OPERATION/CONSTRUCTION MANAGERS

Municipal Services

CIVIL/SANITARY ENGINEERS

Engineering Company, P.A.

September 25, 2007

Mr. Brian Wootton
Solid Waste Section
Division of Waste Management
North Carolina Department of Environment and Natural Resources
401 Oberlin Road, Suite 150
Raleigh, NC 27605

Re: Permit to Construct – Construction Conditions Variance Request
Monitoring Well Abandonment Overdrilling
Iredell County Subtitle D Landfill, phase 4, (49-03)
MESCO Project No. G07014.0

Dear Mr. Wootton:

The permit to construct for the Iredell Co. MSWLF, issued by the Section on July 5, 2007, contains facility construction conditions concerning overdrilling wells within the proposed cell prior to abandonment. This is a new condition appears to have no basis in the current NC rules or guidance documents and is inconsistent with procedures previously approved and utilized. The Section's previously approved abandonment procedure entailed well abandonment in place, per 15A NCAC 2C.0113(b)(1), with the exception of wells installed without a properly grouted annulus space. Wells that lacked a grouted annulus were overdrilled to either the total depth or bentonite layer. This method was approved by the Solid Waste Section for the Cherokee County landfill (attached letter dated October 13, 2003).

Facility Construction Conditions with Presumed Intentions

The only portion of the Permit to Construct that are to be addressed are facility construction conditions 13 & 14.

> 13. Prior to construction of cell(s), all piezometers, ground-water monitoring wells, and borings, located in the proposed cell, shall be properly abandoned by overdrilling first (exception of non-cased borings) and sealed with grout in accordance with 15A NCAC 2C.0113(b)(1), titled "Abandonment of Wells".

The presumed intent of the new overdrilling condition prior to well abandonment within the proposed landfill footprint is to minimize the potential vertical migration of fluids along the borehole, therefore removal of the casing through overdrilling is the required method of well abandonment. When the casing is removed, the borehole can be sealed completely. Based on these requirements, it may be interpreted that the Solid Waste Section contends that the well abandonment procedures set fourth by the Water Quality Section 15A NCAC 2C.0113(b)(1) within a well that is constructed with a grout annulus per 15A NCAC 2C.0108(6) does not provide a a reliable seal with a low enough permeability to prevent potential vertical fluid migration regardless of the well elevation in respect to the finished subgrade or quality of the casing/grout system.

> 14. In areas where soil is to be undercut, wells should not be grouted to pre-grade land surface, but to the proposed base grade surface to prevent having to cut excess grout and possibly damaging the wells.

MESCO interprets the term wells should have read abandoned wells, and is to be performed in conjunction with condition 13.

PO Box 97, Garner, North Carolina 27529 (919) 772-5393
PO Box 828, Morehead City, NC 28557 (252) 726-9481 PO Box 349, Boone, North Carolina 28607 (828) 262-1767

MESCOs interpretation is that all of the wells within the footprint of the cells, regardless of proper grouted annulus, prior abandonment, or elevation in respect to the finished subgrade are required to be overdrilled to the bottom of screen elevation. MESCO contends that from a practical, fiscal, geological, and engineering perspective is that overdrilling the complete depth prior to abandonment is unwarranted and therefore requests a variance.
A proposed alternative abandonment procedure, with additional provisions, will be effective at sealing the wells to prevent potential vertical and horizontal fluids from entering the groundwater in the extremely unlikely event the composite liners within the landfill are compromised.

Well & Proposed Phase Conditions

The proposed Phase has ten (10) type II piezometers ("wells" hereafter) within the footprint which were constructed in strict accordance with 15A NCAC 2C.0108 titled "Standards of Construction of Wells other than Water Supply Wells" under the full time supervision of a geoscientist. As required all of the wells were tremie grouted with a cement bentonite slurry under pressure from the bottom up. The grout was composed of a documented ratio of 5% bentonite and 95% Type I Portland cement. The slurry was mixed in a paddle grout pump with <6 gallons of water per 94lb. cement. A 3 foot thick plug of concrete grout was installed at the surface. The use of the bentonite slurry significantly reduces the swelling and shrinkage of the grout during the curing process and increases the bonding between the grout and PVC casing surface (Kurt & Johnson, 1982). None of the wells cross hydrogeological units, extend beyond uger refusal (rock), cross aquifers, and there is no current contamination issues.

