FILE

Washington State
Department of Transportation

Memorandum

10/9/02

TONY M. ALLEN
STATE OF WASHINGTON
25530
REGISTERED
PROFESSIONAL ENGINEER
EXPIRES JULY 1, 2003

October 9, 2002

TO: J. Weigle/J. Kapur
Bridge and Structures, 47340

FROM: T.M. Allen/W.S. Hegge
OSC Geotechnical Branch, 47365

SUBJECT: SR-104, OL 3305
Hood Canal Bridge Replacement
Geotechnical Recommendations for Anchor Design

INTRODUCTION

At your request, we have prepared the following technical memorandum that summarizes the results of our geotechnical study for the anchors for the proposed replacement of the eastern portion of the Hood Canal Floating Bridge. We understand that you will use the information contained in this memorandum for the final design of the anchors for the proposed bridge replacement.

The analyses, conclusions, and recommendations provided in this report are based on the project description, and site conditions existing at the time of our site visits. The exploratory borings are assumed to be representative of the subsurface conditions at the locations throughout the site. If during construction, subsurface conditions differ from those described in the explorations, we should be advised immediately so that we may reevaluate our recommendations and provide assistance.

PROJECT HISTORY

The Hood Canal Bridge provides a crossing for State Route 104 across Hood Canal, at the western end of Puget Sound near Port Gamble, Washington. Hood Canal forms a natural barrier between Kitsap County and the Olympic Peninsula. The location of the bridge is shown in the Vicinity Map (Figure 1).

The bridge is approximately 1½-miles long, consisting of 836 lineal feet of fixed approach structure, 6470 lineal feet of floating structure, and two steel truss transition spans, each

approximately 280 feet long. These transition spans are located at each end of the bridge, connecting the fixed approach structures with the floating pontoon-supported portion of the bridge. A 28-foot wide, two lane roadway is elevated approximately 20 feet above the water surface on a typical girder concrete viaduct structure, supported by floating pontoons.

The anchorage system for the bridge was designed to provide resistance to both longitudinal and transverse forces. The longitudinal resistance is provided at each end of the bridge through a connection to the fixed approach structures. The transverse resistance is provided by anchor cable connections to submerged anchors. In the original 1950's design, this anchorage system consisted of 42 concrete anchor blocks, each 20 feet by 40 feet by 16 feet high. The anchor cable connection at the top of the anchor was angled upwards at an angle of approximately 12 to 20 degrees.

Construction of the bridge began in 1958. By midwinter of 1959-60, all of the permanent anchors had been placed and 10 bridge pontoons had been installed. On January 29th and February 2nd, 1960, severe storms damaged the structure, most noticeably at the bolted joints connecting the pontoons. Following an independent review, the design and construction methods were modified and the remainder of the bridge was constructed. The bridge was officially opened to traffic on August 12, 1961.

On February 13, 1979, the bridge was subjected to a severe storm with southerly winds exceeding 80 mph, which resulted in the sinking of the 3,775-foot long western section of the floating structure. In addition to this loss, portions of the western transition structure fell into the canal. The landward end of this truss was still supported by a fixed pier. Several studies were conducted to determine the cause of the failure and a new design was prepared for the reconstruction of the entire floating portion of the bridge. Following completion of this design, the western section of the bridge was replaced in 1980. Upgrades were also made to the west transition span and supporting pier. The anchors were changed to circular anchors with an anchor cable connection at each side of the anchor that is angles upwards at eight degrees. Two sizes of anchors were used, a Type 1 Anchor (46 feet in diameter and 26 feet high) and a Type 2 Anchor (56 feet in diameter and 26 feet high).

The eastern portion of the bridge that survived the February 13, 1979 storm was left in service. This portion of the bridge contains a 2695-foot long floating section and the 280-foot long eastern transition span. At the present time, the eastern section of the bridge and both approach spans dating back to the original construction in 1960 are scheduled for replacement.

PROJECT DESCRIPTION

As part of this project, the anchors and anchor cables holding the eastern potion of the bridge will be replaced. The new anchors will consist of concrete cylinders filled with rock ballast. Two anchor types are proposed. The smaller Type 1 anchor has a height of 26 feet and a diameter of 46 feet. The larger Type 2 anchor also has a height of 26 feet and a diameter of 46 feet, but is modified by adding a square concrete base to provide a larger bearing area. These square concrete bases are 50 by 50 feet in size by two feet thick. Concrete shear keys will be

attached to the base of the anchors. These shear keys will be constructed from reinforced concrete cast-in-place as part of the anchor. These shear keys will project 2 feet below the base of the anchors. A preliminary design of these anchors (without the square bases for the Type 2 anchors) is shown in Figure 3.

The purpose of the current investigation was twofold. First, to re-evaluate the geotechnical design parameters used in the 1980 design of the proposed anchors for the floating portion of the bridge, and second, to develop geotechnical design parameters for the reconstruction of the east and west fixed approach spans, which was not addressed in the 1980 design. This technical memorandum will be limited to an evaluation of the proposed anchors for the floating portion of the bridge. A second technical memorandum will be prepared to address the approaches.

PREVIOUS STUDIES

Previous exploratory work in the project vicinity and associated geotechnical studies have been prepared by WSDOT and several geotechnical consultants. The original geotechnical investigations to support the 1960 design are not available for review at this time. However, several studies were conducted following the 1979 failure, which are available at our office for review at this time. These studies are as follows:

"Geotechnical Engineering Studies, Hood Canal Floating Bridge for Tokola Offshore, Inc., Part I: Anchor Design Studies, Phase II, and Part II: Hood Canal Bridge Survey" prepared by Dames and Moore and dated October 12, 1979. This report presents the results of their geophysical studies and bottom soil sampling survey conducted during the period of August 27 through 30, 1979. This report also presents the results of their anchor design studies regarding the preliminary feasibility evaluation of several new anchor types.

"Report, Geotechnical Investigation, Final Design, Hood Canal Bridge for the State of Washington Department of Transportation" prepared by Dames and Moore and dated August 14, 1980. This report presents the results of an additional field exploration program that included rotary wire line drilling and vibracoring. This report also presents the results of their slope stability and liquefaction potential of the subsurface materials in the vicinity of the proposed anchors.

"Report, Hood Canal Bridge Geophysical Survey for the State of Washington Department of Transportation" prepared by Dames and Moore and dated April 2, 1982. This report presents the results of an additional field exploration program that included geophysical studies in the close proximity of the new anchor locations and a diving inspection of Anchor A South.

"Seismic Evaluation, Hood Canal Floating Bridge, Kitsap and Jefferson Counties, Washington" prepared by Shannon and Wilson, Inc. and dated March 1993. This report presents the results of a seismic risk assessment, an evaluation of geologic hazards, and a liquefaction evaluation.

"Hood Canal Floating Bridge Seismic Evaluation for the Washington Department of Transportation" prepared by KPFF Consulting Engineers and dated June 1993. This report presents the results of a seismic evaluation of the bridge structural design.

Previous Anchor Design

The anchors for the entire bridge were redesigned following the 1979 failure. These redesigned anchors were used in the reconstruction of the western half of the bridge in 1980. The design calculations and plans for these anchors are available at our office for review at this time. These design documents are as follows:

"Hood Canal Bridge Replacement Part II, Gravity Anchors – West Span, Soils and Foundation Analysis, Chapter 21" prepared by Parsons Brinkerhoff Quade and Douglas, Inc. and Raymond Technical Facilities Inc. and dated August 1980. This document briefly described the field investigation efforts, site conditions and explicitly defined the design parameters and methods of calculation used to determine the required buoyant weights of the anchors for the western half of the bridge that was replaced in 1980.

"Hood Canal Bridge Replacement Part II, Gravity Anchors – West Span, Soils and Foundation Analysis, Appendix II, Chapter 21" prepared by Parsons Brinkerhoff Quade and Douglas, Inc. and Raymond Technical Facilities Inc. and dated October 1980. This document contained copies of the design calculations used to determine the required buoyant weights of the proposed anchors for the western half of the bridge that was replaced in 1980.

"Hood Canal Bridge Replacement - Units 2 & 3, Substructure Calculations, Chapter P7, Gravity Anchors – Soil and Foundation Analysis" prepared by Parsons Brinkerhoff Quade and Douglas, Inc. and Raymond Technical Facilities Inc. and dated 21 September 1981. This document defined the design parameters and methods of calculation as well as copies of the design calculations used to determine the required buoyant weights of the proposed anchors for the entire bridge.

SITE CONDITIONS

Topography

The Hood Canal Floating Bridge is located along the western boundary of the Puget Lowland, a long north trending structural and topographical depression between the Cascade Mountains on the east and the Olympic Mountains to the west. The Puget Lowland is part of a large glacial drift plain, characterized by low, gently rolling north-south trending ridges, separated by valleys, one of which is occupied by Hood Canal. The bridge alignment crosses Hood Canal near its northern end, between Termination Point and Salisbury Point. In this vicinity, the ground surface rises from sea level to approximately 400 to 500 feet in elevation. Most of the slopes between the upland area and Hood Canal are steep, with bluffs commonly up to 50 feet high.

In the vicinity of the bridge alignment, the canal is approximately 1 1/2 –miles wide and up to 335 feet deep. The sea bottom slopes are generally steeper in the mid-depth zone and flatter in mid-channel. Slopes in the mid-depth zone average 12 percent except along the northern line of the proposed anchors on the eastern portion of the bridge, where the slope is approximately 15 percent in the depth range of 90 to 250 feet. In the vicinity of Anchor T North, the sea bottom reaches a slope of approximately 22 percent, significantly steeper than any other portion of the project.

Geology

We have reviewed the following publications describing the geology in the vicinity of the project site:

"Quaternary Geology and Stratigraphy of Kitsap County, Washington," a Masters Thesis prepared by Jerald D. Deeter as part of the requirements for the Degree of Master of Science from Western Washington University and dated 1979.

"Water Supply Bulletin No. 54, Geology and Ground Water Resources of Eastern Jefferson County, Washington" prepared by Peder Grimstad and Robert J. Corson, published by the Washington State Department of Ecology and dated April 1989.

Coastal Zone Atlas of Washington, Publication # DOE 77-21" prepared by the State of Washington Department of Ecology and dated July 1979.

The Puget Sound Basin was formed approximately 17 million years ago during the uplift of the Olympic Mountains during the Miocene. Bedrock comprising the basin consists of Tertiary marine sandstone, shale, and conglomerate along with volcanic basalt, andesite, and volcanoclastics. The basin was the site of Pleistocene deposition of glacial sands and gravels by the Cordilleran Ice sheet during repeated glaciations. Temperature fluctuations caused the glaciers to advance and withdraw at least four times during the Pleistocene, with each major period of glaciation (designated Stades) separated by interglacial periods (designated Interstades).

These Pleistocene glacial deposits are complex, containing lacustrine sediments, advance outwash sands and gravels, glaciomarine drift, till (both lodgement and ablation), and recessional outwash. These sediments may be about 1,200 feet thick at the east abutment of the bridge and less than 100 feet thick at the west abutment. Holocene alluvial deposits of sand, silt and peat overlie the glacial sediments in the low-lying areas of the basin. While these Holocene deposits may be absent in the upland areas, they may be several hundred feet thick in the low-lying areas of the basin.

The most detailed geologic mapping available is in the Coastal Zone Atlas referenced above. This publication indicates that "Vashon Till" underlies the eastern end of the bridge. This material is described as being a very compact, poorly sorted, nonstratified mixture of gravel,

sand, silt and clay with occasional boulders. This material is mapped as stable on the slope stability map in the Coastal Zone Atlas.

The Coastal Zone Atlas indicates that the materials in the vicinity of the western end of the bridge are more complex. Along the shoreline, the material in the immediate vicinity of the bridge abutment is mapped as "Artificial fill". Artificial fill is described as an area where humans have modified the topography by the placement of soil, sediments, rock, vegetative debris, garbage, and other assorted and varied types of material. This unit includes riprap, and is generally more than 10 feet thick. This material is mapped as modified on the slope stability map. The material located immediately shoreward of the Artificial Fill is mapped as "Undifferentiated Stratified Sediments Older than Vashon Lodgement Till". This material consists mainly of sand and gravel, but in some areas silt, clay, peat and possibly till. This material is mapped as unstable on the slope stability map. The area shoreward of the Undifferentiated Stratified Sediments is mapped as "Vashon Lodgement Till". This is a compact mixture of boulders, cobbles, silt and clay generally overlain by one to five feet of ablation till. The total thickness of this deposit may approach 100 feet. This material is mapped as stable on the slope stability map.

Soils

The subsurface conditions at the project site fall into three broad areas of interest, the west abutment, the east abutment and the proposed anchor locations. This memorandum is only concerned with the subsurface conditions at the proposed anchor locations.

Previous Explorations

Subsurface conditions at the proposed anchor locations were explored in two previous field exploration programs in 1979 and 1980. The field explorations included geophysical lines and vibracores in the vicinity of the proposed anchors. Vibracores are taken using a 40-foot long plastic core barrel with an inside diameter of 3.5-inches mounted on a weighted tripod that is lowered to the seafloor by cable. The vibracore tube is vibrated into the subsurface materials to obtain a sample. The subsurface conditions encountered are included in Appendix B. This appendix references the earlier reports in which the methods and equipment used are described in detail.

The data from these previous explorations indicated that, discounting the debris from the sunken portion of the bridge and the bridge anchors, the ground surface in the area of the proposed anchors is essentially featureless with the exception of an area south of the bridge center. Large ripple marks, with the crests of the ripples oriented perpendicular to a northwest to southeast line, were observed. These areas of large ripple marks, designated Mega Ripples, are shown on the Site Plan, Figure 2. Subbottom profiles in the vicinity of the north and south lines of proposed anchors are shown in Appendix B. These profiles were developed from the information obtained in the previous field explorations. The upper portion of each figure presents the data from the geophysical line conducted closest to the line of proposed anchors.

The lower portion of each figure presents an assessment of the subbottom conditions developed from all of the previous investigation data.

As indicated on the subbottom profiles in Appendix B, the line of the proposed anchors appears to be underlain by loose to medium dense sandy silt or silty sand, loose to medium dense silty sandy gravel, and dense silty gravelly sand (glacial till). The thickness of the looser materials over the till is as great as 85 feet near the midpoint of the channel. Towards the eastern side of the bridge alignment, near the lines of proposed anchors, the thickness of the looser material is much less. Some of the vibracore data indicates looser material thick nesses of 2 feet or less.

Current Explorations

Subsurface conditions at the proposed anchor locations explored by WSDOT drill crews are included in Appendix C. This appendix also includes a detailed discussion of our exploration program. Boring logs presented herein should be made available to all prospective bidders and included in the contract documents. Appendix D provides a discussion of the laboratory testing program and applicable test results.

The principal purposes of the current exploration program were to verify and supplement the subsurface data obtained in the previous investigations. Along the south line of the proposed anchors, Vibracore V-17 was made in the vicinity of H-XS-01 and H-WS-01. The subsurface conditions observed in the vibracore indicated approximately 4 feet of medium dense sandy gravel overlying dense silty sand (glacial till). The subsurface conditions observed in H-XS-01 and H-WS-01 both indicate very dense sand with gravel (glacial till) beginning at or near the mud line. Therefore, this data appears to confirm the previous data. H-VS-01, which was made further downslope, encountered 10 feet of loose gravel with sand overlying very dense gravel with sand (glacial till). Vibracore V-15, made even further downslope, suffered an equipment malfunction that prevented the collection of density data. However, the thickness of loose material at that location was interpreted to be shallow, on the order of 2 feet or so. Based upon the data obtained in H-VS-01, it appears that the depth to dense material (glacial till) may be slightly larger than described in the previous reports.

