Q. *What is your name and business address?*

R. Todd Bohle

DNR-South Puget Sound Region

PO Box 68

Enumclaw, WA 98022

*Q. Where are you employed and what is your job title?*

A. I am a Natural Resource Scientist 2 with the Washington State Department of Natural Resources in the Forest Practices Division. My work station is the South Puget Sound Regional Office in Enumclaw.

*Q. What is your educational background?*

A.

- M.S., Forest Hydrology, May, 1994. Oregon State University, Oregon. Thesis Topic: Summer Stream Temperatures and their relationship with Channel Morphology and Riparian Vegetation characteristics in the Upper Grande Ronde River Watershed, Oregon.
- B.A., Geology, June, 1985. Colorado College, Colorado.

Relevant Course work: Forest Hydrology, Fluid Mechanics, Land Use & Water Quality, Spec. Topics in Forest Hydrology (Peak Flow Estimation), Hydrologic Flow Paths in Forested Watersheds, Riparian Ecology & Management, Stream Ecology, Limnology, Applied Hydrology, Water Resource Seminar, Intro. to Geology, Mineralogy & Crystallography, Paleontology & Stratigraphy, Structural Geology, Sedimentary Petrology, Igneous Petrology, Geochemistry, Historical Geology, Forest Geomorphology, Introduction to Soil Science, Soil Ecosystem Properties, Slope Stability, Applied Fluvial Geomorphology, Harvesting Processes, Plant Physiology, Riparian Ecology and Management.

*Q. What is your professional experience?*

A.

- Forest Hydrologist, June 1994-Present, Washington Department of Natural Resources (DNR), Forest Practices Division, Watershed Analysis Team, Enumclaw, Washington.

Perform hydrology, riparian and stream channel assessments to evaluate the cumulative effects of forest practices on fish habitat per Washington Watershed Analysis (WWA) methodology. Instruct courses in the theory and techniques used in the Stream Channel Module within WWA. Serve as consultant to DNR Foresters about slope stability, riparian and hydrology issues. Peer review Watershed Analyses completed by other scientists. Participate in prescription writing within the WWA process.

- Graduate Research Assistant, January 1992-May 1994, Department of Forest Engineering, Oregon State University, Oregon.

Designed and conducted a study of summer stream temperatures and their relationship with channel morphology and riparian vegetation characteristics. Analyzed the spatial and temporal extent of elevated stream temperatures within a basin and used regression and ordination to isolate environmental parameters most strongly influencing these patterns. Determined the accuracy and precision of a physically-based stream temperature model.

- Biological Technician, May 1991-October 1991, Yukon-Charley Rivers National Preserve, National Park Service, AK.

Developed and executed a project to evaluate the sensitivity of the physical and biologic resources along a tributary of the Yukon River to proposed oil drilling activities. Assessed baseline hydrologic, geomorphic, water quality and biotic conditions within the riparian corridor.

Synthesized results into a report used to regulate activities in the watershed. The protocols developed in this study were used as a prototype for future resource assessment projects.

- Biological Research Technician, May 1988-October 1990, Sequoia & Kings Canyon National Park, National Park Service, CA.

  Developed field data collection, lab analysis, and computer protocols necessary for processing thousands of tree cores used to determine tree age/stand structure. Used dendrochronology to determine age of death for large Giant Sequoia snags. Assisted the Acid Rain Research crew in performing snow surveys in several high elevation drainages as well as in the collection of stream, precipitation, throughfall, and lysimeter samples for chemical analysis. Maintained precipitation and air quality samplers, meteorological stations with data loggers, and stream gauging/recording equipment.

- Geomorphology Research Assistant, May 1986-November 1986, Department of Forest Sciences, Oregon State University, Oregon.

  Developed sampling procedures and collected simultaneous data for geomorphic, hydrologic and vegetative characteristics in high elevation riparian communities; interpreted and mapped complex geomorphic features and drafted accurate maps.

*Q. What is the subject matter of your testimony?*

A. This testimony addresses issues related to forest hydrology and riparian management. In particular, aspects of the application that have the likelihood of altering hillslope hydrologic processes and riparian stand dynamics are addressed. This testimony is relevant to, and may provide information important for understanding, other DNR testimony which addresses forest practices concerns regarding slope stability, channel scour and fish habitat issues.

