STATE OF NEW MEXICO
WATER QUALITY CONTROL COMMISSION

In the Matter of:	)	
PROPOSED AMENDMENTS TO 20.6.6 NMAC (Dairy Rule)	)	**No. WQCC 12-09(R) and No. WQCC 13-08(R)**

Dairy Industry Group for a Clean Environment,
Petitioner

DIRECT PRE-FILED WRITTEN TESTIMONY OF KATHY J. MARTIN

My name is Kathy J. Martin, PE (NM#21522), and I am presenting this written testimony in the New Mexico Water Quality Control Commission (Commission) rule-making hearing case WQCC 13-08(R) and have previously submitted direct written testimony in WQCC 12-09(R) which has been consolidated with this petition. I am testifying as an expert witness on behalf of the Rio Grande Chapter of the Sierra Club, Amigos Bravos, Caballo Concerned Citizens, Lee County Concerned Citizens and Rio Valle Concerned Citizens (collectively the "Coalition"). I am presenting this written technical testimony in response to September 4, 2012 and August 5, 2013 Dairy Industry Group for a Clean Environment (DIGCE) petitions to amend the Commission's Ground Water Protection – Supplemental Permitting Requirements for Dairy Facilities ("Dairy Rule").

I. BACKGROUND AND EXPERIENCE

I have a Bachelor of Science degree in Petroleum Engineering and a Master of Science degree in Civil Engineering from the University of Oklahoma. My graduate research included extensive literature review of liner system performance; liner systems including clay, synthetic, and composite liners; waste-liner compatibility; liner failure mechanisms; and transport and fate

of leakage in the subsurface. An annotated bibliography of that research was provided to NMED during the Roswell public meeting prior to this hearing and is included in this testimony as **Coalition Exhibit KJM-2**.

My work experience includes work for the State of Oklahoma at the Oklahoma Water Resources Board (OWRB) where I was responsible for creating rules and regulations for the use of surface impoundments and land application with respect to non-hazardous industrial wastewater and drafting water quality permits under those rules. The regulations were a direct result of my graduate research on liners and waste/liner compatibility. In addition to updating all non-discharge permits to the new regulations, I was also responsible for overseeing closure of surface impoundments, including closure plan evaluation and approval. While at the OWRB, I served as the third Project Officer of the Tar Creek Superfund Site and helped develop and oversee the ground water monitoring of public water wells within the 50 square mile area affected by lead and zinc mine discharge. When I transferred to the Oklahoma Department of Environmental Quality, I received training in the Clean Air Act including permit writing, air pollution controls, and the hazardous air pollutant program under the Clean Air Act Amendments of 1990 and the Small Business Assistance Program. My duties included providing 'one-stop' permit assistance to various industries in Oklahoma, as well as developing strategies to assist applicants in pursuing all applicable environmental permits.

In 1996, I started a consulting company called Martin Environmental Services and worked with foundry and metal casting facilities for a year preparing Form R's under Superfund Amendments and Reauthorization Act (SARA) Title III community-right-to-know reporting requirements and developing state toxic air emission permit determinations. In 1997, my focus changed to wastewater issues related to concentrated animal feeding operations (CAFOs) and I

have been working on CAFO waste issues for the past 17 years. During that time, I have reviewed several hundred environmental permit applications for CAFOs in 21 States and prepared engineering evaluations of the waste management systems and nutrient management plans associated with large-scale livestock production facilities. A good part of that effort involves evaluating the engineering design plans and specifications for waste storage facilities including liner systems for impoundments, feed storage areas, and mortality handling.

I participated in all stages of the creation of the current Dairy Rule including serving as expert witness for the Coalition before the Water Quality Control Commission during the initial proceedings and the proceedings to approve the negotiated revisions, as well as being involved in the negotiation process for the revisions to the regulations that were memorialized in the settlement agreement on July 7, 2011.

In addition to my experience performing engineering reviews of CAFO environmental permit applications, I have been involved in numerous efforts related to state regulations for livestock production facilities in Oklahoma, Kansas, Nebraska, Colorado, Illinois, and New Mexico. I have testified as an expert witness in matters related to waste management systems, water quality, and air emissions related to livestock production facilities in state agency adjudicatory hearings and in higher Courts.

