Geologic and Engineering Services
Hillslope Area Between Schuster Parkway and Stadium Way
Tacoma, Washington

December 29, 2000

For
City of Tacoma

Geo Engineers

December 29, 2000

City of Tacoma
Department of Public Works
747 Market Street
Tacoma, Washington 98402

Attention: Kathy Van Pelt

We are pleased to present two copies of our "Report, Geologic and Engineering Services, Hillslope Area between Schuster Parkway and Stadium Way, Tacoma, Washington." The scope of services completed for this study is described in our proposal dated June 27, 2000. Our services were authorized by the City of Tacoma on August 3, 2000.

We appreciate the opportunity to be of service to the City of Tacoma. Please call if you have questions regarding this report.

Respectfully submitted,

GeoEngineers, Inc.

Jon W. Koloski
Principal

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TACOMA, WASHINGTON

INTRODUCTION

This report contains the results of our geologic and engineering evaluation of the effect of tree cutting on the hillslope stability between Schuster Parkway and Stadium Way in Tacoma, Washington. Our understanding of the project is based on conversations with you and the maps you provided on June 14, 2000. Our services have been performed in general accordance with our proposal dated June 27, 2000. The City of Tacoma authorized our services on August 3, 2000. The area on which this evaluation is focused is shown on the attached Vicinity Map, Figure 1.

Surficial landsliding has historically occurred within the study area. Some of the historical landslides have affected the function of Schuster Parkway. Logically, the City of Tacoma wishes to limit and/or reduce the amount of landsliding in the study area as much as possible. We understand that the City has received requests to cut trees within the project area to improve views from areas upslope of the study area. The purpose of our consultation is to evaluate the impacts of tree cutting in the study area relative to slope stability and landslide hazards.

PROJECT DESCRIPTION

The project study area consists of the undeveloped portion of the hillslope between Schuster Parkway and Stadium Way in Tacoma as shown on the Vicinity Map, Figure 1. The northwestern end of the project area is bordered by Borough Road (extended) along Garfield Park. The southeastern end is bordered by Stadium Way and Schuster Parkway (Highway 705) just southeast of Sixth Avenue (extended). The study area is approximately 6,600 feet in length. The hillslope varies from less than 100 feet wide on either end to about 400 feet wide near the center of the site. The ground surface in the study area rises steeply for as much as 200 feet from the toe of the slope to the streets, buildings and residential yards at the crest of the slope.

Stadium High School is located in the approximate center of the study area. For purposes of our study, the project area north of Stadium High School is called the "North Half" and the portion south of the high school is the "South Half", as shown in Figures 2A/2B through 5A/5B.

SCOPE OF SERVICES

The purpose of our services is to evaluate and map geologic features within the study area, including existing slide features, as a basis for ranking potential landslide hazard risk areas with respect to tree cutting. The specific scope of services completed for this project consists of the following tasks:

1. Research historical landslides and/or slope instability along the study area. Our research includes evaluation of GeoEngineers' in-house files, published reports and City of Tacoma records.
2. Review of previously published geologic maps and reports prepared for the site area and surrounding vicinity.
3. A detailed geologic reconnaissance of the site area.
4. Map observed landslides and/or areas of slope instability in the site area.
5. Develop a landslide hazard risk classification system based on our experience, research, observations and conversations with City of Tacoma personnel.
6. Develop a map of the landslide/slope instability areas based on the landslide hazard classification system noted above.
7. Summarize our observations and recommendations in a written report.

SITE CONDITIONS

GENERAL

The project area is located on the northeast margin of an upland plateau overlooking Commencement Bay in Tacoma, Washington. The area of interest consists of the undeveloped hillslope between Schuster Parkway and Stadium Way. The project area hillslope is the result of natural erosive processes and modification by development activities. All of the upland adjacent to the slope is developed with buildings and streets.

Development activity has occurred along the top and base of the slope for well over a century. A former roadway called Bayside Drive was located at the immediate base of the shoreline bluff. That road and multiple railroad tracks provided access to various shoreline industrial facilities. The shoreline was essentially fully developed from early in the 1900s until about the 1960s. Most of the original shoreline industrial development was removed by approximately the late 1960s. Schuster Parkway was constructed at the base of the shoreline bluff in the 1970s.

A mid-slope bench that extends nearly the full length of the North Half of the study area was also the location of a rail spur. Trestles extended from the mid-slope spur to some of the industrial facilities along the shoreline. That rail spur was abandoned and is now the location of a pedestrian trail. Several buildings that were partially excavated into the toe of the steep slope have been removed, except for portions of the original foundations.

Development along the southern top of the steep slope includes Stadium Way, Stadium High School and the Stadium Bowl (football stadium), together with some multi-story condominium residence buildings. North of the Stadium Bowl, the top of the slope is lined with single-family residences. These residences generally date to the late 1800s and early 1900s. The Stadium Bowl is constructed in a natural ravine, originally named "Old Woman's Gulch", that was partially filled in the 1930s.

TOPOGRAPHY

Virtually all of the study area is a steep slope. As noted above, the slope results from a combination of natural processes and development activities. The slope is generally aligned parallel to the Commencement Bay shoreline. The upper slope alignment is interrupted by one ravine located about 200 feet north of North 7th Street and by the ravine occupied by Stadium Bowl. Garfield Park, which marks the north end of the study area, is in a natural ravine that extends from the upland surface to the level of the existing shoreline.

The overall slope height varies from about 70 feet to more than 210 feet in the study area. Elevations at the site range from about 20 feet above sea level (MSL) along Schuster Parkway to about Elevation 230 feet MSL along the north portion of Stadium Way and to about Elevation 150 feet in the southern portion of Stadium Way.

We observed slope inclinations in the study area to range between about 20 degrees (from horizontal) and 90 degrees (i.e., vertical) with the average inclination of about 45 degrees (100%). Many areas of near vertical inclination are along the base of the bluff and are clearly the product of excavation for road construction. Near-vertical zones are also common along the mid-slope rail/trail bench; these are also excavated. Additional near-vertical areas occur near the top of the slope, but these are typically the head of past or active landslide areas. Slope inclinations are indicated in Figures 2A/2B. Retaining walls support only a very small portion of the overall slope. The primary wall locations are along the eastern (outboard) edge of Stadium Way south of Division Avenue and along the west edge of the southbound lanes of Schuster Parkway particularly at the extreme southern end of the project area. Aside from the very steep areas noted above, the slope stands as steep as the combination of surficial soil and vegetation will allow. Additional discussion of the geologic conditions, soils and hillslope stability conditions is presented in the following sections of this report.

VEGETATION

The vegetation we observed in the study area includes a comprehensive canopy of mature deciduous trees with some areas of small (recently trimmed) trees, some open grass and brush areas and a very limited area with essentially no vegetation. The character and distribution of vegetation in the study area is indicated on Figures 3A/3B.

It is significant that there are virtually no conifer trees in the mature forest, and we noted very few conifer stumps. We noted that the vast majority of trees are big leaf maple, red alder and black cottonwood. These species of trees are the most common in this region to voluntarily repopulate areas cleared of historical "native" trees. Clearing can occur deliberately, as with logging, or can be the result of landslides. We also observed a few poplars, oaks and other non-indigenous species.

Almost all of the mature deciduous trees are quite tall – typically 50 to 70 feet, and are about the same size. Many large trees have split or toppled. Some portions of the slope under the deciduous canopy forest are practically free of ground cover or understory brush, while moderate to dense brush and blackberry vines occur in other places. The open areas (with sparse or no trees) are characterized by dense grass cover and blackberry vines. The grass areas appear to have been hydroseeded.

