Comments on
Draft Environmental Impact Report for the Expansion/Closure of the Union Mine Disposal Site, El Dorado County, California

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February 24, 1992

James Sweeney, Chairman
The Board of Supervisors
El Dorado County
330 Fair Lane
Placerville, CA 95667

Dear Chairman Sweeney:

Recently, I received copies of the documents:

ERCE, "Draft Environmental Impact Report for the Expansion/Closure of the Union Mine Disposal Site, El Dorado County, California," prepared for County of El Dorado Environmental Management Department by ERC Environmental and Energy Services Co., August (1991).

ERCE, "Final Environmental Impact Report for the Expansion/Closure of the Union Mine Disposal Site, El Dorado County, California," Volume 1, Volume 2 - Appendices, and Volume 3 - Mitigation Monitoring Program, prepared for County of El Dorado Environmental Management Department by ERC Environmental and Energy Services Co., January (1992).

Previously, I had been contacted about the proposed expansion of the Union Mine Landfill by concerned citizens. In response to that contact, last fall I provided information to you and presumably through you to the other members of the El Dorado County Board of Supervisors on the technical issues that should be addressed in a properly developed environmental impact report (EIR) for a proposed landfill including the proposed Union Mine Landfill expansion. I specifically brought to your attention a document prepared by Dr. R. Anne Jones and myself entitled, "Review of Proposed Landfills: Questions that Should be Answered." (November 1991) In that contact I indicated that if there was interest on the part of the El Dorado County Board of Supervisors, Dr. Anne Jones and I would, without cost to the county, conduct a review of the EIR to evaluate if it properly addressed the water quality issues associated with the landfill expansion. I received no response from you or anyone else on this matter.

This past week a concerned citizen provided me with a copy of the draft and final EIR for the proposed Union Mine Landfill. I have examined the EIR from the perspective of its conformance to the requirements of CEQA. I am contacting you on this matter since I understand that the El Dorado County Planning Commission will hold a public hearing on February 27 to consider among other topics, certification of that EIR. I also understand that in the near future that the El Dorado Board of Supervisors will be holding a public hearing to consider certification of this EIR. As an individual greatly concerned for many years that the public and elected officials are not being adequately informed about the long-term environmental and public health consequences of municipal solid waste disposal in lined landfills of the type proposed for the Union Mine Landfill expansion, I am highly sensitive to how well EIRs on proposed landfills address these issues. Since the February 11, 1992 corrected notice of the Notice of Public Hearing invites comments to the Planning Commission and/or the Board of Supervisors on the EIR, I wish to provide the Board of Supervisors and the Planning Commission with the following comments.

OVERALL CONCLUSION

I find that the EIR for the proposed Union Mine Landfill expansion is significantly deficient in informing the public and decision-makers about the long-term environmental and public health consequences of this landfill. The EIR is highly superficial in its evaluation of potential impacts; contains significant technical errors, numerous misleading and otherwise inappropriate statements; and provides an unreliable and incomplete assessment of the ability of the proposed landfill liners, leachate collection and removal system, cover, and groundwater monitoring system to comply with the requirements of Chapter 15 for Class III landfills to prevent impairment of groundwater quality for as long as the wastes represent a threat.

It is my finding that that EIR should not be certified as being adequate since it does not conform to the requirements of CEQA.

REQUIREMENTS OF CEQA

According to the State's Guidelines for EIRs (Section 15151) for CEQA,

"An EIR should be prepared with a sufficient degree of analysis to provide decision makers with information which enables them to make a decision which intelligently takes account of environmental consequences. An evaluation of the environmental effects of proposed projects need not be exhaustive, but the sufficiency of an EIR is to be reviewed in the light of what is reasonably feasible. Disagreement among experts does not make an

EIR inadequate, but the EIR should summarize the main points of disagreement among experts. The courts have looked not for perfection but for adequacy, completeness, and a good faith effort at ***full disclosure***." (emphasis added)

Further, on page 1-1 of the Final EIR Volume 1 it is stated,

"The EIR is intended to inform public decision makers, other responsible or interested agencies, and the general public of the potential environmental effects of a proposed project."

The EIR for the proposed Union Mine Landfill falls far short of presenting such a review and disclosure. It provides the public and decision-makers with a highly inadequate and inappropriate basis upon which to evaluate the environmental consequences of the proposed project. Examples of the significant deficiencies are presented below. This discussion is not intended or represented to be exhaustive of all of the deficiencies of the EIR. A review of the materials that I provided to you as Chairman of the El Dorado County Board of Supervisors last fall provides a technical basis for many of these and other technical aspects of our comments on the EIR.

OVERVIEW OF LINED LANDFILLS EXPECTED PERFORMANCE IN THE REAL WORLD

On page 4-3 of the final EIR under a section titled, "The Relationship Between Short-term Uses of the Environment and Long-term Productivity," it is stated under "Water Resources" that,

"The effects can be reduced to below levels of significance through a number of proposed design, monitoring, control, and mitigation measures."

Utopian statements such as this are highly misleading and do not reflect the real world situation in which a landfill in El Dorado County can be designed, constructed, operated, closed and maintained for as long as the wastes represent a threat to groundwater quality. As discussed below, there are a wide variety of reasons why such statements as this should not be accepted as factual. In fact, upon review of the technical information pertinent to the proposed Union Mine Landfill expansion, it is appropriate to conclude that this statement is not accurate.

As is documented in subsequent sections of this report, and contrary to the assertions made in the EIR, liners of the type being used today for municipal solid waste landfills will allow sufficient transport of leachate through them to pollute groundwaters to impair use for domestic water supply purposes. As discussed subsequently, compacted soil-clay and flexible membrane liners (FMLs) of the types being used today, alone or in combination including those proposed for the Union Mine Landfill expansion, will not prevent leachate from leaving a landfill and polluting groundwater. It is important to understand that while it is asserted in the EIR that the proposed Union Mine Landfill can be designed, constructed, operated, closed, and maintained to protect groundwater quality, in addition to the lack of technical support for that position, that position does not reflect a recognition of the sociological, political, financial, and economic issues that govern the ability of landfill containment systems to **prevent** groundwater pollution for as long as the wastes represent a threat.

In theory it is possible to conceptually design landfill cover and liner systems that can prevent moisture from entering a landfill and leachate from leaving it. However, such performance cannot be achieved in practice with the current liner materials in landfills intended to hold waste and prevent groundwater pollution, or with the economic and sociological constraints that impact their long-term functioning. Further, landfill cover maintenance systems can, in theory, prevent entrance of moisture into the landfill, and thus theoretically prevent groundwater pollution for landfills sited above the groundwater table. However in the real technological, sociological, and economic world in which landfills must exist, there are not unlimited funds for construction of liners and covers for landfills; there are certainly not unlimited funds for landfill cover maintenance and replacement; and there is also no demonstrable societal commitment and mechanism for such maintenance programs *ad infinitum*, i.e., as long as the wastes represent a threat to groundwater quality.

While it might be argued from a utopian perspective that the County will meet all of its obligations in the future and therefore would prevent extensive groundwater pollution beyond the zone of compliance. However, the County does not have a record of providing such levels of diligence at the existing Union Mine Landfill. On December 12, 1989, the California Regional Water Quality Control Board-Central Valley Region had to issue a cease and assist order to the County because the County had not protected the water resources in the vicinity of the existing Union Mine Landfill. Order 88-149 states,

"The County of El Dorado (hereafter Discharger) was requested to submit, by 1 June 1988, a Report of Waste Discharge and supplemental technical information necessary to prepare revised waste discharge requirements for the Union Mine Landfill. The discharger did not comply with this request."

A properly developed EIR should have discussed these issues since they are highly pertinent to evaluating the likelihood that the County will provide the necessary resources in a timely manner to prevent groundwater pollution by the proposed landfill expansion.

In the real economic, political, technical and sociological world that landfills must exist, there are a wide variety of constraints that cause the utopian description of groundwater quality protection associated with the landfill to not be achieved for as long as the wastes represent a threat. There is certainly no reason to believe that El Dorado County will be any more effective in protecting surface and ground water resources in the future than it has been in the past. In fact, because of escalating cost and greater degrees of environmental protection being required, it is likely to be that counties such as El Dorado will find even more difficulties in accomplishing the required activities to comply with Chapter 15. It is for this reason that the EIR should have discussed that there are significant reasons not to site a landfill expansion at the proposed site and therefore further aggravate the significant problems that exist at this site for future generations to have to experience in surface and ground water pollution impacts on their public health and welfare and the very significant cost that they will have to bear to correct the problems caused by the expansion of the proposed Union Mine Landfill.

