CHAPTER 6
GEOTECHNICAL INFORMATION

1. Introduction.

a. Purpose. An examination of geotechnical conditions and concerns pertinent to the proposed Columbia River Channel deepening was made to assess significant features and rock quantities for adequate evaluation for the upcoming Pre-Construction Engineering and Design (PED) Phase and construction contract plans and specifications. Feasibility phase studies included review of existing data on location, size, and character of rock bodies within the proposed channel limits; on slopes and foundations for bridge piers adjacent to the channel, and coordinating efforts for mitigation of blasting effects on fish during rock removal.

b. Tasks. Geotechnical tasks completed during the Feasibility Phase Study included a search for and a review of past rock excavation information. This, and an analysis and contour update of the last 7 years of fathometer survey results, provided estimates of rock quantities to be excavated for various proposed channel alternatives. An analysis of foundation conditions for bridge piers was conducted to identify potential problems related to excavation. A preliminary cost estimate was developed for explorations and tasks to be accomplished during the PED Phase, and a plan was developed for mitigation of effects on fish during any rock removal requiring blasting.

2. Methodology.

a. Research. Geotechnical references and data pertaining to general conditions and past studies for the lower Columbia River area were reviewed for information relative to the proposed channel deepening. Data included general texts, design memorandums and previous plans and specifications for rock removal contracts. Information for bridge pier analysis was compiled from exploration information collected from State and local agencies in charge of the bridges. Blasting information was obtained from rock removal contracts from New York District, US Army Corps of Engineers for comparable navigation improvements done to Kill Van Kull and Newark Bay Channels.

b. Coordination. Port authorities and consultants, river users, and geotechnical experts were consulted regarding locations of known rock bodies and navigation hazards that could possibly be rock within or adjacent to the river channel. State and local Government and other Corps Districts provided additional information for analysis and cost projection.

c. Hydrographic Survey Analyses. Columbia and Willamette River hydrographic surveys are completed several times a year to meet the needs of river navigation and channel maintenance. These fathometer surveys accurately record simultaneously both water depths and survey instrument locations. This information is converted to elevations that represent the top of

undifferentiated soil and rock materials within the channel and adjacent areas on the survey date. Comparisons were made among all of the hydrographic surveys from 1982 to 1997 for each river reach or bar area upstream from Puget Island Bar. A compilation of the data obtained from these comparisons was used to prepare contour maps of various elevations representative of the deepest depths ever recorded within the reach during that time period. The contours were used to help locate possible rock excavation areas. Possible existing rock bodies to be excavated should only be found in these areas where previous fathometer surveys indicate that the top of undifferentiated materials has never been exposed below those elevations.

d. Rock Quantity Estimates. Rock quantities have been computed for each area where rock is known to exist or adjacent to previous excavation contracts. The Slaughters Bar, Lower Vancouver Bar, Vancouver Turning Basin, and Broadway Bridge areas are included in the rock quantities because of the difficulty of excavation, even though the materials to be excavated may not be in-place rock. Morgan Bar is included as it is suspected to contain rock, even though no explorations have been conducted to verify the existence of rock. Rock quantity estimates were prepared by computing the total amount of material that was present contained within and above the contour interval of the suspect area using the software program INROADS, version 7.0, developed by Intergraph. Basic assumptions used in preparing rock quantities are as follows:

(1) Total rock quantities present within and above a specified contour interval are identified within each known or suspect rock area as solid, in-place material.

(2) Quantities of rock material to be excavated at Slaughters Bar, Lower Vancouver Bar and Vancouver Turning Basin, all of which are on the Columbia River, are based on an elevation of –47 feet, plus one foot paid overdepth. For the Broadway Bridge reach quantities for rock material were computed to –46 plus one. For basalt to be blasted and removed in the Columbia River, quantities were computed to an elevation of -49 feet plus one. Willamette River, basalt quantities were computed to an elevation of –46 feet plus one.

(3) Only volumes inside the contour for the required excavation depth were included in the excavation rock quantities. Quantities outside the excavation contour (i.e., the areas considered to be somewhere between –49 and –50 for an overdepth of –50 feet) were not included in the paid overdepth of one foot.

(4) The swell factors used for excavation of the various materials to be encountered are 1.50 for basalt, 1.3 for Slaughters Bar, and 1.3 for the Vancouver Bar and turning basin areas, and 1.25 for the Broadway Bridge area.

(5) Top of rock was estimated from a combination of previous rock excavation contract as-designed data and from fathometer surveys as follows:

(a) Previous excavation removed all rock above at least elevation (El.) –45.5 in the Columbia River except where otherwise noted.