Along the north line of the proposed anchors, Vibracore V-16 was made in the vicinity of H-WN-01. The subsurface conditions observed in the vibracore indicated approximately 3 feet of loose sand with gravel and shell fragments overlying loose silty sand extending to the full depth of the vibracore sample at 18 feet. No dense material (glacial till) was observed in the vibracore. The subsurface conditions observed in H-WN-01 indicate 5 feet of loose gravel with sand overlying dense gravel (glacial till). This apparent discrepancy can be explained by a note on the vibracore log that states "Vibracore fell over on steep slope at indicated penetration depth of 18 feet. Penetration depth may be in error. All soil collected may be near the surface". Based upon the results of the current investigation, it appears that this statement is correct and the proper depth to dense material (glacial till) in this portion of the site is approximately 5 feet.

Subbottom profiles in the vicinity of the north and south lines of proposed anchors on the western portion of the bridge are shown in Figures 4 and 5. Each profile presents an assessment

of the subbottom conditions developed from all of the information obtained in the current and previous field explorations.

RECOMMENDATIONS

The Bridge office provided a preliminary list of the proposed anchor types and weights as well as anchor cable tension for the proposed anchor locations based upon the 1981 design data. Geotechnical analyses were performed to determine if these proposed anchors had an adequate factor of safety against bearing capacity failure, sliding failure, and slope stability failure. A factor of safety of 1.5 is required for all three of these criteria.

Based upon our analyses, we modified the Bridge office's preliminary list of anchor types and weights to create the following table. Where necessary, the proposed anchor type and/or weight were modified to achieve an adequate factor of safety. The following table should be used for the design of the anchors.

Table 1 – Proposed Anchor Types and Weights

Anchor Number	Preliminary Proposed Anchor Type	Preliminary Proposed Minimum Anchor Weight (kips)	Final Proposed Anchor Type	Final Proposed Minimum Anchor Weight (kips)
NN	Type 2	3119	Type 2	3119
P1N	Type 1	2166	Type 1	2166
P2N	Type 1	2048	Type 1	2048
RN	Type 1	2150	Type 1	2150
SN	Type 1	1580	Type 1	1580
TN	Type 1	1163	Type 1	1163
UN	Type 1	1495	Type 1	1495
VN	Type 1	2398	Type 2*	2398
WN	Type 2	3098	Special Type 2**	3098
XN	Type 1	1507	Type 1	1507
NS	Type 2	3464	Type 2	3464
P1S	Type 1	2142	Type 1	2142
P2S	Type 2	3752	Type 2	3752
RS	Type 1	1622	Type 1	1622
SS	Type 1	1674	Type 1	1674
TS	Type 1	1560	Type 1	1560
US	Type 1	1629	Type 1	1629

Table 1 – Proposed Anchor Types and Weights(Continued)

Anchor Number	Preliminary Proposed Anchor Type	Preliminary Proposed Minimum Anchor Weight (kips)	Final Proposed Anchor Type	Final Proposed Minimum Anchor Weight (kips)
VS	Type 2	3523	Type 2	3523
WS	Type 2	2791	Type 2	2791
XS	Type 2	2985	Type 2	2985

*Anchor Type Changed from Type 1 to Type 2 to provide an adequate factor of safety against bearing capacity failure.

**Size of square base for anchor increased from 50 x 50 feet to 52 x 52 feet

During the design process, three anchor modifications were proposed. The first proposed modification was to design the anchors located on the steeper slopes with a sloping base to allow these anchors to rest at an angle closer to level. The results of our geotechnical analyses indicate that this modification is not necessary to achieve adequate factors of safety against slope stability, sliding, and bearing capacity failure. Therefore we do not recommend incorporating this modification into the design.

The second proposed modification was to use drilled shafts or piles to help hold the anchors located on the steeper slopes in place. The results of our geotechnical analyses indicate that this modification is not necessary to achieve adequate factors of safety against slope stability, sliding, and bearing capacity failure. Therefore we do not recommend incorporating this modification into the design.

The third proposed modification was to install jetting tubes into the shear keys on the bases of the anchors to allow them to be jetted into the seafloor. This recommendation was based upon the fact that some of the 1980 anchors did not settle into the seafloor under their own weight. Instead, they remained tilted on the seafloor, held up by their shear keys. However, subsequent divers inspection indicated that these tilted anchors had been placed on bedrock outcrops. No bedrock outcrops are known to be present in the vicinity of the proposed anchor locations for the replacement of the eastern portion of the Hood Canal Floating Bridge and the issue of tilted anchors is not expected to reoccur.

We understand that the proposed anchor design is currently being reviewed by the Bridge office to determine if the proposed anchor weights and cable tensions need to be modified. If new anchor design parameters are developed, they should be given to our office for review to evaluate the new anchors for an adequate factor of safety against bearing capacity failure, sliding stability failure, and slope stability failure. Therefore we do not recommend incorporating this modification into the design.

CONSTRUCTION CONSIDERATIONS

We understand that the anchors will be constructed offsite and floated to the site empty. Once in position, the anchors will be attached to cables from lifting barges and backfilled with rock. Once the anchors are filled to their design weight, they will be lowered to the seafloor using the cables from the lifting barges. They will be allowed to settle into the seafloor under their own weight. Previous experience with this type of anchor during the replacement of the western portion of the bridge in 1980 demonstrates that this approach is feasible.

If you have questions or require further information, please contact William Hegge at (360) 709-5415.

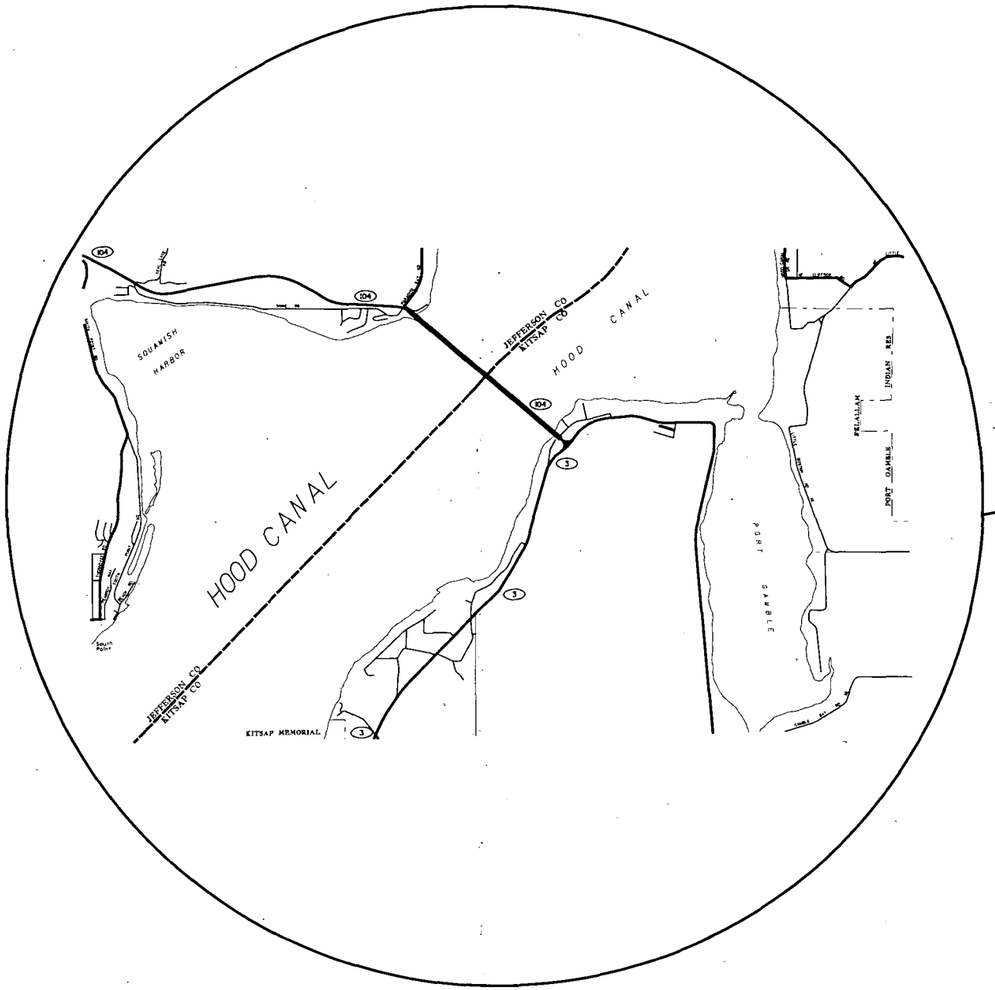
TA:JC:ds/wh

Attachments: *Appendix A – Figures*
Appendix B – Previous Field Explorations
Appendix C – Current Field Explorations
Appendix D – Laboratory Testing

cc: A. Trowbridge, Olympic Region, 434307
P Clarke, OSC Bridge and Structures, 47340

APPENDIX A - FIGURES

WSDOT
OLYMPIC REGION
PUGET SOUND
ENLARGEMENT



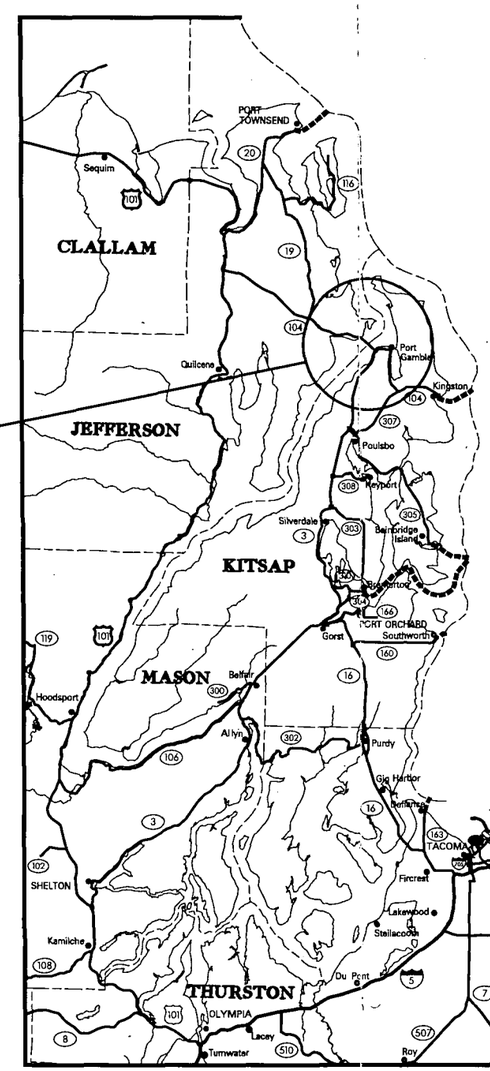


FIGURE 1 - SITE VICINITY

JOB OL-3305 S.R. 104 C.S. 1630

HOOD CANAL BRIDGE

WASHINGTON STATE
TRANSPORTATION COMMISSION
DEPARTMENT OF TRANSPORTATION

MATERIALS BRANCH

T. E. BAKER MATERIALS ENGINEER

DATE 9/2002
SCALE N.T.S. VERT. HORIZ.
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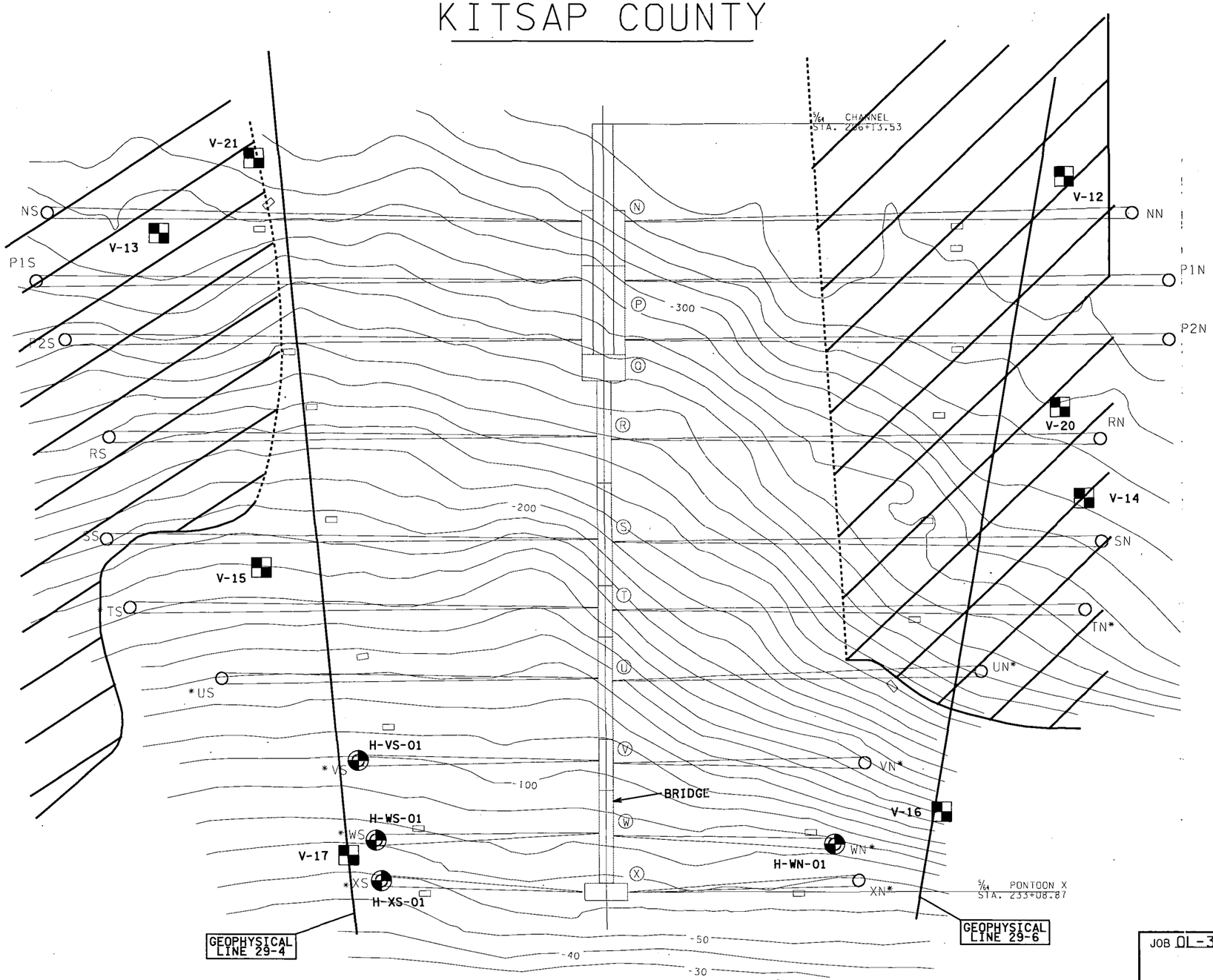
KITSAP COUNTY



LEGEND:

