DESIGN DATA REPORT

Volume 1

Bullard Wash Channel Improvements - Final Design

Flood Control District of Maricopa County
Contract FCD 98-15

Sverdrup Project No. 013884

October 1998

Sverdrup

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Volume 1

Bullard Wash Channel Improvements - Final Design

Flood Control District of Maricopa County
Contract FCD 98-15

Sverdrup Project No. 013884

Bradford D. Olbert

Registered Professional Engineer (Sanitary)
CERTIFICATE NO.
13955
BRADFORD D.
OLBERT
Date Signed 10/14/98
ARIZONA, U.S.A.

October 1998

Sverdrup

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Bradford D. Olbert

Registered Professional Engineer (Sanitary)
CERTIFICATE NO. 13955
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Date Signed 10/14/98
ARIZONA, U.S.A.

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MARICOPA COUNTY
ARIZONA
1871

MARICOPA COUNTY

Not to Scale

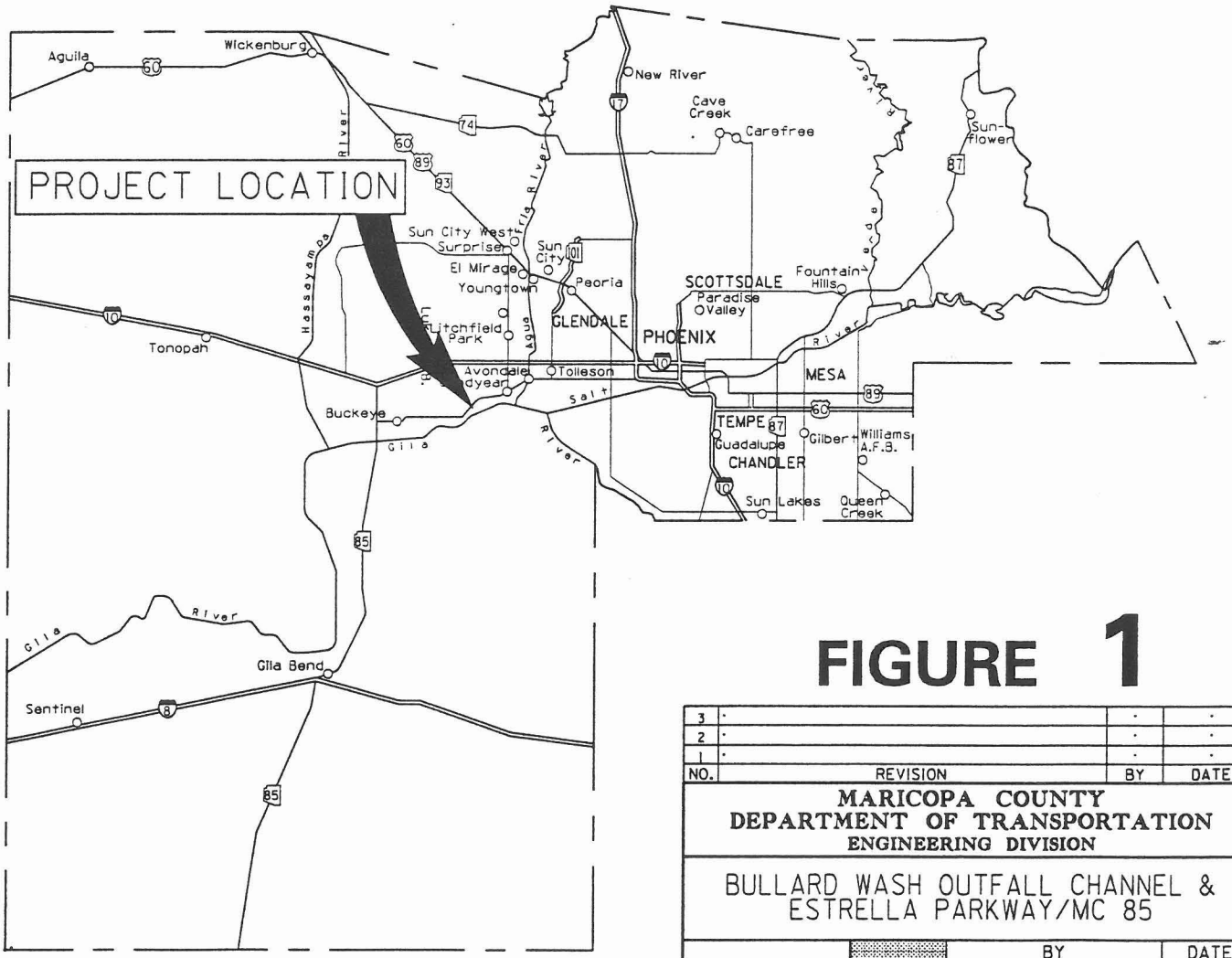


FIGURE 1

NO.	REVISION	BY	DATE
3	.	.	.
2	.	.	.
1	.	.	.

