BEFORE THE WASHINGTON UTILITIES AND TRANSPORTATION COMMISSION
Docket No. UE-070074
Puget Sound Energy, Inc.'s
Motion to Extend Deferred Accounting

EXHIBIT D

JANUARY 8, 2008 LETTER
FEDERAL ENERGY REGULATORY COMMISSION
BOARD OF CONSULTANTS

FERC BOARD OF CONSULTANTS
Ron Mason P.E.
Mel Schaefer Ph.D. P.E.
George Taylor CCM

January 8, 2008

Mr. Lloyd Pernela
Manager of Dam Safety
Puget Sound Energy
10885 NE 4th Street
Bellevue, WA 98004-5591

Re: Baker River Project Part 12 Probable Maximum Flood Study, FERC Project No. 2150

Dear Mr. Pernela:

The Board of Consultants (BOC) has reviewed the December 2007 final report titled Baker River Project Part 12 Probable Maximum Flood Study, prepared by Tetra Tech. Over the course of the study we have provided guidance in conducting the various investigations leading to the development of the Probable Maximum Floods (PMFs) for the Upper Baker and Lower Baker Dams. We have also reviewed the twelve technical memoranda that support the findings described in the final report.

We concur that the proposed PMFs for the Upper Baker and Lower Baker Dams are sufficiently conservative and were developed consistent with current engineering practice. Puget Sound Energy and Tetra Tech are to be commended for their diligence in conducting the PMF study in a manner that has examined all of the contributing factors in great detail.

The findings of the Global Sensitivity Analysis (GSA) have helped in selection of hydrometeorological inputs and watershed model parameters that collectively provide a reasonable level of conservatism without excessive compounding of conservatisms. Extensive efforts were made to utilize historical data as a guide in watershed model development and to confirm realistic operation of the model. The study has employed several new technologies in spatial mapping of precipitation, distributed rainfall-runoff computation, watershed model calibration and stochastic analyses, and represents the cutting edge of hydrologic practice. We believe the current watershed model provides the best depiction of watershed flood response to extreme precipitation that can be achieved with existing technologies, available data and the current state of knowledge.

Sincerely,

Ron Mason P.E.

Mel Schaefer Ph.D. P.E.

George Taylor CCM

BEFORE THE WASHINGTON UTILITIES AND TRANSPORTATION COMMISSION
Docket No. UE-070074
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EXHIBIT E

JANUARY 30, 2008 LETTER
FEDERAL ENERGY REGULATORY COMMISSION

FEDERAL ENERGY REGULATORY COMMISSION
Office of Energy Projects
Division of Dam Safety and Inspections
Portland Regional Office
805 SW Broadway, Suite 550
Portland, Oregon 97205

JAN 3 0 2008

In reply refer to:
P-2150-WA
NATDAM-WA00173

Mr. Edward R. Schild
Director, Energy Production and Storage
Puget Sound Energy, Inc.
P.O. Box 97034, OBC-14N
Bellevue, Washington 98009-9734

Re: Upper and Lower Baker River Dams Seismic (Stability) Analyses, MWH, September 2004.

Dear Mr. Schild:

We have completed our review of the Upper and Lower Baker River Dams Seismic (Stability) Analyses submitted by PSE October 29, 2004 letter for the Baker River Project, FERC No. 2150. Our comments are discussed below.

1. Upper Baker Static Stability Analyses – Our August 7, 2002 letter requested an analysis of the dam assuming that the dam/foundation has no cohesion. Our review of the submitted conventional stability analyses is as follows:

- Each monolith in the dam is separate from the next, i.e., there are no shear keys between monoliths.
- In several monoliths, the dam/foundation interface slopes down in the downstream direction. This means that the angle of inclination of the base is adverse.
- The submitted analyses assumed a flat base for Monolith 12, when photographs indicate that it is sloping downhill downstream.
- Monoliths 2, 3, and 20 have severe downhill downstream slopes, i.e., as much as 20° and 16°.

- The adverse slopes are somewhat offset by foundation roughness that would increase the available friction capability at the interface.

- No two-dimensional analyses have been done for the actual dam/foundation interfaces.

