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MORRISON-KNUDSEN ENGINEERS, INC.
DENVER, CO

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COMMERCE CITY, CO

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13. ABSTRACT *(Maximum 200 words)*

THIS INTERIM RESPONSE ACTION IS AN UPGRADE OF THE TREATED GROUND WATER RECHARGE SYSTEM ASSOCIATED WITH THE NORTH BOUNDARY CONTAINMENT/TREATMENT SYSTEM. IN ORDER TO CORRECT AN HYDRAULIC IMBALANCE, TEN GRAVEL FILLED RECHARGE TRENCHES WERE CONSTRUCTED ALONG THE DOWNGRADIENT SIDE OF THE BARRIER. WATER IS PIPED UNDER PRESSURE FROM THE TREATMENT PLANT THROUGH A NEW EFFLUENT PIPE TO THE TRENCHES. THIS SHOULD INCREASE RECHARGE CAPACITY BY 150 GALLONS PER MINUTE.

THE IMPLEMENTATION PLAN INCLUDES THE FOLLOWING:

1. MOU BETWEEN THE ARMY AND SHELL CONCERNING THE NORTH BOUNDARY TRENCHES IRA
2. SCOPE OF WORK
3. CONSTRUCTION WORK PLAN
4. COST ESTIMATE - $490,000
5. ENGINEERING SPECIFICATIONS
6. ENGINEERING DRAWINGS AND SCHEMATICS

14. SUBJECT TERMS
SPECIFICATIONS, COST, HEALTH AND SAFETY, ENGINEERING DRAWINGS

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FILE COPY

Rocky Mountain Arsenal Information Center Commerce City, Colorado

Shell Oil Company

IMPLEMENTATION DOCUMENT FOR IRA TO IMPROVE THE NORTH BOUNDARY SYSTEM VIA CONSTRUCTION OF GROUNDWATER RECHARGE TRENCHES

FINAL SEPTEMBER 1988

Prepared by
Morrison-Knudsen Engineers, Inc.
Denver, Colorado 80290

Prepared for
Shell Oil Company

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SECTION

IMPLEMENTATION DOCUMENT FOR INTERIM RESPONSE ACTION FOR THE IMPROVEMENT OF THE NORTH BOUNDARY SYSTEM AT THE ROCKY MOUNTAIN ARSENAL VIA CONSTRUCTION OF GROUNDWATER RECHARGE TRENCHES

1.0 INTRODUCTION

The Interim Response Action (IRA) for the Improvement of the North Boundary System at Rocky Mountain Arsenal (RMA) Via Construction Of Groundwater Recharge Trenches is being conducted as part of the IRA Process for RMA in accordance with the June 5, 1987 report to the court in United States v. Shell Oil Co. and the proposed Consent Decree.

The Decision Document for the subject IRA became final on July 6, 1988. The detailed design reflects the comments contained in the Final Decision Document and the engineering drawings and specifications are included in this Implementation Document. In accordance with the proposed Consent Decree a construction cost estimate and schedule have been prepared and are included. The cost of construction is estimated to be $490,000 and the basis of this estimate is given in section 4. The scheduled "Implementation Deadline" for completion of this project is December 30, 1988, subject to extension as described in Section XVIII of the Consent Decree. Intermediate dates shown in the schedule are not considered to be deadlines pursuant to paragraphs 9.13 and 3.47 of the proposed Consent Decree. It may be necessary to change the order of activities to accommodate the delivery of materials or equipment, however, the final completion of the project will occur on or before December 30, 1988.

This IRA project is an upgrade of the treated groundwater recharge system associated with the North Boundary Containment/Treatment System (NBC/TS). The existing system includes a slurry wall, dewatering wells upgradient (south) of the wall, a water treatment facility, and recharge wells downgradient (north) of the slurry wall. The existing recharge system does not have the capability to distribute sufficient

water in appropriate areas downgradient of the slurry wall. The result has been a hydraulic imbalance across the slurry wall. The water table on the upgradient side of the slurry wall is higher than the water table on the downgradient side of the slurry wall which is the reverse of what was intended in the original design. This reverse head difference may impair the effectiveness of the NBC/TS by allowing contaminated groundwater to pass around, under or through the barrier.

In order to correct this hydraulic imbalance, ten gravel filled recharge trenches (160 feet long, approximately 12-20 feet deep, and 2.5-3 feet wide) will be constructed along the downgradient (north) side of the slurry wall. Water will be piped under pressure from the treatment plant through a new effluent pipe to the ten trenches. Flow into each trench will be metered. Two piezometers will be installed in each trench and another between each trench close to the slurry wall for monitoring water elevations. A membrane will be installed on top of the gravel to prevent most gravity-induced silting of the gravel. To minimize maintenance of the trench system with respect to potential carbon fines carry-over, the water distribution system has been designed to accommodate internal cleaning equipment and has cleanout/flushing capabilities.

The construction of the Recharge Trench System is expected to increase the recharge capability by up to 150 gallons per minute during the early operating life of the system. The system allows recharge of treated groundwater to be distributed along the length of the barrier in a controlled manner. As a result of the increased recharge capacity and the ability to control recharge distribution, it is expected that the existing hydraulic imbalance across the slurry wall will be corrected. In addition, operation of this system will provide information that may indicate that recharge trenches are applicable in the the Final Response Actions.

MEMORANDUM OF UNDERSTANDING BETWEEN
THE DEPARTMENT OF THE ARMY AND SHELL OIL COMPANY
WITH RESPECT TO
NORTH BOUNDARY TRENCHES INTERIM RESPONSE ACTION

I. PARTIES

This Memorandum of Understanding ("MOU") specifies the cooperative undertakings which are to occur between the Army (a potentially responsible party under CERCLA) and Shell (a potentially responsible party under CERCLA) with respect to the Scope of Work for the North Boundary Trenches Interim Response Action attached as an exhibit to this MOU.

II. PURPOSE

The purpose of this MOU is to provide an appropriate basis for Shell to participate in the design, engineering and construction work determined to be necessary for the North Boundary Trenches Interim Response Action.

III. DEFINITIONS

The following terms, as defined in the Consent Decree and used in the MOU, shall have the meanings indicated:

(a) "Army" means the United States Department of the Army, and any successors or assigns thereof, and any agency, office or other subdivision thereof; and includes the officers, members, employees and agents of the Army when acting within the scope of their authority.

(b) "Arsenal" means the United States property known as the Rocky Mountain Arsenal and described more particularly on Exhibit A hereto.

(c) "CERCLA" means the Comprehensive Environmental Response, Compensation and Liability Act of 1980, as amended by the Superfund Amendments and Reauthorization Act of 1986.

(d) "Consent Decree" means the Consent Decree agreed to by Shell and the United States and filed with the court in United States of America v. Shell Oil Company, Inc., Civil Action No. 83-C-2379 and State of Colorado v. United States of America and Shell Oil Company, et al., Civil Action No. 83-C-2386, both filed in the United States District Court for the District of Colorado, and any amendments or modifications thereof

and supplements thereto, and all documents, including the RI/FS Process Document, incorporated therein and specifically made a part thereof.

(e) "Contractor" means any commercial party not a part of Shell with which Shell contracts for the performance of Response Action work pursuant to this MOU. Unless otherwise indicated, the term also includes a subcontractor retained by a prime Contractor or another subcontractor.

(f) "Final Response Action" means any Remedial Action for an Operable Unit, as set forth in the ROD for the Operable Unit.

(g) "Financial Manual" means the document identified in paragraph 7.4 of the Consent Decree.

(h) "Force Majeure" means any event arising from causes beyond the control of an Organization that causes a delay in or prevents the performance of any obligation under this MOU. "Force Majeure" includes, but is not limited to: acts of God; fire; war; insurrection; civil disturbance; explosion; unanticipated breakage or accident to machinery, equipment or lines of pipe, despite diligent maintenance; adverse weather conditions which could not be reasonably anticipated; unusual delay in transportation; earthquake; restraint by court order or order of public authority; inability to obtain, at reasonable cost and after exercise of reasonable diligence, any necessary authorizations, approvals, permits or licenses as a result of the action or inaction of any governmental agency or authority other than the Army; delays caused by compliance with applicable statutes or regulations governing contracting, procurement or acquisition procedures, despite the exercise of reasonable diligence; and insufficient availability of appropriated funds, if the Army shall have made timely request for such funds as part of the budgetary process. "Force Majeure" also includes any strike or labor dispute, whether or not within the control of the Organization affected thereby, but shall not include increased costs or expenses of Response Actions, whether or not anticipated at the time such Response Actions were initiated.

(i) "IRA" means an Interim Response Action identified in Section IX of the Consent Decree.

(j) "Lead Party" means the Organization that is designated with responsibility, in accordance with Section XIII of the Consent Decree, for conducting a Response Action, or any part thereof.

(k) "MOU" or "Memorandum of Understanding" means this entire document and any amendments or modifications hereof and supplements hereto, and all documents incorporated herein by reference.

(l) "NCP" means the National Oil and Hazardous Substances Pollution Contingency Plan, 50 Fed. Reg. 47912 (1985) (effective February 18, 1986), and all amendments thereto which are not inconsistent with CERCLA and which are effective and applicable to any activity undertaken pursuant to this MOU.

(m) "Organization" means the Army, EPA or Shell.

(n) "Party" means the Army or Shell; "Parties" means the Army and Shell.

(o) "Response Action" has the same meaning as "Respond" or "Response" as defined in Section 101(25) of CERCLA, 42 U.S.C. § 9601(25).

(p) "RI/FS Process Document" means the document identified in paragraph 11.1 of the Consent Decree and attached thereto as Exhibit E.

(q) "Scope of Work" means a document identified in Part VI by which any Response Action work for which Shell is the Lead Party shall be conducted.

(r) "Shell" means (a) Shell Oil Company and its successors and assigns, (b) the divisions thereof, including Shell Chemical Company, (c) Julius Hyman & Co., and (d) Shell Chemical Corporation; and includes the officers, employees and agents of Shell when acting within the scope of their authority.

(s) "Supplemental Response Action" means a Response Action selected after finalization of the ROD for the last Operable Unit pursuant to Section XII of the Consent Decree. The term does not include either an Emergency Action or modification of a ROD in accordance with paragraph 17.16 of the RI/FS Process Document.

All other capitalized terms used in this MOU shall have the same meaning as in the Consent Decree or the meaning specified in an executed Scope of Work.

IV. SCOPE OF MOU

This MOU and the Consent Decree constitute the entire understanding between the Army and Shell with respect to Shell's assisting the Army in the Response Action work described in the

attached executed Scope of Work, except for any subsequently executed Scope of Work which the Parties may execute with respect to the North Boundary Trenches Interim Response Action; constitute the sole conditions controlling Shell's participation in such North Boundary Trenches Interim Response Action; and with respect to such North Boundary Trenches Interim Response Action, supersede any other agreement(s) between the Parties. In the event of a conflict between the provisions of the Consent Decree and this MOU, the provisions of the Consent Decree shall govern after it is entered by the court.

V. OPERATION OF MOU

By their execution of this MOU, each of the Parties acknowledges and agrees as follows:

(a) The provision of the Response Action work pursuant to this MOU is a reasonable and appropriate contribution to the design and implementation of the North Boundary Trenches Interim Response Action that is protective of the present and future public health and the environment.

(b) The Army's actions under this MOU are not inconsistent with the NCP.

(c) Shell's actions under this MOU, to the extent certified by the Army pursuant to Subpart VI.E., are consistent with the NCP.

(d) This MOU does not operate to establish or to excuse any Shell or Army liability under any law or the Consent Decree, except to the extent provided in this MOU.

(e) This MOU does not operate to render Shell or any of its Contractors a CERCLA response action contractor.

(f) This MOU does not operate to expand or limit any of the rights and obligations of the Army as Lead Agency or Shell as Lead Party under any law or the Consent Decree.

(g) Unless otherwise provided in the Scope of Work, upon acceptance of the Response Action work pursuant to Subpart VI.E, title to any Response Action Structure including all related systems and facilities constructed as a part of this MOU shall pass to the United States.

(h) The Army shall be solely responsible for obtaining necessary permits, if any, and for establishing substantive compliance with all permitting requirements pursuant to Section 121(e) of CERCLA, 42 U.S.C. 9621(c), for any

activities conducted pursuant to this MOU. However, Shell shall provide any necessary technical support necessary for the Army to obtain such permits.

(i) This MOU has no precedential or controlling effect with respect to any matter which is not expressly the subject of this MOU.

(j) This MOU does not create or impose any obligations or responsibilities on the Parties or relieve them of any obligations or responsibilities, except to the extent expressly provided herein.

VI. SHELL'S PERFORMANCE OF RESPONSE ACTION WORK

A. Development of Scope of Work: Pursuant to Section XIV of the Consent Decree, the Army and Shell have developed a Scope of Work by which the North Boundary Trenches Interim Response Action for which Shell is the Lead Party shall be conducted. This Scope of Work includes any required data or specifications for the North Boundary Trenches Interim Response Action work to be performed, a projected schedule for completion and a statement as to the appropriate limits of insurance to be maintained by Shell pursuant to Part VII.

B. Incorporation into this MOU: The Scope of Work developed pursuant to Subpart VI.A and executed by the Army and Shell, and all the terms and conditions therein are incorporated by reference into this MOU.

C. Performance of Work: Upon execution of the Scope of Work by the Army and Shell, Shell shall immediately commence, in consultation and cooperation with the Army, as provided in the Consent Decree, to perform the North Boundary Trenches Interim Response Action work described in the Scope of Work.

D. Hiring of Contractor: Subject to the approval of the Army, Shell may hire at its sole expense, subject to Part VII, a Contractor to perform any Response Action work described in the Scope of Work. A Contractor may be terminated by Shell with the approval of the Army, which approval shall not be unreasonably withheld. Any disagreement with respect to such termination not resolved informally shall be resolved in accordance with the provisions of Part XIII.

E. Acceptance of Work: 1. If Shell performs the Response Action work in accordance with the specifications set forth in the applicable Scope of Work, the Army shall accept Shell's work pursuant to this MOU. The Army shall act promptly to accept

Shell's work, and acceptance shall not be unreasonably withheld. Should the Army decline acceptance, it shall promptly notify Shell in writing, stating with specificity the factual, technical and legal bases for such nonacceptance.

2. If Shell concludes that the Army is in error for treating Shell's performance as incomplete or unacceptable for any reason, Shell shall give notice in writing, within ten business days of the receipt of the Army's written notification, that Shell disagrees. Any such disagreement, if not resolved informally, shall be resolved in accordance with the provisions in Part XIII.

VII. SHELL INSURANCE OBLIGATIONS

Shell shall maintain such insurance or self-insurance as is required by statute or regulation to cover any claims which may reasonably be anticipated to be made as a result of Response Action work done pursuant to any Scope of Work attached as an exhibit to this MOU. At a minimum, Shell shall, at its sole option, procure insurance, maintain insurance or self-insure sufficiently to cover the following:

1. Worker's compensation and occupational disease insurance in amounts sufficient to satisfy applicable state law;

2. Employer's liability insurance in the minimum amount of $100,000 per occurrence; and

3. Comprehensive general liability insurance for bodily injury, death or loss of or damage to property of third persons in the minimum amount of $100,000 per occurrence.

Upon this MOU becoming effective, Shell shall promptly provide the Army with an affidavit that Shell is in compliance with the minimum requirements of this Part. Upon the signing of a Scope of Work, Shell shall promptly provide the Army with an affidavit that Shell is in compliance with this Part as to that Scope of Work. Upon request, Shell shall discuss with the Army the manner in which Shell will fulfill its obligations under this Part.

VIII. ARMY SUPPLEMENTATION OF SHELL INSURANCE

If the Response Action work being performed is an Army-Only Response Action, as defined in the Consent Decree, the Army shall release, defend, indemnify and hold harmless Shell from all losses, fines, penalties, claims, suits, liabilities, judgments, or expenses (including expenses of litigation or settlement) (collectively hereinafter in this Part VIII, "claim") with

respect to any death or injury to any person or loss of or damage to property to the extent that these result from the construction, operation, collapse, rupture or failure of any Response Action Structure, or any part thereof, after the Army's acceptance pursuant to Subpart VI.E. or the operation, collapse, rupture, failure or ineffectiveness of the Response Action Structure as a result of the construction, operation, collapse, rupture or failure of the Response Action work when such claim is not compensated by insurance or self-insurance, to the extent provided below:

(a) Shell is not in material breach of this MOU with respect to the Scope of Work pursuant to which such Response Action work was performed or such Response Action Structure was constructed;

(b) Any claim which is within the deductible amounts of Shell's insurance shall not be subject to this Part;

(c) Shell shall not be reimbursed for any claims (including expenses incidental to such claims) to the extent that they result, in whole or in part, from willful misconduct or recklessness by Shell;

(d) The Army may discharge its obligations under this Part by making payments directly to Shell or directly to any party to whom Shell may be liable upon obtaining a release from that party, which release provides adequate protection for Shell.

(e) If insurance coverage maintained in accordance with Part VII is reduced below the minimums specified in that Part without the Army's knowledge or approval, the liability of the Army under this MOU shall not be increased by reason of such reduction;

(f) To the extent that any claim against Shell may reasonably be expected to involve indemnification under this Part, Shell shall:

(1) promptly notify the Army of such claim against Shell;

(2) furnish evidence or proof of any claim covered by this Part in the manner and form reasonably requested by the Army; and

(3) immediately furnish the Army with copies of all pertinent papers received by Shell.

(g) To the extent that the amount of the claim is not determined to be in excess of the limits set forth in Part VII or to the extent that the amount of the claim cannot reasonably be determined to be or not to be in excess of those limits, Shell and the Army shall conduct a joint defense or settlement. Once it is determined that the amount of the claim is in excess of the limits set forth in Part VII, the Army shall direct and control such defense or settlement, with assistance by Shell as is acceptable to both Parties, and Shell shall execute any authorizations which the Army reasonably requires in connection with such settlement.

(h) Reimbursement for any claims under this Part shall not exceed appropriations available during the time that such claims are represented by final judgments or by settlements approved in writing by the Department of Justice. This agreement to reimburse Shell for certain claims shall not be interpreted as implying that Congress shall, at a later date, appropriate funds sufficient to meet any deficiencies. During all times that claims remain unreimbursed due to lack of appropriated funds, the Army shall exert its best efforts to obtain appropriations for such reimbursement.

IX. TREATMENT OF COSTS INCURRED BY SHELL PURSUANT TO THIS MOU

Any costs incurred by Shell pursuant to this MOU are Reimbursable Costs and shall be governed by the terms of the Consent Decree and the Financial Manual.

X. DELAY OR PREVENTION OF PERFORMANCE

A. As provided in the Consent Decree, if a Party is rendered unable, wholly or in part, by Force Majeure to carry out its obligations under this MOU, then upon that Party's giving written notice as provided in Subpart XI.C., the obligations of that Party, so far as they are affected by the event of Force Majeure therein specified, shall be suspended during the continuance of such cause, but for no longer period, and such cause shall be remedied so far as possible with all reasonable dispatch.

B. The settlement of a strike or other labor dispute shall be entirely within the discretion of the Party involved with such strike or labor dispute, and the requirement that any event of Force Majeure shall be remedied with all reasonable dispatch shall not require the settlement of a strike or labor dispute by acceding to the demands of the opposing party when such course is inadvisable in the discretion of the Party involved with such strike or labor dispute.

C. When circumstances are occurring or have occurred that delay the completion of any obligation, and a Party believes such circumstances constitute an event of Force Majeure, such Party shall notify the other Organizations in writing within 15 days after the notifying Party obtains information indicating that a delay will occur. Such notice shall include a detailed explanation of the reason(s) for and anticipated duration of the delay, the measures taken and to be taken to prevent or minimize the delay, and a schedule for implementation of such measures. Failure to provide notice in accordance with this paragraph within the required 15-day period shall constitute a waiver of any claim of Force Majeure with respect to any event of Force Majeure for which notice was not timely given.

D. If the Organizations cannot agree whether a delay is or was attributable to an event of Force Majeure, any Organization may invoke Dispute Resolution.

E. Scope of Work Modification: In the event that performance of this MOU is delayed because any Party finds it necessary to make modifications to address an unanticipated occurrence which may cause a delay of more than two weeks, such modifications shall be developed and implemented by Shell in consultation and cooperation with the Army. Any disputes not resolved informally shall be resolved pursuant to the provisions of Part XIV. Further, if Shell anticipates the delay resulting from any such modifications will necessitate the extension of a Deadline, it shall request such an extension in accordance with Section XVIII of the Consent Decree.

F. Unaffected Activities: To the extent that the unanticipated occurrence does not necessitate delay in any discrete portion(s) of the activities provided in Part VI, such portion(s) of the activities shall proceed as originally provided in the MOU irrespective of the need for modification of other parts of the MOU.

XI. SHELL ACCESS TO ROCKY MOUNTAIN ARSENAL

A. Pursuant to the terms and conditions of this MOU, the Army authorizes and grants to Shell and its Contractors and consultants, and any invitees of these, nonexclusive access to all areas and systems on the Arsenal (except those which the Program Manager informs Shell are restricted for security or safety reasons) to the extent necessary to conduct the design and implementation of the North Boundary Trenches Interim Response Action.

B. The nonexclusive access authorized and granted in paragraph XI.A shall terminate upon mutual agreement of the Parties.

XII. DISPUTE RESOLUTION AND JUDICIAL REVIEW

A. Dispute Resolution: Any dispute which arises in connection with this MOU may be submitted for resolution as provided in Section XXI of the Consent Decree. Prior to any such submission, Shell and the Army shall meet and attempt to resolve the dispute informally.

B. Judicial Review: 1. Judicial review of issues arising in connection with this MOU shall be obtained as provided in Section XXII of the Consent Decree.

2. The pendency of any dispute shall not affect the responsibility of the United States or Shell to continue their involvement in the assessment, selection, design and implementation of Response Actions or discrete portions of Response Actions not subject to such dispute.

XIII. GENERAL

A. Nothing in this Agreement shall be construed to modify, waive or affect in any way the rights, obligations and remedies available to the parties under (a) the Consent Decree, (b) the Basin F MOU or (c) any other existing CERCLA-related agreement between Shell and the Army.

B. The exercise of the access, use and occupancy hereby granted shall be under the general supervision and subject to the approval of the Program Manager and subject also to such regulations, including, but not limited to, the fire and safety requirements of the Arsenal Regulations and AMCR 385-100 and the security requirements of the Arsenal Regulations and AMCR 190-3, except as provided by the approved Task Plans, as may be prescribed by him or her from time to time. The Army shall furnish Shell with a copy of all such regulations within 5 days of execution of this MOU and shall furnish Shell with copies of changes to such regulations at the same time such changes are furnished to Army personnel or contractors on the Arsenal.

C. Except when damage or loss results directly from activities authorized by or taken pursuant to a Task Plan, any property of the United States or Shell damaged or destroyed by the other in connection with the exercise of the privileges herein granted shall be promptly repaired or replaced by the party responsible for the damage or destruction to the satisfaction of the party owning such property. The obligations of the United States to repair or replace Shell property shall be limited by and consistent with the provisions of statutes authorizing claims against the United States and implementing regulations. The obligations of Shell to repair or replace

United States property shall be limited by any defenses Shell may have with respect to any such claim. If either party is of the opinion that such repair or replacement is not appropriate, it shall so notify the other, together with a proposed alternative. If the Program Manager and the Denver Site Manager cannot agree within 30 days, the party initiating the discussions may cause the matter to be submitted to dispute resolution pursuant to Section XII of this MOU.

D. The United States shall not be responsible for, and Shell shall hold the United States harmless from, any damages to property, injuries to persons (including illness, disease or death) that may arise from or be incident to Shell's exercise of the privileges herein granted to Shell, except as authorized by law.

E. Except as authorized by a Task Plan, a Scope of Work or otherwise, Shell and its Contractors shall not, as a consequence of activities after the effective date of this MOU, release or discharge air emissions, waste, effluent, hazardous substances or contaminants in such a manner that the release or discharge will unlawfully pollute or contaminate the air, ground (including subsurface strata) or water (including groundwater) or become a public nuisance. Shell shall also pay damages, expenses of litigation and fines and penalties imposed by operation of law upon the United States that are related to or caused by any such nonauthorized release or discharge.