Some of these wells were previously abandoned under the supervision of a geoscientist in strict accordance with 15A NCAC 2C.0113(b)(1). These wells were abandoned prior to the issuance of the Phase 4 permit to construct as far back as 2001. Portions of the proposed cell have been utilized as a borrow source, none of the 4 wells in this region have been disturbed. These wells remain upon pinnacles and have not been damaged. The average excavation remaining before final subgrade at all of the well sites range from approximately 2 to 10 feet, with an average of 7 feet. The total depth below subgrade of all of the wells range from 17 to 64 ft with an average depth of 33 feet.

The accurate and detailed information concerning the wells within the footprint are available including all dimensions/elevations, casing condition, quality of the original annulus seal, and the hydrogeologic conditions. All field logs, well construction records, boring logs, and abandonment records are maintained for all of the wells within the footprint.

Since the construction design and quality is known to be excellent and the casing integrity has not been affected there is an extremely low potential for vertical migration through channeling outside the casing.

Financial Impacts:

A substantial increase in costs will be endured due to the overdrilling process as compared to the previously approved method. Most of the costs associated with the obtaining the permit to operate has previously been budgeted without all of the additional overdrilling costs. Overdrilling cost were not budgeted since overdrilling has not been required on prior permits. The cost increase for the drilling contractor will increase approximately $30 per foot translating to an increase of $1,000 to $1,500 per boring/acre or approximately $18,000. Furthermore, many of the wells have been previously abandoned once therefore they will have to be resurveyed, overdrilled and abandoned again. Additional costs will also be realized in an increase in engineering/geologist/surveying time. The intention of constructing the temporary wells to the Standards specified, which costs more, was in part so that overdrilling would not be required upon abandonment and the overall effective cost would be less. An estimated total increase of approximately $25,000, or 200%, would be realized if all of the wells are overdrilled, as compared to previously approved abandonment procedures.

Practical/Technical Aspects:

Through research, personal experience and correspondence with the four (4) other NC certified well contractors we utilize, including the contractor who installed the exact wells, overdrilling properly grouted wells is technically very difficult to impossible to accomplish without ramifications. The grout in the annulus of all of the wells within the footprint have a typical compressive strength of 2050 PSI, which is much stronger than the natural surrounding regolith. The strength of the grout will very likely either cause the auger to penetrate very slowly or drift off the original boring and create another boring adjacent to the original boring.

Overdrilling correctly entails the use of larger size augers than originally utilized to install the well. These augers/bits are not typically used or readily available which dramatically reduces the number of capable contractors. The plumbness of the well also needs to be taken into consideration. If the well was not originally installed plumb overdrilling may be impossible to complete correctly. Casing perforation is not practical in 2" diameter wells and the resources involved are comparable to overdrilling. Extraction of the well casing prior to abandonment is not a viable alternative either due to the likelihood of the casing separating beneath the surface. The well would than have to be overdrilled anyways in order to remove the end screen cap, obstructions, and remaining casing. The contractor who installed the wells claimed that his historical success rate of complete well casing extraction grouted to the same specifications is poor.

Well casing without proper annulus grout maybe subject to extraction/subsurface movement during excavation. Based upon current construction of the wells there is almost a zero probability that well movement will occur. The collapse strength of the well casing scH 40 PVC is only 103 PSI (Corrected for internal threaded pipe) compared to the compressive strength of the cement annulus of 2050 PSI indicate that the well casing will break prior to grout movement. Per the construction contractor the excavation of the subgrade is planned to be completed with scrappers/pans which remove the soil horizontally <0.5' at a time with a sharp blade that will eliminate the potential for casing movement. However, both the contractor and the County will have excavator(s) on site to assist in cautious supervised pinnacle removal.

