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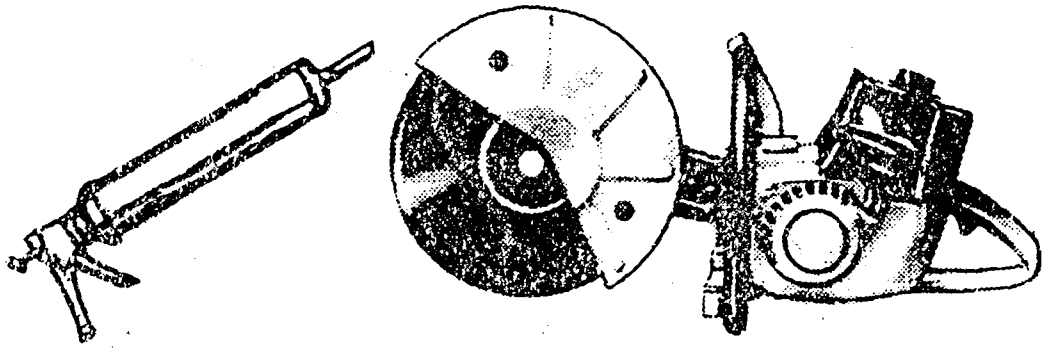
APACHE JUNCTION GILBERT WATERSHED WATERSHED PROTECTION AND FLOOD PREVENTION PROJECT

MARICOPA & PINAL COUNTIES, ARIZONA

PLANS FOR THE REPAIR OF

POWERLINE FLOODWAY



PREPARED FOR THE
FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
BOARD OF SUPERVISORS OF PINAL COUNTY
EAST MARICOPA NATURAL RESOURCE CONSERVATION DISTRICT
BY
SOIL CONSERVATION SERVICE
U.S. DEPARTMENT OF AGRICULTURE

UNITED STATES DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
Phoenix, Arizona
March 1992

FINAL
DESIGN REPORT

JOB: Powerline Floodway Repair

PROJECT: Repair of Damaged Trapezoidal Concrete Floodway

AUTHORITY: PL566 Design Deficiency

PHASE: Final Design

SUMMARY

This report is for the repair of 6.8 miles of concrete channel lining which is 78 percent of the entire floodway length. The remaining 22 percent is an earth lining. The floodway was constructed in 1967. The original design did not provide enough side inlets for overland flow and operation and maintenance roads were not graded away from the floodway. A storm on September 30, 1971 brought water from side washes into the empty channel. At approximately ten locations overbank flows entered between the concrete lining and the subgrade. The water eroded soils beneath the lining and created uplift causing the lining to raise and crack in many areas. An attempt was made to correct the damage by sealing cracks and filling voids behind the lining with concrete slurry. To prevent further damage, the operation and maintenance roads were raised and graded to drain away from the lining, additional side inlets were added, and existing side inlets widened.

Expansion and contraction problems also developed along the floodway. The reinforced concrete lining was originally designed with 1/2-inch expansion joints and cutoff walls spaced every 325 feet. Contraction joints were made by tooling every 50 feet. The expansion joints provided did not allow for enough expansion for the excessive distance between the joints. The channel movement caused joints to exert forces against each other which resulted in considerable spalling and uplifting at the joints.

Investigations were done in 1977 to evaluate the movement in the lining. Temperatures and movements across joints were taken after 6 inch sections were cut out of the lining in several locations. These studies were done to observe joint movement, channel grade, and stresses in concrete.

A study was also done in 1977 by Richard Helm where he presented several different possibilities and analysis describing the possible events leading to the damaged channel lining. Several

concrete cores were taken and a petrographic examination of the coarse aggregate within the slab sections was a part of this study.

In 1988 an Engineering Report was done by Paul Monville and John Weaver to review all previous investigations. The Engineering Report identified the major cause of failure to be the lack of unsealed expansion joints.

The above damages have created the need for an overall repair of the floodway.

DESCRIPTION OF JOB

The job involves removing and replacing 1,755 linear feet of lining at various locations having severe damage. The job also involves removing short sections less than 10 feet long at specific joints that are offset and/or badly spalled. The rest of the joints will be saw cut to 7/8-inch wide, joint filler installed and sealed. Cracks other than hair line will be bonded by an epoxy adhesive injection process. The majority of cracks are longitudinal and are close to the invert.

DESIGN OBJECTIVE

The objective of this repair is to stop the continuing crushing damage that is taking place, mainly at the joints, and to repair those areas that are already damaged by previous overbank flow or compression and buckling at joints.

GENERAL BASIC DATA

The following reference materials were used in designing the Powerline Floodway Repair:

1. Engineering Report - July, 1988
2. "As Built" Plans Powerline Floodway
3. General Motors Desert Proving Grounds Contract File
4. Powerline Floodway Subsidence Survey
5. ACI manual of Concrete Practice 1985 Part 5
6. Powerline Floodway Design 1965 to 1968
7. Engineering Report Evaluation of Expansion Joint Sealant for East Maricopa Floodway - Reach - 4 December 1987
8. East Maricopa Floodway Reach 4 Expansion Joint Sealer Repair Design
9. NEH Chapter 6

10. Far West States Engineering Design Standards

LOCATION AND LAYOUT

The channel is located in Maricopa and Pinal counties between Powerline Dam and East Maricopa Floodway Reach 4. It traverses the south part of General Motors Proving Grounds in an east west direction. In 1991 a level survey was made on the channel bottom and on the subsidence monuments every 2000 feet along the channel. New elevation datum was established from Hawk Rock, a large rock out crop that is not subsiding. All new construction for the repair will be based on the recent survey.

FOUNDATION

Eight samples were taken in the channel bottom at locations where lining was cracked badly and where lining bottom had heaved upward several inches. The eight samples were tested at the Mesa Project office for gradation and Atterburg limits. Two of the eight samples showed evidence of clay and significant fines. These two samples were taken from Station 78+00 and 224+25. Both samples were 4 to 5 feet below channel invert and are 9 to 10 feet below original ground. The samples were tested for shrink swell by Western Technologies Inc. The sample from Station 224+25 had a 7.7 percent expansion at 94 PCF dry density and 8.6 percent expansion at 98 PCF dry density. The sample at Station 78+00 had an expansion of 2.1 percent.

Soils information shown on the original drawings for the channel show a 2 foot clay layer generally between 7 and 10 feet below natural ground between Station 220+00 and Station 236+00.

The expansive clay tested at 224+25 is not considered to be the cause of damage at that location. The damage is a result of the uplift mentioned above in this report. By sealing all joints and cracks in this area, and protecting the top of the lining with berms and an operation and maintenance road that directs the water away from the channel lining, the clay layer is not likely to become saturated and is not considered to be a threat to the repaired structure.

STRUCTURE DESIGN

The July 1988 Engineering Report recommends cutting sections between expansion joints at about the center and allowing time for stress relief. A study has recently been done where nine 6-inch wide sections were removed and movement monitored for a two week period. Results from this study indicate that movement due to stress relief is minimal and that it takes place right after saw cutting the joints. The report is in the design file.

Design of the joint gap was done by using the change in length due to thermal expansion of concrete and an allowable 50 percent expansion and compression for the sealant. The design was also

checked using ACI 504 R-23 using sealant with 50 percent expansion and compression.

Joint removal and repair was based on visual observation and tapping with a hammer of all damaged areas. If damage appeared to penetrate the entire slab thickness, or one side of the joint was noticeably higher than the opposite side, the joint was designated for removal.

A few small holes were observed at the top of the slope at several joints. These areas will be backfilled when the concrete is removed. If other cavities are encountered during concrete removal they will also be backfilled.

The reinforcing steel required for slabs was reduced by calculating the subgrade drag forces. It was decided to use number four bars for all reinforcing and not a wire mesh. The existing wire mesh in the floodway was observed in the recently cut sections to be near or at the subgrade in many areas. The use of reinforcing steel will give better control for location within the slab.

The longitudinal cracks occur where overbank flow entered between the concrete lining and the subgrade. Berms were installed subsequently to prevent drainage from getting under the lining. With the cause for the cracks corrected, it is now possible to seal the cracks by epoxy injection. The Flood Control District of Maricopa County installed some trial crack repairs by high pressure water blasting (up to 10,000 psi) and epoxy sealing the cracks. After curing, the sealed cracks were cored to evaluate penetration. Results of this work show that high pressure water blasting adequately cleaned the various crack widths and proper bonding and adequate penetration was achieved. This procedure will provide a permanent repair for the cracks.

ENVIRONMENTAL CONSIDERATIONS

No negative impact on the conservation of biological or water resources is anticipated by the repair.

CONSTRUCTION DRAWINGS

All drawings were prepared and stored on the Arizona CADD system using Versacad software, Version 5.4. Pertinent information was taken from the original "As Built" drawings in 1967.

SPECIFICATIONS

The NEH Section 20 standard specifications have been used for this project, along with a revised 400 specification for joint sealant that was approved for EMF Reach 4, and one new 400 series specification as follows:

402. Epoxy Adhesive Injection For Concrete Repair of Concrete Lined Floodway.

The following NEH Section 20 specifications were used:

3	Structural Removal
5	Pollution Control
7	Construction Surveys for Layout, Control and Measurement
8	Mobilization
10	Water for Construction
11	Removal of Water
21	Excavation
23	Earthfill
31	Concrete
34	Steel Reinforcement
94	Contractor Inspection

COST ESTIMATE

The engineer's estimate is $503,786. There are no unusual materials or construction methods involved.

CONSTRUCTION SCHEDULE

The construction schedule was based on an average contractor doing the work. The chance that storms could place considerable water in the channel will require that the contractor remove and replace only enough sections to eliminate the possibility of eroding the soil and uplifting the existing lining adjacent to the repair section. Total construction time is 180 days and this was based on doing 2-50 foot sections per day or 6 of the smaller repair sections per day. The remaining work can be accomplished during the placement of concrete.

OPERATION AND MAINTENANCE

An operation and maintenance plan has been written for Powerline Floodway.

This repair work will reduce the operation and maintenance considerably over work required since the channel was constructed. Tumbleweeds, shrubs, grass and debris have been a major maintenance problem due to all the cracks, open joints, and spalled areas. This repair project will reduce the opportunity for plant growth to start. A regular maintenance program should be initiated to check for broken sealant and these areas should be immediately repaired to prevent plant growth. After each major storm the channel should be checked to assure that it is functioning properly, that debris is removed, and that no damage has occurred.

CONSTRUCTION REVIEW

The channel bottom should be inspected by the geologist after sections have been removed in the area where expansive clay was found, and in other areas where soils are questionable.

Crack repair and sealing joints with the manufacturer's representatives should be performed prior to beginning work on these items.

A preconstruction conference will be held at which time questions about the repair or design can be discussed.

AUTHORITY

Tom Jayo 4-1-92

Submitted by: Design Engineer Date

John H. Harrington 4-1-92

Recommended by: State Design Engineer Date

Ralph W. Amrich 4-1-92

Approved by: State Conservation Engineer Date

STRESS RELIEF DOCUMENTATION REPORT

March 26, 1992

Project: Apache Junction-Gilbert Watershed
Job: Powerline Floodway Repair
Location: Maricopa and Pinal Counties, Arizona
Authority: PL 566
Stage: Final Design

Design Review Report recommended that the stress relief be monitored or documented prior to the installation of concrete. Two sites that visually appeared to be under strain as evidenced by very tight soil between the contraction joints and some cracking at the joints were chosen for the study.

Study sites are 1.1 miles apart, one on each side of Ironwood Road. The site east of Ironwood road has four joints saw cut in a 200 foot section of channel. The site west of Ironwood Road has five successive joints with six-inch cuts over a distance of 200 feet. Bolts were set approximately 11 inches apart at each joint at the north and south slopes near the top of the lining and at the bottom of the floodway.

Measurements were taken initially prior to cutting concrete to the outside of the bolts at all joints. Saw cuts were made at joints, and a six-inch wide section of concrete was removed. Number seven rebar were placed at the center of each six-inch opening to provide a reference point for direction of movement. Measurements were taken immediately after saw cutting and once a day for two weeks and twice a day for one week.

Results of the study are as follows:

1. Daily movement due to temperature fluctuation corresponds to theoretical movement as calculated by formula.

2. Movement due to temperature change takes place on a daily cycle.

3. Where 50-foot sections were isolated with six-inch cuts on each side, there is no evidence of any permanent decrease in joint width or increase in slab length due to strain.

4. At the end six-inch cuts, joints 126, 130, 255 and 259, there is evidence of a gradual decrease in joint width at approximately 1/16 inch per week. These joints are not isolated and are being influenced by several 50-foot sections which will move to the open relieved joint.

5. The north side of the channel has 67 percent greater movement than the south side, with the center moving mid-way between the north and south sides. The north side of the channel has more direct sunlight for longer time periods.

6. Temperature has a greater role in slab movement than any strain which may be in the concrete after joints are cut and stress is relieved.

7. Joint width decrease due to cutting joints and relieving stress is small compared to movement due to temperature stress.

Monitoring will continue on a weekly basis for several months to observe movement as mean temperatures continue to increase. This information should provide additional data that will aid us in future work.

Submitted by Tom Joyce

Reviewed by John W. Harrington

Approved Ralph M. Clough Date 3/30/92

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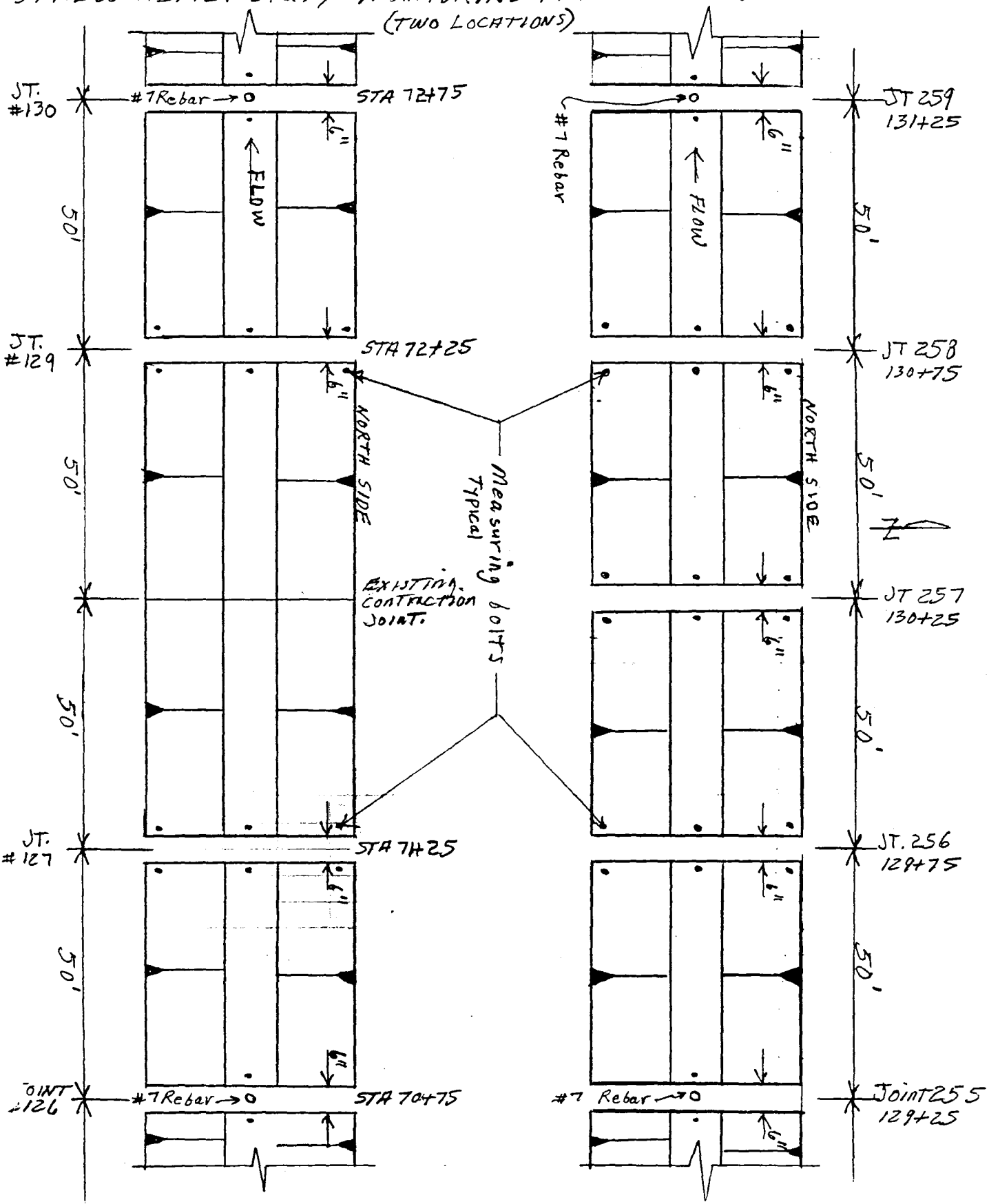
TSJ 3-25-92

POWERLINE FLOODWAY REPAIR

STRESS RELIEF STUDY - MONITORING PLAN (TWO LOCATIONS)

3



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AZ POWERLINE FLOODWAY REPAIR
TSJ 3-25-92
STRESS RELIEF STUDY - LINING MOVEMENT 4
DUE TO TEMPERATURE - THEORETICAL

Given: Temp differential - morning to evening = 20° TO 30°
use $25° = \Delta T$

l_e = slab length = 50 feet
G = Coefficient of thermal expansion for concrete = 6.6×10^{-6}

ΔL = Conc movement due to temperature

$$\Delta L = (\Delta T)(l_e)(G)$$

$$= \underset{\Delta T}{25}\underbrace{(50)(12)}_{l_e}\underset{G}{(6.6 \times 10^{-6})} = 0.099 \text{ inch}$$

use 0.1 inch

North side of channel has more direct sunlight and sun is on on north side for longer time.

Measurements on north top side
= 0.125 in ± from morning measurement to evening measurement.

Measurements on top south side
= 0.075 inch ±

Measurments in center = 0.1 in ±

These measurements correlate with the theoretical calculated concrete movement.

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Az POWERLINE FLOODWAY REPAIR

TSS 3-25-92

STRESS RELIEF STUDY RESULTS 5

TOP NORTH SLOPE MEASYREMENT (inches)

DATE	TEMPERATURE °F	STATION & JOINT NUMBER 129+75 #256	130+25 #257	130+75 #258	71+25 #127	72+25 #129
3-2-92	65 (initial before cut)	11.37	10.78	11.20	10.66	10.90
3-5	87	Right After Cut →			10.59	10.79
3-6	50				10.66	10.93
3-7	75				10.61	10.88
3-10	52 TO 72	Right After Cut ~72°F± 11.25	10.64	11.11	52°F 10.65	10.90
3-11	51	11.36	10.77	11.21	10.64	10.91
3-12	54	11.35	10.75	11.19	10.63	10.89
3-13	57	11.36	10.76	11.19	10.63	10.89
3-14	61	11.36	10.76	11.20	10.62	10.88
3-15	50	11.36	10.76	11.20	10.61	10.88
3-16	61	11.35	10.75	11.18	10.60	10.87
3-17	62	11.34	10.74	11.17	10.60	10.86
3-18	56	11.36	10.79	11.19	10.61	10.88
3-20	70	11.32	10.72	11.14	10.58	10.85

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TSJ 3-25-92

POWERLINE FLOODWAY REPAIR

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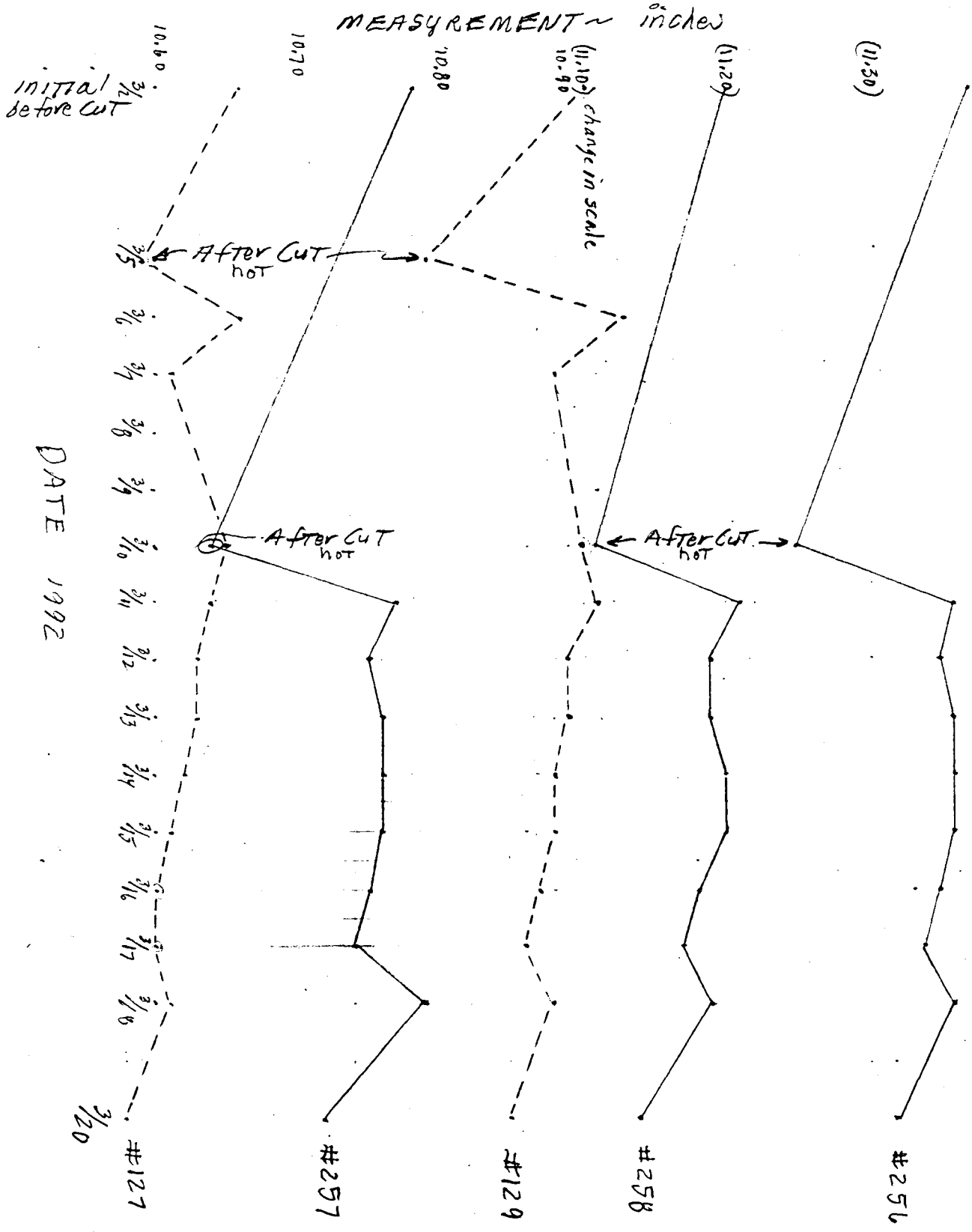
STRESS RELIEF STUDY RESULTS

TOP NORTH SLOPE



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POWERLINE FLOODWAY REPAIR

STRESS RELIEF STUDY RESULTS 7

TOP SOUTH SLOPE MEASUREMENTS (inches)

DATE	TEMPERATURE °F	STATION & JOINT NUMBER 129+75 #256	130+25 #257	130+75 #258	71+25 #127	72+25 #129
3-2-92	65 (initial before cut)	10.99	11.44	11.36	10.78	11.16
3-5	87	Right After Cutting →			10.74	11.12
3-6	50				10.77	11.18
3-7	75				10.76	11.18
3-10	52	Right After Cutting ←	10.98	11.40	11.31	10.78	11.19
3-11	51	11.03	11.45	11.37	10.77	11.18
3-12	54	11.02	11.44	11.35	10.77	11.18
3-13	57	11.01	11.43	11.36	10.76	11.17
3-14	61	11.01	11.43	11.36	10.76	11.17
3-15	50	11.01	11.41	11.35	10.75	11.16
3-16	61	11.00	11.41	11.34	10.74	11.16
3-17	62	10.99	11.40	11.32	10.73	11.15
3-18	56	11.01	11.42	11.35	10.75	11.17
3-20	70	11.00	11.42	11.33	10.74	11.15

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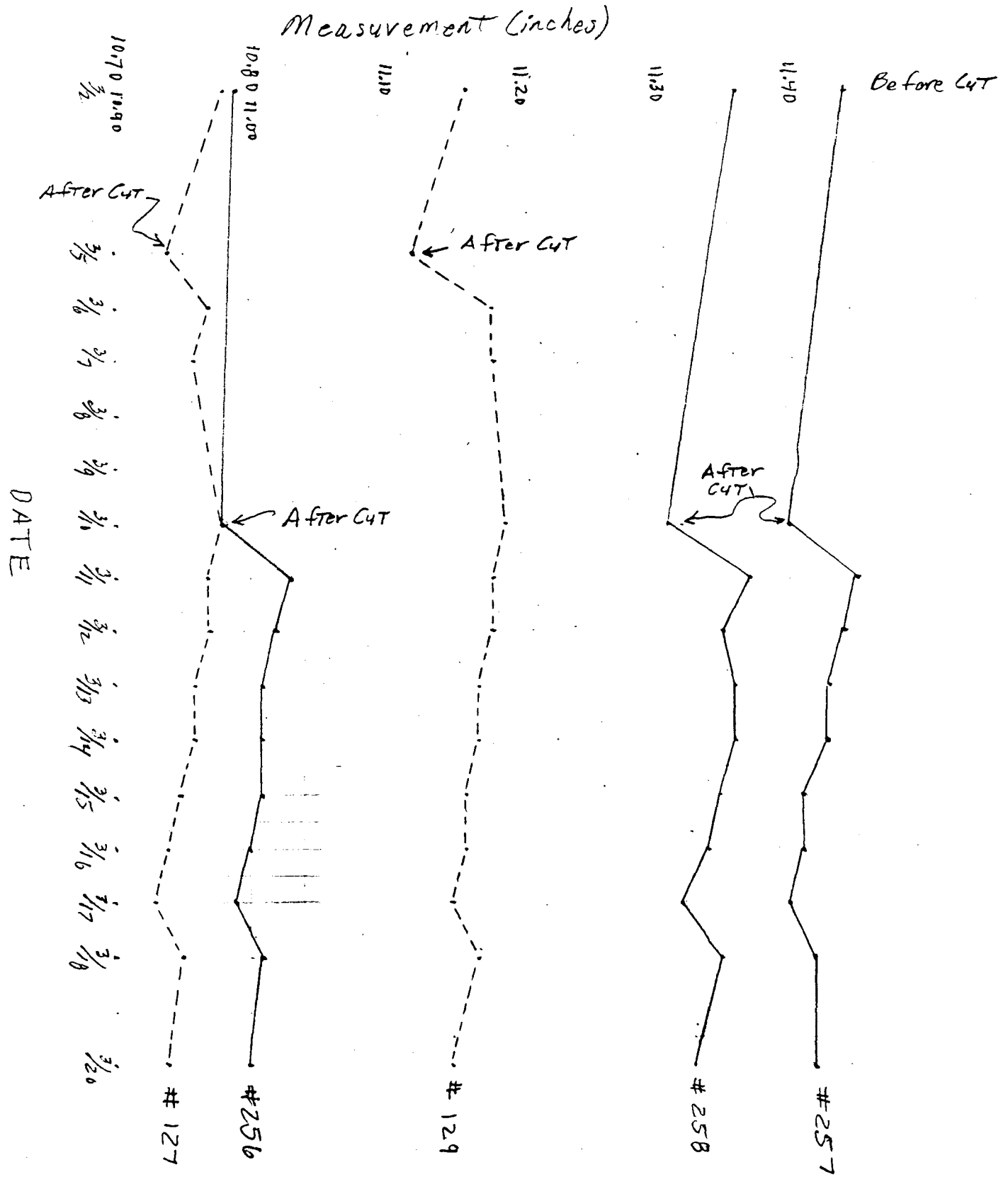
STRESS RELIEF STUDY RESULTS

TOP SOUTH SLOPE

POWERLINE FLOODWAY REPAIR

8



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POWERLINE FLOODWAY REPAIR

STRESS RELIEF STUDY RESULTS 9

END CUTS CENTER, REBAR TO EAST AND WEST
UNCUT LINING

DATE	TEMP °F	STATION & JOINT NUMBER 70+75 #126 (East)	72+75 #130 (West)	129+25 #255 (East)	131+25 #259 (West)	
3/2/92	65	5.57	5.27	5.39	5.17	– Before Cutting
3/5	87	5.55 (5.96)	5.22 (5.60)			– After Cutting
3/6	50	5.53 (5.97)	5.26 (5.64)			
3/7	75	5.50 (5.96)	5.25 (5.62)			
3/8	53°	5.55 (5.85)	No reading			
3/10	50	5.52 (5.96)	5.28 (5.63)	5.35	5.17	– After Cutting #255 & #259 70°F
3/11	51	5.52 (5.95)	5.26 (5.63)	5.37	5.22	
3/12	53 To 61	5.50 5.95	5.25 (5.61)	5.36	5.21	
3/13	51 To 53	5.50 (5.94)	5.25 (5.62)	5.35	5.20	
3/14	61 To 55	5.48 (5.94)	5.25 (5.61)	5.35	5.19	
3/15	50	5.47 (5.92)	5.24 (5.59)	5.34	5.17	
3/16	61	5.47 (5.92)	5.23 (5.60)	5.34	5.17	
3/17	62	5.47 (5.92)	5.22 (5.59)	5.33	5.16	
3/18	56 To 57	5.47 (5.93)	5.24 (5.60)	5.33	5.17	

Movement after cutting varies from 0.04" to 0.08" for approx. 1 week period or approx 1/16 in/week = 0.27"/month

End cuts are closing at a rate of 1/16"/week ±. We expect these cuts to close since we have a considerable length of lining under strain that will move to the open cut. This should pose no problem for repairing the joints.

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POWERLINE FLOODWAY REPAIR

STRESS RELIEF STUDY RESULTS

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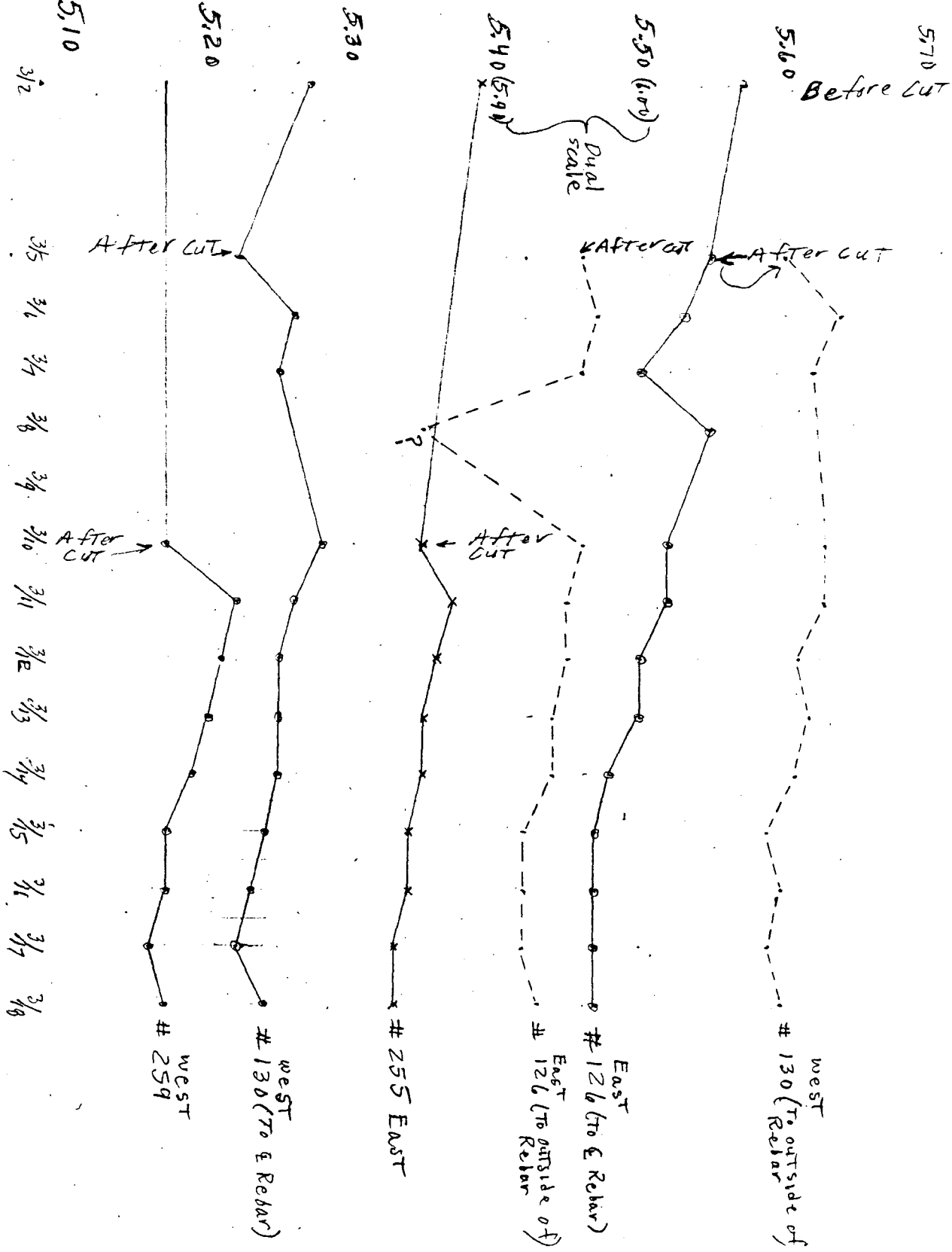
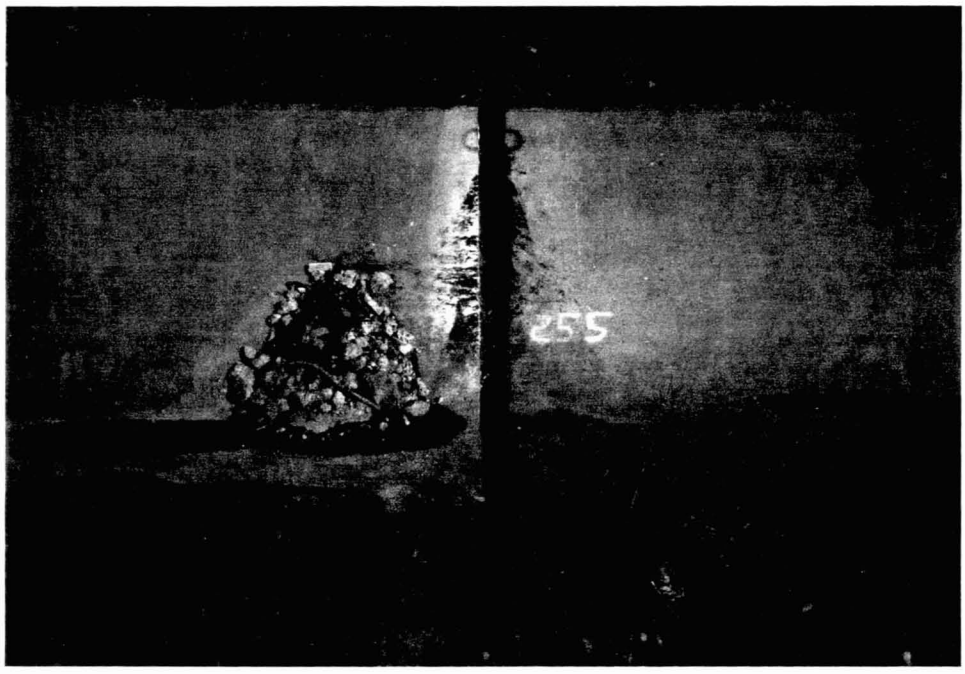
MEASUREMENT-inches (Rebar TO East or WEST)

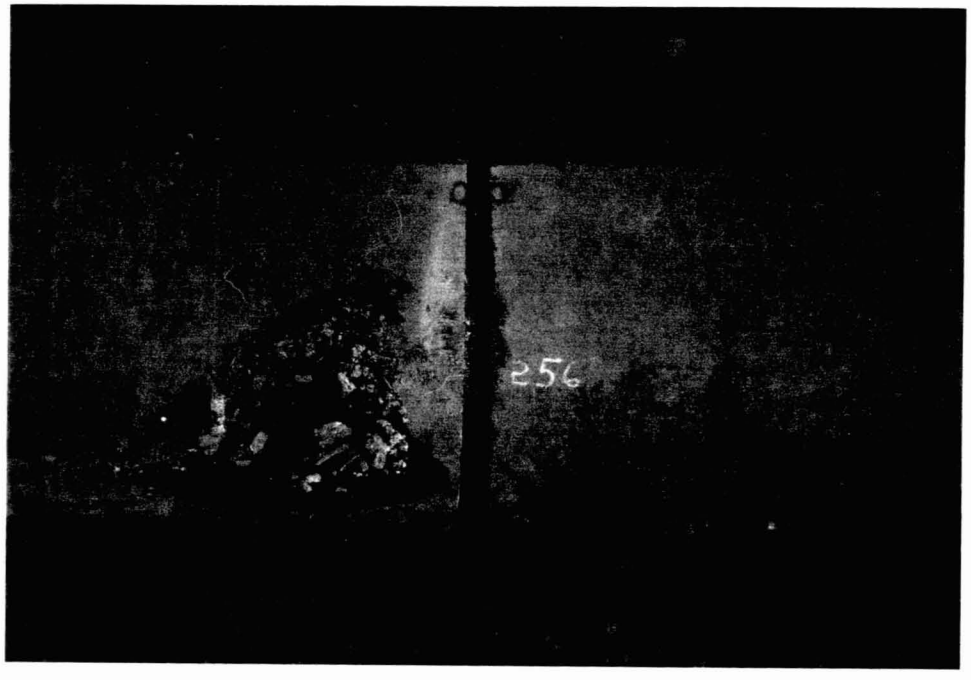


POWERLINE FLOODWAY REPAIR



3/16/92 Sta 129+25 Right slope and channel bottom

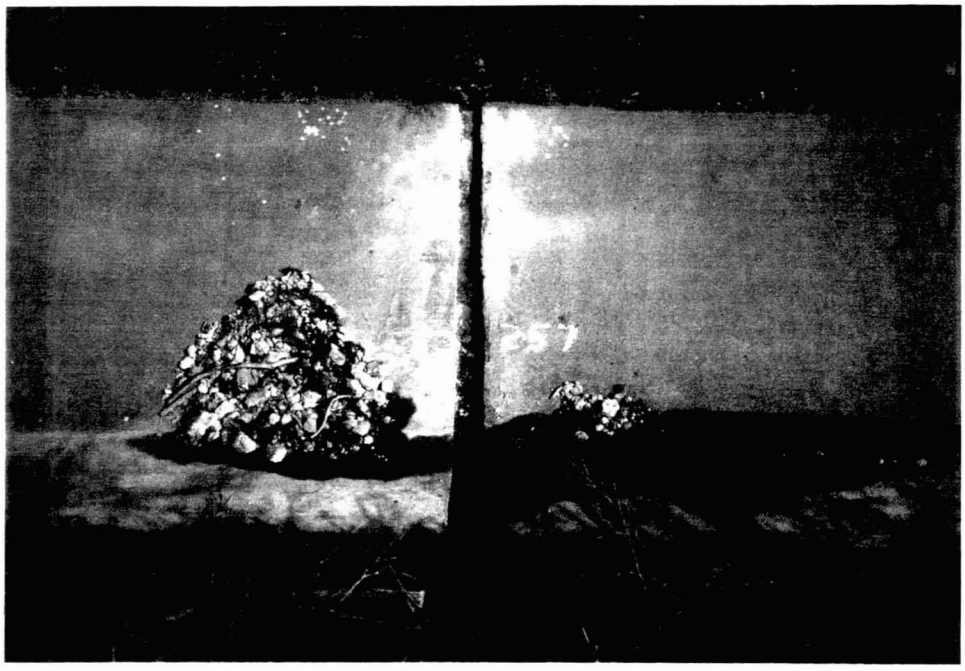
Joint #255 - 6-inch saw cut with rebar and bolts installed



3/16/92 Sta 129+75 Right slope and bottom

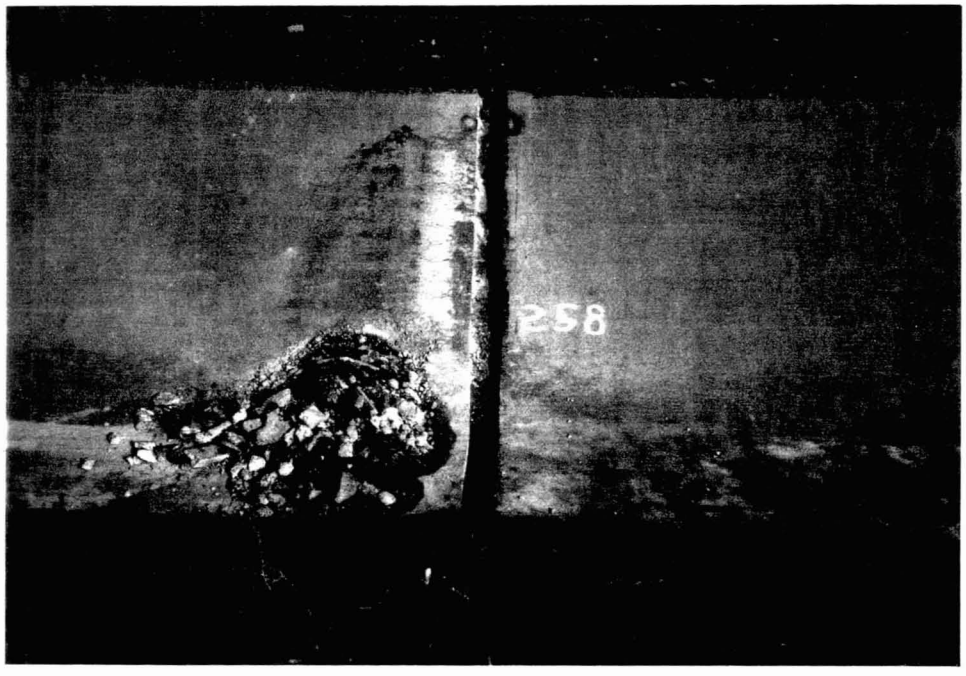
Joint #256 - 6-inch saw cut with rebar and bolts installed

POWERLINE FLOODWAY REPAIR



3/16/92 Sta 130 + 25 Right slope and bottom

Joint #257 - 6-inch saw cut with rebar in bottom and bolts on slopes installed



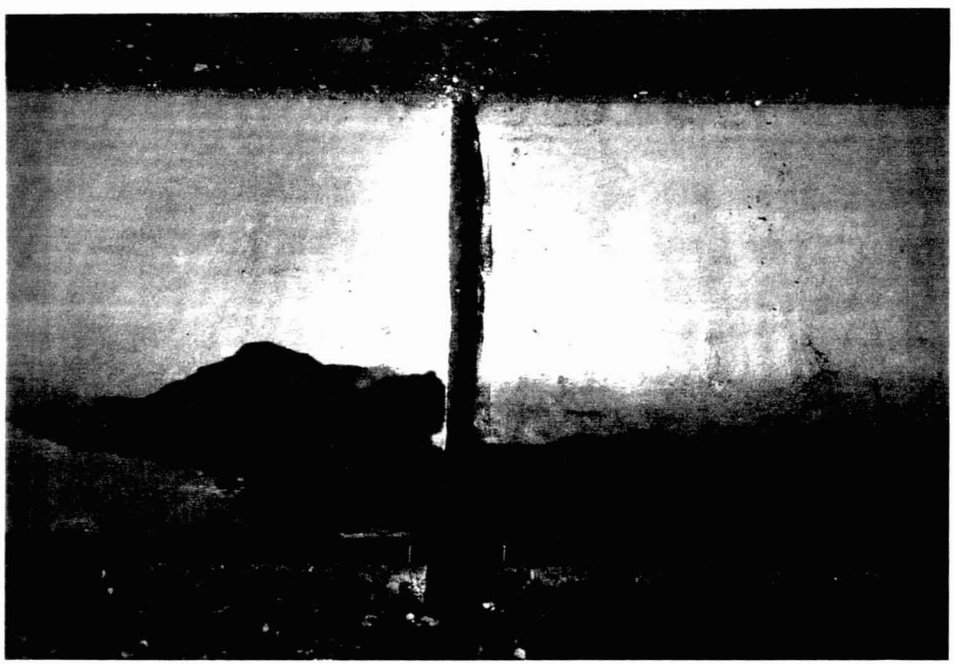
3/16/92 Sta 130 + 75 Right slope and channel bottom

Joint #258 - 6-inch saw cut with rebar in bottom and bolts on slopes installed

POWERLINE FLOODWAY REPAIR

3/16/92 Sta 131+25 Right slope and channel bottom

Joint #259 - 6-inch saw cut with rebar in bottom and bolts on slopes installed



3/16/92 Sta 70+75 Right slope

Joint #126 - 6-inch saw cut with rebar in bottom and bolts on slopes installed

POWERLINE FLOODWAY REPAIR

3/16/92 Sta 71+25 Right slope

Joint #127 - 6-inch saw cut with rebar and bolts in place

3/16/92 Sta 72+25 Right slope

Joint #129 - 6-inch saw cut with rebar and bolts installed

POWERLINE FLOODWAY REPAIR

3/16/92 Sta 72 + 75 Right slope and channel bottom

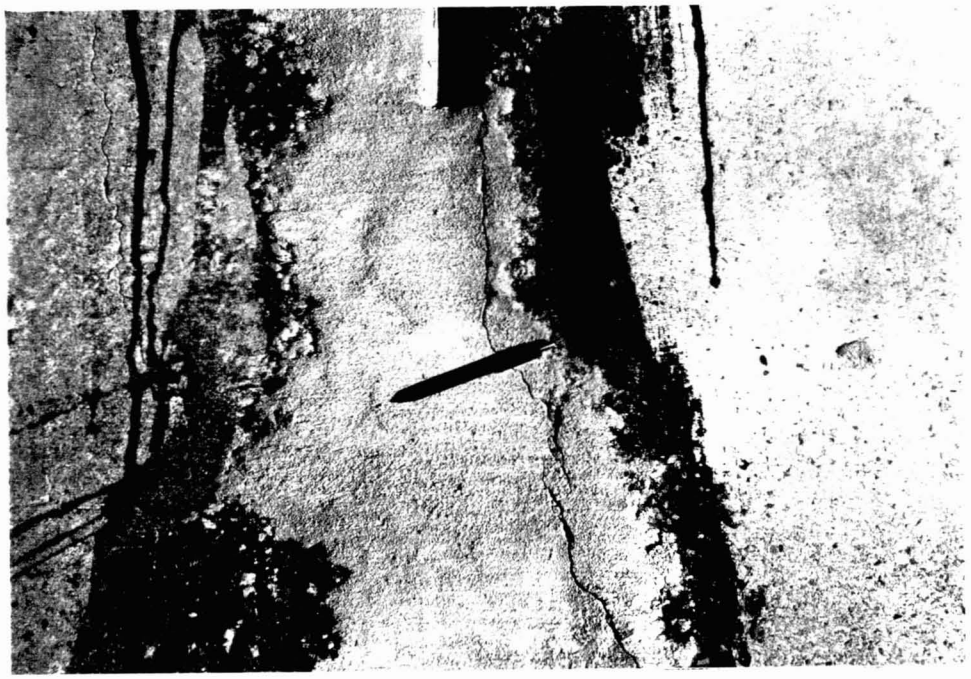
Joint #130 - 6-inch saw cut with rebar and bolts installed

3/16/92 Calipers being used to measure distance between bolts to 0.001 inches on each side of 6-inch cut-out

POWERLINE FLOODWAY REPAIR

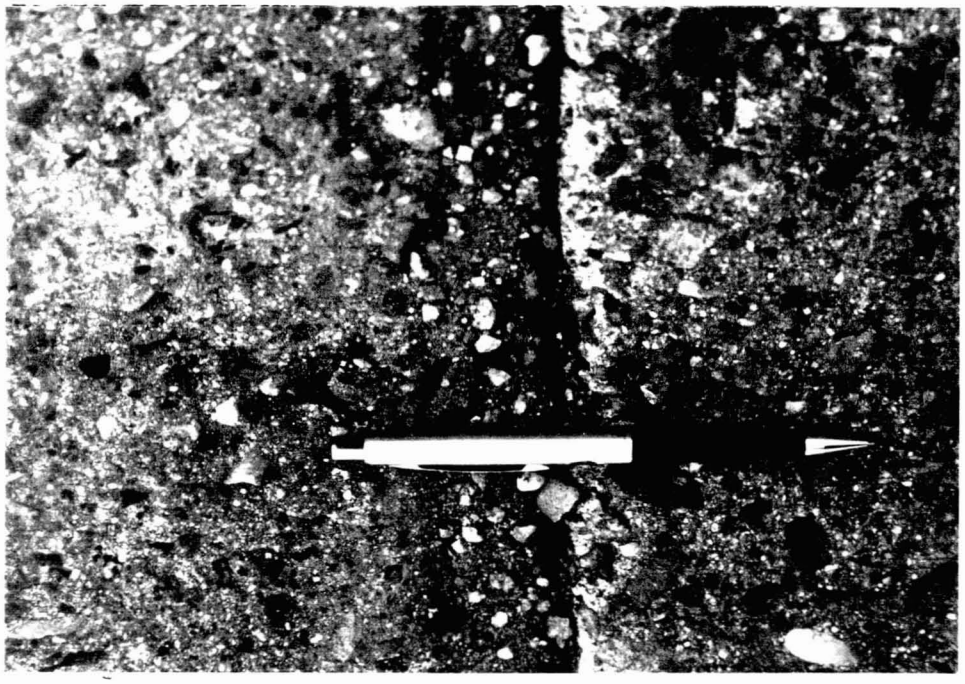
3/16/92 Calipers being used to measure distance between rebar and bolt on one side of 6-inch cut-out to 0.001 inch.

3/16/92 Calipers being used to measure distance between bolts to 0.001 inch across 6-inch cut-out



1/30/92 Sta. 329+57 Right Slope

Crack in recent concrete placed across joint.
Crack due to slab contraction.

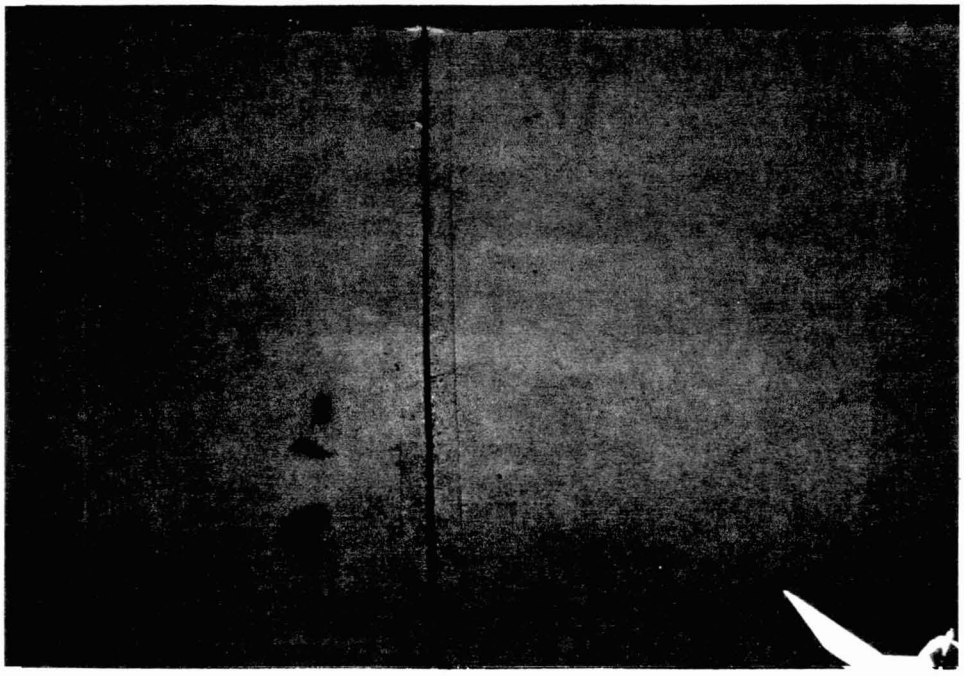


1/30/92 Sta. 208+25 Channel Invert

Slab contraction indicated by crack in silt in joint.

1/30/92 Sta. 208+25 Right Slope

Knife in open joint.



1/30/92 Sta 208+25 Left Slope

Joint open.

1/30/92 Sta. 207+75 Channel Invert

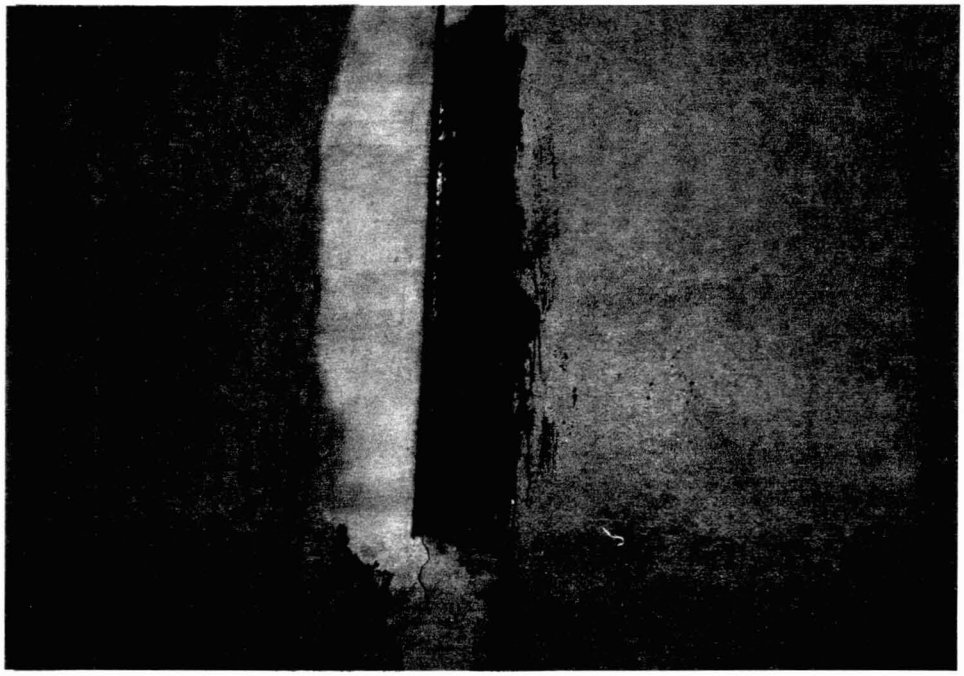
Crack across bottom of channel in recent placed concrete due to slab contraction.

1/30/92 Sta. 207+75 Channel Invert

Close up of slab contraction crack ov recent concrete placed across joint.

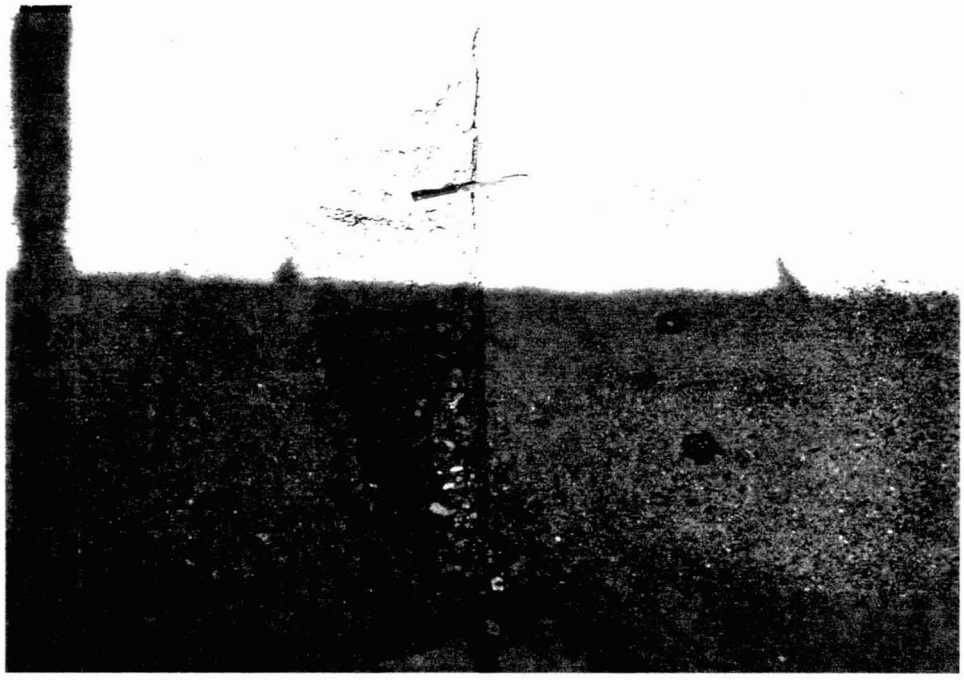
1/30/92 Sta. 207+75 Right Slope

Slab contraction crack in side slope tarred joint.



1/30/92 Sta. 207+75 Left Slope

Slab contraction crack in recent concrete placed across joint. Open joint on bank.



1/30/92 Sta. 203+75 Channel Invert

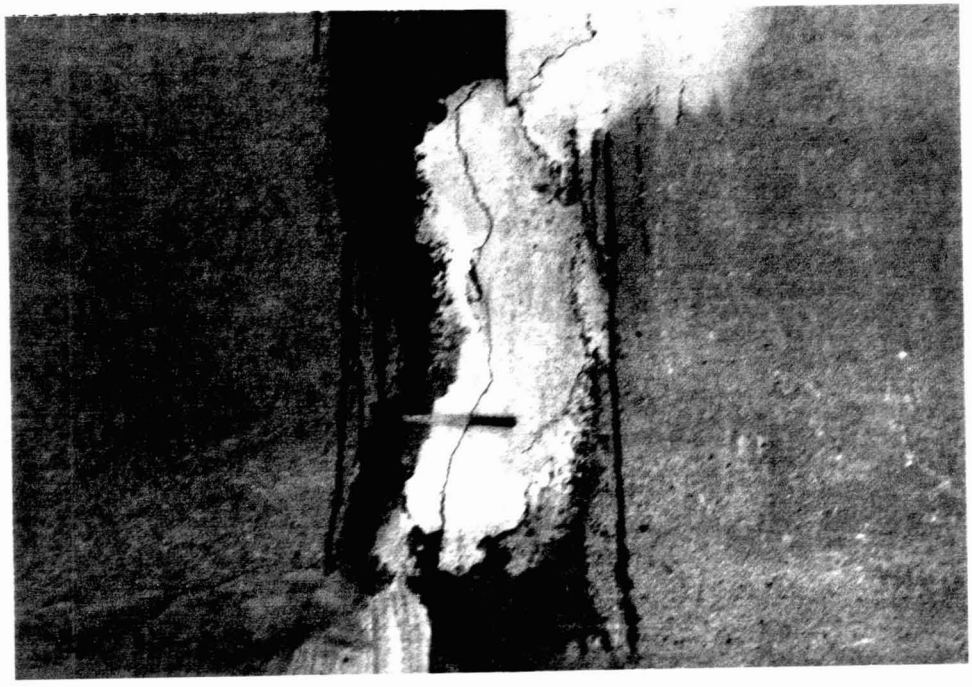
Crack in silted joint due to slab contraction.

1/30/92 Sta. 203+75 Channel Invert

Crack in silted joint due to slab contraction.

1/30/92 Sta. 176+25 Left Slope

Crack in recent concrete placement across joint due to slab contraction.



1/30/92 Sta. 173+50 Left Slope

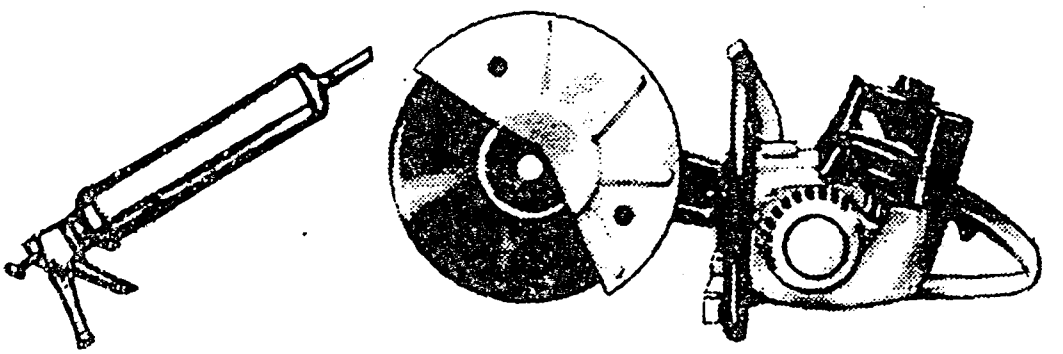
Crack in recent concrete placement across joint due to slab contraction.

APACHE JUNCTION GILBERT WATERSHED WATERSHED PROTECTION AND FLOOD PREVENTION PROJECT

MARICOPA & PINAL COUNTIES, ARIZONA

PLANS FOR THE REPAIR OF

POWERLINE FLOODWAY



PREPARED FOR THE
FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
BOARD OF SUPERVISORS OF PINAL COUNTY
EAST MARICOPA NATURAL RESOURCE CONSERVATION DISTRICT
BY
SOIL CONSERVATION SERVICE
U.S. DEPARTMENT OF AGRICULTURE

UNITED STATES DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
Phoenix, Arizona
March 1992

FINAL
DESIGN REPORT

JOB: Powerline Floodway Repair

PROJECT: Repair of Damaged Trapezoidal Concrete Floodway

AUTHORITY: PL566 Design Deficiency

PHASE: Final Design

SUMMARY

This report is for the repair of 6.8 miles of concrete channel lining which is 78 percent of the entire floodway length. The remaining 22 percent is an earth lining. The floodway was constructed in 1967. The original design did not provide enough side inlets for overland flow and operation and maintenance roads were not graded away from the floodway. A storm on September 30, 1971 brought water from side washes into the empty channel. At approximately ten locations overbank flows entered between the concrete lining and the subgrade. The water eroded soils beneath the lining and created uplift causing the lining to raise and crack in many areas. An attempt was made to correct the damage by sealing cracks and filling voids behind the lining with concrete slurry. To prevent further damage, the operation and maintenance roads were raised and graded to drain away from the lining, additional side inlets were added, and existing side inlets widened.

Expansion and contraction problems also developed along the floodway. The reinforced concrete lining was originally designed with 1/2-inch expansion joints and cutoff walls spaced every 325 feet. Contraction joints were made by tooling every 50 feet. The expansion joints provided did not allow for enough expansion for the excessive distance between the joints. The channel movement caused joints to exert forces against each other which resulted in considerable spalling and uplifting at the joints.

Investigations were done in 1977 to evaluate the movement in the lining. Temperatures and movements across joints were taken after 6 inch sections were cut out of the lining in several locations. These studies were done to observe joint movement, channel grade, and stresses in concrete.

A study was also done in 1977 by Richard Helm where he presented several different possibilities and analysis describing the possible events leading to the damaged channel lining. Several

CONSTRUCTION SPECIFICATION

3. STRUCTURE REMOVAL

1. SCOPE

The work shall consist of the removal, salvage and disposal of structures (including fences) from the designated areas.

2. MARKING

Each structure unit to be removed will be marked by means of stakes, flags, painted markers or other suitable methods.

3. REMOVAL

All structures designated in the contract for removal shall be removed to the specified extent and depth.

4. SALVAGE

Structures that are designated to be salvaged shall be carefully removed and neatly placed in the specified storage areas. Salvaged structures that are capable of being disassembled shall be dismantled into individual members or sections. Such structures shall be neatly match marked with paint prior to disassembly. All pins, nuts, bolts, washers, plates and other loose parts shall be marked or tagged to indicate their proper locations in the structure and shall be fastened to the appropriate structural member or packed in suitable containers. Materials from fences designated to be salvaged shall be placed outside the work area on the property from which they were removed. Wire shall be rolled into uniform rolls of convenient size. Posts and rails shall be neatly piled.

5. DISPOSAL OF REFUSE MATERIALS

Refuse materials resulting from structure removal shall be burned or buried at locations shown on the drawings or as specified in Section 7 of the specification.

6. MEASUREMENT AND PAYMENT

For items of work for which specific lump sum prices are established in the contract, payment for structure removal will be made at the contract lump sum price.

Such payment will constitute full compensation for all labor, equipment, tools, and all other items necessary and incidental to the completion of the work.

Compensation for any item of work described in the contract but not listed in the bid schedule will be included in the payment for the item of work to which it is made subsidiary. Such items and the items to which they are made subsidiary are identified in Section 7 of this specification.

7. ITEMS OF WORK AND CONSTRUCTION DETAILS

Items of work to be performed in conformance with this specification and the construction details are:

(a) Bid Item 1, Structure Removal - Channel Lining

(1) This item consists of the removal and disposal of concrete lined sections, portions of sections, and concrete cutoff collars, as shown on the drawings.

(2) Disposal of concrete rubble and other debris shall be the responsibility of the contractor and shall be disposed of away from the job site.

(3) In Section 6, Measurement and Payment, payment will include compensation for subsidiary item: Pollution Control.

CONSTRUCTION SPECIFICATION

5. POLLUTION CONTROL

1. SCOPE

The work shall consist of installing measures or performing work to control erosion and minimize the production of sediment and other pollutants to water and air during construction operations in accordance with these specifications.

2. MATERIALS

All materials furnished shall meet the requirements of the Material Specifications listed in Section 8 of this specification.

3. EROSION AND SEDIMENT CONTROL MEASURES AND WORKS

The work and measures shall include but not be limited to the following, as shown on the drawings or as specified in Section 8 of this specification.

Staging of Earthwork Activities - The excavation and moving of soil materials shall be scheduled so that the smallest possible areas will be unprotected from erosion for the shortest time feasible.

Seeding - Seedings to protect disturbed areas shall be done as specified on the drawings or in Section 8 of this specification.

Mulching - Mulching shall be used to provide temporary protection to soil surfaces from erosion.

Diversions - Diversions shall be used to divert water away from work areas and/or to collect runoff from work areas for treatment and safe disposition.

Stream Crossings - Culverts or bridges shall be used where equipment must cross streams.

Sediment Basins - Sediment basins shall be used to settle and filter out sediment from eroding areas to protect properties and streams below the construction site.

Straw Bale Filters - Straw bale filters shall be used to trap sediment from areas of limited runoff. Bales are temporary and shall be removed when permanent measures are installed.

Waterways - Waterways shall be used for the safe disposal of runoff from fields, diversions and other structures or measures.

4. CHEMICAL POLLUTION

The Contractor shall provide watertight tanks or barrels or construct a sump sealed with plastic sheets to be used to dispose of chemical pollutants (such as drained lubricating or transmission oils, greases, soaps, asphalt, etc.) produced as a by-product of the project's work. At the completion of the construction work, sumps shall be voided without causing pollution as specified in Section 8 of this specification.

Sanitary facilities such as pit toilets, chemical toilets, or septic tanks shall not be placed adjacent to live streams, wells, or springs. They shall be located at a distance sufficient to prevent contamination of any water sources. At the completion of construction work, facilities shall be disposed of without causing pollution as specified in Section 8 of this specification.

5. AIR POLLUTION

Local and state regulations concerning the burning of brush or slash or disposal of other materials shall be adhered to.

Fire prevention measures shall be taken to prevent the start or the spreading of fires which result from project work. Fire breaks or guards shall be constructed at locations shown on the drawings.

All public access or haul roads used by the contractor during construction of the project shall be sprinkled or otherwise treated to fully suppress dust.

6. MAINTENANCE, REMOVAL, AND RESTORATION

All pollution control measures and works shall be adequately maintained in a functional condition as long as needed during the construction operation. All temporary measures shall be removed and the site restored to as nearly original conditions as practicable.

7. MEASUREMENT AND PAYMENT

Compensation for any item of work described in the contract but not listed in the bid schedule will be included in the payment for the item of work to which it is made subsidiary. Such items, and the items to which they are made subsidiary, are identified in Section 8 of this specification.

8. ITEMS OF WORK AND CONSTRUCTION DETAILS

Items of work to be performed in conformance with this specification and the construction details are:

a. Subsidiary items. Pollution Control

(1) This item consists of all work required to control or reduce pollution.

(2) The contractor is required to adhere to all applicable local, State and Federal laws and regulations pertaining to the control of pollution as may result from construction of this project. These laws and regulations include but are not limited to:

(a) The "Policy on construction and related activities in water" adopted April 13, 1977, by the Water Quality Control Council of Arizona.

(b) The Clean Air Act (42 U.S.C. 1857 et seq. as amended by Pub. L. 91-604) Section 114, and Section 308 of the Federal Water Pollution Control Act (33 U.S.C. 1251 et seq. as amended by Pub. L. 92-500) relating to inspection, monitoring, entry, reports, and information as well as the other requirement of these sections.

(3) The Contractor is responsible for maintaining air, water, and vegetative quality within the work area. Methods include:

(a) Establishing turn areas, haul roads, work site access road, temporary building sites, equipment yards, etc., in approved locations, and staging earthwork activities to prevent contamination of air and water, to minimize destruction of existing vegetation, and to minimize erosion.

(b) Operating mechanized equipment at the job site in a manner that will avoid destruction or removal of trees and shrubs other than as necessary for construction of the measure.

(4) Under Section 2, Materials, there are no material specifications.

(5) In Section 3, Erosion and Sediment Control Measures and Works, the Contractor shall provide a plan for approval by the Contracting Officer prior to the notice to proceed being issued for the following:

(a) Staging of Earthwork Activities.

(b) Diversions.

(6) In section 4, Chemical Pollution, prior to the completion of the job the Contractor shall provide a plan, for approval by the Contracting Officer, to void sump areas and dispose of sanitary facilities as applicable.

(7) In section 7, Measurement and Payment, no separate payment will be made for this item. Compensation for this work will be included in the payment for Bid Item 1, Structure Removal.

CONSTRUCTION SPECIFICATION

7. CONSTRUCTION SURVEYS FOR LAYOUT, CONTROL AND MEASUREMENT

1. SCOPE

The work shall consist of performing: (1) all specified surveys for layout of work and construction controls, and (2) quantity surveys and computations for progress payment estimates. It includes furnishing all necessary equipment, personnel and material to perform the surveys required by the methods specified.

2. EQUIPMENT AND MATERIALS

Equipment for construction surveys shall be of a quality and condition to provide the required accuracy. The equipment shall be maintained in good working order and in proper adjustment at all times. Records of calibration tests, accuracy checks and adjustments shall be maintained and be available for inspection by the Contracting Officer.

Materials include all the necessary field notebooks, stakes, templates, platforms, equipment, spikes, steel pins, tools, and all other items necessary to perform the work specified.

3. QUALITY OF WORK

All work shall follow recognized professional practice and the standards of the industry unless otherwise specified in Section 9. The work shall be performed to the accuracy and detail appropriate for the type of job. Notes, sketches, and other data shall be complete, recorded neatly, legible, reproducible and organized in a manner that will allow reproduction of copies for job documentation.

All computations shall be mathematically correct. Computations shall include information to identify the bid item, date, and who performed, checked and approved the computations. Computations shall be legible, complete and clearly document the source of all information used including assumptions and measurements made.

If a computer program is used to perform the computations, the contractor shall provide the contracting officer with the software identification, venders name, version number, and other pertinent data prior to beginning survey work. Computer generated computations shall show all input data including values assigned and assumptions made.

The elevations of permanent and temporary bench marks shall be determined and recorded to the nearest 0.01 foot. Differential leveling and transit traverses shall be of such precision that the error of vertical closure in feet shall not exceed plus or minus 0.1

times the square root of the traverse distance in miles. Linear measurements shall be accurate to within 1.0 foot in 5000 feet, unless otherwise specified in Section 9. The angular error of closure for transit traverses shall not exceed 1.0 minute times the square root of the number of angles turned.

Slope stakes shall be placed, as a minimum; at 100 foot stations, breaks in the original ground surface and at any other intermediate stations necessary to insure accurate location for construction layout and measurement. Slope stakes and cross sections shall be perpendicular to the centerline. Significant breaks in grade shall be determined for cross sections. Distances shall be measured horizontally and recorded to the nearest 0.1 foot. Side shots for interim construction stakes may be taken with a hand level.

Unless otherwise specified in Section 9, measurement for stationing and establishing the location of structures shall be made to the nearest 0.1 of a foot.

Elevations for concrete work, pipes and mechanical equipment shall be determined and recorded to the nearest 0.01 foot. Elevations for earth work shall be determined and recorded to the nearest 0.1 foot.

4. PRIMARY CONTROL

The baselines and bench marks for primary control, necessary to establish lines and grades needed for construction, are shown on the drawings and have been located on the job site.

These baselines and bench marks shall be used as the origin of all surveys, layouts and measurements to establish construction lines and grades. The Contractor shall take all necessary precautions to prevent the loss or damage of primary control points.

5. CONSTRUCTION SURVEYS

Prior to commencement of work requiring contractor performed surveys, the Contractor shall submit in writing to the Contracting Officer for approval the name, qualifications and experience of the individuals to be assigned to the job.

Contractor performed surveys shall consist of the work necessary for: (1) establishing line and grade for all work, (2) setting slope stakes for all work, (3) checking and any supplemental or interim staking, (4) establishing final grade stakes, (5) performing quantity surveys, measurements and computations for progress payment and (6) other surveys as described in Section 9.

6. STAKING

Prior to the commencement of work on any item the construction staking required for that item shall be completed. Construction staking shall be completed as follows, or as otherwise specified in Section 9:

a. Clearing and grubbing - the boundary of the clearing and grubbing areas shall be staked or flagged at 200 foot intervals, or closer if needed, to clearly mark the limits of work.

b. Excavation and fill - slope stakes shall be placed at the intersection of the specified slopes and ground line. Slope stakes or the reference stakes for slopes shall be marked with the stationing, required cut, slope ratio and horizontal distance. Offset reference stakes and hubs shall be placed, as a minimum, at 100 foot stations, and shall be placed on at least one side of specified excavations and on both sides of specified fills.

c. Structures - centerline and offset reference line stakes for location, alignment and elevation shall be placed for all structures.

7. RECORDS

All survey data shall be recorded in fully identified, standard hard-bound engineering survey field notebooks with consecutively numbered pages. All field notes and printed data shall include the purpose or description of the work, the date the work was performed, weather data, sketches and the personnel who performed and checked the work. Electronically generated survey data and computations shall be bound, page numbered and cross referenced in a bound field notebook containing the index for all survey data.

The construction survey records shall be available at all times during the progress of the work for examination and use by the Contracting Officer and copies shall be made available to the Contracting Officer upon request. The original field notebooks and other records shall be turned over to and become the property of the Contracting Officer prior to final acceptance of the work.

Complete documentation of computations and supporting data for progress payments shall be submitted to the Contracting Officer with each invoice for payment as specified in Section 9.

8. MEASUREMENT AND PAYMENT

Compensation for any item of work described in the contract but not listed in the bid schedule will be included in the payment for the item of work to which it is made subsidiary. Such items and the item to which they are made subsidiary are identified in Section 9 of this specification.

9. ITEMS OF WORK AND CONSTRUCTION DETAILS

Items of work to be performed in conformance with this specification and the construction details are:

a. Subsidiary Item, Surveys

(1) This item consists of furnishing personnel, equipment, materials and performing surveys required to construct the Powerline Floodway Repair.

(2) In Section 5 "other surveys" shall include those required for computation of final quantities and preparation of as-built drawings.

(3) The Contractor shall provide the Government Representative at the beginning of each work week a schedule of surveys to be performed that week.

(4) Base lines and bench marks for primary control are located on the south side of the floodway.

(5) Any primary control monuments damaged or destroyed by the Contractor due to negligence will be replaced by the Government at the Contractor's expense. The actual cost to the Government for replacing the primary control monuments will be deducted from payments due the Contractor or as determined by the Contracting Officer.

(6) All entries shall be consistent with Soil Conservation Service TR-62, "Engineering Layout, Notes, Staking and Calculations".

(7) In Section 3, Quality of Work, third paragraph, it is not necessary to submit the software etc., prior to beginning survey work.

(8) In Section 8, Measurement and Payment, no separate payment will be made for surveys. Compensation for this item will be included in Bid Item 3, Concrete Channel Lining.

CONSTRUCTION SPECIFICATION

8. MOBILIZATION

1. SCOPE

The work shall consist of the mobilization of the Contractor's forces and equipment necessary for performing the work required under the contract. Mobilization will not be considered as work in fulfilling the contract requirement for commencement of work.

Mobilization shall include the cost for transportation of personnel, equipment, and operating supplies to the site; establishment of offices, buildings, and other necessary facilities at the site not covered in specific bid items, and other preparatory work at the site. The cost of the entire amount of premiums paid for performance and payment bonds, including coinsurance and reinsurance agreements as applicable shall be paid upon request when evidence of full payment to the surety has been provided to the Contracting Officer.

Work done under this specification shall not include mobilization for any specific item of work for which payment for mobilization is provided elsewhere in the contract.

The specification covers mobilization for work required by the contract at the time of award. If additional mobilization costs are incurred during performance of the contract as a result of changed or added items of work for which the Contractor is entitled to an adjustment in contract price, compensation for such costs will be included in the price adjustment for the item or items of work changed or added.

2. PAYMENT

Payment will be made as the work proceeds, after presentation of invoices by the Contractor showing his own mobilization costs and evidence of the charges of suppliers, subcontractors, and others for mobilization work performed by them. If the total of such payments is less than the contract lump sum for mobilization, the unpaid balance will be included in the final contract payment. Total payment will be the lump sum contract price for mobilization, regardless of actual cost to the Contractor.

Payment will not be made under this item for the purchase costs of materials having a residual value, the purchase costs of materials to be incorporated in the project, or the purchase costs of operating supplies.

Payment of the lump sum contract price for mobilization will constitute full compensation for all labor, materials, equipment, and all other items necessary and incidental to completion of the work.

3. ITEMS OF WORK AND CONSTRUCTION DETAILS

Item of work to be performed in accordance with this specification and the construction details are:

a. Bid Item 2, Mobilization

(1) This Item consists of the mobilization of the Contractor's equipment and forces for the repair of the Powerline Floodway.

CONSTRUCTION SPECIFICATION

10. WATER FOR CONSTRUCTION

1. SCOPE

The work shall consist of furnishing, transporting, and using water for construction purposes in accordance with the applicable specifications.

2. FACILITIES AND EQUIPMENT

The Contractor shall build and maintain such access and haul roads as are needed, and shall furnish, operate, and maintain all pumps, piping, tanks, and other facilities needed to load, transport, and use the water as specified.

These facilities shall be equipped with meters, tanks, or other devices by which the volume of water supplied can be measured.

3. DUST ABATEMENT AND HAUL ROAD MAINTENANCE

Water for dust abatement and haul road maintenance shall be applied to haul roads and other dust-producing areas as needed to prevent excessive dust and to maintain the roads in good condition for efficient operation while they are in use.

4. EARTHFILL, DRAINFILL, ROCKFILL

Water for earthfill, drainfill, or rockfill shall be used in the fill materials as specified in the applicable construction specifications.

5. CONCRETE, MORTAR, GROUT

Water used in mixing or curing concrete, pneumatically applied mortar, or other portland cement mortar or grout shall meet the requirements of the applicable construction specifications and shall be used in conformance with those specifications. Payment for water used in these items is covered by the applicable concrete, mortar or grout specification.

6. MEASUREMENT AND PAYMENT

For water items for which specific unit prices are established in the contract, the volume of water furnished and used in accordance with the specifications will be measured to the nearest 1000 gallons.

Except as otherwise specified, the measurement for payment will include all water needed at the construction site, except as noted in Section 5, to perform the work required under the contract in accordance with the specifications but will not include water wasted or used in excess of the amount needed. It will not include water used in concrete which is mixed elsewhere and transported to the site.

Payment for water will be made at the contract unit price. Such payment will constitute full compensation for all labor, materials, equipment, and all other items necessary and incidental to furnishing, transporting, and using the water.

7. ITEMS OF WORK AND CONSTRUCTION DETAILS

Items of work to performed in conformance with this specification and the construction details are:

a. Subsidiary Item, Water

(1) This item consists of furnishing, transporting and applying all water necessary for performance of the work as described in this contract.

(2) In Section 6, Measurement and Payment, no separate payment will be made for this item. Compensation for this work will be included in the payment for Bid Item 3, Concrete Channel Lining; and Bid Item 9, Crack Repair.

CONSTRUCTION SPECIFICATION

11. REMOVAL OF WATER

1. SCOPE

The work shall consist of the removal of surface water and ground water as needed to perform the required construction in accordance with the specifications. It shall include (1) building and maintaining all necessary temporary impounding works, channels, and diversions, (2) furnishing, installing and operating all necessary pumps, piping and other facilities and equipment, and (3) removing all such temporary works and equipment after they have served their purposes.

2. DIVERTING SURFACE WATER

The Contractor shall build, maintain and operate all cofferdams, channels, flumes, sumps, and other temporary diversion and protective works needed to divert streamflow and other surface water through or around the construction site and away from the construction work while construction is in progress. Unless otherwise specified, a diversion must discharge into the same natural drainageway in which its headworks are located.

Unless otherwise specified, the Contractor shall furnish to the Contracting Officer, in writing, his plan for diverting surface water before beginning the construction work for which the diversion is required. Acceptance of this plan will not relieve the Contractor of responsibility for completing the work as specified.

3. DEWATERING THE CONSTRUCTION SITE

Foundations, cutoff trenches and other parts of the construction site shall be dewatered and kept free of standing water or excessively muddy conditions as needed for proper execution of the construction work. The Contractor shall furnish, install, operate and maintain all drains, sumps, pumps, casings, wellpoints, and other equipment needed to perform the dewatering as specified. Dewatering methods that cause a loss of fines from foundation areas will not be permitted.

Unless otherwise specified, the Contractor shall furnish to the Contracting Officer, in writing, his plan for dewatering before beginning the construction work for which the dewatering is required. Acceptance of this plan will not relieve the Contractor of responsibility for completing the work as specified.

4. DEWATERING BORROW AREAS

Unless otherwise specified in Section 8, the Contractor shall maintain the borrow areas in drainable condition or otherwise provide for

timely and effective removal of surface and ground waters that accumulate within the borrow areas from any source. Borrow material shall be processed as necessary to achieve proper and uniform moisture content for placement.

If pumping to dewater borrow areas is included as an item of work in the bid schedule, each pump used for this purpose shall be equipped with a water meter in the discharge line. Accuracy of the meters shall be such that the measured quantity of water is within 3 percent, plus or minus, of the true quantity. Means shall be provided by the Contractor to check the accuracy of the water meters when requested by the Contracting Officer.

5. EROSION AND POLLUTION CONTROL

Removal of water from the construction site, including the borrow areas shall be accomplished in such a manner that erosion and the transmission of sediment and other pollutants are minimized.

6. REMOVAL OF TEMPORARY WORKS

After the temporary works have served their purposes, the Contractor shall remove them or level and grade them to the extent required to present a sightly appearance and to prevent any obstruction of the flow of water or any other interference with the operation of or access to the permanent works.

Except as otherwise specified, pipes and casings shall be removed from temporary wells and the wells shall be filled to ground level with gravel or other material approved by the Contracting Officer.

7. MEASUREMENT AND PAYMENT

Compensation for any item of work described in the contract but not listed in the bid schedule will be included in the payment for the item of work to which it is made subsidiary. Such items and the items to which they are made subsidiary are identified in Section 8 of this specification.

8. ITEMS OF WORK AND CONSTRUCTION DETAILS

Items of work to be performed in conformance with this specification and the construction details are:

a. Subsidiary Item, Removal of Water

1. This item consists of the removal or diverting of surface water from the construction areas shown on the drawings.

2. In Section 2, Diverting Surface Water, no plan for diverting water is required. However, Contractor shall be responsible to pass flows through or around the work areas.

3. In Section 7, Measurement and Payment, no separate payment will be made for the Removal of Water. Compensation for this work will be included in the payment for Bid Item 3, Concrete Channel Lining.

CONSTRUCTION SPECIFICATION

21. EXCAVATION

1. SCOPE

The work shall consist of the excavation required by the drawings and specifications and disposal of the excavated materials.

2. CLASSIFICATION

Excavation will be classified as common excavation or rock excavation in accordance with the following definitions or will be designated as unclassified.

Common excavation shall be defined as the excavation of all materials that can be excavated, transported, and unloaded by the use of heavy ripping equipment and wheel tractor-scrapers with pusher tractors or that can be excavated and dumped into place or loaded onto hauling equipment by means of excavators having a rated capacity of one cubic yard and equipped with attachments (such as shovel, bucket, backhoe, dragline or clam shell) appropriate to the character of the materials and the site conditions.

Rock excavation shall be defined as the excavation of all hard, compacted or cemented materials the accomplishment of which requires blasting or the use of excavators larger than defined for common excavation. The excavation and removal of isolated boulders or rock fragments larger than one cubic yard in volume encountered in materials otherwise conforming to the definition of common excavation shall be classified as rock excavation.

Excavation will be classified according to the above definitions by the Engineer, based on his judgment of the character of the materials and the site conditions.

The presence of isolated boulders or rock fragments larger than one cubic yard in size will not in itself be sufficient cause to change the classification of the surrounding material.

For the purpose of this classification, the following definitions shall apply:

Heavy ripping equipment shall be defined as a rear-mounted, heavy duty, single-tooth, ripping attachment mounted on a tractor having a power rating of 200-300 net horsepower (at the flywheel).

Wheel tractor-scraper shall be defined as a self-loading (not elevating) and unloading scraper having a struck bowl capacity of 12-20 yards.

Pusher tractor shall be defined as a track type tractor having a power rating of 200-300 net horsepower (at the flywheel) equipped with appropriate attachments.

3. UNCLASSIFIED EXCAVATION

Items designated as "Unclassified Excavation" shall include all materials encountered regardless of their nature or the manner in which they are removed. When excavation is unclassified, none of the definitions or classifications stated in Section 2 of this specification shall apply.

4. BLASTING

The transportation, handling, storage, and use of dynamite and other explosives shall be directed and supervised by a person of proven experience and ability in blasting operations.

Blasting shall be done in such a way as to prevent damage to the work or unnecessary fracturing of the foundation and shall conform to any special requirements in Section 12 of this specification.

5. USE OF EXCAVATED MATERIALS

To the extent they are needed, all suitable materials from the specified excavations shall be used in the construction of required permanent earthfill or rockfill. The suitability of materials for specific purposes will be determined by the Engineer. The Contractor shall not waste or otherwise dispose of suitable excavated materials.

6. DISPOSAL OF WASTE MATERIAL

All surplus or unsuitable excavated materials will be designated as waste and shall be disposed of by the Contractor at sites of his own choosing away from the site of the work.

7. BRACING AND SHORING

Excavated surfaces too steep to be safe and stable if unsupported shall be supported as necessary to safeguard the work and workmen, to prevent sliding or settling of the adjacent ground, and to avoid damaging existing improvements. The width of the excavation shall be increased if necessary to provide space for sheeting, bracing, shoring, and other supporting installations. The Contractor shall furnish, place and subsequently remove such supporting installations.

8. STRUCTURE AND TRENCH EXCAVATION

Structure or trench excavation shall be completed to the specified elevations and to sufficient length and width to include allowance for forms, bracing and supports, as necessary, before any concrete or earthfill is placed or any piles are driven within the limits of the excavation.

9. BORROW EXCAVATION

When the quantities of suitable materials obtained from specified excavations are insufficient to construct the specified fills, additional materials shall be obtained from the designated borrow areas. The extent and depth of borrow pits within the limits of the designated borrow areas shall be as directed by the Engineer.

Borrow pits shall be excavated and finally dressed in a manner to eliminate steep or unstable side slopes or other hazardous or unsightly conditions.

10. OVEREXCAVATION

Excavation in rock beyond the specified lines and grades shall be corrected by filling the resulting voids with portland cement concrete made of materials and mix proportions approved by the Engineer. Concrete that will be exposed to the atmosphere when construction is completed shall contain not less than 6 sacks of cement per cubic yard of concrete. Concrete that will be permanently covered shall contain not less than 4-1/2 sacks of cement per cubic yard. The concrete shall be placed and cured as specified by the Engineer.

Excavation in earth beyond the specified lines and grades shall be corrected by filling the resulting voids with approved compacted earthfill, except that, if the earth is to become the subgrade for riprap, rockfill, sand or gravel bedding, or drainfill, the voids may be filled with material conforming to the specifications for the riprap, rockfill, bedding or drainfill.

11. MEASUREMENT AND PAYMENT

For items of work for which specific unit prices are established in the contract, the volume of each type and class of excavation within the specified pay limits will be measured and computed to the nearest cubic yard by the method of average cross-sectional end areas. Regardless of quantities excavated, the measurement for payment will be made to the specified pay limits, except that excavation outside the specified lines and grades directed by the Engineer to remove unsuitable material will be included. Excavation required because unsuitable conditions result from the Contractor's improper construction operations, as determined by the Contracting Officer, will not be included for measurement and payment.

Compensation for any item of work described in the contract but not listed in the bid schedule will be included in the payment for the item of work to which it is made subsidiary. Such items and the items to which they are made subsidiary are identified in Section 12 of this specification.

CONSTRUCTION SPECIFICATION

31. CONCRETE

1. SCOPE

The work shall consist of furnishing, forming, placing, finishing and curing portland cement concrete as required to build the structures designated in Section 26 of this specification.

2. MATERIALS

Portland cement shall conform to the requirements of Material Specification 531 for the specified type. One brand only of any type of cement shall be used in any single structure as defined in Section 26.

Aggregates shall conform to the requirements of Material Specification 522 unless otherwise specified. The grading of coarse aggregates shall be as specified in Section 26.

Water used in mixing or curing concrete shall be clean and free from injurious amounts of oil, salt, acid, alkali, organic matter or other deleterious substances.

Air entraining admixtures shall conform to the requirements of Material Specification 532. If air-entraining cement is used, any additional air-entraining admixture shall be of the same type as that in the cement.

Pozzolan shall conform to ASTM C 618, Class F except the loss of ignition shall not exceed 3.0 percent.

Water-reducing, set-retarding admixture shall conform to the requirements of Material Specification 533.

Shear plates shall conform to the requirements of Material Specification 581 for structural quality or commercial or merchant quality steel. Structural quality shall be used if specifically designated in the drawings or specifications.

Preformed expansion joint filler shall conform to the requirements of Material Specification 535.

Waterstops shall conform to the requirements of Material Specifications 537 and 538 for the specified kinds.

Curing compound shall conform to the requirement of Material Specification 534.

3. CLASSES OF CONCRETE

Method 1 Concrete shall be classified according to the required compressive strength. The strength of the concrete at 28 days shall equal or exceed the Minimum Compressive Strength at 28 days tabulated below for the class of concrete specified.

Class of concrete	Minimum Compressive Strength at 28 days (psi)
5000	5000
4000	4000
3000	3000
2500	2500

Method 2 Concrete shall be classified as follows:

Class of Concrete	Water Content (gallons/bag)	Cement Content (bag/cu. yd)
5000X	5	7
4000X	6	6
3000X	7	5
2500X	8	4-1/2

4. AIR CONTENT AND CONSISTENCY

Unless otherwise specified the air content (by volume) of the concrete at the time of placement shall be:

Maximum Size Aggregate	Air Content (%)
3/8 inch to 1/2 inch	6 to 9
Over 1/2 inch to 1 inch	5 to 8
Over 1 inch to 2-1/2 inches	4 to 7

The consistency of the concrete shall be such as to allow it to be worked into place without segregation or excessive laitance. Unless otherwise specified, the slump shall be:

Type of Structure	Slump (inches)
Massive sections, pavements, footings	2 ± 1/2
Heavy beams, thick slabs, thick walls (over 12 in.)	3 ± 1/2
Columns, light beams, thin slabs, thin walls (12 in. or less)	4 ± 1

5. DESIGN OF THE CONCRETE MIX

The Contractor will be responsible for the design of the concrete mixtures. At least 5 days prior to any placement of concrete he shall furnish the Contracting Officer a statement of the materials and mix proportion (including admixtures, if any) he intends to use for each specified class of concrete. The statement shall include evidence satisfactory to the Contracting Officer that the materials and proportions selected will produce concrete of the quality, consistency and strength specified.

The materials and proportions so stated shall constitute the "job mix". After a job mix has been designated, neither the source, character or grading of the aggregates nor the type or brand or quantity of cement or admixture shall be changed without prior notice to the Contracting Officer and establishment of a new job mix supported by evidence, as required for the initial job mix, that the proposed new materials and mix proportions will produce concrete of the quality, consistency, and strength specified.

When specified, a water-reducing, set-retarding admixture shall be used. When conditions are such that the temperature of the concrete at the time of placement is consistently above 75oF, a water-reducing, set-retarding admixture may be used, at the option of the Contractor. The cement content shall be the same as that required in the mix without the admixture.

The use of calcium chloride or other accelerators or antifreeze compounds will not be allowed.

Before placing concrete containing a water-reducing, set-retarding admixture, the Contractor shall furnish test results satisfactory to the Contracting Officer showing that its performance in the job mix meets the requirements of Material Specifications 533, Section 4. When specified, mixes that include fly ash as a partial substitution for portland cement shall be based on absolute volume with a maximum substitution of 20 percent.

6. INSPECTING AND TESTING

During the course of the work, the Engineer will perform such tests as are required to assure the concrete meets the contract requirements. Tests performed by the Engineer are not for the purpose of providing the Contractor with the information required for proper work execution and performance and shall not relieve the Contractor of the necessity to perform tests for that purpose.

The following tests will be performed by the methods indicated:

Test	Method (ASTM Designation)
Sampling	C 172 1/
Slump Test	C 143 1/
Air Content	C 231 1/ or C 173 1/
Compression Test Specimens	C 31 1/, C 42, or C684 2/
Compressive Strength	C 39 2/ or C 42
Unit Weight	C 138

1/ Test of a portion of a batch may be made on samples representative of that portion for any of the following purposes:

(1) Determining uniformity of the batch.

(2) Checking compliance with requirements for slump and air content when the batch is discharged over an extended period of time.

(3) Checking compliance of the concrete with the specifications when the whole amount being placed in a small structure, or a distinct portion of a larger structure, is less than full batch.

2/ For each strength test of specimens made according to ASTM Designation C 39 or C 684, three (3) standard test specimens shall be made. The test result shall be the average of the strength of the three (3) specimens, except that if one (1) specimen in the test shows manifest evidence of improper sampling, molding or testing, it shall be discarded and the strengths of the remaining two (2) specimens shall be averaged. Should more than one (1) specimen representing a test show such defects, the entire test shall be discarded.

The Engineer shall have free entry to the plant and equipment furnishing concrete under the contract. Proper facilities shall be provided for the Engineer to inspect materials, equipment and processes, to obtain samples of the concrete. All tests and inspections will be conducted so as not to interfere unnecessarily with the manufacture and delivery of the concrete.

7. HANDLING AND MEASUREMENT OF MATERIALS

Aggregates shall be stored or stockpiled in such a manner that separation of coarse and fine particles of each size will be avoided and that various sizes will not become intermixed before proportioning. Methods of handling and transporting aggregates shall be such as to avoid contamination, excessive breakage, segregation or degradation, or intermingling of various sizes.

Scales for weighing aggregates and cement shall be beam type or springless dial type. They shall be accurate within 1 percent under operating conditions. All exposed fulcrums, clevises and similar working parts of scales shall be kept clean.

The quantities of cement and aggregates in each batch of concrete, as indicated by the scales, shall be within the following percentage of the required batch weights:

Cement	plus or minus 1.0 percent
Aggregates	plus or minus 2.0 percent

Measuring tanks for mixing water shall be of adequate capacity to furnish the maximum amount of mixing water required per batch and shall be equipped with outside taps and valves to provide for checking their calibration unless other means are provided for readily and accurately determining the amount of water in the tank.

Except as otherwise provided in Section 8, cement and aggregates shall be measured as follows:

Cement shall be measured by weight or in bags of 94 lbs. each. When cement is measured by weight, it shall be weighed on a scale separate from that used for other materials, and in a hopper entirely free and independent of the hopper used for weighing the aggregates. When cement is measured in bags, no fraction of a bag shall be used unless weighed.

Aggregates shall be measured by weight. Mix proportions shall be based on saturated, surface-dry weights. The batch weight of each aggregate shall be the required saturated, surface-dry weight corrected by the weight of surface moisture it contains.

Mixing water shall consist of water added to the batch ice added to the batch, water occurring as surface moisture on the aggregates and water introduced in the form of admixtures. The added water shall be measured by weight or volume to an accuracy of 1 percent of the required total mixing water. Added ice shall be measured by weight. Wash water shall not be used as a portion of the mixing water for succeeding batches.

Dry admixtures shall be measured by weight, and paste or liquid admixtures by weight or volume, within a limit of accuracy of 3 percent.

8. MIXERS AND MIXING

Mixers and mixing shall be in accordance with recommended standards set forth in ACI 304, some specific interpretations of which are stated below.

Concrete may be furnished by batch mixing at the site of the work or by ready-mix methods.

