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ASSESSMENT OF REMEDIAL OPTIONS
GROUNDWATER EXTRACTION AND TREATMENT
LEHR - UC Davis

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1.0 INTRODUCTION

This report presents an assessment of feasible remedial options for groundwater extraction and treatment at the former Laboratory for Energy-Related Health Research (LEHR) at the University of California Davis (UC Davis) campus (Figure 1). This work was conducted at the request of UC Davis and was based on the UC Davis conceptual work plan submitted to the United States Environmental Protection Agency (USEPA) on November 30, 1995. The results of this assessment will be used as the basis for making a directional decision concerning implementation of an Interim Remedial Action (IRA) for groundwater at LEHR.

The assessment was initiated as the first activity in formulating a groundwater treatment scheme at LEHR. On-going groundwater monitoring at LEHR by the United States Department of Energy (DOE) has identified a plume of impacted groundwater that extends downgradient from the former LEHR facility and various facility-related waste disposal areas. Groundwater is impacted by several parameters that include volatile organic compounds (VOCs), nitrate, hexavalent chromium, total dissolved solids, and tritium. The most frequently reported VOC is chloroform, which has been reported with concentrations as high as 24,000 μg/L in one on-site well. Other VOCs reported include bromodichloromethane, 1,1-dichloroethane, 1,1-dichloroethene, and 1,2-dichloroethane. Recent on-site in-situ groundwater sampling and off-site sampling of an agricultural supply well (known as the "Nishi well") have shown that VOC impacted groundwater likely extends past the LEHR site boundary.

1.1 Goals of Assessment

In Order to make this assessment as effective as possible, it was necessary to narrow the direction of the remedial alternatives considered to address the most current concerns regarding groundwater impacts at LEHR. Goals of this assessment were developed that would need to be met by the groundwater IRA, and these goals were used to guide and limit the evaluation of feasible options. These goals for the remedial alternative of choice include:

- the alternative must be implementable within a reasonable time frame (a completion date of December 31, 1996 was selected);
- the alternative cannot require a large amount of additional data collection;

- selection, design, and implementation of the alternative can be based on as much existing data as possible;
- the alternative must address public concerns and risks associated with the plume of VOCs that are migrating off site;
- the alternative must address impacts to the second HSU because of the higher conductivity and greater potential for contaminant migration;
- the alternative should be in compliance with applicable laws and regulations;
- the alternative will not have the potential to cause more damage to the groundwater system than already exists (for example pull site contaminants into previously clean areas);
- the alternative will fit into longer term groundwater and soil remediation scenarios for the site; and
- the alternative must be acceptable to the stakeholders at LEHR in order to be implemented efficiently.

The long term strategy for groundwater remediation at the LEHR site will eventually involve several elements. These elements will include:

1) addressing the VOC plume at its downgradient limits or toe;
2) remediation of groundwater at/or near on-site source(s); and
3) intercepting and treating groundwater at the UC Davis/LEHR site boundary.

Based on the goals established above, this assessment was focussed to address alternatives that intercept and treat the VOC groundwater plume at the UC Davis property boundary. Capturing the plume at the toe would require substantial additional data collection to identify the downgradient extent of impacts, which would preclude meeting the time frame for implementation of the IRA. Remediating groundwater at the source(s) of the VOCs and other parameters would also require additional data collection, and would not capture the downgradient portions of the plume which would continue to migrate off-site.

1.2 Organization of Report

This report is organized into eight sections. The content of each section is described briefly below.

Section 2.0 - describes an evaluation of the key parameters relative to groundwater extraction, treatment, and disposal alternatives at the UC Davis property boundary;

Section 3.0 - describes the preliminary capture zone analysis and groundwater extraction scenarios.

Section 4.0 - presents a review of treatment technologies that are available to address site parameters of concern.

Section 5.0 - reviews discharge options available for treated groundwater.

Section 6.0 - presents remediation alternatives and a feasibility analysis for application at the LEHR site.

Section 7.0 - presents the recommended alternative, a general cost estimate for the recommended alternative relative to other options, and recommendations for the next step in developing the selected remedial option.

Section 8.0 - References.

2.0 EVALUATION OF KEY PARAMETERS

This section presents the results of a limited data review conducted to evaluate key parameters for use in the assessment of groundwater extraction, treatment, and disposal alternatives. The review consisted of evaluating site hydrogeology, general aquifer characteristics for use in a preliminary capture zone analysis, general groundwater quality, the nature and extent of parameters of concern in areas downgradient of the site, and a review of broad technology options. The evaluation focused on data from the second hydrostratigraphic unit (HSU).

2.1 Hydrogeology

The shallow saturated zone beneath the LEHR site has been differentiated into three separate HSUs (Dames & Moore, 1993). The first HSU consists of the saturated fine-grained sediments that occur between the water table to approximately 80 feet below ground surface (bgs). The second HSU consists of coarse sand and gravel that underlie the first HSU and range in thickness from 31 feet to 55 feet. The fourth HSU has been identified in drillers' logs and an unpublished geophysical survey, and consists of a gravel unit approximately 90 feet below the base of the second HSU (PNL, 1994). The fourth HSU is separated from the base of the second HSU by a relatively thick (up to 90 feet) aquitard composed of clay and silt (sometimes referred to as the third HSU). To date there are no site chemical data for fourth HSU groundwater.

Although quarterly groundwater monitoring has indicated that both the first and second HSUs have been impacted by various site parameters, this assessment of feasible remedial options focusses on impacts identified in the second HSU. The second HSU has been targeted because site parameters have been shown to be significantly more mobile in the second HSU than in the finer-grained first HSU, and because recent data indicate that VOCs (especially chloroform) in the second HSU may be migrating off UC Davis property to the east. Data collected during previous investigations (PNL 1995a, Parfitt 1996 [draft]) indicate that groundwater flow in the first HSU has a stronger vertical component than horizontal component. As a result, contaminants are more likely to flow downward from the first HSU to the second HSU than to move horizontally within the first HSU.

2.2 Aquifer Characteristics

Existing stratigraphic information and groundwater hydraulic data for the second HSU were reviewed in order to estimate aquifer parameters for model input. These estimates are summarized in Table 1. Recent slug test data generated by PNL were used to estimate second-HSU hydraulic conductivity (PNL, 1995c). The second-HSU conductivity was calculated using an average of slug test results for monitoring wells UCD2-7, UCD2-15, UCD2-16 and UCD2-17 (Table 2). A thickness of 40 feet was used for the second HSU as recorded in well boring UCD2-27, which is located downgradient of the site within the area impacted by chloroform. An average gradient and flow direction were estimated using second-HSU quarterly groundwater elevation maps from 1992 through 1994 (PNL 1995).

Estimates of storativity and leakage are usually derived from aquifer pumping test data. To date no aquifer pumping tests have been conducted at the LEHR site. Therefore, storativity and leakance estimates from tests conducted at the nearby UC Davis Landfill, located approximately one-mile to the northwest of the LEHR site, were used. A second-HSU constant rate aquifer pumping test was conducted at the UC Davis Landfill site in April 1995. Based on drawdown response observed in observation wells near the pumping well, estimates of storativity and leakance were calculated (Dames & Moore, 1995). Based on the correlation of stratigraphy between the two sites, these estimates are considered reasonable for feasibility level modeling.

Estimates of the maximum sustainable well yield for a second-HSU extraction well were based on use of the Theis equation for confined aquifers. Based on minimum groundwater levels at the site, and using the criteria that drawdown will not be allowed to extend beneath the top of the second HSU, a minimum available drawdown of 12 feet was selected. The Theis equation was used to estimate the maximum sustainable well yield using transmissivity of 9,800 ft^2/day from PNL slug test results, and a storativity estimate of 0.0039 from UC Davis Landfill aquifer testing. The maximum sustainable well yield is estimated to be in excess of 300 gpm assuming 100 percent well efficiency. In practice the maximum sustainable well yield will be considerably less due to well losses.

2.3 Groundwater Quality

Groundwater chemistry data was evaluated in order to estimate groundwater treatment influent concentrations. The review focussed on data from the second HSU and in the vicinity of the UC Davis property boundary, when possible. Data included in the review consisted of: recent site quarterly monitoring data collected between February 1994 and May 1995 (PNL, 1995a; PNL, 1995b); hydropunch data collected in 1990 and 1994 (Dames & Moore 1994; PNL, 1995a); preliminary hydropunch data collected in October and November 1995 (PNL, 1995c), and results from the October 1995 Nishi irrigation well sampling.

Table 3 presents an estimate of concentrations in groundwater treatment influent for general water quality parameters and site parameters of concern. When possible, the estimates were made using second-HSU hydropunch data from downgradient areas near the UC Davis property boundary that would be affected by groundwater extraction and treatment. However, due to limited analyte lists in the hydropunch programs, many of the influent estimates were calculated using data from wells UCD2-7 and UCD2-14, and the October sampling result from the Nishi irrigation well. The estimates from wells UCD2-7 and UCD2-14 were calculated using the range and average concentrations reported during 1994 quarterly monitoring. Data from these wells were used because there are analytical results for a broad range of chemical parameters, and because these wells are located farthest downgradient of second HSU LEHR wells for which ongoing data were available. One full year of data was used to establish concentration ranges and averages, in order to account for seasonal variation which has been observed in well UCD2-14.

Concentrations for several VOCs including bromodichloromethane, 1,1,2 trichloroethane, 1,1 dichloroethane, 1,1 dichloroethene, 1,2 dichloroethane, and 1,2 dichloropropane were estimated from the October 1995 Nishi irrigation well sample result. These compounds have also been reported on-site in first HSU well UCD1-12, however there is no available downgradient second-HSU data. Because as much as 90 percent of the water pumped from the Nishi well is believed to be generated from the second HSU (personal communication, Dennis Parfitt), the concentrations of VOCs observed in the Nishi well sample were used to approximate concentrations that may be observed in groundwater treatment influent extracted at the site perimeter.

Chloroform hydropunch data was used to depict a concentration contour map for areas downgradient of the site (Figure 2)(PNL, 1995c). Data included on this map consists of results from the 1991, 1994, and 1995 hydropunch sampling (PNL 1995c). The contour map shows that there are two separate chloroform plumes, or two lobes to one plume. The north plume, hereafter Plume A, appears to extend from former waste disposal areas on-site near the northern part of Landfill Unit No. 2, to the east toward the property boundary. The much smaller southern plume, hereafter Plume B, is located in the vicinity of Landfill Unit No. 3 in the southeast corner of the site. This map and data were used as the basis to evaluate various groundwater extraction and capture scenarios (see section 3 below). Additional scenarios may have to be evaluated if new data are collected that indicate the nature and extent of impacts in the second HSU differ from our current understanding.

2.4 Technology Options

A variety of technologies were reviewed and considered for inclusion as part of an IRA for groundwater at LEHR. These technologies included various methods for hydraulic control, in-situ treatment methods, and ex-situ treatment methods. Because the focus of this assessment was narrowed to address VOC impacts at the site perimeter, most in-situ methods were evaluated to be impractical for this IRA. Methods such as soil vapor extraction and bioventing should be considered for remedial actions that focus on soils present in source areas, but would not effect conditions at the property boundary in the short term. Other in-situ methods including air sparging, bioremediation, and treatment barriers have some potential to treat organic and inorganic constituents in groundwater near the source areas, but were judged to be impractical given the goal to address off-property VOC migration at the property boundary. Some of the in-situ technologies are experimental and may require extensive bench- and pilot-scale testing prior to implementation. In addition, some constituents (such as TDS) cannot be treated using in-situ methods.

As a result, technologies selected for evaluation in this assessment consisted of groundwater extraction to achieve hydraulic capture, and a variety of ex-situ treatment technologies for the site parameters of concern. Groundwater extraction and treatment is a proven technology which is identified by the EPA as a presumptive remedy for contaminated groundwater. The use of a presumptive remedy at LEHR should significantly streamline the implementation of an IRA under CERLA requirements.

3.0 EVALUATION OF GROUNDWATER EXTRACTION OPTIONS

An evaluation was performed to assess groundwater extraction options in the second HSU along the UC Davis property boundary. Groundwater extraction alternatives were evaluated using the analytical groundwater flow model Quickflow™. The objective of this preliminary groundwater flow modeling was to assess groundwater extraction well field locations with the intent of preventing further off-site migration of chloroform impacted groundwater. As discussed above, site-specific hydrogeologic data generated during previous phases of investigation were used to estimate model parameters. Site specific aquifer parameter estimates were supplemented with estimates from other UC Davis groundwater investigations at nearby sites.

3.1 Groundwater Flow Model

The analytical groundwater flow model Quickflow™ was used to evaluate the feasibility of several groundwater extraction well field scenarios at the UC Davis property boundary. Quickflow™ is a two-dimensional analytical groundwater flow model. Analytical groundwater flow models assume homogeneous, isotropic conditions exist throughout the model domain. These assumptions are viewed as reasonable for feasibility level estimates. More sophisticated numerical groundwater flow modeling would be necessary to refine the extraction well field design when implementation of the groundwater IRA proceeds.

3.2 Modeling Predictive Simulations

Quickflow™ was used to assess different IRA extraction well field design options at the downgradient boundary. Model simulations were performed in the transient mode over a one year period. The transient mode was required in order to use the simulated leakance portion of the model. Particle tracking was used to assess the capture zone geometry of each extraction well field scenario. Particle tracking results were compared to chloroform concentration contours for the second HSU to estimate whether adequate plume capture could be attained with each scenario. Factors considered during extraction well field modeling included:

- Providing hydraulic containment of chloroform impacted groundwater within the second HSU in Plume A and/or Plume B in the vicinity of the UC Davis eastern site boundary;

- Providing enhanced mass removal rates by locating extraction wells along the axis of the plume; and
- Optimization of the number of extraction wells required to achieve plume capture.

Several extraction well field scenarios were evaluated in order to select the optimal extraction well field design considering the factors listed above. For each scenario multiple simulations were conducted to refine flow rate estimates required to attain capture. Three scenarios are presented that best address these objectives. Quickflow™ modeling results for the three extraction well field scenarios are presented in Figures 3 and 4. Each of the scenarios is discussed below.

Scenario 1: In Scenario 1, one second-HSU extraction well (EW-1) is located in the center of Plume A along the eastern site boundary. Model simulations indicate that this extraction well pumping at 90 gpm should provide a capture zone encompassing most of the upgradient extent of second-HSU chloroform impacts in Plume A. The capture zone dimensions are illustrated by particle tracking results presented in Figure 3.

Scenario 2: In Scenario 2, another extraction well (EW-2) was added to the Scenario 1 configuration to address Plume B chloroform impacts in the second HSU. The additional extraction well is located in the middle of Plume B at the eastern site boundary. Model simulations indicate that with the Plume A extraction well pumping at 90 gpm and the Plume B extraction well pumping at 45 gpm the capture zone will encompass most of the on-site extent of chloroform impacts to the second HSU in both Plume A and Plume B. The capture zone dimensions are illustrated by particle tracking results in Figure 3.

Scenario 3: In Scenario 3, one additional extraction well (EW-3) was added to the Scenario 1 configuration, in the center of Plume A approximately 250 feet upgradient of extraction well EW-1. Well EW-3 may be necessary to provide sufficient extraction rate and attain capture if 90 gpm (the flow proposed from one extraction well in Scenario 1) is found to exceed the maximum sustainable flow rates for one extraction well. Additionally, locating a second Plume A extraction well upgradient of the site boundary may enhance chloroform mass removal rates. In this scenario all three extraction wells are pumped at 45 gpm each. Particle tracking results indicate that this configuration should provide a capture zone encompassing most of the on-site extent of chloroform impacts to the second HSU in Plume A and Plume B. However, the full width of the capture zone develops further upgradient in Plume A, as compared to scenarios 1 and 2. The mass removal benefits of adding an additional well in the interior of the plume upgradient of the site boundary (while retaining the downgradient extraction well) was not evaluated quantitatively with this model. A more sophisticated groundwater model would be required for this type of an evaluation.

4.0 REVIEW OF DISCHARGE OPTIONS

Potential options available for disposal of the extracted groundwater include discharge to the UC Davis Wastewater Treatment Plant (WWTP), reinjection into the second HSU aquifer, discharge to Putah Creek, and application to land. Each option is discussed below.

4.1 Discharge to UC Davis Wastewater Treatment Plant (WWTP)

Although several technical and policy issues would need to be addressed, it may be feasible to discharge groundwater to the UC Davis Wastewater Treatment Plant (WWTP) (David Phillips, personal communication). The key technical issue is whether the University could accept this water while continuing to meet all applicable regulatory standards for the WWTP. The principal policy issues is whether the University would be willing too devote a significant portion of its capacity to treat wastewater to this single source.

The University would only be able to accept the water if a thorough technical analysis of the proposed discharge indicates that the discharge would not lead to violations of the WWTP's Waste Discharge Limitations (WDRs), issued by the Central Valley Regional Water Quality Control Board (Board) and all other applicable criteria. The WDRs includes numeric limitations for specific constituents in the discharge and qualitative criteria designed to protect the receiving stream (i.e., Putah Creek). Based on limitations in the WDRs and other criteria, the University has developed both numeric and narrative local limits for the incoming flows to the WWTP. A copy of the numeric local limits is presented in Attachment A. The applicable local limits for constituents found in the groundwater are summarized in Table 4. The groundwater would not be acceptable unless compliance with all local limits is confirmed. The only constituent in the groundwater that exceeds its respective local limit is 1,1-DCE, which is prohibited at any concentration. Complete removal of 1,1-DCE without treatment of the other volatile compounds (VOCs) in the groundwater is not feasible, so all VOCs would be treated to non-detectable levels prior to discharge to the sanitary sewer.

The current WWTP is estimated to have a capacity of 2.0 to 2.4 million gallons per day (MGD) (expressed as a dry-weather monthly average). During the past year (1995), the maximum monthly flow through the WWTP was roughly 1.7 MGD. However, flows are projected to exceed the lower range of the estimated capacity by 2000 due to anticipated growth of the campus. Furthermore, as the WWTP nears its rated capacity, each additional

incremental increase in flow increased the odds of permit violations. Engineering analyses have indicated that suspended solids removal will ultimately limit capacity. It is difficult to predict how the groundwater flows would affect suspended solids performance.

The sewer lines and lift stations in the vicinity of the site are thought to have sufficient hydraulic capacity to accommodate the additional flows from the LEHR site (Davis Phillips, personal communication). However, a detailed hydraulic capacity analysis would need to be conducted to verify the sewer system capacity.

Formal permits are not normally required for discharge to the UC Davis WWTP, but discharge fees are routinely charged to dischargers. The University's cost to treat wastewater generated on the campus is currently approximately $0.87 per 100 cubic feet (CCF). This cost does not include any capital costs for the WWTP. However, given that the groundwater flow would be a significant portion of total capacity, capital costs for the treatment plant should be considered in the economical analysis (David Phillips, personal communication). The University is planning to have a new WWTP in operation by 19999. The new plant will have a dry-weather capacity of 2.7 MGD and is estimated to cost $16,000,000. Accordingly, the groundwater would be approximately 5% of the WWTP's total capacity. Therefore, the capital cost for discharge of the groundwater to the WWTP would be approximately $700,000.

