BEFORE THE STATE OF WASHINGTON
ENERGY FACILITY SITE EVALUATION COUNCIL

In the Matter of Application No. 99-1 SUMAS ENERGY 2, INC. SUMAS ENERGY 2 GENERATION FACILITY	)	EXHIBIT _____ (DJE-T)

WHATCOM COUNTY'S PREFILED TESTIMONY
WITNESS: Dr. Don J. Easterbrook, Ph.D

Q: Please introduce yourself to the Council.

Ans: My name is Don J. Easterbrook. My address is 508 Ridgeway Drive, Bellingham, WA 98225.

Q: What is the subject of your testimony?

Ans: I wish to address potential seismic hazards associated with the site proposed for SE2.

Q: What are your professional qualifications to discuss that subject?

Ans: I have B.S., M.S., and PhD degrees in Geology from the University of Washington and am Professor Emeritus of Geology at Western Washington University. I have taught and performed geologic research at the university for the past 42 years, during which I have studied the geology of Whatcom County. My studies included projects involving the geologic history of the area, earthquake hazards, landslide hazards, and various other environmental issues in the county. In terms of my general background, I have served as national chairman of the Quaternary Geology and Geomorphology Division of the Geological Society of America, chairman of the Geological Society of America national meeting, U.S. representative to a United Nations UNESCO commission, Associate Editor of the Geological Society of America Bulletin, chairman of the geology department at Western Washington University for 12 years, and been a

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member of a number of national and international committees. I have presented papers in 20 countries and have published about 140 professional papers and eight books. I have received 8 National Science Foundation Research grants and 6 research grants from other agencies. I am currently Director of Field Excursions for the 2003 International Quaternary Congress. For a more thorough description of my background and qualifications, please see my resume, a copy of which is provided as Exhibit DJE-1.

Q: What research, if any, have you performed relevant to the proposed site for SE2?

Ans: I first began studying the geology of the Sumas area in 1959 and have continued this research for past 42 years. I have published 23 professional papers in national, refereed, geologic journals and presented 33 papers at Geological Society of America and other professional meetings concerning various aspects of the geology of the Sumas region.

During the last five years, I and my colleagues, Dr David Engebretson, a seismological expert, who is a Professor of Geology at Western Washington University, and Dori Kovanen, who is just finishing her Ph.D at the University of British Columbia, have been engaged in an assessment of seismic hazards in Whatcom County, local faults that relate to the seismicity of Whatcom county, and the relationship of earthquakes to large landslides that occur in the Nooksack Valley. Using new techniques and technology, our research has uncovered new information about the seismic activity of the Sumas Valley and the site upon which the proposed SE2 plant is slated to be built.

Q: How does your research relate to the proposed SE2 site?

Ans: To understand how the results of our recent research efforts relate to the proposed site of SE2, it is critical for the Council to understand that the City of Sumas is situated on a major fault, which we now call the Sumas fault, and is bounded by a second major fault on the other side of the valley, referred to as the Vedder Mountain fault. The entire Sumas Valley has dropped down at least 1,000 feet in very recent geologic time. The Vedder Mountain fault across the valley from Sumas is a very large fault, extending from Canada to the San Juan Islands and perhaps to Vancouver island, a distance of at least 65 miles. We have found evidence of seismic activity on this fault, but of more consequence to construction of SE2 is the fact that our research shows that

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the Sumas fault underlying Sumas is larger and more seismically active than previously thought. Our research findings are more fully described in a preliminary paper we have drafted entitled: "Potential Seismic Hazards of the Sumas and Vedder Mt. faults" a copy of which is submitted as Exhibit DJE-2 and which I wish to incorporate into my testimony by this reference.

Q: In general, what seismic hazards are presented in the Sumas area?

Ans: The results of our recent research indicates several sources of potential seismic hazards in the area. Depending upon its size and location, an earthquake on either fault could prove destructive. Four principal seismic hazards have been identified.