The groundwater resources of California, including El Dorado County, are extremely important to future generation's water resources. The situations that have been allowed to occur in the past under Chapter 15 in which landfills are constructed at geologically unsuitable sites with liners that only temporarily postpone groundwater pollution cannot be allowed to occur in the future. Governor Wilson's task force on developing a new water policy for the state has recently concluded that in 2010 the state is predicted to be about 6 million acre feet/year short in water resources. Surface and ground waters not now being used for water supply purposes will have to be used in the future to meet the needs of the state. Therefore the people of El Dorado County cannot continue to achieve cheaper than real cost garbage disposal at the expense of future generation's water resources. A properly developed EIR should have discussed these issues as part of discussing the long-term consequences of the proposed landfill expansion instead of misleading the reviewers of the EIR to believe there will likely be no future problems associated with the landfill expansion. It is clear that there will be significant problems with the landfill expansion in pollution of groundwaters in the vicinity of the landfill.

All that has to be done is to examine the current state of the civil works infrastructure in the US for roads, bridges, water lines, sewers, etc. - many of which structures are readily accessible to inspection - to see illustrations of the societal commitment and its ability to maintain structures. In the case of landfills, however, inspection of the liners is not possible; the only way that liner failure is found is by finding groundwater pollution. Similar kinds of problems exist for landfill covers. The key component of landfill covers, the "impermeable" layer(s), is buried under vegetation, top soil, and a drainage layer; its location makes the "impermeable" layer(s) inaccessible to inspection.

Chapter 15 is explicit in requiring post-closure care for municipal solid waste landfills for as long as the wastes represent a threat to the beneficial uses of groundwater. It is asserted in the EIR that any leachate generated will be removed via the leachate collection and removal system with the result that there would be no pollution of groundwater. A leachate collection and removal system typically consists of a highly permeable layer (such as sand) under the waste; the liner system is beneath the sand. Theoretically, leachate generated in the waste passes down through the sand until it reaches the liner. It is then to flow along the top of the liner to a sump for removal by pumping. In the real world, however, flexible membrane liners have holes-imperfections in them at the time of construction that allow leachate to pass through the liner. As discussed in this report, Bonaparte and Gross (1990) reported that at the time of construction double-lined landfills with good quality control in liner construction can be expected to leak at a rate of 200 liters/hectare/day (about 20 gallons/acre/day). This means that the leachate collection and removal system will not achieve the theoretical performance at the time of construction much less over the time that municipal solid waste constituents represent a threat to the beneficial uses of groundwater. Further, an important factor that is now becoming widely recognized is that the porous layers in leachate collection and removal systems used for municipal landfills tend to become clogged or blocked by biological growths, thereby leading to ponding of leachate behind clogged areas; such ponding contributes to greater rates of leakage through holes in the liners.

The basic question becomes one of how best to manage municipal solid waste generated in El Dorado County considering both short-term and long-term impacts and their associated costs. For those parts of the wastes that will have to be landfilled, proper landfill siting is the key to protection of groundwater quality. Some sites are more vulnerable to pollution than others. As discussed below, the Union Mine Landfill area is a highly unsuitable site for a landfill that contains wastes that can produce leachate that can readily pollute groundwater. The focus of this discussion is the factors that influence the transport of contaminants in landfill leachate from the proposed Union Mine Landfill expansion through the landfill liner to the groundwater.

EXAMPLES OF SIGNIFICANT DEFICIENCIES IN THE UNION MINE LANDFILL EIR

Groundwater Quality Monitoring

Page ES-2 under the heading, "Water Resources," states,

"Impacts. The potential degradation of groundwater quality due to leachate migration from the existing landfill and the presence of numerous mine workings under the site are considered to be potentially significant impacts. Potential surface water impacts are not considered significant due to the facilities proposed drainage control plans.

Mitigation. The proposed groundwater monitoring program and associated contingency plans will mitigate potential groundwater impacts to below levels of significance."

Volume 3 - Mitigation Monitoring Program states in Table 1,

"Water Quality Design of the ground-water monitoring program will account for the anisotropic nature of the aquifer, the potential for vertical hydraulic gradients and the existing extent of ground-water degradation."

It further states in this table,

"Water Quality Monitoring to evaluate ground-water quality and ensure that ground-water users are not adversely affected."

Decision-makers, professionals, and members of the public who are not familiar with the current state of information on the ability of groundwater monitoring programs at lined landfills to detect leachate-pollution of groundwater at the point of compliance (according to Article 5 of Chapter 15 this is the downgradient edge of the landfill) at the earliest possible time before widespread contamination of groundwater has occurred, are led to believe by the "Water Resources" section of the Executive Summary of the EIR and the Volume 3 - Mitigation Monitoring Program of the EIR that the groundwater monitoring program proposed and/or that can be readily developed will reliably detect groundwater pollution, which can then be mitigated to below levels of significance. This would lead an uninformed reader to conclude that the proposed landfill does not represent a threat to the groundwater resources in the area of the landfill. However, as discussed in a paper entitled, "Ground Water Quality Monitoring at Landfills: It's Time to Stop Deceiving Ourselves and the Public," (Lee and Jones 1991a) sent to you as Chairman of the Board of Supervisors last fall, the groundwater monitoring programs of the type typically proposed for lined landfills have a low probability of detecting groundwater pollution before widespread pollution has occurred. Now that I have seen the EIR which presents the characteristics of the site and a proposed groundwater monitoring program for the proposed Union Mine Landfill where downgradient monitoring wells are hundreds of feet apart, I can state with authority that that monitoring program does not comply with the requirements of Article 5 of Chapter 15. Nor will monitoring programs that are typically or that can be readily developed for this type of landfill and site provide a monitoring program that will detect groundwater pollution before significant groundwater pollution occurs. Therefore, the basic technical premise set forth in the Executive Summary (page ES-2) for water resources impacts is fundamentally flawed. The readers of the EIR's Water Resources statement are being highly mislead about the abilities of the groundwater monitoring program to detect leakage at the earliest possible time as required by Article 5 of Chapter 15.

An important factor to consider in the evaluation of the ability of lined landfills to provide protection of groundwater quality is the ability to monitor for leakage before widespread groundwater contamination occurs from landfill leachate. Article 5 of Chapter 15 (Section 2550.1) requires detection monitoring

"...to provide the best assurance of the detection of subsequent releases from the waste management unit."

Further, a sufficient number of monitoring wells are to be located so that they

"provide for the best assurance of the earliest possible detection of a release from a waste management unit."

Section 2550.5, Article 5, of Chapter 15 states with regard to monitoring points and the point of compliance,

"(a) For each waste management unit, the regional board shall specify in the waste discharge requirements the point of compliance at which the water quality protection standard of Section 2550.2 of this article applies. The point of compliance is a vertical surface located at the hydraulically downgradient limit of the waste management unit that extends through the uppermost aquifer underlying the unit. For each waste management unit, the regional board shall specify monitoring points at the point of

compliance and additional monitoring points at locations determined pursuant to Section 2550.7 of this article at which the water quality protection standard under Section 2550.2 of this article applies and at which monitoring shall be conducted."

The typical groundwater monitoring program being used today for lined landfills, such as that proposed for the Union Mine Landfill expansion, involves the placement of a few wells up-groundwater gradient and several wells down-groundwater gradient spaced hundreds of feet apart at the point of compliance for the landfill monitoring program. It is becoming widely recognized that such a monitoring program has a low probability of detecting leakage through a landfill liner at the "earliest possible" time as required by Chapter 15, Article 5.

The basic problem is that the typical groundwater monitoring program illustrated above was designed for monitoring groundwater associated with unlined landfills from which leakage would occur over a considerable part of the bottom of the landfill. Under those conditions, the plume of leachate-contaminated groundwater would move downgradient as a wide front across the landfill; therefore, close well spacing was not critical (Figure 1). However, as discussed by Lee and Jones (1991a) lined landfills will initially leak from holes, imperfections, or areas of high permeability in the liners. It has been established (Cherry, 1990) that the lateral spread of a leachate-contaminated groundwater plume is very limited. Smith (1990) personal communication, University of Waterloo Groundwater Research Centre, has reported in a study of the lateral dispersion of leachate plumes that a 0.6 m (2 ft) wide source spread laterally to about 2 m (6 ft) in traveling 65 meters in a sand aquifer system. The leakage from point sources such as holes in liners will move downgradient as "fingers" of leachate rather than in fan-shaped plumes (Figure 2). This means that the wells used for monitoring lined landfills must be close enough together to detect fingers of leachate, if the monitoring program is to comply with Article 5, Chapter 15 requirements of detecting leachate at the earliest possible time.