(b) Previous excavations removed all rock above El. –44.5 in the Willamette River except where otherwise noted.

(c) No rock occurs above the elevations indicated on hydrosurvey charts made from about 1982 through May 1997.

(6) Excavation quantities are estimated only for known or adjacent to known areas of previous rock removal except for the Slaughters Bar, Broadway Bridge, Lower Vancouver Bar and Turning Basin, and Morgan Bar areas.

(7) Excavation rock quantities include, where applicable, material present up to 10 feet outside the present channel boundaries.

(8) Quantity computations assume vertical cuts, although final rock cut slopes will be designed as 4V on 1H.

3. Geology.

a. Physiography. The lower Columbia River between Portland and its mouth crosses two distinct geologic provinces, the Puget-Willamette Lowlands and the Coast Range. The Columbia River flows north from Portland along the western border of the Puget-Willamette Lowlands and then turns westward near Longview, Washington, to traverse the Coast Range. The Willamette River flows northward within the Willamette Valley Section of the Puget-Willamette Lowlands and joins the Columbia River at Portland, Oregon. The Puget-Willamette Lowlands is a structural basin consisting mostly of alluvial plains and gently undulating hillsides with locally scattered, steeper rocky hillocks. The Coast Range trends north - south, averages about 1,500 feet in elevation, and includes numerous steep sided rapidly eroding valleys. The coastal plain is relatively narrow and at the Columbia River mouth consists mostly of an enlarged embayment. The Columbia River eroded a much deeper channel beneath the present riverbed during sea level fluctuations that occurred during the Pleistocene and Holocene (Recent) Epochs. Sea level has risen an estimated 100 feet or more during the past 15,000 years resulting in a drowned valley mouth.

b. Riverbed Materials. The ancient Columbia River Valley has been filled with widespread sand and gravel deposits from as far away as Montana and Idaho. The present riverbed consists mostly of sands and local fine silts. Rock only occurs where the river has shifted out of its previous channel over onto the previous side valley slopes. Most of this rock is expected to consist of local layers of dense, hard basalt or basalt flow breccia. Locally resistant igneous intrusives also remain at some locations. Sedimentary siltstones, sandstones, and conglomerates are less common, but also occur within the present streambed area. Materials encountered downstream from the Cowlitz River mouth in Slaughters Bar Reach and to a lesser extent in Walker Island Reach consist of cemented or compact dense gravels, cobbles, boulders, and rock blocks in a clay matrix. The Slaughters Bar materials have also been identified as rock. Whether rock or consolidated rock fragments, they can be expected to be difficult to excavate and are likely to require large excavation equipment. Fine silts from the Portland Harbor below present project maintenance depths have in the past had to be excavated during non-fish periods due to the turbidity caused by excavation.

c. Sedimentary Conditions. The lower Columbia River floodplain width varies considerably from about 1.5 to 9 miles, with numerous sand bars both natural and artificially created by deposition of dredged materials, forming islands along much of the river. Sediments tend to be deposited primarily during winter and late spring. Suspended load has been estimated to average 10^6 metric tons a year, and average bed load discharge has been estimated at the mouth as 10^5 metric tons a year. Upstream bed load must be considerably less than at the mouth since only minimum amounts of sediment have accumulated in Bonneville Lake. River bottom characteristics are continuously changing with areas of erosion and accretion occurring continuously in most areas.

4. Rock Areas and Quantities.

a. General. Locations of known and suspected rock bodies within and adjacent to the existing channel limits are discussed in the following paragraphs. Estimated rock quantities and approximate locations are presented on Table 1.

b. Wauna Bar. An area of basalt rock occurs at Wauna Bar near Columbia River Mile (CRM) 42. Rock was supposedly removed from five locations within the channel limits and from three locations adjacent to the channel in the mid-1960's. Pre-construction records indicate the rock removal pay line was to be El. –46, but the required project depth and sweep line for rock removal was to be El. –45. It can be assumed that rock was removed to at least –45.5. This reach was contoured to a bottom elevation of –50. The cumulative compilation of fathometer surveys shows no material occurring above –47. This area is shown on Figure 1.

c. Stella-Fisher Bar. A basalt rock pinnacle located near CRM 56 in the Stella-Fisher Bar Reach was excavated to approximate El. –47 in the mid-1970's. Exact depth of rock removal is not known and the specifications indicate that there was a 1- to 2-foot tolerance line for rock removal. The cumulative compilation of fathometer depths indicates the area is now greater than –47 feet. This reach was contoured to a bottom elevation of –50. This area is shown on Figure 2.