We contend that every precaution should be taken in order to prevent all potential sources of groundwater contamination but there are limits to what is considered reasonable/practical. However, the probability that fluid will migrate vertically through the perceived channel along the borehole of a well properly abandoned in place after a liner failure is so extremely low that it should be considered inconsequential. As you are aware, the landfill is designed with a 2 foot thick cohesive $>10^{-7}$ clay liner, a textured 60 mil HDPE liner, a reinforced geonet, and a leachate collection system that are all meticulously constructed with QC and QA. Therefore it is extremely unlikely that a leak will occur. If the composite liner is ever breached it takes approximately 20 years for water to penetrate the cohesive clay liner. Composite liners have been found to fail but studies show that typically holes are $<1cm^2$, and are 1 per acre which may leak 0.02 gal/day to 1 gal/day. Per Cherry (1990) initial leakage through a plastic sheeting-lined landfill will produce finger plumes of leachate of limited dimension therefore it can can be inferred that the $<1cm^2$ hole would have to occur directly above the abandoned well to even be at risk to act as a conduit.

Typical vertical permeabilities for casing/grout systems for neat cement were found by Kurt and Johnson (1982) to range from 20 to 100 x 10^{-5} cm/sec. therefore you would expect the permeability to be even lower in the wells within the footprint which annulus's were grouted with bentonite grout. The natural permeability of the regolith underlying the footprint is estimated at an average of 10^{-4} therefore even if the grout/casing system in place was even considered typical at 10^{-5} vertical fluid migration would actually occur everywhere but the well locations. In order to truly conceptualize the irrelevantly small area that all of the wells represent (abandoned & yet to be abandoned) that could potentially provide a conduit if the annulus grout does not adhere to the PVC casing within the footprint is only 0.058 ft or encompassing only 0.0000168% of the entire 12 acre cell. The total surface area of all of the potential vertical channels that could potentially provide a conduit to the groundwater is only 8.3 in^2 or approximately the area encompassing just the circle within the letterhead above. After considering the potential conduits are spread out over a 12 acre cell with the majority hydraulically/topographically up from the sump area the likelihood of impact is reduced even further. The total calculated probability of the typical leaks in the composite liner occurring simultaneously directly over all of the potential conduit space remaining around a well abandoned without overdrilling is 1 in 380,767,863,576,774 (1 in 380 Trillion) or equivalent of winning the PowerBall lottery 2,606,071 times. The overdrilling criteria is analogous to requiring an American to purchase a $25,000 insurance premium to protect against the occurrence of 1,359,885,227 lightning strikes or being struck every second for the next 43 years. Based upon the current field conditions factoring in footprint size, precipitation data, recharge amounts, and total area of potential channelization prior to the landfill even being constructed, the total volume of water originating that could migrate vertically through channelization along the borehole even if the annulus provided no seal which is not the actual circumstances would be only 0.3 gallons/year. However in actuality the lined landfill will be constructed which will decrease total recharge by a typical 90%, constant leachate collection will occur, and the casing/grout system is less permeable than the natural regolith therefore it is extremely unlikely that any vertical migration would occur.

Variance Request

MESCO requests, on behalf of Iredell County, due to the facts presented herein that a variance/modification of just construction condition 13 of Attachment 3 of the permit to construct be considered. The variance request is two parts, wells that have previously been abandoned correctly and wells that have yet to be abandoned.

Unabandoned Wells

We request that due to a culmination of site specific extenuating circumstances including practical and financial aspects that all of the wells within the footprint that have yet to be abandoned due so in strict accordance with 15A NCAC 2C.0113(b)(1) without complete overdrilling but with further provisions enacted that will ensure an adequate seal.

The alternative method entails abandonment of the wells in place with additional quality assurance provisions with an additional impermeable surface seal installed in order to eliminate the perceived potential of direct vertical migration within the casing/grout system. We will make every effort to ensure that the wells are abandoned in a manner that will not compromise the groundwater in anyway.

1. MESCO will have a Quality Assurance (QA) field inspector at the facility full time everyday during the entire construction of the landfill who will constantly monitor the well sites located in the excavation areas until the subgrade is complete. If any evidence of well movement is detected the well will be considered to be compromised and will be overdrilled prior to abandonment.