MARICOPA COUNTY
DEPARTMENT OF TRANSPORTATION
ENGINEERING DIVISION

BULLARD WASH OUTFALL CHANNEL & ESTRELLA PARKWAY/MC 85

PRELIMINARY NOT FOR CONSTRUCTION

	BY	DATE
DESIGNED	D. STOUGH	04/18/98
DRAWN	B. EDGAR	04/19/98
CHECKED	B. OLBERT	04/23/98

Sverdrup CORPORATION

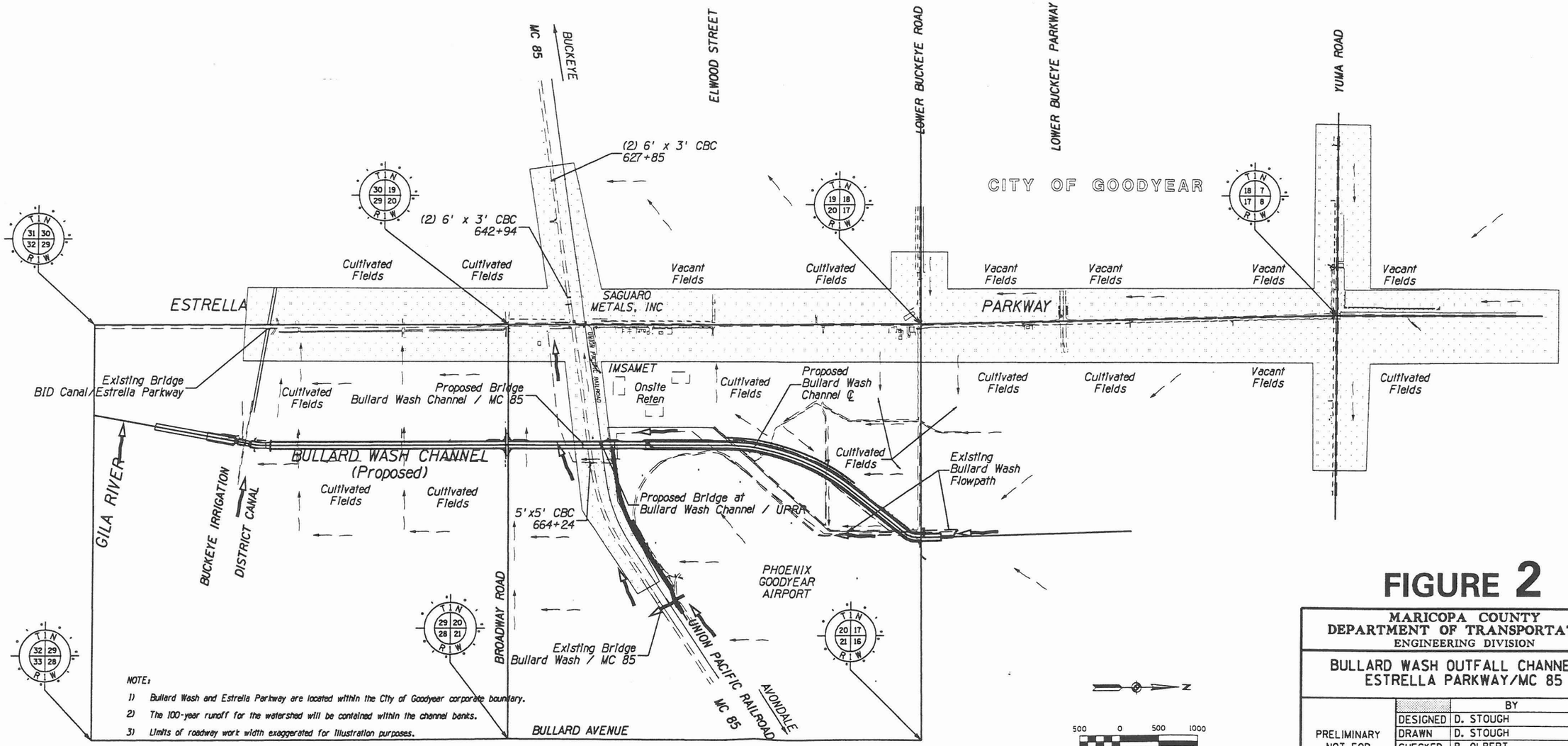
LOCATION MAP

TRACS NO.

F.H.W.A. REGION	STATE	PROJECT NO.	SHEET NO.	TOTAL SHEETS	RECORD DRAWING
9	AZ.	68877/68947			

LEGEND

- LIMITS OF ROADWAY WORK (Note 3)
- OVERLAND FLOW DIRECTION (or minor ditch flows)
- CONCENTRATED FLOW (Greater than 400 cfs)
- EXISTING ROADWAY
- BULLARD WASH EXISTING FLOWPATH
- PROPOSED BULLARD WASH CHANNEL ALIGNMENT
- SECTION CORNER (Township, Range, & Section Numbers)



NOTE:

