Joy Road Area Forest and Watershed Association

3585 Joy Rd.
Occidental, CA 95465-9208
5 September 2001

Mr. William E. Snyder
Deputy Chief, Forest Practice Program
California Department of Forestry and Fire Protection
135 Ridgeway Avenue
Santa Rosa, CA 95401

Dear Mr. Snyder, Re: THP #1-01-219SON ("Fay Creek")

This letter will address the THP's deficiencies and inaccuracies as they relate to fog drip, understory vegetation, water yield, annual net precipitation, groundwater recharge, groundwater availability, and the streamflow of Fay Creek. In so doing, associated inaccuracies and omissions within the THP by RPF Scott Butler, within the PHI Engineering Geologic Review by Thomas Spittler, and within the PHI report by Kenneth Margiott and Stephen Smith will be addressed. Conflicting statements by the RPF and the consulting biologist will also be addressed. Last, the need to address the cumulative effects of the proposed THP with those of the development to follow the THP will be discussed.♦

The RPF failed to do a valid analysis of the multiple significant hydrologic effects this THP would have on this known water scarce area. Contrary to *California Forest Practice Rules*, the RPF either did not research, or chose to ignore, readily available information on severe groundwater availability problems in the area. Also, although the overall plan appears to be more like a conversion than a timber harvest, the RPF failed to assess any of the effects of future homes slated to be built on the property. (An analysis of the potential amount of forest reduction due to development and an analysis of shade canopy reduction that includes a discussion of how development would affect the outcome are covered in separate letters.) For purposes of clarity, however, no in-depth discussion of development will be covered until Sections XII and XIII below. To do so concurrent with each of the other issues above would make the individual discussions too complex.

The removal of 67% of the forest basal area within the THP boundary in this groundwater scarce region will have significant adverse hydrologic effects on understory vegetation, water yield, annual net precipitation, groundwater recharge, groundwater availability, and the streamflow of Fay Creek. These effects will not be limited to just the property in question but some will probably affect surrounding properties as well. As a significant amount of these effects will be due to fog drip reduction, I wish to begin the substantiation of my assertions with a brief discussion of the factors that influence fog drip production and how they relate to the proposed THP.

I. FOG DRIP OVERVIEW:

♦ The author holds a degree in microbiology, a minor in geology, has taken extensive courses in physics and chemistry, and is actively involved in West County forestry and groundwater issues.

Fog drip (mist precipitation) results from the coalescing of fog droplets 0.01-0.1mm in diameter on foliage from blowing fog which then produce large drops that fall to the ground as rain (Lowe, 1960; Kerfoot, 1968). Fog drip can only be effectively harvested naturally by the crowns of trees when fog blows at a level somewhat above ground level (Ingraham & Matthews, 1995).

The amount of precipitation due to fog drip from trees can be quite remarkable. Using a rain gauge, Oberlander caught 150 cm (58.8-inches) of fog precipitation under a tanbark oak on Cahill Ridge on the San Francisco Peninsula in just one rainless period of six weeks. This was more precipitation than occurred during the entire rainy season. Oberlander states: "On the crests of ridges…this summer fog precipitation is most striking…. Here a trail or road may be dusty and dry through the grassland and chaparral then suddenly bog down in mud and pools of water beneath tall trees." (Oberlander, 1956).

On coastal California's forested Bear River Ridge, Azevedo and Morgan collected 173 cm (68.1-inches) of fog precipitation in just 20 days during the summer of 1971 (Azevedo & Morgan, 1974). On the Oregon coast, Isaac measured 26% greater total (annual) net precipitation under the forest canopy than in clearings (Isaac, 1946). Aravena discovered a relationship between fog drip and the ephemeral greening of northern Peru (Aravena, *et al.*, 1989). Independent studies by Loewe (1960) and Kerfoot (1968) analyzing fog precipitation measurements at many places around the world during the last century concluded that, although quantities varied widely, fog drip precipitation was a significant source of water in some areas.

Fog drip has been determined to be an important source of water for California coast redwoods (Byers, 1953). In addition to the root absorption route, fog drip can transpire directly through redwood foliage. It has been suggested that fog traveling from the sea to the coastal ranges of Ecuador may be one of the most important environmental factors determining the distribution of tropical montane rain forests (Grubb & Whitmore, 1966).

II. ANALYSIS OF FACTORS INFLUENCING FOG DRIP PRODUCTION AND THEIR RELEVANCE TO THE PROPOSED THP:

Fog drip is dependant on foliage on which to collect (Ingerwersen, 1985). Fog drip production is related to fog duration, the type and density of the collecting vegetation, and is directly proportional to the surface area of foliage the fog comes in contact with (Ingraham & Matthews, 1988; Harr, 1982). Redwood trees have one of the highest ratios of foliage surface area per unit volume of any tree species. Its shape—needles—produces more fog drip than do broadleaf species. By comparison, brush and grasses produce very little fog drip (Oberlander, 1956). With respect to the proposed THP, the main factor that will most directly affect fog drip production will be the reduction in aggregate foliage of the overstory canopy due to the harvest. The main additional factors will be collateral damage and the stated development of the property.

Surface area of foliage reduction: Although not an exact relationship, overall, a 67% reduction in total basal area will result in an approximately 67% reduction in aggregate foliage provided that the pre and post harvest specie ratios remain constant. As foliage

volume is directly proportional to foliage surface area for each tree species, a reduction in volume of 67% for any one species will result in a reduction in surface area of also approximately 67% for that same species. Since one intent of the THP is that the pre and ratio post harvest ratios of redwoods to hardwoods remain unchanged, with a 67% basal area cut, the aggregate foliage surface area reduction for the entire stand will be approximately 67%. The fact that redwoods have a greater foliage surface area to unit volume ratio than do the other species will not be a factor in determining the amount of foliage surface area reduction. (The different species would only be a factor if the pre and post harvest ratios were different. There is a possibility that this might happen to a certain degree, as explained in Section IV, item 3 below.) Consequently, all other factors remaining equal, the removal of 67% of the basal area will reduce the total foliage *surface area* by approximately 67%. Since the amount of foliage surface area intercepted by fog is directly proportional to fog drip production, all other factors remaining equal, fog drip production will be reduced by approximately 67%.