Riparian Issues:

*Q.* *What are the connections between forest practices and riparian zones?*

A. In general, riparian zones are defined as the area extending from the channel or floodplain into adjacent stands and which influence any part of the aquatic ecosystem. Some important riparian zone functions include providing shade, woody debris, litterfall, stream bank stability, flood control, and wildlife habitat. Forest practices within riparian zones have the potential to physically alter the natural processes which have formed and maintained their physical and biological characteristics through time. One very unique and important attribute of riparian zones is that upstream inputs of sediment, water, wood and nutrients will eventually be routed downstream. This connectivity, in which disturbances and alterations to upstream inputs will affect downstream areas, is what makes forest practices within riparian zones so important.

*Q.* *Do Forest Practice Rules regulate activities within riparian management zones (RMZ's) and along smaller Type 4 and 5 waters?*

A. Yes, forest practice rules regulate activities related to timber harvest, shade retention and stream bank stability within RMZ's (WAC 222-30-020). Within Type 4 and 5 waters forest practice regulations (WAC 222-30-070) restrict activities which might result in instability of the channel bed or banks (see LQ-T).

*Q.* *What is the definition of an RMZ?*

A. As defined in WAC 222-16-010, an RMZ is the specified area alongside Type 1, 2, and 3 waters where specific measures are taken to protect water quality and fish and wildlife habitat. Type 1, 2 and 3 waters are defined in WAC 222-16-030. Type 1 waters are inventoried "shorelines of the state" (RCW 90.58) while Type 2 and 3 waters are classified based on domestic water supply and fish usage. Type 4 and 5 waters are non fish-bearing, perennial and ephemeral waters which potentially influence downstream water quality.

*Q. What are the forest practice rules which restrict Forest Practices within RMZ's?*

A. Specific requirements are described in WAC 222-30-020 and discussed in Exhibit LQ-T. For areas within Watershed Administrative Units (WAU's) where watershed analysis has been completed, additional rules (prescriptions) may also apply. This process is described in WAC 222-22 and relevant prescriptions are discussed in (and attached to) Exhibit NS-T.

In general, restrictions on timber harvest within RMZ's define a distance from the stream within which trees have a high likelihood of falling into the aquatic system. With respect to stream bank stability, regulations exist which minimize or prevent disturbance to understory vegetation, stumps, and root systems within the stream bank, and prevent entry of felled trees (WAC 222-30-030). Regarding shade, a shade analysis is required in order to determine specific shade requirements. Trees are left along most streams in order to ensure adequate levels of shade and thereby reduce the likelihood of elevated stream temperatures.

*Q. What are* the important physical functions which Forest Practice Regulations are designed to maintain?

A. I will summarize the key physical functions with respect to three categories: timber harvest, stream bank stability and shade.

Timber Harvest: In my opinion, the primary objective of restricting tree removal within the RMZ relates to the goal of maintaining both the integrity (stability) of stream banks and the ability of this zone to supply wood to the aquatic system in perpetuity. The physical functions which wood provides to an aquatic system vary with physical channel characteristics such as width, stream gradient and confinement (Bisson et al. 1987; Montgomery and Buffington 1993). Maintaining a supply on wood in streams is important for the creation and maintenance of pools and the control of sediment and organic matter storage. The physical and biological consequences of wood in streams are discussed in Exhibit SCS-T and Bisson et al. (1987), respectively. In general, the source of most wood entering the channel from an RMZ is a function of local stand height (which is a function of age, species and site productivity). For instance, in a study of small streams in western Oregon, McDade (et al. 1990) observed that a source distance for 90% of mature hardwood and mature conifer was approximately 46 feet and 82 feet, respectively. These findings support the intuitive relationship that mature conifer trees tend to be significantly taller than mature alder and therefore have a greater likelihood of falling into the channel from greater distances. In addition, the removal of all trees potentially recruitable (to the stream) within the RMZ can result in a long-term deficit in volumes of both alder and conifer woody debris (Bisson et al. 1987).

Stream bank stability: Physically disturbing and destabilizing stream banks can lead to significant changes in channel shape and in some instances result in dramatic increases in channel width and sediment supply to the channel. As a result of channel widening, channel depths decrease and both the number and depth of pools (commonly important for fish habitat) tend to decrease.