The first hazard is seismic shaking. Such shaking causes buildings to collapse because the intensity of the shaking exerts forces on the structural members of the buildings. The intensity of the shaking increases with both the size of the earthquake and the proximity of the structure to the source of the quake. The principal hazard to the town of Sumas is that it is essentially on top of one of the two faults (the Sumas fault). Furthermore, Sumas is close enough to the Vedder Mountain fault, a mile and a half, that it is also an additional hazard for seismic shaking.

The second hazard is ground failure, which means that a building is subject to collapse if the ground under the foundation slides away. A key component of this hazard is the issue of ground failure by liquefaction of underlying fine-grained sediment. Liquefaction means that during an earthquake, certain soils, such as silt or clay, will behave as if they are a liquid. Our data suggests that Sumas lies on top of a thick fill of unconsolidated sediments that have a moderate to high potential for liquefaction. In previous earthquakes, such as the Lomo Prieta earthquake in California, by far the greatest damage occurred in areas underlain by unconsolidated sediments.

The third seismic hazard, which is considerable in this case, is offset along the fault. Offset is the movement of the land surface on the fault. A good example of the phenomenon is the Seattle fault, which extends from Seattle to Bainbridge Island. We know that Bainbridge Island jumped 21 feet out of the water about 1,000 years ago. Fifteen or twenty feet of land can be offset in a fraction of a second during an earthquake. Offsets pose a serious hazard for Sumas

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simply because it is situated on a fault. No building could survive a 15 or 20 foot offset through any part of it. Although no previous offsets of the land surface have been yet proven, two anomalously straight scarps of possible fault origin occur west of Sumas.

The fourth seismic hazard is from earthquake-generated landslides. It is a secondary effect, but one which can be serious indeed. More than half a dozen large bedrock landslides have been mapped in the Nooksack Valley, the largest of which is about six miles long. Many are two to three miles across and more than two miles long. We are reasonably sure that ancient earthquakes generated these landslides. Such landslides lie in a zone of very intense earthquake activity, and nowhere else. The possible hazard arising in the area would stem from the fact that if there was movement during an earthquake from one of the two faults, a landslide from the adjacent Vedder Mountain or Sumas Mountain could be generated.

Q: Are seismic risks any greater at Sumas than at other places in the Puget Lowland?

Ans: Yes, substantially. The SE2 site unique—it is located directly over a seismically active, major fault with a second fault less than two miles away, underlain by at least 1000 feet of unconsolidated sediments, underlain by fine-grained sediments with high to moderate liquefaction properties, and within reach of potential seismically-induced landslides. No other area in Washington is comparable.

Q: In your opinion, are the seismic conditions at the proposed SE2 site unsuitable?

Ans: Yes. the SE2 site is not suitable because of the high seismic risk and threat to public safety in the town of Sumas.

Q: Did you meet with Mr. Molinari at the request of SE2 to review your evidence for seismic risks?

Ans: Yes. Dr. David Engebretson and I met with him and answered all of his questions.

Q: Are you familiar with the prefiled testimony of Mr. Mark Molinari?

Ans: Yes.

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Q: Do you agree with his assessments of your work and the seismic conditions at the proposed SE2 site?

Ans: No. His characterization of our work is inaccurate and his conclusions are fundamentally flawed.

Q: Can you summarize the views of Mr. Molinari?

Ans: In Mr. Molinari's opinion:

"SE2 repeatedly requested additional data or reports documenting their research. However nothing was provided." (page 7)

