DEMANDS ON GROWER AND REGULATOR IN USING WASTEWATER

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ABSTRACT

Growing alfalfa may be the most environmentally safe and economical way to dispose of wastewater. However, this practice requires the correct amount of water application and having enough forage production to remove the nitrogen applied in the wastewater.

This practice requires the grower, governmental agency producing the wastewater, and the Regional Boards to play their roles appropriately. Performance criteria for each one of these entities are discussed.

Nebeker Ranch has used reclaimed wastewater for sixteen years to produce premium alfalfa hay to receive top dollar from the market place. In this paper, our experiences are shared to point out pitfalls and making recommendations to assist other growers in identifying the problems and potential of using municipal effluent to irrigate alfalfa.

Unfortunately, a growing number of land applications of wastewater in California and other states have resulted in significant and large scale groundwater contamination and degradation problems. Based on experiences at Nebeker Ranch, the High Desert of northern Los Angeles County and the need for improved regulation of the application of wastewater to land, a rational approach to regulation is presented.

Key Words: recycling, alfalfa, municipal wastewater, management, irrigation, regulation

INTRODUCTION

The State Water Resources Control Board website was surveyed to identify recycling projects that use alfalfa to dispose and utilize municipal wastewater. Cooperative Extension Farm Advisors were then contacted in the regions these operations existed. The conclusion was reached that the number of farming operations in the State that utilize this water to produce top

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quality alfalfa hay in a serious and cost effective manner are rare. Most of these operations focus on effluent disposal to the detriment of the farming needs and environmental requirements.

This paper as well as an earlier paper (Nebeker 2001) discussed the sustainable operation at Nebeker Ranch which focuses on production rather than disposal. Nebeker Ranch is a 680 acre alfalfa ranch in the Antelope Valley region (High-Desert) of Los Angeles County. The area has a reputation for high-quality alfalfa hay. Nebeker Ranch supplies only premium horse and dairy hay (Nebeker 1991). Historically, ground water (freshwater) has been used to irrigate alfalfa since 1919 (85 years). Sixteen years ago, the principal source of irrigation water became municipal effluent.

BACKGROUND

The source of this water is the Lancaster Water Reclamation Plant (Plant) owned and operated by the County Sanitation District No. 14 of Los Angeles County (District). More details of this relationship between Nebeker Ranch, Inc., the District and the community are given in Lambert and Nebeker 1996. This plant treats the municipal wastewater from Lancaster and parts of Palmdale to the secondary level for our operation. A 24-inch diameter pipeline, 6.8 miles in length, was installed from the Plant to Nebeker Ranch. The District pays for the cost of pumping water to the ranch from a pumping station, using two 150 HP pumps. As part of this project, 160 acres of reservoirs were constructed to store water that would have to be disposed of during the winter when agricultural demand for water is minimal. A small amount of water from this plant is treated to the tertiary level and provides water to recreational lakes at a local park called "Apollo Park."

Most of the water that is not used at the ranch is diverted to Piute Ponds, which is a wetland area used by many birds and other wildlife on Edwards Air Force Base. During the first few years of operation, the irrigation needs coupled with the storage ponds and Piute Ponds were able to use all the effluent produced by the District. Unfortunately, due to the significant population growth and the District's failure to develop other disposal options, the plant effluent management capacity has been exceeded. As a result, so much water flows to Piute ponds that its capacity is exceeded and parts of Rosamond Dry Lake are flooded during portions of the year. The presence of water on the lakebed interferes with the Air Force's mission. The Air Force uses this lakebed for certain types of testing and to recover aircraft with in-flight emergencies. Also, the likelihood of bird strikes on aircraft becomes greater when water is on the lakebed. Water on the lakebed increases the risks of damage to costly aircraft and possible loss of life.

From an agricultural perspective, the storage reservoirs and the ability to discharge to Piute Ponds means that the Ranch only takes water from the Plant when it is needed for irrigation. To not be forced to take water when alfalfa plants are not actively growing and absorbing nitrogen is a real benefit of this arrangement.

BENEFITS

Nebeker Ranch, Inc. This alfalfa farming operation saves on the costs of operating and maintaining ground water wells and pumps, saves on the reduced energy costs of moving

effluent from the Plant to the ranch as compared to pumping groundwater, and saves on fertilizer costs (both nitrogen and phosphorous). At the present time, about $60,000 is saved on electrical energy and $25,000 on fertilizer costs per year.

