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DUSTPROOFING UNSURFACED AREAS: FACILITIES TECHNOLOGY APPLICATION TEST (FTAT) DEMONSTRATION, FY 85

by

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Dust has been a long time enemy of the military. Dust occurs wherever military equipment operates over dry unsurfaced or gravel surfaced terrain. The amount of dust realized is directly proportional to the type and number of military vehicles operating, the duration of the particular activity, and the weather (moisture) condition during the activity.

Dust occurs when small surface particles are scraped or rubbed away from the traveled surface by a vehicle tire or track and carried airborne by wind forces (in wet weather the same abraded particles are washed away in the form of mud). One vehicle crossing an open field will not usually produce an objectionable amount of dust. Objectionable large, blinding, fog-like clouds occur when many vehicles follow the same unsurfaced route.

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Perhaps the most familiar of these dust-producing routes is the gravel road. A good structural material for gravel roads is coarse aggregate with sufficient sand to fill the voids and adequate clay to bind these materials. Abrasion of the small clay particles begins with the passage of the first vehicle. Gradually, as more and more vehicles pass over the roadway, sufficient small particles are displaced so that the larger particles become unstable. Ruts begin to form thereby requiring maintenance to reduce the severity and extent of rutting. If sufficient clay particles are not replaced to stabilize the larger particles, the time between succeeding maintenance periods will be reduced. A good dust control material which resists the abrasion of the small particles and provides a more stable condition over a longer time period is magnesium chloride ($MgCl_2$). This report describes demonstrations of $MgCl_2$ application on tank trails at Fort Irwin, Calif., and on an assault airstrip at Fort Chaffee, Ark., and provides the user with instructions for the successful conduct of dust control projects.

PREFACE

The study was sponsored by the Office, Chief of Engineers, US Army, as a part of the O&MA Program, Facilities Technology Application Tests (FTAT), Demonstration Program FY 85. The Technical Monitor was Mr. R. W. Williams.

The study was conducted under the general supervision of Dr. W. F. Marcuson III, Chief, Geotechnical Laboratory (GL), and under the direct supervision of Messrs. H. H. Ulery, Jr., Chief, Pavement Systems Division (PSD); and J. W. Hall, Jr., Chief, Engineering Investigations, Testing, and Validation Group, PSD; and Dr. E. R. Brown, Chief, Materials Research Center, PSD. Field test support was provided by Messrs. C. R. Styron, J. P. Armstrong, T. P. Williams and MAJ R. A. Hass, PSD; Messrs. J. V. McGuffie, Jr., Office of Administrative Services; R. L. Smith and R. Felix, Jr., Engineering and Construction Services Division; V. Magee and D. Ray, Information Products Division (IPD), Information Technology Laboratory (ITL); and, Mses. L. H. Garner, G. F. Traxler, and C. P. Purviance, Resource Management Office. The US Army Engineer Waterways Experiment Station (WES) FTAT projects manager was MAJ Hass who also wrote the report. Ms. Odell F. Allen, IPD, ITL, edited the report.

Installation support was provided at Fort Irwin by Messrs. J. McCrary and W. Cassidy, Directorate of Engineering and Housing, and at Fort Chaffee by Mr. J. Lowe and CPT E. Muehlberg, Directorate of Facilities and Engineering.

COL Allen F. Grum, USA, was the previous Director of WES. COL Dwayne G. Lee, CE, is the present Commander and Director. Dr. Robert W. Whalin is Technical Director.

CONTENTS

CONVERSION FACTORS, NON-SI TO SI (METRIC)
UNITS OF MEASUREMENT

Non-SI units of measurement used in this report can be converted to SI (metric) units as follows:

Multiply	By	To Obtain
degree (angle)	0.01745329	radians
Fahrenheit degrees	5/9	Celsius degrees or Kelvins*
feet	0.3048	metres
gallons per squard yard	4.5273	cubic decimetres per square metre
gallons (US liquid)	3.785412	cubic decimetres
inches	2.54	centimetres
square yards	0.8361274	square metres
tons (2,000 pounds, mass)	907.1847	kilograms

* To obtain Celsius (C) temperature readings from Fahrenheit (F) readings, use the following formula: C = (5/9)(F - 32). To obtain Kelvin (K) readings, use K = (5/9)(F - 32) + 273.15.

DUSTPROOFING UNSURFACED AREAS: FACILITIES TECHNOLOGY APPLICATION TEST (FTAT) DEMONSTRATION, FY 85

PART I: INTRODUCTION

Background

1. In 1983 the Director of Research and Development, Office, Chief of Engineers, US Army, requested the Waterways Experiment Station (WES) to demonstrate the procedures and techniques for dustproofing unsurfaced roads and areas on military installations.

2. Pavement engineers at WES had previously conducted intensive research, field experiments, and evaluations of hundreds of dust control agents and palliatives along with numerous dustproofing techniques and procedures. The culmination of this research and development in the area of dustproofing is technology transfer under the auspices of the Facilities Technology Application Test (FTAT) Demonstration Program.

3. This report is the second report in a series of three dedicated to technology transfer on the subject of dustproofing. The first report provided relative data concerning dustproofing demonstrations held at Fort Bliss, Tex., and Fort Stewart, Ga.,* utilizing a magnesium chloride ($MgCl_2$) brine solution on tank trails and polyvinyl acetate (PVA) on lightly traveled and nontraffic areas. The third report will provide data concerning dustproofing demonstrations held at Fort Campbell, Ky., during FY 86. These demonstrations will include the treatment of gravel roads with $MgCl_2$ and calcium chloride and an assault airstrip with calcium chloride.

Occurrence

4. Dust has been a long time enemy of the Army, especially in a tactical scenario. It occurs wherever military equipment operates over dry,

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* C. R. Styron, III, Robert A. Hass, and Karen Kelly. 1985. "Dustrproofing Unsurfaced Areas: Facilities Technology Application Test Demonstrations, FY 84," Technical Report GL-85-11, US Army Engineer Waterways Experiment Station, Vicksburg, Miss.

unsurfaced terrain. This dust occurs when the small surface particles of the soil are scraped or rubbed away from the traveled surface by vehicle tires and tracks (Figure 1) or aircraft landing gear and prop wash (Figure 2) and carried airborne by wind forces.* One vehicle crossing an open field will not usually produce an objectionable amount of dust. However, the large, blinding, fog-like clouds occur when many vehicles follow the same unsurfaced route or when numerous Air Force aircraft sorties use the same unsurfaced airstrip (Figure 3). A good structural material for gravel roads and assault airstrips is a coarse aggregate with sufficient sand to fill the voids and adequate clay to bind these materials together. Abrasion of the small clay soil particles begins with the passage of the first vehicle on the unsurfaced area. Gradually as additional vehicles or aircraft pass over the unsurfaced area, sufficient small soil particles are displaced so that the larger soil particles become unstable. Ruts, potholes, and washboard begin to form and soon maintenance will be required to reduce the severity and extent of deterioration. If sufficient clay soil particles are not replaced to stabilize the larger particles, the time between succeeding maintenance periods will not be reduced. A good dust control material resists the abrasion of the small soil particles, and a more stable condition is realized over a longer time period. Since airborne dust decreases the life of engines (particularly gas turbine engines) and helicopter rotor blades, dust control also decreases tactical equipment maintenance and mean time between failures.

Plan of Demonstrations

5. One of the dust control techniques developed for dustproofing unsurfaced areas is the use of $MgCl_2$ as a dust palliative. This dustproofing technique was demonstrated by a WES project crew at Fort Irwin, Calif., and at Fort Chaffee, Ark. These installations were selected based upon dust control need, varying terrain and soil type, weather conditions, and location.

6. The $MgCl_2$ was selected for use at both installations because of its hygroscopic properties which binds the fine soil particles (dust) to the larger soil particles by absorbing moisture from the air. The surface

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* Note: In wet weather, the same abraded particles are washed away in the form of mud.

produced is a tight, macadam-like surface when compacted. The most effective use of $MgCl_2$ is its utilization on a cohesionless soil which is common on most military installations' unsurfaced tank trails and assault airstrips.

7. Demonstration sites were selected, prepared, and treated at the two military installations. Each site was bladed to remove ruts, potholes, washboard, and all loose material, compacted if necessary, prewet with water to reduce surface tension, and sprayed with the dust control material $MgCl_2$. The $MgCl_2$ was applied with the WES Etnyre asphalt distributor after the pump had been modified to permit external lubrication.

PART II: DEMONSTRATION

Site Selection

8. Fort Irwin, Calif., and Fort Chaffee, Ark., were selected for the FY 85 FTAT demonstration sites. Both locations were visited by a WES engineer prior to site selection to ensure that there was a dust control need and adequate support was available for the conduct of a dustproofing demonstration. Both installations had an immediate need for dust control. Wheeled and tracked vehicles at Fort Irwin were producing dust (Figure 4) on the silty sand roads, maintenance and bivouac areas. This dust was blowing across a major road reducing visibility and intruding into tentage, vehicle cargo areas, and engine compartments. US Air Force C-130 aircraft landing at Fort Chaffee were producing clouds of dust on the gravelly, sandy clay assault airstrips. This dust was billowing 750 to 1,000 ft* into the air and severely reducing safe aircraft operations on the airstrip (Figure 5).

Coordination

9. Messrs. John McCrary (Fort Irwin) and James Lowe (Fort Chaffee) provided storage locations for the material and equipment. They also assigned installation personnel to the demonstration projects to conduct site preparation, prewetting operations, and rolling operations as well as local contacts, when necessary, to accomplish demonstration objectives. Firm dates for the demonstrations were arranged with Messrs. McCrary and Lowe to coincide with training exercises and utilization of areas at the installations by major Army units.

Logistics

10. Delivery arrangements were made with the contractor for the $MgCl_2$ to be transported to each demonstration site. At Fort Irwin, two 10,000 gal temporary storage tanks were provided by the contractor for the $MgCl_2$, and the

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* A table of factors for converting non-SI units of measurement to SI (metric) units is presented on page 3.

brine solution was delivered to the site by 5,000 gal tanker trucks (Figure 6). At Fort Chaffee, the $MgCl_2$ was delivered in two railroad supertanker cars (Figure 7) with the capability of holding 20,000 gal each. The WES modified Etnyre asphalt distributor and operators, as well as photographers, technicians, and laborers were scheduled for the designated demonstration time periods. Notification of each demonstration was sent to all Major Commands (MACOMS) to inform individuals of the date, time, and location of the demonstration to allow Department of Defense (DOD) personnel to attend each demonstration. Handouts, demonstration plans, and briefings were prepared for any attending observers. Appendix A lists both FY 84 and FY 85 points of contact for the dustproofing demonstrations.

