Overview of Testimony of Dr. G. Fred Lee, Potential Impacts of the BFI Proposed Campo Sur Landfill Salinas, Puerto Rico April 22-24, 1997

Prepared by

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Presented herein is a summary of many of the key issues that should be considered in the review of the potential public health, environmental and other potential impact issues associated with the development of the BFI proposed Campo Sur Landfill. This discussion is based on the review of the EIS prepared by BFI, testimony of BFI consultants Dr. Giroud and Mr. Gentile, questions asked of me during my testimony and information provided by consultants to the proposed landfill opponents. The development of my testimony and this statement has been supported by Hacienda-Santa-Elena, Inc., Ganaderias Del Sur, S.E.

My testimony utilized a set of transparencies that summarized issues raised in the EIS and in the testimony of BFI witnesses, Giroud and Gentile. An overview discussion of key issues is presented below in which I review some of the key issues covered on the transparencies used during my testimony. My testimony focused on:

- discussing the unreliable information provided by Giroud on the ability of the proposed Campo Sur Landfill liner and cover systems to prevent groundwater pollution by landfill leachate for as long as the wastes in the landfill will be a threat;

- discussing unreliable information provided by Gentile on the protective nature of the aquifer system, groundwater monitoring and the "no-impact" modeling;

- discussing unreliable information provided in the EIS on the potential environmental impacts of the proposed Campo Sur Landfill; and

- discussing potential impacts of the proposed Campo Sur Landfill on public health, groundwater resources and the environment.

Qualifications

My work on municipal landfill impact matters began in the mid-1950s while I was an undergraduate student in environmental health sciences at San Jose State College in San Jose, California. My specific course and field work involved review of municipal solid waste landfill impacts on public health and the environment. I obtained a Master of Science in Public Health degree from the University of North Carolina in Chapel Hill in 1957. The focus of my masters degree work was on water quality evaluation and management with respect to public health and environmental protection from chemical constituents and pathogenic organisms.

I obtained a PhD degree specializing in environmental engineering from Harvard University in 1960. As part of this degree work I obtained further formal education in the fate, effects and significance and the development of control programs for chemical constituents in surface and groundwater systems. An area of specialization during my PhD work was aquatic chemistry.

For a 30-year period, I held university graduate level teaching and research positions in departments of civil and environmental engineering at several major US universities including the University of Wisconsin-Madison, University of Texas at Dallas and Colorado State University. During this period I taught graduate level environmental engineering courses devoted to water and wastewater analysis, water and wastewater treatment plant design, surface and groundwater quality evaluation and management and solid and hazardous waste management. I have published over 500 professional papers and reports on my research results and professional experience. My research included, beginning in the 1970s, the first work done on the impacts of organics on the permeability of clay liners for landfills and waste lagoons.

In the 1980s, I conducted a comprehensive review of the properties of HDPE liners of the general type being used today for lining municipal solid waste and hazardous waste landfills with respect to their compatibility with landfill leachate and their expected performance in containing waste-derived constituents for as long as the wastes will be a threat.

My consulting work on the impacts of municipal solid waste landfills began in the 1960s where, while directing the Water Chemistry Program in the Department of Civil and Environmental Engineering at the University of Wisconsin-Madison, I became involved in the review of the impacts of municipal solid waste landfills on groundwater quality. In the 1970s while I was Director of the Center for Environmental Studies at the University of Texas at Dallas, I became involved in the review of a number of municipal solid waste landfill situations focusing on the impacts of the potential releases from the landfills on public health and the environment.

In the 1980s while I held the positions of Director of the Site Assessment and Remediation Division of a multi-university consortium hazardous waste research center and a Distinguished Professorship of Civil and Environmental Engineering at the New Jersey Institute of Technology, I was involved in numerous situations involving the impact of landfilling of municipal solid wastes on public health and the environment. At NJIT I taught graduate level environmental engineering courses devoted to municipal solid waste and hazardous waste landfill design. I have served as an advisor to the states of California, Michigan, New Jersey and Texas on solid waste regulations and management.

In the early 1980s while holding a professorship in Civil and Environmental Engineering at Colorado State University, I served as an advisor to Brush, Colorado on the potential impacts of a BFI proposed hazardous waste landfill on the groundwater resources of interest to the community. Based on this work, I published a paper in the Journal of the American Water Works Association discussing the ultimate failure of the liner systems proposed for that landfill in preventing groundwater pollution by landfill leachate. In 1984 this paper was judged by the Water Resources Division of the American Water Works Association as the best paper published in the journal during that year.

In 1989, I retired after 30 years of graduate level university teaching and research and expanded the part-time consulting that I had been doing with governmental agencies and industry into a full-time activity. A principal area of my work since then has been assisting water utilities, municipalities, industry, agricultural interests and others in evaluating the potential public health and environmental impacts of proposed or existing hazardous as well as municipal solid waste landfills. I have been involved in the review of approximately 50 different landfills in various parts of the US and in other countries.

Dr. Jones-Lee, my wife, and I have published extensively on the issues that should be considered in developing new or expanded municipal solid waste and hazardous waste landfills in order to protect public health, groundwater resources, environment and interests of those within the sphere of influence of the landfill. Our over 40 professional papers and reports on landfilling issues provide guidance not only on the problems of today's minimum US EPA Subtitle D landfills but also how landfilling of non-recyclable wastes can and should take place to protect public health, groundwater resources, the environment and the interests of those within the sphere of influence of a landfill. We make many of our publications available as downloadable files from our web site.

In addition to teaching and serving as a consultant in environmental engineering for over 37 years, I am a registered professional engineer in the state of Texas and a Diplomate in the American Academy of Environmental Engineers (AAEE). The latter recognizes my leadership roles in the environmental engineering field. I serve as the chief examiner for the AAEE in north-central California where I am responsible for administering examinations for professional engineers with extensive experience and expertise in various aspects of environmental engineering including solid and hazardous waste management.

My work on landfill matters has included developing and presenting several-day short-courses devoted to landfills and groundwater quality protection issues. These courses have been presented through

the American Society of Civil Engineers, the American Water Resources Association, the National Ground Water Association in several US cities, and the University of California Extension Programs at several of the UC campuses, as well as through other groups.

Cross Examination on Qualifications

BFI attorneys, during their cross examination of me, made several attempts to infer that I was not qualified to present my testimony on the potential problems of BFI's proposed Campo Sur Landfill. I have assisted water utilities, municipalities and others in assessing the potential impacts of several BFI landfills. About 10% of my work on landfills has been devoted to the review of BFI's existing or proposed landfills. As discussed during my cross examination, in the early 1980s while I was assisting Brush, Colorado in evaluating potential impacts of a proposed BFI landfill on Brush's groundwater resources, some unidentified individuals filed a complaint with the state of Colorado Board of Registration for Professional Engineering and Land Surveyors claiming that I was practicing engineering without a license. The Board reviewed this matter and concluded that the allegation was unfounded. While not discussed during my cross examination, a similar situation occurred in California in the early 1990s where, while reviewing a BFI proposed landfill, some unidentified entity filed a complaint with the state of California Board of Registration for Professional Engineers and Land Surveyors claiming that I was practicing engineering without a license. The state Registration Board concluded that the allegation was unfounded.