I am a professional engineer in the field of Civil Engineering and hold licenses for both Oklahoma (OK#18254) and New Mexico (NM# 21522). A current and accurate copy of my Curriculum Vitae and List of Testimony and Deposition is marked as **Coalition Exhibit KJM-3.**

II. SCOPE OF DIRECT TESTIMONY

My direct testimony for this rule-making includes, by reference herein, my previously submitted written direct testimony as Exhibit 1 and A through N attached thereto, for the rule-

making hearing WQCC 12-09(R), dated November 19, 2012, on the topics of backflow prevention, flow meters, and nutrient management plans (referenced herein as **Coalition Exhibit KJM-04**). The remainder of this document will focus on the Coalition's proposed changes to requirement for liners in 20.6.6.17(D)(6). I reserve the right to submit rebuttal testimony on any appropriate topic presented in Notices of Intent submitted by DIGCE and NMED.

III. COALITION PROPOSED CHANGES TO 20.6.6.17(D)(6).

The following proposed language is in reference to Dairy Rule 20.6.6.17(D)(6) and includes strikeout of language currently proposed by DIGCE and underlined text as proposed by the Coalition during the current rule-making process (**Coalition Exhibit WCO-3**):

(6) **Impoundment liner - wastewater or wastewater/stormwater combination.** An applicant or permittee proposing or required to construct a new or to improve an existing wastewater or combination wastewater/stormwater impoundment, shall, at a minimum, ~~use a single liner that is at least 60 mil HDPE or other material having equivalent characteristics with regard to permeability, resistance to degradation by ultraviolet light, compatibility with the liquids anticipated to be collected in the impoundment, tensile strength, and tear and puncture resistance~~. utilize a double synthetic liner system with leak detection composed of an upper liner, a lower liner, a drainage layer, and a fluid removal system that is designed and constructed to meet the following requirements:

(a) The upper liner material shall be a minimum of 60 mil high density polyethylene (HDPE) or other synthetic material having equivalent characteristics with regard to permeability, resistance to degradation by ultraviolet light, compatibility with the liquids anticipated to be collected in the impoundment, tensile strength, and tear and puncture resistance.

(b) The lower liner material shall be a minimum of 40 mil HDPE or other synthetic material having equivalent characteristics with regard to permeability, resistance to degradation by ultraviolet light, compatibility with the liquids anticipated to be collected in the impoundment, tensile strength, and tear and puncture resistance.

(c) The drainage layer shall be constructed between the upper and lower liner in the following manner:

(i) The drainage layer shall include drainage material, such as a geosynthetic drainage net (geonet) or other synthetic drainage system, that has a hydraulic conductivity of 1×10^{-2} centimeters per second (cm/sec) or greater.

(ii) The drainage layer shall be designed and constructed with a slope of at least two percent (2 %) that is calculated to be sufficient to cause leakage to flow towards the fluid removal system in a timely manner considering the maximum length of the flow path.

(iii) A filter layer shall be constructed between the upper liner and the drainage layer in order to protect the upper liner from puncture by underlying material and to provide a filter of fine particles from any leakage passing through the upper liner.

(iv) The drainage layer shall be underlain by a protective material designed to protect the lower liner from puncture.

(v) A series of perforated fluid collection pipes or equivalent transport mechanism shall be installed in the drainage layer to transmit leakage fluid

from the drainage layer to a fluid collection sump(s). Collection pipe material, diameter, wall thickness, connections, and slot size and distribution shall be sufficient to prevent deflection, buckling, collapse, or other failure.

(vi) Collection pipes shall be installed with slopes equivalent to the slope of the drainage layer.

(vii) Collection pipe systems shall be designed to allow for cleaning of all collection pipes with standard pipe cleaning equipment.

(d) The fluid removal system shall be designed and constructed in the following manner to collect fluids in the drainage layer and transport the fluids quickly to a fluid collection sump(s) where it is collected and measured prior to the fluids being pumped back into the impoundment:

(i) The fluid removal system shall consist of a sump(s), a dedicated pump(s), an automated pump activation system, a totalizing flow meter, and an automated alarm system.

(ii) The automated pump activation system shall activate the pump(s) when fluid is collected at a specific level to prevent overtopping.

(iii) The totalizing flow meter shall provide a permanent record of amount of flow per day to be reported monthly to the Department.

(iv) The automated alarm system shall provide warning of pump failure such that the operator can prevent spills and overtopping.