Collateral damage: With a 67% basal area harvest in a relatively dense stand like the proposed THP area, there will be further foliage reduction, and consequent proportional foliage surface area reduction, due to collateral damage. In the process of felling, skidding, and the use of heavy equipment in a relatively dense stand such as this, brush, tree limbs and possibly whole trees that were intended for retention may well inadvertently be destroyed. The damage from these sources will result in further reduction of the remaining foliage surface area (although the brush component will not be relevant from the standpoint of fog drip) and result in yet additional fog drip reduction.

Development: The stated post THP development of at least two homesites, coupled with associated conversions, roads, turnarounds, and leach fields will have a substantial permanent impact on the trees that survive the THP. A separate companion letter addresses the total amount of forest reduction possible for various development scenarios. **That letter concludes that the aggregate amount of potential forest depletion can range up to 75+ to 82+%.** It follows that fog drop production would therefore decline by a similar amount. For purposed of this discussion, however, I will not factor development into the equation. It is mentioned here for purposes of completeness and as something that, in the final analysis, must be dealt with.

Therefore, with a 67% basal area harvest, as a consequence of total foliage surface area reduction, including that due to collateral damage, but **excluding development, fog drip production will be reduced by an indeterminate amount that will exceed 67%.**

III. FOG DRIP PRODUCTION WITHIN THE VICINITY OF THE PROPOSED THP:

The amount of fog precipitation in the vicinity of the THP is impressive. On 26 July, the day of the PHI, the fog did not clear until around 1300. That morning, newspaper placed under redwoods around 0930 in the vicinity of the pond in the THP became 100% covered in fog precipitation in less than 3.5 minutes. For the previous two days, the fog never cleared. Letters submitted (and now resubmitted) by Marie Toscano, Janice Dent, and Jeannette Grant, among others, to the prior THP (# 1-99-296SON. “Togneri”) further attest to the abundance of fog drip and its importance to this area.

In the THP vicinity, the redwoods that lie to the immediate east and west of the ridge-top that Joy Rd. follows constitute the first major obstacle to advancing costal fog. To the southwest of the THP area, along Taylor Lane, the land has been cleared by past timber harvests, and it is now primarily relegated to vineyards and residential use. To the west, the land slopes downward toward Fay Creek and, further to the west at much lower elevations, are open prairie lands that extend to the coast and are punctuated by stands of oak, fir, and other species. Please see Photos 9-14 for views of the THP area from the road leading to the Strieter property to the north, looking over this saddle area. Photos 9, 12, and 13 show the degree of fog looking south toward the THP area around 0900 on 27 July 2001. Photo 14 shows the same view at 1230 that same day. Photos 1-8 and 10 show fog between 0750 and 0850 in the THP area on 27 July from other neighbors' vantage points followed by photos taken from the same locations around noon (after the fog had almost cleared). Photo 11 shows the degree of fog in the THP area around 0840 on 26 July—the day of the PHI.

It is understandable why some of the largest redwoods within the THP boundary are found around the pond at the southwest corner of the property. The forest was cleared to the immediate west and southwest of this pond many years ago, making this area one of the first impact points of coastal fog. The THP area ranges in elevation from approximately 760-920+-ft. (close to the area peak) and the stand is almost 100-years old (ample foliage). People familiar with the area state that it virtually rains under these trees on foggy days. The fog itself promotes growth. Research by Oberlander concluded that seedlings of Douglas fir, Monterey cypress, and eucalyptus appeared to be encouraged beneath fog drip-producing trees (Oberlander, 1956). Further, Azevedo & Morgan discussed the importance of fog drip nutrients to the ecosystem and concluded: "The nutrient contribution from fog to the ecosystem may be at least as significant as that from rain." (Azevedo & Morgan, 1974.)

IV. INACURATE, FALSE, AND MISLEADING STATEMENTS WITHIN THE THP, THE GEOLOGIC REVIEW BY MINES AND GEOLOGY, AND THE PHI REPORT:

1. Mr. Butler states: "While there may be a slight reduction in fog drip (water input) as a result of this operation, it is not expected to be significant." (THP, p.41.) I request that Mr. Butler produce the analysis and data used to support his statement. In reality, this THP will remove, in aggregate, 67% of the stand's entire basal area without changing the pre and post harvest species ratios, thereby resulting in a loss of approximately 67% of foliage surface area of the entire stand. As shown above, this, coupled with collateral damage, will result in **a reduction in fog drip of over 67%.** This is not a "slight reduction." As defined in Section 895.1 of the *California Forest Practice Rules*, "significant adverse impact" means: "a substantial or potentially substantial, adverse change in any physical condition within the area affected by the project including land, air, water,… flora…" A 67+% reduction in fog drip in this water scarce area would be a very significant adverse impact, and it has yet to be addressed, assessed, or mitigated by Mr. Butler.

2. Mr. Spittler states: "The proposed timber harvesting will somewhat reduce interception, evaporation and transpiration of precipitation, and may reduce fog drip, but because the larger trees on the upper slopes are retained, reduction in fog drip is

anticipated to be very minor." (PHI Engineering Geologic Review, p. 3.) This statement is incorrect.

With respect to aggregate fog drip production, the size of the individual trees to be cut as well as their location within *this* THP is not too important. There are also not many instances of slopes facing away from (i.e., to the East of) the prevailing direction of approaching fog and rain. More important are the overall surface area of foliage (especially from the crowns of trees) within the entire THP boundary and the degree of fog interception. Although large redwoods will capture more fog than smaller redwoods in roughly the same location, the relevant facts are that a 67% basal removal of the stand is proposed and that the pre and post species ratios will remain unchanged. Therefore, with respect to fog drip production, the taking of one large redwood is equivalent to the taking of more than one smaller redwood in a similar location that, in aggregate, makes up roughly the same basal area.

For example, the removal of one redwood 3-ft. DBH (28.27 sq. ft.) is the basal equivalent of the removal of 2.25 redwoods at 2-ft. DBH (12.57 sq. ft.). All other factors remaining equal, the aggregate foliage mass of the smaller trees will, in general, roughly equal the foliage mass of the larger tree.

One other factor that may come into play is height. In the current situation, however, the height difference of, say, the 3-ft. DBH tree vs. the 2-ft. DBH tree in the same location within the proposed THP will not be an important factor due to the small height difference between the two trees relative to their elevation above sea level. For example, at an 880-ft. elevation within the THP, a 3-ft. DBH redwood with a height of 200-ft. will be only 6.5% higher in elevation than a 2-DBH redwood with a height of 130-ft. (1,080-ft. vs. 1,010-ft.) More important is that each tree **intercept** the fog—that each tree resides within the stratus cloud layer commonly referred to as "fog" (Ingraham & Matthews, 1988, Azevedo & Morgan, 1974, Byers, 1953). At virtually every location within the THP, and regardless of the tree's height, this interception would occur at or close to costal fog's maximum effect (Byers, 1953).

