



**SOUND TRANSIT
UNIVERSITY
LINK
LIGHT RAIL**

**PRELIMINARY
ENGINEERING**

**GEOTECHNICAL
CONSIDERATIONS
REPORT**

This abridged document contains pages extracted from a longer report with this cover. This report is from the preliminary design package submitted by Sound Transit to Federal Transit Administration in summer 2006.

March 2006



Prepared For:
CENTRAL PUGET SOUND
REGIONAL TRANSIT AUTHORITY

SHANNON & WILSON, INC.
GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS





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GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

SEATTLE
HANFORD
FAIRBANKS
ANCHORAGE
SAINT LOUIS
BOSTON

LETTER OF TRANSMITTAL

Date: 31 March 2006

To: Mr. Robert Parsons
Sound Transit Link Light Rail
401 S. Jackson St., Union Station
Seattle, WA 98104-2826

Regarding: **SOUND TRANSIT LINK, CIVIL FACILITIES DESIGN
GEOTECHNICAL ENGINEERING**

FINAL PE GEOTECHNICAL CONSIDERATIONS REPORT FOR UNIVERSITY LINK


We are sending the following attached items:

<u>Number</u>	<u>Description</u>
7 copies	University Link Preliminary Engineering, Geotechnical Considerations Report
1 copy	Unbound copy for reproduction
1 CD	PDF files of entire report

Bob,

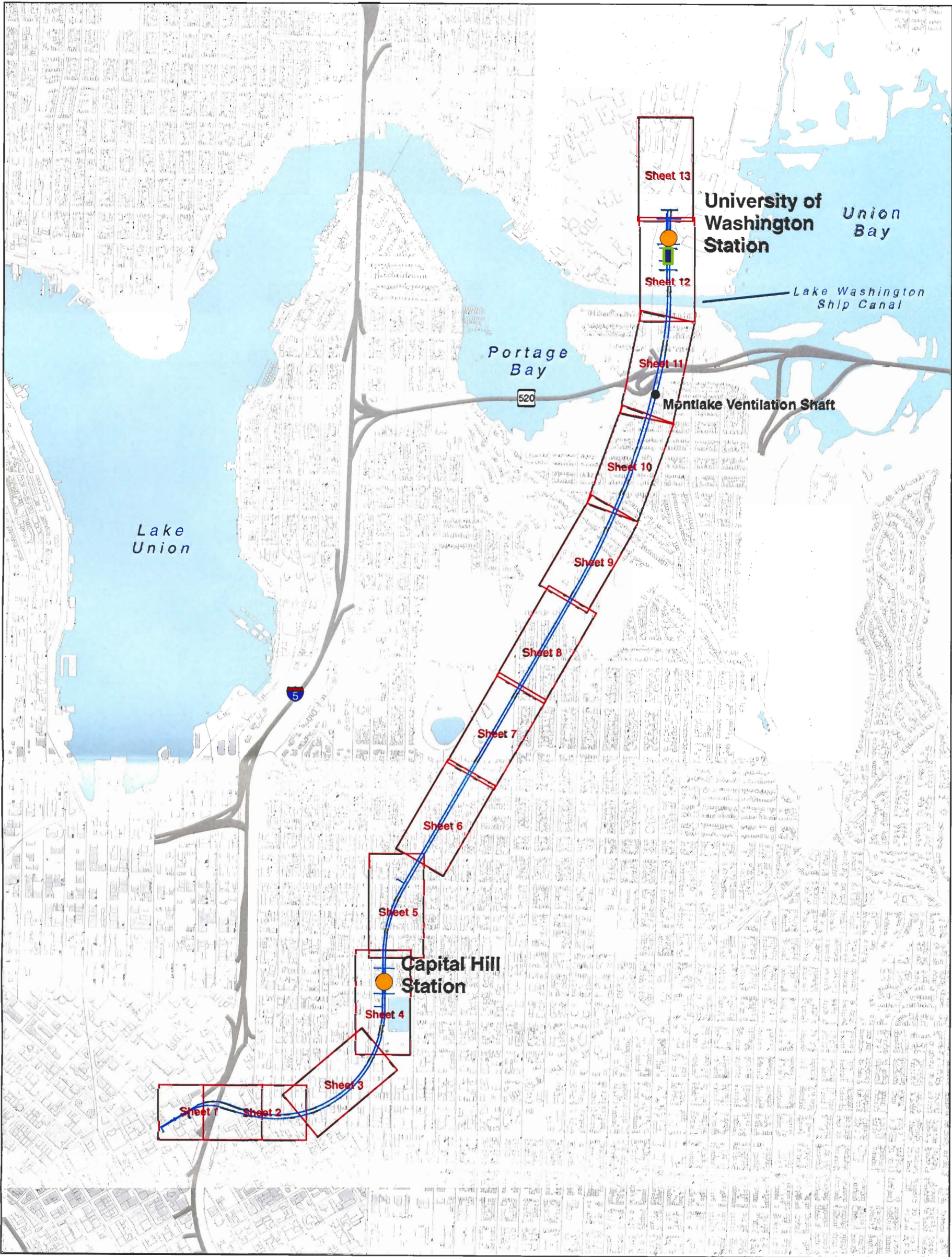
Enclosed is the final version of our Preliminary Engineering, Geotechnical Considerations Report for University Link. Also enclosed is a CD, which includes PDF files of the report.

From:



Ted Hopkins, L.E.G.
Associate

C.: John Chirco, PSTC (2 copies)



- Notes:
- 1. Street and water base data provided by the City of Seattle, 1999.
 - 2. Alignment 'N35_L00_KA(3-7-06).dwg' provided by PSTC, 03-7-06.

LEGEND

- University Link
- Station
- Vent
- Cross-over

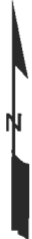
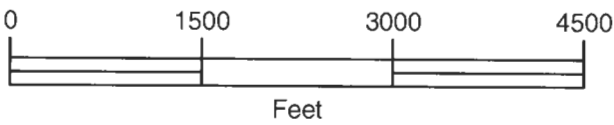


FIG. 1

Puget Sound Transit Consultants
Sound Transit University Link
Civil Facilities Design

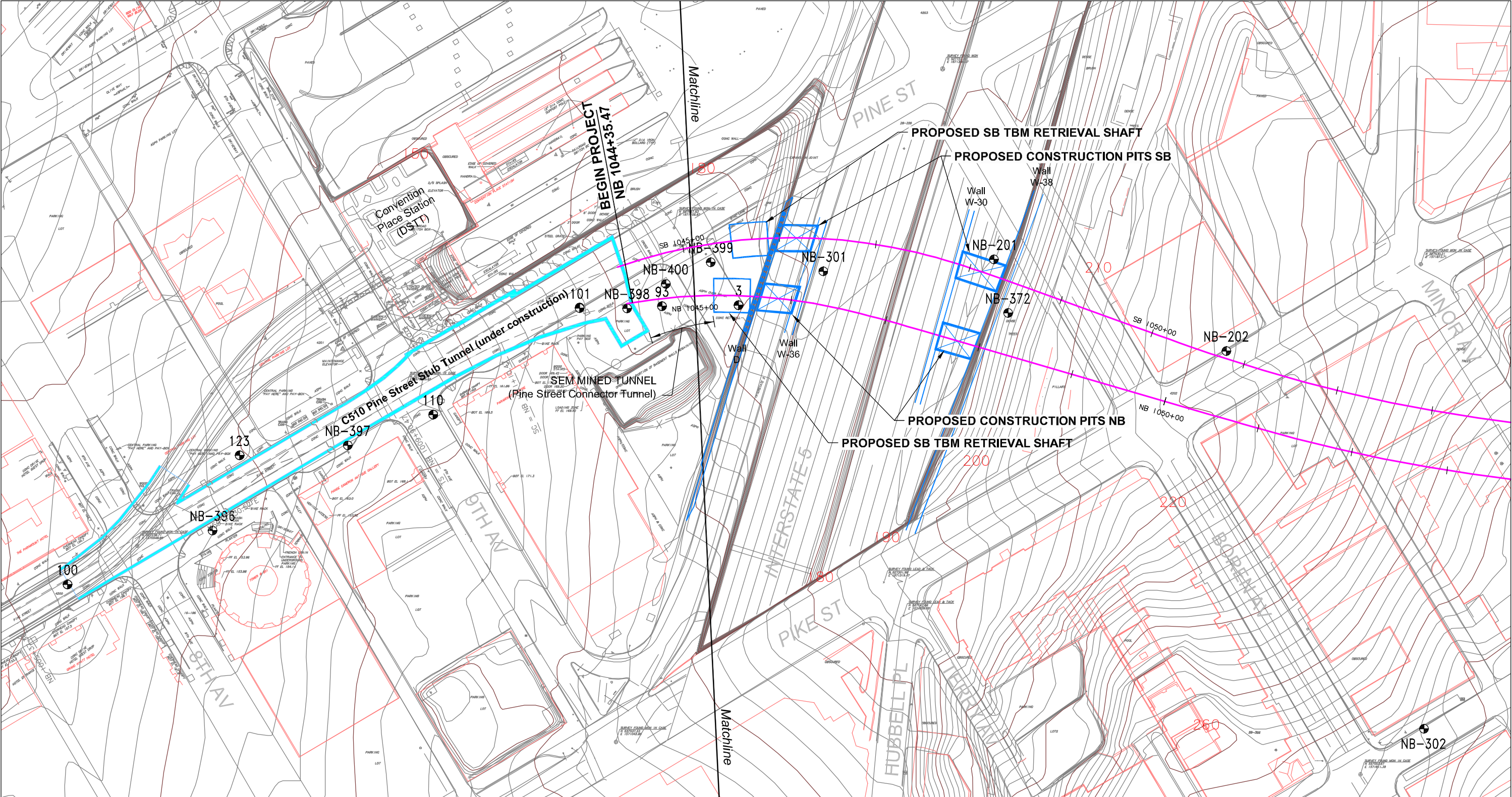
VICINITY MAP OF
PROPOSED ALIGNMENT AND
FACILITY LOCATIONS

March 2006 21-1-08109-074

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FIG. 1

File: J:\21108109-074\21-1-08109-074 Site Plan.dwg Date: 03-28-2006 Author: SAC

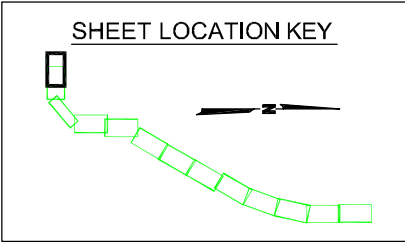


STATIONING BETWEEN MATCHLINES

NB 1210+00 to 1225+00

0 100 200

Scale in Feet



NOTES

- Figure based on electronic files provided by PSTC. Alignment "N35_L00_KA.dwg" received 3-7-06.
- Vertical datum: NAVD88.

LEGEND

- NB-282** Current Project Boring Designation
- NB-389** Previous Project Boring Designation
- 3692** Previous Non-Project Boring Designation and Approximate Location



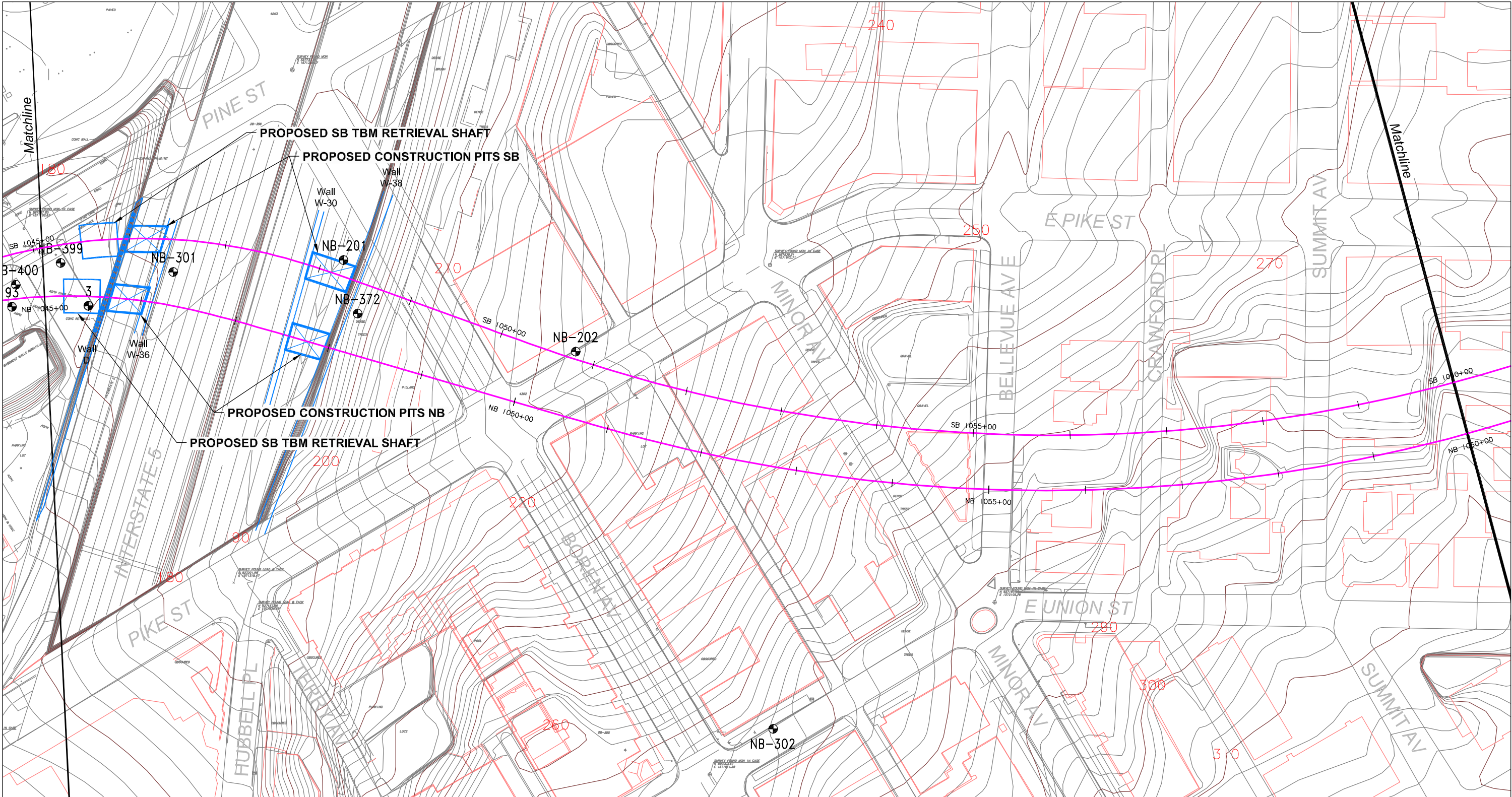
Puget Sound Transit Consultants
Sound Transit University Link
Civil Facilities Design

