Comments on the EnviroWaste Proposed North Waikato Regional Landfill's Potential to be Adverse to Public Health, Groundwater and Surface Water Resources and the Environment

Submitted by

G. Fred Lee, PhD, PE, DEE
G. Fred Lee & Associates
27298 E. El Macero Dr.
El Macero, CA 95618-1005 USA
Ph 530 753-9630 Fx 530 753-9956
em gfredlee@aol.com website www.gfredlee.com

July 22, 2000

The Waikato River Protection Society (Society) requested that I conduct a review of the EnviroWaste Services Limited (EnviroWaste) proposed North Waikato Regional Landfill's potential to cause groundwater and surface water pollution during the time that the wastes proposed to be deposited in this landfill will be a threat to public health and the environment. Copies of documents that EnviroWaste and its consultants, Waikato Regional Council (Council), Waikato District Council and others prepared were provided for my review. My review has included,

Proposed North Waikato Regional Landfill – Application for Resource Consents and Assessment of Environmental Effects, dated March 1999.

Proposed North Waikato Regional Landfill – Appendix 1: Management Plans and Technical Reports, dated March 1999.

Proposed North Waikato Regional Landfill – Appendix 2: Independent Environmental Assessments, dated March 1999.

Proposed North Waikato Regional Landfill – Appendix 3: Plans and Drawings, dated March 1999.

Proposed North Waikato Regional Landfill – Appendix 4: Consultation Documents, dated March 1999.

Further information pursuant to section 92 of the RMA as provided to Waikato District Council by Hegley Acoustic Consultants by letter dated 29 June 1999.

Further information pursuant to section 92 of the RMA as provided to Waikato District Council by Boffa Miskell dated July 1999.

Further information pursuant to section 92 of the RMA as provided to Waikato District Council

by EnviroWaste Services Limited by letter dated 10 August 1999.

Further information pursuant to section 92 of the RMA as provided to Waikato District Council by EnviroWaste services Limited by draft "Management Plan for Waste Acceptance at the North Waikato Landfill" dated 13 August 1999.

Centre for Advanced Engineering University of Canterbury "Landfill Guidelines" Christchurch, New Zealand, 2000.

Selected Sections of the Resources Management Act of 1991.

Overall Findings

I find that EnviroWaste in its "Application for Resource Consents" and the "Assessment of Environmental Effects" (AEE) dated March 10, 1999 for the proposed North Waikato Regional Landfill (NWRLF) has provided substantial unreliable information on the long-term potential for this landfill to cause adverse impacts to public health, groundwater and surface water quality and those within the sphere of influence of this landfill for as long as the waste in this landfill will be a threat. The proposed NWRLF is portrayed as a safe landfill located at an ideal location. The proposed landfill is said to be based on the design used by the US EPA in its Subtitle D landfill used for municipal solid wastes (MSW). EnviroWaste failed to reveal in any of its documents and AEE that the minimum Subtitle D landfill liner design that EnviroWaste has selected for the proposed NWRLF is recognized in the USA as at best, only postponing groundwater pollution by landfill leachate.

The US EPA as part of developing Subtitle D regulations stated, (August 30, 1988a),

> *"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) state,

> *"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."*

As discussed by Lee and Jones-Lee (1998a) in their peer-reviewed comprehensive review of the deficiencies in Subtitle D landfills, the situation today with respect to recognizing the ultimate failure of the Subtitle D landfill liner system with a single composite liner of the type that EnviroWaste proposes to use at the NWRLF, is even stronger today than it was in 1988. The US EPA administration (Dellinger, 1998) acknowledged that the Agency's 1988 statement of ultimate liner failure is applicable to today's Subtitle D landfills. There is no question that ultimately the NWRLF liner system will deteriorate to the point where the liner is no longer effective in collecting leachate (garbage juice) in the leachate collection and removal system and in preventing the passage of leachate through the liner into the underlying groundwater system.

An example of the unreliability of the EnviroWaste Application for Consents and AEE is the estimates of the landfill liner leakage rates. EnviroWaste and its consultants assume that the rate of leakage of the liner will be the smallest rate that has been observed in the literature. They assume that this rate will apply throughout the period that the wastes in the proposed NWRLF will be a threat, i.e., the liner will function as designed forever. In fact with high quality liner construction and careful placement of the waste, the initial rates of liner leakage can be close to those estimated by EnviroWaste. However, over the time that the wastes in the proposed landfill will be a threat the liner will lose its ability to prevent leachate from passing through it with the result that the rate of liner leakage will be much higher than predicted by EnviroWaste. This will lead to much greater pollution of the groundwater than predicted by EnviroWaste.

The AEE and EnviroWaste Application for Consents documentation is highly deficient in providing reliable, unbiased information on landfill liner failure issues since there is no discussion of the eventual deterioration of the liner system. Also missing is a discussion on the impact of the liner deterioration on the pollution of the groundwaters underlying and downgradient of the proposed landfill. Further, the documentation is deficient with respect to informing the reviewers on the ability to reliably monitor liner failure. Lee and Jones-Lee (1998b) and Lee and Jones (1992) have reviewed the problems of trying to reliably detect landfill liner failure before widespread groundwater pollution occurs. These problems have been known since the Cherry (1990) paper. These issues were not discussed by EnviroWaste and the Council.

As discussed by Jones-Lee and Lee (1993) and Lee and Jones-Lee (1998a) many of the components in MSW in a Subtitle D landfill will be a threat to cause groundwater pollution effectively forever, certainly for at least a thousand or more years. These issues are well known in the landfill literature (Belevi and Baccini, 1989; Freeze and Cherry, 1992). There is growing recognition that the USA must abandon the "dry tomb" minimum subtitle D landfill because of the ultimate failure of the liner system and the problems with trying to reliably monitor when this failure/leakage occurs before it causes widespread offsite groundwater pollution. There are 10 states in the USA where the proposed NWRLF could not be constructed because of its proposed design.

EnviroWaste's failure to discuss these issues in the documentation for the consents application, and the AEE as well as the Waikato Regional Council Report of December 9, 1999 establishing the Consents associated with approval of the proposed NWRLF make the current documentation for the proposed NWRLF significantly deficient in informing the regulatory agencies and the public about the long-term potential problems of the proposed NWRLF. Not only should these potential highly significant problems have been discussed, EnviroWaste and the Councils should also have discussed;

- how these problems would be detected,
- reliability of detection,
- cost to remediate source and
- the source of the funds that will be needed to address plausible worst case landfill liner failure for the period that the waste in the landfill will be a threat.

For planning purposes this period should be considered forever.

The key to properly addressing the long-term problems is to first acknowledge the potential problems and then prepare to address them. This approach requires that as part of review of a proposed new or expanded landfill, a well-defined and readily implementable closure and post closure monitoring, maintenance and remediation plan be developed and implemented for as long as the wastes will be a potential threat. By far the most significant deficiency in the EnviroWaste application and AEE and especially the Waikato Regional Council's Consents is the failure to recognize the highly significant long-term public health and environmental problems of the proposed NWRLF and provide a well-defined highly reliable approach to controlling these problems.

Contrary to the propaganda presented by EnviroWaste in its documentation in support of its application, the Hampton Downs Road site is not a naturally protective site. The eventual large scale deterioration of the proposed NWRLF liner will lead to potentially significant groundwater pollution under the landfill. While EnviroWaste claims that it will install and operate a groundwater recovery system that will be able to collect all leachate polluted groundwater "if the liner should leak," there is no information provided on how EnviroWaste will operate and most importantly fund the monitoring and operation of this groundwater pump and treat system for as long as the wastes in the landfill will be a threat.

The Waikato Regional Council approach of allowing EnviroWaste to wait until the final year of operation of this landfill to make public how it will monitor the groundwaters underlying and downgradient of the landfill and operate the polluted groundwater removal system is strongly contrary to the public interest. While EnviroWaste claims that it will meet consent requirements, there are considerable justifiable questions about how EnviroWaste will be financially able to adequately fund the groundwater monitoring, and pump and treat system for as long as the wastes in the proposed landfill will be a threat. Further, there are significant questions about the near-term financial stability/viability of private garbage companies, much less the long-term ability of private companies to fund aftercare operations as needed over the thousand or more years to fully protect public health, groundwater quality and the environment.

No landfill should be approved for operation until a reliably funded aftercare program is developed. This program should be developed as part of landfill permitting and not wait until the year of closure of the landfill before this aftercare program is developed. By that time it could be too late to gain the funding needed from those who deposit wastes in the landfill to properly fund the aftercare program. Hickman (1992, 1995), Lee and Jones-Lee (1992) (1994) have discussed the significant problems with the long-term funding of aftercare for municipal landfills by both public and private landfill owners. The funding of aftercare during the active life of the landfill from disposal fees that are deposited in a trust (bond) is essential for all private landfills. Failure to require a dedicated trust (bond) that is developed during the active life of a landfill for landfills such as EnviroWaste's proposed NWRLF which is to be located at a geologically non-protective site, will almost certainly mean that offsite groundwater and surface water pollution will occur because of the unavailability of the needed funding to monitor and remediate the onsite polluted groundwaters that will occur.

While the focus of my review of the proposed NWRLF has been on groundwater quality pollution issues and the associated surface water pollution, I have also found that there will likely be significant air quality problems as well. Contrary to the repeated statements by EnviroWaste, there are inadequate buffer lands between where the wastes are proposed to be deposited and the adjacent properties. Since EnviroWaste does not propose to use extraordinary means to control gaseous releases from the wastes, the inadequate buffer lands mean that this landfill's airborne emission of odors will be adverse to adjacent property owners/users.

Overall, it is recommended that the appeal of the Councils' approval of the proposed NWRLF be supported, where the Councils' consents are overturned based on the potential problems of this landfill arising out of the characteristics of the site, proposed landfill design and especially the failure to provide the information needed to insure with a high degree of reliability that the funding needed for aftercare will be available for as long as the wastes are a threat. If EnviroWaste wishes to proceed with landfill development for the North Waikato Region, it should find a suitable site for a landfill, reliably design a landfill containment and monitoring system for that site and provide for assured aftercare that recognizes the long-term problems that an MSW landfill at that site can cause to public health and the environment.

Qualifications

Dr. G. Fred Lee, PE, DEE

Expertise and Experience in Landfill Impact Assessment

Dr. G. Fred Lee's work on municipal landfill impact matters began in the mid-1950s while he was an undergraduate student in environmental health sciences at San Jose State College in San Jose, California. His course and field work involved review of municipal solid waste landfill impacts on public health and the environment.

He obtained a Master of Science in Public Health degree from the University of North Carolina, Chapel Hill in 1957. The focus of his masters degree work was on water quality evaluation and management with respect to public health and environmental protection from chemical constituents and pathogenic organisms.

Dr. Lee obtained a PhD degree specializing in environmental engineering from Harvard University in 1960. As part of this degree work he 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 his PhD work was aquatic chemistry.

For a 30-year period, he held university graduate-level teaching and research positions in departments of civil and environmental engineering at several major United States universities, including the University of Wisconsin-Madison, University of Texas at Dallas and Colorado State University. During this period he taught graduate-level environmental engineering courses in water and wastewater analysis, water and wastewater treatment plant design, surface and groundwater quality evaluation and management, and solid and hazardous waste management. He have published over 850 professional papers and reports on his research results and professional experience. His research included, beginning in the 1970s, the first work done on the impacts of organics on clay liners for landfills and waste lagoons.

In the 1980s, he conducted a comprehensive review of the properties of HDPE liners of the 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 waste will be a threat.

His 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, He became involved in the review of the impacts of municipal solid waste landfills on groundwater quality. In the 1970s, while he was Director of the Center for Environmental Studies at the University of Texas at Dallas, he was involved in the review of a number of municipal solid waste landfill situations, focusing on the impacts of releases from the landfill on public health and the environment.

In the 1980s while he 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, he was involved in numerous situations concerning the impact of landfilling of municipal solid waste on public health and the environment. He has 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, he served as an advisor to the town of Brush, Colorado on the potential impacts of a proposed hazardous waste landfill on the groundwater resources of interest to the community. Based on this work, he 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 for that year.

In 1989, he retired after 30 years of graduate-level university teaching and research and expanded the part-time consulting that he had been doing with governmental agencies, industry and community and environmental groups into a full-time activity. A principal area of his work since then has been assisting water utilities, municipalities, industry, community and environmental groups, 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. He has been involved in the review of approximately 60 different landfills in various parts of the United States and in other countries.

Dr. Anne Jones-Lee, his wife, and he 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 the health, groundwater resources, environment and interests of those within the sphere of influence of the landfill. Their over 40 professional papers and reports (list appended) 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. they make many of his publications available as downloadable files from his web site, www.gfredlee.com.

In the early 1990s, he was appointed to a California Environmental Protection Agency's Comparative Risk Project Human Health Subcommittee that reviewed the public health hazards of chemicals in California's air and water. In connection with this activity, Dr. Jones-Lee and he developed a report, "Impact of Municipal and Industrial Non-Hazardous Waste Landfills on Public Health and the Environment: An Overview" (Lee and Jones-Lee, 1994), that served as a basis for the human health advisory panel to assess public health impacts of municipal landfills.

In addition to teaching and serving as a consultant in environmental engineering for over 40 years, he is a registered professional engineer in the state of Texas and a Diplomate in the

American Academy of Environmental Engineers (AAEE). The latter recognizes his leadership roles in the environmental engineering field. He has served as the chief examiner for the AAEE in north-central California and New Jersey, where he have been responsible for administering examinations for professional engineers with extensive experience and expertise in various aspects of environmental engineering, including solid and hazardous waste management.

His work on landfill impacts has included developing and presenting several two-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 United States cities, including New York, Atlanta, Seattle and Chicago, and the University of California Extension Programs at several of the UC campuses, as well as through other groups. He have been and continue to be an American Chemical Society tour speaker, where he is invited to lecture on landfills and groundwater quality protection issues, as well as domestic water supply water quality issues throughout the US.