III. TECHNICAL BASIS FOR PROPOSED CHANGES TO 20.6.6.17(D)(6)

A. Background Information

The current Dairy Rule 20-6-6-17(D)(6) requires a single plastic liner for new or improved wastewater impoundments and then refers the reader to paragraph (5) for the details of how that liner shall be designed and constructed. The requirement for only a single plastic liner, rather than double liner system as proposed by NMED, was a compromise position made by the WQCC during the original rule-making hearing. Now DIGCE would propose to severely restrict the ability for WQCC and NMED to require plastic liners for any reason.

The language proposed by DIGCE removes the requirement for a "single liner that is at least 60 mil HDPE" and redirects the permitee from paragraph (6) to paragraph (5). In paragraph (5), DIGCE removes the reference to plastic liners in the first sentence and inserts language requiring a compacted soil liner. For reasons unknown, DIGCE's proposal appears to leave the remainder of paragraph (5) that describes requirements for design and construction of synthetic liners and fails to provide construction requirements for their proposed compacted soil liner.

In effect, the DIGCE proposal acts to remove the requirement to install a plastic liner and replaces it with a one-sentence requirement to have a compacted soil liner devoid of any specific requirements as to its construction. Regulations of this sort are not helpful, nor protective.

After review of the recordings of the NMED "pre-hearing listening sessions", it became clear to this expert and the Coalition that DIGCE failed to produce new (post-2010 journal articles, research, or valid case studies) and compelling evidence to representatives of NMED that compacted soil liners would be as protective of groundwater as compared to synthetic or plastic liners. Therefore, there is no 'new technology' to evaluate by this expert at this time. Once the Notice of Intent is filed by DIGCE with their rationales for various rule changes, this

expert will hopefully have some actual evidence to evaluate and prepare a rebuttal. With that in mind, this expert reserves the right to rebuttal any rationale provided by DIGCE for their proposed impoundment liner language and rebuttal, if necessary, of NMED on the matter.

The current language in paragraph (6) requiring a plastic liner was the result of compromise between NMED and DIGCE during the prior rule-making process. Now that DIGCE is proposing to further erode the protective nature of the impoundment liner system requirements, the Coalition proposes the opposite approach. Rather than going back in time and allowing the use of antiquated soil liner technology, the Coalition proposes to champion the double-liner system previously proposed by NMED with some minor improvements.

B. Rationale for double-liner system with leak detection rather than single plastic liner.

The rationale for proposing a requirement for a double-liner system with leak detection rather than a single plastic liner for newly constructed wastewater and combined stormwater-wastewater impoundments is to incorporate state-of-the-art liner and leak detection technology that can serve to greatly reduce the amount of wastewater that escapes the liner system, enters the subsurface, and ultimately the groundwater. A double-plastic liner system with leak detection allows for the collection and removal of leakage through the primary or upper liner thus preventing further escape past the secondary or lower plastic liner and the subsurface. Single plastic liners can cause pollution to groundwater due to leakage through manufacture-related pinhole defects and from on-site construction welding defects, as well as rips and tears that may occur during the operation and maintenance of the impoundment (Bonaparte and Gross, 1992). **Coalition Exhibit KJM-05** includes pages 35 to 43 of their 65 page report that includes the information on liner success and failures specific to surface impoundment liner systems.

Over the course of a decade, Bonaparte and Giroud developed equations to calculate 'steady-state leakage rates through liners constructed with geomembranes due to flow through holes' (Bonaparte and Gross, 1992). The researchers determined that 'the rate of flow through geomembrane holes is dependent on the liquid head on the geomembrane, the hydraulic conductivities of the soil layers immediately underlying and overlying the geomembrane, the size and frequency of occurrence of holes in the geomembrane, and for composite liners, the quality of contact between the geomembrane and underlying soil layer" (Bonaparte and Gross, 1992). Note that research in the 1990's referred to synthetic or plastic liners as geomembranes.

What this tells us is that even though plastic liners are designed to not leak, they can leak and this fact should be incorporated into regulatory language for the design of the liner system. The current dairy rule only requires a single plastic liner mainly due to compromises made during the deliberations that tried to defer to scientific understanding of liner reliability under intense pressure from industry to do otherwise. Considering past efforts by NMED to bring the dairy industry into the 21st century of liner construction was managed through permit language, the inclusion of a plastic liner system in state regulations was a much needed step in the right direction. Hopefully, the Commission will take this rule-making as an opportunity to fortify the plastic liner language rather than erase it from existence, so that the Dairy Rule will have a legacy of groundwater protection and not groundwater pollution.

