Circle Four Farms

CIRCLE FOUR FARMS

SLUDGE DISPOSAL AND FARM CLOSURE PLAN

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LICENSED PROFESSIONAL ENGINEER
No. 181768
BYRON JAY MOORE
2/15/00
STATE OF UTAH

BY: B. J. MOORE, P.E.
CIRCLE FOUR FARMS PROJECT ENGINEER

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1.0 GENERAL

This plan identifies disposal options for lagoon sludge (biosolids) for on-going farm operation (maintenance disposal) and farm closure scenarios for all Circle Four farm sites, as well as abandonment practices for lagoon and/or farm closure. The plan for farm closure was first requested by the Department of Environmental Quality on Nov. 30, 1998, in relation to issuance of the Ground Water Discharge Permit No. UGW0100009. A plan for in-situ disposal was submitted on December 12, 1998. DEQ requested that Circle Four further develop sludge disposal on a maintenance basis after review of the first submittal. A second plan for sludge disposal was submitted on October 24, 1999. This plan was not approved due to uncertainties in the future composition of the biosolids when disposal or closure would be required. In review of the second submittal, the DEQ recommended that landfill disposal be presented as the primary viable option for sludge disposal, with land application and alternative technologies discussed as secondary options for disposal.

1.1 Maintenance Disposal. As Circle Four Farms continues to operate the 42 farm sites in it's 32,000 sow Skyline Complex (8 sow farms, 10 nurseries, 23 finishers, and boar stud) and also continues development and operation of farms in its 45,000 sow Blue Mountain Complex (currently three 5,000 head sow farms with accompanying nursery and finishing farm sites it will be necessary to dispose of accumulated biosolids on a maintenance basis for continued operation of the farm. Each primary treatment lagoon has a nominal 1/3 of the total lagoon volume dedicated to biosolids accumulation. Over time, accumulation will continue until the storage capacity is reached. The principal disposal option presented in this plan is to landfill the biosolids. Land application and alternative technologies are secondary options. Each option is presented herein with sufficient detail to outline the option. Selected options will be chosen and formally presented for DEQ approval at the time of maintenance disposal.

1.2 Farm Closure. Should Circle Four Farms discontinue operation at any farm under operation, or totally discontinue operation all together, it will be necessary to close down the waste handling systems and to properly stabilize or dispose of the biosolids. The options for the farm closure scenario also include landfill as the primary option, with land application or alternative technologies employed for secondary processing or conversion into another beneficial nutrient product.

1.3 Option Selection. Although landfill is the primary option, other options are discussed. Therefore no particular option is presented or proposed as the singular mode of disposal. Rather, a combination of the options presented may be utilized, as these options show technical feasibility and are approved by the DEQ. This plan, as approved by the State, outlines the general guidelines for each option presented and the general

requirements. A formal set of specifications and a plan of operations will be submitted to the DEQ at the time of disposal/closure for final approval.

1.4 Scheduling of Disposal Operations. Actual accumulation rates and volumes to be disposed will vary with continued operation of Circle Four farm sites. The amount to be disposed in any given year, or disposal event may be a determining factor in selection of the method utilized. Circle Four Farms, is required by permit to monitor and submit sludge accumulation reports on an annual basis to the DEQ. The first report is due at year-end, 1999. The monitoring and reporting program will provide determination of accumulation rates, as well as assist in forecasting disposal operations (see section 5). It is anticipated that approximately 20 years of farm operation may be allowed before accumulation will require disposal. However, actual accelerated (or decelerated) accumulation rates may determine that disposal events may occur prior to, or after 20 years of farm operation.

Formal submittal of a specifications, sludge composition data, and the selected disposal plan to the DEQ will be required for each farm site within 6 months of any farm site being closed, or within 6 months of any farm site having a measured accumulation volume of 80% of design storage. The target is to dispose of biosolids at 100% of design storage volume. However, disposal may occur for any accumulation amount from 50 percent to 110 percent of design storage accumulation. All disposal plans shall be approved by the DEQ prior to implementation.

1.5 Volume and Sludge Constituencies. The design storage volume of sludge for all current farm sites is listed in Exhibit A. Sampling and testing was performed in March and April of 1998 and 1999 for chemical constituency and physical properties. Testing was done on sludge from one of each of Circle Four's oldest sow farms (41102), nurseries (41202), and finishers (41302). Analytical laboratory test results are included in Exhibit B.

The sludge, as taken from a lagoon in it's wet state tested at 4 to 8 percent (mass) solids content. Of the solids content, 60 percent to 70 percent is volatile material. The bulk density, of the biosolids, in it's wet form, is approximately 1,016 grams per liter, therefore, the specific gravity of the material used in calculations in this plan is 1.0.