Additional information on Dr. Lee's qualifications to undertake this review are appended to these comments.

Specific Comments

Review of
Report of the Waikato Regional Council Hearing Committee,
Dated December 9, 1999

On page 9, under "7.3 Landfill Development," in the first paragraph the statement is made, *"The Committee notes that whilst the liner system proposed for Stage 1 incorporates the best in current technology, consent conditions allow for the implementation of new liner materials and technologies in future stages."* The Committee made a significant error with respect to the assessment that the EnvrioWaste proposed liner system represents the "..best current technology," This liner system is recognized as fundamentally flawed in protecting groundwaters from pollution by landfill leachate. The deficiencies in this liner technology mandate that the minimum design liner system not be used at geologically unsuitable sites such as the Hampton Downs Road site. An owner/regulatory agencies for a landfill located at such a site must recognize that this liner system will eventually fail to prevent leachate from passing through it into the underlying groundwater system and prepare for this failure.

Page 10, section "7.4 Potential Effects on the Waikato River," paragraph 5 states that,

> *"The Committee is satisfied that in the unlikely event that contamination is detected in the underlying groundwater, or in groundwater surrounding the site, there are sufficient contingency methods available, and sufficient time to implement those contingency measures, to ensure that waterways will not be adversely affected."*

This is another mistake made by the Committee. There is little doubt that there will be groundwater pollution in the underlying groundwater and in the groundwater surrounding the site. There are significant questions as to whether the so-called "contingencies" will, in fact, be put in place over the thousands of years that the waste in the landfill will be a threat. Without a clear, firm commitment to closure and post-closure care (aftercare), there is no assurance that these contingencies will be implemented as needed.

Page 10, under "7.5 Air Discharges," states with respect to odors, *"The Committee considers that the adoption of modern management techniques is the most effective method to minimise odour effects."* It is well known in the landfill field that the so-called "modern" management techniques do not prevent offsite odors. The only way to reliably prevent offsite odors with these techniques is to provide adequate buffer lands between the waste deposition area and adjacent properties, so that there is adequate dilution of the odors before they reach the property line.

Page 13, in section 7.13, presents a summary of the Committee's findings, where it is stated, *"It is therefore clear to the Committee that on a technical basis the environmental effects that are the responsibility of Waikato Regional Council are likely to be minor and that consents can be granted, albeit with comprehensive and extensive conditions imposed."* There is need to

review these aftercare conditions, to insure that the fundamentally flawed nature of this landfill design, geologically non protective area, inadequate buffer lands, etc., are adequately addressed in approving the consents for this landfill.

Page 29 states,

> *"That a Discharge Consent (102260) be granted to EnviroWaste Services Limited and Northern Disposal Systems Limited, Private Bag 92810, Penrose, Auckland 1135, to discharge leachate into land in circumstances that may result in contaminants entering groundwater, in the vicinity of Hampton Downs Road, near Meremere..."*

The term of this consent expires 35 years after the date of first exercise of this consent. That condition should be removed. EnviroWaste should be required to monitor leachate levels within the landfill for as long as the leachate has any potential to cause groundwater pollution. Further, EnviroWaste should be required to maintain a leachate level in the landfill that is no greater than 30mm on top of the HDPE component of the landfill liner.

Page 29, item 7 of the consent concerning leachate discharge to land allows 3 m of leachate on top of the HDPE component during Stage 1 at the point of abstraction of leachate. This is an excessive level of leachate, which will increase the potential for groundwater pollution at that point, because of the increased head.

On page 30, item 10 under "Leachate Monitoring," the list should include TOC.

Page 32, item 16, List B should be expanded to include TOC.

Page 33, item 17 establishes that the groundwater monitoring of the boreholes shall be done on an annual basis. Annual monitoring of boreholes is not adequate to insure that the variability that can occur in groundwater characteristics at a site is properly evaluated. For the first five years of operation, this monitoring should be on a quarterly (3-month) basis.

On page 33, List A should be expanded to include VOCs.

Provision should be included to allow the Waikato Regional Council the option of increasing parameters to the "List B" list that are identified as new, significant parameters that are in landfill leachate that are not known now. This approach is justified based on the fact that new groundwater pollutants are being found every few years, which are being incorporated into monitoring programs.

Page 34, item 19 establishes a rather simplistic approach for detecting statistically significant departure with respect to groundwater characteristics, as they may be impacted by landfill leachate. The Waikato Regional Council may wish to review the US EPA or state of California statistical requirements for detecting the potential incipient pollution of groundwaters by landfill leachate.

Page 34, under item 19(iv), states, *"If, after consultation with the consent holder, the Waikato Regional Council deems that remedial measures are required to be undertaken to address contamination of groundwater and surface water, the consent holder shall undertake the remedial works..."* The consent must establish a bond of sufficient magnitude to undertake remediation of the polluted groundwaters to the extent possible at any time in the future. At this time, this issue has not been adequately addressed.

Page 35, items 21-22 require that two years prior to closure of certain stages of the landfill, a proposed groundwater monitoring program be established for the later stages. Based on the information available now, this program should be outlined with reference to what changes, if any, are anticipated to be made in the monitoring program.

Page 35, item 23 allows the chloride concentration in groundwater to increase to 50 g/m^3. Rather than allowing an increase in chloride or boron, any statistically significant increase in parameters that are associated with leachate should be used to trigger termination of discharge of groundwater through the groundwater drains.

Page 35, the last paragraph states,

> *"Discharges to natural waters may recommence with the approval of the Waikato Regional Council when monitoring indicates that the concentrations of all parameters are less than specified in the current edition of the ANZECC Water Quality Guidelines for Fresh and Marine Waters for the Protection of Aquatic Ecosystems."*

Allowing the pollution of surface waters up to the current water quality criteria values is inappropriate when the source of the pollution is landfill leachate. A more appropriate approach is to allow no statistically significant increase of any parameter that is a potential threat to water quality. There could readily be pollutants in the leachate that are adverse to aquatic ecosystems that are not on the ANZECC Guidelines.

Page 36, item 27 requires that a Contingency Plan be developed to address groundwater pollution issues. *"The plan shall be submitted to the Waikato Regional Council for acceptance in writing at least three months prior to the deposition of refuse at the site."* This plan should be developed before approval for the consents is granted and reviewed by the public to insure that it provides adequate protection of their interests.

Page 40: At least annual samples of the stormwater runoff should be analyzed for aquatic life toxicity using the equivalent of US EPA procedures for *Ceriodaphnia*, fathead minnow larvae and the alga *Selenastrum* (Lewis, *et al*., 1993).

Page 44, item 17 allows the consent holder to *"...apply to change or cancel any condition of this resource consent other than a condition as to the duration of the consent, within one month after the first anniversary of the commencement of this consent, and within one month*

after each subsequent anniversary." The public should be entitled to the same privilege of applying to the Waikato Regional Council to modify the consent to incorporate new information as it becomes available into improving the environmental and public health protection associated with the landfill.

Page 45 initiates a discussion of the consent conditions associated with landfill gas emissions. The terms of the landfill gas management expire 35 years after the date construction of the site commences. The terms of the consent should extend for as long as the wastes have the ability to release landfill gas or other volatile components. For planning purposes, this should be considered to be forever.

Page 45, item 2 states, "*As a result of the activities authorised by this resource consent there shall be no odour or particulate matter that causes an objectionable effect beyond the boundary of the land owned by or under control of the consent holder."* A key issue that needs to be understood is the consequences of violating this consent condition. If repeated violations (more than three) occur in a five-year period, EnviroWaste should be forced to shut down the landfill and remove all wastes. I have been associated with many landfill situations where similar requirements are established by regulatory agencies; however, there are repeated offsite odors, where the regulatory agency inspectors ignore them or claim the odors are not significant. Severe penalties must be imposed on EnviroWaste to insure that compliance with this requirement is achieved.

Page 45, items 3 and 4 establish a cumbersome process where those impacted by odors have to file complaints over an extended period of time in order for it to be reviewed by the Waikato Regional Council. The adjacent and nearby property owners/users should have the right to file a complaint immediately with the Waikato Regional Council and be entitled to proper review of their complaint, with appropriate action taken to prevent offsite odors from continuing to occur, including shutting down the landfilling operations.

Page 45, item 6: The development of the odor dispersion model should be done before this consent is approved. It should not be an activity that is to be specified at a later date.

Page 46, under "Landfill Gas," item 10 allows EnviroWaste to develop a Landfill Gas Management Plan after wastes have been received at the landfill. The Landfill Gas Management Plan should be available for public review prior to receipt of any waste and the approval of this consent. This plan must include details on how the Landfill Gas Management Plan will be funded for the hundreds to a thousand or more years that the NWRLF will have the potential to produce landfill gas. Of particular concern is the slow rate of decay of the crushed plastic bags of waste that will be deposited in this landfill.

Page 48, item 15 should be expanded to include dioxins produced in the landfill gas flare.

Page 52, item 4 should include a representative of the environmental community, supported by EnviroWaste, to serve on the Peer Review panel.

Page 55, item 12 establishes the requirement that,

"Prior to the commencement of each stage development, the consent holder shall submit a concept Rehabilitation and Aftercare Plan to the Waikato Regional Council for acceptance in writing. That Plan shall describe the key aspects of closure and rehabilitation that will be implemented should the site close permanently at the completion of the proposed stage."

Page 56 at the top states,

"At least twelve months prior to landfill operations ceasing on this site, the consent holder shall provide to Waikato Regional Council a detailed Rehabilitation and Aftercare Plan, for acceptance in writing."

Since aftercare is the key to long-term public health, groundwater resource and environmental protection, EnviroWaste should be required to prepare a plan now of the type that it would use assuming that wastes had already been deposited at the site. This plan would enable the public to evaluate the adequacy of the proposed approaches. If found to be acceptable, the plan could be modified before implementation to incorporate any new technologies or other requirements that develop.

Page 56, under "Bond," section 17.1 states that,

"Prior to the commencement of the placement of refuse at the site the consent holder shall provide and maintain in favour of the Waikato Regional Council a bond to:

- *Secure compliance with all the conditions of this consent and to enable any adverse effects on the environment resulting from the consent holder's activities, and not authorised by a resource consent to be avoided, remedied or mitigated;*
- *Secure the completion of rehabilitation and closure in accordance with the approved Rehabilitation and Aftercare Plan;*
- *Ensure the performance of any monitoring obligations of the consent holder under this consent;*
- *Enable the Waikato Regional Council to undertake monitoring and management of the site until completion of closure of the site."*

There is an apparent inconsistency with the consent conditions, where a bond is to be established to fund aftercare activities, yet aftercare activities are not required to be defined until one year prior to cessation of operations of the landfill.

Page 57, under 17.2, states that,

"The quantum of the bond shall be sufficient to cover the general items listed in condition 17.1, and in particular:

(i) the estimated costs (including any contingency necessary) of rehabilitation and closure of the landfill in accordance with the conditions of the Waikato Regional Council Consents;

(ii) the estimated costs (including any contingency necessary) of monitoring and management of the site and its effects following closure or abandonment, for as long as may be required to comply with conditions of Waikato Regional Council consents. This shall include the ongoing operation and maintenance of stormwater, leachate and landfill gas management systems;

(iii) the estimated costs of prevention and/or remediation of any adverse effect on the environment that may arise from the landfill including planting and landscaping provisions; and..."

This bond should be established based on a plausible worst case failure scenario for groundwater pollution or adverse impacts to surface waters.

Page 57, section 17.6 allows an arbitrator to be used to fix the amount of the bond between the Waikato Regional Council and EnviroWaste. The public needs to be a participant in this process to insure that its interests are fully protected from the adverse impacts of this landfill.

Page 59 sets forth "Schedule 2 – General Conditions," in item 1, the design of the liner system. This landfill base and side liner system is not adequate for the proposed site. This liner system is well-known to only postpone when substantial groundwater pollution will occur. It will not prevent it. This landfill should not be approved with this proposed liner design.

Page 59, item 2 presents the required design for the final cover. This cover will develop significant cracks in the low permeability layer which will allow much greater amounts of moisture to enter the landfill than predicted based on the modeling that was done. Montgomery and Parsons (1994) have discussed the significant failure mechanisms for this type of cover. Alternative covers are available which could be used to detect when the low permeability layer fails to control moisture entering the landfill.

Page 60, item 5 discusses the inspection. This inspection program should be recognized as not being able to detect cracks that develop in the low permeability layer which is buried under 1200mm of overlying compacted soil, topsoil, etc.

Page 61 presents "Schedule 3 – Groundwater Monitoring Boreholes." An analysis should be conducted of the ability of these boreholes to detect initial leakage through holes, rips and tears in the landfill liner system when the leachate first reaches the region of the boreholes. This evaluation should include estimates of the horizontal and vertical dispersion and the zones of capture of the boreholes. From this information an estimate of the expected reliability of the groundwater monitoring system to detect leakage of leachate through the liner with at least a 95 percent reliability should be developed.

An area that is not adequately covered by the consent-required monitoring program is the potential for hazardous chemicals to bioaccumulate in aquatic life to be a threat to humans who use the organisms as food, or to higher trophic level aquatic life or terrestrial life. The combination of annual monitoring of aquatic life for excessive concentrations of bioaccumulatable chemicals such as the chlorinated hydrocarbon pesticides, PCBs, dioxins and mercury should be a standard part of the monitoring of stormwater runoff and groundwater discharge to surface waters. Monitoring for chemical concentrations of these constituents is not adequate, since bioaccumulation to hazardous levels can occur, where the concentrations measured in water and/or sediments are below analytical methods' detection limits. It is, therefore, necessary to use organisms to bioconcentrate the hazardous chemicals and then evaluate the significance of this bioconcentration.