Thiel and Giroud (2011) presented four scenarios to describe increasing need for leakage control for impoundments and acceptable liner systems for various levels of risk to the structure itself, the environment, and groundwater associated with those scenarios. Scenario 4 involves impoundments used to store 'critical liquids' where the infiltration of those liquids into the subsurface and, for our purposes, the groundwater is an unacceptable risk. Dairy impoundments

that contain the wastes and wastewaters from the milking parlor can be considered a 'scenario 4' because of the high concentration of total dissolved solids (TDS) and nitrogen compounds. These pollutants are of concern to groundwater users because an increase in TDS affects the usability of groundwater and an increase in nitrogen compounds poses a risk due to increased levels of nitrates, which are a human health pollutant (**Coalition Exhibit KJM-06**).

Liner systems appropriate for Scenario 4 must include leakage control with full detection and management, or simply, a liner system that includes two geomembranes and an intervening leakage collection layer. Thiel and Giroud (2011) summarize the rationale for leak collection such that "the monitoring and operation of the leakage collection layer provides direct feedback regarding pond performance." The Coalition language puts the emphasis on leakage control to fortify existing requirements for a plastic liner by including a leak detection system and necessarily, a lower liner to complete the more superior plastic liner system.

The current Dairy Rule does not require a leak detection system for the single liner system and thus does not set a good example to industry about the importance of not only having a lined impoundment, but to continuously insure that the liner is functional. The regulations should impress upon the regulated community that the liner is not only important and valuable, but is a responsibility that includes insuring that the wastewaters impounded do not escape to the subsurface and pose an ongoing and basically uncontrolled threat to groundwater quality.

The Coalition proposes the leak detection system for the main purpose of capturing any leaks and bringing them to the surface in a timely manner so that the permittee is an active participant in the control of the leakage and is made aware of potential problems with the impoundment liner long before the groundwater is contaminated. The Commission should consider the long-term value of preventing groundwater contamination as an economic gain that

far outweighs the costs of installation. If we bow to arguments that liners cost money, without also giving fair hearing to the considerable cost savings from avoiding site abatement and long-term groundwater monitoring, then we do a disservice to all. It is anticipated that liner costs will be a subject of Coalition rebuttal if DIGCE uses that as an excuse to remove those requirements.

A double-liner system consists of a primary or upper liner and a secondary or bottom liner. The upper liner is exposed to the wastewater impounded and to ambient conditions of temperature, UV radiation, wind action, as well as operational conditions related to ingress and egress of the wastewater using piping and mechanical equipment, such as pumps and aerators. It is important to choose a plastic liner that can withstand these conditions and continue to serve its function of containing most if not all of the impounded liquids.

The basic properties of the plastic liner material that measure ability to withstand operational conditions must be addressed in the regulation. Rather than requiring only one type of plastic liner, the Coalition agreed with NMED's prior proposal of providing an option. The proposed language does specify the type and thickness of the plastic that has ideal properties (60 mil HDPE for the upper liner and 40 mil HDPE for the lower liner), but then provides the option for the facility to propose a liner system that meets those properties, be it a 60 mil HDPE or other synthetic liner system. NM-NRCS Construction Specifications for flexible membrane liners for 40 and 60 mil HDPE liner material is provided in **Coalition Exhibit KJM-07.**

The Coalition is intent on protecting groundwater while being mindful of the necessary freedom to design liner systems in the future that can incorporate advances in plastic manufacturing, drainage layer materials, and leak detection methods. For example, an equivalent upper or lower liner system could include a composite liner that is constructed of a sandwich of plastic liner and compacted clay or even a plastic liner with a composite clay fabric.

The Natural Resource Conservation Service (NRCS) has developed a Conservation Practice Standard 313 for Waste Storage Facility specifically for livestock production waste storage facilities in New Mexico (**Coalition Exhibit KJM-08**). In the Standard, there are provisions for additional measures to minimize waste storage liner failure when the impoundment is located in an area (a) that has unconfined shallow groundwater, (b) a vadose zone composed of rock, (c) over an aquifer used as a domestic water supply or otherwise ecologically vital, or (d) where the location overlies vulnerable bedrock, such as limestone or gypsum.