- EXISTING ANCHOR
- P1N — PROPOSED ANCHOR
- GEOPHYSICAL LINE 29-6 — GEOPHYSICAL LINE PERFORMED IN 1979
- V-12 VIBRACORE PERFORMED IN 1980
- H-XS-01 BORING PERFORMED IN 2001
- MEGA RIPPLE AREA 1979 DATA

ANCHOR	STATION	OFFSET	APPROX. DEPTH	NORTHING	EASTING
NS	209+24.134	1956.539'	-317	316,845	1,558,941
NN	209+25.885	1865.017'	-345	319,716	1,562,463
P1S	211+63.561	1994.787'	-282	316,659	1,560,035
P1N	211+61.713	1985.213'	-342	319,658	1,562,726
P2S	213+63.576	1892.805'	-264	316,599	1,560,317
P2N	213+63.713	1885.195'	-341	319,521	1,562,892
RS	217+11.719	1739.835'	-228	316,469	1,560,675
RN	217+19.836	1750.165'	-322	319,106	1,562,983
SS	220+69.532	1750.868'	-192	316,244	1,560,948
SN	220+79.857	1751.133'	-305	318,868	1,563,255
TS	223+08.537	1681.887'	-163	316,147	1,561,172
TN	223+18.165	1683.113'	-287	318,668	1,563,395
US	225+58.017	1345.381'	-130	316,226	1,561,571
UN	225+34.813	1320.681'	-251	318,246	1,563,313
VS	228+48.058	870.394'	-98	316,392	1,562,105
VN	228+56.546	911.066'	-157	317,725	1,563,285
WS	231+27.613	806.545'	-73	316,254	1,562,354
WN	231+41.267	804.456'	-86	317,458	1,563,428
XS	232+70.167	788.924'	-58	316,174	1,562,473
XN	232+69.022	889.012'	-69	317,437	1,563,580

JOB OL-3305 S.R. 104 C.S. 1630

HOOD CANAL BRIDGE

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MATERIALS BRANCH

T. E. BAKER MATERIALS ENGINEER

DATE 9/2002
SCALE N.T.S. VERT. HORIZ.
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FIGURE 2: SITE PLAN-EAST APPROACH

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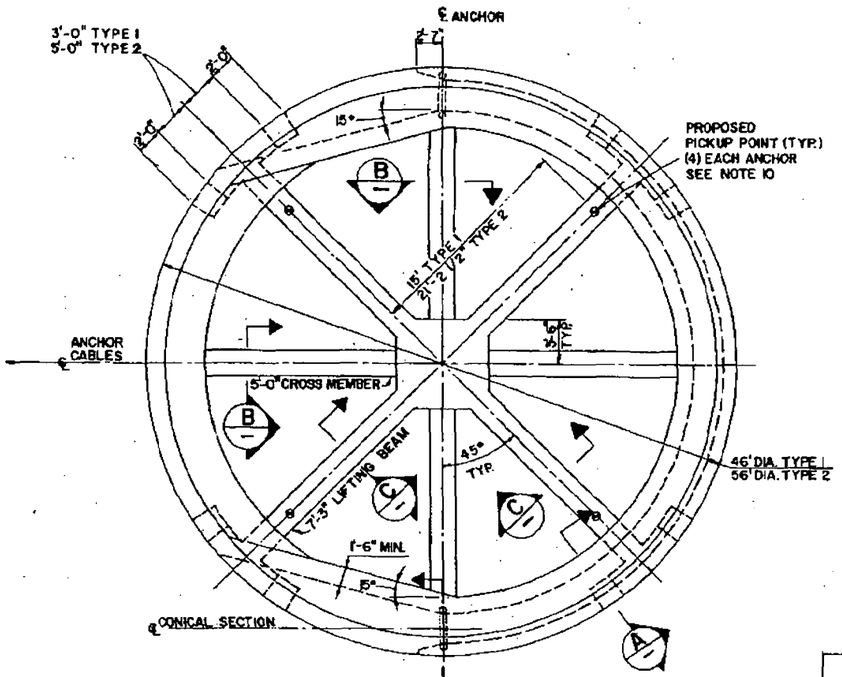
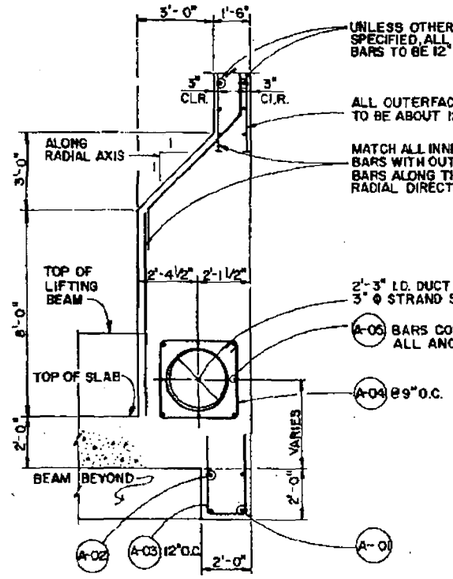
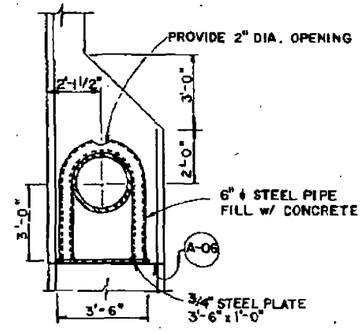
..\9-4-02\hood east anchors.dgn 09/09/2002 10:57:28 AM



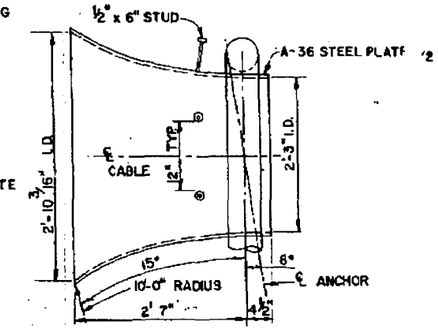
PLAN
N.T.S.



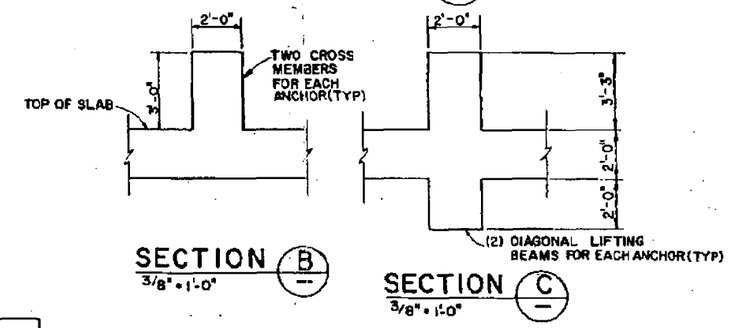
SECTION A
3/8" = 1'-0"



SECTION D
3/8" = 1'-0"



DETAIL 1
1" = 1'-0"



SECTION B
3/8" = 1'-0"

SECTION C
3/8" = 1'-0"

ANCHOR HANDLING LOADS & FORCES

ANCHOR TYPE	COL. 1 MAX. VERT. HANDLING LOAD PER PICKUP POINT	COL. 2 SUBMERGED WEIGHT OF ANCHOR SHELL	COL. 3 DISPLACEMENT OF ANCHOR SHELL IN SEA WATER	COL. 4 FLOATING DRAFT OF ANCHOR SHELL	COL. 5 MAX. LATERAL PULLING FORCE
	(KIPS)	(KIPS)	(KIPS)	(FEET)*	(KIPS)
1	325	1133	1957	20.1	450
2	482	1476	2635	18.7	450

*DRAFT IS MEASURED FROM WATER SURFACE TO THE BOTTOM OF THE ANCHOR SKIRT

THIS DRAWING HAS BEEN REDUCED FROM ITS ORIGINAL SIZE. DO NOT SCALE.

GENERAL NOTES

1) FOUR PICKUP POINTS ON EACH ANCHOR AS INDICATED CAN WITHSTAND A MAX. VERTICAL LIFTING LOAD AT EACH POINT AS SHOWN IN COL. 1 OF THE TABLE. THE TOTAL CALCULATED WEIGHT OF THE EMPTY ANCHOR SHELL IS AS TABULATED IN COL. 2 WHEN COMPLETELY SUBMERGED IN SEA WATER. CONTRACTOR SHALL DESIGN LIFTING ATTACHMENTS, AS REQUIRED. FOR REVIEW BY THE ENGINEER.

2) THE ANCHOR WITHOUT BALLAST OR ANCHOR CABLE HAS AN EQUIVALENT DISPLACEMENT AS TABULATED IN COL. 3, AND A DRAFT AS TABULATED IN COL. 4 WHEN FLOATING IN SEA WATER. TRIM ANGLE IS LESS THAN ONE DEGREE, NOT INCLUDING THE EFFECT OF THE MOORING LINE.

3) IF THE PROPOSED CONSTRUCTION METHOD OF THE ANCHOR REQUIRES THAT IT BE MOVED LATERALLY BEFORE IT IS PLACED IN THE WATER, SUCH LATERAL MOVEMENT SHALL BE ACCOMPLISHED BY INSERTING A LINE OF ADEQUATE STRENGTH IN THE HAWSE PIPE OF THE ANCHOR, AND THEN EXERTING A LATERAL PULLING FORCE NO GREATER THAN THAT TABULATED IN COL. 5 ON EACH PART OF THE LINE, IN A DIRECTION NO HIGHER THAN 8 DEGREES ABOVE THE HORIZONTAL.

4) THE CONTRACTOR SHALL SUBMIT ANCHOR CONSTRUCTION SEQUENCE, AND SINKING PROCEDURES TO THE ENGINEER FOR REVIEW.

5) SEE SPECIAL PROVISIONS FOR CONC. CLASS XYP, REINF. STEEL, STONE BALLAST, & CONCRETE FILL REQUIREMENTS.

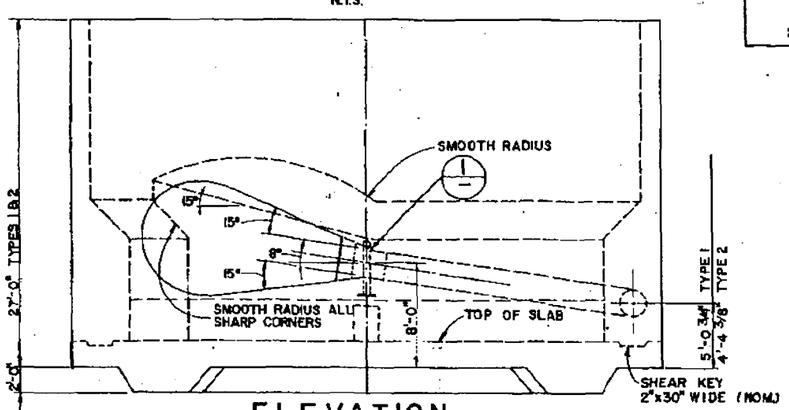
6) UNLESS OTHERWISE SHOWN ON THE PLANS, CONCRETE COVER, AS MEASURED FROM THE FACE OF THE CONCRETE TO ANY REINFORCEMENT BAR, SHALL BE 3".

7) THE CONTRACTOR SHALL SUBMIT THE CONCRETE POURING SEQUENCE AND CONSTRUCTION JOINT LOCATION TO THE ENGINEER FOR REVIEW. ALL CONSTRUCTION JOINTS SHALL BE PROVIDED WITH WATER STOPS.

8) IF UNIT WT. OF CONCRETE EXCEEDS 150 PCF ALL NUMBERS SHOWN IN COLUMNS 2, 3 & 4 SHALL BE MODIFIED AS REQUIRED.

9) *THE 27 INCH DIAMETER DUCT SHALL BE THICK NYLON ANCHORED TO CONCRETE WITHIN EXTERNAL RIBS.*

10) THE CONTRACTOR SHALL SUBMIT ENGINEERING CALCULATIONS FOR REVIEW IF LOCATION OF PICKUP POINTS IS TO BE OTHER THAN AS SHOWN ON PLAN.



ELEVATION
N.T.S.

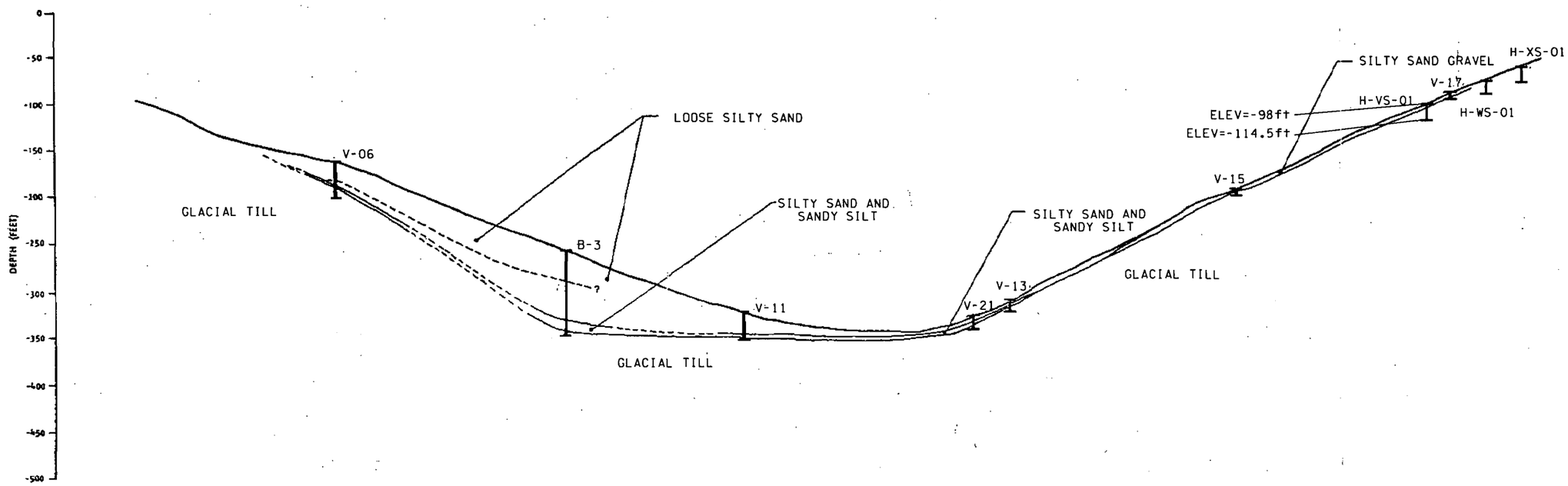
JOB 01-3305 S.R. 104 C.S. 1630

HOOD CANAL BRIDGE

WASHINGTON STATE TRANSPORTATION COMMISSION
DEPARTMENT OF TRANSPORTATION
MATERIALS BRANCH
T. E. BAKER MATERIALS ENGINEER

DATE 9/2002
SCALE N.T.S. VERT. HORIZ.
SHEET ___ OF ___
DRAWN BY W.M.