One local example of timber harvest on stream banks and adjacent floodplains which resulted in significant bank erosion and channel widening exists in segments 15 and 17 within the North Fork Tolt (DNR 1993). As a result of timber harvest within the RMZ's, in addition to peak flows and sediment input from landslides in tributaries, the channel in these segments became much wider and shallower, changing from a meandering pool-riffle to a more straight, braided morphology. As a consequence of this change, the occurrence and frequency of pools was thought to decrease (DNR 1993). While an extreme case, those observed channel changes (in segments 15 and 17) are precisely what the Tolt riparian prescriptions (see Exhibit NS-T) are attempting to prevent. In addition, changes in bank stability can result in significant changes to downstream channel characteristics and habitat (Exhibit SCS-T and Hicks et al. (1991), respectively).

In general, the role of vegetation in promoting bank stability is a function of the size, sorting and shape, and cohesion of bank material. Banks which are composed of a mixture of loose round cobble, gravel and sand are likely to be easily eroded during high flow events. In these areas, stream bank vegetation with roots which bind material together may be very important for maintaining bank stability and enabling the channel to maintain it's current shape. Exceptions to this, however, occur when rooting depths are above the zone of active bank erosion (Shannon & Wilson 1991). In other areas, such as where bank material consists of large boulders and cobbles or with very consolidated, well sorted silt or clay, stream banks may be more resistant to erosion and therefore not be as reliant on stream bank vegetation for stability.

Shade: In general, stream temperatures in very large (>100 feet wide), deep (average of 2-3 feet) streams are not as affected by reductions in shade as small, shallow streams. Where streams are small (e.g., <15 feet wide), mature conifer stands can provide a great deal of shade and result in a relatively large (60-90%) percent of stream surface shaded (Sullivan et al. 1990). Increases in water temperature often occur as a result of reductions in canopy cover (Beschta et al. 1987). The intent of requiring leave trees within RMZ's (based on the shade analysis) is to minimize increases in stream temperature which result primarily from increases in short wave solar radiation (sunlight). Cooling processes, namely evaporation, conduction and convection, can also be affected by changes in canopy cover in so far as they are controlled by local vapor pressure and temperature gradients. Maintaining adequate shade levels in streams is important primarily from a biological perspective since all fish are poikilotherms (cold blooded organisms) and thus have metabolic rates which are directly affected by ambient stream temperature. Therefore, large and long-term deviations from a normal thermal regime are potentially physiologically stressful and may cause irreversible damage to such organisms (Beschta 1987).

Timber Harvest:

*Q. Will Forest Practices associated with the project have an impact on woody debris recruitment processes?*

A. The project will have an impact on these functions where current land use allows for the establishment and growth of mature trees. According to the Application No. 96-1, crossings where this situation exists include the following: #26, 27, 28, 34, 36, 36A, 37, 44, 57, 70-74, 76-78, 147, 186, 196, and 262 (page 3.4-73). For the majority of the above crossings, permanent tree removal will occur along 30 lineal feet and will result in a permanent reduction in the amount of recruitable wood the stand has historically provided to the channel. In addition, within RMZ strips to be replanted with trees, essentially the outer 15 feet of the pipeline corridor, tree removal will result in a short term loss of potentially recruitable wood.

*Q. What is the potential impact of proposed stream crossings on woody debris recruitment processes?*

A. The potential impact at each stream crossing is dependent on current and potential future stand conditions as well as local topography and dominant wood recruitment processes. As the pipeline crosses many watersheds in which there is a current lack of large conifers within RMZ's (see Riparian Assessments for a completed Watershed Analyses(DNR 1993; and Wey Co. 1996)), the harvest of trees within the 30 to 60 foot corridor will only contribute to the problem. In addition, the loss of potentially recruitable trees will be permanent given that conversion of at least a 30 foot corridor adjacent to these streams from trees (conifer and alder) to shrubs.

To assess the potential impact, stand information (tree species, size, height and number) would need to be provided for each crossing. At present, only generic statements about stand condition, namely whether they are dominated by trees or not, are provided in the application. The potential impact is greatest at crossings which are currently dominated by trees (particularly large conifers). If the information on page 3.4-73 of the application is correct, then 21 of the proposed stream crossings will likely experience some reduction in potential future wood recruitment. These crossings include the following: #26, 27, 28, 34, 36, 36A, 37, 44, 57, 70-74, 76-78, 147, 186, 196, and 262. The magnitude of the reduction cannot be determined without the information discussed above.