Mixers shall be capable of thoroughly mixing the concrete ingredients into a uniform mass within the specified mixing time and of discharging the mix without segregation. Each mixer or agitator shall bear a manufacturer's rating plate indicating the rated capacity and

recommended speeds of rotation, and shall be operated in accordance with these recommendations.

Concrete shall be uniform and thoroughly mixed when delivered to the forms. Variations in slump of more than 1 inch within a batch will be considered evidence of inadequate mixing and shall be corrected by changing batching procedures, increasing mixing time, changing mixers or other means. Mixing time shall be within the limits specified below unless the Contractor demonstrates by mixer performance tests that adequate uniformity is obtained by different times of mixing. No mixing water in excess of the amount called for by the job mix shall be added to the concrete during mixing or hauling or after arrival at the delivery point. If less water than the design maximum water-cement ratio has been incorporated in the batch, water to compensate for up to a one (1) inch loss in slump may be added, up to the design maximum water cement ratio. Withholding some of the mixing water until the concrete arrives on the job, then adding the remaining water and turning the mixer 30 revolutions at mixing speed may overcome transporting conditions. When loss of slump or workability cannot be offset by these measures, complete mixing shall be performed on the job using centrally dry batched materials, or by on site batching and mixing.

Batch mixing at the site. For concrete mixed at the site of the work with paving mixers or stationary construction mixers, the time of mixing after all cement and aggregates are in the mixer drum shall be not less than 1-1/2 minutes. The batch shall be so charged into the mixer that some water will enter in advance of the cement and aggregates and all mixing water shall be introduced into the drum before one-fourth of the mixing time has elapsed.

Controls shall be provided to insure that the batch cannot be discharged until the required time has elapsed.

If truck mixers are used, the requirements below for truck mixers and truck-mixed concrete shall apply.

Volumetric batching and continuous mixing at the site. Unless otherwise specified, volumetric batching and continuous mixing at the construction site will be permitted. The batching and mixing equipment shall conform to the requirements of ASTM Specification C 685 and shall be demonstrated prior to placement of concrete, by tests with the job mix, to produce concrete meeting the specified proportioning and uniformity requirements. Concrete made by this

method shall be produced, inspected, and documented in conformance with Sections 6, 7, 8, 13, and 14 of ASTM Specification C 685.

Ready-mixed concrete. Ready-mixed concrete shall be mixed and delivered to the site of the work by one of the following methods:

a. Truck-mixed concrete--Mixed completely in a truck mixer.

b. Shrink-mixed concrete--Mixed partially in a stationary mixer, and the mixing completed in a truck mixer.

c. Central-mixed concrete--completely in a stationary mixer and the mixed concrete transported to the point of delivery in a truck agitator or in a truck mixer operating at agitating speed or in nonagitating equipment.

Truck mixers and agitators shall be equipped with revolution counters by which the number of revolutions of the drum or blades may be readily verified.

When ready mixed concrete is furnished, the Contractor shall furnish the Engineer a statement-of-delivery ticket showing the time of loading, the revolution counter reading at the time of loading and the quantities of materials used for each load of concrete.

Truck mixed concrete. When concrete is mixed in a truck mixer loaded to its maximum capacity, the number of revolutions of the drum or blades at mixing speed shall be not less than 70 nor more than 100. If the batch is at least 1/2 cubic yard less than maximum capacity, the number of revolutions at mixing speed may be reduced to not less than 50. Mixing in excess of 100 revolutions shall be at the speed designated by the manufacturer of the equipment as agitating speed. The mixing operation shall begin within 30 minutes after the cement has been added to the aggregates and the water shall be added during mixing. When mixing is begun during or immediately after charging, a portion of the mixing water shall be added ahead of, or with, the other ingredients.

Shrinked-mixed concrete. When concrete is partially mixed at a central plant and the mixing is completed in a truck mixer, the mixing time in the central plant mixer shall be the minimum required to intermingle the ingredients and shall be not less than 30 seconds. The mixing shall be completed in a truck mixer and the number of revolutions of the drum or blades at mixing speed shall be not less than 50 nor more than 100. Mixing in excess of 100 revolutions shall be at the speed designated by the manufacturer of the equipment as agitating speed.

Central-mixed concrete. For central-mixed concrete, mixing in the stationary mixer shall meet the same requirements as batch mixing at the site.

When an agitator, or truck mixer used as an agitator, transports concrete that has been completely mixed in a stationary mixer, mixing during transportation shall be at the speed designated by the manufacturer of the equipment as agitating speed.

The use of nonagitating equipment to transport concrete to the site of the work will be permitted only if the consistency and uniformity of

the concrete as discharged at the point of delivery meet the requirements of this specification. Bodies of nonagitating hauling equipment shall be so constructed that leakage of the concrete mix, or any part thereof will not occur. Concrete hauled in open-top vehicles shall be protected from rain, and from more than 20 minutes exposure to the sun when the air temperature is above 75oF.

9. FORMS

Forms shall be of wood, plywood, steel or other approved material and shall be mortar tight. The forms and associated falsework shall be substantial and unyielding and shall be constructed so that the finished concrete will conform to the specified dimensions and contours. Form surfaces shall be smooth and free from holes, dents, sags or other irregularities. Forms shall be coated with a nonstaining form release agent before being set into place. Metal ties or anchorages within the forms shall be equipped with cones, she-bolts or other devices that permit their removal to a depth of at least one inch without injury to the concrete. Ties designed to break off below the surface of the concrete shall not be used without cones.

All edges that will be exposed shall be chamfered, unless finished with molding tools as specified in Section 20.

10. PREPARATION OF FORMS AND SUBGRADE

Prior to placement of concrete the forms and subgrade shall be free of chips, sawdust, debris, water, ice, snow, extraneous oil, mortar, or other harmful substances or coatings. Any form release agent on the reinforcing steel or other surfaces required to be bonded to the concrete shall be removed.

Rock surfaces shall be cleaned by air-water cutting, wet sandblasting or wire brush scrubbing, as necessary, and shall be wetted immediately prior to placement of concrete. Earth surfaces shall be firm and damp. Placement of concrete on mud, dried earth, uncompacted fill or frozen subgrade will not be permitted. All ice, snow and frost shall be removed and the temperature of all surfaces to be in contact with the new concrete shall be no colder than 40oF.

Items to be embedded in the concrete shall be positioned accurately and anchored firmly.

Weepholes in walls or slabs shall be formed with nonferrous materials.

11. CONVEYING

Concrete shall be delivered to the site and discharged into the forms within 1-1/2 hours after the introduction of the cement to the

aggregates. In hot weather or under conditions contributing to quick stiffening of the concrete, or when the temperature of the concrete is 85oF or above, the time between the introduction of the cement to the aggregates and discharge shall not exceed 45 minutes.

The Engineer may allow a longer time, provided the setting time of the concrete is increased a corresponding amount by the addition of an approved set-retarding admixture. In any case, concrete shall be conveyed from the mixer to the forms as rapidly as practicable, by methods that will prevent segregation of the aggregates or loss of mortar.

12. PLACING

Concrete shall not be placed until the subgrade, forms and steel reinforcement have been inspected and approved.

The Contractor shall have all equipment and materials required for curing available at the site ready for use before placement of concrete begins.

No concrete shall be placed except in the presence of the Engineer. The Contractor shall give reasonable notice to the Engineer each time he intends to place concrete. Such notice shall be far enough in advance to give the Engineer adequate time to inspect the subgrade, forms, steel reinforcement and other preparations for compliance with specifications. Other preparations include but are not limited to the concrete batching plant, mixing and delivery equipment and system, placing and finishing equipment and system, schedule of work, work force and heating or cooling facilities as applicable. All deficiencies are to be corrected before concrete is delivered for placing.

The concrete shall be deposited as closely as possible to its final position in the forms and shall be worked into the corners and angles of the forms and around all reinforcement and embedded items in a manner to prevent segregation of aggregates or excessive laitance. The depositing of concrete shall be regulated so that the concrete can be consolidated with a minimum of lateral movement.

Concrete shall not be dropped more than 5 feet vertically unless suitable equipment is used to prevent segregation.

13. LAYERS

Unless otherwise specified, slab concrete shall be placed to design thickness in one continuous layer. Formed concrete shall be placed in horizontal layers not more than 20 inches thick. Hoppers and chutes,

pipes or "elephant trunks" shall be used as necessary to prevent splashing of mortar on the forms and reinforcing steel above the layer being placed.

Successive layers shall be placed at a fast enough rate to prevent the formation of "cold joints". If the surface of a layer of concrete in place sets to the degree that it will not flow and merge with the succeeding layer when vibrated, the Contractor shall discontinue placing concrete and shall make a construction joint according to the procedure specified in Section 15.

If placing is discontinued when an incomplete layer is in place, the unfinished end of the layer shall be formed by a vertical bulkhead.

14. CONSOLIDATING

Unless otherwise specified, concrete shall be consolidated with internal type mechanical vibrators capable of transmitting vibration to the concrete at frequencies not less than 6000 impulses per minute. The location, manner and duration of the application of the vibrators shall be such as to secure maximum consolidation of the concrete without causing segregation of the mortar and coarse aggregate, and without causing water or cement paste to flush to the surface. The Contractor shall provide a sufficient number of vibrators to properly consolidate the concrete immediately after it is placed in the work. Vibration shall be applied to the freshly deposited concrete by slowly inserting and removing the vibrator at points uniformly spaced and not farther apart than twice the radius over which the vibration is visibly effective. The vibrator shall extend into the previously placed layer of fresh concrete, at all points, to insure effective bond between layers.

Vibration shall not be applied directly to the reinforcement steel or the forms nor to concrete that has hardened to the degree that it does not become plastic when vibrated.

The use of vibrators to transport concrete in the forms or conveying equipment will not be permitted.

Vibration shall be supplemented by spading and hand tamping as necessary to insure smooth and dense concrete along form surfaces, in corners and around embedded items.

15. CONSTRUCTION JOINTS

Construction joints shall be made at the locations shown on the drawings. If construction joints are needed which are not shown on the drawings, they shall be placed in locations approved by the Engineer. Where a feather edge would be produced at a construction joint, as in the top surface of a sloping wall, an insert form shall be used so that the resulting edge thickness on either side of the joint is not less than 6 inches.

In walls and columns as each lift is completed, the top surfaces shall be immediately and carefully protected from any condition that might adversely affect the hardening of the concrete.

Steel tying and form construction adjacent to concrete in place shall not be started until the concrete has cured at least 12 hours. Before new concrete is deposited on or against concrete that has hardened, the forms shall be retightened. New concrete shall not be placed until the hardened concrete has cured at least 12 hours.

Method 1 Surfaces of construction joints shall be cleaned of all unsatisfactory concrete, laitance, coatings, stains or debris by either sandblasting after the concrete has gained sufficient strength to resist excessive cutting, or air-water cutting as soon as the concrete has hardened sufficiently to prevent the jet from displacing the coarse aggregates, or both. The surface of the concrete in place shall be cut to expose clean, sound aggregate but not so deep as to undercut the edges of larger particles of the aggregate. After cutting, the surface shall be thoroughly washed to remove all loose material. If the surface is congested by reinforcing steel, is relatively inaccessible, or it is considered undesirable to disturb the concrete before it is hardened, cleaning of the joint by air-waterjets will not be permitted and the wet sandblasting method will be required after the concrete has hardened.

The surfaces shall be kept moist for at least one hour prior to placement of new concrete. The new concrete shall be placed directly on the cleaned and washed surface.

Method 2 Surfaces of construction joints shall be cleaned of all unsatisfactory concrete, laitance, coatings, stains, or debris by washing and scrubbing with a wire brush or wire broom or by other means approved by the Engineer. The surfaces shall be kept moist for at least one hour prior to placement of new concrete. The new concrete shall be placed directly on the cleaned and washed surface.

16. EXPANSION AND CONTRACTION JOINTS

Expansion and contraction joints shall be made only at locations shown on the drawings.

Exposed concrete edges at expansion and contraction joints shall be carefully tooled or chamfered, and the joints shall be free of mortar and concrete. Joint filler shall be left exposed for its full length with clean and true edges.

When open joints or weakened plane "dummy" joints are specified, the joints shall be constructed by the insertion and subsequent removal of a wood strip, metal plate or other suitable template in such a manner that the corners of the concrete will not be chipped or broken. The edges of the concrete at the joints shall be finished with an edging tool prior to removal of the joint strips.

Preformed expansion joint filler shall be held firmly in the correct position as the concrete is placed.

17. WATERSTOPS

Waterstops shall be held firmly in the correct position as the concrete is placed. Joints in metal waterstops shall be brazed or welded. Joints in rubber or plastic waterstops shall be cemented, welded or vulcanized as recommended by the manufacturer.

18. REMOVAL OF FORMS

Forms shall be removed only when the Engineer is present and shall not be removed without his approval. Forms shall be removed in such a way as to prevent damage to the concrete. Supports shall be removed in a manner that will permit the concrete to take the stresses due to its own weight uniformly and gradually.

Method 1 Forms shall not be removed sooner than the following minimum times after the concrete is placed. These periods represent cumulative number of days and fractions of days, not necessarily consecutive, during which the temperature of the air adjacent to the concrete is above 50oF.

Element	Time
Beams, arches - supporting forms and shoring	14 days
Conduits, deck slabs - supporting (inside) forms and shoring	7 days
Conduits (outside forms), sides of beams, small structures	24 hours
Columns, walls, spillway riser - with side or vertical load	7 days

12. ITEMS OF WORK AND CONSTRUCTION DETAILS

Items of work to be performed in conformance with this specification and the construction details are:

a. Subsidiary Item, Channel Excavation

1. This item consists of all excavation required to construct the concrete channel repair sections, and berms as shown on the drawings.

2. Suitable channel excavation and berm excavated material shall be utilized to reconstruct the channel subgrade and berms adjacent to the sides of the channel, as approved by the Engineer.

3. No separate payment will be made for channel excavation. Compensation for this item will be included in Bid Item 3, Concrete Channel Lining.

b. Subsidiary Item, Borrow Excavation, Common

1. This item consists of all excavation required for obtaining fill material.

2. If existing channel subgrade materials are insufficient to prepare the subgrade to the design elevations, borrow material shall be obtained at the location shown on the drawings.

3. In Section 9, Borrow Excavation, no separate payment will be made for this item. Compensation for Borrow Excavation will be included in Bid Item 3, Concrete Channel Lining.

20. FINISHING UNFORMED SURFACES

All exposed surfaces of the concrete shall be accurately screeded to grade and then float finished, unless specified otherwise. After placing and consolidating the concrete, all exposed surfaces shall be accurately struck off to grade. Following strike-off, the surfaces shall be immediately smoothed by darbying or bull floating before any free water has bled to the surface. The concrete will then be allowed to rest until the bleed water and water sheen has left the surface and the concrete has stiffened to where it will sustain foot pressure with only about 1/4 inch (6mm) indentation. At this time all joints and edges that will be exposed to view that are not chamfered shall be finished with edging and/or molding tools. After edging and hand-jointing is complete, all exposed surfaces shall be floated with wood or magnesium floats. The floating should work the concrete no more than necessary to remove screed, edger and jointer marks and produce a compact surface, uniform in texture.

Joints and edges on unformed surfaces shall be chamfered or finished with molding tools.

21. CURING

Concrete shall be cured in accordance with the recommended practice of ACI 308, of which some specific interpretations are set forth below. Concrete shall be prevented from drying for a period of at least 7 days after it is placed. Exposed surfaces and concrete formed in absorptive wood forms shall be kept continually wet during the entire curing period or until the forms have been removed. After forms have been removed, the exposed surface shall be kept continuously wet until patching and repair are complete and until the curing period is completed or until a curing compound is applied.

Moisture can be maintained by sprinkling, flooding or fog spraying or by covering with continuously moistened canvas, cloth mats, straw, sand and/or approved material. Water and/or covering shall be applied in such a way that the concrete surface is not eroded or otherwise damaged.

Except as otherwise specified in Section 26, curing compound may be used for exposed surfaces or formed surfaces after patching and repair have been completed. Unless otherwise specified, the curing compound shall be white pigmented and conform to ASTM C 309 Type 2, Class A or B. If surface coatings are to be applied to concrete where curing compound is used, Type 2, Class B shall be used and allowed to age a minimum of 30 days prior to the application of the coating. Clear curing compound (Type 1) or clear with fugitive dye (Type 1-D) may be used only when specified in Section 26.

Curing compound shall be thoroughly mixed before applying and agitated during application. It shall be applied using a continuously agitating pressure sprayer at a uniform rate of not less than one

Columns, walls, spillway riser - with no side or vertical load:	
Concrete supporting more than 30 feet of wall in place above it	7 days
Concrete supporting 20 to 30 feet of wall in place above it1/	3 days
Concrete supporting not more than 20 feet of wall in place above it1/	24 hours

1/ Age of stripped concrete shall be at least 7 days before any load is applied other than the weight of the column or wall, forms and scaffolds for succeeding lifts.

Method 2 Forms, supports and housings shall not be removed until the concrete has attained the strength specified in Section 26 for this purpose. The strength will be determined by compression testing of test cylinders cast by the Engineer for this purpose and cured at the work site in the manner specified in ASTM Method C 31 for determining form removal time.

19. FINISHING FORMED SURFACES

All concrete surfaces shall be true and even, and shall be free from open or rough spaces, depressions or projections.
Immediately after the removal of forms:

All bulges, fins, form marks or other irregularities which in the judgment of the Engineer will adversely affect the appearance or the function of the structure shall be removed. All form bolts and ties shall be removed to a depth at least 1 inch below the surface of the concrete. The cavities produced by form ties and all other holes of similar size and depth shall be thoroughly cleaned and, after the interior surfaces have been kept continuously wet for at least 3 hours, shall be carefully packed with a dry patching mortar mixed not richer than 1 part cement to 3 parts sand. Patching mortar shall be mixed in advance and allowed to stand without addition of water until it has reached the stiffest consistency that will permit placing. Manipulation of the mortar with a trowel during this period shall be performed as required to insure the proper consistency.

Holes left by form bolts or straps which pass through the wall shall be filled solid with mortar.

Patching mortar shall be thoroughly compacted into place to form a dense, well-bonded unit, and the in-place mortar shall be sound and free from shrinkage cracks.

All repaired areas shall be cured as specified in Section 21.

CONSTRUCTION SPECIFICATION

23. EARTHFILL

1. SCOPE

The work shall consist of the construction of earth embankments and other earthfills required by the drawings and specifications.

2. MATERIALS

All fill materials shall be obtained from required excavations and designated borrow areas. The selection, blending, routing and disposition of materials in the various fills shall be subject to approval by the Engineer.

Fill materials shall contain no sod, brush, roots or other perishable materials. Rock particles larger than the maximum size specified for each type of fill shall be removed prior to compaction of the fill.

The types of materials used in the various fills shall be as listed and described in the specifications and drawings.

3. FOUNDATION PREPARATION

Foundations for earthfill shall be stripped to remove vegetation and other unsuitable materials or shall be excavated as specified.

Except as otherwise specified, earth foundation surfaces shall be graded to remove surface irregularities and shall be scarified parallel to the axis of the fill or otherwise acceptably scored and loosened to a minimum depth of 2 inches. The moisture content of the loosened material shall be controlled as specified for the earthfill, and the surface materials of the foundation shall be compacted and bonded with the first layer of earthfill as specified for subsequent layers of earthfill.

Earth abutment surfaces shall be free of loose, uncompacted earth in excess of two inches in depth normal to the slope and shall be at such a moisture content that the earthfill can be compacted against them to effect a good bond between the fill and the abutments.

Rock foundation and abutment surfaces shall be cleared of all loose materials by hand or other effective means and shall be free of standing water when fill is placed upon them. Occasional rock outcrops in earth foundations for earthfill, except in dams and other structures designed to restrain the movement of water, shall not require special treatment if they do not interfere with compaction of the foundation and initial layers of the fill or the bond between the foundation and the fill.

Foundation and abutment surfaces shall be not steeper than 1 horizontal to 1 vertical unless otherwise specified. Test pits or other cavities shall be filled with compacted earthfill conforming to the specifications for the earthfill to be placed upon the foundation.

4. PLACEMENT

Fill shall not be placed until the required excavation and foundation preparation have been completed and the foundation has been inspected and approved by the Engineer. Fill shall not be placed upon a frozen surface, nor shall snow, ice, or frozen material be incorporated in the fill.

Fill shall be placed in approximately horizontal layers. The thickness of each layer before compaction shall not exceed the maximum thickness specified. Materials placed by dumping in piles or windrows shall be spread uniformly to not more than the specified thickness before being compacted. Hand compacted fill, including fill compacted by manually directed power tampers, shall be placed in layers whose thickness before compaction does not exceed the maximum thickness specified for layers of fill compacted by manually directed power tampers.

Adjacent to structures, fill shall be placed in a manner which will prevent damage to the structures and will allow the structures to assume the loads from the fill gradually and uniformly. The height of the fill adjacent to a structure shall be increased at approximately the same rate on all sides of the structure.

Earthfill in dams, levees and other structures designed to restrain the movement of water shall be placed so as to meet the following additional requirements:

a. The distribution of materials throughout each zone shall be essentially uniform, and the fill shall be free from lenses, pockets, streaks or layers of material differing substantially in texture, moisture content, or gradation from the surrounding material.

b. If the surface of any layer becomes too hard and smooth for proper bond with the succeeding layer, it shall be scarified parallel to the axis of the fill to a depth of not less than 2 inches before the next layer is placed.

c. The top surfaces of embankments shall be maintained approximately level during construction, except that a crown or cross-slope of approximately 2 percent shall be maintained to insure effective drainage, and except as otherwise specified for drainfill or sectional zones.

d. Dam embankments shall be constructed in continuous layers from abutment to abutment except where openings to facilitate construction or to allow the passage of stream flow during construction are specifically authorized in the contract.

e. Embankments built at different levels as described under (c) or (d) above shall be constructed so that the slope of the bonding surfaces between embankment in place and embankment to be placed is not steeper than 3 feet horizontal to 1 foot vertical. The bonding surface of the embankment in place shall be stripped of all material not meeting the requirements of this specification, and shall be scarified, moistened and recompacted when the new fill is placed against it as needed to insure a good bond with the new fill and to obtain the specified moisture content and density at the contact of the in place and new fills.

5. CONTROL OF MOISTURE CONTENT

During placement and compaction of fill, the moisture content of the materials being placed shall be maintained within the specified range.

The application of water to the fill materials shall be accomplished at the borrow areas insofar as practicable. Water may be applied by sprinkling the materials after placement on the fill, if necessary. Uniform moisture distribution shall be obtained by disking.

Material that is too wet when deposited on the fill shall either be removed or be dried to the specified moisture content prior to compaction.

If the top surface of the preceding layer of compacted fill or a foundation or abutment surface in the zone of contact with the fill becomes too dry to permit suitable bond it shall either be removed or scarified and moistened by sprinkling to an acceptable moisture content prior to placement of the next layer of fill.

6. COMPACTION

Earthfill shall be compacted according to the following requirements for the class of compaction specified:

Class A compaction. Each layer of fill shall be compacted as necessary to make the density of the fill matrix not less than the minimum density specified. The fill matrix is defined as the portion of the fill material finer than the maximum particle size used in the compaction test method specified.

Class B compaction. Each layer of fill shall be compacted to a mass density not less than the minimum density specified.

Class C compaction. Each layer of fill shall be compacted by the specified number of passes of the type and weight of roller or other equipment specified, or by an approved equivalent method. Each pass shall consist of at least one passage of the roller wheel or drum over the entire surface of the layer.

Fill adjacent to structures shall be compacted to a density equivalent to that of the surrounding fill by means of hand tamping or manually directed power tampers or plate vibrators. Unless otherwise specified, heavy equipment including backhoe mounted powertampers, or vibrating compactors and manually directed vibrating rollers, shall not be operated within 2 feet of any structure. Towed or self-propelled vibrating rollers shall not be operated within 5 feet of any structure. Compaction by means of drop weights operating from a crane or hoist will not be permitted.

The passage of heavy equipment will not be allowed: (1) over cast-in-place conduits prior to 14 days after placement of the concrete; (2) over cradled or bedded precast conduits prior to 7 days after placement of the concrete cradle or bedding; or (3) over any type of conduit until the backfill has been placed above the top surface of the structure to a height equal to one-half the clear span width of the structure or pipe or 2 feet, whichever is greater.

Compacting of fill adjacent to structures shall not be started until the concrete has attained the strength specified in Section 10 for this purpose. The strength will be determined by compression testing of test cylinders cast by the Engineer for this purpose and cured at the work site in the manner specified in ASTM Method C 31 for determining when a structure may be put into service.

When the required strength of the concrete is not specified as described above, compaction of fill adjacent to structures shall not be started until the following time intervals have elapsed after placement of the concrete.

Structure	Time Interval
Retaining walls and counterforts (impact basins)	14 days
Walls backfilled on both sides simultaneously	7 days
Conduits and spillway risers, cast-in-place (with inside forms in place)	7 days
Conduits and spillway risers, cast-in-place (inside forms removed)	14 days

Conduits, precast, cradled	2 days
Conduits, precast, bedded	1 day
Cantilever outlet bents (backfilled both sides simultaneously)	3 days

7. REWORKING OR REMOVAL AND REPLACEMENT OF DEFECTIVE FILL

Fill placed at densities lower than the specified minimum density or at moisture contents outside the specified acceptable range of moisture content or otherwise not conforming to the requirements of the specifications shall be reworked to meet the requirements or removed and replaced by acceptable fill. The replacement fill and the foundation, abutment and fill surfaces upon which it is placed shall conform to all requirements of this specification for foundation preparation, approval, placement, moisture control and compaction.

8. TESTING

During the course of the work, the Engineer will perform such tests as are required to identify materials, to determine compaction characteristics, to determine moisture content, and to determine density of fill in place. These tests performed by the Engineer will be used to verify that the fills conform to the requirements of the specifications. Such tests are not intended to provide the Contractor with the information required by him for the proper execution of the work and their performance shall not relieve the Contractor of the necessity to perform tests for that purpose.

Densities of fill requiring Class A compaction will be determined by the Engineer in accordance with ASTM Method D 1556, D 2167, D 2922 or D 2937 except that the volume and moist weight of included rock particles larger than those used in the compaction test method specified for the type of fill will be determined and deducted from the volume and moist weight of the total sample prior to computation of density or if using the nuclear gauge, added to the specified density to bring it to the measure of equivalent composition for comparison. The density so computed will be used to determine the percent compaction of the fill matrix. Unless otherwise specified, moisture content will be determined by one of the following methods: ASTM Method D 2216 or D 3017.

9. MEASUREMENT AND PAYMENT

Compensation for any item of work described in the contract but not listed in the bid schedule will be included in the payment for the item of work to which it is made subsidiary. Such items and the items to which they are made subsidiary are identified in Section 10 of this specification.

10. ITEMS OF WORK AND CONSTRUCTION DETAILS

Items of work to be performed in conformance with this specification and construction details are:

a. Subsidiary Item, Earthfill

1. This item consists of placing and compacting all earthfill required to:

   (a) Regrade the operation and maintenance roads and berms disturbed by the construction operations.

   (b) Repair the channel lining subgrade in areas where the channel lining has been removed as shown on the drawings.

2. Excess soil materials removed from the channel subgrade shall be spread uniformly on the adjacent O&M roads and graded to blend into the existing grades.

3. The maximum rock size placed shall be two (2) inches.

4. In areas of subgrade that require earthfill, the maximum thickness of a layer prior to compaction shall be six (6) inches.

5. Section 6, Compaction, Class C, shall apply. Each layer of fill shall be compacted with a minimum of three (3) complete passes over the entire surface area using vibratory plates or tampers having a minimum rated capacity of 2,400 pounds per blow or vibratory rollers which weigh a minimum of 1,000 pounds.

6. The fill material shall contain sufficient moisture such that when a small portion is taken in the hand and squeezed, it remains intact when released and does not leave free water on the palm of the hand.

7. In Section 4, Placement, the first sentence in the second paragraph will not apply to the side slopes of channel. Compaction on the slope will be permitted in this area.

8. In Section 9, Measurement and Payment, no separate payment will be made for this item. Compensation for this work will be included in Bid Item 3, Concrete Channel Lining.

gallon per 150 square feet of surface. It shall form a uniform continuous, adherent film that shall not check, crack or peel and shall be free from pinholes or other imperfections.
All surfaces covered with curing compound shall be continuously protected from damage to the protective film during the required curing period.

Surfaces subjected to heavy rainfall or running water within 3 hours after the compound has been applied, or surfaces damaged by subsequent construction operations during the curing period shall be resprayed in the same manner as for the original application.

Unless otherwise specified in Section 26, curing compound shall not be applied to construction joints or other areas that are to receive additional concrete, paint or other material that require a positive bond.

Water for curing shall be clean and free from any substances that will cause discoloration of the concrete.

22. REMOVAL, REPLACEMENT OR REPAIR

When concrete is honeycombed, damaged or otherwise defective, the Contractor shall remove and replace the structure or structural member containing the defective concrete, or correct or repair the defective parts. The Contracting Officer will determine the required extent of removal, replacement or repair and advise the Contractor, in writing, of this determination.

Prior to starting repair work the Contractor shall obtain the Contracting Officer's approval of his plan for making the repair. The appropriate methods described in Chapter VII of the Concrete Manual, Bureau of Reclamation, U.S. Department of the Interior, shall be used as the primary reference for repairs. If approved in writing by the Contracting Officer, proprietary compounds for adhesion or as patching ingredients may be used. Such compounds shall be used in accordance with the manufacturer's recommendations.

Approval of the Contractor's repair plan shall not be considered a waiver of the Contracting Officer's right to require complete removal of defective work if the completed repair does not produce concrete of the required quality and appearance.

Repair work shall be performed only when the Engineer is present. Repair of formed surfaces shall be started within 24 hours after removal of the forms.

Curing as specified in Section 21 shall be applied to repaired areas immediately after the repairs are completed.

23. CONCRETING IN COLD WEATHER

Concreting in cold weather shall be performed in accordance with ACI 306 Recommend Practice for Cold Weather Concreting, of which some specific interpretations are set forth below.

When the atmospheric temperature may be expected to drop below 40oF at the time concrete is delivered to the work site, during placement, or at any time during the curing period, the following provisions also shall apply:

a. The temperature of the concrete at time of placing shall not be less than 50oF nor more than 90oF. The temperature of neither aggregates nor mixing water shall be more than 140oF just prior to mixing with the cement.

b. When the minimum daily atmosphere temperature is less than 40oF,concrete structures shall be insulated or housed and heated after placement. The temperature of the concrete and air adjacent to the concrete shall be maintained at not less than 50oF nor more than 90oF for the duration of the curing period.

c. Methods of insulating, housing and heating the structure shall conform to "Recommended Practice for Cold Weather Concreting," ACI Standard 306.

d. When dry heat is used to protect concrete, means of maintaining an ambient humidity of at least 40 percent shall be provided unless the concrete has been coated with curing compound as specified in Section 21 or is covered tightly with an approved impervious material.

24. CONCRETING IN HOT WEATHER

Concreting in Hot Weather shall be in accordance with the recommended practice of ACI 305, of which some specific interpretations are set forth below.

For the purpose of the specification hot weather is defined as any combination of high temperature, low relative humidity and wind velocity tending to impair the quality of fresh or hardened concrete or otherwise resulting in abnormal properties.

When climatic or other conditions are such that the temperature of the concrete may reasonably be expected to exceed 90oF at the time of delivery at the work site, during placement, or during the first 24 hours after placement, the following provisions shall apply:

a. The Contractor shall maintain the temperature of the concrete below 90oF during mixing, conveying, and placing.

b. The concrete shall be placed in the work immediately after mixing. Truck mixing shall be delayed only until time enough remains to accomplish it before the concrete is placed.

c. Exposed concrete surfaces which tend to dry or set too rapidly shall be continuously moistened by means of fog sprays or other means to maintain adequate moisture during the time between placement and finishing, and after finishing.

d. Finishing of slabs and other exposed surfaces shall be started as soon as the condition of the concrete allows and shall be completed without delay.

e. Formed surfaces shall be kept completely and continuously wet for the duration of curing period (prior to, during and after form removal) or until curing compound is applied as specified in subsection g, below.

f. Concrete surfaces, especially flat work placed with large areas of surface, shall be covered as soon as the concrete has sufficiently hardened and shall be kept continuously wet for at least 24 hours of the curing period. This protective method may be continued for the required curing period or until curing compound as specified in (g) below is applied.

g. Moist curing may be discontinued before the end of the curing period if white pigmented curing compound is applied immediately, following the procedures specified in Section 21.

h. In extreme conditions it may be necessary to (1) restrict placement to late afternoon or evening (2) restrict the depth of layers to assure coverage of the previous layer while it will still respond readily to vibration, (3) suspend placement until conditions improve, and (4) remove forms, repair, patch and reapply wet curing by small areas at a time.

25. MEASUREMENT AND PAYMENT

For items of work for which specific unit prices are established in the contract, concrete will be measured to the neat lines or pay limits shown on the drawings, and the volume of concrete will be computed to the nearest 0.1 cubic yard. No deduction in volume will be made for chamfers, rounded or beveled edges, or for any void or embedded item that is less than five cubic feet in volume. Where concrete is placed against the sides or bottom of an excavation without intervening forms, drainfill, or bedding, the volume of concrete required to fill voids resulting from overexcavation outside the neat lines or pay limits will be included in the measurement for payment where such overexcavation is directed by the Engineer to remove unsuitable foundation material; but only to the extent that the

unsuitable condition is not a result of the Contractor's improper construction operations, as determined by the Contracting Officer.

Payment for each item of concrete will be made at the contract unit price for that item. The payment for concrete will constitute full compensation for all labor, materials, equipment, transportation, tools, forms, falsework, bracing and all other items necessary and incidental to completion of the concrete work, such as joint fillers, waterstops, dowels or other assemblies, and shear plates, but not including reinforcing steel or other items listed for payment elsewhere in the contract.

Measurement and payment for furnishing and placing reinforcing steel will be made as specified in Construction Specification 34.

Compensation for any item of work described in the contract but not listed in the bid schedule will be included in the payment for the item of work to which it is make subsidiary. Such items and the items to which they are made subsidiary are identified in Section 26 of this specification.

26. ITEMS OF WORK AND CONSTRUCTION DETAILS

Items of work to be performed in conformance with this specification and the construction details are:

a. Bid Item 3, Concrete Channel Lining

1. This item consists of furnishing, forming and placing all concrete to repair the floodway as shown on the drawings.

2. In Section 2, Materials, the materials shall be as follows:

(a) Portland Cement shall be Type II or IIA.

(b) Preformed expansion joint filler shall be a sponge rubber material conforming to Material Specification 535 and ASTM D 1752, Type I.

(c) The joint sealing compound shall be Type S, Grade NS, use Use T or NT, low modulus silicone conforming to the requirements of ASTM C 920 and shall tolerate submergence by intermittent flood flows. The sealant shall have the capability to withstand without failure an increase of 50 percent and a decrease of 50 percent of the joint width as measured at the time of application when tested in accordance with ASTM C 719. The elongation shall be a minimum of 800 percent without failure when tested in accordance with ASTM D 412, and 500 percent without adhesion failure when tested in accordance with ASTM C 719.

(d) A bond breaking material shall be compatible with the sealant and conform to the sealant manufacturers requirements. The sealant manufacturers technical representative shall be present during initial installation to insure that the requirements of this specification and the manufacturers specified surface preparation, application and handling techniques are being used by the Contractor.

Bond breaker material shall be adequate to support the sealant until fully cured.

3. Section 3, Classes of Concrete, Method 1 shall apply and the concrete shall be Class 4000.

4. Coarse aggregate shall be size No. 57 in accordance with ASTM C33.

5. In Section 18, Removal of Forms, Method 1 shall apply.

6. Pozzolan shall be used as a partial substitute for portland cement.

7. In Section 15, Construction Joints, Method 1 shall apply.

8. Sealant installation and cleaning shall be in accordance with Construction Specification 400, Section 3, Joint Sealant for Concrete Lined Floodways.

9. All plant roots will be removed from joints.

10. In Section 25, Measurement and Payment, payment will include compensation for Subsidiary Items: Removal of water; Channel Excavation; Borrow Excavation, Common; Earthfill; Construction Surveys for Layout, Control and Measurement.

CONSTRUCTION SPECIFICATION

34. STEEL REINFORCEMENT

1. SCOPE

The work shall consist of furnishing and placing steel reinforcement for reinforced concrete or pneumatically applied mortar.

2. MATERIALS

Steel reinforcement shall conform to the requirements of Material Specification 539. Before reinforcement is placed, the surfaces of the bars and fabric and any metal supports shall be cleaned to remove any loose, flaky rust, mill scale, oil, grease or other coatings or foreign substances. After placement, the reinforcement shall be maintained in a clean condition until it is completely embedded in the concrete.

3. BAR SCHEDULE, LISTS AND DIAGRAMS

Any supplemental bar schedules, bar lists or bar-bending diagrams required to accomplish the fabrication and placement of reinforcement shall be provided by the Contractor. Prior to placement of reinforcement, the Contractor shall furnish four prints or copies of any such lists or diagrams to the Contracting Officer. Acceptance of the reinforcement will not be based on approval of these lists or diagrams but will be based on inspection of the reinforcement after it has been placed.

4. BENDING

Reinforcement shall be cut and bent in compliance with the requirements of the American Concrete Institute Standard 315. Bars shall not be bent or straightened in a manner that will injure the material. Bars with kinks, cracks or improper bends will be rejected.

5. SPLICING BAR REINFORCEMENT

Splices of reinforcement shall be made only at locations shown on the drawings and provided by the steel schedule. Placement of bars at the lap splice locations shown, when not in contact, shall not be farther apart than one-fifth the shown lap length and in any case no greater than 6 inches.

6. SPLICING WELDED WIRE FABRIC

Unless otherwise specified, welded wire fabric shall be spliced in the

following manner:

a. Adjacent sections shall be spliced end to end (longitudinal lap) by overlapping a minimum of one full mesh plus 2 inches plus the length of the two end overhangs. The splice length is measured from the end of the longitudinal wires in one piece of fabric to the end of the longitudinal wires in the lapped piece of fabric.

b. Adjacent sections shall be spliced side to side (transverse lap) a minimum of one full mesh plus 2 inches. The splice length shall be measured from the centerline of the first longitudinal wire in one piece of fabric to the centerline of the first longitudinal wire in the lapped piece of fabric.

7. PLACING

Reinforcement shall be accurately placed and secured in position in a manner that will prevent its displacement during the placement of concrete. Tack welding of bars will not be permitted. Metal chairs, metal hangers, metal spacers and concrete chairs may be used to support the reinforcement. Metal hangers, spacers and ties shall be placed in such a manner that they will not be exposed in the finished concrete surface. The legs of metal chairs or side form spacers that may be exposed on any face of slabs, walls, beams or other concrete surfaces shall have a protective coating or finish by means of hot dip galvanizing, epoxy coating, plastic coating, or be stainless steel. Metal chairs and spacers not fully covered by a protective coating or finish shall have a minimum cover of 3/4 inch of concrete over the unprotected metal portion except for those with plastic coatings may have a minimum cover of 1/2 inch of concrete over the unprotected metal portion. Precast concrete chairs shall be manufactured of the same class of concrete as that specified for the structure and shall have tie wires securely anchored in the chair or a V-shaped groove at least 3/4 inch in depth molded into the upper surface to receive the steel bar at the point of support. Precast concrete chairs shall be moist at the time concrete is placed.

High density or structural plastic rebar accessories, designed to insure maximum concrete bond, may be substituted for metal or concrete accessories in spacer applications as approved by the Contracting Officer. Exposure of plastic rebar accessories at the finished concrete surface shall be kept to a minimum. Plastic rebar accessories, if used, shall be staggered along adjacent parallel bars and shall be placed at intervals no closer than 12 inches. Plastic rebar accessories shall not be used in concrete sections 6 inches or less in thickness.

Reinforcement shall not be placed until the prepared site has been inspected and approved by the Engineer. After placement of the

reinforcement, concrete shall not be placed until the reinforcement has been inspected and approved by the Engineer.

8. STORAGE

Steel reinforcement stored at the work site shall be placed above the ground surface on platforms, skids or other supports and protected from mechanical damage or corrosion.

9. MEASUREMENT AND PAYMENT

For items of work for which specific unit prices are established in the contract, the weight of bar reinforcement placed in the concrete in accordance with the drawings will be determined to the nearest pound by computation from the placing drawings. Measurement of hooks and bends will be based on the requirements of ACI Standard 315. Computation of weights of bar reinforcement will be based on the unit weights established in Table 34-1. The weight of steel reinforcing in extra splices or extra length splices approved for the convenience of the Contractor or the weight of supports and ties will not be included in the measurement for payment.

The area of welded wire fabric reinforcement placed in the concrete in accordance with the drawings will be determined to the nearest square foot by computation from the placing drawings with no allowance for laps.

Payment for furnishing and placing bar reinforcing steel will be made at the contract unit price for bar reinforcement. Payment for furnishing and placing welded wire fabric reinforcing steel will be made at the contract unit price for welded wire fabric reinforcement. Such payment will constitute full compensation for all labor, materials, equipment and all other items necessary and incidental to the completion of the work including preparing and furnishing bar schedules, lists or diagrams; furnishing and attaching ties and supports; and furnishing, transporting, cutting, bending, cleaning, and securing all reinforcement.

Compensation for any item of work described in the contract but not listed in the bid schedule will be included in the payment for the item of work to which it is made subsidiary. Such items to which they are made subsidiary are identified in Section 10 of this specification.

TABLE 34-1. STANDARD REINFORCING BARS

Bar Size No.	Wt. (lb./ft.)
3	0.376
4	0.668
5	1.043
6	1.502
7	2.044
8	2.670
9	3.400
10	4.303
11	5.313
14	7.65
18	13.60

TABLE 34-2. RECTANGULAR WELDED WIRE FABRIC1/

Style Designation By Steel Wire Gauge	Style Designation By W-Number	Weight, lb. Per 100 Sq. Ft.
6 x 6 - 10 x 10	6 x 6 - W1.4 x W1.4	21
6 x 6 - 8 x 8	6 x 6 - W2.1 x W2.1	30
6 x 6 - 6 x 6	6 x 6 - W2.9 x W2.9	42
6 x 6 - 4 x 4	6 x 6 - W4.0 x W4.0	58
4 x 4 - 10 x 10	4 x 4 - W1.4 x W1.4	31
4 x 4 - 8 x 8	4 x 4 - W2.1 x W2.1	44
4 x 4 - 6 x 6	4 x 4 - W2.9 x W2.9	62
4 x 4 - 4 x 4	4 x 4 - W4.0 x W4.0	85
4 x 12 - 8 x 12	4 x 12 - W2.1 x W0.9 2/	25
4 x 12 - 7 x 11	4 x 12 - W2.5 x W1.1 2/	31

1/ Style designation is defined in ACI Standard 315 of the American Concrete Institute.

2/ Welded smooth wire fabric with wires smaller than Size W1.4 is manufactured from galvanized wire.

10. ITEMS OF WORK AND CONSTRUCTION DETAILS

Items of work to be performed in conformance with this specification and the construction details are:

a. Bid Item 5, Steel Reinforcement

1. This item consists of furnishing and installing all steel reinforcement required to construct the channel lining as shown on the drawings.

2. All steel bars shall be ASTM A 615 Grade 40 or 60.

CONSTRUCTION SPECIFICATION 94

CONTRACTOR INSPECTION

1. SCOPE

The work shall consist of developing, implementing, and maintaining a quality control system to ensure that the specified quality is achieved for all materials and work performed. The work shall include all equipment, materials, labor and services necessary to implement and maintain the quality control system throughout the duration of the work.

2. EQUIPMENT AND MATERIALS

Equipment and materials for quality control shall be of the quality and condition required to meet the test specifications cited in the contract references. Testing equipment shall be properly adjusted and calibrated at the start of operations and the calibration maintained at the frequency specified. Records of equipment calibration tests shall be available to the Contracting Officer at all times. Where specific requirements exist, equipment shall be operated and maintained by qualified operators. All equipment and materials used in performing quality control testing shall be as prescribed by the test standards referenced in the contract.

Equipment and materials shall be handled and operated in a safe and proper manner complying with all applicable state and federal regulations pertaining to their use, operation, handling and transportation.

3. QUALITY CONTROL SYSTEM

The Contractor shall develop a system of quality control to provide the specified basic material testing and verification of material quality prior to use. The system activities shall include procedures to verify adequacy of completed work, initiate corrective action to be taken and document the final results. A written plan for the system will not be required other than the identification of the quality control personnel and their duties. This identification shall be submitted to the Contracting Officer within 15 calendar days after notice of award.

4. QUALITY CONTROL PERSONNEL

Quality control activities shall be accomplished by qualified personnel. The Contractor shall identify and furnish to the Contracting Officer, for approval, the names, qualifications, experience and availability of all personnel who will perform the quality control ativities.

5. POST-AWARD CONFERENCE

The Contractor shall meet with the Contracting Officer prior to the beginning of any work and discuss the Contractor's quality control system. The Contracting Officer and the Contractor shall develop a mutual understanding regarding the quality control system. The understanding reached will be documented by the Contracting Officer by correspondence to the Contractor.

6. RECORDS

The Contractor's quality control records shall be kept daily and shall document both acceptable and deficient features of the work. All records shall be on forms approved by the Contracting Officer and shall be legible.

Records shall include but are not limited to the following:

a. The material or item tested, or inspection performed.

b. Date and time of tests or inspections.

c. Type and number of quality control activities and tests involved.

d. The location and extent of work inspected or tested.

e. Test results and description of conditions observed during the quality control activities.

f. Method of testing used (e.g., citation of reference specification).

g. Nature of defects, specifications not met, etc.

h. Proposed corrective action, and reason for corrective action.

i. Corrective actions taken and supporting quality control recertification testing.

j. Signature of authorized testing or inspecting official with appropriate checkers verification.

k. Manufacturers' recommendations and certifications if any.

l. Documentation of material delivered including: quantity, location stored, and results of examinations citing applicable construction, material and reference specification.

m. Documentation of shop drawings including: date submitted to and date approved by the Contracting Officer, and results of examinations citing applicable construction, material and reference specifications and construction drawings.

n. Date of the records creation.

7. REPORTING RESULTS

The results of contractor quality control inspections and tests shall be communicated to the Contracting Officer's representative immediately upon completion of the inspection or test.

8. SUBMITTAL OF RECORDS

The original plus, one copy, of records of inspections, tests preformed and material testing reports shall be submitted to the Contracting Officer's representative weekly. The original plus one copy of documentation of materials delivered shall be submitted to the Contracting Officer's representative prior to the use of the material.

9. ACCESS

The Contracting Officer and the Contracting Officer's representatives shall be given free access to all testing equipment, facilities, sites, and related records.

10. MEASUREMENT AND PAYMENT

For items of work for which lump sum prices are established in the contract, payment will be made as the work proceeds, after presentation of invoices by the Contractor showing their costs. If the total of such payments are less than contract lump sum for this item, the unpaid balance will be included in final contract payment. Total payment will be the lump sum contract price for this item, regardless of actual cost to the Contractor.

Payment will not be made under this item for the purchase cost of materials and equipment having a residual value.

Payment of the lump sum contract price for contractor quality control will constitute full compensation for all labor, materials, equipment, transportation, and all other items necessary and incidental to completion of the work.

Compensation for any item of work described in the contract but not listed in the bid schedule will be included in the payment for the item of work to which it is made subsidiary. Such items and the items to which they are made subsidiary are identified in Section 11.

11. ITEMS OF WORK AND CONSTRUCTION DETAILS

Items of work to be performed in conformance with this specification and the construction details are:

a. Bid Item 6, Contractor Inspection

(1) This item shall consist of furnishing the personnel, equipment and material required by the Contractor to perform the testing and inspection that is necessary to implement an inspection system that will ensure the specified quality is being maintained for:

a. Construction Surveys
b. Excavation
c. Earthfill
d. Concrete
e. Steel Reinforcement
f. Pollution Control (Dust)
g. Removal of Water
h. Joint Sealant
i. Crack repair by epoxy injection

(2) In Section 2, EQUIPMENT AND MATERIALS, equipment and materials needed for materials testing shall be calibrated at the specified frequency given in the appropriate materials testing standards. Records of all calibrations shall be submitted to the Engineer within seven (7) days prior to using equipment.

(3) In Section 3, QUALITY CONTROL SYSTEM, the Contractor's Quality Control System shall provide the degree of inspection and testing necessary to ensure that the specified quality is maintained on all work performed.

The Quality Control System shall include inspections and materials testing as follows:

(a) Inspection of construction staking to ensure its accuracy.

(b) Inspection of all excavation to ensure that it is constructed to the lines and grades shown on the drawings.

(c) The moisture density determinations required for the quality control of earthfill shall be performed by the method outlined in Construction Specification 23, Section 10. a. 5 and 6 and by visually observing compaction operations.

d. The placing of steel reinforcement shall be inspected by quality control personnel twelve (12) hours prior to delivery of concrete. A certification that all bars are the correct size and positioned as specified shall be given to the contracting officer.

e. The quality control for joint sealant will involve monitoring by quality control personnel for the proper size, quality, cleanness of cut, and installation of preformed joint material, bond breaker, and joint sealant all according to drawings, specifications, and manufacturers recommendations.

f. The quality control for repairing cracks will involve monitoring by quality control personnel for adequate cleaning of cracks, and that proper preparation, application, and handling techniques of the epoxy injection gel are applied according to manufacturer's recommendations and contract specifications.

g. The quality control for concrete will involve testing for strength, slump, temperature, and air entrainment. The test frequency shall be one set of tests for each 100 cubic yards, or one test per day, whichever occurs first. Slump and temperature tests will be taken for each truck load of concrete.

(4) The Contractor shall designate an experienced quality control manager and inspection staff whose primary responsibility will be implementing the inspection system. The manager or his/her representative shall be on site during major construction activities and will not be involved in directing production oriented activities unless it pertains to achieving the specified quality for the work being performed. The quality control manager shall be employed by and answerable to the Contractor. The manager's duties cannot be delegated to a subcontractor or others.

CONSTRUCTION SPECIFICATION

400. JOINT SEALANT FOR CONCRETE LINED FLOODWAYS

1. SCOPE

The work shall consist of saw cutting and surface preparation of existing contraction and expansion joints, and placement of preformed joint material, bond breaker material, and joint sealant.

2. MATERIALS

Joint sealer Shall be Type S, Grade NS, use T or NT, low modulus silicone conforming to the requirements of ASTM C 920 and shall tolerate submergence by intermittent flood flows.

The sealant shall have the capability to withstand, without failure, an increase of 50 percent and a decrease of 50 percent of the joint width as measured at the time of application when tested in accordance with ASTM C 719.

The elongation shall be a minimum of 800 percent without failure when tested in accordance with ASTM D-412, and 500 percent without adhesion failure when tested in accordance with ASTM C 719.

Preformed expansion joint filler shall conform to Material Specification 535. The joint filler shall meet ASTM D 1752 requirements for Type I (sponge rubber).

Bond breaker material shall be compatible with the sealant and conform to the sealant manufacturer's requirements. The bond breaker shall be adequate to support the sealant until fully cured.

3. SURFACE PREPARATION AND APPLICATION

The sealant manufacturer's representative shall be present during initial installation to insure that proper surface preparation, application, and handling techniques are being used by the Contractor

Cutting or routing expansion and contraction joints will involve saw cutting or routing as required to attain the width and depth shown on the drawings. Concrete cutting equipment shall be equipped with carbide or diamond blades. All dried laitance and contaminants shall be removed.

Cleaning Each joint face shall be sand-blasted. The sand-blasting nozzle must be held at an angle or fitted with deflectors to direct the sand against the joint face within one or two inches of the pavement. A minimum of one pass shall be made for each joint face.

After sand-blasting, the joint cavity shall be cleaned, removing all sand or other debris that would interfere with joint closure. Just prior to placing preformed joint filler and sealant, the joints shall be air-blasted to remove sand and dust. Air compressors used for sand-blasting and air-blasting shall be equipped with traps to remove moisture and oil from the air. Air-blasting shall be done in one direction only.

The joint shall be considered clean when no residue is evident after rubbing a finger or dark lint free cloth along the cleaned dry joint face. The joint shall be completely clean and air dried, as determined by the Engineer, for a minimum of 24 hours under natural drying conditions, before proceeding with the application of sealant.

Sealant Installation: Bond breaker material shall be placed such that it will prevent adhesion of the sealant with the top surface of the preformed expansion joint filler as shown on the drawings.

Joints must be clean and dry when the sealant is installed. Drying of the joint surfaces may only occur from natural weather conditions.

During the sealant placement the nozzle of the sealant applicator shall be moved steadily along the joint, pushing the sealant ahead to form the required cross section. The minimum and maximum temperature of sealant at installation shall be in accordance with the manufacturer's recommendation. See Section 6 for limiting air temperatures.

Immediately after placement and before a skin forms, the sealant shall be tooled, forcing it onto the bond breaker surface and against the joint faces. The finished tooled surface shall be recessed below the concrete surface as detailed on the drawings. Excess sealant on the concrete surface shall be removed.

4. DELIVERY AND STORAGE

The sealant material shall be delivered in original, tightly sealed containers, clearly labeled with the manufacturer's name, product identification and lot numbers where applicable.

The unopened sealant material shall be stored out of the weather, in original, tightly sealed containers, as recommended by the manufacturer. Storage temperature shall not exceed 90 degrees Fahrenheit.

5. MEASUREMENT AND PAYMENT

For items of work for which specific unit prices are established in the contract, the quantity of repaired joints will be determined to

the nearest lineal foot by measurement of acceptably installed joint repairs along each joint. Payment for joint repair will be made at the contract unit price for the joint specified. Such payment will constitute full compensation for furnishing, transporting, placement and application of all materials; and saw cutting and preparing the concrete joints including labor, tools, equipment, and all other items necessary and incidental to the completion of the work.

Compensation for any item of work described in the contract but not listed in the bid schedule will be included in the payment for the item of work to which it is made subsidiary. Such items and the items to which they are made subsidiary are identified in Section 6 of this specification.

6. ITEMS OF WORK AND CONSTRUCTION DETAILS

Items of work to be performed in conformance with this specification and the construction details are:

a. Bid Item 7, Joint Repair

1. This item consists of saw cutting or routing the existing joints, removing the existing joint filler and sealant where encountered, preparing the joint surfaces, installation of preformed joint filler, bond breaker and placement of the joint sealant.

2. All materials delivered to the site shall conform to the materials called for in the plans and specifications.

3. Cutting or routing the joints and installation of the joint sealant shall be limited to periods when the air temperature at the concrete surface at invert is within the range of 65 degrees Fahrenheit to 100 degrees Fahrenheit.

4. Joint sealant will be placed as shown in the drawings including the flat surfaces at the top of the lining where the top and bottom surfaces come together.

5. The Contractor shall furnish full information showing that each lot of sealant meets the requirements in Section 2, and a letter of assurance from the manufacturer's technical representative stating that the sealant will tolerate submergence by intermittent flood flows typically experienced in the floodway.

CONSTRUCTION SPECIFICATION

402. EPOXY ADHESIVE INJECTION FOR CRACK REPAIR OF CONCRETE LINED FLOODWAY

1. SCOPE

The work shall consist of cleaning and surface preparation of the crack surfaces, and furnishing all materials, tools, equipment, appliances, transportation, labor and supervision to repair cracks by the injection of an epoxy resin adhesive.

2. MATERIALS

A. Epoxy resin adhesive:

1. Component "A" shall be a modified epoxy resin of the eplchlorohydrin bisphenol A Type containing suitable viscosity control agents. It shall not contain butylglycidylether.

2. Component "B" shall be primarily a reaction product of a selected amine blend with an epoxy resin of the epichlorohydrin bisphenol A Type containing suitable viscosity control agents and accelerators.

3. The ratio of Component "A" to Component "B" shall be per manufacturers recommendation.

B. Porting devices for automated application shall be used in conjunction with the pressure injection equipment.

3. SURFACE PREPARATION AND APPLICATION

The epoxy resin adhesive manufacturers representative shall be present during initial installation to insure that proper crack preparation, application, and handling techniques are being used by the Contractor.

Surface preparation will require water or steam blasting all cracks with 6,000 to 10,000 psi pressure or other approved method may be used. All deteriorated loose concrete, dirt, tar, and all bond - inhibiting materials will be removed from the cracks. Repair area may be dry or damp, but free of standing water prior to applying surface seal or injecting gel.

Entry ports shall be provided along the crack at intervals of not less than the thickness of the lining.

Surface seal material used to confine the injection adhesive in the crack during injection shall be applied to the face of the crack between and around the entry ports. Seal material shall have adequate strength before preceeding with injection as recommended by manufacturer.

Equipment for Injection

a. The equipment used to meter and mix the two injection adhesive components and inject the mixed adhesive into the cracks shall be portable, positive displacement type pumps with interlock to provide positive ratio control of exact proportions of the two components at the nozzle.

b. The injection equipment shall have an automatic pressure control capable of discharging the mixed adhesive at any preset pressure up to 160 ±5 psi.

c. The equipment shall have the capability of maintaining the volume ratio for the injection adhesive prescribed by the manufacturer of the adhesive within a tolerance of ± 5 percent by volume at any discharge pressure up to 160 psi.

d. The injection equipment shall be equipped with sensors on both component A and B reservoirs that will automatically stop the machine when only one component is being pumped to the mixing head.

Epoxy Injection

a. Injection of epoxy adhesive shall begin at the lowest port and continue with steady pressure until there is an appearance of epoxy adhesive at the adjacent entry port.

b. When epoxy adhesive travel is indicated by appearance at the next adjacent port, injection shall be discontinued on the entry port being pumped. Epoxy injection shall be continued at the adjacent port where epoxy adhesive has appeared. This procedure will be continued until the entire crack is completely filled.

Finishing

The face of the crack shall be finished flush with the concrete lining surface on each side of the crack.

Curing

Will be accomplished by moist curing with wet burlap or other methods as approved by the Engineer and as recommended by the manufacturer.

4. FIELD QUALITY CONTROL TESTS

a. Pressure tests - The mixing head of the injection equipment shall be disconnected and the two-adhesive component delivery lines shall be attached to the pressure check device. The pressure check device shall consist of two independent valved nozzles capable of controlling flow rate and pressure by adjusting the valve. There shall be a pressure gauge capable of sensing the pressure build-up behind each valve. The valves on the pressure check device shall be closed and the equipment operated until the gauge pressure on each line reads 160 PSI. The pumps shall be stopped and the gauge pressure shall not drop below 150 PSI within three (3) minutes.

b. Ratio test - The mixing head of the injection equipment shall be disconnected and the two adhesive component shall be pumped simultaneously through the ratio check device. The ratio check device shall consist of two independent valved nozzles capable of controlling back pressure by opening or closing the valve. There shall be a pressure gauge capable of sensing the back pressure behind each valve. The discharge pressure shall be adjusted to 160 psi for both adhesive components. Both adhesive components shall be simultaneously discharged in separate calibrated containers. The amounts discharged into the calibrated containers simultaneously during the same time period shall be compared to determine that the volume discharged conforms to the manufacturers recommended ratio for the epoxy resin adhesive.

5. DELIVERY AND STORAGE

The epoxy resin adhesive material shall be delivered to the site in original, tightly sealed containers clearly labeled with the manufacturers name, product identification, date of manufacturer and batch numbers.

The unopened material shall be stored out of the weather, in original tightly sealed containers, and stored at temperatures recommended by the manufacturer.

6. MEASUREMENT AND PAYMENT

For items of work for which specific unit prices are established in the contract, the length of repaired cracks will be measured to the nearest foot for those locations shown on the drawings. Payment will be made at the contract unit price for crack repair. Such payment will constitute full compensation for furnishing, transporting, placement, and application of all materials; and water blasting and preparing the cracks including labor, tools, equipment and all other items necessary and incidental to the completion of the work.

Compensation for any item of work described in the contract but not listed in the bid schedule will be included in the payment for the item of work to which it is made subsidiary. Such items and the items to which they are made subsidiary are identified in Section 7 of this specification.

7. ITEMS OF WORK AND CONSTRUCTION DETAILS

Items of work to be performed in conformance with this specification and the construction details are:

a. Bid Item 9, Crack Repair

1. This item consists of water blasting cracks, removing deteriorated concrete and other sealing compounds in, and in the vicinity of the crack, preparing the crack for injection and furnishing and placement of epoxy resin adhesive as shown on the drawings.

2. Minimum ambient and concrete surface temperatures shall be per manufacturer's recommendation.

3. Minimum and maximum temperatures for storing and conditioning of epoxy resin adhesive before using shall be per manufacturer's recommendation.

4. Ratio of mixing the two components for injection shall be per manufacturer's recommendation.

5. First aid and clean up of spills will be according to manufacturer's recommendations.

6. Epoxy resin adhesive shall be a two (2) component solvent free, moisture - insensitive, high-modulus, high-strength, structural epoxy that conforms to ASTM C 881, Type 1, Grade 3, Class B and C.

7. Compressive strength of the cured epoxy resin adhesive shall be a minimum of 7700 psi at 28 days when tested per ASTM D 695.

8. Bond strength of cured epoxy resin adhesive shall be a minimum of 2200 psi at 14 days when tested per ASTM C 882.

9. The Contractor shall furnish test data showing that each lot of epoxy resin adhesive meets the requirements in Section 2.

10. The Contractor shall prepare a repair plan that identifies the repair methods, equipment to be used, and the materials that are to be used. Work shall not be started on crack repair until the repair plan has been approved by the Engineer.

MATERIAL SPECIFICATION

522. AGGREGATE FOR PORTLAND CEMENT CONCRETE

1. SCOPE

This specification covers the quality of fine aggregate and coarse aggregate for use in the manufacture of portland cement concrete.

2. QUALITY

Aggregate shall conform to the requirements of ASTM Specification C-33 for the specified sizes. Aggregates that fail to meet any requirement may be accepted only when: (1) the specified alternate conditions of acceptance can be proved prior to the use of the aggregates on the job and within a period of time such that no work under the contract will be delayed by the requirements of such proof; or, (2) the specification for concrete expressly contains a provision of special mix requirements to compensate for the effects of the deficiencies.

3. REACTIVITY WITH ALKALIES

The potential reactivity of aggregates with the alkalies in cement shall be evaluated by petrographic examination and, where applicable, the chemical method of test, ASTM Designation C 289, or by the results of previous tests or service records of concrete made from similar aggregates from the same source. The standards for evaluating potential reactivity shall be as described in ASTM Specification C 33, Appendix A1.

Aggregates indicated by any of the above to be potentially reactive shall not be used, except under one of the following conditions:

a. Applicable test results of mortar bar tests, made according to ASTM Method C 227, are available which indicate an expansion of less than 0.10 percent at six months in mortar bars made with cement containing not less than 0.8 percent alkalies expressed as sodium oxide; or

b. Concrete made from similar aggregates from the same source has been demonstrated to be sound after 3 years or more of service under conditions of exposure to moisture and weather similar to those anticipated for the concrete under these specifications.

Aggregates indicated to be potentially reactive, but within acceptable limits as determined by mortar bar test results or service records, shall be used only with "low alkali" cement, containing less than 0.60 percent alkalies expressed as sodium oxide.

4. STORING AND HANDLING

Aggregate of each class and size shall be stored and handled by methods that prevent segregation of particles sizes or contamination by intermixing with other materials.

MATERIAL SPECIFICATION

531. PORTLAND CEMENT

1. SCOPE

This specification covers the quality of portland cements.

2. QUALITY

Portland cement shall conform to the requirements of ASTM Specification C 150 for the specified types of cement, except that, when Type I portland cement is specified, Type IS portland blast-furnace slag cement or Type IP portland-pozzolan cement conforming to the requirements of ASTM Specification C 595 may be used unless prohibited in the specifications.

If air-entraining cement is to be used, the Contractor shall furnish the manufacturer's written statement giving the source, amount and brand name of the air-entraining addition.

3. STORAGE AT THE CONSTRUCTION SITE

Cement shall be stored in such a manner as to be protected from weather, dampness or other destructive agencies. Cement that is partially hydrated or otherwise damaged will be rejected.

MATERIAL SPECIFICATION

532. AIR-ENTRAINING ADMIXTURES (FOR CONCRETE)

1. SCOPE

This specification covers the quality of air-entraining admixtures for concrete.

2. QUALITY

Air-entraining admixtures shall conform to the requirements of ASTM Specification C 260, except that the relative durability factor in the freezing and thawing test shall be not less than 95.

MATERIAL SPECIFICATION

533. WATER-REDUCING AND SET-RETARDING ADMIXTURES FOR PORTLAND CEMENT CONCRETE

1. SCOPE

This specification covers the quality of water-reducing and set-retarding admixtures for portland cement concrete.

2. QUALITY

Water-reducing and set-retarding admixtures shall conform to the requirements of ASTM Specification C 494, except that resistance to freezing and thawing shall be determined in all cases, and the minimum relative durability factor shall be 95.

3. TYPES

Admixtures shall be Type A, Water-Reducing or Type D, Water-Reducing and Retarding , as defined in ASTM Specification C 494.

4. PERFORMANCE IN THE JOB MIX

When added in the manner and amount recommended by the manufacturer to the concrete used on the job, with no change in the cement content or proportions of the aggregates, admixtures shall have the following effects:

Type A or Type D: The water content at the required slump shall be at least 5 percent less with the admixture than without. The air content shall remain within the range specified, but shall not exceed 8 percent in any case.

Type D: The time of initial setting, determined as prescribed in ASTM C 494, shall be from 1 to 3 hours longer with the admixture than without.

MATERIAL SPECIFICATION

534. CURING COMPOUND (FOR CONCRETE)

1. SCOPE

This specification covers the quality of liquid membrane-forming compounds suitable for spraying on concrete surfaces to retard the loss of water during the curing process.

2. QUALITY

The curing compound shall meet the requirements of ASTM Specification C 309.

Unless otherwise specified the compound shall be Type 2.

3. DELIVERY AND STORAGE

All curing compound shall be delivered to the site of the work in the original container bearing the name of the manufacturer and the brand name. The compound shall be stored in a manner to prevent damage to the containers and to protect water-emulsion types from freezing.

MATERIAL SPECIFICATION

535. PREFORMED EXPANSION JOINT FILLER

1. SCOPE

This specification covers the quality of preformed expansion joint fillers for concrete.

2. QUALITY

Preformed expansion joint filler shall conform to the requirements of ASTM Specification D 1752, Type I, Type II or Type III, unless bituminous type is specified. Bituminous type preformed expansion joint filler shall conform to the requirements of ASTM Specification D 994, or D 1751.

MATERIAL SPECIFICATION

539. STEEL REINFORCEMENT (FOR CONCRETE)

1. SCOPE

This specification covers the quality of steel reinforcement for reinforced concrete.

2. QUALITY

All reinforcement shall be free from rust, oil grease, paint or other deleterious matter.

Steel bars for concrete reinforcement requiring bends shall be deformed billet-steel bars conforming to ASTM Specification A 615, Grade 40 or Grade 60.

Straight steel bars shall be deformed bars conforming to one of the following specifications:

Deformed Billet-Steel Bars for Concrete Reinforcement (Grade 40 or Grade 60) - ASTM Designation A 615.

Rail-Steel Deformed Bars for Concrete Reinforcement (Grade 50 or Grade 60) - ASTM Designation A 616.

Axle-Steel Deformed Bars for Concrete Reinforcement (Grade 40 or Grade 60) - ASTM Designation A 617.

Fabricated steel bar mats shall conform to the requirements of ASTM Specification A 184.

Welded steel wire fabric reinforcement shall conform to the requirements of ASTM Specification A 185.

Welded deformed steel wire fabric for concrete reinforcement shall conform to the requirements of ASTM Specification A 497.

Cold-drawn steel wire reinforcement shall conform to the requirements of ASTM Specification A 82.

Deformed steel wire for concrete reinforcement shall conform to the requirements of ASTM Specification A 496.

3. DIMENSIONS OF WELDED WIRE FABRIC

Gauges, spacing and arrangement of wires in welded steel wire fabric shall be as defined in ACI Standard 315 of the American Concrete Institute for the specified style designations.

4. STORAGE

Steel reinforcement stored at the site of the work shall be stored above the ground surface on platforms, skids or other supports and shall be protected from mechanical injury and corrosion.

concrete cores were taken and a petrographic examination of the coarse aggregate within the slab sections was a part of this study.

In 1988 an Engineering Report was done by Paul Monville and John Weaver to review all previous investigations. The Engineering Report identified the major cause of failure to be the lack of unsealed expansion joints.

The above damages have created the need for an overall repair of the floodway.

DESCRIPTION OF JOB

The job involves removing and replacing 1,755 linear feet of lining at various locations having severe damage. The job also involves removing short sections less than 10 feet long at specific joints that are offset and/or badly spalled. The rest of the joints will be saw cut to 7/8-inch wide, joint filler installed and sealed. Cracks other than hair line will be bonded by an epoxy adhesive injection process. The majority of cracks are longitudinal and are close to the invert.

DESIGN OBJECTIVE

The objective of this repair is to stop the continuing crushing damage that is taking place, mainly at the joints, and to repair those areas that are already damaged by previous overbank flow or compression and buckling at joints.

GENERAL BASIC DATA

The following reference materials were used in designing the Powerline Floodway Repair:

1. Engineering Report - July, 1988

2. "As Built" Plans Powerline Floodway

3. General Motors Desert Proving Grounds Contract File

4. Powerline Floodway Subsidence Survey

5. ACI manual of Concrete Practice 1985 Part 5

6. Powerline Floodway Design 1965 to 1968

7. Engineering Report Evaluation of Expansion Joint Sealant for East Maricopa Floodway - Reach - 4 December 1987

8. East Maricopa Floodway Reach 4 Expansion Joint Sealer Repair Design

9. NEH Chapter 6

10. Far West States Engineering Design Standards

LOCATION AND LAYOUT

The channel is located in Maricopa and Pinal counties between Powerline Dam and East Maricopa Floodway Reach 4. It traverses the south part of General Motors Proving Grounds in an east west direction. In 1991 a level survey was made on the channel bottom and on the subsidence monuments every 2000 feet along the channel. New elevation datum was established from Hawk Rock, a large rock out crop that is not subsiding. All new construction for the repair will be based on the recent survey.

FOUNDATION

Eight samples were taken in the channel bottom at locations where lining was cracked badly and where lining bottom had heaved upward several inches. The eight samples were tested at the Mesa Project office for gradation and Atterburg limits. Two of the eight samples showed evidence of clay and significant fines. These two samples were taken from Station 78+00 and 224+25. Both samples were 4 to 5 feet below channel invert and are 9 to 10 feet below original ground. The samples were tested for shrink swell by Western Technologies Inc. The sample from Station 224+25 had a 7.7 percent expansion at 94 PCF dry density and 8.6 percent expansion at 98 PCF dry density. The sample at Station 78+00 had an expansion of 2.1 percent.

Soils information shown on the original drawings for the channel show a 2 foot clay layer generally between 7 and 10 feet below natural ground between Station 220+00 and Station 236+00.

The expansive clay tested at 224+25 is not considered to be the cause of damage at that location. The damage is a result of the uplift mentioned above in this report. By sealing all joints and cracks in this area, and protecting the top of the lining with berms and an operation and maintenance road that directs the water away from the channel lining, the clay layer is not likely to become saturated and is not considered to be a threat to the repaired structure.

STRUCTURE DESIGN

The July 1988 Engineering Report recommends cutting sections between expansion joints at about the center and allowing time for stress relief. A study has recently been done where nine 6-inch wide sections were removed and movement monitored for a two week period. Results from this study indicate that movement due to stress relief is minimal and that it takes place right after saw cutting the joints. The report is in the design file.

Design of the joint gap was done by using the change in length due to thermal expansion of concrete and an allowable 50 percent expansion and compression for the sealant. The design was also

checked using ACI 504 R-23 using sealant with 50 percent expansion and compression.

Joint removal and repair was based on visual observation and tapping with a hammer of all damaged areas. If damage appeared to penetrate the entire slab thickness, or one side of the joint was noticeably higher than the opposite side, the joint was designated for removal.

A few small holes were observed at the top of the slope at several joints. These areas will be backfilled when the concrete is removed. If other cavities are encountered during concrete removal they will also be backfilled.

The reinforcing steel required for slabs was reduced by calculating the subgrade drag forces. It was decided to use number four bars for all reinforcing and not a wire mesh. The existing wire mesh in the floodway was observed in the recently cut sections to be near or at the subgrade in many areas. The use of reinforcing steel will give better control for location within the slab.

The longitudinal cracks occur where overbank flow entered between the concrete lining and the subgrade. Berms were installed subsequently to prevent drainage from getting under the lining. With the cause for the cracks corrected, it is now possible to seal the cracks by epoxy injection. The Flood Control District of Maricopa County installed some trial crack repairs by high pressure water blasting (up to 10,000 psi) and epoxy sealing the cracks. After curing, the sealed cracks were cored to evaluate penetration. Results of this work show that high pressure water blasting adequately cleaned the various crack widths and proper bonding and adequate penetration was achieved. This procedure will provide a permanent repair for the cracks.

ENVIRONMENTAL CONSIDERATIONS

No negative impact on the conservation of biological or water resources is anticipated by the repair.

CONSTRUCTION DRAWINGS

All drawings were prepared and stored on the Arizona CADD system using Versacad software, Version 5.4. Pertinent information was taken from the original "As Built" drawings in 1967.

SPECIFICATIONS

The NEH Section 20 standard specifications have been used for this project, along with a revised 400 specification for joint sealant that was approved for EMF Reach 4, and one new 400 series specification as follows:

402. Epoxy Adhesive Injection For Concrete Repair of Concrete Lined Floodway.

The following NEH Section 20 specifications were used:

3	Structural Removal
5	Pollution Control
7	Construction Surveys for Layout, Control and Measurement
8	Mobilization
10	Water for Construction
11	Removal of Water
21	Excavation
23	Earthfill
31	Concrete
34	Steel Reinforcement
94	Contractor Inspection

COST ESTIMATE

The engineer's estimate is $503,786. There are no unusual materials or construction methods involved.

CONSTRUCTION SCHEDULE

The construction schedule was based on an average contractor doing the work. The chance that storms could place considerable water in the channel will require that the contractor remove and replace only enough sections to eliminate the possibility of eroding the soil and uplifting the existing lining adjacent to the repair section. Total construction time is 180 days and this was based on doing 2-50 foot sections per day or 6 of the smaller repair sections per day. The remaining work can be accomplished during the placement of concrete.

OPERATION AND MAINTENANCE

An operation and maintenance plan has been written for Powerline Floodway.

This repair work will reduce the operation and maintenance considerably over work required since the channel was constructed. Tumbleweeds, shrubs, grass and debris have been a major maintenance problem due to all the cracks, open joints, and spalled areas. This repair project will reduce the opportunity for plant growth to start. A regular maintenance program should be initiated to check for broken sealant and these areas should be immediately repaired to prevent plant growth. After each major storm the channel should be checked to assure that it is functioning properly, that debris is removed, and that no damage has occurred.

CONSTRUCTION REVIEW

The channel bottom should be inspected by the geologist after sections have been removed in the area where expansive clay was found, and in other areas where soils are questionable.

Crack repair and sealing joints with the manufacturer's representatives should be performed prior to beginning work on these items.

A preconstruction conference will be held at which time questions about the repair or design can be discussed.

AUTHORITY

Tom Jayo 4-1-92

Submitted by: Design Engineer Date

John H. Harrington 4-1-92

Recommended by: State Design Engineer Date

Ralph W. Amrich 4-1-92

Approved by: State Conservation Engineer Date

STRESS RELIEF DOCUMENTATION REPORT

March 26, 1992

Project: Apache Junction-Gilbert Watershed
Job: Powerline Floodway Repair
Location: Maricopa and Pinal Counties, Arizona
Authority: PL 566
Stage: Final Design

Design Review Report recommended that the stress relief be monitored or documented prior to the installation of concrete. Two sites that visually appeared to be under strain as evidenced by very tight soil between the contraction joints and some cracking at the joints were chosen for the study.

Study sites are 1.1 miles apart, one on each side of Ironwood Road. The site east of Ironwood road has four joints saw cut in a 200 foot section of channel. The site west of Ironwood Road has five successive joints with six-inch cuts over a distance of 200 feet. Bolts were set approximately 11 inches apart at each joint at the north and south slopes near the top of the lining and at the bottom of the floodway.

Measurements were taken initially prior to cutting concrete to the outside of the bolts at all joints. Saw cuts were made at joints, and a six-inch wide section of concrete was removed. Number seven rebar were placed at the center of each six-inch opening to provide a reference point for direction of movement. Measurements were taken immediately after saw cutting and once a day for two weeks and twice a day for one week.

Results of the study are as follows:

1. Daily movement due to temperature fluctuation corresponds to theoretical movement as calculated by formula.

2. Movement due to temperature change takes place on a daily cycle.

3. Where 50-foot sections were isolated with six-inch cuts on each side, there is no evidence of any permanent decrease in joint width or increase in slab length due to strain.

4. At the end six-inch cuts, joints 126, 130, 255 and 259, there is evidence of a gradual decrease in joint width at approximately 1/16 inch per week. These joints are not isolated and are being influenced by several 50-foot sections which will move to the open relieved joint.

5. The north side of the channel has 67 percent greater movement than the south side, with the center moving mid-way between the north and south sides. The north side of the channel has more direct sunlight for longer time periods.

6. Temperature has a greater role in slab movement than any strain which may be in the concrete after joints are cut and stress is relieved.

7. Joint width decrease due to cutting joints and relieving stress is small compared to movement due to temperature stress.

Monitoring will continue on a weekly basis for several months to observe movement as mean temperatures continue to increase. This information should provide additional data that will aid us in future work.

Submitted by Tom Joyce

Reviewed by John R. Harrington

Approved Ralph M. Clough Date 3/30/92

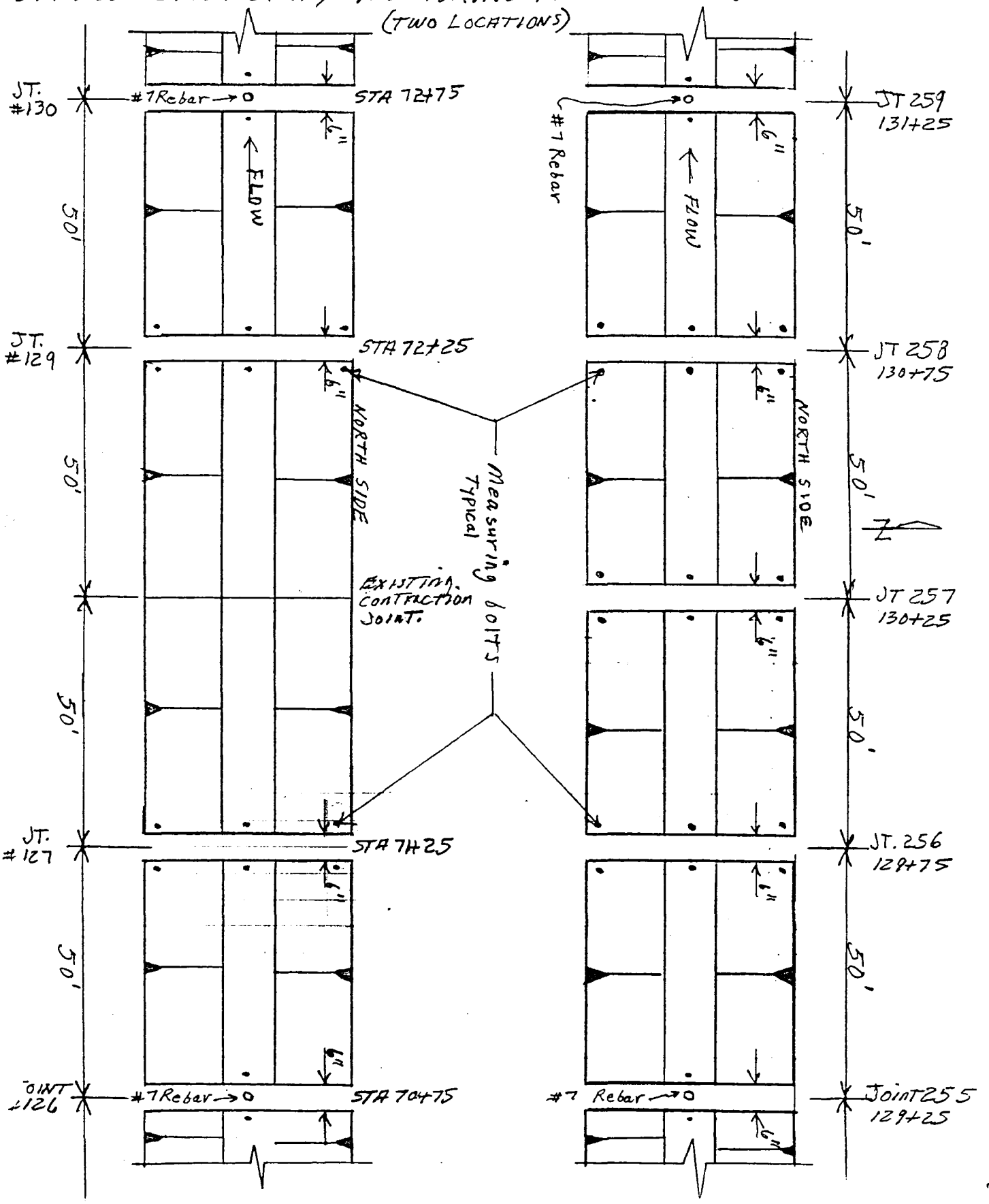
AZ

TSJ 3-25-92

POWERLINE FLOODWAY REPAIR

STRESS RELIEF STUDY - MONITORING PLAN (TWO LOCATIONS)

3



AZ POWERLINE FLOODWAY REPAIR
TSJ 3-25-92
STRESS RELIEF STUDY - LINING MOVEMENT 4
DUE TO TEMPERATURE - THEORETICAL

Given: Temp differential - morning to evening = 20° TO 30°
use $25° = \Delta T$

ℓ_e = slab length = 50 feet
G = Coefficient of thermal expansion for concrete = 6.6×10^{-6}

ΔL = Conc movement due to temperature

$$\Delta L = (\Delta T)(\ell_e)(G)$$

$$= \underset{\Delta T}{25}\underbrace{(50)(12)}_{\ell_e}\underset{G}{(6.6 \times 10^{-6})} = 0.099 \text{ inch}$$

use 0.1 inch

North side of channel has more direct sunlight and sun is on on north side for longer time.

Measurements on north top side
= 0.125 in ± from morning measurement to evening measurement.

Measurements on top south side
= 0.075 inch ±

Measurments in center = 0.1 in ±

These measurements correlate with the theoretical calculated concrete movement.

Az POWERLINE FLOODWAY REPAIR

TSJ 3-25-92

STRESS RELIEF STUDY RESULTS 5

TOP NORTH SLOPE MEASYREMENT (inches)

DATE	TEMPERATURE °F	STATION & JOINT NUMBER 129+75 #256	130+25 #257	130+75 #258	71+25 #127	72+25 #129
3-2-92	65 (initial before cut)	11.37	10.78	11.20	10.66	10.90
3-5	87	Right After Cut →			10.59	10.79
3-6	50				10.66	10.93
3-7	75				10.61	10.88
3-10	52 TO 72	Right After Cut ~72°F± 11.25	10.64	11.11	52°F 10.65	10.90
3-11	51	11.36	10.77	11.21	10.64	10.91
3-12	54	11.35	10.75	11.19	10.63	10.89
3-13	57	11.36	10.76	11.19	10.63	10.89
3-14	61	11.36	10.76	11.20	10.62	10.88
3-15	50	11.36	10.76	11.20	10.61	10.88
3-16	61	11.35	10.75	11.18	10.60	10.87
3-17	62	11.34	10.74	11.17	10.60	10.86
3-18	56	11.36	10.79	11.19	10.61	10.88
3-20	70	11.32	10.72	11.14	10.58	10.85

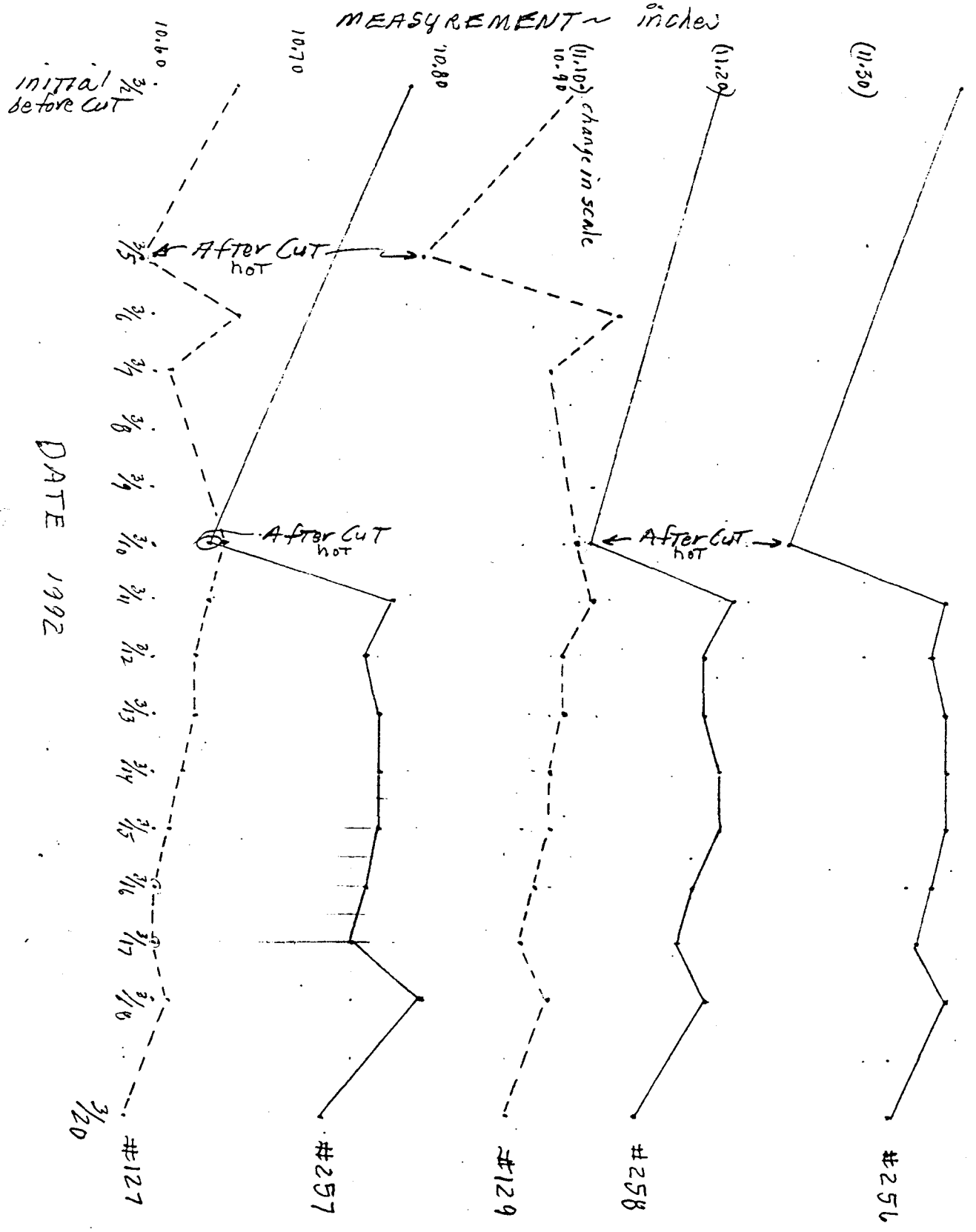
A2
TSJ 3-25-92

POWERLINE FLOODWAY REPAIR

STRESS RELIEF STUDY RESULTS

6

TOP NORTH SLOPE



DATE 1992

AZ
TSJ 3-25-92

POWERLINE FLOODWAY REPAIR

STRESS RELIEF STUDY RESULTS 7

TOP SOUTH SLOPE MEASUREMENTS (inches)

DATE	TEMPERATURE °F	STATION & JOINT NUMBER 129+75 #256	130+25 #257	130+75 #258	71+25 #127	72+25 #129
3-2-92	65 (initial before cut)	10.99	11.44	11.36	10.78	11.16
3-5	87	Right After Cutting →			10.74	11.12
3-6	50				10.77	11.18
3-7	75				10.76	11.18
3-10	52	Right After Cutting ← 10.98	11.40	11.31	10.78	11.19
3-11	51	11.03	11.45	11.37	10.77	11.18
3-12	54	11.02	11.44	11.35	10.77	11.18
3-13	57	11.01	11.43	11.36	10.76	11.17
3-14	61	11.01	11.43	11.36	10.76	11.17
3-15	50	11.01	11.41	11.35	10.75	11.16
3-16	61	11.00	11.41	11.34	10.74	11.16
3-17	62	10.99	11.40	11.32	10.73	11.15
3-18	56	11.01	11.42	11.35	10.75	11.17
3-20	70	11.00	11.42	11.33	10.74	11.15

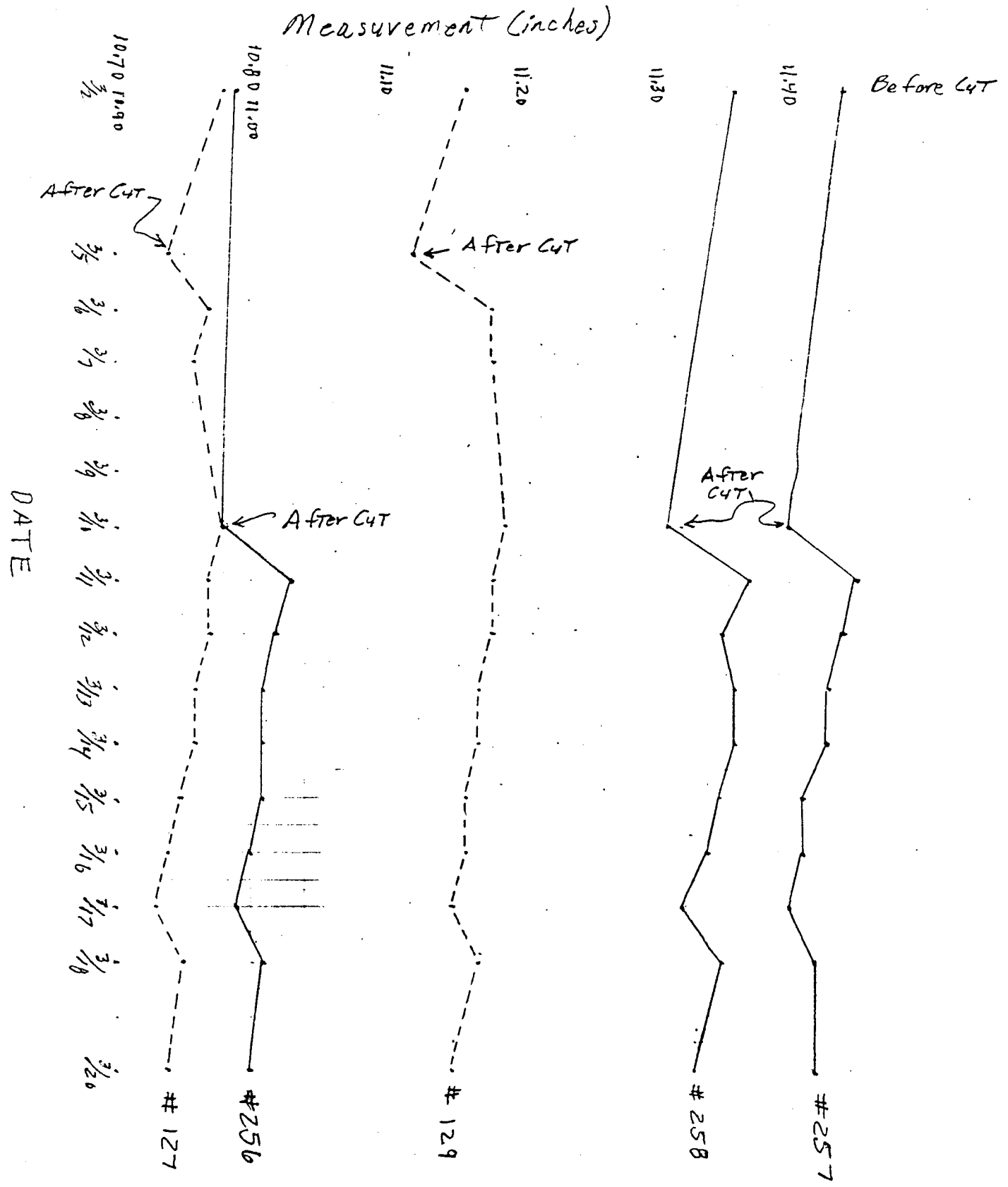
AZ
TSJ 3-25-92

POWERLINE FLOODWAY REPAIR

STRESS RELIEF STUDY RESULTS

8

TOP SOUTH SLOPE



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TSJ 3-25-92

POWERLINE FLOODWAY REPAIR

STRESS RELIEF STUDY RESULTS

9

END CUTS CENTER REBAR TO EAST AND WEST
UNCUT LINING

DATE	TEMP °F	STATION & JOINT NUMBER 70+75 #126 (East)	72+75 #130 (West)	129+25 #255 (East)	131+25 #259 (West)	
3/2/92	65	5.57	5.27	5.39	5.17	– Before Cutting
3/5	87	5.55 (5.96)	5.22 (5.60)			– After Cutting
3/6	50	5.53 (5.97)	5.26 (5.64)			
3/7	75	5.50 (5.96)	5.25 (5.62)			
3/8	53°	5.55 (5.95)	No reading			
3/10	50	5.52 (5.96)	5.28 (5.63)	5.35	5.17	– After Cutting #255 & #259 70°F
3/11	51	5.52 (5.95)	5.26 (5.63)	5.37	5.22	
3/12	53 To 61	5.50 5.95	5.25 (5.61)	5.36	5.21	
3/13	51 To 53	5.50 (5.94)	5.25 (5.62)	5.35	5.20	
3/14	61 To 55	5.48 (5.94)	5.25 (5.61)	5.35	5.19	
3/15	50	5.47 (5.92)	5.24 (5.59)	5.34	5.17	
3/16	61	5.47 (5.92)	5.23 (5.60)	5.34	5.17	
3/17	62	5.47 (5.92)	5.22 (5.59)	5.33	5.16	
3/18	56 To 57	5.47 (5.93)	5.24 (5.60)	5.33	5.17	

Movement after cutting varies from 0.04" to 0.08" for approx. 1 week period or approx 1/16 in/week = 0.27"/month

End cuts are closing at a rate of 1/16"/week ±. We expect these cuts to close since we have a considerable length of lining under strain that will move to the open cut. This should pose no problem for repairing the joints.