1. "While other researchers in this area have previously mapped the Vedder mt. fault, they have not previously mapped the hypothetical Sumas fault." (page 7)
2. He does not believe that the Sumas fault exists. (pages 8, 10)
3. If the Sumas fault is present, it isn't seismically active. (pages 8, 11).
4. If the Sumas fault is present, it would be west of the proposed SE2 site. (page 8)
5. The Sumas fault does not pose a surface rupture hazard at the proposed SE2 site. (page 8)
6. No seismically induced landslide hazards exist at the proposed SE2 site. (page 8)
7. Engineering design can mitigate all potential ground shaking and liquefaction hazards. (page 8)
8. We have not offered any new information about the geology near the site. (page 9)
9. "It is a significant exaggeration of the available scientific data to conclude that the faults are larger and more seismically active than previously thought." (page 10)
10. Neither the Sumas fault nor the Vedder Mt. are seismically active. (page 12)
11. "..there is no surface evidence of displacement of Sumas Stade deposits present along the trace of the hypothetical Sumas fault SW of the SE2 site (Easterbrook, personal communication)" (page 13) [Note that this citation is untrue—I did *not* say this]
12. "…the depth and geometry of the bedrock is not in itself an indication of the presence, amount of displacement, or recency of activity of a fault." (page 14)
13. "In order to conclude that the approximately 2,500 feet elevation difference between the top of Vedder Mt. and the bedrock surface below Sumas Valley is tectonic

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displacement, it must be shown that the rock in both locations is the same type and age." (page 14)

14. "..there are other lines of evidence that indicate: (the basin may not be a graben and (2) much of the apparent elevation difference is either very old tectonic movement and not related to geologically recent activity on the fault, and/or is due to glacial erosion."
15. "*The depth and configuration of the bedrock trough beneath Sumas Valley is similar to other erosional troughs formed and/or significantly modified by glacial processes, such as those within Puget Sound (e.g. Hood Canal)…." "These processes include both erosion by ice and subglacial water (Booth and Hallett, 1993 and Booth, 1994) and could have accounted for the depth of the basin with or without associated tectonic displacement on the Vedder Mt. fault.*"
16. Mr. Molinari suggests that the Sumas graben becomes less distinct SW of Sumas and argues that means it doesn't exist.
17. *".. the Vedder Mt. fault was initiated during the Miocene and experienced significant extensional displacement from approximate 25 million to 16 million years before present ….. If the Sumas Valley is truly a graben, it was probably formed during this time frame and modified since then."*
18. "The Sumas Valley is vulnerable to damage from ground shaking but no more so than other areas of the Puget Sound Lowland and Fraser River Valley underlain by unconsolidated materials." (page 18)
19. "I agree that saturated, loose, fine-grained granular soils (sand and silty clay) are present in the near-surface soils that likely have a "moderate to high" potential for liquefaction…" "However, I don't agree with his overall characterization of the potential hazard." (page 18)
20. Surface displacement "almost always occurred along faults with evidence of prior displacement." (page 21)
21. "…nor is there is evidence of Holocene surface displacement along Easterbrook et al.'s inferred surface trace of the Sumas fault." Therefore, the hypothesized Sumas

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fault is not considered an active fault according to the generally accepted definition, and there is not a fault rupture hazard at the SE2 site." (page 21)

22. "The site is too distant from the western range front of the Vedder Mts. and eastern escarpment of the Lynden upland where seismically induced landslides could occur."

Q: What is your response to these opinions?

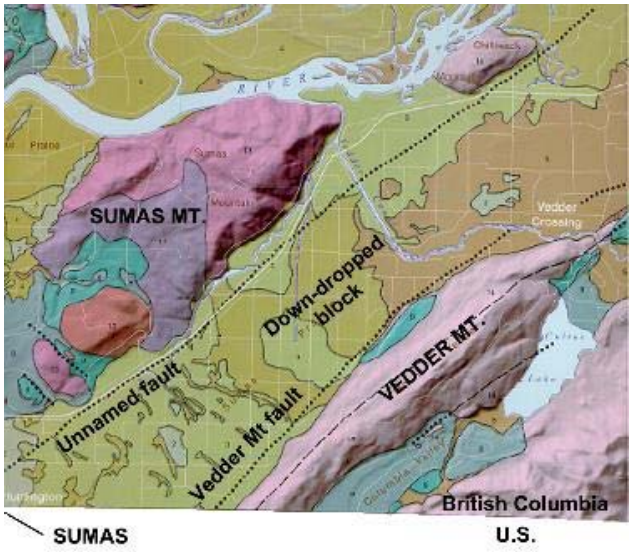
Ans: Each of these opinions is discussed below:

1. "SE2 repeatedly requested additional data or reports documenting their research. However nothing was provided." (page 7)

Response: This is simply not true. We received a single request from SE2 for our report, which we provided as soon as it was finished. At the request of SE2, we later made ourselves available for an interview with Mr. Molinari and an SE2 attorney during which we answered all questions put by Mr. Molinari.