Another issue that needs to be considered in evaluating the potential impacts of the proposed landfill's discharge of potentially contaminated stormwater/groundwater is whether the existing or constructed wetlands that are proposed as supplemental treatment are spawning areas or could become spawning areas for fish from the Waikato River or wildlife habitat areas for aquatic or terrestrial wildlife. Aquatic and terrestrial habitat assessment should be an ongoing program, as part of monitoring the impacts of the proposed landfill.

Comments on Proposed North Waikato Regional Landfill
Application for Resource Consents and Assessment of Environmental Effects
Developed by EnviroWaste, March 1999

EnviroWaste proposes to construct a landfill in the Hamilton Downs area that will have a capacity of 30 million cubic meters of municipal solid waste. This landfill is expected to have an active life of 35 years.

EnviroWaste, in the introductory materials to the Assessment of Environmental Effects (AEE), repeatedly discusses, such as on page 3:2, second bulleted item, *"The ability to be able to manage all effects from the landfill so as to ensure no adverse effects beyond the property boundaries."* This type of statement is propaganda in support of the landfill approval. As discussed herein there are many potential adverse effects of the proposed landfill that have not been adequately addressed by EnviroWaste. Lee and Jones-Lee (1995) have discussed the chronic problem of landfill applicants failing to provide reliable information on the long term problems of proposed landfills. EnvrioWaste application and its AEE are extreme examples of this type of problem.

On page 3:2, under "3.2 Design Philosophy," the statement is made in the second paragraph that,

> *"The adopted design philosophy follows the general principles of the New Zealand Centre for Advanced Engineering (CAE) Guidelines for Landfill Engineering, and the United States Environmental Protection Agency (USEPA) specific design approach."*

A review of the CAE Guidelines for Landfill Engineering, including the recently released Guidelines, shows that these Guidelines do not adequately address long-term problems. They appear to have been written from the perspective of supporting low-cost solid waste disposal with little regard to long-term public health, groundwater and surface water quality protection. The Guidelines do not preclude a landfill applicant or a regulatory agency from recognizing the deficiencies in these areas and taking appropriate steps to correct them.

Also on page 3:2, the statement is made in the last paragraph,

> *"Fundamental to the design philosophy is that of achieving design solutions which incorporate 'multiple redundancy.' Effectively, this means having more than one environmental control in place to mitigate a particular effect, when only one system is really necessary. For example four degrees of redundancy are provided for the containment of discharges from beneath the landfill, by way of:*
> - **$** *the provision of a synthetic liner of High Density Polyethylene (HDPE), which will be underlain by;*
> - **$** *a low permeability engineered clay liner, which will be underlain by;*
> - **$** *favourable geology of low permeability materials, which contains and enable,*
> - **$** *a positive inward groundwater hydraulic gradient to be maintained.*

The HDPE and low permeability clay liners provide two degrees of primary containment, whilst the favourable geology and groundwater conditions provide two degrees of secondary containment."

EnviroWaste is providing considerable propaganda in its AEE on the potential environmental protection provided by the proposed North Waikato Regional Landfill. Those familiar with US EPA Subtitle D regulations, after which EnviroWaste has patterned this landfill, understand that the US EPA, in developing the Subtitle D regulations of a single composite liner as the minimum design requirements, opted for a short-term, somewhat political solution to landfilling of municipal solid waste over providing true, long-term public health and environmental protection. As discussed herein, the plastic sheeting HDPE liner and compacted clay (soil) liner at best only postpone when groundwater pollution occurs. They will not prevent it.

Lee and Jones (1992) and Lee and Jones-Lee (1998a) have presented reviews of the literature on what is known about the properties of flexible membrane liners (FMLs) and clay liners to prevent landfill leachate from passing through them for as long as the wastes in the landfill will be a threat. Peggs (1998) has discussed the inevitable failure of plastic sheeting layers used in landfill covers and liners. Shackelford (1994) has presented a comprehensive review of the potential for waste and compacted soil interactions that alter the hydraulic conductivity of liners. Table 1 summarizes some of the causes of landfill plastic sheeting and clay liner failure.

Table 1
Causes of Liner Failure

Plastic Sheeting FMLs	Soil/Clay Liners
Holes at Time of Liner Construction	Desiccation Cracks
Holes Developed in Waste Placement	Differential Settling Cracks
Stress-Cracks	Cation Exchange Shrinkage (for Expandable-Layer Clays)
Free-Radical Degradation	Inherent Permeability
Permeable to Low-Molecular-Weight Solvents – Permeation	Interactions between Leachate and the Clays
Inherent Diffusion-Based Permeability	
Finite Effective Lifetime – Will Deteriorate and Ultimately Become Non-Functional in Collecting Leachate and as a Barrier to Prevent Groundwater Pollution	*Highly Permeable – Allow Large Amount of Leakage under Design Conditions and Subject to Cracking and Other Failure Mechanisms*

Lee and Jones-Lee discuss each of the failure mechanisms presented in Table 1. They conclude that landfill liners of the type proposed for the North Waikato Regional Landfill, while possibly providing short-term protection of groundwater quality, are not reliable for long-term protection and will ultimately fail to prevent leachate from passing through them.

An area of growing concern with respect to plastic sheeting-lined landfills is that dilute aqueous organic solvents can rapidly permeate through an intact, without holes, HDPE liner. This is a chemical transport process in which the low molecular weight organics dissolve into the liner and exit on the downgradient side. Sakti, *et al.* (1991) and Park, *et al.* (1996) have reviewed the available information on this topic and have conducted extensive research on it. They found that an HDPE liner would have to be over three inches thick to prevent permeation of certain organics through it within a period of 25 years. Buss, *et al.* (1995) have reviewed the information on the mechanisms of leakage through synthetic landfill liner materials. They discuss the importance of permeation of organics through plastic sheeting liners as a landfill liner leakage mechanism that does not require deterioration of the liner properties.

A critical review of the literature and other information associated with the development of the compacted soil/clay and plastic sheeting layers that are used as landfill containment liners and caps shows that the currently used materials in landfill liner cells have not been found and would not be expected to prevent hazardous and other deleterious constituents present in the wastes from penetrating through the liner and causing groundwater pollution. Clay liners were selected in the 1970s as liners for hazardous chemical waste ponds without consideration of their potential to interact with certain waste constituents or their inherent design permeability (leakage rates). A landfill clay liner with one foot of head that has a design permeability of 10^{-7} cm/sec will allow the passage of many waste components through the liner at the rate of about one inch per year. That translates to about 100 gallons/acre/day.

Workman and Keeble (1989), who at the time of publication of a paper, "Design and Construction of Liner Systems," were two BFI (a private garbage company) employees, presented a nomograph that shows that a three-foot-thick clay liner with the permeability of 10^{-7} cm/sec with about one foot of head (leachate depth) that functions as designed can be expected to have breakthrough in about eight years. The North Waikato Regional Landfill liner system is proposed to have a clay liner that will have a permeability of 10^{-7} cm/sec at the time of construction; however, it is well-known that permeabilities of clay liners of this type typically increase significantly within a few years after construction.

EnviroWaste's AEE Figure 3.2 presents a cross-section of the liner system that is proposed for this landfill. It basically consists of a drainage layer that is part of the leachate collection system, a 1.5 mm HDPE liner which is placed on a geocushion and 0.6 m of compacted clay liner. Additional low permeability layers are incorporated at the point where the side slopes contact the bottom and along the central leachate collector drain.

Page 3:29 presents a general overview of the landfill cap. The cross-section of the cap is shown in Figure 3.11. The cap consists of a 200mm thick topsoil, 1,000mm thick subsoil, 600mm conventional compacted clay layer with a permeability no greater than 10^{-7} m/sec. This cap structure will overlay a 300mm final cover above the waste.

As discussed in Lee and Jones-Lee (1998a) this type of design for a landfill located at a site such as the NWRLF site that does not provide for natural protection of the groundwater resources from pollution by landfill leachate, will only postpone when groundwater pollution

occurs. It is highly misleading to claim that this design will be protective of groundwater resources from pollution by landfill leachate for as long as the wastes in the landfill will be a threat.

Page 3:31, section "3.3.16 Closure and Aftercare" states that,

> *"The Landfill Management Plan will include the requirement for a Closure and Aftercare Plan to be prepared in advance of the closure of the landfill. This plan will set out the ongoing maintenance and monitoring requirements of the landfill, based on the operational record of the landfill. The plan will be subject to the approval of the Peer Review Panel and the consent authorities."*

Information on what EnviroWaste is willing to commit to in terms of closure and post-closure (aftercare) monitoring, maintenance and groundwater remediation when the landfill liner fails to prevent leachate from passing through the liner for as long as the waste in the landfill are a threat, is a key part of developing a landfill. Without it, the landfill should not be approved.

On page 4:1, the last bulleted item states that the Closure Plan is *"to be prepared one year prior to closure."* The proper review of a proposed landfill requires that the components of the closure plan be reviewed at the time of landfill permitting, and not wait until it is too late to address the large-scale funding issues that will need to be addressed when there is little chance of obtaining the needed aftercare funding for the thousands of years that it will be needed.

On page 4:2, the first bulleted item states that the Post Closure (Aftercare) Plan is *"to be prepared at the same time as the Closure Plan and completed prior to closure."* An issue of particular concern is whether EnviroWaste is willing to provide the funds needed for perpetual (*ad infinitum*) care, monitoring and maintenance of the landfill for as long as the wastes are a threat. The wastes in this landfill will be a threat, effectively, forever. Who is going to provide the funds to insure that after the closure of the landfill there will be funds available to protect public health and the environment, effectively, forever?

Page 4:4, under "Special Waste" states that the TCLP test will be used to indicate aqueous mobility. The TCLP test is not a reliable test for that purpose. This test was developed by the US EPA to limit the size of the hazardous waste stream that it would have to manage as a hazardous waste. See Lee and Jones-Lee (2000) and Lee and Jones (1981, 1982) for a discussion of the inappropriateness of using the TCLP test to characterize the mobility of waste components.

From the waste listing on page 4:4 and 4:5, it is clear that there could be substantial amounts of hazardous chemicals deposited in this landfill.

Page 4:10 provides some additional discussion of closure and post-closure (aftercare) issues. Basically, EnviroWaste is asserting that it has sufficient financial assets to insure adequacy of funding to meet all aftercare needs for as long as the wastes are a threat. It is apparent that EnviroWaste has limited understanding of the length of time (thousands of years)

that the wastes will be a threat. The failure to address this issue at this time is one of the most significant deficiencies of the proposed NWRLF application.

Page 4:10, second paragraph states that,

> *"A post closure (aftercare) plan will be developed at the same time as the Closure Plan and completed prior to closure to ensure effective management of capping, leachate, gas, stormwater, groundwater and monitoring systems until the landfill no longer presents a significant risk to the environment. Aftercare shall continue until post-closure monitoring is no longer required."*

However, there is no discussion of these issues and no assured funding which is not dependent on the financial health of EnviroWaste to provide for this care. The financial stability/instability of garbage companies is well known. It is recognized that post-closure care funding must be developed based on a dedicated trust fund of sufficient magnitude to address plausible worst-case failure scenarios for as long as the waste in the landfill will be a threat. EnviroWaste needs to acknowledge that, for practical purpose planning, the post-closure care period should be considered infinite.

At several locations, mention is made (see page 9:1, last paragraph) about post-closure use of the area to include returning it to pastoral farmland. This approach could be quite dangerous, through the transfer of hazardous substances from the waste through deep-rooted plants to the surface. This can lead to surface water pollution.

Page 10:12, section "10.4.3 Long Term Fate of the Leachate" states in the first paragraph,

> *"On completion of landfilling, leachate will continue to be removed until the leachate strength reduces to the point where the flow can be safely released directly into the surface water system."*
>
> * * *
>
> *"It is anticipated that leachate will continue to be collected for a period of at least 30 years after completion of the landfill."*

While the wording of these sections indicates that EnviroWaste would be responsible for managing leachate for as long as the waste represents a threat, there is no assurance that EnviroWaste will even be in existence when this situation occurs, which will likely be in 50 to 75 years from now. The leachate generation within the proposed landfill at hazardous or deleterious concentrations will continue for a thousand or more years.

Page 10:14, section "10.5.5 Effect of Liner Leakage on Groundwater Quality" states,

> *"While it is extremely unlikely that any leakage will be detectable, the proposed composite liner and leachate collection system provides for a theoretical leakage loss of 0.8 m^3/day from the completed landfill footprint. Any fugitive leachate seeps would be attenuated by the clay liner and site soils before discharging into*

the groundwater collection system and mixing with the predicted 80 m^3/day groundwater flows."

It is stated in the third paragraph of this section,

"The theoretical modeling and attenuation parameters used are extremely conservative and the predicted increases are not expected to be achieved in practice. Actual monitoring data from existing landfill sites confirms that the predictive tools are extremely conservative."

A critical review of the expected leakage rates from the landfill liner system shows that it is not conservative, but, in fact, EnviroWaste has grossly underestimated the rate of leakage of leachate through the liner system. This issue is discussed in more detail in the review of the specific design calculations.

Page 10:16 under "Leachate Effects" states, *"A composite liner consisting of an HDPE membrane on top of a 600mm thick compacted clay liner will prevent leachate entering the ground."* That statement ignores the well-known properties of HDPE over time where its structural integrity is lost.

Page 12:2, in the first and second paragraphs, mentions that the nearest neighbor to the landfill will be about 1,000 m during the first 15 years, and about 400 m after that. These distances are far too short to dissipate dust, odors and other releases from the landfill. Basically, there is inadequate buffer lands between where landfilling will occur and adjacent properties. Contrary to the statements made, there almost certainly will be times when adjacent property owners will experience obnoxious odors at the property line between the landfill property and adjacent properties. Shusterman (1992) has discussed the effects of environmental odor pollution on health. Some of these gaseous releases from the landfill will be detrimental to human health because of their highly unpleasant characteristics as well as the hazardous VOCs present in landfill gas.