The typical monitoring wells used today involve a four- to eight-inch diameter borehole. Normally those wells are purged by removing three to five borehole volumes prior to sampling at quarterly or so intervals. This means that the zones of capture for such monitoring wells are on the order of a foot from each well. Therefore, monitoring wells that are spaced hundreds of feet apart downgradient of a lined landfill at the edge of the landfill have a very low probability of detecting the fingers of leachate produced by leaks in the liner system (Figure 2). Those fingers of leachate could travel long distances before groundwater pollution is detected. Parsons and Davis (1991) have discussed the issues of monitor well spacing and their associated zones of capture for waste management units. As shown in Figure 3, the monitoring well spacing should be such that the monitoring wells have a high probability of detecting leachate contaminated groundwater arising from the waste management unit at the point of compliance.

On EIR page 3.B-1 the regional hydrogeology was defined as follows.

"The hydrogeology of the Union Mine area is relatively complicated since the primary aquifer in this region is a fractured rock system in which the host rock includes jointed

and fractured meta-sediments, meta-volcanics, and granitic rocks... Within these types of fractured rock systems, groundwater is transported primarily through the fractures and joints in the bedrock."

This type of hydrogeology makes the monitoring of leachate-pollution of groundwater even more difficult thereby enhancing the probability that leachate-pollution of groundwater will occur beyond the point of compliance.

As reported by Waggoner (1991),

"On page 3-1 of the report, CH2M HILL states that 'Since it will not be possible to capture all the leachate from the existing landfill, a peak daily flow of 100 to 200 gpm is anticipated.' These figures suggest that between 400 and 500 gpm of leachate generated from a storm cannot and/or will not be collected."

The inability to capture all the leachate from the existing landfill may be a reflection of the unsuitability of this site for a landfill, much less for a landfill expansion. Part of this unsuitability stems from the extremely complex hydrogeology of the area. This is a characteristic of areas of this type where because the groundwater flow patterns cannot be reliably defined within the resources that are normally made available for such purposes, leachate contaminated groundwater can readily pass monitoring wells without being detected. Further, this also points to the inappropriateness of the statements on page ES-2 of the EIR of being able to mitigate contaminated groundwaters.

It is important to note that there is no real difference from a long range perspective between the existing landfill pollution of groundwater and the proposed lined landfill pollution of groundwater. Both will pollute groundwater. The difference is that the existing landfill started polluting groundwater at the time it was first constructed. The proposed landfill will pollute groundwaters when first constructed to a small extent if good quality control is achieved in construction of the liners. There still however will be pollution at that time. Ultimately both will pollute groundwaters extensively.

Waggoner (1991) notes that there are several negative aspects of the proposed landfill expansion such as "...shallow ground water, limited availability of suitable on-site material for daily and intermediate cover, spring-fed stream near the southern toe..." According to Waggoner on page 2 of his letter,

"Although County representatives are aware of these conditions, they apparently feel that time and cost constraints associated with siting a new landfill outweigh these factors."

Waggoner states,

"However, the County should be aware that the site conditions described above will complicate landfill operations and may even warrant more stringent requirements, (i.e., measures that are above and beyond the prescriptive standards and performance goals

specified in the California Code of Regulations, Title 23, Division 3, Chapter 15, hereafter Chapter 15)."

It is clear from my experience that the County is making a very serious error in continuing to try to site an expanded landfill at the Union Mine location. This is a geologically unsuitable site for landfills which is well demonstrated by the problems with the existing landfill. Those issues should have been discussed in the EIR. The EIR is highly deficient in not discussing these issues.

While the EIR at several locations states that the proposed landfill will meet Chapter 15 requirements, as discussed below, it is obvious upon examination of these requirements compared to the examination of the proposed design for the landfill as presented in the EIR relative to the expected performance of the engineered alternative containment systems that are proposed to try to overcome the significant deficiencies of the proposed site for the landfill expansion proposal that the proposed landfill will not comply with Chapter 15 requirements.

On page 3.B-29 of the final EIR it is stated under Groundwater Quality,

"As part of the final design, documentation for the design of the groundwater monitoring program will be prepared by a qualified professional and implemented to ensure that significant, additional groundwater degradation due to leachate migration from the landfill does not occur. The design will account for the anisotropic nature of the aquifer, the potential for vertical hydraulic gradients, and the existing extent of groundwater degradation. The system will be capable of evaluating the migration of contaminants in groundwater over time and will be designed to ensure that groundwater users in the area are not impacted."

Again, those knowledgeable in the topic know that there is a very low probability that this in fact can be done with the resources that are likely to be made available for it by the County. The extremely complex hydrogeology of the region makes it very difficult without substantial funding far beyond that inferred in the EIR to accomplish the Chapter 15 required levels of groundwater monitoring.

At several locations in the EIR, statements are made that further information will be developed which will enable required monitoring, containment, etc. to be achieved. This EIR should not be certified until detailed information that is required to properly judge the adequacy of the proposed project is in fact available for review by the public. It is highly inappropriate for the County Planning Commission and Board of Supervisors to certify an EIR that is incomplete. It is not in the best interest of the County or the public to assume that because a statement is made in the EIR that something will be accomplished in the future, that what will be accomplished will be adequate to protect the public health and groundwater resources of the region of the existing landfill and proposed landfill expansion.

Characteristics and Performance of Lined Landfill Containment Systems

On Final EIR pages 2-36, and 2-49, discussion is presented on several aspects of the proposed containment system-liner for the landfill. A composite liner consisting of plastic sheeting (60-mil HDPE geomembrane) underlain by 2 ft of compacted soil with a permeability of less than $1x10^{-6}$ cm/sec is proposed for the purpose of preventing leachate-pollution of groundwater. It is well-known from the published literature (see discussion presented below) that such a liner, if constructed with good construction quality assurance, will be expected to leak from the time of initiation of operation at a rate of at least 20 gal/acre/day. Further, it is well-known from the literature that such a liner will not maintain its design performance over time.

On Final EIR page 2-65 information is presented on the proposed cover for the proposed Union Mine Landfill, which is to consist of a 1-ft barrier layer of low-permeability ($1x10^{-6}$ cm/sec) soil. The uninformed reader could readily conclude from the statements made in the EIR that the cover would prevent moisture from entering the landfill and that the liner would prevent leachate from leaving the landfill to pollute groundwater. As discussed below, that conclusion would be a significant error.

Chapter 15 requires that engineered structures such as liners for landfills located at geologically unsuitable sites (such as the proposed Union Mine site) must function to prevent impairment of use of groundwater for as long as the wastes represent a threat, which is, as discussed below, forever. In order to prevent the generation of leachate in a landfill, moisture must be kept out of the landfill. While the cover as proposed was described as being "low permeability," as discussed below, it does not meet the minimum Chapter 15 design specifications for landfill covers. A cover design of the type proposed is widely recognized to be inadequate to significantly impede entrance of moisture into the landfill. Schroeder (1990) of the US Army Corps of Engineers and a US EPA-invited lecturer on the passage of moisture through landfill covers stated at the US EPA landfill cover design seminar held in Oakland, CA, that a cover consisting of a one foot layer of compacted soil having a permeability of $1x10^{-6}$ cm/sec (i.e., the proposed Union Mine Landfill cover design) as the low permeability layer would be "largely ineffective" in preventing entrance of moisture into a landfill.

It is stated on page 2-65 of the final EIR that the proposed final cover complies with the requirements set forth in Chapter 15.

"State of California design requirements for final cover are contained in Title 23 CCR Chapter 15 and Title 14 CCR, Chapter 3, Article 7.8. In accordance with these requirements, the final cover for the existing landfill would consist of a 2-foot foundation layer consisting of compactable, non-decomposable materials obtained onsite, a 1-foot barrier layer of imported low-permeability soil with a hydraulic conductivity no greater than $1 X 10^{-6}$ cm/sec, and an additional 1 foot of native material for revegetation and protection of the barrier layer."

This cover design is the cheapest possible design. However, contrary to the statements made in the EIR, it does not meet the minimum Chapter 15 design specifications for landfill covers.

Chapter 15, Section 2581 requires,

"Closed landfills shall be provided with not less than one foot of soil containing no waste or leachate, placed on top of the foundation layer and compacted to attain a permeability of either $1x10^{-6}$ cm/sec or less, or equal to the permeability of any bottom liner system or underlying natural geologic materials, ***whichever is less****.*" (emphasis added).

That requirement is similar to that required in the Subtitle D regulations governing landfilling of municipal solid wastes issued by the US EPA (1991a). Since the bottom liner proposed for the proposed Union Mine Landfill expansion is a composite liner that contains an FML (that, intact (no holes) has a permeability to water on the order of 10^{-12} cm/sec), the cover proposed in the EIR does not meet the requirements of Chapter 15.