F. The right of access and use granted herein is effective only insofar as the rights of the United States in the property involved are concerned, and Shell shall obtain such permission as may be necessary on account of any other existing rights.

G. Shell shall not discriminate against nor exclude from participation in its operations hereunder any person(s) on the basis of race, color, religion, national origin, sex, age, or handicap. Shell shall furnish as a part of this contract an assurance (Appendix D), that it will comply with Title VI of the Civil Rights Act of 1964 (78 Stat. 241) as amended (42 U.S.C. 2000d) and Department of Defense Directive 5500.00 issued pursuant thereto and published in Part 300 of Title 32, Code of Federal Regulations, the Rehabilitation Act of 1973, as amended 929 U.S.C. 794), and the Age Discrimination Act of 1975 (42 U.S.C. 6102).

H. Notwithstanding any provisions of this MOU, the Army reserves the right to take action affecting the Arsenal that is not consistent with this MOU, including the use of the Arsenal for any purpose, upon the occurrence of either of the following events: (a) a determination by the President that such action is

of paramount importance, or (b) a determination by the United States Secretary of Defense or by the United States Secretary of the Army that such action is necessary and in the interest of national defense. The costs of any action, including any Response Action, taken by the United States pursuant to or as a result of a determination made in accordance with the previous sentence, shall be borne entirely by the United States.

I. It is understood and agreed that Shell's rights with respect to the access and use granted to Shell herein are without any representation or warranty whatsoever by the Army.

J. Term: This MOU shall continue in effect until the Army, pursuant to Subpart VI.E., accepts Shell's work pursuant to this MOU, and the reimbursement or payment has been made pursuant to Part IX.

K. Modification: Any provision of this MOU or of any Scope of Work may be modified at any time by both Parties' agreement. Any modification must: (1) be in writing; (2) show the date signed by the Parties; (3) specify that it is intended to modify this MOU; (4) state the provisions of the MOU to be modified; (5) state the new provisions; and (6) state when the new provisions are to be effective.

L. Effect of Execution: This MOU shall become effective on its execution by the Parties.

IN WITNESS WHEREOF, I have hereunder set my hand as an authorized representative of the United States Department of the Army.

Date: 8/31/88

Lewis D. Walker
Deputy for Environment, Safety and Occupational Health

IN WITNESS WHEREOF, I have hereunder set my hand as an authorized representative of Shell Oil Company.

Date: August 12, 1988

R.G. Dillard
Vice President

SCOPE OF WORK

Shell will perform the following activities as Lead Party for design and implementation of the North Boundary Trenches Interim Response Action:

1. Prepare draft and final Implementation Documents and implement the final Implementation Document, pursuant to Section IX of the Consent Decree.

2. Perform the following work in connection with the trench system, as described more fully in the NBT Implementation Document (as defined below):

   a. Design engineering;

   b. Procurement of all required materials;

   c. Supervisory and construction labor for excavation, installation, backfilling, testing and startup;

   d. Site cleanup in preparation for reseeding by the Army.

All the activities described in this paragraph 2 shall be performed in accordance with the construction work plan, basis of the estimated cost, schedule, technical specifications, engineering drawings, and health and safety plan set forth in the NBT Implementation Document.

The term "NBT Implementation Document" means the following documents, both of which are hereby incorporated herein by reference:

(a) Final Implementation Plan for IRA to Improve the North Boundary System via Construction of Groundwater Recharge Trenches dated August 1988, prepared by Morrison-Knudsen Engineers, Inc. for Shell, and any amendments or modifications thereof and supplements thereto; and

(b) Prior to issuance of the document described in paragraph (a), but only prior to issuance of that document, Draft Implementation Plan for IRA to Improve the North Boundary System via Construction of Groundwater Recharge Trenches dated July 1988, prepared by Morrison-Knudsen Engineers, Inc. for Shell.

IN WITNESS WHEREOF, I have hereunder set my hand as an authorized representative of the United States Department of the Army.

Date: 8/31/88

Lewis D. Walker
Deputy for Environment, Safety
and Occupational Health

IN WITNESS WHEREOF, I have hereunder set my hand as an authorized representative of Shell Oil Company.

Date: August 12, 1988

R.G. Dillard
Vice President

TFCD/BB3

CONSTRUCTION WORK PLAN

1. Survey: Area will be staked to locate and define the limits of excavation.

2. Soil Investigation: Prior to the beginning of the construction work the areas to be excavated will be investigated for contaminants as outlined in the Health & Safety Plan.

   A. Recharge Trenches: One hole per trench will be drilled and tested at various elevations to investigate volatile organic levels.

   B. Pipeline Trench: One hole will be drilled in the alignment of the force main and tested to investigate the presence of volatile organic substances.

   C. Should findings warrant further investigations, additional testwork will be specified and implemented.

3. Recharge Trenches: Excavation of the recharge trenches will be performed in two phases as discussed below:

   A. Bench: Upper 4 to 6 feet of existing soil, will be excavated down to establish a lower working platform to minimize vertical trenching and create an area to stockpile potentially contaminated soils from the vertical trench excavation. Excavation will be started from trench #10 working towards trench #1 i.e.: east to west.

   B. Vertical Trench Excavation: The remaining depth of excavation will be trenched with a 30" to 36" wide bucket to the elevations selected in the field by the geologist.

NOTE: Potentially contaminated soil will be stockpiled on one side of the benched platform to isolate the soil removed during the trenching operation. Personnel working on this side of the trench will decontaminate their clothing prior to leaving this area or crossing the trench if contaminant levels are found to warrant these measures.

4. Geotextile Fabric: Will be installed immediately following excavation of the trench to the final depth. Individual sections of fabric will be draped over each side from the top of the trench. Each section will over lap the next section 18 inches.

NOTE: In order to minimize the possibility of trench failure, the rate at which the trench is excavated will be controlled so that fabric installation and gravel filling follow as soon as possible.

5. Gravel Fill: Will be installed immediately after reaching final depth in the trench. Use of a trench box may be required to maintain the stability of the excavation until gravel fill can be installed to an elevation above unstable soil. Initial excavation will be attempted without a trench box to examine the stability of the sidewalls, however, a trench box will be on hand if required as determined by the MKE Construction Manager.

6. Trench Piezometers: Installed manually following fabric installation and in conjunction with the gravel fill operation as defined in the project specifications. Piezometers will be capped temporarily during construction to prevent foreign materials from dropping into the pipe.

7. Water Line: Installation of the water line will be performed in conjunction with the recharge trench construction and will follow completion of each of the trenches to allow for the earliest possible operation of completed sections.

8. Drilled Piezometers: Installed following backfill operation. Installation will be as outlined in the specifications.

9. Geological Services: An onsite geologist will monitor the construction work to establish depth of excavation along the length of each trench and log information for future reference.

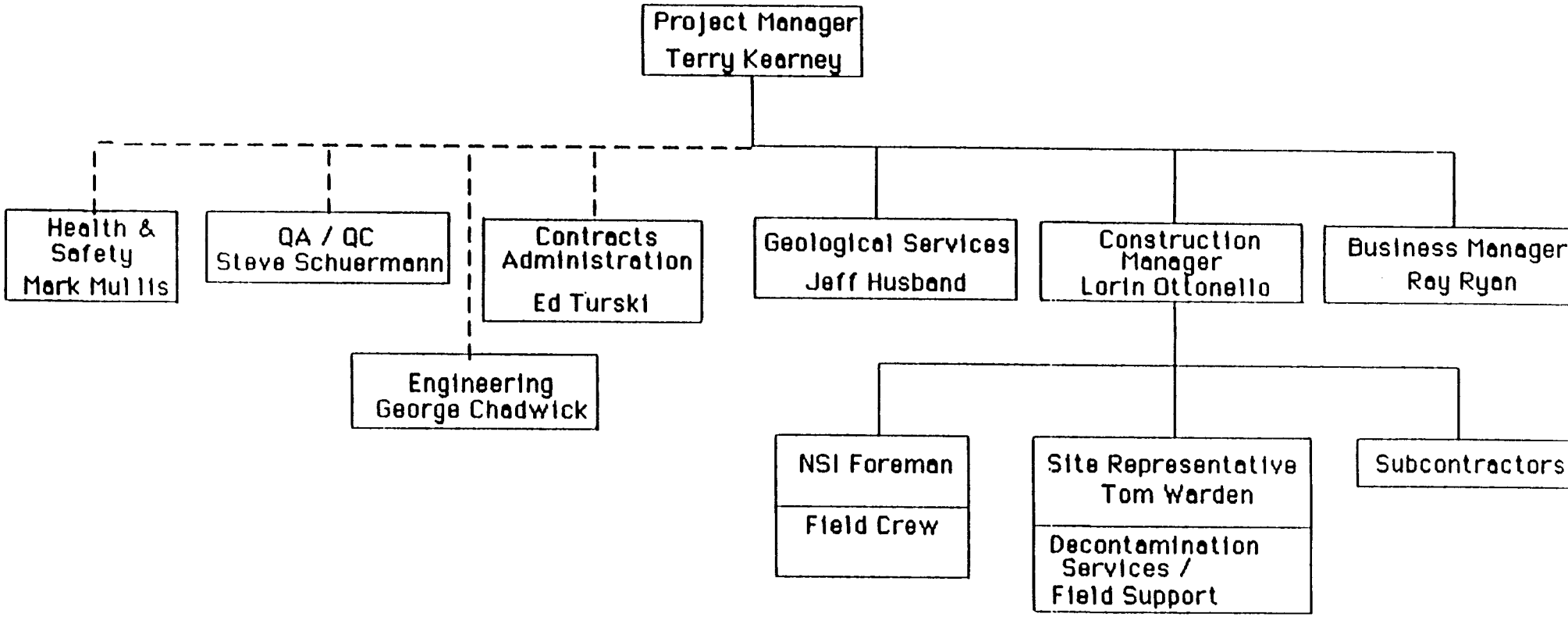
10. Health & Safety: An onsite health and safety officer will constantly monitor the work and test the excavations with an O.V.A. to ensure worker's safety and identify any volatile organic compounds that may be encountered.

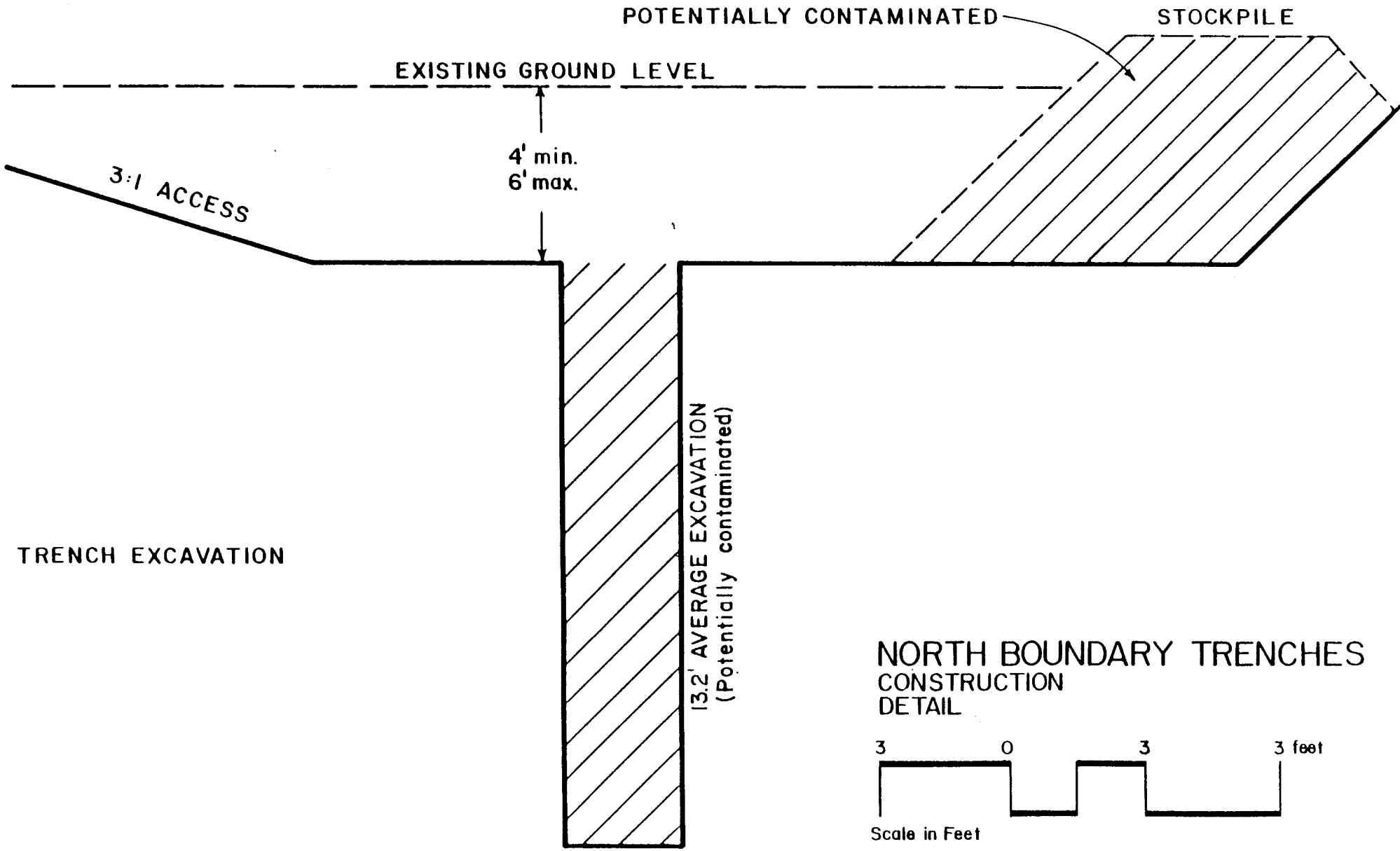
11. Major Equipment List

1	Cat 235 excavator w/30" and 54" bucket
1	Cat 950 loader w/general purpose bucket
1	Case 680 backhoe w/24" bucket, 4 wheel drive
1	Cat D6 dozer w/angle dozer
1	Decontamination truck
	10 wheeler dump trucks (gravel haul)
1	Pickup truck 4x4
1	Flatbed truck

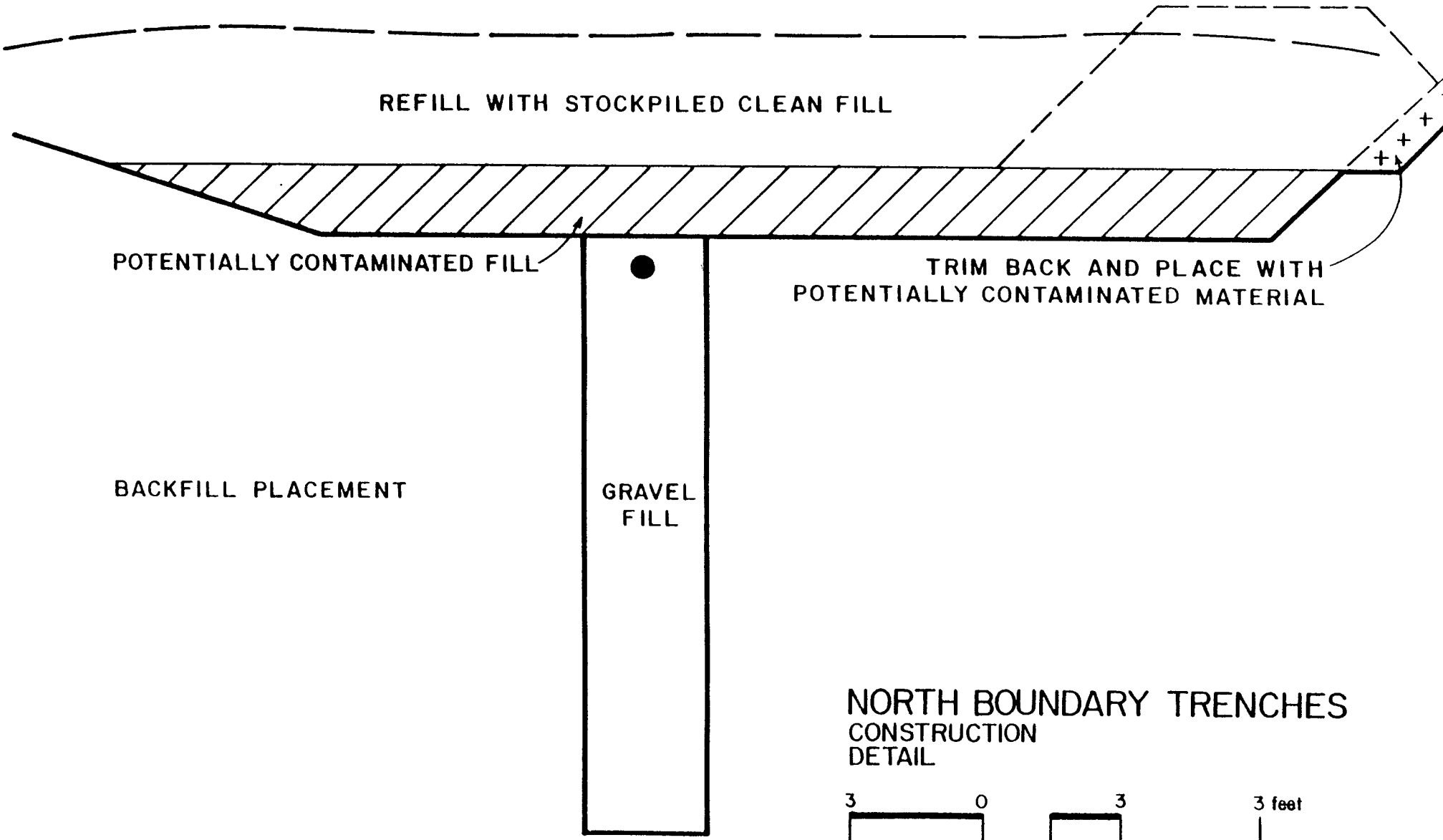
(Equipment sizes and manufactures may vary)

NORTH BOUNDARY RECHARGE TRENCHES - WEST
ORGANIZATIONAL CHART

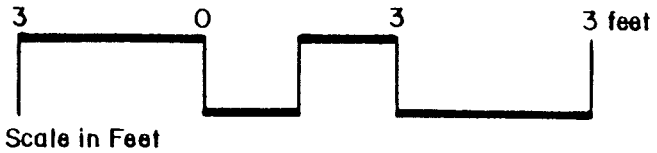




NORTH BOUNDARY TRENCHES
CONSTRUCTION DETAIL



NORTH BOUNDARY TRENCHES
CONSTRUCTION DETAIL



Morrison-Knudsen Engineers

Day _____ Date _____

ROCKY MOUNTAIN ARSENAL
North Boundary Recharge Trenches - West
Daily Construction Report

Work Summary: _____

Safety Comments:

Extra Work / Delays:

Supervisor's Signature _____ Title _____

Morrison-Knudsen Engineers

Day ____________ Date ____________

ROCKY MOUNTAIN ARSENAL
North Boundary Recharge Trenches - West
Daily Personnel Log

Name (Print)	Company	Time In	Time Out

BASIS OF THE ESTIMATE

1. Disposal of Contaminated Soils: The construction work plan and estimated cost have been prepared on the basis of backfilling all excavated soil into the excavation from which it was removed. If, as a result of the soil contamination screening process described in the IRADD para: 8.3.3.3, it is found that there is potentially contaminated soil which is in excess of that required as backfill, then it will be an Army responsibility to sample, analyze, containerize, transport, and store any excess soil for which such treatment is required.

2. Blasting: It is assumed that no blasting is required. Rock which cannot be excavated efficiently with the equipment proposed for use onsite, or that will require blasting may necessitate an increase in estimated cost and a revision of the schedule.

3. Water: It is assumed that no groundwater will be removed from the excavated area. If groundwater must be removed from the excavated area, it will be pumped into drums or tanker trucks and transported to a dedicated storage area or to the Army's groundwater treatment system. The procedures used will be those developed for handling, storage and treatment of contaminated water from well development and groundwater sampling on the RMA. If it becomes necessary to handle water, an increase in the estimated cost and a revision of the schedule will be required.

4. Pipe Bedding: It is assumed that bedding material may be obtained from onsite excavations without screening or separating excavated materials, therefore, no allowance was made for imported bedding material.

5. The estimated cost and the schedule are based on production rates established for modified Level C Personnel Protective Equipment (PPE). If a higher level of PPE is found to be required, a suitable adjustment to the estimated cost and schedule will be required.

6. The estimated cost and schedule are based on provision of accurate (±3 feet horizontally) locations of all buried utilities and pipelines by the Army. Failure to accurately locate such underground systems may require adjustment to the estimated cost and schedule to repair damages.

7. Inspectors for the Corps of Engineers must be made available to inspect and accept or reject segments of the work subject to twenty-four (24) hours prior notification since this is a phased project and open excavations are undesirable. Delays resulting from failure to inspect completed segments of the work will result in adjustments to the estimated cost and schedule.

8. Preliminary drawings and specifications have been reviewed by the Army. The resulting comments have either been incorporated in the final design or have been deleted from further consideration after discussion and agreement with Army personnel.

9. Principal access for workers and delivery of materials to the site will be through the West Gate of the Arsenal. An alternative access for workers will be through the South Gate during the hours specified on the plans. Special access through the North Gate (normally locked) will be arranged for delivery of gravel to the site. Workers and vehicles must all be cleared by RMA security.

10. Logging of the trench will consist solely of logging the depth to the bedrock surface to the extent detectable with a backhoe and visual inspection from the ground surface down to a maximum depth of 20 feet.

11. All permits, and any regulatory arrangements, will be obtained through or made by the Army.

12. Recharge trenches will be constructed to the bedrock surface or a depth of 20 feet, whichever is least.

13. Labor rates are based on performing all construction on a Merit Shop basis.

14. A set of As-Built drawings will be prepared after construction of the system.

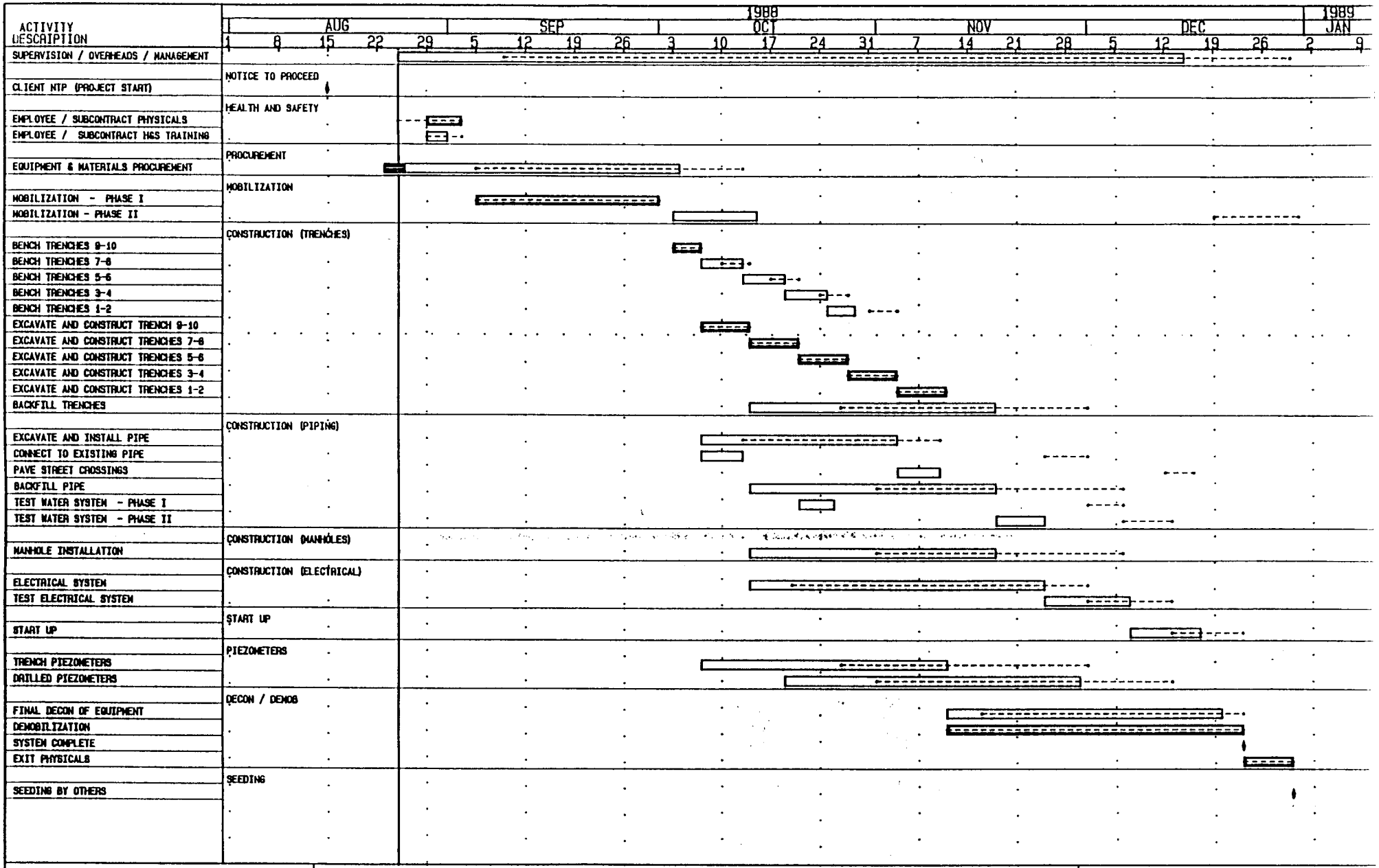
15. Revegetating the disturbed areas will performed by the Army (they have the equipment and seed required).