Edwards Air Force Base. Keeping effluent water off Rosamond Dry Lake for portions of the year by irrigating alfalfa at Nebeker Ranch is considered to have national defense significance. When irrigation with effluent began, no effluent was allowed to flow onto Rosamond Dry Lake. In recent years even with increased flows, irrigation with effluent has allowed the District to limit overflows to approximately four months of the year. Approximately 1.3 billion gallons (4000 acre-feet) per year are kept off the Dry Lake by this practice by Nebeker Ranch taking the effluent. Since the project started 16 years ago, about 10 billion gallons have been prevented from flowing to this Dry Lake bed.

Districts. Irrigation of alfalfa by secondary effluent has saved the District at least $1,000,000 per year in avoided treatment and disposal costs, assuming the alternate disposal option would require treatment to the tertiary level. Total savings to the District so far have been about $14 million.

Community. In addition to the benefits received by Edwards Air Force Base and the District, about 4000 acre-feet or 1.3 billion gallons of water per year (or 10 billion gallons since this project began) has been allowed to remain in the groundwater basin for private and municipal pumpers to enjoy. At a water replacement cost of $200 per acre-foot per year, this savings in potable water can be estimated at $800,000 annually.

Society. Also, this large volume of effluent has been disposed of in an environmentally safe way. It is difficult to quantify this benefit. By comparing the amount of nitrogen present in the wastewater Nebeker Ranch has used over these 16 years to that used at another site in the High Desert that now needs to clean up groundwater contaminated by effluent, the value of safely using the wastewater at Nebeker Ranch is estimated to be approximately 60 million dollars.

Although Nebeker Ranch benefits from this relationship, the benefits to the other parties in this may be an order of magnitude greater. Everybody wins.

WHY IS ALFALFA AN EXCELLENT CROP TO GROW WITH EFFLUENT

Effluent Can Be Disposed in a Beneficial, Productive Manner. As discussed above, effluent can be disposed of to produce a crop that has a reasonable market value.

Large Volumes of Water Can Be Disposed. Alfalfa in our area can use about 7 feet of water per year. This amount is usually greater than most other crops. Care must be taken to not over-irrigate because alfalfa is very sensitive to too much water in the root zone.

Nitrogen Needs Are Large. Alfalfa consumes relatively large amounts of nitrogen in every ton of yield (65 lbs. of nitrogen per ton of yield). Also, since the total yield of alfalfa is high, the total nitrogen requirements are great. For instance, if our yield is 8 tons per acre, the nitrogen needs are 520 pounds per acre per year.

All Nitrogen in the Wastewater can be Taken Up by the Alfalfa. For example, if the total nitrogen content of the wastewater is 25 milligrams per liter, 7 feet of wastewater contain about 470 pounds of nitrogen. However, as mentioned in the preceding section, a yield of 8 tons per acre requires 520 pounds of nitrogen. Emphasis is placed on adequate production because an average yield of 7.2 tons per acre will not absorb all the nitrogen.

Nitrogen Scavenging Ability of the Roots. The literature indicates the alfalfa roots are excellent scavengers of nitrogen. Since alfalfa expends less energy to take up nitrogen in the effluent, it will do so first, and then when supplies are depleted, it will use soil rhizobium bacteria to produce nitrogen in its nodules.

Low Level of Treatment. Alfalfa is a real cost saver to the wastewater treatment plant. Since alfalfa can accept undisinfected secondary effluent. The costs of disinfection and tertiary treatment are avoided.

Market is Relatively Stable and Reliable. The alfalfa market is not subject to the extreme swings of the market for other crops. Therefore, the profitability of an alfalfa operation can be predicted with more certainty.

Wildlife Habitat. The perennial nature of alfalfa fields promotes habitat for birds. Eighty-two bird species have been observed at our ranch (San Miguel 2001)

CULTURAL COMPLEXITIES IN USING EFFLUENT

Many growers and University of California Extension specialists feel that using effluent requires a higher level of management than using water from more traditional sources. Our experiences are consistent with this perception. In particular, we have considered:

Increased Alfalfa Stand Establishment Costs. Our experiences and those of other growers indicate some difficulties are experienced when using effluent water to germinate and establish an alfalfa stand. To avoid these problems, we use groundwater (freshwater) to establish a stand.

Increased Weed Problems During Life of the Stand. Using effluent means that the fields are fertilized with nitrogen during every irrigation. Therefore, weed control is more of a problem than using groundwater. Weeds that have been most troublesome are Rescuegrass, Bermuda-grass, Johnsongrass, Common Purslane, Cheeseweed or Malva, Buckhorn Plantain, and Field Bindweed.

Mosquito Problems. We keep “mosquito fish” or *Gambusia affinis* in our tailwater ponds and reservoirs to keep the mosquito problem in check.