1) Bullard Wash and Estrella Parkway are located within the City of Goodyear corporate boundary.
2) The 100-year runoff for the watershed will be contained within the channel banks.
3) Limits of roadway work width exaggerated for illustration purposes.

FIGURE 2

MARICOPA COUNTY
DEPARTMENT OF TRANSPORTATION
ENGINEERING DIVISION

BULLARD WASH OUTFALL CHANNEL & ESTRELLA PARKWAY/MC 85

PRELIMINARY NOT FOR CONSTRUCTION

	BY	DATE
DESIGNED	D. STOUGH	04/19/98
DRAWN	D. STOUGH	04/19/98
CHECKED	B. OLBERT	04/20/98

Sverdrup CORPORATION

VICINITY MAP AND EXISTING FLOW PATTERNS

SHEET 1 OF 1

TRACS NO.

b.dgn 12/6/93

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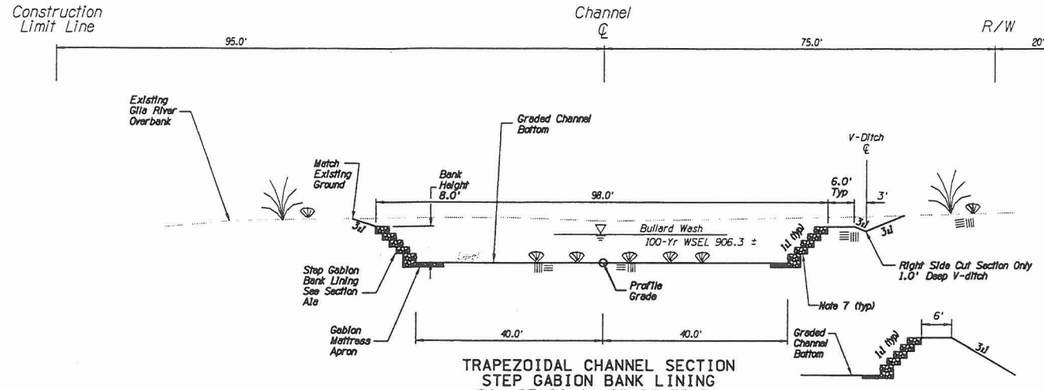
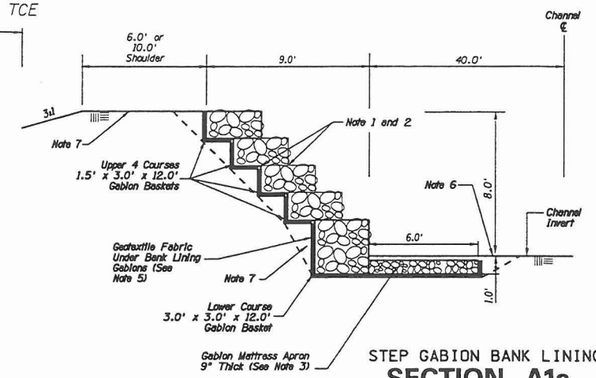