4.2 Reinjection Into the Second HSU Aquifer

Under the Resource Conservation and Recovery Act (RCRA) Section 3020, treated groundwater that has been contaminated with "hazardous waste" can be reinjected into aquifers from which it was pumped if three criteria are met:

1. The groundwater is withdrawn as part of a corrective action required under RCRA or the Comprehensive Environmental Response Compensation and Liability Act (CERCLA) and intended to clean up contamination;

2. The treatment substantially reduces hazardous constituents prior to reinjection;

3. The remedial action producing the treated water will protect human health and the environment upon completion.

Criteria 2 could be interpreted as meaning that not all constituents in groundwater must be removed prior to reinjection of the water into the same aquifer. Thus, if the implementing

regulatory agency determines that the treatment of groundwater as part of the response action has "substantially reduced" the hazardous constituents, and the response action is "sufficient to protect human health and the environment," then the groundwater may be reinjected.

If extracted groundwater is not contaminated with "hazardous waste," it is not subject to the requirements of RCRA, including Section 3020. However, under CERCLA, the requirements of RCRA may be identified as Applicable or Relevant and Appropriate Requirements (ARARs). Hence, reinjection may be allowed, even if all contaminants are not removed. However, it should be noted that, if contaminants remain, the reinjected water must be returned into the impacted portion of the aquifer, which in the case of LEHR is the second HSU. The Board's Nondegradation Policy will not allow water to be reinjected into downgradient portions of the aquifer that are not impacted, even if the remaining contaminants are at levels that do not exceed maximum contaminant levels (MCLs) or other drinking water standards.

Table 4 presents the assumed discharge limits for reinjection based upon the above discussion. It is assumed the VOCs will need to be removed to non-detectable levels.

4.3 Discharge to Putah Creek

Discharge of treated groundwater directly to Putah Creek would require a National Pollutant Discharge Elimination System (NPDES) permit from the Board. The Board's standard practice is to issue an NPDES permit as part of WDRs issued for a discharge to surface water. For purposes of this report, it is assumed that the WDRs for a LEHR treatment system would resemble the June 1995 WDRs for a proposed discharge of the treated groundwater from a treatment system used for groundwater downgradient form the University's Davis Campus Landfill (WDR Order 95-187, Appendix B).

Table 4 presents the applicable limits for discharge to Putah Creek based on Order 95-187. The Order limits daily maximum discharges of total chromium (Cr) and hexavalent chromium (Cr^{+6}) to 0.05 and 0.016 milligrams per liter (mg/L), respectively. In addition, the Order limits concentrations of VOCs in the discharge to below detection limits. The Order states that the average TDS level in Putah Creek is 258 mg/L, and that the secondary drinking water standard is 500 mg/L. The Order requires the Discharger "shall use the best practicable cost-effective control technique currently available to limit TDS to no more than 500 mg/L."

Therefore, it is anticipated that the discharge to Putah Creek from LEHR may require removal of VOCs, and reduction in the levels of hexavalent chromium, nitrate and TDS.

Order 95-187 does not set numerical discharge limits for radiologic materials. The Order does limit discharge of radionuclides to: below MCLs; to below levels that would harm human, plant, animal, or aquatic life; or to below levels that bioaccumulate in aquatic life to and are harmful to humans.

4.4 Discharge to Agricultural Land

Discharge of extracted groundwater, either treated or untreated, solely to adjacent agricultural land does not appear feasible because the groundwater extraction system will be operated continuously, even during the wet season when no agricultural demand for water exists. However, application to land could be accomplished in conjunction with other discharge options and managed in a manner that meets needs of irrigation.

Application of extracted groundwater to land would require WDRs or a Record of Decision (ROD) that contains equivalent requirements. The WDRs or ROD would specify the water quality, designate an application area, and would specify a monitoring program for the discharge. The discharge location would probably be onto the private agricultural parcels to the east of the site, or onto UC Davis agricultural parcels to the west of the site. Because the potential discharge location is under different ownership, the WDRs may require that a contract be written that allows the discharge to continue for a specified period of time or until the remedial action is completed.

5.0 REVIEW OF TREATMENT ALTERNATIVES

The type of treatment unit process as well as the required level of treatment depends upon the influent flow rate and quality, and the conditions and limits for discharge. Section 3.0 discussed the expected flow rate and the quality of the extracted groundwater. Section 4.0 presented flow and quality limits for several discharge options. The influent flow and quality information, and the effluent (discharge) limits were used to evaluate treatment needs. In general, the groundwater flow rate was estimated to be 135 gpm. Depending upon which discharge is selected, treatment may require removal one or more of VOCs, chromium, nitrate, and TDS.

Several alternative technologies were evaluated. These include air stripping, carbon adsorption, ion exchange, and reverse osmosis. Each of the technologies is discussed below and summarized on Table 5. It should be noted that the combination of chemical constituents to be treated in groundwater presents unique treatment challenges. For example, an air stripping unit may be capable of removing VOCs, but ineffective at removing nitrate or inorganic constituents, such as chromium and TDS. Similarly, a reverse osmosis unit may remove TDS, but not organic compounds such as chloroform. Each of the technologies evaluated is described below.

5.1 Air Stripping

Air Stripping Process Description: Air stripping can be effective in removing VOCs. Shallow Tray, a manufacturer of a tray-type air stripper unit (Model 31231), can effectively reduce the VOCs down to non-detectable levels. The air stripper anticipated to be necessary for the LEHR site would be approximately 5 feet 10 inches wide, 12 feet 6 inches long, and have three trays on top of a sump. The stripper would operate using a 20-hp blower at approximately 1,800 standard cubic feet per minute to effectively treat and remove VOCs.

The need to treat the VOCs present in the resulting air stripper outgas was evaluated by reviewing the Yolo-Solano Air Quality Management District (AQMD) New Source Review (NSR) regulations. The regulations address VOC emissions from two perspectives: precursors to ozone formation (criteria pollutant) and health risk (air toxics).

The emission rate for an NSR exemption to obtaining an Authority to Construct (ATC)/Air Permit is currently set at 2 lb/day. The emission rate for an NSR exemption for Best Available Control Technology (BACT) or off-gas treatment requirements is currently set at 10 lb/day. The air emission estimates for the LEHR proposed groundwater treatment system as shown in Table 2, is less than 0.1 lb/day, which is below the NSR exemption level (2 lb/day). Air emissions from the groundwater treatment system were calculated assuming that the air stripper removes 100% of the VOCs from the water. The information indicate that the treatment system does not require an ATC/Air Permit due to emissions, and is not required to apply off-gas emissions treatment or BACT.

The de minimus health risk for requiring an ATC/Air Permit is 1 excess cancer cases per million people ($1x10^{-6}$). The health risk trigger level for applying Toxic-Best Available Control Technology (T-BACT) or off-gas emissions treatment is $1x10^{-5}$. A preliminary health risk assessment was performed by the Yolo-Solano Air Quality Management District and the screening shows the risk from the estimated emission is less than 1 excess cancer cases per million people (Lynn Finley, personal communication). Therefore, the treatment system does not require an ATC/Air Permit due to air toxic emissions, and is not required to apply T-BACT.

Based on the estimated emission rates and considered on its own, the UC Davis/LEHR groundwater treatment system would be exempt from air permitting requirements. However, this evaluation did not consider including the treatment system under UC Davis campus-wide air permits.

Air Stripping Effectiveness and Limitations: Modeling has demonstrated that the air stripper described above can remove 1,1-DCA, 1,1-DCE, 1,2-DCA and chloroform to a concentration less than 1 ppb. The air stripping unit will likely be ineffective in removing nitrate, chromium, and TDS from groundwater.

The presence of the TDS will result in a scaling problem for the air stripping unit and would require regular maintenance. The air stripper manufacturer estimates that the shallow-tray air stripper will require cleaning with a weak acid solution approximately once a month. An alternative to manual cleaning includes pretreatment of the extracted groundwater, such as using chemical additives to limit scaling.

Air Stripping Costs: The air stripper, has a capital cost of approximately $45,000. The annual operating costs are estimated to be on the order of $35,000. The main costs includes power, and labor for an acid wash cleaning once a month.

5.2 Carbon Adsorption

Two forms of carbon adsorption systems were evaluated for removal of VOCS and chromium. Conventional granular activated carbon systems can be effective for removal of VOCs, but may not be cost-effective removing chromium. A specially-treated activated carbon available from Lewis Environmental Systems, called EnviroClean, has shown to be effective in removing chromium. Both forms of carbon are discussed below.

5.2.1 Carbon Adsorption for VOC Removal

Carbon Adsorption Process Description: The carbon adsorption system conceptualized for the LEHR site consists of two carbon adsorbers in series, each containing 20,000 pounds of granular activated carbon and process control equipment. The carbon adsorbers are constructed of carbon steel with chemical-resistant lining. The feed system consists of an equalization tank, pH control, flow totalizer, centrifugal pump, motor control center, and electrical wiring.

Carbon Adsorption Effectiveness and Limitations: The liquid phase adsorption unit will remove VOCs. According to the manufacturer, the presence of TDS will not likely affect adsorption efficiency.

Carbon Adsorption Cost: The estimated cost for the carbon unit described is $145,000. The operating costs for the carbon adsorption unit includes costs for carbon regeneration, and chemical treatment for pH control. The estimated annual operating costs are expected to be approximately $200,000. This assumes that one carbon unit will be regenerated approximately every 35 days per year at cost of approximately $20,000 per change out (the regeneration costs cover labor and disposal of GAC). The regeneration costs are high due to the high carbon usage rate to remove chloroform.

5.2.2 Carbon Adsorption for Chromium Removal

Carbon Adsorption Process Description: A specially-treated activated carbon which removes hexavalent chromium is available from Lewis Environmental Systems. The carbon treatment process, called the EnviroClean Process, involves adsorption of chromium onto a specially-treated granular activated-carbon bed, and transport of the spent bed to an off-site carbon regeneration facility that uses an acidic regenerate process.

The EnviroClean carbon adsorption system consists of two carbon adsorbers in series, each containing 15,000 pounds of granular activated carbon and process control equipment. The carbon adsorbers are constructed of carbon steel with chemical-resistant lining. The feed system consists of an equalization tank, pH control, flow totalizer, centrifugal pump, motor control center, and electrical wiring.

Carbon Adsorption Effectiveness and Limitations: The EnviroClean water adsorption unit can remove chromium. According to the manufacturer, the presence of TDS is not likely to affect the adsorption efficiency. However, VOCs may not be effectively removed using EnviroClean system.

Carbon Adsorption Cost: The estimated cost for the EnviroClean unit sized to remove chromium is $250,000. The operating costs for the carbon adsorption unit includes costs for carbon regeneration, chemical treatment for pH control, and electrical power usage. The estimated annual operating costs for chromium removal only are expected to be approximately $40,000. This assumes that two carbon units will be regenerated each year.

The performance of bench-scale and field pilot trial systems are recommended prior to design and construction of a full-scale unit. A bench-scale test, called a dynamic column study, would be required. Following the dynamic column study, a field trial should be developed and operated.

5.3 Ion Exchange

Ion Exchange Process Description: Ion exchange (IX) involves the use of synthetic resins to remove dissolved ions (frequently heavy metals such as chromium) from solutions. The extracted groundwater is treated by passing it through a column filled with beads called

ion exchange resins. During the process of removing ions from the aqueous stream, other ions that are found on the resin are released into solution. The resin columns are eventually used up or spent. The columns can then be regenerated on- or off-site. For the resins to work effectively, the incoming water should be reasonably clean and void of suspended solids. Therefore, prefiltering is recommended to prevent overloading the resins.

Kinetico Engineered Systems, Inc. manufactures an ion exchange skid mounted with the necessary equipment to operate an ion exchange system: influent tank, pump, filtration (bag and media), quadraplex resin tanks, regeneration storage tank, and controls. Kinetico recommends that the specific unit be designed with a resin that selectively removes chromium. The skid unit occupies a surface of approximately 12 by 45 feet and contains several large 24-inch-diameter columns containing the beads. Each column is approximately 9 feet high. Due to the large size of the treatment system housing it would be very difficult and costly. Most ion exchange systems are weather proofed and can be operated outdoors.

Ion Exchange Effectiveness and Limitations: Ion exchange can remove chromium, nitrate and TDS. Ion exchange is not effective at removing VOCs. The ion exchange column can be affected by the presence of the suspended solids, therefore requiring prefiltration.

A drawback associated with Ion exchange is that a concentrated salt solution (reject) would be generated on a continuous basis. The IX unit is estimated to have a reject of approximately 5 percent of the incoming flow rate; therefore, the reject flow rate would be approximately 5 to 10 gallons per minute. The TDS would be concentrated in the reject flow stream. This concentrated stream would have a hexavalent chromium concentration of approximately 600 μg/L. This level of chromium could not be disposed of in the UC Davis WWTP. Therefore, the chromium would have to be reduced with lime and passed through a filter press to create a sludge that would have to be disposed. Alternatively, the IX reject stream could be treated using the Enviroclean process. The effluent from that treatment process could be discharged to the UC Davis WWTP.

Ion Exchange Cost: The cost for an ion exchange unit is dependent upon the flow rate. If all the chromium, nitrate and TDS are to be removed, the capital cost for a 135-gpm skid-mounted ion exchange unit that removes selected metals, nitrate and TDS will cost approximately $540,000. By comparison, the cost for a 100-gpm unit is estimated to be $450,000.

The operation and maintenance costs include operation of the filter, resin regeneration. The specific cost for operation and maintenance is estimated to be $105,000 annually. The regeneration process would likely be accomplished on-site using a regenerate that would result in a concentrated salt stream containing TDS, nitrate and chromium.

The capital cost for IX stream treatment using a chromium reduction system and filter press unit is estimated to be $70,000. Operations and maintenance costs which include power, and disposal costs are approximately $20,000. This increases the cost of the 135 gpm ion exchange process to $610,000, and the 100 gpm unit to $520,000. The operation and maintenance costs for both the 135 and 100 gpm units are estimated to be approximately $125,000.

Bench-scale and field pilot trial systems are recommended prior to design and construction of a full-scale unit.

5.4 Reverse Osmosis

Reverse Osmosis Process Description: Reverse osmosis (RO) is commonly used to reduce TDS from liquid streams. In using RO, the groundwater extracted from the LEHR site would first be prefiltered to remove solids prior to passing through the reverse osmosis module. The RO process involves creating a pressure gradient and flow across an RO membrane, causing the water to permeate through the membrane. The concentrate (high TDS component) must be appropriately treated and discharged at the UC Davis WWTP, while the permeate (clean groundwater) could be discharged.

Kinetico manufactures a RO unit suitable for removal of TDS, nitrate and chromium. It should be noted that the influent TDS concentration is approximately 660 mg/L, and the discharge limit is 500 mg/L. Therefore, part of the incoming groundwater can bypass the RO unit and a 100-gpm RO unit should be sufficient. The 100-gpm unit would consist of a series of membrane units that would be placed on a skid approximately 9 feet wide and 27 feet long. Due to the relatively large size of the treatment system, housing it would be difficult and costly. Like ion exchange, most reverse osmosis systems are weather proofed and are meant to be used outdoors.

The concentrated stream would have a hexavalent chromium concentration of approximately 100 μg/L. This level of chromium could not be disposed of in the UC Davis WWTP. The chromium would have to be reduced, precipitated, and disposed. The discharge from that treatment process could be discharged to the UC Davis WWTP.

Reverse Osmosis Effectiveness and Limitations: Reverse osmosis is sensitive to the presence of solids. Therefore, pretreatment or filtering will be required. Although RO is effective in removing nitrate, TDS and chromium, RO will not effectively remove VOCs. A drawback associated with RO is that a concentrated salt solution (reject) is generated on a continuous basis. The RO unit may have a reject flow of approximately 30 percent of incoming flow rate (100 gpm); therefore, the reject flow rate estimated for LEHR would approximately 30 gallons per minute. The TDS would be concentrated in this 30-gpm flow stream. For example, the incoming chromium concentration is estimated to be 30 μg/L; therefore, the concentration of chromium in the concentrate will be approximately 100 ppm. This level of chromium could not be disposed of in the UC Davis WWTP. Therefore, the chromium would have to be reduced with lime and passed through a filter press to create a sludge that would have to be disposed.

Reverse Osmosis Cost: The cost for an RO unit is dependent upon the flow rate. If all the chromium, nitrate and TDS are to be removed, the capital cost for a 135-gpm unit will be approximately $560,000. By comparison, the cost for a 100-gpm unit is estimated to be $420,000. The operation and maintenance costs include electric power, membrane replacement, and disposal to the sanitary sewer. The annual operation and maintenance costs are estimated to be $60,000. This includes power costs, a cleaning service contract with the vendor, and replacement of the membrane every three years.

The capital cost for the chrome reduction and filter press unit is $70,000. Operations and maintenance costs which include power, and disposal costs are approximately $20,000. This increases the cost of the 135 gpm reverse osmosis process to $630,000, and the 100 gpm unit to $490,000. The operation and maintenance costs for both the 135 and 100 gpm units are $80,000.

Bench-scale and field pilot trial systems are recommended prior to design and construction of a full-scale unit.

6.0 ANALYSIS OF REMEDIAL ALTERNATIVES

This section presents a discussion of the potential remedial options for extracting, treating, and discharging groundwater from the UC Davis property boundary. This analysis is based upon the previous three sections: Section 3 which included a discussion of extraction well location, flow rate, and expected water quality; Section 4 which addressed possible discharge options and the regulatory limits and conditions for discharge; and section 5 which discussed treatment systems for VOCs, nitrate, chromium, and TDS. A total of four alternatives are presented and include:

- Alternative 1 — Groundwater extraction, treatment using air stripping, and discharge to reinjection wells;
- Alternative 2 — Groundwater extraction, treatment using air stripping, and discharge to the UC Davis WWTP;
- Alternative 3 — Groundwater extraction, treatment using air stripping and ion exchange, and discharge to Putah Creek; and
- Alternative 4 — Groundwater extraction, treatment using air stripping and ion exchange, and discharge to reinjection wells.

The four alternatives were selected because they represent a range of possible treatment and discharge options.

The four alternatives were designed with some commonalities in order to aid in determining the most feasible and cost-effective alternative. Two extraction wells were assumed to be common to for all four alternatives: EW-1 and EW-2 which are both located on the road on the eastern side of the drainage ditch between the Hamel property and UC Davis Raptor Center. EW-1 will be pumped at 90 gallons per minute (gpm), and EW-2 will be pumped at 45 gpm.

The treatment system location is also assumed to be the same for all options. The treatment system location was chosen because: it is a clear spot next to a road near sewer lines for the UC Davis WWTP; it is next to a ditch leading to Putah Creek; and it is close to the extraction wells.

Each of the four options are discussed below. Table 6 includes a summary of the options and includes preliminary cost estimates.

Alternative 1. **Groundwater extraction, treatment using air stripping, and discharge to reinjection wells.** Alternative 1 includes pumping from 2 wells at a flow of 135 gpm, prefiltration using a bag filter, treatment using a shallow tray air stripper and reinjection to the second HSU using four wells.

The conceptual layout for Alternative 1 is presented in Figure 5. The treatment system design includes an influent tank, bag filter, and air stripper. The treatment system will be housed in a 16 by 24 foot building with a concrete pad. The treated discharge will be pumped by a discharge pump through a pipe connecting to injection wells R-1, R-2, R-3 and R-4. The well locations shown on Figure 5 are preliminary and groundwater modeling will have to be performed to determine the exact number of injection wells and the exact well locations.

A gravity drain pipe for the residual effluent stream will connect a manhole where the discharge will flow to the UC Davis WWTP. This connection will allow disposal of small quantities of neutralized acid wash water generated during the cleaning of the air stripper.

The capital cost for the Alternative 1 is estimated to be $475,000. The annual operations and maintenance costs for maintaining the system are $65,000. The total costs for Alternative 1 for one year are $540,000 (Table 5).

