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RICHARD E. BLUBAUGH
Vice President Environmental
and Governmental Affairs

October 16, 1996

40-3453

VIA FEDERAL EXPRESS - PRIORITY
Mr. Daniel Gillen, Acting Chief
U.S. NUCLEAR REGULATORY COMMISSION
High-Level Waste & Uranium Projects Branch (MS T7-J9)
Division of Waste Management
Office of Nuclear Safety & Safeguards
Washington, D.C. 20555-0001

Re: Transmittal of Atlas Corporation's *As-Built Construction Report for the Completion of the Interim Cover*

Dear Mr. Gillen:

Enclosed please find five (5) copies of the *As-Built Construction Report for the Completion of the Interim Cover* for Atlas Corporation's (Atlas) Uranium Mill and Tailings site in Moab, Utah. There were extenuating circumstances which prevented us from providing this report earlier. We regret the delay and hope it does not create any inconvenience.

Please do not hesitate to contact me should there be any questions regarding this report.

Sincerely,

Judith E. Bowen
for Richard E. Blubaugh

Enclosure

cc: D. Edwards, G. Ohland
cc w/o encl.: B. Hassinger, R. Pattison

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As-Built Construction Report for the Completion of the Interim Tailings Cover

Background Information

The Uranium Reduction Company started discharging uranium mill tailings to the existing pile in 1956. Atlas Corporation bought the mill in 1962 and continued to discharge tailings until March 1984 when it placed the mill on standby. Thereafter, no more tailings were produced and the mill was permanently closed in 1988. A total of about 10.5 million tons of tailings now exist covering 130 acres, up to 100 feet deep.

Atlas started the interim cover work in 1989 by placing a minimum 12 inch thickness of clean dirt and low grade ore over a portion of the exposed tailings beaches. The purpose of this work was to eliminate the possibility of blowing tailings and to reduce the radon flux from the bare tailings. Atlas placed this cover in several stages, the first stage next to the embankment and succeeding stages closer to the center of the pile. At first there were no problems, however, during the last stage in 1994 when the work was about 80%[1] complete the project was put on hold due to cover instability.

Also, in 1992, Atlas contracted for the completion of the mill decommissioning, which involved removing remaining equipment and tearing down mill structures. Materials were both shipped off site for re-use or recycling after decontamination and buried (the unsalvageable materials) in the south corner of the tailings pile, shown in Figure 1. Atlas completed this work in May 1996 except for the old office, workshop, and warehouse building, which was retained for use during final reclamation.

To understand the interim cover instability problems Atlas met with, it is first necessary to understand how tailings were deposited in the impoundment. During operations, a single discharge pipe around the full length of the embankment top was used. This pipe was fitted with frequently spaced spigots for alternately discharging tailings to form uniform beaches. These beaches mainly consisted of the faster settling coarser particles, or sands; the finer particles, or slimes, flowed into the pool with the tailings solution and settled much more slowly.

Due to the original natural topography, the starter dikes were only built around the lower elevations of the present pile. The slimes-bearing mill solutions then flowed to the opposite side to form a pool against the natural slope, with most of the slimes settling in the pool. Each succeeding dike, or embankment raise, enclosed a greater portion of the tailings perimeter to provide better containment of the tailings until, ultimately, the dike almost surrounded the pile by a full 360°.