2. "While other researchers in this area have previously mapped the Vedder Mt. fault, they have not previously mapped the hypothetical Sumas fault." (page 7)

Response: Mr. Molinari has not done his homework and is obviously not familiar with the geologic literature published on the Sumas area. Shown below is a geologic map published by Clague and others in the Canadian Geological Survey, clearly showing the Sumas fault (label "Unnamed fault"). Geologists in the U.S. and Canada have long



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recognized this fault and the down dropped block, the Sumas graben, that lies between it and the Vedder Mt. fault

3. He does not believe that the Sumas fault exists. (pages 8, 10)

Response: The Sumas ("Unnamed") fault has long been recognized by many geologists in the area and is shown on published geologic maps. Mr. Molinari is the first geologist I've met in 42 years who doesn't believe it exists, despite apparently having done no field work in the area and having provided no evidence to the contrary.

4. If the Sumas fault is present, it isn't seismically active. (pages 8, 11).

Response: Dr. Engebretson, a seismology expert, has looked at all seismic records in the area and he and Lori Roberts have calculated focal mechanisms for earthquakes in the area of the two faults that clearly show movement parallel to the faults within the past 35 years. Mr. Molinari has provided no evidence to refute these data, other than to contend that the earthquakes aren't accurately enough located. The fact remains that all earthquakes in this area are created by fault movement and the seismic data show that the fault movement is aligned along the two faults.

5. If the Sumas fault is present, it would be west of the proposed SE2 site. (page 8)

Response: The Sumas fault has a bold escarpment that parallels the Vedder Mt. fault on the west side of the Sumas Valley that makes its identification easy. Projecting the slope of the fault scarp beneath the ground surface takes it directly beneath the proposed SE2 site. Although we see a well-defined, single scarp above the ground, that doesn't necessarily mean that the Sumas fault always moves along a single fault plane. Faults of this magnitude commonly splay as they approach the surface and move along several parallel planes. For example, the famous San Andreas "fault" is really made up of a number of parallel slip planes with the San Andreas fault *zone*.

6. The Sumas fault does not pose a surface rupture hazard at the proposed SE2 site. (page 8)

Response: In view of the conditions discussed above, this opinion is not scientifically defensible.

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7. No seismically induced landslide hazards exist at the proposed SE2 site. (page 8)

Response: Mr. Molinari's lack of knowledge of the published geologic literature is again apparent here. At least five large, deep-seated, seismically induced landslides have been identified in the area just south of Sumas. The largest was 6.2 miles long, 1.6 miles wide, and up to 312 feet thick. Three other deep-seated, bedrock landslide were about 2 miles long. Thus, we know that landslides from the valley sides, triggered by earthquakes, could reach Sumas and the SE2 plant. These landslides have been discussed by Engbretson et al. (1995), Kovanen (1996), Kovanen and Easterbrook (1996), and Engbretson et al. (1996). We do not believe that the seismically-induced landslide potential is prohibitively high at Sumas, but it does exist.

8. Engineering design can mitigate all potential ground shaking and liquefaction hazards. (page 8)

Response: Experience teaches us that a large, earthquake-proof structure has never been designed and only a fool would claim that it is possible. Structures can be designed to withstand various levels of shaking, but no building has ever been designed to withstand ground failure beneath the structure or surface rupture beneath a structure.

9. We have not offered any new information about the geology near the site. (page 9)

Response: This is not true and seems to be an attempt to trivialize our research. Virtually all geologic research builds on earlier work and our research is no different. We didn't "discover" the Vedder Mt. and Sumas faults—others did that many years ago. What we have done is to investigate the subsurface extension of these faults, collect evidence for the amount of offset along the faults, examine all seismic records to show which earthquakes occurred along the trace of the faults, what their direction of movement was, estimate the age of unconsolidated sediments filling the graben, and determine the minimum length of the faults. All of this is relevant to the seismic risk at the proposed SE2 site.

