large, mostly single trace normal fault in the northern part of Los Alamos to a broad zone of smaller faults to the south and southwest. The Rendija Canyon fault zone impinges on the Laboratory and TA-3 from the Los Alamos townsite to the north, and the fault zone gets wider along strike to the southwest. A number of features lead us to the conclusion that the Rendija Canyon fault dies out just south of Twomile Canyon.

3) Contrasting styles of deformation, as expressed at the surface, along strike within the major fault zones can range from fairly simple, large normal faults, to broad zones of smaller faults, to monoclines, and to faulted monoclines. Hard constraints are not available, but we suspect contrasting stratigraphic rheologies may be responsible for these variable styles of deformation. Haneberg (1992; 1993) and Plotnikov (1994), for example, have shown that contrasting near-surface mechanical stratigraphies within normal fault zones can be responsible for the differing styles of deformation that we observe. For the local fault zones, we suspect that local thicknesses of unconsolidated sands and gravels at the Cerro Toledo horizon, between the Tshirege and Otowi Members of the Bandelier Tuff, may accommodate a great deal of strain with failure along the stratigraphic horizon; the result is monoclinal folding at the surface, masking normal fault rupture at depth.

4) The seismic surface rupture hazard in the study area is probably very low. TA-3 lies within a structurally complex zone at the southern end of the Diamond Drive graben, whereas TA-55 sits in an area of relatively simple structure. For TA-55 and the eastern part of the study area, the potential for seismic surface rupture has to be extremely low because virtually no deformation in the last 1.22 million years can be documented there. In TA-3, the worst-case scenario would be for facilities sited directly on a *principal rupture plane* of a potentially active fault. Olig et al. (1998) calculate the probabilistic displacement hazard for this worst-case scenario as less than 0.67 inches of displacement in 10,000 years.

5) Although the probabilities for seismic surface rupture are extremely low, the Rendija Canyon fault

zone, the Pajarito fault zone, and the east-southeast trending cross faults must be considered potentially active, or "capable" in the definitions of the Code of Federal Regulations. We recommend, that for facility siting and new construction, these capable fault zones should be treated in a fashion similar to the special study zones of California and that siting new facilities over the trace of a potentially active fault should be avoided.

VI. ACKNOWLEDGEMENTS

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VIII. APPENDIX A: TOTAL STATION SURVEY DATA

Appendix A-1: Surveyed Points for Geologic Units

Appendix A-2: Surveyed Points on Faults at the County Landfill and Downtown Los Alamos Construction Sites

Appendix A-1: Surveyed Points

Explanation of Mapped Contact codes

2 = Within Unit 2
2-3 = Unit 2–Unit 3 Contact
3 = Within Unit 3
3-3T = Unit 3–Unit 3T Contact
S3-3T = Base of surge at Unit 3–Unit 3T Contact
3Tl-u = Contact of Upper and Lower Unit 3T
S3T = Surge within Unit 3T
3T = Within Unit 3T
S3Tl-u = Base of surge at Upper-Lower Unit 3T Contact
3-4 = Unit 3–Unit 4 Contact
S3-4 = Base of surge at Unit 3–Unit 4 Contact
3T-4 = Unit 3T–Unit 4 Contact
S3T-4 = Base of surge at Unit 3T–Unit 4 Contact
S4= Surge within Unit 4
4WB = Welding break within Unit 4
T-A = Bandelier Tuff—Alluvium Contact
Qt = Quaternary Terrace Gravels

Mapped Contact	Northing	Easting	Elevation	Mapped Contact	Northing	Easting	Elevation
2	1775552.28	1620950.30	7134.20	3	1775471.73	1620956.57	7154.29
2	1775493.11	1621397.39	7120.40	3	1775175.66	1619675.67	7287.00
2	1775441.13	1621569.88	7113.93	3	1775234.63	1619331.92	7283.30
2-3	1775574.21	1619532.25	7147.14	2-3	1771076.30	1624537.97	7181.11
2-3	1775574.89	1619595.39	7148.06	2-3	1771096.61	1624484.76	7181.70
2-3	1775609.38	1619798.19	7148.71	2-3	1771101.52	1624438.10	7182.77
2-3	1775619.73	1619859.57	7143.92	2-3	1771095.38	1624341.26	7183.57
2-3	1775618.52	1619871.16	7141.87	2-3	1771103.86	1624208.79	7184.76
2-3	1775621.11	1619875.21	7142.02	2-3	1770415.74	1626278.09	7143.23
2-3	1775619.45	1619879.63	7142.60	2-3	1770383.42	1626288.46	7142.96
2-3	1775620.69	1620205.13	7141.28	2-3	1770265.42	1626055.12	7148.43
2-3	1775611.96	1621526.99	7131.53	2-3	1770238.48	1625950.55	7149.37
2-3	1775276.70	1622777.66	7166.81	2-3	1770228.18	1625853.86	7150.75
2-3	1775210.43	1622818.20	7166.77	2-3	1770240.77	1625906.55	7149.53
2-3	1775200.16	1622901.67	7175.35	2-3	1770220.85	1625760.27	7152.98
2-3	1775147.99	1623034.51	7175.17	2-3	1770223.93	1625660.83	7154.65
2-3	1775127.73	1623120.77	7175.04	2-3	1770219.74	1625617.64	7155.06
2-3	1775121.56	1623171.07	7175.29	2-3	1770211.03	1625573.05	7155.56
2-3	1775095.13	1623244.80	7175.44	2-3	1770208.04	1625472.82	7156.07
2-3	1775079.49	1623301.39	7173.70	2-3	1770210.23	1625436.23	7157.12
2-3	1775153.80	1623501.00	7161.31	2-3	1770208.55	1625407.06	7157.85
2-3	1775055.53	1623520.17	7160.88	2-3	1770216.26	1625344.27	7159.17
2-3	1775041.84	1623635.53	7161.72	2-3	1770217.16	1625277.31	7159.71
2-3	1774931.82	1624017.62	7198.72	2-3	1770121.71	1625582.27	7152.27
2-3	1774893.95	1624144.27	7197.70	2-3	1770106.48	1625637.18	7151.94
2-3	1774879.22	1624216.96	7198.54	2-3	1770084.57	1625731.79	7148.13
2-3	1774847.14	1624320.12	7202.16	2-3	1770082.17	1625787.71	7146.90
2-3	1774828.61	1624366.61	7203.78	2-3	1770056.88	1625914.28	7144.32
2-3	1774823.09	1624462.99	7200.70	2-3	1770720.64	1626419.12	7143.98
2-3	1774812.20	1624656.18	7191.01	2-3	1770755.74	1626334.95	7144.97
2-3	1774751.32	1625148.19	7187.12	2-3	1770836.48	1626262.67	7149.20
2-3	1774734.68	1625246.55	7184.13	2-3	1770864.97	1626165.91	7150.69
2-3	1774681.53	1625516.23	7176.03	2-3	1770878.29	1626110.95	7152.92
2-3	1770718.93	1625988.43	7150.65	2-3	1770886.79	1626045.04	7154.70
2-3	1770754.10	1625918.54	7151.27	2-3	1770921.35	1625973.03	7156.07
2-3	1770790.65	1625847.16	7151.84	2-3	1770934.70	1625938.29	7156.63
2-3	1770802.89	1625749.58	7155.37	2-3	1770964.15	1625887.74	7158.97
2-3	1770831.09	1625674.07	7158.18	2-3	1770973.41	1625851.20	7160.18
2-3	1770841.93	1625632.00	7159.34	2-3	1770995.62	1625782.75	7161.50

Appendix A-1: Surveyed Points (cont.)

Mapped Contact	Northing	Easting	Elevation	Mapped Contact	Northing	Easting	Elevation
2-3	1770865.75	1625552.27	7162.30	2-3	1771014.37	1625719.72	7163.12
2-3	1770886.86	1625485.57	7164.46	2-3	1771038.39	1625687.74	7163.95
2-3	1770903.10	1625392.82	7166.18	2-3	1771056.50	1625647.12	7164.69
2-3	1770910.19	1625329.68	7166.64	2-3	1771082.74	1625581.66	7165.86
2-3	1770929.71	1625264.06	7168.08	2-3	1771090.78	1625496.01	7168.70
2-3	1770955.60	1625173.56	7169.44	2-3	1771090.44	1625376.66	7171.24
2-3	1770958.47	1625113.51	7171.17	2-3	1771095.57	1625259.13	7172.81
2-3	1770970.17	1625031.59	7172.17	2-3	1771107.71	1625212.51	7173.63
2-3	1770986.64	1624950.80	7172.68	2-3	1771115.59	1625154.26	7174.30
2-3	1771007.77	1624890.59	7174.08	2-3	1771114.73	1625108.79	7174.81
2-3	1771026.31	1624790.91	7177.56	2-3	1771126.28	1625038.53	7176.78
2-3	1771053.43	1624690.88	7178.81	2-3	1771130.58	1624994.69	7177.44
2-3	1771195.42	1624700.18	7184.05	2-3	1771137.41	1624933.02	7179.21
2-3	1771210.90	1624614.92	7185.18	2-3	1771148.21	1624851.62	7179.63
2-3	1771215.28	1624569.14	7186.24	2-3	1771165.71	1624787.30	7181.57
2-3	1771222.98	1624510.47	7186.80	2-3	1768093.20	1624929.95	7142.32
2-3	1771223.02	1624447.68	7187.84	2-3	1768005.35	1624983.88	7141.04
2-3	1771222.95	1624387.97	7188.13	2-3	1767980.72	1624994.35	7141.25
2-3	1771217.67	1624339.45	7189.11	2-3	1767942.79	1625012.36	7140.27
2-3	1771205.28	1624291.00	7189.71	2-3	1767880.54	1625064.06	7138.34
2-3	1771227.78	1624144.32	7191.23	2-3	1767840.59	1625062.00	7136.79
2-3	1771242.24	1623984.74	7194.40	2-3	1767752.37	1625065.41	7135.81
2-3	1771204.23	1623776.10	7196.52	2-3	1767653.33	1625111.72	7134.62
2-3	1771127.07	1623783.82	7196.19	2-3	1767622.75	1625165.13	7133.07
2-3	1769656.70	1622551.01	7197.73	2-3	1767581.55	1625248.46	7131.06
2-3	1769645.98	1622522.70	7197.99	2-3	1767542.06	1625331.76	7129.83
2-3	1769632.68	1622387.11	7199.77	2-3	1767508.95	1625391.07	7127.03
2-3	1769635.45	1622355.69	7199.64	2-3	1767490.15	1625470.07	7123.68
2-3	1769634.82	1622340.56	7200.98	2-3	1767477.49	1625534.77	7124.34
2-3	1769637.96	1622326.89	7201.04	2-3	1767468.78	1625584.88	7122.42
2-3	1769648.47	1622243.75	7201.60	2-3	1767458.97	1625616.49	7123.40
2-3	1769661.44	1622193.62	7202.95	2-3	1767463.43	1625664.63	7122.48
2-3	1769722.12	1622131.46	7204.04	2-3	1767442.65	1625701.46	7119.64
2-3	1769745.60	1622116.29	7205.31	2-3	1767437.14	1625750.34	7119.18
2-3	1769793.49	1622088.18	7205.96	2-3	1767456.69	1625801.66	7118.10
2-3	1769824.51	1622055.18	7206.07	2-3	1767441.14	1625844.68	7119.84
2-3	1769839.60	1622037.59	7206.27	2-3	1767429.49	1625918.51	7118.03
2-3	1769842.03	1621997.79	7207.14	2-3	1767427.14	1626021.64	7115.85
2-3	1769834.73	1621915.49	7210.13	2-3	1767449.53	1626054.51	7115.59
2-3	1769832.35	1621879.28	7210.69	2-3	1767424.75	1626209.15	7111.62
2-3	1769890.29	1621828.89	7213.98	2-3	1767415.52	1626254.58	7110.96
2-3	1769916.99	1621779.30	7214.66	2-3	1767428.84	1626304.02	7109.25
2-3	1769929.74	1621759.94	7214.77	2-3	1767425.11	1626378.01	7107.63
2-3	1769964.04	1621698.21	7215.90	2-3	1767413.27	1626395.28	7106.87
2-3	1770013.75	1621626.23	7218.32	2-3	1767393.87	1626419.78	7105.99
2-3	1770049.94	1621566.17	7219.05	2-3	1767382.26	1626449.49	7106.20
2-3	1770073.88	1621532.93	7218.83	2-3	1767364.14	1626492.27	7104.80
2-3	1770041.74	1621588.87	7218.73	2-3	1767429.06	1626642.97	7101.82
2-3	1770141.76	1621391.30	7221.43	2-3	1767478.02	1626684.70	7100.92
2-3	1770165.54	1621335.13	7222.84	2-3	1767495.04	1626744.22	7101.08
2-3	1770170.36	1621307.68	7223.62	2-3	1767485.64	1626783.82	7098.93
2-3	1770204.44	1621244.93	7225.84	2-3	1767502.97	1626820.24	7099.07

Appendix A-1: Surveyed Points (cont.)

Mapped Contact	Northing	Easting	Elevation	Mapped Contact	Northing	Easting	Elevation
2-3	1770266.44	1621179.74	7229.00	2-3	1767439.72	1626883.93	7096.31
2-3	1770284.91	1621164.75	7228.90	2-3	1767331.41	1626942.51	7092.53
2-3	1770325.81	1621143.79	7227.60	2-3	1766967.55	1626953.54	7088.99
2-3	1770365.80	1621120.58	7227.76	2-3	1766760.48	1626960.65	7083.23
2-3	1770407.54	1621098.83	7228.36	2-3	1766869.18	1626954.94	7085.29
2-3	1770495.82	1621078.14	7230.00	2-3	1767104.43	1626943.76	7092.23
2-3	1770530.87	1621058.34	7231.38	2-3	1766468.22	1626969.49	7075.96
2-3	1768322.41	1624782.66	7145.37	2-3	1766422.44	1626958.32	7073.43
2-3	1768227.13	1624820.34	7143.89	2-3	1766307.85	1626943.26	7071.74
2-3	1768185.15	1624848.54	7144.25	2-3	1766234.80	1627029.53	7068.93
2-3	1768157.53	1624875.09	7144.15	2-3	1768671.82	1624202.17	7162.86
2-3	1768770.54	1624062.30	7163.71	2-3	1768162.24	1624301.31	7152.59
2-3	1768247.23	1624165.32	7156.03	2-3	1768733.02	1624110.20	7163.33
2-3	1768807.58	1624029.72	7166.16	2-3	1768190.30	1624255.90	7153.75
2-3	1768334.60	1624002.76	7159.25	2-3	1768557.68	1624375.56	7156.58
2-3	1768817.81	1623989.90	7167.78	2-3	1768641.51	1624360.38	7157.47
2-3	1768435.63	1623845.16	7162.89	2-3	1768654.84	1624294.19	7158.55
2-3	1768840.34	1623933.69	7168.88	2-3	1768651.99	1624255.48	7158.64
2-3	1768567.62	1623739.21	7166.98	2-3	1768664.80	1624161.78	7160.38
2-3	1768900.04	1623828.48	7171.37	2-3	1768668.77	1624308.59	7157.82
2-3	1768586.90	1623702.78	7166.26	2-3	1768658.11	1624338.27	7156.75
2-3	1768705.47	1623511.97	7170.46	2-3	1766900.37	1626494.58	7098.14
2-3	1768868.44	1623270.64	7177.36	2-3	1767753.36	1624534.05	7144.75
2-3	1769140.25	1623659.61	7177.12	2-3	1767782.45	1624561.84	7144.12
2-3	1769107.34	1623675.93	7177.50	2-3	1767811.25	1624560.99	7144.21
2-3	1769171.49	1623648.09	7178.27	2-3	1767855.07	1624566.55	7144.50
2-3	1769231.78	1623639.02	7179.15	2-3	1767914.67	1624563.89	7144.81
2-3	1769246.32	1623581.29	7180.31	2-3	1768067.59	1624428.17	7149.42
2-3	1769226.13	1623527.84	7182.17	2-3	1768100.23	1624371.26	7150.48
2-3	1769207.19	1623494.95	7181.99	2-3	1768561.34	1623747.92	7166.95
2-3	1769090.62	1622728.86	7190.51	2-3	1768586.75	1623702.39	7166.05
2-3	1769582.87	1622885.75	7194.55	2-3	1768701.05	1623512.46	7170.27
2-3	1769308.76	1622523.27	7195.58	2-3	1768759.19	1623483.25	7170.15
2-3	1769608.66	1622817.10	7194.55	2-3	1768841.71	1623406.16	7175.43
2-3	1769623.86	1622750.92	7194.49	2-3	1768867.34	1623270.06	7177.55
2-3	1769624.00	1622705.92	7195.83	2-3	1768864.23	1623114.85	7179.77
2-3	1769646.64	1622657.20	7196.67	2-3	1769007.51	1622843.41	7187.73
2-3	1769680.84	1622637.11	7197.63	2-3	1769313.61	1622456.04	7197.78
2-3	1769244.81	1623581.21	7179.71	2-3	1769318.81	1622404.84	7199.27
2-3	1769225.63	1623531.51	7182.21	2-3	1769297.47	1622327.64	7203.12
2-3	1769207.19	1623495.34	7181.86	2-3	1769318.74	1622204.12	7203.74
2-3	1769200.61	1623452.25	7181.39	2-3	1769337.34	1622071.78	7208.30
2-3	1769205.14	1623415.03	7181.95	2-3	1769349.43	1621853.86	7211.34
2-3	1769216.94	1623346.53	7183.37	2-3	1769318.60	1621529.77	7215.55
2-3	1769242.40	1623216.15	7186.59	2-3	1769571.68	1621590.77	7214.85
2-3	1769254.17	1623186.13	7187.54	2-3	1769674.07	1621680.47	7214.26
2-3	1769303.33	1623100.83	7189.73	2-3	1769719.79	1621631.68	7215.05
2-3	1769328.02	1623063.09	7189.61	2-3	1769769.62	1621600.70	7215.88
2-3	1769412.88	1623009.48	7191.77	2-3	1769817.68	1621551.93	7219.51
2-3	1769466.49	1622994.72	7193.18	2-3	1769905.70	1621423.18	7220.72
2-3	1769499.09	1622969.60	7193.10	2-3	1772768.77	1624251.64	7210.00
2-3	1769520.13	1622958.54	7193.32	2-3	1772762.85	1624327.64	7207.61

Mapped Contact	Northing	Easting	Elevation	Mapped Contact	Northing	Easting	Elevation
2-3	1769573.16	1622937.10	7193.99	2-3	1772726.47	1624401.56	7205.99
2-3	1769106.73	1623675.96	7177.51	2-3	1772710.41	1624455.88	7203.39
2-3	1769047.10	1623711.03	7174.87	2-3	1772699.58	1624500.40	7202.35
2-3	1768989.47	1623744.78	7173.17	2-3	1772701.61	1624524.29	7202.04
2-3	1768325.46	1624661.20	7147.73	2-3	1772705.74	1624567.45	7200.54
2-3	1768338.71	1624636.88	7147.34	2-3	1772432.85	1624605.05	7198.94
2-3	1768392.38	1624552.14	7149.97	2-3	1772420.26	1624708.99	7197.78
2-3	1768438.75	1624512.11	7151.60	2-3	1772394.28	1624817.37	7193.75
2-3	1768462.91	1624467.75	7152.78	2-3	1772369.55	1624916.59	7193.76
2-3	1768501.77	1624423.18	7154.61	2-3	1772714.53	1624791.22	7198.76
2-3	1772703.56	1625120.33	7190.57	2-3	1772681.29	1624873.06	7196.76
2-3	1772765.88	1625179.41	7189.33	2-3	1772662.79	1624953.21	7195.02
2-3	1772707.96	1625298.37	7188.45	2-3	1772673.95	1625035.84	7191.48
2-3	1772621.72	1625387.95	7188.12	2-3	1772424.67	1624429.88	7207.24
2-3	1772358.10	1625054.26	7190.27	2-3	1772418.23	1624512.59	7204.66
2-3	1772351.54	1625187.75	7187.33	2-3	1772837.52	1623949.36	7213.82
2-3	1772583.36	1625433.30	7185.85	2-3	1772804.13	1624056.77	7211.32
2-3	1772566.55	1625453.19	7185.25	2-3	1772813.21	1624110.85	7210.02
2-3	1772522.36	1625506.41	7182.46	2-3	1772777.54	1624159.49	7209.42
2-3	1772488.74	1625551.99	7180.54	2-3	1770593.99	1621005.94	7229.77
2-3	1772456.47	1625639.71	7179.29	2-3	1770619.06	1620950.08	7230.78
2-3	1772459.12	1625701.71	7179.33	2-3	1770624.06	1620899.71	7231.12
2-3	1772276.58	1625286.22	7183.97	2-3	1770643.73	1620854.46	7230.43
2-3	1772188.22	1625346.33	7183.82	2-3	1770668.86	1620772.30	7232.55
2-3	1772142.06	1625421.95	7181.30	2-3	1770677.90	1620726.60	7233.63
2-3	1772118.99	1625534.77	7178.82	2-3	1770663.07	1620683.16	7232.30
2-3	1773134.61	1622707.45	7211.68	2-3	1770643.92	1620646.73	7231.76
2-3	1773154.26	1622695.36	7210.77	2-3	1770635.56	1620590.01	7232.74
2-3	1773125.41	1622736.88	7217.37	2-3	1770634.53	1620545.96	7233.82
2-3	1773093.06	1622758.01	7219.32	2-3	1770645.32	1620492.06	7233.91
2-3	1773059.43	1622800.64	7218.22	2-3	1770682.63	1620394.69	7235.10
2-3	1773037.70	1622844.62	7219.94	2-3	1770325.63	1626254.84	7143.85
2-3	1772997.25	1622922.22	7219.88	2-3	1770384.89	1626284.44	7143.94
2-3	1772736.66	1622792.30	7218.38	2-3	1770546.48	1626172.76	7146.43
2-3	1772748.35	1622871.12	7217.25	2-3	1770627.96	1626110.40	7146.55
2-3	1772652.08	1623094.50	7220.48	2-3	1770104.84	1626701.63	7125.24
2-3	1772597.13	1623210.50	7220.26	2-3	1770092.32	1626631.22	7127.44
2-3	1772566.03	1623322.64	7220.12	2-3	1770064.82	1626511.44	7129.93
2-3	1773008.98	1623010.53	7220.49	2-3	1770027.53	1626370.79	7134.68
2-3	1772593.02	1623410.75	7215.94	2-3	1770020.74	1626262.04	7136.72
2-3	1772993.89	1623061.80	7219.49	2-3	1770055.40	1626188.66	7138.08
2-3	1772972.20	1623114.23	7219.78	2-3	1770063.64	1626096.09	7140.57
2-3	1772964.33	1623152.06	7218.71	2-3	1770068.17	1625953.88	7143.03
2-3	1772505.43	1623593.93	7218.66	2-3	1770180.45	1621258.28	7225.00
2-3	1772957.19	1623189.57	7219.65	2-3	1770113.75	1621489.11	7220.50
2-3	1772946.73	1623218.34	7219.12	2-3	1768040.48	1624964.17	7141.85
2-3	1772924.45	1623260.63	7218.53	2-3	1767474.68	1626078.85	7114.00
2-3	1772911.49	1623302.35	7216.94	2-3	1767383.57	1626607.77	7103.00
2-3	1772923.05	1623349.81	7219.75	2-3	1766826.88	1626957.92	7084.10
2-3	1772930.64	1623459.22	7218.52	2-3	1766704.09	1626986.56	7085.00
2-3	1772500.12	1623722.60	7215.80	2-3	1766699.75	1626982.22	7083.50
2-3	1772945.53	1623502.73	7215.79	2-3	1769847.50	1621487.37	7220.00

Appendix A-1: Surveyed Points (cont.)

Mapped Contact	Northing	Easting	Elevation	Mapped Contact	Northing	Easting	Elevation
2-3	1772930.62	1623565.84	7218.42	2-3	1769382.69	1621973.37	7210.00
2-3	1772898.34	1623627.19	7219.22	2-3	1769275.43	1622585.17	7194.80
2-3	1772875.71	1623698.30	7218.11	2-3	1768923.18	1622978.47	7186.10
2-3	1772841.56	1623784.00	7217.28	2-3	1768891.40	1623035.42	7182.40
2-3	1772832.10	1623891.47	7214.59	2-3	1768861.35	1623171.09	7180.26
2-3	1772485.68	1623784.12	7214.86	2-3	1768866.58	1623305.08	7177.40
2-3	1772473.43	1623904.33	7213.09	2-3	1768829.04	1623436.69	7173.10
2-3	1772454.28	1624116.15	7210.97	2-3	1768600.97	1623660.96	7167.70
2-3	1772440.08	1624271.40	7209.43	2-3	1772789.78	1622640.58	7217.70
2-3	1775586.36	1619728.42	7149.90	2-3	1772454.68	1624188.09	7210.00
2-3	1775602.05	1619773.92	7148.00	2-3	1775576.36	1619625.15	7147.20
2-3	1775624.85	1619891.71	7142.00	2-3	1775583.78	1619712.61	7150.75
2-3	1775656.94	1619954.90	7142.00	2-3	1775588.91	1622071.44	7129.15
2-3	1775630.06	1620008.81	7141.90	2-3	1775558.38	1622105.86	7129.07
2-3	1775633.86	1620057.50	7142.60	2-3	1775557.45	1622173.20	7132.13
2-3	1775636.11	1620106.05	7143.50	2-3	1775555.73	1622189.32	7133.48
2-3	1775648.21	1620148.56	7144.20	2-3	1775548.51	1622213.14	7133.41
2-3	1775638.64	1620251.01	7141.80	2-3	1775539.84	1622262.03	7134.11
2-3	1775651.17	1620278.03	7141.70	2-3	1775544.30	1622313.66	7135.47
2-3	1775663.13	1620304.35	7142.40	2-3	1775528.82	1622332.38	7135.57
2-3	1775690.57	1620362.05	7143.00	2-3	1775524.29	1622376.85	7136.53
2-3	1775714.64	1620440.16	7143.40	2-3	1775517.58	1622393.77	7137.30
2-3	1775740.54	1620562.18	7143.00	2-3	1775512.38	1622416.40	7138.18
2-3	1775745.32	1620602.29	7138.00	2-3	1775538.16	1622504.36	7143.82
2-3	1775748.28	1620639.02	7138.70	2-3	1775554.51	1622534.61	7145.92
2-3	1775754.47	1620689.83	7138.40	2-3	1775585.90	1622587.91	7148.09
2-3	1775721.11	1620791.58	7136.30	2-3	1775516.51	1622596.26	7152.24
2-3	1775730.26	1620823.25	7135.48	2-3	1775507.71	1622597.89	7152.03
2-3	1775732.80	1620860.26	7135.50	2-3	1775478.41	1622602.29	7152.15
2-3	1775762.35	1620919.65	7140.00	2-3	1775446.22	1622620.89	7154.79
2-3	1775740.40	1621017.89	7141.78	2-3	1775389.87	1622649.29	7157.14
2-3	1775715.48	1621080.94	7140.00	2-3	1775338.79	1622699.52	7161.17
2-3	1775702.96	1621134.28	7140.20	2-3	1775301.77	1622727.11	7163.88
2-3	1775668.76	1621228.71	7139.00	2-3	1770766.78	1620271.30	7231.49
2-3	1775654.12	1621251.65	7138.50	2-3	1770785.52	1620255.63	7232.89
2-3	1775648.35	1621271.64	7139.00	2-3	1770822.15	1620242.83	7232.63
2-3	1775632.17	1621350.87	7138.10	2-3	1770603.14	1620310.62	7231.36
2-3	1775622.74	1621425.88	7135.50	2-3	1774961.88	1623856.26	7183.39
2-3	1775603.60	1621616.02	7130.25	2-3	1774944.49	1623934.88	7194.12
2-3	1775596.56	1621664.29	7128.57	2-3	1775003.72	1623735.63	7159.25
2-3	1775217.50	1622860.94	7171.30	2-3	1775020.25	1623703.08	7163.12
2-3	1775177.24	1622993.23	7180.40	2-3	1775330.20	1619682.98	7167.76
2-3	1775105.66	1623362.60	7174.90	2-3	1775361.17	1619815.87	7163.02
2-3	1775089.05	1623375.06	7164.20	2-3	1775426.37	1620248.97	7147.03
2-3	1775035.69	1623572.21	7157.70	2-3	1775479.26	1620508.59	7148.70
2-3	1774920.02	1624078.98	7199.53	2-3	1775178.43	1621883.07	7140.15
2-3	1774825.44	1624853.20	7190.23	2-3	1775149.11	1621965.08	7142.92
2-3	1774768.24	1624960.88	7183.15	2-3	1775142.13	1622041.11	7142.53
2-3	1774767.28	1625068.88	7189.30	2-3	1775128.11	1622100.03	7141.04
2-3	1774666.95	1625649.46	7172.60	2-3	1775107.21	1622180.74	7147.80
2-3	1775608.37	1621748.99	7129.31	2-3	1775061.65	1622287.28	7145.65
2-3	1775613.37	1621772.15	7128.91	2-3	1775011.04	1622392.22	7147.70

Appendix A-1: Surveyed Points (cont.)

Mapped Contact	Northing	Easting	Elevation	Mapped Contact	Northing	Easting	Elevation
2-3	1775614.86	1621821.17	7129.28	2-3	1774968.32	1622447.53	7152.17
2-3	1775629.72	1621867.59	7128.67	2-3	1774932.80	1622476.37	7153.90
2-3	1775665.16	1621888.63	7129.75	2-3	1774877.38	1622520.18	7166.17
2-3	1775723.34	1621890.10	7131.37	2-3	1774791.59	1622604.24	7177.59
2-3	1775756.10	1621891.85	7132.29	2-3	1774710.40	1622727.83	7186.31
2-3	1775728.17	1621952.20	7133.31	2-3	1774586.32	1623119.93	7165.85
2-3	1775640.22	1621988.42	7130.95	2-3	1774544.90	1623172.81	7170.56
2-3	1775606.33	1622032.13	7129.62	2-3	1774536.40	1623316.65	7150.20
2-3	1774423.76	1623524.65	7153.19	2-3	1774502.18	1623365.82	7156.95
2-3	1774350.48	1623605.28	7166.93	2-3	1774478.85	1623416.93	7158.83
2-3	1774325.20	1623682.02	7182.25	2-3	1774461.86	1623465.23	7156.77
2-3	1774315.10	1623757.77	7185.09	2-3	1774653.52	1626802.78	7151.75
2-3	1774294.09	1623858.18	7181.76	2-3	1774638.12	1626855.64	7151.15
2-3	1774270.89	1623944.89	7175.49	2-3	1774629.21	1626892.47	7149.45
2-3	1774243.85	1624088.71	7166.01	2-3	1773900.44	1626700.13	7143.72
2-3	1774196.30	1624187.31	7160.14	2-3	1773882.73	1626822.90	7133.29
2-3	1774170.01	1624215.22	7161.80	2-3	1773851.45	1626899.01	7132.65
2-3	1774114.43	1624398.56	7163.06	2-3	1773849.36	1626988.37	7125.69
2-3	1774083.77	1624491.60	7166.36	2-3	1773806.47	1627111.02	7132.01
2-3	1774097.05	1624555.63	7173.24	2-3	1773815.90	1627241.14	7133.51
2-3	1774087.36	1624651.43	7180.20	2-3	1773795.24	1627371.21	7133.97
2-3	1774080.19	1624728.82	7180.21	2-3	1773818.21	1627508.86	7128.36
2-3	1774071.78	1624806.71	7189.89	2-3	1773827.74	1627638.53	7124.75
2-3	1774064.68	1624919.44	7174.99	2-3	1773846.49	1627702.76	7116.02
2-3	1774045.20	1624987.66	7173.49	2-3	1774607.34	1627000.58	7147.45
2-3	1774047.18	1625042.05	7165.78	2-3	1774583.54	1627129.36	7144.34
2-3	1774007.80	1625171.87	7161.94	2-3	1774596.66	1627211.39	7144.76
2-3	1774002.88	1625293.65	7164.99	2-3	1774602.90	1627399.49	7137.13
2-3	1773985.04	1625417.84	7164.96	3-3T	1771669.12	1617871.88	7375.04
2-3	1773968.05	1625466.98	7169.49	3-3T	1771679.35	1617847.59	7374.94
2-3	1773970.17	1625569.44	7163.80	3-3T	1771695.70	1617816.15	7376.94
2-3	1773953.56	1625625.39	7165.73	3-3T	1771727.78	1617782.22	7377.37
2-3	1773938.92	1625790.28	7146.09	3-3T	1771752.21	1617758.20	7377.50
2-3	1773955.88	1625913.17	7137.66	3-3T	1771784.72	1617729.16	7377.00
2-3	1773956.26	1626035.19	7133.72	3-3T	1771811.40	1617699.81	7376.93
2-3	1773953.80	1626157.68	7129.99	3-3T	1771856.45	1617663.65	7377.22
2-3	1773944.44	1626197.27	7140.03	3-3T	1771900.16	1617619.80	7378.75
2-3	1773947.58	1626375.31	7151.50	3-3T	1771925.13	1617595.75	7378.99
2-3	1774831.16	1624601.39	7196.00	3-3T	1772002.64	1617564.65	7379.24
2-3	1774826.60	1624687.05	7190.31	3-3T	1772053.13	1617560.09	7378.93
2-3	1774854.37	1624744.89	7184.36	3-3T	1772080.59	1617560.70	7379.02
2-3	1774866.93	1624797.27	7188.20	3-3T	1772123.25	1617568.14	7376.92
2-3	1774774.32	1624996.75	7182.00	3-3T	1772295.67	1617436.49	7377.00
2-3	1774762.16	1625098.29	7188.26	3-3T	1771294.22	1618281.10	7377.06
2-3	1774733.65	1625179.11	7187.36	3-3T	1771290.69	1618244.62	7377.28
2-3	1774678.49	1625487.95	7177.96	3-3T	1771291.26	1618202.41	7378.75
2-3	1774664.73	1625804.17	7171.59	3-3T	1771318.43	1618154.32	7378.05
2-3	1774674.56	1625911.34	7167.81	3-3T	1771365.29	1618116.27	7378.94
2-3	1774685.90	1625987.93	7166.10	3-3T	1771394.94	1618073.87	7378.56
2-3	1774737.45	1626027.13	7165.20	3-3T	1771441.48	1618012.09	7378.75
2-3	1774800.95	1626111.60	7165.52	3-3T	1771471.51	1617991.57	7376.86
2-3	1774782.85	1626159.45	7166.15	3-3T	1771502.08	1617989.31	7378.92

Appendix A-1: Surveyed Points (cont.)