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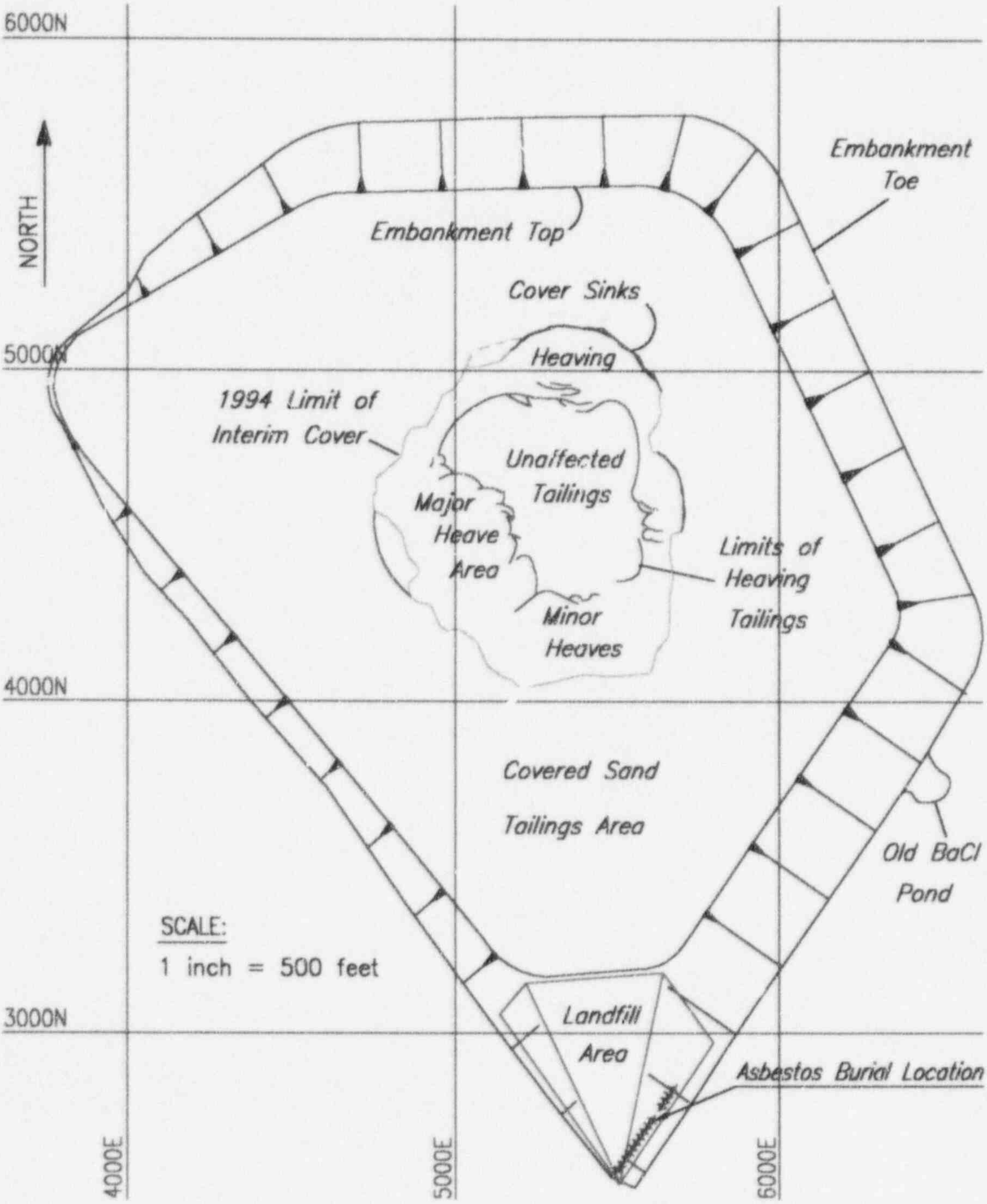
[1] 17.1 acres of the original 90 acre top surface remained uncovered.

Figure 1: The Atlas Tailings Pile Showing the 1994 Limit of Cover and the 1996 Landfill Area



Atlas extended the spigot system after each of these raises to deposit sand tailings over the previously deposited perimeter slimes, thus providing an overlaying blanket of weight for faster slimes consolidation.

Sand tailings beaches totally enclosed the tailings pile by 1979 and subsequent precipitation runoff and supernatant tailings solutions then invariably flowed towards the center of the pile. This helped to consolidate, or stabilize, the underlying slimes layers within several hundred feet of the embankments that probably now act as very good seepage barriers. Moreover, it is now probable that the only unconsolidated mass in the tailings pile is the central slimes portion: roughly 25 acres, at the most.