TRAPEZOIDAL CHANNEL SECTION
STEP GABION BANK LINING
Sta 25+00 to 28+60.56 Rt
Sta 25+00 to 26+55.80 Lt

SECTION A1

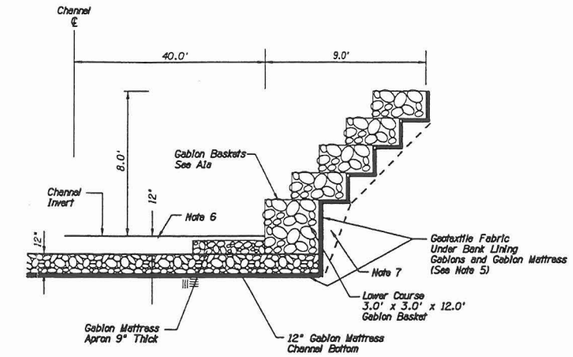
N.T.S.

RIGHT SIDE FILL CONDITION
Sta 28+20 ± to 28+60±



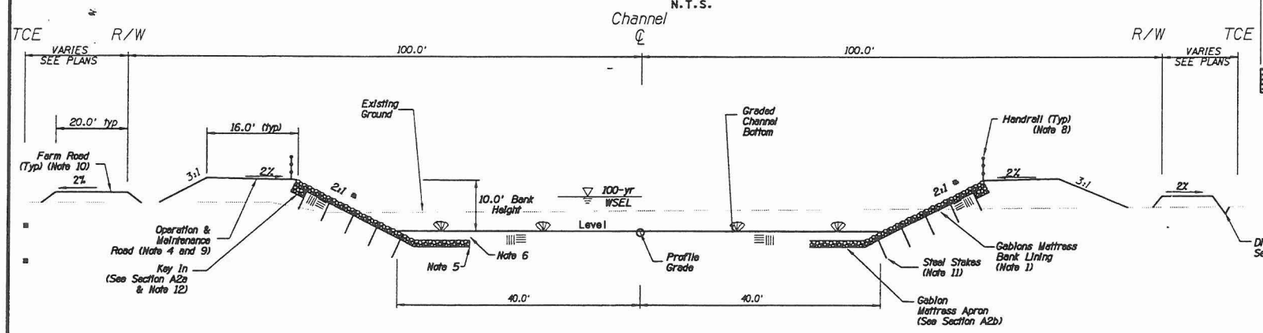
STEP GABION BANK LINING

SECTION A1a



Sta 28+35.56 to 28+60.56 Rt.
GABION MATTRESS CHANNEL BOTTOM

SECTION A1b

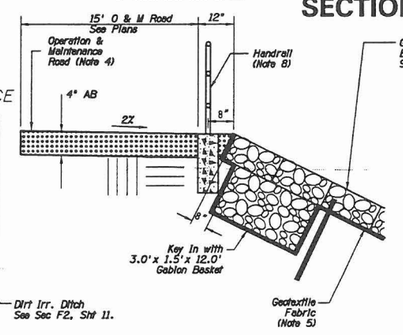


Transition bank slope from 1.5:1 (Sta 33+28± Rt) to 2:1 (Sta 33+80 Rt), and 1.5:1 (Sta 33+35± Lt) to 2:1 (Sta 33+80 Lt)