**SITE AND EXPLORATION PLAN
UNIVERSITY LINK ALIGNMENT**

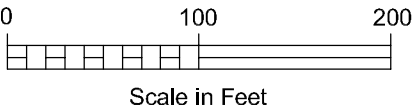
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FIG. 2
Sheet 1 of 13



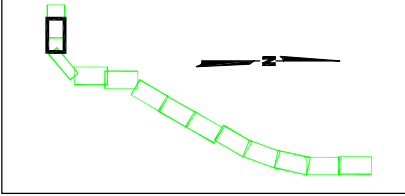
STATIONING BETWEEN MATCHLINES
NB 1210+00 to 1225+00



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SHEET LOCATION KEY

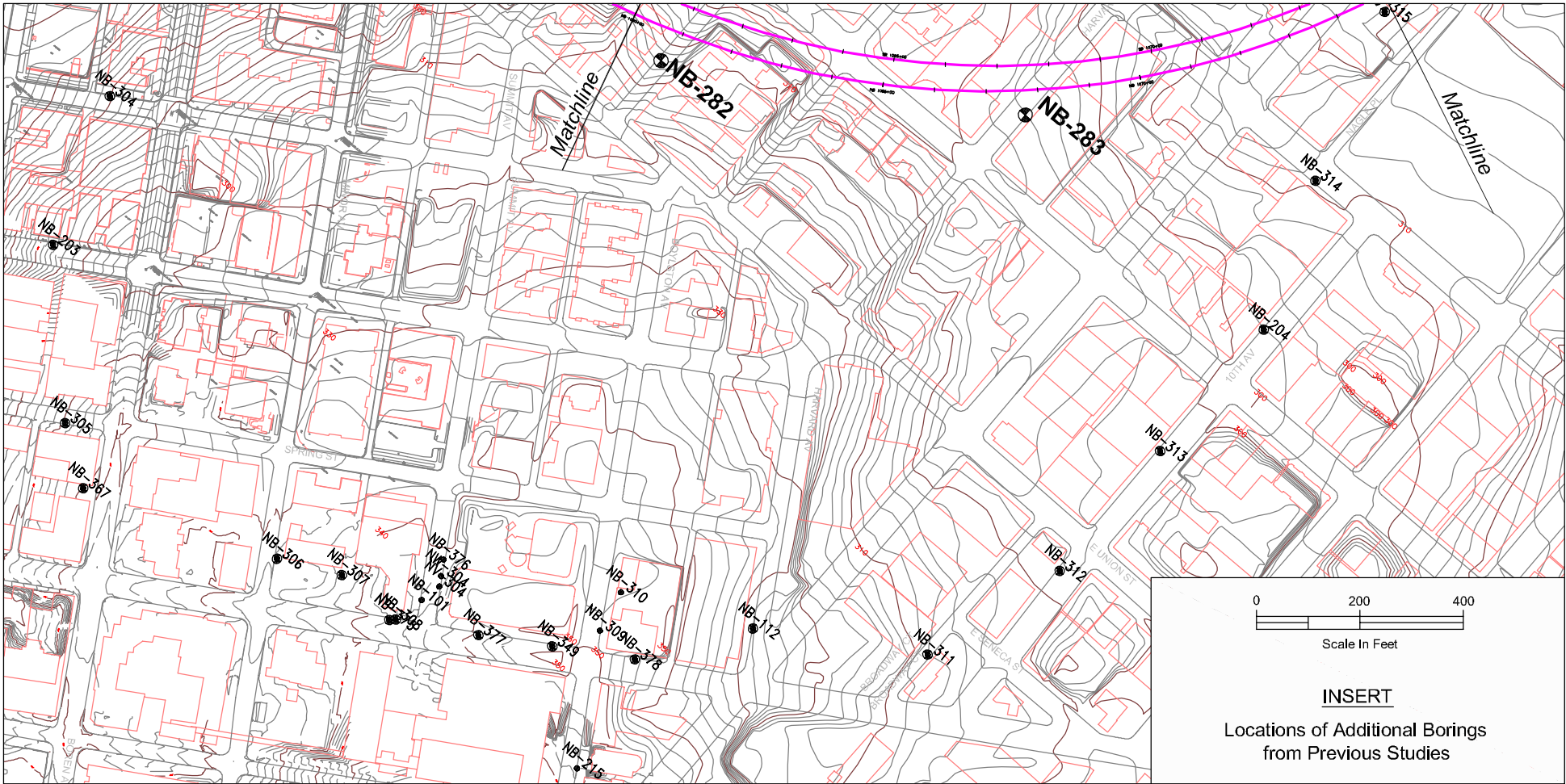
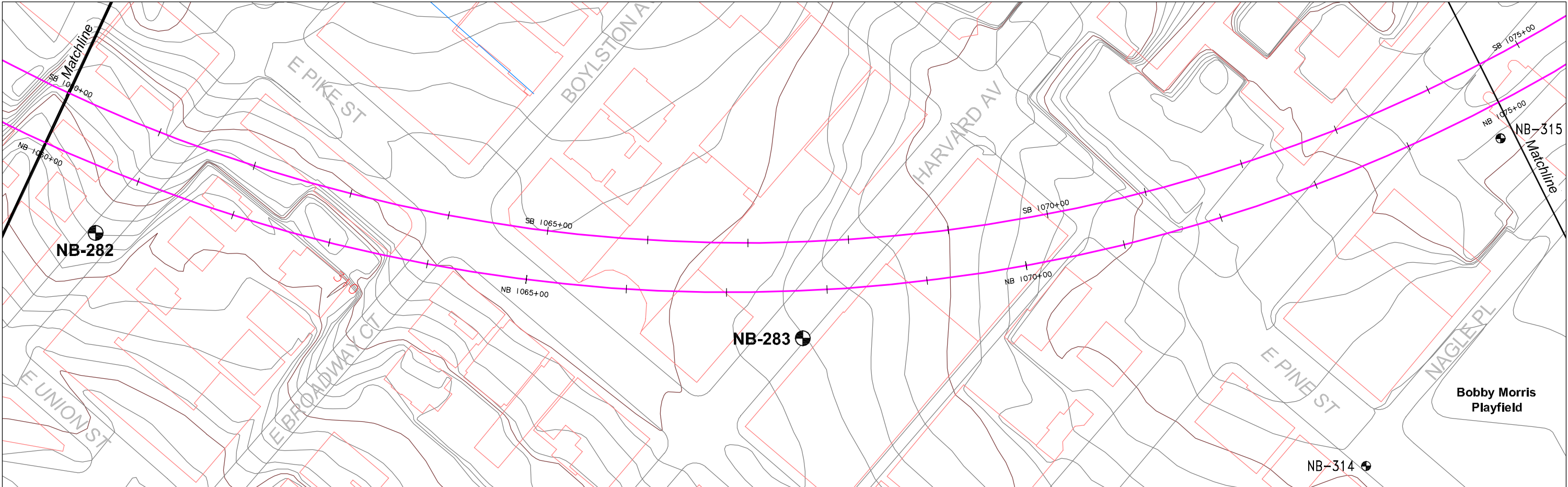


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Puget Sound Transit Consultants Sound Transit University Link Civil Facilities Design	
SITE AND EXPLORATION PLAN UNIVERSITY LINK ALIGNMENT	
March 2006	21-1-08109-074
SHANNON & WILSON, INC. Geotechnical and Environmental Consultants	FIG. 2 Sheet 2 of 13

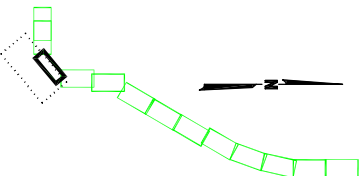
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STATIONING BETWEEN MATCHLINES

