DR. CHARLES WISDOM

POLLUTION CONTROL HEARINGS BOARD
FOR THE STATE OF WASHINGTON

AIRPORT COMMUNITIES COALITION and CITIZENS AGAINST SEA-TAC EXPANSION, Appellants, v. DEPARTMENT OF ECOLOGY and THE PORT OF SEATTLE, Respondents.	No. PCHB 01-160 PREFILED DIRECT TESTIMONY OF DR. CHARLES S. WISDOM

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ORIGINAL

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1. I have personal knowledge of the facts stated in this testimony and would be competent to testify to those facts.

2. I have a Ph.D. in Chemical Ecology from the University of California, Irvine, a Bachelor of Arts Degree in Biology from the University of California, San Diego, and an Associates of Arts Degree in Biology from Orange Coast College. I have over 19 years of consulting experience in risk assessment, environmental chemistry and toxicology, stormwater quality and toxicity, and the assessment of the impacts of man-made chemicals on ecological systems. My recent work has included technical support to clients with respect to the impacts of constituents in wastewater effluent and stormwater generated by transportation projects on threatened and endangered species. I am currently employed as a Senior Project Manager at Parametrix, Inc. A copy of my professional resume is attached as Exhibit A to this testimony.

3. <u>Familiarity With Master Plan Update (MPU) Improvements at Seattle-Tacoma International Airport.</u> I was the lead task manager for the Biological Assessment ("BA") prepared by the Port of Seattle in connection with the Port's plan to construct the Master Plan Update Improvements. The BA received concurrence from the National Marine Fisheries Service ("NMFS") and the United States Fish and Wildlife Service ("USFWS"). This element of the environmental assessment of the MPU Improvements involved evaluating the entire breadth of water quality issues associated with the MPU projects at the Seattle-Tacoma International Airport ("STIA"). This involvement provided me an extended opportunity to review the scientific basis and validity of every element included in my direct testimony.

4. <u>The Port's Proposed Projects Will Comply With Water Quality Criteria</u>. In my opinion, the available evidence indicates that STIA currently complies with the requirements of its current NPDES stormwater permit. In addition, it is my conclusion that the available evidence provides reasonable assurance that the conditions of the §401 Water Quality Certification issued by the Department of Ecology will be met and that the Port's proposed projects will comply with state water

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quality regulations. I base my opinion on a series of observations that are supported in detail in the remainder of my testimony.

5. First, the Port of Seattle has complied with all the conditions of the current State Waste Discharge Baseline General Permit for Stormwater Discharges Associated with Industrial Activities ("Stormwater Discharge Permit"), included in the development and implementation of a Stormwater Pollution Prevention Plan and installation and operation of required BMPs. In my opinion, compliance with the Stormwater Discharge Permit provides reasonable assurance that the Port is in compliance with state water quality regulations. Furthermore, compliance with the Stormwater Discharge Permit provides a more accurate measure of this compliance than a gross comparison of the numbers generated by the Port's discharge monitoring reports with numeric water quality criteria. The reason for this is that, without the assignment of a compliance monitoring location or effluent limitations in the Stormwater Discharge Permit, it is currently not possible to determine whether current stormwater discharges of metals meet state water quality criteria. The inability to make such a determination is particularly confounded by the differences inherent in measuring receiving water concentrations relevant to a stormwater discharge for comparison with the frequency and duration components of State Water Quality Criteria.

6. Second, ethylene and propylene glycol concentrations present in Miller and Des Moines Creeks are significantly below concentrations that will adversely affect aquatic life through increased mortality or decreased survivorship or growth. Additionally, the ACC's experts have inappropriately compared toxicity thresholds of one type of propylene glycol fluid (Type II) with the most common type of propylene glycol fluid (Type I) used at STIA. Based on this inapposite comparison, ACC's experts claim that measured glycol concentrations will harm fish in these water bodies. As is set forth in detail below, my analysis demonstrates that there is no basis whatsoever to conclude that any of the glycol concentrations measured by the ACC's experts will adversely effect any aquatic resources in these water bodies.

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7. Third, the results of the Whole Effluent Toxicity (WET) tests offer reasonable assurance that stormwater discharges are not adversely affecting the aquatic life of Miller and Des Moines Creeks.

8. Lastly, the results of the range-finding experiments conducted as part of the Preliminary Water Effect Ratio study offer reasonable assurance that the metal concentrations in STIA stormwater discharges will be below the site-specific Water Quality Criteria that are being developed as a requirement of the §401 Water Quality Certification. This assurance is provided by the presence of permanent, allocthonous sources of carbon that will maintain elevated levels of Total Organic Carbon in Miller and Des Moines Creek. These elevated levels affect the bioavailability of dissolved metals, reducing their effective concentrations to the point where they do not adversely affect the aquatic resources of these water bodies. Based on this evidence, there is every indication and assurance that STIA stormwater discharges will have no difficulty complying with the stated conditions of the amended §401 Water Quality Certification.

COMPLIANCE ISSUES

9. Two issues must be addressed in any consideration of whether or not STIA stormwater discharges comply with the water quality requirements that are applicable to stormwater. The first concerns compliance with current permit conditions; the second relates to whether or not STIA stormwater discharges comply with State Water Quality Criteria.

10. The Department of Ecology's regulations for water quality state that "the primary means to be used for requiring compliance with the [water quality] standards shall be through <u>best management practices</u> required in waste discharge permits, rules, orders, and directives issued by the department for activities which generate stormwater pollution." WAC 173-201A-160(3)(d) (emphasis added). Consistent with this regulation, the Port's NPDES permit regulates stormwater discharges from STIA through the use of best management practices ("BMPs"). Consistent with this regulation, the NPDES permit for STIA requires BMPs, but does not contain specific effluent limits for stormwater.

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11. There have been no notices of violations of the NPDES permit, and the NPDES permit itself states that "Compliance with this permit is deemed compliance with the Federal Water Pollution Control Act, also known as the Clean Water Act (33 U.S.C. §1251 et seq.) and the Water Pollution Control Act (RCW 90.48)." ACC has presented no documentation showing any present violation of the conditions of the NPDES permit.

12. In compliance with the NPDES permit, the Port conducts annual monitoring and testing of its stormwater outfalls for many parameters (TPH, TSS, turbidity, fecal coliform, BOD5, ethylene glycol, propylene glycol, copper, lead, and zinc). As described in its annual stormwater reports, the Port conscientiously investigates BMP maintenance, sources of potential contamination, and the feasibility of emerging BMP technologies. Given the state-of-the-science with respect to the regulation of stormwater, each of these activities contributes to reasonable assurance that applicable water quality regulations will be met in the future.

13. ACC's contention that in-stream water quality standards are being persistently violated is unfounded. Likewise, ACC's assertion that there is no reasonable assurance that the new project will meet water quality standards is also unfounded.