TRAPEZOIDAL CHANNEL SECTION
GABION MATTRESS BANK LINING
Sta 33+30±to 58+50

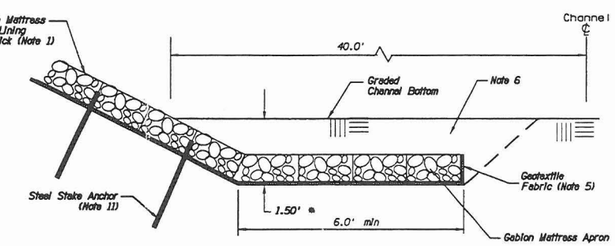
SECTION A2

N.T.S.



FOR SECTIONS A2 & A3

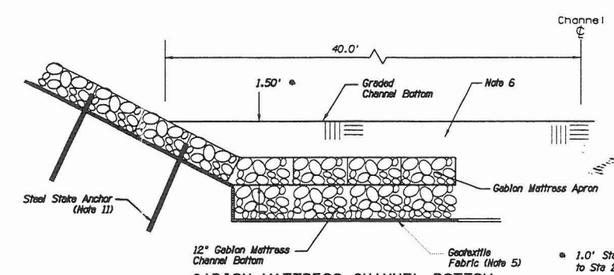
SECTION A2a



FOR SECTIONS A2, A3, C1 & C2

SECTION A2b

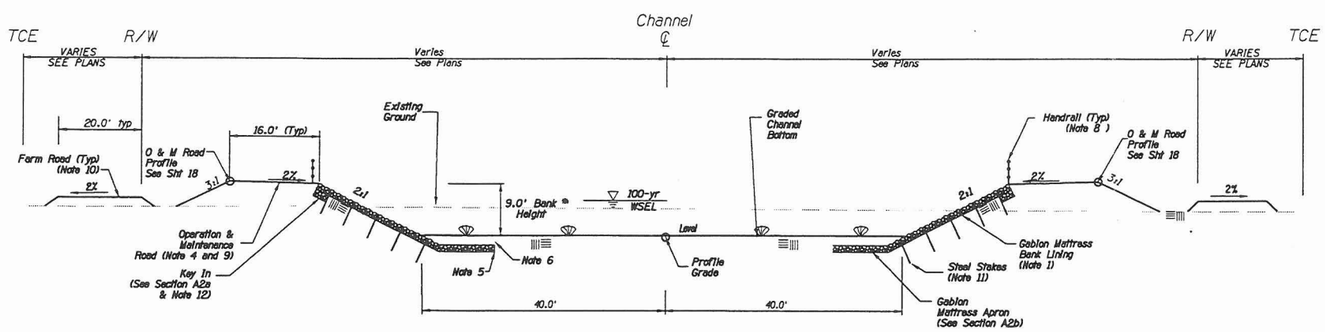
▲ 1.0' Sta 26+55.80 to Sta 28+60.56



▲ 1.0' Sta 28+35.56 to Sta 28+60.56

GABION MATTRESS CHANNEL BOTTOM
Sta 28+35 to 28+60± Lt
Sta 62+71 to 63+01
Sta 72+17 to 72+47

SECTION A2c



Bank Height Transitions from 10.0' to 9.0' Sta 58+50 to 59+00 See Sht 18

TRAPEZOIDAL CHANNEL SECTION
GABION MATTRESS BANK LINING
Sta 58+50 to 72+47

SECTION A3

N.T.S.