10. "It is a significant exaggeration of the available scientific data to conclude that the faults are larger and more seismically active than previously thought." (page 10)

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Response: The evidence we have produce speaks for itself, far more loudly than this kind of rhetoric.

11. Neither the Sumas fault nor the Vedder Mt. are seismically active. (page 12)
Response: The seismic data that we have used shows conclusively that in the past 35 years, fault movement has occurred along the traces of the two faults and that the direction of movement coincides with the orientation of the faults. To argue that this movement could have occurred along faults parallel to the Sumas and Vedder Mt. faults is not likely because once a fault plane has been established, movement is far easier along it than breaking the rock to form a new fault plane.

12. "..there is no surface evidence of displacement of Sumas Stade deposits present along the trace of the hypothetical Sumas fault SW of the SE2 site (Easterbrook, personal communication)" (page 13) [Note that this citation is untrue—I did *not* say this]
Response: Mr. Molinari's citation of me as a "personal communication" is not true—I made no such statement and his assertion is also not true. In fact, at the time of his interview with us, I pointed out two areas of possible surface displacement that ought to be further investigated. He has apparently ignored that part of the interview.

13. "…the depth and geometry of the bedrock is not in itself an indication of the presence, amount of displacement, or recency of activity of a fault."
Response: This is a truly amazing statement for any competent geologist to make. Depth and geometry of the bedrock are *exactly those that are used* to determine the presence, amount of displacement, or recency of activity of a fault. These concepts are routinely taught in courses at every university that deal with such subjects.

14. "In order to conclude that the approximately 2,500 feet elevation difference between the top of Vedder Mt. and the bedrock surface below Sumas Valley is tectonic displacement, it must be shown that the rock in both locations is the same type and age." (page 14)
Response: This is another astonishing statement for a geologist to make. It isn't true. The age of bedrock on opposite sides of a fault is seldom the same age and type, and it isn't

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even necessary to know the age and type of bedrock where fault scarps, such as the Vedder Mt. and Sumas scarps, occur.

15. "..there are other lines of evidence that indicate: (1) the basin may not be a graben and (2) much of the apparent elevation difference is either very old tectonic movement and not related to geologically recent activity on the fault, and/or is due to glacial erosion." (page 15)

Response: Because of the depth and geometry of the bedrock in the graben, it can't really be anything else. *It extends to more than 1000 feet below sea level, so it can't be erosional* and the geometry of the graben precludes it being only a tilted fault block basin made by a single fault. Mr. Molinari suggests glacial erosion for the deep trough and compares it to "narrower troughs of similar depth near Langley and Clearbrook that have not been attributed to faulting." The absurdity of this argument becomes apparent when one realizes that the valleys near Langley and Clearbrook are only a fraction as deep as the Sumas Valley and are developed entirely in unconsolidated sediments, not bedrock.

16 "*The depth and configuration of the bedrock trough beneath Sumas Valley is similar to other erosional troughs formed and/or significantly modified by glacial processes, such as those within Puget Sound (e.g. Hood Canal)…." "These processes include both erosion by ice and subglacial water (Booth and Hallett, 1993 and Booth, 1994) and could have accounted for the depth of the basin with or without associated tectonic displacement on the Vedder Mt. fault.*" (page 15)

Response: This is the most astonishing statement I have ever heard from a geologist. The irrationality of this argument is readily apparent to any competent glacial geologist. (1) To compare the Sumas trough to the Puget troughs is ridiculous because the Puget troughs are a maximum of about 600 feet deep and they are *all developed in unconsolidated sediment*, whereas the Sumas trough is about twice as deep and is developed entirely in bedrock, (2) glacial erosion is inadequate to explain carve a 2500-foot-deep trough 1000 feet below sea level because cosmogenic isotope studies in the Puget Lowland have shown that the last continental, Ice Age glaciers eroded less than a meter or so of bedrock, (3) Mr. Molinari's view that subglacial meltwater could have

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eroded 2500 feet of bedrock is even more untenable because water not only couldn't erode that much bedrock in the short time of Ice Age glaciations but couldn't erode a basin 1000 feet below sea level (water doesn't flow uphill!).

