CALIFORNIA REGIONAL WATER QUALITY CONTROL BOARD
LAHONTAN REGION

MEETING OF APRIL 13 AND 14, 2005

LANCASTER, CA

ITEM NO. **8**

SUBJECT: **EVALUATION OF ALTERNATIVES TO CLEANUP NITRATES IN GROUNDWATER IN PALMDALE RESULTING FROM DISCHARGES OF RECYCLED WATER BY LOS ANGELES COUNTY SANITATION DISTRICT NO. 20 AND THE CITY OF LOS ANGELES WORLD AIRPORTS**

CHRONOLOGY: November 12, 2003 Cleanup and Abatement Order Adopted

ISSUES: Should the Regional Board establish an ultimate cleanup standard at this time?

Is it appropriate to accept a cleanup strategy that results in exacerbating the current groundwater overdraft condition?

DISCUSSION: Cleanup and Abatement Order No. R6V-2003-056 requires the District and the City to cleanup a groundwater nitrate plume. The Dischargers propose to install five groundwater extraction wells that will be pumped for over twenty years. Extracted groundwater would be used to irrigate agricultural fields that were developed to dispose of the effluent from the Palmdale wastewater treatment plant. This action would result in reducing groundwater concentrations of nitrogen to below the drinking water standard of 10 mg/L by mid 2010. At the end of 20 years, this action would result in achieving background nitrogen concentrations (2 mg/l) over much of the aquifer. However, there would still be pockets of groundwater degraded to levels of between 5 and 9 mg/l. The enclosed Staff Report provides a more detailed evaluation of the proposed alternatives.

The short-term use of the pumped groundwater provides combined benefits of restoring the beneficial uses of the groundwater and providing the District with more acres in production for agronomic application of effluent generated from its wastewater treatment facility. Having more acreage minimizes the amount of wastewater that the District will need to dispose of above agronomic rates or land spread (activities that contributed to the groundwater pollution problem). However, once the District completes construction of its currently contemplated new facilities (specifically storage ponds), it will not need this pumped groundwater to maintain the necessary agricultural acreage for wastewater disposal. At that time, the disposal of this pumped groundwater on agricultural land created specifically for this purpose may not be the highest and best use of this water, especially since the aquifer is currently in an overdraft condition. The Proposed Resolution finds that while it is premature to establish a final cleanup

standard at this time, it is appropriate to immediately implement a project that eliminates the condition of pollution. Furthermore, it describes the information that the Regional Board expects the Dischargers to develop before a cleanup standard could be established.

If the Regional Board adopts the resolution as proposed or with amendments, it is the intent of the Executive Officer to issue an amended cleanup and abatement order specifying tasks and schedules consistent with the resolution.

RECOMMEND-ATION: Adoption of the Resolution as proposed.

Enclosures:

1. Proposed Resolution
2. Staff Report

Public/Board Orders 2005/LACSD res gs for item 8 4-1-08 rsd.DOC

CALIFORNIA REGIONAL WATER QUALITY CONTROL BOARD
LAHONTAN REGION

RESOLUTION NO. R6V-2005-(PROPOSED)
WDID NO. 6B190107069

RESPONSE TO THE CLEANUP STRATEGIES SUBMITTED BY THE LOS ANGELES COUNTY SANITATION DISTRICT NO. 20 AND THE CITY OF LOS ANGELES WORLD AIRPORTS TO ADDRESS NITRATES IN GROUNDWATER IN PALMDALE

Los Angeles County

The California Regional Water Quality Control Board, Lahontan Region, (Regional Board) finds:

1. The Los Angeles County Sanitation District No. 20 (District) owns and operates the Palmdale Water Reclamation Plant. The District disposes of effluent on land owned by the City of Los Angeles World Airports. Both entities are hereinafter referred to as "Dischargers" and are responsible for compliance with waste discharge requirements contained in Board Order No. 6-00-57.

2. Effluent discharged from the Water Reclamation Plant has caused a condition of pollution of the groundwater in violation of Board Order No. 6-00-57. The Regional Board adopted Cleanup and Abatement Order No. R6V-2003-056 (CAO) requiring the Dischargers to delineate the nitrate plume to background nitrate levels and to propose and implement a containment and remediation project.

3. On September 15, 2004 the Dischargers submitted a *Containment and Remediation Plan* in response to requirements of the CAO. The Plan evaluated four alternative methods to clean up the groundwater. Additionally, in response to a request by Regional Board staff, on March 1, 2005 the dischargers submitted a *Supplement to the Containment and Remediation Plan* that included an evaluation of a fifth alternative.

4. The United States Geological Survey (USGS) Water Resources Investigations Report 03-4016 entitled "*Simulation of Groundwater Flow and Land Subsidence, Antelope Valley Groundwater Basin, California*" concludes that groundwater pumping in the Antelope Valley exceeds natural recharge causing the aquifer to be in an overdraft condition.

5. Pursuant to California Water Code 13304 and State Water Resources Control Board Resolution No. 92-49, the Regional Board can establish standards for the cleanup of the groundwater. The goal of any cleanup effort must be to restore the quality of the groundwater to background conditions. However, the Regional Board may establish a cleanup standard that is above background levels provided that the standard is fully protective of beneficial uses and provided that the Regional Board finds that allowing some level of degradation is consistent with the maximum benefit to the people of the State.

6. The first of the five alternatives evaluated considered by the dischargers is a "no action" alternative. The other four alternatives developed by the dischargers involve pumping out the polluted groundwater using anywhere from 5 to 25 extraction wells, depending on the particular alternative. The Dischargers developed alternatives 2 through 5 that are all similar, but differ in the particular way each would accelerate the clean up and dispose of the pumped, degraded (or polluted) groundwater. These four alternative approaches, or "strategies", to clean up the groundwater are referred to here as: (2) hot-spot cleanup; (3) limited containment – limited hot-spot; (4) aggressive remediation; and (5) focused hot-spot removal.

7. The Regional Board staff evaluation of these alternatives is contained in a report dated March 30, 2005, entitled "*Evaluation of Alternatives to Cleanup Nitrates in Groundwater*

in Palmdale Resulting from Discharges of Recycled Water by Los Angeles County Sanitation District No. 20 and the City of Los Angeles World Airports" and an addendum to the report.

8. All five of the alternatives would result in reduction in groundwater concentrations of nitrogen to below the drinking water standard of 10 mg/l between 2009 and 2012. This would restore the municipal beneficial use of the groundwater. However, this level of cleanup would not restore the groundwater quality to background conditions, which is a goal of any cleanup as described in Finding No. 4.

9. Alternatives 2, 3, and 5 each would involve disposal of the pumped groundwater at the agricultural irrigation area (effluent disposal area), in the same area that was created for disposal of new wastewater from the District's treatment facility. In the short term, adding the pumped groundwater for irrigation at the agricultural area allows the District to maintain more acreage in production. Having more acreage in production gives the District the ability to apply more wastewater at agronomic rates during the spring, fall and winter seasons when water needs are less than peak summer needs. Maintaining more acreage in production results in less wastewater being spread to land or applied to crops at a rate greater than agronomic rates, actions that may increase the groundwater pollution problem.

8. The District's current wastewater facilities plan is likely to include storage facilities. These storage facilities will allow the District to maintain a minimum amount of acreage in agricultural production to meet its effluent disposal needs. The District will have the ability to store effluent when agronomic water demands are low and use the stored effluent when agronomic needs are high, without relying on another source of water during these peak demand times.

10. Alternative 4 would return approximately 80% of the pumped groundwater to the aquifer after treatment. However, this alternative would still result in the consumptive use of approximately 20,000 acre-feet of groundwater (that lost in the treatment process), an amount equivalent to the amount of groundwater extracted in other more efficient alternatives. While this alternative removes the largest mass of nitrogen from the groundwater, it accomplishes this at a very high cost per pound of mass removed. Additionally, the total cost to implement this alternative is six times the cost of the next most expensive alternative.

11. The application of pumped groundwater to the effluent disposal area (as contemplated in alternatives 2, 3 or 5) in the short term will provide combined benefits. It will remediate the polluted groundwater while also providing additional water to allow the District to maintain more cropland need to provide nitrogen uptake of the District's wastewater effluent until the District implements its facilities plan. However, once this facilities plan is implemented, the Regional Board is concerned that, given the overdraft situation in the area, additional disposal of pumped groundwater in this manner (consumptive use established specifically for disposal of this water) may not be the highest and best use of this pumped groundwater considering the current overdraft condition. In the long run, there may be other disposal options for this pumped groundwater (e.g. substituting existing consumptive uses with this pumped groundwater) that would not result in exacerbating the overdraft condition, while still achieving groundwater cleanup consistent with State policies. At this time, the Regional Board has no information on the feasibility or cost associated with these options since the Dischargers did not evaluate them.

12. It is premature to establish a cleanup standard consistent with State policies given the rather limited range of alternatives proposed, the costs, and the possible consumptive use of pumped groundwater associated with the alternatives considered by the Dischargers. The Regional Board expects the dischargers to evaluate additional options for more suitable

disposal of the pumped groundwater that will not contribute to the overdraft situation before it establishes a final cleanup standard.

13. The available information justifies the need to immediately implement efforts to reduce the levels of nitrogen in groundwater to meet the drinking water standard.