Research by Ingraham and Matthews on the Point Reyes Peninsula further supports the above statements. Collection of fog drip under identical conditions over a four-year period at three sites (the Point Reyes Lighthouse, Pierce Ranch, and Vision Peak) showed that, by far, the highest volume of fog drip was obtained at Vision Peak—the most inland, and highest, site. The lowest volume was recorded at the lighthouse (Ingraham & Matthews, 1995). Fog, or more correctly the stratus cloud layer that is considered as fog along the California coast, is generally not found below 300 feet and is **most commonly seen at elevations of 800 to 1,200 feet** in California's coastal valley areas (Byers, 1953). The heights of all the trees within the THP lie within this zone.

Consequently, because the more important factors in this analysis are the aggregate volume of foliage surface area removal (over 67%), and the subsequent aggregate reduction in fog interception (also over 67%), Mr. Spittler's statement that fog drip reduction is anticipated to be "very minor" is incorrect. To repeat: fog drip production will be reduced by over 67% within the THP area.

3. There is a discrepancy concerning the composition of the stand. Mr. Butler states the stand as being 88% redwoods and 12% hardwoods (THP, p.7) while Consultant Biologist Theodore Wooster states: "I estimate 95% redwood, occasional fir and 5% hardwoods in groups or single tan oak or madrone." (THP, p. 56.50.) The higher percentage of redwoods cited by the biologist would, if closer approximating reality, even further add to aggregate fog drip production (since redwoods have a higher surface area per unit volume than do hardwoods). Also, if the biologist's estimate is more accurate, leaving the post harvest only 88% redwoods would alter the pre and post harvest ratios mentioned earlier and result in yet further fog drip reduction beyond 67%.

4. In their Preharvest Inspection Report, Kenneth Margiott and Stephen Smith state: "The weather was cool and overcast and visibility was good." (PHI report, p.1.) In reality, the weather most of that day had very poor visibility due to heavy fog that lasted until about 1300. "Overcast" is not the same as "foggy." There were no higher clouds than the fog layer. After the fog dissipated, the skies were clear and sunny, and visibility *then* became good. See photograph 11 for a picture of the THP area around 0840 on the day of the PHI. Cherie Blatt represented the California Regional Water Quality Control Board on this PHI. Ms. Blatt informed me that the PHI team arrived on the site around 0930 and stayed until around 1330. The first paragraph of her Water Quality report ends: "The weather was cool and **foggy**."

5. Mr. Butler states: "No significant decrease in water yeild (sic) is expected from a decrease in fog drip." (THP, p. 41.) Mr. Spittler states: "Based on studies by the USDA Forest Service at Caspar Creek in Mendocino County, selective harvesting will probably result in a minor increase in summer flows and total water yield (Keppeler, 1998), and moisture savings due to reduced evapotranspiration which will override any fog precipitation losses." (PHI Engineering Geologic Review, p.3.) I will discuss these often-cited, out of context, inaccurate, false, and misleading statements frequently propounded by the timber industry in the below topic.

V. RELATIONSHIP OF FOG DRIP AND TIMBER HARVESTS TO WATER YIELD, TOTAL (ANNUAL) NET PRECIPITATION, AND EVAPOTRANSPIRATION:

Mr. Spittler states that, per the conclusions of Keppeler's study, this THP will probably result in a minor increase in summer flows and total water yield. This is inaccurate, misleading, and taken out of context. In her report, what Keppeler actually stated was: "At Caspar Creek, 90% of the flow (annual water yield) increase was realized during the rainy high-flow season. Water demand is usually greatest during the low-flow periods in the summer. In addition, that portion of the flow increase that occurred during the low-flow season **diminished rapidly** in the years following logging. **Beyond 5 years after the completion of logging, no significant flow increases were detected, and a possible decline in summer flows relative to prelogging levels was noted.**" (Keppeler and Zeimer, 1990.) The selective cuts at Caspar Creek ranged from 59% to 69% "stand volume." This is similar to what is proposed for this THP, but the elevation of the Caspar Creek area ranged from 37-320m—generally lower than that for this THP. Although fog was noted at Caspar Creek, the elevation was not as optimal for fog interception as that of the proposed THP. If anything, fog drip would probably be a slightly more significant factor in the current situation. With the same "stand volume" removal as at Caspar Creek, the reduction in fog precipitation for the proposed THP should therefore be equal to or

greater than the percent reduction recorded at Caspar Creek. In the long term, then, a **decline** in crucial summer streamflow into Fay Creek from the THP watercourses is to be expected. (It is important to remember that water yield is synonymous with streamflow, not net precipitation.)

In this same report, Keppeler discussed the many variables and factors that needed to be taken into consideration when determining how to evaluate the effects of selective harvesting on water yield. The single factor that she spent the most time addressing was that of fog drip. Under the heading of "Fog Interception Process," she states: "**by the elimination of fog drip through the removal of forest vegetation, anticipated enhancement of summer flows may not occur in areas where fog occurrence is a frequent source of significant moisture."** (Keppeler and Ziemer, 1990.)

Dennis Harr proved that, in fog-prone environments, **total annual net precipitation (i.e., precipitation plus fog drip minus interception loss) would likely decrease following logging**. The interception of wind blown fog is an important source of moisture in the Fox Creek Watersheds Harr extensively studied in the Cascade Range in Western Oregon. **Subsequent removal of vegetation via a patch-cut logging of just 25% of one Fox Creek watershed reduced the annual net precipitation at the soil surface by up to 30% compared to prelogging levels**. This was due to reduced fog interception. (Harr, 1982.)

Harr conservatively estimated that **net precipitation under the forest in the winter at Fox Creek was 17% more than for clearcut areas**. This relative difference **increased to 44%** in the late spring and summer periods. For the 1980 water year, **fog drip not only offset rainfall intercepted and evaporated by the forest. It also provided an additional 498mm (19.7-in.) of water to the forest soil surface.** (Harr, 1982.)