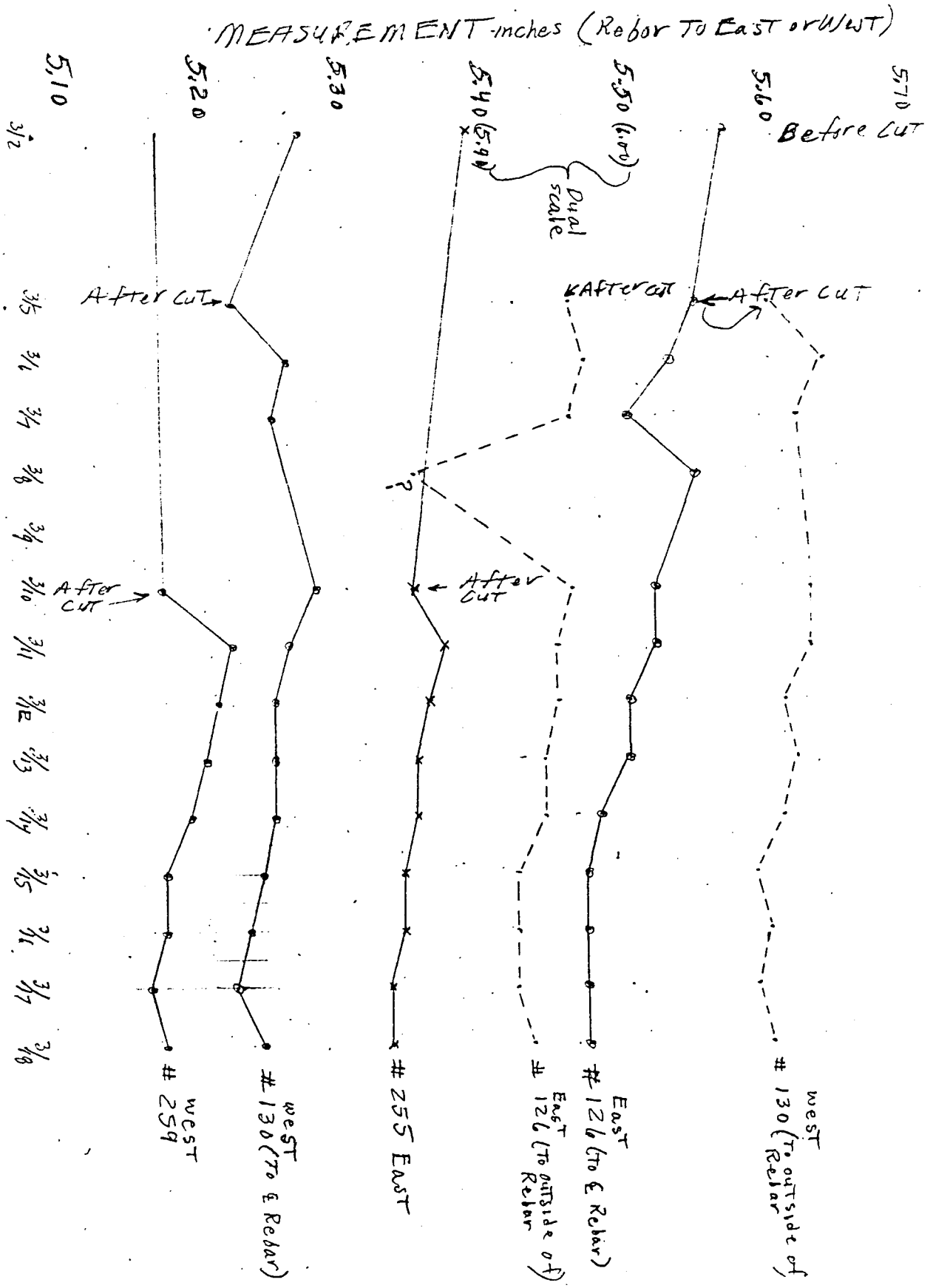
AZ

TJJ 3-25-92

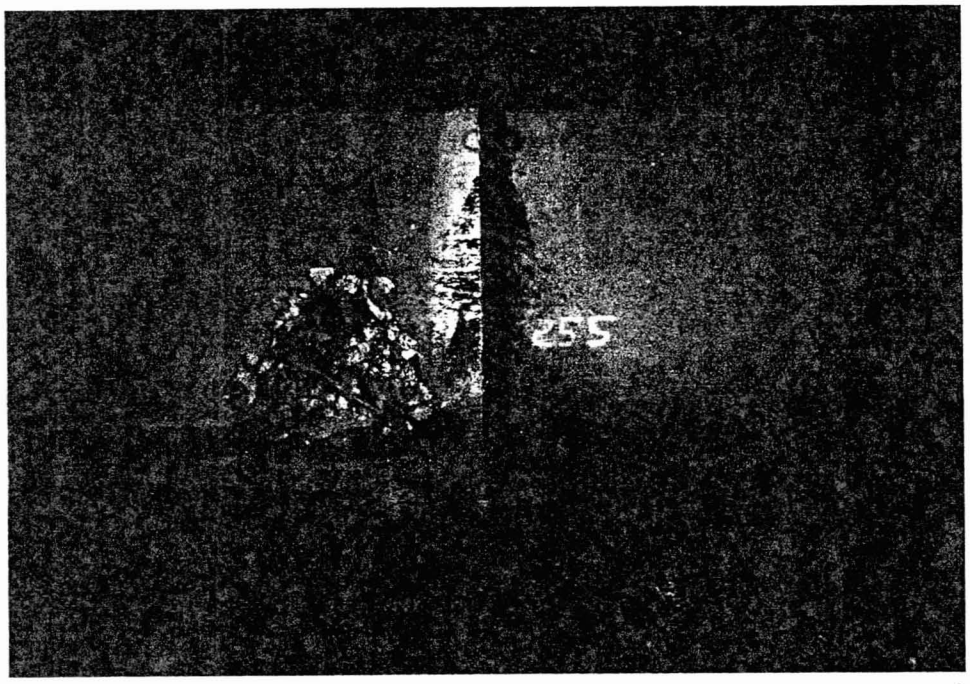
POWERLINE FLOODWAY REPAIR

STRESS RELIEF STUDY RESULTS

10.

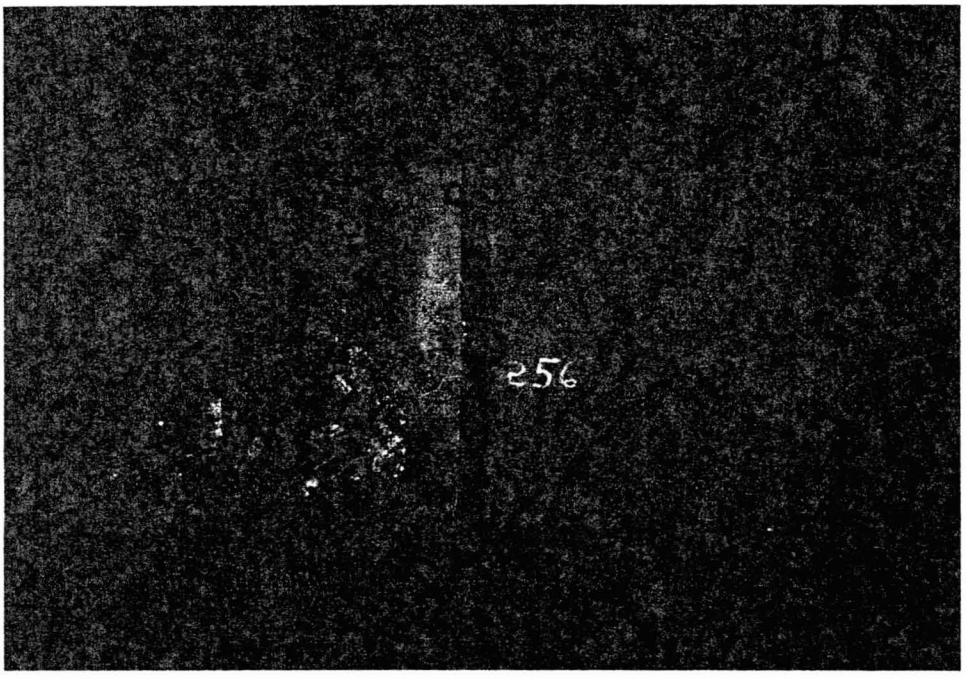


POWERLINE FLOODWAY REPAIR



3/16/92 Sta 129+25 Right slope and channel bottom

Joint #255 - 6-inch saw cut with rebar and bolts installed



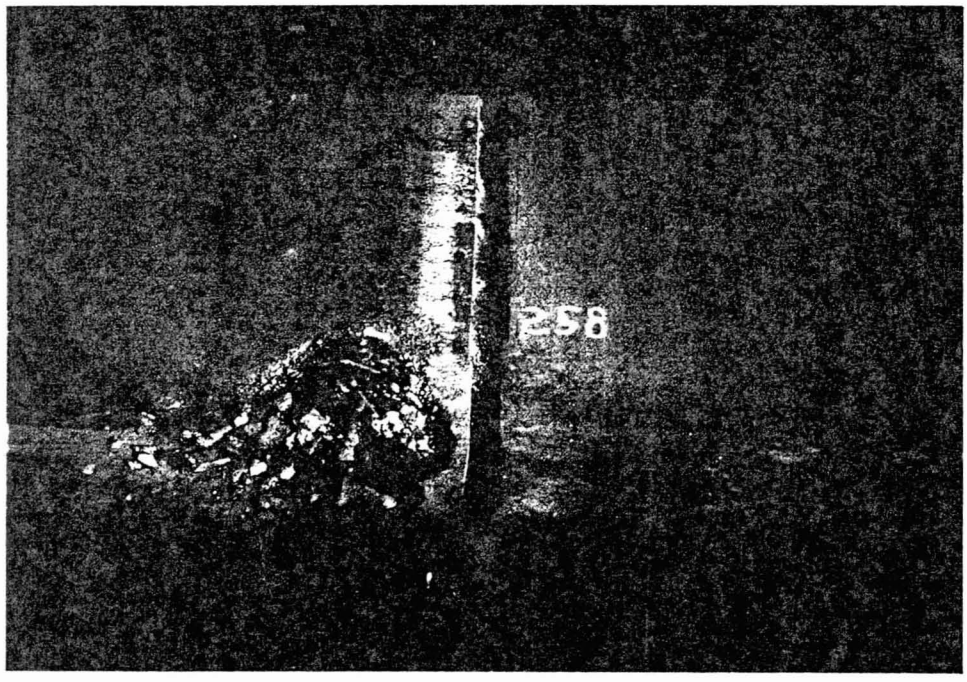
3/16/92 Sta 129+75 Right slope and bottom

Joint #256 - 6-inch saw cut with rebar and bolts installed

POWERLINE FLOODWAY REPAIR

3/16/92 Sta 130 + 25 Right slope and bottom

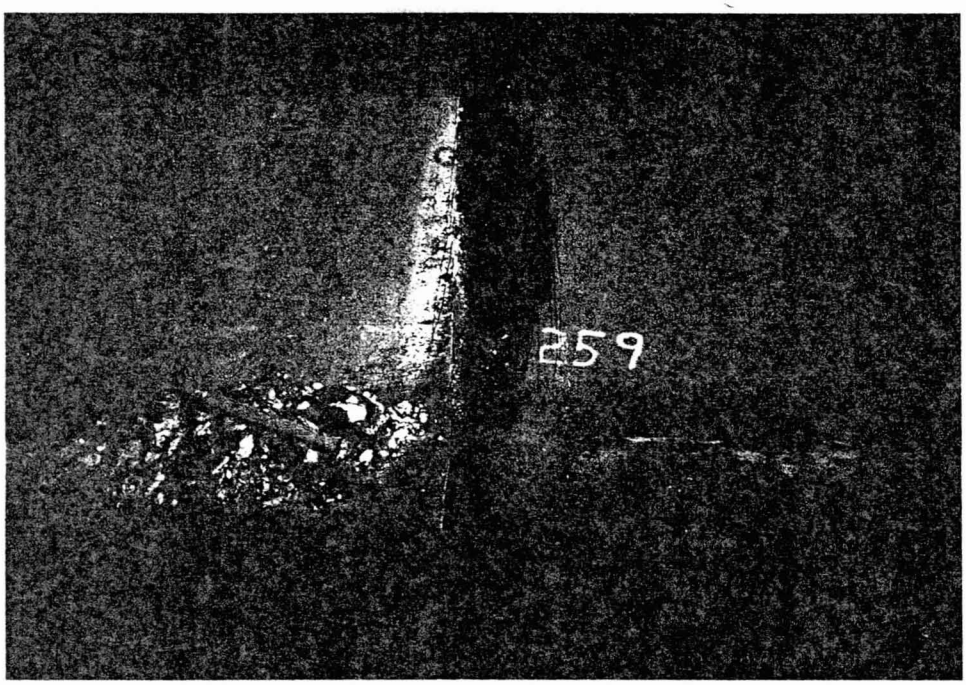
Joint #257 - 6-inch saw cut with rebar in bottom and bolts on slopes installed



3/16/92 Sta 130 + 75 Right slope and channel bottom

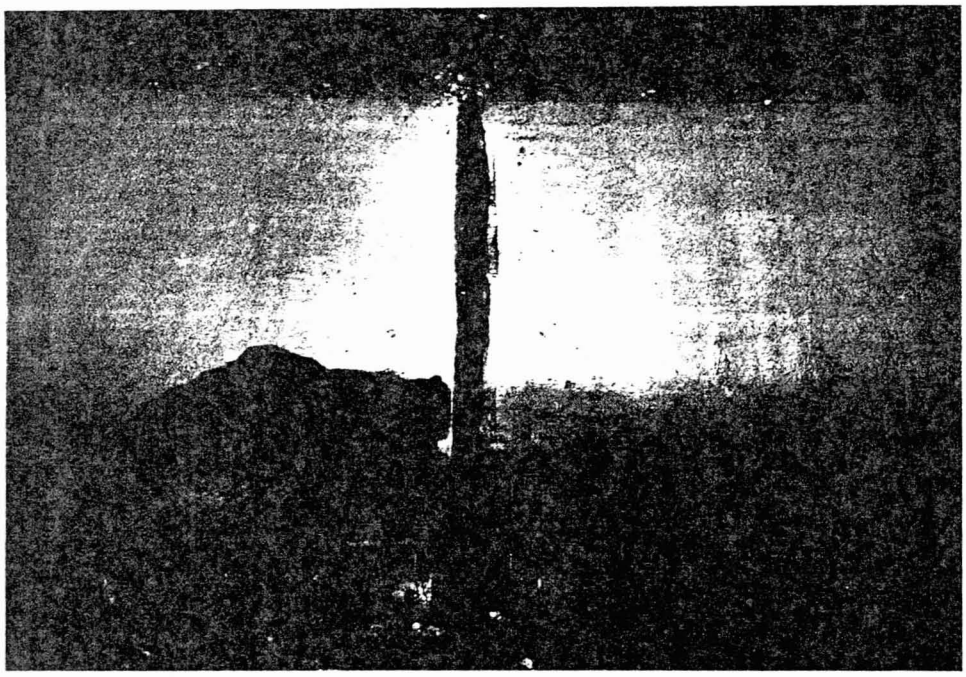
Joint #258 - 6-inch saw cut with rebar in bottom and bolts on slopes installed

POWERLINE FLOODWAY REPAIR



3/16/92 Sta 131+25 Right slope and channel bottom

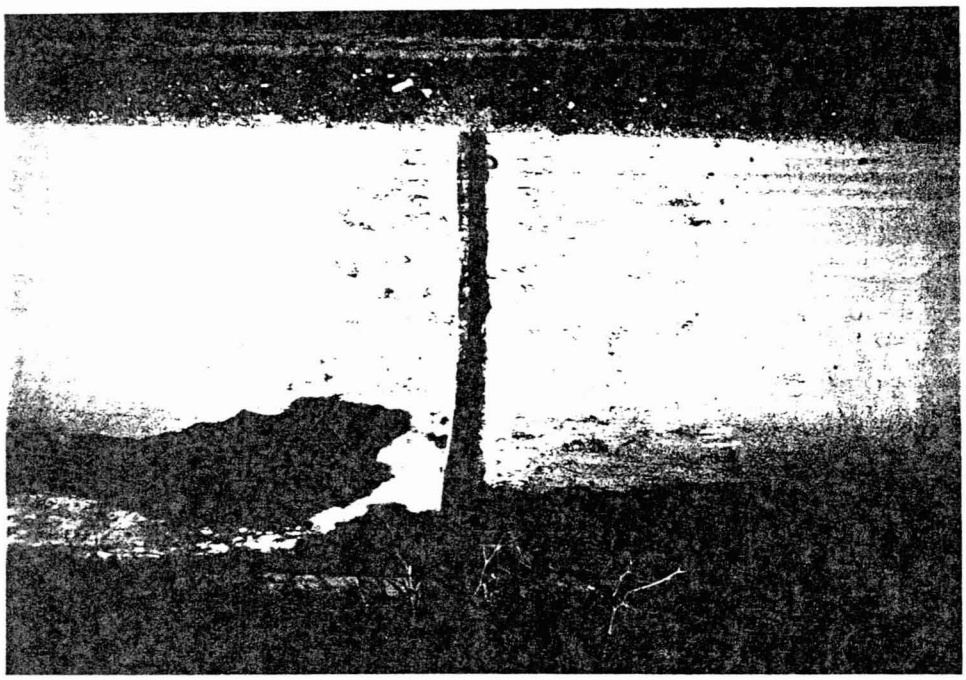
Joint #259 - 6-inch saw cut with rebar in bottom and bolts on slopes installed



3/16/92 Sta 70+75 Right slope

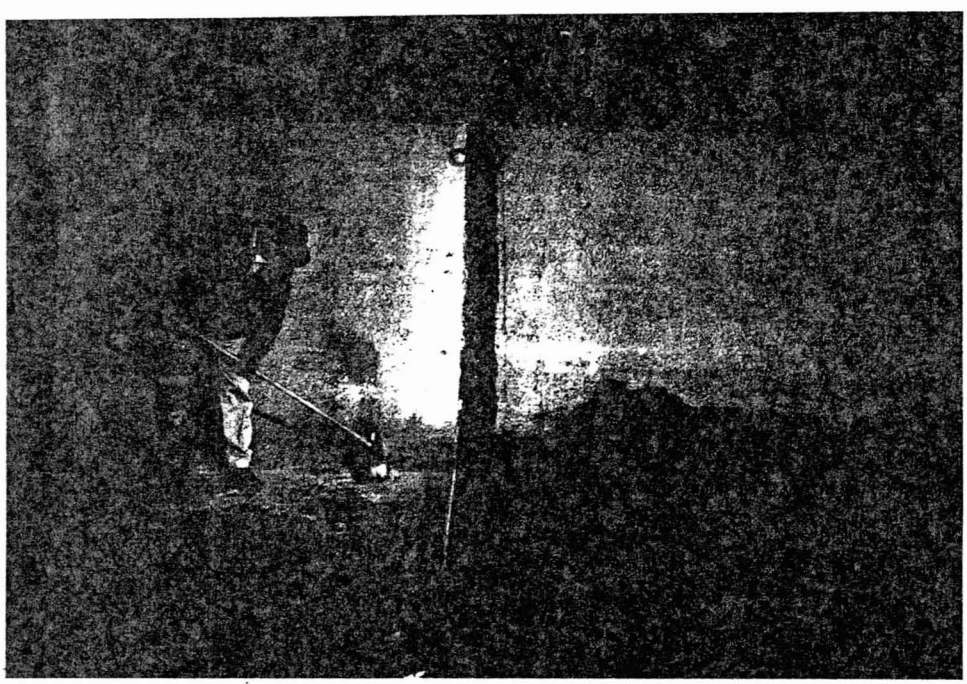
Joint #126 - 6-inch saw cut with rebar in bottom and bolts on slopes installed

POWERLINE FLOODWAY REPAIR



3/16/92 Sta 71+25 Right slope

Joint #127 - 6-inch saw cut with rebar and bolts in place



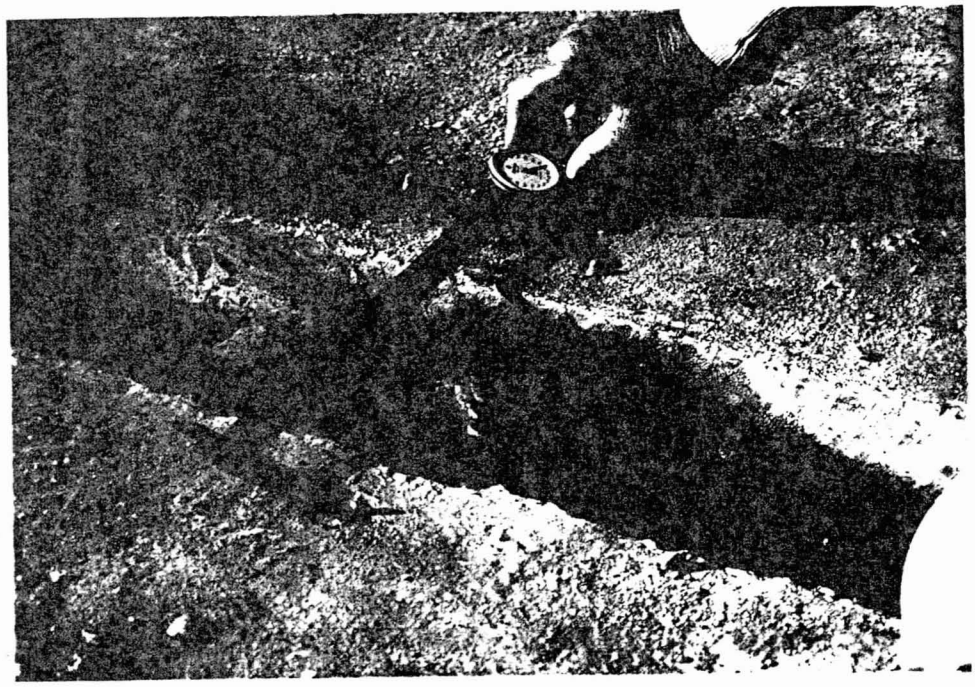
3/16/92 Sta 72+25 Right slope

Joint #129 - 6-inch saw cut with rebar and bolts installed

POWERLINE FLOODWAY REPAIR

3/16/92 Sta 72 + 75 Right slope and channel bottom

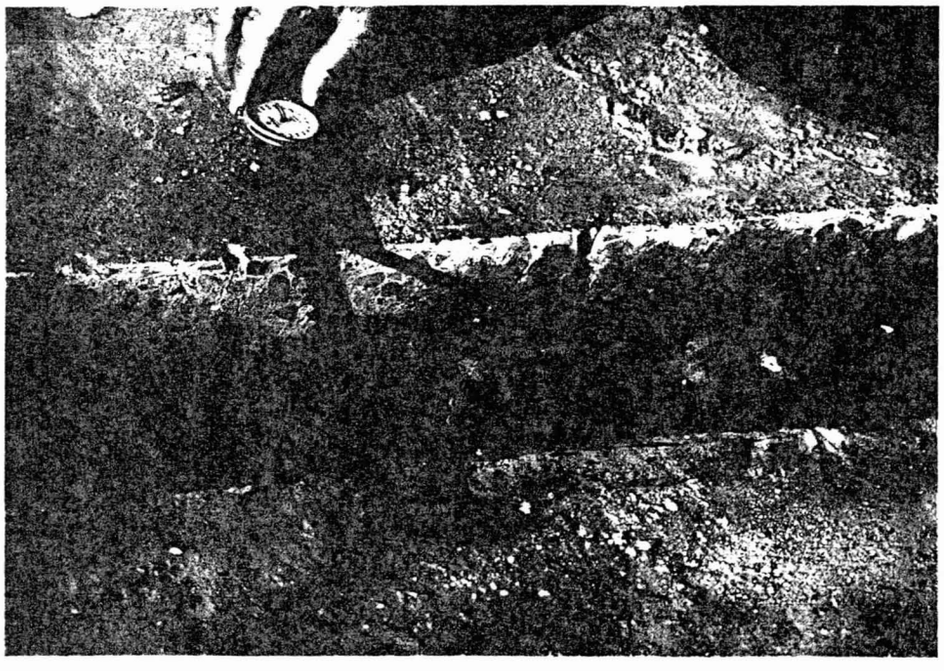
Joint #130 - 6-inch saw cut with rebar and bolts installed



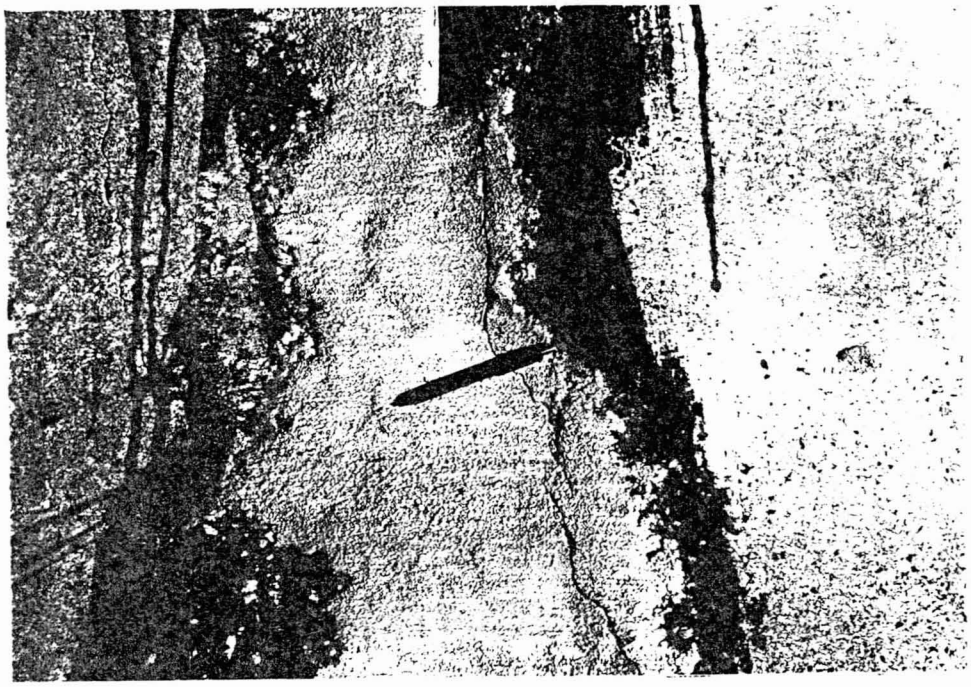
3/16/92 Calipers being used to measure distance between bolts to 0.001 inches on each side of 6-inch cut-out

POWERLINE FLOODWAY REPAIR

3/16/92 Calipers being used to measure distance between rebar and bolt on one side of 6-inch cut-out to 0.001 inch.

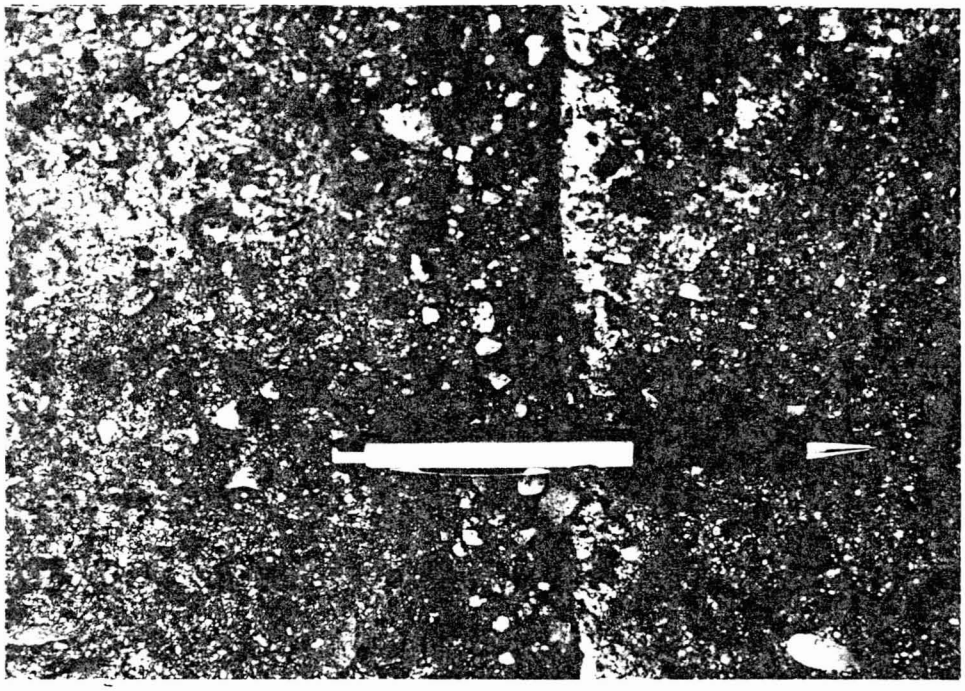


3/16/92 Calipers being used to measure distance between bolts to 0.001 inch across 6-inch cut-out



1/30/92 Sta. 329+57 Right Slope

Crack in recent concrete placed across joint.
Crack due to slab contraction.

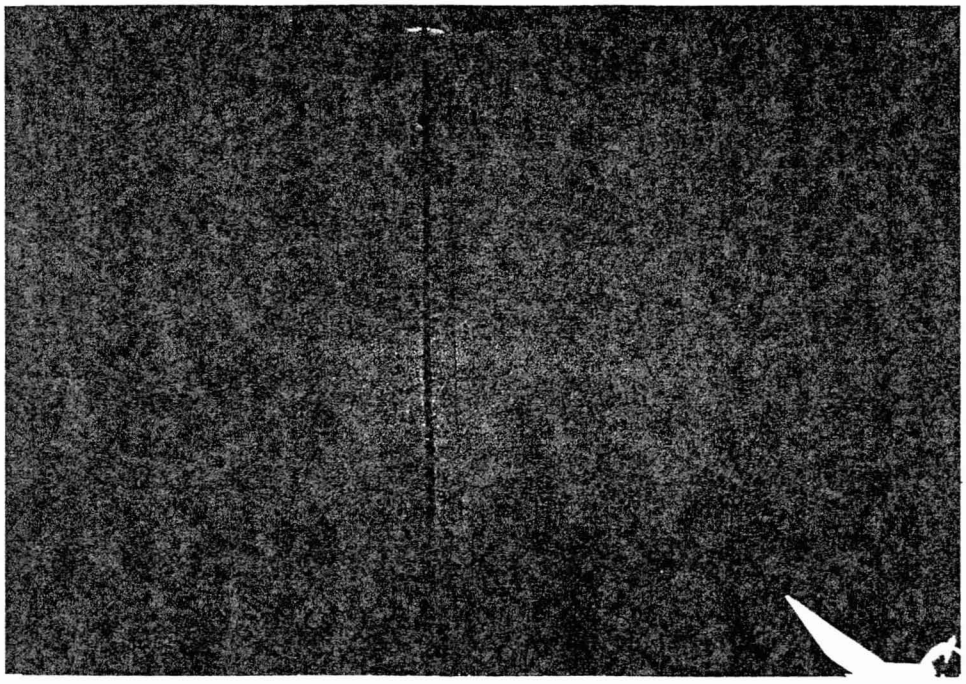


1/30/92 Sta. 208+25 Channel Invert

Slab contraction indicated by crack in silt
in joint.

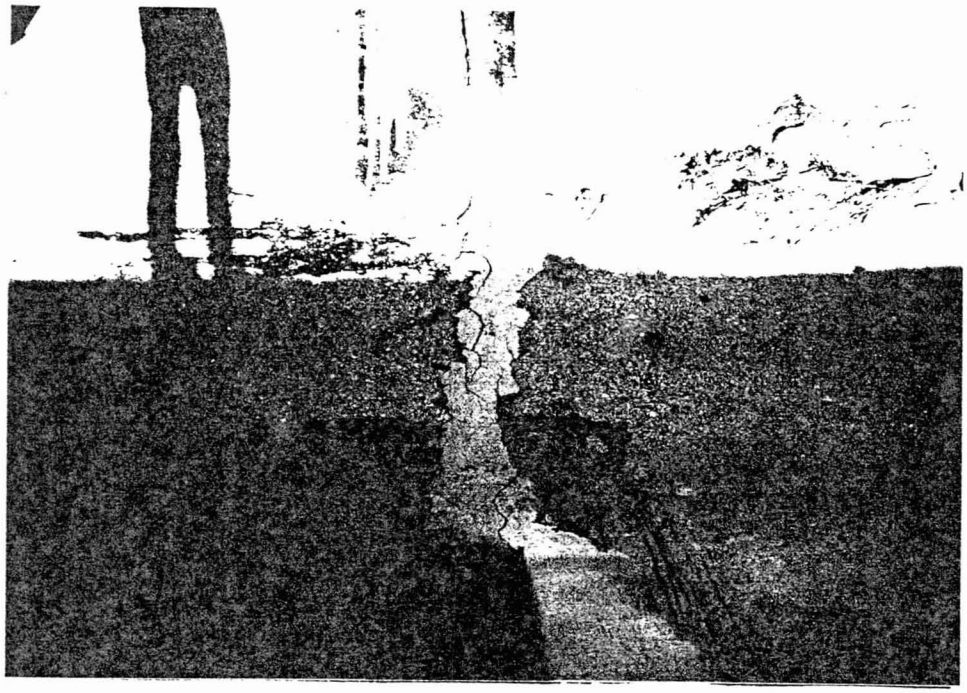
1/30/92 Sta. 208+25 Right Slope

Knife in open joint.



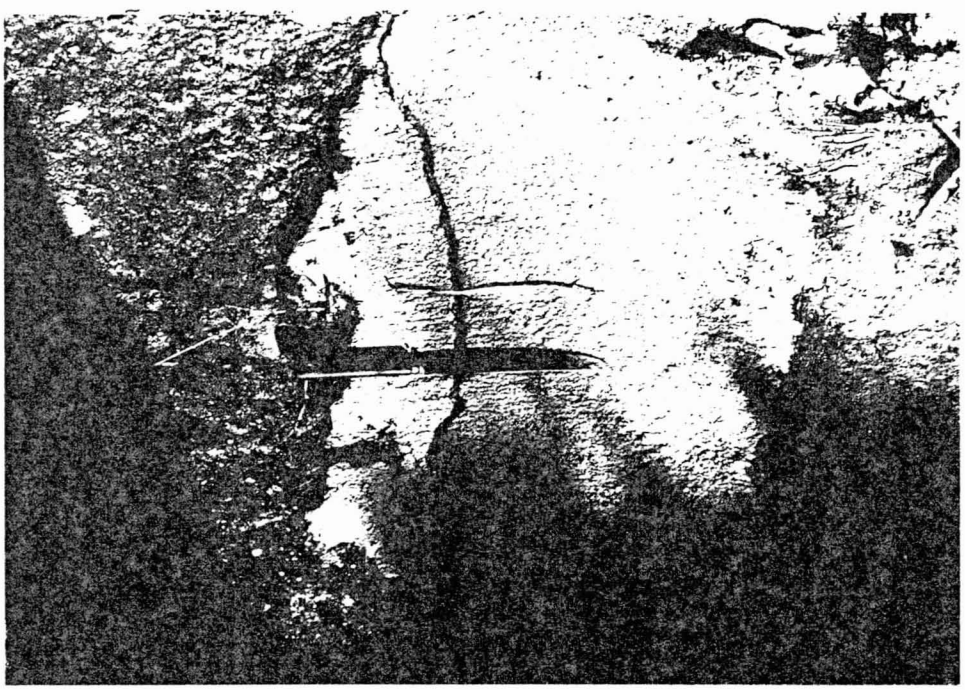
1/30/92 Sta 208+25 Left Slope

Joint open.



1/30/92 Sta. 207+75 Channel Invert

Crack across bottom of channel in recent placed concrete due to slab contraction.

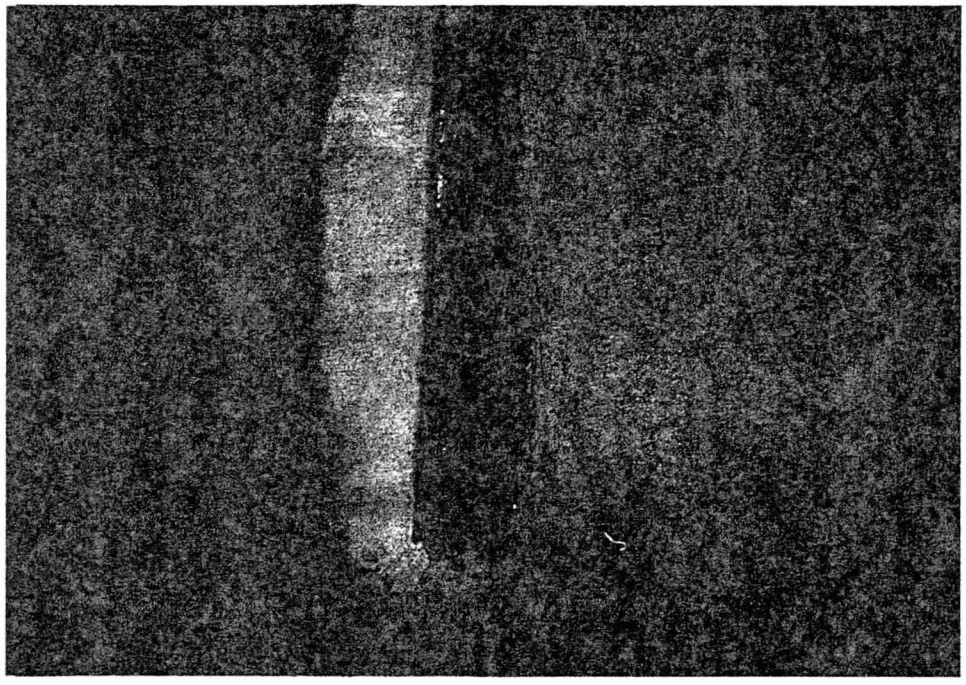


1/30/92 Sta. 207+75 Channel Invert

Close up of slab contraction crack on recent concrete placed across joint.

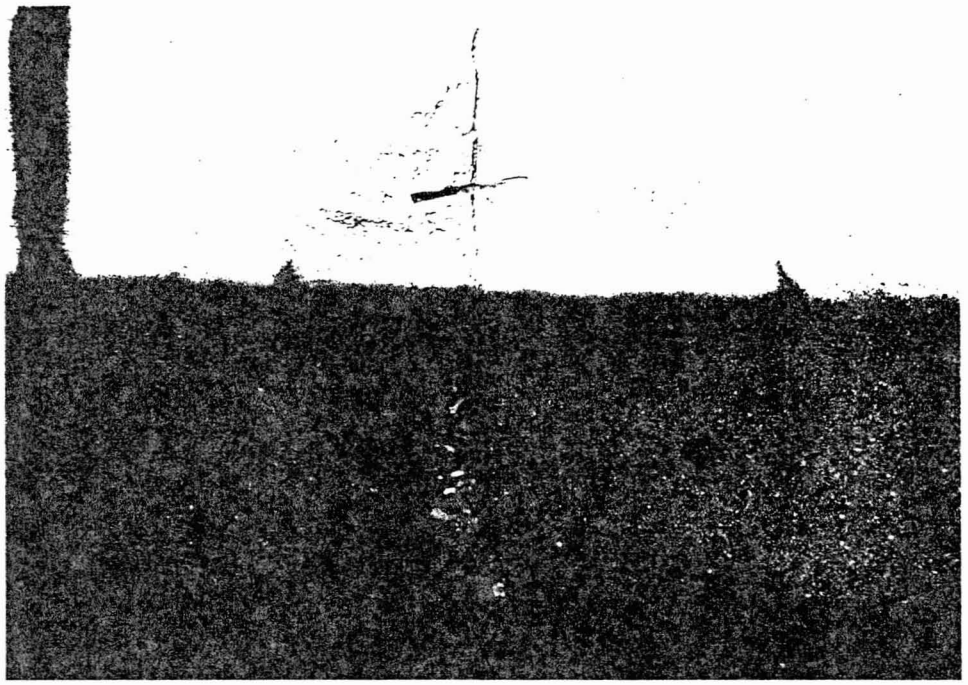
1/30/92 Sta. 207+75 Right Slope

Slab contraction crack in side slope tarred joint.



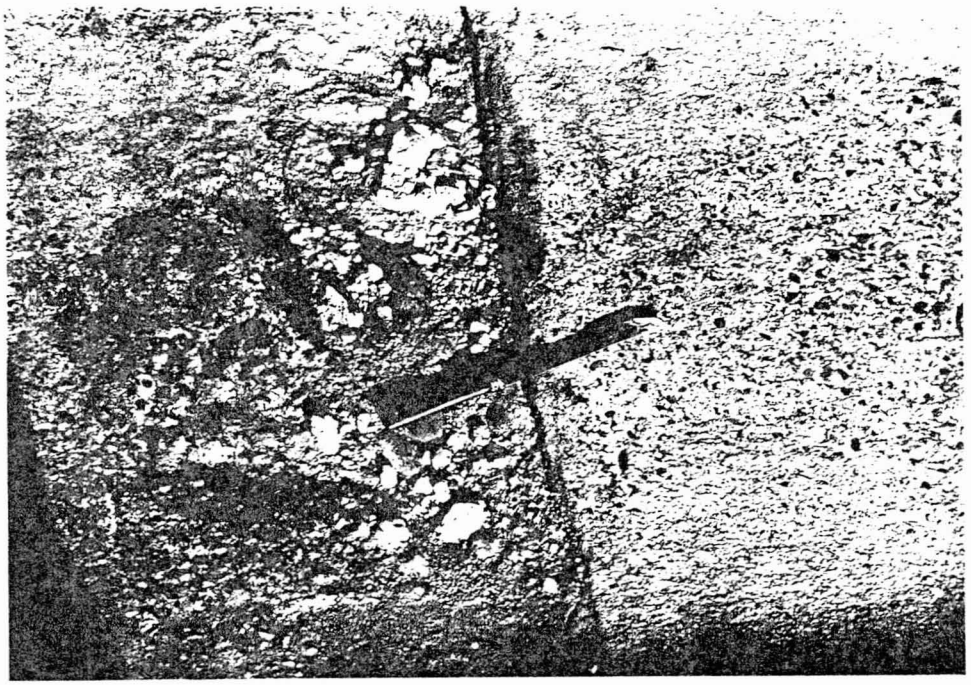
1/30/92 Sta. 207+75 Left Slope

Slab contraction crack in recent concrete placed across joint. Open joint on bank.



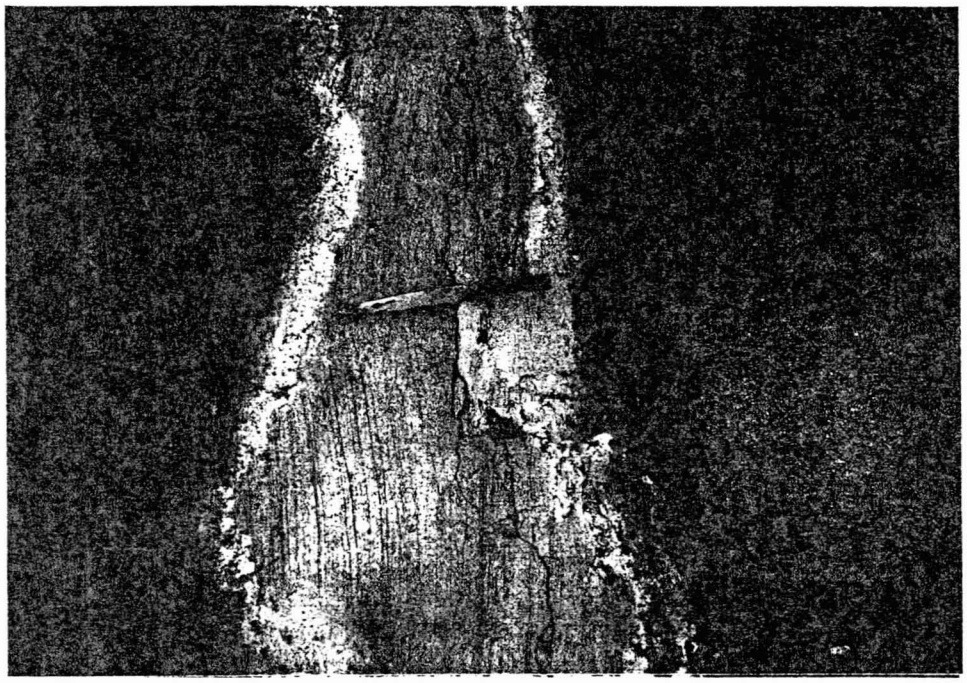
1/30/92 Sta. 203+75 Channel Invert

Crack in silted joint due to slab contraction.



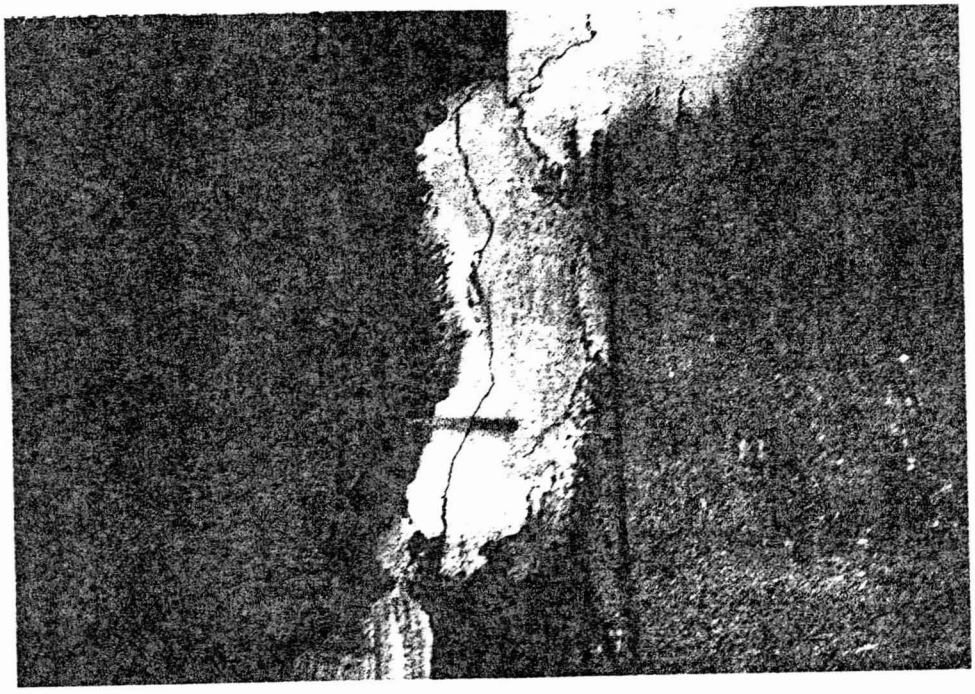
1/30/92 Sta. 203+75 Channel Invert

Crack in silted joint due to slab contraction.



1/30/92 Sta. 176+25 Left Slope

Crack in recent concrete placement across joint due to slab contraction.



1/30/92 Sta. 173+50 Left Slope

Crack in recent concrete placement across joint due to slab contraction.

CONSTRUCTION SPECIFICATION

3. STRUCTURE REMOVAL

1. SCOPE

The work shall consist of the removal, salvage and disposal of structures (including fences) from the designated areas.

2. MARKING

Each structure unit to be removed will be marked by means of stakes, flags, painted markers or other suitable methods.

3. REMOVAL

All structures designated in the contract for removal shall be removed to the specified extent and depth.

4. SALVAGE

Structures that are designated to be salvaged shall be carefully removed and neatly placed in the specified storage areas. Salvaged structures that are capable of being disassembled shall be dismantled into individual members or sections. Such structures shall be neatly match marked with paint prior to disassembly. All pins, nuts, bolts, washers, plates and other loose parts shall be marked or tagged to indicate their proper locations in the structure and shall be fastened to the appropriate structural member or packed in suitable containers. Materials from fences designated to be salvaged shall be placed outside the work area on the property from which they were removed. Wire shall be rolled into uniform rolls of convenient size. Posts and rails shall be neatly piled.

5. DISPOSAL OF REFUSE MATERIALS

Refuse materials resulting from structure removal shall be burned or buried at locations shown on the drawings or as specified in Section 7 of the specification.

6. MEASUREMENT AND PAYMENT

For items of work for which specific lump sum prices are established in the contract, payment for structure removal will be made at the contract lump sum price.

Such payment will constitute full compensation for all labor, equipment, tools, and all other items necessary and incidental to the completion of the work.

Compensation for any item of work described in the contract but not listed in the bid schedule will be included in the payment for the item of work to which it is made subsidiary. Such items and the items to which they are made subsidiary are identified in Section 7 of this specification.

7. ITEMS OF WORK AND CONSTRUCTION DETAILS

Items of work to be performed in conformance with this specification and the construction details are:

(a) Bid Item 1, Structure Removal - Channel Lining

(1) This item consists of the removal and disposal of concrete lined sections, portions of sections, and concrete cutoff collars, as shown on the drawings.

(2) Disposal of concrete rubble and other debris shall be the responsibility of the contractor and shall be disposed of away from the job site.

(3) In Section 6, Measurement and Payment, payment will include compensation for subsidiary item: Pollution Control.

CONSTRUCTION SPECIFICATION

5. POLLUTION CONTROL

1. SCOPE

The work shall consist of installing measures or performing work to control erosion and minimize the production of sediment and other pollutants to water and air during construction operations in accordance with these specifications.

2. MATERIALS

All materials furnished shall meet the requirements of the Material Specifications listed in Section 8 of this specification.

3. EROSION AND SEDIMENT CONTROL MEASURES AND WORKS

The work and measures shall include but not be limited to the following, as shown on the drawings or as specified in Section 8 of this specification.

Staging of Earthwork Activities - The excavation and moving of soil materials shall be scheduled so that the smallest possible areas will be unprotected from erosion for the shortest time feasible.

Seeding - Seedings to protect disturbed areas shall be done as specified on the drawings or in Section 8 of this specification.

Mulching - Mulching shall be used to provide temporary protection to soil surfaces from erosion.

Diversions - Diversions shall be used to divert water away from work areas and/or to collect runoff from work areas for treatment and safe disposition.

Stream Crossings - Culverts or bridges shall be used where equipment must cross streams.

Sediment Basins - Sediment basins shall be used to settle and filter out sediment from eroding areas to protect properties and streams below the construction site.

Straw Bale Filters - Straw bale filters shall be used to trap sediment from areas of limited runoff. Bales are temporary and shall be removed when permanent measures are installed.

Waterways - Waterways shall be used for the safe disposal of runoff from fields, diversions and other structures or measures.

4. CHEMICAL POLLUTION

The Contractor shall provide watertight tanks or barrels or construct a sump sealed with plastic sheets to be used to dispose of chemical pollutants (such as drained lubricating or transmission oils, greases, soaps, asphalt, etc.) produced as a by-product of the project's work. At the completion of the construction work, sumps shall be voided without causing pollution as specified in Section 8 of this specification.

Sanitary facilities such as pit toilets, chemical toilets, or septic tanks shall not be placed adjacent to live streams, wells, or springs. They shall be located at a distance sufficient to prevent contamination of any water sources. At the completion of construction work, facilities shall be disposed of without causing pollution as specified in Section 8 of this specification.

5. AIR POLLUTION

Local and state regulations concerning the burning of brush or slash or disposal of other materials shall be adhered to.

Fire prevention measures shall be taken to prevent the start or the spreading of fires which result from project work. Fire breaks or guards shall be constructed at locations shown on the drawings.

All public access or haul roads used by the contractor during construction of the project shall be sprinkled or otherwise treated to fully suppress dust.

6. MAINTENANCE, REMOVAL, AND RESTORATION

All pollution control measures and works shall be adequately maintained in a functional condition as long as needed during the construction operation. All temporary measures shall be removed and the site restored to as nearly original conditions as practicable.

7. MEASUREMENT AND PAYMENT

Compensation for any item of work described in the contract but not listed in the bid schedule will be included in the payment for the item of work to which it is made subsidiary. Such items, and the items to which they are made subsidiary, are identified in Section 8 of this specification.

8. ITEMS OF WORK AND CONSTRUCTION DETAILS

Items of work to be performed in conformance with this specification and the construction details are:

a. Subsidiary items. Pollution Control

(1) This item consists of all work required to control or reduce pollution.

(2) The contractor is required to adhere to all applicable local, State and Federal laws and regulations pertaining to the control of pollution as may result from construction of this project. These laws and regulations include but are not limited to:

(a) The "Policy on construction and related activities in water" adopted April 13, 1977, by the Water Quality Control Council of Arizona.

(b) The Clean Air Act (42 U.S.C. 1857 et seq. as amended by Pub. L. 91-604) Section 114, and Section 308 of the Federal Water Pollution Control Act (33 U.S.C. 1251 et seq. as amended by Pub. L. 92-500) relating to inspection, monitoring, entry, reports, and information as well as the other requirement of these sections.

(3) The Contractor is responsible for maintaining air, water, and vegetative quality within the work area. Methods include:

(a) Establishing turn areas, haul roads, work site access road, temporary building sites, equipment yards, etc., in approved locations, and staging earthwork activities to prevent contamination of air and water, to minimize destruction of existing vegetation, and to minimize erosion.

(b) Operating mechanized equipment at the job site in a manner that will avoid destruction or removal of trees and shrubs other than as necessary for construction of the measure.

(4) Under Section 2, Materials, there are no material specifications.

(5) In Section 3, Erosion and Sediment Control Measures and Works, the Contractor shall provide a plan for approval by the Contracting Officer prior to the notice to proceed being issued for the following:

(a) Staging of Earthwork Activities.

(b) Diversions.

(6) In section 4, Chemical Pollution, prior to the completion of the job the Contractor shall provide a plan, for approval by the Contracting Officer, to void sump areas and dispose of sanitary facilities as applicable.

(7) In section 7, Measurement and Payment, no separate payment will be made for this item. Compensation for this work will be included in the payment for Bid Item 1, Structure Removal.

CONSTRUCTION SPECIFICATION

7. CONSTRUCTION SURVEYS FOR LAYOUT, CONTROL AND MEASUREMENT

1. SCOPE

The work shall consist of performing: (1) all specified surveys for layout of work and construction controls, and (2) quantity surveys and computations for progress payment estimates. It includes furnishing all necessary equipment, personnel and material to perform the surveys required by the methods specified.

2. EQUIPMENT AND MATERIALS

Equipment for construction surveys shall be of a quality and condition to provide the required accuracy. The equipment shall be maintained in good working order and in proper adjustment at all times. Records of calibration tests, accuracy checks and adjustments shall be maintained and be available for inspection by the Contracting Officer.

Materials include all the necessary field notebooks, stakes, templates, platforms, equipment, spikes, steel pins, tools, and all other items necessary to perform the work specified.

3. QUALITY OF WORK

All work shall follow recognized professional practice and the standards of the industry unless otherwise specified in Section 9. The work shall be performed to the accuracy and detail appropriate for the type of job. Notes, sketches, and other data shall be complete, recorded neatly, legible, reproducible and organized in a manner that will allow reproduction of copies for job documentation.

All computations shall be mathematically correct. Computations shall include information to identify the bid item, date, and who performed, checked and approved the computations. Computations shall be legible, complete and clearly document the source of all information used including assumptions and measurements made.

If a computer program is used to perform the computations, the contractor shall provide the contracting officer with the software identification, venders name, version number, and other pertinent data prior to beginning survey work. Computer generated computations shall show all input data including values assigned and assumptions made.

The elevations of permanent and temporary bench marks shall be determined and recorded to the nearest 0.01 foot. Differential leveling and transit traverses shall be of such precision that the error of vertical closure in feet shall not exceed plus or minus 0.1

times the square root of the traverse distance in miles. Linear measurements shall be accurate to within 1.0 foot in 5000 feet, unless otherwise specified in Section 9. The angular error of closure for transit traverses shall not exceed 1.0 minute times the square root of the number of angles turned.

Slope stakes shall be placed, as a minimum; at 100 foot stations, breaks in the original ground surface and at any other intermediate stations necessary to insure accurate location for construction layout and measurement. Slope stakes and cross sections shall be perpendicular to the centerline. Significant breaks in grade shall be determined for cross sections. Distances shall be measured horizontally and recorded to the nearest 0.1 foot. Side shots for interim construction stakes may be taken with a hand level.

Unless otherwise specified in Section 9, measurement for stationing and establishing the location of structures shall be made to the nearest 0.1 of a foot.

Elevations for concrete work, pipes and mechanical equipment shall be determined and recorded to the nearest 0.01 foot. Elevations for earth work shall be determined and recorded to the nearest 0.1 foot.

4. PRIMARY CONTROL

The baselines and bench marks for primary control, necessary to establish lines and grades needed for construction, are shown on the drawings and have been located on the job site.

These baselines and bench marks shall be used as the origin of all surveys, layouts and measurements to establish construction lines and grades. The Contractor shall take all necessary precautions to prevent the loss or damage of primary control points.

5. CONSTRUCTION SURVEYS

Prior to commencement of work requiring contractor performed surveys, the Contractor shall submit in writing to the Contracting Officer for approval the name, qualifications and experience of the individuals to be assigned to the job.

Contractor performed surveys shall consist of the work necessary for: (1) establishing line and grade for all work, (2) setting slope stakes for all work, (3) checking and any supplemental or interim staking, (4) establishing final grade stakes, (5) performing quantity surveys, measurements and computations for progress payment and (6) other surveys as described in Section 9.

6. STAKING

Prior to the commencement of work on any item the construction staking required for that item shall be completed. Construction staking shall be completed as follows, or as otherwise specified in Section 9:

a. Clearing and grubbing - the boundary of the clearing and grubbing areas shall be staked or flagged at 200 foot intervals, or closer if needed, to clearly mark the limits of work.

b. Excavation and fill - slope stakes shall be placed at the intersection of the specified slopes and ground line. Slope stakes or the reference stakes for slopes shall be marked with the stationing, required cut, slope ratio and horizontal distance. Offset reference stakes and hubs shall be placed, as a minimum, at 100 foot stations, and shall be placed on at least one side of specified excavations and on both sides of specified fills.

c. Structures - centerline and offset reference line stakes for location, alignment and elevation shall be placed for all structures.

7. RECORDS

All survey data shall be recorded in fully identified, standard hard-bound engineering survey field notebooks with consecutively numbered pages. All field notes and printed data shall include the purpose or description of the work, the date the work was performed, weather data, sketches and the personnel who performed and checked the work. Electronically generated survey data and computations shall be bound, page numbered and cross referenced in a bound field notebook containing the index for all survey data.

The construction survey records shall be available at all times during the progress of the work for examination and use by the Contracting Officer and copies shall be made available to the Contracting Officer upon request. The original field notebooks and other records shall be turned over to and become the property of the Contracting Officer prior to final acceptance of the work.

Complete documentation of computations and supporting data for progress payments shall be submitted to the Contracting Officer with each invoice for payment as specified in Section 9.

8. MEASUREMENT AND PAYMENT

Compensation for any item of work described in the contract but not listed in the bid schedule will be included in the payment for the item of work to which it is made subsidiary. Such items and the item to which they are made subsidiary are identified in Section 9 of this specification.

9. ITEMS OF WORK AND CONSTRUCTION DETAILS

Items of work to be performed in conformance with this specification and the construction details are:

a. Subsidiary Item, Surveys

(1) This item consists of furnishing personnel, equipment, materials and performing surveys required to construct the Powerline Floodway Repair.

(2) In Section 5 "other surveys" shall include those required for computation of final quantities and preparation of as-built drawings.

(3) The Contractor shall provide the Government Representative at the beginning of each work week a schedule of surveys to be performed that week.

(4) Base lines and bench marks for primary control are located on the south side of the floodway.

(5) Any primary control monuments damaged or destroyed by the Contractor due to negligence will be replaced by the Government at the Contractor's expense. The actual cost to the Government for replacing the primary control monuments will be deducted from payments due the Contractor or as determined by the Contracting Officer.

(6) All entries shall be consistent with Soil Conservation Service TR-62, "Engineering Layout, Notes, Staking and Calculations".

(7) In Section 3, Quality of Work, third paragraph, it is not necessary to submit the software etc., prior to beginning survey work.

(8) In Section 8, Measurement and Payment, no separate payment will be made for surveys. Compensation for this item will be included in Bid Item 3, Concrete Channel Lining.

CONSTRUCTION SPECIFICATION

8. MOBILIZATION

1. SCOPE

The work shall consist of the mobilization of the Contractor's forces and equipment necessary for performing the work required under the contract. Mobilization will not be considered as work in fulfilling the contract requirement for commencement of work.

Mobilization shall include the cost for transportation of personnel, equipment, and operating supplies to the site; establishment of offices, buildings, and other necessary facilities at the site not covered in specific bid items, and other preparatory work at the site. The cost of the entire amount of premiums paid for performance and payment bonds, including coinsurance and reinsurance agreements as applicable shall be paid upon request when evidence of full payment to the surety has been provided to the Contracting Officer.

Work done under this specification shall not include mobilization for any specific item of work for which payment for mobilization is provided elsewhere in the contract.

The specification covers mobilization for work required by the contract at the time of award. If additional mobilization costs are incurred during performance of the contract as a result of changed or added items of work for which the Contractor is entitled to an adjustment in contract price, compensation for such costs will be included in the price adjustment for the item or items of work changed or added.

2. PAYMENT

Payment will be made as the work proceeds, after presentation of invoices by the Contractor showing his own mobilization costs and evidence of the charges of suppliers, subcontractors, and others for mobilization work performed by them. If the total of such payments is less than the contract lump sum for mobilization, the unpaid balance will be included in the final contract payment. Total payment will be the lump sum contract price for mobilization, regardless of actual cost to the Contractor.

Payment will not be made under this item for the purchase costs of materials having a residual value, the purchase costs of materials to be incorporated in the project, or the purchase costs of operating supplies.

Payment of the lump sum contract price for mobilization will constitute full compensation for all labor, materials, equipment, and all other items necessary and incidental to completion of the work.

3. ITEMS OF WORK AND CONSTRUCTION DETAILS

Item of work to be performed in accordance with this specification and the construction details are:

a. Bid Item 2, Mobilization

(1) This Item consists of the mobilization of the Contractor's equipment and forces for the repair of the Powerline Floodway.

CONSTRUCTION SPECIFICATION

10. WATER FOR CONSTRUCTION

1. SCOPE

The work shall consist of furnishing, transporting, and using water for construction purposes in accordance with the applicable specifications.

2. FACILITIES AND EQUIPMENT

The Contractor shall build and maintain such access and haul roads as are needed, and shall furnish, operate, and maintain all pumps, piping, tanks, and other facilities needed to load, transport, and use the water as specified.

These facilities shall be equipped with meters, tanks, or other devices by which the volume of water supplied can be measured.

3. DUST ABATEMENT AND HAUL ROAD MAINTENANCE

Water for dust abatement and haul road maintenance shall be applied to haul roads and other dust-producing areas as needed to prevent excessive dust and to maintain the roads in good condition for efficient operation while they are in use.

4. EARTHFILL, DRAINFILL, ROCKFILL

Water for earthfill, drainfill, or rockfill shall be used in the fill materials as specified in the applicable construction specifications.

5. CONCRETE, MORTAR, GROUT

Water used in mixing or curing concrete, pneumatically applied mortar, or other portland cement mortar or grout shall meet the requirements of the applicable construction specifications and shall be used in conformance with those specifications. Payment for water used in these items is covered by the applicable concrete, mortar or grout specification.

6. MEASUREMENT AND PAYMENT

For water items for which specific unit prices are established in the contract, the volume of water furnished and used in accordance with the specifications will be measured to the nearest 1000 gallons.

Except as otherwise specified, the measurement for payment will include all water needed at the construction site, except as noted in Section 5, to perform the work required under the contract in accordance with the specifications but will not include water wasted or used in excess of the amount needed. It will not include water used in concrete which is mixed elsewhere and transported to the site.

Payment for water will be made at the contract unit price. Such payment will constitute full compensation for all labor, materials, equipment, and all other items necessary and incidental to furnishing, transporting, and using the water.

7. ITEMS OF WORK AND CONSTRUCTION DETAILS

Items of work to performed in conformance with this specification and the construction details are:

a. Subsidiary Item, Water

(1) This item consists of furnishing, transporting and applying all water necessary for performance of the work as described in this contract.

(2) In Section 6, Measurement and Payment, no separate payment will be made for this item. Compensation for this work will be included in the payment for Bid Item 3, Concrete Channel Lining; and Bid Item 9, Crack Repair.

CONSTRUCTION SPECIFICATION

11. REMOVAL OF WATER

1. SCOPE

The work shall consist of the removal of surface water and ground water as needed to perform the required construction in accordance with the specifications. It shall include (1) building and maintaining all necessary temporary impounding works, channels, and diversions, (2) furnishing, installing and operating all necessary pumps, piping and other facilities and equipment, and (3) removing all such temporary works and equipment after they have served their purposes.

2. DIVERTING SURFACE WATER

The Contractor shall build, maintain and operate all cofferdams, channels, flumes, sumps, and other temporary diversion and protective works needed to divert streamflow and other surface water through or around the construction site and away from the construction work while construction is in progress. Unless otherwise specified, a diversion must discharge into the same natural drainageway in which its headworks are located.

Unless otherwise specified, the Contractor shall furnish to the Contracting Officer, in writing, his plan for diverting surface water before beginning the construction work for which the diversion is required. Acceptance of this plan will not relieve the Contractor of responsibility for completing the work as specified.

3. DEWATERING THE CONSTRUCTION SITE

Foundations, cutoff trenches and other parts of the construction site shall be dewatered and kept free of standing water or excessively muddy conditions as needed for proper execution of the construction work. The Contractor shall furnish, install, operate and maintain all drains, sumps, pumps, casings, wellpoints, and other equipment needed to perform the dewatering as specified. Dewatering methods that cause a loss of fines from foundation areas will not be permitted.

Unless otherwise specified, the Contractor shall furnish to the Contracting Officer, in writing, his plan for dewatering before beginning the construction work for which the dewatering is required. Acceptance of this plan will not relieve the Contractor of responsibility for completing the work as specified.

4. DEWATERING BORROW AREAS

Unless otherwise specified in Section 8, the Contractor shall maintain the borrow areas in drainable condition or otherwise provide for

timely and effective removal of surface and ground waters that accumulate within the borrow areas from any source. Borrow material shall be processed as necessary to achieve proper and uniform moisture content for placement.

If pumping to dewater borrow areas is included as an item of work in the bid schedule, each pump used for this purpose shall be equipped with a water meter in the discharge line. Accuracy of the meters shall be such that the measured quantity of water is within 3 percent, plus or minus, of the true quantity. Means shall be provided by the Contractor to check the accuracy of the water meters when requested by the Contracting Officer.

5. EROSION AND POLLUTION CONTROL

Removal of water from the construction site, including the borrow areas shall be accomplished in such a manner that erosion and the transmission of sediment and other pollutants are minimized.

6. REMOVAL OF TEMPORARY WORKS

After the temporary works have served their purposes, the Contractor shall remove them or level and grade them to the extent required to present a sightly appearance and to prevent any obstruction of the flow of water or any other interference with the operation of or access to the permanent works.

Except as otherwise specified, pipes and casings shall be removed from temporary wells and the wells shall be filled to ground level with gravel or other material approved by the Contracting Officer.

7. MEASUREMENT AND PAYMENT

Compensation for any item of work described in the contract but not listed in the bid schedule will be included in the payment for the item of work to which it is made subsidiary. Such items and the items to which they are made subsidiary are identified in Section 8 of this specification.

8. ITEMS OF WORK AND CONSTRUCTION DETAILS

Items of work to be performed in conformance with this specification and the construction details are:

a. Subsidiary Item, Removal of Water

1. This item consists of the removal or diverting of surface water from the construction areas shown on the drawings.

2. In Section 2, Diverting Surface Water, no plan for diverting water is required. However, Contractor shall be responsible to pass flows through or around the work areas.

3. In Section 7, Measurement and Payment, no separate payment will be made for the Removal of Water. Compensation for this work will be included in the payment for Bid Item 3, Concrete Channel Lining.

CONSTRUCTION SPECIFICATION

21. EXCAVATION

1. SCOPE

The work shall consist of the excavation required by the drawings and specifications and disposal of the excavated materials.

2. CLASSIFICATION

Excavation will be classified as common excavation or rock excavation in accordance with the following definitions or will be designated as unclassified.

Common excavation shall be defined as the excavation of all materials that can be excavated, transported, and unloaded by the use of heavy ripping equipment and wheel tractor-scrapers with pusher tractors or that can be excavated and dumped into place or loaded onto hauling equipment by means of excavators having a rated capacity of one cubic yard and equipped with attachments (such as shovel, bucket, backhoe, dragline or clam shell) appropriate to the character of the materials and the site conditions.

Rock excavation shall be defined as the excavation of all hard, compacted or cemented materials the accomplishment of which requires blasting or the use of excavators larger than defined for common excavation. The excavation and removal of isolated boulders or rock fragments larger than one cubic yard in volume encountered in materials otherwise conforming to the definition of common excavation shall be classified as rock excavation.

Excavation will be classified according to the above definitions by the Engineer, based on his judgment of the character of the materials and the site conditions.

The presence of isolated boulders or rock fragments larger than one cubic yard in size will not in itself be sufficient cause to change the classification of the surrounding material.

For the purpose of this classification, the following definitions shall apply:

Heavy ripping equipment shall be defined as a rear-mounted, heavy duty, single-tooth, ripping attachment mounted on a tractor having a power rating of 200-300 net horsepower (at the flywheel).

Wheel tractor-scraper shall be defined as a self-loading (not elevating) and unloading scraper having a struck bowl capacity of 12-20 yards.

Pusher tractor shall be defined as a track type tractor having a power rating of 200-300 net horsepower (at the flywheel) equipped with appropriate attachments.

3. UNCLASSIFIED EXCAVATION

Items designated as "Unclassified Excavation" shall include all materials encountered regardless of their nature or the manner in which they are removed. When excavation is unclassified, none of the definitions or classifications stated in Section 2 of this specification shall apply.

4. BLASTING

The transportation, handling, storage, and use of dynamite and other explosives shall be directed and supervised by a person of proven experience and ability in blasting operations.

Blasting shall be done in such a way as to prevent damage to the work or unnecessary fracturing of the foundation and shall conform to any special requirements in Section 12 of this specification.

5. USE OF EXCAVATED MATERIALS

To the extent they are needed, all suitable materials from the specified excavations shall be used in the construction of required permanent earthfill or rockfill. The suitability of materials for specific purposes will be determined by the Engineer. The Contractor shall not waste or otherwise dispose of suitable excavated materials.

6. DISPOSAL OF WASTE MATERIAL

All surplus or unsuitable excavated materials will be designated as waste and shall be disposed of by the Contractor at sites of his own choosing away from the site of the work.

7. BRACING AND SHORING

Excavated surfaces too steep to be safe and stable if unsupported shall be supported as necessary to safeguard the work and workmen, to prevent sliding or settling of the adjacent ground, and to avoid damaging existing improvements. The width of the excavation shall be increased if necessary to provide space for sheeting, bracing, shoring, and other supporting installations. The Contractor shall furnish, place and subsequently remove such supporting installations.

8. STRUCTURE AND TRENCH EXCAVATION

Structure or trench excavation shall be completed to the specified elevations and to sufficient length and width to include allowance for forms, bracing and supports, as necessary, before any concrete or earthfill is placed or any piles are driven within the limits of the excavation.

9. BORROW EXCAVATION

When the quantities of suitable materials obtained from specified excavations are insufficient to construct the specified fills, additional materials shall be obtained from the designated borrow areas. The extent and depth of borrow pits within the limits of the designated borrow areas shall be as directed by the Engineer.

Borrow pits shall be excavated and finally dressed in a manner to eliminate steep or unstable side slopes or other hazardous or unsightly conditions.

10. OVEREXCAVATION

Excavation in rock beyond the specified lines and grades shall be corrected by filling the resulting voids with portland cement concrete made of materials and mix proportions approved by the Engineer. Concrete that will be exposed to the atmosphere when construction is completed shall contain not less than 6 sacks of cement per cubic yard of concrete. Concrete that will be permanently covered shall contain not less than 4-1/2 sacks of cement per cubic yard. The concrete shall be placed and cured as specified by the Engineer.

Excavation in earth beyond the specified lines and grades shall be corrected by filling the resulting voids with approved compacted earthfill, except that, if the earth is to become the subgrade for riprap, rockfill, sand or gravel bedding, or drainfill, the voids may be filled with material conforming to the specifications for the riprap, rockfill, bedding or drainfill.

11. MEASUREMENT AND PAYMENT

For items of work for which specific unit prices are established in the contract, the volume of each type and class of excavation within the specified pay limits will be measured and computed to the nearest cubic yard by the method of average cross-sectional end areas. Regardless of quantities excavated, the measurement for payment will be made to the specified pay limits, except that excavation outside the specified lines and grades directed by the Engineer to remove unsuitable material will be included. Excavation required because unsuitable conditions result from the Contractor's improper construction operations, as determined by the Contracting Officer, will not be included for measurement and payment.

Compensation for any item of work described in the contract but not listed in the bid schedule will be included in the payment for the item of work to which it is made subsidiary. Such items and the items to which they are made subsidiary are identified in Section 12 of this specification.

12. ITEMS OF WORK AND CONSTRUCTION DETAILS

Items of work to be performed in conformance with this specification and the construction details are:

a. Subsidiary Item, Channel Excavation

1. This item consists of all excavation required to construct the concrete channel repair sections, and berms as shown on the drawings.

2. Suitable channel excavation and berm excavated material shall be utilized to reconstruct the channel subgrade and berms adjacent to the sides of the channel, as approved by the Engineer.

3. No separate payment will be made for channel excavation. Compensation for this item will be included in Bid Item 3, Concrete Channel Lining.

b. Subsidiary Item, Borrow Excavation, Common

1. This item consists of all excavation required for obtaining fill material.

2. If existing channel subgrade materials are insufficient to prepare the subgrade to the design elevations, borrow material shall be obtained at the location shown on the drawings.

3. In Section 9, Borrow Excavation, no separate payment will be made for this item. Compensation for Borrow Excavation will be included in Bid Item 3, Concrete Channel Lining.

CONSTRUCTION SPECIFICATION

23. EARTHFILL

1. SCOPE

The work shall consist of the construction of earth embankments and other earthfills required by the drawings and specifications.

2. MATERIALS

All fill materials shall be obtained from required excavations and designated borrow areas. The selection, blending, routing and disposition of materials in the various fills shall be subject to approval by the Engineer.

Fill materials shall contain no sod, brush, roots or other perishable materials. Rock particles larger than the maximum size specified for each type of fill shall be removed prior to compaction of the fill.

The types of materials used in the various fills shall be as listed and described in the specifications and drawings.

3. FOUNDATION PREPARATION

Foundations for earthfill shall be stripped to remove vegetation and other unsuitable materials or shall be excavated as specified.

Except as otherwise specified, earth foundation surfaces shall be graded to remove surface irregularities and shall be scarified parallel to the axis of the fill or otherwise acceptably scored and loosened to a minimum depth of 2 inches. The moisture content of the loosened material shall be controlled as specified for the earthfill, and the surface materials of the foundation shall be compacted and bonded with the first layer of earthfill as specified for subsequent layers of earthfill.

Earth abutment surfaces shall be free of loose, uncompacted earth in excess of two inches in depth normal to the slope and shall be at such a moisture content that the earthfill can be compacted against them to effect a good bond between the fill and the abutments.

Rock foundation and abutment surfaces shall be cleared of all loose materials by hand or other effective means and shall be free of standing water when fill is placed upon them. Occasional rock outcrops in earth foundations for earthfill, except in dams and other structures designed to restrain the movement of water, shall not require special treatment if they do not interfere with compaction of the foundation and initial layers of the fill or the bond between the foundation and the fill.

Foundation and abutment surfaces shall be not steeper than 1 horizontal to 1 vertical unless otherwise specified. Test pits or other cavities shall be filled with compacted earthfill conforming to the specifications for the earthfill to be placed upon the foundation.

4. PLACEMENT

Fill shall not be placed until the required excavation and foundation preparation have been completed and the foundation has been inspected and approved by the Engineer. Fill shall not be placed upon a frozen surface, nor shall snow, ice, or frozen material be incorporated in the fill.

Fill shall be placed in approximately horizontal layers. The thickness of each layer before compaction shall not exceed the maximum thickness specified. Materials placed by dumping in piles or windrows shall be spread uniformly to not more than the specified thickness before being compacted. Hand compacted fill, including fill compacted by manually directed power tampers, shall be placed in layers whose thickness before compaction does not exceed the maximum thickness specified for layers of fill compacted by manually directed power tampers.

Adjacent to structures, fill shall be placed in a manner which will prevent damage to the structures and will allow the structures to assume the loads from the fill gradually and uniformly. The height of the fill adjacent to a structure shall be increased at approximately the same rate on all sides of the structure.

Earthfill in dams, levees and other structures designed to restrain the movement of water shall be placed so as to meet the following additional requirements:

a. The distribution of materials throughout each zone shall be essentially uniform, and the fill shall be free from lenses, pockets, streaks or layers of material differing substantially in texture, moisture content, or gradation from the surrounding material.

b. If the surface of any layer becomes too hard and smooth for proper bond with the succeeding layer, it shall be scarified parallel to the axis of the fill to a depth of not less than 2 inches before the next layer is placed.

c. The top surfaces of embankments shall be maintained approximately level during construction, except that a crown or cross-slope of approximately 2 percent shall be maintained to insure effective drainage, and except as otherwise specified for drainfill or sectional zones.

d. Dam embankments shall be constructed in continuous layers from abutment to abutment except where openings to facilitate construction or to allow the passage of stream flow during construction are specifically authorized in the contract.

e. Embankments built at different levels as described under (c) or (d) above shall be constructed so that the slope of the bonding surfaces between embankment in place and embankment to be placed is not steeper than 3 feet horizontal to 1 foot vertical. The bonding surface of the embankment in place shall be stripped of all material not meeting the requirements of this specification, and shall be scarified, moistened and recompacted when the new fill is placed against it as needed to insure a good bond with the new fill and to obtain the specified moisture content and density at the contact of the in place and new fills.

5. CONTROL OF MOISTURE CONTENT

During placement and compaction of fill, the moisture content of the materials being placed shall be maintained within the specified range.

The application of water to the fill materials shall be accomplished at the borrow areas insofar as practicable. Water may be applied by sprinkling the materials after placement on the fill, if necessary. Uniform moisture distribution shall be obtained by disking.

Material that is too wet when deposited on the fill shall either be removed or be dried to the specified moisture content prior to compaction.

If the top surface of the preceding layer of compacted fill or a foundation or abutment surface in the zone of contact with the fill becomes too dry to permit suitable bond it shall either be removed or scarified and moistened by sprinkling to an acceptable moisture content prior to placement of the next layer of fill.

6. COMPACTION

Earthfill shall be compacted according to the following requirements for the class of compaction specified:

Class A compaction. Each layer of fill shall be compacted as necessary to make the density of the fill matrix not less than the minimum density specified. The fill matrix is defined as the portion of the fill material finer than the maximum particle size used in the compaction test method specified.

Class B compaction. Each layer of fill shall be compacted to a mass density not less than the minimum density specified.

Class C compaction. Each layer of fill shall be compacted by the specified number of passes of the type and weight of roller or other equipment specified, or by an approved equivalent method. Each pass shall consist of at least one passage of the roller wheel or drum over the entire surface of the layer.

Fill adjacent to structures shall be compacted to a density equivalent to that of the surrounding fill by means of hand tamping or manually directed power tampers or plate vibrators. Unless otherwise specified, heavy equipment including backhoe mounted powertampers, or vibrating compactors and manually directed vibrating rollers, shall not be operated within 2 feet of any structure. Towed or self-propelled vibrating rollers shall not be operated within 5 feet of any structure. Compaction by means of drop weights operating from a crane or hoist will not be permitted.

The passage of heavy equipment will not be allowed: (1) over cast-in-place conduits prior to 14 days after placement of the concrete; (2) over cradled or bedded precast conduits prior to 7 days after placement of the concrete cradle or bedding; or (3) over any type of conduit until the backfill has been placed above the top surface of the structure to a height equal to one-half the clear span width of the structure or pipe or 2 feet, whichever is greater.

Compacting of fill adjacent to structures shall not be started until the concrete has attained the strength specified in Section 10 for this purpose. The strength will be determined by compression testing of test cylinders cast by the Engineer for this purpose and cured at the work site in the manner specified in ASTM Method C 31 for determining when a structure may be put into service.

When the required strength of the concrete is not specified as described above, compaction of fill adjacent to structures shall not be started until the following time intervals have elapsed after placement of the concrete.

Structure	Time Interval
Retaining walls and counterforts (impact basins)	14 days
Walls backfilled on both sides simultaneously	7 days
Conduits and spillway risers, cast-in-place (with inside forms in place)	7 days
Conduits and spillway risers, cast-in-place (inside forms removed)	14 days

Conduits, precast, cradled	2 days
Conduits, precast, bedded	1 day
Cantilever outlet bents (backfilled both sides simultaneously)	3 days

7. REWORKING OR REMOVAL AND REPLACEMENT OF DEFECTIVE FILL

Fill placed at densities lower than the specified minimum density or at moisture contents outside the specified acceptable range of moisture content or otherwise not conforming to the requirements of the specifications shall be reworked to meet the requirements or removed and replaced by acceptable fill. The replacement fill and the foundation, abutment and fill surfaces upon which it is placed shall conform to all requirements of this specification for foundation preparation, approval, placement, moisture control and compaction.

8. TESTING

During the course of the work, the Engineer will perform such tests as are required to identify materials, to determine compaction characteristics, to determine moisture content, and to determine density of fill in place. These tests performed by the Engineer will be used to verify that the fills conform to the requirements of the specifications. Such tests are not intended to provide the Contractor with the information required by him for the proper execution of the work and their performance shall not relieve the Contractor of the necessity to perform tests for that purpose.

Densities of fill requiring Class A compaction will be determined by the Engineer in accordance with ASTM Method D 1556, D 2167, D 2922 or D 2937 except that the volume and moist weight of included rock particles larger than those used in the compaction test method specified for the type of fill will be determined and deducted from the volume and moist weight of the total sample prior to computation of density or if using the nuclear gauge, added to the specified density to bring it to the measure of equivalent composition for comparison. The density so computed will be used to determine the percent compaction of the fill matrix. Unless otherwise specified, moisture content will be determined by one of the following methods: ASTM Method D 2216 or D 3017.

9. MEASUREMENT AND PAYMENT

Compensation for any item of work described in the contract but not listed in the bid schedule will be included in the payment for the item of work to which it is made subsidiary. Such items and the items to which they are made subsidiary are identified in Section 10 of this specification.

10. ITEMS OF WORK AND CONSTRUCTION DETAILS

Items of work to be performed in conformance with this specification and construction details are:

a. Subsidiary Item, Earthfill

1. This item consists of placing and compacting all earthfill required to:

   (a) Regrade the operation and maintenance roads and berms disturbed by the construction operations.

   (b) Repair the channel lining subgrade in areas where the channel lining has been removed as shown on the drawings.

2. Excess soil materials removed from the channel subgrade shall be spread uniformly on the adjacent O&M roads and graded to blend into the existing grades.

3. The maximum rock size placed shall be two (2) inches.

4. In areas of subgrade that require earthfill, the maximum thickness of a layer prior to compaction shall be six (6) inches.

5. Section 6, Compaction, Class C, shall apply. Each layer of fill shall be compacted with a minimum of three (3) complete passes over the entire surface area using vibratory plates or tampers having a minimum rated capacity of 2,400 pounds per blow or vibratory rollers which weigh a minimum of 1,000 pounds.

6. The fill material shall contain sufficient moisture such that when a small portion is taken in the hand and squeezed, it remains intact when released and does not leave free water on the palm of the hand.

7. In Section 4, Placement, the first sentence in the second paragraph will not apply to the side slopes of channel. Compaction on the slope will be permitted in this area.

8. In Section 9, Measurement and Payment, no separate payment will be made for this item. Compensation for this work will be included in Bid Item 3, Concrete Channel Lining.

CONSTRUCTION SPECIFICATION

31. CONCRETE

1. SCOPE

The work shall consist of furnishing, forming, placing, finishing and curing portland cement concrete as required to build the structures designated in Section 26 of this specification.

2. MATERIALS

Portland cement shall conform to the requirements of Material Specification 531 for the specified type. One brand only of any type of cement shall be used in any single structure as defined in Section 26.

Aggregates shall conform to the requirements of Material Specification 522 unless otherwise specified. The grading of coarse aggregates shall be as specified in Section 26.

Water used in mixing or curing concrete shall be clean and free from injurious amounts of oil, salt, acid, alkali, organic matter or other deleterious substances.

Air entraining admixtures shall conform to the requirements of Material Specification 532. If air-entraining cement is used, any additional air-entraining admixture shall be of the same type as that in the cement.

Pozzolan shall conform to ASTM C 618, Class F except the loss of ignition shall not exceed 3.0 percent.

Water-reducing, set-retarding admixture shall conform to the requirements of Material Specification 533.

Shear plates shall conform to the requirements of Material Specification 581 for structural quality or commercial or merchant quality steel. Structural quality shall be used if specifically designated in the drawings or specifications.

Preformed expansion joint filler shall conform to the requirements of Material Specification 535.

Waterstops shall conform to the requirements of Material Specifications 537 and 538 for the specified kinds.

Curing compound shall conform to the requirement of Material Specification 534.

3. CLASSES OF CONCRETE

Method 1 Concrete shall be classified according to the required compressive strength. The strength of the concrete at 28 days shall equal or exceed the Minimum Compressive Strength at 28 days tabulated below for the class of concrete specified.

Class of concrete	Minimum Compressive Strength at 28 days (psi)
5000	5000
4000	4000
3000	3000
2500	2500

Method 2 Concrete shall be classified as follows:

Class of Concrete	Water Content (gallons/bag)	Cement Content (bag/cu. yd)
5000X	5	7
4000X	6	6
3000X	7	5
2500X	8	4-1/2

4. AIR CONTENT AND CONSISTENCY

Unless otherwise specified the air content (by volume) of the concrete at the time of placement shall be:

Maximum Size Aggregate	Air Content (%)
3/8 inch to 1/2 inch	6 to 9
Over 1/2 inch to 1 inch	5 to 8
Over 1 inch to 2-1/2 inches	4 to 7

The consistency of the concrete shall be such as to allow it to be worked into place without segregation or excessive laitance. Unless otherwise specified, the slump shall be:

Type of Structure	Slump (inches)
Massive sections, pavements, footings	2 ± 1/2
Heavy beams, thick slabs, thick walls (over 12 in.)	3 ± 1/2
Columns, light beams, thin slabs, thin walls (12 in. or less)	4 ± 1

5. DESIGN OF THE CONCRETE MIX

The Contractor will be responsible for the design of the concrete mixtures. At least 5 days prior to any placement of concrete he shall furnish the Contracting Officer a statement of the materials and mix proportion (including admixtures, if any) he intends to use for each specified class of concrete. The statement shall include evidence satisfactory to the Contracting Officer that the materials and proportions selected will produce concrete of the quality, consistency and strength specified.

The materials and proportions so stated shall constitute the "job mix". After a job mix has been designated, neither the source, character or grading of the aggregates nor the type or brand or quantity of cement or admixture shall be changed without prior notice to the Contracting Officer and establishment of a new job mix supported by evidence, as required for the initial job mix, that the proposed new materials and mix proportions will produce concrete of the quality, consistency, and strength specified.

When specified, a water-reducing, set-retarding admixture shall be used. When conditions are such that the temperature of the concrete at the time of placement is consistently above 75oF, a water-reducing, set-retarding admixture may be used, at the option of the Contractor. The cement content shall be the same as that required in the mix without the admixture.

The use of calcium chloride or other accelerators or antifreeze compounds will not be allowed.

Before placing concrete containing a water-reducing, set-retarding admixture, the Contractor shall furnish test results satisfactory to the Contracting Officer showing that its performance in the job mix meets the requirements of Material Specifications 533, Section 4. When specified, mixes that include fly ash as a partial substitution for portland cement shall be based on absolute volume with a maximum substitution of 20 percent.

6. INSPECTING AND TESTING

During the course of the work, the Engineer will perform such tests as are required to assure the concrete meets the contract requirements. Tests performed by the Engineer are not for the purpose of providing the Contractor with the information required for proper work execution and performance and shall not relieve the Contractor of the necessity to perform tests for that purpose.

The following tests will be performed by the methods indicated:

Test	Method (ASTM Designation)
Sampling	C 172 1/
Slump Test	C 143 1/
Air Content	C 231 1/ or C 173 1/
Compression Test Specimens	C 31 1/, C 42, or C684 2/
Compressive Strength	C 39 2/ or C 42
Unit Weight	C 138

1/ Test of a portion of a batch may be made on samples representative of that portion for any of the following purposes:

(1) Determining uniformity of the batch.

(2) Checking compliance with requirements for slump and air content when the batch is discharged over an extended period of time.

(3) Checking compliance of the concrete with the specifications when the whole amount being placed in a small structure, or a distinct portion of a larger structure, is less than full batch.

2/ For each strength test of specimens made according to ASTM Designation C 39 or C 684, three (3) standard test specimens shall be made. The test result shall be the average of the strength of the three (3) specimens, except that if one (1) specimen in the test shows manifest evidence of improper sampling, molding or testing, it shall be discarded and the strengths of the remaining two (2) specimens shall be averaged. Should more than one (1) specimen representing a test show such defects, the entire test shall be discarded.

The Engineer shall have free entry to the plant and equipment furnishing concrete under the contract. Proper facilities shall be provided for the Engineer to inspect materials, equipment and processes, to obtain samples of the concrete. All tests and inspections will be conducted so as not to interfere unnecessarily with the manufacture and delivery of the concrete.

7. HANDLING AND MEASUREMENT OF MATERIALS

Aggregates shall be stored or stockpiled in such a manner that separation of coarse and fine particles of each size will be avoided and that various sizes will not become intermixed before proportioning. Methods of handling and transporting aggregates shall be such as to avoid contamination, excessive breakage, segregation or degradation, or intermingling of various sizes.

Scales for weighing aggregates and cement shall be beam type or springless dial type. They shall be accurate within 1 percent under operating conditions. All exposed fulcrums, clevises and similar working parts of scales shall be kept clean.

The quantities of cement and aggregates in each batch of concrete, as indicated by the scales, shall be within the following percentage of the required batch weights:

Cement	plus or minus 1.0 percent
Aggregates	plus or minus 2.0 percent

Measuring tanks for mixing water shall be of adequate capacity to furnish the maximum amount of mixing water required per batch and shall be equipped with outside taps and valves to provide for checking their calibration unless other means are provided for readily and accurately determining the amount of water in the tank.

Except as otherwise provided in Section 8, cement and aggregates shall be measured as follows:

Cement shall be measured by weight or in bags of 94 lbs. each. When cement is measured by weight, it shall be weighed on a scale separate from that used for other materials, and in a hopper entirely free and independent of the hopper used for weighing the aggregates. When cement is measured in bags, no fraction of a bag shall be used unless weighed.

Aggregates shall be measured by weight. Mix proportions shall be based on saturated, surface-dry weights. The batch weight of each aggregate shall be the required saturated, surface-dry weight corrected by the weight of surface moisture it contains.

Mixing water shall consist of water added to the batch ice added to the batch, water occurring as surface moisture on the aggregates and water introduced in the form of admixtures. The added water shall be measured by weight or volume to an accuracy of 1 percent of the required total mixing water. Added ice shall be measured by weight. Wash water shall not be used as a portion of the mixing water for succeeding batches.

Dry admixtures shall be measured by weight, and paste or liquid admixtures by weight or volume, within a limit of accuracy of 3 percent.

8. MIXERS AND MIXING

Mixers and mixing shall be in accordance with recommended standards set forth in ACI 304, some specific interpretations of which are stated below.

Concrete may be furnished by batch mixing at the site of the work or by ready-mix methods.

Mixers shall be capable of thoroughly mixing the concrete ingredients into a uniform mass within the specified mixing time and of discharging the mix without segregation. Each mixer or agitator shall bear a manufacturer's rating plate indicating the rated capacity and

recommended speeds of rotation, and shall be operated in accordance with these recommendations.

Concrete shall be uniform and thoroughly mixed when delivered to the forms. Variations in slump of more than 1 inch within a batch will be considered evidence of inadequate mixing and shall be corrected by changing batching procedures, increasing mixing time, changing mixers or other means. Mixing time shall be within the limits specified below unless the Contractor demonstrates by mixer performance tests that adequate uniformity is obtained by different times of mixing. No mixing water in excess of the amount called for by the job mix shall be added to the concrete during mixing or hauling or after arrival at the delivery point. If less water than the design maximum water-cement ratio has been incorporated in the batch, water to compensate for up to a one (1) inch loss in slump may be added, up to the design maximum water cement ratio. Withholding some of the mixing water until the concrete arrives on the job, then adding the remaining water and turning the mixer 30 revolutions at mixing speed may overcome transporting conditions. When loss of slump or workability cannot be offset by these measures, complete mixing shall be performed on the job using centrally dry batched materials, or by on site batching and mixing.

Batch mixing at the site. For concrete mixed at the site of the work with paving mixers or stationary construction mixers, the time of mixing after all cement and aggregates are in the mixer drum shall be not less than 1-1/2 minutes. The batch shall be so charged into the mixer that some water will enter in advance of the cement and aggregates and all mixing water shall be introduced into the drum before one-fourth of the mixing time has elapsed.

Controls shall be provided to insure that the batch cannot be discharged until the required time has elapsed.

If truck mixers are used, the requirements below for truck mixers and truck-mixed concrete shall apply.

Volumetric batching and continuous mixing at the site. Unless otherwise specified, volumetric batching and continuous mixing at the construction site will be permitted. The batching and mixing equipment shall conform to the requirements of ASTM Specification C 685 and shall be demonstrated prior to placement of concrete, by tests with the job mix, to produce concrete meeting the specified proportioning and uniformity requirements. Concrete made by this

method shall be produced, inspected, and documented in conformance with Sections 6, 7, 8, 13, and 14 of ASTM Specification C 685.

Ready-mixed concrete. Ready-mixed concrete shall be mixed and delivered to the site of the work by one of the following methods:

a. Truck-mixed concrete--Mixed completely in a truck mixer.

b. Shrink-mixed concrete--Mixed partially in a stationary mixer, and the mixing completed in a truck mixer.

c. Central-mixed concrete--completely in a stationary mixer and the mixed concrete transported to the point of delivery in a truck agitator or in a truck mixer operating at agitating speed or in nonagitating equipment.

Truck mixers and agitators shall be equipped with revolution counters by which the number of revolutions of the drum or blades may be readily verified.

When ready mixed concrete is furnished, the Contractor shall furnish the Engineer a statement-of-delivery ticket showing the time of loading, the revolution counter reading at the time of loading and the quantities of materials used for each load of concrete.

Truck mixed concrete. When concrete is mixed in a truck mixer loaded to its maximum capacity, the number of revolutions of the drum or blades at mixing speed shall be not less than 70 nor more than 100. If the batch is at least 1/2 cubic yard less than maximum capacity, the number of revolutions at mixing speed may be reduced to not less than 50. Mixing in excess of 100 revolutions shall be at the speed designated by the manufacturer of the equipment as agitating speed. The mixing operation shall begin within 30 minutes after the cement has been added to the aggregates and the water shall be added during mixing. When mixing is begun during or immediately after charging, a portion of the mixing water shall be added ahead of, or with, the other ingredients.

Shrinked-mixed concrete. When concrete is partially mixed at a central plant and the mixing is completed in a truck mixer, the mixing time in the central plant mixer shall be the minimum required to intermingle the ingredients and shall be not less than 30 seconds. The mixing shall be completed in a truck mixer and the number of revolutions of the drum or blades at mixing speed shall be not less than 50 nor more than 100. Mixing in excess of 100 revolutions shall be at the speed designated by the manufacturer of the equipment as agitating speed.

Central-mixed concrete. For central-mixed concrete, mixing in the stationary mixer shall meet the same requirements as batch mixing at the site.

When an agitator, or truck mixer used as an agitator, transports concrete that has been completely mixed in a stationary mixer, mixing during transportation shall be at the speed designated by the manufacturer of the equipment as agitating speed.

The use of nonagitating equipment to transport concrete to the site of the work will be permitted only if the consistency and uniformity of

the concrete as discharged at the point of delivery meet the requirements of this specification. Bodies of nonagitating hauling equipment shall be so constructed that leakage of the concrete mix, or any part thereof will not occur. Concrete hauled in open-top vehicles shall be protected from rain, and from more than 20 minutes exposure to the sun when the air temperature is above 75oF.

9. FORMS

Forms shall be of wood, plywood, steel or other approved material and shall be mortar tight. The forms and associated falsework shall be substantial and unyielding and shall be constructed so that the finished concrete will conform to the specified dimensions and contours. Form surfaces shall be smooth and free from holes, dents, sags or other irregularities. Forms shall be coated with a nonstaining form release agent before being set into place. Metal ties or anchorages within the forms shall be equipped with cones, she-bolts or other devices that permit their removal to a depth of at least one inch without injury to the concrete. Ties designed to break off below the surface of the concrete shall not be used without cones.

All edges that will be exposed shall be chamfered, unless finished with molding tools as specified in Section 20.

10. PREPARATION OF FORMS AND SUBGRADE

Prior to placement of concrete the forms and subgrade shall be free of chips, sawdust, debris, water, ice, snow, extraneous oil, mortar, or other harmful substances or coatings. Any form release agent on the reinforcing steel or other surfaces required to be bonded to the concrete shall be removed.

Rock surfaces shall be cleaned by air-water cutting, wet sandblasting or wire brush scrubbing, as necessary, and shall be wetted immediately prior to placement of concrete. Earth surfaces shall be firm and damp. Placement of concrete on mud, dried earth, uncompacted fill or frozen subgrade will not be permitted. All ice, snow and frost shall be removed and the temperature of all surfaces to be in contact with the new concrete shall be no colder than 40oF.

Items to be embedded in the concrete shall be positioned accurately and anchored firmly.

Weepholes in walls or slabs shall be formed with nonferrous materials.

11. CONVEYING

Concrete shall be delivered to the site and discharged into the forms within 1-1/2 hours after the introduction of the cement to the

aggregates. In hot weather or under conditions contributing to quick stiffening of the concrete, or when the temperature of the concrete is 85oF or above, the time between the introduction of the cement to the aggregates and discharge shall not exceed 45 minutes.

The Engineer may allow a longer time, provided the setting time of the concrete is increased a corresponding amount by the addition of an approved set-retarding admixture. In any case, concrete shall be conveyed from the mixer to the forms as rapidly as practicable, by methods that will prevent segregation of the aggregates or loss of mortar.

12. PLACING

Concrete shall not be placed until the subgrade, forms and steel reinforcement have been inspected and approved.

The Contractor shall have all equipment and materials required for curing available at the site ready for use before placement of concrete begins.

No concrete shall be placed except in the presence of the Engineer. The Contractor shall give reasonable notice to the Engineer each time he intends to place concrete. Such notice shall be far enough in advance to give the Engineer adequate time to inspect the subgrade, forms, steel reinforcement and other preparations for compliance with specifications. Other preparations include but are not limited to the concrete batching plant, mixing and delivery equipment and system, placing and finishing equipment and system, schedule of work, work force and heating or cooling facilities as applicable. All deficiencies are to be corrected before concrete is delivered for placing.

The concrete shall be deposited as closely as possible to its final position in the forms and shall be worked into the corners and angles of the forms and around all reinforcement and embedded items in a manner to prevent segregation of aggregates or excessive laitance. The depositing of concrete shall be regulated so that the concrete can be consolidated with a minimum of lateral movement.

Concrete shall not be dropped more than 5 feet vertically unless suitable equipment is used to prevent segregation.