2. All wells whether previously abandoned or not in areas of the proposed excavation will continue to be protected from disturbance by machinery by remaining upon a soil pinnacle. When the subgrade elevations are achieved the pinnacles will meticulously be removed in a manner that does not promote horizontal movement of the well under the close inspection of both a MESCO geologist and a QA inspector.

3. All abandonment will be completed by a certified NC well contractor as directed in the field full time by a MESCO geologist/well contractor under supervision of a NC Professional Geologist in strict accordance with 15A NCAC2C.0113(b)(1).

4. All wells shall be abandoned in such a manner that it does not become a channel for the vertical movement of fluids to the groundwater. If either subsurface or surface conditions are noticed during the abandonment process that may not provide an adequate seal the well will be overdrilled prior to abandonment.

5. All wells shall be measured for correct depth prior to sealing to ensure that it is free from any obstructions that may interfere with sealing operation. If an irremovable obstruction is encountered the well will be overdrilled and abandoned.

6. The PVC casing shall be removed from each well at a depth of 3 ft. below the finished subgrade in order to ensure placement of an effective surface seal. The casing will be removed internally and the entire depth of the boring sounded again. If the well is free of all obstructions the entire borehole will be pressure grouted from the bottom up to 3 feet below finished subgrade. The well will than be overdrilled to a larger size than the original well to 3 feet below subgrade. A monolithic surface plug consisting of an approved grout will than be completed from 0.5 feet below subgrade to 3 feet with a 0.5 feet thick 10^{-7}cohesive clay barrier at the subgrade. The cohesive clay will protect any subsurface movement/dessication. The surface seal will eliminate the perceived potential for vertical channeling originating from the surface between the annulus and remaining casing.

7. During the subgrade inspection per construction condition 24 a MESCO Professional Geologist will examine the abandoned wells. If the Geologist contends that an adequate seal may not permanently be achieved the well will be reabandoned with complete overdrilling. The findings of the abandoned well inspection will be included in the subgrade certification report which will be submitted to the Section in writing.

8. Complete, accurate records of the abandonment procedure shall be kept for each well abandoned. The well abandonment record for Non-Residential wells GW-30 Rev. 5/06 completed by the NC well contractor and certified by our NC Professional Geologist will also be filed with the Solid Waste and Water Quality Sections.

Previously Abandoned Wells

We request that all wells that have previously been properly abandoned prior to the issuance of the permit to construct be exempt from the new overdrilling construction condition.

Conclusion

In order to achieve the Section's presumed overall objective the alternative methods and additional provisions are technically practical, in compliance with current NC applicable rules/laws, protective of the environment, and consumes much less time/resources. This proposed variance is a balance of the best available technology that is economically reasonable based upon the astronomical low probability of potential harm to the environment.

Thank you very much for consideration of our request for a variance of the construction condition 13 of the permit to construct phase 4. At your request we can schedule a meeting to further discuss this project and can provide more detailed information/supporting documentation if required. The construction of the landfill is expected to commence very soon and additional financing and planning may need to be implemented therefore a prompt response would be appreciated. If you have any questions regarding this request, please contact me at (919) 772-5393 or by email at jpfohl@mesco.com.

Sincerely,
MUNICIPAL ENGINEERING SERVICES CO., P.A.

Jonathan Pfohl
Environmental Specialist/NC CWD 3301

Ethan J. Cladwell, PG

Enclosures
cc: Mr. David Lambert
Iredell County

Kurt, Carl E. and R.C. Johnson, Jr., 1982. Permeability of grout seals surrounding thermoplastic well casing; Ground-Water, vol. 20, no. 4, pp.415-419

Cherry, J. 1990. "Groundwater Monitoring: Some Deficiencies and Opportunities," In: Hazardous Waste Site Investigations: Towards Better Decisions, Proc. 10th ORNL Life Sciences Symposium, Gatlinburg, TN, May 1990, Lewis Publishers.