Harr then used his findings and calculations to explain a number of stream flow anomalies in earlier studies by himself and others. One of the problems with these studies was the measurement of annual precipitation via rain gauges set in *clearings*. "Standard rain gauges installed in open areas where fog is common may be collecting up to 30 percent less precipitation than would be collected in the forest." (Harr, 1982.) Using throughfall relationships developed by Rothacher from interception studies in an old growth Douglas fir forest where fog was *not* prevalent, Harr was able to account for the difference between both the measured and predicted net precipitation following clearcuts and the net precipitation in fog prone forests prior to cutting as being due to fog drip. (Rothhacher, 1963; Harr, 1982.) When Harr factored in the estimate of fog drip's contribution to annual precipitation for the study areas in question, **water yields for post harvest clearcut areas dropped substantially** and fell in line with those of other studies. These **studies that showed an increase in water yield following logging in fog prone forests had therefore made an experimental procedural error in rain gauge placement.**

In 1980, Harr reported decreases in annual water yield in small watersheds after logging in clearcut patches totaling just 25% of the watershed area instead of the 3.9-5.9-in. increases suggested by other studies. (Harr, 1980.) Harr deduced that **the expected increases that should have resulted from reduced evapotranspiration were more than offset by reduced fog interception and consequent fog drip reduction.** The

same argument was used to explain the decrease in summer stream flow following logging in fog prone areas. **Elimination of fog drip in clearcut areas more than offset any increases in summer stream flow that would have resulted from reduced transpiration from trees.**

In contrast, Hicks, *et. al*. monitored long-term changes in summer seasonal water yield at three adjacent watersheds in the H. J. Andrews Experimental Forest in the Cascade Range of Oregon. **In this region, fog is <u>not</u> a factor**, and the vast majority of precipitation falls as rain. The researchers specifically mentioned the climatic differences in the Fox Creek studies. For the H.J. Andrews study, the middle watershed was left untouched as a control while the watersheds on either side were logged between 1962 and 1966 (one clearcut and one 25% patch cut). Hydrologic data spanned 36 years, which included about 10 years of prelogging calibration. In this case, annual water yield increased substantially in both logged watersheds immediately post logging (although most of the increase occurred from October to March when water is typically not in short supply). However, only the **annual** water yield in the clearcut watershed remained substantially elevated over the years. Even with the lack of fog precipitation in this region, by 1979, annual water yield from the 25% patch cut dropped to a level not significantly different than prelogging levels. Also, for the clearcut watershed, the period of increased summer yield was short—lasting only eight years. **For the subsequent 19 years prior to their 1991 report, the critical summer yield in this watershed was <u>lower</u> than for the control**. The researchers believe that it may take several more decades before conifer growth will be able to return water yield to prelogging levels. (Hicks*, et. al.,* 1991.)

In summary, in fog prone coastal forest areas, fog drip can be expected to result in <u>increased</u> annual and summer water yields, <u>increased</u> annual net precipitation, and <u>will more than offset losses</u> from both the evaporation and evapotranspiration of vegetation. The above scientific evidence shows that Mr. Butler and Mr. Spittler argued with misinformation in assessing this THP's hydrologic effects.

Since Fay Creek is a tributary of Salmon Creek, summer water yield, and hence fog drip, is important to the endangered anadromous fish populations in the lower Salmon Creek area. In the THP area, however, the importance of winter and spring water yield is not as important as is **groundwater recharge**. The vegetation and duff on the forest floor help retain water and prevent excessive runoff in the rainy season. This promotes water recharge of the aquifer and fissures within the Franciscan Formation (discussed below). The removal of trees will desiccate understory plants that derive approximately 66% of their water supply from redwood fog drip during the crucial summer months (Dawson, 1998). The use of heavy equipment, logging trucks, and future vehicular traffic from the proposed homes will compact the soil, resulting in reduced infiltration capacity, increased bulk density, and a conversion of soil macropores to micropores. (Keppeler and Ziemer, 1990.) All these factors serve to reduce soil permeability and promote runoff, erosion, and siltation of Fay Creek during the rainy season instead of allowing rain and fog drip water to percolate into, and thereby recharge, the local aquifer and fissures.

Sonoma County acknowledged this relationship over 27-years ago. In 1974, the Sonoma County Planning Department published the Joy Road Study (copy attached). Under the topic of "Water Availability," it states: "Also, were more development to take place, trees logged, and soil and vegetative cover disturbed, **there would be less groundwater**

recharge due to runoff into creeks rather than absorption into the ground." (Joy Road Study, p.9). Other factors remaining constant, water yield is inversely proportional to groundwater recharge.

In conclusion, in the geographical location of this THP, with its abundance of summer fog and current fog drip, **one can expect a <u>decrease</u> in the critically important summer yield** (especially in the long term), **<u>decrease</u> in winter yield, <u>decrease</u> in annual net precipitation, and <u>reduced groundwater recharge</u> following the proposed THP**. This is what current science dictates. The burden of proof lies with the RPF and/or the landowner to scientifically prove how any of these effects would be otherwise.

VI. RELATIONSHIP OF FOG DRIP TO UNDERSTORY VEGETATION:

Redwoods significantly influence the magnitude of water input to the plants below their canopy. A 3-year analysis of fog drip input into plants in fog-inundated forests in Northern California showed that **34% of their total annual hydrologic input was from fog drip from redwood trees**. In the absence of trees, this figure dropped to17%, demonstrating that redwoods significantly influence the magnitude of fog drip water input into the ecosystem. In the summer, approximately 19% of the water within redwoods and **approximately 66% of the water within the understory plants came from fog precipitation from overstory redwoods**. For all plants studied, there was a **significant reliance** on fog drip as a water source (Dawson, 1998).

With respect to the proposed THP, the removal of 67% of the basal area of redwoods that comprise 88% of the trees in the THP area, coupled with **further reductions due to development** (i.e., clearings for homes, roads, turnarounds, and leach fields) should **result in <u>depletion of over 44% of the total water supply to these plants</u> during the crucial summer months** (67+% removal of 66% of the water supply).

CDF asks "Will the proposed project, as presented, in combination with past, present, and reasonably foreseeable, probable, future projects…have a reasonable potential to cause or add to significant cumulative impacts in any of the following resources? 3. Biological" Mr. Butler checked off "No, after mitigation." (THP, p.37.) Yet, the increased exposure of understory plants due to an approximately 67+% shade canopy reduction coupled with a reduction of over 44% of the total water supply to these understory plants in the summer months, although constituting a significant adverse impact, has **not** been mitigated. The RPF and/or landowner must explain what will be done to prevent the desiccation of the understory plants.