THEREFORE BE IT RESOLVED:

A. As soon as possible, the Dischargers should initiate a cleanup project to reduce nitrate concentrations in groundwater to less than 10 mg/L (as N) in the shortest possible time. The Regional Board does not, at this time, accept a level that is just below the drinking water standard to be an acceptable final cleanup standard.

B. The Dischargers must evaluate additional options for the remediation of the degraded groundwater that will remain after the actions described in A. above are complete. The options should focus on reducing nitrate concentrations in affected groundwater to background levels (approximately 2 mg/L nitrate – as N) or to levels consistent with State cleanup policies (State Water Resources Control Board Resolution 92-49). Furthermore, these options should consider uses of the pumped groundwater that do not exacerbate the overdraft condition. The Dischargers should submit this evaluation within 12 months of the date of adoption of this resolution; thereby allowing sufficient time to establish a final cleanup standard, and implementation of any additional actions by 2009, the time when the facilities plan referred to in Finding No. 8 should be implemented.

I, Harold J. Singer, Executive Officer, do hereby certify that the foregoing is a full, true, and correct copy of a Resolution adopted by the California Regional Water Quality Control Board, Lahontan Region, on April 13, 2005.

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HAROLD J. SINGER
EXECUTIVE OFFICER

California Regional Water Quality Control Board, Lahontan Region

Staff Report

Evaluation of Alternatives to Cleanup Nitrates in Groundwater in Palmdale Resulting from Discharges of Recycled Water by Los Angeles County Sanitation District No. 20 and the City of Los Angeles World Airports

March 30, 2005

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I. Introduction

On November 12, 2003, the Regional Water Quality Control Board adopted a Cleanup and Abatement Order No. R6V-2003-056. It required the Los Angeles County Sanitation District No. 20 (District) and the Los Angeles World Airports (LAWA), hereafter referred to as the "Dischargers", to prepare a plan to achieve plume containment and to implement the plan and remediate the nitrate groundwater pollution created by the improper management of recycled wastewater discharged from the Palmdale Water Reclamation Plant. The Cleanup and Abatement Order required the Dischargers to achieve plume containment by September 30, 2005. The Dischargers investigated five alternative projects and recommended one for implementation. Regional Board staff's evaluation of each alternative is presented in this Staff Report along with a recommendation.

This Staff Report has been prepared in advance of the Regional Board's consideration of several issues at its next regular meeting scheduled for April 13-14, 2005 in Lancaster. The main issues before the Board at that time will be:

- Is the nitrate plume sufficiently delineated?
- Would the project alternative proposed complete the cleanup in an acceptable time frame?
- Are the projected cleanup levels (concentrations remaining in the groundwater after completion of the cleanup) appropriate?

II. Policies and Guidelines Pertaining to Cleanup Standards

The primary policy and guidance document that pertains to the cleanup of groundwater is the State Water Resources Control Board's **Resolution 92-49 (*Policies and Procedures for Investigation and Cleanup and Abatement of Discharges Under Water Code Section 13304*).**

The Resolution establishes the basis for determining cleanup levels of waters of the State. Dischargers are required to clean up and abate the effects of discharges "in a manner that promotes attainment of either background water quality, or the best water quality which is reasonable if background levels of water quality cannot be restored, . . ." Alternative cleanup levels less stringent than background must, among other things, not unreasonably affect present and anticipated beneficial uses of waters of the State. The Resolution also includes procedures to investigate the nature and horizontal and vertical extent of a discharge and procedures to determine appropriate cleanup and abatement measures.

A cleanup level less stringent than background, but which still meets numerical standards protective of beneficial uses, is considered water quality "degradation". The State Water Resources Control Board's (State Board), **Resolution 68-16 (*Statement of Policy with Respect to Maintaining High Quality of Waters in California*)** provides direction for maintaining existing high quality waters and specifies conditions under which degradation can be allowed. This resolution and its direction are referenced in Resolution 92-49.

Pursuant to Resolution 68-16, cleanup levels other than to background (e.g. allowing some degradation) still must:

1. Be consistent with the maximum benefit to the people of the state;
2. Not unreasonably affect present and anticipated beneficial uses of such water; and
3. Not result in water quality less than that prescribed in the Water Quality Control Plans and Policies adopted by the State and Regional Water Boards.

A Water Quality Degradation Analysis is the technical report where these evaluations are made. **Resolution 92-49** also requires that consideration be given to the factors specified in **Title 23, Section 2550.4, California Code of Regulations** in establishing a cleanup level less stringent than background. To consider a cleanup level above background, the Regional Board must first find that it is technologically or economically infeasible to achieve background levels. Factors that must be considered include hydrogeologic characteristics, groundwater quantity and direction of flow, proximity and withdrawal rates of groundwater users, current and potential uses of groundwater and health risks to humans.

The ***Water Quality Control Plan for the Lahontan Region*** **(Basin Plan)** has assigned the following beneficial uses for the groundwater quality of the Lancaster Subbasin: municipal (MUN), agricultural (AGR), industrial (IND), and freshwater replenishment (FRSH). The water quality objective contained in the Basin Plan for the MUN use with respect to nitrate is 10 mg/L (as N).

The Cleanup and Abatement Order requires the Discharger's Containment and Remediation Plan to describe how compliance will be achieved with State Board Resolutions 92-49 and 68-16.

III. Description of Palmdale Water Reclamation Plant

The Palmdale Water Reclamation Plant, oxidation ponds, and Effluent Management Site are located east of the City of Palmdale within the Antelope Valley Groundwater Basin. The treatment and disposal facilities are operated under Waste Discharge Requirements issued by the Regional Board to both Dischargers: the District, as plant owner and operator with day-to-day oversight of disposal operations, and LAWA, as landowner of the disposal site. The Palmdale Water Reclamation Plant is designed to treat and dispose of an average of 15 million gallons per day (mgd). The current average flow is 9.4 mgd[1]. Following primary treatment (sedimentation), wastewater receives secondary-level treatment in unlined biological oxidation and stabilization ponds[2]. After treatment, effluent is disinfected by chlorination. The wastewater ponds are located at the 30th St. and 40th St. East facilities northeast of the City of Palmdale and west of Little Rock Wash. (**Figure 1**). Anerobically digested sludge is currently hauled offsite to District-owned farmland in the Central Valley (Kern County) for use as soil amendment. The District has 25 acres of wastewater ponds at the 30th St. site and 119 acres of wastewater ponds at the 40th St. location, for a total of 144 acres of wastewater ponds.

The District leases 2,680 acres of LAWA property for its wastewater disposal. This area is referred to as the Effluent Management Site. Historically, the Dischargers have disposed of the wastewater primarily by land spreading[3]. While agricultural irrigation has always been used to dispose of a portion of the effluent during the summer, in recent years the Dischargers have been converting more of the leased

[1] 2004 Annual Monitoring Report
[2] The facility has unlined secondary oxidation stabilization ponds that allow for some percolation to underlying groundwater.
[3] The District's term used to describe its practice of discharging effluent to the ground and letting it percolate and evaporate

property to farming using recycled effluent for crop irrigation. Land spreading occurred primarily on the south ½ (320 acres) of Section 9 and the southwest ¼ (160 acres) of Section 10. For the last three years, there has been about 1,800 million gallons per year (4.9 mgd) of effluent land spread. Some effluent is also lost through percolation from the wastewater ponds. The general location of the Palmdale Water Reclamation Plant and Effluent Management Site are shown on **Figure 2.** The plant is not designed for nitrogen removal. In 2004, the effluent contained an average total nitrogen concentration of 35 mg/L[4].

IV. Groundwater Pollution Resulting from Percolation of Effluent

Data show that nitrate levels in groundwater beneath the effluent disposal areas and wastewater ponds exceed the primary drinking water standard (also referred to as the drinking water Maximum Contaminant Level, or "MCL") of 10 mg/L as N. Because groundwater in the Antelope Valley is designated for a MUN use, any waste discharge that causes the groundwater to contain concentrations of constituents exceeding the drinking water standards, has, by definition, polluted the groundwater.

The actual time when groundwater pollution began is unknown because monitoring wells were not installed until after land spreading began. The closest monitoring wells down gradient of the Effluent Management Site are MW-4 (installed in 1989) and MW-20 (installed in 2002). These well locations are shown in **Figures 2 & 5**. Monitoring well MW-18 is located on the east side of the nitrate plume in Section 11 near Little Rock Wash. Beneath the land spreading areas, a groundwater mound has been created and is moving laterally outward and to the north/northwest in the direction of regional groundwater flow. Groundwater monitoring data for nitrate in wells MW-4, MW-18 and MW-20 are shown in **Figure 3** and indicate that concentrations of nitrate above 10 mg/L were documented. Quarterly monitoring data of nitrate from well MW-4 from 1989 to 1995 ranged from 8 to 13 mg/L. Almost all of the nitrate data after early 1991 exceeded 10 mg/L until 1995 in that well. Today, the highest nitrate concentration detected in the plume is 14.20 mg/L, found in well MW-20.

Until the 1970's, there were numerous small private farms in the vicinity of the Effluent Management Site until LAWA purchased land for a future Palmdale Airport. These small farms and the current irrigated agriculture operations (both those operated by the Dischargers and other adjacent farming operations) may have contributed nitrate to groundwater. The extent to which these sources (other than the disposal of wastewater by land spreading) have contributed to the nitrate plume is unknown. The District continues groundwater and geochemical studies to determine if there are sources of nitrate other than effluent disposal that have contributed to the plume.