TABLE 1
COLUMBIA RIVER CHANNEL DEEPENING
ROCK EXCAVATION SUMMARY

River Reach (RR)	BORR RM*	EORR RM**	Rock Type	Required (BCY)	Required (LCY)	Paid O Depth (BCY)	Paid O Depth (LCY)	Quantity (LCY)	Area (Sq. Ft.)	Exc. Method
Columbia River	**49 plus 1 and at Slaughters Bar, L. Vancouver Bar & Vancouver Turning Basin 47 plus 1 ,Basalt Rx swelled by 1.50 & Slaughters Bar conglomerate swelled by 1.3**									
Wauna/Driscoll	40+40	44+27	Basalt	4,737	7,106	5,137	7,705	14,811	138,690	Drill & Blast
Stella/Fisher Bar	55+30	59+12	Basalt	122	183	145	218	401	3,918	Drill & Blast
Slaughters Bar	63+10	67+06	Basalt	79,553	115,712	157,370	236,056	351,767	4,249,000	Clamshell
Warrior Rock	87+15	90+20	Basalt	28,387	42,581	16,641	24,961	67,542	449,300	Drill & Blast
Morgan Bar	97+40	101+18	Basalt?	38,509	57,764	36,540	54,810	112,573	986,573	Drill & Blast
L. Vancouver Bar	101+18	104+31	Gr,Bldrs,Sd	12,740	15,925	32,641	40,801	56,726	881,300	Clamshell
Van. Turn. Basin	104+31	106+23	Gr,Bldrs,Sd	47,400	59,250	89,322	111,653	170,903	2,411,700	Clamshell
Willamette River		**46 plus 1, Basalt Rx. swell factor 1.5 and gravels & sand 1.25**								
P.O. Range-RM 7.5	3+25	7+30	Basalt	46,219	69,329	47,845	71,833	141,096	1,291,817	Drill & Blast
RM 7.5 - Brdwy Br.	7+30	11+36	Gr,Bldrs,Sd	20,836	26,045	11,889	17,833	43,878	321,000	Clamshell
Required (BCY) - Total in-place quantity of rock above El. -49 (or 47, or 46) contour										
Required (LCY) - is the quantity of in-place material to be removed to El. -49 (or 47, or 46) swelled by 1.5 (or 1.3, or 1.25)										
Paid O Depth (BCY) - In-place Overdepth material - determined by: (areaXdepth(1 ft)) /27 ft/cy= embankment yardage.										
Paid O Depth (LCY) - In-place Overdepth material swelled by 1.5 (or 1.3, or 1.25)										
Quantity (LCY) - is the total quantity of material to be removed to El. -50 (or 48, or 47), (Required (LCY) plus Paid O Depth (LCY))										
Area (Sq.Ft.) - Surface area of El. -49 (or 47, or 46) rock contour										

* BORR RM - Beginning of river reach, River Mile
** EORR RM - End of river reach, River Mile.
BCY - Bank cubic yards
LCY - Loose cubic yards

d. Slaughters Bar.

(1) General. Materials of questionable composition, but sufficiently difficult to excavate that they should be considered as rock, occur at Slaughters Bar and the upper portion of Walker Island Bar, from approximate CRM 63 to CRM 67. Materials removed from this area in the mid-1960's consisted of plastic clay and coarse gravels. Additional materials were removed in the mid-1970's, but no data could be found on the nature of these materials. Design memorandums indicate the mid-1970's material removal pay line was to be at El. –45 and the required project depth and sweep line were to be at El. –44. It can be assumed that material was removed to at least –44.5. This reach was contoured to a bottom elevation of –48. This area is shown on Figure 3.

(2) Composition of Materials. Materials to be excavated from Slaughters Bar Reach are either well cemented gravels, cobbles, boulders and displaced large rock blocks, or in-place rock. Construction data for Longview Bridge which is in the Slaughters bar Reach indicate the bridge is underlain at depth by compact sandy gravel, cobbles, and boulders, and that the piers adjacent to the channel were founded in this material at elevations of –60.7 and –72.0. A 1970 drill hole near an Oregon shore pier indicated similar materials to El –129. Bedrock beneath the river channel at the Trojan Nuclear Site (approximate river mile 73) is estimated through geophysical explorations to be below El. –300. Material thought to be in-place rock was encountered, however, in 1970 clamshell explorations at elevations as high as –40 within the channel in the vicinity of the bridge. This rock was classified at different locations as hard gray basalt, green flow breccia, or slab rock.