16. In cases where approved equal must be substituted for specified items of material or equipment, approval or disapproval will be given by the Corps of Engineers representative within one (1) week of the request for approval.

17. The estimate contains the cost for insurance coverage under Workmen's Compensation, Employer's Liability and Comprehensive General Liability to the limits specified in the Memorandum of Understanding (MOU) for response action work which was attached to the proposed Consent Decree of February 1, 1988. No additional costs for insurance are included in the estimate pending negotiation of the project specific MOU for this IRA.

ESTIMATED COST SUMMARY

Mobilize/Demobilize	6,000.00
Working Surface Excavation	3,779.00
Injection Trench Excavation	61,494.00
Injection Trench Backfill	26,583.00
Working Surface Backfill	10,362.00
Manhole/Lateral Excavation	6,477.00
Manholes	27,442.00
Forcemain Excavation	4,563.00
Forcemain Backfill	15,154.00
Asphalt Paving	3,178.00
Forcemain Piping	27,491.00
Manholes Piping	30,282.00
Electrical/Controls	41,291.00
Piezometers	14,196.00
Health and Safety	62,476.00
As-Builts	1,050.00
Survey	4,976.00
Supervision/General Expense/Overheads	87,113.00
Incentive Fee	17,356.00
	451,263.00
Contingency	38,737.00
TOTAL ESTIMATED COST	$490,000.00



Activity Bar/Early Dates
Critical Activity
Progress Bar
Activity Late Dates

Primavera Systems, Inc. 1984 1985 1986 1987

Project Start : 1AUG88
Project Finish: 30DEC88

ROCKY MOUNTAIN ARSENAL
NORTH BOUNDARY TRENCHES
CONSTRUCTION BARCHART

Sheet 1 of 1

Data Date: 25AUG88

MORRISON KNUDSEN ENGINEERS, INC.

Date	Revision	Checked	Approved

TECHNICAL SPECIFICATIONS
NORTH BOUNDARY RECHARGE TRENCHES - WEST
ROCKY MOUNTAIN ARSENAL, COMMERCE CITY, CO

MORRISON-KNUDSEN ENGINEERS, INC.

JULY 1988

TABLE OF CONTENTS

SPECIFICATION 38-0108

SUMMARY OF WORK

CLIENT: SHELL OIL COMPANY

PROJECT: NORTH BOUNDARY RECHARGE TRENCHES - WEST

LOCATION: ROCKY MOUNTAIN ARSENAL, COMMERCE CITY, CO

CONTENTS

SECTION 38-0108

SUMMARY OF WORK

1. PROJECT DESCRIPTION

A. Project Title: North Boundary Recharge Trenches - West

B. Project Owner: U. S. Department of the Army

C. Project Location and Elevation:

1. The project is located along the northern boundary of the Rocky Mountain Arsenal in Sections 23 and 24, Township 2 South, Range 67 West in Adams County, Colorado.

2. The surface elevation ranges from about 5140 to about 5155 feet above sea level.

D. General Description of the Project:

The basic element of the project is construction of ten trenches, each about 160 feet in length and about 12 to 20 feet in depth. The trenches will be filled with gravel to within about 4 to 6 feet of the surface where a 4-inch polyethelene drain pipe will be placed and covered with gravel. The drain pipe will be connected through a manhole to a pressure pipe placed in a 4 to 5 foot deep trench. In operation, water will be pumped from an existing treatment plant through the pressure pipe into the drain pipe and the gravel backfill. From the gravel the water will recharge the aquifer.

Piezometers will be placed within the gravel in the trench and also in a line about 30 feet south of the trenches and 15 feet north of the existing slurry wall to monitor ground water levels after the project is placed in operation.

2. SCOPE OF WORK

A. The contract work to be performed by the Contractor consists of constructing and completing the project in accordance with the drawings and the specifications and all applicable provisions of the contract documents, the Final Implementation Plan, and the Consent Decree.

B. The contract work includes the Contractor furnishing all plant, labor, tools, equipment, appliances, materials, transportation, and services called for in these specifications or in the design drawings, unless specifically excepted. The contract work includes performing all operations necessary for, and properly incidental to, the construction and proper completion of the project (unless specifically excepted in these specifications or in the design drawings), as shown and noted in

the drawings and as specified in these specifications. Elements of the contract work are classified under respective items contained in the bid schedule. Contract work shall generally include, but not be limited to, the following items:

- o Mobilization at "work site"
- o Excavation and backfill of recharge and pressure pipe trenches
- o Installation of drain pipe, pressure pipe, and manholes, valving, and instrumentation
- o Installation of piezometers

3. MANUFACTURERS' SPECIFICATIONS AND INSTRUCTIONS

A. Unless otherwise indicated or specified, all manufactured materials, products, processes, equipment, or the like shall be installed or applied in accordance with the manufacturers' instructions, directions or specifications. Said installation or application shall be in accordance with the printed instructions furnished by the manufacturer of the material or equipment concerned for use under conditions existing at the work site. Two copies of such instructions shall be furnished to the Engineer and his acceptance thereof shall be obtained before work is begun.

B. Any deviation from the manufacturers' printed recommendations shall be explained and acknowledged in writing by the particular manufacturer as correct for the circumstances. Contractor will be held responsible for all installations contrary to the manufacturers' recommendations. If any item of material or equipment is found to be installed not in accordance with the manufacturer's recommendations, Contractor shall make all changes necessary to achieve such compliance within the terms of his contract.

4. WORK QUALITY

All contract work shall be erected and installed plumb, level, square, and true, or true to the indicated angle, and in proper alignment and relationship to the work of other trades. All finished work shall be free from defects and damage.

5. FIELD MEASUREMENT AND TEMPLATES

Contractor shall secure all field measurements required for proper and accurate fabrication and installation of the contract work. Exact measurements are the Contractor's responsibility. Contractor shall also furnish or obtain all templates, patterns, and setting instructions required for the installation of all contract work. All dimensions shall be the responsibility of the Contractor in the field. All dimensions and surveying will be subject to verification by the MKE Field Engineer.

6. SPECIAL CONDITIONS

1. The Rocky Mountain Arsenal is a Military Reservation and persons admitted to the site are subject to existing safety and security regulations.

2. U.S. Citizenship is required for access to the site.

3. Names of each person as shown on a drivers license, including delivery personnel to be admitted to site, must be submitted to MKE one week in advance of arrival at the site.

4. Entry to the site will be through the west entrance to the Rocky Mountain Arsenal on Quebec Street, thence east on December 7th Avenue to D Street and north to the work site. A secondary point of entry is at the southern Arsenal boundary during some hours as shown on sheet 2 of the design drawings.

5. No firearms or cameras are permitted on the Arsenal.

6. Current registration and proof of insurance for each vehicle to be admitted to the Arsenal must be submitted upon arrival at the site.

SPECIFICATION SECTION 34-0202

SITE PREPARATION AND GRADING

CLIENT: SHELL OIL COMPANY

PROJECT: NORTH BOUNDARY RECHARGE TRENCHES - WEST

LOCATION: ROCKY MOUNTAIN ARSENAL, COMMERCE CITY, CO

CONTENTS

SPECIFICATION SECTION 34-0202

SITE PREPARATION AND GRADING

1. SCOPE

A. This specification section and other Contract Documents cover the furnishing of all equipment, labor, materials, and performance of work for site preparation, grading, and incidental items as required by applicable drawings and as specified herein.

B. Generally, required items of work include:

1) Established line and elevation control.

2) Grading of recharge trench sites.

3) Locate and protect existing underground pipelines.

4) Incidental items.

2. RELATED WORK

The following related work is covered in other sections of the specifications:

Excavating and backfilling for recharge trenches (10), manholes (11), and underground piping; maintaining temporary roads during subsequent activities; finish grading (Section 34-0203).

3. GENERAL PROCEDURES

A. Reference Points: Carefully maintain bench marks, monuments and other reference points. Replace them as the Morrison Knudsen Engineers, Inc. (MKE) Field Engineer directs if they are disturbed or destroyed.

B. Soil Investigation: Refer to MKE drawing sheet 3 which notes, in part, the U.S. Army Engineer sources of "Information for the topography, boreholes, wells, and bedrock". A copy of each listed report is available for review at the MKE office in downtown Denver.

C. Inspector: The services of a qualified Inspector will be provided by MKE to determine by observation and testing the quality of work and materials during site preparation and grading. He will judge the adequacy of site preparation, acceptability of available fill material, and the correct placement and compaction of fill to specified

densities. Work procedures require his approval as they are successively performed. Any work found unsatisfactory shall be corrected in an approved manner by the Contractor within the terms of his contract.

4. INSPECTION

A. All materials and the work shall be subject to inspection by the Engineer. The Engineer shall be provided access to all parts of the work and shall be furnished with such information and assistance as is required to make a complete and detailed inspection.

B. The Engineer may direct that portions of the work be removed or uncovered. After examination, said portions of the work shall be restored to the standard required by these specifications.

C. Do not proceed with the work until lines, grades, and/or structure locations have been established. Any work performed contrary to the drawings, specifications, or instructions of the Engineer, beyond the lines and grades shown on the drawings, or any extra work done without authorization of the Field Engineer, may be ordered removed or replaced, at the Contractor's expense.

5. GRADING

A. General: Perform necessary grading to achieve final elevations closely approximating those shown by the drawings. Surfaces shall be well-compacted, reasonably smooth, and free from irregularities, with uniform transitions made to adjacent areas.

B. Ditches and Swales: Finish to drain readily. Take measures to prevent erosion of freshly graded areas by appropriate means before vegetation is promptly reestablished by Army. Repair and reestablish areas of settlement or erosion to required elevations and slopes prior to acceptance of the work.

C. Road Subgrades: New permanent roads are not required nor provided. New 6" PVC underground pipe shall be installed in a trench that will be cut across "D" Street. After the pipe is installed and tested, and the trench is properly backfilled, restore paved "D" Street and parking area to near original crown and grade.

6. INCIDENTAL ITEMS

A. Safeguards: Provide, erect, maintain, and later remove temporary safeguards such as barricades, guard rails, signs, lights, and flares for protection of personnel, the public, equipment, and materials, as the Engineer directs and as required by state, federal, and local codes and ordinances.

B. Water Removal: Maintain grades to promote water drainage. Provide and operate equipment to keep construction areas free of surface and storm water. Provide necessary diversion ditches or other Engineer approved facilities for removing water. Dispose of surface and storm water as directed by the MKE Field Engineer so construction and storage areas, streets, roads, and other surfaces are not flooded.

C. Temporary Roads: Locate and construct temporary roads at locations directed or approved by the Engineer to serve as a means of access during construction activities.

D. Culverts: are not required and shall not be provided.

E. Riprap: is not required nor provided.

F. Clearing and Grubbing: In excavated areas for both the recharge trenches and the pressure manifold, the top 8 to 12 inches of soil shall be separately excavated and stockpiled for later use in providing the top layer of backfill over the trenches.

G. Finish Grading: Spread soil from on-site stockpiles onto previously stripped areas, including the recharge trench areas, that have been rough graded. Select materials to eliminate large stones, vegetation, and debris. Spread soil smoothly and uniformly, in sufficient quantity to allow for natural settlement, so that final dressing can be performed satisfactorily. Raking or compacting is not required.

H. Revegetation: is not required nor provided under this specification, but is to be provided by Army.

SPECIFICATION 34-0203

EXCAVATING AND BACKFILLING

CLIENT: SHELL OIL COMPANY

PROJECT: NORTH BOUNDARY RECHARGE TRENCHES - WEST

LOCATION: ROCKY MOUNTAIN ARSENAL, COMMERCE CITY, CO

CONTENTS

SPECIFICATION 34-0203

EXCAVATING AND BACKFILLING

1. SCOPE

A. This specification and other Contract Documents cover the furnishing of all equipment, labor, materials and performance of work for all excavating, backfilling and incidental items as required by applicable drawings and as specified herein.

B. Ten (10) trenches, 160 feet in length, up to 3 feet wide, and a maximum of 20 feet in depth shall be excavated as recharge trenches. The trenches will be excavated in alluvial materials ranging from clay to gravel.

A trench approximately 3,000 feet in length, approximately 2 feet in width and generally 4 to 5 feet deep will be excavated as a pressure pipe trench.

C. Generally, required items of work include:

1) Excavating for structures and preparing subgrades for trenches and manholes.

2) Filling, backfilling and compacting.

3) Grading around structures.

4) Incidental items.

2. RELATED WORK

A. The following related work is covered in other specifications:

1) Site preparation and grading (Specification 34-0202)

2) Excavating and backfilling for underground piping and associated manholes (Specifications 35-1501 and 35-1511)

3. GENERAL PROCEDURES

A. Reference Points: Carefully maintain bench marks, monuments and other reference points. Replace items as the Field Engineer directs if they are disturbed or destroyed.

B. Soil Investigation: A report of soil conditions investigated on the site is shown on the drawings. Accuracy of this report is not

guaranteed in that conditions at the present time and at other locations on the site may vary from those disclosed.

C. Engineer: The services of an Engineer will be provided by MKE to determine by observation and testing the quality of work and materials during excavating and backfilling. He will judge: acceptability and advantageous use of available fill and backfill materials; and the correct placement and compaction of fill and backfill to specified densities. Excavating, filling, backfilling, and compacting procedures require his approval as they are successively performed. Any work found unsatisfactory shall be corrected in an approved manner.

4. EXCAVATING FOR STRUCTURES

A. Dimensions: Excavate to required elevations and dimensions, allowing ample space for form and material placement, inspection, and form removal. If the nature of the soil permits and the Engineer gives prior approval, excavation may be made to correct dimensions and used as a concrete form. Degree of slope for open cut earth banks in all excavations over 5 feet deep in which a man enters will be as outlined in the Health and Safety Standard Operating Procedure.

B. Removing Materials: Excavate all materials encountered, except for existing services and permanent structures. Remove rock, boulders, portions of abandoned structures, and other hard obstructions to a depth at least 6" below planned excavation level in the pressure pipe trench. Soil conditions at bottom of excavation shall be subject to the Engineer's approval. Surfaces shall be level, or sloped if required, clean, and clear of mud or frozen material.

C. Suitable Bearing: Where unsuitable material is exposed at completion of planned excavation, perform further excavation as directed by the Engineer until suitable bearing is reached. Place and compact fill as specified herein to correct elevations.

D. Overexcavation: If materials are removed below required elevations, through error or careless excavating, the Field Engineer shall notify the Design Engineer who will determine corrective measures.

E. Rock Excavation:

1) Rock is defined as stone or hard shale in original ledge, and boulders over 1/2 cu.yd in volume or over 3'-0" in greatest dimension, which require special equipment and/or explosives to remove.

2) It is assumed that materials at the job site can be excavated with normal equipment such as a power shovel or bulldozer. If rock is encountered, notify the Field Engineer for his consideration before proceeding with further excavating.

3) The recharge trenches shall not be excavated beneath the bedrock surface. When excavating near the expected depth of the bedrock surface, the Contractor shall notify the Field Engineer. The Field Engineer will make the judgement of the depth at which the bedrock surface is encountered.

F. Material Storage and Disposal: Select excavated materials which can be reused later shall be classified and stockpiled. The top 4 to 6 feet of excavated material from the recharge trenches shall be stockpiled for later reuse as trench backfill. Dispose of other unsuitable and excess material and debris elsewhere on the Owner's property as directed by the Field Engineer.

G. Existing Underground Lines and Services: Locating existing underground lines and services within 3 feet shall be the responsibility of the Army to carefully uncover, support and protect. Do not cut, remove or damage these items without the Engineer's prior written approval; otherwise repair or replace them to the Field Engineer's satisfaction. Remove abandoned utilities, if any, as directed by the Field Engineer.

5. FILLING, BACKFILLING AND COMPACTING

A. Fill and Backfill Materials: Use Field Engineer approved materials obtained from: stockpiles of excavated material, borrow areas, or off-site locations. Provide suitable fill free of: debris, organic material, and large rocks; frozen matter; and excessive moisture or dryness.

1) Fill Beneath Manholes and Foundations which may be required to achieve proper grade elevation shall be gravel of the same specifications as the recharge trench backfill.

2) All Other Fill and Backfill: Use clean earth.

B. Placing Fill and Backfill:

1) The recharge trench shall be backfilled to a depth of 4 to 6 feet below the initial surface with gravel of the following gradation:

Size	% passing
1"	100
1/2"	0-40
3/8"	0-32
#4 sieve	0-3
#8 sieve	0-2

The recharge pipe shall be covered with no less than 6 inches of gravel, and the remainder of the trench filled with random fill.

2) The gravel backfill shall be separated from silt and clay in the sidewalls and on the top of the fill by 4 oz./sq.yd. non-woven, polyester geotex tile fabric as shown in the drawings.

3) The pressure pipe trench shall be bedded and backfilled as described in Specification 35-1501. Above the initial backfill, the trench shall be backfilled with random fill from trench excavation with no rocks over 6 inches in diameter. Except under "D" Street or in the parking area the random fill shall be compacted by wheel roll when 6 inches below grade.

Under "D" Street and the parking area, the backfill shall be random fill to within one foot of the surface. Six inches of gravel corresponding to that filling the recharge trench is then placed. The backfill shall be compacted to 95% modified Proctor density. The remaining six inches needed to match the original surface is filled with asphalt as shown in the Plans.

6. GRADING

A. General: Perform necessary grading to achieve final elevations closely approximating those required by the drawings. Surfaces shall be well-compacted, reasonably smooth, and free from irregularities, with uniform transitions made to adjacent areas. Neither raking nor reseeding are required as this will be provided by the Army.

7. INSPECTION

A. All materials and each part or detail of the work shall be subject to inspection by the Engineer. The Engineer shall be provided access to all parts of the work and shall be furnished with such information and assistance by the contractor as is required to make a complete and detailed inspection.

B. The Field Engineer may direct the contractor to remove or uncover portions of the work. After examination, the contractor shall restore said portions of the work to the standard required by these specifications.

C. The contractor shall not proceed until the lines, grades and/or structure locations have been established. Any work done by the contractor contrary to the drawings, specifications or instructions of the Field Engineer, beyond the lines and grades shown on the drawings, or any extra work done without authorization of the Field Engineer, may be ordered removed or replaced at the contractor's expense.

8. INCIDENTAL ITEMS

A. Safeguards: Provide, erect, maintain, and later remove temporary safeguards such as barricades, bridges, guard rails, signs, lights, and flares for protection of personnel, the public, equipment, and materials as the Field Engineer directs and as required by state and local codes and ordinances.

B. Retaining Excavations: Provide shoring, sheeting, and bracing necessary to retain excavations, maintain banks securely, withstand water pressure, prevent cave-ins, and protect life and property. As backfilling proceeds, remove shoring, sheeting, and bracing in a manner to prevent damage or disturbance to the construction and surrounding areas.

C. Water Removal: Maintain grades to promote water drainage. Provide and operate equipment to keep construction areas free of surface and storm water. Provide necessary diversion ditches or dewatering systems. Dispose of surface and storm water as directed by the Field Engineer so construction and storage areas, streets, roads, and other surfaces are not flooded. Do not remove any ground water from any excavations except for water attached to the in-place soils to be excavated.

D. Temporary Roads: Maintain temporary roads in operating condition.

SPECIFICATION 35-1501

PIPING AND INSTRUMENTATION

CLIENT: SHELL OIL COMPANY

PROJECT: NORTH BOUNDARY RECHARGE TRENCHES - WEST

LOCATION: ROCKY MOUNTAIN ARSENAL, COMMERCE CITY, CO

CONTENTS

SPECIFICATION 35-1501

PIPING AND INSTRUMENTATION

1. SCOPE

A. This specification and applicable design drawings cover the furnishing, installing, and testing of underground piping to distribute treated effluent from the existing water treatment plant effluent line to the ten (10) new North Boundary Recharge Trenches.

The existing pumps at the Effluent Wet Well have sufficient capacity and pressure capability for the required distribution.

B. The work includes:

1) Connecting to an existing 6" D.I. underground pipeline leading from the Effluent Wet Well. The existing line is located east of Building 808.

2) An underground line south from the above said connection to a new underground east-west PVC distribution header.

3) The underground east-west header to supply effluent to ten (10) Recharge Trench Manholes located at intervals in an overall distance of approximately 2,800 feet.

4) Piping inside each of eleven (11) manholes, plus discharge piping and perforated drain line into each Recharge Trench.

5) Effluent pressure and flowmeters in each manhole.

2. RELATED WORK

A. Related work is covered in other sections of the specifications:

1) Excavating and Backfilling (Section 34-0203)

2) Manholes (Section 35-1511)

3) Trench Piezometers (Section 22-3227)

3. REFERENCE STANDARDS

A. The piping components and instruments shall be designed, manufactured, and tested in accordance with applicable standards and references:

1) ASTM, American Society for Testing and Materials

2) ANSI, American National Standards Institute

3) ISA, Instrument Society of America

4) Text, Plastic Piping Systems, by David A. Chasis

5) National Sanitation Foundation

4. GENERAL REQUIREMENTS

A. Codes, Permits and Fees, Tests, and Certificates

1) All work performed under this specification shall meet the requirements of the codes, rules, and/or regulations of the State of Colorado and the Federal Government.

2) The U.S. Army shall obtain and pay for all permits and certificates of inspection required for this work by governing authorities.

3) Notification shall be given to the U.S. Army of all tests performed during progress of the work and prior to completion, so an Army representative may witness the tests.

4) All certificates of inspection, testing, and/or approval shall be delivered to the Army by MKE, Inc. before the specified work will be considered completed.

B. Coordination and Interferences

1) MKE, Inc. shall be responsible to coordinate the work under this specification with work performed in the same areas by other trades such as the site work, excavating, grading, and trench and manhole construction.

2) MKE, Inc. shall also request that the location of any underground utilities be identified by an Army representative.

5. MATERIAL REQUIREMENTS

A. Refer to items 1.B.1), 2), and 3) above. The underground effluent pipe and fittings shall be PVC manufactured from a compound that meets the requirements of Type 1, Grade 1, Polyvinyl Chloride as outlined in ASTM D-1784. A Type 1, Grade 1 compound is characterized as having the highest requirements for mechanical properties and chemical resistance.

The compound from which PVC pipe is produced shall have a design stress rating of 2,000 psi at 73F, listed by The Plastic Pipe Institute.

Materials from which PVC pipe and fittings are manufactured shall have been tested and approved for conveying potable water, by The National Sanitation Foundation.

PVC pipe shall conform to the requirements of ASTM D-1785. Fittings shall conform to the requirements of ASTM D-2467 for Schedule 80 socket type and ASTM D-2464 for Schedule 80 threaded type. All PVC socket and threaded connections shall be joined and installed using the manufacturer's recommended procedure.

The PVC pipe and fittings shall be supplied by an approved manufacturer.

B. The valves shown in Section C on MKE drawing Sheet 7, and in details 3 and 4 on Sheet 8, shall be supplied by the manufacturers indicated, or approved equal.