14. ACC's conclusions in this regard seem to be based primarily on a comparison of chemical concentration data from end-of-pipe stormwater samples (or worse, within-pipe stormwater samples) with the generic numerical water quality criteria for receiving streams in WAC 173-201A. It is invalid to conclude that end-of-pipe tests (which are not in waters of the state) demonstrate a failure to comply with numerical water quality standards (which apply to in-stream waters of the state). Even ACC's comparisons to apparent in-stream data (1997) are irrelevant to current conditions and even more so to future conditions. The Port owns only a small portion of the relevant watersheds of Miller, Walker and Des Moines creeks, and without further documentation, it is impossible to determine compliance, even if numerical water quality standards are applied to stormwater at STIA (an inappropriate application). Furthermore, ACC's experts have based their claims on chronic (long-term) criteria, which

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are inappropriate for the short duration of stormwater discharges at STIA. As discussed in more detail below, there are several lines of evidence that provide reasonable assurance that the projects at STIA for which the §404 permit is required will meet the water quality regulations which are applicable to stormwater.

15. Unlike waste process water continuously discharged by a industrial processor, stormwater is inherently variable – depending upon the nature of the storm event, the number of dry days prior to the storm event, the nature of the surface over which it drains, and other factors. Samples of end-of-pipe stormwater reflect this variability. The differences between continuously discharged point sources and variably discharging non-point sources (such as the STIA stormwater system) seriously hampers any determination of compliance or non-compliance with state water quality criteria. Typically, in order to determine the compliance of stormwater with such criteria, it is necessary to identify a specific point of compliance, identify the design storm for compliance purposes (often the two-year storm), and identify critical receiving water conditions. In the absence of these kinds of parameters, it is not possible to determine compliance with water quality criteria based on random grab samples collected from either in-pipe or below discharges.

16. Additionally, compliance with state water quality criteria requires specific durations and frequencies that are rarely if ever met by stormwater discharges. This is particularly true for chronic water quality criteria, which, by definition, are the measured average over a four-day period. It is highly unlikely that many storms ever occur over this duration at STIA, a fact that further distinguishes continuously discharging point sources from intermittently discharging stormwater non-point sources in determining compliance. Consequently, the comparisons made by ACC's experts are inappropriate and meaningless in determining compliance with state water quality criteria. Because the sample cited by ACC were not collected under the appropriate conditions and because no specific compliance point has been determined for the non-point discharge of stormwater from STIA, it is simply not possible to determine numeric compliance using that sample data.

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17. In contrast, it *is* possible to determine whether stormwater from a particular location is adversely effecting water quality by conducting Whole Effluent Toxicity Tests. At STIA, in addition to the whole effluent toxicity ("WET") testing regime specified in the NPDES permit, toxicity testing of in-stream samples collected from Miller Creek, Walker Creek and Des Moines Creek, as well as STIA outfall SDS3, was conducted in 1999. Those tests showed no evidence of in-stream or outfall toxicity. The testing was done during a qualifying storm event in January 1999. (A "qualifying" storm event is defined in the testing protocols pursuant to the STIA NPDES, and requires an event of a certain size, within a certain time period, and after a dry period of a certain time, in order to obtain a representative sample of stormwater quality.)

18. During that event, the Port collected in-stream samples from Miller Creek, Walker Creek, the east and west branches of Des Moines Creek, as well as outfall SDS3. Outfall SDS3 was selected for toxicity testing since it drains a majority of the STIA airfield (runways, taxiways, and infields) and was therefore deemed to be representative of future stormwater runoff from the new third runway project (which is primarily runways, taxiways and infields). All samples were tested for toxicity using a sensitive freshwater test species, *Ceriodaphnia dubia,* using standard test protocols at a Department of Ecology accredited testing laboratory. All samples were tested undiluted and none exhibited toxicity to *C. dubia* (i.e., there was 100 percent survival in 100 percent of the site and outfall water). All control responses and reference toxicant results were within acceptable ranges for all tests. To further test future conditions expected, SDS3 runoff was proportionally mixed with Miller Creek and Walker Creek for toxicity testing. As with the unmixed samples, the resultant "site-water" was also not toxic since *C. dubia* exhibited 100 percent survival in these mixed samples also. <u>In sum, the results showed no toxicity for the in-stream water in creeks near STIA</u>.

19. In paragraph #5 of his pre-filed testimony, Dr. Strand states that the "Port's analyses of impacts for the proposed Master Plan Update Improvements are inadequate because the Port has yet to undertake a quantitative survey of the fish and other aquatic organisms found in the project streams."

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This statement has no relevance to the determination of compliance with the conditions of the current STIA Stormwater Discharge Permit, the §401 Water Quality Certification, or to the determination of whether stormwater discharges from STIA are adversely affecting the aquatic resources of Miller or Des Moines Creeks. Such a quantitative survey would reflect all limiting factors impacting these water bodies, most importantly the changes in habitat that have occurred in these water bodies related to development in the surrounding cities. Additionally, metal concentrations in these water bodies will reflect all contributing sources in the watershed, not just STIA. Consequently, this suggestion is without merit and should be disregarded in any evaluation of the §401 Water Quality Certification.

20. In summary, the demonstration of no toxicity in the WET test results, the demonstration of a significant reduction in metal bioavailability in the range finding WER study, and the presence of significant carbon sources (extensive peat formations) at the headwaters of both Miller and Des Moines creeks provides reasonable assurance that the requirements of the §401 certification will be met following implementation, ensuring that construction and operation of the STIA MPU Improvements will not impact water quality of these water bodies, and the proposed construction of those improvements will satisfy state water quality regulations.

AIRCRAFT DEICERS AND ANTI-ICING FLUIDS

21. In evaluating the environmental impact of Aircraft Deicers And Anti-Icing Fluids ("ADAFs"), two facts are important to bear in mind: (1) there are no U.S. Environmental Protection Agency (USEPA) or Washington Department of Ecology (WDOE) Water Quality Criteria for these formulations; and, (2) ADAFs are mixtures of many compounds based primarily on either ethylene glycol or propylene glycol. Consequently, measurements of ethylene or propylene glycol must be extrapolated to represent the specific formulations of ADAFs used at STIA. Failure to do so can result in apples and oranges-like comparisons, as has been offered in the pre-filed testimony of Dr. Strand.

22. Glycols are utilized as a safety feature to de-ice airplanes during certain weather conditions. As an initial matter, it should be noted that glycols are present only infrequently in the STIA

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stormwater. This is generally because of the relatively mild Puget Sound climate. Heavy glycol usage is usually limited to the infrequent, one or two day winter weather episodes. In addition, it is important to remember that the vast majority of the glycols used are routed to the STIA Industrial Wastewater System ("IWS") – and not discharged to stormwater – because all glycol applications must take place in the portion of STIA that drains to the IWS. Any glycol that winds up in stormwater is usually the result of drip or shear off the wings of planes as they take off, or as they wait in line on a runway to take off.

23. When glycols have been detected in stormwater, the Port has implemented appropriate BMPs such as unclogging IWS drain inlets (possible cause of sporadic glycol detection in SDS3) and re-routing additional drainage areas to the IWS. Monitoring for the year 2000-2001 period indicates that the IWS drain inlet is functioning and shows that glycol concentrations have been substantially reduced in SDS1 discharges.

