ED-D

DEPARTMENT OF THE ARMY
ROCK ISLAND DISTRICT, CORPS OF ENGINEERS
CLOCK TOWER BUILDING – P.O. BOX 2004
ROCK ISLAND, ILLINOIS 61204-2004

REPLY TO ATTENTION OF:

May 28, 1993

Planning Division

SEE DOCUMENT DISTRIBUTION LIST

The Rock Island District of the U.S. Army Corps of Engineers (Corps) has enclosed a copy of the Feature Design Memorandum (FDM) with Environmental Assessment (EA) and an unsigned copy of the Finding of No Significant Impact (FONSI) for the Des Moines Recreational River and Greenbelt, Red Rock Multi-Purpose Trail, Segment 3.

This document addresses proposed construction of a segment of multi-purpose trail along the north side of Lake Red Rock, Marion County, Iowa.

The FDM is being circulated for a 30-day public review period, commencing from the date of this letter. If, at the end of the 30 days, no comments are received that alter the determination that no significant environmental impact will result, the FONSI will be signed and kept on file at the Corps' Rock Island District office.

Please send any comments to the address listed below:

District Engineer
U.S. Army Engineer District, Rock Island
ATTN: Planning Division
Clock Tower Building
P.O. Box 2004
Rock Island, Illinois 61204-2004

Sincerely,

Albert J. Kraus
Colonel, U.S. Army
District Engineer

DES MOINES RECREATIONAL RIVER AND GREENBELT
FEATURE DESIGN MEMORANDUM #9
WITH ENVIRONMENTAL ASSESSMENT

RED ROCK MULTI-PURPOSE TRAIL
SEGMENT 3

LAKE RED ROCK, IOWA

REVISED MAY 1993

U.S. ARMY CORPS OF ENGINEERS
ROCK ISLAND DISTRICT
CLOCK TOWER BUILDING
ROCK ISLAND, ILLINOIS 61204-2004

ACKNOWLEDGMENTS

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DES MOINES RECREATIONAL RIVER AND GREENBELT
FEATURE DESIGN MEMORANDUM #9
WITH ENVIRONMENTAL ASSESSMENT

RED ROCK MULTI-PURPOSE TRAIL
SEGMENT 3

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DES MOINES RECREATIONAL RIVER AND GREENBELT
FEATURE DESIGN MEMORANDUM #9
WITH ENVIRONMENTAL ASSESSMENT

RED ROCK MULTI-PURPOSE TRAIL
SEGMENT 3

LAKE RED ROCK, IOWA

1. INTRODUCTION

a. Purpose and Scope

The purpose of this report is to establish the project requirements and to evaluate the project on the basis of engineering, economic, and environmental viability. This report includes a project description, design and construction considerations, operation and maintenance considerations, a detailed cost estimate, an economic analysis, design analyses and an environmental assessment.

b. Project Authority

The Des Moines Recreational River and Greenbelt (hereinafter referred to as the Greenbelt) was authorized on August 15, 1985 by Public Law 99-88, the 1985 Supplemental Appropriations Act. The Greenbelt calls for the development, operation, and maintenance of a recreational area on, and along, the Des Moines and Boone Rivers from Fort Dodge and Webster City, Iowa, downstream to relocated U.S. Highway 92 in the vicinity of Red Rock Dam. A Greenbelt location and vicinity map can be found on Plate 1. Red Rock Multi-Purpose Trail, Segment 3 is one of many Greenbelt Projects.

c. General Design Memorandum

The General Design Memorandum (GDM) for Greenbelt covers the administration, comprehensive plan, plan for initial development and coordination of this project, and discusses the conditions for Federal participation. The comprehensive plan addresses the entire Greenbelt. The Red Rock Multi-Purpose Trail, Segment 3 project is one of the projects included in the comprehensive plan.

d. Other Reports

A list of Feature Design Memorandums (FDM) prepared for other Greenbelt projects follows:

FDM #1: Bennington Bridge Access, May 1986
FDM #2: Jester Park Campground Improvements, August 1989
FDM #3: Red Rock Multi-Purpose, Segment 1, May 1989
FDM #4: Lutheran Hospital Bike Trail, March 1990
FDM #5: Dragoon Trail Scenic Road Route, October 1991

FDM #6: Red Rock Multi-Purpose Trail, Segment 2, March 1991
FDM #7: Hamiliton County Scenic Overlooks, Canceled
FDM #8: Downtown River front Plaza/Amphitheater, August 1992

e. Advisory Committee

A Greenbelt Advisory Committee was established in accordance with the Conference Report on H.R. 2577, dated July 29, 1985. This committee is composed of local officials from the cities, counties, and state governments in the Greenbelt project areas as well as from the Corps of Engineers. At the September 4, 1987 meeting, the advisory committee recommended nine separable projects, including the Red Rock Multi-Purpose Trail, Segment 3 project, to the Corps of Engineers for construction.

f. Principles and Guidelines

Principles and Guidelines activities were accomplished by a combination of activities documented in the September 1987 General Design Memorandum (GDM) and Programmatic Environmental Impact Statement (PEIS), in the workings of the Advisory Committee, and in this report. A number of alternatives for the overall project were addressed in the PEIS and the plans were formulated in the GDM for each separable element in coordination with the local sponsors and the Advisory Committee. Extensive public involvement activities and public meetings have been conducted on a continuing basis under the guidance of the Greenbelt Advisory Committee.

g. Local Sponsor

The Red Rock Multi-Purpose Trail System, as described in the Greenbelt General Design Memorandum, is authorized to be funded entirely by the Federal government. Segment 3, like Segments 1 and 2, is not cost-shared with a local sponsor and does not require a local cooperation agreement. The project is funded entirely by the Federal government and will be built entirely on land owned by the Federal government. The Corps of Engineers is the project sponsor.

2. DESCRIPTION OF PROJECT

a. Project Purpose

The purpose of Segment 3 is to provide a recreational facility for use by the public. The project makes areas of publicly owned land which are presently accessible only to hikers, accessible to pedestrians, bicyclists, cross country skiers, and disabled individuals. Segment 3 will connect a previously constructed trail which begins in the tail water area of Red Rock Dam with the Wallashuck Recreation Area. Segment 3 is the last in a series of trail segments which will provide a continuous multi-purpose trail between the Red Rock Dam Tail water Area and the Wallashuck Recreation Area. Segment 4, the next segment of the Red Rock Trail System, will provide a continuation of the Red Rock Trail System beyond the Wallashuck Recreation Area.

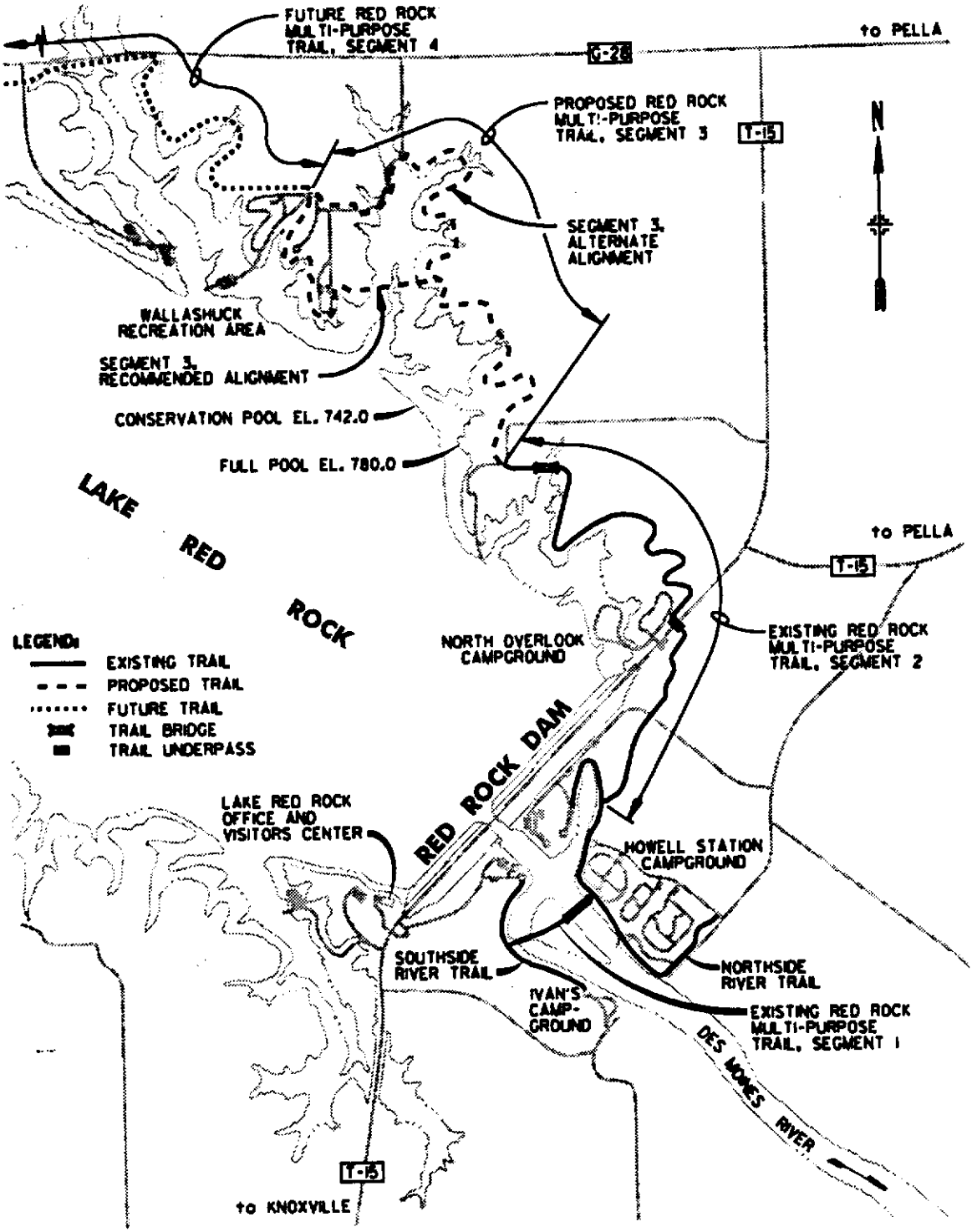
b. Project Location

The project is located along the northeast shore of Lake Red Rock in Township 77 North, Range 18 West, Sections 7 and 18 , and Township 77 North, Range 19 West, Section 12 (U.S.G.S. , Pella, 15' quadrangle), Marion County, Iowa. The project begins approximately 2500 feet upstream from Red Rock Dam and runs northwest alongside Lake Red Rock for approximately two miles.

c. Project Description:

(1) The project involves the construction of 10,000 feet of asphalt surfaced trail. The trail will have an asphalt paved width of 10 feet and a minimum 3-foot -shoulder on each side. The trail crosses several small drainages, two streams, and a 1,250-foot-wide portion of Lake Red Rock. All small drainages and the stream at Station 30+60 are crossed via culvert and embankment. The stream at Station 29+00 is crossed via a 171-foot-long timber bridge. The portion of Lake Red Rock is crossed via a 1,250-foot-long embankment over an 8-foot-square reinforced concrete box culvert. The terrain the trail passes through is generally very hilly with both forested and grassland areas.

(2) This project is only one segment of the Red Rock Multi-Purpose Trail system authorized by the Greenbelt General Design Memorandum(see Figure 2-1). Segment 1, described in FDM #3, involved the construction of approximately 1000 feet of trail and a 500-foot-long-bridge over the Des Moines River. Segment 2, described in FDM #6, involved the construction of approximately 10,700 of trail to include an underpass below Marion County Highway T-15 and a 400-foot-long bridge over a portion of Lake Red Rock. Segment 4 is a future project which involves the construction of approximately 8 miles of multi-purpose trail. Segment 4 begins in the Wallashuck Recreation Area where Segment 3 ends, and runs along the north shore of Lake Red Rock to Iowa State Highway 14.



PROJECT LOCATION PLAN

2000 0 2000 4000 6000

APPROXIMATE SCALE IN FEET

Figure 2-1: Project Location Plan

3. DESIGN AND CONSTRUCTION CONSIDERATIONS

a. Civil Design

(1) The proposed horizontal and vertical alignments were designed to minimize alterations of the natural terrain and clearing of vegetative cover while maintaining gradients and curves that would not be too difficult or dangerous for the users to negotiate. Several different horizontal and vertical alignments were considered. The proposed trail design was selected because it provides a recreational facility that best meets both environmental and user requirements.

(2) Geometrics to include horizontal alignment, vertical alignment and cross sections are based on August 1991 American Association of State Highway and Transportation Officials (AASHTO) criteria for the development of new bicycle facilities. Grades on the trail are kept below or close to five percent. Vertical crest curves were selected to allow for adequate stopping sight distance and vertical sag curves were selected to avoid abrupt changes in grade. All horizontal curves have a minimum design speed of 20 miles per hour. The trail is 10-feet wide to accommodate both bicycle and pedestrian traffic.

b. Conservation of Existing Resources

One of the major design objectives for this project is to minimize disturbance to existing natural resources. Particular care was taken in selecting the horizontal alignment to follow the natural contours of the land as much as possible and still maintain geometric design criteria. The design profile was determined by following the existing ground line as close as practically possible. During the plans and specifications stage, the areas which will be cleared will be field staked and minor changes will be incorporated into the horizontal alignment to minimize the clearing of large diameter trees.

c. Stream Crossing at Station 29+00

(1) Description: The trail crosses an intermittent stream at Station 29+00 as shown on Plate 7. The stream has a drainage area of 26 acres, which is delineated on Plate 1 of Appendix F. The stream runs through a mature hardwood forest in an undeveloped area. Two alternatives for crossing the stream were considered. Following is a brief discussion of each alternative.

(2) Bridge Crossing

(a) A 171-foot-long-timber-bridge was designed to cross the stream. The bridge deck will be 12 feet wide and the superstructure will consist of eight trapezoidal sections constructed to form a 200-foot-radius horizontal curve. The bridge will be supported by seven timber trestle piers and two timber abutments. Plans and sections for the bridge are shown on Plates 12 and 13. A structural analysis for the bridge is located in Appendix D. The estimated construction cost for the bridge is $119,000.

(b) The elevation of the bridge superstructure was determined by meeting AASHTO design criteria for safe approach gradients to the structure. The design profile for the trail at each end of the bridge will be 3.7%. The

design profile for the riding surface of the bridge will also be 3.7%. The elevation of the bridge superstructure was then checked to insure that it would clear the stream at maximum flow. The lowest portion of the bridge superstructure above the stream channel is at elevation 796. Using Iowa Regression Equations for Hydrologic Region 3, a 500-year-storm-event for the stream's drainage basin was determined to produce a stream flow of 250 cubic feet per second. The natural channel was conservatively estimated to have a minimum bottom width of 1-foot, 1H-1V side slopes and a 3.5% channel slope. Using the above parameters, it was calculated that the existing natural channel can accommodate the 500-year-event discharge of 250 cubic feet per second at a channel depth of 5 feet. Since the channel bottom is approximately at elevation 780, the bridge will safely clear the 500-year-event discharge elevation of 785 by 11 feet.

(c) Crossing the stream via a bridge will minimize the clearing of existing trees and alterations to the existing natural terrain. This is a significant advantage since the stream is located in an area which is considered likely habitat for an endangered species(for a detailed discussion see the Environmental Assessment in Section 7). A bridge crossing is also a desirable alternative in terms of aesthetics since a timber bridge will blend in nicely with the natural surroundings as opposed to a large embankment which will require a large amount of clearing.

(d) Advantages of this alternative are initial construction costs, minimum environmental impacts, and aesthetics. Disadvantages of a bridge crossing are higher maintenance costs in than a culvert.

(e) After considering costs, aesthetics, and impacts to existing natural resources, wildlife, and endangered species, a bridge was selected as the best alternative for crossing the stream.

(3) Culvert and Embankment Crossing: The only other viable alternative considered for crossing the stream was a culvert and embankment crossing. This alternative would involve constructing a 7,000 cubic yard embankment over a 54 inch diameter culvert. The embankment would be constructed of clay fill from borrow area 1(for location see Borings BT-92-8 and BT-92-9 on Plate 8) and would have side slopes of 3H-1V. Construction of the embankment would require clearing 0.25 acres of mature hardwood forest. The estimated construction cost for this alternative is $132,000. Advantages of a culvert and embankment crossing are lower maintenance costs than a bridge. Disadvantages of this alternative are initial construction costs, environmental impacts, and poor aesthetics. After considering costs, aesthetics, and impacts to existing natural resources, wildlife, and endangered species, crossing the stream via a culvert and embankment was determined to be the least desirable alternative.

d. Stream Crossing at Station 30+60

(1) Description: The trail crosses another intermittent stream at Station 30+60 as shown on Plate 7. This stream also has a drainage area of 26 acres which is delineated on Plate 1 of Appendix F. This stream runs through a mature hardwood forest but differs from the stream at Station 29+00 in that at the point where it intersects the trail it runs adjacent to the south edge of a previously cleared area with relatively young scrub growth. Two alternatives

for crossing the stream were considered. Following is a brief discussion of each alternative.

(2) Culvert/Gatewell and Embankment Crossing

(a) Crossing the stream via a culvert/gatewell and embankment will involve constructing a 2,000 cubic yard embankment over a 42-inch diameter culvert and a 48-inch-square gatewell structure as shown on Plate 7. The embankment will have side slopes of 3H-1V and will be constructed of clay fill from borrow area 1. The estimated construction cost for this alternative is $42,000.

(b) The nature of the crossing site is conducive to damming the stream and creating a permanent 0.21 acre pond. A geotechnical analysis for the embankment is located in Appendix C. A hydraulic analysis for the gatewell structure and culvert can be found in Appendix F. Creating a permanent pond is a significant advantage of this alternative. The pond will aesthetically add to the trail and will benefit wildlife.

(c) This alternative will require clearing a 0.05 acre area for the construction of the embankment. The area to be cleared will consist of the stream bed and the north side of the stream as shown on Plate 7. Since both of these areas are not densely populated with mature hardwood trees, the impacts will not be a significant disadvantage.

(d) Advantages of this alternative are initial construction costs, maintenance costs, minimum impacts to the environment, aesthetics and potential benefits to wildlife. The only real disadvantage of a culvert and embankment crossing at this location, is the construction of the embankment will require a small amount of clearing.

(e) After considering costs, aesthetics, and impacts to existing natural resources, wildlife, and endangered species; crossing the stream via a culvert/gatewell and embankment was selected as the best alternative.

(3) Bridge Crossing: Crossing the stream via a bridge would involve the construction of a 70-foot-long-timber bridge similar to the bridge designed for the stream crossing at Station 29+00, except it would not be curved. The bridge would be supported by three timber trestle piers and two timber abutments. The estimated construction cost of this alternative is $51,000. Advantages of this alternative are aesthetics and minimal environmental impacts. Disadvantages are initial construction costs and maintenance costs. After considering costs, aesthetics, and impacts to existing natural resources, wildlife, and endangered species, a bridge was determined to be the least desirable alternative for crossing the stream.

e. Lake Crossing Between Station 50+00 and 62+50

(1) Description: The trail will cross a portion of the Lake Red Rock flood control pool between Stations 50+00 and 62+50 as shown in Figure 2-1 and Plate 9. The elevation of the maximum flood control pool at Lake Red Rock is 780 feet above sea level. Conservation pool at Lake Red Rock is at elevation 742, except during autumn(Sept 15 to Dec 15) when the pool is raised to elevation 744 for the benefit of migrating water fowl. A duration curve and

frequency curve for Lake Red Rock is shown in Figures 3-1 and 3-2 respectively. It should be noted that the duration curve is for the period between 15 April and 15 October which is when the trail will receive most of its use. Several alternatives for crossing the lake were considered. Following is a discussion of each.

(2) Culvert and Embankment Crossing at Elevation 770

(a) Crossing the lake via a culvert and embankment at elèvation 770 will involve constructing a 205-foot-long 8-foot by 8-foot reinforced concrete box culvert and a 53,500 cubic yard embankment. The embankment will have side slopes of 3H-1V and will be armored on the lake side with a 22-inch layer of riprap on a 12-inch layer of bedding stone. The estimated total project cost for the trail is $2,659,500. The resulting total project benefit cost ratio is 1.72, and the resulting total project net annual benefits are $167,574. Periodic inspection and maintenance will be required for the riprap stone protection, however these maintenance costs are not expected to differ significantly from the other alternatives considered. A summary of the detailed cost estimate for this alternative is found in Section 5.

(b) The portion of embankment above elevation 745 will be constructed of 43,100 compacted cubic yards of impervious fill material. All of the impervious fill material will be excavated from borrow area 1(for location see borings BT-92-8 and BT-92-9 on Plate 8). Since borrow area 1 is located entirely in the flood control pool between elevations 750 and 770, the construction of embankment above elevation 745 will result in no change in flood storage volume. The portion of embankment below elevation 745 will be constructed of 10,400 compacted cubic yards of pervious fill material from a source outside of the flood control pool. All of the fill below elevation 742 will be below the flood pool and will result no loss in flood storage. The amount of impervious fill between elevations 742 and 745 is approximately 5,700 compacted cubic yards. Borrow area 1 will be used as a source for approximately 3,000 bank cubic yards of fill for the trail between Stations 30+00 and 50+00 and 7,500 bank cubic yards of fill between Stations 62+50 and 101+55. Since the amount of material removed from the flood control pool(3,000 cy + 7,500 cy=10,500 cy), exceeds the amount of material placed in the flood control pool(5,700 cy), the project will result in a net increase in flood storage.

(c) Crossing the pool at elevation 770 will mean that a portion of the trail will be periodically inundated. Allowing for three feet of wave run up, the trail will be able to be used by the public until the lake reaches elevation 767. Trail closure gates will be installed at elevation 783 at both sides of the lake, so a high water event will result in a 1,030-foot section of trail between the closure gates being closed to the public. As shown in Figure 3-2, an elevation of 767 results in a percent exceedence probability of 11 percent which translates to a 9-year-flood-event. As shown in Table 3-1, the average length of duration for elevation 767 is about five weeks. Therefore a trail at elevation 770 will be inundated, statistically, every 9 years for a period of approximately five weeks. This periodic inundation will result in a loss of average annual benefits of $4,614 and an estimated additional maintenance cost of $4,000 per inundation.

Red Rock Pool Duration

15 April - 15 October

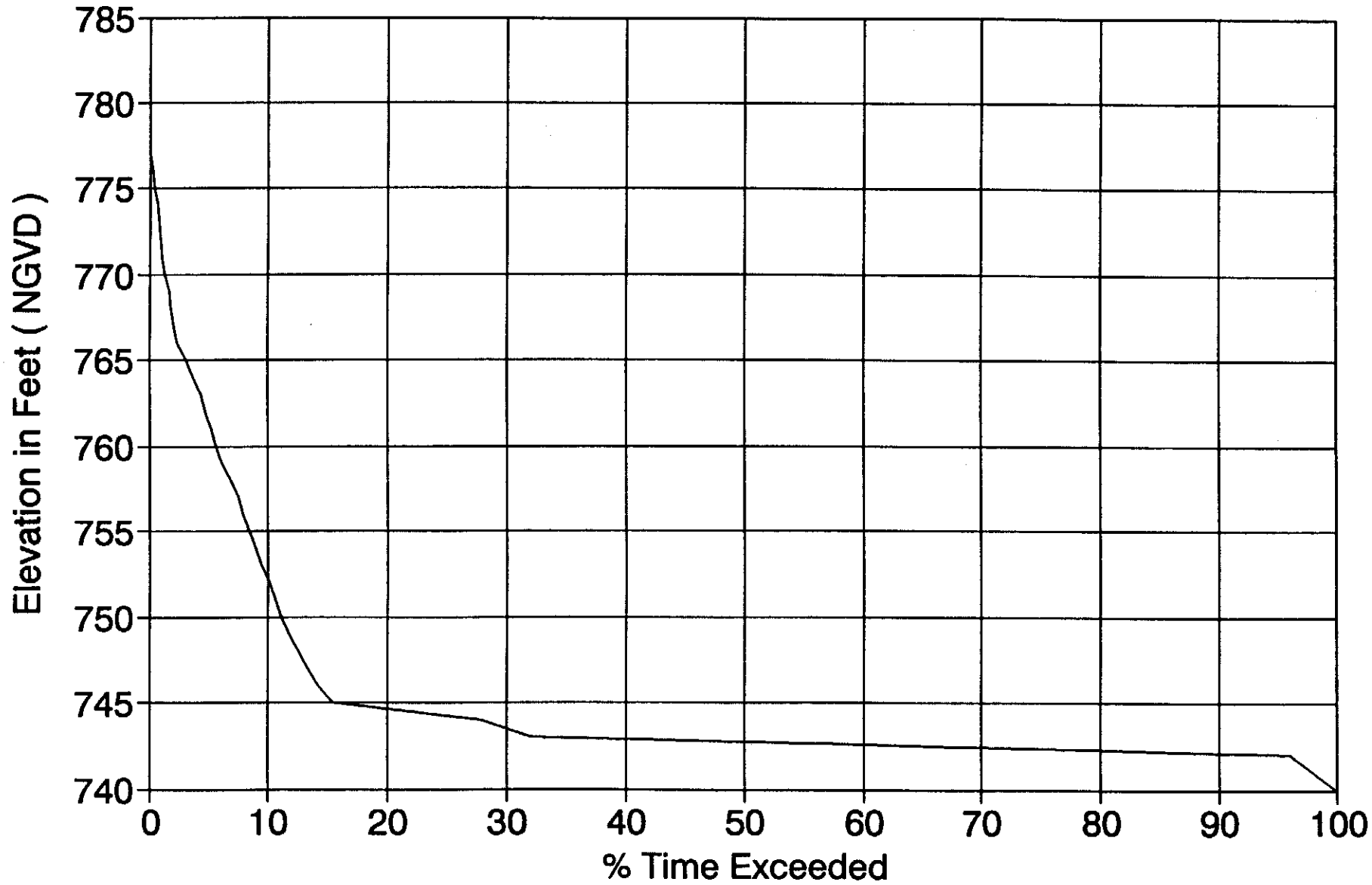


Figure 3-1

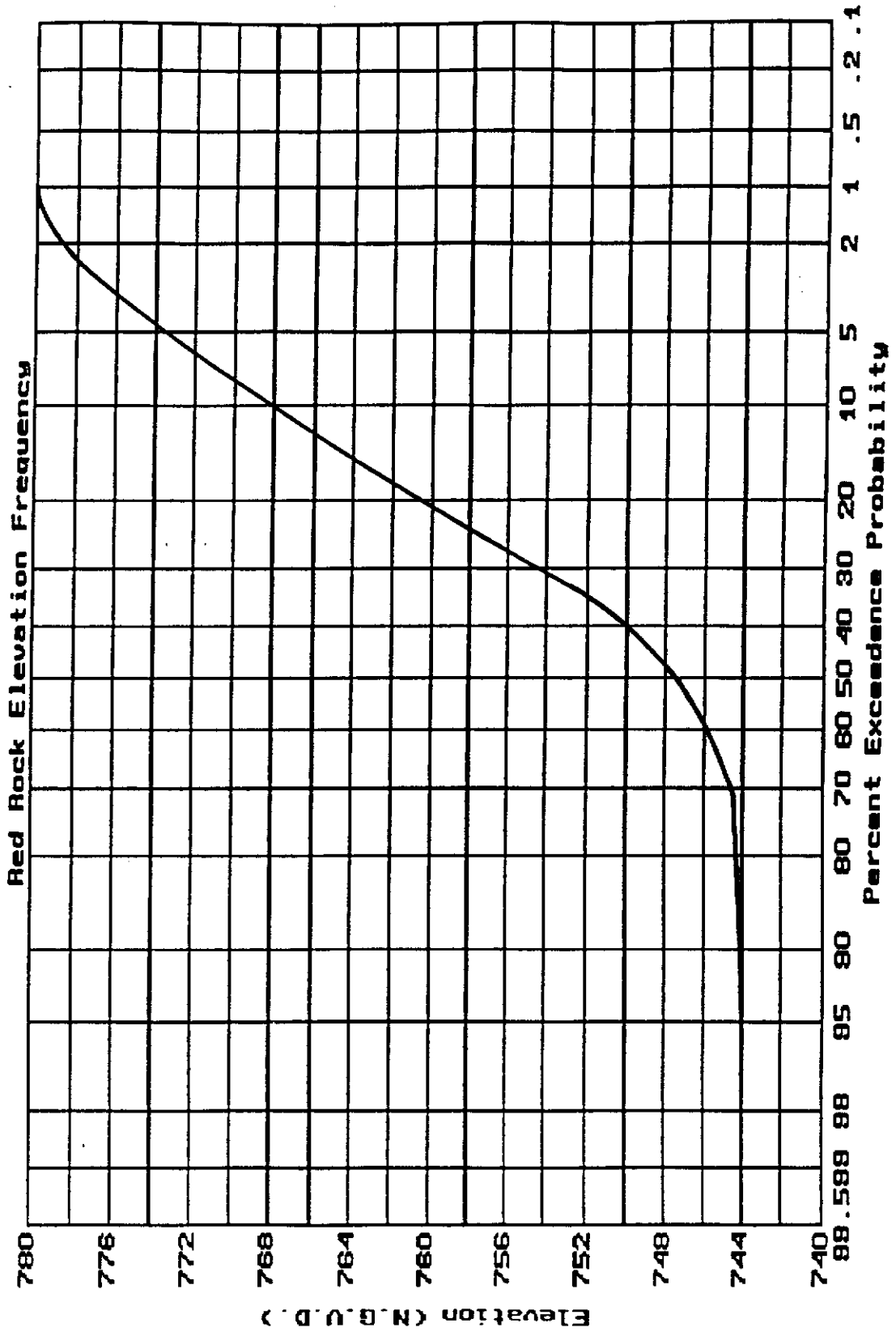

Red Rock Elevation Frequency
Percent Exceedance Probability
99.5 99 98 95 90 80 70 60 50 40 30 20 10 5 2 1 .5 .2 .1
780 776 772 768 764 760 756 752 748 744 740
Elevation (N.G.V.D.)

Figure 3-2

Red Rock Pool Duration
15 April - 15 October
1917 - 1991

Elevation	days	Percent	# Events	Ave Length
730	13800	100.0%	75	184.0
742	13240	95.9%	95	139.4
743	4427	32.1%	131	33.8
744	3843	27.8%	116	33.1
745	2133	15.5%	67	31.8
746	1967	14.3%	57	34.5
747	1842	13.3%	50	36.8
748	1728	12.5%	45	38.4
749	1627	11.8%	37	44.0
750	1541	11.2%	30	51.4
751	1468	10.6%	29	50.6
752	1393	10.1%	29	48.0
753	1314	9.5%	28	46.9
754	1246	9.0%	28	44.5
755	1172	8.5%	29	40.4
756	1105	8.0%	27	40.9
757	1038	7.5%	25	41.5
758	960	7.0%	26	36.9
759	859	6.2%	21	40.9
760	787	5.7%	19	41.4
761	722	5.2%	16	45.1
762	666	4.8%	13	51.2
763	599	4.3%	15	39.9
764	519	3.8%	15	34.6
765	427	3.1%	16	26.7
766	329	2.4%	11	29.9
767	283	2.1%	8	35.4
768	251	1.8%	7	35.9
769	230	1.7%	6	38.3
770	186	1.3%	6	31.0
771	155	1.1%	5	31.0
772	138	1.0%	5	27.6
773	115	.8%	5	23.0
774	89	.6%	3	29.7
775	59	.4%	6	9.8
776	38	.3%	4	9.5
777	16	.1%	2	8.0
778	4	.0%	2	2.0
779	0	.0%	0	.0
780	0	.0%	0	.0
781	0	.0%	0	.0
782	0	.0%	0	.0
783	0	.0%	0	.0
784	0	.0%	0	.0
785	0	.0%	0	.0

Table 3-1

RED ROCK MULTI-PURPOSE TRAIL
SEGMENT 3
FEATURE DESIGN MEMORANDUM

PROJECT COST SUMMARY
DIVISION OF COST

MARCH 1993

ACCOUNT	FEATURE		CURRENT WORKING ESTIMATE (CWE)		FULLY FUNDED ESTIMATE (FFE)	
			FEDERAL	NON-FEDERAL	FEDERAL	NON-FEDERAL
14.	RECREATION FACILITIES		$1,960,000		$2,083,088	
30.	PLANNING, ENGINEERING AND DESIGN		485,000		500,147	
	FEATURE DSGN MEMO	$360,000				
	PLANS & SPECS	120,000				
	ENGR DURING CONSTR	5,000				
31.	CONSTRUCTION MANAGEMENT		214,500		234,191	
	CONTRCT ADMIN	$75,000				
	SHOP DWG REVIEW	21,500				
	QUALITY ASSURNCE	118,000				
	SUBTOTAL		$2,659,500	0	2,817,426	0
	COMBINED TOTAL PROJECT COST		$2,659,500		$2,817,426	

NOTES:

1. TOTAL PROJECT COST IS 100% FEDERAL COST; PROJECT LANDS ARE GOVERNMENT OWNED.

2. CONSTRUCTION SCHEDULED FOR SEP 93 - MAY 96. FULLY FUNDED ESTIMATE (FFE) IS BASED ON MIDPOINT OF CONSTRUCTION DATE OF DEC 94, GIVING INFLATION FACTORS OF 1.0918 FOR SALARIES AND 1.0628 FOR ALL OTHER COSTS PER CECW-B MEMO, 7 FEB 92, SUBJECT: FACTORS FOR UPDATING STUDY/PROJECT COST ESTIMATES FOR THE FY 1994 BUDGET SUBMISSION.

Table 5-1

total project cost for the trail using this alternative is $3,052,000. The resulting total project benefit cost ratio is 1.53, and the resulting total project net annual benefits are $139,637.

(b) A major advantage of this alternative is it will not require any earth fill material to be permanently placed in the lake. Other advantages are less maintenance costs than an armored embankment, aesthetics, minimum environmental impacts, and the trail will never be inundated. Disadvantages of this alternative are initial construction cost, benefit cost ratio and annual net benefits. Crossing the pool via a 1,050-foot-bridge will cost $392,500 more than the selected alternative and have $27,900 less in net annual benefits.

(5) Culvert and Embankment Crossing at Elevation 775

(a) Crossing the lake via a culvert and embankment at elevation 775 would involve constructing a 235-foot-long reinforced concrete box culvert and a 75,000 compacted cubic yard embankment. The embankment would be armored on the lake side with a 25-inch layer of riprap on a 12-inch layer of bedding stone. The estimated total project cost for the trail using this alternative is $2,932,500. The resulting total project benefit cost ratio is 1.58 and the resulting total project net annual benefits are $146,411.

(b) Crossing the pool at elevation 775 will mean the trail will be periodically inundated. Allowing for three feet of wave run up, the trail will be able to be used by the public until the lake reaches elevation 772. As shown in Figure 3-2, an elevation of 772 results in a percent exceedence probability of 7 percent which translates to a 14-year-flood-event. As shown in Table 3-1, the average length of duration for elevation 772 is about four weeks. Therefore a trail at elevation 775 will be inundated, statistically, every 14 years for a period of approximately four weeks. This periodic inundation will result in a loss of average annual benefits of $2,966 and an estimated additional maintenance cost of $4,000 per inundation.

(c) Advantages of this option are the trail will be inundated less often. Disadvantages are initial construction cost, benefit cost ratio, and net annual benefits. Crossing the pool via a culvert and embankment at elevation 775 will cost $273,000 more than the selected alternative and have $21,200 less in net annual benefits.

(6) Culvert and Embankment Crossing at Elevation 765

(a) Crossing the lake via a culvert and embankment at elevation 765 would involve constructing a 200-foot-long reinforced concrete box culvert and a 42,000 compacted cubic yard embankment. The embankment would be armored on the lake side with a 22-inch layer of riprap on a 12-inch layer of bedding stone. The estimated total project cost for the trail using this alternative is $2,545,000. The resulting total project benefit cost ratio is 1.78 and the resulting total project net annual benefits are 173,147.

(b) Crossing the pool at elevation 765 will mean the trail will be periodically inundated. Allowing for three feet of wave run up, the trail will be able to be used by the public until the lake reaches elevation 762. As shown in Figure 3-2, an elevation of 762 results in a percent exceedence probability of 18 percent which translates to a 5-year-flood-event.. As shown in Table 3-1,

Public Law 99-88 specifically states that the purchase of private property must be with the consent of the owner and that no condemnation authority is authorized. Construction of the alternate alignment will require purchasing land from five different private land owners. The Corps of Engineers has not been able to obtain permission from the land owners to purchase their property. Since the project authority does not allow for the condemnation of private property, the proposed alternate alignment is not a viable alternative.

4. OPERATION AND MAINTENANCE CONSIDERATIONS

a. Operation

The project will be operated by the Corps of Engineers. Operation will include enforcing applicable load limits, vehicle restrictions, and closure devices required to maintain the safe operation of the facility.

b. Maintenance

The project maintenance will be the responsibility of the Corps of Engineers. Maintenance activities will include shoulder and pavement inspection and repair, riprap inspection and repair, culvert and bridge inspection and repair, culvert clean out, pavement markings, traffic control sign replacements, and mowing adjacent to grassed areas as required.

Public Law 99-88 specifically states that the purchase of private property must be with the consent of the owner and that no condemnation authority is authorized. Construction of the alternate alignment will require purchasing land from five different private land owners. The Corps of Engineers has not been able to obtain permission from the land owners to purchase their property. Since the project authority does not allow for the condemnation of private property, the proposed alternate alignment is not a viable alternative.

4. OPERATION AND MAINTENANCE CONSIDERATIONS

a. Operation

The project will be operated by the Corps of Engineers. Operation will include enforcing applicable load limits, vehicle restrictions, and closure devices required to maintain the safe operation of the facility.

b. Maintenance

The project maintenance will be the responsibility of the Corps of Engineers. Maintenance activities will include shoulder and pavement inspection and repair, riprap inspection and repair, culvert and bridge inspection and repair, culvert clean out, pavement markings, traffic control sign replacements, and mowing adjacent to grassed areas as required.

total project cost for the trail using this alternative is $3,052,000. The resulting total project benefit cost ratio is 1.53, and the resulting total project net annual benefits are $139,637.

(b) A major advantage of this alternative is it will not require any earth fill material to be permanently placed in the lake. Other advantages are less maintenance costs than an armored embankment, aesthetics, minimum environmental impacts, and the trail will never be inundated. Disadvantages of this alternative are initial construction cost, benefit cost ratio and annual net benefits. Crossing the pool via a 1,050-foot-bridge will cost $392,500 more than the selected alternative and have $27,900 less in net annual benefits.

(5) Culvert and Embankment Crossing at Elevation 775

(a) Crossing the lake via a culvert and embankment at elevation 775 would involve constructing a 235-foot-long reinforced concrete box culvert and a 75,000 compacted cubic yard embankment. The embankment would be armored on the lake side with a 25-inch layer of riprap on a 12-inch layer of bedding stone. The estimated total project cost for the trail using this alternative is $2,932,500. The resulting total project benefit cost ratio is 1.58 and the resulting total project net annual benefits are $146,411.

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(c) Advantages of this option are the trail will be inundated less often. Disadvantages are initial construction cost, benefit cost ratio, and net annual benefits. Crossing the pool via a culvert and embankment at elevation 775 will cost $273,000 more than the selected alternative and have $21,200 less in net annual benefits.

(6) Culvert and Embankment Crossing at Elevation 765

(a) Crossing the lake via a culvert and embankment at elevation 765 would involve constructing a 200-foot-long reinforced concrete box culvert and a 42,000 compacted cubic yard embankment. The embankment would be armored on the lake side with a 22-inch layer of riprap on a 12-inch layer of bedding stone. The estimated total project cost for the trail using this alternative is $2,545,000. The resulting total project benefit cost ratio is 1.78 and the resulting total project net annual benefits are 173,147.

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RED ROCK MULTI-PURPOSE TRAIL
SEGMENT 3
FEATURE DESIGN MEMORANDUM

PROJECT COST SUMMARY
DIVISION OF COST

MARCH 1993

ACCOUNT	FEATURE	CURRENT WORKING ESTIMATE (CWE)		FULLY FUNDED ESTIMATE (FFE)	
		FEDERAL	NON-FEDERAL	FEDERAL	NON-FEDERAL
14.	RECREATION FACILITIES	$1,960,000		$2,083,088	
30.	PLANNING, ENGINEERING AND DESIGN	485,000		500,147	
	FEATURE DSGN MEMO $360,000				
	PLANS & SPECS 120,000				
	ENGR DURING CONSTR 5,000				
31.	CONSTRUCTION MANAGEMENT	214,500		234,191	
	CONTRCT ADMIN $75,000				
	SHOP DWG REVIEW 21,500				
	QUALITY ASSURNCE 118,000				
	SUBTOTAL	$2,659,500	0	2,817,426	0
	COMBINED TOTAL PROJECT COST	$2,659,500		$2,817,426	

NOTES:

1. TOTAL PROJECT COST IS 100% FEDERAL COST; PROJECT LANDS ARE GOVERNMENT OWNED.

2. CONSTRUCTION SCHEDULED FOR SEP 93 - MAY 96. FULLY FUNDED ESTIMATE (FFE) IS BASED ON MIDPOINT OF CONSTRUCTION DATE OF DEC 94, GIVING INFLATION FACTORS OF 1.0918 FOR SALARIES AND 1.0628 FOR ALL OTHER COSTS PER CECW-B MEMO, 7 FEB 92, SUBJECT: FACTORS FOR UPDATING STUDY/PROJECT COST ESTIMATES FOR THE FY 1994 BUDGET SUBMISSION.

Table 5-1

RED ROCK MULTI-PURPOSE TRAIL SEGMENT 3 FEATURE DESIGN MEMORANDUM
PROJECT CONSTRUCTION COST ESTIMATE
FEBRUARY 1993 PRICE LEVEL

Code of Accounts	Item	Quantity	Unit	Price	Cont %	Contingency	Reason
14	RECREATION						
14.0.3.-	Bicycle Trail						
14.0.3.B	Trail, Sta. 0+00 - 43+00						
14.0.3.B	Bike Trail Embankment	1	JOB	$78,256	15%	$11,738	1,2,3
14.0.3.B	Bike Trail Pavement	1	JOB	$52,322	20%	$10,464	1,3,4
14.0.3.B	Culverts	1	JOB	$19,039	15%	$2,856	4
14.0.3.B	Seeding	1	JOB	$10,827	15%	$1,624	1,4
14.0.3.B	Signs	1	JOB	$1,485	20%	$297	1,4
14.0.3.B	Gatewell Structure	1	JOB	$20,637	15%	$3,096	1,2,4
14.0.3.B	Site Preparation	1	JOB	$29,851	20%	$5,970	2
14.0.3.B	Mob and Demob	1	JOB	$24,426	10%	$2,443	1,3
14.0.3.B	Timber Bridge	1	JOB	$107,843	10%	$10,784	1,2,3,4
	Total			$344,686		$49,272	
14.0.3.B	Trail, Sta. 43+00 - 64+00						
14.0.3.B	Site Preparation	1	JOB	$29,851	20%	$5,970	2
14.0.3.B	Construct Box Culvert	1	JOB	$207,263	15%	$31,089	1,2,4
14.0.3.B	Bike Trail Embkmnt El 770	1	JOB	$792,871	10%	$79,287	1,2,3,4
14.0.3.B	Bike Trail Pavement	1	JOB	$38,776	20%	$7,755	1,3,4
14.0.3.B	Mob + Demob	1	JOB	$32,103	10%	$3,210	1,3
14.0.3.B	Gravel Access Road	1	JOB	$11,659	15%	$1,749	1,2,3,4
	Total			$1,112,523		$129,061	
14.0.3.B	Trail, Sta. 64+00 - 101+55						
14.0.3.B	Bike Trail Embankment	1	JOB	$126,918	15%	$19,038	1,2,3
14.0.3.B	Bike Trail Pavement	1	JOB	$47,542	20%	$9,508	1,3,4
14.0.3.B	Culverts	1	JOB	$12,682	10%	$1,268	4
14.0.3.B	Seeding	1	JOB	$8,421	15%	$1,263	1,4
14.0.3.B	Signs	1	JOB	$1,931	20%	$386	1,4
14.0.3.B	Site Preparation	1	JOB	$29,385	20%	$5,877	2
	Total			$226,879		$37,341	
14.0.3.B	Reforestation						
14.0.3.B	Segment II	1	JOB	$23,248	20%	$4,650	1,2,3,4
14.0.3.B	Segment III	1	JOB	$24,000	35%	$8,340	1,2,3,4
	Total			$47,248		$12,990	
	SUBTOTAL, Bicycle Trail			$1,731,336			
	Contingencies, Average of	13.2%				$228,664	
	TOTAL , RECREATION FACILITIES			$1,960,000			

REASONS FOR CONTINGENCIES
1 QUANTITY UNKNOWNS 2 UNKNOWN SITE CONDITIONS 3 UNKNOWN HAUL DISTANCE 4 UNIT PRICE UNKNOWNS

Table 5-2

of contingencies was deemed appropriate to account for the uncertainty in design and quantity calculation and further discussion is not included.

(2) 14.0.3.B Trail, Sta. 0+00 - 43+00. Quantities for this segment of bicycle trail as well as the segment from sta. 64+00 - 101+55 were developed by Design Branch. Construction methods for this work are similar to previously constructed trails in the Lake Red Rock area. For this reason, contingency amounts are not excessive. Material quotes were used in the developed cost for the timber bridge construction. The bike trail pavement is given a 20 percent contingency to account for fluctuating prices of bituminous materials and remote paving areas.

(3) 14.0.3.B Trail, Sta. 64+00 - 101+55. Quantities for this segment of bicycle trail were developed by the Design and Cost Engineering Branches. This work requires standard construction methods and practices and again contingencies are not deemed to be excessive. Standard dewatering methods using temporary sheeting and pumps are included in the construction cost of the 8'x 8' concrete reinforced box culvert. Material quotes were used for truck delivered sand used in the lower part of the embankment. The cost of the clay material in the upper embankment was developed using scraper haul from a nearby borrow site. The cost of the in place riprap material protecting the embankment was developed using material quotes for the delivered rock material. A separate mobilization and demobilization cost is included for this work to allow for staged construction.

(4) 14.0.3.B Reforestation. The Segment 2 reforestation is an MCACES generated cost. The Segment 3 cost is estimated based on Segment 2 but is not a developed cost. Therefore, a 35 percent contingency is assigned to Segment 3.

(5) The project's overall construction cost contingency is 13.2 percent.

e. Feature 30, Planing Engineering & Design

The engineering and design for this project includes all planning and design work necessary to complete the Feature Design Memorandum and prepare construction plans and specifications. This cost also includes engineering support during construction. The design effort for the construction was analyzed to determine the man-year effort required. This estimate is based upon moneys expended to date, discussions between the project engineer and project manager, and historical data and experience gained on other projects of similar nature.

f. Feature 31, Construction Management

Construction management includes the following items: review of project reports, plans and specifications, and conferences of construction staff to become familiar with design requirements; biddability, constructability, and operability reviews; preaward activities to acquaint prospective bidders with the nature of work; administration of construction contracts; administration of A/E contracts which provide for supervision and inspection; establishment of bench marks and baselines required for layouts of construction, relocations, and clearing; review of shop drawings, manuals, catalog cuts, and other information submitted by the construction contractor; assure specifications compliance by

supervision and inspection on construction work, conferences with the contractors to coordinate various features of the project and enforce compliance with schedules; sampling and testing during the construction phase to determine suitability and compliance with plans and specifications; negotiation with the contractor on all contract modifications, including preparation of all contract documents required therefore; estimate quantities, determine periodic payments to contractors, and prepare, review and approve contract payments; review and approve construction schedules and progress charts; prepare progress and completion reports; project management and administration not otherwise identified; and district overhead. These costs may be incurred at the job site, an area office, or at the District Office. For the construction of the Red Rock Multi-Purpose Trail, Segment 3, the estimated cost of construction management is $214,500 for a construction contract with a three year duration and an estimated value of $1.9 million.

6. PLAN IMPLEMENTATION

a. Schedule for Design and Construction

The project will be broken into four stages for design and construction. Segment 3A will consist of the trail between Stations 0+00 and 43+00. Plans and specifications are scheduled to be completed and construction initiated in FY 93 for Segment 3A. The construction of Segment 3A is scheduled to be complete in FY 94. Segment 3B will consist of the trail between Stations 43+00 and 101+55. Plans and specifications are scheduled to be completed and construction initiated in FY 94 for Segment 3B. The construction of Segment 3B is scheduled to be complete in FY 95. The Reforestation for Segment 2 is scheduled for design completion and contract award in FY 93 with a completion date in FY 94. The Reforestation for Segment 3 is scheduled for design completion and contract award in FY 95 with a completion date in FY 96.

b. Implementation Responsibilities

The Corps of Engineers is responsible for design, construction, and operation and maintenance of this project.

c. Coordination

Close coordination has been maintained between planning, engineering, and operations personnel within the Rock Island District. Government officials from the State of Iowa, Marion County, City of Pella and the City of Knoxville have been kept informed of the projects status through the Greenbelt Advisory Committee meetings. There is strong local support for the project.

7. ENVIRONMENTAL ASSESSMENT

a. Project Purpose and Alternatives

(1) The purpose of this Environmental Assessment is to address the effects of construction of the multi-purpose trail segment as described in Section 2 of the main report. Alternatives to the proposed action include the no Federal action alternative, and other designs and alignments for trail construction.

(2) The selected design will traverse a variety of landscapes and will combine with previously constructed trail segments to provide non motorized access between the North Overlook and Wallashuck campgrounds. Objectives considered in formulating trail design and alignment included remaining within existing Federal boundaries, maximizing user safety, minimizing impacts to terrestrial habitat, minimizing trail length below the Red Rock flood pool elevation, and maximizing aesthetic values. With no Federal action, no project impacts would occur; however, no long-term benefits to recreation would be expected.

(3) Preliminary review of alternative trail designs included examination of alignments which would have increased trail length, and of designs which either would raise the trail above the flood pool to increase its usability, or would lower it to decrease the embankment or bridge span required to cross the reservoir (see section 3 for additional information on design alternatives). Alternatives which increased trail could have increased aesthetic benefits for trail users; however, greater adverse effects on terrestrial rescues also would be expected during construction. Designs or alignments which kept the trail surface above the flood control pool would in most cases reduce impacts to aquatic resources, but would significantly increase project costs or require condemnation of private lands. Consequently, the overall impacts of these alternatives to the human environment natural resources is expected to be equal to or greater than those anticipated for the preferred plan.

b. Major Findings and Conclusions

The project is expected to be beneficial to recreation resources in the Lake Red Rock with no significant impacts to natural, cultural, economic or social resources. For this reason, an Environmental Impact Statement (EIS) will not be prepared for this action. Because the project involves construction within the flood pool of Lake Red Rock, a 404(b)(1) Evaluation has been prepared for compliance with the provisions of the Clean Water Act (see Appendix B). Section 401 water quality certification has been received from the Iowa Department of Natural Resources in a letter dated March 5, 1993.

c. Relationship to Environmental Requirements

(1) The project will comply with Federal environmental laws, Executive orders and policies, and State and local policies including the Clean Air Act, as amended; the Clean Water Act, as amended; the Endangered Species Act of 1973, as amended; the Federal Water Project Recreation Act; the Fish and Wildlife Coordination Act of 1958, as amended; the Land and Water Conservation Fund Act of 1966, as amended; the National Environmental

Policy Act of 1969, as amended; and the National Historic Preservation Act of 1966, as amended.

(2) The proposed project will be located on Federally owned lands and will not result in the conversion of farmland to other uses. No loss of wetlands will occur from construction or operation. The borrow site to be used for the project is located within the flood control pool of Lake Red Rock so that flood storage volume will not be decreased by the placement of earth fill. This segment of the Des Moines River is not a Federally recognized wild or scenic river. Therefore, this action will not conflict with the provisions of the Farmland Protection Policy Act of 1981; Executive Order 11990, Protection of Wetlands, Executive Order 11988, Flood plain Management, or the Wild and Scenic Rivers Act of 1968.

d. Affected Environment

(1) The site of proposed trail construction is located in Sections 7 and 18, T76N, R18W, and in Section 12, T76N, R19W, Marion County, Iowa. Segment III begins at the crossing of a county road in the SE 1/4 of the NW 1/4 of Section 18, at the northern terminus of Segment II (Greenbelt Multi-Purpose Trail at Red Rock) construction.

(2) The proposed alignment is located entirely within the Federal boundary. Most of this land is zoned for high density recreational use, with the exception of a tract of reserve forest land in Section 18. The alignment traverses a variety of land use and habitat types. These include developed recreation areas, plantations of trees and prairie grasses, and natural areas with herbaceous, shrub or deciduous forest cover. Borrow material to be used for trail construction will be obtained from an 18-acre site located in the flood control pool. Borrow activity will not affect significant cultural resources or other environmental concerns.

(3) The compartment report for the Natural Resource Inventory System for Lake Red Rock lists the upland forest tract in Sections 7 and 18 as notable in maturity and diversity of woody vegetation. Dominant species include white oak (Quercus alba), red oak (Quercus rubra), and shagbark hickory (Carya ovata). Other notable species include American basswood (Tilia americana), bur oak (Quercus macrocarpa), black cherry (Prunus serotina), and slippery elm (Ulmus rubra). Understory species include slippery elm, shagbark hickory, and rough-leafed dogwood (Cornus drummondii).

(4) Wildlife species found in the project area include songbirds and small mammals such as mice, shrews, voles, squirrels, rabbits, opossums, raccoons, and skunks. In addition, game species such as white-tailed deer, bobwhite quail, ring-necked pheasant, and wild turkey may utilize this area. The mature forest also provides habitat for the northern flicker and other woodpecker species, as well as nesting cavities for owls and small mammals.

e. Environmental Effects

(1) Construction of the trail segment will result in the loss of some woody and herbaceous vegetation. The area to be cleared and grubbed for construction of the 2.0-mile trail segment is estimated at 13 acres. About 0.5 mile of the trail segment will traverse a 40-acre tract of mature aged oak-

hickory forest in the NE 1/4 of the NW 1/4 of section 18. Approximately 3 acres of the 40-acre oak-hickory forest will be impacted by trail construction. Following construction, all areas outside the paved trail surface will be revegetated; however, replacement of mature trees will require several decades to complete.

(2) The long-term effect of the project is expected to be beneficial to man-made resources in the area with no significant adverse effect on natural resources. No mining activity is present in the project area and no mineral resources will be affected by the proposed action. Minor, temporary impacts to noise levels and air quality may occur as a result of construction and transportation of materials. No long-term significant impacts are anticipated and no air quality standards should be violated.

(3) Minor, temporary increases in turbidity and levels of suspended sediments would occur during construction activity. No long-term adverse impacts to water quality are anticipated. A Section 404(b)(1) Evaluation has been prepared to address the placement of construction materials for the pool crossing in the Des Moines River (see Appendix B). Section 401 certification has been received from the State of Iowa by letter dated March 5, 1993 (see Appendix A).

(4) There are two federally listed threatened or endangered species listed for Marion County. These are the bald eagle (Haliaeetus leucocephalus) and the Indiana bat (Myotis sodalis). Bald eagles utilize large trees along the shoreline of the Des Moines River below Red Rock Dam as resting and feeding perches during winter months. The proposed alignment is primarily located in upland areas upstream of the dam and construction and use of the trail is not expected to disrupt eagle feeding or roosting habits.

(a) The Indiana bat uses large trees with cavities or loose bark as summer roosts, and uses caves as winter hibernacula. The presence of the species in the vicinity of the proposed project was documented by Dr. John Bowles of Central College in Pella, Iowa, during surveys conducted from 1980 through 1983. Although the Indiana bat may potentially occur within any of the habitat types found in the project area, the mature upland forested tracts have the greatest potential for utilization as summer maternity roosting habitat.

(b) In planning and designing the proposed trail segment, the Rock Island District has incorporated several measures to avoid direct impacts to the Indiana bat and minimize adverse effects to potential summer roosting habitat for the species. The initial trail alignment was designed to minimize impacts to mature woody vegetation where possible. Prior to construction, the alignment will be reinspected and minor adjustments will be made, where possible, to further minimize loss of potential roost trees. No clearing of wooded areas for trail construction will be allowed during the period from May 1 through August 30, to avoid the potential for direct impacts to summer maternity roosts. In a letter dated December 21, 1993, the U.S. Fish and Wildlife Service concurred with the District's opinion that, provided the aforementioned measures are incorporated into the project, no adverse impacts to the species are anticipated.