C. All pipe fittings and nipples located in the manholes shall be threaded galvanized steel Class 150, or Class 2000 Forged Steel, as indicated on MKE drawing Sheet 7.

D. The effluent piping flow sensor in each of the ten (10) recharge manholes shall be a 1" Halliburton Industrial Meter with magnetic pick-up. The flowmeter in the main line near Building 808 shall be a 3" Flanged Halliburton Industrial Meter with magnetic pick-up.

E. The outflow piping from a manhole to a Recharge Trench shall be furnished and installed with materials as indicated on MKE drawing Sheet 7.

6. INSTALLATION AND TESTING OF PVC PIPE

A. Instruction: Installation workers shall be instructed in the proper handling and joining techniques. Piping shall not be thrown, whipped, or dropped during handling.

B. Storage: In outside storage, the pipe and fittings shall be covered with light tarpaulin to prevent excessive heat build-up. Loose pipe stacks shall not exceed 3 feet in height.

C. Excavation, Trenching and Backfill: Shall be according to the requirements of Specification 34-0203 except as otherwise specified herein or on the drawings. Generally, installations of PVC pipe shall be in open trenches. The trench width below top of pipe barrel shall be the minimum required to provide working space for pipe jointing, bedding, and inspection.

D. Bedding: PVC pipe shall be bedded on material free from rock particles greater than 1/2-inch diameter in such a way as to support the full barrel length. If natural bedding materials do not meet these requirements or will not provide adequate pipe support, overexcavate and place a minimum of 4 inches of tamped sand to provide pipe support.

E. Backfilling: After the pipe is bedded and successfully initially tested as described under Section 6.F, the pipe shall be covered with 6 to 8 inches of soil free of rocks, debris, or particles larger than one-half inch. This initial backfill layer shall be tamped to restrain the pipe during high pressure testing, and to act as a cushion for final backfill.

After successfully passing the high pressure test, the initial soil cover shall be compacted on both sides of the pipe, with special care at the pipe haunches. Material placed at pipe joints shall not be compacted. Final backfill shall not contain any large sharp rocks in the first 18 inches that could penetrate the initial cushioning layer. Afterwards, the remaining backfilling will be accomplished according to Specification 35-0203.

F. Testing: After the pipe is bedded, an initial hydrostatic test shall be conducted at 10% of maximum test pressure, not to exceed 50 psi, to ascertain any initial leakage. Solvent-cemented joints shall have dried a specified period of time dependent on the surface temperature. After a successful initial test, sufficient backfill shall be placed as mentioned above to prevent pipe movement during subsequent high pressure testing.

The high test pressure shall be between 1.2 and 1.5 times the maximum operating pressure or the design pressure rating, whichever is lower.

The high pressure test shall be conducted for a period of not less than 2 hours. To successfully pass the high pressure test, the volume of water required to maintain the test pressure shall not exceed the amount calculated by the equation:

$$L = \frac{ND\sqrt{P}}{7400}$$

where L = Make-up water (gal/hr)
N = Number of joints in the tested line
D = Nominal pipe diameter (in)
P = Average test pressure (psi)

When testing sections of line having more than one pipe size, the allowable leakage shall be computed by applying the above equation to each section of pipe having a different diameter, then summing the allowable leakages for each pipe section.

Test records shall be delivered to an Army representative by MKE, Inc.

In the event that low temperatures make testing with water impractical, an equivalent air test will be allowed.

SPECIFICATION 35-1511

MANHOLES

CLIENT: SHELL OIL COMPANY

PROJECT: NORTH BOUNDARY RECHARGE TRENCHES - WEST

LOCATION: ROCKY MOUNTAIN ARSENAL, COMMERCE CITY, CO

CONTENTS

SPECIFICATION 35-1511

MANHOLES

1. SCOPE

   A. This specification section covers the furnishing and installing of ten (10) each precast concrete eccentric cone manholes that shall be located to serve the ten (10) each North Boundary Recharge Trenches, and one (1) manhole that will be used to house the 3-inch flowmeter.

   B. The trench and manhole locations are shown on MKE, Inc. drawing sheets 4, 5, and 6, and a typical manhole is shown on sheet 7.

2. RELATED WORK

   A. Related work is covered under other specification sections:

      1) Site Preparation and Grading (Section 34-0202)

      2) Excavating and Backfilling (Section 34-0203)

      3) Piping and Instrumentation (Section 35-1501)

3. REFERENCE STANDARDS

   A. Organizations whose standards are referenced herein include the following:

      ASTM - American Society for Testing and Materials

   B. Any reference to the above standards shall be the edition in effect as of the date of this specification unless stated otherwise.

4. MATERIALS

   A. Gray Iron Castings (rated for H-20 load). ASTM A48-83, Class 35B.

   B. Grout: Non-shrink, nonmetallic, non-corrosive: Five Star Grout (U.S. Grout Co.), or as approved by the Engineer.

   C. Precast Concrete Units: ASTM C478.

   D. Aluminum Cover.

   E. Butyl Resin Mastic as manufactured by Concrete Sealant, KT Snyder (Ramnek), or approved equal.

5. INSTALLATION

A. Manholes:

1) Excavate earth to a minimum of 8 inches below required manhole base elevation, then fill and level gravel up to the required manhole base elevation. The gravel shall be as specified for the Recharge Trenches.

2) Set the manhole cylindrical base portion atop the leveled gravel fill on the pre-established centerline. Be certain that the pipe inlet and outlet openings in the manhole sidewall are properly aligned for the pipelines.

3) Join the concentric cone to the cylindrical base with cold applied bituminous joints sealant.

D. Piping and Instrumentation

1) Refer to Specification 35-1501.

2) Install watertight non-shrink grout between manhole openings and the inlet and outlet pielines.

SPECIFICATION 34-0301

CAST-IN-PLACE CONCRETE

CLIENT: SHELL OIL COMPANY

PROJECT: NORTH BOUNDARY RECHARGE TRENCHES - WEST

LOCATION: ROCKY MOUNTAIN ARSENAL, COMMERCE CITY, CO

CONTENTS

SPECIFICATION 34-0301

CAST-IN-PLACE CONCRETE

1. SCOPE

A. The cast-in-place concrete requirements consist only of the various non-reinforced thrust blocks and supports for piping installed underground, and the concrete caps and aprons at piezometers, and the concrete used in constructing the steel protective posts as shown on the design drawings.

B. This very brief specification applies only for the above said type of work. In the event that other more extensive cast-in-place concrete becomes necessary, other appropriate specifications would be issued.

2. RELATED WORK

A. The following related work is covered in other sections of the specifications:

1) Excavating and Backfilling (Specification 34-0203).

2) Manholes (Specification 35-1511).

3) Piping and Instrumentation (Specification 35-1501).

3. REFERENCE STANDARD

A. Organizations whose standards are referenced herein include the following:

ACI - American Concrete Standard

ASTM - American Society for Testing and Materials

B. Any references to the above standards shall be the edition in effect as of the date of this specification unless otherwise stated.

4. GENERAL

A. Shop Drawings: None are required and none will be furnished. Cast-in-place concrete shall be located and sized as required by the design drawings.

B. Earth Compaction: The earth upon which each of the concrete thrust blocks will bear shall be undisturbed soil.

5. MATERIALS

A. Concrete: 3,000 psi or commercial dry mix for pouring small quantities.

B. Portland Cement: ASTM C150, type I.

C. Sand: ASTM C144, Washed natural sand, free from impurities.

D. Aggregate: Washed natural aggregate maximum 1/2" size, free from impurities.

E. Water: Free of deleterious amounts of acids, alkalis, and organic materials.

6. FINISH

A. Trowel finish the concrete aprons at piezometers.

SPECIFICATION 22-3227

TRENCH PIEZOMETERS

CLIENT: SHELL OIL COMPANY

PROJECT: NORTH BOUNDARY RECHARGE TRENCHES - WEST

LOCATION: ROCKY MOUNTAIN ARSENAL, COMMERCE CITY, CO

CONTENTS

SPECIFICATION 22-3227

TRENCH PIEZOMETERS

1. GENERAL

A. This specification covers all piezometers located within the recharge trenches. Two piezometers shall be located in each trench as shown on the drawings.

B. Generally, the required work and materials include furnishing and placing or driving the piezometer screen and conductor pipe, concrete around the upper 3 feet of the conductor pipe and concreting a surface pad.

The Contractor will provide all required equipment, labor, and materials. MKE will provide professional supervision in the field.

MKE Health and Safety procedures are set forth in the Health and Safety Plan. The Contractor will be required to follow and employ above procedures.

2. REFERENCE STANDARDS

A. Organizations whose standards are referenced herein include the following:

ASTM - American Society for Testing and Materials

B. Any reference to the above standards shall be the edition in effect as of the date of this specification unless stated otherwise.

3. MATERIALS

A. Cement shall meet the requirements of ASTM C150 Type I or V. Cement shall be compatible with existing ground water. Type V cement shall be used if the sulfate (S04) concentration exceeds 1500 mg/l.

B. Casing and Piezometer Screen. The well point shall be 1-1/4" in diameter, 36 inches in length. It shall be of stainless steel with Number 60 gauze. The blank casing above the well point will be 1-1/4" galvanized steel pipe, threaded to the well point. The protective casing shall be Schedule 40 steel pipe.

4. TRENCH PIEZOMETER CONSTRUCTION

A. See MKE Drawing Sheet 7 for design details of trench piezometers.

B. The construction procedure and design of the piezometer may vary, depending upon the method used to place gravel in the trench. If feasible, the bottom of the screen will be placed on the bottom of the trench and gravel backfilled around it. If that is infeasible, the piezometer shall be placed atop the first lift of gravel and driven into the gravel, to the bottom of the trench if possible.

C. Capping of Piezometers

Each piezometer shall be equipped with a 4-inch diameter steel pipe casing embedded into the concrete as shown in the drawings. Locking covers to prevent unwarranted access to the piezometer shall be installed.

Any piezometer that will be left uncompleted for a period of greater than eight hours, shall be capped by the Subcontractor with a watertight cap and equipped with some type of "vandal proof" cover satisfying the Engineer and applicable state or local regulations.

The top of the piezometer shall be protected from the inflow of surface water by a concrete cap and apron as shown on the drawings.

SPECIFICATION 22-3226

DRILLED PIEZOMETERS

CLIENT: SHELL OIL COMPANY

PROJECT: NORTH BOUNDARY RECHARGE TRENCHES - WEST

LOCATION: ROCKY MOUNTAIN ARSENAL, COMMERCE CITY, CO

CONTENTS

SPECIFICATION 22-3226

DRILLED PIEZOMETERS

1. GENERAL

A. This specification covers all drilled piezometers and associated work as required by the applicable drawings and as specified herein.

B. Generally, required work and materials include: drilling of piezometer holes and furnishing and installing well points and conductor pipe, filter pack, bentonite pellets, bentonite and cement grout, concrete for a surface pad, and protective casings.

C. The contractor will auger, soil sample, and construct 10 (ten), 1-1/4 inch diameter piezometers adjacent to the North Boundary Recharge Trenches - West at points designated on the design drawings. Piezometers will be within unconsolidated alluvial deposits.

The driller will provide all required equipment, labor, and materials. MKE will also provide a professional geologist for field supervision.

The drilling may result in contact with contaminated ground water. It is MKE's understanding that the degree of hazard associated with the effort is relatively low. Ingestion by breathing or swallowing sprays/mists from, or dermal irritation by contact with, contaminated ground water appear to be the most likely avenues for personal exposure. These potential occurrences can be readily anticipated, recognized, and avoided. Refer to Health and Safety Plan for further information.

MKE health and safety procedures are set forth in the Health and Safety Plan. The Contractor will be required to follow and employ these procedures. Entrance and exit physicals may be required and, if so, will be provided by MKE at no cost to the contractor.

2. REFERENCE STANDARDS

A. Organizations whose standards are referenced herein include the following:

ASTM - American Society for Testing and Materials

B. Any reference to the above standards shall be the edition in effect as of the date of this specification unless stated otherwise.

3. MATERIALS

A. Cement shall meet the requirements of ASTM C150 Type I or V. Cement shall be compatible with existing ground water. Type V cement shall be used if the sulfate (SO_4) concentration exceeds 1500mg/1.

B. Neat cement grout shall be a mixture of one sack of Portland cement (94 pounds) to 5 to 6 gallons of water. Commercially processed bentonite clay, 4 to 6 percent by weight, shall be added to the neat cement grout.

C. Casing and Piezometer Screen. The well point shall be 1-1/4" in diameter, 36 inches in length. It shall be of stainless steel with Number 60 gauze. The blank casing above the well point will be 1-1/4" galvanized steel pipe, threaded to the well point. The protective casing shall be Schedule 40 steel pipe.

4. CONSTRUCTION

A. See Drawing Sheet 8 for design details of the piezometers.

B. Piezometer Construction

The standard procedure for constructing a piezometer will be to drill a minimum 4-inch hole to bedrock surface as determined by the MKE geologist in the field with hollow-stem auger.

C. Sand Filter

After the casing and the screen have been installed in their proper position to the full depth of the well, an envelope of siliceous sand filter ranging from 10 to 30 mesh in size shall be placed in the annular space between the well bore and the casing/screen. The filter material shall extend a minimum of 2 feet above screen sections.

Materials used for the filter shall be clean and washed. The filter shall be tremied or placed in a manner to minimize segregation.

D. Bentonite Pellets

A transition zone consisting of bentonite pellets shall be placed immediately above the sand/gravel filter as shown in the drawing. The pellets shall be placed in such manner as is approved by the Engineer.

E. Grouting

To protect the piezometer against the entry of unwanted water and contaminants from the surface, the annular space between the casing and the bore hole shall be grouted from the top of the bentonite transition zone to approximately 3 feet from the ground surface. Grout material shall be placed in a manner approved by the Engineer. Grout shall be placed in one continuous operation. The grout shall consist of a

mixture of Portland cement and 4% to 6% bentonite. Other admixtures to reduce permeability, increase fluidity, and control time of set and the composition of the resultant slurry shall be as approved by the Engineer.

F. Capping of Piezometers

Each piezometer shall be equipped with a 4" diameter steel pipe casing embedded into concrete as shown on the drawings. Locking covers to prevent unwarranted access to the piezometer shall be installed.

Any piezometer that will be left uncompleted for a period of greater than eight hours, shall be capped by the Subcontractor with a watertight cap and equipped with some type of "vandal proof" cover satisfying the Engineer and applicable state or local regulations of recommendations.

The top of the piezometer shall be protected from the inflow of surface water by a concrete cap and apron as shown on the drawings.

G. Abandonment

Should the Subcontractor elect or be required to abandon a piezometer, he shall grout the abandoned hole.

H. Disposal of Materials

Debris, rubbish, and other materials resulting from drilling operations shall be removed from the site, and the site shall be left in a neat presentable condition.

SPECIFICATION 37-1601

ELECTRICAL WORK

CLIENT: SHELL OIL COMPANY

PROJECT: NORTH BOUNDARY RECHARGE TRENCHES - WEST

LOCATION: ROCKY MOUNTAIN ARSENAL, COMMERCE CITY, CO.

CONTENTS PAGE

SPECIFICATION 37-1601

ELECTRICAL WORK

1. SCOPE

A. This specification and applicable drawings cover the furnishing and installing of electrical work as required by the drawings and as specified herein.

2. REFERENCE STANDARDS

A. All equipment, materials, construction and installation shall be in accordance with the following applicable codes and standards:

1) ANSI - American National Standards Institute

2) NEMA - National Electrical Manufacturers Association

3) NFPA/NEC - National Fire Protection Association/ National Electrical Code

4) Applicable State of Colorado Electrical, Building, Energy, Fire, and Safety Codes

5) Local codes

3. RELATED WORK

A. Several items of work are specified in other specifications and are not included in the work covered by this specification.

1) Excavating and Backfilling (Specification 34-0203)

2) Manholes (Specification 35-1511)

3) Piping and Instrumentation (Specification 3-1501)

4. GENERAL REQUIREMENTS

A. In the event of any discrepancy between one drawing and another or between the drawings and this specification, the Contractor shall bring such discrepancies to the attention of the Engineer for a ruling.

B. It shall be the Contractor's responsibility to assure that all requirements of inspection authorities are complied with.

C. Names of approved manufacturers are listed in this specification to establish a standard of quality. Products of other manufacturers may be used with the approval of the Engineer.

5. REQUIRED ITEMS OF WORK

A. The work involved shall be in accordance with the following:

1) The drawings for construction and their references.

2) The contents and references of this specification.

3) The installation instructions of the manufacturers of equipment or materials supplied to the Contractor for installation.

B. All electrical systems, both above grade and below grade, shall be completed as outlined on the drawings and in this specification, and be ready for use.

C. Labor and materials which are necessary for the completion and satisfactory operation of the electrical installation shall be furnished.

6. WIRE AND CABLE METHODS

A. General: As required by the drawings, all power and control wiring shall be furnished and installed unless otherwise specified, and shall meet NEC standards for wire, cable and workmanship.

B. 600-V Conductors: All single conductor wiring for power installed in conduit for operating at 600 V or below shall be UL approved stranded soft annealed copper, type XHHW or THHN.

C. Telephone Cable: Cable shall consist of No. 22 AWG solid annealed copper conductors twisted in pairs; each conductor shall have polyethylene insulation. The cable shall have an overall copper shield and polyethylene jacket. Cable shall be Anixter telephone cable Type PE-22 or approved equal.

7. CONDUIT AND CONDUIT FITTINGS

A. General: Conduit sizes, type and length shall be furnished and installed as required by the drawings and meet the latest edition of the NEC.

B. Materials:

1) Conduit:

a) Rigid Galvanized Steel Conduit (RGS) shall conform to ANSI C80.1 and be standard weight, mild rigid steel, hot-dipped

galvanized with inside and outside finished with a protective zinc coating. Couplings, elbows and bends shall meet these same requirements. Fittings shall be of the threaded type.

b) Flexible Conduit shall be liquid-tight with an integral grounding conductor, per ANSI/UL 360, Anaconda Sealtite type UA or equal.

2) Boxes and fittings:

a) Exposed Work: All conduit fittings, junction and device boxes shall be cast Type FS or FD with threaded hubs, steel covers and gaskets for use with RGS.

b) For weatherproof locations, proper sealing gaskets in addition to self-closing hinged lids for replacement covers shall be provided.

c) Gasket material for conduit fittings and boxes shall be neoprene or other approved plastic.

C. Installation:

1) Above Grade Conduit System:

a) Field bends and offsets shall be uniform and symmetrical, without conduit flattening or finish scarring. Field bends shall be made with standard tools and equipment manufactured specifically for conduit bending. Minimum bend radii shall be as required by the NEC, but in no case less than six times conduit diameter.

b) All conduit ends shall be cut square, properly threaded and reamed. All connections shall be made up tight, engaging not less than five threads, and coated with approved thread compound.

c) Pull fittings or boxes shall be installed wherever necessary on conduit systems to facilitate pulling wire and cables and shall be in accessible locations.

d) Open ends of conduit shall be carefully plugged or capped during construction to prevent the entrance of foreign materials or moisture into the conduit. Before pulling wire or cable into the conduit system, a swab shall be drawn through the entire length of the conduit to remove any moisture, metal cuttings or other foreign material.

e) Where conduit enters through exterior walls, the entrance shall be made water-tight.

f) Outside above grade conduit runs that are extended below grade shall e provided with drain-seal fittings in a vertical drop directly above grade.

g) Conduit connections to flowmeters shall be liquid-tight flexible steel conduit with suitable fittings.

h) All steel conduit joints shall be weatherproof, using suitable metal oxide for joint makeup.

i) In wet areas indoors and areas subject to washdown, the entire wiring system, boxes, conduit, and fittings must be mounted so that 1/4 inch space exists between system and supporting surface.

j) At all entrances to panelboards, pull boxes or outlet boxes (without threaded hubs or bases), conduit runs shall be secured in place by a galvanized locknut with an O-ring seal outside the box and a locknut and bushing on the inside. Bushings shall be of the insulating type. NEMA 1 panelboards, pull boxes, etc., shall be secured in place by a galvanized locknut outside the box and a locknut and bushing inside. Bushings shall be of the insulating type.

k) Exposed conduit shall be rigidly maintained and fastened to structural steel by means of an approved clamp or device made for this purpose. On masonry structures, conduits shall be fastened with one-hold conduit clamps and backstrips with flush anchors. The type of conduit support will depend on the type of construction, and/or details as indicated on drawings. Pull boxes shall be rigidly supported with structural steel supports.

l) All steel bolts, nuts, washers and screws shall be galvanized or cadmium plated.

m) Conduit bodies Type "LB," "LR," "LT," etc., shall not be used as splice boxes.

n) Conductor supports shall be in accordance with the NEC and the method of support shall be approved in writing by the Engineer.

2) Conduit in Contact with Earth:

a) Conduit in direct contact with earth shall be galvanized steel.

b) Conduits shall be installed at least 30 inches below grade on undisturbed ground at the bottom of the trench after the trench has been smoothed and tamped.

c) Conduit bending radii shall be as large as possible and shall be not less than eight times nominal conduit diameter, and free from flats, kinks or damage.

d) Conduit installation shall follow excavating as closely as possible. Conduit shall be installed in dry trenches maintained free of accumulated water.

e) Conduit runs shall be kept closed at all times using pipe caps or plugs.

f) Steel conduit ends shall be cut square, properly threaded and reamed. All connections shall be made up tight, engaging not less than five threads and coated with approved thread compounds.

g) After conduits are in place, backfill and compact fill to a depth of 10 to 12 inches above conduits as specified in drawings and Specification 34-0203. Install a continuous warning strip of red plastic in the excavation and continue backfill per specifications.

h) Conduits in the same trench shall have a minimum horizontal and vertical separation of three inches.

8. GROUNDING SYSTEM

A. Flowmeter analyzer shall be grounded as required by the manufacturer.

B. The telephone cable shield shall be grounded by means of a grounding electrode as required per NEC. The shield shall be grounded only at one end to prevent leakage current loops.

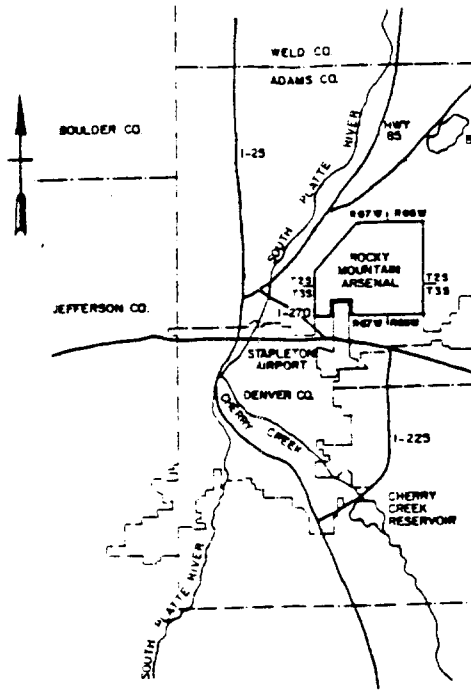
9. AS-BUILTS

A. One (1) complete set of drawings issued for this contract shall be maintained exclusively for record purposes by the Contractor and all changes and modifications shall be shown and noted thereon in red color. Supplemental drawings or sketches may be added. Dimensions, clearances, sizes and significant references shall be added.

B. Drawings shall be kept neat and clean and shall be available at all times for reference. All sketches, notes and data shall be sufficiently clear to permit photo reproductions when needed.