V. Site Hydrogeology

The vadose zone beneath the land disposal application areas and agricultural reuse areas consist of approximately 300 feet of sediments made up of sands and gravels with interbedded silts and clays. The vadose zone is located over the Lancaster Subbasin; one of 12 subbasins in the Antelope Valley Groundwater Basin. Groundwater flow typically parallels Little Rock Wash that is adjacent (east) of the Effluent Management Site. Little Rock wash provides a major source of natural recharge to the underlying aquifer from the San Gabriel Mountains to the south. The natural recharge is highly variable. The Lancaster Subbasin is a stratified aquifer system comprised of a Principal Aquifer separated from a Deep Aquifer by a thick lacustrine clay (**Figure 4**). Only the Principal Aquifer has been impacted with nitrate. The Deep Aquifer is further divided into two zones referred to as the Middle Aquifer and Lower Aquifer.

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[4] Measured as total kjeldahl nitrogen, Table 3.8, 2004 Annual Report

Depth to groundwater below the disposal areas ranges from 250 to 500 feet below ground surface (bgs). The depth to water beneath Section 9 is generally 300 feet bgs. Regional groundwater flow is typically to the north/northwest towards Rogers Dry Lakes, which are the lowest topographical points in the Antelope Valley Groundwater Basin. As previously stated, effluent disposal practices have created a groundwater mound in the Principal Aquifer below the disposal areas. Local groundwater flow has been altered towards groundwater cones of depression formed by agricultural and municipal pumping wells. The nearest municipal drinking water wells are located at Air Force Plant 42, down gradient (northwest) of the groundwater mound and in the Palmdale Water District well field down gradient (southwest) of the ponds and Effluent Management Site. The Palmdale Water District wells may be separated from the nitrate plume by lower permeability soils. There are also a number of agricultural supply wells located within the area of the nitrate plume. These wells are in production primarily during the summer growing season. Data indicate that the agricultural well SW-10 has nitrate concentrations greater than 10 mg/L. Another agricultural supply well, SW-7, has increasing nitrate concentrations, but less than 10 mg/L. Both wells are located adjacent to the land spreading area.

Horizontal conductivity varies over the site due to soil heterogeneity. The District has recently conducted a single well pump test and a series of single well tracer tests. The District is using the results of these tests to update its computer groundwater model to better predict the nitrate plume geometry and optimize the number and placement of extraction wells for a cleanup remedy.

The United States Geological Survey (USGS) has estimated that groundwater pumping in the Antelope Valley exceeds natural recharge. For the period 1991 to 1995, representative of current conditions, the estimated groundwater recharge is 30,300 acre-feet per year and pumping averaged 81,700 acre feet per year.[5] Continued pumping of groundwater in excess of natural recharge amounts leads to overdraft conditions. In the future, policy makers in the Antelope Valley may be facing decisions regarding: 1) allocating existing groundwater resources between users, 2) defining appropriate water uses that do not lead to waste and unreasonable use, and 3) economic and environmental considerations regarding importing additional State Water Project to supply a growing water demand. Uses of treated wastewater effluent may be a factor in these decisions. In 1995, the USGS estimated that 7,500 acre-feet per year of wastewater from the Palmdale Water Reclamation Plant potentially infiltrated to the aquifer. While wastewater flows have increased since that time due to urban growth, the Dischargers have shifted effluent disposal to greater recycled water uses for crop irrigation. Thus, recharge from the facility has likely decreased. In addition, while recycled water used for crop irrigation may be a beneficial use, the Dischargers have not replaced any existing pumping of groundwater for irrigation with recycled water. Therefore, it has created a new consumptive use of water to irrigate crops not previously grown.

VI. Description of Nitrate Plume

Nitrate plume delineation was performed in the summer of 2004 by: 1) evaluating historical groundwater data from existing municipal, agricultural and monitoring wells, 2) installing 20 exploratory borings and collecting both soil and groundwater data, 3) constructing nine additional monitoring wells and 4) installing a test extraction well and performing a pump test. As a result, the nitrate plume is generally delineated (both vertically and laterally) to a nitrate concentration of about 2 mg/L. Two areas that require delineation remain: 1) down gradient of the plume towards Air Force Plant 42 and 2) adjacent to the wastewater ponds. The District intends to complete groundwater delineation adjacent to the wastewater ponds as the cleanup project is implemented and new wastewater ponds are

[5] USGS Water Resources Investigations Report 03-4016, Simulation of Groundwater Flow and Land Subsidence, Antelope Valley Groundwater Basin, California

constructed to store winter flow. The Dischargers have sufficiently delineated the plume to proceed with developing the Containment and Remediation alternatives.

Historical background nitrate concentrations are less than 1-2 mg/L. The area of groundwater that is degraded by nitrate (greater than 2 mg/L) is a plume of about ten square miles (**Figure 4**). Elevated nitrate concentrations are present in the upper 150 feet of the aquifer. Using an assumed soil porosity of 20%, the District estimates the volume of groundwater affected by the nitrate plume to be 190,000 acre-feet[6]. This volume represents the affected volume of groundwater within the estimated 2 mg/L nitrate iso-contour line and in soil pore water. The District also estimates that the volume of groundwater containing greater than 10 mg/L of nitrate (over the drinking water standard) to be about 21,000 acre-foot.

Primarily due to land spreading of effluent, an area of polluted groundwater (nitrate greater than 10 mg/L) is about four square miles in extent at the water table. Conditions of pollution are generally limited to the upper 50 feet of the saturated zone, except near agricultural pumping wells adjacent to the nitrate plume that may be drawing polluted groundwater deeper into the aquifer. Conditions of degradation are generally limited to the upper 150 feet of the saturated zone. For illustrative purposes, using the above assumptions and assuming that nitrate concentrations are evenly distributed within the plume, there is about 1,700 tons of nitrate present in the affected groundwater (**Attachment 1**). Of the 1,700 tons total, 1,200 tons represents the amount of nitrate that is above background.

VII. Summary of Containment and Remediation Alternatives

On September 15, 2004, the Dischargers initially submitted their *Containment and Remediation Plan* that described an analysis of four alternatives to contain and cleanup the groundwater nitrate plume. Following a December 21, 2004 meeting between Regional Board staff and the Dischargers a fifth alternative was proposed to provide a more aggressive “hot spot” remedial approach. The Dischargers submitted the fifth alternative on March 1, 2005.

The Dischargers have evaluated applicable remedial and containment technologies and determined that the most applicable technology to meet project objectives and regulatory compliance was removal of nitrate-contaminated groundwater using groundwater extraction wells. The extracted water would be used to irrigate crops that would provide nitrogen removal through crop uptake. A summary of each of the five alternatives is discussed below and provided in **Table 1**. A computer groundwater model was used to evaluate the long-term results of each alternative at increments out to year 2025 (20 years).

Alternative 1

Alternative 1 is essentially the base case or “No action” scenario. It assumes that the extraction of groundwater from the seven existing agricultural wells will continue. This alternative also evaluates the effects of implementing previously proposed actions to eliminate the continued discharge of nitrogen through land spreading and the effects of existing agricultural pumping. Although the District has not yet proposed a nitrogen treatment standard for the new treatment plant, assumptions were made in the model that new storage ponds would not leak and all effluent would be applied to crops at agronomic rates. To compensate for irrigation inefficiency, the modelers assumed that 25% more water than crop demand was applied during the growing season. These actions are common to all alternatives. The major common element is the

[6] One acre-foot is about 325,000 gallons

implementation of the projects proposed in the Abatement Report[7]. These will be primarily: 1) expansion of the agricultural re-use area to utilize more effluent for crop irrigation between now and 2009 and 2) treatment plant upgrades for nitrogen removal and the construction of winter storage ponds. By fall 2009, over 500 acres of new storage reservoirs will be constructed to retain winter effluent flow that will be applied the following spring/summer to crops at agronomic rates. However, some nitrate removal is provided through the continued operation of existing agricultural pumping wells. For each alternative, natural attenuation (dilution through dispersion and diffusion) plays a significant role in reducing nitrate concentrations in groundwater. The District has not quantified the effects of these mechanisms.

Alternative 2

Alternative 2 is a "hot-spot" cleanup using five extraction wells pumping for six months per year and discharging extracted water in the existing 40th St. wastewater ponds. Water from those ponds is delivered to the Effluent Management Site to irrigate crops at agronomic rates during the growing season. During the peak summer growing season (July – September) the Dischargers require additional water to supplement treatment plant effluent to maintain crop growth. This alternative would supply the additional water. However, groundwater extracted at the same rate during the spring and fall may contribute to a water surplus during these periods when there is lower irrigation water demand. This alternative contains two scenarios to address this imbalance. One, additional cropland is acquired to more effectively balance available extracted water along with effluent to meet crop demand. Alternatively, groundwater extraction may be reduced during the spring and fall to meet the crop demand on the existing farmland.

Alternative 3

Alternative 3 is a "limited containment-limited hot spot" alternative using 15 extraction wells pumping for 6 months per year. Extracted groundwater will be disposed into the existing 40th St. wastewater ponds. Groundwater extraction will occur for 6 months per year during the spring and summer growing season. Water will be applied to crops at agronomic rates. An additional temporary storage pond must be constructed to retain the volume of groundwater extracted. Additional land is required to dispose of the discharged water and meet crop demand.