(c) State-listed endangered, threatened or special concern species for Marion County include the Indiana bat, Cooper's hawk (Accipiter cooperii),

long-eared owl (Asio otus), southern bog lemming (Synaptomys cooperi), wild indigo duskywing (Erynnis baptisiae), golden corydalis (Corydalis aurea), and yellow trout-lily (Erythronium americanum). Records provided by the DNR's Bureau of Preserves and Ecological Services show occurrences of the yellow trout-lily in the Lake Red Rock Project area, but none of these are located in the vicinity of the proposed trail project and no adverse impacts to the species are expected to result from this action.

f. Affected Cultural Resources

An archeological survey of the proposed trail alignment was conducted in November 1991 by American Resources Group, Ltd. under contract with the Rock Island District. The survey determined that no historic properties will be affected by the proposed project. The State Historical Society of Iowa concurred with this determination in a letter dated March 26, 1992. The proposed project may proceed in full compliance with the National Historic Preservation Act.

g. Social Impact Assessment

(1) Community and Regional Growth

No significant impacts to community or regional growth would result from construction of the proposed multi-purpose trail.

(2) Displacement of People

The proposed project would not require any residential relocations or displacement of people.

(3) Farm Displacement

No farmstead displacement would result from the proposed project.

(4) Community Cohesion

The proposed project would extend an existing multi-purpose trail from one recreation area to another recreation area. The project would eliminate the disruption caused by users of the existing trial seeking access from one recreation area to the other. It will have a positive impact on community cohesion.

(5) Public Facilities and Services

Public facilities and services would greatly benefit from the proposed trail, which will allow greater accessibility for trail users and provide for a more enjoyable recreation experience. Construction of the trail segment will help fulfill the current and projected public demand for recreation trails within the Des Moines Recreational River and Greenbelt boundaries

(6) Life, Health, and Safety

The new multi-purpose trail would provide nonmotorized passage between the affected recreation amenities, reducing potential life, health, and safety threats associated with the highway routes trail users currently travel to access the affected recreation areas. Reservoir lands located between North Overlook and Wallashuck recreation areas are currently open to public hunting. Use of this portion of trail, which traverses these lands, may need to be restricted at seasonal periods during late fall and winter to avoid conflicts in use. Trail use is low at these times; and because the trail will remain open in areas where hunting is not currently allowed, no significant reduction in trail use is anticipated.

(7) Property Values and Tax Revenues

The project is totally on Federal lands and therefore will not affect property values or tax revenues.

(8) Business and Industrial Growth

No business relocations would be necessitated by the proposed multi-purpose trail. No changes in business activity would be noticed during or after construction. For these reasons, the project is not expected to affect business and industrial growth in the region.

(9) Employment and Labor Force

Construction of the project would slightly increase employment in the area but would have no noticeable affect on the employment and labor force in Marion County, Iowa.

(10) Noise Levels

Heavy machinery would generate temporary increases in noise levels during construction. This increase has the potential to disturb visitors or users of the existing trail. There will be no permanent impact to sensitive receptors.

(11) Aesthetic Values

There will be a temporary adverse impact to aesthetic values during construction of the proposed trail. In areas where trail bridges will be constructed, a slightly negative impact will remain for a few years because of the clearing necessary to allow access by construction equipment. There will be no permanent negative impact on the aesthetic values of the project area.

h. Coordination

(1) Coordination has been maintained throughout the planning and design process with the U.S. Environmental Protection Agency, the U.S. Fish and Wildlife Service, the Iowa Department of Natural Resources, and the State Historic Preservation Officer (SHPO). Copies of coordination letters and telephone conversation records are contained in Appendix A. Development of multi-purpose trails at Lake Red Rock was proposed and coordinated in the

Resource Master Plan, Design Memorandum No. 24b for Red Rock Dam and Lake Red Rock (December 1976).

(2) The Greenbelt Multi-Purpose Trail project was documented and coordinated in the programmatic EIS for the Greenbelt General Design Memorandum, dated September 1987. FDMs with environmental assessments were prepared for Segments I and II of the Red Rock component of the Multi-Purpose Trail in May 1989 and January 1991, respectively. This action was not selected for review by the State of Iowa under Executive Order 12372, State Single Point of Contact; therefore, the project is being coordinated with the Governor's Representative for Civil Works, which is the Department of Natural Resources.

8. FINDING OF NO SIGNIFICANT IMPACT

FINDING OF NO SIGNIFICANT IMPACT

DES MOINES RECREATIONAL RIVER AND GREENBELT
FEATURE DESIGN MEMORANDUM NO. 9

RED ROCK MULTI-PURPOSE TRAIL
SEGMENT 3

LAKE RED ROCK, IOWA

I have reviewed the information provided by this Environmental Assessment, along with data obtained from cooperating Federal, State and local agencies and from the interested public. Based on this review, I find that construction of the proposed trail segment will not significantly affect the quality of the human environment. Therefore, it is my determination that an Environmental Impact Statement is not required for this action. This determination will be reevaluated if warranted by later developments.

Alternatives considered along with the preferred action were:

- No Federal Action

- Other trail alignments and designs

Factors considered in making a determination that an Environmental Impact Statement was not required are as follows:

a. The action is expected to enhance low-density recreational use on land zoned for that purpose.

b. The selected alignment was designed to minimize adverse effects on natural resources while providing non motorized access between developed recreation areas across Federal lands.

c. No significant social, economic, environmental or cultural resource impacts are anticipated as a result of this action.

_____
Date

Albert J. Kraus
Colonel, U.S. Army
District Engineer

9. RECOMMENDATION

I recommend the construction of the Red Rock Multi-Purpose Trail, Segment 3, under the authority of the Des Moines Recreational Greenbelt, at a Federal cost of $2,659,500. This project will be operated and maintained by the Federal government.

_____
Date

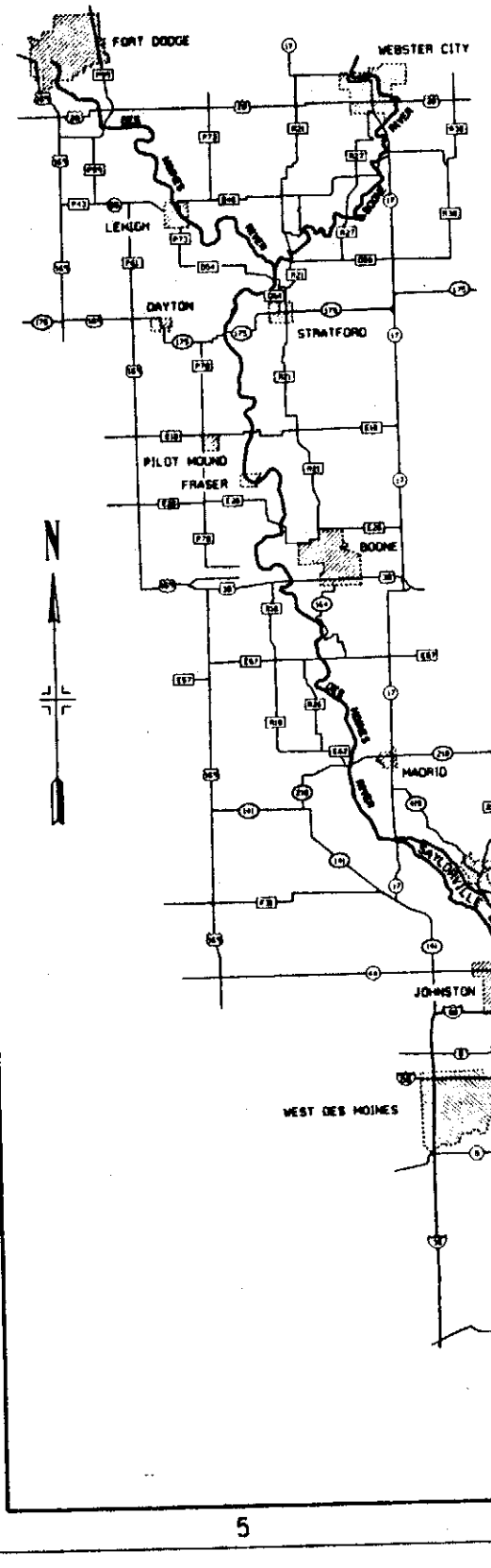
Albert J. Kraus
Colonel, U.S. Army
District Engineer

Resource Master Plan, Design Memorandum No. 24b for Red Rock Dam and Lake Red Rock (December 1976).

(2) The Greenbelt Multi-Purpose Trail project was documented and coordinated in the programmatic EIS for the Greenbelt General Design Memorandum, dated September 1987. FDMs with environmental assessments were prepared for Segments I and II of the Red Rock component of the Multi-Purpose Trail in May 1989 and January 1991, respectively. This action was not selected for review by the State of Iowa under Executive Order 12372, State Single Point of Contact; therefore, the project is being coordinated with the Governor's Representative for Civil Works, which is the Department of Natural Resources.

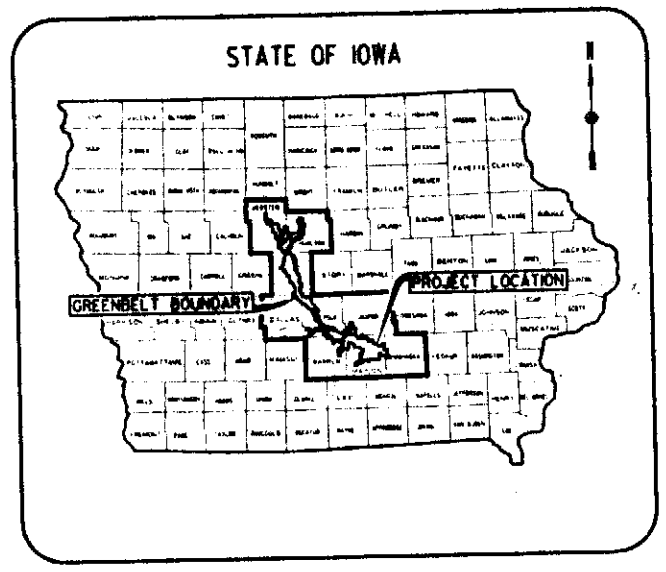
DES MOINES RECREATIONAL RIVER AND GREENBELT

RED ROCK MULTI-PURPOSE TRAIL - SEGMENT III



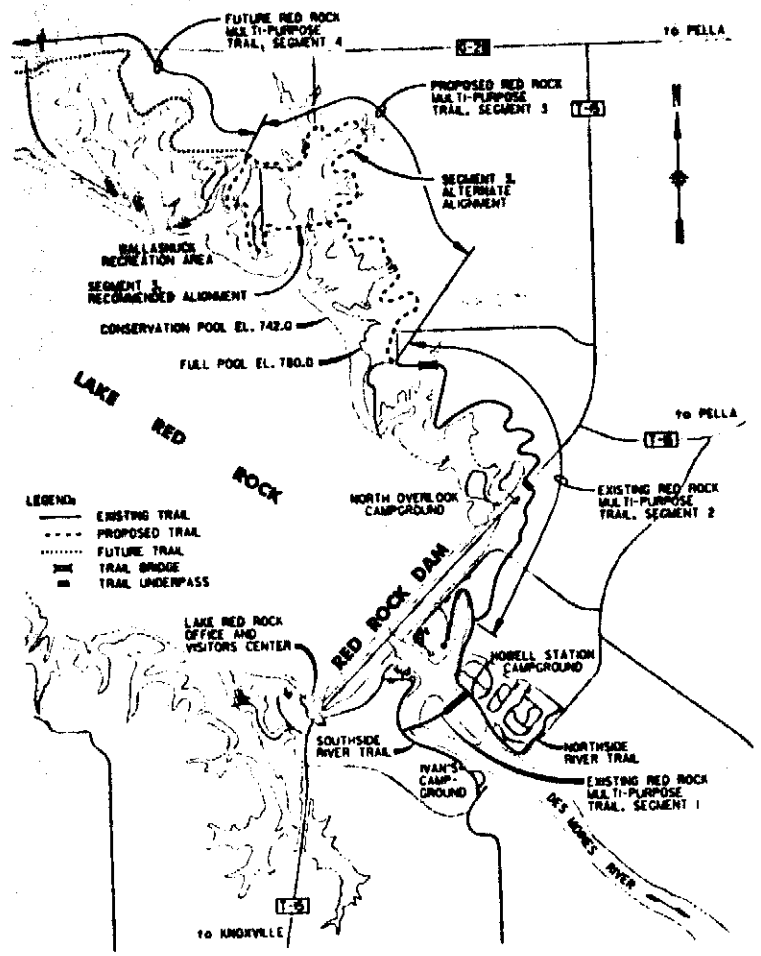
GREENBELT LOCATION MAP

5 0 5 10 15
SCALE IN MILES



GREENBELT VICINITY MAP

NO SCALE



PROJECT LOCATION PLAN

2000 0 2000 4000 6000
APPROXIMATE SCALE IN FEET

GENERAL NOTES:

1. XXXX

INDEX

PLATE NO.	SHEET REF. NO.	TITLE OF DRAWING
1	X-1	LOCATION MAPS AND INDEX
2	C-1	HYDRAULIC DATA I
3	C-2	HYDRAULIC DATA II
4	C-3	BORING LOGS I
5	C-4	BORING LOGS II
6	C-5	PLAN AND PROFILE - STA. 0+00 TO STA. 22+00
7	C-6	PLAN AND PROFILE - STA. 22+00 TO STA. 43+00
8	C-7	PLAN AND PROFILE - STA. 43+00 TO STA. 64+00
9	C-8	PLAN AND PROFILE - STA. 64+00 TO STA. 82+00
10	C-9	PLAN AND PROFILE - STA. 82+00 TO STA. 101+55.18
11	C-10	TYPICAL SECTIONS
12	S-1	BRIDGE PLANS
13	S-2	BRIDGE SECTIONS
14	S-3	CULVERT LAYOUT AND SECTIONS

SIGNATURES AFFIXED BELOW INDICATE OFFICAL RECOMMENDATION AND APPROVAL OF ALL DRAWINGS IN THIS SET AS INDICATED ON EACH INDIVIDUAL TITLE BLOCK

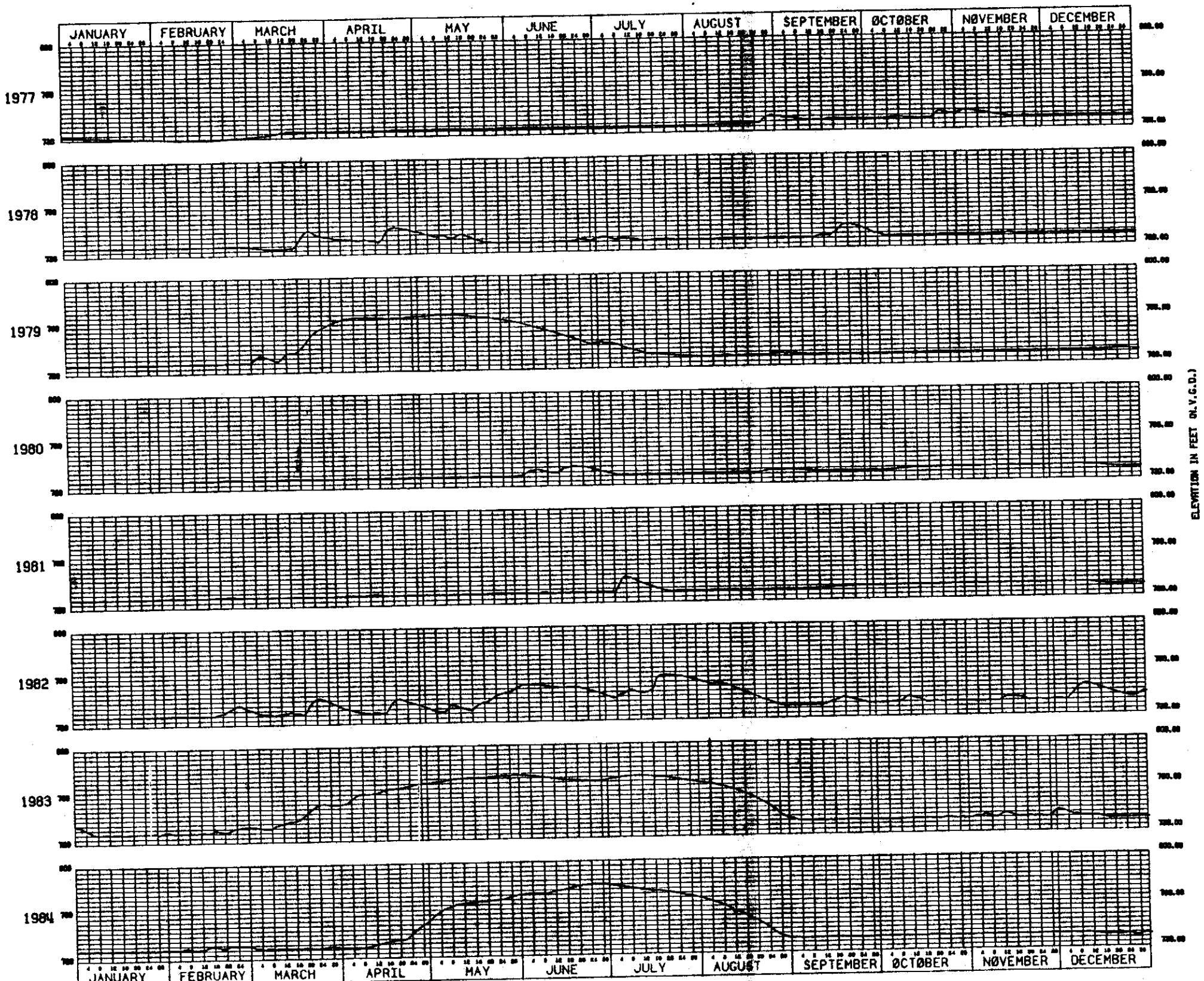
Prepared by: U.S. ARMY ENGINEER DISTRICT, ROCK ISLAND	
Submitted by: CHIEF, DESIGN BR.	
CHIEF, HYDRAULICS BR.	
CHIEF, GEOTECHNICAL BR.	
Recommended by: CHIEF, ENGINEERING DIV.	
Approved by: COL, CORPS OF ENGINEERS	Date

Revisions			
Symbol	Description	Date	Approved

U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
ROCK ISLAND, ILLINOIS

Designed by: T.G.H.	DES MOINES RECREATIONAL RIVER AND GREENBELT RED ROCK MULTI-PURPOSE TRAIL SEGMENT III		
Drawn by: R.L.C.	LOCATION MAPS AND INDEX		
Checked by: D.R.C.			
Reviewed by: J.J.C.	Scale: AS SHOWN	Sheet reference number: X-1	dgd\gd06\gd06c01.dgn
Approved by: ALBERT J. KRAUS COL., CORPS OF ENGINEERS	Date:		Solicitation Number: DACW25-9 -B-
	Drawing Code:		Sheet of

PLATE 1



HYDROGRAPH -
RED ROCK POOL

Revisions			
Symbol	Description	Date	Approved

U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
ROCK ISLAND, ILLINOIS

DES MOINES RECREATIONAL RIVER AND GREENBELT
RED ROCK MULTI-PURPOSE TRAIL
SEGMENT III

HYDRAULIC DATA I

Designed by:	NA
Drawn by:	B.J.G.
Checked by:	T.G.H.
Reviewed by:	G.E.J.
Approved by:	ALBERT J. ADAMS, COL., CORPS OF ENGINEERS
Scales	
Dates	
Drawing Codes	
Sheet reference number	C1
Sheet	of

PLATE 2

PLATE 3

HYDROGRAPH - RED ROCK POOL

DES MOINES RIVER

NOTE-

1992 1991 1990 1989 1988 1987 1986 1985

JANUARY FEBRUARY MARCH APRIL MAY JUNE JULY AUGUST SEPTEMBER OCTOBER NOVEMBER DECEMBER

ELEVATION IN FEET (N.G.V.D.)

Symbol	Revisions Description	Date	Approved

U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
ROCK ISLAND, ILLINOIS

DES MOINES RECREATIONAL RIVER AND GREENBELT
RED ROCK MULTI-PURPOSE TRAIL
SEGMENT II

HYDRAULIC DATA 11

Designed by:	NA
Drawn by:	B.J.G.
Checked by:	T.G.M.
Revised by:	G.E.J.
Approved by:	ALBERT J. KRAUS Col., Corps of Engineers
Sheet reference number:	C2
Scale:	
Date:	
Drawing Code:	
Sheet	of

ELEV.

770
760
750
740
730

BT-92-4

TOP ELEVATION 765.2

BR. SANDY TOPSOIL
CL BR. SANDY LEAN CLAY (TILL)
OCC. WEATHERED LIMESTONE
CL GR. BR. SANDY LEAN CLAY (TILL)
CL GR. SANDY LEAN CLAY (TILL)
CL GR. SANDY LEAN CLAY
CL-CH BR. MEDIUM CLAY
GR. SANDY LEAN CLAY (TILL)

STA 51+55
2' R
26 FEBRUARY 1992

BT-92-5

TOP ELEVATION 766.9

CL GR. LEAN CLAY (SOFT)
CL-CH GR. MEDIUM CLAY (STIFF)
CL BR. LEAN CLAY
GR. SANDY LEAN CLAY WITH THIN LAYERS OF SAND
SC BR. CLAYEY SAND
SC BR. GRAVELLY CLAYEY SAND
CL GR. LEAN CLAY
CL BR. SANDY LEAN CLAY (TILL)

STA 54+30
10' R
23 FEBRUARY 1992

BT-92-6

TOP ELEVATION 770.3

CL BR. GR. LEAN CLAY
CL BR. LEAN CLAY
CL GR. BR. SANDY LEAN CLAY TRACE GRAVEL (TILL)
CL GR. BR. LEAN CLAY
CL-CH GR. BR. SANDY MEDIUM CLAY (TILL)
CL GR. LEAN CLAY TRACE COAL
CH-CL GR. SHALEY FAT CLAY
SC GR. CLAYEY SAND

STA 58+07
40' R
27 FEBRUARY 1992

BT-92-7

TOP ELEVATION 761.3

CL-CH BR. MEDIUM CLAY
CL GR. SANDY LEAN CLAY (TILL)

STA 52+31
20' L
27 FEBRUARY 1992
—— NO WATER LEVEL ENCOUNTERED

LEGEND

BORING NUMBER

ELEV.

790
780
770
760
750

BT-92-8

TOP ELEVATION 758.9

CL DK. BR. LEAN CLAY
CL-CH BR. MEDIUM CLAY
CL BR. SANDY LEAN CLAY (TILL)
CL-CH GR. BR. SANDY MEDIUM CLAY (TILL)
SHALE GR. GR.

STA 56+88
620' L
27 FEBRUARY 1992
—— NO WATER LEVEL ENCOUNTERED

BT-92-9

TOP ELEVATION 770.3

CL DK. BR. LEAN CLAY
CH BR. FAT CLAY
CL BR. LEAN CLAY

STA 49+80
634' L
27 FEBRUARY 1992
—— NO WATER LEVEL ENCOUNTERED

BT-92-10

TOP ELEVATION 782.8

CL DK. BR. LEAN CLAY
CL GR. BR. LEAN CLAY
CL GR. BR. SANDY LEAN CLAY (TILL)
CL GR. BR. SANDY LEAN CLAY (TILL)
CL GR. BR. SANDY LEAN CLAY (TILL)
TRACE COAL AT 18.0'
SHALE LT. GR., SOFT, WEATHERED

STA 28+35
10' R
28 FEBRUARY 1992

BT-92-11

TOP ELEVATION 782.1

CL DK. BR. LEAN CLAY
CL-CH GR. BR. SANDY MEDIUM CLAY (TILL)
CL GR. SANDY LEAN CLAY (TILL)
CL GR. BR. SANDY LEAN CLAY TRACE COAL (TILL)
SHALE LT. GR., COAL SEAM AT 20.0'

STA 35+27
14' L
28 FEBRUARY 1992
—— NO WATER LEVEL ENCOUNTERED

Revisions			
Symbol	Description	Date	Approved

U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
ROCK ISLAND, ILLINOIS

Designed by: N/A	DES MOINES RECREATIONAL RIVER AND GREENBELT RED ROCK MULTI-PURPOSE TRAIL SEGMENT II
Drawn by: A.E.K.	BORING LOGS I
Checked by: T.G.H.	
Reviewed by: G.J.M.	Sheet Reference number: C-3
Approved by: ALBERT J. KRAUS CH., CORPS OF ENGINEERS	Drawing Code:
	Solicitation Number: DACW25-9 -B-
	Sheet of

PLATE 4

ELEV.

790
780
770
760
750
740
730
720
710

BT-92-12

TOP ELEVATION 788.8

CL DK. BR. LEAN CLAY
CL GR. SANDY LEAN CLAY
CL GR. BR. SANDY LEAN CLAY (TILL)
SHALE DK. GR., SILTY

STA 31+02
8' L
28 FEBRUARY 1992
—— NO WATER LEVEL ENCOUNTERED

BT-92-13

TOP ELEVATION 745.8

CL GR. BR. SANDY LEAN CLAY
CL GR. SANDY LEAN CLAY TRACE GRAVEL (TILL)
CL GR. BR. MOTTLED SANDY LEAN CLAY TRACE GRAVEL (TILL)
CL GR. LEAN CLAY (SOFT SILTY LENS 10.6 - 10.8)
CL DK. GR. LEAN CLAY WITH SAND PARTINGS
SC GR. CLAYEY SAND
SHALE DK GR. WEATHERED, MED. HARD, WITH PYRITE NODS AND SEC. CALCAREOUS STRINGERS

STA 56+02
21' L
18 AUGUST 1992

BT-92-14

TOP ELEVATION 751.8

CL DK.BR. SANDY LEAN CLAY
CL-CH DK. MOTTLED REDDISH CLAY TRACE SAND
CL GR. BR. MOTTLED LEAN CLAY (WATER ZONE 13.0 - 14.0)
CH GR. BR. FAT CLAY
CL GR. BR. YEAR SANDY LEAN CLAY TRACE COR.
CLAY, SAND, GRAVEL MIXTURE (WEATHERED TILL)
LIMESTONE DK. GR. FINE GRAINED, CARBONACEOUS, HARD
LIMESTONE GR. MODULAR, STRINGERS
SHALE GR. WEATHERED, SOFT
SHALE, GR. GR. WITH PYRITE NODS AND LEAVES, MED HARD

STA 53+12
1' L
18 AUGUST 1992

Summary of Shallow Hand Auger Borings Along Bike Trail Alignment

Hole	Sheet	Depth	Moisture	Limits	Description
BT-92-15 Sta 4+38	1	0-1.5	29		BRN MED CLAY
	2	1.5-3.0	31		BRN MED CLAY
BT-92-16 Sta 12+64	1	0-2.5	26	38/17	DK BRN LEAN CLAY
	2	2.5-3.5	26		BRN MED CLAY
BT-92-17 Sta 31+02	1	0-0.8	27		DK BRN LEAN CLAY
	2	0.8-3.0	27		BRN MED CLAY
BT-92-18 Sta 48+28	1	0-1.5	28		BRN MED CLAY
	2	1.5-3.0	29		BRN MED CLAY
BT-92-19 Sta 71+66	1	0-1.5	26		BRN MED CLAY
	2	1.5-3.0	27		BRN MED CLAY
BT-92-20 Sta 79+59	1	0-1.5	25	51/18	BRN MED CLAY
	2	1.5-3.0	27	57/27	BRN FAT CLAY
BT-92-21 Sta 91+00	1	0-1.5	25		BRN MED CLAY
	2	1.5-3.0	26		BRN MED CLAY
BT-92-22 Sta 96+00	1	0-1.5	28		BRN MED CLAY
	2	1.5-3.0	30	51/16	BRN MED CLAY

Water levels were not encountered in any holes

Revisions Symbol	Description	Date	Approved

U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
ROCK ISLAND, ILLINOIS

DES MOINES RECREATIONAL RIVER AND GREENBELT
RED ROCK MULTI-PURPOSE TRAIL
SEGMENT III

BORING LOGS II

Designed by: N/A
Drawn by: A.E.K.
Checked by: T.G.M.
Reviewed by: G.J.M.
Approved by: ALBERT J. KRAUS, COL., CORPS OF ENGINEERS
Scale:
Date:
Drawing Code:
Sheet reference number: C-4
Solicitation Number: DACW25-1-92-
Sheet of

PLATE 5

P.I. STA. 2+97.64
Δ = 72°22'36"
D = 22°55'13"
R = 249.98'
T = 182.88'
L = 315.78'
E = 59.75'
P.C. STA. 1+14.76
P.T. STA. 4+30.54

P.I. STA. 7+43.22
Δ = 47°12'57"
D = 22°39'20"
R = 252.90'
T = 110.53'
L = 208.41'
E = 23.10'
P.C. STA. 6+32.69
P.T. STA. 8+41.10

P.I. STA. 18+64.02
Δ = 82°16'22"
D = 36°58'54"
R = 154.93'
T = 135.33'
L = 222.47'
E = 50.78'
P.C. STA. 17+28.69
P.T. STA. 19+51.16

P.I. STA. 5+46.53
Δ = 17°06'22"
D = 22°36'42"
R = 253.39'
T = 38.11'
L = 75.65'
E = 2.85'
P.C. STA. 5+08.42
P.T. STA. 5+84.07

P.I. STA. 11+96.97
Δ = 44°09'11"
D = 36°54'37"
R = 155.23'
T = 62.96'
L = 119.62'
E = 12.28'
P.C. STA. 11+34.01
P.T. STA. 12+53.63

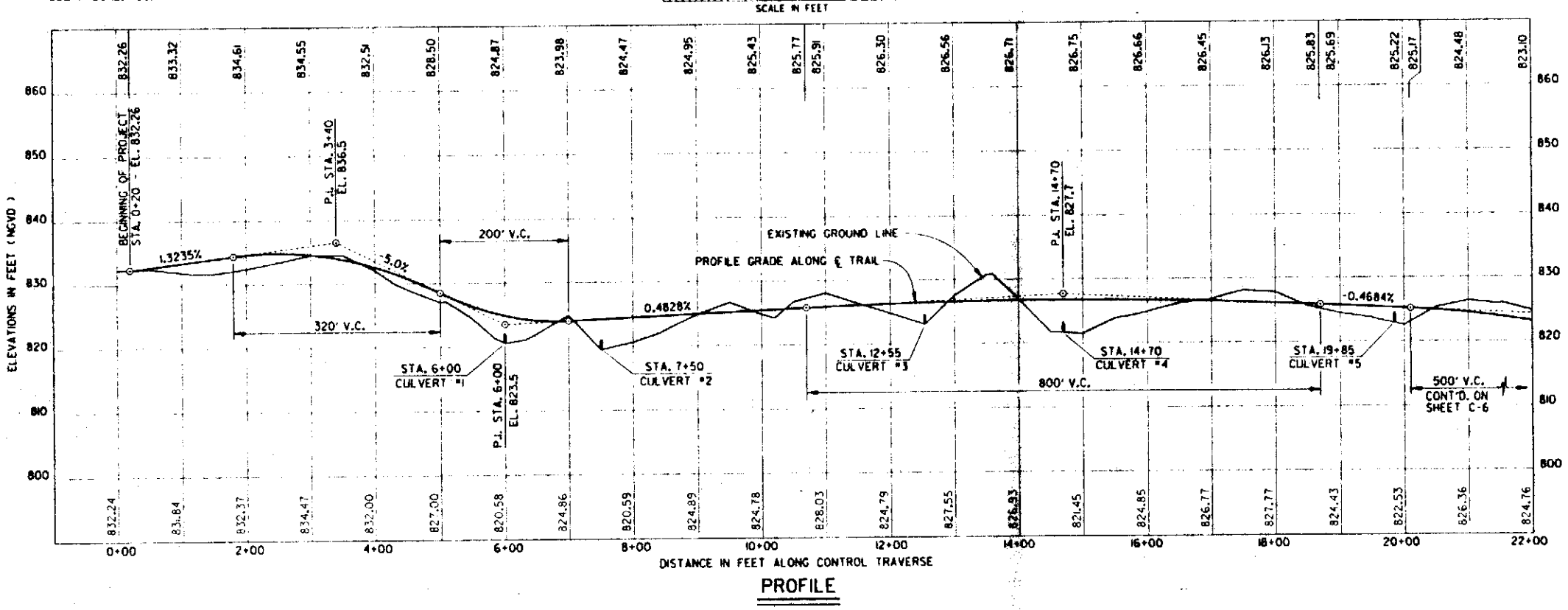
P.I. STA. 15+44.66
Δ = 123°23'51"
D = 57°19'28"
R = 99.95'
T = 185.62'
L = 215.26'
E = 110.87'
P.C. STA. 13+59.04
P.T. STA. 15+74.30

P.I. STA. 0+00.0 IRON REBAR
P.I. STA. 2+97.64 IRON REBAR
P.I. STA. 7+43.22 IRON REBAR
P.I. STA. 5+46.53 IRON REBAR
P.I. STA. 11+96.97 IRON REBAR
P.I. STA. 18+64.02 IRON REBAR
P.I. STA. 15+44.66 IRON REBAR
P.C. STA. 21+39.24
MATCH LINE - STA. 22+00
STA. 5+00
STA. 10+00
STA. 15+00
STA. 20+00
CULVERT #1
CULVERT #2
CULVERT #3
CULVERT #4
CULVERT #5
62°00'52"
239.35'
TRI-6
BEGINNING OF PROJECT STA. 0+20.0
EXISTING ACC SURFACED TRAIL
CONSTRUCT 10' WIDE ACC SURFACED TRAIL, SEE TYPICAL SECTIONS ON SHEET C-10
EDGE OF DISTURBED EARTH
EDGE OF DISTURBED EARTH
CONTROL TRAVERSE = ℄ TRAIL

TRI-6:
CONCRETE MONUMENT APPROXIMATELY 40' EAST OF ℄ OF GRAVEL COUNTY ROAD. GRID COORDINATES N 506,145.12, E 2,142,996.37 IOWA STATE PLANE, SOUTH ZONE. EL. 842.92 (NGVD).

PLAN

100 0 100 200 300
SCALE IN FEET



PROFILE

Revisions			
Symbol	Description	Date	Approved

U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
ROCK ISLAND, ILLINOIS

DES MOINES RECREATIONAL RIVER AND GREENBELT
RED ROCK MULTI-PURPOSE TRAIL
SEGMENT II

PLAN AND PROFILE
STA. 0+00 TO STA. 22+00

Designed by: T.G.H.	Scales: AS SHOWN	Sheet reference number: C-5	Solicitation Number: DACW25-9 -B-
Drawn by: R.L.C.	Dates:		Sheet of
Checked by: D.R.C.	Drawing Codes:		
Reviewed by: J.J.C.			
Approved by: ALBERT J. KRAUS COL., CORPS OF ENGINEERS			

PLATE 6

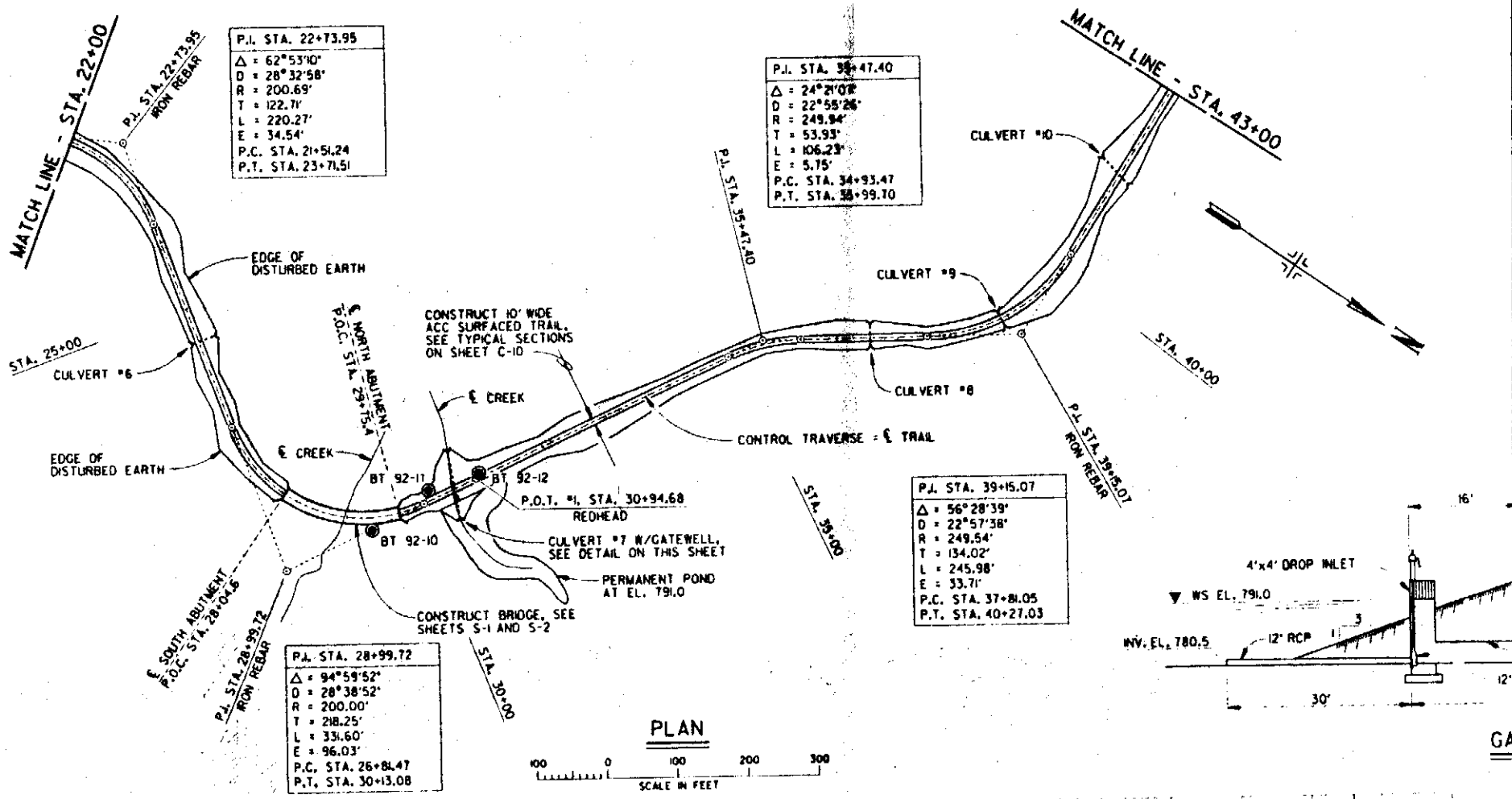
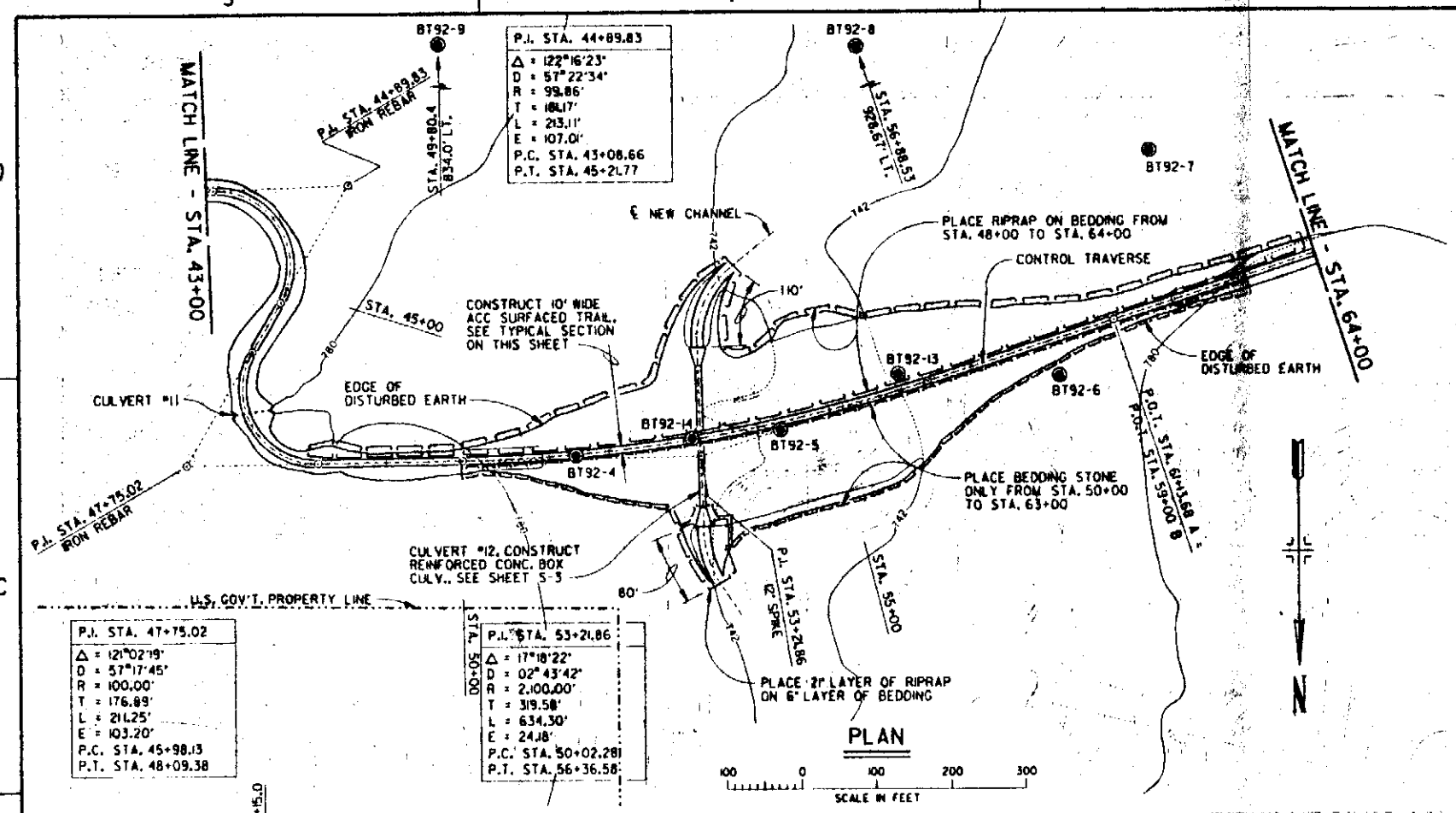
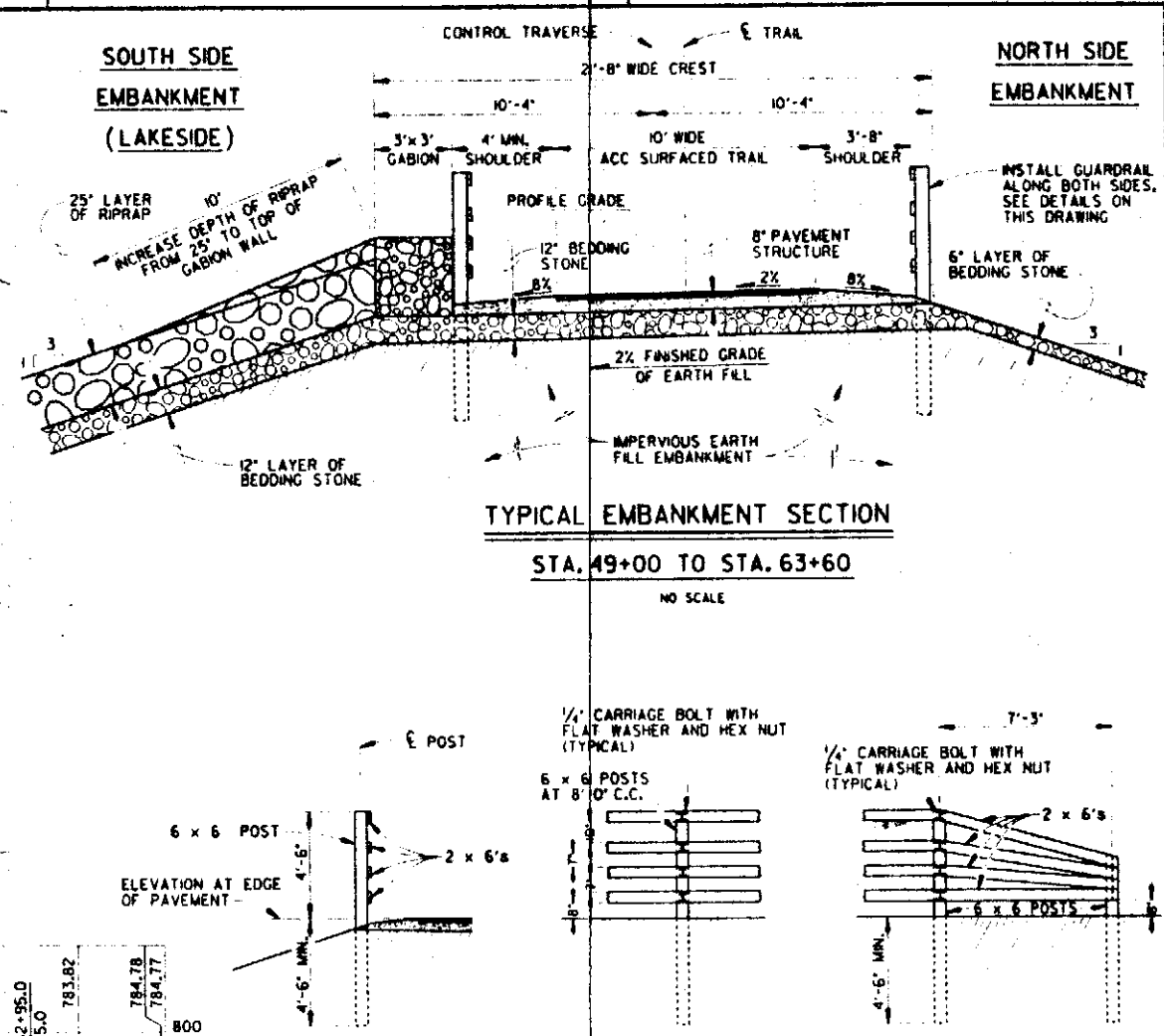

MATCH LINE - STA. 22+00
P.I. STA. 22+73.95
IRON REBAR
P.I. STA. 22+73.95
Δ = 62°53'10"
D = 28°32'58"
R = 200.69'
T = 122.71'
L = 220.27'
E = 34.54'
P.C. STA. 21+51.24
P.T. STA. 23+71.51
EDGE OF DISTURBED EARTH
STA. 25+00
CULVERT #6
EDGE OF DISTURBED EARTH
℄ CREEK
℄ NORTH ABUTMENT P.O.C. STA. 29+75.4
℄ CREEK
BT 92-11
BT 92-12
BT 92-10
P.O.T. #1, STA. 30+94.68
REDHEAD
CULVERT #7 W/GATEWELL, SEE DETAIL ON THIS SHEET
PERMANENT POND AT EL. 791.0
CONSTRUCT BRIDGE, SEE SHEETS S-1 AND S-2
℄ SOUTH ABUTMENT P.O.C. STA. 28+04.6
P.I. STA. 28+99.72 IRON REBAR
P.I. STA. 28+99.72
Δ = 94°59'52"
D = 28°38'52"
R = 200.00'
T = 218.25'
L = 331.60'
E = 96.03'
P.C. STA. 26+81.47
P.T. STA. 30+13.08
STA. 30+00
CONSTRUCT 10' WIDE ACC SURFACED TRAIL, SEE TYPICAL SECTIONS ON SHEET C-10
CONTROL TRAVERSE = ℄ TRAIL
P.I. STA. 35+47.40
P.I. STA. 35+47.40
Δ = 24°21'01"
D = 22°55'26"
R = 249.94'
T = 53.93'
L = 106.23'
E = 5.75'
P.C. STA. 34+93.47
P.T. STA. 36+99.70
CULVERT #8
CULVERT #9
CULVERT #10
MATCH LINE - STA. 43+00
STA. 35+00
STA. 40+00
P.I. STA. 39+15.01 IRON REBAR
P.I. STA. 39+15.07
Δ = 56°28'39"
D = 22°57'38"
R = 249.54'
T = 134.02'
L = 245.98'
E = 33.71'
P.C. STA. 37+81.05
P.T. STA. 40+27.03
PLAN
100 0 100 200 300
SCALE IN FEET
℄ TRAIL
16' 8' 8'
4'x4' DROP INLET
WS EL. 791.0
INV. EL. 780.5
12" RCP
3
3
TOP OF EMBANKMENT EL. 794.0
20'
INV. EL. 780.0
CULVERT #7, 42" RCP w/APRON
12" SLUICE GATE
30'
75'
RIPRAP
GATEWELL DETAIL
NO SCALE
ELEVATIONS IN FEET (NGVD)
830
820
810
800
790
780
770
823.10
818.38
815.03
814.66
811.50
807.57
803.83
800.10
796.36
794.87
794.20
795.50
796.00
798.33
801.97
804.24
805.16
805.41
804.88
804.62
804.42
803.79
802.95
801.90
800.64
799.79
799.49
797.71
P.I. STA. 22+60 EL. 824.0 821.07
PROFILE GRADE ALONG ℄ TRAIL
℄ ABUTMENT STA. 28+04.6
CONSTRUCT BRIDGE
℄ ABUTMENT STA. 29+75.4
P.I. STA. 33+50 EL. 806.00
P.I. STA. 39+10 803.50
500' V.C. CONT'D. ON SHEET C-5
STA. 25+50 CULVERT #6
-3.7349%
EXISTING GROUND LINE
100' V.C.
5.0%
400' V.C.
-0.4464%
STA. 37+00 CULVERT #8
STA. 38+90 CULVERT #9
500' V.C.
-1.485%
STA. 41+60 CULVERT #10
STA. 30+60 CULVERT #7
P.I. STA. 30+90 EL. 793.00
22+00
24+00
26+00
28+00
30+00
32+00
34+00
36+00
38+00
40+00
42+00
DISTANCE IN FEET ALONG CONTROL TRAVERSE
PROFILE
Revisions
Symbol | Description | Date | Approved
U.S. ARMY ENGINEER DISTRICT CORPS OF ENGINEERS ROCK ISLAND, ILLINOIS
Designed by T.G.H.
Drawn by R.L.C.
Checked by D.R.C.
Reviewed by J.J.C.
Approved by ALBERT J. KRAUS COL., CORPS OF ENGINEERS
DES MOINES RECREATIONAL RIVER AND GREENBELT
RED ROCK MULTI-PURPOSE TRAIL
SEGMENT III
PLAN AND PROFILE
STA. 22+00 TO STA. 43+00
Scale AS SHOWN
Date
Drawing Code
Sheet reference number C-6
Sheet of
Solicitation Number DACW25-9 -B-
MATCH LINE - STA. 22+00
MATCH LINE - STA. 43+00

PLATE 7





TYPICAL EMBANKMENT SECTION

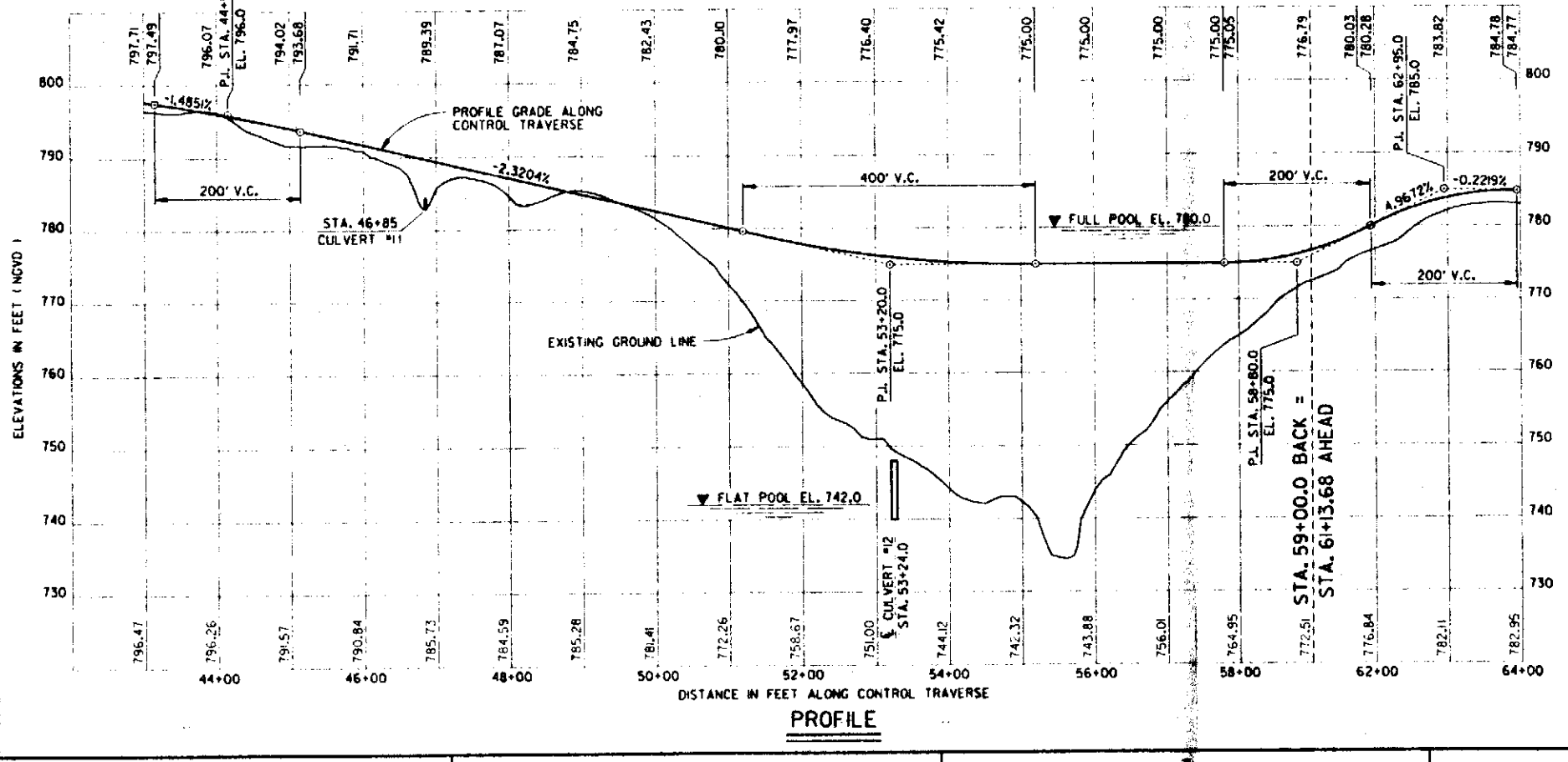
STA. 49+00 TO STA. 63+60

NO SCALE

POST RAILING END SECTION

WOOD GUARDRAIL DETAILS

NO SCALE



PROFILE

Revisions		
Symbol	Description	Date Approved

U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
ROCK ISLAND, ILLINOIS

DES MOINES RECREATIONAL RIVER AND GREENBELT
RED ROCK MULTI-PURPOSE TRAIL
SEGMENT X

PLAN AND PROFILE
STA. 43+00 TO STA. 64+00

Designed by T.G.H.	Scale AS SHOWN	Sheet reference number C-7	Solicitation Number DACW25-8 -0-
Drawn by R.L.C.	Date		
Checked by D.R.C.	Drawing Code		Sheet of
Reviewed by J.J.C.			
Approved by ALBERT J. BRAUS COL., CORPS OF ENGINEERS			

PLATE 8

P.I. STA. 73+24.83
Δ = 67°21'09"
D = 57°18'47"
R = 99.97'
T = 66.61'
L = 117.52'
E = 20.16'
P.C. STA. 72+58.21
P.T. STA. 73+75.73

P.I. STA. 74+75.69
Δ = 17°37'37"
D = 14°41'27"
R = 390.01'
T = 60.47'
L = 119.99'
E = 4.66'
P.C. STA. 74+15.22
P.T. STA. 75+35.21

P.I. STA. 77+20.84
Δ = 47°09'02"
D = 36°58'1"
R = 154.98'
T = 67.63'
L = 127.54'
E = 14.1'
P.C. STA. 76+53.21
P.T. STA. 77+80.75

P.I. STA. 69+95.14
Δ = 94°31'08"
D = 57°19'07"
R = 99.96'
T = 108.17'
L = 164.90'
E = 47.33'
P.C. STA. 68+86.97
P.T. STA. 70+51.87

P.I. STA. 78+64.10
Δ = 29°31'02"
D = 36°57'28"
R = 155.03'
T = 40.84'
L = 79.87'
E = 5.29'
P.C. STA. 78+23.26
P.T. STA. 79+03.13

P.I. STA. 67+67.77
Δ = 118°47'59"
D = 57°19'49"
R = 99.94'
T = 168.99'
L = 207.22'
E = 96.39'
P.C. STA. 65+98.78
P.T. STA. 68+06.00

P.I. STA. 80+86.88
Δ = 54°41'49"
D = 22°54'49"
R = 250.05'
T = 129.33'
L = 238.71'
E = 31.47'
P.C. STA. 79+57.55
P.T. STA. 81+96.26

P.I. STA. 64+87.41
Δ = 46°04'32"
D = 36°58'20"
R = 154.97'
T = 65.90'
L = 124.62'
E = 13.43'
P.C. STA. 64+21.51
P.T. STA. 65+46.13

P.I. STA. 73+24.83 IRON REBAR

P.I. STA. 74+75.69 IRON REBAR

P.I. STA. 78+64.10 IRON REBAR

CONTROL TRAVERSE = ℄ TRAIL

CULVERT #14

P.I. STA. 69+95.14 IRON REBAR

STA. 75+00

STA. 70+00

CULVERT #13

P.I. STA. 64+87.41 IRON REBAR

P.I. STA. 77+20.84 IRON REBAR

EDGE OF DISTURBED EARTH

EDGE OF DISTURBED EARTH

P.I. STA. 80+86.88 IRON REBAR

STA. 80+00

MATCH LINE - STA. 64+00

P.I. STA. 67+67.77 IRON REBAR

CONSTRUCT 10' WIDE ACC SURFACED TRAIL, SEE TYPICAL SECTIONS ON SHEET C-10

STA. 65+00

MATCH LINE - STA. 82+00

N

PLAN

100 0 100 200 300

SCALE IN FEET

784.77 784.55 784.32 784.10 783.88 783.85 783.89 784.64 786.14 786.55 787.45 788.23 789.20 795.28 798.52 800.02 800.39 803.19 804.46 806.04 806.22 805.45 804.88 803.18 801.48 799.77

P.I. STA. 75+39 EL. 802.0

P.I. STA. 77+17 EL. 806.0

300' V.C.