October 9, 200

Ms. Elizabeth Stewart
Solid Waste Section
Division of Waste Management
North Carolina Department of Environmen
401 Oberlin Road, Suite 150
Raleigh, NC 27605

Re: Piezometer Abandonment Procedure
Cherokee County Subtitle D Landfill (Pha
MESCO Project No. G01099.6

Dear Ms. Stewart:

The Cherokee County Subtitle D Landfill
approval to construct is granted. In prep
piezometers, which were installed for bot
abandoned. This site consists of 8 piezom
constructed with a cement grout annulus in
kept for water level readings, and 1 will

Approximately 18 piezometers that were i
exist and were constructed the same way w
These wells are mostly 1" PVC installed w
soil cuttings upon the bentonite seal. We
that it is required by the Solid Waste Se
be overdrilled, to remove the soil cutting
cement/bentonite grout. However, we requ
particular site that is more cost effective
overdrill than abandon all of the piezome
therefore several of the piezometers loca
be completely overdrilled at this time. Th
in the field and many are likely to be de
making it very difficult to abandon prope
like to abandon all of the piezometers si
are located and if not done now there is a

This is the exact situation which occurred
Subtitle D Landfill project. We decided
sufficient seal in the prevention of possi
PVC Overdrill Entire Depth and than aban

consuming and is not superior to the other alternatives. 2. Grout internal PVC completely than overdrill w/ HSA to the top of bentonite layer than grout the annulus leaving the PVC in Place. This is significantly less costly than # 1 and in essence is exactly the same as abandoning a piez. That is constructed w/ a grout annulus. 3. Tremie grout internal PVC . This is the most cost effective means and most viable option especially in the locations which will never comprise a landfill cell. This is the method outlined in the Well Construction Standards 15A NCAC 02C.0113(b)(1)(G)(ii).

We really appreciate you taking the time to review our petition for an alternative abandonment procedure. When a decision is made we request a letter be issued to us to be kept on file. I have attached a table below for your convenience and can forward a site map upon request. If you need any more information concerning this request please call me at (919) 772- 5393 or by email at jpfohl@ mesco.com

Sincerely,
MU NICIPAL ENGINEERING SERVICES CO., P.A.

J onathan Pfohl
Environmental Specialist
Enclosures

Table 1. Piezometer Abandonment Procedures

Piezometer Location	**Number of Piez.**	**1r. Over Entire**	**2 drill Overdrill Depth to Bentonite**	**3r. Tremie Tremie Depth to Internal**	**Grout PVC Only**
Within Phases 2- 3 Proposed FootPrint	2				
Within Phases 4- 5 Proposed FootPrint	3				
Buffer Zone/Planned to Never be within a FootPrint	13				

North Carolina
Department of Environment and Natural Resources
Division of Waste Management

NCDENR

Michael F. Easley, Governor
William G. Ross Jr., Secretary
Dexter R. Matthews, Director

October 13, 2003

MUNICIPAL ENGINEERING RECEIVED
OCT 16 2003
SERVICES COMPANY

Mr. Jonathon Pfohl
Municipal Engineering Services Company, P.A.
PO Box 97
Garner, NC 27529

Re: Approval of Abandonment Procedures
Cherokee County Municipal Solid Waste Landfill, Phase 2 – Permit # 20-02
Marble, NC

Dear Mr. Pfohl:

The Solid Waste Section has received your letter dated October 9, 2003 regarding the piezometer abandonment procedures for the Cherokee County MSW, Phase 2 to be constructed in the future.

After review of this letter, the proposed abandonment procedures for the remaining 18 piezometers has been approved. Per our conversation, it has been approved that five of the wells located in the footprint of potential waste cells be abandoned via procedure #2 outlined in your letter. It was discussed that these piezometers will be abandoned after the final subgrade has been established. The remaining 13 piezometers, located in the buffer zone, will be abandoned using procedure #3 described in your letter.

If you have any questions, please fell free to call me at (919) 733-0692 x346 or email me at elizabeth.stewart@ncmail.net.