Perhaps even more significant than the inferior design of the proposed cover is the issue of cover maintenance that was not addressed adequately in the EIR. It is not realistic to expect that even an appropriate cover will be adequately maintained and replaced as needed *ad infinitum* within the funding levels typically available for such purposes.

The key moisture retardation component of the cover for the proposed Union Mine Landfill, the "low-impermeable" layer, is buried under vegetation, and one foot of top soil and drainage layer; its location makes the "low-impermeable" layer inaccessible to inspection. An inspector walking across the surface of the landfill cover could conclude from visual inspection of the surface that the cover is functioning adequately when in actuality, the low-permeability layer could readily have desiccation cracks in it, cracks from differential settling, or other breaches that would allow entrance of far greater moisture into the landfill than theoretically predicted or seen by visual surface inspection.

Desiccation-cracking will occur in a compacted soil layer in a landfill cover during months of little or no precipitation. Since the one-foot layer of compacted soil in the proposed cover for the landfill is proposed to be relied upon for "minimization" of entrance of moisture into the landfill through the cover, and since that layer will be beneath the cover's topsoil and drainage layers, desiccation-cracking of the compacted soil layer will be essentially impossible to detect with techniques currently used. As discussed by Daniel (1990), since desiccation-cracks do not heal to original design/construction permeability upon wetting, shortly after landfill closure the cover will likely have a much higher permeability than the design specification, and thereby allow greater leachate generation than that estimated. Similarly, it is also widely recognized that small amounts of differential settling of solid waste that normally occurs in landfills can cause cracks to develop in the compacted soil layer in the cover (Daniel, 1990). The problems for keeping moisture from the landfill caused by those cracks and the inability to detect their presence are the same as those for desiccation cracks (See Lee and Jones, 1991c).

In a section devoted to "long-term considerations: problem areas and unknowns" for landfill liners, the US EPA (1989) concluded, *"The performance of a capped and closed waste facility is critically important. If a breach should occur many years after closure, there is a high likelihood that maintenance forces would be unavailable. In that event, surface water could enter the facility with largely unknown consequences. Thus the design stage must be carefully thought out with long-term considerations in mind."*

Duration and Costs of Post-Closure Care

Chapter 15 (Section 2580(a)) states,

"The post-closure maintenance period shall extend as long as the wastes pose a threat to water quality."

It is not known the number of years that post-closure care will have to be provided for the proposed Union Mine Landfill (See Lee, 1990; Lee and Jones, 1991d,e). However, the general magnitude of time can be understood by review of the literature. It is well-known that in a typical landfill at which there is no attempt to restrict moisture from entering the waste to generate leachate, the leaching period is much greater than the 22 years of proposed operation of the proposed Union Mine Landfill expansion plus 30 years of post-closure, i.e., 52 years. Belevi and Baccini (1989) reported on the concentrations of heavy metals and other constituents that would be expected to be present in municipal solid waste leachate over extended periods of leaching in such a landfill. They projected that hazardous chemicals such as lead in municipal solid waste could occur in municipal landfill leachate at concentrations that are above US EPA drinking water standards for more than 2,000 years.

Freeze and Cherry (1979) reported,

"Although it is well established that [unlined] *landfills in nonarid regions produce leachate during at least the first few decades of their existence, little is known about the capabilities for leachate production over much longer periods of time. In some cases leachate production may continue for many decades or even hundreds of years. It has been observed, for example, that some landfills from the days of the Roman Empire are still producing leachate."*

Lee and Jones (1991c,d) reported on Lee's paleoclimatological investigations in the 1970's of an American Indian midden (garbage pile) at a site in Iowa that was last occupied in about 1500 AD; that midden was still producing leachate when investigated.

These observations indicate that in order to protect groundwater quality, the leachate collection and removal system, liners, underdrain, cover and other "containment/isolation" features for a lined landfill must work perfectly for thousands of years. However, Belevi and Baccini's projections and the long-term leachate production documented above, were for landfills at which moisture was allowed to enter; the period of time over which chemical contaminants would be expected to leach from a landfill with a so-called "impervious" cover of the type being constructed at some landfills today in the US, would extend throughout the period over which the wastes are, in fact, kept dry, plus the leaching period. For example, if El Dorado County could keep all moisture out of a landfill for only 500 years after which time, cover maintenance becomes inadequate and moisture is allowed to enter the landfill, the initiation of the leaching period would begin in the 501st year and extend until all constituents that could impair beneficial uses of groundwater are leached, which as noted by Belevi and Baccini for heavy metals would be expected to be thousands of years. In order to protect groundwater quality during that leaching period, the leachate collection and removal system and flexible membrane liner would have to work perfectly throughout that period. The long-term production of leachate that can occur in a landfill, once moisture is added to the waste, makes most post-closure care funding for the proposed Union Mine Landfill expansion a mandatory requirement that should be considered necessary in perpetuity in order to protect groundwater quality.

The costs for post-closure care of the proposed landfill have not been reliably determined since post-closure care needed in accord with Chapter 15 can extend well-beyond the 30-year period for which irrevocable funding must be established. However, estimates of the magnitude of funding that will be required can be determined from the literature. Carden (1981), as reported by Lee and Jones (1991c), conducted a review of the potential costs of landfill cap (cover) maintenance. He reported that the costs for 200 years of cover maintenance for one landfill ranged from $28 billion (at 5%/yr inflation) to $154 trillion (at 10%/yr inflation). Given its design, the Class III proposed Union Mine Landfill could not be expected to stop being a threat to groundwater quality at 200 years. It will extend well beyond that time.

In its review of post-closure care funding for landfills, the General Accounting Office of the US Congress (GAO 1990) stated under the heading: "Funding Mechanisms Questionable,"

"Owners/operators are liable for any postclosure costs that may occur. However, few funding assurances exist for postclosure liabilities. EPA only requires funding assurances for maintenance and monitoring costs for 30 years after closure and corrective action costs once a problem is identified. No financial assurances exist for potential but unknown corrective actions, off-site damages, or other liabilities that may occur after the established postclosure period."

Thus, there are legitimate questions about the funding of the post-closure care for the proposed Union Mine Landfill that have not been adequately addressed in the EIR. The EIR is highly deficient in addressing long-term groundwater quality protection issues associated with the proposed landfill expansion. For example, page 2-65 of the Final EIR states

"A post-closure maintenance program (as required by CCR Title 23 Chapter 15 Article 8) would be instituted at the landfill to verify that containment and monitoring facilities retain their integrity. Surface drainage control facilities, final vegetated soil cover areas, groundwater monitoring facilities, and leachate control facilities would be routinely

evaluated. Cracks detected in the final cover would be sealed and any erosion damage would be repaired."

This statement is highly misleading in that it does not adequately inform the decision-makers and the public about the problems associated with achieving the requirements of Chapter 15 of providing long-term postclosure care that will be needed for the proposed Union Mine Landfill. For example, the EIR states, *"...that containment and monitoring facilities* [will be maintained to] *retain their integrity."* To the uninformed, it would appear upon reading this statement that the post-closure maintenance program would be able to detect liner leakage and make repairs. However, it is obvious that that cannot be the situation. The liner at some locations will be under one hundred or so feet of garbage. The only way that liner leakage will be known may be because of groundwater pollution, which as discussed elsewhere in this report, may not be detected by the groundwater monitoring system used. Therefore it may be water wells on adjacent properties that first detect liner leakage.

Contrary to the statements made in the EIR, there is no maintenance program for the key part of the containment system, i.e. the liner. Since as discussed below, it is well-known that the liners used for this landfill will not maintain their integrity for as long as the wastes represent a threat, a strict interpretation of this statement means that at some time in the future that El Dorado County residents would be required to pay for removal of all wastes deposited in the landfill in order to repair the liners. Landfill liner companies only warrant their liners for 20 years. Yet, the liner and cover must function perfectly for thousands of years if groundwater pollution is to be avoided.

Chapter 15, Article 8, Section 2581(c):

"Throughout the post-closure maintenance period, the discharger shall:

(1) maintain the structural integrity and effectiveness of all containment structures, and maintain the final cover as necessary to correct the effects of settlement or other adverse factors;

(2) continue to operate the leachate collection and removal system as long as leachate is generated and detected;

(3) maintain monitoring systems and monitor the ground water, surface water, and the unsaturated zone in accordance with applicable requirements of Article 5 of this subchapter;

(4) prevent erosion and related damage of the final cover due to drainage; and

(5) protect and maintain surveyed monuments."