The underbrush is most common where light penetration is best, e.g., where mature trees have been topped or removed, or where the trees have been displaced by past landslides. We noted that almost no underbrush occurs under the tall canopy trees in a large portion of the South Half of the study area. Trimming or pruning of trees has occurred along the upper portion of the slope, especially adjacent to the residences north of the Stadium Bowl. Additional tree crown trimming is evident along the east edge of the southern portion of Stadium Way. The upper slope trees have been completely removed immediately adjacent to the apartment buildings located just south of Stadium High School. A substantial amount of landscape waste has been dumped on the upper crest of the slope adjacent to these apartment buildings. Based on our conversations with City of Tacoma staff, we understand that trees in the project area were regularly topped or cut until the 1970s.

Throughout most of the project area, we noted that the mature deciduous trees are extensively invaded with climbing vines. In many places, the vines have reached the uppermost tips of the tree canopy. The climbing vines include ivy and nightshade. Many of the trees invaded by vines appear to be dead or dying.

We observed that both trees and brush in areas where springs occur (i.e., wet soil conditions) are the type that commonly prefer wet soils on a year-around basis suggesting that the springs are more or less perennial.

GEOLOGIC AND SOIL CONDITIONS

Our understanding of geologic conditions within the site area is based on a geologic reconnaissance performed at the site from September 14 to September 18, 2000, our review of published and unpublished reports and our experience. The approximate distribution of geologic materials at the site is shown in Figures 4A/4B.

The Puget Sound basin, including the project area, was covered on several occasions over the last 1-plus million years by glacial ice that advanced from the north then melted and disappeared. Between glacial periods climatic and geologic process conditions were similar to modern conditions. The time between glaciations is called an interglacial period. The most recent ice advance is called the Vashon glaciation – this ice reached a maximum thickness of approximately 2,000 feet or more in this project area, then melted and disappeared from this region approximately 12,000 years ago. The soils deposited during the pre-Vashon interglacial period are called the Kitsap formation. After disappearance of the Vashon ice, weathering, erosion and deposition processes similar to those of today resumed. All of the pre-Vashon soils were overridden and highly consolidated by the weight of the ice. The post-glacial soils are typically quite loose by comparison. Geologic materials exposed in the study area consist of a series of glacial and interglacial deposits, recently deposited colluvium, slide material, and fill.

The oldest geologic unit at the site is the Kitsap formation. The Kitsap formation in this area consists of two relatively distinct layers. The upper layer is very dense laminated silt and clayey silt with scattered fine sand lenses. The lower layer consists of a dense to very dense mixture of brownish-gray interbedded gravel and sand. The Kitsap formation is only exposed in the North Half of the project area. Very dense silt layers within the Kitsap formation commonly form near-vertical slopes at the site area; the Kitsap silt material severely restricts downward percolation of ground water.

Vashon advance outwash is mapped above the Kitsap formation. The advance outwash consists of medium dense to dense sand and gravel that was deposited by meltwater streams as the Vashon-age ice sheet advanced through the site area. Advance outwash was consolidated by the over-riding Vashon glacial ice sheet, but, due to the gradation, this outwash is highly permeable.

Vashon glacial till is mapped above the advance outwash, but we observed no exposures of till in the study area. Glacial till consists of a very dense mixture of silt, sand and gravel that was deposited and compacted at the base of the advancing ice sheet.

Fill may exist on the edges of yard areas at the top of the slope in the North Half of the site and may also be present beneath all or part of Stadium Way in the South Half of the site. The distribution and content of these fills is presently unknown. Fill exists in two additional areas of the site: an unnamed ravine located about 250 feet northwest of North 7th Street, and beneath the Stadium High School football stadium (Old Woman's Gulch). The content and history of the fill in the unnamed gully is unknown. Our understanding of the fill in Old Womens Gulch is based on our review of a report prepared by Hart Crowser in 1977. The fill is reported to consist of loose to dense silty sand with cinders and lenses of wood. The fill extends to a maximum depth of about 80 feet beneath the northern end of the football field, based on the report.

Recent slide material and colluvium consists of a mixture of native material in a loose to medium dense condition. Landslide-deposited material is generally found at the base of bluffs or at the base of slide scarps within the site area. A blanket of loose colluvium covers most of the hillslope in the study area, where the dense glacial and interglacial soils are obscured. All of the hillslope vegetation is rooted in colluvium or fill soils. The colluvium blanket is especially loose in the South Half of the study area where no ground cover of underbrush occurs.

GROUND WATER CONDITIONS

The occurrence of ground water depends on precipitation, topographic setting and geologic stratigraphy. Stormwater collection systems, and land uses can also influence the occurrence of ground water.

We observed and mapped about 20 springs during our site reconnaissance in September 2000. Dames & Moore identified 27 springs at the project site in 1970. Most of the springs identified by Dames & Moore were observed during our site reconnaissance. The approximate locations of the springs are shown in Figures 3A/3B.

The majority of the springs are located near the base of the advance outwash unit, near the contact between the advance outwash and the Kitsap formation and are typically located well above the base of the study area slope. As noted above, the silt layers in the upper portion of the Kitsap formation are relatively impermeable to the vertical flow of ground water.

We observed seven springs located within the advance outwash unit, about thirty feet above the contact between the advance outwash and the Kitsap formation; these springs are also well above the slope toe. These springs are located east of Division Avenue in the South Half of the site area and are shown on Figure 3B. These springs probably occur on a discontinuous silt layer within the advance outwash.

Flowing or standing water was observed at all the spring locations. We estimate that groundwater flow from the springs ranged from less than 1 gallon per minute to about 3 gallons per minute at the time of our site visits. We expect that the groundwater flow from the springs and seeps varies according to season. Higher flows can be expected during and immediately after the wet winter months. The hillslope is saturated below each of the springs. Some of the spring water flows directly to the base of the slope, while some is intercepted and diverted some distance by the mid-slope rail/trail bench.

SURFACE WATER CONDITIONS

Surface water can be a major factor in the destabilization of slopes. Surface water runoff sources include direct rainfall plus runoff from roof downspouts, storm sewer discharge pipes, infiltration facilities, impervious surfaces (streets) or from unpaved surfaces (lawns or undeveloped areas). Our reconnaissance was completed during a period of relatively dry weather and the presence of surface water flowing to the site from up-slope areas was not observed. Based on conversations with City of Tacoma personnel, we understand that surface water runoff from up-slope areas was historically discharged to street ends and/or to unnamed gullies on the hillslope. We also understand that surface water runoff from streets and sidewalks is now captured by the City of Tacoma storm sewer system, but discharge control from private properties is not documented.

LANDSLIDE HAZARDS

GENERAL

Historically, the primary type of landslide event to occur in this study area consists of earth/mud flows. These landslides ranged in volume from a few tens of cubic yards to a few thousand cubic yards. This type of failure involves the surface soils, such as colluvium and fill, but the underlying very dense native soils are only rarely included. These events almost always occur during or shortly following major precipitation events, especially when a heavy rain squall occurs within a prolonged period of wet weather. The direct cause is commonly concentrated surface water flow or broad area saturation of surface soils caused by rain-on-snow. The most severe type of event is a rapid failure of a significant volume of soil that liquefies and flows to the base of the bluff or beyond. The damage from earth/mud flow events is usually more pronounced at the toe of the slope or in the "run-out" area as compared to loss of ground support at the head of the slide. Large trees transported by earth/mud flows are particularly dangerous projectiles.

