ATTACHMENT
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November 11, 1999

ADaPT Job No. WA99-3006

American Tower Corporation
6613 South 192nd Place, Suite K-102
Kent, Washington 98032

Attention: Mr. Larry Smith

Subject: Geotechnical Engineering Evaluation
Proposed Rock Candy/Capitol Peak Communications Tower
American Tower Site Number WRN13/40463
Northwest ¼ of Section 31, Township 18 North, Range 3 West
Thurston County, Washington

Dear Mr. Smith:

Pursuant to your request, ADaPT Engineering, Inc. (ADaPT) is pleased to submit this report describing our recent geotechnical engineering evaluation for the above-referenced site. The purpose of this study was to interpret general surface and subsurface site conditions, from which we could evaluate the feasibility of the project and formulate design recommendations concerning site preparation, equipment pad and tower foundations, structural fill, and other considerations. Our scope of services consisted of a surface reconnaissance, a subsurface exploration, geotechnical analyses, and report preparation. Authorization to proceed with our study was provided in a Notice to Proceed from Sturman Architects, Inc. on behalf of American Tower Corporation, dated October 29, 1999. This report has been prepared for the exclusive use of American Tower Corporation, Sturman Architects, Inc., and their agents, for specific application to this project in accordance with generally accepted geotechnical engineering practice.

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This report is provided for the information of the client only. Reproduction and transmittal of this report or any section of this report, to a third party, by any means, except in full, without the written permission of ADaPT Engineering, Inc. is prohibited.

We appreciate the opportunity to be of service to you. If you have any questions, or if we can be of further assistance to you, please contact us at (206) 654-7045.

ADaPT Engineering, Inc.

Respectfully submitted,

Ngoc H. Vu

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Geotechnical Engineer

K. V. Lew, P. Eng.
Senior Geotechnical Engineer

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Senior Geotechnical Engineer
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KVL/nhv

Attachments:	Figure 1	Location Map
	Figure 2	Site and Exploration Plan
	Appendix A	Test Pit Logs TP-1 and TP-2

AMERICAN TOWER CORPORATION

Geotechnical Engineering Evaluation

Proposed Rock Candy Communication Tower
American Tower Site # WRN13/40463
NW 1/4 of S 31, T 18 N, R 3 W
Thurston County, Washington

WA99-3006
November 1999

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PROJECT DESCRIPTION

The host parcel is located approximately 7.5 miles from Rock Candy Road, south of State Highway 8, in Thurston County, Washington. The host property is timberland owned by Washington State Department of Natural Resources (DNR). The proposed tower site is a 35 by 100-foot parcel situated on top of a ridge at the end of an existing logging road. The proposed tower site area is fairly level. However, the topography of the surrounding area drops down on order of 30 to 40 percent grades to the north, east, and west of the site. The ground surface is covered with approximately 1-foot of coarse gravel (roadbase). The proposed tower site can be accessed via a net work of logging roads. At time of our test pit exploration program, we observed ongoing construction along the last ¼ mile of access road alignment leading to the proposed tower site. We understand American Tower Corporation proposes to construct a 250-foot self supporting three-legged lattice communication tower and associated cellular support equipment building or cabinets. The project site and surrounding area are shown on the attached site vicinity map (Location Map, Figure 1). The attached Site and Exploration Plan (Figure 2) shows the approximate location of the proposed cellular tower lease area in relation to other site features.

It should be emphasized that the conclusions and recommendations contained in this report are based on our understanding of the currently proposed utilization of the project site, as derived from written and verbal information supplied to us by American Tower Corporation and Sturman Architects. Consequently, if any changes are made to the project, we recommend that we review the changes and modify our recommendations, if appropriate, to reflect those changes.

EXPLORATORY METHODS

We explored surface and subsurface conditions at the project site on November 9, 1999. Our surface exploration consisted of a visual site reconnaissance. Our subsurface exploration consisted of advancing two exploratory test pits, designated as TP-1 and TP-2, to a depth of 3 feet below the existing site grade. The location of test pits TP-1 and TP-2 are shown on the attached Site and Exploration Plan (Figure 2).

The specific locations and depths of the exploration performed were selected in relation to the proposed site features, under the constraints of budget and site access. The location of the test pits and other features shown on Figure 2 were obtained by hand taping from existing site features. As such, the exploration location shown on Figure 2 should be considered accurate to the degree implied by the measuring methods used.

