February 20, 2001

Mr. Ray Seid
United States Environmental Protection Agency
Region IX
75 Hawthorne Street
San Francisco, California 94 105

Dear Mr. Seid:

The enclosed Five-Year Review is forwarded for your information and future reference.

This document includes revisions that were made as a result of your earlier reviews. In addition, all information in this document provides for protection of human health and the environment.

Finally, this document continues to fully comply with the record of Decision for Riverbank Army Ammunition Plant (RBAAP).

Sincerely,

SIGNED

James E. Gansel
Commander's Representative

Enclosure

Copies Furnished (w/encl):

Mr. Jim Pinasco, California EPA, Department of Toxic Substances Control,
1015 1 Croydon Way, Suite 3, Sacramento, CA 95827-2106
Mr. Jim Barton, California Regional Water Quality Control Board, 3443 Routier Road,
Suite A, Sacramento, CA 95827-3098
Commander, U. S. Army Operations Support Command, ATTN: SOSMA-ISE-R/
Dr. Henry Crain, Rock Island, IL 61299-6000
Commander, U. S. Army Environmental Center, 5 179 Hoadley Road/Mr. James Daniel
Aberdeen Proving Ground, MD 2 10 1 0-540 1

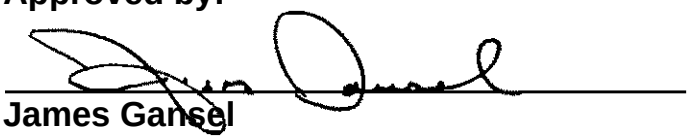
Five-Year Review Report

First Five-Year Review Report
For
Riverbank Army Ammunition Plant
City of Riverbank
Stanislaus County, California

February 2001

PREPARED BY:
Department of the Army
Riverbank Army Ammunition Plant

Approved by: **Date:**



2/20/01

James Gansel
Commander's Representative
U.S. Army, Riverbank Army Ammunition Plant

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION IX
75 Hawthorne Street
San Francisco, CA 94105-3901

September 24, 2001

Mr. James E. Gansel
Commander's Representative
Department of the Army
Riverbank Army Ammunition Plant
Riverbank, CA 95367-0670

RE: Five-Year Review Report of Remedial Actions at Riverbank Army Ammunition Plant in Riverbank, California (Stanislaus County)

Dear Mr. Gansel

The United States Environmental Protection Agency (EPA) has reviewed the Army's Five-Year Review Report dated February 2001 and the September 21, 2001 Letter Addendum for the remedial actions at Riverbank Army Ammunition Plant located in Stanislaus County in Riverbank, California.

EPA agrees with the findings, conclusions, and recommendations povided in the Report and Letter Addendum, and concurs that the remedies are protective of human health and the environment. Post-ROD provisions of the March 1994 Record of Decision (ROD) for Riverbank include, among other things, response actions on groundwater recharge of the A-Aquifer Zone pursuant to the ROD, and investigation/corrective action for the contamination in and around the Industrial Waste Treatment Plant (IWTP) area pursuant to requirements of the Resource Conservation and Recovery Act (RCRA). We believe the Army is making early progress towards its response to contaminants in the recharging A-Aquifer Zone, which is consistent with the ROD, and California's Department of Toxic Substances Control (DTSC) is overseeing the Army's response to the IWTP area under RCRA, which is also consistent with the ROD. The Army will continue its routine long-term monitoring and assessment of the A-Aquifer Zone recharging, and implement required response actions as necessary in accordance with the ROD. Data assessment and response action are coordinated with regulatory agencies through the monthly and quarterly reports for Riverbank.

Similarly, as part of its comprehensive basewide monitoring, extraction, and treatment system, the Army will continue its routine long-term monitoring and assessment of groundwater contaminant levels in the A', B, and C Aquifer Zones (which specifically include the areas of

MW65A' in the A'-Aquifer Zone and MW109B in the B-Aquifer Zone), and implement required response actions as necessary in accordance with the ROD. Data assessment and response action are coordinated with regulatory agencies through the monthly and quarterly reports for Riverbank.

The Army is following monitoring and maintenance provisions of its Closure and Post-Closure Maintenance Plan for the closed landfill, and its capping and monitoring remedy remains protective of human health and the environment. Likewise, the excavation and off-site disposal of contaminated sediments in the Evaporation/Percolation Ponds, performed early on as a removal action, remain protective of human health and the environment.

The Five-Year Review Report and Letter Addendum satisfactorily address the requirements of Section 121(c) of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and EPA's OSWER Directive 9355.7-03B-P (April 1999). They also address EPA's comments by letter dated August 15, 2001. Should you have questions regarding this letter, you may contact our Remedial Project Manager for Riverbank, Raymond Seid, at (415) 744-2394.

Sincerely,

Chief, Federal Facilities
and Site Cleanup Branch (SFD-8)

cc: Dan Ward, Office of Military Facilities, DTSC, Sacramento
John Russell, RWQCB, Central Valley Region, Sacramento
James Pinasco, RPM, DTSC, Sacramento
Brian Taylor, RWQCB, Central Valley Region, Sacramento

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List of Acronyms

ARARs	applicable or relevant and appropriate requirements
CCRs	California Code of Regulations
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
COCs	contaminants of concern
COE	U.S. Army Corps of Engineers
DTSC	California Department of Toxic Substances Control
E/P	evaporation/percolation
EPA	U.S. Environmental Protection Agency
GOCO	government-owned, contractor-operated
gpm	gallons per minute
GWTP	Groundwater Treatment Plant
GWTS	Groundwater Treatment System
IGWTS	Interim Groundwater Treatment System
IWTP	Industrial Waste Treatment Plant
LLNL	Lawrence Livermore National Laboratory
MCLs	maximum contaminant levels
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
ND	non-detect
NPL	National Priority List
O&M	operation and maintenance
OSC	U.S. Army Operations Support
ppb	parts per billion
QAPP	Quality Assurance Project Plan

QA/QC	quality assurance/quality control
RA	remedial action
RBAAP	Riverbank Army Ammunition Plant
RD	remedial design
RI	Remedial Investigation
ROD	Record of Decision
RWQCB	California Regional Water Quality Control Board, Central Valley Region
TPH	total petroleum hydrocarbons
TTLC	California Total Threshold Limit Concentration
µg/L	micrograms per liter
U.S.	United States

Executive Summary

The initial five-year review for the Riverbank Army Ammunition Plant (RBAAP) in Riverbank, California was completed in August 2000. The results of the five-year review indicate that the remedy is expected to be protective of human health and the environment. Overall, the groundwater extraction and treatment system and landfill cover remedial actions are functioning as designed and are operated and maintained in an appropriate manner. A few deficiencies that do not immediately impact the protectiveness of the remedy were noted in the five-year review summary form (attached to the end of this executive summary).

Protection of human health and the environment by the landfill and groundwater remedial actions at RBAAP are discussed below. Appropriate health and safety and emergency response protocol are in place and being properly implemented to control risks. The landfill remedial action is protective of human health and the environment. The groundwater remedial action is operating as designed and is expected to be protective of human health and the environment when complete. Accordingly, the remedy for RBAAP is currently be protective of human health and the environment and is expected to continue to be protective through completion.

Landfill

The landfill remedy is protective of human health and the environment. The cap is effective at containing contaminants through preventing infiltration of rainwater and preventing direct contact with contaminated soils. Institutional controls at the landfill remain in place and are effective. RBAAP is fully fenced and access is controlled through a manned gate and security patrols. Warning signs are in place at the landfill.

Groundwater

When complete, the groundwater remedial action is expected to be protective of human health and the environment. Immediate threats have been addressed, and the groundwater extraction and treatment system is operating and functioning as designed. Containment of

the contaminated areas has been achieved through establishment of inward gradients that limit migration of the groundwater plumes. Except in the source area, levels of contaminants are falling and the size of the contaminated areas is shrinking as expected. The Army previously provided (December 1992) an alternate water supply and deeper wells for the residents downgradient of the site to prevent groundwater use downgradient of the plume.

FIVE YEAR REVIEW SUMMARY FORM

Site Identification

Site Name (*from WasteLAN*): Riverbank Army Ammunition Plant

EPA ID (*from WasteLAN*):

Region: 09 | **State:** California **City/County:** Riverbank/Stanislaus County

Site Status

NPL status [X] final [ ] deleted [ ] other specify _____

Remediation status (choose all that apply) [ ] Under Construction [X] Operating [X] Complete

Multiple OUs*? [ ] YES [X] NO **Construction completion date:** 09/27/97

Has site been put into reuse? [X] YES [ ] NO Portions of the facility have been leased to private party tenants.

Review Status

Reviewing agency: [ ] EPA [ ] State [ ] Tribe [X] Other Federal Agency: U.S. Army

Author name: David Towell

Author title: Project Manager | **Author affiliation:** CH2M HILL (U.S. Army Contractor)

Review period:** May 2000 to August 2000

Date(s) for site inspection: 5/18/00

Type of review.***
[X] Statutory
[ ] Policy [ ] (Post SARA [ ] NPL –Removal only
[ ] Non-NPL Remedial Action Site [ ] NPL State/Tribe Lead
[ ] Regional Discretion)

Review number [X] 1(first) [ ] 2(second) [ ] 3 third __ other (specify)_____

Triggering action.
[X] Actual RA Onsite Construction at the Landfill
[ ] Actual TA Start at OU#___
[ ] Construction Completion
[ ] Previous Five Year Review Report
[ ] Other(specify)_____

Triggering action date (*from WasteLAN*): 6/5/1995

Due Date (*five years after triggering action*): 6/5/2000

Five-Year Review Summary Form

Deficiencies:

Three general deficiencies were identified:

- An evaluation of the need for supplemental remedial actions in the A-zone source areas has not been completed.

- The existing extraction system would not contain contaminant migration from the small area of A′-zone chromium contamination present near the landfill.

- The O&M Manual and As-Built Drawings have not been fully updated to account for all of the changes made during system optimization.

None of these deficiencies currently effect the protectiveness of the remedy.

Recommendations and Follow-up Actions:

Three actions are required to correct these deficiencies and ensure that protectiveness is maintained in the future:

- The ongoing evaluations of A zone source area remediation need to be completed and recommendations made on the need for and type of (if any) additional remedial actions that may be beneficial.

- There should be continued monitoring of the A′ zone contamination detected in MW65′ near the landfill. If concentrations begin to increase in downgradient monitoring wells (all are currently non-detect for chromium), MW45A′ (see Plate 1) will be equipped as an extraction well.

- The as-built drawings and O&M Manual should be updated to reflect all of the changes made during system optimization. This will ensure that future O&M can be completed in a timely and efficient manner.

Protectiveness Statement(s):

The landfill remedial action is protective and the groundwater remedial action is operating as designed and is expected to be protective when complete. Because both of the remedial actions are protective, the overall remedy for RBAAP is protective of human health and the environment.

I. Introduction

The United States (U.S.) Army has conducted a five-year review of the remedial actions implemented at the Riverbank Army Ammunition Plant (RBAAP) in Riverbank, California. This review was conducted from May 2000 through August 2000. This report documents the results of the review. CH2M HILL, under contract to the U.S. Army Operations Support Command (OSC) at Rock Island, Illinois, supported the Army in performance of this first formal five-year review.

The purpose of five-year reviews is to determine whether the remedy at a site is protective of human health and the environment. The methods, findings, and conclusions of review are documented in five-year review reports. In addition, five-year review reports identify deficiencies during the review, if any, and recommendations to address them.

This review is required by statute. EPA must implement five-year reviews consistent with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and the National Oil and Hazardous Substances Pollution Contingency Plan (NCP). CERCLA Section 121c, as amended, states:

> If the President selects a remedial action that results in any hazardous substances pollutants, or contaminants remaining at the site, the President shall review such remedial action no less often than each five years after initiation of such remedial action to assure that human health and the environment are being protected by the remedial action being implemented.

The NCP part 300.430(f)(4)(ii) of the Code of Federal Regulations (CFR) states:

> If a remedial action is selected that results in hazardous substances, pollutants, or contaminants remaining at the site above levels that allow for unlimited use and unrestricted exposure, the lead agency shall review such action no less often than every five years after the initiation of the selected remedial action.

This is the first formal five-year review for the RBAAP, although the Army did conduct an initial five-year review in August 1996. The triggering action for this review is the initiation of remedial action on the landfill at RBAAP on June 5, 1995. A five-year review is required

because hazardous substances, pollutants, or contaminants remain at the site above levels that allow for unrestricted use and unlimited exposure.

II. Site Chronology

Table 1 lists the chronology of events for the RBAAP site.

Table 1: Chronology of Site Events

Date	Event
1980	The Army published an Installation Assessment that identified potential sites at RBAAP that potentially contain hazardous materials.
1984 to 1986	Contamination Survey completed in three phases. Chromium and cyanide identified in groundwater at concentrations exceeding background.
1987 to 1991	Three phase Remedial Investigation (RI) program completed. Confirms chromium and cyanide as only contaminants of concern (COCs) in groundwater.
1989	Interim response action initiated. Design of the Interim Groundwater Treatment System (IGWTS) completed.
2/21/90	National Priority List (NPL) Listing.
1990	Construction of the IGWTS completed.
4/5/90	Federal Facility Agreement signed.
10/91	IGWTS operation commenced with extraction from onsite wells.
12/92	City of Riverbank water supply lines extended to residential area west of RBAAP.
12/93	Evaporation/Percolation (E/P) Ponds Removal Action completed.
3/23/94	Record of Decision (ROD) signed.
2/13/95	Remedial Design (RD) for the landfill cap approved.
6/5/95	Remedial Action (RA) initiated for the landfill. This is the triggering action for this five-year review.
10/3/96	Construction of the landfill cap, including drainage systems, completed.
11/96	Construction of the expanded groundwater treatment system (GWTS) completed.

Date	Event
9/15/97	Final off-base groundwater extraction well installed and operational.
9/29/97	Construction completion.
9/30/97	Preliminary Close Out Report submitted.

III. Background

The RBAAP facility is located at 5300 Claus Road, Riverbank, Stanislaus County, California, one mile south of the Stanislaus-San Joaquin County border and approximately five miles northeast of the City of Modesto. The plant lies in a moderate climatologic region of the San Joaquin Valley in central California to the west of the Sierra Nevada Mountains. RBAAP is a government-owned, contractor-operated (GOCO) facility. The operating contractor is NI Industries, Inc.. NI Industries, Inc. has operated the facility since early 1952. RBAAP occupies a total of 173 acres of land in a primarily rural area. RBAAP is bordered on the north, west and south by sparse residential areas, with the densest housing community lying west of the plant. RBAAP is bordered on the east by pastureland.

RBAAP was originally constructed by ALCOA as an aluminum reduction plant supplying the military. The plant was built under authority of the Defense Plant Corporation in 1942 and production of aluminum began in May 1943. The plant was subsequently closed in August 1944. During the period of operation by ALCOA, cyanide-containing wastes were generated and disposed of in the southern section of the landfill located in the northeastern portion of the main plant area. From 1951 until present, the RBAAP has produced steel cartridge cases with production reaching peaks during the Korean and Vietnam conflicts. During the years between those conflicts (1958-1966), the plant was placed in layaway and standby status. From 1977 through 1990, only grenade and mortar production lines were operational and the grenade production was ceased in June 1990. Currently, RBAAP activities are limited to the operation of the mortar production line, layaway of idle facilities, limited manufacturing and technology updates, and maintenance and protection of the overall plant. In addition, buildings at the plant have been leased out to private business that conduct a variety of light to heavy industrial activities. These tenants include:

Tenant	Type of Business
Ceracon	Manufacturing of metal parts
LMC-West	Manufacturing of large metal process equipment
Pacific Coast Machining	Machine shop
Wholesale Services, Inc.	Wholesaler of propane
Leisure RV Storage	RV storage facility
D&M Hancock	General engineering contractor
Pete & Sons Electric	Electrical contractor
WonderGlass	Manufacturing of glass products
Riverbank Oil Transfer	Transfer of used waste oil
California Highway Technology	Manufacturing of steel reinforcement for highways/ bridges

The Army's installation restoration program conducted at RBAAP concluded that chromium (almost exclusively in the hexavalent form) and cyanide (present as free cyanide) from past plant operations had contaminated groundwater both on and off the installation. These are the only two groundwater COCs at the site. The off-site contamination impacted or potentially impacted the domestic wells of 70 residences west of the plant. Sources of chromium contamination were determined to be the old industrial wastewater treatment system redwood tanks and to a lesser degree chromium contaminated brick debris located on the landfill. The source of cyanide contamination was determined to be pot liner from ALCOA aluminum production operation of the early 1940's which were disposed of on the landfill. In addition, the E/P ponds, located one mile north of the plant on the banks of the Stanislaus River, contained levels of zinc in excess of the California Total Threshold Limit Concentration (TTLC). The E/P Ponds have received various degrees of treated plant effluent since discharge to the ponds was begun in 1952, resulting in contamination of the pond sediments.

Prior to the ROD, three response (removal) actions were conducted at the site. The removal actions are summarized as follows:

- **E/P Ponds Removal Action.** A removal action was required at the ponds to address zinc contamination in the soils within the ponds. Between September and December

1993, the Army excavated a total of 1,118.5 cubic yards of contaminated soil and disposed of it an approved offsite landfill.

- **Permanent Potable Water Supply Response Action.** A response action was necessary to protect residents from potential exposure to groundwater contaminated with chromium and cyanide migrating downgradient of RBAAP to the west. Initially, the Army provided bottled water to residents potentially impacted by the contamination. To provide a permanent source of clean water, the Army extended the City of Riverbank's public water supply system into the residential areas west of Riverbank. In December 1992, residents were connected to the City's public water supply.

- **IGWTS Response Action.** The IGWTS response action was established as a non-time-critical removal action to mitigate further off-base migration of groundwater contamination. As part of the IGWTS response action, the Army converted a total of 8 monitoring wells (4 in the B zone and 4 in the C zone) to extraction wells. The treatment system, consisting of reduction/precipitation for chromium and cyanide removal followed by selective anion exchange for additional cyanide removal, was built in 1991 and full operation of the groundwater and extraction system began in October 1991.

IV. Remedial Actions

A. Remedy Selection

The only ROD for the RBAAP site was signed on March 23,1994. The discussion of remedial actions is separated into the three components of the remedy, groundwater, E/P ponds, and the landfill. In addition, the ROD mentioned additional activities that may need to be addressed in the future. The remedial action objectives and associated remedial actions are as follows:

Groundwater

- Complete hydraulic capture of A′-, B- , and C-zone groundwater contaminated with chromium in excess of the drinking water standard (i.e., the maximum contaminant level [MCL]) of 50 µg/L.
- Complete hydraulic capture of A′-, B- , and C-zone groundwater contaminated with cyanide in excess of the drinking water standard (MCL) of 200 µg/L.

The ROD did not specifically address action for A-zone groundwater because the A zone was not saturated at the time. The A zone is discussed below in the section on Post-ROD Actions.

The groundwater remedial action includes routine groundwater monitoring to ensure that the remedy is effective.

E/P Ponds

- Remove sediments contaminated with zinc and total petroleum hydrocarbons (TPH).

This remedial action was completed in December 1993, before the ROD. However, groundwater monitoring occurs on a routine basis to ensure that the remedy has been successful.

Landfill

- Install a final cover and maintain the cover for 20 years. The final cover should be constructed in accordance with the substantive provisions of California Code of Regulations (CCRs), Title 23, Chapter 15, Articles 5 and 8, Corrective Action and Closure Requirements
- Install additional monitoring wells downgradient of the landfill.

This remedial action includes routine groundwater monitoring to check that the remedial action is effective and that the cleanup objectives are being maintained.

Post-ROD Actions

The ROD described two conditions that, although they were not part of the selected remedy, may have to be addressed based on events that occur after approval and implementation of the ROD. These are: recharge of the A zone, and investigation of the IWTP source area upon base closure. Each of these is discussed below.

Recharge of the A Zone

The ROD calls for continued monitoring of the A zone to determine if it recharges and, if it does recharge, investigation of the extent of contamination. If groundwater cleanup levels (MCLs) are exceeded, the A-zone groundwater will be investigated and remediated.

IWTP Source Investigation Upon Base Closure

The IWTP was identified as a source of chromium contamination in the groundwater during the RI. Investigations conducted around the current IWTP tanks determined that there was no threat to groundwater from the residual contamination in the soils investigated. However, because the IWTP is an operational system, investigations were limited to the perimeter of the tanks. In accordance with RCRA closure requirements, the Army will perform a more complete investigation of the IWTP area upon base closure to ensure that potential impacts to the environment are mitigated.

B. Remedy Implementation

The U.S. Army Corps of Engineers (COE) contracted with CH2M HILL to complete the remedial design of the selected remedy, both for the landfill and the groundwater extraction and treatment system. The RBAAP remedial design was started in 1994 with the preparation of the *Final Closure and Post-Closure Maintenance Plan – Riverbank Army Ammunition Plant Landfill*, December 1994. This document presents the remedial design for landfill closure. EPA approved the remedial design on February 13, 1995. The *Final Closure and Post-Closure Maintenance Plan – Riverbank Army Ammunition Plant Landfill* was subsequently modified and finalized in May 1996, after landfill construction was complete.

The remedial design for the groundwater extraction and treatment system began in 1994 and was completed in June 1995, as presented in the *Riverbank Army Ammunition Plant*

Groundwater Extraction and Treatment System 100 Percent Design Document. Extraction system design and operating criteria are described in the *Riverbank Army Ammunition Plant Final Extraction System Design and Monitoring Plan with System Operating Procedures*, dated September 24,1997. Additional supplements to the remedial design documentation were included in a technical memorandum titled *Supplement to Design Documentation for the Groundwater Extraction and Monitoring Network, IGWTS, GWTS, and IWTP*, dated September 23, 1997. EPA, in consultation with the State of California, approved these documents, collectively considered the 100 percent design documentation for the remedial design, on September 29, 1997.