Alternative 2. **Groundwater extraction, treatment using air stripping, and discharge to the UC Davis WWTP.** Alternative 2 includes pumping from 2 wells at a flow of 135 gpm, prefiltration using a bag filter, treatment using a shallow tray air stripper and discharge to the UC Davis WWTP.

Figure 6 shows the conceptual layout for Alternative 2. The treatment system design includes an influent tank, bag filter, and air stripper. The treatment system will be housed in a 16 by 24 foot building with a concrete pad. A gravity drain effluent pipe will connect to the nearest manhole where the discharge will flow to the UC Davis WWTP.

The capital cost for the Alternative 2 is estimated to be $1,085,000. The bulk of the capital costs is a capital improvements fee of $700,000 for the construction of the new UC Davis WWTP. The annual operations and maintenance costs for maintaining the system are $155,000. The bulk of the operations and maintenance costs are the $0.88 per 100 cubic foot water charge to discharge to the UC Davis WWTP. The total cost for Alternative 2 for one year is $1,240,000 (Table 5).

Alternative 3

Groundwater extraction, air stripping and ion exchange, and discharge to Putah Creek. Alternative 3 includes pumping from 2 wells at a flow of 135 gpm, treatment using an air stripper and ion exchange unit, and discharge to Putah Creek.

Figure 7 shows the conceptual layout for Alternative 3. The treatment system will be not be housed in a building because of the size of the system. An ion exchange system, excluding the air stripper, will occupy a 12 by 45 foot area. A reverse osmosis system, again excluding the air stripper, will fit on a 9 by 27 foot skid. We recommend placing the skid on a reinforced concrete pad. The treatment system will be surrounded by a chain-link fence. The discharge pipe will connect the treatment system to the 6 foot deep 20 foot wide ditch which runs directly south to Putah Creek. The ditch runs through a pipe under the Putah Creek levee and has one foot high outfall into Putah Creek. Effluent water will not be allowed to come in contact with landfill waste that is intersected by this drainage ditch.

Like Alternative 1 and 2, a gravity drain pipe for the residual effluent stream will connect to the nearest manhole where the discharge will flow to the UC Davis WWTP. This drain will allow disposal of acid wash water when cleaning the air stripper. The relatively concentrated reject from the ion exchange unit would be discharged to the UC Davis WWTP via sewer line in the vicinity of the Raptor Center.

The capital cost for the Alternative 3 (IX, 100 gpm) is estimated to be $920,000. The annual operations and maintenance costs for maintaining the system are $200,000. The capital cost for the Alternative 3 (IX, 135 gpm) is estimated to be $1,020,000. The annual operations and maintenance costs for maintaining the system are $200,000. The total cost of Alternative 3 (IX, 135 gpm) are $1,220,000 (Table 5).

Should this option be selected, more research should be performed to determine if ion exchange or reverse osmosis is more cost-effective at removing chromium, nitrate and TDS. Also bench scale testing should be performed on ion exchange and/or reverse osmosis to evaluate the need for pretreatment and confirm the removal efficiency for chromium, nitrate and TDS.

Alternative 4

Groundwater extraction, treatment using air stripper and ion exchange, and discharge to reinjection wells. Alternative 4 includes extraction from the same two wells assumed for Alternatives 1,2, and 3, and discharge of treated water to a reinjection well system discussed for Alternative 1.

The capital cost for Alternative 4 is estimated to be $1,180,000. The annual operation and maintenance costs for the system are $215,000. The total costs of Alternative 4 are $1,395,000 (Table 5).

7.0 SUMMARY AND CONCLUSIONS

This summary reviews the assessment process and assumptions used to evaluate various remedial alternatives to capture and remove groundwater contaminants along the UC Davis property boundary. The conclusions present the results of the assessment that consist of groundwater extraction, treatment, and discharge scenarios. In addition, recommendations are presented for several specific activities necessary to further evaluate the appropriate IRA.

7.1 Summary

This assessment was conducted to evaluate potential remediation alternatives that address groundwater impacts at the LEHR site for an IRA. Because of the complex nature of the site and variety of groundwater impacts, the direction of the assessment was focussed on chloroform and VOC-impacted groundwater in the second HSU that appears to be migrating off UC Davis property. Although site remediation will also have to address the toe of the plume and upgradient source areas, this assessment focussed on alternatives that could be implemented as an IRA and would capture and treat VOCs at the property boundary. The alternatives included various groundwater extraction scenarios, ex-situ treatment technologies, and effluent discharge options.

Chemical and hydrogeology data were reviewed to estimate the chemical composition of groundwater treatment influent water and to estimate aquifer characteristics for input into a hydrogeologic model. Chemical concentrations were estimated for areas of potential extraction well locations at the UC Davis property boundary east of the LEHR site. Based on previous investigations, site parameters of concern include chloroform and other VOCs, nitrate, hexavalent chromium, and TDS. The chemical concentration estimates were used to evaluate treatment and disposal options. Second HSU aquifer characteristics were estimated using recent slug test data (PNL, 1995c) and aquifer pumping tests conducted at the nearby UC Davis Landfill. Hydrogeologic characteristics were entered into an analytical groundwater flow model to evaluate various extraction well locations and pumping rates.

Four discharge alternatives were considered for groundwater extracted and treated from the site perimeter: discharge to the UC Davis WWTP; discharge to adjacent agricultural land; re-injection to the second HSU; and discharge to Putah Creek. Discharge to the UC Davis WWTP is feasible but will require treatment for VOCs and verification that sewer lines

and lift stations in the area of the site have the hydraulic capacity to accept a discharge from a groundwater treatment plant at LEHR. Discharge to the UC Davis WWTP would also require the university to devote a significant portion of the plant capacity to this project.

Permission to reinject extracted groundwater to the second HSU may depend on meeting three RCRA criteria. It is possible that the only treatment that may be required for reinjection is for VOCs, however, further evaluation will be necessary to pursue this option. The feasibility of discharging treated groundwater directly to Putah Creek was evaluated based on NPDES permit conditions for a similar discharge proposed at the UC Davis Landfill. Preliminary information suggests that the extracted groundwater from the LEHR site would have to be treated for removal of VOCs, nitrate, chromium, and TDS. Discharge of treated groundwater to adjacent agricultural parcels is a viable option if used in conjunction with one of the other options.

Four treatment options were evaluated to address parameters of concern estimated to be in extracted groundwater. The technologies included: air stripping; activated carbon (GAC); ion exchange (IX); and reverse osmosis (RO). Based on the evaluation, VOCs are best removed by air stripping. Removal of chromium, TDS, and nitrate can be accomplished using IX or RO. The cost for purchasing and operating these IX and RO systems are similar and more detailed testing will be necessary to determine the most cost effective option for the LEHR site. Both IO or RO would result in the discharge of a concentrated salt stream to the UC Davis WWTP. To meet the plant limits the salt stream will have to be treated to remove chromium.

7.2 Conclusions

The results of the assessment indicate that chloroform and VOC-impacted second HSU groundwater can be intercepted and captured at the UC Davis property boundary using 2 to 3 extraction wells pumping at and estimated 90 to 135 gallons per minute. Model simulations indicate that one well can achieve capture of the main, northern, VOC plume extending from the LEHR site by pumping at approximately 90 gpm. One well can achieve capture of the smaller, southern, chloroform impacts associated with UC Davis Landfill Unit #3 by pumping at 45 gpm. It is also estimated that an additional well can be placed upgradient of the property boundary along the plume axis to aid in plume capture or in mass removal.

Based on the estimated concentrations of general chemical parameters and site parameters of concern, likely available treatment technologies include air stripping for chloroform and other VOCs, and ion exchange or reverse osmosis for removal of chromium, nitrate, and TDS.

Discharge options for treated water include discharge to the UC Davis sanitary sewer, reinjection to the second HSU, and direct discharge to Putah Creek. The selected discharge option will depend on regulatory limits for concentrations and the treatment costs associated with achieving those limits. It is likely that any selected discharge option will include provisions for on-demand use by UC Davis or local agriculture.

An analysis of the described treatment technologies and discharge options resulted in an assessment of four remedial alternatives to address the groundwater impacts at the UC Davis property perimeter. The alternatives cover a range of potential scenarios and included:

- Alternative 1 — Groundwater extraction, treatment using air stripping, and discharge to reinjection wells;
- Alternative 2 — Groundwater extraction, treatment using air stripping, and discharge to the UC Davis WWTP;
- Alternative 3 — Groundwater extraction, treatment using air stripping and Ion exchange, and discharge to Putah Creek; and
- Alternative 4 — Groundwater extraction, treatment using air stripping and ion exchange, and discharge to reinjection wells.

Preliminary capital and operation and maintenance costs were provided for each of the alternatives. A summary showing the technical and cost information for each option is provided in Table 6.

7.3 Recommendations

Based on the conclusions of the assessment, there are several specific activities that can be initiated that will advance the implementation of an IRA for groundwater at the LEHR site. Several of these activities were proposed in the UC Davis conceptual work plan (November 30, 1995), and relate to implementing groundwater extraction, selecting treatment

and discharge alternatives, and resolving general critical issues for remediation at the LEHR site. The recommendations are presented below.

Groundwater Extraction

To further assess groundwater extraction scenarios, we recommend conducting an aquifer pumping test to generate data for the design of the extraction and treatment system. The test could be conducted by installing one of the proposed extraction wells (EW-1) and appropriate piezometers and conducting a step drawdown test and a 48-hour constant rate test to assess aquifer parameters. In addition, samples could be collected for chemical analysis to more accurately estimate the composition of influent groundwater. Results from the aquifer tests would then be used to construct a numerical groundwater flow model to further constrain additional groundwater extraction well locations, and to assess potential reinjection well locations for the groundwater IRA.

Treatment and Discharge

To further address uncertainties in treatment and discharge alternatives, we recommend discussions with key personnel and regulatory agency representatives to refine discharge criteria for the UC Davis Wastewater Treatment Plant, Putah Creek, and re-injection to groundwater. These discussion would be most productive if conducted after completion of groundwater chemical analysis of samples collected during aquifer testing.

Critical Issues

During this assessment, several critical issues emerged that will have significant impacts on the direction of future decisions concerning a groundwater IRA and/or other potential remediation at the LEHR site. These issues consist of various technical and regulatory questions that should be answered early in the process of implementing groundwater remedial measures. Several of the most critical issues are described briefly below:

- The success of an IRA that addresses the VOC plume at the site boundary will ultimately depend on implementing remedial actions near the site sources. It will therefore be important to perform a similar assessment on the feasibility of remedial actions for soil and groundwater near the source areas. The

assessment should address hydraulic control near the source, in-situ and ex-situ technologies, and the need for addtiional data colection.

- An important assumption of this assessment was that the VOC plume migrating off UC Davis property must be addressed. If there are changes in public or regulatory concern over the migrating VOCs, the focus of potential interim remediation alternatives may also change.

- The operation of the Nishi irrigation well was not included in the evaluation of groundwater extraction scenarios. However, because the well extracts an estimated 800-1000 gpm (mostly from the second HSU, Dennis Parfitt - personal communication), continued operation of the well would significantly decrease the effectiveness of an extraction and treatment system at the UC Davis perimeter. The future status of this well must be resolved prior to the design and implementation of a groundwater IRA.

- The LEHR site is a NPL listed site. As such, an IRA will have to comply with various CERCLA requirements and follow appropriate procedures. These requirements and procedures should be considered and evaluated as to their impact on the implementation and schedule of the IRA.

- The USDOE is one of the stakeholders of the LEHR site. As a result it will be necessary to evaluate if DOE procedures and requirements will have to be considered prior to UC Davis implementing a groundwater IRA.

7.4 Schedule

Table 7 presents a schedule of activities that will be performed to lead up to and to implement a groundwater IRA at LEHR. These activities are based on our current understanding of site groundwater conditions and on the general approach to the IRA presented in this assessment. New information from the on-going site investigation may change the priorities and timing of anticipated remedial measures and as a result change the activities and schedule. In addition, the schedule will be dependent upon timely response and/or approval as required by the appropriate regulatory agencies and stakeholders at LEHR.

8.0 REFERENCES

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TABLE 1

SECOND-HSU MODEL INPUT PARAMETERS
ASSESSMENT OF REMEDIAL OPTIONS
GROUNDWATER EXTRACTION AND TREATMENT
LEHR - UC Davis

Parameter	Value	Source of Data
Hydraulic Conductivity	434 ft/day	1995 Slug test Data (PNL, 1995)
Storativity	0.0039	UC Davis Landfill Pump Test
Leakage Factor	1,300 ft	
Porosity	0.28	Book Estimate
Uniform Gradient	0.0014	Groundwater Elevation Contour Maps 1992-1994
Direction of Uniform Gradient	86°	
Elevation of Top of Aquifer	-33 feet MSLD	Boring Logs for UCD2-27
Elevation of Bottom of Aquifer	-77 feet MSLD	

TABLE 2

SECOND-HSU SLUG TEST DATA[1]
ASSESSMENT OF REMEDIAL OPTIONS
GROUNDWATER EXTRACTION AND TREATMENT
LEHR - UC Davis

Well	Transmissivity (ft^2/day)	Hydraulic Conductivity (ft/day)
UCD2-7	1,400	142
UCD2-15	8,987	359
UCD2-16	12,300	578
UCD2-17	16,500	659

(1 PNL, 1995c.

TABLE 3

SUMMARY OF SECOND-HSU CHEMICAL PARAMETERS
ASSESSMENT OF REMEDIAL OPTIONS
GROUNDWATER EXTRACTION AND TREATMENT
LEHR - UC Davis

Parameter	Unit	Estimated Value	Source of Data
Chloroform	µg/L	40	Approximated from Hydropunch locations HPL225, HPL226, HPL14
Bromodichloromethane	µg/L	ND	October 1995 Nishi well data
1,1,2 TCA	µg/L	ND	October 1995 Nishi well data
1,1 DCA	µg/L	0.4	October 1995 Nishi well data
1,1 DCE	µg/L	0.5	October 1995 Nishi well data
1,2 DCA	µg/L	1.2	October 1995 Nishi well data
1,2 Dichloropropane	µg/L	0.3	October 1995 Nishi well data
Hexavalent chromium	µg/L	30	1994 Hydropunch data
Nitrogen as nitrate	mg/L	20	1994 and 1995 Hydropunch data
Tritium	mg/L	ND	1994 and 1995 Downgradient Hydropunch data
TDS	mg/L	658	Average of 1994 data from wells UCD2-7 and UCD2-14
Chloride	mg/L	31.3	Average of 1994 data from wells UCD2-7 and UCD2-14
Sulfate	mg/L	53.6	Average of 1994 data from wells UCD2-7 and UCD2-14
Alkalinity (as $CaCO_3$)	mg/L	468	Average of 1994 data from wells UCD2-7 and UCD2-14
Sodium	mg/L	47.7	Average of 1994 data from wells UCD2-7 and UCD2-14
Calcium	mg/L	42.6	Average of 1994 data from wells UCD2-7 and UCD2-14
Magnesium	mg/L	106.5	Average of 1994 data from wells UCD2-7 and UCD2-14
Potassium	mg/L	<2	1994 Data from wells UCD2-7 and UCD2-14
Specific Conductance	µmhos/cm	885	Average of 1994 data from wells UCD2-7 and UCD2-14
pH	standard units	6.97-7.57	Range of 1994 data from wells UCD2-7 and UCD2-14
COD	mg/L	<10	1994 Data from wells UCD2-7 and UCD2-14

TABLE 4

DISCHARGE WATER QUALITY ESTIMATE
ASSESSMENT OF REMEDIAL OPTIONS
GROUNDWATER EXTRACTION AND TREATMENT
LEHR – UC DAVIS

Contaminants	Units	MCL	Estimated Concentration	UC Davis Local Sewer Limits[1]	Putah Creek Discharge Limits[2]	Reinjection Limits[3]
Chloroform	ug/L	100	40	420	ND	ND
Bromodichloromethane	ug/L	100	ND	140	ND	ND
1,1,2 TCA	ug/L	5	ND	-	ND	ND
1,1 DCA	ug/L	5	0.4	-	ND	ND
1,1 DCE	ug/L	6	0.5	0	ND	ND
1,2 DCA	ug/L	0.5	1.2	-	ND	ND
1,2 Dichloropropane	ug/L	5	0.3	-	ND	ND
Chromium VI	ug/L	-	30	59	16	-
Total Chromium	ug/L	50	33	-	50	-
Nitrogen as Nitrate	mg/L	10	20	-	10	-
Tritium	pCi/L	20,000	0	7,441[4]	20,000	-
TDS	mg/L	500*	658	-	500	-
Chloride	mg/L	250*	31.25	-	-	-
SO4 (Sulfate)	mg/L	400	53.6	-	-	-
Alkalinity as CaCO3	mg/L		468	-	-	-
Sodium	mg/L		47.7	-	-	-

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TABLE 4 (CONTINUED)

DISCHARGE WATER QUALITY ESTIMATE
ASSESSMENT OF REMEDIAL OPTIONS
GROUNDWATER EXTRACTION AND TREATMENT
LEHR – UC DAVIS

Contaminants	Units	MCL	Estimate Weighted Mean Concentration	UC Davis Local Sewer Limits[1]	Putah Creek Discharge Limits[2]	Reinjection Limits[3]
Calcium	mg/L		42.6	-	-	-
Magnesium	mg/L		106.48	-	-	-
Potassium	mg/L		<2	-	-	-
EC (Specific Conductance)	micromhos	900*	885	-	-	-
pH	std. units	6.5-8.5*	6.97-7.57	5-11	6.5-8.5	-
Chemical Oxygen Demand	ppm		<10	-	-	-
Flow Rate	gpm		135	-	-	-
Flow Rate (Peak)	MGD		0.2	-	0.4	-

Notes:
MCL = Maximum Contaminant Level
* = Recommended Secondary Maximum Contaminant Level
ND = Non-Detect
- = No Limit
[1] = Final Local Limits provided by Dave Phillips, P.E., UC Davis Facilities- Engineering Services
[2] = Waste Discharge Requirements for UC Davis Campus Landfill Ground Water Cleanup System, Yolo County
[3] = Resource Conservation and Recovery Act (RCRA) Section 3020
[4] = Based on 2 Curies per year (per Steve Kubo, UC Davis EH&S) and a discharge rate of 135 gpm
Shading = Concentration exceeds one or more limit

TABLE 5

ASSESSMENT OF REMEDIAL OPTIONS
TREATMENT TECHNOLOGIES - PLANNING LEVEL COST ESTIMATE
GROUNDWATER EXTRACTION AND TREATMENT
LEHR - UC Davis

Treatment Technology	Air Stripper (AS)	Vapor Phase Carbon (GAC)	Liquid Phase Carbon (GAC)	Specially Activated Liquid Phase Carbon (GAC)	Ion Exchange (IX)	Ion Exchange (IX)	Reverse Osmosis (RO)	Reverse Osmosis (RO)
GPM	135	135	135	135	100	135	100	135
Target Pollutants	VOCs	VOCs	VOCs	Cr+6	Chromium TDS Nitrate	Chromium TDS Nitrate	Chromium TDS Nitrate	Chromium TDS Nitrate
Capital Costs	$45,000	$50,000	$145,000	$250,000	$520,000	$610,000	$490,000	$630,000
Annual O&M Costs	$35,000	$200,000	$195,000	$40,000	$125,000	$125,000	$80,000	$80,000
Vendors (Reps)	Shallow Tray (Northeast Environmental)	Carbonair	Cameron Yakima (West General Assoc.)	Enviroclean (Lewis Environmental)	Kinetico (Technica USA)	Kinetico (Technica USA)	Kinetico (Technica USA)	Kinetico (Technica USA)

Notes: Many of the above technologies require bench and pilot scale testing. The cost of these tests have not been included.