VII. RELATIONSHIP OF FOG DRIP TO GROUNDWATER RECHARGE:

Analysis of stable isotopes of hydrogen and oxygen appears to be the best tool currently available to trace fog water movement through the hydrosphere and below the earth's surface. Fog water is considerably more isotope enriched than is rain. Fog water has a considerably higher proportion of the deuterium isotope ("heavy hydrogen") of hydrogen and a considerably higher proportion of ^{18}O (an oxygen isotope with an atomic weight of 18) than does rain. Via mass spectrometer analysis of these hydrogen and oxygen isotopes (in the form of H_2 and CO_2) from rain, fog drip, and groundwater samples, it is possible to determine the percentage of groundwater due to fog drip and the percentage

due to rain. Analyses using this technique in Kenya, Point Reyes Peninsula, and Northern California coastal forests showed fog drip to be a major component of the groundwater samples studied. **Fog water has been proven to be a substantial source of groundwater recharge in areas of substantial mist precipitation.** (Ingraham & Matthews, 1988; Ingraham & Matthews, 1995, Dawson, 1998.)

On the Point Reyes Peninsula, groundwater samples from each of five different locations were each found to have a substantial fog drip constituent that showed little isotopic variation despite substantially different volumes of fog drip collected in these same areas. That study concluded that: "If all of the observed differences in stable isotopic ratios between precipitation and ground water were attributed to fog-drip recharge, **up to 25% of the ground water would be derived from fog water. Ground water recharge of this large a quantity of fog-drip water may have occurred under more vegetation, before any land use changes on the peninsula involved the clearing of trees for agricultural purposes**." (Ingraham and Matthews, 1990; Ingraham & Matthews, 1995.)

Oberlander surmised that fog precipitation played a prominent role in maintaining groundwater levels on Cahill Ridge on the San Francisco Peninsula (Oberlander, 1956).

Considering the large amount of fog drip production currently in the THP area**, the large reduction in fog drip due to the THP will result in substantially reduced groundwater recharge**. **Soil compaction** caused by the THP logging operations and road and landing construction, coupled with the **development to follow**, will further compromise groundwater recharge. The effects of reduced groundwater recharge have not been, and must be, addressed in the THP.

VIII. GROUNDWATER SCARCITY IN THE VICINITY OF THE THP:

Groundwater is very scarce in the THP area, and it is primarily confined to one local self-contained aquifer. There are at least six properties in the immediate surrounding that have no natural water source. **There are at least 22 properties within 3,000-ft. of the proposed THP that are experiencing substantial decreases in well production and/or water quality due to overdevelopment**. (See attached "Map: Groundwater Problems in the Joy Road Area-- Vicinity of Joy Road and Taylor Lane." and companion "Joy Road Area Water Quantity and Quality Problems" well information spreadsheet. **Neither this map nor the well information is a complete picture**. These are just the problem properties that the map compilers know about. The map compilers have asked/been told about the groundwater situation on less than half the parcels in the area shown. This map reproduction is part of a larger map covering approximately six times the area of the one submitted.)

At a county Project Review and Advisory Committee (PRAC) lot line adjustment (LLA) hearing at the Permit Resource and Management Department (PRMD) **on this very property** on 13 April 2000, about **28 local residents gave testimony on groundwater problems** in this area. They expressed concern for both themselves and for future homeowners on the THP site running out of water. This hearing is available on videotape. (See attached 10 letters on water scarcity and well production submitted at this April 2000 hearing, including the mailing by the Joy Road Neighborhood Association of June 2000 entitled "Groundwater Stewardship for Rural Residents." See the 7 pages of

handwritten notes taken by PRMD staff at this hearing and a PRAC member's interdepartmental memo on the hearing to Nancy Lingafeldt.)

All the aforementioned material (except for the water scarcity maps) was readily available at PRMD for the RPF to review. All Mr. Butler had to do was to check the file on the THP property at the PRMD Self Help desk. All he needed was either a street address or the assessor's parcel number to do so. Per *California Forest Practice Rules* Board of Forestry Technical Rule Addendum No. 2: Cumulative Impact Assessment: "This assessment **shall include evaluation of both on-site and off-site interactions of proposed activities (which may not be significant when considered alone) with impacts of past and reasonably foreseeable future projects…The RPF preparing a THP shall conduct an assessment based on information that is reasonably available before submission of the THP**…Common sources for cumulative effects assessment are identified below…1. Consultation with Experts and Organizations. **(a) County Planning Department."**

Even though this was the first source listed, and the property file is readily available to anyone, Mr. Butler either did not check the property file or decided to ignore the voluminous water scarcity information within it. The landowner just bought the property in April and knew, or should have known, about all this as well. Earlier this year, I personally spoke with Randy Rousseau, the listing agent for this property. Mr. Rousseau was familiar with the PRMD file and the water scarcity situation/testimony. **Why was the property file not checked or why were the contents ignored?**

The reasons for groundwater scarcity in this area are explained below.

IX. GEOLOGY AND HYDROLOGY OF THE THP AREA:

A simplified geologic and hydrologic picture of this area was described by the Sonoma County Planning Department in the Joy Road Study. (Joy Road Study, pp.7-9B.) In this area of West Sonoma County, a vast, virtually impermeable, ancient Franciscan Formation has been scalloped into bowl-shaped depressions along the ridges in the Joy Road area. Sitting as "caps" atop these bowl-shaped depressions lies the relatively porous Wilson Grove Formation (formerly called the Merced Formation). One of the three main "caps" of Wilson Grove in the Joy Road area encompasses the intersection of Joy Rd. and Taylor Lane and roughly extends to the South, West, and East from that point. (See attached 1975 geologic map of Joy Rd./Taylor Lane area by State Department of Water Resources. The Wilson Grove Formation is shown in red and labeled as "Tm" (Tertiary marine). The Franciscan Formation is shown in aquamarine and labeled "JK.")

The Wilson Grove Formation is a good source of groundwater due to its generally good permeability. Simplistically speaking, rain and fog drip percolate through this formation and are stopped upon contact with the Franciscan Formation. Groundwater is therefore contained in and relegated to the Wilson Grove within these Franciscan "bowls." The only other sources of groundwater in the area lie in elusive fracture joints within the Franciscan Formation. Occasionally, one will also find a "pocket" of water trapped within the Franciscan Formation, but such sources of groundwater are invariably short lived, as the rate of recharge is usually very slow relative to typical residential and/or agricultural demand.