2.0 PROJECTED ANNUAL DISPOSAL QUANTITIES

The anticipated annual volume of sludge to be disposed can be estimated using development rates of Circle Four Farms production facilities. Circle Four has developed at a steady pace since the summer of 1994. By June of year 2000, Circle Four will have pork production farms for 47,500 sows (and their offspring). This is a development rate of approximately 7,917 sows per year. The equivalent number of pork production facilities on a per-sow space basis, sludge accumulation design, and average weight is tabulated as follows:

A. Animal Type	*B. Per Sow Equivalent Space Req'd*	*C. Sludge Accumulation Storage Design Parameter (ft^3/lb.live animal weight)**	*D. Avg. Animal Wt. (lbs.)*	*E. Sludge Storage Space per sow (ft^3)= BXCXD*
Sow	1 hd	0.6	450	270.00
Nursery	3.375 hd	0.290	30	29.36
Finish	7.875 hd	0.6	150	708.75
Total Sludge Volume Per Sow				1,008.11

* Actual design storage parameters and on-site storage varies from site to site, but listed above is based on latest design parameters.

2.1 Annual Sludge Disposal Liquid Volume

Based on 100 percent of sludge storage capacity, the total annual sludge disposal volume (wet) requires disposal of (7,917 sows/yr. X 1,008.11 ft^3 per sow) = 7,981,207 cubic feet/yr.

2.2 Annual Sludge Disposal Tonnage

Converting 7,981,207 cubic feet into dry weight of solids @ 7% solids content (conservatively high value) content equates to an estimated 17,430 tons per year of dry material to be disposed.

3.0 MAINTENANCE DISPOSAL OPTIONS

The maintenance disposal options outlined in this section include landfill, land application, and switched technologies.

3.1 Landfilling

This option for disposal involves either conversion of existing primary lagoons to landfills, or construction of new basins for landfilling.

3.1.1. Existing Basin Conversion. The use of existing basins has the potential to provide an economically favorable and technically viable sludge disposal option. For example, a farm with a primary lagoon near full could have a new primary lagoon (or other treatment system) constructed nearby or adjacent to receive the farm's waste and to provide continued discharge to the evaporation basin. The old primary lagoon could then be utilized as the landfill disposal basin, for not only the sludge that has accumulated for that farm, but could also be utilized to receive sludge from other farms as well. For any such conversion of a primary lagoon to a landfill, the farm site should have demonstrated a history of compliance. Conversion of an existing primary lagoon to a landfill in this manner, then provides assurance of containment of sludge constituents due to a proven liner and containment history, as well as utilization of existing monitor wells to assure in the future, that liner integrity has not been compromised.

Construction and operational requirements for the existing basin conversion scenario involves very few requirements. Initially, the primary lagoon to be converted would stay as such until said time that waste from the farm could be converted to a newly designed, constructed and permitted primary lagoon or other treatment system. Once the new waste treatment system is constructed, farm wastewater would be diverted to the new system, and stopped from discharging to the old primary. The primary to be converted would be allowed to sit dormant for several months to allow for continued decomposition of solids and to provide settling. This dormancy period could last up to 24 months. At the conclusion of the dormancy period, remaining water above the sludge surface will be pumped from the conversion basin and diverted to either the headworks of the new treatment lagoon or system, to the evaporation basin at the site, to an adjacent farm site with capacity to receive the water, or land applied as per permit requirements. It may be desirable to add lime to the lagoon during the dormancy period to provide substance and compaction to the accumulated biosolids.[1]

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[1] Current research and trial projects performed by Continental Lime, Inc. have shown that the addition of lime to swine waste lagoons is effective in flocclating, settling, stabilization, and compaction of manures and sludges.

After decanting, the biosolids will be allowed to dry out for a period of time. If it is initially found that the dormancy period and the addition of lime has resulted in the development of a firm and compact sludge blanket in a short period of time after decanting, additional drying may not be required. However, if the sludge blanket is unstable, and requires additional drying, a drying basin will have to be constructed near the basin. The drying basin shall consist of an appropriately sized concrete or sealed asphalt pad surrounded by containment walls or lined containment embankment. The drying bed will be constructed to receive at approximately 100 percent of the accumulated sludge volume at the site, or of the design accumulation volume from any individual site that would use the converted landfill basin. A 0.5 feet of freeboard for transferred solids will always be maintained at the drying bed. As solids are turned and dried sufficiently, the material may be transferred back to the landfill conversion basin. The drying bed can then be utilized to receive sludge from nearby farm sites.

Eventually, sufficient sludge will have been dried and transferred to the converted basin to the point where it is filled and ready for capping. For capping requirements, see section 3.1.3 "Landfill Completion" for a description of landfill capping.

3.1.2 New Constructed Landfill Basins. At Circle Four's option, newly constructed landfill shall be designed, sized, located, and constructed to receive biosolids for a particular farm site, or to receive biosolids from multiple sites. Constructed landfills shall be lined with a minimum of 12-inches of clay having a maximum permeability of 10-7 cm/sec or 40 mil HDPE FML (flexible membrane liner). Economies of scale will likely be realized in larger landfills to receive biosolids from multiple sites. Initially, newly constructed landfills shall be constructed identically to the most recent specifications and requirements for construction of wastewater treatment and containment lagoons at Circle Four Farms. However, to minimize potential damage to the groundwater resource, a minimum separation of 10 feet from top of landfill basin bottom to the static groundwater surface shall be maintained in the design. Additionally, to assure no damage to an FML lined landfill is incurred from transfer of solids thereto, an 8-inch layer of sand, silt, or clay shall be constructed over the top of the liner after construction. Appropriately situated upgradient and downgradient monitor wells shall be constructed for monitoring of the landfill site.