PART III: PROJECT PROCEDURE

Objective

11. The main objective of these demonstrations is to familiarize Directors of Engineering and Housing (DEH) with the new technology by providing first-hand experience through observation, either by onsite or videotape viewing of the dustproofing techniques and procedures.

Examples of Dust Problems

12. A few examples of dust control problems that occur on military installations where dustproofing techniques should be considered for implementation are as follows:

- a. Dust generated by military vehicles operating on unsurfaced tank trails intrudes into housing areas or commercial activities that are adjacent to these tank trails.
- b. Dust from tank trails impairs visibility on adjacent highways, roads, and streets.
- c. Dust clouds generated by military vehicles operating on tank trails impair the visibility of military vehicle operators while driving on the tank trails.
- d. Dust clouds generated by military aircraft operating on unsurfaced airstrips or helipads reduce the safe operations of the aircraft in those areas.
- e. Dust intrudes into engines, engine compartments, air filtering systems, vehicle/aircraft turbines, and vehicle/aircraft cargo areas which increases wear and tear on the vehicles and aircraft.
- f. Dust irritates the lungs and eyes of soldiers operating military vehicles.
- g. Dust clouds generated by military aircraft or vehicle operations provide a recognizable signature to enemy forces in a tactical situation.

Construction Method Recommended

13. The area to be treated is bladed to remove all loose material, ruts, potholes, and washboard. Compact the bladed surface with a pneumatic rubber-tired roller as necessary to achieve a hard surface that is not easily

rutted by the using traffic. Water is sprayed on the area to be treated. The prewetting operation is required to reduce surface tension, to allow maximum penetration of the dust control agent, and to ensure a uniform application of the dust control liquid over the applied area. The amount of water utilized during the prewetting operation is varied by surface conditions, soil type, and prevailing weather conditions, but the amount usually ranges between 0.03 and 0.30 gal/sq yd. After the prewetting operation, if any water has ponded, it should be broomed or swept away before applying the dust control material.

14. The dust control material is applied as a liquid. Most dust control liquids can be applied with a common asphalt distributor or even a gravity-fed water truck. Some require agitation during transport and application to prevent segregation of the solution, and some require special equipment.* Regardless of the method used for application, the application rate for the majority of dust control liquids for the initial application should be 0.50 gal/sq yd. Higher application rates have a tendency to runoff, and lower application rates are not efficient or effective. Subsequent application rates for maintenance of previously treated areas can be as low as 0.25 gal/sq yd depending upon the degree of maintenance required.**

15. It is essential that close coordination occurs between the distributor driver and the spray bar operator to ensure that the spray bar is opened and closed at the proper locations and that a 6- to 12-in. overlap is maintained on previously treated strips.

16. Close observation is required for applying the dust control material to the selected area. If the selected area is too dry from too little prewet water or evaporation of the water, the dust control material will not penetrate the surface area, and total coverage will not be achieved. Thus adequate coating of the in situ material will not occur. The discontinuity of the dust control material on the surface area and subsequent untreated areas formed are called fisheyes. Application operations should be terminated whenever fisheyes occur and additional water added before applying any more dust control material.

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* Headquarters, Departments of the Army and Air Force. 1974 (Sep). "Dust Control," Technical Manual TM 5-830-3/AFM 88-17, Chap. 3, Washington, DC.

** See paragraph 3 for reference.

17. The selected area treated with the dust control material is allowed to cure. Some dust control materials required 4 hr or longer to cure before vehicle traffic is allowed to travel over the areas, or dust control effectiveness may be sacrificed. The degree of effectiveness sacrificed is directly attributed to the actual cure time allowed versus the actual cure time necessary.

Materials Required

18. The dust control material selected for the FY 85 demonstrations was $MgCl_2$. This product was subjected to a series of tests at WES. These tests indicated that $MgCl_2$ had the potential for adequate dust control during a finite period when applied to gravel roads or areas having cohesionless type soil surfaces which are subjected to different types of vehicular traffic.*

19. $MgCl_2$ is a commercial by-product of salt mining operations. The brownish yellow liquid brine solution is composed mainly of $MgCl_2$ which is the primary dust control element. The brine solution is applied as received from the supplier with no dilution required. The application rate of this liquid is no more than 0.50 gal/sq yd. The brine solution is considered mildly corrosive, and vehicles or aircraft that come in contact with $MgCl_2$ treated areas should be washed during normal after-operation preventive maintenance periods. Appendix B contains a message provided to all airfield users prior to the Fort Chaffee demonstration. Personnel who come in contact with $MgCl_2$ should follow basic hygiene practices.

Equipment Required

20. A motor grader is needed to blade the area to be treated, and a pneumatic rubber-tired roller and a steel wheel roller (for airstrip and helipad compaction) are needed to compact the bladed surface. A water truck is used to prewet the surface. An asphalt distributor or a water truck capable

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* C. R. Styron, III, and A. C. Spivey, Jr. 1982 (Sep). "MX Road Design Criteria Studies, Report 2, Investigation of a Proprietary Material for Dust Control," Technical Report GL-82-11, US Army Engineer Waterways Experiment Station, Vicksburg, Miss.

of metering liquids can be used to apply the $MgCl_2$. $MgCl_2$ can be pumped through an asphalt distributor; but since it is not a natural lubricant, it will eventually bind the pump. Therefore, it is recommended that the pump on the asphalt distributor be modified for external lubrication as indicated in Figure 8.

Personnel Required

21. Experienced operators are required for the motor grader, pneumatic rubber-tired roller, steel wheel roller (if required), water truck, and asphalt distributor. A civil engineer or engineering technician familiar with dust control operations and an equipment foreman should be present when the dust control material is being placed.

Recommended Procedure for Dustproofing with $MgCl_2$

22. The following guidance is the recommended procedure for dustproofing with $MgCl_2$:

a. Planning:

(1) Determine the area to be treated (square yards).

(2) Order enough $MgCl_2$ for an initial treatment of no more than 0.50 gal/sq yd but not less than 0.42 gal/sq yd and plan for a follow-up maintenance application of approximately 0.25 to 0.30 gal/sq yd after 8 to 12 months service life.

(3) Plan the project so that equipment and personnel are available to accomplish the preparation and application procedures in an orderly step-by-step process.

(4) Ensure that storage facilities and/or a storage area for the dust control material is designated near the project site.

b. Equipment and personnel:

(1) Equipment

(a) A standard motor grader to blade the surface of the selected area to be treated.

(b) A 5,000 gal water truck with displacement pump to prewet the selected area. A smaller capacity water truck can be used; however, it should have a capacity approximately twice that of the vehicle used to apply the $MgCl_2$.

(c) A pneumatic rubber-tired roller to compact the selected area before the prewetting operation and after application of the $MgCl_2$ (if necessary).

(d) A modified asphalt distributor or a water truck capable of metering application of the $MgCl_2$.

(e) Plumbing attachments consisting of a 90- or 45-deg pipe collar which must fit a threaded pipe 4.25 in. in diameter on the bottom of the tank car and the opposite end to fit the 3-in. flexible metal hose on the modified asphalt distributor (see Figure 9). Also, pipe fittings consisting of a 2-in. threaded nipple connected to the bottom of the tank car, a 2- to 3-in. bushing, and a 3-in. elbow which are all connected together so that the 3-in. flexible metal hose from the modified asphalt distributor can be attached (see Figure 10).

(f) A steel wheel roller to provide a smooth tight surface (for airstrip and helipads only).

(2) Personnel

(a) Civil engineer or civil engineering technician, one.

(b) On-site foreman, one.

(c) Water truck driver and pump operator, two.

(d) Motor grader operator, one.

(e) Pneumatic rubber-tire roller operator, one.

(f) Modified asphalt distributor operator and pump/spray bar operator, two.

(g) Steel wheel roller operator (if required), one.

(h) Total personnel, nine.

c. Site preparation:

(1) Blade away all ruts, potholes, washboard, and loose excess surface material to expose a hard surface.

(2) Compact the bladed surface as necessary with a pneumatic rubber-tired roller to ensure that a hard surface is achieved so that rutting is not caused by using traffic.

(3) Prewet the selected area to be treated with the water truck to reduce surface tension and increase the $MgCl_2$ penetration. Recommended application rate for the prewetting operation is between 0.03 to 0.30 gal/sq yd (application rate is dependent upon temperature and evaporation rate).*

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* Note: The surface to be treated should be damp when $MgCl_2$ is applied. Puddles or ponded water should be swept or broomed away.

d. Material application:

(1) Spray the $MgCl_2$ with a modified asphalt distributor or apply the $MgCl_2$ with a water truck capable of metering liquids at an application rate of between 0.42 and 0.50 gal/sq yd. A 6- to 12-in. overlap of treated strips is required to ensure that a uniform application is maintained on the treated area.

(2) Again compact the treated area with a pneumatic rubber-tired roller to ensure the stability of the smaller particles. A curing period of at least 24 hr should be observed prior to compaction (only for airstrips and helipads). Four to six passes of the roller are required. Rolling should be halted or postponed for a period of approximately 2 to 4 hr if the pneumatic rubber tires pick up too much soil particles from the treated surface or cause ruts to form. Military vehicles can be allowed to traffic the treated tank trails immediately after the $MgCl_2$ is applied; however, the effectiveness and efficiency of the $MgCl_2$ may be reduced in the long term.

(3) Compact the treated area with a steel wheel roller in the nonvibratory mode following the pneumatic rubber-tire roller. Two to four passes are required to provide a smooth, hard surface. This step is needed for only airstrips and helipads.

e. Maintenance:

(1) Following periods of low rainfall or low humidity (humidity less than 30 percent), the hygroscopic properties of the $MgCl_2$ is rendered ineffective or dormant, and dust will appear again. The $MgCl_2$ can be reactivated with an application of plain water at approximately 0.10 to 0.20 gal/sq yd. Periodic watering should be repeated as long as the dry periods continue and whenever they occur.