TABLE 6

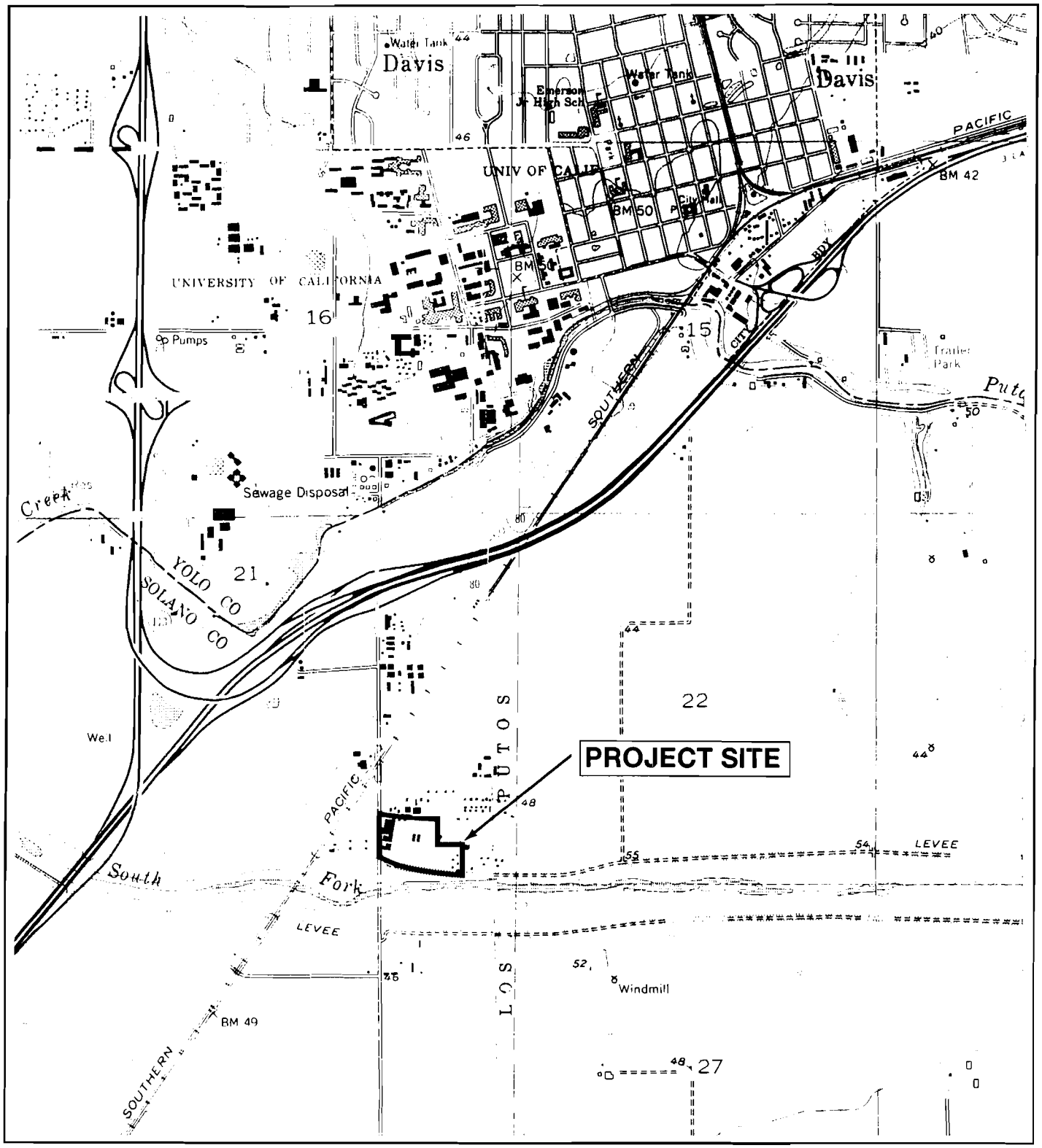
ASSESSMENT OF REMEDIAL OPTIONS
FEASIBILITY COST ESTIMATE
GROUNDWATER EXTRACTION AND TREATMENT
LEHR - UC Davis

Alternative	Extraction Rate	Treatment Technology	Target Pollutants	Selected Discharge	Capital Cost	Operation and Maintenance (1 year)	Total Estimated Cost
1	135	Air Stripper	VOCs	Re-injection to second HSU with connection to sanitary sewer	$475,000	$65,000	$540,000
2	135	Air Stripper	VOCs	UC Davis Wastewater Treatment Plant	$1,085,000	$155,000	$1,240,000
3	135	Air Stripper, Ion Exchange	VOCs, nitrate, hexavalent Chromium, TDS	Direct to Putah Creek with connection to sanitary sewer	$1,020,000	$200,000	$1,220,000
4	135	Air Stripper, Ion Exchange	VOCs, nitrate, hexavalent Chromium, TDS	Re-injection to second HSU with connection to sanitary sewer	$1,180,000	$215,000	$1,395,000

TABLE 7

ASSESSMENT OF REMEDIAL OPTIONS
SCHEDULE
GROUNDWATER EXTRACTION AND TREATMENT
LEHR - UC Davis

TASK	ANTICIPATED COMPLETION DATE
Technology Review/Assessment of Remedial Options	February 29, 1996
Meeting with Appropriate Regulatory Agencies	March 15, 1996
Field Hydraulic Testing	March 31, 1996
Hydrogeologic Modeling	May 10, 1996
Pilot Testing	June 1, 1996
Design Basis, Develop Remedial Goals	June 30, 1996
Remedial Design	August 30, 1996
Implement Remedial Action	December 31, 1996



REFERENCE: USGS 7.5' Quadrangle Merritt CA, 1981, Davis CA, 1982

N

0 2000

Scale in Feet

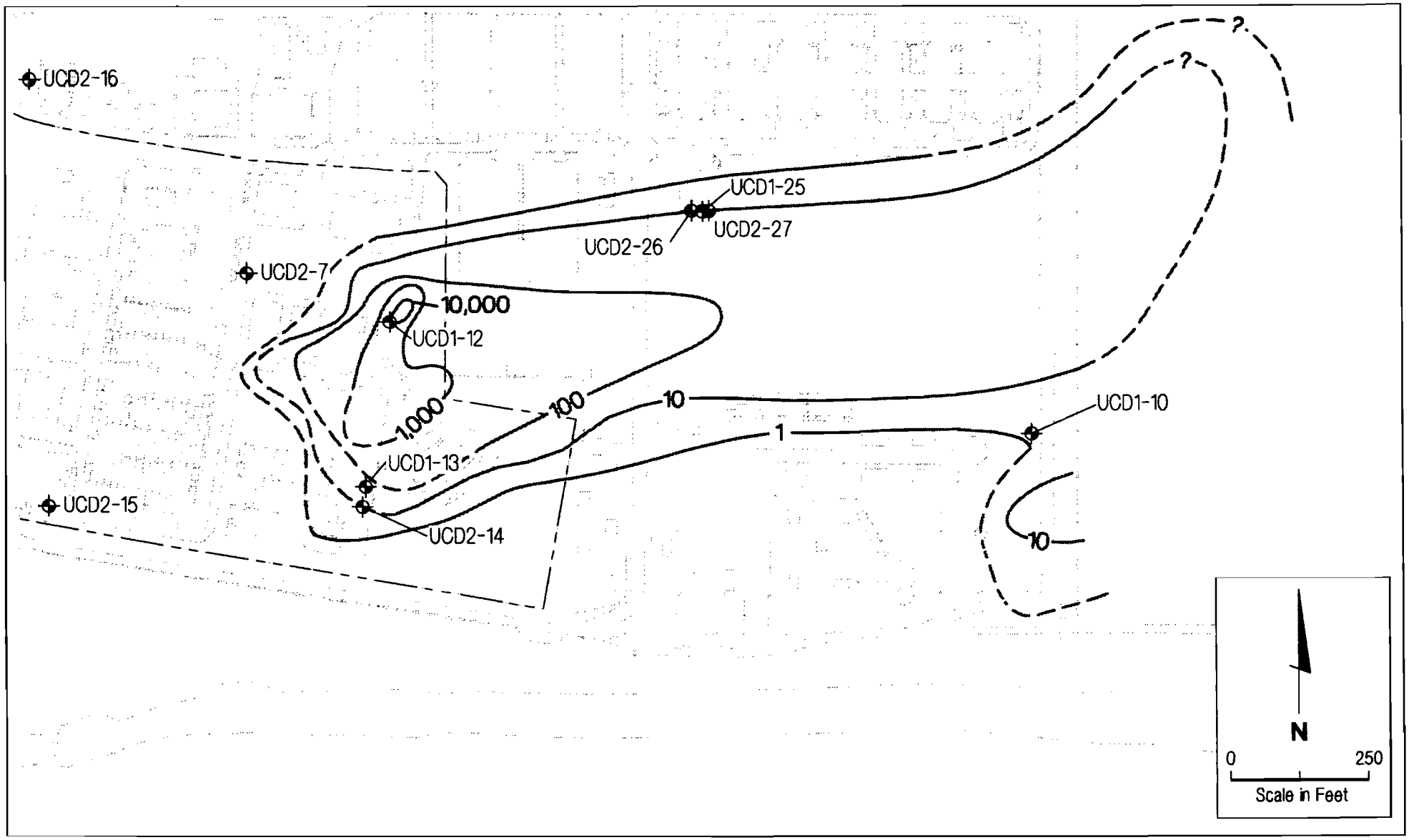
SITE VICINITY MAP

UC Davis/LEHR Feasibility Study
University of California Davis
Davis, California

DAMES & MOORE

00234-224-0103-044

FIGURE 1



EXPLANATION

UCD2-26 Monitoring Well Locations

—100— Chloroform Concentration Contours

SECOND HSU CHLOROFORM CONCENTRATION CONTOUR MAP

UC Davis/LEHR Feasibility Study
University of California Davis
Davis, CA

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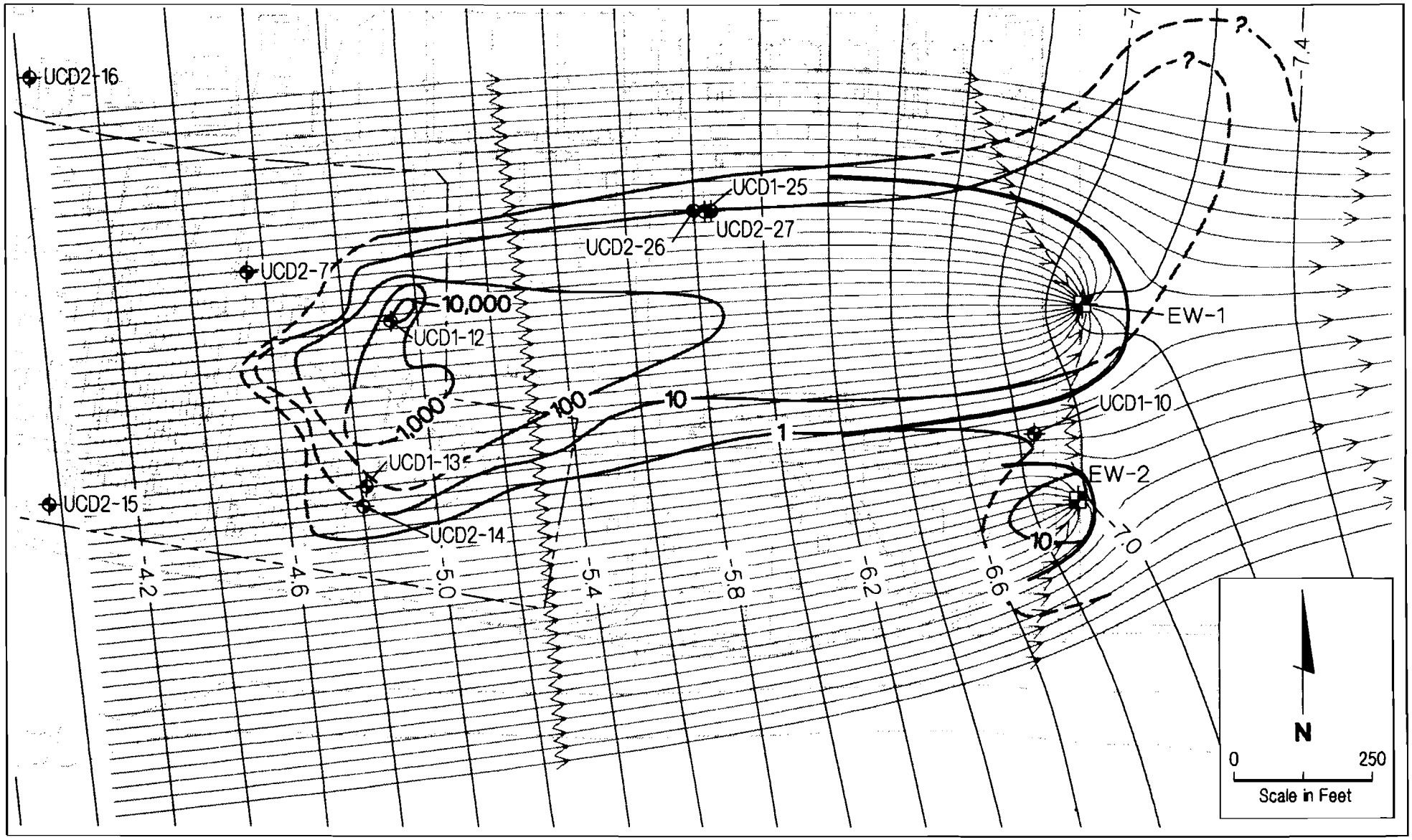
00234-224-0103-044 ah 0103C 2/20/96

FIGURE 2



EXPLANATION

- UCD2-26 Monitoring Well Locations
- EW-1 Simulated Extraction Well Locations
- 100 Chloroform Concentration Contours
- -7.4 Simulated Groundwater Elevation Contour in Feet MSLD
- Simulated Particle Paths
- Approximate Combined Capture Zone for EW-1, and EW-2

GROUNDWATER EXTRACTION WELL FIELD SIMULATION SCENARIOS 1 AND 2

UC Davis/LEHR Feasibility Study
University of California Davis
Davis, CA

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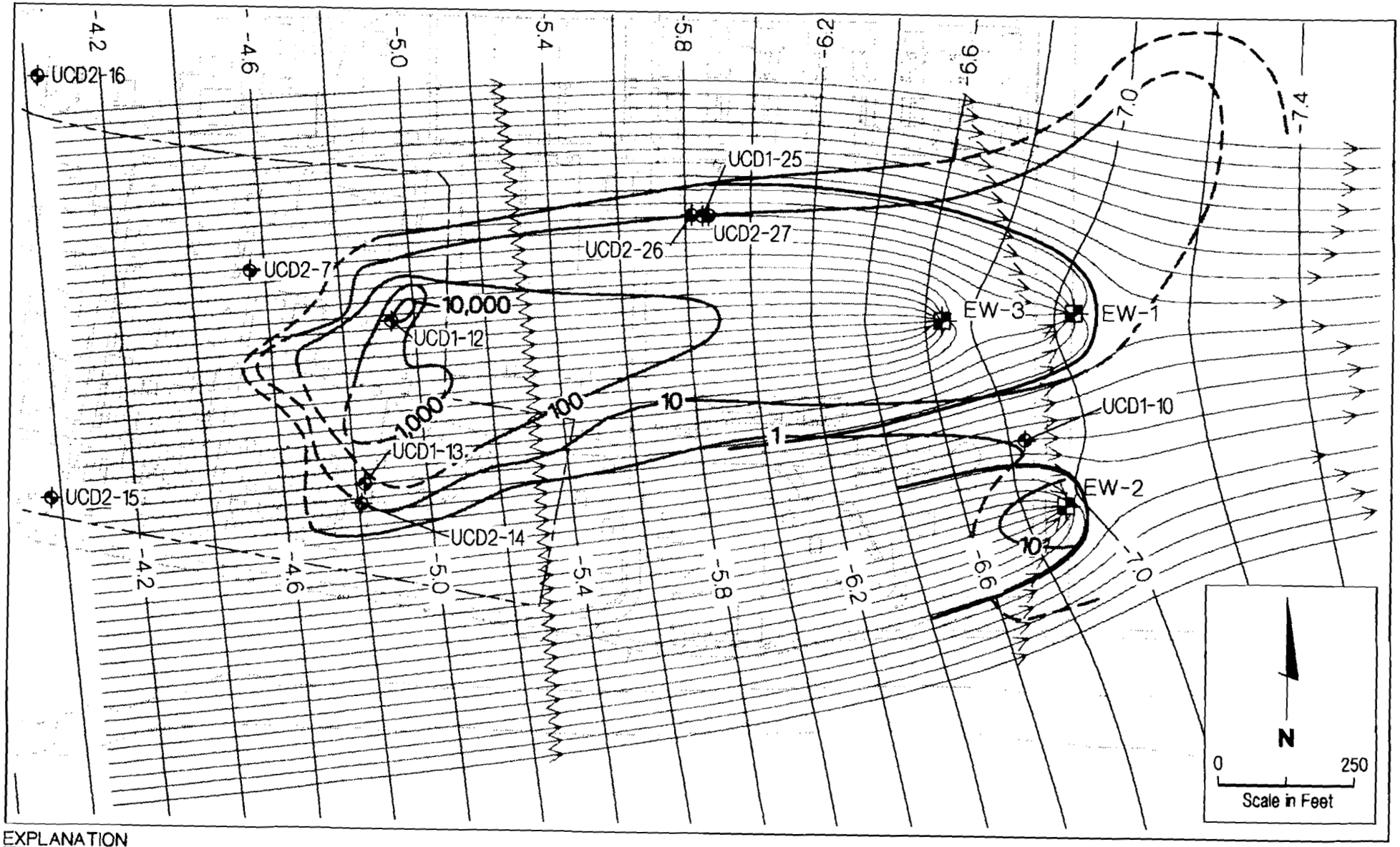
00234-224-0103-044 maj 01038 2/20/96

FIGURE 3



EXPLANATION

- UCD2-26 Monitoring Well Locations
- EW-1 Simulated Extraction Well Locations
- 100 Chloroform Concentration Contours
- 7.0 Simulated Groundwater Elevation Contour in Feet MSLD
- Simulated Particle Paths
- Approximate Combined Capture Zone for EW-1, EW-2, and EW-3