Construction of the two remedial actions proceeded on independent tracks. The landfill remedial action began in June 1995 and initial work was completed in October 1995. Additional seeding was performed in 1996 and the final construction was complete on October 3, 1996. In accordance with the plan, the landfill cap included, from top to bottom, a 2-foot-thick vegetative cover layer, a 0.25-inch-thick geosynthetic liner, and a 2-foot-thick foundation layer. The landfill cap was designed and constructed to drain rainfall runoff off of and away from the landfill. After installation of the cap and associated drainage and final grading, the cover was hydroseeded with native gas.

Implementation of the groundwater remedial action system actually began with initial operations in the IGWTS, which was constructed in 1990, and brought on-line in October 1991. The IGWTS was used initially to provide capture of contaminated groundwater flowing westward across the installation boundaries. The original extraction system consisted of a series of extraction wells clustered at four locations on the RBAAP property all feeding into the IGWTS which was designed to treat 80 to 100 gallons of groundwater per minute. As required under the ROD, the IGWTS was retained as an integral part of the final groundwater treatment system based on its demonstrated performance.

Following the final ROD and remedial design effort (completed in 1995), the Army modified the groundwater extraction system to include extraction wells west of the RBAAP facility designed to provide full capture of the chromium and cyanide plumes. This entailed construction of 6 new off-base extraction wells. Concurrently, the Army constructed the GWTS, with a capacity of approximately 250 gpm, to supplement the IGWTS. During design and construction of the GWTS, the Army upgraded the IGWTS to

increase its capacity to 120 gpm to allow immediate hookup of the off-base (off-base refers to the area beyond the RBAAP boundary) extraction wells, thereby expediting plume capture. Expansion of the overall groundwater treatment plant (consisting of the IGWTS and the GWTS) to handle increased pumping from the expanded extraction system was completed in November 1996. The final extraction well was installed and operating by September 15, 1997.

Major design and remedial action contractors included CH2M HILL (remedial design for the landfill closure and the groundwater extraction and treatment system) and Kvaerner-Davy International (remedial construction for the landfill closure and groundwater extraction and treatment system). The Army COE provided review, oversight, and construction management of all remedial design and construction activities. Construction of the extraction and treatment systems was completed under an accelerated schedule to expedite plume capture and completion of the remedial action.

EPA conducted an inspection of the groundwater extraction and treatment system on September 22, 1997. The inspector found all key components to have been constructed, installed, and operating with no exceptions noted. EPA provided a letter dated September 29, 1997, indicating that they had determined that the groundwater extraction and treatment system was operational and functional). The system began full-capacity operation on September 15, 1997, extracting and treating contaminated groundwater at approximately 289 gpm.

The RBAAP facility achieved construction completion status when the Preliminary Close-Out Report was signed by the regulatory agencies on September 30, 1997.

C. System Operations

NI Industries, Inc. is the operating contractor for the RBAAP facility. As part of this role, they perform site security and access control for the facility. In addition, the Army has contracted with NI Industries, Inc. to perform operations and maintenance (O&M) activities for each of the remedial actions constructed at RBAAP. NI Industries, Inc. has been operating the IGWTS and the onsite extraction well system since operations started in 1991. NI Industries, Inc. has continued in this role through the system expansion, including the

addition of the GWTS and off-base extraction well system in 1996. NI Industries, Inc. also performs the routine landfill O&M activities. NI Industries, Inc. has been the sole O&M contractor for this site to date.

System O&M and monitoring requirements are described in the following documents, all approved by EPA, in consultation with the State of California:

- *Riverbank Army Ammunition Plant Interim Groundwater Treatment System (IGWTS) Operation and Maintenance Manual*, January 1991, prepared by WTS
- *Final Closure and Post-Closure Maintenance Plan - Riverbank Army Ammunition Plant Landfill*, May 1996, prepared by CH2M HILL
- *Riverbank Army Ammunition Plant Final Extraction System Design and Monitoring Plan with System Operating Procedures*, September 24, 1997, prepared by CH2M HILL
- *O&M Manual, Riverbank Army Ammunition Plant, Groundwater Treatment System (GWTS)*, September 1997, prepared by CH2M HILL

The O&M activities are being conducted in accordance with these approved plans. There have been modifications to some of the procedures since the O&M documents were finalized. These modifications are generally documented in systems operations process bulletins prepared by NI, although this is not always the case. In addition, there have been minor system modifications that are not reflected in any as-built drawings.

System operational and monitoring requirements include the following:

Landfill

- Groundwater monitoring downgradient to evaluate effectiveness of the cover and migration of contaminants.
- Surface water runoff monitoring
- Final cover monitoring, including monitoring and maintenance of vegetative cover growth, surface erosion, and settlement and grading
- Surface water drainage monitoring and maintenance

All of these activities are performed on a quarterly frequency. In addition, routine daily site security checks provide supplemental observations that would detect any significant erosion or surface water drainage problems.

Groundwater Extraction and Treatment

- Daily monitoring of treatment plant and extraction system operations
- Ongoing maintenance of the groundwater extraction and treatment systems in accordance with the O&M Manual. System maintenance comprises three main components: routine preventative maintenance, minor equipment maintenance and repair, and major equipment repair/replacement.
- Quarterly sampling of groundwater monitoring wells and continuous (for numerous wells) and monthly monitoring of groundwater elevations
- Weekly sampling of groundwater treatment plant influent
- Daily sampling of the GWTS and IGWTS ion exchange column effluent and the final effluent discharged to the sanitary sewer or E/P ponds

The groundwater treatment plant is staffed essentially full-time during the day, Monday through Friday, and part time during the day on Saturday and Sunday. Outside of these times, operator support is available on-call, as necessary. Routine daily O&M tasks include, but are not limited to, the following:

1. Monitor extraction well and influent pump flow rates and adjust as necessary.
2. Monitor pressures across the multimedia filters and ion exchange columns.
3. Conduct ion exchange regeneration and backwashes as needed and operate the regenerant evaporator.
4. Prepare and submit work orders as peeded for the repair of GWTP equipment.
5. Operate the backwash system for the multimedia filters as needed.
6. Perform routine housekeeping for maintenance of the facility.
7. Record pertinent operational data, including totalizer readings and flow rates.

Landfill maintenance has generally been limited to routine mowing and weed control and occasional revegetation, repairs of minor erosion, and drainage system repairs. However, there was one instance where more significant landfill cap repairs were required. On September 16, 1997, a contractor performing grading and drainage work on the railroad line bordering the western side of the landfill damaged the vegetative layer and subdrainage system along the landfill's western slope. In October 1997, repairs were made to rectify the damage to the landfill cover system. Two memoranda that provide additional explanation of the landfill cover damage and subsequent repairs are provided in Attachment 2.

Groundwater extraction and treatment system maintenance has primarily been limited to routine system maintenance and repairs. During the first year of startup and shakedown operation of the GWTS several operational and maintenance issues arose, primarily related to optimizing the most cost-effective chemical addition rates and excessive solids loading on the multimedia filters and ion exchange columns. As these issues were being resolved, the overall output from the groundwater extraction and treatment system consistently met or exceeded the flow rates required for containment of the groundwater contamination.

Subsequent to the remedy achieving construction completed and being determined to be "operational and functional" in September 1997, the Army has undertaken an aggressive system optimization process intended to reduce operational costs while maintaining require flow rates. Figure 1 shows the actual cumulative gallons extracted and treated at RBAAP for the period from October 1997 through September 2000 versus the flow rate required for containment during that same time frame. The figure demonstrates that the target extraction rates (as determined by groundwater modeling) have been achieved throughout the last 3 years of operations.

The treatment plant optimization conducted over the last three years has contributed to a significant reduction in system operation costs. At initial startup, in late 1996, the operational contractor was projecting an operating cost of $1.9 million per year. The current annual budget for system operation (for the April 2000 through March 2001 period) is approximately $800,000. Although there have been a number of factors contributing to the reduction in operational costs, the bulk of the savings (more than $600,000) can be attributed to treatment plant optimization efforts. Table 2 illustrates the annual operating costs for the last four years.

Table 2: Annual System O&M Costs

Dates		Approximate Total O&M Costs
From	**To**	
4/97	3/98	$1,400,000
4/98	3/99	$1,300,000
4/99	3/00	$950,000
4/00	3/01	$800,000(1)

(1) Projected costs

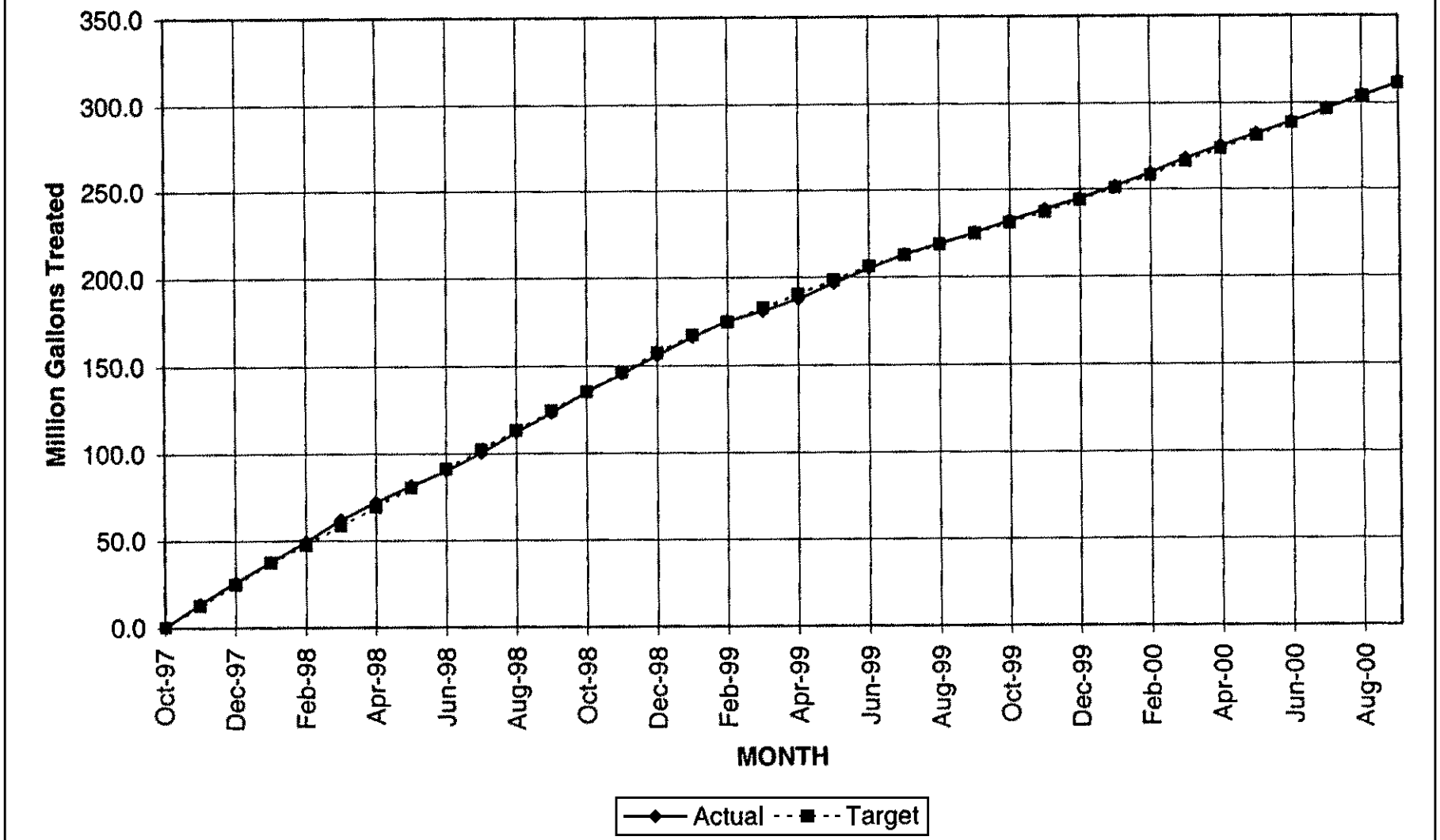
Post-ROD Actions

As described above, the ROD listed two potential areas that may need to be addressed even though they are specific components of the selected remedy. These include the A zone and the IWTP area.

For the last several years, RBAAP has been monitoring water levels and water quality in the A zone. The A zone has recharged and elevated levels of chromium and cyanide are presented in selected wells in the IWTP area and an area between the IWTP and the landfill (see Plate 1). Sufficient monitoring points are available to delineate the extent of A zone contamination. As is discussed below (and illustrated in Figure 2), A-zone contamination will ultimately be contained by pumping in the A′ zone, primarily by extraction from 113A′. In addition, the Army is evaluating supplemental source control actions to accelerate remediation of the A zone (see Section 8 for a complete description). At this time, RBAAP is still evaluating potential A-zone remediation options.

Investigation of the IWTP is deferred to base closure. The IWTP area that will be investigated at closure includes both the IWTP itself and the associated industrial and cyanide wastewater collection systems that historically transported water from the production areas at RBAAP to the IWTP.

Figure 1
Riverbank GWTP Cumulative Gallons Treated (10/97 - 9/00)



V. Five-Year Review Process

The RBAAP five-year review was led by David Towell, CH2M HILL's Project Manager for work at the RBAAP facility. CH2M HILL is under contract to the OSC to provide environmental support at the RBAAP facility. CH2M HILL works closely with NI Industries, Inc. on system O&M, monitoring, and optimization activities. The following team members assisted in the review:

- Jim Gansel/U.S. Army Commander's Representative for RBAAP
- Luther Stover/U.S. Army environmental management staff at RBAAP

The five-year review consisted of the following activities: a review of relevant documents (see Attachment 1); interviews with agency personnel and Army staff at RBAAP; and a site inspection. In addition, the completed report will be placed in the information repository. Notice of its completion will be placed in the local newspaper. A brief summary of this report will be made available to interested community members.

VI. Five-Year Review Findings

A. Interviews

As part of the site inspection (described below), brief interviews were conducted with Luther Stover, Environmental Management, RBAAP and with staff from NI Industries, Inc., the onsite contractor that operates the remedial action. Because the Army is actively overseeing onsite activities, and has a substantial ongoing presence in O&M and monitoring of the remedial action, it was determined that more extensive interviews were not necessary as part of the five-year review process.

The following summarizes some highlights of the short interviews conducted during the site inspection. The Army is continuing its aggressive program to lease out areas and buildings at RBAAP for use by external commercial and industrial occupants. However, the

Army does not currently have any plans to close the RBAAP facility. Mr. Stover did not note any particular problems with system O&M. In fact, he noted the benefits of the ongoing optimization activities in minimizing and streamlining the O&M requirements and associated costs. Mr. Stover also indicated that the Army is performing several data evaluation and treatability study activities to determine the potential benefits and associated costs of implementing: 1) supplemental source control remedial actions in the A zone at the facility, and 2) increasing the efficiency of the off-base groundwater extraction system through installation of an additional extraction well.

B. Site Inspection

CH2M HILL and Army staff took part in a site inspection on May 18, 2000. During the site inspection, remedial systems were inspected and treatment plant operations were observed. The inspection evaluated the landfill cap, the groundwater treatment system, the surface water drainage system, site fencing, and groundwater extraction system. A summary of the site inspection findings is presented below. Refer to Attachment 3 for the site inspection checklist that details the inspection findings. Attachment 4 contains a number of photos documenting site conditions observed during the site inspection.

Conditions during the inspection were favorable with mild temperatures and no precipitation. Measurable precipitation had not been recorded in the RBAAP vicinity for at least a week prior to the inspection.

The vegetation on the landfill had not been mowed recently making it somewhat difficult to observe the condition of the landfill cap. The landfill cap appeared to be in good condition. The vegetative cover was generally thorough with no distressed areas. A star thistle weed has invaded the cover. NI Industries, Inc. is trying to mitigate this problem with the application of herbicide. The most recent application occurred in March 2000 additional applications are planned each spring as necessary.

No landfill cap damage was observed. There was evidence of small rodent burrows across much of the cap. NI Industries, Inc. has initiated a squirrel abatement program at RBAAP to address the problem. In Spring 2000, a basewide application of fumigant (aluminum phosphide) was performed in all burrows, including those at the landfill. The fumigant

(brand name Fumatoxin) tablets were placed in each burrow and the burrows sealed with newspaper. NI Industries, Inc has reported a substantial drop in the squirrel population at RBAAP. In Fall 2000, poison grain bait was placed in all open burrows present on the landfill. An additional application of fumigant is planned for late January 2001 as part of the ongoing squirrel abatement program.

NI Industries, Inc. quarterly landfill maintenance reports have not noted any substantial issues with ponding, cracking or other landfill cap problems. There are no remaining indications of the landfill cover damage caused in 1997 by a contractor doing work on the adjoining railroad tracks (Attachment 2 includes technical memoranda documenting the damage and recommended repairs). Minor erosion was observed along some of the landfill side slopes.

There is evidence of minor erosion and ponding apparent in limited stretches (10 to 20 feet in length) of the perimeter ditch along the northern and eastern perimeters of the landfill. These do not effect the integrity of the landfill cover or drainage system. Drainage improvements have been made at the north end of the landfill to address surface water run-on from adjacent agricultural fields. No other deficiencies of the cover system or appurtenant structures, including drainage channels, access roads, or warning signs were noted.

There does not appear to be any deficiencies with the site fencing in the landfill vicinity. All parts of the RBAAP facility are secured and closely monitored to ensure that unauthorized access does not occur. With the exception of the rodent holes, no intrusive activities were noted on the cover system. There is no exposure of landfill waste or landfill cover liners.

The groundwater treatment plant (consisting of the GWTS and the IGWTS) was found to be operating and functioning properly. No operational problems were observed. The current operating mode, which uses ion exchange only, results in very straightforward operation procedures. The primary operator activity is to regenerate the resin in the ion exchange columns when it is spent. Currently, each ion exchange column is regenerated approximately every two weeks. The as-built drawings and O&M manual have not yet

been completely updated to reflect the change in operations. The change to ion exchange occurred in spring 1999.

All groundwater extraction well vaults were intact with no signs of damage. The pumps were extracting water from the A′, B and C zones with a total combined extraction rate of approximately 175 gpm.

The annual groundwater monitoring event was conducted the week prior to the site inspection. The sampling crews did not note any problems with well heads, well locks, or access. Based on a review of the sampling documentation and discussions with the field teams, the samples were collected in accordance with the approved Sampling Plan. The laboratory results for recent groundwater monitoring events are discussed in the data review section below.

The IWTP area and its associated wastewater influent pipeline systems remain capped by concrete, asphalt and large production buildings. There is not currently any mechanism for additional transport of contaminants from these potential source areas down to the groundwater aquifer. If the Army decides to close the RBAAP facility or embark on major land use changes, additional investigation of conditions in these areas will be required.

C. Changes in ARARs or Exposure Pathways

There are three types of applicable or relevant and appropriate requirements (ARARs) - chemical-specific, location-specific, and action-specific. Of the ARARs listed in the ROD, the primary requirements that could potentially question the protectiveness of the remediation goals are the state and federal drinking water regulations and the landfill cover and post-closure requirements.

There have not been any changes to these ARARs that would affect the protectiveness of the remedy. The drinking water requirements (i.e., MCLs) listed in the ROD (50 µg/L for chromium and 200 µg/L for cyanide) have not become more stringent since the signing of the ROD in 1994. Both MCLs remain the same.

The ARARs in the ROD reference the substantive requirements of the state of California's CCR Title 23, Division 3, Chapter 15, Articles 5 and 8 for landfill cover and post-closure

maintenance requirements. These action-specific ARARs that specify landfill closure actions requirements have not changed since the signing of the ROD.

Site conditions and associated exposure pathway assumptions remain consistent with those assumed in the Risk Assessment. Installation of the landfill cover has further restricted the potential for receptors to contact the contaminated soil. Land use in the off-base areas of contamination has not change, remaining rural residential. There are not currently any drinking water wells operating within the areas of contamination present in the A/A′, B, or C zones. Land use at RBAAP continues to be limited to commercial/industrial activities by outside businesses and ongoing facility operations by the Army and its contractor. The Army does not currently have any plans to change the land use pattern at RBAAP and the facility is only accessible through a checkpoint that is manned 24 hours/day.

D. Data Review

A review of monthly operation reports and quarterly groundwater monitoring reports through June 2000 indicates that more than 300 million gallons of water have been extracted and treated over the last 3 years (October 1997 through September 2000). The beginning of this time period corresponds to the date when it was determined that remedial action construction was complete on the groundwater extraction and groundwater treatment systems. Figure 1 shows the cumulative volume of water extracted over this time period.