(2) Blading will be substantially reduced. If minor rutting occurs, spraying the area with a light application of water will assist the $MgCl_2$ in binding the small and large soil particles together again. Only blade the treated area if substantial rutting occurs.

(3) $MgCl_2$ will eventually leach from the treated area with continued exposure to weather extremes. A second application of $MgCl_2$ should be planned/anticipated following 8 to 12 months of service. The second application procedure is the same as the first, except $MgCl_2$ is applied at a lower rate of 0.25 to 0.30 gal/sq yd.

f. Safety:

(1) Local and federal safety regulations apply.

(2) Military vehicles and aircraft that traffic treated areas should be washed after being exposed to $MgCl_2$. $MgCl_2$ is a mildly corrosive material.

(3) Normal hygiene practices should be all that is required if the $MgCl_2$ comes in contact with skin or clothes of personnel.

(4) The manufacturers' application recommendations and safety labels should be read.

PART IV: CONDUCT OF DEMONSTRATIONS

23. The sites selected for the FY 85 "Dustproofing Unsurfaced Areas" demonstrations were the National Training Center, Fort Irwin, Calif., and Arrowhead Assault Airstrip, Fort Chaffee, Ark.. The DEH at Fort Irwin and the Director of Facilities and Engineering (DFAE) at Fort Chaffee were responsible for the project site preparation and storage area for the $MgCl_2$. The WES was responsible for contracting the $MgCl_2$, the modified asphalt distributor use, and application procedures.

Fort Irwin, California

24. The Fort Irwin, Calif., demonstration was conducted during the period 11-15 March 1985. Seven areas were preselected during an initial site investigation (Figure 11), and a demonstration project plan was approved.

25. Areas 1, 3, and 7 were tank trails adjacent to a paved road which had large amount of military vehicle traffic. The dust generated by military convoys caused dust clouds which obscured visibility on both the tank trail and paved road, increased safety hazards, and increased maintenance on the military vehicle utilizing the tank trails.

26. Areas 2, 4, 5, and 6 were unsurfaced vehicle maintenance areas, marshaling areas, and bivouac areas. The dust produced in these areas was a major maintenance problem for vehicles, safety hazard, and a nuisance to soldiers.

27. The basis for selecting the areas at Fort Irwin was that the areas received heavy truck and mechanized vehicle traffic (Figure 12) during the training cycles at the National Training Center, the dust generated by this traffic is a major maintenance problem for vehicles, and the dust was a major nuisance factor for the soldiers who utilize the areas in preparing their vehicles for turn-in or shipment back to their respective installations.

28. Two hundred seventy-five tons or approximately 50,900 gal of $MgCl_2$ were purchased for $20,000.00 for this specific project. The price included material purchase, transportation, and temporary storage. The $MgCl_2$ was purchased from a local contractor who transported the liquid brine to Fort Irwin by 5,000 gal tanker trucks. Temporary storage was provided by the contractor on the project site in two 10,000 gal storage tanks.

29. Prior to the site preparation, the WES modified asphalt distributor used to apply the $MgCl_2$ was checked thoroughly to ensure that all working mechanisms were functioning. The inspection included:

a. The spray bar and nozzles checked for any debris which may cause clogging during the spraying operation.

b. The pump checked for proper operation in filling the distributor tank and for proper lubrication during application procedures.

c. A test run accomplished with water to check pump controls and speed to ensure that the proper application rate could be achieved.

30. The selected areas were prepared for treatment first by blading the unpaved surface using a motor grader (Figure 13). This blading operation removed ruts, potholes, washboard, and loose excess surface material. The blading exposed a fairly hard surface, and the project engineer on site determined that rolling with a pneumatic rubber-tired roller was not required. This decision was based upon the surface exposed and the amount of traffic expected in the areas.

31. A 5,000-gal commercial water truck (Figure 14) was used to prewet the selected areas. The prewetting operation ensured reduction of the surface tension and increased the $MgCl_2$ penetration. The prewetting application rate for the water at Fort Irwin was approximately 0.30 gal/sq yd.

32. The WES modified asphalt distributor, a 900-gal Etnyre distributor (Figure 15), was used to apply the $MgCl_2$. The distributor tank was loaded utilizing the positive displacement pump on the rear of the distributor to suction the brine solution from the storage tanks directly through the 3-in. flexible metal hose to the distributor. The flexible metal hose was attached to the storage tanks' 3-in. straight faucet nozzle by the hoses quick disconnect (Figure 16). No special collar device or pump fittings were necessary.

33. The $MgCl_2$ was applied as received at an application rate of not more than 0.50 gal/sq yd. All the dust control material was applied directly to the selected unsurfaced areas, and none was allowed to runoff into adjacent areas or drainage ditches. The spray bar operator on the rear of the distributor ensured that there was at least a 6-in. overlap on the previously treated area. Figure 17 shows a typical area after treatment.

34. Since mechanized and rubber-tired vehicle traffic was anticipated on the Fort Irwin sites the following day, rolling the treated areas with a pneumatic rubber-tired roller was not necessary. However, it was recommended

to the Fort Irwin DEH representatives that a pneumatic rubber-tired roller be utilized if the anticipated traffic did not occur on the treated areas.

35. The total area treated at Fort Irwin was 104,816 sq yd (Figure 17). The amount of $MgCl_2$ applied was 48,900 gal for an overall application rate of 0.47 gal/sq yd, which falls within the recommended application rate of 0.42 to 0.50 gal/sq yd. The cost of the $MgCl_2$ was approximately $0.40/gal for a treatment expense of approximately $0.20/sq yd.

Fort Chaffee, Arkansas

36. The Fort Chaffee, Ark., demonstration was conducted during the period 15-28 September 1985. During initial coordination an assault airstrip (Figure 18) was preselected and a demonstration project plan was approved.

37. Arrowhead Assault Airstrip at Fort Chaffee has been in operation since June 1984. The airstrip is 4,500 ft long with an additional 500 ft at each end for turn around/overrun clearance for a total of 5,500 ft in length. The width is approximately 120 ft. An area 4,500 ft long and 110 ft wide was selected for treatment (Figure 19).

38. The assault airstrip is used by US Air Force C-130 aircraft in support of US Army and US Air Force training exercises. These exercises are conducted regularly throughout the year.

39. The $MgCl_2$ was delivered to Fort Chaffee by the contractor in two supertanker railroad tank cars (Figure 7). To suction the $MgCl_2$ from the tank car, some particular pipe fittings were utilized. These pipe fittings consisted of a 2-in. threaded nipple which was connected to the bottom of the tank car, a 2- to 3-in. bushing, and a 3-in. elbow which were connected to the 2-in. nipple so that the 3-in. quick connect/disconnect on the flexible metal hose from the distributor could be attached (Figure 10).

40. As at Fort Irwin, Arrowhead Assault Airstrip at Fort Chaffee was bladed smooth using motor graders in tandem (Figure 20). The blading operation removed all excess surface material, ruts, and potholes which exposed a hard, compacted surface. Normally, a pneumatic rubber-tire roller would have been used to compact the material exposed by the blading operation. However, the surface exposed was a tightly compacted soil over a sandstone base which eliminated a step in the demonstration plan. The soil on the airstrip was classified as a gravelly, sandy, red-brown clay.

41. After the blading operation was completed, the prewetting operation began utilizing a 1,000-gal water truck (Figure 21). This was the only available water truck at the time of the demonstration. The spray bar on the rear of the truck was modified by adding two 3-ft spray bar sections to the existing 6-ft spray bar which provided a total spray bar width of 12 ft. This modification matched the width of the asphalt distributor spray bar. The prewetting operation applied water to the airstrip in 1,000- by 12-ft sections. This procedure was used to maintain the prewetting operation ahead of the $MgCl_2$ application to ensure maximum $MgCl_2$ penetration. The modified water truck applied the water during the prewetting operation at an application rate of approximately 0.75 gal/sq yd. The high application rate was used based upon two major factors. First, the exposed hard soil was extremely dry and a lower application rate was not penetrating into the airstrip surface. Second, the wind and heat conditions in the area of the assault airstrip caused a fast evaporation rate of the water being applied.

42. The WES modified asphalt distributor was used to apply the $MgCl_2$ (Figure 22). As at Fort Irwin, the asphalt distributor was checked thoroughly and a test run conducted prior to the demonstration to ensure operability of all mechanisms. A total area of approximately 60,000 sq yd was treated with $MgCl_2$. No runoff of the brine solution was allowed into adjacent areas or drainage ditches.

43. The application of the $MgCl_2$ was accomplished by applying the material in the same 1,000- by 12-ft sections as the water in the prewetting operation. Again, this allowed maximum penetration of the $MgCl_2$ into the airstrip surface.

44. The $MgCl_2$ treated sections were allowed to cure approximately 24 to 36 hr. This curing period was necessary because of the clayey material present in the assault airstrip pavement structure and to maximize penetration of the $MgCl_2$ into the surface of the airstrip.

45. Following the cure period, a pneumatic rubber-tired roller (Figure 23) made six passes over the treated sections to compact the fine material and the gravelly material together. Following this rolling pattern, a steel wheel roller (Figure 24) in the nonvibratory mode was utilized, making two passes. This rolling pattern and procedure produced a smooth, tight surface on the assault airstrip.

46. During the final rolling phase of the demonstration, a heavy rain occurred with a total accumulation of approximately 2 in. in a 24-hr period. This rain caused the compacted surface to swell (Figure 25). After allowing the airstrip surface to dry and cure, an additional two passes of the pneumatic rubber-tired roller and one pass of the steel wheel roller in the nonvibratory mode were performed to ensure compaction of the surface fine material, and gravelly material was accomplished.

47. The final product was a smooth, well-compacted and relatively dust free landing surface (Figure 26).

48. Of special note during this project was the effect of overnight humidity on the $MgCl_2$ treated surface of the assault airstrip. The clayey material on the runway would absorb moisture from the cool, night air causing the surface to slightly swell and become sticky (Figure 27). As the sun and wind evaporated the excess moisture, the surface material would shrink and crack (Figure 28). Passing over the area with the steel wheel roller in the nonvibratory one time tightened this surface. The best overall surface occurred in areas where gravel complemented the clayey fines.