GROUNDWATER EXTRACTION WELL FIELD SIMULATION SCENARIO 3

UC Davis/LEHR Feasibility Study
University of California Davis
Davis, CA

FIGURE 4

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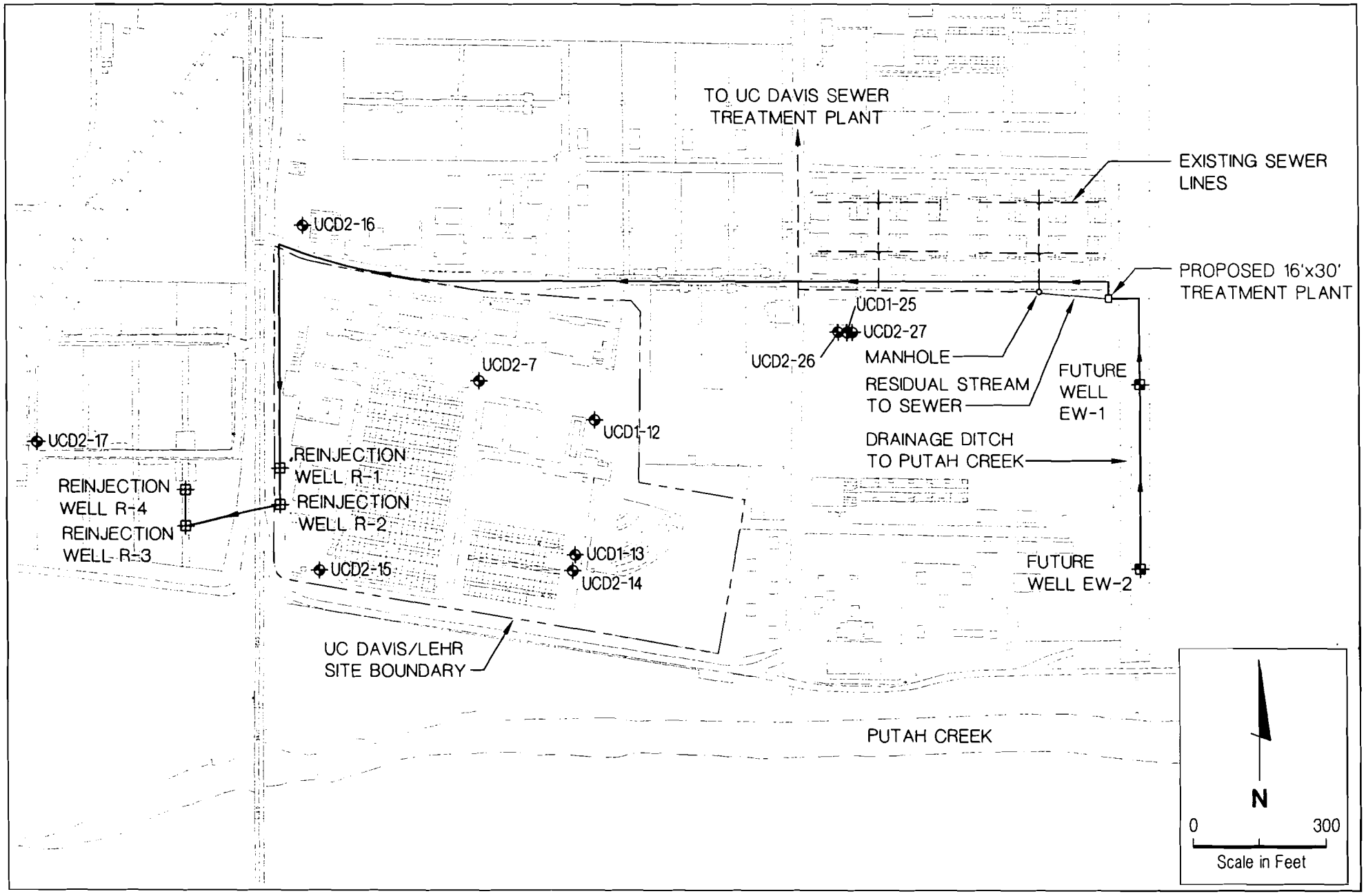
00234-224-0103-044 maj 0103A 2/20/96



CONCEPTUAL PLAN ALTERNATIVE 1
REINJECTION

UC Davis/LEHR
University of California Davis
Davis, CA

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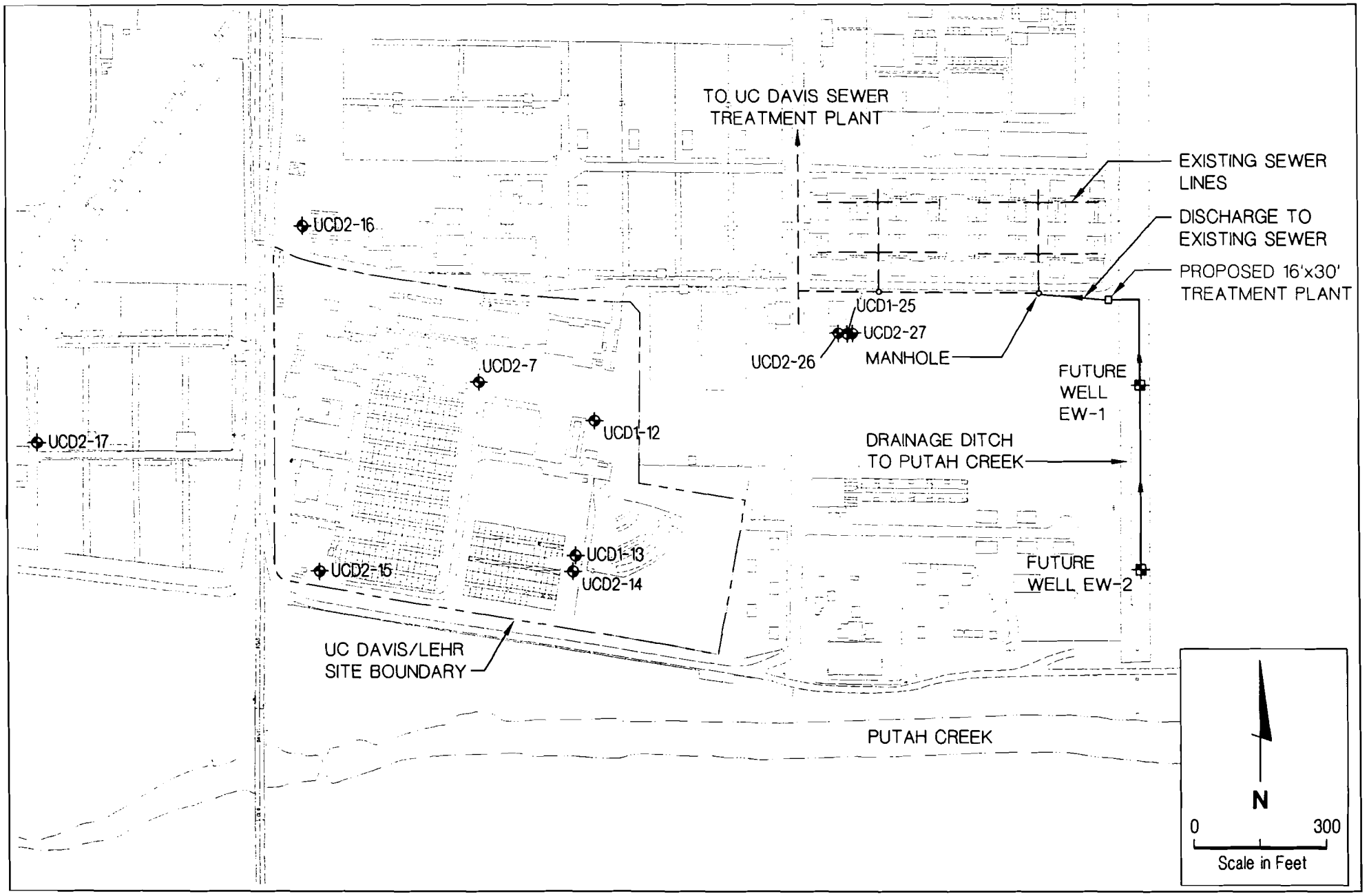
00234-224-9303-044 maj 9303A 2/13/96

FIGURE 5



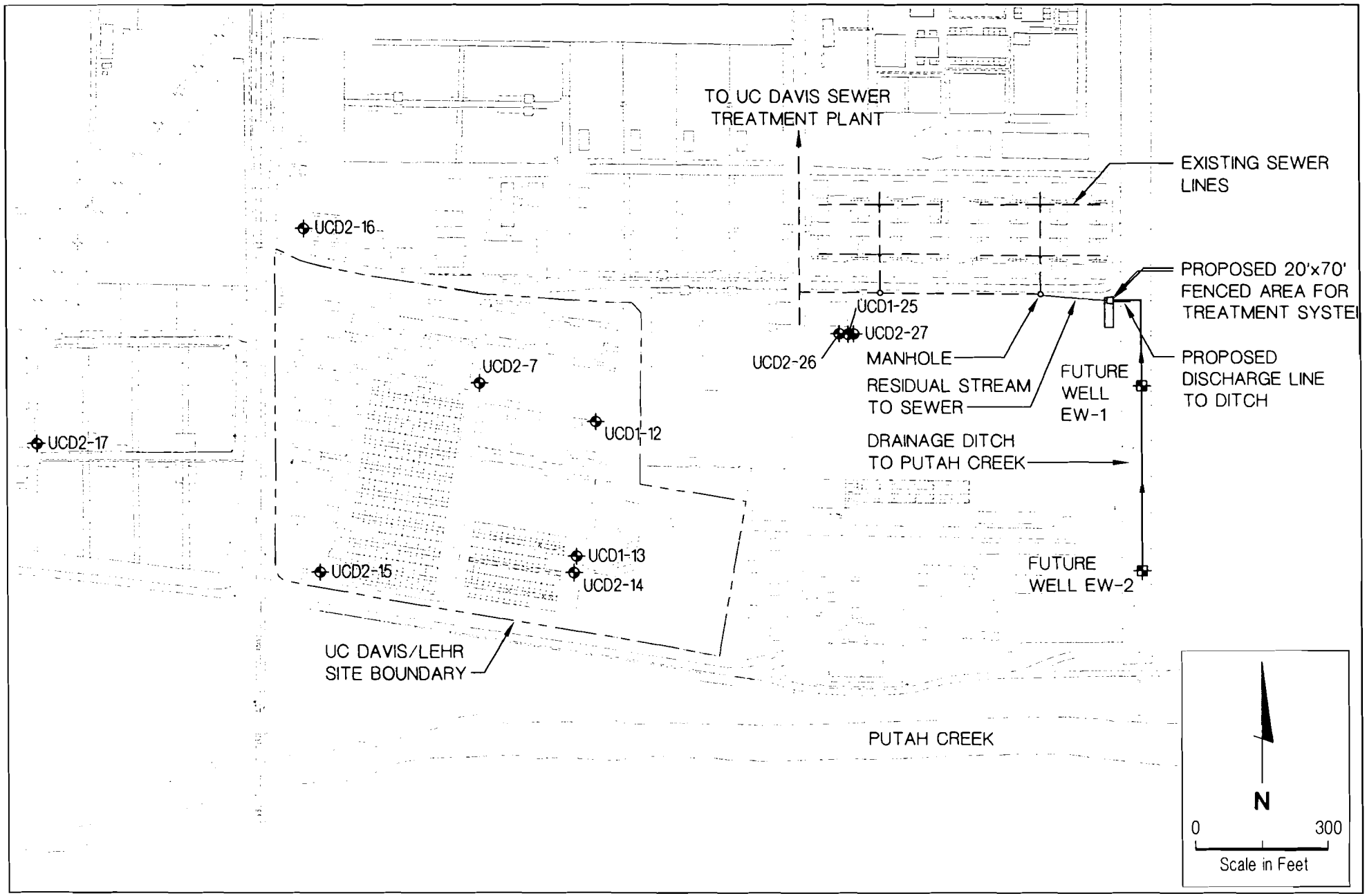
CONCEPTUAL PLAN ALTERNATIVE 2
DISCHARGE TO UCD WASTEWATER TREATMENT PLANT

UC Davis/LEHR Feasibility Study
University of California Davis
Davis, CA

DAMES & MOORE

00234-224-9303-044 maj 9303A 2/13/96

FIGURE 6



CONCEPTUAL PLAN ALTERNATIVE 3
DISCHARGE TO PUTAH CREEK

UC Davis/LEHR Feasibility Study
University of California Davis
Davis, CA

DAMES & MOORE

00234-224-9303-044 maj 9303A 2/13/96

FIGURE 7

APPENDIX A

UC Davis Wastewater Treatment Plant Numeric Local Limits

UNIVERSITY OF CALIFORNIA, DAVIS
NUMERIC LOCAL LIMITS

Constituent	Proposed Local Limit*		
	lbs/day	mg/l	µg/l
General			
Ammonia–Nitrogen	4,306	540	540,000
BOD (5)	**	**	---
Cyanide	0.14	0.02	20
Total Suspended Solids	**	**	---
Metals			
Aluminum	11.7	0.94	940
Antimony	0.072	0.008	8
Arsenic	0.061	0.008	8
Barium	9.0	0.7	700
Beryllium	0.045	0.004	4
Cadmium	0.049	0.006	6
Chromium VI (Hexavalent)	0.71	0.059	59
Chromium, Total	1.77	0.20	200
Cobalt	15.3	1.2	1200
Copper	1.41	0.18	180
Iron	21.5	3	3000
Lead	0.17	0.021	21
Molybdenum	0.072	0.0085	8.5
Nickel	0.90	0.1	100
Selenium	0.036	0.0044	4.4
Thallium	0.019	0.0022	2.2
Vanadium	4.6	0.54	540
Zinc	3.74	0.47	470
Purgeable Halocarbons			
Bromodichloromethane	1.17	0.14	140
Chlorobenzene	0.57	0.071	71
Chloroform	***	0.42	420
Dibromochloromethane	1.08	0.13	130
1,2–Dichlorobenzene (o-DCB)	1.80	0.2	200
1,3–Dichlorobenzene (m-DCB)	8.60	1.07	1,070
1,4–Dichlorobenzene (p-DCB)	0.054	0.007	7
Dichloromethane (MeCl2)	0.81	0.10	100
cis–1,3–Dichloropropene	0.0057	0.0007	0.7
Purgeable Aromatics			
Benzene	0.045	0.004	4
Ethylbenzene	***	1.6	1,600
Toluene	11.7	0.97	970
Xylenes	***	2.0	2,000

UNIVERSITY OF CALIFORNIA, DAVIS
NUMERIC LOCAL LIMITS

Constituent	Proposed Local Limit*		
	lbs/day	mg/l	µg/l
Phenols			
2-Chlorophenol	22.50	2.8	2,800
2,4-Dichlorophenol	1.08	0.13	130
4-Nitrophenol	1.69	0.21	210
Phenol	180	22	22,000
2,4,6-Trichlorophenol	10.9	1.4	1,400
Chlorniated Pesticides & PCBs			
Aldrin	0.036	0.004	4
alpha-, beta-, and delta-BHC	0.00090	0.00011	0.11
gamma-BHC (Lindane)	0.00090	0.00011	0.11
Endosulfan I	0.00063	0.000079	0.079
Endosulfan II	0.00063	0.000079	0.079
Endosulfan sulfate	0.00063	0.000079	0.079
Methoxychlor	0.00036	0.00004	0.04
Chlorinated Hydrocarbons			
2-Chloronaphthalene	18	2.2	2,200
Hexachlorobenzene	0.0090	0.001	1
Hexachloroethane	0.022	0.0026	2.6
1,2,4-Trichlorobenzene	0.81	0.1	100
Chlorinated Herbicides			
2,4-D	***	0.013	13
Dicamba	18.7	2.3	2,300
Dinoseb	0.081	0.01	10
2,4,5-T	***	5,000	5,000,000
2,4,5-TP (Silvex)	0.027	0.0034	3.4
Semi-Volatile Organics			
Bis(2-chloroisopropyl)ether	16.2	2.0	2,000
Diethyl phthalate	603	75	75000
Di-n-butylphthalate	***	1.9	1,900
4-Methylphenol	***	310	310,000
Naphthalene	***	1.0	1,000

UNIVERSITY OF CALIFORNIA, DAVIS
NUMERIC LOCAL LIMITS

Constituent	Proposed Local Limit*		
	lbs/day	mg/l	µg/l
Other			
Acetone (Dimethyl ketone)	***	1,097	1,097,000
Formaldehyde	***	0.07	70

* = Constituents which are specifically prohibited from discharge to the sewer in any amount are listed below.

** = Local Limit must be determined on a case-by-case basis based on 90% of the difference between
a) design capacity of the wastewater treatment plant for that month in lbs/day; and
b) the average loading in the treatment plant influent for the previous 30-day period in lbs/day.

*** = Limit not possible in lbs/day since concentration limit is based upon fume toxicity.

Specifically Prohibited Constituents:

General: pH (<5 or >11); and Temperature (>104°F).

Metals: Arsenic, Manganese, Mercury, and Silver.

Other Organics: Carbon tetrachloride; 1,1-Dichloroethene (1,1-DCE); 2-Methyl-4,6-dinitrophenol; Benzidine; 3,3'-Dichlorobenzidine; alpha-Chlordane; DDD; DDE; DDT; Dieldrin; Endrin aldehyde; Heptachlor; Hexachlorobutadiene; Hexachlorocyclopentadiene; and Bis(2-ethylhexyl)phthalate.

Total Petroleum Hydrocarbons: Diesel Fuel and Gasoline.

Other: Asbestos (at levels causing effluent to exceed drinking water standard or municipal sludge to exceed state hazardous substance criteria); and Excessive Total Oil and Grease.

C2117\1PNUMLL1 (12/12/95)

APPENDIX B

Adopted New Waste Discharge Requirements
for University of California, Davis Campus Landfill

STATE OF CALIFORNIA - Environmental Protection Agency

PETE WILSON, Governor

CALIFORNIA REGIONAL WATER QUALITY CONTROL BOARD
CENTRAL VALLEY REGION
3443 Routier Road, Suite A
Sacramento, CA 95827-3098
PHONE: (916) 255-3000
FAX: (916) 255-3015

FILE

27 June 1995

NOTICE

ADOPTED NEW WASTE DISCHARGE REQUIREMENTS
FOR
UNIVERSITY OF CALIFORNIA
DAVIS CAMPUS LANDFILL
GROUND WATER CLEANUP SYSTEM
YOLO COUNTY

Ms. Julie MacNeil, Director
Environmental Health & Safety
University of California
Davis, CA 95616

CERTIFIED MAIL
Z 175 115 256

TO ALL CONCERNED PERSONS AND AGENCIES:

Waste Discharge Requirements Order No. 95-187 for the above named discharger was adopted by the California Regional Water Quality Control Board, Central Valley Region, on 23 June 1995. The Order was amended.

APPROVED
author RPM
senior

ROBERT J. YEADON
Senior Engineer

RPM:ldj

Enclosures (Adopted Order & Standard Provisions)

cc: U.S. Environmental Protection Agency, San Francisco
U.S. Army Corps of Engineers, Sacramento
U.S. National Marine Fisheries, Santa Rosa
Department of Water Resources, Central District, Sacramento
Ms. Betsy Jennings, State Water Resources Control Board, Sacramento
Mr. Archie Matthews, State Water Resources Control Board, Sacramento
Office of Historic Preservation, Sacramento
Office of Drinking Water, Department of Health Services, Sacramento
Department of Fish and Game, Rancho Cordova
Yolo County Health Department, Colusa
Yolo County Planning Department, Colusa
Ms. Jeane-Marie Olmo-Resendiz, Davis
Ms. Julie Roth, Davis
Mr. Larry Bidinian, Davis
Mr. G. Fred Lee, El Macero

CALIFORNIA REGIONAL WATER QUALITY CONTROL BOARD
CENTRAL VALLEY REGION

ORDER NO. 95-187

NPDES NO. CA0083712

WASTE DISCHARGE REQUIREMENTS FOR UNIVERSITY OF CALIFORNIA DAVIS CAMPUS LANDFILL GROUND WATER CLEANUP SYSTEM YOLO COUNTY

The California Regional Water Quality Control Board, Central Valley Region, (hereafter Board) finds that:

1. The University of California (hereafter Discharger) submitted a Report of Waste Discharge, dated 24 January 1995, and applied for authorization to discharge waste under the National Pollutant Discharge Elimination System (NPDES) from the Davis Campus Landfill ground water cleanup system. Supplemental information to complete filing of the application was submitted on 10 April 1995 and 18 May 1995.