Biosolids shall be sufficiently dried out in a constructed drying bed either at the site, or at the origination site of solids accumulation before wasting in the newly constructed landfill basin. Construction of drying beds shall be as described in the previous section.

3.1.3 Landfill Completion. Eventually biosolids transferred to the site will fill the landfill basin to capacity. Approximately 2 feet of freeboard between the top of berm and top of landfilled biosolids is expected at the time of landfill completion. At this stage, the landfill will require construction of a permanent cap. The soil cap will be constructed at a minimum of 24-inches in thickness. The soil used for the landfill cap will be relatively impermeable native soil, placed in 8-inch lifts. Soil covers, both lower and upper layers shall placed and compacted to a minimum of 90% maximum dry density (Standard Proctor). The cap shall be graded with a slope of 0.25% from the center line of the landfill cap to the center. The top 6-inches of soil shall be furrowed after compaction testing and drill seeded to facilitate vegetative growth and to protect against soil erosion. Vents shall be installed through the cap and grouted into the top of the biosolids layer at an appropriate grid frequency. This will provide additional assurance that no damage is done to the landfill cap. At completion, the landfill site will appear as a slightly mounded area. Signs will be installed at maximum 200 feet intervals around the perimeter of the landfill site, and no less than 2 signs per side. The signs shall post "prohibited excavation without receiving authorization of the Circle Four Farms and the DEQ.

Monitoring of groundwater by the monitor wells shall be carried out for a period of 5-years after construction and certification of the landfill cap.

Exhibit C shows a schematic of proposed landfill construction.

3.1.4 Transfer of Dried Biosolids to Landfill Basins. Dried biosolids shall be transferred and wasted into the basin from front loading or end dumping equipment at the embankments or by driving through the basin and appropriately dumping to provide and even deposited layer of biosolids. Care shall be taken to assure that sufficient structure exists in the bottom of the landfill basin prior to wasting dried biosolids thereto, i.e. the bottom is sufficiently dry so as to support hauling equipment. In the event solids must be disposed of, a road may be constructed using front-end loading equipment and rollers to provide a sufficient structure base to drive through the basin, diagonally from corner to corner. If this case exists, side-dumping equipment shall be used to transfer and dump biosolids loads from the constructed road through the basin. Solids shall be spread using a smooth tired front end loader or trackhoe. Eventually sufficient biosolids will have been wasted into the basin to provide a thick protective cover to the liner (at least 18-inches) and will allow free movement of heavy equipment over the biosolids layer without concern for the landfill basin liner. Only qualified equipment operators will be allowed to operate spreading or loading equipment within the landfill basin and care shall be taken to assure no damage is done to the basin liner.

3.1.5 Landfill Plans and Specifications. Plans and specifications for construction of each landfill site will be submitted to the DEQ for approval. This will include a geotechnical investigation of the landfill site. Analytical tests of the solids to be disposed of will be included. In addition, a hydraulic evaluation of the proposed landfill cap will have to be performed and submitted using a program such as the Army Corps H.E.L.P. to assure that no significant leaching of biosolids will occur through the landfill liner due to meteoritic water. It is anticipated, however, that most designs will be viable, as the annual evaporation in the area exceeds precipitation by a factor of 5. Plans and specifications will include a site plan, demonstrating the origin site of the biosolids in relation to the landfill site. Dredging method(s) and conveyance equipment to be used to displace biosolids to the landfill site will be specified. The design will conform to the recommendations contained in the geotechnical report. Construction of the basin and landfill cap will be certified at completion of construction of the receiving basin by an independent engineering consultant.

3.2 Land Application

3.2.1 General. Land application of biosolids is a potentially viable alternative for disposal. Land application will be done taking into consideration two principal nutrient parameters, nitrogen and phosphorus as well as taking into consideration the metals content of the biosolids. Because it is not known what the actual chemical constituency of the biosolids will be until the material is tested and ready for disposal, it is difficult to identify this alternative as fully viable.

Analytical data is presented in Exhibit B for the current chemical constituency of biosolids at a few selected farm sites. If land application is to be performed, an evaluation of the metals contained in the biosolids will have to be performed. Land application of metals in the biosolids will have to be checked and verified to assure that applications follow the provisions of 40 CFR Part 503. Currently, this requires analysis and evaluation of the following metals: As, Ba, Cd, Cr, Cu, Pb, Hg, Se, Ag, and Zn. Biosolids will not be land applied at concentrations exceeding the established concentrations in Table 1 of Part 503.

The remainder of this section, describing land application, is based on applying biosolids using nitrogen and phosphorus as the limiting nutrient factors in land application. As described previously, metals concentration cannot be ignored. The information, does however, present how nutrient loading for land application is to be evaluated if land application is to be used as a viable alternative.