49. The dustproofed assault airstrip was trafficked by 31 sorties of the C-130 cargo aircraft which were combat loaded (Figure 29). The traffic occurred 2 days after the final rolling was completed which was the final phase of the demonstration project (Figure 30). General comments by members of the Air Force Airlift Control Element and the Army Combat Control Team were that there was an 85 to 95 percent reduction in dust and flight operations that improved 100 percent (Figure 31). The increase of flight operations safety and the effectiveness of the $MgCl_2$ also allowed the C-130 sorties to operate at night on the assault airstrip.

50. The tightly compacted airstrip surface provided a relatively dust free landing surface as depicted in Figure 32 by the black skid marks left by the C-130 landing gear tires (Figure 33).

51. Rutting of the assault airstrip surface was minimal and occurred at one area where a C-130 aircraft had bounced during a "hot" landing (Figure 34) and at the entrance to the parking apron where the force of the nose gear turning caused some damaged (Figure 35). This minor rutting did not affect the flight operations. These areas were repaired with minimal equipment and manpower after the flight operations had been completed. The repair procedure was a simple wetting of the rutted area which allowed the $MgCl_2$ present in the

surface material to "melt" the damaged area back together (Figure 36). A cure period of approximately 24 hr was accomplished, and then two passes of the pneumatic rubber-tired roller and one pass of the steel wheel roller in the nonvibratory mode completed the repair.

52. It is important to note that no blading with motor graders of the assault airstrip was necessary after completion of the C-130 sorties, which is normally a maintenance requirement on most unsurfaced military assault airstrips following the C-130 operations.

53. The 60,000 sq yd area on Arrowhead Assault Airstrip at Fort Chaffee was treated with a total of 26,000 gal of the $MgCl_2$ brine solution. The average application rate was 0.43 gal/sq yd. This application rate was within the recommended application rate of 0.42 to 0.50 gal/sq yd. The cost per gallon was approximately 0.57 cents/gal for a treatment expense of approximately 0.25 cents/sq yd. The higher cost of the $MgCl_2$ compared between Fort Irwin and Fort Chaffee was that of the shipping cost to Fort Chaffee.

PART V: KEY FACTORS FOR DUSTPROOFING

54. Some of the key factors recommended for a successful dustproofing project are:

- a. Order enough dust control material for the selected areas to be treated at an application rate of not more than 0.50 gal/sq yd.
- b. Be sure to plan the project so that equipment and personnel are available to complete the preparation and application procedures in a step by step process.
- c. Ensure that storage facilities for the dust control material are near the project site.
- d. Check to ensure that the equipment to be used during the project is in operating order and a test run of both the water truck and distributor is accomplished to verify flow and application rates.
- e. Plan to compact the area to be treated with a pneumatic rubber-tired roller both before and after treatment.
- f. If dustproofing an airstrip or helipad, plan to compact the treated area with both a pneumatic rubber-tired roller and a steel wheel roller in the nonvibratory mode.
- g. During application of the dust control material, ensure there is a 6- to 12-in.-overlap of the spray bar on treated sections.
- h. Ensure that commanders of units that traffic the treated areas know that vehicles and aircraft should be washed during the after operations preventive maintenance period. $MgCl_2$ is a mildly corrosive material.
- i. If there is an extended period of little or no rainfall or periods of humidity less than 30 percent, a light application of water at approximately 0.10 to 0.20 gal/sq yd will reactivate the $MgCl_2$. Periodic watering during the dry period of approximately once or twice a month should be sufficient.
- j. The modification to an asphalt distributor costs approximately \$200. The schematic shown in Figure 8 indicates the modifications to the pump for external lubrication. The pump is lubricated twice a day to ensure proper operation of the mechanism and then flushed and lubricated at the end of the project.
- k. The $MgCl_2$ will provide dust control on the areas treated for approximately 8 to 12 months with minimal maintenance. The duration of dust control will depend on the type and amount of actual traffic and the weather extremes experienced over the treated areas. However, deterioration of the treated areas will begin at approximately 3 months after treatment.
- l. $MgCl_2$ can be over sprayed with more $MgCl_2$ if required. Succeeding treatments are placed at an application rate of 0.25 to 0.30 gal/sq yd. Some buildup or accumulation of the dust control material will occur in the treated area resulting in longer periods of dust control effectiveness.

PART VI: ECONOMICS

55. A fact sheet was prepared for $MgCl_2$ (Appendix C) and was available for interested personnel. Applying $MgCl_2$ purchased at the bulk rate with no associated freight costs (the price is listed FOB Ogden, Utah) amounts to a material cost in place of $0.11/sq yd.

56. $MgCl_2$ is the most economically known product for controlling dust under tracked vehicles on cohesionless (sand and gravel) soils. It is not effective on totally fine-grain soils. Product $MgCl_2$ (Appendix D) will leach with rainfall, and in the southeast United States, the effectiveness of a 0.5-gal/sq yd application is reduced approximately 50 percent following a year's annual rainfall (50 to 60 in.). In the southwest United States, the effectiveness of the same application rate as the southeast United States is reduced approximately 50 percent following 4 months of low humidity (humidity less than 30 percent).

57. The design life of $MgCl_2$ is greatly enhanced when effort is directed to compacting the surface before treatment. $MgCl_2$ imparts little strength to the overall pavement structure.

58. Evidence exists that $MgCl_2$ treated areas benefit from successive treatments and from periodic maintenance (watering).

PART VII: ADVANTAGES AND DISADVANTAGES

59. Reduction in the migration of the fine materials in the surface of an unsurfaced pavement (i.e. controlling dust) will reduce the formation of ruts caused when sufficient fines are displaced to render the larger particles unstable. By limiting the instability of the fine material and postponing the formation of ruts, the need for blading, compacting, etc., is substantially decreased resulting in lower maintenance costs. Actual dollar savings will vary with location and weather extremes during the period of observation. During a previous demonstration project utilizing $MgCl_2$, blading of the treated project site was reduced from 12 to 4 times a year at the installation.*

60. $MgCl_2$ has received limited evaluation as to its environmental influence. The practice of spraying the material with a spray bar height of 6 to 10 in. above the roadway and ensuring the material is sprayed only on the roadbed with no runoff permitted provide an environmentally acceptable procedure and product. $MgCl_2$ is known to leach out of the treated material with time; however, a long time and considerable rainfall is required.**,†

61. A dust control surface is not designed in the same sense as engineering projects. A dustproofing material is selected depending on cost, type traffic, soil type, and weather extremes. The material is applied at a rate that avoids all runoff and does not exceed 0.50 gal/sq yd. Maintenance or additional applications are scheduled as required depending on actual use and existing weather conditions. A combined Army and Air Force dust control manual exists for assistance.††

62. $MgCl_2$ provides a finite period of dust control on unsurfaced pavement structures which improve vehicle operator safety and aircraft landing visibility, substantially increase flight operations, and decrease the dust signature of vehicles and aircraft.

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* See paragraph 3 for reference.

** See paragraph 18 for reference.

† T. D. Houston, Jr. 1983 (Jul). "In-Place Performance Test, Evaluation Studies, Investigation of Magnesium Chloride for Dust Control," Technical Report V2 0092-2-J, Directorate of Engineering and Housing, Fort Stewart, Ga.

†† See paragraph 14 for reference.

PART VIII: CONCLUSIONS AND RECOMMENDATIONS

Conclusions

63. During these demonstrations, the $MgCl_2$ treated sections provided a relatively dust free, unpaved riding surface. The lack of dust clouds and suspended dust could result in less wear and maintenance on engines, propellers, turbines, and sensitive mounted equipment in vehicles and aircraft. The dollar savings could be substantial in the long term.

64. Aircraft landing signatures (dust clouds) and vehicle signatures (suspended dust) provide an enemy with recognizable indications of assault airstrips and vehicle movements in a tactical scenario. $MgCl_2$ could provide a finite period of dust control in rear area operations that may have an overall impact on the battlefield and provide the surprise and tactical supremacy at a given point in time.

65. These demonstrations have utilized $MgCl_2$ in the brine solution form. $MgCl_2$ is also produced in the dry form (pellet or snowflake). In the dry form, it has been used in the northern United States as a road deicer. This dry form may be an acceptable bulk material for dust control if applied on unsurfaced roads like a fertilizer then over sprayed with water.

66. The application and performance of $MgCl_2$ was demonstrated at Fort Irwin, Calif., and Fort Chaffee, Ark. The method of application, equipment required, and labor necessary to conduct a dust control project was described and explained. A videotape report was prepared for those DOD personnel who are interested in the dustproofing procedures described in this report but could not attend the demonstration. $MgCl_2$ was observed to control dust, and the advantages and disadvantages of $MgCl_2$, including cost, were presented.

67. $MgCl_2$ is a viable dustproofing material that should be considered for use on Government unsurfaced roads and airstrips.

Recommendations

68. Three key recommendations for future studies have been identified. It is encumbent upon the research community to pursue the following:

a. An equipment impact study that would determine the net result of $MgCl_2$ in the reduction of wear and maintenance on vehicles and aircraft overall.

b. A project in Central America that would indicate the decrease in landing and vehicle signatures utilizing $MgCl_2$ on unsurfaced assault airstrips and roads.

c. A study which would determine the procedure for application of dust control materials in dry form and their effectiveness.