FIGURE 3: PRELIMINARY ANCHOR DESIGN



B-1 BORING PERFORMED IN 1980

V-17 VIBRACORE PERFORMED IN 1980

H-VS-01 BORING PERFORMED IN 2001

FIGURE 4: SOUTH ANCHOR LINE SUBSURFACE PROFILE

JOB 01-3305 S.R. 104 C.S. 1630

HOOD CANAL BRIDGE

WASHINGTON STATE
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DEPARTMENT OF TRANSPORTATION

MATERIALS BRANCH

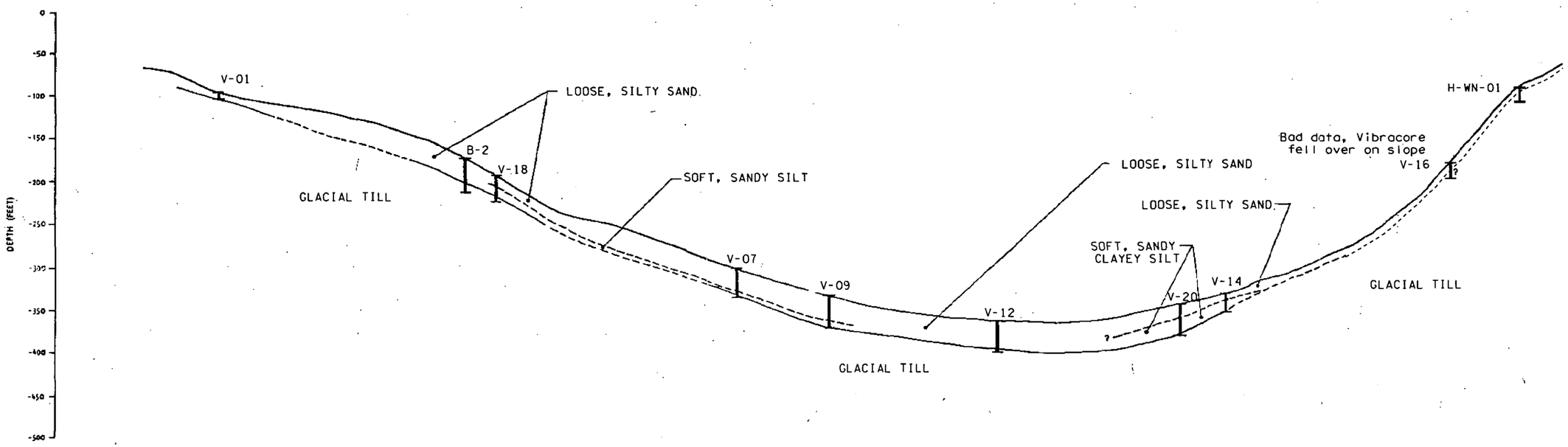
T. E. BAKER MATERIALS ENGINEER

DATE 10/2002

SCALE N.T.S. VERT. HORIZ.

SHEET ___ OF ___

DRAWN BY W.M.



B-2 BORING PERFORMED IN 1980

V-12 VIBRACORE PERFORMED IN 1980

H-WN-01 BORING PERFORMED IN 2001

JOB 01-3305 S.R. 104 C.S. 1630

HOOD CANAL BRIDGE

WASHINGTON STATE
TRANSPORTATION COMMISSION
DEPARTMENT OF TRANSPORTATION

MATERIALS BRANCH

T. E. BAKER MATERIALS ENGINEER

DATE 10/2002

SCALE N.T.S. VERT. HORIZ.

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DRAWN BY W.M.

FIGURE 5: NORTH ANCHOR LINE SUBSURFACE PROFILE

APPENDIX B – PREVIOUS FIELD EXPLORATIONS

Previous Field Explorations

The previous field exploration program was completed in three phases. Only two of the three phases were conducted in the vicinity of the proposed anchor locations. The first phase was conducted during the period of August 27 through 30, 1979. The field exploration work consisted of geophysical studies and limited subbottom sampling. The field explorations included six geophysical lines in the vicinity of the proposed anchors. Three of the geophysical lines, designated 29-3, 29-4 and 29-12, were conducted on the south side of the bridge. Of these, the geophysical line designated 29-4 was located closest to the proposed southern anchors. Three geophysical lines, designated 19-5, 29-6 and 29-11, were conducted on the north side of the bridge. Of these, the geophysical line designated 29-6 was located closest to the proposed northern anchors. The locations of geophysical lines 29-4 and 29-6 are shown on the Site Plan, Figure 2. The methods and equipment used are described in detail in the report entitled "Geotechnical Engineering Studies, Hood Canal Floating Bridge for Tokola Offshore, Inc., Part I: Anchor Design Studies, Phase II, and Part II: Hood Canal Bridge Survey" prepared by Dames and Moore and dated October 12, 1979.

The second phase of the field investigation was conducted in 1980. The field exploration work consisted of rotary wire line drilling and vibracoring. Only a partial description of the vibracoring equipment is presented in the previous reports. However, the information is sufficient to determine that the vibracoring consisted of vibrating a 40-foot long plastic core barrel with an inside diameter of 3.5-inches into the seafloor. The vibracore tube and vibrator were mounted on a weighted tripod lowered to the seafloor by cable. No blow counts were obtained to determine the density of the subsurface materials. However, empirical correlations were used to estimate the density based upon the rate of advance of the vibracore.

The field explorations included eight vibracores in the vicinity of the proposed anchors. Four of the vibracores, designated V-13, V-15, V-17 and V-21, were conducted in the vicinity of the proposed southern anchors. The remaining four vibracores, designated V-12, V-14, V-16 and V-20, were conducted in the vicinity of the proposed northern anchors. The location of these vibracores is shown on the Site Plan, Figure 2. The methods and equipment used are described in detail in the report entitled *"Report, Geotechnical Investigation, Final Design, Hood Canal Bridge for the State of Washington Department of Transportation"* prepared by Dames and Moore and dated August 14, 1980.

Another phase of the field investigation was conducted in 1982. However, this phase of the field exploration was conducted near the western portion of the bridge, away from the vicinity of the proposed anchors. The methods and equipment used for the third phase of the field explorations are described in detail in the report entitled *"Report, Hood Canal Bridge Geophysical survey for the State of Washington Department of Transportation"* prepared by Dames and Moore and dated April 2, 1982.

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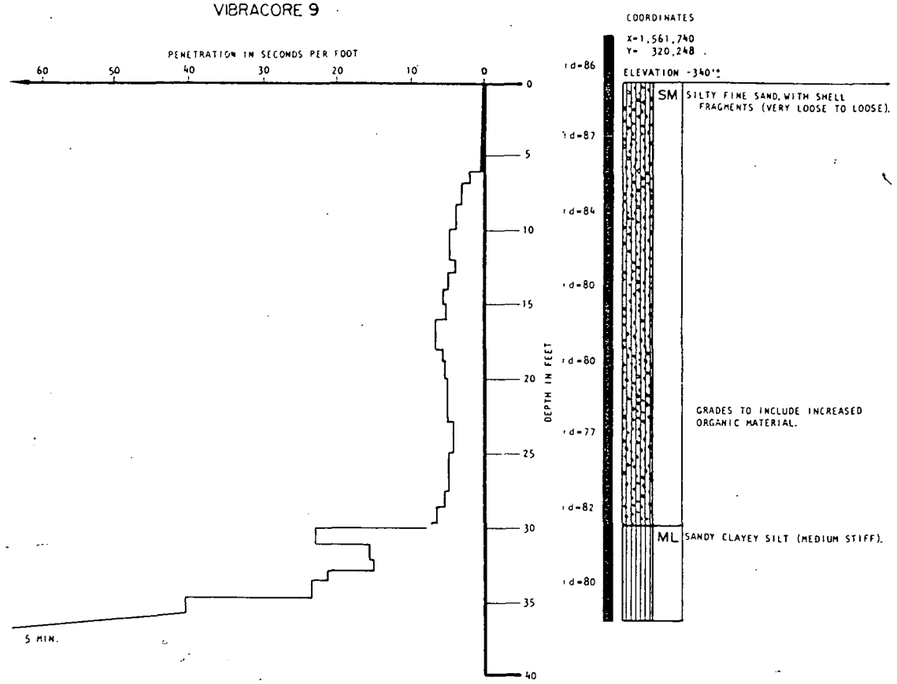

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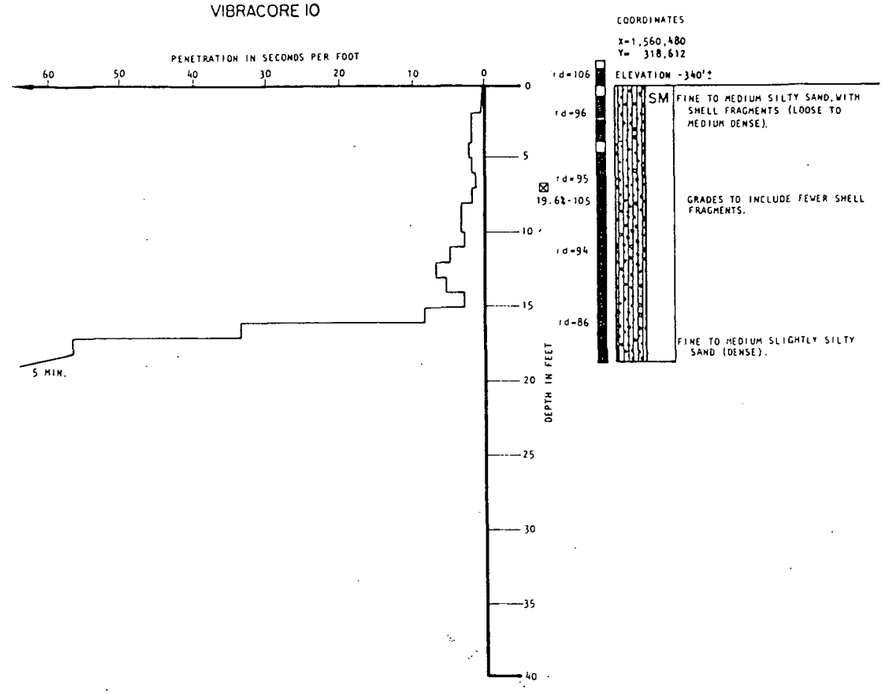

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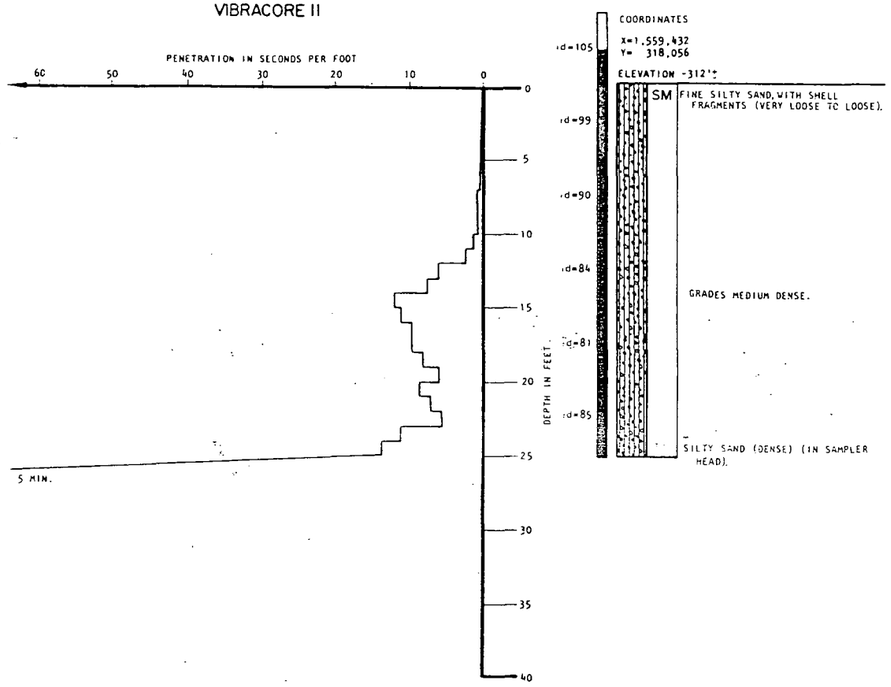

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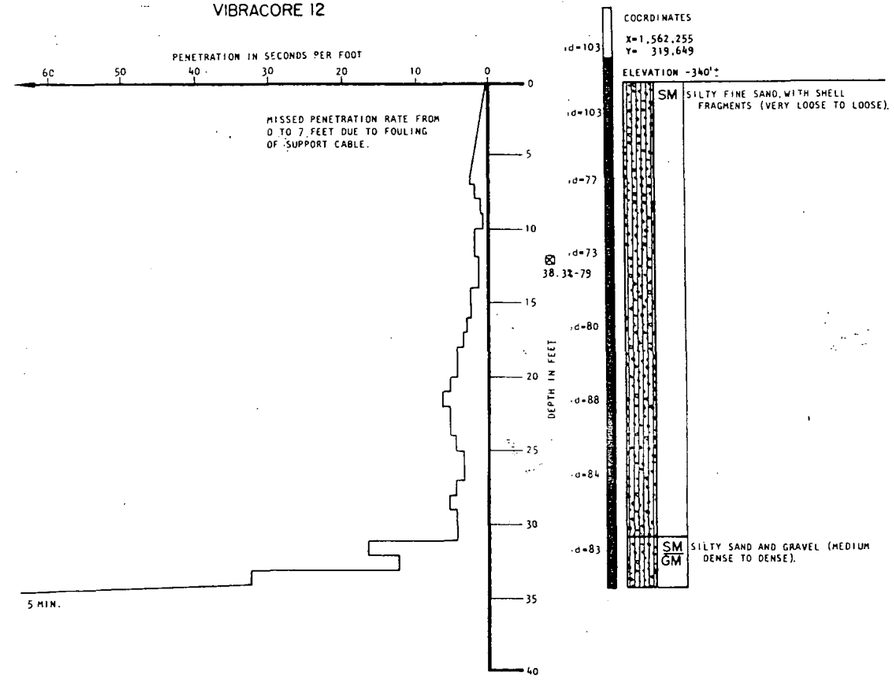

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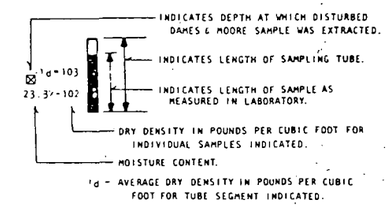

γd - AVERAGE DRY DENSITY IN POUNDS PER CUBIC FOOT FOR TUBE SEGMENT INDICATED.

NOTE: THE DISCUSSION IN THE TEXT OF THIS REPORT IS NECESSARY FOR A PROPER UNDERSTANDING OF THE NATURE OF THE SUBSURFACE MATERIALS.

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DESIGNED BY H.G. LANDAU
DRAWN BY RANDY KARRY
CHECKED BY S. JOHNSTON
IN CHARGE J.K. TUTTLE
DATE 13 AUG 80.