NORTH BOUNDARY RECHARGE T

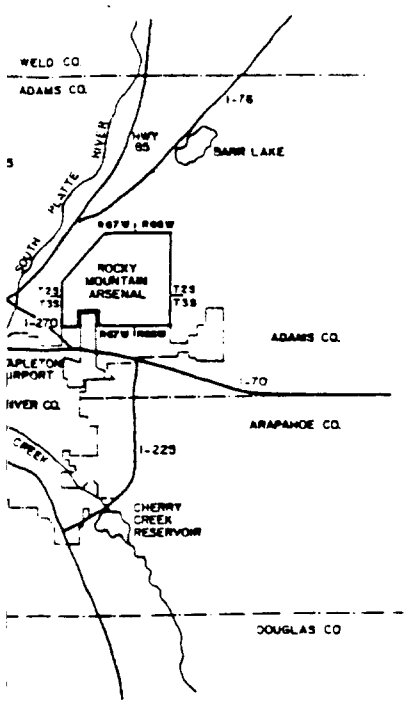
ROCKY MOUNTAIN ARSENAL



INDEX

ECHARGE TRENCHES-WEST

ADAMS COUNTY, COLORADO



ROCKY MOUNTAIN ARSENAL

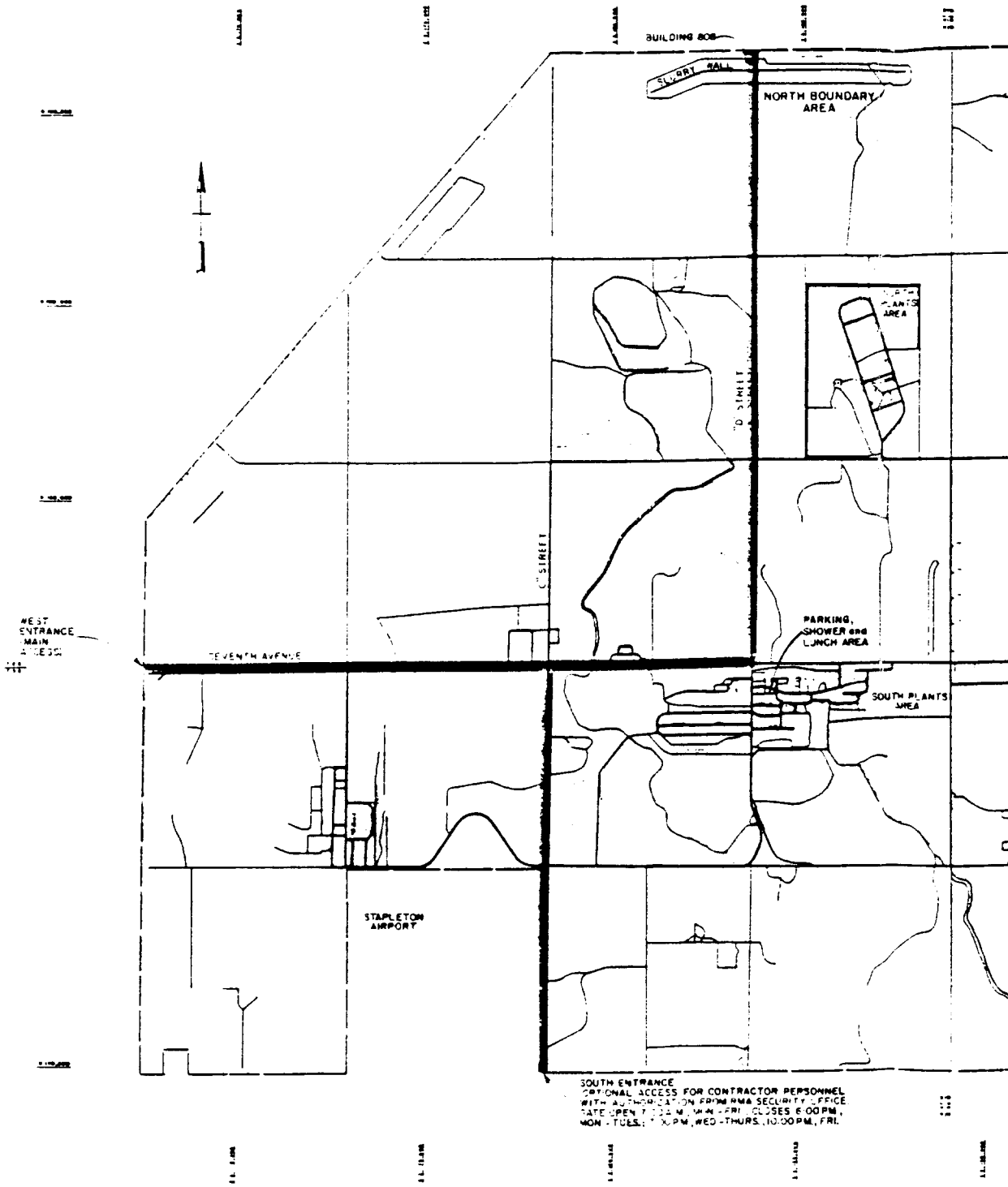
NORTH BOUNDARY RECHARGE TRENCHES-WEST

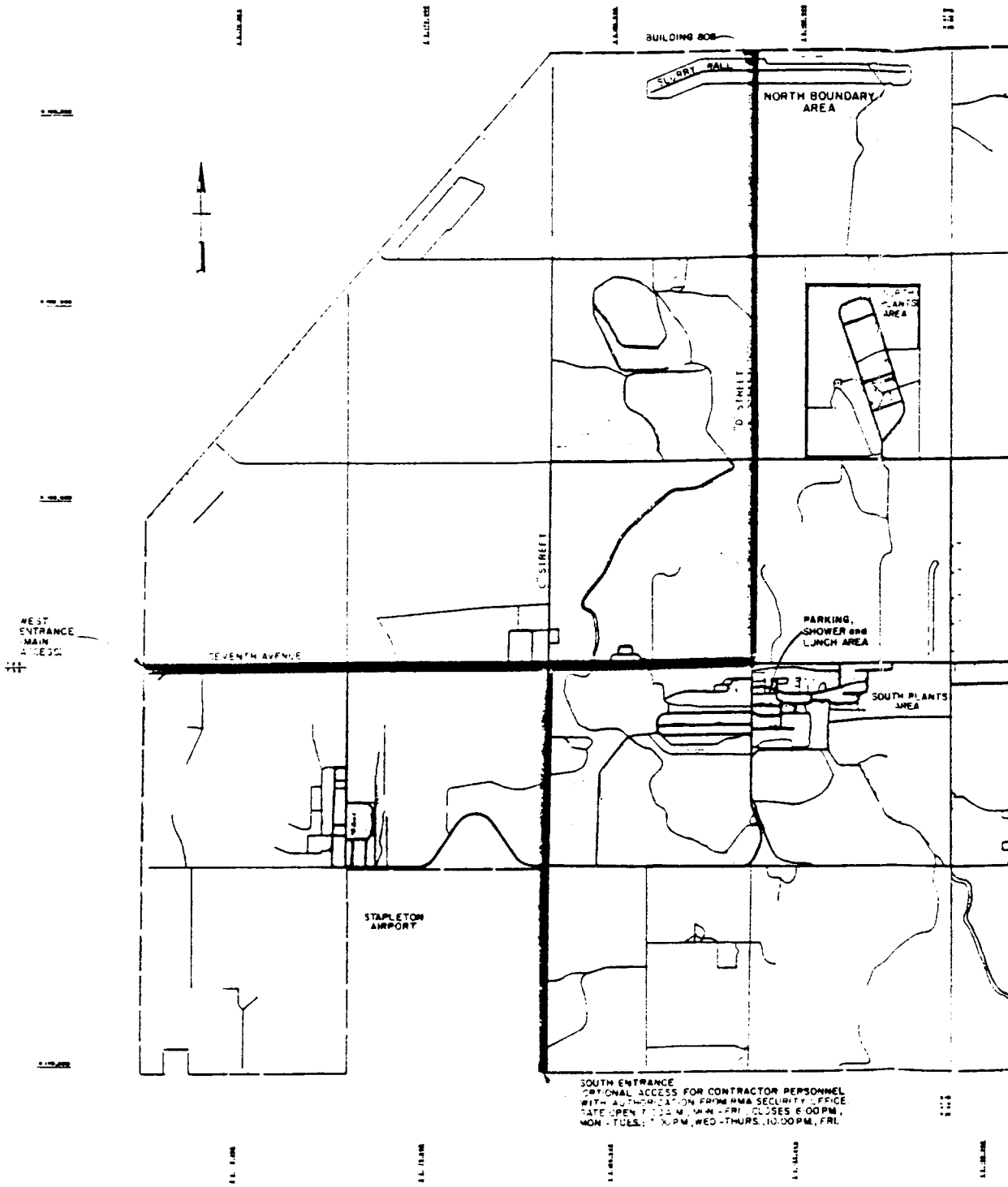
COVER SHEET

Drawn By:	Date:	Review		SHEET 1 OF 9
App'd. By:		Date:		
Design By:		Dwg. No.:		
App'd. By:				

MORRISON-KNUDSEN ENGINEERS, INC.

1700 Broadway, Suite 1600
Denver, Colorado 80290


BUILDING 806
SLURRY WALL
NORTH BOUNDARY AREA
D STREET
C STREET
WEST ENTRANCE MAIN ACCESS
SEVENTH AVENUE
PARKING, SHOWER and LUNCH AREA
SOUTH PLANTS AREA
STAPLETON AIRPORT
SOUTH ENTRANCE
OPTIONAL ACCESS FOR CONTRACTOR PERSONNEL
WITH AUTHORIZATION FROM RMA SECURITY OFFICE
GATE OPEN 7:00 A.M., MON.-FRI. CLOSES 6:00 PM.,
MON.-TUES. 7:00 P.M., WED.-THURS. 10:00 P.M., FRI.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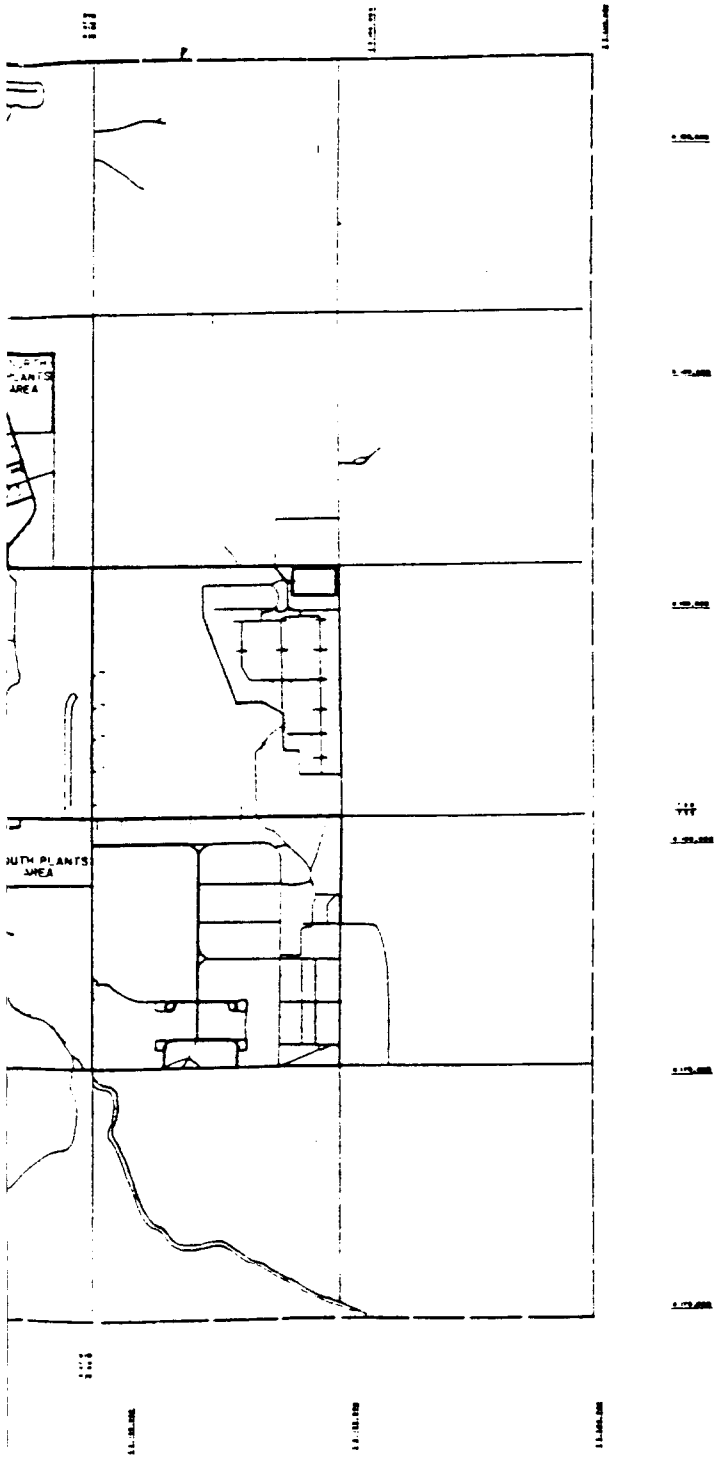
MON.-TUES.; 7:00 P.M., WED.-THURS., 10:00 PM., FRI.

LEGEND

	CONTRACTOR ACCESS
	PRIMARY ROAD
	SECONDARY ROAD
	TERTIARY ROAD

ROCKY MOUNTAIN ARSENAL BOUNDARY



REFERENCE
U.S. ARMY ENGINEER DISTRICT, OMAHA
CORPS OF ENGINEERS, OMAHA, NEBRASKA
MASTER PLAN, BASIC INFORMATION MAPS
GENERAL ROAD MAP
JUNE 1984, DWG NO 18-02-04, SHEET 3 OF 71

REVISION

NO.	BY	DATE	CKD	DESCRIPTION
C	DM	7-[illegible]	[illegible]	ISSUED FOR PARTIES' APPROVAL
B	AL	10-1-87	MC	ISSUED FOR CLIENT APPROVAL
A		[illegible]		ISSUED FOR REVIEW

ROCKY MOUNTAIN ARSENAL

NORTH BOUNDARY RECHARGE TRENCHES-WEST

CONTRACTOR ACCESS

Drawn By:	Date	Shown on Sheets	SHEET 2 OF 9
App'd. By:	7/1987	Date	
Design By:	Date	Dwg. No.	
App'd. By:	7-1987		

MORRISON-KNUDSEN ENGINEERS, INC.
A MORRISON KNUDSEN COMPANY
1700 Broadway, Suite 1600
Denver, Colorado 80290

0-037

NOTES

1. INFORMATION FOR THE TOPOGRAPHY, BOREHOLES, WELLS, AND BEDROCK IS FROM THE FOLLOWING SOURCES.
   - o BLACK AND VEATCH. 1980. "LIQUID WASTE DISPOSAL FACILITY, ROCKY MOUNTAIN ARSENAL," U.S. ARMY ENGINEER DISTRICT, OMAHA, NEBRASKA. DACA 45-80-R-0161. DESIGN DRAWINGS REVISED TO SHOW "AS BUILT" CONDITIONS, 4-12-82. DACA45-81-C-0054.
   - o DEPARTMENT OF THE ARMY. 1977. DESIGN DRAWINGS FOR THE "PILOT CONTAINMENT/TREATMENT SYSTEM," ROCKY MOUNTAIN ARSENAL, COMMERCE CITY, COLORADO 80022.
   - o DEPARTMENT OF THE ARMY. USATHAMA COMPUTERIZED DATA BASE, ABERDEEN PROVING GROUND, MARYLAND.
2. WATER LEVEL INFORMATION IS FROM:
   - o WATERWAYS EXPERIMENT STATION. 1987. "NORTH BOUNDARY CONTAINMENT TREATMENT SYSTEM, WATER TABLE ELEVATION MAP, FT., AUG. 1986 (FOURTH QTR. FY 86)," DEPARTMENT OF THE ARMY, ROCKY MOUNTAIN ARSENAL, COMMERCE CITY, COLORADO. PLATE 8.
3. THE PROFILES AND TOPOGRAPHY WERE DRAWN FROM BLUE LINE PRINTS PROVIDED BY THE ROCKY MOUNTAIN ARSENAL. THERE IS SOME DEVIATION FROM A TRUE SCALE.

SOIL CLASSIFICATIONS

MOST USCS CLASSIFICATIONS ARE BASED ON VISUAL INTERPRETATIONS

LETTER	DESCRIPTION
SP	POORLY GRADED SANDS, OR GRAVELLY SANDS, LITTLE OR NO FINES.
SM	SILTY SANDS, SAND-SILT MIXTURES.
SC	CLAYEY SANDS, SAND-CLAY MIXTURES.
ML	INORGANIC SILTS AND VERY FINE SANDS, ROCK FLOUR, SILTY OR CLAYEY FINE SANDS OR CLAYEY SILTS WITH SLIGHT PLASTICITY
CL	INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS

ROCK CLASSIFICATIONS

DESCRIPTION
SANDSTONE, SILTY OR CLAYEY SANDSTONE
SILTSTONE, SANDY OR CLAYEY SILTSTONE
CLAYSTONE, SILTY OR SANDY CLAYSTONE

CLAY CONSISTENCY

CHARACTERISTIC	DESCRIPTION	BLOWS/FT.
SOFT	READILY DEFORMED BY FINGERS WITH LIGHT PRESSURE OR EASILY SQUEEZED THROUGH FINGERS.	<2
MEDIUM STIFF	EASILY DEFORMED BY FINGERS WITH MODERATE PRESSURE, BUT CANNOT BE SQUEEZED THROUGH FINGERS.	2 - 4
STIFF	DEFORMED WITH DIFFICULTY BY FINGERS. A PENCIL JABBED INTO THE SAMPLE WILL PENETRATE AND TEND TO STICK	8 - 15

COMPACTNESS (SILT AND SAND)

CHARACTERISTIC	BLOWS/FT.
LOOSE	<10
MEDIUM DENSE	10 - 30
DENSE	30 - 50
VERY DENSE	>50

ROCK-FRACTURES

CHARACTERISTICS	DESCRIPTION
FRAGMENTED	CORE IN PIECES (BUT NOT MECHANICALLY BROKEN), WHICH WERE TOO SMALL EVEN TO BE MEASURED AS CORE LENGTHS.
CLOSELY FRACTURED	FRACTURES SPACED GENERALLY LESS THAN 0.5 FEET APART.
MODERATELY FRACTURED	FRACTURES SPACED GENERALLY BETWEEN 0.5 FEET AND 1.0 FEET APART

ROCK-HARDNESS

CHARACTERISTIC	DESCRIPTION
SOFT	CAN BE SCRATCHED WITH FINGERNAIL.
FRIABLE	EASILY REDUCED TO CRUMB OR GRAIN WITH MODERATE FINGER PRESSURE.
MODERATELY HARD	CAN BE SCRATCHED EASILY WITH A KNIFE. CANNOT BE SCRATCHED WITH A FINGERNAIL.
HARD	DIFFICULT TO SCRATCH WITH A KNIFE.
VERY HARD	CANNOT BE SCRATCHED WITH A KNIFE.

SYMBOLS

1019 — BORE HOLE NEVER COMPLETED AS A WELL OR OUT OF SERVICE.

259 — BORE HOLE COMPLETED AS A WELL AND STILL IN SERVICE.

23209 — EXISTING MONITOR WELL

▼ ESTIMATED GROUNDWATER LEVEL

N NUMBER OF BLOWS/FOOT FROM STANDARD PENETRATION TEST.

BORE HOLE WAS DRILLED DEEPER THAN SHOWN ON THIS PROFILE.

▲ NEW PIEZOMETER

○ MH MANHOLE

GATE VALVE

● CO CLEAN OUT

ABBREVIATIONS

BOH	BOTTOM OF HOLE
CL	CLOSE(LY)
FT	FEET
FRAG	FRAGMENTED
TOB	TOP OF BEDROCK
W/	WITH

REVISION				
NO.	BY	DATE	CKD	DESCRIPTION
C				ISSUED FOR PARTIES' APPROVAL
B			GC	ISSUED FOR CLIENT APPROVAL
A				ISSUED FOR REVIEW

ROCKY MOUNTAIN ARSENAL

NORTH BOUNDARY RECHARGE TRENCHES-WEST

NOTES

Drawn By	Scale	SHEET 3 OF 9
Appd By	Date	
Design By	Dwg. No.	
Appd By		

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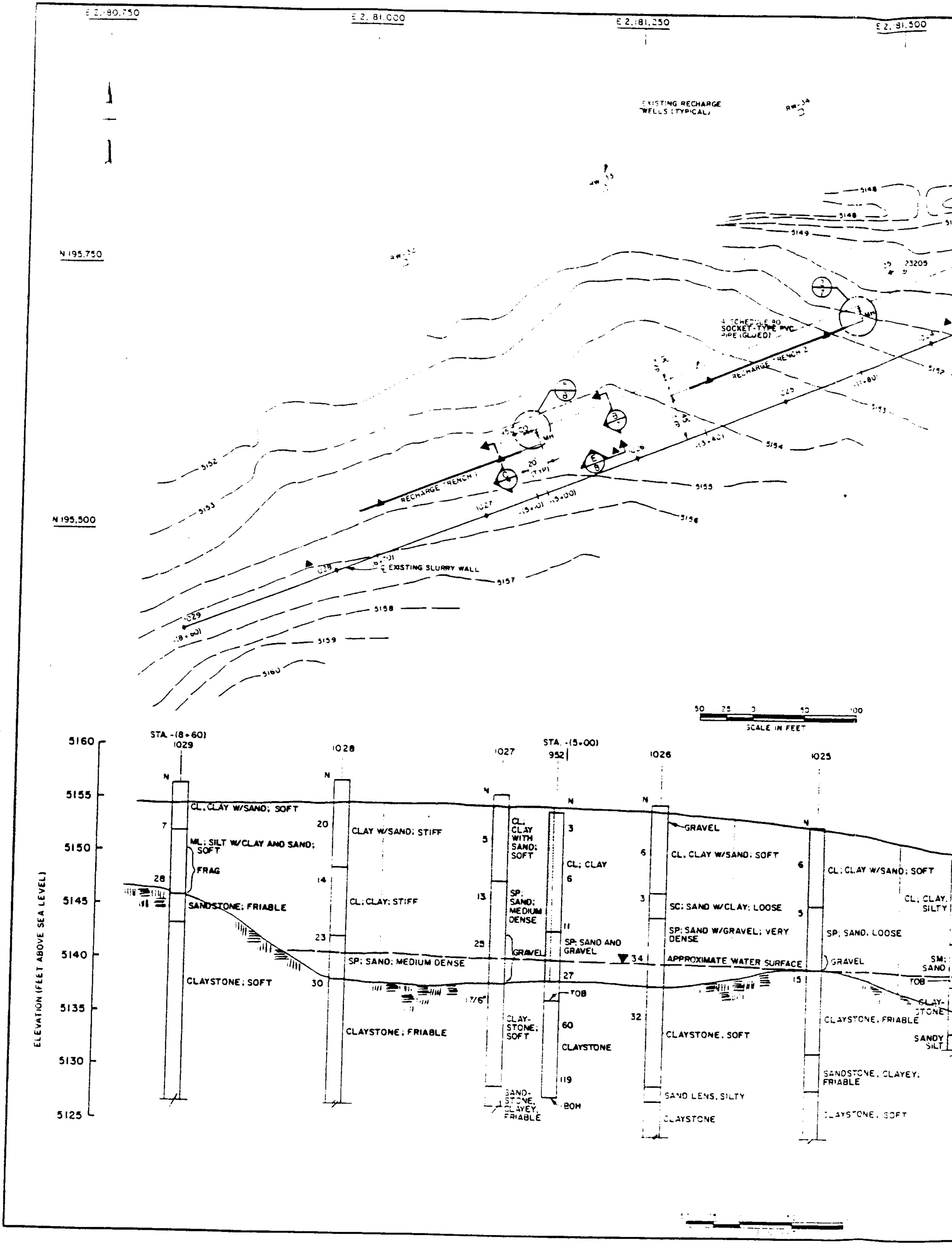
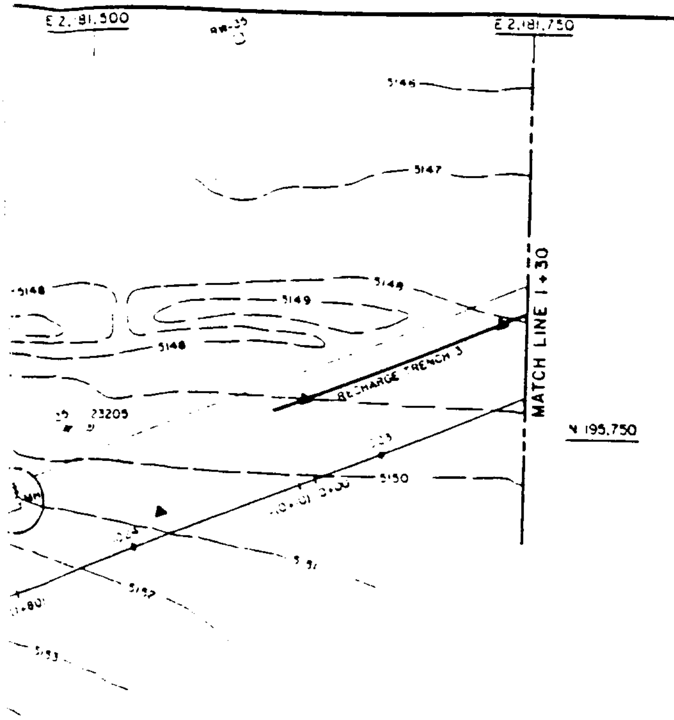