I have frequently encountered situations when I testify on behalf of municipalities and others that a particular landfill design, operation, closure and post-closure care would not protect public health, groundwater resources and the environment for as long as the wastes in the landfill would be a threat, the landfill proponent attorneys attempt to discredit my testimony by asserting such statements as were made by BFI attorneys in the Campo Sur Landfill matter that I do not have a degree in engineering. As I have discussed previously and testified in the Campo Sur Landfill hearing, the PhD degree diploma from Harvard University is written in Latin (ARTEM MECHINALEM) which literally translates as "mechanical arts." "Mechanical arts" is understood as engineering. Appended to these comments is a letter from Harvard University which specifically states that my degree is in engineering and that my fields of study were in four areas of environmental engineering. Further, while BFI attorneys tried to assert that the what is now called environmental engineering program at Harvard University was not initiated until after I graduated from there in 1960, the fact is that the environmental engineering program at Harvard University is one of the oldest programs in the country devoted to water and wastewater treatment, and water supply and solid waste management engineering that was first initiated in the 1920s.

Letter to William Ruckelshaus. BFI's attorneys attempted to claim that in some ill-defined way my testimony on the significant public health, groundwater resource and environmental threats of the proposed Campo Sur Landfill was in some way inappropriate based on a letter that I wrote January 28, 1989 to William Ruckelshaus, then chairman of BFI, concerning exploring the possibility of a position for Dr. Anne Jones and me with BFI in working toward improving the landfilling of municipal solid waste in the US. As I testified, in 1989 I had taught graduate level environmental engineering and environmental science courses

for 30 years. It was at that time that I decided to retire from teaching and research and become active as a full-time professional in the environmental engineering field. As indicated in the letter to Ruckelshaus who was a former administrator for the US EPA, in January 1989 I contacted the US EPA and Mr. Ruckelshaus as well as others in order to explore the possibility of developing positions for Dr. Anne Jones and me that would enable us to work toward developing more appropriate approaches for managing municipal solid waste and other environmental problems than were occurring at that time. I was particularly impressed with the fact that BFI had appointed William Ruckelshaus as its CEO and a former high ranking US EPA official, Marcia Williams, as one of BFI's top management. Further, as stated in the letter, in December 1988 I heard Mr. Ruckelshaus discuss the future of solid waste management in the US at a New York City meeting which indicated to me that BFI had the potential to play a major leadership role in reshaping municipal solid waste landfilling from the recalcitrant polluter approach that BFI and other garbage companies had traditionally followed in the past to one that would address in a meaningful way the long-term problems associated with the landfilling of municipal solid waste.

It is totally inappropriate to infer that my testimony in the Campo Sur Landfill matter is in any way influenced by my 1989 letter to William Ruckelshaus. As is evidenced by the reports I have developed on various landfill matters in which I have been involved (several of which are available on our web site), the basic thrust of my testimony on these issues is the same whether it is a BFI landfill or a landfill being developed by another private or public entity. BFI, as well as others, are still attempting to develop landfills that will enable landfilling of municipal garbage to take place at initial costs which do not protect the health and interests of those within the sphere of influence of the landfill during its active life and which are cheaper than the real long-term costs associated with the eventual groundwater pollution and the associated superfund-like clean-up that will have to be used to prevent the spread of the landfill leachate pollution beyond the point where it is finally discovered and action is taken.

Advisor to the State of California WRCB. Another area that BFI attorneys spent time in cross examining me was associated with an April 23, 1992 memorandum that was written by a state of California Water Resources Control Board staff member, H. Schueller, concerning my role as an advisor to the state in the development of the state's current solid waste regulations. As I testified, and as is confirmed in H. Schueller's memorandum, I have been asked to serve as an advisor to a number of states, such as California, Michigan, Colorado, Texas and New Jersey, on the development of landfilling regulations for municipal solid waste or hazardous waste. The memorandum the BFI attorneys introduced into the Campo Sur Landfill hearing confirmed that I was requested by the state of California Water Resources Control Board staff to review the then-proposed landfilling regulations which have become known now as Chapter 15. At that time, I held a professorship in civil and environmental engineering in the University of Texas system. Further, while not discussed in the memorandum, I was asked by the same Water Resources Control Board staff member to testify in a state of California Water Resources Control Board hearing held in 1984 devoted to adopting the Chapter 15 regulations. I also, at the request of the State Board staff, presented a short-course on groundwater monitoring near landfills to State Board and regional board staff. As discussed below, my work with the state of California Water Resources Control Board staff in helping to develop Chapter 15 regulations has caused me to become aware of the original intent of the regulations

relative to how they have been implemented by the regional board staff. The problems with reliable implementation of Chapter 15 were well recognized in the early 1990s. H. Schueller stated in a memo dated December 27, 1990,

> *"Following the meetings, staff conducted a detailed analysis of the regulations to determine the need for additional revisions."*
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> * * *
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> *"It concludes that there are few compelling reasons for revision of the regulations at this time, and recommends that the focus of our attention during the next year be on improving the implementation of the existing regulations."*

The H. Schueller memorandum of April 23, 1992 confirmed my interest in working toward trying to improve the landfilling of municipal solid wastes where, without financial support, I assisted the state of California in developing its solid waste regulations. My work in this area can be confirmed by contacting Mr. Gil Torres (916-756-9488), formerly of the State Water Resources Control Board. He was the Board staff member with whom I directly worked in the early 1980s on the Chapter 15 regulations.

Letter to William Reilly. Another letter introduced into the Campo Sur Landfill hearing was a November 29, 1991 letter I wrote to US EPA Administrator William Reilly concerning the deficiencies that I found in the US EPA's Subtitle D regulations. This letter provided, as enclosures, documentation as to the lack of protection of groundwaters from impaired use for as long as the wastes represent a threat. Don R. Clay, Assistant Administrator, responded in his December 23, 1991 letter on behalf of W. Reilly addressing the issues I raised in my November 29, 1991 letter,

> *"I believe that the Subtitle D criteria, in addition to other EPA efforts, are an important step in improving the safety of municipal solid waste landfills. The criteria are part of EPA's three-tier approach to better managing municipal solid wastes — improved landfilling, along with increased source reduction and recycling, will further serve to protect our nation's ground water."*

It is important to note that Mr. Clay did not state that the minimum Subtitle D landfill liner systems will be protective of groundwater resources from pollution by municipal landfill leachate for as long as the wastes in a landfill will be a threat. In his December 23, 1991 letter he acknowledged that there are significant problems with the long-term protection provided by "dry tomb" type landfills that would be permitted under Subtitle D. It is for this reason that the US EPA was highly involved in supporting so-called wet landfill research devoted to trying to shorten the time that the wastes in a landfill would be a threat.

Rather than confirming BFI's position in the Campo Sur Landfill hearing that the US EPA believed in adopting Subtitle D regulations that a minimum composite liner would protect groundwaters from impaired use for as long as the wastes represent a threat, Mr. Clay's letter was strongly supportive of my position that Subtitle D landfills of the "dry tomb" type will only postpone when groundwater pollution

occurs. In subsequent correspondence, Mr. Clay informed me that there was no new information from that published by the US EPA in 1988 as part of developing Subtitle D regulations which would show that eventually a minimum composite liner will not protect groundwaters from impaired use for as long as the wastes will be a threat. Further, it is clear that the US EPA in adopting Subtitle D did not adequately and reliably evaluate the ability of the groundwater monitoring systems that are typically used to detect leachate-polluted groundwaters at the point of compliance for groundwater monitoring before widespread groundwater pollution occurs under off-site properties.