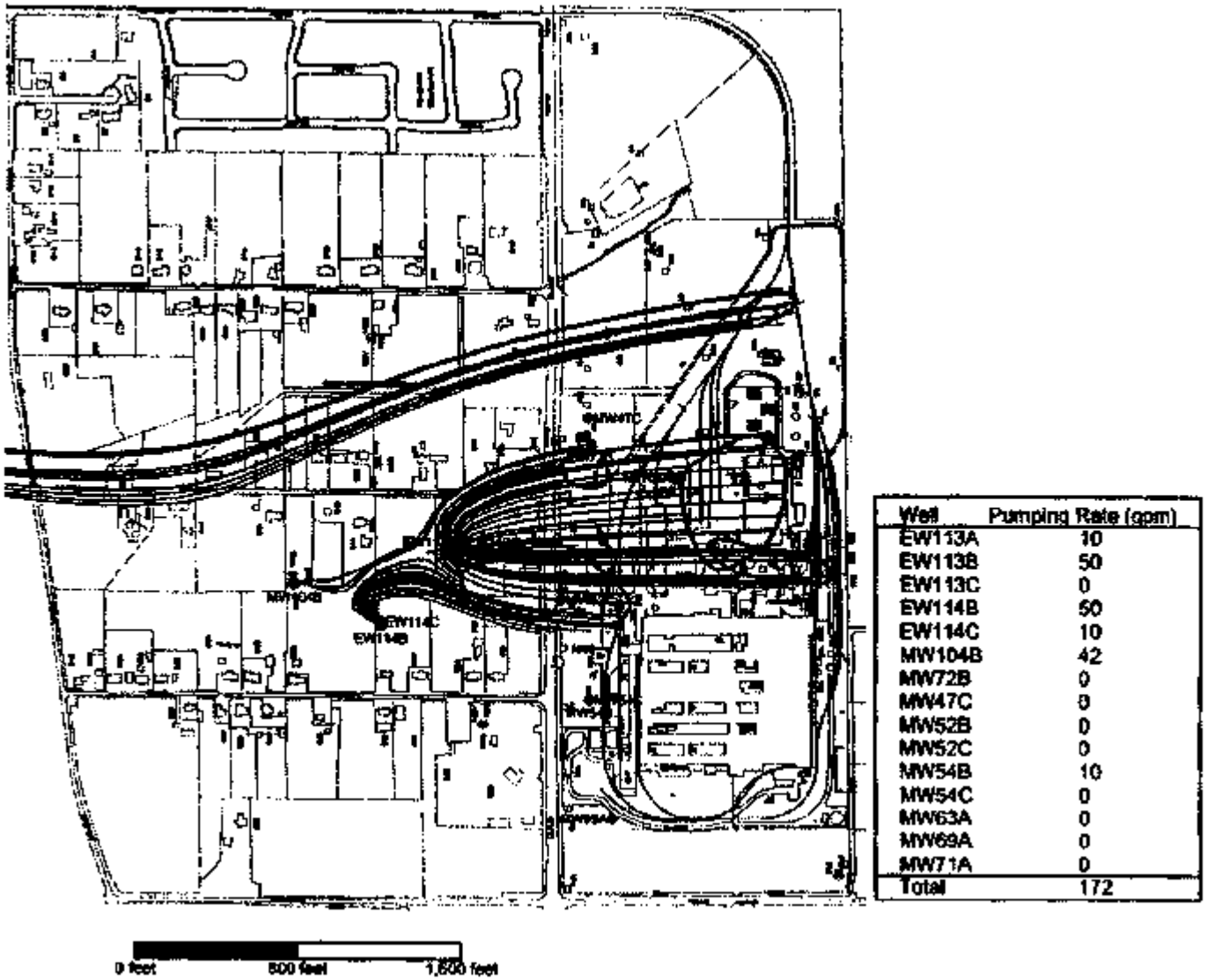
Figure 1 also shows the cumulative target extraction volume over time. The recommended target extraction rates have been changed several times in response to changing contaminant conditions and ongoing attempts to optimize and minimize the amount of water being extracted while still meeting the goal of providing complete containment of the contamination in the A/A′, B, and C zones. Table 3 presents the target extraction rates over time since September 1997. Each recommended change in the target extraction rate has been supported by simulations of groundwater flow that demonstrate the ability of the pumping scenario to contain the areas of contamination. These simulation results and associated recommendations are presented in quarterly groundwater monitoring reports. In general, the contaminated areas are much smaller now then they were in 1997. The reduced extent of contamination requires less extraction to maintain capture.

Table 3: Target Extraction Rates – September 1997 to September 2000

Time Period		Target Extraction Rate (gpm)
9/97	1/98	282
1/98	2/99	248
2/99	7/99	180
7/99	12/99	140
12/99	2/00	155
2/00	4/00	175
4/00	9/00	172

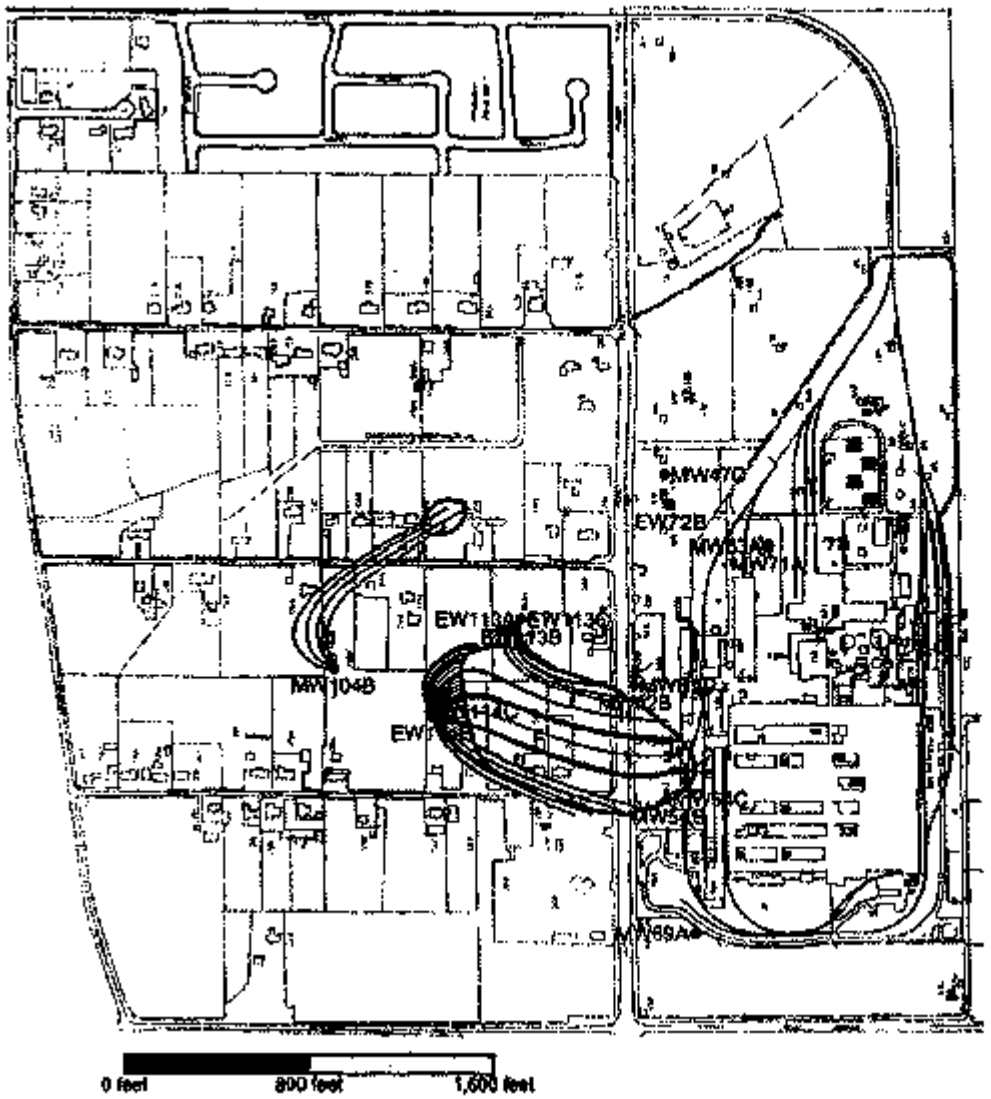
The modeling simulations conducted to confirm that the 172 gpm target extraction rate is adequate to capture the groundwater contamination at RBAAP are presented in the Quarterly Groundwater Monitoring Report, RBAAP Groundwater Monitoring Program, 2000 - First Quarter (CH2M HILL, 2000b). Simulation results taken from the quarterly report are presented herein on Figures 2, 3, and 4 for the A/A′, B, and C zones, respectively. These figures show groundwater flowlines emanating from the boundaries of the contaminated areas at RBAAP. There is just one small area of contamination that would not be captured under the 172 gpm scenario. This is a small area of chromium contamination located adjacent to the landfill. The Quarterly Groundwater Monitoring Report (CH2M HILL, 2000b) states that all of the A/A′ zone wells downgradient of the small area of contamination are non-detect for chromium at this time, indicating that the chromium contamination has not migrated a significant distance away from the landfill. The Quarterly Report recommends continued monitoring of this area to detect any migration of the chromium contamination. As described above, if downgradient concentrations begin to increase, monitoring well MW45A′ can be converted into an extraction well.

Figure 2
Flowlines Starting at the Edge of the
A Zone Target Areas
172 gpm Scenario
First Quarter 2000



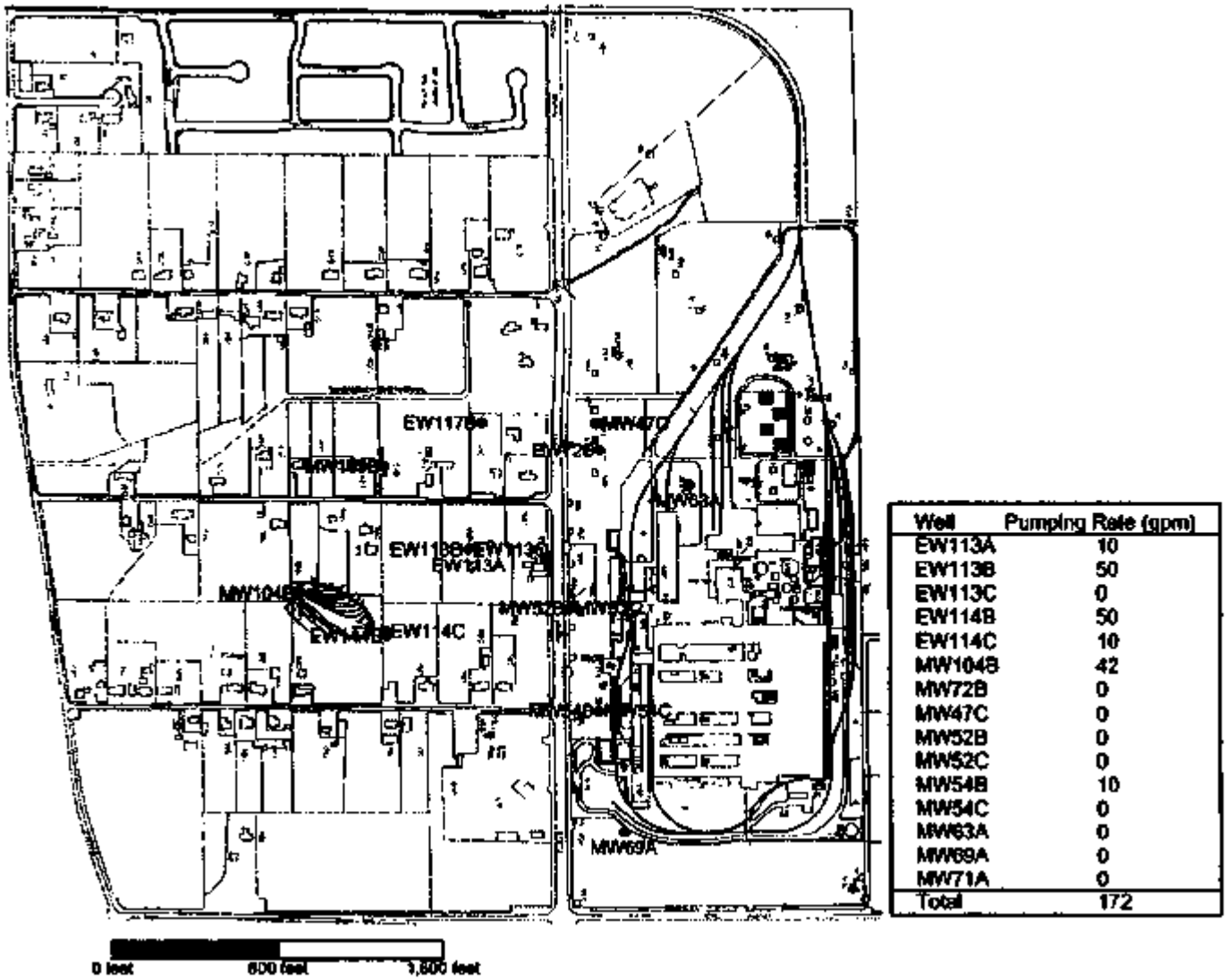
Well	Pumping Rate (gpm)
EW113A	10
EW113B	50
EW113C	0
EW114B	50
EW114C	10
MW104B	42
MW72B	0
MW47C	0
MW52B	0
MW52C	0
MW54B	10
MW54C	0
MW63A	0
MW69A	0
MW71A	0
Total	172

Figure 3
Flowlines Starting at the Edge of the
B Zone Target Areas
172 gpm Scenario
First Quarter 2000



Well	Pumping Rate (gpm)
EW113A	10
EW113B	50
EW113C	0
EW114B	50
EW114C	10
MW104B	42
MW72B	0
MW47C	0
MW52B	0
MW52C	0
MW54B	10
MW54C	0
MW63A	0
MW69A	0
MW71A	0
Total	172

Figure 4
Flowlines Starting at the Edge of the
C Zone Target Areas
172 gpm Scenario
First Quarter 2000



The current areas of contamination in each zone at RBAAP (based on the 2nd Quarter 2000 sampling data) are shown in Plates 1, 2, and 3 for the A/A′, B, and C zones, respectively. The maximum chromium and cyanide concentrations in groundwater are summarized in Table 4 below. The data show that contaminant concentrations in the A′, B, and C zones have decreased considerably since the time the ROD was signed in 1994. However, except for cyanide concentrations in the C zone, all zones still exceed the cleanup levels specified in the ROD. Not only have the contaminant concentrations decreased dramatically, the areas of contamination are also much smaller. Figure 5 illustrates the reduction in the size of the chromium-contaminated areas between 1993 and 2000. The chromium contamination contours shown in this figure represent a composite of the A/A′, B, and C zones.

Table 4: Comparison of Historic and Current Groundwater Concentrations

Contaminant	Zone	1986 to 1993 Peak Concentrations (ppb)	1st and 2nd Quarter 2000 Peak Concentrations (ppb)	Cleanup Level (ppb)
On-Base				
Chromium	A	1,300	1,680	50
Cyanide	A	22,600	5,580	200
Chromium	A′	312	83.6	50
Cyanide	A′	1,660	231	200
Chromium	B	515	229	50
Cyanide	B	1,075	69	200
Chromium	C	42	ND (<10)	50
Cyanide	C	229	ND (<20)	200
Off-Base				
Chromium	A′	140	45.6	50
Cyanide	A′	93.3	72	200
Chromium	B	395	228	50
Cyanide	B	139	231	200
Chromium	C	110	63.9	50
Cyanide	C	283	21	200

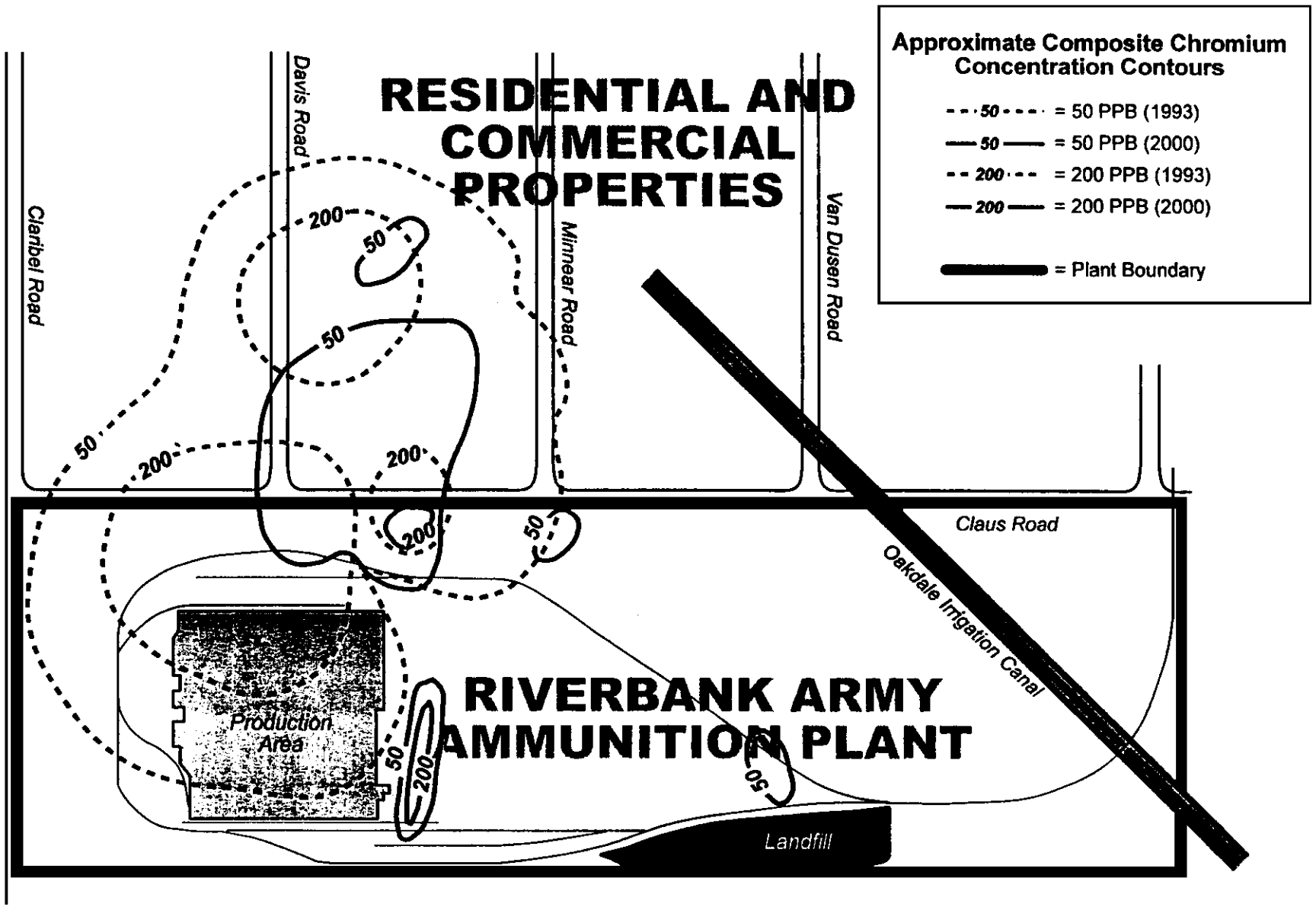


Figure 5
Groundwater Cleanup at Riverbank Army Ammunition Plant
Riverbank, California
(1993-2000)

CH2MHILL

In general, contaminant levels have not declined significantly in the shallow A zone. A-zone contaminant levels have actually increased since they were last measured in the early 1990s. The increase may be attributable to the fact that the A zone was unsaturated for a number of years before beginning to recharge over the last two years. During this initial recharge period, higher flux of contaminants from the soil to groundwater can be expected. The Army is currently evaluating options to enhance remediation of the A zone. These options include increasing the amount of groundwater extraction from the A/A′ zone onsite and in-situ remediation of the chromium and cyanide within the source areas. The ROD includes provisions for the recharge of the A zone that require the Army to investigate and, if necessary, remediate the groundwater in the A zone in accordance with the remediation goals (i.e., MCLs).

Recent GWTP influent and effluent data (from July 2000) are summarized in Table 5. The data show that the treatment system is currently removing contaminants to below detection limits. The monthly operations reports for the last three years document that the treatment plant effluent is consistently non-detect (ND) for chromium and cyanide.

Table 5: Treatment System Influent and Effluent Concentrations – July 2000

Contaminant	Date	Influent Concentrations		Effluent Concentrations
		On-Base (ppb)	Off-Base (ppb)	(ppb)
Chromium	7/5/00	239	31	ND (<10)
Cyanide	7/5/00	21	41	ND (<10)
Chromium	7/12/00	229	32	ND (<10)
Cyanide	7/12/00	ND (<10)	18	ND (<10)
Chromium	7/19/00	235	34	ND (<10)
Cyanide	7/19/00	ND (<10)	16	ND (<10)
Chromium	7/26/00	246	32	ND (<10)
Cyanide	7/26/00	ND (<10)	19	ND (<10)

ND = non-detect.

A review of the water level contours presented in Plates 1, 2, and 3 demonstrate the inward gradients created by the operation of the groundwater extraction system. The capture

zones generated by the RBAAP extraction wells appear to extend well beyond the areas of chromium and cyanide contamination. These water level contours, which were developed based on field water level measurements taken from the monitoring well network, support the conclusions of the model simulations. The contours confirm that operation of the extraction system under the 172 gpm scenario will capture the contaminated areas at RBAAP.

In summary, the goals of the remedial action at RBAAP are being met by: the intact landfill cover, which prevents potential exposure to contaminated materials and inhibits further infiltration of contaminants to the groundwater; and operation of the groundwater extraction system which captures and removes contaminants from the groundwater beneath RBAAP. Monitoring results show decreased concentrations of contaminants at extraction and monitoring wells, except in the shallow A zone. This indicates that contaminant loading to all but the shallowest groundwater zones has substantially decreased. Further migration of contaminated groundwater is controlled through the establishment of an inward gradient in groundwater flow. Monitoring results indicate that the groundwater treatment system is meeting all effluent discharge limits.

VII. Assessment

The following conclusions support the determination that the remedy at RBAAP is expected to be protective of human health and the environment upon completion.

Question A: Is the Remedy Functioning as Intended by the Decision Documents?