Except for a possible relatively minor seepage loss, Atlas has retained all mill solutions and precipitation within this tailings "bowl" since 1977. The only liquid that has entered the pile since 1987, when Atlas ceased adding freshwater, is direct precipitation runoff. In Moab's dry climate[2] the pond was first evaporated dry in 1993. Evaporation of the upward-seeping solutions from near-surface[3] saturated slimes has continued until three to six inch thick salt crusts formed over the slimes by the summer of 1995, thus contributing to the progressive stabilization of the central slimes tailings area.

As previously mentioned, Atlas experienced no settlement problems in covering the sand-sized tailings. However, as work continued towards the central area of unconsolidated slimes it became increasingly difficult, due to global failures of the cover material. In the typical mode of failure the fill simply sank into the slimes as shown in Figure 2. Another type of failure occurred in which the leading edge of the fill sank into the slimes causing tension cracks several yards back in the fill. The trailing edge of the fill in front of these cracks then had no strength and thus also sank into the slimes. In this case the fill appeared to fail by shearing.

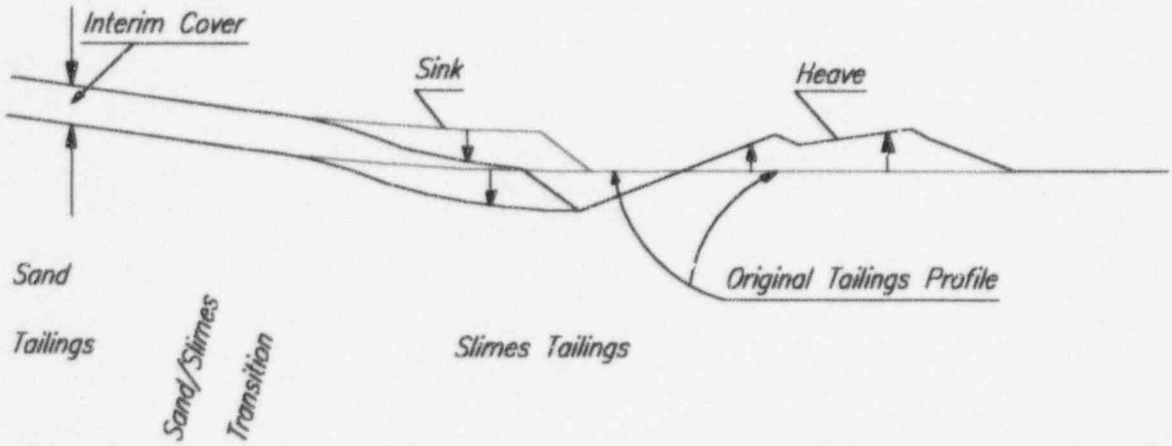
Nevertheless, in all cases the volume and weight of cover material sinking into the slimes simultaneously caused the tailings in front of the leading edge of the fill to rise, or heave, above the tailings pool level, in some cases as much as four feet (see Figure 1). Only about 7-8 acres were unaffected. Adding more fill only made matters worse. In addition, using lighter weight, low ground pressure (LGP) equipment did not help much because it was the weight of the cover that was the main problem. These global failures occurred because the underlying slimes tailings were less able to support the cover weight than the sand tailings. Furthermore, although the salt crust could support a person's weight, it could not support the weight of thick earth cover or heavy equipment due to the unconsoli-

[2] Annual pan evaporation rate is 60 inches and rainfall is about 8 inches.

[3] The capillary rise in unconsolidated silts that are as fine as Atlas' slimes can be as much as seven feet, or more – *Groundwater Hydrology, by David Keith Todd, Table 2.4 on page 35.*

dated, weak nature of the underlying saturated slimes. Atlas therefore investigated different methods to overcome the problem during 1994 and 1995. This included various methods of accelerating the de-watering of the slimes and of using different types of reinforcing materials.