Dr. Daniel's Letter to BFI. BFI attorneys introduced into the record a 1989 letter from Dr. David Daniel to a Gary Johnson of BFI where Dr. Daniel comments on a late 1980s report that Dr. Anne Jones-Lee and I developed on the potential problems with municipal solid waste landfills as they were proposed to be developed under the then-proposed Subtitle D regulations. These regulations had been proposed by the US EPA in August 1988. While I have not seen this letter before, I find upon review of it, as I testified, that Dr. Daniel made several significant errors in his comments. While Dr. Daniel states that pollution of groundwaters by MSW leachate in arid areas is not inevitable, it is clear that Dr. Daniel was not aware of the work that had been done in California at that time by the State Water Resources Control Board in the Solid Waste Assessment Test of landfills located in various parts of California. It was known then that 83% of California's over 2,200 landfills were polluting groundwaters with landfill leachate. More than half of these landfills are located in what typically would be considered to be arid areas. While arid area landfills produce less leachate and their leachate production is intermittent with respect to leachate being produced only during the rainfall periods, they produce some leachate that does, in fact, pollute groundwaters.

With respect to Dr. Daniel's statement, *"Examples of landfills that are working extremely well include the Keele Valley landfill near Toronto (with a 1-m-thick clay liner and leachate collection system)..."* I am familiar with the Keele Valley landfill situation through my work on landfills in Ontario, Canada. Contrary to Dr. Daniel's statement, the Keele Valley landfill situation will result in the pollution of groundwaters by landfill leachate. In fact, Metro Toronto staff acknowledged that this pollution will occur. They, however, have planned for it through the development of a pump and treat system that will capture the polluted groundwaters before they trespass under adjacent properties. The hydrogeology of the Keele Valley landfill area is such that such a system can be made to work. It will, however, require that the pump and treat system be operated for hundreds of years in order to prevent off-site groundwater pollution. Further, with reference to the Campo Sur site, such a pump and treat system could not reliably be operated at the Campo Sur Landfill site because of the inability to reliably capture leachate-polluted groundwaters that could pass by collection wells in the fractured bedrock system.

With respect to Dr. Daniel's statement about success of the Wisconsin land fills with thick clay liners, as I testified, it is my understanding that the US EPA found that Wisconsin's thick clay liner systems were not reliable in preventing groundwater pollution. While very thick clay liners can significantly slow down the rate of groundwater pollution, they will not prevent it. The wastes in such landfills would be a

threat forever. Clays have a finite permeability which will eventually allow some leachate components to pass through them, polluting the underlying groundwaters.

Dr. Daniel's statement, *"We know from large underdrains installed beneath the liners at these sites that contamination is not occurring."* represents an incomplete discussion of issues. He should have discussed based on the short time such landfills have been operated whether it would be expected to see contamination occurring. Dr. Daniel has taken a very short-term perspective in evaluating the long-term potential for groundwater pollution associated with municipal solid waste landfills.

Overall, while Dr. Daniel has done high quality work in a number of areas of landfill liner systems, his comments to Johnson of BFI reflect a lack of proper review of issues and knowledge of specific areas that should have been considered and reported on as part of his commenting on Dr. Jones-Lee's and my report, "Municipal Solid Waste Management: Long-Term Public Health and Environmental Protection." As I commented during my testimony, what Dr. Daniel may have said about our report has no relevance to the Campo Sur Landfill situation. The problems with municipal solid waste landfills of the Campo Sur type have been more adequately documented in the last almost 10 years since Dr. Jones-Lee and I developed our initial review on long-term public health and environmental protection problems associated with municipal solid waste management.

Protective Nature of Minimum Subtitle D Landfills

Considerable attention was devoted by BFI attorneys in my cross examination to trying to convince the hearing examiner that my testimony on the ultimate pollution of the environment by the Campo Sur Landfill was contradictory to what the US EPA stated a number of years ago about the protective nature of minimum Subtitle D landfills. First, even if the situation was that as of the early 1990s where those in the landfilling field did not understand the highly significant problems that are well known today with minimum Subtitle D landfills, what was stated by those responsible for promulgating Subtitle D regulations in 1991 has little relevance to the Campo Sur Landfill situation today. It was understood by a few then and it is well understood now that minimum Subtitle D landfills will not be protective of groundwater resources from impaired use by landfill leachate for as long as the wastes in the landfill will be a threat.

The US EPA staff and administration in developing Subtitle D regulations were significantly impaired by a variety of pressures in developing landfills that would be protective for as long as the wastes represent a threat. Subtitle D regulations, like most regulations, are compromises between what is known to be needed to protect public health and the environment and economic and other factors that tend to cause the development of regulations that are less than fully protective. As is the case with Subtitle D regulations, this compromise resulted in a regulatory approach that was known then to only postpone when groundwater pollution occurs. In the approximately half a dozen years since the Subtitle D final regulatory approach was formulated, considerable additional information has been developed that clearly shows that minimum Subtitle D landfills will not be protective of groundwater resources for those landfills, like the

proposed Campo Sur Landfill, that are to be sited at a geologically unsuitable site in which there are important high-quality groundwater resources connected to the base of the landfill.

The most important new information that has been developed since the Subtitle D landfilling approach was first proposed in 1988 is the work of Dr. Cherry of the University of Waterloo. As I testified, in 1990 Dr. Cherry published a paper entitled, "Groundwater Monitoring: Some Deficiencies and Opportunities," in which he discussed the fact that traditional monitoring approaches used for classical sanitary landfills of a few monitoring wells spaced hundreds of feet apart at the point of compliance for groundwater monitoring is not reliable for detecting groundwater pollution from plastic sheeting-lined landfills when the pollution first reaches the groundwater monitoring point of compliance. As he discussed, while unlined landfills tend to leak leachate to the groundwater system at all locations, thereby producing large plumes that are easily detected by a limited number of monitoring wells, plastic sheeting-lined landfills initially produce finger plumes of leachate that typically have limited lateral spread in moving the distance from the edge of the landfill to the point of groundwater monitoring. The traditional and currently accepted approach of monitoring wells spaced hundreds to a thousand or more feet apart with each well having a zone of capture (sampling) of about one foot, is highly unreliable in detecting leachate-polluted groundwaters in accord with US EPA Subtitle D requirements.

Unreliable Groundwater Monitoring. It is unknown whether the US EPA in developing the final Subtitle D regulations released in 1992 was aware of Dr. Cherry's initial publication on the deficiencies in monitoring lined landfills. However, in January 1991, the American Society for Testing and Materials held a national conference devoted to Current Practices in Ground Water and Vadose Zone Investigations in which Dr. Cherry and others, such as Parsons and Davis in their paper, " A Proposed Strategy for Assessing Compliance with the RCRA Ground-Water Monitoring Regulations," discussed the deficiencies in groundwater monitoring that exist in lined landfills. Subsequently, because I found that there were few regulatory agency personnel and others who were aware of the problem of reliably monitoring plastic sheeting-lined landfills, in 1994 Dr. Jones-Lee and I published a review on this topic, "A Groundwater Protection Strategy for Lined Landfills," in which we discussed the results of Dr. Cherry's investigations and suggested that the approach that had been adopted by the state of Michigan for monitoring lined landfills using a double composite liner in which the lower liner is a leak detection system for the upper liner should be adopted nationally.

It appears that BFI and Gentile testifying on behalf of BFI were well aware of this problem for the Campo Sur Landfill situation since both BFI in its EIS and Gentile in his testimony on behalf of BFI followed the highly unusual approach of not providing a proposed groundwater monitoring approach for the proposed landfill. As I testified, without such information, it is impossible to judge the potential impacts of a proposed landfill since the primary defense against off-site groundwater pollution is the reliability of the groundwater monitoring system. It appears that BFI chose not to discuss this problem in its EIS or in Gentile's testimony with the hope that no one who is familiar with the literature on this topic would review the EIS or Gentile's testimony and thereby point out the deficiencies in the groundwater monitoring approach that BFI has proposed for the Campo Sur Landfill. However, as I testified, while BFI refused

to provide information on the groundwater monitoring system that it proposes to use for the Campo Sur Landfill, if BFI follows the typical approach that it has used at other landfills of groundwater monitoring wells located hundreds of feet apart at the point of compliance, the Campo Sur Landfill groundwater monitoring system would obviously not function as Gentile described in his "no impact" scenario evaluation of detecting leachate-polluted groundwaters when they first reach the point of compliance.