APPROVED

WASHINGTON STATE DEPARTMENT OF TRANSPORTATION
W.A. BULLEY, Secretary

Dames & Moore
SUBMITTED 15 AUG 80

PB/RTF
Parsons Brinckerhoff Quade & Douglas, Inc.
Raymond Technical Facilities, Inc.
APPROVED

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HOOD CANAL BRIDGE REPLACEMENT
VIBRACORE LOGS
9 THROUGH 12

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SHEET OF SHEETS

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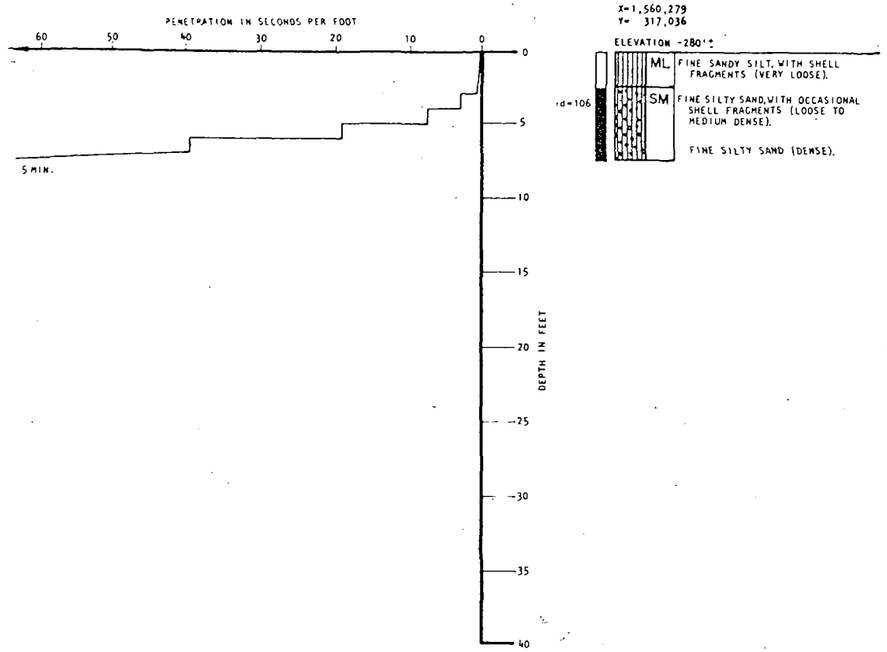

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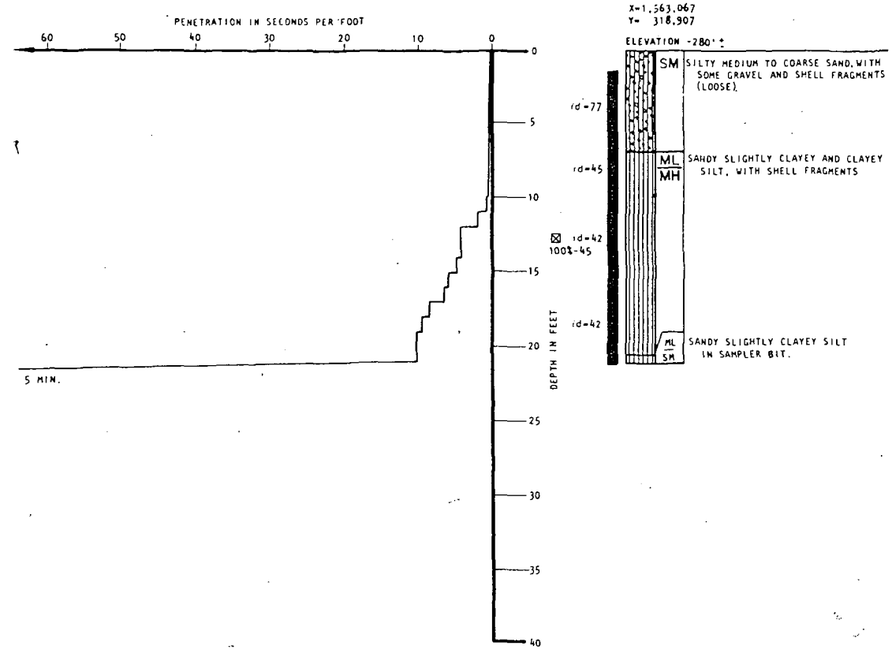

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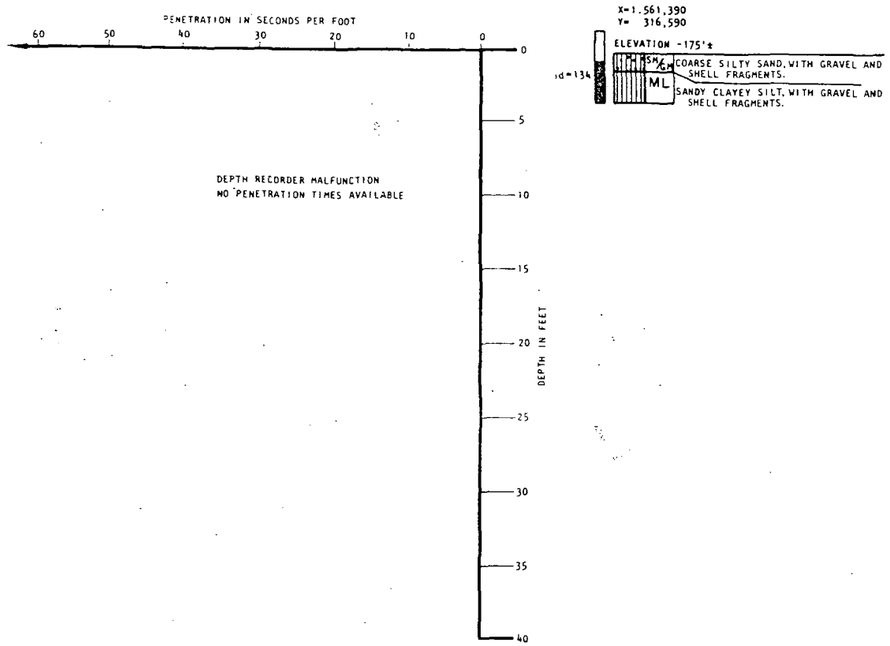

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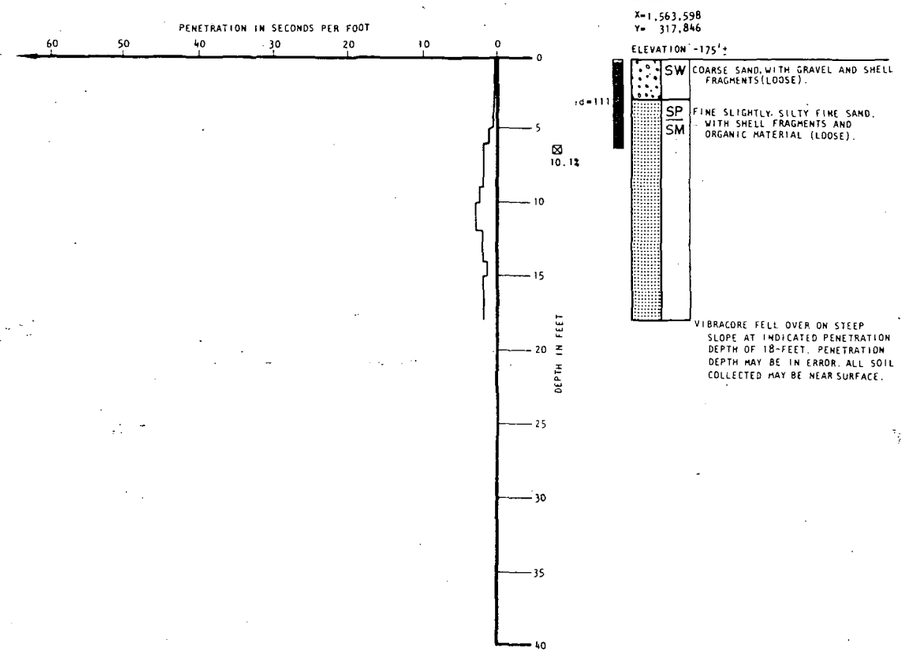

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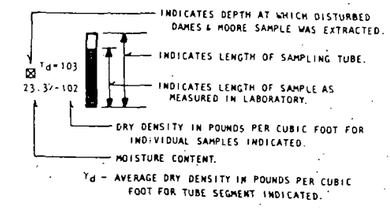

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WASHINGTON STATE DEPARTMENT OF TRANSPORTATION
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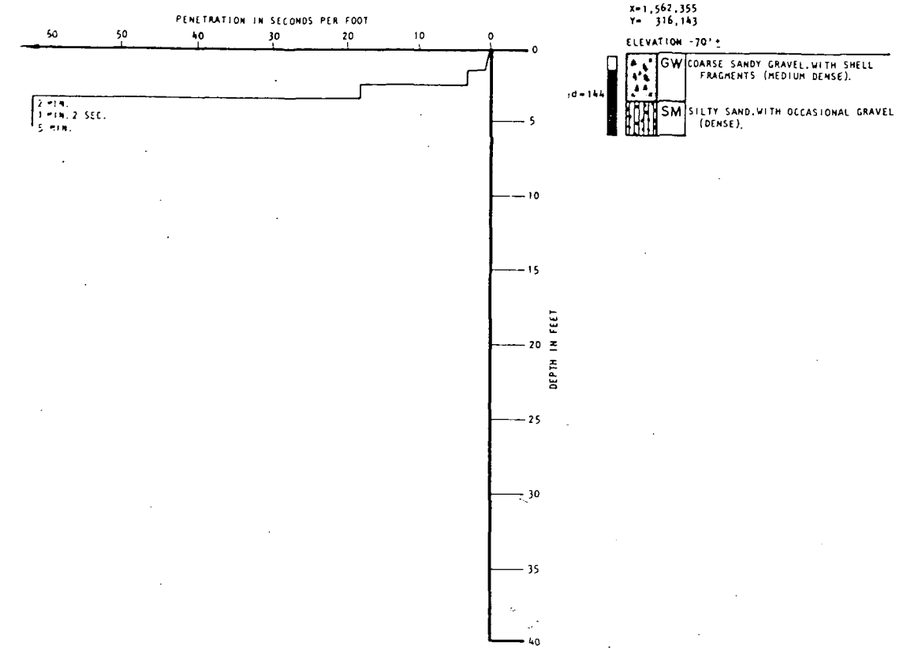

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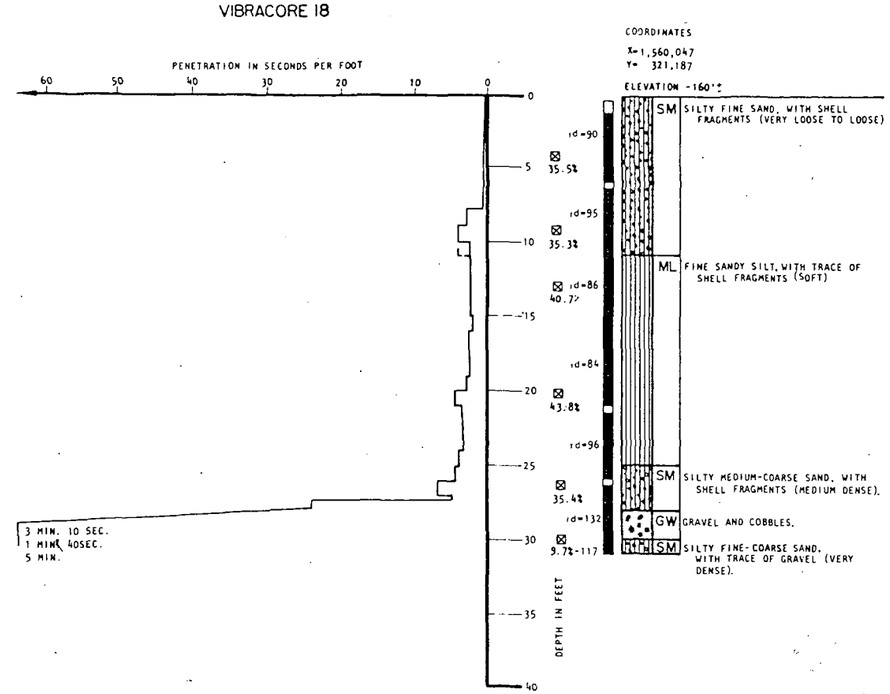

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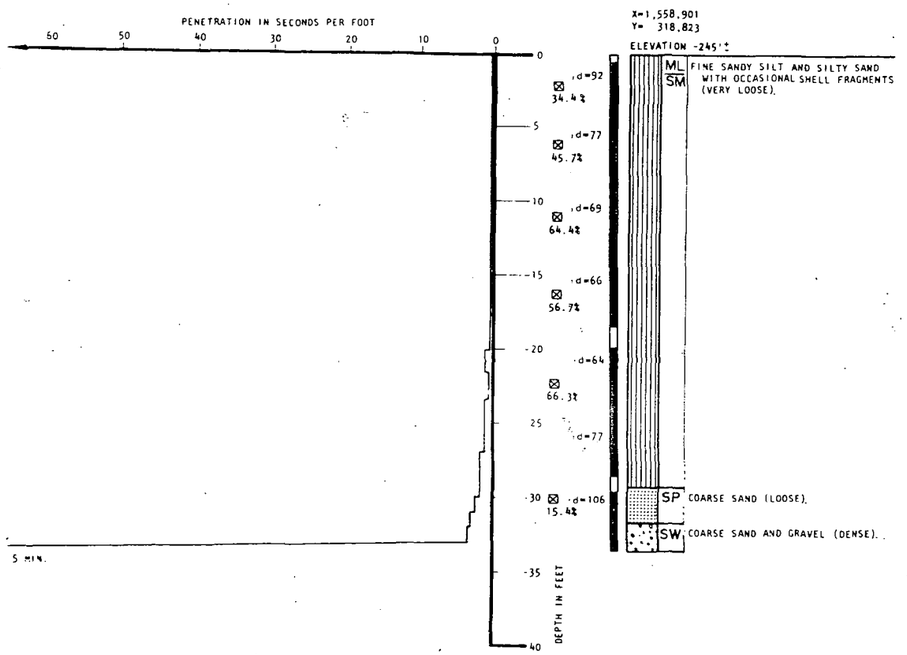

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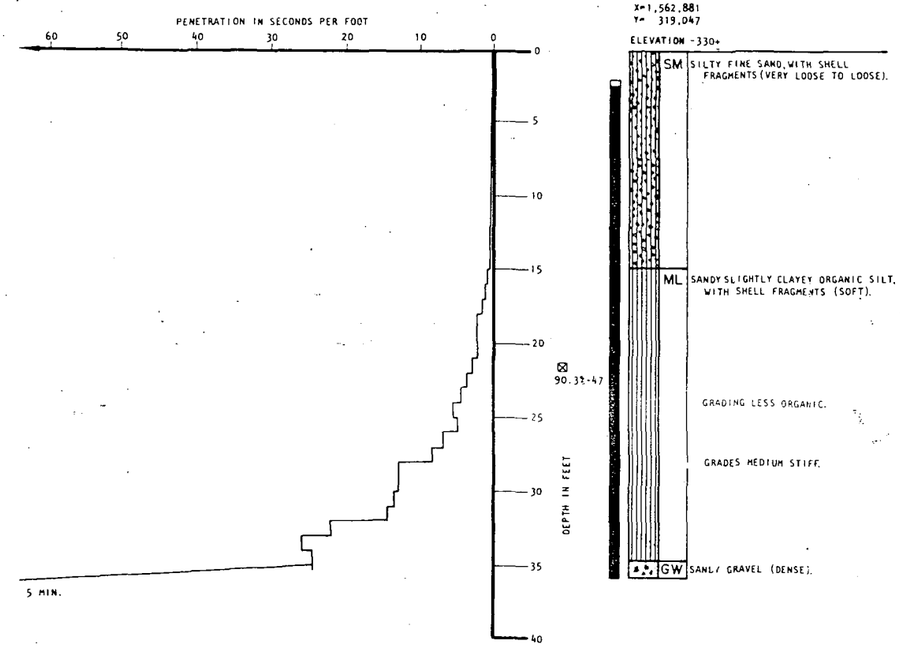

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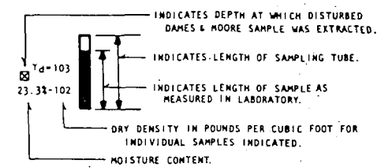

γd – AVERAGE DRY DENSITY IN POUNDS PER CUBIC FOOT FOR TUBE SEGMENT INDICATED.