Figure 2: Typical Mode of Cover Failure

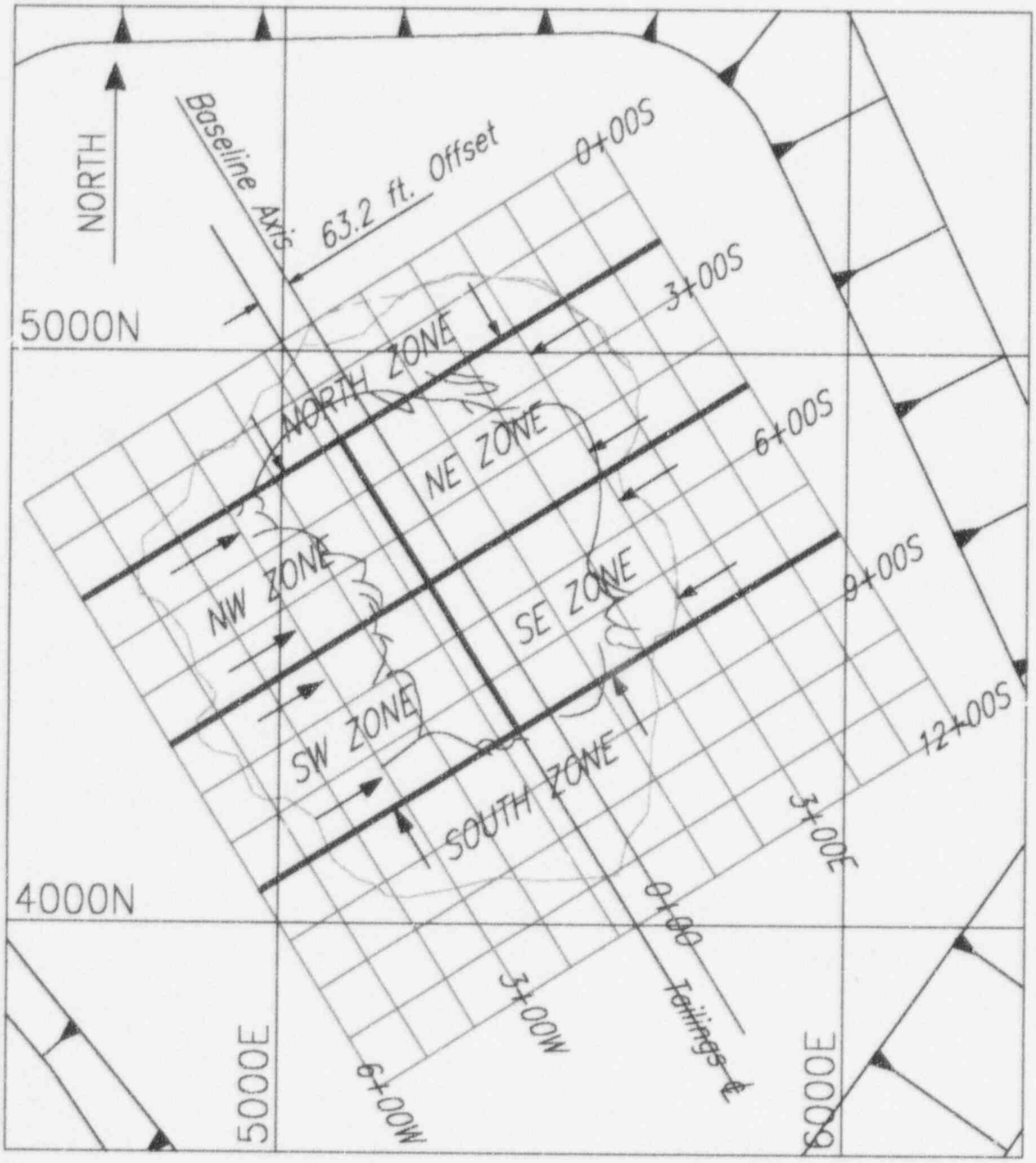


Atlas and Smith Environmental concluded that accelerated de-watering would not be feasible to implement before it was necessary to complete the interim cover. Instead, they chose to use a biaxial geogrid material (Biaxial Geo-grid BX1100), supplied by Tensar Environmental Systems, to provide reinforcing support for the cover and the best chance to prevent further global failures. This geogrid consists of high density polypropylene that has high flexural rigidity and tensile strength relative to the cover dirt. To complement the biaxial geogrid it was also necessary to use low weight LPG equipment. The work of completing the interim tailings cover using this reinforcing geogrid is described in this report, which includes problems met and what was done to overcome them.

Preparation Work

A pre-bid site inspection and meeting were held with earthmoving contractors and Tensar engineers on August 1, 1995, in which the contractors were instructed on the precautions needed to maximize the chances of success and how the work was intended to be done. The longitudinal baseline axis of the geogrid area was marked out that day and surveyors accurately placed 100-foot grid stake markers on the following day as shown in Figure 3. Five hundred and fifteen rolls of geogrid were ordered: 487 rolls to cover the 18 acres of exposed tailings and failed cover areas and 28 rolls for 1,530 feet of proposed roadways.

Figure 3: Details of the Slimes Cover Area



DRAWING SCALE: 1 inch = 300 feet

In spite of the precise manner in which the work was expected to be done, the successful contractor did not agree and, after many lengthy discussions, a mutually acceptable method of doing the work could not be reached. Since the geogrids arrived at the mill on September 18,1995, another contractor had to be selected by September 26, 1995, to get things moving and to get the required