The groundwater monitoring situation at the proposed Campo Sur Landfill is even more unreliable than normally associated with the development of a Subtitle D landfill due to the fact that the Campo Sur area hydrogeology as well as the hydrogeology underlying the Coastal Plain aquifer system consists of fractured bedrock. It is well understood in the field that fractured rock bedrock systems of the type that exist near the Campo Sur site are impossible to reliably monitor for landfill leachate pollution. There can readily be preferred pathways of leachate migration through the fractured rock system that would not be detected by groundwater monitoring wells, even if they are spaced a few feet apart. This is the result of the fact that the wells could sample waters from one set of fractures, yet the leachate could be moving in a separate set of fractures that are not necessarily hydraulically connected to the sampled fracture aquifer system.

Overall, Subtitle D regulations, if implemented as proposed by BFI where, as described by Gentile in his "no impact" scenario, groundwater monitoring at the point of compliance is the key defense for preventing off-site pollution, will not be protective of groundwater resources in the Campo Sur as well as Coastal Plain aquifer systems. This type of problem is not unique to the Campo Sur situation. It is widely recognized in the landfill field as a fundamentally flawed situation in the existing Subtitle D regulations as they are being implemented today. As I testified, the state of Michigan recognized this problem and has taken a significantly different approach for monitoring the leakage of leachate through a single composite liner of the type required in Subtitle D. In our "A Groundwater Protection Strategy for Lined Landfills" paper, we recommend the state of Michigan's approach of a double composite liner where when leachate is found between the two composite liners, the landfill owner must either stop leachate generation or exhume (mine) the wastes since it is only a matter of time until leachate that has passed through the upper composite liner will also pass through the lower composite liner.

Uncertainty of Long-Term Funding. As I discussed in my testimony, the key to preventing groundwater pollution by a landfill is the availability of funds of sufficient magnitude to be able to take action at any time in the infinite future that the wastes in a municipal solid waste landfill, like the proposed Campo Sur Landfill, will be a threat. Because of the uncertainty of the availability of funds to take action after thirty years of post-closure care and monitoring, this will require that a dedicated trust fund be developed from disposal fees of sufficient magnitude to address all plausible worst-case scenario failure situations that could develop at a particular landfill. The situation that exists today where groundwater pollution at existing landfills is allowed to continue because the landfill owner is no longer available or willing to fund corrective action should not be allowed in the future. As I have published in "Landfill Post-Closure Care: Can Owners Guarantee the Money Will Be There?", L. Hickman, former executive director of the Solid Waste Association of North America, has published several reviews of the deficiencies in the long-term funding

situation such as, "Financial Assurance - Will the Check Bounce?," in which he recommends that a dedicated trust be used to ensure that funds will be available when needed to address post-closure problems associated with a landfill.

Unreliability of Clay-Lined Landfills. It became clear during my testimony that BFI was concerned that I mentioned that the state of California Water Resources Control Board had constructed clay-lined landfills which have subsequently been found to pollute groundwaters like unlined landfills. It was brought at the hearing out just before my testimony that BFI has apparently proposed to construct a liner system for the Campo Sur Landfill which would have less than the minimum Subtitle D single composite liner. BFI attorneys tried unsuccessfully to get me to acknowledge that BFI's views of the minimum liner required for a Subtitle D landfill was not a single composite liner. As I testified, such a proposal is highly inappropriate. While Subtitle D regulations allow a landfill proponent to demonstrate, on a site-specific basis, equivalent protection to that of a Subtitle D minimum composite liner, this demonstration should not be interpreted to mean that minimum Subtitle D requirements do not include a single composite liner. A critical review of Subtitle D regulations will clearly show that the minimum liner design generally acceptable is a single composite liner. Landfill applicants can, on a site-specific basis, attempt a demonstration that would allow less than a single composite liner, such as a clay liner system.

In 1984, the state of California adopted Chapter 15 regulations which specified that the minimum liner design was one foot of compacted soil with a permeability of less than 1×10^{-6} cm/sec. The Chapter 15 regulations also specified that whatever landfill liner system, cover system and monitoring systems are used, they must achieve an overall groundwater quality protection (performance standard) of no impaired use of groundwaters by landfill leachate for as long as the wastes in the landfill will be a threat. The State Water Resources Control Board staff responsible for the development of Chapter 15 regulations understood that a one-foot-thick compacted soil layer with a permeability of less than 1×10^{-6} cm/sec would not be a suitable liner for many landfills since based on a simple Darcy's law calculation, leachate could pass through such a liner in a few months. Unfortunately, in California the regional water quality control boards' staffs chose to implement Chapter 15's liner requirements by assuming that the one-foot-thick clay layer would provide the minimum groundwater protection performance standard set forth in the regulations. This has resulted in a situation where the landfills constructed between 1984 and 1993 which had the minimum liner system (1 foot of compacted clay) have been found by the State Water Resources Control Board to be, as expected, polluting groundwaters. The results of this review have been published in a recent report, "Solid Waste Assessment Test (SWAT) Program Report to the Integrated Waste Management Board, 96-1CWP, December, 1995," which states on page 3, *"Thus, information collected through the SWAT Program demonstrates that unlined or clay-lined landfills leak, regardless of factors such as climate or site-specific geology."* As I testified, the clay-lined landfills that are now polluting groundwaters were designed with leachate collection and removal systems. However, it is obvious that a clay layer is not a suitable base for such systems since leachate can readily pass through the clay on its way to polluting groundwaters. It is now recognized that the California regional water quality control boards made serious errors in failing to conduct a simple Darcy's law calculation on how

rapidly leachate could pass through a clay liner of the type that was specified as the minimum liner that would be allowed under Chapter 15 regulations.

Disagreement with US EPA Statements. There were a number of questions asked by BFI attorneys about whether I disagreed with US EPA statements on the protective nature of Subtitle D landfills as issued in 1988 or 1992. With few exceptions, my response was that I agreed with parts of the US EPA's statements, especially with respect to short-term performance that was achievable with the minimum Subtitle D liner. However, I disagreed that any inference that the US EPA, or for that matter, anyone else, today can justifiably claim that a minimum Subtitle D landfill containment system, such as BFI has proposed for the Campo Sur site, will be protective of groundwater resources from impaired use by waste-derived constituents for as long as the wastes will be a threat. This was the fundamental problem associated with Giroud's testimony where he only discussed short-term issues with respect to expected landfill containment system performance and did not address adequately or reliably the long-term issues that must be addressed as part of properly evaluating the potential impacts of the proposed Campo Sur Landfill.