3.2.2 Nutrient Based Land Application. The land application of biosolids option is based on surface application of the solids and/or incorporation (tilled or disked) into receiving acreage. The approach for determination of the nutrient based application rate to a given parcel will be based on plant available nitrogen within the sludge coupled with monitoring of plant available phosphorus in the receiving soil. Nitrogen levels in the sludge are low (approx. 24 lbs. per dry ton) versus total phosphorus content (134 lbs. per dry ton). However, only minimal amounts of phosphorus contained in sludge is plant available. This allows for higher application rates.

The plant available phosphorus left in soil after application of sludge cannot be pre-calculated by using data from analytical testing of phosphorus in sludge alone. However, it can be estimated by coupling analytical testing of phosphorus content in sludge and measuring it's effects on residual testing for phosphorus after land application for any given parcel. This is the approach to be taken in land application of biosolids from Circle Four lagoons.

Phosphorus in a sludge receiving parcel is to monitored and kept below soil phytotoxicity levels. The phytotoxic plant available phosphorus level in soil is approximately 220 ppm[2]. To assure that plant available phosphorus levels in soil, for any parcel receiving sludge from a Circle Four lagoon are kept below this level, a cutoff of 200 ppm shall be used in all land application calculations.

The mode of operation to be used shall be to land apply based on nitrogen plant uptake rates, if soil phosphorus levels are below 100 ppm. For parcels where soil tests contain over 100 ppm of plant available phosphorus, the historical effects of sludge application shall be considered to assure that phosphorus is kept below the cutoff level of 200 ppm. This rule is based on experience of land application of manures from other livestock operations.[3]

3.2.3 Estimated Plant Nutrient Uptake Rates. The specific plant nitrogen uptake rates for nitrogen and phosphorus are tabulated below:

	Nitrogen Uptake	**Phosphorus Uptake**
Corn	240 lbs./acre	44 lbs./acre

[2] Maximum plant available phosphorus in soil approaching phytotoxicity levels as recommended by Utah State University Soil Science Staff.

[3] Dr. Rich Koenig, Soil Specialist, Utah State University assures that pytotoxicity levels can be protected in this manner, and estimates de-minimus levels of phosphorus increase after land application based on nitrogen plant uptake rates. He refers to an example where, in a field trial, 25 dry tons/acre of poultry manure, testing at 42,000 ppm (total P) was land applied. This resulted in 2100 lb.(total P) per acre, or a total P application rate equivalent to a total soil phosphorus concentration of 500 ppm. Initial plant available p in soil testing was 8 ppm, final soil test after land application was 51 ppm.

Wheat	186 lbs./acre	24 lbs./acre
Alfalfa	450 lbs./acre	35 lbs./acre
Range	50 lbs./acre	9 lbs./acre
BLM seed mix	75 lbs./acre	13 lbs./acre
Irrigated seed mix	150 lbs./acre	22 lbs./acre

3.2.4 Nitrogen Based Application Rate

Biosolids nitrogen content and soil nutrient levels will be accounted for in land application of solids. In calculation of nitrogen based application rates, a volatilization factor of 0.5 shall be applied to ammonium-nitrogen content in the biosolids. A mineralization rate of 0.2 shall be factored into organic nitrogen content. Nitrogen availability in the irrigation water is assumed to be negligible. Calculation of the nitrogen based application rate shall be as per Example 1. Example 1 uses the actual weighted average nitrogen constituent levels found in current analytical sludge testing:

Example 1. Nitrogen based Land Application Rate

Sludge Nitrogen Content
Sludge NH_3 Nitrogen content (typ.) = 18,750 mg/kg
NH_3 X 0.5 Volatilization = 9,375 mg/ kg = 18.75 lbs./ton
Sludge Total Kjeldahl Nitrogen (typ.) = 27,925 mg/kg
Sludge Mineralized Nitrogen content =
(Total Kjeldahl – NH_3) X 0.2 = 1,835 mg/kg = 3.67 lbs./ton
Sludge Nitrate/Nitrite content (negligible) = 0 lbs./ton
Total Sludge Nitrogen Content = 18.75 + 3.67 + 0 = 22.42 lbs. per ton

Parcel Soil Nitrogen Content
Zero to one foot deep soil nitrogen residual (example value) = 7 ppm
One to two feet deep soil Nitrogen residual (example value) = 5 ppm
Two to three feet deep soil Nitrogen residual (example value) = 2 ppm
Residual N available to crop[4] = 4 X (7+5+2) = 56 lbs. N per acre

Application Rate
Agronomic N uptake rate (alfalfa) = 450 lbs./acre
Less soil N availability = 450 – 56 = 394 lbs./acre
Nitrogen Based Application Rate = 394 lbs. / acre ÷22.42 lbs./ton = **17.57 ton/ac.**

3.2.5 Soil Phosphorus Loading

Soils with phosphorus residuals below 100 ppm may receive land application of biosolids based on crop nitrogen uptake rates. For soil testing at plant available phosphorus above 100 ppm, land application shall be done taking into consideration historical phosphorus increases in soils from previous land application scenarios. In the event a parcel tests

[4] The multiplier 4 used in this calculation converts parts per million tested in soil to lbs. per acre, as is standard practice among soil agronomists. An estimated specific gravity of soil of 1.5 is used, in the determination.

for phosphorus levels higher than 100 ppm, future land application of sludge shall be done to assure that plant available phosphorus in the soil is kept below the cutoff level of 200 ppm. Phosphorus is immobile and when incorporated into soil, stays fixed unless utilized by plants. Therefore, only the first 1-foot of soil is to be used in phosphorus soil residual evaluations. Example 2 demonstrates land application rates on a parcel where phosphorus in soil is above 100 ppm.