Figure 1. Armored Personnel Carriers (APC) generating dust

Figure 2. Downwash from helicopter rotor blades causing dust

Figure 3. C-130 aircraft generating dust clouds upon landing

Figure 4. APC generating dust at Fort Irwin

Figure 5. Dust engulfing C-130 aircraft landing on assault airstrip at Fort Chaffee

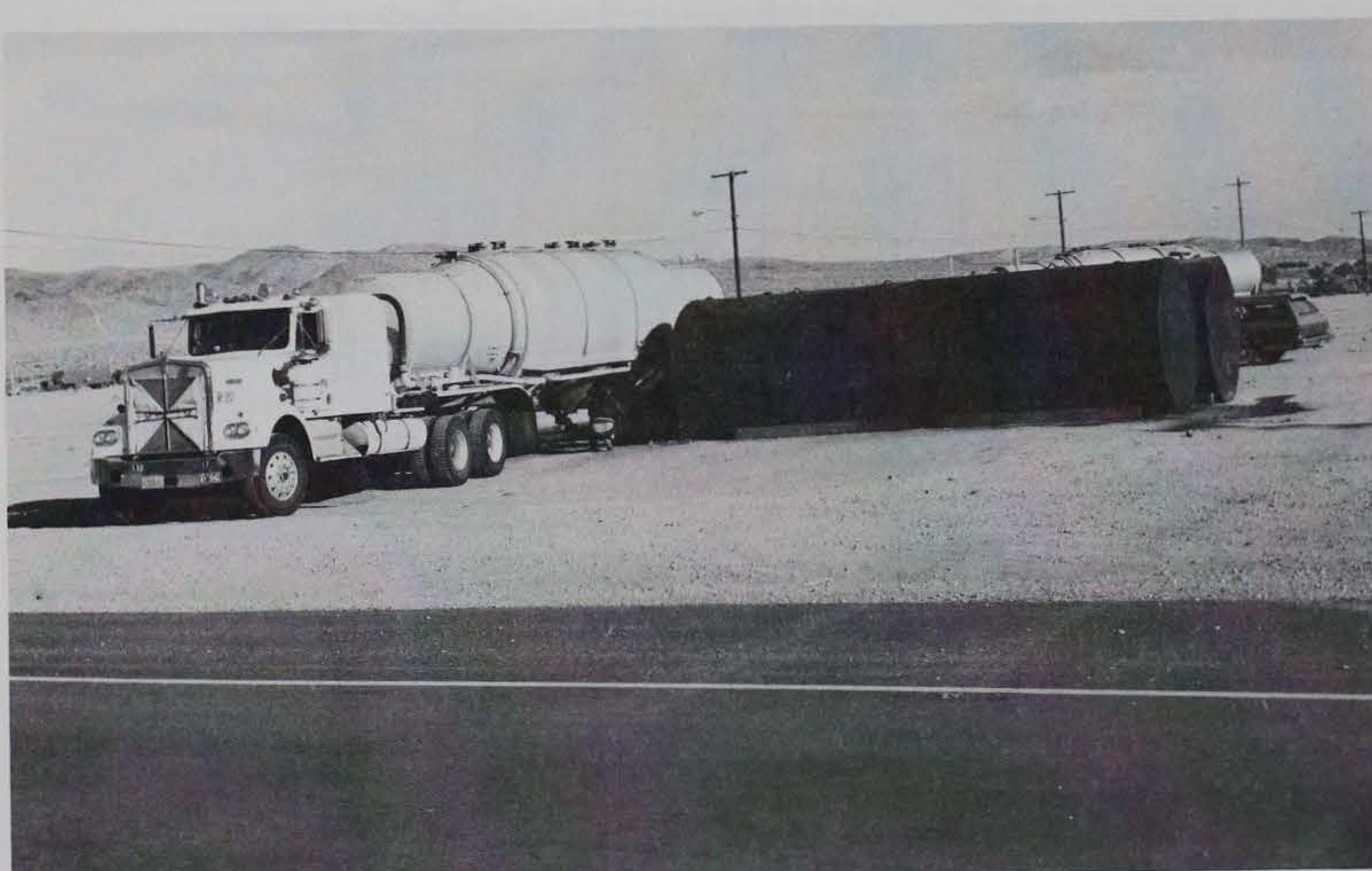

Figure 6. A 5,000-gal tanker unloading $MgCl_2$ at Fort Irwin

Figure 7. Railroad supertanker car being readied for unloading

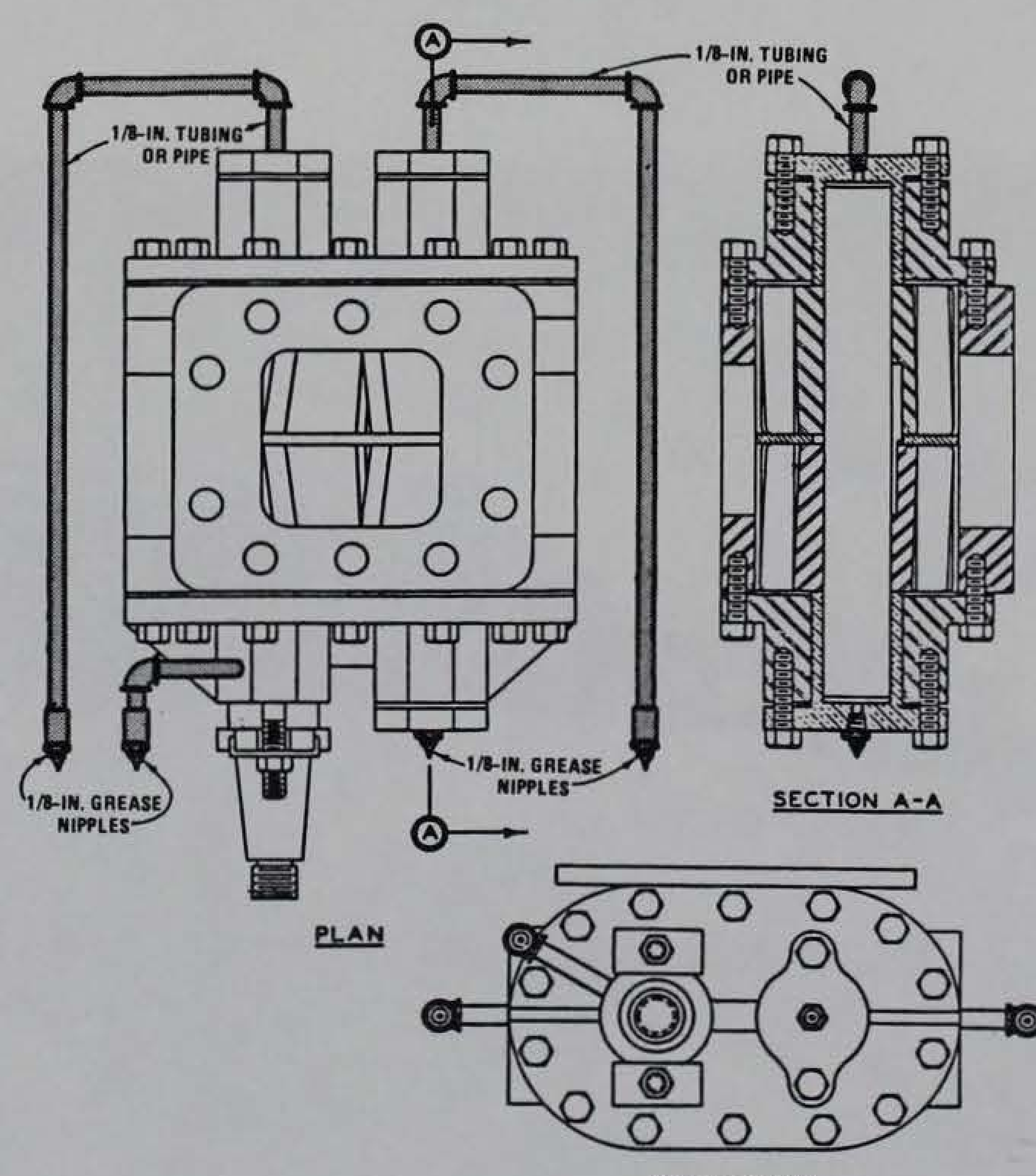

Figure 8. Positive displacement pump modifications