(3) Explanation of Interpretations. A possible explanation for the different materials encountered could be the result of past Mount St. Helens volcanic eruptions. Volcanic debris including fines, sands, gravels, cobbles, boulders, and large rock blocks could have been disgorged from the Cowlitz River mouth and deposited beneath the existing Columbia River channel, and could even have resulted in the southward relocation of the Columbia River from its original deeper channel to a much shallower channel perhaps in part flowing over rock at its present location.

(4) Difficulty of Excavation. Excavation of material from Slaughters Bar Reach is expected to be difficult, no matter which interpretation of geologic conditions or material classification is used. Clamshell explorations with a 2.5 cubic yard bucket were unable to penetrate the materials classified as rock. It is anticipated that large mechanical excavation equipment will be able to remove all material except for any in-place rock or displaced large rock blocks encountered. Blasting is not expected to be required. However, if any basalt rock or large rock blocks are encountered, blasting might be necessary.

e. Warrior Rock. An area of basalt rock occurs at Warrior Rock near CRM 87. Rock was removed from this area in the mid-1960's. Pre-construction records indicate the rock removal pay line was at El. –44, and the required project depth and sweep line for rock removal was at El. –43. It is assumed that rock has been removed to at least El. –43.5. The cumulative compilation of fathometer depths indicates rock is present above El. –45. This reach was contoured to a bottom elevation of –50. This area is shown on Figure 4.

f. Morgan Bar. A suspected rock area occurs in the Morgan Bar Reach near CRM 101. Known rock on the west bank appears to project out into the channel between approximate Stations 100+38+00 and 100+50+00. Explorations need to be accomplished in this area to verify the presence of rock. If rock is present in this area, it will probably be basalt, requiring blasting methods for removal. The cumulative compilation of fathometer depths identify material present above El. –47 feet. This reach was contoured to a bottom elevation of –50. This area is shown on Figure 5.

g. Post Office Range – River Mile 7.5. An area of basalt rock occurs in Portland Harbor within the Post Office Range – River Mile 7.5 reach between approximate Willamette River Mile (WRM) 4 and WRM 6. Rock was removed from five locations within the channel limits and from two locations adjacent to the channel. Rock excavations occurred in both the mid-1960's and again in the mid-1970's. Design memorandums for the mid-1970's excavations indicate the rock removal pay line was at El. –45 and the required project depth and sweep line for rock removal were at El. –44. Based on this, it can be assumed that rock was removed to El. –44.5. Rock could possibly be higher in some of these locations, however, since not all of the locations of the mid-1960's excavations were re-excavated in the mid-1970's. The mid-1960's rock removal pay line was at El. –43 and the rock removal line was at El. –42. Thus, some rock could possible be found as high as approximate El. –42.5. A proposed channel realignment has been used to miss some of the known rock bodies to minimize the amount of excavation required. Rock quantities have been calculated only within the proposed channel limits. Even so, as excavation gets deeper in the vicinity of these known rock bodies, the chances of encountering additional rock increases. Results of cumulative compilation of fathometer depths has identified additional possible rock bodies or extensions of existing rock. Explorations will need to be conducted to verify the existence of rock. This reach has been contoured to a bottom elevation of –47. This area is shown on Figure 6.

h. Broadway Bridge Area. An area of known sand, gravel, and boulders is present just downstream of the Broadway Bridge, between WRM 10 and WRM 11. This area was identified through water jet probe explorations conducted during the 1960's. No information is available as to the final rock removal depth. It is anticipated that mechanical dredging equipment, such as a clamshell will be required to remove this material. Cumulative compilation of fathometer depths shows material present to around El. –43 on the northern margin of the proposed channel realignment. This portion of the reach has been contoured to a bottom elevation of –47. This area is also shown on Figure 6.

i. Lower Vancouver Bar and Turning Basin. Vancouver Bar excavations in the past have encountered considerable amounts of "...cemented sand and gravel, hard-packed sand and gravel, and cobblestones." One area encountered during the last deepening occurred near CRM 105. This area required heavy-duty mechanical dredging equipment to break up and remove the rock material. The character of this material is not consistent, cemented areas are found in a variety of areas at different elevations, making quantity estimates difficult. Cumulative compilation of fathometer depths shows material is present up to El. –46. These reaches have been contoured to a bottom elevation of –48. This area is shown on Figure 7.