Example 2. Sludge Plant Available Phosphorus Content
Sludge is to be land applied on a parcel with soil testing 160 ppm plant available phosphorus. The sludge to be land applied has a total P concentration of 40,000 ppm. Three previous land applications based on nitrogen uptake were performed on this parcel. Testing on nitrogen content in the sludge suggests land applying at 17 tons per acre. Will this be O.K.? Test data from the previous land applications were as follows:

Land App #	Sludge Total P	Initial soil P	P after application	Rate
1	35,000 ppm	35 ppm	65 ppm	17 Ton/ac
2	45,000 ppm	60 ppm	101 ppm	16 Ton/ac
3	78,000 ppm	98 ppm	165 ppm	18 Ton/ac

First, calculate the weight of phosphorus applied per acre per each application.
Land App 1 = 17 ton X 2,000 lbs. X 35,000 ppm = 1,190 lbs./acre
Land App 2 = 16 ton X 2,000 lbs. X 45,000 ppm = 1,440 lbs./acre
Land App 3 = 18 ton X 2,000 lbs. X 78,000 ppm = 2,808 lbs./acre

Second, calculate the plant available phosphorus residual left per pound of total phoshorus applied.

Land App 1 = (65-35) ppm ÷ 1,190 lb. per acre applied = 0.0252 ppm/lb.-ac. applied
Land App 2 = (101–60) ppm ÷1,440 lb. per acre applied = 0.0285 ppm/lb.-ac applied
Land App 3 = (165-98) ppm ÷2,808 lb. per acre applied = 0.0239 ppm/lb.-ac applied

Take phosphorus increase rate determined above @ 0.0285 ppm/lb.-ac applied!

Project phosphorus increase on the current proposed land application:
17 ton/ac X 2,000 lb. X 40,000 ppm = 1,360 lbs. per acre total P.
Projected phosphorus increase:
= 1,360 lbs. total P X 0.0285 ppm/lb.-ac applied = 38.76 ppm increase.

Projected phosphorus after land application = 160+38.76 = 198.76

∴ 198.76 < 200 (cutoff), so o.k. to land apply!

Example 2 raises the question about future land application on a parcel that exhibits phosphorus levels near the cutoff. Continued land application of lagoon biosolids on the example parcel would have to be discontinued for a few years until phosphorus levels were reduced. An alfalfa crop

would uptake 35 lbs. per acre, or reduce plant available phosphorus at a rate of 8 ppm per year. Similarly, a corn crop would reduce soil phosphorus by 10 ppm per year. Therefore, after a particular parcel nears the cutoff point, an estimated 4 to 5 year delay would be required before land application on a parcel could be done based at nitrogen uptake rates.

3.2.6 Estimated Land Requirements / Availability

The estimated annual biosolids production shown in Section 2.2 was demonstrated at 17,430 dry tons per year. Based on land applying based on nitrogen uptake rates and application at an average of 17 tons per acre, the required acreage per year is 1,025 acres. The Milford Flat area consists of an estimated 14,000 irrigated acres, while the Beryl/Enterprise areas consist of 25,000 irrigated acres. Crop yields are between 7 and 9 tons of alfalfa per-acre per-year. This demonstrates that there is ample potential acreage for receiving lagoon biosolids.

Taking a hypothetical view, several years into the future, at an instance where all crop parcels in the Milford/Enterprise area were phosphorus limited, an estimated 5-year period would be required between land application events on any parcel to apply at nitrogen based application rates. This would make available approximately 2,800 acres per year to be land applied to in the Milford Flat area and 5,000 acres per year in the Beryl/Enterprise area.

Land application therefore, is a potentially viable option for biosolids utilization. However, it is premature to conclude that agreements can be secured with enough alfalfa growers in the area to receive all of the biosolids produced. Circle Four will begin negotiating agreements with growers to receive the biosolids. The actual scope of disposal by land application will not be determined, nor selected at this time, as economic viability and secured agreements for land application are not completed.

3.2.7 Other Land Application Options. Other potential receiving sites for land application of biosolids include broadcasting onto range land, mining reclamation sites, or at BLM fire-brush re-seeding areas.

For land application at each of these types of sites, the application rate will be calculated similarly as to what is described herein for cropland application. However, it is proposed that in addition to land applying at nitrogen uptake rates, and testing for phosphorus residuals, that an allowance to land apply at twice the projected agronomic nitrogen uptake rates be allowed on a one-time application to any particular parcel. It is likely that both nitrogen and phosphorus levels would be deplete at such sites. Therefore, land application of biosolids would not be detrimental, but rather beneficial, at either one or two times the nitrogen plant uptake rate. If annual disposal requires land application of 17,430 tons in this

manner, assuming an agronomic uptake rate of 75 lbs. per acre per year for a typical BLM seed mix, it would require approximately 5,950 acres of range land, mining reclamation, or BLM re-seeding area.