300' V.C.

5.3488%

3.2086%

-1.7030%

74' V.C.

300' V.C.

PROFILE GRADE ALONG ℄ TRAIL

-0.2219%

2.0349%

EXISTING GROUND LINE

STA. 68+70 CULVERT #13

P.I. STA. 68+71 EL. 783.5

STA. 71+28 CULVERT #14

P.I. STA. 73+15 EL. 790.5

ELEVATIONS IN FEET (NGVD)

810 800 790 780 770

783.67 783.34 784.12 779.13 774.90 775.48 783.85 787.07 786.34 790.31 792.94 799.18 803.41 806.13 805.73 804.24 800.59 799.98 798.59

64+00 66+00 68+00 70+00 72+00 74+00 76+00 78+00 80+00 82+00

DISTANCE IN FEET ALONG CONTROL TRAVERSE

PROFILE

Revisions			
Symbol	Description	Date	Approved

U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
ROCK ISLAND, ILLINOIS

DES MOINES RECREATIONAL RIVER AND GREENBELT
RED ROCK MULTI-PURPOSE TRAIL
SEGMENT II

PLAN AND PROFILE
STA. 64+00 TO STA. 82+00

Designed by: T.G.H.	Scale: AS SHOWN	Sheet reference number: C-8	Solicitation Numbers: DACW25-8 -B-
Drawn by: R.L.C.	Date:		
Checked by: D.R.C.	Drawing Code:		Sheet of
Reviewed by: J.J.C.			
Approved by: ALBERT J. KRAUS COL., CORPS OF ENGINEERS			

10-MAR-1993 14:44 /usr2/projects/gbds/...

PLATE 9

P.I. STA. 89+44.03
Δ = 122°28'55"
D = 57°18'47"
R = 99.97'
T = 182.15'
L = 213.71'
E = 107.81'
P.C. STA. 87+61.88
P.T. STA. 89+75.58

P.I. STA. 92+13.08
Δ = 26°27'38"
D = 14°41'12"
R = 390.12'
T = 91.72'
L = 180.17'
E = 10.64'
P.C. STA. 91+21.36
P.T. STA. 93+01.53

P.I. STA. 94+53.32
Δ = 08°48'40"
D = 09°34'09"
R = 598.76'
T = 45.43'
L = 90.68'
E = 1.72'
P.C. STA. 94+07.89
P.T. STA. 94+98.58

P.I. STA. 100+80.79
Δ = 34°17'20"
D = 36°38'53"
R = 156.34'
T = 48.23'
L = 93.56'
E = 7.27'
P.C. STA. 100+32.56
P.T. STA. 101+26.12

P.I. STA. 86+22.76
Δ = 142°40'12"
D = 57°18'47"
R = 99.97'
T = 295.94'
L = 248.93'
E = 212.40'
P.C. STA. 83+26.81
P.T. STA. 85+75.74

P.I. STA. 98+91.30
Δ = 33°02'07"
D = 36°57'37"
R = 155.02'
T = 46.97'
L = 89.38'
E = 6.87'
P.C. STA. 98+05.33
P.T. STA. 98+94.71

P.I. STA. 99+76.76
Δ = 34°34'05"
D = 36°57'54"
R = 155.00'
T = 48.23'
L = 93.52'
E = 7.33'
P.C. STA. 99+28.53
P.T. STA. 100+22.04

P.I. STA. 89+44.03 IRON REBAR
STA. 90+00
P.I. STA. 92+13.08 IRON REBAR
EDGE OF DISTURBED EARTH
STA. 95+00
STA. 98+00
P.I. STA. 100+80.79
END OF PROJECT P.O.T. STA. 101+55.18 PK NAIL IN ℄ ROAD
CONTROL TRAVERSE = ℄ TRAIL
P.O.T. STA. 86+55.86 IRON REBAR
EDGE OF DISTURBED EARTH
CULVERT #17
CULVERT #16
CULVERT #18
MATCH LINE - STA. 82+00
P.I. STA. 94+53.32 IRON REBAR
CONSTRUCT 10' WIDE ACC SURFACED TRAIL, SEE TYPICAL SECTIONS ON SHEET C-10
STA. 85+00
CULVERT #15
P.O.T. STA. 83+25.84 IRON REBAR
P.I. STA. 86+22.76
P.I. STA. 98+91.30 IRON REBAR
P.I. STA. 99+76.76 IRON REBAR

PLAN

SCALE IN FEET 100 0 100 200 300

ELEVATIONS IN FEET (NGVD)

PROFILE GRADE ALONG ℄ TRAIL
EXISTING GROUND LINE
P.I. STA. 92+10 EL. 846.0
P.I. STA. 98+50 EL. 828.0
P.I. STA. 84+51 EL. 795.5
P.I. STA. 88+69 EL. 800.0
P.I. STA. 99+75 EL. 825.5
300' V.C.
180' V.C.
500' V.C.
175' V.C.
75' V.C.
-1.703%
1.0766%
4.692%
1.8750%
-2.0%
6.325%
STA. 84+11 CULVERT #15
STA. 85+70 CULVERT #16
STA. 94+50 CULVERT #17
STA. 99+70 CULVERT #18
END OF PROJECT STA. 101+55.18

DISTANCE IN FEET ALONG CONTROL TRAVERSE

PROFILE

Revisions			
Symbol	Description	Date	Approved

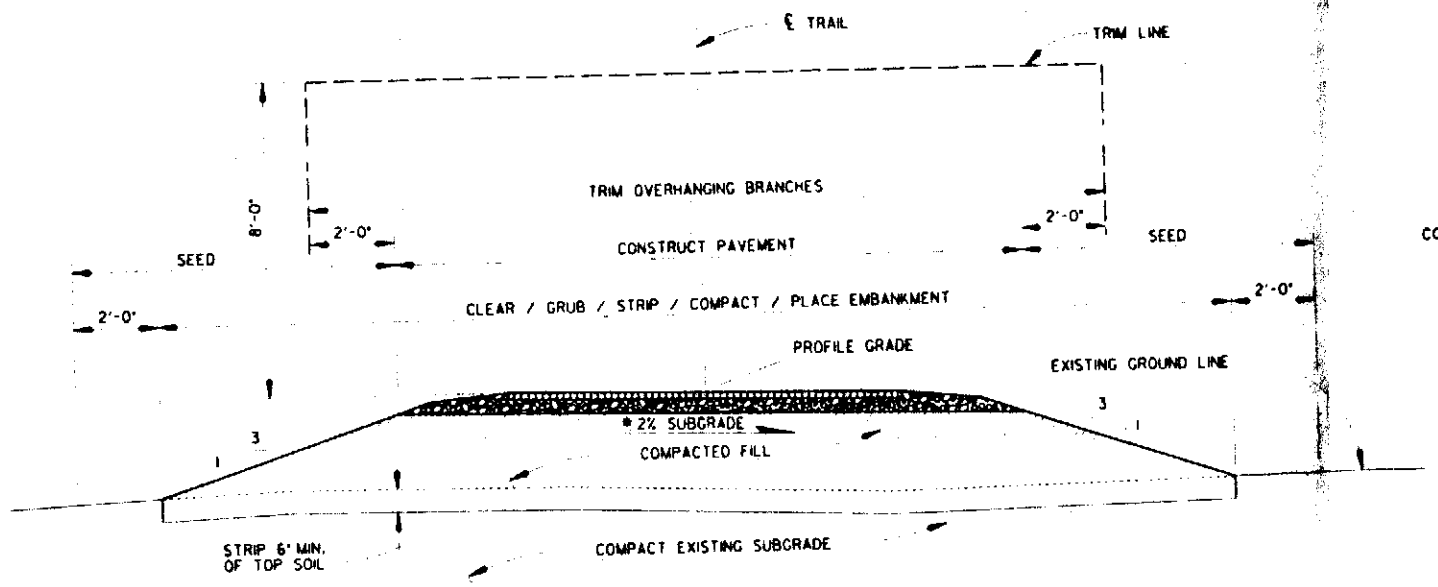
U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
ROCK ISLAND, ILLINOIS

DES MOINES RECREATIONAL RIVER AND GREENBELT
RED ROCK MULTI-PURPOSE TRAIL
SEGMENT III

PLAN AND PROFILE
STA. 82+00 TO STA. 101+55.18

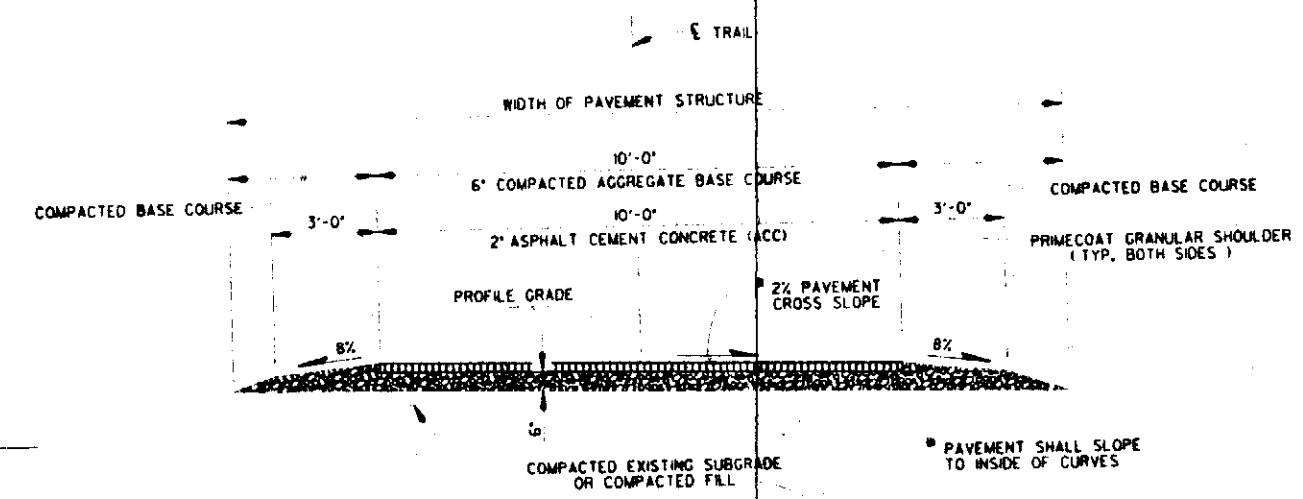
Designed by: T.G.H.
Drawn by: R.L.C.
Checked by: D.R.C.
Reviewed by: J.J.C.
Approved by: ALBERT J. KRAUS COL., CORPS OF ENGINEERS
Scales: AS SHOWN
Dates:
Drawing Code:
Sheet reference number: C-9
Solicitation Number: DACW25-8 -B-
Sheet of

PLATE 10



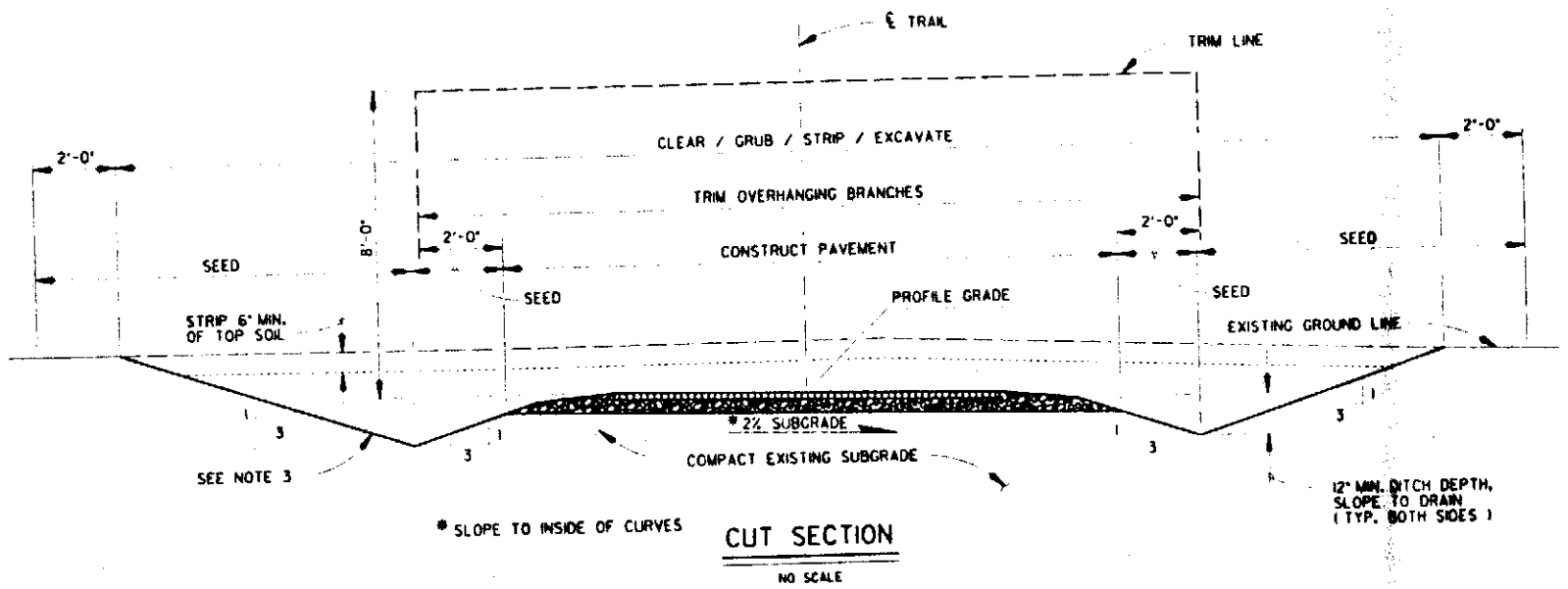
FILL SECTION

NO SCALE



PAVEMENT STRUCTURE DETAIL

NO SCALE



CUT SECTION

NO SCALE

NOTES:

1. THE TRAIL SHALL BE CLEARED, GRUBBED, AND TOPSOIL STRIPPED AS SHOWN.
2. DEAD TREES ADJACENT TO THE TRAIL, WHICH PRESENT A HAZARD OR ARE LIKELY TO PRESENT A HAZARD, ARE TO BE CUT AS DIRECTED BY THE CONTRACTING OFFICER. OVERHANGING LIMBS SHALL BE TRIMMED TO A MINIMUM HEIGHT OF 8' ABOVE THE TRAIL RIDING SURFACE, FROM 3' BEYOND THE EDGE OF THE PAVEMENT OR BRIDGE STRUCTURE. NO TREES SHALL BE TRIMMED WITHOUT THE PRIOR APPROVAL OF THE CONTRACTING OFFICER.

Revisions			
Symbol	Description	Date	Approved

U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
ROCK ISLAND, ILLINOIS

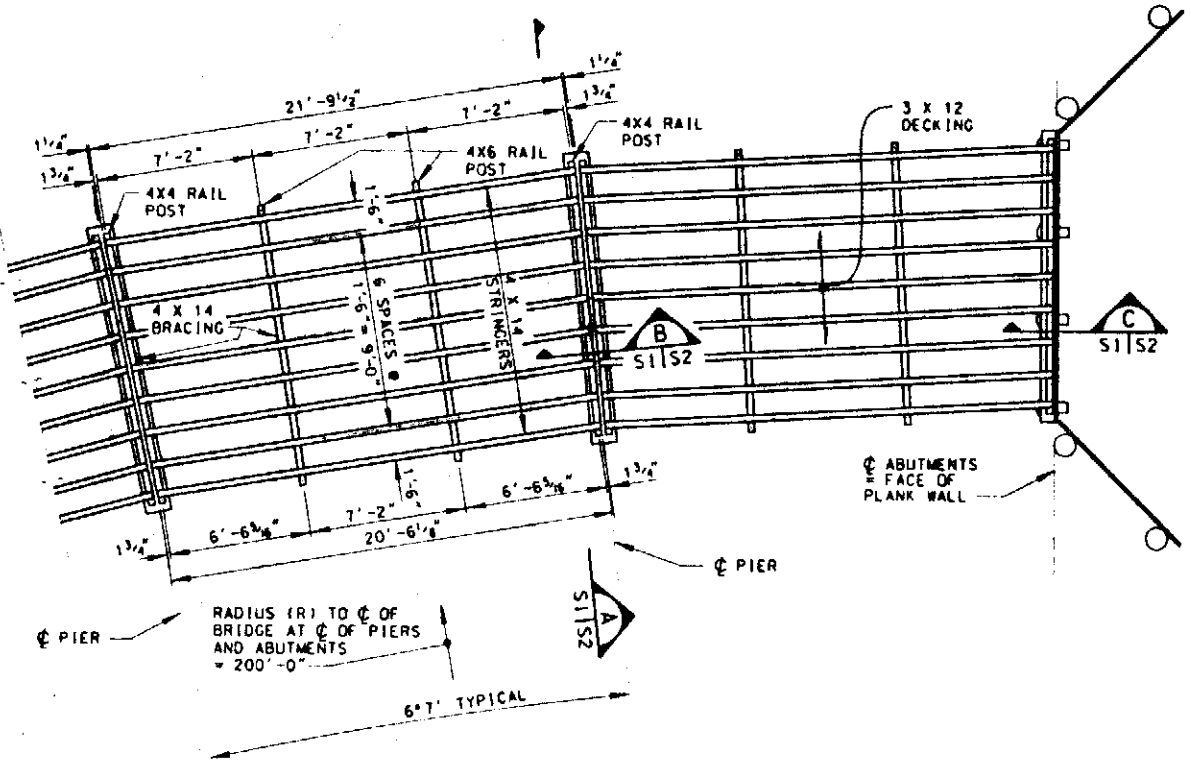
DES MOINES RECREATIONAL RIVER AND GREENBELT
RED ROCK MULTI-PURPOSE TRAIL
SEGMENT III

TYPICAL SECTIONS

Designed by: T.G.H.	Scale: AS SHOWN	Sheet reference number: C-10	Solicitation Number: DACW25-9 -B-
Drawn by: R.L.C.	Date:		Sheet of
Checked by: D.R.C.	Drawing Code:		
Reviewed by: J.J.C.			
Approved by: ALBERT J. KRAUS COL., CORPS OF ENGINEERS			

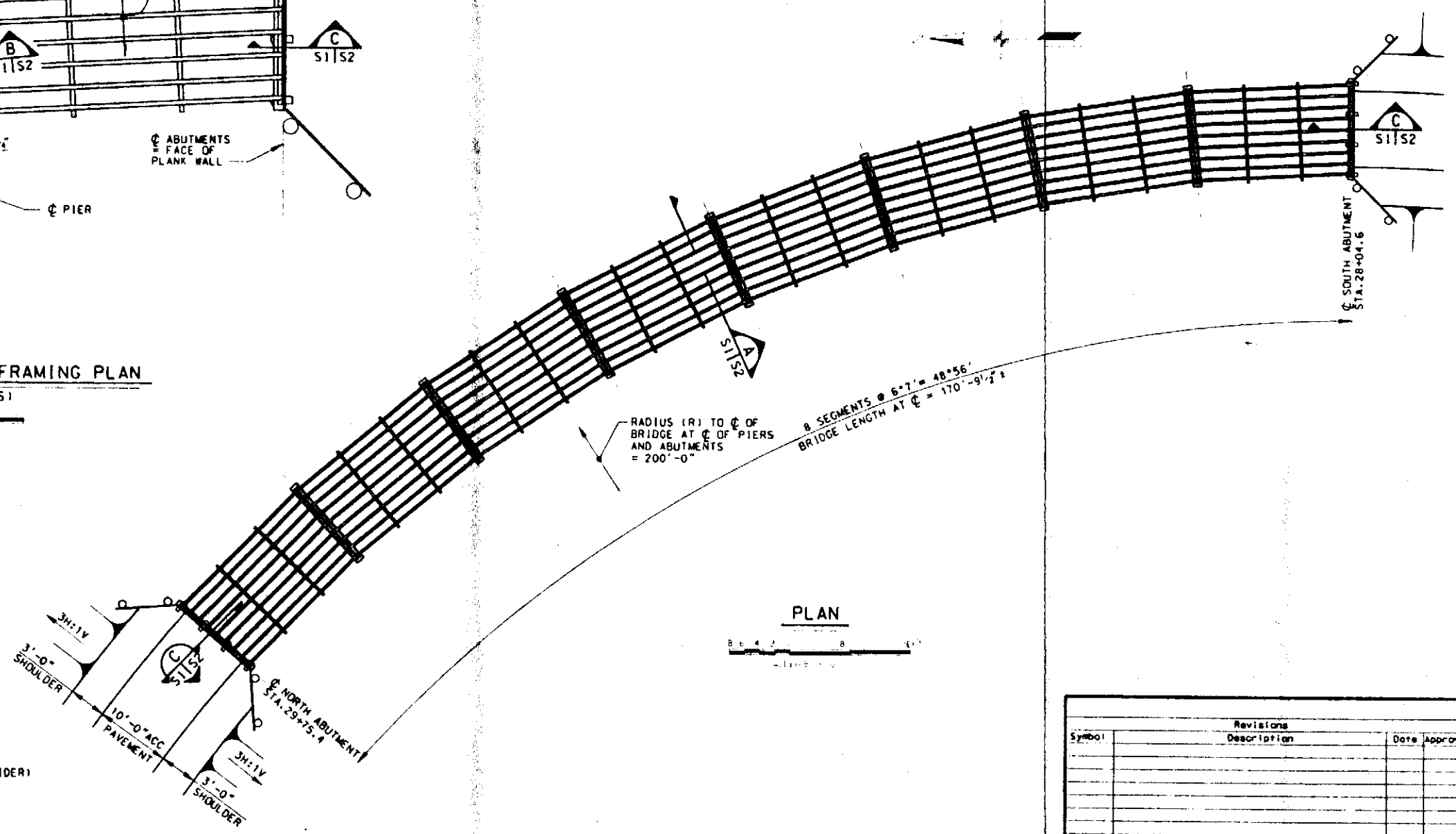
PLATE 11

10-MAR-1993 14:47
/usr2/projects/gdd/gdd



TYPICAL BRIDGE SEGMENT FRAMING PLAN

(PROVIDE EIGHT THUS)



PLAN

NOTES:

1. THE MINIMUM DESIGN LOADING SHALL BE:
   a) UNIFORM LIVE LOAD - 60 psf *
   b) VEHICLE LOAD - 10,000 POUNDS + 30% IMPACT *
   c) WIND LOAD - PER AASHTO, STANDARD SPECIFICATIONS FOR HIGHWAY BRIDGES, 14th ED., 1989
   d) CENTRIFICAL LOAD - PER AASHTO
   * THE LIVE LOAD AND VEHICLE LOAD NEED NOT BE APPLIED AT THE SAME TIME.
2. WOOD DESIGN: NATIONAL FOREST PRODUCTS ASSOCIATION, NATIONAL DESIGN SPECIFICATION FOR WOOD CONSTRUCTION, 1986 ED., INCLUDING 1988 SUPPLEMENT.
   a) STRINGERS - NO.1 DOUGLAS FIR - LARCH (BEAMS/STRINGERS) fb = 1,300 psi
   b) DECK - NO.2 DOUGLAS FIR - LARCH (3"THICK,5" AND WIDER) fb = 1,250 psi
   c) RAILS & POSTS - NO.1 DOUGLAS FIR - LARCH (POSTS/TIMBERS) fb = 1,200 psi
   d) SEAT BEAMS & PIER CAPS - NO.2 DOUGLAS FIR - LARCH (POSTS/TIMBERS) fb = 725 psi
   e) 14"ø PILES - SOUTHERN PINE (EM 1110-2-2906) fc = 825 psi, fb = 1,650 psi
3. ALL SUB-STRUCTURE ELEMENTS OF THE BRIDGE, EXCEPT PIER CAPS AND PIER BRACING, SHALL BE TREATED TO MEET THE REQUIREMENTS OF AWPB LP 55.
4. ALL SUPER-STRUCTURE ELEMENTS OF THE BRIDGE, THE PIER CAPS AND PIER BRACING SHALL BE TREATED TO MEET THE REQUIREMENTS OF AWPB LP 2.
5. ALL PILES SHALL BE CONTINUOUS FULL LENGTH.
6. FOR BRIDGE PROFILE AND LOCATIONS SEE PLATE 7.

Revisions			
Symbol	Description	Date	Approved

U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
ROCK ISLAND, ILLINOIS

Designed by: K.E.W.
Drawn by: R.D.G.
Checked by: K.E.W.
Reviewed by: R.C.A.
Approved by: ALBERT J. KRAUS COL., CORPS OF ENGINEERS

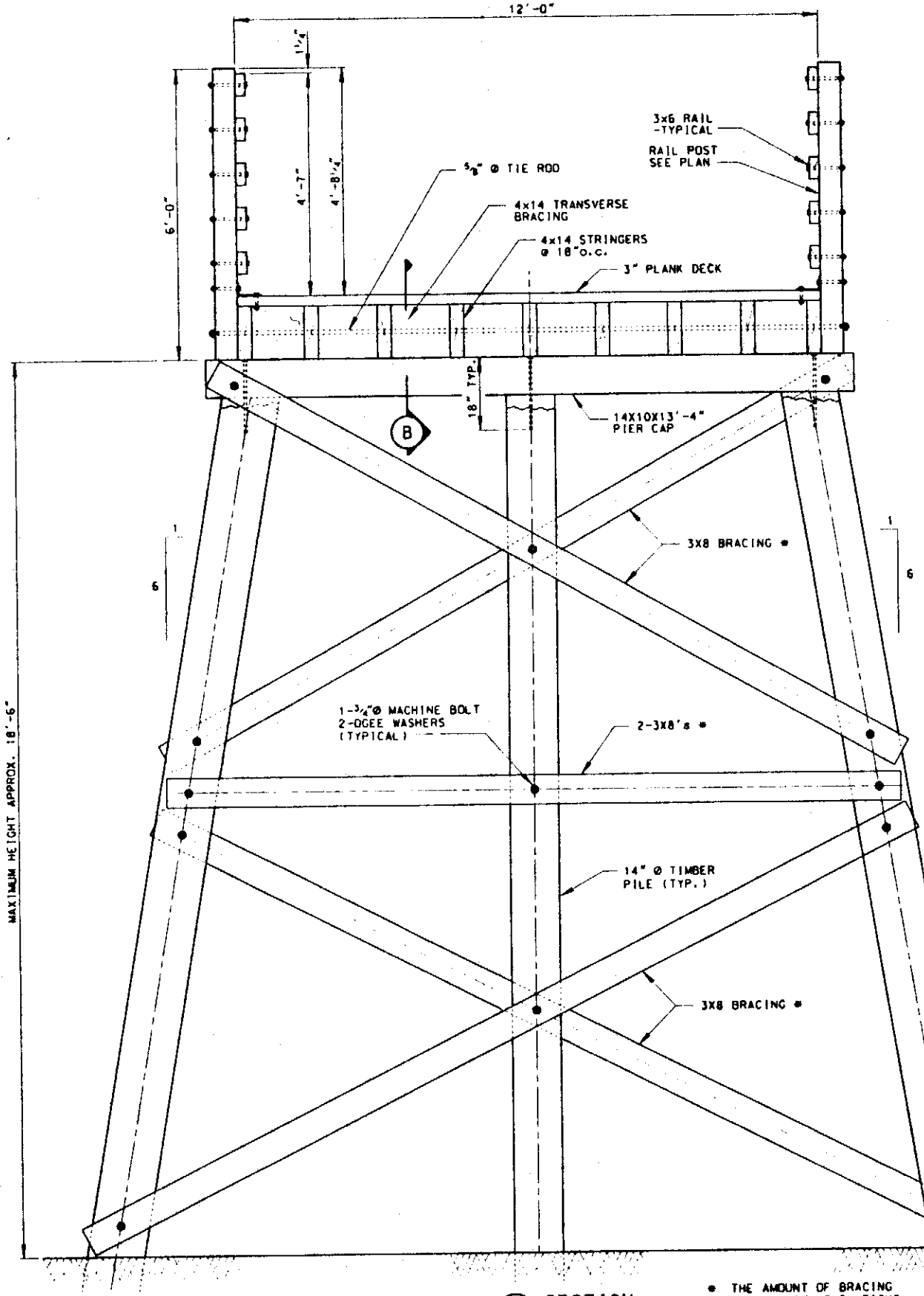
US Army Corps of Engineers

DES MOINES RECREATIONAL RIVER AND GREENBELT
RED ROCK MULTI-PURPOSE TRAIL
SEGMENT III

BRIDGE PLANS

Scale: AS SHOWN
Date:
Drawing Code:
Sheet reference number: S1
Sheet of

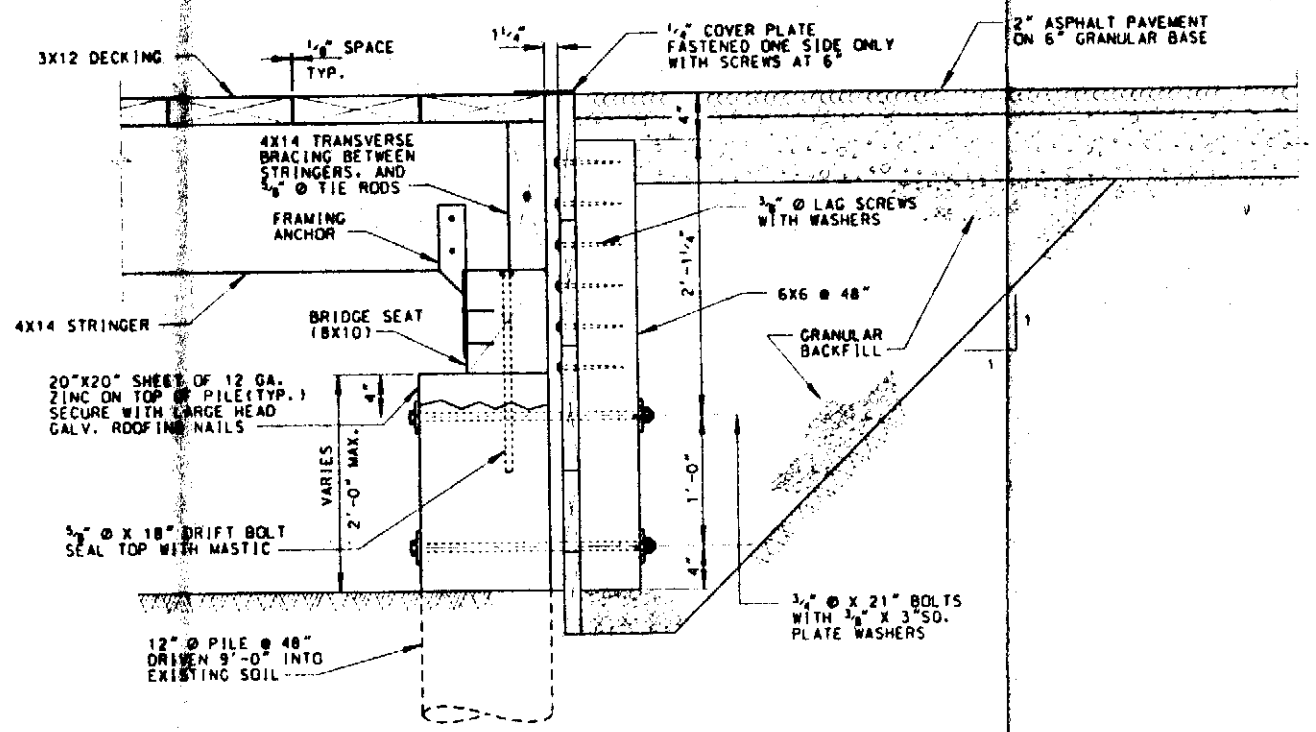
PLATE 12



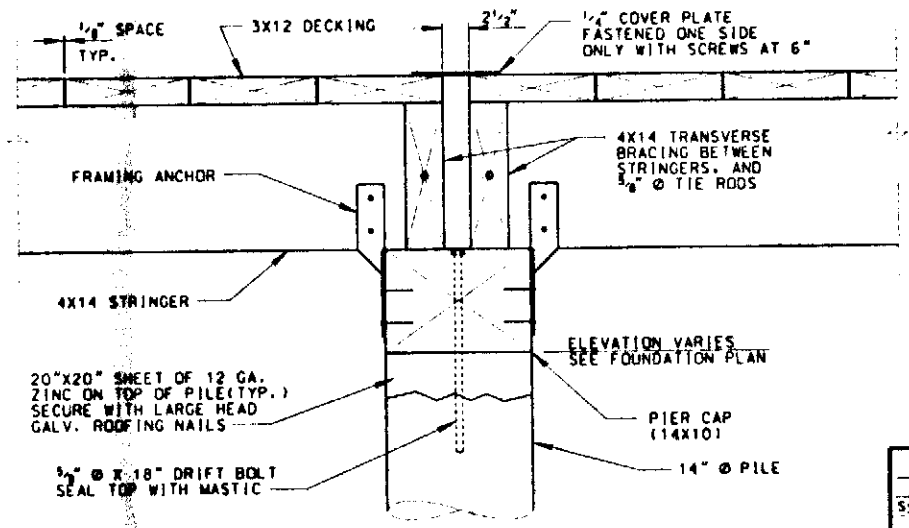
NOTE: MINIMUM PILE EMBEDMENT SHALL BE 15 FEET OR TO REFUSAL

A SECTION
S1|S2 SCALE: ¾"= 1'-0"

* THE AMOUNT OF BRACING VARIES WITH THE HEIGHT OFTHE PIER.



C SECTION THRU ABUTMENT
S1|S2 SCALE: 1½"= 1'-0"



B SECTION THRU PIER
S1|S2 SCALE: 1½"= 1'-0"

Symbol	Revisions Description	Date	Approved

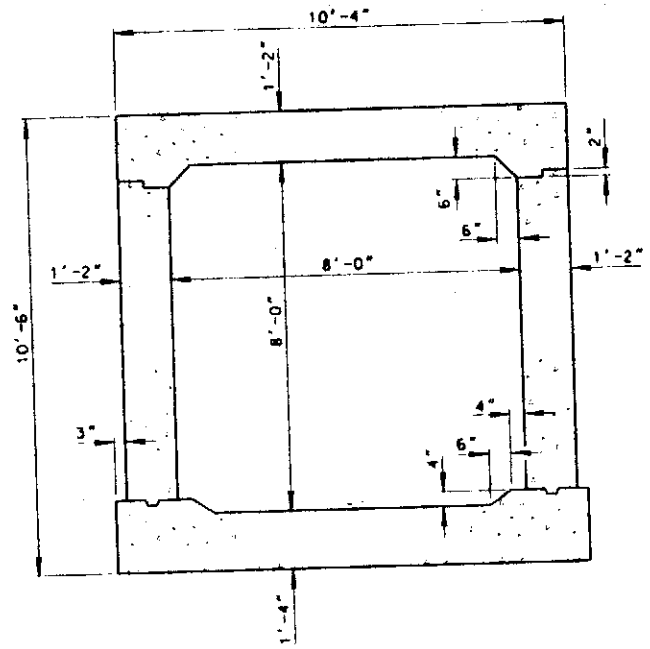
U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
ROCK ISLAND, ILLINOIS

DES MOINES RECREATIONAL RIVER AND GREENBELT
RED ROCK MULTI-PURPOSE TRAIL
SEGMENT III

BRIDGE SECTIONS

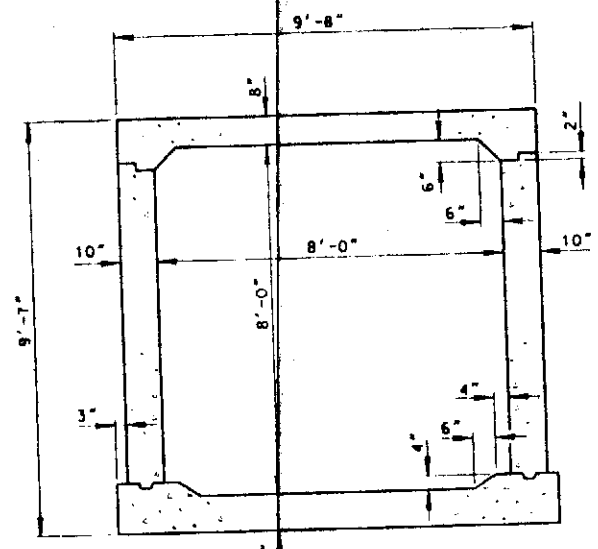
Designed by: K.E.W.			
Drawn by: R.D.G.			
Checked by: K.E.W.			
Revised by: R.C.A.	Scale: AS SHOWN	Sheet reference number: S2	
Approved by: ALBERT G. KRAUS, COL., CORPS OF ENGINEERS	Date:		Sheet of
	Drawing Code:		

PLATE 13



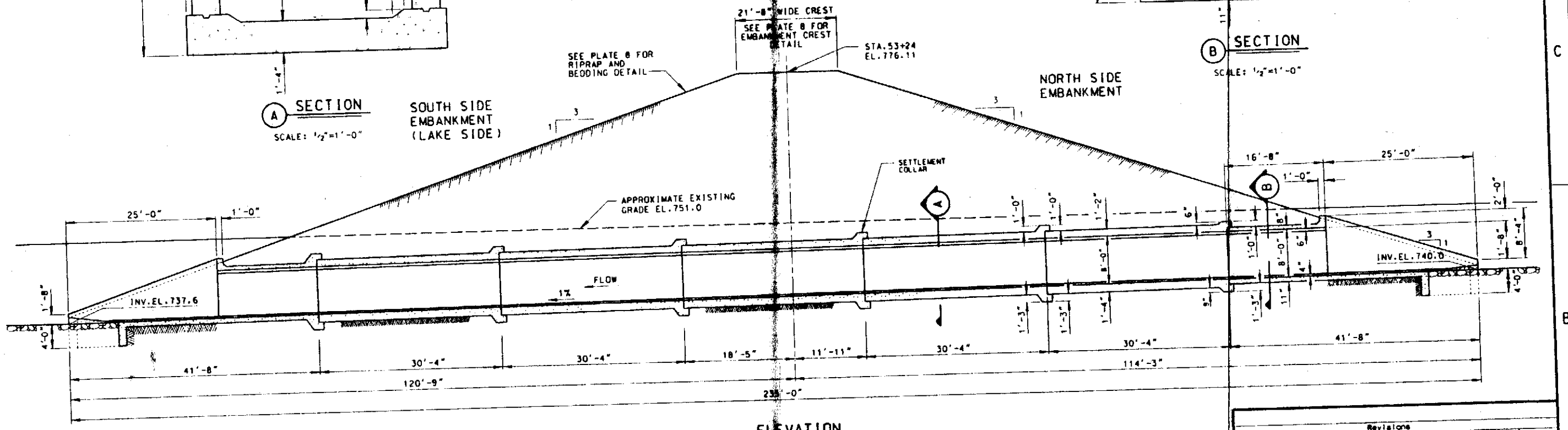
A SECTION

SCALE: 1/2"=1'-0"



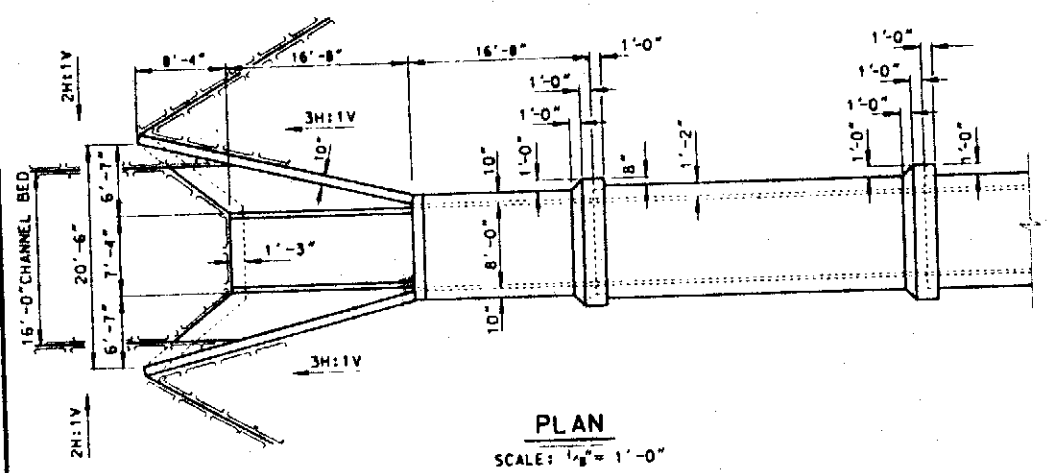
B SECTION

SCALE: 1/2"=1'-0"



ELEVATION

SCALE: 1/8"= 1'-0"



PLAN

SCALE: 1/8"= 1'-0"

NOTES:

1. DESIGN LOADS:
   a) AASHTO. STANDARD SPECIFICATIONS FOR HIGHWAY BRIDGES. 14TH EDITION. 1989.
   b) EM 1110-2-2902. CONDUITS. CULVERTS AND PIPES. 3 MARCH 1962.
2. CONCRETE DESIGN: ACI 318-89. BUILDING CODE REQUIREMENTS FOR REINFORCED CONCRETE.
   a) CONCRETE STRENGTH. f'c @ 28 DAYS. 4,000 psi
   b) REINFORCING STEEL. ASTM A615 GRADE 50 DEFORMED BARS. fy=48,000 psi
3. TO COMPENSATE FOR SETTLEMENT OF THE EMBANKMENT THE CULVERT WILL BE BUILT WITH A CAMBER OF APPROXIMATELY 12 INCHES.
4. FOR PLAN AND PROFILE OF CULVERT LOCATION SEE PLATE 8.

Revisions			
Symbol	Description	Date	Approved

U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
ROCK ISLAND, ILLINOIS

Designed by: K.E.W.
Drawn by: R.D.G.
Checked by: K.E.W.
Reviewed by: R.C.A.
Approved by: ALBERT J. KRAUS COL., CORPS OF ENGINEERS

DES MOINES RECREATIONAL RIVER AND GREENBELT
RED ROCK MULTI-PURPOSE TRAIL
SEGMENT III

CULVERT LAYOUT AND SECTIONS

Scales: AS SHOWN
Dates:
Drawing Code:
Sheet Reference Number: S3
Sheet of

PLATE 14

APPENDIX A

CORRESPONDENCE

DES MOINES RECREATIONAL RIVER AND GREENBELT
FEATURE DESIGN MEMORANDUM NO. 9
WITH ENVIRONMENTAL ASSESSMENT

RED ROCK MULTI-PURPOSE TRAIL
SEGMENT 3

LAKE RED ROCK, IOWA

APPENDIX A
CORRESPONDENCE

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Letter from Kathy Gourley, State Historical Society of Iowa, dated March 26, 1992	A-3
Letter to Larry J. Wilson, Iowa Department of Natural Resources, dated November 23, 1992	A-4
Letter from Richard C. Nelson, U.S. Fish and Wildlife Service, dated December 21, 1992	A-9
Letter to Ralph Turkle, Iowa Department of Natural Resources, requesting State 401 Water Quality Certification, dated January 8, 1993	A-11
Conversation Record with Tom Anderson, Iowa Department of Natural Resources, dated August 14, 1991	A-13
Conversation Record with Darryl Howell, Iowa Department of Natural Resources, dated August 19, 1991	A-14
Letter from Janet A. Gastineau, Iowa Department of Natural Resources, Water Resource Section, granting State 401 Water Quality Certification, dated March 5, 1993	A-15

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION VII
726 MINNESOTA AVENUE
KANSAS CITY, KANSAS 66101

June 26, 1991

Mr. Dudley M. Hanson
Chief, Planning Division
U.S. Army Engineer District, Rock Island
Clock Tower Building - P.O. Box 2004
Rock Island, Illinois 61204-2004

Dear Mr. Hanson:

This is in response to your June 10, 1991, request for comments from the Environmental Protection Agency on the addition of a two-mile segment of bike trail at Lake Red Rock, Marion County, Iowa.

We have reviewed the information provided within view of our earlier comment letters on Multipurpose Trail Segments I and II. We have no comments to offer at this time.

Thank you for the opportunity to comment.

Sincerely,

Lawrence M. Cavin
Chief, Environmental Review
and Coordination Section

STATE OF IOWA
TERRY E. BRANSTAD, GOVERNOR

DEPARTMENT OF NATURAL RESOURCES
LARRY J. WILSON, DIRECTOR

August 7, 1991

Colonel John R. Brown
District Engineer
U.S. Army Engineer District, Rock Island
ATTN: Planning Division
Clock Tower Building - P.O. Box 2004
Rock Island, IL 61204-2004

Dear Colonel Brown,

We have reviewed your letter outlining the Corps desire to construct a 2 mile segment of an asphalt-surfaced trail on the north side of Lake Red Rock. We have record of at least one state and federal endangered species in the immediate vicinity of the project, the Indiana bat - Myotis sodalis. Disturbance in this area requires a survey for them.

Therefore, the Iowa Department of Natural Resources would request additional information regarding 1) the habitat type, number and size that will be disturbed, 2) species to be disturbed, and 3) the dates in which construction is planned.

Sincerely,

LARRY J. WILSON
DIRECTOR

WALLACE STATE OFFICE BUILDING / DES MOINES, IOWA 50319 / 515-281-5145 / TDD 515-242-5967

State Historical Society of Iowa

The Historical Division of the Department of Cultural Affairs

March 26, 1992

In reply refer to:
R&C#: 920363061

Dudley M. Hanson, P. E.
Chief, Planning Division
Rock Island District Corps of Engineers
Clock Tower Building
P. O. Box 2004
Rock Island, IL 61204-2004

RE: COE - MARION COUNTY - RED ROCK MULTI-PURPOSE TRAIL SEGMENT III - PHASE I ARCHAEOLOGICAL RECONNAISSANCE

Dear Mr. Hanson:

Based on the information you provided, we find that there are no historic properties which might be affected by the proposed undertaking. Therefore, we recommend project approval.

However, if the proposed project work uncovers an item or items which might be of archeological, historical or architectural interest, or if important data come to light in the project area, you should make reasonable efforts to avoid or minimize harm to the property until the significance of the discovery can be determined.

Should you have any questions or if the office can be of further assistance to you, please contact the Review & Compliance program at 515-281-8743.

Sincerely,

Kathy Gourley
Archeologist, Review and Compliance Program
Historic Preservation Bureau

/kh

☐ 402 Iowa Avenue
Iowa City, Iowa 52240
(319) 335-3916

☑ Capitol Complex
Des Moines, Iowa 50319
(515) 281-5111

☐ Montauk
Box 372
Clermont, Iowa 52135
(319) 423-7173

November 23, 1992

Planning Division (1165-2-26a)

Mr. Larry J. Wilson
Director
Iowa Department of Natural Resources
Wallace State Office Building
Des Moines, Iowa 50319

Dear Mr. Wilson:

We are writing in response to your request for information concerning a proposed segment of trail to be located on the north side of Lake Red Rock in sections 7 and 18, Township 76 North, Range 18 West, and section 12, Township 76 North, Range 19 West, Marion County, Iowa (see enclosed trail location map).

The proposed trail segment is a component of the Des Moines Recreational River and Greenbelt, Multi-Purpose Trail System (Red Rock, Segment III). The enclosed map shows the location of Segment III in relation to existing and future components of the Red Rock trail system.

In a letter to our office, dated August 7, 1991, you noted that your agency's records documented the presence of the Indiana bat (Myotis sodalis) in the project area. This species is on the Federal and State list of endangered species. Your letter requested additional information regarding the habitat type, number and size that will be disturbed, species to be disturbed, and dates of planned construction.

The total length of the proposed trail Segment III is approximately 2.0 miles. The total area of impact (area to be cleared and grubbed for trail construction) is approximately 13 acres. Borrow material will be obtained from an 18-acre site near the trail alignment and within the flood control pool of Lake Red Rock. The trail alignment will pass through or near a variety of habitat types, including developed recreation areas, restored prairie and pine plantations, and upland deciduous forest (No bottom land forest will be affected by the project). Although the Indiana bat may potentially occur within any of these habitat types, the mature upland forested areas have the greatest potential for utilization as summer maternity roosting habitat.

Approximately 0.5 mile of the 2-mile trail segment will traverse a 40-acre tract of mature aged oak-hickory forest in the NE1/4 of the NW1/4 of section 18. The average width of the construction right-of-way for this portion of the trail is 47 feet. Approximately 3 acres of the 40-acre oak-hickory forest will be impacted by trail construction. Following construction, all areas outside the paved trail surface will be revegetated; however, replacement of mature trees will require several decades to complete.

In planning and designing the Red Rock Trail Segment III project, the Rock Island District of the U.S. Army Corps of Engineers has incorporated several measures to avoid direct impacts to the Indiana bat and minimize adverse effects to potential summer roosting habitat for the species. No clearing of wooded areas for trail construction will be allowed during the period from May 1 through August 30 (This "no-cut" period also was required for construction of Segment II). The initial trail alignment was designed to minimize impacts to mature woody vegetation, where possible. Prior to construction, the alignment will be reinspected and minor adjustments will be made, where possible, to avoid or minimize loss of potential roost trees.

We are currently completing preparation of the Feature Design Memorandum and Environmental Assessment (FDM/EA) for this project. As we informed you in our initial coordination letter dated June 10, 1991, this FDM/EA will be provided to your agency for review.

The project information outlined in the preceding paragraphs will be incorporated into the FDM/EA. If you have any additional comments or concerns which should be addressed prior to public review of the FDM/EA, please provide them to us in writing within 15 days of the date of this letter.

If you have any questions or need additional information regarding this project, please call Ms. Charlene Carmack of our Environmental Analysis Branch, telephone 309/788-6361, Ext. 6570.

Written responses may be sent to the following address:

District Engineer
U.S. Army Engineer District, Rock Island
ATTN: Planning Division
Clock Tower Building
P.O. Box 2004
Rock Island, Illinois 61204-2004

Sincerely,

ORIGINAL SIGNED BY

Dudley M. Hanson, P.E.
Chief, Planning Division

Enclosure

Copies Furnished:

Mr. Richard Nelson
Field Supervisor
Rock Island Field Office
U.S. Fish and Wildlife Service
4469 - 48th Avenue Court
Rock Island, Illinois 61201 (w/enclosure)

Mr. Morris Kay
U.S. Environmental Protection Agency
726 Minnesota Avenue
Kansas City, Kansas 66101 (w/enclosure)

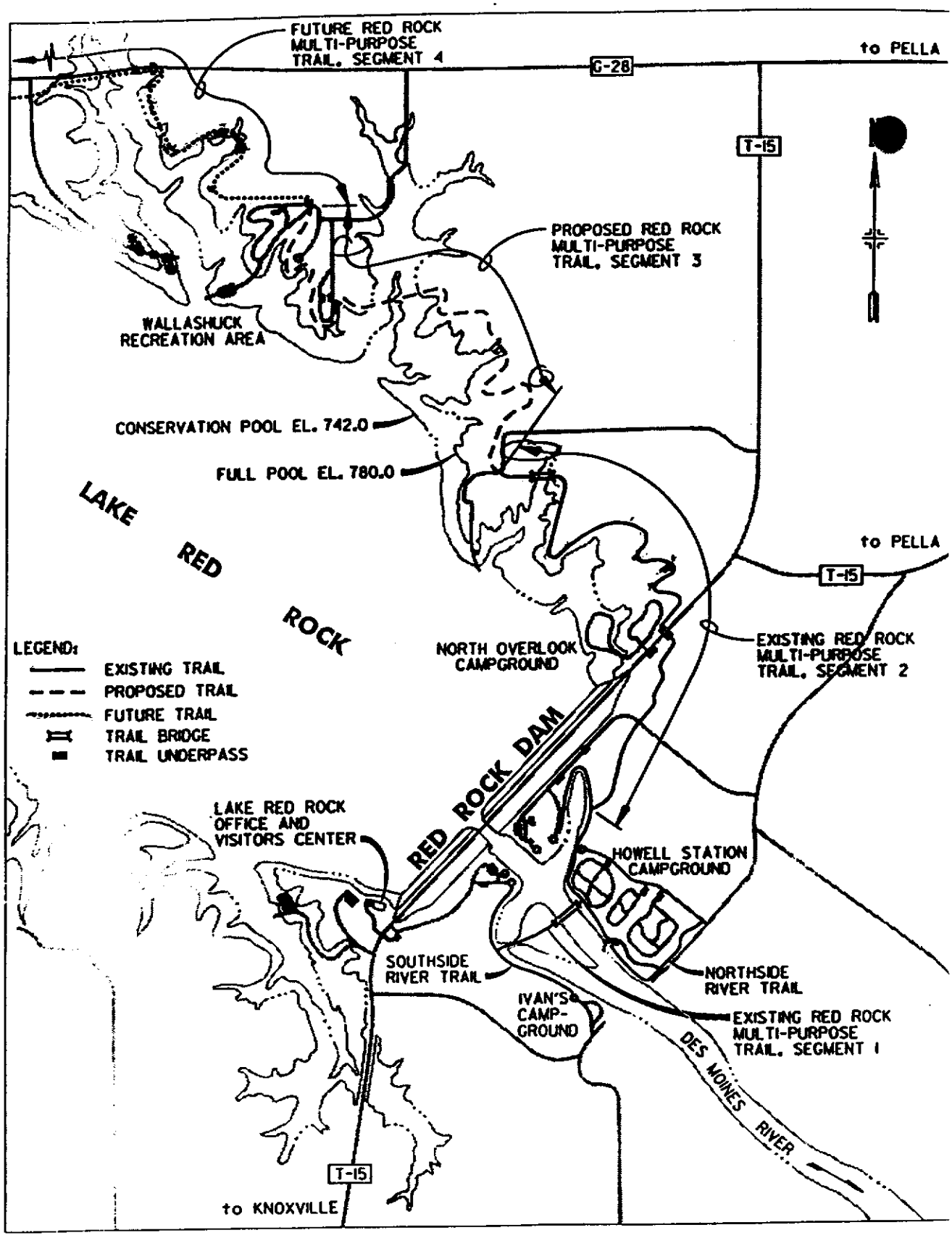
ATTN: Mr Tom Anderson
Mr. Larry Wilson
Iowa Department of Natural Resources
Wallace State Office Building
Des Moines, Iowa 50319 (w/enclosure)

ATTN: Fish and Wildlife Bureau
Mr. Larry Wilson
Iowa Department of Natural Resources
Wallace State Office Building
Des Moines, Iowa 50319 (w/enclosure)

Chairman
Marion County Board of Supervisors
County Courthouse
Knoxville, Iowa 50138 (w/enclosure)

Mr. Abie Davis
Marion County Engineer
R.R. # 5, Box 2
Knoxville, Iowa 50138 (w/enclosure)

Director
Marion County Conservation Board
Box 106
Pella, Iowa 50219 (w/enclosure)


FUTURE RED ROCK MULTI-PURPOSE TRAIL, SEGMENT 4
to PELLA
G-28
T-15
PROPOSED RED ROCK MULTI-PURPOSE TRAIL, SEGMENT 3
WALLASHUCK RECREATION AREA
CONSERVATION POOL EL. 742.0
FULL POOL EL. 780.0
LAKE RED ROCK
to PELLA
T-15
EXISTING RED ROCK MULTI-PURPOSE TRAIL, SEGMENT 2
NORTH OVERLOOK CAMPGROUND
LEGEND:
EXISTING TRAIL
PROPOSED TRAIL
FUTURE TRAIL
TRAIL BRIDGE
TRAIL UNDERPASS
RED ROCK DAM
LAKE RED ROCK OFFICE AND VISITORS CENTER
HOWELL STATION CAMPGROUND
SOUTHSIDE RIVER TRAIL
NORTHSIDE RIVER TRAIL
IVAN'S CAMP-GROUND
EXISTING RED ROCK MULTI-PURPOSE TRAIL, SEGMENT 1
DES MOINES RIVER
T-15
to KNOXVILLE

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Rock Island Field Office (ES)
4469 - 48th Avenue Court
Rock Island, Illinois 61201

IN REPLY REFER TO:

309/793-5800

December 21, 1992

Colonel Albert J. Kraus
District Engineer
U.S. Army Engineer District
Rock Island
Clock Tower Building, P.O. Box 2004
Rock Island, Illinois 61204-2004

Dear Colonel Kraus:

This letter supplements our July 5, 1992, Fish and Wildlife Coordination Act report for the proposed bike trail at Lake Red Rock, in Marion County, Iowa. These comments reference the third segment of the Des Moines Recreational River and Greenbelt, Multi-Purpose Trail project.