5. Bridge Pier Analysis.

a. General. An analysis of the bridge piers within the channel deepening limits was made to determine the likelihood of compromising the bridge foundations by the removal of overburden or rock or through scour at the pier foundation. All available design drawings and foundation information for all bridges was secured and analyzed based on the new proposed channel depths and alignments. It was assumed that the maximum channel depth for the Columbia River was El. –48 with an El. –50 rock depth. A maximum study depth of El. –45 with an El. –46 rock depth is assumed for the Willamette River.

b. Astoria Bridge. The Astoria Bridge crosses the Columbia River at approximate River Mile 13.6. The existing channel in this location is, for the most part, deeper than the study depth, however, the channel approaches 40 feet at the southern limit. This would necessitate dredging up to 8 feet of overburden which is most likely sands and silts. There is no current information on the foundation material but design drawings indicate sand and silt to a depth of at least 80 feet. It does not appear that the maximum study depth will cause a problem with either main pier. Design drawings show the south pier to be founded slightly deeper (approximate El. -100 feet NGVD to the top of the piles) than the north pier (approximate El. -80 feet to the top of the piles) where the channel is substantially deeper than the maximum study depth. Additionally, design drawings indicate the channel was approximately -47 at the time of the contract for the bridge piers. Significant scour is not anticipated given the tidal fluctuations and the width of the river at this point.

c. Longview Bridge. The Longview Bridge crosses the Columbia River at approximate River Mile 66. There is no indication that the maximum study depth will have a detrimental effect on the bridge piers if the current channel configuration is maintained. The piers appear to be founded on gravelly sand at elevations of –60 and –72 for the main piers and –50 for the two secondary piers near each side of the shore. A current hydrosurvey of the area indicates the Longview port area limit is at least 100 feet upstream of the bridge alignment. If the port area is adjusted any nearer to the alignment of the bridge, pier #4 (closest to the north shore) will need to be examined more closely. Flows high enough to scour the gravelly sand are not anticipated in this area of the river due to the width of the channel.

d. St. Johns Bridge. The St. Johns Bridge crosses the Willamette River at approximate River Mile 5.8. It does not appear that the maximum study depth will cause a problem with either main pier. The most recent hydrosurvey indicates the channel is near or below the maximum study depth in the area of the bridge. The new Willamette channel alignment crosses beneath the bridge to the east side where the channel is the deepest. Oregon Department of Transportation drawings indicate the current channel limits are approximately 350 feet from the east main pier. Given the minimal amount of dredging in the area, the distance from the channel limit and the fact that the pier is rip-rapped to elevation –30 it is not likely the pier will be affected. The east main pier is founded on piles that have an average depth of –85 and are cut-off at –49; the foundation material is sand. The west main pier is founded into rock at least 2.0 feet at an approximate elevation of –25.

e. Burlington Northern Railroad Bridge. The Burlington Northern Railroad Bridge crosses the Willamette at approximate River Mile 6.9. Rock throughout the area is for the most part deeper than the proposed rock excavation depth of El. –46. The main west pier (no. IV), however, is founded at –45.9. A thin layer of rock extends up to about El. –43 adjacent to the pier and extends about 15 feet into the channel at El. –46. It is proposed to remove the overburden to this rock line and leave this portion of the rock intact adjacent to the pier. The main east pier is founded at a depth of approximately –80 and is not a concern. Preliminary information indicates the piers are founded on Troutdale Formation; this material is generally fairly hard cemented gravels, however, it tends to have pockets of fairly soft material.

f. Fremont Bridge. The Fremont Bridge crosses the Willamette River at approximate River Mile 11.1. The piers for this bridge are founded on land and will be unaffected by a deepening of the channel.

g. Broadway Bridge. The Broadway Bridge crosses the Willamette at approximate River Mile 11.7 and is at the upstream end of the 40-foot channel. Piers 5 and 6, in the middle of the river, are supported by timber caissons installed in the river bottom from El. –30 to –80. Materials adjacent to the caissons are anticipated to be unconsolidated sediments, based on the depth of the caissons. There is no information available on foundation material and current channel depth at the piers at this time. Underwater examinations of the piers and caissons reveal that the exposed timber framework is still intact. It is not likely a problem would be created with excavation.