Drainage. We have laser leveled all our fields and provide special tailwater return and recovery systems.

Regulatory Concerns. Our irrigators are trained in the regulatory requirements and know how to respond to problems.

FATE AND EFFECTS OF CONSTITUENTS OF CONCERN

Nitrogen species, chloride, phosphorous species, salts, some metals, and some microorganisms such as bacteria and viruses are often found in secondary effluent. Phosphorous is usually not a threat to groundwater because it is retained in surface and subsurface soils by chemical changes and adsorption. Microorganisms and metals are filtered out in the top few feet of the soil.

The nitrogen species are readily converted to nitrate, which is very soluble in the water. Chloride and salts are also very soluble and travel with the water into the soil. The amount of salt in the effluent is similar to the amount in the groundwater in our area so this salt is leached below the root zone similar to most agricultural operations. Chloride is also not a concern because the amount that can be assimilated by the groundwater without causing a problem is very large. Nitrate is the "contaminant" in the effluent that we must manage judiciously. High concentrations of nitrates in potable water supplies have been found to cause methoglobinemia or "blue baby syndrome." Even though nitrate is very soluble, managing application rates with crop needs at expected production rates will preclude problems.

Recent soil tests at Nebeker Ranch for nitrate, phosphate, and heavy metals have confirmed many of these behaviors. Phosphate is confined to the upper foot of soil. Heavy metal concentrations are at the same level (background) as those at raw land in the vicinity of the ranch. Nitrate and phosphate concentrations are high at the soil surface, but become very low at a depth of only three feet.

GROWER CONSIDERATIONS IN USING EFFLUENT

The following considerations must be included in the grower's decision to use wastewater

Efficient Irrigation Required

Crop Production Performance Standard Required

Reclamation Requirements Enforceable by Regional Board Required

Grower must understand nitrogen and water balances and agree to be "environmental steward" of the land and not focus on maximizing profit. Grower must have trust and credibility within the community.

Must deal with municipality or sanitation agency

Must deal with feeling that your land is stigmatized

Must deal with feeling your product may be stigmatized

Must deal with feeling you are overly liable to public

Must deal with feeling you are overly liable to your employees

Must deal with added weed problem

Marketing of product without damaging the local economy (other growers, feed stores, etc.). The use of reclaimed water in regions where irrigation water is scarce or expensive gives the user of reclaimed water an unfair advantage in the market place.

REGIONAL BOARD REGULATORY REQUIREMENTS IN GENERAL

The California Water Code authorizes the California Regional Water Quality Control Boards (Regional Boards) to regulate any discharge of waste that could affect the quality of the waters of the State, both ground and surface. Even though effluent is a valuable resource, the use of reclaimed wastewater constitutes such a discharge. A Regional Board will normally issue permits, termed waste discharge requirements and reclamation requirements, to both the agency treating the wastewater and the grower, respectively.

The waste discharge requirements issued to the agency supplying the wastewater will specify the minimum quality of the treated effluent that can be supplied to the irrigator. These requirements will be based on the proposed use of the effluent. Many of the requirements have been established by the California Department of Health Services and are implemented through the waste discharge requirements. This permit will also require the agency to sample the effluent at regular intervals and to report the results to the Regional Board. The reports are public record and provide assurance to both the grower and the public that the irrigation water has been treated to the appropriate level.

Reclamation requirements are issued to the grower using the treated effluent. These requirements are tailored to the nature of the proposed use. The grower will need to advise the Regional Board in a reclamation report as to the type of crop to be irrigated, type of irrigation method to be used, nature of the site conditions (soil types, depth to groundwater, proximity to surface waters and flood zones, etc.). Typical reclamation requirements may specify: that signs be posted around the farm to indicate reclaimed water is used; that irrigation water be maintained on site; that cross contamination protection devices (prevent wastewater from mixing with potable water) be maintained; that buffer zones be established between irrigation areas and streams, flood zones, wells, etc.; and that the use be limited to agronomic nutrient needs. Further, the reclamation requirements will prohibit the creation of a pollution of waters of the state or nuisance conditions. (Pollution is defined as the alteration of the quality of waters to a degree that unreasonably affects the waters for beneficial uses. Nuisance is defined as something that is injurious to health or is indecent or offensive to the senses so as to interfere with the comfortable enjoyment of life or property, affects an entire community and occurs as a result of disposal of waste.) A grower may be required to perform visual observations of the fields to detect violation of reclamation requirements and to install and regularly sample monitoring wells. Additionally, a grower may be required to maintain records and submit reports on the visual observations and results of well sampling, the areas irrigated, type of crop grown, and

disposition of the crop, and the amount of water used. These reports are public record. Finally, the grower may be charged an annual fee for the reclamation requirements and may be visited by a Regional Board staff member periodically.