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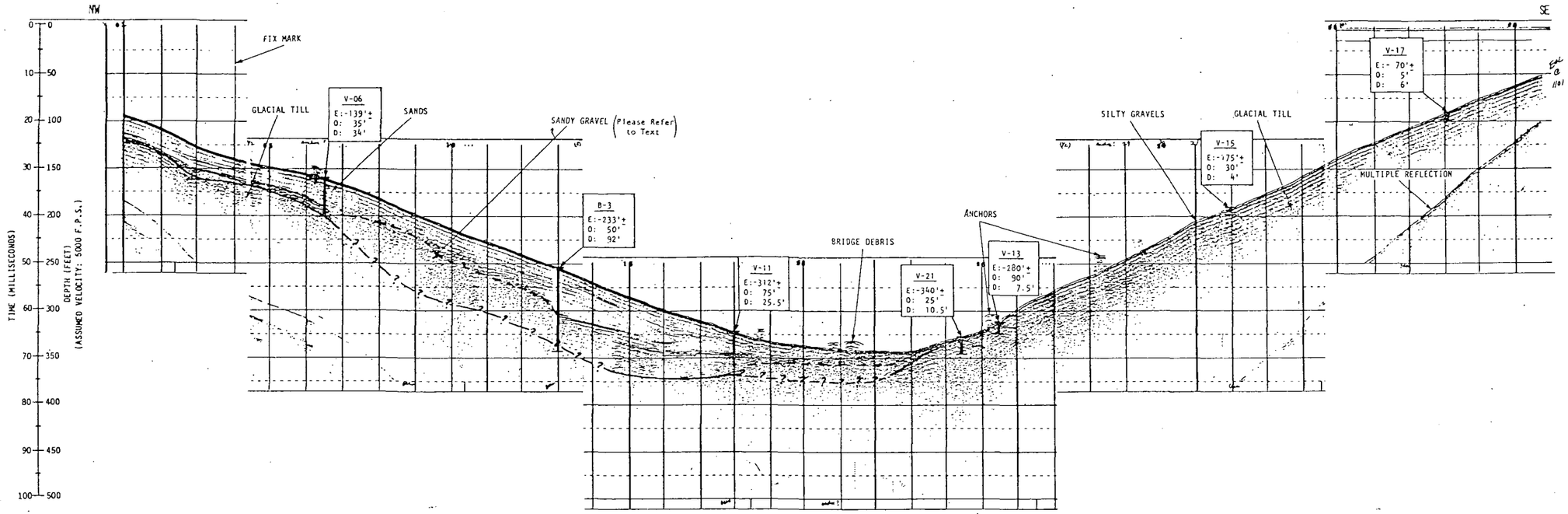
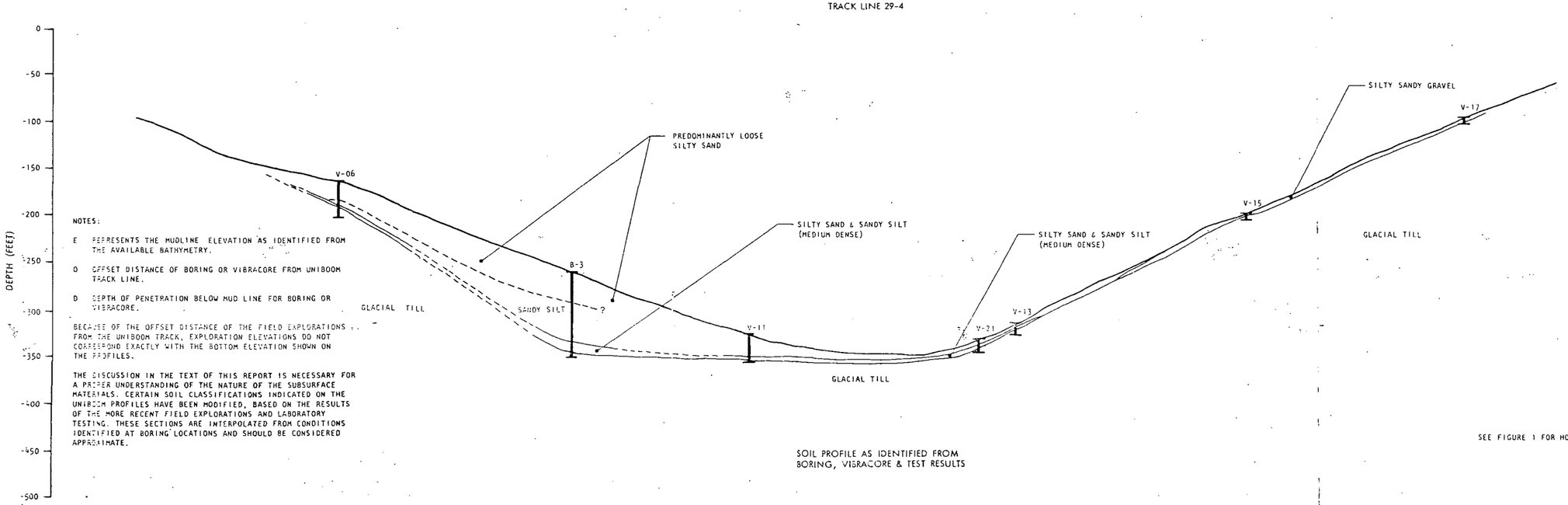


SOIL PROFILE AS IDENTIFIED FROM UNIBOOM RESULTS ALONG TRACK LINE 29-4



NOTES:

E REPRESENTS THE MUDLINE ELEVATION AS IDENTIFIED FROM THE AVAILABLE BATHYMETRY.

O OFFSET DISTANCE OF BORING OR VIBRACORE FROM UNIBOOM TRACK LINE.

D DEPTH OF PENETRATION BELOW MUD LINE FOR BORING OR VIBRACORE.

BECAUSE OF THE OFFSET DISTANCE OF THE FIELD EXPLORATIONS FROM THE UNIBOOM TRACK, EXPLORATION ELEVATIONS DO NOT CORRESPOND EXACTLY WITH THE BOTTOM ELEVATION SHOWN ON THE PROFILES.

THE DISCUSSION IN THE TEXT OF THIS REPORT IS NECESSARY FOR A PROPER UNDERSTANDING OF THE NATURE OF THE SUBSURFACE MATERIALS. CERTAIN SOIL CLASSIFICATIONS INDICATED ON THE UNIBOOM PROFILES HAVE BEEN MODIFIED, BASED ON THE RESULTS OF THE MORE RECENT FIELD EXPLORATIONS AND LABORATORY TESTING. THESE SECTIONS ARE INTERPOLATED FROM CONDITIONS IDENTIFIED AT BORING LOCATIONS AND SHOULD BE CONSIDERED APPROXIMATE.

SOIL PROFILE AS IDENTIFIED FROM BORING, VIBRACORE & TEST RESULTS

SEE FIGURE 1 FOR HORIZONTAL SCALE

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WASHINGTON STATE DEPARTMENT OF TRANSPORTATION
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PROFILE
SOUTH SIDE ANCHOR LINE

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SHEET OF SHEETS

FED. ROAD DIV. NO.	STATE	FED. AID PROJ. NO.	FISCAL YEAR	SHEET NO.	TOTAL SHEETS
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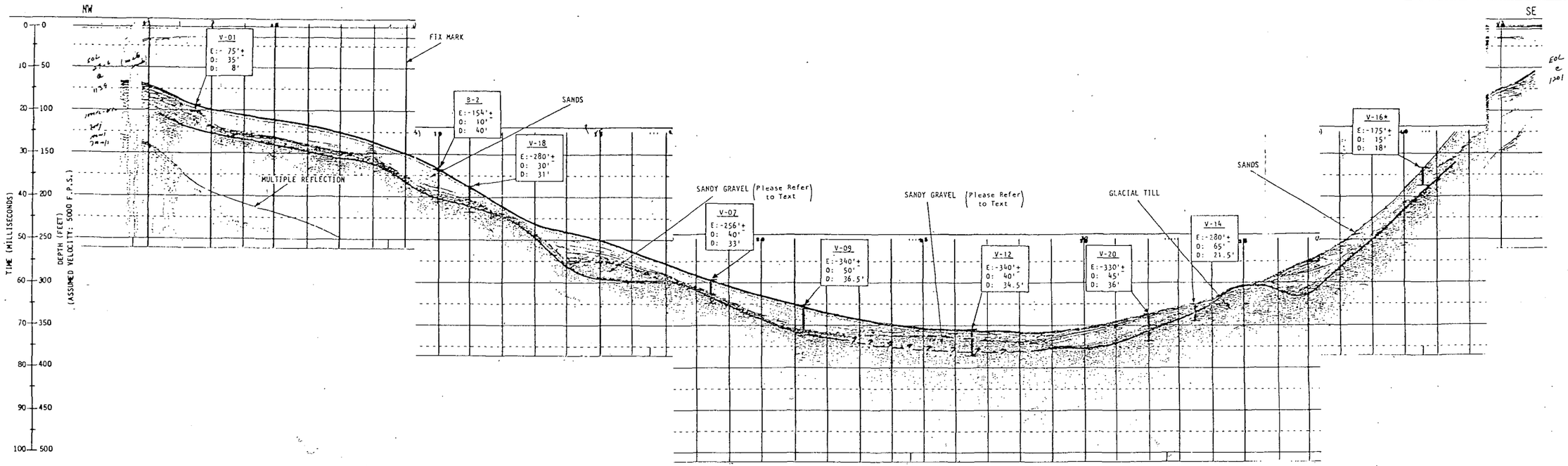
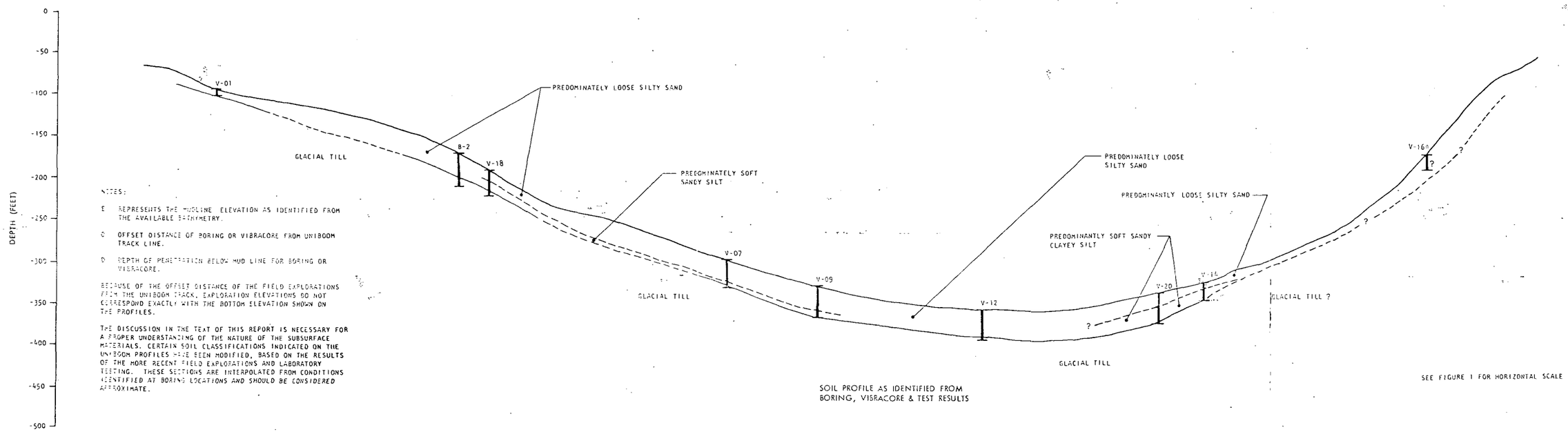


SOIL PROFILE AS IDENTIFIED
FROM UNIBOOM RESULTS ALONG
TRACK LINE 29-6



NOTES:

E REPRESENTS THE MUDLINE ELEVATION AS IDENTIFIED FROM THE AVAILABLE BATHYMETRY.

O OFFSET DISTANCE OF BORING OR VIBRACORE FROM UNIBOOM TRACK LINE.

D DEPTH OF PENETRATION BELOW MUD LINE FOR BORING OR VIBRACORE.

BECAUSE OF THE OFFSET DISTANCE OF THE FIELD EXPLORATIONS FROM THE UNIBOOM TRACK, EXPLORATION ELEVATIONS DO NOT CORRESPOND EXACTLY WITH THE BOTTOM ELEVATION SHOWN ON THE PROFILES.

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SOIL PROFILE AS IDENTIFIED FROM
BORING, VIBRACORE & TEST RESULTS

SEE FIGURE 1 FOR HORIZONTAL SCALE

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PROFILE
NORTH SIDE ANCHOR LINE

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APPENDIX C – CURRENT FIELD EXPLORATIONS

Current Field Explorations

The current field exploration program for the proposed anchor locations consisted of drilling four offshore exploratory borings, designated H-VS-01, H-WS-01, H-XS-01 and H-WN-01. Additional borings were planned, but strong currents and high wave action resulted in several drill string breaks causing the offshore drilling program to be terminated at four borings. Logs of the test borings are attached and should be included in the contract documents.

The offshore exploratory borings were drilled using a skid-mounted CME 45 drill rig from a barge. The locations of these borings (as determined through Global Positioning System (GPS) measurements) are shown on the Site Plan, Figure 2. All of the borings were advanced using wet rotary drilling and methods to the depths and elevations described above. In some cases where difficult drilling in gravels was encountered, the boring was advanced between sampling locations using rock-coring techniques. This rock coring was accomplished using a HQ x 40.0 triple tube wireline coring system powered by the same drill rig. Soil samples were obtained during drilling using a SPT (Standard Penetration Test) sampler, in general accordance with ASTM D-1586. SPTs are obtained by driving a 2-inch outside diameter split-spoon sampler 18 inches into the soil with a 140-pound hammer. The number of blows required to achieve each 6 inches of penetration is recorded and the soil's SPT resistance, or N-value, is calculated as the number of blows required to achieve the final 12 inches of penetration. The skid-mounted drill rig is equipped with an automatic trip hammer to drive the split-spoon sampler. The automatic hammer is rated at approximately 70 percent efficiency, as compared to approximately 60 percent for manual hammers.

Select soil samples were then submitted to the OSC Materials Laboratory for laboratory testing.

