A GEOGRID REINFORCED SOIL WALL
FOR LANDSLIDE CORRECTION ON THE OREGON COAST

Experimental Feature
Final Report
Project OR 83-01

by

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ABSTRACT

In June and July 1983, the Oregon State Highway Division constructed a geogrid retained soil wall to stabilize a landslide on the Oregon Coast. The project was a Federal Highway Administration Experimental Features Project. The experimental aspects of the project were to assess construction problems of near vertical walls with high density polyethylene geogrids and to investigate the feasibility of establishing vegetation on the wall face to provide a natural appearance at an esthetically sensitive site.

This report presents the experience gained in the design and construction of the geogrid wall. Problems encountered during construction are discussed and recommendations are made for improved methods for future application.

It is concluded that geogrid wall construction is practical. Geogrids are more labor intensive than conventional geotextiles, but their greater strength and ultraviolet light resistance are compensating advantages. Establishment of vegetation on the face of a geogrid wall is possible by placing sod strips between the backfill and the geogrid. Care must be provided, however, to properly irrigate the sod until it is well established. A coarse backfill or a filter fabric should be used if sod is not placed against the face to limit the loss of fines.

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INTRODUCTION

The Oregon State Highway Division has utilized a high density polyethylene grid reinforced wall to stabilize a landslide on the Oregon Coast. The geogrid used was Tensar® SR-2. Geogrids have been used around the world and have the potential for many applications (1*). They have not, however, been used previously for near vertical retaining walls in the U.S.A.

The slide correction was performed as a Federal Highway Administration (FWHA) Experimental Features Project and was constructed during the summer of 1983. The objectives of the experimental features project were to assess the construction of geogrid walls and to investigate establishment of vegetation on the wall face. The purpose of this report is to present the experiences gained in the design and construction of the geogrid wall.

BACKGROUND

The experimental features project is located just off the Oregon Coast Highway on Otter Rock Highway 182 in the vicinity of Devil's Punch Bowl State Park, approximately 15 miles north of Newport, Oregon. Figure 1 shows the general location of the project on the Oregon Coast.

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* Refer to Bibliography, Page 15.

The experimental geogrid wall was a replacement for a 12-foot concrete rubble wall. The replacement was necessitated by a slide failure that occurred in December 1981. The slide dropped the pavement 4 feet on the easterly edge, severely cracked a concrete rubble wall, and forced the closure of the main entrance to the popular Devil's Punch Bowl State Park. Figure 2 shows the original concrete rubble wall and the extent of the slide failure.

Three alternatives were considered by the Oregon State Highway Division for stabilizing the slide. The first alternative was a tie-back soldier pile wall with precast concrete panels and a lightweight backfill. The second alternative was a nonwoven geotextile retaining wall with a gunite facing. The geogrid wall, the third alternative, was chosen over the other two alternatives for two reasons:

1. The geogrid retaining wall had the lowest estimated cost.
2. The open face of the geogrid wall allowed establishment of vegetation on the wall which provided a natural appearance compatible with the surroundings of the state park.

The geogrid wall had the lowest estimated cost because it did not require a facing for protection from ultraviolet (UV) light as did the conventional geotextile wall. In the planning stages of the project, preliminary designs for both the geogrid and a conventional geotextile were completed. For these preliminary estimates, the geotextile design required 36 layers of reinforcement, using 11,500 square yards of fabric. Because of its greater strength, the geogrid wall only required 21 layers and 6,000 square yards of material. The total geogrid material costs were calculated to be 50 percent higher than the geotextile costs because of its higher unit cost.

The geogrid wall did require handling less reinforcing material, but the unit cost for placing the geogrid was estimated to be greater than the unit cost for the geotextile. The two main reasons for the difference were:

1. The geogrid was supplied in rolls 3.3 feet wide, while the geotextile rolls were 17.5 feet wide; therefore, many more individual geogrid pieces must be handled; and,
2. The geogrid required forming thicker layers, so more robust, complex forms were needed.

It was estimated that the backfill placement costs would be nearly the same for the two materials. The geotextile wall would have been less expensive since the material had a lower unit price; but because of its low UV resistance, it would have required an additional expense for a protective facing. Thus, the geogrid wall was selected because it did not require a facing to protect it from sunlight; and, it was possible to provide a more natural appearance that would not detract from the esthetics of the park area.

SITE INVESTIGATION

Site investigation was carried out by the local region Highway Division Soils and Geology Section during July 1982. Six boreholes were located within the slide area, and two steel inclinometer tubes were installed to establish the plane of failure and to monitor the groundwater levels. Monitoring of the site was carried out during the winter of 1982.

The soil profile, defined by the exploration phase, consisted of a 12-foot layer of medium to stiff yellow brown sand and a layer of soft gray silty clay varying in thickness from 0 to 12 feet underlain by gray shale. The failure plane defined by the inclinometer tubes was at the clay-shale interface. Figure 3 shows a typical cross-section of the slide and the failure plane. The slide resulted from water deteriorating the fractured shale into a soft weak clay. Two faults in the slide area caused the hard gray shale to fracture, and excess water from the sand layer triggered the slide. Therefore, the main objectives of the slide correction were to control the water flowing in the sand layer and to prevent further deterioration of the shale.

SLIDE CORRECTION DESIGN

The general scheme of the slide correction was to excavate to the firm intact shale, build the layered geogrid wall, and provide perforated drain pipes below the sand layer to control the groundwater. Figure 4 shows a typical cross-section of the geogrid wall.

The decision was made to build the geogrid wall on a 6 (vertical) to 1 (horizontal) slope to attain a neat face and provide an area for natural vegetation. The final section was dictated by the presence of an existing 24-inch storm sewer pipe, a public restroom facility, and the requirement of maintaining two 12-foot travel lanes and a 4-foot shoulder plus guardrail. The bottom of the excavation was to be made to Elevation 45 to intercept the firm shale below the failure surface. The geogrid wall was to be founded on a one-foot layer of well compacted gravel at an elevation of 46 feet.

The front view of the geogrid wall approximates a trapezoid, with the bottom 70 feet long and tapered on both sides to a top length of 170 feet. The wall at the top is stepped to fit the vertical curve of the roadway. The sag point elevation was 74.5 feet, which dictated the minimum height of the wall to be 29.5 feet. An elevation view of the wall and the controlling elevations are shown in Figure 5.

The design also called for common backfill to be placed over the lower face of the wall to re-establish the natural ground surface. Above the natural ground line sod was to be placed between the gravel backfill and the Tensar® geogrid. The sod was believed to be the most economical way to establish vegetation on the face. To accommodate future growth, a dirty backfill (Class "B" backfill) was placed in the first 2 feet behind the sod, and a cleaner gravel (Class "A" backfill) was used as the remainder of the fill.

GEOGRID WALL DESIGN

The geogrid polymer is a high-density polyethylene stabilized with carbon black to provide ultraviolet light resistance. The grid material is illustrated in Figure 7. The grids are supplied in rolls 3.3 feet wide and 165 feet long. Tensar® SR-2 has a strength of 5.413 kips per foot in the principal direction and a weight of 27.61 ounces per square yard. Strain at failure is 12 percent and strain at 40 percent of maximum strength is 3 percent. In comparison, a conventional nonwoven geotextile, Trevira® 1127, has a strength of 1.1 kips per foot and a weight of 6.5 ounces per square yard.

The backfill materials used for the geogrid wall were a graded crushed basalt with 2-inch maximum size; the "A" zone material has a maximum of 10 percent fines, and the "B" zone has a maximum of 20 percent fines to accommodate the growth of the sod. Specifications required at least 95 percent of standard optimum dry unit weight (AASHTO T99). The bulk density and angle of internal friction for the backfill were assumed to be 140.0 pounds per cubic foot and 40 °, respectively.

To limit possible creep of the reinforcement, the working stress for the geogrids was taken as 40 percent of the ultimate strength. The open structure of the grids allows for the interlocking of the backfill material across the grid; therefore, the full soil friction was assumed to be developed at the soil-geogrid interfaces.

The wall was designed assuming the grids had to resist the active Rankine lateral earth pressures by the portion of the reinforcement extending beyond the theoretical Rankine failure surface. The method of analysis was described by Lee, et al. (2) and Hausmann (3) for Reinforced Earth® walls and was modified for geotextile walls by Bell and his co-workers at Oregon State University (4, 5). This method has been used by the U.S. Forest Service (6, 7), New York Department of Transportation (8) Colorado Department of Highways (9) and others to construct successful geotextile walls in the United States.