Page 12:5, section "12.3 Landfill Gas" fails to mention, associated with landfill gas flaring, that landfill gas flares have been found to produce dioxins (Eden, 1993).

Page 12:6, Figure 12.1 presents a diagram showing landfill gas generation. There is no indication of a time period over which the generation will occur. It is much longer than landfill leachate generation. See Lee and Jones-Lee (1998a) for further information.

Page 12:7 states in section "12.4 Greenhouse Gases," second bulleted item, "*It is estimated that in 2048, only 14,800 tonnes of methane will be released, compared to 60,500 tonnes if gas collection and utilisation were not in operation.*" As discussed by Lee and Jones-Lee (1999) the prediction of the amounts of methane produced after landfill closure are highly unreliable, since they are dependent on the rate of leakage of moisture into the landfilled waste through the cover. Also the plastic bags that are used to dispose of household garbage tend to hide the wastes in the crushed bags and thereby greatly extend the period of time that the waste

will be a threat to generate gas. The plastic bags will have to decompose first before moisture that enters the landfill will interact with the waste to produce landfill gas. This issue has recently been reviewed by Jones-Lee and Lee (2000).

Page 12:8 presents a summary of air quality issues. This is an unreliable assessment of a number of issues, such as dust, odor, VOCs associated with landfill gas, the failure to mention that dioxins are formed in flared landfill gas, etc.

Page 17:2, section "17.5 Groundwater Monitoring" states in the second paragraph,

> *"Groundwater monitoring bores will be located around the perimeter of the refuse placement areas and upgradient and down gradient of identified groundwater flow paths, in positions that will be agreed with Environment Waikato."*

This approach is not appropriate for assessing potential environmental effects, since it fails to consider the significant problems that exist with groundwater monitoring associated with lined landfills of the type that EnviroWaste proposes to construct. There is no assurance that Environment Waikato and EnviroWaste will develop a groundwater monitoring system that will detect leachate-polluted groundwaters before they cause offsite pollution for as long as the waste in the landfill will be a threat. The issues of groundwater monitoring of lined landfills are discussed in a subsequent section of these comments.

The section on the bottom of page 17:2 and the top of page 17:3 is far too nebulous to accept as a credible discussion of the monitoring issues. There is no question about the fact that the landfill liner system will fail to prevent leachate from passing through it at sufficient rates to cause significant groundwater pollution. In order to address this problem, EnviroWaste must be required to define the groundwater monitoring program that it proposes to use for this landfill as part of the Assessment of Environmental Effects so that the public and regulatory agencies can assess whether EnviroWaste will conduct a reliable monitoring program or will address this issue in a superficial way as they are proposing to do with a number of areas associated with the development of this landfill.

Page 17:3 at the top mentions alert levels and response levels. The concentrations of the constituents of concern, however, are not provided. This should be provided as part of an Assessment of Environmental Effects.

Page 17:3, the last paragraph in section "17.6 Stormwater Monitoring" indicates that, *"Conductivity alert levels will be set at each of the monitoring locations, exceedance of which will activate an alarm, following which the source of contamination will be traced and remedial works carried out as appropriate."* The measurement of electrical conductivity is not sufficiently sensitive to detect potentially hazardous constituents released from a landfill. The surface water monitoring must be based on a more comprehensive suite of constituents. The details of the surface water monitoring are not provided, and, therefore, the adequacy of this monitoring cannot be evaluated.

Page 17:4, under section “17.7 Landfill Gas Monitoring,” no information is provided on the details of the proposed monitoring. This, like the other monitoring sections, is deficient, in that those who review the landfill cannot judge whether EnviroWaste and the regulatory agencies will be protective of public health and the environment.

Review of Proposed North Waikato Regional Landfill
Appendix 1: Management Plans and Technical Reports
Developed by EnviroWaste Services Limited, March 1999

On page 1, item (g) states that,

"(vi) Closure Plan (to be prepared one year prior to closure).
(vii) Post Closure (Aftercare) Plan (to be prepared at the same time as the Closure Plan and completed prior to closure)."

This information is needed now to properly review the proposed landfill, since the closure plan and post closure plan, and especially the funding associated with the implementation of these plans is critical to public health and environmental protection for as long as the waste in the proposed landfill will be a threat.

On page 2, (h) states that, *"A summary of reports sent to the Group Manager, Env-Waikato, will be sent to the Peer Review Representatives."* In order to insure that the environmental perspective is properly incorporated into the peer review process, a member of the peer review representatives should be someone from the environmental community who is an expert in the topic areas.

Page 4, under "5.0 PRINCIPAL DESIGN FEATURES," item (d) states that, *"Landfilling, from commencement to closure, will be carried out as a <u>modern</u> landfill operation in accordance with current recognised <u>good</u> practice."* [Emphasis added.] Such statements are misleading, since what is "modern" and what is "good practice" is highly variable, depending on the views of those conducting the review. EnviroWaste should specify in detail how it will prevent adverse impacts to public health, groundwater resources, surface waters and the environment for as long as the waste in the landfill will be a threat. For example, will EnviroWaste prevent all odors from trespass onto adjacent properties? Is EnviroWaste committed to preventing groundwater pollution beyond the landfill area? What is the reliability of the proposed groundwater monitoring system that it plans to use? Etc.

Page 6, "7.0 LEACHATE MANAGEMENT" states under item (a),

"Leachate management systems are employed:-
(i) to contain and store the leachate, thus preventing the downward and lateral movement of leachate into the strata and groundwater underlying and adjacent to the landfill."

Such a statement is propaganda. There will be leachate migration under the current design under the landfill into the underlying groundwater system.

Page 7, under section "8.0 GROUNDWATER MANAGEMENT," item (a) states,

"A fundamental aspect of the design philosophy for the landfill is the groundwater containment of a substantive part of the landfill site, by way of an 'hydraulic trap.'"

While there is an inward groundwater gradient (high groundwater table) for part of the landfill, there is a substantial part of the landfill where there will be leakage through the liner system into the underlying groundwaters, which will not be subject to the hydraulic trap. Further, the hydraulic trap aspects of this could eventually lead to massive amounts of leachate generation, which can ultimately lead to greater groundwater pollution as the flexible membrane liner deteriorates.

Item (e) of that same section states,

"In the close out stages of the landfill (Stages 6 and 7), the groundwater captured within these drains will be piped beneath the landfill into three groundwater abstraction manholes, located within the clay bund at the base of the landfill."

The groundwater management plan as set forth, in order to be effective, requires a far better understanding of groundwater hydrology than EnviroWaste has demonstrated. It also requires long-term, likely *ad infinitum,* funding to make this system work for as long as the wastes are a threat.

Item (g) of that same section states,

"Groundwater monitoring bores will be located within the landfill site, primarily around the perimeter of the refuse placement areas and both upgradient and downgradient of identified groundwater flowpaths."

Information is needed on the reliability of the proposed groundwater monitoring system to detect leaks before offsite pollution occurs. EnviroWaste should be required to provide this information.

Page 8, under "9.0 LANDFILL GAS MANAGEMENT," item (a) states that,

"The primary objectives of landfill gas management practices at the site is to mitigate the odours associated with landfill gas emissions and to remove potential areas where hazardous gases might collect. This will ensure that there are no noxious, objectionable or offensive odours or hazardous gas areas at and/or beyond the landfill boundary."

This statement is virtually impossible to carry out without extraordinary odor control far beyond that which EnviroWaste proposes to provide with such limited buffer lands around the landfill waste deposition area. One of the issues that needs to be addressed is what happens if obnoxious odors are detected at the landfill boundary with adjacent properties. Is EnviroWaste prepared to shut down the landfill and remove all waste if it cannot control the odors as is promised?

Item (b) of that same section states that the landfill gas will be flared under "*...conditions to eliminate the discharge of harmful constituents to the atmosphere and reduce greenhouse gas emissions.*" No mention, however, is made about the monitoring of the landfill gas flares to insure that dioxins are not produced in the flares. As discussed by Lee and Jones-Lee (1998a), Eden (1993) has reported that landfill gas flares have been found to produce dioxins.

At the bottom of page 8, item (e), the provision is made for "*inspections of the landfill site and gas extraction system at no less frequently than weekly intervals.*" Over what period of time will this schedule be carried out? For as long as the waste in the landfill will be able to produce landfill gas?

Page 12, section "11.0 MONITORING, CLOSURE AND AFTERCARE," states,

> *"(b) A closure plan will be developed one year prior to closure to ensure that the completed landfill will result in minimum risk to the environment during the aftercare period."*
>
> *(c) A post closure (aftercare) plan will be developed at the same time as the Closure Plan and completed prior to closure to ensure effective management of capping, leachate, gas, stormwater, groundwater and monitoring systems until the landfill no longer presents a significant risk to the environment.*
>
> *(d) Aftercare shall continue until such time as the Group Manager, Env-Waikato, certifies that post-closure monitoring is no longer required. If required, full operational monitoring and maintenance may be continued during this time.*
>
> *(e) An aftercare fund will be established to ensure adequate financial resources are available to provide for aftercare requirements, as set out in the resource consent conditions."*

The key issue in the aftercare is will a dedicated trust (bond) be established that can address all plausible worst case scenario failures for the landfill for as long as the waste in the landfill will be a threat. For planning purposes, this period of time should be considered forever.

Page 14, under "14.0 PEER REVIEW PROCESS," a key aspect of the peer review process will be EnviroWaste's funding of one or more individuals to serve as peer reviewers who are involved from the environmental, public health perspective, and who are acceptable to those concerned about these issues.

On an unnumbered page headed by "SPECIAL WASTE ACCEPTANCE PROTOCOL," section 3 discusses the use of the TCLP extract. TCLP is not a reliable way to distinguish between hazardous and nonhazardous wastes. The TCLP test is a political test that was contrived by the US EPA to limit the size of the hazardous waste stream that would have to be managed as hazardous waste. Substantial hazardous chemicals can be present in the so-called

"nonhazardous" waste, based on TCLP procedures. Lee and Jones (1981, 1982) and Lee and Jones-Lee (2000) have reviewed the unreliability of the TCLP to distinguish between hazardous and nonhazardous wastes.

Review of Appendix 1 B
Earthtech Consulting Limited 1999:
North Waikato Regional Landfill:
Geotechnical and Hydrogeological Investigation Report

Page 2-13, under the discussion of groundwater at the proposed landfill site, in section "2.6 Implications For Proposed Landfill Site," states in item ii),

> *"The proposed landfill footprint is underlain by an extensive sequence of interlayered sandstones and siltstones of the Amokura Formation which are characterised by low hydraulic conductivity (10^{-6} to 10^{-8} m/s)."*

10^{-6} m/s is not a particularly low conductivity. With a head of one foot, a 10^{-6} m/s permeability could represent a leachate polluted groundwater transport of about 100 ft/yr. Basically, the groundwater characteristics as summarized on pages 2-13 and 2-14 indicate that there is useable groundwater associated with the proposed landfill area that can be polluted by landfill leachate.

Page 4-1 begins a discussion on site geology. From the information provided, it is clear that the proposed landfill site does not provide for natural protection of groundwater from pollution by the landfill leachate that will leak through the landfill liner system. This, coupled with the groundwater hydrology of the region, means that there is a significant potential for offsite groundwater pollution by landfill leachate.

Page 6-11, near the bottom under the discussion on groundwater modeling,, indicates that a geometric mean for the hydraulic conductivity was used. What should have been used was the worst case (highest) hydraulic conductivity measured. Those who want to use groundwaters down hydraulic gradient from the landfill are not interested in the geometric mean velocity of the groundwater that will be polluted, but what is the fastest rate. According to the data provided, this could be 100 times higher than that used in the modeling efforts.

Following page 6-18 is a section on "Groundwater Chemistry for Existing Site." A review of the information presented in this section shows that there is high-quality groundwater underlying the proposed landfill site that could be severely impacted by landfill leachate.

Page 6-21, in section "6.6 Groundwater Flows," in the first paragraph indicates again that, the *"geometric mean hydraulic conductivity data from on-site testing"* was used. This is conservative on behalf of the landfill applicant, and not necessarily protective of offsite groundwater users.

Page 7-8, under "7.5 Groundwater Pressures," indicates that *"a maximum leachate level build-up of 5m has been allowed in the landfill floor."* The depth of leachate on the liner should not be allowed to exceed 30 cm in order to reduce the leakage of leachate through the liner.

Page 8-1, in the section "8.0 SEISMIC ISSUES," subsection "8.2 Performance of Landfills in Earthquakes," in the first paragraph mentions that three landfills in California have

been reviewed with respect to their performance under seismic activity. Their performance has been assessed to be good to excellent. Caution should be used in accepting that type of characterization. A more detailed review with the State of California Integrated Waste Board staff that investigated this situation indicates that there were major failures that were detected in one of these landfills, and there may have been other failures that were not detected.

On page 11-3, under section "11.4 Compacted Clay Liners (CCL)," one of the issues that was not addressed in the discussion of the clay liner is the potential for desiccation cracking, where the moisture used as part of compaction of the liner moves out of the compacted clay, by unsaturated flow, causing the liner to shrink and crack.

Page 11-16, section "11.6.4 Estimated Leakage Rates" presents information on the rates of leakage for new HDPE liners. There is no discussion of the deteriorated HDPE liner leakage rates. The reported leakage rates are only for high quality construction when the liner is new. There is no question about the fact that over time HDPE liners will deteriorate in their structure, leading to increased leakage rates.

Page 11-17 presents 6 options for liner design. The option that should have been included and the one used for design is a double composite liner with a leak-detection system between the two liners. This is the one that is considered the state-of-the-art/engineering today.

This section on leakage rates of liners is significantly deficient in addressing the issues that should have been addressed in a credible discussion of this topic – namely, the long-term properties of the liners relative to rates of leakage. Also, the failure to discuss desiccation cracking as a means of enhanced permeability for clay liners is a significant deficiency with this discussion. This failure causes the discussion on page 12-2, section "12.1.4 Contaminant Transport" to be technically invalid. It only addresses the issues of when the liner system is relatively new and does not discuss the long-term properties of the liner that need to be discussed in a credible presentation on this topic.