Mapped Contact	Northing	Easting	Elevation	Mapped Contact	Northing	Easting	Elevation
2-3	1774758.32	1626297.01	7162.77	3-3T	1771521.52	1617995.82	7380.12
2-3	1774755.98	1626355.69	7161.23	3-3T	1771655.82	1617991.25	7375.10
2-3	1774738.87	1626411.18	7160.66	3-3T	1771654.36	1617907.09	7374.24
2-3	1774736.87	1626474.64	7158.35	3-3T	1771172.27	1617295.51	7390.88
2-3	1774740.57	1626565.46	7155.44	3-3T	1771174.13	1617324.72	7390.08
2-3	1774718.37	1626602.41	7154.33	3-3T	1771197.90	1616756.84	7402.96
2-3	1774697.52	1626692.12	7153.09	3-3T	1771195.55	1616789.92	7403.46
2-3	1774643.14	1627528.03	7138.43	3-3T	1771196.34	1616909.59	7403.66
2-3	1774660.51	1627625.15	7131.47	3-3T	1771201.83	1616937.55	7399.86
2-3	1774701.61	1627691.25	7133.34	3-3T	1771222.34	1617040.61	7396.69
2-3	1774697.62	1627839.31	7127.70	3-3T	1771421.85	1616334.52	7412.47
2-3	1774666.07	1627947.86	7124.09	3-3T	1771388.51	1616366.72	7413.55
2-3	1774674.80	1628039.57	7126.45	3-3T	1771308.24	1616393.82	7411.14
2-3	1774675.17	1628117.60	7119.38	3-3T	1771227.15	1616526.67	7409.35
2-3	1774705.37	1628213.99	7120.22	3-3T	1771216.43	1616547.62	7409.00
2-3	1774706.71	1628311.75	7119.52	3-3T	1771206.33	1616647.71	7406.25
2-3	1774671.43	1628406.04	7118.30	3-3T	1771431.32	1616301.91	7414.67
2-3	1774647.06	1628527.86	7116.65	3-3T	1771430.60	1616274.49	7416.97
2-3	1774609.23	1628641.95	7111.99	3-3T	1771427.89	1616263.19	7416.89
2-3	1774576.36	1628759.31	7109.52	3-3T	1771430.11	1616226.55	7417.36
2-3	1774660.00	1627755.01	7128.71	3-3T	1771434.05	1616198.12	7417.71
2-3	1775500.00	1620955.00	7144.00	3-3T	1771434.41	1616154.06	7417.01
3-3T	1772251.43	1617534.13	7373.62	3-3T	1770833.84	1617762.04	7383.12
3-3T	1772333.70	1617334.67	7379.38	3-3T	1770814.79	1617831.10	7383.08
3-3T	1772353.93	1617293.86	7381.31	3-3T	1770829.99	1618027.04	7384.87
3-3T	1772366.55	1617277.65	7382.02	3-3T	1770841.00	1618105.26	7386.08
3-3T	1772375.23	1617231.29	7383.30	3-3T	1771188.11	1617851.13	7384.69
3-3T	1772379.20	1617211.35	7384.33	3-3T	1771238.63	1617812.99	7382.90
3-3T	1772383.03	1617186.86	7383.46	3-3T	1771348.45	1617704.85	7382.36
3-3T	1772395.39	1617139.92	7388.63	3-3T	1771628.03	1617552.48	7385.60
3-3T	1772577.93	1616877.35	7392.47	3-3T	1771585.68	1617580.06	7384.59
3-3T	1772581.85	1616857.35	7393.61	3-3T	1771501.90	1617626.36	7382.68
3-3T	1772593.10	1616834.77	7393.86	3-3T	1771428.03	1617644.16	7384.37
3-3T	1772606.27	1616812.22	7394.97	3-3T	1771810.82	1617377.31	7388.21
3-3T	1772628.18	1616783.09	7396.55	3-3T	1771695.56	1617504.49	7385.94
3-3T	1772641.82	1616758.24	7398.83	3-3T	1771836.32	1617318.86	7388.74
3-3T	1772656.13	1616740.87	7400.18	3-3T	1772086.73	1617284.01	7390.06
3-3T	1772682.58	1616709.93	7400.02	3-3T	1771971.97	1617299.25	7388.83
3-3T	1772692.61	1616691.91	7401.39	3-3T	1771923.97	1617292.13	7387.18
3-3T	1771166.02	1617860.16	7385.69	3-3T	1771868.73	1617292.06	7386.06
3-3T	1771119.94	1617872.24	7384.16	3-3T	1772276.89	1616943.63	7395.74
3-3T	1771092.31	1617869.87	7383.75	3-3T	1772254.66	1616998.93	7396.16
3-3T	1771071.15	1617836.94	7386.28	3-3T	1772225.42	1617127.01	7391.57
3-3T	1771075.24	1617813.41	7385.82	3-3T	1772187.81	1617206.10	7392.02
3-3T	1771090.19	1617781.40	7385.38	3-3T	1772317.53	1616899.41	7396.69
3-3T	1771107.84	1617750.01	7383.81	3-3T	1772365.77	1616870.27	7396.76
3-3T	1771130.35	1617709.44	7383.82	3-3T	1772407.71	1616777.91	7397.22
3-3T	1771143.34	1617692.63	7385.92	3-3T	1772466.09	1616773.77	7400.06
3-3T	1771180.39	1617580.64	7382.91	3-3T	1772511.90	1616725.28	7400.53
3-3T	1771191.79	1617535.94	7384.71	3-3T	1772580.38	1616651.91	7401.78
3-3T	1771192.51	1617474.72	7388.52	3-3T	1776116.54	1618846.32	7271.94
3-3T	1771186.67	1617436.25	7386.95	3-3T	1776039.34	1618786.11	7274.71

Mapped Contact	Northing	Easting	Elevation	Mapped Contact	Northing	Easting	Elevation
3-3T	1771209.81	1616989.36	7397.89	3-3T	1775935.46	1618734.50	7275.27
3-3T	1771210.73	1617079.36	7395.76	3-3T	1775917.32	1618677.61	7276.15
3-3T	1771198.19	1617153.94	7393.98	3-3T	1775645.62	1615309.78	7538.63
3-3T	1771189.65	1617186.83	7391.34	3-3T	1775637.68	1615285.87	7541.40
3-3T	1771177.35	1617219.30	7392.82	3-3T	1775504.78	1614941.88	7592.78
3-3T	1771167.52	1617264.78	7391.35	3-3T	1775498.71	1614894.89	7599.24
3-3T	1775921.66	1618610.75	7278.59	3-3T	1773227.29	1615800.61	7454.51
3-3T	1775967.94	1618518.94	7279.66	3-3T	1773234.74	1615776.29	7457.42
3-3T	1775942.74	1618179.93	7289.35	3-3T	1773252.01	1615723.39	7459.52
3-3T	1775937.89	1617983.95	7295.49	3-3T	1773263.38	1615700.68	7460.31
3-3T	1775958.95	1617898.33	7296.33	3-3T	1773209.79	1615594.17	7454.06
3-3T	1775969.06	1617826.79	7299.50	3-3T	1773294.73	1615656.01	7463.76
3-3T	1776017.07	1617625.06	7307.09	3-3T	1773318.02	1615626.51	7465.89
3-3T	1776011.22	1617458.09	7309.65	3-3T	1773402.93	1615558.80	7471.92
3-3T	1776048.89	1617353.41	7312.78	3-3T	1773440.17	1615534.12	7473.15
3-3T	1776075.03	1617304.07	7318.12	3-3T	1773465.65	1615516.94	7473.12
3-3T	1776109.09	1617116.94	7322.77	3-3T	1773501.69	1615512.16	7473.34
3-3T	1776082.47	1617083.41	7324.46	3-3T	1773556.34	1615445.65	7477.49
3-3T	1776036.48	1616910.06	7332.77	3-3T	1773514.92	1615427.26	7478.81
3-3T	1776021.79	1616871.01	7335.32	3-3T	1773476.44	1615415.76	7482.26
3-3T	1776011.25	1616808.70	7336.38	3-3T	1773429.81	1615390.74	7482.34
3-3T	1775990.11	1616545.71	7353.40	3-3T	1773533.74	1615509.40	7475.47
3-3T	1775989.74	1616545.85	7353.38	3-3T	1773563.07	1615489.73	7473.52
3-3T	1775969.67	1616478.80	7363.48	3-3T	1773574.16	1615486.02	7473.36
3-3T	1775961.86	1616457.34	7366.44	3-3T	1773410.02	1615297.87	7485.36
3-3T	1775976.16	1616341.67	7387.34	3-3T	1773417.20	1615278.49	7488.92
3-3T	1775984.13	1616313.50	7393.18	3-3T	1773420.28	1615237.24	7491.18
3-3T	1775976.92	1616279.10	7400.04	3-3T	1773272.19	1615270.42	7486.80
3-3T	1775985.91	1616230.09	7415.54	3-3T	1773410.09	1615197.02	7492.86
3-3T	1775975.94	1616180.42	7428.37	3-3T	1773386.78	1615158.96	7495.03
3-3T	1775957.08	1616080.44	7452.41	3-3T	1773369.55	1615120.76	7498.48
3-3T	1775923.47	1615897.51	7494.46	3-3T	1773387.64	1615050.26	7502.76
3-3T	1775292.18	1619131.78	7297.80	3-3T	1773390.27	1615016.63	7505.64
3-3T	1775315.15	1619007.84	7289.54	3-3T	1773408.10	1614936.35	7511.75
3-3T	1775350.68	1618964.55	7288.13	3-3T	1773430.67	1614886.69	7513.57
3-3T	1775357.69	1618908.39	7288.18	3-3T	1773286.32	1614800.33	7521.00
3-3T	1775358.67	1618826.00	7290.69	3-3T	1773269.62	1614779.71	7522.92
3-3T	1775366.00	1618780.32	7294.82	3-3T	1773253.04	1614699.83	7528.88
3-3T	1775315.68	1618640.23	7293.49	3-3T	1773252.48	1614687.44	7531.20
3-3T	1775335.40	1618436.27	7290.77	3-3T	1773248.93	1614678.69	7531.20
3-3T	1775343.98	1618374.82	7289.18	3-3T	1773252.96	1614647.87	7533.43
3-3T	1775301.89	1618260.46	7290.28	3-3T	1773250.44	1614624.24	7534.99
3-3T	1775367.30	1618178.76	7296.67	3-3T	1773250.19	1614604.15	7536.80
3-3T	1775401.16	1618130.12	7295.25	3-3T	1773248.90	1614594.02	7537.08
3-3T	1775431.70	1618014.19	7298.59	3-3T	1773236.02	1614575.02	7539.72
3-3T	1775439.40	1617924.78	7301.18	3-3T	1773236.94	1614539.58	7542.54
3-3T	1775564.85	1617035.10	7326.56	3-3T	1773240.08	1614475.18	7546.08
3-3T	1775573.37	1616981.33	7327.56	3-3T	1773234.84	1614446.63	7548.30
3-3T	1775510.65	1616654.36	7348.74	3-3T	1773230.25	1614437.12	7547.41
3-3T	1775538.13	1616331.55	7362.13	3-3T	1773234.64	1614409.17	7549.41
3-3T	1775891.15	1615815.54	7503.09	3-3T	1773255.35	1614393.73	7550.45
3-3T	1775899.53	1615771.81	7511.46	3-3T	1773270.79	1614358.82	7553.87

Appendix A-1: Surveyed Points (cont.)

Mapped Contact	Northing	Easting	Elevation	Mapped Contact	Northing	Easting	Elevation
3-3T	1775887.66	1615674.78	7519.19	3-3T	1773285.33	1614334.23	7557.14
3-3T	1775895.19	1615635.36	7524.30	3-3T	1773433.34	1617634.30	7359.41
3-3T	1775765.38	1615497.74	7529.13	3-3T	1773351.25	1613664.86	7605.23
3-3T	1775714.92	1615445.79	7526.42	3-3T	1772678.60	1618571.21	7344.93
3-3T	1775690.64	1615385.70	7530.06	3-3T	1772502.63	1618622.93	7349.57
3-3T	1773308.23	1614263.88	7561.38	3-3T	1772403.05	1618671.66	7353.41
3-3T	1773340.21	1614227.08	7565.48	3-3T	1772262.75	1618683.60	7355.00
3-3T	1773377.12	1614156.48	7570.92	3-3T	1772075.21	1618750.74	7358.36
3-3T	1773293.77	1614080.49	7573.28	3-3T	1772841.96	1619229.61	7333.70
3-3T	1773244.72	1614023.48	7577.80	3-3T	1772662.37	1619206.36	7342.41
3-3T	1773222.94	1613982.13	7580.51	3-3T	1772450.75	1619309.24	7347.72
3-3T	1773216.21	1613924.42	7584.11	3-3T	1772412.72	1619061.52	7348.41
3-3T	1773251.58	1613873.74	7587.73	3-3T	1773115.09	1617929.48	7353.52
3-3T	1773298.29	1613824.63	7592.61	3-3T	1773058.30	1617617.11	7362.39
3-3T	1773326.49	1613794.72	7596.05	3-3T	1773148.02	1617769.11	7357.46
3-3T	1773358.24	1613739.35	7602.25	3-3T	1773621.48	1617818.29	7351.04
3-3T	1773297.36	1617876.36	7352.13	3-4	1769285.50	1624228.54	7292.60
3-3T	1773296.73	1617515.48	7361.35	3-4	1769273.25	1624244.97	7292.74
3-4	1775757.01	1619721.10	7262.67	3-4	1769266.48	1624252.63	7292.11
3-4	1775766.99	1619769.10	7262.11	3-4	1769258.60	1624263.48	7291.88
3-4	1770743.14	1621399.27	7345.60	3-4	1771526.81	1620584.18	7360.90
3-4	1770739.21	1621396.09	7345.70	3-4	1771583.64	1620451.17	7362.00
3-4	1770732.60	1621393.52	7346.49	3-4	1771584.82	1620424.33	7363.00
3-4	1770724.55	1621387.96	7346.02	3-4	1771635.74	1620365.92	7358.50
3-4	1770709.01	1621378.39	7346.61	3-4	1771662.58	1620270.80	7363.00
3-4	1768046.74	1623187.96	7292.85	3-4	1771705.60	1620206.86	7363.00
3-4	1769418.40	1624094.54	7297.10	3-4	1771745.15	1620050.93	7362.00
3-4	1769412.87	1624103.70	7297.80	3-4	1771785.62	1619979.63	7358.50
3-4	1769324.06	1624181.59	7295.52	3-4	1771816.45	1619943.01	7358.50
3-4	1769314.50	1624192.60	7294.35	3-4	1772054.39	1620188.04	7349.50
3-4	1769306.35	1624202.81	7293.82	3-4	1772081.63	1620533.42	7342.40
3-4	1769297.70	1624213.31	7293.32	3-4	1772182.70	1620720.62	7347.50
3-4	1769251.18	1624273.79	7291.64	3-4	1772209.94	1620830.47	7345.80
3-4	1769223.73	1624311.53	7290.26	3-4	1772223.13	1621335.80	7346.00
3-4	1769219.56	1624317.21	7289.92	3-4	1773164.68	1621082.23	7331.80
3-4	1769208.78	1624332.79	7289.80	3-4	1773159.13	1621072.68	7333.50
3-4	1769202.99	1624339.71	7288.87	3-4	1773157.36	1621064.54	7332.20
3-4	1769191.88	1624355.89	7287.97	3-4	1773442.19	1620886.94	7326.50
3-4	1770241.85	1622893.71	7326.04	3-4	1773632.11	1620203.07	7321.00
3-4	1770224.78	1622902.33	7325.75	3-4	1773691.98	1620170.80	7319.00
3-4	1770210.00	1622971.36	7324.53	3-4	1773635.85	1620146.94	7320.50
3-4	1773808.42	1619924.41	7318.04	3-4	1773582.52	1620150.68	7320.20
3-4	1771390.78	1619916.59	7364.90	3-4	1773575.97	1620064.61	7321.50
3-4	1768849.06	1624810.79	7275.50	3-4	1773636.78	1620041.69	7321.50
3-4	1768868.45	1624785.78	7276.00	3-4	1773717.24	1620009.88	7320.00
3-4	1768907.24	1624753.12	7276.00	3-4	1773856.63	1619914.46	7314.00
3-4	1768949.08	1624708.72	7276.50	3-4	1773913.70	1619790.97	7314.50
3-4	1768984.81	1624675.55	7277.00	3-4	1774058.24	1620303.17	7306.60
3-4	1769032.27	1624629.11	7277.50	3-4	1774048.88	1620332.17	7305.80
3-4	1769083.82	1624591.34	7279.00	3-4	1774038.13	1620366.32	7304.60
3-4	1769099.13	1624567.86	7280.50	3-4	1774033.92	1620388.77	7303.80
3-4	1769130.26	1624476.00	7283.00	3-4	1774033.45	1620402.34	7303.10

Appendix A-1: Surveyed Points (cont.)

Mapped Contact	Northing	Easting	Elevation	Mapped Contact	Northing	Easting	Elevation
3-4	1769168.03	1624435.17	7285.00	3-4	1774045.14	1620438.82	7303.40
3-4	1769549.77	1624034.03	7300.50	3-4	1774053.09	1620445.84	7303.60
3-4	1769872.52	1623626.58	7313.96	3-4	1774068.06	1620463.15	7304.40
3-4	1769899.47	1623434.19	7315.92	3-4	1774081.16	1620477.65	7304.80
3-4	1770425.54	1621686.92	7340.00	3-4	1775757.07	1619462.14	7262.00
3-4	1770470.96	1621651.19	7343.00	3-4	1775802.94	1619318.89	7265.00
3-4	1770477.59	1621612.91	7345.00	3-4	1771370.58	1619748.26	7360.67
3-4	1770467.39	1621473.59	7341.35	3-4	1771379.72	1619703.03	7360.87
3-4	1770488.31	1621433.78	7343.00	3-4	1771376.78	1619665.01	7358.22
3-4	1770456.16	1621570.55	7343.00	3-4	1771372.51	1619599.34	7359.16
3-4	1770667.45	1621380.70	7345.00	3-4	1771366.61	1619565.84	7359.60
3-4	1770841.99	1621398.57	7346.20	3-4	1771368.64	1619531.24	7358.86
3-4	1771315.65	1620183.58	7365.10	3-4	1771370.96	1619483.20	7358.92
3-4	1771331.05	1620134.64	7364.00	3-4	1771367.99	1619451.53	7359.94
3-4	1771398.48	1619865.07	7363.00	3-4	1771346.92	1619408.83	7361.84
3-4	1771404.85	1619811.39	7364.00	3-4	1771310.71	1619364.68	7360.12
3-4	1771279.34	1621126.86	7353.30	3-4	1771301.37	1619324.36	7358.98
3-4	1771338.15	1621102.39	7349.50	3-4	1771298.05	1619296.61	7361.30
3-4	1771357.88	1621058.19	7350.60	3-4	1771289.87	1619257.68	7361.65
3-4	1771385.91	1621021.48	7353.40	3-4	1770746.99	1619672.82	7357.23
3-4	1771396.96	1621015.17	7353.50	3-4	1770798.80	1619497.69	7360.44
3-4	1771410.38	1620998.20	7353.84	3-4	1770825.08	1619406.76	7359.05
3-4	1771415.11	1620980.04	7353.90	3-4	1770821.58	1619359.15	7362.14
3-4	1771418.66	1620964.25	7353.70	3-4	1770834.80	1619255.65	7361.81
3-4	1771417.48	1620893.21	7357.20	3-4	1770850.34	1619130.93	7363.91
3-4	1771426.16	1620882.95	7357.00	3-4	1770853.34	1619034.52	7365.38
3-4	1771441.95	1620847.82	7357.00	3-4	1770645.15	1619806.08	7355.16
3-4	1771455.37	1620825.72	7357.50	3-4	1770577.96	1619833.02	7355.53
3-4	1771468.79	1620794.54	7357.00	3-4	1770523.85	1619842.76	7359.00
3-4	1771487.73	1620727.05	7356.00	3-4	1770435.99	1619934.72	7358.41
3-4	1771507.86	1620706.13	7356.00	3-4	1770399.31	1620063.26	7357.88
3-4	1771279.87	1619218.24	7360.42	3-4	1770348.33	1620197.71	7356.44
3-4	1771272.62	1619185.60	7360.32	3-4	1770310.78	1620321.67	7351.98
3-4	1771282.03	1619144.32	7359.86	3-4	1770261.00	1620444.03	7351.12
3-4	1771285.26	1619109.65	7359.89	3-4	1770263.80	1620550.18	7349.42
3-4	1771289.38	1619091.45	7360.75	3-4	1770258.99	1620665.92	7348.10
3-4	1771290.08	1619034.92	7360.95	3-4	1770257.00	1620709.83	7345.96
3-4	1771282.01	1619006.25	7361.45	3-4	1770235.70	1620732.42	7347.88
3-4	1771275.71	1618958.46	7362.39	3-4	1770844.32	1618329.61	7380.88
3-4	1771281.19	1618932.77	7363.25	3-4	1770849.66	1618254.22	7382.93
3-4	1771295.44	1618895.07	7363.33	3-4	1770859.67	1618169.12	7384.39
3-4	1771335.29	1618834.66	7362.59	3-4	1775920.93	1619122.55	7269.21
3-4	1771345.56	1618770.28	7364.04	3-4	1776008.64	1619092.28	7270.52
3-4	1771343.02	1618708.26	7364.46	3-4	1773646.58	1624596.82	7300.71
3-4	1771347.87	1618678.45	7364.73	3-4	1775189.87	1619874.24	7284.70
3-4	1771341.76	1618706.09	7365.43	3-4	1775210.96	1619993.94	7281.51
3-4	1771337.09	1618648.90	7365.03	3-4	1775253.80	1620195.80	7273.04
3-4	1771327.12	1618621.72	7365.87	3-4	1775261.05	1620256.72	7266.90
3-4	1771302.92	1618576.04	7367.17	3-4	1775263.99	1620344.33	7268.35
3-4	1771280.06	1618550.63	7367.24	3-4	1775258.98	1620400.78	7268.31
3-4	1771256.43	1618524.10	7369.25	3-4	1775243.63	1620590.18	7266.95
3-4	1771243.42	1618489.90	7370.40	3-4	1775229.32	1620659.07	7266.80

Appendix A-1: Surveyed Points (cont.)

Mapped Contact	Northing	Easting	Elevation	Mapped Contact	Northing	Easting	Elevation
3-4	1771235.93	1618464.61	7371.45	3-4	1775191.01	1620714.29	7266.51
3-4	1771237.49	1618435.18	7373.48	3-4	1775154.13	1620722.96	7267.85
3-4	1771251.16	1618404.90	7373.28	3-4	1775144.35	1620803.41	7270.57
3-4	1771269.33	1618393.35	7375.13	3-4	1775112.08	1620881.40	7270.31
3-4	1771280.27	1618356.24	7375.40	3-4	1775082.12	1620927.42	7273.36
3-4	1771289.71	1618331.76	7375.28	3-4	1775037.18	1620964.78	7270.97
3-4	1773081.95	1616497.05	7408.73	3-4	1775037.10	1621027.14	7272.44
3-4	1773112.07	1616462.30	7411.41	3-4	1775040.92	1621067.96	7271.74
3-4	1773103.92	1616448.00	7412.78	3T-4	1771724.15	1617818.04	7391.01
3-4	1773092.13	1616388.85	7412.18	3T-4	1771770.83	1617765.62	7390.16
3-4	1773085.45	1616335.88	7415.36	3T-4	1771799.32	1617742.26	7389.55
3-4	1773089.16	1616237.40	7420.02	3T-4	1771860.43	1617690.94	7391.52
3-4	1773096.22	1616218.87	7423.35	3T-4	1771910.76	1617640.60	7390.36
3-4	1773116.62	1616174.29	7427.12	3T-4	1771941.29	1617615.11	7391.89
3-4	1773153.06	1616119.82	7427.31	3T-4	1771991.11	1617587.00	7389.90
3-4	1773184.27	1616088.79	7430.92	3T-4	1772064.02	1617574.04	7387.50
3-4	1773224.90	1616040.44	7430.50	3T-4	1772119.81	1617585.99	7384.87
3-4	1773250.49	1615986.01	7438.45	3T-4	1772270.99	1617505.36	7384.15
3-4	1773239.83	1615891.92	7449.66	3T-4	1772285.17	1617480.40	7384.92
3-4	1773235.61	1615838.20	7453.02	3T-4	1772329.47	1617402.56	7384.15
3-4	1770838.81	1618960.26	7366.97	3T-4	1772358.89	1617332.74	7388.34
3-4	1770846.42	1618903.35	7365.11	3T-4	1772381.71	1617270.01	7391.52
3-4	1770867.08	1618795.86	7364.27	3T-4	1772387.50	1617228.22	7391.73
3-4	1770874.00	1618709.14	7370.82	3T-4	1772611.87	1616837.81	7402.52
3-4	1770871.82	1618679.18	7373.30	3T-4	1772636.53	1616795.22	7404.59
3-4	1770828.91	1618545.52	7374.91	3T-4	1772650.71	1616761.46	7405.40
3-4	1770813.00	1618476.60	7378.85	3T-4	1772668.12	1616741.94	7405.04
3-4	1770814.02	1618421.21	7378.81	3T-4	1772682.02	1616723.04	7404.23
3-4	1770692.17	1619782.25	7354.19	3T-4	1772702.91	1616694.69	7407.42
3-4	1770718.26	1619723.71	7357.65	3T-4	1772714.50	1616676.34	7408.18
3-4	1774987.08	1621612.06	7272.58	3T-4	1773077.83	1616503.69	7413.37
3-4	1774995.34	1621731.78	7270.91	3T-4	1773137.16	1616480.26	7414.17
3-4	1774993.65	1621859.89	7274.73	3T-4	1773117.39	1616464.97	7413.47
3-4	1774967.51	1621953.35	7277.60	3T-4	1771147.19	1616373.78	7435.18
3-4	1774983.08	1622010.04	7274.10	3T-4	1771026.22	1616873.41	7416.34
3-4	1774938.45	1622141.91	7279.76	3T-4	1771044.42	1616742.90	7422.24
3-4	1774749.60	1622241.61	7293.29	3T-4	1771066.83	1616617.74	7423.64
3-4	1774708.23	1622297.96	7292.10	3T-4	1771080.48	1616518.60	7427.19
3-4	1774668.73	1622382.65	7296.17	3T-4	1771112.36	1616360.90	7435.16
3-4	1774653.10	1622446.18	7299.07	3T-4	1771184.81	1616337.39	7438.70
3-4	1774649.15	1622558.36	7297.51	3T-4	1771220.07	1616301.55	7437.75
3-4	1775036.91	1621116.58	7273.01	3T-4	1771295.87	1616258.21	7435.86
3-4	1774983.76	1621142.28	7276.50	3T-4	1771338.50	1616221.79	7438.65
3-4	1774933.03	1621200.31	7276.94	3T-4	1771344.16	1616189.79	7441.95
3-4	1774947.30	1621247.06	7273.56	3T-4	1771382.03	1616112.49	7441.16
3-4	1774952.75	1621326.27	7273.58	3T-4	1770940.45	1617611.56	7387.70
3-4	1774955.50	1621370.52	7273.05	3T-4	1770919.76	1617627.58	7391.78
3-4	1774963.31	1621436.12	7272.07	3T-4	1770874.86	1617669.10	7391.59
3-4	1774979.02	1621478.43	7270.58	3T-4	1770794.53	1617820.42	7393.64
3-4	1774950.88	1621540.60	7273.24	3T-4	1770807.38	1617991.84	7391.27
3-4	1773233.30	1617903.11	7353.35	3T-4	1770821.54	1618044.88	7389.91
3-4	1773532.61	1617472.83	7359.84	3T-4	1771005.49	1617446.02	7393.24

Appendix A-1: Surveyed Points (cont.)

Mapped Contact	Northing	Easting	Elevation	Mapped Contact	Northing	Easting	Elevation
3T	1773991.58	1623606.31	7310.88	3T-4	1770992.09	1617337.02	7398.15
3T	1773943.84	1623676.15	7316.21	3T-4	1770975.08	1617170.34	7417.42
3T	1773907.76	1623732.96	7318.12	3T-4	1770969.34	1617281.55	7409.48
3T	1773303.68	1615470.00	7464.69	3T-4	1771023.84	1617045.70	7417.04
3T-4	1772393.88	1617186.85	7393.04	3T-4	1771030.67	1616782.80	7422.85
3T-4	1772406.60	1617132.68	7396.47	3T-4	1771054.55	1616696.72	7420.63
3T-4	1772595.26	1616887.85	7399.02	3T-4	1770832.26	1618094.32	7389.23
3T-4	1772508.03	1616714.05	7406.85	3T-4	1771884.64	1617248.39	7403.94
3T-4	1776225.72	1616838.54	7382.42	3T-4	1771951.44	1617272.26	7401.85
3T-4	1776230.08	1616732.37	7388.43	3T-4	1772052.41	1617264.38	7404.43
3T-4	1775988.72	1615877.81	7551.62	3T-4	1772091.96	1617266.67	7400.70
3T-4	1776017.63	1615950.48	7537.85	3T-4	1772141.28	1617241.58	7397.90
3T-4	1776056.11	1615999.13	7525.34	3T-4	1772176.76	1617203.39	7398.81
3T-4	1776056.41	1616231.32	7466.33	3T-4	1772204.20	1617131.14	7402.76
3T-4	1776038.22	1616344.93	7432.27	3T-4	1772214.37	1617079.02	7402.05
3T-4	1776108.23	1616422.27	7418.81	3T-4	1772241.33	1616998.23	7401.61
3T-4	1776114.10	1616515.66	7404.76	3T-4	1772365.88	1616760.40	7408.32
3T-4	1776089.29	1616597.64	7396.10	3T-4	1772348.59	1616832.10	7407.47
3T-4	1775534.45	1617051.30	7358.61	3T-4	1772314.01	1616870.85	7406.14
3T-4	1775525.83	1617107.59	7354.11	3T-4	1772240.57	1616915.30	7410.75
3T-4	1775520.60	1617148.80	7350.01	3T-4	1772455.82	1616752.51	7410.68
3T-4	1775511.44	1617183.66	7353.37	3T-4	1772562.43	1616655.60	7408.69
3T-4	1775516.21	1617212.96	7348.14	3T-4	1775968.14	1615678.79	7578.27
3T-4	1775341.18	1618904.93	7300.95	3T-4	1775961.04	1615595.04	7581.18
3T-4	1775344.18	1618829.59	7299.66	3T-4	1775926.59	1615514.72	7578.37
3T-4	1775321.12	1618764.07	7307.57	3T-4	1775888.28	1615425.85	7589.68
3T-4	1775306.92	1618633.25	7298.89	3T-4	1775766.54	1615401.62	7595.82
3T-4	1775274.64	1618325.76	7306.38	3T-4	1775704.20	1615329.12	7603.78
3T-4	1775266.38	1618264.40	7304.53	3T-4	1775679.84	1615292.44	7613.58
3T-4	1775359.96	1618122.05	7311.93	3T-4	1775652.93	1615249.18	7611.44
3T-4	1775421.68	1618006.51	7312.36	3T-4	1775644.61	1615200.10	7625.44
3T-4	1775430.60	1617885.64	7313.67	3T-4	1775616.60	1615102.02	7634.50
3T-4	1775500.72	1616864.36	7375.29	3T-4	1775585.61	1615042.26	7644.92
3T-4	1775436.44	1616425.92	7397.08	3T-4	1775582.95	1614946.93	7652.03
3T-4	1775430.44	1616593.78	7395.80	3T-4	1775590.59	1614884.25	7660.08
3T-4	1775440.40	1616657.80	7390.08	3T-4	1775586.86	1614682.80	7673.89
3T-4	1775487.48	1616754.55	7375.11	3T-4	1775607.40	1614618.95	7686.56
3T-4	1775424.37	1616285.93	7430.34	3T-4	1775655.55	1614490.96	7717.39
3T-4	1775417.45	1616229.75	7441.12	3T-4	1775736.09	1614262.56	7740.84
3T-4	1775403.48	1616116.94	7457.90	3T-4	1775775.03	1614235.39	7748.81
3T-4	1775370.16	1616055.17	7480.02	3T-4	1775856.39	1614122.61	7760.77
3T-4	1775335.24	1615976.83	7498.88	3T-4	1775882.11	1613981.11	7773.86
3T-4	1775312.93	1615930.15	7506.02	3T-4	1775994.46	1613961.18	7781.44
3T-4	1775293.26	1615888.37	7512.86	3T-4	1775992.10	1613456.91	7798.10
3T-4	1775269.35	1615860.86	7517.05	3T-4	1776028.82	1613365.28	7805.74
3T-4	1775216.35	1615816.17	7517.48	3T-4	1776107.59	1613247.88	7823.95
3T-4	1775192.97	1615784.05	7519.12	3T-4	1776203.78	1613205.13	7832.12
3T-4	1775026.72	1615652.88	7514.14	3T-4	1776300.81	1612945.01	7861.94
3T-4	1774984.75	1615596.70	7516.24	3T-4	1776443.79	1612624.85	7870.34
3T-4	1774952.37	1615550.04	7525.36	3T-4	1776944.09	1612071.82	7989.96
3T-4	1774908.65	1615481.15	7529.56	3T-4	1776705.33	1616668.67	7396.60
3T-4	1774876.26	1615426.56	7535.60	3T-4	1776721.59	1616686.01	7394.99

Appendix A-1: Surveyed Points (cont.)

Mapped Contact	Northing	Easting	Elevation	Mapped Contact	Northing	Easting	Elevation
3T-4	1774862.02	1615357.64	7538.13	3T-4	1776737.58	1616713.36	7394.68
3T-4	1774811.54	1615149.21	7572.28	3T-4	1776743.50	1616726.76	7393.84
3T-4	1776027.98	1615980.79	7530.17	3T-4	1776752.40	1616743.43	7394.43
3T-4	1776002.13	1615914.41	7545.70	3T-4	1776762.55	1616760.14	7392.57
3T-4	1775976.31	1615825.12	7561.03	3T-4	1776790.85	1616811.80	7387.44
3T-4	1775968.83	1615734.00	7573.17	3T-4	1776796.13	1616821.85	7388.76
3T-4	1773136.03	1615638.44	7468.62	3T-4	1776805.08	1616833.80	7386.66
3T-4	1773103.72	1615728.14	7462.57	3T-4	1776810.45	1616844.35	7384.86
3T-4	1773083.18	1615788.26	7459.27	3T-4	1776826.12	1616872.58	7386.64
3T-4	1773276.55	1615431.39	7480.74	3T-4	1776844.23	1616930.82	7379.71
3T-4	1773303.27	1615662.93	7470.55	3T-4	1776845.02	1616946.81	7380.46
3T-4	1773377.63	1615596.46	7476.70	3T-4	1776844.95	1616957.12	7381.06
3T-4	1773411.79	1615572.96	7480.21	3T-4	1776839.73	1616987.19	7377.04
3T-4	1773446.13	1615377.55	7492.81	3T-4	1776835.27	1616998.00	7376.66
3T-4	1773488.83	1615401.74	7492.30	3T-4	1776825.19	1617016.23	7375.94
3T-4	1773527.58	1615419.58	7490.43	3T-4	1776803.18	1617038.69	7372.36
3T-4	1773598.06	1615498.58	7485.42	3T-4	1776779.43	1617051.98	7371.75
3T-4	1773555.51	1615511.43	7481.49	3T-4	1773239.37	1615787.99	7462.02
3T-4	1773511.93	1615523.87	7480.89	3T-4	1773250.81	1615752.04	7464.59
3T-4	1773484.88	1615528.63	7481.43	3T-4	1773266.46	1615717.27	7466.19
3T-4	1773428.59	1615556.41	7480.61	3T-4	1773167.32	1615615.39	7466.04
3T-4	1773431.43	1615300.30	7499.54	3T-4	1771583.50	1615034.46	7502.09
3T-4	1773437.80	1615256.41	7504.20	3T-4	1771579.09	1614982.52	7504.28
3T-4	1773435.04	1615193.64	7509.95	3T-4	1771461.88	1615026.04	7501.06
3T-4	1773418.01	1615149.37	7514.32	3T-4	1771539.22	1614658.54	7519.35
3T-4	1773233.99	1615211.47	7493.85	3T-4	1771572.07	1614607.82	7519.66
3T-4	1773408.74	1615120.12	7519.12	3T-4	1771617.83	1614807.45	7511.66
3T-4	1773416.07	1615069.73	7522.38	3T-4	1771647.36	1614756.59	7512.34
3T-4	1773422.48	1615027.18	7526.03	3T-4	1771645.51	1614689.06	7516.26
3T-4	1773445.66	1614944.79	7532.71	3T-4	1771660.96	1614624.50	7520.53
3T-4	1773483.14	1614890.53	7540.06	3T-4	1771701.29	1614474.28	7528.40
3T-4	1773457.26	1614835.19	7546.48	3T-4	1771683.18	1614328.22	7534.00
3T-4	1773410.93	1614820.15	7552.21	3T-4	1772678.60	1618571.21	7355.03
3T-4	1773370.01	1614807.45	7549.46	3T-4	1772502.63	1618622.93	7357.37
3T-4	1773346.55	1614757.02	7553.39	3T-4	1772403.05	1618671.66	7359.51
3T-4	1773126.17	1614992.99	7525.67	3T-4	1772262.75	1618683.60	7362.30
3T-4	1773175.63	1615073.36	7512.44	3T-4	1772075.21	1618750.74	7363.96
3T-4	1773019.42	1614701.68	7550.77	3T-4	1772841.96	1619229.61	7344.66
3T-4	1773348.98	1614616.26	7566.19	3T-4	1772662.37	1619206.36	7348.41
3T-4	1773370.70	1614526.32	7576.92	3T-4	1772450.75	1619309.24	7350.22
3T-4	1773395.04	1614475.28	7583.22	3T-4	1772412.72	1619061.52	7356.11
3T-4	1773391.20	1614432.21	7584.76	3T-4	1773179.06	1617595.94	7363.74
3T-4	1773461.01	1614363.99	7596.14	3T-4	1773115.09	1617929.48	7358.02
3T-4	1773496.57	1614313.24	7600.60	3T-4	1773058.30	1617617.11	7368.29
3T-4	1771588.21	1615820.16	7464.75	3T-4	1773148.02	1617769.11	7359.06
3T-4	1771573.58	1615736.84	7467.81	3T-4	1773621.48	1617818.29	7351.54
3T-4	1771595.66	1615640.28	7474.01	3T-4	1773297.36	1617876.36	7354.53
3T-4	1771633.28	1615531.12	7479.92	3T-4	1773433.34	1617634.30	7359.41
3T-4	1771637.65	1615471.83	7481.89	3Tl-u	1771112.73	1617849.57	7394.06
3T-4	1771640.37	1615406.09	7486.34	3Tl-u	1771164.53	1617844.24	7392.48
3T-4	1771616.27	1615330.58	7489.10	3Tl-u	1771229.80	1616965.87	7417.04
3T-4	1771589.46	1615268.15	7489.67	3Tl-u	1771229.10	1616941.75	7419.31

Appendix A-1: Surveyed Points (cont.)