The areas most prone to earth/mud flow landslides are concentrations of loose fill or colluvium, especially those which do not have a protective vegetation cover or some type of external support, e.g., a retaining wall. Vegetation cover has a number of benefits. The roots add cohesion to loose soil. A dense evergreen canopy or ground cover of dense brush or grass protects the soil from direct impact of rainfall, thus providing erosion protection. Trees help to remove water from the soil through evapotranspiration. Conifer trees and evergreen shrubs transpire water year-round, but deciduous trees are only effective for that purpose when leaves are in place and growing.

The most effective type of vegetation is small- to moderate-sized healthy trees in combination with dense brush ground cover. Mature tall trees have a much lower ratio of root spread to height than more modest sized trees. The larger trees also have a large "wind sail" area and thus are more subject to toppling. Very often an actual landslide initiation occurs when a large tree topples and the uprooting action destabilizes a significant volume of loose saturated soil.

CITY OF TACOMA DEFINITION

Landslide hazards at the site were evaluated by a review of the City of Tacoma Municipal Code, Chapter 13-11, Critical Areas Preservation, revised June 2000, our observations at the site and conversations with City of Tacoma personnel. The City of Tacoma defines a Landslide Hazard Area as follows (quoted portion in italics):

1. *Any area characterized by slopes greater than 15 percent; and impermeable soils (typically silt and clay) interbedded with permeable granular soils (predominantly sand and gravel) or impermeable soils overlain with permeable soils; and springs and ground water seepage.*
2. *Any area which has exhibited movement during the Holocene epoch (from 10,000 years ago to present) or which is underlain by mass wastage debris of that epoch.*
3. *Any area potentially unstable due to rapid stream incision, stream bank erosion or undercutting by wave action.*
4. *Any area location on an alluvial fan presently subject to or potentially subject to inundation by debris flows or deposition of stream transported sediment.*
5. *Any area where the slope is inclined at an angle greater than the angle of repose of the soil.*
6. *Any area with a slope defined by the United States Department of Agriculture Soil Conservation Service as having a "severe" building limitation for building site development.*
7. *Any shoreline designated or mapped as Class U, Uos, Urs or I by the Washington Department of Ecology Coastal Zone Atlas.*

CONCLUSIONS AND RECOMMENDATIONS

GENERAL

The entire project area meets one or more of the criteria stated above for a Landslide Hazard Area, as defined by the City of Tacoma. It is noteworthy that the existing Landslide Hazard Area designation is not further subdivided to indicate a relative degree of risk. It is our opinion that the landslide hazard risk is not consistent throughout the site area, but the risk is significant throughout.

It is our opinion that appropriate trimming of trees as discussed below will not be detrimental to slope stability. Some vegetation management and enhancement is recommended that will help to improve relative slope stability conditions over the conditions that exist at this time. The recommendations include removal of some trees under closely controlled conditions. We also recommend that specific criteria be developed for tree trimming or removal.

We conclude that some additional research should be conducted to evaluate public and private storm drainage measures adjacent to the study area.

LANDSLIDE HAZARD RISK EVALUATION

Our evaluation of landslide risk within the study area results in two qualitative risk categories: Moderate Risk and High Risk Landslide Hazard Areas as described below. Ordinarily a "Low Risk" category should also be defined, but in our opinion that is not appropriate for this study area.

All of the project area is mapped as High Risk to Moderate Risk landslide hazard area. The highest risk areas generally consist of the steepest slopes, poor or no stabilizing vegetation, water-softened areas, advance outwash over Kitsap formation silt and existing or historic slide areas. Several of the mapped High Risk landslide hazard areas occur near the end of streets up-slope of the study area. This may indicate active or historical disposal of surface water runoff in these areas. The disposal of storm runoff from private property was not investigated a part of this study, but that source of water is a likely contributory cause of hillslope instability. Many other past or active landslide areas are directly related to springs or seeps.

In our opinion "Moderate Risk" areas as those that appear to be relatively stable in their present configuration. "High Risk Areas" are those which are marginally stable (or unstable) in their present configuration, typically because of a number of interrelated factors as listed below.

Removal of most, or all, vegetation in either of these areas would have a decided negative impact on slope stability in the immediate and adjacent areas. As noted below we recommend activities to encourage more vegetation development throughout the hillslope. The approximate distribution of the Moderate Risk and High Risk landslide hazard areas are shown in Figures 5A/5B. The criteria we considered to define the risk areas are as follows:

Moderate Risk Landslide Hazard Areas

- All of the study area slope that is more than 20 feet outside of areas designated as a High Risk potential.

High Risk Landslide Hazard Areas

- All slopes steeper than 15 percent.
- Within 20 feet of active and historic landslide areas.
- Hillslope areas above springs or seeps and water-softened or marshy areas down-slope of seepage areas.
- Hillslopes with observed surficial instability (creep).

VEGETATION IMPACTS

In our opinion, it is possible to top or trim any of the existing trees in the study area as long as the pruning does not kill the tree. It should be noted that tree stump root systems will rot after about 5 to 7 years. Decomposed roots will leave voids in the soil. The voids will act as conduits for surface and ground water, potentially lowering the overall stability of the slope. It is also our opinion that dead trees or those in serious jeopardy of survival should be felled.

We recommend that all tree trimming or removal be accomplished with minimum disturbance to the surrounding soil. Trees that must be felled or trimmed should be considered individually relative to access, the method of removal or trimming and the disposition of the limbs and/or trunks. We further recommend that trimming or pruning be accomplished to result in a generally uniform tree height.

We recommend that dense, low vegetation growth at the site be encouraged, especially in areas where existing ground cover is sparse or absent. The ground cover vegetation can consist of shrubs and low trees and particularly evergreen brush. The vegetation will improve slope stability by limiting erosion and by increasing evapotranspiration of surface and ground water. We recommend that an arborist be consulted to:

1. Develop specific details for trimming, pruning and/or removal of trees depending on the species, vitality and other relevant factors.
2. Develop recommendations for dealing with the trees that are invaded with climbing vines.
3. Provide recommendations for the type of ground cover that will function as noted above and be suitable for the site conditions.

DRAINAGE IMPROVEMENTS

We recommend that the City of Tacoma investigate surface water runoff patterns in the area immediately up-slope of the project area. As previously stated, High Risk landslide areas were mapped down-slope of the intersections of North 6th and Stadium Way, North 4th and Stadium Way, Division Avenue and Stadium Way, and South 4th and Stadium Way. The existence of these features relative to the roadway intersections may indicate discharge of surface water runoff to the hillslope in these areas.

We recommend drainage improvements be accomplished to reduce the area and extent of saturated surface soils caused by water emerging from seeps and springs. The measures will reduce the potential for massive ground movement as well as the potential for erosion/sedimentation in the presently saturated areas. The details of the drainage recommendation are not a part of this consultation, but we would be please to assist the City in such an effort.

We appreciate the opportunity to be of continued service to the City of Tacoma on this project. Please contact us if you have questions regarding this revised report.

Yours very truly,

GeoEngineers, Inc.