13. LAYERS

Unless otherwise specified, slab concrete shall be placed to design thickness in one continuous layer. Formed concrete shall be placed in horizontal layers not more than 20 inches thick. Hoppers and chutes,

pipes or "elephant trunks" shall be used as necessary to prevent splashing of mortar on the forms and reinforcing steel above the layer being placed.

Successive layers shall be placed at a fast enough rate to prevent the formation of "cold joints". If the surface of a layer of concrete in place sets to the degree that it will not flow and merge with the succeeding layer when vibrated, the Contractor shall discontinue placing concrete and shall make a construction joint according to the procedure specified in Section 15.

If placing is discontinued when an incomplete layer is in place, the unfinished end of the layer shall be formed by a vertical bulkhead.

14. CONSOLIDATING

Unless otherwise specified, concrete shall be consolidated with internal type mechanical vibrators capable of transmitting vibration to the concrete at frequencies not less than 6000 impulses per minute. The location, manner and duration of the application of the vibrators shall be such as to secure maximum consolidation of the concrete without causing segregation of the mortar and coarse aggregate, and without causing water or cement paste to flush to the surface. The Contractor shall provide a sufficient number of vibrators to properly consolidate the concrete immediately after it is placed in the work. Vibration shall be applied to the freshly deposited concrete by slowly inserting and removing the vibrator at points uniformly spaced and not farther apart than twice the radius over which the vibration is visibly effective. The vibrator shall extend into the previously placed layer of fresh concrete, at all points, to insure effective bond between layers.

Vibration shall not be applied directly to the reinforcement steel or the forms nor to concrete that has hardened to the degree that it does not become plastic when vibrated.

The use of vibrators to transport concrete in the forms or conveying equipment will not be permitted.

Vibration shall be supplemented by spading and hand tamping as necessary to insure smooth and dense concrete along form surfaces, in corners and around embedded items.

15. CONSTRUCTION JOINTS

Construction joints shall be made at the locations shown on the drawings. If construction joints are needed which are not shown on the drawings, they shall be placed in locations approved by the Engineer. Where a feather edge would be produced at a construction joint, as in the top surface of a sloping wall, an insert form shall be used so that the resulting edge thickness on either side of the joint is not less than 6 inches.

In walls and columns as each lift is completed, the top surfaces shall be immediately and carefully protected from any condition that might adversely affect the hardening of the concrete.

Steel tying and form construction adjacent to concrete in place shall not be started until the concrete has cured at least 12 hours. Before new concrete is deposited on or against concrete that has hardened, the forms shall be retightened. New concrete shall not be placed until the hardened concrete has cured at least 12 hours.

Method 1 Surfaces of construction joints shall be cleaned of all unsatisfactory concrete, laitance, coatings, stains or debris by either sandblasting after the concrete has gained sufficient strength to resist excessive cutting, or air-water cutting as soon as the concrete has hardened sufficiently to prevent the jet from displacing the coarse aggregates, or both. The surface of the concrete in place shall be cut to expose clean, sound aggregate but not so deep as to undercut the edges of larger particles of the aggregate. After cutting, the surface shall be thoroughly washed to remove all loose material. If the surface is congested by reinforcing steel, is relatively inaccessible, or it is considered undesirable to disturb the concrete before it is hardened, cleaning of the joint by air-waterjets will not be permitted and the wet sandblasting method will be required after the concrete has hardened.

The surfaces shall be kept moist for at least one hour prior to placement of new concrete. The new concrete shall be placed directly on the cleaned and washed surface.

Method 2 Surfaces of construction joints shall be cleaned of all unsatisfactory concrete, laitance, coatings, stains, or debris by washing and scrubbing with a wire brush or wire broom or by other means approved by the Engineer. The surfaces shall be kept moist for at least one hour prior to placement of new concrete. The new concrete shall be placed directly on the cleaned and washed surface.

16. EXPANSION AND CONTRACTION JOINTS

Expansion and contraction joints shall be made only at locations shown on the drawings.

Exposed concrete edges at expansion and contraction joints shall be carefully tooled or chamfered, and the joints shall be free of mortar and concrete. Joint filler shall be left exposed for its full length with clean and true edges.

When open joints or weakened plane "dummy" joints are specified, the joints shall be constructed by the insertion and subsequent removal of a wood strip, metal plate or other suitable template in such a manner that the corners of the concrete will not be chipped or broken. The edges of the concrete at the joints shall be finished with an edging tool prior to removal of the joint strips.

Preformed expansion joint filler shall be held firmly in the correct position as the concrete is placed.

17. WATERSTOPS

Waterstops shall be held firmly in the correct position as the concrete is placed. Joints in metal waterstops shall be brazed or welded. Joints in rubber or plastic waterstops shall be cemented, welded or vulcanized as recommended by the manufacturer.

18. REMOVAL OF FORMS

Forms shall be removed only when the Engineer is present and shall not be removed without his approval. Forms shall be removed in such a way as to prevent damage to the concrete. Supports shall be removed in a manner that will permit the concrete to take the stresses due to its own weight uniformly and gradually.

Method 1 Forms shall not be removed sooner than the following minimum times after the concrete is placed. These periods represent cumulative number of days and fractions of days, not necessarily consecutive, during which the temperature of the air adjacent to the concrete is above 50oF.

Element	Time
Beams, arches - supporting forms and shoring	14 days
Conduits, deck slabs - supporting (inside) forms and shoring	7 days
Conduits (outside forms), sides of beams, small structures	24 hours
Columns, walls, spillway riser - with side or vertical load	7 days

Columns, walls, spillway riser - with no side or vertical load:	
Concrete supporting more than 30 feet of wall in place above it	7 days
Concrete supporting 20 to 30 feet of wall in place above it1/	3 days
Concrete supporting not more than 20 feet of wall in place above it1/	24 hours

1/ Age of stripped concrete shall be at least 7 days before any load is applied other than the weight of the column or wall, forms and scaffolds for succeeding lifts.

Method 2 Forms, supports and housings shall not be removed until the concrete has attained the strength specified in Section 26 for this purpose. The strength will be determined by compression testing of test cylinders cast by the Engineer for this purpose and cured at the work site in the manner specified in ASTM Method C 31 for determining form removal time.

19. FINISHING FORMED SURFACES

All concrete surfaces shall be true and even, and shall be free from open or rough spaces, depressions or projections.
Immediately after the removal of forms:

All bulges, fins, form marks or other irregularities which in the judgment of the Engineer will adversely affect the appearance or the function of the structure shall be removed. All form bolts and ties shall be removed to a depth at least 1 inch below the surface of the concrete. The cavities produced by form ties and all other holes of similar size and depth shall be thoroughly cleaned and, after the interior surfaces have been kept continuously wet for at least 3 hours, shall be carefully packed with a dry patching mortar mixed not richer than 1 part cement to 3 parts sand. Patching mortar shall be mixed in advance and allowed to stand without addition of water until it has reached the stiffest consistency that will permit placing. Manipulation of the mortar with a trowel during this period shall be performed as required to insure the proper consistency.

Holes left by form bolts or straps which pass through the wall shall be filled solid with mortar.

Patching mortar shall be thoroughly compacted into place to form a dense, well-bonded unit, and the in-place mortar shall be sound and free from shrinkage cracks.

All repaired areas shall be cured as specified in Section 21.

20. FINISHING UNFORMED SURFACES

All exposed surfaces of the concrete shall be accurately screeded to grade and then float finished, unless specified otherwise. After placing and consolidating the concrete, all exposed surfaces shall be accurately struck off to grade. Following strike-off, the surfaces shall be immediately smoothed by darbying or bull floating before any free water has bled to the surface. The concrete will then be allowed to rest until the bleed water and water sheen has left the surface and the concrete has stiffened to where it will sustain foot pressure with only about 1/4 inch (6mm) indentation. At this time all joints and edges that will be exposed to view that are not chamfered shall be finished with edging and/or molding tools. After edging and hand-jointing is complete, all exposed surfaces shall be floated with wood or magnesium floats. The floating should work the concrete no more than necessary to remove screed, edger and jointer marks and produce a compact surface, uniform in texture.

Joints and edges on unformed surfaces shall be chamfered or finished with molding tools.

21. CURING

Concrete shall be cured in accordance with the recommended practice of ACI 308, of which some specific interpretations are set forth below. Concrete shall be prevented from drying for a period of at least 7 days after it is placed. Exposed surfaces and concrete formed in absorptive wood forms shall be kept continually wet during the entire curing period or until the forms have been removed. After forms have been removed, the exposed surface shall be kept continuously wet until patching and repair are complete and until the curing period is completed or until a curing compound is applied.

Moisture can be maintained by sprinkling, flooding or fog spraying or by covering with continuously moistened canvas, cloth mats, straw, sand and/or approved material. Water and/or covering shall be applied in such a way that the concrete surface is not eroded or otherwise damaged.

Except as otherwise specified in Section 26, curing compound may be used for exposed surfaces or formed surfaces after patching and repair have been completed. Unless otherwise specified, the curing compound shall be white pigmented and conform to ASTM C 309 Type 2, Class A or B. If surface coatings are to be applied to concrete where curing compound is used, Type 2, Class B shall be used and allowed to age a minimum of 30 days prior to the application of the coating. Clear curing compound (Type 1) or clear with fugitive dye (Type 1-D) may be used only when specified in Section 26.

Curing compound shall be thoroughly mixed before applying and agitated during application. It shall be applied using a continuously agitating pressure sprayer at a uniform rate of not less than one

gallon per 150 square feet of surface. It shall form a uniform continuous, adherent film that shall not check, crack or peel and shall be free from pinholes or other imperfections.
All surfaces covered with curing compound shall be continuously protected from damage to the protective film during the required curing period.

Surfaces subjected to heavy rainfall or running water within 3 hours after the compound has been applied, or surfaces damaged by subsequent construction operations during the curing period shall be resprayed in the same manner as for the original application.

Unless otherwise specified in Section 26, curing compound shall not be applied to construction joints or other areas that are to receive additional concrete, paint or other material that require a positive bond.

Water for curing shall be clean and free from any substances that will cause discoloration of the concrete.

22. REMOVAL, REPLACEMENT OR REPAIR

When concrete is honeycombed, damaged or otherwise defective, the Contractor shall remove and replace the structure or structural member containing the defective concrete, or correct or repair the defective parts. The Contracting Officer will determine the required extent of removal, replacement or repair and advise the Contractor, in writing, of this determination.

Prior to starting repair work the Contractor shall obtain the Contracting Officer's approval of his plan for making the repair. The appropriate methods described in Chapter VII of the Concrete Manual, Bureau of Reclamation, U.S. Department of the Interior, shall be used as the primary reference for repairs. If approved in writing by the Contracting Officer, proprietary compounds for adhesion or as patching ingredients may be used. Such compounds shall be used in accordance with the manufacturer's recommendations.

Approval of the Contractor's repair plan shall not be considered a waiver of the Contracting Officer's right to require complete removal of defective work if the completed repair does not produce concrete of the required quality and appearance.

Repair work shall be performed only when the Engineer is present. Repair of formed surfaces shall be started within 24 hours after removal of the forms.

Curing as specified in Section 21 shall be applied to repaired areas immediately after the repairs are completed.

23. CONCRETING IN COLD WEATHER

Concreting in cold weather shall be performed in accordance with ACI 306 Recommend Practice for Cold Weather Concreting, of which some specific interpretations are set forth below.

When the atmospheric temperature may be expected to drop below 40oF at the time concrete is delivered to the work site, during placement, or at any time during the curing period, the following provisions also shall apply:

a. The temperature of the concrete at time of placing shall not be less than 50oF nor more than 90oF. The temperature of neither aggregates nor mixing water shall be more than 140oF just prior to mixing with the cement.

b. When the minimum daily atmosphere temperature is less than 40oF,concrete structures shall be insulated or housed and heated after placement. The temperature of the concrete and air adjacent to the concrete shall be maintained at not less than 50oF nor more than 90oF for the duration of the curing period.

c. Methods of insulating, housing and heating the structure shall conform to "Recommended Practice for Cold Weather Concreting," ACI Standard 306.

d. When dry heat is used to protect concrete, means of maintaining an ambient humidity of at least 40 percent shall be provided unless the concrete has been coated with curing compound as specified in Section 21 or is covered tightly with an approved impervious material.

24. CONCRETING IN HOT WEATHER

Concreting in Hot Weather shall be in accordance with the recommended practice of ACI 305, of which some specific interpretations are set forth below.

For the purpose of the specification hot weather is defined as any combination of high temperature, low relative humidity and wind velocity tending to impair the quality of fresh or hardened concrete or otherwise resulting in abnormal properties.

When climatic or other conditions are such that the temperature of the concrete may reasonably be expected to exceed 90oF at the time of delivery at the work site, during placement, or during the first 24 hours after placement, the following provisions shall apply:

a. The Contractor shall maintain the temperature of the concrete below 90oF during mixing, conveying, and placing.

b. The concrete shall be placed in the work immediately after mixing. Truck mixing shall be delayed only until time enough remains to accomplish it before the concrete is placed.

c. Exposed concrete surfaces which tend to dry or set too rapidly shall be continuously moistened by means of fog sprays or other means to maintain adequate moisture during the time between placement and finishing, and after finishing.

d. Finishing of slabs and other exposed surfaces shall be started as soon as the condition of the concrete allows and shall be completed without delay.

e. Formed surfaces shall be kept completely and continuously wet for the duration of curing period (prior to, during and after form removal) or until curing compound is applied as specified in subsection g, below.

f. Concrete surfaces, especially flat work placed with large areas of surface, shall be covered as soon as the concrete has sufficiently hardened and shall be kept continuously wet for at least 24 hours of the curing period. This protective method may be continued for the required curing period or until curing compound as specified in (g) below is applied.

g. Moist curing may be discontinued before the end of the curing period if white pigmented curing compound is applied immediately, following the procedures specified in Section 21.

h. In extreme conditions it may be necessary to (1) restrict placement to late afternoon or evening (2) restrict the depth of layers to assure coverage of the previous layer while it will still respond readily to vibration, (3) suspend placement until conditions improve, and (4) remove forms, repair, patch and reapply wet curing by small areas at a time.

25. MEASUREMENT AND PAYMENT

For items of work for which specific unit prices are established in the contract, concrete will be measured to the neat lines or pay limits shown on the drawings, and the volume of concrete will be computed to the nearest 0.1 cubic yard. No deduction in volume will be made for chamfers, rounded or beveled edges, or for any void or embedded item that is less than five cubic feet in volume. Where concrete is placed against the sides or bottom of an excavation without intervening forms, drainfill, or bedding, the volume of concrete required to fill voids resulting from overexcavation outside the neat lines or pay limits will be included in the measurement for payment where such overexcavation is directed by the Engineer to remove unsuitable foundation material; but only to the extent that the

unsuitable condition is not a result of the Contractor's improper construction operations, as determined by the Contracting Officer.

Payment for each item of concrete will be made at the contract unit price for that item. The payment for concrete will constitute full compensation for all labor, materials, equipment, transportation, tools, forms, falsework, bracing and all other items necessary and incidental to completion of the concrete work, such as joint fillers, waterstops, dowels or other assemblies, and shear plates, but not including reinforcing steel or other items listed for payment elsewhere in the contract.

Measurement and payment for furnishing and placing reinforcing steel will be made as specified in Construction Specification 34.

Compensation for any item of work described in the contract but not listed in the bid schedule will be included in the payment for the item of work to which it is make subsidiary. Such items and the items to which they are made subsidiary are identified in Section 26 of this specification.

26. ITEMS OF WORK AND CONSTRUCTION DETAILS

Items of work to be performed in conformance with this specification and the construction details are:

a. Bid Item 3, Concrete Channel Lining

1. This item consists of furnishing, forming and placing all concrete to repair the floodway as shown on the drawings.

2. In Section 2, Materials, the materials shall be as follows:

(a) Portland Cement shall be Type II or IIA.

(b) Preformed expansion joint filler shall be a sponge rubber material conforming to Material Specification 535 and ASTM D 1752, Type I.

(c) The joint sealing compound shall be Type S, Grade NS, use Use T or NT, low modulus silicone conforming to the requirements of ASTM C 920 and shall tolerate submergence by intermittent flood flows. The sealant shall have the capability to withstand without failure an increase of 50 percent and a decrease of 50 percent of the joint width as measured at the time of application when tested in accordance with ASTM C 719. The elongation shall be a minimum of 800 percent without failure when tested in accordance with ASTM D 412, and 500 percent without adhesion failure when tested in accordance with ASTM C 719.

adding clause 50 cement mortar only

? adding clause 500

(d) A bond breaking material shall be compatible with the sealant and conform to the sealant manufacturers requirements. The sealant manufacturers technical representative shall be present during initial installation to insure that the requirements of this specification and the manufacturers specified surface preparation, application and handling techniques are being used by the Contractor.

Bond breaker material shall be adequate to support the sealant until fully cured.

3. Section 3, Classes of Concrete, Method 1 shall apply and the concrete shall be Class 4000.

4. Coarse aggregate shall be size No. 57 in accordance with ASTM C33.

5. In Section 18, Removal of Forms, Method 1 shall apply.

6. Pozzolan shall be used as a partial substitute for portland cement.

7. In Section 15, Construction Joints, Method 1 shall apply.

8. Sealant installation and cleaning shall be in accordance with Construction Specification 400, Section 3, Joint Sealant for Concrete Lined Floodways.

9. All plant roots will be removed from joints.

10. In Section 25, Measurement and Payment, payment will include compensation for Subsidiary Items: Removal of water; Channel Excavation; Borrow Excavation, Common; Earthfill; Construction Surveys for Layout, Control and Measurement.

CONSTRUCTION SPECIFICATION

34. STEEL REINFORCEMENT

1. SCOPE

The work shall consist of furnishing and placing steel reinforcement for reinforced concrete or pneumatically applied mortar.

2. MATERIALS

Steel reinforcement shall conform to the requirements of Material Specification 539. Before reinforcement is placed, the surfaces of the bars and fabric and any metal supports shall be cleaned to remove any loose, flaky rust, mill scale, oil, grease or other coatings or foreign substances. After placement, the reinforcement shall be maintained in a clean condition until it is completely embedded in the concrete.

3. BAR SCHEDULE, LISTS AND DIAGRAMS

Any supplemental bar schedules, bar lists or bar-bending diagrams required to accomplish the fabrication and placement of reinforcement shall be provided by the Contractor. Prior to placement of reinforcement, the Contractor shall furnish four prints or copies of any such lists or diagrams to the Contracting Officer. Acceptance of the reinforcement will not be based on approval of these lists or diagrams but will be based on inspection of the reinforcement after it has been placed.

4. BENDING

Reinforcement shall be cut and bent in compliance with the requirements of the American Concrete Institute Standard 315. Bars shall not be bent or straightened in a manner that will injure the material. Bars with kinks, cracks or improper bends will be rejected.

5. SPLICING BAR REINFORCEMENT

Splices of reinforcement shall be made only at locations shown on the drawings and provided by the steel schedule. Placement of bars at the lap splice locations shown, when not in contact, shall not be farther apart than one-fifth the shown lap length and in any case no greater than 6 inches.

6. SPLICING WELDED WIRE FABRIC

Unless otherwise specified, welded wire fabric shall be spliced in the

following manner:

a. Adjacent sections shall be spliced end to end (longitudinal lap) by overlapping a minimum of one full mesh plus 2 inches plus the length of the two end overhangs. The splice length is measured from the end of the longitudinal wires in one piece of fabric to the end of the longitudinal wires in the lapped piece of fabric.

b. Adjacent sections shall be spliced side to side (transverse lap) a minimum of one full mesh plus 2 inches. The splice length shall be measured from the centerline of the first longitudinal wire in one piece of fabric to the centerline of the first longitudinal wire in the lapped piece of fabric.

7. PLACING

Reinforcement shall be accurately placed and secured in position in a manner that will prevent its displacement during the placement of concrete. Tack welding of bars will not be permitted. Metal chairs, metal hangers, metal spacers and concrete chairs may be used to support the reinforcement. Metal hangers, spacers and ties shall be placed in such a manner that they will not be exposed in the finished concrete surface. The legs of metal chairs or side form spacers that may be exposed on any face of slabs, walls, beams or other concrete surfaces shall have a protective coating or finish by means of hot dip galvanizing, epoxy coating, plastic coating, or be stainless steel. Metal chairs and spacers not fully covered by a protective coating or finish shall have a minimum cover of 3/4 inch of concrete over the unprotected metal portion except for those with plastic coatings may have a minimum cover of 1/2 inch of concrete over the unprotected metal portion. Precast concrete chairs shall be manufactured of the same class of concrete as that specified for the structure and shall have tie wires securely anchored in the chair or a V-shaped groove at least 3/4 inch in depth molded into the upper surface to receive the steel bar at the point of support. Precast concrete chairs shall be moist at the time concrete is placed.

High density or structural plastic rebar accessories, designed to insure maximum concrete bond, may be substituted for metal or concrete accessories in spacer applications as approved by the Contracting Officer. Exposure of plastic rebar accessories at the finished concrete surface shall be kept to a minimum. Plastic rebar accessories, if used, shall be staggered along adjacent parallel bars and shall be placed at intervals no closer than 12 inches. Plastic rebar accessories shall not be used in concrete sections 6 inches or less in thickness.

Reinforcement shall not be placed until the prepared site has been inspected and approved by the Engineer. After placement of the

reinforcement, concrete shall not be placed until the reinforcement has been inspected and approved by the Engineer.

8. STORAGE

Steel reinforcement stored at the work site shall be placed above the ground surface on platforms, skids or other supports and protected from mechanical damage or corrosion.

9. MEASUREMENT AND PAYMENT

For items of work for which specific unit prices are established in the contract, the weight of bar reinforcement placed in the concrete in accordance with the drawings will be determined to the nearest pound by computation from the placing drawings. Measurement of hooks and bends will be based on the requirements of ACI Standard 315. Computation of weights of bar reinforcement will be based on the unit weights established in Table 34-1. The weight of steel reinforcing in extra splices or extra length splices approved for the convenience of the Contractor or the weight of supports and ties will not be included in the measurement for payment.

The area of welded wire fabric reinforcement placed in the concrete in accordance with the drawings will be determined to the nearest square foot by computation from the placing drawings with no allowance for laps.

Payment for furnishing and placing bar reinforcing steel will be made at the contract unit price for bar reinforcement. Payment for furnishing and placing welded wire fabric reinforcing steel will be made at the contract unit price for welded wire fabric reinforcement. Such payment will constitute full compensation for all labor, materials, equipment and all other items necessary and incidental to the completion of the work including preparing and furnishing bar schedules, lists or diagrams; furnishing and attaching ties and supports; and furnishing, transporting, cutting, bending, cleaning, and securing all reinforcement.

Compensation for any item of work described in the contract but not listed in the bid schedule will be included in the payment for the item of work to which it is made subsidiary. Such items to which they are made subsidiary are identified in Section 10 of this specification.

TABLE 34-1. STANDARD REINFORCING BARS

Bar Size No.	Wt. (lb./ft.)
3	0.376
4	0.668
5	1.043
6	1.502
7	2.044
8	2.670
9	3.400
10	4.303
11	5.313
14	7.65
18	13.60

TABLE 34-2. RECTANGULAR WELDED WIRE FABRIC1/

Style Designation By Steel Wire Gauge	Style Designation By W-Number	Weight, lb. Per 100 Sq. Ft.
6 x 6 - 10 x 10	6 x 6 - W1.4 x W1.4	21
6 x 6 - 8 x 8	6 x 6 - W2.1 x W2.1	30
6 x 6 - 6 x 6	6 x 6 - W2.9 x W2.9	42
6 x 6 - 4 x 4	6 x 6 - W4.0 x W4.0	58
4 x 4 - 10 x 10	4 x 4 - W1.4 x W1.4	31
4 x 4 - 8 x 8	4 x 4 - W2.1 x W2.1	44
4 x 4 - 6 x 6	4 x 4 - W2.9 x W2.9	62
4 x 4 - 4 x 4	4 x 4 - W4.0 x W4.0	85
4 x 12 - 8 x 12	4 x 12 - W2.1 x W0.92/	25
4 x 12 - 7 x 11	4 x 12 - W2.5 x W1.12/	31

1/ Style designation is defined in ACI Standard 315 of the American Concrete Institute.

2/ Welded smooth wire fabric with wires smaller than Size W1.4 is manufactured from galvanized wire.

10. ITEMS OF WORK AND CONSTRUCTION DETAILS

Items of work to be performed in conformance with this specification and the construction details are:

a. Bid Item 5, Steel Reinforcement

1. This item consists of furnishing and installing all steel reinforcement required to construct the channel lining as shown on the drawings.

2. All steel bars shall be ASTM A 615 Grade 40 or 60.

CONSTRUCTION SPECIFICATION 94

CONTRACTOR INSPECTION

1. SCOPE

The work shall consist of developing, implementing, and maintaining a quality control system to ensure that the specified quality is achieved for all materials and work performed. The work shall include all equipment, materials, labor and services necessary to implement and maintain the quality control system throughout the duration of the work.

2. EQUIPMENT AND MATERIALS

Equipment and materials for quality control shall be of the quality and condition required to meet the test specifications cited in the contract references. Testing equipment shall be properly adjusted and calibrated at the start of operations and the calibration maintained at the frequency specified. Records of equipment calibration tests shall be available to the Contracting Officer at all times. Where specific requirements exist, equipment shall be operated and maintained by qualified operators. All equipment and materials used in performing quality control testing shall be as prescribed by the test standards referenced in the contract.

Equipment and materials shall be handled and operated in a safe and proper manner complying with all applicable state and federal regulations pertaining to their use, operation, handling and transportation.

3. QUALITY CONTROL SYSTEM

The Contractor shall develop a system of quality control to provide the specified basic material testing and verification of material quality prior to use. The system activities shall include procedures to verify adequacy of completed work, initiate corrective action to be taken and document the final results. A written plan for the system will not be required other than the identification of the quality control personnel and their duties. This identification shall be submitted to the Contracting Officer within 15 calendar days after notice of award.

4. QUALITY CONTROL PERSONNEL

Quality control activities shall be accomplished by qualified personnel. The Contractor shall identify and furnish to the Contracting Officer, for approval, the names, qualifications, experience and availability of all personnel who will perform the quality control ativities.

5. POST-AWARD CONFERENCE

The Contractor shall meet with the Contracting Officer prior to the beginning of any work and discuss the Contractor's quality control system. The Contracting Officer and the Contractor shall develop a mutual understanding regarding the quality control system. The understanding reached will be documented by the Contracting Officer by correspondence to the Contractor.

6. RECORDS

The Contractor's quality control records shall be kept daily and shall document both acceptable and deficient features of the work. All records shall be on forms approved by the Contracting Officer and shall be legible.

Records shall include but are not limited to the following:

a. The material or item tested, or inspection performed.

b. Date and time of tests or inspections.

c. Type and number of quality control activities and tests involved.

d. The location and extent of work inspected or tested.

e. Test results and description of conditions observed during the quality control activities.

f. Method of testing used (e.g., citation of reference specification).

g. Nature of defects, specifications not met, etc.

h. Proposed corrective action, and reason for corrective action.

i. Corrective actions taken and supporting quality control recertification testing.

j. Signature of authorized testing or inspecting official with appropriate checkers verification.

k. Manufacturers' recommendations and certifications if any.

l. Documentation of material delivered including: quantity, location stored, and results of examinations citing applicable construction, material and reference specification.

m. Documentation of shop drawings including: date submitted to and date approved by the Contracting Officer, and results of examinations citing applicable construction, material and reference specifications and construction drawings.

n. Date of the records creation.

7. REPORTING RESULTS

The results of contractor quality control inspections and tests shall be communicated to the Contracting Officer's representative immediately upon completion of the inspection or test.

8. SUBMITTAL OF RECORDS

The original plus, one copy, of records of inspections, tests preformed and material testing reports shall be submitted to the Contracting Officer's representative weekly. The original plus one copy of documentation of materials delivered shall be submitted to the Contracting Officer's representative prior to the use of the material.

9. ACCESS

The Contracting Officer and the Contracting Officer's representatives shall be given free access to all testing equipment, facilities, sites, and related records.

10. MEASUREMENT AND PAYMENT

For items of work for which lump sum prices are established in the contract, payment will be made as the work proceeds, after presentation of invoices by the Contractor showing their costs. If the total of such payments are less than contract lump sum for this item, the unpaid balance will be included in final contract payment. Total payment will be the lump sum contract price for this item, regardless of actual cost to the Contractor.

Payment will not be made under this item for the purchase cost of materials and equipment having a residual value.

Payment of the lump sum contract price for contractor quality control will constitute full compensation for all labor, materials, equipment, transportation, and all other items necessary and incidental to completion of the work.

Compensation for any item of work described in the contract but not listed in the bid schedule will be included in the payment for the item of work to which it is made subsidiary. Such items and the items to which they are made subsidiary are identified in Section 11.

11. ITEMS OF WORK AND CONSTRUCTION DETAILS

Items of work to be performed in conformance with this specification and the construction details are:

a. Bid Item 6, Contractor Inspection

(1) This item shall consist of furnishing the personnel, equipment and material required by the Contractor to perform the testing and inspection that is necessary to implement an inspection system that will ensure the specified quality is being maintained for:

a. Construction Surveys
b. Excavation
c. Earthfill
d. Concrete
e. Steel Reinforcement
f. Pollution Control (Dust)
g. Removal of Water
h. Joint Sealant
i. Crack repair by epoxy injection

(2) In Section 2, EQUIPMENT AND MATERIALS, equipment and materials needed for materials testing shall be calibrated at the specified frequency given in the appropriate materials testing standards. Records of all calibrations shall be submitted to the Engineer within seven (7) days prior to using equipment.

(3) In Section 3, QUALITY CONTROL SYSTEM, the Contractor's Quality Control System shall provide the degree of inspection and testing necessary to ensure that the specified quality is maintained on all work performed.

The Quality Control System shall include inspections and materials testing as follows:

(a) Inspection of construction staking to ensure its accuracy.

(b) Inspection of all excavation to ensure that it is constructed to the lines and grades shown on the drawings.

(c) The moisture density determinations required for the quality control of earthfill shall be performed by the method outlined in Construction Specification 23, Section 10. a. 5 and 6 and by visually observing compaction operations.

d. The placing of steel reinforcement shall be inspected by quality control personnel twelve (12) hours prior to delivery of concrete. A certification that all bars are the correct size and positioned as specified shall be given to the contracting officer.

e. The quality control for joint sealant will involve monitoring by quality control personnel for the proper size, quality, cleanness of cut, and installation of preformed joint material, bond breaker, and joint sealant all according to drawings, specifications, and manufacturers recommendations.

f. The quality control for repairing cracks will involve monitoring by quality control personnel for adequate cleaning of cracks, and that proper preparation, application, and handling techniques of the epoxy injection gel are applied according to manufacturer's recommendations and contract specifications.

g. The quality control for concrete will involve testing for strength, slump, temperature, and air entrainment. The test frequency shall be one set of tests for each 100 cubic yards, or one test per day, whichever occurs first. Slump and temperature tests will be taken for each truck load of concrete.

(4) The Contractor shall designate an experienced quality control manager and inspection staff whose primary responsibility will be implementing the inspection system. The manager or his/her representative shall be on site during major construction activities and will not be involved in directing production oriented activities unless it pertains to achieving the specified quality for the work being performed. The quality control manager shall be employed by and answerable to the Contractor. The manager's duties cannot be delegated to a subcontractor or others.

CONSTRUCTION SPECIFICATION

400. JOINT SEALANT FOR CONCRETE LINED FLOODWAYS

1. SCOPE

The work shall consist of saw cutting and surface preparation of existing contraction and expansion joints, and placement of preformed joint material, bond breaker material, and joint sealant.

2. MATERIALS

Joint sealer Shall be Type S, Grade NS, use T or NT, low modulus silicone conforming to the requirements of ASTM C 920 and shall tolerate submergence by intermittent flood flows.

The sealant shall have the capability to withstand, without failure, an increase of 50 percent and a decrease of 50 percent of the joint width as measured at the time of application when tested in accordance with ASTM C 719.

The elongation shall be a minimum of 800 percent without failure when tested in accordance with ASTM D-412, and 500 percent without adhesion failure when tested in accordance with ASTM C 719.

Preformed expansion joint filler shall conform to Material Specification 535. The joint filler shall meet ASTM D 1752 requirements for Type I (sponge rubber).

Bond breaker material shall be compatible with the sealant and conform to the sealant manufacturer's requirements. The bond breaker shall be adequate to support the sealant until fully cured.

3. SURFACE PREPARATION AND APPLICATION

The sealant manufacturer's representative shall be present during initial installation to insure that proper surface preparation, application, and handling techniques are being used by the Contractor

Cutting or routing expansion and contraction joints will involve saw cutting or routing as required to attain the width and depth shown on the drawings. Concrete cutting equipment shall be equipped with carbide or diamond blades. All dried laitance and contaminants shall be removed.

Cleaning Each joint face shall be sand-blasted. The sand-blasting nozzle must be held at an angle or fitted with deflectors to direct the sand against the joint face within one or two inches of the pavement. A minimum of one pass shall be made for each joint face.

After sand-blasting, the joint cavity shall be cleaned, removing all sand or other debris that would interfere with joint closure. Just prior to placing preformed joint filler and sealant, the joints shall be air-blasted to remove sand and dust. Air compressors used for sand-blasting and air-blasting shall be equipped with traps to remove moisture and oil from the air. Air-blasting shall be done in one direction only.

The joint shall be considered clean when no residue is evident after rubbing a finger or dark lint free cloth along the cleaned dry joint face. The joint shall be completely clean and air dried, as determined by the Engineer, for a minimum of 24 hours under natural drying conditions, before proceeding with the application of sealant.

Sealant Installation: Bond breaker material shall be placed such that it will prevent adhesion of the sealant with the top surface of the preformed expansion joint filler as shown on the drawings.

Joints must be clean and dry when the sealant is installed. Drying of the joint surfaces may only occur from natural weather conditions.

During the sealant placement the nozzle of the sealant applicator shall be moved steadily along the joint, pushing the sealant ahead to form the required cross section. The minimum and maximum temperature of sealant at installation shall be in accordance with the manufacturer's recommendation. See Section 6 for limiting air temperatures.

Immediately after placement and before a skin forms, the sealant shall be tooled, forcing it onto the bond breaker surface and against the joint faces. The finished tooled surface shall be recessed below the concrete surface as detailed on the drawings. Excess sealant on the concrete surface shall be removed.

4. DELIVERY AND STORAGE

The sealant material shall be delivered in original, tightly sealed containers, clearly labeled with the manufacturer's name, product identification and lot numbers where applicable.

The unopened sealant material shall be stored out of the weather, in original, tightly sealed containers, as recommended by the manufacturer. Storage temperature shall not exceed 90 degrees Fahrenheit.

5. MEASUREMENT AND PAYMENT

For items of work for which specific unit prices are established in the contract, the quantity of repaired joints will be determined to

the nearest lineal foot by measurement of acceptably installed joint repairs along each joint. Payment for joint repair will be made at the contract unit price for the joint specified. Such payment will constitute full compensation for furnishing, transporting, placement and application of all materials; and saw cutting and preparing the concrete joints including labor, tools, equipment, and all other items necessary and incidental to the completion of the work.

Compensation for any item of work described in the contract but not listed in the bid schedule will be included in the payment for the item of work to which it is made subsidiary. Such items and the items to which they are made subsidiary are identified in Section 6 of this specification.

6. ITEMS OF WORK AND CONSTRUCTION DETAILS

Items of work to be performed in conformance with this specification and the construction details are:

a. Bid Item 7, Joint Repair

1. This item consists of saw cutting or routing the existing joints, removing the existing joint filler and sealant where encountered, preparing the joint surfaces, installation of preformed joint filler, bond breaker and placement of the joint sealant.

2. All materials delivered to the site shall conform to the materials called for in the plans and specifications.

3. Cutting or routing the joints and installation of the joint sealant shall be limited to periods when the air temperature at the concrete surface at invert is within the range of 65 degrees Fahrenheit to 100 degrees Fahrenheit.

4. Joint sealant will be placed as shown in the drawings including the flat surfaces at the top of the lining where the top and bottom surfaces come together.

5. The Contractor shall furnish full information showing that each lot of sealant meets the requirements in Section 2, and a letter of assurance from the manufacturer's technical representative stating that the sealant will tolerate submergence by intermittent flood flows typically experienced in the floodway.

CONSTRUCTION SPECIFICATION

402. EPOXY ADHESIVE INJECTION FOR CRACK REPAIR OF CONCRETE LINED FLOODWAY

1. SCOPE

The work shall consist of cleaning and surface preparation of the crack surfaces, and furnishing all materials, tools, equipment, appliances, transportation, labor and supervision to repair cracks by the injection of an epoxy resin adhesive.

2. MATERIALS

A. Epoxy resin adhesive:

1. Component "A" shall be a modified epoxy resin of the eplchlorohydrin bisphenol A Type containing suitable viscosity control agents. It shall not contain butylglycidylether.

2. Component "B" shall be primarily a reaction product of a selected amine blend with an epoxy resin of the epichlorohydrin bisphenol A Type containing suitable viscosity control agents and accelerators.

3. The ratio of Component "A" to Component "B" shall be per manufacturers recommendation.

B. Porting devices for automated application shall be used in conjunction with the pressure injection equipment.

3. SURFACE PREPARATION AND APPLICATION

The epoxy resin adhesive manufacturers representative shall be present during initial installation to insure that proper crack preparation, application, and handling techniques are being used by the Contractor.

Surface preparation will require water or steam blasting all cracks with 6,000 to 10,000 psi pressure or other approved method may be used. All deteriorated loose concrete, dirt, tar, and all bond - inhibiting materials will be removed from the cracks. Repair area may be dry or damp, but free of standing water prior to applying surface seal or injecting gel.

Entry ports shall be provided along the crack at intervals of not less than the thickness of the lining.

Surface seal material used to confine the injection adhesive in the crack during injection shall be applied to the face of the crack between and around the entry ports. Seal material shall have adequate strength before preceeding with injection as recommended by manufacturer.

Equipment for Injection

a. The equipment used to meter and mix the two injection adhesive components and inject the mixed adhesive into the cracks shall be portable, positive displacement type pumps with interlock to provide positive ratio control of exact proportions of the two components at the nozzle.

b. The injection equipment shall have an automatic pressure control capable of discharging the mixed adhesive at any preset pressure up to 160 ±5 psi.

c. The equipment shall have the capability of maintaining the volume ratio for the injection adhesive prescribed by the manufacturer of the adhesive within a tolerance of ± 5 percent by volume at any discharge pressure up to 160 psi.

d. The injection equipment shall be equipped with sensors on both component A and B reservoirs that will automatically stop the machine when only one component is being pumped to the mixing head.

Epoxy Injection

a. Injection of epoxy adhesive shall begin at the lowest port and continue with steady pressure until there is an appearance of epoxy adhesive at the adjacent entry port.

b. When epoxy adhesive travel is indicated by appearance at the next adjacent port, injection shall be discontinued on the entry port being pumped. Epoxy injection shall be continued at the adjacent port where epoxy adhesive has appeared. This procedure will be continued until the entire crack is completely filled.

Finishing

The face of the crack shall be finished flush with the concrete lining surface on each side of the crack.

Curing

Will be accomplished by moist curing with wet burlap or other methods as approved by the Engineer and as recommended by the manufacturer.

4. FIELD QUALITY CONTROL TESTS

a. Pressure tests - The mixing head of the injection equipment shall be disconnected and the two-adhesive component delivery lines shall be attached to the pressure check device. The pressure check device shall consist of two independent valved nozzles capable of controlling flow rate and pressure by adjusting the valve. There shall be a pressure gauge capable of sensing the pressure build-up behind each valve. The valves on the pressure check device shall be closed and the equipment operated until the gauge pressure on each line reads 160 PSI. The pumps shall be stopped and the gauge pressure shall not drop below 150 PSI within three (3) minutes.

b. Ratio test - The mixing head of the injection equipment shall be disconnected and the two adhesive component shall be pumped simultaneously through the ratio check device. The ratio check device shall consist of two independent valved nozzles capable of controlling back pressure by opening or closing the valve. There shall be a pressure gauge capable of sensing the back pressure behind each valve. The discharge pressure shall be adjusted to 160 psi for both adhesive components. Both adhesive components shall be simultaneously discharged in separate calibrated containers. The amounts discharged into the calibrated containers simultaneously during the same time period shall be compared to determine that the volume discharged conforms to the manufacturers recommended ratio for the epoxy resin adhesive.

5. DELIVERY AND STORAGE

The epoxy resin adhesive material shall be delivered to the site in original, tightly sealed containers clearly labeled with the manufacturers name, product identification, date of manufacturer and batch numbers.

The unopened material shall be stored out of the weather, in original tightly sealed containers, and stored at temperatures recommended by the manufacturer.

6. MEASUREMENT AND PAYMENT

For items of work for which specific unit prices are established in the contract, the length of repaired cracks will be measured to the nearest foot for those locations shown on the drawings. Payment will be made at the contract unit price for crack repair. Such payment will constitute full compensation for furnishing, transporting, placement, and application of all materials; and water blasting and preparing the cracks including labor, tools, equipment and all other items necessary and incidental to the completion of the work.

Compensation for any item of work described in the contract but not listed in the bid schedule will be included in the payment for the item of work to which it is made subsidiary. Such items and the items to which they are made subsidiary are identified in Section 7 of this specification.

7. ITEMS OF WORK AND CONSTRUCTION DETAILS

Items of work to be performed in conformance with this specification and the construction details are:

a. Bid Item 9, Crack Repair

1. This item consists of water blasting cracks, removing deteriorated concrete and other sealing compounds in, and in the vicinity of the crack, preparing the crack for injection and furnishing and placement of epoxy resin adhesive as shown on the drawings.

2. Minimum ambient and concrete surface temperatures shall be per manufacturer's recommendation.

3. Minimum and maximum temperatures for storing and conditioning of epoxy resin adhesive before using shall be per manufacturer's recommendation.

4. Ratio of mixing the two components for injection shall be per manufacturer's recommendation.

5. First aid and clean up of spills will be according to manufacturer's recommendations.

6. Epoxy resin adhesive shall be a two (2) component solvent free, moisture - insensitive, high-modulus, high-strength, structural epoxy that conforms to ASTM C 881, Type 1, Grade 3, Class B and C.

7. Compressive strength of the cured epoxy resin adhesive shall be a minimum of 7700 psi at 28 days when tested per ASTM D 695.

8. Bond strength of cured epoxy resin adhesive shall be a minimum of 2200 psi at 14 days when tested per ASTM C 882. 1,200 Type 1

9. The Contractor shall furnish test data showing that each lot of epoxy resin adhesive meets the requirements in Section 2.

10. The Contractor shall prepare a repair plan that identifies the repair methods, equipment to be used, and the materials that are to be used. Work shall not be started on crack repair until the repair plan has been approved by the Engineer.

MATERIAL SPECIFICATION

522. AGGREGATE FOR PORTLAND CEMENT CONCRETE

1. SCOPE

This specification covers the quality of fine aggregate and coarse aggregate for use in the manufacture of portland cement concrete.

2. QUALITY

Aggregate shall conform to the requirements of ASTM Specification C-33 for the specified sizes. Aggregates that fail to meet any requirement may be accepted only when: (1) the specified alternate conditions of acceptance can be proved prior to the use of the aggregates on the job and within a period of time such that no work under the contract will be delayed by the requirements of such proof; or, (2) the specification for concrete expressly contains a provision of special mix requirements to compensate for the effects of the deficiencies.

3. REACTIVITY WITH ALKALIES

The potential reactivity of aggregates with the alkalies in cement shall be evaluated by petrographic examination and, where applicable, the chemical method of test, ASTM Designation C 289, or by the results of previous tests or service records of concrete made from similar aggregates from the same source. The standards for evaluating potential reactivity shall be as described in ASTM Specification C 33, Appendix A1.

Aggregates indicated by any of the above to be potentially reactive shall not be used, except under one of the following conditions:

a. Applicable test results of mortar bar tests, made according to ASTM Method C 227, are available which indicate an expansion of less than 0.10 percent at six months in mortar bars made with cement containing not less than 0.8 percent alkalies expressed as sodium oxide; or

b. Concrete made from similar aggregates from the same source has been demonstrated to be sound after 3 years or more of service under conditions of exposure to moisture and weather similar to those anticipated for the concrete under these specifications.

Aggregates indicated to be potentially reactive, but within acceptable limits as determined by mortar bar test results or service records, shall be used only with "low alkali" cement, containing less than 0.60 percent alkalies expressed as sodium oxide.

4. STORING AND HANDLING

Aggregate of each class and size shall be stored and handled by methods that prevent segregation of particles sizes or contamination by intermixing with other materials.

MATERIAL SPECIFICATION

531. PORTLAND CEMENT

1. SCOPE

This specification covers the quality of portland cements.

2. QUALITY

Portland cement shall conform to the requirements of ASTM Specification C 150 for the specified types of cement, except that, when Type I portland cement is specified, Type IS portland blast-furnace slag cement or Type IP portland-pozzolan cement conforming to the requirements of ASTM Specification C 595 may be used unless prohibited in the specifications.

If air-entraining cement is to be used, the Contractor shall furnish the manufacturer's written statement giving the source, amount and brand name of the air-entraining addition.

3. STORAGE AT THE CONSTRUCTION SITE

Cement shall be stored in such a manner as to be protected from weather, dampness or other destructive agencies. Cement that is partially hydrated or otherwise damaged will be rejected.

MATERIAL SPECIFICATION

532. AIR-ENTRAINING ADMIXTURES (FOR CONCRETE)

1. SCOPE

This specification covers the quality of air-entraining admixtures for concrete.

2. QUALITY

Air-entraining admixtures shall conform to the requirements of ASTM Specification C 260, except that the relative durability factor in the freezing and thawing test shall be not less than 95.

MATERIAL SPECIFICATION

533. WATER-REDUCING AND SET-RETARDING ADMIXTURES FOR PORTLAND CEMENT CONCRETE

1. SCOPE

This specification covers the quality of water-reducing and set-retarding admixtures for portland cement concrete.

2. QUALITY

Water-reducing and set-retarding admixtures shall conform to the requirements of ASTM Specification C 494, except that resistance to freezing and thawing shall be determined in all cases, and the minimum relative durability factor shall be 95.

3. TYPES

Admixtures shall be Type A, Water-Reducing or Type D, Water-Reducing and Retarding , as defined in ASTM Specification C 494.

4. PERFORMANCE IN THE JOB MIX

When added in the manner and amount recommended by the manufacturer to the concrete used on the job, with no change in the cement content or proportions of the aggregates, admixtures shall have the following effects:

Type A or Type D: The water content at the required slump shall be at least 5 percent less with the admixture than without. The air content shall remain within the range specified, but shall not exceed 8 percent in any case.

Type D: The time of initial setting, determined as prescribed in ASTM C 494, shall be from 1 to 3 hours longer with the admixture than without.

MATERIAL SPECIFICATION

534. CURING COMPOUND (FOR CONCRETE)

1. SCOPE

This specification covers the quality of liquid membrane-forming compounds suitable for spraying on concrete surfaces to retard the loss of water during the curing process.

2. QUALITY

The curing compound shall meet the requirements of ASTM Specification C 309.

Unless otherwise specified the compound shall be Type 2.

3. DELIVERY AND STORAGE

All curing compound shall be delivered to the site of the work in the original container bearing the name of the manufacturer and the brand name. The compound shall be stored in a manner to prevent damage to the containers and to protect water-emulsion types from freezing.

MATERIAL SPECIFICATION

535. PREFORMED EXPANSION JOINT FILLER

1. SCOPE

This specification covers the quality of preformed expansion joint fillers for concrete.

2. QUALITY

Preformed expansion joint filler shall conform to the requirements of ASTM Specification D 1752, Type I, Type II or Type III, unless bituminous type is specified. Bituminous type preformed expansion joint filler shall conform to the requirements of ASTM Specification D 994, or D 1751.

MATERIAL SPECIFICATION

539. STEEL REINFORCEMENT (FOR CONCRETE)

1. SCOPE

This specification covers the quality of steel reinforcement for reinforced concrete.

2. QUALITY

All reinforcement shall be free from rust, oil grease, paint or other deleterious matter.

Steel bars for concrete reinforcement requiring bends shall be deformed billet-steel bars conforming to ASTM Specification A 615, Grade 40 or Grade 60.

Straight steel bars shall be deformed bars conforming to one of the following specifications:

Deformed Billet-Steel Bars for Concrete Reinforcement (Grade 40 or Grade 60) - ASTM Designation A 615.

Rail-Steel Deformed Bars for Concrete Reinforcement (Grade 50 or Grade 60) - ASTM Designation A 616.

Axle-Steel Deformed Bars for Concrete Reinforcement (Grade 40 or Grade 60) - ASTM Designation A 617.

Fabricated steel bar mats shall conform to the requirements of ASTM Specification A 184.

Welded steel wire fabric reinforcement shall conform to the requirements of ASTM Specification A 185.

Welded deformed steel wire fabric for concrete reinforcement shall conform to the requirements of ASTM Specification A 497.

Cold-drawn steel wire reinforcement shall conform to the requirements of ASTM Specification A 82.

Deformed steel wire for concrete reinforcement shall conform to the requirements of ASTM Specification A 496.

3. DIMENSIONS OF WELDED WIRE FABRIC

Gauges, spacing and arrangement of wires in welded steel wire fabric shall be as defined in ACI Standard 315 of the American Concrete Institute for the specified style designations.

4. STORAGE

Steel reinforcement stored at the site of the work shall be stored above the ground surface on platforms, skids or other supports and shall be protected from mechanical injury and corrosion.

Interoffice Memorandum

Date: January 13, 1992

To: H. Scott Clements

From: E. Biathrow VIA: E. Raleigh

Re: Powerline Floodway Preliminary Repair Plans and Specifications

A review of the submitted documentation has been made, the respective comments included in the attached. It is recommended that you forward it to the SCS for their consideration in preparing the final project bid package.

Powerline Floodway

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Review Comments, Preliminary Project Documents

Powerline Floodway, 1991/92 repair

A. Design Report

1. Subheading, DESCRIPTION OF JOB: Add the following; The 2,000 l.f. +/- of cracks scheduled to be repaired, have been filled with asphalt tar and, in the case of larger cracks (>1/4"), a backer rod of expanded foam material is installed. These cracks will have to be cleaned of such materials prior to injecting the epoxy adhesive.

   Note that there is a proposal wherein the FCDMC will clean such materials from those cracks scheduled to have the epoxy treatment. If completed, then the above concern is mute.

2. Subheading, CONSTRUCTION SCHEDULE: Consider the following; The 57 spall repairs originally scheduled is included in the construction schedule. Given that the FCDMC has recently repaired all significantly spalled areas along the floodway length, it is recommended that the spall repair table be eliminated from the plans (scope of work) and that the FCDMC be responsible for future maintenance and/or repair of all such areas except where any new spalling occurs in any channel liner or joint repairs placed as a part of the current SCS repair project. Since this repair work had been originally scheduled during the course of major concrete placement, there may be no impact on the total time required to complete the project with the elimination of such work.

   For an equitable evaluation of any possible flood damage to the site during the course of construction, it is recommended that the construction contract documents state that the contractor is responsible for allowing passage of <u>(to be determined)</u> cfs, a value considered equivalent to the runoff from a 10 year event. Flows exceeding this amount and causing damage to either the contractor's work or FCDMC's facilities will be paid for by SCS upon acceptance by SCS of proper invoices for said damages.

3. Subheading, OPERATION AND MAINTENANCE (O&M): Consider the recommendation of item A.2 above, and if found appropriate, include the defined responsibilities in the O&M manual.

B. Correspondence

1. No comment.

C. Design and Drawing Notes

1. The use of the joint sealant and underlying preformed joint filler for the defined 0.75" joint is considered suitable for the length of the transverse joint; however, the closing or sealing of the joint at each end does not appear to be addressed. It is recommended that the sealant material be extended horizontally across the top of the exposed liner (at the top of the floodway liner) and also vertically on the outside of the cutoff wall where such walls are constructed.

2. The presented detail for the joint provided for a concave surface (0.25" below the adjacent edges of concrete). The sealant's minimum and maximum thicknesses (at the center of the joint) permitted for effective sealant performance need to be specified. The item is of special significance since the bottom shape of the sealant is flat.

D. Soils

1. The overall approach to evaluate soil conditions that may have attributed to existing conditions or that may have an adverse effect on the proposed repairs is considered appropriate. The investigative program included evaluation of the soil expansion potential in two areas showing major distress to the liner. In both cases, neither the in situ soil density nor the optimum density were determined. This data combined with the actual surcharge load (soil overburden plus concrete liner) provides for a realistic evaluation of the expansion potential under worst case conditions. For the sample at Station 224+25, the measured plasticity index was 24, a value sufficiently high to be concerned about. The P.I. at Station 78+00 was 7. It is recommended that for the area represented by soils found at Station 224+25 the in situ density be determined and that the expansion potential be reevaluated using test conditions approximating that found at the site.

E. Specifications

If the final bid package will present the specification numbering sequence given, then the inclusion of a statement to the effect that the missing number specifications are not a part of the bid package is recommended.

Section Number	Title	Bid Item Number
3	Structure Removal	1
5	Pollution Control	1, included item
7	Constr. Surveys for Layout, Control, & Measurement	1 & 3 included items
8	Mobilization	2
21	Excavation	3, included item
23	Earthfill	3, included item
31	Concrete	
	a. Concrete Channel Lining	3
	b. Cement	4
34	Steel Reinforcement	5
94	Contractor Inspection	6
400	Joint Sealant	7
401	Polymer Modified Patching Compound for Spall Repair	8
402	Epoxy Adhesive Injection for Crack Repair	9
403	Grout	3, included item

1. 3. Structure Removal: Item 1 Scope; It is recommended that a specific statement be included that clearly indentifies the maximum expected

volume of water the contractor shall be responsible for passing through the work area and that for any damage suffered by either the floodway and/or the contractor, the SCS will provide compensation for.

2. 3. Structure Removal: Item 2 Marking; The party responsible for said marking shall be identified, i.e. the contractor or the SCS.

3. 5. Pollution Control: Item 3 Erosion and Sediment Control Measures and Works; It is recommended that the Contractor be required to provide a plan prior and that such plan be approved prior to the Notice to Proceed being issued. This plan shall included all aspects of items covered in this specification, not just the chemical pollution discussed on page 5-4.

4. 7. Constr. Surveys for Layout, etc: Item 5 Constr. Surveys; It is recommended that a requirement for the responsible surveyor be registered in the State of Arizona in the appropriate category for the type of work being performed.

5. 7. Constr. Surveys for Layout, etc: Item 9 Items of Work, etc; It is recommended that the responsible surveyor be required to sign and seal a certificate on each page of the "As-built" plans. The certificate stating the following or equivalent: "AS-BUILT DRAWING: I hereby certify that the "As-Built" measurements as shown herein were made under my supervision and are correct to the best of my knowledge and belief."

6. 8. Mobilization: Item 1 Scope; It is recommended that a specific statement be included that this item include demobilization as a subsidiary item.

7. 23. Earthfill: Item 6 Compaction; Compaction of the side slopes does not appear to be addressed. The method of specified compaction, 3 passes with a vibratory plate or roller, when used on 1.5:1 slopes may not result in adequate compaction. It is recommended that (1) the thickness of loose material subject to compactive effort be reduced to four inches, (2) the minimum compaction of the soil be specified as 95% of optimum density as determined by ASTM D-698, and (3) the soil moisture content be within 3 % +/- of optimum moisture at the time of compactive effort application.

8. 31. Concrete: Item 2 Materials; A number of Material Specifications are referenced without being provided. It is recommended that all such references be included.

9. 31. Concrete: Item 4 Air Content and Consistency; Considering the slopes on which the concrete is to be placed, 1.5:1, the allowable minimum slump, 1.5", may be too high. It is recommended that the minimum slump be reduced to 1.0".

   In addition, the specified air content may be difficult to achieve with low slump concrete. Since the specified concrete has a relatively high

minimum cement content and compressive strength for the floodway liner, it is recommended that the air content requirement be eliminated.

10. 31. Concrete: Item 5 Design of the Concrete Mix; The utilization of Method 2 is questioned. It would appear that since the contractor is required to provide a quality control program and monitor the course of construction, that to require the contractor to provide his own mix design with SCS approval would allow the contractor to be totally responsible for producing a workable mix that meets the specifications. Given the relatively steep slope of the liner, use of Method 1 may eliminate a source of a contract claim and is so recommended.

    In addition to the above, the inclusion of a shrinkage requirement per ASTM standards is recommended. The shape of the liner, exaggerated longitudinal axis, and the type of previous liner failure demands that the concrete mixture itself exhibit a minimum shrinkage characteristic.

11. 94. Contractor Inspection: Item 11 Items of work, etc.; Referencing the previous discussion above regarding deleting the work involving concrete spall removal, it is recommended that item 11.a.1.i be removed.

    Item 11.a.3.c shall be revised to reflect the recommendation regarding optimum moisture usage. The number of such tests shall be based on each 100 cubic yards or per 1,000 square feet, whichever results in a greater number of tests.

    In addition, provisions for compaction testing per above recommendation be provided, providing for at least one test per 100 cubic yards or per 1,000 square feet, whichever results in a greater number of tests.

    Item 11.a.3.f shall be eliminated per the discussion above regarding concrete spalls.

    Item 11.a.5 shall be eliminated since the cost of on-site laboratory establishment would be expected to exceed that of laboratory personnel commuting cost and the necessity of having test result information available without delay is not present.

12. 403. Grout: Item 8 Conveying and Placing; Add the following: Each void to be grouted shall be sounded, a weep hole (1" minimum diameter) drilled at the base of the cavity, and grout placed in such a manner that grout exits the weep hole without providing excessive uplift force on the liner.

F. Performance Time
1. No comment.

G. Preliminary Cost Estimate
1. No comment.

H. Survey Data
1. Not reviewed.

Review Comments, Preliminary Project Documents, continued
Powerline Floodway, 1991/92 repair

I. Project Plans

1. Title Sheet

a. Add the word "County" to both Maricopa and Pinal labels in the vicinity map.

b. In the Definition Table, add the following:

1.	Air Force Base	A.F.B.
2.	Avenue	Ave.
3.	Benchmark	BM
4.	Boulevard	BLVD.
5.	Centerline	C/L
6.	Feet	FT.
7.	Flood Retarding Structure	F.R.S.
8.	General Motors	G.M.
9.	Junction	JCT.
10.	Maricopa County Highway Department	MCHD
11.	Natural Resource Conservation District	N.R.C.D.
12.	Number	No. or #
13.	Operations and Maintenance	O&M
14.	Reinforced Concrete	R/C
15.	Typical	typ
16.	Sheet	Sht.
17.	United States	U.S.
18.	United States Geological Survey	U.S.G.S.

2. Location Map & Control Monuments

a. Control Monuments schedule:

1. The use of the schedule title "Control Monuments" is confusing with respect to the relationship of a "control monument" to a "benchmark". Are they both to be used for elevation control throughout the construction project or do they have different purposes? If the use is the same, then the term "Temporary Benchmark, (TBM)" and "Benchmark (BM)", respectively is recommended.

   It is understood that the benchmark for the project is at Hawk Rock. Has this elevation been transferred to the MCHD BM?

b. The stationing referred to in the above table is not referenced to any plan view in the drawings. It is recommended that beginning, ending, and the MCHD BM stationing be shown on the "Project Site" map.

3. Details; As-built of floodway

a. Add a note: "At Station _____, the bottom width increases from 6' to 8."
b. In the typical section, the single vertical lines appear to be contraction joints. If that is what they are, label one and mark it as "typical".

4. Details; joint removal and repair

a. The elevation along the centerline calls for a sawcut. If the sawcut is to be full depth, it should be so stated.

b. At section A-A, the typical clear distance between the longitudinal reinforcement and the joint filler is not defined. A value of 2" is recommended.

c. At section C-C, the transverse reinforcement overlap distance is not called out. This is an ideal place to do so.

5. Table, joint repair

a. No comment.

6. Profiles; Liner, removal and replacement sections

a. No. comment.

7. Details; concrete liner replacement

a. The phrase "or as shown on sht. 7" is used twice; however, there is no instance found where a different spacing is presented. It is recommended that it be eliminated to avoid confusion.

b. At both A-A sections, the typical clear distance between the reinforcement and the earth in the vertical cutoff walls (at the top of the liner) is not specified. A value of 3" is recommended.

c. The boxed set of values in the lower left hand corner of the sheet could be entitled "Reinforcement Schedule" or some equivalent value.

d. At detail D, the clear distance between the longitudinal reinforcement and the joint filler material has not be stated. A value of 2" is recommended.

8. Details; crack, spall, & cavity repair

a. Delete the "Spall Repair Table", "Plan spall repair", and "Section B-B" per the discussion above.

b. At section A-A, the cavity to be filled with grout is shown. A weep hole shall be shown at the base of the cavity to allow both air to escape and ensure full grout placement.

9. Table and details; cut and seal existing joints

a. Revise General Note 2 to read: Prepare joint, placing preformed joint filler, and joint sealant in accordance with the ...".

b. At the Joint Repair Detail, the note describing the thickness of the joint sealant is ambiguous. Revise to read: Minimum joint sealant thickness shall be 3/8" +/- 1/16" in the center area after tooling. The upper surface shall be tooled 1/4" below concrete surface.

Arizona
Watt 1-25-65
Capacity of Concrete Lined Channel

$n = .014 \quad Q = 600 \quad b = 6' \quad SS = 1\frac{1}{2}:1$

$$K' = \frac{Qn}{b^{8/3} S^{1/2}} = \frac{600 \times .014}{119 \times S^{1/2}} = .0706$$

$d_c = 4.67 \quad S_c^{1/2} = \frac{600 \times .014}{164} = .0512 \quad S_c = .00263$

S	$S^{1/2}$	K'	d/b	d	A	V	hv	F	D
.005	.07071	.998	.647	3.88	45.9	13.07		0.97	4.85
.006	.07746	.911	.619	3.71	42.9	14.0		0.93	4.64
.007	.08367	.844	.595	3.57	40.5	14.8		0.89	4.46
.008	.08944	.789	.575	3.45	38.6	15.5		0.86	4.31
.004	.06325	1.116	.684	4.10	49.8	12.0		1.03	5.13

$Q = 1070 \quad n = .014 \quad b = 6' \quad SS = 1\frac{1}{2}:1$

$$K_1' = \frac{1070 \times .014}{119 \times S^{1/2}} = \frac{.12588}{S^{1/2}}$$

S	$S^{1/2}$	K'	d/b	d	A	V	hv	F	D
.004	.06325	1.990	.903	5.42	76.6	14.0		1.35	6.77
.005	.07071	1.780	.857	5.14	70.5	15.17		1.28	6.42
.006	.07746	1.625	.82	4.92	65.8	16.26	39.17	1.23	6.15
.007	.08367	1.504	.79	4.74	62.1	17.23		1.18	5.92
.008	.08944	1.407	.764	4.58	58.9	18.16		1.14	5.72
.003	.05477	2.298	.966						

$Q = 1210 \quad n\ .014 \quad b = 6 \quad SS = 1\frac{1}{2}:1$

$$K' = \frac{1210 \times .014}{119 \times S^{1/2}} = \frac{.14235}{S^{1/2}} \quad d_c = 6.35 \quad S_c^{1/2} = \frac{1210 \times .014}{332} =$$

$S_c = .0026$

S	$S^{1/2}$	K'	d/b	d	A	V	hv	F	D
.005	.07071	2.013	.908	5.44	77.0	15.71		1.36	6.80
.006	.07746	1.838	.87	5.22	72.2	16.75	49.21	1.30	6.52
.007	.08367	1.701	.838	5.02	67.9	17.82		1.26	6.28
.008	.08944	1.592	.813	4.88	65.0	18.61		1.22	6.10

Arizona
Watt 1-25-65
Capacity of Concrete Lined Channel

$Q = 1070 \quad n = .014 \quad b = 8' \quad SS = 1\tfrac{1}{2}:1$

$d_c = 5.7 \quad S_c = \left(\frac{1070 \times .014}{311}\right)^2 = .0023$

$K' = \frac{1070 \times .014}{256 \times S^{1/2}} = \frac{.0585}{S^{1/2}}$

$S_c = 00232$

S	$S^{1/2}$	K'	d/b	d	A	V		F	D
.005	.07071	.827	.589	4.71	71.0	15.07		1.18	5.89
.006	.07746	.755	.563	4.50	66.4	16.11	2.30	1.13	5.63
.007	.08367	.699	.541	4.33	62.8	17.03		1.08	5.41
.008	.08944	.654	.523	4.18	59.6	17.95		1.05	5.23
.004	.06325	.925	.623	4.98	77.0	13.9		1.25	6.23
.003	.05477	1.068	.67	5.36	86.0	12.4		1.34	6.70

$Q = 1210 \quad n = .014 \quad b = 8' \quad SS = 1\tfrac{1}{2}:1$

$K' = \frac{1210 \times .014}{256 \times S^{1/2}} = \frac{.0661}{S^{1/2}} \quad d_c = 6.17 \quad S_c^{1/2} = \frac{1210 \times .014}{366} = .0463$

$S_c = .00214$

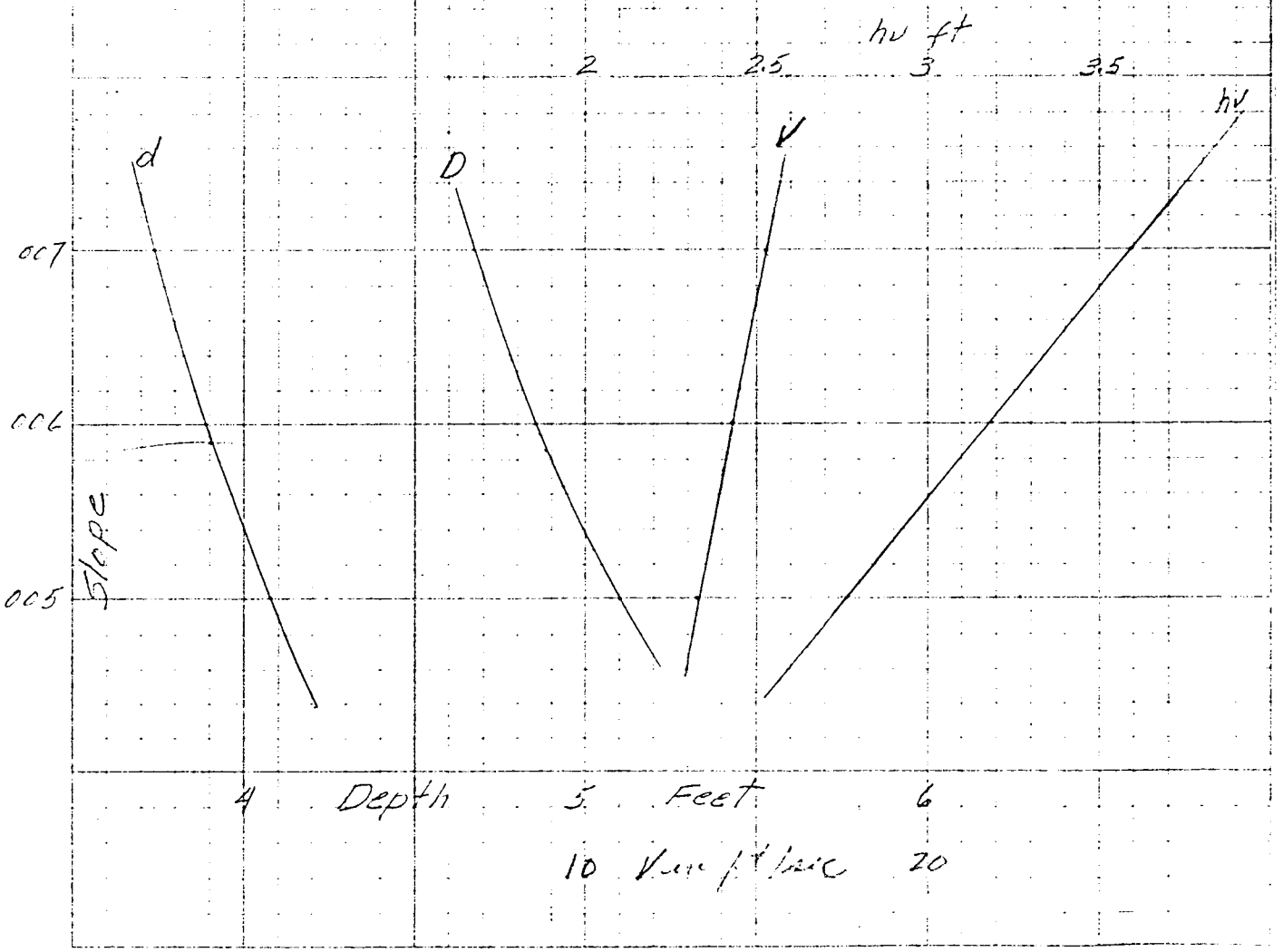
S	$S^{1/2}$	K'	d/b	d	A	V	Rv	F	D
.005	.07071	.934	.626	5.01	77.7	15.57	3.77	1.25	6.26
.006	.07746	.853	.598	4.78	72.5	16.68	4.32	1.20	5.98
.007	.08367	.790	.576	4.61	68.8	17.6	4.82	1.15	5.76
.008	.08944	.739	.556	4.45	65.3	18.52	5.33	1.11	5.56
.004	.06325	1.045	.661	5.29	84.3	14.4	3.22	1.32	6.61
.003	.05477	1.205	.709	5.67	93.6	12.9		1.42	7.09

Arizona Penciline Channel C
Watt
Capacity Conc. lined Channel

For Q = 660 b = 6.0 n = .014 S.S = 1½:1

S	S½	K'	D/b	D	A	V	hv	Total D = 1.25D
.005	.07071	1.10	.680	4.08	49.44	13.35	2.77	5.10
.006	.07746	1.003	.649	3.89	46.04	14.33	3.19	4.86
.007	.08367	.928	.624	3.74	43.42	15.20	3.59	4.67

$$K' = \frac{660 \times .014}{119 \times 5^{1/2}} = \frac{.0776}{5^{1/2}}$$



COMPUTATION SHEET
FOR USE IN FIELD OFFICE

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

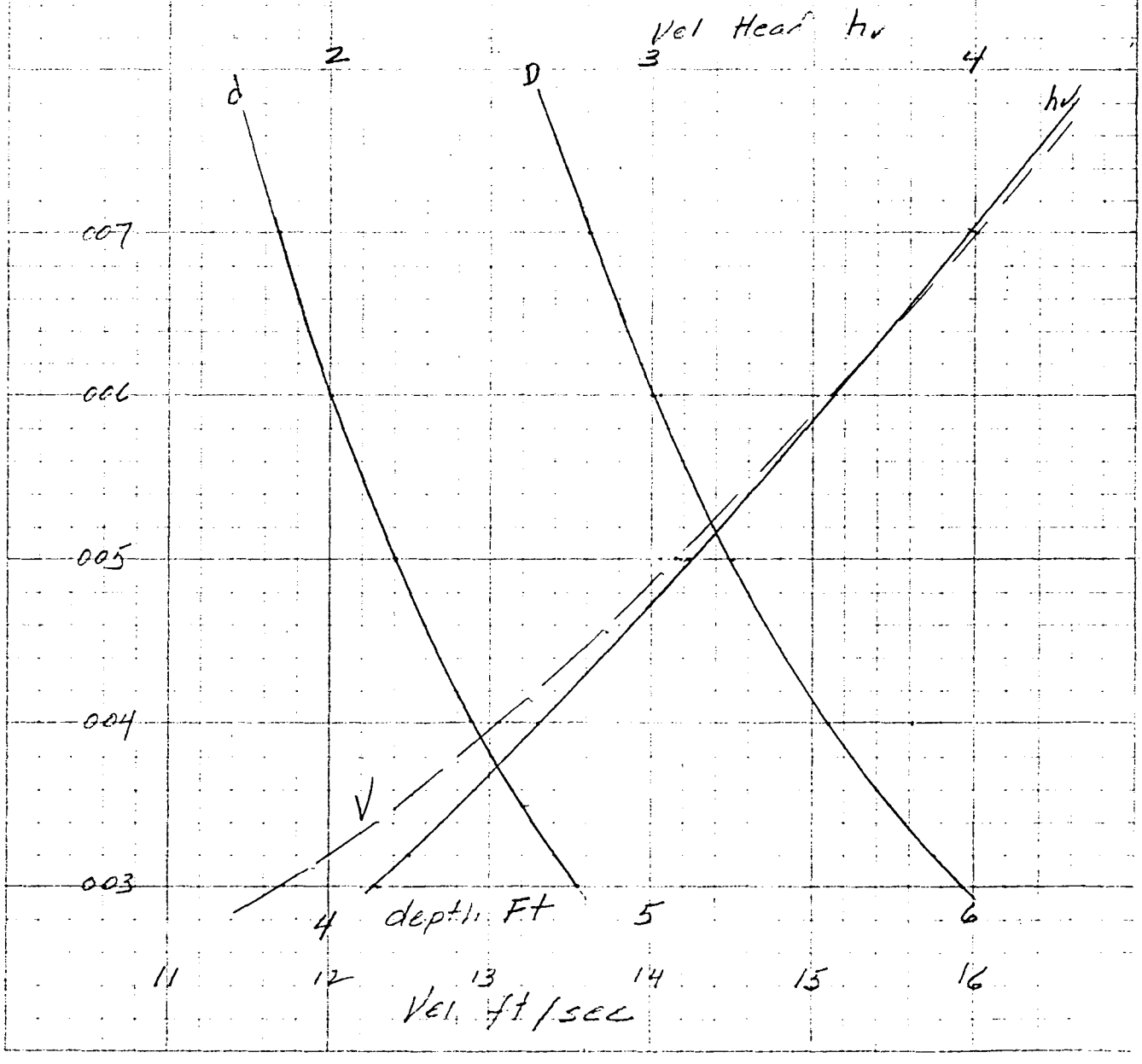
Arizona Powerline Channel
Watt 4-23-65
Capacity of Channel

For Q = 850 C.F.S. b = 8 SS = 1½:1 n = .014

$$K' = \frac{850 \times .014}{256 \times 5^{1/2}} = \frac{.0463}{5^{1/2}}$$

d+F .150

Slope	$S^{1/2}$	K'	B/b	d	A	V	hv	D
.004	.06325	.735	.555	4.44	65.09	13.06	2.65	5.55
.005	.07071	.658	.525	4.20	60.06	14.15	3.11	5.25
.006	.07746	.600	.501	4.01	56.20	15.13	3.56	5.01
.007	.08367	.556	.481	3.85	53.03	16.03	3.99	4.81
.003	.05477	.849	.597	4.78	72.51	11.72	2.14	5.97



COMPUTATION SHEET
SCS-126A REV 5-56

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

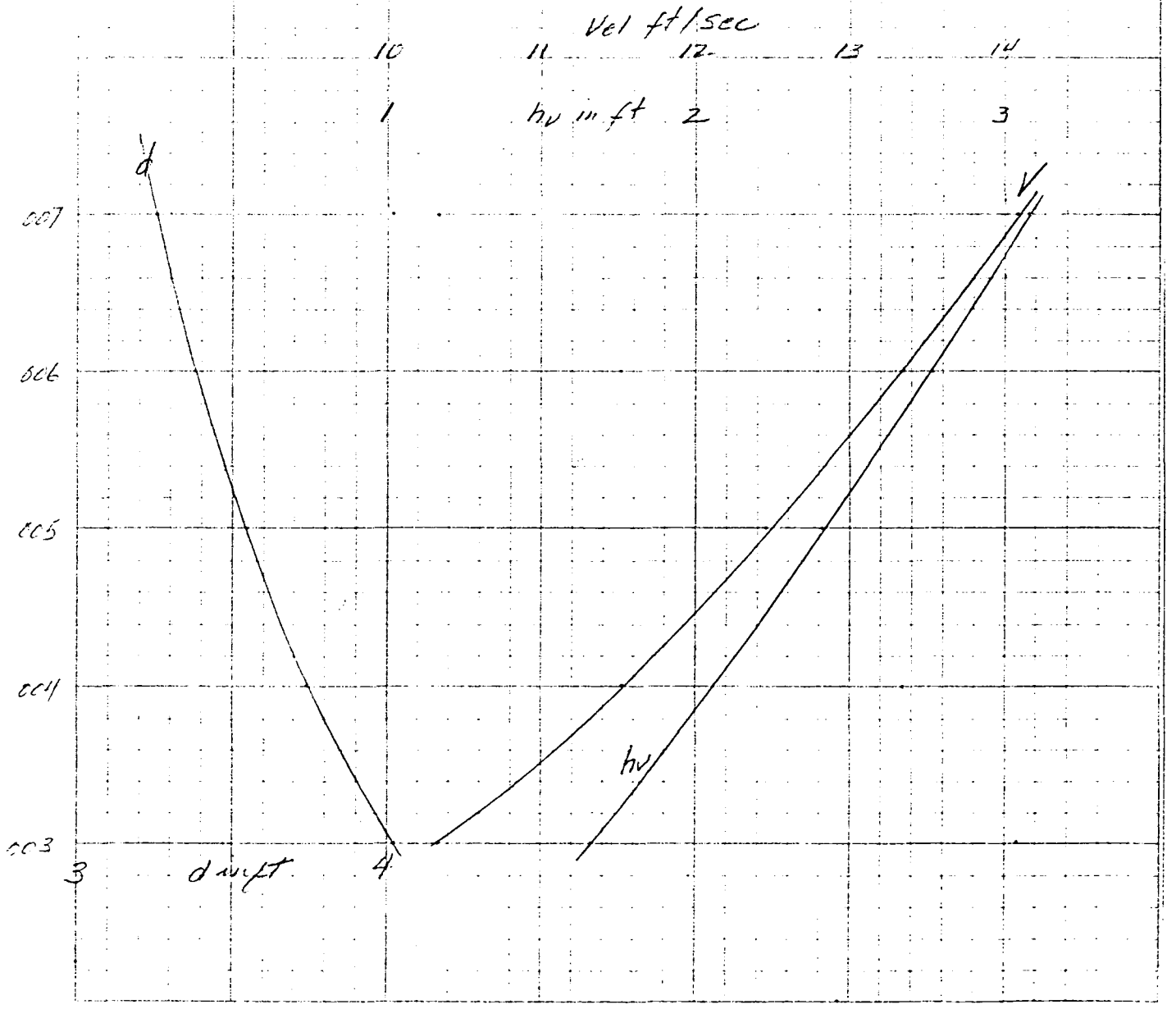
Watt

C

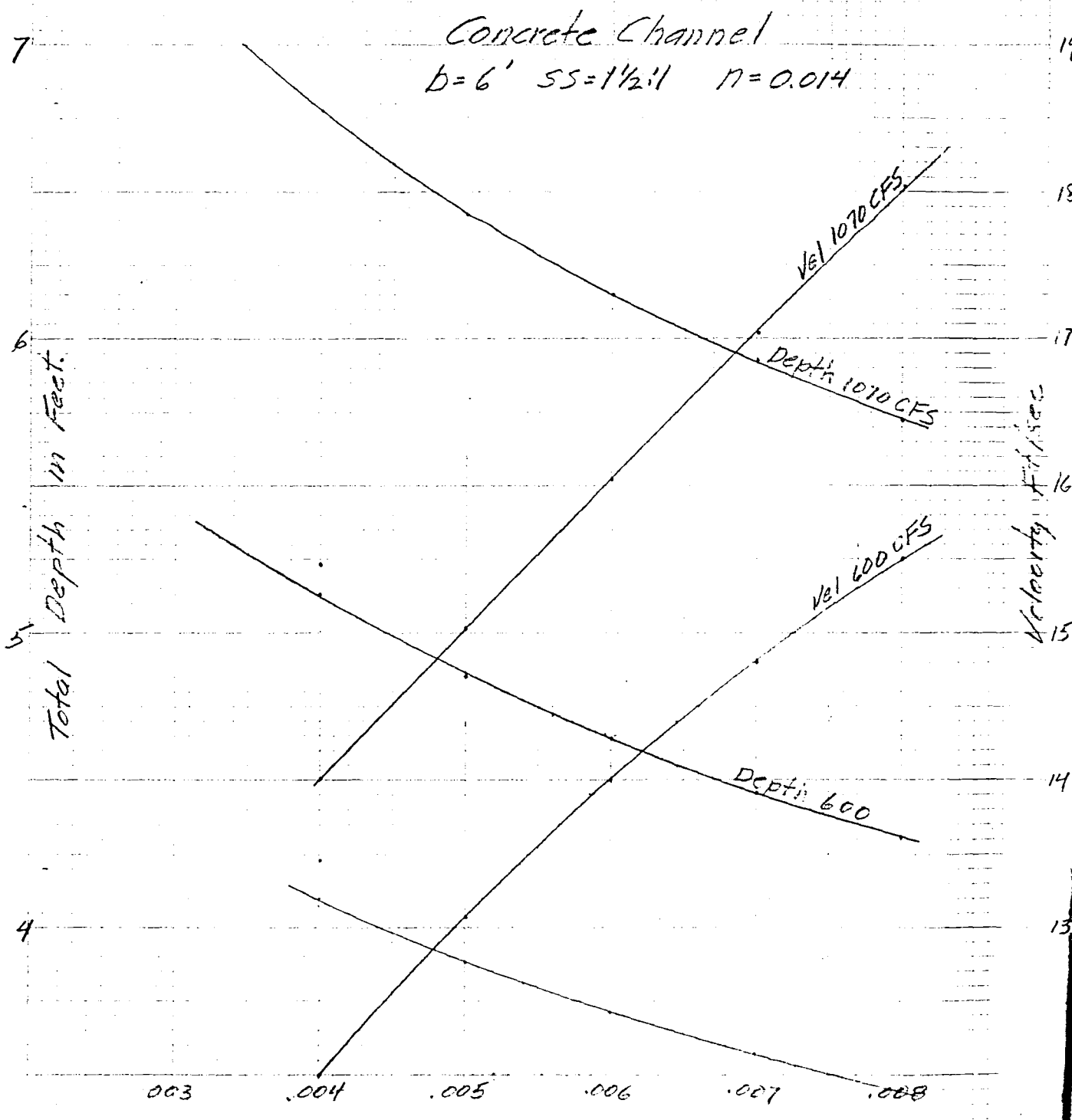
$b = 6$ $SS = 1\frac{1}{2}:1$ $n = .014$
$Q = 500$ C.F.S.

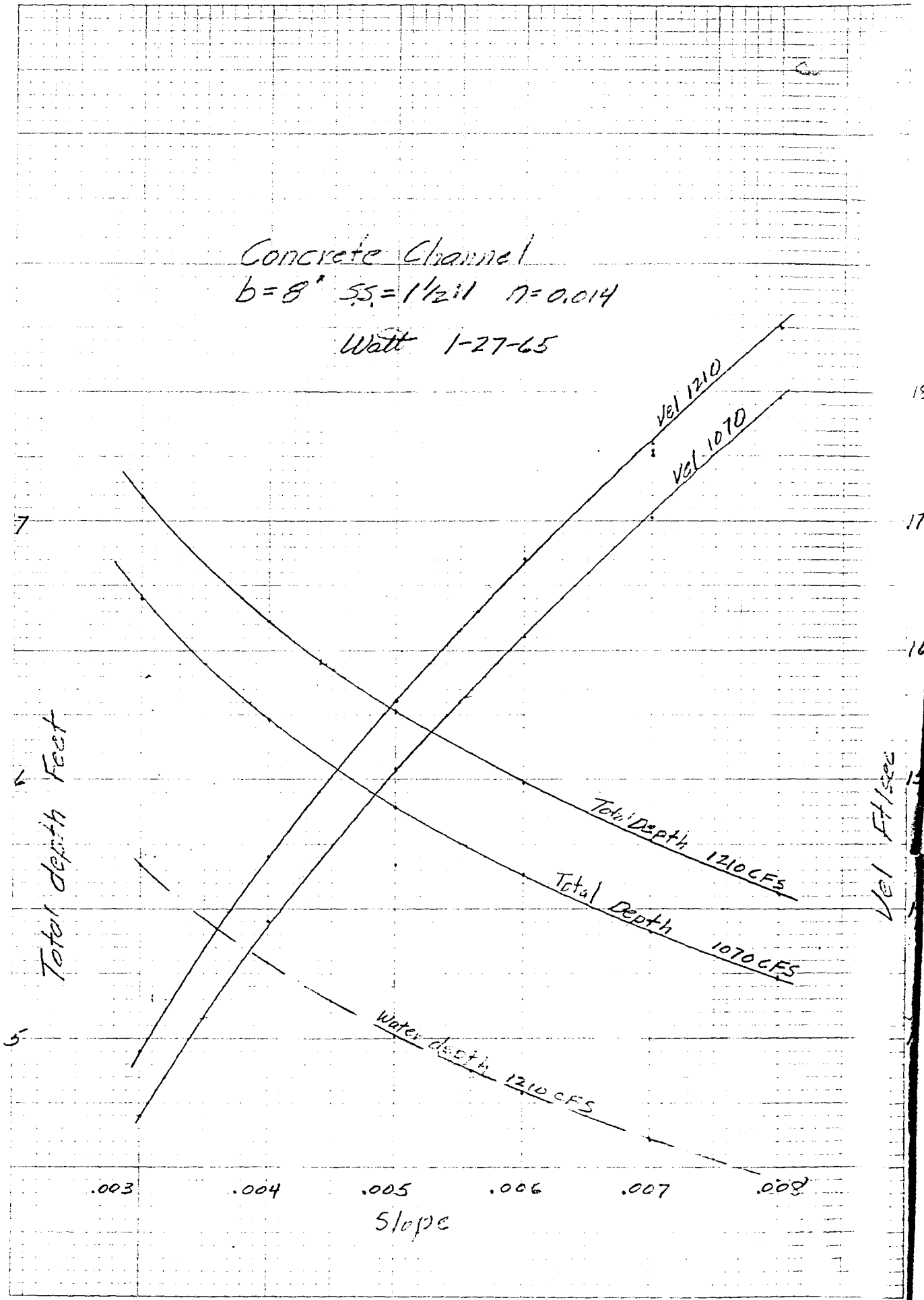
$K' = \frac{500 \times .014}{1.49 \times S^{1/2}} = \frac{.05882}{S^{1/2}}$

S	$S^{1/2}$	K'	D/b	d	A	V	h_v	$1.25\,d$ D
.003	.05477	1.074	.670	4.02	48.36	10.33	1.66	5.02
.004	.06325	.928	.624	3.74	43.42	11.52	2.06	4.67
.005	.07071	.832	.591	3.55	40.20	12.44	2.41	4.44
.006	.07746	.759	.564	3.38	37.42	13.36	2.78	4.23
.007	.08367	.703	.543	3.26	35.50	14.08	3.08	4.07



C


Concrete Channel
b=6' SS=1½:1 n=0.014
Total Depth in Feet.
Velocity in Feet/sec
7
6
5
4
19
18
17
16
15
14
13
Vel 1070 CFS
Depth 1070 CFS
Vel 600 CFS
Depth 600
.003
.004
.005
.006
.007
.008

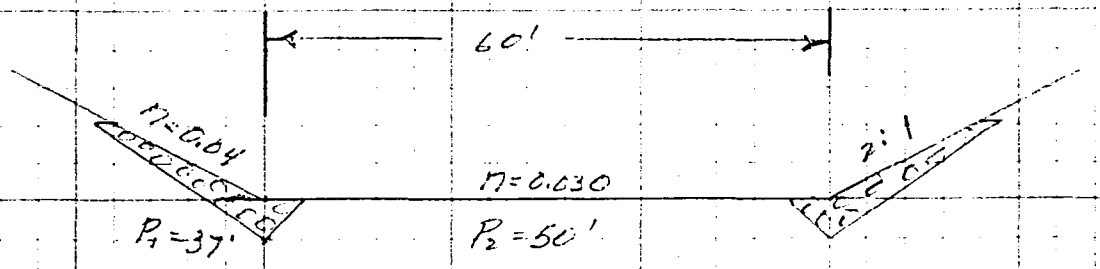

Concrete Channel
b=8' SS=1½:1 n=0.014
Watt 1-27-65
Vel 1210
Vel 1070
Total Depth 1210 CFS
Total Depth 1070 CFS
Water depth 1210 CFS
Total depth Feet
Vel Ft/sec
7
6
5
18
17
16
15
.003
.004
.005
.006
.007
.008
Slope

COMPUTATION SHEET
SCS-523A REV 5-58

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

STATE Arizona PROJECT Powerline Channel
BY Watt DATE 5-13-65 CHECKED BY DATE JOB NO
SUBJECT Capacity of Channel 375 to SHEET OF

Channel b=60 Q= 3250+580 = 3830 C.F.S. = 1% Storm



$$n = \left(\frac{37 \times .04^{3/2} + 50 \times .03^{3/2}}{87}\right)^{2/3} =$$

$$= (.00639)^{2/3} = .034$$

For b=60' $K' = \frac{Q n}{b^{8/3} S^{1/2}} = \frac{3830 \times .034}{55{,}400\ S^{1/2}} = \frac{.00236}{S^{1/2}}$

S	$S^{1/2}$	K'	D/b	D	A	V	He	D+F
.002	.04472	.0528	.129	7.74	584	6.56	8.41	9.4
.003	.05477	.0431	.115	6.90	509	7.52	7.78	8.5
.004	.06325	.0373	.106	6.36	462	8.28	7.42	7.9
.005	.07071	.0334	.099	5.94	427	8.96	7.18	7.2

For Q of 1200 C.F.S. $K' = \frac{.000739}{S^{1/2}}$

.002	.04472	.0165	.066	3.96	269	4.46
.003	.05477	.0135	.058	3.48	233	5.15
.004	.06325	.0117	.054	3.24	215	5.58
.005	.07071	.01045	.0503	3.02	199	6.03

COMPUTATION SHEET
SCS-522 REV 5-58

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

GPO : 1958 O—470868

STATE	PROJECT		
Arizona	Powerline Channel		
BY: Watt	DATE: 5-13-65	CHECKED BY	DATE	JOB NO.
SUBJECT: Capacity of Lower Channel			SHEET ____ OF ____

For 2% Uncontrolled $Q = 2560 + 580 = \underline{3140}$ $n = .034$
+ 1% from Dams $b = 60$ $S = 2:1$

$$K' = \frac{3140 \times .034}{55{,}190 \times S^{1/2}} = \frac{.001934}{S^{1/2}}$$

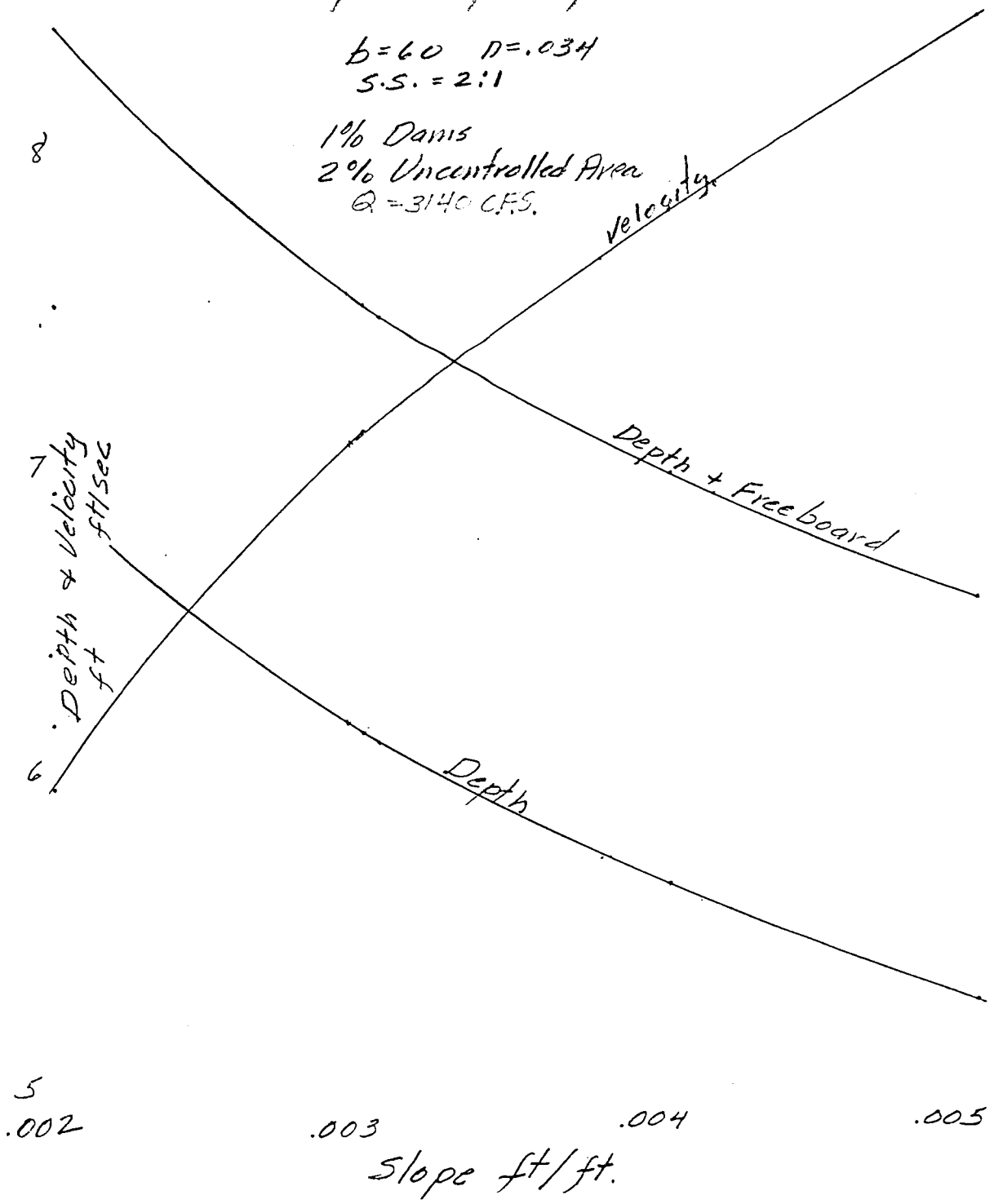
S	$S^{1/2}$	K'	D/b	D	A	V	H_E	D+F
.001	.0316	.0612	.140	8.4	695.0	4.9		
.002	.04472	.0432	.115	6.90	509.2	6.16	7.49	8.40
.003	.05477	.0353	.102	6.12	442.1	7.10	6.90	7.50
.004	.06325	.0306	.094	5.64	402.0	7.81	6.59	6.96
.005	.07071	.0274	.088	5.28	372.6	8.43	6.39	6.56

For 4% Storm $Q = 2060 + 580 = 2640$
$K' = .001626 / S^{1/2}$

S	$S^{1/2}$	K'	D/b	D	A	V
.002	.04472	.0364	.104	6.23	451.4	5.95
.003	.05477	.0297	.093	5.67	404.5	6.53
.004	.06325	.0257	.085	5.10	359.2	7.35
.005	.07071	.0230	.080	4.80	334.0	7.90

Use 10.5. for top Rip Rap for Q=3140
or 6" + Top Dike to 7.50 for S = .00305

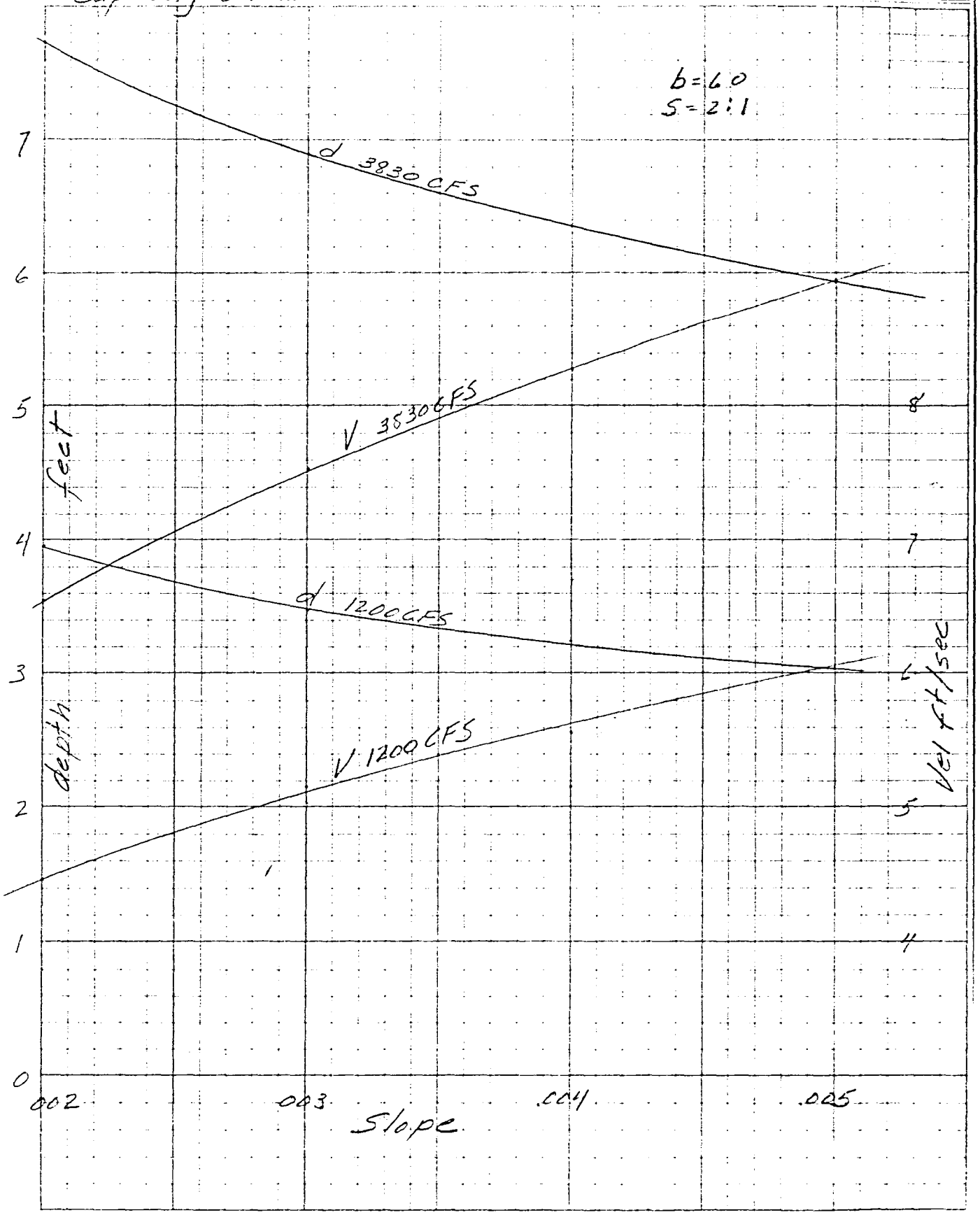
Arizona
Watt 5-13-65
Channel Depth Capacity Relations



COMPUTATION SHEET
SCS-523A REV 5-58

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

STATE Arizona PROJECT Powerline Channel
BY Watt DATE 5-13-65 CHECKED BY DATE JOB NO.
SUBJECT Capacity Channel 375-0 SHEET OF



FROM W ANDERSON FCD 4/6/72

All construction inspection was performed by SCS personnel. George M. England was government representative and project engineer. Several men acted as inspectors on the job. The job diary notes the names of the men involved.