- **Health and Safety Plan/Contingency Plan:** NI Industries, Inc., the onsite contractor performing O&M of the remedial action, has an active, onsite Safety Department that oversees work activities and implements safety procedures. NI Industries, Inc. has appropriate health and safety and emergency response protocol to control risks.
- **Implementation of Institutional Controls and Other Measures:** Adequate access controls are in place that prevent potential exposure. These include fences and limited

access to the entire facility, as well as considerable warning signs at the landfill and groundwater treatment plant. If the Army decides to close the facility, deed restrictions will be required for the landfill to ensure continued integrity of the landfill cover.

Institutional controls are in place and no current or planned changes in land use at RBAAP suggest that they are not effective. The land use at RBAAP continues to be commercial and industrial use by the Army, its contractor NI Industries, Inc., and various private companies that lease space at the facility. The IWTP source area and its associated wastewater influent pipeline systems remain capped by concrete, asphalt and buildings. If the Army decides to close the RBAAP facility or embark on major land use changes, additional investigation of conditions in these areas will be required to evaluate the need for supplemental remedial actions.

- **Remedial Action Performance:** The landfill cover system has been effective in isolating the contaminants present in the landfill. There is some very minor erosion occurring on the landfill slopes and animal burrows were found on the cover, however, neither of these affects the performance or integrity of the cover system. The groundwater extraction and treatment system is fully operational, has established containment of the contaminated areas and is meeting discharge requirements. The remedial actions continue to be effective and the groundwater extraction and treatment system is operating and functioning as designed. As detailed below in the discussion of deficiencies, there are two areas of groundwater contamination that require additional monitoring and evaluation. These are the A-zone sources areas beneath the facility and the small area of chromium contamination in the A′ zone near the landfill. Depending on the outcome of ongoing monitoring and evaluation activities, remedy modifications may be warranted in these two areas.

  For the A′ zone contamination near the landfill, the remedy modification could entail equipping MW45A′ as an extraction well. The adjacent MW45B and MW45C monitoring wells were historically used as extraction wells, so pipelines are available at this location to carry water back to the treatment plant.

- **System Operations/O&M:** The current system operating procedures, as implemented, are effective and consistent with requirements. There have not been any significant

operational difficulties with the extraction system or treatment plant since the construction complete status was attained in September 1997.

- **Cost of System Operations/O&M:** As described above in Section IV, annual operating costs have been reduced dramatically from the initial expenditures. This reduction in costs has been realized through the extensive system optimization efforts implemented over the last two years at RBAAP.

- **Opportunities for Optimization:** The Army has implemented extensive optimization at RBAAP over the last two years. Major changes in treatment system and effluent discharge operations have streamlined operations and reduced costs. In addition, the groundwater extraction scenarios are reviewed every quarter to assess opportunities for further optimization. Currently, the Army is considering installation of an additional off-base extraction well to increase the efficiency of containment. This extraction well would be located closer to the cyanide contamination in the vicinity of 109B and would be able to provide containment of this contamination at a lower extraction rate than is required using MW104B pumping.

  Concurrent with the system optimization efforts, the monitoring program has been evaluated on a quarterly basis to identify appropriate increases or reductions in monitoring frequency at individual wells. It is expected that the monitoring program optimization will continue.

- **Early Indicators of Potential Remedy Failure:** No early indicators of potential remedy failure were noted during the review. Cost and maintenance requirements have been in line with or below expectations and the extraction system is capturing all of the contaminated groundwater migrating downgradient of the source areas. If the A′ zone contamination near the landfill begins to migrate toward the facility boundary, modifications to the extraction system may be required.

Question B: Are the Assumptions Used at the Time of Remedy Selection Still Valid?

- **Changes in Standards and To Be Considered:** The state and federal drinking water MCLs for chromium and cyanide identified as cleanup standards in the ROD have not changed since the ROD was signed.

- **Changes in Exposure Pathways:** No changes in the site conditions that affect exposure pathways were identified as part of the five-year review. Although portions of the facility have been leased for use by private companies, there are no current or planned changes in land use and no new contaminant sources or routes of exposure. There is no indication that hydrogeologic conditions are not adequately characterized. Although there has been variability in the location and magnitude of groundwater contamination, the changes observed have been in accordance with the understanding of the conceptual model of the groundwater conditions at the RBAAP site.

- **Changes in Toxicity, Other Contaminant Characteristics, and Risk Assessment Methodologies:** The primary pathways evaluated in the risk assessment were related to exposure to contaminants in soil at the landfill and exposure to contaminated groundwater. The landfill cover eliminates potential exposure to soil contaminants and there are not any wells producing water from the contaminated areas. Because there are no complete exposure pathways, no effort was put into re-assessing toxicity, contaminant characteristics, or risk assessment methodologies during the five-year review.

Question C: Has Any Other Information Come to Light that Could Call Into Question the Protectiveness of the Remedy?

No additional information has been identified that would call into question the protectiveness of the remedy.

VIII. Deficiencies

Several deficiencies were noted during the five-year review and are identified in Table 6. None of these are sufficient to warrant a conclusion that the remedy is not protective. The deficiencies are the type that could affect the long-term performance of the remedy and may ultimately result in the need for system modification.

Table 6: Identified Deficiencies

Deficiencies	Currently Affects Protectiveness
An evaluation of the need for supplemental remedial actions in the A-zone source areas has not been completed.	No
The existing extraction system would not contain contaminant migration from the small area of A′-zone chromium contamination present near the landfill.	No
The O&M Manual and As-Built Drawings have not been updated to account for all of the changes made during system optimization.	No

Remediation of the A-zone source areas that have recently recharged has not been adequately evaluated at this time. The Army is currently performing two evaluations that may result in modification to the current system or implementation of additional remedial actions. The ongoing evaluations include an assessment of the benefits of attempting to increase extraction from the A/A′ zone on the RBAAP facility to accelerate cleanup. The second evaluation involves potential in-situ remediation efforts.

The second deficiency is related to the containment of the small area of chromium contamination in the vicinity of the landfill. At the present time, there is no indication that this small area of contamination is a threat to migrate beyond the RBAAP boundary. However, if that changes, the current extraction system would not be able to capture this area of contamination. Additional extraction capacity to the north would be required. As described above, this could entail equipping MW45A′ as an extraction well.

IX. Recommendations and Follow-up Actions

The recommendations and follow-up actions necessary to address the deficiencies are outlined in Table 7 below. The Army has already initiated evaluations to assess the need for and potential types of remedial actions for the A zone source area at RBAAP. The Army is evaluating the benefits of attempting to increase extraction from the A/A′ zone on the RBAAP facility site to accelerate cleanup. However, the A zone only has a few feet of saturation and is unlikely to yield significant volumes of water to an extraction well or wells. A second evaluation involves potential in-situ remediation efforts. Fieldwork was conducted in October 1999 to collect soil samples in the apparent source areas at RBAAP. These samples were analyzed for chromium and cyanide at Lawrence Livermore National Laboratory (LLNL). LLNL staff are now performing pilot scale treatability testing on these samples to assess the potential for in-situ remediation of both chromium and cyanide. This remedial action would involve the addition of a buffered chemical solution into the source area groundwater. For the chromium source areas the solution would act to reduce the hexavalent chromium to an insoluble trivalent chromium compound. For cyanide, the solution would contain an oxidant that would destroy the cyanide through oxidation. Work on these evaluations needs to continue and result in recommendations for addressing the A zone source areas.

Table 7: Recommendations and Follow-up Actions

Deficiencies	Recommendations/ Follow-up Actions	Milestone Date	Follow-up Actions: Affect Protectiveness?
A zone source area remediation	Complete ongoing evaluations and make recommendations on the need for and type of additional remedial actions.	1st Quarter 2001 Groundwater Monitoring Report (4/2001)	No
A′ zone containment near landfill	Continue monitoring, develop contingency plans for expanding extraction system if migration is detected.	1st Quarter 2001 Groundwater Monitoring Report (4/2001)	No
As-builts/O&M Manual not updated	Update as-built drawings and O&M Manual	6/1/2001	No

X. Protectiveness Statements

Protection of human health and the environment by the landfill and groundwater remedial actions at RBAAP are discussed below. Appropriate health and safety and emergency response protocol are in place and being properly implemented to control risks. The landfill remedial action is protective of human health and the environment. The groundwater remedial action is operating as designed and is expected to be protective of human health and the environment when complete. Accordingly, the remedy for RBAAP is currently be protective of human health and the environment and is expected to continue to be protective through completion.

Landfill

The landfill remedy is protective of human health and the environment. The cap is effective at containing contaminants through preventing infiltration of rainwater and preventing direct contact with contaminated soils. Institutional controls at the landfill remain in place and are effective. RBAAP is fully fenced and access is controlled through a manned gate and security patrols. Warning signs are in place at the landfill.

Groundwater

When complete, the groundwater remedial action is expected to be protective of human health and the environment. Immediate threats have been addressed, and the groundwater extraction and treatment system is operating and functioning as designed. Containment of the contaminated areas has been achieved through establishment of inward gradients that limit migration of the groundwater plumes. Except in a small portion of the A-zone near the IWTP source area, contaminant concentrations in groundwater are falling and the size of the contaminated areas is shrinking as expected. To prevent potential exposure, the Army previously provided (December 1992) an alternate water supply for residents west of RBAAP in the vicinity of the groundwater contamination. The Army also drilled deeper wells for a small number of residents that still want to use wells for irrigation purposes.

XI. Next Review

This is a statutory site that requires ongoing five-year reviews. The next review will be completed within five years of the original due date for this five-year review report -June 2005.

Attachment 1

Documents Reviewed

Attachment 1

Documents Reviewed

CH2M HILL, *1995. Riverbank Army Ammunition Plant Groundwater Extraction and Treatment System 100 Percent Design Document.* June.

_____, 1996. *Final Closure and Post-Closure Maintenance Plan - Riverbank Army Ammunition Plant Landfill.* May.

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_____, *1997b. Riverbank Army Ammunition Plant Final Extraction System Design and Monitoring Plan with System Operating Procedures.* September 24.

_____, 1997c. *O&M* Manual, Riverbank Army Ammunition *Plant, Groundwater* Treatment System *(GWTS).* September.

_____, 1999a. *Quarterly Groundwater Monitoring Report, RBAAP Groundwater Monitoring Program, 1999 - First Quarter.* Prepared for Riverbank Army Ammunition Plant. April.

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_____, 2000a. *Quarterly Groundwater Monitoring Report, RBAAP Groundwater Monitoring Program, 1999 - Fourth Quarter.* Prepared for Riverbank Army Ammunition Plant. January.

_____, 2000b. *Quarterly Groundwater Monitoring Report, RBAAP Groundwater Monitoring Program,* 2000 - First Quarter. Prepared for Riverbank Army Ammunition Plant. April.

_____, 2000c. *Quarterly Groundwater Monitoring Report, RBAAP Groundwater Monitoring Program, 2000 - Second Quarter.* Prepared for Riverbank Army Ammunition Plant. August.

Harding Lawson Associates [HLA], *1998. Groundwater Treatment System Assessment Report, August 1996 through November* 2997. Prepared for Riverbank Army Ammunition Plant. September.

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Attachment 2

Memoranda Documenting 1997 Landfill Cover Damage and Repairs

Riverbank Army Ammunition Plant
Landfill Cap Damage

PREPARED FOR: Ms. Judy Soutiere/Sacramento District Corps of Engineers
James Gansel/RBAAP Army

PREPARED BY: Serge Terentieff/CH2M HILL

COPIES: Stan Sturges/CH2M HILL
Robert Reeves/RWQCB

DATE: September 23, 1997

This memorandum summarizes our observations of the damage that occurred to the Riverbank Army Ammunition Plant (RBAAP) landfill cover on September 16, 1997, based on our site visit on September 17, 1997, and conversations with NI Industries staff. The following personnel were present during the site visit:

- Robert Reeves/RWQCB
- Judy Soutiere/USACE Technical Manager
- Hy Morrow /USACE Geologist
- Gary Endicott/RBAAP Army Project Administrator
- Serge Terentieff/CH2M HILL Civil Engineer
- John Ashley/NI Industries, Inc. Director of Marketing
- Linda Svoboda/NI Industries, Inc. Purchasing Manager
- Steve LuQuire/NI Industries, Inc. Environmental Manager

On September 16, 1997, a contractor performed grading and drainage work on the railroad line bordering the western side of the landfill. The work, which is complete, included additional ballast fill (crushed rock) and a 12-inch-diameter perforated, corrugated HDPE pipe. The approximate extent of crushed rock and drainage pipe placement is shown on Figure 1 (Sections A and C). To perform this work, the contractor apparently first stockpiled crushed rock on the southern and northwestern end of the top deck of the landfill, and then proceeded to place crushed rock along the railroad by pushing the material down the western 3:1 (horizontal:vertical) side slope. The landfill vegetative cover and side slope subdrainage system were damaged in the process of stockpiling and pushing the crushed rock in place.

Based on our site observations, the following general observations were made about the landfill cover at the time of our visit:

- The vegetative cover was removed (scraped off) along the western side slope and portions of the top deck of the landfill.

- Small, isolated mounds of crushed rock are strewn across the scraped-off areas.

- The current subgrade condition in the scraped-off areas consists of loose silty and sandy soil with organics (scraped-off grass).

- The cover drainage system relief pipes, which daylight near the toe of the western 3:1 slope at approximately every 100 feet, were crushed, apparently in the process of pushing the crushed rock in place. While most of the relief pipes were visible during our site visit, approximately five pipes could not be located (one at the northern end and four near the southern end of the western side slope). These outlet pipes could not be readily located because of loose soil conditions along the toe of slope.

- The geosynthetic clay liner (GCL) and composite drainage net (CDN) did not appear to be impacted.

The approximate extent of vegetative cover damage is shown on Figure 1. The approximate extent of damage shown on this figure is not to scale, and field survey measurements should be performed to determine the exact aerial extent of vegetative cover damage. A typical section showing the perforated drainage pipe with approximate extent of additional crushed rock placed along portions of the toe of the western slope is shown on Figure 2. As indicated on this figure, the additional ballast material and drainage pipe result in a modification to the western landfill perimeter drainage system.

***

Based on the vegetative cover and subdrainage system damage that occurred on September 16, 1997, it is recommended that the following actions be taken:

- Remove all remaining crushed rock, loose soil, and organic debris from the landfill cap surface.

- In areas where significant soft soil is present, carefully remove all soft soil and confirm that the CDN and/or GCL was not damaged.

- Re-compact additional soil as needed to fill in areas were soft soil has been removed.

- Repair all 3-inch-diameter subdrainage system relief pipes by replacing the crushed sections (i.e., removing crushed portions and splicing on new sections) and installing new rodent screens. Re-compact soil as needed around all repaired outlet pipes to restore the western slope to its original 3:1 grade.

- Replace gravel drain at each outlet (see Figure 2).

- Scarify and re-hydroseed all cap surface areas where vegetative cover has been removed and/or significantly damaged.

- Irrigate newly hydroseeded areas until a satisfactory stand of grass has taken root.

- Locate all drainage outlet pipes along the western side slope, including the five relief pipes that could not be readily located during our site visit.

- Provide adequate construction oversight to ensure that all repair work is adequately performed and that repair activities are appropriately recorded.

- Place additional crushed rock and/or an erosion mat upstream from the new 12-inch perforated HDPE pipe and between the two perforated HDPE pipe sections, to reduce the potential for ditch erosion and excessive siltation of the pipe.

The above repair work should be performed immediately to provide adequate erosion protection to the landfill cap prior to the rainy season. As an interim emergency measure, hay bales could be used to prevent erosion damage to the landfill cover.

In addition to the above construction activities, the following actions also should be taken:

- Perform hydraulic calculations to confirm that the new 12-inch-diameter perforated HDPE pipe will have sufficient capacity to handle the anticipated landfill runoff during a 100-year storm event. This would include a determination of the capacity of the pipe to collect sheet flow from the landfill cover off of the western side slope, to ensure that adequate landfill perimeter surface water drainage is maintained.

- Prepare a technical memorandum summarizing the repair activities and describing the changes to the landfill perimeter drainage system.

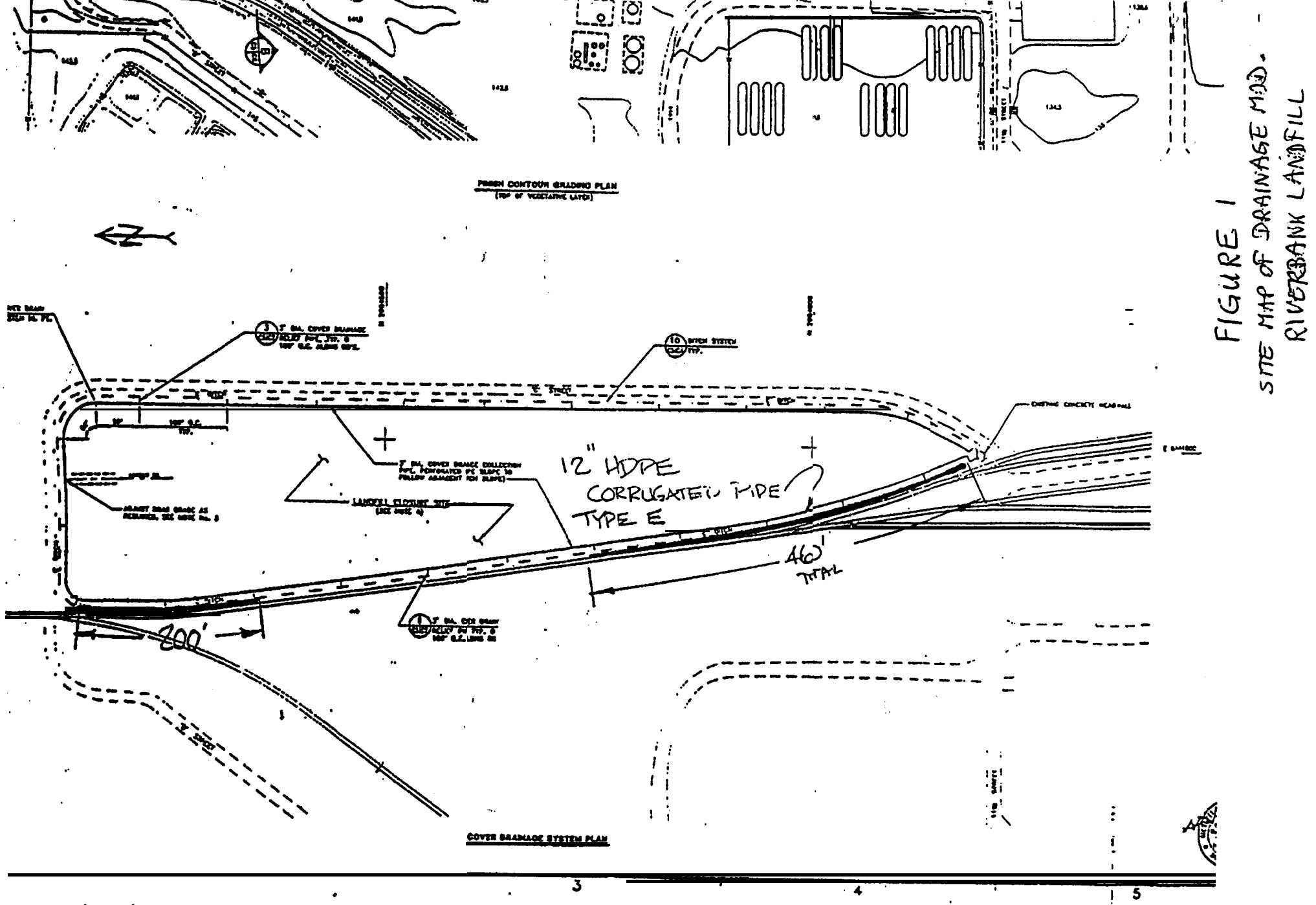
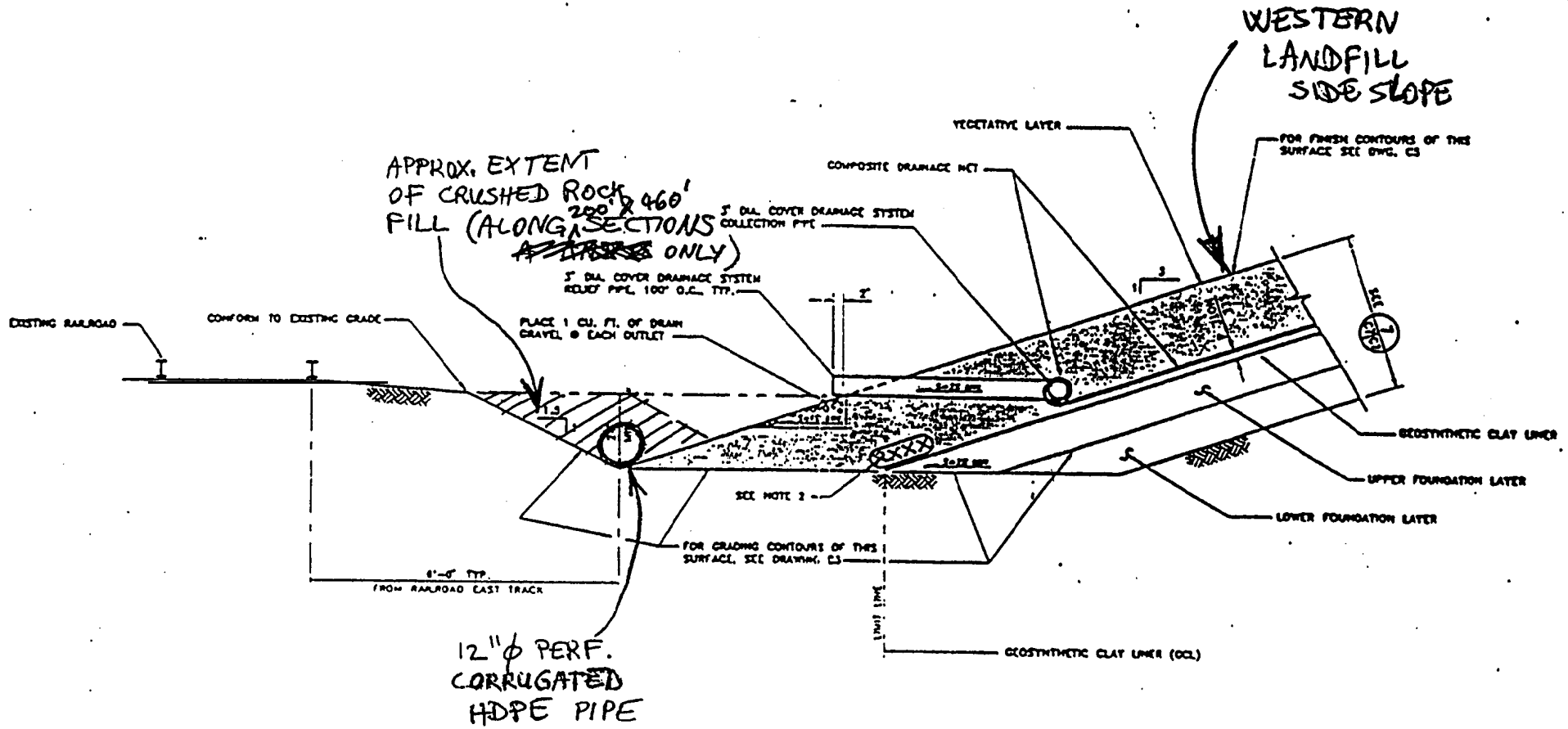


FIGURE 1
SITE MAP OF DRAINAGE MOD. - RIVERBANK LANDFILL



LOOKING NORTH

TYP. TOE DRAIN AND V-DITCH ADJACENT TO RAILROAD

DETAIL 5 (C4C7) 6 (C5C7) 6 (C6C7)

N.T.S.