This letter provides comments under the authority of and in accordance with provisions of the Fish and Wildlife Coordination Act (48 Stat. 401, as amended; 16 U.S.C. 661 et seq.); and the Endangered Species Act of 1973, as amended.

As we understand it, Segment III of the trail is approximately 2.0 miles in length. A portion of the trail (0.5 miles) bisects a 40 acre tract of mature oak-hickory forest. The area is known to be utilized by the Federally Endangered Indiana bat (Myotis sodalis). Mature woods of this type serve as roosting and foraging sites as well as maternity areas for lactating females to rear their young.

During your planning and design phases of the project, measures were incorporated to avoid impacts to Indiana bats. We agree that if the removal of any trees (especially trees of large diameter) needs to done to construct the trail, the clearing should not take place from May 1 through August 30 to alleviate the possibility of disturbing nursery trees of the Indiana bat. In addition, the alignment should maintain some flexibility to avoid clearing the larger trees, which are most preferred by the species.

If construction is planned during the winter months, the schedule should be such that wintering bald eagles are not disturbed if they are present within the project area.

Should the above conditions be incorporated into the project, this precludes the need for further action as required under Section 7 of the Endangered Species Act of 1973, as amended. Should this project be modified, the above conditions not be incorporated, or new information indicate listed or proposed species may be affected, consultation or additional coordination with this office, as appropriate, should be initiated.

If you have further questions, please contact Mr. Joe Slater of my staff at (309) 793-5800.

Sincerely,

Richard C. Nelson
Field Supervisor

cc: IADNR (Howell)

JS:hw

DEPARTMENT OF THE ARMY
ROCK ISLAND DISTRICT, CORPS OF ENGINEERS
CLOCK TOWER BUILDING – P.O. BOX 2004
ROCK ISLAND, ILLINOIS 61204-2004

REPLY TO
ATTENTION OF

January 8, 1993

Engineering Division
General Engineering Section

Mr. Ralph Turkle
Water Quality Planning Section
Iowa Department of Natural Resources
Wallace State Office Building
900 East Grand Street
Des Moines, Iowa 50319-0034

Dear Mr. Turkle:

The Corps of Engineers, Rock Island District, is constructing a "Des Moines Recreational River and Greenbelt" project called "Red Rock Multi-Purpose Trail - Segment 3." This project will connect to an existing multi-purpose trail north of Red Rock Dam and run north along the shore of Lake Red Rock to the Wallashuck Recreation Area.

The trail in the project is approximately 2 miles in length and has an asphalt paved width of 10 feet with 3-foot-shoulders on each side. The trail will cross several small intermittent steams via culverts and fill, one intermittent stream via a 171-foot-long timber bridge and a portion of Lake Red Rock via a concrete culvert and fill.

The construction of the trail will involve placing approximately 75,000 cubic yards of earth fill material and 20,000 cubic yards of riprap bank protection within Lake Red Rock.

The total estimated volume of fill materials to be placed below the calculated Ordinary High Water (OHW) elevation of 744 is 17,500 cubic yards. Approximately 13,500 cubic yards of the fill material will be earth fill excavated from a nearby borrow site. Approximately 4,000 cubic yards of the fill material will be riprap and will be clean quarry run rock. The borrow site for the earth fill material is located within the Red Rock Flood Control Pool so that flood storage volume will not be decreased by the placement of the earth fill.

An Environmental Assessment (EA) will be prepared by the Rock Island District. Aspects requiring processing under Section 404 of the Clean Water Act are in progress. A copy of our report will be forwarded to your office for review. We are requesting your expedient review and issuance of 401 Water Quality Certification for the proposed project. Enclosed is an application packet containing the required forms and project information.

If you have any questions regarding the project, please call Mr. Tim Hess of my staff at 309/788-6361, extension 6140, or you may write to the following address:

District Engineer
U.S. Army Engineer District, Rock Island
ATTN: Engineering Division (Tim Hess)
Clock Tower Building, P.O. Box 2004
Rock Island, Illinois 61204-2004

Sincerely,

Robert W. Kelley

Robert W. Kelley, P.E.
Chief, Engineering Division

Enclosure

CONVERSATION RECORD	TIME: 0830	DATE: 14 August 91

TYPE ( )VISIT ( )CONFERENCE (X)TELEPHONE (X)INCOMING ( )OUTGOING

ROUTING

NAME	INT

NAME CONTACTED	ORGANIZATION	TELEPHONE
Tom Anderson	IDNR	(515)281-8673

SUBJECT: Greenbelt Multi-Purpose Trail, Red Rock-Segment III, Letter of Comment from IDNR

SUMMARY:

Tom Called to follow up yesterday's conversation on the subject project. Tom reported that he had spoken with Darryl Howell (Chief of Preserves and Ecological Services Bureau) about the concerns raised in their 7 August 91 letter and our responses. Tom reported that Darryl had recommended a "no cut" period from May 15 - Aug 30 in areas where bats may be present. Tom also said that Darryl's staff had found that a state listed threatened plant species, the yellow trout lily (Erythronium americanum) was recorded in the vicinity of the proposed project by someone affiliated with Central College in Pella. I told Tom I would call Central College to investigate further and contact Darryl HOwell to confirm that their concerns had been addressed.

ACTION REQUIRED

Will call back Darryl Howell to confirm that their concerns are being addressed.

NAME OF PERSON DOCUMENTING CONVERSATION:	SIGNATURE	DATE
Charlene Carmack	Charlene Carmack	8/14/91

ACTION TAKEN

SIGNATURE	TITLE	DATE

50271-101 CONVERSATION RECORD (12-76)

CONVERSATION RECORD	TIME: 0830	DATE: 19 August 91

TYPE ( )VISIT ( )CONFERENCE (X)TELEPHONE ( )INCOMING (X)OUTGOING

ROUTING: NAME | INT

NAME CONTACTED	ORGANIZATION	TELEPHONE
Darryl Howell	IDNR	(515)281-8524

SUBJECT: Greenbelt Multi-Purpose Trail, Red Rock-Segment III, Letter of Comment from IDNR

SUMMARY:

I called Darryl Howell to confirm that their concerns regarding impacts of the subject project on the Indiana bat had been addressed, and to request additional information on the recorded occurrence of the yellow trout lily in the project area. Darryl stated that his agency would recommend a "no cut" period of May 1 - August 30 for wooded areas along the trail alignment (to minimize potential impacts to the Indiana bat). I asked if he had more specific location information for the records of the yellow trout lily. He said that Mark Loescke of his staff would send me copies of the records but cautioned that the locational data would not be more specific than section number. He suggested I contract Central College for more information.

ACTION REQUIRED

Contact Central College biology department to try to obtain more specific location information on yellow trout lily.

NAME OF PERSON DOCUMENTING CONVERSATION:	SIGNATURE	DATE
Charlene Carmack	Charlene Carmack	8/19/91

ACTION TAKEN

SIGNATURE	TITLE	DATE

50271-101 CONVERSATION RECORD (12-76)

STATE OF IOWA

TERRY E. BRANSTAD, GOVERNOR

DEPARTMENT OF NATURAL RESOURCES
LARRY J. WILSON, DIRECTOR

March 5, 1993

Mr. Robert Kelley P.E.
Rock Island District, Corps of Engineers
Engineering Division
PO Box 2004
Rock Island, Illinois 61204-2004

Subject: Request for State 401 Water Quality Certification
Proposed placement of fill material and riprap within Lake Red Rock for the construction of a multi-use recreational trail.
Section 12, T76N, R19W, Marion County

Water Quality Designation: The Des Moines River, including Laek Red Rock, is designated as a Class A Primary Contact Recreation and Class B(WW) Significant Resource warm water stream. Such waters are to be protected for primary contact recreation, for the maintenance of a wide variety of warm water species, including sensitive species, and for wildlife, aquatic, and semiaquatic uses.

Dear Mr. Kelley:

This department has received and reviewed the request for State Certification pursuant to Section 401 of the Clean Water Act. State Section 401 Certification is required by the Army Corps of Engineers before a Section 404 permit can be issued. Section 401 Certification is this department's concurrence that this project is consistent with Iowa's Water Quality Standards.

This letter certifies that this department has determined there is reasonable assurance the proposed activity will be conducted in a manner which will not violate water quality standards of the state of Iowa.

Sincerely,

Janet A. Gastineau
Water Resource Section

WALLACE STATE OFFICE BUILDING / DES MOINES, IOWA 50319 / 515-281-5145 / TDD 515-242-5967 / FAX 515-281-8895

CLEAN WATER ACT
404(b)(1) EVALUATION

APPENDIX B

DES MOINES RECREATIONAL RIVER AND GREENBELT
FEATURE DESIGN MEMORANDUM NO. 9
WITH ENVIRONMENTAL ASSESSMENT

RED ROCK MULTI-PURPOSE TRAIL
SEGMENT 3

LAKE RED ROCK, IOWA

APPENDIX B
CLEAN WATER ACT
SECTION 404(b)(1) EVALUATION

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DES MOINES RECREATIONAL RIVER AND GREENBELT
FEATURE DESIGN MEMORANDUM NO. 9
WITH ENVIRONMENTAL ASSESSMENT

RED ROCK MULTI-PURPOSE TRAIL
SEGMENT 3

LAKE RED ROCK, IOWA

APPENDIX B
CLEAN WATER ACT
SECTION 404(b)(1) EVALUATION

1. PROJECT DESCRIPTION

a. Location.

The project site is located along the northeast shore of Lake Red Rock, about 4 miles southwest of the town of Pella in Marion County, Iowa.

b. General Description.

The project is a 2.0 mile multi-purpose trail segment. The trail will have an asphalt paved width of 10 feet with 3-foot shoulders on each side. The trail alignment will cross several intermittent streams via culverts and fill, one intermittent stream via a 171-foot-long timber bridge, and a portion of Lake Red Rock via a concrete culvert and fill. The culvert and fill crossing of Lake Red Rock will involve placement of fill material in regulated waters of the United States, necessitating the preparation of this 404(b)(1) Evaluation.

c. Authority and Purpose.

The Des Moines Recreational River and Greenbelt was funded and authorized by Public Law 99-88 as approved on August 15, 1985. The project is for the development, operation and maintenance of a recreational and greenbelt area on and along the Des Moines River in Iowa from U.S. Highway 20 in Fort Dodge, downstream to relocated U.S. Highway 92 in the vicinity of the Red Rock Dam. Development of multi-purpose trails is one of the projects included in the comprehensive plan for the Greenbelt.

d. General Description of Dredged and Fill Material.

Earth fill will be obtained from a site in the SW 1/4 of the SW 1/4 of Section 7, Township 76 North, Range 18 West. This site is located within the Lake Red Rock flood

control pool so that flood storage volume will not be decreased by the placement of the earth fill. Sand fill material will consist of quarry run sand. The nearest potential source is a commercial quarry located approximately 3 miles southeast of the project area near the town of Harvey, Iowa. Riprap material will consist of clean quarry run rock obtained from a local quarry. Another commercial quarry site which may be used as a source of material is located approximately 5 miles north of the town of Sully in Jasper County (about 20 miles north of the project area).

e. Description of Proposed Discharge Site.

Construction of the trail will involve placing approximately 43,100 cubic yards of earth fill material, 10,400 cubic yards of sand fill material, and 20,000 cubic yards of riprap bank protection within Lake Red Rock. The total estimated volume of fill materials to be placed below the calculated Ordinary High Water (OHW) elevation of 744 NGVD is 14,400 cubic yards. Approximately 10,400 cubic yards of the fill material will be sand fill and 4,000 cubic yards will be riprap material.

f. Description of Disposal Method.

The fill material will be placed at the construction site by mechanical means.

2. FACTUAL DETERMINATIONS

a. Physical Substrate Determinations.

The substrate of the Des Moines River at the project site is generally composed of sand, silt, and gravel. The riverbank under the embankment site contains varying layers of modern alluvium of mixed sand and silt layers.

b. Water Circulation, Fluctuation, and Salinity Determinations.

Water chemistry, clarity, color, odor, taste, dissolved gas levels, nutrients, and eutrophication will not be affected by the project. Salinity determinations are not applicable to the area. Circulation, flow, velocity, stratification and hydrologic regime will not be significantly affected. Water level fluctuations are primarily determined by Red Rock Reservoir which both stores and releases water in conduction with its flood control purpose. The proposed project would cause no noticeable change in water level fluctuations. Current pattern may be slightly altered near the fill area.

c. Suspended Particulate/Turbidity Determinations.

There will be a minor temporary increase in suspended particulates and turbidity during construction. Following project completion, these factors should return to pre-construction levels.

d. Contaminant Determinations.

Construction materials will be chemically stable and noncontaminating. Construction will take place in a non-industrial, non-commercial area where the soil is unlikely to be contaminated. Neither the fill nor its placement will cause relocation or increases of contaminants in the aquatic ecosystem. Certification of the project under Section 401 of the Clean Water Act has been received from the Iowa Department of Natural Resources in a letter dated March 5, 1993 (see Appendix A), and all requirements will be met prior to construction.

e. Aquatic Ecosystem and Organism Determinations.

The proposed action should have no noticeable effect on the aquatic ecosystem. No significant impacts to benthos, plankton, or nekton are anticipated. Two Federally listed endangered or threatened species, the bald eagle (Haliaeetus leucocephalus) and the Indiana bat (Myotis sodalis) are listed for Marion County. Threatened and endangered species are discussed in the preceding Environmental Assessment. It was determined that there would be no significant impacts to either species. No State listed threatened or endangered species are known to occur within the project area, and no impacts are anticipated.

f. Proposed Disposal Site Determinations.

The proposed project may cause minor, temporary increases in turbidity during construction; however, no violation of water quality standards should occur. Riprap will be obtained from an approved quarry site near the project area. The proposed action will have no adverse effect on municipal or private water supplies; recreational or commercial fisheries; or water-related recreation, aesthetics, parks, national historic monuments, or similar preserves.

g. Determination of Cumulative Effects on the Aquatic Ecosystem.

Impacts from construction would be temporary. The permanent riprap would be composed of chemically stable, noncontaminating material. Therefore, no detrimental cumulative or secondary impacts are expected to occur. Implementation of the project could increase fisheries habitat through the placement of riprap.

h. Determination of Secondary Effects on the Aquatic Ecosystem.

No adverse secondary effects are expected. Implementation of the project could increase fisheries habitat due to the placement of riprap.

3. FINDINGS OF COMPLIANCE WITH THE RESTRICTIONS ON DISCHARGE

a. No significant adaptations of the 404(b)(1) guidelines were made relating to this evaluation.

b. The alternative of No Federal Action was not feasible because it did not provide nonmotorized access to surrounding recreational areas.

c. Certification under Section 401 of the Clean Water Act has been received from the Iowa Department of Natural Resources.

d. The project would not introduce toxic substances into nearby waters or result in appreciable increases in existing levels of toxic materials.

e. No significant impacts to Federal or State listed endangered or threatened species will result from the project.

f. The project is located in an inland freshwater system. No marine sanctuaries are involved.

g. No municipal or private water supplies would be affected. Minor impacts would result from construction. No sensitive or critical habitats would be affected, and no long-term adverse impacts would occur.

h. Project construction materials will be physically and chemically stable.

i. The proposed actions will not significantly affect water quality or the aquatic ecosystem and are in compliance with the requirements of guidelines for Section 404(b)(1) of the Clean Water Act, as amended.

_____
Date

Albert J. Kraus
Colonel, U.S. Army
District Engineer

APPENDIX C

GEOTECHNICAL ANALYSIS

DES MOINES RECREATIONAL RIVER AND GREENBELT
FEATURE DESIGN MEMORANDUM NO. 9
WITH ENVIRONMENTAL ASSESSMENT

RED ROCK MULTI-PURPOSE TRAIL
SEGMENT 3

LAKE RED ROCK, IOWA

APPENDIX C
GEOTECHNICAL ANALYSIS

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DES MOINES RECREATIONAL RIVER AND GREENBELT
FEATURE DESIGN MEMORANDUM NO. 9
WITH ENVIRONMENTAL ASSESSMENT

RED ROCK MULTI-PURPOSE TRAIL
SEGMENT 3

LAKE RED ROCK, IOWA

APPENDIX C
GEOTECHNICAL ANALYSIS

1. PURPOSE AND SCOPE

This appendix presents the soil exploration program and the geology, design, and analysis of the proposed project based on soil conditions encountered in the field. The scope of the study includes the review of Red Rock Dam foundation reports, field trips by the Geotechnical Branch personnel to the proposed project site, analyses of the detailed geotechnical investigation, and discussions with in-house personnel.

2. LOCATION

The project is located in the upstream area of Lake Red Rock about four miles southeast of the town of Pella in Marion County, Iowa. The location of the project is shown on plate 1 of the main report.

3. PROJECT DESCRIPTION

The proposed project consists of the construction of approximately two miles of an asphalt surfaced multi-purpose recreational trail. The trail will include the construction of a 171-foot long timber bridge, a small gatewell structure, two impervious compacted embankments, and a 230-foot long 8-ft by 8-ft. reinforced concrete box culvert through the larger impervious embankment. The project will connect an existing multi-purpose trail to the Wallashuck Recreation Area.

4. REGIONAL GEOLOGY

a. The area surrounding Lake Red Rock lies in the province known as the Southern Iowa Drift Plain. Throughout most of the region, the glacial drift consists of till belonging to the Kansan stage of glaciation underlain by some earlier Nebraskan till. The Kansan age ended approximately one-half million years ago. The surface has not been glaciated since, and very little, if any, direct glacial topography remains. Since the Kansan age, the valleys south of Des Moines have established broad

floodplains with far-reaching tributaries. At the beginning of the Wisconsinan glaciation 14,000 to 16,000 years ago, loess was deposited across the area and the present landscape began to develop its current form.

b. The topography of this area is one of steeply rolling hills interspersed with areas of uniformly level upland divides and level alluvial lowlands. Individual hillsides often display a texture of fine rills or drainage ways that give a ribbed or furrowed appearance. Near the larger drainage features such as the Des Moines River, the valleys become more deeply incised into the drift until they encounter bedrock, an ancient soil profile, or paleosol, whereupon downward erosion slows and lateral erosion and valley widening begins.

c. The paleosol is a clay rich layer, often several feet thick, below the loess that retards the downward percolation of water and may produce seeps or springs where it intercepts the surface. There is evidence of such a condition in the swale just south of the eastern end of the large embankment located at Station 50+00. The upper bedrock in this area consists of Pennsylvanian age cyclic deposits of sandstone, siltstone, shale, limestone, and coal. These units are occasionally exposed at tributary valley nick points or along eroded hillsides. Older Mississippian age deposits of carbonates and sandstones underlie these but are not exposed in the project area.

5. GEOTECHNICAL INVESTIGATION

a. A detailed geotechnical investigation was conducted to obtain subsurface information and engineering properties of different soils encountered at the proposed project site. This investigation included soil drilling and sampling, field testing, and laboratory testing.

b. A total of eighteen borings were taken along the proposed trail alignment. Borings were taken at the proposed locations for the embankments, the 8-ft by 8-ft concrete culvert, the timber bridge, the proposed borrow area, and along the trail alignment. The borings were drilled to depths varying from 3 feet to 43 feet below the ground surface. The boring locations are shown on plates 4 and 5 of the main report.

6. DRILLING PROCEDURES

a. The subsurface exploration procedures were in accordance with U.S. Army Corps of Engineers and ASTM standards as follows:

(1) EM 1110-1-1804, "Geotechnical Investigations"
(2) EM 1110-2-1907, "Soil Sampling"
(3) ASTM D 1586, "Penetration Test and Split-Barrel Sampling of Soils"

b. The eleven drill borings (10 to 43 feet deep) were made with an all-terrain vehicle (ATV) mounted rotary drilling rig Central Mine Equipment (CME) Model 55. The borings were advanced using hollow stem augers (3-1/4" inside diameter) to stabilize the sides of the borehole. The eight shallow borings (each 3 feet deep) were made with a 4-inch diameter Iwan hand auger.

7. SAMPLING PROCEDURES

Soil samples were obtained using a 2-inch outside diameter split spoon sampler as part of the standard penetration test (ASTM D 1586) and 4-inch diameter Iwan augers. All borings were sampled at two-foot intervals or breaks in stratigraphy. Representative samples obtained were placed in sample jars. Bag samples (about 50 lbs. each) from borrow sites were also obtained to perform the standard proctor tests.

8. TESTING PROGRAM

The purpose of the laboratory testing program was to classify and provide engineering properties of the soils encountered. The laboratory testing program consisted of the following tests: (a) visual classification, (b) moisture content, and (c) atterberg limits. Visual classification was performed on all samples. All soil samples were tested for moisture content. Selected fine-grained representative samples were tested for atterberg limits. The standard proctor tests were also performed on samples from the borrow sites in accordance with ASTM D 698.

9. EARTH EMBANKMENTS

a. The two separate compacted impervious embankments will be constructed at locations as shown on plates 7 and 8 of the main report. A large embankment will be constructed between Stations 50+00 and 59+00 and will be approximately 44 feet high at its highest point. A typical embankment section for the large embankment is shown on plate 8 of the main report. The smaller embankment will be constructed between Stations 30+40 and 30+90 with a maximum height of 14 feet. A detail showing the embankment section is shown on plate 7 of the main report. This embankment will create a small pond (approximately 0.21 acres) with a maximum depth at the embankment of 11 feet. The crown of the large and small embankments will be 20 feet and 16 feet respectively for ease of construction and to accommodate the multi-

purpose trail. Both side slopes of the embankments will be constructed to a uniform slope of 1 vertical (V) on 3 horizontal (H).

b. The large embankment, from elevation 744 MSL to 777 MSL, and the smaller embankment, will be constructed of impervious materials classified as CL, CL-CH, and CH with not less than 50 percent by weight passing the no. 200 sieve or SC with not less than 35 percent by weight passing the no. 200 sieve. The large embankment below elevation 744 MSL, or below the pool water surface elevation during the time of construction, will be constructed of pervious material. It is not economically feasible to build a clay embankment below the water surface since it would require an extensive dewatering system for the placement of the clay fill material in dry conditions. Elevation 742 is normal low pool; however, every year during autumn (Sep 15 to Dec 15), the conservation pool is raised to 744 for the benefit of the migrating water fowl. The pervious materials classified as SP or SW with less than 5% by weight passing the No. 200 sieve will be used.

c. Maximum density of the sand will be controlled by placement and shaping of the material. Construction of the compacted impervious embankment will be controlled by moisture and density control to eliminate slope stability problems and to provide an embankment of low compressibility. For moisture control, a range of plus 2 to minus 2 percentage points deviation from the optimum moisture content will be used. For density control, the uncompacted lift thickness (9 inches with tamper-type roller and 12 inches with rubber-tired roller) of impervious fill will be compacted to not less than 95 percent of maximum density, utilizing a 25-blow proctor compaction test in accordance with EM 1110-2-1906 while using standard compaction equipment.

d. Both contractor quality control (CQC) and government quality assurance (GQA) testing will serve to assure that a quality embankment is constructed using this construction plan. The contractor will be required to run field in-place density tests (ASTM D 1556 or ASTM D 2167) for every 4,000 cubic yards of embankment placed (minimum of one test per day during embankment placement). Any materials encountered that become too wet or too dry for proper compaction will require the contractor to either dry-back or pre-wet the material prior to rolling operations.

10. EMBANKMENT PROTECTION

a. During occasional occurrences of higher pools, the large embankment located at approximately station 50+00 will be subjected to some degree of inundation. Therefore, some protection from wave attack is required. The worst case

situation for wind driven waves was determined to be a slightly southwesterly wind driving up the valley against the embankment. The Automated Coastal Engineering System (ACES) program developed by the Coastal Engineering Research Center (CERC) was used to evaluate 16 permutations of variables affecting the site. The design wave height and period were determined after establishing the most probable set of adverse conditions addressing wind speed, duration, and direction; temperature difference; water depth; and fetch geometry.

b. These in conjunction with the nearshore and structure slope, rock weight, damage level, and permeability coefficient were used to calculate the required riprap and filter layer gradations and thicknesses. The gradations and curves for the riprap and filter layer are shown on plates C-8 and C-9 respectively. The thickness of the riprap and filter layers are shown on plate 8 of the main report. The resultant gradation and structural design alternatives were discussed with personnel from CERC. Although they knew of no historical documentation or model studies for a structure of this type and in this circumstance, the proposed basic design parameters and concepts were validated.

c. The original concept was to extend the armor layer thickness straight across the top of the embankment thus providing protection to the crest and upper edge of the landward side, and then to construct the roadway on top of choked riprap. Subsequent discussions raised the potential of maintenance problems due to the vulnerability to surging and breaking waves acting on the choke stone and road surface and of the possibility of voids created under the road surface. The final concept is to extend the one-foot bedding layer material up the reservoir side and across the crest and then continue it down the landward side at a thickness of six inches to protect against minor wave action and possible surging problems at intermediate depths. The roadway structure will then be constructed on the bedding layer. The riprap blanket will be extended up the reservoir side until it abuts a gabion wall approximately 3 feet high, running along the edge of the reservoir side shoulder. This design is intended to dissipate wave action occurring when the pool is slightly above or below the crest elevation, thus protecting the roadway from through surge and lateral wave attack. Wave propagation and riprap gradations have been evaluated for crest elevation of 777, with nominal top sizes ranging from roughly 500 to 700 pounds. The riprap gradation and curves for the maximum crest elevation 777 MSL are shown on Plate C-8.

11. FOUNDATION FOR EARTH EMBANKMENT

a. The entire foundation beneath both of the proposed embankments will be cleared and stripped to remove vegetation and other deleterious materials to a depth of 6 inches. All tap roots, lateral roots, or other projections over 1.5 inches in diameter within the embankments' foundation areas will be removed to a depth of 3 feet below natural ground surface.

b. An extensive field investigation was made to ascertain the proposed earth embankments foundation conditions. The top stratum consists of sandy clayey soils, mostly sandy lean clay (CL), according to borings BT-92-4, BT-92-5, BT-92-6, and BT-92-11 through BT-92-14, which were taken along the large and small embankments' alignment. It varies in thickness from 14 to 43 feet. The moisture content ranges from 14 to 32 percent. Atterberg limit testing reveals a range from 32/12 (liquid limit/plastic limit) to 49/18. The standard penetration test "N" values that were recorded during the drilling operation ranged from 4 to 29 blow counts with average "N" values of 12, with the exception of one "N" value of 2 in boring BT-92-5 at 16 feet deep below the ground surface. At this depth, the soil consists of gravelly clayey sand (SC). A detailed description of the encountered soils are shown on the boring logs (see plates 4 and 5 of the main report).

c. Borings BT-92-13 and BT-92-14 along the proposed large embankment alignment were extended into the bedrock to depths ranging from 10 to 13 feet. The top elevations at which bedrock was encountered ranged from approximately 729 to 722 MSL. The bedrock was NX cored from each hole to determine the rock's top elevation and quality. The bedrock was classified as shale, with exception of the top one-half foot of sandstone and siltstone in boring BT-92-14. Borings BT-92-11 and BT-92-12 which were taken along the smaller embankment alignment were also extended into bedrock. The top elevations at which bedrock was found ranged from approximately 775 to 768 MSL. Detailed descriptions of the bedrock are shown on the boring logs (plates 4 and 5 of the main report).

12. FOUNDATION FOR THE TIMBER BRIDGE

a. Seven timber piers (Sta. 28+04 to Sta. 29+75) will be built to support a 171-foot long timber bridge. The location of the proposed timber bridge is shown on plate 7 of the main report. Borings BT-92-10, BT-92-11, and BT-92-12 were taken to determine the engineering characteristics of the foundation materials and to provide criteria for the proposed bridge foundation design.

b. Based on these borings, the top 14 to 24 feet of stratum consists of lean clay (CL) and sandy lean clay (CL). This clay has medium to very stiff consistency and a natural moisture content ranging from 11 to 28 percent with an average natural moisture content of 20 percent. Atterberg limit testing revealed a range from 30/12 (liquid limit/plastic limit) to 51/13. The standard penetration test "N" values were also recorded during drilling operation. The values ranged from 5 to 23 blow counts with average "N" value of 12 blow counts. A detailed description of the encountered soils is shown on plates 4 and 5 of the main report.

c. All three borings were also extended to bedrock. The bedrock was classified as shale. The top elevation at which bedrock was encountered ranged approximately from 775 to 768 MSL. The detailed description of the shale materials is shown on boring logs on plates 4 and 5 of the main report.

d. Based on a visual inspection of each soil sample, laboratory test results analyses, and an engineering judgement based on test results of similar soils from construction of similar projects, the following design parameters for the encountered clay soils were recommended:

saturated unit weight	=	125 pcf
moist unit weight	=	120 pcf
angle of friction (Q-str)	=	0 degrees
cohesion (Q-str)	=	950 psf

13. FOUNDATION FOR OTHER STRUCTURES

a. A reinforced concrete box culvert, a 230-foot long, 8 ft by 8 ft structure near Station 55+24, and a small gatewell structure at Station 30+60 will be built as part of the proposed project. The location of the proposed structures is shown on plates 7 and 8 of the main report. Borings BT-92-11, BT-92-12, and BT-92-14 (16 to 37 feet deep) were taken to evaluate physical characteristics of subsurface conditions. Detailed descriptions of soils encountered are shown on boring logs on plates 4 and 5 of the main report. The borings do not show undesirable or soft material.

b. Any unsuitable material which might not have been encountered by these borings will be replaced with appropriate fill. The replacement material will be placed and compacted to obtain a density equal to the adjacent undisturbed foundation. A dewatering system will be required to maintain the excavation area in dry condition below approximate elevation 742 MSL to build the reinforced

concrete box culvert. Foundation design details of the proposed 8'x 8' concrete box culvert are given in Appendix D.

14. GROUNDWATER

a. Groundwater level observations were monitored during drilling operations and were noted on the boring logs as shown on plates 4 and 5 of the main report. Based on these observations, the groundwater levels encountered along the proposed multi-purpose trail ranged from 2 to 21 feet (elev. 752 to 742 feet MSL). The water levels should be expected to fluctuate with changes in the climatic conditions and reservoir levels.

b. Water levels were not encountered in borings BT-92-7, BT-92-8, BT-92-9, BT-92-11, BT-92-12, and BT-92-15 through BT-92-23.

15. SLOPE STABILITY

a. A detailed study of all embankment sections and soil profile along the embankment alignment indicated that the proposed embankment near Stations 55+60 and 54+30 is most critical with respect to slope stability. The stability of slopes was analyzed by the Modified Swedish Method for Circular Arc Slope Stability Analysis in accordance with EM 110-2-1902, "Engineering Design Stability of Earth and Rockfill Dams," dated 1 April 1970. The selected critical section was also checked using the UTEXAS3 program.

b. The maximum height of the proposed embankment at these selected sections is approximately 44 feet at Station 55+60 and 33 feet at Station 54+30 (42 feet at Station 55+60 and 31 feet at Station 54+30, 2 feet to compensate for anticipated settlement). The typical cross sections with one vertical and three horizontal on both side slopes are shown on plates C-1 and C-2.

c. To estimate the stability of the embankment, a range of conservative undrained shear strengths (Q) was assumed for the most severe configuration of compacted embankment and foundation. The undrained shear strength of the compacted impervious embankment is estimated to be at least 1500 psf with no friction angle; this estimate is based on test results of similar soils from construction of similar projects. The proposed embankment in these reaches will be founded on medium to stiff foundation soils. The foundation consists of generally lean clay (CL) and sandy lean clay (CL). Shear strength estimates vary from 500 psf to 1500 psf based on an empirical relationship between SPT and several soils properties, test results of similar soils, a visual inspection of each soil sample, and engineering

judgement. The conservation shear strength values assumed are shown on plates C-1 and C-2. In order to assure the validity of the selected shear strength parameters, undisturbed samples will be obtained prior to preparing the plans and specifications for the project.

d. Successive trials of various sliding surfaces were analyzed, and determination of the critical failure arc having the lowest safety factor was made. The summary of the slope stability analyses for critical sections and the solution of the most critical arcs appear on plates C-1 and C-2. The computed minimum safety factors were found to be 1.42 at Station 55+60 and 1.60 at Station 54+30. These exceed the 1.3 that is required by EM 1110-2-1913, "Design and Construction of Levees," dated March 31, 1978. Stability analyses for the critical cross section were checked and confirmed using the UTEXAS3 program Spencer method. The safety factor was found to be 1.50. Therefore, no slope stability problems are expected. The District's experience with the performance of impervious embankments during high water provided a basis for judging the adequacy of the proposed sections for slope stability during falling or constant Lake Red Rock Reservoir stages. Slope stability analyses were considered unnecessary for any loading condition other than the end of construction condition.

16. SETTLEMENT

The proposed earth embankment near station 54+30 was found to be most critical with respect to settlement. The 31-foot high embankment will impose a maximum load of 1.94 tons per square foot on a 23-foot thick stratum of medium consistency clay foundation stratum. A summary of the settlement analysis is shown on plates C-3 and C-4; it indicates total settlement to be approximately two feet. The specifications will require that the embankment be overbuilt by five percent to allow for any consolidation of the embankment and settlement in the foundation.

17. BORROW MATERIAL

a. The borrow material for the proposed multi-purpose trail embankment will be removed from areas as shown on plates 4 and 5 of the main report. According to borings (BT-92-7, BT-92-8, and BT-92-9) pertinent to borrow areas, the material consists of clays (CL, CL-CH, and CH). From ground surface to 5 feet deep, the moisture content varies from 24 percent to 30 percent, with an average moisture content of 27 percent. The atterberg limits testing reveals a range from 49/18 (liquid limit/plastic limit) to 58/20. The optimum moisture content is 21 percent with a maximum dry density of 103 lbs/cu ft.

b. From 5 to 12 feet, the moisture contents ranges from 16 to 30 percent with an average moisture content of about 23 percent. The atterberg limits testing reveals a range of 38/14 to 46/17. The optimum moisture content varies from 16.5 percent to 20 percent with a maximum dry density of 108 to 102.5 lbs/cu ft. The boring logs are shown on plates 4 and 5 of the main report. The compaction test results are shown on plates C-5, C-6, and C-7. Groundwater was not encountered in any borings. Shale was encountered in boring BT-92-8 approximately 8 feet deep at elevation 751 MSL. The borrow materials appeared suitable for the multi-purpose trail and embankment construction. The borrow material will require drying prior to placement. No compaction or shear strength difficulties with this material are anticipated.

c. Rock suppliers in the immediate vicinity of Red Rock may experience some difficulty producing riprap of the required size; therefore, the source may prove to be at some distance. The rock used in the 1984 upstream dam face remediation was transported by train from Huntington, Missouri.

18. SEEPAGE.

a. The smaller earth embankment that will be constructed between stations 30+40 and 30+50 will create a small pond as mentioned in paragraph 9a of this appendix. The foundation material for this embankment consists of medium to stiff consistency sandy lean clay (fill). A detailed description of the encountered soils has previously been discussed in paragraph 11 of this appendix. For the given foundation conditions, minimal or no seepage is expected to occur.

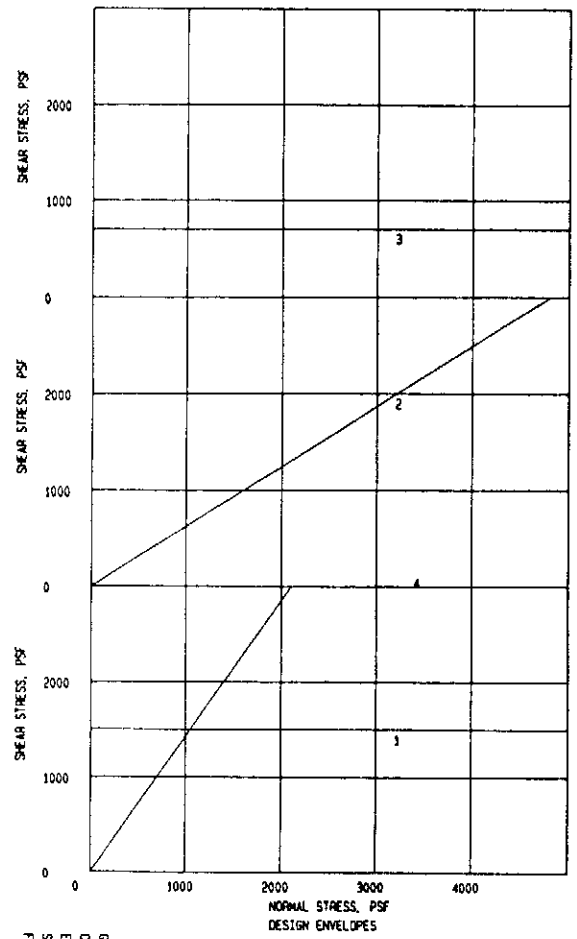
b. A toe drain will be provided on the landside of the impervious embankment to control the line of seepage of a phreatic surface development within the embankment itself.

19. PAVEMENT STRUCTURE.

a. The pavement structure designed for the trail will consist of 2 inches of asphalt placed on 6 inches of compacted aggregate base course. Loadings on the trails will include bicyclists, pedestrians, emergency vehicles such as an ambulance and occasional maintenance vehicles. A detailed pavement design and analysis was not required due to the very small loads which are anticipated on the trail. Two inches of asphalt was selected as a minimum asphalt lift thickness regardless of loading. Six inches of aggregate was determined to provide adequate foundation strength for the anticipated trail use. The proposed pavement structure has been used in the District for the past 15 years with acceptable success. Rock Island District is currently

developing a standard pavement structure for new multi-purpose trails. Options being considered are the current design, a full depth asphalt cement concrete, a full depth portland cement concrete and a portland cement concrete on a a granular base. Pavement drainage designs for multi-purpose trails are also being investigated.

b. According to borings which were taken along the multi-purpose trail, the water table was not encountered and the soil consists of poorly drained clay materials (CL-CH and CH). The potential for frost susceptibility is very low. Drainage ditches will be provided on both sides of the trail to collect rainfall and surface run-off.

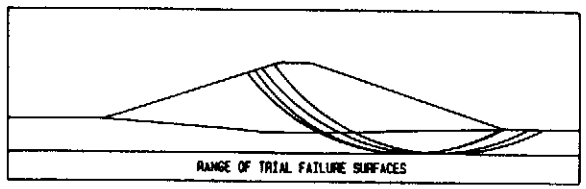


MATERIAL		SOIL WT. LBS./CUFT		SHEAR STRENGTH							
				Q		R		S		(R+S)/2	
		MOIST	SAT.	PHI DEGREES	COHESION PSF	PHI DEGREES	COHESION PSF	PHI DEGREES	COHESION PSF	PHI DEGREES	COHESION PSF
CON IMP EMBANKMENT EL 744 TO EL 777	1	125.00	128.00	.00	1500.00						
PERVIOUS EMBANKMENT EL 733 TO EL 744	2	120.00	120.00	32.00	.00						
IMP CLAY (CL) FND. EL 720 TO EL 733	3	123.00	125.00	.00	700.00						
FIRM FOUNDATION BELOW EL 720	4	130.00	130.00	55.00	.00						

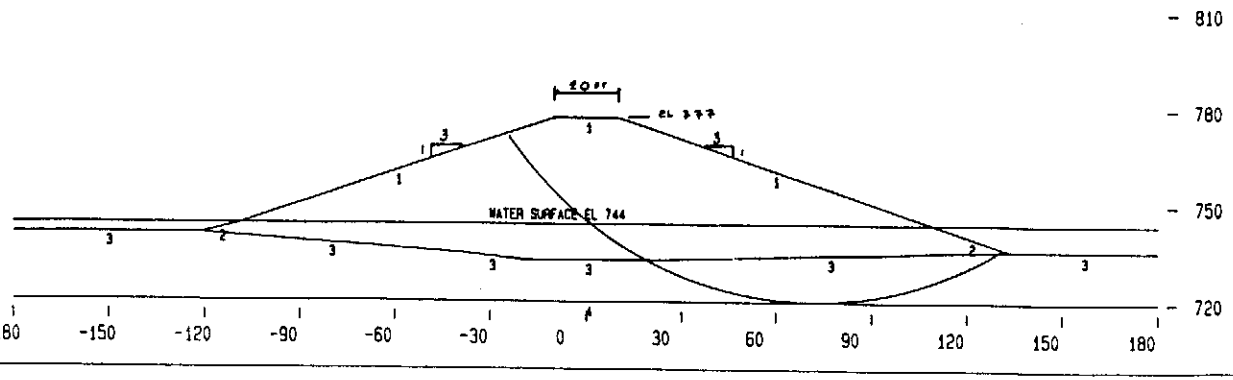
CIRCLE FAILURE SURFACE
USE CORPS OF ENGINEERS METHODS

TANGENT TO ELEV 720.10
TRIAL ARCS

RADIUS OF CIRCLE	CENTER OF CIRCLE		F.S.	
	DISTANCE FROM ℄	ELEV	Q	
			Ψ= .00	
115.70	71.80	835.80	1.42	
125.70	71.00	845.80	1.43	
131.90	85.50	852.00	1.48	
131.90	95.00	852.00	1.59	

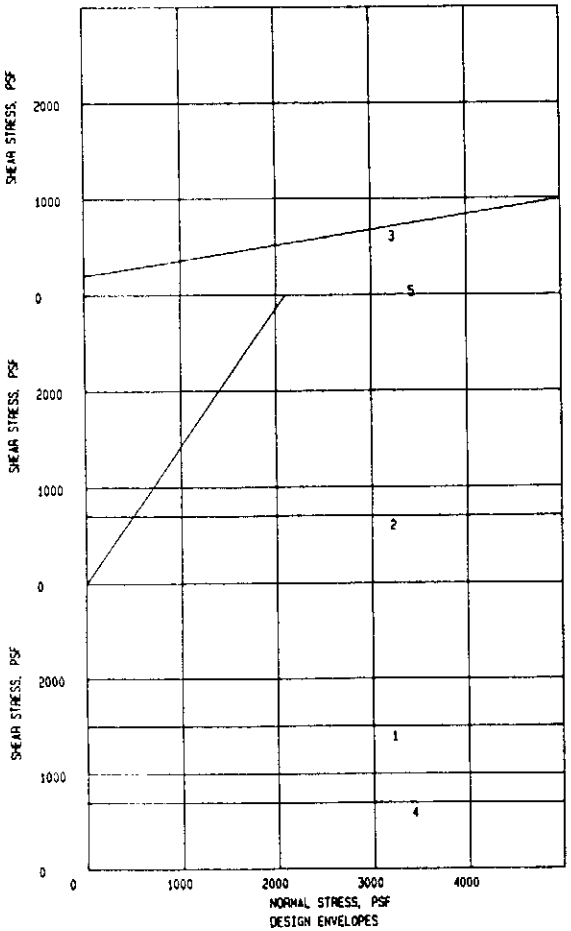


NOTES:
(1) ANALYSES WERE RUN ACCORDING TO EM 1110-2-1902 DATED APRIL 1970
(2) PSI=SIESMIC COEFFICIENT USED IN THE ANALYSES



GREENBELT BIKE TRAILS - SEC. III
CIRCLE STABILITY ANALYSIS
END OF CONSTRUCTION CONDITION
STA. 55+60
FEB 1983 (SAT)

PLATE C-1

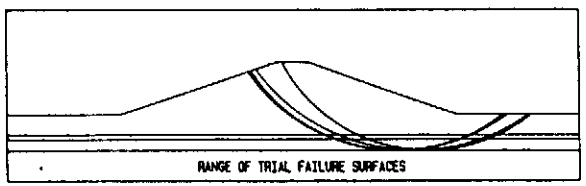


MATERIAL		SOIL WT. LBS./CUFT		SHEAR STRENGTH							
				Q		R		S		(R+S)/2	
		MOIST	SAT.	PHI DEGREES	COHESION PSF	PHI DEGREES	COHESION PSF	PHI DEGREES	COHESION PSF	PHI DEGREES	COHESION PSF
COMP IMP EMBANKMENT EL 744 TO EL 777	1	125.00	128.00	.00	1500.00						
IMP CLAY (CL) FND. EL 731 TO EL 744	2	123.00	125.00	.00	700.00						
CLAYEY SAND (SC) FND EL 728 TO EL 731	3	115.00	120.00	9.00	200.00						
IMP CLAY (CL) FND EL 721 TO EL 728	4	123.00	125.00	.00	700.00						
FIRM FOUNDATION BELOW EL 721	5	130.00	130.00	55.00	.00						

CIRCLE FAILURE SURFACE
USE CORPS OF ENGINEERS METHODS

TANGENT TO ELEV 721.10
TRIAL ARCS

RADIUS OF CIRCLE	CENTER OF CIRCLE DISTANCE FROM ℄	CENTER OF CIRCLE ELEV	F.S. Q V= .00	
108.90	65.50	830.00	1.60	
113.80	66.00	834.90	1.61	
122.80	76.90	843.90	1.69	
102.90	85.00	824.00	1.78	



NOTES:
(1) ANALYSES WERE RUN ACCORDING TO EM 1110-2-1902 DATED APRIL 1970
(2) PSI=SIESMIC COEFFICIENT USED IN THE ANALYSES

SPRINGBELT BIKE TRAILS - SEG. III
CIRCLE STABILITY ANALYSIS
END OF CONSTRUCTION CONDITION
STA 54+30
FEB 1993 (SM2)

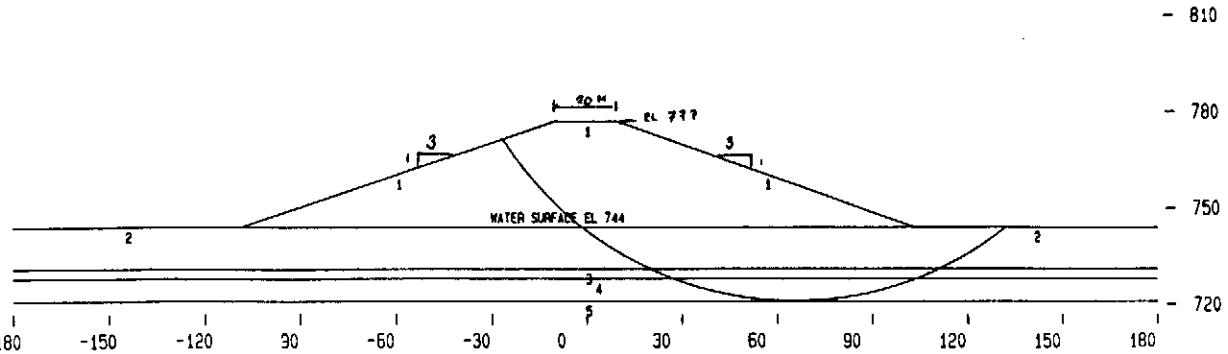
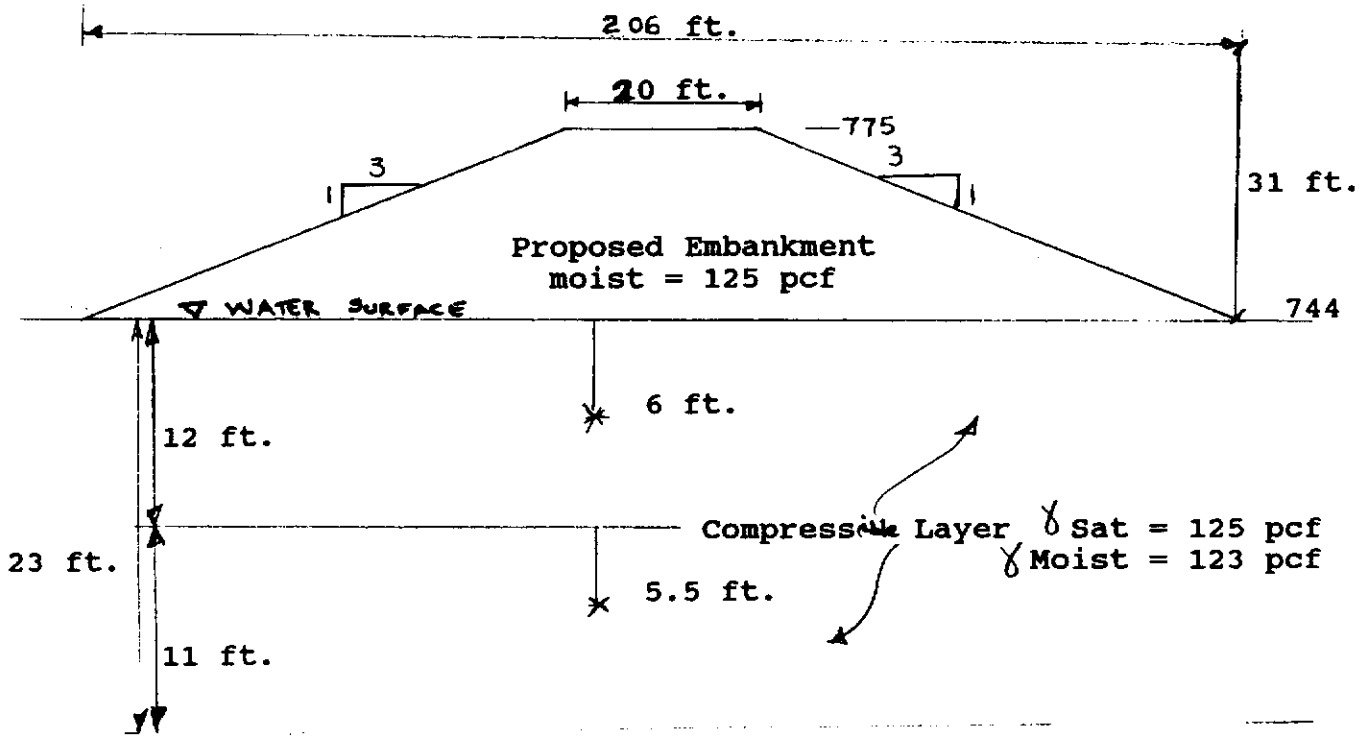


PLATE C-2

Subject: Des Moines Recreational River and Greenbelt Multi-Purpose Trail, Seg. III			
Date: Jan 93	Computed by: SZ	Checked by: GR	Sheet 1 of 2

Settlement Analysis
Station 54+30



Assumptions:

Ave. Moisture Content of Comp. Layer = 26%
Ave. LL(WL) = 39
Ave. PL(WP) = 15
Specific Gravity = 2.67
e = WGS = (.26)(2.67) = .694

Compression Index, C_c:
$C_c = .009(LL-10) = .261$
$C_c = .37(e_o+.003WL+.0004W_n-.34)=.178$
$C_c = .30(e_o-.27) = .127$
Use $C_c = 0.178$ as recommended by Joseph E. Bowles, which has a reported 86% reliability

References:

(1) Soil Mechanics in Engineering Practice by Karl Terzaghi and Ralph Peck
(2) Foundation Analysis and Design, 3rd Edition by Joseph E. Bowles
(3) Physical and Geotechnical Properties Soils by Joseph E. Bowles

PLATE C-3

Subject: Des Moines Recreational River and Greenbelt Multi-Purpose Trail, Seg. III			
Date: Jan 93	Computed by: SZ	Checked by: GR	Sheet 2 of 2

P_o:

@ mid depth of layer No. 1 = 6 (125 - 62.4) = 376 psf
@ mid depth of layer No. 2 = 17.5 (125 - 62.4) = 1,096 psf

ΔP @ layer 1 Boussinesq coefficient * h * m
(.989) * (31) * (125) = 3,832

@ layer 2 Boussinesq coefficient * h * m
(.920) * (31) * (125) = 3,565

$$\Delta S = \frac{C_c}{1 + e_o} \; H \log_{10} \frac{P_o + \Delta P}{P_o}$$

Depth (feet)		P_o (p.s.f)	ΔP (p.s.f.)	H (feet)	ΔS (feet)
0	6	376	3,832	12	1.3
12	17.5	1,096	3,565	11	0.7
23					

Total Settlement = 2 feet = 24 inches

PLATE C-4

Terracon

MOISTURE-DENSITY RELATIONSHIP

Job No. 07921009 Date 4/24/92

Project Red Rock Trail Stage III - USAED Call No.Y001

Source of Material Composite Sample,BT-92-7,1-8 BT-92-8,0.5-5';BT-92-9,1-6'

Description of Material Lean ~~to Fat~~ Clay, Brown (CL)