Mapped Contact	Northing	Easting	Elevation	Mapped Contact	Northing	Easting	Elevation
3T-4	1771496.30	1615476.17	7480.59	3Tl-u	1771226.83	1616843.04	7422.17
3T-4	1771498.24	1615387.12	7484.64	3Tl-u	1771221.80	1616794.53	7423.96
3T-4	1771471.69	1615268.81	7488.77	3Tl-u	1771224.63	1616765.15	7424.22
3T-4	1771575.34	1615201.96	7494.32	3Tl-u	1771230.33	1616742.87	7425.11
3T-4	1771578.74	1615122.69	7497.34	3Tl-u	1771232.22	1616710.29	7424.68
3T-4	1773296.73	1617515.47	7363.45	3Tl-u	1771230.38	1616686.24	7425.84
3Tl-u	1771086.00	1617823.77	7393.70	3Tl-u	1771234.67	1616652.63	7427.19
3Tl-u	1771112.86	1617773.14	7394.46	3Tl-u	1771239.84	1616611.48	7428.61
3Tl-u	1771139.67	1617736.95	7396.60	3Tl-u	1771238.73	1616586.96	7429.60
3Tl-u	1771166.90	1617696.79	7397.17	3Tl-u	1771239.08	1616568.15	7430.51
3Tl-u	1771193.18	1617648.17	7398.33	3Tl-u	1771241.49	1616544.11	7430.77
3Tl-u	1771201.20	1617595.48	7395.81	3Tl-u	1771247.57	1616524.12	7430.71
3Tl-u	1771209.70	1617565.21	7397.20	3Tl-u	1771266.11	1616494.70	7432.49
3Tl-u	1771214.79	1617546.71	7398.84	3Tl-u	1771284.83	1616471.95	7432.44
3Tl-u	1771215.14	1617505.17	7399.52	3Tl-u	1771309.33	1616448.81	7432.55
3Tl-u	1771211.13	1617473.78	7401.12	3Tl-u	1771333.21	1616426.13	7432.30
3Tl-u	1771209.11	1617448.22	7401.03	3Tl-u	1771391.86	1616386.77	7433.71
3Tl-u	1771208.01	1617423.44	7402.48	3Tl-u	1771454.08	1616342.75	7433.40
3Tl-u	1771203.82	1617400.80	7402.43	3Tl-u	1771474.69	1616323.19	7434.13
3Tl-u	1771197.55	1617324.37	7406.07	3Tl-u	1771475.37	1616117.72	7438.74
3Tl-u	1771193.37	1617302.95	7406.73	3Tl-u	1771473.44	1616159.23	7438.05
3Tl-u	1771194.55	1617275.48	7409.57	3Tl-u	1771469.21	1616191.39	7437.69
3Tl-u	1771206.32	1617227.59	7410.24	3Tl-u	1771461.95	1616245.27	7435.59
3Tl-u	1771219.15	1617190.67	7412.59	3Tl-u	1771463.20	1616283.81	7435.34
3Tl-u	1771225.77	1617151.77	7412.29	3Tl-u	1771489.03	1616090.78	7440.62
3Tl-u	1771230.06	1617116.15	7412.78	3Tl-u	1771502.84	1616065.37	7440.78
3Tl-u	1771237.71	1617081.83	7414.43	3Tl-u	1771513.31	1616039.23	7441.09
3Tl-u	1771245.69	1617048.38	7415.98	3Tl-u	1771519.76	1616020.74	7442.61
3Tl-u	1771246.13	1617018.32	7416.60	3Tl-u	1771522.27	1616007.57	7442.02
3Tl-u	1771236.75	1616988.68	7417.55	3Tl-u	1771524.65	1615958.27	7443.76
3Tl-u	1771636.92	1617510.02	7399.29	3Tl-u	1771536.92	1615927.95	7443.95
3Tl-u	1771670.00	1617488.72	7398.69	3Tl-u	1771550.73	1615906.66	7444.20
3Tl-u	1771683.13	1617458.16	7399.50	3Tl-u	1771503.99	1615919.57	7443.22
3Tl-u	1771748.27	1617372.97	7401.68	3Tl-u	1771483.90	1615892.68	7443.91
3Tl-u	1771783.04	1617318.24	7402.82	3Tl-u	1771501.90	1615834.80	7445.09
3Tl-u	1771809.05	1617245.65	7406.01	3Tl-u	1771513.09	1615809.82	7448.09
3Tl-u	1771368.09	1617656.51	7393.20	3Tl-u	1771522.54	1615740.92	7450.25
3Tl-u	1771426.19	1617619.82	7393.30	3Tl-u	1771527.59	1615703.13	7452.91
3Tl-u	1771494.68	1617598.56	7394.18	3Tl-u	1771540.45	1615647.56	7455.70
3Tl-u	1771521.88	1617576.20	7396.40	3Tl-u	1771546.58	1615587.95	7457.54
3Tl-u	1771574.96	1617555.74	7396.64	3Tl-u	1771577.29	1615507.71	7459.98
3Tl-u	1771251.01	1617764.53	7390.65	3Tl-u	1771220.22	1617814.66	7388.19
3Tl-u	1771309.73	1617698.95	7394.01	3T	1776451.39	1612745.49	7896.87
3T	1776937.88	1612043.51	7999.28	3T	1776925.97	1612126.31	8004.27
3T	1770975.87	1617173.81	7416.56	4WB	1771546.62	1616247.30	7463.06
3T	1771018.25	1617126.32	7409.37	4WB	1771545.17	1616283.93	7461.88
3T	1771020.46	1616997.54	7417.43	4WB	1771549.16	1616310.83	7457.70
3T	1771110.57	1616419.70	7433.07	4WB	1771545.27	1616339.31	7457.03
4WB	1771464.89	1616515.15	7453.16	4WB	1771519.45	1616428.12	7453.99
4WB	1771299.33	1617301.10	7433.79	4WB	1771641.24	1615981.30	7470.43
4WB	1771312.69	1617284.21	7435.50	4WB	1771652.74	1615938.21	7475.34
4WB	1771325.21	1617216.68	7438.32	4WB	1771651.88	1615908.65	7474.23

Appendix A-1: Surveyed Points (cont.)

Mapped Contact	Northing	Easting	Elevation	Mapped Contact	Northing	Easting	Elevation
4WB	1771309.15	1617179.68	7437.18	Qt	1775524.50	1622459.08	7147.05
4WB	1771301.95	1617154.77	7436.95	Qt	1775534.22	1622462.81	7147.71
4WB	1771308.00	1617082.76	7441.60	Qt	1771343.52	1616294.62	7428.29
4WB	1771318.47	1617023.08	7444.77	Qt	1770748.21	1620194.32	7237.29
4WB	1771312.60	1616964.89	7445.61	Qt	1770530.23	1620316.05	7256.09
4WB	1771291.17	1616957.47	7442.15	Qt	1775977.15	1617335.30	7283.54
4WB	1771282.37	1616915.83	7440.45	Qt	1775452.24	1620611.65	7159.31
4WB	1771275.34	1616886.70	7440.56	Qt	1775470.78	1620768.13	7159.30
4WB	1771278.21	1616832.63	7441.78	Qt	1775395.08	1621057.67	7149.93
4WB	1771282.49	1616782.78	7443.83	S3-3T	1772387.93	1617165.98	7385.52
4WB	1771289.23	1616757.53	7444.33	S3-3T	1775938.66	1618093.14	7291.49
4WB	1771288.25	1616706.51	7444.68	S3-3T	1776009.83	1617517.67	7310.26
4WB	1771275.34	1616678.14	7445.84	S3-3T	1776115.44	1617266.78	7317.41
4WB	1771557.74	1616217.94	7463.03	S3-3T	1773345.47	1615605.99	7468.05
4WB	1771580.44	1616185.31	7466.80	S3-3T	1773404.11	1614972.99	7510.22
4WB	1771580.10	1616139.37	7466.69	S3-3T	1773297.12	1614829.85	7519.57
4WB	1771568.12	1616112.31	7468.22	S3-3T	1773291.54	1614808.10	7520.90
4WB	1771569.82	1616087.24	7468.65	S3-3T	1773262.29	1614756.77	7525.09
4WB	1771580.73	1616069.63	7469.34	S3-3T	1773260.91	1614748.61	7525.47
4WB	1771589.91	1616045.44	7470.50	S3-3T	1773233.10	1614564.39	7539.69
4WB	1771608.31	1616022.19	7470.82	S3-3T	1773345.57	1614121.59	7574.00
4WB	1771696.29	1615784.78	7477.08	S3-3T	1773355.14	1613626.56	7607.18
4WB	1771718.26	1615762.78	7477.89	S3-4	1773127.12	1621447.74	7333.07
4WB	1771735.09	1615738.53	7481.27	S3-4	1773122.39	1621429.66	7332.40
4WB	1771718.11	1615732.08	7482.20	S3-4	1773117.07	1621412.59	7332.44
4WB	1771682.46	1615754.93	7478.57	S3-4	1773114.31	1621335.65	7332.38
4WB	1771645.12	1615770.75	7476.97	S3-4	1773114.94	1621329.67	7332.94
4WB	1771602.22	1615776.74	7478.61	S3-4	1773116.69	1621319.07	7332.96
4WB	1771599.75	1615751.56	7480.96	S3-4	1773115.68	1621317.18	7333.61
4WB	1771597.49	1615718.22	7479.07	S3-4	1773115.85	1621313.61	7333.42
4WB	1771600.23	1615694.28	7481.89	S3-4	1773115.00	1621309.26	7333.39
4WB	1771606.96	1615673.30	7482.43	S3-4	1773172.10	1621103.74	7330.27
4WB	1771620.99	1615644.54	7484.48	S3-4	1773167.96	1621090.98	7330.30
4WB	1771624.35	1615636.44	7484.84	S3-4	1773182.51	1620967.52	7330.91
4WB	1771633.02	1615585.91	7485.58	S3-4	1773189.23	1620965.76	7330.47
4WB	1771636.63	1615999.84	7471.51	S3-4	1773439.66	1620886.86	7326.00
4WB	1771654.98	1615890.44	7471.16	S3-4	1773439.60	1620887.12	7326.59
4WB	1771666.10	1615862.15	7473.21	S3-4	1773465.79	1620858.50	7327.03
4WB	1771670.14	1615849.03	7472.36	S3-4	1774054.10	1620207.59	7308.63
S3-4	1770032.72	1623298.97	7319.87	S3-4	1774304.62	1622226.17	7314.42
S3-4	1770012.10	1623366.15	7320.19	S3-4	1774304.87	1622224.94	7313.98
S3-4	1769931.15	1623376.02	7315.72	S3-4	1774305.24	1622223.19	7313.76
S3-4	1769673.21	1623981.76	7304.17	S3-4	1774305.76	1622221.25	7313.54
S3-4	1775895.43	1619171.27	7268.88	S3-4	1774306.49	1622219.37	7313.84
S3-4	1775905.68	1619160.28	7270.84	S3-4	1774307.15	1622217.75	7313.81
S3-4	1772212.84	1621372.32	7347.74	S3-4	1774308.98	1622211.92	7313.55
S3-4	1772198.56	1621378.70	7346.92	S3-4	1774310.14	1622209.03	7313.92
S3-4	1772183.48	1621408.64	7346.00	S3-4	1774312.61	1622201.47	7313.99
S3-4	1772232.88	1621361.53	7346.83	S3-4	1774313.48	1622198.76	7313.87
S3-4	1772293.11	1620935.52	7345.41	S3-4	1774315.26	1622193.60	7314.29
S3-4	1772164.35	1620664.35	7347.21	S3-4	1774316.04	1622191.60	7314.57
S3-4	1772064.02	1620203.66	7349.62	S3-4	1774316.73	1622189.47	7314.61

Appendix A-1: Surveyed Points (cont.)

Mapped Contact	Northing	Easting	Elevation	Mapped Contact	Northing	Easting	Elevation
S3-4	1772063.76	1620199.54	7349.99	S3-4	1774319.14	1622182.25	7314.48
S3-4	1772045.46	1620113.21	7350.86	S3-4	1774334.65	1622134.92	7313.05
S3-4	1772046.02	1620104.46	7350.78	S3-4	1774336.62	1622129.22	7311.59
S3-4	1772051.85	1620078.30	7352.19	S3-4	1774338.69	1622122.52	7311.89
S3-4	1772065.33	1619968.23	7354.48	S3-4	1774340.92	1622115.82	7311.97
S3-4	1772066.23	1619963.18	7355.23	S3-4	1774345.49	1622101.44	7311.72
S3-4	1772065.79	1619958.68	7354.95	S3-4	1774350.13	1622087.14	7311.29
S3-4	1772059.43	1619947.72	7353.30	S3-4	1774353.20	1622078.43	7311.50
S3-4	1771538.85	1620550.67	7360.91	S3-4	1774355.98	1622070.42	7311.18
S3-4	1771511.09	1620628.90	7360.20	S3-4	1774355.09	1622045.21	7310.38
S3-4	1771470.80	1620770.18	7358.53	S3-4	1774357.99	1622033.34	7310.21
S3-4	1769756.23	1623952.80	7306.33	S3-4	1774360.67	1622026.07	7309.13
S3-4	1769926.00	1623779.50	7311.36	S3-4	1774363.00	1622019.69	7309.77
S3-4	1767977.79	1622971.39	7294.07	S3-4	1774365.99	1622011.81	7310.09
S3-4	1768002.02	1623071.34	7295.26	S3-4	1774369.81	1621998.52	7309.69
S3-4	1767988.24	1622857.45	7296.35	S3-4	1774382.02	1621954.03	7308.44
S3-4	1769429.92	1624087.82	7297.40	S3-4	1774379.50	1621949.93	7307.18
S3-4	1769181.54	1624371.41	7287.74	S3-4	1773799.37	1622683.49	7313.63
S3-4	1770341.19	1622515.27	7331.09	S3-4	1773803.55	1622676.50	7313.71
S3-4	1770341.12	1622513.23	7331.22	S3-4	1771394.36	1619889.44	7363.12
S3-4	1770355.27	1622442.61	7331.17	S3-4	1771394.77	1619905.09	7365.02
S3-4	1770355.58	1622440.86	7331.16	S3-4	1771387.30	1619935.61	7364.48
S3-4	1770362.58	1622427.47	7331.95	S3-4	1771381.91	1619970.93	7364.24
S3-4	1770369.23	1622415.05	7331.06	S3-4	1771372.42	1619999.76	7363.04
S3-4	1770369.32	1622415.00	7331.03	S3-4	1771370.11	1620008.38	7362.76
S3-4	1770343.69	1622617.99	7331.79	S3-4	1771356.79	1620050.23	7363.42
S3-4	1770342.32	1622616.43	7331.52	S3-4	1771351.81	1620073.49	7365.77
S3-4	1770231.52	1622837.62	7327.19	S3-4	1771335.15	1620118.64	7363.96
S3-4	1770128.57	1623132.86	7322.11	S3-4	1771370.52	1619787.88	7363.32
S3-4	1770056.92	1623297.89	7320.78	S3-4	1771388.70	1619792.37	7363.73
S3-4	1770051.10	1623297.53	7320.72	S3-4	1771368.42	1619787.06	7363.28
S3-4	1774376.18	1621941.94	7309.00	S3-4	1773127.03	1616479.75	7409.57
S3-4	1774367.23	1621932.09	7309.08	S3-4	1775905.12	1619155.31	7269.56
S3-4	1773792.78	1622695.34	7314.45	S3T-4	1775229.60	1615822.23	7516.26
S3-4	1773796.21	1622689.45	7313.43	S3T-4	1775129.12	1615739.15	7514.29
S3T-4	1776776.79	1616775.35	7392.63	S3T-4	1775074.24	1615685.20	7515.69
S3T-4	1776791.93	1616813.75	7387.09	S4	1776776.18	1617053.62	7372.70
S3T-4	1776837.53	1616899.14	7384.02	S4	1776777.37	1617053.02	7373.39
S3T-4	1775478.47	1617373.94	7350.50	T-A	1774034.94	1622873.96	7308.18
S3T	1776599.05	1616649.62	7370.16	T-A	1774035.27	1622872.44	7308.03
S3T	1776614.77	1616643.36	7370.69	T-A	1774035.47	1622870.81	7306.81
S3T	1776667.93	1616650.60	7371.30	T-A	1774036.33	1622868.07	7306.84
S3T	1773240.58	1614505.47	7547.45	T-A	1774037.46	1622864.92	7306.77
S3T	1773244.82	1614497.30	7548.44	T-A	1774039.50	1622860.66	7306.91
S3T	1773246.88	1614485.80	7549.78	T-A	1774040.23	1622857.28	7306.97
S3T	1773242.08	1614476.15	7550.49	T-A	1774042.60	1622853.25	7307.09
S3T	1773242.48	1614463.80	7551.47	T-A	1774044.47	1622849.43	7307.37
S3T	1773240.52	1614457.63	7551.76	T-A	1774045.87	1622846.02	7307.36
S3T	1773250.06	1614410.63	7554.77	T-A	1774047.68	1622841.48	7307.34
S3T	1773287.57	1614339.17	7561.33	T-A	1774048.29	1622839.80	7307.19
S3T	1773289.77	1614064.93	7581.91	T-A	1775324.84	1617283.14	7397.32
S3T	1771593.11	1615467.03	7461.48	T-A	1773993.55	1622962.00	7308.56

Appendix A-1: Surveyed Points (cont.)

Mapped Contact	Northing	Easting	Elevation
S3T	1771595.44	1615458.47	7461.99
S3T	1771600.51	1615448.51	7462.62
S3T	1771603.27	1615406.83	7463.83
S3T	1771596.84	1615388.39	7464.19
S3T	1771589.79	1615370.49	7465.33
S3T	1771580.65	1615357.57	7465.22
S3Tl-u	1771223.81	1616934.45	7418.76
S4	1775176.26	1619366.88	7292.78
S4	1775189.58	1619321.83	7293.22
S4	1775193.05	1619315.58	7293.09
S4	1775197.41	1619308.61	7294.00
S4	1775200.98	1619303.56	7294.43
S4	1775206.20	1619293.79	7294.18
S4	1775209.13	1619288.37	7294.64
S4	1775212.17	1619282.29	7294.68
S4	1775216.23	1619275.45	7294.68
S4	1775220.26	1619267.17	7295.99
S4	1775223.18	1619260.01	7295.15
S4	1775227.02	1619251.94	7295.28
S4	1775226.79	1619252.64	7295.17
S4	1775230.24	1619245.58	7295.41
S4	1772616.16	1616921.63	7410.22
S4	1773112.80	1616407.54	7423.82
S4	1773103.30	1616346.71	7425.42
S4	1773097.97	1616325.37	7425.73
S4	1771999.42	1617608.65	7400.85
S4	1772033.16	1617599.95	7400.25
S4	1772038.61	1617599.97	7400.00
S4	1772041.15	1617600.46	7400.03
S4	1772045.51	1617599.50	7400.12
S4	1775517.62	1617147.57	7352.27
T-A	1774050.54	1622835.66	7307.20
T-A	1774052.08	1622832.04	7307.41
T-A	1774053.68	1622828.61	7307.77
T-A	1774055.49	1622824.30	7307.60
T-A	1774057.03	1622821.33	7308.12
T-A	1774059.54	1622819.12	7307.96
T-A	1774060.99	1622818.42	7307.02
T-A	1774061.76	1622817.24	7307.19
T-A	1774062.31	1622815.94	7307.46
T-A	1774064.90	1622809.83	7308.76
T-A	1774067.83	1622805.57	7308.51
T-A	1774069.25	1622802.58	7308.00
T-A	1774071.05	1622800.84	7308.41
T-A	1774071.70	1622796.19	7308.25
T-A	1774072.92	1622792.75	7308.31
T-A	1774075.04	1622788.65	7308.50
T-A	1774077.93	1622783.83	7308.34
T-A	1774079.65	1622779.54	7308.48
T-A	1774083.20	1622774.72	7308.60
T-A	1774084.47	1622772.73	7305.41
T-A	1774084.62	1622770.62	7305.75

Mapped Contact	Northing	Easting	Elevation
T-A	1773994.86	1622958.58	7308.64
T-A	1773996.96	1622955.00	7308.67
T-A	1773998.85	1622949.07	7308.70
T-A	1774001.26	1622944.73	7308.73
T-A	1774012.54	1622929.39	7310.43
T-A	1774023.61	1622913.34	7312.61
T-A	1774021.40	1622909.50	7306.52
T-A	1774023.31	1622904.92	7307.11
T-A	1774024.11	1622899.99	7307.33
T-A	1774026.00	1622898.27	7308.55
T-A	1774026.45	1622896.85	7308.72
T-A	1774026.56	1622893.93	7308.81
T-A	1774027.03	1622889.56	7309.30
T-A	1774030.37	1622885.09	7309.44
T-A	1774034.00	1622879.42	7309.89
T-A	1774032.73	1622878.08	7307.81
T-A	1774033.61	1622876.43	7307.98
T-A	1774110.81	1622714.74	7303.08
T-A	1774112.18	1622711.45	7303.01
T-A	1774113.54	1622708.66	7302.62
T-A	1774116.08	1622705.07	7302.93
T-A	1774118.04	1622701.07	7302.27
T-A	1774119.04	1622697.57	7301.43
T-A	1773977.86	1622989.28	7308.34
T-A	1773973.68	1622996.11	7308.19
T-A	1773970.03	1623003.20	7308.41
T-A	1773968.16	1623006.45	7308.91
T-A	1773967.61	1623007.29	7307.60
T-A	1773965.41	1623009.63	7307.89
T-A	1773964.02	1623012.07	7308.01
T-A	1773962.54	1623014.20	7308.25
T-A	1773962.31	1623017.97	7308.24
T-A	1773961.89	1623018.50	7307.29
T-A	1773959.72	1623019.49	7307.04
T-A	1773958.00	1623022.46	7306.25
T-A	1773955.83	1623026.59	7306.66
T-A	1773954.05	1623030.51	7306.22
T-A	1773951.20	1623035.94	7306.62
T-A	1773948.05	1623041.12	7306.70
T-A	1773944.70	1623045.70	7305.71
T-A	1773943.10	1623047.85	7305.25
T-A	1773943.60	1623048.65	7306.94
T-A	1773941.60	1623051.97	7306.90
T-A	1773940.77	1623057.41	7308.04
T-A	1773938.46	1623058.78	7307.71
T-A	1773936.00	1623061.55	7306.40
T-A	1773932.98	1623064.94	7305.90
T-A	1773930.95	1623068.69	7305.38
T-A	1773930.27	1623071.43	7306.85
T-A	1773929.22	1623072.99	7306.48
T-A	1773914.35	1623099.78	7314.35
T-A	1773913.38	1623102.12	7315.12

Appendix A-1: Surveyed Points (cont.)

Mapped Contact	Northing	Easting	Elevation	Mapped Contact	Northing	Easting	Elevation
T-A	1774085.52	1622767.78	7306.00	T-A	1773913.67	1623104.73	7313.33
T-A	1774086.79	1622763.91	7306.41	T-A	1773912.77	1623106.07	7313.56
T-A	1774088.56	1622760.22	7306.77	T-A	1773912.30	1623106.72	7316.12
T-A	1774090.45	1622756.99	7306.91	T-A	1773911.77	1623108.30	7315.10
T-A	1774092.27	1622754.36	7307.11	T-A	1773911.34	1623108.50	7315.52
T-A	1774093.24	1622754.02	7308.54	T-A	1773911.66	1623108.63	7316.80
T-A	1774093.59	1622753.59	7308.51	T-A	1773911.52	1623108.95	7317.84
T-A	1774093.88	1622753.12	7308.29	T-A	1773911.29	1623110.08	7319.17
T-A	1774092.67	1622751.09	7305.40	T-A	1773912.33	1623113.89	7321.65
T-A	1774094.56	1622747.18	7305.04	T-A	1773910.45	1623116.84	7322.18
T-A	1774096.34	1622743.51	7305.07	T-A	1773909.30	1623118.62	7322.50
T-A	1774099.05	1622739.53	7305.31	T-A	1773907.56	1623121.44	7322.43
T-A	1774101.54	1622732.75	7305.27	T-A	1773905.52	1623124.84	7322.86
T-A	1774103.59	1622728.90	7304.75	T-A	1773903.70	1623128.01	7322.87
T-A	1774105.98	1622723.91	7304.22	T-A	1773900.44	1623133.91	7322.95
T-A	1774107.56	1622720.83	7303.73	T-A	1773899.53	1623135.31	7322.74
T-A	1774108.04	1622720.13	7303.28	T-A	1773720.75	1623302.75	7318.86
T-A	1774109.16	1622717.65	7302.96	T-A	1773715.32	1623302.00	7318.95
T-A	1773891.66	1623139.24	7319.24	T-A	1773707.72	1623301.23	7320.12
T-A	1773888.66	1623143.57	7319.25	T-A	1773701.73	1623300.40	7320.68
T-A	1773885.87	1623148.16	7319.11	T-A	1773696.76	1623298.54	7320.80
T-A	1773883.76	1623153.94	7319.23	T-A	1773691.08	1623296.74	7320.46
T-A	1773877.63	1623163.18	7319.48	T-A	1773685.92	1623294.82	7320.72
T-A	1773874.51	1623167.02	7319.55	T-A	1773673.05	1623288.94	7322.29
T-A	1773872.45	1623170.17	7319.45	T-A	1773665.80	1623285.20	7322.73
T-A	1773871.70	1623174.14	7319.27	T-A	1773666.14	1623284.09	7321.68
T-A	1773870.18	1623177.63	7319.27	T-A	1773658.61	1623278.25	7322.00
T-A	1773867.36	1623180.22	7319.63	T-A	1773656.21	1623277.07	7321.91
T-A	1773650.05	1624291.21	7314.25	T-A	1773655.24	1623275.84	7321.23
T-A	1773864.69	1623183.30	7319.72	T-A	1773650.06	1623273.04	7321.34
T-A	1773862.93	1623186.65	7319.60	T-A	1773646.86	1623271.12	7322.24
T-A	1773861.07	1623188.97	7319.68	T-A	1773634.29	1623267.96	7323.85
T-A	1773859.25	1623192.25	7317.08	T-A	1773626.94	1623263.56	7325.24
T-A	1773857.23	1623194.57	7316.77	T-A	1773621.26	1623259.31	7326.36
T-A	1773856.68	1623195.76	7316.59	T-A	1773612.47	1623253.18	7327.70
T-A	1773855.33	1623196.14	7314.45	T-A	1773604.43	1623248.64	7329.79
T-A	1773854.52	1623198.99	7315.74	T-A	1773608.04	1623243.22	7322.45
T-A	1773850.92	1623202.36	7314.23	T-A	1774120.86	1622693.68	7300.39
T-A	1773848.57	1623206.33	7312.31	T-A	1774122.97	1622689.29	7301.51
T-A	1773847.07	1623208.84	7309.84	T-A	1774137.61	1622659.33	7300.53
T-A	1773843.19	1623214.42	7310.21	T-A	1774138.74	1622657.02	7301.51
T-A	1773842.02	1623216.16	7309.74	T-A	1774140.34	1622655.70	7307.24
T-A	1773841.21	1623221.48	7317.14	T-A	1774157.52	1622639.73	7311.91
T-A	1773837.43	1623223.97	7316.05	T-A	1774159.33	1622636.09	7314.21
T-A	1773836.08	1623226.71	7315.39	T-A	1774160.88	1622633.04	7317.97
T-A	1773835.26	1623227.58	7314.23	T-A	1774162.97	1622629.86	7320.24
T-A	1773833.67	1623229.57	7313.30	T-A	1774190.63	1622560.85	7318.95
T-A	1773831.56	1623232.30	7312.43	T-A	1774194.15	1622548.21	7320.12
T-A	1773830.32	1623234.16	7312.45	T-A	1774196.19	1622542.55	7320.54
T-A	1773829.85	1623235.16	7313.69	T-A	1774197.64	1622538.68	7318.73
T-A	1773828.15	1623237.25	7312.01	T-A	1774199.22	1622534.74	7319.12
T-A	1773826.13	1623239.64	7311.03	T-A	1774201.86	1622531.46	7319.29

Appendix A-1: Surveyed Points (cont.)

Mapped Contact	Northing	Easting	Elevation	Mapped Contact	Northing	Easting	Elevation
T-A	1773823.25	1623242.31	7310.08	T-A	1774203.36	1622526.74	7319.13
T-A	1773805.49	1623266.24	7311.12	T-A	1774206.53	1622521.73	7319.33
T-A	1773803.24	1623269.13	7312.14	T-A	1774207.83	1622517.53	7318.51
T-A	1773801.66	1623270.14	7311.94	T-A	1774210.18	1622512.73	7318.31
T-A	1773800.90	1623272.23	7314.18	T-A	1774212.17	1622509.15	7315.88
T-A	1773799.83	1623273.79	7315.07	T-A	1774212.45	1622504.93	7317.30
T-A	1773796.97	1623276.25	7316.32	T-A	1774213.24	1622500.66	7317.14
T-A	1773795.53	1623279.31	7316.55	T-A	1774214.56	1622496.89	7314.27
T-A	1773793.48	1623282.92	7316.71	T-A	1774214.13	1622498.24	7314.62
T-A	1773791.18	1623286.73	7317.22	T-A	1774213.39	1622500.29	7317.11
T-A	1773788.03	1623290.42	7316.87	T-A	1774216.20	1622491.55	7317.95
T-A	1773785.60	1623292.74	7316.48	T-A	1774217.59	1622487.05	7318.26
T-A	1773782.29	1623295.79	7316.68	T-A	1774219.60	1622481.73	7318.92
T-A	1773776.80	1623300.40	7315.41	T-A	1774222.04	1622474.85	7320.14
T-A	1773771.65	1623303.98	7316.08	T-A	1774223.49	1622470.27	7320.18
T-A	1773767.48	1623307.64	7316.21	T-A	1774294.31	1622257.25	7316.27
T-A	1773763.19	1623311.42	7316.64	T-A	1774294.71	1622256.31	7314.79
T-A	1773759.09	1623313.34	7316.85	T-A	1774295.32	1622254.18	7315.28
T-A	1774224.27	1622467.63	7316.06	T-A	1774296.18	1622251.53	7315.22
T-A	1774225.83	1622463.45	7316.03	T-A	1774296.79	1622249.82	7314.95
T-A	1774228.38	1622460.85	7317.39	T-A	1774297.40	1622247.82	7314.56
T-A	1774229.58	1622456.32	7318.18	T-A	1774298.42	1622244.77	7314.17
T-A	1774229.52	1622452.09	7313.36	T-A	1774299.58	1622240.86	7313.85
T-A	1774231.13	1622447.08	7314.19	T-A	1774300.73	1622237.57	7314.05
T-A	1774232.81	1622442.41	7315.95	T-A	1774301.73	1622234.89	7314.43
T-A	1774233.87	1622439.95	7315.78	T-A	1774302.94	1622231.02	7314.42
T-A	1774234.60	1622436.82	7318.34	T-A	1774304.16	1622227.55	7314.67
T-A	1774236.10	1622431.74	7318.21	T-A	1774305.82	1622222.08	7314.06
T-A	1774237.44	1622428.12	7318.60	T-A	1774306.59	1622219.86	7314.14
T-A	1774238.39	1622426.12	7319.34	T-A	1774307.39	1622217.58	7314.52
T-A	1774239.47	1622422.58	7318.50	T-A	1774308.09	1622215.34	7314.97
T-A	1774240.49	1622419.10	7318.29	T-A	1774309.16	1622212.12	7315.03
T-A	1774242.18	1622413.79	7318.17	T-A	1774309.97	1622209.67	7315.11
T-A	1774242.58	1622412.28	7317.10	T-A	1774310.80	1622207.43	7314.93
T-A	1774243.67	1622408.70	7317.01	T-A	1774311.75	1622204.55	7314.45
T-A	1774245.50	1622403.54	7317.17	T-A	1774312.83	1622201.50	7314.91
T-A	1774247.56	1622397.35	7317.44	T-A	1774313.63	1622198.80	7314.67
T-A	1774248.86	1622393.74	7317.18	T-A	1774314.22	1622196.63	7314.67
T-A	1774249.00	1622392.28	7315.47	T-A	1774315.14	1622194.43	7315.18
T-A	1774250.74	1622387.50	7315.93	T-A	1774316.89	1622188.85	7315.16
T-A	1774252.55	1622382.14	7316.59	T-A	1774318.09	1622185.18	7314.44
T-A	1774253.92	1622377.51	7317.24	T-A	1774319.17	1622181.98	7314.61
T-A	1774255.09	1622374.13	7315.99	T-A	1774320.71	1622177.38	7314.77
T-A	1774256.81	1622368.85	7317.60	T-A	1774322.10	1622173.01	7314.88
T-A	1774258.43	1622363.75	7317.10	T-A	1774323.54	1622169.03	7315.08
T-A	1774259.80	1622359.92	7317.80	T-A	1774325.19	1622163.81	7314.61
T-A	1774263.44	1622350.36	7317.79	T-A	1774326.99	1622158.33	7314.39
T-A	1774264.78	1622345.08	7316.88	T-A	1774328.67	1622152.99	7314.21
T-A	1774267.62	1622336.72	7316.24	T-A	1774330.12	1622148.48	7314.07
T-A	1774268.43	1622334.23	7315.56	T-A	1774333.02	1622139.96	7314.12
T-A	1774269.36	1622331.74	7316.08	T-A	1774335.28	1622133.16	7313.73
T-A	1774270.23	1622328.82	7315.43	T-A	1774337.32	1622127.26	7313.35

Mapped Contact	Northing	Easting	Elevation	Mapped Contact	Northing	Easting	Elevation
T-A	1774271.31	1622325.89	7316.03	T-A	1774338.47	1622123.90	7313.00
T-A	1774272.35	1622322.42	7316.38	T-A	1774340.37	1622118.20	7312.95
T-A	1774273.32	1622319.58	7316.65	T-A	1774341.82	1622112.87	7312.74
T-A	1774275.38	1622313.48	7316.02	T-A	1774343.54	1622108.13	7312.92
T-A	1774276.48	1622309.94	7315.63	T-A	1774345.32	1622102.66	7312.70
T-A	1774278.69	1622303.44	7315.83	T-A	1774347.25	1622096.70	7312.84
T-A	1774281.22	1622296.30	7316.75	T-A	1774348.77	1622091.26	7312.73
T-A	1774283.16	1622291.81	7316.79	T-A	1774353.06	1622079.09	7312.85
T-A	1774284.18	1622287.89	7316.11	T-A	1774355.38	1622072.76	7313.07
T-A	1774285.22	1622284.76	7315.79	T-A	1774359.24	1622061.53	7311.99
T-A	1774285.49	1622283.77	7315.24	T-A	1774358.38	1622033.55	7310.55
T-A	1774286.71	1622279.87	7315.32	T-A	1774363.84	1622019.60	7310.62
T-A	1774288.27	1622275.27	7314.96	T-A	1774366.67	1622011.46	7310.52
T-A	1774289.77	1622270.71	7315.81	T-A	1774372.32	1621995.05	7310.58
T-A	1774291.52	1622265.19	7315.83	T-A	1773643.22	1624364.53	7311.22
T-A	1774292.50	1622262.56	7316.03	T-A	1773644.68	1624399.76	7310.88
T-A	1774293.50	1622259.27	7316.30	T-A	1773646.98	1624432.66	7310.65
T-A	1774373.38	1621991.51	7310.59	T-A	1773646.75	1624434.93	7309.66
T-A	1774379.22	1621978.69	7310.40	T-A	1773650.51	1624470.86	7308.44
T-A	1774383.69	1621955.58	7310.00	T-A	1773650.73	1624505.28	7306.75
T-A	1774379.66	1621946.17	7309.02	T-A	1773647.46	1624560.53	7302.68
T-A	1774376.64	1621941.52	7309.53	T-A	1773647.43	1624635.79	7300.83
T-A	1774368.26	1621933.33	7309.87	T-A	1775361.78	1617605.37	7377.06
T-A	1773810.02	1622665.64	7314.42	T-A	1775368.53	1617562.87	7380.16
T-A	1773805.29	1622673.41	7314.55	T-A	1775420.87	1617381.95	7385.06
T-A	1773800.51	1622681.32	7314.16	T-A	1775461.30	1617331.34	7376.16
T-A	1773796.38	1622688.46	7314.65	T-A	1775467.28	1617292.03	7375.55
T-A	1773792.41	1622695.40	7315.01	T-A	1775470.50	1617236.33	7381.89
T-A	1773525.55	1623159.65	7332.01	T-A	1775476.22	1617186.38	7384.05
T-A	1773530.88	1623147.76	7330.71	T-A	1775487.16	1617133.49	7382.15
T-A	1773537.81	1623130.85	7330.91	T-A	1775329.40	1618905.90	7307.54
T-A	1773544.45	1623115.00	7329.86	T-A	1775316.51	1618832.66	7311.70
T-A	1774264.55	1623112.00	7294.47	T-A	1775289.89	1618675.59	7306.67
T-A	1774256.59	1623160.88	7298.89	T-A	1775173.01	1618339.27	7334.03
T-A	1774247.99	1623184.57	7295.71	T-A	1775193.08	1618246.34	7343.08
T-A	1774244.12	1623195.96	7298.65	T-A	1775365.73	1616893.76	7423.22
T-A	1774236.74	1623209.92	7295.86	T-A	1771795.07	1614907.08	7559.46
T-A	1774226.92	1623229.13	7295.85	T-A	1771820.59	1614860.59	7562.95
T-A	1774222.17	1623238.98	7297.42	T-A	1771833.79	1614823.29	7565.08
T-A	1774208.80	1623260.30	7297.60	T-A	1771858.46	1614796.63	7568.14
T-A	1774196.83	1623278.92	7298.30	T-A	1771876.03	1614777.83	7569.77
T-A	1774186.12	1623297.24	7298.94	T-A	1771896.56	1614742.13	7572.03
T-A	1774169.87	1623323.72	7301.39	T-A	1776531.63	1624109.62	7311.09
T-A	1774152.53	1623350.67	7300.69	T-A	1776542.17	1624121.42	7311.48
T-A	1774114.64	1623404.10	7306.35	T-A	1776543.08	1624122.33	7311.36
T-A	1774094.99	1623438.29	7305.16	T-A	1776544.11	1624122.94	7310.49
T-A	1774087.62	1623451.43	7306.58	T-A	1776551.09	1624130.97	7309.86
T-A	1774079.47	1623463.92	7304.93	T-A	1776560.31	1624139.21	7308.94
T-A	1774069.53	1623478.81	7305.57	T-A	1776561.87	1624140.69	7309.21
T-A	1774057.03	1623496.31	7302.19	T-A	1776563.29	1624140.68	7307.41
T-A	1774044.71	1623515.09	7301.02	T-A	1776575.11	1624142.47	7306.52
T-A	1773828.75	1623850.30	7319.62	T-A	1776594.50	1624150.54	7305.41

Appendix A-1: Surveyed Points (cont.)