FIGURE 2

TYP. DETAIL OF PERIMETER DRAINAGE MODIFICATION RBAAP LANDFILL

DEPARTMENT OF THE ARMY
SACRAMENTO DISTRICT, CORPS OF ENGINEERS
SACRAMENTO, CALIFORNIA

S. WILLIAMS
L. TODD
A. O'BRIEN

RIVERBANK ARMY AMMUNITION PLANT CALIFORNIA

LANDFILL CLOSURE

DETAILS

AS SHOWN

C7

199-28-043

Riverbank Army Ammunition Plant Observations of Landfill Cap Repairs and Drainage Recommendations

PREPARED FOR: James Gansel/Riverbank Army Ammunition Plant
Judy Soutiere/Sacramento District Corps of Engineers

PREPARED By: Serge Terentieff /CH2M HILL
Pamela Dalcin-Walling/CH2M HILL

COPIES: Stan Sturges/CH2M HILL

DATE: October 30, 1997

Two segments of 12-inch pipe, covered with ballast material, were installed as part of grading and drainage work recently completed along the railroad line adjacent to the Riverbank Army Ammunition Plant Landfill (landfill). The landfill's cover/cap was damaged in the process of performing this work, and the pipe and ballast material resulted in a modification to the landfill's perimeter drainage system.

This memorandum summarizes our observations of the landfill cover repair work, based on our site visit on October 29, 1997. This memorandum also discusses drainage maintenance considerations and recommendations based on preliminary results of our hydraulic evaluation of the drainage modifications and presents additional field observations based on our October 29, 1997 inspection. (For a description of the landfill cap damage and repair recommendations, please refer to CH2M HILL's memorandum dated September 23, 1997.)

Field Observations

The following general observations were made during our October 29, 1997, site inspection of the new 12-inch drainage pipe and landfill cap repair areas:

1. The damaged portions of the vegetative cover were generally restored to their original condition, including removal of remaining crushed rock, regrading, and re-hydroseeding of damaged cap areas.

2. Newly hydroseeded areas were being irrigated, and vegetation was beginning to take root.

3. All 3-inch diameter subdrainage system relief pipes on the western slope were exposed and rodent screens were reinstalled. However, we observed that the required 2 percent minimum slope for the outlet pipes was not maintained (see Figure 1). The invert of the outlet pipe was generally on the order of a few inches above the subdrainage collection pipe. This condition is of concern because it will result in water pressure buildup in the

subdrainage collection pipe, which could potentially result in vegetative cover erosion and/or slope stability problems.

4. A more detailed inspection of the 12-inch pipe segments placed in the landfill V-ditch along the railroad tracks indicated that on the order of 5 inches of crushed rock was placed below the pipes. The invert elevation of the perforated pipes is, therefore, higher than the ditch invert elevation beyond the pipe segments. This condition indicates that surface water flow may back-up in the ditch beyond the pipe segments, resulting in flow through the gravel underlying the pipe and/or localized ponding of water in the ditch north of the 200-foot pipe segment and in between the two pipe segments.

Preliminary Drainage Analyses Results

Preliminary analysis of the pipe/ditch systems indicates that under 100-year storm conditions, the railroad ballast adjacent to each system is capable of accommodating all of the tributary runoff. In addition, the underlying perforated pipe is able to accept all of the runoff conveyed through the ballast. Further analysis of pipe capacity indicates that the northerly pipe flows at approximately 24 percent of capacity and the southerly pipe flows at approximately 75 percent of capacity during 100-year storm conditions. Therefore, based on these results, it is expected that the current pipe/ditch systems will be able to maintain adequate surface water drainage along the landfill's western perimeter.

As part of the pipe capacity analysis, we determined that the velocities in the northern and southern pipe segments are 2.4 and 1.7 feet per second, respectively. Since Table 4 of the Stanislaus County Storm Drainage Manual indicates that a velocity of 2.5 feet per second is acceptable for sandy loam earth ditches, no additional treatment is required at the pipe outlets. More detailed results of our hydraulic analyses will be presented in a separate memorandum.

Maintenance Considerations

Due to the combination of relatively fine on-site soils and the crushed rock without a filter around the pipe, siltation of the inverts will likely occur at a relatively rapid rate. According to final design calculations for the landfill closure plan, long term soil loss from the landfill cap is expected to be approximately 0.12 ton/acre/year. With about 1.5 acres contributing to the western perimeter pipe/ditch system, the total annual soil loss would be approximately 0.18 ton (360 pounds). While some of this soil will be lost through wind erosion, the majority will likely be conveyed through storm runoff.

Both pipes will likely experience some degree of siltation. However, it is expected that this will be more prevalent in the southern pipe due to its mild slope, low-flow velocities, and greater tributary area. The buildup of silt will ultimately diminish the pipes' future hydraulic efficiency, reducing flow capacities and inhibiting runoff intake.

Drainage Modification Recommendations

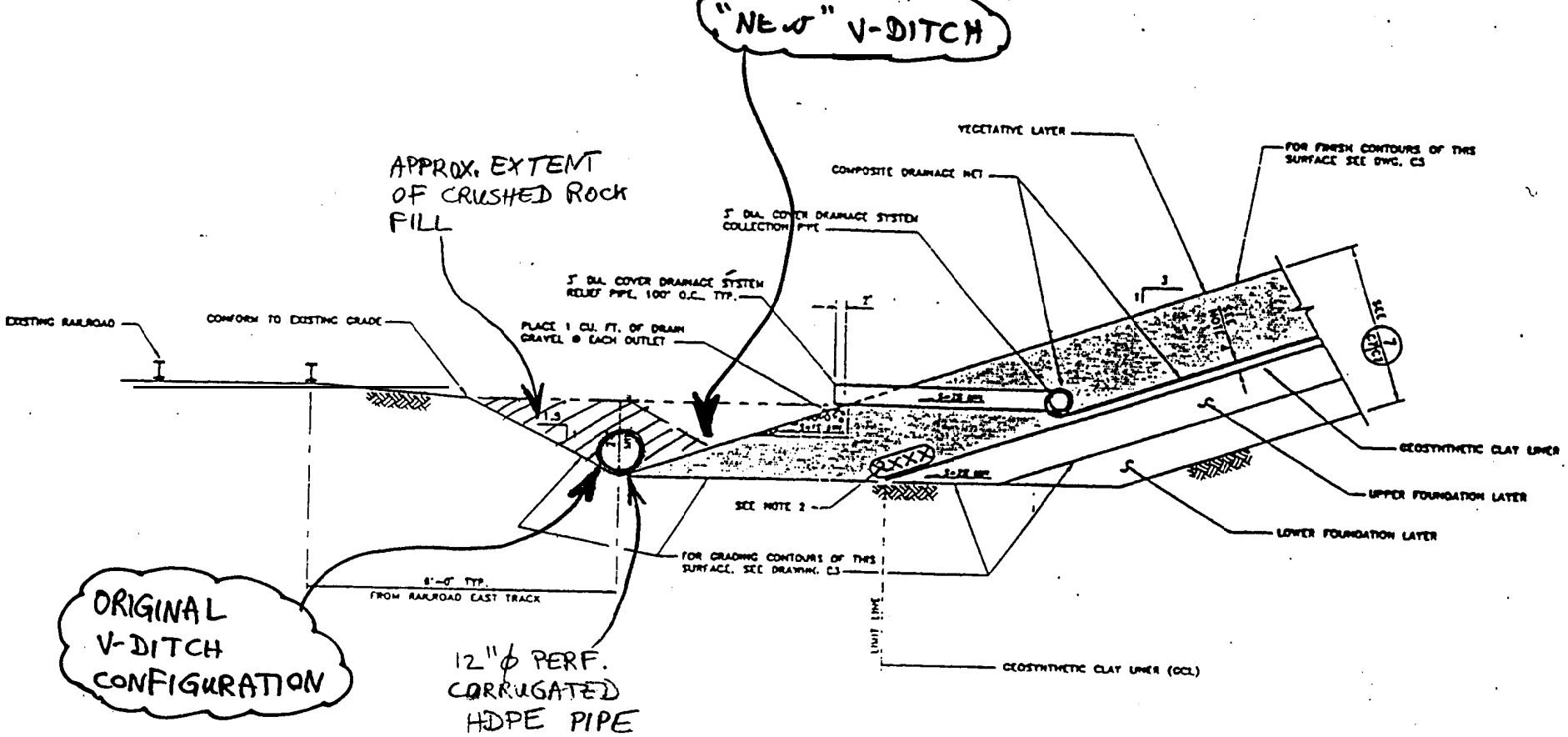
Based on the field observations discussed above, we recommend that all 3-inch diameter subdrainage system relief pipes on the western slope be reconfigured to ensure that a 2 percent minimum slope is maintained between the lateral collection pipe and the relief pipe outlet inverts (see Figure 1).

Based on the field observations, preliminary results of drainage analyses, and maintenance considerations, we also recommend that the following drainage modifications/options be considered:

1. Leave the perforated pipe segments and crushed rock "as-is". Under this option, the crushed rock will likely clog over time causing the cover side slope sheet-flow runoff to be carried through the "new" ditch, adjacent to the pipe. Figure 1, attached, shows a cross-section of the landfill cap including the altered V-ditch. To reduce the potential for ponding upstream of the pipe inverts and water flow through the crushed rock under the pipe segments, we also recommend that the invert elevation of the V-ditch to the north of the 200-foot pipe segment be increased by about 4 to 6 inches (to be verified/adjusted in the field). Similarly, the grades of the V-ditch between the two pipe segments should be increased from approximately 4-6 inches at the invert of the 460-foot section to zero at the outlet of the 200-foot section. These proposed V-ditch invert grade adjustments are illustrated on the attached conceptual profile (Figure 2).

2. Remove the pipe segments and crushed rock to restore the western landfill perimeter drainage system to its previous V-ditch condition. While the pipe was determined to have sufficient capacity for a 100-year storm event, this option is recommended because siltation of the pipe and potential clogging of the crushed rock around the pipe may occur over time, and become a significant maintenance issue. This option, while preferable from a landfill drainage standpoint, may not be practical due to railroad operation requirements.

If the pipe segments are left in place (Option 1 above), long-term maintenance issues will need to be addressed as part of the landfill's post-closure maintenance requirements. Silt is likely to accumulate not only inside the pipes and within the crushed rock around the pipes, but also at the inlet of each pipe segment. Periodic silt removal near the pipe inlets and clean-out of the pipe interiors using high-pressure flows will therefore be required. Long-term clogging of the crushed rock will result in flows being conveyed along the "newly created" V-ditch along the pipe segments.



LOOKING NORTH

TYP. TOE DRAIN AND V-DITCH ADJACENT TO RAILROAD

DETAIL 5 (C4/C7) 6 (C5/C7) 6 (C6/C7)

N.T.S.

FIGURE 1

TYP. DETAIL OF PERIMETER DRAINAGE MODIFICATION RBAAP LANDFILL

CH2M HILL, 2485 NATOMAS PARK DRIVE, SUITE 600, SACRAMENTO, CALIFORNIA 95833	DEPARTMENT OF THE ARMY, SACRAMENTO DISTRICT, CORPS OF ENGINEERS, SACRAMENTO CALIFORNIA
S. WILLIAMS	RIVERBANK ARMY AMMUNITION PLANT CALIFORNIA
L. TODD	LANDFILL CLOSURE
A. O'BRIEN	DETAILS
Edward C. Lambe	SCALE AS SHOWN | DATE — 9506
	C7
	199-28-045

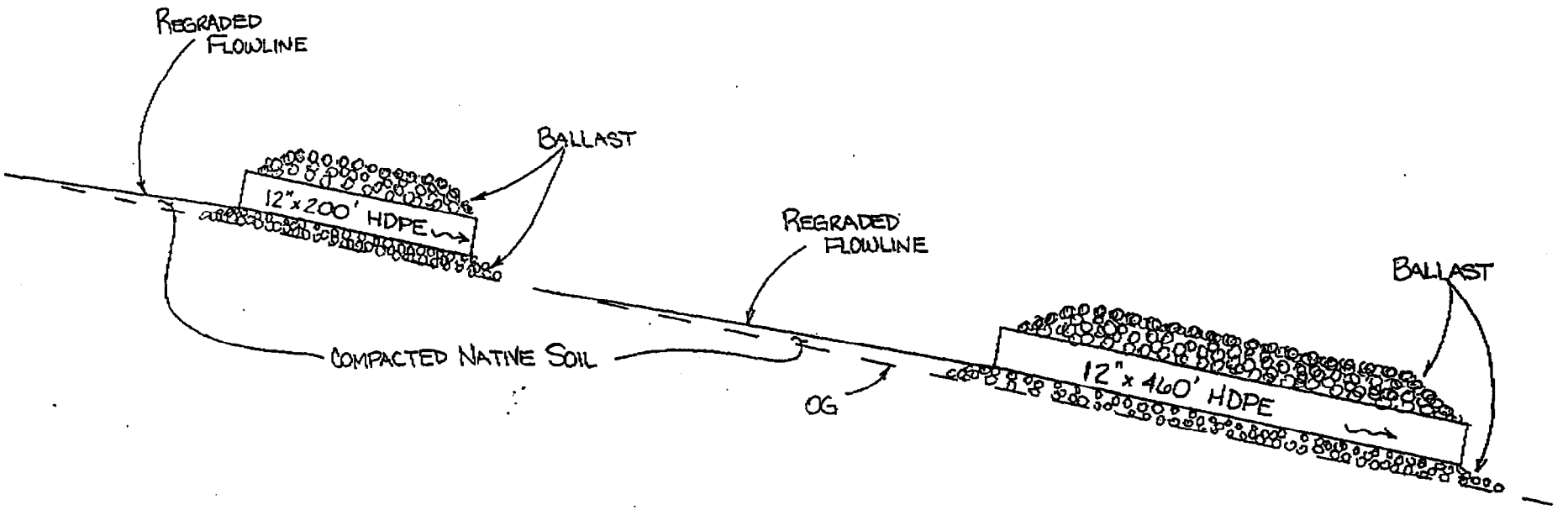


FIGURE 2 : TYPICAL PROFILE ALONG NEW HDPE PIPE SEGMENTS (NTS)

Attachment 3

Site Inspection Checklist

Five-Year Review Site Inspection Checklist (Template)

I. SITE INFORMATION

Site name: RBAAP	**Date of inspection:** 5/18/00
Location and Region: Riverbank, CA - Region 9	**EPA ID:**
Agency, office, or company leading the five-year review: U.S. Army	**Weather/temperature:** Sunny, warm, high 70s

Remedy Includes: (Check all that apply)

- ☑ Landfill cover/containment
- ☑ Access controls
- ☑ Institutional controls
- ☑ Groundwater pump and treatment
- ☐ Surface water collection and treatment
- ☐ Other _____

Attachments: ☐ Inspection team roster attached ☐ Site map attached

II. INTERVIEWS (Check all that apply)

1. **O&M site manager** LUTHER STOVER / U.S. Army Env. Protection Specia 5/18/00
   Name Title Date
   Interviewed ☑ at site ☐ at office ☐ by phone Phone no. _____
   Problems, suggestions; ☐ Report attached No problems noted

2. **O&M staff** MARK MACEDO / NI INDUSTRIES, Inc 5/18/00
   Name Title Date
   Interviewed ☑ at site ☐ at office ☐ by phone Phone no. _____
   Problems, suggestions; ☐ Report attached No problems noted that affect system performance

3. **Local regulatory authorities and response agencies** (i.e., State and Tribal offices, emergency response **office,** police department, office of public health or environmental health, zoning office, recorder of deeds, or other city and county **offices,** etc.) Fill in all that apply.

Agency _____
Contact _____ _____ _____ _____
Name Title Date Phone no.
Problems; suggestions; ☐ Report attached _____

Agency _____
Contact _____ _____ _____ _____
Name Title Date Phone no.
Problems; suggestions; Cl Report attached _____

Agency _____
Contact _____ _____ _____ _____
Name Title Date Phone no.
Problems; suggestions; ☐ Report attached _____

Agency _____
Contact _____ _____ _____ _____
Name Title Date Phone no.
Problems; suggestions; Cl Report attached _____

4. **Other interviews** (optional) ☐ Report attached.

III. ONSITE DOCUMENTS & RECORDS VERIFIED (Check all that apply)

1. **O&M Documents**
   - ☑ O&M manual — ☑ Readily available — ☐ Up to date — ☐ N/A
   - ☑ As-built drawings — ☑ Readily available — ☐ Up to date — ☐ N/A
   - maintenance logs — ☑ Readily available — ☑ Up to date — ☐ N/A

   Remarks: Recent modifications made as part of system optimization have not been incorporated

2. **Site-Specific Health and Safety Plan** — ☑ Readily available — ☑ Up to date — ☐ N/A
   - ☑ Contingency plan/emergency response plan — ☑ Readily available — ☑ Up to date — ☐ N/A

   Remarks:

3. **O&M and OSHA Training Records** — ☑ Readily available — ☑ Up to date — ☐ N/A

   Remarks:

4. **Permits and Service Agreements**
   - ☐ Air discharge permit — ☐ Readily available — ☐ Up to date — ☑ N/A
   - ☑ Effluent discharge — ☑ Readily available — ☑ Up to date — ☐ N/A
   - ☑ Waste disposal, POTW — ☑ Readily available — ☑ Up to date — ☐ N/A
   - ☐ Other permits — ☐ Readily available — ☐ Up to date — ☑ N/A

   Remarks: Finalizing modification to change NPDES permit to WDR. RWQCB is having a hearing

5. **Gas Generation Records** — ☐ Readily available — ☐ Up to date — ☑ N/A

   Remarks:

6. **Settlement Monument Records** — ☑ Readily available — ☑ Up to date — ☐ N/A

   Remarks:

7. **Groundwater Monitoring Records** — ☑ Readily available — ☑ Up to date — ☐ N/A

   Remarks:

8. **Leachate Extraction Records** — ☐ Readily available — ☐ Up to date — ☑ N/A

   Remarks:

9. **Discharge Compliance Records**
   - ☐ Air — ☐ Readily available — ☐ Up to date — ☑ N/A
   - ☑ Water (effluent) — ☑ Readily available — ☑ Up to date — ☐ N/A

   Remarks:

10. **Daily Access/Security Logs** — ☑ Readily available — ☑ Up to date — ☐ N/A

    Remarks: Facility access controlled 24 hours/day

IV. O&M COSTS

1. **O&M Organization**
   - ☐ State in-house
   - ☐ Contractor for State
   - ☐ PRP in-house
   - ☐ Contractor for PRP
   - ☑ Other U.S. Army contractor - NI Industries, Inc.

2. **O&M Cost Records**
   - ☑ Readily available
   - ☑ Up to date
   - ☑ Funding mechanism/agreement in place
   - Original O&M cost estimate $1.9 million/year ☐ Breakdown attached
   - Total annual cost by year for review period if available > Summarized in 5-Yr Review Report.

From	To		
Date	Date	Total cost	☐ Breakdown attached
From	To		☐ Breakdown attached
Date	Date	Total cost	
From	To		☐ Breakdown attached
Date	Date	Total cost	
From	To		☐ Breakdown attached
Date	Date	Total cost	
From	To		☐ Breakdown attached
Date	Date	Total cost	

3. **Unanticipated or Unusually High O&M Costs During Review Period**
   Describe costs and reasons: No high costs. Significant cost reductions resulting from optimization efforts.