Further Chapter 15, Article 8, Section 2580(a) states, *"The post-closure maintenance period shall extend as long as the wastes pose a threat to water quality."* which as discussed above will likely be thousands of years, effectively forever. Rather than making blanket, highly misleading statements about compliance with Chapter 15 requirements, the EIR should have discussed the problems of complying with the requirements set forth in Chapter 15, and certainly should have discussed the expense of such compliance. The highly unsuitable character of the proposed Union Mine Landfill site will cause the true long-term expense associated with expanding a landfill at this site compared to other sites or other methods of solid waste management to be very great. It is clear that future generations in El Dorado County will be paying large amounts of funds to try to prevent groundwater pollution at the Union Mine Landfill site by the proposed landfill expansion. A properly developed EIR would have discussed the potential problems and the expenses associated with trying to comply with Chapter 15 requirements for postclosure care. As it stands now, the decision-makers and the public have been led to believe that they can continue to dispose of garbage at the Union Mine Landfill area at a cost comparable to what they have been paying in the past. In reality, however, because of the environmental regulations and the unsuitable nature of this site, the current and future residents of El Dorado County will be paying large amounts of money trying to comply with Chapter 15 requirements while not preventing groundwater pollution.

Pollutional Characteristics of Municipal Landfill Leachate

In evaluating the appropriateness of the statements made in the EIR on the ability to remediate municipal landfill leachate contaminated groundwaters, it is important to examine the chemical characteristics of municipal landfill leachate. Lee and Jones (1991b) have discussed these characteristics. Municipal landfill leachate contains a wide variety of chemical contaminants at high concentrations that can readily render a groundwater non-useable for domestic water supply purposes. In addition to conventional pollutants such as total dissolved solids (TDS), oxygen demand, sodium, calcium, magnesium, chloride, sulfate, iron, manganese, sulfide, and ammonia, municipal landfill leachate contains a variety of hazardous chemicals that are toxic to man and other animals and/or can cause cancer in animals and man. These include heavy metals such as lead, cadmium, mercury, organic solvents, and a variety of other hazardous organics. As discussed by Lee and Jones (1991b), the majority of the organic matter present in municipal landfill leachate is of unknown character. Further, the hazards that these materials represent to human health are also unknown. This group of non-conventional pollutants makes municipal landfill leachate contaminated groundwaters and aquifers unsafe for consumption even if all of the known contaminants are below the US EPA drinking water standards (MCLs).

The basic problem with assuming that if none of the measured constituents in a leachate contaminated groundwater are above the drinking water standards that the water is safe to drink is that only a few of the chemicals that could be hazardous to man in drinking water are measured in a conventional water analysis. Typically, on the order of 150 to 200 chemicals are measured in such analyses. At this time, it is estimated that there are over 63,000 chemicals in common use today. It is therefore obvious that water analyses as normally practiced even with extraordinary efforts to evaluate potential hazards fall far short of what is needed to be certain that a groundwater that has been contaminated by municipal landfill leachate is safe to drink. It was only a few years ago that many of the most hazardous chemicals known today such as dioxins were unknown. It is clear that all the chemicals that could be as hazardous as dioxins have not yet been found and that some of these chemicals could be present in municipal solid waste.

Municipal landfill leachate (garbage juice) contains a variety of organics that only very slowly are removed from groundwater aquifers. This slow removal means that the part of an aquifer once contaminated by landfill leachate must be considered permanently destroyed for domestic water supply use.

Remediation of Leachate-Contaminated Groundwater and Aquifers

On page 3.F-19 under the section Cumulative Impacts,

"Areas of the landfill planned for closure and areas proposed for expansion will be monitored through environmental monitoring programs to detect releases of contaminants to the air and ground/surface water. Implementing the monitoring programs, and taking corrective actions when monitoring indicates that releases of contaminants in excess of acceptable levels has occurred, will mitigate the potential adverse effects resulting from past waste disposal practices."

This statement is highly misleading in that it would lead an uninformed reader to conclude that corrective action can be taken which would mitigate adverse impacts resulting from groundwater contamination by landfill leachate. Those knowledgeable in the topic area, however, know that there is no cleanup of municipal landfill leachate contaminated groundwater aquifer that would restore the contaminated parts of the aquifer so that it could be again used for domestic water supply purposes. In his review of superfund and groundwater remediation, Rowe (1991) stated,

"The commentary by Curtis Travis and Carolyn Doty on groundwater remediation at Superfund sites (ES&T, October 1990, p. 1464) emphasizes a proverb that is worth repeating: Don't pollute groundwater resources because contaminant plumes have no quick fix. This was underscored 10 years ago when earth scientists at the U.S. Geological Survey stated that, '...deterioration in [groundwater] quality constitutes a permanent loss of water resources because treatment of the water or rehabilitation of the aquifers is presently generally impractical' and 'solutions rest largely in changing [land- and water-management practices] to take into account the susceptibility of the groundwater resources to degradation' (1). Thanks in part to the U.S. Geological Survey, the above proverb comes as no big surprise."

As part of developing the regulatory impact analysis for the Subtitle D regulations governing landfilling of municipal solid wastes released on October 9, 1991 (US EPA, 1991a), the US EPA concluded that the contamination of an aquifer by municipal solid waste landfill leachate destroys the contaminated part of the aquifer as a domestic water supply source and requires that a new water supply source be substituted (US EPA, 1988c). The US EPA's updated regulatory impact analysis for municipal solid waste landfill regulations also accepted the fact that once contaminated by municipal landfill leachate, the affected groundwater and aquifer area will have to be abandoned as a water supply and new wells constructed (US EPA, 1991b).

Today, large amounts of money are being spent at "superfund" and other sites in attempts to clean up chemically contaminated groundwaters. The focus of clean-up programs at those sites are the so-called "hazardous" chemicals as defined under RCRA and CERCLA which normally are the volatile organic chemicals (VOC's) such as trichloroethylene and its transformation product, vinyl chloride. While several years ago it was assumed by some that it would be relatively easy to clean-up VOC-contaminated groundwater, today as discussed by Rowe (1991) even the ability to clean-up VOC-contaminated groundwater is now in question. As discussed by Lee and Jones (1991f,g,h), municipal landfill leachate-contaminated aquifers cannot be "cleaned-up" so that they could be considered suitable for domestic water supply again.

Liner Durability

One of the issues that should have been addressed in the EIR, which is well-known in the technical landfill literature, is the potentially limited durability of the flexible membrane liner (FML) (geomembrane-plastic sheeting). A review of the technical literature on the durability of the liner system components that are proposed for the proposed Union Mine Landfill shows that both the geosynthetic (i.e., polymer-based) and geologic (i.e., soil-based) components of the liner components are subject to failure. In 1988, the US EPA Hazardous Waste Engineering Research Laboratory (HWERL) convened an ad hoc technical committee to review the "Service in Landfills of Flexible Membrane Liners and Other Synthetic Polymeric Materials of Construction." A primary conclusion of that committee regarding durability and functioning of geomembrane liners, as reported by Haxo and Haxo (1988), was

"The polymers that were discussed and first-grade compounds based on these polymers should maintain their integrity in landfill environments for considerable lengths of time, probably in terms of 100's of years. Nevertheless, when these polymers or compounds are used in products such as FMLs, drainage nets, geotextiles, and pipe, they are subject to mechanical and combined mechanical and chemical stresses which may cause deterioration of some of the important properties of these polymeric products in shorter times."

In addition, Haxo and Haxo reported on *"areas of concern that may affect the service life of components of liner systems and the functioning of the liner system as originally designed."* Those "areas of concern" include:

"The combined mechanical and chemical stresses under which the liner system functions may cause cracking and breaking of the components due to environmental stress-cracking or possibly to mechanical fatigue under long service."

* * *

"Seams of FMLs continue to be an area of concern, as none of the test methods truly assess the effects of long-term exposure in landfills."

* * *

"Clogging of drainage and detection systems continues to present a problem. The clogging can be by biological clogging due to growth or sedimentation or through precipitation of dissolved constituents."

Mitchell and Jaber (1990) stated,

"In waste containment applications, however, conditions do not remain the same. The permeation of a compacted clay liner by chemicals of many types is inevitable, since no compacted clay or any other type of liner material is either totally impervious or immune to chemical interactions of various types. In addition, most clay liner systems are subjected to distortional stresses that may cause differential movement. If these movements lead to formation of open cracks, then the liquid retention ability of the system will be lost."

Therefore, Mitchell and Jaber (1990) recognize that soil-clay liners may be subjected to chemical and mechanical stresses within a landfill that diminish their ability to serve as an effective liner.