Stephen W. Helvey
Project Geologist

Jon W. Koloski
Principal

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Doc ID: 057004700R2.Doc

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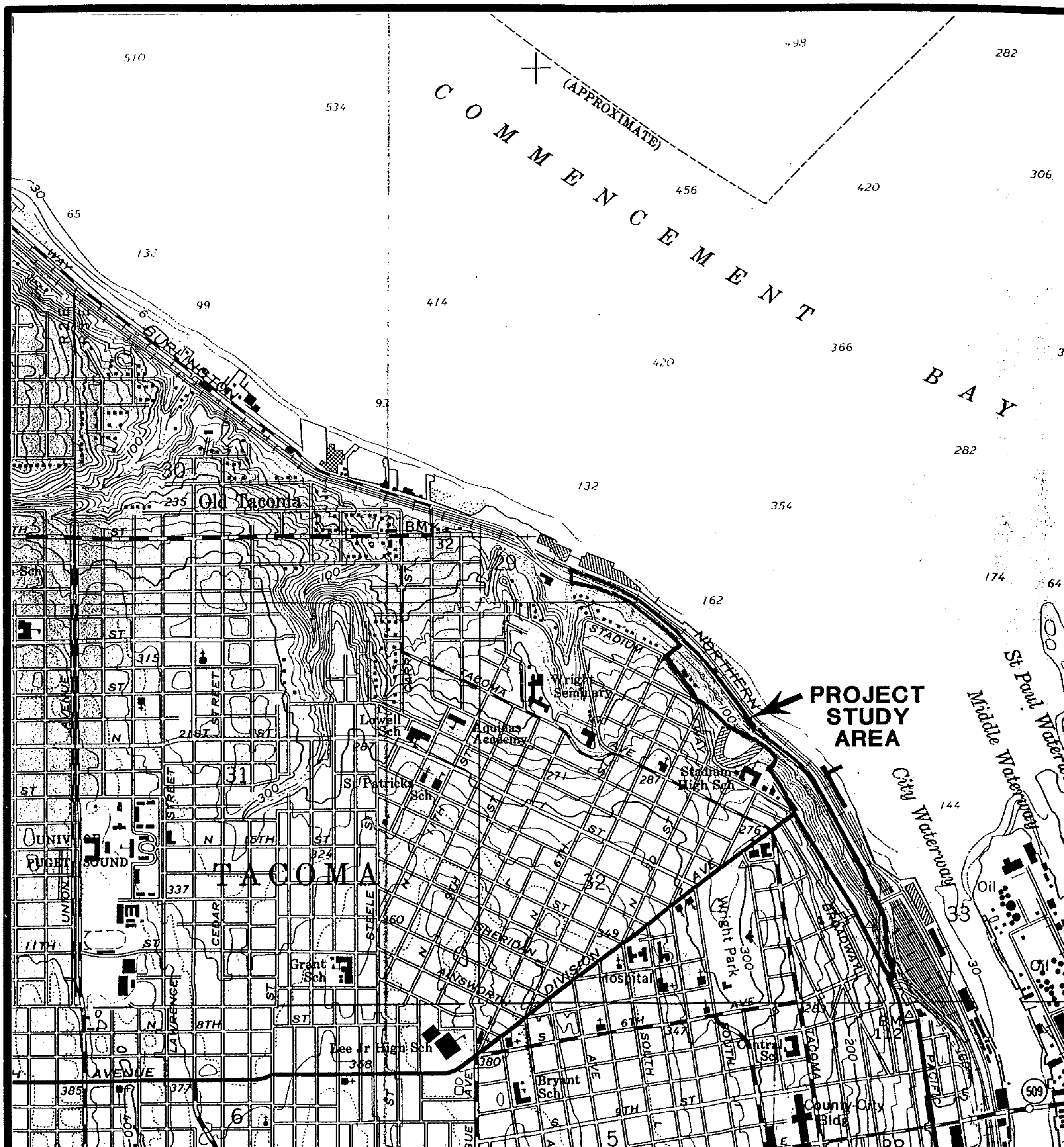

0 2000 4000

SCALE IN FEET

N

Reference: USGS 7.5' topographic quadrangle map, "Tacoma North, WA," dated 1961 photorevised 1981.

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VICINITY MAP

FIGURE 1

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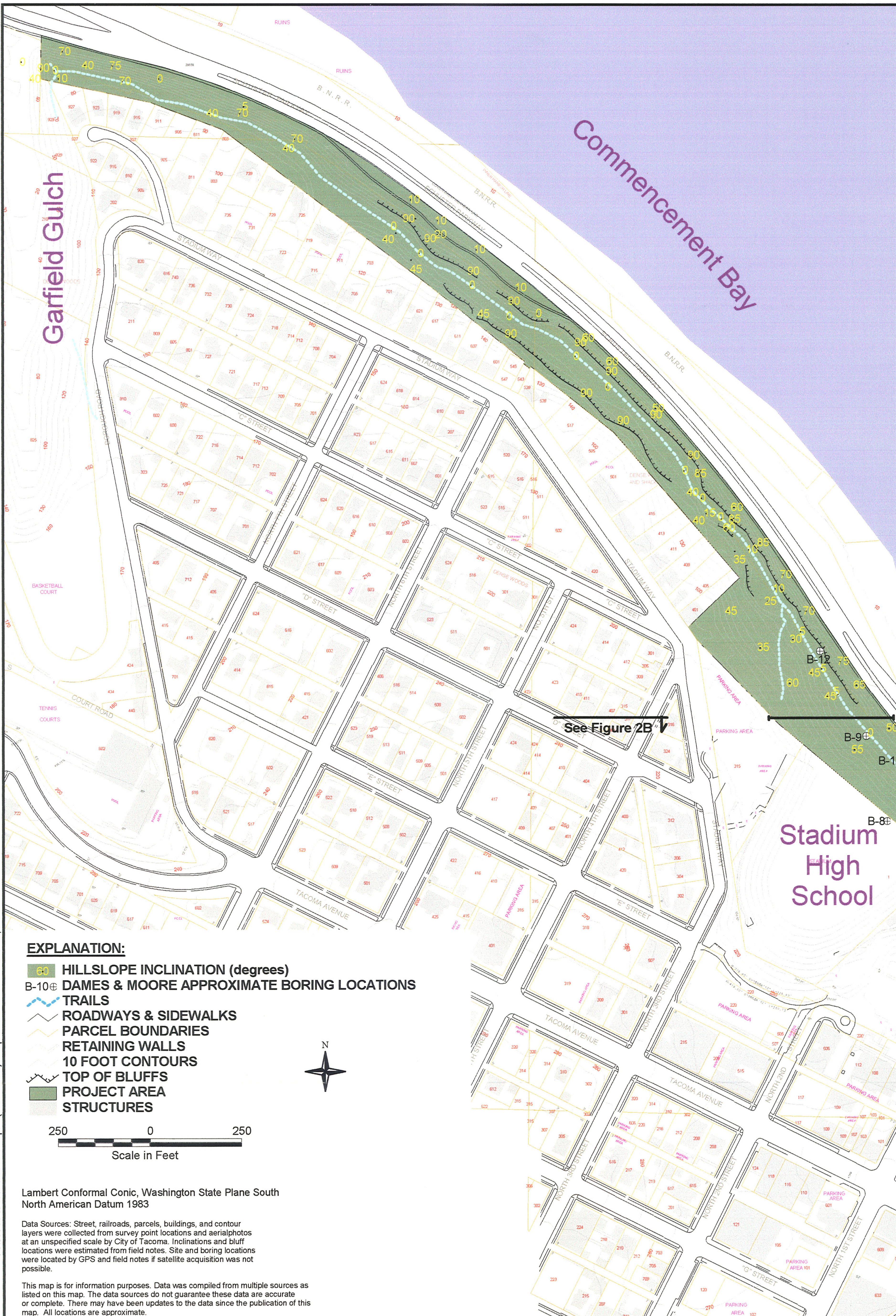

EXPLANATION:

- 60 HILLSLOPE INCLINATION (degrees)
- B-10⊕ DAMES & MOORE APPROXIMATE BORING LOCATIONS
- TRAILS
- ROADWAYS & SIDEWALKS
- PARCEL BOUNDARIES
- RETAINING WALLS
- 10 FOOT CONTOURS
- TOP OF BLUFFS
- PROJECT AREA
- STRUCTURES

250 0 250
Scale in Feet

Lambert Conformal Conic, Washington State Plane South
North American Datum 1983

Data Sources: Street, railroads, parcels, buildings, and contour layers were collected from survey point locations and aerialphotos at an unspecified scale by City of Tacoma. Inclinations and bluff locations were estimated from field notes. Site and boring locations were located by GPS and field notes if satellite acquisition was not possible.