In those cases, page 7 of the Standard includes the following recommendations for an appropriate liner system: (a) a clay liner under the plastic liner (a composite liner), (b) a second flexible membrane liner (a double-liner system), (c) a geosynthetic clay liner with the flexible membrane liner (a variation of a composite liner), or (d) a concrete liner designed to be watertight. The Commission should consider the importance of the NRCS Conservation Practice Standards as they are written specifically for New Mexico and are tailored especially for waste management of livestock production wastes and wastewaters. NRCS Standards represent minimum best management practices for the livestock production industry and by virtue of their very existence become an important component of good engineering design. The Commission should at the very least incorporate those minimum best management practices in the Dairy Rule.

The drainage layer should have "high fluid transmissivity to allow leakage to quickly and efficiently be conveyed to the low point (usually a sump)" (**Coalition Exhibit KJM-06**). The literature supports a typical hydraulic conductivity of 1 x 10^{-2}cm/sec as the minimum to satisfy the need for high fluid transmissivity in the drainage layer portion of the double-liner system (**Coalition Exhibit KJM-09**).

Drainage layers can include granular material or geonets depending on the limitations of the installation, such as trying to install loose rock layer on impoundment side-slopes when the use of a roll-out material, like geonets, would be more appropriate. Geosynthetic drainage nets or geonets are manufactured for various chemical resistance, flow path designs, creep resistance, and durability under compressive forces. The Coalition language allows for the design engineer to propose a site-specific drainage layer yet provides some minimum requirements dictating its purpose of high transmissivity and basic components of the drainage layer, such as materials and minimum slope.

The US EPA has several publications dedicated to liner design, including **Coalition Exhibit KJM-09** "Solid Waste Disposal Facility Criteria – Technical Manual", that focuses on landfill liner design, which can be adapted to provide best engineering practices for drainage layers for double-lined impoundments containing liquids. The concepts are similar in that the purpose of the drainage layer under an impoundment is to transmit the leakage to a collection point or sump for measurement and proper disposal. The Technical Manual provides discussion of how to evaluate various drainage layer compositions in order to choose an appropriate system that has void spaces large enough to cause rapid liquid transport, yet small enough to prevent solids from dominating the structure and causing long-term clogging.

The purpose of a filter layer is two-fold; to protect the upper and lower plastic liners from puncture and to provide a filter to keep fine particles that are in the leakage fluid from entering and thus clogging up the drainage layer materials. Not only can clogging occur due to fine particle migration, it can also occur due to chemical and biological activities in the drainage layer itself. The Coalition language attempts to address these operational hazards by requiring filter layers below the upper liner and above the lower liner.

The Coalition language includes requirements for a perforated pipe system to be included in the drainage layer. This language was also proposed by NMED in the original rule-making. The purpose of a perforated pipe system under a surface impoundment mimics the use in landfill design to collect and transport landfill leachate. In our case, we are attempting to accelerate the flow of any leakage through the drainage layer by basically providing a French drain system that criss-crosses underneath the impoundment. **Coalition Exhibit KJM-09** includes detailed discussion of how to design and install a perforated pipe system, including how to determine adequate flow rates and then use the flow rate and installation slope to determine the appropriate pipe diameter.

The Technical Manual states "chemical clogging can occur when dissolved species in the leachate [or in our case, leakage] precipitate in the piping and the drainage layer. Clogging can be minimized by periodically flushing pipes or by providing a sufficiently steep slope in the system to allow for high flow velocities for self-cleansing." Biological clogging can occur because of the organic material in the leakage; in the case of dairy milking parlor wastewater that would include milk solids from the milk tank and piping washdown and manure solids from cleaning the milking parlor floor of manure and urine. That is why the Coalition language includes the requirement to design the perforated pipe system so that it can be flushed.

The bottom liner of the double-liner system serves to prevent any leakage that enters the drainage layer from escaping vertically to the subsurface and the groundwater (**Coalition Exhibit KJM-06**). The Coalition language allows for a 40 mil HDPE liner or its equivalent with similar freedom given to the applicant to propose a bottom liner or liner system other than HDPE. NM-NRCS Construction Specifications for 40 mil HDPE material is provided in **Coalition Exhibit KJM-07.**

Finally, I want to discuss the leakage monitoring and removal language as proposed by the Coalition and provide references to the Commission to use during deliberations. Clearly, the whole purpose of a double-lined system is to trap leakage and keep it from escaping into the subsurface and the groundwater. The drainage layer collects the leakage and with the assistance of the perforated pipes, transports that leakage to a sump located outside the impoundment. The sump contains a pump that is triggered when the fluid reaches a specific depth in the sump and causes the leakage fluid to be pumped back into the surface impoundment automatically.