The grower is responsible to comply with the reclamation requirements. Any violations of recycled water use permits are subject to enforcement action pursuant to the California Water Code. Enforcement actions normally taken by the Regional Board can vary from verbal notices, formal written notices of noncompliance, cleanup and abatement orders, and cease and desist orders. Violations can subject the grower to monetary penalties. These penalties can be substantial and could be a high as $25,000 per day of each violation.

NEED FOR IMPROVED REGULATION AND OTHER IMPROVEMENTS

The roles of the grower, governmental agency disposing of the wastewater, and the Regional Boards should be played appropriately for this practice to be beneficial to them and the community. In the last few years, disturbing trends have emerged. Some isolated, but not uncommon examples are described along with suggestions for improvement..

Grower

Some examples of past behavior

The grower does not understand the importance of irrigation system design and irrigation management. "The more water the better."

The grower does not understand nitrogen balances and nutrient management. "The more fertilizer the better"

The grower does not understand he/she must be an environmental steward, not simply maximize profits.

What is needed

An understanding of irrigation management, nutrient management, and willingness and capability of being an "environmental steward.

Government Agency Disposing of Wastewater

Some examples of past behavior

Contaminated extensive areas of groundwater by improper land application of wastewater.

These agencies have been warned for more than a decade that their disposal practices were inappropriate.

Excluded experienced and knowledgeable individuals on farming practices with wastewater.

Public distrusts some of these agencies. Public believes that representatives of these agencies lie and misrepresent issues to them. Public believes that representatives of these agencies lie and misrepresent issues to the Regional Board in written communications and oral testimony.

Some repeatedly attempt to intimidate Board Members of the Regional Board and their staff and cloud and stall issues in a disingenuous manner.

Managing Boards of these agencies perform no oversight or control of their activities.

Instead of accepting the blame for inappropriate disposal practices, some of these agencies sought to blame others including growers for groundwater and other problems. As a result, growers are exceedingly reluctant to enter into a relationship with these agencies.

Instead of considering farming with wastewater as a difficult and demanding activity that requires experience and a demonstrated track record of the grower, these agencies often develop relationships with anyone who can demonstrate "they can sit upright on a tractor."

Consequences

Public confidence in these agencies is non-existent.

State wide effort is underway to prohibit these agencies from participating in farming operations. The community views these agencies as untrustworthy and environmentally dangerous.

What is needed

Managing Boards of these entities need to become knowledgeable about the agencies activities and take control and give direction.

Provide motive and incentive to the agency to understand and follow proper farming procedures and practices.

Provide motive and incentive to the agency to protect the environment and fulfill the needs of the community.

Outreach to the public.

Develop relationships with growers that have demonstrated the appropriate knowledge, experience and integrity that inspires public confidence.

Regional Board

Past behavior

Not understanding the threat to environment of improper land application and disposal practices.

What is needed

A rational approach to regulation that provides appropriate opportunities to the grower, assures public confidence, and protects the environment.

AGRICULTURAL WASTEWATER REGULATION

In light of the above pattern of past performance, the challenge of rational and equitable regulation is demanding.

Global Objectives

Prevent over irrigation from causing deep percolation of wastewater into the soil profile or groundwater.
Be sure the agricultural production uses up all the nitrogen in the wastewater and eventually removes it from the site

Specific Objectives

Irrigation

The gross irrigation requirement of a crop = evapotranspiration requirement of the crop + water not applied for crop growth but results from irrigation system inefficiency.

This water in excess of the evapotranspiration is considered to be dissipated by deep percolation through the soil, ponding, and runoff from the field. The objective is to use an efficient irrigation system that will minimize the amount of this excess water that might result in deep percolation. In practice, irrigation efficiencies usually vary between 65 to 90%.

Evapotranspiration can be calculated every month throughout the year from references such as Goldhamer & Snyder 1989 using an average crop coefficient for alfalfa such as 0.95.

Nutrients

The main groundwater contaminant of concern is nitrogen because its MCL (Maximum Contaminant Level is the maximum amount of the contaminant allowed in a public water supply) is relatively low and easily exceeded and the most common form of nitrogen, namely nitrate, is easily transported through the soil.