Washington State
Department of Transportation

Test Boring Legend

Sampler Symbols

	Standard Penetration Test
	Oversized Penetration Test (Dames & Moore, California)
	Shelby Tube
P	Piston Sample
	Washington Undisturbed
	Vane Shear Test
	Core
	Becker Hammer
B	Bag Sample

Well Symbols

	Cement Surface Seal
	Piezometer Pipe in Granular Bentonite Seal
	Piezometer Pipe in Sand
	Well Screen in Sand
	Granular Bentonite Bottom Seal
	Inclinometer Casing in Concrete Bentonite Grout

Laboratory Testing Codes

UU	Unconsolidated Undrained Triaxial
CU	Consolidated Undrained Triaxial
CD	Consolidated Drained Triaxial
UC	Unconfined Compression Test
DS	Direct Shear Test
CN	Consolidation Test
GS	Grain Size Distribution
MC	Moisture Content
SG	Specific Gravity
OR	Organic Content
DN	Density
AL	Atterberg Limits
PT	Point Load Compressive Test
SL	Slake Test
DG	Degradation
LA	LA Abrasion

Soil Density Modifiers

Gravel, Sand & Non-plastic Silt		Elastic Silts and Clay	
SPT Blows/ft	Density	SPT Blows/ft	Consistency
0-4	Very Loose	0-1	Very Soft
5-10	Loose	2-4	Soft
11-24	Medium Dense	5-8	Medium Stiff
25-50	Dense	9-15	Stiff
>50	Very Dense	16-30	Very Stiff
		31-60	Hard
		>60	Very Hard

Angularity of Gravel & Cobbles

Angular	Coarse particles have sharp edges and relatively plane sides with unpolished surfaces.
Subangular	Coarse grained particles are similar to angular but have rounded edges.
Subrounded	Coarse grained particles have nearly plane sides but have well rounded corners and edges.
Rounded	Coarse grained particles have smoothly curved sides and no edges.

Soil Moisture Modifiers

Dry	Absence of moisture; dusty, dry to touch
Moist	Damp but no visible water
Wet	Visible free water

Soil Structure

Stratified	Alternating layers of varying material or color at least 6mm thick; note thickness and inclination.
Laminated	Alternating layers of varying material or color less than 6mm thick; note thickness and inclination.
Fissured	Breaks along definite planes of fracture with little resistance to fracturing.
Slickensided	Fracture planes appear polished or glossy, somtimes striated.
Blocky	Cohesive soil that can be broken down into smaller angular lumps which resist further breakdown.
Disrupted	Soil structure is broken and mixed. Infers that material has moved substantially - landslide debris.
Homogeneous	Same color and appearance throughout.

HCL Reaction

No HCL Reaction	No visible reaction.
Weak HCL Reaction	Some reaction with bubbles forming slowly.
Strong HCL Reaction	Violent reaction with bubbles forming imediately.

Degree of Vesicularity of Pyroclastic Rocks

Slightly Vesicular	5 to 10 percent of total
Moderately Vesicular	10 to 25 percent of total
Highly Vesicular	25 to 50 percent of total
Scoriaceous	Greater than 50 percent of total

Washington State Department of Transportation

Test Boring Legend

Grain Size

Fine Grained	< 1mm	Few crystal boundaries/grains are distinguishable in the field or with hand lens.
Medium Grained	1mm to 5mm	Most crystal boundaries/grains are distinguishable with the aid of a hand lens.
Coarse Grained	> 5mm	Most crystal boundaries/grains are distinguishable with the naked eye.

Weathered State

Term	Description	Grade
Fresh	No visible sign of rock material weathering; perhaps slight discoloration in major discontinuity surfaces.	I
Slightly Weathered	Discoloration indicates weathering of rock material and discontinuity surfaces. All the rock material may be discolored by weathering and may be somewhat weaker externally than its fresh condition.	II
Moderately Weathered	Less than half of the rock material is decomposed and/or disintegrated to soil. Fresh or discolored rock is present either as a continuous framework or as core stones.	III
Highly Weathered	More than half of the rock material is decomposed and/or disintegrated to soil. Fresh or discolored rock is present either as discontinuous framework or as core stone.	IV
Completely Weathered	All rock material is decomposed and/or disintegrated to soil. The original mass structure is still largely intact.	V
Residual Soil	All rock material is converted to soil. The mass structure and material fabric is destroyed. There is a large change in volume, but the soil has not been significantly transported.	VI

Relative Rock Strength

Grade	Description	Field Identification	Uniaxial Compressive Strength approx
R1	Very Weak	Specimen crumbles under sharp blow from point of geological hammer, and can be cut with a pocket knife.	1 to 25 MPa
R2	Moderately Weak	Shallow cuts or scrapes can be made in a specimen with a pocket knife. Geological hammer point indents deeply with firm blow.	25 to 50 MPa
R3	Moderately Strong	Specimen cannot be scraped or cut with a pocket knife, shallow indentation can be made under firm blows from a hammer.	50 to 100 MPa
R4	Strong	Specimen breaks with one firm blow from the hammer end of a geological hammer.	100 to 200 MPa
R5	Very Strong	Specimen requires many blows of a geological hammer to break intact sample.	Greater than 200 MPa

Discontinuities

Spacing	
Very Widely	Greater than 3 m
Widely	1 m to 3 m
Moderately	0.3 m to 1 m
Closely	50 mm to 300 mm
Very Closely	Less than 50 mm

RQD (%)

$$\frac{100(\text{length of core in pieces} > 100\text{mm})}{\text{Length of core run}}$$

Condition	
Excellent	Very rough surfaces, no separation, hard discontinuity wall
Good	Slightly rough surfaces, separation less than 1 mm, hard discontinuity wall.
Fair	Slightly rough surfaces, separation greater than 1 mm, soft discontinuity wall.
Poor	Slickensided surfaces, or soft gouge less than 5 mm thick, or open discontinuities 1 to 5 mm.
Very Poor	Soft gouge greater than 5 mm thick, or open discontinuities greater than 5 mm.

Fracture Frequency (FF) is the average number of fractures per 300 mm of core.
Does not include mechanical breaks caused by drilling or handling.

Washington State
Department of Transportation

LOG OF TEST BORING

Job No. OL-3305 SR 1630 HOLE No. H-VS-01

PROJECT Hood Canal Bridge Replacement Sheet 1 of 1

Inspector Dan Reed

Station 228+48 Offset 870ft Lt. Equipment CME 45 w/ autohammer

Latitude Longitude Method Wet Rotary

Northing Easting Casing HW/HQ

Ground Elevation -88.0 (-26.8 m) Start Date July 9, 2001 Completion Date July 10, 2001

Depth (ft)	Meters (m)	Profile	Standard Penetration Blows/ft (10 20 30 40)	SPT Blows/6" (N)	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
				0/6" (0/6")		D-1		No Recovery		
5	1			2 3 5 (8)		D-2		Well graded GRAVEL with sand, loose, gray, wet, Homogeneous, no HCl reaction Length Recovered 0.5 ft, Length Retained 0.5 ft		
10	2 3		>>	18 25 30 (55)		D-3	GS MC	GW, MC=5% Well graded GRAVEL with sand, very dense, gray, wet, Homogeneous, no HCl reaction Length Recovered 1.0 ft, Length Retained 1.0 ft		
15	4 5		>>	27 38 (65)		D-4		Well graded GRAVEL with sand, subrounded, very dense, gray, wet, Homogeneous, no HCl reaction, drove on cobble Length Recovered 1.0 ft, Length Retained 1.0 ft		
20	6							End of test hole boring at 16.5 ft below ground elevation. This is a summary Log of Test Boring. Soil/Rock descriptions are derived from visual field identifications and laboratory test data.		

Washington State
Department of Transportation

LOG OF TEST BORING

Job No. OL-3305 SR 1630 HOLE No. H-WS-1-01

PROJECT Hood Canal Bridge Replacement Sheet 1 of 1

Inspector Cleo Andrews

Station 231+27 Offset 805ft Lt. Equipment CME 55 w/ autohammer

Latitude Longitude Method Wet Rotary

Northing Easting Casing HWT x 120.0'

Ground Elevation -63.0 (-19.2 m) Start Date June 28, 2001 Completion Date June 28, 2001

Depth (ft)	Meters (m)	Profile	Standard Penetration Blows/ft (10 20 30 40)	SPT Blows/6" (N)	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
								0.0' to 3.0' Poorly graded SAND with gravel, very dense gray, as indicated by drilling and wash return. (Till), 100% drilling fluid return.		
	1		>>	100/3 (100/3")		D-1		Silty SAND, very dense, medium gray, moist, Homogeneous, no HCl reaction, slightly cemented with a silt matrix. (Till). Length Recovered 0.2 ft, Length Retained 0.2 ft		
5	2									
10	3			40 50/3 (50/3")		D-2	GS MC	SM, MC=11% Silty SAND, very dense, medium gray, moist, Homogeneous, no HCl reaction, slightly cemented with a silt matrix. (Till). Length Recovered 0.8 ft, Length Retained 0.8 ft		
	4		>>	100/4 (100/4")		D-3		Silty SAND, very dense, medium gray, moist, Homogeneous, no HCl reaction, slightly cemented with a silt matrix. (Till). Length Recovered 0.3 ft, Length Retained 0.3 ft		
15	5							End of test hole boring at 14.3 ft below ground elevation.		
								This is a summary Log of Test Boring. Soil/Rock descriptions are derived from visual field identifications and laboratory test data.		
20	6									

Washington State
Department of Transportation

LOG OF TEST BORING

Job No. OL-3305 SR 1630 HOLE No. H-XS-1-01

PROJECT Hood Canal Bridge Replacement Sheet 1 of 1

Inspector Cleo Andrews

Station 232+71 Offset 780ft Lt. Equipment CME 55 w/ autohammer

Latitude Longitude Method Wet Rotary

Northing Easting Casing Hwt x 90.0'

Ground Elevation -50.0 (-15.2 m) Start Date June 27, 2001 Completion Date June 27, 2001

Depth (ft)	Meters (m)	Profile	Standard Penetration Blows/ft (10 20 30 40)	SPT Blows/6" (N)	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
								0.0' to 5.0' Poorly graded SAND with gravel, very dense, gray, slightly cemented, (Till), as indicated by drilling and wash return. 100% drilling fluid return.		
5	1, 2		>>	28 47 41 (88)		D-1		Silty SAND, very dense, medium gray, moist, Stratified, no HCl reaction, with 0.5' of Well graded GRAVEL with sand, traces of seashell, slightly cemented with a silt matrix. (Till). Length Recovered 1.5 ft, Length Retained 1.0 ft		
10	3		>>	80/6 (80/6")		D-2	GS MC	SM, MC=11% Silty SAND, very dense, medium gray, moist, Homogeneous, no HCl reaction, slightly cemented with a silt matrix. (Till). Length Recovered 0.5 ft, Length Retained 0.5 ft		
15	4, 5		>>	60/5 (60/5")		D-3		Silty SAND, very dense, medium gray, moist, Homogeneous, no HCl reaction, slightly cemented with a silt matrix. (Till). Length Recovered 0.5 ft, Length Retained 0.5 ft		
20	6							End of test hole boring at 16.5 ft below ground elevation.		

This is a summary Log of Test Boring. Soil/Rock descriptions are derived from visual field identifications and laboratory test data.

Washington State
Department of Transportation

LOG OF TEST BORING

Job No. **OL-3305** SR **1630** HOLE No. **H-WN-01**

PROJECT **Hood Canal Bridge Replacement** Sheet **1** of **1**

Inspector **Dan Reed**

Station **231+41** Offset **804ft Rt.** Equipment **CME 45 w/ autohammer**

Latitude Longitude Method **Wet Rotary**

Northing Easting Casing **HW/HQ**

Ground Elevation **-68.0 (-20.7 m)** Start Date **July 2, 2001** Completion Date **July 3, 2001**

Depth (ft)	Meters (m)	Profile	Standard Penetration Blows/ft (10 20 30 40)	SPT Blows/6" (N)	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
				2 3 2 (5)		D-1		Well graded GRAVEL with sand, subrounded, loose, gray, wet, Homogeneous, no HCl reaction Length Recovered 0.5 ft, Length Retained 0.5 ft		
5	1		>>	14 22 32 (54)		D-2		Well graded GRAVEL with sand, subrounded, dense, gray, wet, Homogeneous, no HCl reaction Length Recovered 1.0 ft, Length Retained 1.0 ft		
10	2		>>	23 36 (59)		D-3		Well graded GRAVEL with sand, subrounded, very dense, gray, wet, Homogeneous, no HCl reaction Length Recovered 1.0 ft, Length Retained 1.0 ft		
15	3		>>	38 40 (78)		D-4	GS MC	GW, MC=4% Well graded GRAVEL with sand, subrounded, very dense, gray, wet, Homogeneous, no HCl reaction, Drove on cobble Length Recovered 1.0 ft, Length Retained 1.0 ft		
	4							End of test hole boring at 16.5 ft below ground elevation.		
	5							This is a summary Log of Test Boring. Soil/Rock descriptions are derived from visual field identifications and laboratory test data.		
20	6									

APPENDIX D – LABORATORY TESTING

Laboratory Testing

Grain size analysis testing was performed on selected samples from the current field exploration program. The test was performed in general accordance with AASHTO guide specifications. After the testing was complete, the samples were classified in general accordance with the Unified Soil Classification System (USCS).

Job No. **OL-3305** Date **September 4, 2002**

Hole No. **H-VS-01** Sheet **1** of **1**

Project **Hood Canal Bridge Replacement**

Laboratory Summary

Washington State Department of Transportation

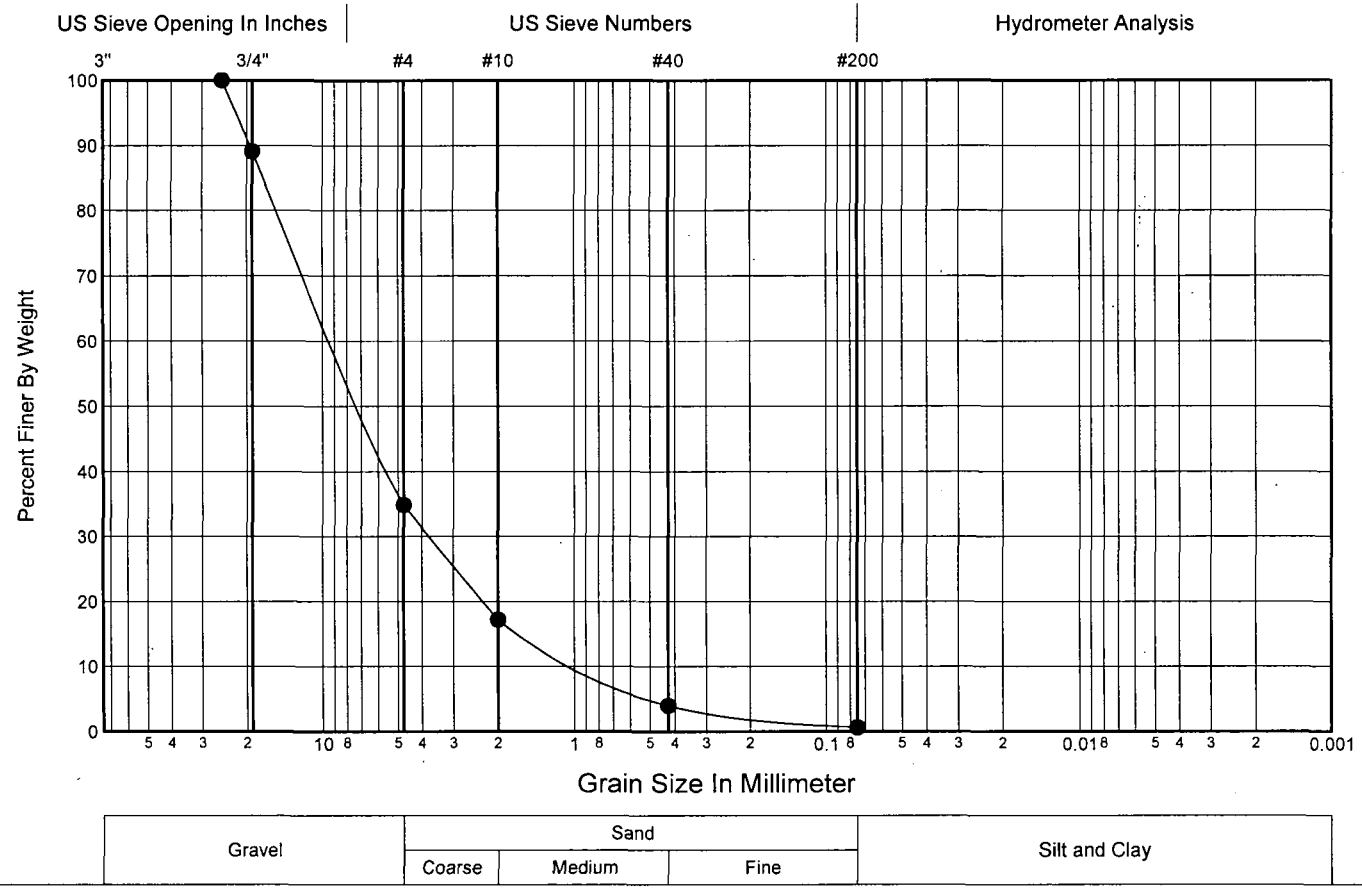
	Depth (ft)	Depth (m)	Sample No.	USCS	Color	Description	MC%	LL	PL	PI
●	**10.0**	**3.05**	**D-3**	**GW**	**See Boring Log**	**WELL-GRADED GRAVEL with SAND**	**5**			