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Boring Methods

We explored surface and subsurface conditions at the project site on November 9, 1999. Our surface exploration consisted of a visual site reconnaissance. Our subsurface exploration consisted of the excavation of two exploratory test pits at the location of the proposed tower site area using a rubber tire backhoe. The backhoe was operated by an independent company working under subcontract to ADaPT. A geotechnical engineer from our firm continuously observed the test pit, obtained representative soil samples, and logged the subsurface conditions. After the test pits were completed, the test pits were backfilled with a native soil.

The purpose of the test pit excavation was to expose the subsurface soils condition at the tower location, examine the conditions of native soils and underlying bedrock at the site, and evaluate the feasibility of constructing the proposed 250 feet self-supporting lattice tower at this location.

SITE CONDITIONS

The following sections describe our observations, measurements, and interpretations concerning surface, soil, groundwater, and seismic conditions at the project site.

Surface Conditions

The host parcel is located approximately 7.5 miles from Rock Candy Road, south of State Highway 8, in Thurston County, Washington. The host property is timberland owned by Washington State Department of Natural Resources (DNR). The proposed tower site is a 35 by 100-foot parcel situated on top of a ridge at the end of an existing logging road. The proposed tower site area is fairly level. However, the topography of the surrounding area drops down on order of 30 to 40 percent grades to the north, east, and west of the site. The ground surface is covered with approximately 1-foot of coarse gravel (roadbase). The proposed tower site can be accessed via a net work of logging roads. At time of our test pit exploration program, we observed ongoing construction along the last ¼ mile of access road alignment leading to the proposed tower site. We understand American Tower Corporation proposes to construct a 250-foot self supporting three-legged lattice communication tower and associated cellular support equipment building or cabinets. The project site and surrounding area are shown on the attached site vicinity map (Location Map, Figure 1). The attached Site and Exploration Plan (Figure 2) shows the approximate location of the proposed cellular tower lease area in relation to other site features.

Subsurface Conditions

Surficial soils encountered at the test pits location consisted of about one foot thickness of coarse gravel (roadbase) over native medium dense to dense sandy silt/silty sand with fractured rock. We observed the ongoing placement of approximately 1-foot coarse gravel (roadbase) over the last ¼ mile along the access roadway alignment to the proposed tower site during our exploratory fieldwork. Hard digging conditions were encountered due to oversize fractured rock. The test pits were terminated at 3 feet bgs due to refusal to further excavation due to hard fractured bedrock. Basalt rock was noted in outcrop at several locations in roadway exposures on the way to the lease area. We interpret native soils encountered at the proposed tower lease area as Katula, very cobbly loam overlying bedrock at shallow depth, based on visual observation and the Soil Survey of Thurston County Area published by United States Department of Agriculture, Soil Conservation Service (SCS).

Groundwater was not encountered at time of excavation. Site conditions are conducive to development 'perched' groundwater. It should be recognized that groundwater levels could fluctuate due to factors such as seasonal changes, precipitation or future site utilization.

Seismic Conditions

According to the Seismic Zone Map of the United States contained in Figure 16-2 of the 1997 Uniform Building Code (UBC), the project site lies within Seismic Risk Zone 3. Based on our subsurface exploration, we interpret the site conditions to correspond to a seismic Soil Profile type S_B, for Rock, as defined by Table 16-J of the 1997 Uniform Building Code, based on the interred shear wave velocity for rock deposits of this type. Soil Profile type S_B applies to a profile consisting of a rock-like material characterized by a shear-wave velocity between 2,500 to 5,000 feet per second (760 to 1,500 m/s) or other suitable means of classification.

CONCLUSIONS AND RECOMMENDATIONS

Current development plans call for construction of a 250-foot three-legged lattice tower and associated cellular equipment cabinets. Based on the subsurface conditions encountered in our exploration, we recommend that the proposed lattice tower be supported on a mat foundation. Design criteria for compressive, uplift and lateral support of mat foundations are presented below. Our specific recommendations concerning site preparation, foundation support for equipment cabinets or building, tower foundations, access driveway and structural fill are presented in the following report sections.