Springs flow from the junction of the Wilson Grove and Franciscan whenever the groundwater table rises above the "brim" of the Franciscan bowls. In the past fifteen years, two springs less than 150-ft. from the proposed THP area have gone permanently dry—one on Linda Cupp's property at 3240 Joy Rd. and one on Ninfa Hall's property at 3286 Joy Rd. (Mrs. Cupp's spring was a year round source of groundwater as recently as about1984-1985. Her ancestors used it as a dependable water source since the 1880's.) Mrs. Cupp has had to since drill a well and install a water storage tank.

X. PARCELIZATION, AND HOW IT HAS CONTRIBUTED TO GROUNDWATER DEPLETION:

At the time the 1974 Joy Road Study was published, the average parcel size in the study area was 16.1 acres. Just seven years prior to the study, the average parcel size was 36.4 acres. The most current tax assessor's parcel map for the area that includes the proposed THP parcels (1996) shows that only five of the 50 parcels mapped are of the minimum 10-acre size or larger. In other words, **90% of the parcels in the vicinity of the proposed THP are now less than the 10-acre minimum stipulated in the Sonoma County General Plan**. This parcelization/development cycle has made groundwater an increasingly scarce resource in this area.

The State Water Resources Board did a pilot groundwater study in the Joy Road/Taylor Lane/Joy Woods subdivision areas prior to the Joy Road Study. The study referenced the Water Resources Board's findings, which concluded **"…water consumption had reached its maximum and perhaps surpassed it in relation to water recharge."** The Joy Road Study then went on to conclude: "Thus, **the impact of increased parcelization into small lots would irreparably damage the life support capacity of this area's groundwater reserves."** (Joy Road Study, p.9.) Despite such dire warnings by the Sonoma County Planning Department, development of this area continued unabated. Indeed, even the 12.89-acre THP area was split from one parcel into three via Certificates of Compliance in 1999 despite this 10-acre minimum requirement.

XI. WELL DRILLING IN THE JOY ROAD AREA:

Due to increased parcelization/development in the Joy Road area, coupled with a finite groundwater resource, there has been a frenzy of well drilling activity. People who have no water have tried multiple times to drill for it. People whose wells or springs have dried up drill yet more holes in search of a new water source. Newly created parcels require new wells that must yield the prerequisite 1gpm well production needed for development. If one well cannot yield 1 gpm, the County has permitted the drilling and interconnection of multiple wells on the same parcel (well systems) to obtain the precious 1 gpm minimum needed for development. Many of these newly drilled marginal wells and substandard well systems are destined to fail. (By comparison, at the time of the Joy Road Study, the suggested minimum well production standard for both the State and County Health Departments was **5** gpm for a two-hour sustained yield (Joy Road Study)). There is a definite major problem that may result from this intense well-drilling activity—the inadvertent draining of the local Wilson Grove aquifer into the Franciscan Formation. Registered professional geologist and hydrologist Dr. Robert Curry states: "By punching wells through the Merced and into the Franciscan, especially where a sandy pocket is

intersected in the Franciscan, one can inadvertently drain the overlying Merced." (Dr. Curry believes that there is a distinct possibility that this happened in 1990 at the Frank Meyers property on Bones Lane.) (Curry, 1994.) The additional groundwater demand that would result from the development of the THP area, coupled with reduced groundwater recharge due to effects of the THP and the creation of new homesites, will intensify local well drilling and increase the likelihood of this drainage scenario occurring.

Nowhere in the THP does the RPF discuss the effects of the development to follow on this area's already overtaxed groundwater supply.

XII. THE NEED TO CONSIDER THE PROPOSED THP AND HOUSING DEVELOPMENT AS ONE PROJECT EIR:

Due to the recent "lot split" created by the above mentioned Certificates of Compliance, the known development to take place following the proposed THP, and the documented serious groundwater crisis in the area, CDF, as the lead agency, must follow *CEQA Guidelines* Sec.15165 (Multiple and Phased Projects) and analyze the impacts of the proposed development in conjunction with the impacts of the THP itself. Contrary to what Mr. Butler states, there will indeed be substantial adverse environmental impacts. Most of the impacts will also be permanent.

(I request that CDF and Mr. Butler refer to my separate letter of 3 September that addresses just the cumulative effects of THP tree reduction combined with the additional tree reduction that would result from planned future development. To do so here would be to get off on a tangent to the subject at hand, but the analysis of development impacts on just this one issue, trees, yielded startling results.)

Under "Proposed Future Projects" on p.36, Mr. Butler states: **"It is the desire of the landowner to build a home on two of the parcels…The propose** (sic) **landing locations planned for this THP could be used as future building sites."** He then follows this by stating: **"It is also recognized that a less that three acre conversion application may be required in order to address requirements of county and state regulations as it relates to building permits. This may include excavation required for building sites, leach fields, and turn a round's** (sic) **for vehicles."** Mr. Butler hints at one conversion by using the singular, but he uses the plural for "landing location**s"**, "building permit**s,**" "building site**s**," "leach field**s**," and "turn a round'**s**." At least **two** conversions would be needed for what is already admitted herein to accommodate the minimal desires of the landowner at this time.

Contrary to what Mr. Butler and the landowner would like CDF and others to believe, this "line of thought" cited by Mr. Butler is not just "conjecture." Under "Sale of Property" Mr. Butler again clearly states: "The intent is to harvest trees and build a residence for long term ownership…"(THP, p.22). Under "Retain the property in its present condition," Mr. Butler states: "The long term value of the property would be reduced due to the lack of cash flow from the sale of timber, lack of access that would result from the harvest and loss of the residence for the landowner." (THP, p. 23.)

It is confusing and misleading that Mr. Butler uses "residence" here in the singular but later refers to "home site**s**" in the plural and further states: "The propose (sic) landing locations planned for this THP could be used as future building site**s**." And: "It is the desire of the landowner **to build a home on two of the parcels**." One must take the landowner's expressed desire in the preceding sentences as statements of actual intent (and assume a typo error was made that should have read "residence**s**") and therefore treat the building of two home**s**, leach field**s**, etc. as what will indeed follow the THP. It is not merely "conjecture" as Mr. Butler would have you believe. This is further supported by the following:

1.) It is established that there are three lots within the THP area.
2.) The well production on one of the parcels was measured in August 2000 as approximately 2.1 gpm, now legally sufficient for two homes.
3.) Percolation tests were done throughout the property last December, with a report stating that there is adequate septic for at least two homes and possibly three.