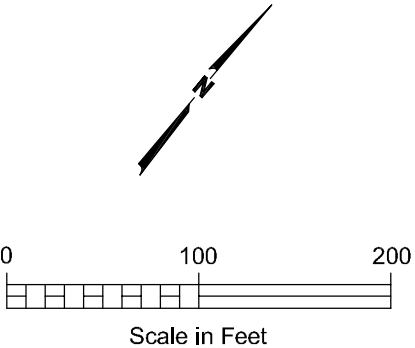
NB 1060+00 to 1075+00

SHEET LOCATION KEY



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Civil Facilities Design

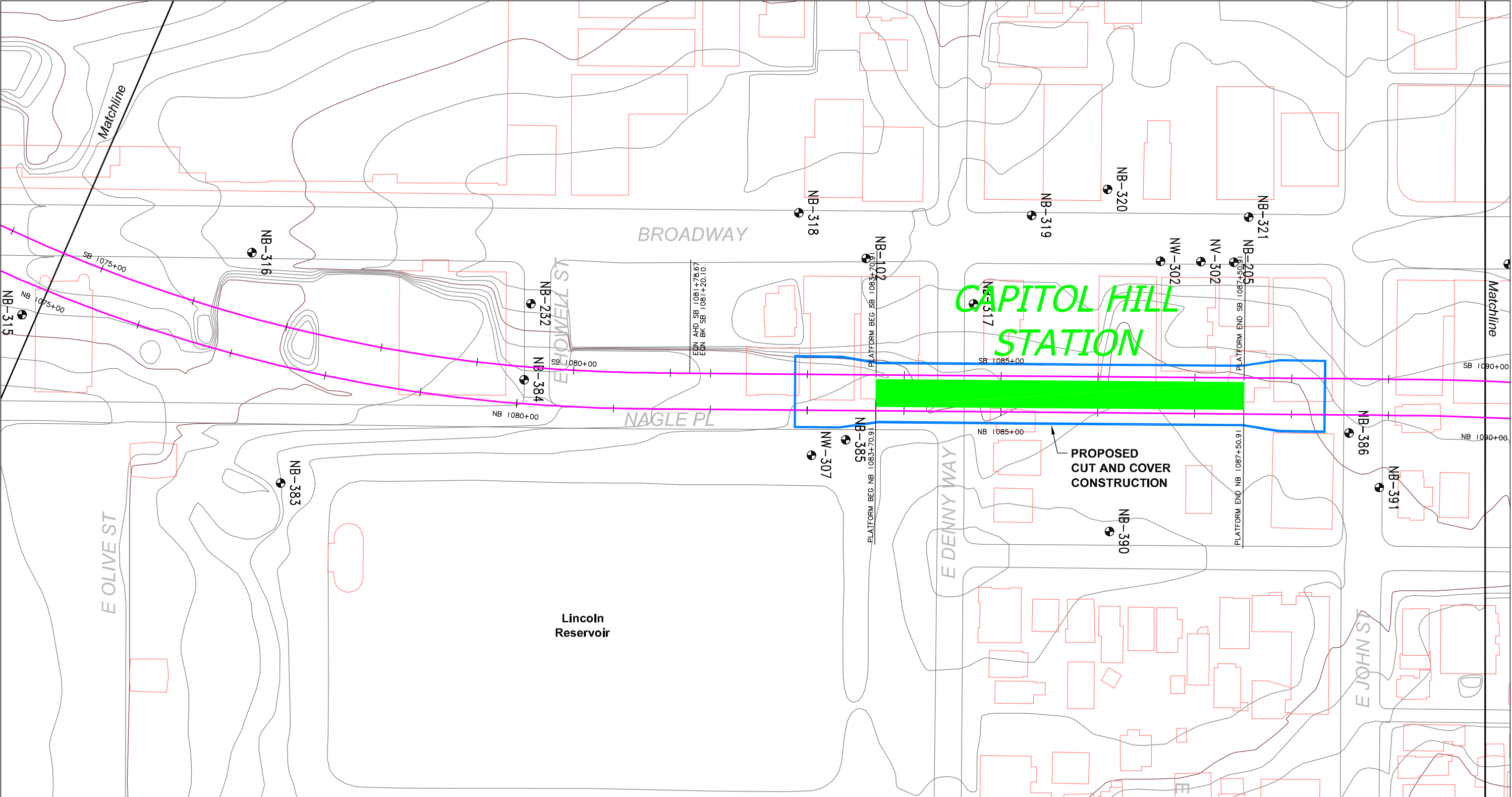
**SITE AND EXPLORATION PLAN
UNIVERSITY LINK ALIGNMENT**

March 2006

21-1-08109-074

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FIG. 2
Sheet 3 of 13



STATIONING BETWEEN MATCHLINES

NB 1210+00 to 1225+00

0 100 200



Scale in Feet

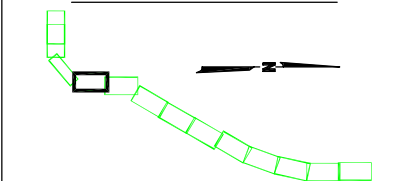
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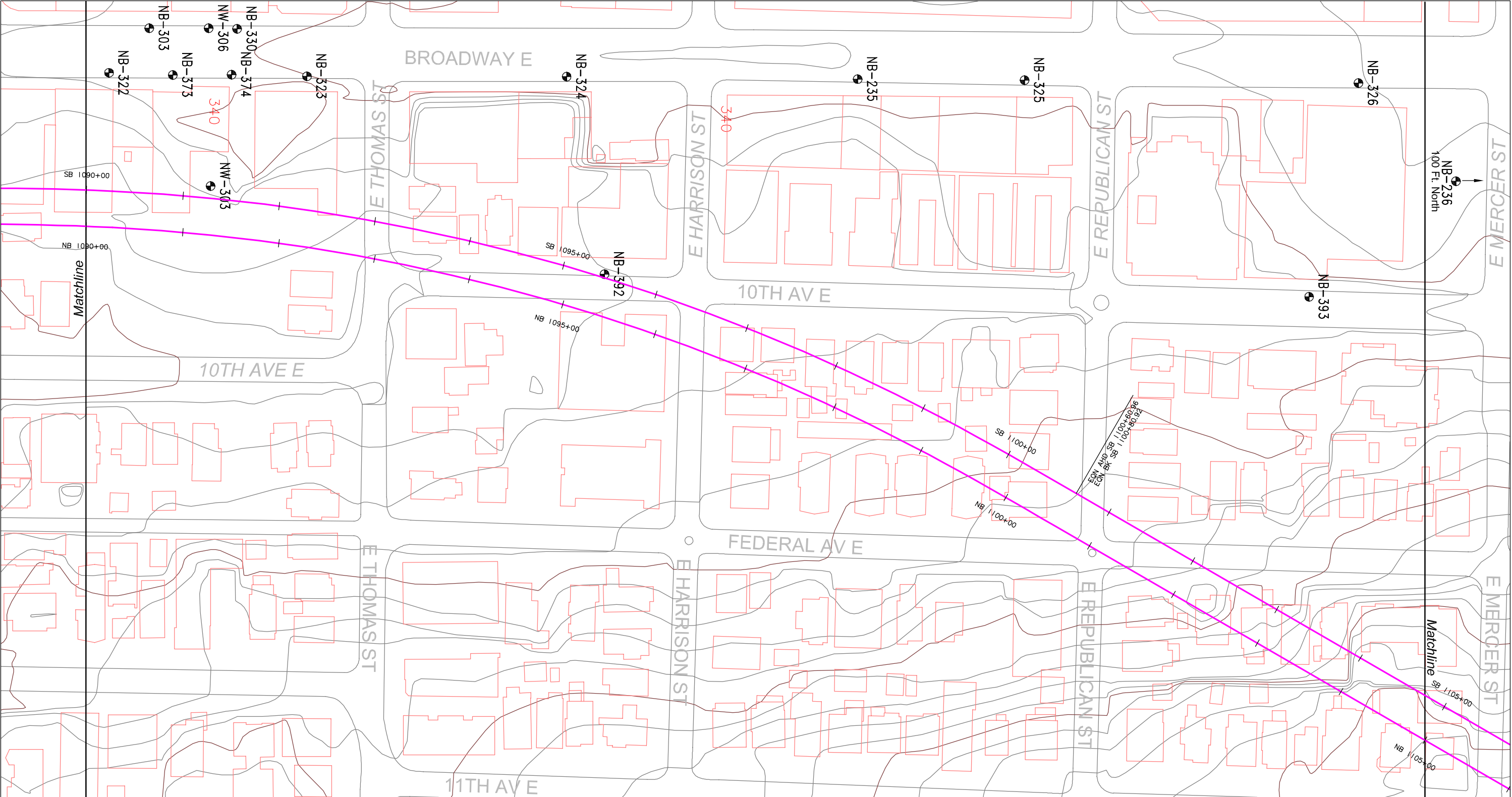
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Sound Transit University Link
Civil Facilities Design

**SITE AND EXPLORATION PLAN
UNIVERSITY LINK ALIGNMENT**

March 2006 21-1-08109-074

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FIG. 2
Sheet 4 of 13



STATIONING BETWEEN MATCHLINES

NB 1210+00 to 1225+00

0 100 200

Scale in Feet

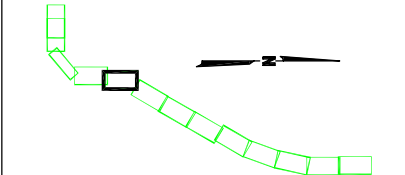
LEGEND

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SHEET LOCATION KEY



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Civil Facilities Design

SITE AND EXPLORATION PLAN
UNIVERSITY LINK ALIGNMENT

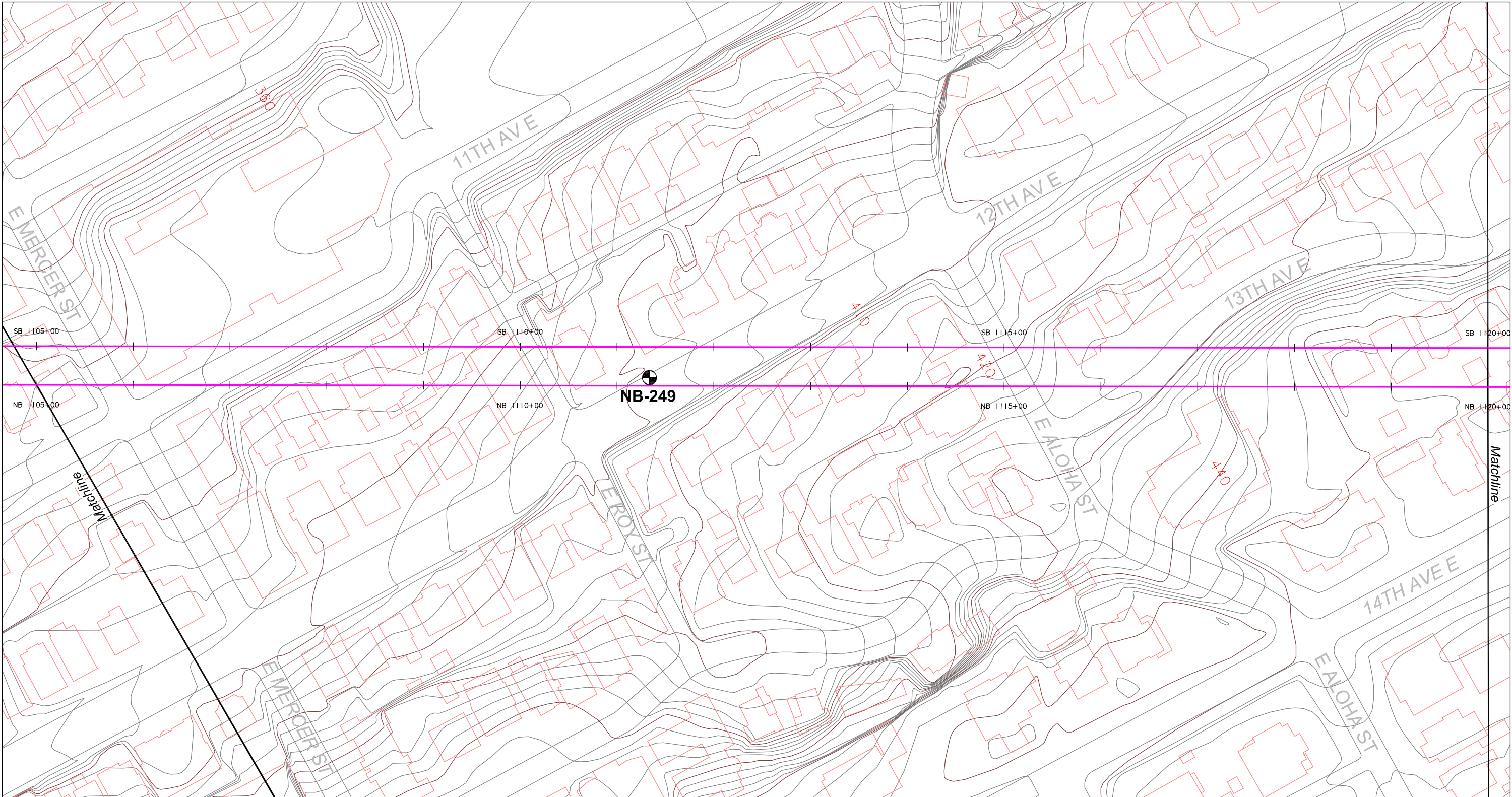
March 2006

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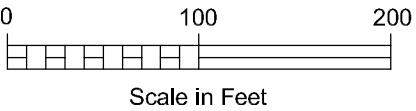
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FIG. 2
Sheet 5 of 13

File: J:\21108109-074\21-1-08109-074 Site Plan.dwg Date: 03-28-2006 Author: SAC

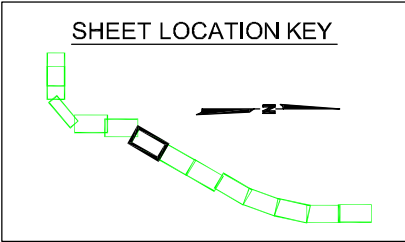


STATIONING BETWEEN MATCHLINES
NB 1210+00 to 1225+00






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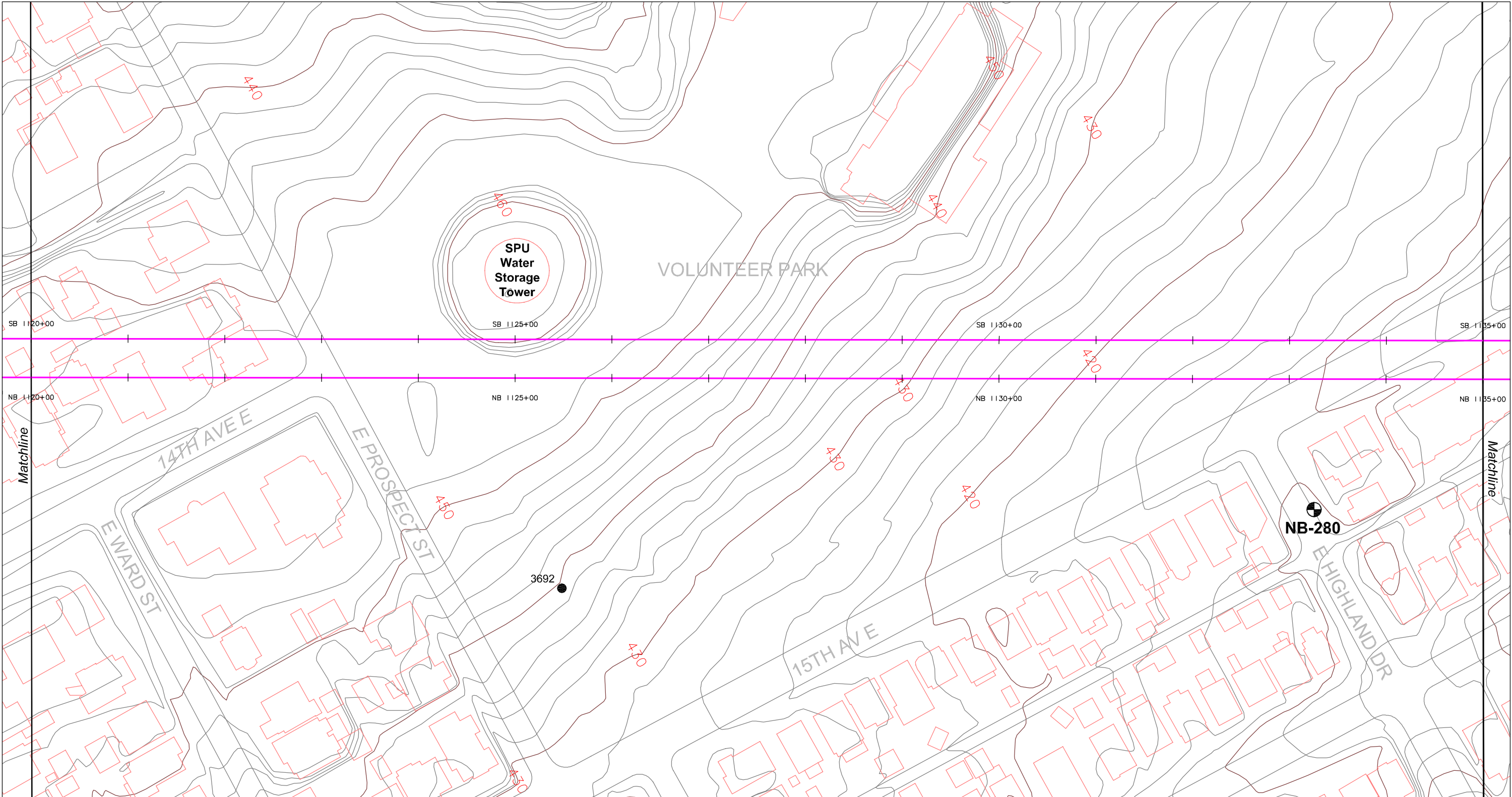
LEGEND

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Puget Sound Transit Consultants Sound Transit University Link Civil Facilities Design	
SITE AND EXPLORATION PLAN UNIVERSITY LINK ALIGNMENT	
March 2006	21-1-08109-074
SHANNON & WILSON, INC. Geotechnical and Environmental Consultants	FIG. 2 Sheet 6 of 13

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STATIONING BETWEEN MATCHLINES

NB 1210+00 to 1225+00

0 100 200

Scale in Feet

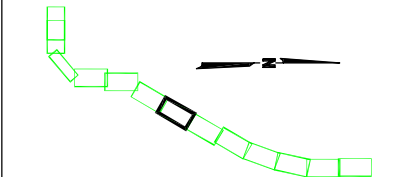
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Sound Transit University Link
Civil Facilities Design