This map is for information purposes. Data was compiled from multiple sources as listed on this map. The data sources do not guarantee these data are accurate or complete. There may have been updates to the data since the publication of this map. All locations are approximate.

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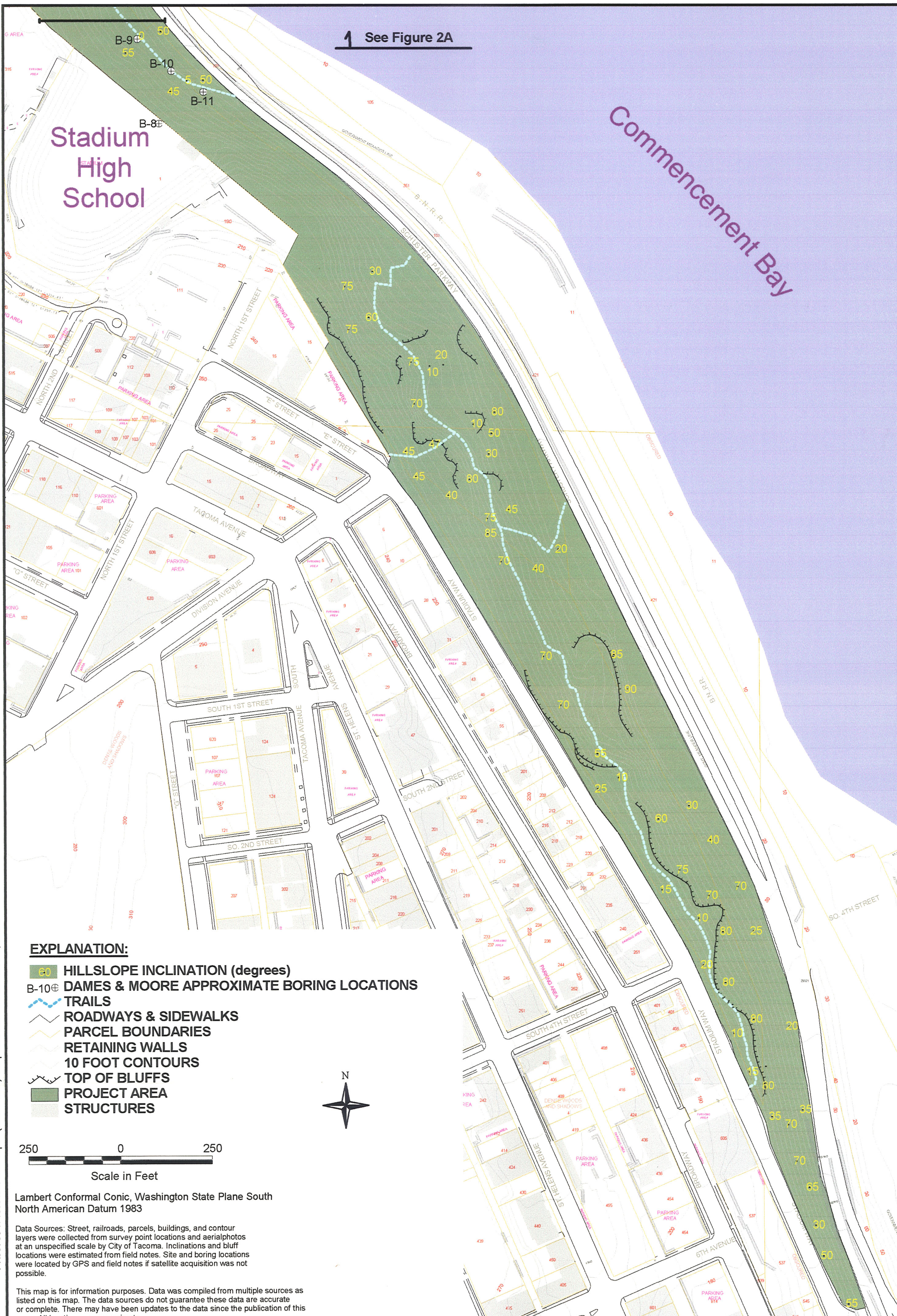
PROJECT SITE MAP:NORTH HALF

FIGURE 2A



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PROJECT SITE MAP: SOUTH HALF

FIGURE 2B

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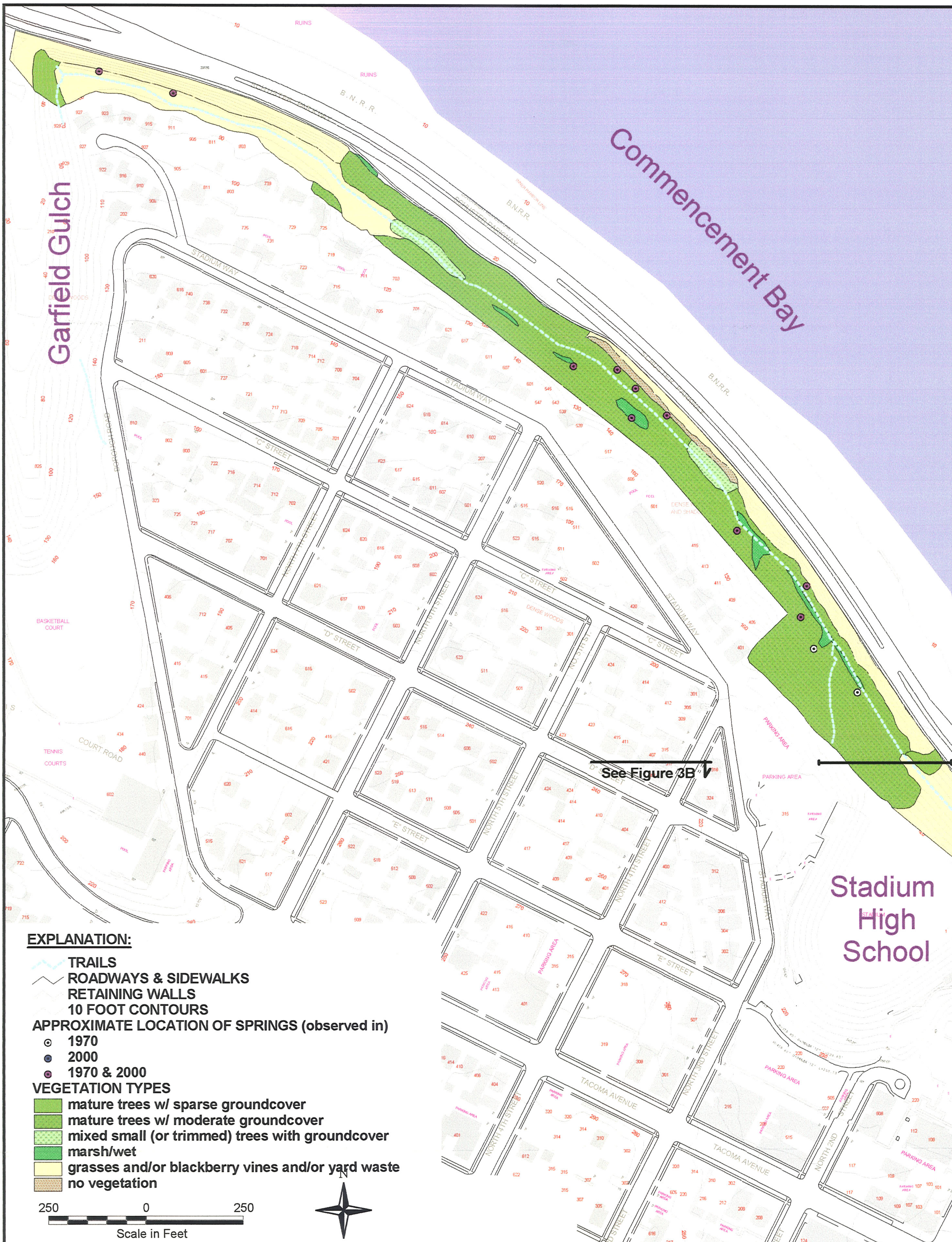