- The 2004 Part 12 Report advised that there is a three-dimensional aspect of the stability, but no analysis has considered all of the relevant factors. Analyses completed by Stone and Webster in 1984 assumed 290 psi cohesion at the dam/foundation interface and did not separate the dam into individual monoliths. A three-dimensional analysis would need to be performed to fully evaluate the interaction between the side forces between each block, the dam, and the foundation.

D2SI-PRO staff conducted a two-dimensional analyses using OGSTAB. Our analyses indicated that the normal factors of safety for Monoliths 2, 3, and 20 are less than 1.3 for c=0 and drain efficiencies (DfEff) = 100 percent. Monoliths 8, 9, and 12 also had normal factors of safety of less than 1.5. This means that if there is no cohesion, the factors of safety are less than the FERC minimum required, even if the drains are 100 percent efficient. Blocks 2, 3, 8 through 16, and 20 were found to have a factor of safety less than 1.5 with a drain efficiency of less than 50 percent. If only two-dimensional effects are considered, the stability of the dam appears to be sensitive to drain efficiency.

2. March 26, 2007 Meeting – A meeting was held in PSE offices with the Co-consultants, Messrs Tarbox and deRubertis, and your staff to discuss these issues. The consultants advised that they believed that the dam is going to act three dimensionally and is not going to fail in sliding for the following reasons:

- The consultants indicated that the dam/foundation interface has cohesion because it was well cleaned.

- Many of the block foundation contacts have irregular enough surfaces that the dam would have to break intact concrete or rock to fail.

- The individual blocks are going to act together, three dimensionally because of the side slope in the foundation.

During the meeting, we agreed that the drains are important to the safety of the dam and that there is, most likely, an associated failure mode that hasn't been fully evaluated. We further agreed that the issues discussed above need to be fully

documented.

We agreed that there is not a good as-built drawing of the dam and the dam/ foundation interface. It may not be possible to fully develop a good as-built drawing, but it is possible to use existing information to provide a better characterization of the dam and foundation.

3. November 20, 2007 Meeting – Another meeting was held on November 20, 2007 with you and your staff about these issues. We agreed in that meeting that a new analysis should be performed to fully document the stability of this dam for the record. Puget Sound Energy plans to request a Statement of Qualifications for engineers capable of this kind of analysis, likely a 3-D, non-linear, static structural analysis, with a post-earthquake evaluation. We concur.

4. Upper Baker Foundation Drainage and Potential Failure Planes – We have also reevaluated the following reports because of the sensitivity of the drain efficiency:

- Report on Geology of Dam Site, Record of Grout Curtain and Subsurface Drains, Upper Baker Dam, Stone and Webster Engineering, submitted October 16, 1960.
- Report on Additional Drainage – Blocks 5 Through 10 – Upper Baker Dam, Stone and Webster Engineering, submitted by August 27, 1963 letter.
- Seismic Analyses of Baker River Dams, Volume 3, Upper Baker Dam, Stone and Webster Engineering, January 1984, Revised November 1987.
- Foundation Drainage Investigation, Upper Baker River Dam, Final Report, Volume 1, Stone and Webster Engineering, November 1990.
- Foundation Drainage Investigation, Upper Baker River Dam, Final Report, Volume 11 – Appendices, Stone and Webster Engineering, November 1990.

Our comments are as follows:

Drainage

- The stability of Upper Baker Dam is sensitive to drainage decreases and has had several drainage problems during its

history. Foundation drains have been added four times since the original drains were installed because of high drain flows and pressures.

- The 1990 report indicates that the drain efficiencies were below acceptable levels prior to work to clean existing drains and install new ones.

- The existing program to clean the drains and monitor them does not thoroughly document how much improvement in the drain efficiency the drain cleaning program accomplishes.

- The pressures under the dam/foundation blocks are monitored under only blocks 7, 9 through 13, 15, 17, and 19. The other sixteen blocks are not monitored.

Foundation Failure Planes

- Although the 1984 and 1990 reports indicate that there are no failure planes in the foundation, it is not clear that this has been adequately documented. There are techniques available to more clearly demonstrate this, e.g., stereonet techniques for mapping joint, fault, and dam intersections. It would be prudent to more thoroughly document this.