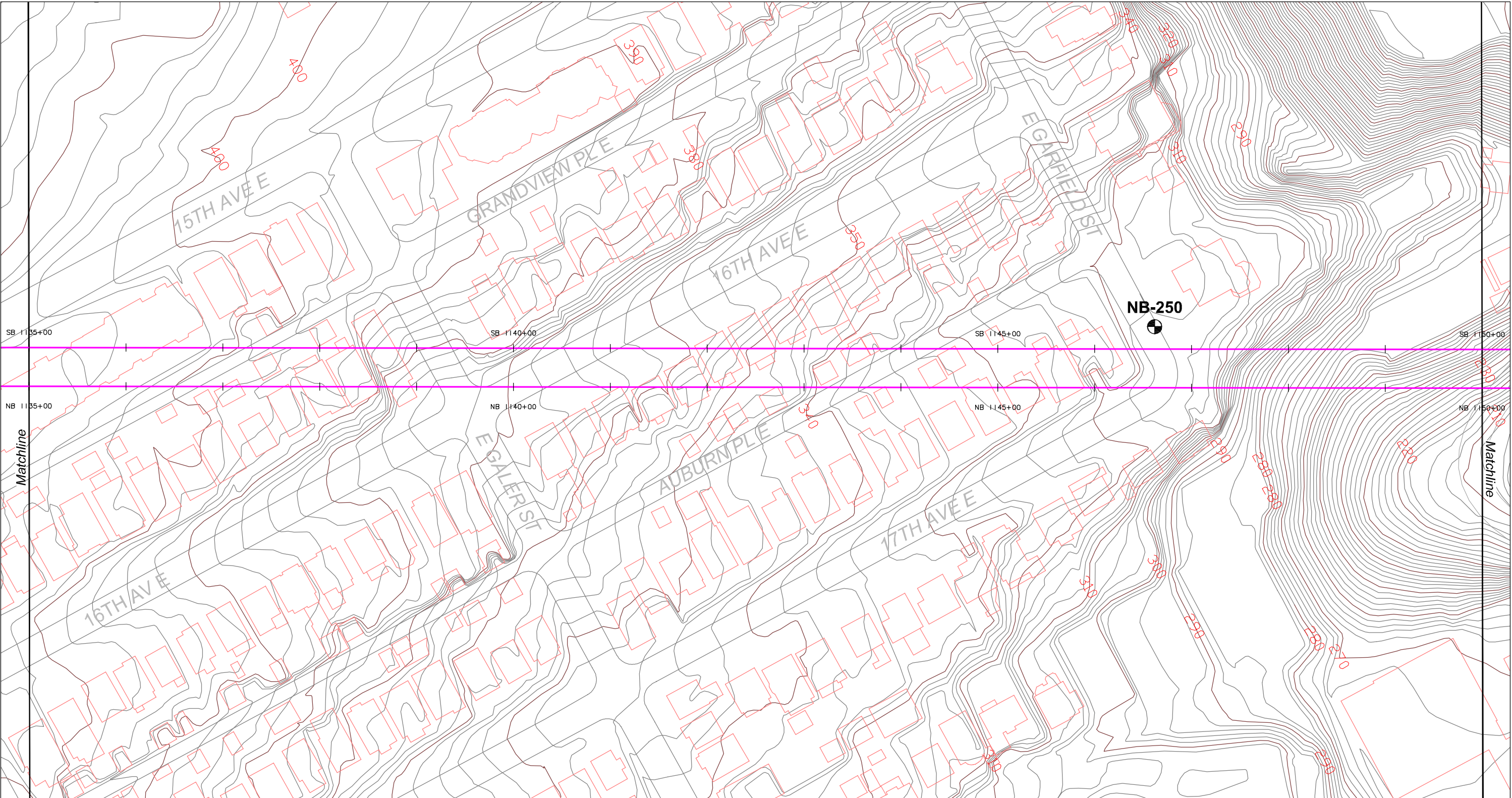
**SITE AND EXPLORATION PLAN
UNIVERSITY LINK ALIGNMENT**

March 2006 21-1-08109-074

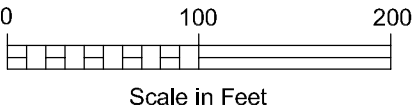
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FIG. 2
Sheet 7 of 13

File: J:\21108109-074\21-1-08109-074 Site Plan.dwg Date: 03-28-2006 Author: SAC

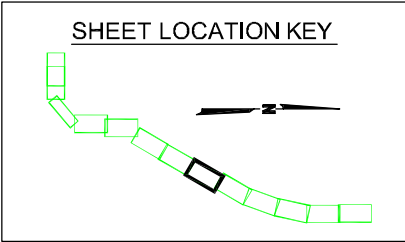


STATIONING BETWEEN MATCHLINES
NB 1210+00 to 1225+00






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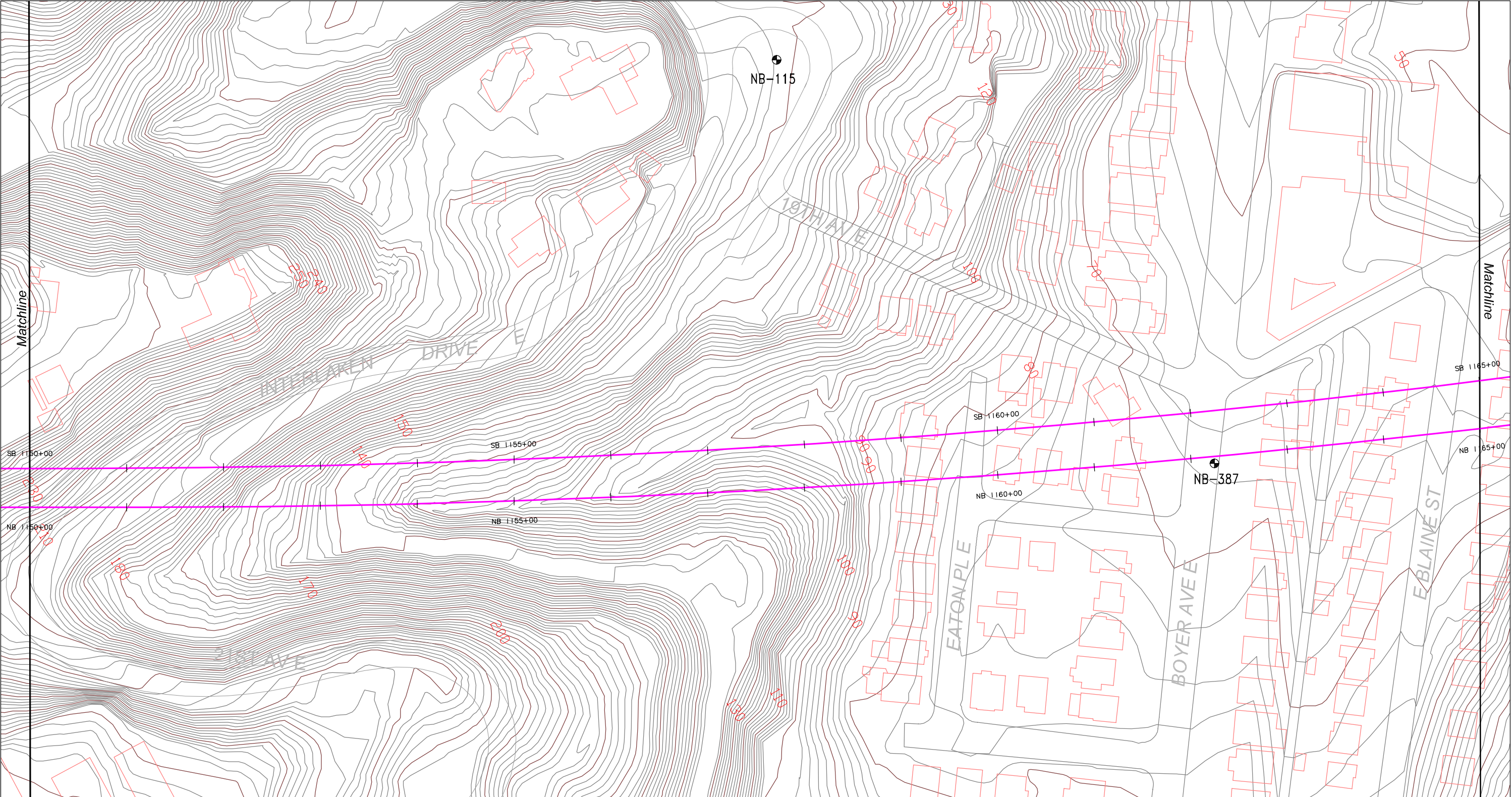
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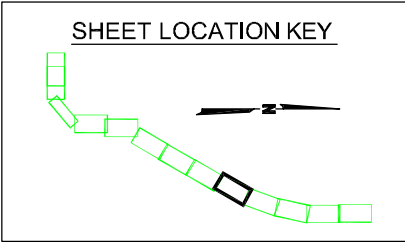
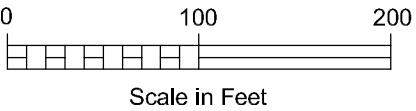


Puget Sound Transit Consultants Sound Transit University Link Civil Facilities Design	
SITE AND EXPLORATION PLAN UNIVERSITY LINK ALIGNMENT	
March 2006	21-1-08109-074
SHANNON & WILSON, INC. Geotechnical and Environmental Consultants	FIG. 2 Sheet 8 of 13

File: J:\21108109-074\21-1-08109-074 Site Plan.dwg Date: 03-28-2006 Author: SAC



STATIONING BETWEEN MATCHLINES
NB 1210+00 to 1225+00



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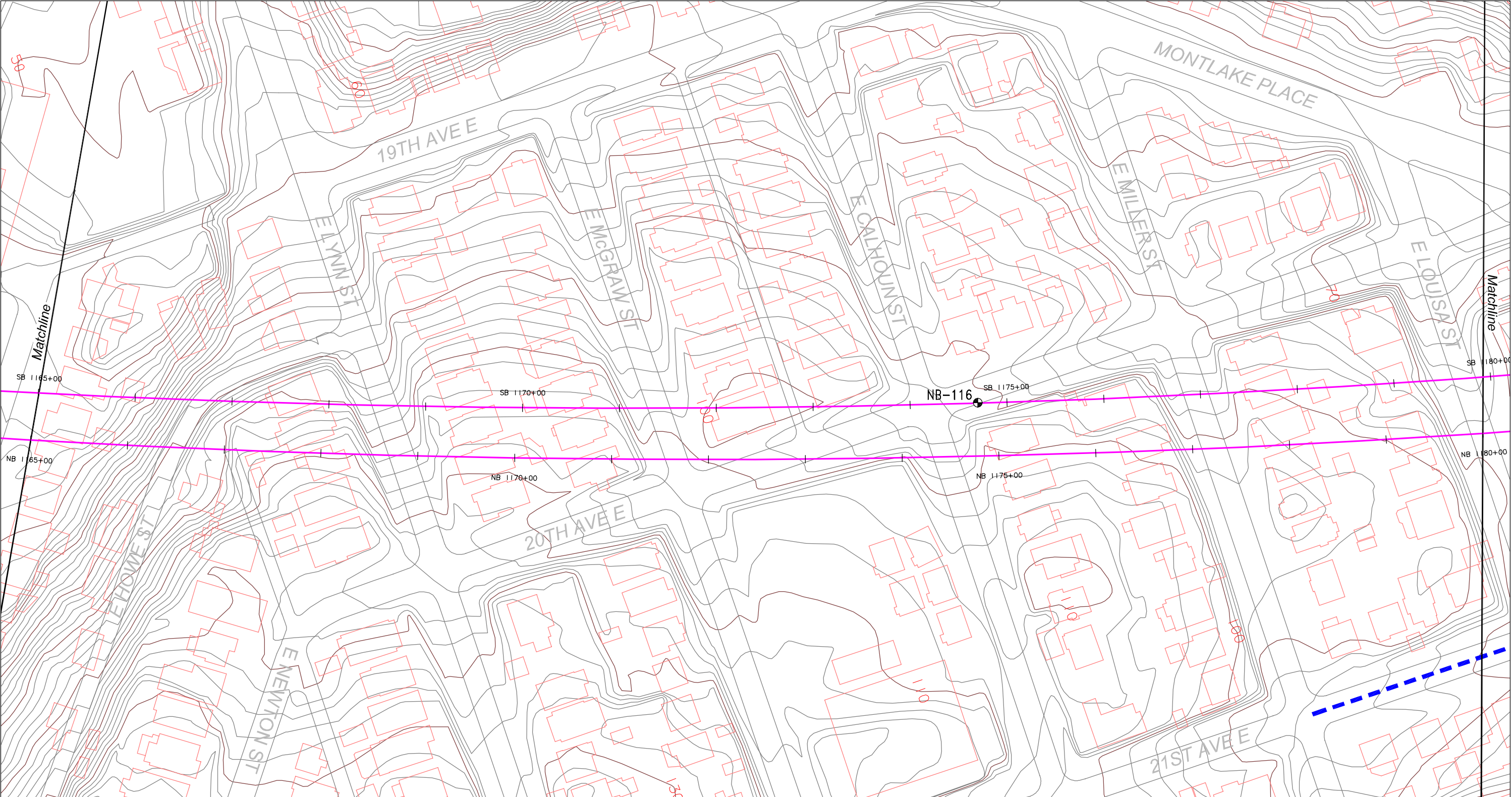
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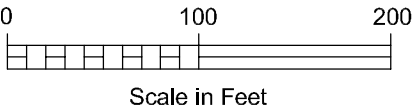


Puget Sound Transit Consultants Sound Transit University Link Civil Facilities Design	
SITE AND EXPLORATION PLAN UNIVERSITY LINK ALIGNMENT	
March 2006	21-1-08109-074
SHANNON & WILSON, INC. Geotechnical and Environmental Consultants	FIG. 2 Sheet 9 of 13