equipment. Atlas also decided to provide the engineering oversight rather than using the Tensar engineers and a concentrated effort was made to help the new contractor find the recommended equipment in time for working on the slimes. The equipment obtained is compared against Tensar's recommendations below. Other equipment proposed for use on the job included two front end loaders for loading the trucks, a bulldozer, road grader, and water truck.

	Recommended equipment		Actual equipment
4	Caterpillar D4C-LGP	2	Caterpillar D4C-LGP
		1	Caterpillar D4C-XL
		1	Caterpillar D5C-XL
2	Caterpillar D5H-LGP	1	Caterpillar D5H-LGP
		1	Caterpillar D6H-LGP
4	50,000lb. Max. GVW rear dump trucks	4	50,000lb. Max. GVW rear dump trucks

It was determined that the longitudinal center line of the area of exposed tailings was 63.2-feet offset from the baseline axis. After allowing for this, the work area was split into six manageable zones as shown in Figure 3; the arrows indicating the required direction for fill advancement and unrolling the 13-foot wide (164-foot long) geogrid rolls in each zone. The roll widths were intended to be over-lapped by 3-feet and the plan was to work two zones simultaneously. Two D4C-LPG's were to be used at the leading edge of the fill, fed by one D5H-LPG from the specially constructed roadways and over previously laid fill in each zone. The roadways would be constructed at the center of each zone to allow for this and to allow the loaded trucks access onto the pile. A 50,000lb gross vehicle weight limitation was placed on the size of trucks allowed onto the slimes area. Where possible, cover material from existing upper tailings areas was proposed to be used. The first equipment arrived on September 28, 1995.

Chronology of Work Done

Week #1: October 3-6,1995

Dale Edwards conducted a radiation safety school and we instructed contractor employees on the special precautions and working conditions related to this job on October 3, 1995. Work started on the north section near the end of this shift by smoothing the leading edge of the fill with the two D4C-LPG's to facilitate subsequent geogrid installation and to give workers a feel for the job. We tested upper areas of the existing cover for the thickness of borrow material available.

We also received the D5H-LPG bulldozer on site and hauled about a third of the geogrids up to the tailings work area.