The US EPA (1989) stated with regard to problems with clay liners in landfills,

"While clays do not experience degradation or stress cracking [compared with FML's], *they can have problems with moisture content and clods. High concentrations of organic solvents, and severe volume changes and desiccation also cause concern at specific sites."*

Based on the second law of chemical thermodynamics plastic sheeting can be expected to deteriorate over time and fail to function as an effective liner for landfills to prevent leachate from migrating through it. In its proposed Subtitle D regulations governing municipal solid waste landfills, the US EPA (1988a) stated,

"First, even the best liner and leachate collection system will ultimately fail due to natural deterioration, and recent improvements in MSWLF (municipal solid waste landfill) containment technologies suggest that releases may be delayed by many decades at some landfills."

In addition, the US EPA (1988b) stated with reference to lined municipal solid waste landfills,

"Once the unit is closed, the bottom layer of the landfill will deteriorate over time and, consequently, will not prevent leachate transport out of the unit."

Koerner *et al.* (1990) stated:

"Perhaps the most frequently asked question regarding geomembranes (or any other type of geosynthetic material) is, 'how long will they last?' The answer to this question is illusive (in spite of a relatively large data base on polymer degradation) mainly because of the buried nature of geomembranes. Soil burial greatly diminishes, and even eliminates many of the degradation processes and synergistic effects which have been most widely investigated by the polymer industry for exposed plastics. However, different degradation processes coming from chemical interactions and extremely long time frames may be involved via exposure to liquids like leachate for systems intended to last for many decades or even hundreds of years. Thus the lifetimes of buried geomembranes can be significantly different than exposed plastics, but a quantitative method to predict 'how long' is still not available."

* * *

"While accelerated test methods are attractive to assess the various phenomena, these procedures may significantly misrepresent the actual long-term performance of geomembranes."

In a subsequent paper Koerner *et al.* (1991) state with regard to long-term durability of geomembranes:

"Several phenomena can accelerate the individual degradation mechanisms, but quantifying these synergistic effects is complicated, the database is weak."

* * *

"We know what geomembranes can do but still haven't learned exactly how long they will last."

One of the primary concerns with the long-term durability of HDPE liners is stress-cracking. Shortly after plastic sheeting constructed of HDPE began to be used as liners for waste ponds, problems with large cracks' appearing in the plastic sheeting were found to occur after liners had been installed; visual inspection of the liners in the ponds revealed that large cracks had developed in the HDPE, typically near seams. Those cracks have been characterized as "stress-cracks" or "brittle fractures." Examination of the literature on that topic indicates the potential importance of the stress-cracking failure mechanism in the long-term stability of liners for municipal solid waste landfills. For example, Peggs and Carlson (1990) discussed the stress-cracking (brittle fracture) of HDPE and state:

"The common concept of polyethylene [of which HDPE is one type] *in geomembrane form is that of a compliant ductile material that yields at 12% elongation but will actually break only after reaching 800% or more elongation. That is so, but over*

extended periods of time polyethylene will also fail by brittle cracking at essentially zero elongation.

Within two years of installation, brittle cracks have developed in geomembrane liners exposed on the side slopes of liquid impoundments. Such cracking has occurred at stresses well below the yield stress of the material."

Peggs and Carlson (1990) also discussed the experience with stress-cracking with polyethylene (PE) pipe, including HDPE pipe. They reported that at the time the pipes were first installed, it was thought that they would readily provide 50 years of service. However, according to Peggs and Carlson (1990),

"After as little as two years, it was found [3] that a large amount of the installed pipe was cracking in a brittle manner, necessitating extensive replacement programs." They also stated, *"Stress cracking is a fundamental characteristic of PE and, as previously mentioned, occurs to different degrees in different resins."* and concluded, ***"Brittle fracture, including the various forms of stress cracking, fatigue, and slow crack growth, occurs in PE geomembrane. This fact must be recognized, acknowledged, and investigated further."***

Halse et al. (1990) stated:

"The surface temperature of the FML's can be reduced significantly by using some type of cover materials, thereby ***reducing*** the stress cracking potential of the FML's." (emphasis added). They went on to state, "Minimizing the surface temperature and direct sunlight exposure will ***probably extend*** the performance of these materials." (emphasis added).

At two different conferences-seminars, Koerner has discussed the stress-cracking phenomenon and indicated to the audiences that he cannot be certain that stress-cracking will not occur in landfill liners.

Stress-cracking is an example of the kinds of problems that can occur with liners. The long-term properties/stability of HDPE and FML are poorly understood. The literature clearly does not support the position that flexible membrane liners of the type being used today and those proposed for the proposed expansion of the Union Mine Landfill will prevent leachate migration through them for as long as the wastes represent a threat to groundwater quality.

Therefore the implications of the EIR that the liner system will be a significant barrier to leachate-pollution of groundwater for as long as the wastes represent a threat is not in keeping with the literature. There is no indication in the literature, nor would it be expected to be found, that HDPE liners in landfills would function perfectly forever, i.e., for as long as the wastes represent a threat, as an impermeable barrier to leachate transport.

Bonaparte and Gross (1990) stated:

"Liquid flows have been observed from the leakage detection layers of many double-lined landfills and surface impoundment facilities."

They went on to conclude:

"Based on the data in this study, an action leakage rate of 50 lphd [liters per hectare per day] is too restrictive and presents a performance standard that, if promulgated by USEPA, frequently will not be met by facilities that were constructed to present standards with rigorous third-party CQA programs. An action leakage rate of 200 lphd appears to be reasonable for landfills that have been constructed using rigorous third-party CQA programs."

They found that double liners in landfills constructed with rigorous quality assurance and quality control for liner construction, leak at the time of construction at a rate of about 200 liters/hectare/day, which is about 7,800 gallons per acre of landfill liner, per year. This means that annually thousands of gallons of leachate can pass through an acre of a landfill's double-liner at the time of construction. For the 14 acres that will be covered by the landfill expansion, that leakage rate has the potential to pollute large amounts of groundwater.

The liner "action leakage rate" referred to by Bonaparte and Gross is the rate of liner leakage that is considered to represent "failure" of the liner system. As Bonaparte and Gross indicated, the US EPA has proposed a "threshold" "action leakage rate" of 50 liters/hectare/day. **Bonaparte and Gross found that even new landfills with the best of liner construction cannot be expected to meet that performance standard and recommended that it be quadrupled in order that landfills can be in "compliance" with the US EPA regulations.**

The findings of Bonaparte and Gross (1990) on this issue are in accord with those reported in 1989 by the US EPA. In a discussion of the requirements for hazardous waste landfill liner design, construction, and closure, the US EPA (1989) stated,

"EPA realizes that even with a good construction quality assurance plan, flexible membrane liners (FMLs) will allow some liquid transmission either through water vapor permeation of an intact FML, or through small pinholes or tears in a slightly flawed FML. Leakage rates resulting from these mechanisms can range from less than 1 to 300 gallons per acre per day (gal/acre/day)."

The key to achieving a composite liner is the ability of the contractor to achieve intimate contact between the flexible membrane liner (FML) and the underlying soil layer throughout the lined area. In theory, such liners minimize leakage better than either component alone or both components not in intimate contact. However, it is recognized that it is difficult, if not impossible, to keep leakage rates as low as those estimated based on the attainment of a true composite liner, under field conditions. In areas in which intimate contact between the FML and compacted soil is not achieved, the liners act separately, not as a composite; the components of a composite liner acting alone or separately are capable of transporting leachate at high rates.

The composite liner of the type proposed for the Union Mine Landfill will not prevent leachate migration for as long as the wastes pose a threat to water quality. In describing "Leakage through a composite liner" Giroud and Bonaparte (1989) state:

"A composite liner is comprised of a geomembrane upper component and a low-permeability soil layer lower component. Therefore, leakage migrates first through the geomembrane component and, then, through the soil component." "...there are two mechanisms by which leakage can migrate through a geomembrane: permeation through the geomembrane (i.e. flow through a geomembrane that has no defects); and flow through geomembrane defects such as holes or pinholes."

With regard to the achievement of intimate contact between the FML and compacted soil layer, Giroud and Bonaparte (1989) state:

"There may be no space between the geomembrane component and the soil component of a composite liner if the geomembrane is sprayed directly onto the low-permeability soil layer. This technique is not very often used, and, in the more usual case of a geomembrane manufactured in a plant, there will be some space between the geomembrane component and the soil component of a composite liner in almost all applications because: the geomembrane has wrinkles (note that geomembrane wrinkles may exist even under very high pressures as shown by Stone [14]); there are clods or irregularities at the underlying soil surface; and/or even if the underlying soil surface is apparently smooth, the geomembrane bridges small spaces between soil particles."