In addition to the site-specific impacts to tree removal, in watersheds where the pipeline crosses several current (or potential future) forested RMZ's, the potential for observing a cumulative effect to downstream resources is possible. The drainage which appears to have the greatest occurence of forested stream crossings (in close proximity to each other) is the South

Fork Snoqualmie River between pipeline crossings 70 to 78. Depending on the role of wood in stabilizing the channel bed and banks, promoting sediment storage, and transporting wood to downstream reaches, potential cumulative effects could be an increase in sediment transport to downstream (fish bearing waters) and a decrease in amount of wood delivered to downstream channels.

As recorded in Table 1 (below), stream crossings 26, 27, 28, and 34 occur within completed Watershed Administrative Units (DNR 1993; and WeyCo. 1996) and have additional rules (prescriptions) which address tree removal within the RMZ (NS-T). In each case, prescriptions do not allow harvest of trees within the channel migration zone (see NS-T). Depending on channel type and dominant tree species (to be determined in the field), RMZ's of either 70 or 100 foot are required. The objective of these prescriptions is the maintenance of woody debris recruitment processes in order to provide wood necessary for forming pools and stabilizing banks (Exhibit NS-T).

Predicting what the impacts to resources will be in other locations where trees will be removed from the RMZ cannot be made without a more complete description of channel characteristics (at the crossing location) which includes an assessment of current wood loadings within the channel and identification of primary wood functions (e.g. step formation, sediment storage, bank stability, pool scour). The removal of large trees adjacent to channels which currently have low amounts of wood may have a larger relative impact than removal of similar trees adjacent to a river with currently more adequate wood loadings, at least in the near future (see Exhibit CJC-T for details). In addition, the removal of small deciduous trees will likely have a relatively small (short-term) impact on wood in a large channel which typically requires large diameter (>24 inches in diameter) wood to be stable. Removal of small deciduous trees adjacent to smaller channels (<15 feet wide), however, could pose a greater risk to the resource since that wood has a higher potential to become stable and function in the channel.

*Q. Have any mitigation measures been identified that address these expected impacts?*

A. In my opinion, though the expected impacts of tree removal are briefly discussed on page 3.4-104, no mitigation measures were proposed which have the potential to address some of the resource concerns described above. If the information in App. No. 96-1, page 3.4-73 in correct, then the extent to which the proposed pipeline will jeopardize future wood recruitment is limited to the following crossings: #26, 27, 28, 34, 36, 36A, 37, 44, 57, 70-74, 76-78, 147, 186, 196, and 262.

Stream bank stability:

*Q. Will Forest Practices associated with the project have an impact on stream bank stability?*

A. In locations where trenching techniques are used, activities will likely result in destabilization of stream banks. As the application is proposing to trench over 150 of the streams, this project has the potential to affect a large number of streams. All proposed crossings with corresponding proposed crossing method are listed in Table 3.4-8.

*Q. What is the potential impact of proposed stream crossings on stream bank stability?*

A. In my opinion, not enough information is presented to make an informed opinion about the likely impacts. To fully evaluate the potential impact of each proposed crossing, the applicant needs to provide a detailed plan for each crossing and specific information about channel characteristics which include channel cross-sections and plan view map, as well as descriptions of bank composition and cohesion.  While App. No 96-1 does include predictions of bank stability for each crossing by means of a "hydrologic/ geomorphic sensitivity rating" (Tables 3.3-5&6), a discussion of how to interpret these ratings are not presented.  In addition, the relative values for the ratings do not appear to be supported by channel observations made in nearby streams (WeyCo. 1996; DNR 1993; and Shannon & Wilson 1991).  Three examples are discussed below:

1)  Pipeline crossing 26-27 (Tolt River).  App. No. 96-1 does not refer to any information included in the channel assessment report of the Tolt Watershed Analysis (Exhibit TB-2) or within the Shannon & Wilson (1991) (Exhibit TB-11) channel migration study.  According to the Shannon & Wilson study, this portion of the river (Reach C) experienced a channel avulsion event in 1983 which resulted in a dramatic reduction (1500 feet) in channel length through this reach.  As a result, channel erosion rates have increased dramatically, from <2 ft/year pre-1983 (1964-1977) to approximately 12 ft/year (1977-1991).  This information suggests that significant bank erosion is occurring even though the hydrologic/geomorphic sensitivity rating is 9 and 7 (out of 12), respectively.