The hydraulic capacity and dimensions of the concrete-lined floodway vary, along ~~with~~ its length. The following is a listing of these values.

Station	Capacity	Bottom Width	Depth	Lining Thickness
12+00 to 87+95	600 cfs	6'-0"	4'-9"	4½"
88+50 to 214+25	660 cfs	6'-0"	5'-0"	4½"
214+75 to 260+75	850 cfs	8'-0"	5'-9"	5"
261+00 to 332+75	1200 cfs	8'-0"	6'-3"	5"
333+00 to 373+39	1210 cfs	8'-0"	6'-6"	5"

?

COMPUTATION SHEET
SCS-SCT-A REV 5-68

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

STATE Arizona PROJECT Powerline Channel
BY Watt DATE 4-23-65 CHECKED BY DATE JOB NO.
SUBJECT Hydrology of Inlets For individual inlet capacity. SHEET OF

Area 1 = 1.05 mi^2 Length = 2.1 × 2640 = 5280
168 ac
Sta. 891

T_c @ 3'/sec = .5 hr $T_p = T_c^{1/2} + .6T_c$ = 1.0 hr Curve No. 80

	30 min P	Runoff in	Runoff Peak CFS
50 yr	1.9	.49	62
25 yr	1.7	.38	48

Area 2 = 1.75 mi^2 Length 4" = 10560 Curve No. 80
280 Ac
Sta 215+

T_c = 1.0 hr T_p = 1.6 hr $q = \frac{484\,AQ}{T_p \times 640} = 0.756\,\frac{AQ}{T_p}$

	P/1 hr		
50 yr	2.4	.81	108
25 yr	2.1	.61	81

Area 3 = 1.07 mi^2 Length = 4" = 5940 Curve No. 80
171 ac

T_c = 0.5 hr T_p = 1.0 hr

	30' P	Runoff in	
50 yr	1.9	.49	63
25 yr	1.7	.38	49

Area 4 = 2.97 mi^2 Length = 6" = 15840 Curve No. 80
475.
Sta. 261

T_c = 1.5 hr T_p = 2.1 hr

	P/1.5 hr	Runoff	
50 yr	2.7	1.02	175 CFS
25 yr	2.4	0.81	140 CFS

Arizona
Watt 4-23-65
Capacity Conc. Channel Revised

Discharge From Powerline Dam	188 CFS
" " Vineyard Rd	358
Total	546
Emg Sp Area	54 C.F.S.
At 15+00 ±	600 CFS
Inlet @ Sta 89+00	62
Sub Total	662
Inlets @ 215	108
	63
Sub total	833
Inlet @ 260	175
Sub total	1008

From Previous Hydrology @

Elsworth Rd ± use	1200 C.F.S.

Water may be diverted to channel at later date

COMPUTATION SHEET
SCS-523A REV 5-56

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

STATE Arizona PROJECT Flowline Channel
BY Watt DATE 4-23-65 CHECKED BY DATE
SUBJECT Grade Determination SHEET C OF

Sta	Grade	Elev	Q	D	B	t	Use
12+10		1558.7					
			600	4.67	6	4½	49"
45+00	.00588	1539.28					
50+00		1536.4					
	.00746		660	4.4'	6	4½	49"
76+00		1517.0					
85+00	.00538	1512.15	600	4.77	6	4½	49"
89+00		1510					
			Inlet	Detail	6	4½	
89+20		1509.3					
	.005843		660	4.89	6	4½	50"
113+00		1495.40					
125+00	.005843	1488.38	660	4.89	6	4½	
132+50		1484.0					
	.00774		660	4.6	6	4½	
148		1472					
165		1461.87					
	.00596		660	4.86	6	4½	
195		1444					
205	0.00535 ~~.00562~~	1438.45	660	4.93	6	4½	5.05 around curve
215+~~45~~							
215+10 End		1432.5					
			Inlet			4½	
215+35		1431.4					

COMPUTATION SHEET
SCS 513A, REV 5-58

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

STATE: Arizona
PROJECT: Powerline Channel
DATE: 4-25-65
CHECKED BY: DATE: JOB NO.
SUBJECT: Grade Determination
SHEET OF

Sta	Grade	Elev	Q	D	b	t	USE D
215+35		1431.40					
245+00	.00350	1421.00	850	5.75	8	5"	5'9"
261+00		1415.40					
261+60		1413.9	Inlet				
	.00385		1025	6.25	8	5"	6'3"
276+00		1408.36					
285	.00665	1402.92	1025	5.62	8	5"	
308+00		1389.00					
325+00	.00560	1379.48	1200	6.10	8	5"	6'3"
333+00		1375.00					

Arizona Powerline Channel

Watt 3-21-66

Elev - Grade

C

Sta	Grade	Elev	Q	D	b	Use D
333+00		1375.00				
			1210	6.42	8.0	6'6"
365+00	.00450	1360.00				
373+00		1357.00				
	SAF					
373+42		1354.00				
	.00414		3140	6.9	8.0	7'6"
400+00		1343.00				
405		1341.49				
	.00305		3140	7.45	6.0	7'6"
445		1329.28				
465+50		1323.00				

Arizona Powerline Channel
Watt 2-3-65
Outlet Channel

Powerline Dam	188	C.F.S.
Vineyard	358	
Total	546	
Uncontrolled Area	54	Emg Sp Area ✓
Total	600	CFS

Wier at Transition

$b = 20$ $SS = 1\frac{1}{2}:1$ $d_c = 2.82$ $Q = 600$

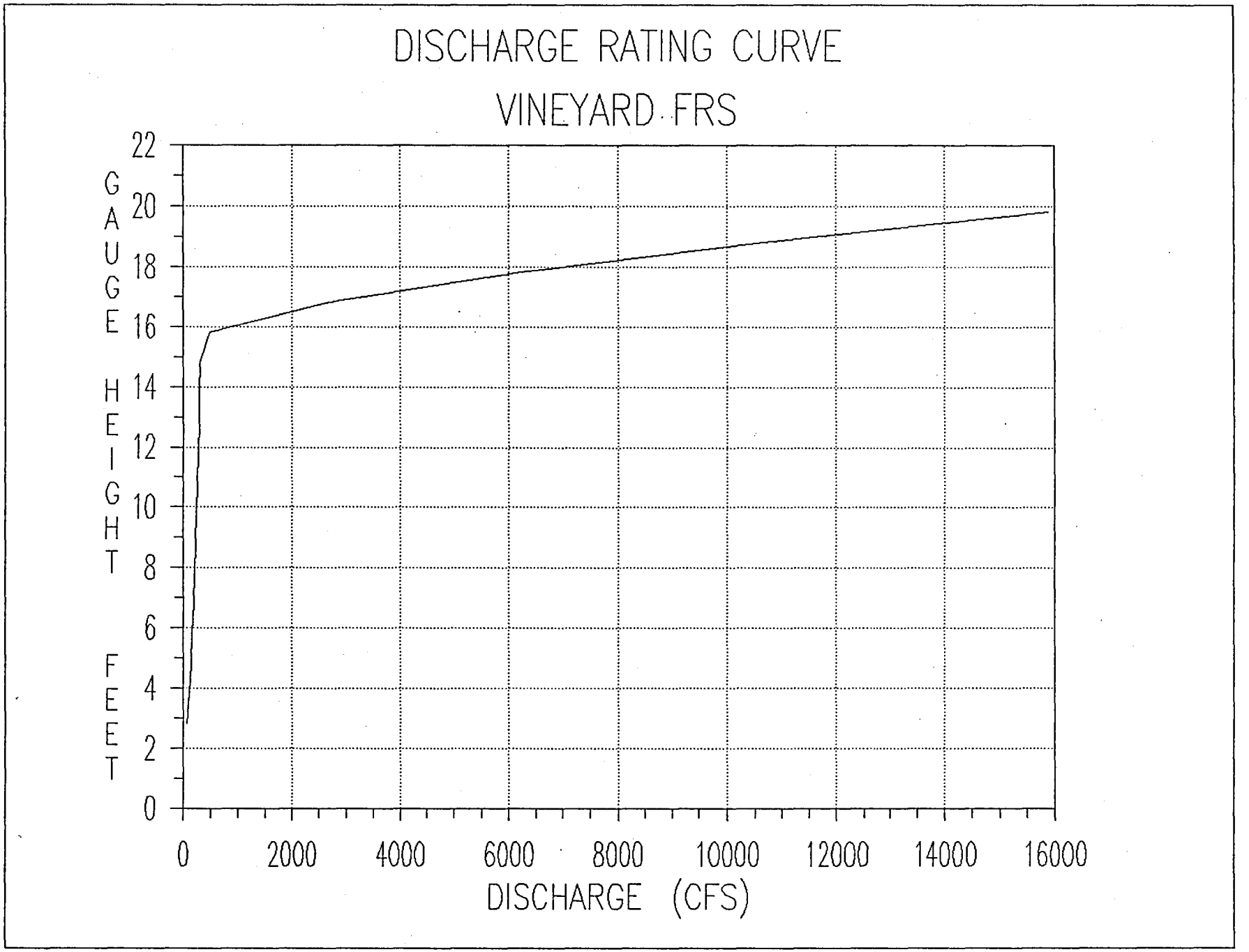
$n = .035$

for $(l-l)n^2 = 25 \times .035^2 = .031$ $U = 2.7 \times 10^{-4}$

$\frac{Q^2}{2g} \times U = \frac{600^2}{64.4} \times \frac{2.7}{10000} = 1.51'$ $d @ U=0 = 2.82 + 1.51$
$= 4.33$

Channel $b = 20$ $SS = 2:1$ $n = .035$

0+00	2.82 = dc
0+25	4.23
0+50	
1+00	4.28
2+00	4.34
4+00	4.42


DISCHARGE RATING CURVE
VINEYARD FRS
GAUGE HEIGHT FEET
0
2
4
6
8
10
12
14
16
18
20
22
0
2000
4000
6000
8000
10000
12000
14000
16000
DISCHARGE (CFS)

RATING CURVE - VINEYARD FRS (5613)

ELEV.	GAUGE Ht.	OUTLET (1)	SPILLWAY (2)	TOP (3)	TOTAL
1559.17	0	0			0
1562.0	2.83	63			63
1563	3.83	109			109
1564	4.83	141			141
1565	5.83	167			167
1566	6.83	189			189
1567	7.83	209			209
1568	8.83	228			228
1569	9.83	245			245
1570	10.83	260			260
1571	11.83	275			275
1572	12.83	289			289
1573	13.83	303			303
1574	14.83	316	0		316
1575	15.83	328	161		489
1576	16.83	340	2366		2706
1577	17.83	352	5874		6226
1578	18.83	363	10,304		10,667
1579	19.83	374	15,493	0	15,867
1580	20.83	384	21,344	33,635	55,363
1581	21.83	394	27,788	174,775	202,957

(1) $Q = CA\sqrt{2gh}$, $C = 0.7$, $A = 15.9\ ft^2$, El @ ℄ = 1561.5

(2) $Q = CLH^{3/2}$, $C = 3.0$, $L = 600$, Crest El. = 1574.8

(3) $Q = CLH^{3/2}$, $C = 3.3$, $L = 28,829$, Crest El. = 1579.5

POWERLINE FLOODWAY REPAIR

PRELIMINARY DESIGN

Design Report

UNITED STATES DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

Phoenix, Arizona
November 1991

PRELIMINARY
DESIGN REPORT

JOB: Powerline Floodway Repair

PROJECT: Repair of Damaged Trapezoidal Concrete Floodway

AUTHORITY: PL566 Design Deficiency

PHASE: Preliminary Design

SUMMARY

35,904'

This report is for the repair of 6.8 miles of concrete channel lining which is 78 percent of the entire floodway length. The remaining 22 percent is an earth lining. The floodway was constructed in 1967. The original design did not provide enough side inlets for overland flow and operation and maintenance roads were not graded away from the floodway. A storm on September 30, 1971 brought water from side washes into the empty channel. At approximately ten locations overbank flows entered between the concrete lining and the subgrade. The water eroded soils beneath the lining and created uplift causing the lining to raise and crack in many areas. An attempt was made to correct the damage by sealing cracks and filling voids behind the lining with concrete slurry. To prevent further damage, the operation and maintenance roads were raised and graded to drain away from the lining, additional side inlets were added, and existing side inlets widened.

Expansion and contraction problems also developed along the floodway. The reinforced concrete lining was originally designed with 1/2-inch expansion joints and cutoff walls spaced every 325 feet. Contraction joints were made by tooling every 50 feet. The expansion joints provided did not allow for enough expansion for the excessive distance between the joints. The channel movement caused joints to exert forces against each other which resulted in considerable spalling and uplifting at the joints.

Investigations have been done to evaluate the movement in the lining. Temperatures and movements across joints were taken after 6 inch sections were cut out of the lining in several locations. These studies were done to observe joint movement, channel grade, and stresses in concrete. The result of the investigation and analysis identified the major cause of failure to be the lack of unsealed expansion joints.

The above damages have created the need for an overall repair of the floodway.

DESCRIPTION OF JOB

The job involves removing and replacing approximately 1,750 linear feet of lining at various locations having severe damage. The job also involves removing short sections less than 10 feet long at specific joints that are offset and/or badly spalled. The rest of the joints will be saw cut to 3/4-inch wide, joint filler installed and sealed. Cracks other than hair line will be bonded by an epoxy adhesive injection process. The majority of cracks are longitudinal and are close to the invert. Smaller spall areas will be repaired by a polymer modified patching compound. Voids beneath the lining will be repaired by filling them with grout. (5% of length)

DESIGN OBJECTIVE

The objective of this repair is to stop the continuing crushing damage that is taking place, mainly at the joints, and to repair those areas that are already damaged by previous overbank flow or compression and buckling at joints.

GENERAL BASIC DATA

The following reference materials were used in designing the Powerline Floodway Repair:

1. Powerline Repair Investigation Report
2. "As Built" Plans Powerline Floodway
3. General Motors Desert Proving Grounds Contract File
4. Powerline Floodway Subsidence Survey
5. ACI manual of Concrete Practice 1985 Part 5
6. Powerline Floodway Design 1965 to 1968
7. Engineering Report Evaluation of Expansion Joint Sealant for East Maricopa Floodway - Reach - 4 December 1987
8. East Maricopa Floodway Reach 4 Expansion Joint Sealer Repair Design
9. NEH Chapter 6
10. Far West States Engineering Design Standards

LOCATION AND LAYOUT

The channel is located in Maricopa and Pinal counties between Powerline Dam and East Maricopa Floodway Reach 4. It traverses the

south part of General Motors Proving Grounds in an east west direction. In 1991 a level survey was made on the channel bottom and on the subsidence monuments every 2000 feet along the channel. New elevation datum was established from Hawk Rock, a large rock out crop that is not subsiding. All new construction for the repair will be based on the recent survey.

FOUNDATION

Eight samples were taken in the channel bottom at locations where lining was cracked badly and where lining bottom had heaved upward several inches. The eight samples were tested at the Mesa Project office for gradation and Atterburg limits. Two of the eight samples showed evidence of clay and significant fines. These two samples came from Station 78+00 and 224+25. Both samples were 4 to 5 feet below channel invert which is 9 to 10 feet below original ground. These two samples were tested for shrink swell by Western Technologies Inc. The sample at Station 224+25 had a 7.7 percent and 8.6 percent expansion. The sample at Station 78+00 had an expansion of 2.1 percent.

Soils information shown on the original drawings for the channel show a 2 foot clay layer generally between 7 and 10 feet below natural ground between Station 220+00 and Station 236+00.

The expansive clay tested at 224+25 is not considered to be the cause of damage at that location. The damage is a result of the uplift mentioned above in this report. By sealing all joints and cracks in this area, and protecting the top of the lining with berms and an operation and maintenance road that directs the water away from the channel lining, the clay layer is not likely to become saturated and is not considered to be a threat to the repaired structure.

STRUCTURE DESIGN

Design of joint gap is based on previous designs and experience on past jobs. Reinforcing steel was based on National Engineering Handbook Notice 6-4 dated December 30, 1980. Joint Sealant selection was based on the latest findings based on past experiences with various sealants. The epoxy adhesive injection process was chosen for cracks since it will provide a structural bond and the majority of cracks are in a longitudinal direction where minimum expansion contraction will occur. The polymer modified patching compound was chosen in place of epoxy repair because it's expansion contraction is similar to concrete. It was also recommended by a number of concrete repair consultants and the WNTC Construction Engineer.

ENVIRONMENTAL CONSIDERATIONS

No negative impact on the conservation of biological or water resources is anticipated by the repair.

CONSTRUCTION DRAWINGS

All drawings were prepared and stored on the Arizona CADD system using Versacad software, Version 5.4. Pertinent information was taken from the original "As Built" drawings in 1967.

SPECIFICATIONS

The NEH Section 20 standard specifications have been used for this project, along with a revised 400 specification for joint sealant that was approved for EMF Reach 4, and three new 400 series specifications as follows:

401. Polymer Modified Patching Compound For Spall Repair of Concrete Lined Floodway.

402. Epoxy Adhesive Injection For Concrete Repair of Concrete Lined Floodway.

403. Grout

The 403 Grout specification was made by revising Construction Specification 62 Grouted Rock Riprap.

The following NEH Section 20 specifications were used:

3	Structural Removal
5	Pollution Control
7	Construction Surveys for Layout, Control and Measurement
8	Mobilization
10	Water for Construction
11	Removal of Water
21	Excavation
23	Earthfill
31	Concrete
34	Steel Reinforcement
94	Contractor Inspection

COST ESTIMATE

The preliminary estimate is $602,378. There are no unusual materials or construction methods involved.

CONSTRUCTION SCHEDULE

The construction schedule was based on an average contractor doing the work. The chance that storms could place considerable water in the channel will require that the contractor remove and replace only enough sections to eliminate the possibility of eroding the soil and uplifting the existing lining adjacent to the repair section. Total construction time is 180 days and this was based on doing 2-50 foot sections per day or 6 of the smaller repair sections per day. The remaining work can be accomplished during the placement of concrete.

OPERATION AND MAINTENANCE

The files will be reviewed for an O&M plan and its adequacy during the preliminary design review. If an O&M plan can not be found one will be written for the final design phase.

This repair work will reduce the operation and maintenance considerably over work required since the channel was constructed. Tumbleweeds, shrubs, grass and debris have been a major maintenance problem due to all the cracks, open joints, and spalled areas. This repair project will reduce the opportunity for plant growth to start. A regular maintenance program should be initiated to check for broken sealant and these areas should be immediately repaired to prevent plant growth. After each major storm the channel should be checked to assure that it is functioning properly, that debris is removed, and that no damage has occurred.

CONSTRUCTION REVIEW

The channel bottom should be inspected by the geologist after sections have been removed in the area where expansive clay was found, and in other areas where soils are questionable.

A review of spall repair, crack repair, and sealing joints with the manufacturer's representative should be performed prior to beginning work on these items.

A preconstruction conference will be held at which time questions about the repair or design can be discussed.

AUTHORITY

Tom Jayo 11-26-91

Submitted by: Design Engineer Date

John [illegible] 11-26-91

Recommended by: State Design Engineer Date

Ralph M. Irwin 11-27-91

Approved by: State Conservation Engineer Date

Correspondence

United States
Department of
Agriculture

Soil
Conservation
Service

201 E. Indianola Avenue
Suite 200
Phoenix, Arizona 85012

September 25, 1991

Dan Sagramoso, P.E.
Chief Engineer and General Manager
Flood Control District of Maricopa Co.
3335 West Durango Street
Phoenix, Arizona 85009

RE: Powerline Floodway Repair - Crack Investigation

Dear Mr. Sagramoso:

We want to express our appreciation to the Flood Control District for providing equipment and labor during the crack investigation of the Powerline Floodway on September 17 and 23, 1991. The investigation was successfully accomplished and we obtained the information necessary to proceed with the preliminary design. We especially commend Mr. Ellery Biathrow of your staff for his efforts in coordinating the work at the site and for arranging to have the special equipment available for the investigation. He gave us excellent suggestions and was very cooperative to our needs.

We plan on taking several soil samples for testing purposes where sections have raised several inches. We will make this information available to you.

We thank you again for your help during this investigation. It is a pleasure working with the Flood Control District.

Sincerely,

Donald W. Gohmert

DONALD W. GOHMERT
State Conservationist

United States
Department of
Agriculture

Soil
Conservation
Service

201 E. Indianola Avenue
Suite 200
Phoenix, Arizona 85012

Subject: Powerline Floodway Repair - Field trip to check questionable areas for complete removal.

Date: September 25, 1991

To: John Harrington
State Design Engineer

File Code: 210-13

On 9/13/91 a field study was made on Powerline Floodway with Ralph Arrington, John Sullivan and Ellery Biathrow. We looked at ten areas that previously had been selected as areas where the entire section may have to be removed. Conclusion of field trip was as follows:

1. STA 41+25 do not remove section in this area. Blend high area at joint by cutting 3 feet on each side of joint. Add station to table for repairs greater than 4 feet.

2. Repair crack down center of Floodway from station 36+00 to station 40+50.

3. Replace section station 77+75± to station 80+25±. Parts of this section have raised and it was agreed that the MCFCD would cut 1x1 sections out of the invert so that two to four samples of soil can be taken for testing purposes. The exact length to be replaced in this area will be determined after level surveys are completed for the entire floodway.

ok 4. Replace concrete lining station 154+50 to station 156+25. Ellery suggested the MCFCD perform a demonstration with a new water blast machine to see if it will clean out the cracks satisfactory. He also agreed to trying a bush hammer they have for widening and deepening the cracks for placement of joint sealer. He proposed doing this on 9/17 or 9/18. SCS agreed to work with Ellery during the testing and investigation.

ok 5. Replace section station 166+50 to station 168+00. It was agreed by group that the weir at station 167+70 would not be removed. The new lining will be placed around the existing weir.

ok 6. Replace section station 215+15 to station 215+39. Cut a new joint at STA 213+60±.

ok 7. Replace section station 216+25 to station 217+00.

8. Replace section station 223+96 to station 225+50.

[illegible] FROM STA 251+44 TO STA 253+50

9. Model water surface for adequate free board from station 250+30 to station 252+50 before considering removal in this area.

10. Replace section station 260+72 to station 260+82.

Tom Jayo

Tom Jayo
Design Engineer

cc: Ralph Arrington, State Conservation Engineer

AZ Power line Floodway Repair

Tom Jay 9/13/91

Field Trip to CK Questionable Areas 1

STA 41+00 - blend Joint - over 2 to 5' on each side of joint

Crack center of channel - STA 40+50 to STA 36+00

Bad area @ 30+00 - document with 2 to 4 samples center of Floody.

Replace section 154+50 to 156+25

tears or wed - demo @ this area - chisel & water blast by FCD.

Replace sec 166+50 to 168+00

all new section put cutoff on top of sidewalls 1' deep ±.

@ 167+70 leave weir inlet in place south side

Replace sec 215+15 to transition with bridge only

Put joint @ 213+60± needs to be measured in

Replace sec 216+25 to 217+00

Replace sec 223+96 to 225+50 @ bridge transition

Model [illegible] 250+30 to 252+50 - ck freeboard

255+75

Replace sec 260+72 to 260+82 3' upstream of JT

short sec tole replaced

Replace sec sta 255+75 to 256+25 if Hydraulics dictate it. or to 256+50. If hydraulics dictate must go to 255+50 to eliminate high point.

Note major void @ 266+00 @ Joint

↓ need to ck stationing on this joint

United States Department of Agriculture

Soil Conservation Service

201 E. Indianola Avenue
Suite 200
Phoenix, Arizona 85012

Subject: Powerline Floodway Repair-Crack Repair Investigation with Maricopa County Flood Control District

Date: September 24, 1991

To: John Harrington
State Design Engineer

File Code: 210-13

On 9-17-91 I met Ellery Biathrow and maintence crew at station 78+00 of Powerline Floodway. Ellery's crew demonstrated the following:

1. A hydroblaster combination of 3000 psi water and sand was used to clean a 20'length ± of crack from station 78+20 to station 78+40. The hydroblaster did a good job of cleaning out the existing crack. The crack measured 3/16" to 1/4" wide. A fine film of sand was left in the crack which would require high pressure air to remove. The hydroblaster did not remove any concrete. It is questionable whether this method will work unless the crack is already wide enough to receive the joint sealer.

2. A 185 CFM air compressor operating an air operated bush hammer was tried on 10' of crack located at station 78+00. Head on bush hammer measured 2" x 2". This method was fast and a depth at 1/4" to 1/2" was obtained quite easily. The disadvantage of this particular hammer was the top width of concrete removed was excessive. They tried angling the hammer into the crack which decreased the top width and appeared to be a better way of using this size head.

3. A 3/4" ± air operated chisel was used on a 15' section of crack. The chisel worked well but breakout was irregular and only one side of the crack was broken out, leaving the other side soiled where soil sealant would not adhere without sand blasting. The operator indicated that it was very difficult to operate chisel to get the desired size of opening. It took the operator 2 minutes to do 10' of crack and he was trying to make as much footage as possible. The crack opening was larger than desired and was quite irregular. More time chiseling the 10' length would have produced a more uniform crack. An estimate of 5 minutes per 10' of crack would provide a more uniform crack.

4. FCD personnel saw cut 1'x 1' sections out of the channel bottom at stations 78+00, 155+10, 167+40 and station 224+25.

It was agreed that soil samples would be taken at above stations on 9-24-91. The county would also run some trials with a smaller bush hammer and I agreed to supply joint sealant for sealing the cracks opened by the county. The FCD agreed to place concrete in the 1 x 1 cutouts where soil samples were taken. Pictures were taken of above trials.

Tom Jayo

Tom Jayo
Design Engineer

cc: Ralph Arrington, SCE, Phoenix

October 24, 1977

Mr. Charles Burm
General Motors Proving Grounds
13303 South Ellsworth Road
Mesa, Arizona 85224

RE: Powerline Floodway

Dear Mr. Burm:

The Flood Control District has reviewed the proposed modifications of the Powerline Floodway which include four box culverts within District right-of-way and approves the plans.

Due to a layout error by Phoenix Engineering Company, the centerline of the 400 foot box culvert underneath the straightaway structure was constructed approximately 2.5 feet south of the original design position. Phoenix Engineering has proposed that the alignment shift be corrected by modifying the outlet transition and the east 150 feet of the structure as shown on their drawing entitled "Straightaway Structure Outlet Transition Modification." This can be done because neither the outlet transition nor the east 150 feet of the structure have been constructed. We approve this modification.

Located adjacent and west of the easternmost box culvert at Station 217 there is a 50 foot section and a 25 foot section of the existing concrete liner that appears to have two voids underneath the liner. These two sections should be removed. Also, there is a 50 foot section adjacent and east of the above noted box culvert that has a void underneath the existing concrete liner. This joint will need to be removed and replaced.

If you have an alternate solution to the removal of these three sections, please contact Jack Leavitt of my staff.

Sincerely,

Signed - Herbert P. Donald

Herbert P. Donald, P.E.
Chief Engineer and General Manager

DES

JAL JAL

cc: Mr. Raymond W. Stadler
Phoenix Engineering

Powerline
G.M.

LEAVITT/ly

UNITED STATES DEPARTMENT OF AGRICULTURE

Const. Office

SOIL CONSERVATION SERVICE Room 3008 Federal Bldg., Phoenix, AZ 85025

BJECT: ENG - Design - PL566 - Williams-Chandler WPP, Arizona - Powerline Floodway

DATE: April 13, 1978

TO: Ralph Arrington
State Conservation Engineer

I attended a meeting at General Motors Proving Grounds on April 13, 1978 for the purpose of discussing the damage to the floodway lining that had occurred during the construction of the General Motors test tract. A list of persons attending is attached.

Warren Anderson described results of coring between Station 260+24 and Station 267+50 during March 1978. The SCS survey conducted during September 1977 was introduced. The condition of the lining and subgrade was discussed. The question was raised as as to whether a considerable amount of voids had existed prior to the failure of the culvert. This question was not totally resolved.

Jack Leavitt defined the measures of repair that would be satisfactory to the Flood Control District. The most economical of these measures would be grouting the voids. Methods of grouting were discussed.

Jack requested a proposal for the section discussed, as well as for the damaged section upstream. The General Motors representative requested a letter concerning the request for a proposal. They will then respond.

Paul J. Monville
Design Engineer

Attachment

bcc: Tom Jayo
Joe Knisley

Flood Control District
of
Maricopa County
3325 WEST DURANGO STREET
PHOENIX, ARIZONA 85009

November 2, 1971

MEMO TO: Col. Lowry

SUBJECT: POWERLINE FLOODWAY DAMAGE

Reference is made to memorandum of October 5, 1971, regarding damage to the Powerline Floodway during the storm of September 30, 1971.

In accordance with the last paragraph of that memorandum, a more thorough investigation of the damage opposite the General Motors Proving Ground was made by L. E. Ohsiek and S. Bingham on October 28, after water had stopped running in the channel. The results of the investigation are shown graphically on the attached sketch.

I concluded that water penetrated between the underside of the lining and the supporting sandy silt. As it moved down in this area it leached out the easily melted silty material until a large space existed. The flow also contained sand picked up in the desert and from the sandy silt. As this sediment reached obstacles, such as the cut-off collars constructed each 325', the sand filled the opening and gradually the space between the lining and the ground was refilled. At the time of the investigation the sand under the floor of the lining was in a saturated condition, indicating that it had recently contained water, possible until water stopped flowing in the channel in the last few days.

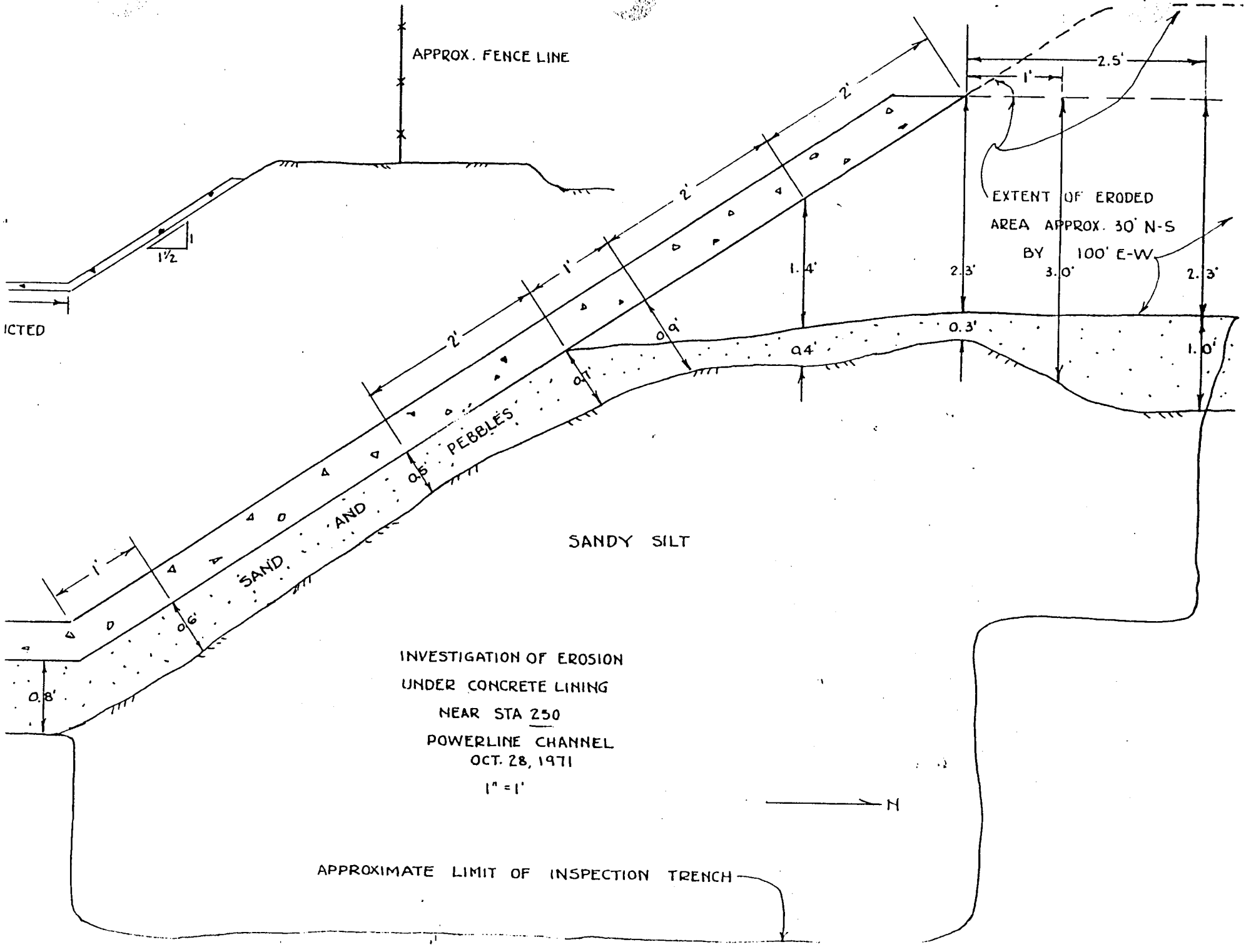
This situation will be discussed further with Soil Conservation Service engineers to determine methods of corrective construction, and funding thereof. Mr. Don Riddle, SCS, was present and also inspected the last part of the investigation.

L. E. OHSIEK

LEO/aa

Enclosure

cc: R. Arrington, Soil Conservation Service
D. Riddle, Soil Conservation Service
C. Burm, General Motors Proving Ground


APPROX. FENCE LINE
1
1½
ICTED
2'
2'
1'
2'
1'
0.9'
0.1'
0.5'
0.6'
0.8'
SAND
AND
PEBBLES
SANDY SILT
1.4'
0.4'
2.3'
0.3'
3.0'
2.5'
1'
2.3'
1.0'
EXTENT OF ERODED
AREA APPROX. 30' N-S
BY 100' E-W
INVESTIGATION OF EROSION
UNDER CONCRETE LINING
NEAR STA 250
POWERLINE CHANNEL
OCT. 28, 1971
1" = 1'
N
APPROXIMATE LIMIT OF INSPECTION TRENCH

October 5, 1971

MEMO FOR FILE

SUBJECT: POWERLINE FLOODWAY DAMAGE

On October 4, 1971, Lee Ohsiek and Barry Nauseda visited Powerline Floodway from Ellsworth Road east to the first concrete channel-crossing bridge. The Flood Control District was alerted to this problem by Mr. Burm of the General Motors Proving Grounds.

In many locations the Channel lining has been undercut by the local inflow. The greatest damage was caused by the storm of September 30, from 4:00 p.m., to 5:00 p.m. Apache Junction had 1.68 inches of rain that hour and General Motors Proving Grounds had 1.18 inches. In some areas the concrete lining has failed by sagging into voids where foundation material has been removed by the undermining flows. General Motors Proving Grounds called because a large section of lining on their side of the channel has been undercut to the extent that footings for their chain-link fence posts have been exposed. (The fence posts are eight feet from the channel lining.)

The first inlet (for local flows) was not adequate and undercut and settling has occurred (located just east of General Motors Proving Grounds).

On preliminary investigation it appears one of the following occurred: (1) The local inflow as it entered the channel ran partially parallel to the lining thus cutting and removing material from beneath the lining. (2) The inflow ran beneath the lining for some distance downstream then flowed and erupted out in a "boiling action", therefore washing material. (3) The flow ran beneath the lining then out from the joints and perhaps the weep holes in the bottom of the channel.

It has been requested that SCS personnel visit the site and perhaps lend guidance to what type of repair can be quickly and efficiently made. (If another storm would occur some lining could be lost and channel capacity greatly reduced).

Inspection of the remainder of the channel was not possible because of time, and a visit to Mr. Burm at General Motors Proving Grounds had to be made. The remainder of the channel should be inspected to determine the true extent of repairs necessary.

At General Motors Proving Grounds Mr. Burm drove us to the damaged area along General Motor's fence. He stated the local inlets (culverts and concrete aprons) could not handle the large flows of September 30, and as the water flowed over the berms to the channel the undercutting occurred. He stated when repairs are to be made General Motors will arrange for trucks and equipment to enter onto the proving ground for access to the washouts.

After repairs are made regrading of the access roads will be needed to prevent further washouts. Also more inlets should be provided to carry flows into the channel, if the current design will handle additional inflow confluences. (This will be checked with SCS).

It is expected that the flow in the channel will continue to about October 10, 1971, then a more thorough investigation can be made and repairs initiated.

Barry Nauseda

BARRY NAUSEDA

BN/aa

UNITED STATES DEPARTMENT OF AGRICULTURE

SOIL CONSERVATION SERVICE Room 6029 Federal Bldg., Phoenix, AZ 85025

SUBJECT: WS - Request for Repair Work on Powerline Floodway, Apache Junction-Gilbert Watershed (2006)

DATE: January 20, 1972

TO: Kenneth E. Grant, Administrator
SCS, Washington, D. C.

We are requesting funds to enlarge two existing inlets and install two additional inlets on the subject watershed project. Our request follows paragraph 115.02 WPH in outline.

a. The Powerline Floodway was constructed during 1967-68 with a completion date of May 28, 1968. The construction cost was $375,630.1 of which $29,161.03 was sponsor cost. It is located about five miles south of Apache Junction, Arizona.

The Powerline Floodway is 6 to 8 feet wide, 4-3/4 to 6-1/2 feet deep, lining thickness of 4-1/2 to 5 inches, and 6-1/2 miles long. The lining is scored every 50 feet for contraction and expansion joints are placed on 325-foot intervals.

Provision was made for local surface runoff to enter through the lining by 16 corrugated metal arch pipe sections ranging in sizes from 25" x 16" to 43" x 27" and over the top of the lining through 3 weir inlets.

b. and c. On the afternoon of September 1, 1971, after minor rains of the preceeding day, a convective type storm approaching from the Southwest travelled up the channel (increasing in intensity) as it travelled. A rain gage near the lower end of the floodway measured 1.13 inches. Further northeast 2.5 inches was recorded. The duration of the storm was something less than an hour.

The side washes filled quickly, bringing floodwaters toward the relatively empty channel. At approximately ten locations overbank flows entered between the lining and the earth bank, seeping toward the open weep holes and contraction joints. As the seepage pressure increased, the lining lifted three to four inches, rotating channel sections primarily northward. This allowed deeper erosion to occur with the increased velocities. As side inflows receded, the channel lining settled back into place. The non-uniform bank surface provided uneven support for the lining. As the channel loaded with runoff waters from the dams upstream, the lining cracked longitudinally at the uplifted locations.

d. The Flood Control District of Maricopa County has adequately maintained the lining since its completion in 1968. It operates under a county budget system and calls upon county maintenance equipment to perform work as needed.

e. The runoff pattern of the adjacent somewhat uniform desert lands is complex and difficult to predict. This particular storm indicated additional inlet capacity is necessary unless extensive earth grading is done to direct all flows toward the existing inlets. The need for two new inlets at Station 167+00 and Station 252+75 are apparent since greater concentrations of runoff entered at these locations. Two new inlets of 25 feet and 30 feet respectively are proposed. Existing inlets on each side of the channel at Station 214+50 were overtopped by this storm and require increased capacity to handle future storms of this magnitude. We propose to enlarge these inlets.

f. The Flood Control District of Maricopa County is responsible for maintenance of the floodway and will perform all maintenance work resulting from this storm. They will complete or have completed the following:

1. Raising side road grade as needed.
2. Grading and cleaning out at existing side drainage ditches.
3. Replace and repair dike work as needed.
4. Backfill beneath lining with sand and gravels as needed.
5. Repair cracks in lining, including removal of displaced sections and replacing to near uniform grade as possible.

We propose that the Service enlarge the existing inlets and provide two additional inlets as indicated above.

g. Estimated cost of Service repair work: $5,000.00.

h. A copy of flood damage report prepared by the State Conservation Engineer with a photo is attached.

M. E. Strong
State Conservationist

Attachments

cc: Paul Tilker, EWPU

UNITED STATES DEPARTMENT OF AGRICULTURE

SOIL CONSERVATION SERVICE Room 6029 Federal Bldg., Phoenix, AZ 8502

SUBJECT: ENG - Powerline Channel Damages
Apache Junction-Gilbert Watershed

DATE: December 6, 1971

TO: M. E. Strong
State Conservationist

November 15, 1971 Ralph Arrington and I accompanied Lee Chsiek, Assistant Engineer of the Flood Control District of Maricopa County, to the Powerline Channel. We were met at the site by George England. A reconnaissance survey was made of the type and extent of storm damage to the concrete lined channel and the repairs considered needed. It was agreed that a copy of this joint report would be sent to the Flood Control District for their information.

Our findings are as follows:

1. Arch pipe inlet - Vineyard Floodway, approx. Sta. 7+87

   Damage: Two 15" to 24" piping holes, one on each side of pipe, near the top of the pipe.

   Cause: Settlement of pipe allowed piping to occur along the upper earth contact zone.

   Repair: Trench and excavate the dike fill along the pipe alignment. Replace fill with ABC sand and gravel backfill, compacting in place with vibrator compactors. (8-10 cu.yds. needed).

2. Powerline Channel, Sta. 35+75, southside

   Damage: Hole eroded beneath concrete lining. Approx. 40 ft. in length by 8 ft. in depth, with average thickness of 6 inches.

   Cause: Side drainage overflow into cracks beneath concrete lining. Water flow eroded larger zone beneath lining.

   Repair: Prepare free flowing sand slurry and inject into eroded zone (3-5 cu.yds. needed)

3. Powerline Channel, Sta. 72+00, southside

   Damage: Hole eroded beneath concrete lining, approx. 30' wide, 3-5 ft. depth, and 3"-4" average thickness.

Cause: Side drainage overflow into zone beneath concrete lining.

Repair: Prepare free flowing sand slurry and inject into eroded zone (1½ to 2 cu. yds.)

4. Powerline Channel, Sta. 89+00, southside inlet.

Damage: Backfill around headwall eroded away. Some minor erosion beneath lining in area adjacent to headwall.

Cause: Approximately 1.0 ft. depth of flow over crest of inlet. Water flowed around headwall and overflowed lining. Backfill around headwall was inadequate.

Repair: Rebuild bank around downstream headwall to an elevation above concrete. (Approximately 2 cu.yds. needed).

5. Powerline Channel, Sta. 105+00, northside

Damage: Erosion beneath concrete lining, creating hole 30 ft. wide, 8 ft. deep, 4" to 6" in thickness. Additional headcutting caused a hole 5' wide by 10 ft. long and 3 ft. in depth adjacent to lining.

Cause: Side drainage overflow into cracks beneath lining.

Repair: Place 5 cu. yds. of gravel into bulk of eroded zone; then prepare approximately 2 cu.yds. of sand slurry and inject into eroded zone beneath lining.

scheduled for replacement

6. Powerline Channel, Sta. 156+00, southside

Damage: Longitudinal crack full length of 325-foot section at base of south lining slope. Lining rotated and lifted approximately 3-inch offset and change in invert slope. Displaced 3"-4" from adjacent lining along slope at contraction joint. Erosion beneath lining created hole 25 ft. wide, 6 ft. deep and 1 ft. to 3 ft. thick.

Cause: Side drainage overflow into cracks beneath lining. Side drainage preceded flow in concrete channel and in sufficient quantity to uplift lining, rotating it northward. As side drainage receded and channel flow increased, lining settled back into position of 3" to 4" offset and cracking at base of juncture occurred.

Repair: Fill bulk of eroded area with approximately 3 cu.yds. of gravels; then inject approximately 5 cu.yds. sand slurry into zones beneath lining. No concrete repair necessary at this location.

scheduled for replacement 7. Powerline Channel, Sta. 167+00, southside.

Damage: Lining rotated approximately 3 inches and uplifted with an offset approximately 6 inches from adjacent slab at contraction joint. Erosion beneath lining eroded hole 150 ft. long, 6 ft. deep and 0.3 to 2 ft. wide. Cracking of base occurred as it was loaded from channel flow.

Cause: Side drainage overflow into cracks beneath lining caused uplift and rotation. Cracking of base occurred as the lining settled back into place and was loaded with channel flow.

Repair: Provide a 25-ft. side inlet overpour structure along the south side. Break out and replace approximately 140 sq. ft. of lining near upstream contraction joint and approximately 40 sq. ft. of lining at the downstream expansion joint. Fill bulk of eroded hole with gravel (approximately 25 cu.yds.) and inject free flowing sand slurry into deeper cracks, approximately 5 cu.yds.

scheduled for replacement 8. Powerline Channel, Sta. 214+50, side inlets (north and south sides)

Southside -

Damage: Right wing wall of inlet structure uplifted the lining rotated about the left side wall, cracking wing walls and inlet headwall. Slope of lining cracked below right side wall. Side drainage overflow into crack beneath lining eroded hole along 100 ft. upstream of side inlet.

Cause: Side drainage exceeded capacity of inlet, overflowing around wing walls each side. Overflow entered beneath lining, causing uplift and displacement. Erosion created hole beneath lining.

Repair: Enlarge inlet an additional 10 ft. upstream to expansion joint. Break out and replace lining downward on a 45° from right wing sidewall. Compact earth fill around wing walls. Fill in trainer dike across road. Fill eroded zones beneath lining with sand slurry (approximately 6 cu.yds.)

Northside -

Damage: Overflow waters enlarged beneath lining, eroding a hole 80 ft. in length, 8 ft. deep, and 3 inches wide.

Cause: Side drainage flow exceeded the capacity of inlet structure, allowing overflow of lining along upstream reach.

Repair: Enlarge inlet by extending apron, side wall, and wing 10 ft. downstream. Refill eroded areas with sand slurry, approximately 6 cu.yds.

scheduled for replacement 223+96 to 225+50

9. Powerline Channel, Sta. 222+00, northside

Damage: Overflow seepage uplifted lining slope, cracking near base of south slope for 50 ft. length, displaced approximately 3 inches. Eroded hole created beneath lining.

Cause: Side drainage overflow uplifted north bank of lining rotating toward south bank.

Repair: Fill eroded area with sand slurry, (approximately 5 cu.y

water surface in this area to be modified

10. Powerline Channel, Sta. 252+75, northside and southside, along General Motors Proving Ground

Damage: Side drainage overflow entered beneath lining both sides of channel. South side 80 ft. long, 8 ft. deep and 2"-3" wide. North side, 150 ft. long, 6 ft. deep, 2 to 6 ft. wide. Heavy headcutting along north side. Lining only slightly displaced.

Cause: Water flowing along General Motors Proving Grounds fence parallel to channel exceeded capacity of single CMP inlet and overflowed lining.

Repair: Replace the bulk of the eroded zone with gravelly backfill approximately 150 cu.yds. Fill smaller cracks with sand slurry approximately 15 cu.yds.

Install approximately 20 ft. wide overflow inlet to carry excess waters.

J. J. Turner
State Conservation Engineer

cc: Col. Lowry
G. Welsh
J. Hickerson

POWERLINE FLOODWAY APPROXIMATE STATION 252+75 NEAR
GENERAL MOTORS PROVING GROUND

Design & Drawing Note

7Z Power line Floodway Repair

SJ 10-1-91

Follow up To letter Dated 9/25/91 to John Harrington on areas to be Replaced—

As a result of drawing profile of channel bottom and checking history of areas where overland flood waters came in over top of lining eroding soil beneath lining and causing uplift, causing cracking and loss of channel grade, the following areas require replacement.

		Length FT.
1.	STA 37+25 TO STA 80+25.	300.00
2.	STA 154+50 TO STA 156+25	175.00
3.	STA 166+48 TO STA 168+02	150.00
4.	STA 215+15 TO STA 215+39	24.00
5.	STA 216+25 TO STA 217+00	75.00
6.	STA 223+50 TO STA 225+50	200.00
7.	STA 250+98 TO STA 256+50	550.00
8.	STA 260+25 TO STA 263+00	275.00
		10.00

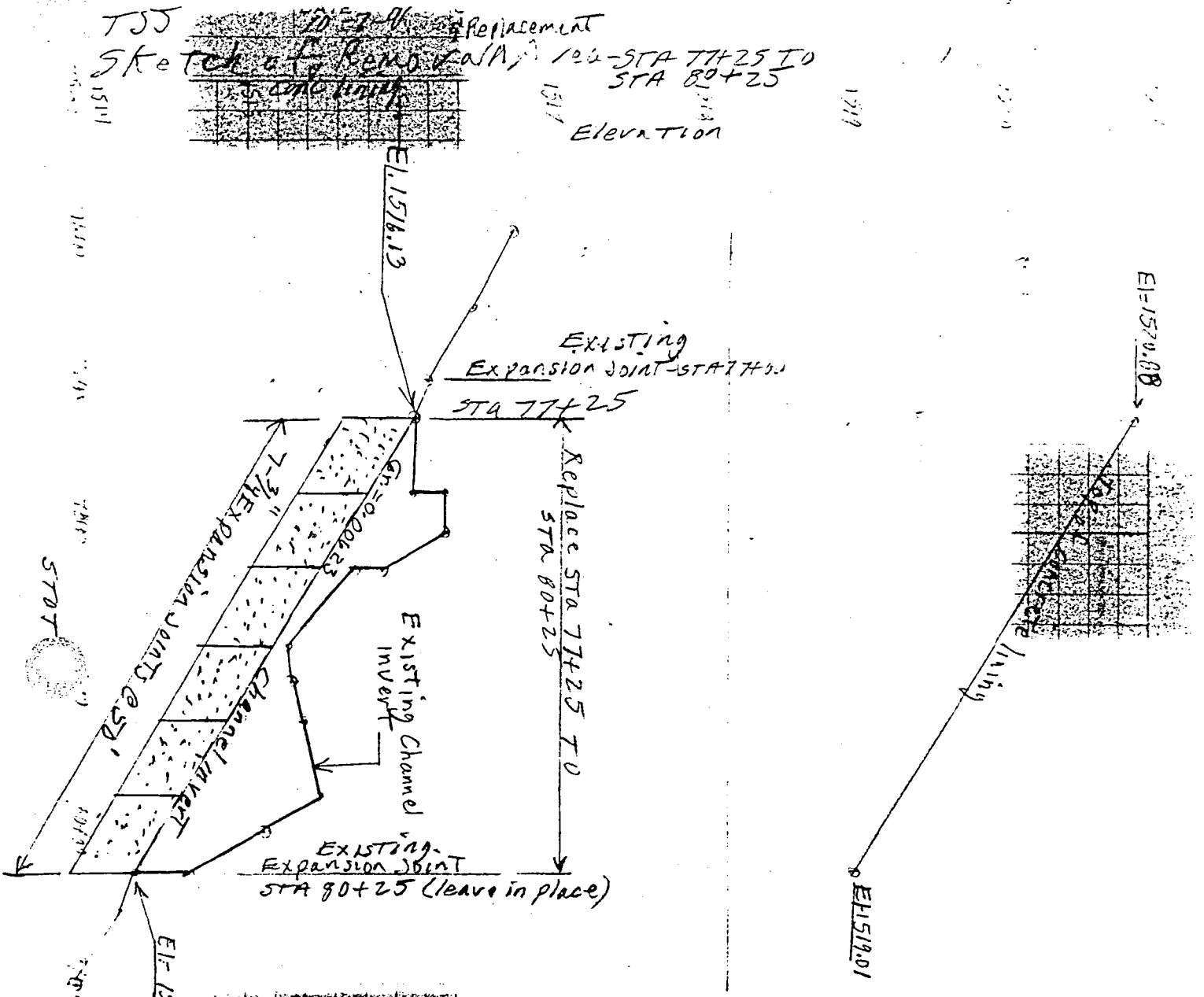
>Need To look @ This sec in field.

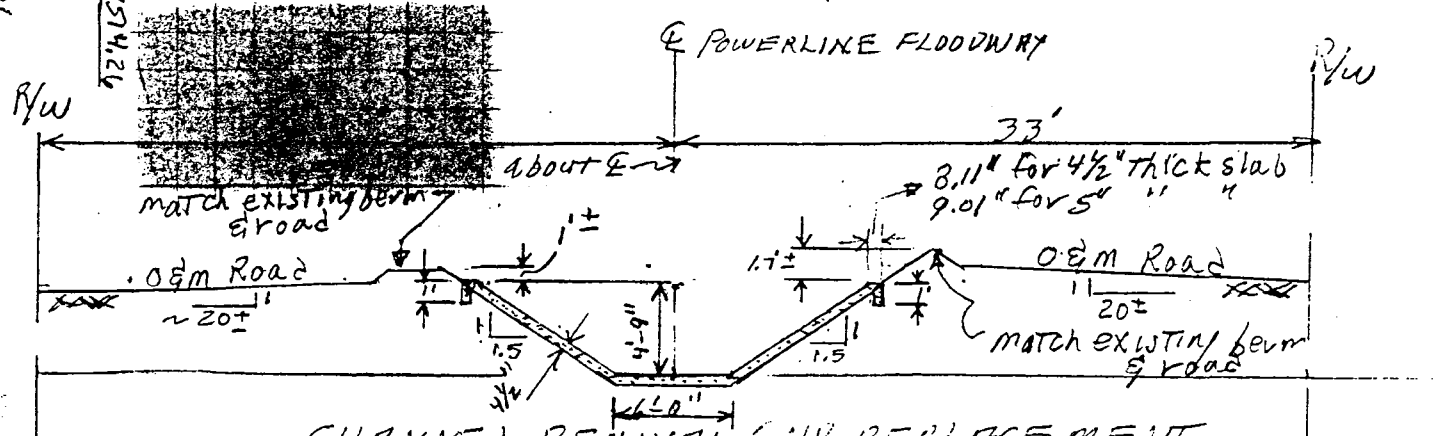
TOTAL = 1,758.0 FT

#8 changed from 10' To 275' as a result of drawing up profile and finding That a major washout in this area from 2 CMPs on 1/18/78 caused area To uplift, cause erosion beneath slab and caused lining to buckle & crack longitudinally. Ralph A & John H. reviewed this on 10/2/91 and agreed to removed questionable area from STA 260+25 To STA 263+00 per The profile.

AZ
TJJ
Sketch of Removal/Replacement - STA 77+25 TO STA 80+25

Powerline Floodway Repair





CHANNEL REMOVAL AND REPLACEMENT
FROM STA 77+25 TO STA 80+25

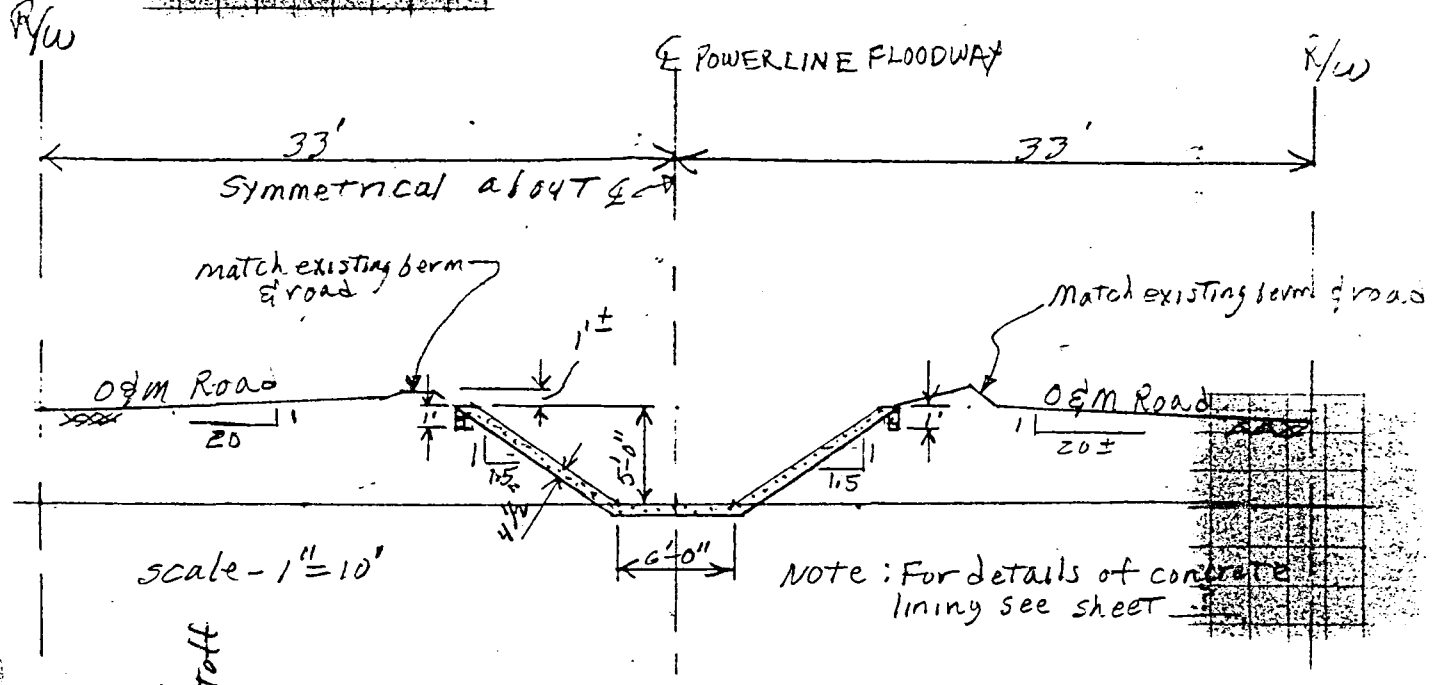
Note: For details of concrete lining see sheet ?

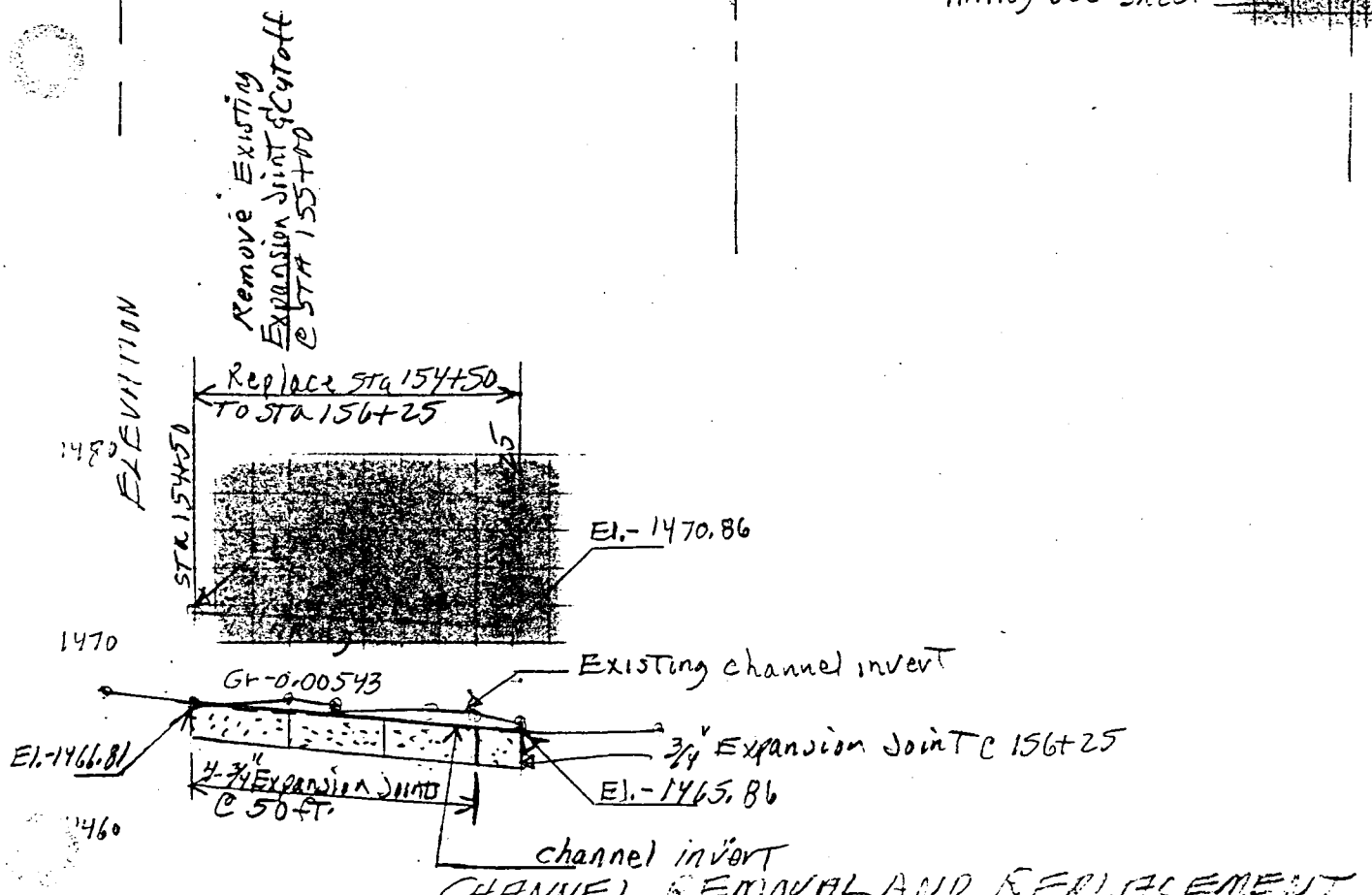
AZ Powerline Floodway Repair

TJJ DATE 7-8-91

Sketch of Removal & Replacement Area STA 154+50 TO STA 156+25 2

Conc lining





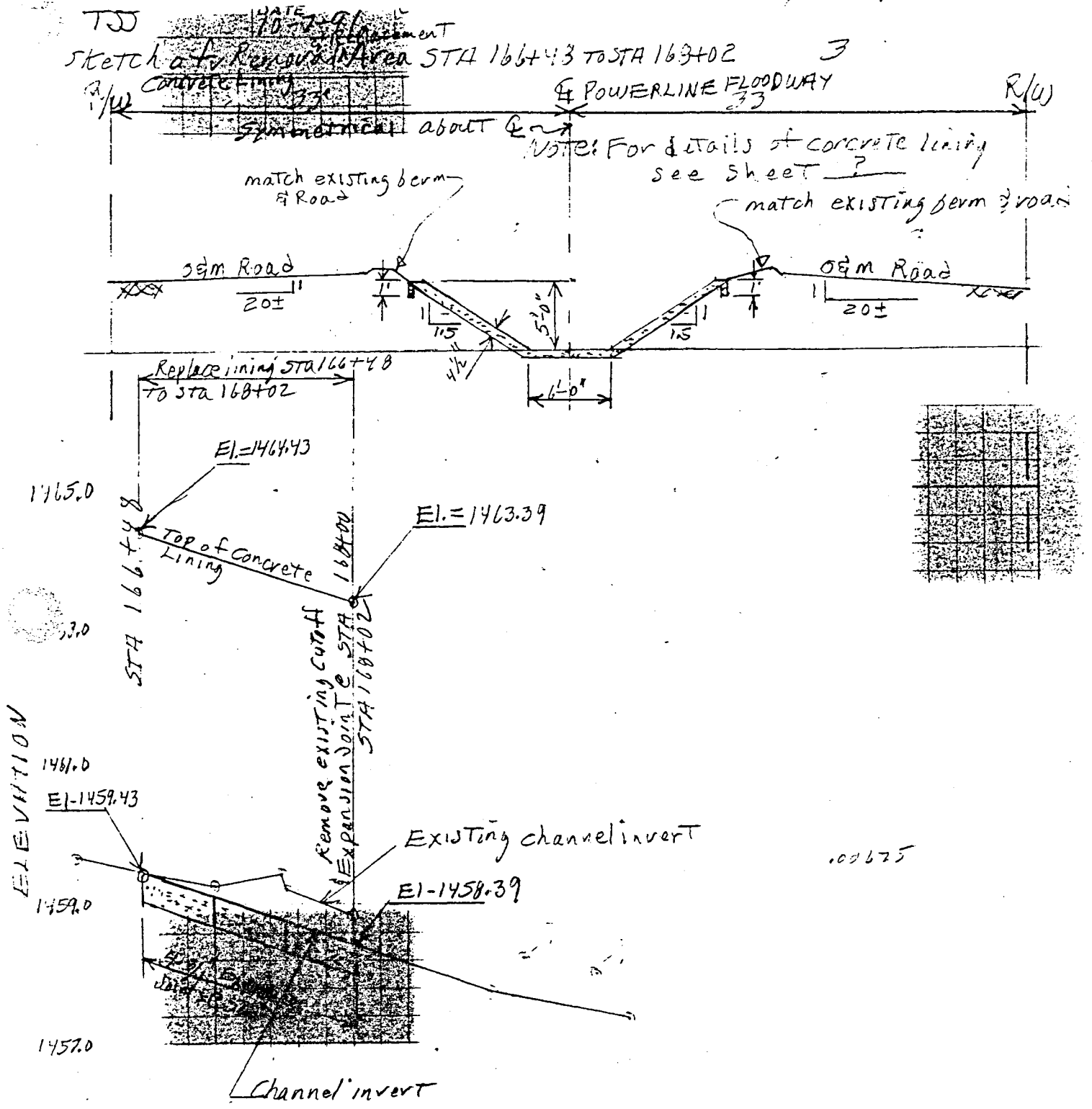
CHANNEL REMOVAL AND REPLACEMENT FROM STA 154+50 TO STA 156+25

A2

TJW

Powerline Floodway Repair

Sketch of Repair Area STA 166+43 TO STA 163+02 3



CHANNEL REMOVAL AND REPLACEMENT FROM STA 166+48 TO STA 168+02

AZ

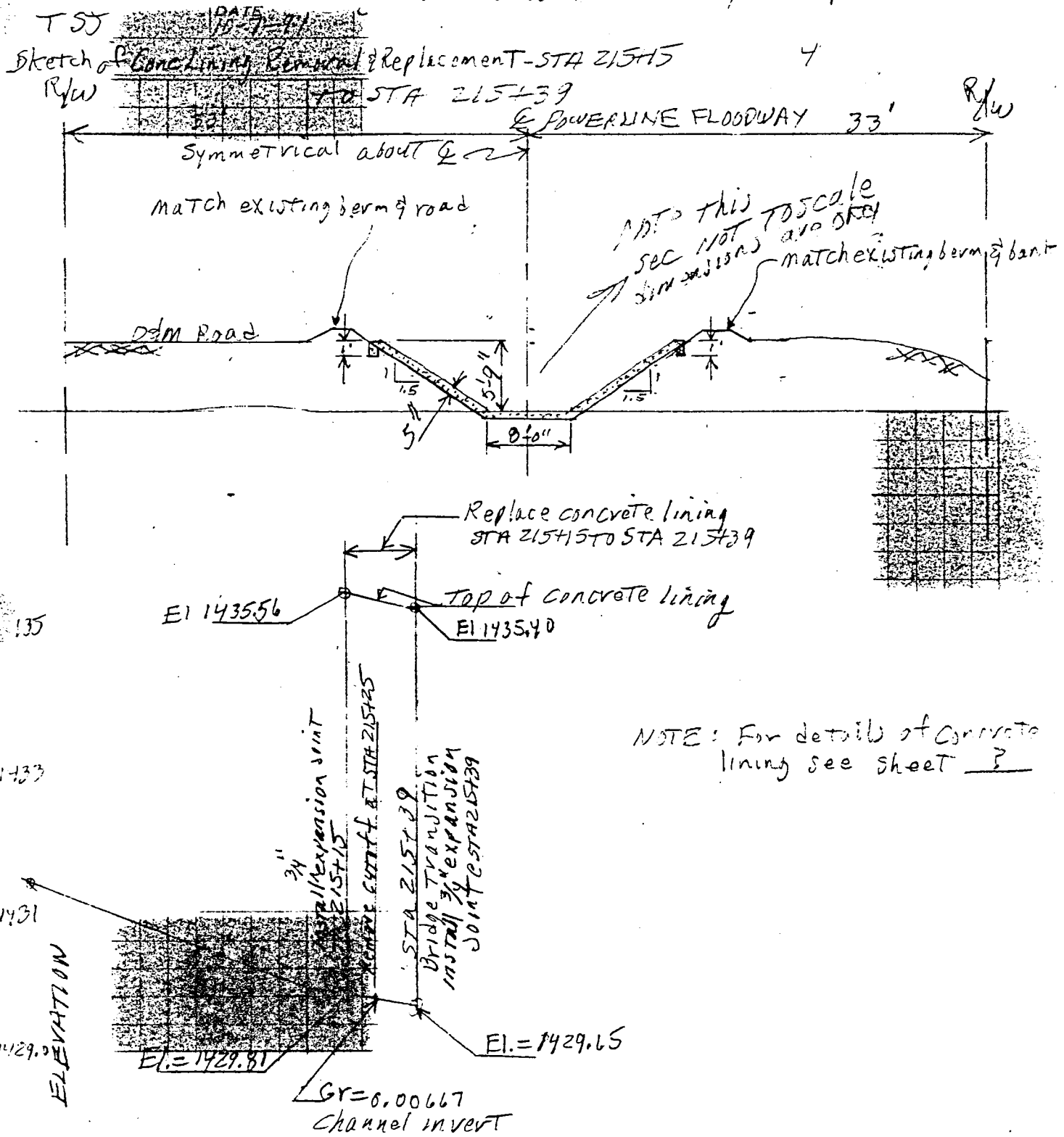
TSJ

Powerline Floodway Repair

DATE 10-7-94

Sketch of Conc Lining Removal & Replacement - STA 215+15 TO STA 215+39

4



CHANNEL REPLACEMENT
FROM STA 215+15 TO STA 215+39

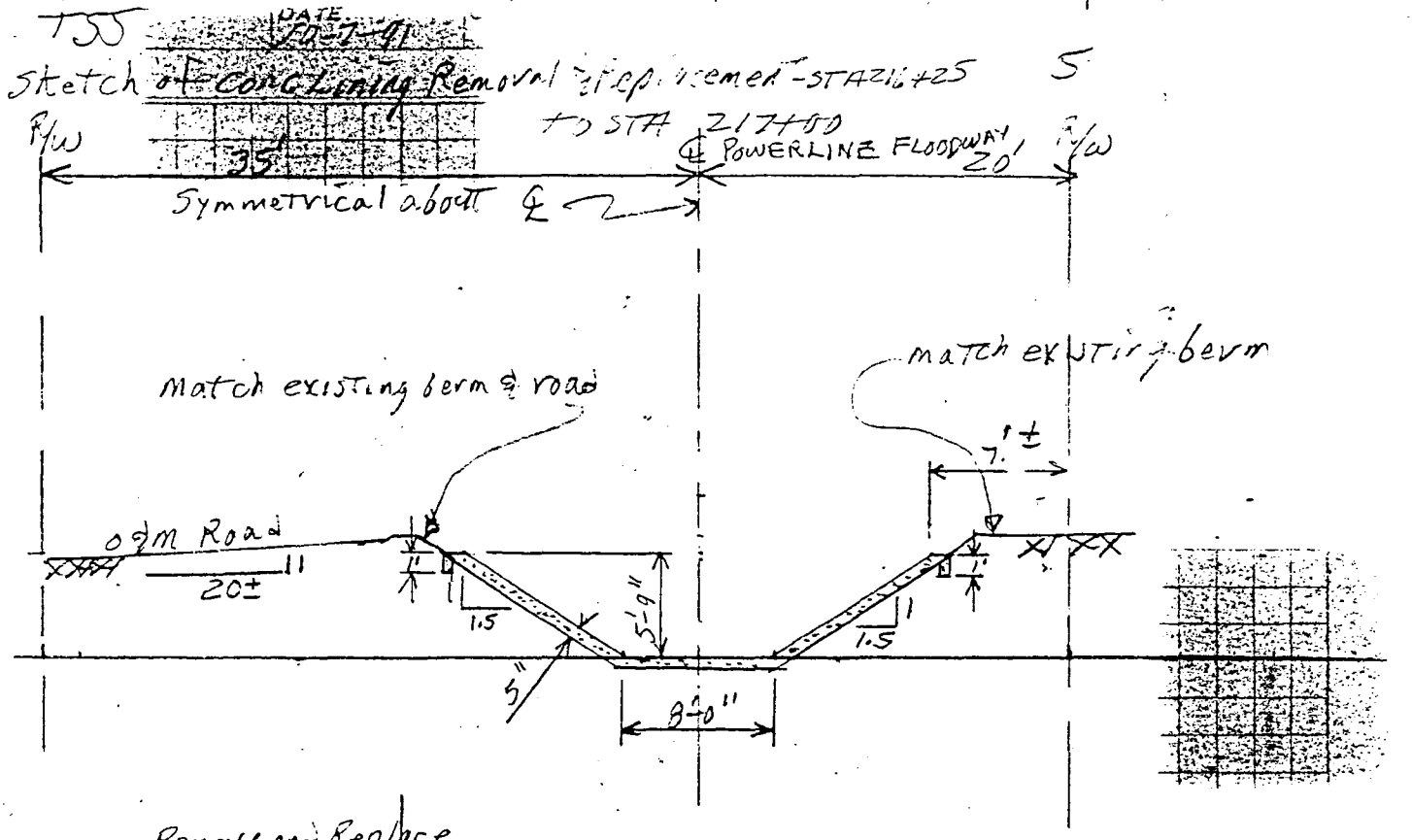
A2
T55

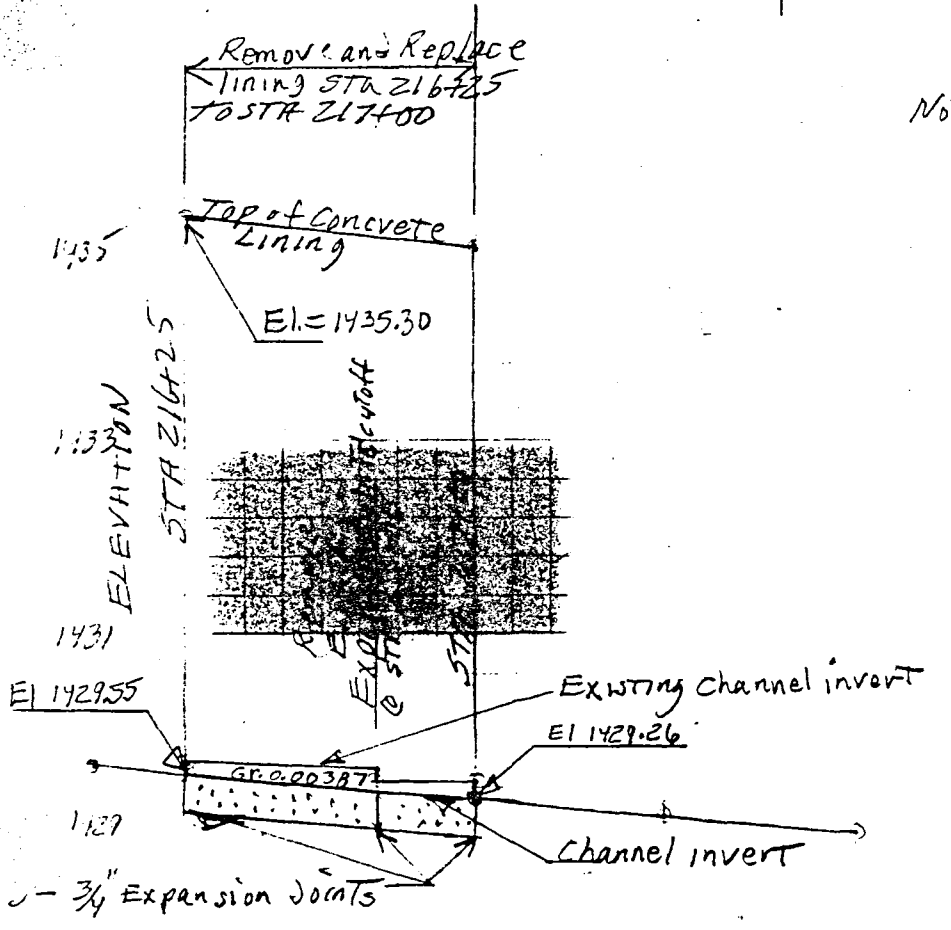
Powerline Floodway Repair

DATE 10-7-91

Sketch of Conc Lining Removal & Replacement - STA 216+25 to STA 217+00

5





Note: For details of concrete lining see Sheet ?

CHANNEL REMOVAL AND REPLACEMENT
FROM STA 216+25 TO STA 217+00

216+50 217+00 219+50
STATION

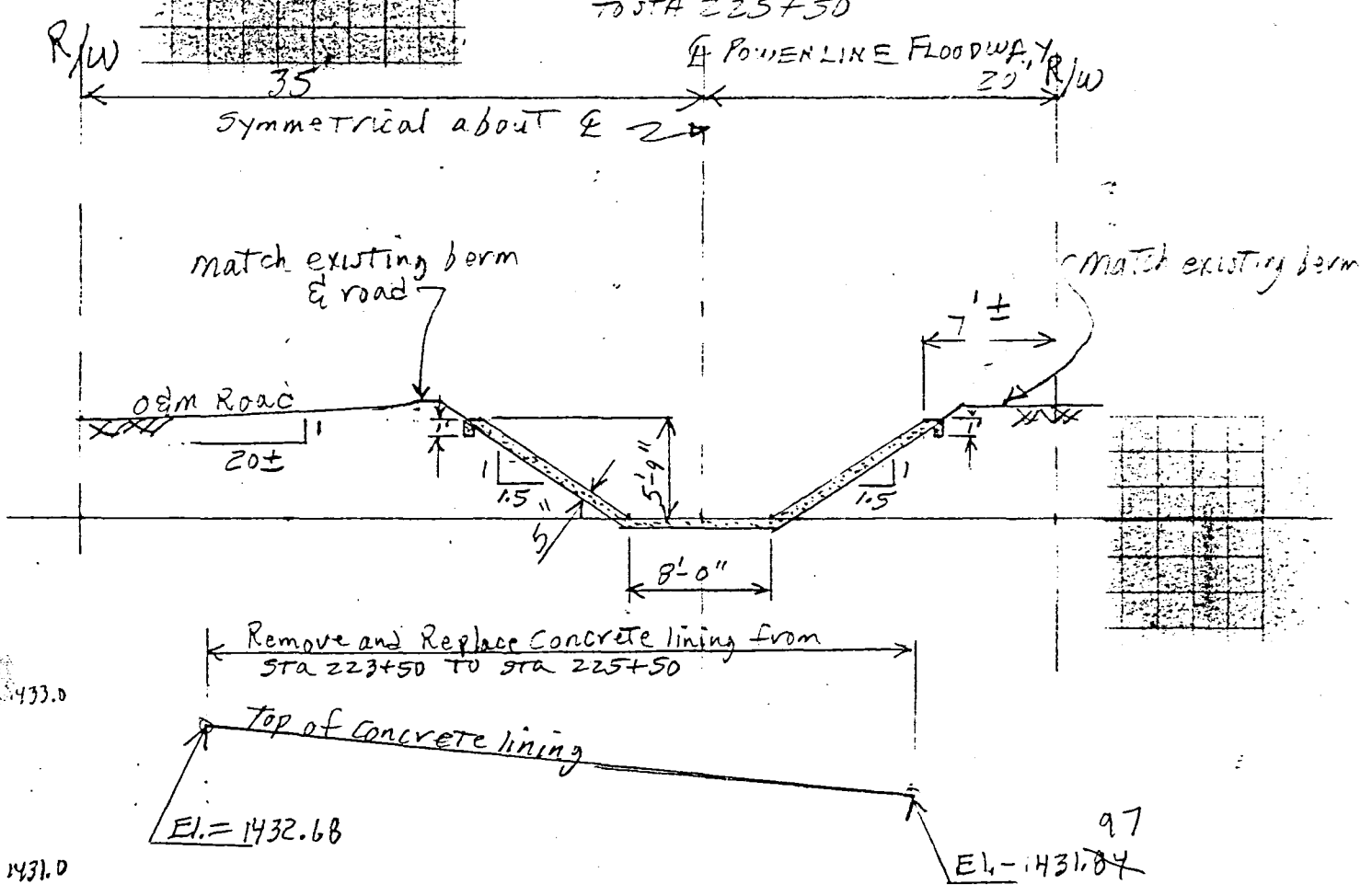
AZ

Powerline Floodway Repair

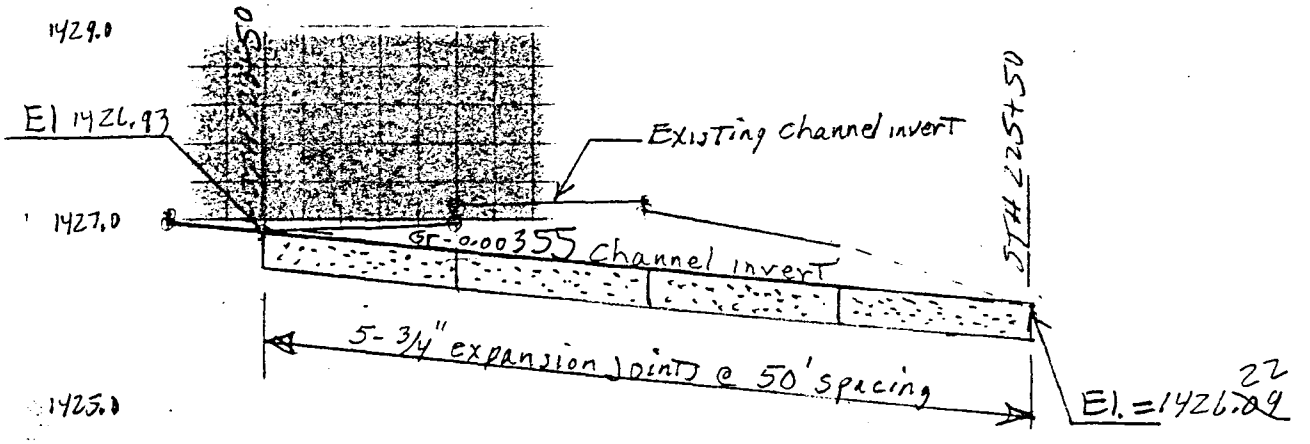
TSJ DATE 10-7-91

Sketch of Conc. Lining Removal & Replacement STA 223+50 TO STA 225+50

6



NOTE: For details of concrete lining see sheet 7



CHANNEL REMOVAL AND REPLACEMENT FROM STA 223+50 TO STA 225+50

223+00 224+00 225+00 226+00

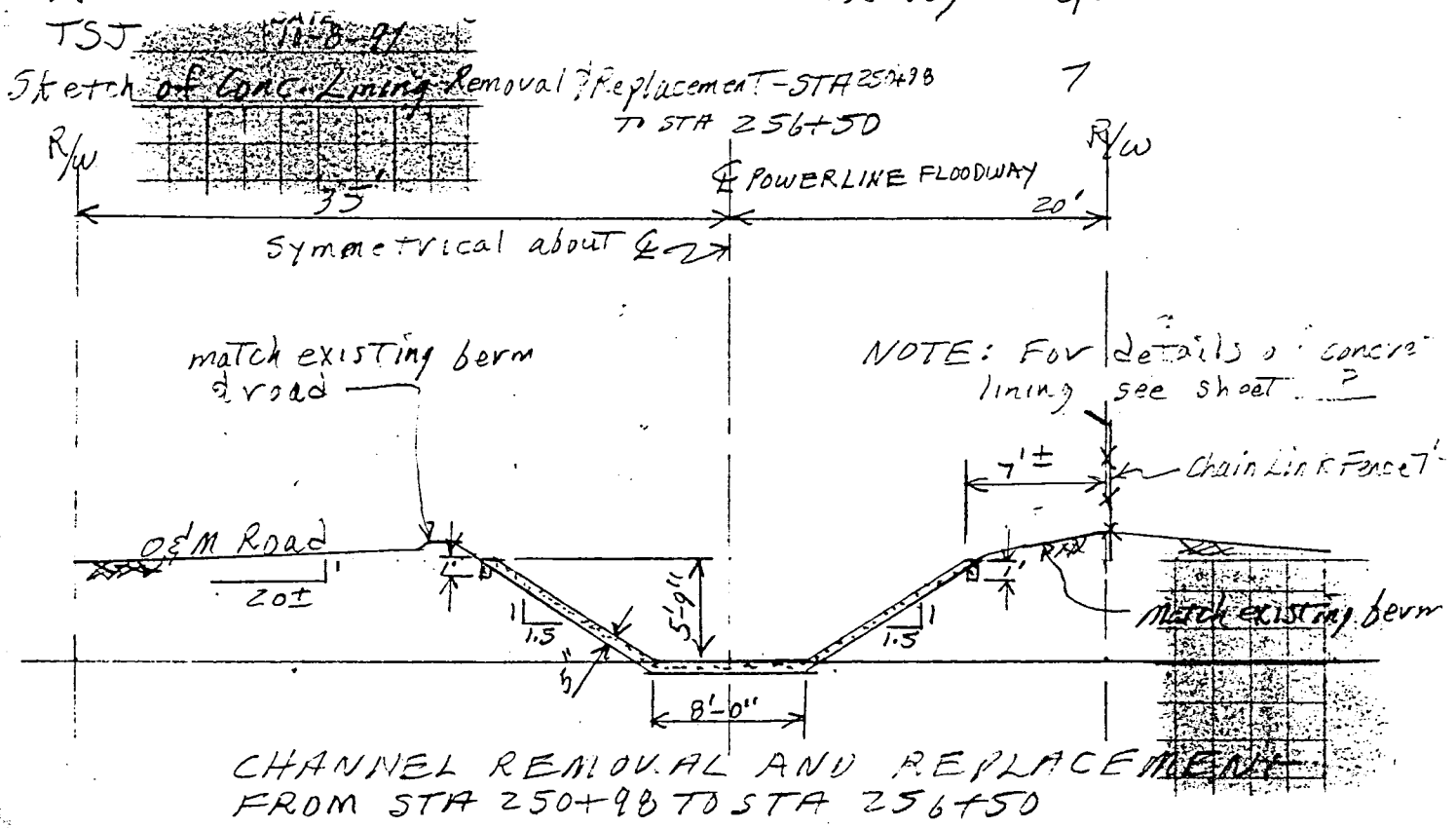
AZ

TSJ

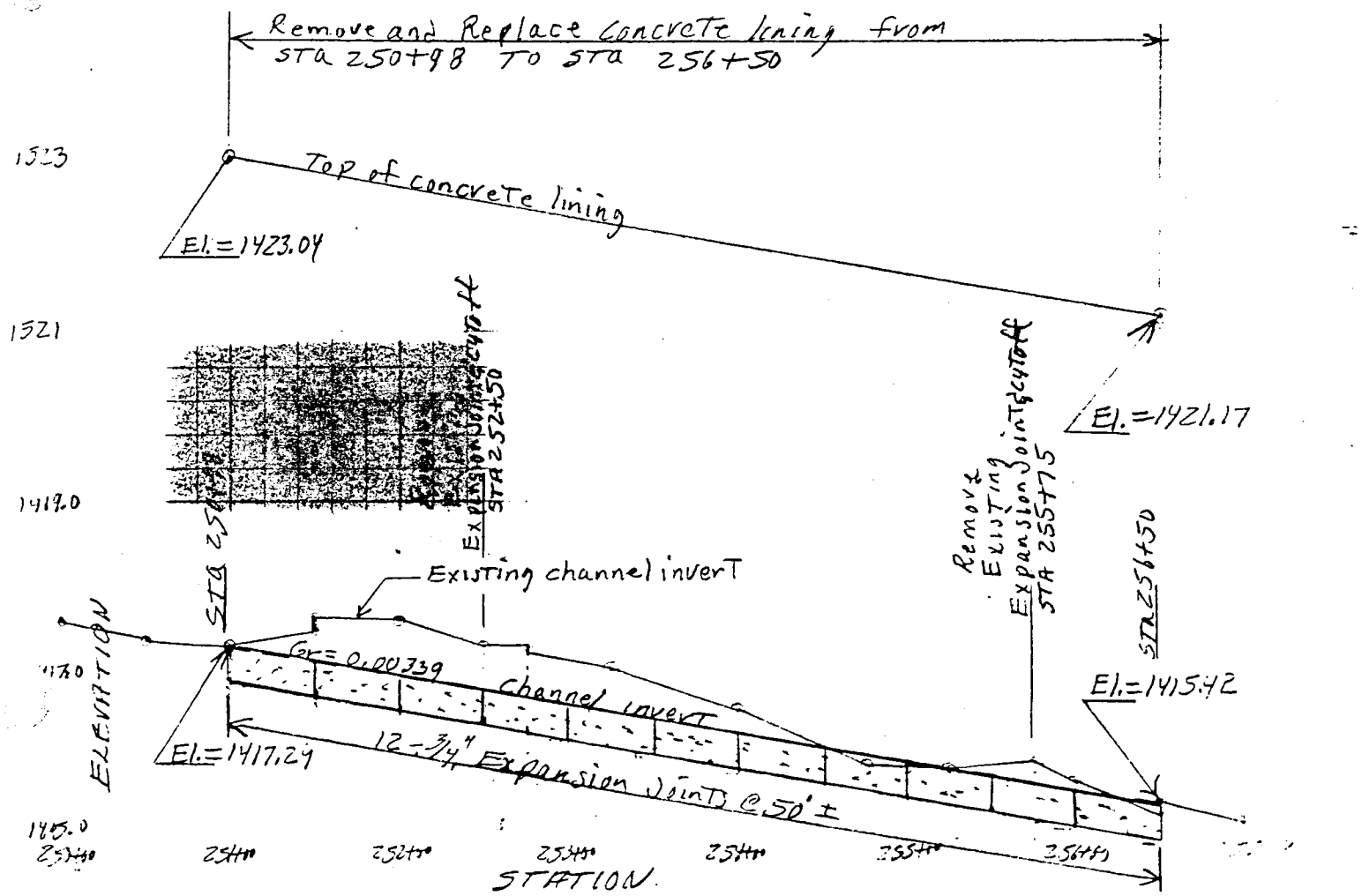
Powerline Floodway Repair

7

Sketch of Conc. Lining Removal & Replacement - STA 250+98 TO STA 256+50



CHANNEL REMOVAL AND REPLACEMENT FROM STA 250+98 TO STA 256+50



AZ

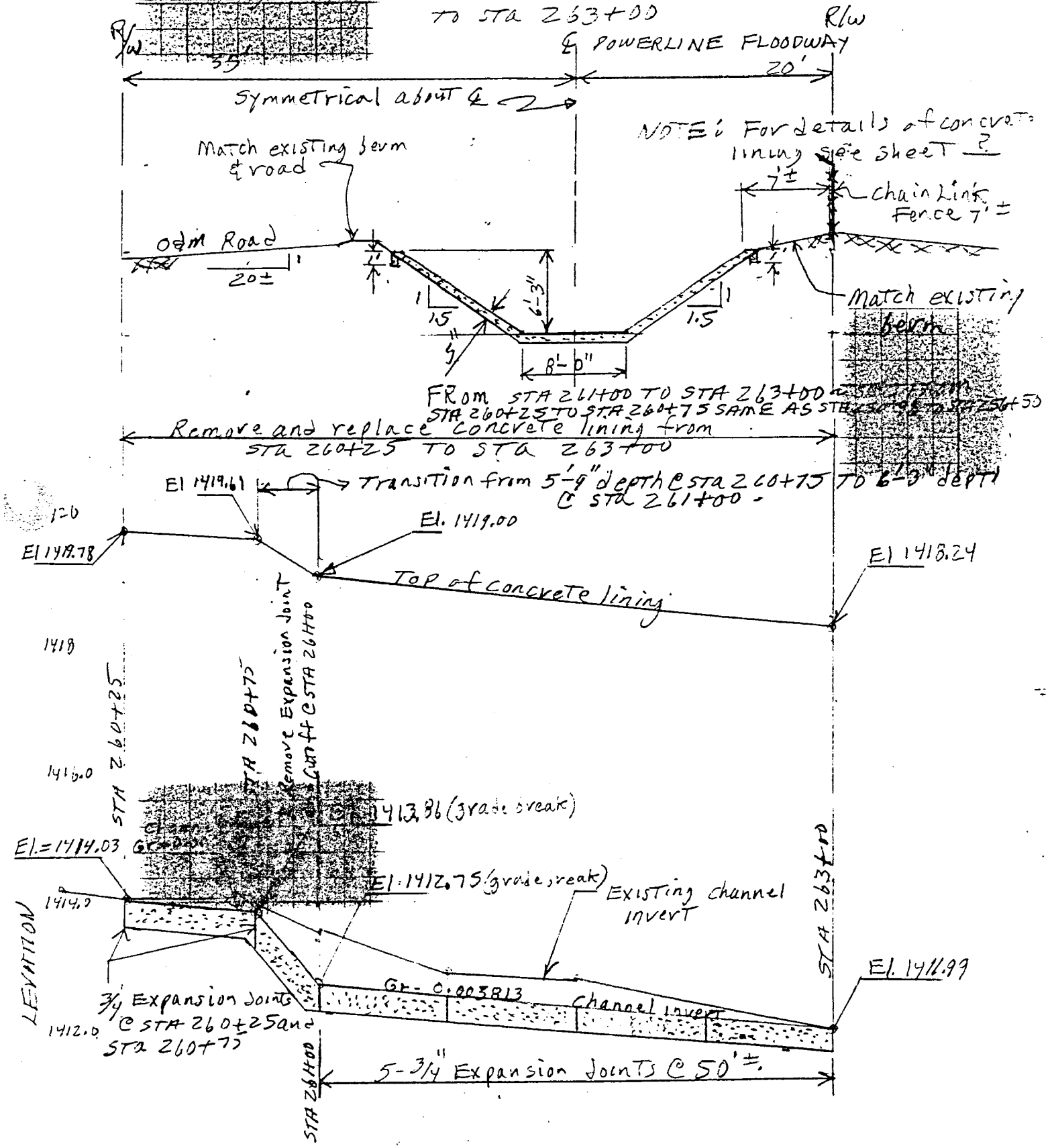
TSJ

DATE 10-2-91

Powerline Floodway Repair

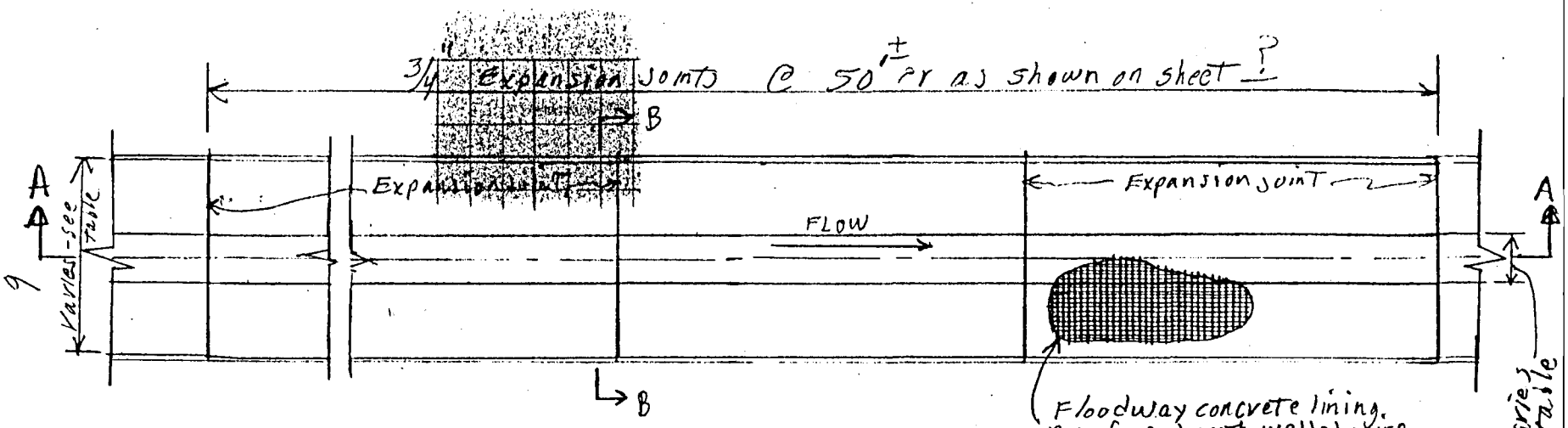
Sketch of Conc lining Removal & Replacement - STA 260+25 to STA 263+00

8

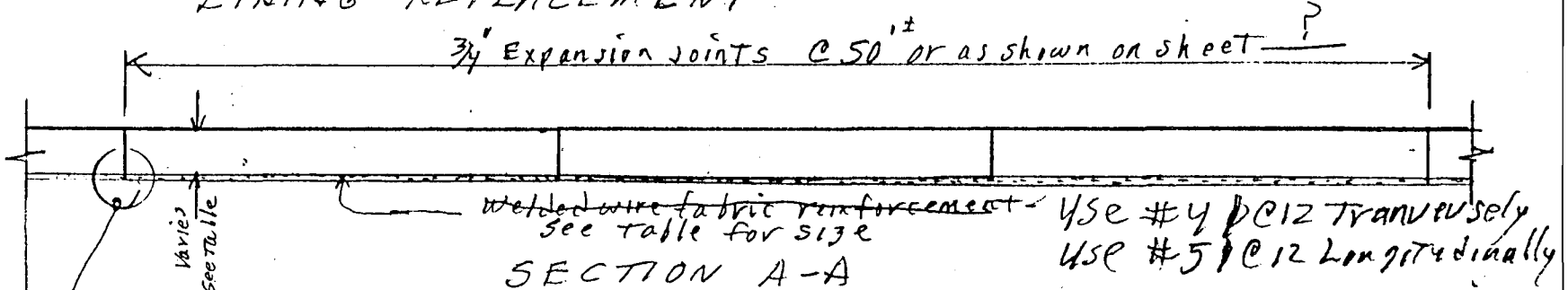


Power line Floodway Repair

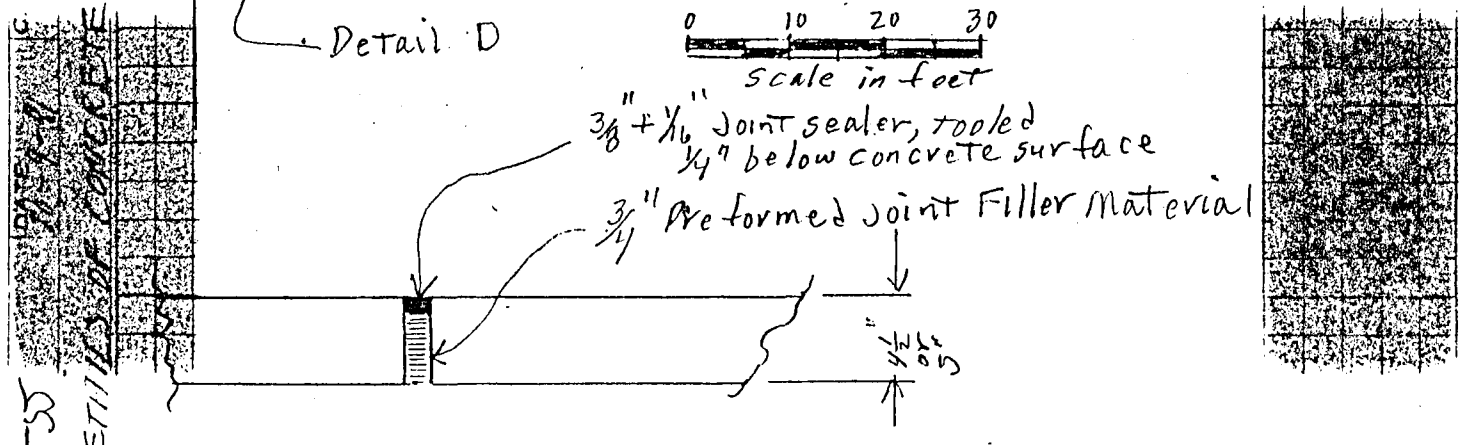
LINED CHANNEL



TYPICAL PLAN OF CONCRETE LINING REPLACEMENT



SECTION A-A



DETAIL D
(TYPICAL FOR ALL JOINTS)

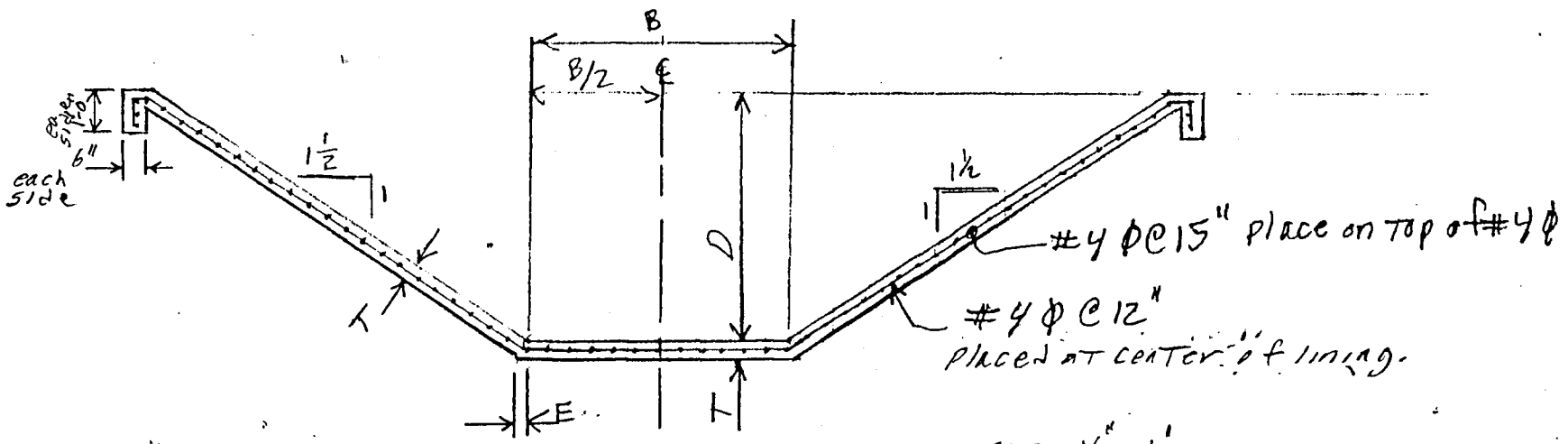
AZ T55 DETAILS OF CONCRETE

Powerline Floodway Repair

DETAILS OF CONCRETE LINED CHANNEL

AZ 155 15

Place this material with material on sheet 9



SECTION B-B SCALE - ¼" = 1'

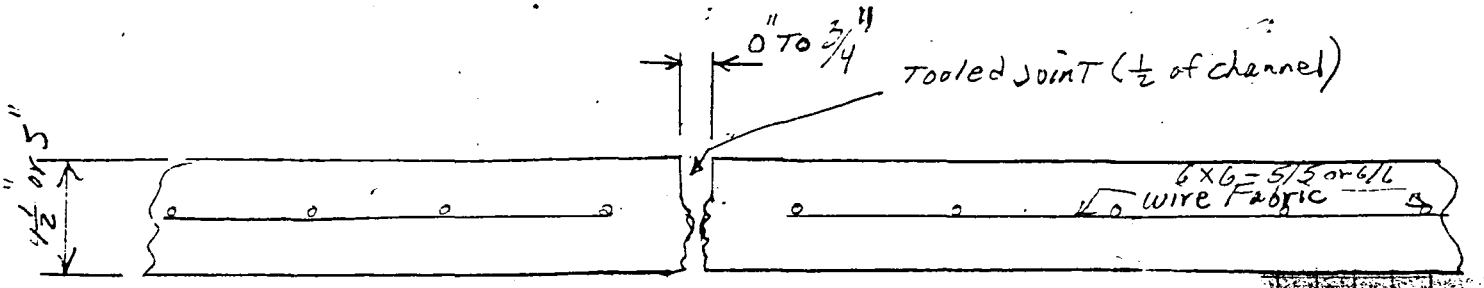
Location Station	to Station	Description	Elevation From	To	B	D	E	T	Transverse Steel	Longitudinal Steel
77+25	80+25	Concrete lined Channel	1516.13	1514.26	6-0	4-9	[illegible]	0'-4½	#4ϕ@12	#5ϕ@12
154+50	156+25	Concrete lined Channel	1466.81	1465.86	6-0	5-0	[illegible]	0'-4½	#4ϕ@12	#5ϕ@12
166+48	168+02	Concrete lined Channel	1459.43	1458.39	6-0	5-0	[illegible]	0-4½	#4ϕ@12	#5ϕ@12
215+15	215+39	Concrete lined Channel	1429.81	1429.65	6-0	5-9	[illegible]	0-5	#4ϕ@12	#5ϕ@12
216+25	217+00	Concrete lined Channel	1429.55	1429.26	8-0	5-9	[illegible]	0-5	#4ϕ@12	#5ϕ@12
224+50	225+50	Concrete lined Channel	1426.93	1426.22	8-0	5-9	[illegible]	0-5	#4ϕ@12	#5ϕ@12
252+98	256+50	Concrete lined Channel	1417.29	1415.42	8-0	5-9	[illegible]	0-5	#4ϕ@12	#5ϕ@12
260+25	260+75	Concrete lined Channel	1414.13	1413.86	8-0	5-9	[illegible]	0-5	#4ϕ@12	#5ϕ@12
260+75	261+00	Concrete lined Channel	1413.86	1412.75	8-0	Varies From 5-9 To 1-3	0-1½	0-5	#4ϕ@12	#5ϕ@12
261+00	263+00	Concrete lined Channel	1412.75	1411.99	8-0	6-3	0-1½	0-5	#4ϕ@12	#5ϕ@12

AZ Powerline Floods Repair

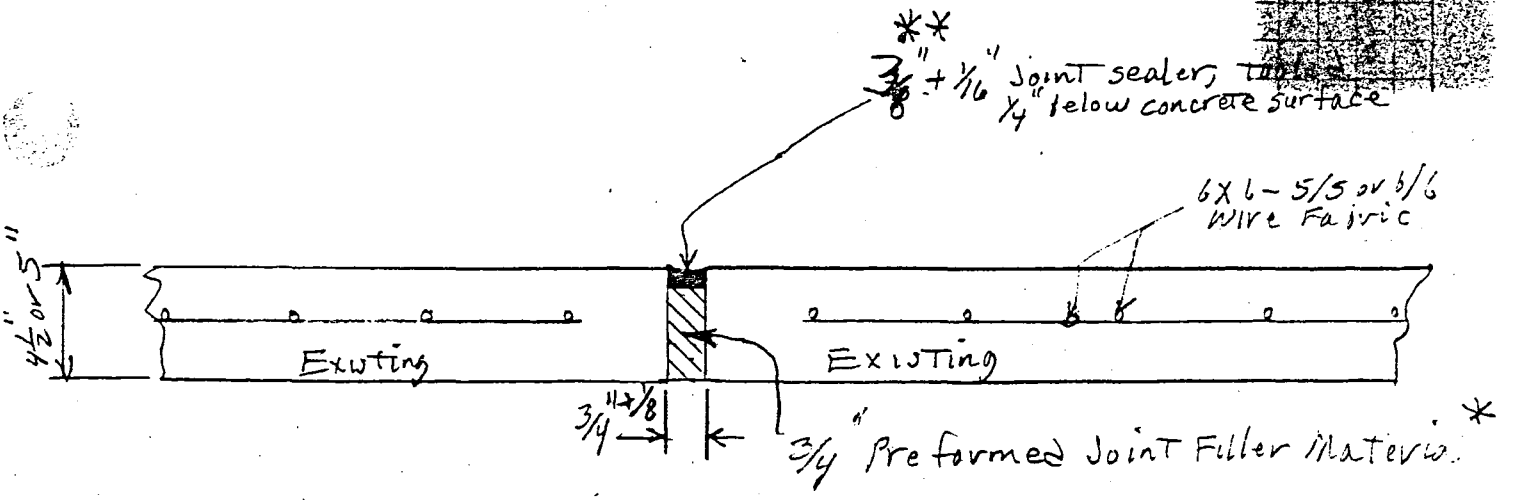
TOM DATE 9-11-91

Cut & Seal Existing Joints Details

For Plans -



EXISTING CONTRACTION JOINTS



JOINT

JOINT REPAIR

DETAILS (Contraction Joints)

* For existing joints that are wider than 3/4 inch place joint sealer to actual width of joint.