Mapped Contact	Northing	Easting	Elevation	Mapped Contact	Northing	Easting	Elevation
T-A	1773816.24	1623869.08	7319.79	T-A	1776600.19	1624157.11	7305.11
T-A	1773796.83	1623902.38	7319.85	T-A	1776599.93	1624157.93	7306.07
T-A	1773784.76	1623922.68	7318.42	T-A	1776611.33	1624167.01	7304.84
T-A	1773762.67	1623961.69	7318.17	T-A	1776622.53	1624172.89	7303.41
T-A	1773743.94	1623995.34	7316.63	T-A	1776633.70	1624178.97	7303.33
T-A	1773730.27	1624021.92	7317.13	T-A	1776648.20	1624186.76	7302.14
T-A	1773719.24	1624045.85	7316.36	T-A	1776683.01	1624200.67	7300.42
T-A	1773695.96	1624102.68	7316.76	T-A	1776688.05	1624203.11	7300.49
T-A	1773687.71	1624125.79	7316.33	T-A	1776688.21	1624204.13	7301.67
T-A	1773685.58	1624132.84	7315.82	T-A	1776705.65	1624210.59	7300.35
T-A	1773675.65	1624163.50	7316.11	T-A	1776716.06	1624213.85	7300.29
T-A	1773665.98	1624197.12	7315.64	T-A	1776716.42	1624214.31	7300.53
T-A	1773660.29	1624222.25	7314.91				
T-A	1773645.93	1624340.64	7311.83				
T-A	1773655.15	1624239.25	7315.59				

Appendix A-2: Surveyed Faults at County Landfill, Mesa Library, and 2500 Central Construction Site

Northing	Easting	Elevation	Notes
1776865.21	1624091.90	7267.86	East side of 7-foot-wide open fissure/graben filled w/ alluvium; strike N40W
1776864.47	1624085.41	7268.05	West side of 7-foot-wide open fissure/graben filled w/ alluvium; strike N40W
1776835.84	1624108.62	7275.95	Southwest side of 7-foot-wide open fissure/graben; strike N40W
1776844.12	1624107.87	7275.81	Northeast side of 7-foot-wide open fissure/graben; strike N40W
1776707.24	1623883.17	7277.64	large fissure N2E, 83 SW
1774024.21	1622912.57	7311.80	N45E; 5 feet offset down to the West
1774023.67	1622911.76	7310.62	N45E; 5 feet offset down to the West
1774023.16	1622911.23	7309.53	N45E; 5 feet offset down to the West
1774022.23	1622910.18	7308.20	N45E; 5 feet offset down to the West
1774021.45	1622909.69	7306.55	N45E; 5 feet offset down to the West
1774021.35	1622909.47	7304.51	N45E; 5 feet offset down to the West
1774024.77	1622898.26	7307.16	N10W; 1ft offset down to East, point is along tuff-alluvium contact
1774033.28	1622878.84	7308.58	N28E; 3 ft offset down to the West
1774032.68	1622877.83	7307.70	N28E; 3 ft offset down to the West
1774031.83	1622877.50	7306.28	N28E; 3 ft offset down to the West
1774083.96	1622773.27	7307.09	NS, 83W; approximately 2 feet offset down to the West
1774084.07	1622773.34	7305.40	NS, 83W; approximately 2 feet offset down to the West
1774083.44	1622773.22	7303.63	NS, 83W; approximately 2 feet offset down to the West
1774082.85	1622772.83	7301.11	NS, 83W; approximately 2 feet offset down to the West
1774093.54	1622752.94	7307.50	N45W, 85S; 3 feet offset down to the Southwest
1774093.20	1622752.56	7304.98	N45W, 85S; 3 feet offset down to the Southwest
1774092.16	1622753.21	7301.42	N45W, 85S; 3 feet offset down to the Southwest
1773928.00	1623070.20	7300.31	N3W; offset 1.5 feet down to the West
1773929.48	1623070.18	7303.78	N3W; offset 1.5 feet down to the West
1773930.51	1623070.14	7306.10	N3W; offset 1.5 feet down to the West
1773930.95	1623071.39	7310.71	West side of graben; N70E, 62S; 7 feet offset down to the South
1773929.74	1623072.85	7308.30	West side of graben; N70E, 62S; 7 feet offset down to the South
1773928.55	1623073.97	7306.07	West side of graben; N70E, 62S; 7 feet offset down to the South
1773927.23	1623074.71	7303.77	West side of graben; N70E, 62S; 7 feet offset down to the South
1773925.84	1623075.23	7301.30	West side of graben; N70E, 62S; 7 feet offset down to the South
1773913.51	1623100.35	7306.78	East side of graben; N2E, 70E; reverse fault with >10 feet offset
1773914.90	1623099.98	7308.56	East side of graben; N2E, 70E; reverse fault with >10 feet offset
1773915.96	1623099.08	7311.00	East side of graben; N2E, 70E; reverse fault with >10 feet offset
1773916.96	1623099.11	7315.98	East side of graben; N2E, 70E; reverse fault with >10 feet offset
1773913.90	1623106.87	7316.51	N40E
1773913.20	1623106.92	7315.18	N40E
1773892.29	1623137.51	7315.60	N12W; 3 feet offset down to East
1773892.04	1623137.72	7311.48	N12W; 3 feet offset down to East
1773891.80	1623137.96	7308.03	N12W; 3 feet offset down to East
1773886.46	1623138.90	7303.95	N12W; 3 feet offset down to East
1773860.46	1623189.92	7317.46	shatter zone average fracture orientation NS, with down to East offset
1773859.24	1623191.82	7316.23	shatter zone average fracture orientation NS, with down to East offset
1773859.64	1623189.80	7314.24	shatter zone average fracture orientation NS, with down to East offset
1773856.57	1623192.12	7311.49	shatter zone average fracture orientation NS, with down to East offset
1773857.36	1623189.24	7307.64	shatter zone average fracture orientation NS, with down to East offset
1773854.61	1623191.86	7307.66	shatter zone average fracture orientation NS, with down to East offset
1773856.35	1623195.97	7316.15	N45E; 0.5 feet offset down to East
1773855.00	1623195.67	7313.41	N45E; 0.5 feet offset down to East
1773854.17	1623195.31	7310.20	N45E; 0.5 feet offset down to East
1773853.13	1623195.18	7307.74	N45E; 0.5 feet offset down to East
1773841.92	1623217.18	7310.48	
1773841.98	1623218.10	7312.65	

Appendix A-2: Surveyed Faults at County Landfill, Mesa Library, and 2500 Central Construction Site (cont.)

Northing	Easting	Elevation	Notes
1773842.39	1623219.81	7314.49	
1773842.33	1623220.67	7316.85	
1773801.55	1623270.31	7310.87	N60E, 79NW
1773801.43	1623271.37	7312.91	N60E, 79NW
1773801.31	1623271.77	7316.08	N60E, 79NW
1773801.30	1623272.16	7318.06	N60E, 79NW
1773604.05	1623247.84	7327.46	shatter zone in tuff, overlying sediments not disturbed
1773604.15	1623247.38	7323.47	shatter zone in tuff, overlying sediments not disturbed
773604.16	1623246.76	7319.39	shatter zone in tuff, overlying sediments not disturbed
1773665.80	1623285.20	7322.73	N25W, offset 1.5 feet down to the North
1773913.38	1623102.12	7315.12	N5W, down to the East
1773943.10	1623047.85	7305.25	N20W; 1.5 feet offset down to the Southwest
1773962.31	1623017.97	7308.24	N20W; 1 foot offset down to the Northeast
1773968.16	1623006.45	7308.91	N62E; offset 1 foot down to the Southeast
1774107.56	1622720.83	7303.73	N45E, dips West; 1 foot offset down to the West
1774121.96	1622692.32	7301.61	NS, vertical; 2 feet offset down to the West; 1 foot of fissure fill
1774121.49	1622692.48	7300.65	NS, vertical; 2 feet offset down to the West; 1 foot of fissure fill
1774121.38	1622692.42	7299.56	NS, vertical; 2 feet offset down to the West; 1 foot of fissure fill
1774123.38	1622688.51	7301.72	East side of 10-foot-wide graben; N30E, 90; 5 feet offset down to the West
1774123.92	1622687.47	7299.37	East side of 10-foot-wide graben; N30E, 90; 5 feet offset down to the West
1774136.62	1622661.00	7300.95	West side of minigraben; N20W, 70E
1774135.52	1622661.72	7299.05	West side of minigraben; N20W, 70E
1774134.62	1622662.67	7296.72	West side of minigraben; N20W, 70E
1774139.84	1622655.85	7306.92	N10E, 90; 9 feet offset down to the East
1774139.43	1622655.94	7304.87	N10E, 90; 9 feet offset down to the East
1774139.02	1622655.89	7301.73	N10E, 90; 9 feet offset down to the East
1774179.12	1622561.74	7297.11	W side of 10 ft wide graben; N40E, 80W
1774180.45	1622563.70	7303.11	W side of 10 ft wide graben; N40E, 80W
1774181.54	1622565.57	7308.99	W side of 10 ft wide graben; N40E, 80W
1774178.14	1622571.94	7308.47	East side of graben; N38E, 80W
1774178.21	1622570.34	7304.28	East side of graben; N38E, 80W
1774176.15	1622568.59	7296.58	East side of graben; N38E, 80W
1774187.48	1622583.94	7321.25	East side of 10-foot-wide fault zone; N38E, 80W; >15 feet offset
1774185.43	1622581.26	7317.38	East side of 10-foot-wide fault zone; N38E, 80W; >15 feet offset
1774184.11	1622579.34	7313.32	East side of 10-foot-wide fault zone; N38E, 80W; >15 feet offset
1774190.79	1622563.33	7318.88	East side of 10-foot-wide fault zone; N38E, 80W; >15 feet offset
1774189.46	1622565.08	7315.18	East side of 10-foot-wide fault zone; N38E, 80W; >15 feet offset
1774183.80	1622566.68	7310.91	East side of 10-foot-wide fault zone; N38E, 80W; >15 feet offset
1774197.19	1622540.82	7320.39	N10E, 90; 2 feet offset down to the West
1774196.76	1622540.33	7318.39	N10E, 90; 2 feet offset down to the West
1774210.46	1622512.15	7317.59	East side of small graben; N40E, 90; 3 feet offset down to the West
1774210.01	1622511.50	7315.57	East side of small graben; N40E, 90; 3 feet offset down to the West
1774213.00	1622507.56	7316.91	West side of small graben; N20W, 85E; 2 feet offset down to the East
1774212.46	1622507.93	7315.96	West side of small graben; N20W, 85E; 2 feet offset down to the East
1774215.32	1622494.69	7318.29	West side of graben; N20W, 90; 7 feet offset down to the East
1774215.09	1622495.46	7315.98	West side of graben; N20W, 90; 7 feet offset down to the East
1774214.72	1622495.87	7314.18	West side of graben; N20W, 90; 7 feet offset down to the East
1774223.81	1622469.56	7318.69	N15E, 90; 7 feet offset down to the West
1774223.84	1622469.31	7317.28	N15E, 90; 7 feet offset down to the West
1774223.88	1622469.30	7315.81	N15E, 90; 7 feet offset down to the West
1774229.72	1622455.09	7315.59	NS, 90; 10 feet offset down to the West
1774229.57	1622454.17	7313.31	NS, 90; 10 feet offset down to the West

Appendix A-2: Surveyed Faults at County Landfill, Mesa Library, and 2500 Central Construction Site (cont.)

Northing	Easting	Elevation	Notes
1774233.86	1622438.77	7318.60	N25W, 90; 2 feet offset down to the East
1774234.66	1622439.39	7316.30	N25W, 90; 2 feet offset down to the East
1774242.18	1622413.79	7318.17	NS, 90: 2 feet offset down to the West
1774249.28	1622393.10	7315.88	N20W, 90; 2 feet offset down to the West
1774253.92	1622377.51	7317.24	2 feet offset down to the West
1774255.64	1622372.33	7315.87	N30W, 75E; 1 foot offset down to the East
1774255.88	1622371.78	7317.14	N30W, 75E; 1 foot offset down to the East
1774267.82	1622336.29	7316.48	N28E, 90; 1 foot offset down to the West
1774267.82	1622336.32	7315.04	N28E, 90; 1 foot offset down to the West
1774267.61	1622336.17	7311.76	N28E, 90; 1 foot offset down to the West
1774285.23	1622284.67	7316.70	N12E, 90; 8 inches offset down to the West
1774284.91	1622284.72	7313.97	N12E, 90; 8 inches offset down to the West
1774284.62	1622284.82	7310.98	N12E, 90; 8 inches offset down to the West
1774294.49	1622256.94	7318.24	NS, 90; 1.5 feet down to the West
1774294.37	1622256.81	7314.32	NS, 90; 1.5 feet down to the West
1774294.09	1622256.51	7312.13	NS, 90; 1.5 feet down to the West
1773831.68	1622618.31	7322.86	N10E, 90; >15 feet offset down to the East
1773832.98	1622617.26	7320.37	N10E, 90; >15 feet offset down to the East
1773841.84	1622620.47	7309.94	N10E, 90; >15 feet offset down to the East
1773843.65	1622620.95	7305.71	N10E, 90; >15 feet offset down to the East
1773844.63	1622621.27	7302.65	N10E, 90; >15 feet offset down to the East
1773845.44	1622621.10	7299.49	N10E, 90; >15 feet offset down to the East
1773847.53	1622623.21	7293.04	N10E, 90; >15 feet offset down to the East
1773850.69	1622623.91	7287.96	N10E, 90; >15 feet offset down to the East
1776598.00	1624431.00		N54W, 87SW; 0.7-1.5 feet offset down to the Southwest
1776611.00	1624461.00		N20E, 77E; offset down to the West; 1.5 to 2 foot wide breccia zone in tuff
1776610.00	1624458.00		N35E; small splay; 0.7 feet down to the Southwest; shallows with depth
1776627.00	1624463.00		N75W, 87-70N
1776642.00	1624465.00		N4W, 86E; 0.6 feet offset down to the West

IX. APPENDIX B: GEOCHEMICAL SAMPLE LOCATION MAPS AND DATA

NOTES:

1) Negative values indicate contents below detection limits.

2) LOI = Loss on ignition

3) Majors refers to major element oxides, reported in weight percent.

4) Trace refers to trace elements, reported in parts per million.

5) err = analytical uncertainty, reported as two-sigma values

LEGEND FOR FIGUREs B-1a THROUGH B-1m

☆ Sample Locations

Surveyed Points

- Quaternary Terrace Deposits
- Bandelier Tuff-Mesa-top Alluvium Contact
- Surge within Unit 4
- Welding break within Unit 4
- Surge at Unit 3-Unit 4 Contact
- Unit 3-Unit 4 Contact
- Surge at Unit 3T-Unit 4 Contact
- Unit 3T-Unit 4 Contact
- Surge at Lower 3T-Upper 3T Contact
- Lower Unit 3T-Upper Unit 3T Contact
- Surge within Unit 3T
- Within Unit 3T
- Surge at Unit 3-Unit 3T Contact
- Unit 3-Unit 3T Contact
- Within Unit 3
- Unit 2-Unit 3 Contact
- Within Unit 2
- Seismic Hazards Boreholes
- 20-Foot Contour Lines
- 100-Foot Contour Lines

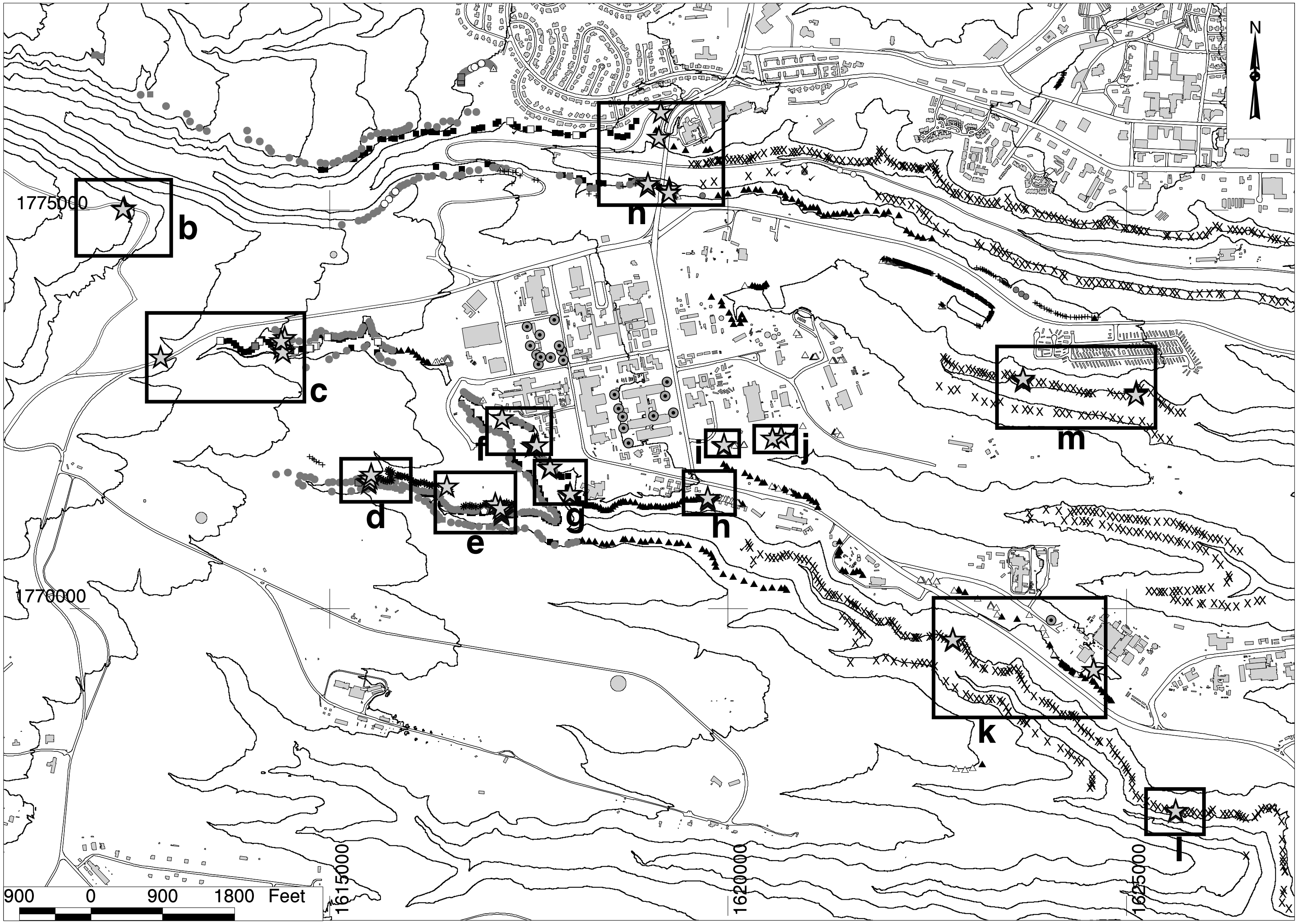


Figure B-1a. Map showing the location of geochemical samples in the map area. The locations of Figures B-1a through B-1m are shown by lettered boxes. The legend precedes the map. The grid is in the State Plane Coordinate System (in feet), New Mexico Central Zone, 1983 North American Datum.

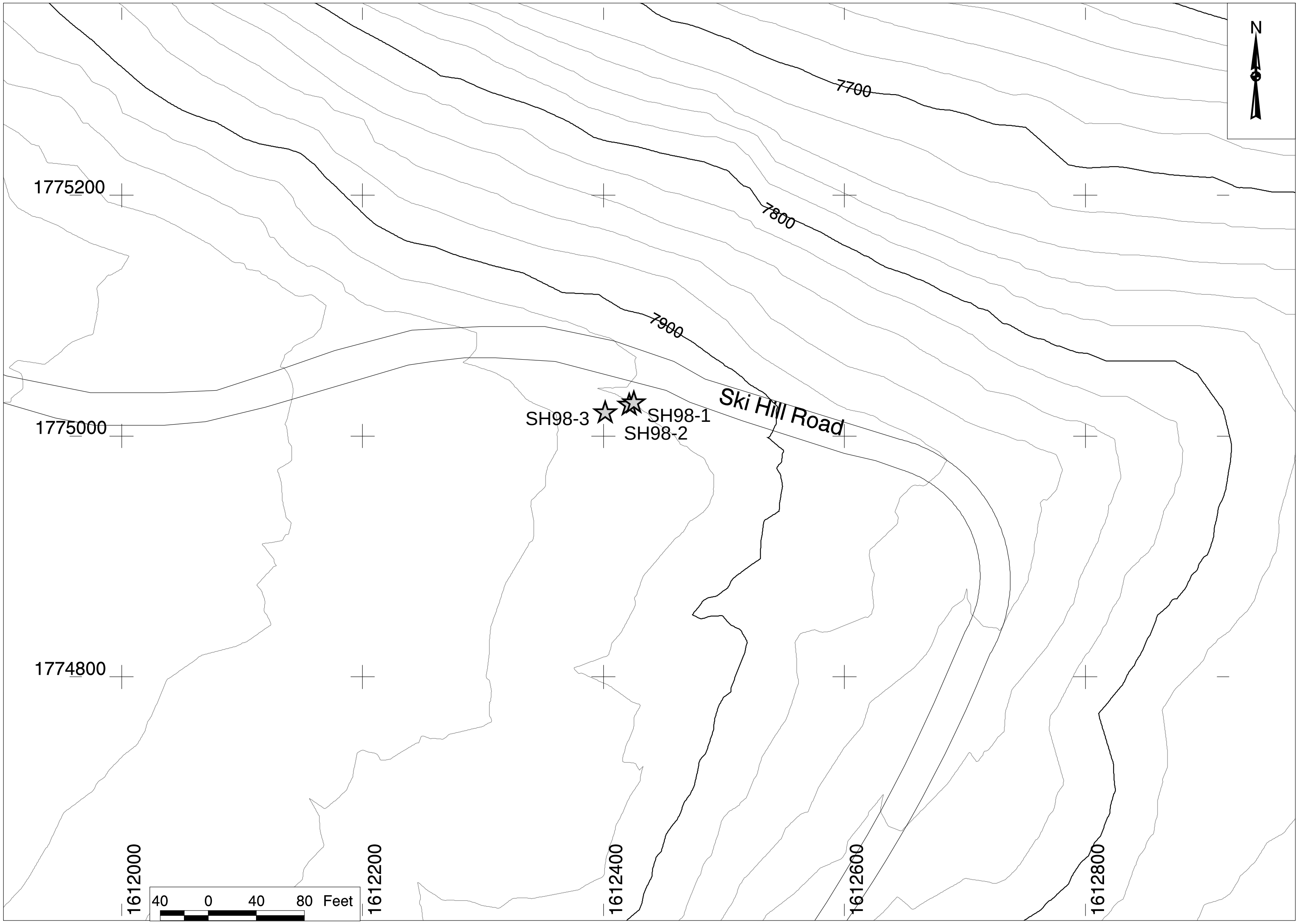


Figure B-1b. Map showing the location of geochemical samples SH98-1, SH98-2, and SH98-3 on the South side of Los Alamos Canyon, near Ski Hill Road. See Figure B-1 for location of map. See Appendix B-1 for geochemical data, sample location, and unit designation. The grid is in the State Plane Coordinate System (in feet), New Mexico Central Zone, 1983 North American Datum.

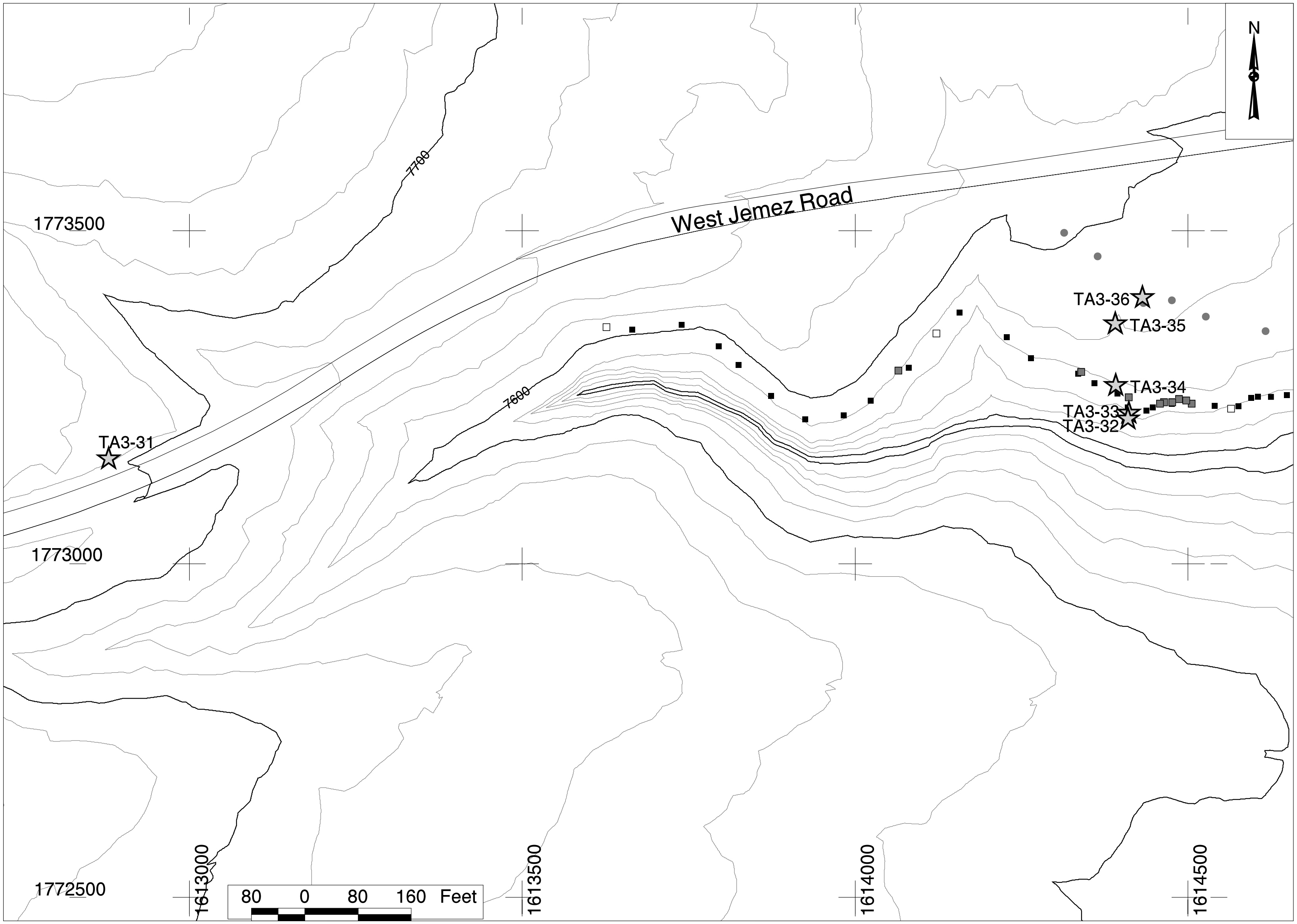


Figure B-1c. Map showing the location of geochemical samples TA3-31 through TA3-36 in the north fork of Twomile Canyon near West Jemez Road. See Figure B-1 for location of map. See Appendix B-1 for geochemical data, sample location, and unit designation. The grid is in the State Plane Coordinate System (in feet), New Mexico Central Zone, 1983 North American Datum.

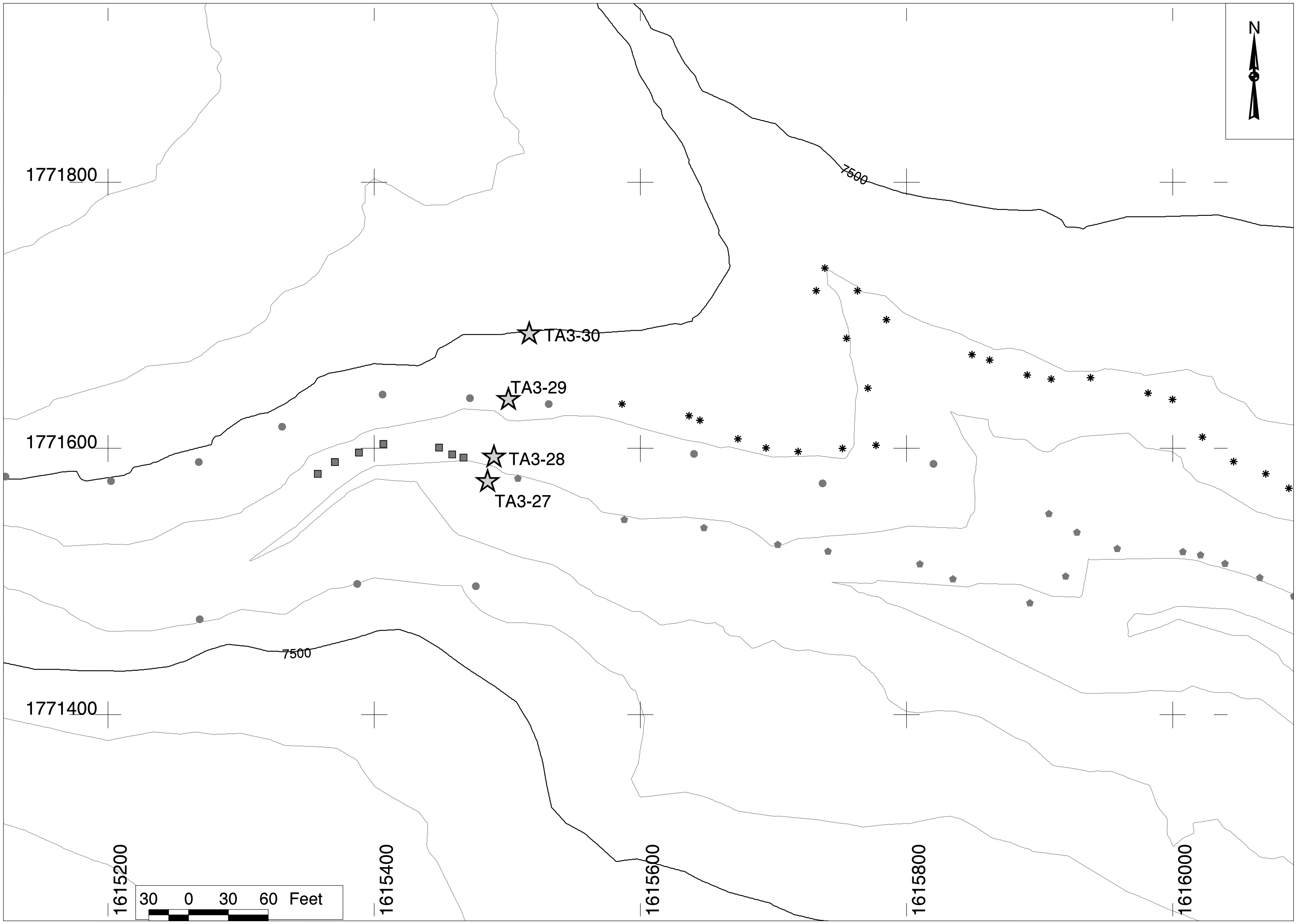


Figure B-1d. Map showing the location of geochemical samples TA3-27 through TA3-30 in the south fork of Twomile Canyon. See Figure B-1 for the location of the map. See Appendix B-1 for geochemical data, sample location, and unit designation. The grid is in the State Plane Coordinate System (in feet), New Mexico Central Zone, 1983 North American Datum.