2) According to the Tolt Channel Assessment document (Exhibit TB-2), segments 12b, 13, 15, and 17 have experienced dramatic bank erosion (and subsequent channel widening).  These segments are Type 3 waters which are approximately 50-100 feet wide, and have gradients between <1-2% and banks composed of unconsolidated cobble, gravel and sand.  Using the proposed sensitivity rating for these segments would yield a value of 6 or 7 (out of 12).  While no guidelines are presented with which to understand the rating numbers, it seems as if the rating under-predicts the stability of these banks given that the lowest rating (least sensitive) in Table

3.3-6 appears to be 5.

3) A third comparison of field observations versus predicted hydrologic/geomorphic sensitivity rating can be made at pipeline stream crossing 28 (Griffin Creek). The channel assessment conducted during watershed analysis (Exhibit TB-4) observed that approximately 40% of the stream bank exhibited active erosion, and that banks were composed of unconsolidated fine and coarse sediments and that the shallow root systems provided by shrubs did not appear to provide adequate bank protection. Like the other 2 examples, this site-specific information does not seem to be accurately characterized by the hydrologic/geomorphic sensitivity rating, which for this reach is 7.

While this is admittedly a very limited review of the issue, it strongly suggests that the ratings devised for this analysis are an inadequate substitute for field observations and the integration of external information such as exists within Exhibits TB-1 through TB-11. It is my opinion that the reliability and interpretation of the hydrologic/geomorphic ratings have not been critically evaluated and, more importantly, are potentially very misleading. It is also my opinion that EFSEC should require review and approval of the plans by a qualified specialist.

*Q. What other information exists which can be used to understand the potential impacts to stream bank stability?*

A. Watershed analyses have also been conducted in several east side watersheds, specifically Mosquito-Keechelus, Big Creek and Cabin Creek WAU's (see Exhibit NS-T for details). Included in these analyses are observations and discussions about the relative role and importance of wood and riparian vegetation in maintaining bank stability and general channel characteristics. Though it should be emphasized that this information is based on an extrapolation of field observations made in channels throught these WAU's, it is my opinion that this information is a good predictive tool which should be used to understand potential impacts for App. No. 96-1. While a crossing by crossing discussion of this data is not feasible, I will discuss observations of two different groups of channels, termed Geomorphic Map Units (GMU's) within watershed analysis, to emphasize the quality of directly relevant information which has thus far not been utilized.

GMU P1 (Keechelus-Mosquito WAU): This group of segments represent channel conditions at pipeline crossings 104, 105, and 106. The following excerpt is taken directly from Exhibit TB-3 (page 10): "GMU P1- Standing trees as well as LWD berms were observed to be important in limiting channel avulsion. Large woody debris is important in forming steps and controlling the local base level in these dynamic environments, and in scouring pools associated with steps, and in protecting banks."

GMU P2 (Keechelus-Mosquito WAU): This group of segments represent channel conditions at pipeline crossings 103, 109, 111, 113, 114, and 116. The following excerpt is taken directly from Exhibit TB-3 (page 10): "Standing mature trees were observed to be important in trapping debris torrents. Segment LMO117 [crossing 114] includes an excellent example of the role of mature coniferous forest in trapping a debris torrent." The discussion also indicates that "Buried LWD was observed to be important in limiting channel down-cutting and widening in LMO117, where new channels were being cut into older debris deposits which include LWD. As with unit P1, it is important that the extent of these fan-head areas be delineated based on field evidence for a history of debris deposition and channel shifting, and that the entire delineated unit be considered for the effects of standing forests."