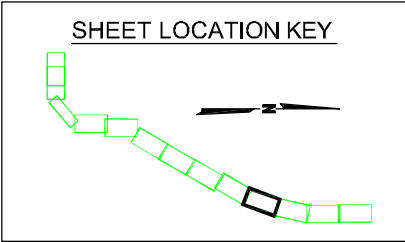
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STATIONING BETWEEN MATCHLINES
NB 1210+00 to 1225+00



- NOTES
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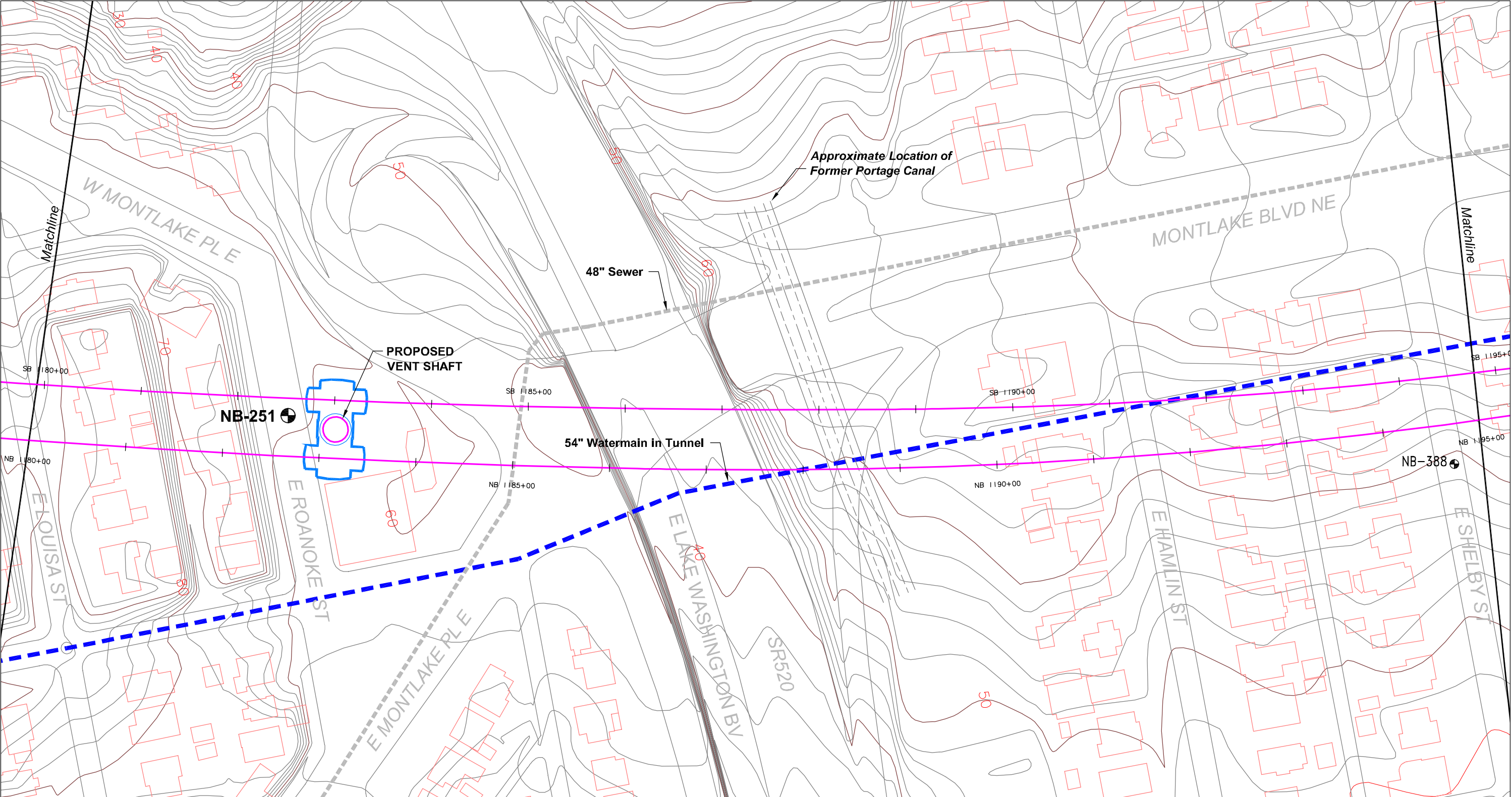


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SITE AND EXPLORATION PLAN UNIVERSITY LINK ALIGNMENT	
March 2006	21-1-08109-074
SHANNON & WILSON, INC. Geotechnical and Environmental Consultants	FIG. 2 Sheet 10 of 13

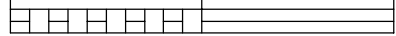
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STATIONING BETWEEN MATCHLINES

NB 1210+00 to 1225+00

0 100 200



Scale in Feet

LEGEND

NB-282



Current Project Boring Designation

NB-389



Previous Project Boring Designation

3692

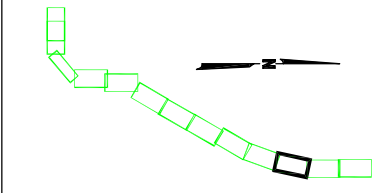


Previous Non-Project Boring Designation and Approximate Location

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SHEET LOCATION KEY



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Sound Transit University Link
Civil Facilities Design

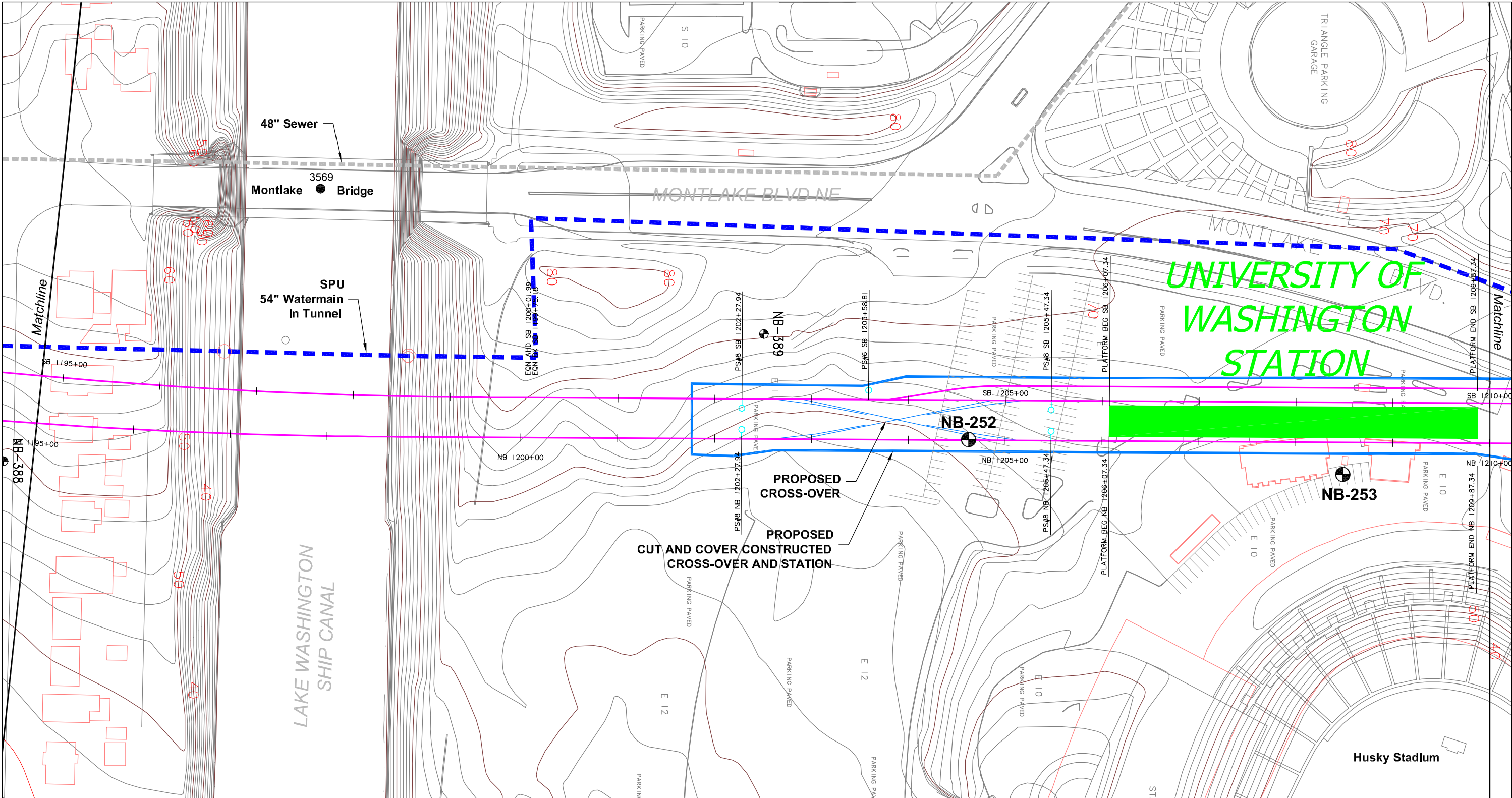
SITE AND EXPLORATION PLAN
UNIVERSITY LINK ALIGNMENT

March 2006

21-1-08109-074

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FIG. 2
Sheet 11 of 13






STATIONING BETWEEN MATCHLINES

NB 1210+00 to 1225+00

0 100 200

Scale in Feet

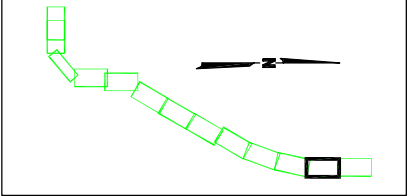
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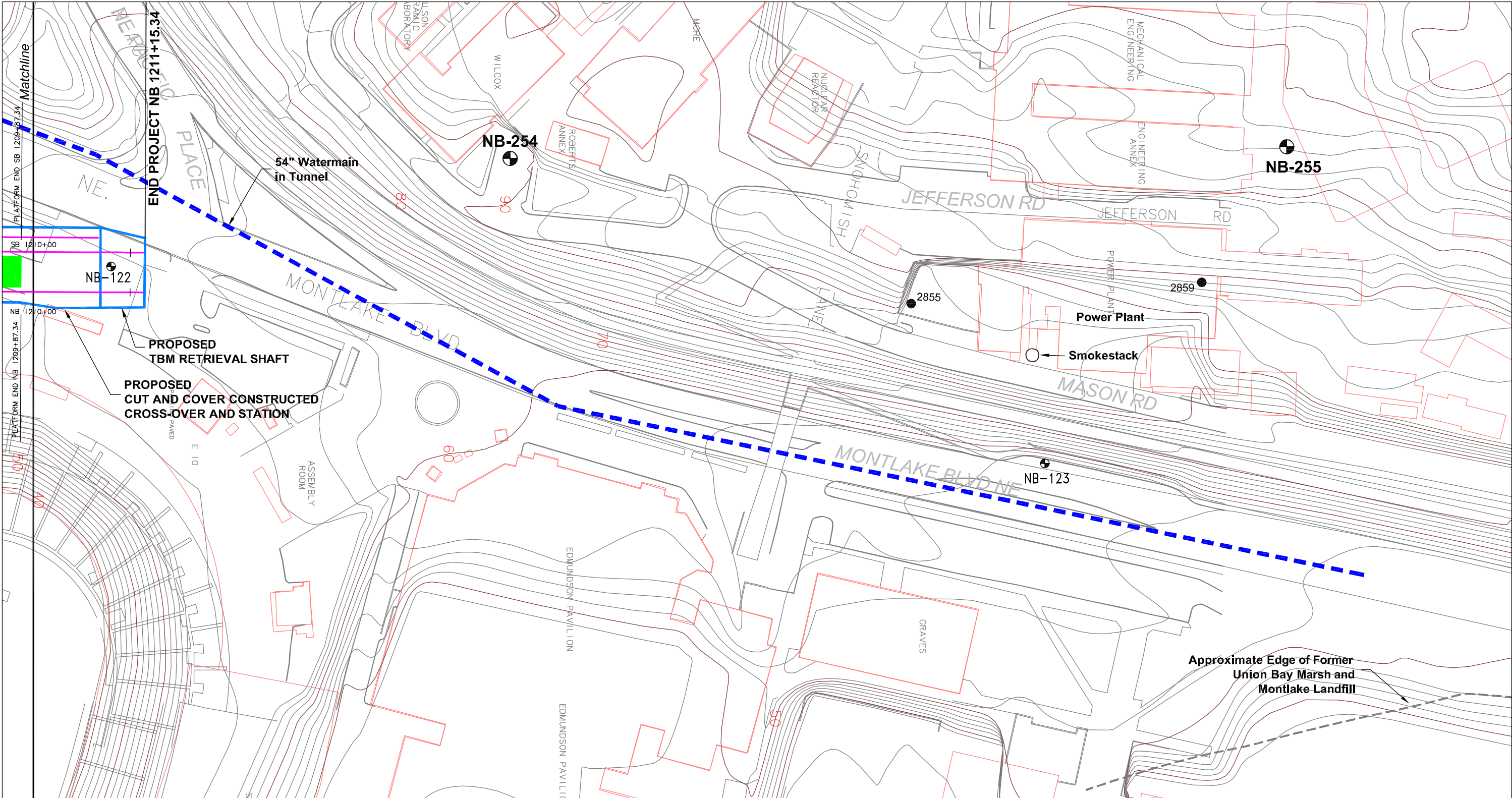
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**SITE AND EXPLORATION PLAN
UNIVERSITY LINK ALIGNMENT**