Geogrid lengths and vertical spacings were calculated to provide minimum safety factors of 2.0 for dead load only, and 1.15 for dead load plus live load whichever was more restrictive. The reduced factor with live loads was allowed because:

1. After construction, truck traffic would be limited to recreational vehicles and an occasional service vehicle; and,
2. The allowable working load included a safety factor of 2.5 against a short-term failure.

The vertical spacing calculated for the geogrid wall was 1 foot at the bottom of the wall and approximately 4.6 feet at the top. For appearance and construction considerations, the wall was detailed with 3-foot steps. Each step was set back 6 inches from the one below to give the wall an average batter of 1:6, see Figure 4. The lower three layers were given reinforcement spacings of 1 foot, the mid-height layers spacings of 1.5 feet, and the top two layers a reinforcement spacings of 3 feet. To give a uniform appearance the geogrids were folded back into the backfill at mid-layer height for the top two layers. This fold was only anchored a distance of 5 feet into the backfill because the embedment was only required to stabilize the face and was not required for overall stability. The anchored distance at the top was the same as the 5-foot overlap embedment used for each layer.

The geogrid reinforcement lengths were 16 feet. This length was required at the top for resistance to failure by pullout of the reinforcement; and, it was required at the bottom to provide resistance to horizontal sliding of the total reinforced block.

To keep the costs of the geogrid wall competitive, it was necessary to select a simple effective method of supporting the face during construction. Scaffolding from the ground level in front of the wall has been used successfully in England and other places (10). The steep site, wall geometry, and the need to operate equipment in front of the wall made scaffolds impractical for this wall. As has been done on geotextile walls (6, 8, 9) the State suggested the use of moveable self-supporting forms.

Since reinforcment spacing was 3 feet at the top, a 3-foot forming system was required. The decision was made to use the same system throughout and construct the wall with 3-foot steps. Experience on a wall in Glenwood Canyon, Colorado, indicated that the simple moveable forms previously used were not suitable for layers greater than about 15 inches. Therefore, a forming system was suggested by the State in the contract documents that incorporated the same concepts of the previously used geotextile forms, but had special features to allow for thicker layers.

The suggested forming system is illustrated in Figure 6. The contract documents indicated that the contractor could use another system or modify the suggested method. The State had hoped the contractor would add ideas and modify the system during construction leading to the development of a more efficient forming system that could be used on future projects.

The suggested form consisted of a 3 foot by 8 foot sheet of 3/4-inch plywood held in place by the upright on the form support. To resist overturning, the form support was anchored in the backfill. There was concern that if the form suport base extended into the backfill far enough to provide stability, friction would make it very difficult to pull the base out at the completion of the layer. Therefore, a sacrificial reaction pipe was anchored in the backfill, and the rod on the form support was inserted into the pipe. The rod on the form support was bent upwards to prevent kickout of the bottom of the plywood form. Since there was little friction on the form support base, an anchor rod was used to provide lateral resistance.

As shown by the typical installation in Figure 6, it was anticipated that the forms for a completed layer would be left in place while the next layer was constructed. The lower form would add stability to the upper form and help maintain vertical and horizontal alignments. The form supports would be leveled and shimmed as required, depending on the placement of the lower layer. When the upper layer was completed, the lower forms would be removed and moved up to form the next layer, et cetera. It was believed this system and procedure would be simple, expedient, and stable for the 3-foot layers.

CONSTRUCTION

Final design of the geogrid wall was completed in February 1983, and the contract was awarded in April. The Highway Division estimated the project cost to be $165,802, and the low bid was received at $166,328. A total of 5 contractors bid on the project, and the highest bid for the work was $269,000.

A summary of the salient features and a cost comparison with other walls appear in Table 1.

Excavation of the site began June 6. The month of June was quite wet and portions of the excavation slopes failed. Actual wall construction did not begin until the middle of the month and not before encountering problems with the excavation, the ground water, and surface runoff.

Uncovered in the excavation were plugged horizontal drain pipes which were installed in 1975. Once broken by the backhoe, they immediately began to flow water into the excavation. The added water resulted in the further deterioration of the shale layer, and the plugged drain pipes were thought to have contributed to the recent slide.

The general procedure followed by the contractor in the early stages of the wall construction was:

1. Set the proposed forms at gradeline
2. Lay out prefabricated sections, comprised of 2 to 3 sheets of geogrid
3. Drape the fabric over the forms, allowing for required embedment lengths and secure the fabric with No. 3 rebar anchor pins
4. Place hog rings to secure the panels to one another at the face
5. Place Class "A" backfill in 6-inch lifts to desired layer thickness
6. Level and compact
7. Place sod in position behind the geogrid
8. Place Class "B" backfill and compact
9. Fold overlap and pin fabric to completed backfill
10. Continue lifts until the top of the 3-foot form was reached, then remove forms and move up for the next 3-foot layer. Figures 7 through 14 illustrate this wall construction procedure.

Figure 7 shows a worker securing the sheets of geogrid into a section and splicing the ends of the geogrid with No. 3 rebar. The masonry circular saw shown in the background was used to cut the geogrid. Figure 8 illustrates the initial forming system and the draping of the grid over the form. Figure 9 is an overview of the initial wall construction which shows the restricted space and the placement of the Class "A" backfill. Figure 10 shows a worker hanging the sod strips on the form, and shows the space left for the dirty Class "B" backfill. Figure 11 depicts the light compaction equipment used near the face of the wall to compact the Class "B" backfill. Figure 12 shows the pinning of the overlap and deflections experienced with the initial forming system. Figure 13 depicts the equipment used by the contractor and part of the drainage network installed to intercept the groundwater.

As the geogrid wall gained in height, several problems began to occur. The first problem was that the contractor was not achieving 95 percent of the standard maximum dry density. The frequent rain showers and the backfill gradation did not allow the material to drain, so the in-place moisture content was several points above optimum. The decision was then made to lower the density requirement to 90 percent, and place a rock blanket of 1-1/2 to 2-1/2 inch material against the excavation backslope to intercept groundwater and improve the drainage.

The second problem was the sagging and bulging of the wall face. This problem was due to excessive flexibility in the proposed forms and the loss of Class "B" backfill through the grid where sod was not placed between the geogrid and the backfill. The time between when the forms were removed and when the face was covered by common backfill was long enough for significant amounts of the fine Class "B" backfill to fall out from behind the grid. Where sod was placed against the geogrid reinforcement, the fines were inhibited from movement and the wall face was near vertical. The bulging problems were not deemed important in the lower layers, since the layer would be covered. However, the sagging of the wall resulted in the contractor modifying the method of forming the face of the wall.

As stated previously, the suggested forming system was too flexible. The combination of the 3/4-inch plywood forms and the 18-inch form supports on 4-foot centers resulted in the deflection of the forms. A more serious problem, which led the contractor to modify the forming method, resulted from the loss of support from under the forms.

As discussed in the preceding section, it was expected that the forms for a completed 3-foot step would be left in place until the forms above were set and at least the first lift of that step was in place. The contractor elected not to follow the double form system and moved the forms as each 3-foot step was completed. Also, the contractor used plastic rather than steel reaction pipes. Both decisions resulted in the stability of the forms being totally dependent on the support of the backfill directly under the metal plate of the previous 3-foot layer, see Figure 6. Without the lower form in place, the slight inevitable bulging of the face resulted in tipping of the form support. Loss of the finer backfill compounded the problem of the form support; and with the form support stiffened only by the plastic reaction pipe, the form tipped even further. Also, due to the loss of backfill material, the effectiveness of the form support anchor was reduced which caused the form system to become unstable.

The contractors' solution to the forming problem is shown in Figures 15 and 16. Figure 15 is an illustration of their forming method, and Figure 16 is a construction photo of the new forms. The forms employed by the contractor were stiffened with 2 inch by 4 inch lumber, and braced against a 2 inch by 4 inch support extending 4 feet into the backfill to provide an anchor. The protruding end of the horizontal anchor was supported by a vertical member and an 8-inch spike was driven at the end of the support into the lower layer. The bottom of the 3/4-inch plywood form was held in place by 2" x 4" lumber nailed to the anchor support. At least 3 braces were used on each 8-foot forming unit. The new forming system required considerably more time to construct, but did provide a stable face to build against.

The geogrid wall was completed July 27. The construction time was considerably longer than the estimated ten working days. Actual construction days for just the wall was 21, including excavation; the number of days totaled 32. This resulted from adverse weather conditions, difficulties in scheduling the work due to the confined space, and the labor intensive nature of the construction. The completed wall is shown in Figure 14.