The following day we started laying the geogrids and dirt on the north section according to Tensar's recommendations. Nonetheless, we found it unnecessary to construct the recommended haul roads because of the short 150 foot advance distance involved with this zone.

We limited the work to the north section to give the operators and supervisor a better chance to become familiar with the special conditions. This was also good because we found it impossible to keep up with the dust control with our small 3,000 gallon water truck in the very dry and windy conditions. We therefore ordered an 8,000 gallon Cat 621 water wagon to replace the smaller water truck and decided to delay starting work on the south side until we could be sure of maintaining control of the dust. We were very careful not to "bust any more crust" until we could get control of the dusty conditions.

We continued laying geogrids solely in the north zone on October 5th. Pore pressure from this area started causing free-flowing seeps in front of the fill dirt, but it flowed harmlessly onto the flat low-lying area of the pond to evaporate. We received the 8,000 gallon water wagon at the end of shift.

The contractor started laying geogrids and dirt on the south zone on October 6th. However, we were unable to simultaneously work on the north section and had to arrange to train additional people because we had trouble with worker no-shows, quits, etc.

We worked 736 hours, laid about 3 acres of geogrid and 5,000 cubic yards of fill this week and, except for the initial dust problem, without incident.

Week #2: October 9-13,1995

On Monday we continued laying geogrid and dirt on the south zone of soft tailings and survey-staked the work done to-date. On Tuesday Dale instructed new workers in radiation safety and we instructed them in the methods needed for laying geogrids and dirt. We then started laying geogrids and dirt in both the north and south zones for the first time and noticed above-cover seeps in the south zone and therefore had to avoid working equipment over these areas.

We continued laying geogrids and dirt on the north and south zones for the rest of the week. A major global failure started in the south zone from the weight of excessive cover thickness, shown in Figure 4. This was a "shear"-type failure and resulted in a minor amount of heaving ahead of the fill. We took immediate steps to lighten the weight ahead of the fracture and implemented a method of measuring the cover depth to prevent a recurrence of placing too much fill. We observed no further movement at this particular fracture. Mr. Blubaugh visited

the property on this day: Wednesday. We started laying geogrids in the northeast zone on Friday.

We worked 998 hours, laid 3 acres of geogrid and about 10,000 cubic yards of fill this week and, except for the relatively insignificant global failure, without incident.

Week #3: October 16-20,1995

On Monday we completed laying geogrids and dirt on the north zone and continued working on the south zone. We extended the north zone geogrids by 40 feet and the south zone by 60 feet for the full pond width and started laying dirt on the northeast zone. Pore pressure solutions now covered the full low-lying area and tested between 2 and 4 pH. We will use hydrated lime to correct this problem. Saturated slimes tailings started to ooze out at three locations in the south zone, like lava from small volcanoes. We planned to work around these areas to prevent further problems.

On Tuesday we continued laying dirt on the northeast and south zones and started laying geogrid on the southeast zone. The two western zones were the main areas that experienced global failures in 1994. We dressed up the west side in preparation for geogrids and issued acid resistant gloves to the laborers and started using hydrated lime to neutralize the pond solution.

On Wednesday we continued laying geogrids and dirt on the east zones, started laying geogrids and dirt on the west zones, and continued using hydrated lime to neutralize the pond solution.