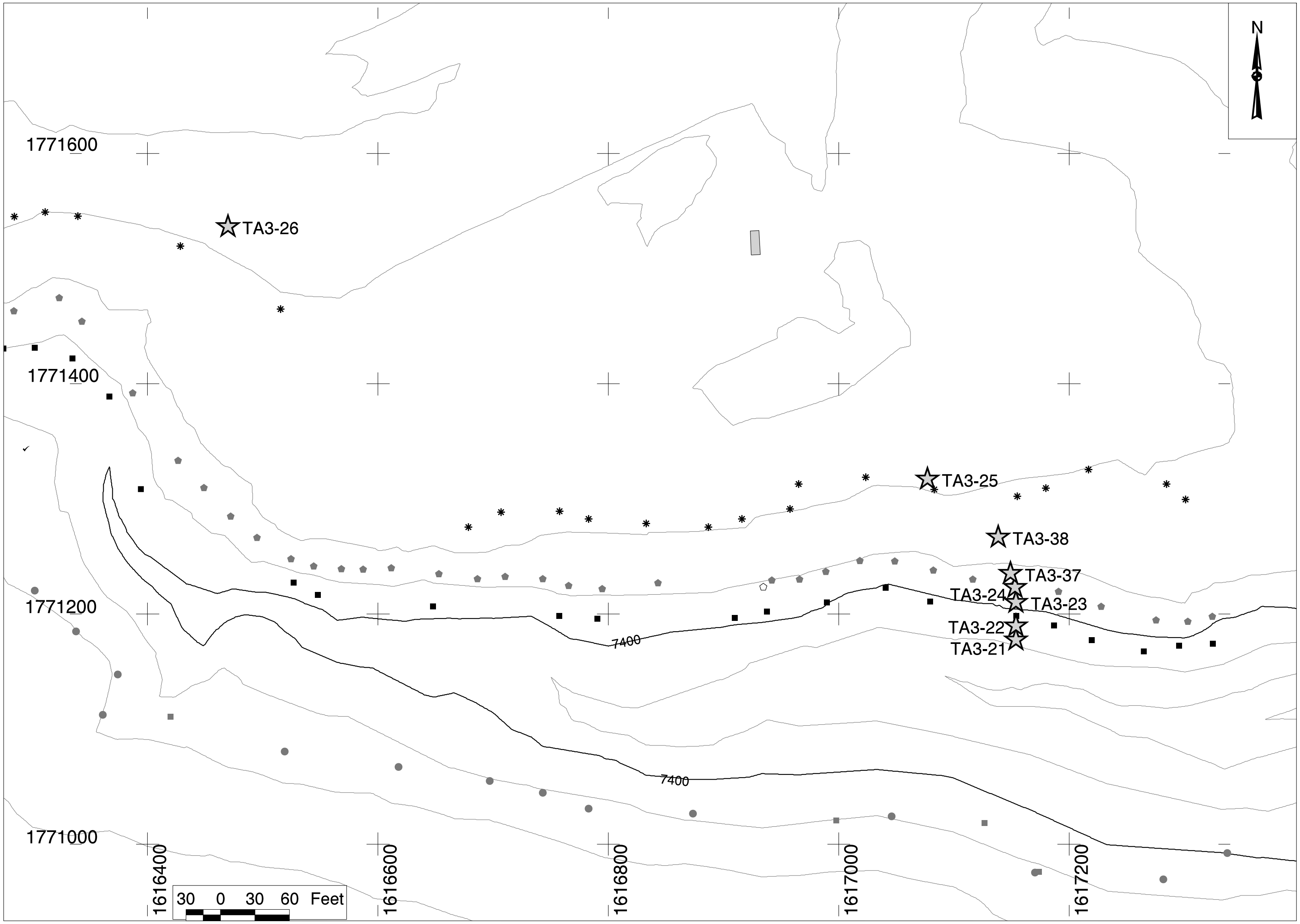


Figure B-1e. Map showing the location of geochemical samples TA3-21 through TA3-26, and samples TA3-37 and TA3-38 in the south fork of Twomile Canyon. See Figure B-1 for the location of the map. See Appendix B-1 for geochemical data, sample location, and unit designation. The grid is in the State Plane Coordinate System (in feet), New Mexico Central Zone, 1983 North American Datum.

Figure B-1f. Map showing the location of geochemical samples TA3-16 through TA3-20 in the north fork of Twomile Canyon. See Figure B-1 for the location of the map. See Appendix B-1 for geochemical data, sample location, and unit designation. The grid is in the State Plane Coordinate System (in feet), New Mexico Central Zone, 1983 North American Datum.

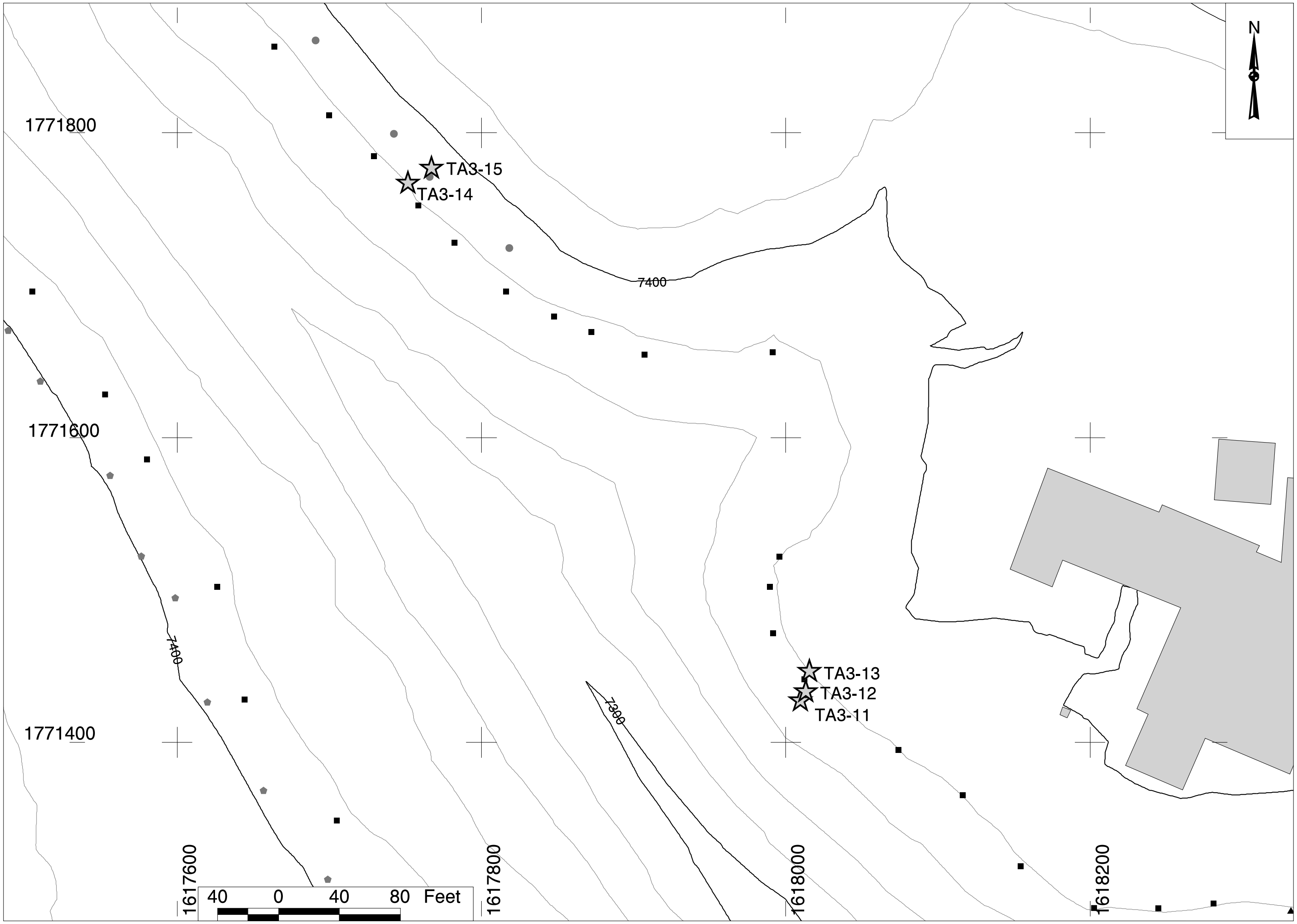


Figure B-1g. Map showing the location of geochemical samples TA3-11 through TA3-15 in the north fork of Twomile Canyon. See Figure B-1 for the location of the map. See Appendix B-1 for geochemical data, sample location, and unit designation. The grid is in the State Plane Coordinate System (in feet), New Mexico Central Zone, 1983 North American Datum.

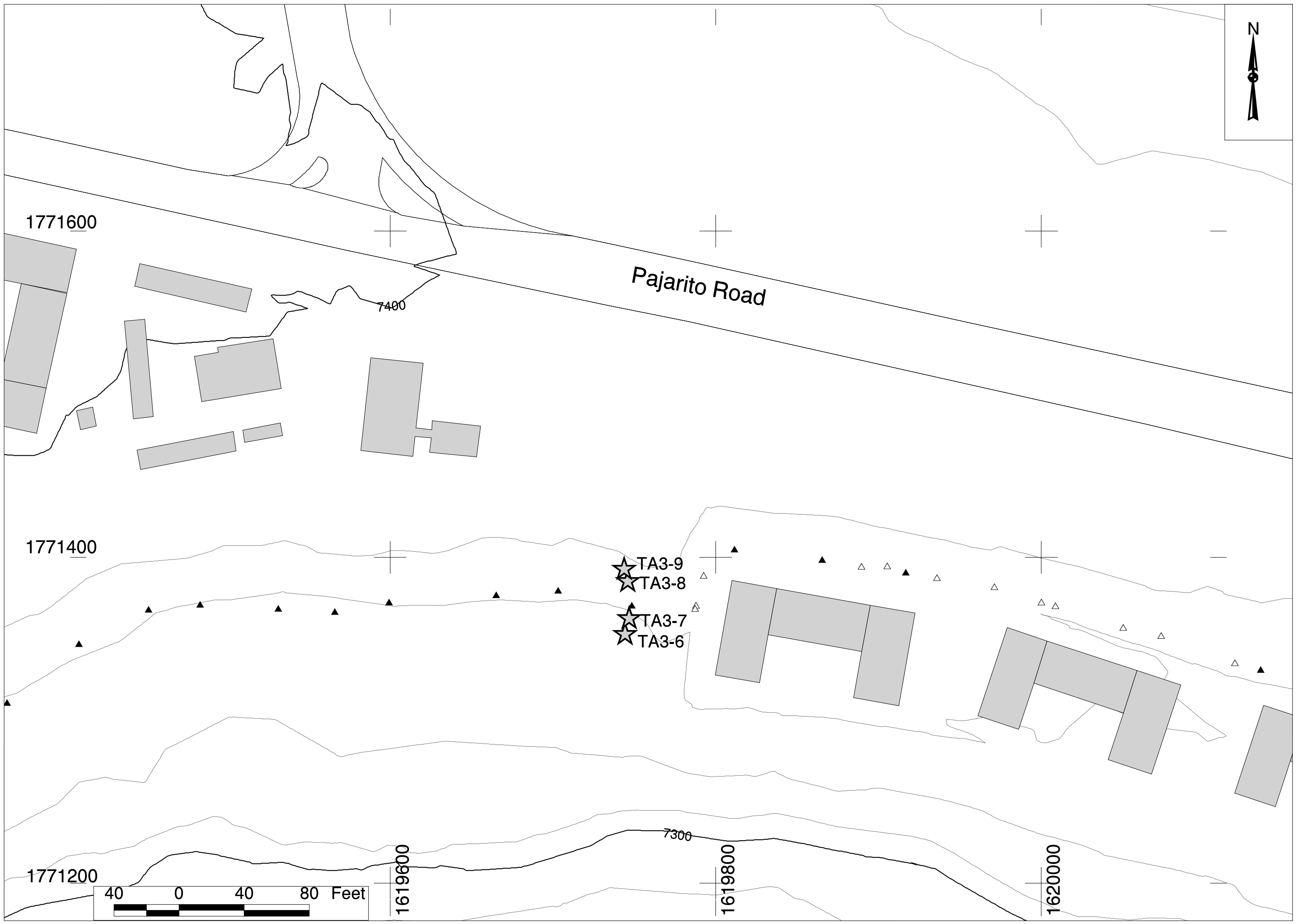


Figure B-1h. Map showing the location of geochemical samples TA3-6 through TA3-9 in Twomile Canyon near Pajarito Road. See Figure B-1 for the location of the map. See Appendix B-1 for geochemical data, sample location, and unit designation. The grid is in the State Plane Coordinate System (in feet), New Mexico Central Zone, 1983 North American Datum.

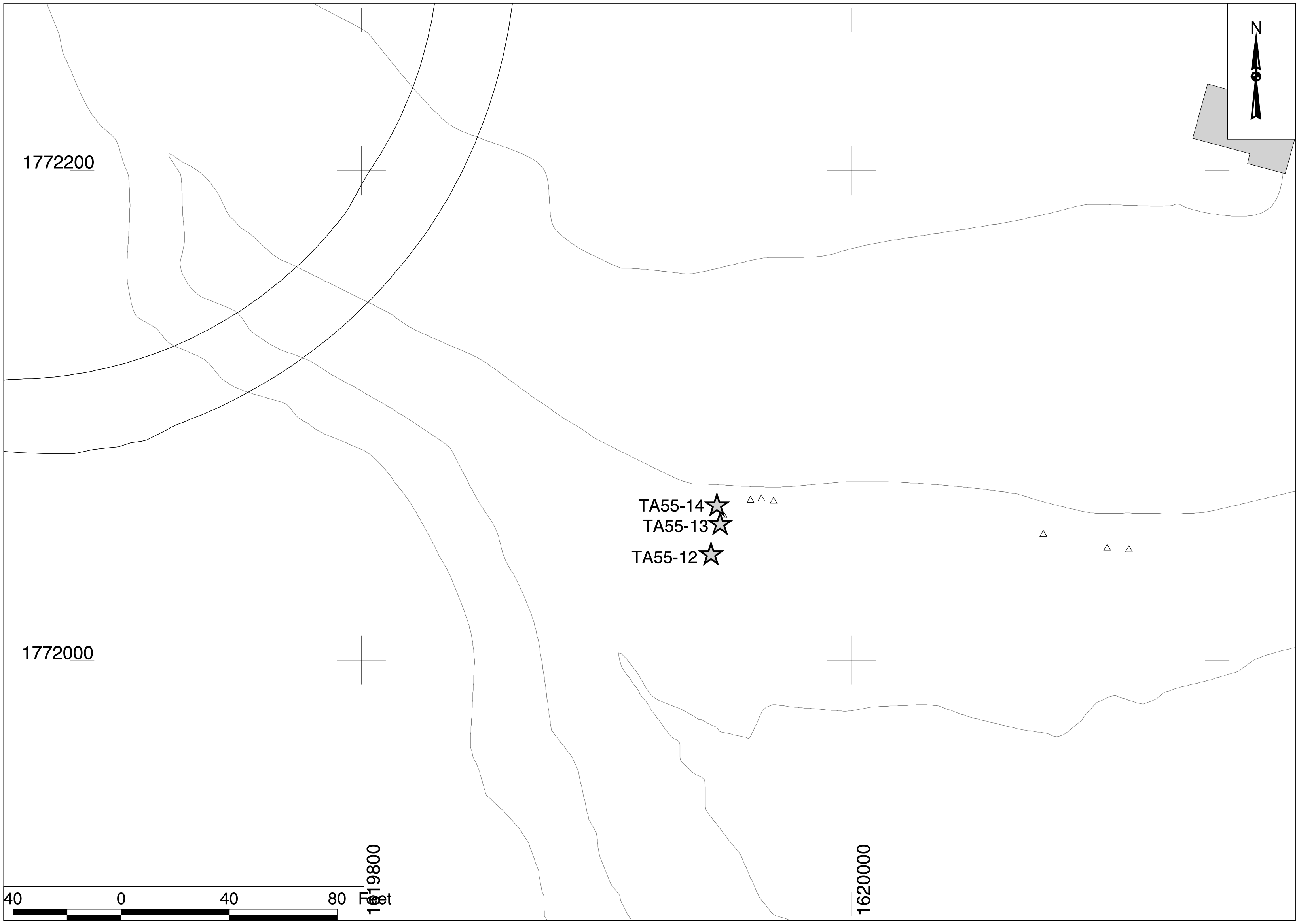


Figure B-1i. Map showing the location of geochemical samples TA55-12 through TA55-14 in Mortandad Canyon. See Figure B-1 for the location of the map. See Appendix B-1 for geochemical data, sample location, and unit designation. The grid is in the State Plane Coordinate System (in feet), New Mexico Central Zone, 1983 North American Datum.

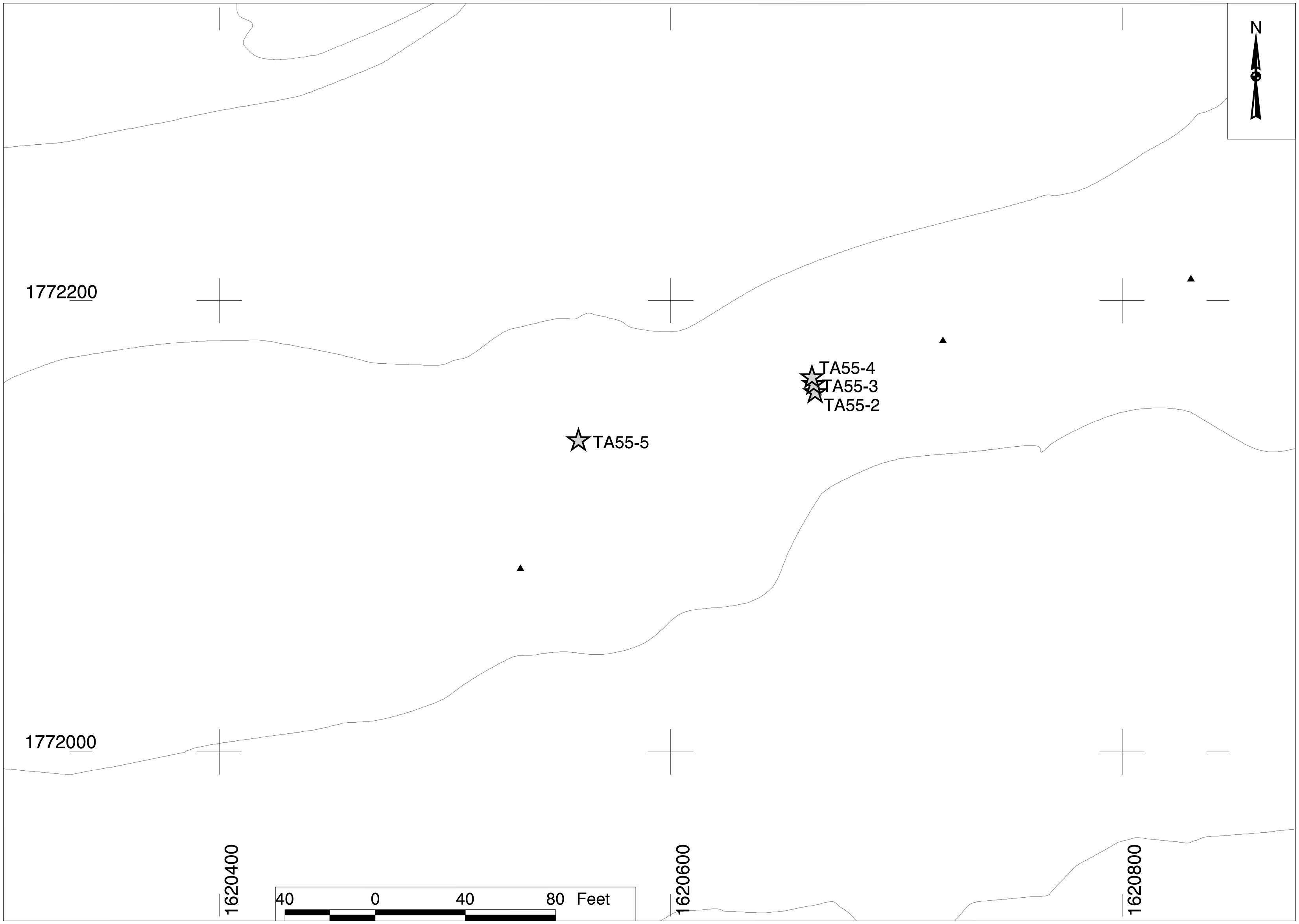


Figure B-1j. Map showing the location of geochemical samples TA55-2 through TA55-5 in Mortandad Canyon. See Figure B-1 for the location of the map. See Appendix B-1 for geochemical data, sample location, and unit designation. The grid is in the State Plane Coordinate System (in feet), New Mexico Central Zone, 1983 North American Datum.

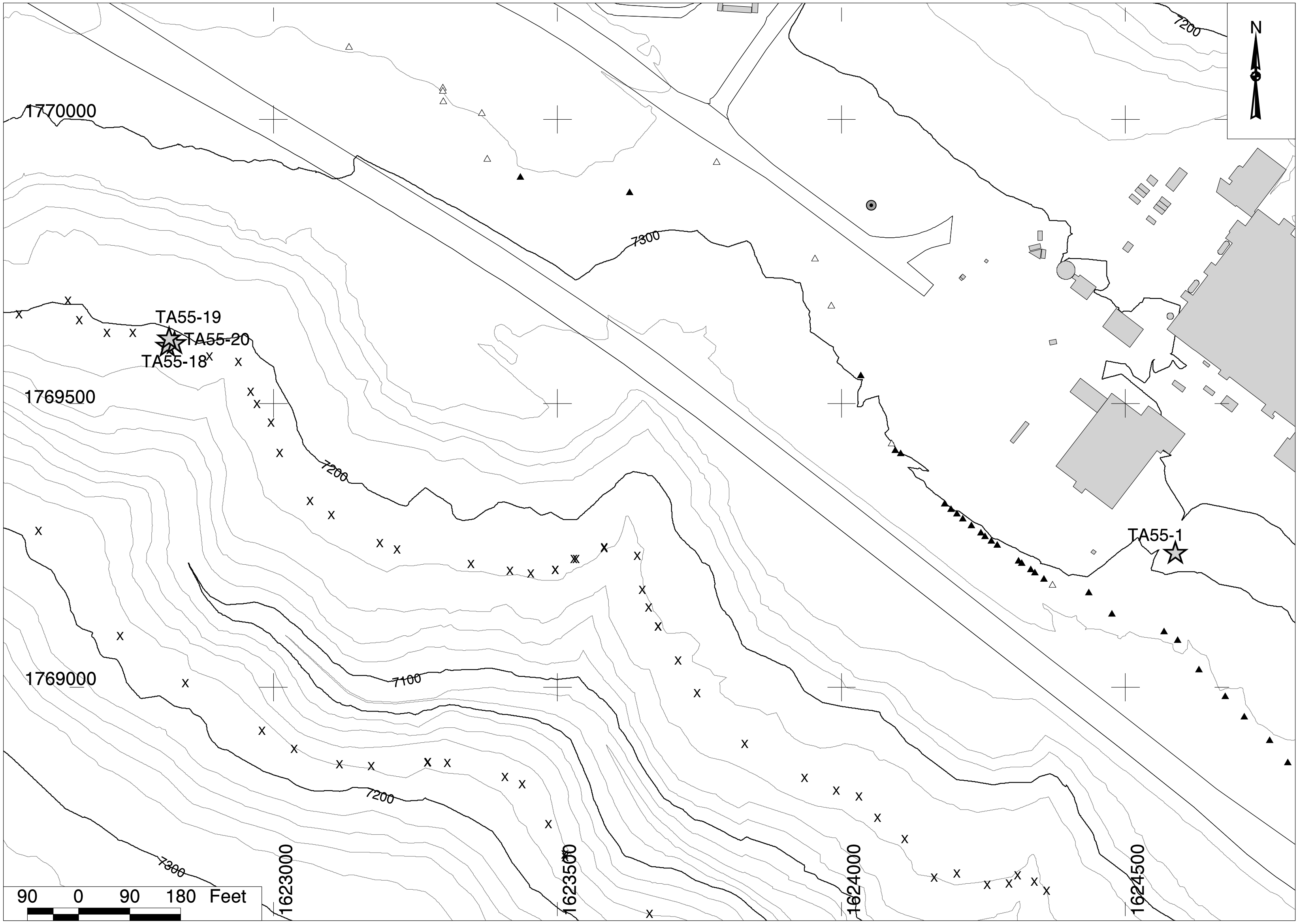


Figure B-1k. Map showing the location of geochemical samples TA55-1, and TA55-18 through TA55-20 in Twomile Canyon near TA-48 and TA-55. See Figure B-1 for the location of the map. See Appendix B-1 for geochemical data, sample location, and unit designation. The grid is in the State Plane Coordinate System (in feet), New Mexico Central Zone, 1983 North American Datum.

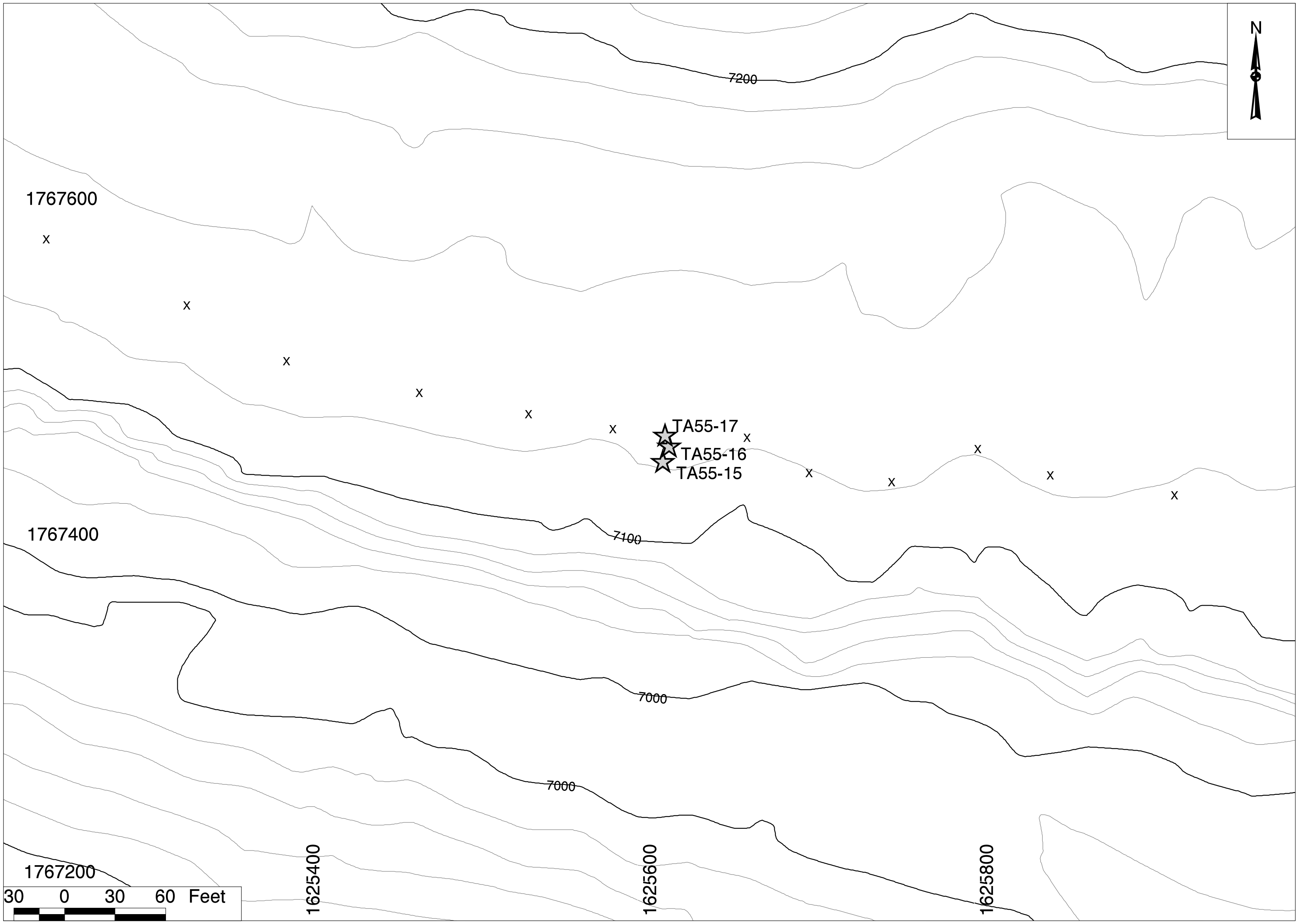


Figure B-1l. Map showing the location of geochemical samples TA55-15 through TA55-17 in Twomile Canyon east of TA-55. See Figure B-1 for the location of the map. See Appendix B-1 for geochemical data, sample location, and unit designation. The grid is in the State Plane Coordinate System (in feet), New Mexico Central Zone, 1983 North American Datum.

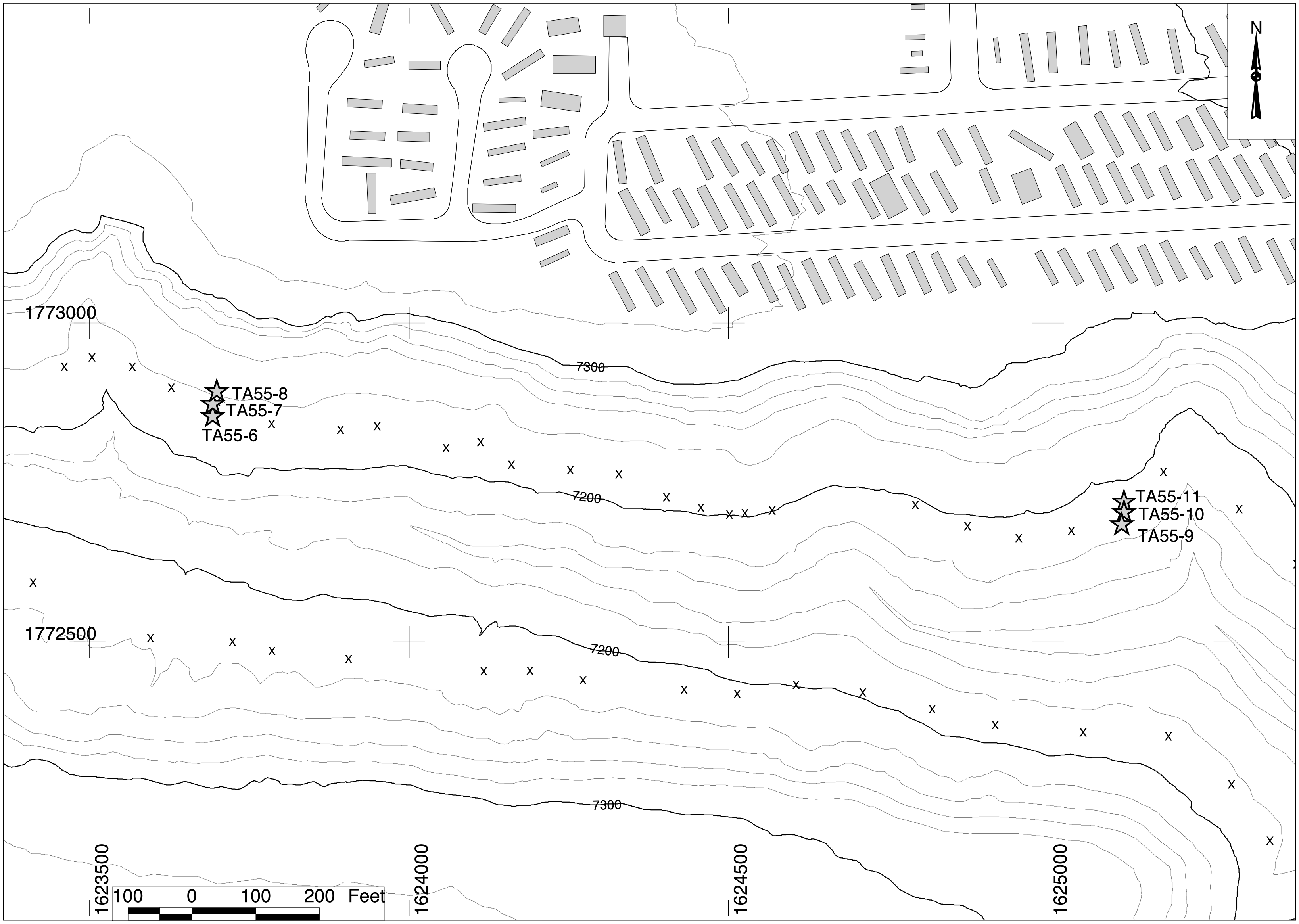


Figure B-1m. Map showing the location of geochemical samples TA55-6 through TA55-11 in Sandia Canyon. See Figure B-1 for the location of the map. See Appendix B-1 for geochemical data, sample location, and unit designation. The grid is in the State Plane Coordinate System (in feet), New Mexico Central Zone, 1983 North American Datum.

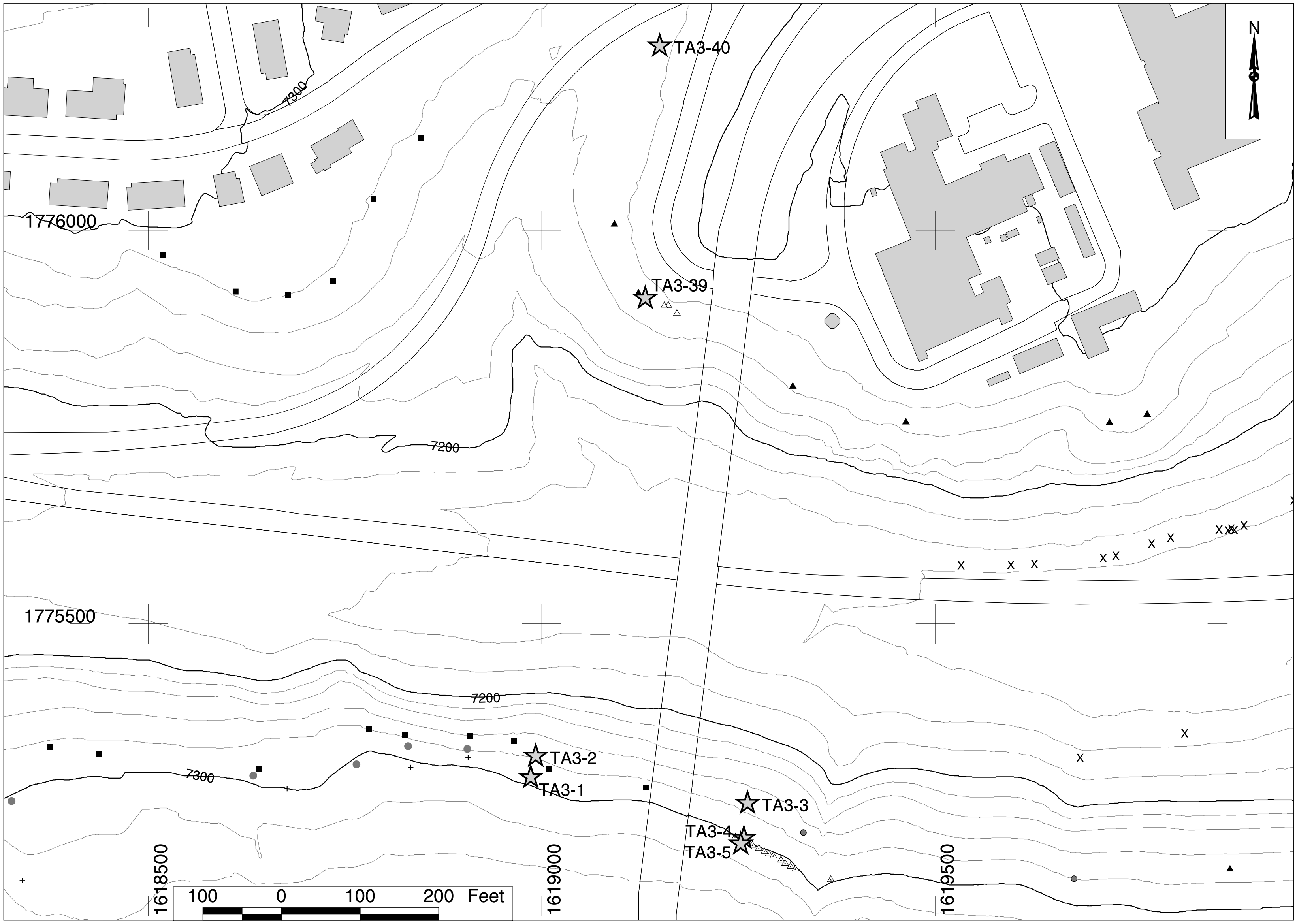


Figure B-1n. Map showing the location of geochemical samples TA3-1 through TA3-5, TA3-39, and TA3-40 in Los Alamos Canyon near the Omega bridge. See Figure B-1 for the location of the map. See Appendix B-1 for geochemical data, sample location, and unit designation. The grid is in the State Plane Coordinate System (in feet), New Mexico Central Zone, 1983 North American Datum.