Sincerely,

Elizabeth R. Stewart

Elizabeth R. Stewart
Hydrogeologist

Cc: Jim Patterson – Waste Management Specialist, Asheville Regional Office
Sherri Coghill – Engineer, DWM-Solid Waste Section
Jim Barber – Section Chief, DWM
File room

15A NCAC 02C .0214 ABANDONMENT AND CHANGE-OF-STATUS OF WELLS

(a) In the event any injection or associated monitoring well is abandoned, either temporarily or permanently, the well owner shall notify the Director within 15 days and the well(s) shall be abandoned in accordance with one of the following procedures or other alternatives approved by the Director based on a demonstration of not adversely affecting human health or the environment:

(1) Procedures for temporarily abandoned wells.

(A) Upon temporary removal from service, or prior to being put into service, the well shall be sealed with a water-tight cap or seal compatible with the casing and installed so that it cannot be removed without the use of hand or powers tools.

(B) The well shall be maintained whereby it is not a source or channel of contamination to an underground source of drinking water during its temporary status.

(C) The well shall be repaired, to achieve compliance with the Rules in this Section, or permanently abandoned within 30 days of receipt of notice from the department, upon finding that a well is acting as a source or channel of contamination to an underground source of drinking water.

(2) Procedures for permanently abandoned wells.

(A) All casing and materials may be removed prior to initiation of abandonment procedures if the Director finds such removal will not be responsible for, or contribute to, the contamination of an underground source of drinking water. Any casing not grouted in accordance with 15A NCAC 2C .0113 shall be removed or properly grouted.

(B) The entire depth of the well shall be sounded before it is sealed to insure freedom from obstructions that may interfere with sealing operations.

(C) The well shall be thoroughly disinfected, prior to sealing, if the Director determines that failure to do so could lead to the contamination of an underground source of drinking water.

(D) Drilled wells shall be completely filled with cement grout, which shall be introduced into the well through a pipe which extends to the bottom of the well and is raised as the well is filled. "Bored" or hand-dug wells over 24 inches in diameter may be filled with an alternative material approved by the Director based on a demonstration of not adversely affecting human health or the environment.

(E) In the case of gravel-packed wells in which the casing and screens have not been removed, neat-cement shall be injected into the well completely filling it from the bottom of the casing to the top.

(F) In those cases when, as a result of the injection operations, a subsurface cavity has been created, the well shall be abandoned in such a manner that will prevent the movement of fluids into or between underground sources of drinking water and in accordance with the terms and conditions of the permit.

(b) Exploratory or test wells, constructed for the purposes of obtaining information regarding an injection well site, shall be permanently abandoned in accordance with Subparagraph (2) of this Rule upon completion of their exploratory or testing status.

(c) An injection well shall be permanently abandoned by the drilling contractor before removing his equipment from the site if the well casing has not been installed or has been removed from the well bore.

History Note: Authority G.S. 87-87; 87-88; 143-211; 143-215.1A; 143-215.3(a)(1); 143-215.3(c);
Eff. August 1, 1982;
Amended Eff. February 1, 1997; October 1, 1996.

15A NCAC 02C .0108 STANDARDS OF CONSTRUCTION: WELLS OTHER THAN WATER SUPPLY

(a) No well shall be located, constructed, operated, or repaired in any manner that may adversely impact the quality of groundwater.

(b) Injection wells shall conform to the standards set forth in Section .0200 of this Subchapter.

(c) Monitoring wells and recovery wells shall be located, designed, constructed, operated and abandoned with materials and by methods which are compatible with the chemical and physical properties of the contaminants involved, specific site conditions and specific subsurface conditions. Specific construction standards will be itemized in the construction permit, if such a permit is required, but the following general requirements will apply:

(1) The borehole shall not penetrate to a depth greater than the depth to be monitored or the depth from which contaminants are to be recovered.

(2) The well shall not hydraulically connect:

(A) separate aquifers; or

(B) those portions of a single aquifer where known or suspected contamination would occur in separate and definable layers within the aquifer.

(3) The well construction materials shall be compatible with the depth of the well and the contaminants to be monitored or recovered.