17. Mr. Molinari suggests that the Sumas graben becomes less distinct SW of Sumas and argues that means it doesn't exist. (page 16)

Response: The subsurface expression of the Sumas graben is less distinct SW of Sumas, not because it isn't there, but because it is no longer in the mountains, so relief is much lower, and very few wells are deep enough to penetrate the overlying unconsolidated deposits. It's just much more difficult to locate it beneath the sediment cover.

18 ".. the Vedder Mt. fault was initiated during the Miocene and experienced significant extensional displacement from approximate 25 million to 16 million years before present ….. If the Sumas Valley is truly a graben, it was probably formed during this time frame and modified since then."

Response: The Sumas graben is filled with 1000 feet of very young, unconsolidated sediment. If it had been formed 16-25 million years ago it should be filled with rock of that age, not young, unconsolidated sediment. The only other option would be to have maintained an open trough 1000 feet below sea level without filling it with anything. Neither of these makes any sense geologically.

19 The Sumas Valley is vulnerable to damage from ground shaking but no more so than other areas of the Puget Sound Lowland and Fraser River Valley underlain by unconsolidated materials." (page 18)

Response: In order for this to be true, one would have to completely ignore the presence of (1) not one, but two closely-spaced, major faults, (2) 1000 feet of unconsolidated deposits that amplify earthquake waves, (3) thick, fine-grained sediment subject to liquefaction, (4) historic earthquakes along the fault traces, and (5) fault focal mechanisms that show fault movement parallel to the two major faults. Not only do no areas similar to this exist in the Puget or Fraser Lowlands, but none have been recognized anywhere in the state.

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20. “I agree that saturated, loose, fine-grained granular soils (sand and silty clay) are present in the near-surface soils that likely have a “moderate to high” potential for liquefaction…” “However, I don’t agree with his overall characterization of the potential hazard.” (page 18)

Response: If we agree on the presence of thick, fine-grained sediments subject to liquefaction, why would we not also agree on its potentially hazard?

21. Surface displacement “almost always occurred along faults with evidence of prior displacement.” (page 21)

Response: Two things are wrong with this opinion: (1) if surface displacement only occurs on faults with evidence of prior surface displacement, then how could you get the initial surface offset?, and (2) we have pointed out two areas of possible surface displacement that need further investigation, so Mr. Molinari’s original assumption of no prior surface displacement may well be invalid.

22.“…nor is there is evidence of Holocene surface displacement along Easterbrook et al.’s inferred surface trace of the Sumas fault.” Therefore, the hypothesized Sumas fault is not considered an active fault according to the generally accepted definition, and there is not a fault rupture hazard at the SE2 site.” (page 21)

Response: Several things are wrong with this statement. (1) his assumption of no prior surface displacement may be incorrect, (2) a fault does not have to have surface rupture to be considered an active fault (Holocene movement and historic earthquakes suffice to make a fault “active), and (3) because of (1) and (2) Mr. Molinari’s conclusion is invalid.

23. “The site is too distant from the western range front of the Vedder Mts. and eastern escarpment of the Lynden upland where seismically induced landslides could occur.” (page 21)

Response: see discussion in (7) above. Mr. Molinari clearly hasn’t read the geologic literature.

Q: Have you read the prefiled testimony of Mr. Alan Porush?

Ans: Yes.

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Q: What is your response?

Ans: My responses are listed below:

(1) Mr. Porush states that it is almost always possible to address seismic hazards through structural design. (page 8)

Response: *Some* seismic hazards can be addressed by engineering design, but not all—ground failure beneath a structure, fault displacement of the surface beneath a structure, and landslides cannot be taken care of by engineering design.