Appendix B

Sample	TA3-1	TA3-2	TA3-3	TA3-4	TA3-5	TA3-6	TA3-7
Unit	4	3	3	4	4	3	3
Northing	1775306.55	1775333.33	1775273.47	1775229.37	1775213.61	1771353.26	1771362.90
Easting	1618985.44	1618991.75	1619261.11	1619256.38	1619253.23	1619744.23	1619746.64
Elevation	7291.00	7281.00	7280.00	7293.00	7297.00	7355.70	7358.70
SiO_2 wt %	74.96	78.11	76.53	74.28	71.42	78.01	77.14
SiO_2 err	0.81	0.83	0.82	0.81	0.79	0.83	0.82
TiO_2 wt %	0.20	0.12	0.14	0.19	0.26	0.13	0.13
TiO_2 err	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Al_2O_3 wt %	13.34	12.11	12.65	12.77	14.15	12.23	12.44
Al_2O_3 err	0.21	0.21	0.21	0.21	0.21	0.21	0.21
Fe_2O_3T wt %	2.11	1.61	1.89	1.95	2.56	1.65	1.69
Fe_2O_3T err	0.05	0.05	0.05	0.05	0.06	0.05	0.05
MnO wt %	0.08	0.05	0.06	0.07	0.07	0.07	0.05
MnO err	0.01	0.01	0.01	0.01	0.01	0.01	0.01
MgO wt %	-0.11	-0.11	-0.11	0.13	0.25	-0.11	-0.11
MgO err				0.10	0.10		
CaO wt %	0.25	0.21	0.20	0.44	0.51	0.25	0.25
CaO err	0.11	0.11	0.11	0.11	0.11	0.11	0.11
Na_2O wt %	4.40	4.04	3.94	5.06	4.31	4.05	4.15
Na_2O err	0.10	0.10	0.10	0.11	0.10	0.10	0.10
K_2O wt %	4.80	4.30	4.36	4.64	4.40	4.39	4.41
K_2O err	0.07	0.06	0.06	0.06	0.06	0.06	0.06
P_2O_5 wt %	0.02	0.01	0.02	0.02	0.04	0.01	-0.01
P_2O_5 err	0.01	0.01	0.01	0.01	0.01	0.01	
LOI %	0.36	0.44	1.01	1.34	1.69	0.41	0.70
Total Majors	100.16	100.56	99.79	99.55	97.97	100.80	100.28
Zn ppm	65.32	40.09	52.29	67.67	69.72	43.91	51.41
Zn err	11.96	11.67	10.87	10.46	10.40	11.34	11.19
Rb ppm	96.22	101.12	104.69	90.27	91.15	97.00	99.79
Rb err	6.59	6.42	6.38	5.19	5.10	4.99	4.94
Sr ppm	38.34	29.72	35.01	41.81	71.09	37.17	31.07
Sr err	5.20	5.41	5.05	5.05	4.33	5.18	5.39
Y ppm	35.07	43.04	36.62	38.26	38.05	34.96	34.87
Y err	7.45	7.39	7.34	7.28	7.41	7.27	7.31
Zr ppm	341.10	219.35	238.84	336.84	330.22	229.48	240.60
Zr err	15.01	11.64	11.81	14.66	16.79	11.92	11.94
Nb ppm	89.96	46.14	55.10	49.44	44.69	48.00	56.99
Nb err	9.81	8.81	8.88	8.84	8.91	8.81	10.93
Ba ppm	214.73	143.94	146.81	240.87	351.46	195.63	214.82
Ba err	49.10	49.76	49.42	47.73	46.53	48.54	47.74
Total Trace wt %	0.11	0.08	0.08	0.11	0.12	0.08	0.09
Total wt %	100.27	100.64	99.87	99.66	98.09	100.89	100.37
Total + LOI	100.62	101.08	100.88	101.00	99.78	101.30	101.07

Appendix B (cont.)

Sample	TA3-8	TA3-9	TA3-11	TA3-12	TA3-13	TA3-14	TA3-15
Unit	4	4	3	3	3T	3T	4
Northing	1771378.56	1771387.00	1771427.96	1771433.98	1771447.24	1771767.73	1771777.37
Easting	1619747.84	1619746.64	1618009.25	1618012.86	1618015.27	1617751.41	1617767.07
Elevation	7364.70	7370.70	7370.00	7376.70	7380.70	7382.00	7388.00
SiO_2 wt %	73.56	73.42	76.48	77.57	74.53	74.45	74.82
SiO_2 err	0.80	0.80	0.82	0.83	0.81	0.81	0.79
TiO_2 wt %	0.25	0.26	0.13	0.14	0.18	0.18	0.21
TiO_2 err	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Al_2O_3 wt %	13.96	13.84	12.47	12.43	12.66	12.68	13.32
Al_2O_3 err	0.21	0.21	0.21	0.21	0.21	0.21	0.19
Fe_2O_3T wt %	2.42	2.51	1.61	1.60	1.93	1.88	2.10
Fe_2O_3T err	0.05	0.05	0.05	0.05	0.05	0.05	0.05
MnO wt %	0.05	0.04	0.06	0.05	0.07	0.07	0.08
MnO err	0.01	0.01	0.01	0.01	0.01	0.01	0.01
MgO wt %	0.22	0.24	-0.11	-0.11	-0.11	-0.11	-0.11
MgO err	0.10	0.10					
CaO wt %	0.45	0.47	0.21	0.21	0.19	0.24	0.28
CaO err	0.11	0.11	0.11	0.11	0.11	0.11	0.11
Na_2O wt %	4.18	4.12	4.22	4.09	4.39	4.50	4.53
Na_2O err	0.10	0.10	0.10	0.10	0.10	0.10	0.08
K_2O wt %	4.55	4.60	4.60	4.45	4.86	4.87	4.87
K_2O err	0.06	0.06	0.06	0.06	0.07	0.07	0.06
P_2O_5 wt %	0.02	0.01	0.01	-0.01	0.01	0.02	0.02
P_2O_5 err	0.01	0.01	0.01		0.01	0.01	0.01
LOI %	1.32	1.26	0.50	0.58	0.41	0.34	0.34
Total Majors	99.65	99.52	99.79	100.55	98.82	98.88	100.23
Zn ppm	62.68	61.32	66.83	67.62	84.01	64.53	53.43
Zn err	10.33	10.89	10.57	10.50	11.21	10.71	10.68
Rb ppm	94.92	93.99	106.46	102.48	103.27	109.72	91.09
Rb err	5.12	6.62	6.41	4.92	6.50	6.44	6.55
Sr ppm	59.99	65.38	36.85	32.56	30.65	28.48	39.90
Sr err	4.52	4.47	5.20	5.27	5.43	5.51	5.11
Y ppm	35.36	33.28	42.94	49.47	47.37	29.59	30.42
Y err	7.28	7.46	7.57	7.61	7.73	7.37	7.30
Zr ppm	339.98	336.55	246.18	223.01	337.07	338.21	350.99
Zr err	14.65	14.89	13.48	13.22	14.92	14.92	14.94
Nb ppm	45.15	57.45	43.84	46.78	56.48	54.50	48.08
Nb err	8.84	9.13	8.89	8.90	9.08	8.97	8.91
Ba ppm	308.84	323.51	177.44	182.03	166.98	171.83	220.81
Ba err	46.51	47.13	49.45	49.29	49.97	49.55	48.03
Total Trace wt %	0.12	0.12	0.09	0.09	0.10	0.10	0.10
Total wt %	99.77	99.65	99.88	100.63	98.93	98.98	100.34
Total + LOI	101.08	100.90	100.37	101.21	99.34	99.32	100.68

Appendix B (cont.)

Sample	TA3-16	TA3-17	TA3-18	TA3-19	TA3-20	TA3-21	TA3-22
Unit	3	3T	3T	4	3T	3	3
Northing	1772037.61	1772047.25	1772053.28	1772056.89	1772395.45	1771178.56	1771190.61
Easting	1617544.18	1617564.66	1617574.30	1617592.37	1617163.45	1617153.81	1617153.81
Elevation	7359.00	7382.00	7389.00	7394.00	7386.00	7380.00	7389.00
SiO_2 wt %	77.57	75.88	75.88	73.96	76.31	78.29	78.03
SiO_2 err	0.83	0.82	0.82	0.78	0.82	0.83	0.83
TiO_2 wt %	0.12	0.19	0.17	0.25	0.17	0.13	0.13
TiO_2 err	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Al_2O_3 wt %	12.22	12.87	13.02	13.29	12.87	12.13	12.30
Al_2O_3 err	0.21	0.21	0.21	0.21	0.21	0.21	0.21
Fe_2O_3T wt %	1.45	1.95	1.89	2.37	1.87	1.75	1.67
Fe_2O_3T err	0.05	0.05	0.05	0.05	0.05	0.05	0.05
MnO wt %	0.05	0.06	0.06	0.07	0.08	0.02	0.06
MnO err	0.01	0.01	0.01	0.01	0.01	0.01	0.01
MgO wt %	-0.11	-0.11	-0.11	0.17	-0.11	-0.11	-0.11
MgO err				0.10			
CaO wt %	0.20	0.22	0.18	0.46	0.20	0.20	0.24
CaO err	0.11	0.11	0.11	0.11	0.11	0.11	0.11
Na_2O wt %	4.16	4.45	4.38	4.38	4.43	3.95	3.99
Na_2O err	0.10	0.10	0.10	0.08	0.10	0.10	0.10
K_2O wt %	4.46	4.84	4.87	4.70	4.76	4.36	4.37
K_2O err	0.06	0.07	0.07	0.06	0.07	0.06	0.06
P_2O_5 wt %	0.01	0.02	0.01	0.03	0.01	0.01	0.01
P_2O_5 err	0.01	0.01	0.01	0.01	0.01	0.01	0.01
LOI %	0.46	0.35	0.45	0.81	0.29	0.46	0.42
Total Majors	100.24	100.48	100.47	99.69	100.71	100.85	100.79
Zn ppm	50.26	70.17	55.89	47.10	71.09	46.86	55.54
Zn err	11.47	10.48	10.81	11.14	10.17	11.71	11.11
Rb ppm	104.28	98.60	101.07	91.89	104.41	98.39	99.07
Rb err	6.40	5.05	6.46	6.61	6.41	6.47	6.39
Sr ppm	28.12	27.25	27.54	61.36	28.44	28.62	35.77
Sr err	5.47	5.49	5.41	4.48	5.49	5.48	5.16
Y ppm	32.21	28.96	41.11	50.35	40.86	30.57	40.85
Y err	7.33	7.24	7.47	7.61	7.36	7.30	7.42
Zr ppm	214.29	344.92	334.36	352.75	324.16	230.35	227.04
Zr err	11.68	15.13	14.69	17.22	14.49	13.26	13.02
Nb ppm	49.75	49.96	52.69	46.20	52.81	50.88	47.90
Nb err	8.82	8.93	8.95	8.95	8.91	8.93	8.82
Ba ppm	127.31	188.14	179.94	310.23	212.11	177.42	168.12
Ba err	50.27	48.44	49.11	46.95	48.27	49.07	48.61
Total Trace wt %	0.08	0.10	0.10	0.12	0.10	0.08	0.08
Total wt %	100.32	100.58	100.57	99.81	100.81	100.93	100.88
Total + LOI	100.77	100.93	101.02	100.61	101.11	101.39	101.30

Appendix B (cont.)

Sample	TA3-23	TA3-24	TA3-25	TA3-26	TA3-27	TA3-28	TA3-29
Unit	3T	4	4	4	3T	3T	4
Northing	1771211.09	1771229.16	1771318.32	1771537.60	1771576.16	1771594.23	1771637.60
Easting	1617153.81	1617156.22	1617076.70	1616469.45	1615485.09	1615489.91	1615500.76
Elevation	7400.00	7415.00	7445.00	7460.00	7456.00	7462.00	7481.00
SiO_2 wt %	74.78	74.67	72.92	74.68	75.43	75.16	74.57
SiO_2 err	0.81	0.81	0.80	0.81	0.81	0.81	0.81
TiO_2 wt %	0.18	0.21	0.26	0.25	0.17	0.18	0.22
TiO_2 err	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Al_2O_3 wt %	12.90	13.34	13.32	13.29	12.63	12.73	13.41
Al_2O_3 err	0.21	0.21	0.21	0.21	0.21	0.21	0.21
Fe_2O_3T wt %	1.92	2.06	2.42	2.31	1.88	1.93	2.12
Fe_2O_3T err	0.05	0.05	0.05	0.05	0.05	0.05	0.05
MnO wt %	0.07	0.08	0.08	0.08	0.05	0.07	0.08
MnO err	0.01	0.01	0.01	0.01	0.01	0.01	0.01
MgO wt %	-0.11	-0.11	0.16	0.14	-0.11	-0.11	-0.11
MgO err			0.10	0.10			
CaO wt %	0.21	0.25	0.59	0.44	0.20	0.19	0.34
CaO err	0.11	0.11	0.11	0.11	0.11	0.11	0.11
Na_2O wt %	4.51	4.39	4.43	4.54	4.33	4.32	4.35
Na_2O err	0.10	0.10	0.10	0.10	0.10	0.10	0.10
K_2O wt %	4.92	4.79	4.73	4.78	4.82	4.88	4.81
K_2O err	0.07	0.07	0.06	0.07	0.07	0.07	0.07
P_2O_5 wt %	0.02	0.03	0.04	0.03	0.02	0.02	0.02
P_2O_5 err	0.01	0.01	0.01	0.01	0.01	0.01	0.01
LOI %	0.18	0.43	0.54	0.55	0.25	0.29	0.44
Total Majors	99.51	99.82	98.95	100.53	99.54	99.49	99.92
Zn ppm	72.57	65.11	57.29	67.26	61.79	82.85	57.51
Zn err	10.30	10.66	11.12	10.45	10.87	9.76	11.11
Rb ppm	99.49	93.87	89.40	86.87	106.08	99.25	83.30
Rb err	6.53	6.55	5.22	5.21	6.47	6.50	6.83
Sr ppm	29.20	38.14	66.36	60.08	21.93	27.68	50.09
Sr err	5.49	5.18	4.45	4.57	5.74	5.48	4.85
Y ppm	42.68	18.43	32.03	34.73	37.86	39.44	53.86
Y err	7.61	9.54	7.36	7.36	7.48	7.45	7.89
Zr ppm	338.36	329.70	364.47	352.68	334.36	336.56	359.17
Zr err	14.94	17.18	15.42	17.21	14.87	14.77	15.33
Nb ppm	53.12	43.45	43.33	45.91	45.34	54.92	48.32
Nb err	9.03	8.90	8.93	8.93	8.92	9.01	8.99
Ba ppm	176.75	214.56	281.41	278.36	84.87	164.66	262.80
Ba err	49.68	48.62	47.83	47.53	52.45	49.67	48.17
Total Trace wt %	0.10	0.10	0.12	0.11	0.09	0.10	0.11
Total wt %	99.61	99.92	99.07	100.64	99.63	99.59	100.04
Total + LOI	99.79	100.36	99.61	101.20	99.88	99.87	100.48

Appendix B (cont.)

Sample	TA3-30	TA3-31	TA3-32	TA3-33	TA3-34	TA3-35	TA3-36
Unit	4	3T	3	3	3T	3T	4
Northing	1771687.00	1773159.46	1773219.51	1773228.01	1773269.55	1773362.07	1773401.72
Easting	1615516.42	1612878.36	1614409.63	1614410.58	1614390.75	1614390.28	1614430.87
Elevation	7495.00	7730.00	7535.00	7547.00	7550.50	7580.00	7584.00
SiO_2 wt %	74.13	74.67	77.79	77.29	75.62	76.01	74.78
SiO_2 err	0.81	0.81	0.83	0.83	0.82	0.82	0.81
TiO_2 wt %	0.24	0.19	0.13	0.13	0.17	0.17	0.21
TiO_2 err	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Al_2O_3 wt %	13.93	13.33	11.88	12.11	12.81	12.86	13.34
Al_2O_3 err	0.21	0.21	0.21	0.21	0.21	0.21	0.21
Fe_2O_3T wt %	2.25	1.96	1.54	1.62	1.85	1.92	2.14
Fe_2O_3T err	0.05	0.05	0.05	0.05	0.05	0.05	0.05
MnO wt %	0.07	0.05	0.05	0.06	0.06	0.06	0.08
MnO err	0.01	0.01	0.01	0.01	0.01	0.01	0.01
MgO wt %	-0.11	-0.11	-0.11	-0.11	-0.11	-0.11	-0.11
MgO err							
CaO wt %	0.42	0.23	0.21	0.20	0.17	0.20	0.34
CaO err	0.11	0.11	0.11	0.11	0.11	0.11	0.11
Na_2O wt %	4.21	4.49	3.87	3.94	4.28	4.30	4.42
Na_2O err	0.10	0.10	0.10	0.10	0.10	0.10	0.10
K_2O wt %	4.70	4.82	4.30	4.44	4.78	4.74	4.73
K_2O err	0.06	0.07	0.06	0.06	0.07	0.06	0.06
P_2O_5 wt %	0.03	-0.01	-0.01	-0.01	-0.01	0.01	0.02
P_2O_5 err	0.01					0.01	0.01
LOI %	0.80	0.44	0.39	0.48	0.45	0.32	0.43
Total Majors	99.99	99.75	99.75	99.79	99.74	100.27	100.06
Zn ppm	56.17	48.07	49.14	54.69	67.42	63.75	87.84
Zn err	10.84	11.62	11.55	11.23	10.52	10.72	9.60
Rb ppm	86.66	87.76	95.28	103.38	112.52	101.00	90.14
Rb err	5.18	5.25	6.55	4.92	6.41	6.51	6.64
Sr ppm	57.59	39.65	31.92	26.85	27.02	30.09	52.37
Sr err	4.64	5.15	5.36	5.54	5.55	5.45	4.78
Y ppm	27.11	21.09	37.02	49.77	28.77	38.39	46.34
Y err	7.14	7.12	7.44	7.73	7.33	9.85	7.68
Zr ppm	351.80	339.56	242.69	238.49	316.46	319.54	367.54
Zr err	17.12	14.96	13.42	11.96	14.56	14.64	17.90
Nb ppm	44.38	45.74	46.53	49.34	60.57	52.98	42.89
Nb err	8.81	8.90	8.88	10.90	9.09	11.00	8.95
Ba ppm	381.05	199.48	152.48	152.34	175.66	127.59	218.06
Ba err	46.12	49.10	50.30	50.23	49.99	51.19	48.86
Total Trace wt %	0.12	0.10	0.08	0.08	0.10	0.09	0.11
Total wt %	100.11	99.85	99.84	99.87	99.83	100.36	100.18
Total + LOI	100.91	100.29	100.22	100.35	100.28	100.67	100.60

Appendix B (cont.)

Sample	TA3-37	TA3-38	TA3-39	TA3-40	SH98-1	SH98-2	SH98-3
Unit	4	4	3	4	3T	4	4
Northing	1771236.12	1771267.79	1775915.02	1776235.20	1775028.58	1775026.64	1775020.15
Easting	1617148.80	1617138.24	1619131.13	1619149.55	1612423.45	1612421.18	1612401.09
Elevation	7421.00	7426.00	7266.00	7277.00	7918.00	7926.00	7938.00
SiO_2 wt %	74.68	74.41	78.06	75.55	75.83	75.12	75.19
SiO_2 err	0.81	0.81	0.83	0.82	0.82	0.81	0.81
TiO_2 wt %	0.21	0.25	0.12	0.20	0.17	0.20	0.22
TiO_2 err	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Al_2O_3 wt %	13.49	13.37	11.98	13.14	12.63	13.14	13.39
Al_2O_3 err	0.21	0.21	0.21	0.21	0.21	0.21	0.21
Fe_2O_3T wt %	2.12	2.27	1.58	2.04	1.85	2.02	2.07
Fe_2O_3T err	0.05	0.05	0.05	0.05	0.05	0.05	0.05
MnO wt %	0.08	0.09	0.06	0.07	0.07	0.07	0.08
MnO err	0.01	0.01	0.01	0.01	0.01	0.01	0.01
MgO wt %	-0.11	0.13	-0.11	-0.11	-0.11	-0.11	0.11
MgO err		0.10					0.10
CaO wt %	0.27	0.49	0.24	0.23	0.28	0.32	0.44
CaO err	0.11	0.11	0.11	0.11	0.11	0.11	0.11
Na_2O wt %	4.50	4.42	4.18	4.54	4.44	4.54	4.48
Na_2O err	0.10	0.10	0.10	0.10	0.10	0.10	0.10
K_2O wt %	4.89	4.69	4.40	4.89	4.74	4.81	4.80
K_2O err	0.07	0.06	0.06	0.07	0.06	0.07	0.07
P_2O_5 wt %	0.02	0.03	0.01	0.02	0.02	0.02	0.03
P_2O_5 err	0.01	0.01	0.01	0.01	0.01	0.01	0.01
LOI %	0.40	0.54	0.21	0.26	0.25	0.29	0.25
Total Majors	100.27	100.14	100.63	100.68	100.03	100.24	100.81
Zn ppm	58.81	91.57	51.95	79.25	66.92	63.13	61.87
Zn err	11.00	10.92	11.38	11.33	10.56	10.76	10.83
Rb ppm	87.62	91.76	100.47	97.32	97.78	94.83	89.48
Rb err	6.70	6.64	4.96	5.06	6.54	5.09	5.21
Sr ppm	40.60	64.93	29.54	35.59	25.64	41.99	56.09
Sr err	5.13	4.49	5.44	5.28	5.60	5.08	4.68
Y ppm	38.35	29.84	38.03	43.75	45.17	19.00	45.40
Y err	7.49	7.36	7.42	9.89	7.64	7.11	7.58
Zr ppm	342.57	354.00	238.40	344.32	315.77	351.59	344.71
Zr err	17.46	15.25	13.35	17.51	14.53	17.56	17.48
Nb ppm	44.37	56.40	54.71	45.90	52.60	48.11	40.60
Nb err	10.89	9.10	8.98	10.95	9.01	8.92	8.90
Ba ppm	285.56	356.76	181.54	232.90	200.13	218.54	256.96
Ba err	47.51	46.91	49.41	48.08	48.50	48.45	48.03
Total Trace wt %	0.11	0.13	0.09	0.11	0.10	0.10	0.11
Total wt %	100.38	100.27	100.71	100.79	100.13	100.35	100.92
Total + LOI	100.78	100.81	100.92	101.05	100.37	100.63	101.17

Appendix B (cont.)

Sample	TA55-1	TA55-2	TA55-3/3	TA55-3/4	TA55-4	TA55-5	TA55-6
Unit	4	3	4	4	4	4	2
Northing	1769237.78	1772159.63	1772163.39	1772163.39	1772166.40	1772138.45	1772854.56
Easting	1624587.51	1620663.99	1620663.23	1620663.23	1620662.48	1620558.97	1623692.21
Elevation	7300.00	7346.00	7347.50	7347.50	7348.50	7350.00	7215.00
SiO_2 wt %	73.73	76.70	71.23	71.18	74.03	74.30	77.20
SiO_2 err	0.90	0.93	0.88	0.88	0.91	0.91	0.93
TiO_2 wt %	0.25	0.13	0.26	0.25	0.27	0.24	0.09
TiO_2 err	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Al_2O_3 wt %	13.12	11.86	13.35	12.84	12.87	13.24	11.90
Al_2O_3 err	0.23	0.23	0.23	0.23	0.23	0.23	0.23
Fe_2O_3T wt %	1.98	1.59	2.88	2.51	2.49	2.19	1.43
Fe_2O_3T err	0.06	0.05	0.06	0.06	0.06	0.06	0.05
MnO wt %	0.05	0.05	0.04	0.04	0.07	0.07	0.06
MnO err	0.01	0.01	0.01	0.01	0.01	0.01	0.01
MgO wt %	0.19	-0.11	0.60	0.60	0.29	0.16	-0.11
MgO err	0.10		0.09	0.09	0.10	0.10	
CaO wt %	0.61	0.26	1.19	1.99	0.72	0.55	-0.11
CaO err	0.11	0.11	0.10	0.10	0.11	0.11	
Na_2O wt %	4.38	4.15	3.91	3.86	4.08	4.48	3.99
Na_2O err	0.11	0.10	0.10	0.10	0.10	0.11	0.10
K_2O wt %	4.60	4.38	4.06	4.16	4.48	4.61	4.48
K_2O err	0.07	0.07	0.06	0.06	0.07	0.07	0.07
P_2O_5 wt %	0.03	-0.01	0.03	0.04	0.05	0.04	-0.01
P_2O_5 err	0.01		0.01	0.01	0.01	0.01	
LOI %	0.59	0.48	2.44	2.56	0.65	0.34	0.33
Total Majors	98.93	99.12	97.55	97.47	99.33	99.88	99.15
Zn ppm	53.30	67.50	102.40	90.40	121.40	80.90	64.70
Zn err	11.30	10.80	9.70	10.00	10.50	10.30	10.90
Rb ppm	83.80	104.80	99.20	87.60	91.40	77.40	138.60
Rb err	5.70	6.60	6.80	7.00	5.50	7.20	6.60
Sr ppm	73.60	32.60	98.30	133.60	93.00	66.70	14.70
Sr err	4.20	5.60	3.70	5.10	3.80	4.40	6.40
Y ppm	29.30	42.90	47.20	31.40	42.30	34.90	44.40
Y err	7.10	7.20	7.40	7.30	9.70	7.10	9.80
Zr ppm	345.90	235.00	241.80	243.10	298.40	312.20	218.70
Zr err	15.30	13.70	13.60	13.70	14.60	14.70	12.30
Nb ppm	51.30	53.00	39.00	38.10	50.60	43.10	65.40
Nb err	8.90	8.80	8.70	8.70	8.90	8.70	9.20
Ba ppm	337.30	190.60	325.10	327.70	331.60	275.20	90.80
Ba err	46.90	47.10	46.80	47.40	46.60	47.50	49.00
Total Trace wt %	0.12	0.09	0.12	0.12	0.13	0.11	0.08
Total wt %	99.05	99.21	97.67	97.59	99.46	99.99	99.23
Total + LOI	99.64	99.69	100.11	100.15	100.11	100.35	99.56

Appendix B (cont.)

Sample	TA55-7	TA55-8-1	TA55-8-2	TA55-9	TA55-10	TA55-11	TA55-12
Unit	2	3	2	2	2	3	3
Northing	1772874.10	1772893.64	1772893.64	1772685.21	1772704.75	1772721.04	1772043.52
Easting	1623692.21	1623698.72	1623698.72	1625115.37	1625118.63	1625118.63	1619942.56
Elevation	7218.00	7220.00	7220.00	7185.00	7190.50	7193.00	7345.00
SiO_2 wt %	78.41	77.75	78.31	77.39	77.41	78.24	77.22
SiO_2 err	0.94	0.94	0.94	0.93	0.93	0.94	0.93
TiO_2 wt %	0.09	0.09	0.09	0.09	0.10	0.09	0.12
TiO_2 err	0.01	0.01	0.01	0.01	0.01	0.01	0.13
Al_2O_3 wt %	11.30	11.49	11.38	12.14	11.87	11.16	12.30
Al_2O_3 err	0.23	0.23	0.23	0.23	0.23	0.23	0.23
Fe_2O_3T wt %	1.32	1.29	1.28	1.47	1.48	1.38	1.46
Fe_2O_3T err	0.05	0.05	0.05	0.05	0.05	0.05	0.05
MnO wt %	0.06	0.05	0.05	0.07	0.07	0.06	0.05
MnO err	0.01	0.01	0.01	0.01	0.01	0.01	0.01
MgO wt %	-0.11	-0.11	-0.11	-0.11	-0.11	-0.11	-0.11
MgO err							
CaO wt %	0.14	0.29	0.13	0.12	0.15	0.19	0.18
CaO err	0.11	0.11	0.11	0.11	0.11	0.11	0.11
Na_2O wt %	3.82	4.00	38.10	3.78	3.90	3.73	3.96
Na_2O err	0.10	0.10	0.10	0.10	0.10	0.10	0.10
K_2O wt %	4.25	4.35	4.29	4.39	4.38	4.11	4.48
K_2O err	0.07	0.07	0.07	0.07	0.07	0.06	0.07
P_2O_5 wt %	-0.01	0.01	-0.01	-0.01	-0.01	0.01	0.01
P_2O_5 err		0.01				0.01	0.01
LOI %	0.05	0.43	0.33	0.51	0.29	0.31	0.41
Total Majors	99.38	99.33	99.34	99.45	99.36	98.98	99.80
Zn ppm	64.50	56.50	62.00	66.50	59.20	68.20	48.70
Zn err	10.90	11.20	11.00	10.80	11.10	10.80	11.50
Rb ppm	118.20	119.50	127.10	130.30	132.80	118.00	93.00
Rb err	6.50	6.50	6.50	6.50	6.60	6.50	6.80
Sr ppm	24.60	25.30	20.60	13.70	20.00	25.10	28.70
Sr err	5.90	5.90	6.10	6.40	6.10	5.90	5.70
Y ppm	59.30	60.10	58.20	48.00	35.70	50.10	44.90
Y err	10.00	10.00	10.00	7.50	9.70	9.90	7.40
Zr ppm	192.90	193.30	210.10	230.80	203.50	183.40	235.80
Zr err	12.00	12.00	12.20	12.40	12.10	12.00	13.80
Nb ppm	60.40	55.60	56.50	66.30	60.90	55.00	44.70
Nb err	9.10	10.90	9.00	11.10	9.10	9.00	8.80
Ba ppm	62.20	148.40	86.10	86.10	90.60	-49.60	186.20
Ba err	50.00	48.40	49.40	49.50	49.20		47.70
Total Trace wt %	0.07	0.08	0.08	0.08	0.08	0.06	0.08
Total wt %	99.45	99.41	99.42	99.53	99.43	99.04	99.88
Total + LOI	99.90	99.84	99.75	100.04	99.72	99.35	100.29

Appendix B (cont.)

Sample	TA55-13	TA55-14	TA55-15	TA55-16	TA55-17	TA55-18	TA55-19
Unit	4	4	2	2	2	2	3
Northing	1772055.96	1772063.43	1767449.59	1767458.61	1767465.05	1769602.65	1769607.80
Easting	1619946.30	1619945.05	1625614.72	1625618.59	1625616.01	1622812.28	1622825.16
Elevation	7352.60	7355.00	7118.00	7123.00	7128.00	7189.50	7194.50
SiO_2 wt %	73.80	73.72	77.87	78.64	77.51	79.00	76.73
SiO_2 err	0.90	0.90	0.94	0.94	0.93	0.95	0.93
TiO_2 wt %	0.25	0.28	0.09	0.09	0.10	0.10	0.11
TiO_2 err	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Al_2O_3 wt %	13.15	13.01	11.73	11.27	11.71	11.97	11.96
Al_2O_3 err	0.23	0.23	0.23	0.23	0.23	0.23	0.23
Fe_2O_3T wt %	2.19	2.35	1.45	1.36	1.52	1.48	1.51
Fe_2O_3T err	0.06	0.05	0.05	0.05	0.05	0.05	0.05
MnO wt %	0.07	0.06	0.06	0.05	0.06	0.07	0.04
MnO err	0.01	0.01	0.01	0.01	0.01	0.01	0.01
MgO wt %	0.14	0.22	-0.11	-0.11	-0.11	-0.11	-0.11
MgO err	0.11	0.10					
CaO wt %	0.46	0.60	0.14	0.14	0.16	0.15	0.22
CaO err	0.11	0.11	0.11	0.11	0.11	0.11	0.11
Na_2O wt %	4.37	4.32	3.97	3.90	3.80	3.86	3.91
Na_2O err	0.11	0.11	0.10	0.10	0.10	0.10	0.10
K_2O wt %	4.75	4.59	4.42	4.26	4.18	4.37	4.32
K_2O err	0.07	0.07	0.07	0.07	0.06	0.07	0.07
P_2O_5 wt %	0.03	0.04	-0.01	-0.01	-0.01	-0.01	-0.01
P_2O_5 err	0.01	0.01					
LOI %	0.62	1.10	0.20	0.24	0.69	0.35	0.44
Total Majors	99.21	99.18	99.72	99.71	99.03	101.00	98.80
Zn ppm	79.90	80.20	80.40	60.10	60.00	80.20	73.90
Zn err	10.40	10.40	10.40	11.10	11.10	10.40	10.60
Rb ppm	82.40	95.60	139.30	117.90	124.30	133.10	131.90
Rb err	5.80	5.40	6.70	6.50	6.50	6.60	6.60
Sr ppm	59.40	80.90	21.90	22.00	16.00	30.50	32.00
Sr err	4.60	4.00	6.00	6.00	6.30	5.70	5.60
Y ppm	42.20	41.20	44.00	47.10	51.40	54.40	54.50
Y err	7.30	7.30	9.80	7.40	9.90	9.90	10.00
Zr ppm	353.70	362.30	210.20	182.30	188.60	211.60	211.20
Zr err	15.50	15.70	12.20	11.90	12.00	12.20	12.20
Nb ppm	42.60	37.50	71.90	60.80	50.10	66.50	69.80
Nb err	8.90	8.90	11.20	9.10	8.90	9.20	9.30
Ba ppm	279.80	307.10	124.30	71.70	85.70	124.00	209.90
Ba err	47.40	47.50	48.60	50.10	49.00	48.40	46.80
Total Trace wt %	0.12	0.13	0.09	0.07	0.07	0.09	0.10
Total wt %	99.33	99.31	99.81	99.78	99.11	101.09	98.90
Total + LOI	99.95	100.41	100.01	100.02	99.80	101.44	99.34

Appendix B (cont.)

Sample	TA55-20	TA55-21	TA55-22	TA55-23	TA55-24	TA55-25	TA55-26
Unit	2	2	2	3	2	3	3
Northing	1769615.53	1770981.34	1771001.89	1771006.34	1771199.70	1771211.94	1771226.00
Easting	1622816.14	1625772.99	1625772.67	1625773.45	1624447.25	1624449.69	1624448.98
Elevation	7195.50	7159.05	7162.09	7164.09	7182.62	7185.91	7189.02
SiO_2 wt %	78.68	78.14	77.97	78.04	77.62	77.71	77.51
SiO_2 err	0.94	0.94	0.94	0.94	0.93	0.93	0.93
TiO_2 wt %	0.09	0.09	0.09	0.09	0.09	0.09	0.11
TiO_2 err	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Al_2O_3 wt %	11.20	11.47	12.09	11.63	12.04	11.76	11.93
Al_2O_3 err	0.23	0.23	0.23	0.23	0.23	0.23	0.23
Fe_2O_3T wt %	1.37	1.41	1.46	1.34	1.42	1.42	1.55
Fe_2O_3T err	0.05	0.05	0.05	0.05	0.05	0.05	0.05
MnO wt %	0.06	0.07	0.07	0.06	0.06	0.06	0.07
MnO err	0.01	0.01	0.01	0.01	0.01	0.01	0.01
MgO wt %	-0.11	-0.11	-0.11	-0.11	-0.11	-0.11	-0.11
MgO err							
CaO wt %	0.13	0.11	0.14	0.15	0.14	0.13	0.18
CaO err	0.11	0.11	0.11	0.11	0.11	0.11	0.11
Na_2O wt %	3.74	3.91	4.03	3.91	4.02	3.91	4.10
Na_2O err	0.10	0.10	0.10	0.10	0.10	0.10	0.10
K_2O wt %	4.19	4.34	4.41	4.38	4.51	4.40	4.37
K_2O err	0.06	0.07	0.07	0.07	0.07	0.07	0.07
P_2O_5 wt %	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	0.02
P_2O_5 err							0.01
LOI %	0.40	0.37	0.45	0.28	0.33	0.32	0.37
Total Majors	99.46	99.54	100.25	99.60	99.91	99.48	99.83
Zn ppm	49.00	68.00	66.60	67.70	62.10	67.20	76.70
Zn err	11.50	10.80	10.80	10.80	11.00	10.80	10.50
Rb ppm	120.50	127.50	129.30	121.20	134.20	137.00	123.30
Rb err	6.50	6.50	6.50	6.50	6.60	6.60	6.50
Sr ppm	28.80	-7.00	15.30	24.50	12.10	19.90	40.80
Sr err	5.70		6.30	5.90	6.50	6.10	5.30
Y ppm	46.70	55.10	48.40	49.30	43.50	34.70	50.10
Y err	7.40	10.00	9.90	7.50	9.80	9.70	9.90
Zr ppm	189.80	212.90	205.60	198.10	216.50	219.10	192.40
Zr err	12.00	12.20	13.50	12.10	12.20	12.20	12.10
Nb ppm	54.00	51.30	57.60	53.90	72.50	68.00	64.90
Nb err	10.80	10.80	10.90	8.90	11.20	9.20	11.10
Ba ppm	124.30	95.50	114.60	153.00	124.30	138.60	166.90
Ba err	48.10	49.60	48.80	48.40	48.80	48.20	47.90
Total Trace wt %	0.08	0.08	0.08	0.08	0.08	0.08	0.09
Total wt %	99.53	99.62	100.33	99.68	99.99	99.56	99.92
Total + LOI	99.93	99.99	100.78	99.96	100.32	99.88	100.29

Appendix B (cont.)