Later in the document they state with reference to composite liners:

"In fact, geomembranes are never in close contact with the soil (with the possible exception of geomembranes sprayed directly onto the soil) because of small soil surface irregularities that are bridged by the geomembrane."

Giroud and Bonaparte (1989) conclude:

"In spite of their limitations, the tests show that composite liners are significantly more effective than either low-permeability soil liners or geomembrane liners. However, the test results also indicate that composite liners as they are usually built (i.e. by unrolling a geomembrane on a layer of low-permeability soil) do not perform as well as an ideal composite liner, which would be made of a geomembrane in perfect contact with a low-permeability soil (i.e. a geomembrane sprayed on the soil)."

It is evident that composite liners leak at the time of construction at sufficient rates to violate Chapter 15 requirements, and that over time the composite liner that is proposed for the Union Mine Landfill will deteriorate in its ability to retard leachate migration through it.

It should be noted that a composite liner is proposed to only be used under the bottom part of the Union Mine Landfill. A geomembrane liner alone is proposed to be used on the side slopes. On page 2-36 of the final EIR, it states,

"A synthetic liner (60-mil HDPE geomembrane) would be placed on the natural slopes of the expansion area and on the side slopes of the existing fill area."

It is well known from the literature that such a liner can leak at a very high rate and are considered largely ineffective in preventing groundwater pollution by landfill leachate (See Daniel 1990). In October 1991, the US EPA (1991a) promulgated the regulations governing the disposal of wastes in municipal landfills. These regulations require that composite liners be used to line the landfill. Neither soil liners nor geomembrane liners alone will be allowed in landfills to meet the minimum US EPA requirements. The US EPA, however, acknowledges that these minimum requirements (a composite liner) will not prevent groundwater pollution. Such a liner is allowed under federal regulations since RCRA does not require the same degree of groundwater quality protection as required in California by Chapter 15. Chapter 15 is explicit in requiring no impairment of uses of groundwater for as long as the wastes represent a threat by landfill leachate. A single composite liner as the type proposed for the Union Mine Landfill expansion will not comply with Chapter 15 requirements.

As discussed by Lee and Jones (1991c), some states such as New York and New Jersey recognized several years ago that single composite liners are not adequate for groundwater quality protection. These states adopted double composite lining systems. Daniels and Koerner (1991) have recently indicated that the current state of the art design of landfill liners is a double composite liner. However, even double composite lined systems constructed and operated as is typically done today will ultimately fail to prevent groundwater pollution by landfill leachate.

Organic Permeation through HDPE FML Liners

It has been known for some time that certain organic chemicals such as organic solvents, many of which are known or suspected carcinogens can pass through intact (no holes) HDPE liners used for solid waste landfills. While it is sometimes asserted that organic permeation through HDPE liners only occurs from concentrated solutions of organics, recent research results from the University of Wisconsin (Sakti et al. 1991, 1992) provide confirmation that low molecular weight solvents in dilute aqueous solutions will readily pass through intact HDPE liners. From their study of the permeation of m-xylene, toluene, trichloroethylene (TCE), and methylene chloride from dilute aqueous solutions through HDPE geomembrane liner material, Sakti et al. (1991) reported,

"These chemicals penetrated through 0.76, 1.52, and 2.54 mm HDPE geomembranes in about one, four, and thirteen days, respectively."

2.54-mm HDPE is equivalent to 100-mil HDPE liner material. The HDPE liner material proposed for the Union Mine Landfill is only 60-mil. They also found that stretching the geomembrane by 5% increased the rate of permeation. Sakti et al. (1991) concluded that a geomembrane would have to be on the order of 7.3 cm (about 3 inches) thick to prevent organic permeation for a period of 25 years. After that period of time, those organics would pass even that thickness of liner. It is evident that organic permeation through intact HDPE liners is of concern since the organic solvents of concern can be purchased and are commonly used by the public for cleaning purposes. As discussed by Lee and Jones (1991c), small amounts of these solvents can pollute large amounts of groundwater. For example, a half gallon of TCE which is purchasable at hardware stores when discarded in household trash could readily pass undetected by any trash inspection program into the landfill. Eventually the can will rust out and the TCE present in the can at the time of disposal could pass through the liner, even without any holes in it, and pollute millions of gallons of groundwater with concentrations of carcinogens above those allowed by the Department of Health Services for drinking water.

Chapter 15 Requirements for Protection of Groundwater Quality

Article 3 of the SWRCB Chapter 15 regulations governing discharges of waste to land, sets forth the classification and siting of waste management units. Quoted below are several sections of Article 3 that pertain to characteristics of the natural strata that must be met for the placement of a Class III landfill.

Section 2530(a):

"Waste management units shall be classified according to their ability to contain wastes. Containment shall be determined by geology, hydrology, topography, climatology, and other factors relating to the ability of the waste management unit to protect water quality."

Section 2530(c):

"All new landfills, waste piles, and surface impoundments shall be sited, designed, constructed, and operated to ensure that wastes will be a minimum of 5 feet above the highest anticipated elevation of underlying ground water."

Section 2530(d):

"All containment structures at waste management units shall have a foundation or base capable of providing support for the structures and capable of withstanding hydraulic pressure gradients to prevent failure due to settlement, compression, or uplift as certified by a registered civil engineer or certified engineering geologist."

Section 2533(a):

"Class III landfills shall be located where site characteristics provide adequate separation between nonhazardous solid waste and waters of the state."

Section 2533(b)(1):

"New Class III and existing Class 11-2 landfills shall be sited where soil characteristics, distance from waste to ground water, and other factors <u>will ensure no impairment of beneficial uses of surface water or of ground water beneath or adjacent to the landfill.</u>" (emphasis added)

Section 2533(b)(2):

"Where consideration of the factors in subsection (b)(1) of this section indicates that site characteristics alone do not ensure protection of the quality of ground water or surface water, Class III landfills shall be required to have a single clay liner with permeability of 1×10^{-6} cm/sec <u>or less</u>." [emphasis added]

Section 2540(c):

"Class III landfills shall have <u>containment structures which are capable of preventing degradation of waters of the state</u> as a result of waste discharges to the landfills if site characteristics are inadequate." (emphasis added)

Thus, to site a Class III landfill such as the proposed expansion of the Union Mine Landfill at a particular location, the natural geology must prevent impairment of the waters of the state for as long as wastes pose a threat.

Article 1, Section 2510(b)(1) and (2) states,

"Unless otherwise specified, alternatives to construction or prescriptive standards contained in this subchapter may be considered. Alternatives shall only be approved where the discharger demonstrates that:

(1) The construction or prescriptive standard is not feasible as provided in subsection (c) of this section, and

(2) There is a specific engineered alternative that

(A) is consistent with the performance goal addressed by the particular construction or prescriptive standard, and

(B) affords equivalent protection against water quality impairment."

Thus, Chapter 15 allows consideration to be given to the development of a waste management unit in a geologically unsuitable site if the performance standards of Chapter 15 are demonstrated to be met by the engineered alternative. In the case of a Class III landfill such as the proposed Union Mine Landfill expansion, the performance standard is the prevention of impairment of uses of the waters of the state for as long as the wastes pose a threat. With regard to the design of engineered alternatives, Chapter 15 provides a number of minimum boundary specifications that must be met as part of the requirement to meet the performance standard. These include the following.

"A liner system which conforms to the requirements of Article 4 of this subchapter with a permeability of not more than $1x10^{-6}$ cm/sec shall be used for landfills and waste piles when natural geologic materials do not satisfy the requirements in subsection (b)(1) of this section." [2532(b)(4)]

"Clay liners for a Class I or Class II waste management unit shall be a minimum of 2 feet thick and shall be installed at a relative compaction of at least 90 percent. For a Class III landfill, a clay liner, if required, shall be a <u>minimum</u> of 1-foot thick and shall be installed at a relative compaction of at least 90 percent." [2542(b)] (emphasis added)

"Synthetic liners shall have a ***minimum*** thickness of 40 mils." [2542(c)] (emphasis added)

Thus, a proper reading of the provisions of Chapter 15 shows that the overriding requirement is to prevent impairment of use of waters of the state from the waste management unit for as long as the wastes represent a threat to water quality. Given the nature of Class III wastes, that threat will exist for as long as the materials are present in the waste management unit. This issue has been discussed in detail by Lee and Jones (1991b). Where the natural geological strata are insufficient to provide that level of protection, a clay liner with a **minimum** permeability of $1x10^{-6}$ cm/sec may be allowed if it is sufficiently thick **to prevent** fluid migration that causes groundwater use impairment.