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FIG. 2
Sheet 12 of 13



STATIONING BETWEEN MATCHLINES

NB 1210+00 to 1225+00

0 100 200

Scale in Feet

LEGEND

NB-282



Current Project Boring Designation

NB-389



Previous Project Boring Designation

3692

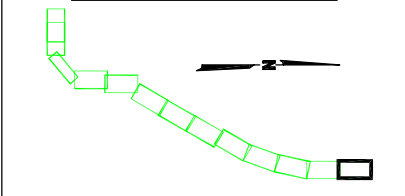


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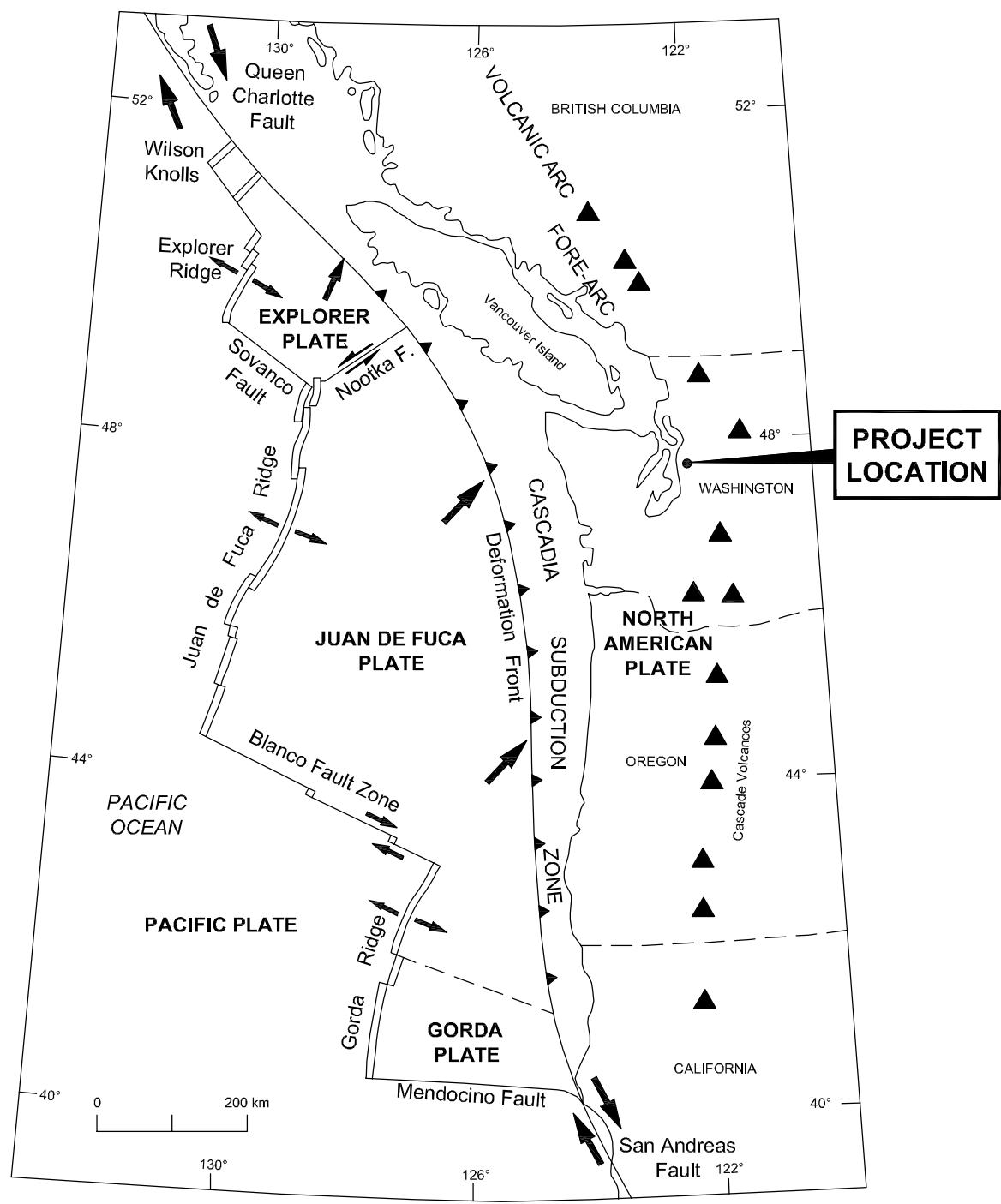
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FIG. 2
Sheet 13 of 13

File: J:\21108109-074\21-1-08\109-074 Fig 03.dwg Date: 03-28-2006 Author: SAC



LEGEND

- ▲ Loading Edge of Deformation Front (Sawtooth on Upper Plate)
- ▲ Active Volcano

NOTE

Map based on Hyndman and Wang (1993).

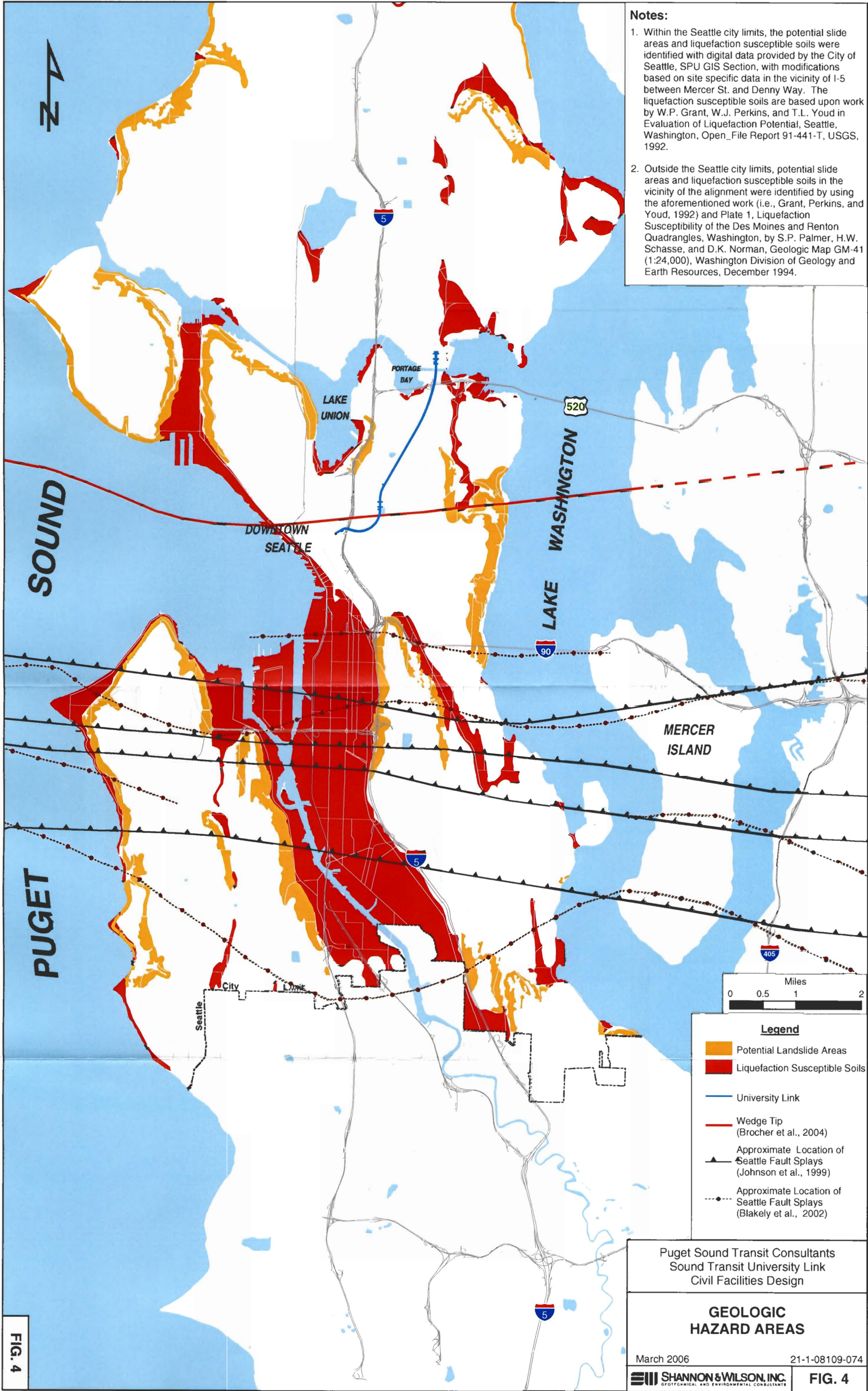
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REGIONAL TECTONIC MAP

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





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FIG. 3












GEOLOGIC EXPLANATION












HOLOCENE DEPOSITS

	Hf	FILL: Fill placed by humans, both engineered and nonengineered Various materials, including debris; cobbles and boulders common; commonly dense or stiff if engineered, but very loose to dense or very soft to stiff if nonengineered
	Hh	HYDRAULIC FILL: Fill placed by dredging from river or bay or sluiced into place from adjacent hills Clay and Silt; very soft to medium stiff (from hills); Silt and fine Sand, scattered shells; very loose to medium dense (not from hills)
	Hc	COLLUVIUM: Hillside slope accumulations due to gravity emplacement Disturbed, heterogeneous mixture of several soils types, including organic debris; loose or soft
	Hls	LANDSLIDE DEPOSITS: Deposits of landslides, normally at and adjacent to the toe of slopes Disturbed, heterogeneous mixture of several soil types; loose or soft, with random dense or hard pockets
	Ha	ALLUVIUM: River or creek deposits, normally associated with historic streams, including overbank deposits Sand, silty Sand, gravelly Sand; very loose to very dense
	Hp	PEAT DEPOSITS: Depression fillings of organic materials Peat, peaty Silt, organic Silt; very soft to medium stiff
	He	ESTUARINE DEPOSITS: Estuary deposits of the ancestral Duwamish River Silty Clay and fine Sand; very soft to very stiff or loose to dense
	HI	LAKE DEPOSITS: Depression fillings of fine-grained soils Silt, clayey Silt, silty Clay; commonly with scattered organics; very soft to stiff or very loose to medium dense
	Hb	BEACH DEPOSITS: Deposits along present and former shorelines of Puget Sound and tributary river mouths Silty Sand, sandy Gravel, Sand, scattered fine gravel, organic debris; loose to medium dense
	Hrw	REWORKED GLACIAL DEPOSITS: Glacially deposited soils that have been reworked by fluvial or wave action Heterogenous mixture of several soil types; lies on top of glacially overridden soils; loose to dense






QUATERNARY VASHON DEPOSITS

	Qvro	RECESSIONAL OUTWASH DEPOSITS: Glaciofluvial sediment deposited as glacial ice retreated Clean to silty Sand, gravelly Sand, sandy Gravel; cobbles and boulders common; loose to very dense
	Qvrl	RECESSIONAL LACUSTRINE DEPOSITS: Glaciolacustrine sediment deposited as glacial ice retreated Fine Sand, Silt, and Clay; dense to very dense, soft to hard
	Qvri	ICE-CONTACT DEPOSITS: Heterogeneous soils deposited against or adjacent to ice during the wasting of glacial ice; commonly reworked Stratified to irregular bodies of Gravel, Sand, Silt, and Clay; loose to dense
	Qvat	ABLATION TILL: Heterogeneous soils deposited during the wasting of glacial ice; generally not reworked Gravelly silty Sand, silty gravelly Sand, with some clay; cobbles and boulders common; loose to very dense or soft to hard
	Qvt	TILL: Lodgment till laid down along the base of the glacial ice Gravelly silty Sand, silty gravelly Sand ("hardpan"); cobbles and boulders common; very dense
	Qvd	TILL-LIKE DEPOSITS (DIAMICT): Glacial deposit intermediate between till and outwash; subglacially reworked Silty gravelly Sand, silty Sand, sandy Gravel; highly variable over short distances; cobbles and boulders common; dense to very dense
	Qva	ADVANCE OUTWASH: Glaciofluvial sediment deposited as the glacial ice advanced through the Puget Lowland Clean to silty Sand, gravelly Sand, sandy Gravel; dense to very dense
	Qvgl	GLACIOLACUSTRINE DEPOSITS: Fined-grained glacial flour deposited in proglacial lake in Puget Lowland Silty clay, Clayey Silt, with interbeds of Silt and fine Sand; locally laminated; scattered organic fragments near base; hard or dense to very dense
	Qvgm	GLACIOMARINE DEPOSITS: Till-like deposit with clayey matrix deposited in proglacial lake by icebergs, floating ice, and gravity currents Heterogeneous and variable mixture of of Clay, Silt, Sand, and Gravel; rare shells; cobbles and boulders common; very dense or hard

QUATERNARY PRE-VASHON DEPOSITS

	Qpnf	FLUVIAL DEPOSITS: Alluvial deposits of rivers and creeks Clean to silty Sand, gravelly Sand, sandy Gravel; very dense
	Qpnl	LACUSTRINE DEPOSITS: Fine-grained lake deposits in depressions, large and small Fine sandy Silt, silty fine Sand, clayey Silt; scattered to abundant fine organics; dense to very dense or very stiff to hard
	Qpnp	PEAT DEPOSITS: Depression fillings of organic materials Peat, peaty Silt, organic Silt; hard
	Qpns	PALEOSOL: Buried weathered horizon Clay-rich with various amounts of clastic debris; commonly contains organic material; typically greenish in color; hard or very dense
	Qpls	LANDSLIDE DEPOSITS: Heterogeneous deposits of landslide debris Chaotically bedded silt, sand,clay and gravel; may contain wood and other organics; hard or very dense
	Qpgo	OUTWASH: Glaciofluvial sediment deposited as the glacial ice advanced through the Puget Lowland Clean to silty Sand, gravelly Sand, sandy Gravel; very dense
	Qpgl	GLACIOLACUSTRINE DEPOSITS: Fine-grained glacial flour deposited in proglacial lake in Puget Lowland Silty Clay, clayey Silt, with interbeds of Silt and fine Sand; very stiff to hard or very dense
	Qpgt	TILL: Lodgment till laid down along the base of the glacial ice Gravelly silty Sand, silty gravelly Sand ("hardpan"); cobbles and boulders common; very dense
	Qpgd	TILL-LIKE DEPOSITS (DIAMICT): Glacial deposit intermediate between till and outwash; subglacially reworked Silty gravelly Sand, silty Sand, sandy Gravel; highly variable over short distance; cobbles and boulders common; very dense
	Qpgm	GLACIOMARINE DEPOSITS: Till-like deposit with clayey matrix deposited in proglacial lake by icebergs, floating ice, and gravity currents Heterogeneous and variable mixture of of Clay, Silt, Sand, and Gravel; rare shells; cobbles and boulders common; very dense or hard
		Overprint indicates that Qvgl or Qpgl has Qpnl-like seams and layers

TERTIARY BEDROCK

	Tsi	SILTSTONE: Siltstone, sandy Siltstone, commonly tuffaceous
	Tss	SANDSTONE: Sandstone, Silty Sandstone, commonly tuffaceous
	Tcs	CLAYSTONE: Claystone, Silty Claystone, sandy Claystone, commonly tuffaceous
	Tvc	VOLCANICLASTIC ROCKS: Tuff, Lapilli Tuff, Volcanic Breccia, Agglomerate
	Tva	ANDESITE: Andesite and Basalt

NOTE

The description of each geologic unit includes only general information regarding the environment of deposition and basic soil characteristics. For example, cobbles and boulders are only included in the description of those units where they are most prominent. Futher details of each geologic unit are presented in the report.