(2) "potential "ground failure" can be and is very commonly addressed through design/mitigation measures. Such measures have been successfully employed in seismic hazard environments significantly more severe that those that appear to be present in the Sumas Valley." (page 10)

Response: Simply looking at severe damage to structures in past earthquakes, such as the Lomo Prieta and Kobe, Japan earthquakes, many of the collapsed structures were built on fine-grained unconsolidated sediments and engineering design was clearly inadequate to deal with magnitude of the failure. Seismic condition at the proposed SE2 site are not unlike those at Lomo Prieta and Kobe (in fact, seismic conditions at Kobe have been compared with those in Puget Lowland).

(3) "In theory, dynamic settlement could be an issue, but it does not appear that the material under the site is sufficiently loose or unconsolidated so as to lend itself to such behavior." (page 11)

Response: Mr. Porush apparently unaware of geologic maps of the Sumas Valley that show it is filled with more than 1000 feet of loose, unconsolidated material, including thick fine-grained deposits subject to liquefaction.

(4) "It is my understanding that the SE2 site contains neither the vertical offsets of a bluff geometry nor the clays of the type that would be susceptible to such flows." (page 11)

Response: Either Mr. Porush is unaware of the geologic conditions at the proposed SE2 site or doesn't understand the meaning of liquefaction.

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(5) "…Dr. Easterbrook ….. appears to presume that if a phenomena occurs, it will occur at the extreme upper end of severity for that type of phenomena. This would be like saying that if it rains, the runoff will automatically be equivalent to the million-year flood." (page 12)

Response: Nowhere in our report or other statements have we made such presumptions. Our conclusions about possible hazards are consistent with known historic earthquakes. The analogy to every rain being equivalent to a "million year flood" is poorly chosen—every seismic phenomena we discuss is seen in historic quakes. Rather than a scientific argument, Mr. Porush's statement seems more like an attempt to paint us as some kind of extremists in lieu of a logical counter view.

(6) "…his general conclusion about not being able to design against soil failure is exaggerated to the point of being basically untrue." (page 12)

Response: Mr. Porush apparently believes that he can design large earthquake-proof structures, something that has never been accomplished by any engineer. While we all wish this could be done, a look at any recent damaging earthquake teaches us otherwise. To be sure, engineering design can *reduce* damage from shaking, but it has never been possible to design a large structure that could survive foundation failure.

(7) Mr. Porush cites an example of a design intended to resist failure from fault rupture over a *small* fault and contends that to say "an engineered solution is "impossible" is flat wrong." (page 13)

Response: Two points seem relevant here: (1) Mr. Porush is talking about a small fault, whereas we are talking about a very large fault, and (2) since this structure apparently hasn't been built and since it hasn't been tested against an actual fault rupture, no one can tell if the design is successful, even for a small fault.

(8) Mr. Porush cites an example of a design to "provide structural systems capable of resisting (this) very intense level of shaking." (page 13)

Response: Until this structure actually survives 0.5 g ground acceleration, we have no way of knowing whether or not the design was successful. Designing a structure to withstand shaking is not the same thing as designing a structure to withstand ground failure beneath the foundation, so it proves nothing.

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(9) Mr. Porush cites an example of a *design* intended to withstand partial liquefaction of a few feet. As with the other examples, we won't know if the design was successful or not and the question remains, what about liquefaction of more than "a few feet?" Again, this proves nothing.

(10) "I do not believe the upper soil layers in the Sumas Valley are particularly susceptible to liquefaction." (page 14)

Response: Either Mr. Porush is unaware of the geologic conditions at the proposed SE2 site or doesn't understand liquefaction. Thick, unconsolidated, fine-grained sediments subject to liquefaction have been mapped by geologists on both sides of the international border.

(11) "The first common approach is to remove several feet of the looser material." (page 14)

Response: The thickness of unconsolidated, fine-grained sediments subject to liquefaction in the Sumas Valley are much thicker than just "several feet," so this approach would be useless.