24. In evaluating ADAF toxicity in Miller and Des Moines creeks, it is important to note that 99% of the ADAFs applied to commercial aircraft at the Seattle Tacoma International Airport (STIA) in 1998/1999 were either Type I EG or PG fluids (Table 1). The more toxic Types II and IV comprised only 1% of all ADAFs applied to aircraft at STIA during this time period (Table 1).

Table 1. Relative usage of aircraft de-icing / anti-icing fluids for April 1, 1998 – March 31, 1999 at the Seattle Tacoma International Airport (STIA).

	Type I (EG)	Type I (PG)	Type II (PG)	Type IV (PG)
Percent of total ADAFs used	4.1%	94.8%	0.8%	0.2%

EG: ethylene glycol based PG: propylene glycol based

25. Therefore, rather than simply making blanket assertions about the presence of "glycols," as Dr. Strand does, any appropriate evaluation of ADAF toxicity in the creeks must involve comparing measured concentrations of EG and PG in stormwater discharges to Miller and Des Moines creeks to toxicity values measured for Type I EG or PG ADAFs (as was done in the Biological Assessment [FAA 2000]). Additionally, the older the study, the greater the likelihood that the tested material differs from

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the ADAF formulations currently being used today, introducing a greater level of uncertainty that must be taken in consideration in forming any conclusions about toxicity to aquatic resources.

26. In his comments about potential toxicity of glycols at STIA, Dr. Strand based his conclusions solely on a single study reported in Hartwell et al. 1995. The Hartwell study involved the toxicity testing of an unspecified formulation of Type I ethylene glycol (a de-icer) and an unspecified formulation of Type II propylene glycol (an anti-icer) in use at the Baltimore-Washington International Airport (BWI) in 1991, as well as the histological examination of fathead minnows following exposure to both ADAF types. Additionally, Dr. Strand relies significantly on a study cited by Hartwell that is described by Fisher in a paper published in 1995. Fisher's study reported the results of the chemical analysis and toxicity tests conducted on stormwater effluent discharged from BWI during two separate deicing operations in 1993.

27. In his comment, Dr. Strand asserts "that concentrations of total glycols cited in the 1999 and 2000 Annual Stormwater Monitoring Reports, and in the February 2001 stormwater analyses (Port 2001) also exceed the concentrations reported by Hartwell et al. (1995) to be toxic to aquatic life." On the basis of this study, Dr. Strand infers that concentrations of total glycols present in Miller and Des Moines will result in (1) acute toxicity to fish exposed to total glycols in these creeks and that (2) exposed fish will form gill lesions from which it "is reasonable to assume that a fish with these symptoms will die if the exposure continued at this same level". Both of these assertions are addressed individually below.

28. Dr. Strand's assertion that the total glycol concentrations present in Miller and Des Moines creeks will exceed the concentrations reported by Hartwell et al. (1995) to be toxic to aquatic life is flawed. Dr. Strand's claims fail for three, independent reasons:

- The amounts of Type II Propylene glycol ADAF used at BWI in 1993 differed with the amounts of this ADAF type used at STIA in 1998/1999, making Dr. Strand's comparison inappropriate;

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- As a result of the general age of the Hartwell et al. 1995 study (conducted in 1991), there is significant uncertainty surrounding comparisons of the toxicity of ADAFs in use in 1991 with the toxicity of ADAF formulations in use at STIA in 1999 and 2000;
- The Hartwell et al. 1995 study incorrectly reports the toxicity data units presented in Fisher et al. 1995, resulting in an incorrect comparison by Dr. Strand between toxicity levels as reported in Hartwell and the actual concentrations of glycols found in the watersheds.

29. As noted above, determinations of toxicity should be made only between similar types of ADAFs. Patterns of ADAF use at STIA indicate that less than 1% of the ADAFs applied to commercial aircraft are Type II propylene glycol (Table 1). These same data indicate that approximately 95% of propylene glycol-based ADAFs applied in 1998/1999 at STIA were Type I. This difference is critical because Type I propylene glycol anti-deicing fluids range from five to 100 times less toxic to the same test organisms than Type II propylene glycol anti-icing fluids. In contrast, Type II propylene glycol anti-icing fluids made up ≤ 10% of the ADAFs applied at BWI in 1993 (Hartwell et al. 1995).

30. Dr. Strand's comparison of total glycols measured in Miller and Des Moines creeks to the Type II Propylene Glycol toxicity level reported in Hartwell et al. 1995 is inappropriate,[1] in that it presumes 100% of the propylene glycol present is derived from Type II fluids. Based on the data shown in Table 1, the ADAF additives contributing to toxicity in the Hartwell et al. (1995) study of Type II Propylene Glycol anti-icing fluids likely differ significantly from the additives present in the Type I Propylene Glycol anti-deicing fluids used at STIA. Therefore, Dr. Strand's observation that Hartwell et al. (1995) reports a toxicity level in the range of glycol concentrations found by the ACC is also inappropriate. Less than 1% of the propylene glycol present in the STIA watershed could be derived from Type II Propylene Glycol anti-icing fluids (based on data reported in Table 1). Therefore this toxicity level is not relevant to the conditions present in the STIA watershed and it is inappropriate to compare measured total glycols to a toxicity study of Type II Propylene Glycol anti-icing fluids.

[1] Dr. Strand incorrectly reports that "Hartwell et al. (1995) determined that the 7-day LC_{50} for commercial anti-icer to fathead minnow ranged between 24.2 and 43.3 mg/L, based on the concentration of total glycols in the test solution." In fact, Hartwell et al. (1995) actually reports in their Table 4 (p. 1379) that this data was for their Anti-Icer solution – meaning Type II Propylene Glycol. The use of total glycols in this sentence incorrectly implies that more than one type of glycol was present in the test solution.

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31. Finally, and most significantly, available information indicates that the Hartwell et al. (1995) citation of the Fisher study is in error. Dr. Strand states in his declaration "It is my opinion that de-icers and their additives can be toxic to aquatic life at relatively low concentrations (1.8-8.7 mg/L), which I base on the work of Hartwell et al. (1995)". However, close examination of Hartwell et al. 1995 reveals that the values of 1.8 to 8.7 mg/L were not experimentally determined by Hartwell et al., but are actually a citation from work reported in another study (Fisher et al. 1995). Fisher et al. (1995) reports the results of acute whole effluent toxicity of storm water generated at BWI during two de-icing events in 1993. This study collected storm water effluent discharged from airport runways, and determined the toxicity of these effluents to standard EPA toxicity test organisms using serial dilutions.

32. The authors of the Fisher et al. 1995 study conducted whole effluent toxicity tests on effluent consisting of a complex mixture of constituents (see their Table 8, p. 1109). These authors make a common assumption of attributing all the toxicity measured in this complex mixture to a single set of constituents – glycols – while discounting the potential contribution of other constituent to measured toxicity. Even disregarding this issue, a careful examination of Fisher et al. 1995 revealed that Hartwell et al. 1995 misidentified the concentrations of acute effluent toxicity to fathead minnows (*Pimephales promelas*) and waterfleas (*Daphnia magna)* reported by Fisher et al. 1995 by a factor of 1,000. That is, the actual LC_{50} values for *Daphnia magna* reported by Fisher et al. 1995 range from 1,998 to 8,666 mg/L (Table 2) and not the 1.8-8.7 mg/L as reported in Hartwell et al. 1995 and used by Dr. Strand in formulating the opinion stated in his pre-filed testimony. This error is shown in the data set forth in Table 2 below:

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Table 2. Sample concentration data, measured and calculated *Daphnia magna* LC50s using data from Fisher et al. 1995.