Alternative 4

Alternative 4 is an "aggressive" remediation strategy using 25 extraction wells pumping year round. A reverse-osmosis system will be used to treat the water and reduce nitrate to less than 2 mg/L for disposal in new percolation ponds constructed near Little Rock Wash. Brine would be disposed in new evaporation ponds and the sludge disposed in a landfill.

Alternative 5

Alternative 5 is a "focused hot-spot" alternative using components of Alternatives 2 and 3 and may be considered "more aggressive hot spot" removal. Alternative 5 is comprised of eight extraction wells that are spaced more closely together in order to improve mass removal in the area of the plume beneath the Effluent Management Site where nitrate exceeds 10 mg/L. Until 2009 only 6 extraction wells will be installed. Extracted groundwater will be discharged into the existing 40th St. wastewater ponds. The remaining two extraction wells would be placed online in

[7] Abatement Report, March 30, 2004 & Addendum to Abatement Report, August 2, 2004

the vicinity of the 30th Street East and 40th Street East wastewater ponds when these ponds are taken out of service in 2009.

Summary

According to the Dischargers' March 1, 2005 *Containment and Remediation Report Supplement*, except for immediately beneath the wastewater ponds, the model predicts nitrate concentrations to be below 10 mg/L by around 2010 for all of the alternatives. Each alternative will result in groundwater quality conditions that approach, but do not fully achieve, complete restoration of groundwater quality to conditions that predate the Discharger's disposal activities. For example, concentrations after 2025 will be in the range of 2 to 4 mg/L for Alternative 5. Limited areas beneath the wastewater ponds will remain at concentrations just below 10 mg/L after 20 years. Each alternative will require the development and implementation of a monitoring plan to verify performance. Monitoring will consist of installing an as-yet-to-be-determined number of new monitoring wells to supplement the existing monitoring well network for data collection to assess plume movement and the extraction and treatment system operational performance.

The 2 mg/L nitrate (as N) plume boundary is predicted to be in essentially the same location in 2025 for each alternative as it is now. Only Alternatives 3 and 4 propose pumping wells at the down gradient plume boundary to provide hydraulic containment. . No extraction well capture zone or natural attenuation dilution analysis was provided to assess plume containment at the perimeter of the 2 mg/L plume boundary. The effectiveness of the selected remedy to achieve plume containment will need to be validated by data collected from a dedicated groundwater-monitoring network that has yet to be established. Dilution within the aquifer would be the primary mechanism that low levels of nitrate are dissipated. Vertical plume migration deeper into the aquifer can be expected due to the agricultural pumping activities. This is now occurring as demonstrated by increasing nitrate concentrations in some extraction wells.

The District's consultants contend that the modeling shows that the District's planned abatement projects (e.g., tertiary level treatment and additional lands to be irrigated), along with the abatement actions being implemented (increasing volume of effluent used for irrigation at agronomic rates), will provide the greatest benefit to improve groundwater quality.

Recently collected data from soil borings and well pump tests are being used to update the model. This information suggests that there are areas with lower hydraulic conductivity than originally believed. This information will change the model results, which may demonstrate the need for additional extraction wells to achieve the same performance result for each alternative. The additional wells will increase the projected capital and operating costs for each alternative. The model will not be updated until May 2005 and will be used for the detailed final design of the extraction and monitoring well network. However, for the purposes of screening and comparing alternatives, the use of the existing computer model results is sufficient with the understanding that the final well configuration and costs may differ.

VIII. Discharger's Preferred Alternative

The Dischargers recommend that Alternative 2 be implemented because it is the least costly alternative that would supply water to support summer crop growth. Based on the computer modeling, the District believes that Alternative 1 will result in eventual plume stabilization and remediation through primarily the elimination of land spreading in 2009 after the 2025 Plan is implemented. However, additional water

is needed during the summer months from now until 2009 to support crop growth on the new agricultural fields planned for Sections 14, 15 and 16. Alternative 2 would remove 119 tons of nitrate mass through extraction and subsequent removal through crop uptake and cost about $10.7 million to implement. The District has indicated that it will not invest public funds to implement this alternative until they receive Regional Board concurrence. Additionally, the District must obtain concurrence from LAWA to install groundwater extraction wells on LAWA property. This process may take more than eight months. The District and LAWA agreed to not begin this process until after receiving Regional Board concurrence on a cleanup remedy.[8]

The Dischargers plan to manage pumping over time to optimize performance. For example, the following actions are proposed to be implemented as part of an adaptive management approach. After monitoring data are analyzed, the Dischargers would make adjustments and modifications to:

- Reduce or terminate pumping over time from extraction wells as mass removal efficiency decreases;
- Add extraction wells to address the "hot spot" leading edge of the plume if plume movement is greater than predicted;
- Add extraction wells adjacent to the 30th St wastewater ponds following completion of additional groundwater investigations;
- Consider in greater detail the number, construction and spacing of wells to improve the nitrate removal efficiency following completion of the revised numerical computer model;
- Complete the 2025 Facility Plan and determining what the final effluent concentrations are from the new treatment plant. This includes determining whether groundwater degradation will result from new storage wastewater pond leakage and from normal crop over-irrigation;
- Use extracted groundwater for irrigation by existing agricultural operators or local water purveyors; and
- Consider treatment of the extracted groundwater followed by groundwater recharge to address (or offset) conditions of groundwater overdraft in the Antelope Valley.

In December 2004, the District certified a Negative Declaration for Alternative 2 to satisfy the California Environmental Quality Act. This allowed the District to sell bonds to begin full-scale design of this alternative.

IX. Staff's Review of Alternatives

Board staff's analysis is based on evaluating how each alternative, including the Dischargers' preferred alternative, is predicted to achieve cleanup of the nitrate that has degraded and polluted the groundwater, taking into consideration the guidance and requirements of *State Board Resolution 92-49*. Additional information was requested to complete Board staff's analysis of each alternative (**Attachment 2)**[9]. The Dischargers indicate they are unable to provide information to quantify the degree of containment and specific cleanup levels that would be obtained for each alternative until the computer groundwater model is updated. It seems reasonable to consider that the plume is contained when it is stabilized to some known concentration in both the lateral and vertical directions. Therefore, until additional

[8] November 18, 2004 letter from LAWA to District
[9] December 28, 2004 letter from Board staff to Dischargers

information is provided, Board staff is unable to completely assess all of the elements with respect to Resolutions 92-49 and 68-16. The unknown elements are listed below.

1. Although the Dischargers have estimated the time to restore the groundwater quality to the concentration of nitrate needed for all beneficial uses, they have not yet determined the time required to restore to groundwater to background levels.
2. Although the Dischargers have predicted the nitrate concentrations that are likely to be attained by the year 2025, the technological and economical analysis to justify leaving "hot spot" areas with elevated nitrate above background has not provided.

Regional Board staff believes that there is sufficient information to conclude that cleanup should begin now. The update of the computer groundwater model needs to be expeditiously completed. Following this, detailed component designs, including numbers and locations of extraction and monitoring wells should be provided. The Dischargers should be required to evaluate and recommend cleanup strategies to expedite restoring background nitrate concentrations in the "hot spots" that remain after initial cleanup is completed. This analysis should consider technologies that will not waste the groundwater resource by irrigating land that does not currently grow crops with fresh water.

Staff's detailed analysis of comparisons of the Alternatives is shown below.

A. Remedy Effectiveness

The Alternatives have been evaluated in different ways to compare the effectiveness of each approach. Comparisons of Alternatives were made by looking at various characteristics, such as: nitrate mass removed, pounds of nitrate removed per unit cost, volume of groundwater extracted and effect on the regional groundwater table. The comparisons are summarized below.

Table 2 – Mass Removal
(Tons of nitrate removed)

Alternative	Tons of NO_3
4	351
3	181
5	130
2	119
1	0.0

Table 3 – Groundwater Removed
(Acre-Feet of groundwater extracted potentially impacting other groundwater users)

Alternative	Acre feet removed
4	102,030
3	51,880
2	20,260
5	19,390
1	0.0

Note: 80% of Alternative 4 water is returned to the aquifer.

Table 4 – Mass Removal Efficiency

(Pounds of nitrate removed per acre-foot of groundwater extracted)

Alternative	Lb/Acre-Foot
5	13.4
2	11.7
3	7.0
4	6.9
1	0.0

Table 5 – Cost Effectiveness
(The # of lbs of nitrate removed per $1,000 of cost)

Alternative	Lb/$1,000 cost
2	22.3
5	19.0
3	13.8
4	4.4
1	0.0

Table 6 – Total Cost
(Net Present Value of Capital and Operating Costs)

Alternative	Millions of $
4	158.5
3	26.3
5	13.7
2	10.7
1	0.0

Alternative 4 removes the highest volume of groundwater and nitrate mass and has the highest cost to implement. Of the four active alternatives evaluated, Alternative 4 causes the least amount of groundwater elevation decline because the water that is extracted is treated[10] and returned to the aquifer.

