ATTACHMENT 2

# STATEMENT OF LAWRENCE E. HAGADORN

Before the Division of State Lands (Division) and the
Department of Land Conservation and Development (DLCD)
of the State Oregon
Regarding Proposed Administrative Rules For Granting Easements for Fiber Optic and Other Cables on State-Owned Submerged and Submersible Land Within the Territorial Sea and Tidally Influenced Waters

1. My name is Lawrence. E. Hagadorn and I live at 43 Winding Way, Stirling, New Jersey, 07980. I am 54 years old.

2. I have been asked by AT&T to provide this statement as an expert in the field of submarine cable maintenance and repair. I retired from AT&T in June of 1997, after serving for 34.5 years. During my AT&T career, I worked as a Submarine Cable Technician, Cable Landing Station Supervisor, Cable Landing Station Manager and in AT&T Headquarters as a Senior Transmission Engineer. For the final 19 years of my AT&T career I served as the Shipboard EIC (Engineer In-Charge) for 90 submarine cable repair operations, for both Analog and Fiber Optic type systems.

3. After retiring from AT&T, I accepted a position in July of 1997 with a private telecommunications firm, serving as their Marine Maintenance Manager, with duties nearly identical to my AT&T job function. I am currently employed and responsible for the planning and execution of submarine cable repairs on the world's longest fiber optic submarine cable system (greater than 27,000 km) which has landings in 15 countries between Great Britain and Japan. In this capacity I have personally planned and supervised 13 repairs, bringing my total to date to 103.

4. My life's work has been the planning and performance of submarine cable repairs. Because I have been directly responsible for this work as a shipboard engineer, I have seen with my own eyes the results of natural forces and external aggression on submarine cables of almost every type (armored and lightweight) and manufacturers variations. I have worked in all depths, between a record 6500 meters in the Mariannas Trench up

to “wading range” on Jamaican beaches. I have performed numerous repairs on both coasts of the United States (including the areas off California, Oregon and Washington), in the open Atlantic and Pacific Oceans, in the Caribbean, Mediterranean, South and East China Seas and in the Gulf of Suez. I am not aware of anyone else who has personally attended as many repair operations as I have, taking direct and complete responsibility for the planning, fault location, cable engineering, transmission testing, cable handling, shipboard supervision and final report preparation. I am familiar with the custom and practice in the submarine cable business, and my statement reflects this custom and practice.

5. Submarine cable installation and repair work, by its nature, is very expensive. The task requires the chartering of various classes of marine equipment, including specialized vessels and submersibles (ROVs , or Remotely Operated Vehicles), special tools, including splicing and recovery grapnels, and the hiring of qualified individuals to operate this equipment. Charter costs for this equipment and personnel can exceed $100,000/day. In addition to the marine equipment needed, the cable owner must provide spare cable and splice boxes (known as Universal Cable Jointing kits) that will be consumed in the repair. Typical costs for the hardware needed to make a splice average around $15,000 each, and the cable consumed runs between $11,000 to $35,000 per kilometer, depending on the type involved in the damaged area. In addition to these costs, the owner often must pay for service restoration, which is the rental charge for external transmission facilities on which to temporarily replace its failed service. Emergency restoration costs can vary widely, depending on the availability of spare facilities (i.e. satellites or other cables) and the capacity required, but the expense can easily be in the millions of dollars per occasion. Total costs for a repair will vary then, depending on the availability of a nearby ship, the depth of water at the repair sight (deeper water requires more operational time and cable), the need to unbury, and then rebury the cable, and the availability of restoration facilities. Multi-million dollar repair costs, even under the best of conditions, are not at all uncommon.

6. The actual repair plan will vary, depending primarily on the location of the fault. The simplest repairs are generally in moderate depths (1000 to 2000 meters) in the lightweight cable types. Here the cable is usually unburied, and the lightweight cable used is less expensive and easier to

handle than the armored variants. The most difficult repairs are in depths from the shoreline out to around 1000 meters. This cable is frequently buried, and is almost always armored. Here we face the difficulty of acquiring the cable from the trench, handling the heavily armored cable without causing kinks, and then the retro-burial of the cable after the repair.

7. A typical repair plan requires that the cable be cut on the bottom, because there insufficient slack in the cable to reach the surface of the water. Once cut (using a cutting grapnel or an ROV), a holding grapnel is used to bring one of the cut ends to the surface. This end is inspected for damage, which if found is cut out. Once the first recovered end is proven good by transmission testing towards the distant cable terminal, it is sealed and returned to the bottom, with a cable buoy attached to the end. A second holding drag is performed for the other side of the cut, and similar tests for damage are made. Once cleared of all faults, this second end is spliced (jointed) to a spare piece on board of sufficient length to reach back to the cable buoy. The first joint (also called the "Initial Splice") is laid in the water, and the ship sails towards the buoy while laying cable. The buoy is recovered, and the first end is once again retrieved to the surface and joined to the end of the spare piece. This "Final Splice" is laid in the water, where it is lowered to the bottom using ropes, as the ship slowly follows a track perpendicular to the original cable track. Frequently an acoustic release device is used to minimize the amount of rope that is left attached to the cable on the bottom.