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GEOLOGIC UNIT DESCRIPTION

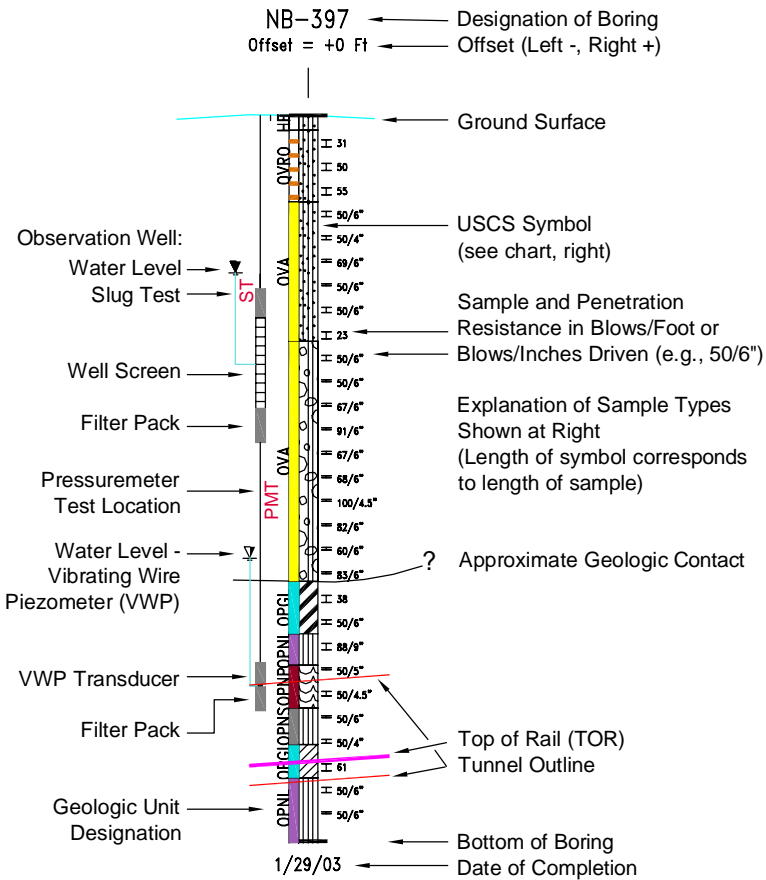
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FIG. 5

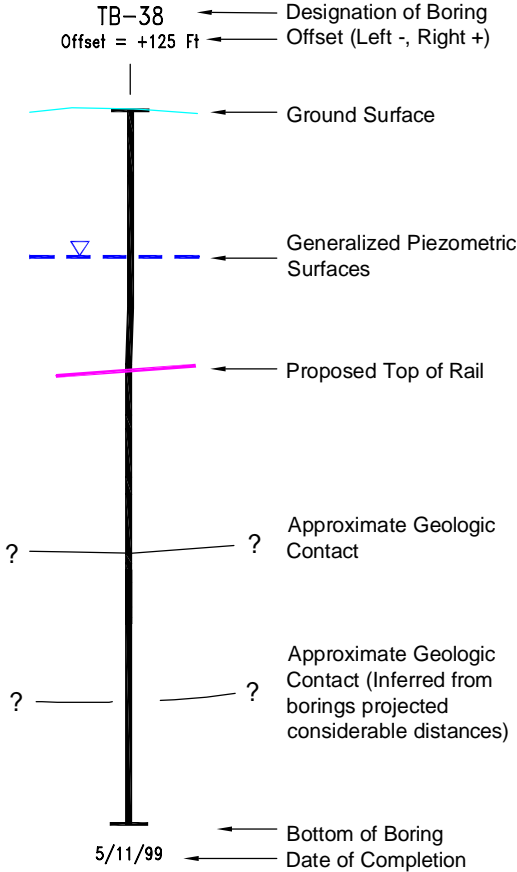
BORING LOG LEGEND

(Project Borings)



BORING LOG LEGEND

(Non-Project Borings)



NOTES

- The profiles are constructed from surface elevations based on the North American Vertical Datum 1988 (NAVD88). The geology shown is derived from borings conducted by Shannon & Wilson, Inc. for this study and from borings conducted by Shannon & Wilson and others for other studies. Elevations and geologic contacts should be considered approximate. Variations between the profile and actual conditions are likely to exist.
- Detailed logs of the current project explorations are presented in Appendix A of the GDR. Water levels shown on current project borings were generally measured in December 2004. Water levels shown on previous project borings were measured at various dates. Groundwater fluctuations should be expected.
- Tunnel alignment and grades were provided by PSTC on 3-7-06.
- Piezometric surface lines were inferred between locations of groundwater measurement and are approximate. Water levels may fluctuate seasonally and may have changed since the last reading. Absence of piezometric surface lines along the alignment does not indicate the absence of groundwater; groundwater may be present in areas where no piezometric surface lines are shown.

UNIFIED SOIL CLASSIFICATION SYSTEM

(From ASTM D 2488-93 & 2487-93)

GW	SM
GP	SC
GW-GM	CL
GP-GM	ML
GM	OL
GC	CH
SW	MH
SP	OH
SW-SM	PT
SP-SM	

SAMPLE TYPES

- * Sample Not Recovered
- 2" O.D. Split Spoon Sample with 140 lb. Hammer (standard penetration test - SPT)
- 2.5" O.D. Split Spoon Sample with 300 lb. Hammer (non-standard)
- 3" O.D. Split Spoon Sample with 300 lb. Hammer (non-standard)
- Sonic Coring Run
- 3" O.D. Shelby Tube Sample
- Osterberg Sample
- Pitcher Barrel Sample
- 2.5" O.D. Thin Wall Tube Sample
- Grab Sample
- Soil Coring Run

- Dual Symbols (symbols separated by a hyphen, i.e., SP-SM, slightly silty fine SAND) are used for soils with between 5% and 12% fines or when the liquid limit and plasticity index values plot in the CL-ML area of the plasticity chart.
- Borderline symbols (symbols separated by a slash, i.e., CL/ML, silty CLAY/clayey SILT; GW/SW, sandy GRAVEL/gravelly SAND) indicate that the soil may fall into one of two possible basic groups, based on ASTM D 2488-93 Visual Manual Classification System. The graphic symbol of only the first group symbol is shown on the profile.

NOMENCLATURE

GEOLOGIC AGE DESIGNATION		DEPOSITIONAL ENVIRONMENT, GEOLOGIC PROCESS, OR LITHOLOGY			
Present	H = Holocene		f = fill h = hydraulic fill c = colluvium ls = landslide	a = alluvium p = peat e = estuarine	l = lacustrine (lake) b = beach rw = reworked glacial
	Q = Quaternary	v = Vashon	r = recessional	o = outwash l = lacustrine i = ice contact	
at = ablation till					
p = Pre-Vashon 6 or more glacial and interglacial episodes		t = till (lodgment) d = till-like (diamict) a = advance outwash	gm = glaciomarine gl = glaciolacustrine		
		n = nonglacial (interglacial) ls = landslide	f = fluvial l = lacustrine	p = peat s = soil (paleosol)	
		g = glacial	o = outwash l = lacustrine t = till-like (diamict) d = till-like m = marine		
2,000,000 yrs BP	T = Tertiary		si = siltstone ss = sandstone	cs = claystone vc = volcanics	

* These radiometric (C¹⁴) dates are based on data in Central Puget Lowland. Equivalent calendar years before present are approximately 15,000 and 18,000 yrs BP. These dates may differ from onset and end of Vashon (late Pleistocene) glacial episode in other parts of the Puget Lowland.

NOTE

The nomenclature graphic was created to explain the distinctions among geologic deposits in the Central Puget Lowland for engineering purposes, e.g. engineering properties of geologic deposits. The actual geologic designations and dates, according to internationally accepted stratigraphic rules, may be slightly different.

GEOLOGIC NOMENCLATURE

Each geologic unit has a two- to four-letter abbreviation composed of a leading capital letter signifying geologic age, followed by one or more lowercase letters indicating further breakdown of geologic age, depositional environment or geologic process.

LEGEND

Years BP Radiocarbon Years Before Present (1950)

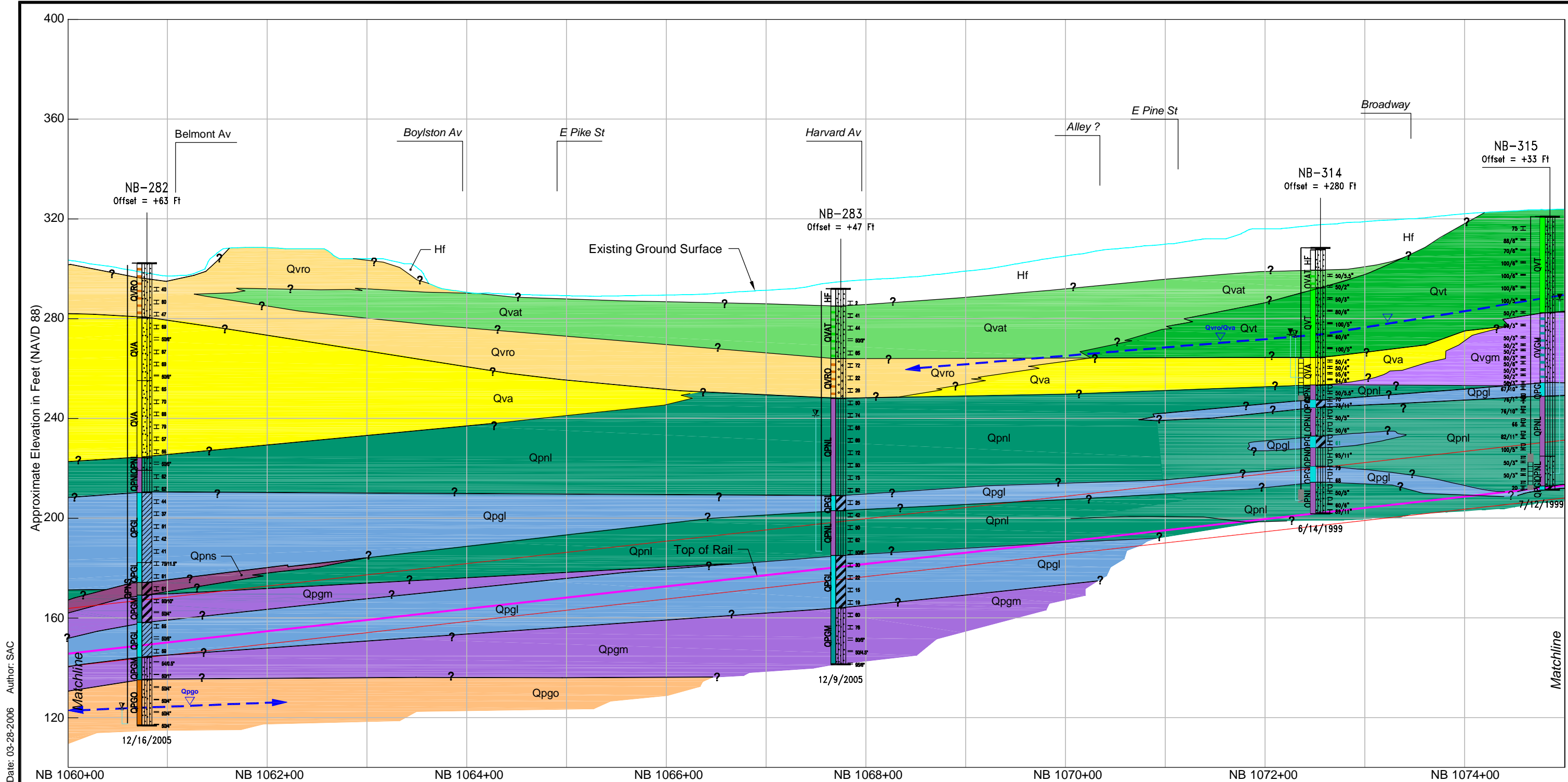
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GEOLOGIC PROFILE
LEGEND AND NOTES

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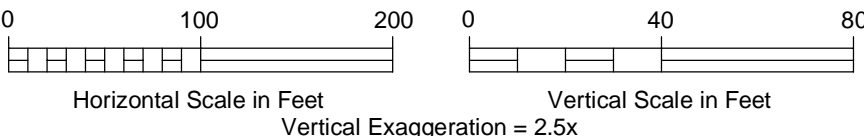
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FIG. 6