Material Designation C

Test Method ASTM D-698, Method A

TEST RESULTS

Maximum Dry Density 103.0 PCF

Optimun Water Content 21.0 %

ATTERBERG LIMITS

LL	PL	PI
42	20	22

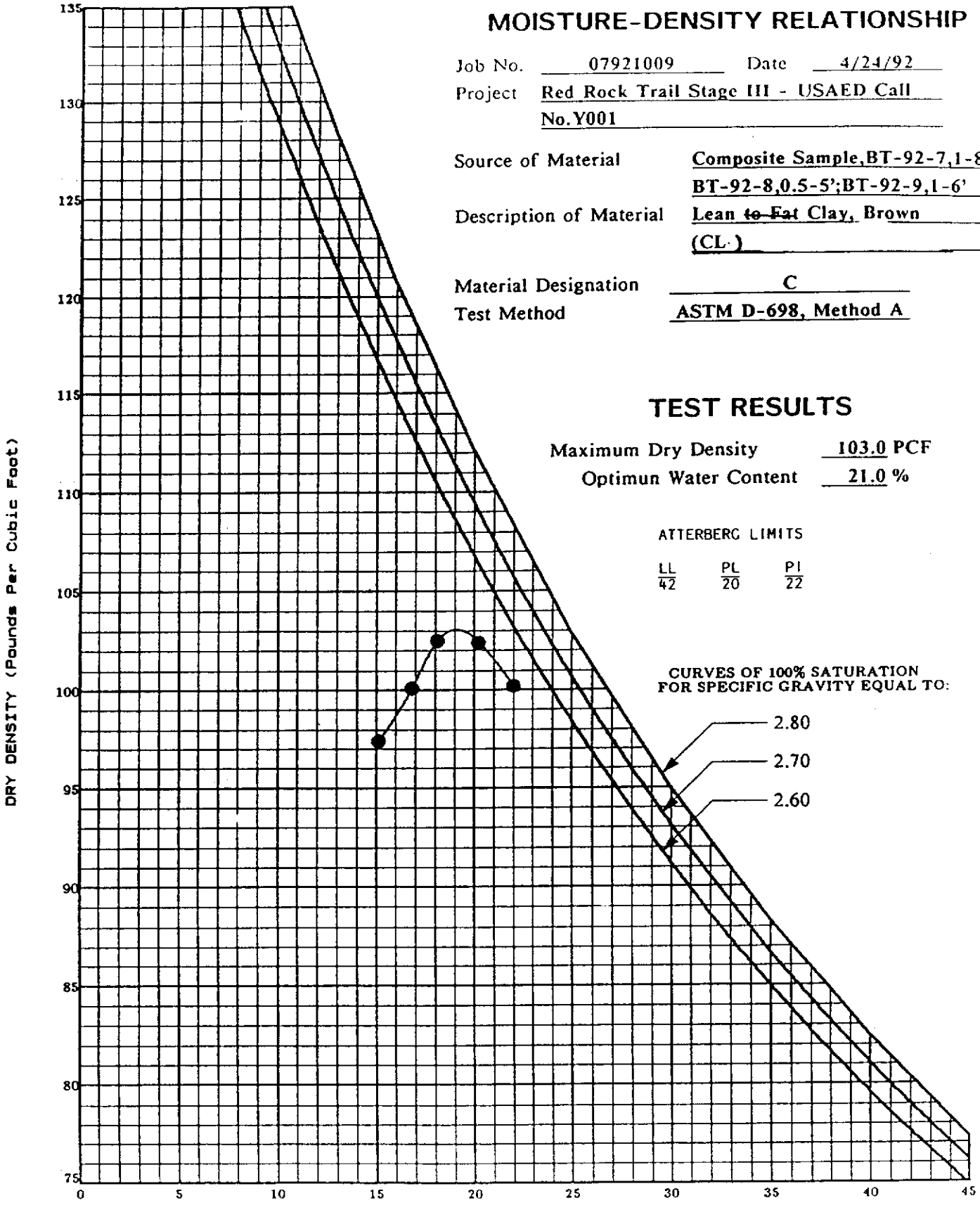


PLATE C-5

Terracon

MOISTURE-DENSITY RELATIONSHIP

Job No. 07921009 Date 4/24/92

Project Red Rock Trail Stage III - USAED Call No.Y001

Source of Material BT-92-9, 6-12 Feet

Description of Material Lean Clay, Brown (CL)

Material Designation B

Test Method ASTM D-698, Method A

TEST RESULTS

Maximum Dry Density 102.5 PCF

Optimun Water Content 20.0 %

ATTERBERG LIMITS

LL	PL	PI
38	19	19

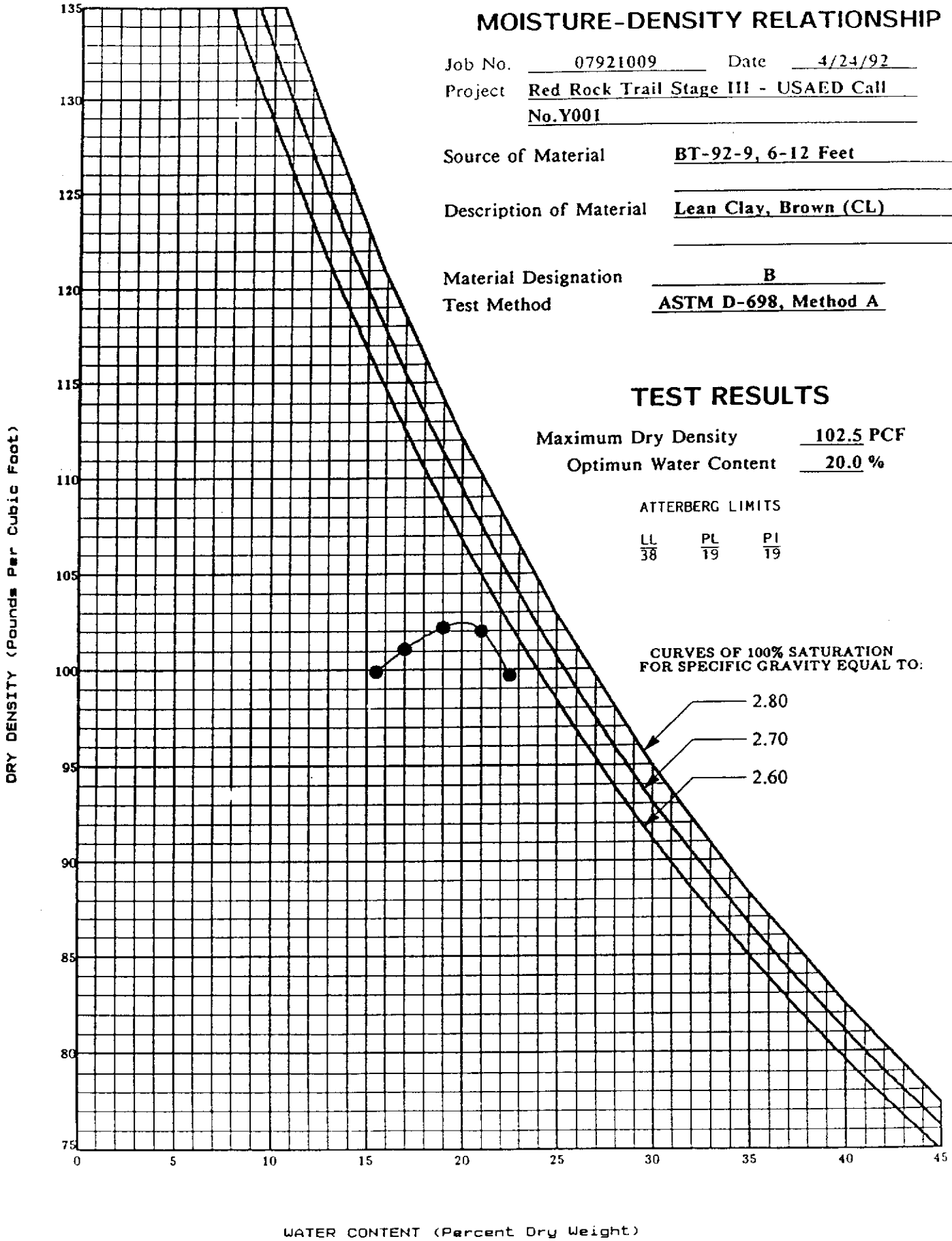


PLATE C-6

Terracon

MOISTURE-DENSITY RELATIONSHIP

Job No. 07921009 Date 4/24/92

Project Red Rock Trail Stage III - USAED Call No.Y001

Source of Material Composite Sample of BT-92-7, 8-10 Ft; BT-92-8, 5.5-8.0

Description of Material Lean Clay with Sand, Brown (CL-CH)

Material Designation A

Test Method ASTM D-698, Method A

TEST RESULTS

Maximum Dry Density 108.0 PCF

Optimun Water Content 16.5 %

ATTERBERG LIMITS

LL	PL	PI
49	22	27

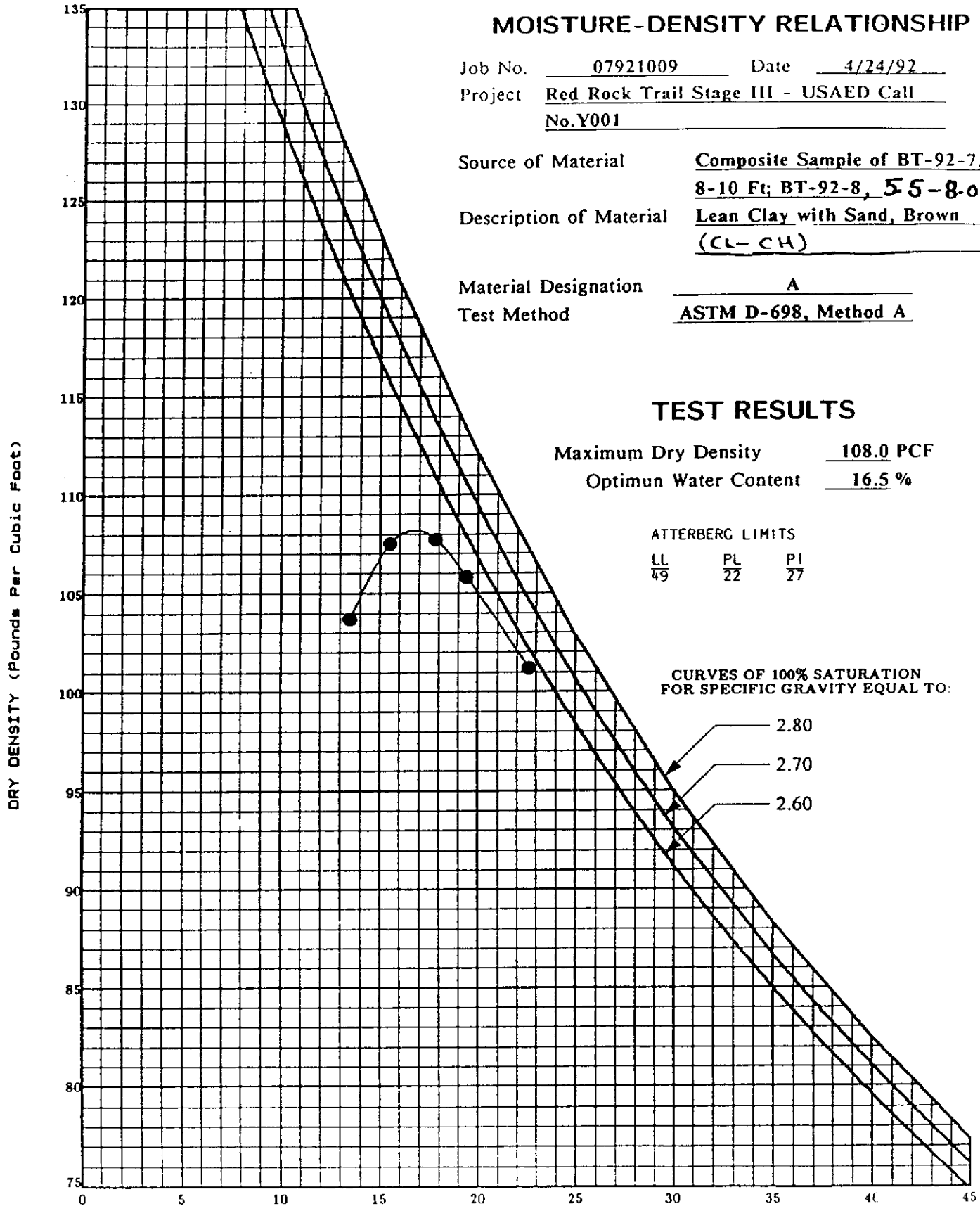
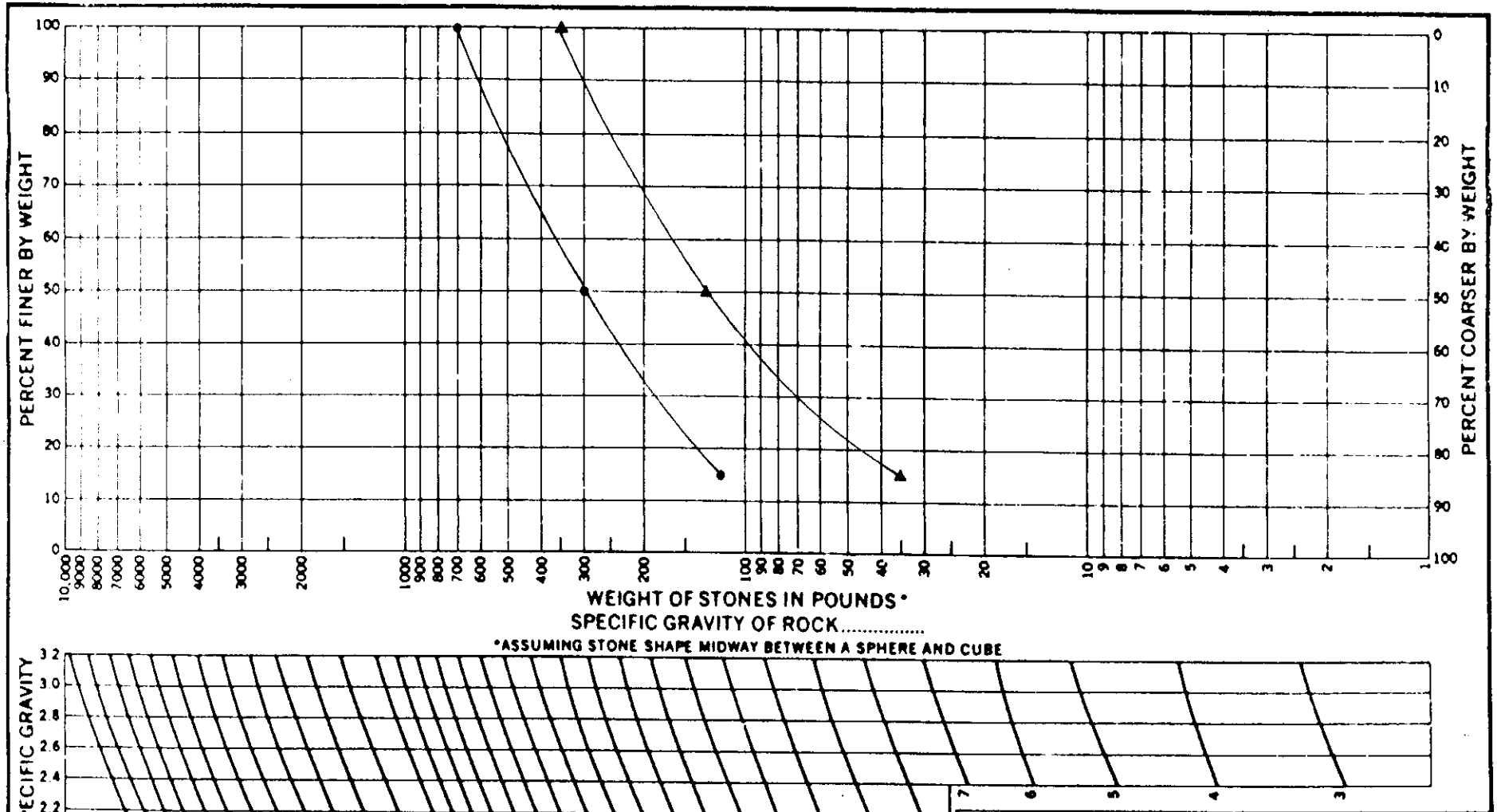


PLATE C-7



% Lighter by Wt.	SIZE OF STONE IN INCHES	Limits of Stone Wt. (lbs) Upper	Lower
100	RIPRAP GRADATION	700	350
50		300	140
15		120	35

PROJECT DES MOINES RECREATIONAL RIVER AND GREENBELT MULTI-PURPOSE TRAIL

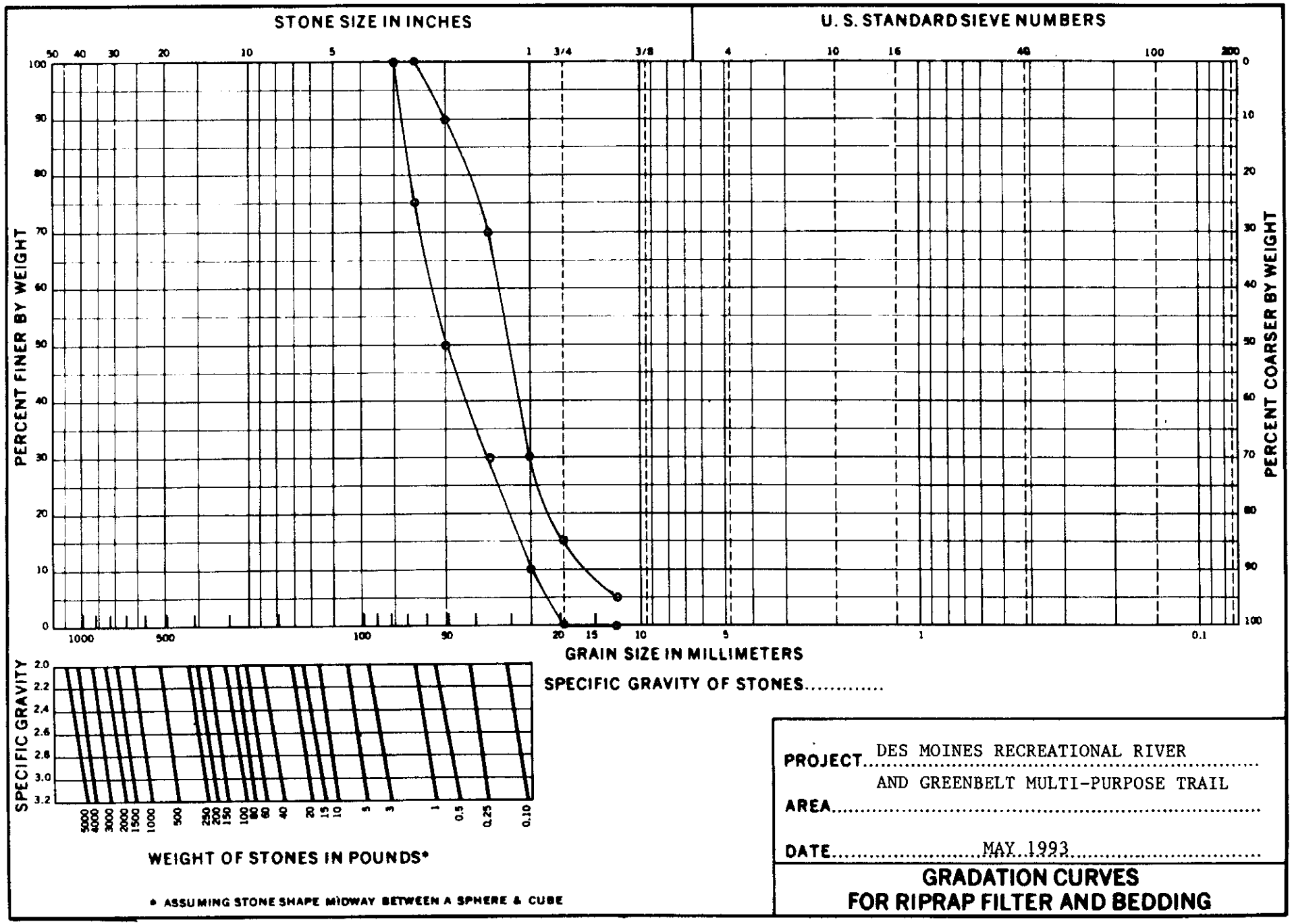
AREA.....

DATE MARCH 1993

RIPRAP GRADATION CURVES

ENG FORM 4055 APR 67

PLATE C-8



PROJECT DES MOINES RECREATIONAL RIVER AND GREENBELT MULTI-PURPOSE TRAIL

AREA

DATE MAY 1993

GRADATION CURVES FOR RIPRAP FILTER AND BEDDING

PLATE C-9

ENG FORM 4056
APR 67

STRUCTURAL ANALYSIS

APPENDIX D

DES MOINES RECREATIONAL RIVER AND GREENBELT
FEATURE DESIGN MEMORANDUM NO. 9
WITH ENVIRONMENTAL ASSESSMENT

RED ROCK MULTI-PURPOSE TRAIL
SEGMENT 3

LAKE RED ROCK, IOWA

APPENDIX D
STRUCTURAL ANALYSIS

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DES MOINES RECREATIONAL RIVER AND GREENBELT
FEATURE DESIGN MEMORANDUM NO. 9
WITH ENVIRONMENTAL ASSESSMENT

RED ROCK MULTI-PURPOSE TRAIL
SEGMENT 3

LAKE RED ROCK, IOWA

APPENDIX D
STRUCTURAL ANALYSIS

1. INTRODUCTION.

This appendix is intended to describe the methods used in designing the structures required in the project. Supporting information such as design criteria, basic data and assumptions, loading conditions, and typical design computations, is included.

Sufficient design computations have been performed to establish accurate cost information. Additional computations will be performed during preparation of the plans and specifications.

2. DESIGN CRITERIA.

a. References.

(1) AASHTO, Standard Specifications for Highway Bridges, Fourteenth Edition 1989.

(2) USDA Forest Service, Timber Bridges, Design, Construction, Inspection and Maintenance, June 1990.

(3) EM 1110-2-2902, Conduits, Culverts, and Pipes, 3 March 1969.

(4) EM 1110-2-2906, Design of Pile Foundations, 15 January 1991.

(5) National Forest Products Association, National Design Specification for Wood Construction, 1986 Edition, Including 1988 Supplement.

(6) ACI 318-89, Building Code Requirements for Reinforced Concrete.

b, Timber Bridge.

Wood for the various members of the timber bridge shall be the following species and grades, as listed in reference 2.a.(5).

(1) Stringers - No. 1 Doug. Fir-Larch (Beams/Stringers)
f_b = 1,300 psi

(2) Deck - No. 2 Doug. Fir-Larch (3" thick, 5" and wider)
f_b = 1,250 psi

(3) Rail and Posts - No. 1 Doug. Fir-Larch (Posts/Timbers)
f_b = 1,2000 psi

(4) Seat Beams- and Pier Cope - No. 2 Doug. Fir-Larch (Posts/Timbers)
f_b = 725 psi

Wood piles shall be Southern Pine, conforming to ASTM D25 ,f_a = 825 psi and f_b = 1,650 psi.

c. Reinforced Concrete Box Culvert.

The reinforced concrete box culvert was designed by the Ultimate Strength Design (USD) method, using f'c = 4,000 psi and fy = 48,000 psi. The load factors used were those for hydraulic structures:

$$U = H_f \{1.4D + 1.7L\} = 1.3 \{1.4D + 1.7L\} = 1.82D + 2.21L$$

3. DESIGN OF STRUCTURES.

a. Background.

Two structures were designed for this project: an eight span timber bridge and an 8 foot by 8 foot single barrel reinforced concrete box culvert.

This project is a continuation of existing multi-purpose trails. The trails are designed to accommodate both bicycle and pedestrian traffic, as well as light maintenance and emergency vehicles. The structures were designed for a live load of 60 psf and a 5 ton vehicular load plus 30% impact. The live load and vehicular load were not applied at the same time.

b. Timber Bridge.

The timber bridge was analyzed in accordance with references 2.a.(1), 2.a.(2), and 2.a.(5). Since the bridge will be used primarily for bicycle and pedestrian traffic, the vehicular loads and those associated with vehicles were based on one vehicle. Centrifugal force was based on a velocity of 25 MPH. Wind on the bridge was based on a girder bridge. The bridge is considered a recreational structure and not essential to life support; therefore, earthquake forces were not considered.

The bridge railings were loaded as bicycle railings.

The CFRAME computer program was used to determine the bridge pier reactions. The loads considered were as follows: Dead load (D), live load (L), centrifugal force (CF), wind on the structure (W), and wind on the vehicle (WL). Three load combinations were considered: 1) D+L+CF, 2) {D+W} / 1.25, and 3) {D+L+CF+0.3W + WL} / 1.25.

Soil boring BT-92-10 is nearest the bridge. The soil is lean clay to sandy lean clay (CL), having an undrained shear strength of 950 psf. Using a factor of safety of 3, one-foot diameter piles having an embedment of approximately 15 feet will resist the vertical reactions.

The 15 foot minimum embedment is that computed for the highest pier, based on skin friction pile capacity, using a factor or safety of 3.

In-field pile capacity will be determined by load testing one of the piles at the north abutment and correlating the test results with blow count. The correlation would then be used to evaluate the capacity of the remaining piles.

Use of an abutment pile will allow incorporating the test pile as well as the resistance piles into the abutment foundation.

Pile refusal will be defined as 3-4 blows per inch, when using 7,500 ft-lb of hammer energy.

c. Reinforced Concrete Box Culvert.

The box culvert was analyzed using the CORTCUL computer program. Loads were determined in accordance with references 2.a.(1) and 2.a.(3).

The invert elevations and culvert opening size were determined by hydraulic analysis discussed in Appendix F.

It is anticipated the embankment and culvert will settle approximately 12 inches at the point of heaviest load. Therefore, camber will have to be built into the culvert and settlement collars used.

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TIMBER BRIDGE

MINIMUM LIVE LOADS FROM SEGMENT I AND SEGMENT II BRIDGES

a) UNIFORM LOAD = 60 PSF

b) VEHICLE LOAD = 10,000# + 30% IMPACT*

c) WIND LOAD = 30 PSF ON THE VERT. PROJECTED AREA AS IF ENCLOSED.

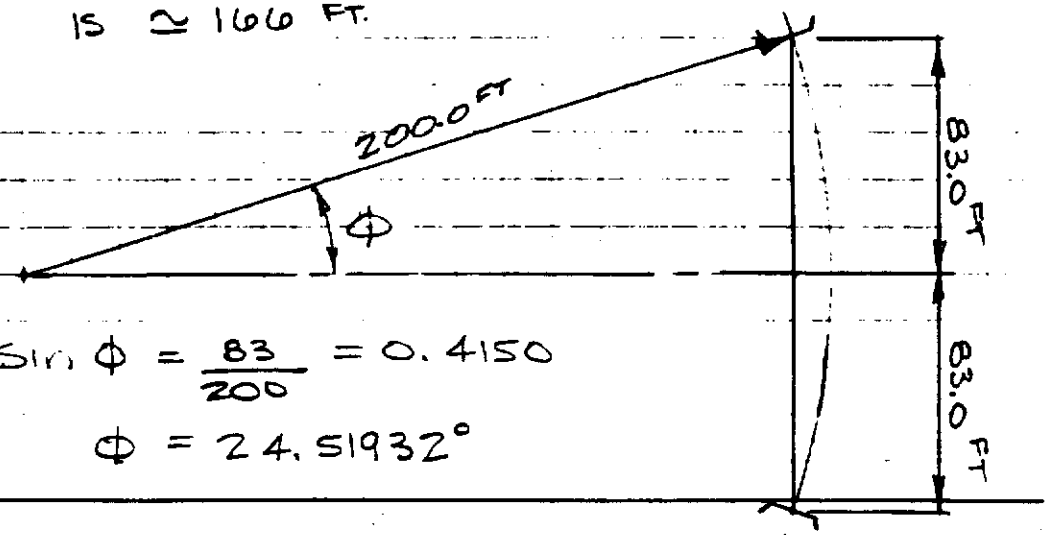
* SEE AASHTO, ED., SEC. 3.8.2.1

GEOMETRY

a) THE ℄ OF THE BRIDGE IS ON A HORIZONTAL CURVE WITH 200 FT. RADIUS.

b) ASSUMED DISTANCE BETWEEN OUTSIDE STRINGERS IS 12 FT. OR 8 SPACES @ 1.5 FT.

c) FROM PRELIMINARY TRAIL LAYOUT THE ℄ CHORD DISTANCE BETWEEN THE ABUTMENTS IS ≃ 166 FT.



$$\sin \Phi = \frac{83}{200} = 0.4150$$

$$\Phi = 24.51932^\circ$$

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TIMBER BRIDGE

GEOMETRY (CONT.)

d) BRIDGE IS INSCRIBED BY 2Φ OR 49.03863 AND ARC DISTANCE BETWEEN THE ABUTMENTS IS $\simeq \frac{2\pi 200}{360°}(49.04) = 171.18^{FT}$

e) ASSUMING EIGHT SPANS, EACH SPAN ALONG THE BRIDGE ℄ IS $\simeq \frac{171.18}{8} \simeq 21.397$ FT

f) BY PROPORTION THE SPAN OF THE LONG OUTSIDE STRINGER IS $\simeq \frac{21.397}{200}(200) \simeq 22$

SAY 22^{FT}

BASED ON 22 FT LONG STRINGER THE ℄ CHORD DISTANCE BETWEEN THE ABUTMENTS IS = 165.724 FT

SAY 165'-8"

AND 2Φ = 48.936°

g) EACH SPAN IS INSCRIBED BY 6.117° = 6° 7'

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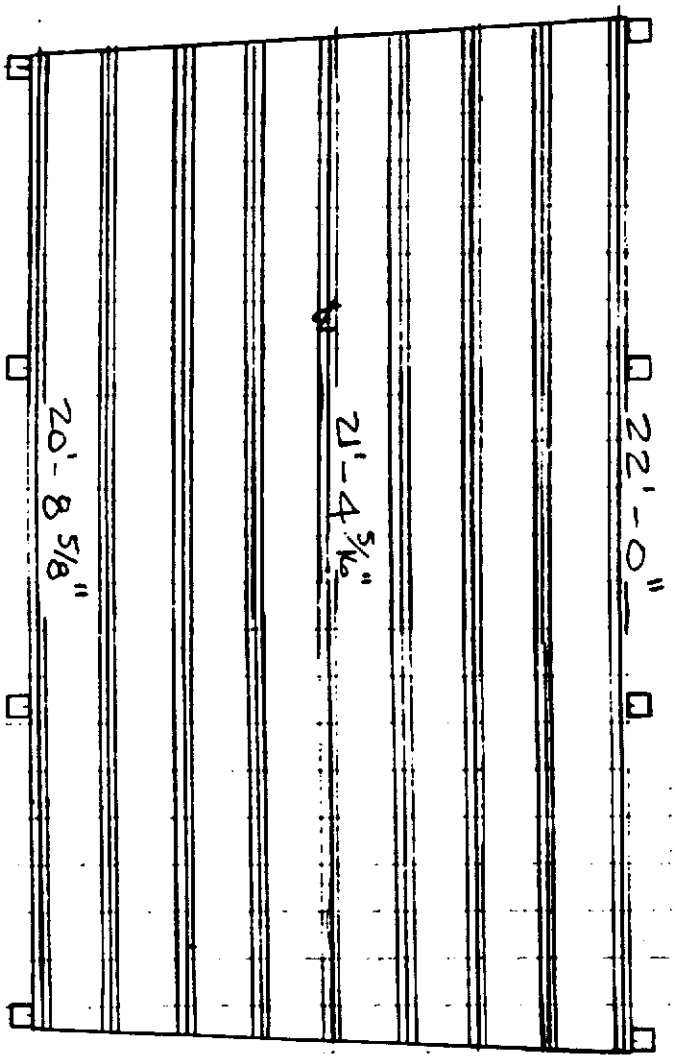

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TIMBER BRIDGE

STRINGER DESIGN

ASSUME 3" x 14" STRINGERS @ 1'-6" O.C.

ASSUME 3" DECK (DOUG. FIR-LARCH = 50 PCF)

CHECK UNIFORM LIVE LOAD

$$UF = \underset{LL}{60}(1.5) + \underset{DECK}{\frac{9.766}{11.25}(12)(1.5)} + \underset{STRINGERS}{11.502}$$

$$= 117.13 \text{ plf} \quad \text{SAY } 118 \text{ plf}$$

ASSUME 21 FT BRG.-BRG. SPAN

$$M = 118\left(\frac{21}{8}\right)^2 = 6,505 \text{ FT-\#}$$

$$S_{REQ'D} = \frac{6,505(12)}{1,300(0.86)} = 69.83 \text{ IN}^3 < \underset{73.15}{3" \times 14"}$$

0.86 ← MOISTURE FACTOR [REF: NDS-SUPP TABLE-4A (9)]

1,300 ← No.1 DOUG. FIR-LARCH BEAMS AND STRINGERS

$$V_d = 118\left(\frac{21}{2} - \frac{13.25}{12}\right) = 1,109 \text{ \#}$$

$$A_{REQ'D} = 1.5\frac{(1109)}{85(0.97)} = 20.18 \text{ IN}^2 < \underset{33.12}{3" \times 14"}$$

REF. ① "NATIONAL DESIGN SPECIFICATION" (NDS), WOOD CONSTR., 1986 ED. & NDS SUPPLEMENT, JUNE 1988.

Subject		Date
REL ROCK TRAILS – SEGMENT III		24 JULY 92
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TIMBER BRIDGE

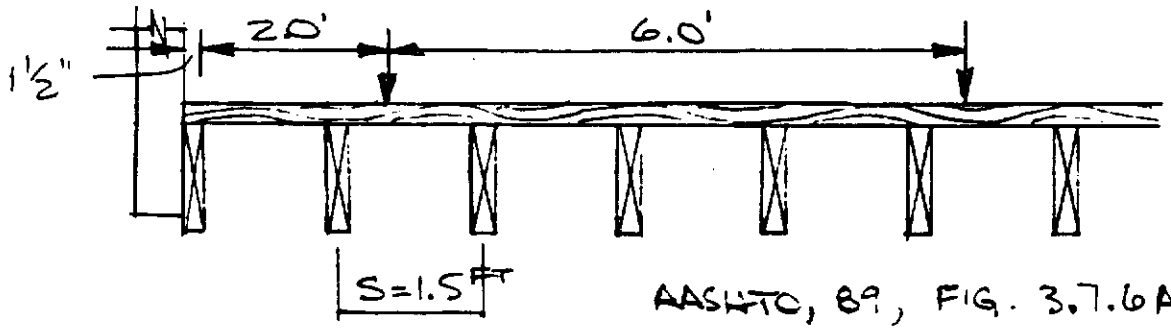
STRINGER DESIGN (CONT.)

CHECK VERTICAL LOAD

$$W_{DL} = 9.766\frac{(12)(1.5)}{11.25} + 11.502 = 27.13 \text{ plf} \quad \text{SAY } 28 \text{ plf}$$

(DECK) (STRINGER)

DISTRIBUTION OF VERTICAL LOAD TO MOMENT



AASHTO, 89, FIG. 3.7.6A.

AASHTO, 1989, SEC. 3.23.2

$$\text{DIST. OF WHEEL LOADS} = \frac{S}{4.0} = \frac{1.5}{4.0} = 0.375$$

$$\text{CENTROID OF WHEEL LOADS} = \frac{4{,}000(14.0)}{5{,}000}$$

$$\frac{\text{SPAN}}{2} = \frac{22}{2} = 11.0^{FT} < 11.2^{FT} = 11.2^{FT} \text{ FROM FRONT AXIAL}$$

∴ M_{MAX} OCCURS WHEN REAR AXIAL IS AT ℄ OF SPAN

NOTE: IMPACT IS NOT INCLUDED PER AASHTO, 89, SEC. 3.8.1.2.

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STRINGER DESIGN (CONT.)

$$M = 28\frac{(21)^2}{8} + 0.375(4{,}000)\left(\frac{21.0}{4}\right)$$

$$= 1{,}543.5 + 7{,}875.0 = 9{,}418.5 \text{ F-\#}$$

$$S_{REQ'D} = \frac{9{,}418.5(12)}{1{,}300(0.86)(0.989)} = 102.22 \text{ IN}^3 < \underset{4\times14}{103.41}$$

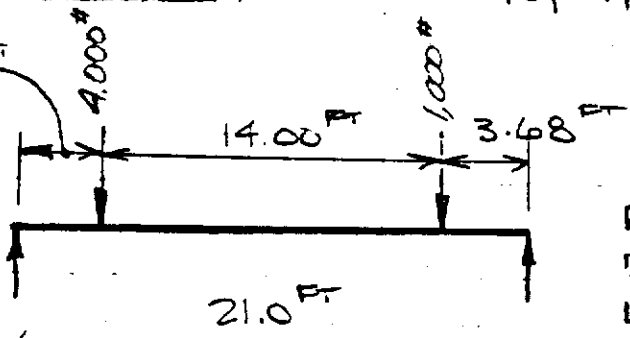
↳ SHAPE FACTOR NDS 4.3.4.1

HORIZONTAL SHEAR AASHTO, 89, SEC. 13.3.1

$3d = 3\left(\frac{13.25}{12}\right) = 3.32^{FT}$

OR

$\frac{L}{4} = \frac{21}{4} = 5.25^{FT}$



REF. ② "TIMBER BRIDGES", DCIM, USDA, FOREST SERVICE

V_{LL}

$$V_{LL} = \frac{4{,}000(17.68) + 1{,}000(3.68)}{21.00} = 3{,}542.9^{\#}$$

$$V_{LD} = 0.375(3{,}542.9) = 1{,}328.6^{\#}$$

$$V_{LL} = 0.5\left[0.6V_{LL} + V_{LD}\right] \quad \text{TIMBER BRDG (7-1)}$$

$$= 0.5\left[0.6(3{,}542.9) + 1{,}328.6\right] = 1{,}727.2^{\#}$$

$$V_{d\,DL} = 31.7\left(\frac{21 - 13.25}{2}\right)\frac{1}{12} = 297.8^{\#}$$

NEW $W_{DL} = \underset{\text{DECK}}{9.766\frac{(12)}{11.25}(1.5)} + \underset{\text{STRINGER}}{16.094} = 31.7$ plf

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TIMBER BRIDGES

STRINGER DESIGN (CONT.)

$$A_{REQ'D} = \frac{1.5(1,727.2 + 297.8)}{85\,(0.97)} = 36.84\,IN^2 < \underset{4\times14}{46.37\,IN^2}$$

PLANK DECK DESIGN

ASSUME 2" NOMINAL PLANK (S4S)

WHEEL DIST. WIDTH IN DIRECTION OF DECK SPAN
AASHTO, 89, SEC. 3.25 & SEC. 3.30

$$b_t = \sqrt{0.025P} = \sqrt{0.025(4{,}000)} = 10\,IN$$ TMBR. BLDG. (7-10)

WHEEL DIST. WIDTH IN DIRECTION OF TRAFFIC EQUALS WIDTH OF PLANK

DECK SPAN = CLEAR DISTANCE BETWEEN STRINGERS + ONE-HALF STRINGER WIDTH

$\leq$ CLEAR DISTANCE BETWEEN STRINGERS + DECK THICKNESS

$= 18 - 3\frac{1}{2} + 1\frac{3}{4} = 16.25\,IN$

$> 18 - 3\frac{1}{2} + 1\frac{1}{2} = 16.00\,IN \Leftarrow$

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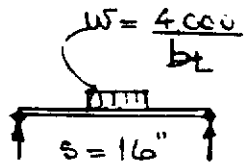
PLANK DECK DESIGN (CONT.)

$$M_{DL} = \frac{5.86}{12}\frac{(16.0)^2}{8} = 15.63 \text{ IN-LB}$$

↑ WT. OF 2×12



$$M_{LL} = \frac{4{,}000(16.00)}{4} - \frac{4{,}000}{10.0}\left(\frac{10.0}{2}\right)^2\frac{1}{2}$$

$$= 16{,}000 - 5{,}000 = 11{,}000 \text{ IN-LB}$$

$$f_b = \frac{M_{DL} + M_{LL}}{S} = \frac{11{,}015.63}{11{,}719} = 940 \text{ PSI}$$

↑ 3×12

$$F_b = 1{,}250(0.86)(1.16) = 1{,}247 \text{ PSI} > 940 \text{ PSI} \quad \text{OKAY}$$

↑ FLATWISE FACTOR 3" THICK, 5" AND WIDER

↑ No2. DOUG. FIR--LARCH

HORIZONTAL SHEAR

$$V = V_{DL} + V_{LL} = \frac{5.86}{12}\left(\frac{16.0}{2} - 2.50\right) + \frac{4{,}000}{16.0}\left(16.0 - 2.5 - \frac{10.0}{2}\right)$$

$$= 2.686 + 2{,}125 = 2{,}127.7\#$$

$$f_v = \frac{1.5V}{A} = \frac{1.5(2{,}127.7)}{2.5(11.25)(0.97)(1.33)} = 88 \text{ PSI} < 95 \text{ PSI}$$

↑ MOISTURE FACTOR

↑ SHEAR MOD. FACTOR

* SOME TYPE OF OIL PRESERVATIVE SHOULD BE USED OR CONTROL SPLITS AND SHAKES BY SPECIFICATION.

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TIMBER BRIDGE

GUARD RAIL DESIGN

AASHTO, 89, SEC. 2.7.2

BASED ON BRIDGE GEOMETRY THE MAXIMUM SPACING OF THE RAIL POSTS IS 7'-2" AND THE RAIL IS THREE SPAN.

w = 50 PLF TRANSVERSELY & VERTICALLY, ACTING SIMULTANEOUSLY ON RAIL

$$M_{max} = 0.1167\, w l^2 = 0.1167\,(50)(7.167)^2 = 299.7^{ft\#}$$

$$V_{max} = 0.617\, w l = 0.617(50)(7.167) = 221.1^{\#}$$

$$R_{min} = 1.20\, w l = 1.20(50)(7.167) = 430.0^{\#}$$

$$S_{REQ'D} = \frac{2(299.7)(12)}{1{,}200\,(0.86)} = 6.97\ IN^3$$

(2 ← BENDING IN BOTH DIRECTIONS; 0.86 ← MOISTURE FACTOR; 1,200 ← No. 1 DOUG. FIR-LARCH POSTS/TIMBER)

4x4: $7.15\ IN^3$

$$A_{REQ'D} = \frac{1.5(221.1)}{85\,(0.97)} = 4.02\ IN^2$$

4x6: $12.25\ IN^2$

$$A_{BRG.\ REQ'D} = \frac{430}{625\,(0.67)} = 1.03\ IN^2$$

4x1: $2.625\ IN^2$

BOLTED CONNECTION

NDS, 86, SEC. 8.5.8.2 & TABLE 8.5A

$$\frac{5/8"\Phi \times 7"}{2} = \frac{1260\,(7)}{2\ \ 7.5} = 588^{\#} > 430^{\#}$$

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TIMBER BRIDGE

CONSIDER A 3" x 5" RAIL

$$f_{b_{3\times5}} = \frac{299.7\,(12)}{8.43^2} = 426.2 \text{ PSI}$$

$$f_{b_{5\times3}} = \frac{299.7\,(12)}{4.68^2} = 767.2 \text{ PSI}$$

$$F_{b_{3\times5}} = 1{,}250(0.86) = 1{,}075 \text{ PSI}$$

(No. 2 DOUG FIR-LARCH)

$$F_{b_{5\times3}} = 1{,}250\,(0.86)(1.16) = 1{,}247 \text{ PSI}$$

$$\frac{426.2}{1{,}075} + \frac{767.2}{1{,}247} = 0.396 + 0.616 = 1.012 \simeq 1.00$$

NOTE: IF A LOAD DURATION FACTOR FOR ONE DAY DURATION WERE APPLIED THE 5"x 3" RAIL IS OKAY.

BOLTED CONNECTION

NDS, 86, SEC. 8.5.8.2 & TABLE 8.5A

$$\frac{5/8"\,\Phi \times 5"}{2} = \frac{1396\,(5)}{2\quad 5.5} = 631.8^{\#} > 430^{\#}$$

RAIL POSTS

$$P_{INT} = R_{MAX} = 430^{\#}$$

$$F_{END} = 0.450\,w\ell = 0.450\,(50)(7.167) = 162^{\#}$$

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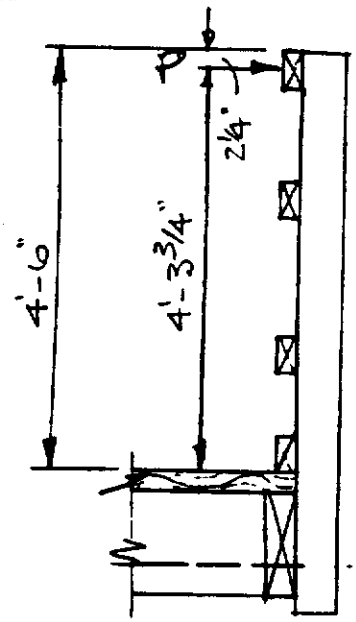
INTERMEDIATE RAIL POSTS



$M = 430\,(4.3125) = 1,854.4^{FT-\#}$

$S_{REQ'D} = \dfrac{1,854.4\,(12)}{1,200\,(0.86)}$

$= 21.56\ IN^3$

3 x 8 — $21.90\ IN^3$

6 x 6 — $27.72\ IN^3$

CONSIDERING ONE FOR DURATION FACTOR

$S_{REQ'D} = \dfrac{1,854.4\,(12)}{1,200\,(0.86)(1.33)}$

$= 16.22\ IN^3$

4 x 6 — $17.65\ IN^3$

CONSIDER SLENDERNESS FACTOR NDS, 86, Sec. 3.3.3

$l_u = 4.3125^{FT} = 51.75^{IN}$

$l_e = 1.44\,l_u + 3d = 1.44\,(51.75) + 3\,(7.5) = 97.02^{IN}$

$C_s = \sqrt{\dfrac{l_e\,d}{b^2}} = \sqrt{\dfrac{97.02\,(7.5)}{(2.5)^2}} = 10.79 > 10$

$C_K = 0.811\sqrt{\dfrac{1,600,000}{1,200}} = 29.6$

$F_b' = F_b\left[1 - \tfrac{1}{3}\left(\dfrac{C_s}{C_K}\right)^4\right] = 0.994\,F_b$

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INTERMEDIATE RAIL POSTS (CONT.)

$$S_{REQ'D} = \frac{21.56}{0.994} = 21.69 \text{ in}^3 < \frac{3\times8}{21.90} \text{ in}^3$$

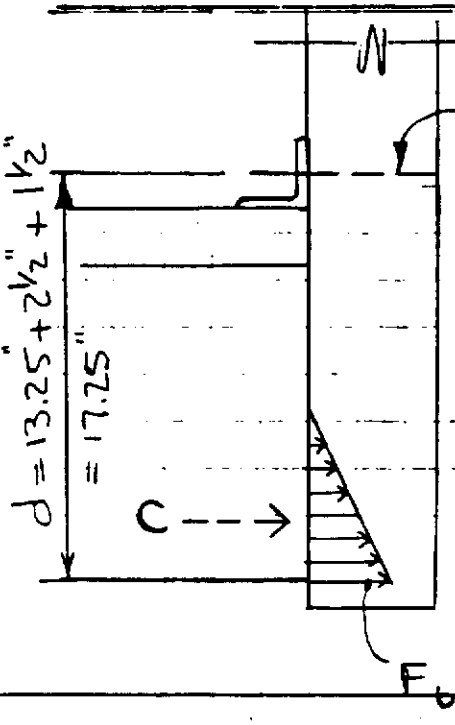
END RAIL POSTS

$$M = 162\,(4.3125) = 698.7 \text{ FT-\#}$$

$$S_{REQ'D} = \frac{698.7\,(12)}{1{,}200\,(0.66)(1.33)} = 6.12 \text{ in}^3 \qquad \frac{4\times4}{5.14} \text{ in}^3$$

POST BASE CONNECTION

USE CONCRETE BEAM ANALOGY



$$\frac{F_t}{n} = \frac{20{,}000}{n} = \frac{f_s}{n} = 1{,}069.5 \text{ psi}$$

$$n = \frac{E_s}{E_c} = \frac{29{,}000{,}000}{1{,}600{,}000\,(0.97)} = 18.7$$

$$k = \frac{1}{1 + \frac{f_s}{n f_c}} = \frac{1}{1 + \frac{20{,}000}{18.7(557)}} = 0.342$$

$$F_{b\perp} = 625\,(0.67)(1.33) = 557 \text{ psi}$$

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TIMBER BRIDGE

POST BASE CONNECTION (CONT.)

$$j = 1 - \frac{k}{3} = 1 - \frac{0.342}{3} = 0.886$$

$$T = C = \frac{M}{jd} = \frac{1,854.4\,(12)}{0.886\,(17.25)} = 1,456^{\#}$$

$$A_s = \frac{1,456}{20,000} = 0.0728\ IN^2 \quad \text{SAY } 1/2"\Phi \text{ BOLT, MIN.}$$

WASHER AREA BASED ON f_{cg}

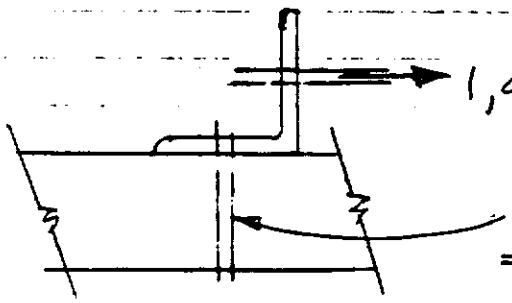
$$A_{bcg} = \frac{1456}{557} = 2.614\ IN^2$$

$$A_{WASHER} = A_{bcg} + A_{HOLE} = 2.614 + \pi\left(\frac{9}{32}\right)^2$$

$$= 2.863\ IN^2 = 1\ 11/16" \text{ SQ. PL.}$$

$$R_{WASHER} = \sqrt{\frac{2.863}{\pi}} = 0.955\ IN$$

$$D_{WASHER} = 2(0.955) = 1.909\ IN = 2"\Phi \text{ PL.}$$



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TIMBER BRIDGE

POST BASE CONNECTION (CONT.)

BOLT SIZE NDS, 86, SEC. 8.5, 8.3, 8.5.6.3, & TABLE 8.5 A

TRY 5/8" ϕ BOLT IN 2½ WOOD, USING COL. 3

$P = 1,820^{\#}$

FROM SEC. 8.5.6.3: THE CAPACITY OF THE BOLT CAN BE INCREASED 75% FOR BOLTS ≤ ½"ϕ AND 25% FOR 1½"ϕ BOLTS. WITH PROPORTIONATELY FOR INTERMEDIATE DIAMETERS. 50% CHANGE FOR 1" DIAM. CHANGE OR 6.25% CHANGE FOR ⅛" DIAM. CHANGE.

5/8"ϕ BOLT CAPACITY CAN BE INCREASED 75% − 6.25% OR 68.75%

$\frac{P'}{2} = \frac{1,820}{2}(1.6875) = 1,535^{\#} > 1,456^{\#}$ ⇐ O.K.

↑ SEE SHT. 13

TRY ½"ϕ BOLT IN 2½" WOOD, USING COL. 3

$P = 1,260^{\#}$

$\frac{P'}{2} = \frac{1,260}{2}(1.750) = 1,102^{\#} < 1,456^{\#}$ NO GOOD

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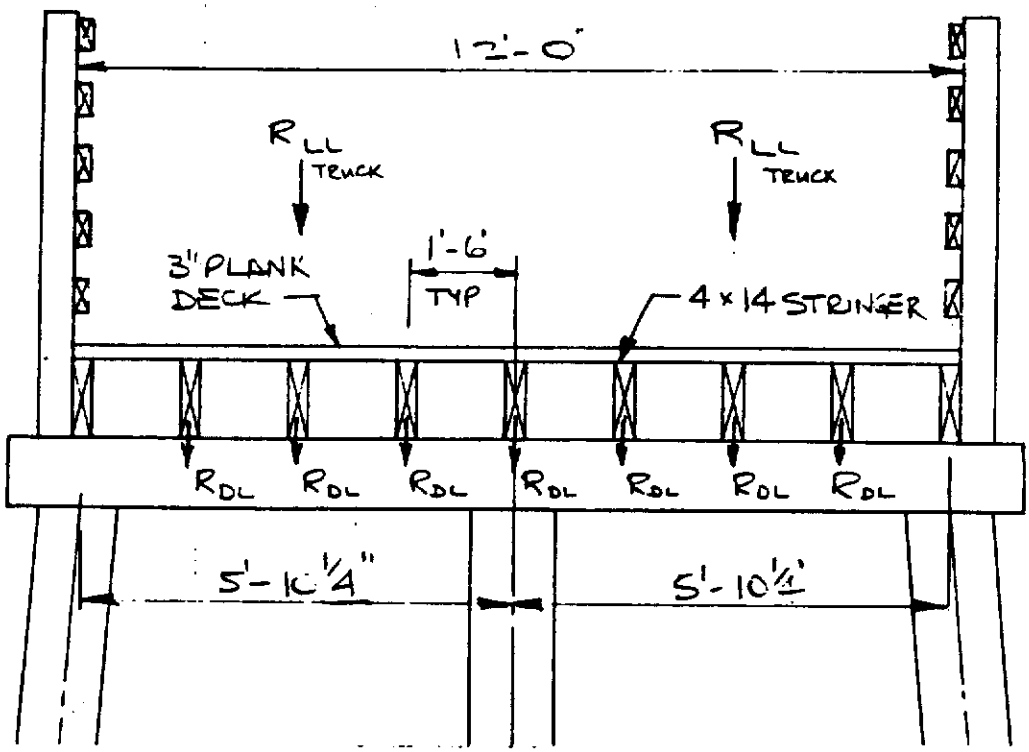
TIMBER BRIDGE

SEAT BEAM (PIER CAP)



$$R_{DL\ AVG.} = \left[9.766\ \underbrace{(12)}_{11.25}\ (1.5) + 16.094\right] 21.36 = 678^{\#}$$

(3 x 12 DECK; 4 x 14 STRINGER)

$$R_{LL\ TRUCK} = 4{,}000 + 1{,}000\left(\frac{21.36 - 14.0}{21.36}\right) = 4{,}345^{\#}$$

$$M^{*} = 2(678)\frac{(1.354)(4.500)}{4(5.854)^2}(5.854+1.354) + 2(678+4{,}345)\frac{(2.854)(3.000)}{4(5.854)^2}(5.854+2.854)$$

$$+ 2(678)\frac{(4.354)(1.500)}{4(5.854)^2}(5.854+4.354) = 434.5 + 5{,}464.1 + 659.5$$

$$= 6{,}558.1^{FT-\#}$$

* SEE THE AISC "MANUAL OF STEEL CONST", 8TH ED, PAGE 2-124, BEAM DIAG. # 31.