E 2,180,750
E 2,181,000
E 2,181,250
E 2,181,500
N 195,750
N 195,500
EXISTING RECHARGE WELLS (TYPICAL)
4" SCHEDULE 80 SOCKET-TYPE PVC PIPE (GLUED)
RECHARGE TRENCH 2
RECHARGE TRENCH 1
20' (TYP)
EXISTING SLURRY WALL
5148
5149
5152
5153
5154
5155
5156
5157
5158
5159
5160
1025
1026
1027
1028
1029
SCALE IN FEET
50 25 0 50 100
ELEVATION (FEET ABOVE SEA LEVEL)
5160
5155
5150
5145
5140
5135
5130
5125
STA. -(8+60)
STA. -(5+00)
952
CL, CLAY W/SAND; SOFT
ML; SILT W/CLAY AND SAND; SOFT
FRAG
SANDSTONE; FRIABLE
CLAYSTONE; SOFT
CLAY W/SAND; STIFF
CL; CLAY; STIFF
SP; SAND; MEDIUM DENSE
CLAYSTONE; FRIABLE
CL; CLAY WITH SAND; SOFT
SP; SAND; MEDIUM DENSE
GRAVEL
CLAY-STONE; SOFT
SAND-STONE, CLAYEY, FRIABLE
CL; CLAY
SP; SAND AND GRAVEL
TOB
CLAYSTONE
BOH
GRAVEL
CL, CLAY W/SAND; SOFT
SC; SAND W/CLAY; LOOSE
SP; SAND W/GRAVEL; VERY DENSE
APPROXIMATE WATER SURFACE
CLAYSTONE, SOFT
SAND LENS, SILTY
CLAYSTONE
CL; CLAY W/SAND; SOFT
SP; SAND, LOOSE
GRAVEL
CLAYSTONE, FRIABLE
SANDSTONE, CLAYEY; FRIABLE
CLAYSTONE, SOFT
CL, CLAY, SILTY
SM; SAND
CLAY-STONE
SANDY SILT



LEGEND

Symbol	Description
	BORE HOLE WAS NEVER COMPLETED AS A WELL OR OUT OF SERVICE
	BORE HOLE COMPLETED AS A WELL AND STILL IN SERVICE
	EXISTING MONITOR WELL
▼	ESTIMATED GROUND WATER LEVEL
N	NUMBER OF BLOWS/FEET FROM STANDARD PENETRATION TEST
	BORE HOLE WAS DRILLED DEEPER THAN SHOWN ON THIS PROFILE
▲	NEW PIEZOMETER
MH	MANHOLE
	GATE VALVE
CO	CLEAN OUT

ABBREVIATIONS

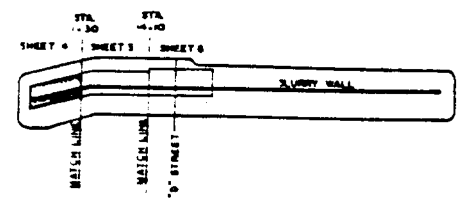
BOH	BOTTOM OF HOLE
CL	CLOSE(LY)
FT	FEET
FRAG	FRAGMENTED
TOB	TOP OF BEDROCK
W/	WITH

NOTES

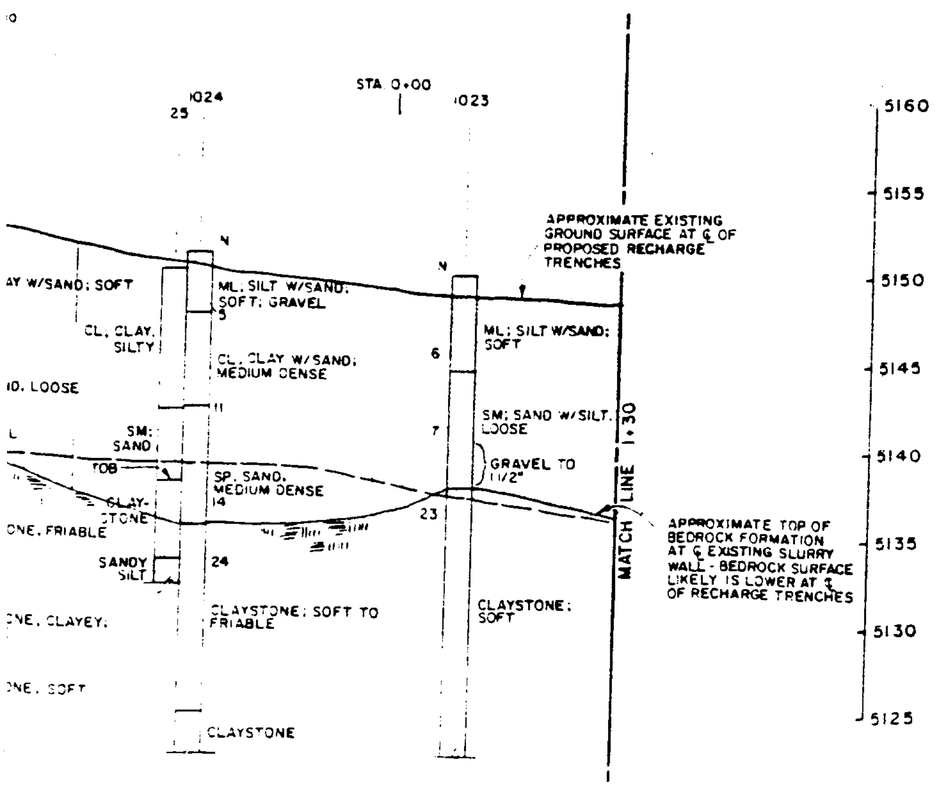
SEE NOTES ON SHEET 3 FOR DESCRIPTIONS OF GEOLOGIC TERMS.

LETTER INDICATES SECTION
NUMBER INDICATES DETAIL

NUMBER OF SHEET WHERE SECTION/DETAIL IS SHOWN.
— INDICATES THAT SECTION/DETAIL IS CUT AND DRAWN ON SAME SHEET



KEY PLAN



REVISION

NO.	BY	DATE	CKD	DESCRIPTION
C	BM	11-15-88		ISSUED FOR PARTIES' APPROVAL
B	AL	12/1/87	GC	ISSUED FOR CLIENT APPROVAL
A				ISSUED FOR REVIEW

ROCKY MOUNTAIN ARSENAL

NORTH BOUNDARY RECHARGE TRENCHES—WEST

PLAN AND PROFILE

Drawn By:	Date	Scale: as shown		SHEET
App'd. By:	11/4/87	Date:		4 OF 9
Design By:	Date			
App'd. By:	11/4/87	Dwg. No.:		

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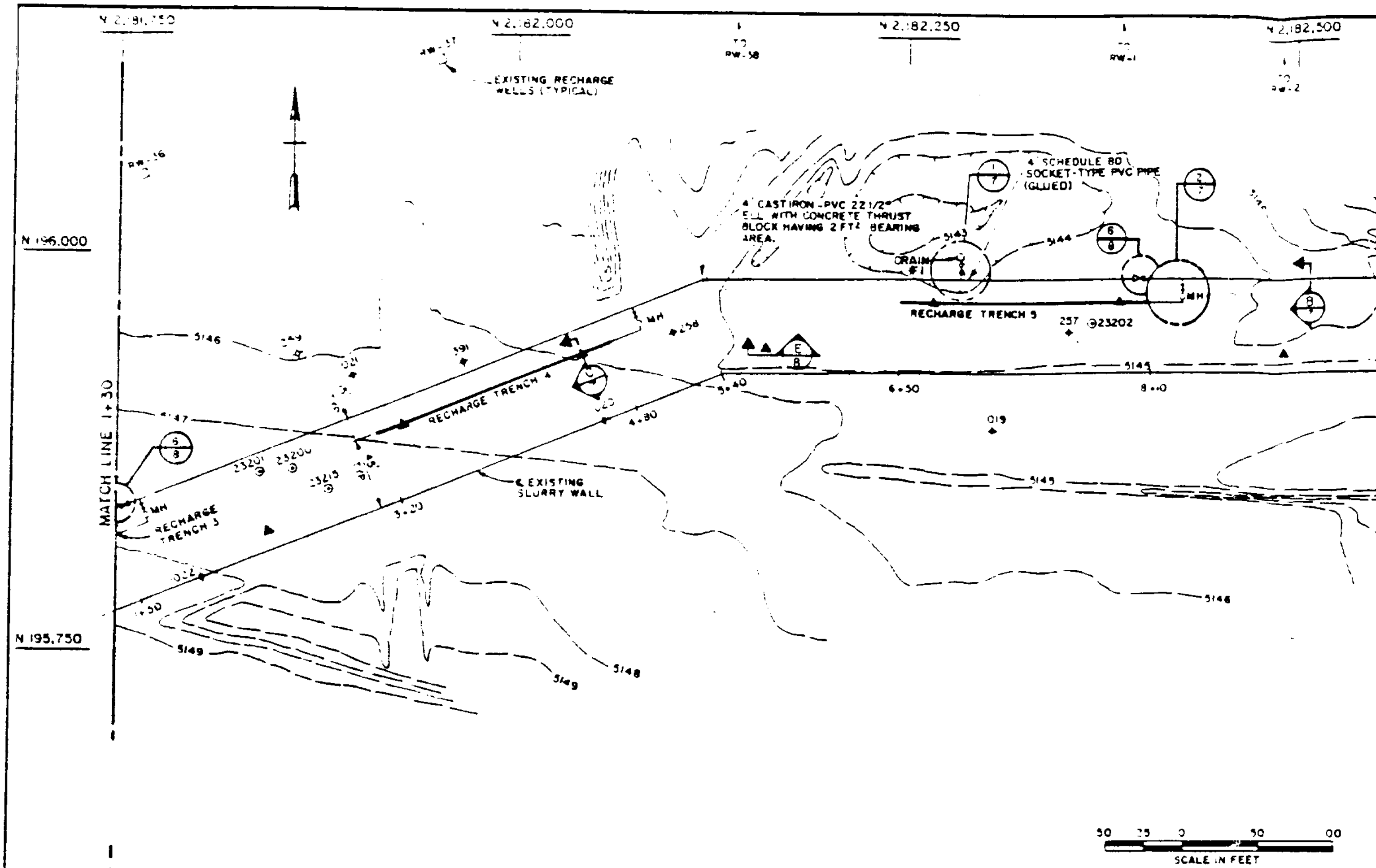
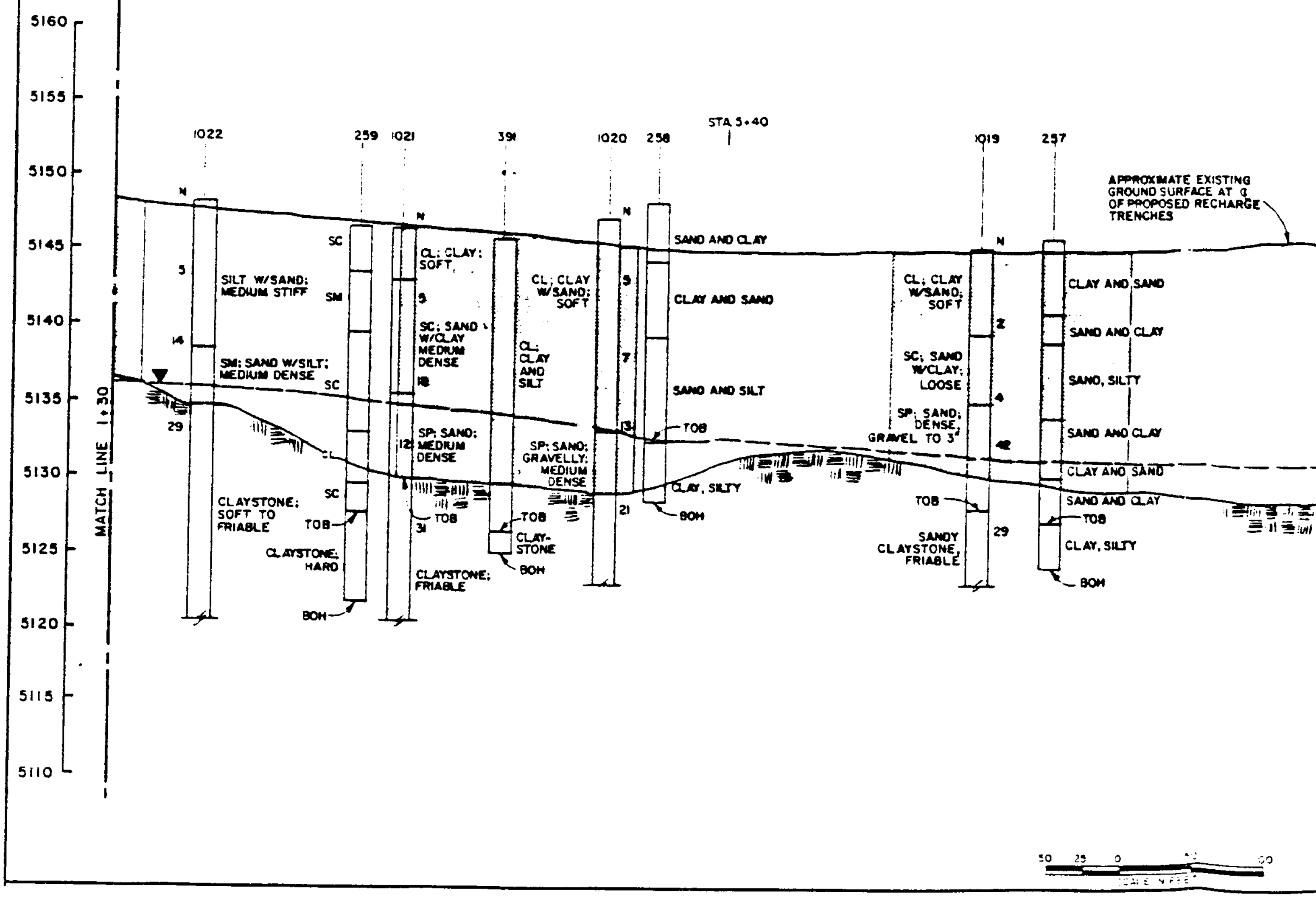
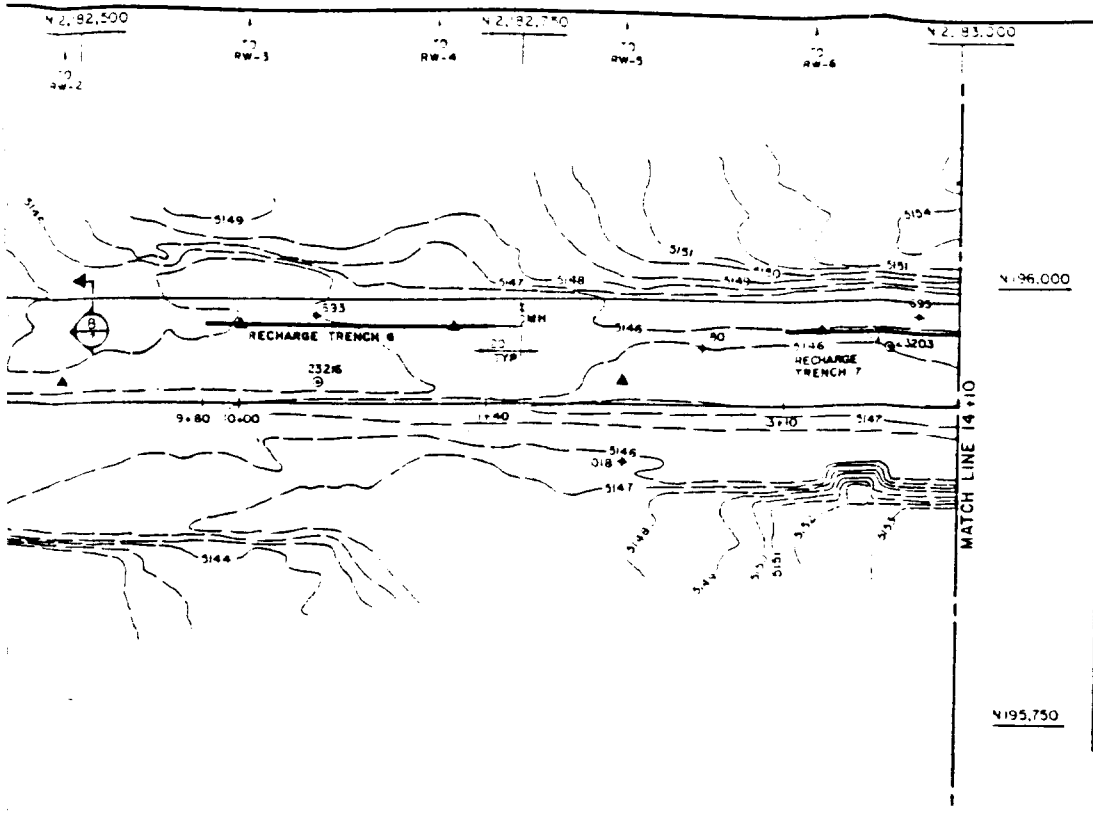

N 2,181,750
N 2,182,000
N 2,182,250
N 2,182,500
EXISTING RECHARGE WELLS (TYPICAL)
RW-58
RW-1
N 196,000
N 195,750
4" SCHEDULE 80 SOCKET-TYPE PVC PIPE (GLUED)
4" CAST IRON - PVC 22 1/2° ELL WITH CONCRETE THRUST BLOCK HAVING 2 FT² BEARING AREA.
DRAIN #1
MH
RECHARGE TRENCH 5
257 ⊙23202
RECHARGE TRENCH 4
RECHARGE TRENCH 3
℄ EXISTING SLURRY WALL
MATCH LINE 1+30
5146
5147
5145
5144
5149
5148
6+50
8+10
5+40
4+80
3+20
1+50
019
391
23201
23200
23215
SCALE IN FEET


5160
5155
5150
5145
5140
5135
5130
5125
5120
5115
5110
MATCH LINE 1+30
STA 5+40
1022
259
1021
391
1020
258
1019
257
APPROXIMATE EXISTING GROUND SURFACE AT ℄ OF PROPOSED RECHARGE TRENCHES
SILT W/SAND; MEDIUM STIFF
SM; SAND W/SILT; MEDIUM DENSE
CLAYSTONE; SOFT TO FRIABLE
CLAYSTONE; HARD
CL; CLAY; SOFT
SC; SAND W/CLAY MEDIUM DENSE
SP; SAND; MEDIUM DENSE
CLAYSTONE; FRIABLE
CL; CLAY W/SAND; SOFT
CL; CLAY AND SILT
SP; SAND; GRAVELLY; MEDIUM DENSE
CLAY-STONE
SAND AND CLAY
CLAY AND SAND
SAND AND SILT
CLAY, SILTY
SC; SAND W/CLAY; LOOSE
SP; SAND; DENSE, GRAVEL TO 3"
SANDY CLAYSTONE, FRIABLE
SAND, SILTY
TOB
BOH
SCALE IN FEET



LEGEND

	BORE HOLE WAS NEVER COMPLETED AS A WELL OR OUT OF SERVICE
	BORE HOLE COMPLETED AS A WELL AND STILL IN SERVICE
	EXISTING MONITOR WELL
▼	ESTIMATED GROUND WATER LEVEL
N	NUMBER OF BLOWS/FEET FROM STANDARD PENETRATION TEST
	BORE HOLE WAS DRILLED DEEPER THAN SHOWN ON THIS PROFILE
▲	NEW PIEZOMETER
MH	MANHOLE
	GATE VALVE
CO	CLEAN OUT

ABBREVIATIONS

BOH	BOTTOM OF HOLE
	CLOSE(LY)
FT	FEET
FRAG	FRAGMENTED
TOB	TOP OF BEDROCK
W/	WITH

NOTES

SEE NOTES ON SHEET 3 FOR DESCRIPTIONS OF GEOLOGIC TERMS.

LETTER INDICATES SECTION
NUMBER INDICATES DETAIL

NUMBER OF SHEET WHERE SECTION/DETAIL IS SHOWN
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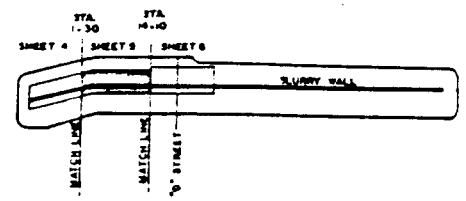
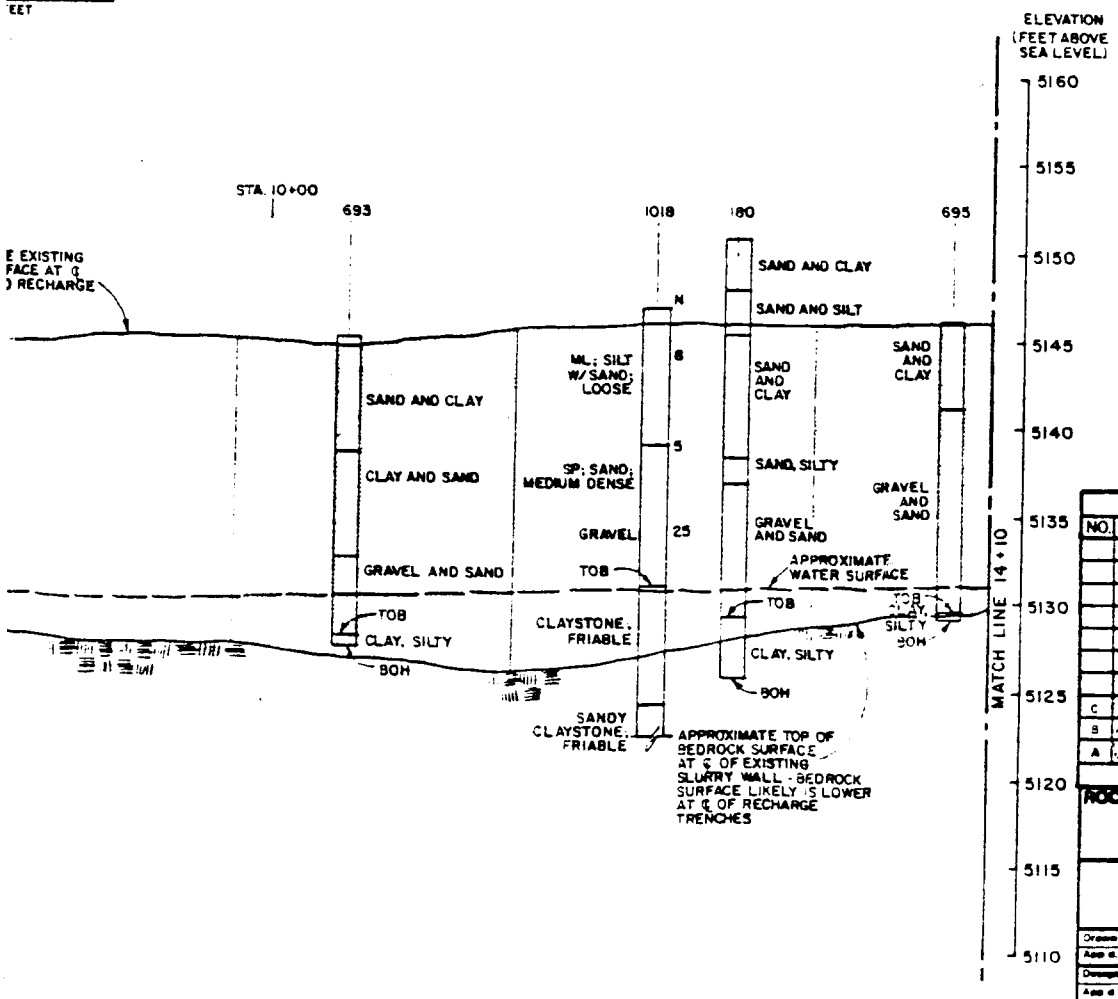