Sample	TA55-27	SHB-CMR-1/46	SHB-CMR-1/47	SHB-CMR-1/49	SHB-CMR-1/59.0	SHB-CMR-1/62.0	SHB-CMR-10/41.0
Unit	3	4	3T	3T	3	3	4
Northing	1768842.12	1772678.60	1772678.60	1772678.60	1772678.60	1772678.60	1772412.72
Easting	1624808.50	1618571.21	1618571.21	1618571.21	1618571.21	1618571.21	1619061.52
Elevation	7274.04	7356.20	7355.20	7353.20	7343.20	7340.20	7357.40
SiO_2 wt %	75.31	75.28	75.84	75.81	76.79	77.08	74.70
SiO_2 err	0.92	0.81	0.82	0.82	0.82	0.82	0.81
TiO_2 wt %	0.15	0.23	0.18	0.18	0.13	0.13	0.23
TiO_2 err	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Al_2O_3 wt %	12.88	13.16	12.87	12.82	12.48	12.29	13.18
Al_2O_3 err	0.23	0.21	0.21	0.21	0.21	0.21	0.21
Fe_2O_3T wt %	2.31	2.12	1.89	1.90	1.74	1.67	2.22
Fe_2O_3T err	0.06	0.05	0.05	0.05	0.05	0.05	0.05
MnO wt %	0.03	0.07	0.06	0.07	0.05	0.05	0.11
MnO err	0.01	0.01	0.01	0.01	0.01	0.01	0.01
MgO wt %	0.21	0.17	-0.11	-0.11	0.12	-0.11	0.19
MgO err	0.10	0.10			0.10		0.10
CaO wt %	0.34	0.54	0.33	0.30	0.31	0.31	0.48
CaO err	0.11	0.11	0.11	0.11	0.11	0.11	0.11
Na_2O wt %	3.70	4.41	4.41	4.41	3.94	4.00	4.41
Na_2O err	0.10	0.10	0.10	0.10	0.10	0.10	0.10
K_2O wt %	4.16	4.72	4.84	4.93	4.34	4.29	4.74
K_2O err	0.06	0.06	0.07	0.07	0.06	0.06	0.06
P_2O_5 wt %	0.01	0.03	0.02	0.02	0.01	0.01	0.03
P_2O_5 err	0.01	0.01	0.01	0.01	0.01	0.01	0.01
LOI %	1.53	0.21	0.25	0.18	0.74	0.55	0.33
Total Majors	99.11	100.74	100.44	100.43	99.91	99.86	100.28
Zn ppm	93.70	65.58	59.46	65.12	48.80	61.36	62.38
Zn err	11.10	10.67	10.99	10.68	11.60	10.86	10.84
Rb ppm	103.80	87.05	94.68	103.14	97.67	92.76	94.05
Rb err	6.60	6.72	6.56	6.47	6.51	5.11	6.64
Sr ppm	33.60	56.96	26.57	24.23	33.99	35.49	53.35
Sr err	5.60	4.66	5.56	5.65	5.30	5.24	4.76
Y ppm	31.20	34.89	36.60	41.19	37.05	35.32	45.28
Y err	7.30	9.83	7.45	7.57	7.48	7.38	10.09
Zr ppm	235.50	341.67	330.59	320.56	220.52	216.30	359.76
Zr err	12.50	15.05	14.80	14.65	11.79	13.18	17.82
Nb ppm	53.00	43.48	52.87	53.33	45.74	41.66	52.20
Nb err	9.10	8.98	9.00	9.02	8.93	8.85	11.05
Ba ppm	141.50	321.14	181.72	172.10	177.37	201.40	267.45
Ba err	48.70	46.88	49.38	49.58	49.50	48.78	47.99
Total Trace wt %	0.09	0.12	0.10	0.10	0.08	0.09	0.12
Total wt %	99.19	100.86	100.53	100.52	100.00	99.94	100.40
Total + LOI	100.72	101.07	100.79	100.70	100.73	100.49	100.74

Appendix B (cont.)

Sample	SHB-CMR-10/43.1	SHB-CMR-10/46.6	SHB-CMR-10/48.0	SHB-CMR-10/51.5	SHB-CMR-10/54.0	SHB-CMR-10/56.5	SHB-CMR-2/41.5
Unit	3T	3T	3T	3	3	3	4
Northing	1772412.72	1772412.72	1772412.72	1772412.72	1772412.72	1772412.72	1772502.63
Easting	1619061.52	1619061.52	1619061.52	1619061.52	1619061.52	1619061.52	1618622.93
Elevation	7355.30	7351.80	7350.40	7346.90	7344.40	7341.90	7358.30
SiO_2 wt %	75.54	76.16	74.60	77.64	76.63	79.24	75.25
SiO_2 err	0.82	0.82	0.81	0.83	0.82	0.84	0.81
TiO_2 wt %	0.18	0.18	0.16	0.14	0.13	0.12	0.21
TiO_2 err	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Al_2O_3 wt %	12.69	12.56	12.38	11.69	11.83	11.23	12.77
Al_2O_3 err	0.21	0.21	0.21	0.21	0.21	0.21	0.21
Fe_2O_3T wt %	1.84	1.89	1.73	1.65	1.61	1.38	2.14
Fe_2O_3T err	0.05	0.05	0.05	0.05	0.05	0.05	0.05
MnO wt %	0.06	0.07	0.06	0.07	0.06	0.05	0.08
MnO err	0.01	0.01	0.01	0.01	0.01	0.01	0.01
MgO wt %	-0.11	-0.11	-0.11	-0.11	-0.11	-0.11	0.20
MgO err							0.10
CaO wt %	0.30	0.27	0.28	0.40	0.39	0.35	0.48
CaO err	0.11	0.11	0.11	0.11	0.11	0.11	0.11
Na_2O wt %	4.46	4.46	4.48	4.16	4.13	3.94	4.15
Na_2O err	0.10	0.10	0.10	0.10	0.10	0.10	0.10
K_2O wt %	4.78	4.82	4.81	4.38	4.45	4.19	4.41
K_2O err	0.07	0.07	0.07	0.06	0.06	0.06	0.06
P_2O_5 wt %	0.02	0.02	0.01	0.01	0.01	0.01	0.03
P_2O_5 err	0.01	0.01	0.01	0.01	0.01	0.01	0.01
LOI %	0.17	0.14	0.15	0.02	0.09	0.09	0.56
Total Majors	99.86	100.43	98.51	100.14	99.25	100.50	99.72
Zn ppm	64.64	68.91	64.82	62.73	59.88	55.86	68.23
Zn err	10.70	10.48	10.70	10.81	10.96	11.17	10.52
Rb ppm	101.51	94.33	106.56	86.12	102.50	80.21	95.30
Rb err	6.48	6.59	6.46	6.71	6.45	5.41	6.58
Sr ppm	23.38	29.13	28.29	31.79	42.16	41.40	60.88
Sr err	5.68	5.48	5.51	5.37	5.04	5.04	4.56
Y ppm	39.07	37.51	46.55	32.59	30.68	32.96	37.20
Y err	7.53	9.87	7.72	7.39	7.37	7.28	7.50
Zr ppm	329.17	328.38	302.20	248.02	243.04	207.02	292.49
Zr err	14.76	14.77	14.32	13.51	13.47	11.60	14.18
Nb ppm	55.50	63.62	54.61	71.66	49.81	38.64	41.93
Nb err	10.94	11.13	9.00	11.14	8.92	8.75	10.96
Ba ppm	162.29	147.94	211.25	172.83	187.47	182.99	277.01
Ba err	50.02	50.52	48.81	49.79	49.57	49.76	47.52
Total Trace wt %	0.10	0.10	0.10	0.09	0.09	0.08	0.11
Total wt %	99.96	100.52	98.61	100.23	99.34	100.58	99.83
Total + LOI	100.13	100.67	98.76	100.25	99.43	100.68	100.38

Appendix B (cont.)

Sample	SHB-CMR-2/48.5	SHB-CMR-2/49.9	SHB-CMR-2/51.0	SHB-CMR-2/54.1	SHB-CMR-2/55.8	SHB-CMR-2/58.8	SHB-CMR-2/61.8
Unit	3T	3T	3	3	3	3	3
Northing	1772502.63	1772502.63	1772502.63	1772502.63	1772502.63	1772502.63	1772502.63
Easting	1618622.93	1618622.93	1618622.93	1618622.93	1618622.93	1618622.93	1618622.93
Elevation	7351.30	7349.90	7348.80	7345.70	7344.00	7341.00	7338.00
SiO_2 wt %	75.95	76.40	78.80	78.96	78.27	77.22	77.42
SiO_2 err	0.82	0.82	0.83	0.84	0.83	0.83	0.83
TiO_2 wt %	0.18	0.17	0.14	0.12	0.12	0.15	0.13
TiO_2 err	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Al_2O_3 wt %	12.77	12.76	11.25	11.76	11.82	12.33	12.29
Al_2O_3 err	0.21	0.21	0.21	0.21	0.21	0.21	0.21
Fe_2O_3T wt %	1.82	1.79	1.54	1.47	1.47	1.81	1.60
Fe_2O_3T err	0.05	0.05	0.05	0.05	0.05	0.05	0.05
MnO wt %	0.07	0.06	0.06	0.05	0.05	0.07	0.06
MnO err	0.01	0.01	0.01	0.01	0.01	0.01	0.01
MgO wt %	-0.11	-0.11	-0.11	-0.11	-0.11	-0.11	-0.11
MgO err							
CaO wt %	0.29	0.29	0.38	0.29	0.28	0.32	0.29
CaO err	0.11	0.11	0.11	0.11	0.11	0.11	0.11
Na_2O wt %	4.41	4.42	3.86	4.08	4.01	4.11	4.10
Na_2O err	0.10	0.10	0.10	0.10	0.10	0.10	0.10
K_2O wt %	4.83	4.77	3.97	4.38	4.37	4.39	4.47
K_2O err	0.07	0.07	0.06	0.06	0.06	0.06	0.06
P_2O_5 wt %	0.02	0.02	0.01	0.01	0.01	0.01	0.01
P_2O_5 err	0.01	0.01	0.01	0.01	0.01	0.01	0.01
LOI %	0.20	0.23	0.18	0.15	0.22	0.41	0.35
Total Majors	100.33	100.67	100.00	101.13	100.40	100.42	100.36
Zn ppm	69.03	75.18	45.55	55.67	41.53	69.29	68.45
Zn err	10.46	11.51	11.79	11.20	12.06	10.48	10.51
Rb ppm	96.92	97.71	73.48	98.07	94.89	108.83	99.78
Rb err	6.56	6.53	5.63	5.01	5.06	6.41	6.48
Sr ppm	23.63	28.18	46.00	37.24	30.38	45.39	32.95
Sr err	5.67	5.51	4.91	5.18	5.41	4.94	5.33
Y ppm	32.38	33.07	27.04	22.25	37.56	40.31	37.43
Y err	7.40	7.36	7.19	7.18	7.39	7.57	7.48
Zr ppm	319.76	311.97	172.92	219.77	237.56	242.42	233.11
Zr err	14.61	14.47	11.38	11.75	11.93	12.03	13.34
Nb ppm	51.44	48.14	28.41	48.53	53.59	58.08	41.88
Nb err	8.97	8.91	8.72	8.86	8.94	9.08	8.85
Ba ppm	225.34	123.85	201.70	168.23	129.59	157.53	167.97
Ba err	48.19	51.18	49.22	50.07	51.12	50.46	50.01
Total Trace wt %	0.10	0.09	0.07	0.08	0.08	0.09	0.09
Total wt %	100.43	100.76	100.08	101.21	100.48	100.51	100.44
Total + LOI	100.63	101.00	100.26	101.35	100.70	100.91	100.80

Appendix B (cont.)

Sample	SHB-CMR-3/35.8	SHB-CMR-3/38.8	SHB-CMR-3/40.2	SHB-CMR-3/44.8	SHB-CMR-3/45.1	SHB-CMR-3/46	SHB-CMR-3/49.6
Unit	4	4	3T	3T	3T	3	3
Northing	1772403.05	1772403.05	1772403.05	1772403.05	1772403.05	1772403.05	1772403.05
Easting	1618671.66	1618671.66	1618671.66	1618671.66	1618671.66	1618671.66	1618671.66
Elevation	7362.80	7359.80	7358.40	7353.80	7353.50	7352.60	7349.00
SiO_2 wt %	74.64	74.94	75.95	75.63	76.40	79.76	77.93
SiO_2 err	0.81	0.81	0.82	0.82	0.82	0.84	0.83
TiO_2 wt %	0.24	0.29	0.19	0.19	0.17	0.14	0.13
TiO_2 err	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Al_2O_3 wt %	13.16	12.71	12.90	13.16	12.82	10.76	11.78
Al_2O_3 err	0.21	0.21	0.21	0.21	0.21	0.21	0.21
Fe_2O_3T wt %	2.23	2.74	1.93	2.03	1.83	1.64	1.56
Fe_2O_3T err	0.05	0.06	0.05	0.05	0.05	0.05	0.05
MnO wt %	0.08	0.10	0.08	0.08	0.08	0.08	0.06
MnO err	0.01	0.01	0.01	0.01	0.01	0.01	0.01
MgO wt %	0.19	0.20	-0.11	0.12	-0.11	-0.11	-0.11
MgO err	0.10	0.10		0.10			
CaO wt %	0.53	0.62	0.30	0.41	0.36	0.43	0.33
CaO err	0.11	0.11	0.11	0.11	0.11	0.11	0.11
Na_2O wt %	4.43	4.33	4.37	4.18	4.33	3.78	4.09
Na_2O err	0.10	0.10	0.10	0.10	0.10	0.09	0.10
K_2O wt %	4.71	4.41	4.83	4.65	4.75	3.92	4.37
K_2O err	0.06	0.06	0.07	0.06	0.07	0.06	0.06
P_2O_5 wt %	0.04	0.04	0.02	0.02	0.02	0.01	0.01
P_2O_5 err	0.01	0.01	0.01	0.01	0.01	0.01	0.01
LOI %	0.32	0.30	0.29	0.70	0.25	0.14	0.17
Total Majors	100.25	100.38	100.57	100.47	100.76	100.53	100.26
Zn ppm	81.52	89.23	66.57	63.58	70.77	42.92	56.62
Zn err	11.37	9.59	10.60	12.04	11.73	11.94	11.12
Rb ppm	91.97	65.55	102.57	103.69	107.64	78.62	96.03
Rb err	5.16	5.95	6.47	6.46	6.43	5.47	6.52
Sr ppm	51.58	64.66	28.16	30.31	24.97	36.82	32.50
Sr err	4.81	4.48	5.51	5.44	5.62	5.20	5.34
Y ppm	33.52	25.83	44.05	37.38	32.13	30.20	31.60
Y err	7.42	7.32	7.66	9.88	7.41	7.25	7.38
Zr ppm	352.65	342.46	333.78	336.74	319.17	213.43	235.01
Zr err	15.26	15.07	14.87	14.91	14.59	13.07	13.35
Nb ppm	49.77	44.69	55.78	57.49	61.74	36.80	44.61
Nb err	9.04	9.05	10.98	9.12	11.01	8.76	10.78
Ba ppm	277.12	309.50	181.38	185.70	186.56	158.05	143.95
Ba err	48.10	47.44	49.57	49.50	48.99	49.98	50.42
Total Trace wt %	0.12	0.12	0.10	0.10	0.10	0.07	0.08
Total wt %	100.36	100.50	100.67	100.57	100.86	100.61	100.34
Total + LOI	100.69	100.80	100.96	101.28	101.11	100.74	100.51

Appendix B (cont.)

Sample	SHB-CMR-3/51.5	SHB-CMR-4/29.5	SHB-CMR-4/31.7	SHB-CMR-4/34.6	SHB-CMR-4/38.7	SHB-CMR-4/41.7	SHB-CMR-4/43.8
Unit	3	4	4	4	3T	3T	3
Northing	1772403.05	1772262.73	1772262.73	1772262.73	1772262.73	1772262.73	1772262.73
Easting	1618671.66	1618683.58	1618683.58	1618683.58	1618683.58	1618683.58	1618683.58
Elevation	7347.10	7368.90	7366.70	7363.80	7359.70	7356.70	7354.60
SiO_2 wt %	78.16	74.80	74.41	73.93	75.86	76.31	76.84
SiO_2 err	0.83	0.81	0.81	0.81	0.82	0.82	0.82
TiO_2 wt %	0.13	0.25	0.23	0.23	0.18	0.17	0.13
TiO_2 err	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Al_2O_3 wt %	12.00	13.15	13.20	13.51	12.79	12.75	12.52
Al_2O_3 err	0.21	0.21	0.21	0.21	0.21	0.21	0.21
Fe_2O_3T wt %	1.57	2.28	2.17	2.32	1.89	1.83	1.69
Fe_2O_3T err	0.05	0.05	0.05	0.05	0.05	0.05	0.05
MnO wt %	0.06	0.08	0.07	0.07	0.06	0.07	0.05
MnO err	0.01	0.01	0.01	0.01	0.01	0.01	0.01
MgO wt %	-0.11	0.18	0.18	0.21	-0.11	-0.11	-0.11
MgO err		0.10	0.10	0.10			
CaO wt %	0.32	0.61	0.57	0.53	0.28	0.27	0.31
CaO err	0.11	0.11	0.11	0.11	0.11	0.11	0.11
Na_2O wt %	4.16	4.52	4.40	4.35	4.34	4.40	3.99
Na_2O err	0.10	0.10	0.10	0.10	0.10	0.10	0.10
K_2O wt %	4.43	4.68	4.67	4.64	4.81	4.75	4.40
K_2O err	0.06	0.06	0.06	0.06	0.07	0.06	0.06
P_2O_5 wt %	0.01	0.04	0.03	0.03	0.02	0.02	0.01
P_2O_5 err	0.01	0.01	0.01	0.01	0.01	0.01	0.01
LOI %	0.19	0.29	0.30	0.76	0.24	0.21	0.63
Total Majors	100.84	100.59	99.94	99.81	100.23	100.57	99.95
Zn ppm	51.64	65.85	65.20	61.63	67.16	69.03	71.37
Zn err	11.41	10.64	10.69	12.16	10.58	10.48	10.35
Rb ppm	104.14	86.44	83.42	88.11	99.34	93.80	98.95
Rb err	6.42	6.75	5.37	6.72	6.52	6.60	6.50
Sr ppm	29.88	58.85	68.54	58.49	26.57	29.70	34.87
Sr err	5.43	4.62	4.39	4.62	5.56	5.45	5.27
Y ppm	42.52	30.54	36.51	37.67	32.21	39.45	40.53
Y err	9.91	7.41	7.43	7.54	7.39	7.52	7.55
Zr ppm	243.10	372.77	338.20	331.55	342.14	326.15	240.63
Zr err	12.00	18.08	14.99	14.83	15.01	14.71	13.40
Nb ppm	53.12	40.30	54.11	40.67	52.95	46.89	56.15
Nb err	8.98	8.94	9.05	8.92	10.93	8.92	9.02
Ba ppm	134.19	296.33	296.84	291.36	215.51	201.19	138.76
Ba err	50.67	47.56	47.70	47.73	48.93	49.55	50.78
Total Trace wt %	0.08	0.12	0.12	0.11	0.10	0.10	0.09
Total wt %	100.92	100.71	100.06	99.93	100.33	100.67	100.03
Total + LOI	101.11	101.00	100.36	100.69	100.58	100.88	100.66

Appendix B (cont.)

Sample	SHB-CMR-4/46.7	SHB-CMR-4/48.5	SHB-CMR-4/50.1	SHB-CMR-5/31.1	SHB-CMR-5/34.0	SHB-CMR-5/35.1	SHB-CMR-5/37.1
Unit	3	3	3	4	3T	3T	3T
Northing	1772262.73	1772262.73	1772262.73	1772075.21	1772075.21	1772075.21	1772075.21
Easting	1618683.58	1618683.58	1618683.58	1618750.74	1618750.74	1618750.74	1618750.74
Elevation	7351.70	7349.90	7348.30	7366.40	7363.50	7362.40	7360.40
SiO_2 wt %	78.05	77.93	77.92	73.98	74.10	75.93	76.39
SiO_2 err	0.83	0.83	0.83	0.81	0.81	0.82	0.82
TiO_2 wt %	0.12	0.12	0.13	0.24	0.17	0.18	0.18
TiO_2 err	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Al_2O_3 wt %	12.26	12.15	12.10	13.49	12.80	13.04	12.73
Al_2O_3 err	0.21	0.21	0.21	0.21	0.21	0.21	0.21
Fe_2O_3T wt %	1.54	1.61	1.65	2.37	1.93	1.98	1.86
Fe_2O_3T err	0.05	0.05	0.05	0.05	0.05	0.05	0.05
MnO wt %	0.05	0.05	0.05	0.08	0.07	0.07	0.07
MnO err	0.01	0.01	0.01	0.01	0.01	0.01	0.01
MgO wt %	-0.11	-0.11	-0.11	0.23	-0.11	-0.11	-0.11
MgO err				0.10			
CaO wt %	0.28	0.29	0.28	0.49	0.30	0.31	0.29
CaO err	0.11	0.11	0.11	0.11	0.11	0.11	0.11
Na_2O wt %	4.04	4.03	4.05	4.34	4.40	4.43	4.43
Na_2O err	0.10	0.10	0.10	0.10	0.10	0.10	0.10
K_2O wt %	4.42	4.35	4.46	4.61	4.80	4.76	4.79
K_2O err	0.06	0.06	0.06	0.06	0.07	0.07	0.07
P_2O_5 wt %	0.01	0.01	-0.01	0.03	0.02	0.02	0.01
P_2O_5 err	0.01	0.01		0.01	0.01	0.01	0.01
LOI %	0.21	0.29	0.14	0.91	0.44	0.33	0.17
Total Majors	100.78	100.54	100.64	99.84	98.58	100.70	100.74
Zn ppm	59.40	60.40	73.40	73.16	69.99	73.43	56.22
Zn err	12.22	10.92	11.57	10.17	10.42	10.25	11.17
Rb ppm	112.51	102.94	106.19	97.22	103.15	103.36	99.23
Rb err	6.38	6.43	6.43	5.05	6.50	6.47	5.00
Sr ppm	32.23	33.39	34.87	53.25	29.30	28.24	28.37
Sr err	5.35	5.31	5.27	4.75	5.49	5.51	5.50
Y ppm	40.70	33.29	46.94	33.75	38.97	45.37	43.63
Y err	7.55	7.38	7.71	7.48	9.88	7.69	7.58
Zr ppm	234.98	231.49	235.30	335.96	308.69	346.14	335.09
Zr err	11.91	11.86	11.93	14.88	14.43	15.08	14.88
Nb ppm	41.31	46.65	55.17	47.66	41.78	49.56	52.43
Nb err	8.84	8.87	9.00	9.08	10.89	8.97	8.98
Ba ppm	168.02	158.34	158.39	256.83	147.86	186.31	186.52
Ba err	50.21	50.18	50.35	47.73	50.58	49.24	49.59
Total Trace wt %	0.09	0.08	0.11	0.11	0.09	0.10	0.10
Total wt %	100.87	100.62	100.75	99.95	98.67	100.80	100.84
Total + LOI	101.08	100.91	100.89	100.87	99.11	101.13	101.01

Appendix B (cont.)

Sample	SHB-CMR-5/38.6	SHB-CMR-5/39.6	SHB-CMR-5/40.8	SHB-CMR-6/46.5	SHB-CMR-6/48.0	SHB-CMR-6/49.01	SHB-CMR-6/50.2
Unit	3T	3	3	4	3T	3T	3
Northing	1772075.21	1772075.21	1772075.21	1772823.24	1772823.24	1772823.24	1772823.24
Easting	1618750.74	1618750.74	1618750.74	1619258.44	1619258.44	1619258.44	1619258.44
Elevation	7358.90	7357.90	7356.70	7345.70	7344.20	7343.20	7342.00
SiO_2 wt %	75.44	77.81	78.06	75.21	76.05	76.17	77.62
SiO_2 err	0.81	0.83	0.83	0.81	0.82	0.82	0.83
TiO_2 wt %	0.18	0.12	0.12	0.23	0.17	0.18	0.13
TiO_2 err	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Al_2O_3 wt %	13.02	12.09	12.01	12.94	12.80	12.82	11.99
Al_2O_3 err	0.21	0.21	0.21	0.21	0.21	0.21	0.21
Fe_2O_3T wt %	2.08	1.56	1.52	2.12	1.79	1.85	1.62
Fe_2O_3T err	0.05	0.05	0.05	0.05	0.05	0.05	0.05
MnO wt %	0.07	0.06	0.06	0.07	0.08	0.08	0.06
MnO err	0.01	0.01	0.01	0.01	0.01	0.01	0.01
MgO wt %	0.16	-0.11	-0.11	0.15	-0.11	-0.11	-0.11
MgO err	0.10			0.10			
CaO wt %	0.35	0.29	0.28	0.47	0.34	0.29	0.31
CaO err	0.11	0.11	0.11	0.11	0.11	0.11	0.11
Na_2O wt %	4.22	4.18	4.16	4.45	4.47	4.46	4.12
Na_2O err	0.10	0.10	0.10	0.10	0.10	0.10	0.10
K_2O wt %	4.59	4.46	4.41	4.72	4.80	4.81	4.42
K_2O err	0.06	0.06	0.06	0.06	0.07	0.07	0.06
P_2O_5 wt %	0.02	-0.01	-0.01	0.04	0.02	0.01	0.01
P_2O_5 err	0.01			0.01	0.01	0.01	0.01
LOI %	0.71	0.18	0.16	0.19	0.25	0.17	0.16
Total Majors	100.13	100.56	100.62	100.38	100.52	100.67	100.29
Zn ppm	69.56	50.44	51.66	67.60	62.03	66.33	35.93
Zn err	10.44	11.49	11.42	10.56	10.82	10.62	12.39
Rb ppm	110.68	109.26	92.12	99.57	106.08	103.06	100.06
Rb err	6.42	6.39	6.59	5.02	6.47	4.95	6.51
Sr ppm	27.20	29.04	29.30	52.16	33.40	25.66	35.21
Sr err	5.55	5.46	5.45	4.78	5.34	5.60	5.27
Y ppm	46.21	30.58	37.90	44.41	35.74	35.77	37.90
Y err	10.07	7.36	7.46	7.62	7.47	9.78	7.49
Zr ppm	299.75	242.68	235.56	331.60	334.67	349.72	248.34
Zr err	14.30	12.01	13.35	17.38	17.25	17.58	13.52
Nb ppm	47.01	52.00	49.15	43.83	43.81	52.71	45.38
Nb err	10.96	8.93	8.89	8.97	10.82	9.02	8.95
Ba ppm	229.26	168.08	202.10	248.34	166.81	176.77	143.61
Ba err	48.20	49.79	48.92	48.55	49.42	49.58	50.11
Total Trace wt %	0.10	0.08	0.09	0.11	0.10	0.10	0.10
Total wt %	100.23	100.65	100.70	100.50	100.62	100.77	100.38
Total + LOI	100.94	100.83	100.86	100.69	100.87	100.94	100.55

Appendix B (cont.)

Sample	SHB-CMR-6/51.1	SHB-CMR-6/52.1	SHB-CMR-6/52.6	SHB-CMR-6/54.1	SHB-CMR-6/55.0	SHB-CMR-6/56.1	SHB-CMR-6/57.5
Unit	3	3	3	3	3T	3T	3T
Northing	1772823.24	1772823.24	1772823.24	1772823.24	1772823.24	1772823.24	1772823.24
Easting	1619258.44	1619258.44	1619258.44	1619258.44	1619258.44	1619258.44	1619258.44
Elevation	7341.10	7340.10	7339.60	7338.10	7337.20	7336.10	7334.70
SiO_2 wt %	77.86	77.90	78.84	77.54	75.76	75.73	75.91
SiO_2 err	0.83	0.83	0.84	0.83	0.82	0.82	0.82
TiO_2 wt %	0.13	0.12	0.14	0.13	0.18	0.18	0.17
TiO_2 err	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Al_2O_3 wt %	12.06	12.10	11.30	12.04	12.65	12.73	12.73
Al_2O_3 err	0.21	0.21	0.21	0.21	0.21	0.21	0.21
Fe_2O_3T wt %	1.58	1.52	1.67	1.63	1.86	1.87	1.84
Fe_2O_3T err	0.05	0.05	0.05	0.05	0.05	0.05	0.05
MnO wt %	0.06	0.05	0.06	0.06	0.09	0.08	0.08
MnO err	0.01	0.01	0.01	0.01	0.01	0.01	0.01
MgO wt %	-0.11	-0.11	-0.11	-0.11	-0.11	-0.11	-0.11
MgO err							
CaO wt %	0.33	0.28	0.42	0.31	0.27	0.28	0.27
CaO err	0.11	0.11	0.11	0.11	0.11	0.11	0.11
Na_2O wt %	4.19	4.22	3.90	4.22	4.45	4.43	4.47
Na_2O err	0.10	0.10	0.10	0.10	0.10	0.10	0.10
K_2O wt %	4.41	4.51	4.11	4.47	4.88	4.89	4.78
K_2O err	0.06	0.06	0.06	0.06	0.07	0.07	0.07
P_2O_5 wt %	0.01	0.01	0.01	0.01	0.01	0.02	0.02
P_2O_5 err	0.01	0.01	0.01	0.01	0.01	0.01	0.01
LOI %	0.16	0.13	0.12	0.11	0.23	0.16	0.20
Total Majors	100.63	100.70	100.46	100.40	100.15	100.20	100.27
Zn ppm	41.55	45.41	41.57	45.10	50.26	57.67	43.54
Zn err	12.02	11.80	12.03	11.83	11.50	11.10	11.90
Rb ppm	104.90	105.21	72.80	109.34	103.82	112.11	109.23
Rb err	6.47	6.44	5.68	6.43	6.49	6.43	6.45
Sr ppm	37.74	28.55	37.84	34.21	29.02	24.99	25.99
Sr err	5.18	5.47	5.18	5.29	5.49	5.62	5.60
Y ppm	43.08	40.03	26.98	43.11	31.35	37.58	38.51
Y err	9.95	9.85	7.22	9.97	9.74	7.52	9.83
Zr ppm	218.93	230.16	216.07	234.13	314.41	337.48	333.93
Zr err	13.20	13.29	11.72	13.37	14.54	14.94	14.87
Nb ppm	44.13	60.06	32.06	40.87	51.84	47.27	60.72
Nb err	8.96	9.08	8.84	10.83	9.07	8.93	9.19
Ba ppm	211.13	115.13	220.62	192.18	186.13	162.30	176.44
Ba err	48.50	51.62	48.80	49.35	49.55	50.03	49.80
Total Trace wt %	0.09	0.08	0.08	0.09	0.10	0.10	0.10
Total wt %	100.72	100.78	100.53	100.49	100.24	100.30	100.37
Total + LOI	100.88	100.90	100.65	100.59	100.48	100.46	100.57

Appendix B (cont.)

Sample	SHB-CMR-7/44.0	SHB-CMR-7/48.0	SHB-CMR-7/50.5	SHB-CMR-7/54.1	SHB-CMR-8/35.5	SHB-CMR-8/40.0	SHB-CMR-8/44.0
Unit	4	3T	3T	3	4	4	3T
Northing	1772670.59	1772670.59	1772670.59	1772670.59	1772450.24	1772450.24	1772450.24
Easting	1619211.22	1619211.22	1619211.22	1619211.22	1619307.99	1619307.99	1619307.99
Elevation	7350.90	7346.90	7344.40	7340.80	7357.20	7352.70	7348.70
SiO_2 wt %	74.78	76.65	75.69	77.87	74.21	74.57	73.82
SiO_2 err	0.81	0.82	0.82	0.83	0.81	0.81	0.81
TiO_2 wt %	0.23	0.18	0.17	0.13	0.24	0.23	0.18
TiO_2 err	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Al_2O_3 wt %	13.19	12.54	12.75	11.98	13.17	13.36	13.72
Al_2O_3 err	0.21	0.21	0.21	0.21	0.21	0.21	0.21
Fe_2O_3T wt %	2.17	1.87	1.86	1.58	2.31	2.25	2.28
Fe_2O_3T err	0.05	0.05	0.05	0.05	0.05	0.05	0.05
MnO wt %	0.07	0.07	0.07	0.06	0.06	0.06	0.06
MnO err	0.01	0.01	0.01	0.01	0.01	0.01	0.01
MgO wt %	0.16	-0.11	-0.11	-0.11	0.16	0.13	0.22
MgO err	0.10				0.10	0.10	0.10
CaO wt %	0.50	0.31	0.35	0.36	0.50	0.45	0.35
CaO err	0.11	0.11	0.11	0.11	0.11	0.11	0.11
Na_2O wt %	4.49	4.30	4.42	4.08	4.44	4.45	4.17
Na_2O err	0.10	0.10	0.10	0.10	0.10	0.10	0.10
K_2O wt %	4.75	4.77	4.83	4.41	4.68	4.74	4.58
K_2O err	0.06	0.07	0.07	0.06	0.06	0.06	0.06
P_2O_5 wt %	0.04	0.02	0.02	0.01	0.03	0.03	0.02
P_2O_5 err	0.01	0.01	0.01	0.01	0.01	0.01	0.01
LOI %	0.14	0.15	0.17	0.05	0.25	0.23	1.44
Total Majors	100.39	100.71	100.17	100.49	99.80	100.26	99.40
Zn ppm	82.07	76.77	75.79	55.81	73.65	74.86	84.57
Zn err	11.30	11.48	10.14	11.18	10.26	10.20	11.19
Rb ppm	93.14	107.47	104.34	104.19	90.58	92.96	102.12
Rb err	6.63	6.45	6.48	6.46	6.68	5.15	6.50
Sr ppm	54.63	25.92	30.56	32.71	57.27	58.80	29.76
Sr err	4.72	5.58	5.43	5.34	4.65	4.62	5.46
Y ppm	40.50	36.80	35.93	39.51	35.66	37.24	47.42
Y err	7.59	9.87	7.47	7.55	7.49	7.46	10.13
Zr ppm	351.36	327.47	320.22	247.58	371.38	336.20	313.83
Zr err	15.22	14.76	14.63	13.51	15.60	17.44	14.47
Nb ppm	52.37	45.81	47.68	37.95	54.20	45.14	56.93
Nb err	9.03	8.96	10.87	10.78	9.08	8.98	9.13
Ba ppm	243.63	181.56	147.98	134.28	252.85	267.72	238.18
Ba err	48.84	49.71	50.12	50.61	47.98	48.08	47.84
Total Trace wt %	0.11	0.10	0.10	0.08	0.12	0.11	0.11
Total wt %	100.51	100.81	100.26	100.57	99.91	100.38	99.52
Total + LOI	100.65	100.95	100.44	100.62	100.16	100.61	100.95

Appendix B (cont.)

Sample	SHB-CMR-8/46.5	SHB-CMR-8/49.0	SHB-NISC-1/70.0	SHB-NISC-1/73.8	SHB-NISC-1/75.6	SHB-NISC-1/77.1	SHB-NISC-2/72.0
Unit	3	3	4	4	3T	3	4
Northing	1772450.24	1772450.24	1773179.06	1773179.06	1773179.06	1773179.06	1773233.30
Easting	1619307.99	1619307.99	1617595.94	1617595.94	1617595.94	1617595.94	1617903.11
Elevation	7346.20	7343.70	7369.20	7365.40	7363.60	7362.10	7356.10
SiO_2 wt %	77.81	77.52	74.71	75.12	77.30	77.82	75.01
SiO_2 err	0.83	0.83	0.81	0.81	0.83	0.83	0.81
TiO_2 wt %	0.12	0.12	0.25	0.20	0.16	0.13	0.23
TiO_2 err	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Al_2O_3 wt %	11.80	11.94	12.97	12.72	12.36	12.28	13.05
Al_2O_3 err	0.21	0.21	0.21	0.21	0.21	0.21	0.21
Fe_2O_3T wt %	1.48	1.53	2.21	1.91	1.78	1.56	2.09
Fe_2O_3T err	0.05	0.05	0.05	0.05	0.05	0.05	0.05
MnO wt %	0.05	0.06	0.08	0.07	0.06	0.05	0.07
MnO err	0.01	0.01	0.01	0.01	0.01	0.01	0.01
MgO wt %	-0.11	-0.11	0.20	-0.11	-0.11	-0.11	0.15
MgO err			0.10				0.10
CaO wt %	0.27	0.29	0.64	0.40	0.45	0.37	0.48
CaO err	0.11	0.11	0.11	0.11	0.11	0.11	0.11
Na_2O wt %	4.17	4.25	4.33	4.29	4.29	4.23	4.40
Na_2O err	0.10	0.10	0.10	0.10	0.10	0.10	0.10
K_2O wt %	4.45	4.54	4.47	4.70	4.39	4.44	4.67
K_2O err	0.06	0.06	0.06	0.06	0.06	0.06	0.06
P_2O_5 wt %	-0.01	0.01	0.04	0.03	0.02	0.01	0.03
P_2O_5 err		0.01	0.01	0.01	0.01	0.01	0.01
LOI %	0.12	0.11	0.45	0.14	0.08	0.10	0.19
Total Majors	100.16	100.26	99.90	99.43	100.80	100.90	100.18
Zn ppm	54.73	50.48	77.26	65.95	29.86	33.95	70.16
Zn err	11.25	11.49	10.07	10.65	12.81	12.53	11.76
Rb ppm	100.20	108.33	96.31	98.07	82.78	104.05	99.21
Rb err	6.48	6.42	5.08	6.54	5.37	6.44	6.54
Sr ppm	23.57	32.10	76.35	44.84	36.92	35.31	50.30
Sr err	5.65	5.36	4.25	4.99	5.21	5.25	4.83
Y ppm	41.92	37.28	31.28	32.56	40.36	39.65	27.04
Y err	7.57	9.85	7.34	7.43	7.48	7.52	9.76
Zr ppm	250.45	248.83	339.01	341.17	282.49	249.75	360.06
Zr err	13.49	13.49	14.98	15.01	14.00	13.50	15.37
Nb ppm	60.28	55.25	48.17	45.04	57.37	47.71	47.32
Nb err	9.04	10.91	8.97	8.90	10.94	8.86	9.00
Ba ppm	144.13	148.87	315.37	215.29	177.29	144.06	301.54
Ba err	50.30	50.24	48.23	49.41	49.23	50.18	47.39
Total Trace wt %	0.08	0.08	0.13	0.10	0.09	0.08	0.12
Total wt %	100.24	100.34	100.03	99.53	100.89	100.98	100.30
Total + LOI	100.36	100.46	100.48	99.67	100.97	101.08	100.49

Appendix B (cont.)