Subject	ZED ROCK TRAILS – SEGMENT III	Date 21 AUG 92
Computed by K. WILSON	Checked by MW	Sheet 15 of

TIMBER BRIDGE

SEAT BEAM (CONT)

MAXIMUM +M IS UNDER R_{LL} (137.0 K)

$$+M_1 = 678\left(\frac{(1.354)(4.500)}{4(5.854)^3}\right)\left[4(5.854)^2 - 1.354(5.854+1.354) - \frac{434.5(1.354)}{2(5.854)}\right]$$

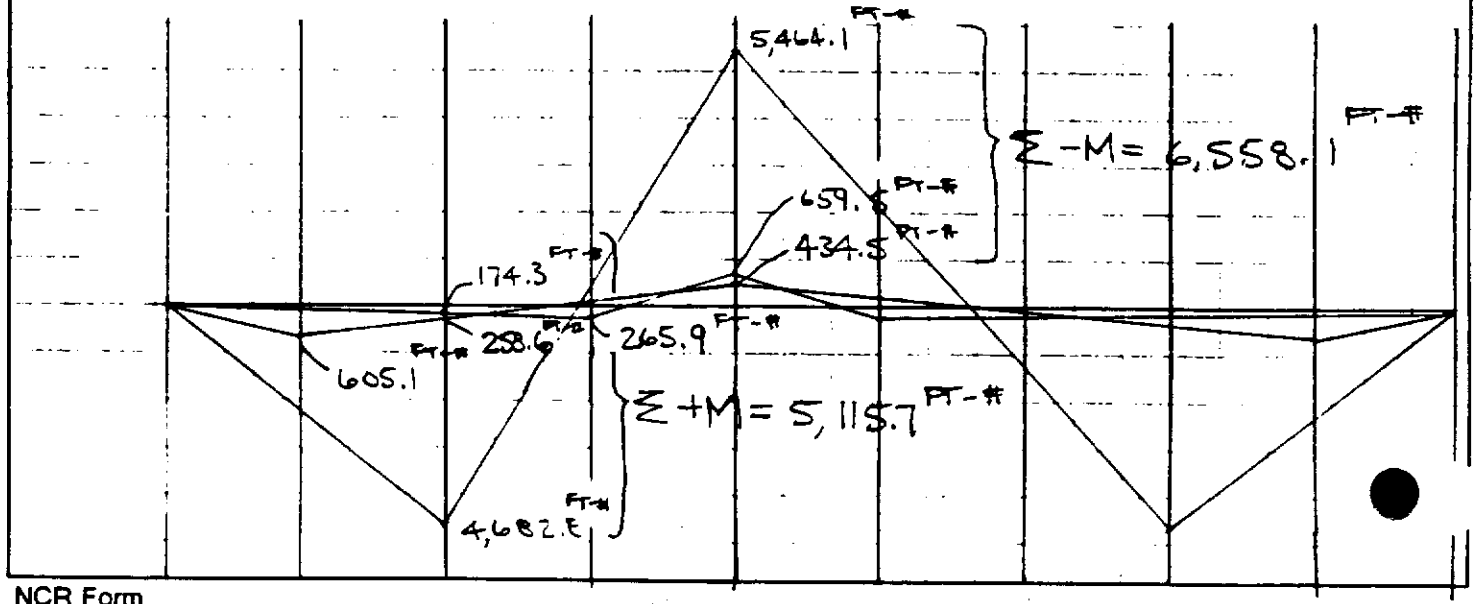
$$= 655.4 - 50.3 = 605.1 \text{ FT-K}$$

$$+M_2 = (678+4,345)\left(\frac{(2.854)(3.500)}{4(5.854)^3}\right)\left[4(5.854)^2 - 2.854(5.854+2.854) - \frac{5,464.1(2.854)}{2(5.854)}\right]$$

$$= 6,014.8 - 1,332.0 = 4,682.8 \text{ FT-K}$$

$$+M_3 = 678\left(\frac{(4.354)(1.500)}{4(5.854)^3}\right)\left[4(5.854)^2 - 4.354(5.854+4.354) - \frac{659.5(4.354)}{2(5.854)}\right]$$

$$= 511.2 - 245.3 = 265.9 \text{ FT-K}$$



Subject RED ROCK TRAILS - SEGMENT III		Date [illegible]
Computed by K. WILSON	Checked by MW	Sheet 16 of

TIMBER BRIDGE

SEAT BEAM (CONT.)

$$S = \frac{6,558.1\ (12)}{1,200\ (0.96)} = 76.3\ IN^3$$

1,200 ← No. 1 DENSE FIR-LARCH POSTS AND TIMBERS

0.96 ← MOISTURE FACTOR

$76.3 < \frac{16 \times 6}{78.15}$

$\frac{14 \times 8}{126.56}$

CHK No. 2 DENSE FIR-LARCH

$$S = \frac{6,558.1\ (12)}{\text{REQ'D}\ 725\ (0.96)} = 126.2\ IN^3$$

$126.2 < \frac{14 \times 8}{126.56}$

$\frac{16 \times 8}{145.31}$

MAX. V (SHIFT 2 LL TRUCK ONE STRINGER CLOSER TO CNTR SUPPORT)

$$V = \frac{678(1.354)\left[4(5.854)^2 + 4.500(5.854+1.354)\right]}{4(5.854)^3}$$

$$+ \frac{678\ (2.854)}{4(5.854)^3}\left[4(5.854)^2 + 3.000(5.854+2.854)\right]$$

$$+ \frac{(678+4,345)(4.354)}{4(5.854)^3}\left[4(5.854)^2 + 1.500(5.854+4.354)\right]$$

$$= 193.9 + 393.5 + 4,153.3 = 4,740.7\ \#$$

$$A_{REQ'D} = \frac{3}{2}\frac{(4,740.7)}{(85)(0.97)} = 86.3\ IN^2$$

$86.3 < \frac{14 \times 8}{101.25}$

$\frac{16 \times 6}{85.25}$

Subject	RED ROCK TRAILS – SEGMENT II	Date 25 AUG. 97
Computed by K. WILSON	Checked by MW	Sheet 17

TIMBER BRIDGE

SEAT BEAM (CONT.)

CHECK BEAM FOR UNIFORM LIVE LOAD OF 60 PSF

$$R_{LL_{UNIF.}} = 60(1.5)(21.36) = 1,922^{\#}$$

LOAD MULTIPLICATION FACTORS

$$\frac{R_{LL_{UNIF.}} + R_{DL_{AVG.}}}{R_{DL_{AVG.}}} = \frac{1,922 + 678}{678} = 3.834$$

$$\frac{R_{LL_{UNIF.}} + R_{DL_{AVG.}}}{R_{LL_{TRUCK}} + R_{DL_{AVG.}}} = \frac{1,922 + 678}{4345 + 678} = 0.5176$$

$$-M = 434.5(3.834) + 5,464.1(0.5176) + 659.5(3.834)$$

$$= 1,666.2 + 2,828.2 + 2,529.1 = 7,023.6^{FT-\#}$$

$$+M_1 = 605.1(3.834) = 2,320.4^{FT-\#}$$

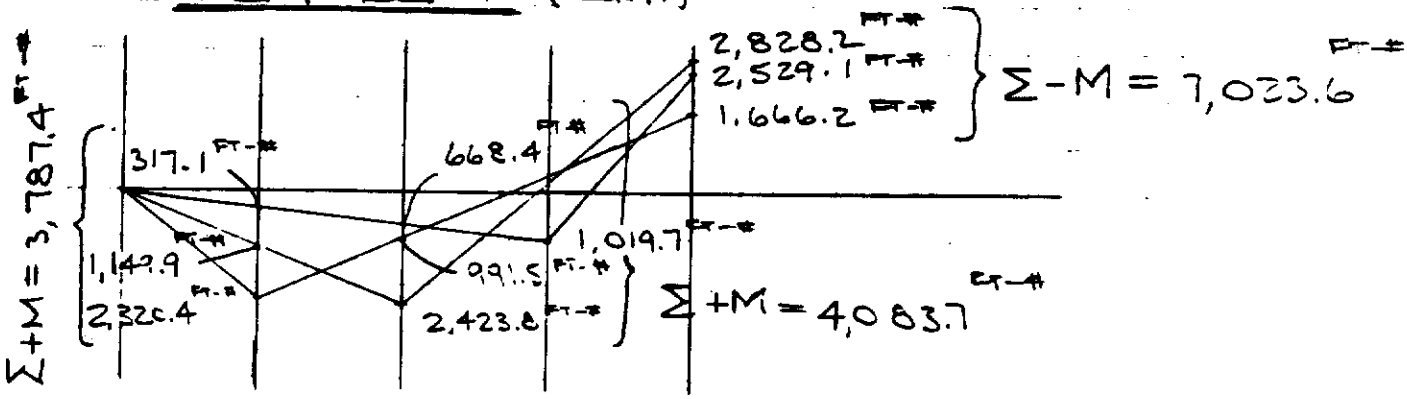
$$+M_2 = 4,682.8(0.5176) = 2,423.8^{FT-\#}$$

$$+M_3 = 265.9(3.834) = 1,019.7^{FT-\#}$$

Subject		Date
RED ROCK TRAILS – SEGMENT III		25 JUL 97
Computed by K. WILSON	Checked by MW	Sheet 18 of

TIMBER BRIDGE

SEAT BEAM (CONT.)



$$S = \frac{7,023.6\ (12)}{1200\ (0.86)} = 81.7\ IN^3$$

14 x 8 → 126.54 IN^3

CLK No. 2 DOUG. FIR – LARCH

$$S = \frac{7,023.6\ (12)}{725\ (0.86)} = 135.2\ IN^3$$

12 x 10 → 172.98 IN^3

MAX. V

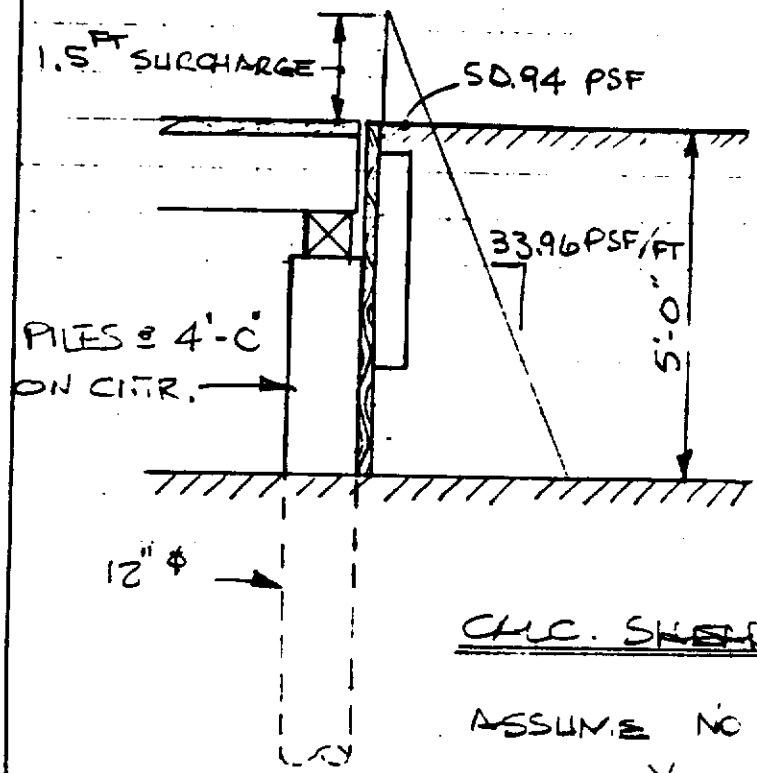
$$V = 193.9\ (3.8348) + 393.5\ (3.8348) + 4,153.3\ (0.5176)$$

$$= 743.6 + 1,509.0 + 2,149.7 = 4,402.3^{\#} < 4,740.7^{\#}$$

∴ 14x8 IS OKAY

Subject	RED ROCK TRAILS - SEGMENT II	Date	19 AUG. 82
Computed by K.WILSON	Checked by MW	Sheet	LI-1 of

ABUTMENT DESIGN



$\phi = 34^\circ$; $\gamma = 120$ PCF

$K_a = 0.283$; $K_p = 3.534$

$p_a = 0.283(120) = 33.96$ PSF/FT

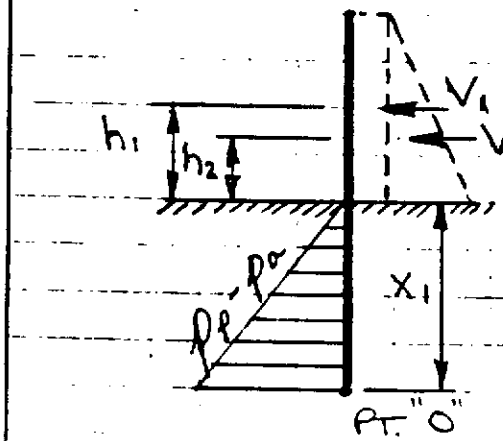
$p_p = 3.534(120) = 424.08$ PSF/FT

CALC. SHEET ABOVE GROUND

ASSUME NO RESISTANCE FROM BRIDGE.

$$V = \underset{V_1}{50.94(4.0)(5.0)} + \underset{V_2}{33.96(4.0)(5.0)\left(\frac{5.0}{2}\right)}$$

V_1: 1,018.8 $\quad$ V_2: 1,698.0 $\quad = 2,716.8$ #



CALC PENETRATION, X_1, BY "SIMPLIFIED LOADING"

ASSUME ROTATION ABOUT POINT "O".

$$1,018.8\left(\frac{5.0}{2} + X_1\right) + 1,698.0\left(\frac{5.0}{3} + X_1\right) - (424.08 - 33.96)(1.0)(X_1)\left(\frac{X_1}{2}\right)\left(\frac{X_1}{3}\right) = 0$$

(390.12)

REF: "STEEL H-BEAMS & STEEL SHT. PILING USED AS CANTILEVER IN SOIL", CARNEGIE-ILLINOIS STEEL CORPORATION, 1938.

Subject	RED ROCK TRAILS - SEGMENT II	Date 19 AUG. 92
Computed by K. WITSELL	Checked by MW	Sheet AE-2 of

$$2,547.0 + 1,018.8\,X_1 + 2,830.0 + 1,698.0X_1 - 65.0\,X_1^3 = 0$$

$$65.0\,X_1^3 - 2,716.8\,X_1 - 5,377.0 = 0$$

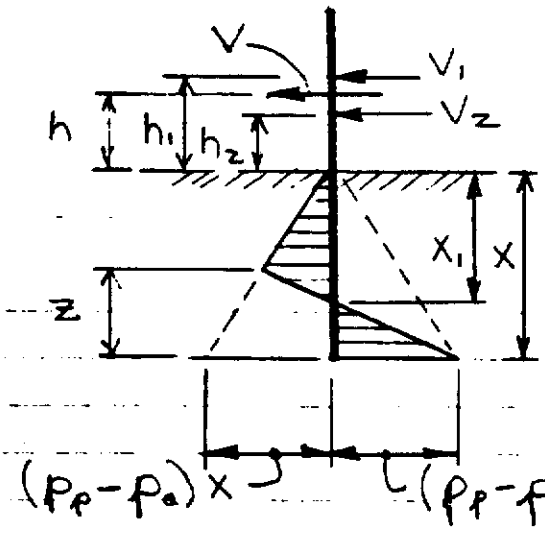
$X_1 = 7.50^{FT}$; $27,421.9 - 20,376.0 - 5,377.0 = 1,668.9$ FT

$X_1 = 7.40^{FT}$; $26,339.6 - 20,104.3 - 5,377.0 = 858.3$ FT

$X_1 = 7.30^{FT}$; $25,286.1 - 19,832.6 - 5,377.0 = 76.5$ FT

$X_1 = 7.28^{FT}$; $25,078.8 - 19,778.3 - 5,377.0 = -76.5$ FT

$X_1 = 7.29^{FT}$; $25,182.3 - 19,805.5 - 5377.0 = -0.2$ FT



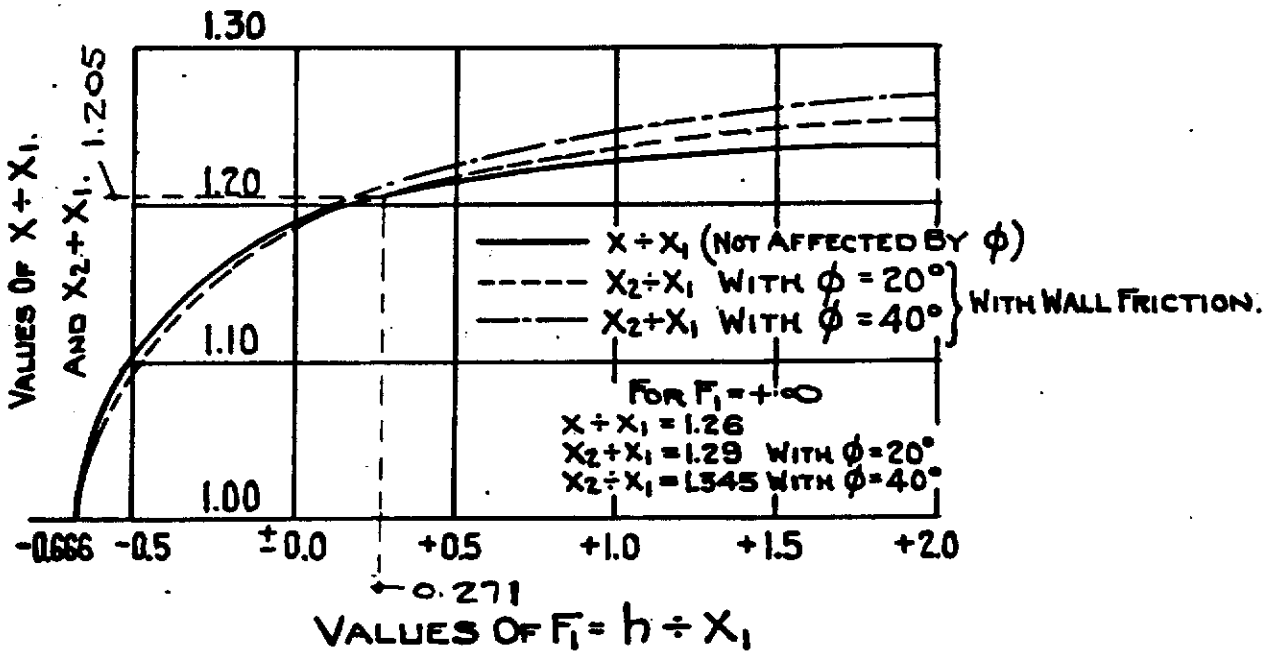
DETERMINE LOCATION, h, OF RESULTANT $V = V_1 + V_2$

$$h = \frac{1,018.8\left(\frac{5.0}{2}\right) + 1,698.0\left(\frac{5.0}{3}\right)}{2,716.8} = 1.979'$$

FIND $F_1 = \frac{h}{X_1} = \frac{1.979}{7.29} = 0.271$

Subject	RED ROCK TRAILS - SEGMENT III	Date	19 AUG. 92
Computed by	K. WILSON	Checked by	MW
		Sheet	AB - 3 of

ABUTMENT DESIGN



FROM GRAPH $\frac{X}{X_1} = 1.205$

$X = 1.205(X_1) = 1.205(7.29) = 8.784^{FT}$ SAY 9'-0"

$$Z = \frac{(\rho_p - \rho_a)X^2 - 2Y}{2(\rho_p - \rho_a)X} = \frac{390.12(9.00)^2 - 2(2,716.8)}{2(390.12)(9.00)}$$

$$= 3.726^{FT}$$

CHECK THE 12"ϕ PILE FOR BENDING AND SHEAR

Subject		Date
REL ROCK TRUCK - SEGMENT III		21 AUG. 92
Computed by K. WILSON	Checked by MW	Sheet AB-2 of

ABUTMENT DESIGN

$$\Sigma V = 0 = 2{,}716.8 - 390.12\,(1.0)\frac{y^2}{2}$$

$$y = \sqrt{\frac{2(2{,}716.8)}{390.12(1.0)}} = 3.732^{FT} < X-Z = 8.784 - 3.726 = 5.058^{FT}$$

$$M = 2{,}716.8(h+y) - 390.12(1.0)(y)\frac{(y)}{2}\frac{(y)}{3}$$

$$= 2{,}716.8(1.979 + 3.732) - 390.12\,\frac{(3.732)^3}{6}$$

$$= 15{,}515.6 - 3{,}379.7 = 12{,}135.9^{FT-\#}$$

$$f_b = \frac{12{,}135.9(12)}{\frac{\pi(12)^3}{32}(0.90)} = 954\ psi < 1{,}650\ psi$$

↑ PERMANENT LOAD FACTOR

SO. PINE EM 1110-2-2906 15 JAN. 92

APPROXIMATE REMAINING STRESS FOR AXIAL LOAD

$$\frac{f_a}{F_a} + \frac{f_c}{F_c} = 1.0$$

SO. PINE EM 1110-2-2906

$$f_a \simeq \left(1.0 - \frac{f_b}{F_b}\right)F_a \simeq \left(1.0 - \frac{954}{1{,}650}\right)825(0.9) = 313.2\ psi$$

↑ PERMANENT LOAD FACTOR

$$P \simeq \pi(6)^2(313.2) \simeq 35{,}422^{\#}$$

THIS APPEARS TO BE MORE THAN ENOUGH CAPACITY TO CARRY THE VERT. LOADS.

Subject	Date
RED ROCK TRAILS - SEGMENT II	21 Aug. 97
Computed by K. WILSON / Checked by MW	Sheet AB-5 of

ABUTMENT DESIGN

$$A_{REQ'D} = \frac{3'2,716.8)}{2(90)(0.90)} = 50.31\ IN^2 < \pi(6)^2 = 113\ PSI$$

SIZE WILL PLANK

$$w = 50.94 + 33.96(4.5) = 203.76\ plf$$

$$M = 203.76\left(\frac{11.25}{12}\right)\left(\frac{4.0}{10}\right)^2 = 305.64^{FT-IN}$$

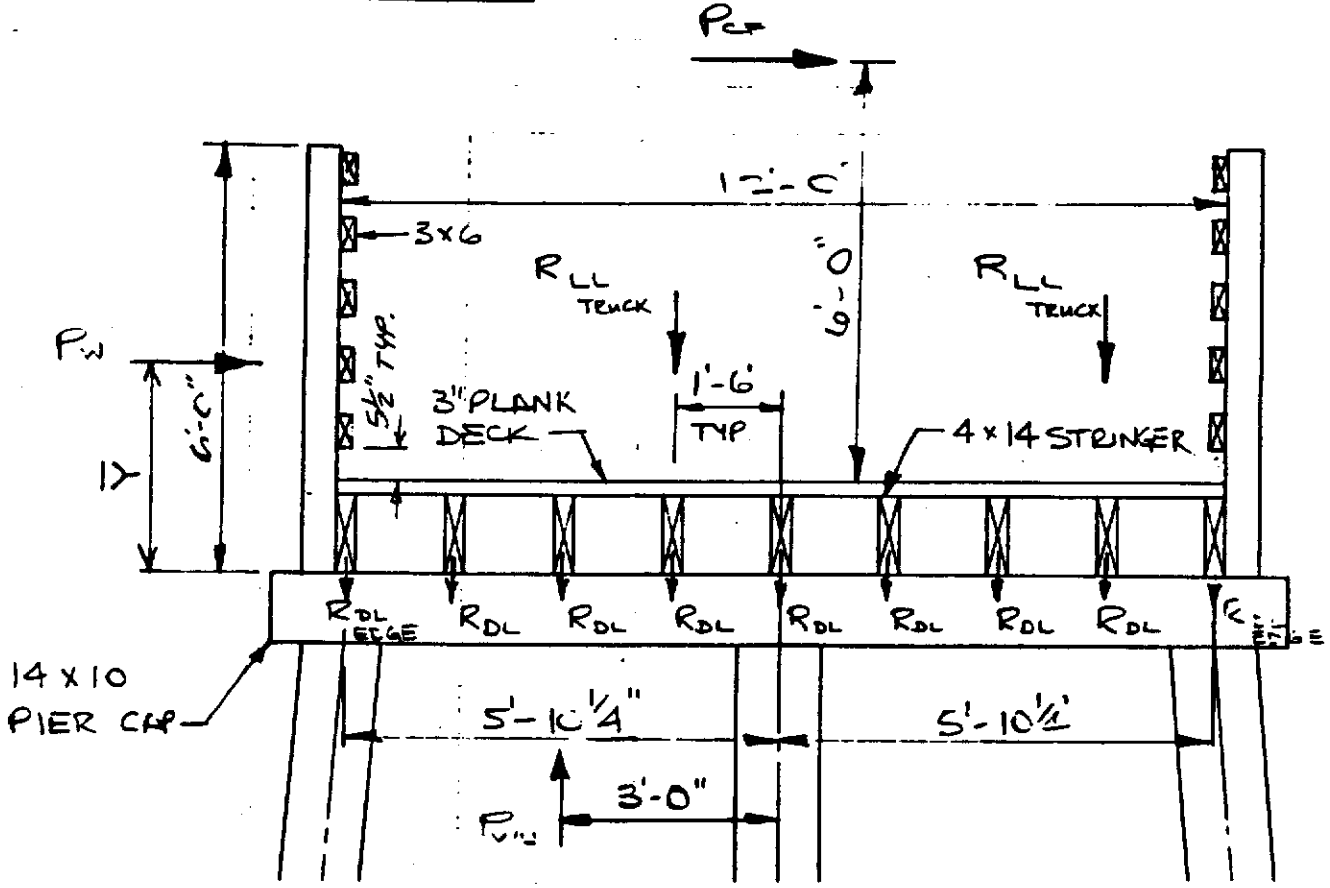
↑ 3 SPAN CONT.

$$S_{REQ'D} = \frac{305.64(12)}{1,250(0.86)(0.90)(1.16)} = 3.268\ IN^3 < \frac{2\times12\ FLAT}{4.219^3}$$

↑ FLATWISE FACTOR
↑ PERMANENT LOAD FACTOR
↑ MOISTURE FACTOR
↑ NO. 2 DOUG. FIR

Subject		Date
RED ROCK TRAILS - SEGMENT III		25 AUG 9-
Computed by K. WILSON	Checked by MW	Sheet P-1 of

PIER DESIGN



$R_{DL_{AVG}} = 678^{\#}$ (SEE SHT. 14)

$R_{DL_{EDGE}} = 5(4.774)(21.36) + 2(4.253)(6.00) + 2(6.684)(6.00)$ (3x6 RAILS; 4x4 END POSTS; 4x6 INT. POSTS)

$+ 9.766\frac{(12)}{11.25}\frac{(1.5)}{(2)}(21.36) + 16.094(21.36) = 1,152^{\#}$ (3x12 DECK; 4x14 STRINGER)

$R_{LL_{TRUCK}} = 4,345^{\#}$ (SEE SHT. 14)

$W_{SELF\ BEAM\ (14x10)} = 44.531$ plf

Subject	RE: ROCK TRAILS – SEGMENT III	Date	25 AUG 0-
Computed by	K. WILSON	Checked by	MW
		Sheet	5 of

PIER DESIGN

CENTRIFICAL FORCES

AASHTO 3.10

$$C = 6.68\frac{S^2}{R} \qquad \text{WHERE } S = 25 \text{ MPH}, \; R = 200 \text{ FT}$$

$$= 20.875\%$$

$$P_{CF} = 2\,R_{LL_{TRUCK}}\,C = 2(4{,}345)(0.20875)$$

$$= 1{,}814^{\#}$$

WIND LOADS

AASHTO 3.15

BASE WIND VELOCITY = 100 MPH AASHTO
RED ROCK WIND VELOCITY = 80 MPH TMS-80?-1

$$\text{WIND LOAD REDUCTION FACTOR} = \frac{80^2}{100^2} = 0.64$$

THE ABOVE REDUCTION FACTOR SHALL BE USED ON GROUP II AND GROUP V LOADINGS ONLY

FORCES ON ELEVATION OF BRIDGE SPAN

AASHTO 3.15.1.1.1 (50)(0.64)

UNIT	FORCE	ARM	MOMENT
RAILS	$5(\frac{5.5}{12})(20.72)(32) = 1{,}519.5^{\#}$	3.834	5,825.6 FT-#
POSTS	$4(\frac{3.5}{12})(4.69)(32) = 175.1$	3.656	640.1
BEAM & DECK	$(\frac{13.25+2.5}{12})(20.72)(32) = \frac{870.2}{2{,}564.8^{\#}}$	0.656 1.313	571 ~~1,142.6~~
			~~3,608.3~~ FT-#
		$\bar{Y} =$ ~~2.966~~ FT 2.743	7,036.7

NCR Form 1 Aug 80 381b

D-7/8

Subject		Date
RED ROCK TRAILS - SEGMENT III		26 AUG. 92
Computed by K. WILSON	Checked by MW	Sheet P-3 of

PIER DESIGN

FORCES PER LINEAR FOOT = $\frac{2,564.8}{20.72}$ — AASHTO 3.15.1.1.2

= 124 PLF < 300 (0.64) = 192 PLF

∴ $P_W = 192 (20.72) = 3,978^{\#}$/PIER

GROUP I AND GROUP VI LOADS — AASHTO 3.15.1.2

$P_{VI} = \frac{3,978}{0.64}(0.70) = 4,352^{\#}$

$P_{W\ TRUCK} = 100(20) = 2,000^{\#}$

20 — ASSUMED LENGTH OF ONE EMERGENCY VEHICLE

WIND UPWARD FORCE — AASHTO 3.15.3

$P_{WU} = 20(0.64)(12.0)(21.36_{AVG}) = 3,281^{\#}$ GROUPS I & V

OR

$P_{WU} = 6(12)(21.36) = 1,538^{\#}$ GROUPS IV & VI

STREAM CURRENT, FLOATING ICE & DRIFT FORCES

THE BRIDGE IS OVER A GULLY THAT CARRIES RUNOFF FROM RAINS WHICH IS NOT CONSIDERED SIGNIFICANT TO THE PIER DESIGN.

Subject	RED ROCK TRAILS - SEGMENT III	Date 26 Aug. 97
Computed by K. WILSON	Checked by MW	Sheet P-4 of

PIER DESIGN

EARTHQUAKE FORCES

THE BRIDGE IS A RECREATIONAL STRUCTURE AND NOT CONSIDERED ESSENTIAL TO LIFE SUPPORT, THEREFORE EARTHQUAKE FORCES ARE NOT CONSIDERED.

COMBINATIONS OF LOADS

~~AASHTO~~ 3.22

GROUP I	D, L, CF, ~~E~~, ~~B~~, ~~SF~~	100%
GROUP II	D, ~~E~~, ~~B~~, ~~SF~~, W	125%
GROUP III	D, L, CF, ~~E~~, ~~B~~, ~~SF~~, 0.3W, WL, ~~LF~~	125%
~~GROUP IV~~	D, L, CF, ~~E~~, ~~B~~, ~~SF~~, ~~R+S+T~~	~~125%~~
~~GROUP V~~	D, ~~E~~, ~~B~~, ~~SF~~, W, ~~R+S+T~~	~~140%~~
~~GROUP VI~~	D, L, CF, ~~E~~, ~~B~~, ~~SF~~, 0.3W, WL, ~~LF~~, ~~R+S+T~~	~~140%~~

Subject RED ROCK TRAILS – SEGMENT II		Date 26 AUG 97
Computed by K. WILSON	Checked by MH	Sheet P-5 of

PIER DESIGN

$R_{DL} = 678^{\#}$ $\quad \frac{R_{DL}}{1.25} = 543^{\#}$

$R_{DL\ EDGE} = 1{,}152^{\#}$ $\quad \frac{R_{DL\ EDGE}}{1.25} = 922^{\#}$

$R_{LL\ TRUCK} = 4{,}345^{\#}$ $\quad \frac{R_{LL\ TRUCK}}{1.25} = 3476^{\#}$

$R_{LL\ UNIF} = 1{,}922^{\#}$ $\quad \frac{R_{LL\ UNIF}}{1.25} = 1{,}538^{\#}$

$P_{CF} = 1{,}814^{\#}$ $\quad \frac{P_{CF}}{1.25} = 1{,}451^{\#}$

$P_W = 3{,}9\_\_^{\#}$ $\quad \frac{P_W}{1.25} = 3{,}1\_\_^{\#}$ GROUP I ✓

$\frac{0.3P_W}{1.25} = \frac{955}{\cancel{1{,}045}}$ GROUP II

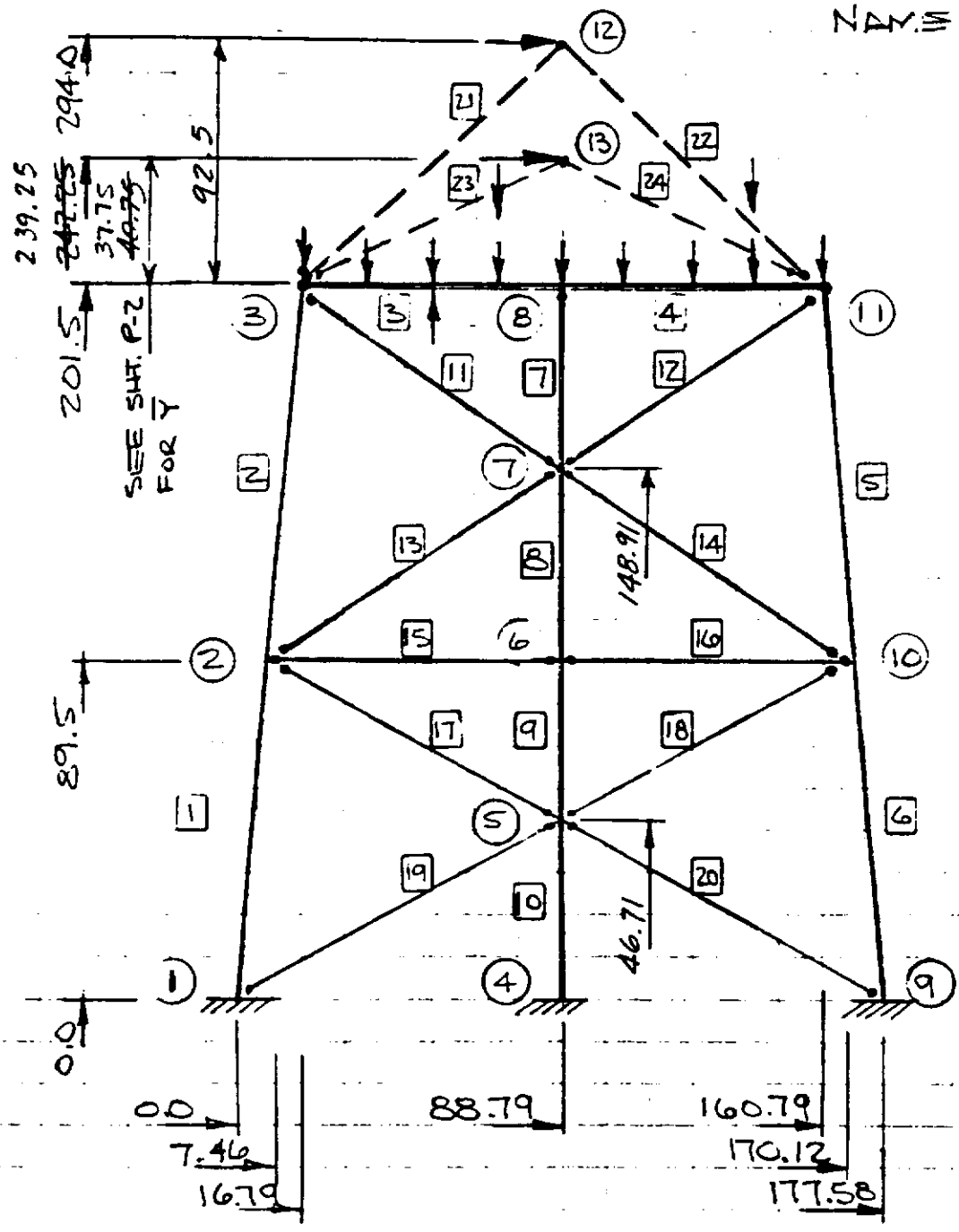
$\frac{P_{W\ TRUCK}}{1.25} = 1{,}600$ GROUP II ✓

$P_{WW} = 3{,}281^{\#}$ OR $1536^{\#}$ $\quad \frac{P_{WW}}{1.25} = 2{,}625$ OR $1{,}230$ GROUP II ✓ GROUP III ✓

Subject		Date
RES ROCK TRIALS - SEGMENT III		31 Aug. 87
Computed by K. Wilson	Checked by MW	Sheet P-6 of

PIER DESIGN

INPUT FILE NAME = RRS3 P2



PIER LAYOUT FOR CFILE COMPUTER PROGRAM

Subject		Date
RED ROCK TRUSS – SEGMENT III		1 SEP. 92
Computed by K. WILSON	Checked by MW	Sheet P-7 of

PIER DESIGN

FROM COMPUTER PROGRAM OUTPUT THE MAXIMUM AXIAL LOADS ON THE PILES ARE:

$P_{COMP} = 10{,}460^{\#}$

$P_{TENSION} = 4{,}187^{\#}$

FROM ED-G, SOIL BORING BT-92-10 IS AT THE BRIDGE AND THE SOIL IS CL-LEAN CLAY TO SANDY LEAN CLAY.

$C = 950$ psf $= 0.475$ TSF

COMPUTE PILE LENGTH REQ'D TO RESIST TENSION

REF: EM 1110-2-2906

$Q_u = Q_{s\,TENSION} = f_s A_s$

WHERE $f_s = C_a = \alpha C$

$\alpha = 0.80$ FIG 4-5a

$Q_{ALL} = \frac{Q_{s\,TENSION}}{F.S.}$

WHERE F.S. $= 3.0$

$\therefore Q_{ALL} = \frac{0.80(950)}{3.0} A_s = \frac{0.80(950)}{3.0} \pi D L$

WHERE D = PILE DIAM. $= 1.0^{ft}$

L = PILE LENGTH – REQ'D.

Subject		Date
REC ROCK TRAILS + SESMSIT III		1 SEP. 92
Computed by K. WILSON	Checked by MW	Sheet P-8 of

PIER DESIGN

$$L_{TENSION} = \frac{3.0\,Q_{ALL.}}{0.80(950)\,\pi\,(1)} = \frac{3.0\,(4,187)}{0.80(950)\,\pi\,(1)}$$

$$= 5.26\ ft \quad \text{SAY 6 FEET}$$

AT SOIL BORING BT-92-10 THERE IS 12 FT OF LEAN CLAY ABOVE SOFT, WEATHERED SHALE, THEREFORE, THE PILES CAN BE DRILLED FLUSH ENOUGH INTO THE CLAY TO RESIST PULL-OUT. ALSO POINT BRG. AND SKIN FRICTION WILL RESIST THE 10.46K COMPRESSIVE FORCES.

```
0100 RED ROCK TRAILS SEGMENT III, BRIDGE PIER - RRS3P2
0110 13 24 5 1700000. .3
0120 1  0.00 0.00 2 7.46 89.50 3 16.79 201.50 4 88.79 0.00 5 88.79 46.71
0125 6 88.79 89.50 7 88.79 148.91 8 88.79 201.50 9 177.58 0.00
0130 10 170.12 89.50 11 160.79 201.50 12 88.79 294.00 13 88.79 ~~342.25~~ 294.25
0140 FIX X 1 4 9 FIX Y 1 4 9 FIX R 1 4 9
0150 1 1 2 2 2 3 3 3 8 4 8 11 5 10 11 6 9 10 7 7 8 8 6 7 9 5 6 10 4 5 11 3 7
0160 12 11 7 13 2 7 14 7 10 15 2 6 16 6 10 17 2 5 18 5 10 19 1 5 20 5 9
0170 21 3 12 22 11 12 23 3 13 24 11 13
0180 PIN A 3 11 12 13 14 15 16 17 18 19 20 21 22 23 24
0190 PIN B 4 7 11 12 13 14 15 16 17 18 19 20 22 24
0200 1018. 113. 113. 1 2 5 6 7 8 9 10
0210 947. 139. 139. 3 4
0220 88. 19. 19. 11 12 13 14 15 16 17 18 19 20
0230 1000. 1000. 1000. 21 22 23 24
0240 LOAD CASE 1 0 0 2 3 0 [D+L+CF] - GROUP I
0250 3. 18. 678. 0. 36. 678. 0. 54. 678. 0. 3 4
0260 1. 54. 4345. 0. 3 4
0270 0. -1152. 0. 3 11
0280 0. -678. 0. 8
0290 1814. 0. 0. 12
0300 LOAD CASE 2 0 0 2 3 0 [D+W]/1.25 - GROUP II
0310 3. 18. 543. 0. 36. 543. 0. 54. 543. 0. 3 4
0320 1. 36. -2625. 0. 3
0330 3182. 0. 0. 13
0340 0. -922. 0. 3 11
0350 0. -543. 0. 8
0360 LOAD CASE 3 0 0 3 5 0 [D+L+CF+0.3W+WL]/1.25 - GROUP II
0370 3. 18. 543. 0. 36. 543. 0. 54. 543. 0. 3 4
0380 1. 54. 3476. 0. 3 4
0390 1. 36. -1230. 0. 3
0400 1045. 0. 0. 13
0410 0. -922. 0. 3 11
0420 0. -543. 0. 8
0430 1600. 0. 0. 12
0435 1451. 0. 0. 12
0440 LOAD CASE 4 0 0 2 4 0 [D+LU] - UNIF. GROUP I
0450 3. 18. 678. 0. 36. 678. 0. 54. 678. 0. 3 4
0460 3. 18. 1922. 0. 36. 1922. 0. 54. 1922. 0. 3 4
0470 0. -1152. 0. 3 11
0480 0. -678. 0. 8
0490 0. -961. 0. 3 11
0500 0. -1922. 0. 8
0510 LOAD CASE 5 0 0 3 5 0 [D+LU+0.3W]/1.25 - UNIF. GROUP III
0520 3. 18. 543. 0. 36. 543. 0. 54. 543. 0. 3 4
0530 3. 18. 1538. 0. 36. 1538. 0. 54. 1538. 0. 3 4
0540 1. 36. -1230. 0. 3
0550 ~~1045.~~ 945. 0. 0. 13
0560 0. -922. 0. 3 11
0570 0. -543. 0. 8
0580 0. -769. 0. 3 11
0590 0. -1538. 0. 8
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1*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*
 PROGRAM CFRAME V02.05 24JUL84
 *-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*


 RUN DATE = 01-SEP-1992
 RUN TIME =  8.05.52


 RED ROCK TRAILS SEGMENT III, BRIDGE PIER


 *** JOINT DATA ***

                                  ------------------FIXITY------------------
 JOINT      X          Y       X  Y  R        KX            KY            KR

    1        .00        .00    *  *  *
    2       7.46      89.50
    3      16.79     201.50
    4      88.79        .00    *  *  *
    5      88.79      46.71
    6      88.79      89.50
    7      88.79     148.91
    8      88.79     201.50
    9     177.58        .00    *  *  *
   10     170.12      89.50
   11     160.79     201.50
   12      88.79     294.00
   13      88.79     242.25


 *** MEMBER DATA ***

         END END
 MEMBER  A   B     LENGTH       I           A           AS          E           G

    1    1   2      89.81   .1018E+04   .1130E+03   .1130E+03   .1700E+07   .6538E+06
    2    2   3     112.39   .1018E+04   .1130E+03   .1130E+03   .1700E+07   .6538E+06
    3   -3   8      72.00   .9470E+03   .1390E+03   .1390E+03   .1700E+07   .6538E+06
    4    8 -11      72.00   .9470E+03   .1390E+03   .1390E+03   .1700E+07   .6538E+06
    5   10  11     112.39   .1018E+04   .1130E+03   .1130E+03   .1700E+07   .6538E+06
    6    9  10      89.81   .1018E+04   .1130E+03   .1130E+03   .1700E+07   .6538E+06
    7    7  -8      52.59   .1018E+04   .1130E+03   .1130E+03   .1700E+07   .6538E+06
    8    6   7      59.41   .1018E+04   .1130E+03   .1130E+03   .1700E+07   .6538E+06
    9    5   6      42.79   .1018E+04   .1130E+03   .1130E+03   .1700E+07   .6538E+06
   10    4   5      46.71   .1018E+04   .1130E+03   .1130E+03   .1700E+07   .6538E+06
   11   -3  -7      89.16   .8800E+02   .1900E+02   .1900E+02   .1700E+07   .6538E+06
   12  -11  -7      89.16   .8800E+02   .1900E+02   .1900E+02   .1700E+07   .6538E+06
   13   -2  -7     100.72   .8800E+02   .1900E+02   .1900E+02   .1700E+07   .6538E+06
   14   -7 -10     100.72   .8800E+02   .1900E+02   .1900E+02   .1700E+07   .6538E+06
   15   -2  -6      81.33   .8800E+02   .1900E+02   .1900E+02   .1700E+07   .6538E+06
   16   -6 -10      81.33   .8800E+02   .1900E+02   .1900E+02   .1700E+07   .6538E+06
   17   -2  -5      91.90   .8800E+02   .1900E+02   .1900E+02   .1700E+07   .6538E+06
   18   -5 -10      91.90   .8800E+02   .1900E+02   .1900E+02   .1700E+07   .6538E+06
   19   -1  -5     100.33   .8800E+02   .1900E+02   .1900E+02   .1700E+07   .6538E+06
   20   -5  -9     100.33   .8800E+02   .1900E+02   .1900E+02   .1700E+07   .6538E+06
   21   -3  12     117.22   .1000E+04   .1000E+04   .1000E+04   .1700E+07   .6538E+06
```

22	-11	-12	117.22	.1000E+04	.1000E+04	.1000E+04	.1700E+07	.6538E+06
23	-3	13	82.73	.1000E+04	.1000E+04	.1000E+04	.1700E+07	.6538E+06
24	-11	-13	82.73	.1000E+04	.1000E+04	.1000E+04	.1700E+07	.6538E+06

*** LOAD CASE 1 [D+L+CF] - GROUP I

MEMBER	L	P	ANGLE
3	18.00	.6780E+03	.00
3	36.00	.6780E+03	.00
3	54.00	.6780E+03	.00
3	54.00	.4345E+04	.00
4	18.00	.6780E+03	.00
4	36.00	.6780E+03	.00
4	54.00	.6780E+03	.00
4	54.00	.4345E+04	.00

JOINT	FORCE X	FORCE Y	MOMENT
3	.0000E+00	-.1152E+04	.0000E+00
8	.0000E+00	-.6780E+03	.0000E+00
11	.0000E+00	-.1152E+04	.0000E+00
12	.1814E+04	.0000E+00	.0000E+00

*** LOAD CASE 2 [D+W]/1.25 - GROUP II

MEMBER	L	P	ANGLE
3	18.00	.5430E+03	.00
3	36.00	.5430E+03	.00
3	54.00	.5430E+03	.00
3	36.00	-.2625E+04	.00
4	18.00	.5430E+03	.00
4	36.00	.5430E+03	.00
4	54.00	.5430E+03	.00

JOINT	FORCE X	FORCE Y	MOMENT
3	.0000E+00	-.9220E+03	.0000E+00
8	.0000E+00	-.5430E+03	.0000E+00
11	.0000E+00	-.9220E+03	.0000E+00
13	.3182E+04	.0000E+00	.0000E+00

*** LOAD CASE 3 [D+L+CF+0.3W+WL]/1.25 - GROUP II

MEMBER	L	P	ANGLE

3	18.00	.5430E+03	.00
3	36.00	.5430E+03	.00
3	54.00	.5430E+03	.00
3	54.00	.3476E+04	.00
3	36.00	-.1230E+04	.00
4	18.00	.5430E+03	.00
4	36.00	.5430E+03	.00
4	54.00	.5430E+03	.00
4	54.00	.3476E+04	.00

JOINT	FORCE X	FORCE Y	MOMENT
3	.0000E+00	-.9220E+03	.0000E+00
8	.0000E+00	-.5430E+03	.0000E+00
11	.0000E+00	-.9220E+03	.0000E+00
12	.3051E+04	.0000E+00	.0000E+00
13	.1045E+04	.0000E+00	.0000E+00

*** LOAD CASE 4 [D+LU] - UNIF. GROUP I

MEMBER	L	P	ANGLE
3	18.00	.6780E+03	.00
3	36.00	.6780E+03	.00
3	54.00	.6780E+03	.00
3	18.00	.1922E+04	.00
3	36.00	.1922E+04	.00
3	54.00	.1922E+04	.00
4	18.00	.6780E+03	.00
4	36.00	.6780E+03	.00
4	54.00	.6780E+03	.00
4	18.00	.1922E+04	.00
4	36.00	.1922E+04	.00
4	54.00	.1922E+04	.00

JOINT	FORCE X	FORCE Y	MOMENT
3	.0000E+00	-.2113E+04	.0000E+00
8	.0000E+00	-.2600E+04	.0000E+00
11	.0000E+00	-.2113E+04	.0000E+00

*** LOAD CASE 5 [D+LU+0.3W]/1.25 - UNIF. GROUP III

MEMBER	L	P	ANGLE
3	18.00	.5430E+03	.00
3	36.00	.5430E+03	.00
3	54.00	.5430E+03	.00
3	18.00	.1538E+04	.00

3	36.00	.1538E+04	.00
3	54.00	.1538E+04	.00
3	36.00	-.1230E+04	.00
4	18.00	.5430E+03	.00
4	36.00	.5430E+03	.00
4	54.00	.5430E+03	.00
4	18.00	.1538E+04	.00
4	36.00	.1538E+04	.00
4	54.00	.1538E+04	.00

JOINT	FORCE X	FORCE Y	MOMENT
3	.0000E+00	-.1691E+04	.0000E+00
8	.0000E+00	-.2081E+04	.0000E+00
11	.0000E+00	-.1691E+04	.0000E+00
13	.1045E+04	.0000E+00	.0000E+00

1 LOAD CASE 1 [D+L+CF] = GROUP I

STRUCTURE REACTIONS

JOINT	FORCE X	FORCE Y	MOMENT
1	-.2664E+03	.4025E+03	.2499E+04
4	-.1039E+03	.7290E+04	.4814E+04
9	-.1444E+04	.8048E+04	.3602E+04
TOTAL	-.1814E+04	.1574E+05	

1 LOAD CASE 2 [D+W]/1.25 = GROUP II

STRUCTURE REACTIONS

JOINT	FORCE X	FORCE Y	MOMENT
1	-.1357E+04	-.3702E+04	.5963E+04
4	-.2346E+03	.9260E+03	.1002E+05
9	-.1591E+04	.5796E+04	.6070E+04
TOTAL	-.3182E+04	.3020E+04	

1 LOAD CASE 3 [D+L+CF+0.3W+WL]/1.25 = GROUP II

STRUCTURE REACTIONS

JOINT	FORCE X	FORCE Y	MOMENT
1	-.1487E+04	-.4187E+04	.6958E+04
4	-.2708E+03	.5180E+04	.1196E+05
9	-.2338E+04	.1037E+05	.7736E+04
TOTAL	-.4096E+04	.1137E+05	

1 LOAD CASE 4 [D+LU] - UNIF. GROUP I

STRUCTURE REACTIONS

JOINT	FORCE X	FORCE Y	MOMENT
1	.8380E+03	.5981E+04	-.7946E+03
4	-.7603E-04	.1046E+05	.2800E-02
9	-.8380E+03	.5981E+04	.7946E+03
TOTAL	.0000E+00	.2243E+05	

1 LOAD CASE 5 [D+LU+0.3W]/1.25 - UNIF. GROUP III

STRUCTURE REACTIONS

JOINT	FORCE X	FORCE Y	MOMENT
1	.1404E+03	.2864E+04	.1367E+04
4	-.7502E+02	.7722E+04	.3231E+04
9	-.1110E+04	.6133E+04	.2534E+04
TOTAL	-.1045E+04	.1672E+05	

1 MEMBER END FORCES

MEMBER	LOAD CASE	JOINT	AXIAL	SHEAR	MOMENT	MOMENT EXTREMA	LOCATION
1	1	1	-.5548E+03	.2318E+02	-.2499E+04	-.4169E+03	89.81
		2	-.5548E+03	-.2318E+02	-.4169E+03	-.2499E+04	.00
	2	1	.3182E+04	.7237E+02	-.5963E+04	.5366E+03	89.81
		2	.3182E+04	-.7237E+02	.5366E+03	-.5963E+04	.00
	3	1	.3624E+04	.7900E+02	-.6958E+04	.1370E+03	89.81
		2	.3624E+04	-.7900E+02	.1370E+03	-.6958E+04	.00
	4	1	-.5825E+04	-.1665E+02	.7946E+03	.7946E+03	.00
		2	-.5825E+04	.1665E+02	-.7008E+03	-.7008E+03	89.81
	5	1	-.2921E+04	.1143E+02	-.1367E+04	-.3397E+03	89.81
		2	-.2921E+04	-.1143E+02	-.3397E+03	-.1367E+04	.00

2	1	2	-.9280E+03	.3710E+01	-.4169E+03	-.1049E-03	112.39
		3	-.9280E+03	-.3710E+01	-.1049E-03	-.4169E+03	.00
	2	2	.1547E+04	-.4774E+01	.5366E+03	.5366E+03	.00
		3	.1547E+04	.4774E+01	.2221E-03	.2221E-03	112.39
	3	2	.1944E+04	-.1219E+01	.1370E+03	.1370E+03	.00
		3	.1944E+04	.1219E+01	.9931E-04	.9931E-04	112.39
	4	2	-.5191E+04	.6236E+01	-.7008E+03	-.2193E-03	112.39
		3	-.5191E+04	-.6236E+01	-.2193E-03	-.7008E+03	.00
	5	2	-.2992E+04	.3023E+01	-.3397E+03	-.6276E-04	112.39
		3	-.2992E+04	-.3023E+01	-.6276E-04	-.3397E+03	.00
3	1	3	-.5711E+03	.1237E+04	.0000E+00	.3234E+05	36.00
		8	-.5711E+03	.5142E+04	-.6235E+05	-.6235E+05	72.00
	2	3	-.2255E+02	-.5079E+03	.0000E+00	.0000E+00	.00
		8	-.2255E+02	-.4881E+03	-.7136E+03	-.2806E+05	36.00
	3	3	-.3998E+03	.4833E+03	.0000E+00	.1847E+05	53.28
		8	-.3998E+03	.3392E+04	-.4213E+05	-.4213E+05	72.00
	4	3	-.8204E+03	.2772E+04	.0000E+00	.5298E+05	36.00
		8	-.8204E+03	.5028E+04	-.8123E+05	-.8123E+05	72.00
	5	3	-.5977E+03	.1711E+04	.0000E+00	.3054E+05	18.72
		8	-.5977E+03	.3302E+04	-.5725E+05	-.5725E+05	72.00
4	1	8	-.5600E+03	.2969E+04	-.6235E+05	.6021E+05	53.28
		11	-.5600E+03	.3410E+04	.0000E+00	-.6235E+05	.00
	2	8	-.1895E+02	.8244E+03	-.7136E+03	.1919E+05	36.00
		11	-.1895E+02	.8046E+03	.0000E+00	-.7136E+03	.00
	3	8	-.3857E+03	.2269E+04	-.4213E+05	.5020E+05	53.28
		11	-.3857E+03	.2836E+04	.0000E+00	-.4213E+05	.00
	4	8	-.8204E+03	.5028E+04	-.8123E+05	.5298E+05	36.00
		11	-.8204E+03	.2772E+04	.0000E+00	-.8123E+05	.00
	5	8	-.5959E+03	.3917E+04	-.5725E+05	.4629E+05	36.00
		11	-.5959E+03	.2326E+04	.0000E+00	-.5725E+05	.00
5	1	10	-.6434E+04	-.4963E+01	.5578E+03	.5578E+03	.00
		11	-.6434E+04	.4963E+01	.8137E-04	.8137E-04	112.39
	2	10	-.3601E+04	-.5751E+01	.6464E+03	.6464E+03	.00
		11	-.3601E+04	.5751E+01	-.3578E-04	-.3578E-04	112.39
	3	10	-.7375E+04	-.7360E+01	.8272E+03	.8272E+03	.00
		11	-.7375E+04	.7360E+01	.1438E-04	.1438E-04	112.39
	4	10	-.5191E+04	-.6236E+01	.7008E+03	.7008E+03	.00
		11	-.5191E+04	.6236E+01	.1363E-03	.1363E-03	112.39
	5	10	-.4856E+04	-.6159E+01	.6922E+03	.6922E+03	.00
		11	-.4856E+04	.6159E+01	.8334E-04	.8334E-04	112.39
6	1	9	-.7679E+04	.4632E+02	-.3602E+04	.5578E+03	89.81
		10	-.7679E+04	-.4632E+02	.5578E+03	-.3602E+04	.00
	2	9	-.5252E+04	.7478E+02	-.6070E+04	.6464E+03	89.81
		10	-.5252E+04	-.7478E+02	.6464E+03	-.6070E+04	.00
	3	9	-.9657E+04	.9535E+02	-.7736E+04	.8272E+03	89.81
		10	-.9657E+04	-.9535E+02	.8272E+03	-.7736E+04	.00
	4	9	-.5825E+04	.1665E+02	-.7946E+03	.7008E+03	89.81
		10	-.5825E+04	-.1665E+02	.7008E+03	-.7946E+03	.00
	5	9	-.5847E+04	.3592E+02	-.2534E+04	.6922E+03	89.81
		10	-.5847E+04	-.3592E+02	.6922E+03	-.2534E+04	.00
7	1	7	-.8789E+04	.1108E+02	-.5827E+03	.0000E+00	52.59
		8	-.8789E+04	-.1108E+02	.0000E+00	-.5827E+03	.00
	2	7	-.8793E+03	.3601E+01	-.1894E+03	.0000E+00	52.59
		8	-.8793E+03	-.3601E+01	.0000E+00	-.1894E+03	.00