GRADATION FRACTIONS

	%Gravel	%Sand	%Fines	Cc	Cu
●	**65.2**	**34.2**	**0.6**	**1.8**	**10.5**

GRADATION VALUES

	D60	D50	D30	D20	D10
●	**9.037**	**7.00**	**3.75**	**2.30**	**0.862**



Job No. **OL-3305** Date **September 9, 2002**

Hole No. **H-WS-1-01** Sheet **1** of **1**

Project **Hood Canal Bridge Replacement**

Laboratory Summary

Washington State Department of Transportation

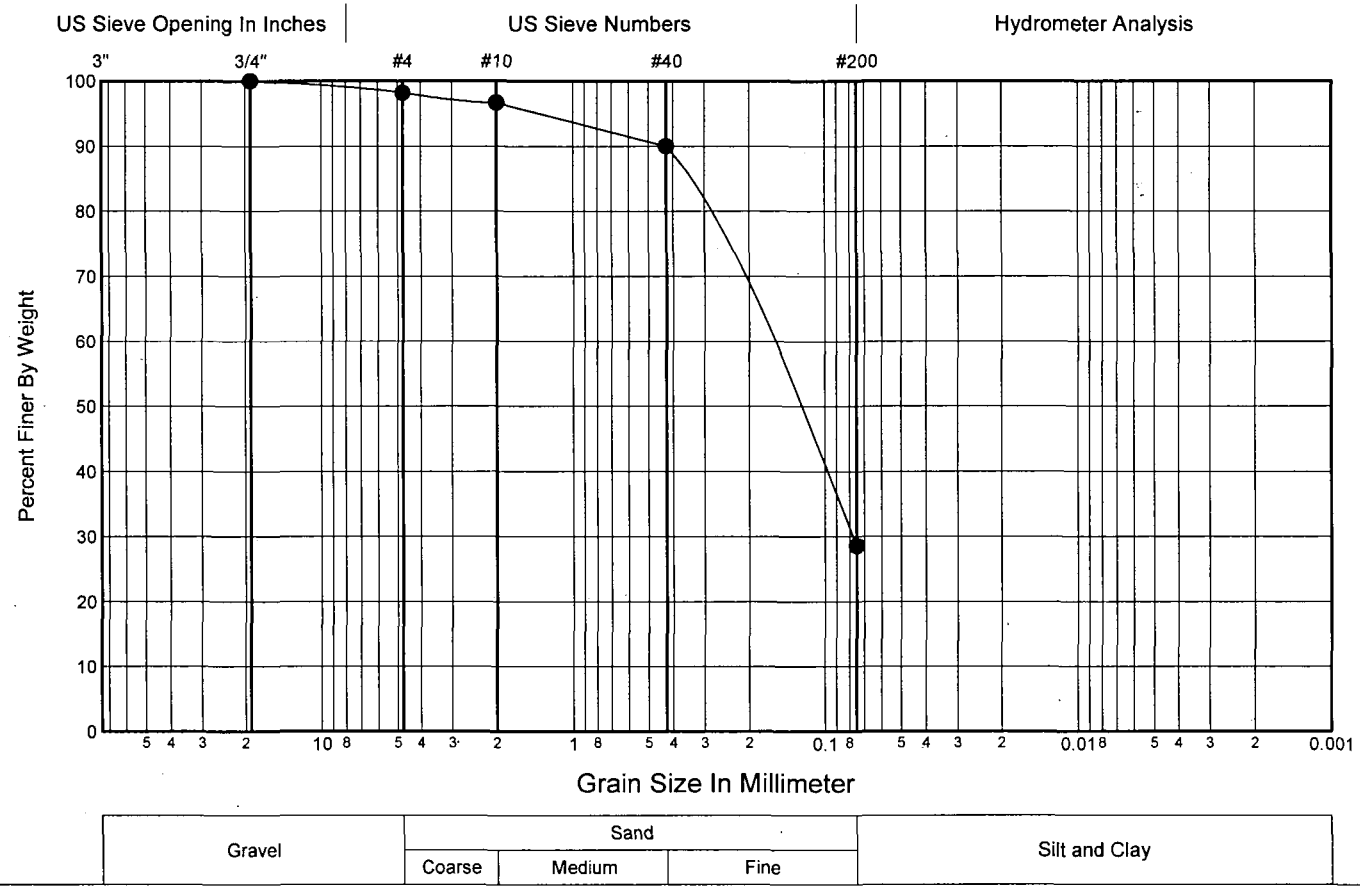
	Depth (ft)	Depth (m)	Sample No.	USCS	Color	Description	MC%	LL	PL	PI
●	**9.0**	**2.74**	**D-2**	**SM**	**See Boring Log**	**SILTY SAND**	**11**			

GRADATION FRACTIONS

	%Gravel	%Sand	%Fines	Cc	Cu
●	**1.9**	**69.6**	**28.6**		

GRADATION VALUES

	D60	D50	D30	D20	D10
●	**0.182**	**0.14**	**0.08**		



Job No. **OL-3305** Date **September 9, 2002**

Hole No. **H-XS-1-01** Sheet **1** of **1**

Project **Hood Canal Bridge Replacement**

Laboratory Summary

Washington State Department of Transportation

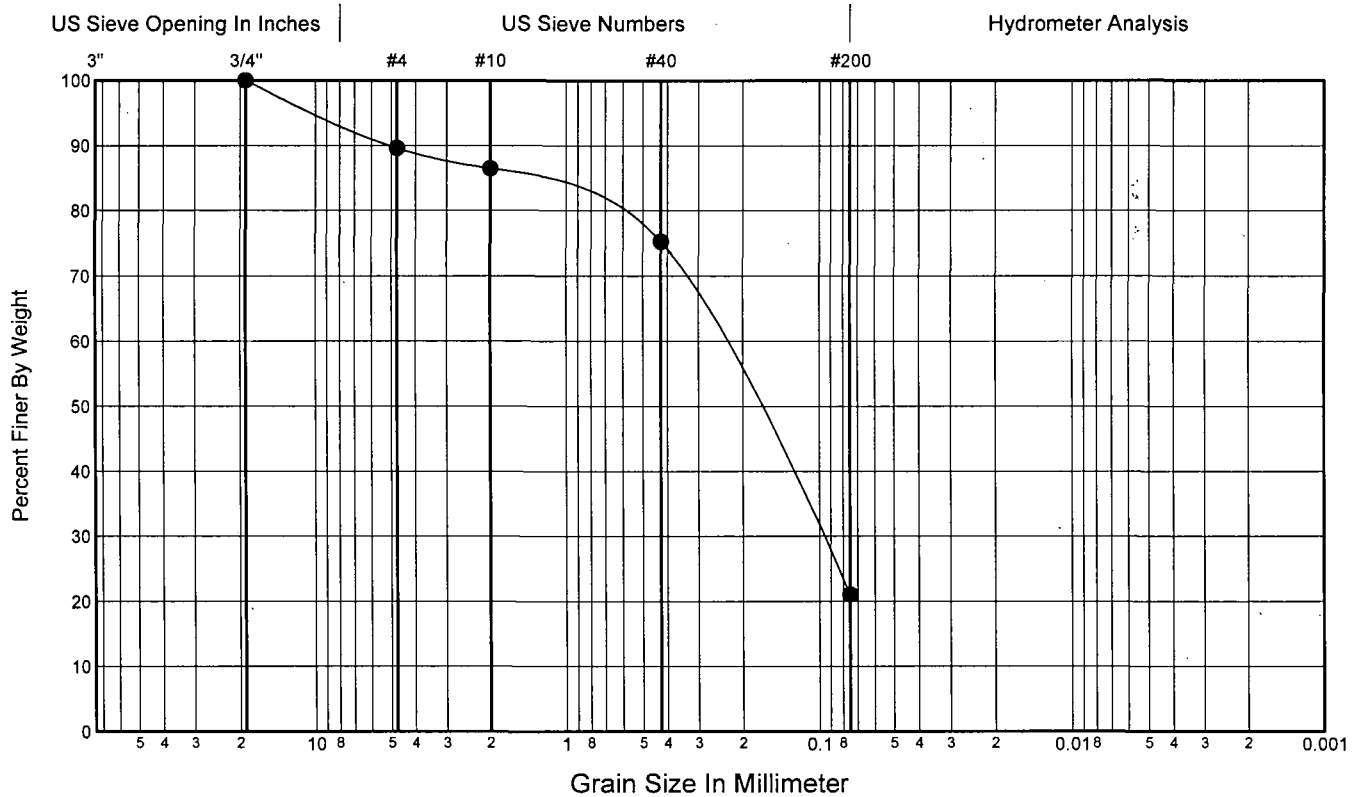
	Depth (ft)	Depth (m)	Sample No.	USCS	Color	Description	MC%	LL	PL	PI
●	**10.0**	**3.05**	**D-2**	**SM**	**See Boring Log**	**SILTY SAND**	**11**			
⊠										
▲										
★										
⊙										

GRADATION FRACTIONS

	%Gravel	%Sand	%Fines	Cc	Cu
●	**10.4**	**68.5**	**21.0**		
⊠					
▲					
★					
⊙					

GRADATION VALUES

	D60	D50	D30	D20	D10
●	**0.261**	**0.19**	**0.10**		
⊠					
▲					
★					
⊙					



Gravel	Sand			Silt and Clay
	Coarse	Medium	Fine	

Job No. **OL-3305** Date **September 4, 2002**

Hole No. **H-WN-01** Sheet **1** of **1**

Project **Hood Canal Bridge Replacement**

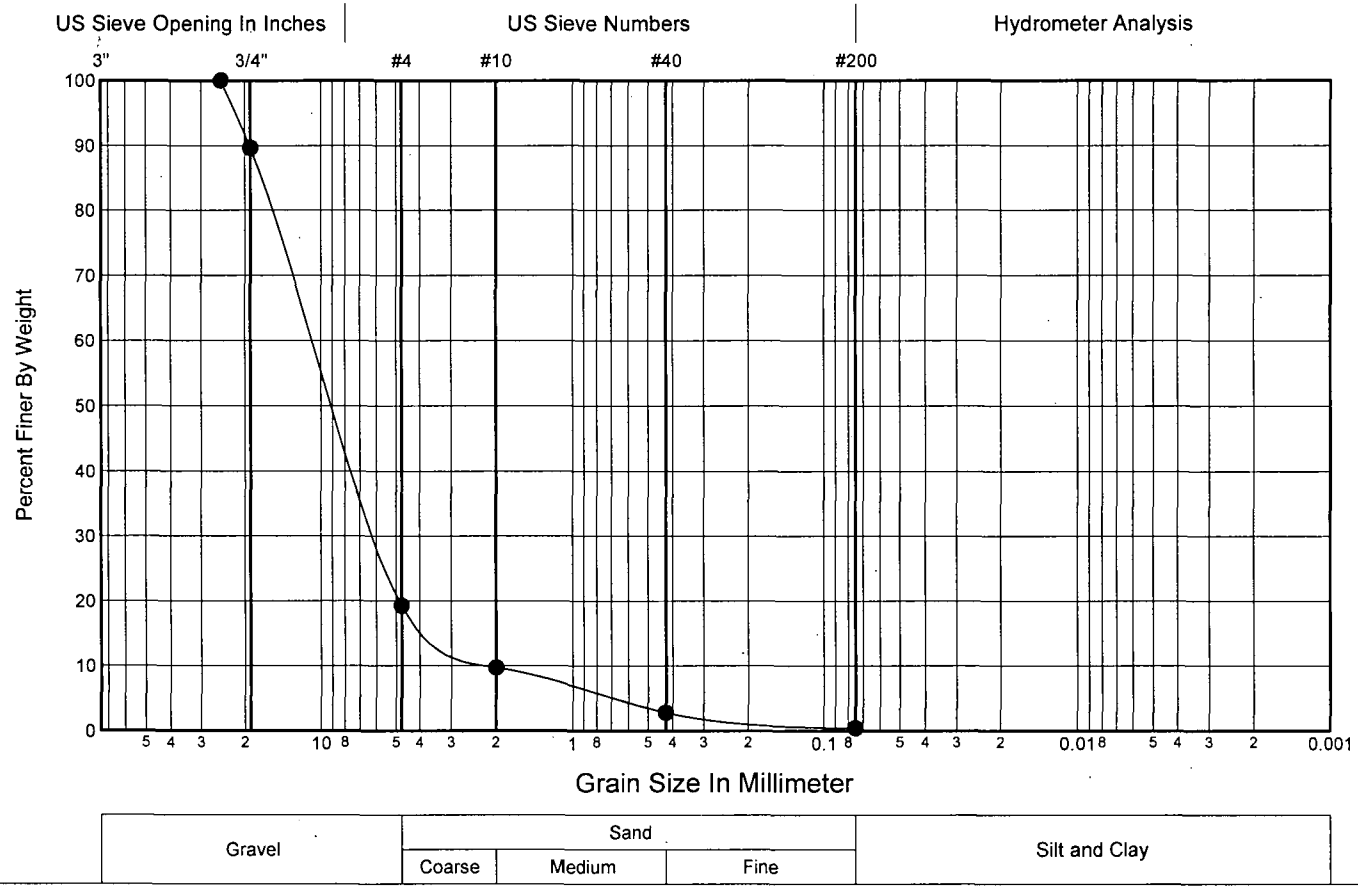
Laboratory Summary

Washington State Department of Transportation

	Depth (ft)	Depth (m)	Sample No.	USCS	Color	Description	MC%	LL	PL	PI
●	**15.0**	**4.57**	**D-4**	**GW**	**See Boring Log**	**WELL-GRADED GRAVEL with SAND**	**4**			

GRADATION FRACTIONS

	%Gravel	%Sand	%Fines	Cc	Cu
●	**80.7**	**18.8**	**0.4**	**1.6**	**5.2**

GRADATION VALUES

	D60	D50	D30	D20	D10
●	**10.597**	**8.70**	**5.87**	**4.82**	**2.057**