NOTES:

1) Connect edges of gabions to adjacent baskets/mattress.
2) Gabion baskets stacked with 50-percent overlap, filled with rounded river rock D50=6.0 inches.
3) Both edges of gabion mattress apron attached to bottom course gabion basket (Section A1a & A1b only). Apron filled with rounded river rock D50=4.5 inches, over geotextile fabric.
4) Install 4" thick AB to All operation and maintenance roads. Compact AB to 95%
5) Geotextile fabric to be installed under all gabion baskets, gabion mattress bank lining and aprons. See special provisions for burst strength, permeability, and pore opening size.
6) Overexcavate to base of apron or gabion basket. Backfill over gabion mattress apron to channel invert, compact to 85%
7) Backfill behind each course of gabion baskets and compact to 95%. Compact channel bank fill to 95%.
8) Install handrail 8" behind slope mattress gabions unless shown otherwise on plans. (See Detail 9 Sheet 57)
9) Compact ground to 95% behind slope mattress gabions. Compact berm and O&M road to 95%.
10) Construct 20' wide farm road with inside edge at R/W unless shown otherwise on plans See Detail H3, Sheet 12. Compact to 85 %
11) Steel stake anchors are 1" nominal diameter 4-foot long, galvanized steel pipe. (See Detail 5g, Sheet 53)
12) Install counterfort at junction of slope mattress gabion bank lining with concrete bank lining. (See Details 5b and 5c, Sheet 53)

NO.	REVISION	BY	DATE
3	-	-	-
2	-	-	-
1	-	-	-

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
ENGINEERING DIVISION

BULLARD WASH
CHANNEL IMPROVEMENTS PROJECT
PROJECT NO. 4700731

PRELIMINARY NOT FOR CONSTRUCTION

	BY	DATE
DESIGNED	D. STOUGH	8/25/98
DRAWN	B. EDGAR	9/08/98
CHECKED	R. MILES/B. OLBERT	9/08/98

Sverdrup CORPORATION

CHANNEL TYPICAL SECTIONS
A1, A2, A3 (GABION BANK LINING)

SHEET 7 OF 81

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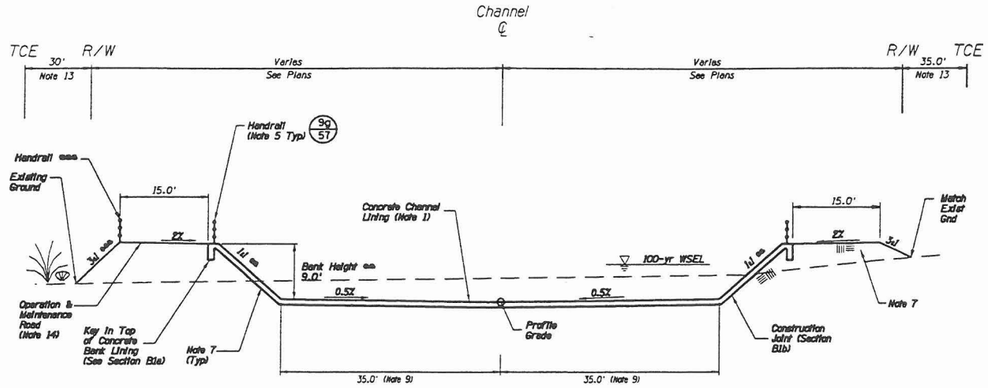
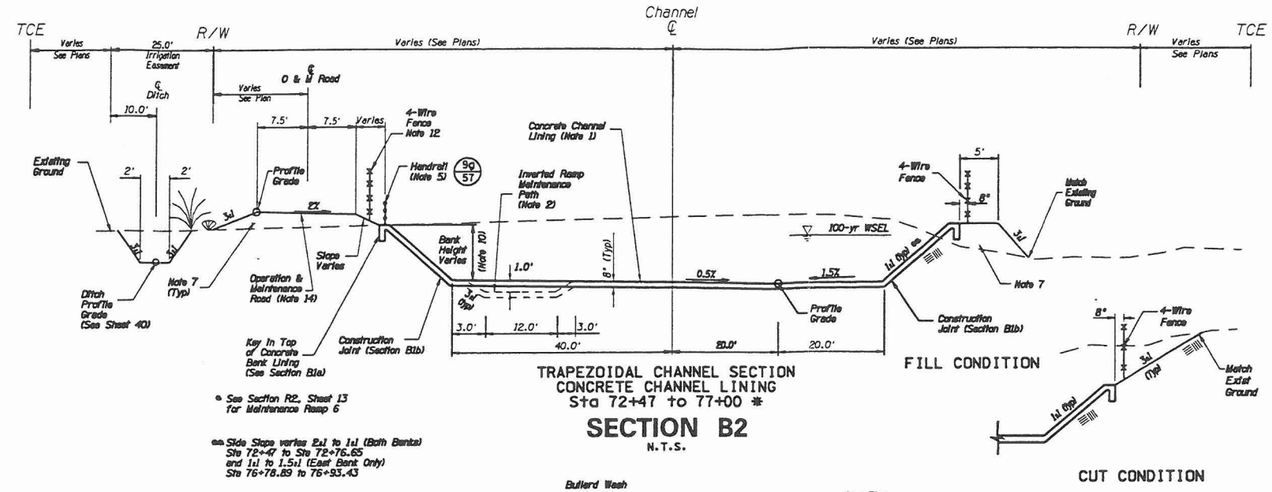