6. Blasting Information.

a. General. Blasting will be required to remove in-place basalt from several areas within the Columbia and Willamette Rivers. Blasting has been accomplished in the past during previous rock removal contracts in the 1960's and 1970's. Unfortunately, very little information is available detailing how blasting was accomplished in these areas, leaving questions as to the character of the rock remaining.

b. Rock Requiring Blasting. Blasting will be required to remove rock to El. –50, which is the projected pay line, at Wauna Bar, Stella Fisher Bar , Warrior Rock, and possibly Morgan Bar on the Columbia River. Blasting will also be required to remove rock within the Willamette River at several possible locations in the Post Office Range to River Mile 7.5 Range to El. –47. Rock is all anticipated to be basalt, which is a hard, igneous rock created as a terrestrial lava flow. The character of this material is unknown, other than the hardness. Depending on location within the flow, the rock may be massive or highly jointed. Also, due to previous blasting techniques, the upper surface of areas of previous rock removal may be highly fractured, with loose material present at the surface of rock body. Explorations are required to determine the true nature of the material.

c. Proposed Blasting Plan. The proposed blasting plan is patterned after rock removal efforts conducted by New York District for channel improvements done to Kill Van Kull and

Newark Bay Channels. Rock encountered in these excavations is a diabase, which is similar to the basalt in the Columbia and Willamette Rivers. Drill holes measuring approximately 4.5 inches in diameter are to be placed on a 10-foot by 10-foot pattern drilled approximately 10 feet below the new grade line. Explosives to be used are expected to be a cartridged water gel. Rock would be removed after blasting by clamshell.

d. Mitigation of Blasting Effects on Fish. All possible measures are to be utilized to minimize blasting effects on fish during rock removal. Blasting will only be accomplished during scheduled in-water work periods. Actual blast effects will be minimized by limiting peak overpressure from blasting to 10 psi or less at the least distance possible from the shot area. This can be accomplished by ensuring every shot will have blasting delays such that explosives in each individual blast will be detonated on a different delay. This will limit the pounds of explosives per delay to about 100 pounds maximum. Information collected from other projects using this criteria indicate that peak overpressures can be controlled to 10 psi or less at distances of 30 to 50 meters from the blast point. Hazing tactics will be employed to scare fish from the immediate area just prior to each blast.

7. Explorations. Explorations are proposed for upcoming PED Phase work to better identify the location and extent of the rock bodies and to better determine the quantity and character of the material. Explorations are to begin with geophysical investigations utilizing sub-bottom profiling techniques to better determine the presence and depth of rock bodies. Once known and suspected rock bodies are better identified, a series of water jet probes and core drill holes will be placed at specific locations to verify the depth to, nature of, and quantity of rock. The nature of the rock, whether massive, jointed, slightly or highly fractured, will aid in what specific equipment or techniques will be necessary to remove the material. Planned explorations, including approximate numbers and costs are included in Attachment 1.

COLUMBIA RIVER CHANNEL DEEPENING
SUMMARY - PED EXPLORATIONS

GEOPHYSICAL EXPLORATIONS	
Hydrosurvey Boat	$30,000
Geophysical Contractor	$32,400
Inspection	$ 8,000
Contract Preparation and Administration	$11,500
Branch S&A	$ 2,700
Total	$84,600
JET PROBE/CORE DRILLING EXPLORATIONS	
Contract Costs	$788,200
A/E Delivery Order Contract - Inspection	$ 19,900
Inspection	$ 34,400
A/E Delivery Order Contract - Contract P&S	$ 23,800
Contract Preparation and Administration	$ 27,100
Total	$893,400
SLAUGHTERS BAR EXPLORATIONS	
Contract Costs	$171,000
A/E Delivery Order Contract - Inspection	$ 19,100
Inspection	$ 15,400
A/E Delivery Order Contract - Contract P&S	$ 23,800
Contract Preparation and Administration	$ 23,400
Total	$252,700

TOTAL PED EXPLORATIONS COSTS - $1,230,700

Attachment 1

COLUMBIA RIVER CHANNEL DEEPENING
PED - GEOPHYSICAL EXPLORATIONS

GENERAL ASSUMPTIONS

Work to be completed in 10, 10-hour days, no standby days.
Work to include a 60-mile stretch of the Columbia and 11 miles of the Willamette.
Work to be done early Summer 1999
Work to be accomplished by In-house Labor efforts