Page 13-7, under item "C. Design of an Hydraulic Trap," states, *"This effectively means that no leachate or groundwater can escape from the site other than by pumping."* There is no assurance that EnviroWaste will be able to maintain the groundwater below the landfill at an artificially low level for as long as the wastes are a threat. This requires an *ad infinitum* maintenance of this landfill system and the funding to carry out this maintenance.

In the last paragraph on page 13-7, it is stated that, *"Once the leachate has stabilised to the point where no further treatment is necessary, the pumping systems can be abandoned and both the leachate and groundwater systems allowed to discharge via gravity flow."* For this type of landfill, that could readily be several thousand years.

On page 13-8, under "D. Liner Design," the statement, *"In essence, there is sufficient data to demonstrate that an unlined landfill would be fully contained on this site,"* is not in accord with the information available.

Page 13-8, in the fourth paragraph states, *"The selected liner design for this site utilises the existing natural containment features which have been backed up by well proven engineered liner systems."* This is another of the propaganda statements that prevail through EnviroWaste's application supporting documents. The so-called "well-proven" engineering is not in terms of demonstrated performance to protect groundwaters from pollution by landfill leachate for as long as the waste in the landfill will be a threat. Those who understand and will discuss the characteristics of these liners report that it is only a matter of time until the liners fail to be an effective barrier for leachate transport through the liner.

Page 13-8, at the bottom of the page, discusses the landfill liner design. This design is quite similar to the US EPA's minimum Subtitle D liner. There are ten US states that would not allow a landfill with this design to be constructed, because of the inevitable failure of this liner system.

Referring to page 13-9, section "F. The 'Managed-Wet' Operating Concept," EnviroWaste wants the reviewers of this application to believe that the system would largely be stabilized at the time of closure of the landfill. There is no discussion, however, of the fact that large amounts of the waste that will be placed in this landfill will be placed in plastic bags, which, while crushed, are not shredded. This, in turn, will lead to very slow leaching and fermentation of the wastes that are "hidden" by the bags. The bags will have to decompose before stabilization of the waste to a non-polluting residue will occur. This decomposition is estimated to take from many decades to hundreds of years.

Page 13-9, under "G. Landfill Cap Design," states in the second paragraph that, *"The cap design recognises that aftercare will be required to repair and top up certain areas."* Page 13-10 presents the details of the landfill cover design, which includes a 600mm compacted, low permeability clay layer, which is buried below 200mm of topsoil, 600mm of growing medium and 400 to 600mm of extra rooting depth. While not mentioned, the low permeability layer in the cap can readily develop cracks, which will not be manifested in the surface layer.

Page 14-4, under "Rate of Groundwater Divide Migration," in the third paragraph states, *"Conservative assessments of groundwater travel times through the proposed landfill liner and the Amokura Formation below the liner are in the order of 10's to 100's of years."* This appears to be based on a geometric mean hydraulic conductivity, rather than the higher permeabilities that have actually been measured at the site, which would greatly shorten the time of migration through the liners and groundwater system.

Page 14-5, section "14.2 Groundwater Quality Effects," states in the second paragraph, *"The assessment of groundwater quality effects has been carried out in terms of expected groundwater drain quality over the life of the landfill."* That statement is not true. The predictions on groundwater quality effects were based on assuming that the properties of the liners, and especially the HDPE liner, that are achievable with high-quality construction will persist throughout the period of time that the waste in the landfill will be a threat. Even though well-understood, no discussion has been provided by EnviroWaste or any of its consultants on the ultimate deterioration of the HDPE liner. The results of the calculations presented on page

14-5 on the concentrations of constituents in the groundwater are based on a fundamentally flawed approach for assuming rates of leakage through the liner over the period of time that the wastes in the landfill will be a threat.

Page 14-6, section "14.3 Effects on Existing Bore Users," states that, "*With the proposed hydraulic trap and a minimum separation distance from the nearest bore to the edge of the landfill footprint of 650m, no adverse effects on existing bore users are expected.*" First of all, adjacent property owners should be able to put a well at their property line. There should be no trespass of leachate-polluted groundwaters from the landfill property. This statement about no adverse impacts on existing bore users is not based on a proper analysis of the situation for as long as the wasted in the landfill will be threat.

Page 15-1, under "15. FUTURE MONITORING," asserts that two monitoring wells plus monitoring of the groundwater abstraction manholes provide suitable long-term monitoring. A more detailed analysis of this situation needs to be done to insure that this type of monitoring will, in fact, adequately sample all groundwaters that are polluted by leachate. Further, there has to be assurance that there will be funds to operate and maintain this monitoring system for thousands of years.

On page 17-1, section "17. CONCLUSIONS AND RECOMMENDATIONS," under "17.1.2 Site Hydrogeology," EnviroWaste again characterizes the site as having "*very low hydraulic conductivities.*" That is a comparative that needs to be explained. "Very low" hydraulic conductivities only slow down when offsite groundwater pollution occurs; they do not prevent it. In fact, they may cause problems because of the inadequate attention to the long-term issues associated with the pollution of groundwater by liner leakage.

Page 17-2, under section "17.1.3 Liner Attenuation," fails to consider the large-scale leakage of the HDPE liner which, as it occurs, will lead to saturation of the attenuation capacity of the clay liner. Further there are hazardous constituents in the MSW leachate such as many of the VOCs that are not significantly attenuated by clay liners.

A well known method of landfill liner leakage that is not mentioned by EnviroWaste and its consultants is permeation. Low molecular weight solvents such as the VOCs can pass through an intact (no holes) HDPE liner in days. This issue has been discussed in landfill literature since the late 1980s (Haxo and Lahey, 1988) and has been reviewed by Lee and Jones-Lee (1998a)

Following page 17-6 is section "18. REFERENCES." A review of the references shows that the authors of this section have failed to adequately present references to the substantial literature that discusses the problems with these types of landfill liners, monitoring and other systems. An example of unreliable reporting is the US EPA (1991) reference to the Environmental Protection Agency's "Solid Waste Disposal Facility Criteria; Final Rule." However the references do not include the 1988 discussion (presented herein) by the US EPA that all landfill liners of this type will eventually fail to protect groundwater.

On pages 22-23 in the PDP section, Tables 5 and 6 present the estimated chemical characteristics of the leachate from the proposed North Waikato Regional Landfill. These results indicate that small amounts of this leachate will have a significant potential to cause substantial groundwater pollution. It should be noted that there are a number of constituents in MSW leachate, such as the VOCs, that are not listed in these tables. This is a significant omission in providing reliable information on the characteristics of the leachate, since many of the VOCs of concern can pass through the intact HDPE liner within a few days. Further, many of these VOCs are carcinogens.

Page 28 discusses the proposed leachate management system, in which the leachate pumped from the landfill will be transported to a nearby municipal sewerage system for disposal. It also discusses alternative approaches, which include local (to the landfill area) treatment and discharge to land or to the Waikato River. The local treatment and discharge to nearby land or to the river will require extensive treatment to protect surface water quality. Even with treatment, it cannot be certain that there are not some constituents or combination of constituents that will be adverse to aquatic life. It is important to understand that meeting the ANZECC aquatic guidelines does not mean that there are no constituents in the leachate which can cause significant adverse impacts to aquatic life.

Page 41 mentions the use of wetlands for polishing treated leachate. Care must be exercised with wetlands-based treatment systems to be sure that they are operational year-round. In many climates, wetland treatment systems only function effectively for part of the year under low hydraulic and pollutant loadings.

Section "2.0 Landfill Development Strategy" in the SCS Wetherill Environmental report, "Preliminary Landfill Gas Management Plan for the North Waikato Regional Landfill," page 3 states that the nearest dwelling is greater than 250 m. Offsite properties from landfill areas should have at least a mile of buffer lands to dissipate odors. In some areas, greater distances are needed.

Page 5, section 3 discusses in "3.4 Flare(s)" that the landfill gas will be flared. No mention is made, however, of checking the flare combustion products to be certain that dioxins are not formed.

Page 8, section 4.0 discusses "Landfill Gas Systems - Operation and Maintenance." No discussion is provided on the extremely long time over which landfill gas production will occur, due to the reduced moisture content of the landfill and the plastic-bagged garbage.

Exhibit A-1 presents the projected landfill gas generation rate. This is based on US EPA AP42 information. That approach does not consider the low permeability cover effects on landfill gas production or the long-term plastic bag "hiding" of solid wastes from moisture, which will extend the period of time of landfill gas production. These issues are reviewed by Lee and Jones-Lee (1999).

Review of "Opening Submissions on behalf of the Applicant"

This document appears to be an introduction to the presentation by EnviroWaste at the hearing. As documented below, it contains considerable propaganda by EnviroWaste on potential environmental impacts.

Overall, this submission by EnviroWaste contains much of the same propaganda as discussed in other submissions. For example, on page 2, section 1.4 states, *"As the evidence for the applicant will demonstrate, the proposed landfill has been designed to the highest international standards."* That is certainly not the case. There are at least ten states in the US where this landfill could not be constructed because of its inadequate non-state-of-the-art design.

Page 2, section 1.5, fourth bulleted item states that, *"The site has a favourable geological setting with no characteristics which are adverse to the development of the site for landfill purposes."* This site is far from an appropriate site for a landfill. The so-called "natural" geological protection provided by the site only slows down groundwater pollution; it does not prevent it.

The fifth bulleted item states, *"There is a natural groundwater containment at the site which can be developed to maintain inward hydraulic gradient into the landfill at all times."* Again, EnviroWaste has provided unreliable information. Only part of the landfill can have an inward gradient, because of the high groundwater table.

Page 3, under the fifth bullet on the page, *"There is the ability to manage all effects from the landfill so as to ensure no adverse effects beyond the property boundaries..."* That is certainly not the case. There are inadequate buffer lands to control odors, and there is a substantial probability that groundwater pollution offsite will occur.

Page 7, section 3.2.3 states, *"The size of the property available for the landfill facility provides a substantial buffer area of not less than 500 meters between the proposed landfill itself and any surrounding properties."* Five hundred meters is not adequate buffer lands to dissipate the active life impacts of landfills of this type.

Page 9, section 4.2.1 states, *"EnviroWaste has adopted a design philosophy to ensure that there will be no adverse environmental effects beyond the site boundary."* This is more propaganda. There is a substantial likelihood of adverse impacts beyond the site boundary, due to gaseous releases and groundwater pollution.

Section 4.2.2 states, *"The design philosophy follows the general principles of the New Zealand Centre for Advanced Engineering (CAE) guidelines for landfill engineering, and the United States Environmental Protection Agency (USEPA) specific design approach."* The fact is not discussed that the US EPA acknowledged that this design approach will eventually lead to groundwater pollution. The statement in the same paragraph that, *"These philosophies are non-prescriptive, but require the design of a landfill to achieve the objective of no adverse environmental effects beyond the site boundary,"* reflects the fact that EnviroWaste, as part of

this document, has not taken time to become familiar with the US EPA regulations. These regulations are based on an assessment that there will be a certain number of people die from acquiring cancer due to consuming groundwaters which are polluted by landfill leachate in a minimum Subtitle D landfill liner design of the type that EnviroWaste proposes to use.

The statement is made on page 10, section 4.2.6, that, *"The HDPE and low permeability clay liners provide two degrees of primary containment, whilst the favourable geology and groundwater conditions provide two degrees of secondary containment."* EnviroWaste did not discuss that all four of these "degrees of containment" are flawed and will fail. The plastic sheeting liner has a finite period of time when it can be expected to function properly before significant decay occurs. The compacted clay layer is subject to considerable problems, including finite permeability. The geology and hydrogeology of the site are such that they slow down the rate of leachate-polluted groundwater migration offsite, but they do not prevent it. This gives a false sense of security and postpones the problems.

Page 11, section 4.3.2, the last two sentences state, *"The sandstone layers tend to dominate over the siltstone layers. These characteristics ensure natural secondary containment of the site."* This is propaganda. "Containment" means prevention of transport of leachate-polluted groundwaters offsite. This is certainly not the case. The siltstone and sandstone layers provide avenues for transport.

Page 11, section 4.3.4 states, *"Groundwater flows are into the landfill site and not in the direction of the Waikato River."* There are significant questions about the reliability of this statement.

One of the most significant deficiencies of this application is the failure of EnviroWaste to acknowledge that this landfill will be a threat to pollute groundwaters for thousands of years. EnviroWaste has failed to address the key issues associated with closure and post-closure (aftercare), and especially the funding of the aftercare for as long as the wastes in this landfill will be a threat. These are key issues that have to be addressed now as part of permitting of the landfill. Failure to do so could easily result in a situation where, in the last year of operation of the landfill, it will be realized that there is inadequate funding to carry out many of the provisions that are essential for this landfill to be protective of public health, groundwater resources and the environment for as long as the wastes are a threat.

Page 52, section 10.3.14, states,

> *"In summary, odour effects will not be a significant issue at this landfill due to the separation distances between the landfill and the nearest residential properties, the extensive gas control measures that have been incorporated into the landfill design and the proposed operational standards to be implemented at the site."*

It is my experience that, with such limited buffer lands between the location where the wastes will be deposited and adjacent properties, there is a significant potential for offsite odors to occur.

Page 56, under section "10.8 Litter control," subsection 10.8.1 states, "*The proposed landfill will have a huge buffer area with a minimum of 500 metres.*" This is not a "huge" buffer area. Rather than being a huge buffer area, it is an inadequate buffer land area.

Page 61, under "12.0 Conclusions," subsection 12.1.1 states, "*These applications concern a proposal to establish a state-of-the-art landfill which will encompass the most up to date technology available in New Zealand and which has been designed to the highest international standards.*" This is more of the propaganda. It is certainly not a "state-of-the-art" landfill in other areas. It would not be allowed in ten US states because of deficiencies in design.