2. The Discharger owns and is constructing a ground water extraction, treatment, and disposal system for polluted ground water underlying the Davis Campus landfill. The landfill, ground water extraction wells and treatment systems are in Section 19, T8N, R2E and Section 24, T8N, R1E, MDB&M, as shown on Attachment A, a part of this Order. Treated ground water is proposed to be discharged to Putah Creek, a water of the United States at the point, latitude 38°, 31', 40" and longitude 121°, 47', 40".

3. Ground water underlying the landfill has been found to be polluted with volatile organic compounds (VOC) from landfilled wastes and from old chemical burn trenches. The VOCs detected in at least 10% of the ground water samples include: carbon tetrachloride, chloroethane, chloromethane, 1,1-dichloroethane, 1,1-dichloroethene, 1,2-dichloropropane, dichloromethane (methylene chloride), tetrachloroethane, 1,1,1-trichloroethane, trichloroethene, trichloro-flouromethane and vinyl chloride. The pollutants form two separate plumes, one consists principally of chloroform and emanates from old chemical burn trenches near the landfill entrance, the second, generally underlies the landfill and consists of VOCs and elevated minerals typical of Class III landfills.

4. The ground water is generally divided into three water bearing zones, zone A (35 to 55 feet below ground surface (bgs)), zone B (75 to 95 ft. bgs) and zone C (127 to 170 ft. bgs). The VOC pollution has been found to be lying within the A and B ground water zones. Assessment of the C zone is not yet complete. The Discharger proposes to begin extraction at a rate of approximately 0.30 mgd from the A and B zones. Extraction from the C zone will be done if necessary, based on an ongoing ground water assessment.

5. The treatment system consists of an air stripping unit to remove volatile organic compounds from extracted ground water. The Report of Waste Discharge describes the discharge as follows:

Monthly Average Flow:	0.30 million gallons per day (mgd)
Design Flow:	0.40 mgd
Average Temperature:	18° C
Volatile Organic Compounds:	non detectable

6. The U.S. Environmental Protection Agency (EPA) and the Board have classified this discharge as a minor discharge.

7. The Board adopted a Water Quality Control Plan, Third Edition, the Sacramento River and the San Joaquin River Basin (hereafter Basin Plan) which contains water quality objectives for all waters of the Basin. These requirements implement the Basin Plan.

8. The beneficial uses of Putah Creek downstream of the discharge are municipal and domestic, and agricultural supply; water contact and noncontact recreation; esthetic enjoyment; navigation; ground water recharge, fresh water replenishment; and preservation and enhancement of fish, wildlife and other aquatic resources.

9. The beneficial uses of the underlying ground water are municipal and domestic, industrial, and agricultural supply.

10. The permitted discharge is consistent with the antidegradation provisions of 40 CFR 131.12 and State Water Resources Control Board Resolution 68-16. This Order provides for an increase in the volume and mass of pollutants discharged. The increase will not cause significant impacts on aquatic life or secondary drinking water standards, which are the beneficial uses most likely affected by the pollutant (total dissolved solids) discharged. The increase allows for a ground water cleanup project which is considered to be a benefit to the people of the State.

11. The Report of Waste Discharge indicates concentrations of total dissolved solids (TDS) in the shallowest ground water zone underlying the landfill are elevated, high values are reported as 1,500 mg/l. The average TDS in the deeper (B zone) is 405 mg/l. Sampling conducted in Putah Creek detected an average TDS of 258 mg/l. The treated wastewater is a blend of polluted groundwater extracted from the shallow (higher TDS), as well as deeper, zones. The blended effluent is projected to be approximately 486 mg/l, which is below the TDS secondary drinking water standard of 500 mg/l.

12. The Report of Waste Discharge indicates concentrations of total chromium (Cr) in the B ground water zone (75 to 95 ft. bgs) may exceed the California primary maximum contaminant level (MCL) for drinking water. The total Cr primary MCL is 0.05 mg/l. U.S. EPA's recommended criteria for the protection of freshwater aquatic life is 0.016 mg/l for chromium VI. Samples in the shallow A zone ranged from nondetectable (ND) concentrations to 0.024 mg/l (total Cr). Samples in the B zone ranged from ND to 0.096 mg/l (total Cr). The average combined effluent is projected to be approximately 0.036 mg/l (total Cr). This permit limits the discharge to 0.05 mg/l for total chromium and 0.016 mg/l for chromium VI as daily maximums. The discharge of volatile organic compounds is limited to nondetectable concentrations in accordance with antidegradation provisions.

13. Federal regulations require effluent limitations for all pollutants that are or may be discharged at a level that will cause or have the reasonable potential to cause, or contribute to an in-stream excursion above a narrative or numerical water quality standard. Based on information submitted as part of the application, the Board finds that the discharge does have a reasonable potential to cause or contribute to an excursion above a water quality objective for volatile organic compounds and total chromium. Effluent limitations for these constituents are included in this Order.

14. Operation of the landfill is regulated under separate Waste Discharge Requirements, Order No.94-266.

15. The action to adopt an NPDES permit is exempt from the provisions of Chapter 3 of the California Environmental Quality Act (CEQA) (Public Resources Code Section 21100, et seq.), in accordance with Section 13389 of the California Water Code.

16. The University, as lead agency, is expected to certify a final environmental impact report (EIR) during July 1995, in accordance with the California Environmental Quality Act (CEQA) (Public Resources Code Section 21000, et seq.), and the CEQA Guidelines. This permit may be reopened and modified after the final EIR is certified.

17. The Board has notified the Discharger and interested agencies and persons of its intent to prescribe waste discharge requirements for this discharge and has provided them with an opportunity for a public hearing and an opportunity to submit their written views and recommendations.

18. The Board, in a public meeting, heard and considered all comments pertaining to the discharge.

19. This Order shall serve as an NPDES permit pursuant to Section 402 of the CWA, and amendments thereto, and shall take effect upon the date of hearing, provided EPA has no objections.

IT IS HEREBY ORDERED that the University of California, its agents, successors and assigns, in order to meet the provisions contained in Division 7 of the California Water Code and regulations adopted thereunder, and the provisions of the Clean Water Act and regulations and guidelines adopted thereunder, shall comply with the following:

A. Discharge Prohibitions:

1. Discharge of treated wastewater at a location or in a manner different from that described in the Findings is prohibited.

2. The by-pass or overflow of wastes to surface waters is prohibited, except as allowed by the attached Standard Provisions and Reporting Requirements A.13.

B. Effluent Limitations:

1. Effluent shall not exceed the following limits:

Constituents	Units	Monthly Average	Daily Maximum
Total chromium (Cr)	mg/l		0.05
Chromium VI	mg/l		0.016
Volatile Organic Compounds[1]	µg/l	ND[2]	2XND[3]
Vinyl chloride	µg/l		0.13[4]

[1] Volatile Organic Compounds (VOC) include bromodichloromethane, bromoform, bromomethane, carbon tetrachloride, chlorobenzene, chloroethane, 2-chloroethyl vinyl ether, chloroform, chloromethane, dibromochloromethane, 1,2-dichlorobenzene, 1,3-dichlorobenzene, 1,4-dichlorobenzene, dichlorodiflouromethane, 1,1-dichloroethane, 1,2-dichloroethane, 1,1-dichloroethene, trans-1,2-dichloroethene, 1,2-dichloropropane, cis-1,3-dichloropropene, trans-1,3-dichloropropene, dichloromethane, 1,1,2,2-tetrachloroethane, 1,1,1-trichloroethane, 1,1,2-trichloroethane, trichloroethene,

trichloroflouromethane, vinyl chloride.

[2] ND (nondetectable) concentrations are below the minimum detection level of 0.5 μg/l for the above VOCs with the exception of: 2-chloroethyl vinyl ether (1.0 μg/l), 1,1-dichloroethene (0.2 μg/l), dichloromethane (1.0 μg/l).

[3] The daily maximum is set at two times the minimum detection level to allow for common sampling and laboratory errors.

[4] The daily maximum discharge limitation for vinyl chloride is set at 0.13 μg/l based on California EPA's recommended cancer potency factor as a water quality criteria. The typical analytical minimum detection level for vinyl chloride is 0.50 μg/l.

2. The discharge shall not have a pH less than 6.5 nor greater than 8.5.

3. The peak discharge flow shall not exceed 0.40 mgd.

4. Survival of aquatic organism in 96-hour acute bioassays of undiluted waste shall be no less than:

   Minimum for any one bioassay - - - - - - - - - 70%
   Median for any three or more consecutive bioassays - - - - 90%

C. Receiving Water Limitations:

Receiving Water Limitations are based upon water quality objectives contained in the Basin Plan and the Plan. As such, they are a required part of this permit.

The discharge shall not cause the following in the receiving water:

1. Concentrations of dissolved oxygen to fall below 5.0 mg/l.

2. Oils, greases, waxes, or other materials to form a visible film or coating on the water surface or on the stream bottom.

3. Oils, greases, waxes, floating material (liquids, solids, foams, and scums) or suspended material to create a nuisance or adversely affect beneficial uses.

4. Aesthetically undesirable discoloration.

5. Fungi, slimes, or other objectionable growths.

6. Turbidity to increase more than 20 percent over background levels.

7. The normal ambient pH to fall below 6.5, exceed 8.5, or change by more than 0.5 units.

8. Deposition of material that causes nuisance or adversely affects beneficial uses.

9. The normal ambient temperature to increase more than 5°F.

10. Taste or odor-producing substances to impart undesirable tastes or odors to fish flesh or other edible products of aquatic origin or to cause nuisance or adversely affect beneficial uses.

11. Radionuclides to be present in concentrations that exceed maximum contaminant levels specified in the California Code of Regulations, Title 22; that harm human, plant, animal or aquatic life; or that result in the accumulation of radionuclides in the food web to an extent that presents a hazard to human, plant, animal, or aquatic life.

12. Aquatic communities and populations, including vertebrate, invertebrate, and plant species, to be degraded.

13. Toxic pollutants to be present in the water column, sediments, or biota in concentrations that adversely affect beneficial uses; that produce detrimental response in human, plant, animal, or aquatic life; or that bioaccumulate in aquatic resources at levels which are harmful to human health.

14. Violation of any applicable water quality standard for receiving waters adopted by the Board or the State Water Resources Control Board pursuant to the CWA and regulations adopted thereunder.

D. Provisions:

1. The Discharger shall not allow pollutant-free wastewater to be discharged into the collection, treatment, and disposal system in amounts that significantly diminish the system's capability to comply with this Order. Pollutant-free wastewater means rainfall, cooling waters, and condensates that are essentially free of pollutants.

2. The Discharger shall conduct the chronic toxicity testing specified in the Monitoring and Reporting Program. If the testing indicates that the discharge causes, has the reasonable potential to cause, or contributes to an excursion above the water quality objective for toxicity, the Discharger shall submit a workplan to conduct a Toxicity Reduction Evaluation (TRE) and upon approval conduct the TRE, and this order will be reopened and a chronic toxicity limitation included and/or limitation for the specific toxicant identified in the TRE

included. Additionally, if a chronic toxicity water quality objective is adopted by the State Water Resources Control Board, this Order may be reopened and a limitation based on that objective included.

3. The Discharger shall use the best practicable cost-effective control technique currently available to limit total dissolved solids to no more than 500 mg/l.

4. The Discharger shall comply with all the items of the "Standard Provisions and Reporting Requirements for Waste Discharge Requirements (NPDES)", dated 1 March 1991, which are part of this Order. This attachment and its individual paragraphs are referred to as "Standard Provision(s)."

5. The Discharger shall comply with the attached Monitoring and Reporting Program No. 95-187, which is part of this Order, and any revisions thereto, as ordered by the Executive Officer.

6. This Order expires on 23 June 1996, and the Discharger must file a Report of Waste Discharge in accordance with Title 23, CCR, not later than 180 days in advance of such date in application for renewal of waste discharge requirements if it wishes to continue the discharge.

   When requested by EPA, the Discharger shall complete and submit Discharge Monitoring Reports. The submittal date shall be no later than the submittal date specified in the Monitoring and Reporting Program for Discharger Self Monitoring Reports.

7. Prior to making any change in the discharge point, place of use, or purpose of use of the wastewater, the Discharger shall obtain approval of or clearance from the State Water Resources Control Board (Division of Water Rights).

8. In the event of any change in control or ownership of land or waste discharge facilities presently owned or controlled by the Discharger, the Discharger shall notify the succeeding owner or operator of the existence of this Order by letter, a copy of which shall be immediately forwarded to this office.

   To assume operation under this Order, the succeeding owner or operator must apply in writing to the Executive Officer requesting transfer of the Order. The request must contain the requesting entity's full legal name, the State of incorporation if a corporation, the name, address, and telephone number of the persons responsible for contact with the Board, and a statement. The statement shall comply with the signatory paragraph of Standard Provision

D.6 and state that the new owner or operator assumes full responsibility for compliance with this Order. Failure to submit the request shall be considered a discharge without requirements, a violation of the California Water Code. Transfer shall be approved or disapproved in writing by the Executive Officer.

I, WILLIAM H. CROOKS, Executive Officer, do hereby certify the foregoing is a full, true, and correct copy of an Order adopted by the California Regional Water Quality Control Board, Central Valley Region, on 23 June 1995.

WILLIAM H. CROOKS, Executive Officer

RPM:ldj

Attachments

CALIFORNIA REGIONAL WATER QUALITY CONTROL BOARD
CENTRAL VALLEY REGION

MONITORING AND REPORTING PROGRAM NO. 95-187

NPDES NO. CA0083712

FOR
UNIVERSITY OF CALIFORNIA
DAVIS CAMPUS LANDFILL
GROUND WATER CLEANUP SYSTEM
YOLO COUNTY

Specific sample station locations shall be established under direction of the Board's staff, and a description of the stations shall be attached to this Order.

EFFLUENT MONITORING

Effluent samples shall be collected downstream from the last connection through which wastes can be admitted into the outfall. Effluent samples should be representative of the volume and quality of the discharge. Time of collection of samples shall be recorded. Effluent monitoring shall include at least the following:

Constituents	Units	Type of Sample	Sampling Frequency
Total Dissolved Solids	mg/l	grab	monthly
Electrical Conductivity @25°C	µmhos/cm	grab	twice weekly
Metals[2]	µg/l	grab	quarterly
pH	pH units	grab	twice weekly
Acute Toxicity[3]	% survival	grab	twice annually
Flow	mgd	meter	continuous
Temperature	°F	grab	twice weekly
Chronic Toxicity[4]	% survival	grab	twice annually
Volatile organic compounds[1]	µg/l	grab	weekly
Total chromium	µg/l	grab	twice monthly
Chromium VI	µg/l	grab	twice monthly

[1] Volatile organic compound sampling shall include, at least: bromodichloromethane, bromoform, bromomethane, carbon tetrachloride, chlorobenzene, chloroethane, 2-chloroethyl vinyl ether, chloroform, chloromethane, dibromochloromethane, 1,2-dichlorobenzene, 1,3-dichlorobenzene, 1,4-dichlorobenzene, dichlorodiflouromethane, 1,1-dichloroethane, 1,2-dichloroethane, 1,1-dichloroethene, trans-1,2-dichloroethene, 1,2-dichloropropane, cis-1,3-dichloropropene, trans-1,3-dichloropropene, dichloromethane, 1,1,2,2-tetrachloroethane, 1,1,1-trichloroethane, 1,1,2-trichloroethane, trichloroethene, trichloroflouromethane and vinyl chloride. The minimum detection level must be sufficient to determine permit compliance.

[2] Metals analysis shall include antimony, arsenic, cadmium, lead, mercury, nickel, selenium, thallium, chromium, magnesium, silver, vanadium and zinc.

[3] The acute toxicity testing shall use EPA test method EPA/600/4-90/027 (or later amendment) with Pimephales promelas (fathead minnows) as the test species. The acute test shall be a 96-hour static-renewal.

[4] Chronic toxicity testing as specified in EPA 600/4-89-001 shall use Pimephales promelas, Ceriodaphnia dubia, and Selenastrum capricornutum as the test species. The test shall be conducted in 100% effluent without dilution since the receiving stream is considered ephemeral. Time of collection samples shall be recorded. The effluent tests must be conducted with concurrent reference toxicant tests. Monthly laboratory reference toxicant tests may be substituted upon approval. Both the reference toxicant and effluent test must meet all test acceptability criteria as specified in the chronic manual. If the test acceptability criteria is not achieved, then the Discharger must re-sample and re-test within 14 days.
The acute and chronic toxicity testing shall be rotated on a quarterly basis.

If the discharge is intermittent rather than continuous, then on the first day of each such intermittent discharge, the Discharger shall monitor and record data for all of the constituents listed above, after which the frequencies of analysis given in the schedule shall apply for the duration of each such intermittent discharge. In no event shall the Discharger be required to monitor and record data more often than twice the frequencies listed in the schedule.

RECEIVING WATER MONITORING

All receiving water samples shall be grab samples. Receiving water monitoring, when the Creek is flowing, shall include at least the following:

Station	Description
R-1	50 feet upstream from the point of discharge
R-2	100 feet downstream from the point of discharge

INFORMATION SHEET

UNIVERSITY OF CALIFORNIA
DAVIS CAMPUS LANDFILL
GROUND WATER CLEANUP SYSTEM
YOLO COUNTY

The University of California owns and operates the Davis Campus Class III landfill. Ground water underlying the landfill has been found to be polluted with volatile organic compounds (VOC) from landfilled wastes and from old chemical burn trenches. The VOCs detected in at least 10% of the ground water samples include: carbon tetrachloride, chloroethane, chloromethane, 1,1-dichloroethane, 1,1-dichloroethene, 1,2-dichloropropane, dichloromethane (methylene chloride), tetrachloroethane, 1,1,1-trichloroethane, trichloroethene, trichloroflouromethane and vinyl chloride. The pollutants form two separate plumes, one consists principally of chloroform and emanates from old chemical burn trenches near the landfill entrance, the second, generally underlies the landfill and consists of VOCs and elevated minerals typical of Class III landfills. The University proposes to extract and treat the polluted ground water. The treatment system consists of an air stripping unit to remove volatile organic compounds from extracted ground water.

Treated ground water is proposed to be discharged to Putah Creek. Putah Creek is an ephemeral stream running along the southern campus boundary. The beneficial uses of Putah Creek downstream of the discharge are municipal and domestic, and agricultural supply; water contact and noncontact recreation; esthetic enjoyment; navigation; ground water recharge, fresh water replenishment; and preservation and enhancement of fish, wildlife and other aquatic resources.

The ground water is generally divided into three water bearing zones, zone A (35 to 55 feet below ground surface (bgs)), zone B (75 to 95 ft. bgs) and zone C (127 to 170 ft. bgs). The VOC pollution has been found to be lying within the A and B ground water zones. Assessment of the C zone is not yet complete. The Discharger proposes to begin extraction at a rate of approximately 0.30 mgd from the A and B zones. Extraction from the C zone will be done if necessary, based on an ongoing ground water assessment.

The Report of Waste Discharge indicates concentrations of total dissolved solids (TDS) in the shallowest ground water zone underlying the landfill is elevated, high values are reported as 1,500 mg/l. The average TDS in the deeper (B zone) is 405 mg/l. Sampling conducted in Putah Creek detected an average TDS of 258 mg/l. The treated wastewater is a blend of polluted groundwater extracted from the shallow (higher TDS), as well as deeper, zones. The blended effluent is projected to be approximately 486 mg/l, which is below the TDS secondary drinking water standard of 500 mg/l. The proposed permit requires the University use the best practicable cost-effective control technique currently available to limit TDS to no more than 500 mg/l in the discharge.