V. ACCESS AND INSTITUTIONAL CONTROLS ☑ Applicable ☐ N/A

A. Fencing

1. **Fencing damaged** ☐ Location shown on site map ☑ Gates secured ☐ N/A
   Remarks Entire facility is fenced

B. Other Access Restrictions

1. **Signs and other security measures** ☐ Location shown on site map ☐ N/A
Remarks Access controlled security patrols, landfill has warning signs every ~150' barbed-wire topped fence

C. Institutional Controls

1. **Implementation and enforcement**
Site conditions imply ICs not properly implemented ☐ Yes ☑ No ☐ N/A
Site conditions imply ICs not being fully enforced ☐ Yes ☑ No ☐ N/A

Type of monitoring (e.g., self-reporting, drive by) Security patrols - drive by
Frequency Multiple times/day
Responsible party/agency NI Industries, Inc. security department
Contact _____ (Name) _____ (Title) _____ (Date) _____ (Phone no.)

Reporting is up-to-date ☑ Yes ☐ No ☐ N/A
Reports are verified by the lead agency ☑ Yes ☐ No ☐ N/A

Specific requirements in deed or decision documents have been met ☐ Yes ☑ No* ☐ N/A
Violations have been reported ☐ Yes ☐ No ☑ N/A
Other problems or suggestions: ☐ Report attached
* Deed restrictions have not been implemented. As required in the ROD, deed restrictions will be required for the landfill if the Army closes the RBAAP facility.

2. **Adequacy** ☑ ICs are adequate ☐ ICs are inadequate ☐ N/A
Remarks

D. General

1. **Vandalism/trespassing** ☐ Location shown on site map ☑ No vandalism evident
Remarks

2. **Land use changes onsite** ☐ N/A
Remarks None. Space has been leased to private companies but land use has not changed.

3. **Land use changes offsite** ☐ N/A
Remarks None

VI. GENERAL SITE CONDITIONS

A. Roads ☑ Applicable • I N/A

1. **Roads damaged** Cl Location shown on site map ☑ Roads adequate ☐ N/A
Remarks

B. Other Site Conditions

Remarks

VII. LANDFILL COVERS ☑ Applicable ☐ N/A

A. Landfill Surface

1. **Settlement** (Low spots) ☐ Location shown on site map ☑ Settlement not evident
Area1 extent Depth
Remarks

2. **Cracks** ☐ Location shown on site map @Cracking not evident
Lengths Widths Depths
Remarks

3. **Erosion** ☐ Location shown on site map * ☐ Erosion not evident
Area1 extent Depth
Remarks * Evidence of minor (no more than 1" deep) along some side slopes. Landfill liner is not exposed.

4. **Holes** • i Location shown on site map * ☐ Holes not evident
Areal extent Depth
Remarks * Evidence of squirrel burrows. NI Industries has embarked on a squirrel abatement program (see 5-yr Review Report)

5. **Vegetative Cover** Q&ass ☑ Cover properly established ☐ No signs of stress
☐ Trees/Shrubs (indicate size and locations on a diagram)
Remarks Star thistle invasion. Attempting to mitigate w/application of herbicide in March 2000.

6. **Alternative Cover (armored rock, concrete, etc.)** ☑ N/A
Remarks

7. **Bulges** ☐ Location shown on site map ☑ **Bulges** not evident
Areal extent _____ Height _____
Remarks _____

8. **Wet Areas/Water Damage** ☑ Wet areas/water damage not evident
☐ Wet areas Cl Location shown on site map Area1 extent _____
Cl Ponding Cl Location shown on site map Area1 extent _____
Cl Seeps ☐ Location shown on site map Area1 extent _____
Cl Soft **subgrade** ☐ Location shown on site map Area1 extent _____
Remarks _____

9. **Slope Instability** ☐ Slides • i Location shown on site map ☑ No evidence of slope instability
Area1 extent _____
Remarks _____

B. Benches ☐ Applicable ☑ N/A
(Horizontally constructed mounds of earth placed across a steep landfill side slope to interrupt the slope in order to slow down the velocity of surface runoff and intercept and convey the runoff to a lined channel.)

1. **Flows Bypass Bench** ☐ Location shown on site map ☐ N/A or okay
Remarks _____

2. **Bench Breached** Cl Location shown on site map ☐ N/A or okay
Remarks _____

3. **Bench Overtopped** ☐ Location shown on site map Cl N/A or okay
Remarks _____

C. Letdown Channels ☐ Applicable ☑ N/A
(Channel lined with erosion control mats, **riprap,** grout bags, or **gabions** that descend down the steep side slope of the cover and will allow the runoff water collected by the benches to move off of the landfill cover without creating erosion gullies.)

1. **Settlement** Cl Location shown on site map ☐ No evidence of settlement
Area1 extent _____ Depth _____
Remarks _____

2. **Material Degradation** ☐ Location shown on site map ☐ No evidence of degradation
Material type _____ Area1 extent _____
Remarks _____

3. **Erosion** ☐ Location shown on site map ☐ No evidence of erosion
Area1 extent _____ Depth _____
Remarks _____

4. **Undercutting** ☐ Location shown on site map Cl No evidence of undercutting
Area1 extent _____ Depth _____
Remarks _____

5. **Obstructions** Type _____ Cl No obstructions
Cl Location shown on site map Area1 extent _____
Size _____
Remarks _____

6. **Excessive Vegetative Growth** Type _____
☐ No evidence of excessive growth
❑ Vegetation in channels does not obstruct flow
Cl Location shown on site map Area1 extent _____
Remarks _____

D. Cover Penetrations ☑ Applicable ☐ N/A

1. **Gas Vents** ☐ Active ☐ Passive
☐ Properly secured/locked ☐ Functioning ☐ Routinely sampled Cl Good condition
Cl Evidence of leakage at penetration ☐ Needs O&M ☑ N/A
Remarks _____

2. **Gas Monitoring Probes**
☐ Properly secured/locked Cl Functioning Cl Routinely sampled Cl Good condition
☐ Evidence of leakage at penetration Cl Needs O&M ☑ N/A
Remarks _____

3. **Monitoring Wells** (within surface area of landfill)
Cl Properly secured/locked ☐ Functioning ☐ Routinely sampled ☐ Good condition
☐ Evidence of leakage at penetration ☐ Needs O&M ☑ N/A
Remarks _____

4. **Leachate Extraction Wells**
Cl Properly secured/locked Cl Functioning ☐ Routinely sampled ☐ Good condition
Cl Evidence of leakage at penetration • i Needs O&M ☑ N/A
Remarks _____

5. **Settlement Monuments** ☑ Located ☐ Routinely surveyed ☐ N/A
Remarks Monuments updated with the placement of brass caps in concrete - July 1999

E. Gas Collection and Treatment ☐ Applicable ☑ N/A

1. **Gas Treatment Facilities**
Cl Flaring ☐ Thermal destruction Cl Collection for reuse
☐ Good condition ☐ Needs O&M
Remarks

2. **Gas Collection Wells, Manifolds and Piping**
Cl Good condition Cl Needs O&M
Remarks

3. **Gas Monitoring Facilities (e.g.,** gas monitoring of adjacent homes or buildings)
Cl Good condition ☐ Needs O&M ☐ N/A
Remarks

F. Cover Drainage Layer D/Applicable ☐ N/A

1. **Outlet Pipes Inspected** ☑ Functioning ☐ N/A
Remarks

2. **Outlet Rock Inspected** ☑ Functioning ☐ N/A
Remarks

G. Detention/Sedimentation Ponds ☐ Applicable ☑ N/A

1. **Siltation** Area1 extent _____ Depth _____ ☐ N/A
☐ Siltation not evident
Remarks

2. **Erosion** Area1 extent _____ Depth _____
☐ Erosion not evident
Remarks

3. **Outlet Works** ☐ Functioning ☐ N/A
Remarks

4. **Dam** ☐ Functioning Cl N/A
Remarks

H. Retaining Walls ☐ Applicable ☑ N/A

1. **Deformations** ☐ Location shown on site map Cl Deformation not evident
Horizontal displacement _____ Vertical displacement _____
Rotational displacement _____
Remarks _____

2. **Degradation** ☐ Location shown on site map ☐ Degradation not evident
Remarks _____

I. Perimeter Ditches/Off-Site Discharge ☑ Applicable ☐ N / A

1. **Siltation** ☐ Location shown on site map ☑ Siltation not evident
Area1 extent _____ Depth _____
Remarks _____

2. **Vegetative Growth** ☐ Location shown on site map ☐ N/A
☑ Vegetation does not impede flow
Area1 extent _____ Type _____
Remarks _____

3. **Erosion** ☐ Location shown on site map #Cl Erosion not evident
Areal extent _____ Depth _____
Remarks * Very minor erosion of perimeter ditches apparent, not enough to effect ditch performance. No action necessary.

4. **Discharge Structure** ☑ Functioning ☐ N/A
Remarks North entrance to landfill top deck - asphalt diversion drain installed Nov. '98 that directs stormwater run-on to **

VIII. VERTICAL BARRIER WALLS Cl Applicable ☑ N/A

1. **Settlement** Cl Location shown on site map • i Settlement not evident
Area1 extent _____ Depth _____
Remarks _____

2. **Performance Monitoring** Type of monitoring _____
☐ Performance not monitored
Frequency _____ • i Evidence of breaching
Head differential _____
Remarks _____

** landfill perimeter ditch. There is periodic on-site flow of stormwater from adjacent, off-base, agricultural fields at this location.

IX. GROUNDWATER/SURFACE WATER REMEDIES ☑ Applicable ☐ N/A

A. Groundwater Extraction Wells, Pumps, and Pipelines &&Applicable ☐ N/A

1. **Pumps, Wellhead Plumbing, and Electrical**

☑ Good condition ☑ All required wells located ☐ Needs O&M ☐ N/A

Remarks Modifications are planned to allow remote operation of MW104B extraction well. MW104B was converted to an extraction well after construction of the primary control *

2. **Extraction System Pipelines, Valves, Valve Boxes, and Other Appurtenances**

☑ Good condition ☐ Needs O&M

Remarks

3. **Spare Parts and Equipment**

@'Readily available Cl Good condition ☐ Requires upgrade ☐ Needs to be provided

Remarks Pumps available onsite, ongoing contracts for as-needed repairs

B. Surface Water Collection Structures, Pumps, and Pipelines ☐ Applicable ☑ N/A

1. **Collection Structures, Pumps, and Electrical**

☐ Good condition Cl Needs O&M

Remarks

2. **Surface Water Collection System Pipelines, Valves, Valve Boxes, and Other Appurtenances**

Cl Good condition ☐ Needs O&M

Remarks

* system. For expediency, this well was tied to EW113A in the programmable logic control (PLC) program for remote operation.

3. **Spare Parts and Equipment**
☐ Readily available Cl Good condition ☐ Requires upgrade ☐ Needs to be provided
Remarks

C. Treatment System ☑ Applicable ☐ N/A

1. **Treatment Train** (Check components that apply)
☑ **Metals** removal ☐ Oil/water separation ☐ Bioremediation
☐ Air stripping El Carbon **adsorbers**
☐ Filters
☐ Additive (e.g., chelation agent, flocculent)
Cl Others
☑ **Good** condition ☐ Needs O&M
☐ Sampling ports properly marked and functional - Need better markings
☑ **Sampling/maintenance** log displayed and up to date
☑ **Equipment** properly identified
☑ **Quantity** of groundwater treated annually Approx 170 4 gm continuous
☐ Quantity of surface water treated annually N/A
Remarks

2. **Electrical Enclosures and Panels** (properly rated and functional)
☐ N/A ☑ **Good** condition ☐ Needs O&M
Remarks

3. **Tanks, Vaults, Storage Vessels**
☐ N/A ☑ **Good** condition ☑ **Proper** secondary containment Cl Needs O&M
Remarks

4. **Discharge Structure and Appurtenances**
☐ N/A ☑ **Good** condition Cl Needs O&M
Remarks

5. **Treatment Building(s)**
☐ N/A ☑ **Good** condition (esp. roof and doorways) ☐ Needs repair
☑ **Chemicals** and equipment properly stored
Remarks

6. **Monitoring Wells** (pump and treatment remedy)
☑ **Properly** secured/locked ☑ **Functioning** ☑ **Routinely** sampled ☑ **Good** condition
☑ **All** required wells located ☐ Needs O&M ☐ N/A
Remarks

D. Monitored Natural Attenuation

1. **Monitoring Wells** (natural attenuation remedy)

☐ Properly secured/locked ☐ Functioning ☐ Routinely sampled ☐ Good condition
☐ All required wells located Cl Needs O&M Cl N/A

Remarks _____

X. OTHER REMEDIES

If there are remedies applied at the site which are not covered above, attach an inspection sheet describing the physical nature and condition of any facility associated with the remedy. An example would be soil vapor extraction.

XI. OVERALL OBSERVATIONS

A. Implementation of the Remedy

Describe issues and observations relating to whether the remedy is effective and functioning as designed. Begin with a brief statement of what the remedy is to accomplish (i.e., to contain contaminant plume, minimize infiltration and gas emission, etc.).

The landfill cover and groundwater extraction and treatment system all appear to be in very good condition and operating as intended.

B. Adequacy of O&M

Describe issues and observations related to the implementation and scope of O&M procedures. In particular, discuss their relationship to the current and long-term protectiveness of the remedy.

O&M has been streamlined through system optimizations. Limited onsite oversight of system now required. The O&M Manual needs to be updated.

C. Early Indicators of Potential Remedy Failure

Describe issues and observations such as unexpected changes in the cost or scope of O&M or a high frequency of unscheduled repairs, that suggest that the protectiveness of the remedy may be compromised in the future.

- A small area of chromium contamination detected in MW65A' near the landfill would not be contained by the current extraction system.

D. Opportunities for Optimization

Describe possible opportunities for optimization in monitoring tasks or the operation of the remedy.

- The Five-Year Review Report details the optimization activities completed to date + planned.