*Q. Have any mitigation measures been identified that address these expected impacts?*

A. No. The application presents an incomplete investigation as to specific resource concerns and therefore an incomplete picture of expected impacts. In general, numerous potential strategies are presented in the application which could be employed in an attempt to mitigate expected impacts to stream banks (App. No. 96-1, sect. 3.4.4.3). In my opinion, however, the application does not clearly present specific mitigation measures which will be employed at each stream crossing. Some specific questions regarding mitigation measures include the following:

- How will disturbed stream banks be stabilized using native vegetation, bioengineering and engineering methods?
- When and how will in-stream deflectors and anchor logs be deployed?
- What are the criteria for determining a high velocity stream?
- What are the criteria for determining when a bank is vulnerable?
- What are the criteria for determining when to use riprap revetment?
- How will monitoring be conducted on these features and how will the long term monitoring plan evaluate effectiveness?
- How will stream bank stability be evaluated and by whom? What are the criteria which trigger a geotechnical investigation and what documentation will be provided? How will the review process of these geotechnical investigations be conducted?

The questions presented above must be answered so that EFSEC has enough information to completely evaluate the potential environmental impacts and the degree to which specific mitigation practices will prevent damage to public resources of the state.

In general, the permanent removal of trees within channel migration zones, namely the generally flat area adjoining a channel which is prone to reoccupation by the channel as a result of avulsions (sudden shifts), is likely where the greatest potential exists for environmental impacts to occur. While the maintenance of large trees with deep tree roots does not guarantee the stability of these areas through time, a more continuous network of roots may impede and restrict the area occupied and scoured during any given channel avulsion event. In addition, large conifers (alone or in larger accumulations) can promote channel stability by creating depositional sites where riparian vegetation can take hold and by deflecting flows away from erodible banks. With respect to stream crossings 26-27 (Tolt River) and 28 (Griffin Ck), locations where observations of current bank erosion and instability were made, stabilizing one section of bank (at the pipeline crossing) would not guarantee long term protection of the pipeline. Bank erosion processes up and downstream of the pipeline could potentially result in exposure of the pipeline. Resolving these issues requires site-specific investigation and analysis. In my opinion, the presence of channel migration zones have not been been adequately identified or discussed at other crossings and therefore warrant the same concern as those expressed for pipeline crossings 26, 27, and 28.

In my opinion, App. No. 96-1 suffers from a lack of specific information regarding channel characteristics at each crossing and vague mitigation strategies for preventing impacts to fish habitat and water quality. In order to ensure that significant damage to public resources is not does not occur as a result of this project, EFSEC should require that this information be provided and critically reviewed by a qualified specialist.

Shade:

*Q. Will Forest Practices associated with the project have an impact on shade retention and elevated stream temperatures?*

A. In several locations, primarily within western Washington, this project will result in impacts to trees which currently provide shade to the stream. Comparable to sites with wood recruitment potential, the following currently forested crossings have the potential to be impacted by the removal of shade trees: #'s 26, 27, 28, 34, 36, 36A, 37, 44, 57, 70-74, 76-78, 147, 186, 196, and 262. Within these forested crossings, the degree to which removal of shade within the pipeline corridor results in elevated stream temperatures is not only dependent on local stream attributes (discussed earlier in this testimony) but also upstream shade levels. At proposed stream and canal crossings where current and future vegetation within the RMZ consists of shrubs and forbs, the impact on shade will likely be relatively small and short-term.

*Q. What is the potential impact of proposed stream crossings on shade retention and increases in stream temperature?*

A. It is my opinion that the potential for proposed stream crossings to result in increases in stream temperature is very low for most of the proposed stream crossings since all but 21 of them are within RMZ's not dominated by trees which provide shade. Of course the impact could be greater if more than 21 streams are currently dominated by trees (or other tall vegetation) which currently function to provide shade to the stream.

The potential impact varies between crossings. At the currently forested Tokul Creek (34) and Yakima River (147) crossings, stream temperature criteria are already exceeded. Getting resolution to the question about the effect of shade removal on stream temperature increases at these crossings would likely require the use of a physically based stream temperature model. What is likely, however, is that the removal of trees adjacent to these already impaired channels has the potential to slightly increase stream temperatures and thereby further degrade fish habitat.

At present this issue has not been addressed within App. No. 96-1.

Other crossings which are on the Federal Clean Water Act (Section 303d) list and are presently not meeting state temperature criteria include Snoqualmie River (11 & 38), Cabin Creek (117), Big Creek (127), Wilson Creek (187), Swauk Creek (151), Cooke Creek (199) and Lower Crab Creek (244)(Table 3.3-2). At these 8 crossings, however, the application indicates that the proposal will not result in the harvest of trees which provide shade (page 3.4-104). (Actually, documentation on page 3.4-104 did not list crossings 11, 38, 117, and 187). If the information in the application (No. 96-1) is correct then the pipeline has a very low likelihood of increasing stream temperatures and no additional mitigation measures would be necessary.