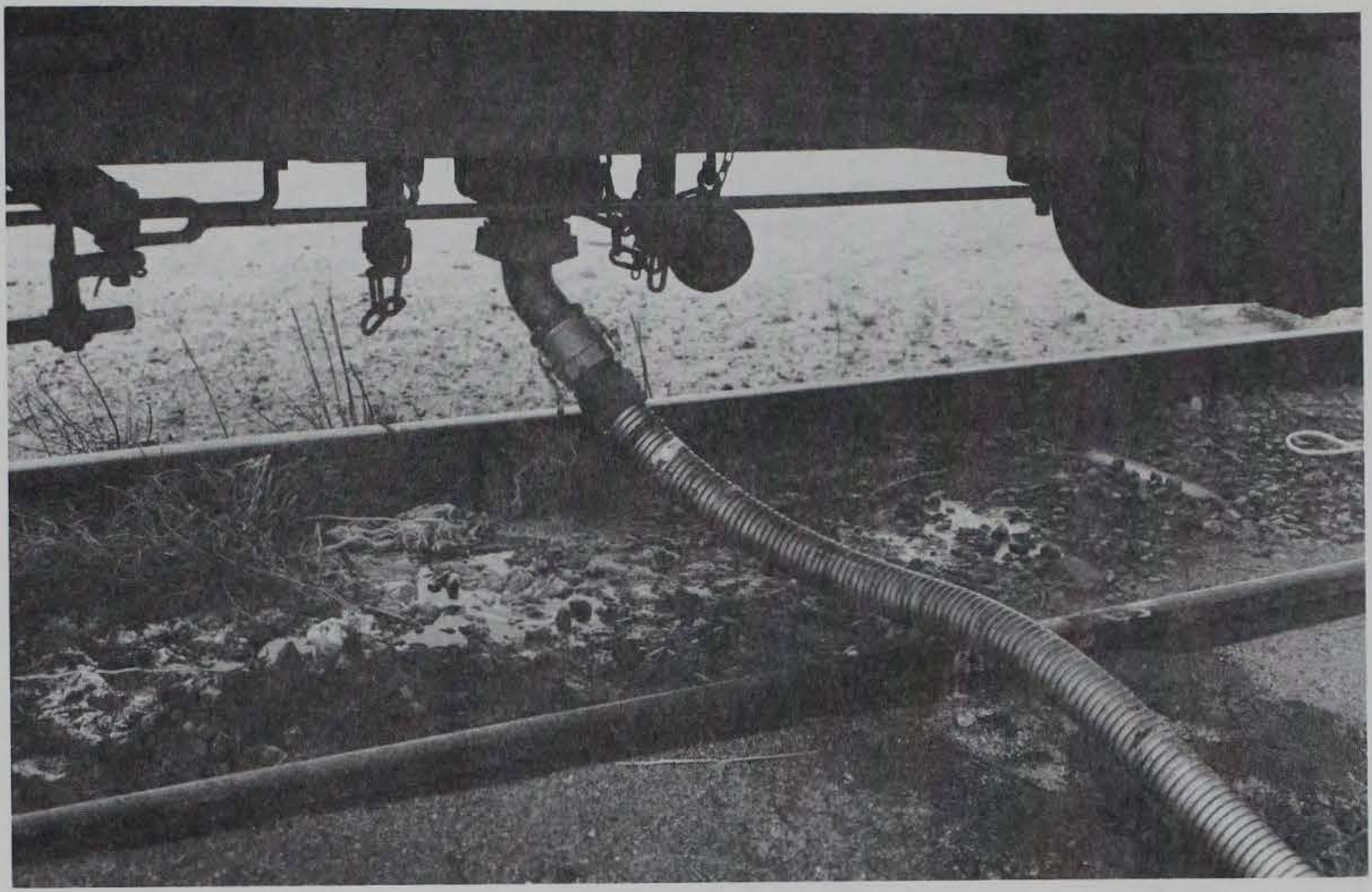

Figure 9. Plumbing attachments for railroad tank car with the 45 deg pipe collar

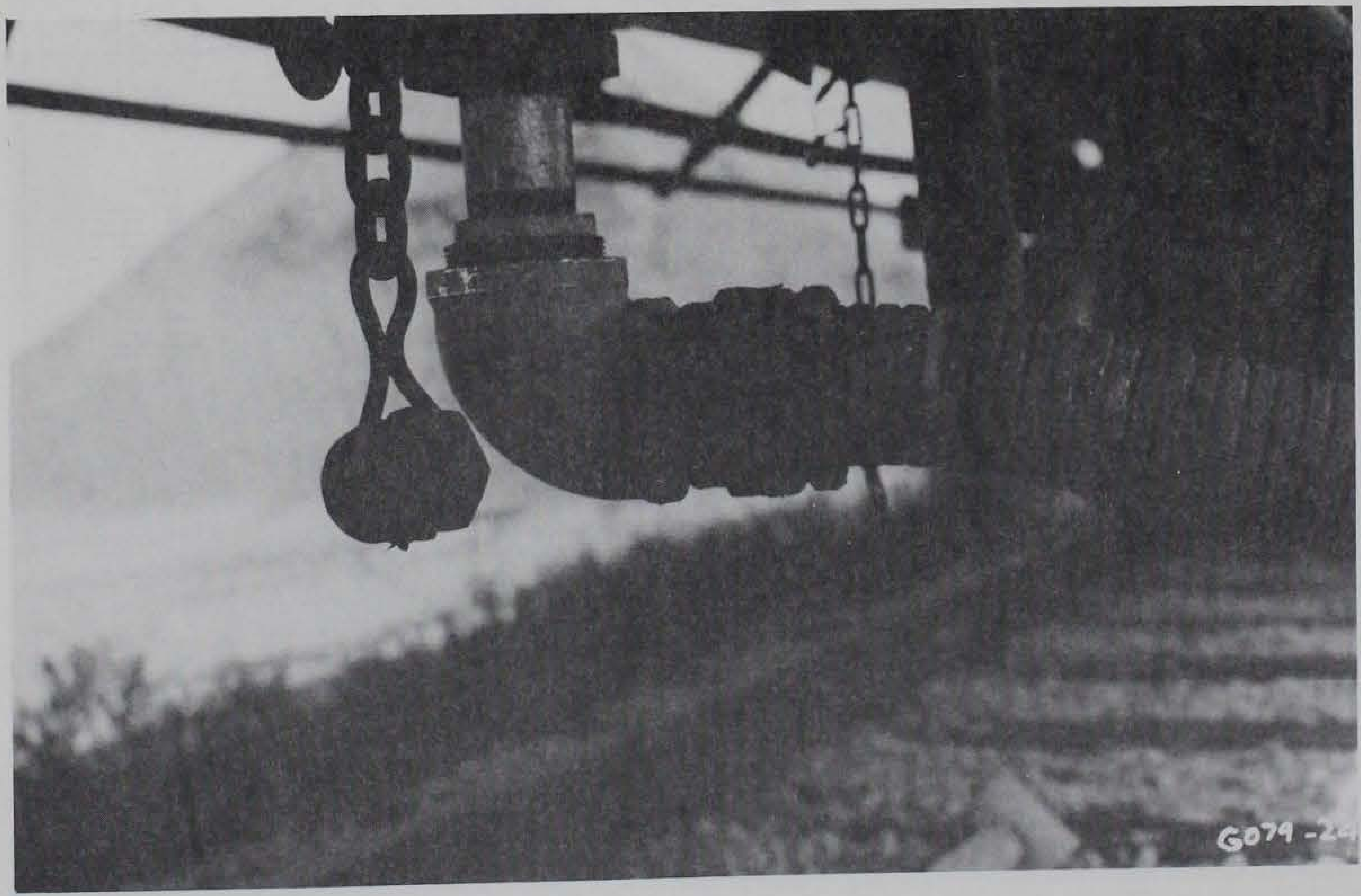

Figure 10. Pipe fittings for railroad tank car

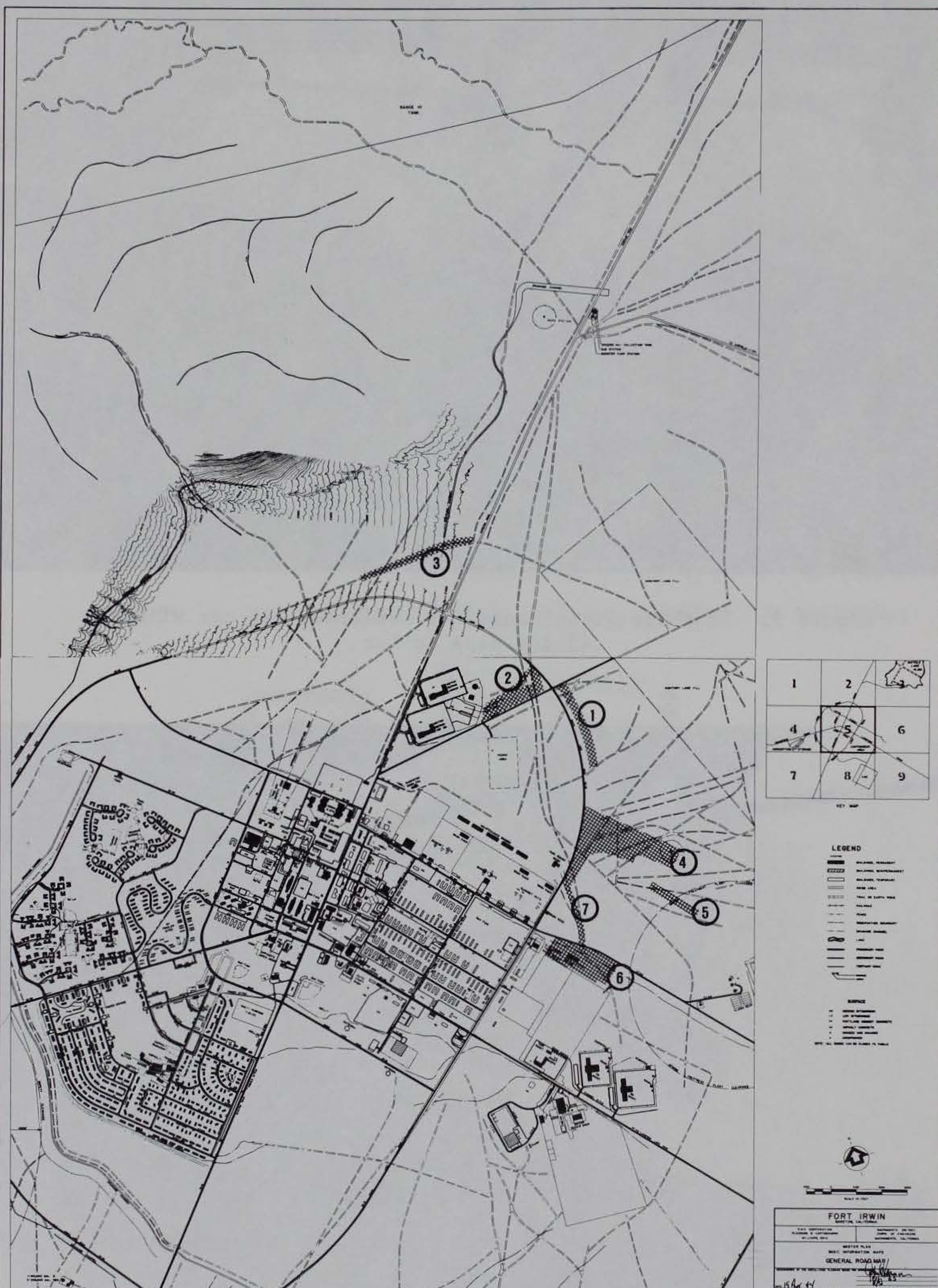

Figure 11. Fort Irwin areas selected for treatment with $MgCl_2$

Figure 12. Typical vehicles that traffic areas to be treated at Fort Irwin

Figure 13. Motor grader removing loose excess surface material

Figure 14. A 5,000-gal water truck prewetting area to be treated