Effluent Sample[a]	Concentrations in Effluent Sample (mg/L)				Measured 48-h LC50 as % Effluent Sample[b]	Measured LC50 as Total Glycols (mg/L)[b]	Calculated LC50 as Total Glycols (mg/L)[c]
	Ethylene Glycol	Diethylene Glycol	Propylene Glycol	Total Glycol			
Event 1, Peak	13,000	ND	2,800	15,800	54.8%	8,666	8,658.4
Event 1, Composite	6,600	300	1,700	8,600	69.3%	5,960	5,959.8
Event 2, Peak	98,000	2,900	130,000	230,900	1.7%	3,988	3,925
Event 2, Composite	31,000	1,500	85,000	117,500	1.7%	2,003	1,998

[a]Event 1 samples were collected at Site 1 on 2/12/93 and Event 2 samples were collected at Site 1 on 2/26/93 (Fisher et al. 1995)
[b]As reported in Fisher et al. 1995
[c]Calculated by Parametrix by multiplying the Measured 48h LC50 as % Effluent Sample times the total glycol concentration in each effluent sample

33. If the values reported in Fisher et al. 1995 are correct and the values reported in Hartwell et al. 1995 incorrect, then the "relatively low concentration" referred to in Dr. Strand's pre-filed testimony is off by a factor of 1,000. If that is the case, then Dr. Strand's "opinion that de-icers and their additives can be toxic to aquatic life at relatively low concentrations" is unsubstantiated.

34. Based on these lines of evidence, it is my opinion that the correct LC50 range is that reported in Fisher et al. 1995 (1,998 to 8,666 mg/L), and that the range reported in Hartwell et al. 1995 (1.8-8.7 mg/L) is incorrect. This analysis was confirmed in a recent conversation with Dr. D.J. Fisher of the Wye Research and Education Center, Queenstown, Maryland, the lead author of the Fisher et al. 1995 study (personal communication with Dr. C.S. Wisdom of Parametrix, Inc., September 26, 2001). Dr. Fisher confirmed in this conversation that the values in his 1993 study were reported in the thousands of milligrams per liter, and the numbers cited in Hartwell et al. (1995) are incorrect.

35. In my opinion, Dr. Strand's conclusion regarding glycol toxicity are based on incorrectly reported data and, accordingly, has no validity in evaluating the toxicity of glycols present in the STIA watershed. Dr. Strand's assertion of direct water column glycol toxicity is incorrect and without merit.

36. Dr. Strand also asserts in his testimony that the concentrations of propylene glycol recently measured by ACC in January 2002 (18 mg/L and 11 mg/L) are in a range sufficient to produce lesions on exposed fish. He again bases this assertion on the data presented in Hartwell et al. 1995. Hartwell et al. (1995) reports that the lowest concentration of Type I ethylene glycol producing mild lesions in 3 or more fish was 275 mg/L, while the lowest concentration of Type II propylene glycol producing mild lesions in 3 or more fish was 17.6 mg/L. In his pre-filed testimony, Dr. Strand states that "It is reasonable to assume that fish suffering these symptoms will die if the exposure to glycols continues at these same levels."

37. Dr. Strand inappropriately uses a Type II propylene glycol effects threshold (17.6 mg/L) to compare with what must be primarily Type I propylene glycol concentrations based on the usage records recorded at STIA (Table 1). Using the percentage of propylene glycol formulations that are Type II, the amount of propylene glycol measured by the ACC's consultants in January 2002 would translate to 0.09 – 0.15 mg/L of Type II propylene glycol, significantly below the level that produced the lesions reported in the Hartwell et al. 1995 paper.

38. Consequently, Dr. Strand's assertion that the propylene glycol measured in January 2002 will cause lesions in exposed fish is without foundation, based on the information provided in Hartwell et al. 1995.

39. In summary, Dr. Strand's opinions regarding glycol toxicity are based on incorrectly reported data and inappropriate comparisons. Accordingly, Dr. Strand's opinions regarding glycol toxicity have no scientific basis. Therefore, in contrast to Dr. Strand's invalid and inappropriately developed assertions, there is every reasonable assurance that glycols discharged in stormwater from STIA will not adversely affect fish.

METALS

40. Both Dr. Strand's and Dr. Willing's pre-filed testimony contain numerous statements concerning the presence of copper, lead, and zinc in STIA stormwater and in Miller and Des Moines

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Creeks. I have already addressed the lack of relevance of these statements in my earlier testimony concerning the issues involved in determining compliance with State Water Quality Criteria above. In my opinion, there is reasonable assurance that the §401 Water Quality Certification requirements will assure that state water quality standards will be met once these requirements have been implemented. This conclusion is supported by the range-finding Water Effect Ratio studies undertaken by the Port of Seattle that I discuss below.

41. Both Dr. Strand and Dr. Willing have made several inaccurate or plainly incorrect assertions in their pre-filed testimony. These are elaborated below.

42. In paragraphs #14 and #15 of his pre-filed testimony, Dr. Strand notes that there are detectable concentrations of copper, lead, and zinc in sediments collected above and below Lake Reba. He also notes that copper concentrations in sediments below Lake Reba exceed the Lowest Effects Level for copper included in the Province of Ontario's sediment guidelines. Since no effort was made to contact the Port of Seattle prior to sampling these locations, the Port can only presume that these samples were collected outside of STIA property lines. This is critical as the area below the Port property is influenced by a number of other non-point sources, e.g. SR 518 and SR 509. Thus, the data cited by Dr. Strand concerning sediment concentrations has a strong potential for reflecting multiple sources, and cannot be solely attributed to STIA stormwater discharges.

43. While citing and relying on the Ontario sediment guidelines, Dr. Strand has failed to note the general scientific criticism on the use of the Ontario sediment guidelines. These guidelines are based on what are termed Apparent Effect Thresholds (AET) and do not constitute a direct cause and effect relationship as is required in the development of surface water quality criteria promulgated by USEPA and adopted by WDOE.

44. AETs are based on field observations of the lowest concentration of a specific compound that will elicit a particular response in an aquatic organism (typically a benthic invertebrate). The problem with this approach is that these field sediment observations are almost inevitably contaminated

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with other toxic constituents. As a result, it becomes impossible to directly attribute the adverse response to any specific sediment contaminant (or even to the combination of everything present).