It is important to remember that the fluid removal system as proposed by the Coalition is meant to focus the dairy operator on the measurement of leakage volume and to track that volume over time. The proposed language includes provisions for using a totalizing flow meter to measure the volume of flow and to create a permanent record (digital or otherwise) that is reported regularly to the NMED. Leakage volume records can be used by the operator to strategize with NMED to develop timely and appropriate liner maintenance and repair schedules.

IV. PROFESSIONAL OPINION

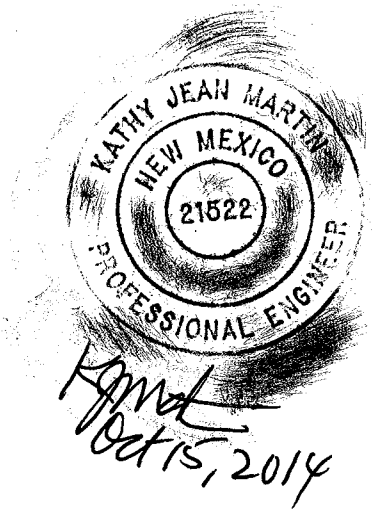
It is my professional engineering opinion that the proposed Coalition language for double liners and leak collections systems will fortify the current Dairy Rule and, when implemented properly, should greatly reduce the incidence of groundwater pollution from dairy wastewater impoundments.

The Coalition has inspected the Petitions submitted DIGCE in WQCC 12-09(R) and 13-08(R). Other than issues described in this direct testimony in support of more stringent regulations regarding plastic liners, the Coalition considers the current regulations (Dairy Rule) to be reasonable, correct, and comporting with the best available science applied to the prevention of pollution from dairies. As the Coalition and this witness have not, to date, been

provided any rationale or statement of support for DIGCE's second petition, nor any statements from NMED indicating its position to either support or oppose any of the positions in DIGCE's petition, I reserve my opinion on the positions and support for such positions from DIGCE and NMED for my rebuttal testimony. This includes any new testimony DIGCE and/or NMED may attempt to provide on the first petition.

This concludes my written, pre-filed direct testimony on the proposed Coalition language requiring double-liner and leak collection systems for new and improved dairy wastewater impoundments. As stated earlier, this expert witness reserves the opportunity for rebuttal on this petition and the previously filed one after reviewing the Notices of Intent for both DIGCE and NMED.

I, Kathy J. Martin, PE (NM#21522), swear that the foregoing is true and correct.



Kathy J. Martin, PE (NM#21522)

V. REFERENCES

Bonaparte and Gross (1992), "LDCRS Flow From Double-Lined Landfills and Surface Impoundments", USEPA Risk Reduction Engineering Laboratory, Contract No. 68-C0-0068. http://nepis.epa.gov/Exe/ZyNET.exe/30002TE7.TXT?ZyActionD=ZyDocument&Client=EPA&Index=1991+Thru+1994&Docs=&Query=&Time=&EndTime=&SearchMethod=1&TocRestrict=n&Toc=&TocEntry=&QField=&QFieldYear=&QFieldMonth=&QFieldDay=&IntQFieldOp=0&ExtQFieldOp=0&XmlQuery=&File=D%3A\zyfiles\Index%20Data\91thru94\Txt\00000008\30002TE7.txt&User=ANONYMOUS&Password=anonymous&SortMethod=h|-&MaximumDocuments=1&FuzzyDegree=0&ImageQuality=r75g8/r75g8/x150y150g16/i425&Display=p|f&DefSeekPage=x&SearchBack=ZyActionL&Back=ZyActionS&BackDesc=Results%20page&MaximumPages=1&ZyEntry=1&SeekPage=x&ZyPURL#

NM-NRCS Standard 313 – Waste Storage Facility http://efotg.sc.egov.usda.gov/references/public/NM/313-STD-July2011.pdf

NM-NRCS Construction Specification 521A Flexible Membrane Liner http://www.nrcs.usda.gov/wps/portal/nrcs/detail/nm/technical/?cid=nrcs144p2_068826

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