Lambert Conformal Conic, Washington State Plane South
North American Datum 1983

Data Sources: Street, railroads, building, and contour layers were collected from survey point locations and aerialphotos at an unspecified scale by City of Tacoma. Vegetation boundaries and bluff locations are estimated from field notes. Seeps were located by GPS and field notes if satellite acquisition was not possible.

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VEGETATION TYPES:NORTH HALF

FIGURE 3A

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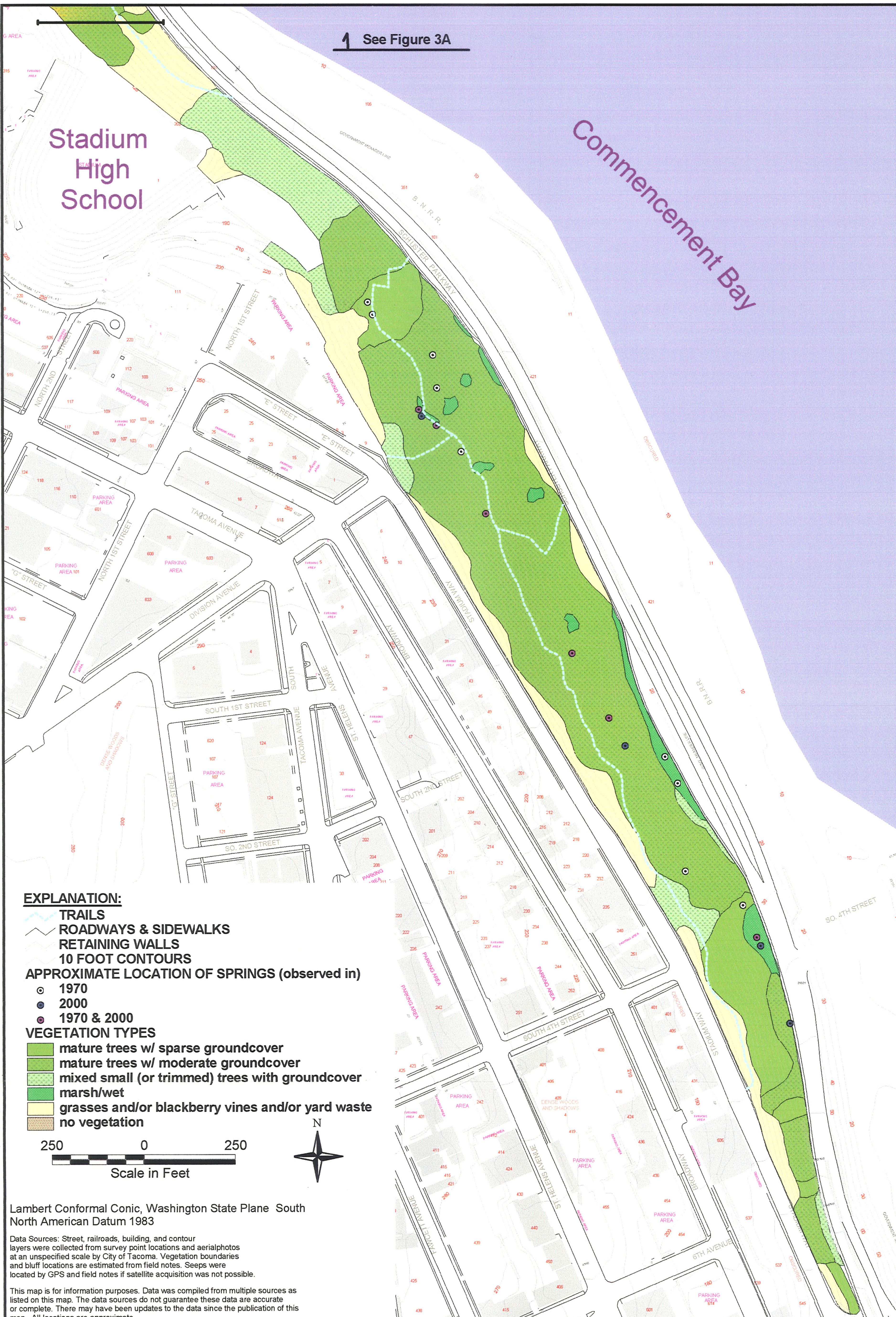