Unreliable Reporting of Literature. BFI attorneys attempted to portray my views as inconsistent where, for example, with respect to Dr. Daniel's work, I indicated that he had developed a paper that discussed the fact that a high-density polyethylene liner would be expected to pass leachate-derived constituents through the liner in less than two years. BFI attorneys tried to portray the image that it is inappropriate for an expert in a field to find that another expert in the field is correct on some issues and incorrect on others. This situation is highly appropriate. As I testified, Giroud is an expert on developing landfills for short-term protection of groundwater from pollution by landfill leachate. However, as I documented, Giroud is not an expert on the long-term behavior of HDPE liner systems, and he has significant difficulties adequately and reliably reporting on the literature on this topic. As I testified, Giroud has been found to quote only the first paragraph of the Haxo and Haxo (1988) statement on the expected performance of HDPE liners. As I have documented in my comments on his publication, "The Durability of HPDE Geomembranes," he leaves out of his discussion the part of the Haxo and Haxo report which in the next paragraph following the discussion of HPDE liner materials lasting hundreds of years in a landfill environment as a waste, Haxo and Haxo (1988) state,

> *"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."*

As I documented during my testimony, Giroud's statements during his testimony about the durability of clays as reported by Professor Mitchell was another incomplete statement compared to that which Professor Mitchell has published on the durability of clays versus the durability of clay liners for waste containment systems. As read into the record during my testimony, Professor Mitchell published in, "Factors Controlling the Long-Term Properties of Clay Liners,"

"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 of the system will be lost."

Giroud has been highly selective in presenting Haxo and Haxo's and Professor Mitchell's work on clay and flexible membrane liners. To leave out of a discussion what Professor Mitchell has published on the expected performance of clay liners, as Giroud has done, represents highly unreliable reporting of the literature.

Unreliable Discussion of Landfill Containment and Monitoring Issues

As I repeatedly documented throughout my testimony, Giroud's and Gentile's testimonies and BFI's EIS were designed to support BFI in siting and developing the Campo Sur Landfill where only information was provided that would support BFI's development of this landfill without discussing the well known problems with the minimum Subtitle D landfills located at geologically unsuitable sites, such as the Campo Sur site. It is important to note that this situation is not one of disagreement among experts on technical issues. I have documented in my testimony the inadequate, unreliable and distorted information that BFI in its EIS and Giroud and Gentile in their testifying on behalf of BFI have presented on the expected protective nature of the proposed Campo Sur Landfill.

Environmental Ethics Issues. Associated with my testimony on the unreliable reporting of information by Giroud and Gentile, BFI attorneys asked me a number of questions about an article that I developed with Dr. Jones-Lee, "Environmental Ethics: The Whole Truth," that was published in *Civil Engineering* "Forum" in 1995 in which we summarized the significant problems that exist today in the environmental field where project (landfill) proponents and their consultants only present information that is supportive of the proponent's project (landfill). They do not typically conform to professional engineering codes of ethics where for matters of public health and safety, a professional engineer is required to provide full disclosure of potential problems associated with the project. As discussed during my testimony, the "Forum" one-page summary makes reference to a more comprehensive review of the topic which is available from me. We have received several hundred requests for the more comprehensive discussion. A number of those who have commented to us on the "Forum" article have thanked us for discussing what is a well known problem in the professional engineering field of professional engineers violating the codes of ethics with regard to full disclosure in matters of public health and safety.

Over the objections of BFI attorneys, the full discussion of the environmental ethics issues developed by Dr. Jones-Lee and myself, "Practical Environmental Ethics: Is There an Obligation to Tell the Whole Truth?," was introduced into the hearing record. In that discussion Dr. Jones-Lee and I present an independent, peer review approach where the relative reliability of the BFI EIS and Giroud's and

Gentile's testimonies vs. my findings on the unreliability of these testimonies could be reviewed by a panel of experts who have no financial interests in doing future work for landfill applicants. As I indicated during my testimony, if there is any question about the technical validity of my testimony on the unreliable, inadequate and, in some cases, distorted information provided by BFI in its EIS and by Giroud and Gentile in their testimonies, an independent, public peer review of these issues should be conducted. I am confident that such a review will show that my testimony is in accord with what is known today on the expected inability of the proposed Campo Sur Landfill containment systems and monitoring systems to prevent groundwater pollution by landfill leachate for as long as the wastes in the landfill will be a threat.

Unchallenged Testimony

BFI attorneys chose to focus the cross examination of my testimony on issues other than the primary points of my testimony. Basically, BFI attorneys chose to allow my testimony on key issues pertinent to reviewing the suitability of the Campo Sur site for the proposed Campo Sur Landfill and the potential environmental impact of the proposed landfill to go unchallenged. The cross examination focused on several late 1980s and early 1990s letters that were presented by BFI attorneys as having relevance to the technical validity of my testimony on the unreliable information presented in BFI's EIS and Giroud's and Gentile's testimonies on the public health, groundwater resources, environmental and other problems that will occur if BFI's proposed Campo Sur Landfill is permitted as currently proposed. It is obvious that the issue that needs to be addressed is not what the US EPA or, for that matter, anyone else published or presented in a letter of the late 1980s or early 1990s. The issue that needs to be addressed in the hearing is the ability of the proposed Campo Sur Landfill to protect groundwaters from impaired use for as long as the wastes in the landfill will be a threat. This issue should be reviewed in terms of what is well known in the literature today on the inadequacies of minimum Subtitle D landfills in protecting public health, groundwater resources, the environment and the interests of those within the sphere of influence of the Campo Sur Landfill for as long as that landfill will be a threat.

The following key issues of my testimony were unchallenged:

C The Campo Sur site is a poor site for the proposed landfill.

The geology of the site and nearby areas of concern consisting of a fractured bedrock system and the rapid transport of leachate-polluted groundwater to the important Coastal Plain aquifer provide limited protection from adverse impacts due to the leachate-polluted groundwaters that will be developed when the landfill liner system fails to prevent leachate formed in the landfill from entering the Campo Sur aquifer system.

The lack of adequate bufferlands between the proposed landfill waste deposition area and adjacent properties means that either BFI will have to practice highly extraordinary control of operating life waste-derived emissions which are not discussed in the EIS or the adjacent property owners and users will experience highly derogatory conditions due to

landfill releases such as odors, blowing papers, bird droppings, rodents, public health hazards due to explosive and hazardous gases, etc.

The importance of the Coastal Plain aquifer to the people of the area now and in the future mandates that the groundwater resources potentially impacted by the proposed landfill be protected from pollution by landfill leachate. Pollution of this aquifer system by landfill leachate will be highly detrimental to public health, groundwater resources, the environment and the interests of the people who today and in the future will be dependent on the groundwater resources as a water supply.

C Municipal landfills under Subtitle D can accept hazardous chemicals and unregulated hazardous wastes. Subtitle D landfill leachates typically represent significant threats to public health and the environment.

C While Giroud testified that municipal landfill leachate is only 1% contaminants, with the implication that such a "small" percentage should be of limited concern, as I testified, this small percentage represents a wide variety of conventional pollutants, Priority Pollutants that are hazardous to public health and the environment, and unconventional pollutants which are not now regulated under Subtitle D which could in the future be found to be highly hazardous to groundwater resources, public health and the environment.

The salt content of MSW leachate is typically sufficient to cause it to have a density greater than that of water which would cause leachate-polluted groundwaters to sink to the bottom of the aquifer into the fractured bedrock system. It appears that the groundwater modeling that has been done by BFI has ignored this issue.

C The proposed design of the landfill will not prevent leachate generation and passage of the leachate through the liner into the underlying groundwater system.

Giroud's testimony on the number of defects per acre in the plastic sheeting component of the landfill liner system describes the situation that can be achieved with good quality construction and proper placement of the wastes in the landfill. It ignores the number of holes/defects per acre that will develop over time as the plastic sheeting layer deteriorates. The US EPA, as part of developing Subtitle D landfilling regulations in the US EPA Solid Waste Disposal Criteria (August 30, 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."*

The US EPA Criteria for Municipal Solid Waste Landfills (July 1988b) stated,

> *"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."*

I testified that the situation today is even more certain than it was in 1988 with respect to the eventual deterioration of the landfill liner system's ability to prevent leachate from passing through the liner and polluting groundwaters for as long as the wastes in the landfill will be a threat.