3.2.8 Protocols Prior to Land Application

3.2.8.a. Biosolids Testing. Candidate disposal lagoons shall have the sludge tested once per every 5,000 cubic yards of material stored. Samples shall be taken from evenly spaced, random locations throughout the lagoon and at varying depths of accumulation. Biosolids shall be tested for ammonia nitrogen, total kjeldahl nitrogen, phosphorus and metals listed in section 3.2.1. The tests shall be averaged for the lagoon. If sludge from a combination of lagoons is to be land applied to the same parcel of land, the biosolids must be mixed and the application rates determined based on weighted-average constituent levels. The land could also be sectioned proportionately to receive solids from each lagoon, section by section based on constituent or residual levels. If biosolids-receiving capability varies in sections of an irrigated parcel, the parcel could be sectioned to receive biosolids at varying application rates.

3.2.8.b. Soil Testing. Candidate parcels to receive biosolids shall be tested for nitrogen once per every 50 acres at random locations on the parcel. Soil in each test location shall be sampled and tested for Nitrogen at 0 to 1 feet, 1 to 2 feet, and 2 to 3 feet. Large parcels may be evaluated for trends in constituent levels to make application rates on a certain section at higher rates if warranted by a demonstrated residual level. Otherwise tests will be averaged for an overall application rate to the parcel. Phosphorus will be similarly tested at the same locations, but only in the top 12-inches of soil.

3.2.8.c. Land Application Plans. Land Application Plans for each event shall be submitted to the DEQ for review and approval prior to land application. Land application plans shall include test results, application rate calculations, identify the parcel to be land applied to, and describe the method and equipment used to dredge, convey, and land apply the solids from the lagoon.

3.2.9 Processing/Temporary Storage

A liquid/solids separation process may be required or implemented prior to land application of biosolids. This will considerably reduce the bulk volume and tonnage of material to be hauled and land applied. Liquid/solids separation process may be done by mechanical means at the time of sludge dredging, or by impoundment in a temporary storage/drying basin.

For mechanical separation, the solids may be loaded directly into trucks at the time of dredging, or may require temporary storage tankage to provide further settlement. Water decanted from tank storage would be conveyed back to the lagoon system. If a very efficient liquid solids separation process is utilized that allows piling of solids material, with a slump test of less than 8-inches, it will be acceptable to temporarily store solids on a flat concrete pad. Such storage would require at least an 8-inch berm constructed of relatively impermeable soils or concrete around the perimeter of the storage pad to prevent runoff due to rainfall.

Liquid/solids separation could also be accomplished in a lined temporary storage/drying basin. This option would provide Circle Four with a buffer in making arrangements for a parcel of land for application of the solids. Solids could be stored in a temporary basin for several years after removal from a primary lagoon. The storage/drying basin will be constructed either adjacent to, or situated centrally between several farms. Temporary storage basins will be constructed in such a manner as to allow re-use of the basin. The basin will be constructed flat with a perimeter embankment height of 7 feet. This will allow for removal and filling of the basin with wet biosolids to a total of 6 feet in height with 12 inches of freeboard. The basin will be lined with either clay, or flexible membrane liner (FML) with a coefficient (K), of hydraulic permeability of no greater than $1X10^{-7}$ cm/sec.

For clay lining of the temporary storage basin, a 1-foot thick layer of clay will be constructed under a 6-inch bed of armor plate gravel. The gravel will protect the integrity of the liner from erosion or desiccation cracking. It will also provide structural support for front-end loading equipment and trucks to enter the basin and remove dried biosolids for transport to land application sites.

Similarly, an FML-lined storage basin will be constructed over a relatively impermeable compacted soil subgrade, 8-inches in thickness. An 8-inch thick silt, sand, or silty sand cover will be constructed over the FML liner, followed by construction of a 6-inch layer of compacted armor plate gravel.

Plans and specifications for construction of the temporary storage basin will be submitted to the DEQ for approval. Plans and specifications will include a site plan, demonstrating the origin site of the biosolids in relation to the storage basin. Dredging method(s), and conveyance equipment to be used to displace biosolids to the drying basin will be specified. The plans and specifications will also include a geotechnical investigation of the basin site. The design will conform to the recommendations contained in the geotechnical report. Construction of the basin will be certified at completion of construction of the basin by an independent engineering consultant.

3.3 Switched Technology / In-Situ Management

This option, although not thoroughly defined, could involve abandonment of the current anaerobic treatment process as the lagoons currently operate. The lagoons could possibly be converted to facultative/aerobic total-containment lagoons if an effective technology could be found to facilitate this. It could be accomplished by intercepting the waste stream as it leaves the hog barns and incorporating a liquid solid separation process prior to discharging to the lagoons. Some research and development in liquid/solids separation processes are developing which may become viable for this application. The solids portion of the waste stream will be contained in tanks, or placed on a drying bed while the liquid portion of the waste stream will be discharged to the lagoon system. The target water quality discharge levels to the lagoons for such a system would be around 300 - 400 mg/L BOD_5. This would allow the lagoon system to be operated as a total containment lagoon, similar to municipal wastewater lagoon systems. Greater efficiencies of liquid solids separation would result in the ponds acting as total containment, evaporative ponds, with little or no treatment provided or needed from the lagoons.