EVALUATION AND RECOMMENDATIONS

The geogrid wall has only been in service a short time, but it appears to have stabilized the site. The sod facing improved the apperance of the wall and helped in retaining the fines in backfill "B". However, most of it died due to lack of proper irrigation during its establishment period. Also, backfill "B" consisted mainly of crushed rock from backfill "A"; it lacked organics needed for the growth of the sod, and because of its gradation, it was unable to retain the required water. It is recommended for future projects that provisions be included in the contract for post-construction care of the sod for a period until it is well established. The geogrids have potential and are competitive in cost with the conventional geotextile walls where a natural appearance is desirable. Improvements in construction techniques are necessary to fully utilize the potential of geogrid materials.

At suitable sites, scaffolding may be the solution to the forming problems. In other situations, a modification of the moveable forms originally suggested for this project are recommended. Several modifications to the forming system are proposed:

1. Stiffen the plywood form with 2 inch by 4 inch lumber along the top
2. Secure adjacent forms to each other with battens
3. Lengthen the upright on the form supports to be 6 inches shorter than the form
4. Eliminate the reaction pipe and all anchor pins and extend the base plate of the form support 3 feet into the backfill
5. Weld rings on the short end of the form support base plate so mechanical aides can be used if necessary to pull it free after the layer is completed
6. Use at least three form supports on each 8-foot form
7. Use backfill coarser than the grid openings, or use a layer of a geotextile behind the face of the wall to prevent loss of backfill through the grid
8. Exercise care to compact near the forms and tightly secure the geogrid overlaps on the tops of the layers.

With these considerations, the forms should perform satisfactorily and may be removed and moved up with each layer. These changes will expedite construction and make the geogrid walls even more practical.

ACKNOWLEDGEMENTS

The project was constructed during the summer of 1983 as an FHWA Experimental Features Project. The wall was built by Dan D. Allsup, Contractor, Eugene, Oregon. The design of the wall was conducted in cooperation with the Oregon Department of Transportation-Highway Division Regional Soils and Geology Section, the Headquarter's Bridge Foundation Unit, the Geotechnical Unit and the Road Design Section. The authors wish to specially thank Chuck Elroy, the Project Manager, Claudious Groves, the construction inspector, Tensar Incorporated, Ontario, Canada for providing a field engineer during the early stages of the wall construction, and Judy Banegas, Management Assistant-ODOT, for typing the manuscript.

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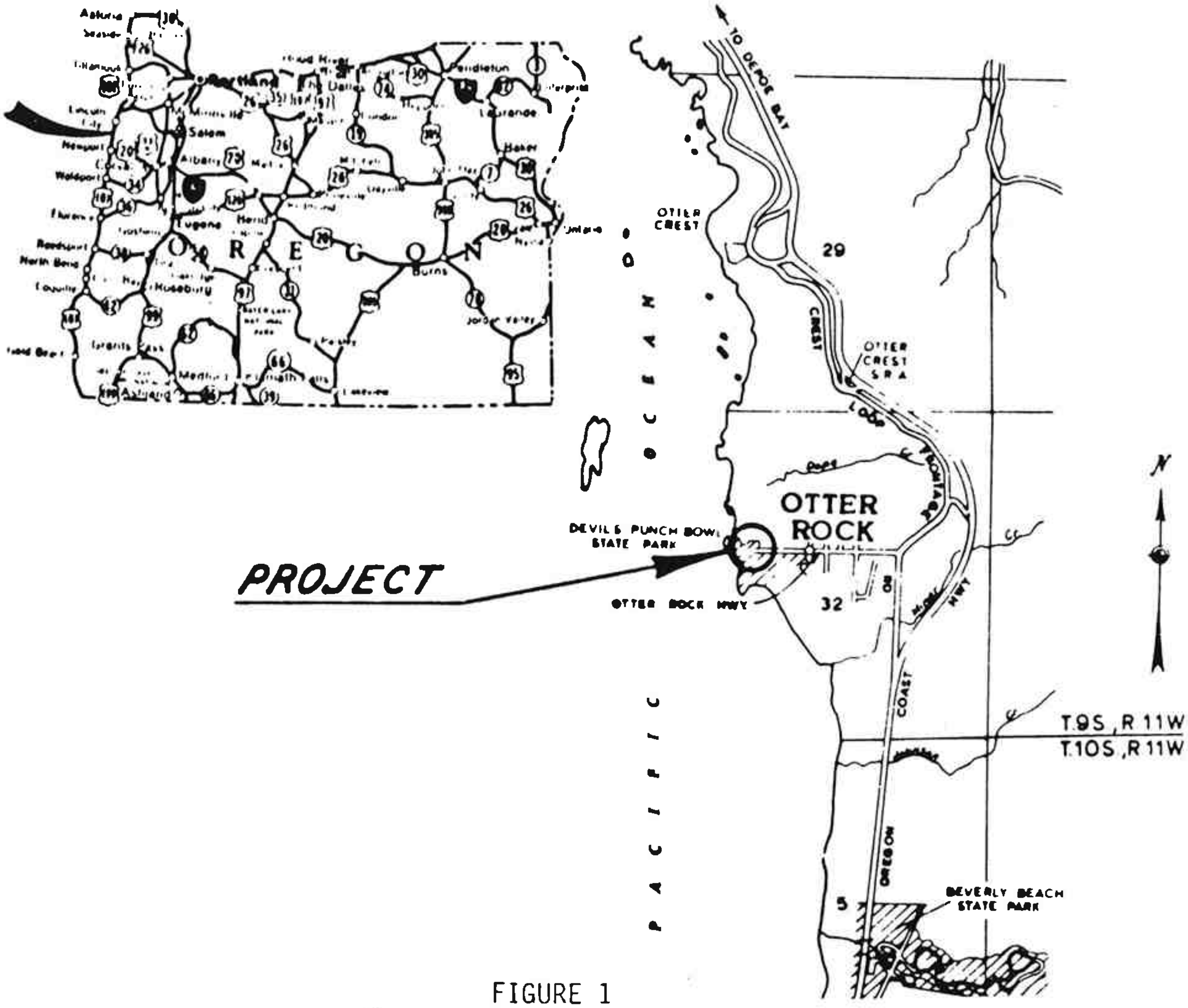


FIGURE 1
Geogrid wall site location.

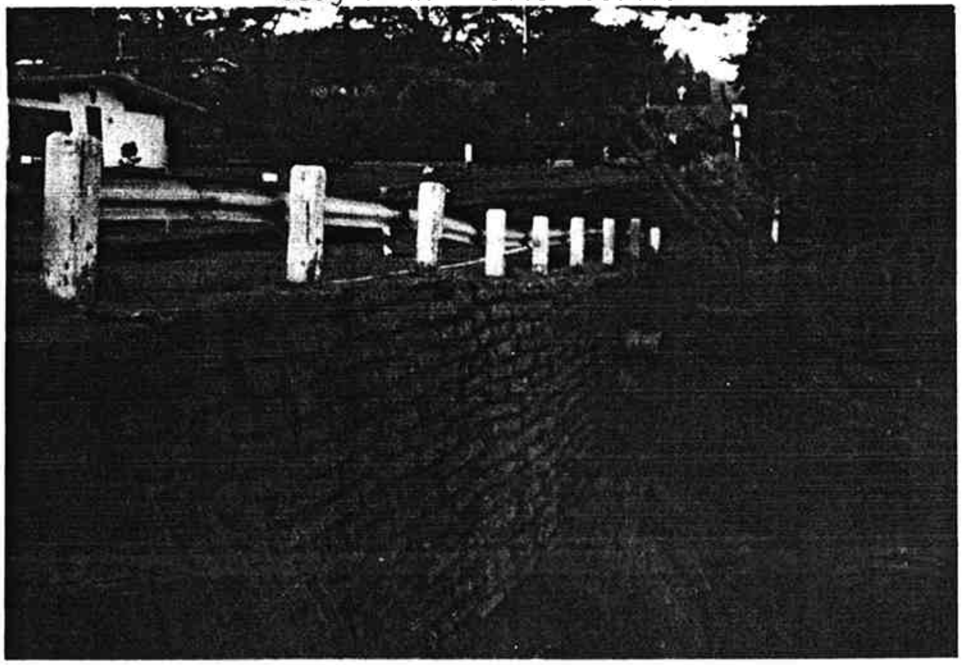


FIGURE 2 Site before construction.