- Giroud's testimony concerning the functioning of the leachate collection system failed to discuss the problems associated with biological fouling of such systems which cause blockage of the system's ability to quickly transport leachate to the leachate collection sump where it can be removed from the landfill. Biological fouling of leachate collection systems is a well known, important problem that should have been discussed.

- There are eight US states or parts of states where a minimum Subtitle D landfill of the type that BFI proposes to construct at the Campo Sur site would not be allowed because of the inevitable failure of the liner system and the resultant pollution of groundwaters.

- BFI's proposed practice of disposal of some of the leachate collected in the leachate collection system of dumping it into the landfill will result in increased hydraulic loading of the landfill which can lead to increased groundwater pollution.

- The disposition of excess leachate collected from the landfill that is not disposed of in the landfill is unclear at this time. While it is stated in the EIS that it can be taken to a nearby domestic wastewater treatment plant for disposal, it appears that arrangements for this disposal approach have not been formalized and that no information is available at this time on the degree of pretreatment that will be provided for the leachate before disposal.

  Domestic wastewater treatment plants are becoming increasingly reluctant to take municipal landfill leachate because of the problems it causes to their treatment works and the violations it causes in meeting effluent discharge standards.

- Giroud's testimony on the ability of a Subtitle D landfill cover to prevent leachate generation for as long as the wastes represent a threat is unreliable. He only discussed the situation that can apply when the cover is new. He ignored the fact that the wastes in the landfill will be a threat forever and that the key low permeability layer of the cover (the plastic sheeting layer) underlies 18 inches of topsoil and drainage layer which cannot be inspected for holes, points of deterioration, etc. by visual inspection of the landfill surface.

Holes will develop in the landfill cover low permeability layer which will allow moisture to enter the landfill that will generate leachate. Giroud's statements about predicting the amount of leachate that will be generated using the US EPA's HELP model ignores the fact that the HELP model is not reliable for predicting leachate generation rates under conditions of a deteriorated plastic sheeting layer that will develop in the landfill cover. Giroud's statement about the waste being able to absorb moisture and not generate leachate ignores unsaturated transport of moisture-leachate in the wastes.

C Giroud's testimony on the California Lopez Canyon landfill having "survived very successfully" the 1994 earthquake is not in accord with published information on this landfill.

C Giroud's testimony that the US EPA's assessment that a composite liner is designed to be protective at all locations, including poor locations, does not properly consider the adequacy of the US EPA's early 1990s evaluation of the reliability of the Subtitle D groundwater monitoring system and the limited number of people that the US EPA assumed would be exposed to leachate-polluted groundwaters by a landfill for as long as the wastes will be a threat. Further, Giroud did not report that the US EPA considered only a few carcinogens and did not adequately consider the threat to groundwater resources that the unregulated constituents in landfill leachate represent.

C Giroud's testimony on the demonstrated reliable performance of Subtitle D landfills ignores the short period of time that such landfills have been used relative to the period of time that wold be needed to observe failure of the liner system. It also ignores the unreliability of the groundwater monitoring system that is used to detect landfill liner failure. The facts are that the failure of existing Subtitle D landfill liner systems to prevent leachate from polluting groundwaters would not be expected to be observed at this time. Further, if proper quality construction and waste placement was achieved, the failure of the liner system would not become evident for a number of decades.

As discussed above, Giroud did not reliably report on Professor Mitchell's findings of the potential problems with clay liners preventing groundwater pollution by landfill leachate for a long as the wastes in the landfill will be a threat. He also did not report on the US EPA (1989) findings on clay liners:

> *"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."*

Giroud did not discuss the well known problems of desiccation cracking of clay liners in a composite liner where, through unsaturated transport, the moisture used to achieve optimum clay liner compaction is lost. Desiccation of the clay layer will lead to cracks which will enable leachate

to pass through the clay layer at a much higher rate than that predicted based on its design permeability.

Giroud did not discuss the work of Dr. Daniel, where Daniel and Shackelford (1989) "Containment of Landfill Leachate with Clay Liners," stated,

> *"Clay liners can slow the movement of pollutants out of land disposal facilities in several ways. Attenuation processes also work to slow the transport of many contaminants."*

As I testified, Dr. Daniel reported that the breakthrough times for a clay liner is about 11.5 years and for a 60 mil HDPE liner is 1.7 years. This breakthrough time is diffusion controlled for liners without holes or cracks in them. Breakthrough times can be faster.

- Giroud's testimony on the durability of geomembranes was unreliable with respect to what is known today. His statement that there is no energy in a geomembrane ignores basic principles of chemical thermodynamics and entropy. His statement about oxygen not being available to cause degradation does not apply to the underside of the liner. Further, he should have reported on the results about the initiation of the deterioration of HDPE liner materials occurring at about 30 years.

- Giroud's testimony on the permeation of HDPE liners by organic solvents was unreliable where he indicated that this was only a problem due to pure solvents. It is well known in the literature that dilute solutions of solvents that can readily be purchased at a local hardware store, many of which are carcinogens, can pass through an HDPE liner in a few days.

- Giroud's testimony that HDPE liners represent a proven, highly reliable technology ignores what is well known in the field today about the long-term failure issues associated with the fact that the wastes in the landfill will be a threat forever. There is only a limited time relative to the time that the wastes are a threat that an HDPE liner can be expected to function as an effective barrier for leachate transport through the liner.

- Overall, I testified that Giroud provided unreliable, inadequate and, in some cases, distorted information on the expected ability of the proposed Campo Sur Landfill liner system to prevent leachate transport through it for as long as the wastes in the landfill will be a threat. My testimony on these issues was unchallenged by BFI attorneys.

- Gentile testified that his analysis showed that the proposed Campo Sur Landfill represented, *"...no potential significant impacts to groundwater resources,"* as well as that his evaluation that the Campo Sur site, *"...was a suitable site for a municipal solid waste landfill*." As documented in my testimony, Gentile's analysis of the potential for the Campo Sur Landfill to pollute groundwaters was fundamentally flawed. It is based on:

- C Unreliable reporting of what is known on the reliability of Subtitle D groundwater detection monitoring,
- C Unreliable discussion of assessment and remediation monitoring,
- C Inappropriate assessment of existing groundwater supply wells that can be polluted by the proposed Campo Sur Landfill leachate, and
- C Unreliable groundwater modeling of pollutant transport in the Campo Sur and Coastal Plain aquifers.

C The US Geological Survey has found that groundwater transport in the Campo Sur area can be as high as 2.5 ft/day. This is rapid movement of groundwaters that can lead to off-site groundwater pollution by the Campo Sur Landfill in a short period of time.

C Gentile's testimony regarding the relative significance of the Campo Sur aquifer vs. the South Coast Regional Aquifer (Coastal Plain aquifer) does not address the key issue of concern to the people in the area, namely that the pollution of the Campo Sur aquifer by Campo Sur Landfill leachate will lead to pollution of the South Coast Regional Aquifer, rendering the polluted parts of the aquifer unsuitable for domestic and many agricultural purposes.

C Gentile testified that, *"Our evaluation of these hydrogeologic aspects did not discern any significant potential impacts and no change in the evaluation that this is a potentially good site for a landfill."* Actually, as I testified, the Campo Sur site is a poor site for a landfill because:

- C High quality important groundwater is connected to the base of the proposed landfill;
- C Extensive use of groundwater is made that is in the path of the groundwater leachate plume that will develop from the landfill;
- C Rapid movement of groundwaters occurs which will rapidly transport leachate-polluted groundwaters to off-site areas;
- C Leachate-polluted groundwater cannot be reliably monitored due to the fractured bedrock system; and
- C Limited natural protection of groundwater resources exists in the path of the groundwater leachate plumes.