Attachment 4

Photos Documenting Site Conditions

Photo 1: Groundwater Treatment Plant Building

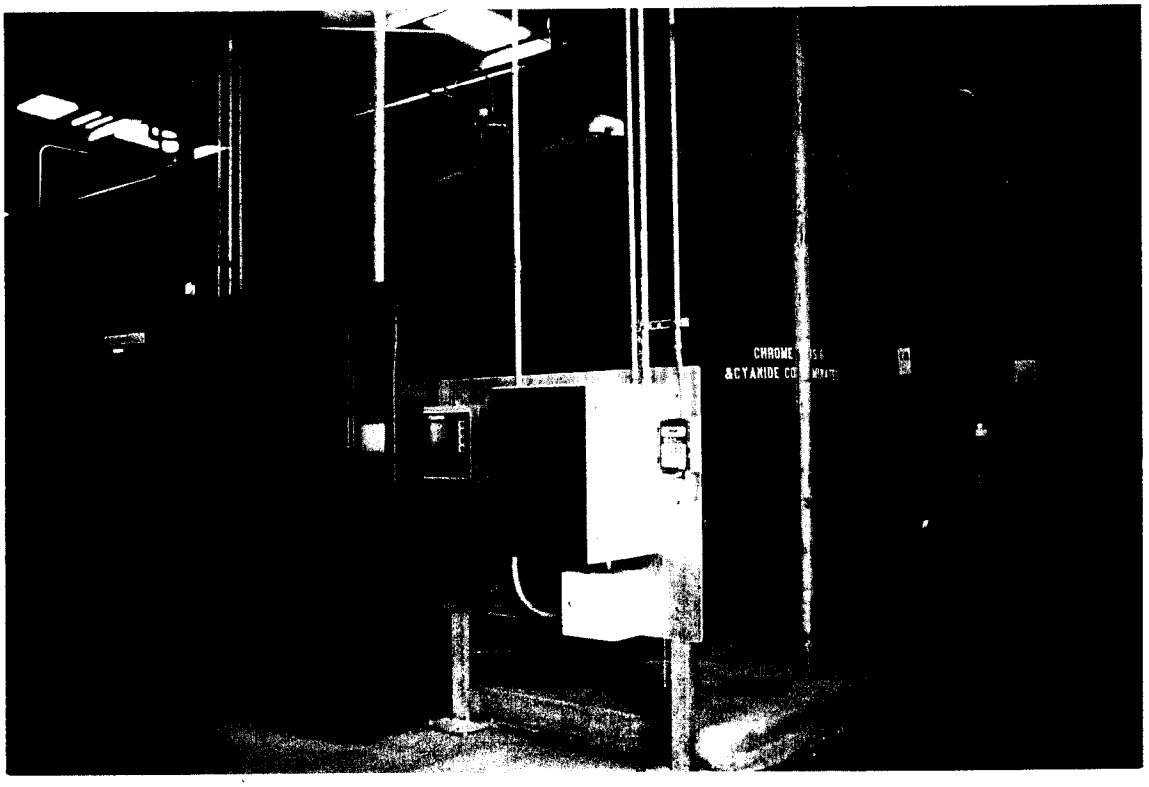


Photo 2: Influent Tank and Control System

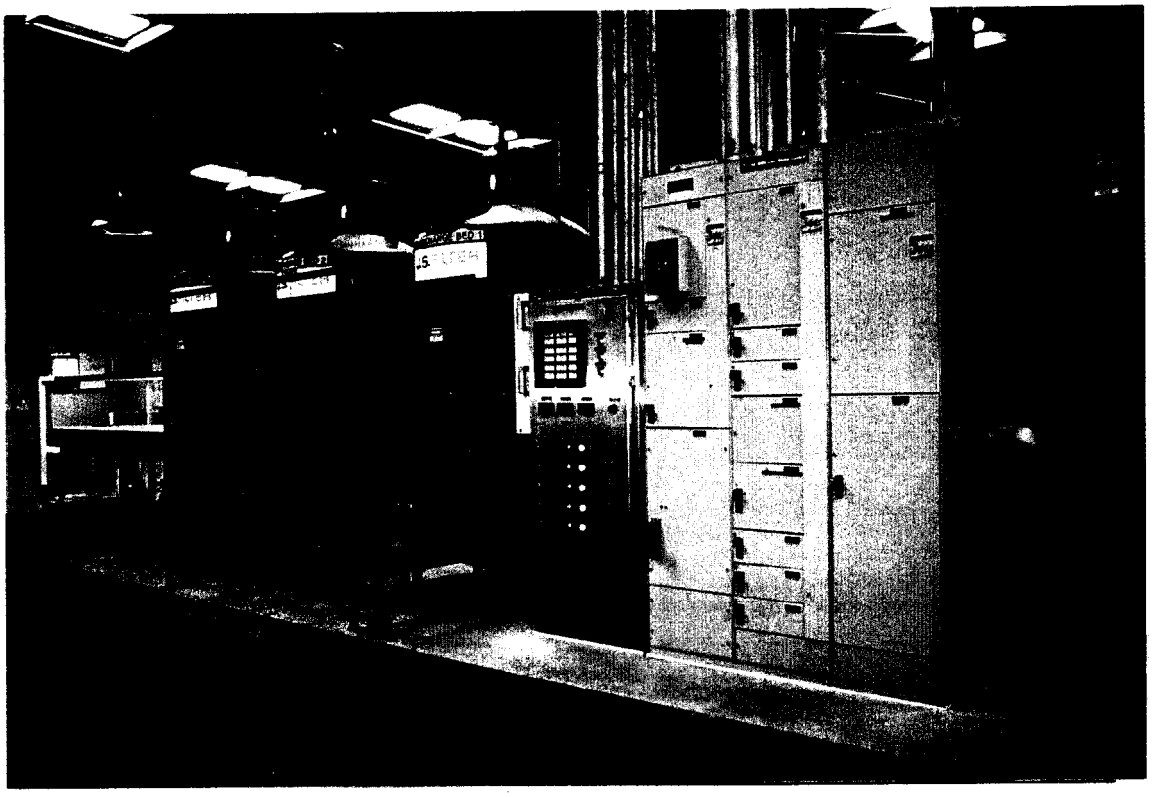


Photo 3: GWTS Ion Exchange Vessels and Control System

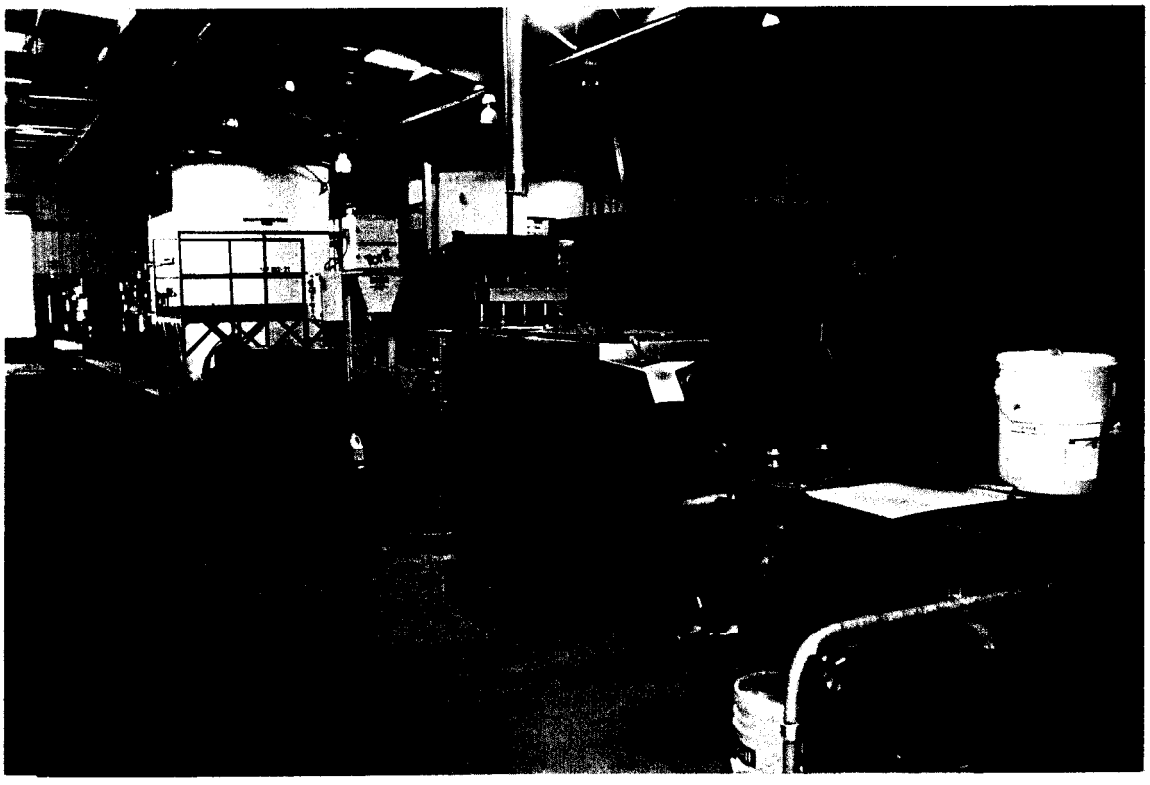


Photo 4: Evaporator Used to Concentrate Ion Exchange Regenerate

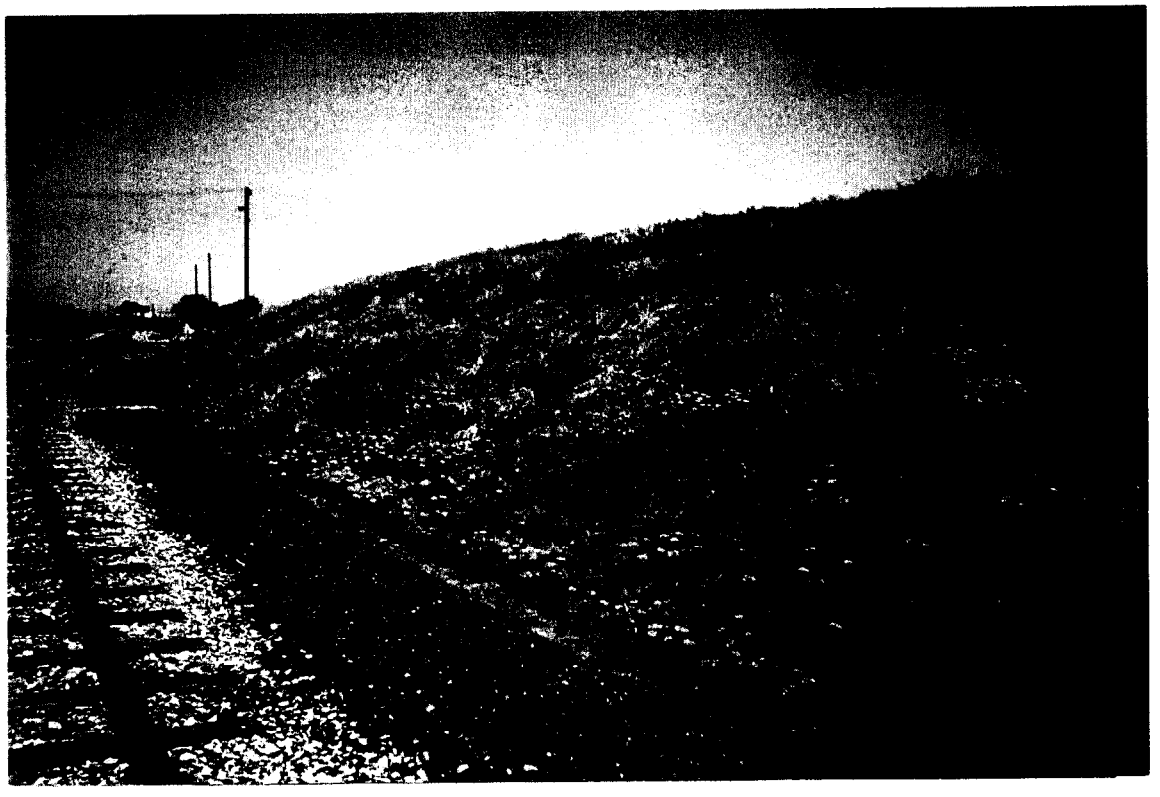


Photo 7: Western Landfill Slope and Adjacent Railroad Tracks

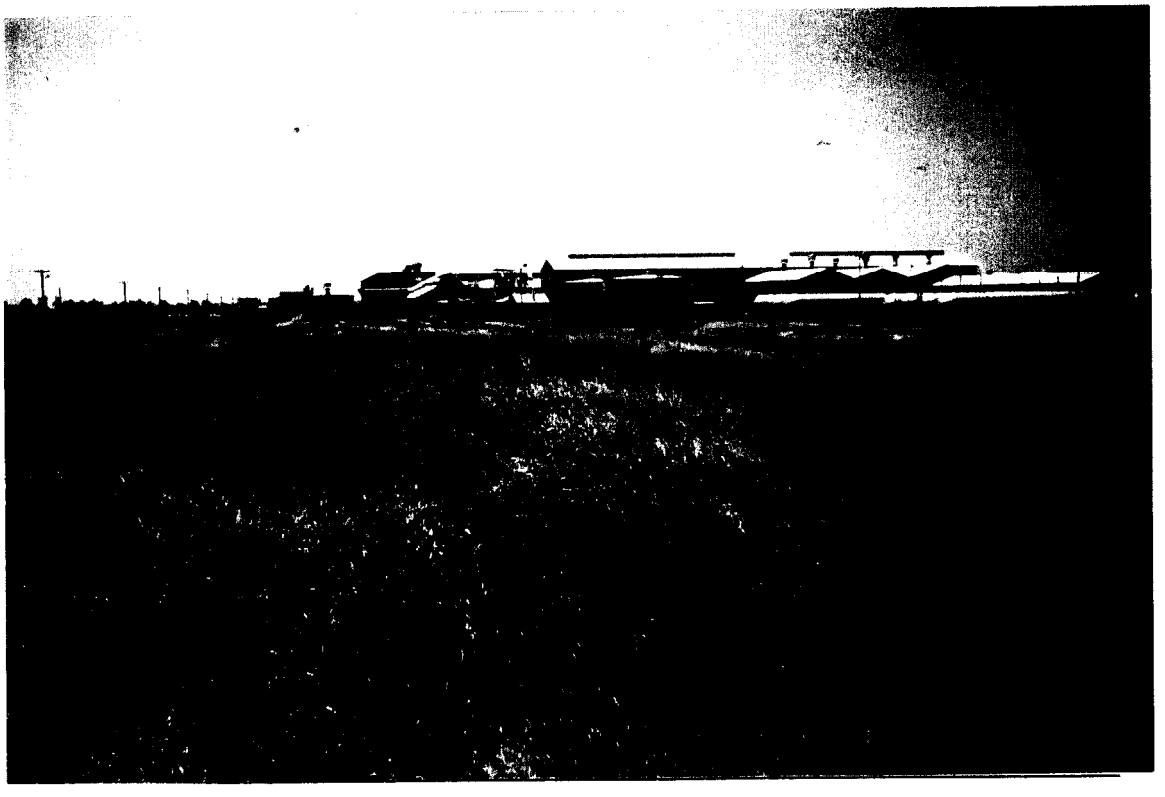


Photo 8: Landfill Top Deck- Looking South

Photo 9: Offsite Extraction Wells and Control System- 113 cluster

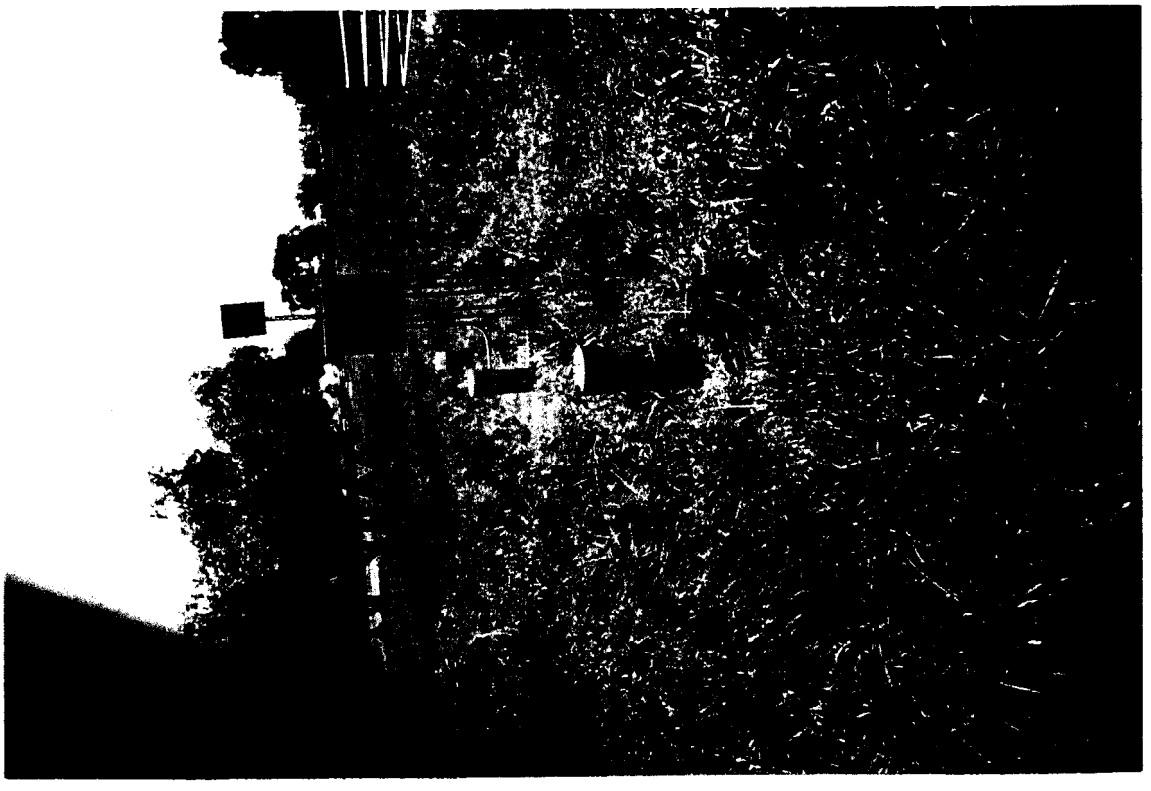
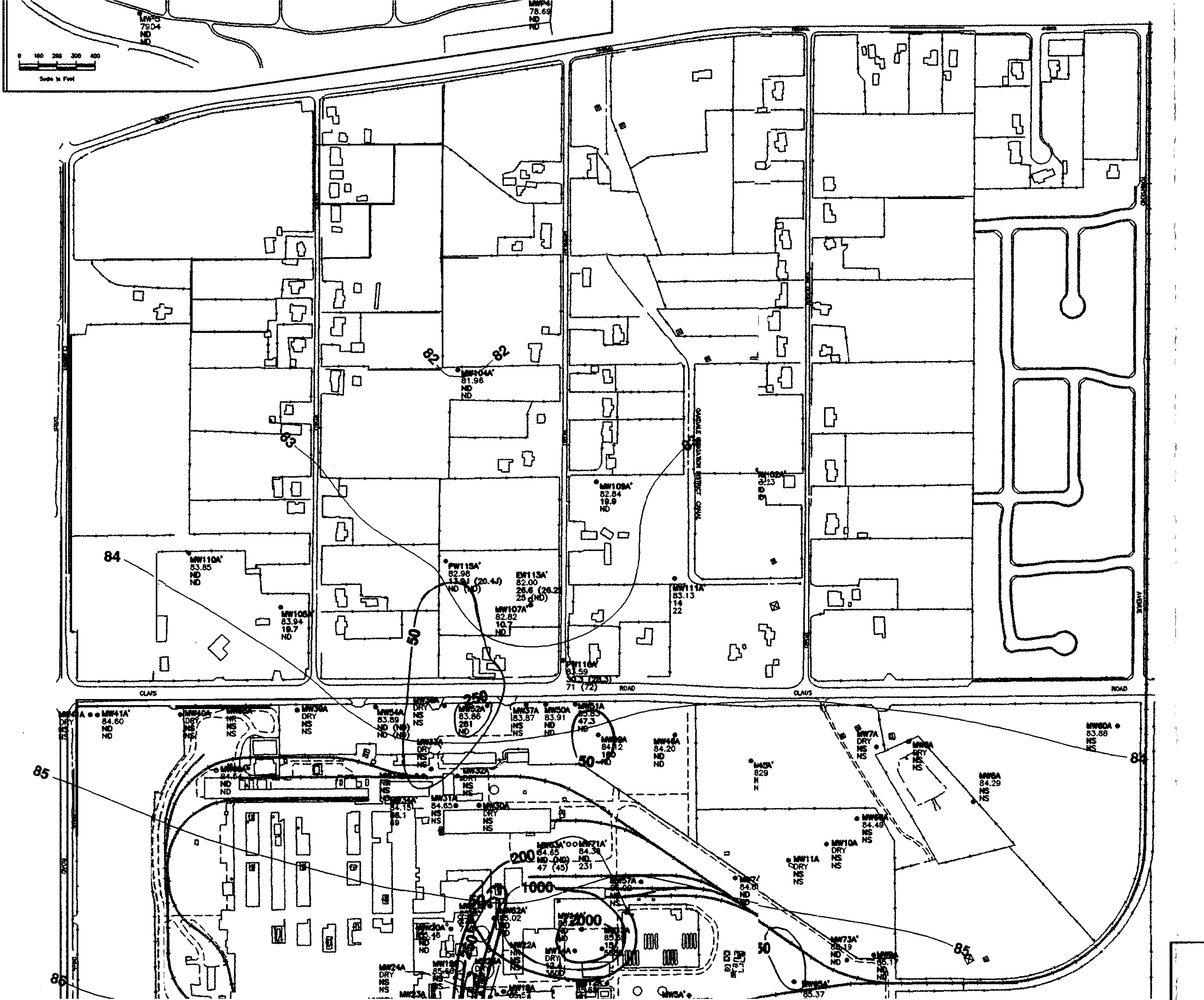
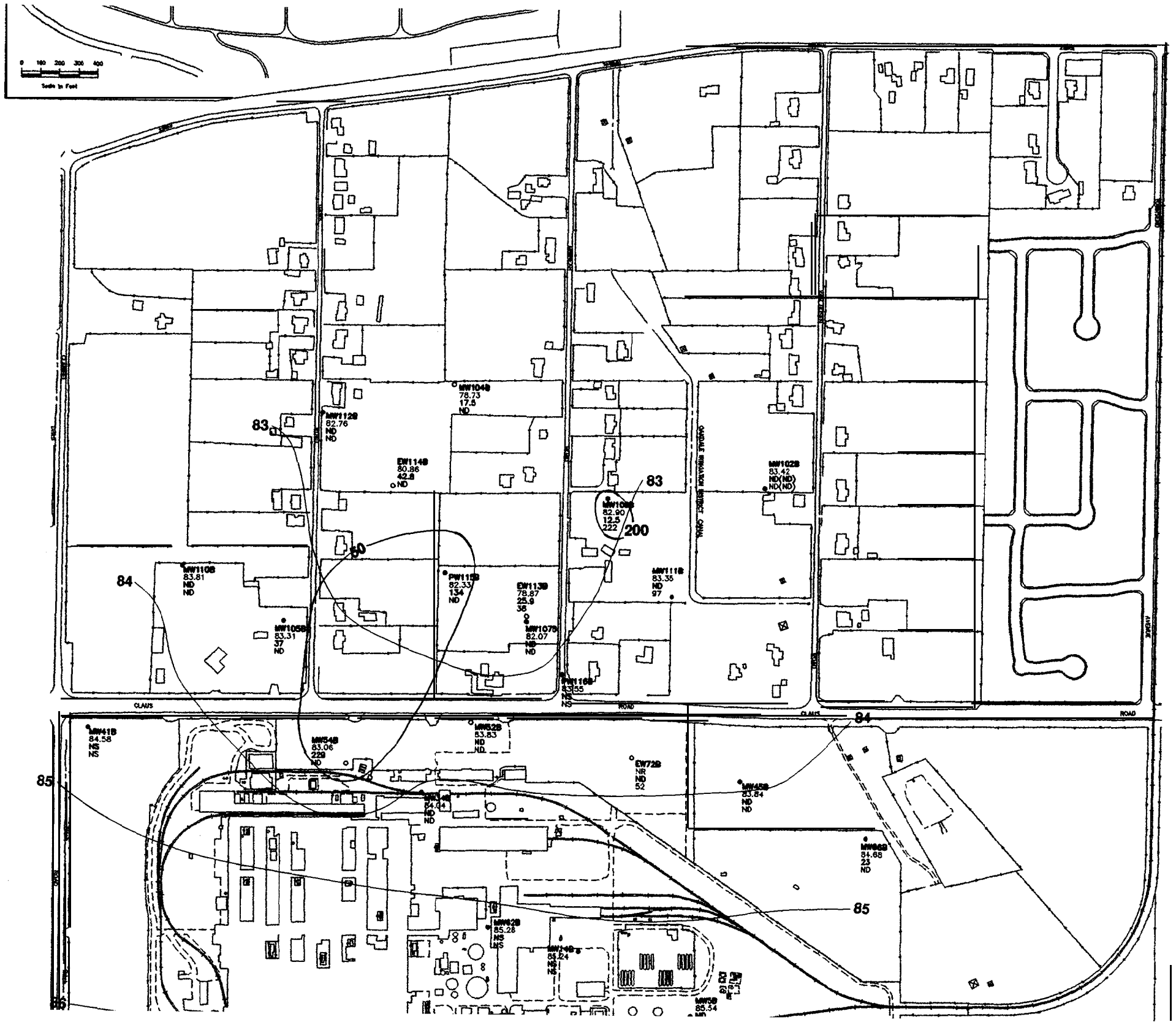
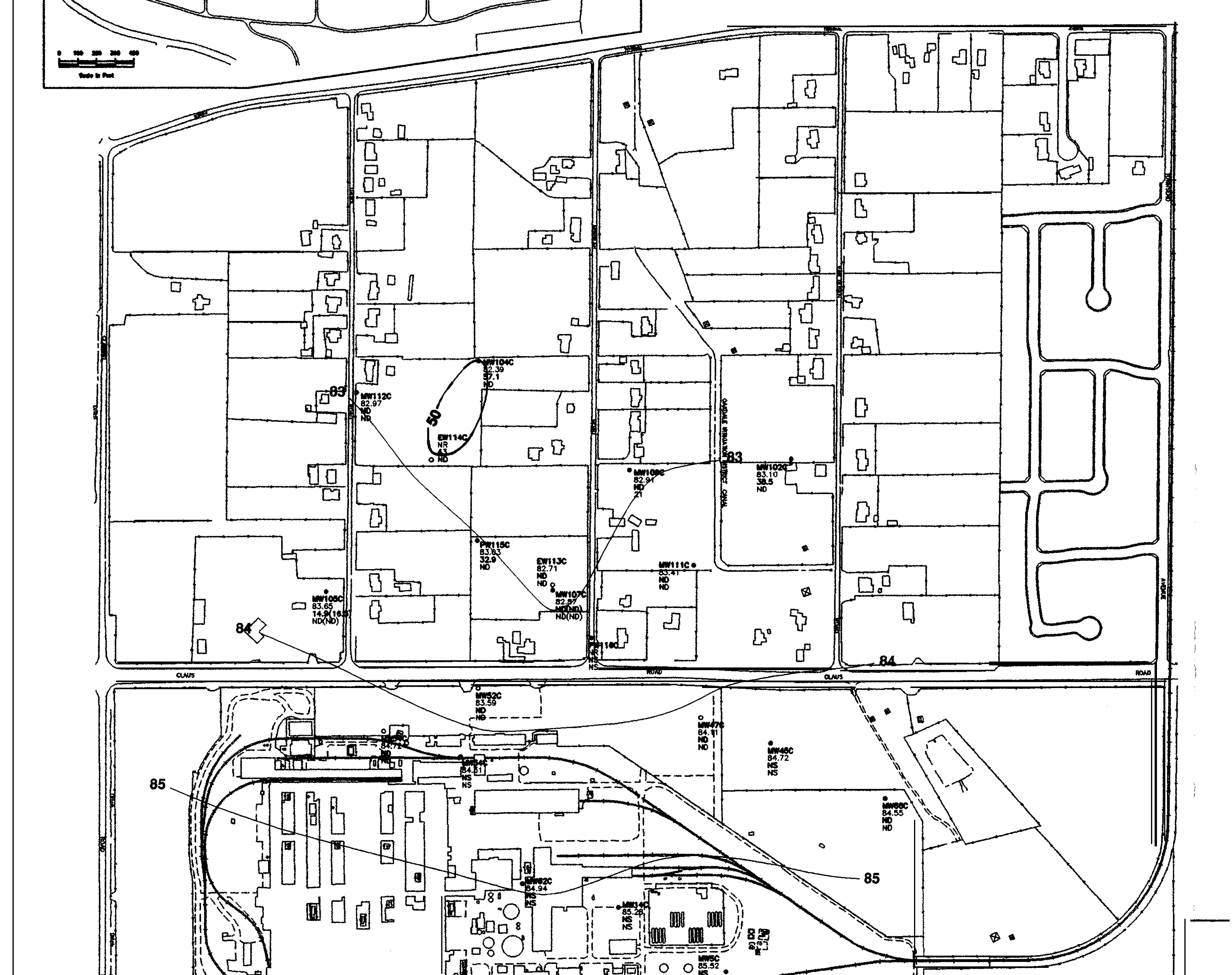