(4) The well shall be constructed in such a manner that water or contaminants from the land surface cannot migrate along the borehole annulus into any packing material or well screen area.

(5) Packing material placed around the screen shall extend at least one foot above the top of the screen. Unless the depth of the screen necessitates a thinner seal; a one foot thick seal, comprised of bentonitic clay or other material approved by the Director, shall be emplaced directly above and in contact with the packing material.

(6) Grout shall be placed in the annular space between the outermost casing and the borehole wall from the land surface to the top of the bentonite clay seal above any well screen or to the bottom of the casing for open end wells. To provide stability for the well casing, the uppermost three feet of grout below land surface must be a concrete or cement-type grout.

(7) All wells shall be secured, with a locking well cap, to reasonably ensure against unauthorized access and use.

(8) All wells shall be afforded reasonable protection against damage during construction and use.

(9) Any wells that would flow under natural artesian conditions shall be valved so that the flow can be regulated.

(10) The well casing shall be terminated no less than 12 inches above land surface datum unless both of the following conditions are met:

(A) site-specific conditions directly related to business activities, such as vehicle traffic, would endanger the physical integrity of the well; and

(B) the well head is completed in such a manner so as to preclude surficial contaminants from entering the well.

(11) Each well shall have securely affixed an identification plate constructed of a durable material and shall contain the following information:

(A) drilling contractor, or pump installation contractor, name and applicable certification or registration numbers;

(B) date well completed;

(C) total depth of well;

(D) a warning that the well is not for water supply and that the groundwater may contain hazardous materials; and

(E) depth(s) to the top(s) and bottom(s) of the screen(s).

(12) Each well shall be developed such that the level of turbidity or settleable solids does not preclude accurate chemical analyses of any fluid samples collected.

(d) Wells constructed for the purpose of monitoring or testing for the presence of liquids associated with tanks regulated under 15A NCAC 02N (Criteria and Standards Applicable to Underground Storage Tanks) shall be constructed in accordance with 15A NCAC 02N .0504.

(e) Wells constructed for the purpose of monitoring for the presence of vapors associated with tanks regulated under 15A NCAC0 2N shall:

(1) be constructed in such a manner as to prevent the entrance of surficial contaminants or water into or alongside the well casing; and

(2) be provided with a lockable cap in order to reasonably ensure against unauthorized access and use.

(f) Temporary wells and all other non-water supply wells shall be constructed in such a manner as to preclude the vertical migration of contaminants within and along the borehole channel.

(g) For monitoring, sand-or gravel packed wells, centering guides must be evenly distributed in the borehole.

History Note: Authority G.S. 87-87; 87-88;
Eff. February 1, 1976;
Amended Eff. April 1, 2001; December 1, 1992; September 1, 1984; April 20, 1978.

Probability of potential leaks in composite liner & all casing/grout leaks occurring simultaneously over top of each other at all 10 locations within the 12 acre footprint.
Iredell Co. Subtitle D LF, Phase 4

Probability is 1 in 380,767,863,576,774 (1 in 380 Trillion)

Assumptions:
Total cumulative Leaks from the 10 Annulus's is 8in^2 or 0.8in^2 per boring that are completely permeable
Total Leaks in Composite Liner 1.86 in^2 or 1 cm^2 per Acre over 12 acres

(Typical Leaks w/ Good QC/QA per Published Research)
Power Ball Odds: 1 in 146,107,962
Lightning Strike person in US: 1 in 280,000

Method:
P(A and B) = P(A) * P(B|A)

Probability of Composite Leakage occuring at a given location in relation to total area of the cell is :
1 in 40,468,645

Probability of Casing/Grout Leakage from all of the 10 wells if abandoned w/out overdrilling:
1 in 9,408,960

Total Probability of both occuring simultaneously on top of each other is:
1 in 380,767,863,576,774

Well Leakage (B)

voids in^2	cell in^2	probability it Does Leak
8	75,271,680	0.000000106

Liner Leakage (A)

voids in^2	cell in^2	probability it Does Leak
1.86	75,271,680	0.000000025