Comments on "Closing Submissions on behalf of the Applicant"
Presented at Hearing on 3 November 1999

On page 2, item (a), EnviroWaste states, *"The site geology provides natural containment for leachate to be generated within the landfill."* This statement is not true. The site geology does not provide for natural containment. The site geology will eventually allow offsite groundwater pollution by landfill-derived leachate, if EnviroWaste at any time over the thousands of years that the wastes in the landfill will be a threat fails to properly maintain the consents requiring capture of all groundwaters exiting from under the landfill.

On page 2, item (b), EnviroWaste has again provided unreliable information with regard to the groundwater flow regime and the potential for leachate to leak through the liner system. First, those who understand and reliably report on the characteristics of this type of liner system know that it eventually will fail to prevent significant leachate from passing through it. Second, the so-called "inward groundwater gradient" does not naturally prevent offsite pollution. In order for this site to not cause significant offsite groundwater pollution, it will be necessary for EnviroWaste to operate and maintain a pump and treat system, effectively, forever. There is no assurance that EnviroWaste will, in fact, be willing and/or able to fund this type of commitment.

On page 2, item (c), EnviroWaste has again provided unreliable information where it states, *"That though these unique beneficial natural conditions would alone suffice to provide containment for leachate within the site the applicant proposes to establish a state-of-the-art primary liner system employing an HDPE liner overlaying an engineered clay liner 600mm thick."* This is another highly distorted statement of the facts. The natural conditions of the site do not prevent offsite pollution. The HDPE liner is not "state-of-the-art;" in the US it is the minimum necessary to just get by what are well-recognized as inadequate liner requirements for US EPA Subtitle D landfills. It is recognized that these liners will eventually fail to prevent leachate from passing through them that will cause significant groundwater pollution.

On page 2, item (d), EnviroWaste has again distorted the information, where it claims that, *"The applicant identified a site that is well isolated from local residential activity. It has secured sufficient land under its control to ensure that at all times an adequate buffer for the landfilling activity is maintained in relation to any adjoining property."* That statement is not true. Typically, at least a mile (2.5 km) of landfill-owned land should exist between where wastes are deposited and adjacent property lines in order to dissipate most of the adverse impacts associated with the active life of the landfill. This landfill will certainly have offsite odor problems for adjacent property owners.

Page 2, in section 1.3, EnviroWaste states that the proposed North Waikato Regional Landfill site is well suited for the proposed landfilling activity. This is not true. This is not a good site for this landfill. There is inadequate buffer; there is no natural containment; and there is no assurance that EnviroWaste can and will provide for the extensive, expensive long-term maintenance and eventual groundwater remediation that will have to take place at this site to protect public health and the environment for as long as the waste in the landfill will be a threat.

Page 10, under "5.0 Odour effects," section 5.5 states, *"The applicant is confident that the North Waikato Regional Landfill odour mitigation facilities will perform far better than at any existing landfill."* That is not the issue. Most landfills have excessive odors at the property line. This landfill, because of inadequate buffer lands between where wastes will be deposited and adjacent properties, will also have excessive odors at the property line.

Page 10, section 5.6 states, *"Furthermore, unlike other sites, this site will enjoy extensive buffer distances from adjoining properties."* This is not a reliable assessment of the buffer lands needed to dissipate odors from a facility of this type employing the approaches that are proposed to be employed in managing the wastes.

Pages 11 and 12 discuss the approaches proposed for control of birds at the landfill. It is my experience that even with the proposed approaches, birds can still be a problem to adjacent property owners because of the existence of the landfill in their area. This is another reason for significantly increasing the buffer lands between where wastes will be deposited and adjacent properties.

Page 21, under section 9.4 (a), EnviroWaste again perpetuates its ongoing propaganda, where it states that, *"The Hampton Downs landfill will employ the latest technology and liner systems which together will ensure that there will be no real risk of gas migration beyond the land controlled by the applicant."* There is no recognition in any of the documentation provided by EnviroWaste that this landfill could readily develop landfill gas for hundreds of years as the plastic bags in the landfill slowly deteriorate, making available organics which can be converted to landfill gas upon contact with water.

On page 28, at the bottom, in section "11.0 Impact on local property values," I have been involved in landfill review issues for nearly 20 years. At virtually every landfill siting situation the landfill applicant and its consultants will claim that there are no property value decreases associated with developing a landfill in the area; yet independent assessments, such as those of Hirschfeld, *et al.* (1992), have shown that property values typically decrease for several miles from the landfill.

Page 34, under "15.0 Conclusions," EnviroWaste threatens the region, districts and the public with the potential of developing lower standard landfills if the EnviroWaste Hampton Downs landfill is not accepted. This is clearly an inappropriate approach. The regulatory agencies in New Zealand should impose the standards necessary to insure that any new landfills developed in New Zealand are fully protective of public health, the environment and water resources for as long as the wastes are a threat.

On page 34, section 15.2, EnviroWaste has perpetuated its propaganda, where it states, in the second paragraph, *"...which uses the best available technology and ensures that the adverse effects are no more than minor..."* This landfill is far from being the "best available technology," and there are significant questions about EnviroWaste's assurance that it will manage adverse impacts for as long as the wastes represent a threat.

Page 34, section 15.3 states, *"The landfill gas system will ensure that landfill gas generation will cease during the aftercare period."* This can potentially be true if the aftercare period extends over hundreds to a thousand years or so – i.e., the time necessary for the wastes that are "hidden" within the crushed plastic bags to eventually be exposed to moisture, which can generate landfill gas.

The facts are:

This landfill will be adverse to adjacent property owners during its active life;

There is a high probability that the groundwater pollution that will occur under the landfill will be carried offsite because of the inability of EnviroWaste to collect and treat all groundwaters that will be polluted by landfill leachate that passes through the liner into the underlying groundwaters. This offsite pollution can lead to pollution of the nearby watercourses and the Waikato River.

References

Belevi, H. and Baccini, P., "Water and Element Fluxes from Sanitary Landfills," In: *Sanitary Landfilling: Process, Technology and Environmental Impact*, Academic Press: San Diego, pp.391-397 (1989).

Buss, S.E., Butler, A.P., Johnston, P.M., Sollars, C.J. and Perry, R., "Mechanisms of Leakage through Synthetic Landfill Liner Materials," J. CIWEM, 9:353-359 (1995).

Cherry, J.A., "Groundwater Monitoring: Some Deficiencies and Opportunities" In *Hazardous Waste Site Investigations: Towards Better Decisions, Proc. 10th Oak Ridge National Laboratories' Life Sciences Symposium*, Lewis Publishers: Gatlinburg, TN (1990).

Dellinger, R., Personal communication to G. Fred Lee, G. Fred Lee & Associates, El Macero, CA, (1998).

Eden, R., "Toxic Emissions from Different Types of LFG Burners," In: *Proceedings of Sardinia '93 IV International Landfill Symposium*, Sardinia, Italy, pp. 635-636, October (1993).

Freeze, R.A. and Cherry, J.A., *Groundwater*, Prentice-Hall, Inc., Englewood Cliffs, NJ (1979).
Gintautas, P., Daniel, S. and Macalady, D., "Phenoxyalkanoic Acid Herbicides in Municipal Landfill Leachates," Environ. Sci. & Technol. 26:517-521 (1992).

Haxo, H.E. and Lahey, T.P., "Transport of Dissolved Organics from Dilute Aqueous Solutions through Flexible Membrane Liners," Hazardous Wastes & Hazardous Materials, 5(4):275-294 (1988).
Hickman, L., "Financial Assurance-Will the Check Bounce?" Municipal Solid Waste News, March (1992).

Hickman, L., “Ticking Time Bombs?” Municipal Solid Waste News, Solid Waste Association of North America, March (1995).

Hirschfeld, S., Vesilind, P.A. and Pas, E.I., “Assessing the True Cost of Landfills,” Waste Management & Res., 10:471-484 (1992).

Jones-Lee, A. and Lee, G.F., "Groundwater Pollution by Municipal Landfills: Leachate Composition, Detection and Water Quality Significance," Proceedings of Sardinia '93 IV International Landfill Symposium, Sardinia, Italy, pp. 1093-1103 (1993).

Jones-Lee, A. and Lee, G. F. “Appropriate Use of MSW Leachate Recycling in Municipal Solid Waste Landfilling, ” Proceedings Air and Waste Management Association 93rd national annual meeting CD rom paper 00-455, Pittsburgh, PA, June (2000).

Lee, G.F. and Jones, R.A., "Application of Site-Specific Hazard Assessment Testing to Solid Wastes," In: Hazardous Solid Waste Testing: First Conference, ASTM STP 760, ASTM, pp 331-344 (1981).

Lee, G.F. and Jones, R.A., "A Risk Assessment Approach for Evaluating the Environmental Significance of Chemical Contaminants in Solid Wastes," In: Environmental Risk Analysis for Chemicals, Van Nostrand, New York, pp 529-549 (1982).

Lee, G.F. and Jones, R. A., "Municipal Solid Waste Management in Lined, `Dry Tomb' Landfills: A Technologically Flawed Approach for Protection of Groundwater Quality," Report of G. Fred Lee & Associates, El Macero, CA, 68pp (1992).

Lee, G.F. and Jones-Lee, A., "Municipal Landfill Post-Closure Care Funding: The '30-Year Post-Closure Care' Myth," Report of G. Fred Lee & Associates, El Macero, CA, 19pp (1992).

Lee, G.F. and Jones-Lee, A., "Landfilling of Solid & Hazardous Waste: Facing Long-Term Liability," Proceedings of the 1994 Federal Environmental Restoration III & Waste Minimization II Conference, Hazardous Materials Control Resources Institute, Rockville, MD, pp. 1610-1618 (1994).

Lee, G.F. and Jones-Lee, A., "Municipal and Industrial Non-Hazardous Waste Landfills Impact on Public Health and the Environment: An Overview," Report to State of California Environmental Protection Agency Comparative Risk Project, Berkeley, CA (1994).

Lee, G.F., and Jones-Lee, A., "Practical Environmental Ethics: Is There an Obligation to Tell the Whole Truth?," Published in condensed form as "Environmental Ethics: The Whole Truth" Civil Engineering 65:6 American Society of Civil Engineers (1995).

Lee, G.F. and Jones-Lee, A., “Assessing the Potential of Minimum Subtitle D Lined Landfills to Pollute: Alternative Landfilling Approaches,” Proc. of Air and Waste Management Association

91st Annual Meeting, San Diego, CA, available on CD ROM as paper 98-WA71.04(A46), 40pp, June (1998). Also available at http://www.gfredlee.com.

Lee, G.F. and Jones-Lee, A., "Deficiencies in Subtitle D Landfill Liner Failure and Groundwater Pollution Monitoring," Presented at the NWQMC National Conference *Monitoring: Critical Foundations to Protect Our Waters,* US Environmental Protection Agency, Washington, D.C., July (1998b).

Lee, G.F. and Jones-Lee, A., "Unreliability of Predicting Landfill Gas Production Rates and Duration for Closed Subtitle D MSW Landfills," Report of G. Fred Lee & Associates, El Macero, CA, September (1999).

Lee, G.F. and Jones-Lee, A., "Evaluation of the Adequacy of Hazardous Chemical Site Remediation by Landfilling," Remediation of Hazardous Waste Contaminated Soils, 2nd Edition, Marcel Dekker, Inc. (2000). in press preprint available at www.gfredlee.com.

Lewis, P.A., Klemm, D.J, *et al*. (eds.), Short-term Methods for Estimating the Chronic Toxicity of Effluents and Receiving Waters to Freshwater Organisms, Third Edition, *EPA/600/4-91/002*. Environmental Monitoring Systems Laboratory, Office of Research and Development. U.S. Environmental Protection Agency, Cincinnati, OH (1994).

Montgomery, R.J., and Parsons, L.J., "The Omega Hills Final Cover Test Plot Study: Three Year Data Summary," presented at the 1989 Annual Meeting of the National Solid Waste Management Association, Washington, D.C. (1994).

Park, J.K., Sakti, J.P. and Hoopes, J.A., "Transport of Organic Compounds in Thermoplastic Geomembranes. I: Mathematical Model," Journal of Environ. Engr., 122(9):800-806 (1996).

Peggs, I.D., "Leak Location and Flaw Detection Technologies for Quality Assurance and Analysis of Geomembrane Lining Systems," I-Corp International, Boynton Beach, FL (undated).

Sakti, J.P., Park, J.K. and Hoopes, J.A., "Permeation of Organic Chemicals through HDPE Geomembranes," In: Proc. of ASCE National Environmental Engineering Conference, ASCE, New York, July (1991).

Shackelford, C.D., "Waste-Soil Interactions that Alter Hydraulic Conductivity," Hydraulic Conductivity and Waste Contaminant Transport, ASTM STP 1142, D.E. Daniel and S.J. Trautwein (eds.), American Society for Testing and Materials, Philadelphia (1994).
Shusterman, D. "Critical Review: The Health Significance of Environmental Odor Pollution," Archives of Environmental Health, 47(1):76-87 (1992).

US EPA, "Solid Waste Disposal Facility Criteria; Proposed Rule," Federal Register 53(168):33314-33422, 40 CFR Parts 257 and 258, US EPA, Washington, D.C., August 30, (1988a).

US EPA, "Criteria for Municipal Solid Waste Landfills," US EPA Washington D.C., July (1988b).

Workman, J.P. and Keeble, R.L., "Design and Construction of Liner Systems," In: Sanitary Landfilling: Process, Technology and Environmental Impact, T.H. Christensen, R. Cossu, and R. Stegmann (eds.), Academic Press, San Diego, CA (1989).