Figure 15. WES modified asphalt distributor applying $MgCl_2$ at Fort Irwin

Figure 16. WES distributor loading $MgCl_2$ from storage tanks

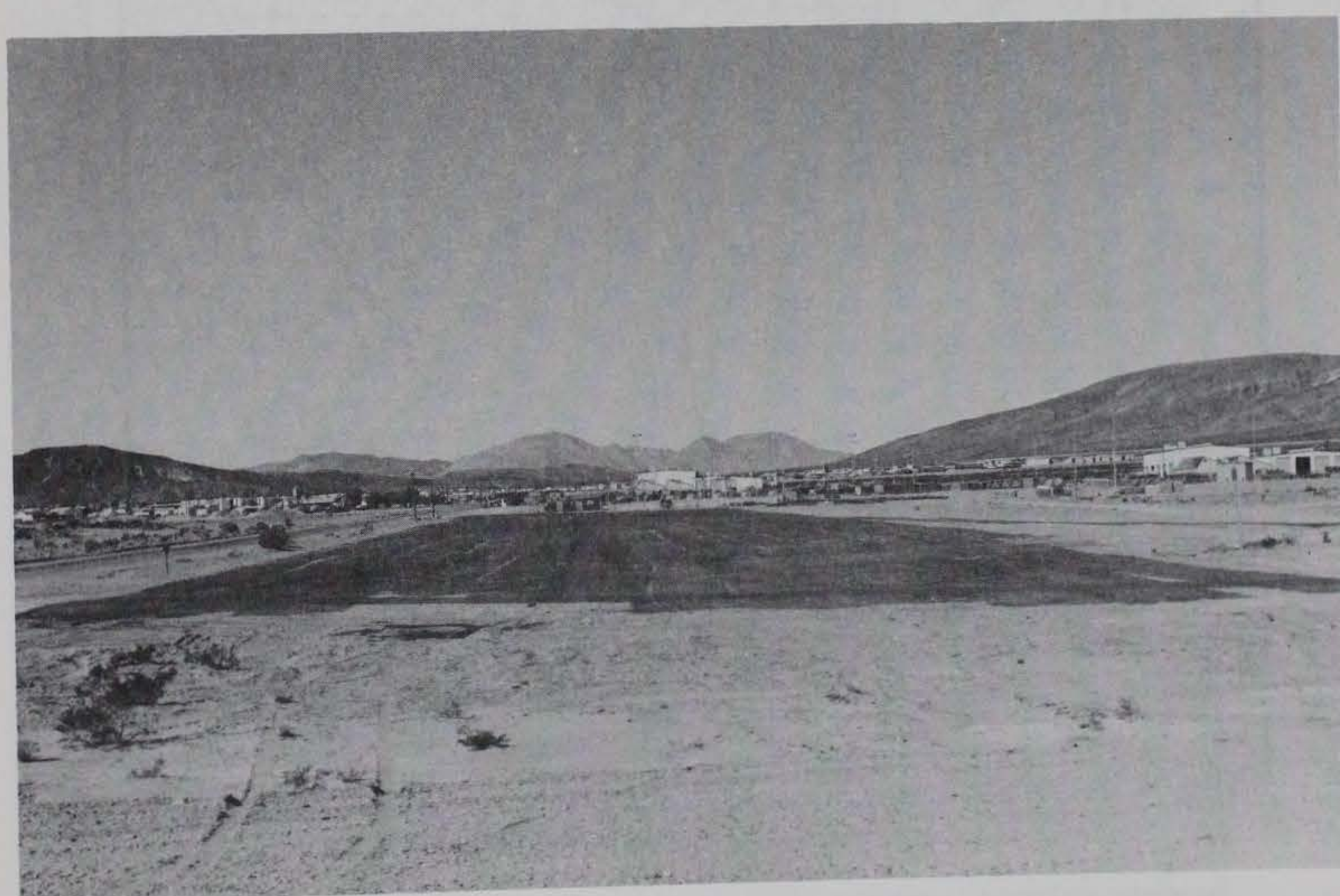

Figure 17. Area 6 at Fort Irwin after treatment with $MgCl_2$

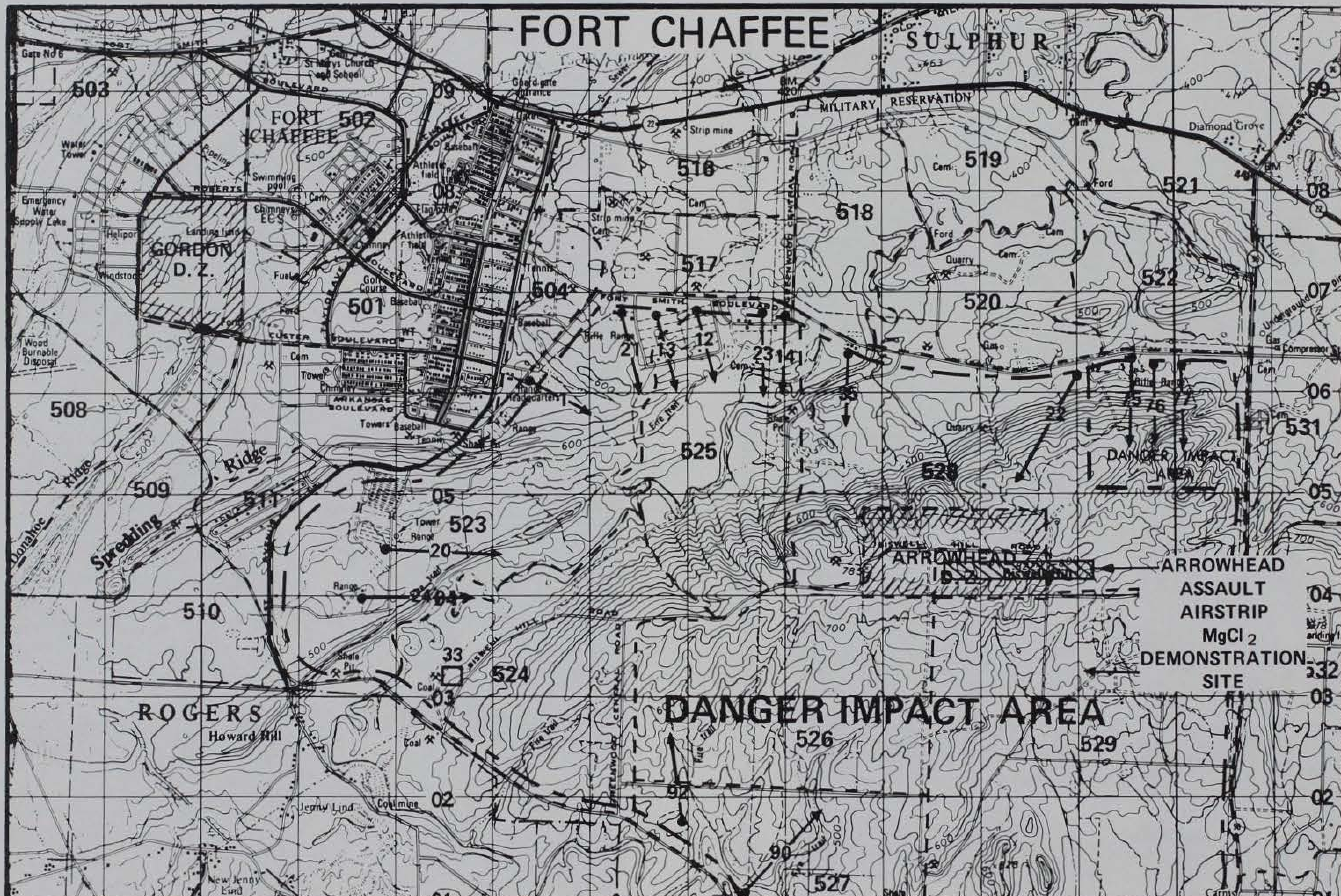

Figure 18. Fort Chaffee reservation and Arrowhead Assault Airstrip

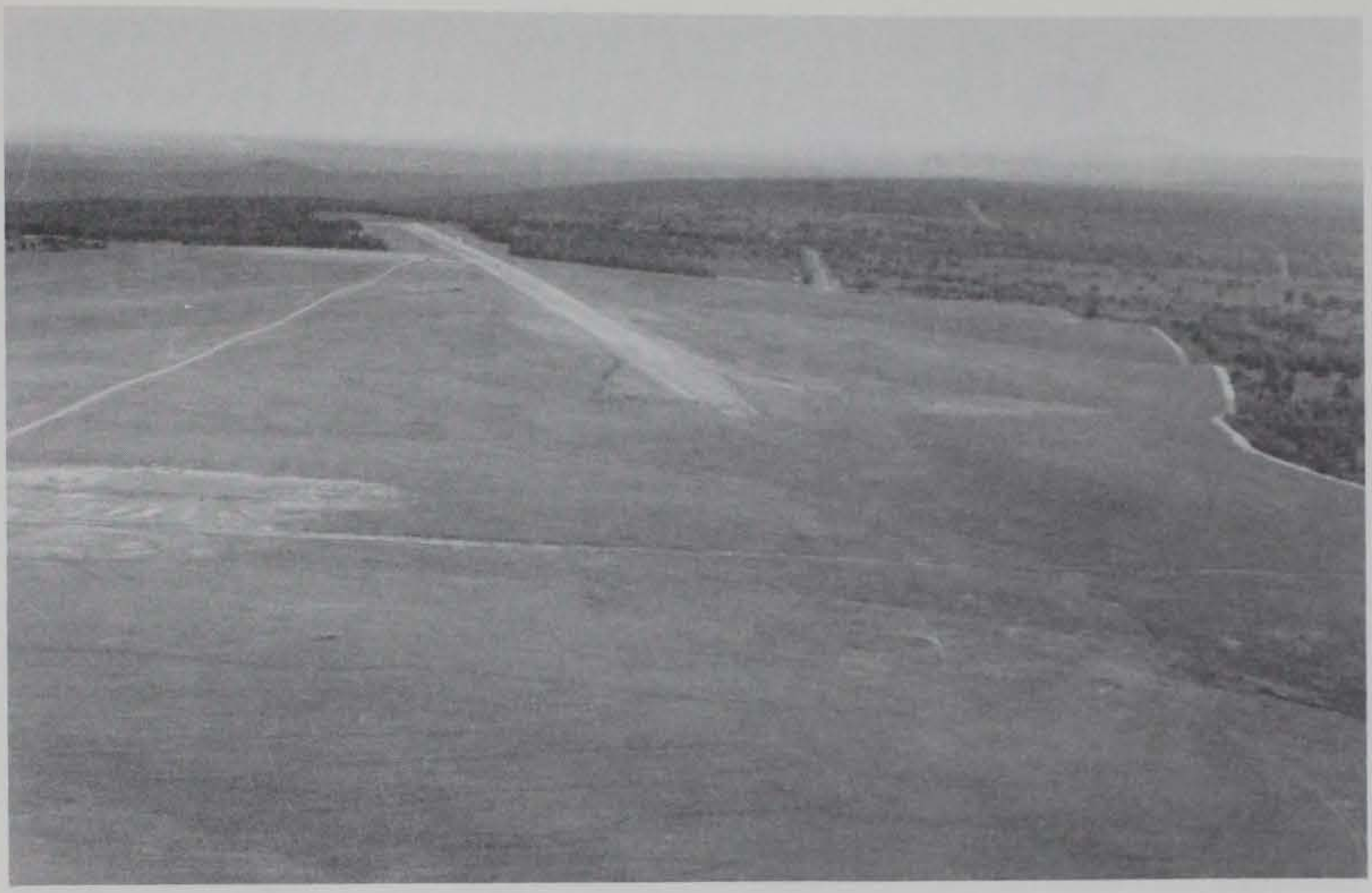

Figure 19. Aerial view of the assault airstrip at Fort Chaffee

Figure 20. Motor graders operating in tandem removing excess surface material and ruts