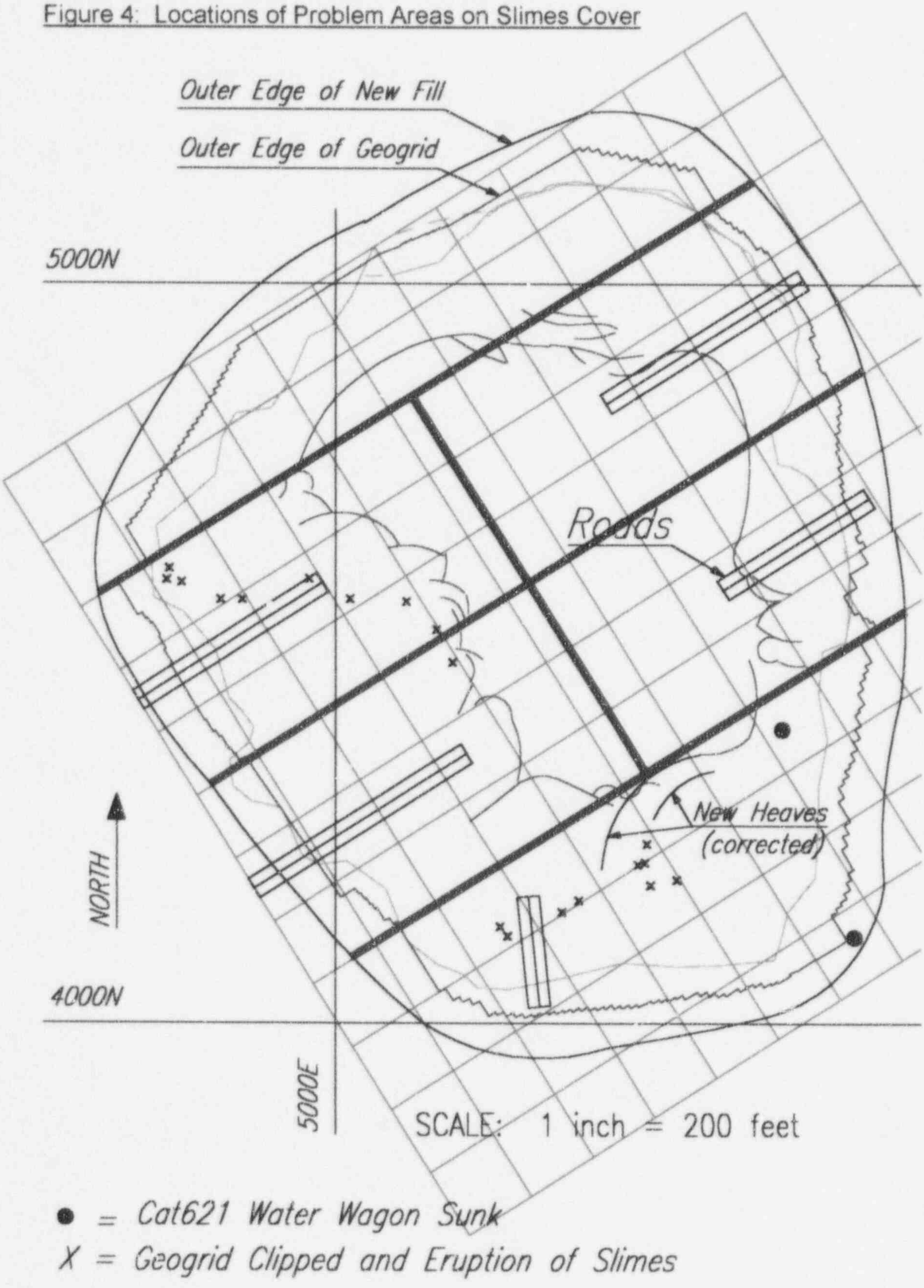
We continued laying geogrids and dirt on the east and west zones through the end of the week. We inspected and supervised the removal of the east side piping and electrical cables to expose more borrow dirt and inspected the perimeter berms for a source of borrow. On Friday we measured the work progress to-date, timed equipment operation, and measured volumes moved to see where we can improve the efficiency of operation.

We worked 982 hours, laid 8 acres of geogrid and 20,000 cubic yards of fill this week without incident.

Week #4: October 23-27,1995

We ordered an additional 48 rolls of geogrid and extra ties on Monday and continued laying geogrids and dirt on the east and west sides for the rest of the week. On Tuesday, we surveyed and started building the two west side roads but the job slowed due to problems with dump truck breakdowns.