- Although it seems more likely that the left abutment has potential failure planes than the right abutment does, some of the right abutment core logs indicate that there are fracture zones in the right abutment foundation. These fracture zones seem to carry higher drain flows and drain pressures. If these fractures zones are continuous under a monolith block, this could also be a failure plane. The undulatory and downstream down sloping nature of the dam/foundation interface means that this fracture zone might only have to extend through part of the base of the dam to be a failure plane.

- The 1984 report indicates there is at least one possible fault plane in the upper part of the right abutment that could be a failure plane. This potential failure plane needs to be evaluated.

We request submittal of a reevaluation of the potential failure planes in the foundation of Upper Baker Dam, as discussed above. The submittal should include:

a. A thorough identification and discussion of the geologic structure

in the foundation.

b. Evaluation of potential failure planes and formation of blocks from intersecting discontinuities.

c. Stability analyses, if needed, including a discussion of shear strength and uplift pressure assumptions.

The issues of monitoring the dam will be further discussed after completion of the two analyses requested above.

5. Upper Baker Seismic (Stability) Analysis – This analysis is not consistent with our Chapter 3 Engineering Guidelines, Gravity Dam. Our comments are as follows:

- No post-earthquake analysis was conducted or discussed.
- The analysis is linear and does not evaluate the potential for foundation or drain damage during the earthquake.
- We had previously advised in our August 7, 2002 letter, "to correctly model base cracking, the FEM model should have been constructed with a thin interface layer of elements. This procedure has the benefit of allowing interface elements to be systematically deleted so that a cracked base analysis may be performed in an iterative manner along the theoretical crack. The use of a thin interface layer of elements allows uplift pressure to be applied to the bottom of the dam and the top of the foundation. The resulting stress output for these interface elements then can include the effects of uplift." This analysis does not appear to have appropriately responded to these comments.
- The analysis had the same issues discussed above for the static analysis.
- While the 1984 Report was more thorough, it did not evaluate individual blocks.
- We request a post-earthquake analysis of Upper Baker Dam.

6. Lower Baker Seismic Analysis – This analysis is not consistent with our Engineering Guidelines, Chapter 11, Arch Dam. Our comments are as follows:

- The analysis is linear and does not evaluate the interaction with the foundation or other non-linear characteristics during the

earthquake.

- There is no discussion of post-earthquake stability or the potential for significant cracking.
- As discussed above, the analysis did not appear to allow for base cracking or uplift.
- There is no discussion for the potential for a block rocking failure or any discussion of failure modes.

Please discuss the issues listed above regarding the seismic analysis of Lower Baker Dam.

As discussed in our March 19, 2007 letter, we believe that these issues should be included in a reevaluation of the potential failure modes for the project. However, the analyses and discussions requested above should be completed prior to this reevaluation.

As discussed in the November 20, 2007 meeting, please submit, within 30 days of the date of this letter, three copies of your plan and schedule in response to the items listed above.

We suggest that a meeting be held to discuss the new analyses after the consultant is selected, so that there is no confusion about the analyses techniques that will be used. Please Mr. David Lord of this office at (503) 552-2728, or david.lord@ferc.gov to set up the meeting.

We appreciate your cooperation regarding dam safety matters. If you have any questions regarding this letter, please contact Mr. Lord.

Sincerely,

Patrick J. Regan, P.E.
Regional Engineer

BEFORE THE WASHINGTON UTILITIES AND TRANSPORTATION COMMISSION
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EXHIBIT F

SCOPE
PUGET SOUND ENERGY ELECTRIC REGULATORY STUDIES

EXHIBIT F

SCOPE
PUGET SOUND ENERGY
ELECTRIC REGULATORY STUDIES

Baker Project New Probable Maximum Flood

Phase One, Initial PMF and effects	
Complete and submit final PMF report to FERC	$ 15,000
Model downstream consequences of flood flows	200,000
Determine project's Inflow Design Floods (IDF)	170,000
Adequacy to safely pass IDF per FERC guidelines	320,000
Risk Assessment of IDF	400,000
TOTAL	$1,105,000