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Site Preparation

Site preparation will involve removal of near surface soil, grading, and preparing subgrades. The following comments and recommendations apply to site preparation:

Clearing and Grubbing: We do not anticipate that significant grade changes will be required to achieve proposed site grades. At this location, site preparation will largely consist of grading, followed by foundation preparation for the three-legged lattice tower and cellular equipment building or cabinet platforms. Backfill materials, where required, should be placed and compacted according to the recommendations presented in the Structural Fill section of this report. In our opinion, site excavations may be accomplished with conventional earthwork equipment, such as a trackhoe.

Wet Conditions: Because of the high silt content of the existing near surface native site soils below the road base, these soils are both moisture-sensitive and prone to disturbance when wet. The contractor should minimize traffic above the prepared subgrade areas to minimize disturbance and softening which would require removal of the unstable soils. During wet conditions, the use of a working surface of quarry spalls or clean sand and gravel may be required to protect the subgrade, especially from vehicular traffic.

Frozen Subgrades: If earthwork takes place during freezing conditions, we recommend that all exposed subgrades be allowed to thaw and be recompacted prior to placing subsequent lifts of structural fill.

Equipment Building or Cabinet Foundation

It is our understanding that the foundation for the proposed equipment building or cabinets will consist of a poured in place concrete slab-on-grade with thickened edges. We anticipate that the pad bearing pressure will be relatively light. However, we recommend that the thickened slab edges be designed as spread footings. Depending on where the cabinets are to be located, up to 3 feet of medium dense to dense sandy silt/silty sand with fractured rock may be present above fractured bedrock. However, bedrock is exposed in outcrop at the ground surface in the vicinity of the proposed tower site. Several foundation options are possible. As the weight of the cabinets is negligible, one option would be to support the cabinets on the towers mat foundation. If a separate foundation is desired, depending on the location selected, foundations bearing on either rock or the existing soil are possible. The following report section discusses spread footing support assuming fill is present below the cabinet location. If rock is present at depths above 1.5 feet below finish grades, the foundations may be supported directly on the rock.

Subgrade Conditions: If it is necessary to construct a new foundation, the proposed equipment pad may be supported by thickened slab edges extended to bear on the existing sandy silt/silty sand with fractured

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bedrock soils encountered at the site, after they have been compacted in place resulting in a firm and unyielding subgrade condition, or upon structural fill placed above similarly prepared soils. We anticipate the subsoil encountered at the proposed foundation grade will likely consist of medium dense to dense silty sand/sandy silt with fractured rock. The surficial soils were noted contain a significant amount of fractured rock. We recommend the condition of the bearing soils be evaluated at the time of construction. Depending on the time of year that construction proceeds, it may be possible to compact the soils in place. Some overexcavation may be necessary if excessively soft or wet subgrade conditions were to be encountered at the foundation design grade levels. Footings should never be cast atop soft, loose, organic, or frozen soils; nor atop subgrades covered by standing water. A representative from ADaPT should be retained to observe the condition of footing subgrades before concrete is poured to verify that they have been adequately prepared.

Footing Dimensions: We recommend that the thickened edge of the slab be designed as a spread footing and be constructed to have a minimum width of 12 inches. For frost protection, the footings should penetrate at least 18 inches below the lowest adjacent exterior grades, if founded in soil, or supported directly above bedrock. Footings may be supported on structural fill placed on prepared soil or rock subgrade. The horizontal limits of the fill pad below the building or cabinet foundation may be established by extending a line outward from the base of the thickened slab at an angle of 1 Horizontal: 1Vertical (1H: 1V) down to the upper surface of the bearing horizon.

Bearing Pressure: At the location of the cabinet foundation, the near surface soil should be stripped, excavated to a depth of at least 18-inches below the lowest adjacent grade. If soils extend to that depth, the soils at that elevation should be compacted in place if the moisture content allows, resulting in a firm and unyielding subgrade condition. Alternatively, the cabinets could be supported directly above bedrock, if encountered at depths less than 1.5 feet below finish grades, or above a maximum thickness of two feet of compacted fill, underlain by a layer of geotextile (filter fabric), if required. A maximum allowable soil bearing pressure of 1,500 pounds per-square-foot can be used for static footing loads. This bearing pressure can be increased by one-third to accommodate transient wind or seismic loads. An allowable base friction coefficient of 0.38 and an allowable passive earth pressure of 300 pounds per cubic foot (pcf), expressed as an equivalent fluid unit weight, may be used for that portion of the foundation embedded more than 1 foot below finished exterior subgrade elevation.