Alternative 1, the baseline scenario common to all others, results in an average decline in the groundwater table in most areas of the nitrate plume of between 35 to 60 feet. Beneath Section 9, the groundwater mound will dissipate due to decreases in local recharge as a result of less effluent percolating to groundwater from land spreading. The result will be about a 75 foot decline in the water table. Alternatives 2, 3 and 5 result in additional groundwater declines beneath the focused pumping areas of: three feet (Alternative 2), five feet (Alternative 5) and ten feet (Alternative 3). Alternative 4, which provides the largest amount of groundwater extraction, yet recharges 80% of the extracted water back into the aquifer, results in about a five foot greater groundwater table decline in the vicinity of the plume than the base line scenario, but it would increase the groundwater table elevations near Little Rock Wash.[11] (see **Table 1)**.

Alternatives 2 and 5 are the most cost effective remedial alternatives and will supply needed water to summer crops planted in Sections 14, 15 and 16 through 2010. This will allow the Dischargers to reduce the volume of effluent disposed of by land spreading and assist in achieving the nitrogen loading reductions required in the Cease and Desist Order R6V-2004-039. These alternatives concentrate on removing nitrate mass in the “hot-spot” of the plume.

[10] Nitrate removal by reverse osmosis
[11] Containment and Remediation Plan, September 15, 2004, Appendix C, pages 38, 41, 45 and 47; Containment and Remediation Plan Supplement, March 1, 2005, page 17

None of the alternatives include elements to demonstrate that complete plume containment will be achieved by September 30, 2005 as required in the Cleanup and Abatement Order. Only Alternatives 3 and 4 propose extraction wells at the perimeter of the plume for hydraulic containment. Alternative 4 proposes the largest number of wells at the perimeter of the plume and within the "hot spots" and is more capable than Alternative 3 to achieve hydraulic containment of the plume down to the 2-mg/L nitrate concentration. Alternatives 2 and 5 do not include extraction wells at the periphery of the plume. This may be acceptable because a very low nitrate mass but high water volume would be removed from extraction wells at the periphery of the plume at a high cost with little water quality benefit. Also, modeling results indicate that regardless of which alternative is implemented, the leading 2 mg/L edge of the plume does not migrate significantly. The Dischargers provided no well capture zone analysis to evaluate actual containment in any alternative. In addition, the time needed to implement Alternatives 2 through 5 ranges from 1.5 to 5 years from now, well beyond the September 30, 2005 deadline. All alternatives rely on natural attenuation to re-distribute the nitrate mass remaining after active cleanup is completed.

As previously stated, the computer model predicts little overall movement of the nitrate plume and there was no further analysis of how each alternative achieves containment at various nitrate concentrations. Additionally, Alternatives 2, 3 and 5 would only extract groundwater for six months of the year, with no active containment for the other six months. Groundwater extraction from the pumping by agricultural wells in the area complicates things and makes it difficult or impossible to contain the plume vertically. These wells may help to contain the plume laterally, but also cause the plume to be drawn deeper in the aquifer. Therefore, the pollution (plume > 10 mg/L nitrate) cannot be contained by any of the alternatives.

The amount of nitrate mass removed by each alternative over 20 years ranges from 119 tons for Alternative 2 to 351 tons for Alternative 4. The amount of nitrate that is estimated to be dissolved in the aquifer above background is about 1,200 tons. Additional nitrate mass currently in the vadose zone will be added to groundwater over time. From 2004 through 2009 another 559 tons of nitrogen will become available to the groundwater due to land spreading[12]. While not all nitrogen in the vadose zone will reach groundwater, the amount of nitrogen removed by active remediation is small in comparison to what is estimated to be in the groundwater.

The socioeconomic costs of cleanup can be considered in a number of ways. The cost to implement each alternative must be evaluated against other costs, some of which cannot be accurately computed. The Discharger's preferred Alternative 2 has a Net Present Value of $10.674 million. This cost can be compared to the cost associated with replacing the amount of polluted groundwater with State Water Project Water. The Antelope Valley-East Kern Water Agency currently charges $236/acre-foot of water to municipal users[13]. To purchase 21,000 acre-feet of water to replace an equal amount of polluted water would require approximately $5 million, excluding delivery and treatment costs. Active remediation costs are not excessive compared to the value of the affected groundwater resource. Costs not easily calculated are the value of the groundwater resource that is not currently available to support all beneficial uses and potential water treatment costs if that water were required for municipal supply. To prevent further water quality impairment, it may make more economic sense to put money into

[12] Cease and Desist Order R6V-2004-0039
[13] http://www.avek.org/rates.html

expediting nitrogen removal before 2009 by either adding interim nitrogen removal improvements at the treatment plant or expediting construction of winter storage reservoirs

B. Cleanup Time

It is unknown how long it will take to restore ground water nitrate concentrations to the natural background concentration of less than 2 mg/L. In each alternative, the ground water model predicts that nitrate concentrations will be less than 10 mg/L across the entire site sometime between 2010 and 2018. Moreover, it would take longer than 20 years to restore nitrate concentrations to background. The computer model includes estimates for continued residual drainage of water from the vadose zone beneath the wastewater ponds and land-spreading area after use is discontinued in 2009. This results in small "pockets" of groundwater with elevated groundwater nitrate concentrations of 5 to 9 mg/L remaining beneath the 30th St wastewater ponds, 40th St wastewater ponds and land spreading areas for an undetermined amount of time. Implementing Alternatives 2, 3 and 5 would result in discharging extracted groundwater back into the 40th St wastewater ponds until 2009. This "re-circulates" some nitrate back to groundwater because the District estimates that about 5% of the pond volume is lost through leakage.

C. Groundwater Restoration to Background Levels

Based on model predictions, none of the alternatives achieve cleanup level to background of less than 2 mg/L (as N) across the entire site sooner than 20 years. Although it was requested by Regional Board staff, the District has not submitted an analysis of what it would take to restore all of the affected groundwater to background level.

D. Adequacy of Degradation Justification

To justify a cleanup level less stringent than background, the Regional Board must ensure that the less stringent level will:

a. Be consistent with the maximum benefit to the people of the state;
b. Not unreasonably affect present and anticipated beneficial uses of such water; and
c. Not result in water quality less than that prescribed in the Water Quality Control Plans and Policies adopted by the State and Regional Water Boards.

In addition, the Dischargers must demonstrate that it is technologically or economically infeasible to achieve the background value. Additionally, the best practicable treatment or control of the remaining degraded groundwater must be employed. This evaluation is to consider: 1) past, present and probable future groundwater uses, 2) economic and social costs both tangible and intangible, 3) environmental aspects of the proposed degradation, and 4) feasible alternative controls. With respect to economic costs, both costs to the Discharger and the affected public must be considered. Cost savings to the Dischargers alone are insufficient to allow degradation. The District's socioeconomic evaluation of alternatives considered impacts to: 1) beneficial uses, 2) water resources and costs thereof, 3) sewer rates, 4) community financial impacts, and 5) property values. The Discharger has not provided information to assess whether it is technologically or economically infeasible to cleanup to background.

X. Conclusion and Recommendation

The Discharger has proposed to implement Alternative No. 2 in response to cleanup requirements of the Regional Board. The Discharger has not provided sufficient information to assess whether it is technically or economically infeasible to restore background water quality as required. However, sufficient information is known about the nitrate plume and the Dischargers' short-term disposal capacity limitations to make a recommendation at this time.

Because groundwater basin overdraft is occurring, the Regional Board should consider whether it is in the best interests of the Antelope Valley residents to accept a cleanup project that includes significant consumptive water uses, specifically a use that was developed to dispose of treated wastewater. It may be appropriate to accept a short-term cleanup project that has limited consumptive water loss, in order to reduce nitrate concentrations to below 10 mg/L, thereby restoring groundwater beneficial use. However, for any long-term cleanup, Board staff recommends the Regional Board require the Dischargers to propose a plan that will conserve more water. That plan should include an evaluation of cleanup and, more importantly, options for disposal of any pumped groundwater that will result in completing cleanup without wasting the groundwater resource.

In the short term the Dischargers should be required to implement groundwater cleanup to address the higher concentration "hot-spot" areas. The goal of this short-term cleanup should be to bring groundwater nitrate concentrations to below the drinking water standard of 10 mg/L as soon as possible. Alternative No's 2 and 5 appear the most reasonable to accomplish this task. From now until 2012, Alternative 5 would remove about 7,200 acre-feet from the aquifer. This water loss seems to be a reasonable tradeoff to restore a beneficial use. Emphasis should be given to removing the most nitrate mass in the shortest time while stopping the further plume migration towards the Air Force Plant 42 well field and ensuring that the plume does not threaten Air Force Plant 42's wells or those of the Palmdale Water District. Following the completion of the revised computer groundwater model, a detailed design analysis should be provided before implementation begins.

The currently proposed use of pumped groundwater for crop irrigation puts additional stress on an already over drafted aquifer and clearly warrants the development of another long-term strategy to be implemented in the next five years. The Regional Board should require the Dischargers to submit a "long-term" strategy by the fall of 2006. That plan should evaluate pumping and treating groundwater to remove nitrogen with disposal of the treated water back to the aquifer, or the replacement of an existing use of groundwater. This plan should evaluate alternatives that fully restore groundwater to background nitrate concentrations of 2 mg/L (as nitrate) or less - or fully justify a cleanup level between 2 and 10 mg/L as required in Resolution 92-49. It should be implemented once the new wastewater storage ponds are constructed.