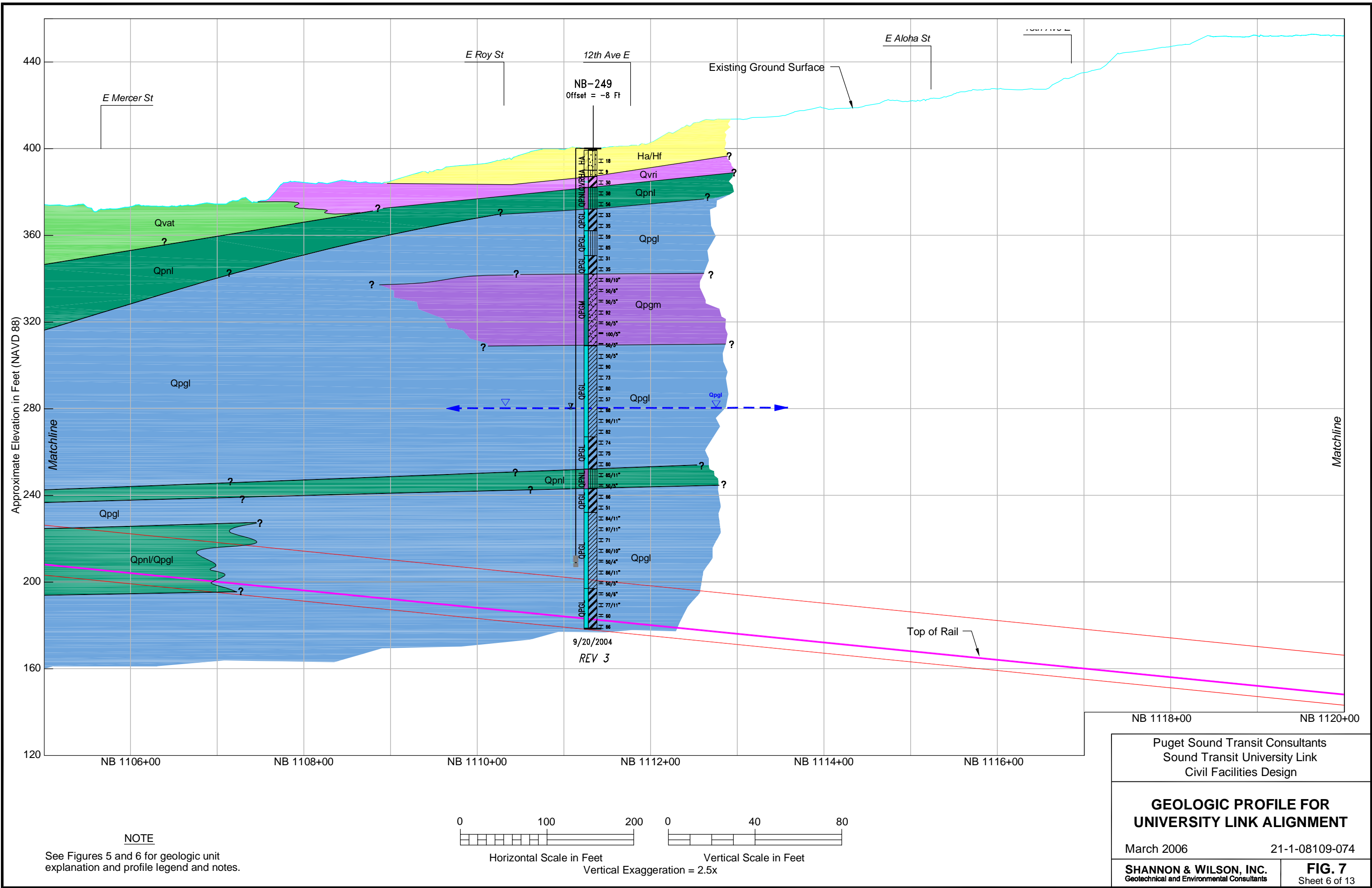
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NOTE
See Figures 5 and 6 for geologic unit explanation and profile legend and notes.

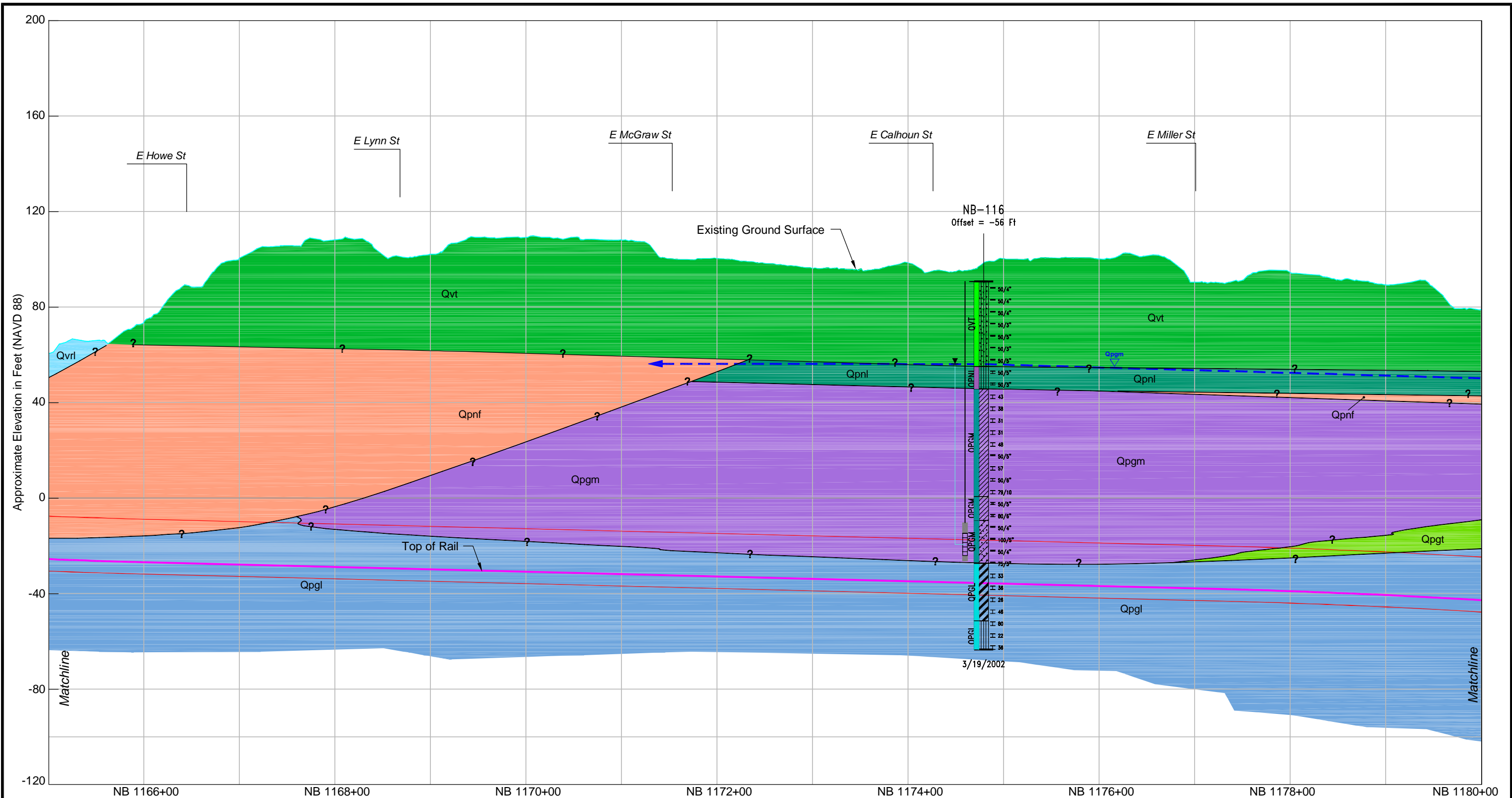


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GEOLOGIC PROFILE FOR UNIVERSITY LINK ALIGNMENT	
March 2006	21-1-08109-074
SHANNON & WILSON, INC. Geotechnical and Environmental Consultants	FIG. 7 Sheet 3 of 13

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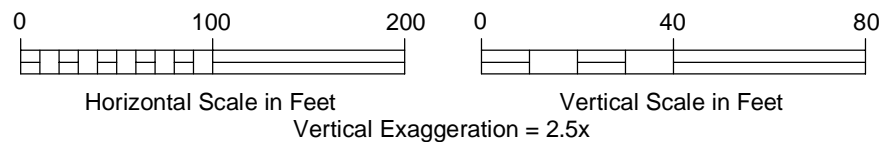


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NOTE

See Figures 5 and 6 for geologic unit explanation and profile legend and notes.



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**GEOLOGIC PROFILE FOR
UNIVERSITY LINK ALIGNMENT**

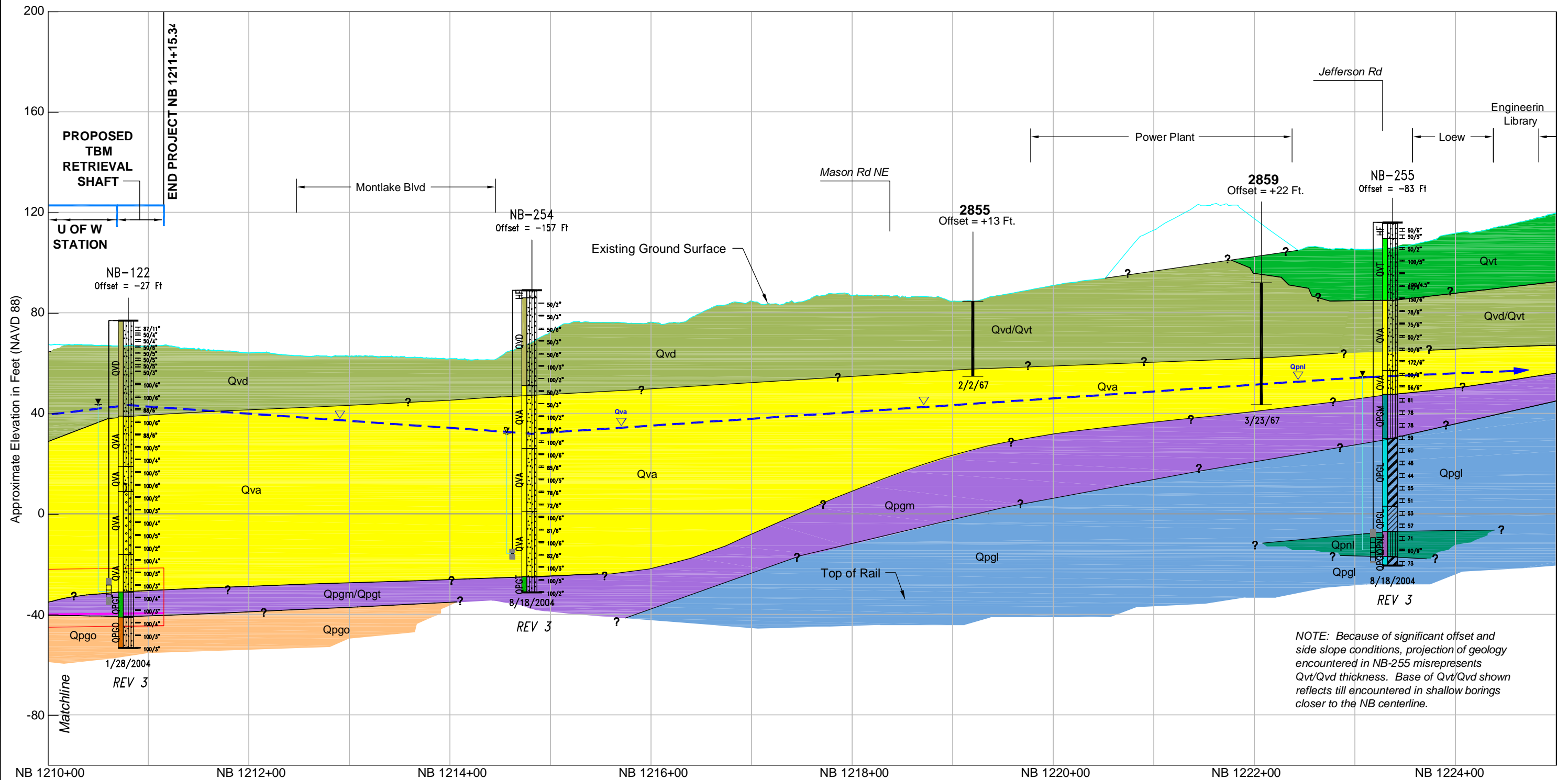
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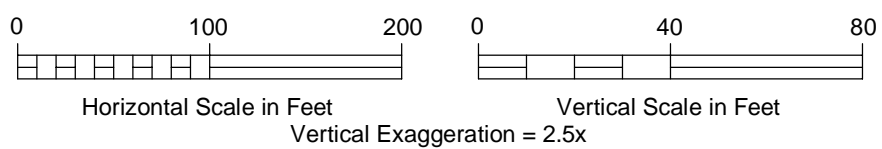
FIG. 7
Sheet 10 of 13

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NOTE: Because of significant offset and side slope conditions, projection of geology encountered in NB-255 misrepresents Qvt/Qvd thickness. Base of Qvt/Qvd shown reflects till encountered in shallow borings closer to the NB centerline.

NOTE
See Figures 5 and 6 for geologic unit explanation and profile legend and notes.



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GEOLOGIC PROFILE FOR UNIVERSITY LINK ALIGNMENT	
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SHANNON & WILSON, INC. Geotechnical and Environmental Consultants	FIG. 7 Sheet 13 of 13