45. Additionally, Dr. Strand did not make any apparent effort to simultaneously measure Acid Volatile Sulfide (AVS) in any of the sediments in which metals were measured. In fact, in his deposition Dr. Strand went so far as to ask "why should he?" when questioned if he had requested any AVS measurements in sediments he had collected and submitted for analysis. The reason AVS is measured simultaneously with extractable metals is that the ratio of AVS to extractable metals is a direct reflection of the bioavailability of these metals. While the importance of AVS decreases in fast flowing streams, the conditions in the vicinity of Lake Reba below the Port property line which all that was accessible to Dr. Strand for sampling are likely to produce levels of AVS that could affect metal bioavailability in sediments.[2]

46. Dr. Strand's conclusions that "there is a high probability that sediment concentrations of copper, lead, and zinc occurring below Lake Reba are toxic to greater than five percent of the aquatic genera inhabiting this site" are called into question (1) by the use of the Ontario freshwater sediment guidelines; and, (2) by his failure to measure AVS in these sediments.

47. Dr. Willing's opinion in paragraph #30 of his pre-filed testimony is that the use of a filter media is ineffective for metals removal. He appears to ground this conclusion solely on the observation that the use of a single filter media has never worked before to reduce metal concentrations in his experience. Condemning the results of experiments that Dr. Willing has not had the opportunity to review is at best un-scientific, and certainly should have no bearing in determining the adequacy and efficiency of BMPs being evaluated by the Port of Seattle in its efforts to implement the requirements of the §401 Water Quality Certification.

48. Both Dr. Strand in his deposition and Dr. Willing in paragraph #41of his pre-filed testimony make incorrect statements concerning hardness rendering "metal ions in water less toxic by

[2] AVS is typically generated under anoxic conditions from the decomposition of organic matter accumulated in sediments.

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providing positively charged exchange sites for the metals to attach themselves." Although Dr. Willing does correctly note in the previous sentence that "hardness is defined as the sum of calcium and magnesium, expressed as the calcium carbonate equivalent," he does not appear to understand that positively charged copper, lead, and zinc dissolved ions will not "attach themselves" to positively charged calcium and magnesium ions. Instead, the increased levels of calcium and magnesium act to competitively bind to negatively charged sites on the gills of fish, reducing the number of sites available to bind copper, lead, or zinc. Such misstatements by both Drs. Strand and Willing combined with other misunderstandings concerning the effects of AVS and Total Organic Carbon on metal bioavailability call into question their general understanding of the growing appreciation and importance of the effect of water and sediment quality parameters on metals toxicity.

49. In paragraph #42 of his pre-filed testimony, Dr. Willing presents his concerns about the use of different hardness values in determining the appropriate Water Quality Criteria for metals (28 mg/L versus 56 mg/L). In the following paragraph (#43), Dr. Willing goes on to mention the changes and variability in hardness associated with meteorological events. Ignoring for the moment the issues raised earlier concerning the determination of compliance, the use of the 56 mg/L hardness number is actually a better point descriptor of a variable water quality parameter. This is because the 56 mg/L is actually the median value of seven in-stream samples collected in Miller and Des Moines Creek in 1999, as opposed to a single point measurement of hardness at any one point in time. As a result, the median hardness is the best single measure of hardness that will be encountered by fish moving through the aquatic habitats of Miller and Des Moines creeks.

50. Dr. Willing states in paragraph #44 of his pre-filed testimony that use of Water Effect Ratios constitutes a "relaxation of the water quality standards." Frankly, nothing could be further from the truth. USEPA and WDOE have long provided stringent and reproducible methodologies for the development of site-specific criteria that allow for the protection of aquatic resources as mandated by

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WAC 173-201A and the Federal Water Pollution Control Act. To state otherwise is to purposely seek to confuse the regulatory directive of the §401 Water Quality Certification Process.

WATER EFFECT RATIOS

51. In response to past concerns regarding stormwater from STIA, the Port has proactively undertaken several water quality screening studies to evaluate the development of site-specific water quality criteria in accordance with WAC 173-201A-040. WAC 173-201A-040 (3) states "The department may revise [water quality] criteria on a state-wide or waterbody-specific basis as needed to protect aquatic life occurring in waters of the state and to increase the technical accuracy of the criteria being applied." This is more specifically defined in footnotes to the numerical criteria tables (see footnote dd) which states "Metals criteria may be adjusted on a site-specific basis when data are made available to the department clearly demonstrating the effective use of the water effects ratio approach established by USEPA, as generally guided by the procedures in USEPA Water Quality Standards Handbook, December 1983, as supplemented or replaced."

52. The U.S. EPA first published guidelines for developing site-specific water quality criteria in the early 1980's, which were later modified in 1994. Based on those federal guidelines, the Washington Department of Ecology has incorporated its own guidelines on conducting a water effect ratio (WER) study in Appendix 6 of the DOE permit writer's manual.

53. The premise behind the WER approach is that the bioavailability (and hence toxicity) of chemicals in receiving streams, creeks, or rivers, is reduced by the presence of natural constituents such as suspended particles or organic matter. This is in contrast to the laboratory water or spring water used in the toxicity tests upon which the generic water quality criteria are based. In a WER study, concurrent toxicity tests are used to calculate the ratio of a chemical's toxicity in site-water to its toxicity in laboratory, or spring, water. The chemical of concern is spiked into the laboratory water and site-water at known concentrations. A median lethal concentration is then determined for each water, and the two are compared to generate a WER: this ratio provides an empirical determination of the difference in

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metal bioavailability –attributed to site-water– and is used to adjust the generic water quality criterion. For example, if the water quality criterion for a chemical is 3 μg/L, and a WER of 3 is derived for a particular site, the resulting site-specific water quality criterion would be 9 μg/L. The resulting standard gives the necessary level of protection intended by the more generic (laboratory water) standard, but with the standard adjusted for the particular characteristics of the water in that particular stream.

54. As the science of metals bioavailability and toxicity has advanced in recent years, particularly in the stormwater arena where site-specific conditions are far removed from laboratory conditions, there has been an increased recognition of a need to derive site-specific criteria. Indeed, a recent review of proposed federal water quality standards for Indian Country (*Federal Register Proposed Rule January 18, 2001*) shows that all metals criteria are to be explicitly calculated using a WER.

55. To this end, the Port conducted a "range-finding" WER study for copper in February 1999. A range-finding WER differs from a comprehensive WER study in that it is based on nominal chemical concentrations and does not examine the effects of seasonal variation. As discussed in Ecology's WER guidance, a preliminary range-finding study is highly recommended, since it provides an excellent indication of what the WER might be for a site prior to embarking on a comprehensive study. In layman's terms, the range-finding study is a good predictor of the range within which the WER standard would fall.

56. The February 1999 range-finding study at STIA used three different types of site-water to calculate a WER for copper. Two of the site-waters consisted of SDS3 stormwater mixed with Miller Creek water and Walker Creek water, in ratios anticipated for the new outfalls. That is, it was assumed that the water quality characteristics of current runway and taxiway runoff from SDS3, as well as Miller Creek and Walker Creek water quality, would be representative of future conditions. The third site-water tested consisted of Des Moines Creek water sampled downstream of SDS3. Concurrent site-water

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and laboratory-water toxicity tests were conducted using standard protocols with the sensitive freshwater species, *Ceriodaphnia dubia* (waterflea).