Project Upper Baker Structural Sliding Stability

Complete UBK Dam Drainage Inventory	$ 90,000
Complete Definition of Foundation Dam-Rock Interface	30,000
Non-linear 3-dimensional Finite Element Analysis of Dams	350,000
Potential Upper Baker Dam Failure Planes in phyllite foundation	150,000
TOTAL	$ 620,000

TOTAL	**$1,725,000**

Project **Baker River Revised Probable Maximum Flood**

Driver FERC Part 12 Subpart D "2004 Baker Project "Inspection by Independent Consultant" FERC Order March 19, 2007

Description FERC, based on the independent engineering consultants' 2004 Part 12D investigation, ordered PSE to update the Baker River Probable Maximum Precipitation ("PMP") and Probable Maximum Flood ("PMF) based on the latest FERC guidelines and latest National Weather Service's Hydrometeorological Report, Number 57 (HMR-57). FERC's Board of Consultants ("BOC") for the PMF study approved the 2008 PMF in January 2008. Next step is for FERC to approve the PMF and order PSE to conduct studies and investigations to document if any structural modifications are warranted in the event of an Inflow Design Flood (IDF).

Task One. Per FERC order submit the final PMP/PMF with BOC approval to FERC as a supplement to 2004 Part 12D inspection report for FERC approval. Requires incorporation of reviewers' comments in the final PMF report. FERC then must approve our plan and schedule for any remediation studies. Cost is $15,000.

Task Two. Develop downstream inundation consequence model for flood flows up to the PMF and flood induced breakage of the dams. This model is used in the determination of the IDF and risk assessment, which are used in the determination of any FERC required structural remediation. FERC mandates that all inundation mapping now be in GIS format. Cost is $200,000.

Task Three. Determine the IDF per FERC Guidelines, Chapter II, *Selecting and Accommodating Inflow Design Floods for Dams*. The IDF, the project design flood maybe less than the PMF. The IDF is determined by analyzing the downstream inundation impacts assuming incremental IDF flows and the Baker Project dams break in a domino fashion. The resultant flow is routed downstream and inundates parts of the Skagit valley. The IDF is the flow at which there is no further significant inundation damage and the IDF is limited to the PMF. Cost is $170,000.

Task Four. Licensee must document that the project can safely pass the IDF per FERC guidelines. The IDF could be such that no remedial action is required i.e. that the dam spillgates and dikes are adequate per FERC engineering guidelines. Or could be such that corrective actions must be taken to safely pass the IDF, e.g. abutment protection, dam anchors, raising the dam and/or dike crests, new and/or modified gates, allow for safe overtopping, and/ or other dam and/or dike modifications. Analysis of Upper Baker dam and Lower Baker dam to pass the PMF will utilize the 3-dimensional non-linear finite element analysis for Upper Baker dam stability, see Task 3 below. Cost estimate is $320,000.

Task Five. Risk Analysis and Risk Assessment of an IDF is a combined measure of the probability and severity of an adverse event and is represented as the product of the probability of the event occurring and expected consequences. FERC allows for consideration of risk associated with the event, structural failure, and inundation consequences. An IDF and/or resulting dam breach may be extremely unlikely or the inundation consequences minimal, in which case corrective action may be unwarranted. Event tree analyses (ETA) represents the logic of an initiating event, such as the IDF, leading to various types of inundation damage and structural failures. Failure mode and consequence analysis contain inherent uncertainties. The undertaking of a Risk Assessment for the IDF was highly recommended by the BOC to FERC and PSE. It is anticipated that FERC will require a BOC for the risk assessment. The Risk Assessment will demonstrate to FERC if any modifications to the dam(s) are likely. Cost estimate is $400,000.

Project **Baker Dams – Structural Stability**

Driver FERC Part 12 Subpart D: 2004 Baker Project "Inspection by Independent Consultant" FERC Order of March 19, 2007, Directive letter January 30, 2008.