Primary Support Documents
A copy of these primary supporting documents is available from
www.gfredlee.com in the landfill section

"Assessing the Potential of Minimum Subtitle D Lined Landfills to Pollute: Alternative Landfilling Approaches"

"Municipal Solid Waste Management in Lined, 'Dry Tomb' Landfills: A Technologically Flawed Approach for Protection of Groundwater Quality"

"Geosynthetic Liner Systems for Municipal Solid Waste Landfills: An Inadequate Technology for Protection of Groundwater Quality?"

"Deficiencies in Subtitle D Landfill Liner Failure and Groundwater Pollution Monitoring"

"Landfill Post-Closure Care: Can Owners Guarantee the Money Will Be There?"

"Landfilling of Solid & Hazardous Waste: Facing Long-Term Liability"

"Municipal Landfill Post-Closure Care Funding: The '30-Year Post-Closure Care' Myth"

"Environmental Ethics: The Whole Truth"

Copies are available from Dr. Lee's web site: http://www.gfredlee.com

SUMMARY BIOGRAPHICAL INFORMATION

NAME: G. Fred Lee

ADDRESS: 27298 E. El Macero Dr.
El Macero, CA 95618-1005

SOCIAL SECURITY:
573-42-8765

DATE & PLACE OF BIRTH:
July 27, 1933
Delano, California, USA

TELEPHONE: 530/753-9630 (home/office)

FAX: 530/753/9956 (home/office)

E-MAIL: gfredlee@aol.com

WEB PAGE: www.gfredlee.com

EDUCATION

Ph.D. Environmental Engineering & Environmental Science, Harvard University, Cambridge, Mass. 1960

M.S.P.H. Environmental Science-Environmental Chemistry, School of Public Health, University of North Carolina, Chapel Hill, NC 1957

B.A. Environmental Health Science, San Jose State University 1955

ACADEMIC AND PROFESSIONAL EXPERIENCE

Current Position:

Consultant, President, G. Fred Lee and Associates

Previous Positions:

Distinguished Professor, Civil and Environmental Engineering, New Jersey Institute of Technology, Newark, NJ, 1984-89

Senior Consulting Engineer, EBASCO-Envirosphere, Lyndhurst, NJ (part-time), 1988-89

Coordinator, Estuarine and Marine Water Quality Management Program, NJ Marine Sciences Consortium Sea Grant Program, 1986

Director, Site Assessment and Remedial Action Division, Industry, Cooperative Center for Research in Hazardous and Toxic Substances, New Jersey Institute of Technology et al., Newark, NJ, 1984-1987

Professor, Department of Civil and Environmental Engineering, Texas Tech University, 1982-1984

Professor, Environmental Engineering, Colorado State University, 1978-1982

Professor, Environmental Engineering & Sciences; Director, Center of Environmental Studies, University of Texas at Dallas, 1973-1978

Professor of Water Chemistry, Department of Civil & Environmental Engineering, University of Wisconsin-Madison, 1961-1973

Registered Professional Engineer, State of Texas, Registration No. 39906

PUBLICATIONS AND AREAS OF ACTIVITY

Published over 850 professional papers, chapters in books, professional reports, and similar materials. The topics covered include:

Studies on sources, significance, fate and the development of control programs for chemicals in aquatic and terrestrial systems.
Analytical methods for chemical contaminants in fresh and marine waters.
Landfills and groundwater quality protection issues.
Impact of landfills on public health and environment.
Environmental impact and management of various types of wastewater discharges including municipal, mining, electric generating stations, domestic and industrial wastes, paper and steel mill, refinery wastewaters, etc.

Stormwater runoff water quality evaluation and BMP development for urban areas and highways

Eutrophication causes and control, groundwater quality impact of land disposal of municipal and industrial wastes, environmental impact of dredging and dredged material disposal, water quality modeling, hazard assessment for new and existing chemicals, water quality and sediment criteria and standards, water supply water quality, assessment of actual environmental impact of chemical contaminants on water quality.

LECTURES

Presented over 750 lectures at professional society meetings, universities, and to professional and public groups.

GRANTS AND AWARDS

Principal investigator for over six million dollars of contract and grant research in the water quality and solid and hazardous waste management field.

GRADUATE WORK CONDUCTED UNDER SUPERVISION OF G. FRED LEE

Over 90 M.S. theses and Ph.D. dissertations have been completed under the supervision of Dr. Lee.

ADVISORY ACTIVITIES

Consultant to numerous international, national and regional governmental agencies, community and environmental groups and industries.

Surface and Groundwater Quality Evaluation and Management
and
Municipal Solid & Industrial Hazardous Waste Landfills

http://www.gfredlee.com

Dr. G. Fred Lee and Dr. Anne Jones-Lee have prepared professional papers and reports on the various areas in which they are active in research and consulting including domestic water supply water quality, water and wastewater treatment, water pollution control, and the evaluation and management of the impacts of solid and hazardous wastes. Publications are available in the following areas:

Landfills and Groundwater Quality Protection

Water Quality Evaluation and Management for Wastewater Discharges, Stormwater Runoff, Ambient Waters and Pesticide Water Quality Management Issues

Impact of Hazardous Chemicals -- Superfund, LEHR Superfund Site Reports

Contaminated Sediment -- Aquafund, BPTCP

Domestic Water Supply Water Quality

Excessive Fertilization/Eutrophication

Reuse of Reclaimed Wastewaters

Watershed Based Water Quality Management Programs:
- Sacramento River Watershed Program,
- Delta -- CALFED Program, and
- Upper Newport Bay Watershed Program
- San Joaquin River Watershed DO and OP Pesticide TMDL Programs

Stormwater Runoff Water Quality Science/Engineering Newsletter

Municipal Solid Waste Landfills and Groundwater Quality Protection Issues Publications

Drs. G. Fred Lee and Anne Jones-Lee have prepared several papers and reports on various aspects of municipal solid waste (MSW) management and hazardous waste management by landfilling, groundwater quality protection issues, as well as other issues of concern to those within a sphere of influence of a landfill. These materials provide an overview of the key problems associated with landfilling of MSW and hazardous waste utilizing lined "dry tomb" landfills and suggest alternative approaches for MSW management that will not lead to groundwater pollution by landfill leachate and protect the health and interests of those within the sphere of influence of a landfill. Copies of many of these papers and reports are available as downloadable files from Drs. G. Fred Lee's and Anne Jones-Lee's web page (http://www.gfredlee.com).

Overall Problems with "Dry Tomb" Landfills

Lee, G.F. and Jones-Lee, A, "`Dry Tomb' Landfills," MSW Management, 6:82-89 (1996).

Lee, G.F. and Jones-Lee, A., "Municipal and Industrial Non-Hazardous Waste Landfills Impact on Public Health and the Environment: An Overview," Report to State of California Environmental Protection Agency Comparative Risk Project, Berkeley, CA (1994).

Lee, G.F. and Jones, R.A., "Landfills and Ground-water Quality," Guest editorial, J. Ground Water 29:482-486 (1991).

Lee, G.F. and Jones-Lee, A., "Deficiencies in US EPA Subtitle D Landfills in Protecting Groundwater Quality for as Long as MSW is a Threat: Recommended Alternative Approaches," Report of G. Fred Lee & Associates, El Macero, CA (1997).

Lee, G.F. and Jones-Lee, A., "Subtitle D Municipal Landfills vs. Classical Sanitary Landfills: Are Subtitle D Landfills a Real Improvement?" Report of G. Fred Lee & Associates, El Macero, CA, 5pp, May (1996).

Lee, G.F. and Jones-Lee, A., " Developing Landfills that Protect People: The True Costs," MSW Management **7**(6:18-23, Nov/Dec (1997).

Lee, G.F. and Jones-Lee, A., "Unreliability of Predicting Landfill Gas Production Rates and Duration for Closed Subtitle D MSW Landfills," Report of G. Fred Lee & Associates, El Macero, CA, September (1999).

Lee, G. F., "Criteria For Municipal Solid Waste Landfills" (Section 610 Review) Submitted to US EPA Docket Number F-1999-MLFN-FFFFF Washington DC, January (2000).

Liner Failure Issues

Lee, G.F. and Jones-Lee, A., "Assessing the Potential of Minimum Subtitle D Lined Landfills to

Pollute: Alternative Landfilling Approaches," Proc. of Air and Waste Management Association 91st Annual Meeting, San Diego, CA, available on CD ROM as paper 98-WA71.04(A46), 40pp, June (1998). Also available at http://www.gfredlee/.com.

Lee, G.F. and Jones, R. A., "Municipal Solid Waste Management in Lined, `Dry Tomb' Landfills: A Technologically Flawed Approach for Protection of Groundwater Quality," Report of G. Fred Lee & Associates, El Macero, CA, 68pp (1992).

Lee, G.F. and Jones, R. A., "Geosynthetic Liner Systems for Municipal Solid Waste Landfills: An Inadequate Technology for Protection of Groundwater Quality?" Waste Management & Research, 11:354-360 (1993).

Lee, G.F., "Comments on Tisinger and Giroud 'The Durability of HDPE Geomembranes'," Letter to the Editor, Geotechnical Fabrics Report, Minneapolis, MN Submitted by G. Fred Lee & Associates, El Macero, CA, 4pp (1994).

Lee, G.F. and Jones-Lee, A., "Disadvantages of Synthetic Liners for Landfills," Letter to the Editor, National Environmental Journal, Submitted by G. Fred Lee & Associates, El Macero, CA, 2pp (1994).

Groundwater Pollution by Leachate

Jones-Lee, A. and Lee, G.F., "Groundwater Pollution by Municipal Landfills: Leachate Composition, Detection and Water Quality Significance," Proceedings of Sardinia '93 IV International Landfill Symposium, Sardinia, Italy, pp. 1093-1103 (1993).

Lee, G.F. and Jones-Lee, A., "Landfill Leachate Management: Overview of Issues," MSW Management 6:18-23 (1996).

Groundwater Monitoring

Lee, G.F. and Jones-Lee, A., "Deficiencies in Subtitle D Landfill Liner Failure and Groundwater Pollution Monitoring," Presented at the NWQMC National Conference *Monitoring: Critical Foundations to Protect Our Waters*, US Environmental Protection Agency, Washington, D.C., July (1998).

Lee, G.F. and Jones-Lee, A., "Unreliability of Groundwater Monitoring at Lined Landfills," HydroVisions 6(3):3, 10-12 (1997).

Lee, G.F. and Jones-Lee, A., "A Groundwater Protection Strategy for Lined Landfills," Environmental Science & Technology, 28:584-5 (1994).
Lee, G.F. and Jones-Lee, A., "Groundwater Quality Monitoring at Lined Landfills: Adequacy of Subtitle D Approaches," Report of G. Fred Lee & Associates, El Macero, CA, 28pp (1993).

Lee, G.F. and Jones-Lee, A., “Detection of the Failure of Landfill Liner Systems,” Report of G. Fred Lee & Associates, El Macero, CA, 13pp (1996).

Post-Closure Care

Lee, G.F. and Jones-Lee, A., “Landfill Post-Closure Care: Can Owners Guarantee the Money Will Be There?” Solid Waste & Power, 7:35-38 (1993).

Lee, G.F. and Jones-Lee, A., “Municipal Landfill Post-Closure Care Funding: The '30-Year Post-Closure Care' Myth,” Report of G. Fred Lee & Associates, El Macero, CA, 19pp (1992).

Lee, G.F. and Jones-Lee, A., “Overview of Landfill Post Closure Issues,” Presented at American Society of Civil Engineers Convention session devoted to "Landfill Closures - Environmental Protection and Land Recovery," San Diego, CA (1995).

Lee, G.F. and Jones-Lee, A., "Landfilling of Solid & Hazardous Waste: Facing Long-Term Liability," Proceedings of the 1994 Federal Environmental Restoration III & Waste Minimization II Conference, Hazardous Materials Control Resources Institute, Rockville, MD, pp. 1610-1618 (1994).

Lee, G.F. and Jones-Lee, A., "Closed Landfill Cover Space Reuse: Park, Golf Course or a Tomb?" Report G. Fred Lee & Associates (1994).

Permitting of Landfills

Lee, G.F. and Jones, R. A., "Review of Proposed Landfills: Questions that Should Be Answered," Report of G. Fred Lee & Associates, El Macero, CA, 22pp (1991).

Lee, G.F. and Jones-Lee, A., “Questions that Regulatory Agencies Staff, Boards and Landfill Applicants and their Consultants Should Answer About a Proposed Subtitle D Landfill or Landfill Expansion,” Report of G. Fred Lee & Associates, El Macero, CA, April (1997).

Lee, G.F. and Jones-Lee, A., "Evaluation of the Potential for a Proposed or Existing Landfill to Pollute Groundwater," Report of G. Fred Lee & Associates, El Macero, CA, 18pp, July (1996).

Lee, G.F. and Jones-Lee, A., “Development of a Potentially Protective Landfill: Issues Governing the True Cost of Landfilling,” Report of G. Fred Lee & Associates, El Macero, CA, July (1997).

Lee, G.F. and Jones-Lee, A., “Potential Impacts of the Proposed Minimum Subtitle D Landfills on Agricultural and Greater Area Municipal Resident Interests,” Report of G. Fred Lee & Associates, El Macero, CA, August (1997).

Lee, G.F. and Jones-Lee, A., "Recommended Design, Operation, Closure and Post-Closure Approaches for Municipal Solid Waste and Hazardous Waste Landfills," Report of G. Fred Lee & Associates, El Macero, CA, 14pp (1995).

Lee, G.F. and Jones-Lee, A., "Permitting of New Hazardous Waste Landfills and Landfill Expansions: A Summary of Public Health, Groundwater Resource and Environmental Issues," Report of G. Fred Lee & Associates, El Macero, CA, 82pp, October (1996).

Lee, G.F. and Jones-Lee, A., "Subtitle D Municipal Landfills vs Classical Sanitary Landfills: Are Subtitle D Landfills a Real Improvement?" Report of G. Fred Lee & Associates, El Macero, CA, 5pp (1996).