HYDROSURVEY BOAT COSTS

Boat, Crew, & PD (Hickson or Rodolf (220V)) and SEABAT - $3,000/10-hour day

Total Boat Cost - 10 days x $3,000/day = $30,000

GEOPHYSICAL CONTRACTOR

Equipment - Boomer (250 Hz), GPR (50 mHz antenna), Corps Side Scan Sonar
Equipment Rate - Boomer - $500/day, GPR - $300/day, Side Scan - NC
Total Equipment Cost - $800/day x 10 days + $300 mob/demob = $8,300
Personnel - 2 people plus PD and Van rental
Personnel Rate - Senior Geophysicist - $70/hr x 10 hrs = $700/day
Staff Geophysicist - $50/hr x 10 hrs = $500/day
Total Personnel Cost - $1,200/day x 10 days = $12,000
Per Diem and Van Rental - 2 people @ $75/day + $50/day van = $200/day
Total PD & Van Cost - $200/day x 10 days = $2,000
Data Reduction - Senior Geophysicist, 15 days @ 8 hrs/day
Total Data Reduction Cost - $8,400
Report Preparation - Senior Geophysicist, 3 days
Total Report Cost - $1,700

Total Cost - $32,400

INSPECTION

Geologist, GS-11 @ $72/hr
Inspection - $72/hr x 10 days = $7,200
PD - $75/day x 8 days = $600
Car - $200

Total Cost - $8,000

CONTRACT PREPARATION AND ADMINISTRATION

Geologist, GS-11 @ $72/hr
- Prepare Contract - 8 days - $4,600
- S & A - 3 days - $1,800
- Coordination - 3 days - $1,800

Supervision, GS-13 @ $102/hr x 8 hrs = $800

Contracting - $2,500

Total Contract Costs - $11,500

BRANCH S&A (15% on In-House Labor)

Geologist, GS-11 Costs - $17,200
Geologist, GS-13 Costs - $800

Total Branch S&A - $2,700

TOTAL GEOPHYSICAL EXPLORATIONS COSTS - $84,600

COLUMBIA RIVER CHANNEL DEEPENING
PED - JET PROBE/CORE DRILLING EXPLORATIONS

GENERAL ASSUMPTIONS

Work to be done in Summer 1999
Work to be done in a 60-mile stretch of the Columbia and 11-miles of the Willamette
Work to be patterned after the Coos Bay Deepening explorations in 1994 using similar equipment and production rates. Unit prices include support equipment costs.
Costs based on an average of Coos Bay bids and using a 14% inflation factor from 1994 to 1999
Explorations to last approximately 30 days
Estimate is based on using an A/E Contract vs. In-house labor efforts.

CONTRACT COSTS

Mob/Demob			$ 88,000
Water Jet Probes			
1st 339	Unit Price	$1,025	$347,000
Over 339 (115)		$ 410	$ 47,200
Core Drill Setups			
1st 19	Unit Price	$2,766	$ 52,600
Over 19 (9)		$1,371	$ 12,300
Core Drilling			
1st 190 LF	Unit Price	$ 956	$181,600
Over 190 LF (90)		$ 656	$ 59,000
		Subtotal	$788,200

A/E DELIVERY ORDER CONTRACT - INSPECTION (Prepare Statement of Work, Coordination, S&A, etc.)

Prepare and Negotiate Statement of Work
Geologist, GS-11 - 100 hrs x $72/hr = $7,200

Coordination
Geologist, GS-11 - 3 days x $72/hr = $1,700

S&A
Geologist, GS-11 - 5 days x $72/hr = $2,900
Supervision, GS-13 - 4 days x $102/hr = $3,300

Branch S&A (15%) = $2,300
A/E Contracting Costs (PE-TA) = $ 2,500

Total Cost - $ 19,900

INSPECTION (By A/E)

Geologist, GS-11 Equivalent @ $72/hr
- Inspection - $72/hr x 10 hrs/day x 30 days = $21,600
- PD - $75/day x 30 days = $2,300
- Car - $500
- Drill Logs, Probe Spreadsheet, and Plan Maps - $72/hr x 7 days = $4,000
- Report - $72/hr x 5 days = $2,900
- Profit (10%) - $3,100

Total Cost - $34,400

A/E DELIVERY ORDER CONTRACT - PREPARE EXPLORATION CONTRACT PLANS AND SPECS (Preliminary Layout of Work, Prepare and Negotiate Statement of Work, Coordination, S&A, etc.)