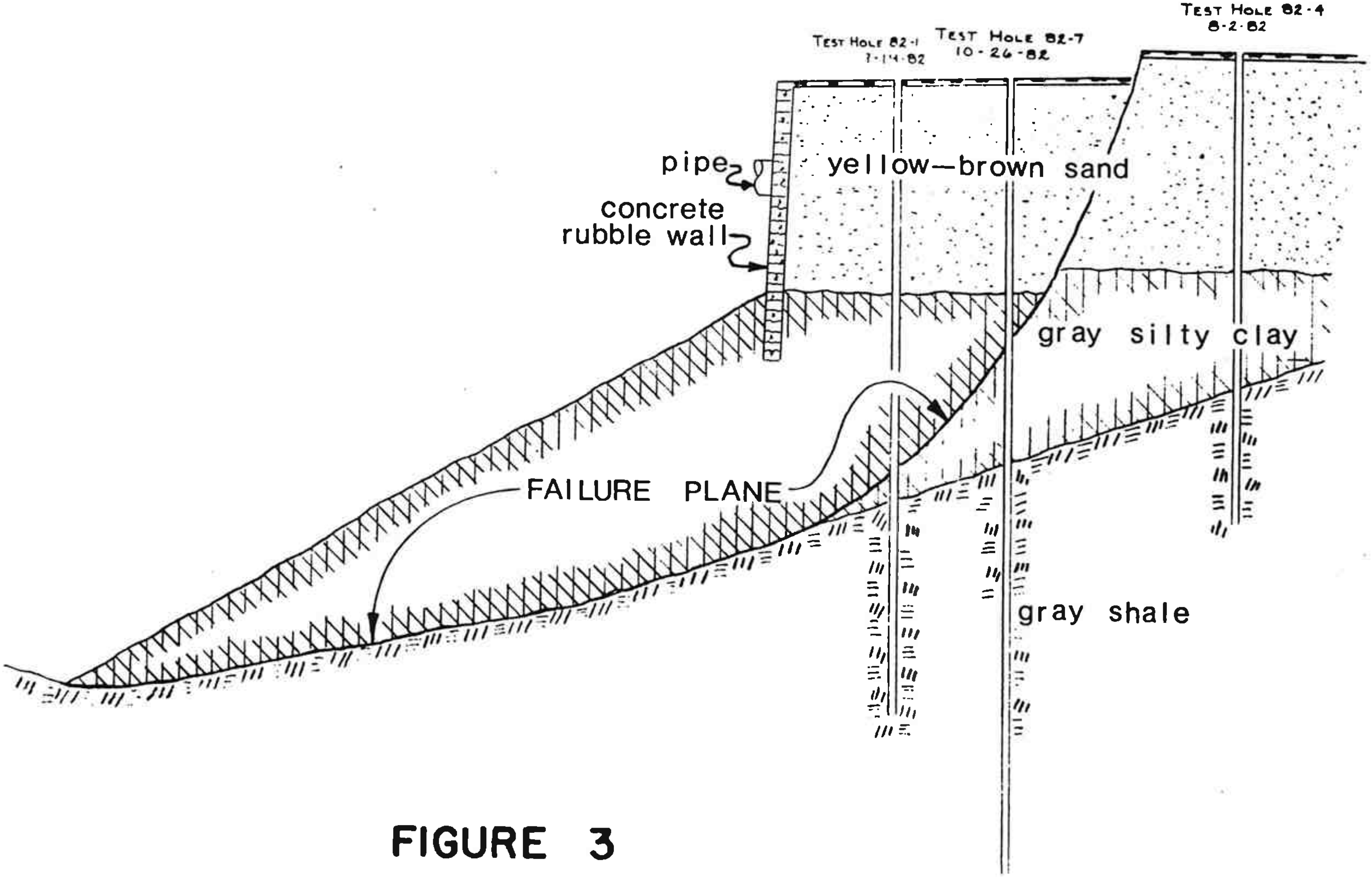


FIGURE 3

GEOLOGIC CROSS-SECTION OF SITE

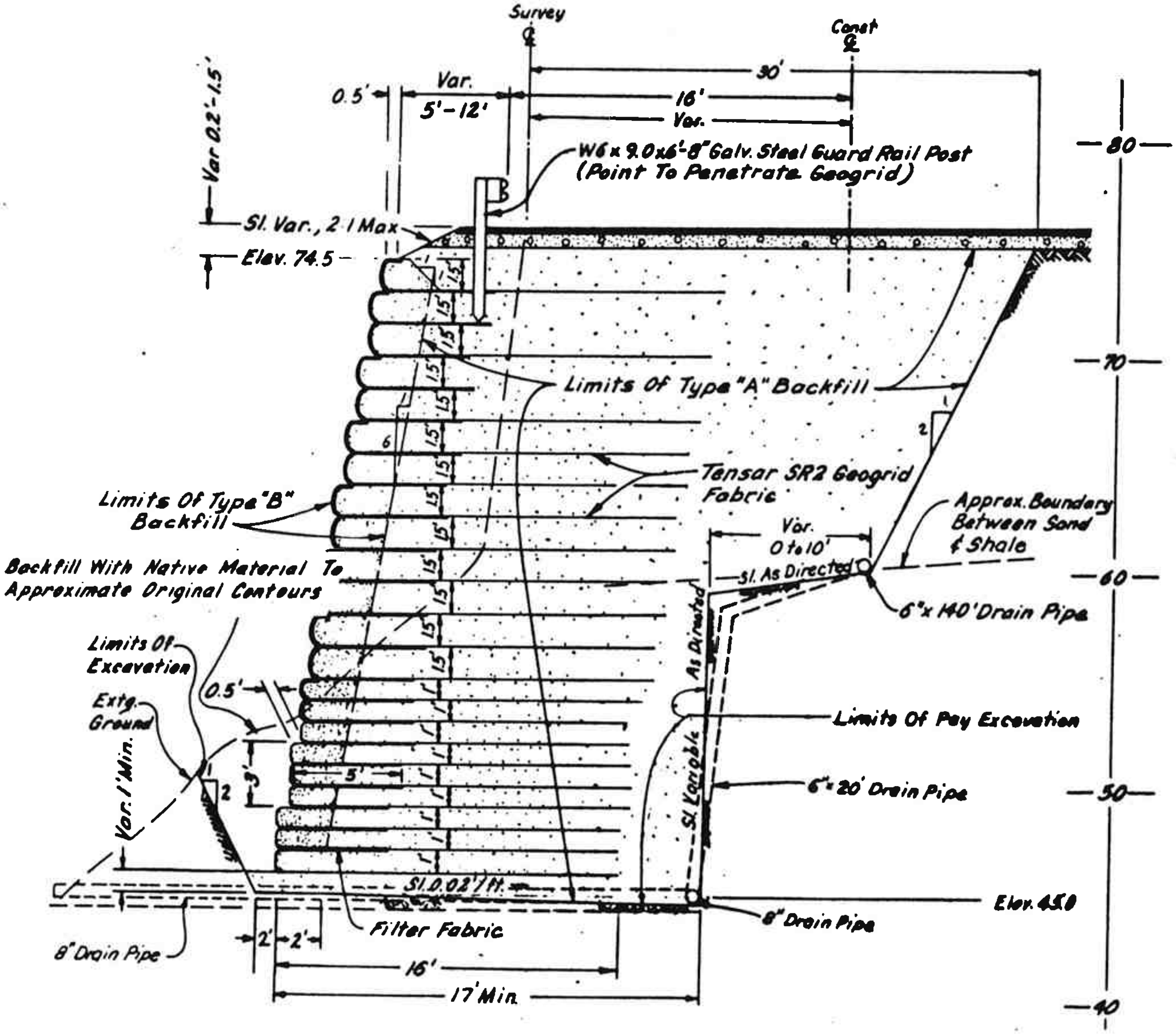


FIGURE 4. Cross section of geogrid wall.