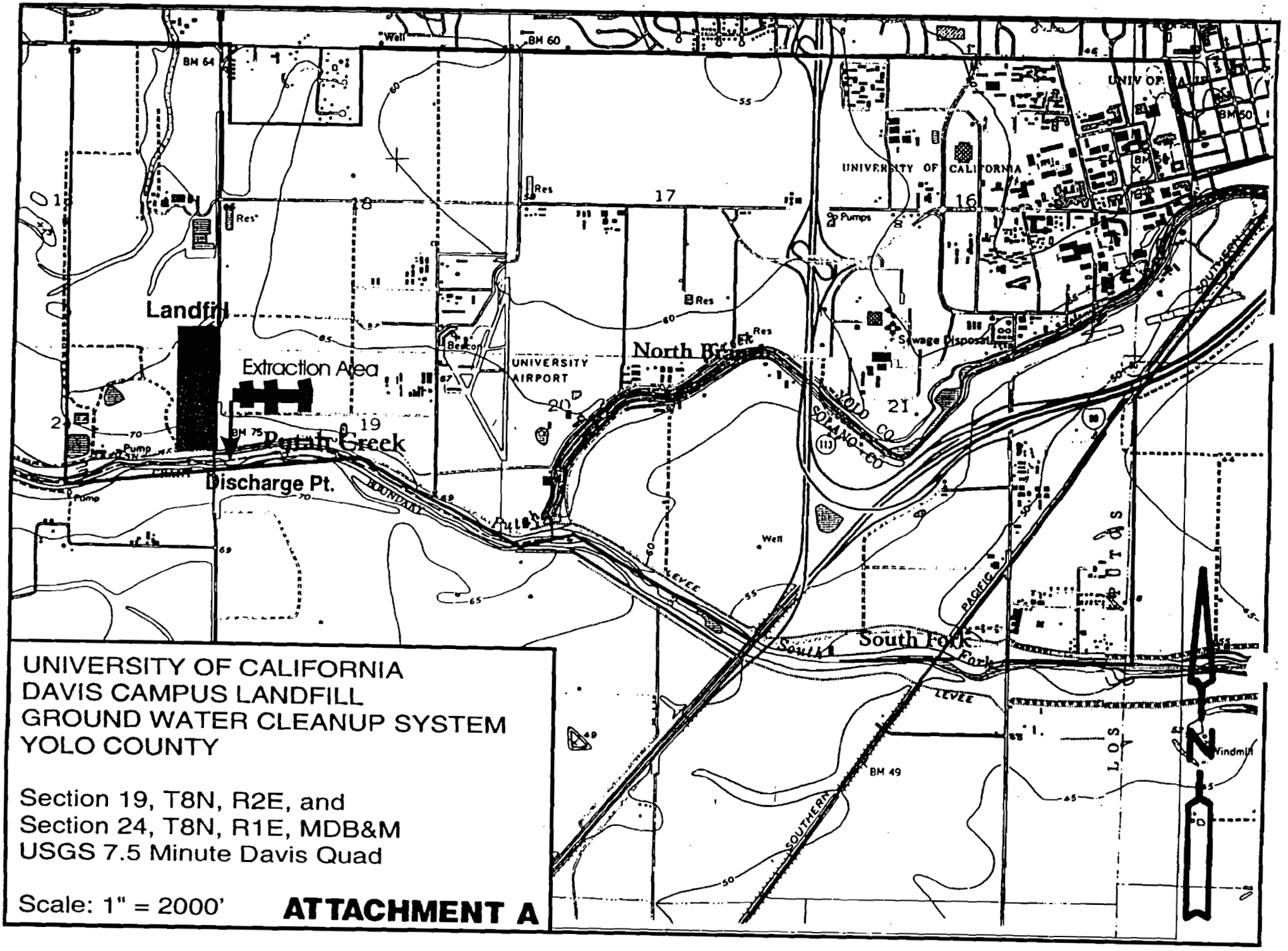
INFORMATION SHEET

UNIVERSITY OF CALIFORNIA
DAVIS CAMPUS LANDFILL
GROUND WATER CLEANUP SYSTEM
YOLO COUNTY

The Report of Waste Discharge indicates concentrations of total chromium (Cr) in the B ground water zone (75 to 95 ft. bgs) may exceed the California primary maximum contaminant level (MCL) for drinking water. The total Cr primary MCL is 0.05 mg/l. Samples in the shallow A zone ranged from nondetectable (ND) concentrations to 0.024 mg/l (total Cr). Samples in the B zone ranged from ND to 0.096 mg/l (total Cr). The average combined effluent is projected to be approximately 0.036 mg/l (total Cr). This permit limits the discharge to 0.05 mg/l (total Cr) as a daily maximum and 0.016 mg/l for chromium VI.

In accordance with antidegradation provisions of 40 CFR 131.12 and State Water Resources Control Board Resolution 68-16 the effluent discharge limit for volatile organic compounds is nondetectable at specified minimum detection levels as a monthly average. Sampling and analysis techniques for volatile organics are frequently the subject of error. Therefore, the daily maximum discharge has been set at twice the detection level to account for lab inaccuracies. The 30 day average discharge level is the limiting criteria in the regulation of the VOCs, and the daily maximum will not allow degradation. The monthly average concentration shall be calculated using one half the detection level for daily samples reported as nondetectable. The daily maximum allowable discharge concentration for vinyl chloride has been set at 0.13 µg/l, which is below the typical minimum detection level, based on Cal EPA's proposed cancer potency factor as a water quality criterion.

RPM:ldj



UNIVERSITY OF CALIFORNIA
DAVIS CAMPUS LANDFILL
GROUND WATER CLEANUP SYSTEM
YOLO COUNTY

Section 19, T8N, R2E, and
Section 24, T8N, R1E, MDB&M
USGS 7.5 Minute Davis Quad

Scale: 1" = 2000'

ATTACHMENT A

Constituents	Units	Station	Sampling Frequency
Dissolved Oxygen	mg/l	R-1, R-2	monthly
pH	pH units	R-1, R-2	weekly
Turbidity	NTU	R-1, R-2	monthly
Temperature	°F (°C)	R-1, R-2	weekly
Electrical Conductivity @25°C	μmhos/cm	R-1, R-2	weekly
Radionuclides	PCi/l	R-1, R-2	twice annually

In conducting the receiving water sampling, a log shall be kept of the receiving water conditions throughout the reach bounded by Stations R-1 and R-2. Attention shall be given to the presence or absence of:

a. Floating or suspended matter
b. Discoloration
c. Bottom deposits
d. Aquatic life
e. Visible films, sheens or coatings
f. Fungi, slimes, or objectionable growths
g. Potential nuisance conditions

Notes on receiving water conditions shall be summarized in the monitoring report.

REPORTING

Monitoring results shall be submitted to the Regional Board by the **20th day of the month** following sample collection. Quarterly and annual monitoring results shall be submitted by the **20th day of the month** following each calendar quarter and year, respectively.

In reporting the monitoring data, the Discharger shall arrange the data in tabular form so that the date, the constituents, and the concentrations are readily discernible. The data shall be summarized in such a manner to illustrate clearly whether the discharge complies with waste discharge requirements. The highest daily maximum for the month, monthly and weekly averages should be determined and recorded.

If the Discharger monitors any pollutant at the locations designated herein more frequently than is required by this Order, the results of such monitoring shall be included in the calculation and reporting of the values required in the discharge monitoring report form. Such increased frequency shall be indicated on the discharge monitoring report form.

By **30 January of each year**, the Discharger shall submit a written report to the Executive Officer containing the following:

a. The names and telephone numbers of persons to contact regarding the plant for emergency and routine situations.

b. A statement certifying when the flow meter and other monitoring instruments and devices were last calibrated, including identification of who performed the calibration (Standard Provision C.6).

The Discharger may also be requested to submit an annual report to the Board with both tabular and graphical summaries of the monitoring data obtained during the previous year. Any such request shall be made in writing. The report shall discuss the compliance record. If violations have occurred, the report shall also discuss the corrective actions taken and planned to bring the discharge into full compliance with the waste discharge requirements.

All reports submitted in response to this Order shall comply with the signatory requirements of Standard Provision D.6.

The Discharger shall implement the above monitoring program on the first day of the month following effective date of this Order.

Ordered by: William H. Crooks
WILLIAM H. CROOKS, Executive Officer

23 June 1995
(Date)

RPM:ldj

STATE OF CALIFORNIA - Environmental Protection Agency

PETE WILSON, Governor

CALIFORNIA REGIONAL WATER QUALITY CONTROL BOARD
CENTRAL VALLEY REGION
3443 Routier Road, Suite A
Sacramento, CA 95827-3098
PHONE: (916) 255-3000
FAX: (916) 255-3015

FILE

27 June 1995

NOTICE

ADOPTED NEW WASTE DISCHARGE REQUIREMENTS
FOR
UNIVERSITY OF CALIFORNIA
DAVIS CAMPUS LANDFILL
GROUND WATER CLEANUP SYSTEM
YOLO COUNTY

Ms. Julie MacNeil, Director
Environmental Health & Safety
University of California
Davis, CA 95616

CERTIFIED MAIL
Z 175 115 256

TO ALL CONCERNED PERSONS AND AGENCIES:

Waste Discharge Requirements Order No. 95-187 for the above named discharger was adopted by the California Regional Water Quality Control Board, Central Valley Region, on 23 June 1995. The Order was amended.

APPROVED
author RPM
senior

ROBERT J. YEADON
Senior Engineer

RPM:ldj

Enclosures (Adopted Order & Standard Provisions)

cc: U.S. Environmental Protection Agency, San Francisco
U.S. Army Corps of Engineers, Sacramento
U.S. National Marine Fisheries, Santa Rosa
Department of Water Resources, Central District, Sacramento
Ms. Betsy Jennings, State Water Resources Control Board, Sacramento
Mr. Archie Matthews, State Water Resources Control Board, Sacramento
Office of Historic Preservation, Sacramento
Office of Drinking Water, Department of Health Services, Sacramento
Department of Fish and Game, Rancho Cordova
Yolo County Health Department, Colusa
Yolo County Planning Department, Colusa
Ms. Jeane-Marie Olmo-Resendiz, Davis
Ms. Julie Roth, Davis
Mr. Larry Bidinian, Davis
Mr. G. Fred Lee, El Macero

CALIFORNIA REGIONAL WATER QUALITY CONTROL BOARD
CENTRAL VALLEY REGION

ORDER NO. 95-187

NPDES NO. CA0083712

WASTE DISCHARGE REQUIREMENTS FOR UNIVERSITY OF CALIFORNIA DAVIS CAMPUS LANDFILL GROUND WATER CLEANUP SYSTEM YOLO COUNTY

The California Regional Water Quality Control Board, Central Valley Region, (hereafter Board) finds that:

1. The University of California (hereafter Discharger) submitted a Report of Waste Discharge, dated 24 January 1995, and applied for authorization to discharge waste under the National Pollutant Discharge Elimination System (NPDES) from the Davis Campus Landfill ground water cleanup system. Supplemental information to complete filing of the application was submitted on 10 April 1995 and 18 May 1995.

2. The Discharger owns and is constructing a ground water extraction, treatment, and disposal system for polluted ground water underlying the Davis Campus landfill. The landfill, ground water extraction wells and treatment systems are in Section 19, T8N, R2E and Section 24, T8N, R1E, MDB&M, as shown on Attachment A, a part of this Order. Treated ground water is proposed to be discharged to Putah Creek, a water of the United States at the point, latitude 38°, 31', 40" and longitude 121°, 47', 40".

3. Ground water underlying the landfill has been found to be polluted with volatile organic compounds (VOC) from landfilled wastes and from old chemical burn trenches. The VOCs detected in at least 10% of the ground water samples include: carbon tetrachloride, chloroethane, chloromethane, 1,1-dichloroethane, 1,1-dichloroethene, 1,2-dichloropropane, dichloromethane (methylene chloride), tetrachloroethane, 1,1,1-trichloroethane, trichloroethene, trichloro-flouromethane and vinyl chloride. The pollutants form two separate plumes, one consists principally of chloroform and emanates from old chemical burn trenches near the landfill entrance, the second, generally underlies the landfill and consists of VOCs and elevated minerals typical of Class III landfills.

4. The ground water is generally divided into three water bearing zones, zone A (35 to 55 feet below ground surface (bgs)), zone B (75 to 95 ft. bgs) and zone C (127 to 170 ft. bgs). The VOC pollution has been found to be lying within the A and B ground water zones. Assessment of the C zone is not yet complete. The Discharger proposes to begin extraction at a rate of approximately 0.30 mgd from the A and B zones. Extraction from the C zone will be done if necessary, based on an ongoing ground water assessment.

5. The treatment system consists of an air stripping unit to remove volatile organic compounds from extracted ground water. The Report of Waste Discharge describes the discharge as follows:

Monthly Average Flow:	0.30 million gallons per day (mgd)
Design Flow:	0.40 mgd
Average Temperature:	18° C
Volatile Organic Compounds:	non detectable

6. The U.S. Environmental Protection Agency (EPA) and the Board have classified this discharge as a minor discharge.

7. The Board adopted a Water Quality Control Plan, Third Edition, the Sacramento River and the San Joaquin River Basin (hereafter Basin Plan) which contains water quality objectives for all waters of the Basin. These requirements implement the Basin Plan.

8. The beneficial uses of Putah Creek downstream of the discharge are municipal and domestic, and agricultural supply; water contact and noncontact recreation; esthetic enjoyment; navigation; ground water recharge, fresh water replenishment; and preservation and enhancement of fish, wildlife and other aquatic resources.

9. The beneficial uses of the underlying ground water are municipal and domestic, industrial, and agricultural supply.

10. The permitted discharge is consistent with the antidegradation provisions of 40 CFR 131.12 and State Water Resources Control Board Resolution 68-16. This Order provides for an increase in the volume and mass of pollutants discharged. The increase will not cause significant impacts on aquatic life or secondary drinking water standards, which are the beneficial uses most likely affected by the pollutant (total dissolved solids) discharged. The increase allows for a ground water cleanup project which is considered to be a benefit to the people of the State.

11. The Report of Waste Discharge indicates concentrations of total dissolved solids (TDS) in the shallowest ground water zone underlying the landfill are elevated, high values are reported as 1,500 mg/l. The average TDS in the deeper (B zone) is 405 mg/l. Sampling conducted in Putah Creek detected an average TDS of 258 mg/l. The treated wastewater is a blend of polluted groundwater extracted from the shallow (higher TDS), as well as deeper, zones. The blended effluent is projected to be approximately 486 mg/l, which is below the TDS secondary drinking water standard of 500 mg/l.

12. The Report of Waste Discharge indicates concentrations of total chromium (Cr) in the B ground water zone (75 to 95 ft. bgs) may exceed the California primary maximum contaminant level (MCL) for drinking water. The total Cr primary MCL is 0.05 mg/l. U.S. EPA's recommended criteria for the protection of freshwater aquatic life is 0.016 mg/l for chromium VI. Samples in the shallow A zone ranged from nondetectable (ND) concentrations to 0.024 mg/l (total Cr). Samples in the B zone ranged from ND to 0.096 mg/l (total Cr). The average combined effluent is projected to be approximately 0.036 mg/l (total Cr). This permit limits the discharge to 0.05 mg/l for total chromium and 0.016 mg/l for chromium VI as daily maximums. The discharge of volatile organic compounds is limited to nondetectable concentrations in accordance with antidegradation provisions.

13. Federal regulations require effluent limitations for all pollutants that are or may be discharged at a level that will cause or have the reasonable potential to cause, or contribute to an in-stream excursion above a narrative or numerical water quality standard. Based on information submitted as part of the application, the Board finds that the discharge does have a reasonable potential to cause or contribute to an excursion above a water quality objective for volatile organic compounds and total chromium. Effluent limitations for these constituents are included in this Order.

14. Operation of the landfill is regulated under separate Waste Discharge Requirements, Order No.94-266.

15. The action to adopt an NPDES permit is exempt from the provisions of Chapter 3 of the California Environmental Quality Act (CEQA) (Public Resources Code Section 21100, et seq.), in accordance with Section 13389 of the California Water Code.

16. The University, as lead agency, is expected to certify a final environmental impact report (EIR) during July 1995, in accordance with the California Environmental Quality Act (CEQA) (Public Resources Code Section 21000, et seq.), and the CEQA Guidelines. This permit may be reopened and modified after the final EIR is certified.

17. The Board has notified the Discharger and interested agencies and persons of its intent to prescribe waste discharge requirements for this discharge and has provided them with an opportunity for a public hearing and an opportunity to submit their written views and recommendations.

18. The Board, in a public meeting, heard and considered all comments pertaining to the discharge.

19. This Order shall serve as an NPDES permit pursuant to Section 402 of the CWA, and amendments thereto, and shall take effect upon the date of hearing, provided EPA has no objections.

IT IS HEREBY ORDERED that the University of California, its agents, successors and assigns, in order to meet the provisions contained in Division 7 of the California Water Code and regulations adopted thereunder, and the provisions of the Clean Water Act and regulations and guidelines adopted thereunder, shall comply with the following:

A. Discharge Prohibitions:

1. Discharge of treated wastewater at a location or in a manner different from that described in the Findings is prohibited.

2. The by-pass or overflow of wastes to surface waters is prohibited, except as allowed by the attached Standard Provisions and Reporting Requirements A.13.

B. Effluent Limitations:

1. Effluent shall not exceed the following limits:

Constituents	Units	Monthly Average	Daily Maximum
Total chromium (Cr)	mg/l		0.05
Chromium VI	mg/l		0.016
Volatile Organic Compounds[1]	µg/l	ND[2]	2XND[3]
Vinyl chloride	µg/l		0.13[4]

[1] Volatile Organic Compounds (VOC) include bromodichloromethane, bromoform, bromomethane, carbon tetrachloride, chlorobenzene, chloroethane, 2-chloroethyl vinyl ether, chloroform, chloromethane, dibromochloromethane, 1,2-dichlorobenzene, 1,3-dichlorobenzene, 1,4-dichlorobenzene, dichlorodiflouromethane, 1,1-dichloroethane, 1,2-dichloroethane, 1,1-dichloroethene, trans-1,2-dichloroethene, 1,2-dichloropropane, cis-1,3-dichloropropene, trans-1,3-dichloropropene, dichloromethane, 1,1,2,2-tetrachloroethane, 1,1,1-trichloroethane, 1,1,2-trichloroethane, trichloroethene,

trichloroflouromethane, vinyl chloride.

[2] ND (nondetectable) concentrations are below the minimum detection level of 0.5 μg/l for the above VOCs with the exception of: 2-chloroethyl vinyl ether (1.0 μg/l), 1,1-dichloroethene (0.2 μg/l), dichloromethane (1.0 μg/l).

[3] The daily maximum is set at two times the minimum detection level to allow for common sampling and laboratory errors.

[4] The daily maximum discharge limitation for vinyl chloride is set at 0.13 μg/l based on California EPA's recommended cancer potency factor as a water quality criteria. The typical analytical minimum detection level for vinyl chloride is 0.50 μg/l.