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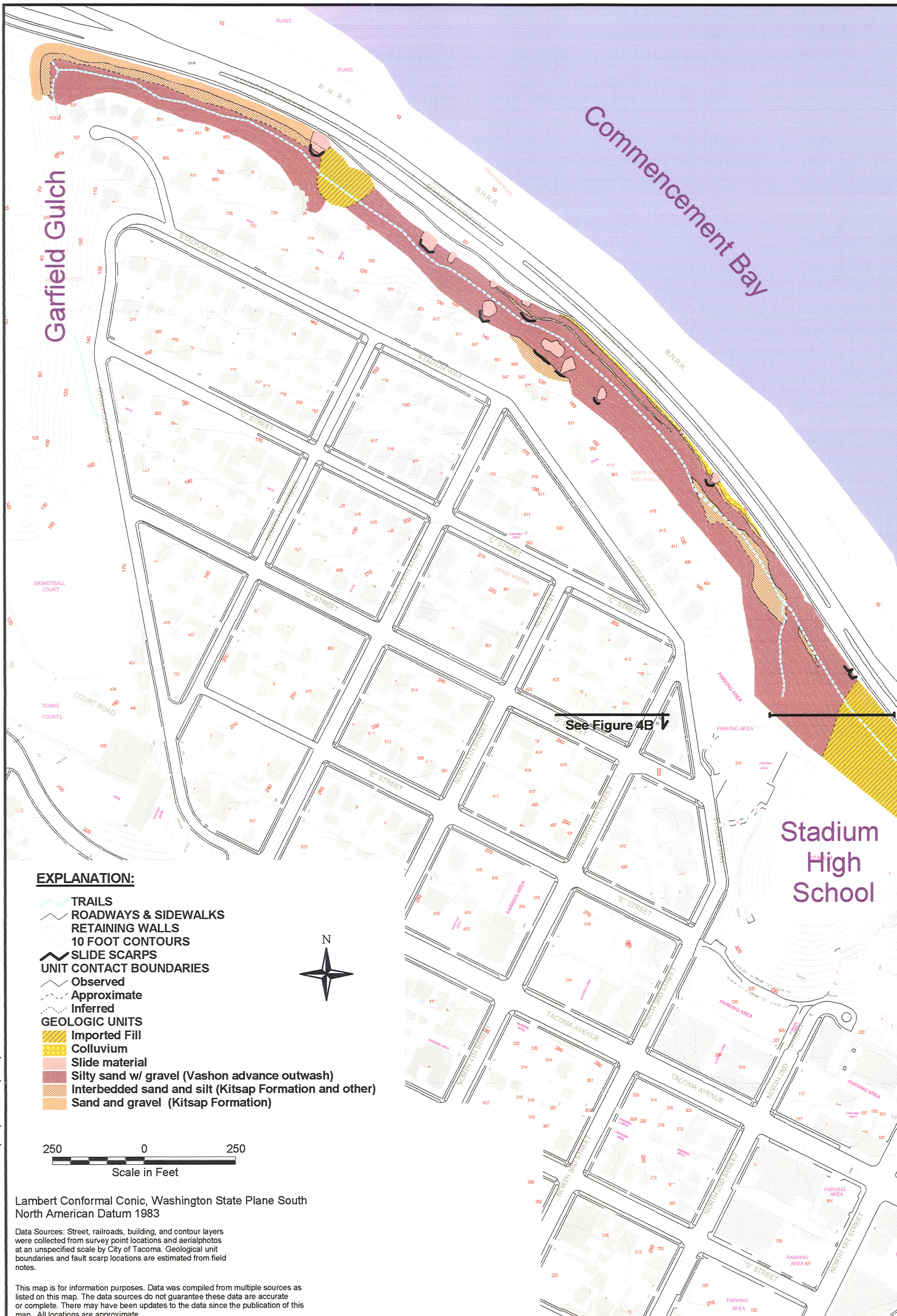
VEGETATION TYPES:SOUTH HALF

FIGURE 3B



Lambert Conformal Conic, Washington State Plane South
North American Datum 1983

Data Sources: Street, railroads, building, and contour layers were collected from survey point locations and aerialphotos at an unspecified scale by City of Tacoma. Geological unit boundaries and fault scarp locations are estimated from field notes.

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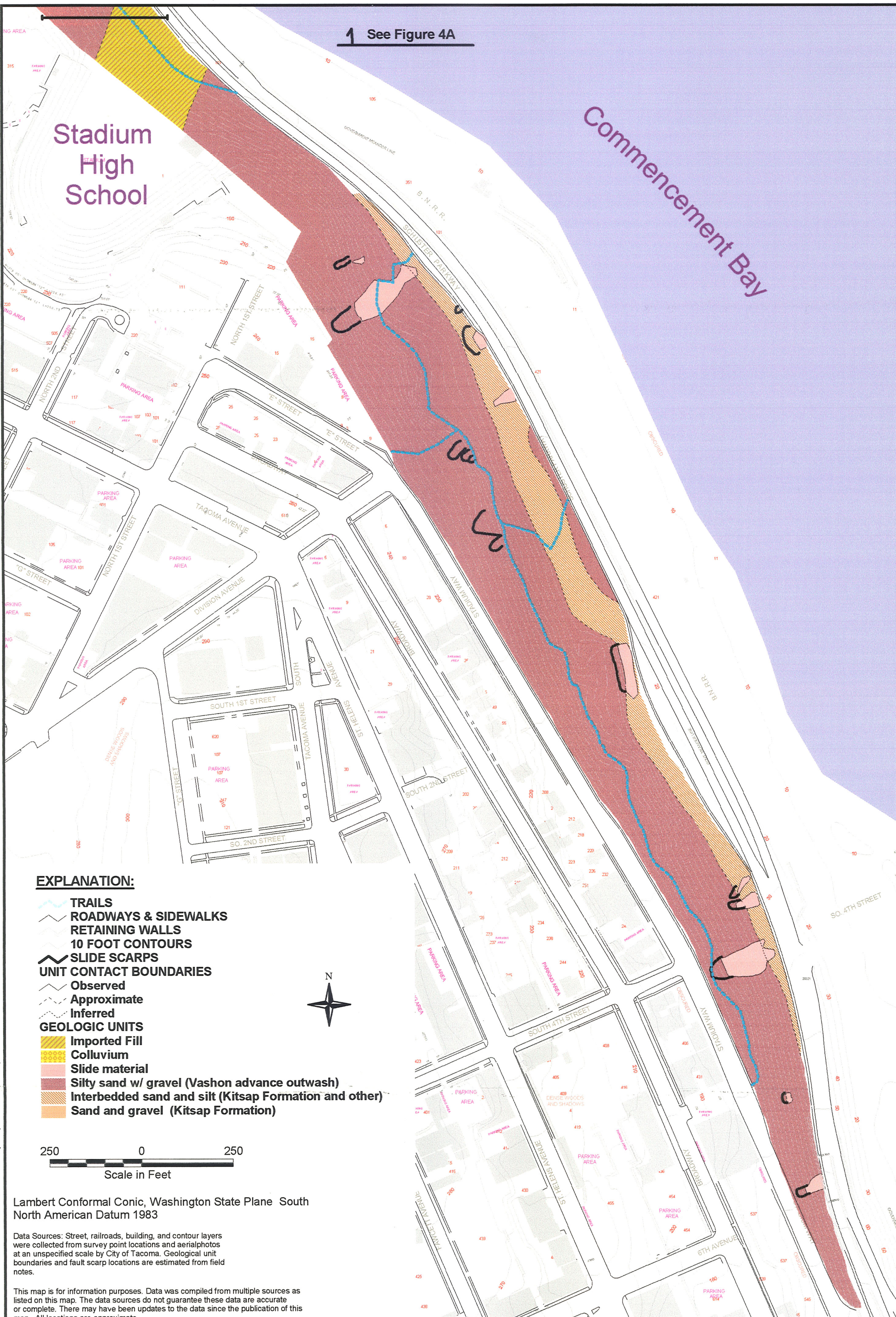
GEOLOGIC MAP:NORTH HALF