Based upon the amount of irrigation water that is applied to a field each year and the average nitrogen content of the water and other sources of nitrogen, the amount of nitrogen that must be removed by the crop to take up this nitrogen can be calculated. The calculation should be based on that portion of the crop that is removed from the site. As an example, for alfalfa hay, the entire plant is removed. For a grain crop, just the grain kernels are taken.

Present Regulations

The following are excerpts taken from a Monitoring and Reporting Program issued by the Lahontan Regional Board.

Groundwater Monitoring

Groundwater samples are to be obtained from the upper 5 feet of monitoring wells. Supply wells are to be sampled from the uppermost portion of the aquifer, to the maximum extent possible.

Vadose Zone Monitoring

Soil pore-fluid samples should be collected from lysimeters. The Regional Board Staff must approve location, installation procedures, monitoring protocols and methods to measure soil pore moisture.

Effluent Management Site Monitoring

1. An Annual Cropping Plan shall be submitted on November 15 of each year containing, but not limited to:
    a. Names, addresses and telephone numbers of all secondary users of reclaimed wastewater at the Effluent Management Site.
    b. For each field, provide the following information:
        i. Location using a US Geological Survey 7.5 minute topographic quadrangle map.
        ii. Acreage
        iii. Crop names and types ((i.e. fodder, seed or other)
        iv. Approximate planting dates.
        v. Approximate harvest dates.
        vi. Irrigation method.
        vii. Volume of water expected to be used based on crop needs (irrigation efficiency, evapotranspiration and need for maintenance leaching). Provide basis for calculations including field data or references.
        viii. Amount of nitrogen expected to be applied to the crop from all sources including estimates of nitrogen available in the root zone.
        ix. Amount of nitrogen expected in the harvested crop per harvest and total amount expected to be removed for the field per year.
        x. Describe the fate of nitrogen that has been applied or is available in the root zone that is not accounted for in the crops harvested.

2. The following shall be reported in the Effluent Management Site Monitoring Report on a quarterly basis.
    a. Monthly analysis and summary, by a certified soil scientist or qualified agronomist, of the amount of water and nitrogen applied or is available to the crops per irrigated field. The analysis must compare the actual water and nitrogen applications to those predicted in the Annual Cropping Plan and discuss any significant differences. Additionally, this monthly report must include an evaluation of the actual crop production (percent germination, growth status) to that projected in the Annual Cropping Plan at harvest.
    b. For each harvest completed during the quarter, the report must include the total amount of nitrogen harvested based on the results of site-specific plant tissue analysis. Conservative estimates of the amount of nitrogen may be used in lieu of site-specific plant tissue analysis provided the estimate is justified by literature references. The production from the field may be determined by multiplying the number of bales by an average bale weight. The results of this calculation must be compared to the total amount of nitrogen applied to the crop from all sources (wastewater, other water, and fertilizer) or available during production. Any significant differences must be addressed in the context of this crop and any modifications needed to the overall Farm Management Plan of Annual Cropping Plan.

c. Recycled water balance for the quarter and the crop cycle including: the amount of water applied to each field, water losses due to irrigation inefficiency, evapotransporation, and the amount of water in storage in the vadose zone or available for percolation below the root zone. These values must be compared to the values proposed in the Annual Cropping Plan and any significant differences must be addressed. If recycled water is blended with non-recycled water to meet the increased water demand during warmer seasons, the quantity and percentage of recycled water and the total water applied shall be determined and reported. Nitrogen content of non-recycled water shall also be determined and reported.

d. Information that demonstrates that all recycled water applied complied with the State Department of Health services water recycling requirements specified in the Waster Discharge Permit. The information should include verification that the level of treatment required for water recycling was achieved and that the methods of recycled water application were implemented as required.

3. The Discharger shall report the status of compliance with its health and safety plan requirements especially if using undisinfected reclaimed water.

4. An Effluent Management Site Operations Report shall be reported quarterly, maintained onsite, and made available for inspection by Board staff.

CONCLUSIONS AND RECOMMENDATIONS

Wastewater is a valuable resource. Growing alfalfa may be the best way to utilize this resource in a way that is environmentally safe and economical. However, the grower, government agency that produces this wastewater and the Regional Boards must play their roles appropriately. To attain these goals, the following management practices should be implemented.

Education Program. A program discussing the attributes and problems of using recycled water would be useful in having more growers accept this practice.

Practical Guidance Manual for the Proper Use of Wastewater. This manual should more fully discuss and analyze the subjects mentioned above. If someone desires to use, dispose of, or regulate wastewater for irrigation, detailed information should be available to guide their efforts.

Improved Regulation. A rational approach should be established to protect the environment in a way that should not be onerous and is acceptable to the grower.

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