2. The discharge shall not have a pH less than 6.5 nor greater than 8.5.

3. The peak discharge flow shall not exceed 0.40 mgd.

4. Survival of aquatic organism in 96-hour acute bioassays of undiluted waste shall be no less than:

   Minimum for any one bioassay - - - - - - - - - 70%
   Median for any three or more consecutive bioassays - - - - 90%

C. Receiving Water Limitations:

Receiving Water Limitations are based upon water quality objectives contained in the Basin Plan and the Plan. As such, they are a required part of this permit.

The discharge shall not cause the following in the receiving water:

1. Concentrations of dissolved oxygen to fall below 5.0 mg/l.

2. Oils, greases, waxes, or other materials to form a visible film or coating on the water surface or on the stream bottom.

3. Oils, greases, waxes, floating material (liquids, solids, foams, and scums) or suspended material to create a nuisance or adversely affect beneficial uses.

4. Aesthetically undesirable discoloration.

5. Fungi, slimes, or other objectionable growths.

6. Turbidity to increase more than 20 percent over background levels.

7. The normal ambient pH to fall below 6.5, exceed 8.5, or change by more than 0.5 units.

8. Deposition of material that causes nuisance or adversely affects beneficial uses.

9. The normal ambient temperature to increase more than 5°F.

10. Taste or odor-producing substances to impart undesirable tastes or odors to fish flesh or other edible products of aquatic origin or to cause nuisance or adversely affect beneficial uses.

11. Radionuclides to be present in concentrations that exceed maximum contaminant levels specified in the California Code of Regulations, Title 22; that harm human, plant, animal or aquatic life; or that result in the accumulation of radionuclides in the food web to an extent that presents a hazard to human, plant, animal, or aquatic life.

12. Aquatic communities and populations, including vertebrate, invertebrate, and plant species, to be degraded.

13. Toxic pollutants to be present in the water column, sediments, or biota in concentrations that adversely affect beneficial uses; that produce detrimental response in human, plant, animal, or aquatic life; or that bioaccumulate in aquatic resources at levels which are harmful to human health.

14. Violation of any applicable water quality standard for receiving waters adopted by the Board or the State Water Resources Control Board pursuant to the CWA and regulations adopted thereunder.

D. Provisions:

1. The Discharger shall not allow pollutant-free wastewater to be discharged into the collection, treatment, and disposal system in amounts that significantly diminish the system's capability to comply with this Order. Pollutant-free wastewater means rainfall, cooling waters, and condensates that are essentially free of pollutants.

2. The Discharger shall conduct the chronic toxicity testing specified in the Monitoring and Reporting Program. If the testing indicates that the discharge causes, has the reasonable potential to cause, or contributes to an excursion above the water quality objective for toxicity, the Discharger shall submit a workplan to conduct a Toxicity Reduction Evaluation (TRE) and upon approval conduct the TRE, and this order will be reopened and a chronic toxicity limitation included and/or limitation for the specific toxicant identified in the TRE

included. Additionally, if a chronic toxicity water quality objective is adopted by the State Water Resources Control Board, this Order may be reopened and a limitation based on that objective included.

3. The Discharger shall use the best practicable cost-effective control technique currently available to limit total dissolved solids to no more than 500 mg/l.

4. The Discharger shall comply with all the items of the "Standard Provisions and Reporting Requirements for Waste Discharge Requirements (NPDES)", dated 1 March 1991, which are part of this Order. This attachment and its individual paragraphs are referred to as "Standard Provision(s)."

5. The Discharger shall comply with the attached Monitoring and Reporting Program No. 95-187, which is part of this Order, and any revisions thereto, as ordered by the Executive Officer.

6. This Order expires on 23 June 1996, and the Discharger must file a Report of Waste Discharge in accordance with Title 23, CCR, not later than 180 days in advance of such date in application for renewal of waste discharge requirements if it wishes to continue the discharge.

   When requested by EPA, the Discharger shall complete and submit Discharge Monitoring Reports. The submittal date shall be no later than the submittal date specified in the Monitoring and Reporting Program for Discharger Self Monitoring Reports.

7. Prior to making any change in the discharge point, place of use, or purpose of use of the wastewater, the Discharger shall obtain approval of or clearance from the State Water Resources Control Board (Division of Water Rights).

8. In the event of any change in control or ownership of land or waste discharge facilities presently owned or controlled by the Discharger, the Discharger shall notify the succeeding owner or operator of the existence of this Order by letter, a copy of which shall be immediately forwarded to this office.

   To assume operation under this Order, the succeeding owner or operator must apply in writing to the Executive Officer requesting transfer of the Order. The request must contain the requesting entity's full legal name, the State of incorporation if a corporation, the name, address, and telephone number of the persons responsible for contact with the Board, and a statement. The statement shall comply with the signatory paragraph of Standard Provision

D.6 and state that the new owner or operator assumes full responsibility for compliance with this Order. Failure to submit the request shall be considered a discharge without requirements, a violation of the California Water Code. Transfer shall be approved or disapproved in writing by the Executive Officer.

I, WILLIAM H. CROOKS, Executive Officer, do hereby certify the foregoing is a full, true, and correct copy of an Order adopted by the California Regional Water Quality Control Board, Central Valley Region, on 23 June 1995.

WILLIAM H. CROOKS, Executive Officer

RPM:ldj

Attachments

CALIFORNIA REGIONAL WATER QUALITY CONTROL BOARD
CENTRAL VALLEY REGION

MONITORING AND REPORTING PROGRAM NO. 95-187

NPDES NO. CA0083712

FOR
UNIVERSITY OF CALIFORNIA
DAVIS CAMPUS LANDFILL
GROUND WATER CLEANUP SYSTEM
YOLO COUNTY

Specific sample station locations shall be established under direction of the Board's staff, and a description of the stations shall be attached to this Order.

EFFLUENT MONITORING

Effluent samples shall be collected downstream from the last connection through which wastes can be admitted into the outfall. Effluent samples should be representative of the volume and quality of the discharge. Time of collection of samples shall be recorded. Effluent monitoring shall include at least the following:

Constituents	Units	Type of Sample	Sampling Frequency
Total Dissolved Solids	mg/l	grab	monthly
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Metals[2]	µg/l	grab	quarterly
pH	pH units	grab	twice weekly
Acute Toxicity[3]	% survival	grab	twice annually
Flow	mgd	meter	continuous
Temperature	°F	grab	twice weekly
Chronic Toxicity[4]	% survival	grab	twice annually
Volatile organic compounds[1]	µg/l	grab	weekly
Total chromium	µg/l	grab	twice monthly
Chromium VI	µg/l	grab	twice monthly

[1] Volatile organic compound sampling shall include, at least: bromodichloromethane, bromoform, bromomethane, carbon tetrachloride, chlorobenzene, chloroethane, 2-chloroethyl vinyl ether, chloroform, chloromethane, dibromochloromethane, 1,2-dichlorobenzene, 1,3-dichlorobenzene, 1,4-dichlorobenzene, dichlorodiflouromethane, 1,1-dichloroethane, 1,2-dichloroethane, 1,1-dichloroethene, trans-1,2-dichloroethene, 1,2-dichloropropane, cis-1,3-dichloropropene, trans-1,3-dichloropropene, dichloromethane, 1,1,2,2-tetrachloroethane, 1,1,1-trichloroethane, 1,1,2-trichloroethane, trichloroethene, trichloroflouromethane and vinyl chloride. The minimum detection level must be sufficient to determine permit compliance.

[2] Metals analysis shall include antimony, arsenic, cadmium, lead, mercury, nickel, selenium, thallium, chromium, magnesium, silver, vanadium and zinc.

[3] The acute toxicity testing shall use EPA test method EPA/600/4-90/027 (or later amendment) with Pimephales promelas (fathead minnows) as the test species. The acute test shall be a 96-hour static-renewal.

[4] Chronic toxicity testing as specified in EPA 600/4-89-001 shall use Pimephales promelas, Ceriodaphnia dubia, and Selenastrum capricornutum as the test species. The test shall be conducted in 100% effluent without dilution since the receiving stream is considered ephemeral. Time of collection samples shall be recorded. The effluent tests must be conducted with concurrent reference toxicant tests. Monthly laboratory reference toxicant tests may be substituted upon approval. Both the reference toxicant and effluent test must meet all test acceptability criteria as specified in the chronic manual. If the test acceptability criteria is not achieved, then the Discharger must re-sample and re-test within 14 days.
The acute and chronic toxicity testing shall be rotated on a quarterly basis.

If the discharge is intermittent rather than continuous, then on the first day of each such intermittent discharge, the Discharger shall monitor and record data for all of the constituents listed above, after which the frequencies of analysis given in the schedule shall apply for the duration of each such intermittent discharge. In no event shall the Discharger be required to monitor and record data more often than twice the frequencies listed in the schedule.

RECEIVING WATER MONITORING

All receiving water samples shall be grab samples. Receiving water monitoring, when the Creek is flowing, shall include at least the following:

Station	Description
R-1	50 feet upstream from the point of discharge
R-2	100 feet downstream from the point of discharge

INFORMATION SHEET

UNIVERSITY OF CALIFORNIA
DAVIS CAMPUS LANDFILL
GROUND WATER CLEANUP SYSTEM
YOLO COUNTY

The University of California owns and operates the Davis Campus Class III landfill. Ground water underlying the landfill has been found to be polluted with volatile organic compounds (VOC) from landfilled wastes and from old chemical burn trenches. The VOCs detected in at least 10% of the ground water samples include: carbon tetrachloride, chloroethane, chloromethane, 1,1-dichloroethane, 1,1-dichloroethene, 1,2-dichloropropane, dichloromethane (methylene chloride), tetrachloroethane, 1,1,1-trichloroethane, trichloroethene, trichloroflouromethane and vinyl chloride. The pollutants form two separate plumes, one consists principally of chloroform and emanates from old chemical burn trenches near the landfill entrance, the second, generally underlies the landfill and consists of VOCs and elevated minerals typical of Class III landfills. The University proposes to extract and treat the polluted ground water. The treatment system consists of an air stripping unit to remove volatile organic compounds from extracted ground water.

Treated ground water is proposed to be discharged to Putah Creek. Putah Creek is an ephemeral stream running along the southern campus boundary. The beneficial uses of Putah Creek downstream of the discharge are municipal and domestic, and agricultural supply; water contact and noncontact recreation; esthetic enjoyment; navigation; ground water recharge, fresh water replenishment; and preservation and enhancement of fish, wildlife and other aquatic resources.

The ground water is generally divided into three water bearing zones, zone A (35 to 55 feet below ground surface (bgs)), zone B (75 to 95 ft. bgs) and zone C (127 to 170 ft. bgs). The VOC pollution has been found to be lying within the A and B ground water zones. Assessment of the C zone is not yet complete. The Discharger proposes to begin extraction at a rate of approximately 0.30 mgd from the A and B zones. Extraction from the C zone will be done if necessary, based on an ongoing ground water assessment.

The Report of Waste Discharge indicates concentrations of total dissolved solids (TDS) in the shallowest ground water zone underlying the landfill is elevated, high values are reported as 1,500 mg/l. The average TDS in the deeper (B zone) is 405 mg/l. Sampling conducted in Putah Creek detected an average TDS of 258 mg/l. The treated wastewater is a blend of polluted groundwater extracted from the shallow (higher TDS), as well as deeper, zones. The blended effluent is projected to be approximately 486 mg/l, which is below the TDS secondary drinking water standard of 500 mg/l. The proposed permit requires the University use the best practicable cost-effective control technique currently available to limit TDS to no more than 500 mg/l in the discharge.

INFORMATION SHEET

UNIVERSITY OF CALIFORNIA
DAVIS CAMPUS LANDFILL
GROUND WATER CLEANUP SYSTEM
YOLO COUNTY

The Report of Waste Discharge indicates concentrations of total chromium (Cr) in the B ground water zone (75 to 95 ft. bgs) may exceed the California primary maximum contaminant level (MCL) for drinking water. The total Cr primary MCL is 0.05 mg/l. Samples in the shallow A zone ranged from nondetectable (ND) concentrations to 0.024 mg/l (total Cr). Samples in the B zone ranged from ND to 0.096 mg/l (total Cr). The average combined effluent is projected to be approximately 0.036 mg/l (total Cr). This permit limits the discharge to 0.05 mg/l (total Cr) as a daily maximum and 0.016 mg/l for chromium VI.

In accordance with antidegradation provisions of 40 CFR 131.12 and State Water Resources Control Board Resolution 68-16 the effluent discharge limit for volatile organic compounds is nondetectable at specified minimum detection levels as a monthly average. Sampling and analysis techniques for volatile organics are frequently the subject of error. Therefore, the daily maximum discharge has been set at twice the detection level to account for lab inaccuracies. The 30 day average discharge level is the limiting criteria in the regulation of the VOCs, and the daily maximum will not allow degradation. The monthly average concentration shall be calculated using one half the detection level for daily samples reported as nondetectable. The daily maximum allowable discharge concentration for vinyl chloride has been set at 0.13 µg/l, which is below the typical minimum detection level, based on Cal EPA's proposed cancer potency factor as a water quality criterion.

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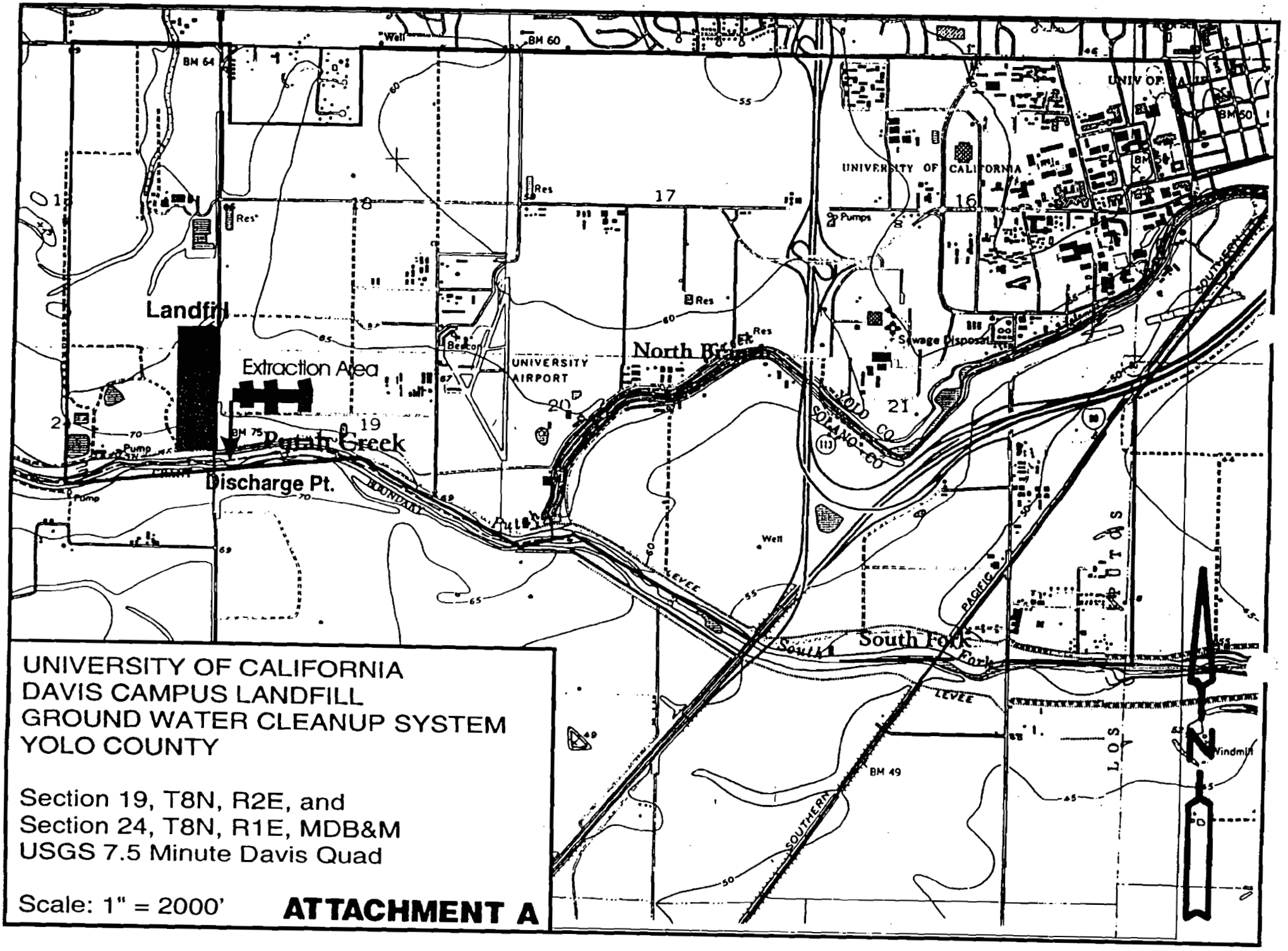

UNIVERSITY OF CALIFORNIA
DAVIS CAMPUS LANDFILL
GROUND WATER CLEANUP SYSTEM
YOLO COUNTY

Section 19, T8N, R2E, and
Section 24, T8N, R1E, MDB&M
USGS 7.5 Minute Davis Quad

Scale: 1" = 2000'

ATTACHMENT A

Constituents	Units	Station	Sampling Frequency
Dissolved Oxygen	mg/l	R-1, R-2	monthly
pH	pH units	R-1, R-2	weekly
Turbidity	NTU	R-1, R-2	monthly
Temperature	°F (°C)	R-1, R-2	weekly
Electrical Conductivity @25°C	μmhos/cm	R-1, R-2	weekly
Radionuclides	PCi/l	R-1, R-2	twice annually

In conducting the receiving water sampling, a log shall be kept of the receiving water conditions throughout the reach bounded by Stations R-1 and R-2. Attention shall be given to the presence or absence of:

a. Floating or suspended matter
b. Discoloration
c. Bottom deposits
d. Aquatic life
e. Visible films, sheens or coatings
f. Fungi, slimes, or objectionable growths
g. Potential nuisance conditions

Notes on receiving water conditions shall be summarized in the monitoring report.

REPORTING

Monitoring results shall be submitted to the Regional Board by the **20th day of the month** following sample collection. Quarterly and annual monitoring results shall be submitted by the **20th day of the month** following each calendar quarter and year, respectively.

In reporting the monitoring data, the Discharger shall arrange the data in tabular form so that the date, the constituents, and the concentrations are readily discernible. The data shall be summarized in such a manner to illustrate clearly whether the discharge complies with waste discharge requirements. The highest daily maximum for the month, monthly and weekly averages should be determined and recorded.

If the Discharger monitors any pollutant at the locations designated herein more frequently than is required by this Order, the results of such monitoring shall be included in the calculation and reporting of the values required in the discharge monitoring report form. Such increased frequency shall be indicated on the discharge monitoring report form.

By **30 January of each year**, the Discharger shall submit a written report to the Executive Officer containing the following:

a. The names and telephone numbers of persons to contact regarding the plant for emergency and routine situations.

b. A statement certifying when the flow meter and other monitoring instruments and devices were last calibrated, including identification of who performed the calibration (Standard Provision C.6).

The Discharger may also be requested to submit an annual report to the Board with both tabular and graphical summaries of the monitoring data obtained during the previous year. Any such request shall be made in writing. The report shall discuss the compliance record. If violations have occurred, the report shall also discuss the corrective actions taken and planned to bring the discharge into full compliance with the waste discharge requirements.

All reports submitted in response to this Order shall comply with the signatory requirements of Standard Provision D.6.

The Discharger shall implement the above monitoring program on the first day of the month following effective date of this Order.

Ordered by: William H. Crooks
WILLIAM H. CROOKS, Executive Officer

23 June 1995
(Date)

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