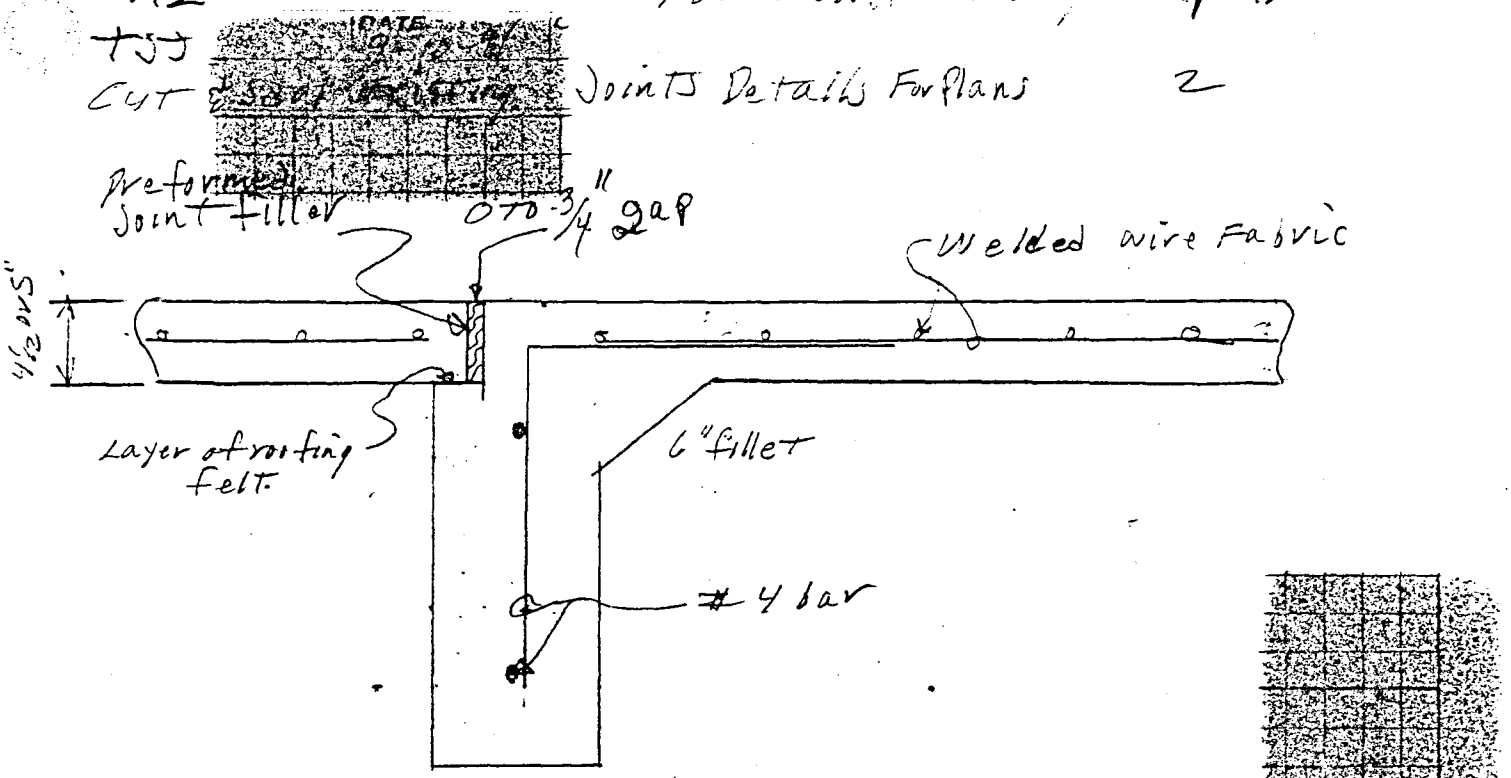
* For existing joints that are wider than 3/4 inch place two or more thicknesses of joint filler or cut joint filler to match gap.

Az

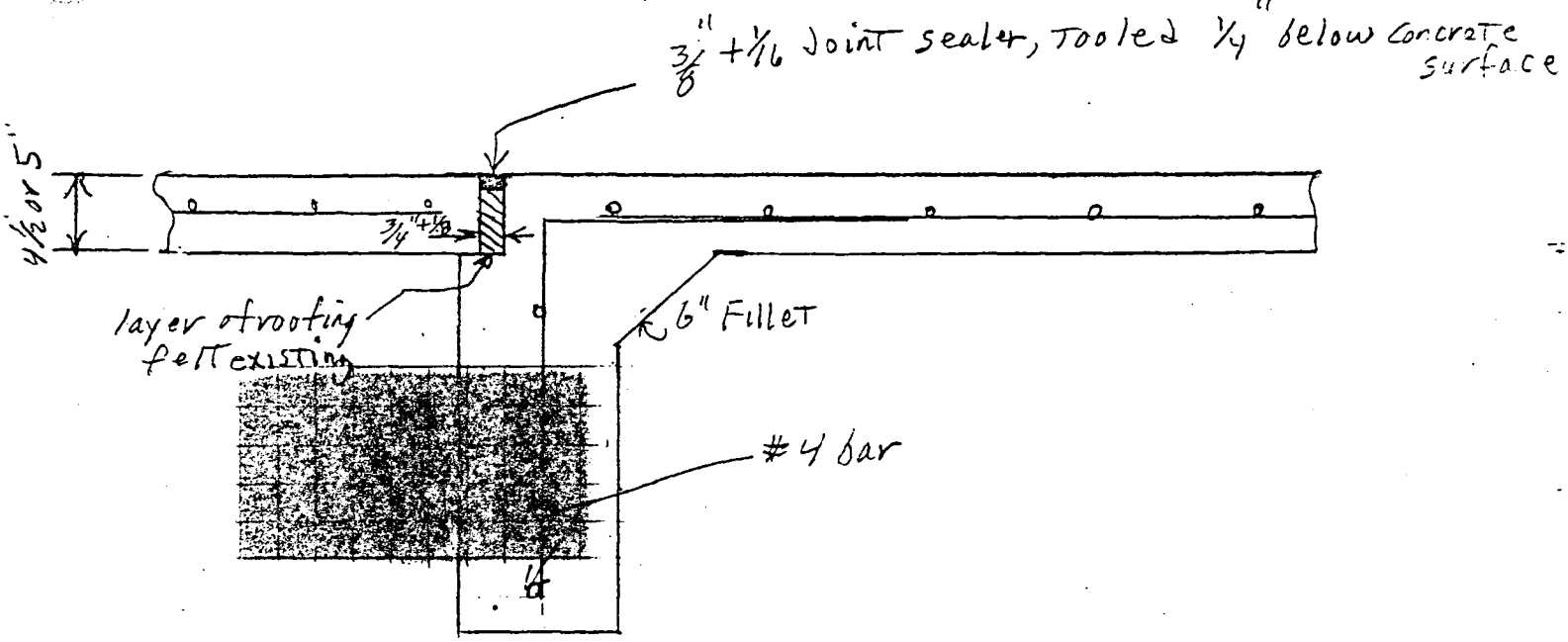
Power line Flooding Repair

TJJ

Joints Details For Plans 2



EXISTING EXPANSION JOINTS

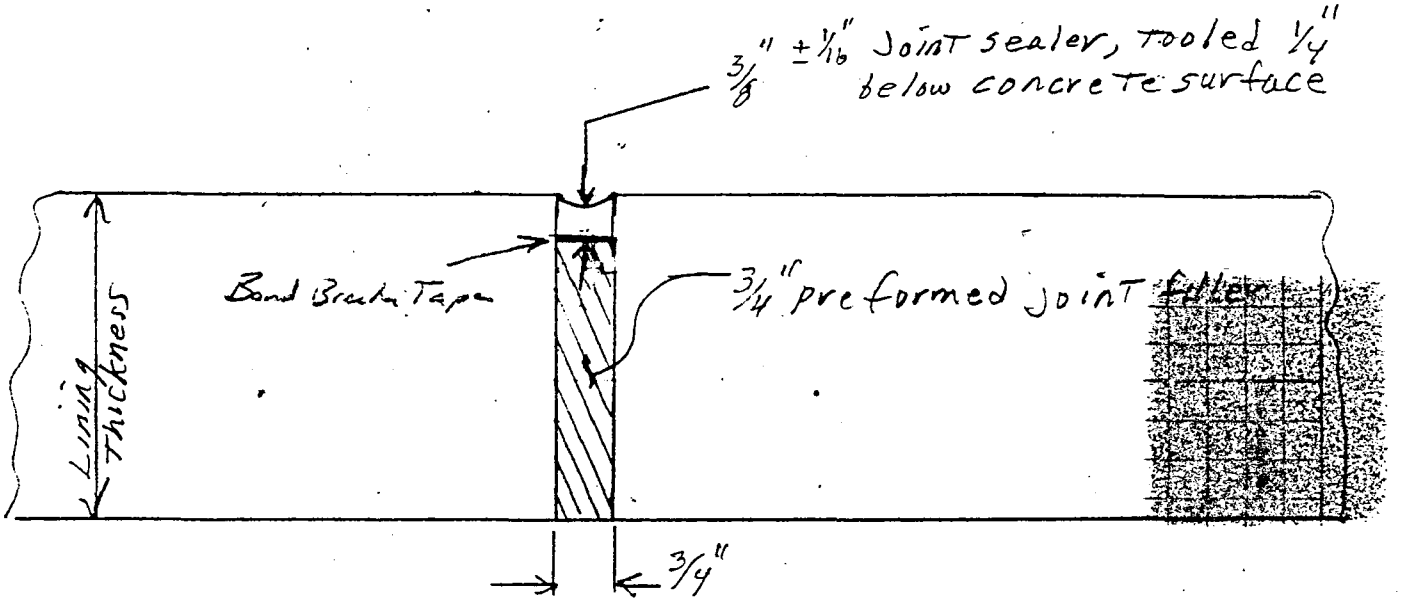


3/4 - INCH EXPANSION JOINT
JOINT REPAIR DETAILS

AZ
SJ
Joint Crack Repair Detail

Powerline Floodway Repair

1



Joint Repair Detail

A2 Powerline Fluidy Repair
TSS DATE 2-10-91
Cut & Seal Existing Joints Detail 3
For Plans —

GENERAL NOTES

a. Saw cut the 3/4-inch joint to attain the dimensions shown.

b. Remove existing joint fillers, asphalt, ram neck, and loose concrete, plants and debris to the minimum depths shown.

c. Prepare joint and place preformed joint filler in accordance with the specifications and as approved by the Contracting Officer.

d. After sandblasting and prior to installation of preformed joint filler and joint sealer, remove all sand, coatings, and dust from the joint cavity by air blasting.

AZ
JJ 9-9-91

Powerline Flurdy Repair

Check on steel required for 9" Repair

Sec –

1.0 Steel requirement per Sec 6 Structural Design National Eng Handbook Notice 6-4 dated 12-30-80 page 6.4-32 –

$P_t = 0.002 + 0.001 = 0.003$ for single grid of steel

$P_t = \frac{A_s}{bt}$

$A_s = P_t(b)(t) = 0.003(12)(9) = 0.324 \text{ in}^2$

Use #5 ϕ @ 12 in – $A_s = 0.31 \text{ in}^2$ – slightly lower ok in center of slab.

2. Steel Reqd – For 50' sec longitudinally

5" slab – $A_s = 0.005(12)(5) = 0.3 \square''/FT$ use #5 @ 12"

$4\frac{1}{2}$" slab – $A_s = 0.005(12)(4.5) = 0.27 \square''/F$ $A_s = 0.31 \square''/FT$

3. Steel Reqd for Transverse Steel

length < 50'

5" slab – $A_s = 0.003(12)(5) = 0.18 \square''/FT$

$4\frac{1}{2}$" slab – $A_s = 0.003(12)(4.5) = 0.162 \square''/FT$

} use #4 ϕ @ 12" $A_s = 0.20 \square''/FT$

4. Steel Reqd. For 50' sec longitudinal steel if slab Thickness = 6"

$A_s = 0.005(12)(6) = 0.36 \square''/FT$ use #5 @ 12 $A_s = 0.31$

5. Steel Reqd for transverse steel for 6" Thick slab

$A_s = 0.003(12)(6) = 0.22 \square''/FT$

use #4 ϕ @ 12" $A_s = 0.20 \square''/FT$

6. Summary –

Use 6" slab @ #5 ϕ @ 12" & 4 @ 12"

longitudinal → transverse

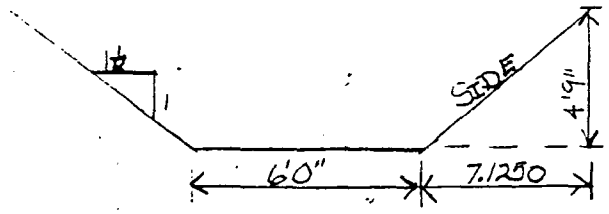
ARIZONA POWERLINE FLOODWAY REPAIR

TOD R. [redacted] 8-1-91

JOINT [redacted]

1 2

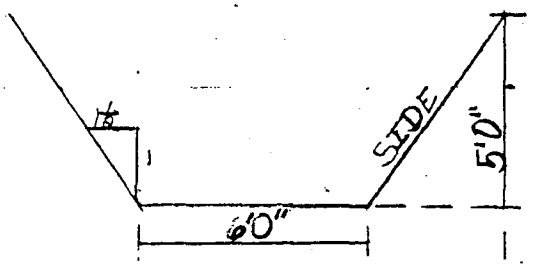
STA #12+00 TO STA #87+95



SIDE = $\sqrt{4.75^2 + 7.125^2}$

(2x8.56)+6 = 23.12 ft.

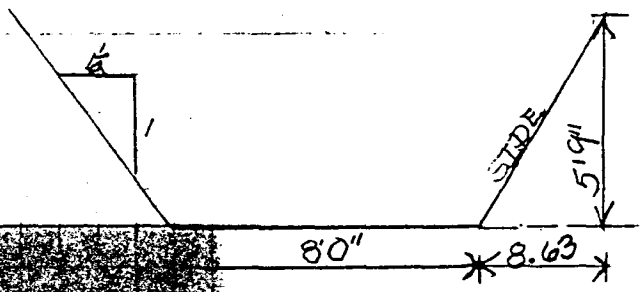
STA # 38+50 TO STA # 214+25



SIDE = $\sqrt{5.0^2 + 7.50^2}$

(2x9.01)+6 = 24.02 ft.

STA #214+75 TO STA # 261+75



SIDE = $5.75^2 + 8.63^2$

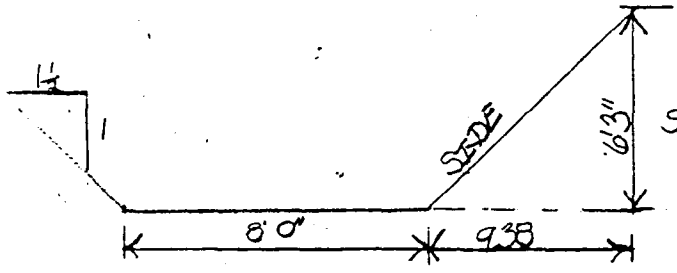
+8 = 28.74 ft

ARIZONA POWERLINE FLOODWAY REPAIR

TOD R. [redacted] JMH 8-1-91

JOB NO. [redacted]

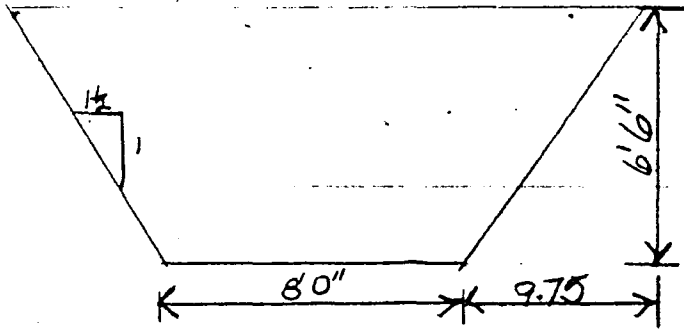
Sta# 261+00 TO Sta# 332+75



SIDE = $\sqrt{6.25^2 + 9.38^2}$

$(2 \times 11.27) + 8 = 30.54$ ft.

Sta# 333+00 TO Sta# 373+39.1



SIDE = $\sqrt{6.5^2 + 9.75^2}$

$(2 \times 11.72) + 8 = 31.44$ ft.

[redacted]

AZ

Powerline Floodway Repair

TSS [redacted]

Material Suppliers & Info

1

1. Smalley & Company (only distributor know that handles Dow Corning 888 which will warrenty use of a Silicone in flood control Projects)
269-7089
Steve Durbin - Doug Nelke

2. T-L Smith - (Tucson) 297-2581

3. Lane Concrete Cutting

4. DOW CORNING CORP - Irvine Calif 714-757-5000
Steven Rolka Highway/Airport Products Specialist

[redacted]

Specialty Sealants
~~934-6024~~ - Jim

Southwest Caulking
268-0567 - Mike

Vern [redacted] Inc
[redacted] Vern

All have experience with chipping out cracks & sealing them

DATE

Joint Sealer: Shall be type S, Grade NS, Use NT or T, low modulus silicone conforming to the requirements of ASTM C-920 and shall tolerate submergence by intermittent flows.

The sealant shall have the capability to withstand without failure an increase of 100 percent and a decrease of 50 percent of the joint width as measured at the time of application when tested in accordance with ASTM C-719.

The elongation shall be a minimum of 800 percent without failure when tested in accordance with ASTM D-412, and 500 percent without adhesion failure when tested in accordance with ASTM C-719

Dow Corning 888 Mike Vance

Self Leveling = S.L.

Non Sag - = NS

Power line Floodway Repair

55 11-13-91

Summary of Shrink Swell Tests 1

Eight samples were taken in the channel bottom at locations where lining was cracked badly and where lining bottom had raised above grade several inches. The eight samples were tested at the Mesa Project office for gradation and atterberg limits. Two of the eight samples showed evidence of clay and ~~some~~ significant fines and plasticity. These two samples were from station 78+00 at 4 to 5 feet below channel lining bottom and from sta 224+25 at 4 to 5 feet below channel bottom. These two samples were tested for shrink swell by Western Technologies Inc. and sample at 224+25 had a 7.7 and 8.6 percent expansion. Sample at 78+00 had an expansion of 2.1 percent.

Original soils investigation done for design of channel shows a 2 foot thick clay layer from 7 to 10 feet below natural ground between station 220+00 and station 236+00, being 10 feet deep at station 236+00 and 7 feet deep at station 220+00.

Previous repairs show that a large storm in 1971 created over land flow that went over the channel in numerous locations including station 222+00, north side. This over flow seepage uplifted lining slope, cracked lining at base of south slope for 50 ft. length and displaced lining about 3 inches. A hole was eroded beneath the lining. The hole was filled with sand slurry. This is just 150 feet upstream of where channel lining is presently uplifted 6 inches ±.

Shrink swell tests were run with 100 PSF surcharge and clay is located beneath 4 foot of soil which will yield 400 PSF ± surcharge. This will decrease the expansion percentage.

Since 1971, berms have been built at the top of the lining and the operation and maintenance roads have been graded away from the channel. This prevents any over land flow from getting beneath the lining and into the clay material. Also all joints will be sealed along with all major cracks. Area where lining has uplifted will be replaced from station 223+50 to station 225+50. Based on . . . r prevented water from entering the clay and an indication that damage in the area

was caused by the 1971 storm or damage from 1971 storm allowed water to enter beneath lining in subsequent years following the storm creating a situation for wetting the clay and causing uplift, it is felt that no additional work will be required in this area. No additional work will be required in vicinity of station 28+00 since expansion percentage is low in this area.

Also the 2 foot clay lense that lays 7 ft to 13 ft below natural ground between sta 220+00 and sta 236+00 has not indicated a problem beneath the channel. Joints have been open and there are numerous cracks that would have allowed water to enter the subgrade.

SOIL PROPERTIES

Station Number	Depth Feet	Unified Soil Class	Soil Property		Compression / Consolidation			Expansion			Shear Strength			Water Soluble Matter, PPM		Remarks
			Initial Dry Density pcf	Initial Water Content %	Surcharge KSF	Total Comp. %	Void Ratio	Surcharge KSF	Expansion %	Max. Swell Pressure KSF	Test Method	C KSF	Ø Deg.	Salts	Sulfates	
224+25	4-5	CL	98	15.8				0.10	+8.6							1,3
			94	16.5				0.10	+7.7							1,3
78+00	4-5	CL	105	9.4				0.10	+2.1							1,3

Note: Initial Dry Density and Initial Water Content are in-situ values unless otherwise noted.

Shear Strength Test Method

DS Direct Shear
DS Direct Shear (saturated)
UC Unconfined Compression
UU Unconsolidated Undrained
CU Consolidated Undrained w/pore press.
CU Consolidated Undrained
CD Consolidated Drained

NOTE:

Remarks

1. Compacted density (approx. 95% of ASTM D698 max. density at moisture content slightly below optimum).
2. Compacted density (approx. 95% of ASTM D1577 max. density at moisture content slightly below optimum).
3. Submerged to approximate saturation
4. Dry Density determined from one ring of a multiring sample
5. Visual Classification

JOB NO. 2121K9971

REVIEWED BY D. Clark, P.E.
PREPARED S. Pataray

Power Line Fluidy

Soil Properties

WESTERN TECHNOLOGIES INC.

Date: 11-11-91 | Figure Numb 1

SOIL PROPERTIES

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Power Line Fluidy

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Date: 11-11-91 | Figure Num 1

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JOB NO. 2121K9971

REVIEWED BY D. Clark, P.E.
PREPARED S. Pataray

Power Line Fluidy

Soil Properties

WESTERN TECHNOLOGIES INC.

Date: 11-11-91 | Figure Num 1

U.S. GPO 1988-213-583/90452

PROCUREMENT REQUEST

INSTRUCTIONS: Agencies must provide entires in unshaded areas. See reverse.

TO: (Procurement Office)
Soil Conservation Service
201 E. Indianola Ave, Suite 200
Phoenix, Az 85012

1. REQUESTING OFFICE
Soil Conservation Service
201 E Indianola Ave, Su
Phoenix, Az 85012
Engineering

2 RECEIVING OFFICE NO.	3 CONTRACT NUMBER (If Applicable)	4 ORDER DATE	5	6 UNIT CODE	7 FUND CODE	8 PURCHASE/DELIVERY ORDER NUMBER	9 SUB.

1A. PROCUREMENT REQUEST NO

1B. DATE
November 6, 1991

CHECK ONE
☑ Purchase Order
☐ Delivery Order

10. TO: (Seller)

11. SHIP TO: (Consignee and Destination)
Soil Conservation Service
201 E Indianola Ave, Suite 200
Phoenix, Az 85012
c/o Tom Jayo
☐ INSIDE DELIVERY REQUESTED

12 LINE ITEM	13 ACT. CODE	14 DESCRIPTION	15 BUDGET OBJECT	16 ACC. LINE	17 QUANTITY	18 UNIT ISSUE	19 UNIT PRICE	20 AMOUNT
01		Expansion-Swell Tests Needed for design of Powerline Floodway Repair (See Justification) For Sample No 78+00 4'-5' & Sample No 224+25 4'-5'			2		$55.00	$110.00

For additional information, please contact:
Tom Jayo — TECHNICAL CONTACT
602-640-5151 — TELEPHONE NO.

21 FOB POINT

22 DISCOUNT TERMS

Sub-Total ▶ 25

23 REQUIRED DELIVERY (Do not use ASAP)

23A NEGOTIATED DELIVERY

24 SHIP VIA

26 ESTIMATED FREIGHT

TOTAL ▶ $110.00

28 ACC. LINE	29 ACCOUNTING CLASSIFICATION A	B	C	D	E	30 DISTRIBUTION	31 AMOUNT
01							

RECOMMENDED SOURCE(S) (If necessary, use attachment)
Western Technologies Inc.
3737 East Broadway Road
P.O. Box 21387
Phoenix, Arizona 85036
602-437-3737 (Scott Neal)

I certify that the above items are necessary for use in the public service.

TITLE

SIGNATURE OF AUTHORIZED REPRESENTATIVE

AZ
TSJ 11-6-91

Power line Floodway Repair -

Soil Tests - Cost Justification

Contacted The following Soil Testing Labs for costs to do shrink swell tests.

	Cost/Test	No. of Tests	Total Cost
1. Western Technology: 3737 E Broadway P.O. Box 21387 Phoenix, Az 85036 Phone - 602-437-3737 Contact person Donald Clark or Scott Nealy			
Expansion swell Test	55.00	2	$110.00
2. ATL Testing Laboratories 2922 W Claredon Ave - Phx phone: 241-1097 Contact person - David Hays			
Expansion Swell test	75.00	2	$150.00
3. Sergent Hauskins & Beckwith Engineers 3232 W Virginia Av Phx, phone 272-8848 Contact person - Rich Bailey			
Expansion Swell Test	$90.00	2	$180.00

Recommendation —

Recommend we use the services of Western Technology To perform the expansion - swell tests.

Tom Jays 11/6/91

AZ
SJ

POWERLINE FLOODWAY REPAIR

DATE 3/26/91

Soil Tests - Cost Estimates

1

1. Western Technology - Don Clark or Scott Neely
437-3737
3737 E Broadway Rd.

1.	Gradation -	55.00/sample x 8 =	440.00
2.	Atterbergs -	35.00/sample x 8 =	280.00
3.	Expansion Swell	55.00/sample x 8 =	440.00
			$1,160.00

2. Expansion - Swell Test - 8 samples
ASTM Std No 29-2

2. ATL Testing Laboratories David Hayes
2922 W Clarendon Av 241-1097

1.	Gradation	25.00/sample x 8 =	200.00
2.	Atterbergs	30.00/sample x 8 =	240.00
3.	Expansion-Swell	75.00/sample x 8 =	600.00
			$1,040.00

3. Thomas Hartig & Associates Inc. - Ken Ricker
7031 W Oakland ST. Chandler - 961-1169
Phoenix 437-5450

1.	Gradation [redacted] 2.00 for both	35.00 x 8 =	280.00
2.	[redacted]	27.00 x 8 =	216.00
3.	[redacted] well	50.00 x 8 =	400.00
	For Proctor if needed	70.00/sample	$896.00

4 Sergent Hauskins & Beckwith Engineers
3232 W Virginia Av. 272-6848
Rich Bailey

1.	Gradation	48.00 x 8 =	384.00
2.	Atterbergs	34.00 x 8 =	272.00
3.	Expansion Swell	90.00 x 8 =	720.00
	80.00 ea proctor		$1376.00

TSC-PO-ENG-9
12-74

U. S. DEPARTMENT OF AGRICULTURE
Soil Conservation Service

MTS No. _____

This sample scheduled for shrink swell test

MECHANICAL ANALYSIS

Project POWERLINE FLW. Date 10-3-91

Sample No. 78+00 4'-5' Operator G. MASON

P-13

SIEVE ANALYSIS BOWL # 4

.11 Coarse	
Wt. Sample, Air Dry	4.67
Wt. Sample, Oven Dry	
Wt. Ret. No. 4, Oven Dry	
% Ret. No. 4 Sieve	2.3
% Finer No. 4 Sieve	97.7

Fine				
			% Finer	
Sieve	Wt.	%	Obs.	Corr.
10	1.55	1.6	98.4	96.1
20	3.55	3.7	94.7	92.5
40	5.74	6.0	88.7	86.7
60	6.04	6.4	82.3	80.4
100	5.68	6.0	76.3	74.5
200	7.93	8.4	67.9	66.3

HYDROMETER ANALYSIS

Wt. Dispersed Sample: Air Dry _____ Hydr. No. _____

Oven Dry 94.97 Jar No. _____

Hydr. Reading			Time (Min.)	Temp. °C	Grain Size (MM)	% Finer	
Calgon	Real	Corr.				Obs.	Corr.
			:1				
			2				
			5				
			15				
			30				
			60				
			120				

USDA SCS PORTLAND, OREG. 1969

SCS-ENG-361
REV. 2-71

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

POWERLINE
STA 78+00
4'-5'

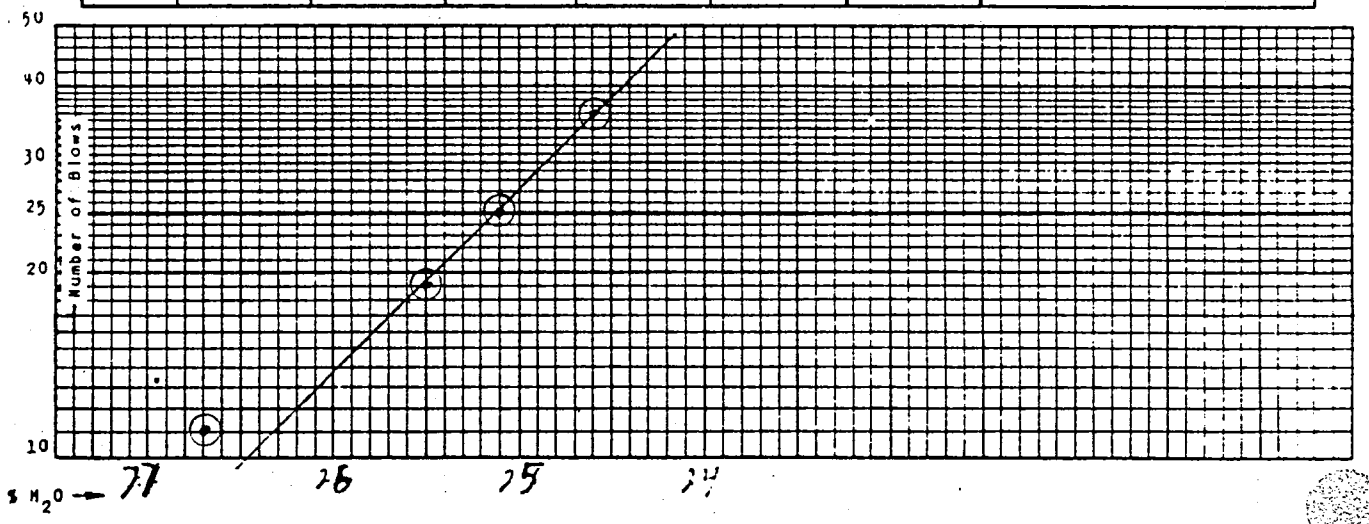
WORK SHEET FOR ATTERBERG LIMITS

LIQUID LIMIT DATA

① Can No.	② Wet Wt.	③ Dry Wt.	④ H_2O Wt. ②-③	⑤ Empty Wt.	⑥ Dry Soil ③-⑤	⑦ % H_2O 100 x ④/⑥	⑧ No. Blows	Laboratory Sample Number
503	28.22	24.75	3.47	11.77	12.98	26.7	11	
504	30.04	26.30	3.74	11.63	14.67	25.5	19	L.L. = 25.1
509	29.66	26.06	3.60	11.69	14.37	25.1	25	P.L. = 18.0
514	31.13	27.27	3.86	11.58	15.69	24.6	36	P.I. = 7.1
								L.L. =
								P.L. =
								P.I. =
								L.L. =
								P.L. =
								P.I. =
								L.L. =
								P.L. =
								P.I. =
								L.L. =
								P.L. =
								P.L. =
								L.L. =
								P.L. =
								P.I. =

PLASTIC LIMIT DATA

74	15.51	14.35	1.16	7.89	6.46	18.0	
84	16.17	14.84	1.33	7.41	7.43	17.9	



Completed by: _____ Recorded by: _____

Checked by: _____ Date: _____

59M-95

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

SCS-ENG-353
2-80

MATERIALS TESTING REPORT: SOIL CLASSIFICATION

Project and state POWERLINE — Sample location STA. 78+00 — Laboratory No. ____

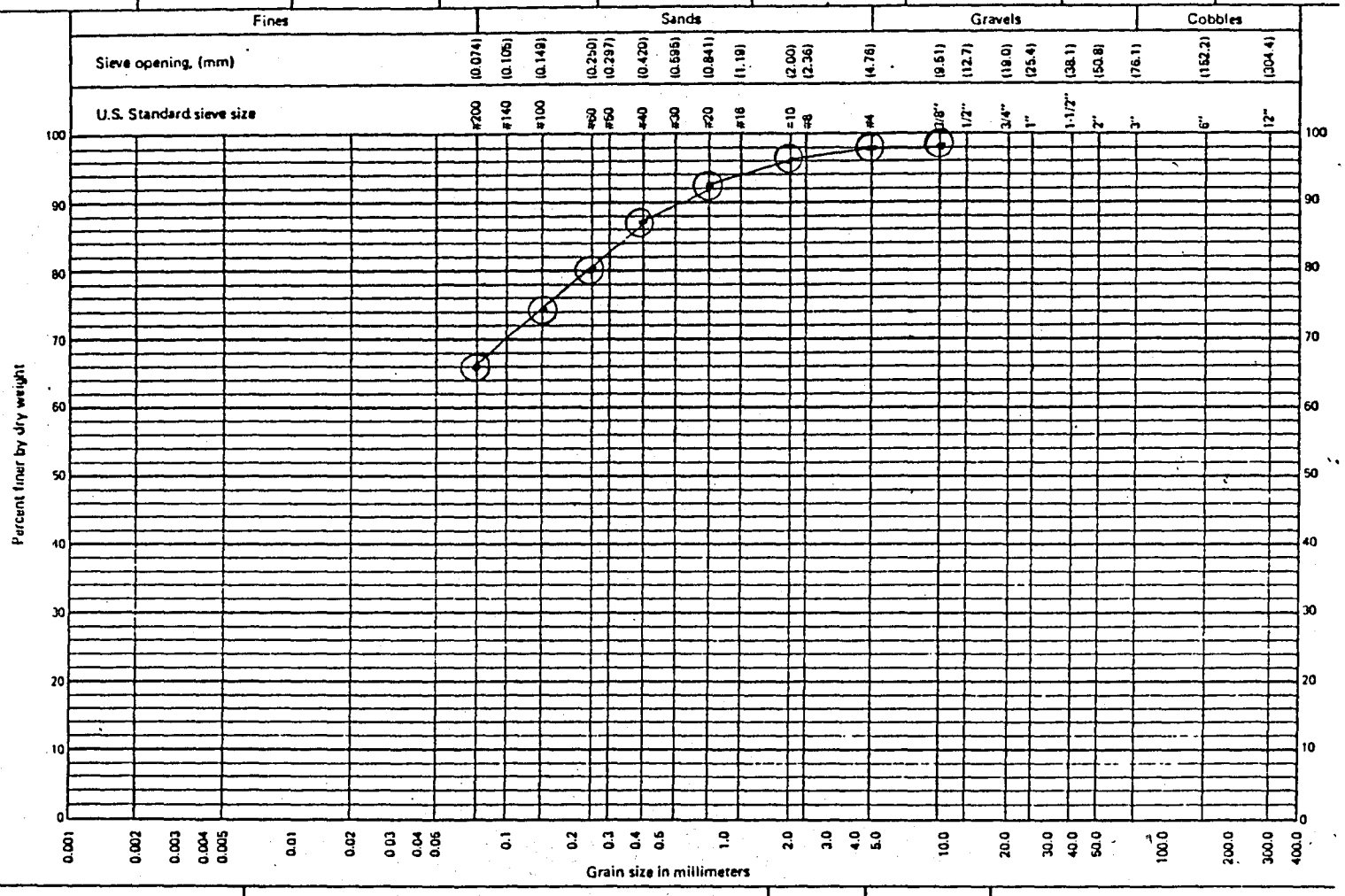
Field sample No. ____ — Depth 4'-5' — Geologic origin ____

Type of sample ____ — Tested at MPO — Approved by G.M.Lee — Date 10-3-81

Symbol ____ — Description CLAY

Grain Size Distribution

D_{10}	D_{15}	D_{30}	D_{50}	D_{50}	D_{85}	$D_{Maximum}$	C_u	C_c



Specific gravity (G_s)		Atterberg limits						Soluble salts	Shrinkage limit	Undisturbed condition	
		Natural moisture		Air dry		Ovendry				Moisture	Dry unit weight
– No. 4	+ No. 4	LL	PI	LL	PI	LL 25.1	PI 7.1	%	%	%	g/cm³ / lb/ft³

Remarks:

TSC-PO-ENG-9
12-74

U. S. DEPARTMENT OF AGRICULTURE
Soil Conservation Service

MTS No. _____

This sample sche[illegible] for shrink swell test

MECHANICAL ANALYSIS

Project POWERLINE FLW Date 10-3-91

Sample No. 224+25 4'-5' Operator G. MASON

P74

SIEVE ANALYSIS Bowl #1

.03 Coarse	
Wt. Sample, Air Dry	4.85
Wt. Sample, Oven Dry	
Wt. Ret. No. 4, Oven Dry	
% Ret. No. 4 Sieve	0.8
% Finer No. 4 Sieve	99.2

Fine				
			% Finer	
Sieve	Wt.	%	Obs.	Corr.
10	1.08	1.2	98.8	98.0
20	1.83	2.1	96.7	95.9
40	3.99	4.5	92.2	91.5
60	4.87	5.5	86.7	86.0
100	5.57	6.3	80.4	79.8
200	8.55	9.6	70.8	70.2

HYDROMETER ANALYSIS

Wt. Dispersed Sample: Air Dry _____ Hydr. No. _____

Oven Dry 89.08 Jar No. _____

Hydr. Reading			Time (Min.)	Temp. °C	Grain Size (MM)	% Finer	
Calgon	Real	Corr.				Obs.	Corr.
			:1				
			2				
			5				
			15				
			30				
			60				
			120				

USDA SCS-PORTLAND, OREG. 1969

[illegible]

POWERLINE
STA. 221+25
4-5'

SCS-ENG-361
REV. 2-71

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

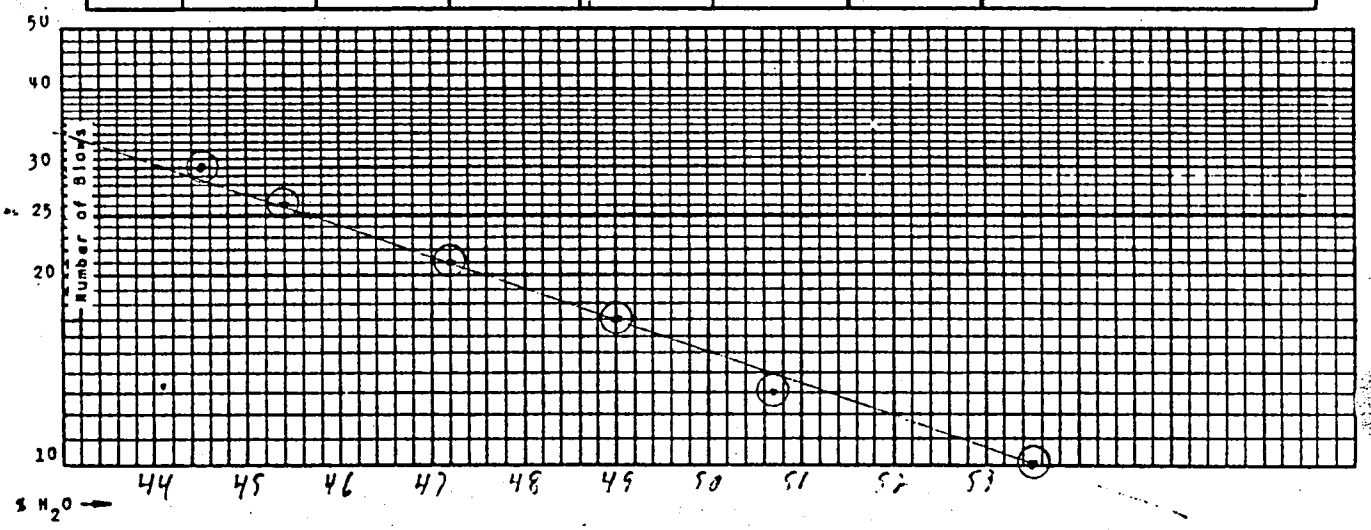
WORK SHEET FOR ATTERBERG LIMITS

LIQUID LIMIT DATA

① Can No.	② Wet Wt.	③ Dry Wt.	④ H_2O Wt. ②-③	⑤ Empty Wt.	⑥ Dry Soil ③-⑤	⑦ % H_2O $\frac{100 \times ④}{⑥}$	⑧ No. Blows	Laboratory Sample Number
500	27.73	22.88	4.85	11.98	10.90	44.5	30	
501	28.35	23.08	5.27	11.47	11.61	45.4	26	L.L. = 45.7
502	27.99	22.73	5.26	11.58	11.15	47.2	21	P.L. = 21.9
513	28.20	22.80	5.40	11.78	11.02	49.0	17	P.I. = 23.8
507	26.65	21.67	4.98	11.84	9.83	50.7	13	
506	27.66	22.04	5.62	11.53	10.51	53.5	10	L.L. =
								P.L. =
								P.I. =
								L.L. =
								P.L. =
								P.I. =
								L.L. =
								P.L. =
								P.I. =
								L.L. =
								P.L. =
								P.L. =
								L.L. =
								P.L. =
								P.I. =

PLASTIC LIMIT DATA

89	13.46	12.47	.99	7.90	4.57	21.7	21.9
95	13.41	12.43	.98	7.97	4.46	22.0	



Completed by: _____ Recorded by: _____

Checked by: _____ Date: _____

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

SCS-ENG-353
2-80

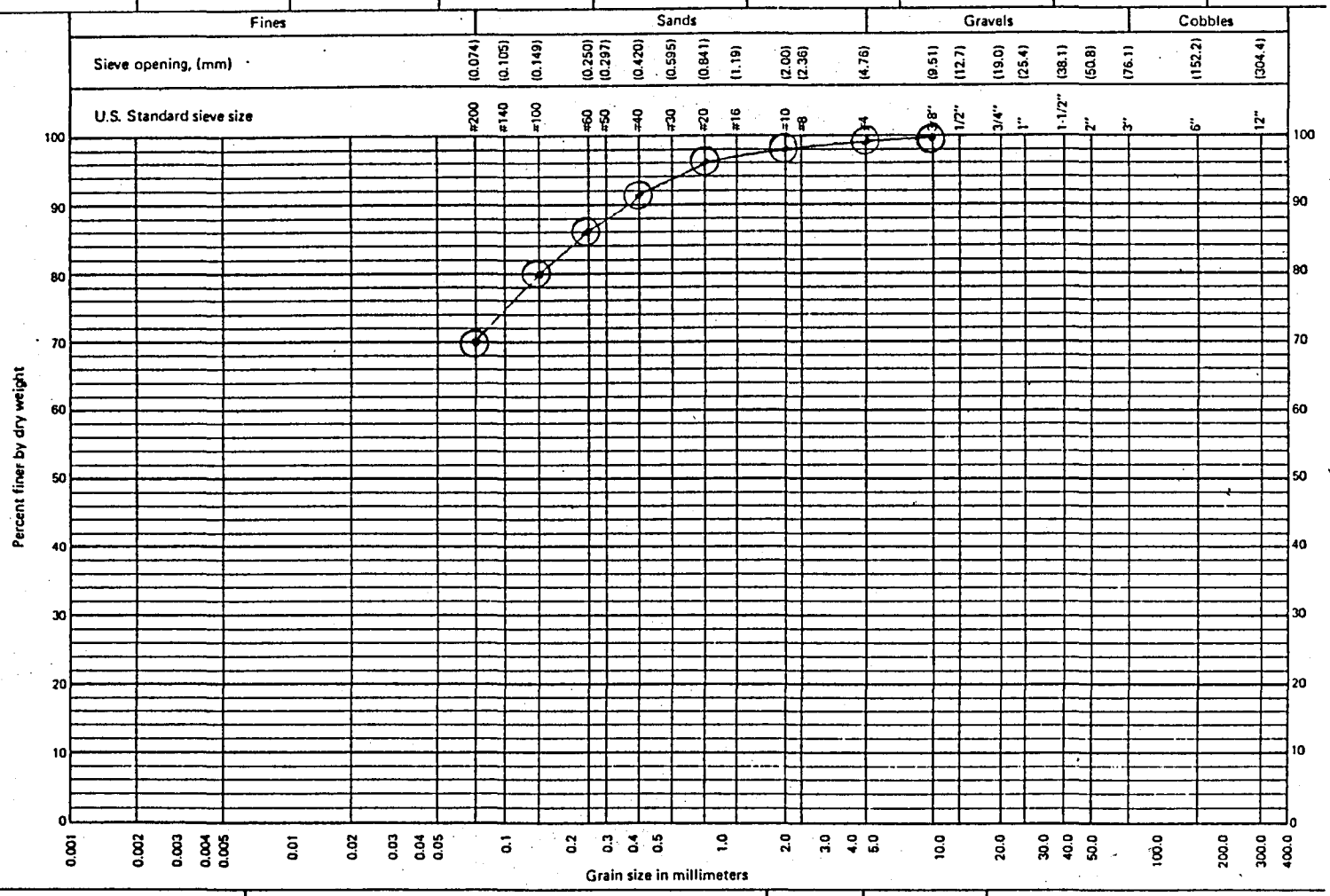
MATERIALS TESTING REPORT: SOIL CLASSIFICATION

Project and state: POWERLINE
Sample location: STA. 224+25
Laboratory No.:
Field sample No.:
Depth: 4'-5'
Geologic origin:
Type of sample: P.P.C.
Tested at:
Approved by: G. [illegible]
Date: 10-2-91
Symbol: CL
Description: CLAY

(NOTE THIS IS CLOSE TO [illegible] CLASSIFICATION)

Grain Size Distribution

D_{10}	D_{15}	D_{30}	D_{50}	D_{60}	D_{85}	$D_{Maximum}$	C_u	C_c



Specific gravity (G_s)		Atterberg limits						Soluble salts	Shrinkage limit	Undisturbed condition	
		Natural moisture		Air dry		Ovendry				Moisture	Dry unit weight
– No. 4	+ No. 4	LL	PI	LL	PI	LL 45.7	PI 23.8	%	%	%	g/cm³ / lb/ft³

Remarks:

TSC-PO-ENG-9
12-74

U. S. DEPARTMENT OF AGRICULTURE
Soil Conservation Service

MTS No. _____

NS TESTING [illegible]
STA 155+10 [illegible]

MECHANICAL ANALYSIS

Project POWERLINE FLW Date 10-3-91

Sample No. 155+10 0'-1' Operator G. MASON

M-1 [illegible]

SIEVE ANALYSIS Bowl #8

Coarse	
Wt. Sample, Air Dry	24.91
Wt. Sample, Oven Dry	
Wt. Ret. No. 4, Oven Dry	
% Ret. No. 4 Sieve	11.4
% Finer No. 4 Sieve	88.6

Fine				
			% Finer	
Sieve	Wt.	%	Obs.	Corr.
10	11.93	12.1	87.9	77.9
20	14.19	14.4	73.5	65.1
40	13.99	14.2	59.3	52.5
60	10.19	10.4	48.9	43.3
100	10.62	10.8	38.1	33.8
200	12.74	13.0	25.1	22.2

HYDROMETER ANALYSIS

Wt. Dispersed Sample: Air Dry _____ Hydr. No. _____

Oven Dry 98.22 Jar No. _____

Hydr. Reading			Time (Min.)	Temp. °C	Grain Size (MM)	% Finer	
Calgon	Real	Corr.				Obs.	Corr.
			1				
			2				
			5				
			15				
			30				
			60				
			120				

USDA SCS PORTLAND, OREG. 1968

SCS-ENG-361
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U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

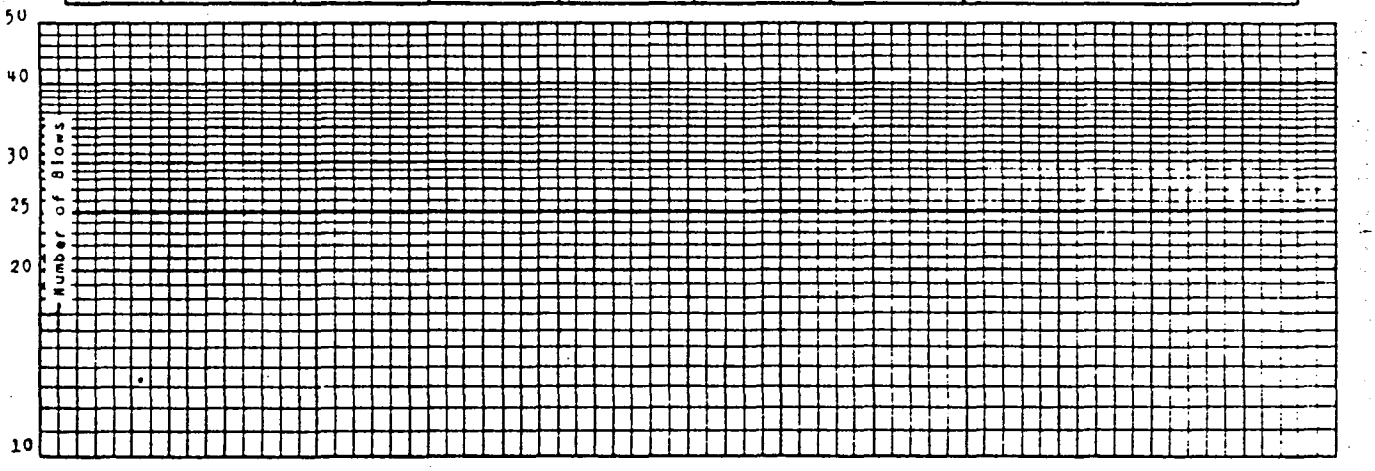
POWERLINE
STA. 155+10
0-1'

WORK SHEET FOR ATTERBERG LIMITS

LIQUID LIMIT DATA

① Can No.	② Wet Wt.	③ Dry Wt.	④ H_2O Wt. ②-③	⑤ Empty Wt.	⑥ Dry Soil ③-⑤	⑦ % H_2O $\frac{100 \times ④}{⑥}$	⑧ No. Blows	Laboratory Sample Number
								L.L. =
								P.L. =
								P.I. =
	NON-PLASTIC							L.L. =
								P.L. =
								P.I. =
								L.L. =
								P.L. =
								P.I. =
								L.L. =
								P.L. =
								P.I. =
								L.L. =
								P.L. =
								P.L. =
								L.L. =
								P.L. =
								P.I. =

PLASTIC LIMIT DATA



% H_2O →

Completed by: _____ Recorded by: _____

Checked by: _____ Date: _____

50M-04

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

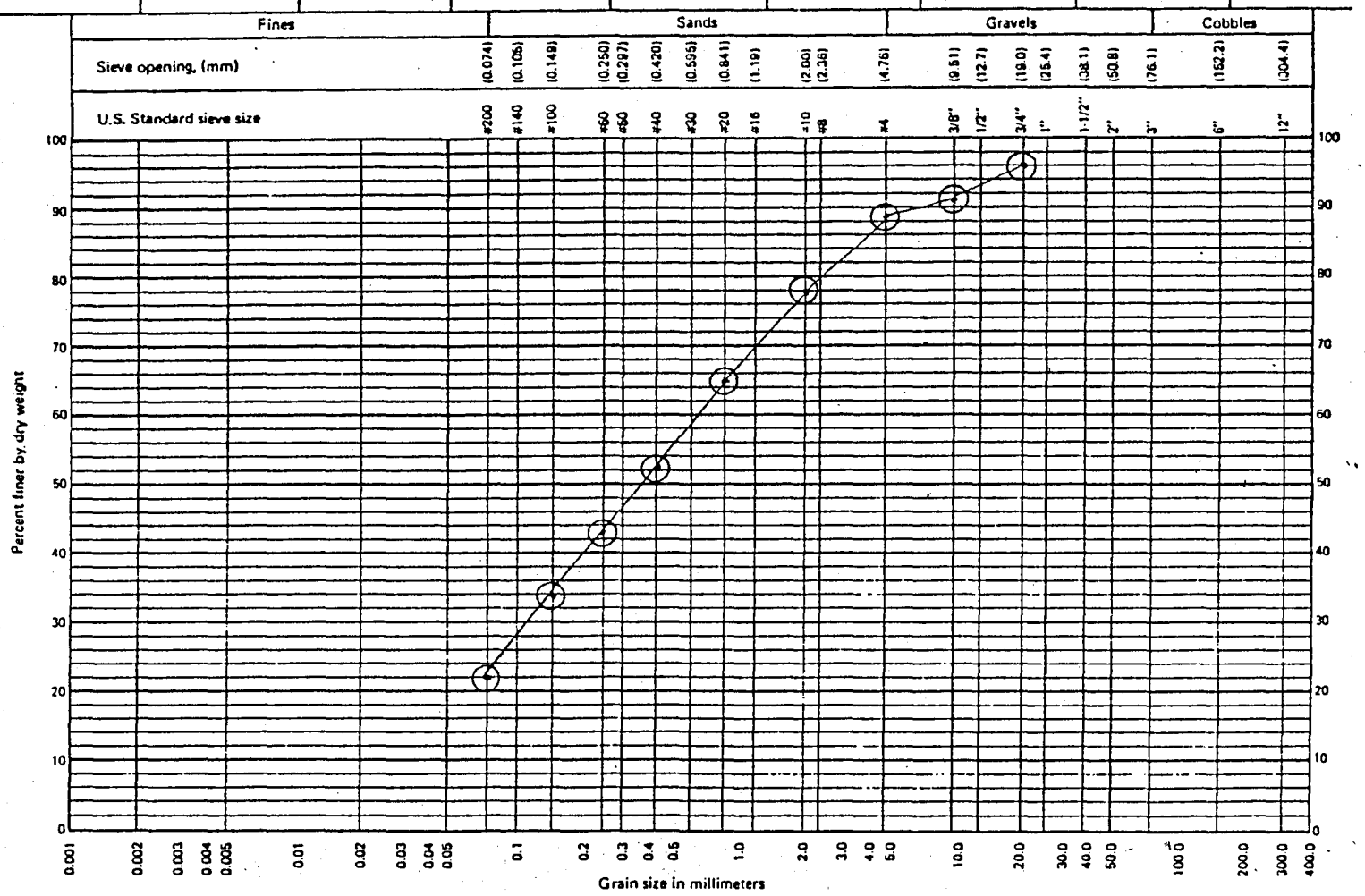
MATERIALS TESTING REPORT: SOIL CLASSIFICATION

SCS-ENG-353
2-80

Project and state: POWERLINE
Sample location: STH 155+10
Laboratory No.:
Field sample No.:
Depth: 0-1'
Geologic origin:
Type of sample: SP
Tested at: M.P.O.
Approved by: E. PASSON
Date: 10-3-91
Symbol:
Description: SILTY SAND

Grain Size Distribution

D_{10}	D_{15}	D_{30}	D_{50}	D_{60}	D_{85}	$D_{Maximum}$	C_u	C_c



Specific gravity (G_s)		Atterberg limits						Soluble salts	Shrinkage limit	Undisturbed condition	
		Natural moisture		Air dry		Ovendry				Moisture	Dry unit weight
– No. 4	+ No. 4	LL	PI	LL	PI	LL	PI	%	%	%	g/cm³ / lb/ft³

Remarks:

TSC-PO-ENG-9
12-74

U. S. DEPARTMENT OF AGRICULTURE
Soil Conservation Service

No Testing needed for shrink swell
STA 155+10 depth 2.5-3.5'

MTS No. _____

MECHANICAL ANALYSIS

Project PONTALINE FLW Date 10-3-91

Sample No. 155+10 2.5-3.5' Operator L. MASON.
M-14

SIEVE ANALYSIS Bowl #11

5.31 Coarse		Fine				
				% Finer	
Wt. Sample, Air Dry	16.78	Sieve	Wt.	%	Obs.	Corr.
Wt. Sample, Oven Dry		10	20.10	20.5	79.5	54.8
Wt. Ret. No. 4, Oven Dry		20	23.90	24.4	55.1	38.0
% Ret. No. 4 Sieve	31.1	40	21.10	21.5	33.6	23.2
% Finer No. 4 Sieve	68.9	60	8.64	8.8	24.8	17.1
		100	4.89	5.0	19.8	13.6
		200	4.10	4.2	15.6	10.7

HYDROMETER ANALYSIS

Wt. Dispersed Sample: Air Dry 100 Hydr. No. _____

Oven Dry 98.0 Jar No. _____

Hydr. Reading			Time (Min.)	Temp. °C	Grain Size (MM)	% Finer	
Calgon	Real	Corr.				Obs.	Corr.
			:1				
			2				
			5				
			15				
			30				
			60				
			120				

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REV. 2-71

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

POWERHOUSE
STA. 155+10
2.5-7.5'

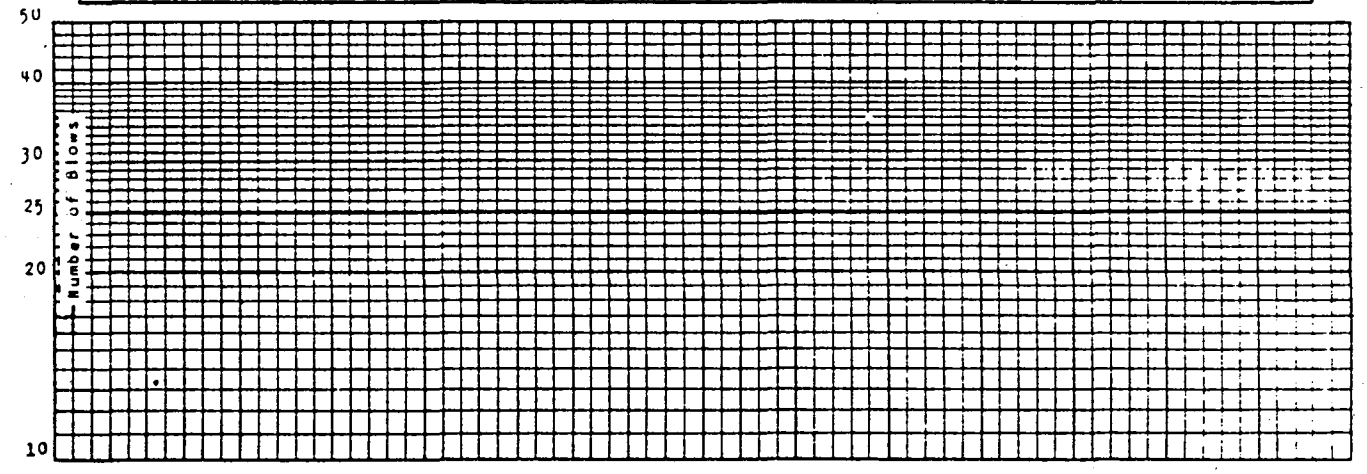
WORK SHEET FOR ATTERBERG LIMITS

LIQUID LIMIT DATA

① Can No.	② Wet Wt.	③ Dry Wt.	④ H_2O Wt. ②-③	⑤ Empty Wt.	⑥ Dry Soil ③-⑤	⑦ % H_2O $\frac{100 \times ④}{⑥}$	⑧ No. Blows	Laboratory Sample Number
								L.L. =
								P.L. =
								P.I. =
								L.L. =
								P.L. =
								P.I. =
								L.L. =
								P.L. =
								P.I. =
								L.L. =
								P.L. =
								P.I. =
								L.L. =
								P.L. =
								P.L. =
								L.L. =
								P.L. =
								P.I. =

NON-PLASTIC

PLASTIC LIMIT DATA



Completed by: _____ Recorded by: _____

Checked by: _____ Date: _____

59M-90

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

SCS-ENG-353
2-80

MATERIALS TESTING REPORT: SOIL CLASSIFICATION

Project and state: POWERLINE

Field sample No.: _____

Depth: 2.5 - 3.5'

Sample location: STA. 155+10

Laboratory No.: _____

Type of sample: SP

Tested at: F.P.O.

Geologic origin: _____

Symbol: _____

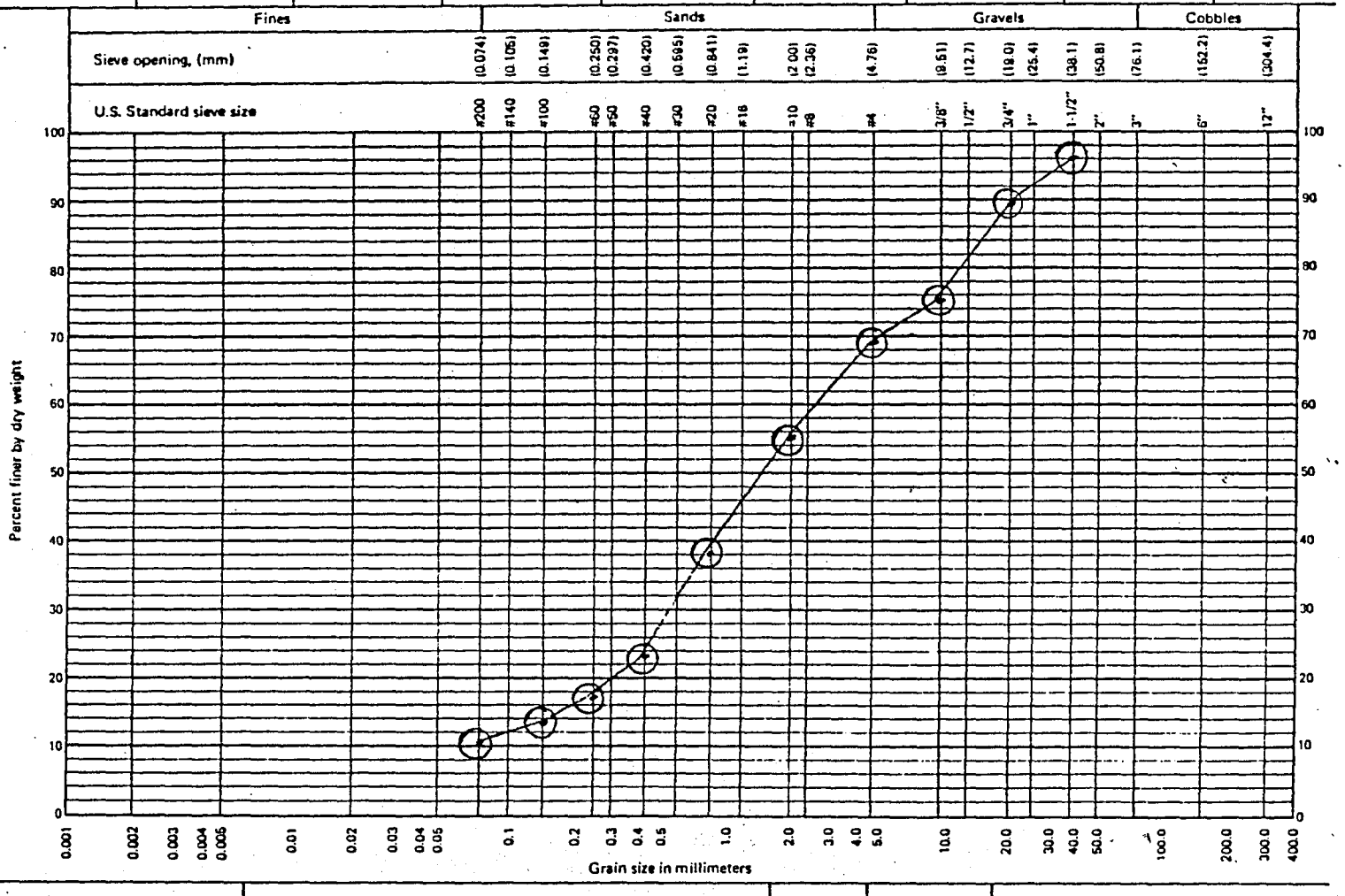
Description: SILTY SAND

Approved by: L. PIRSON

Date: 10-3-01

Grain Size Distribution

D_{10}	D_{15}	D_{30}	D_{50}	D_{60}	D_{85}	$D_{Maximum}$	C_u	C_c



Specific gravity (G_s)		Atterberg limits						Soluble salts	Shrinkage limit	Undisturbed condition	
		Natural moisture		Air dry		Ovendry				Moisture	Dry unit weight
– No. 4	+ No. 4	LL	PI	LL	PI	LL	PI	%	%	%	g/cm³ / lb/ft³

Remarks:

TSC-PO-ENG-9
12-74

U. S. DEPARTMENT OF AGRICULTURE
Soil Conservation Service

MTS No. _____

No testing [illegible] for [illegible] [illegible] STA 167+40 [illegible] 1.5'

MECHANICAL ANALYSIS

Project POWERLINE FLW Date 10-7-91

Sample No. 167+40 1.5'-2.5' Operator G. MASON

P-5 SIEVE ANALYSIS Bowl #7

5.12 Coarse	
Wt. Sample, Air Dry	12.83
Wt. Sample, Oven Dry	
Wt. Ret. No. 4, Oven Dry	
% Ret. No. 4 Sieve	37.2
% Finer No. 4 Sieve	62.8

Fine				
			% Finer	
Sieve	Wt.	%	Obs.	Corr.
10	21.20	22.2	77.8	48.9
20	16.95	17.8	60.0	37.7
40	9.97	10.4	49.6	31.
60	7.42	7.8	41.8	26.3
100	6.02	6.3	35.5	22.3
200	7.25	7.6	27.9	17.5

HYDROMETER ANALYSIS

Wt. Dispersed Sample: Air Dry _____ Hydr. No. _____

Oven Dry 95.45 Jar No. _____

Hydr. Reading			Time (Min.)	Temp. °C	Grain Size (MM)	% Finer	
Calgon	Real	Corr.				Obs.	Corr.
			1				
			2				
			5				
			15				
			30				
			60				
			120				

SCS-ENG-361
REV. 2-71

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

POWERLINE
STA. 167+40
1.5'-2.5'

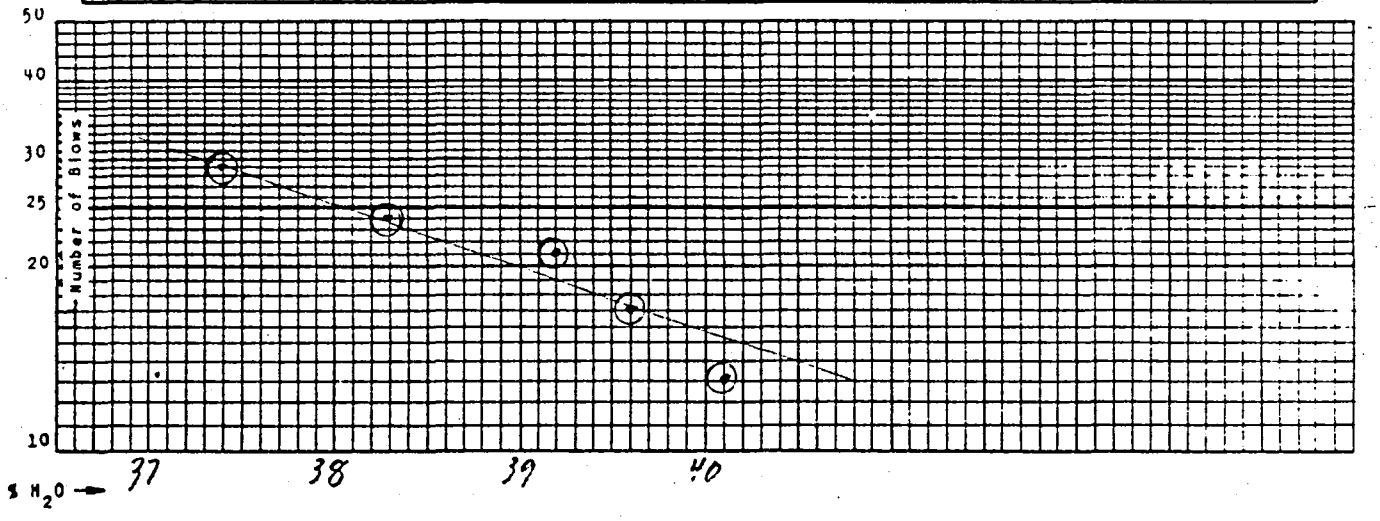
WORK SHEET FOR ATTERBERG LIMITS

LIQUID LIMIT DATA

① Can No.	② Wet Wt.	③ Dry Wt.	④ H_2O Wt. ②-③	⑤ Empty Wt.	⑥ Dry Soil ③-⑤	⑦ % H_2O $\frac{100 \times ④}{⑥}$	⑧ No. Blows	Laboratory Sample Number
508	28.61	23.81	4.80	11.84	11.97	40.1	13	
510	27.57	23.00	4.57	11.46	11.54	39.6	17	L.L. = 38
511	27.94	23.33	4.61	11.58	11.75	39.2	21	P.L. = 24
512	28.68	23.97	4.71	11.67	12.30	38.3	24	P.I. = 14
504	28.08	23.61	4.47	11.65	11.96	37.4	29	
								L.L. =
								P.L. =
								P.I. =
								L.L. =
								P.L. =
								P.I. =
								L.L. =
								P.L. =
								P.I. =
								L.L. =
								P.L. =
								P.L. =
								L.L. =
								P.L. =
								P.I. =

PLASTIC LIMIT DATA

10	13.43	12.33	1.10	7.84	4.49	24.5	24.4
83	14.44	13.16	1.28	7.88	5.28	24.2	



Completed by: _____ Recorded by: _____

Checked by: _____ Date: _____

50M-96

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

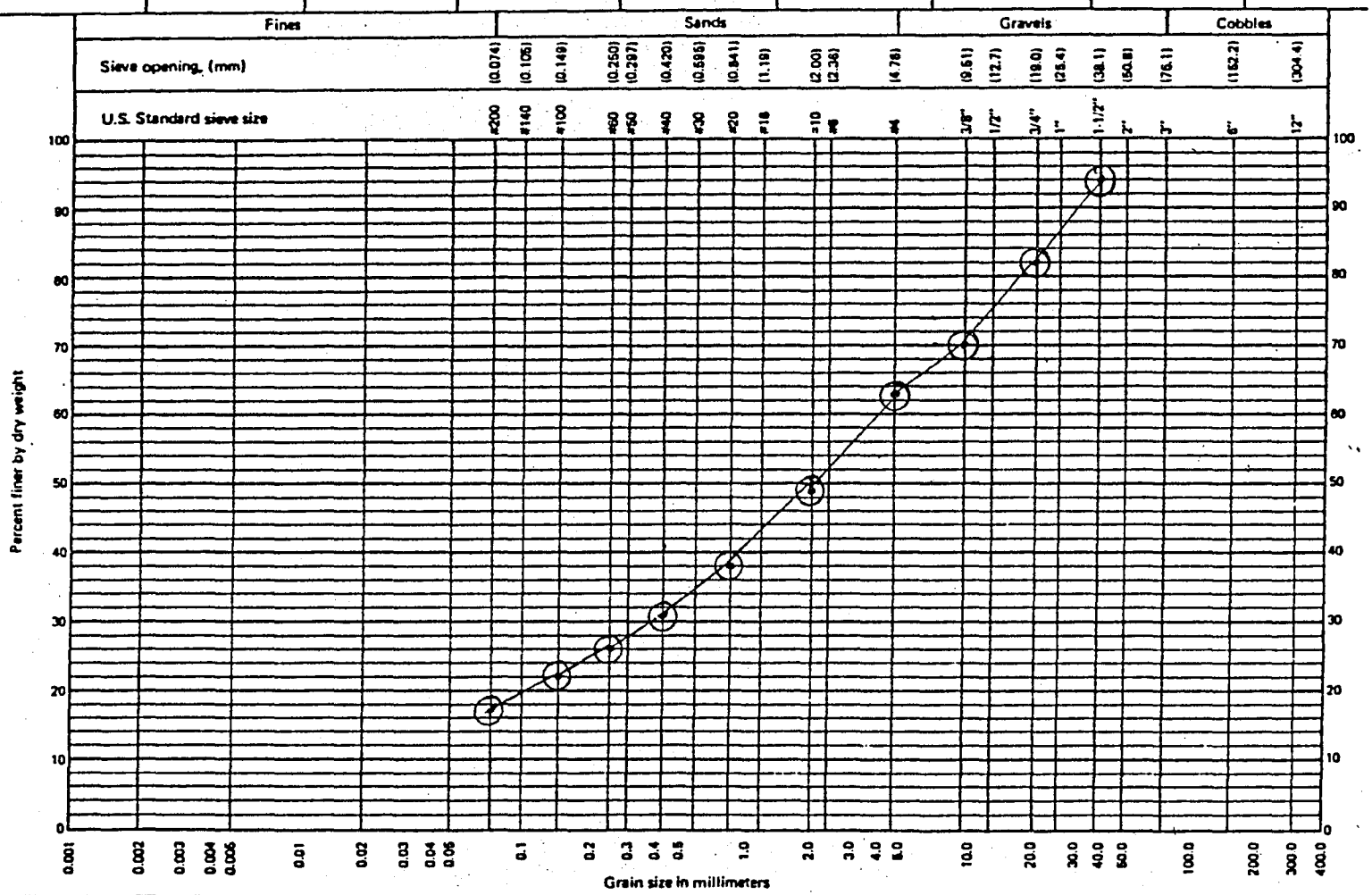
SCS-ENG-353
2-80

MATERIALS TESTING REPORT: SOIL CLASSIFICATION

Project and state: POWERLINE
Sample location: STA. 167+40
Laboratory No.:
Field sample No.:
Depth: 1.5 - 2.5'
Geologic origin:
Type of sample: SC
Tested at: R.P.O.
Approved by: E. MASON
Date: 10-7-91
Symbol:
Description: AUTOST ON A-LINE.

Grain Size Distribution

D_{10}	D_{15}	D_{30}	D_{50}	D_{60}	D_{85}	$D_{Maximum}$	C_u	C_c



Specific gravity (G_s)		Atterberg limits						Soluble salts	Shrinkage limit	Undisturbed condition	
		Natural moisture		Air dry		Ovendry				Moisture	Dry unit weight
− No. 4	+ No. 4	LL	PI	LL	PI	LL	PI	%	%	%	g/cm³ lb/ft³

Remarks:

TSC-PO-ENG-9
12-74

U. S. DEPARTMENT OF AGRICULTURE
Soil Conservation Service

MTS No. _____

No testing needed for service small STA 224+25 0-1'

MECHANICAL ANALYSIS

Project POWERLINE FARM Date 10-3-91

Sample No. 224+25 0'-1' Operator G. MASON

M-13 SIEVE ANALYSIS BOWL # 9

1.36 Coarse	
Wt. Sample, Air Dry	15.03
Wt. Sample, Oven Dry	
Wt. Ret. No. 4, Oven Dry	
% Ret. No. 4 Sieve	7.9
% Finer No. 4 Sieve	92.1

Fine				
			% Finer	
Sieve	Wt.	%	Obs.	Corr.
10	7.84	8.1	91.9	84.6
20	7.18	7.5	84.4	77.7
40	5.76	6.0	78.4	72.2
60	5.66	5.9	72.5	66.8
100	8.00	8.3	64.2	59.1
200	12.18	12.7	51.5	47.4

HYDROMETER ANALYSIS

Wt. Dispersed Sample: Air Dry 100 Hydr. No. _____

Oven Dry 96.26 Jar No. _____

Hydr. Reading			Time (Min.)	Temp. °C	Grain Size (MM)	% Finer	
Calgon	Real	Corr.				Obs.	Corr.
			1				
			2				
			5				
			15				
			30				
			60				
			120				

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REV. 2-71

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

POWERLINE
STA. 224+25
0-1'

WORK SHEET FOR ATTERBERG LIMITS

LIQUID LIMIT DATA

① Can No.	② Wet Wt.	③ Dry Wt.	④ H_2O Wt. ②-③	⑤ Empty Wt.	⑥ Dry Soil ③-⑤	⑦ % H_2O $\frac{100 \times ④}{⑥}$	⑧ No. Blows	Laboratory Sample Number
								L.L. =
								P.L. =
								P.I. =
								L.L. =
								P.L. =
								P.I. =
								L.L. =
								P.L. =
								P.I. =
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								P.I. =
								L.L. =
								P.L. =
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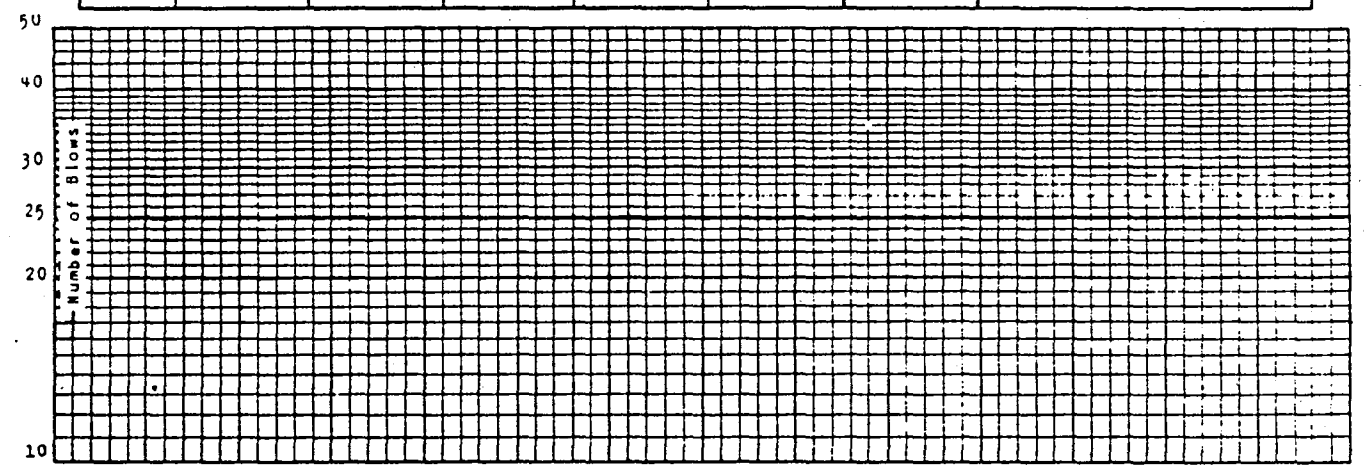
								L.L. =
								P.L. =
								P.I. =

NO ZONE PLACE

PLASTIC LIMIT DATA



Completed by: _____ Recorded by: _____

Checked by: _____ Date: _____

59M-04

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

MATERIALS TESTING REPORT: SOIL CLASSIFICATION

SCS-ENG-353
2-80

Project and state POWERLINE | Sample location STA. 224+25 | Laboratory No.