Several potential options exist for the separated solids portion of the waste. It would be beneficial to combine solids streams from several farms to a central location for secondary processing or utilization of the solids. Potential options include, but are not limited to, composting, tank digestion of solids for biogas and power generation, fluidized bed power generation, ethyl alcohol production, and fertilizer or soil amendment production.

If such an option were to be implemented at a time corresponding to sludge accumulation reaching design capacity, removal of biosolids would not necessarily have to be performed at that time. Sludge removal would however, be required at the time of farm closure, or abandonment. To facilitate the lagoon system functioning as a "cleaner liquid" system, lime could be broadcast into the lagoons to aid in solids stabilization, settlement, consolidation, and compaction within in the lagoon.

Implementation of this option will require continued planning, research, and development. The solids/liquid separation process, as well as secondary utilization processes would have to be demonstrated as viable through either an on-site pilot plant, or an existing demonstration plant located anywhere that effectively treats and utilizes solids separated hog manure.

4.0 FARM CLOSURE

This portion of the plan addresses the event of farm closure at an individual farm, or shutdown of all of Circle Four's permitted facilities. Farm closure will require effective disposal of sludge and abandonment of the farm's waste handling facilities. The primary option for sludge disposal for the farm closure scenario is in-situ stabilization and management with final landfill disposal. Harvesting and land application, or harvesting and removal of biosolids for secondary processing or conversion into another beneficial product are other potential options. Descriptively, the options for farm closure sludge disposal are very similar to maintenance options. However, requirements and specifications differ slightly, and are described in this section.

4.0.1 Maximum Disposal Volume. The worst possible case scenario for biosolids disposal would be closure of all farms simultaneously. It is estimated that the maximum total sludge that could be resident in the event of total farm closure would be 75 percent of design storage accumulation volume. Combining Circle Four's 42 existing Skyline farm sites, and 9 existing Blue Mountain farm sites, the total sludge design accumulation volume is 44,000,000 cubic feet. 75 percent of this volume taken at 7 percent solids content results in a maximum disposal of 96,096 dry tons.

4.1 In-Situ Stabilization and Management

In-situ stabilization and management as described herein is a preliminary method of handling the waste prior to final disposal and could be employed for all options contained herein. The initial operation for in-situ stabilization at farm closure would be removal of liquid from the system. This could be done by either land-application of the liquids adjacent to the lagoon sites, or by evaporation.

Land application of lagoon liquids (if feasible) shall be done at nitrogen plant uptake rates as required and provided for in Circle Four's Ground Water Discharge Permits.

Drying by evaporation would involve periodic transfer of water and biosolids to the containment basin at each site. Naturally high evaporation rates in the area will be utilized to dry out the liquid from the lagoons, as well as facilitating final drying of the biosolids. Primary anaerobic lagoons typically contain 25 feet of water, which would require approximately 5 years to dry out if influent flow were to be stopped. However, water can be transferred from the primary pond to the containment basin to provide approximately 1 ½ to 2 times the evaporative capacity. In conjunction with the removal of liquid from the primary pond to the containment basin, water can be pumped from near, or inside the lagoon bottoms to begin sludge transfer to the containment

basin. At, or near the point where most of the lagoon liquids are evaporated, and only wet biosolids remain, a significant transfer of biosolids to the containment basins will commence. The target will be to completely fill the containment basin with wet sludge up to 1 foot of freeboard to allow for stormwater accumulation and wave action. This would be the final pumping operation, or transfer of liquids/solids from the primary lagoon to the containment basin. It is anticipated that final drying of the lagoons and biosolids would be complete within 3 to 4 years of farm closure. Taken at a 50% wet to drying shrinkage volume, the remaining residual sludge layer thickness at the completion of drying would leave approximately 2 to 3 feet of solids in the containment basin, and 4 to 6 feet of solids in the primary lagoon. As biosolids are dried out, implementation of final disposal options can commence.

4.2 Landfill Disposal

Landfill disposal for the farm closure option is near identical to maintenance disposal options. Circle Four has the option to construct new landfill sites, or convert existing primary (and secondary) lagoons into landfill sites as long as said conversion lagoon sites have displayed a history of compliance which suggests an effective liner is in place and will provide effective permanent containment of sludge constituents.

In the event of total farm closure (all of Circle Four's farm sites) drying bed construction may be unnecessary as drying of biosolids could be accomplished as outlined in section 4.1 above. Additionally, because several large primary ponds will be available for conversion to landfill sites it is likely that there may be little need for construction of new landfills, and that the large primary lagoons could receive solids from several sites.

See section 3.1 for a description of requirements of implementing a landfill for biosolids disposal. The requirements shall be the same for design, permitting, implementation, transfer of biosolids, capping, closure, and post closure monitoring.