With respect to crossing 28 (Griffin Creek) and 34 (Tokul Creek), shade prescriptions require leaving approximately 70% canopy cover with 100 feet of stream or not removing any shade within 70 feet of the channel (see NS-T regarding Shade prescriptions for Griffin-Tokul WAU).

*Q.* *Have any mitigation measures been identified that address these expected impacts?*

A. In my opinion, App. No. 96-1 did not consider decreases in shade created by tree removal at stream crossings to be a significant impact which would result in elevated stream temperatures. As such, it appears that no mitigation measures were identified. It is difficult to determine the appropriateness of these determinations without understanding their technical rationale. Before concluding on the appropriateness of dismissing mitigation measures related to canopy removal I recommend that EFSEC have a qualified specialist evaluate the assumptions and the data supporting these determinations.

Hydrology Questions:

*Q. Are there any unresolved questions related to hydrologic impacts and if so, why do they need to be answered prior to approval by EFSEC?*

A. In my opinion, there are a number of unanswered questions which need to be addressed. What follows is a list of questions, each followed by a brief statement as to why it needs to be explicitly addressed within the application.

1) How can EFSEC evaluate potential hydrologic impacts to the resource when specific Best Management Practices are to be negotiated (at some time in the future) with a variety of state and local agencies?.

Since explicit mitigation measures for each stream crossing are not presented, EFSEC is not able to fully evaluate what the potential impacts will be on fish habitat and public works for both individual crossings as well as cumulatively within a watershed.

2) Are potential future channel changes considered when evaluating stream crossing locations?

In my opinion, future scenarios of urbanization within the adjacent watersheds and the degree to which these land use changes will result in channel incision (down-cutting) and bank erosion at proposed crossings have not been considered. Many streams within the Puget lowlands have undergone incision and/or bed coarsening as a result of urbanization (Booth 1990) and such processes could be expected to occur to varying degrees at the following OPL stream crossings: 6, 7, 8, 9, 10a, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24 and 25. Should some of these channels begin to down-cut following installation of the pipeline, the pipeline would have a much greater risk to damage from physical processes including abrasion by moving water and sediment and falling trees.

3)  What is meant by "aggressive" slope drainage control measures during pipeline construction (as indicated in Table 2.10-1)?

In situations where erosive soils occur on steep slopes immediately above flowing water, the application indicates that aggressive drainage control measures will be used, without clearly stating what these measures are and where they will be employed.  In situations which merit these "aggressive" drainage control strategies, failing to mitigate appropriately can result in significant erosion of fine sediment into streams.  In order to evaluate the potential impacts and effectiveness of these measures EFSEC needs to understand what and where individual mitigation measures will be employed.

4)  How will they decide on the seasonal construction window?  What are the criteria with which they will use to define that window?

Clearly defining the window of time when construction will occur, and where it will occur, is important in trying to predict what the likely impacts to soil erosion and surface water will be.  Where soils are saturated and clay-rich, for instance, they are very prone to compaction when wet.  Should compaction occur, water would be more likely to flow over the top of the surface (not infiltrate into the soil), resulting in erosion and gully formation which could potentially deliver large quantities of fine sediment to surface water and important fish habitat.

5)  What are the erosion/water control structures to be utilized in the Columbia Plateau streams to deal with intense summer thunderstorms?  Are there unique design considerations?

Intense thunderstorms which deliver large volumes of rainfall to isolated areas in a short span of time do occur, particularly on the Columbia Plateau.  In the event that such a storm occurs over the pipeline during active construction, significant erosion of fine sediment could occur, particularly when activities are on slopes immediately above Typed waters.  In order to evaluate potential impacts of proposed activities to water resources, EFSEC needs to know what the specific mitigation measures will be.

6) What constitutes "low velocity" in wet trench situations (page 2.14-10)?