Settlements: We estimate that total post-construction settlements of properly designed footings bearing on properly prepared subgrades could approach 1-inch, with differential settlements approaching one-half of the total.

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Access Driveway

The existing network of gravel logging roads beginning at Rock Candy Road off of State Highway 8 can be used as a construction access driveway, therefore construction of an access driveway does not appeared to be required. We noticed the ongoing placement of coarse gravel of the last ¼ mile access road leading to the proposed tower site, at time of test pits exploration.

Tower Mat Foundations

The tower may be supported by three individual mat foundations, or alternatively by a single pad supporting all three tower legs. It would appear that the single pad alternatively would reduce the amount of forming required, and may be more suitable to resist the uplift forces and overturning moments. Vertical compressive loads could be resisted by conventional mat foundation bearing directly on bedrock. All surficial loose soils must be removed to expose the bedrock surface. For design purposes, we recommend the use of an assumed value for the maximum allowable bearing capacity for the bedrock of equal to 8,000 pounds per square foot (psf). This bearing pressure can be increased by one-third to accommodate transient wind or seismic loads. An allowable coefficient of base friction (concrete on rock) of 0.65 is recommended. If compacted granular backfill were to be utilized around the mat foundation to achieve a level surface grade, an allowable passive earth pressure of 300 pounds per cubic foot (pcf), expressed as an equivalent fluid unit weight, may be used for that portion of the foundation embedded more than 1 foot below finished exterior grade elevation. The passive pressure would apply for the condition of a level compacted granular fill extending at least 1.5 times the depth of the foundation embedment in all directions.

We recommend that vertical uplift forces be resisted by gravity forces (i.e. the dead weight of the mat), in addition to using rock bolts, as necessary. The rock bolts are generally installed in small-diameter drilled holes advanced using percussive or air rotary techniques. We recommend the bolts be at least 10-feet long measuring from the bottom side of the mat foundation and penetrate at least 6-feet into sound rock. We recommend the anchors be limited to a design capacity equal to 20-psi applied at the interface of the anchor and sound rock. The condition of the rock needs to be confirmed at the time the anchors are installed. Should extensive thickness of fractured rock be encountered, the design can be field-modified to suit the actual conditions encountered during installation. This would entail the use of a lower adhesion value, or the lengthening of the bolt. The use of strand anchors versus bar anchors would be more flexible to accommodate potential variations in anchor length.

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Tower Drilled Pier Foundations

Due to hard bedrock encountered at shallow depth, we are not recommending a drilled pier foundation. Owing to the limited soil cover and the specialized equipment to drill large diameter piers in rock, it would likely not be economical to construct a drilled pier foundations at this location.

Structural Fill

The following comments, recommendations, and conclusions regarding structural fill are provided for design and construction purposes:

Materials: Structural fill includes any fill materials placed under footings, pavements, driveways, and other such structures. Typical materials used for structural fill include: clean, well-graded sand and gravel (pit-run); clean sand; crushed rock; controlled-density fill (CDF); lean-mix concrete; and various soil mixtures of silt, sand, and gravel. Recycled concrete, asphalt, and glass, derived from pulverized parent materials may also be used as structural fill.

Placement and Compaction: Generally, CDF, and lean-mix concrete do not require special placement and compaction procedures. In contrast, pit-run, sand, crushed rock, soil mixtures, and recycled materials should be placed in horizontal lifts not exceeding 8 inches in loose thickness, and each lift should be thoroughly compacted with a mechanical compactor. Using the modified Proctor maximum dry density (ASTM: D-1557) as a standard, we recommend that structural fill used for various on-site applications be compacted to the following minimum densities:

Fill Application	Minimum Compaction
Slab/Footing subgrade	90 percent
Gravel drive subgrade (upper 1 foot)	95 percent
Gravel drive subgrade (below 1 foot)	90 percent

Subgrades and Testing: Regardless of location or material, all structural fill should be placed over firm, unyielding subgrade soils. We recommend that a representative from ADaPT be retained to observe the condition of subgrade soils before fill placement begins, and to perform a series of in-place density tests during soil fill placement. In this way, the adequacy of soil compaction efforts may be evaluated as earthwork progresses.