Sample	SHB-NISC-2/72.5	SHB-NISC-2/73.5	SHB-NISC-2/74.0	SHB-NISC-2/74.3	SHB-NISC-2/75.0	SHB-NISC-2/76.8	SHB-NISC-2/80.2
Unit	4	4	4	4	3	3	3
Northing	1773233.30	1773233.30	1773233.30	1773233.30	1773233.30	1773233.30	1773233.30
Easting	1617903.11	1617903.11	1617903.11	1617903.11	1617903.11	1617903.11	1617903.11
Elevation	7355.70	7354.60	7354.10	7353.80	7353.10	7351.40	7347.90
SiO_2 wt %	76.23	75.68	75.56	76.29	78.17	76.92	78.28
SiO_2 err	0.82	0.82	0.82	0.82	0.83	0.82	0.83
TiO_2 wt %	0.15	0.26	0.28	0.26	0.12	0.12	0.12
TiO_2 err	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Al_2O_3 wt %	12.41	12.31	12.41	12.13	11.91	12.07	11.79
Al_2O_3 err	0.21	0.21	0.21	0.21	0.21	0.21	0.21
Fe_2O_3T wt %	1.54	2.68	2.87	2.74	1.44	1.57	1.46
Fe_2O_3T err	0.05	0.06	0.06	0.06	0.05	0.05	0.05
MnO wt %	0.06	0.09	0.11	0.10	0.05	0.06	0.05
MnO err	0.01	0.01	0.01	0.01	0.01	0.01	0.01
MgO wt %	-0.11	0.22	0.28	0.28	-0.11	-0.11	-0.11
MgO err		0.10	0.10	0.10			
CaO wt %	0.38	0.71	0.79	0.82	0.36	0.40	0.33
CaO err	0.11	0.11	0.11	0.11	0.11	0.11	0.11
Na_2O wt %	4.12	4.26	4.27	4.16	4.00	4.07	4.04
Na_2O err	0.10	0.10	0.10	0.10	0.10	0.10	0.10
K_2O wt %	4.58	4.32	4.26	4.16	4.42	4.38	4.27
K_2O err	0.06	0.06	0.06	0.06	0.06	0.06	0.06
P_2O_5 wt %	0.01	0.03	0.04	0.04	0.01	0.01	0.01
P_2O_5 err	0.01	0.01	0.01	0.01	0.01	0.01	0.01
LOI %	0.18	0.12	0.03	0.12	0.05	0.10	0.10
Total Majors	99.47	100.56	100.86	100.98	100.48	99.59	100.35
Zn ppm	46.91	89.39	61.52	67.97	48.58	26.08	35.80
Zn err	11.71	9.59	10.89	11.90	11.60	13.06	12.41
Rb ppm	91.64	68.96	60.15	66.49	107.30	91.44	104.05
Rb err	5.13	5.85	5.27	5.94	6.41	6.61	6.42
Sr ppm	30.81	63.18	51.23	64.61	33.22	33.11	33.54
Sr err	5.40	4.52	4.82	4.49	5.31	5.33	5.30
Y ppm	43.78	21.55	22.83	21.08	29.83	43.50	31.47
Y err	7.48	7.29	7.20	7.28	7.30	7.56	7.37
Zr ppm	269.13	318.83	306.39	320.98	239.29	253.96	233.55
Zr err	13.76	14.67	14.42	14.68	11.94	12.15	13.28
Nb ppm	60.24	34.16	28.31	33.74	51.93	45.20	56.17
Nb err	9.01	9.00	8.92	8.97	10.75	10.75	8.94
Ba ppm	197.05	237.87	348.67	353.90	144.22	197.48	163.39
Ba err	49.14	49.22	46.63	47.18	49.43	48.53	49.90
Total Trace wt %	0.09	0.10	0.11	0.11	0.08	0.09	0.08
Total wt %	99.56	100.66	100.97	101.09	100.57	99.68	100.44
Total + LOI	99.74	100.78	101.00	101.21	100.62	99.78	100.54

Appendix B (cont.)

Sample	SHB-NISC-3/67.0	SHB-NISC-3/69.5	SHB-NISC-3/70.0	SHB-NISC-3/71.0	SHB-NISC-3/74.5	SHB-NISC-4/70.0	SHB-NISC-4/72.5
Unit	4	4	3T	3T	3	4	3T
Northing	1773115.09	1773115.09	1773115.09	1773115.09	1773115.09	1773058.30	1773058.30
Easting	1617929.48	1617929.48	1617929.48	1617929.48	1617929.48	1617617.11	1617617.11
Elevation	7360.80	7358.30	7357.80	7356.80	7353.30	7369.30	7366.80
SiO_2 wt %	74.46	73.54	76.02	77.01	77.34	75.78	75.09
SiO_2 err	0.81	0.80	0.82	0.82	0.83	0.82	0.81
TiO_2 wt %	0.22	0.21	0.15	0.15	0.11	0.23	0.17
TiO_2 err	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Al_2O_3 wt %	13.09	13.51	12.61	11.85	12.16	13.13	12.50
Al_2O_3 err	0.21	0.21	0.21	0.21	0.21	0.21	0.21
Fe_2O_3T wt %	2.09	2.08	1.55	1.74	1.43	2.10	1.82
Fe_2O_3T err	0.05	0.05	0.05	0.05	0.05	0.05	0.05
MnO wt %	0.08	0.10	0.05	0.09	0.05	0.07	0.07
MnO err	0.01	0.01	0.01	0.01	0.01	0.01	0.01
MgO wt %	0.16	0.17	-0.11	0.17	-0.11	-0.11	-0.11
MgO err	0.10	0.10		0.10			
CaO wt %	0.51	0.60	0.37	0.55	0.36	0.45	0.25
CaO err	0.11	0.11	0.11	0.11	0.11	0.11	0.11
Na_2O wt %	4.43	4.73	4.26	4.09	4.22	4.46	4.44
Na_2O err	0.10	0.11	0.10	0.10	0.10	0.10	0.10
K_2O wt %	4.69	4.71	4.59	4.12	4.38	4.68	4.86
K_2O err	0.06	0.06	0.06	0.06	0.06	0.07	0.07
P_2O_5 wt %	0.03	0.03	0.02	0.02	0.01	0.04	0.02
P_2O_5 err	0.01	0.01	0.01	0.01	0.01	0.01	0.01
LOI %	0.11	0.11	0.07	0.17	0.12	0.19	0.21
Total Majors	99.76	99.68	99.62	99.79	100.05	100.94	99.23
Zn ppm	65.89	61.15	48.01	30.40	42.69	61.18	61.41
Zn err	10.64	10.89	11.64	12.76	11.95	10.90	10.87
Rb ppm	92.44	79.38	87.45	57.24	92.52	91.73	102.75
Rb err	5.15	5.49	5.24	6.24	6.56	5.17	6.50
Sr ppm	52.03	59.72	33.72	54.03	34.54	57.14	23.37
Sr err	4.78	4.58	5.31	4.70	5.27	4.66	5.68
Y ppm	30.76	37.44	38.80	22.09	32.88	40.56	34.89
Y err	7.32	7.44	7.43	7.13	7.37	9.91	9.80
Zr ppm	345.56	313.76	270.83	212.84	219.38	336.57	321.95
Zr err	15.07	14.50	13.82	11.71	11.74	14.93	14.62
Nb ppm	49.81	35.35	41.23	34.63	48.40	47.74	51.78
Nb err	8.94	8.80	8.82	8.76	8.86	9.02	10.89
Ba ppm	263.22	365.48	153.50	303.29	187.95	282.23	162.49
Ba err	48.10	46.68	50.40	47.09	49.12	48.27	50.30
Total Trace wt %	0.11	0.12	0.08	0.09	0.08	0.11	0.10
Total wt %	99.88	99.80	99.70	99.88	100.14	101.05	99.32
Total + LOI	99.99	99.91	99.77	100.05	100.26	101.24	99.53

Appendix B (cont.)

Sample	SHB-NISC-4/74.6	SHB-NISC-4/74.9	SHB-NISC-4/75.0	SHB-NISC-4/75.3	SHB-NISC-4/77.0	SHB-NISC-5/71.1	SHB-NISC-5/72.6
Unit	3T	3T	3	3	3	4	4
Northing	1773058.30	1773058.30	1773058.30	1773058.30	1773058.30	1773148.02	1773148.02
Easting	1617617.11	1617617.11	1617617.11	1617617.11	1617617.11	1617769.11	1617769.11
Elevation	7364.70	7364.40	7364.30	7364.00	7362.30	7361.40	7359.90
SiO_2 wt %	76.02	76.48	76.91	77.71	77.48	75.22	76.16
SiO_2 err	0.82	0.82	0.82	0.83	0.83	0.81	0.82
TiO_2 wt %	0.17	0.15	0.15	0.12	0.12	0.23	0.20
TiO_2 err	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Al_2O_3 wt %	12.86	12.70	12.45	11.94	12.16	13.26	12.65
Al_2O_3 err	0.21	0.21	0.21	0.21	0.21	0.21	0.21
Fe_2O_3T wt %	1.85	1.85	1.78	1.49	1.49	2.03	2.00
Fe_2O_3T err	0.05	0.05	0.05	0.05	0.05	0.05	0.05
MnO wt %	0.12	0.12	0.10	0.07	0.05	0.08	0.07
MnO err	0.01	0.01	0.01	0.01	0.01	0.01	0.01
MgO wt %	-0.11	0.11	0.11	-0.11	-0.11	0.15	0.13
MgO err		0.10	0.10			0.10	0.10
CaO wt %	0.23	0.25	0.30	0.28	0.31	0.51	0.48
CaO err	0.11	0.11	0.11	0.11	0.11	0.11	0.11
Na_2O wt %	4.36	4.29	4.27	4.09	4.19	4.53	4.29
Na_2O err	0.10	0.10	0.10	0.10	0.10	0.10	0.10
K_2O wt %	4.81	4.74	4.55	4.46	4.46	4.73	4.48
K_2O err	0.07	0.06	0.06	0.06	0.06	0.06	0.06
P_2O_5 wt %	0.01	0.01	0.01	-0.01	-0.01	0.03	0.03
P_2O_5 err	0.01	0.01	0.01			0.01	0.01
LOI %	0.17	0.29	0.19	0.12	0.09	0.17	0.18
Total Majors	100.44	100.71	100.62	100.15	100.26	100.78	100.50
Zn ppm	46.92	57.52	45.55	38.52	35.32	65.45	82.68
Zn err	11.72	11.11	11.82	12.23	12.43	10.68	9.84
Rb ppm	118.12	117.89	113.72	101.01	94.56	97.95	87.26
Rb err	6.43	6.41	4.85	6.48	6.57	6.57	5.27
Sr ppm	27.35	24.28	31.73	30.32	33.63	59.68	45.50
Sr err	5.54	5.64	5.38	5.41	5.30	4.59	4.97
Y ppm	39.15	39.02	31.05	42.63	31.08	26.73	30.66
Y err	9.95	9.97	9.78	7.61	7.38	7.34	7.33
Zr ppm	340.18	305.30	267.18	234.39	227.88	350.75	298.10
Zr err	14.98	14.37	13.81	13.33	13.28	15.20	14.30
Nb ppm	54.59	60.45	57.79	41.56	48.49	39.09	39.79
Nb err	9.06	9.15	9.09	8.84	8.88	8.85	10.85
Ba ppm	215.49	167.36	182.10	119.97	139.42	219.51	244.08
Ba err	48.45	49.96	49.67	51.23	50.54	48.67	48.02
Total Trace wt %	0.10	0.10	0.10	0.08	0.08	0.11	0.11
Total wt %	100.54	100.80	100.72	100.23	100.34	100.89	100.60
Total + LOI	100.71	101.09	100.91	100.35	100.43	101.06	100.78

Appendix B (cont.)

Sample	SHB-NISC-5/74.0	SHB-NISC-5/75.5	SHB-NISC-5/77.5	SHB-SCC-1/69.0	SHB-SCC-1/75.0	SHB-SCC-1/77.5	SHB-SCC-1/80.0
Unit	3	3	3	4	4	4	3T
Northing	1773148.02	1773148.02	1773148.02	1773532.61	1773532.61	1773532.61	1773532.61
Easting	1617769.11	1617769.11	1617769.11	1617472.83	1617472.83	1617472.83	1617472.83
Elevation	7358.50	7357.00	7355.00	7371.20	7365.20	7362.70	7360.20
SiO_2 wt %	77.52	77.75	78.05	74.61	74.66	75.09	77.10
SiO_2 err	0.83	0.83	0.83	0.81	0.81	0.81	0.82
TiO_2 wt %	0.12	0.12	0.12	0.24	0.25	0.23	0.15
TiO_2 err	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Al_2O_3 wt %	12.15	12.00	12.01	12.96	13.26	13.14	12.36
Al_2O_3 err	0.21	0.21	0.21	0.21	0.21	0.21	0.21
Fe_2O_3T wt %	1.55	1.50	1.51	2.11	2.20	2.15	1.78
Fe_2O_3T err	0.05	0.05	0.05	0.05	0.05	0.05	0.05
MnO wt %	0.06	0.05	0.06	0.07	0.07	0.07	0.06
MnO err	0.01	0.01	0.01	0.01	0.01	0.01	0.01
MgO wt %	-0.11	-0.11	-0.11	0.17	0.18	0.15	0.11
MgO err				0.10	0.10	0.10	0.10
CaO wt %	0.38	0.35	0.32	0.60	0.66	0.54	0.42
CaO err	0.11	0.11	0.11	0.11	0.11	0.11	0.11
Na_2O wt %	4.18	4.09	4.07	4.52	4.46	4.46	4.24
Na_2O err	0.10	0.10	0.10	0.10	0.10	0.10	0.10
K_2O wt %	4.46	4.40	4.43	4.65	4.58	4.63	4.41
K_2O err	0.06	0.06	0.06	0.06	0.06	0.06	0.06
P_2O_5 wt %	0.01	0.01	-0.01	0.04	0.04	0.04	0.02
P_2O_5 err	0.01	0.01		0.01	0.01	0.01	0.01
LOI %	0.06	0.07	0.10	0.16	0.23	0.28	0.21
Total Majors	100.43	100.28	100.58	99.97	100.36	100.51	100.65
Zn ppm	62.15	45.04	45.19	71.23	81.12	76.27	65.50
Zn err	10.83	11.81	11.81	10.37	11.32	11.50	10.66
Rb ppm	105.92	99.42	97.20	81.25	90.87	97.84	89.79
Rb err	6.42	6.49	6.53	6.86	5.20	6.56	6.67
Sr ppm	33.72	31.86	27.71	66.86	70.45	58.86	44.47
Sr err	5.30	5.36	5.50	4.42	4.36	4.61	4.98
Y ppm	36.44	36.36	41.46	33.41	36.77	37.69	31.90
Y err	7.48	9.84	7.58	7.46	7.43	7.53	9.73
Zr ppm	236.38	220.23	246.79	336.74	345.96	338.99	269.42
Zr err	13.36	11.76	13.46	14.94	15.10	17.44	13.82
Nb ppm	58.22	44.03	45.76	52.29	50.79	51.32	50.45
Nb err	9.00	8.87	8.86	8.98	8.99	9.01	8.97
Ba ppm	163.54	168.45	158.64	340.61	306.15	262.59	273.95
Ba err	49.75	49.53	49.80	47.37	48.23	48.89	48.18
Total Trace wt %	0.09	0.08	0.08	0.12	0.12	0.11	0.10
Total wt %	100.52	100.36	100.66	100.09	100.48	100.62	100.75
Total + LOI	100.58	100.43	100.76	100.25	100.71	100.90	100.96

Appendix B (cont.)

Sample	SHB-SCC-1/81.5	SHB-SCC-1/84.8	SHB-SCC-1/85.3	SHB-SCC-1/91.0	SHB-SCC-2/77.0	SHB-SCC-2/78.0	SHB-SCC-2/79.1
Unit	3	3	3	3	4	4	3T
Northing	1773532.61	1773532.61	1773532.61	1773532.61	1773621.48	1773621.48	1773621.48
Easting	1617472.83	1617472.83	1617472.83	1617472.83	1617818.29	1617818.29	1617818.29
Elevation	7358.70	7355.40	7354.90	7349.20	7353.50	7352.50	7351.50
SiO_2 wt %	77.52	77.46	77.12	76.41	73.88	74.74	76.92
SiO_2 err	0.83	0.83	0.82	0.82	0.81	0.81	0.82
TiO_2 wt %	0.12	0.13	0.13	0.14	0.28	0.25	0.16
TiO_2 err	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Al_2O_3 wt %	11.85	12.04	12.20	12.43	13.51	13.00	12.64
Al_2O_3 err	0.21	0.21	0.21	0.21	0.21	0.21	0.21
Fe_2O_3T wt %	1.51	1.52	1.59	1.69	2.52	2.34	1.68
Fe_2O_3T err	0.05	0.05	0.05	0.05	0.06	0.05	0.05
MnO wt %	0.05	0.06	0.06	0.07	0.08	0.09	0.05
MnO err	0.01	0.01	0.01	0.01	0.01	0.01	0.01
MgO wt %	-0.11	-0.11	-0.11	-0.11	0.28	0.21	-0.11
MgO err					0.10	0.10	
CaO wt %	0.36	0.33	0.34	0.37	0.65	0.56	0.35
CaO err	0.11	0.11	0.11	0.11	0.11	0.11	0.11
Na_2O wt %	4.23	4.24	4.36	4.32	4.09	4.29	4.18
Na_2O err	0.10	0.10	0.10	0.10	0.10	0.10	0.10
K_2O wt %	4.39	4.38	4.53	4.49	4.46	4.52	4.46
K_2O err	0.06	0.06	0.06	0.06	0.06	0.06	0.06
P_2O_5 wt %	-0.01	0.01	0.01	0.01	0.05	0.04	0.02
P_2O_5 err		0.01	0.01	0.01	0.01	0.01	0.01
LOI %	0.04	0.07	0.10	0.08	0.73	0.29	0.28
Total Majors	100.03	100.17	100.34	99.93	99.80	100.05	100.45
Zn ppm	50.27	45.28	60.03	55.63	87.09	76.26	45.59
Zn err	11.51	11.79	10.94	11.20	9.68	11.52	11.81
Rb ppm	90.13	100.33	109.07	109.37	98.13	116.98	89.27
Rb err	5.19	4.98	6.44	6.42	5.05	6.44	6.64
Sr ppm	28.40	33.46	32.19	38.28	78.65	73.94	35.75
Sr err	5.48	5.30	5.36	5.17	4.22	4.30	5.25
Y ppm	32.51	33.44	35.72	27.62	42.68	21.91	37.06
Y err	7.37	7.34	9.88	9.75	7.65	7.36	9.82
Zr ppm	228.88	232.66	234.29	255.20	333.94	321.47	265.91
Zr err	13.29	11.87	11.92	13.64	17.32	14.70	13.73
Nb ppm	47.11	57.16	45.76	53.24	46.44	38.14	50.98
Nb err	8.88	8.93	8.91	9.01	9.00	8.92	8.96
Ba ppm	187.84	144.01	148.71	138.99	343.12	348.92	172.38
Ba err	49.37	50.73	50.25	50.74	46.69	46.73	49.40
Total Trace wt %	0.08	0.08	0.08	0.08	0.13	0.12	0.09
Total wt %	100.11	100.25	100.42	100.01	99.92	100.17	100.54
Total + LOI	100.15	100.32	100.52	100.09	100.65	100.46	100.82

Appendix B (cont.)

Sample	SHB-SCC-2/81.5	SHB-SCC-2/84.0	SHB-SCC-3/70.8	SHB-SCC-3/72.3	SHB-SCC-3/74.2	SHB-SCC-3/76.0	SHB-SCC-3/80.7
Unit	3	3	4	4	3T	3	3
Northing	1773621.48	1773621.48	1773297.36	1773297.36	1773297.36	1773297.36	1773297.36
Easting	1617818.29	1617818.29	1617876.36	1617876.36	1617876.36	1617876.36	1617876.36
Elevation	7349.00	7346.50	7357.30	7355.80	7353.90	7352.10	7347.40
SiO_2 wt %	78.11	78.19	74.36	75.19	77.21	77.26	77.02
SiO_2 err	0.83	0.83	0.81	0.81	0.83	0.83	0.82
TiO_2 wt %	0.12	0.12	0.23	0.23	0.14	0.13	0.13
TiO_2 err	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Al_2O_3 wt %	12.05	11.84	12.86	13.00	12.09	12.46	11.94
Al_2O_3 err	0.21	0.21	0.21	0.21	0.21	0.21	0.21
Fe_2O_3T wt %	1.47	1.51	2.08	2.22	1.63	1.58	1.61
Fe_2O_3T err	0.05	0.05	0.05	0.05	0.05	0.05	0.05
MnO wt %	0.05	0.05	0.09	0.08	0.06	0.05	0.06
MnO err	0.01	0.01	0.01	0.01	0.01	0.01	0.01
MgO wt %	-0.11	-0.11	0.15	0.17	-0.11	-0.11	-0.11
MgO err			0.10	0.10			
CaO wt %	0.30	0.29	0.49	0.59	0.42	0.38	0.36
CaO err	0.11	0.11	0.11	0.11	0.11	0.11	0.11
Na_2O wt %	4.04	3.97	4.37	4.35	4.09	4.23	4.12
Na_2O err	0.10	0.10	0.10	0.10	0.10	0.10	0.10
K_2O wt %	4.32	4.29	4.62	4.42	4.24	4.49	4.38
K_2O err	0.06	0.06	0.06	0.06	0.06	0.06	0.06
P_2O_5 wt %	0.01	0.01	0.04	0.03	0.01	0.01	0.01
P_2O_5 err	0.01	0.01	0.01	0.01	0.01	0.01	0.01
LOI %	0.18	0.14	0.18	0.16	0.20	0.10	0.14
Total Majors	100.46	100.29	99.27	100.28	99.88	100.59	99.64
Zn ppm	45.15	40.68	60.23	64.33	48.59	40.13	46.45
Zn err	11.82	12.09	10.96	10.73	11.61	12.11	11.74
Rb ppm	90.18	109.49	95.48	75.41	79.40	101.58	107.39
Rb err	6.59	6.39	5.09	5.28	6.83	6.46	6.42
Sr ppm	36.21	32.43	48.20	57.24	36.96	32.86	38.08
Sr err	5.21	5.34	4.90	4.65	5.20	5.32	5.17
Y ppm	25.70	36.25	30.66	31.53	27.74	49.48	31.69
Y err	7.24	9.80	7.36	7.32	7.29	9.98	9.78
Zr ppm	221.54	233.76	342.73	322.25	224.08	242.06	239.82
Zr err	11.75	13.32	17.54	14.70	11.81	13.38	13.42
Nb ppm	42.30	47.49	51.73	42.17	39.43	57.08	36.66
Nb err	8.78	8.90	8.99	8.92	8.79	8.96	8.84
Ba ppm	148.95	134.16	287.08	253.16	216.14	143.97	167.97
Ba err	50.28	50.44	47.82	48.59	49.11	50.17	49.94
Total Trace wt %	0.08	0.08	0.11	0.10	0.08	0.08	0.08
Total wt %	100.54	100.37	99.38	100.39	99.96	100.67	99.72
Total + LOI	100.72	100.51	99.56	100.55	100.16	100.77	99.86

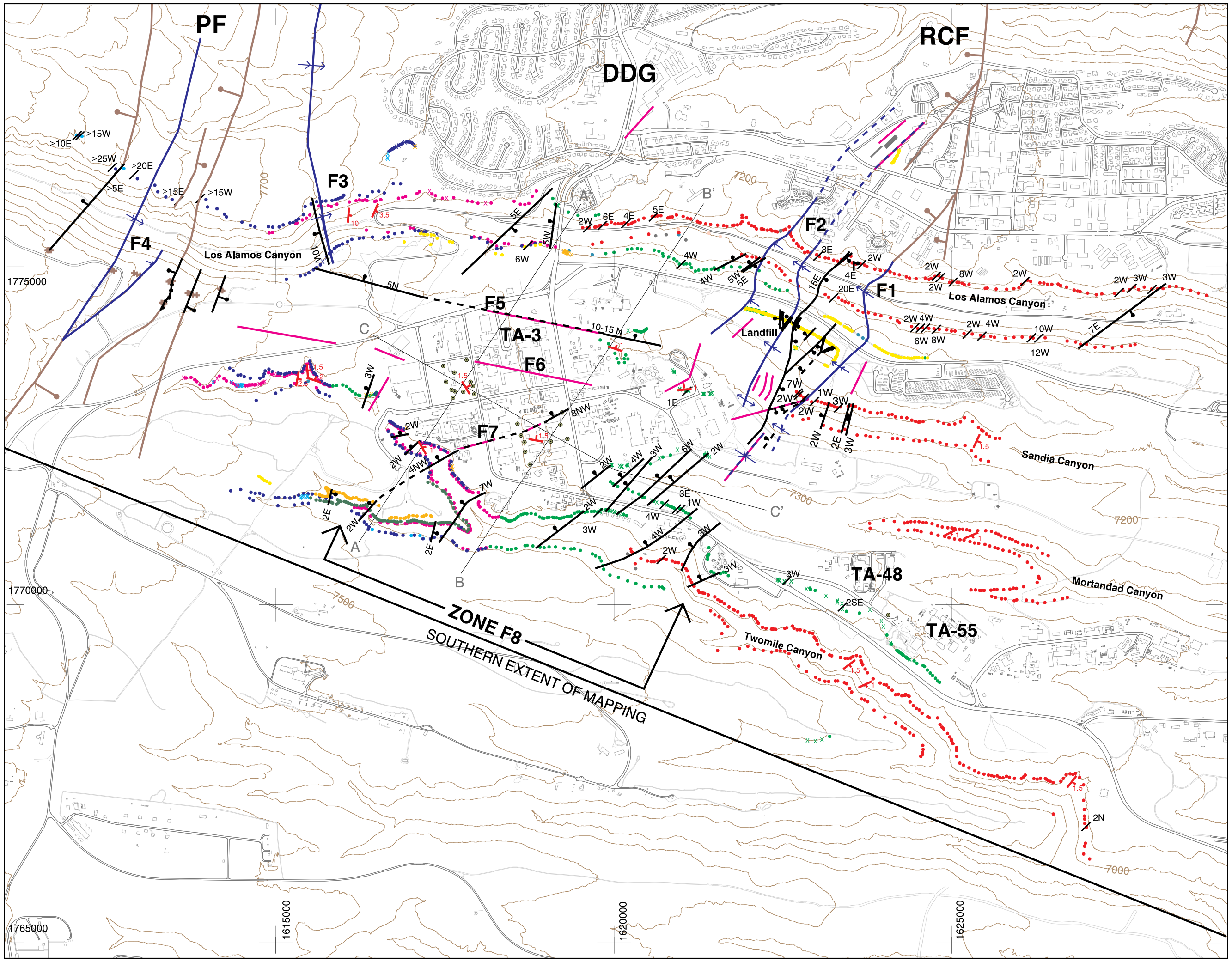
Appendix B (cont.)

Sample	SHB-SCC-4/74.0	SHB-SCC-4/75.5	SHB-SCC-4/77.4	SHB-SCC-4/78.5	SHB-SCC-4/81.5	SHB-SCC-5/74.7	SHB-SCC-5/75.2
Unit	4	4	4	3T	3	4	4
Northing	1773296.73	1773296.73	1773296.73	1773296.73	1773296.73	1773433.34	1773433.34
Easting	1617515.47	1617515.47	1617515.47	1617515.47	1617515.47	1617634.30	1617634.30
Elevation	7367.90	7366.40	7364.50	7363.40	7360.40	7361.00	7360.50
SiO_2 wt %	74.27	74.27	75.27	75.67	77.46	75.09	74.48
SiO_2 err	0.81	0.81	0.81	0.82	0.83	0.81	0.81
TiO_2 wt %	0.25	0.25	0.21	0.18	0.14	0.21	0.22
TiO_2 err	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Al_2O_3 wt %	13.36	13.37	12.99	12.51	12.39	12.86	12.99
Al_2O_3 err	0.21	0.21	0.21	0.21	0.21	0.21	0.21
Fe_2O_3T wt %	2.20	2.35	2.06	1.90	1.65	1.94	1.96
Fe_2O_3T err	0.05	0.05	0.05	0.05	0.05	0.05	0.05
MnO wt %	0.07	0.07	0.07	0.07	0.06	0.06	0.07
MnO err	0.01	0.01	0.01	0.01	0.01	0.01	0.01
MgO wt %	0.19	0.22	0.15	0.14	-0.11	0.12	0.14
MgO err	0.10	0.10	0.10	0.10		0.10	0.10
CaO wt %	0.63	0.56	0.50	0.50	0.41	0.50	0.52
CaO err	0.11	0.11	0.11	0.11	0.11	0.11	0.11
Na_2O wt %	4.34	4.17	4.44	4.28	4.35	4.31	4.46
Na_2O err	0.10	0.10	0.10	0.10	0.10	0.10	0.10
K_2O wt %	4.65	4.54	4.68	4.44	4.59	4.66	4.66
K_2O err	0.06	0.06	0.06	0.06	0.06	0.06	0.06
P_2O_5 wt %	0.04	0.04	0.03	0.02	0.01	0.03	0.04
P_2O_5 err	0.01	0.01	0.01	0.01	0.01	0.01	0.01
LOI %	0.28	0.62	0.15	0.12	0.13	0.16	0.12
Total Majors	100.01	99.84	100.38	99.71	101.06	99.79	99.54
Zn ppm	78.83	80.56	85.59	70.61	60.74	62.89	62.75
Zn err	10.01	9.94	9.72	10.40	10.92	10.80	10.80
Rb ppm	86.81	98.51	91.12	80.10	96.07	93.12	93.98
Rb err	6.75	6.57	5.18	6.83	6.56	5.13	5.12
Sr ppm	73.11	63.03	48.38	49.83	34.88	43.65	58.61
Sr err	4.31	4.52	4.89	4.83	5.28	5.02	4.61
Y ppm	32.20	36.23	28.54	28.55	39.56	25.00	21.71
Y err	7.44	7.56	7.31	7.33	7.57	9.64	7.20
Zr ppm	338.40	343.65	322.66	291.25	254.48	341.40	332.22
Zr err	14.99	15.09	14.71	14.15	13.63	15.03	14.86
Nb ppm	37.17	45.45	51.32	35.06	49.52	44.96	34.23
Nb err	8.88	8.99	9.00	8.83	8.94	8.93	8.80
Ba ppm	282.06	329.52	244.24	215.69	173.00	248.96	306.94
Ba err	48.16	47.17	48.73	49.28	50.05	48.17	47.30
Total Trace wt %	0.12	0.12	0.11	0.10	0.09	0.11	0.11
Total wt %	100.13	99.96	100.49	99.80	101.15	99.89	99.65
Total + LOI	100.41	100.58	100.64	99.92	101.28	100.05	99.77

Appendix B (cont.)

Sample	SHB-SCC-5/75.8	SHB-SCC-5/76.5	SHB-SCC-5/78.2
Unit	4	3T	3
Northing	1773433.34	1773433.34	1773433.34
Easting	1617634.30	1617634.30	1617634.30
Elevation	7359.90	7359.20	7357.50
SiO_2 wt %	74.63	75.21	77.88
SiO_2 err	0.81	0.81	0.83
TiO_2 wt %	0.22	0.19	0.12
TiO_2 err	0.01	0.01	0.01
Al_2O_3 wt %	12.85	12.79	11.81
Al_2O_3 err	0.21	0.21	0.21
Fe_2O_3T wt %	2.10	2.10	1.48
Fe_2O_3T err	0.05	0.05	0.05
MnO wt %	0.07	0.07	0.05
MnO err	0.01	0.01	0.01
MgO wt %	0.15	0.19	-0.11
MgO err	0.10	0.10	
CaO wt %	0.53	0.59	0.37
CaO err	0.11	0.11	0.11
Na_2O wt %	4.40	4.28	4.16
Na_2O err	0.10	0.10	0.10
K_2O wt %	4.63	4.34	4.33
K_2O err	0.06	0.06	0.06
P_2O_5 wt %	0.04	0.03	0.01
P_2O_5 err	0.01	0.01	0.01
LOI %	0.14	0.27	0.10
Total Majors	99.62	99.78	100.22
Zn ppm	72.69	75.72	44.22
Zn err	10.29	10.14	11.86
Rb ppm	94.88	82.99	91.53
Rb err	6.61	5.39	5.15
Sr ppm	55.65	55.83	35.56
Sr err	4.69	4.68	5.24
Y ppm	37.59	27.96	27.38
Y err	7.54	7.31	7.24
Zr ppm	337.99	269.04	214.69
Zr err	14.96	13.87	11.69
Nb ppm	41.06	44.36	44.36
Nb err	8.92	8.95	8.82
Ba ppm	243.73	306.92	158.82
Ba err	48.50	47.46	50.03
Total Trace wt %	0.11	0.11	0.08
Total wt %	99.73	99.89	100.29
Total + LOI	99.87	100.16	100.39

PLATE 1: MAP OF GEOLOGIC FEATURES



LEGEND

Faults (this study; with >5ft at county landfill; ball and bar on downthrown block)
- faults
- inferred faults
- Previously Mapped Faults (ball and bar on downthrown block)
- Faults of undetermined orientation (apparent strike is arbitrary)
- Mapped Faults at Mesa Library and 2500 Central (see Appendix A-2)
- Top Hinge of Monocline
- Bottom Hinge of Monocline
- Anticline
- Syncline
- Aerial Photograph Lineaments

Surveyed Points
- Quaternary Terrace Deposits
- Bandelier Tuff-Mesa-top Alluvium Contact
- Surge within Unit 4
- Welding Break within Unit 4
- Surge at Unit 3-Unit 4 Contact
- Unit 3-Unit 4 Contact
- Surge at Unit 3T-Unit 4 Contact
- Unit 3T-Unit 4 Contact
- Surge at lower 3T-upper 3T Contact
- Lower 3T-Upper 3T Contact
- Surge within Unit 3T
- Within Unit 3T
- Surge at Unit 3-Unit 3T Contact
- Unit 3-Unit 3T Contact
- Within Unit 3
- Unit 2-Unit 3 Contact
- Within Unit 2
- Seismic Hazards Boreholes

Surveyed Points at Trenches
- Faults
- Trenches
- 100-Foot Contour Lines
- Cross Section Lines (see Figure 9 for cross sections)
- Strike and Dip of Contacts

3W Amount and sense of vertical offset on the Bandelier Tuff (eg. 3W = 3 feet of vertical offset down to the West); for faults at county landfill, see Figure 14

F7 Geologic Features discussed in text

N S E W

1000 0 1000 2000 3000 Feet

Grid is in State Plane Coordinate System (in feet), New Mexico Central Zone, 1983 North American Datum
Mapping by Jamie Gardner, Giday WoldeGabriel, Alexis Lavine, David Vaniman, Donathon Krier, Claudia Lewis, Peggy Reneau, M.J. Snow, and Emily Kluk.

NOTE: Because spatial accuracy of surveyed geologic features on this map exceeds the accuracy of the base map (i.e. topography, roads, buildings), enlargement of this map is inappropriate.

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