Lee, G.F., "Comments on State Board Revisions to Chapter 15 Governing Landfilling of Municipal Solid Wastes," Letter to J. Caffrey, State Water Resources Control Board, Sacramento, CA, October 12 (1997).

Lee, G.F. and Jones, R.A., "Comments on US EPA `Solid Waste Disposal Criteria' Final Rule - October 9, 1991," Report of G. Fred Lee & Associates, El Macero, CA, 14pp (1991).

Lee, G.F. and Jones-Lee, A., "Evaluation of the Potential for a Proposed or Existing Landfill to Pollute Groundwater," Report of G. Fred Lee & Associates, El Macero, CA, 18pp, July (1996).

Lee, G.F. and Jones-Lee, A., "The Cost of Groundwater Quality Protection in Landfilling," Report of G. Fred Lee & Associates, El Macero, CA, 8pp (1993).

Lee, G.F., and Jones-Lee, A., "Practical Environmental Ethics: Is There an Obligation to Tell the Whole Truth?," Published in condensed form as "Environmental Ethics: The Whole Truth" Civil Engineering 65:6 American Society of Civil Engineers (1995).

Lee, G.F. and Jones-Lee, A., "Revisions of State MSW Landfill Regulations: Issues in Protecting Groundwater Quality," Environmental Management Review, 29:32-54, Government Institutes Inc., Rockville, MD, August (1993).

Lee, G.F, "Petition to the State Water Resources Control Board to Review California Regional Water Quality Control Board Waste Discharge Requirements for University of California, Davis Class III Landfill, Yolo County, Order 96-228, Adopted on August 9, 1996," G. Fred Lee & Associates, El Macero, CA 22pp, September 9 (1996).

Fermentation/Leaching "Wet Cell" Landfills

Jones-Lee, A. and Lee, G. F. "Appropriate Use of MSW Leachate Recycling in Municipal Solid Waste Landfilling, " Proceedings Air and Waste Management Association 93rd national annual meeting CD rom paper 00-455, Pittsburgh, PA, June (2000).

Lee, G.F. and Jones, R. A., "Managed Fermentation and Leaching: An Alternative to MSW Landfills," Biocycle, 31:78-80,83 (1990).

Lee, G.F. and Jones-Lee, A., "Leachate Recycle Process Offers Pros and Cons," World Wastes 37(8): 16,19 (1994).

Lee, G.F. and Jones-Lee, A., "Advantages and Limitations of Leachate Recycle in MSW Landfills," Report G. Fred Lee & Associates (1994).

Lee, G.F. and Jones-Lee, R. A., "Wet Cell Versus Dry Tomb: Pay a Little Now or More Later," MSW Management 5:70,72 (1995).

Lee, G.F. and Sheehan, W., "MSW Recycling Protects Groundwaters: Reply to `Recycling is Garbage'," Letter to the editor New York Times, Hydrovision 5(3):6 (1996).

Lee, G.F., and Jones-Lee, A., "MSW Landfill Leachate Recycle and Groundwater Quality Protection," Report of G. Fred Lee & Associates, El Macero, CA, November (1995).

Lee, G.F. and Jones-Lee, A., "Landfills and Groundwater Pollution Issues: `Dry Tomb' vs F/L Wet-Cell Landfills," Proc. of Sardinia '93 IV International Landfill Symposium, Sardinia, Italy, pp. 1787-1796 (1993).

Landfill Mining

Lee, G.F. and Jones, R.A., "Use of Landfill Mining in Solid Waste Management," Proc. Water Quality Management of Landfills, Water Pollution Control Federation, Chicago, IL, 9pp, July (1990).

Lee, G.F. and Jones, R. A., "Managing Solid Wastes with Landfill Mining," Water Environment and Technology, Water Pollution Control Federation 3:32-34 (1991).

Landfills and the 3R's

Lee, G. F. and Jones-Lee, A, "Three Rs Managed Garbage Protects Groundwater Quality," Proceedings Air and Waste Management Association 93rd national annual meeting CD rom paper 00-454, Pittsburgh, PA, June (2000).

Lee, G.F. and Sheehan, W., "Landfills Offer False Sense of Security," Biocycle 37(9):8 (1996).

Lee, G.F. and Jones-Lee, A., "Three R's Managed Garbage Protects Groundwater Quality," Report of G. Fred Lee & Associates, El Macero, CA, July (1996).

Lee, G.F. and Sheehan, W., "MSW Recycling Protects Groundwaters: Reply to `Recycling is Garbage'," Letter to the editor New York Times, Hydrovision 5(3):6 (1996).

Lee, G.F. and Jones-Lee, A., "Three R's Managed Garbage Protects Groundwater Quality," Presented at California Resource Recovery Association annual meeting, Monterey, CA, May (1997).

NIMBY Issues

Lee, G.F. and Jones-Lee, A., "Environmental Impacts of Alternative Approaches of Municipal Solid Waste Management: An Overview," Report of G. Fred Lee & Associates, El Macero, CA, 52pp (1993).

Lee, G.F. and Jones-Lee, A., "Addressing Justifiable NIMBY: A Prescription for Siting MSW Landfills," Environmental Management Review, 31:115-138, Government Institutes Inc., Rockville, MD (1994).

Lee, G.F., Jones-Lee, A., and Martin, F., "Landfill NIMBY and Systems Engineering: A Paradigm for Urban Planning," IN: "Systems Engineering: "Proc. Fourth Annual International Symposium of the National Council on Systems Engineering, 1:991-998 (1994).

Review of Specific Landfills

Lee, G.F., "Technical Deficiencies in the CVRWQCB Order No. 96-227 Discharge of the UCD "West" Landfill Leachate-Polluted Groundwater to Putah Creek Presented to CVRWQCB September 20, 1996 Hearing," Report of G. Fred Lee & Associates, El Macero, CA, 19pp (1996).

Lee, G.F., "Comments on Addendum Subsequent EIR Groundwater Pollution Issues - Landfill Liner Integrity Presentation to Colusa County Board of Supervisors, March 17, 1997," Report of G. Fred Lee & Associates, El Macero, CA, April (1997).

Lee, G.F., "Overview Assessment of the Potential Public Health, Environmental and Groundwater Resource and Other Impacts of the Proposed Adams Mine Site Landfill," Report to the AMSLF Public Liaison Committee and Metropolitan Toronto, Toronto, Canada, December (1995).

Lee, G.F. and Gallaugher, B., "Comments on the SENES/Notre Review of the Overview Comments Submitted by G. Fred Lee on the Potential Problems of Developing the Adams Mine Site as a Municipal Solid Waste Landfill for Metropolitan Toronto," Report of G. Fred Lee & Associates, El Macero, CA, July (1996).

Lee, G.F., "Comments on 'Calabasas Landfill Special Use Permit Environmental Assessment' Prepared by the US Department of Interior, National Park Service, Santa Monica Mountains National Recreation Area Dated February 1997," Report of G. Fred Lee & Associates, El Macero, CA, August 3 (1997).

Lee, G.F., "Evaluation of the Water Quality Impacts of the Proposed BFI Rosser Landfill," Report to the City of Winnipeg, Manitoba, G. Fred Lee & Assoc., El Macero, CA, Nov (1995).

Lee, G.F., "Comments on Final EIR/EIS for the Proposed Rail Cycle • Bolo Station Landfill," Submitted to San Bernardino County Planning Commission, 72pp, August (1994).

Lee, G.F. and Jones-Lee, A., "Comments on the `Draft Environmental Impact Report UC Davis Landfill Expansion and Permit Revision,' dated August 1994," Submitted to University of California, Davis, 42pp, August (1994).

Lee, G.F., "Comments on the Azusa Landfill Revised ROWD," Submitted to California Regional Water Quality Control Board, Los Angeles Region, 26pp, December (1994).

Lee, G.F., "Review of Regulatory Compliance of the Western Regional Sanitary Landfill, Placer County, California," Report of G. Fred Lee & Associates, El Macero, CA, 145pp, February (1995).

Lee, G.F., "Review of January 1990 Draft Environmental Impact Report Environmental Impact Statement for the Proposed North County Class III Landfill," Report of G. Fred Lee & Associates, El Macero, CA, March (1990).

Lee, G.F., "Comments on Final Environmental Impact Statement/Environmental Impact Report Eagle Mountain Landfill and Recycling Center Project, Volume 1, Final EIS/EIR," Report of G. Fred Lee & Associates, El Macero, CA, June (1997).

Gallaugher, B., and Lee, G.F., "Review of Potential Public Health, Groundwater Resource, Financial and other Impacts of the Proposed Crane Mountain Landfill," Report of G. Fred Lee & Associates, El Macero, CA, February (1997).

Hazardous Waste Landfills

Lee, G.F. and Jones-Lee, A., "Stormwater Runoff Water Quality Evaluation and Management Program for Hazardous Chemical Sites: Development Issues," *Superfund Risk Assessment in Soil Contamination Studies: Third Volume, ASTM STP 1338,* American Society for Testing and Materials, pp. 84-98, (1998).

Lee, G.F. and Jones-Lee, A., "Evaluation of the Adequacy of Hazardous Chemical Site Remediation by Landfilling," to be published in Remediation of Hazardous Waste Contaminated Soils, 2nd Edition, Marcel Dekker, Inc. (1999).

Lee, G.F. and Jones-Lee, A., "Evaluation of Surface Water Quality Impacts of Hazardous Chemicals," *Remediation*, 9:87-118, 1999) (1999).

Lee, G. F., "Review of the Adequacy of the BFI/CECOS Aber Road Hazardous Waste Landfill Facility Closure and Post-closure Plans to Protect Public Health and the Environment ," Report to Clermont County Board of Com. by G. Fred Lee & Assoc, El Macero, CA, Jan (1999).

Lee, G.F. and Jones-Lee, A., "Superfund Site Remediation by On-Site RCRA Landfills: Inadequacies in Providing Groundwater Quality Protection," Proc. Superfund/Hazwaste Management West Conference, Las Vegas, NV, pp. 311-329 (1996).

Lee, G.F., "Management of Hazardous Wastes: Issues in Mexico," Presentation Greenpeace Mexico Conference, "Foro Ciudadano Sobre Desechos Toxicos," San Luis Potosi, SLP, Mexico (1995).

Lee, G.F. and Jones-Lee, A., "Permitting of New Hazardous Waste Landfills and Landfill Expansions: A Summary of Public Health, Groundwater Resource and Environmental Issues," Report of G. Fred Lee & Associates, El Macero, CA (1996).

Lee, G.F. and Jones-Lee, A., "Hazardous Chemical Site Remediation Through Capping: Problems with Long-Term Protection," Remediation 7(4):51-57 (1997).

Lee, G.F., "Redevelopment of Brownfield Properties: Future Property Owners/Users Proceed With Your Eyes Open," Environmental Progress 16(4):W3-W4 (1997).

Examples of Landfills Evaluated by
Drs. G. Fred Lee and A. Jones-Lee

Arizona *(State Landfilling Reg.*)	Verde Valley - Copper Tailings Pile Closure
California *(State Landfilling Reg.)*	Colusa County - CERRS Landfill San Gabriel Valley - Azusa Landfill City of Industry - Puente Hills Landfill North San Diego County, three landfills San Diego County - Gregory Canyon Landfill El Dorado County Landfill and turkey carcass waste disposal area Yolo County Landfill Half Moon Bay - Apanolio Landfill Pittsburg - Keller Canyon Landfill Chuckwalla Valley - Eagle Mountain Landfill Barstow - Hidden Valley and Broadwell Hazardous Waste Landfills Cadiz - Bolo Station-Rail Cycle Landfill University of California -Davis Landfills San Marcos - San Marcos Landfill Placer County - Western Regional Sanitary Landfill Imperial County - Mesquite Landfill
Colorado (*State Landfilling Reg.)*	Last Chance/Brush – Hazardous Waste Landfill Denver - Lowry Hazardous Waste Landfill Telluride/Idarado Mine Tailings
Florida (*State Landfilling Reg.*)	Alachua County Landfill
Illinois (*State Landfilling Reg.*)	Crystal Lake - McHenry County Landfill Wayne County Landfill
Indiana (*State Landfilling Reg.*)	Posey County Landfill New Haven-Adams Center Landfill (Hazardous Waste)
Michigan (*State Landfilling Reg.*)	Menominee Township - Landfill Ypsilanti- Waste Disposal Inc. (Hazardous Waste - PCB's)
Minnesota	Reserve Mining Co., Silver Bay - taconite tailings Wright County Superior FCR Landfill
Missouri	Jefferson County - Bob's Home Service Hazardous Waste Landfill

New Jersey (*State Landfilling Reg.*)	Meadowlands - Landfill Fort Dix Landfill Scotch Plains Leaf Dump
New York	Staten Island - Fresh Kills Landfill Niagara Falls - Hazardous Waste Landfill
Ohio	Clermont County, Ohio - BFI/CECOS Hazardous Waste Landfill
Rhode Island	Richmond - Landfill
South Carolina	Spartanburg - Palmetto Landfill
Texas (*State Landfilling Regulations*)	Dallas/Sachse - Landfill Fort Worth - Acme Brick Hazardous Waste Landfill
Washington (*State Landfilling Reg.*)	Tacoma - 304th and Meridian Landfill
Wisconsin	Madison and Wausau Landfills
Ontario, Canada (*Prov. Landfilling Reg.*)	Greater Toronto Area - Landfill Siting Issues Kirkland Lake - Adams Mine Site Landfill Pembroke - Cott Solid Waste Disposal Areas
Manitoba, Canada (*Prov. Landfilling Reg.*)	Winnipeg Area - Rosser Landfill
New Brunswick, Canada (*Prov. Landfilling Reg.*)	St. John's - Crane Mountain Landfill
Mexico (*Haz. Waste Landfilling Reg.*)	San Luis Pontosi - Hazardous Waste Landfill
Puerto Rico	Salinas - Campo Sur Landfill
Hong Kong	Three New MSW Landfills
Korea	Yukong Gas Co. - Hazardous Waste Landfill