Figure 21. Prewetting the airstrip surface with a 1,000-gal water truck

Figure 22. WES modified asphalt distributor applying $MgCl_2$ at Fort Chaffee

Figure 23. Pneumatic rubber-tired roller compacting the $MgCl_2$ treated airstrip surface

Figure 24. Steel wheel roller completing the finish rolling of the airstrip

Figure 25. Airstrip surface showing surface swell and some puddling

Figure 26. East end of airstrip looking west

Figure 27. One small area of the sticky, clayey material

Figure 28. Airstrip surface showing some shrinkage cracks beginning to form

Figure 29. C-130 aircraft landing on Arrowhead Assault Airstrip (Note the lack of dust clouds)

Figure 30. C-130 aircraft operating on the treated airstrip

Figure 31. The C-130 aircraft landing on the treated airstrip

Figure 32. Black skid marks from the C-130 landing gear

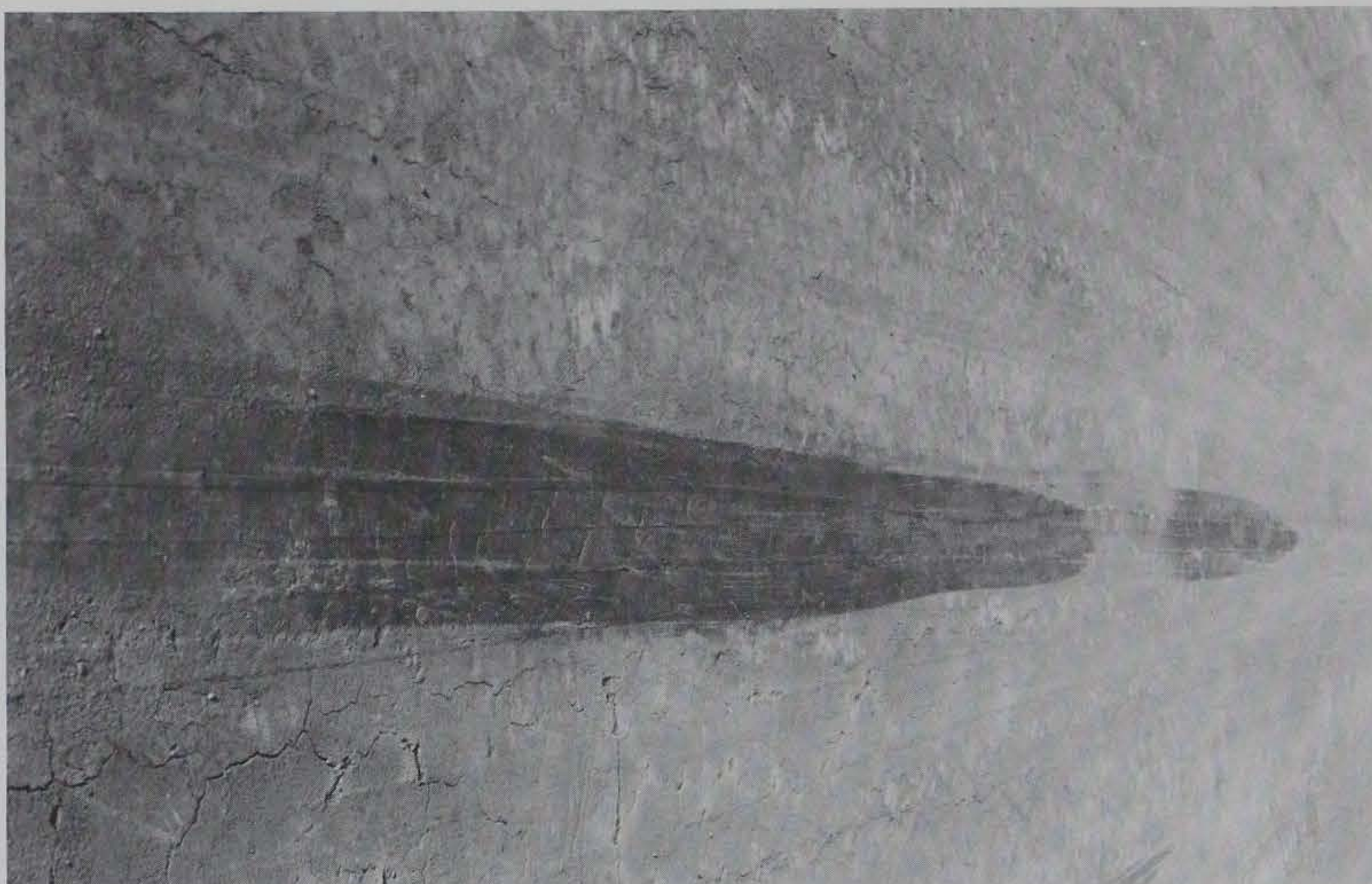

Figure 33. Close-up of one of the skid marks

Figure 34. Minor rutting of airstrip surface where a C-130 aircraft bounced during a hot landing

Figure 35. Nose gear ruts at the entrance to the parking apron

Figure 36. Wetting a damaged area by applying a light coat of water and allowing the treated material to melt back together

APPENDIX A: POINTS OF CONTACT

Directorate of Engineering and Housing
HQ, 24th Infantry Division (Mechanized) and Fort Stewart
ATTN: AFZP-FE/Mr. T. D. Houston
Fort Stewart, Ga. 31313-5000

Directorate of Engineering and Housing
ATTN: ATZC-DEH-C/Mr. Enrique Rey
Box 1163
Fort Bliss, Tex. 79916-5000

Directorate of Engineering and Housing
National Training Center
ATTN: AFZJ-FE/ATTN: Mr. W. Cassidy
Fort Irwin, Calif. 92310-5000

Directorate of Facilities and Engineering
US Army Garrison
ATTN: Chief, Roads and Grounds/Mr. James Lowe
Fort Chaffee, Ark. 72905-5000

US Army Engineer Waterways Experiment Station
ATTN: WESGP-EM/Mr. Jeff Armstrong
PO Box 631
Vicksburg, Miss. 39180-0631

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CDRUSAEWES VICKSBURG MS //WESGP-IM//

CDR FORSCOM FT MCPHERSON GA

HQ MAC SCOTT AFB IL

HQ SAC OFFUTT AFB NE

HQ AFESC TYNDALL AFB FL

HQ AF LOGISTICS COMMAND WRIGHT-PATTERSON AFB OH

INFO CDR TRADOC FT MONROE VA

UNCLAS

SUBJ: USE OF MAGNESIUM CHLORIDE AT FT CHAFFEE, AR, 27-30 SEP 85

A. REF TM 5-830-3/AFM 88-77 (DRAFT), DUST CONTROL

1. MAGNESIUM CHLORIDE IN A BRINE SOLUTION IS BEING UTILIZED AS A DUST CONTROL AGENT ON UNSURFACED TANK TRAILS, MOTOR PARKS, ASSAULT AIRSTRIPS AND HELIPADS AT FT CHAFFEE, AR, 27-30 SEP 85. IN REF IT IS LISTED AS A SALT IN WATER EMULSION.

2. THIS DUST CONTROL AGENT HAS BEEN SUCCESSFULLY DEMONSTRATED AT INSTALLATIONS IN BOTH CONUS AND OCONUS.

3. CHLORIDES IN SOLUTION ARE CONSIDERED CORROSIVE IN NATURE AND COULD EFFECT EXPOSED METAL ON VEHICLES AND/OR AIRCRAFT THAT TRAFFIC AREAS THAT HAVE BEEN TREATED WITH THIS TYPE BRINE SOLUTION.

4. IT IS RECOMMENDED THAT COMMANDERS WHOSE VEHICLES AND/OR AIRCRAFT

CPT ROBERT A. HASS, RESEARCH & DEVELOPMENT COORDINATOR, WESGP-IM
(601) 634-2955/FTS 542-2955

COL ALLEN GRUM, DIRECTOR
(601) 634-2513/FTS 542-2513

UNCLASSIFIED

JOINT MESSAGEFORM | UNCLASSIFIED

02 02 171530Z SEP 85 RR RR UUUU AT ZYUW

TRAFFIC TREATED AREAS ENSURE THAT THEIR EQUIPMENT IS WASHED IN THE AFTER OPERATIONS PREVENTATIVE MAINTENANCE PERIOD.

5. REQUEST DISSEMINATION TO SUBORDINATE COMMANDS AND UNITS.

6. POC THIS HQ IS CPT R. A. HASS, COMMERCIAL TELEPHONE (601) 634-2955, FTS 542-2955, OR AV 782-5011 EXT 2955.

DISTR

DRAFTER TYPED NAME TITLE OFFICE SYMBOL PHONE

SPECIAL INSTRUCTIONS

RELEASER TYPED NAME TITLE OFFICE SYMBOL AND PHONE

SIGNATURE

SECURITY CLASSIFICATION UNCLASSIFIED

DATE TIME GROUP

APPENDIX C: FACT SHEET

Product Trade Name:	Dustgard
Supplier:	Great Salt Lakes Mineral and Chemical Corporation PO Box 1190 Ogden, Utah 84402 800-453-4515
Contact:	Mr. Gene Hansen
Description:	Dustgard is a liquid brine composed mainly of $MgCl_2$ with other inorganic elements
Dilution:	None - applied as received
Application Rate:	0.5 gal/sq yd
Cost:	FTA project - $33.54/drum; bulk cost - $39/ton FOB Ogden, Utah
General:	This material is a liquid brine by-product of the Great Salt Lakes Mineral and Chemical Corporation mining operation. It is an amber liquid easily sprayed and mildly corrosive but harmless with basic hygiene practices.

APPENDIX D: PRODUCT $MgCl_2$

Product Specifications

Chemical

Major Constituents	Typical Analysis,* %	Limits Minimum	Limits Maximum
$MgCl_2$	32.0	28	35
SO_4	2.5	+1	
K	0.3	--	
Na	0.3	--	
Ca	0.05	--	
Water	Varies	--	

Total 100.00 percent

Minor Elements	Typical Analysis*
Li	600 ppm
B	500 ppm
Br	900 ppm
Fe	< 1 ppm
Ni	< 1 ppm
Cu	< 1 ppm
Zn	< 1 ppm
As	< 0.5 ppm

Physical

1 gal = 10.8 lb

Specific Gravity = 1.30±0.05

Viscosity = 5 cycles/sec @ 77°F

* Weight brine basis (a standard identification test procedure).