Fill Content: Soils used for structural fill should not contain individual particles greater than about 6 inches in diameter and should be free of organics, debris, and other deleterious materials. Given these prerequisites, the suitability of soils used for structural fill depends primarily on the grain-size distribution

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and moisture content of the soils when they are placed. When the "fines" content (that soil fraction passing the U.S. No. 200 Sieve) increases, soils become more sensitive to small changes in moisture content. Soils containing more than about 5 percent fines (by weight) cannot be consistently compacted to a firm, unyielding condition when the moisture content is more than about 2 percentage points above optimum. The existing native near-surface soils at this site consist of silty sand/sandy silt with fractured rock, contain an elevated fines content, and should be considered highly moisture sensitive. The gravel roadbase fill above the native soils are predominantly granular in nature, and are less moisture-sensitive. The use of "clean" soil is necessary for fill placement during wet-weather site work, or if the in-situ moisture content of the silty sand/sandy silt with fractured rock soils is too high to allow adequate compaction. Clean soils are defined as granular soils that have a fines content of less than 5 percent (by weight) based on the soil fraction passing the U.S. No.3/4-inch Sieve.

CLOSURE

The conclusions and recommendations presented in this report are based, in part, on the exploration that we performed for this study. If variations in subsurface conditions are discovered during earthwork, we may need to modify this report. The future performance and integrity of the tower foundation will depend largely on proper initial site preparation, drainage, and construction procedures. Monitoring by experienced geotechnical personnel should be considered an integral part of the construction process. We are available to provide geotechnical engineering services during the earthwork and foundation construction phases of the project. If variations in the subgrade conditions are observed at that time, we would be able to provide additional geotechnical recommendations, thus minimizing delays as the project develops. We are also available to review preliminary plans and specifications before construction begins, and to provide geotechnical inspection and testing services during construction.

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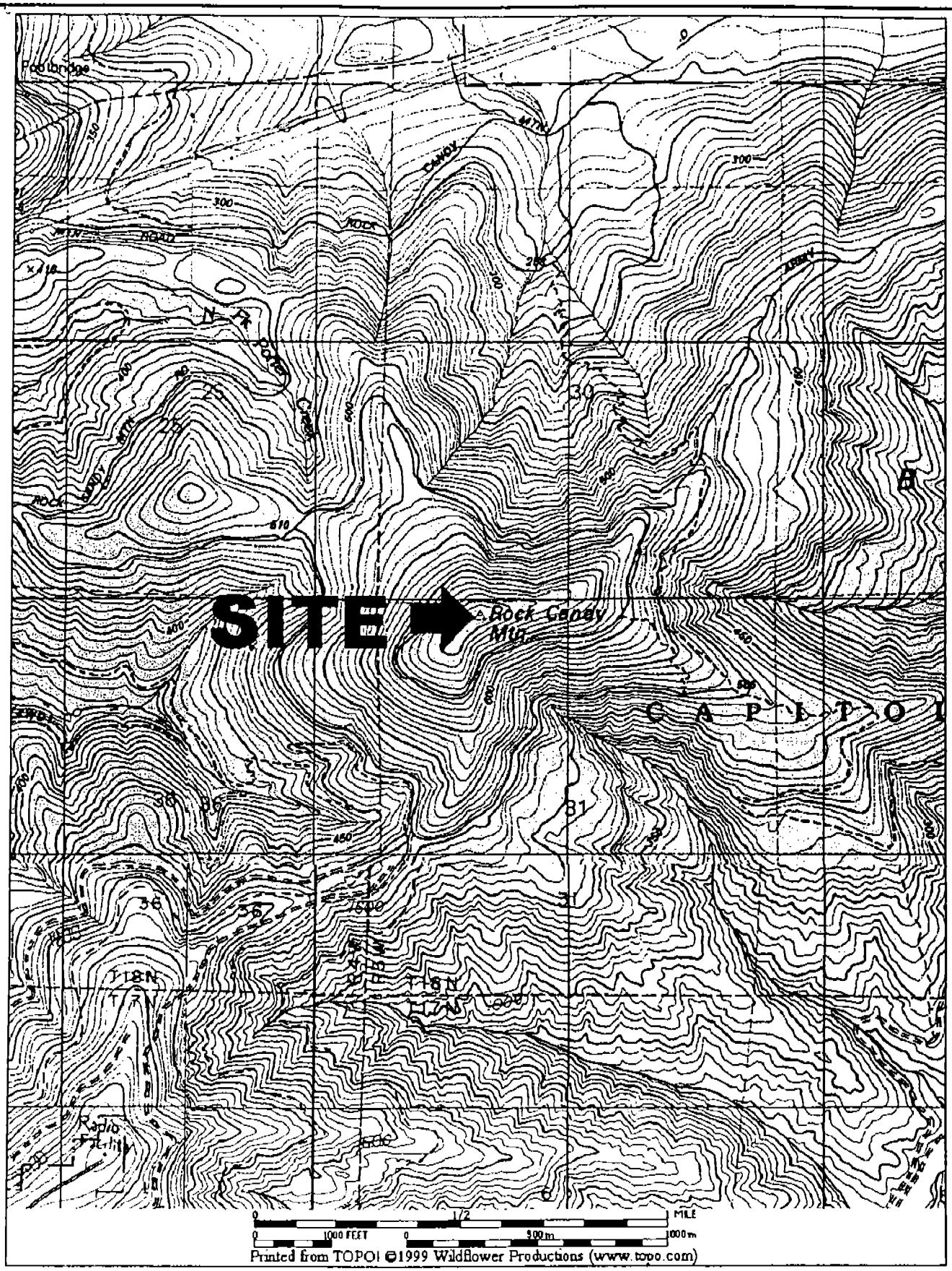