Description FERC requires the dam owner to document that a dam is safe or to improve its safety as specified in FERC regulations and engineering guidelines. FERC, in its review of the October 2004 Eighth Independent Consultant's Safety Inspection Report (Part 12D Report and "Supporting Technical Information", stated "We are unable at this time to determine that the Upper Baker Dam meets Commission dam safety standards and criteria … We do not concur that the Probabilistic Failure Mode Analysis Report (PFMA) is adequate; the Report did not include any Potential Failure Mode Analyses for a sliding failure of Upper Baker Dam." The 2004 Part 12D report mandated a number of analyses to insure that Upper Baker and Lower Baker dam meets FERC dam safety standards and criteria. These additional FERC directed studies will determine per FERC's latest guidelines whether structural modifications are necessary at Lower Baker per Chapter 11 Arch Dams and Upper Baker dam, per Chapter 3 Gravity Dams (e.g. hardening the crest, covering the abutments, anchoring the dam to the rock foundation, etc.)

Task One. Define the Upper Baker dam foundation and rock interface. Some dam blocks have an adverse downstream slope. Dam cohesion and topography must be documented. Same definition tasks for Lower Baker. Cost is $90,000.

Task Two. Drains at the base of the Upper Baker dam are to be inventoried. "Our evaluation of the stability of the dam has led us to conclude that the stability of the dam is sensitive to the efficiency of the drains." PSE is to evaluate the effectiveness of the drains in contributing to stability of the concrete gravity dam. Cost is $30,000.

Task Three. The above two elements with the Upper Baker dam 3-dimension CAD model will be used to perform the stability analysis. A 3-dimensional non-linear finite element model (FEM) of the Upper Baker dam is acceptable to FERC to prove the dam is stable. The January 30, 2008 letter directed PSE address for both Upper and Lower Baker dams' non-linear characteristics dam and rockbed during a seismic event, post earthquake, cracking/uplift and individual blocks. Modifications to either dam, if needed per FERC guidelines will be addressed. Cost is $350,000.

Task Four. FERC is concerned about potential failure planes in the phyllite rock under the foundation of the left abutment at Upper Baker. The Upper Baker analysis will use the FEM model. Additional Potential Failure Mode Analysis may be identified by the Part 12D independent consultants. Cost is $150,000.

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EXHIBIT G

FERC PART 12 STUDIES COST ANALYSIS

WUTC Docket No. UE-021577 for FERC Part 12 Studies

SEISMIC/ STABILITY ANALYSIS

WUTC ORDER - February 12, 2003	2003	2004				PLANNED	ACTUAL	Comments
Structural Seismic Analysis & Potential Failure Mode Analysis	$338,195	$319,115				$1,000,000	**$657,310**	FERC Review in 2007 & 2008
CURRENT PETITION - February 2008				**2008**	**2009**	**PETITION**		
				$520,000	$100,000	$620,000		FERC directive Jan. 30, 2008
Task One - Define interface dam & foundation				$90,000	$0	$90,000		
Task Two - Drains/uplift at base of dam				$30,000	$0	$30,000		
Task Three - 3D non-linear finite element analysis				$300,000	$50,000	$350,000		
Task Four - Potential Failure Modes in rock				$100,000	$50,000	$150,000		

PROBABLE MAXIMUM FLOOD & EFFECTS

WUTC ORDER - February 2, 2007			2007			PLANNED	ACTUAL	Comments
			$213,328			$2,300,000	**$213,328**	Final PMF Jan. 8, 2008
Phase One - PMF and effects			$213,328			$1,100,000	$213,328	No PMF effects analyzed
Phase Two - Site Specific Study			$0			$800,000	$0	Dropped, new PMF to large
Phase Three - Risk Assessment			$0			$400,000	$0	Not initiated
CURRENT PETITION - February 2008				**2008**	**2009**	**PETITION**		
				$665,000	$440,000	$1,105,000		Assess PMF effects
Task One - Final PMF filing				$15,000	$0	$15,000		
Task Two - Downstream Inundation				$200,000	$0	$200,000		
Task Three - Inflow Design Flood				$150,000	$20,000	$170,000		
Task Four - Structural Effects				$150,000	$170,000	$320,000		
Task Five - Risk Assessment				$150,000	$250,000	$400,000		