• • •

Table 1 – Containment and Remediation Plan Alternatives

Alternative	1	2	3	4	5
Description	**Base Case - No Action[1] - 2025 Plan**	**Hot Spot Remediation[1]**	**Limited Containment[1]**	**Aggressive Remediation[1]**	**Focused Hot Spot Remediation[2]**
Groundwater quality by the year 2025	• 2-4 mg/L at most of the site • 5-7 mg/L in the western half of section 10 • 9 mg/L at the 40th St ponds.	• 2-4 mg/L at most of the site • 5-7 mg/L in the western half of section 10 • 9 mg/L at the 40th St ponds.	• 2-4 mg/L at most of the site • 5-7 mg/L in the western half of section 10 • 9 mg/L at the 40th St ponds.	• 1-3 mg/L at most of the site • 4-5 mg/L in a localized area in the western half of section 10 • 7 mg/L at the 40th St ponds.	• 2-4 mg/L at most of the site • 5-6 mg/L in a localized area in the western half of section 10 • 8-9 mg/L at the 40th St ponds.
Time to Implement	None	1 year	> 1 year	3-5 years	1 Year + 6 mo after 2009
Groundwater decline due to project[3]	0 feet	3 feet	10 feet	5 feet (with an increase near Little Rock Wash)	5 feet
Tons nitrate removed	NA	119	181	351	130
Nitrate removal efficiency (lbs/acre-ft)	NA	11.7	7.0	6.9	13.4
New groundwater extraction wells	0	5	15	25	6 wells now 2 wells after 2009
Combined Flow	0	1,500 gpm (2.2 mgd)	3,900 gpm (5.6 mgd)	5,000 gpm (7.2 mgd)	1,500 gpm (2.2 mgd) 1,950 gpm after 2010
Pumping Period	0	Six months/yr	Six months/yr	Year round	Six months/yr
Linear Feet of Piping	0	16,000	64,470	90,620	32,370
Other Features	None	None	Additional storage pond	Additional storage pond Reverse osmosis system Brine evaporation ponds Percolation basins	Additional storage ponds after 2009
Capital Cost	$ 0	$ 6,456,000	$ 16,691,000	$ 108,587,000	$8,735,000
20-yr O&M Cost	$ 0	$ 6,769,000	$ 15,476,000	$ 68,634,000	$13,661,000
Net Present Value Cost	Not Reported	$10,674,000	$26,335,000	$158,544,000	$13,661,000
Cost effectiveness (lbs/$1000)	Not Reported	22.3	13.8	4.4	19.0
Sewer Rate Cost – per connection per year	$ 71 (Current)	$ 161	$ 255	$ 446	$180

[1] Containment and Remediation Plan dated September 15, 2004 prepared by Geomatrix for LACSD – 20 Palmdale Water Reclamation Plant.
[2] Containment and Remediation Plan Supplement dated March 1, 2005 prepared by Geomatrix for LACSD – 20 Palmdale Water Reclamation Plant.
[3] For all scenarios there is an estimated 75 foot decline beneath Section 9 as the groundwater mound dissipates due to 1) regional groundwater pumping in municipal and agricultural wells and 2) elimination of land spreading in 2009 as the District's 2025 Plan is implemented. The changes described are in addition to these effects following active remediation. For alternative 4, an estimated 80% of the extracted water is returned to the aquifer, but at a location other than Section 9.

Figure No. 1
Palmdale WRP and Effluent Management Site

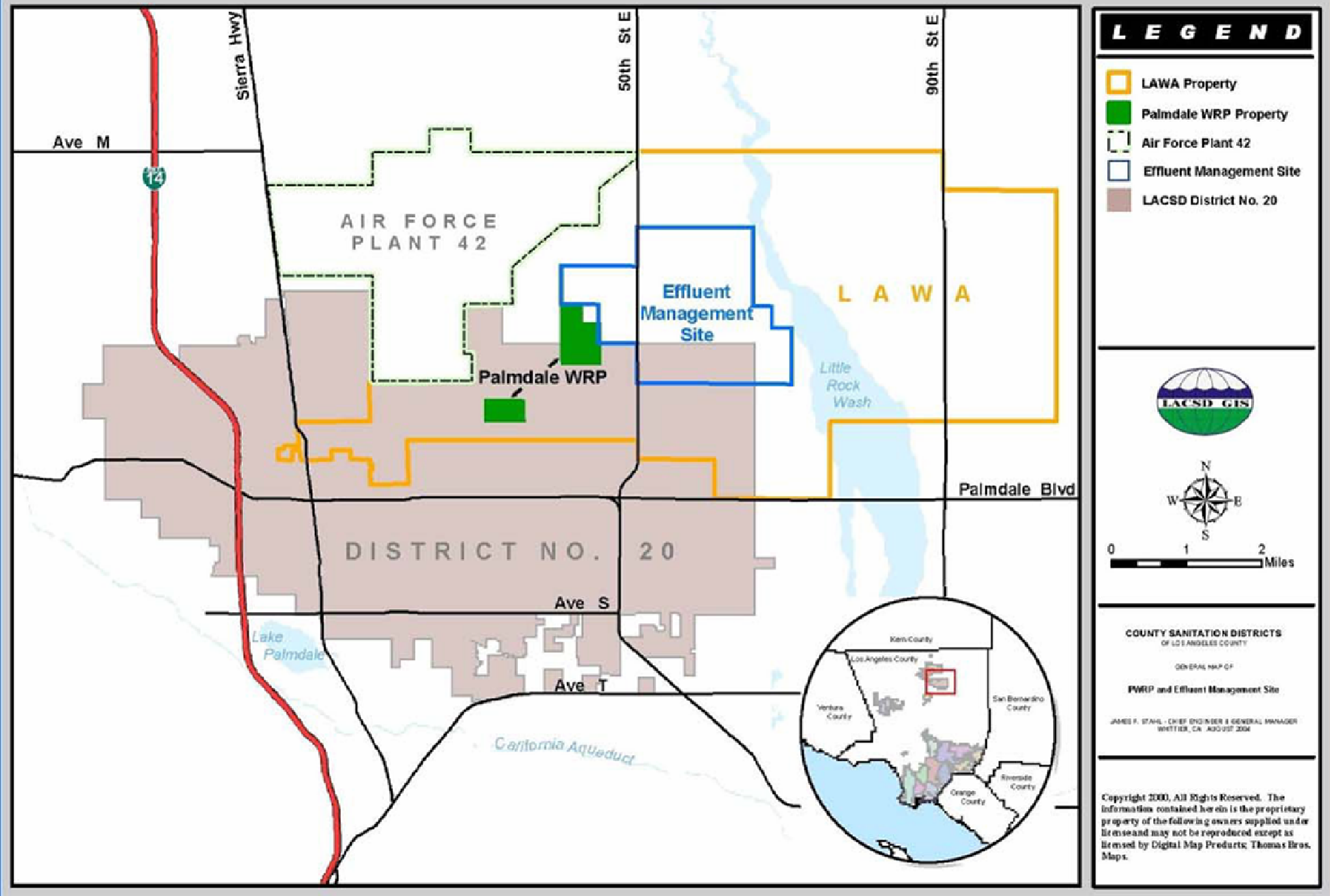
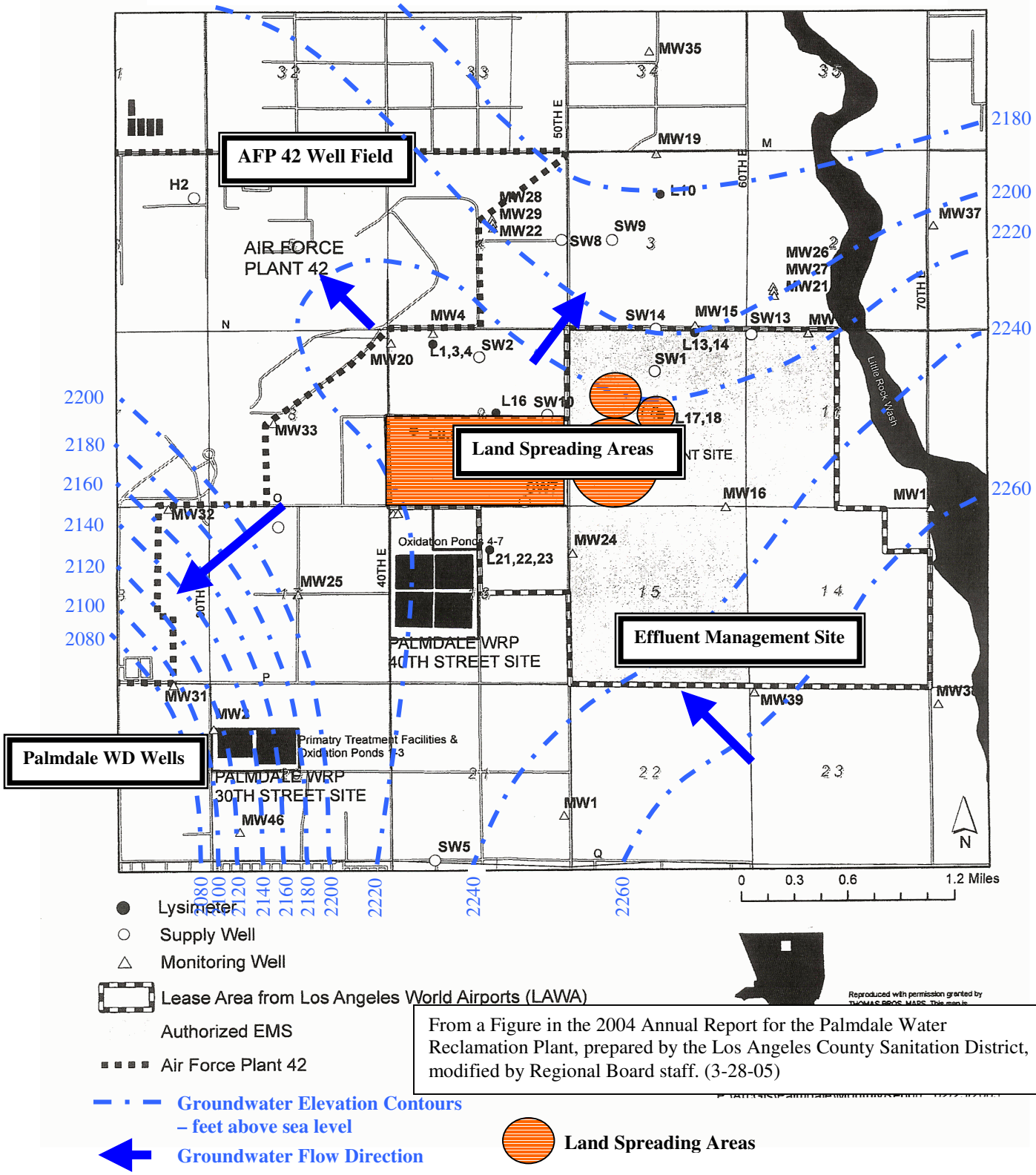