FIGURE 4A



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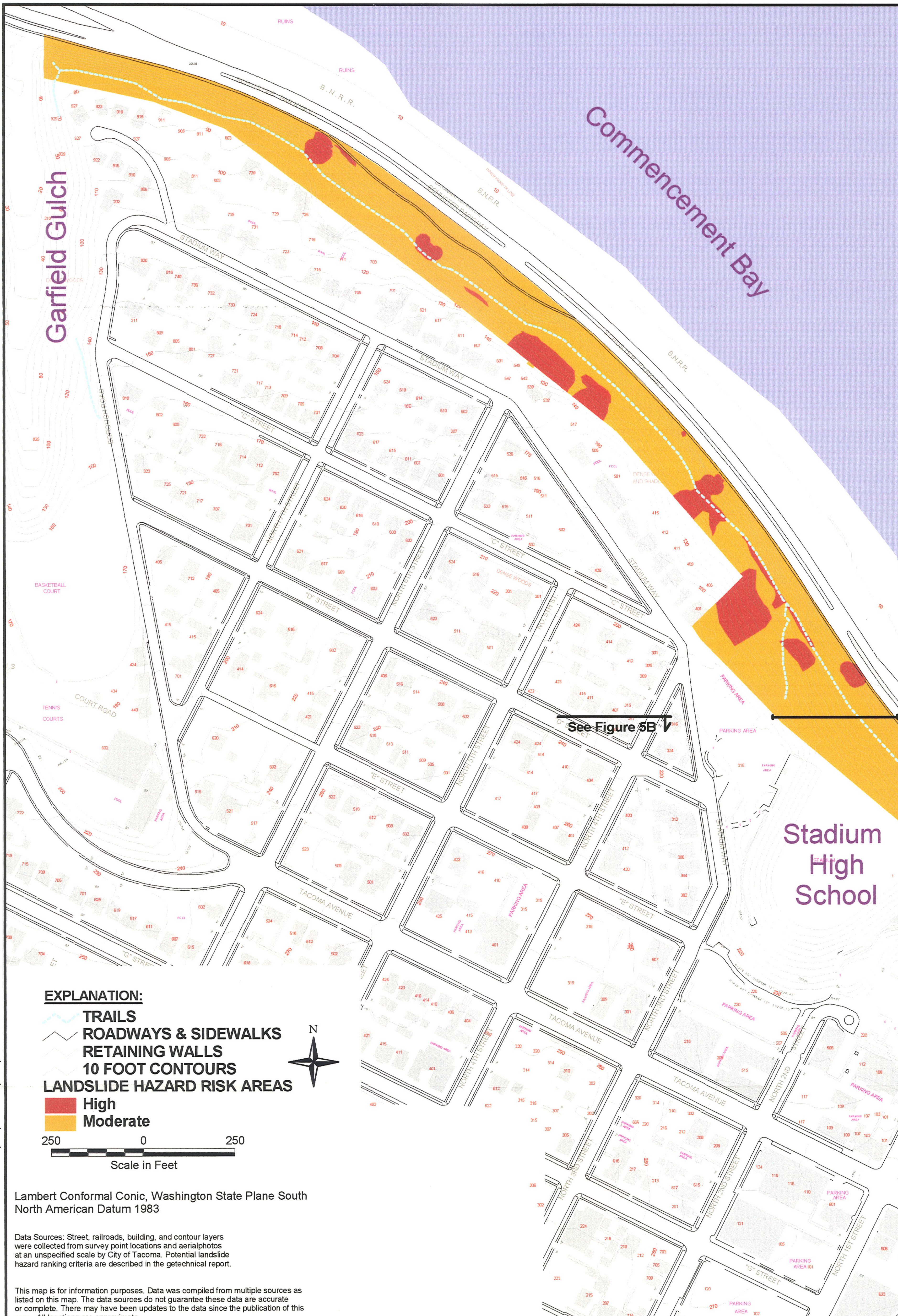
GEOLOGIC MAP:SOUTH HALF

FIGURE 4B



EXPLANATION:

TRAILS
ROADWAYS & SIDEWALKS
RETAINING WALLS
10 FOOT CONTOURS

LANDSLIDE HAZARD RISK AREAS
High
Moderate

250 0 250
Scale in Feet

Lambert Conformal Conic, Washington State Plane South
North American Datum 1983

Data Sources: Street, railroads, building, and contour layers were collected from survey point locations and aerialphotos at an unspecified scale by City of Tacoma. Potential landslide hazard ranking criteria are described in the getechnical report.

This map is for information purposes. Data was compiled from multiple sources as listed on this map. The data sources do not guarantee these data are accurate or complete. There may have been updates to the data since the publication of this map. All locations are approximate.

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LANDSLIDE HAZARD RISK AREAS:NORTH HALF

FIGURE 5A

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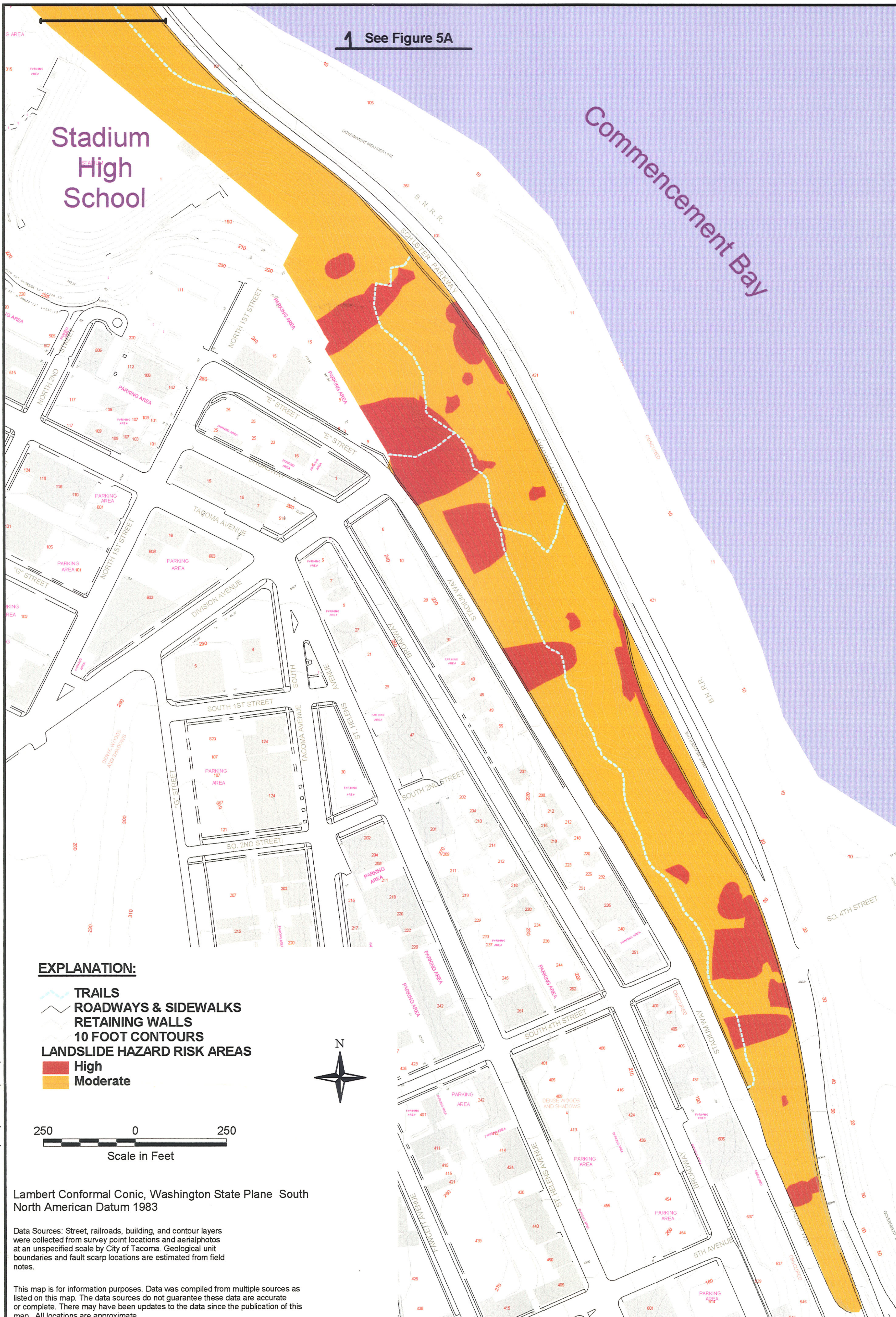

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LANDSLIDE HAZARD RISK AREAS:SOUTH HALF

FIGURE 5B

P:\0570047\GIS\0570047.apr (Hazs17P) Map Revised: December 29, 2000

DJS