4.3 Land Application of Closure Biosolids.

Land application shall be based on nutrient uptake rates, and metals content of the biosolids. The requirements for land application for disposal of biosolids in the farm closure scenario is identical to the process described in Section 3.2.

4.4 Biosolids Re-use Options

The potential for harvesting the solids and reusing as an added value type of material for potting soil or fertilizer exists. Should solids be harvested and re-used in secondary products, it will be necessary to notify the DEQ and provide information as to how the material will be stabilized harvested, and transported off site.

4.5 Treatment and Containment Lagoon Abandonment

In the event of farm closure, it will be necessary to properly abandon the lagoons after sludge has been removed. This shall be accomplished by tearing down the liners (FML or Clay) from the sideslopes and laying it out in the bottom of each respective pond. The liner materials will then be covered with soil to a minimum of 2-feet in thickness. The side-slopes of the primary lagoons and containment basins shall be re-constructed at a 4:1 ration (horizontal:vertical) or flatter to provide at least two feet of cover over liner materials. This will provide adequate soil cover and burying of the liner material on primary lagoons, however, on containment basins, it may require import of additional soil into the basin. Built-up dikes shall be excavated down to a level corresponding to the top of the soil cover.

4.6 Other Waste Handling Facilities Abandonment

Farm closure will necessarily require abandonment of other regulated on-farm waste retention and conveyance facilities. The concrete pits under the slatted or grated flooring of the production building would be emptied of waste. The pits would be filled once with fresh water and then once again drained. The pipeline into the lagoon systems will be excavated back to behind the embankment and permanently capped and buried so no further inflow is introduced into the abandoned lagoon area. A drawing of how this is to be accomplished is included in Exhibit D. This plan does not address whether or not the building and it's related flooring would be demolished or left in place. The clean-outs on the waste lines would be excavated and all above ground piping would be removed and disposed. The main trunk lines will be excavated, dis-jointed, and backfilled at the clean-out locations, providing additional assurance that no water or under-draining would occur through the abandoned waste pipes.

4.7 Notification of Closure and Abandonment

In the event a farm or treatment system is to be abandoned, the DEQ shall be notified and a plan shall be submitted as to the selected form of sludge disposal as outlined herein. Detailed information shall be presented in the plan and approval shall be received prior to commencement of the selected closure option.

5.0 SLUDGE MONITORING

Effective, and beginning the fall/winter of 1999, Circle Four will commence a detailed sludge monitoring program. The purpose of the monitoring program will be to monitor accumulation rates, calculate sludge storage capacity remaining, and project future sludge disposal events. In addition, sludge samples will be taken and analyzed for chemical composition. The monitoring will result in an annual report, which shall be submitted to the DEQ by February 1, of each year.

5.1 Monitoring Schedule & Methodology

Sludge accumulation monitoring will begin for each farm after 1 year of the startup of any new farm lagoon system. Accumulation monitoring will be performed at least once annually. Preferred monitoring will occur in late fall. At Circle Four's option, spring monitoring may be done. This will provide data on undigested materials in the lagoon due to the seasonal cooling and digestive inactivity in the treatment ponds. If spring monitoring is done, the data from this monitoring will be included in the annual report. Fall monitoring will provide a comparison of accumulation rates after seasonally high digestion activity during the summer months.

The method used to monitor sludge accumulation shall be as follows. Circle Four shall utilize a row boat to access primary lagoons for measurement. First, the overall depth of the pond shall be measured and recorded using a long staff gauge (30 foot long piece of PVC pipe). This measurement may not need to be repeated if the operating level of pond is at maximum, and the measurement has already been ascertained by this method. The depth to sludge shall also be measured using a sludge-gun or sludge-judge device.

Depths to sludge shall be measured at 5 locations in the treatment pond bottom in a pattern relating to the number 5 shown on playing dice. The depth to sludge measurement shall be subtracted from the overall water depth measurement to determine sludge depths in these locations. The nominal sludge accumulation depth shall be calculated and reported as the average of the calculated depths from the 5 locations.

5.2 Sludge Sampling and Testing

Sludge sampling shall be done at one of each of the three types of farm sites (sow farm, nursery, or finishing). Preferably, this will be done at sites with the least amount of sludge accumulation space (or time) remaining. An attempt will be made to grab samples from differing depths in the sludge layer. The material will be combined, evenly mixed, and placed in two separate containers as representative samples to be tested. Samples

will be tested for phosphorus, nitrate+nitrite, ammonia nitrogen, total kjeldahl nitrogen (TKN), and metals as listed in section 3.2.1.

5.3 Reporting

Results from sludge monitoring shall be combined and reported on a spreadsheet indicating all data obtained. The report shall include columnar data, one column each for the following: farm site, initial site population date, overall liquid depth, sludge depth measurements, average depth, volume of accumulated solids, design storage volume, percentage of design volume taken, and projected sludge capacity/disposal date.

The projected sludge capacity/disposal date shall be preliminarily calculated in linear accumulation rates. As the database increases, the calculation shall be made by linear regression. The data may suggest that a curve may best fit accumulation rates and may be the best method to project at-capacity or disposal dates.

Results of analytical testing shall also be reported.