57. Based on nominal concentrations for total copper, copper WERs for Miller, Walker and Des Moines Creeks ranged from 7 to 16. That is, copper was shown to be between 7 and 16 times *less* toxic in site-water (i.e., Miller Creek, Walker Creek and Des Moines Creek waters) than in the laboratory water.

58. A second range-finding study for copper was conducted in April 2000. This time, site-water consisted of receiving stream water collected upstream of the Port's outfalls, and sufficiently downstream to represent a "complete-mix" scenario in accordance with U.S. EPA protocols. Five different types of site-water were tested, two representing upstream conditions and three representing complete-mix conditions. As with the previous range-finding study, these five different site-waters all resulted in nominal copper WERs of around 15 and higher. Once again, the indication was that in site-water, copper was 15 or more times *less* toxic than in standard laboratory water.

59. In conclusion, the two range-finding studies show that development of site-specific standards is feasible at STIA. The site-specific standard for copper would be expected to be within the range of standards discussed above – that is, the site-specific standard for copper would be from 6 to 17 times the generic numeric ambient water quality standard. It should be stressed, however, that this is not a decrease in the protectiveness of the standard. The site-specific standard would be just as protective (in site-specific water) as the generic standard (for the laboratory water on which that generic standard was based).

60. As noted above, the range finding WERs described above were performed solely for the purpose of determining whether this approach would be feasible for the derivation of site-specific criteria, as is required by the §401 Water Quality Certification. Consequently the concerns raised by Dr. Willing in paragraphs #50, 52, 53 and 54 of his pre-filed testimony have no relevance to the process that the Port of Seattle will follow when the Port implements the requirements of the §401 Water Quality

Certification. When appropriate and required, the Port of Seattle will provide all information and conduct the process of developing site-specific water quality criteria as is required by the Department of Ecology through the Washington Administrative Code.

61. Finally, it is important to reiterate that Dr. Willing is completely incorrect in asserting in paragraph #53 of his pre-filed testimony that the "Port's apparent intention is to work out a relaxation of the criteria in private with Ecology, and then present the public with *a fait accompli*." Development of site-specific water quality criteria are provided for in both state and federal regulations and are equally, if not more, protective of the aquatic life of the Miller and Des Moines Creek basins. Any such statements to the contrary are un-scientific and should be disregarded.

WHOLE EFFFLUENT TOXICITY TESTING

62. In compliance with Special Condition S10 of the NPDES permit for STIA, the Port has completed at least two rounds of whole effluent toxicity (WET) testing at four of its stormwater outfalls. The outfalls are two outfalls in the Miller Creek basin and two outfalls in the Des Moines Creek basin: outfalls SDS3, SDE4, SDN4 and SDN1. As mentioned above, the SDS3 outfall is the largest runway and taxiway outfall at STIA, and includes stormwater from runways, taxiways and infields at STIA. Because of this, SDSE is a good surrogate for the new third runway project at STIA, which will also be comprised of runway, taxiways and infield uses. The results of this testing have been reported in the Port's annual stormwater monitoring report and in a required summary report delivered to Ecology in May 2000 – the Stormwater Whole Effluent Toxicity (WET) Testing at Seattle-Tacoma International Airport Final Report.

63. Whole effluent toxicity (WET) testing, as its name implies, tests the toxicity of the whole sample, rather than testing for the toxicity due to a single chemical. The tests are conducted according to standard protocols using standard sensitive aquatic species such as the waterflea, *Ceriodaphnia dubia*, or juvenile fathead minnows, *Pimephales promelas*. WET testing is a standard approach in the scientific community for measuring the toxicity of effluents, and the protocols were originally developed and

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adopted by EPA in the mid-1980s. The Department of Ecology has developed its own approved testing criteria based on the EPA protocols.

64. WET testing has several advantages over standard chemical analysis of discharges. First, it relies on biology, not chemistry, as a measure of aquatic life protection. Second, because WET testing tests the "whole effluent," it provides a test of what the affected aquatic organisms actually "see" with regard to the multitude of constituents, known or unknown, in any one sample.

65. Of the four outfalls tested by the Port, three of the outfalls (SDE4, SDS3, and SDN4) met Ecology's performance criteria for organism survival in undiluted, 100 percent stormwater. Significantly, this includes outfall SDS3, which is representative of the proposed third runway project.

66. As a follow up to whole effluent toxicity testing required by the Port's NPDES permit, the Port proactively undertook a study to identify the nature and source of toxicity for a small subbasin at the northern end of STIA (i.e., subbasin SDN1) where toxicity test performance criteria were not met. By working back up-the-pipe and using metal chelating techniques as described by Hockett and Mount (1996), the Port was able to attribute observed toxicity to zinc from uncoated galvanized rooftops in the SDN1 subbasin (POS May 2000, Tobiason and Logan, 2000, 2001).

67. Based on these findings, the Port undertook further studies on the efficacy of different filter media for metals removal and toxicity reduction of stormwater like that from the SDN1 subbasin (Tobiason et al., 2002). Test media included both those that are commercially, as well as newer experimental media. The study not only looked at metals removal by measuring zinc concentrations in pre- and post-filter samples, but more importantly, measured toxicity in the pre- and post-filter samples as well. Toxicity was tested using the sensitive waterflea, *Ceriodaphnia dubia*.

68. The organic based media (e.g., commercially available leaf compost, and soybean hulls) were superior to the inorganic based media (e.g., zeolite/perlite mix, and a polyamine sponge) for metals removal and reducing toxicity. For example, the leaf compost media removed up to 75 percent of the zinc and significantly reduced toxicity for pre-filter concentrations of up to around 300 ppb zinc.

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Similarly, the soybean hull material removed 80 to 99 percent of the zinc and post-filter samples were non-toxic (following pH adjustment) at all zinc concentrations tested (i.e., > 1000 ppb zinc).

69. What this testing demonstrates is that, for this particular issue at SDN1, there are BMPs that can be designed to address the issue – either by the use of filtering media (to treat the runoff) or by coating or otherwise treating the rooftop (to treat the source). The results of the testing present no problem for the new projects covered by the §401 Water Quality Certification, however, because those projects will simply be required to be constructed using non-leaching rooftops, which are easily available commercially.

70. In conclusion, the WET testing program at STIA is functioning exactly as designed for existing operations of an already-constructed facility. This approach allows the Port and Ecology to identify any potential problems, trace the potential problem, and design or apply appropriate BMPs to remedy the problem. The knowledge gained from the WET testing also allowed Ecology to be reasonably assured that future STIA stormwater will meet applicable water quality regulations. The results from outfall SDS3, which showed no whole effluent toxicity problems, represent the same types of uses that will be discharging from the new third runway and taxiways. There is also reasonable assurance regarding the new rooftop areas on other portions of the new project because they will utilize non-leaching rooftop materials as an effective BMP.