FIGURE 2
PALMDALE WATER RECLAMATION PLANT
Effluent Management Site, Wells and Lysimeters



From a Figure in the 2004 Annual Report for the Palmdale Water Reclamation Plant, prepared by the Los Angeles County Sanitation District, modified by Regional Board staff. (3-28-05)

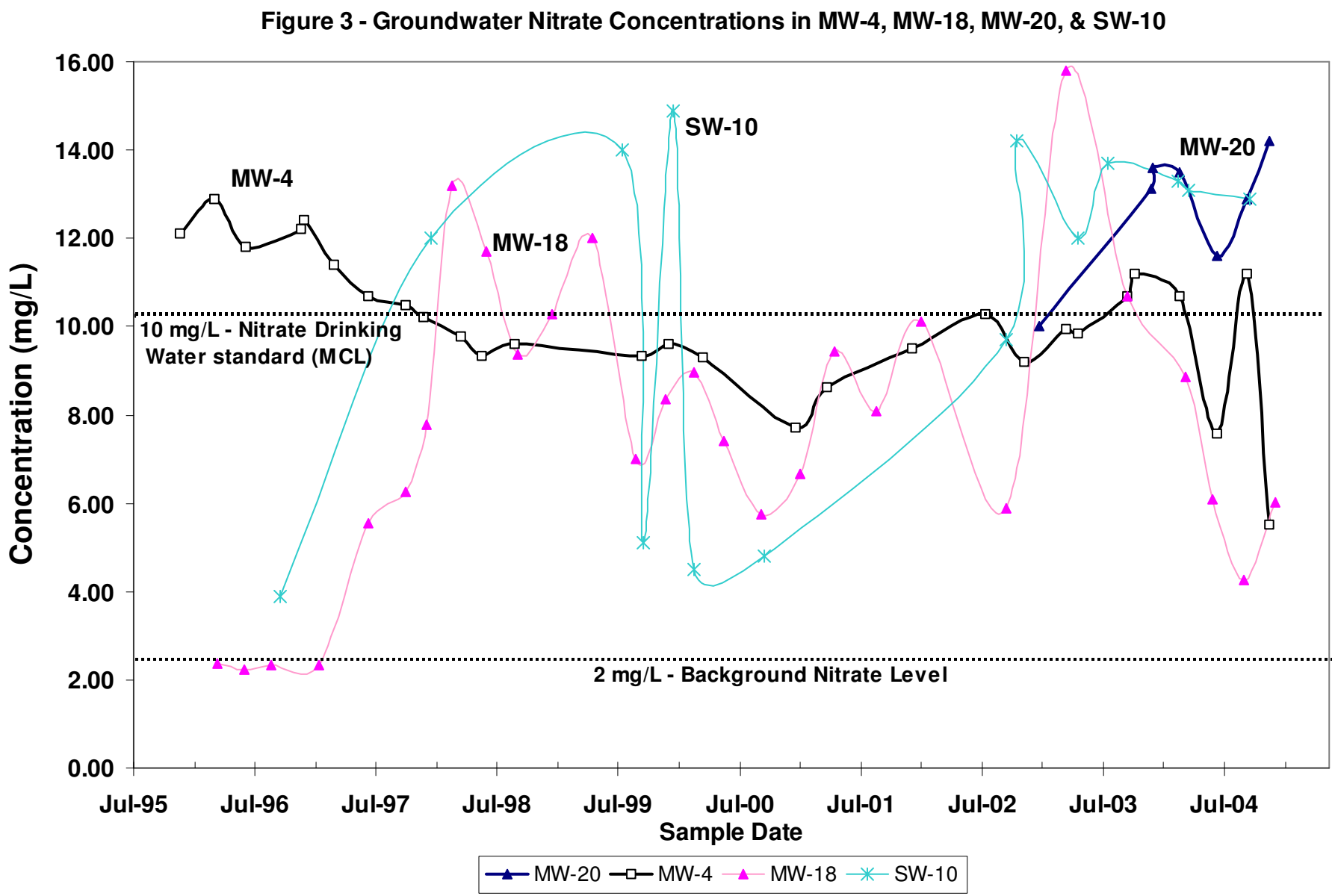


Figure 3 - Groundwater Nitrate Concentrations in MW-4, MW-18, MW-20, & SW-10
16.00
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
Concentration (mg/L)
MW-4
MW-18
SW-10
MW-20
10 mg/L - Nitrate Drinking Water standard (MCL)
2 mg/L - Background Nitrate Level
Jul-95
Jul-96
Jul-97
Jul-98
Jul-99
Jul-00
Jul-01
Jul-02
Jul-03
Jul-04
Sample Date
MW-20
MW-4
MW-18
SW-10