KEY PLAN

50 00
EET



REVISION

NO.	BY	DATE	CKD	DESCRIPTION
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B				ISSUED FOR CLIENT APPROVAL
A				ISSUED FOR REVIEW

ROCKY MOUNTAIN ARSENAL

NORTH BOUNDARY RECHARGE TRENCHES-WEST

PLAN AND PROFILE

Drawn By		Scale: AS SHOWN	SHEET 5 OF 9
App'd. By		Date:	
Design By		Dwg. No.:	
App'd. By			

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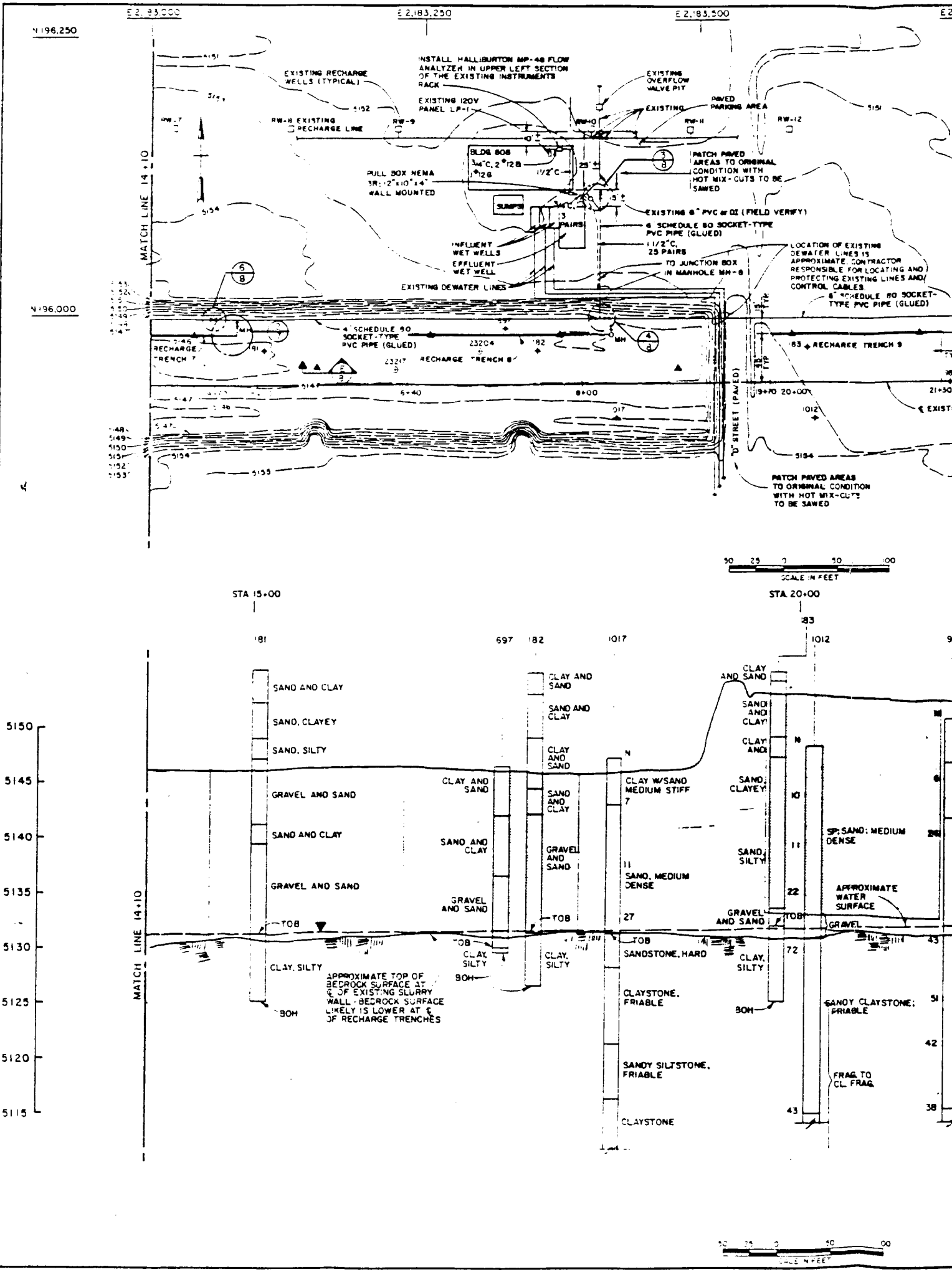
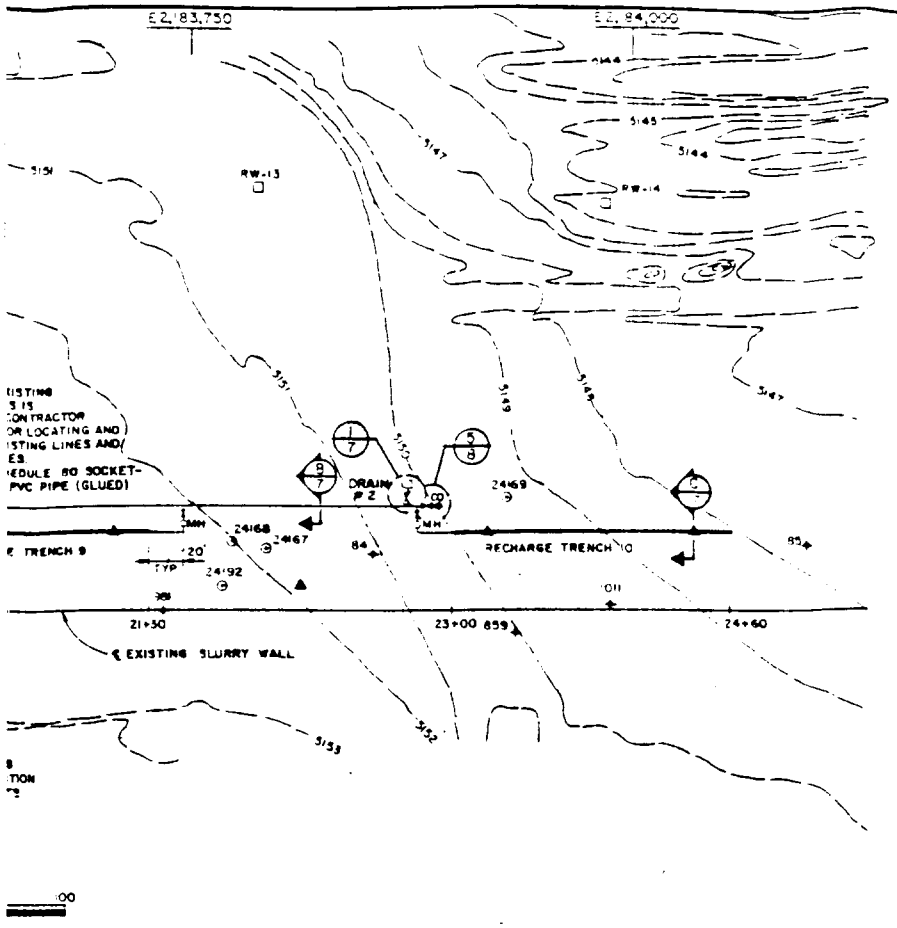

E 2,183,000
E 2,183,250
E 2,183,500
N 196,250
N 196,000
MATCH LINE 14+10
INSTALL HALLIBURTON MP-48 FLOW ANALYZER IN UPPER LEFT SECTION OF THE EXISTING INSTRUMENTS RACK
EXISTING RECHARGE WELLS (TYPICAL)
EXISTING 120V PANEL LP-1
EXISTING OVERFLOW VALVE PIT
EXISTING PAVED PARKING AREA
RW-H EXISTING RECHARGE LINE
RW-7
RW-9
RW-10
RW-11
RW-12
BLDG. 808
PULL BOX NEMA 3R; 12"x10"x4" WALL MOUNTED
PATCH PAVED AREAS TO ORIGINAL CONDITION WITH HOT MIX-CUTS TO BE SAWED
SUMP
EXISTING 8" PVC or DI (FIELD VERIFY)
6 SCHEDULE 80 SOCKET-TYPE PVC PIPE (GLUED)
INFLUENT WET WELLS
EFFLUENT WET WELL
TO JUNCTION BOX IN MANHOLE MH-8
LOCATION OF EXISTING DEWATER LINES IS APPROXIMATE. CONTRACTOR RESPONSIBLE FOR LOCATING AND PROTECTING EXISTING LINES AND/OR CONTROL CABLES.
EXISTING DEWATER LINES
8" SCHEDULE 80 SOCKET-TYPE PVC PIPE (GLUED)
4" SCHEDULE 80 SOCKET-TYPE PVC PIPE (GLUED)
RECHARGE TRENCH 7
RECHARGE TRENCH 8
RECHARGE TRENCH 9
MH
"D" STREET (PAVED)
PATCH PAVED AREAS TO ORIGINAL CONDITION WITH HOT MIX-CUTS TO BE SAWED
SCALE IN FEET
STA 15+00
STA 20+00
MATCH LINE 14+10
SAND AND CLAY
SAND, CLAYEY
SAND, SILTY
GRAVEL AND SAND
SAND AND CLAY
GRAVEL AND SAND
CLAY, SILTY
TOB
BOH
APPROXIMATE TOP OF BEDROCK SURFACE AT ℄ OF EXISTING SLURRY WALL - BEDROCK SURFACE LIKELY IS LOWER AT ℄ OF RECHARGE TRENCHES
CLAY AND SAND
SAND AND CLAY
CLAY AND SAND
SAND AND CLAY
GRAVEL AND SAND
SAND, MEDIUM DENSE
CLAY W/SAND MEDIUM STIFF
SANDSTONE, HARD
CLAYSTONE, FRIABLE
SANDY SILTSTONE, FRIABLE
CLAYSTONE
CLAY AND SAND
SAND AND CLAY
SAND, CLAYEY
SAND, SILTY
GRAVEL AND SAND
SP; SAND; MEDIUM DENSE
APPROXIMATE WATER SURFACE
GRAVEL
SANDY CLAYSTONE; FRIABLE
FRAG. TO CL. FRAG.
5150
5145
5140
5135
5130
5125
5120
5115



LEGEND

	BORE HOLE WAS NEVER COMPLETED AS A WELL OR OUT OF SERVICE
	BORE HOLE COMPLETED AS A WELL AND STILL IN SERVICE
	EXISTING MONITOR WELL
▼	ESTIMATED GROUND WATER LEVEL
N	NUMBER OF BLOWS/FEET FROM STANDARD PENETRATION TEST
	BORE HOLE WAS DRILLED DEEPER THAN SHOWN ON THIS PROFILE
▲	NEW PIEZOMETER
MH	MANHOLE
	GATE VALVE
CO	CLEAN OUT

ABBREVIATIONS

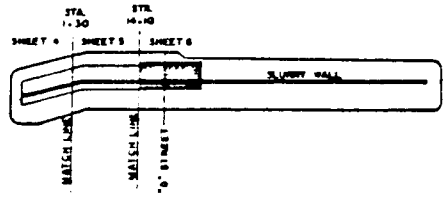
BOH	BOTTOM OF HOLE
	LOOSE(LY)
FT	FEET
FRAG	FRAGMENTED
TOB	TOP OF BEDROCK
W/	WITH

NOTES

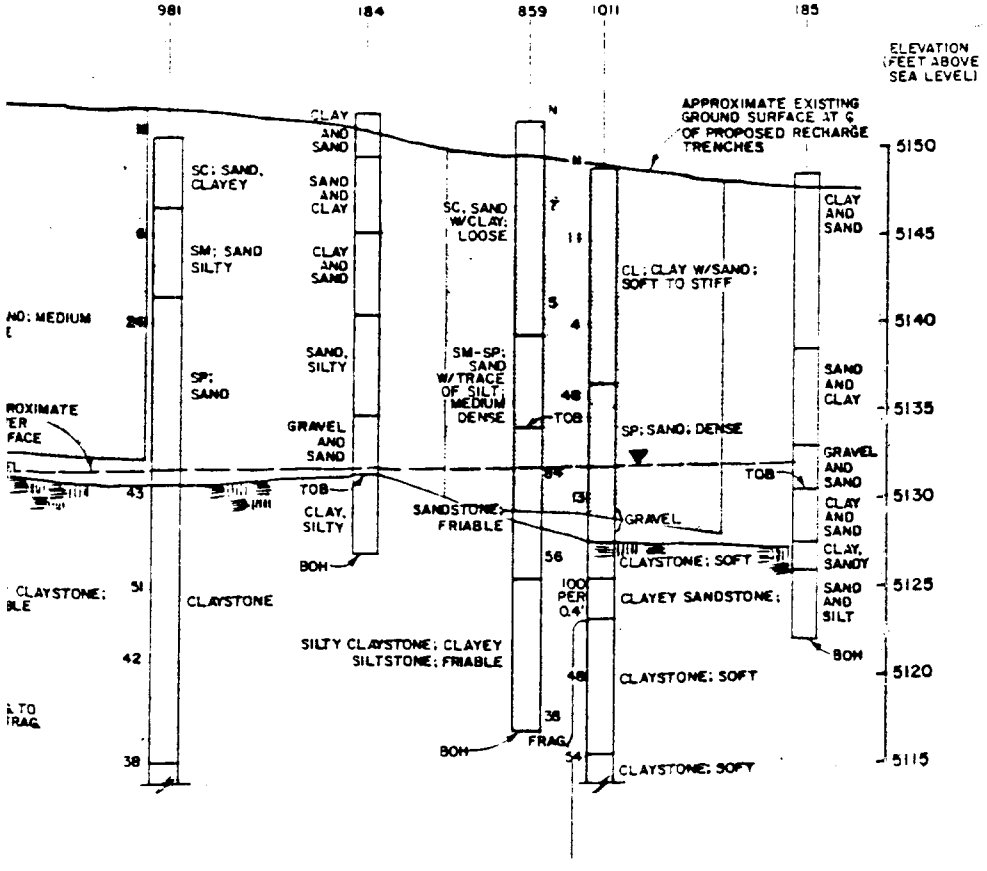
SEE NOTES ON SHEET 3 FOR DESCRIPTIONS OF GEOLOGIC TERMS.

LETTER INDICATES SECTION
NUMBER INDICATES DETAIL

NUMBER OF SHEET WHERE SECTION/DETAIL IS SHOWN.
—INDICATES THAT SECTION/DETAIL IS CUT AND DRAWN ON SAME SHEET



KEY PLAN



REVISION

NO	BY	DATE	CKD	DESCRIPTION
C				ISSUED FOR PARTIES' APPROVAL
B				ISSUED FOR CLIENT APPROVAL
A				ISSUED FOR REVIEW

ROCKY MOUNTAIN ARSENAL

NORTH BOUNDARY RECHARGE TRENCHES-WEST

PLAN AND PROFILE

Drawn By:	Date:	Scale: As Shown	SHEET 6 OF 9
App'd. By:		Date:	
Design By:	Date:	Dwg. No.:	
App'd. By:			

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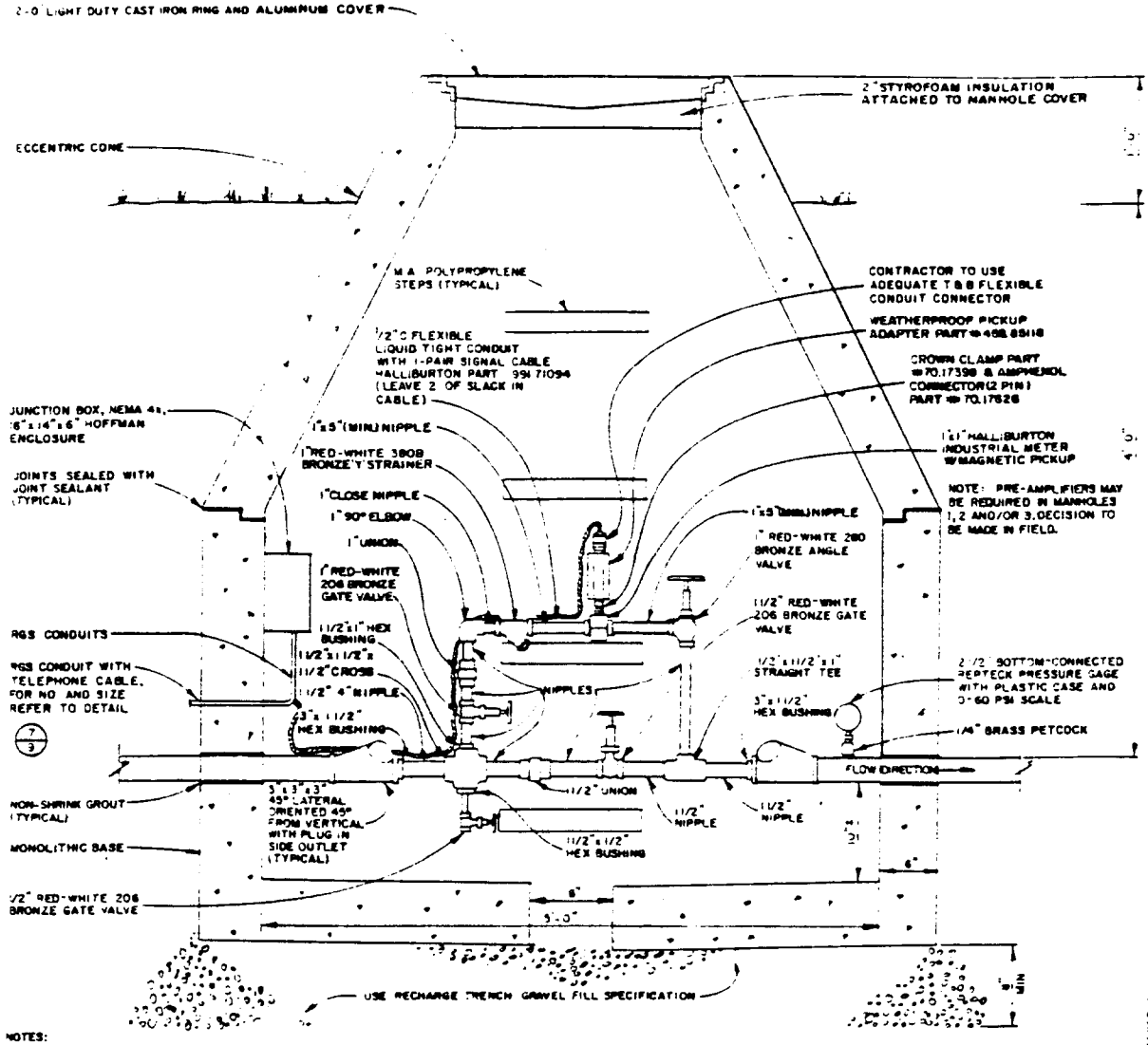
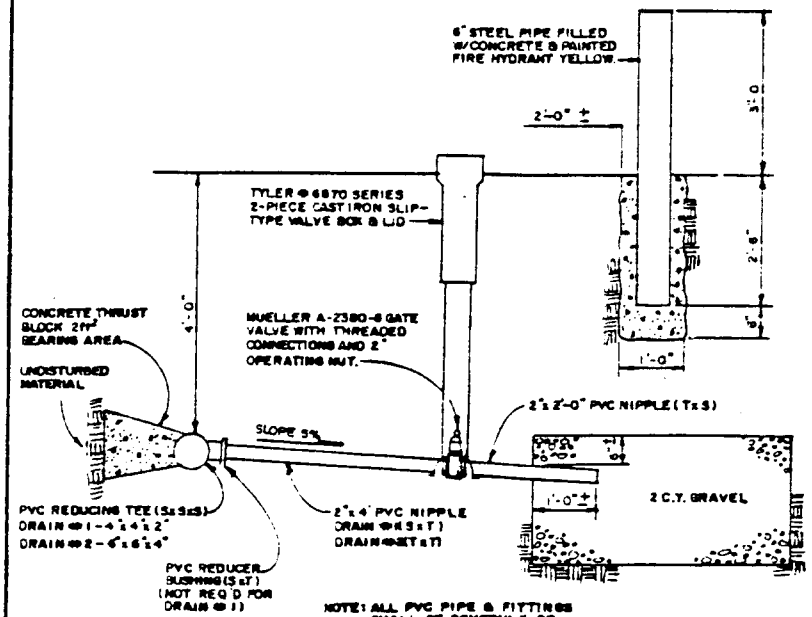


NOTES:
1 ALL PLUGS AND HEX BUSHINGS IN MANHOLE SHALL BE CL 2000 FORGED STEEL
2 ALL OTHER STEEL FITTINGS SHALL BE CLASS 150 GALVANIZED IRON.
3 ALL NIPPLES AND PIPE SHALL BE STANDARD, THREADED GALVANIZED IRON.