Are CDF and the public to believe that all these steps/tests were possibly done for nothing? Yet Mr. Butler states: "*If* the landowner can meet these criteria…[for building]. " This, in itself, is misleading. As shown above, all the criteria have apparently already been met for the development of at least two homes. All the foregoing information is readily available in the property file at PRMD and should have been known to Mr. Butler. This property was listed for $650,000 and advertised as having a "potential lot split." Who would buy such a property just for the purposes of a THP? The property price was set at an amount that reflected its development potential.

In Leslie Markham's 28 June letter to Mr. Butler, she listed 34 items that required more information or corrections. Item #33 asks: "Please disclose in greater detail the proposed housing sites for the property under the Alternatives discussion and under 'Proposed Future Projects,' ref. page 36. Include in your discussion the potential for impacts as a result of these future projects, so cumulative impacts can be more fully evaluated." Mr. Butler's reply on 2 July does not answer Ms. Markham's question on potential for impacts at all. Mr. Butler simply states: **"Future activity may have potential to add additional impacts. These additional impacts will be addressed <u>at that time</u>."** Ms. Markham specifically states that **CDF wished to evaluate cumulative impacts caused by these acknowledged "future projects,"** yet Mr. Butler states that those impacts would only be addressed when homebuilding activities would commence. (If this were allowed to happen, CDF would no longer even have jurisdiction. The County would then make an assessment, if at all, using the post THP landscape as a new baseline.) **Mr. Butler is therefore telling CDF that he is partitioning the project** and that, despite being asked to do so, he will not address the very substantial impacts of the development to follow. I was unaware that independent RPFs had such authority.

The THP states home construction as an objective of the THP. Mr. Butler and the landowner have therefore made home construction both part of the THP and a result of the THP. For CDF to allow Mr. Butler and the landowner to separate the stated development from the THP would be to allow the illegal partitioning of a phased project.

Per *CEQA Guidelines* Sec. 15165, "**Where** individual projects are, or **a phased project is, to be undertaken and where the total undertaking comprises a project with significant environmental effect, the lead agency shall prepare a single program EIR for the ultimate project** as described in Section 15168."

Per Section 15168, " **A program EIR** is an EIR which may be prepared **on a series of actions that can be characterized as one large project and are related either:…(1) Geographically, (2) As logical parts in the chain of contemplated actions."** This THP fits at least these two of the four listed criteria.

CDF would therefore be in violation of CEQA to not address the cumulative effects of the THP and the development to follow as a program EIR.

Further, CDF asks "**Will the proposed project, as presented, in combination with** past, present, and **reasonably foreseeable, probable, future projects…have a reasonable potential to cause or add to significant cumulative impacts** in any of the following resources? 1. Watershed, 2. Soil Productivity, 3. Biological." Mr. Butler checked off "No, after mitigation" for all three (THP, p.37). For "5. Visual and 6. Traffic" Mr. Butler checked off "No reasonable potential for Significant effects" for both (THP, p. 37). **These replies are all untrue.** In reality, the cumulative effects of the THP and development will have significant adverse impacts on **all** the aforementioned resources for both the THP area and/or the surrounding area.

Per *California Forest Practice Rules* Board of Forestry Technical Rule Addendum No. 2: Cumulative Impacts Assessment: Past and Future Activities: B. "Identify and give the location and description of any known, continuing significant environmental problems caused by past projects as defined in 14 CCR 895.1. **The RPF** who prepares the plan or supervised designee **shall obtain information from plan submitters (timberland or timber owner), and from appropriate agencies, landowners, and individuals about past, and future land management activities** and shall consider past experience, if any, in the assessment area related to past impacts and the impacts of the proposed operations, rates of recovery, and land uses**. A poll of adjacent land owners** (sic) **is encouraged and may be required by the Director to determine such activities and significant adverse environmental problems on adjacent ownerships**." Mr. Butler should therefore have queried the landowner and adjacent landowners about the groundwater scarcity problems both he and the landowner should have known about and assessed the impacts the proposed THP and development would have on future groundwater availability. Why was this not done?

Considering the permanent conversions to homesites, the permanent clearings around the homes to follow, permanent clearings for leach fields, and the permanent roads and turnarounds to be constructed, the forest in this area will never fully recover. Further, the reduction in fog drip recharge of the groundwater supply will worsen an already serious situation. However, the cumulative effects of development go beyond forest, fog drip, and groundwater issues. They also involve effects on habitat, soil productivity, viewshed, fire hazards, public health, septic, and traffic. Although these issues are beyond the scope of this letter, per CEQA, all these effects must be addressed and assessed, and all significant adverse effects must be mitigated.
As mentioned at the outset of this letter, other than for occasional references to them, **the cumulative effects of the development that is to follow the THP have not been factored into the discussions of fog drip, summer water supply to understory**

vegetation, seasonal and annual water yields, net annual precipitation, groundwater recharge, groundwater supply, and streamflow into Fay Creek. As I have shown in my companion letter on cumulative forest reduction, a potential reduction of 9.7-10.6 acres of the total 12.9 acres of forest area is indeed possible with approval of this THP. . All the aforementioned factors must be addressed, assessed, and mitigated in light of the potential reduction of up to 75+ to 82+% of the forest in this area. Below is an analysis of how this degree of forest reduction could effect just groundwater recharge and availability.

XIII. CUMULATIVE EFFECT OF FOG DRIP REDUCTION FROM THE THP AND DEVELOPMENT ON GROUNDWATER RECHARGE AND AVAILABILITY:

A potential reduction in 75+ to 82+% of the trees in the THP area resulting from the cumulative effects of the THP and the development to follow will probably result in a somewhat greater 75+ to 82+% cumulative reduction in fog drip production for the same reasons as described in Section II above. The effects of a 75+ to 82+ % reduction in fog drip production on groundwater supply and consequent well production must be assessed to determine its impact on the water supplies for both the slated development and the existing population. Such a large reduction in fog drip will also impact the summer recharge of Fay Creek.

As stated earlier, Harr measured a reduction in annual net precipitation at the soil surface of up to 30% for **just a 25% patch cut** at Fox Creek. In the present situation, there is a potential reduction of 75+ to 82+% of the forest—with a substantial portion being permanent. Clearly, the reduction to be expected in annual net precipitation should exceed Harr's figures for a 25% patch cut.