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FIGURE 1 - Location/Topographic Map

Location : Capitol Peak / Rock Candy WRN-13/40463
NW 1/4 of SEC 31, T 18 N, R 3 W
Thurston County, Washington

Client : American Tower Corp.

Date : 11/12/99 **Job #** S-WA-99-3006

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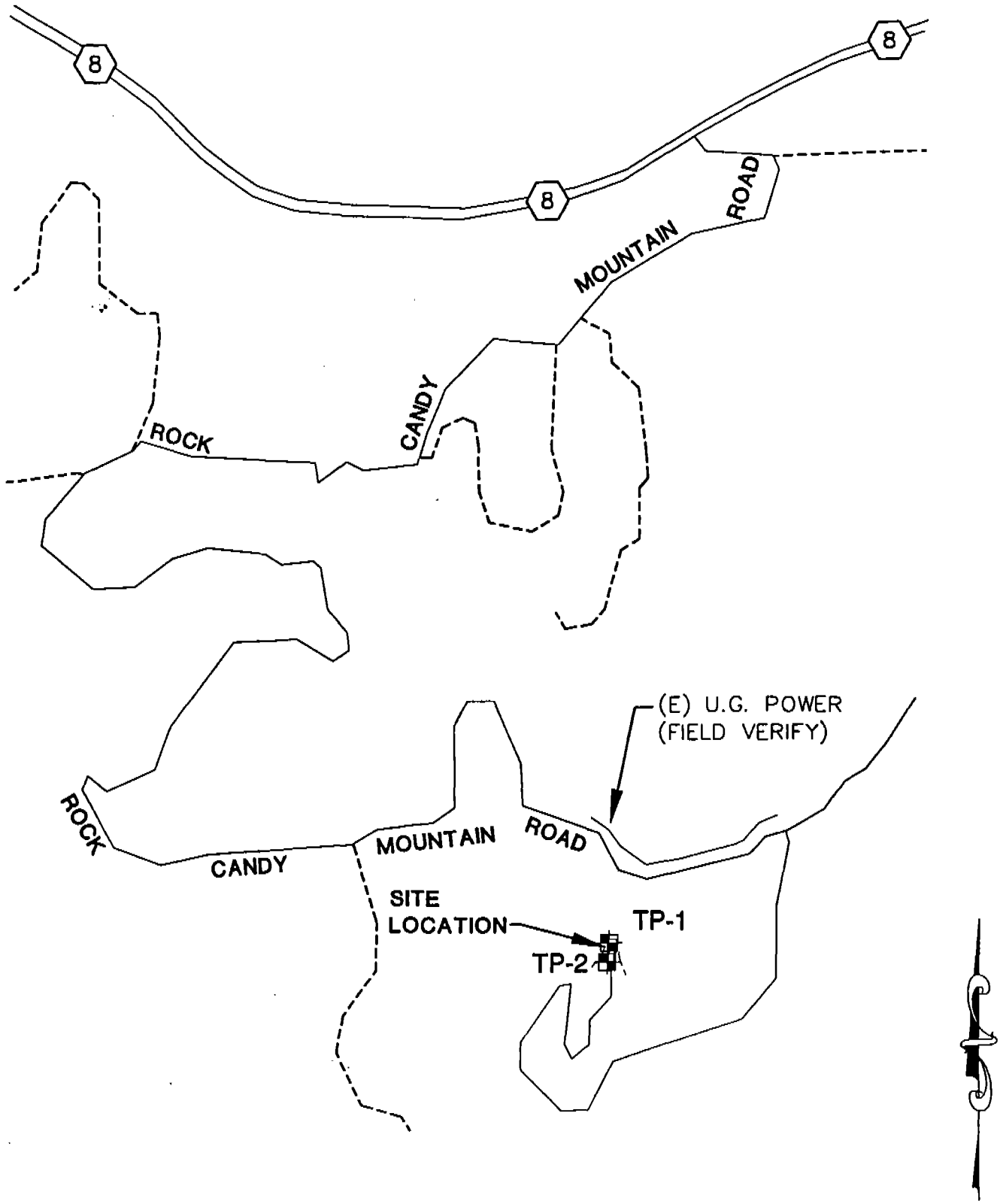