8. Because two ends of the cable must reach the surface during a repair, and because the amount of pulling tension that the cable can withstand without self-destructing is limited, there must be additional cable (thus slack) introduced into the system. Typically, the "extra" slack equals at least twice the depth of water in the area where the final splice is performed, plus the amount necessary to feed through the shipboard lifting and holding machinery. Obviously, the deeper the water, the more slack is required. This factor impacts minimum separation distances between cables as described in paragraph 10.

9. If the cable was buried before the repair, and the repair has occurred because of external aggression, then logic (and frequently the maintenance contract) dictates that the cable must be reburied in order to avoid similar future damage. If at all possible in fact, the retro-burial

should be deeper than the original burial, or at least an attempt should be made to put the cable out of reach of whatever caused the original damage. This is where the greatest difficulties in cable repairs are encountered. The cable is no longer conveniently laid out in a straight line. In the case of armored cable, the extra slack at the final splice bight must be carefully laid down perpendicular to the original track in order to avoid loops and kinks in the cable in the slack area. Even though every attempt is made to lay the bight out smoothly, it is quite common to have loops present in the bight. These loops are extremely difficult to bury, especially in the presence of heavy current and low visibility.

10. It can thus be understood that repair conditions are directly related to the original installation operation. If a cable is to be repaired using typically available current technology, then certain factors must be considered during the installation lay. These factors include route separation, crossing angles, and burial depth, as discussed below.

**A. Route Separation**

The minimum distance between two parallel cables should be at least twice the depth of water. This is primarily to allow room for dragging grapnels across one cable without damaging another (which if damaged, must be repaired first before continuing with the original repair). This also allows room for deploying the final slack bight from the repair without crossing over the second cable's route.

**B. Cable Crossing Angles**

Where one cable crosses another, the crossing angle should be as near to 90 degrees as possible. In the case of shallow crossing angles, there is no room for grapnel recovery operations without possibly damaging the other cable.

**C. Burial Depth**

The cable must be buried far enough below the seabed to minimize contact by fishing equipment typically used in the area, and burial must continue out to depths that are beyond the expected fishing depths. However, if buried *too* deeply into the seabed, then recovery for repair becomes prohibitively expensive, and extremely time consuming.

Part of the problem is that in order to retrieve a buried cable, the grapnel needs to be able to *slice* through the seabed without cutting through the cable. This becomes more and more difficult with deeper burial depths, and becomes essentially infeasible using current technology below approximately 1.2 meters depth (assuming typical seabed material offshore of Oregon) as stated above. A narrow grapnel prong can penetrate the bottom deeply, but is more likely to cut the cable before it is lifted out of the trench. (Then you have to start over, not knowing whether the cable was cut or not.) A wide prong protects the cable, but in deeper, more densely packed sediments begins to act as an anchor, stopping movement or creating towing tensions so high that you don't even notice the tension increase that would indicate contact with the cable.

A related limiting factor is vessel power. The deeper the burial, the bigger the grapnel needed to recover the cable from the trench. In order to get a prong to penetrate the seabed, you need to make the grapnel heavy. To keep the grapnel from tipping over, it has to have a wide footprint. To keep it from tumbling, it has to have a long base. This escalates to the point where you need a grapnel as big as the plow that buried the cable in order to get it out of the trench. This means you need a ship powerful enough to tow a plow, just to get the cable out of the bottom. Many cable ships, especially those used to conduct repairs, aren't equipped to pull or recover plows.

11. The bottom in some areas is too hard for conventional seaplows to penetrate to a depth sufficient to protect against trawl gear. In limited circumstances rock-cutters (ROVs with cutting wheels or chain cutters in place of jetting devices) can be used. However, they are extremely slow-working and thus very expensive to use, and in addition are essentially limited to initial installations in shallow waters. They pose too much of a danger to the cable itself to be used after a repair, because they cannot accurately follow the resultant curves in the repaired cable route.

12. The seabed topography offshore Oregon includes many areas where there are ledges and cracks. In these places it is impossible to force the cable

into a trench, even if one could be dug. This unavoidably results in cable suspensions in such areas.

13. Given my experience in this area, the target depth for cable burial off the Pacific Northwest, using conventional, commercially available equipment and techniques, should be approximately 1 meter for protection from currently used trawl gear. This target depth will however be affected by the limitations described at paragraphs 11 and 12, above. In my opinion, any extraordinary measures that might be employed to consistently guarantee this measure of burial along the entire cable route will not only be prohibitively expensive during initial construction, but will also prohibit (or at least unreasonably complicate) repair efforts. It would not be unreasonable to expect the complete replacement of sections of cable that are unrecoverable.

I swear and affirm under penalties of perjury that the facts contained in this statement are, to the best of my knowledge and belief, accurate, correct and complete.

Dated: October 7, 1999

L. E. Hagadorn

Lawrence E. Hagadorn