Arguing conservatively, with just a 70% reduction of fog drip that provides just 25% of the groundwater to this area, there will be an 18% reduction in annual aggregate groundwater recharge (25% of a 70% reduction). How will such a drop in groundwater recharge affect the well production on this property and on neighboring properties? If this property's existing well production were to drop, say, proportionately, the current 2.1 gpm yield would drop to approximately **1.7 gpm**. There would then be insufficient water production for the two proposed residences. However, this decreased yield would probably not fully manifest itself until after all development was completed. Clearly, this is too late and unacceptable. The problem is actually quite complex because we do not even know the relationship between a stated reduction in groundwater production and what the corresponding reduction in well production would be. The well may continue to produce 2.1 gpm most of the year but then seasonally run dry. The relationship/effect may very likely vary from well to well in the immediate area. Also, the degree of potential reduction in the recharge of Fay Creek is an unknown. The only definite is that an 18% reduction in annual aggregate groundwater recharge from reduced fog drip will affect the summer recharge of Fay Creek and probably dry season well production also.

The degree of reduction in groundwater recharge must therefore be assessed prior to project (THP) approval. The impact that this reduction will have on the summer recharge of Fay Creek and could have on well production in this water scarce area is very real and must be assessed. This has not been done. Also, being that none of the groundwater recharge in the THP area is currently being utilized for human subsistence in

the THP area, all such groundwater is available to, and presently being utilized by, other residents in the area and/or for the recharge of Fay Creek. **Any** human habitation that results from development of this property will consequently result in **less** groundwater available to other local residents and/or **less** groundwater recharge of Fay Creek. **These are yet further reasons why, just from the standpoint of groundwater recharge, the impact of the THP and the slated development to follow must be assessed together.**

The "Executive Summary" section of the Dunne Report states: "We emphasize that Cumulative Watershed Effects (CWE) cannot be predicted through the existing parcel-by-parcel analysis for Timber Harvest Plan applications, even if it were based upon the best current understanding. … Members of this committee have been told explicitly by some RPFs that, in preparing a THP, they would never conclude that a CWE is likely because of the unnecessary regulatory burden that such an admission would bring. …The fundamental purpose of requiring a CWE as part of a forest management decision (THP approval) is to state explicitly what is likely to happen as a consequence of the proposed actions. Not only must the individual THP under consideration be evaluated in the context of past activities, but **it must be linked to probable future activities and conditions**. Without a forward-looking, predictive analysis, the inevitable consequence is that each THP will be seen in its own narrow context, and be described as just another small drop in the bucket, with the hard decision about limiting or modifying activities being handed off progressively into a receding future." (University of California Committee on Cumulative Watershed Effects, 2001). I urge the Director to read this in-depth report and to request that the Board adopt its recommendations.

XIV. CONCLUSIONS:

This THP is flawed due to substantial inaccuracies and omissions. The reduction in fog drip following the THP alone should exceed 67%. This degree of fog drip reduction, in turn, will likely cause a reduction of over 44% of the total summer water supply to understory vegetation, reduced seasonal and annual water yields, reduced annual net precipitation, reduced groundwater recharge, reduced groundwater supply for both present and future populations, and reduced stream flow into Fay Creek. Mr. Butler failed to correctly identify and address all these significant environmental effects. Per CEQA he must do so and also explain how he would mitigate all adverse effects. Also, per *CEQA Guidelines* Sections 15165 and 15168, the very significant effects of the development to follow the proposed THP **must be assessed and addressed** in conjunction with the THP. This has not been done.

The cutting of so many trees, followed by the development of at least two homes on this area of poor soil and marginal water supply, can be expected to doom unsuspecting future homeowners on this site to failing wells, and exacerbate the existing water supply problems of other residents in the vicinity. Mr. Butler must quantify and mitigate these very significant adverse effects. Contrary to *California Forest Practice Rules* requirements, Mr. Butler failed to check or chose to ignore the severe groundwater supply problems in the area although voluminous information about said problems was "reasonably available" in the County's file on this property.

Per *CEQA Guidelines* Section 15126.2: "Direct and indirect significant effects of the project on the environment shall be clearly identified and described, giving due

consideration to both the short-term and long-term effects. The discussion should include …physical changes, alterations to ecological systems,…the human use of the land (including … residential development)…and other aspects of the resource base such as… water." Further, many of these effects will not be confined just to the THP area in question but will, in turn, adversely impact other residents in the vicinity. All the aforementioned effects and/or impacts need to be addressed and assessed in this known water scarce area. None of this has been done. Also, any statements concerning these effects and/or impacts need to be based upon science, not unsubstantiated rhetoric.

Pursuant to Section 898.2 (c) of *California Forest Practice Rules*, the Director shall disapprove a THP if "There is evidence that the information contained in the plan is incorrect, incomplete, or misleading in a material way, or is insufficient to evaluate significant environmental effects." Pursuant to Section 898.2 (c) and the evidence given herein, this THP, in its present form, must be disapproved.

I request that my concerns and questions be answered point by point with reference to the specific section number (Roman numeral). I also request that CDF allow adequate time for public review of and reply to any and all responses to the concerns raised and questions asked herein. Finally, per *CEQA Guidelines*, Article 8, Section 15105, please note that CDF must allow at least 30 days for public review of any resubmission of this THP. Thank you.

Respectfully submitted,

Carl J. Wahl, Jr.

Encl:

- References cited.
- Map: Groundwater Problems in the Joy Road Area—Reprint of one section of E-25 in vicinity of Joy Road and Taylor Lane. (Work still in progress.) Exhibit A.
- "Joy Road Area Water Quantity and Quality Problems" well info. Exhibit B.
- Photographs # 1-12. Exhibits C-K.
- Geologic Map: Joy Road and Taylor Lane area enlargement. State Dept. of Water Resources, 1975. Exhibit L.
- Copy of Joy Road Study. (8-1/2 x 14 format version submitted.) Exhibit M.
- Copy of 8 letters submitted circa April 2000 to PRAC on groundwater scarcity around THP site in response to proposed Lot Line Adjustments for same site. Exhibits N-V.
- Copy of "Watershed Stewardship for Rural Residents" mailing and cover letter to Lola Coretti of PRAC. Exhibits W-X.
- Copy of seven pages of handwritten notes by PRAC member on groundwater testimony taken at 4/ 2000 PRAC hearing on LLA on THP property. Exhibit Y.
- Copy of note by PRAC member to Nancy Lingafeldt, PRAC, on groundwater testimony at April 2000 PRAC hearing on LLA on THP property. Exhibit Z.

- Highlighted excerpts from 18 pp. of the most pertinent articles. Exhibits AA-RR.

Reference documents available upon request.

Cc: Mike Reilly, 5th District Supervisor, Sonoma County

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