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FIGURE 2 - Site Plan

Location : Capital Peak / Rock Candy WRN-13/40463
NW 1/4 of SEC 31, T 18 N, R 3 W
Thurston County, Washington
Client : American Tower Corp.
Date : 11/12/99 **Job # :** S-WA-99-3006

APPENDIX A

TEST PIT LOG

TEST PIT LOG

APT Engineering, Inc.
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PROJECT : Capital Peak ARock Candy
NW 1/4 of SEC 31, T 18 n, R 3 W
Thurston County, Washington

Job Number : WA99-3006
WRN - 13 / 40463
American Tower Corp.

Test Pit No. : TP-1

DEPTH (feet)	SAMPLE TYPE	POCKET PENETROMETER (tons/ft²)	TORVANE (tons/ft²)	MOISTURE CONTENT (%)	IN-SITU DRY DENSITY (lbs/ft³)	WATER BEARING ZONE	MATERIAL DESCRIPTION	TESTING
0							Gravel (Road base)	
							Medium dense to dense, moist, orange-brown, silty SAND and sandy SILT with fractured rock	
							Test pit terminated at 3 feet due to very hard fractured bedrock	
5								
10								
15								
20								

LEGEND

DATE — Static Water Level at Drilling
DATE — Static Water Level
Perched Groundwater
5 gal. Bucket — Bucket Sample
100 to 1000 g — Bag Sample
Water Bearing
Water Seepage Indicator

Page : 1 of 1

Drilling Start Date : 11/9/99 Drilling Completion Date : 11/9/99 Logged By : NHV

TEST PIT LOG

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PROJECT : Capital Peak / Rock Candy
NW 1/4 of SEC 31, T 18 n, R 3 W
Thurston County, Washington

Job Number : WA99-3006
WRN - 13 / 40463
American Tower Corp.

Test Pit No. : TP-2

DEPTH (feet)	SAMPLE TYPE	POCKET PENETROMETER (tons/ft²)	TORVANE (tons/ft²)	MOISTURE CONTENT (%)	IN-SITU DRY DENSITY (lbs/ft³)	WATER BEARING ZONE	MATERIAL DESCRIPTION	TESTING
0							Gravel (Road base)	
							Medium dense to dense, moist, orange-brown, silty SAND and sandy SILT with fractured rock	
							Test pit terminated at 3 feet due to very hard fractured bedrock	
5								
10								
15								
20								

LEGEND

DATE — Static Water Level at Drilling
DATE — Static Water Level
Perched Groundwater
5 gal. Bucket — Bucket Sample
100 to 1000 g — Bag Sample
Water Bearing
Water Seepage Indicator

Page : 1 of 1

Drilling Start Date : 11/9/99 Drilling Completion Date : 11/9/99 Logged By : NHV