The application indicates that stream crossings in which "low velocities" occur will allow disturbance of the channel bed and bank without the use of a diversion barrier. In order for EFSEC to evaluate the applications assumption that streams with "low velocity" will have disturbed sediments (during construction) settle out quickly and not be routed to downstream reaches, the committee needs to know what the criteria for "low velocity" is. If OPL's assumption is incorrect and fine sediment does not settle out quickly, then downstream transport of this material might result in disturbance of important habitat lower in the drainage.

Table 1: Pipeline Crossings within Watershed Administrative Units (see NS-T).

| Pipeline Stream Crossing No. | Watershed Analysis Channel Segment No. | Watershed Analysis Geomorphic Map Unit | Large Woody Debris Causal Mechanism Report or (Prescription) | Shade Causal Mechanism Report or (Prescription) |
|---|---|---|---|---|
| Tolt Watershed Administrative Unit | | | | |
| 26 & 27 | 2 | 1b | LWD1 | ? |
| Griffin-Tokul Watershed Administrative Units | | | | |
| 28 | 3 | 3 | (S1, S5) | (RS1) |
| 29 | 20 | 3 | na | na |
| 31 | 12 | 6 | na | na |
| 32 | 113(?) | 6 | na | na |
| 34 | 101 | 1 | (S1, S5) | (RS2) |
| Mosquito Creek-Keechelus Watershed Administrative Units | | | | |
| not identified | COA12 | S4 | R9 | ? |
| not identified | COA11 | S4 | R9 | ? |
| 85 | MIL21 | S4 | R9 | ? |
| 86 | MIL4 | P4 | R6 | ? |
| 87 | MIL1 | S2 | R7 | ? |
| 88 | COL1 | P4 | R6 | ? |
| 89 | WTR17 | S5-ND | R9 | ? |
| 90 | WTR15 | S5-ND | R9 | ? |
| 91 | WTR14 | S5-ND | R9 | ? |
| 92 | WTR13 | S5-ND | R9 | ? |
| 93 | WTR11 | S5-ND | R9 | ? |
| 94 | WTR4 | S5-ND | R9 | ? |
| 95 | WTR2 | unknown | | ? |
| 96 | WTR1 | S5-TR&BR | R9 | ? |

| | | | | |
|---|---|---|---|---|
| 97 | LOS11 | P5 | R6 | ? |

Table 1 (continued):

| Pipeline Stream Crossing No. | Watershed Analysis Segment No. | Watershed Analysis Geomorphic Map Unit | Large Woody Debris Causal Mechanism Report or (Prescription) | Shade Causal Mechanism Report or (Prescription) |
|---|---|---|---|---|
| Mosquito Creek-Keechelus Watershed Administrative Units (continued) | | | | |
| 98 | LOS1 | S2 | R7 | ? |
| 99 | MEA1 | P4 | R6 | ? |
| 100 | - | | | |
| 101 | UMO104 | S3 | R8 | ? |
| 102 | UMO59 | S3 | R8 | ? |
| 103 | UMO52 | P2 | R4 | ? |
| 104 | UMO2 | P1 | R4 | ? |
| 105 | LMO97 | P1 | R4 | ? |
| 106 | LMO77 | P1 | R4 | ? |
| 107 | LMO63 | S2 | R7 | ? |
| 108 | LMO66 | unknown | | |
| 109 | LMO55 | P2 | R4 | ? |
| 110 | LMO51-52 | S5 | R9 | ? |
| 111 | LMO35 | P2 | R4 | ? |
| 112 | LMO37-38 | S5 | R9 | ? |
| 113 | LMO119 | P2 | R4 | ? |
| 114 | LMO117 | P2 | R4 | ? |
| 115 | LMO17 | S5 | R9 | ? |
| 116 | LMO16 | P2 | R4 | ? |
| Big Creek Watershed Administrative Unit | | | | |
| 127 | 2; RCU B3c | Cluster 1 | High Hazard | High Hazard |
| 129 | 29; RCU L3f | unknown | High Hazard | High Hazard |

| | | | | |
|---|---|---|---|---|
| Cabin Creek Watershed Administrative Unit | | | | |
| 117 | 1.1 | 1 | High Hazard | High Hazard |

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I certify and declare under penalty of perjury under the laws of the State of Washington that the foregoing is true and correct to the best of my knowledge and belief.

SIGNED AT Olympia, Washington on this 10th day of February, 1999.

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Todd Bohle