C Gentile's statement that US EPA Subtitle D landfill requirements, which include a liner system, leachate collection and removal system, leachate monitoring system and groundwater monitoring system, have inherent redundancies to minimize potential for release of leachate and thus are protective of groundwater ignores the fact that the liner system has a limited period of time when leachate generated in the landfill will be effectively collected and the groundwater monitoring systems that are typically used are unreliable in detecting leachate-polluted groundwaters before widespread pollution occurs.

- Gentile's evaluation of no impact of the proposed Campo Sur Landfill on groundwater quality in which he concludes that the Campo Sur Landfill will not be adverse to groundwater quality is based on highly inappropriate assumptions regarding the ability of the landfill liner system and cover to:

  - prevent leachate generation and the passage of leachate into the underlying groundwater system through the liner system,
  - the unreliability of detection monitoring for the presence of leachate at the groundwater monitoring point of compliance,
  - the potential unreliability of the assessment monitoring with respect to its initiation when needed, and
  - the unreliability of the implementation of corrective measures when needed to prevent off-site groundwater pollution.

  Further, his estimated travel time for leachate -polluted groundwaters from the property line to the nearest public water supply well of 12 to 51 years could be longer than the actual travel time through the fractured bedrock system of the region.

  As I testified, the facts are that the base of the proposed Campo Sur Landfill is hydraulically connected to a regional groundwater system that can allow rapid transport of leachate from the landfill to a number of existing domestic and agricultural water supply wells as well as at least one public water supply well.

  Further, BFI's investigation of the groundwater hydrology in the region has not been adequately conducted to rule out the likelihood of significant transport of leachate-polluted groundwaters through the fractured rock system under the existing hills to the south of the proposed landfill.

- Gentile's so-called "theoretical" release from the proposed landfill is not a theoretical release, but will actually occur if the landfill is constructed as proposed. Leachate will pollute the groundwaters underlying the landfill. According to Gentile's estimates, leachate-polluted groundwaters could reach the point of compliance within 0.5 years.

- While neither BFI nor Gentile specified the groundwater monitoring array that would be used at the point of compliance, if, as I testified, BFI uses a typical groundwater monitoring array that is used at other Subtitle D landfill sites, the monitoring wells will have a low probability of detecting leachate-polluted groundwaters when they first reach the point of compliance.

  The ability to reliably monitor leachate-polluted groundwaters at the point of compliance for groundwater monitoring at the Campo Sur site is much worse than that normally experienced for Subtitle D landfills due to the fractured bedrock system of the region. As I testified, even if closely spaced monitoring wells of only a few feet apart were installed by BFI, such wells could fail to detect leachate-polluted groundwater transport through the fractured rock system as a result of the

fractures in which transport is occurring in fractures that are not hydraulically connected to or not being adequately sampled by the monitoring wells. Haitjema (1991) stated with respect to monitoring landfill leachate-polluted groundwaters in fractured rock systems,

> *"An extreme example of equation (1) (aquifer heterogeneity) is flow through fractured rock. The design of monitoring well systems in such an environment is a nightmare and usually not more than a blind gamble."*
>
> * * *
>
> *"Monitoring wells in the regional aquifer are unreliable detectors of local leaks in a landfill."*

C Gentile's assumptions about assessment monitoring to define the extent of groundwater pollution by landfill leachate and the implementation of corrective action when the extent of groundwater pollution is known assumes that the groundwater monitoring approaches are highly reliable and that the regulatory agencies will require that BFI take action when pollution is first discovered to first assess the extent of pollution and then implement clean-up of the polluted groundwaters. As I testified, BFI has a history at the Azusa Landfill in southern California of denying that groundwater pollution was occurring for a period of five years after it was obvious, based on BFI's monitoring data, that pollution was occurring. Further, the regulatory agencies' staff and board chose to ignore this pollution even though it was obvious. Eventually, the US EPA, using BFI's monitoring data, declared that BFI was the responsible party in a Superfund program for polluting the San Gabriel Basin Aquifer with hazardous chemicals.

In addition, as I testified, while BFI has been forced to terminate its expansion of its Azusa Landfill by the state regulatory board and the courts, BFI is still trying to gain permission to continue to operate the Azusa Landfill. Recently, the courts have ruled against BFI's proposal for continued operations.

As I testified, there is no assurance that BFI will follow the approach assumed by Gentile of immediately implementing assessment monitoring when the highly unreliable groundwater monitoring system that could be developed at the Campo Sur site finally detects groundwater pollution by landfill leachate. Further, because of the high cost, it is unlikely that BFI would immediately implement the corrective action necessary to stop the spread of groundwater pollution by the Campo Sur Landfill.

C It is known today that the pollution of groundwater by municipal landfill leachate results in a permanent loss of the polluted groundwaters and the aquifer system for future use for domestic and other water supply purposes. Such pollution cannot be cleaned up so that the polluted part of the aquifer can be considered safe for future domestic water supply purposes.

C According to BFI's EIS, BFI plans to only implement post-closure care for the Campo Sur Landfill for up to 30 years after closure. The waste in the proposed Campo Sur Landfill will be a threat forever. It is possible that the groundwater pollution problems associated with the Campo Sur Landfill will not be discovered during the 30-year period that BFI plans to provide for post-closure care. Further, there is no assurance that the regulatory agencies will in the future require, in accord with Subtitle D RCRA requirements, to extend the post-closure care period for as long as the wastes in the landfill will be a threat. Contrary to Gentile's assumptions, there is no assurance that funds will, in fact, be available for as long as the wastes will be a threat to provide for detection monitoring, assessment monitoring and remediation of the polluted groundwaters that will arise from the Campo Sur Landfill. This could mean that there will be no funds available to protect the interests of those who own or use properties within the sphere of influence of the Campo Sur Landfill for as long as the wastes represent a threat. The net result is that the groundwater pollution that will occur at this landfill will likely become a widespread problem of the region which will destroy the use of the groundwaters impacted by the leachate for domestic and many other purposes.

The polluted groundwaters can also adversely impact the coastal marine surface water resources through the transport of leachate-polluted waters under the near-shore marine waters where they would surface in the Bahia de Jobos.

Another factor to consider, as I testified, is that BFI has significant financial problems at this time based on the fact that frequently there are articles about these problems in the solid waste trade magazines. BFI's existing financial problems are small compared to those that will eventually develop when BFI's current Subtitle D landfills are found to be polluting groundwaters. BFI is, as are other garbage companies, accumulating massive liabilities that are projected to exceed the financial ability of the company to meet them. This could readily result in a situation where when funds are needed for continued detection monitoring, assessment monitoring and remediation they will not be available for as long as the wastes will be a threat. This situation makes it imperative that minimum Subtitle D landfills of the type that BFI proposes to construct at the Campo Sur site not be located at geologically unsuitable sites such as the Campo Sur site.

C Gentile testified that the leachate components would be "absorbed." As I testified, Gentile used the wrong term. He should have used "adsorbed." Further, his statements with respect to the chemicals being "absorbed" applied to only some constituents. There are some constituents in municipal landfill leachate that are not "adsorbed."

C Gentile's "no impact" scenario was a contrived, superficial evaluation of the potential impacts of BFI's proposed Campo Sur Landfill on groundwater resources. As I testified, it was unbelievable and irresponsible of Gentile to evaluate the impacts of landfill leachate-polluted groundwaters which did not consider the impacts on the numerous domestic and agricultural water supply wells in the

path of the leachate-polluted groundwaters. Subtitle D does not allow the pollution of individual homeowners', agricultural or other wells by landfill leachate.