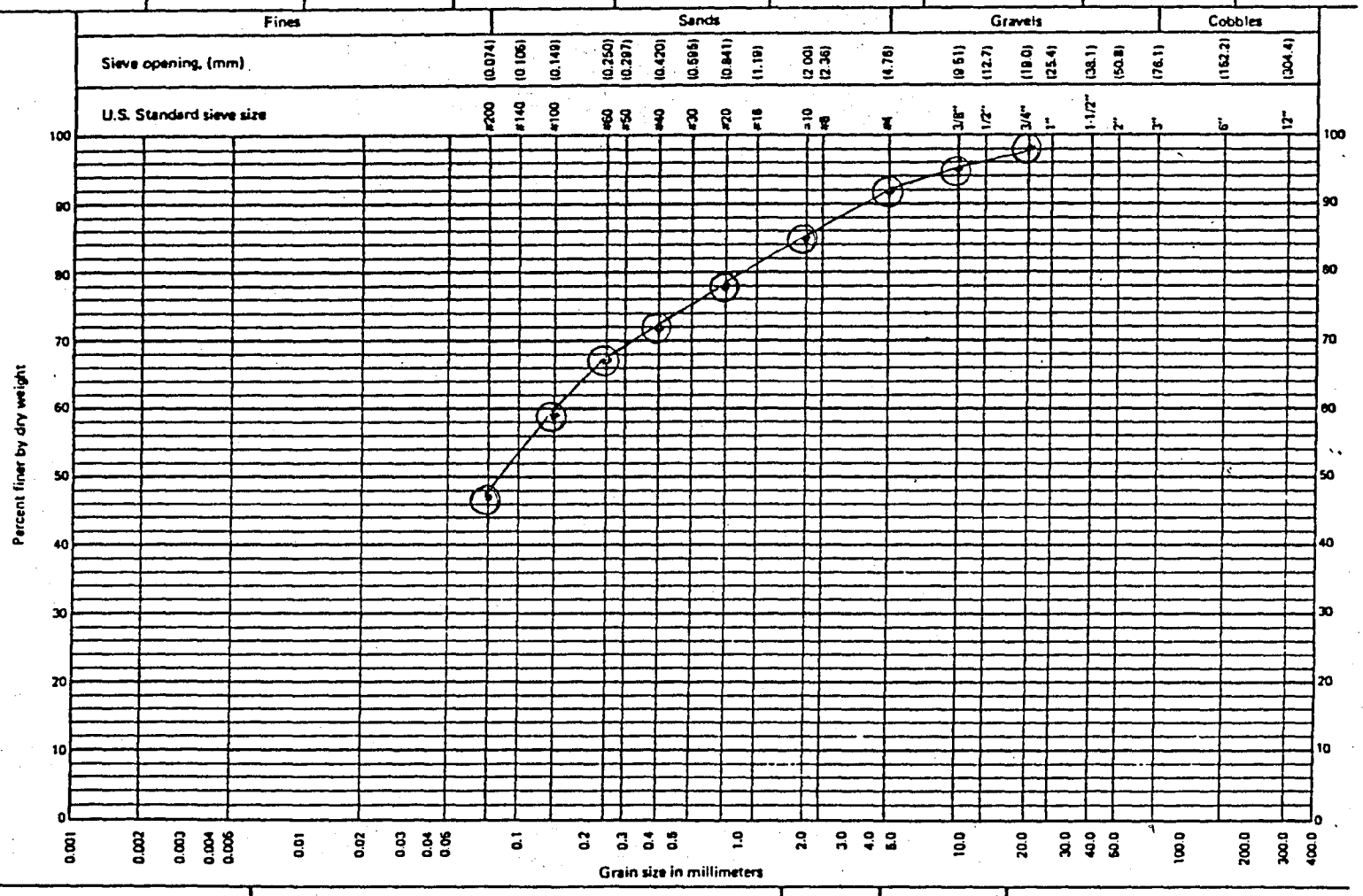
Field sample No. | Depth 0-1' | Geologic origin

Type of sample TP.P.O. | Tested at | Approved by E. PERSON | Date 10-7-81

Symbol SM | Description SILTY SAND

Grain Size Distribution

D_{10}	D_{15}	D_{30}	D_{50}	D_{60}	D_{85}	$D_{Maximum}$	C_u	C_c



Specific gravity (G_s)		Atterberg limits						Soluble salts	Shrinkage limit	Undisturbed condition	
		Natural moisture		Air dry		Ovendry				Moisture	Dry unit weight, γ
− No. 4	+ No. 4	LL	PI	LL	PI	LL	PI	%	%	%	g/cm³ lb/ft³

Remarks:

TSC-PO-ENG-9
12-74

U. S. DEPARTMENT OF AGRICULTURE
Soil Conservation Service

No testing needed for physical for sample 78+00 0-1'

MTS No. _____

MECHANICAL ANALYSIS

Project POWERLINE FLW Date 10-3-91

Sample No. 78+00 0'-1' Operator G. MASON

M-51

SIEVE ANALYSIS BOWL #13

4.49 Coarse		Fine				
					% Finer	
Wt. Sample, Air Dry	19.73	Sieve	Wt.	%	Obs.	Corr.
Wt. Sample, Oven Dry		10	16.52	17.0	83.0	65.6
Wt. Ret. No. 4, Oven Dry		20	17.52	17.9	70.1	55.4
% Ret. No. 4 Sieve	21	40	13.10	13.5	56.6	44.7
% Finer No. 4 Sieve	79	60	11.91	12.3	44.3	35.0
		100	11.59	11.9	32.4	25.6
		200	10.61	10.9	21.5	17.0

HYDROMETER ANALYSIS

Wt. Dispersed Sample: Air Dry _____ Hydr. No. _____

Oven Dry 97.17 Jar No. _____

Hydr. Reading			Time (Min.)	Temp. °C	Grain Size (MM)	% Finer	
Calgon	Real	Corr.				Obs.	Corr.
			1				
			2				
			5				
			15				
			30				
			60				
			120				

SCS-ENG-361
REV. 2-71

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

POWERLINE
STA. 78+00
0-1'

WORK SHEET FOR ATTERBERG LIMITS

LIQUID LIMIT DATA

① Can No.	② Wet Wt.	③ Dry Wt.	④ H_2O Wt. ②-③	⑤ Empty Wt.	⑥ Dry Soil ③-⑤	⑦ % H_2O $\frac{100 \times ④}{⑥}$	⑧ No. Blows	Laboratory Sample Number
								L.L. =
								P.L. =
								P.I. =
	NON	-	PLASTIC					L.L. =
								P.L. =
								P.I. =
								L.L. =
								P.L. =
								P.I. =
								L.L. =
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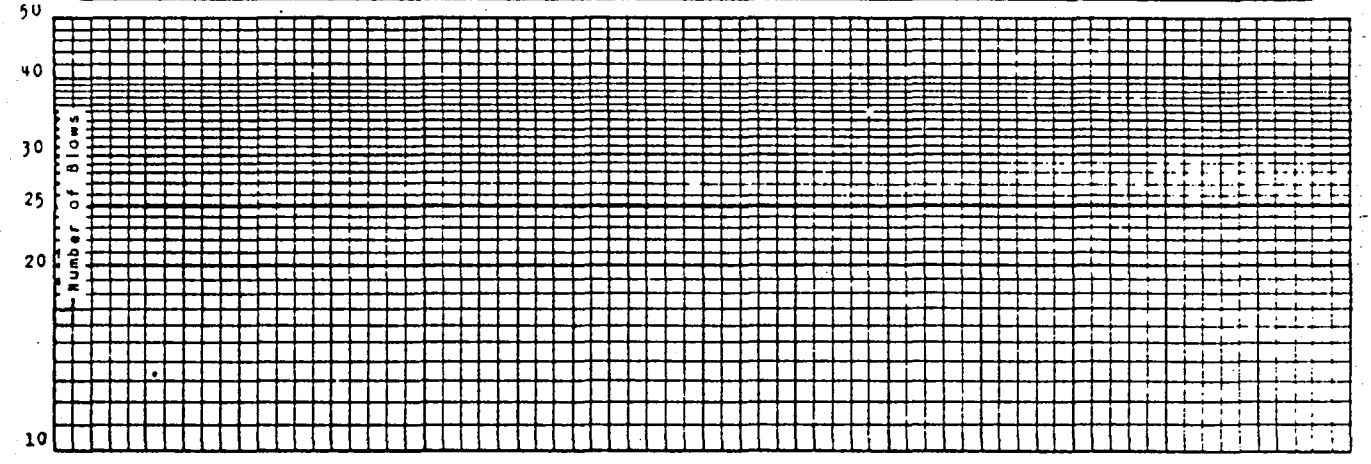
								P.L. =
								P.L. =
								L.L. =
								P.L. =
								P.I. =

PLASTIC LIMIT DATA



% H_2O →

Completed by: _____ Recorded by: _____

Checked by: _____ Date: _____

59M-95

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

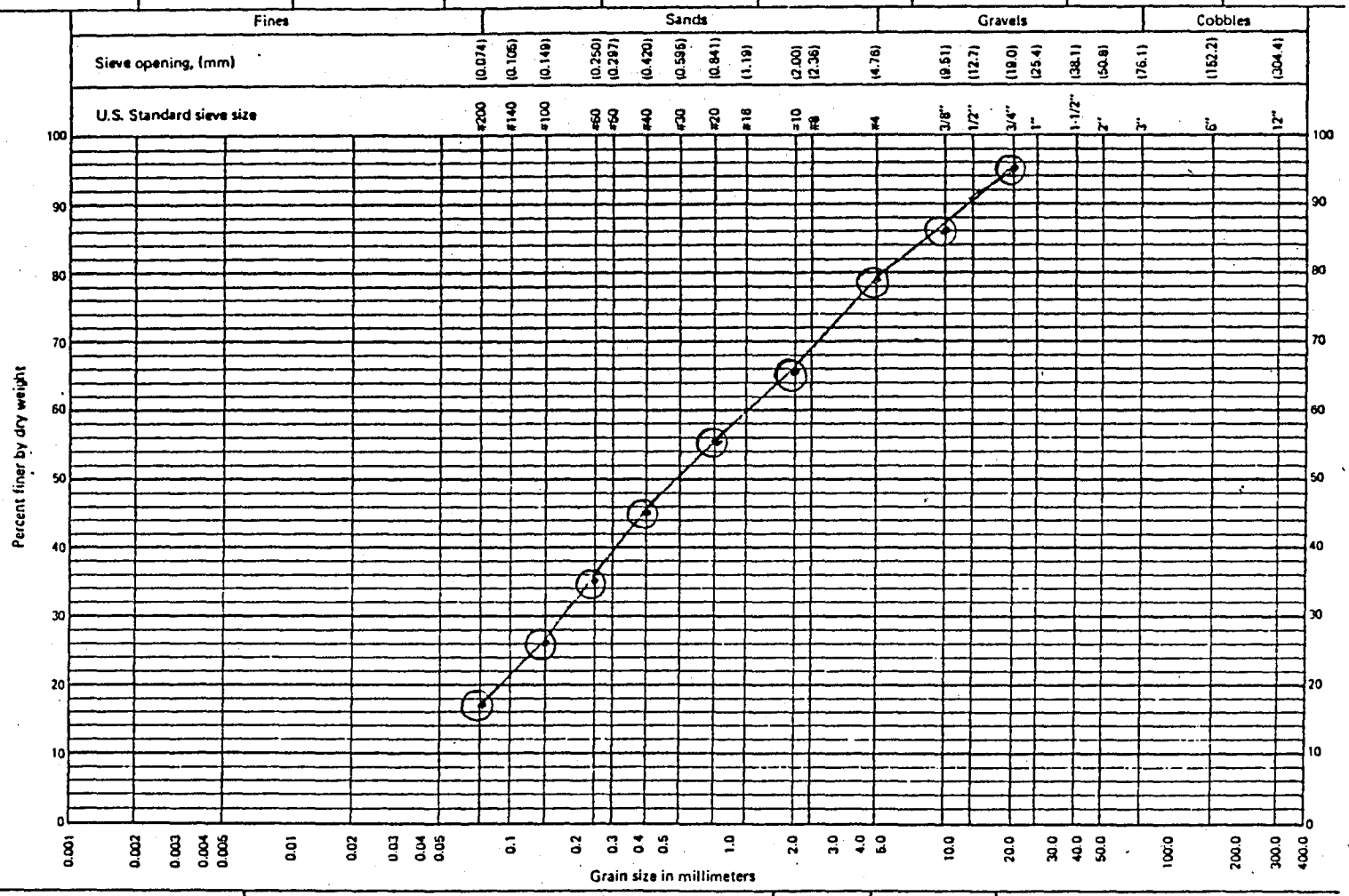
MATERIALS TESTING REPORT: SOIL CLASSIFICATION

SCS ENG-353
7-80

Project and state: PAWHERLINE
Sample location: STA. 78+00
Laboratory No.:
Field sample No.:
Depth: 0-1'
Geologic origin:
Type of sample: SIT
Tested at: DRO.
Approved by: C. MASTER
Date: 10-7-81
Symbol:
Description: SILTY SAND

Grain Size Distribution

D_{10}	D_{15}	D_{30}	D_{50}	D_{60}	D_{85}	$D_{Maximum}$	C_u	C_c



Specific gravity (G_s)		Atterberg limits						Soluble salts	Shrinkage limit	Undisturbed condition	
		Natural moisture		Air dry		Ovendry				Moisture	Dry unit weight
– No. 4	+ No. 4	LL	PI	LL	PI	LL	PI	%	%	%	g/cm³ lb/ft³

Remarks:

TSC-PO-ENG-9
12-74

U. S. DEPARTMENT OF AGRICULTURE
Soil Conservation Service

MTS No. _____

1/8 Testing needed for sieve [illegible] for sample 167+40 0-1'

MECHANICAL ANALYSIS

Project POWERLINE FLW Date 10-3-91

Sample No. 167+40 0-1' Operator G. MASON

P-8 [illegible]

SIEVE ANALYSIS BOWL #5

1.27 Coarse	
Wt. Sample, Air Dry	12.04
Wt. Sample, Oven Dry	
Wt. Ret. No. 4, Oven Dry	
% Ret. No. 4 Sieve	6.5
% Finer No. 4 Sieve	93.5

Fine				
			% Finer	
Sieve	Wt.	%	Obs.	Corr.
10	12.58	13.3	86.7	81.1
20	12.18	12.8	73.9	69.1
40	13.51	14.2	59.7	55.8
60	9.86	10.4	49.3	46.1
100	10.02	10.6	38.7	36.2
200	10.78	11.4	27.3	25.5

HYDROMETER ANALYSIS

Wt. Dispersed Sample: Air Dry _____ Hydr. No. _____

Oven Dry 94.90 Jar No. _____

Hydr. Reading			Time (Min.)	Temp. °C	Grain Size (MM)	% Finer	
Calgon	Real	Corr.				Obs.	Corr.
			1				
			2				
			5				
			15				
			30				
			60				
			120				

USDA SCS PORTLAND, OREG. 1969

SCS-ENG-361
REV. 2-71

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

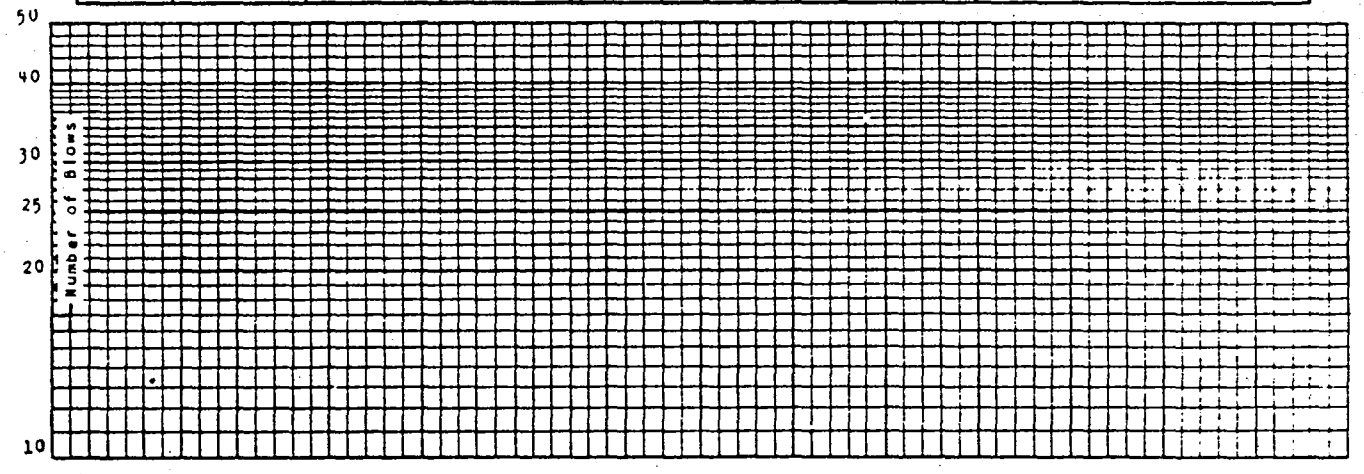
POWERLINE
STA. 167+40
0-1'

WORK SHEET FOR ATTERBERG LIMITS

LIQUID LIMIT DATA

① Can No.	② Wet Wt.	③ Dry Wt.	④ H_2O Wt. ②-③	⑤ Empty Wt.	⑥ Dry Soil ③-⑤	⑦ % H_2O $\frac{100 \times ④}{⑥}$	⑧ No. Blows	Laboratory Sample Number
								L.L. =
								P.L. =
								P.I. =
	NON-PLASTIC							
								L.L. =
								P.L. =
								P.I. =
								L.L. =
								P.L. =
								P.I. =
								L.L. =
								P.L. =
								P.I. =
								L.L. =
								P.L. =
								P.L. =
								L.L. =
								P.L. =
								P.I. =

PLASTIC LIMIT DATA



Completed by: _____ Recorded by: _____

Checked by: _____ Date: _____

50M-96

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

MATERIALS TESTING REPORT: SOIL CLASSIFICATION

SCS-ENG-353
2-80

Project and state POWERLINE Sample location STA. 167+40 Laboratory No. ____

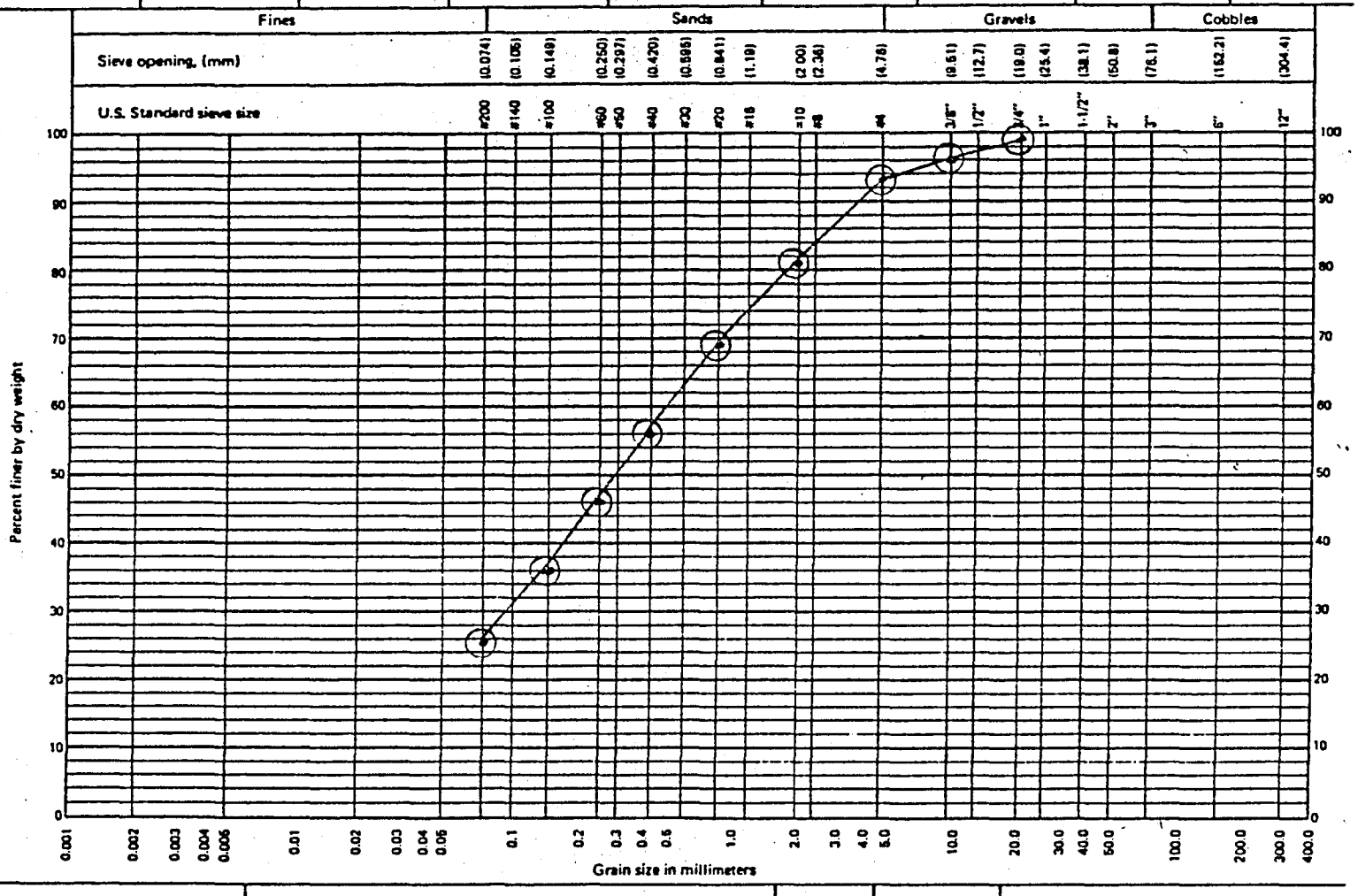
Field sample No. ____ Depth 0-1' Geologic origin ~~Sample~~

Type of sample ____ Tested at TPCO. Approved by E. Cooper Date 10-2-81

Symbol SM Description SILTY SAND

Grain Size Distribution

D_{10}	D_{15}	D_{30}	D_{50}	D_{60}	D_{85}	$D_{Maximum}$	C_u	C_c



Specific gravity (G_s)		Atterberg limits						Soluble salts	Shrinkage limit	Undisturbed condition	
		Natural moisture		Air dry		Ovendry				Moisture	Dry unit weight
– No. 4	+ No. 4	LL	PI	LL	PI	LL	PI	%	%	%	g/cm³ / lb/ft³

Remarks:

Specifications

CONSTRUCTION SPECIFICATION

3. STRUCTURE REMOVAL

1. SCOPE

The work shall consist of the removal, salvage and disposal of structures (including fences) from the designated areas.

2. MARKING

Each structure unit to be removed will be marked by means of stakes, flags, painted markers or other suitable methods.

3. REMOVAL

All structures designated in the contract for removal shall be removed to the specified extent and depth.

4. SALVAGE

Structures that are designated to be salvaged shall be carefully removed and neatly placed in the specified storage areas. Salvaged structures that are capable of being disassembled shall be dismantled into individual members or sections. Such structures shall be neatly match marked with paint prior to disassembly. All pins, nuts, bolts, washers, plates and other loose parts shall be marked or tagged to indicate their proper locations in the structure and shall be fastened to the appropriate structural member or packed in suitable containers. Materials from fences designated to be salvaged shall be placed outside the work area on the property from which they were removed. Wire shall be rolled into uniform rolls of convenient size. Posts and rails shall be neatly piled.

5. DISPOSAL OF REFUSE MATERIALS

Refuse materials resulting from structure removal shall be burned or buried at locations shown on the drawings or as specified in Section 7 of the specification.

6. MEASUREMENT AND PAYMENT

For items of work for which specific lump sum prices are established in the contract, payment for structure removal will be made at the contract lump sum price.

Such payment will constitute full compensation for all labor, equipment, tools, and all other items necessary and incidental to the completion of the work.

Compensation for any item of work described in the contract but not listed in the bid schedule will be included in the payment for the item of work to which it is made subsidiary. Such items and the items to which they are made subsidiary are identified in Section 7 of this specification.

7. ITEMS OF WORK AND CONSTRUCTION DETAILS

Items of work to be performed in conformance with this specification and the construction details are:

(a) Bid Item 1, Structure Removal - Channel Lining

(1) This item consists of the removal and disposal of concrete lined sections and portions of sections as shown on the drawings.

(2) Disposal of channel lining materials shall be the responsibility of the contractor and shall be disposed of away from the job site.

(3) In Section 6, Measurement and Payment, payment will include compensation for subsidiary items: Pollution Control; Removal of Water; and Excavation.

CONSTRUCTION SPECIFICATION

5. POLLUTION CONTROL

1. SCOPE

The work shall consist of installing measures or performing work to control erosion and minimize the production of sediment and other pollutants to water and air during construction operations in accordance with these specifications.

2. MATERIALS

All materials furnished shall meet the requirements of the Material Specifications listed in Section 8 of this specification.

3. EROSION AND SEDIMENT CONTROL MEASURES AND WORKS

The work and measures shall include but not be limited to the following, as shown on the drawings or as specified in Section 8 of this specification.

Staging of Earthwork Activities - The excavation and moving of soil materials shall be scheduled so that the smallest possible areas will be unprotected from erosion for the shortest time feasible.

Seeding - Seedings to protect disturbed areas shall be done as specified on the drawings or in Section 8 of this specification.

Mulching - Mulching shall be used to provide temporary protection to soil surfaces from erosion.

Diversions - Diversions shall be used to divert water away from work areas and/or to collect runoff from work areas for treatment and safe disposition.

Stream Crossings - Culverts or bridges shall be used where equipment must cross streams.

Sediment Basins - Sediment basins shall be used to settle and filter out sediment from eroding areas to protect properties and streams below the construction site.

Straw Bale Filters - Straw bale filters shall be used to trap sediment from areas of limited runoff. Bales are temporary and shall be removed when permanent measures are installed.

Waterways - Waterways shall be used for the safe disposal of runoff from fields, diversions and other structures or measures.

4. CHEMICAL POLLUTION

The Contractor shall provide watertight tanks or barrels or construct a sump sealed with plastic sheets to be used to dispose of chemical pollutants (such as drained lubricating or transmission oils, greases, soaps, asphalt, etc.) produced as a by-product of the project's work. At the completion of the construction work, sumps shall be voided without causing pollution as specified in Section 8 of this specification.

Sanitary facilities such as pit toilets, chemical toilets, or septic tanks shall not be placed adjacent to live streams, wells, or springs. They shall be located at a distance sufficient to prevent contamination of any water sources. At the completion of construction work, facilities shall be disposed of without causing pollution as specified in Section 8 of this specification.

5. AIR POLLUTION

Local and state regulations concerning the burning of brush or slash or disposal of other materials shall be adhered to.

Fire prevention measures shall be taken to prevent the start or the spreading of fires which result from project work. Fire breaks or guards shall be constructed at locations shown on the drawings.

All public access or haul roads used by the contractor during construction of the project shall be sprinkled or otherwise treated to fully suppress dust.

6. MAINTENANCE, REMOVAL, AND RESTORATION

All pollution control measures and works shall be adequately maintained in a functional condition as long as needed during the construction operation. All temporary measures shall be removed and the site restored to as nearly original conditions as practicable.

7. MEASUREMENT AND PAYMENT

Compensation for any item of work described in the contract but not listed in the bid schedule will be included in the payment for the item of work to which it is made subsidiary. Such items, and the items to which they are made subsidiary, are identified in Section 8 of this specification.

8. ITEMS OF WORK AND CONSTRUCTION DETAILS

Items of work to be performed in conformance with this specification and the construction details are:

a. Subsidiary items. Pollution Control

(1) This item consists of all work required to control or reduce pollution.

(2) The contractor is required to adhere to all applicable local, State and Federal laws and regulations pertaining to the control of pollution as may result from construction of this project. These laws and regulations include but are not limited to:

(a) The "Policy on construction and related activities in water" adopted April 13, 1977, by the Water Quality Control Council of Arizona.

(b) The Clean Air Act (42 U.S.C. 1857 et seq. as amended by Pub. L. 91-604) Section 114, and Section 308 of the Federal Water Pollution Control Act (33 U.S.C. 1251 et seq. as amended by Pub. L. 92-500) relating to inspection, monitoring, entry, reports, and information as well as the other requirement of these sections.

(3) The Contractor is responsible for maintaining air, water, and vegetative quality within the work area. Methods include:

(a) Establishing turn areas, haul roads, work site access road, temporary building sites, equipment yards, etc., in approved locations, and staging earthwork activities to prevent contamination of air and water, to minimize destruction of existing vegetation, and to minimize erosion.

(b) Operating mechanized equipment at the job site in a manner that will avoid destruction or removal of trees and shrubs other than as necessary for construction of the measure.

(4) Under Section 2, Materials, no material specifications are required.

(5) Under Section 3, Seeding, no seeding is required.

(6) Section 4, Chemical Pollution, prior to the completion of the job the Contractor shall provide a plan, for approval by the Contracting Officer, to void sump areas and dispose of sanitary facilities as applicable.

(7) Section 7, Measurement and Payment, no separate payment will be made for this item. Compensation for this work will be included in the payment for Bid Item 1, Structure Removal.

CONSTRUCTION SPECIFICATION

7. CONSTRUCTION SURVEYS FOR LAYOUT, CONTROL AND MEASUREMENT

1. SCOPE

The work shall consist of performing: (1) all specified surveys for layout of work and construction controls, and (2) quantity surveys and computations for progress payment estimates. It includes furnishing all necessary equipment, personnel and material to perform the surveys required by the methods specified.

2. EQUIPMENT AND MATERIALS

Equipment for construction surveys shall be of a quality and condition to provide the required accuracy. The equipment shall be maintained in good working order and in proper adjustment at all times. Records of calibration tests, accuracy checks and adjustments shall be maintained and be available for inspection by the Contracting Officer.

Materials include all the necessary field notebooks, stakes, templates, platforms, equipment, spikes, steel pins, tools, and all other items necessary to perform the work specified.

3. QUALITY OF WORK

All work shall follow recognized professional practice and the standards of the industry unless otherwise specified in Section 9. The work shall be performed to the accuracy and detail appropriate for the type of job. Notes, sketches, and other data shall be complete, recorded neatly, legible, reproducible and organized in a manner that will allow reproduction of copies for job documentation.

All computations shall be mathematically correct. Computations shall include information to identify the bid item, date, and who performed, checked and approved the computations. Computations shall be legible, complete and clearly document the source of all information used including assumptions and measurements made.

If a computer program is used to perform the computations, a copy of the program, with user information, shall be submitted with the first set of computations. Computer generated computations shall show the input data used including the source of all information used and software assumptions.

The elevations of permanent and temporary bench marks shall be determined and recorded to the nearest 0.01 foot. Differential leveling and transit traverses shall be of such precision that the error of vertical closure in feet shall not exceed plus or minus 0.1

times the square root of the traverse distance in miles. Linear measurements shall be accurate to within 1.0 foot in 5000 feet, unless otherwise specified in Section 9. The angular error of closure for transit traverses shall not exceed 1.0 minute times the square root of the number of angles turned.

Slope stakes shall be placed, as a minimum; at 100 foot stations, breaks in the original ground surface and at any other intermediate stations necessary to insure accurate location for construction layout and measurement. Slope stakes and cross sections shall be perpendicular to the centerline. Significant breaks in grade shall be determined for cross sections. Distances shall be measured horizontally and recorded to the nearest 0.1 foot. Side shots for interim construction stakes may be taken with a hand level.

Unless otherwise specified in Section 9, measurement for stationing and establishing the location of structures shall be made to the nearest 0.1 of a foot.

Elevations for concrete work, pipes and mechanical equipment shall be determined and recorded to the nearest 0.01 foot. Elevations for earth work shall be determined and recorded to the nearest 0.1 foot.

4. PRIMARY CONTROL

The baselines and bench marks for primary control, necessary to establish lines and grades needed for construction, are shown on the drawings and have been located on the job site.

These baselines and bench marks shall be used as the origin of all surveys, layouts and measurements to establish construction lines and grades. The Contractor shall take all necessary precautions to prevent the loss or damage of primary control points.

5. CONSTRUCTION SURVEYS

Prior to commencement of work requiring contractor performed surveys, the Contractor shall submit in writing to the Contracting Officer for approval the name, qualifications and experience of the individuals to be assigned to the job.

Contractor performed surveys shall consist of the work necessary for: (1) establishing line and grade for all work, (2) setting slope stakes for all work, (3) checking and any supplemental or interim staking, (4) establishing final grade stakes, (5) performing quantity surveys, measurements and computations for progress payment and (6) other surveys as described in Section 9.

6. STAKING

Prior to the commencement of work on any item the construction staking required for that item shall be completed. Construction staking shall be completed as follows, or as otherwise specified in Section 9:

a. Clearing and grubbing - the boundary of the clearing and grubbing areas shall be staked or flagged at 200 foot intervals, or closer if needed, to clearly mark the limits of work.

b. Excavation and fill - slope stakes shall be placed at the intersection of the specified slopes and ground line. Slope stakes or the reference stakes for slopes shall be marked with the stationing, required cut, slope ratio and horizontal distance. Offset reference stakes and hubs shall be placed, as a minimum, at 100 foot stations, and shall be placed on at least one side of specified excavations and on both sides of specified fills.

c. Structures - centerline and offset reference line stakes for location, alignment and elevation shall be placed for all structures.

7. RECORDS

All survey data shall be recorded in fully identified, standard hard-bound engineering survey field notebooks with consecutively numbered pages. All field notes and printed data shall include the purpose or description of the work, the date the work was performed, weather data, sketches and the personnel who performed and checked the work. Electronically generated survey data and computations shall be bound, page numbered and cross referenced in a bound field notebook containing the index for all survey data.

The construction survey records shall be available at all times during the progress of the work for examination and use by the Contracting Officer and copies shall be made available to the Contracting Officer upon request. The original field notebooks and other records shall be turned over to and become the property of the Contracting Officer prior to final acceptance of the work.

Complete documentation of computations and supporting data for progress payments shall be submitted to the Contracting Officer with each invoice for payment as specified in Section 9.

8. MEASUREMENT AND PAYMENT

Compensation for any item of work described in the contract but not listed in the bid schedule will be included in the payment for the item of work to which it is made subsidiary. Such items and the item to which they are made subsidiary are identified in Section 9 of this specification.

9. ITEMS OF WORK AND CONSTRUCTION DETAILS

Items of work to be performed in conformance with this specification and the construction details are:

a. Subsidiary Item, Surveys

(1) This item consists of furnishing personnel, equipment, materials and performing surveys required to construct the Powerline Floodway Repair.

(2) In Section 5 "other surveys" shall include those required for computation of final quantities and preparation of as-built drawings.

(3) The Contractor shall provide the Government Representative at the beginning of each work week a schedule of surveys to be performed that week.

(4) Base lines and bench marks for primary control are located on the south side of the floodway.

(5) Any primary control monuments damaged or destroyed by the Contractor due to negligence will be replaced by the Government at the Contractor's expense. The actual cost to the Government for replacing the primary control monuments will be deducted from payments due the Contractor.

(6) All entries shall be consistent with Soil Conservation Service TR-62, "Engineering Layout, Notes, Staking and Calculations".

(7) No separate payment will be made for surveys. Compensation for this item will be included in Bid Item 1, Structure Removal, and Bid Item 3, Concrete Channel Lining.

CONSTRUCTION SPECIFICATION

8. MOBILIZATION

1. SCOPE

The work shall consist of the mobilization of the Contractor's forces and equipment necessary for performing the work required under the contract. Mobilization will not be considered as work in fulfilling the contract requirement for commencement of work.

Mobilization shall include the cost for transportation of personnel, equipment, and operating supplies to the site; establishment of offices, buildings, and other necessary facilities at the site not covered in specific bid items, and other preparatory work at the site. The cost of the entire amount of premiums paid for performance and payment bonds, including coinsurance and reinsurance agreements as applicable shall be paid upon request when evidence of full payment to the surety has been provided to the Contracting Officer.

Work done under this specification shall not include mobilization for any specific item of work for which payment for mobilization is provided elsewhere in the contract.

The specification covers mobilization for work required by the contract at the time of award. If additional mobilization costs are incurred during performance of the contract as a result of changed or added items of work for which the Contractor is entitled to an adjustment in contract price, compensation for such costs will be included in the price adjustment for the item or items of work changed or added.

2. PAYMENT

Payment will be made as the work proceeds, after presentation of invoices by the Contractor showing his own mobilization costs and evidence of the charges of suppliers, subcontractors, and others for mobilization work performed by them. If the total of such payments is less than the contract lump sum for mobilization, the unpaid balance will be included in the final contract payment. Total payment will be the lump sum contract price for mobilization, regardless of actual cost to the Contractor.

Payment will not be made under this item for the purchase costs of materials having a residual value, the purchase costs of materials to be incorporated in the project, or the purchase costs of operating supplies.

Payment of the lump sum contract price for mobilization will constitute full compensation for all labor, materials, equipment, and all other items necessary and incidental to completion of the work.

3. ITEMS OF WORK AND CONSTRUCTION DETAILS

Item of work to be performed in accordance with this specification and the construction details are:

a. Bid Item 2, Mobilization

(1) This Item consists of the mobilization of the Contractor's equipment and forces for the repair of the Powerline Floodway.

CONSTRUCTION SPECIFICATION

21. EXCAVATION

1. SCOPE

The work shall consist of the excavation required by the drawings and specifications and disposal of the excavated materials.

2. CLASSIFICATION

Excavation will be classified as common excavation or rock excavation in accordance with the following definitions or will be designated as unclassified.

Common excavation shall be defined as the excavation of all materials that can be excavated, transported, and unloaded by the use of heavy ripping equipment and wheel tractor-scrapers with pusher tractors or that can be excavated and dumped into place or loaded onto hauling equipment by means of excavators having a rated capacity of one cubic yard and equipped with attachments (such as shovel, bucket, backhoe, dragline or clam shell) appropriate to the character of the materials and the site conditions.

Rock excavation shall be defined as the excavation of all hard, compacted or cemented materials the accomplishment of which requires blasting or the use of excavators larger than defined for common excavation. The excavation and removal of isolated boulders or rock fragments larger than one cubic yard in volume encountered in materials otherwise conforming to the definition of common excavation shall be classified as rock excavation.

Excavation will be classified according to the above definitions by the Engineer, based on his judgment of the character of the materials and the site conditions.

The presence of isolated boulders or rock fragments larger than one cubic yard in size will not in itself be sufficient cause to change the classification of the surrounding material.

For the purpose of this classification, the following definitions shall apply:

Heavy ripping equipment shall be defined as a rear-mounted, heavy duty, single-tooth, ripping attachment mounted on a tractor having a power rating of 200-300 net horsepower (at the flywheel).

Wheel tractor-scraper shall be defined as a self-loading (not elevating) and unloading scraper having a struck bowl capacity of 12-20 yards.

Pusher tractor shall be defined as a track type tractor having a power rating of 200-300 net horsepower (at the flywheel) equipped with appropriate attachments.

3. UNCLASSIFIED EXCAVATION

Items designated as "Unclassified Excavation" shall include all materials encountered regardless of their nature or the manner in which they are removed. When excavation is unclassified, none of the definitions or classifications stated in Section 2 of this specification shall apply.

4. BLASTING

The transportation, handling, storage, and use of dynamite and other explosives shall be directed and supervised by a person of proven experience and ability in blasting operations.

Blasting shall be done in such a way as to prevent damage to the work or unnecessary fracturing of the foundation and shall conform to any special requirements in Section 12 of this specification.

5. USE OF EXCAVATED MATERIALS

To the extent they are needed, all suitable materials from the specified excavations shall be used in the construction of required permanent earthfill or rockfill. The suitability of materials for specific purposes will be determined by the Engineer. The Contractor shall not waste or otherwise dispose of suitable excavated materials.

6. DISPOSAL OF WASTE MATERIAL

All surplus or unsuitable excavated materials will be designated as waste and shall be disposed of by the Contractor at sites of his own choosing away from the site of the work.

7. BRACING AND SHORING

Excavated surfaces too steep to be safe and stable if unsupported shall be supported as necessary to safeguard the work and workmen, to prevent sliding or settling of the adjacent ground, and to avoid damaging existing improvements. The width of the excavation shall be increased if necessary to provide space for sheeting, bracing, shoring, and other supporting installations. The Contractor shall furnish, place and subsequently remove such supporting installations.

8. STRUCTURE AND TRENCH EXCAVATION

Structure or trench excavation shall be completed to the specified elevations and to sufficient length and width to include allowance for forms, bracing and supports, as necessary, before any concrete or earthfill is placed or any piles are driven within the limits of the excavation.

9. BORROW EXCAVATION

When the quantities of suitable materials obtained from specified excavations are insufficient to construct the specified fills, additional materials shall be obtained from the designated borrow areas. The extent and depth of borrow pits within the limits of the designated borrow areas shall be as directed by the Engineer.

Borrow pits shall be excavated and finally dressed in a manner to eliminate steep or unstable side slopes or other hazardous or unsightly conditions.

10. OVEREXCAVATION

Excavation in rock beyond the specified lines and grades shall be corrected by filling the resulting voids with portland cement concrete made of materials and mix proportions approved by the Engineer. Concrete that will be exposed to the atmosphere when construction is completed shall contain not less than 6 sacks of cement per cubic yard of concrete. Concrete that will be permanently covered shall contain not less than 4-1/2 sacks of cement per cubic yard. The concrete shall be placed and cured as specified by the Engineer.

Excavation in earth beyond the specified lines and grades shall be corrected by filling the resulting voids with approved compacted earthfill, except that, if the earth is to become the subgrade for riprap, rockfill, sand or gravel bedding, or drainfill, the voids may be filled with material conforming to the specifications for the riprap, rockfill, bedding or drainfill.

11. MEASUREMENT AND PAYMENT

For items of work for which specific unit prices are established in the contract, the volume of each type and class of excavation within the specified pay limits will be measured and computed to the nearest cubic yard by the method of average cross-sectional end areas. Regardless of quantities excavated, the measurement for payment will be made to the specified pay limits, except that excavation outside the specified lines and grades directed by the Engineer to remove unsuitable material will be included. Excavation required because unsuitable conditions result from the Contractor's improper construction operations, as determined by the Contracting Officer, will not be included for measurement and payment.

Compensation for any item of work described in the contract but not listed in the bid schedule will be included in the payment for the item of work to which it is made subsidiary. Such items and the items to which they are made subsidiary are identified in Section 12 of this specification.

12. ITEMS OF WORK AND CONSTRUCTION DETAILS

Items of work to be performed in conformance with this specification and the construction details are:

a. Subsidiary Item, Channel Excavation

1. This item consists of all excavation required to construct the concrete channel repair sections as shown on the drawings.

2. Suitable channel excavation and berm material shall be utilized to reconstruct the channel subgrade and berms adjacent to the sides of the channel, as approved by the Engineer.

3. No separate payment will be made for channel excavation. Compensation for this item will be included in Bid Item 3, Concrete Channel Lining.

b. Subsidiary Item, Borrow Excavation, Common

1. This item consists of all excavation required for obtaining fill material.

2. If existing channel subgrade materials are insufficient to prepare the subgrade to the design elevations, borrow material shall be obtained at the location shown on the drawings.

3. No separate payment will be made for Borrow Excavation. Compensation for Borrow Excavation will be included in Bid Item 3, Concrete Channel Lining.

CONSTRUCTION SPECIFICATION

23. EARTHFILL

1. SCOPE

The work shall consist of the construction of earth embankments and other earthfills required by the drawings and specifications.

2. MATERIALS

All fill materials shall be obtained from required excavations and designated borrow areas. The selection, blending, routing and disposition of materials in the various fills shall be subject to approval by the Engineer.

Fill materials shall contain no sod, brush, roots or other perishable materials. Rock particles larger than the maximum size specified for each type of fill shall be removed prior to compaction of the fill.

The types of materials used in the various fills shall be as listed and described in the specifications and drawings.

3. FOUNDATION PREPARATION

Foundations for earthfill shall be stripped to remove vegetation and other unsuitable materials or shall be excavated as specified.

Except as otherwise specified, earth foundation surfaces shall be graded to remove surface irregularities and shall be scarified parallel to the axis of the fill or otherwise acceptably scored and loosened to a minimum depth of 2 inches. The moisture content of the loosened material shall be controlled as specified for the earthfill, and the surface materials of the foundation shall be compacted and bonded with the first layer of earthfill as specified for subsequent layers of earthfill.

Earth abutment surfaces shall be free of loose, uncompacted earth in excess of two inches in depth normal to the slope and shall be at such a moisture content that the earthfill can be compacted against them to effect a good bond between the fill and the abutments.

Rock foundation and abutment surfaces shall be cleared of all loose materials by hand or other effective means and shall be free of standing water when fill is placed upon them. Occasional rock outcrops in earth foundations for earthfill, except in dams and other structures designed to restrain the movement of water, shall not require special treatment if they do not interfere with compaction of the foundation and initial layers of the fill or the bond between the foundation and the fill.

Foundation and abutment surfaces shall be not steeper than 1 horizontal to 1 vertical unless otherwise specified. Test pits or other cavities shall be filled with compacted earthfill conforming to the specifications for the earthfill to be placed upon the foundation.

4. PLACEMENT

Fill shall not be placed until the required excavation and foundation preparation have been completed and the foundation has been inspected and approved by the Engineer. Fill shall not be placed upon a frozen surface, nor shall snow, ice, or frozen material be incorporated in the fill.

Fill shall be placed in approximately horizontal layers. The thickness of each layer before compaction shall not exceed the maximum thickness specified. Materials placed by dumping in piles or windrows shall be spread uniformly to not more than the specified thickness before being compacted. Hand compacted fill, including fill compacted by manually directed power tampers, shall be placed in layers whose thickness before compaction does not exceed the maximum thickness specified for layers of fill compacted by manually directed power tampers.

Adjacent to structures, fill shall be placed in a manner which will prevent damage to the structures and will allow the structures to assume the loads from the fill gradually and uniformly. The height of the fill adjacent to a structure shall be increased at approximately the same rate on all sides of the structure.

Earthfill in dams, levees and other structures designed to restrain the movement of water shall be placed so as to meet the following additional requirements:

a. The distribution of materials throughout each zone shall be essentially uniform, and the fill shall be free from lenses, pockets, streaks or layers of material differing substantially in texture, moisture content, or gradation from the surrounding material.

b. If the surface of any layer becomes too hard and smooth for proper bond with the succeeding layer, it shall be scarified parallel to the axis of the fill to a depth of not less than 2 inches before the next layer is placed.

c. The top surfaces of embankments shall be maintained approximately level during construction, except that a crown or cross-slope of approximately 2 percent shall be maintained to insure effective drainage, and except as otherwise specified for drainfill or sectional zones.

d. Dam embankments shall be constructed in continuous layers from abutment to abutment except where openings to facilitate construction or to allow the passage of stream flow during construction are specifically authorized in the contract.

e. Embankments built at different levels as described under (c) or (d) above shall be constructed so that the slope of the bonding surfaces between embankment in place and embankment to be placed is not steeper than 3 feet horizontal to 1 foot vertical. The bonding surface of the embankment in place shall be stripped of all material not meeting the requirements of this specification, and shall be scarified, moistened and recompacted when the new fill is placed against it as needed to insure a good bond with the new fill and to obtain the specified moisture content and density at the contact of the in place and new fills.

5. CONTROL OF MOISTURE CONTENT

During placement and compaction of fill, the moisture content of the materials being placed shall be maintained within the specified range.

The application of water to the fill materials shall be accomplished at the borrow areas insofar as practicable. Water may be applied by sprinkling the materials after placement on the fill, if necessary. Uniform moisture distribution shall be obtained by disking.

Material that is too wet when deposited on the fill shall either be removed or be dried to the specified moisture content prior to compaction.

If the top surface of the preceding layer of compacted fill or a foundation or abutment surface in the zone of contact with the fill becomes too dry to permit suitable bond it shall either be removed or scarified and moistened by sprinkling to an acceptable moisture content prior to placement of the next layer of fill.

6. COMPACTION

Earthfill shall be compacted according to the following requirements for the class of compaction specified:

Class A compaction. Each layer of fill shall be compacted as necessary to make the density of the fill matrix not less than the minimum density specified. The fill matrix is defined as the portion of the fill material finer than the maximum particle size used in the compaction test method specified.

Class B compaction. Each layer of fill shall be compacted to a mass density not less than the minimum density specified.

Class C compaction. Each layer of fill shall be compacted by the specified number of passes of the type and weight of roller or other equipment specified, or by an approved equivalent method. Each pass shall consist of at least one passage of the roller wheel or drum over the entire surface of the layer.

Fill adjacent to structures shall be compacted to a density equivalent to that of the surrounding fill by means of hand tamping or manually directed power tampers or plate vibrators. Unless otherwise specified, heavy equipment including backhoe mounted powertampers, or vibrating compactors and manually directed vibrating rollers, shall not be operated within 2 feet of any structure. Towed or self-propelled vibrating rollers shall not be operated within 5 feet of any structure. Compaction by means of drop weights operating from a crane or hoist will not be permitted.

The passage of heavy equipment will not be allowed: (1) over cast-in-place conduits prior to 14 days after placement of the concrete; (2) over cradled or bedded precast conduits prior to 7 days after placement of the concrete cradle or bedding; or (3) over any type of conduit until the backfill has been placed above the top surface of the structure to a height equal to one-half the clear span width of the structure or pipe or 2 feet, whichever is greater.

Compacting of fill adjacent to structures shall not be started until the concrete has attained the strength specified in Section 10 for this purpose. The strength will be determined by compression testing of test cylinders cast by the Engineer for this purpose and cured at the work site in the manner specified in ASTM Method C 31 for determining when a structure may be put into service.

When the required strength of the concrete is not specified as described above, compaction of fill adjacent to structures shall not be started until the following time intervals have elapsed after placement of the concrete.

Structure	Time Interval
Retaining walls and counterforts (impact basins)	14 days
Walls backfilled on both sides simultaneously	7 days
Conduits and spillway risers, cast-in-place (with inside forms in place)	7 days
Conduits and spillway risers, cast-in-place (inside forms removed)	14 days

Conduits, precast, cradled	2 days
Conduits, precast, bedded	1 day
Cantilever outlet bents (backfilled both sides simultaneously)	3 days

7. REWORKING OR REMOVAL AND REPLACEMENT OF DEFECTIVE FILL

Fill placed at densities lower than the specified minimum density or at moisture contents outside the specified acceptable range of moisture content or otherwise not conforming to the requirements of the specifications shall be reworked to meet the requirements or removed and replaced by acceptable fill. The replacement fill and the foundation, abutment and fill surfaces upon which it is placed shall conform to all requirements of this specification for foundation preparation, approval, placement, moisture control and compaction.

8. TESTING

During the course of the work, the Engineer will perform such tests as are required to identify materials, to determine compaction characteristics, to determine moisture content, and to determine density of fill in place. These tests performed by the Engineer will be used to verify that the fills conform to the requirements of the specifications. Such tests are not intended to provide the Contractor with the information required by him for the proper execution of the work and their performance shall not relieve the Contractor of the necessity to perform tests for that purpose.

Densities of fill requiring Class A compaction will be determined by the Engineer in accordance with ASTM Method D 1556, D 2167, D 2922 or D 2937 except that the volume and moist weight of included rock particles larger than those used in the compaction test method specified for the type of fill will be determined and deducted from the volume and moist weight of the total sample prior to computation of density or if using the nuclear gauge, added to the specified density to bring it to the measure of equivalent composition for comparison. The density so computed will be used to determine the percent compaction of the fill matrix. Unless otherwise specified, moisture content will be determined by one of the following methods: ASTM Method D 2216 or D 3017.

9. MEASUREMENT AND PAYMENT

Compensation for any item of work described in the contract but not listed in the bid schedule will be included in the payment for the item of work to which it is made subsidiary. Such items and the items to which they are made subsidiary are identified in Section 10 of this specification.

10. ITEMS OF WORK AND CONSTRUCTION DETAILS

Items of work to be performed in conformance with this specification and construction details are:

a. Subsidiary Item, Earthfill

1. This item consists of placing and compacting all earthfill required to:

   (a) Regrade the operation and maintenance roads and berms disturbed by the construction operations.

   (b) Repair the channel lining subgrade in areas where the channel lining has been removed as shown on the drawings.

2. Excess soil materials removed from the channel subgrade shall be spread uniformly on the adjacent O&M roads and graded to blend into the existing grades.

3. The maximum rock size placed shall be two (2) inches.

4. In areas of subgrade that require earthfill, the maximum thickness of a layer prior to compaction shall be six (6) inches.

5. Section 6, Compaction, Class C, shall apply. Each layer of fill shall be compacted with a minimum of three (3) complete passes over the entire surface area using vibratory plates or tampers having a minimum rated capacity of 2,400 pounds per blow or vibratory rollers which weigh a minimum of 1,000 pounds.

6. The fill material shall contain sufficient moisture such that when a small portion is taken in the hand and squeezed, it remains intact when released and does not leave free water on the palm of the hand.

7. Section 9, Measurement and Payment, no separate payment will be made for this item. Compensation for this work will be included in Bid Item 3, Concrete Channel Lining.

CONSTRUCTION SPECIFICATION

31. CONCRETE

1. SCOPE

The work shall consist of furnishing, forming, placing, finishing and curing portland cement concrete as required to build the structures designated in Section 26 of this specification.

2. MATERIALS

Portland cement shall conform to the requirements of Material Specification 531 for the specified type. One brand only of any type of cement shall be used in any single structure as defined in Section 26.

Aggregates shall conform to the requirements of Material Specification 522 unless otherwise specified. The grading of coarse aggregates shall be as specified in Section 26.

Water used in mixing or curing concrete shall be clean and free from injurious amounts of oil, salt, acid, alkali, organic matter or other deleterious substances.

Air entraining admixtures shall conform to the requirements of Material Specification 532. If air-entraining cement is used, any additional air-entraining admixture shall be of the same type as that in the cement.

Pozzolan shall conform to ASTM C 618, Class F except the loss of ignition shall not exceed 3.0 percent.

Water-reducing, set-retarding admixture shall conform to the requirements of Material Specification 533.

Shear plates shall conform to the requirements of Material Specification 581 for structural quality or commercial or merchant quality steel. Structural quality shall be used if specifically designated in the drawings or specifications.

Preformed expansion joint filler shall conform to the requirements of Material Specification 535.

Waterstops shall conform to the requirements of Material Specifications 537 and 538 for the specified kinds.

Curing compound shall conform to the requirement of Material Specification 534.

3. CLASSES OF CONCRETE

Method 1 Concrete shall be classified according to the required compressive strength. The strength of the concrete at 28 days shall equal or exceed the Minimum Compressive Strength at 28 days tabulated below for the class of concrete specified.

Class of concrete	Minimum Compressive Strength at 28 days (psi)
5000	5000
4000	4000
3000	3000
2500	2500

Method 2 Concrete shall be classified as follows:

Class of Concrete	Water Content (gallons/bag)	Cement Content (bag/cu. yd)
5000X	5	7
4000X	6	6
3000X	7	5
2500X	8	4-1/2

4. AIR CONTENT AND CONSISTENCY

Unless otherwise specified the air content (by volume) of the concrete at the time of placement shall be:

Maximum Size Aggregate	Air Content (%)
3/8 inch to 1/2 inch	6 to 9
Over 1/2 inch to 1 inch	5 to 8
Over 1 inch to 2-1/2 inches	4 to 7

ASTM Size 57
C33

The consistency of the concrete shall be such as to allow it to be worked into place without segregation or excessive laitance. Unless otherwise specified, the slump shall be:

Type of Structure	Slump (inches)
Massive sections, pavements, footings	2 ± 1/2
Heavy beams, thick slabs, thick walls (over 12 in.)	3 ± 1/2
Columns, light beams, thin slabs, thin walls (12 in. or less)	4 ± 1

5. DESIGN OF THE CONCRETE MIX

Method 1 The Contractor will be responsible for the design of the concrete mixtures. At least 5 days prior to any placement of concrete he shall furnish the Contracting Officer a statement of the materials and mix proportion (including admixtures, if any) he intends to use for each specified class of concrete. The statement shall include evidence satisfactory to the Contracting Officer that the materials and proportions selected will produce concrete of the quality, consistency and strength specified.

The materials and proportions so stated shall constitute the "job mix". After a job mix has been designated, neither the source, character or grading of the aggregates nor the type or brand or quantity of cement or admixture shall be changed without prior notice to the Contracting Officer and establishment of a new job mix supported by evidence, as required for the initial job mix, that the proposed new materials and mix proportions will produce concrete of the quality, consistency, and strength specified.

When specified, a water-reducing, set-retarding admixture shall be used. When conditions are such that the temperature of the concrete at the time of placement is consistently above 75oF, a water-reducing, set-retarding admixture may be used, at the option of the Contractor. The cement content shall be the same as that required in the mix without the admixture.

The use of calcium chloride or other accelerators or antifreeze compounds will not be allowed.

Before placing concrete containing a water-reducing, set-retarding admixture, the Contractor shall furnish test results satisfactory to the Contracting Officer showing that its performance in the job mix meets the requirements of Material Specifications 533, Section 4. When specified, mixes that include fly ash as a partial substitution for portland cement shall be based on absolute volume with a maximum substitution of 20 percent.

Method 2 At least 35 days prior to any placement of concrete the Contractor shall inform the Contracting Officer in writing of the source and grading of aggregates and the brand and type of cement and the brand and type of admixture, if any, he proposes to use for each class of concrete, and shall furnish test results or other evidence satisfactory to the Contracting Officer that the proposed materials meet the requirements of the specifications.

When acceptable sources, types and gradings of aggregates are designated in the contract, test results or other data to verify that the aggregates meet the specification will not be required. Grading will be tested at the site.

Job mix proportions and batch weights will be determined by the Engineer. During the course of the work, the Engineer will adjust the job mix proportions and batch weights whenever necessary.

After the job mix has been designated, neither the source, character

or grading of the aggregates nor the type or brand of cement or admixture shall be changed without prior notice to the Engineer. If such changes are necessary, no concrete containing such new or altered materials shall be placed until the Engineer has designated a revised job mix.

When specified, a water-reducing, set-retarding admixture shall be used. When conditions are such that the temperature of the concrete at the time of placement is consistently above 75oF, a water-reducing, set-retarding admixture may be used, at the option of the Contractor. The cement content shall be the same as that required in the mix without the admixture.

The use of calcium chloride or other accelerators or antifreeze compounds will not be allowed.

When it is anticipated that a water-reducing, set-retarding admixture will be used, the Contractor shall furnish to the Engineer a sample of the admixture he proposes to use sufficient for the tests required by Material Specification 533, Section 4. Concrete containing the admixture shall not be placed until test results have been obtained showing that its performance in the job mix meets the requirements of Material Specification 533, Section 4.

6. INSPECTING AND TESTING

During the course of the work, the Engineer will perform such tests as are required to assure the concrete meets the contract requirements. Tests performed by the Engineer are not for the purpose of providing the Contractor with the information required for proper work execution and performance and shall not relieve the Contractor of the necessity to perform tests for that purpose.

The following tests will be performed by the methods indicated:

Test	Method (ASTM Designation)
Sampling	C 172 1/
Slump Test	C 143 1/
Air Content	C 231 1/ or C 173 1/
Compression Test Specimens	C 31 1/, C 42, or C684 2/

Compressive Strength	C 39 2/ or C 42
Unit Weight	C 138

1/ Test of a portion of a batch may be made on samples representative of that portion for any of the following purposes:

(1) Determining uniformity of the batch.

(2) Checking compliance with requirements for slump and air content when the batch is discharged over an extended period of time.

(3) Checking compliance of the concrete with the specifications when the whole amount being placed in a small structure, or a distinct portion of a larger structure, is less than full batch.

2/ For each strength test of specimens made according to ASTM Designation C 39 or C 684, three (3) standard test specimens shall be made. The test result shall be the average of the strength of the three (3) specimens, except that if one (1) specimen in the test shows manifest evidence of improper sampling, molding or testing, it shall be discarded and the strengths of the remaining two (2) specimens shall be averaged. Should more than one (1) specimen representing a test show such defects, the entire test shall be discarded.

The Engineer shall have free entry to the plant and equipment furnishing concrete under the contract. Proper facilities shall be provided for the Engineer to inspect materials, equipment and processes, to obtain samples of the concrete. All tests and inspections will be conducted so as not to interfere unnecessarily with the manufacture and delivery of the concrete.

7. HANDLING AND MEASUREMENT OF MATERIALS

Aggregates shall be stored or stockpiled in such a manner that separation of coarse and fine particles of each size will be avoided and that various sizes will not become intermixed before proportioning. Methods of handling and transporting aggregates shall be such as to avoid contamination, excessive breakage, segregation or degradation, or intermingling of various sizes.

Scales for weighing aggregates and cement shall be beam type or springless dial type. They shall be accurate within 1 percent under operating conditions. All exposed fulcrums, clevises and similar working parts of scales shall be kept clean.

The quantities of cement and aggregates in each batch of concrete, as indicated by the scales, shall be within the following percentage of the required batch weights:

Cement	plus or minus 1.0 percent
Aggregates	plus or minus 2.0 percent

Measuring tanks for mixing water shall be of adequate capacity to furnish the maximum amount of mixing water required per batch and shall be equipped with outside taps and valves to provide for checking their calibration unless other means are provided for readily and accurately determining the amount of water in the tank.

Except as otherwise provided in Section 8, cement and aggregates shall be measured as follows:

Cement shall be measured by weight or in bags of 94 lbs. each. When cement is measured by weight, it shall be weighed on a scale separate from that used for other materials, and in a hopper entirely free and independent of the hopper used for weighing the aggregates. When cement is measured in bags, no fraction of a bag shall be used unless weighed.

Aggregates shall be measured by weight. Mix proportions shall be based on saturated, surface-dry weights. The batch weight of each aggregate shall be the required saturated, surface-dry weight corrected by the weight of surface moisture it contains.

Mixing water shall consist of water added to the batch ice added to the batch, water occurring as surface moisture on the aggregates and water introduced in the form of admixtures. The added water shall be measured by weight or volume to an accuracy of 1 percent of the required total mixing water. Added ice shall be measured by weight. Wash water shall not be used as a portion of the mixing water for succeeding batches.

Dry admixtures shall be measured by weight, and paste or liquid admixtures by weight or volume, within a limit of accuracy of 3 percent.

8. MIXERS AND MIXING

Mixers and mixing shall be in accordance with recommended standards set forth in ACI 304, some specific interpretations of which are stated below.

Concrete may be furnished by batch mixing at the site of the work or by ready-mix methods.

Mixers shall be capable of thoroughly mixing the concrete ingredients into a uniform mass within the specified mixing time and of discharging the mix without segregation. Each mixer or agitator shall bear a manufacturer's rating plate indicating the rated capacity and

recommended speeds of rotation, and shall be operated in accordance with these recommendations.

Concrete shall be uniform and thoroughly mixed when delivered to the forms. Variations in slump of more than 1 inch within a batch will be considered evidence of inadequate mixing and shall be corrected by changing batching procedures, increasing mixing time, changing mixers or other means. Mixing time shall be within the limits specified below unless the Contractor demonstrates by mixer performance tests that adequate uniformity is obtained by different times of mixing. No mixing water in excess of the amount called for by the job mix shall be added to the concrete during mixing or hauling or after arrival at the delivery point. If less water than the design maximum water-cement ratio has been incorporated in the batch, water to compensate for up to a one (1) inch loss in slump may be added, up to the design maximum water cement ratio. Withholding some of the mixing water until the concrete arrives on the job, then adding the remaining water and turning the mixer 30 revolutions at mixing speed may overcome transporting conditions. When loss of slump or workability cannot be offset by these measures, complete mixing shall be performed on the job using centrally dry batched materials, or by on site batching and mixing.

Batch mixing at the site. For concrete mixed at the site of the work with paving mixers or stationary construction mixers, the time of mixing after all cement and aggregates are in the mixer drum shall be not less than 1-1/2 minutes. The batch shall be so charged into the mixer that some water will enter in advance of the cement and aggregates and all mixing water shall be introduced into the drum before one-fourth of the mixing time has elapsed.

Controls shall be provided to insure that the batch cannot be discharged until the required time has elapsed.

If truck mixers are used, the requirements below for truck mixers and truck-mixed concrete shall apply.

Volumetric batching and continuous mixing at the site. Unless otherwise specified, volumetric batching and continuous mixing at the construction site will be permitted. The batching and mixing equipment shall conform to the requirements of ASTM Specification C 685 and shall be demonstrated prior to placement of concrete, by tests with the job mix, to produce concrete meeting the specified proportioning and uniformity requirements. Concrete made by this method shall be produced, inspected, and documented in conformance with Sections 6, 7, 8, 13, and 14 of ASTM Specification C 685.

Ready-mixed concrete. Ready-mixed concrete shall be mixed and delivered to the site of the work by one of the following methods:

a. Truck-mixed concrete--Mixed completely in a truck mixer.

b. Shrink-mixed concrete--Mixed partially in a stationary mixer, and the mixing completed in a truck mixer.

c. Central-mixed concrete--completely in a stationary mixer and the mixed concrete transported to the point of delivery in a truck agitator or in a truck mixer operating at agitating speed or in nonagitating equipment.

Truck mixers and agitators shall be equipped with revolution counters by which the number of revolutions of the drum or blades may be readily verified.

When ready mixed concrete is furnished, the Contractor shall furnish the Engineer a statement-of-delivery ticket showing the time of loading, the revolution counter reading at the time of loading and the quantities of materials used for each load of concrete.

Truck mixed concrete. When concrete is mixed in a truck mixer loaded to its maximum capacity, the number of revolutions of the drum or blades at mixing speed shall be not less than 70 nor more than 100. If the batch is at least 1/2 cubic yard less than maximum capacity, the number of revolutions at mixing speed may be reduced to not less than 50. Mixing in excess of 100 revolutions shall be at the speed designated by the manufacturer of the equipment as agitating speed. The mixing operation shall begin within 30 minutes after the cement has been added to the aggregates and the water shall be added during mixing. When mixing is begun during or immediately after charging, a portion of the mixing water shall be added ahead of, or with, the other ingredients.

Shrinked-mixed concrete. When concrete is partially mixed at a central plant and the mixing is completed in a truck mixer, the mixing time in the central plant mixer shall be the minimum required to intermingle the ingredients and shall be not less than 30 seconds. The mixing shall be completed in a truck mixer and the number of revolutions of the drum or blades at mixing speed shall be not less than 50 nor more than 100. Mixing in excess of 100 revolutions shall be at the speed designated by the manufacturer of the equipment as agitating speed.

Central-mixed concrete. For central-mixed concrete, mixing in the stationary mixer shall meet the same requirements as batch mixing at the site.

When an agitator, or truck mixer used as an agitator, transports concrete that has been completely mixed in a stationary mixer, mixing during transportation shall be at the speed designated by the manufacturer of the equipment as agitating speed.

The use of nonagitating equipment to transport concrete to the site of the work will be permitted only if the consistency and uniformity of

the concrete as discharged at the point of delivery meet the requirements of this specification. Bodies of nonagitating hauling equipment shall be so constructed that leakage of the concrete mix, or any part thereof will not occur. Concrete hauled in open-top vehicles shall be protected from rain, and from more than 20 minutes exposure to the sun when the air temperature is above 75oF.

9. FORMS

Forms shall be of wood, plywood, steel or other approved material and shall be mortar tight. The forms and associated falsework shall be substantial and unyielding and shall be constructed so that the finished concrete will conform to the specified dimensions and contours. Form surfaces shall be smooth and free from holes, dents, sags or other irregularities. Forms shall be coated with a nonstaining form release agent before being set into place. Metal ties or anchorages within the forms shall be equipped with cones, she-bolts or other devices that permit their removal to a depth of at least one inch without injury to the concrete. Ties designed to break off below the surface of the concrete shall not be used without cones.

All edges that will be exposed shall be chamfered, unless finished with molding tools as specified in Section 20.

10. PREPARATION OF FORMS AND SUBGRADE

Prior to placement of concrete the forms and subgrade shall be free of chips, sawdust, debris, water, ice, snow, extraneous oil, mortar, or other harmful substances or coatings. Any form release agent on the reinforcing steel or other surfaces required to be bonded to the concrete shall be removed.

Rock surfaces shall be cleaned by air-water cutting, wet sandblasting or wire brush scrubbing, as necessary, and shall be wetted immediately prior to placement of concrete. Earth surfaces shall be firm and damp. Placement of concrete on mud, dried earth, uncompacted fill or frozen subgrade will not be permitted. All ice, snow and frost shall be removed and the temperature of all surfaces to be in contact with the new concrete shall be no colder than 40oF.

Items to be embedded in the concrete shall be positioned accurately and anchored firmly.

Weepholes in walls or slabs shall be formed with nonferrous materials.

11. CONVEYING

Concrete shall be delivered to the site and discharged into the forms within 1-1/2 hours after the introduction of the cement to the

aggregates. In hot weather or under conditions contributing to quick stiffening of the concrete, or when the temperature of the concrete is 85oF or above, the time between the introduction of the cement to the aggregates and discharge shall not exceed 45 minutes.

The Engineer may allow a longer time, provided the setting time of the concrete is increased a corresponding amount by the addition of an approved set-retarding admixture. In any case, concrete shall be conveyed from the mixer to the forms as rapidly as practicable, by methods that will prevent segregation of the aggregates or loss of mortar.

12. PLACING

Concrete shall not be placed until the subgrade, forms and steel reinforcement have been inspected and approved.

The Contractor shall have all equipment and materials required for curing available at the site ready for use before placement of concrete begins.

No concrete shall be placed except in the presence of the Engineer. The Contractor shall give reasonable notice to the Engineer each time he intends to place concrete. Such notice shall be far enough in advance to give the Engineer adequate time to inspect the subgrade, forms, steel reinforcement and other preparations for compliance with specifications. Other preparations include but are not limited to the concrete batching plant, mixing and delivery equipment and system, placing and finishing equipment and system, schedule of work, work force and heating or cooling facilities as applicable. All deficiencies are to be corrected before concrete is delivered for placing.

The concrete shall be deposited as closely as possible to its final position in the forms and shall be worked into the corners and angles of the forms and around all reinforcement and embedded items in a manner to prevent segregation of aggregates or excessive laitance. The depositing of concrete shall be regulated so that the concrete can be consolidated with a minimum of lateral movement.

Concrete shall not be dropped more than 5 feet vertically unless suitable equipment is used to prevent segregation.

13. LAYERS

Unless otherwise specified, slab concrete shall be placed to design thickness in one continuous layer. Formed concrete shall be placed in horizontal layers not more than 20 inches thick. Hoppers and chutes,

pipes or "elephant trunks" shall be used as necessary to prevent splashing of mortar on the forms and reinforcing steel above the layer being placed.

Successive layers shall be placed at a fast enough rate to prevent the formation of "cold joints". If the surface of a layer of concrete in place sets to the degree that it will not flow and merge with the succeeding layer when vibrated, the Contractor shall discontinue placing concrete and shall make a construction joint according to the procedure specified in Section 15.

If placing is discontinued when an incomplete layer is in place, the unfinished end of the layer shall be formed by a vertical bulkhead.

14. CONSOLIDATING

Unless otherwise specified, concrete shall be consolidated with internal type mechanical vibrators capable of transmitting vibration to the concrete at frequencies not less than 6000 impulses per minute. The location, manner and duration of the application of the vibrators shall be such as to secure maximum consolidation of the concrete without causing segregation of the mortar and coarse aggregate, and without causing water or cement paste to flush to the surface. The Contractor shall provide a sufficient number of vibrators to properly consolidate the concrete immediately after it is placed in the work. Vibration shall be applied to the freshly deposited concrete by slowly inserting and removing the vibrator at points uniformly spaced and not farther apart than twice the radius over which the vibration is visibly effective. The vibrator shall extend into the previously placed layer of fresh concrete, at all points, to insure effective bond between layers.

Vibration shall not be applied directly to the reinforcement steel or the forms nor to concrete that has hardened to the degree that it does not become plastic when vibrated.

The use of vibrators to transport concrete in the forms or conveying equipment will not be permitted.

Vibration shall be supplemented by spading and hand tamping as necessary to insure smooth and dense concrete along form surfaces, in corners and around embedded items.

15. CONSTRUCTION JOINTS

Construction joints shall be made at the locations shown on the drawings. If construction joints are needed which are not shown on the drawings, they shall be placed in locations approved by the Engineer. Where a feather edge would be produced at a construction joint, as in the top surface of a sloping wall, an insert form shall be used so

that the resulting edge thickness on either side of the joint is not less than 6 inches.

In walls and columns as each lift is completed, the top surfaces shall be immediately and carefully protected from any condition that might adversely affect the hardening of the concrete.

Steel tying and form construction adjacent to concrete in place shall not be started until the concrete has cured at least 12 hours. Before new concrete is deposited on or against concrete that has hardened, the forms shall be retightened. New concrete shall not be placed until the hardened concrete has cured at least 12 hours.

Method 1 Surfaces of construction joints shall be cleaned of all unsatisfactory concrete, laitance, coatings, stains or debris by either sandblasting after the concrete has gained sufficient strength to resist excessive cutting, or air-water cutting as soon as the concrete has hardened sufficiently to prevent the jet from displacing the coarse aggregates, or both. The surface of the concrete in place shall be cut to expose clean, sound aggregate but not so deep as to undercut the edges of larger particles of the aggregate. After cutting, the surface shall be thoroughly washed to remove all loose material. If the surface is congested by reinforcing steel, is relatively inaccessible, or it is considered undesirable to disturb the concrete before it is hardened, cleaning of the joint by air-waterjets will not be permitted and the wet sandblasting method will be required after the concrete has hardened.

The surfaces shall be kept moist for at least one hour prior to placement of new concrete. The new concrete shall be placed directly on the cleaned and washed surface.

Method 2 Surfaces of construction joints shall be cleaned of all unsatisfactory concrete, laitance, coatings, stains, or debris by washing and scrubbing with a wire brush or wire broom or by other means approved by the Engineer. The surfaces shall be kept moist for at least one hour prior to placement of new concrete. The new concrete shall be placed directly on the cleaned and washed surface.

16. EXPANSION AND CONTRACTION JOINTS

Expansion and contraction joints shall be made only at locations shown on the drawings.

Exposed concrete edges at expansion and contraction joints shall be carefully tooled or chamfered, and the joints shall be free of mortar and concrete. Joint filler shall be left exposed for its full length with clean and true edges.

When open joints or weakened plane "dummy" joints are specified, the joints shall be constructed by the insertion and subsequent removal of a wood strip, metal plate or other suitable template in such a manner

that the corners of the concrete will not be chipped or broken. The edges of the concrete at the joints shall be finished with an edging tool prior to removal of the joint strips.

Preformed expansion joint filler shall be held firmly in the correct position as the concrete is placed.

17. WATERSTOPS

Waterstops shall be held firmly in the correct position as the concrete is placed. Joints in metal waterstops shall be brazed or welded. Joints in rubber or plastic waterstops shall be cemented, welded or vulcanized as recommended by the manufacturer.

18. REMOVAL OF FORMS

Forms shall be removed only when the Engineer is present and has given approval. Forms shall be removed in such a way as to prevent damage to the concrete. Supports shall be removed in a manner that will permit the concrete to take the stresses due to its own weight uniformly and gradually.

Method 1 Forms shall not be removed sooner than the following minimum times after the concrete is placed. These periods represent cumulative number of days and fractions of days, not necessarily consecutive, during which the temperature of the air adjacent to the concrete is above 50oF.

Element	Time
Beams, arches - supporting forms and shoring	14 days
Conduits, deck slabs - supporting (inside) forms and shoring	7 days
Conduits (outside forms), sides of beams, small structures	24 hours
Columns, walls, spillway riser - with side or vertical load	7 days
Columns, walls, spillway riser - with no side or vertical load:	
Concrete supporting more than 30 feet of wall in place above it	7 days
Concrete supporting 20 to 30 feet of wall in place above it1/	3 days

Concrete supporting not more than 20 feet of wall in place above it1/	24 hours

1/ Age of stripped concrete shall be at least 7 days before any load is applied other than the weight of the column or wall, forms and scaffolds for succeeding lifts.

Method 2 Forms, supports and housings shall not be removed until the concrete has attained the strength specified in Section 26 for this purpose. The strength will be determined by compression testing of test cylinders cast by the Engineer for this purpose and cured at the work site in the manner specified in ASTM Method C 31 for determining form removal time.

19. FINISHING FORMED SURFACES

All concrete surfaces shall be true and even, and shall be free from open or rough spaces, depressions or projections.
Immediately after the removal of forms:

All bulges, fins, form marks or other irregularities which in the judgment of the Engineer will adversely affect the appearance or the function of the structure shall be removed. All form bolts and ties shall be removed to a depth at least 1 inch below the surface of the concrete. The cavities produced by form ties and all other holes of similar size and depth shall be thoroughly cleaned and, after the interior surfaces have been kept continuously wet for at least 3 hours, shall be carefully packed with a dry patching mortar mixed not richer than 1 part cement to 3 parts sand. Patching mortar shall be mixed in advance and allowed to stand without addition of water until it has reached the stiffest consistency that will permit placing. Manipulation of the mortar with a trowel during this period shall be performed as required to insure the proper consistency.

Holes left by form bolts or straps which pass through the wall shall be filled solid with mortar.

Patching mortar shall be thoroughly compacted into place to form a dense, well-bonded unit, and the in-place mortar shall be sound and free from shrinkage cracks.

All repaired areas shall be cured as specified in Section 21.

20. FINISHING UNFORMED SURFACES

All exposed surfaces of the concrete shall be accurately screeded to grade and then float finished, unless specified otherwise.
After placing and consolidating the concrete, all exposed surfaces

shall be accurately struck off to grade. Following strike-off, the surfaces shall be immediately smoothed by darbying or bull floating

before any free water has bled to the surface. The concrete will then be allowed to rest until the bleed water and water sheen has left the surface and the concrete has stiffened to where it will sustain foot pressure with only about 1/4 inch (6mm) indentation. At this time all joints and edges that will be exposed to view that are not chamfered shall be finished with edging and/or molding tools. After edging and hand-jointing is complete, all exposed surfaces shall be floated with wood or magnesium floats. The floating should work the concrete no more than necessary to remove screed, edger and jointer marks and produce a compact surface, uniform in texture.

Joints and edges on unformed surfaces shall be chamfered or finished with molding tools.

21. CURING

Concrete shall be cured in accordance with the recommended practice of ACI 308, of which some specific interpretations are set forth below. Concrete shall be prevented from drying for a period of at least 7 days after it is placed. Exposed surfaces and concrete formed in absorptive wood forms shall be kept continually wet during the entire curing period or until the forms have been removed. After forms have been removed, the exposed surface shall be kept continuously wet until patching and repair are complete and until the curing period is completed or until a curing compound is applied.

Moisture can be maintained by sprinkling, flooding or fog spraying or by covering with continuously moistened canvas, cloth mats, straw, sand and/or approved material. Water and/or covering shall be applied in such a way that the concrete surface is not eroded or otherwise damaged.

Except as otherwise specified in Section 26, curing compound may be used for exposed surfaces or formed surfaces after patching and repair have been completed. Unless otherwise specified, the curing compound shall be white pigmented and conform to ASTM C 309 Type 2, Class A or B. If surface coatings are to be applied to concrete where curing compound is used, Type 2, Class B shall be used and allowed to age a minimum of 30 days prior to the application of the coating. Clear curing compound (Type 1) or clear with fugitive dye (Type 1-D) may be used only when specified in Section 26.

Curing compound shall be thoroughly mixed before applying and agitated during application. It shall be applied using a continuously agitating pressure sprayer at a uniform rate of not less than one gallon per 150 square feet of surface. It shall form a uniform continuous, adherent film that shall not check, crack or peel and shall be free from pinholes or other imperfections.

All surfaces covered with curing compound shall be continuously protected from damage to the protective film during the required curing period.

Surfaces subjected to heavy rainfall or running water within 3 hours after the compound has been applied, or surfaces damaged by subsequent construction operations during the curing period shall be resprayed in the same manner as for the original application.

Unless otherwise specified in Section 26, curing compound shall not be applied to construction joints or other areas that are to receive additional concrete, paint or other material that require a positive bond.

Water for curing shall be clean and free from any substances that will cause discoloration of the concrete.

22. REMOVAL, REPLACEMENT OR REPAIR

When concrete is honeycombed, damaged or otherwise defective, the Contractor shall remove and replace the structure or structural member containing the defective concrete, or correct or repair the defective parts. The Contracting Officer will determine the required extent of removal, replacement or repair and advise the Contractor, in writing, of this determination.

Prior to starting repair work the Contractor shall obtain the Contracting Officer's approval of his plan for making the repair. The appropriate methods described in Chapter VII of the Concrete Manual, Bureau of Reclamation, U.S. Department of the Interior, shall be used as the primary reference for repairs. If approved in writing by the Contracting Officer, proprietary compounds for adhesion or as patching ingredients may be used. Such compounds shall be used in accordance with the manufacturer's recommendations.

Approval of the Contractor's repair plan shall not be considered a waiver of the Contracting Officer's right to require complete removal of defective work if the completed repair does not produce concrete of the required quality and appearance.

Repair work shall be performed only when the Engineer is present. Repair of formed surfaces shall be started within 24 hours after removal of the forms.

Curing as specified in Section 21 shall be applied to repaired areas immediately after the repairs are completed.

23. CONCRETING IN COLD WEATHER

Concreting in cold weather shall be performed in accordance with ACI 306 Recommended Practice for Cold Weather Concreting, of which

some specific interpretations are set forth below.

When the atmospheric temperature may be expected to drop below 40oF at the time concrete is delivered to the work site, during placement, or at any time during the curing period, the following provisions also shall apply:

a. The temperature of the concrete at time of placing shall not be less than 50oF nor more than 90oF. The temperature of neither aggregates nor mixing water shall be more than 140oF just prior to mixing with the cement.

b. When the minimum daily atmosphere temperature is less than 40oF, concrete structures shall be insulated or housed and heated after placement. The temperature of the concrete and air adjacent to the concrete shall be maintained at not less than 50oF nor more than 90oF for the duration of the curing period.

c. Methods of insulating, housing and heating the structure shall conform to "Recommended Practice for Cold Weather Concreting," ACI Standard 306.

d. When dry heat is used to protect concrete, means of maintaining an ambient humidity of at least 40 percent shall be provided unless the concrete has been coated with curing compound as specified in Section 21 or is covered tightly with an approved impervious material.

24. CONCRETING IN HOT WEATHER

Concreting in Hot Weather shall be in accordance with the recommended practice of ACI 305, of which some specific interpretations are set forth below.

For the purpose of the specification hot weather is defined as any combination of high temperature, low relative humidity and wind velocity tending to impair the quality of fresh or hardened concrete or otherwise resulting in abnormal properties.

When climatic or other conditions are such that the temperature of the concrete may reasonably be expected to exceed 90oF at the time of delivery at the work site, during placement, or during the first 24 hours after placement, the following provisions shall apply:

a. The Contractor shall maintain the temperature of the concrete below 90oF during mixing, conveying, and placing.

b. The concrete shall be placed in the work immediately after mixing. Truck mixing shall be delayed only until time enough remains to accomplish it before the concrete is placed.

c. Exposed concrete surfaces which tend to dry or set too rapidly shall be continuously moistened by means of fog sprays or other means to maintain adequate moisture during the time between placement and finishing, and after finishing.

d. Finishing of slabs and other exposed surfaces shall be started as soon as the condition of the concrete allows and shall be completed without delay.

e. Formed surfaces shall be kept completely and continuously wet for the duration of curing period (prior to, during and after form removal) or until curing compound is applied as specified in subsection g, below.

f. Concrete surfaces, especially flat work placed with large areas of surface, shall be covered as soon as the concrete has sufficiently hardened and shall be kept continuously wet for at least 24 hours of the curing period. This protective method may be continued for the required curing period or until curing compound as specified in (g) below is applied.

g. Moist curing may be discontinued before the end of the curing period if white pigmented curing compound is applied immediately, following the procedures specified in Section 21.

h. In extreme conditions it may be necessary to (1) restrict placement to late afternoon or evening (2) restrict the depth of layers to assure coverage of the previous layer while it will still respond readily to vibration, (3) suspend placement until conditions improve, and (4) remove forms, repair, patch and reapply wet curing by small areas at a time.

25. MEASUREMENT AND PAYMENT

For items of work for which specific unit prices are established in the contract, concrete will be measured to the neat lines or pay limits shown on the drawings, and the volume of concrete will be computed to the nearest 0.1 cubic yard. No deduction in volume will be made for chamfers, rounded or beveled edges, or for any void or embedded item that is less than five cubic feet in volume. Where concrete is placed against the sides or bottom of an excavation without intervening forms, drainfill, or bedding, the volume of concrete required to fill voids resulting from overexcavation outside the neat lines or pay limits will be included in the measurement for payment where such overexcavation is directed by the Engineer to remove unsuitable foundation material; but only to the extent that the unsuitable condition is not a result of the Contractor's improper construction operations, as determined by the Contracting Officer.

Payment for each item of concrete will be made at the contract unit price for that item. The payment for concrete will constitute full

compensation for all labor, materials, equipment, transportation, tools, forms, falsework, bracing and all other items necessary and incidental to completion of the concrete work, such as joint fillers, waterstops, dowels or other assemblies, and shear plates, but not including furnishing and placing reinforcing steel or furnishing and handling cement or other items listed for payment elsewhere in the contract.

Measurement and payment for furnishing and placing reinforcing steel will be made as specified in Construction Specification 34.

Cement will be measured by dividing the volume of concrete accepted for payment by the yield of the applicable job mix. The yield will be determined by the procedure specified in ASTM Designation C 138. If the amount of cement actually used per batch exceeds the amount in the job mix specified by the Engineer, the measurement will be based on the latter. One barrel of cement will be considered equal to 4 bags or 376 pounds. Payment for each type of cement will be made at the contract unit price for furnishing and handling that type of cement and such payment will constitute full compensation for all materials, labor, equipment, storage, transportation and all other items necessary and incidental to furnishing and handling the cement.

Compensation for any item of work described in the contract but not listed in the bid schedule will be included in the payment for the item of work to which it is make subsidiary. Such items and the items to which they are made subsidiary are identified in Section 26 of this specification.

26. ITEMS OF WORK AND CONSTRUCTION DETAILS

Items of work to be performed in conformance with this specification and the construction details are:

a. Bid Item 3, Concrete Channel Lining

1. This item consists of furnishing, forming and placing all concrete to ~~construct the lining~~ repair the Floodway ~~sections~~ as shown on the drawings.

2. In Section 2, Materials, the materials shall be as follows:

   (a) Portland Cement shall be Type II or IIA.

   (b) Preformed expansion joint filler shall conform to material specification 535 and ASTM D 1752, Type I.

   (c) The joint sealing compound shall be Type S, Grade NS, use NT or T, low modulus silicone conforming to the requirements of ASTM C-920 and shall tolerate submergence by intermittent flood flows. The sealant shall have the capability to withstand without failure an increase of 50 percent and a decrease of 50 percent of the joint width as measured at the time of application when tested in accordance with ASTM C-719. The elongation shall be a minimum of 800 percent without failure when tested in accordance with ASTM D-412, and 500 percent without adhesion failure when tested in accordance with ASTM C-719. A bond breaking material shall be compatible with the sealant and conform to the sealant manufacturers requirements. The sealant manufacturers representative shall be present during initial installation to insure that proper surface preparation, application and handling techniques are being used by the Contractor.

   (d) Bond breaker material shall be adequate to support the sealant until fully cured. The material shall not cause extrusion of the sealant when compressed to 50 percent of its placed width.

3. Section 3, Classes of Concrete, Method 2 shall apply and the concrete shall be Class 4000X.

4. Coarse aggregate shall be size No. 57 in accordance with ASTM C33.

5. Pozzolan shall be used as a partial substitute for portland cement not to exceed a maximum substitution of 20 percent based on absolute volume.

6. Section 5, Design of the Concrete Mix, Method 2 shall apply.

7. Section 15, Construction Joints, Method 1 shall apply.

8. Sealant installation and cleaning shall be in accordance with Construction Specification 400, Section 3, Joint Sealant for Concrete Lined Floodways.

b. Bid Item 4, Cement

1. This item consists of furnishing and handling all cement and pozzolan for concrete class 4000X as shown on the drawings.

2. Cement shall be Type II or IIA for 4000X concrete.

CONSTRUCTION SPECIFICATION

34. STEEL REINFORCEMENT

1. SCOPE

The work shall consist of furnishing and placing steel reinforcement for reinforced concrete or pneumatically applied mortar.

2. MATERIALS

Steel reinforcement shall conform to the requirements of Material Specification 539. Before reinforcement is placed, the surfaces of the bars and fabric and any metal supports shall be cleaned to remove any loose, flaky rust, mill scale, oil, grease or other coatings or foreign substances. After placement, the reinforcement shall be maintained in a clean condition until it is completey embedded in the concrete.

3. BAR SCHEDULE, LISTS AND DIAGRAMS

Any supplemental bar schedules, bar lists or bar-bending diagrams required to accomplish the fabrication and placement of reinforcement shall be provided by the Contractor. Prior to placement of reinforcement, the Contractor shall furnish four prints or copies of any such lists or diagrams to the Contracting Officer. Acceptance of the reinforcement will not be based on approval of these lists or diagrams but will be based on inspection of the reinforcement after it has been placed.

4. BENDING

Reinforcement shall be cut and bent in compliance with the requirements of the American Concrete Institute Standard 315. Bars shall not be bent or straightened in a manner that will injure the material. Bars with kinks, cracks or improper bends will be rejected.

5. SPLICING BAR REINFORCEMENT

Splices of reinforcement shall be made only at locations shown on the drawings and provided by the steel schedule. Placement of bars at the lap splice locations shown, when not in contact, shall not be farther apart than one-fifth the shown lap length and in any case no greater than 6 inches.

6. SPLICING WELDED WIRE FABRIC

Unless otherwise specified, welded wire fabric shall be spliced in the

following manner:

a. Adjacent sections shall be spliced end to end (longitudinal lap) by overlapping a minimum of one full mesh plus 2 inches plus the length of the two end overhangs. The splice length is measured from the end of the longitudinal wires in one piece of fabric to the end of the longitudinal wires in the lapped piece of fabric.

b. Adjacent sections shall be spliced side to side (transverse lap) a minimum of one full mesh plus 2 inches. The splice length shall be measured from the centerline of the first longitudinal wire in one piece of fabric to the centerline of the first longitudinal wire in the lapped piece of fabric.

7. PLACING

Reinforcement shall be accurately placed and secured in position in a manner that will prevent its displacement during the placement of concrete. Tack welding of bars will not be permitted. Metal chairs, metal hangers, metal spacers and concrete chairs may be used to support the reinforcement. Metal hangers, spacers and ties shall be placed in such a manner that they will not be exposed in the finished concrete surface. The legs of metal chairs or side form spacers that may be exposed on any face of slabs, walls, beams or other concrete surfaces shall have a protective coating or finish by means of hot dip galvanizing, epoxy coating, plastic coating, or be stainless steel. Metal chairs and spacers not fully covered by a protective coating or finish shall have a minimum cover of 3/4 inch of concrete over the unprotected metal portion except for those with plastic coatings may have a minimun cover of 1/2 inch of concrete over the unprotected metal portion. Precast concrete chairs shall be manufactured of the same class of concrete as that specified for the structure and shall have tie wires securely anchored in the chair or a V-shaped groove at least 3/4 inch in depth molded into the upper surface to receive the steel bar at the point of support. Precast concrete chairs shall be moist at the time concrete is placed.

High density or structural plastic rebar accessories, designed to insure maximum concrete bond, may be substituted for metal or concrete accessories in spacer applications as approved by the Contracting Officer. Exposure of plastic rebar accessories at the finished concrete surface shall be kept to a minimum. Plastic rebar accessories, if used, shall be staggered along adjacent parallel bars and shall be placed at intervals no closer than 12 inches. Plastic rebar accessories shall not be used in concrete sections 6 inches or less in thickness.

Reinforcement shall not be placed until the prepared site has been inspected and approved by the Engineer. After placement of the

reinforcement, concrete shall not be placed until the reinforcement has been inspected and approved by the Engineer.

8. STORAGE

Steel reinforcement stored at the work site shall be placed above the ground surface on platforms, skids or other supports and protected from mechanical damage or corrosion.

9. MEASUREMENT AND PAYMENT

For items of work for which specific unit prices are established in the contract, the weight of bar reinforcement placed in the concrete in accordance with the drawings will be determined to the nearest pound by computation from the placing drawings. Measurement of hooks and bends will be based on the requirements of ACI Standard 315. Computation of weights of bar reinforcement will be based on the unit weights established in Table 34-1. The weight of steel reinforcing in extra splices or extra length splices approved for the convenience of the Contractor or the weight of supports and ties will not be included in the measurement for payment.

The area of welded wire fabric reinforcement placed in the concrete in accordance with the drawings will be determined to the nearest square foot by computation from the placing drawings with no allowance for laps.

Payment for furnishing and placing bar reinforcing steel will be made at the contract unit price for bar reinforcement. Payment for furnishing and placing welded wire fabric reinforcing steel will be made at the contract unit price for welded wire fabric reinforcement. Such payment will constitute full compensation for all labor, materials, equipment and all other items necessary and incidental to the completion of the work including preparing and furnishing bar schedules, lists or diagrams; furnishing and attaching ties and supports; and furnishing, transporting, cutting, bending, cleaning, and securing all reinforcement.

Compensation for any item of work described in the contract but not listed in the bid schedule will be included in the payment for the item of work to which it is made subsidiary. Such items to which they are made subsidiary are identified in Section 10 of this specification.

TABLE 34-1. STANDARD REINFORCING BARS

Bar Size No.	Wt. (lb./ft.)
3	0.376
4	0.668
5	1.043
6	1.502
7	2.044
8	2.670
9	3.400
10	4.303
11	5.313
14	7.65
18	13.60

TABLE 34-2. RECTANGULAR WELDED WIRE FABRIC1/

Style Designation By Steel Wire Gauge	Style Designation By W-Number	Weight, lb. Per 100 Sq. Ft.
6 x 6 - 10 x 10	6 x 6 - W1.4 x W1.4	21
6 x 6 - 8 x 8	6 x 6 - W2.1 x W2.1	30
6 x 6 - 6 x 6	6 x 6 - W2.9 x W2.9	42
6 x 6 - 4 x 4	6 x 6 - W4.0 x W4.0	58
4 x 4 - 10 x 10	4 x 4 - W1.4 x W1.4	31
4 x 4 - 8 x 8	4 x 4 - W2.1 x W2.1	44
4 x 4 - 6 x 6	4 x 4 - W2.9 x W2.9	62
4 x 4 - 4 x 4	4 x 4 - W4.0 x W4.0	85
4 x 12 - 8 x 12	4 x 12 - W2.1 x W0.92/	25
4 x 12 - 7 x 11	4 x 12 - W2.5 x W1.12/	31

1/ Style designation is defined in ACI Standard 315 of the American Concrete Institute.

2/ Welded smooth wire fabric with wires smaller than Size W1.4 is manufactured from galvanized wire.

10. ITEMS OF WORK AND CONSTRUCTION DETAILS

Items of work to be performed in conformance with this specificatio and the construction details are:

a. Bid Item 5, Steel Reinforcement, ~~Welded Wire Fabric~~

1. This item consists of furnishing and installing all reinforcing steel ~~and welded wire fabric~~ in the concrete channel lining as shown on the drawings.

2. All steel bars shall be ASTM A615 Grade 40 or 60.

CONSTRUCTION SPECIFICATION 94

CONTRACTOR INSPECTION

1. SCOPE

The work shall consist of developing, implementing, and maintaining a quality control system to ensure that the specified quality is achieved for all materials and work performed. The work shall include all equipment, materials, labor and services necessary to implement and maintain the quality control system throughout the duration of the work.

2. EQUIPMENT AND MATERIALS

Equipment and materials for quality control shall be of the quality and condition required to meet the test specifications cited in the contract references. Testing equipment shall be properly adjusted and calibrated at the start of operations and the calibration maintained at the frequency specified. Records of equipment calibration tests shall be available to the Contracting Officer at all times. Where specific requirements exist, equipment shall be operated and maintained by qualified operators. All equipment and materials used in performing quality control testing shall be as prescribed by the test standards referenced in the contract.

Equipment and materials shall be handled and operated in a safe and proper manner complying with all applicable state and federal regulations pertaining to their use, operation, handling and transportation.

3. QUALITY CONTROL SYSTEM

The Contractor shall develop, implement and maintain a system adequate to achieve the specified quality of all work performed, material incorporated and equipment furnished. The system established shall be documented in a written plan developed by the Contractor and approved by the Contracting Officer. The system activities shall include the material testing and inspection work needed to verify the adequacy of completed work and procedures to be followed when corrective action is required. Daily Records to substantiate the conduct of the system shall be maintained by the Contractor. The quality control plan shall cover all aspects of quality control and shall address, as a minimum, any specified testing and inspection requirements. The system provided shall be consistent with the planned performance in the Contractor's approved construction schedule. The system shall identify the Contractor's on-site quality control manager and provide an organizational listing of all quality control personnel and their specific duties. The system shall be submitted to the Contracting Officer within 15 calendar days after notice of award.

4. QUALITY CONTROL PERSONNEL

Quality control activities shall be accomplished by qualified personnel such as licensed engineers, or inspection technicians certified by the American Concrete Institute; and by qualified facilities such as testing laboratories certified by the U.S. Army Corps of Engineers. The Contractor's written quality control plan shall identify the name, qualification, training, experience and availability of all personnel who will perform the quality control activities. The quality control manager's primary responsibility shall be in quality control activities.

5. POST-AWARD CONFERENCE

The Contractor shall meet with the Contracting Officer prior to beginning any work and discuss the Contractor's written quality control plan. The Contracting Officer and the Contractor shall develop a mutual understanding regarding the quality control plan. The finalized plan will be approved by the Contracting Officer.

6. RECORDS

The Contractor's quality control Records shall be kept daily and shall document both acceptable and deficient features of the work. All Records shall be on forms approved by the Contracting Officer and shall be legible.

Records shall include but are not limited to the following:

a. The material or item tested, or inspection performed.

b. Date and time of tests or inspections.

c. Type and number of quality control activities and tests involved.

d. The location and extent of work inspected or tested.

e. Test results and description of conditions observed during the quality control activities.

f. Method of testing used (e.g., citation of reference specification).

g. Nature of defects, specifications not met, etc.

h. Proposed corrective action, and reason for corrective action.

i. Corrective actions taken and supporting quality control recertification testing.

j. Signature of authorized testing or inspecting official with appropriate checkers verification.

k. Manufacturers' recommendations and certifications if any.

l. Documentation of material delivered including quantity, location stored, and results of examinations citing applicable construction, material and reference specification.

m. Documentation of shop drawings including date submitted to and date approved by the Contracting Officer, and results of examinations citing applicable construction, material and reference specifications and construction drawings.

n. Date of the Records creation.

7. REPORTING RESULTS

The results of contractor quality control inspections and tests shall be communicated to the Contracting Officer's representative immediately upon completion of the inspection or test.

8. SUBMITTAL OF RECORDS

The original plus one copy of records of inspections, tests preformed and material testing reports shall be submitted to the Contracting Officer's representative weekly. The original plus one copy of documentation of materials delivered shall be submitted to the Contracting Officer's representative prior to the use of the material.

9. ACCESS

The Contracting Officer and the Contracting Officer's representatives shall be given free access to all testing equipment, facilities, sites, and related Records.

10. MEASUREMENT AND PAYMENT

For items of work for which lump sum prices are established in the contract, payment will be made as the work proceeds, after presentation of invoices by the Contractor showing their costs. If the total of such payments are less than contract lump sum for this item, the unpaid balance will be included in final contract payment. Total payment will be the lump sum contract price for this item, regardless of actual cost to the Contractor.

Payment will not be made under this item for the purchase cost of materials and equipment having a residual value.

Payment of the lump sum contract price for contractor quality control will constitute full compensation for all labor, materials, equipment, transportation, and all other items necessary and incidental to completion of the work.

Compensation for any item of work described in the contract but not listed in the bid schedule will be included in the payment for the item of work to which it is made subsidiary. Such items and the items to which they are made subsidiary are identified in Section 11.

11. ITEMS OF WORK AND CONSTRUCTION DETAILS

Items of work to be performed in conformance with this specification and the construction details are:

a. Bid Item 6, Contractor Inspection

(1) This item shall consist of furnishing the personnel, equipment and material required by the Contractor to perform the testing and inspection that is necessary to implement an inspection system that will ~~x~~ensure the specified quality is being maintained for:

a. Construction Surveys
b. Excavation
c. Earthfill
d. Concrete
e. Steel Reinforcement
f. Pollution Control (Dust)
g. Removal of Water
h. Joint Sealant ~~for concrete lined Floodway~~
i. Concrete Spall Repair
j. Crack repair by epoxy injection
k. Cavity grout repair

(2) In Section 2, EQUIPMENT AND MATERIALS, equipment and materials needed for materials testing shall be calibrated at the specified frequency given in the appropriate materials testing standards. Records of all calibrations shall be submitted to the Engineer within seven (7) days prior to using equipment.

(3) In Section 3, QUALITY CONTROL SYSTEM, the Contractor's Quality Control System shall provide the degree of inspection and testing necessary to ensure that the specified quality is maintained on all work performed.

The written plan shall describe how the Contractor intends to monitor the work, establish the frequency or timing of testing and inspections and the procedure used for selecting the work to be tested.

The Quality Control System shall include inspections and materials testing as follows:

(a) Inspection of construction staking to ensure its accuracy.

(b) Inspection of all excavation to ensure that it is constructed to the lines and grades shown on the drawings.

(c) The moisture density determinations required for the quality control of earthfill shall be performed by the method outlined in Construction Specification 23, Section 10. a. 5 and 6 and by visually observing compaction operations. The Test frequency shall be (1) Test per 50 cubic yards of compacted earthfill for moisture and density control.

Frequency? →

d. The placing of steel reinforcement shall be inspected by quality control personnel twenty four (24) hours prior to delivery of concrete. A certification that all bars are the correct size and positioned as specified shall be given to the contracting officer.

e. The quality control for joint sealant will involve monitoring by quality control personnel for the proper size, quality, cleanness of cut, and installation of preformed joint material and joint sealant all according to drawings and specifications.

f. The quality control for concrete spall repair will involve monitoring and recording by quality control personnel that loose weakened concrete has been removed, area cleaned, and that mixing and placing of polymer modified patching compound is applied according to manufacturer's recommendations and contract specifications.

g. The quality control for repairing cracks will involve monitoring by quality control personnel for adequate cleaning of cracks by water blasting, and that proper preparation, application, and handling techniques of the epoxy injection gel are applied according to manufacturer's recommendations and contract specifications.

h. The quality control for filling cavities beneath the concrete lining will involve monitoring and recording the extent and size of cavity, quality of grout, and installation of grout according to specifications.

(4) The Contractor shall designate an experienced quality control manager and inspection staff whose primary responsibility will be implementing the inspection system. The manager shall be on site during major construction activities and will not be involved in directing production oriented activities unless it pertains to achieving the specified quality for the work being performed. The quality control manager shall be employed by and answerable to the Contractor. The manager's duties cannot be delegated to a subcontractor or others.

(5) Suitable lab facilities will be established at the site and will be used exclusively for testing purposes.

May not be necessary for this size project.

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CONSTRUCTION SPECIFICATION

400. JOINT SEALANT FOR CONCRETE LINED FLOODWAYS

DRAFT

1. SCOPE

The work shall consist of saw cutting and surface preparation of existing contraction and expansion joints, and placement of preformed joint material and joint sealant.

2. MATERIALS

Joint sealer Shall be Type S, Grade NS, use NT or T, low modulus silicone conforming to the requirements of ASTM C-920 and shall tolerate submergence be intermittent flood flows.

The sealant shall have the capability to withstand without failure an increase of 50 percent and a decrease of 50 percent of the joint width as measured at the time of application when tested in accordance with ASTM C-719.