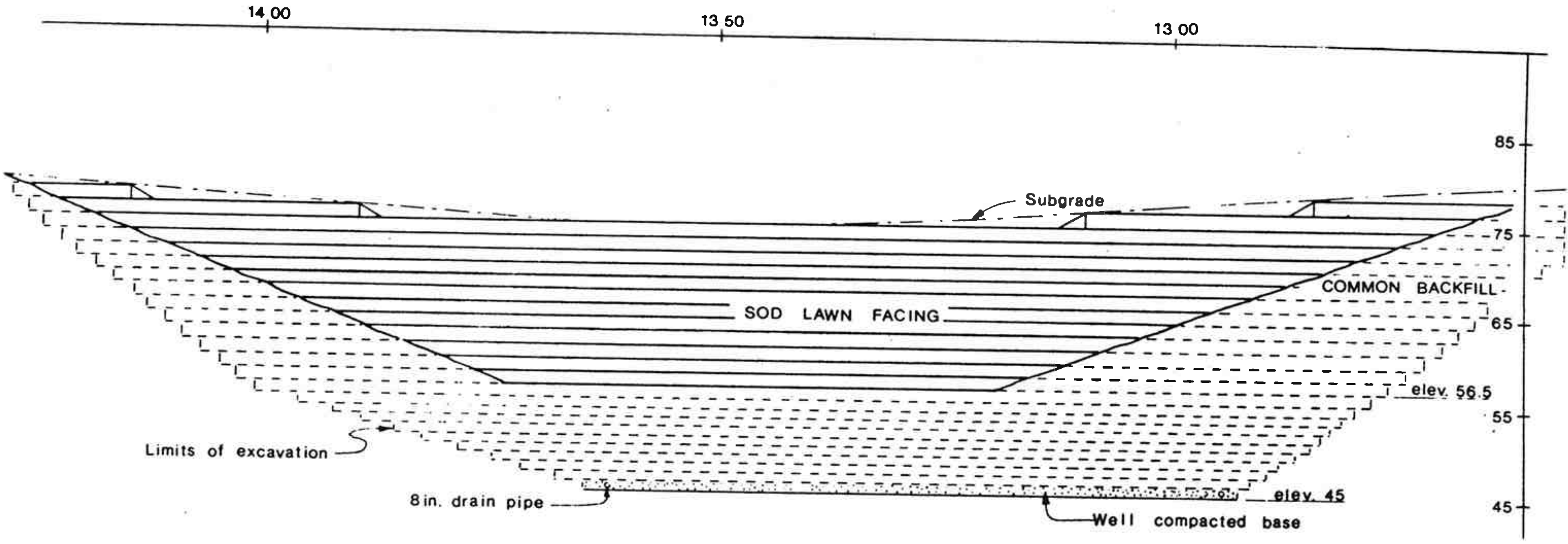
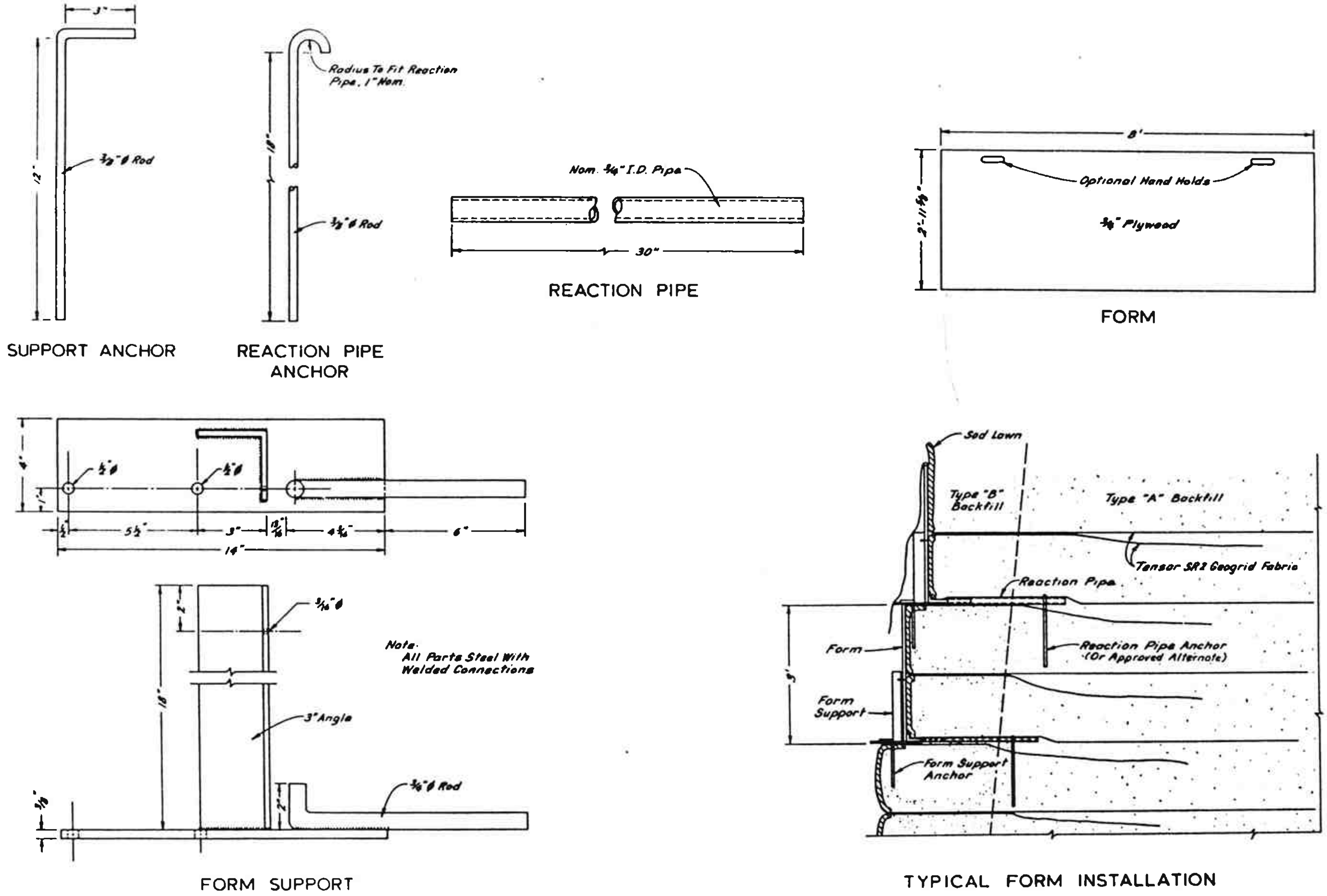


FIGURE 5
DEVILS PUNCH BOWL SLIDE CORRECTION
WALL ELEVATION



SUPPORT ANCHOR

REACTION PIPE ANCHOR

REACTION PIPE

FORM

FORM SUPPORT

TYPICAL FORM INSTALLATION

FIGURE 6

Suggested construction form details.

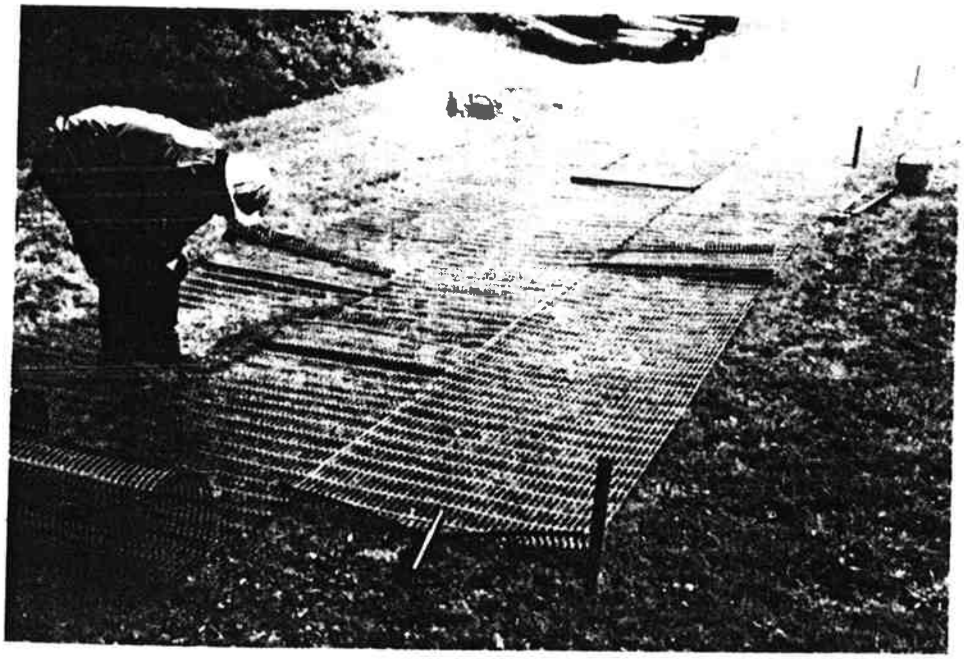


FIGURE 7. Fastening the geogrid strips together.