(12) "This approach is to pressure grout this very susceptible layer." (page 14)

Response: As with the previous "solution" this one is useless because of the thickness of the unconsolidated, fine-grained sediments subject to liquefaction.

(13) "A third approach may be practical if only the top say 10 to 15 feet are particularly susceptible to liquefaction." (consisting of local dewatering and relief valves of stone columns) (page 14)

Response: As with the other "solutions" this one is useless because of the thickness of the unconsolidated, fine-grained sediments subject to liquefaction.

(14) "Ultimately, the approach is usually to place the foundations for the main structures and equipment on piles. Such piles might in a worst case scenario, need to extend through the softer material, perhaps as much as 50 or 60 feet down below grade into the more dense material." (page 15)

Response: Unfortunately this solution is also useless because even piling 50-60 feet long wouldn't "extend through the softer material' and would not reach into "more dense material." (The thicknesses are far in excess of this).

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(15) "I understand from Mr. Molinari's testimony that the possibility of fault rupture is not an issue at the SE2 site. (page 16)

Response: As shown above, Mr. Molinari's testimony is inaccurate on this point and fault ruptures of 15-20 must be considered possible. This is well in excess of the capacity of engineering design to mitigate.

(16) "It is my understanding that landslide (as the term is normally understood) is not an issue at the SE2 site." (age 16)

Response: As shown above, Mr. Molinari's testimony is inaccurate on this point and large landslides several miles long from the valley sides analogous to those found just south of Sumas must be considered possible. For landslides of this size, "retaining walls, tiebacks, rock bolts, and other engineering solutions" would be useless.

(17) The statement that shaking causes buildings to collapse "is a sensationalized, gross exaggeration of what happens in earthquakes." "Poorly designed or poorly constructed buildings are the ones that you may see in the newspapers." (page 17)

Response: Apparently Mr. Porush's view is that only poorly designed buildings collapse during earthquakes. The results of damaging earthquakes such as Lomo Prieta, Kobe, Anchorage, and others shows a closer correlation to subsurface unconsolidated materials than to poor design. Mr. Porush's attempt to portray our views as "sensationalized, gross exaggeration of what happens in earthquake" is easily refuted by simply looking at the pattern of failure of large structures in these earthquakes. His view that only poorly designed structures fail is simplistic and not supported by facts.

(18) "…to suggest that just because these is seismically-induced shaking, and "the shaking exerts forces on the structural members of the buildings," that this leads to the scenario that everything collapses, is so grossly exaggerated as to be irresponsible. (page 18)

Response: This rather unkind characterization is both inaccurate and simply an attempt to convince by rhetoric, rather than scientific facts and logic. The statement imply that our view is that any seismic shaking will cause collapse of structures is inaccurate and taken out of context. What we said was that *if* the shaking forces exceed the strength of the structural members, they will fail, a very well-know fact or basic physics. We are not

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being irresponsible in pointing out very real hazards that are born out by historic earthquakes. Rather the irresponsibility is in endangering the lives of innocent people by attempting to disguise hazards with rhetoric.

Q: Do you have any recommendations for the Council's consideration?

Ans: Yes. Given the hazards associated with seismic activity and the findings uncovered by our recent research on the existence of the faults and the level of seismic activity underlying the proposed SE2 site Sumas area, it is of paramount importance for the Council to consider the implications for public safety in making its siting decision in this case. Engineering alone cannot fully address the geologic risks identified at the proposed SE2 site so they comprise a siting issue, not just an engineering design issue.

Q: Are you saying that given the geology and seismic activity of the Sumas Valley no major projects should be built in this locale?

Ans: No. The nature of the project, its structure, and its contents are all factors to consider in reaching a reasoned decision as to whether development may be appropriate. In this case, I am simply trying to emphasize that it may not be wise to place a facility which provides an essential service to the public, such as the power plant in this instance, or which contains hazardous materials, on a site where a geologic hazard could disrupt the service provided or create an unacceptable risk of harm to people in the town of Sumas.

END OF TESTIMONY

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