Geologist, GS-11 - 15 days x $72/hr = $8,600

Coordination
Geologist, GS-11 - 5 days x $72/hr = $2,900

S&A
Geologist, GS-11 - 5 days x $72/hr = $2,900
Supervision, GS-13 - 5 days x $102/hr = $4,100

Branch S&A (15%) = $2,800
A/E Contracting Costs (PE-TA) = $ 2,500

Total Cost - $ 23,800

EXPLORATION CONTRACT P&S PREPARATION AND ADMINISTRATION (By A/E)

Geologist, GS-11 Equivalent @ $72/hr x 25 days = $14,400

Supervision
Geologist, GS-13 Equivalent @ $102/hr x 4 days = $3,300

Coordination
Geologist, GS-11 Equivalent @ $72/hr x 3 days = $1,700

Miscellaneous Expenditures - $2,000

Office Overhead (15%) - $3,200

Profit (10%) - $2,500

Total Cost - $27,100

TOTAL JET PROBE/CORE DRILLING EXPLORATIONS COSTS - $893,400

COLUMBIA RIVER CHANNEL DEEPENING
PED - SLAUGHTERS BAR EXPLORATIONS

GENERAL ASSUMPTIONS

Assume clam shell operation digging test pits in 40 locations
Production rate of 4 test pits/day based on 1970 explorations
Assume using barge-mounted 10cy clam w/ 1 bottom dump scow, 2 tugs
Current estimate based on Coos Bay Channel Deepening Contract, 1997 using comparable equipment and rates.
Explorations to last 10 days
Estimate is based on using an A/E Contract vs. In-house labor efforts.
Work to be done Summer 1999

CONTRACT COSTS

Mob/Demob
Assume mob radius of 300 miles @ 5 mi/hr = 60 hrs

Equipment
Barge-mounted clam $200/hr
Bottom Dump Scow $35/hr
Tugs $230/hr x 2
Pickups $8/hr x 2
Total Hr Rate = $710/hr

Mob = $710 x 60 = $42,600 ~ $50,000
Demob = ½ Mob = $25,000

Total Mob/Demob = $75,000

Equipment and Labor Rates (Cost/Day)
Assume work 10 hr days
Equipment listed above = $710/hr x 10 hrs = $7,100/day x 10 days = $71,000

Dredging Crew
Foreman - $45/hr x 10 hrs = $450/day
Clam Operator - $42/hr x 10 hrs = $420/day
Oiler - $31/hr x 10 hrs = $310/day
Deckhand - $33/hr x 10 hrs = $330/day
Total Crew Rate = $1510/day x 10 days = $15,000

SubTotal Cost - $161,200 x 6% inflation for FY99

Total Contract Cost - $171,000

A/E DELIVERY ORDER CONTRACT - INSPECTION (Prepare Statement of Work, Coordination, S&A, etc.)

Prepare and Negotiate Statement of Work
Geologist, GS-11 - 90 hrs x $72/hr = $6,500

Coordination
Geologist, GS-11 - 3 days x $72/hr = $1,700

S&A
Geologist, GS-11 - 5 days x $72/hr = $2,900
Supervision, GS-13 - 4 days x $102/hr = $3,300

Branch S&A (15%) = $2,200
A/E Contracting Costs (PE-TA) = $ 2,500

Total Cost - $ 19,100

INSPECTION (By A/E)

Geologist, GS-11 Equivalent @ $72/hr
- Inspection - $72/hr x 10 hrs/day x 10 days = $7,200
- PD - $75/day x 10 days = $750
- Car - $200
- Exploration Logs, Spreadsheet, and Plan Maps - $72/hr x 6 days = $3,500
- Report - $72/hr x 4 days = $2,300
- Profit (10%) - $1,400

Total Cost - $15,400

A/E DELIVERY ORDER CONTRACT - PREPARE EXPLORATION CONTRACT PLANS AND SPECS (Preliminary Layout of Work, Prepare and Negotiate Statement of Work, Coordination, S&A, etc.)

Geologist, GS-11 - 15 days x $72/hr = $8,600

Coordination
Geologist, GS-11 - 5 days x $72/hr = $2,900

S&A
Geologist, GS-11 - 5 days x $72/hr = $2,900
Supervision, GS-13 - 5 days x $102/hr = $4,100

Branch S&A (15%) = $2,800
A/E Contracting Costs (PE-TA) = $ 2,500

Total Cost - $ 23,800

EXPLORATION CONTRACT P&S PREPARATION AND ADMINISTRATION (By A/E)

Geologist, GS-11 Equivalent @ $72/hr x 20 days = $11,500

Supervision
Geologist, GS-13 Equivalent @ $102/hr x 4 days = $3,300

Coordination
Geologist, GS-11 Equivalent @ $72/hr x 3 days = $1,700

Miscellaneous Expenditures - $2,000

Office Overhead (15%) - $2,800

Profit (10%) - $2,100

Total Cost - $23,400

TOTAL SLAUGHTERS BAR EXPLORATIONS COSTS - $252,700