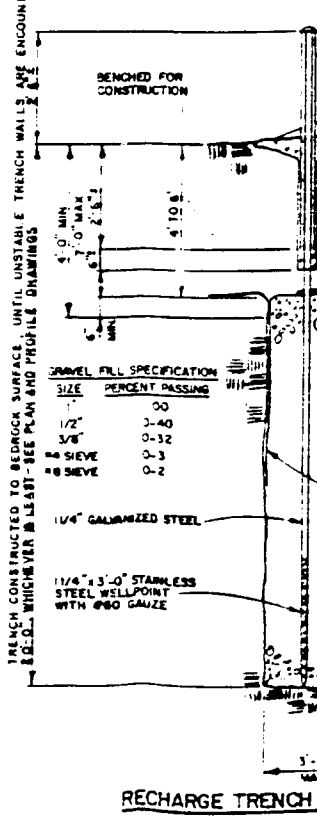
PRECAST CONCRETE MANHOLE AND PIPING DETAIL

SECTION A
NOT TO SCALE



NOTE: ALL PVC PIPE & FITTINGS SHALL BE SCHEDULE 80

DETAIL 1/5.6
NOT TO SCALE



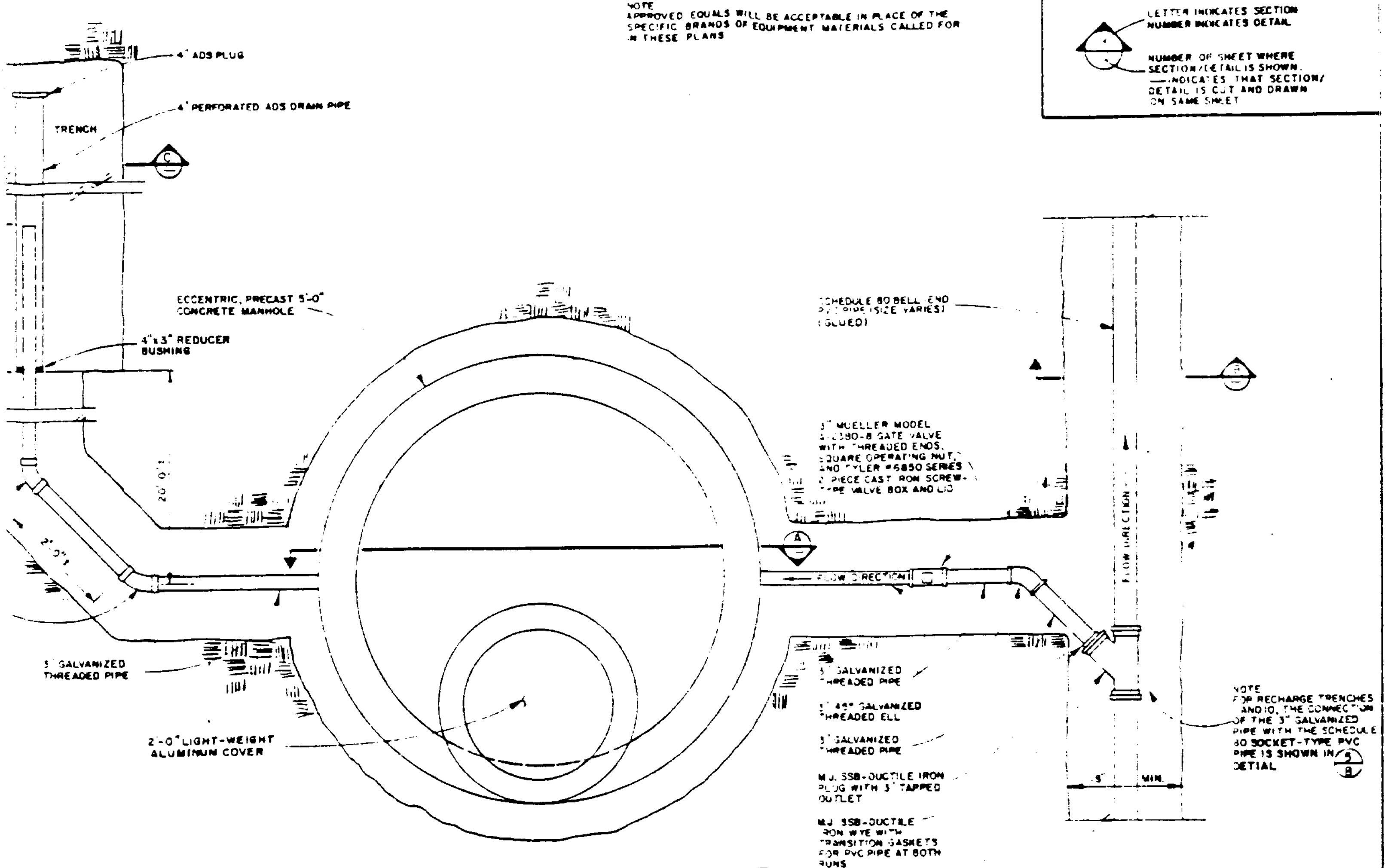
RECHARGE TRENCH SECTION
NOT TO SCALE

NOTE
APPROVED EQUALS WILL BE ACCEPTABLE IN PLACE OF THE SPECIFIC BRANDS OF EQUIPMENT MATERIALS CALLED FOR IN THESE PLANS

NOTES

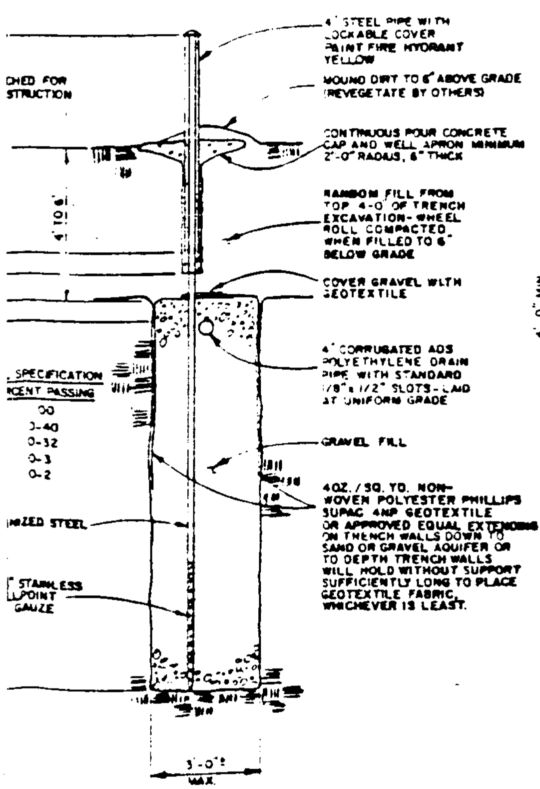
LETTER INDICATES SECTION
NUMBER INDICATES DETAIL

NUMBER OF SHEET WHERE SECTION/DETAIL IS SHOWN.
— INDICATES THAT SECTION/DETAIL IS CUT AND DRAWN ON SAME SHEET



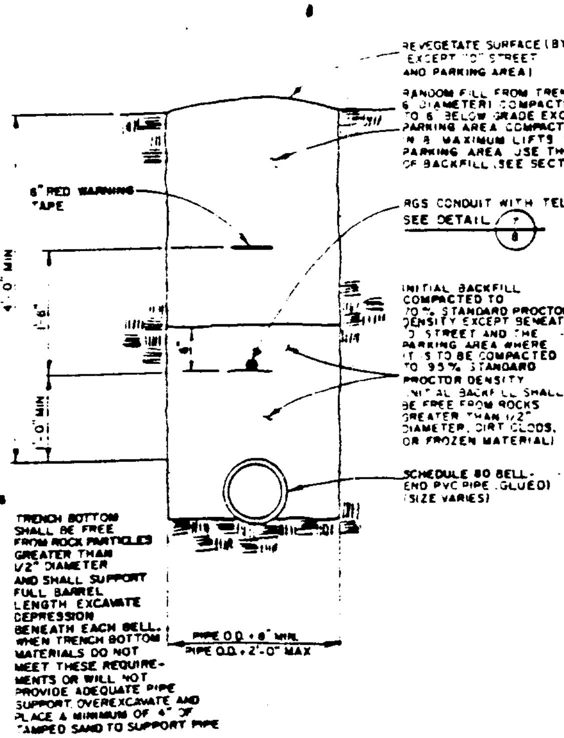
PLAN VIEW OF MANHOLE AND VICINITY

DETAIL 2 — 4,5,6
NOT TO SCALE



RECHARGE TRENCH AND PIEZOMETER

SECTION C — 4,5,6
NOT TO SCALE



PRESSURE PIPE TRENCH

SECTION B — 4,5,6
NOT TO SCALE

REVISION

NO	BY	DATE	CKD	DESCRIPTION
C	[illegible]	[illegible]	[illegible]	ISSUED FOR PARTIES' APPROVAL
B	[illegible]	[illegible]	[illegible]	ISSUED FOR CLIENT APPROVAL
A	[illegible]	[illegible]	[illegible]	ISSUED FOR REVIEW

ROCKY MOUNTAIN ARSENAL

NORTH BOUNDARY RECHARGE TRENCHES-WEST

MANHOLE AND TRENCH DETAILS

Scale: NONE
SHEET 7 OF 9

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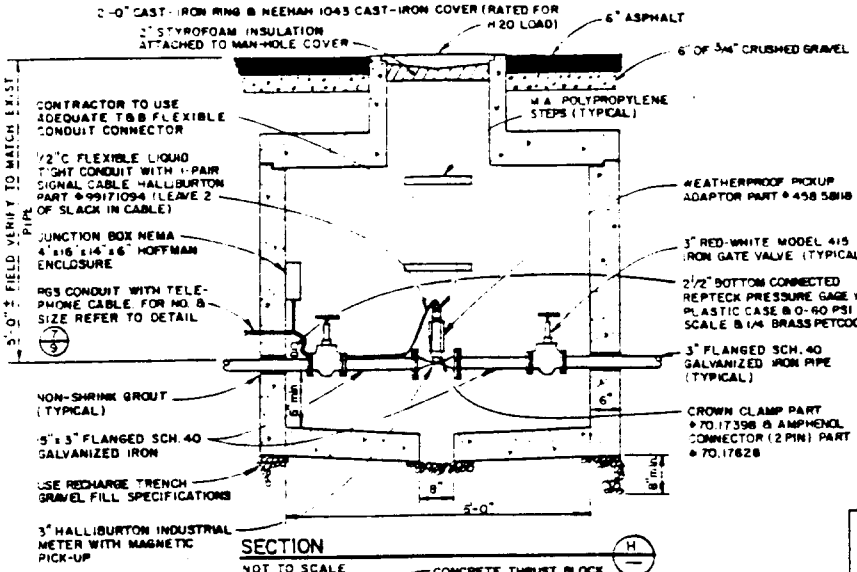
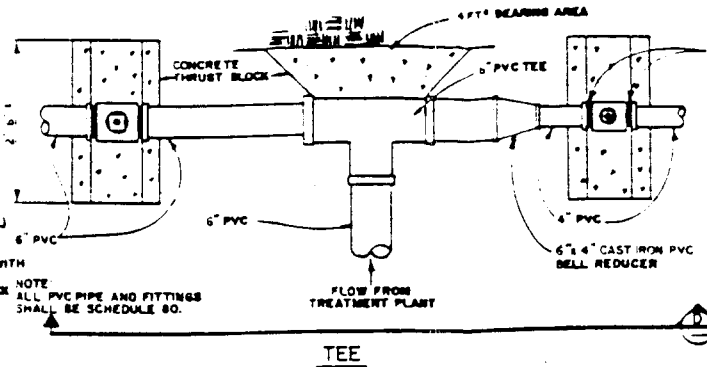
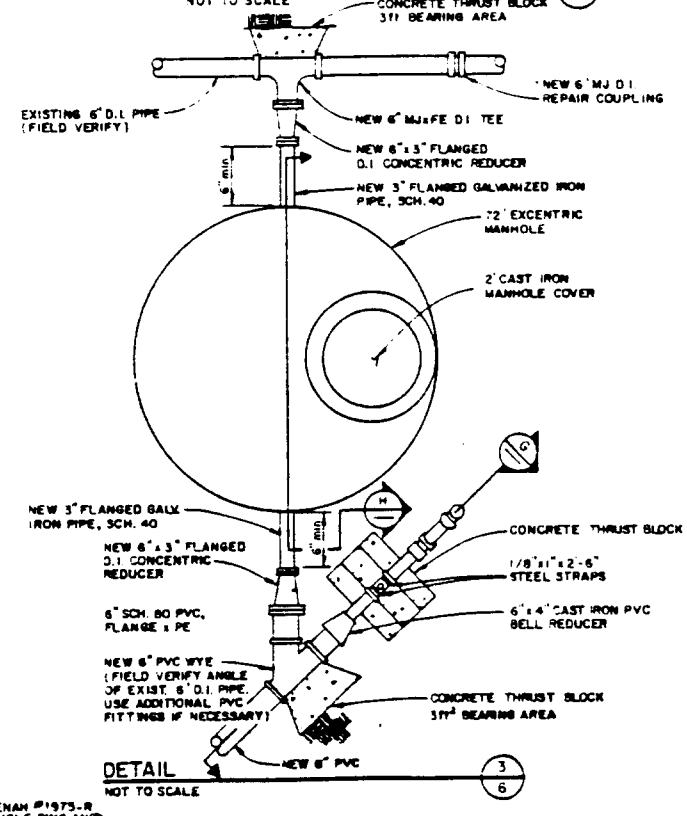


SECTION H
NOT TO SCALE

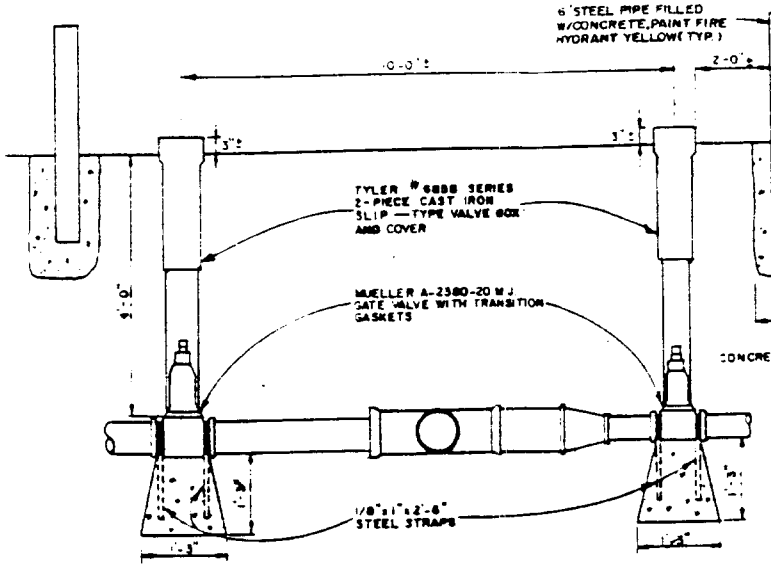


TEE

DETAIL 4/6
NOT TO SCALE



DETAIL 3/6
NOT TO SCALE



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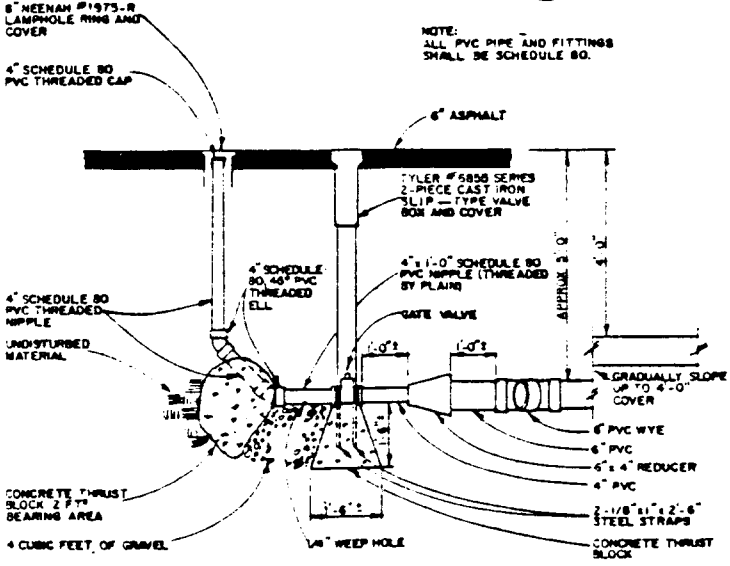

SECTION G
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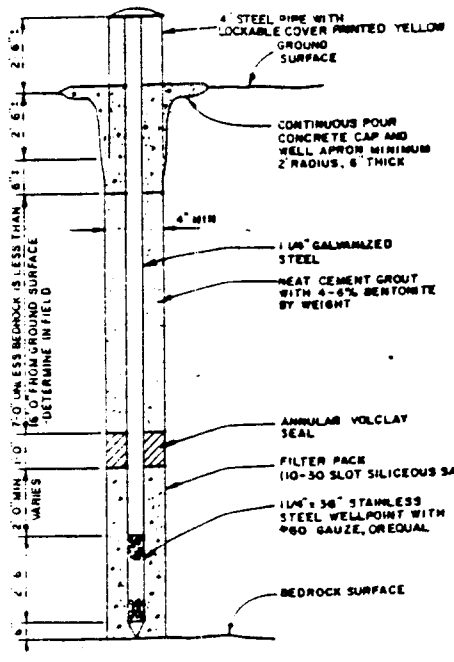
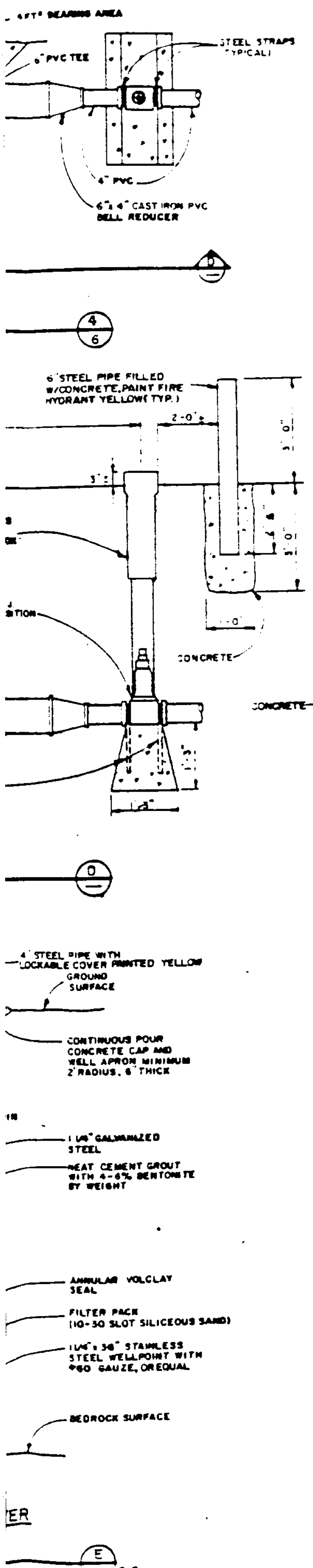


DRILLED PIEZOMETER

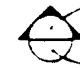
SECTION E
NOT TO SCALE

4,5,6



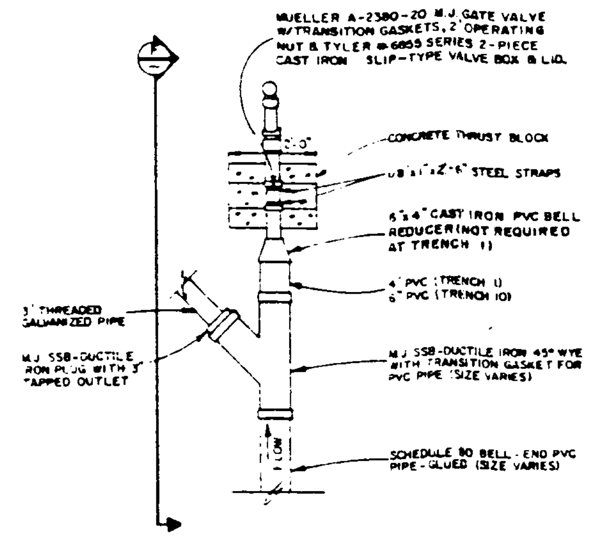
E
4,5,6

NOTES



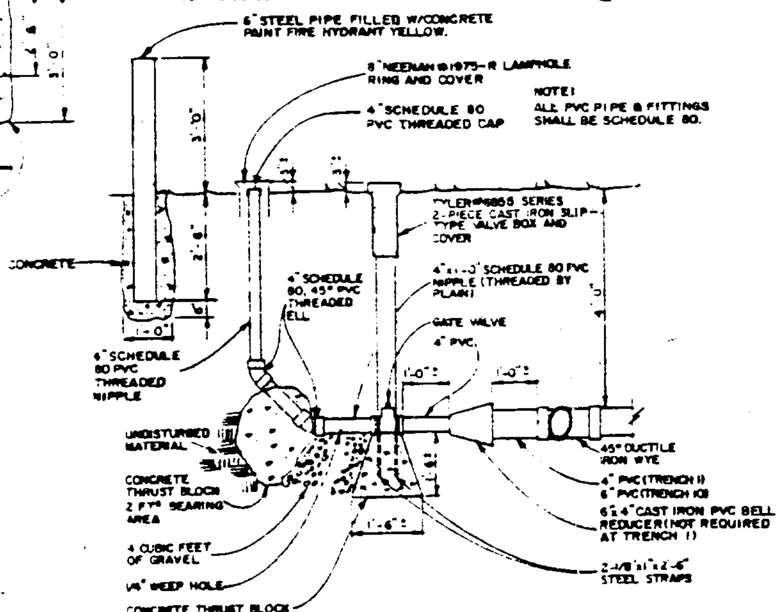
LETTER INDICATES SECTION
NUMBER INDICATES DETAIL

NUMBER OF SHEET WHERE SECTION/DETAIL IS SHOWN.
— INDICATES THAT SECTION/DETAIL IS CUT AND DRAWN ON SAME SHEET

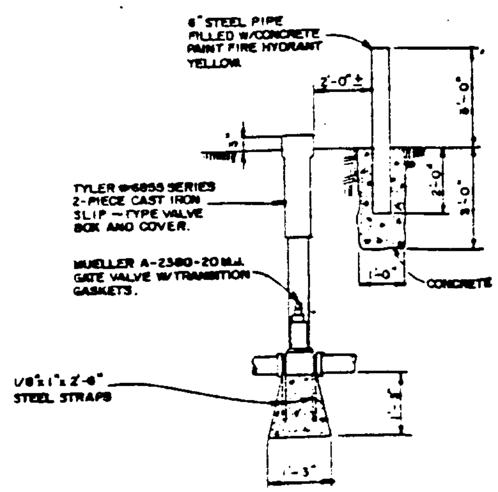


CLEAN-OUT

DETAIL
NOT TO SCALE
5
4,6,7



SECTION
NOT TO SCALE
F



GATE VALVE

DETAIL
NOT TO SCALE
6
5,6

REVISION				
NO.	BY	DATE	CKD	DESCRIPTION
C	[illegible]	[illegible]	[illegible]	ISSUED FOR PERMIT APPROVAL
B	[illegible]	[illegible]	[illegible]	ISSUED FOR CLIENT APPROVAL
A	[illegible]	[illegible]	[illegible]	ISSUED FOR REVIEW

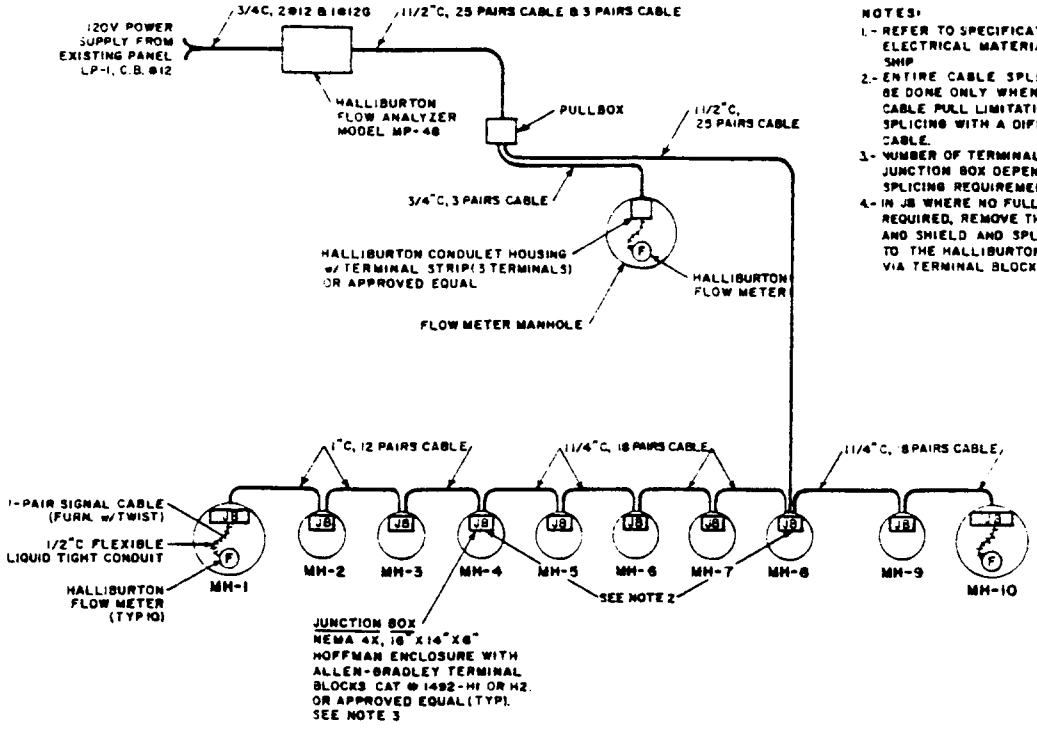
ROCKY MOUNTAIN ARSENAL

NORTH BOUNDARY RECHARGE TRENCHES-WEST

PIPING LAYOUT AND PIEZOMETER DETAILS

SHEET 8 OF 9

MORRISON-KNUDSEN ENGINEERS, INC.
1700 Broadway, Suite 1800
Denver, Colorado 80290



NOTES:

1.- REFER TO SPECIFICATION 37-1601 FOR ELECTRICAL MATERIAL AND WORKMANSHIP

2.- ENTIRE CABLE SPLICING SHALL BE DONE ONLY WHEN THERE IS A CABLE PULL LIMITATION OR WHEN SPLICING WITH A DIFFERENT KIND OF CABLE.

3.- NUMBER OF TERMINAL BLOCKS IN EACH JUNCTION BOX DEPENDS ON CONDUCTOR SPLICING REQUIREMENTS.

4.- IN JB WHERE NO FULL CABLE SPLICING IS REQUIRED, REMOVE THE OVERALL JACKET AND SHIELD AND SPLICE ONLY ONE PAIR TO THE HALLIBURTON SIGNAL CABLE, VIA TERMINAL BLOCK

SYSTEM BLOCK WIRING DIAGRAM

DETAIL

NOT TO SCALE

7 7 7 8

REVISION				
NO.	BY	DATE	CKD	DESCRIPTION
A	[illegible]	[illegible]	[illegible]	ISSUED FOR PARTIES' APPROVAL

ROCKY MOUNTAIN ARSENAL

NORTH BOUNDARY RECHARGE TRENCHES-WEST

ELECTRICAL PLAN

Drawn By:	Date	Scale: as shown	SHEET 9 OF 9
App'd By: [illegible]	[illegible] Date	Date	
Design By: [illegible]	[illegible] Date	Dwg. No.	
App'd By: [illegible]	[illegible] Date		

MORRISON-KNUDSEN ENGINEERS, INC.
A [illegible] COMPANY
1700 Broadway, Suite 1600
Denver, Colorado 80290