	3	7	-.6203E+04	.1409E+02	-.7408E+03	.0000E+00	52.59
		8	-.6203E+04	-.1409E+02	.0000E+00	-.7408E+03	.00
	4	7	-.1266E+05	.0000E+00	.1430E-03	.1430E-03	.00
		8	-.1266E+05	.0000E+00	.0000E+00	.0000E+00	52.59
	5	7	-.9299E+04	.1791E+01	-.9421E+02	.0000E+00	52.59
		8	-.9299E+04	-.1791E+01	.0000E+00	-.9421E+02	.00
8	1	6	-.7710E+04	-.7364E+01	-.1452E+03	-.1452E+03	.00
		7	-.7710E+04	.7364E+01	-.5827E+03	-.5827E+03	59.41
	2	6	-.9425E+03	.5919E+01	-.5410E+03	-.1894E+03	59.41
		7	-.9425E+03	-.5919E+01	-.1894E+03	-.5410E+03	.00
	3	6	-.5472E+04	-.3624E+01	-.5255E+03	-.5255E+03	.00
		7	-.5472E+04	.3624E+01	-.7408E+03	-.7408E+03	59.41
	4	6	-.1107E+05	-.2017E-04	.1344E-02	.1344E-02	.00
		7	-.1107E+05	.2017E-04	.1464E-03	.1464E-03	59.41
	5	6	-.8165E+04	.1220E+01	-.1667E+03	-.9421E+02	59.41
		7	-.8165E+04	-.1220E+01	-.9421E+02	-.1667E+03	.00
9	1	5	-.7710E+04	-.4349E+01	.4091E+02	.4091E+02	.00
		6	-.7710E+04	.4349E+01	-.1452E+03	-.1452E+03	42.79
	2	5	-.9425E+03	-.3445E+02	.9331E+03	.9331E+03	.00
		6	-.9425E+03	.3445E+02	-.5410E+03	-.5410E+03	42.79
	3	5	-.5472E+04	-.2834E+02	.6870E+03	.6870E+03	.00
		6	-.5472E+04	.2834E+02	-.5255E+03	-.5255E+03	42.79
	4	5	-.1107E+05	.1380E-04	.7567E-03	.1347E-02	42.79
		6	-.1107E+05	-.1380E-04	.1347E-02	.7567E-03	.00
	5	5	-.8165E+04	-.1028E+02	.2733E+03	.2733E+03	.00
		6	-.8165E+04	.1028E+02	-.1667E+03	-.1667E+03	42.79
10	1	4	-.7290E+04	.1039E+03	-.4814E+04	.4091E+02	46.71
		5	-.7290E+04	-.1039E+03	.4091E+02	-.4814E+04	.00
	2	4	-.9260E+03	.2346E+03	-.1002E+05	.9331E+03	46.71
		5	-.9260E+03	-.2346E+03	.9331E+03	-.1002E+05	.00
	3	4	-.5180E+04	.2708E+03	-.1196E+05	.6870E+03	46.71
		5	-.5180E+04	-.2708E+03	.6870E+03	-.1196E+05	.00
	4	4	-.1046E+05	.7603E-04	-.2800E-02	.7513E-03	46.71
		5	-.1046E+05	-.7603E-04	.7513E-03	-.2800E-02	.00
	5	4	-.7722E+04	.7502E+02	-.3231E+04	.2733E+03	46.71
		5	-.7722E+04	-.7502E+02	.2733E+03	-.3231E+04	.00
11	1	3	-.5068E+03	.0000E+00	.0000E+00	.0000E+00	.00
		7	-.5068E+03	.0000E+00	.0000E+00	.0000E+00	.00
	2	3	-.1789E+04	.0000E+00	.0000E+00	.0000E+00	.00
		7	-.1789E+04	.0000E+00	.0000E+00	.0000E+00	.00
	3	3	-.1843E+04	.0000E+00	.0000E+00	.0000E+00	.00
		7	-.1843E+04	.0000E+00	.0000E+00	.0000E+00	.00
	4	3	.4899E+03	.0000E+00	.0000E+00	.0000E+00	.00
		7	.4899E+03	.0000E+00	.0000E+00	.0000E+00	.00
	5	3	-.2108E+03	.0000E+00	.0000E+00	.0000E+00	.00
		7	-.2108E+03	.0000E+00	.0000E+00	.0000E+00	.00
12	1	11	.1161E+04	.0000E+00	.0000E+00	.0000E+00	.00
		7	.1161E+04	.0000E+00	.0000E+00	.0000E+00	.00
	2	11	.1631E+04	.0000E+00	.0000E+00	.0000E+00	.00
		7	.1631E+04	.0000E+00	.0000E+00	.0000E+00	.00
	3	11	.2265E+04	.0000E+00	.0000E+00	.0000E+00	.00
		7	.2265E+04	.0000E+00	.0000E+00	.0000E+00	.00
	4	11	.4899E+03	.0000E+00	.0000E+00	.0000E+00	.00
		7	.4899E+03	.0000E+00	.0000E+00	.0000E+00	.00
	5	11	.8933E+03	.0000E+00	.0000E+00	.0000E+00	.00

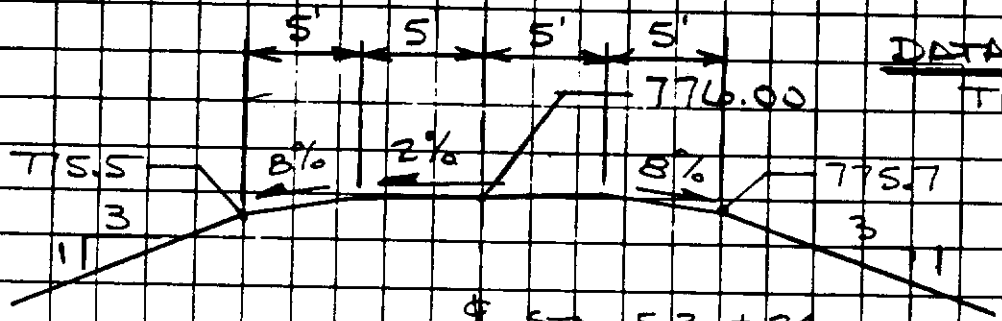
		7	.8933E+03	.0000E+00	.0000E+00	.0000E+00	.00
13	1	2	.2579E+03	.0000E+00	.0000E+00	.0000E+00	.00
		7	.2579E+03	.0000E+00	.0000E+00	.0000E+00	.00
	2	2	.1683E+04	.0000E+00	.0000E+00	.0000E+00	.00
		7	.1683E+04	.0000E+00	.0000E+00	.0000E+00	.00
	3	2	.1656E+04	.0000E+00	.0000E+00	.0000E+00	.00
		7	.1656E+04	.0000E+00	.0000E+00	.0000E+00	.00
	4	2	-.8518E+03	.0000E+00	.0000E+00	.0000E+00	.00
		7	-.8518E+03	.0000E+00	.0000E+00	.0000E+00	.00
	5	2	-.6786E+02	.0000E+00	.0000E+00	.0000E+00	.00
		7	-.6786E+02	.0000E+00	.0000E+00	.0000E+00	.00
14	1	7	-.1433E+04	.0000E+00	.0000E+00	.0000E+00	.00
		10	-.1433E+04	.0000E+00	.0000E+00	.0000E+00	.00
	2	7	-.1734E+04	.0000E+00	.0000E+00	.0000E+00	.00
		10	-.1734E+04	.0000E+00	.0000E+00	.0000E+00	.00
	3	7	-.2474E+04	.0000E+00	.0000E+00	.0000E+00	.00
		10	-.2474E+04	.0000E+00	.0000E+00	.0000E+00	.00
	4	7	-.8517E+03	.0000E+00	.0000E+00	.0000E+00	.00
		10	-.8517E+03	.0000E+00	.0000E+00	.0000E+00	.00
	5	7	-.1173E+04	.0000E+00	.0000E+00	.0000E+00	.00
		10	-.1173E+04	.0000E+00	.0000E+00	.0000E+00	.00
15	1	2	.2569E+03	.0000E+00	.0000E+00	.0000E+00	.00
		6	.2569E+03	.0000E+00	.0000E+00	.0000E+00	.00
	2	2	.5271E+02	.0000E+00	.0000E+00	.0000E+00	.00
		6	.5271E+02	.0000E+00	.0000E+00	.0000E+00	.00
	3	2	.1959E+03	.0000E+00	.0000E+00	.0000E+00	.00
		6	.1959E+03	.0000E+00	.0000E+00	.0000E+00	.00
	4	2	.3710E+03	.0000E+00	.0000E+00	.0000E+00	.00
		6	.3710E+03	.0000E+00	.0000E+00	.0000E+00	.00
	5	2	.2794E+03	.0000E+00	.0000E+00	.0000E+00	.00
		6	.2794E+03	.0000E+00	.0000E+00	.0000E+00	.00
16	1	6	.2599E+03	.0000E+00	.0000E+00	.0000E+00	.00
		10	.2599E+03	.0000E+00	.0000E+00	.0000E+00	.00
	2	6	.1234E+02	.0000E+00	.0000E+00	.0000E+00	.00
		10	.1234E+02	.0000E+00	.0000E+00	.0000E+00	.00
	3	6	.1712E+03	.0000E+00	.0000E+00	.0000E+00	.00
		10	.1712E+03	.0000E+00	.0000E+00	.0000E+00	.00
	4	6	.3710E+03	.0000E+00	.0000E+00	.0000E+00	.00
		10	.3710E+03	.0000E+00	.0000E+00	.0000E+00	.00
	5	6	.2679E+03	.0000E+00	.0000E+00	.0000E+00	.00
		10	.2679E+03	.0000E+00	.0000E+00	.0000E+00	.00
17	1	2	-.4686E+03	.0000E+00	.0000E+00	.0000E+00	.00
		5	-.4686E+03	.0000E+00	.0000E+00	.0000E+00	.00
	2	2	-.1355E+04	.0000E+00	.0000E+00	.0000E+00	.00
		5	-.1355E+04	.0000E+00	.0000E+00	.0000E+00	.00
	3	2	-.1484E+04	.0000E+00	.0000E+00	.0000E+00	.00
		5	-.1484E+04	.0000E+00	.0000E+00	.0000E+00	.00
	4	2	.2725E+03	.0000E+00	.0000E+00	.0000E+00	.00
		5	.2725E+03	.0000E+00	.0000E+00	.0000E+00	.00
	5	2	-.2378E+03	.0000E+00	.0000E+00	.0000E+00	.00
		5	-.2378E+03	.0000E+00	.0000E+00	.0000E+00	.00
18	1	5	.8391E+03	.0000E+00	.0000E+00	.0000E+00	.00
		10	.8391E+03	.0000E+00	.0000E+00	.0000E+00	.00
	2	5	.1323E+04	.0000E+00	.0000E+00	.0000E+00	.00

		10	.1323E+04	.0000E+00	.0000E+00	.0000E+00	.00
	3	5	.1733E+04	.0000E+00	.0000E+00	.0000E+00	.00
		10	.1733E+04	.0000E+00	.0000E+00	.0000E+00	.00
	4	5	.2725E+03	.0000E+00	.0000E+00	.0000E+00	.00
		10	.2725E+03	.0000E+00	.0000E+00	.0000E+00	.00
	5	5	.6267E+03	.0000E+00	.0000E+00	.0000E+00	.00
		10	.6267E+03	.0000E+00	.0000E+00	.0000E+00	.00
19	1	1	.3270E+03	.0000E+00	.0000E+00	.0000E+00	.00
		5	.3270E+03	.0000E+00	.0000E+00	.0000E+00	.00
	2	1	.1153E+04	.0000E+00	.0000E+00	.0000E+00	.00
		5	.1153E+04	.0000E+00	.0000E+00	.0000E+00	.00
	3	1	.1251E+04	.0000E+00	.0000E+00	.0000E+00	.00
		5	.1251E+04	.0000E+00	.0000E+00	.0000E+00	.00
	4	1	-.3814E+03	.0000E+00	.0000E+00	.0000E+00	.00
		5	-.3814E+03	.0000E+00	.0000E+00	.0000E+00	.00
	5	1	.1026E+03	.0000E+00	.0000E+00	.0000E+00	.00
		5	.1026E+03	.0000E+00	.0000E+00	.0000E+00	.00
20	1	5	-.8584E+03	.0000E+00	.0000E+00	.0000E+00	.00
		9	-.8584E+03	.0000E+00	.0000E+00	.0000E+00	.00
	2	5	-.1220E+04	.0000E+00	.0000E+00	.0000E+00	.00
		9	-.1220E+04	.0000E+00	.0000E+00	.0000E+00	.00
	3	5	-.1629E+04	.0000E+00	.0000E+00	.0000E+00	.00
		9	-.1629E+04	.0000E+00	.0000E+00	.0000E+00	.00
	4	5	-.3814E+03	.0000E+00	.0000E+00	.0000E+00	.00
		9	-.3814E+03	.0000E+00	.0000E+00	.0000E+00	.00
	5	5	-.6655E+03	.0000E+00	.0000E+00	.0000E+00	.00
		9	-.6655E+03	.0000E+00	.0000E+00	.0000E+00	.00
21	1	3	.1477E+04	.0000E+00	.0000E+00	.0000E+00	.00
		12	.1477E+04	.0000E+00	.0000E+00	.0000E+00	.00
	2	3	.0000E+00	.0000E+00	.0000E+00	.0000E+00	.00
		12	.0000E+00	.0000E+00	.0000E+00	.0000E+00	.00
	3	3	.2484E+04	.0000E+00	.0000E+00	.0000E+00	.00
		12	.2484E+04	.0000E+00	.0000E+00	.0000E+00	.00
	4	3	.0000E+00	.0000E+00	.0000E+00	.0000E+00	.00
		12	.0000E+00	.0000E+00	.0000E+00	.0000E+00	.00
	5	3	.0000E+00	.0000E+00	.0000E+00	.0000E+00	.00
		12	.0000E+00	.0000E+00	.0000E+00	.0000E+00	.00
22	1	11	-.1477E+04	.0000E+00	.0000E+00	.0000E+00	.00
		12	-.1477E+04	.0000E+00	.0000E+00	.0000E+00	.00
	2	11	.0000E+00	.0000E+00	.0000E+00	.0000E+00	.00
		12	.0000E+00	.0000E+00	.0000E+00	.0000E+00	.00
	3	11	-.2484E+04	.0000E+00	.0000E+00	.0000E+00	.00
		12	-.2484E+04	.0000E+00	.0000E+00	.0000E+00	.00
	4	11	.0000E+00	.0000E+00	.0000E+00	.0000E+00	.00
		12	.0000E+00	.0000E+00	.0000E+00	.0000E+00	.00
	5	11	.0000E+00	.0000E+00	.0000E+00	.0000E+00	.00
		12	.0000E+00	.0000E+00	.0000E+00	.0000E+00	.00
23	1	3	.0000E+00	.0000E+00	.0000E+00	.0000E+00	.00
		13	.0000E+00	.0000E+00	.0000E+00	.0000E+00	.00
	2	3	.1828E+04	.0000E+00	.0000E+00	.0000E+00	.00
		13	.1828E+04	.0000E+00	.0000E+00	.0000E+00	.00
	3	3	.6004E+03	.0000E+00	.0000E+00	.0000E+00	.00
		13	.6004E+03	.0000E+00	.0000E+00	.0000E+00	.00
	4	3	.0000E+00	.0000E+00	.0000E+00	.0000E+00	.00
		13	.0000E+00	.0000E+00	.0000E+00	.0000E+00	.00

	5	3	.6004E+03	.0000E+00	.0000E+00	.0000E+00	.00
		13	.6004E+03	.0000E+00	.0000E+00	.0000E+00	.00
24	1	11	.0000E+00	.0000E+00	.0000E+00	.0000E+00	.00
		13	.0000E+00	.0000E+00	.0000E+00	.0000E+00	.00
	2	11	-.1828E+04	.0000E+00	.0000E+00	.0000E+00	.00
		13	-.1828E+04	.0000E+00	.0000E+00	.0000E+00	.00
	3	11	-.6004E+03	.0000E+00	.0000E+00	.0000E+00	.00
		13	-.6004E+03	.0000E+00	.0000E+00	.0000E+00	.00
	4	11	.0000E+00	.0000E+00	.0000E+00	.0000E+00	.00
		13	.0000E+00	.0000E+00	.0000E+00	.0000E+00	.00
	5	11	-.6004E+03	.0000E+00	.0000E+00	.0000E+00	.00
		13	-.6004E+03	.0000E+00	.0000E+00	.0000E+00	.00

Subject		Date
RED ROCK TRAILS – SEGMENT III		15 DEC. 92
Computed by K. WILSON	**Checked by** MW	**Sheet** C-1 **of**

CULVERT



DATA FROM EDDG
TIM HESS

LOW INVERT

FLOW

SLOPE OF CULVERT = 1%

UP STREAM INVERT = 740.0

WATER LEVEL – NORMAL POOL = 742.0

CULVERT LENGTH ≈ 240'

DOWN STREAM INVERT ≈ 740.0 – 24 (0.01)
≈ 737.6

GRADE BEHIND WINGWALLS AT INVERTS
= INVER EL. + 1 FT

U.S. TOE LENGTH = 3 [775.7 – (740.0 + 1.0)] = 104.1 FT

D.S. TOE LENGTH = 3 [775.5 – (737.6 + 1.0)] = 110.7 FT

TOTAL LENGTH OF CULVERT = 104.1 + 20.0 + 110.7
FT
= 234.8 SAY 235 FT.

NCR Form 381b
1 Aug 80

Subject		Date
RED ROCK TRAILS - SEGMENT II		15 DEC 92
Computed by K. WILSON	Checked by MW	Sheet C-2 of

CULVERT

DESIGN 8'x8' SINGLE BOX PER MARV MARTENS ED-HH 12-10-92

DESIGN THE CULVERT IN ACCORDANCE WITH AASHTO "STANDARD SPECIFICATIONS FOR HIGHWAY BRIDGES", 1989 AND EM 1110-2-2902, CONDUITS, CULVERTS, AND PIPES, MARCH 1960.

USE COMPUTER PROGRAM "CORTCUL-DESIGN/INVESTIGATION OF ORTHOGONAL CULVERTS", 1988 (XCOR4)

FILL OVER CULVERT @ ROADWAY	776.00	
	− 738.86	INV. @ ROADWAY
	37.14	
	8.00	CULVERT OPNG
	29.14	
	1.16	TOP SLAB
	27.98 FT	
		SAY 28 FT

$f'_c = 4{,}000$ PSI ; $f_y = 48{,}000$ PSI ; $\beta_1 = 0.85$

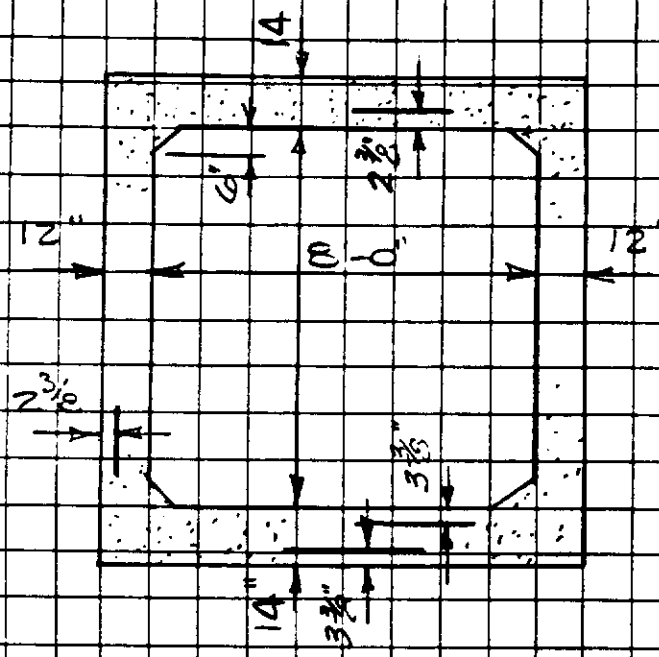
LIVE LOAD MAY BE NEGLECTED BECAUSE FILL DEPTH (28 FT) EXCEEDS DISTANCE BETWEEN END SUPPORTS (8'-0"). AASHTO SEC. 6.4

VERTICAL EARTH PRESSURE	120 PCF	
LATERAL EARTH PRESSURE	30 PSF	(CASE I)
	60 PSF	(CASE I)

Subject		Date
RED ROCK TRAILS - SEGMENT III		15 DEC. 92
Computed by: K. WILSON	Checked by: MW	Sheet C-3 of

CULVERT

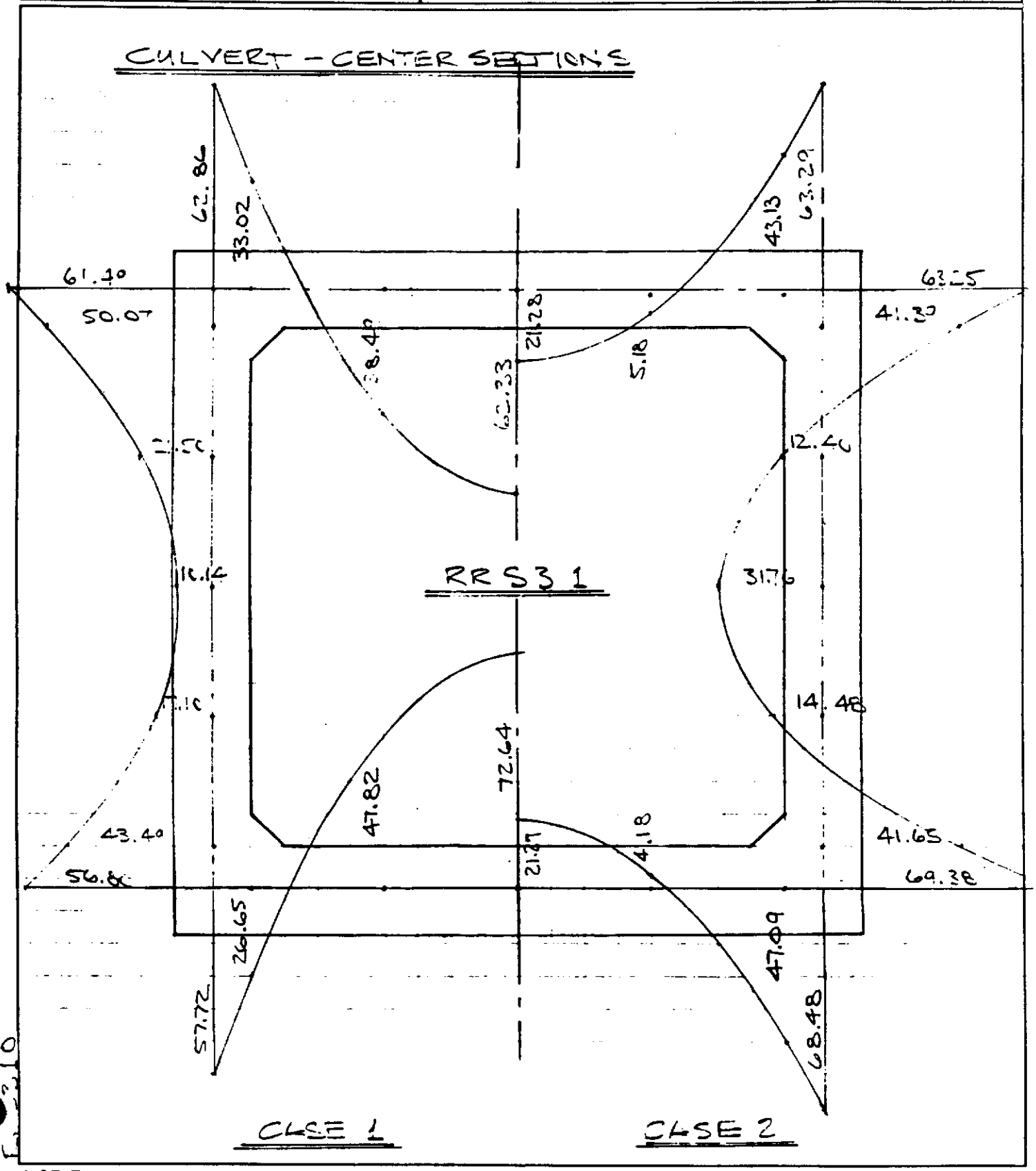
PRELIMINARY SECTION



SEE COMPUTER INPUT FILE - RRS31I AND OUTPUT FILE - RRS31O FOR CENTER 9'-0" OF CULVERT LENGTH AND INPUT FILE - RRS31AI AND OUTPUT FILE - RRS31AO FOR NEXT 30-4' ON EITHER END.

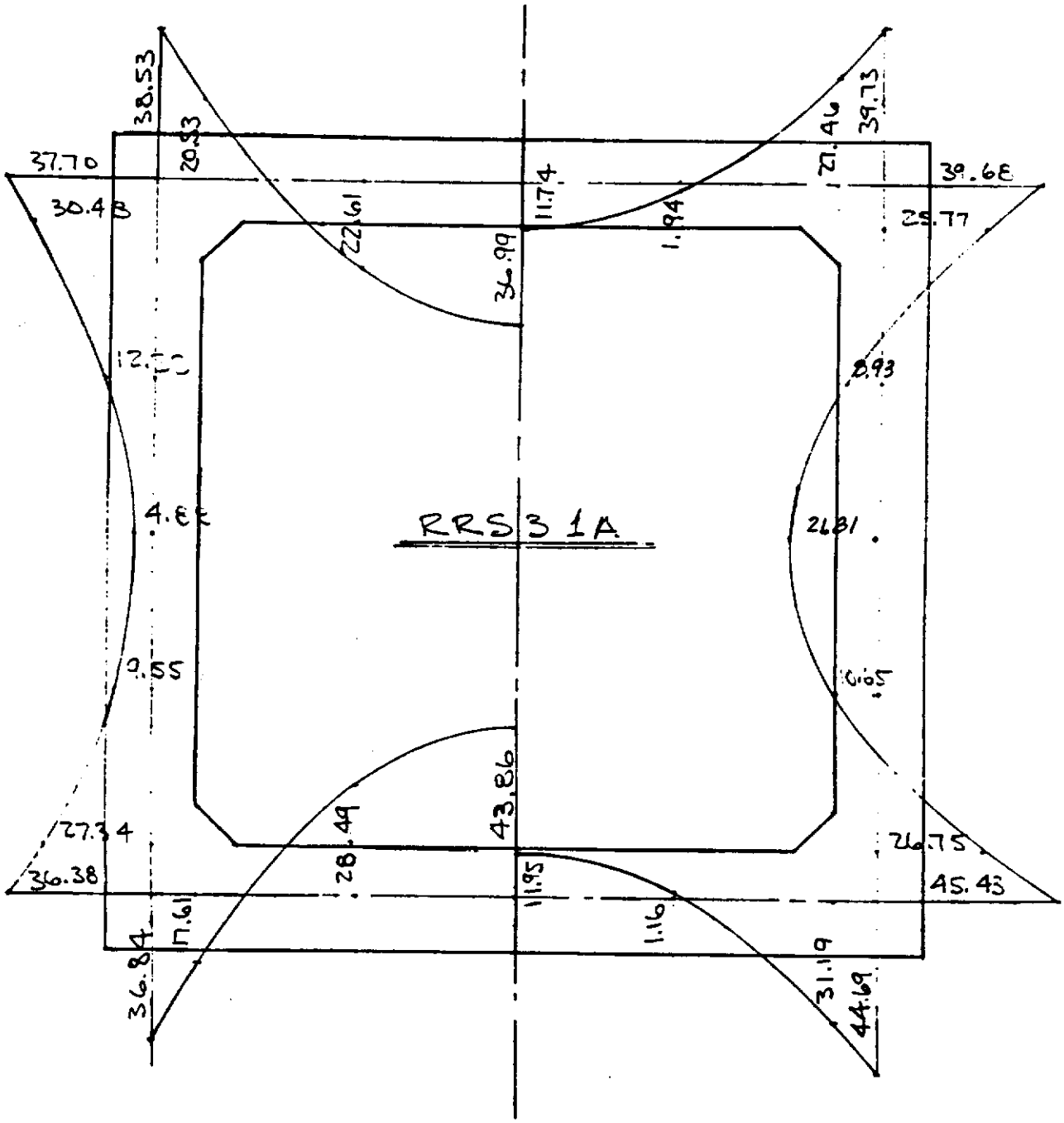
THE FINAL 16'-8 ON EITHER END AND THE HEADWALLS ARE OF IOWA DOT STANDARD DESIGN.

Subject		Date
REL ROCK TRAILS - SEGMENT III		SEP 93
Computed by K. WILSON	Checked by MW	Sheet C-1 of



Subject RED ROCK TRAILS - SEGMENT III		Date 18 DEC. 2_
Computed by K. WILSON	Checked by MW	Sheet C-5 of

CULVERT - END SECTIONS

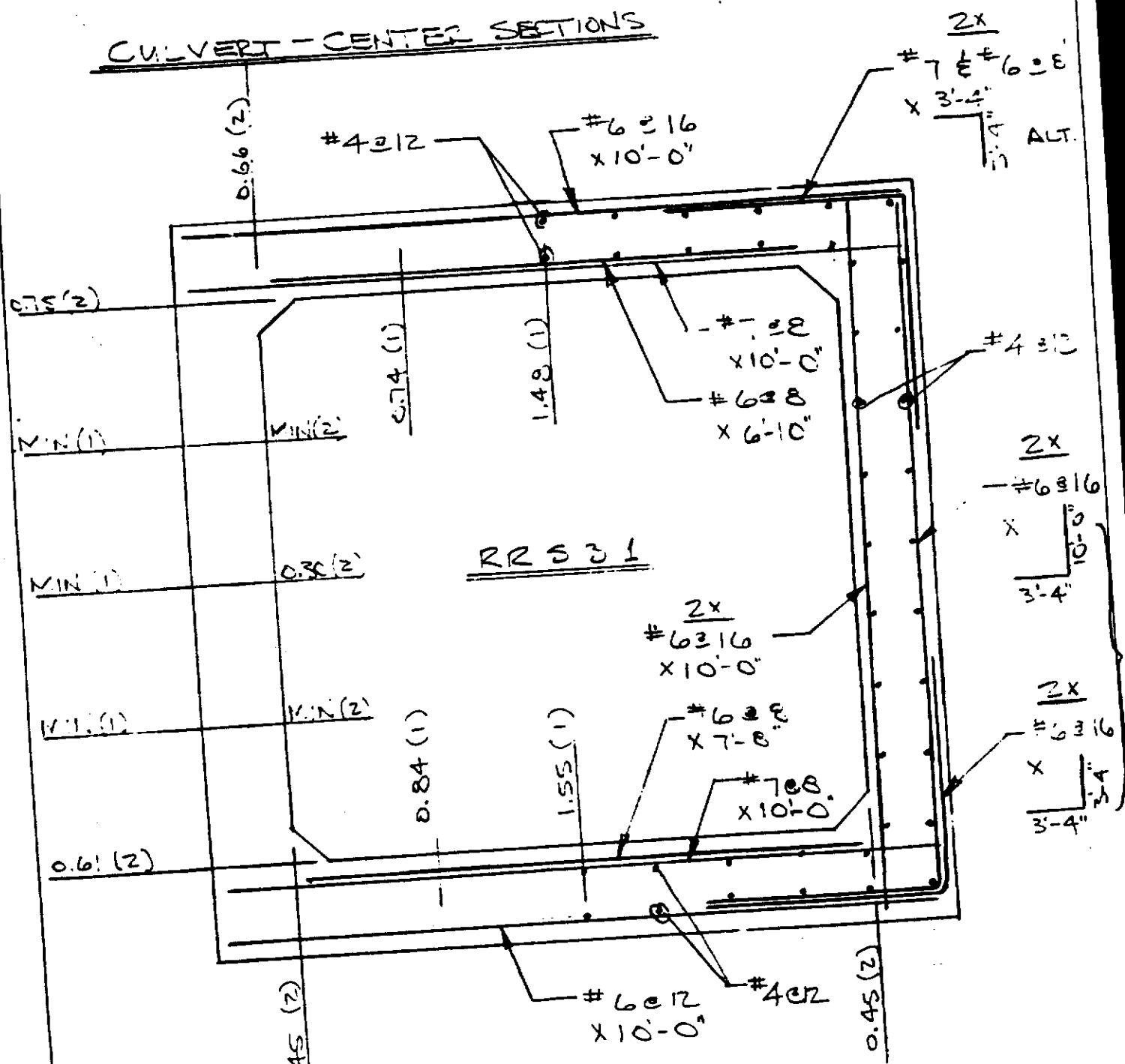


CASE 1 CASE 2

RRS 31A0

Subject RED ROCK TRAILS - SEGMENT III		Date DEC 97
Computed by K. WILSON	Checked by MW	Sheet C6 of

CULVERT - CENTER SECTIONS

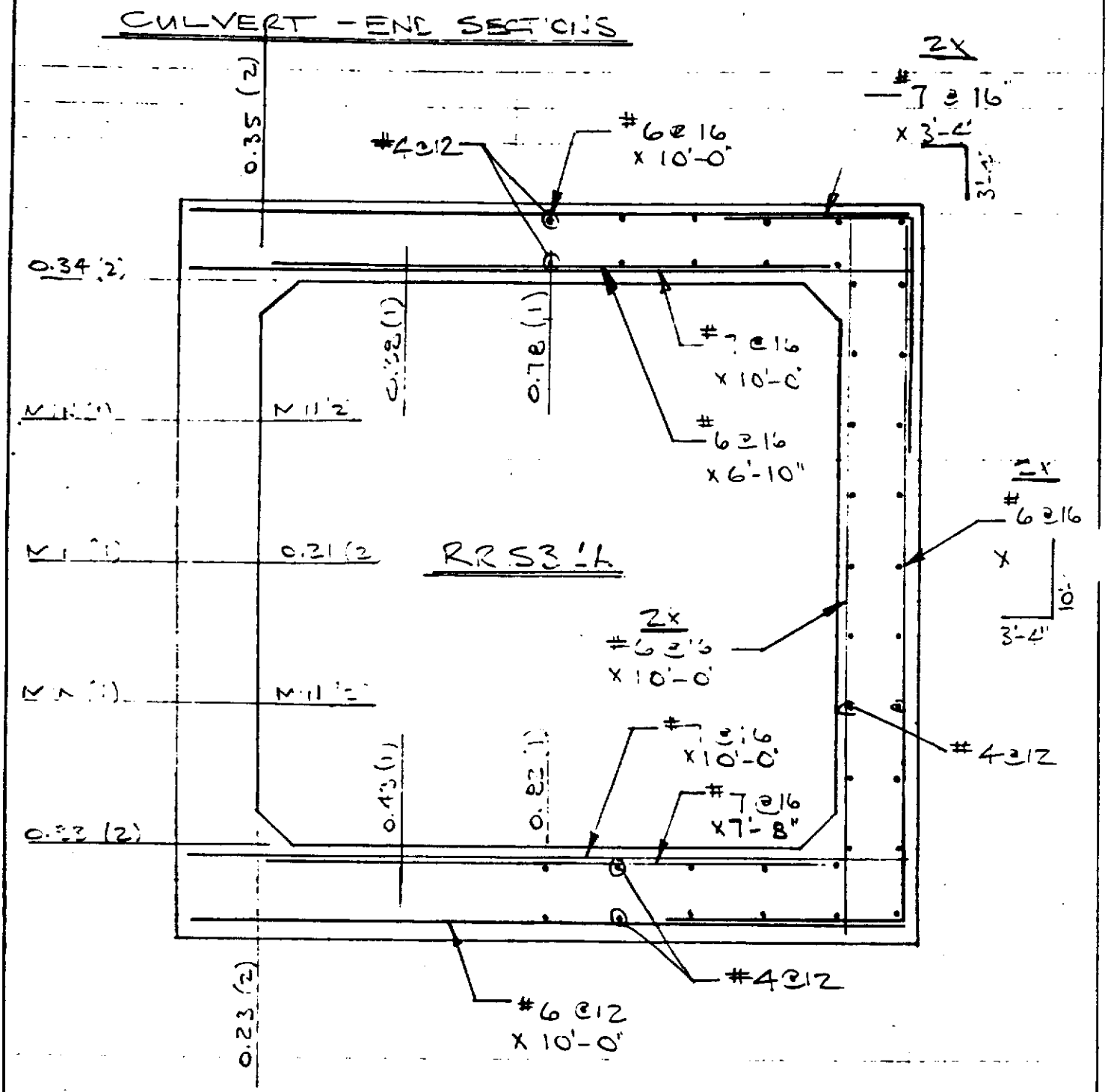


MIN. REINF. $A_{s\,TRANS.} = 0.002\,bt \leq$ #8@12

$A_{s\,LONG.} = 0.001\,bt \leq$ #6@12

EM 1110-2-2902

Subject		Date
RE: ROCK TRAILS - SEGMENT III		18 DEC. 02
Computed by K. WILSON	Checked by MW	Sheet C-7 of



```
1000 4 DESIGN OF SINGLE CELL CULVERT -RR531I
1010   STRENGTH DESIGN PROCEDURE
1020   SHEAR DESIGN WITH COMBINATIOON OF UI 440 AND ACI 63
1030   TWO LOAD CASES
1040 D SD   2
1050  4000.0  48000.0   150.0  .3750  .0000
1060   1   8.00   0.00  0.00   8.00
1070     2.38     2.38     3.38
1080    14.00    12.00    14.00
1090     3.00     3.00     3.00
1100   1
1110     37.16  128.00   125.00
1120   2  62.50
1130     1.50      .50      .00   0.00
1140     1.00     1.00      .00   0.00
1150     2.21     1.82
1160     1.00     1.00
```

PROGRAM CORTCUL - DESIGN/INVESTIGATION OF ORTHOGONAL CULVERTS
DATE: 92/12/15 RR5310 TIME: 14.57.35

1. INPUT DATA

1.A.--HEADING

DESIGN OF SINGLE CELL CULVERT
STRENGTH DESIGN PROCEDURE
SHEAR DESIGN WITH COMBINATIOON OF UI 440 AND ACI 63
TWO LOAD CASES

1.B.--MODE AND PROCEDURE
DESIGN USING ACI STRENGTH DESIGN PROCEDURE, AND
SHEAR DESIGN OPTION 2

1.C.--MATERIAL PROPERTIES

CONCRETE:

ULTIMATE STRENGTH	=	4000.	(PSI)
ULTIMATE STRAIN	=	.003	
COMP. BLOCK RATIO	=	.85	
UNIT WEIGHT	=	150.	(PCF)

REINFORCEMENT:

YIELD STRENGTH	=	48000.	(PSI)
MODULUS OF ELASTICITY	=	29.E+06	(PSI)
MAXIMUM REINF RATIO	=	.38	

STRENGTH REDUCTION FACTOR = VARIABLE

1.D.--GEOMETRY

NO OF CELLS	CELL HEIGHT (FT)	HAUNCH WIDTH (IN)	INVERT ELEV (FT)	CELL WIDTH (FT)
1	8.00	.00	.00	8.00

REINFORCEMENT COVER (IN):		MINIMUM THICKNESS (IN):	
EXTERIOR SURFACES	= 2.38	ROOF SLAB	= 14.00
INTERIOR ROOF/END WALLS	= 2.38	EXTERIOR WALLS	= 12.00
INTERIOR BASE SLAB	= 3.38	BASE SLAB	= 14.00

MAXIMUM REINF AREA (SQIN):

ROOF SLAB	= 3.00
EXTERIOR WALLS	= 3.00
BASE SLAB	= 3.00

1.E.--LOAD DATA

1.E.1.--STANDARD LOAD CASES

SOIL DATA:

LAYER NO	ELEV AT TOP OF LAYER (FT)	SATURATED UNIT WEIGHT (PCF)	MOIST UNIT WEIGHT (PCF)
1	37.16	128.00	125.00

STANDARD LOAD CASE DATA
WATER UNIT WEIGHT = 62.5 (PCF)

LOAD CASE	PRESSURE COEFFICIENTS VERTICAL	HORIZONTAL	SURFACE SURCHARGE (PSF)	GROUND WATER ELEVATION (FT)
1	1.50	.50	.00	.00
2	1.00	1.00	.00	.00

FOUNDATION REACTION COEFFICIENTS:
OUTER EDGES = 1.00
CENTERLINE = 1.00

1.E.2--SPECIAL LOAD CASES

NO SPECIAL LOAD CASES

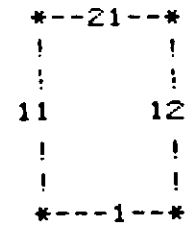
1.E.3.--LOAD FACTORS FOR ACI STRENGTH DESIGN:

LIVE LOAD FACTOR = 2.21
DEAD LOAD FACTOR = 1.82

1.E.4--INTERNAL WATER DATA

NO INTERNAL WATER

SCHEMATIC OF CULVERT:



```
LOCAL COORDINATE SYSTEMS:
     HORIZONTAL MEMBERS: ORIGIN AT LEFT END, X-AXIS TO RIGHT, Y-AXIS U
     VERTICAL MEMBERS  : ORIGIN AT BOTTOM, X-AXIS UP, Y-AXIS TO LEFT

SIGN CONVENTIONS:
     POSITIVE LATERAL LOAD ACTS IN PLUS Y DIRECTION
     POSITIVE BENDING MOMENT PRODUCES COMPRESSION
          ON PLUS Y FACE OF MEMBER
     POSITIVE SHEAR TENDS TO MOVE MEMBER IN PLUS Y DIRECTION
     POSITIVE AXIAL LOAD ACTS IN PLUS X DIRECTION
     POSITIVE AXIAL INTERNAL FORCE IS COMPRESSION
```

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PROGRAM CORTCUL - DESIGN/INVESTIGATION OF ORTHOGONAL CULVERTS
DATE: 92/12/15                                        TIME: 14.58.06

2.--DESIGN RESULTS

2.A.--HEADING

DESIGN OF SINGLE CELL CULVERT
STRENGTH DESIGN PROCEDURE
SHEAR DESIGN WITH COMBINATIOON OF UI 440 AND ACI 63
TWO LOAD CASES


2.B.--DESIGN THICKNESSES
      DESIGN USING ACI STRENGTH DESIGN PROCEDURE, AND
      SHEAR DESIGN OPTION 2

                          DESIGN       <------CONTROLLING------>
                        THICKNESS      LOAD      STRESS
                          (IN)         CASE    CONDITION    MEMBER
                                       <-------MINIMUM--------->
     ROOF SLAB      :      14.
     EXTERIOR WALLS:       14.          2       SHEAR         11
     BASE SLAB      :      16.          1       SHEAR          1

     CONCRETE AREA IN CROSS SECTION =     44.50 (SQFT)
```

2.C.--DESIGN REINFORCEMENT DATA FOR LEFT HALF OF SYSTEM
DESIGN USING ACI STRENGTH DESIGN PROCEDURE, AND
SHEAR DESIGN OPTION 2

MEMBER NUMBER 1

DIST FROM LEFT END (FT)	<------CONTROLLING------> LOAD CASE	BENDING MOMENT (K-FT)	AXIAL FORCE (KIPS)	REINFORCEMENT LOCATION	AREA (SQI
.58	2	47.09	52.09	BOT	.45
2.58	1	-47.82	25.27	TOP	.84
4.58	1	-72.64	25.27	TOP	1.55
6.58	1	-47.82	25.27	TOP	.84
8.58	2	47.09	52.09	BOT	.45

MEMBER NUMBER 11

DIST FROM LEFT END (FT)	<------CONTROLLING------> LOAD CASE	BENDING MOMENT (K-FT)	AXIAL FORCE (KIPS)	REINFORCEMENT LOCATION	AREA (SQIN
.67	2	-41.65	43.94	TOP	.61
2.67	1	-17.10	63.28	TOP	MIN
	2	14.48	43.30	BOT	MIN
4.67	1	-10.14	62.64	TOP	MIN
	2	31.76	42.66	BOT	.30
6.67	1	-21.50	62.00	TOP	MIN
	2	12.40	42.02	BOT	MIN
8.67	1	-50.07	61.37	TOP	.75

MEMBER NUMBER 21

DIST FROM LEFT END (FT)	<------CONTROLLING------> LOAD CASE	BENDING MOMENT (K-FT)	AXIAL FORCE (KIPS)	REINFORCEMENT LOCATION	AREA (SQIN
.58	2	-43.13	44.35	TOP	.66
2.58	1	38.49	23.01	BOT	.74
4.58	1	62.33	23.01	BOT	1.48
6.58	1	38.49	23.01	BOT	.74
8.58	2	-43.13	44.35	TOP	.66

3.--DESIGN MEMBER LOAD/FORCE DATA, LOAD CASE 1
DESIGN USING ACI STRENGTH DESIGN PROCEDURE, AND
SHEAR DESIGN OPTION 2

DESIGN LOAD/FORCE DATA FOR MEMBER 1

DIST FROM LEFT END (FT)	LATERAL LOAD (KSF)	BENDING MOMENT (K-FT)	SHEAR (KIPS)	AXIAL FORCE (KIPS)
.00	12.41	57.72	-56.89	25.27
.58	12.41	26.65	-49.65	25.27
2.58	12.41	-47.82	-24.82	25.27
4.58	12.41	-72.64	.00	25.27
6.58	12.41	-47.82	24.82	25.27
8.58	12.41	26.65	49.65	25.27
9.17	12.41	57.72	56.89	25.27

DESIGN LOAD/FORCE DATA FOR MEMBER 11

DIST FROM LEFT END (FT)	LATERAL LOAD (KSF)	BENDING MOMENT (K-FT)	SHEAR (KIPS)	AXIAL FORCE (KIPS)
.00	-5.27	-56.80	21.70	64.13
.67	-5.13	-43.49	18.23	63.91
2.67	-4.86	-17.10	8.25	63.28
4.67	-4.58	-10.14	-1.19	62.64
6.67	-4.30	-21.50	-10.08	62.00
8.67	-4.03	-50.07	-18.41	61.37
9.25	-3.95	-61.49	-20.73	61.18

DESIGN LOAD/FORCE DATA FOR MEMBER 12

DIST FROM LEFT END (FT)	LATERAL LOAD (KSF)	BENDING MOMENT (K-FT)	SHEAR (KIPS)	AXIAL FORCE (KIPS)
.00	5.27	56.80	-21.70	64.13
.67	5.13	43.49	-18.23	63.91
2.67	4.86	17.10	-8.25	63.28
4.67	4.58	10.14	1.19	62.64
6.67	4.30	21.50	10.08	62.00
8.67	4.03	50.07	18.41	61.37
9.25	3.95	61.49	20.73	61.18

DESIGN LOAD/FORCE DATA FOR MEMBER 21

DIST FROM LEFT END (FT)	LATERAL LOAD (KSF)	BENDING MOMENT (K-FT)	SHEAR (KIPS)	AXIAL FORCE (KIPS)
.00	-11.92	-62.86	54.63	23.01
.58	-11.92	-33.02	47.67	23.01
2.58	-11.92	38.49	23.84	23.01
4.58	-11.92	62.33	.00	23.01
6.58	-11.92	38.49	-23.84	23.01
8.58	-11.92	-33.02	-47.67	23.01
9.17	-11.92	-62.86	-54.63	23.01

3.--DESIGN MEMBER LOAD/FORCE DATA, LOAD CASE 2
DESIGN USING ACI STRENGTH DESIGN PROCEDURE, AND
SHEAR DESIGN OPTION 2

DESIGN LOAD/FORCE DATA FOR MEMBER 1

DIST FROM LEFT END (FT)	LATERAL LOAD (KSF)	BENDING MOMENT (K-FT)	SHEAR (KIPS)	AXIAL FORCE (KIPS)
.00	8.54	68.48	-39.16	52.09
.58	8.54	47.09	-34.18	52.09
2.58	8.54	-4.18	-17.09	52.09
4.58	8.54	-21.27	.00	52.09
6.58	8.54	-4.18	17.09	52.09
8.58	8.54	47.09	34.18	52.09
9.17	8.54	68.48	39.16	52.09

DESIGN LOAD/FORCE DATA FOR MEMBER 11

DIST FROM LEFT END (FT)	LATERAL LOAD (KSF)	BENDING MOMENT (K-FT)	SHEAR (KIPS)	AXIAL FORCE (KIPS)
.00	-10.45	-69.38	45.05	44.15
.67	-10.27	-41.65	38.15	43.94
2.67	-9.71	14.48	18.17	43.30
4.67	-9.16	31.76	-.70	42.66
6.67	-8.61	12.40	-18.47	42.02
8.67	-8.06	-41.39	-35.14	41.39
9.25	-7.89	-63.25	-39.79	41.20

DESIGN LOAD/FORCE DATA FOR MEMBER 12

DIST FROM LEFT END (FT)	LATERAL LOAD (KSF)	BENDING MOMENT (K-FT)	SHEAR (KIPS)	AXIAL FORCE (KIPS)
.00	10.45	69.38	-45.05	44.15
.67	10.27	41.65	-38.15	43.94
2.67	9.71	-14.48	-18.17	43.30
4.67	9.16	-31.76	.70	42.66
6.67	8.61	-12.40	18.47	42.02
8.67	8.06	41.39	35.14	41.39
9.25	7.89	63.25	39.79	41.20

DESIGN LOAD/FORCE DATA FOR MEMBER 21

DIST FROM LEFT END (FT)	LATERAL LOAD (KSF)	BENDING MOMENT (K-FT)	SHEAR (KIPS)	AXIAL FORCE (KIPS)
.00	-8.05	-63.29	36.90	44.35
.58	-8.05	-43.13	32.21	44.35
2.58	-8.05	5.18	16.10	44.35
4.58	-8.05	21.28	.00	44.35
6.58	-8.05	5.18	-16.10	44.35
8.58	-8.05	-43.13	-32.21	44.35
9.17	-8.05	-63.29	-36.90	44.35