Figure 4: Locations of Problem Areas on Slimes Cover



We continued building the two west side roads on the next two days and surveyed the east side roads and instructed operators how we wanted the dirt removed from the perimeter berms on Thursday. We started construction of the east side roads and measured the work progress on Friday.

We worked 973.5 hours, laid about 5 acres of geogrid and 20,000 cubic yards of fill this week without incident.

Week #5: October 30 -- November 3, 1995

We continued laying geogrid and dirt on the east and west zones and advanced the east side roadways. We started using low grade ore from the southeast roadway and the results are excellent – it is probable that we will not need roads with this material.

From Tuesday on, all equipment was used to haul low grade from the southeast roadway onto the flat lying remaining tailings, including the eastern side of the west zones. We also found it easier to continue advancing the fill westwards over the severely heaved areas, rather than in the planned east direction for these zones. But, we ran out of geogrids.

Richard Blubaugh inspected the work progress on Thursday and we measured the work progress to-date on Friday.

We worked 996 hours, laid 2 acres of geogrid and 32,000 cubic yards of fill this week without incident.

Week #6: November 6-10, 1995

On Monday we inspected the tailings and plant areas for suitable borrow and started hauling material from the northeast plant area. However, this was temporary as we timed the trucks to find that it took twice as long to haul material from this area so we reverted to hauling material from the existing tailings cover and tailings embankment on Tuesday. This was good because it helped to lower the overall height of the pile.

By the end of shift on Tuesday we only had a third of an acre to cover to complete the job. However, an accumulation of about 250,000 gallons of pore water on the remaining exposed tailings created a major problem in completing the work. We constructed temporary berms and "pushed" this water onto the new cover to reduce the amount of water in the remaining work area. Although this helped us to complete the job by 3:30pm on Wednesday November 8, 1995, the last 0.1 acre was extremely difficult to complete.

We worked 160 hours, laid 2 acres of geogrid and 4,000 cubic yards of fill this week without incident.

General Comments and Conclusions

For the total job we covered 21 acres with geogrid and placed about 90,000 cubic yards of material – about three times what we expected.

The natural dirt proved to be much worse than low grade ore for covering the slimes, primarily because it was poorly graded material. This was proven by the fact that we did not even need roads when we used the low grade ore. Actual roads used are shown in Figure 4. This figure also shows locations where we had difficulties, such as new heaves, etc. In addition, we had to use a greater thickness of natural dirt than low grade ore because it tended to sieve through the geogrid rather than setting up on top of the grid. Comparing the loads of natural dirt hauled against the depth of fill on top of the geogrid we estimated that almost 40% fell through the geogrid.

Since the Caterpillar 621 water wagon is in essence a scraper, it proved that it would have been folly to use scrapers for this job since it sank into the tailings on two occasions. For this reason, the operator had to be always alert as to his position on the tailings.

Although the tracks were six inches narrower on the XL machines, we experienced no more problems with them than with the D4C-LGP's because they were relatively light weight machines. Also, the D5C-XL was only slightly heavier than the D4C-XL and much lighter than the D4H-LGP's. We therefore experienced no problems on the job with the D5C-XL -- the difference was unnoticeable.

The D5H- and D6H-LGP's are very heavy machines and we had to be careful where we used them. The wide tracks did not make much difference since it was more the weight of the machine that was important. At times, watching these machines ride over the fill was like watching a boat on an ocean swell.

Operating on the lowest-lying flat tailings was a lot easier than working on the previously heaved areas. The badly heaved areas made it difficult to evenly lay the geogrid and frequently resulted in the grid folding over on itself creating high points that the operators regularly clipped and tore with their equipment. This caused high areas to form on the cover and, contrary to one's instincts, we then needed to make these areas yet higher by placing extra reinforcing grid and cover weight to balance, or press down, the fluid-like slimes. Moreover, we could not have completed the job without the reinforcing geogrid material.

Robert S. Pattison