It is evident from the above listing of Chapter 15 requirements that in order to conform to Chapter 15 requirements, the engineered structures must achieve protection of ground water quality. For example, the engineered alternative liner must be capable of preventing degradation of waters of the state and have a permeability no greater than $1x10^{-6}$ cm/sec and be of sufficient thickness to prevent vertical movement of fluid, including waste and leachate, from waste management units to waters of the state causing their degradation as long as wastes in such units pose a threat to water quality.

On page 2-36 of the final EIR, it states that,

"d) Liners

The expansion area would be constructed with a liner system as required to meet state standards (Title 14 and Title 23, Chapter 15). Both synthetic liners, high density polyethylene geomembrane (HDPE), and composite liners, clay soil, and HDPE would be used. The purpose of liner systems is to inhibit the downward migration of leachate and to allow for the collection and removal of leachate. A synthetic liner (60-mil HDPE geomembrane) would be placed on the natural slopes of the expansion area and on the side slopes of the existing fill area. The bottom of the expansion area canyon would be constructed with a composite liner consisting of a 2-foot-thick layer of low-permeability clay soil overlain by a 60-mil HDPE geomembrane."

Contrary to the statement made in the final EIR, none of the provisions of Chapter 15 specify that either a 2-ft thick layer of clay compacted to a permeability of $1x10^{-6}$ cm/sec or a 60-mil synthetic liner, alone or in combination, or any other specific liner thickness or permeability will necessarily meet the requirement for protection of ground and surface water quality. The specification for the liner(s) is that it provide unequivocal protection of the waters of the state from degradation from contaminants derived from the waste management unit. The design of a liner must achieve that performance standard in order to achieve equivalency to the natural protection required for as long as the wastes pose a threat. Contrary to statements made in the EIR two feet of soil compacted to a permeability of $1x10^{-6}$ cm/sec is not specified by Chapter 15 as being equivalent to natural geologic strata of sufficient thickness to prevent groundwater use impairment. It is therefore obvious that the EIR statements that the liners will comply with the requirements of Chapter 15 is inaccurate.

Leachate Collection and Removal System Performance

On page 2-52 of the final EIR, the statement is made

"A leachate collection and removal system (LCRS) would be constructed in the expansion area in accordance with state regulations (CCR Title 23 Chapter 15)."

On page 2-55 it is stated,

"Leachate generated in the expansion area would be collected at the base of the compacted refuse by a granular drainage blanket covering the composite liner in the canyon bottom."

This is a highly misleading statement. Those not knowledgeable could conclude that **all** leachate would be collected by this system. Those knowledgeable however know that that is not the case; that leachate collection removal systems do not collect all leachate. They collect only part of the leachate while they are functioning. Leachate collection removal systems depend on the integrity of the flexible membrane liner (geomembrane - plastic sheeting) to prevent leachate from passing through the lower liner of compacted soil into the groundwater system. As discussed elsewhere in this report, Bonaparte and Gross (1990) have found that at the time of construction, the flexible membrane liners - plastic sheeting leak at the rate of 20 gallons/acre/day through holes in the liner.

A leachate collection and removal system of the type proposed for the Union Mine Landfill expansion theoretically operates as follows. Leachate generated in the waste passes down through the sand (or geocomposite) until it reaches the liner; it then flows along the top of the liner to a sump where it can be removed. It is sometimes asserted that, due to the capabilities of the leachate collection system, there is little potential for the buildup of a sustained leachate head on the liner. As discussed below, there will be locations within the proposed landfill where a sustained leachate head can develop and therefore leaks in the holes that exist in the FML at the time of construction will occur at a greater rate than if the sustained head were not present. It is also asserted that if there is no sustained leachate head, there is no potential for leakage. That statement is not technically correct. A sustained head is not a prerequisite for leaks. Leaks will occur even without buildup of sustained head. It is not necessary that there be any head of leachate to drive it through the liner, although the rate of leakage will be affected by head. Leakage through holes in the liner can occur by unsaturated contaminant transport for which there is no measurable, in the normal sense, head of leachate.

Further, an important factor that is now becoming widely recognized is that the porous layers in leachate collection and removal systems used for municipal landfills tend to become clogged or blocked by biological growths, thereby leading to ponding of leachate behind clogged areas; such ponding contributes to greater rates of leachate transport through holes in the liners.

The US EPA (1989) stated with regard to problems with clogging of leachate collection and removal systems,

"Clogging is the primary cause of concern for the long-term performance of leachate collection and removal systems. Particulate clogging can occur in a number of locations. First, the sand filter itself can clog the drainage gravel. Second, the solid material within the leachate can clog the drainage gravel or geonet. Third, and most likely, the solid suspended material within the leachate can clog the sand filter or geotextile filter."

The US EPA (1989) also stated,

"Biological clogging can arise from many sources including slime and sheath formation, biomass formation, ochering, sulfide deposition, and carbonate deposition." "Sand filters and geotextile filters are most likely to clog, with gravel, geonets, and geocomposites next in order from most to least likely."

Koerner and Koerner (1990) presented the results of a study of biological growth-induced clogging of geotextile filters used in municipal solid waste landfill leachate collection and removal systems. They indicated that municipal landfill leachate is particularly prone to cause biological growth-induced clogging of leachate collection and removal systems because of the warm temperatures and abundant food sources for microorganisms.

Thus, the leachate collection and removal systems, including the type designed for the proposed Union Mine Landfill expansion, can leak from the time of construction and will deteriorate over time, becoming increasingly less efficient in collecting leachate. Further, biological growths within the porous layer of the leachate collection and removal system will clog the system leading to ponding on the liner, increasing the rate of leakage in those areas.

Examination of the performance characteristics of the geomembrane liner and composite liner used for the proposed Union Mine Landfill expansion leads to the undebatable conclusion that such a liner will not contain/isolate the wastes from the waters of the state so that they do not cause degradation-use impairment of these waters. These liners will not prevent leachate migration through them at the time of construction which can cause groundwater pollution-use impairment. Further, over the period of time that the wastes represent a threat to ground water quality, there will be an undeniable degradation of their design performance characteristics. Therefore, the proposed Union Mine Landfill expansion does not conform to the requirements set forth in Chapter 15. This is a fundamental error made in the EIR that is significantly misleading to the decision makers and the public on even the short-term much less long-term ability of this proposed landfill to protect the waters of the state from degradation by waste components.

Is This "NIMBY"?

Since I have not met with any of the various concerned citizens who have contacted me regarding the proposed expansion of the Union Mine Landfill, I do not know the details and specific bases for their individual particular concerns. However, from my review of the situation, I believe that the concerned citizens have justification for opposing the landfill expansion based on the inability of the proposed landfill to comply with Chapter 15 requirements. Further, the County's past record regarding protection of groundwater and surface water quality from the existing Union Mine Landfill leaves little reason to believe that the County will be any more able to protect the public health, groundwater and surface water resources, the environment, and economic welfare of adjacent and nearby property owners and residents in the future from impacts of the proposed landfill expansion than the County has provided from the existing landfill. Under the current situation, the citizens, nearby property-owners, and area residents do not appear to be simply crying "NIMBY." Anyone facing the situation they face would likely conclude that the expansion of the Union Mine Landfill is strongly contrary to their interests.

Until the time that the people who contribute waste to a landfill make the provisions and take the appropriate and complete responsibility to properly site landfills and pay the total costs of solid waste disposal so that those who live and/or use lands adjacent and near the landfill are not adversely affected by the landfill now or in the future, there will be justification to oppose siting of landfills or landfill expansions in many areas. The people in El Dorado County who contribute to the county landfill should not be able to continue to dispose of their wastes for costs less than the real costs of proper siting, design, operation, and proper ad infinitum maintenance, at the expense and welfare of current and future adjacent and nearby residents and property-owners. Those who reside near a proposed landfill are entitled to protection of their and their future generations' economic, public health, and groundwater resource interests.

Dr. Jones and I have previously scheduled commitments for Thursday, February 27, and will therefore not be able to attend the El Dorado County Planning Commission hearing for certification of this EIR. I can, however, make myself available to meet with El Dorado County Planning Commission members and with members of the El Dorado

County Community Development Department Planning Division and Board of Supervisors at another time to discuss any aspect of these comments. If you or others have any specific questions about these comments, please contact me.

Sincerely yours,

G. Fred Lee, Ph.D.
President

copy to: Darol Rasmussen, Chairman Planning Commission
Steven Hust, El Dorado County Planning Division
Michael Waggoner, CA RWQCB-Central Valley Region
William Crooks, CA RWQCB-Central Valley Region
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