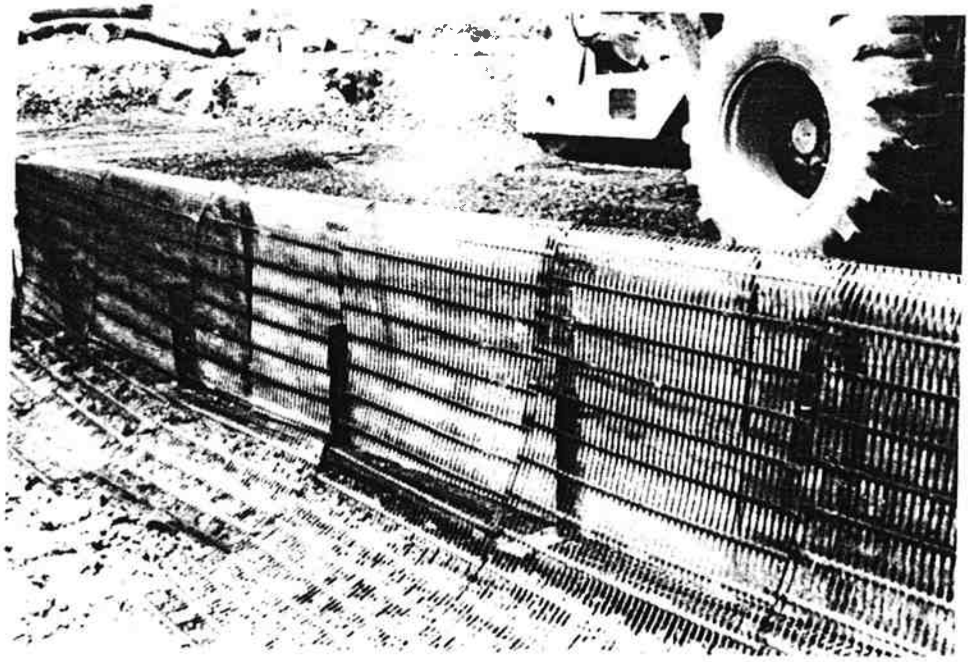


FIGURE 8. Suggested forming system with geogrid inplace.

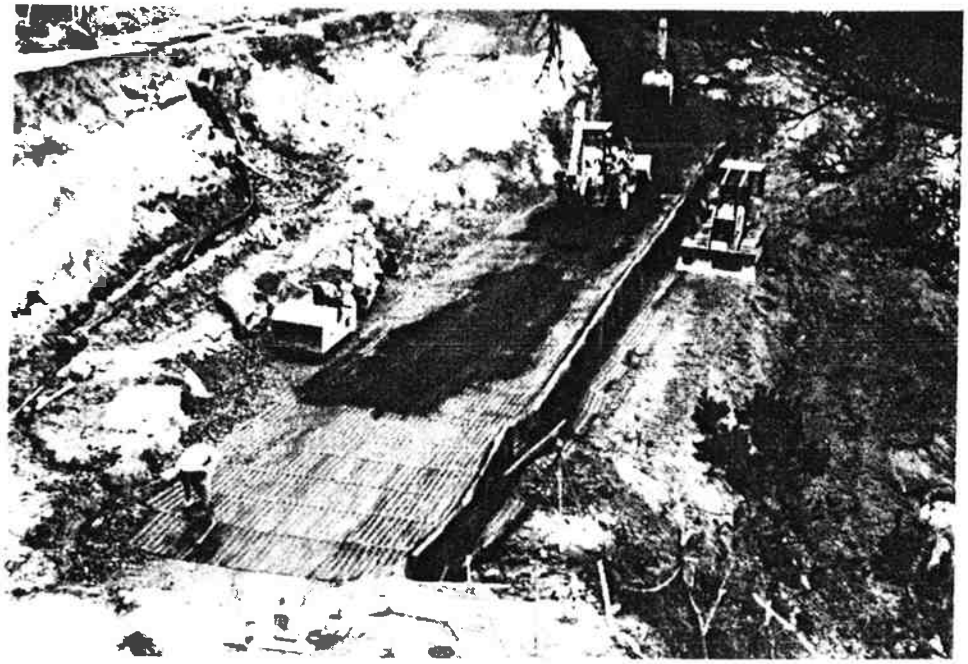


FIGURE 9. General view of construction site, class "A" backfill being placed.

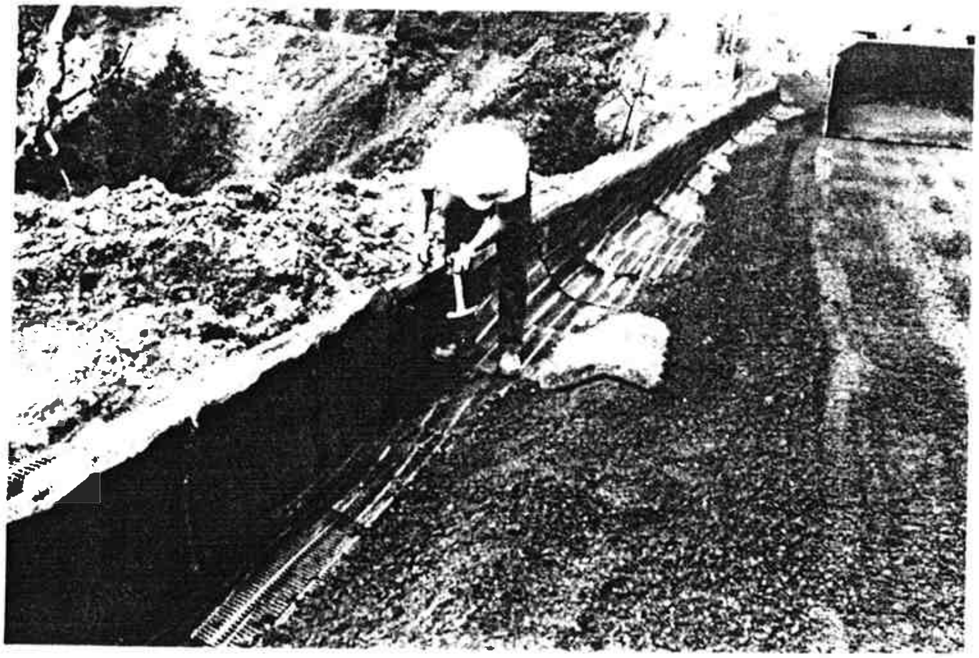


FIGURE 10. Hanging sod on back of forms.

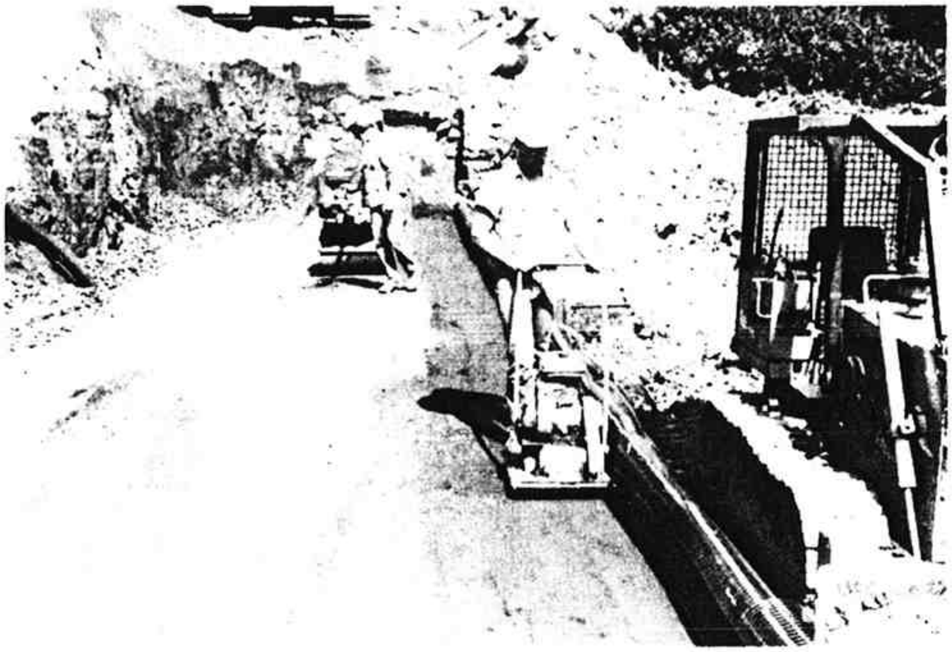


FIGURE 11. Compacting class "B" backfill near the forms.