FIGURE 4- Cross Section of Antelope Valley

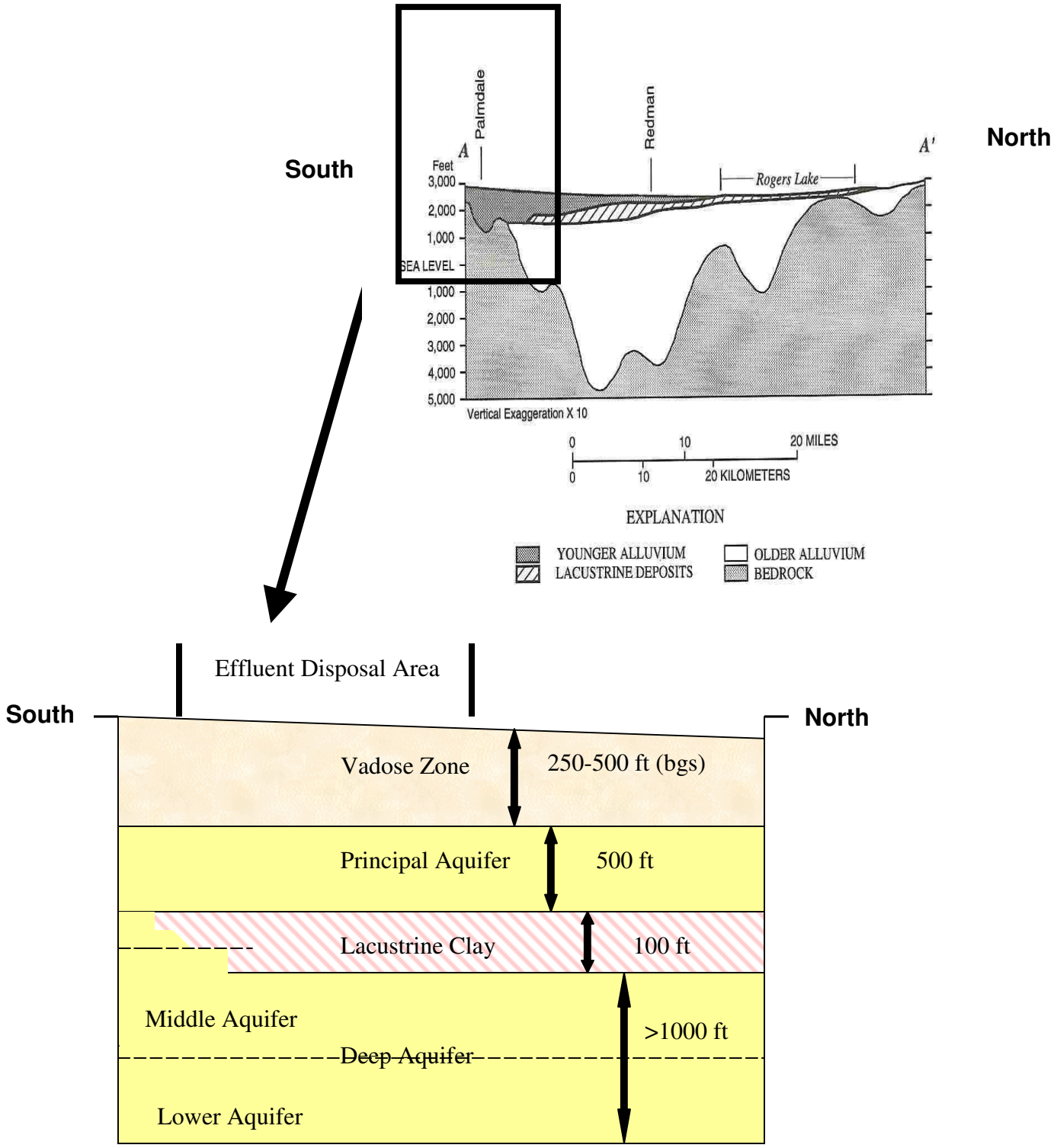
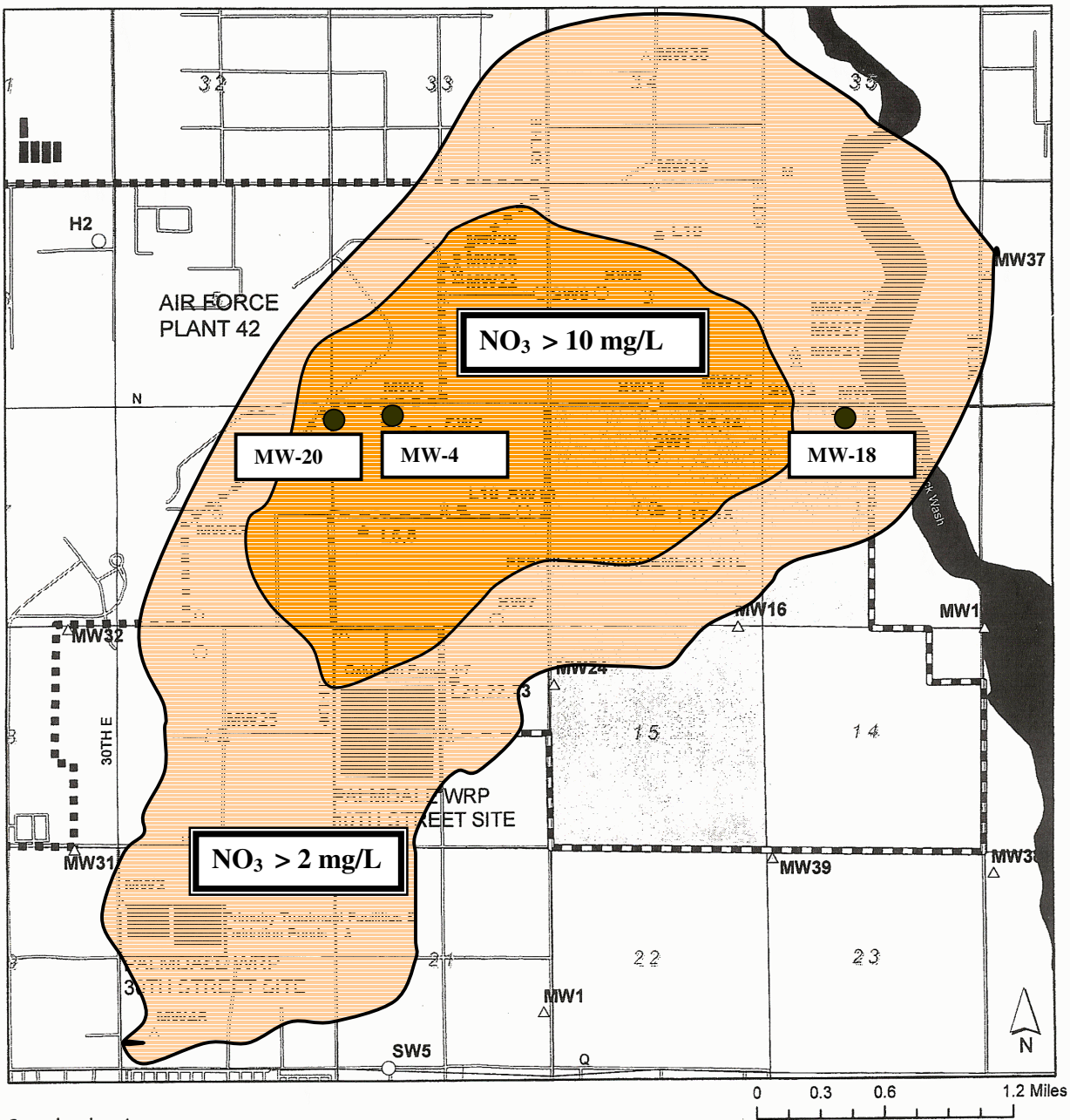


FIGURE 5
PALMDALE WATER RECLAMATION PLANT
Nitrate (NO_3) Plume Boundary- >2 mg/L, >10 mg/L



Lysimeter

Supply Well

Monitoring Well

Lease Area from Los Angeles World Airports (LAWA)

Authorized EMS

Air Force Plant 42

Nitrate > 10 mg/L

Nitrate > 2 mg/L

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From a Figure in the 2004 Annual Report for the Palmdale Water Reclamation Plant, prepared by the Los Angeles County Sanitation District, modified by Regional Board staff. (3-28-05)

Attachment 1

Estimate of Nitrate Mass in Plume

1. Assume entire nitrate plume greater than background (2 mg/L as nitrogen) contains 190,000 acre-feet (AF) and polluted groundwater plume greater than drinking water standard (10 mg/L as nitrogen) contains 21,000 AF.

2. Assume Plume A = Nitrate plume between 2 mg/L and 10 mg/L with an average nitrate concentration of 6 mg/L. Then:

   190,000 Acre-Feet (AF) – 21,000 AF = 169,000 AF
   169,000 AF * 325,000 gal/AF = 54,925 million gallons (MG)
   = 55 billion gallons (BG)

3. Assume Plume B = Nitrate plume greater than 10 mg/L with an average nitrate concentration of 12 mg/L. Then:

   21,000 AF * 325,000 gal/AF = 6,825 MG
   = 6.8 BG

4. Consider the following equation to determine mass:

   Volume (MG) * Concentration (mg/L) * 8.34 (lb/MG/mg/L) = Load (lb)
   Divide by 2000 lb/ton = tons

5. Plume A: (54,925 * 6 * 8.34)/2000 = 1,400 tons

6. Plume B: (6,825 * 12 * 8.34)/2000 = 300 tons

7. Total Nitrate Mass in Plume = Mass in Plume A + Mass in Plume B = **<u>1,700 tons</u>**

8. Mass of nitrate less than background (2 mg/L): [(54,925 + 6,825) * 2 * 8.34]/2000 = 500 tons

9. Mass of nitrate that is above background (2/mg/L): 1,700 – 500 = **<u>1,200 tons</u>**

The above calculations are rounded for simplicity.

Attachment 2

Information Requested from the District to Evaluate Alternatives

Improved Analysis Comparing Alternatives with Respect to SWRCB Resolution 92-49

The District agreed to complete further evaluation of the cleanup alternatives proposed with respect to Resolution 92-49 to provide the Regional Board with a comparable alternative analysis. This analysis should provide a narrative, graphical and tabular evaluation in the following areas.

1. Describe the current nitrate plume volume, mass, and aerial and lateral extent.

2. Describe the estimated volume and mass of nitrate removed for each alternative.

3. Describe the volume, mass and aerial and lateral extent of nitrate remaining following cleanup for each alternative. This should include an estimate of the nitrate mass added to the vadose zone and groundwater disposal, mass removed by proposed abatement actions, mass removed by denitrification, and mass remaining in the vadose zone for potential transport to groundwater.

4. Evaluate the remediation time to reach the 10, 5 and 1.5 mg/L (assumed background is 1 – 2 mg/L) nitrate concentrations for different portions of the affected plume (e.g. beneath disposal areas, ponds and throughout the remainder of the plume).

5. Clarify where and how natural attenuation is a component of each alternative.

6. Clarify the role agricultural pumping wells have in each alternative and options to reduce or eliminate localized agricultural groundwater pumping that draws the plume deeper and may require additional, deeper, monitoring wells over time to assess vertical plume movement.

7. Provide an accurate comparison of the costs for each alternative. For example, alternative No. 2 costs should be reduced by the cost to provide summer supplemental water to Sections 14, 15 and 16 because the District has indicated that the volume of water to be pumped in alternative 2 is necessary even if cleanup was not required. Operation and maintenance costs should not be included after wells are predicted for shut down.

8. Include a "No-Action" alternative showing the effect of continuing the current disposal practices (as described in the District's Abatement Report) to compare the effect of each alternative.

9. Include an analysis of the resulting TDS concentrations and salt loading that remains for each alternative. As we discussed during the meeting, it would be appropriate to update the TDS assessment from the 2003 Degradation Analysis for each of the proposed alternatives.

10. Describe the long-term monitoring aspects for each alternative necessary to determine if the alternative is achieving its theorized effectiveness.

11. Describe the computer model uncertainties that may be over or under conservative.

12. Include an improved description of the computer model layers related to groundwater elevations with annotated cross-sections.