CONCLUSION

71. There are two critical water quality questions in this proceeding: (1) whether STIA is complying with the requirements of its current NPDES Stormwater Discharge Permit; and, (2) whether the available data offers reasonable assurance that the conditions of the §401 Water Quality Certification will assure compliance with water quality regulations. In my opinion, based on my evaluations of the data presented in my testimony and information I reviewed in connection with the formulation of the Biological Assessment, the answer to both questions is "yes."

72. In summary, the Port of Seattle has complied with all conditions of the current State Waste Discharge Baseline General Permit for Stormwater Discharges Associated with Industrial Activities. Additionally, ethylene and propylene glycol concentrations present in Miller and Des Moines Creeks are significantly below concentrations that will adversely affect aquatic life through increased mortality or decreased survivorship or growth. It is also my opinion that the results of the Whole Effluent Toxicity (WET) tests conducted with in-stream samples offer reasonable assurance that stormwater discharges are not adversely affecting the aquatic life of Miller and Des Moines Creeks. Lastly, in my opinion, the results of the range-finding experiments conducted as part of the Preliminary Water Effect Ratio study offer reasonable assurance that the metal concentrations in STIA stormwater discharges will be below the site-specific Water Quality Criteria that will be developed as a requirement of the §401 Water Quality Certification.

I declare under penalty of perjury under the laws of the state of Washington that the foregoing is true and correct.

Executed at Kirkland, Washington, this 6th day of March 2002.

Charles S. Wisdom

Charles S. Wisdom, Ph.D.

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Charles S. Wisdom, Ph.D.

Ph.D., Chemical Ecology
Bachelor of Arts, Biology
Associate of Arts, Biology

Charles Wisdom is an ecologist with 19 years of experience investigating the impacts of human activities on aquatic and terrestrial ecosystems using a risk assessment approach. Dr. Wisdom has assessed the environmental impacts of current and future mining activities and discharges from sewage treatment plants to aquatic life, wildlife, and humans. He has assessed the potential for exposure of fish, birds, mammals, and humans to chemicals, physical effects, and habitat modifications, and predicted the level of adverse impact (if any) on these organisms from their exposure. Additionally, he has been active in the use of risk assessments to determine the impacts of human activities on aquatic endangered species and establishing the relationships between of the Clean Water Act and the Endangered Species Act. Dr. Wisdom's research career has included field and laboratory evaluations of plant biochemical and ecophysiological responses to ozone exposure and aerosol deposition of nitrogenous compounds. He has conducted comparative studies on responses of various plant species (e.g., photosynthesis and water relations) to patterns of water availability in the environment.

Project Experience

Parametrix (1995-Present)

Sammamish-Washington Analysis and Modeling Program (SWAMP). King County Department of Natural Resources – Washington
Currently assisting wastewater capital planning, habitat conservation planning, and salmon recovery and watershed planning efforts by developing a set of scientific tools to better understand the Sammamish/Washington watershed system, and using the tools to explore resource management options. These tools and information include water and sediment quality monitoring results, water quality and quantity modeling, ecological and human health risk assessment, and habitat and biological assessments. The SWAMP project is seeking to (1) understand existing conditions in the study area and identify any associated risks to aquatic life, wildlife, and people and as well as under buildout conditions; and (2) understand the effects of using reclaimed water in the watershed on existing and future conditions and resulting potential risks. Technical studies are supporting wastewater reuse planning, wastewater treatment plant siting, wastewater habitat conservation planning for endangered species act compliance, and watershed basin planning for endangered species recovery. These studies include water and sediment quality analysis, water quality modeling, human site use surveys, human health and ecological risk assessment, and habitat and biological surveys. Water quality studies include field sampling, modeling, and ecological and human health risk assessment in the major lakes in the study area. Various biological and habitat surveys are being conducted in areas where a potential treatment plant and/or reuse project may be located.

Seattle Tacoma International Airport Master Plan Update Improvements Biological Assessment. Port of Seattle, Seattle, Washington.
Managed the preparation of a Biological Assessment (BA) to fulfill the ESA Section 7 Consultation requirements of the Federal Aviation Authority (FAA) for the proposed Master Plan Update (MPU) Improvements at Seattle Tacoma International Airport. This BA assessed the impacts of construction and operation of the proposed MPU Improvements on chinook salmon and bull trout in Miller and Des

Moines Creek watersheds and the Green River. Additionally evaluated were potential effects on marbled murrelets and bald eagles. Both potential water quality and hydrologic impacts were evaluated in this process, as well as proposed mitigation efforts for the overall project. The determinations of the BA were concurred with by both the National Marine Fisheries Service (NMFS) and the United States Fish and Wildlife Service (USFWS).

Link Light Rail Biological Assessment. Sound Transit – Seattle, Washington
Managed the preparation of a Biological Assessment to fulfill the ESA Section 7 Consultation requirements of the Federal Transit Authority (FTA) for the proposed Link Light Rail system to be constructed in the City of Seattle. This BA assessed the impacts of construction and operation of the proposed Link Light Rail system on chinook salmon and bull trout in the Duwamish River and associated tributaries. Additionally evaluated were potential effects on bald eagles. Both potential water quality and hydrologic impacts were evaluated in this process, as well as proposed mitigation efforts for the overall project. The determinations of the BA were concurred with by both the National Marine Fisheries Service (NMFS) and the United States Fish and Wildlife Service (USFWS).

North Treatment Facility (NTF) – Marine Outfall Siting Study (MOSS). King County Department of Natural Resources – Seattle, WA
Parametrix is assisting King County to site a new marine outfall as part of the siting and construction of their proposed North Treatment Facility and conveyance system. The Parametrix team will evaluate the human health, aquatic life and wildlife impacts and risks posed by existing physical, biological and chemical conditions and how those impacts and risks could potentially change during construction and operation of the new outfall. Additionally, the Parametrix team will evaluate potential risks to chinook salmon and other potentially threatened and endangered species and their habitat from existing and proposed County discharges to Puget Sound in support of the County's efforts to develop and implement a Habitat Conservation Plan. Both of these evaluations will require an assessment of the physical, biological and chemical conditions of the outfall and Wastewater Habitat Conservation Plan (HCP) marine study areas.

NEPA Environmental Assessments – United States Navy, EFA Northwest – Poulsbo, WA
Assisted in the preparation of an Environmental Assessment for the Navy Limited Partnership Housing project near Marysville (Everett II). Provided evaluations used in the selection of the final site for this housing complex from three proposed sites. Completed a Biological Assessment of potential impacts on endangered species required for this project. Currently assisting in the preparation of an Environmental Assessment of the proposed redevelopment of the 1942 Victory Housing complex located at Naval Air Station, Whidbey Island.

Water Quality Assessment – King County Department of Natural Resources, WA
Assessed the risks to aquatic life, wildlife, and human health from baseline conditions with and without Combined Sewer Overflow contributions to the Duwamish River and Elliott Bay. Risks were assessed to fish, benthic organisms, wildlife, and people working and recreating on the river and bay from exposure to metals and organics, physical stressors, and human pathogens that are present in both freshwater and marine ecosystems in the Duwamish Estuary.