Photo 10: Offsite Monitoring Wells – 107 Cluster



Scale in Feet
0 100 200 300 400
MWP5
7904
ND
ND
MWP4
78.69
ND
ND
CLAUS ROAD
OAKDALE IRRIGATION DISTRICT CANAL
AVENUE
MW104A'
81.96
ND
ND
MW110A'
83.85
ND
ND
MW108A'
83.94
19.7
ND
PW115A'
82.98
EW113A'
82.00
MW107A'
82.82
10.7
ND
MW109A'
82.84
19.9
ND
MW111A'
83.13
14
22
PW116A'
83.59
MW41A'
84.60
ND
ND
MW54A
83.89
MW52A
83.86
281
ND
MW37A
83.87
MW50A
83.91
ND
ND
MW51A
47.3
ND
MW48A
84.20
ND
ND
M45A'
829
MW60A
83.88
NS
NS
MW8A
84.29
NS
NS
MW31A
84.65
MW11A
DRY
NS
NS
MW10A
DRY
NS
NS
MW73A'
MW5A'
82
83
84
85
50
250
200
1000
2000


0 100 200 300 400
Scale in Feet
CLAUS ROAD
ONONDAGA RESERVATION
83
84
85
200
MW104B 78.73 17.5 ND
MW112B 82.76 ND ND
EW114B 80.86 42.8 ND
MW108B 82.90 12.5 222
MW102B 83.42 ND(ND) ND(ND)
MW110B 83.81 ND ND
MW105B 83.31 37 ND
PW113B 82.33 134 ND
EW113B 78.87 25.9 36
MW107B 82.07 ND ND
MW111B 83.35 ND 97
MW116B 83.55
MW41B 84.58 NS NS
MW54B 83.06 229 ND
MW52B 83.83 ND ND
EW72B NS NS 52
MW45B 83.84 ND ND
MW44B 84.44 NS ND
MW66B 84.68 23 ND
MW62B 85.28 NS NS
MW14B 83.24
MW58 85.54


0 100 200 300 400
Scale in Feet
CLAUS
ROAD
CLAUS
ROAD
AVENUE
OAKDALE IRRIGATION DISTRICT CANAL
85
85
84
84
83
83
50
MW104C
82.39
57.1
ND
MW112C
82.97
ND
ND
EW114C
NR
43
ND
MW108C
82.91
ND
21
MW102C
83.10
38.5
ND
PW115C
83.63
32.9
ND
EW113C
82.71
ND
ND
MW107C
82.87
ND(ND)
ND(ND)
MW111C
83.41
ND
ND
MW105C
83.65
14.9(16.5)
ND(ND)
MW52C
83.59
ND
ND
MW47C
84.11
ND
ND
MW46C
84.72
NS
NS
MW53C
84.55
ND
ND
MW34C
84.61
NS
NS
MW62C
84.94
NS
NS
MW14C
85.28
NS
NS
MW5C
85.52
NS

DEPARTMENT OF THE ARMY
RIVERBANK ARMY AMMUNITION PLANT
PO BOX 670
RIVERBANK, CA 95367-0670

REPLY TO
ATTENTION OF

September 21, 2001

Mr. Ray Seid
United States Environmental Protection Agency
Region IX
75 Hawthorne Street
San Francisco, California 94105

Dear Mr. Seid:

In accordance with your previous comments, we have revised the original five-year review to include this addendum.

This Final Addendum, dated September 21, 2001 represents this office's best attempt to fully address all your concerns. In addition, at the same time this assures the compliance with the intent of the five-year review.

Sincerely,

James E. Gansel
Commander's Representative

Enclosure

Copies Furnished (w/encl):

Mr. Brian Taylor, CRWQCB, 3443 Routier Rd., Ste. A, Sacramento, CA 95827-3098
Mr. Jim Pinasco, Cal EPA, DTSC, 8800 Cal Center Drive, Sacramento, CA 95826-3200
USA OSC, Mr. Cyril Onewokae, SOSMA-ISE-R, 1 Rock Island, Rock Island, IL 61299-6000
USA OSC, Dr. Henry Crain, SOSMA-ISE-R, 1 Rock Island, Rock Island, IL 61299-6000

Final Addendum to the Five-Year Review Report for the Riverbank Army Ammunition Plant

PREPARED FOR: Ray Seid/U.S. EPA Region IX

PREPARED BY: David Towell/CH2M HILL

COPIES: Jim Gansel/U.S. Army - Riverbank

DATE: September 21, 2001

This technical memorandum provides the Army's responses to comments on *the First Five-Year Review Report for the Riverbank Army Ammunition Plant* (RBAAP) dated February 2001. These comments were provided in a letter from U.S. Environmental Protection Agency Region IX (EPA) to Army staff at RBAAP dated August 15, 2001. Responses are provided below to the EPA comments. As is indicated in the following responses, the Army will use the Quarterly Groundwater Monitoring Reports (typically submitted to the agencies in January, April, July, and October) to provide updates on conditions related to each of the issues EPA has raised.

This final memorandum should be considered an addendum to *the First Five-Year Review Report for the Riverbank Army Ammunition Plant* dated February 2001.

EPA Comment No. 1: RESPONSE ACTION TO A-AQUIFER ZONE RECHARGE – *In Section IV.A, under Recharge of the A Zone, contrary to what is stated here, the Army is required by the ROD to investigate the extent of the contamination and to remediate the groundwater if contaminant levels exceed MCLs, once the A-Aquifer Zone recharges. Since the A-Aquifer Zone is recharging, the Army must begin to cluzracterize the extent of the contamination in addition to its implementing the current treatability study initiative. In addition, since the extent of the contamination in the A-Aquifer Zone has yet to be characterized as a post-ROD action, the statement cannot be made in Tables 6 and 7 that the contaminants do no affect protectiveness. Thus, for the Purpose of this Report, the Army should acknowledge that the A-Aquifer Zone recharging is a post-ROD action that the Army is in the early stages of responding to with its treatabilitv study, and the Army should submit a short outline of its commitment to assess the extent of the contamination in the A-Aquifer Zone as well as its commitment to remediate contaminants in the A-Aquifer Zone.*

Response to EPA Comment No.1: The Army remains fully committed to addressing A-Zone contamination as the A Zone recharges. This includes characterizing the contamination and, if necessary, implementing remedial actions focused on the A Zone. To date, only limited recharge of the A Zone has occurred. For example, in the 2nd Quarter 2001 groundwater monitoring event, water levels were measured in 52 A-Zone monitoring wells. Twenty-nine of these wells were dry and another 7 contained less than 2 feet of water and could not be sampled. Following several years of increasing levels, water levels in the A-Zone have now declined by approximately 1 foot over the last two years.

To characterize A-Zone contamination, the Army will continue to monitor water levels in the 52 A-Zone wells and will perform routine sampling of selected A-Zone wells that

contain sufficient water to yield reliable sample results. Of the 17 A-Zone monitoring wells that have been sampled periodically over the last two plus years, seven have exceeded the cleanup standards for either chromium or cyanide or both (one well). The data presented on the A/A′-Zone Plate (Plate 1 in the Quarterly Reports) provided in each Quarterly Groundwater Monitoring Report illustrates that the extent of A-Zone contamination is limited and is reasonably well defined. If additional A-Zone recharge occurs, the need for supplemental characterization will be reevaluated. A section will be added to each Quarterly Report to assess the status of A-Zone recharge.

Regarding A-Zone remedial actions, limited saturation and low permeability eliminate the potential for direct extraction from the A Zone at this time. However, the groundwater flow simulations presented in each Quarterly Groundwater Monitoring Report (see Figure 4-3 in the Quarterly Reports) demonstrate that all A-Zone contamination is captured by the extraction system under the current extraction scenario. As part of the pilot testing program (described below), testing will be performed to further evaluate the hydraulic properties of the A Zone.

Because direct extraction is not currently feasible, in-situ remediation techniques provide the greatest opportunity for enhancing A-Zone remediation. The Five-Year Review Report discusses the in-situ remediation pilot testing program that the Army has initiated at RBAAP. Fieldwork has started on the next phase of the pilot testing program for in-situ chromium reduction. Over the next several months, the Army hopes to perform injection tests with the reductant solution to assess the viability of this technique for A-Zone source area remediation. The Quarterly Groundwater Monitoring Reports will provide updates on the status of the in-situ pilot testing program and summarize pertinent findings.

EPA Comment No. 2: RESPONSE ACTION FOR A′-AQUIFER ZONE CONTAMINANT EXCEEDANCE- *In Section VI.D under Data Review, the 2nd quarter 2000 sampling data for MW65A′ actually showed Cr at 71.9 ug/L, exceeding the MCL of 50 ug/L. In addition, 1st quarter 2000 showed 83.6 and 81.6 ug/L for Cr at MW65A′; 3rd quarter 2000 at 56.3 ug/L; and 4th quarter 2000 at 59.6 ug/L – further indicating that a response action is necessary. In that this exceedance is inconsistent with full capture of contaminants as specified in the ROD regardless of what the MW45A′ data indicates. Merely monitoring MW45A′ as a trigger point for responding to this exceedance is not sufficient. Thus, for the purpose of this Report, the Army should acknowledge this exceedance as being inconsistent with ROD requirement, and submit a short outline of its commitment to respond to the Cr exceedances at MW65A′.*

Response to EPA Comment No. 2: The chromium concentrations in monitoring well MW65A′ over the last 11 quarterly monitoring events are illustrated below in Table 1. Chromium concentrations in Monitoring Well (MW) 65A′ have exceeded the cleanup standard (50 :g/L) for much of the last three years, however, concentrations from the most recent three quarters are at or below the standard. Further, the concentration trend over the last 10 quarters has been steadily downward. Monitoring well MW65A′ is located near the far eastern (upgradient) side of the RBAAP. Assuming average groundwater velocities, groundwater in the MW65A′ vicinity would take 5 to 10 years to even approach the western facility boundary. All other A′-Zone monitoring wells cross gradient and downgradient from MW65A′ are currently non-detect for chromium.

Table 1 - MW65A′ Chromium Concentrations

Monitoring Event	Chromium Concentration
1st Quarter 1999	57 :g/L
2nd Quarter 1999	154 :g/L
3rd Quarter 1999	101 :g/L
4th Quarter 1999	83.5 :g/L
1st Quarter 2000	83.6/81.6 :g/L
2nd Quarter 2000	71.9 :g/L
3rd Quarter 2000	56.3 :g/L
4th Quarter 2000	59.6 :g/L
1st Quarter 2001	42.8 :g/L
2nd Quarter 2001	50.7 :g/L
3rd Quarter 2001	47.9 :g/L

The current operating scenario (extraction at 172 gpm) for the groundwater extraction system does not create a capture zone large enough to contain water in the MW65A′ area. MW65A′ is considerably further north than any of the other current areas of contamination. The ROD requires full containment of all areas exceeding cleanup standards in the A′-, B-, and C-Zones. Although the Army acknowledges that this area of contamination would not be contained under the current operation scenario, extraction rates could be increased to provide capture of this area. Figure 1 (below) shows groundwater modeling simulation results prepared to demonstrate full capture at RBAAP at the time of the Construction Complete certification (September 1997). The location of MW65A′ was added to the 1997 figure to illustrate that it falls well within the capture zone under the 288 gpm extraction scenario. Under the 288 gpm scenario, water from the MW65A′ area eventually is captured at the off-base 113 extraction well cluster.

There are several factors that provide justification for not increasing the extraction rates at the current time:

- Chromium concentrations in MW65A′ are currently below the MCL.
- Based on the available monitoring data, it does not appear that there is sufficient mass of chromium in the MW65A′ area to create a plume of >50 :g/L contamination that could reach the facility boundary. Further, chromium is currently non-detect in all cross-gradient and downgradient monitoring wells.
- The contamination does not represent any threat to human health as there is no pathway for exposure to the on-site A′-Zone contamination.
- Based on the groundwater flow conditions in the area and the distribution of extraction wells, the extraction rate could be increased 5 to 10 years from now and the contamination would still be captured by the extraction system in essentially the same manner that it would be captured if the extraction rate were increased now.

Flowlines starting in the upgradient A/A′ aquifer with MW104B pumping at 35 gpm and total pumping at 288 gpm

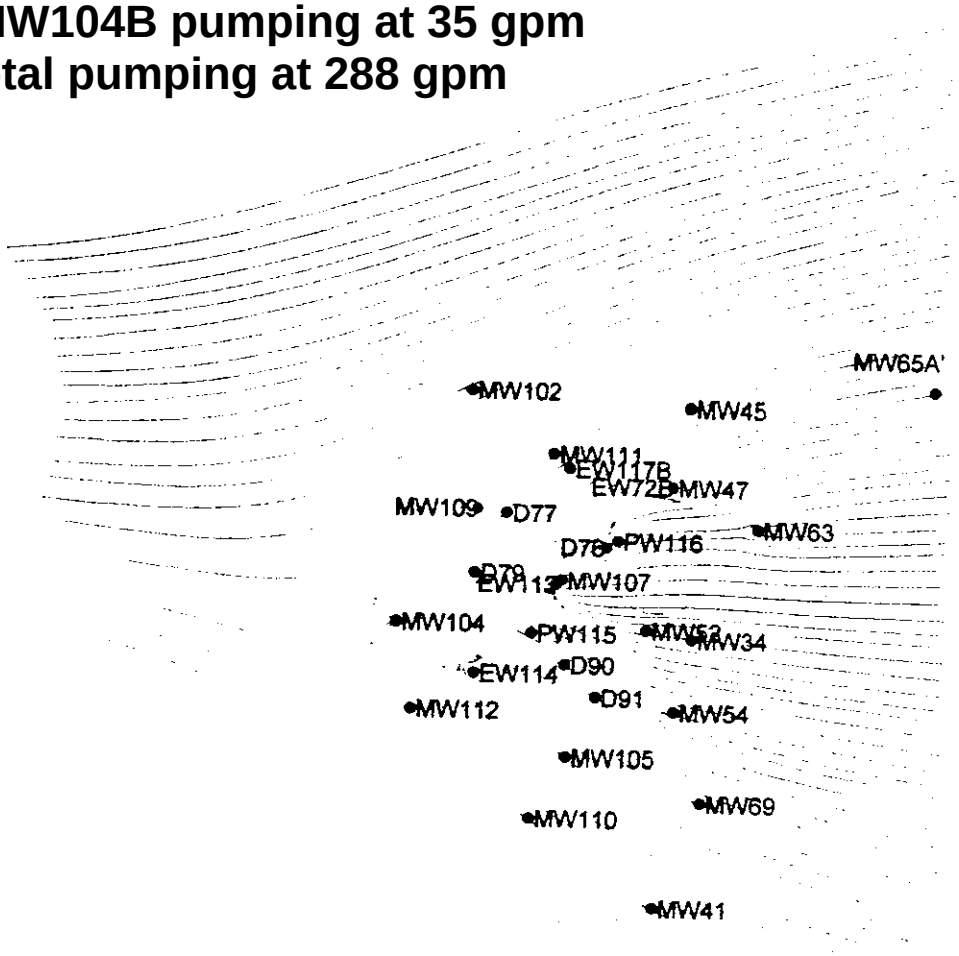


Figure 1

The Army is committed to complying with the ROD and providing full capture of all contamination in excess of cleanup standards in the A′-, B-, and C-Zones. There is plenty of time to continue to monitor conditions in the area before an increase in extraction is necessary to capture the MW65A′ contamination. If conditions change, the Army will reassess the need for and timing of increased extraction rates. The types of changes that may warrant accelerating implementation of the modified extraction scenario include: concentration increases in MW65A′ that result in levels in excess of 100 :g/L for several quarters in a row; concentration increases (into the 20 to 30 :g/L range) in downgradient monitoring wells that indicate a larger area of contamination than currently mapped; or changes in groundwater flow conditions that affect the orientation of the flow field. Each

Quarterly Monitoring Report, beginning with the 3rd Quarter 2001 Report, will provide an update on conditions in the MW65A′ vicinity. If warranted, based on changing conditions, the report will also present a plan for increasing extraction rates to capture the isolated chromium contamination.

EPA Comment No. 3: RESPONSE ACTION FOR OFF-BASE B-AQUIFER ZONE INCREASE IN CONTAMINANT - *In Section VI.D. under Data Review, contrary to the statement made here that "contaminant concentrations in the A′, B, and C zones have decreased considerably since the ROD was signed in 1994", the off-base CN concentrations in the B-Aquifer Zone have actually increased from a 139 ug/L peak in 1986 –1993 to a 231 ug/L peak in 1st Qtr 2000. Statements as such in this section need to be corrected for accuracy, and the Army needs to consider adjusting its monitoring and extraction rate matrices in response to this increase in CN concentration in the B Aquifer Zone off-base at MW109B. Thus, for the purpose of this Report, the Army should acknowledge the data showing increases in CN levels at MW109B, and to submit a short outline of its commitment to respond to this increase.*

Response to EPA Comment No. 3: Off-base B-Zone cyanide concentrations have increased since the ROD was signed in 1994. This new area of contamination was detected in early 1997, the Army implemented an accelerated response to the discovery and converted MW104B into an extraction well capable of extracting up to 40 gpm. The conversion of MW104B to an extraction well was included as a key component in the demonstration that the system was operational and functional and meeting all of the requirements of the ROD. The extraction scenario implemented in 1997 included extraction from MW104B specifically to address the elevated cyanide present in MW109B and MW111B. MW104B continues to serve this purpose in the current 172 gpm extraction scenario. Thus, no additional response is needed to contain the elevated off-base B-zone cyanide contamination.

However, as part of ongoing optimization efforts, the Army continues to evaluate options that provide for more cost-effective operation of the extraction and treatment system and accelerate groundwater cleanup. As is stated in the Five-Year Review Report (page 29), the Army is currently considering installation of an extraction well near MW109B that would directly target the B-Zone cyanide contamination. A new well at this location would allow the overall extraction rate needed for full containment to be lowered and accelerate removal of this elevated cyanide plume.

Currently, the U.S. Army Corps of Engineers is making contact with the appropriate land owners to pursue modifications to existing easements and leases that would allow for installation of the additional extraction well and the pipelines necessary to connect into the current system. If these negotiations proceed favorably, the Army will attempt to obtain funding to install the new well and associated conveyance facilities. Each Quarterly Groundwater Monitoring Report will provide and update on the progress of property acquisition As it the access agreements near completion, a more detailed implementation plan will be included in the Quarterly Report.

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION IX
75 Hawthorne Street
San Francisco, CA 94105-3901

September 24, 2001

Mr. James E. Gansel
Commander's Representative
Department of the Army
Riverbank Army Ammunition Plant
Riverbank, CA 95367-0670

RE: Five-Year Review Report of Remedial Actions at Riverbank Army Ammunition Plant in Riverbank, California (Stanislaus County)

Dear Mr. Gansel:

The United States Environmental Protection Agency (EPA) has reviewed the Army's Five-Year Review Report dated February 2001 and the September 21, 2001 Letter Addendum for the remedial actions at Riverbank Army Ammunition Plant located in Stanislaus County in Riverbank, California.

EPA agrees with the findings, conclusions, and recommendations provided in the Report and Letter Addendum, and concurs that the remedies are protective of human health and the environment. Post-ROD provisions of the March 1994 Record of Decision (ROD) for Riverbank include, among other things, response actions on groundwater recharge of the A-Aquifer Zone pursuant to the ROD, and investigation/corrective action for the contamination in and around the Industrial Waste Treatment Plant (IWTP) area pursuant to requirements of the Resource Conservation and Recovery Act (RCRA). We believe the Army is making early progress towards its response to contaminants in the recharging A-Aquifer Zone, which is consistent with the ROD, and California's Department of Toxic Substances Control (DTSC) is overseeing the Army's response to the IWTP area under RCRA, which is also consistent with the ROD. The Army will continue its routine long-term monitoring and assessment of the A-Aquifer Zone recharging, and implement required response actions as necessary in accordance with the ROD. Data assessment and response action are coordinated with regulatory agencies through the monthly and quarterly reports for Riverbank.

Similarly, as part of its comprehensive basewide monitoring, extraction, and treatment system, the Army will continue its routine long-term monitoring and assessment of groundwater contaminant levels in the A′, B, and C Aquifer Zones (which specifically include the areas of

MW65A′ in the A′-Aquifer Zone and MW 109B in the B-Aquifer Zone), and implement required response actions as necessary in accordance with the ROD. Data assessment and response action are coordinated with regulatory agencies through the monthly and quarterly reports for Riverbank.

The Army is following monitoring and maintenance provisions of its Closure and Post-Closure Maintenance Plan for the closed landfill, and its capping and monitoring remedy remains protective of human health and the environment. Likewise, the excavation and off-site disposal of contaminated sediments in the Evaporation/Percolation Ponds, performed early on as a removal action, remain protective of human health and the environment.

The Five-Year Review Report and Letter Addendum satisfactorily address the requirements of Section 121(c) of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and EPA's OSWER Directive 9355.7-03B-P (April 1999). They also address EPA's comments by letter dated August 15, 2001. Should you have questions regarding this letter, you may contact our Remedial Project Manager for Riverbank, Raymond Seid, at (415) 744-2394.

Sincerely,

Chief, Federal Facilities
and Site Cleanup Branch (SFD-8)

cc: Dan Ward, Office of Military Facilities, DTSC, Sacramento
John Russell, RWQCB, Central Valley Region, Sacramento
James Pinasco, RPM, DTSC, Sacramento
Brian Taylor, RWQCB, Central Valley Region, Sacramento