The elongation shall be a minimum of 800 percent without failure when tested in accordance with ASTM D-412, and 500 percent without adhesion failure when tested in accordance with ASTM C-719.

Preformed expansion joint filler shall conform to material specification 535, ASTM D 1752 and 2, Type 1.

Bond breaker material ~~shall~~ be compatible with the sealant and conform to the sealant manufacturer's requirements. The bond breaker shall be adequate to support the sealant until fully cured. The material shall not cause extrusion of sealant when compressed to 50% of its placed width.

3. SURFACE PREPARATION AND APPLICATION

The sealant manufacturer's representative shall be present during initial installation and as stated in Section 6 to insure that proper surface preparation, application, and handling techniques are being used by the contractor and to evaluate the performance of the sealant.

Cutting expansion and contraction joints will involve a saw cut as required to attain the width and depth shown on the drawings. Concrete cutting equipment shall be equipped with carbide or diamond blades. All dried laitance and contaminants shall be removed.

Cleaning Each joint face shall be sand-blasted. The sand-blasting nozzle must be held at an angle or fitted with deflectors to direct the sand against the joint face within one or two inches of the pavement. A minimum of one pass shall be made for each joint face.

After sand-blasting, the joint cavity shall be cleaned, removing all sand or other debris that would interfere with joint closure. Just prior to placing preformed joint filler and sealant, the joints shall be air-blasted to remove sand and dust. Air compressors used for sand-blasting and air-blasting shall be equipped with traps to remove moisture and oil from the air. Air-blasting shall be done in one direction only.

The joint considered to be clean when no residue is evident after rubbing your finger or dark lint free cloth along the cleaned dry joint face. The joint shall be completely clean and air dried, as determined by the Engineer, for a minimum of 24 hours under natural drying conditions, before proceeding with the application of sealant.

Sealant Installation: Bond breaker material shall be placed such that it will prevent adhesion of the sealant with the top surface of the preformed expansion joint filler, and also establish the sealant cross section shown on the drawings.

Joints must be clean and dry when the sealant is installed. Drying of the joint surfaces may only occur from natural weather conditions.

During the sealant placement the nozzle of the sealant applicator shall be moved steadily along the joint, pushing the sealant ahead to form the required cross section. The minimum and maximum temperature of sealant at installation shall be in accordance with the manufacturer's recommendation. See Section 6 for limiting air temperatures.

Immediately after placement and before a skin forms, the sealant shall be tooled, forcing it onto the bond breaker surface and against the joint faces. The finished tooled surface shall be recessed below the concrete surface as detailed on the drawings. Excess sealant on the concrete surface shall be removed.

4. DELIVERY AND STORAGE

The sealant material shall be delivered in original, tightly sealed containers, clearly labeled with the manufacturer's name, product identification and lot numbers where applicable.

The unopened sealant material shall be stored out of the weather, in original, tightly sealed containers, as recommended by the manufacturer. Storage temperature shall not exceed 90 degrees Fahrenheit.

5. MEASUREMENT AND PAYMENT

For items of work for which specific unit prices are established in the contract, the quantity of repaired joints will be determined to the nearest lineal foot by measurement of acceptably installed joint repairs along each joint. Payment for joint repair will be made at the contract unit price for the joint specified. Such payment will constitute full compensation for furnishing, transporting, placement and application of all materials; and saw cutting and preparing the concrete joints including labor, tools, equipment, and all other items necessary and incidental to the completion of the work.

6. ITEMS OF WORK AND CONSTRUCTION DETAILS

Items of work to be performed in conformance with this specification and the construction details are:

a. Bid Item 7, ~~Three Quarter Inch Channel Joints~~ Joint Repair

1) This item ~~shall~~ consists of saw cutting the existing joints as required to attain the dimensions shown on the drawings, removing the existing joint filler and sealant where encountered, preparing the joint surfaces, installation of preformed joint filler, bond breaker and placement of the joint sealant.

2) The existing preformed expansion joint filler at expansion joints is a joint filler conforming the Federal Specification HH-F-341.

3) The minimum 28 day compressive strength of the concrete was 3000 PSI.

4) All materials delivered to the site shall conform to the materials called for in the plans and specifications.

5) ~~Air temperatures next to the concrete channel bottom shall be measured and recorded by the Contractor during the beginning and end of the cutting and sealant installation of each joint. Copies of these records shall be provided to the Engineer on a weekly basis.~~

Cutting the joints and installation of the joint sealant shall be limited to periods when the air temperature at the concrete surface at invert is within the range of 65 degrees Fahrenheit to 100 degrees Fahrenheit.

6) The Contractor shall furnish certification showing that each lot of sealant meets the requirements in Section 2, and a letter of assurance from the manufacturer stating that the sealant will tolerate submergence by intermittent flood flows.

CONSTRUCTION SPECIFICATION

401. POLYMER MODIFIED PATCHING COMPOUND FOR SPALL REPAIR OF CONCRETE LINED FLOODWAY

1. SCOPE

The work shall consist of cutting the edges of the spall area, surface preparation and cleaning the designated spalled areas and furnishing and placing of polymer modified patching compound.

2. MATERIALS

Patching mortar Shall be a polymer-modified, portland-cement, 2-component, fast-setting, trowel grade, easy tooling mortar for horizontal or vertical surfaces.

3. SURFACE PREPARATION AND APPLICATION

The patching compounds manufacturers representative shall be present during initial installation and as stated in Section 6 to ensure that proper surface preparation, application, and handling techniques are being used by the contractor and to evaluate the performance of the patching compound.

Surface preparation will require removal of all deteriorated concrete, dirt, oil, grease, and all bond-inhibiting materials from the surface by sand-blasting. The sand-blasting nozzle shall be positioned within one or two inches of the repair area. Nozzle shall make a minimum of one pass over the entire repair area. Air compressors used for sand-blasting or air-blasting shall be equipped with traps to remove moisture and oil from the air. Bush hammering will be used where necessary to remove cracked or loose concrete. Air blasting will be used to clean dust and sand from surface prior to placing patching compound. Saturate surface with clean water. Substrate shall be saturated surface dry (SSD) with no standing water during placement of patching compound.

Entire repair area will be a minimum of 1/8 inch in depth. Preparation work will be done by a bush hammer or scabbler or other approved method to obtain an aggregate-fractured surface with a minimum surface profile of ± 1/16 inch.

Mixing will be done with mechanical mixing using a low-speed drill and appropriate mixing paddle. Mixing will be accomplished per the manufacturer's recommendation.

Application and finish mortar shall be scrubbed into the substrate, filling all pores and voids, forcing the material against the edge of repair area, and worked toward the center. Patching compound will be consolidated after filling and then screeded and wood float finished, after mortar has set. Manufacturer's recommendations will be followed where multiple lifts are required to build final depth. Where repair areas are deeper than one (1) inch the patching compound may be extended by adding 1/4 inch minus aggregate according to manufacturer's recommendation. Excess patching compound on the concrete surface shall be removed.

Curing - will be accomplished by moist curing with wet burlap. Non-solvent-based curing compounds, that will require pretesting prior to using may be used. Patching material will be protected against rain until properly cured.

4. DELIVERY AND STORAGE

The patching compound material shall be delivered to the site in original, tightly sealed packaging clearly labeled with the manufacturer's name, product identification, date of manufacture and lot numbers where applicable.

The unopened patching compound material shall be stored out of the weather, in original tightly sealed packaging and at temperatures not exceeding temperatures recommended by the manufacturer.

5. MEASUREMENT AND PAYMENT

For items of work for which specific unit prices are established in the contract, the number of spall areas will be counted per the stations shown in the drawings. Payment will be made at the contract unit price for each spall area. Such payment will constitute full compensation for furnishing, transporting, placement, and application of all materials; and bush hammering and preparing the spall areas including labor, tools, equipment, and all other items necessary and incidental to the completion of the work.

6. ITEMS OF WORK AND CONSTRUCTION DETAILS

Items of work to be performed in conformance with this specification and the construction details are:

a. Bid Item 8, Spall Repair

1) This item ~~shall~~ consists of removing and disposing of the existing spalls, bush hammering or removing materials at perimeter of spall for minimum of 1/4 inch depth, preparing the spall surface area and furnishing and placement of patching compound as shown on the drawings.

2) Spall areas shall be formed as required at the expansion joint to provide backing for preformed joint filler and joint sealant.

3) Minimum ambient and surface temperatures will be per manufacturer's recommendation.

4) Concrete color will be concrete gray after placement.

5) Patching mortar will not debond when tested per ASTM C-884 (modified) for coefficient of thermal expansion of concrete.

6) Material shall be Sika Top 122 from Sika Corporation or equal.

7) Compressive strength of patching mortar shall be 8800 PSI at 28 days when tested per ASTM C-109 at 73 degrees Fahrenheit and 50 percent relative humidity.

8) Bond strength of patching motor shall be 2200 PSI at 28 days when tested per ASTM C-882 modified and mortar is scrubbed into substrate.

9) The Contractor shall furnish certification showing that each lot of patching compound meets the requirements in Section 2.

CONSTRUCTION SPECIFICATION

402. EPOXY ADHESIVE INJECTION FOR CRACK REPAIR OF CONCRETE LINED FLOODWAY

1. SCOPE

The work shall consist of cleaning and surface preparation of the crack surfaces, and furnishing all materials, tools, equipment, appliances, transportation, labor and supervision to repair cracks by the injection of an epoxy resin adhesive.

2. MATERIALS

A. Epoxy resin adhesive:

1. Component "A" shall be a modified epoxy resin of the eplchlorohydrin bisphenol A Type containing suitable viscosity control agents. It shall not contain butylglycidylether.

2. Component "B" shall be primarily a reaction product of a selected amine blend with an epoxy resin of the epichlorohydrin bisphenol A Type containing suitable viscosity control agents and accelerators.

3. The ratio of Component "A" to Component "B" shall be per manufacturers recommendation.

B. Porting devices for automated application shall be used in conjunction with the pressure injection equipment.

3. SURFACE PREPARATION AND APPLICATION

The epoxy resin adhesive manufacturers representative shall be present during initial installation and as stated in Section 7 to insure that proper crack preparation, application, and handling techniques are being used by the Contractor and to evaluate the performance of the epoxy resin adhesive.

Surface preparation will require water blasting all cracks with a minimum of 3500 psi pressure. All deteriorated loose concrete, dirt, and all bond - inhibiting materials will be removed from the cracks. Repair area may be dry or damp, but free of standing water prior to applying surface seal or injecting gel.

Entry ports shall be provided along the crack at intervals of not less than the thickness of the lining.

Surface seal material used to confine the injection adhesive in the crack during injection shall be applied to the face of the crack between and around the entry ports. Seal material shall have adequate strength before preceding with injection.

Equipment for Injection

a. The equipment used to meter and mix the two injection adhesive components and inject the mixed adhesive into the cracks shall be portable, positive displacement type pumps with interlock to provide positive ratio control of exact proportions of the two components at the nozzle.

b. The injection equipment shall have an automatic pressure control capable of discharging the mixed adhesive at any preset pressure up to 160±5Psi.

c. The equipment shall have the capability of maintaining the volume ratio for the injection adhesive prescribed by the manufacturer of the adhesive within a tolerance of ± 5 percent by volume at any discharge pressure up to 160 psi.

d. The injection equipment shall be equipped with sensors on both component A and B reservoirs that will automatically stop the machine when only one component is being pumped to the mixing head.

Epoxy Injection

a. Injection of epoxy adhesive shall begin at the lowest port and continue until there is an appearance of epoxy adhesive at the adjacent entry port.

b. When epoxy adhesive travel is indicated by appearance at the next adjacent port, injection shall be discontinued on the entry port being pumped. Epoxy injection shall be continued at the adjacent port where epoxy adhesive has appeared. This procedure will be continued until the entire crack is completely filled.

Finishing

The face of the crack shall be finished flush with the concrete lining surface on each side of the crack.

Curing

Will be accomplished by moist curing with wet burlap or other methods as approved by the Engineer and as recommended by the manufacturer.

4. FIELD QUALITY CONTROL TESTS

a. Pressure tests - The mixing head of the injection equipment shall be disconnected and the two-adhesive component delivery lines shall be attached to the pressure check device. The pressure check device shall consist of two independent valved nozzles capable of controlling flow rate and pressure by adjusting the valve. There shall be a pressure gauge capable of sensing the pressure build-up behind each valve. The valves on the pressure check device shall be closed and the equipment operated until the gauge pressure on each line reads 160 PSI. The pumps shall be stopped and the gauge pressure shall not drop below 150 PSI within three (3) minutes.

b. Ratio test - The mixing head of the injection equipment shall be disconnected and the two adhesive component shall be pumped simultaneously through the ratio check device. The ratio check device shall consist of two independent valved nozzles capable of controlling back pressure by opening or closing the valve. There shall be a pressure gauge capable of sensing the back pressure behind each valve. The discharge pressure shall be adjusted to 160 psi for both adhesive components. Both adhesive components shall be simultaneously discharged in separate calibrated containers. The amounts discharged into the calibrated containers simultaneously during the same time period shall be compared to determine that the volume discharged conforms to the manufacturers recommended ratio for the epoxy resin adhesive.

5. DELIVERY AND STORAGE

The epoxy resin adhesive material shall be delivered to the site in original, tightly sealed containers clearly labeled with the manufacturers name, product identification, date of manufacturer and batch numbers.

The unopened material shall be stored out of the weather, in original tightly sealed containers, and stored at temperatures recommended by the manufacturer.

6. MEASUREMENT AND PAYMENT

For items of work for which specific unit prices are established in the contract, the length of crack will be measured to the nearest foot for those stations shown on the drawings. Payment will be made at the contract unit price for crack repair. Such payment will constitute full compensation for furnishing, transporting, placement, and application of all materials; and water blasting and preparing the cracks including labor, tools, equipment and all other items necessary and incidental to the completion of the work.

7. ITEMS OF WORK AND CONSTRUCTION DETAILS

Items of work to be performed in conformance with this specification and the construction details are:

a. Bid Item 9, Crack Repair

1. This item ~~shall~~ consists of water blasting cracks, removing deteriorated concrete and other sealing compounds in vicinity of crack, preparing the crack for injection and furnishing and placement of epoxy resin adhesive as shown on the drawings.

2. Minimum ambient and concrete surface temperatures will be per manufacturer's recommendation.

3. Minimum and maximum temperatures for storing and conditioning of epoxy resin adhesive before using will be per manufacturer's recommendation.

4. Ration of mixing the two components for injection will be per manufacturer's recommendation.

5. First aid and clean up of spills will be according to manufacturer's recommendations.

6. Epoxy resin adhesive shall be a two (2) component solvent free, moisture - insensitive, high-modulus, high-strength, structural epoxy that conforms to ASTM C 881, Type 1, Grade 3, Class B and C.

7. Compressive strength of the cured epoxy resin adhesive shall be a minimum of 7700 psi at 28 days when tested per ASTM D 695.

8. Bond strength of cured epoxy resign adhesive shall be a minimum of 2200 psi at 14 days when tested per ASTM C 882.

9. The Contractor shall furnish ~~certification~~ test data showing that each lot of epoxy resin adhesive meets the requirements in Section 2.

CONSTRUCTION SPECIFICATION

403. GROUT

1. SCOPE

The work shall consist of furnishing, transporting, and placing concrete grout in the construction of grouted sections.

2. MATERIALS

Filter or bedding materials when required, shall unless otherwise specified, conform to the requirements of Material Specification 521.

Portland cement shall conform to the requirements of Material Specification 531 for the specified type.

Pozzolan. Unless otherwise specified in Section 12 of this specification, pozzolans conforming to Specification ASTM C-618 class F in amounts not to exceed 20 percent, based on absolute volume, may be substituted for an equivalent amount of portland cement in the grout mixture.

Aggregates shall conform to the requirements of Material Specification 522, except that the grading for coarse aggregate shall be as specified in the construction details.

Water shall be clean and free from injurious amounts of oils, acid, alkali, organic matter or other deleterious substances.

Air-entraining admixtures shall conform to the requirements of Material Specification 532.

Curing compound shall conform to the requirements of Material Specification 534.

Other admixtures, when required, shall be as specified in the construction details.

3. SUBGRADE PREPARATION

Grout shall not be placed until the subgrade surfaces have been inspected and approved by the Engineer.

4. FILTER LAYERS OR BEDDING

When filter layers or bedding beneath the grout is specified, the material shall be spread uniformly on the prepared subgrade surfaces to the depth shown on the drawings. Compaction of the material will not be required but the surfaces of such layers shall be finished reasonably free of mounds, dips, or windrows.

5. DESIGN OF THE GROUT MIX

The mix proportions for the grout mix shall be as specified in the construction details. During the course of the work the Engineer will require adjustment of the mix proportions whenever necessary. After the mix has been designated, it shall not be changed without the approval of the Engineer.

6. HANDLING AND MEASUREMENT OF MATERIAL

Materials shall be stockpiled and batched by methods that will prevent segregation or contamination of aggregates and insure accurate proportioning of the ingredients of the mix. Except as otherwise provided in Section 10, cement and aggregates shall be measured as follows:

Cement shall be measured by weight or in bags of 94 pounds each. When cement is measured in bags, no fraction of a bag shall be used unless weighed.

Aggregates shall be measured by weight. Mix proportions shall be based on saturated, surface-dry weights. The batch weight of each aggregate shall be the required saturated, surface-dry weight plus the weight of surface moisture it contains.

Water shall be measured, by volume or by weight, to an accuracy within one percent of the total quantity of water required for the batch.

Admixtures shall be measured within a limit of accuracy of ± 3 percent.

7. MIXERS AND MIXING

The mixer, when loaded to capacity, shall be capable of combining the ingredients of the grout mix into a thoroughly mixed and uniform mass and of discharging it with a satisfactory degree of uniformity.

Mixer shall be operated within the limits of the manufacturer's guaranteed capacity and speed of rotation. The time of mixing after all cement and aggregates are in the mixer drum shall be not less than one minute for mixers having a capacity of one cubic yard or less. For mixers of larger capacities, the minimum time shall be increased fifteen seconds for each cubic yard or fraction thereof of additional capacity. The batch shall be so charged into the mixer that some water will enter in advance of cement and aggregate, and all mixing water shall be introduced into the drum before one-fourth of the mixing time has elapsed.

When ready-mixed grout mix is furnished, the Contractor shall furnish to the Engineer a delivery ticket showing the time of loading and the quantities of materials used for each load of grout mix.

No mixing water in excess of the amount called for by the job mix shall be added to the grout mix during mixing or hauling or after arrival at the delivery point.

8. CONVEYING AND PLACING

The grout mix shall be delivered to the site and placed within 1-1/2 hours after the introduction of the cement to the aggregates. In hot weather or under conditions contributing to quick stiffening of the concrete, the time between the introduction of the cement to the aggregates and discharge shall not exceed 45 minutes. The Engineer may allow a longer time, provided the setting time of the concrete is increased a corresponding amount by the addition of an approved set-retarding admixture. In any case, concrete shall be conveyed from the mixer to the final placement as rapidly as practicable by methods that will prevent segregation of the aggregates or loss of mortar.

Grout mix shall not be dropped more than 5 feet vertically unless suitable equipment is used to prevent segregation. The grout mix shall not be placed until the subgrade has been inspected and approved by the Engineer.

Voids or areas to be grouted shall be kept moist immediately prior to grouting.

After completion of any strip or panel, no workman or other load shall be permitted on the grouted surface for a period of twenty-four (24) hours. The grouted surface shall be protected from injurious action by the sun, rain, flowing water and mechanical injury.

9. CURING AND PROTECTION

The surface of treatment materials shall be prevented from drying for a curing period of at least 7 days after it is placed. Exposed surfaces shall be kept continuously moist for the entire period, or until curing compound is applied as specified below. Moisture shall be maintained by sprinkling, flooding or fog spraying or by covering with continuously moistened canvas, cloth mats, straw, sand or other approved material. Water or covering shall be applied in such a way that the concrete surface is not eroded or otherwise damaged. The grout may be coated with an approved curing compound in lieu of continued application of moisture. The compound shall be sprayed on the moist concrete surfaces as soon as free water has disappeared, but shall not be applied to any surface until finishing of that surface is completed.

The compound shall be applied at a uniform rate of not less than one gallon per 150 square feet of surface and shall form a continuous adherent membrane over the entire surface. Curing compound shall not be applied to surfaces requiring bond to subsequently placed concrete. If the membrane is damaged during the curing period, the damaged area shall be resprayed at the rate of application specified above.

Grout mix shall not be placed when the daily minimum temperature is less than 40oF unless facilities are provided to insure that the temperature of the materials is maintained at not less than 50oF nor more than 90oF during placement and the curing period. Grout mix shall not be placed on frozen surfaces. When freezing conditions prevail, area to be grouted must be covered and heated to a range of 50oF to 90oF for at least 24 hours prior to placing treatment materials.

10. INSPECTING AND TESTING FRESH GROUT

The Engineer will inspect and test grout during the course of the work. Sampling of fresh grout will be done by the methods prescribed in ASTM Designation C 172. The volume of each batch will be determined by the methods prescribed in ASTM Designation C 138.

The Engineer shall have free entry to all parts of the Contractor's plant and equipment which concern mixing and placing the grout while work on the contract is being performed. Proper facilities shall be provided for the Engineer to inspect materials and processes used in mixing and placing the grout as well as for securing samples of the grout mix. All tests and inspections shall be so conducted as not

to interfere unnecessarily with the mixing and placing of the grout.

When ready-mixed grout is furnished, the Contractor shall furnish to the Engineer a statement-of-delivery ticket for each batch delivered to the job site. The ticket shall show the total weights in pounds of cement, water, and fine and coarse aggregates, amount of air-entraining agent, time of loading, and the revolution counter reading at the time of batching.

11. MEASUREMENT AND PAYMENT

Compensation for any item of work described in the contract but not listed in the bid schedule will be included in the payment for the item of work to which it is made subsidiary. Such items and the items to which they are made subsidiary are identified in Section 12 of this specification.

12. ITEMS OF WORK AND CONSTRUCTION DETAILS

Items of work to be performed in conformance with this specification and the construction details are:

a. Subsidiary Item, Grout

1. This item consists of furnishing and placing grout in the voids beneath the channel lining as shown on the drawings.

2. In Section 5, Design of the Grout Mix, the Contractor Shall be responsible for proportioning the grout mix. The grout shall consist of Portland cement, fine and coarse aggregate, water, and air entraining agent. The cement content shall be 5 1/2 bags per cubic yard of concrete. The maximum nominal size of coarse aggregate shall be 3/4 inch. The slump shall be within the range of 6 to 10 inches. The air content (by volume) of the grout mixture at the time of placement shall be five (5) to seven (7) percent. At least five (5) days prior to placement of the grout, the Contractor shall furnish the Engineer with a statement of the mix proportions for approval.

3. Cement shall be Type II or Type IIA. Pozzolan shall be used as a partial substitute for Portland cement not to exceed a maximum substitution of 20 percent based on absolute volume.

4. Curing compound shall be Type 2 conforming to Material Specification 524 and ASTM C 309. The curing compound shall be continuously stirred or agitated during application.

5. Section 11, Measurement and Payment, no separate payment will be made for this item. Compensation for this item will be included in Bid Item 3, Concrete Channel Lining.

Performance Time

A 2 Powerline Floodway Repair

TSJ [redacted] JMH 11-13-91

Performance Time 1

1. [redacted]

	Working Days	Calendar Days
use 20 calendar days - working days $= \frac{5}{7}(20) =$	14.3	20

2. Structure Removal

use performance time to remove section STA 250+98 to STA 256+50 ~L=552'

in place vol = 259.2 C.Y.

surface area = 1762 sq yds.

estimate 1 day to do initial breakup & start stockpiling 1

[redacted]

estimate 2 loads/hr & 10 C.Y. trucks.

= 20 C.Y./hr or 160 C.Y/day

$$\text{Days} = \frac{259.2}{160} = 1.68 \text{ days use 2 days} \quad 2$$

Remaining removal can be sequenced in just prior to completing concrete on a previous section.

3. Survey & reshape compact & regrade channel lining - estimate 2 day 2

4. Set ~~wire mesh~~ reinforcement in 2 sections & form 2 sec estimate 1 day 1

5. Concrete Placement -

4 [redacted] c @ 50 ft

est [redacted] sec/day $= \frac{37}{2} = 18.5$ days use 18

[redacted] 40 to 50 C.Y./day

6. Concrete Placement - 4' & >4' Repairs

No of 4' repair areas = 302

No of >4' repair areas = 38

TOTAL = 340 repair areas

Estimate 6 repair areas/day approx 24 C.Y./day

$$\text{Days} = \frac{340}{6} = 57 \text{ days} \quad 57$$

Az Powerline Floodway Repair

TSJ 11-13-91 JMB 11-13-91

Per [redacted] Time

	Working Days	Calendar Days
7. [redacted] 4' & >4' Repair Areas		
[redacted] 6 sections & haul To landfill - Approx 24 c.y.	2	
Survey, excavate and grade for 6 sec		
Set reinforcing bar for 6 sec		
8. Joint Sealant -		
Assume spall repair & crack repair & 75% of joint sealant occurs during concrete placement.		
Allow 10 days for completing joint sealant and clean up	10	
TOTAL =	107.3	150.2

[redacted]

Weather - state climatologist @ A54 @ Tempe - 965-6265

Data for Chandler Heights gauging sta for 32 years of record thru 1986.

	inches	Rain Days >0.25"		inches	Rain Days >0.25"
Jan -	0.94	1	July -	0.71	1
Feb -	0.80	1	Aug -	1.27	1
Mar -	1.06	2	Sept -	0.76	1
Apr -	0.24	0	OCT -	0.75	1
May -	0.15	0	Nov -	0.63	1
Jun -	0.09	0	Dec -	0.97	1

Assume Repair work will be done July thru Dec

[redacted] Days = 6

Allow [redacted] rain day = 18

TOTAL = 24 weather days

Holidays = New Years, President, Memorial = 3

TOTAL Time = 150 + 24 + 3 = 177 day

Use 6 month or 180 days for performance time.

Reviewed & Approved by _____ Date _____

Preliminary Cost Est.

[redacted]

[redacted]NE FLOODWAY
REPAIR

PRELIMINARY COST ESTIMATE

Item NO	Work or Material	Spec No.	Quantity	Unit	Unit Price	Amount
1	Structural Removal	3	1	L.S.	XXX	$66,560.00
2	Mobilization	8	1	L.S.	XXX	15,070.00
3	Concrete Channel Lining	31	2189	C.Y.	140.[redacted]	[redacted]
4	Cement	31	3420	Bbls.	16.0[redacted]	[redacted]
5	Steel Reinforcement	34	189,132	lbs.	0.40	[redacted]
6	Contractor Inspection	94	1	L.S.	XXX	15,000.00
7	Joint Repair	400	10,065	FT.	4.00	40,260.00
8	Spall Repair	401	57	ea.	125.00	7125.00
9	Crack Repair	402	2400	FT	9.00	21,600.00
				TOTAL	$	602,377.80

Approv[redacted]ervation Engineer Date

AZ
TSS [redacted]

Powerline Floodway Repair

[redacted]

2

Material to be Excavated

Reinforced concrete (RC) — 1,318 C.Y. (in place)

Earth – 4'&7' repairs $= \frac{576}{2} = 288$ C.Y.
1'x9" – cutoff trench – $1755(2)(1)(0.75)(\frac{1}{27}) = 98$ C.Y.
Berms – 0.26 C.Y./FT (2'14+1755+1212) = 827 C.Y.
Channel
1,213 C.Y.
} use 1500 C.Y.

only RC will be hauled to land fill
earth will be used to put berm back & remainder will be graded on O&M roads.

[redacted]

PRODUCTION RATES –

RC – Assume 10½ C.Y./truck load

$\frac{1318}{10.5} = 126$ truck loads

Assume 1 hour truck time per load = 126 hours 1 truck
truck time = 16 days hauling

Use 2 trucks – time = $\frac{126}{2} = 63$ hrs

[redacted]

AZ
TJJ
Co[redacted] Cond.

Powerline Floodway Repair

3

Item	[redacted] Rate/hr	Hours	Stand Hours by estimate	Production Cost	Stand by Cost 1/2
Foreman 1/2 Time	25.20	32	50 hrs.	806.40	
Laborer 1	10.57	63	standby	665.91	
Laborer 2	10.57	63		665.91	
Breaker/Crawler operator	60.64 23.67 84.31	63	21.22 x 500	5311.53	10,610
Loader operator	56.63 23.67 80.30	63	16.24 x 500	5058	[redacted]
Loader/Backhoe operator	27.60 23.67 51.27	63	8.25 x 500	3230.01	[redacted]
Truck #1 Driver	27.98 20.59 48.57	63	6.24 x 500	3059.91	3120
Truck #2 Driver	27.98 20.59 48.57	63	6.24 x 500	3059.91	3120
			TOTAL	21,858.48	$29,095.00

[redacted]

TOTAL COST = 50,953.48
Overhead + Profit = 7643.02
@ 15%
58,596.50

Use 59,000.00

Land Fill Costs = 7560.00

$66,560.00

TOTAL
Structural Removal

A2 Powerline Floodway Repair-

TSJ [redacted]

Co[redacted] Cond-

1.0 S[redacted]oval — $66,560 ~~$59,000.00~~

2. [redacted] — estimate @ 3%± — 15,000.00

Earth excavation Cost

(a) estimate 5.00/C.Y. = 1500 (5) = $7,500.00

3 Concrete-

estimate 130.40/cu yd - X2189 = $285,445.60

4 Cement

estimate $16.00/bbl = 3420 ($16.00) — $54,720.00

5. Reinforcing Steel

estimate 70¢/lb x 189,132 (lbs) = $75,[redacted]

6. Contractor Inspection - est @ 3%± — 15,[redacted]

(b) estimate 100 C.Y. @ 8.00/C.Y. (Earth fill) — $800.00

7 Joint Repair

total length = 10,065 FT

Estimate $4.00/FT based on similar jobs-

COST = 4 (10,065) = 40,260.00

8 S[redacted]T = 7125.00

9 Crack Repair - See sht 5

2400 ft @ 9.00/ft = $21,600.00

(c) water - Assume 3.00/m gal & 500 m gal = 1500.00 charge To bid Item 3

(d) Surveys - estimate @ 2%± = 10,000.00

(e) Grout - estimate 20 ± @ $60.00/C.Y. = 1200.00

(f) ~~Land fill Cost~~ = ~~7560.00~~

(Include under structure Removal)

$ 603,363.40

A2
TSJ
Cost Estimate
8. Small Repair

Powerline Floodway Repair

5

57 repair areas -

Ave size = 1.3 X 1.3 = 1.69 ft^2

Assume Ave depth = 2"

vol = $\frac{1.69 (2)}{12}$ = 0.28 ft^3

1 - polymer packaged unit volume = 0.4 ft^3

therefore with 15% waste vol = 0.32 c.y.
use 80% unit / patch
unit cost = 78.00
material cost = 78 X 0.8 = $62.40 / patch

Assume labor & equip cost = mat.l. cost = 62.40

total cost = $124.80 / patch - use 125.00 / patch

total cost = 125 (57) = $7,125.00

9. Crack Repair

Length = 1866 ft - this no is low - use 2400 ft as estimate

epoxy injection gel process is running $6.00 to $11.00 / foot per local contractor who does much of the work in the

Es[illegible] ft

[illegible] = 9 (2400) = $21,600.00

A2 Powerline Floodway Repair

TJJ 11-13-91

Land fill Costs -

Quote from Pinal County Phone 868-5801 ext 409 on 11-13-91 for placing waste in land fill off Tomahawk road east of Apache Junction -

COST = 6.00/cuyd :- & based on truck size

they assume 12 C.Y. truck is carrying 12 C.Y.

COST/trip for 12 C.Y. truck = 6 X 12 = $72.00/load.

$$\# \text{ of load} = \frac{1516}{12} = 126 \text{ loads}$$

COST = 126 (60.00) = $7,560.00 → Land Fill Cost

Survey info

A2 Powerline Flwdy Repair

TJJ 9/26/91

Adjust Level Survey To Dave Clough Datum 9/91

STA	Elev 9/91
76+50	16.49
77+00	16.20
77+25	16.13
77+75	16.11
77+76	16.31
78+25	15.89
78+26	15.70
78+75	15.23
79+25	15.37
79+78	15.47
80+25	14.61
80+26	14.26
80+50	14.18
81+50	13.88

Amer Geo datum dropped 0.14 FT To compare with Dave Clough 9-1991 Survey of Channel Bottom.

AZ
TJJ 9/26/91

Power line Flwdy Repair

Adjust Level Survey to Dave Clough Datum 9/91

2.

Amer Geo Datum dropped 0.29 FT to compare with Dave Clough 9/91 survey of Channel Bottom -

STA	Elev
153+50	1467.56
154+00	1467.17
154+50	1466.81
154+50	1466.78
155+00	1466.91
155+25	1466.81
155+25	1466.77
155+75	1466.32
156+25	1465.93
156+25	1465.86

AZ Powerline Flwdy Repair

TJJ 9/26/91

Adjust Level Survey to Dave Clough Datum 9/91 3

Amer Geo Datum dropped 0.29 FT TO compare with Dave Clough 9/91 survey of channel bottom -

STA	Elev
166+00	1459.69
166+50	1459.43
167+00	1459.25
167+48	1459.43
167+51	1459.20
168+00	1458.82 ✓
168+02	1458.39 ✓
168+25	1458.20 ✓
168+75	1457.89 ✓

Az

Power line Floodway Repair

TSS 9/30/91

Adjust Level survey TO 9/91 Survey Datum by Dave Clough.

STA	Elev- 9/91
216+25	1429.55
216+25	1429.62
216+75	1429.58
216+75	1429.52
217+00	1429.41
217+00	1429.26
217+50	1429.05
217+50	1429.06
218+00	1428.87
218+00	1428.89
222+25	1427.24
222+25	1427.24
222+75	1427.10
222+75	1427.10
223+25	1427.02
223+25	1426.98
223+50	1426.93
223+50	1426.93
224+00	1426.98
224+00	1427.13
224+50	1427.18
224+50	1427.10
225+00	1426.74
225+00	1426.74

Amer Geo Datum dropped 0.35 ft TO compare with Dave Clough 9/91 survey of channel bottom - used sub sidence Monument PF-11 for Surveys.

AZ

TJJ 9/30/91

Powerline Floodway Repair

Adjust Level Survey to 9/91 Survey Datum by Dave Clough

5

Amer Geo Datum dropped 0.29 ft to compare with Dave Clough 9/91 survey of channel bottom used subsidence monument PF-13 for surveys

STA	Elev
249+50	1417.74
249+50	1417.73
250+00	1417.58
250+00	1417.58
250+50	1417.40
250+50	1417.39
251+00	1417.29
251+00	1417.28
251+50	1417.55
251+50	1417.59
252+00	1417.60
252+00	1417.59
252+50	1417.29
252+50	1417.29
252+75	1417.29
252+75	1417.26
253+25	1417.00

STA	Elev
254+75	1415.88
254+75	1415.87
255+25	1415.79
255+25	1415.80
255+75	1415.93
255+75	1415.94
256+00	1415.70
256+00	1415.69
256+50	1415.35
256+50	1415.42

STA	Elev
259+75	1414.25
259+75	14.27
260+25	14.03
260+25	14.03
260+68	14.04
260+68	14.07
260+75	13.88
260+75	13.92
261+00	13.53
261+00	13.58
261+50	12.88
261+50	12.88

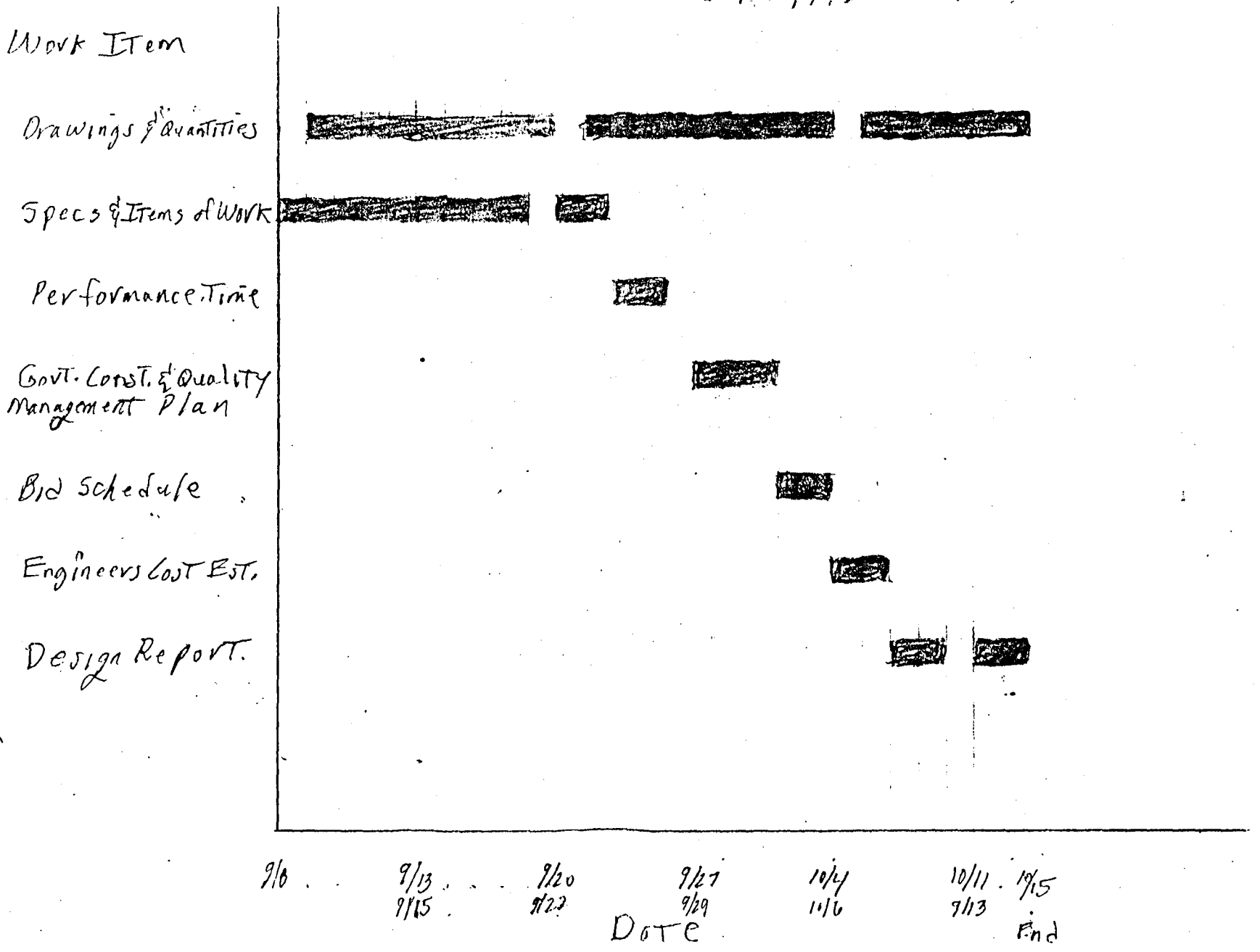
POWERLINE FLUMY

POWERLINE FLUMY REPAIR

Schedule

9-4-91 Design

Arizona Tom Joyo Prelim



AZ
TJJ

Powerline Flwdy Repair

9-25-91

Comparison of 1986 TO 1991 Level Surveys

STA	Stamped 1570.36 Monument Powerline FRS outlet headwall	Am. Geo 2/86 Elev	SBS 10/89	SCS 9/91	Difference 86 TO 91
6+49		1570.03	1569.886	1569.786	-0.24
20+00	PF-1	1558.56		1558.26	-0.30
40+00	PF2	1547.72		1547.47	-0.25
60+00	PF3	1533.40		1533.22	-0.18
75+28	Stamped 1524.66 Vineyard Rd Headwall	1524.70		1524.526	-0.17
80+00	PF4	1519.40		1519.26	-0.14
100+00	PF5	1507.24		1507.12	-0.12
120+00	PF6	1495.82		1495.59	-0.23
140+00	PF7	1482.22		1481.95	-0.27
160+00	PF8	1468.29		1468.00	-0.29
180+00	PF9	1456.30		1455.96	-0.34
200+00	PF10	1444.10		1443.75	-0.35
220+00	PF-11	1434.13		1433.78	-0.35
240+00	PF12	1427.30		1426.96	-0.34
260+00	PF13	1420.03		1419.74	-0.29
280+00	PF14	1411.15		1410.97	-0.18
300+00	PF15	1399.54		1399.36	-0.18
320+00	PF16	1387.93		1387.77	-0.16
324+60	BM "W364"	1387.98		1387.81	-0.17
324+67	BM stamped "1390.54"	1389.44		1389.28	-0.16
340+00	PF17	1378.13		1378.03	-0.10
360+00	PF18	1368.30		1368.21	-0.09
374+59	PF18A	1361.87		[illegible]	[illegible]

AZ
TSJ

Powerline Flood way Repair

10-1-91

Comparison of Subsidence Difference
From 2/86 survey with channel change 1967 to 1991

STA	Difference (Subsidence Monuments) 2/86 to 9/91	Difference per Year (5.5 yr)	Channel Bottom - 1967 to 9/91	Channel bottom 1967 to 1991 Diff/year 24 yr
6+49	-0.24	0.043		
20+00	-0.3	0.054	-0.33	0.016
40+00	-0.25	0.045	-0.45	0.019
60+00	-0.18	0.032	-0.25	0.010
ineyard 75+28	-0.17	0.030		
Bridge 80+00	-0.14	0.025	-0.2	0.008
100+00	-0.12	0.022	-0.38	0.016
120+00	-0.23	0.041	-0.30	0.033
140+00	-0.27	0.048	-1.05	0.044
160+00	-0.29	0.052	-1.5	0.063
180+00	-0.34	0.061	-2.0	0.083
200+00	-0.35	0.063	-2.15	0.09
220+00	-0.35	0.036	-2.15	0.09
240+00	-0.34	0.061	-1.90	0.079
260+00	-0.29	0.052	-1.60	0.067
280+00	-0.18	0.032	-1.20	0.05
300+00	-0.18	0.032	-1.40	0.058
320+00	-0.16	0.029	-1.20	0.05
Hawoth 321+60	-0.17	0.030		
Bridge 321+67	-0.16	0.029	-	
340+00	-0.10	0.018	-0.95	0.04
360+00	-0.09	0.016	-1.10	0.045
373+59	-0.08	0.014	-1.20	0.05

End of conc lining

AZ
TSS 10-1-91

Power line Floodway Repair

Survey Needs -

Done Ellsworth Rd Bridge -

1. elev @ start of transition STA 74+73
2. elev & sta @ inlet to box culvert - 74+98
3. elev & sta @ outlet to box culvert - 75+58
4. elev @ end of transition at STA 75+83

Done 2. STA 169+00, 169+55, 169+55 & 170+50

Done 3. Mountain Road Bridge
(a) entrance sta & elev.
(b) exit sta & elev.

Done 4. 400' General Motors Bridge -

(a) elev @ STA 225+50 @ start of transition
(b) station at entrance to tunnel
(c) station & elev @ end of tunnel
(d) elev @ 230+50 at end of transition

5. Bridge or exit end of General Motors Proving Grounds
(a) elev & sta at entrance to bridge
(b) elev @ 215+95 @ start of transition down stream
(c) elev @ 216+25 @ west end of transition down stream
did not get this data ?

Done 6. General Motors Bridge STA 309+50 ±
(a) elev @ STA 307+68.5 @ start of transition upstrm
(b) STA & elev @ actual start of tunnel upstrm
(c) STA & elev @ actual end of tunnel down stream.
(d) elev @ STA 309+29 at west end of transition down stream

Done 7. Ellsworth Road Bridge
~~(a) elev @ STA 320+07 at start of bridge transition upstream~~
(b) STA & elev @ actual start of tunnel upstream -
(c) STA & elev @ actual end of tunnel down stream
~~(d) elev~~

engineering bulletin no. 11

extra copy

Chapter 4

SEWERAGE COLLECTION SYSTEMS

ARIZONA DEPARTMENT OF HEALTH SERVICES

JULY 1978

CHAPTER IV - SEWAGE COLLECTION SYSTEMS

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The testing shall be administered using the shortest length of line that is practical. All lines shall be cleaned before placing in service to remove extraneous material. It is also recommended that the sewers be examined by television or other methods to assure proper construction.

Suitable waterstops shall be provided at all manhole seams.

All test results shall be made available for review by the Department prior to project acceptance.

Sewer lines installed in areas where the pipe is subject to high ground water infiltration shall be tested using direct flow measurements in each specified reach of pipe.

a. Infiltration Testing - The total infiltration shall not exceed 200 gallons per day per inch diameter per mile of pipe. If the quantity of infiltration exceeds the maximum quantity specified, immediate action shall be taken to reduce infiltration to within the specified limits.

Diameter of Sewer	Infiltration Gals/hr/100 ft.	Diameter of Sewer	Infiltration Gals/hr/100 ft.
8	1.26	54	8.51
10	1.57	60	9.45
12	1.89	66	10.39
15	2.36	72	11.34
18	2.83	78	12.29
21	3.31	84	13.23
24	3.78	90	14.17
27	4.25	96	15.12
30	4.73	102	16.07
36	5.67	108	17.01
42	6.61	114	17.95
48	7.56	120	18.90

Allowable M. H. Infiltration — 0.1 gallons per hour per vert. ft

Allowable Limits of Infiltration
200 Gal/Inch Dia/Mi/Day

b. Low Pressure Air Testing - Low pressure air testing shall be limited to pipes less than 30 inches in diameter.

1) Test Procedure:

a) Clean and wet the line to be tested.

b) Plug all pipe outlets with suitable test plugs and securely brace each plug.

c) Add air slowly to the portion of the pipe installation under test until the internal air pressure is raised to 4.0 psig.

d) Check exposed pipe and plugs for leakage by coating with a soap solution. If any failures are observed, bleed off air and make necessary repairs.

e) After an internal pressure of 4.0 psig is obtained, allow at least two minutes for internal air temperature to stabilize, adding only the amount of air required to maintain pressure.

f) After the two minute period, disconnect the air supply.

g) When the pressure decreases to 3.5 psig, start timing. Determine the time in seconds that is required for the pressure to fall from 3.5 psig to 2.5 psig. This test duration time must be equal to or greater than the minimum test duration time obtained as outlined below.

2) Minimum Test Duration Times - The following procedures for obtaining minimum test duration times from the nomograph, Figure IV - 1, are based on a maximum air loss of 0.003 cfm per square foot of internal cross sectional area but not more than 2 cfm for the entire length under test.

a) For test sections of one diameter or for sections such as laterals with a few short taps.

If the length of the section under test is not grater than the length shown in Column L_A, read the minimum test duration time in seconds from Scale T_A.

If the length of section under test is greater than L_A, but within the limits of Scale L, extend a straight line from the diameter on Scale D to the length of Scale L and read the minimum test duration in seconds on Scale T_B.

b) For test sections consisting of more than one size pipe, and for lengths not falling within the limits of Scale L.

For test section lengths falling within the limits of Scale L. extend a straight line from the diameter read on Scale D to the corresponding length of Scale L for each size

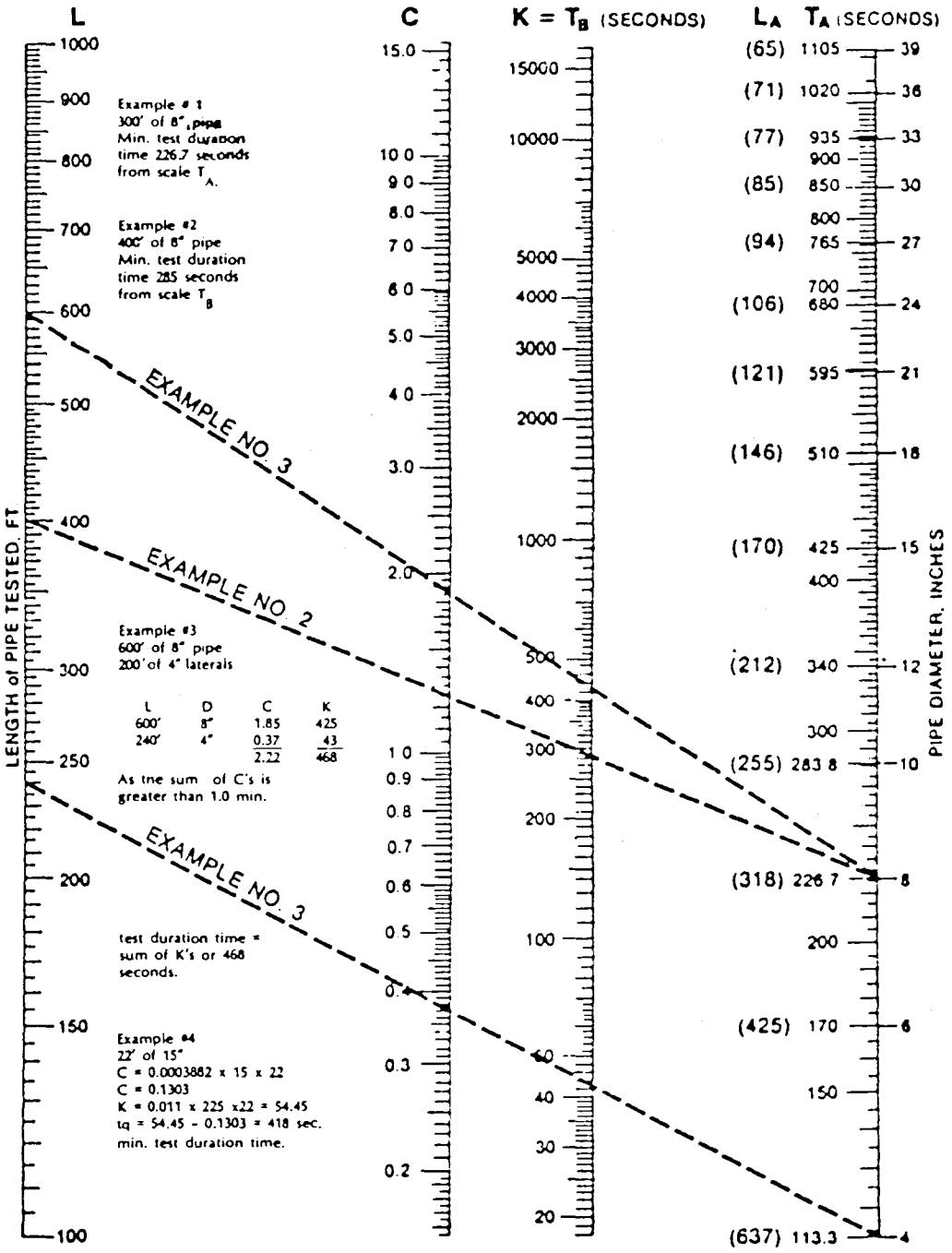


Figure IV - 1

Nomograph - Sewer Line
Air Testing

of pipe included and read values for C and K directly from the corresponding Scales.

For test section lengths not falling within the limits of Scale L, calculate C and K from the formulas at the bottom of the nomograph.

Add C's and add K's.

If the total of C's is 1.0 or greater, the sum of K's equals the minimum test duration in seconds.

If the total of C's is less than 1.0, divide the sum of K's by the sum of C's. The quotient is the minimum test duration in seconds.

c. Exfiltration Testing - In areas where the sewer is not located in natural ground water table, exfiltration tests or low pressure air tests shall be used to give an indication of sewer tightness.

The exfiltration test should be conducted as follows:

1) Plug sewer at lower end of section to be tested.

2) Plug the highest end of the sewer to be tested. The sewer plug shall have a suitable air vent to allow trapped air removal.

3) Place a calibrated container at the average height of four (4) feet above the flow line of the sewer. Check the system for leaks in hoses, plugs, calibrated containers, etc. while filling through a positive shut-off valve. After filling the sewer, allow one hour for absorption of water and refill sewer line. When the water overflows the calibrated container, close the input valve and begin the test.

4) Record the elapsed time to empty the container of water and calculate the loss rate (gal/hr.).

Diameter of Sewer	Gals/Hr/100 ft.	Diameter of Sewer	Gals/Hr/100 ft.
8	1.26	18	2.83
10	1.57	21	3.31
12	1.89	24	3.78
15	2.36	27	4.25

Allowable Limits of Exfiltration
200 Gal/Inch Dia/Mi/Day @ (4 ft. head)

Exfiltration from manholes shall be limited to 0.1 gallons per hour per vert. foot.

4. Protecting Public Water Supply - Caution should be taken in design and construction to protect all water supplies from waste water contamination.

The Department has adopted regulations prohibiting cross connections. To minimize the potential of cross contamination, the Engineer shall design the horizontal and vertical separation of water and sewer lines as follows:

a. Horizontal - When water lines and sewers are laid parallel to each other, the horizontal distance between them shall not be less than six (6) feet. Each line shall be laid on undisturbed or bedded material in a separate trench. Where conditions prevent the minimum horizontal separation set forth above, or where both lines are in the same trench, both the water line and sewer shall be constructed of mechanical joint cast iron pipe, or other approved pipe, which is pressure tested to assure water tightness before backfilling. In such instances, a complete description of the circumstances and details of the proposed construction shall be attached to the plans submitted to the Department.

b. Vertical - When a sewer crosses two (2) feet or more below a water line, no extra protection is required. When a sewer crosses less than two (2) feet below a water line, the sewer shall be constructed of cast iron pipe with leaded or mechanical joints, or other approved pipe, for at least six (6) feet in both directions from the crossing, or the sewer shall be encased in concrete of 6-inch minimum thickness for the same distance. When a water line must cross under a sewer, a vertical separation of at least 18 inches between the bottom of the sewer and the top of the water line shall be maintained with support provided for the sewer to prevent settling. The sewer shall be constructed of cast iron pipe with leaded or mechanical joints, or other approved pipe at least six (6) feet in both directions from the crossing, or the sewer shall be encased in concrete of 6-inch minimum thickness for the same distance.

c. No water pipe shall pass through or come into contact with any part of the sewer manhole.

C. CAPACITIES.

Sanitary sewers should be designed for the following existing and anticipated future flows:

(1) Maximum rate of flow of domestic sewage for the entire service area for a specified time period.

(2) Infiltration that is allowed for the entire service area.

(3) Anticipated flow rates from commercial and industrial areas.

1. Design Period - Design periods should be chosen carefully and consider the following:

a. Useful life of the equipment and its component structures, taking into account obsolescence and wear and tear.

b. The ease, or difficulty, of expanding or relocating the system.

c. The anticipated population rate increase including commercial and industrial contributions.

d. The present rate of interest on accrued bond indebtedness.

e. Inflation and escalation of material and labor during the period of indebtedness.

f. The ability of the system to function properly at present flows after the expanded system is placed in operation

RECOMMENDED DESIGN PERIODS

Type of Structure	Design Period Years	Note
Laterals and submains less than 15 inches in diameter	Full Development	Requirements may change rapidly in a limited area.
Main sewers, outfalls, and interceptors	50, full development, or as specified by EPA	Difficult and expensive to enlarge

2. Design Flows - The estimates of flow of residential domestic areas can be expressed by the following equations:

$$Q_{max}/Q_{avg} = 5.0/P^{1/6}$$

$$Q_{min}/Q_{avg} = 0.2P^{1/6}$$

$$Q_{max}/Q_{min} = 25.0P^{1/3}$$

Where Q is the flow rate in gallons per day and P is the poulation in thousands.

Other widely used relationships of flow from moderate sized domestic sewage areas are

Maximum daily flow = 2 x avg daily flow
Maximum hourly flow = 1.5 x maximum daily flow, or
= 3 x average daily flow
Minimum hourly flow = 2/3 x average daily flow, or
Minimum hourly flow = 1/2 x minimum daily flow, or
= 1/3 x average daily flow

In the absence of flow data new domestic sewerage systems shall be designed on the basis of an average daily flow of not less than 100 gallons per capita per day, or as specified by EPA's cost effectiveness guidelines. Lateral and submain sewers should be designed with capacities, when flowing full, of not less than 400 gallons per capita per day. Sewer mains should be designed for not less than 250 gallons per capita per day flowing full. Interceptors should be designed for maximum flows using the preceding equations.

In commercial areas the normal domestic flow should be added to that of the commercial areas. Commercial flows should be based upon known data in the design region.

Normal dry industrial flows should be based upon known data in the design region. Any residential flow should be added to these values.

Design for wet industry should be on an industry-by-industry basis.

D. DESIGN DETAILS.

1. No sewers other than house laterals shall be less than six inches in diameter. Six-inch diameter sewers will be permitted for lines under 400 feet in length in areas where the line cannot be extended, unless indicated otherwise in this Bulletin. A manhole shall be placed at the end of the six-inch line. If the six-inch diameter line is 200 feet or less in length, a cleanout at the end of the line may be used.

   All other sewers shall be at least 8 inches in diameter.

2. Minimum Slope - All sewers shall be so designed and constructed to give mean velocities, when flowing full, of not less than 2.0 feet per second, based upon Manning's formula using an "n" value of 0.013. Use of other practical "n" values may be permitted by the plan reviewing agency if deemed justifiable on the basis of research or field data presented. Figures IV - 2 and IV - 3 are provided as a design aid.

   To prevent deposition of sand and gravel, a mean velocity of 2.5 fps should be used when the circumstances permit. To prevent abrasive action of the pipe material, the maximum velocity in the sewer shall be limited to 10 fps. Where velocities exceed this maximum figure, the lines shall be constructed of ductile iron pipe or its equivalent. Manhole inverts shall also be protected.

   All sewer lines shall be designed with due consideration given to sulfide production and control. Recommended references include EPA Process Design Manual for Sulfide Control in Sanitary Sewer Systems, and D. K. B. Thistlethwayte's Control of Sulphides in Sewerage Systems.

3. Alignment.

   a. Straight - Where a sewer with straight alignment is desired, the sewer shall be laid with uniform grade and straight alignment between manholes.

   b. Curvilinear - Horizontal and vertical curvilinear sewers will be accepted providing they meet the following criteria:

      1) The minimum velocity in the sewer flowing full is not less than 2.0 fps.

      2) The minimum radius of curvature shall be 200 feet or the radius calculated based upon one-half of the maximum allowable deflection per joint per pipe material, whichever is greater.

3) In addition to the acceptance test, the sewer line shall be cleaned to remove foreign material.

4) Manholes shall be placed at each end of the curve not to exceed 400 feet spacing.

4. Manholes and Cleanouts.

a. Location - Except as itemized below, manholes shall be installed at the end of each line, at all changes of grade, pipe size, or alignment, at all sewer pipe intersections, and at distances not exceeding those shown below:

MANHOLE SPACING

Pipe Size (in.)	Max. Manhole Spacing (ft.)
8 - 15	500
18 - 30	600
36 - 60	800
Over 60	1300

Cleanouts may be used in place of manholes at the end of laterals less than 200 feet in length.

Where manholes are located in areas of flooding, consideration shall be given in design to eliminate storm water entrance.

Sewer Size		Minimum Slope to Maintain Velocity of:					
(in)	(mm)	2.0 fps (0.6 m/s)			2.5 fps (0.75 m/s)		
n		.010	.013	.015	.010	.013	.015
8	200	.0020	.0033	.0045	.0031	.0052	.0070
10	250	.0015	.0024	.0033	.0023	.0037	.0052
12	300	.0011	.0019	.0026	.0018	.0030	.0040
15	380	.00085	.0014	.0019	.0013	.0022	.0030
18	450	.00067	.0011	.0015	.0010	.0017	.0023
24	600	.00045	.00077	.0010	.00071	.0012	.0016

Table IV-1

Minimum Slope To Maintain Indicated Velocities Flowing Full (From Manning's Formula)

b. Drop Manholes - If the difference in invert elevations between inflow and outflow sewers exceeds 30 inches, a drop manhole shall be installed.

If the difference in invert elevations between inflow and outflow sewers is less than 30 inches, the manhole invert should be filleted to prevent solids deposition.

The Engineer should design drop manholes with due consideration given to sulfides and sulfide control. Recommended references include EPA Process Design Manual for Sulfide Control in Sanitary Sewerage Systems, and D. K. B. Thistlethwayte's Control of Sulphides in Sewerage Systems.

Elimination of drop manholes by a substitution of a vertically curved sewer into a standard manhole will be considered, provided detailed hydraulic calculations are submitted showing the vertical transition curve and its conformance with velocities and principals of open channel hydraulics.

c. Diameter - The minimum inside diameter of manholes shall be 48 inches.

d. Steps - Manhole steps should be installed in sewers when the depth of the manhole exceeds 48 inches. The steps shall be spaced from 15 to 18 inches apart vertically and constructed of cast iron or plastic coated cast iron.

Ladders with cast-in anchors will be an acceptable alternate to steps.

e. Flow Channel - The flow channel through the manhole shall be steel trowel finished to conform in shape and slope to that of the sewers. The manhole shelf shall be brush or broom finished with a slope of one inch per foot.

f. Water-Tightness - Manholes should be protected from storm drainage flooding conditions whenever possible. Where the flooding cannot be avoided, solid manhole covers shall be used to prevent infiltration. Suitable waterstops shall be provided at all manhole seams.

Manholes constructed of brick or concrete block shall be waterproofed on the exterior to prevent infiltration. Where pre-cast manholes are found to leak, the manholes shall be waterproofed on the exterior.

5. Depressed Sewers - The use of depressed sewers (inverted siphons) should be kept to a minimum.

To keep velocities to a maximum and clogging by sediments to a minimum and to provide easier maintenance, at least two parallel pipes should be designed with a minimum pipe diameter of six (6) inches.

A minimum velocity of 3.0 fps should be maintained in each sewer pipe. The system should be designed to provide the minimum velocity in one pipe

at minimum flows with the inlet structure arranged in such a manner as to bring additional pipes progressively into operation as the flow increases to its ultimate design flow.

Manholes shall be installed at each end of the depressed sewer to provide for cleaning and rodding.

Where circumstances warrant, a bar screen may have to be installed in a structure prior to the depressed sewer inlet. This could be especially true where 6-inch pipes are used. The design Engineer should give careful analysis and attention to potential clogging problems.

6. Depth of Sewers - Sewers shall be installed at a depth sufficient to insure adequate drainage of wastes from each service and to prevent frost damage.

   All sewers shall be designed to absorb superimposed loads and back-fill overburden, without damage to the pipe material, and without adversely affecting the hydraulic characteristics of the pipe.

   It is recommended that the sewer pipe be installed at a minimum depth of 3 feet (finished grade to pipe spring line). Where pipes are required to bridge ravines, washes, and caverns, the pipe shall be of high strength material and shall be supported properly to prevent settlement or washout during storm flows.

7. Easements and Rights-of-Way - No public sewer shall be installed unless the owner has in his possession evidence of his obtaining the necessary easements and rights-of-way.

   Failure to produce these agreements upon request is ground for withdrawal of the Department's "Approval to Construct."

8. Special Conditions for Condominiums, Mobile Home, Travel Trailer, and Recreation Vehicle Parks - Condominiums, mobile home, travel trailer, and recreational parks shall be designed using the requirements of the uniform plumbing code, excluding the water-sewer main separation. The requirements of this Bulletin regarding water and sewer separation shall also apply to condominiums, mobile home, travel trailer, and recreational vehicle parks.

E. PLAN - DETAIL REQUIREMENTS.

In general, the engineering drawings submitted to the Department for approval shall meet the following requirements:

1. Standard Drawing Size - The engineering drawings shall be reproduced on paper not greater 24" x 36".

2. Plan View and Profile - Plans and profiles for sanitary sewers shall be submitted and shall be prepared using the following scales:

Horizontal	Vertical
1" = 20 feet	1" = 2 feet
1" = 30 feet	1" = 4 feet
1" = 40 feet	1" = 5 feet
1" = 50 feet	1" = 6 feet
1" - 60 feet	1" - 10 feet
1" - 100 feet	

The plans and profiles shall be in sufficient detail so as to provide a clear understanding of the size. invert and grade elevations and type of material used in construction.

The plans and profiles should show all utility locations, easements and rights-of-way. and other structural features of the sewer.

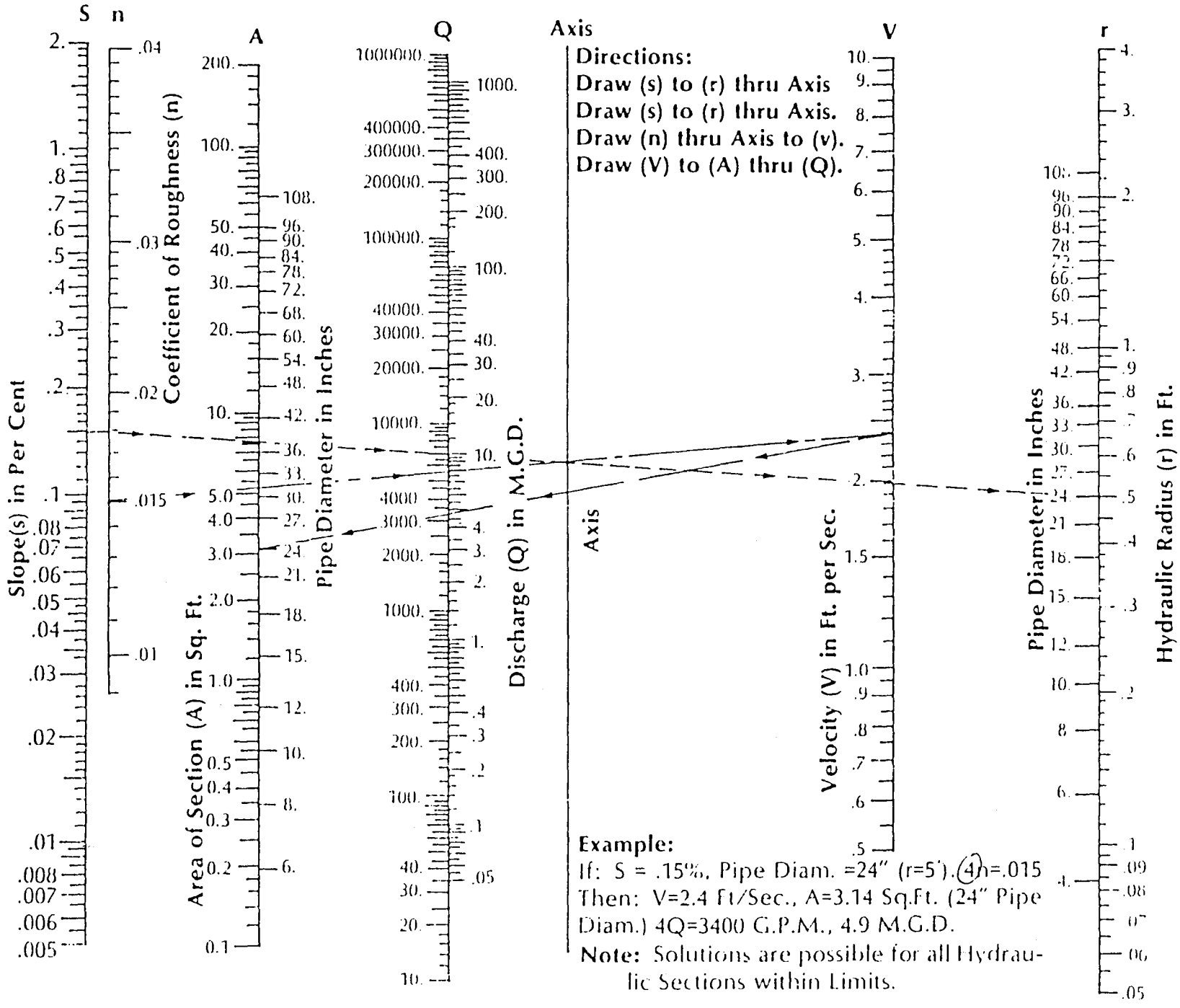
A general map. showing the vicinity of the project, area to be serviced, the location of the proposed sewers (referenced to plans and profiles), site or sites of all water and wastewater plants, wells, streets. parks, drainage areas, lakes, creeks, streams, water mains, and storm sewers, shall be included as part of the engineering drawings.

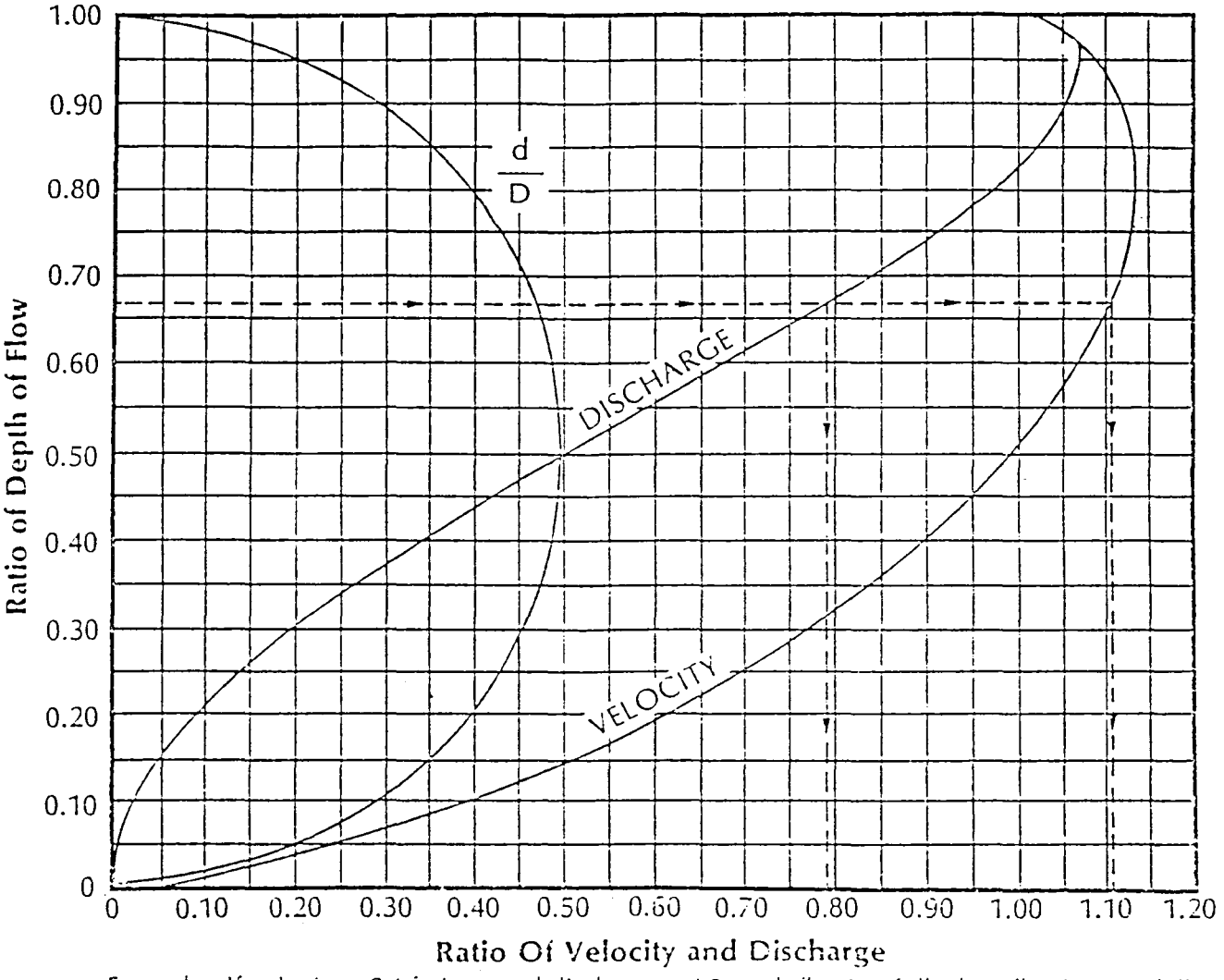
It is recommended that the general map include topographic contours at intervals of 2 feet minimum and 5 feet maximum.

Figure IV-2

Solution of Mannings Formula

$$V=\frac{1.486r^{2/3}}{n}\left(\frac{S}{100}\right)^{1/2} \text{ AND } Q=AV$$





Example: If velocity = 2.4 ft./sec. and discharge = 4.9 mgd. flowing full: then flowing 2/3 full the velocity will be 2.4 x 1.11 = 2.68 ft./sec. and discharge will be 4.9 x 0.79 = 3.79 mgd.

Figure IV-3

Velocity and Discharge for Partially Full Circular Sewers
(Comparison of the filled section to the full section from Manning's Formula)

APACHE JUNCTION-GILBERT WATERSHED PROTECTION AND FLOOD PREVENTION PROJECT

MARICOPA & PINAL COUNTIES, ARIZONA

PLANS FOR THE CONSTRUCTION OF

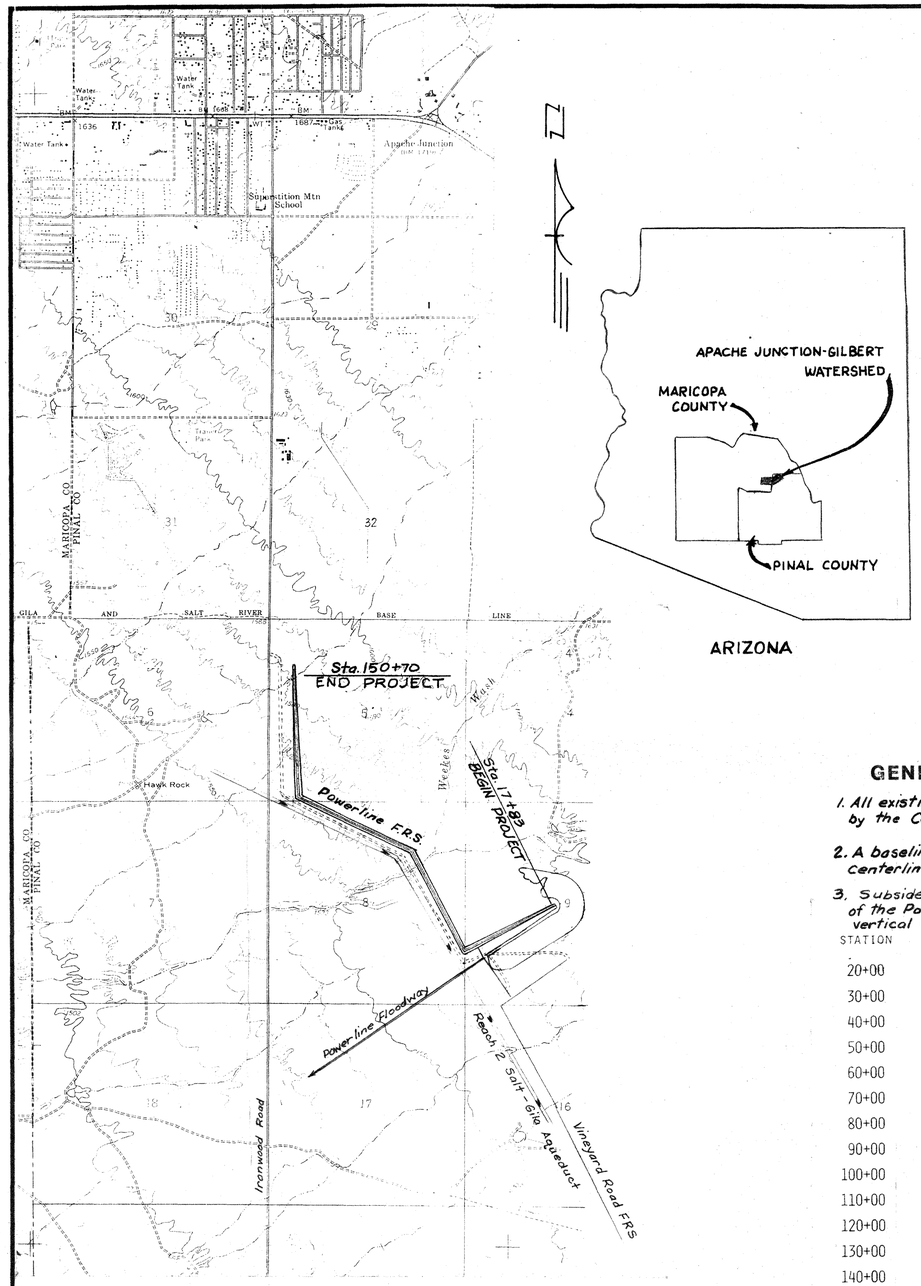
POWERLINE F.R.S. REPAIR

PREPARED FOR

THE FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

BY

U.S. DEPARTMENT OF AGRICULTURE
THE SOIL CONSERVATION SERVICE



LOCATION MAP

ARIZONA

GENERAL NOTES

1. All existing fences and gates are to be maintained by the Contractor in order to control livestock
2. A baseline is established at 500 ft. stations on the centerline of the Powerline F.R.S.
3. Subsidence monuments located approximately 7' left of the Powerline F.R.S. centerline are to be used for vertical control.

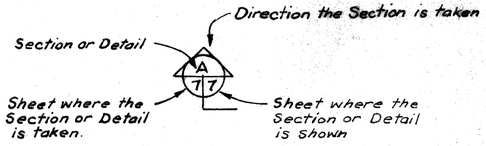
STATION	MONUMENT	ELEVATION
20+00	A 1	1588.89'
30+00	A 2	1588.38'
40+00	A 3	1588.14'
50+00	A 4	1588.13'
60+00	A 5	1588.04'
70+00	A 6	1587.79'
80+00	A 7	1587.35'
90+00	A 8	1586.85'
100+00	A 9	1587.92'
110+00	A 10	1589.50'
120+00	A 11	1588.17'
130+00	A 12	1587.76'
140+00	A 13	1586.59'
145+00	A 14	1586.17'
46+50	BM STAMPED "1570.36" = EL. 1569.89'	
HAWK ROCK	BM "X-473"	EL. 1539.626'

INDEX OF DRAWINGS

1 LOCATION & INDEX OF DRAWINGS
2 PLAN & PROFILE STA.10+00 to STA.80+00
3 PLAN & PROFILE STA.80+00 to STA.150+00
4 CROSS SECTIONS

FLOOD CONTROL DISTRICT RECEIVED FEB 01 '90
CH ENG | P & RM
DEP | PROJ.
ADMIN. | LIMGT.
FINANCE | FILE
C & O
ENGR
REMARKS

PRELIMINARY
FEB 1 1990
SOIL CONSERVATION SERVICE



EAST MARICOPA N.R.C.D.
APPROVED
DATE — CHAIRMAN BOARD OF SUPERVISORS

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
APPROVED
DATE — CHIEF ENGINEER

REVISIONS

LOCATION & INDEX OF DRAWINGS
POWERLINE F.R.S. REPAIR
APACHE JUNCTION-GILBERT W.P.P.
MARICOPA & PINAL COUNTIES, ARIZONA

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

		Date
Designed	TSJ	12-89
Drawn	JEB	12-89
Traced		
Checked	JMH	1-90

Approved by: Ralph M. Cunningham
Title: STATE CONSERVATION ENGINEER
Title: HEAD ENGINEERING STAFF W.N.T.C.
Sheet No. 1 of 4
Drawing No. AZ-90010-CH

SCS-ENG-313C (REV. 6-75)

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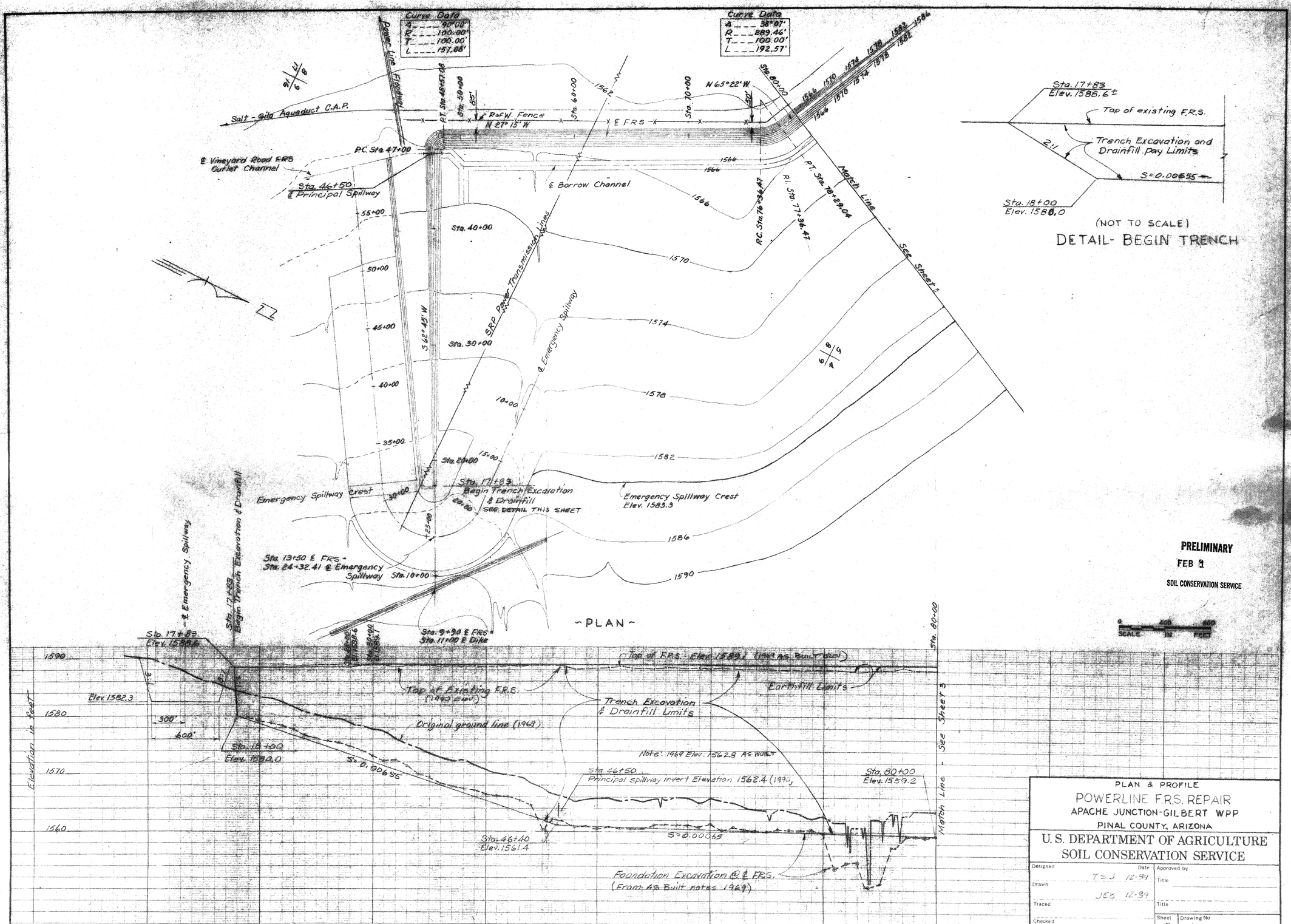


PLAN & PROFILE

POWERLINE F.R.S. REPAIR

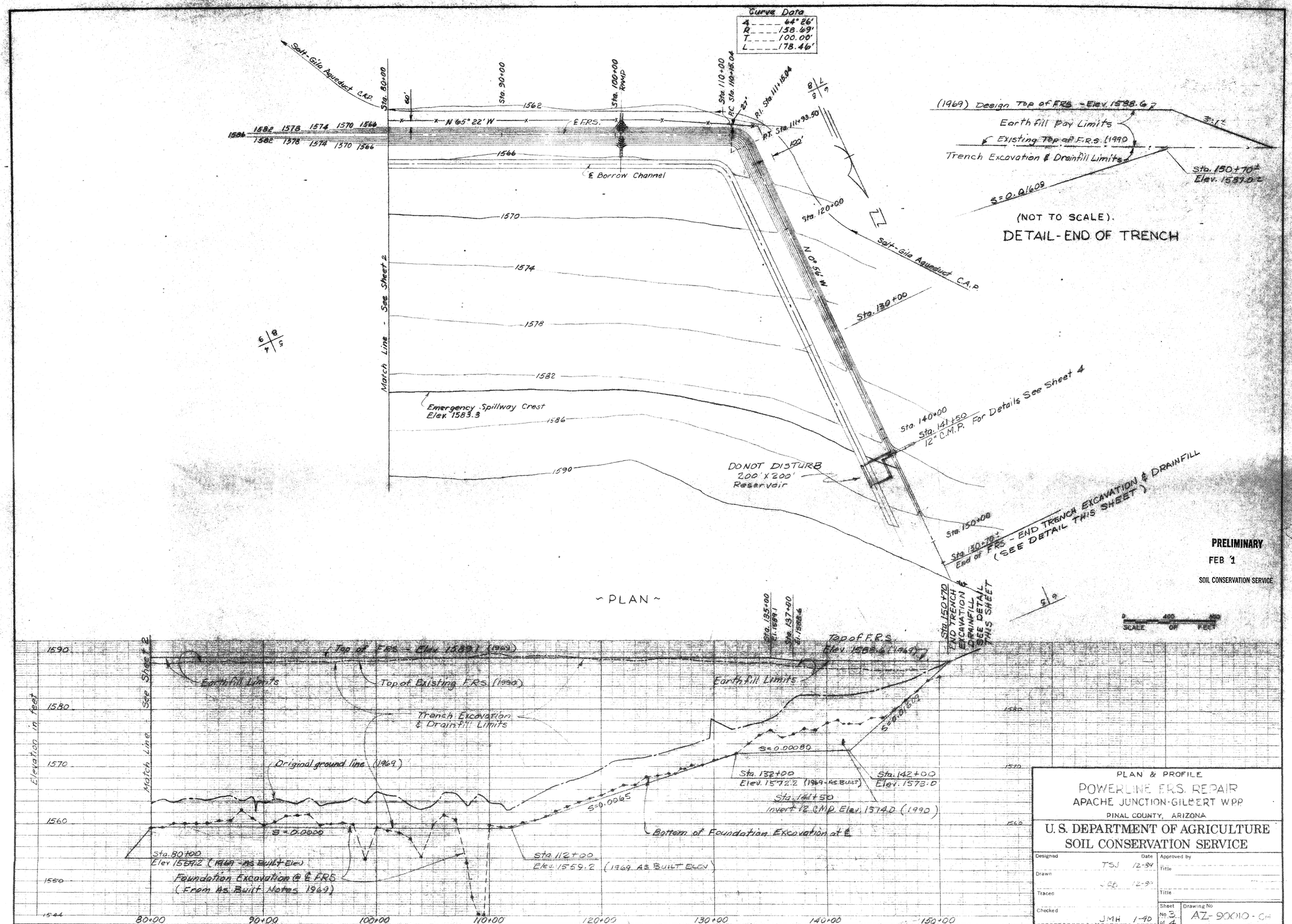
APACHE JUNCTION-GILBERT WPP

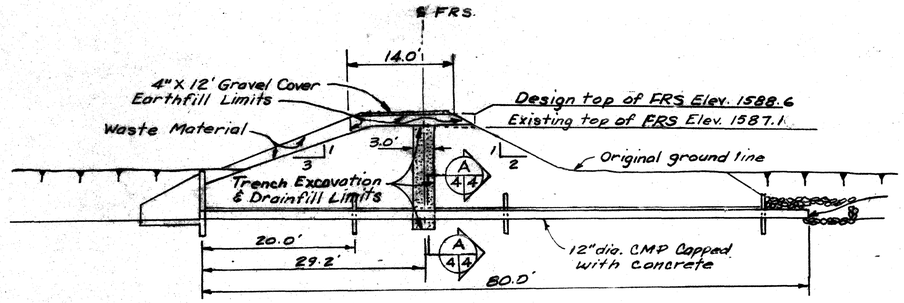
PINAL COUNTY, ARIZONA

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

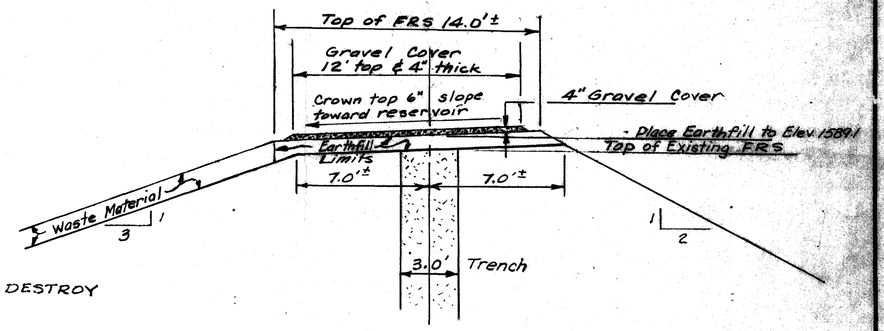
Designed	TSJ 12-89	Approved by	
Drawn	JEB 12-89	Title	
Traced		Title	
Checked	JMH 1-90	Sheet No 2 of 4	Drawing No AZ-90010-CH

U.S. GOVERNMENT PRINTING OFFICE: 1951 O - 999286

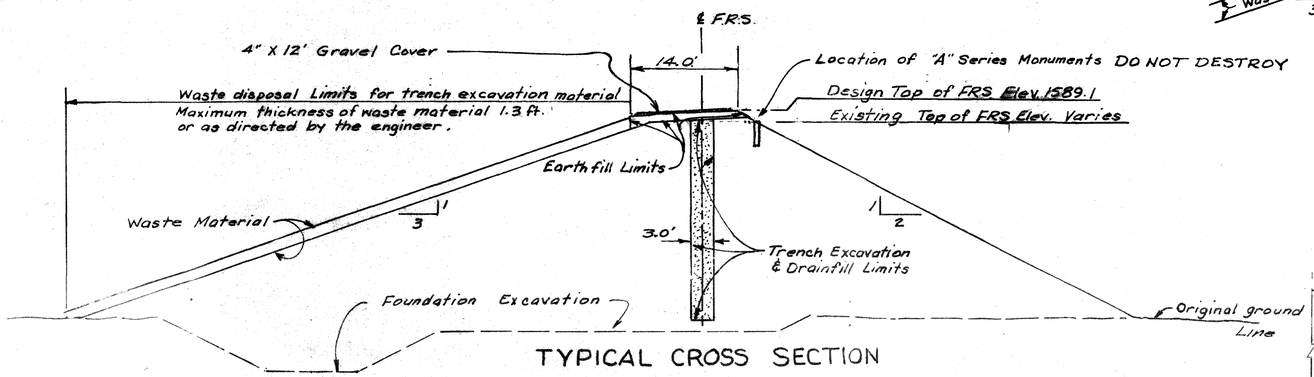

Curve Data
Δ ---- 64° 26'
R ---- 158.69'
T ---- 100.00'
L ---- 178.46'
Salt-Gila Aqueduct C.A.P.
Sta. 80+00
Sta. 90+00
Sta. 100+00 Ramp
Sta. 110+00
P.C. Sta. 110+15.04
P.I. Sta. 111+15.04
P.T. Sta. 111+93.50
N 65° 22' W
℄ F.R.S.
℄ Borrow Channel
Sta. 120+00
Sta. 130+00
N 0° 54' W
Sta. 140+00
Sta. 141+50
12" C.M.P. For Details See Sheet 4
Sta. 150+00
Sta. 150+70±
End of F.R.S. - END TRENCH EXCAVATION & DRAINFILL (SEE DETAIL THIS SHEET)
Emergency Spillway Crest
Elev. 1583.3
DO NOT DISTURB
200' X 200'
Reservoir
Match Line - See Sheet 2
~ PLAN ~
(1969) Design Top of FRS - Elev. 1588.6 ±
Earth fill Pay Limits
Existing Top of F.R.S. (1990)
Trench Excavation & Drainfill Limits
Sta. 150+70±
Elev. 1587.0 ±
S=0.01609
(NOT TO SCALE).
DETAIL - END OF TRENCH
PRELIMINARY
FEB 1
SOIL CONSERVATION SERVICE
SCALE OF FEET
Sta. 135+00
El. 1589.1
Sta. 137+60
El. 1588.6
Sta. 150+70 END TRENCH EXCAVATION & DRAINFILL SEE DETAIL THIS SHEET
Top of F.R.S. (1969)
Top of F.R.S. = Elev. 1589.1 (1969)
Earthfill Limits
Top of Existing F.R.S. (1990)
Trench Excavation & Drainfill Limits
Original ground line (1969)
S=0.0009
S=0.00080
S=0.0065
Sta. 132+00
Elev. 1572.2 (1969 - As Built)
Sta. 142+00
Elev. 1573.0
Sta. 141+50
Invert 12" CMP Elev. 1574.0 (1990)
Bottom of Foundation Excavation at ℄
Sta. 112+00
Elev. 1559.2 (1969 As Built Elev.)
Sta. 80+00
Elev. 1559.2 (1969 - As Built Elev.)
Foundation Excavation @ ℄ FRS
(From As Built Notes 1969)
Elevation in feet
1590
1580
1570
1560
1550
80+00
90+00
100+00
110+00
120+00
130+00
140+00
150+00
PLAN & PROFILE
POWERLINE F.R.S. REPAIR
APACHE JUNCTION-GILBERT WPP
PINAL COUNTY, ARIZONA
U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
Designed TSJ 12-89
Drawn EB 12-89
Traced
Checked JMH 1-90
Approved by
Title
Sheet No. 3 of 4
Drawing No. AZ-90010-CH
Form SCS-318 (November 1955)



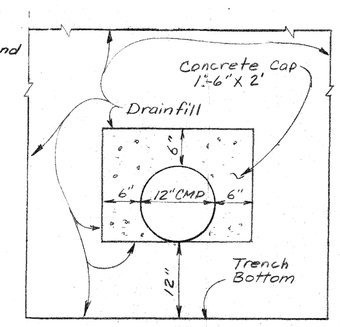
CROSS SECTION AT STA. 141+50



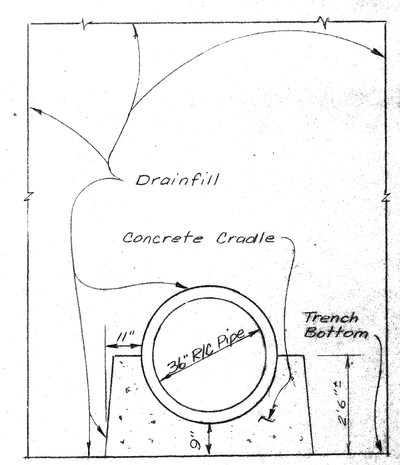
TYPICAL DETAIL TOP OF F.R.S.



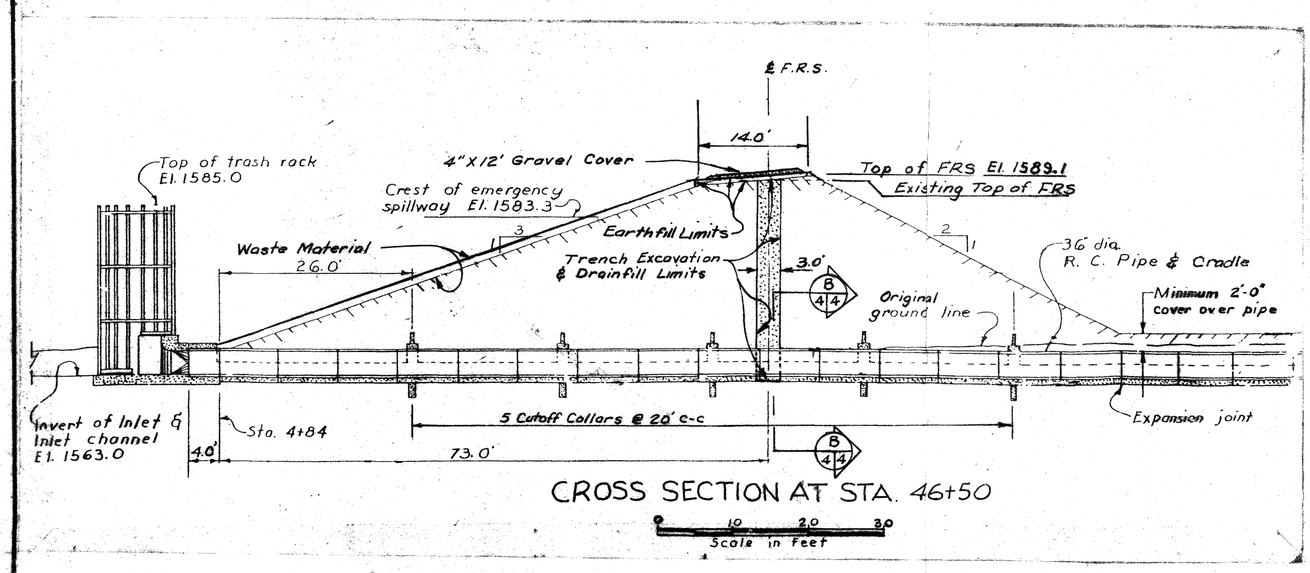
TYPICAL CROSS SECTION



SECTION A/4/4



SECTION B/4/4



CROSS SECTION AT STA. 46+50

PRELIMINARY

FEB '1

SOIL CONSERVATION SERVICE

CROSS SECTIONS
POWERLINE F.R.S. REPAIR
APACHE JUNCTION-GILBERT WPP
PINAL COUNTY, ARIZONA

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

		Date		
Designed	TSJ	12-89	Approved by	
Drawn	JEB	12-89	Title	
Traced			Title	
Checked	JMH	1-90	Sheet No. 4 of 4	Drawing No. AZ-90010-CH

SCS-ENG-235C REV. 5-78

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