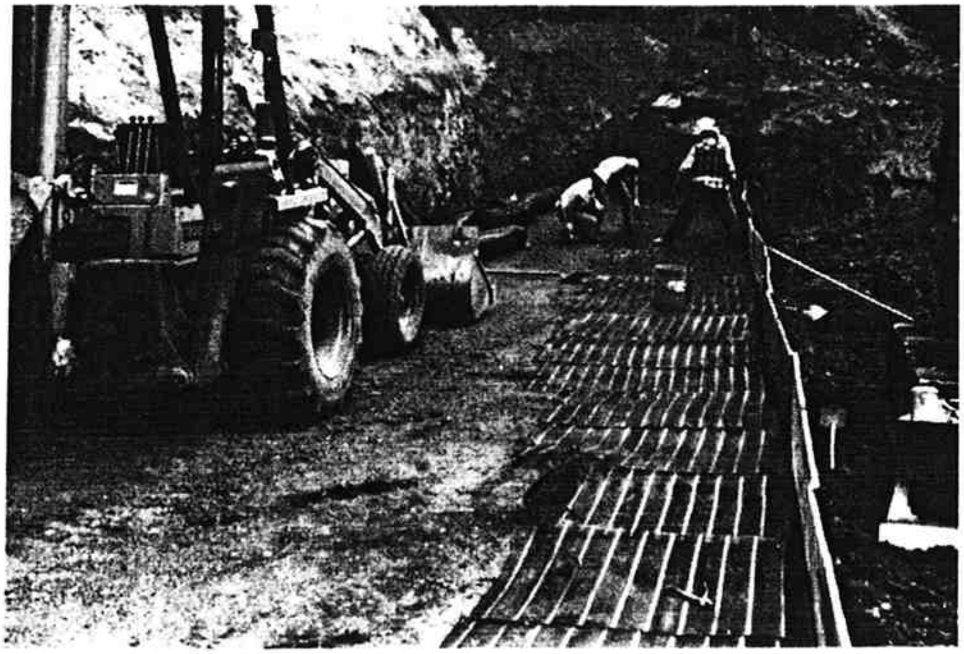


FIGURE 12. Pinning geogrid overlap in place.

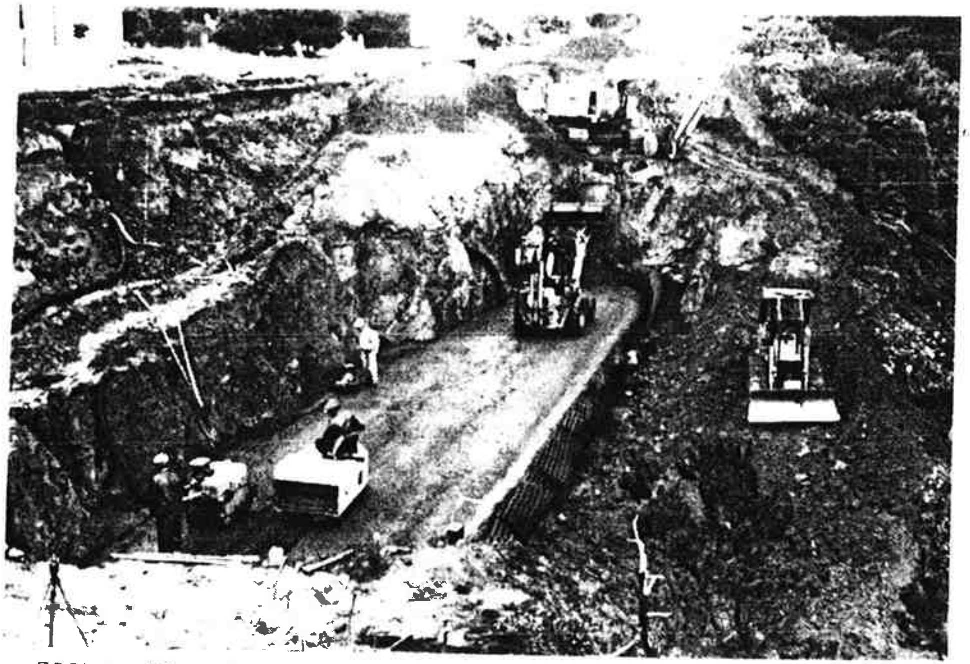


FIGURE 13. General view of the construction site during backfill compaction.

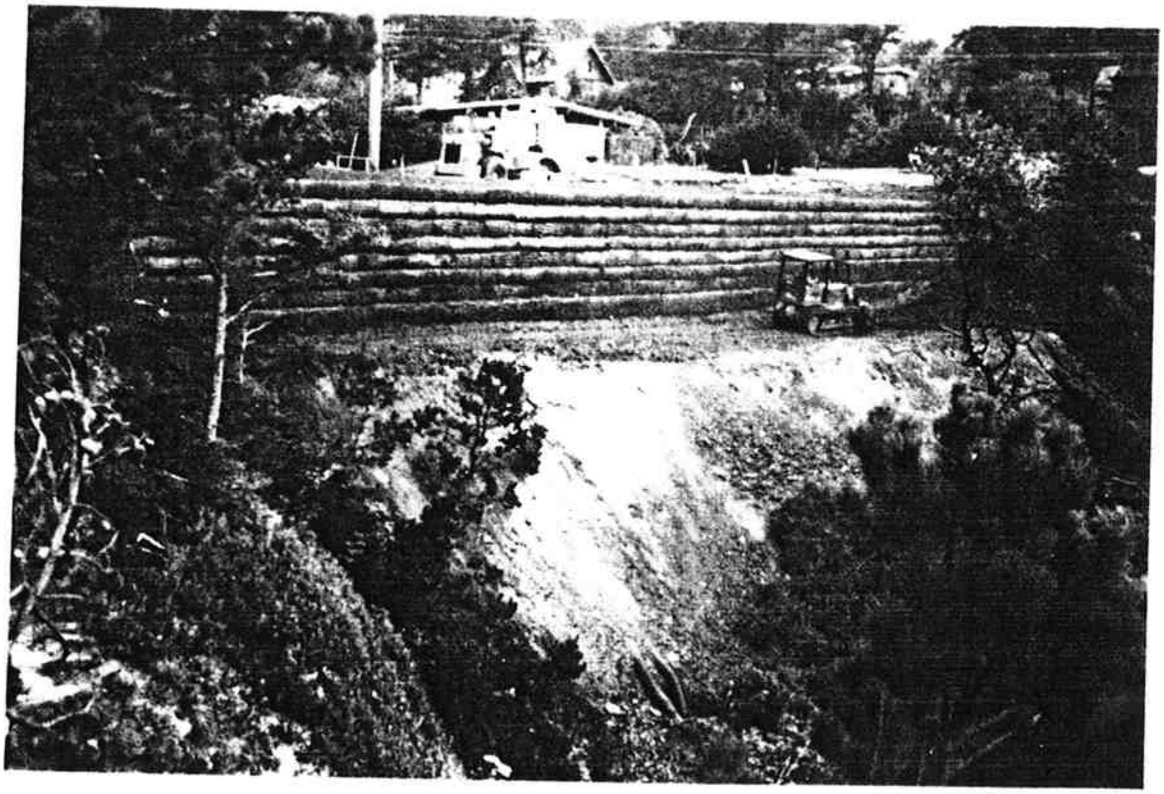


FIGURE 14. Completed geogrid wall.