```
1000 4 DESIGN OF SINGLE CELL CULVERT - RR531A1
1010   STRENGTH DESIGN PROCEDURE
1020   SHEAR DESIGN WITH COMBINATIOON OF UI 440 AND ACI 63
1030   TWO LOAD CASES
1040 D SD   2
1050  4000.0  48000.0   150.0  .3750  .0000
1060   1   8.00   0.00  0.00   8.00
1070     2.38     2.38     3.38
1080    14.00    14.00    16.00
1090     3.00     3.00     3.00
1100   1
1110     25.75  128.00   125.00
1120   2  62.50
1130     1.50      .50      .00   0.00
1140     1.00     1.00      .00   0.00
1150     2.21     1.82
1160     1.00     1.00
```

PROGRAM CORTCUL - DESIGN/INVESTIGATION OF ORTHOGONAL CULVERTS
DATE: 92/12/17 RRS3 AC TIME: 15.07.10

1. INPUT DATA

1.A.--HEADING

DESIGN OF SINGLE CELL CULVERT
STRENGTH DESIGN PROCEDURE
SHEAR DESIGN WITH COMBINATIOON OF UI 440 AND ACI 63
TWO LOAD CASES

1.B.--MODE AND PROCEDURE
DESIGN USING ACI STRENGTH DESIGN PROCEDURE, AND
SHEAR DESIGN OPTION 2

1.C.--MATERIAL PROPERTIES

CONCRETE:

ULTIMATE STRENGTH	=	4000.	(PSI)
ULTIMATE STRAIN	=	.003	
COMP. BLOCK RATIO	=	.85	
UNIT WEIGHT	=	150.	(PCF)

REINFORCEMENT:

YIELD STRENGTH	=	48000.	(PSI)
MODULUS OF ELASTICITY	=	29.E+06	(PSI)
MAXIMUM REINF RATIO	=	.38	

STRENGTH REDUCTION FACTOR = VARIABLE

1.D.--GEOMETRY

NO OF CELLS	CELL HEIGHT (FT)	HAUNCH WIDTH (IN)	INVERT ELEV (FT)	CELL WIDTH (FT)
1	8.00	.00	.00	8.00

REINFORCEMENT COVER (IN):

EXTERIOR SURFACES	= 2.38
INTERIOR ROOF/END WALLS	= 2.38
INTERIOR BASE SLAB	= 3.38

MINIMUM THICKNESS (IN):

ROOF SLAB	= 14.00
EXTERIOR WALLS	= 14.00
BASE SLAB	= 16.00

MAXIMUM REINF AREA (SQIN):

ROOF SLAB	= 3.00
EXTERIOR WALLS	= 3.00
BASE SLAB	= 3.00

1.E.--LOAD DATA

1.E.1.--STANDARD LOAD CASES

SOIL DATA:

LAYER NO	ELEV AT TOP OF LAYER (FT)	SATURATED UNIT WEIGHT (PCF)	MOIST UNIT WEIGHT (PCF)
1	25.75	128.00	125.00

STANDARD LOAD CASE DATA
WATER UNIT WEIGHT = 62.5 (PCF)

LOAD CASE	PRESSURE COEFFICIENTS VERTICAL	HORIZONTAL	SURFACE SURCHARGE (PSF)	GROUND WATER ELEVATION (FT)
1	1.50	.50	.00	.00
2	1.00	1.00	.00	.00

FOUNDATION REACTION COEFFICIENTS:
OUTER EDGES = 1.00
CENTERLINE = 1.00

1.E.2--SPECIAL LOAD CASES

NO SPECIAL LOAD CASES

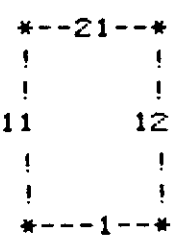
1.E.3.--LOAD FACTORS FOR ACI STRENGTH DESIGN:

LIVE LOAD FACTOR = 2.21
DEAD LOAD FACTOR = 1.82

1.E.4--INTERNAL WATER DATA

NO INTERNAL WATER

SCHEMATIC OF CULVERT:



LOCAL COORDINATE SYSTEMS:
HORIZONTAL MEMBERS: ORIGIN AT LEFT END, X-AXIS TO RIGHT, Y-AXIS UI
VERTICAL MEMBERS : ORIGIN AT BOTTOM, X-AXIS UP, Y-AXIS TO LEFT

SIGN CONVENTIONS:
POSITIVE LATERAL LOAD ACTS IN PLUS Y DIRECTION
POSITIVE BENDING MOMENT PRODUCES COMPRESSION
ON PLUS Y FACE OF MEMBER
POSITIVE SHEAR TENDS TO MOVE MEMBER IN PLUS Y DIRECTION
POSITIVE AXIAL LOAD ACTS IN PLUS X DIRECTION
POSITIVE AXIAL INTERNAL FORCE IS COMPRESSION

PROGRAM CORTCUL - DESIGN/INVESTIGATION OF ORTHOGONAL CULVERTS
DATE: 92/12/17 TIME: 15.07.34

2.--DESIGN RESULTS

2.A.--HEADING

DESIGN OF SINGLE CELL CULVERT
STRENGTH DESIGN PROCEDURE
SHEAR DESIGN WITH COMBINATIOON OF UI 440 AND ACI 63
TWO LOAD CASES

2.B.--DESIGN THICKNESSES
DESIGN USING ACI STRENGTH DESIGN PROCEDURE, AND
SHEAR DESIGN OPTION 2

	DESIGN THICKNESS (IN)	<------CONTROLLING------> LOAD CASE	STRESS CONDITION	MEMBER
ROOF SLAB :	14.	<-------MINIMUM--------->		
EXTERIOR WALLS:	14.	<-------MINIMUM--------->		
BASE SLAB :	16.	<-------MINIMUM--------->		

CONCRETE AREA IN CROSS SECTION = 44.50 (SQFT)

2.C.--DESIGN REINFORCEMENT DATA FOR LEFT HALF OF SYSTEM
DESIGN USING ACI STRENGTH DESIGN PROCEDURE, AND
SHEAR DESIGN OPTION 2

MEMBER NUMBER 1

DIST FROM LEFT END (FT)	<------CONTROLLING------> LOAD CASE	BENDING MOMENT (K-FT)	AXIAL FORCE (KIPS)	REINFORCEMENT LOCATION	AREA (SQI
.58	2	31.19	35.37	BOT	.2
2.58	1	-28.49	17.29	TOP	.4
4.58	1	-43.86	17.29	TOP	.8
6.58	1	-28.49	17.29	TOP	.4
8.58	2	31.19	35.37	BOT	.2

MEMBER NUMBER 11

DIST FROM LEFT END (FT)	<------CONTROLLING------> LOAD CASE	BENDING MOMENT (K-FT)	AXIAL FORCE (KIPS)	REINFORCEMENT LOCATION	AREA (SQIN
.67	2	-26.75	27.65	TOP	.3
2.67	1	-9.55	38.85	TOP	MIN
	2	10.65	27.01	BOT	MIN
4.67	1	-4.88	38.21	TOP	MIN
	2	21.81	26.38	BOT	.21
6.67	1	-12.22	37.57	TOP	MIN
	2	8.93	25.74	BOT	MIN
8.67	2	-25.77	25.10	TOP	.34

MEMBER NUMBER 21

DIST FROM LEFT END (FT)	<------CONTROLLING------> LOAD CASE	BENDING MOMENT (K-FT)	AXIAL FORCE (KIPS)	REINFORCEMENT LOCATION	AREA (SQIN
.58	2	-27.46	27.97	TOP	.35
2.58	1	22.61	14.44	BOT	.38
4.58	1	36.99	14.44	BOT	.78
6.58	1	22.61	14.44	BOT	.38
8.58	2	-27.46	27.97	TOP	.35

3.--DESIGN MEMBER LOAD/FORCE DATA, LOAD CASE 1
DESIGN USING ACI STRENGTH DESIGN PROCEDURE, AND
SHEAR DESIGN OPTION 2

DESIGN LOAD/FORCE DATA FOR MEMBER 1

DIST FROM LEFT END (FT)	LATERAL LOAD (KSF)	BENDING MOMENT (K-FT)	SHEAR (KIPS)	AXIAL FORCE (KIPS)
.00	7.68	36.84	-35.22	17.29
.58	7.68	17.61	-30.73	17.29
2.58	7.68	-28.49	-15.37	17.29
4.58	7.68	-43.86	.00	17.29
6.58	7.68	-28.49	15.37	17.29
8.58	7.68	17.61	30.73	17.29
9.17	7.68	36.84	35.22	17.29

DESIGN LOAD/FORCE DATA FOR MEMBER 11

DIST FROM LEFT END (FT)	LATERAL LOAD (KSF)	BENDING MOMENT (K-FT)	SHEAR (KIPS)	AXIAL FORCE (KIPS)
.00	-3.70	-36.38	14.78	39.70
.67	-3.56	-27.34	12.36	39.49
2.67	-3.28	-9.55	5.52	38.85
4.67	-3.00	-4.88	-.76	38.21
6.67	-2.73	-12.22	-6.49	37.57
8.67	-2.45	-30.48	-11.67	36.94
9.25	-2.37	-37.70	-13.08	36.75

DESIGN LOAD/FORCE DATA FOR MEMBER 12

DIST FROM LEFT END (FT)	LATERAL LOAD (KSF)	BENDING MOMENT (K-FT)	SHEAR (KIPS)	AXIAL FORCE (KIPS)
.00	3.70	36.38	-14.78	39.70
.67	3.56	27.34	-12.36	39.49
2.67	3.28	9.55	-5.52	38.85
4.67	3.00	4.88	.76	38.21
6.67	2.73	12.22	6.49	37.57
8.67	2.45	30.48	11.67	36.94
9.25	2.37	37.70	13.08	36.75

DESIGN LOAD/FORCE DATA FOR MEMBER 21

DIST FROM LEFT END (FT)	LATERAL LOAD (KSF)	BENDING MOMENT (K-FT)	SHEAR (KIPS)	AXIAL FORCE (KIPS)
.00	-7.19	-38.53	32.96	14.44
.58	-7.19	-20.53	28.76	14.44
2.58	-7.19	22.61	14.38	14.44
4.58	-7.19	36.99	.00	14.44
6.58	-7.19	22.61	-14.38	14.44
8.58	-7.19	-20.53	-28.76	14.44
9.17	-7.19	-38.53	-32.96	14.44

3.--DESIGN MEMBER LOAD/FORCE DATA, LOAD CASE 2
DESIGN USING ACI STRENGTH DESIGN PROCEDURE, AND
SHEAR DESIGN OPTION 2

DESIGN LOAD/FORCE DATA FOR MEMBER 1

DIST FROM LEFT END (FT)	LATERAL LOAD (KSF)	BENDING MOMENT (K-FT)	SHEAR (KIPS)	AXIAL FORCE (KIPS)
.00	5.39	44.69	-24.72	35.37
.58	5.39	31.19	-21.57	35.37
2.58	5.39	-1.16	-10.79	35.37
4.58	5.39	-11.95	.00	35.37
6.58	5.39	-1.16	10.79	35.37
8.58	5.39	31.19	21.57	35.37
9.17	5.39	44.69	24.72	35.37

DESIGN LOAD/FORCE DATA FOR MEMBER 11

DIST FROM LEFT END (FT)	LATERAL LOAD (KSF)	BENDING MOMENT (K-FT)	SHEAR (KIPS)	AXIAL FORCE (KIPS)
.00	-7.30	-45.43	30.43	27.86
.67	-7.11	-26.75	25.63	27.65
2.67	-6.56	10.65	11.95	27.01
4.67	-6.01	21.81	-.61	26.38
6.67	-5.46	8.93	-12.08	25.74
8.67	-4.90	-25.77	-22.44	25.10
9.25	-4.74	-39.68	-25.25	24.92

DESIGN LOAD/FORCE DATA FOR MEMBER 12

DIST FROM LEFT END Q(FT)	LATERAL LOAD (KSF)	BENDING MOMENT (K-FT)	SHEAR (KIPS)	AXIAL FORCE (KIPS)
.00	7.30	45.43	-30.43	27.86
.67	7.11	26.75	-25.63	27.65
2.67	6.56	-10.65	-11.95	27.01
4.67	6.01	-21.81	.61	26.38
6.67	5.46	-8.93	12.08	25.74
8.67	4.90	25.77	22.44	25.10
9.25	4.74	39.68	25.25	24.92

DESIGN LOAD/FORCE DATA FOR MEMBER 21

DIST FROM LEFT END (FT)	LATERAL LOAD (KSF)	BENDING MOMENT (K-FT)	SHEAR (KIPS)	AXIAL FORCE (KIPS)
.00	-4.90	-39.73	22.46	27.97
.58	-4.90	-27.46	19.60	27.97
2.58	-4.90	1.94	9.80	27.97
4.58	-4.90	11.74	.00	27.97
6.58	-4.90	1.94	-9.80	27.97
8.58	-4.90	-27.46	-19.60	27.97
9.17	-4.90	-39.73	-22.46	27.97

ECONOMIC ANALYSIS

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DES MOINES RECREATIONAL RIVER AND GREENBELT
FEATURE DESIGN MEMORANDUM #9
WITH ENVIRONMENTAL ASSESSMENT

RED ROCK MULTI-PURPOSE TRAIL
SEGMENT 3

APPENDIX E
ECONOMIC ANALYSIS

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DES MOINES RECREATIONAL RIVER AND GREENBELT
FEATURE DESIGN MEMORANDUM #9
WITH ENVIRONMENTAL ASSESSMENT

RED ROCK MULTI-PURPOSE TRAIL
SEGMENT 3

APPENDIX E
ECONOMIC ANALYSIS

1. Introduction

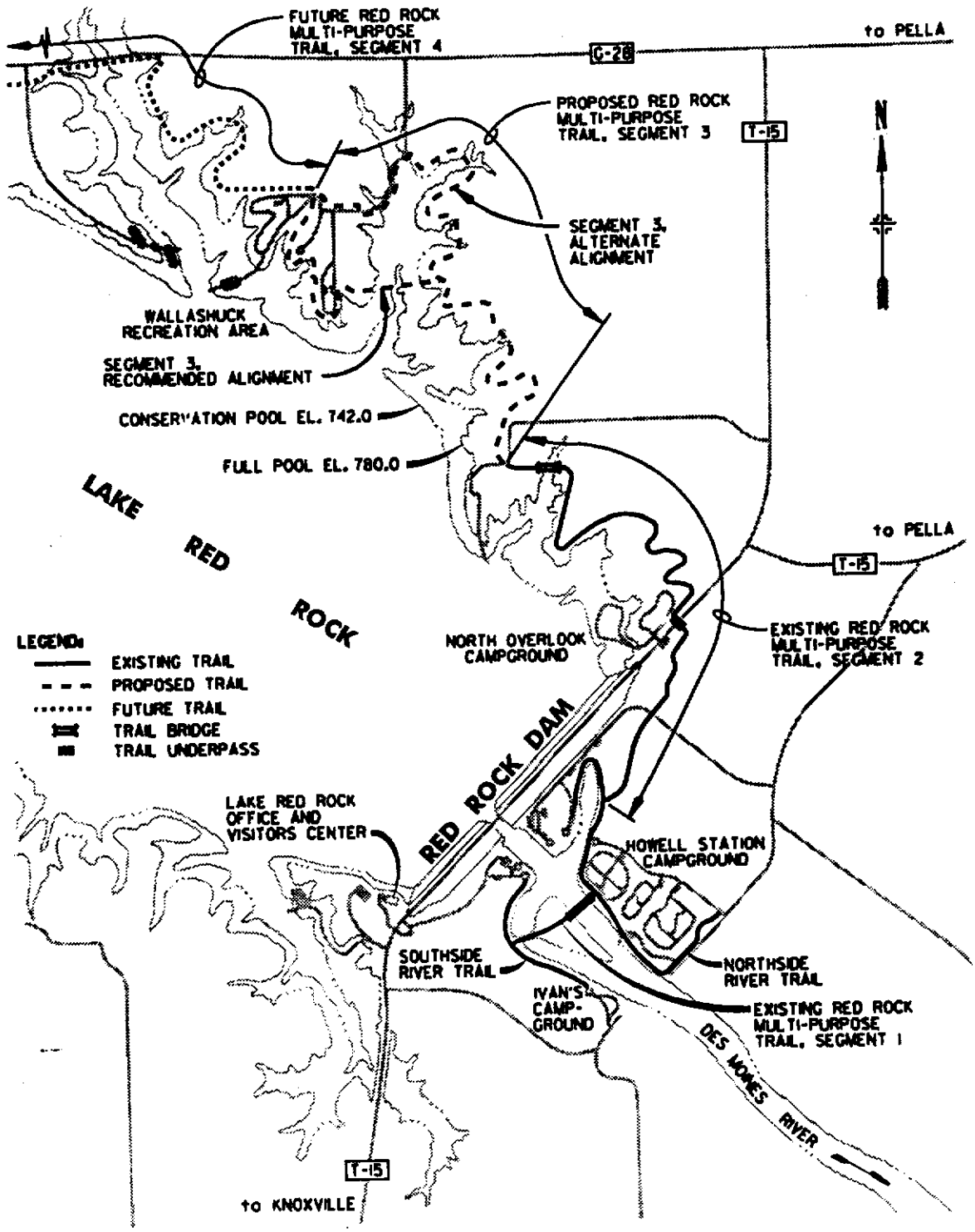
This analysis examines the economic feasibility of constructing an additional two miles of multi-purpose trail to extend the existing trail at Lake Red Rock, Marion County, Iowa. The proposed trail would enhance the recreation experience afforded at the Federally owned and managed park complex, and eliminate the need for trail users to travel county and state highways while using the Lake Red Rock trail system. In addition, the trail segment would help fulfill current and future demand for trail facilities in central Iowa.

2. Existing Conditions

Existing recreational facilities at Lake Red Rock include various multi-purpose trails which have been linked through the construction of Segments 1 and 2 of the Greenbelt project (See Plate E-1). Table E-1 shows the existing trail system at Lake Red Rock.

Table E-1
Existing Trail System at Lake Red Rock

	Trail
Segment 1 constructed	0.31 miles
to connect:	
Southside River Trail and	1.42 miles
Northside River Trail	1.20 miles
and provide access to:	
Howell Station Prairie Trail	2.50 miles
Federal Boundary Trail	0.67 miles
Segment 2 constructed	2.0 miles
to continue Segment 1 and provide access to:	
North Overlook Trail	1.1 miles



PROJECT LOCATION PLAN

2000 0 2000 4000 6000

APPROXIMATE SCALE IN FEET

Lake Red Rock Trail System

Plate E-1

This 9.2 mile trail system connects day use and overnight recreation areas and is heavily used by walkers, cyclists and others.

3. Trail System Improvements

(a) Segment 3 of the project proposes construction of 10,016 feet, or 1.9 miles of additional multi-purpose trail at Lake Red Rock. The new trail would begin where Segment 2 ends and continue the extension of the existing trail from North Overlook to Wallashuck Recreation Areas (See Plate E-1). The new 1.9-mile trail will connect the 2.3-mile Wallashuck Trail to the 9.2-mile Lake Red Rock trail system. Completion of Segment 3 will increase the overall length of trail at Lake Red Rock to 13.4 miles.

(b) Construction of the new trail will help fulfill current and forecasted public demand for recreation trails suitable for hiking, walking, and cycling. The need for additional miles of trail is supported by the market analysis provided in the Des Moines Recreational River and Greenbelt General Design Memorandum (GDM). The GDM reported that because of the increasing popularity of trail recreation over 500 additional miles of trail would be required to fulfill Greenbelt market area demand through 1995.

(c) Trail users will be able to stay within the Lake Red Rock recreation area without having to cycle or walk major highways to journey from one Red Rock trail system to another. The proposed multi-purpose trail would enhance recreation opportunities for trail users at Red Rock and within the Des Moines Recreational River and Greenbelt boundaries.

(d) There is one low location along the proposed trail route. Based upon various trail elevations, this location would either never be underwater, or would be underwater once every 5 to 14 years.

4. Benefit Computation

(a) The criteria used in selecting an appropriate procedure to evaluate recreation projects is detailed in Figure 6.7 of the Guidelines for Conducting Civil Works Planning Studies (ER 1105-2-100). The steps indicated in the Guidelines result in the Unit Day Value Method being used to determine the benefits associated with the proposed trail at Lake Red Rock. The criteria for selecting an appropriate procedure for evaluating recreation improvements at Lake Red Rock is shown in Table E-2.

This 9.2 mile trail system connects day use and overnight recreation areas and is heavily used by walkers, cyclists and others.

3. Trail System Improvements

(a) Segment 3 of the project proposes construction of 10,016 feet, or 1.9 miles of additional multi-purpose trail at Lake Red Rock. The new trail would begin where Segment 2 ends and continue the extension of the existing trail from North Overlook to Wallashuck Recreation Areas (See Plate E-1). The new 1.9-mile trail will connect the 2.3-mile Wallashuck Trail to the 9.2-mile Lake Red Rock trail system. Completion of Segment 3 will increase the overall length of trail at Lake Red Rock to 13.4 miles.

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(d) There is one low location along the proposed trail route. Based upon various trail elevations, this location would either never be underwater, or would be underwater once every 5 to 14 years.

4. Benefit Computation

(a) The criteria used in selecting an appropriate procedure to evaluate recreation projects is detailed in Figure 6.7 of the Guidelines for Conducting Civil Works Planning Studies (ER 1105-2-100). The steps indicated in the Guidelines result in the Unit Day Value Method being used to determine the benefits associated with the proposed trail at Lake Red Rock. The criteria for selecting an appropriate procedure for evaluating recreation improvements at Lake Red Rock is shown in Table E-2.

Table E-2
Selection Criteria

Criteria	Answer
Is a regional model available?	No
If "No", do uses affected involve specialized recreation activities?	No
If "No", do expected recreation costs exceed 25-percent of expended total project costs?	Yes
If "Yes", do specific annual Federal recreation costs exceed $1,750,000 FY 91 ($1,000,000 FY82)?	No
If "No", then use Unit Day Values for evaluating recreation benefits resulting from the proposed project.	

(b) The Guidelines selection criteria detailed in Table E-2 allows for consideration of the size of the recreation benefit created and the nature of the activities affected. Selection of a specific evaluation procedure is based on these components as well as the relative importance of any specialized recreation activity, the advantages of the respective methods, and cost considerations. Following the decision criteria and considering the small scale of the proposed project, the Unit Day Value Method is the preferred evaluation procedure for this analysis.

(c) Using Table 6-29 from ER 1105-2-100, "Guidelines for Assigning Points for General Recreation", judgment factor points were determined for both the existing "without project" and the proposed "with project" conditions. There is no existing trail connecting the 2.3-miles of trail at Wallashuck Recreation Areas to the other trails at Lake Red Rock. Wallashuck recreationists must drive, cycle or walk from Wallashuck over highway G-28 to highway T-15 and down to North Overlook Recreation Area in order to gain access to the existing 9.5 miles of Lake Red Rock trails.

(d) Unique characteristics of the proposed trail will allow recreationists to cross streams, traverse open prairie, sojourn through forests which have a wide mix of coniferous and deciduous trees, all the while enjoying the undulating terrain. Table E-3 presents a summary of the Unit Day Value Method Assessment for recreation experience on a multi-purpose trail for bicycling, hiking, jogger, roller skaters/roller bladers, skateboards, walkers, sight-seers, photographers, etc. (Users).

Table E-3
Segment 3 Unit Day Value Assessment for Users

Criteria	Judgment Factor Points Without Proj	With Proj	Comments
Recreation Experience	5.0	10.0	New trail would enhance the recreation experience. Winding through a topographically varied area with many diverse scenic enhancements. It would create a multi-purpose trail experience quite different from the existing Lake Red Rock trail system. Highway travel between trails would no longer be necessary.
Availability of Opportunity	5.0	9.0	New trail features wooded and varied vegetative plains areas, wooded topographic areas, and creates a very intriguing outdoor recreation opportunity for users, particularly urban dwellers. The new trail segment would provide a unique recreation experience in central Iowa.
Carrying Capacity	2.0	9.0	New trail would be 10,560 feet long and would connect Wallashuck users to the existing Lake Red Rock trail. This new trail segment would provide optimum facilities for users with its paved surface and well marked trail.
Accessi-bility	6.0	13.0	New trail would connect and link existing recreation amenities at the eastern edge of the reservoir by continuing the existing trail from North Overlook recreation area to the Wallashuck recreation area. There are good access roads to the site and good access within the Lake Red Rock recreation complex. Users would no longer have to travel on county and state highways to go

			from one Lake Red Rock multi-purpose trail to another.
Environ-mental	6.0	14.0	New trail has a very high aesthetic quality and will roam over varying topography, through diverse vegetative areas ranging from woods to prairie. The trail will cross three creeks. The users will have an almost continually changing scenic view from low prairie lands to an elevated position on the bluffline overlooking the lake.

Total Judgment Factor Points			
Without Project	24.0	With Project	55.0
Point Value	$3.30		$5.13

Net increase in value per User = $1.83

(e) As indicated in Table E-3, the proposed trail improvement would provide an enhanced recreation experience and an increased opportunity for Wallashuck users on a longer multi-purpose trail, increase trail carrying capacity, improve accessibility to and between Lake Red Rock recreation amenities, and increase the users opportunity to view the environmental features of the area. These categories are detailed in the Guidelines, Section VIII, paragraph 6-115 Unit Day Value Method.

(f) Based on ER 1105-2-100, Revised Table 6-28 (FY93), the Unit Day Value of one user on the existing trail network at Lake Red Rock is $3.30. Following completion of the proposed 1.9-mile long trail extension toward Wallashuck Recreation Area, this value for cyclists/hikers would increase by $1.83 cents to $5.13 per recreationist.

5. Anticipated Use of New Trail

(a) The Des Moines Recreational River and Greenbelt General Design Memorandum (GDM) reported that a minimum of 500 additional miles of multi-purpose trail within the Greenbelt boundaries would be required to fulfill demand through 1995. The 1990 Iowa SCORP, conducted by the State of Iowa, reflected state recreational needs on a county and regional basis and indicated demand for an additional 77 miles of foot trail in the area. Based on these analyses, it was assumed that the proposed 1.9-mile long multi-purpose trail at Lake Red Rock would be fully utilized

during the peak summer months of the cycling/hiking season. Using the design criteria detailed in the GDM, a total of 5,145 walkers, hikers, and cyclists could use the trail on a prime weekend day without overcrowding.

(b) Survey data for Rock Island District managed recreation areas indicate that 80-percent of all recreation takes place on weekends. The maximum daily recreational use of the proposed new trail segment was converted to peak monthly use:

Cyclists/Hikers:

5,145	-:-	0.4	x	4.3	=	55,309
peak daily use of new trail		percent of recreation occurring on one weekend day		weeks per month		peak monthly use of proposed trail

(c) Peak monthly use was converted to estimated annual new trail use by applying the monthly recreation attendance trends at the Lake Red Rock complex. Attendance for fiscal years 1990, 1991 and 1992 of 641,200, 735,500, and 744,300, respectively, was used to determine the average monthly usage by percent of total usage. Highest monthly usage at Lake Red Rock occurs in July with 20.1% of annual users. Table E-4 gives a summary of monthly trail use for the proposed 1.9-mile segment, based upon 20.1% of annual usage occurring in July or 55,309. It should be noted that winter use of the trail would include hiking, sightseeing, and general winter activities.

Table E-4
Expected Monthly Use of the Proposed Trail

Month	Recreationists	Percent
January	3,399	1.2
February	5,237	1.9
March	9,096	3.3
April	12,679	4.6
May	32,432	11.8
June	52,461	19.0
July	55,309	20.1
August	45,846	16.6
September	34,361	12.5
October	13,414	4.9
November	7,626	2.8
December	3,951	1.4
Total	275,811	100.0

(d) Based on Table E-4, the GDM Market Analysis and the Iowa SCORP, it was assumed that the trail segment would be fully utilized during the peak summer months. Weather comparisons were taken from Des Moines, Iowa, climatological records for the past five years to determine the impact of weather on trail use. Records indicate that, on average, 83% of weekends between May 1st and September 30th are in the good to optimum range for trail use. Realistically applying the probability of lowered attendance because of unfavorable weather conditions, all benefit calculations were performed using 80% of total users.

6. Trail Analysis

(a) Various options for the proposed trail were considered and an economic analysis performed for each option considered. Each of the options has the trail located at a different elevation. Options 4 and 5 include constructing bridges. The analyses are shown in the following tables: Table E-5 "Option 1 - Embankment at Elv. 775"; Table E-6 "Option 2 - Embankment at Elv. 770"; Table E-7 "Option 3 - Embankment at Elv. 765"; Table E-8 "Option 4 - Embankment at Elv. 785 with 300-foot Long Bridge"; and Table E-9 "Option 5 - Embankment at Elv. 790 with 1000-foot Long Bridge". Table E-10 gives the economic summary of each option.

Table E-10
Summary of Trail Options
(March 1993 Price Levels - Dollars In Thousands)

	Options				
Item	1	2	3	4	5
Total Project First Costs	$2932.5	$2659.5	$2545.2	$3307.0	$3052.0
Avg. Ann. Costs	254.4	231.6	222.3	285.6	264.2
Avg. Ann. Benft	400.8	399.2	395.5	403.8	403.8
Net Benefit	146.4	167.6	173.1	118.2	139.6
BCR	1.58	1.72	1.78	1.41	1.53

Table E-5
OPTION 1 - Embankment at Elv. 775

Flood Pool: Elv. 780 Flat Pool: Elv. 742

Inundation: Once every 14 years a portion of trail will be inundated about 4 weeks between 15 Apr and 15 Oct.

Year	Usage
1	275,811
2	275,811
3	275,811
4	275,811
5	275,811
6	275,811
7	275,811
8	275,811
9	275,811
10	275,811
11	275,811
12	275,811
13	275,811
14	

CLOSURE of 1,030 feet out of 10,016

Feet of trail usable 8986
Percentage of trail open 89.7%

Year 14--Users based on % of useable trail = 247,448

Total Years 1 through 13 = 3,585,543

14 Year Total = 3,832,991

Average per year = 273,785

Good/Inclement Weather adjustment * 80% = 219,028

PROJECT COST:	Construction Cost	$2,205,000
	PED	485,000
	CM	242,500
	TOTAL PROJECT COST	$2,932,500

No interest during construction as trail used as completed.

Interest + Amortization	0.0841	246,623	
Operations and Maintenance		7,500	
Adjustment to O+M (1)		300	
Total Average Annual Cost			$254,423

Annual Benefit				
Visitors	273,785			
Usage at 80%	219,028	Value at	$1.83	$400,821

Total Project First Costs	$2,932,500
Average Annual Cost	254,423
Average Annual Benefit	400,821
Net Benefits	$146,398
Benefit-to-Cost Ratio	1.58

(1) Adjustment to O+M: Once every 14 years a portion of trail will be inundated about 4 weeks between 15 Apr and 15 Oct. $4,000 addit'l O+M once every 14 years = $300/yr

Table E-6
OPTION 2 - Embankment at Elv. 770

Flood Pool: Elv. 780 Flat Pool: Elv. 742

Inundation: Once every 9 years a portion of trail will be inundated about 5 weeks between 15 Apr and 15 Oct.

Year	Usage
1	275,811
2	275,811
3	275,811
4	275,811
5	275,811
6	275,811
7	275,811
8	275,811
9	

CLOSURE of 1,030 feet out of 10,016

Feet of trail usable 8986
Percentage of trail open 89.7%

Year 9--Users based on % of useable trail = 247,448

Total Years 1 through 8 = 2,206,488
9 Year Total = 2,453,936
Average per year = 272,660

Good/Inclement Weather adjustment * 80% = 218,128

PROJECT COST:

Construction Cost	$1,960,000
PED	485,000
CM	214,500
TOTAL PROJECT COST	$2,659,500

No interest during construction as trail used as completed.

Interest + Amortization	0.0841	223,664	
Operations and Maintenance		7,500	
Adjustment to O+M (1)		450	
Total Average Annual Cost			$231,614

Annual Benefit

Visitors	272,660	
Usage at 80%	218,128	
Value at	$1.83	$399,174

Total Project First Costs	$2,659,500
Average Annual Cost	231,614
Average Annual Benefit	399,174
Net Benefits	$167,560
Benefit-to-Cost Ratio	1.72

(1) Adjustment to O+M: Once every 9 years a portion of trail will be inundated about 5 weeks between 15 Apr and 15 Oct. $4,000 addit'l O+M once every 9 years = $450/yr

Table E-7
OPTION 3 - Embankment at Elv. 765

Flood Pool: Elv. 780 Flat Pool: Elv. 742

Inundation: Once every 5 years a portion of trail will be inundated about 6 weeks between 15 Apr and 15 Oct.

Year	Usage	CLOSURE of 1,030 feet out of 10,016	
1	275,811	Feet of trail usable	8986
2	275,811	Percentage of trail open	89.7%
3	275,811		
4	275,811	Year 5--Users based on %	
5		of useable trail =	247,448
		Total Years 1 through 4 =	1,103,244
		5 Year Total =	1,350,692
		Average per year =	270,138

Good/Inclement Weather adjustment * 80% = 216,111

PROJECT COST:

Construction Cost			$1,856,000
PED			485,000
CM			204,160
TOTAL PROJECT COST			$2,545,160

No interest during construction as trail used as completed.

Interest + Amortization	0.0841	214,048	
Operations and Maintenance		7,500	
Adjustment to O+M (1)		800	
Total Average Annual Cost			$222,348

Annual Benefit		
Visitors	270,138	
Usage at 80%	216,111	
Value at	$1.83	$395,483

Total Project First Costs	$2,545,160
Average Annual Cost	222,348
Average Annual Benefit	395,483
Net Benefits	$173,135
Benefit-to-Cost Ratio	1.78

(1) Adjustment to O+M: Once every 5 years a portion of trail will be inundated about 6 weeks between 15 Apr and 15 Oct. $4,000 addit'l O+M once every 5 years = $800/yr

Table E-8

OPTION 4 - Embankment at Elv. 785 and 300-foot Long Bridge

PROJECT COST:	Construction Cost		$2,543,000
	PED		485,000
	CM		279,000
	TOTAL PROJECT COST		$3,307,000

No interest during construction as trail used as completed.

Interest + Amortization	0.0841	278,119	
Operations and Maintenance		7,500	
Total Average Annual Cost			$285,619

Annual Benefit		
Visitors	275,811	
Usage at 80%	220,649	
Value at	$1.83	$403,787

Total Project First Costs	$3,307,000
Average Annual Cost	285,619
Average Annual Benefit	403,787
Net Benefits	$118,169
Benefit-to-Cost Ratio	1.41

Table E-9

OPTION 5 - Embankment at Elv. 790 and 1000-foot Long Bridge

PROJECT COST:	Construction Cost		$2,313,000
	PED		485,000
	CM		254,000
	TOTAL PROJECT COST		$3,052,000

No interest during construction as trail used as completed.

Interest + Amortization	0.0841	256,673	
Operations and Maintenance		7,500	
Total Average Annual Cost			$264,173

Annual Benefit		
Visitors	275,811	
Usage at 80%	220,649	
Value at	$1.83	$403,787

Total Project First Costs	$3,052,000
Average Annual Cost	264,173
Average Annual Benefit	403,787
Net Benefits	$139,614
Benefit-to-Cost Ratio	1.53

(b) Option 3 has the highest net benefits. However, a portion of the trail will experience more frequent flooding of a longer duration than the Option 2 trail, which is at a higher elevation. Consideration must be given to public perception and social impacts. From a social impact standpoint, having a trail that is not fully usable for six weeks every five years is less acceptable than a trail which has a portion unusable for five weeks in one out of nine years. The $5,500 difference in annual net benefits is not significant when compared to the general public's disdain for what will be perceived as poor planning, and to the general social and economic cost of trail users who come to use the trail and discover that portions are unusable.

(c) Option 2 is the recommended trail. With an embankment at elevation 770, for about 5 weeks between 15 April and 15 October, once every 9 years a portion of the trail would be inundated. Taking into account inundation of less than 9-percent of the trail once every 9 years, results in average annual recreation usage of 272,660 (Table E-6).

7. Average Annual Benefit

Assuming there is no additional change in annual visitation or use of the new trail because of weather conditions, 218,128 hikers and cyclists would benefit from the 1.9-mile trail addition for the life of the project (50 years) at a benefit of $1.83 each. Discounting at 8-1/4 percent and for a 50-year project life, results in average annual benefits for the new trail of $399,200.

8. Average Annual Cost

(a) Construction, operation, and maintenance costs detailed in this report are presented at March 1993 price levels. Interest during construction is not calculated as project benefits accrue as each phase of the trail construction is completed. A detailed cost estimate is shown in the main report.

(b) Each time that a portion of the trail is inundated, an additional $4,000 worth of maintenance will be required to bring this portion of the trail back to use. With an expected occurrence of only once every 9 years, an additional $450 was included to the annual operations and maintenance costs to reflect this expense. Table E-11 presents the average annual cost computed at an 8 1/4-percent discount rate and a 50-year period of analysis.

Table E-11
Summary of Annual Costs - Red Rock Trail Segment 3
March 1993 Price Levels

Estimated Project Cost	$2,659,500	
Annualized First Cost		$223,660
Annual Operation and Maintenance	7,500	
Inundation Clearance	450	7,950
Total Annual Cost		$231,600

9. Economic Summary

Table E-12 presents the summary economic analysis for the proposed recreation enhancement project. As indicated, the project is economically justified with net annual benefits totalling $170,200 and a benefit-to-cost ratio of 1.7:1.

Table E-12
Benefits and Cost Summary, Red Rock Trail Segment 3
8-1/4 Percent Discount Rate
March 1993 Price Levels

Total First Cost	$2,600,000	
Annual Benefit		$401,800
Annual Cost		231,600
Average Annual Cost	223,700	
Annual Operation and Maintenance	7,900	
Net Annual Benefit		$170,200
Benefit-to-Cost Ratio		1.7:1

10. Sensitivity Analysis

A sensitivity analysis was performed to determine the effect of reduced recreation usage of the proposed trail. Assuming only 60% of the 272,660 estimate actually used the trail, benefits would be $239,500 (272,660 * 80% = 218,128 * 60% = 130,877 * $1.83), net annual benefits would be $7,900 and the BCR would be 1.03:1.

11. Additional Benefits

(a) This assessment measures only those benefits realized by recreationists traveling the proposed multi-purpose trail. These benefits are based on recreationists pursuing cycling, hiking, walking, jogging and general sight-seeing activities.

(b) Additional benefits would also be realized but were not included in this analysis. The new trail segment would likely result in increased use of camping, picnicking and other recreation amenities at the reservoir complex. As mentioned, provision of a trail connecting Wallashuck Recreation Campgrounds to the existing Lake Red Rock trail system would also reduce the travel distance and inconvenience associated with traveling between these recreation areas by the existing roadway and trail system, as well as provide additional safety to recreationists, who presently travel along the highways to reach the trail segments. Nor does this estimate include recreationists from adjoining non-federal recreational areas who would use this unique trail. These benefits were not included in this analysis in order to simplify the calculations. With their inclusion, the resulting project benefits would be even greater.

HYDROLOGY AND HYDRAULIC ANALYSIS

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DES MOINES RECREATIONAL RIVER AND GREENBELT
FEATURE DESIGN MEMORANDUM NO. 9
WITH ENVIRONMENTAL ASSESSMENT

RED ROCK MULTI-PURPOSE TRAIL
SEGMENT 3

LAKE RED ROCK, IOWA

APPENDIX F
HYDROLOGY AND HYDRAULIC ANALYSIS

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DES MOINES RECREATIONAL RIVER AND GREENBELT
FEATURE DESIGN MEMORANDUM NO.9
WITH ENVIRONMENTAL ASSESSMENT

RED ROCK MULTI-PURPOSE TRAIL
SEGMENT 3

LAKE RED ROCK, IOWA

APPENDIX F
HYDROLOGY AND HYDRAULIC ANALYSIS

1. Pool Crossing at Station 53+24

a. Hydrologic and hydraulic analyses were performed to determine the required waterway opening for the Red Rock Multi-Purpose Trail, Segment 3, Pool Crossing at Station 53+24.

b. Flow frequency values were computed using the Iowa state regression equations (U.S. Geological Survey Water Resources Investigation Report 87-4132, Method for Estimating the Magnitude and Frequency of Floods at Ungaged Sites on Unregulated Rural Streams in Iowa, 1987). The drainage area at Station 53+24 is .85 square miles and is delineated on Plate 1. The flow frequency curve for this site is shown on Plate 2.

c. Hydraulic computations at this site assume a ponding elevation of 750 feet NGVD, a tailwater elevation of 742 feet NGVD (conservation pool elevation), and a 50-year flow frequency value of 650 cfs.

d. Based on the above assumptions, an 8 foot x 8 foot concrete box culvert (approximately 230 feet long, at a 1% slope with the inlet invert elevation at 740 feet NGVD, and a roughness coefficient of .015) was selected to accommodate the design discharge of 650 cfs. Drawings of the culvert are shown on Plates 8 and 14 of the main report. The rating table for the 8 foot x 8 foot box culvert is shown in Table 1. The culvert outlet channel will have an approximate 16 foot bottom width with channel side slopes shaped in the field. The outlet rating curve is based on a constant tailwater elevation of 742. The rating curve for the outlet channel is shown on Plate 3.

e. The riprap required for the outlet channel is designed based on TR H-74-9, Practical Guidance for Design of Lined Channel Expansions at Culvert Outlets, and EM 1110-2-1601, Hydraulic Design of Flood Control Channels. A 21-inch thick layer of riprap of the gradation shown in Table 2

should be placed along the channel bed and banks on 6-inch bedding.

f. The trail embankment fill above elevation 745 will be acquired from a borrow site within the reservoir flood control pool. The trail embankment below elevation 745 will be a sand fill from a source outside of the pool. The borrow area within the flood control pool will be used as a source of borrow material for the trail between station 30+00 and 50+00 and station 62+50 and 101+55. The amount of material excavated from the borrow area within the flood storage pool will exceed the amount of sand fill placed in the conservation and flood control pools. Therefore, the project will result in a net increase in flood storage.

Table 1

Box rating for 8 x 8 culvert with 742.00 tailwater

ke	k	m	h1	k1	n	length
0.40	0.0730	0.7500	6.2400	0.0410	0.0150	230.0

Elevation	Flow	Control
742.00	0	outlet
742.13	35	outlet
742.41	71	outlet
743.02	106	outlet
743.67	142	outlet
744.27	177	outlet
744.83	212	outlet
745.37	248	outlet
745.88	283	outlet
746.36	319	outlet
746.84	354	outlet
747.29	390	outlet
747.74	425	outlet
748.17	460	outlet
748.59	496	outlet
749.00	531	outlet
749.40	567	outlet
749.80	602	outlet
750.19	637	outlet
750.57	673	outlet
750.94	708	outlet
751.31	744	outlet
751.67	779	outlet
752.84	814	inlet submerged
753.43	850	inlet submerged
754.04	885	inlet submerged
754.68	921	inlet submerged
755.35	956	inlet submerged
756.04	991	inlet submerged
756.76	1027	inlet submerged

TABLE 2

Outlet Channel Gradation

% Lighter by Weight	Limits of Stone Weight (pounds)	
100	460	190
50	140	95
15	70	30

2. Stream Crossing at Station 30+60

a. Hydrologic and hydraulic analyses were performed to determine the drainage structure required for the Red Rock Multi-Purpose Trail, Segment 3 Stream Crossing at Station 30+60.

b. Flow frequency values were computed using the Iowa state regression equations (U.S. Geological Survey Water Resources Investigation Report 87-4132, Method for Estimating the Magnitude and Frequency of Floods at Ungaged Sites on Unregulated Rural Streams in Iowa, 1987). The drainage area at this site is .04 square mile and is delineated on Plate 1. The flow frequency curve for this site is shown on Plate 4.

c. Hydraulic computations at the site assume a normal ponding elevation of 791 feet NGVD, with a maximum ponding elevation of 793 feet NGVD, and a 50-year flow frequency value of 125 cfs. The top of the embankment fill is at elevation 794 feet NGVD which provides for one foot of freeboard for the 50 year design event. A maximum storage volume (between elevations 780 feet NGVD and 793 feet NGVD) was computed to be 1.8 acre-feet.

d. Based on the above assumptions a 4 foot x 4 foot gatewell with a 42-inch diameter reinforced concrete discharge pipe (75 feet long, inlet invert elevation of 780.25 feet NGVD, outlet invert elevation of 780.0 feet NGVD, and a roughness coefficient of .015) was selected to accommodate the design discharge of 125 cfs. The outlet rating table is shown in Table 3. A detail of the gatewell structure is shown on Plate 7 of the main report.

e. The riprap required for the outlet is designed based on TR H-74-9, Practical Guidance for Design of Lined Channel Expansions at Culvert Outlets, and EM 1110-2-1601, Hydraulic Design of Flood Control Channels. A 21-inch thick layer of riprap of the gradation shown in Table 2 should be placed at the outlet on 6-inch bedding.

f. A 12-inch reinforced concrete pond-drainage pipe (30 feet long, inlet invert elevation of 780.5, outlet invert elevation of 780.25, and a roughness coefficient of .015) to the gatewell will evacuate the pond within two days (or less) depending on the starting pond elevation. The drainage pipe rating table is shown on Table 4.

Table 3

Pipe rating for 42" dia pipe and 782.00 tailwater

ke	k	m	hl	kl	n	length
0.43	0.0098	2.0000	2.3450	0.0645	0.0150	75.0

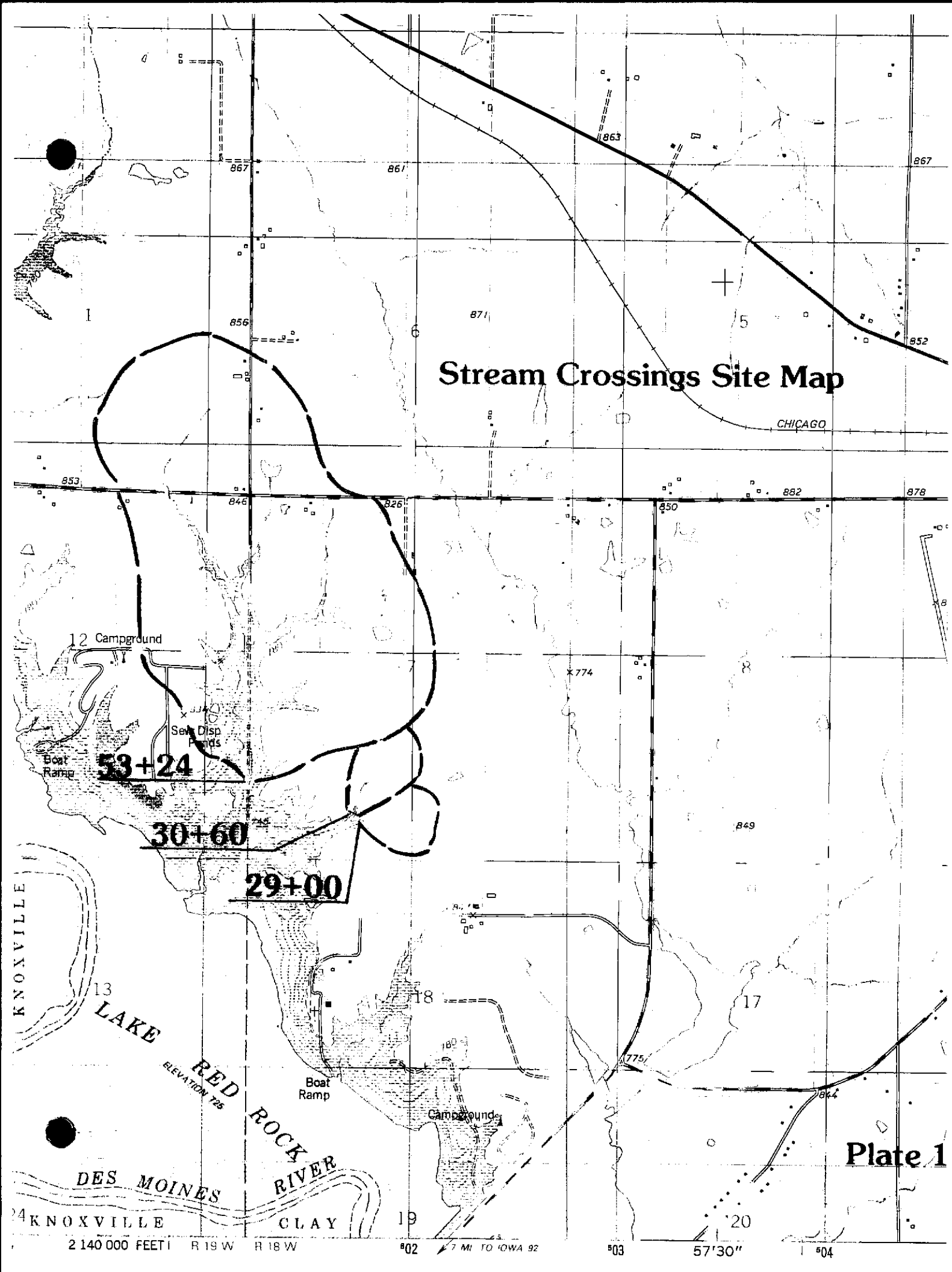
Elevation	Flow	Control
782.00	0	outlet
782.15	6	outlet
782.33	12	outlet
782.51	19	outlet
782.70	25	outlet
782.92	31	outlet
783.15	37	outlet
783.41	43	outlet
783.69	50	outlet
783.99	56	outlet
784.31	62	outlet
784.66	68	outlet
785.03	75	outlet
785.42	81	outlet
785.84	87	outlet
786.32	93	inlet submerged
786.84	99	inlet submerged
787.38	106	inlet submerged
787.97	112	inlet submerged
788.58	118	inlet submerged
789.23	124	inlet submerged
789.91	130	inlet submerged
790.62	137	inlet submerged
791.37	143	inlet submerged
792.15	149	inlet submerged
792.96	155	inlet submerged
793.81	162	inlet submerged
794.68	168	inlet submerged
795.60	174	inlet submerged
796.54	180	inlet submerged

Table 4

Pipe rating for 12" dia pipe and 782.00 tailwater

ke	k	m	hl	kl	n	length
0.43	0.0098	2.0000	0.6700	0.0645	0.0150	30.0

Elevation	Flow	Control
782.00	0	outlet
782.01	0	outlet
782.05	1	outlet
782.12	1	outlet
782.21	2	outlet
782.33	2	outlet
782.47	3	outlet
782.64	3	outlet
782.84	4	outlet
783.06	4	outlet
783.31	4	outlet
783.58	5	outlet
783.88	5	outlet
784.21	6	outlet
784.56	6	outlet
784.94	7	outlet
785.35	7	outlet
785.78	7	outlet
786.24	8	outlet
786.72	8	outlet
787.23	9	outlet
787.77	9	outlet
788.33	10	outlet
788.92	10	outlet
789.53	11	outlet
790.17	11	outlet
790.84	11	outlet
791.54	12	outlet
792.25	12	outlet
793.00	13	outlet


Stream Crossings Site Map
53+24
30+60
29+00
Plate 1
Campground
Sew. Disp. Ponds
Boat Ramp
LAKE RED ROCK
ELEVATION 725
Boat Ramp
Campground
DES MOINES RIVER
KNOXVILLE
CLAY
CHICAGO
2 140 000 FEET
R 19 W
R 18 W
57'30"

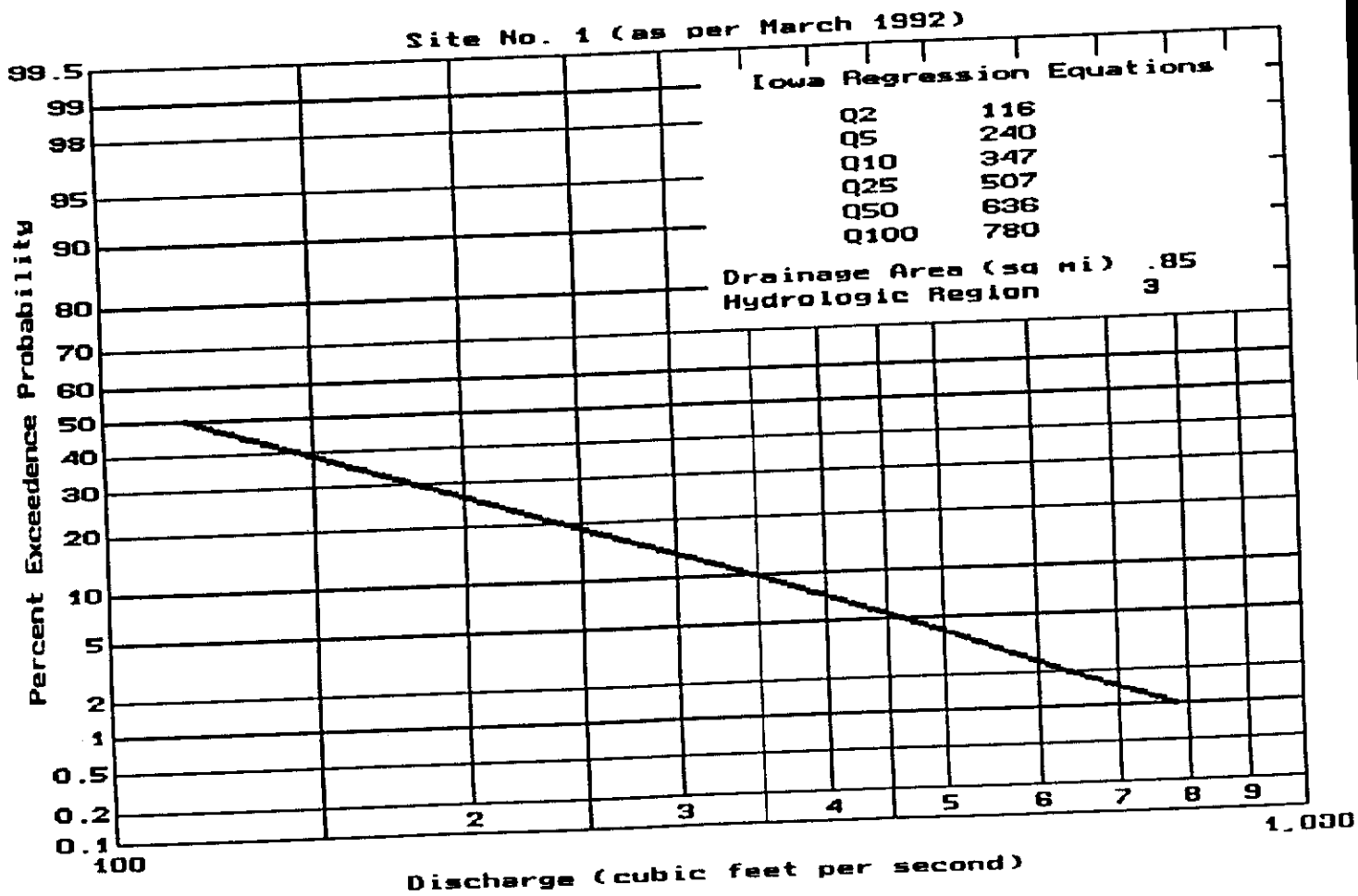

Site No. 1 (as per March 1992)
Iowa Regression Equations
Q2 116
Q5 240
Q10 347
Q25 507
Q50 636
Q100 780
Drainage Area (sq mi) .85
Hydrologic Region 3
Percent Exceedence Probability
99.5
99
98
95
90
80
70
60
50
40
30
20
10
5
2
1
0.5
0.2
0.1
100
2
3
4
5
6
7
8
9
1,000
Discharge (cubic feet per second)

Plate 2

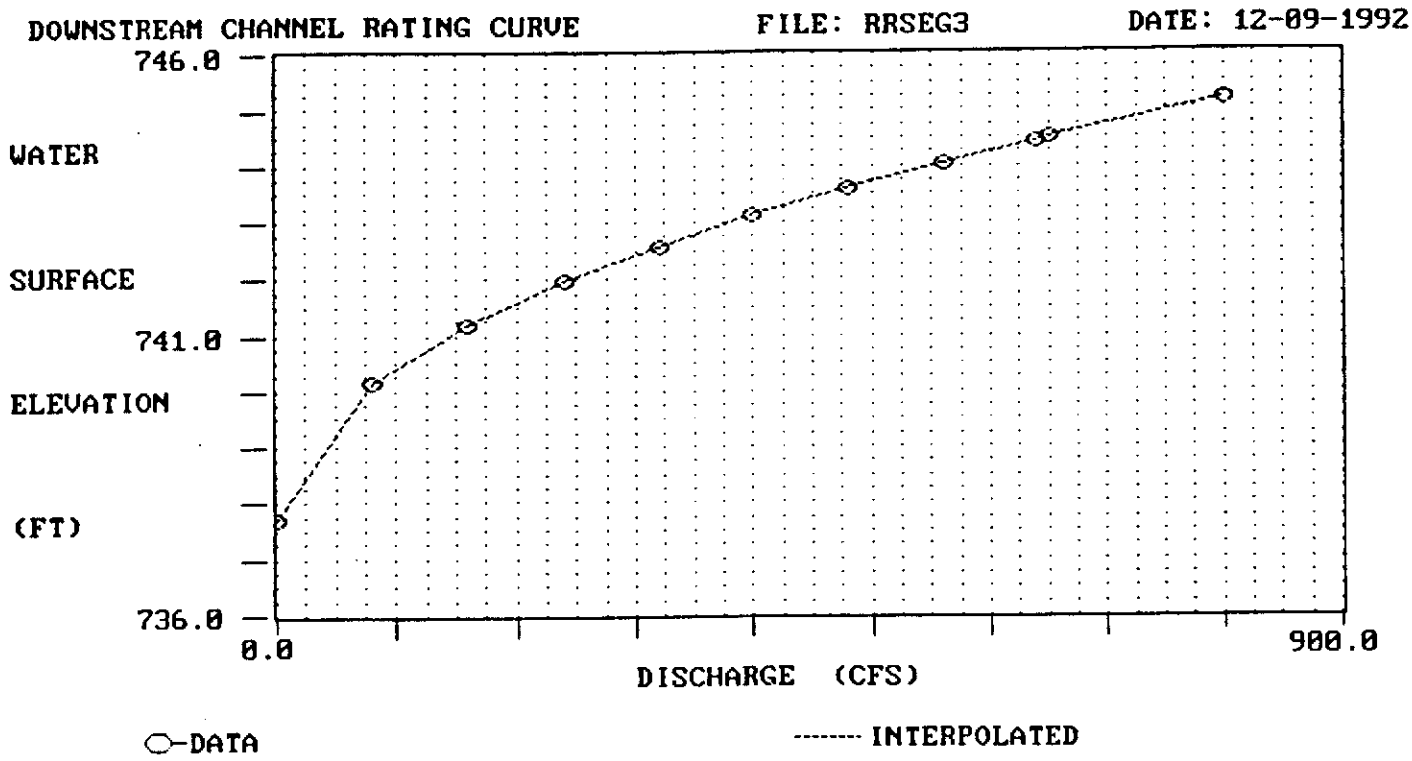

DOWNSTREAM CHANNEL RATING CURVE
FILE: RRSEG3
DATE: 12-09-1992
746.0
WATER
SURFACE
741.0
ELEVATION
(FT)
736.0
0.0
900.0
DISCHARGE (CFS)
DATA
INTERPOLATED

Plate 3

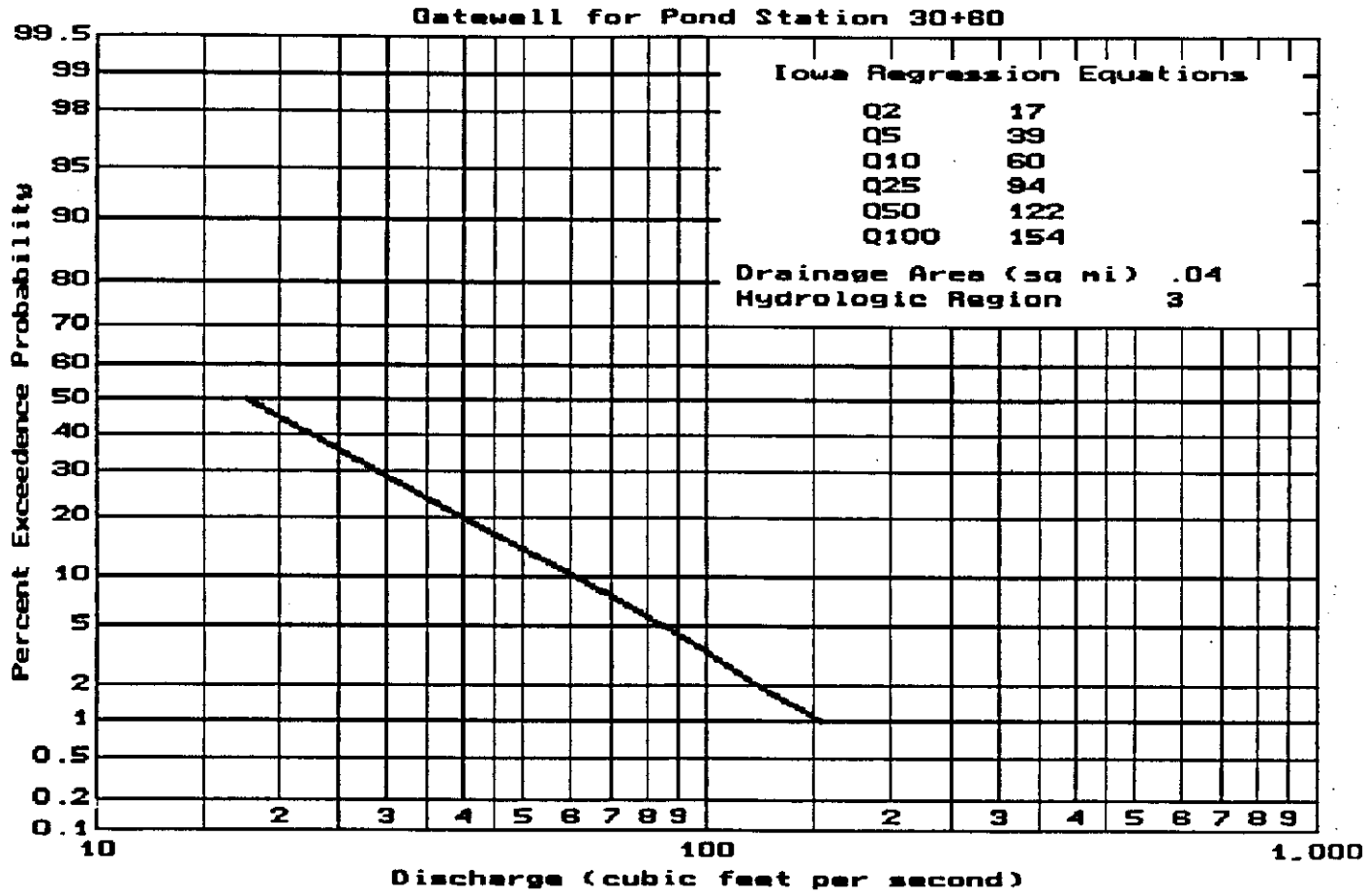

Gatewell for Pond Station 30+80
Iowa Regression Equations
Q2 17
Q5 39
Q10 60
Q25 94
Q50 122
Q100 154
Drainage Area (sq mi) .04
Hydrologic Region 3
Percent Exceedence Probability
99.5
99
98
95
90
80
70
60
50
40
30
20
10
5
2
1
0.5
0.2
0.1
2 3 4 5 6 7 8 9
10
100
2 3 4 5 6 7 8 9
1,000
Discharge (cubic feet per second)

Plate 4