Aquatic Life Risk Assessment Sydney – Water Corporation, Sydney, Australia
Assessed the risks to aquatic life from wet-weather discharges from three Sewage Treatment Plants operated by the Sydney Water Corporation. Risks were assessed to fish and benthic organisms from

exposure to dissolved metals that would be present in both freshwater and marine ecosystems in the greater Sydney metropolitan area.

Environmental Impact Statement – Bureau of Land Management, Nevada
Conducted a third party review of an aquatic life risk assessment of the proposed Cortez South Pipeline project for a Bureau of Land Management EIS. The review involved critiquing the scientific validity of the risk assessment and summarizing the risk assessment for the draft EIS.

Environmental Risk Assessment – P.T. Freeport Indonesia, Irian Jaya, Indonesia
Assessed the risks to aquatic life, human health, and a tropical mangrove ecosystem for metals present surface water resulting from increased operations of a combined gold and copper mine. Risks were assessed to humans, fish, benthos, and plants from exposure to dissolved metals present in the Ajkwa River.

Aquatic Life and Human Health Risk Assessment – Phelps Dodge Corporation, Montana
Managed an aquatic life and human health risk assessment for metals present in groundwater and surface water at a site of a proposed gold pit mine. Risks were assessed to humans and fish from exposure to dissolved metals that would be present in the Blackfoot River once the mine begins operation.

Human Health and Wildlife Risk Assessment – Sante Fe Pacific Gold Corporation, Nevada
Managed a human health and wildlife risk assessment for a future pit mine lake. Risks were assessed to humans, birds and mammals from exposure to dissolved metals that will be present the lake once it forms, including mercury, methylmercury, arsenic, cadmium, and zinc.

Human Health and Wildlife Ecological Risk Assessment – Aluminum Company of America, Texas
Directed the identification of background sites for use in human health and wildlife risk assessments from elevated metal (e.g., mercury, lead and cadmium) and organic (e.g., PCBs and PAHs) concentrations related to Alcoa's Point Comfort Operation in Lavaca Bay, Texas. Background sites are being used in the identification of Chemicals of Potential Concern and the establishment of future Remedial Action Levels.

Wildlife Risk Assessment – Kennecott Utah Copper, Utah
Managed a wildlife risk assessment in wetlands properties adjacent to the Kennecott mining operations in Salt Lake City, Utah. Risks were assessed to birds from exposure to metals present in sediments, water and invertebrate prey in these wetlands, including arsenic, cadmium, copper, lead, selenium and zinc.

Wildlife Risk Assessment – Asarco, Inc., Nebraska
Managed an aquatic risk assessment from metals and organics present groundwater seeping into the Missouri river. Chemical concentrations were compared to EPA Ambient Water Quality Criteria to determine whether aquatic life were at risk from exposure to these chemicals.

Housing Demolition Environmental Assessment - EFA NW, Poulsbo, Washington
Parametrix prepared sections of an Environmental Assessment of the proposed demolition of the existing Victory Housing at the Whidbey Island Naval Air Station and the construction of new housing on the same location.

Beak Consultants (1992-1995)

Guidelines for Development and Operation Manual – King County, WA
Assisted in the preparation of toxicological guidelines for King County's Best Management Practices for Golf Course Development and Operation manual. Designed guidelines for the seasonal use and application of pesticides.

Toxicity Evaluations to Support NPDES Permit Requirements – Various Clients in Washington State
Managed the determination of acute and chronic toxicity of wastewater discharges at treatment plants for the following municipal clients: Edmonds, Duvall, Lynnwood, Spokane, Goldendale, Othello, Pasco, and Bellingham. Dr. Wisdom managed similar projects for the Department of Ecology/Manchester Laboratory, and the Department of Corrections at the Cedar Creek Corrections Center and the Clallum Bay Corrections Center.

Toxicity Evaluations to Support NPDES Permit Requirements – Various Industrial Clients in Washington State
Managed the determination of acute and chronic toxicity of freshwater and marine discharges at treatment plants for the following industrial clients: Texaco Refining & Marketing, Shell Oil/801 Division, Longview Fibre Company, Foss Shipyard, and Jorgenson Forge.

Wisdom Associates (1991)

Environmental Technologies Consultant. Dr. Wisdom evaluated control technologies and market trends in the waste management industry (air quality, groundwater contamination, plastics recycling and noise and vibration control) for a confidential client. This involved the assessment of technology feasibilities, impacts of governmental regulations on environmental technologies and the analysis of market directions.

University of New Mexico, Department of Biology (1986-1992)

Assistant Professor. Responsible for conducting a grant-supported research program, teaching undergraduate and graduate students (classes in botany, plant ecology, plant physiology, plant-herbivore interactions and spatial statistics) and participating in university administrative committees. Dr. Wisdom designed and conducted research to investigate plant chemistry, toxicity of chemicals to insects, brine shrimp and bacteria and environmental influences on plant chemical production. He also investigated the biodegradation of chemicals in soils, performed chemical analyses by chromatography (HPLC, GC, TLC) and identified structures by spectroscopy (UV, MS, NMR). In addition, Dr. Wisdom performed multivariate statistical analyses of experimental data by computer software (LOTUS, SAS, SPSSX) and programmed computers in FORTRAN and PASCAL to aid data analyses. Specific research activities conducted by Dr. Wisdom at UNM included:

USDA Forest Service, Rocky Mountain Experimental Station Sponsored Research
Herbivorous arthropods on snakeweed: Influence of associated plants on arthropod distributions and of the environment on snakeweed terpene chemistry.

NSF Biological Systems and Resources Division Sponsored Research
Long-term ecological research on climatic and ecological gradients: Sevilleta National Wildlife Refuge.? Co-principal Investigator with Dr. James R. Gosz and many other members of the Department of Biology.

Biomedical Research Support Grant, University of New Mexico Sponsored Research
Chemical surveys of medicinally used plants of the arid Southwest.

USDA Forest Service, Rocky Mountain Experimental Station Sponsored Research
Impact of a Southwestern semi-arid rangeland plant invader on soil biology and chemistry.

USDA Forest Service, Rocky Mountain Experimental Station Sponsored Research
Ecophysiology and herbivory of Gutierrezia in disturbed and undisturbed sites.

University of California, Los Angeles, Laboratory of Biomedical and Environmental Sciences (1983-1986)

Postdoctoral Scholar. Responsible for the development of organic analyses laboratory and planning/conducting/analyzing field research on the interaction of native herbivorous insects on Prosopis glandulosa (mesquite trees) in the Mojave Desert of California. Determined the toxicity of mesquite chemicals in bioassays using native herbivorous insects.

University of California, Irvine, Department of Ecology and Evolutionary Biology (1977-1982)

Research Assistant/Teaching Assistant. Dr. Wisdom assisted his dissertation advisor in ecological research, conducting laboratory analyses of plant chemical content and field collection of plant and insect distributions. Planned, conducted and analyzed dissertation research on the interaction of desert plant chemicals and herbivorous insects. Developed culturing techniques for insects involved in this research.

NSF Doctoral Dissertation Improvement Grant, Sponsored Research
The multiple-component defense system of Encelia farinosa: Ecology and evolution. Dissertation advisor – Dr. Eloy Rodriguez.

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