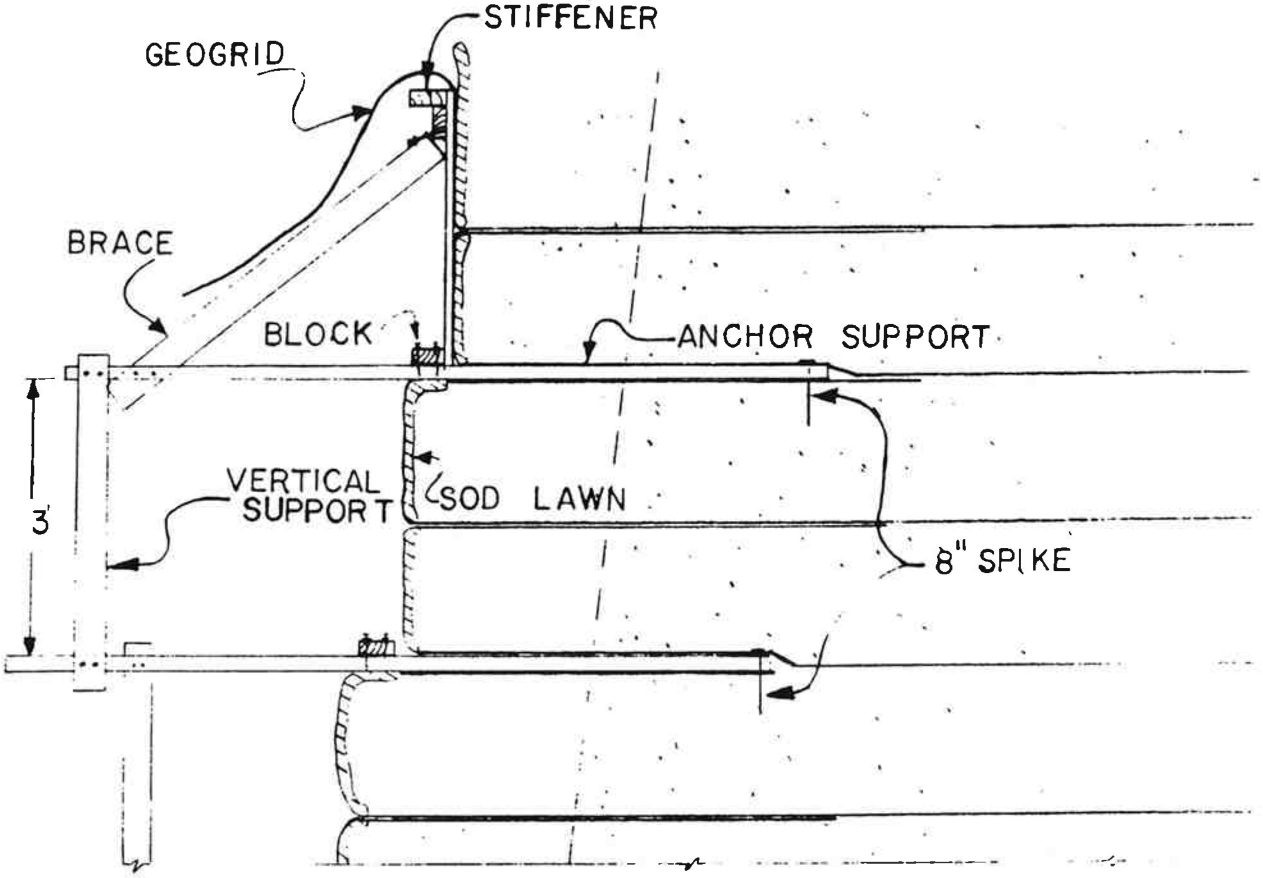


FIGURE 15. Modified forming system.

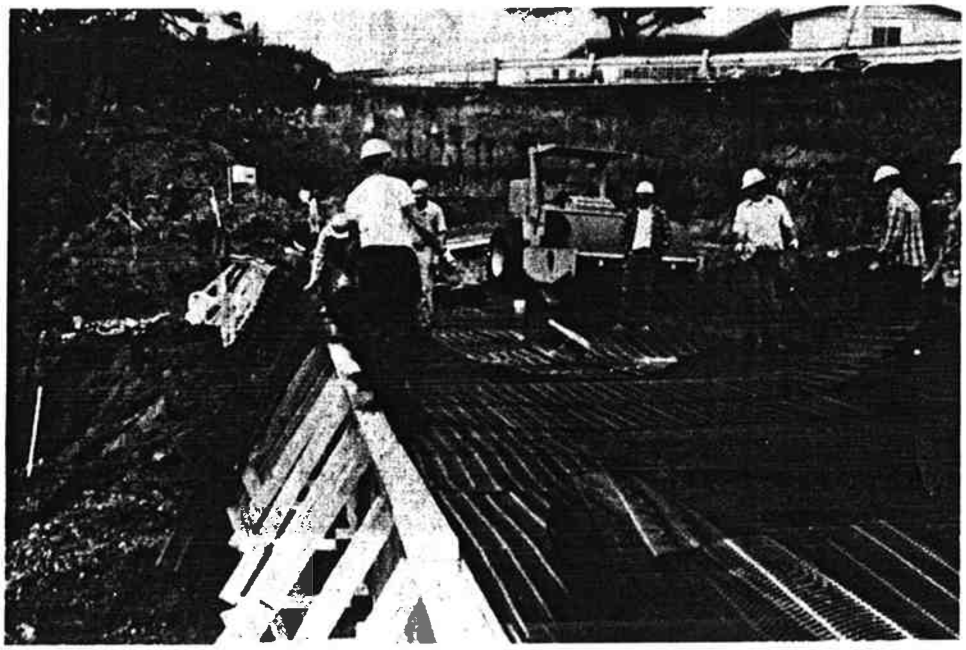


FIGURE 16 Modified forming system and the heavy vibrating roller used for backfill compaction.

DEVILS PUNCHBOWL PARK SLIDE
OTTER ROCK

	ITEM DESCRIPTION	QUANTITY	UNIT	ENGINEER'S ESTIMATE		DAN D. ALLSUP CONSTRUCTION		FINAL CONTRACT PAYMENTS	
					AMOUNT	BID PRICE	AMOUNT	UNIT	AMOUNT
1. – 7.	Mobilization and Traffic Control				$23,033.00		$13,089.00		$ 9,989.00
3.	Temporary Signs	1	LUMP SUM	Lump Sum	2,330.00	1,000.00	1,000.00		
4.	Temporary Barricades	64	SQ.FT.	6.00	684.00	9.00	576.00		
5.	Temporary Continuous Rail Traffic Barrier-Lighted	4	EACH	80.00	320.00	125.00	500.00		
6.	Temporary Bi-Directional Yellow Type I Markers	175	LIN.FT.	12.00	2,100.00	19.00	3,325.00		
7.	Flagmen	22	EACH	4.50	99.00	4.00	88.00		
		250	HOUR	18.00	2,500.00	12.40	3,100.00		
	ROADWORK								
8.	Removal of Structures and Obstructions	1	LUMP SUM	Lump Sum	1,500.00	500.00	500.00	Lump Sum	1,000.00
9.	General Excavation	3,340	CU.YD.	6.00	20,040.00	4.97	16,599.80	4,800.00	23,856.00
10.	Geogrid Mesh	7,250	SQ.YD.	7.00	50,750.00	6.75	48,937.50	5,897.80	39,810.15
11.	Type A Backfill	3,060	CU.YD.	8.50	26,010.00	13.40	41,004.00	2,647.00	35,469.80
12.	Type B Backfill	220	CU.YD.	10.00	2,200.00	14.00	3,080.00	194.00	2,716.00
13.	Sod Lawn	275	SQ.YD.	10.00	2,750.00	15.00	4,125.00	500.00	7,500.00
14.	Trench Excavation	260	CU.YD.	15.00	3,900.00	12.50	3,250.00	1,747.00	2,183.75
15.	Aggregate Base	380	TON	8.50	3,230.00	8.45	3,211.00	552.00	4,664.35
16.	Class "B" Asphalt Concrete	200	TON	37.00	7,400.00	40.00	8,000.00	279.00	11,160.00
17.	12-Inch Sewer Pipe	12	LIN.FT.	20.00	240.00	14.50	174.00	174.00	2,523.00
18.	18-Inch Sewer Pipe	38	LIN.FT.	18.00	684.00	25.00	950.00	38.00	950.00
19.	24-Inch Sewer Pipe	140	LIN.FT.	30.00	4,200.00	32.00	4,480.00	127.50	4,080.00
20.	24-Inch Slip Joint	1	EACH	350.00	350.00	500.00	500.00	1	500.00
21.	Extra for Pipe Under Pavement	58	LIN.FT.	10.00	580.00	12.50	725.00	88.00	1,100.00
22.	Concrete Manholes	1	EACH	1,200.00	1,200.00	1,150.00	1,150.00	2	2,300.00
23.	Concrete Inlets Type G-2	3	EACH	500.00	1,500.00	400.00	1,200.00	2	800.00
24.	Concrete Inlets Type G-2MA	1	EACH	600.00	600.00	450.00	450.00	0	--
25.	6-Inch Drain Pipe	180	LIN.FT.	10.00	1,800.00	6.50	1,170.00	206.00	1,339.00
26.	8-Inch Drain Pipe	110	LIN.FT.	8.00	880.00	10.20	1,122.00	252.00	2,570.40
27.	Filter Fabric	135	SQ.YD.	2.00	270.00	3.50	472.50	914.20	3,199.70
28.	Gravel in Drains	11	CU.YD.	20.00	220.00	19.00	209.00	39.40	748.60
29.	Guardrail Type 2A	375	LIN.FT.	15.00	5,625.00	12.00	4,500.00	150.00	1,800.00
30.	Guardrail Anchors Type 1	4	EACH	350.00	1,400.00	140.00	560.00	4	560.00
31.	Rail end Pieces Type C	4	EACH	85.00	340.00	80.00	320.00	4	320.00
32.	Concrete Curbs	160	LIN.FT.	10.00	1,600.00	10.00	1,600.00	170.40	1,704.00
33.	Extra for Asphalt Approaches	4	EACH	150.00	600.00	175.00	700.00	3	525.00
34.	Adjusting Inlets	1	EACH	200.00	200.00	250.00	250.00	1	250.00
35.	Wood Stairway	1	LUMP SUM	Lump Sum	3,000.00	4,000.00	4,000.00	1	4,000.00
	Price Agreement -- 3001A 2½"x1½" Drain Rock						15.78/CU.YD.	681.60	10,755.65
	Miscellaneous Price Agreements								5,020.80
	GRAND TOTAL								$183,395.20