C As I testified, overall, Gentile's testimony was unreliable with respect to evaluating the potential impacts of the proposed Campo Sur Landfill on the groundwater resources of the region. The assumptions that he used in his "no impact" scenario evaluation of everything working perfectly forever is obviously fundamentally flawed. A proper evaluation would have discussed the plausible worst-case scenario situations that could readily occur and then provide a discussion of how these problems would be detected, controlled and remediated, including where the funds needed for post-closure monitoring, maintenance, remediation and, if necessary, waste exhumation will be derived for as long as the wastes represent a threat.

C The proposed Campo Sur Landfill represents a threat to surface water resources from several perspectives. There is the potential for breakout of leachate from the sides of the landfill through the formation of perched layers arising from vertical flow barriers due to garbage bags forming an effective liner where the leachate would move laterally upon encountering the layer of bags through the sides of the landfill. Further, there will be several ponds, one of which would contain leachate, and others containing stormwater and drainage from the composting area, which will contain highly polluted waters. There is a potential for failure of the ponds and especially their overflow during periods of intense rainfall. This could lead to surface water transport of waste-derived pollutants which, in addition to impacting the lands in the path of the flow, could impact both the Canal De Guamani Oeste and the Canal De Patillas. This could lead to the spread of pollution far beyond just the flow path of surface waters and groundwaters from the landfill.

C Composting of wastes is proposed to be conducted by BFI at the Campo Sur site. While BFI, in its EIS, claims that the composting will be conducted to control adverse impacts, such claims are typically made by composting advocates as part of gaining permission for the landfilling and composting of wastes. As I testified, I am aware of a number of locations where even with attempts to control odors associated with composting, following composting approaches of the type described by BFI in its EIS, the odors are sufficiently severe so that eventually the composting operation has to be shut down because of the inability to control odors. I testified that I would be opposed to composting as BFI has proposed for the Campo Sur site based on potential adverse impacts of odors, surface and groundwater pollution, rodents, birds, etc. This does not mean that I am opposed to composting. I support composting if done properly. It must be done, however, in such a way as to fully protect the health, welfare and interests of those who own or use properties near the composting operation.

C The proposed Campo Sur Landfill could be adverse to those within the sphere of influence of the landfill in the following areas:

  C Groundwater and surface water quality - *public health, economics, aesthetics;*

- Migration of methane and VOCs - *public health, explosions, toxicity to plants and animals;*
- Illegal roadside dumping and litter near landfill - *aesthetics, public health, economics;*
- Truck traffic - *highway safety;*
- Noise - *nuisance, public health;*
- Odors - *nuisance, public health;*
- Dust - *nuisance, public health;*
- Wind-blown litter - *aesthetics, pubic health;*
- Vectors, insects, rodents, birds - *nuisance, public health;*
- Condemn adjacent properties for many future uses;
- Impaired view; and
- Decreased property values.

While BFI claims in its EIS that many of these issues will be addressed and controlled, there is little reason to believe that these claims are reliable, especially in light of the fact that there is such a limited bufferland between where the wastes will be deposited and adjacent properties. For example, odors from Subtitle D landfills with limited open active faces can still be obnoxious at distances over a mile from the landfill. It has been my experience that once a landfill is constructed, rarely do the regulatory agencies enforce the regulations that often require that adverse impacts of the landfill be controlled at the landfill property line. It is situations such as this that cause those within the sphere of influence of a Subtitle D landfill to justifiably become a NIMBY ("not in my backyard"). As I testified, landfills rarely are good neighbors. I have yet to find anyone who wants a landfill next to their property.

- One of the issues of concern that I discussed in my testimony is the economics of landfilling today. Landfilling in many areas is competitive with respect to acquisition of waste streams that are needed to financially support the development and operations of the landfill. In the US, the elimination of garbage flow control means that a municipality can deposit its garbage in any landfill. Typically, they choose the landfill with the least cost. In order to remain competitive, other landfill owners, both public and private, reduce their tipping fees (disposal costs). This makes landfills less profitable for private companies like BFI, with the result that the company's stockholders and others become concerned about the profitability of the company. This, in turn, leads to attempts by the landfill owner, both public and private, to cut costs of operation. Normally, the first areas cut are those associated with environmental protection. Further, with inadequate funding of regulatory agencies and other factors, often situations develop where such agencies do not fully enforce the regulations designed to protect those potentially impacted by the landfill. This leads to landfills typically becoming deleterious to those who own or use properties near the landfill, both during the active life and in the post-closure care period. There is no indication from the EIS that BFI will be any more protective of the Campo Sur Landfill area residents and property users than has occurred at other locations where BFI has developed landfills.

- One of the issues of particular concern to nearby property owners for a landfill is decreased property values. It is my experience that garbage companies can find land appraisers who will claim that the construction of a landfill will not decrease property values. As I testified, there has been one independent study of this issue. This is the work of Hirshfeld *et al.* "Assessing the True Cost of Landfills," which shows that property values decrease for considerable distances from a landfill. While BFI attorneys asserted, through their questioning of me, that these results would not be applicable to Subtitle D landfills, the facts are that the US EPA Subtitle D regulations did not address providing adequate bufferlands between the waste deposition areas and adjacent properties to dissipate the releases from the landfill that are adverse to public health, surface and groundwater resources, and the interests and welfare of those within the sphere of influence of the landfill.

- One of the unavoidable impacts of even properly operated landfills with adequate bufferlands is the altered viewshed where the landfill is constructed above ground to such an extent as to impair the aesthetic quality of the area. This is an important issue for the Campo Sur site since a number of people own properties on the hills to the north of the site. The projected height of the Campo Sur Landfill will significantly impair these property owners' and users' view of the region.

- Overall, Giroud, Gentile and BFI's EIS provided unreliable information on the potential impacts of the BFI proposed Campo Sur Landfill.

    - The Campo Sur Landfill, if permitted, will contain wastes that will generate leachate that will be a highly significant threat to public health, groundwater resources and the environment, effectively forever.
    - The Campo Sur Landfill proposed cover will not prevent moisture from entering the landfill that will generate leachate for as long as the wastes in the landfill will be a threat.
    - The Campo Sur Landfill liner system will deteriorate and fail to prevent leachate pollution of groundwaters while the wastes are still a threat.
    - There will be rapid transport of leachate through the groundwater system and to off-site groundwaters.
    - Low probability exists that leachate-polluted groundwater will be detected when it first reaches the point of compliance for groundwater monitoring.
    - The Campo Sur site is a poor site for the BFI proposed landfill.
    - Domestic and agricultural water supply wells will be polluted in a few years after MSW leachate passes through the landfill liner system.
    - There are questions as to whether BFI will provide the funds needed to stop further groundwater pollution by landfill leachate for as long as the wastes will be a threat.
    - BFI and its consultants have provided unreliable, inadequate and, in some instances, distorted information on the potential impacts of the proposed Campo Sur Landfill to public health, groundwater resources, the environment and the interests of those within the sphere of influence of the landfill.

- BFI's EIS is one of the most inadequate, unreliable discussions of potential impacts of a landfill that I have encountered.

- Puerto Rico is at a turning point in its solid waste management. There is need for properly sited, designed, operated and closed municipal solid waste landfills. Puerto Rico should not make the mistake of allowing the development of minimum Subtitle D landfills at sites where there are high-value groundwaters hydraulically connected to the landfill. The BFI proposed Campo Sur Landfill should not be permitted.

References

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