- See Section R2, Sheet 13 for Maintenance ramps 2 & 3
- Sideslope vary 1:1 to 1 1/2:1 and bank height varies 9.0' to 10' Sta 32+65 to 33+34 Lt and Sta 32+65 to 33+28 Rt
- Backslope varies 3:1 to 2:1 Sta 33+00 to 33+34 Lt and 2:1 to 3:1 Sta 33+34 to 33+80 Lt See Plans for location. set Handrail at Lt Edge of O & M road

TRAPEZOIDAL CHANNEL SECTION
CONCRETE CHANNEL LINING
Sta 30+88.94 to 33+30± *

SECTION B1

N.T.S.



- See Section R2, Sheet 13 for Maintenance Ramp 6

Side Slope varies 2:1 to 1:1 (Both Banks) Sta 72+47 to Sta 72+76.65 and 1:1 to 1.5:1 (East Bank Only) Sta 76+78.89 to 76+93.43

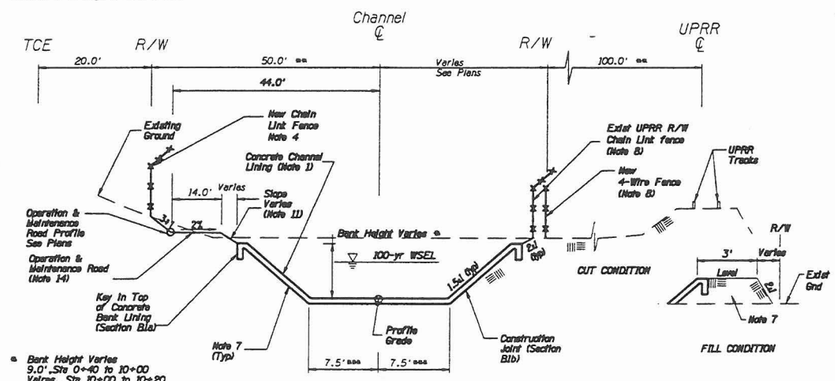
TRAPEZOIDAL CHANNEL SECTION
CONCRETE CHANNEL LINING
Sta 72+47 to 77+00 *

SECTION B2

N.T.S.

FILL CONDITION

CUT CONDITION

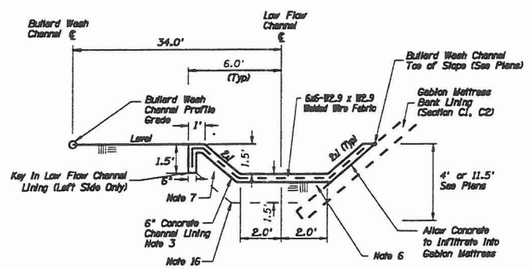


- Bank Height Varies 9.0'.Sta 0+40 to 10+00 Varies. Sta 10+00 to 10+20 7.0', Sta 10+20 to 21+62.73 varies, Sta 21+63.73 to 21+90.22
- Distances Vary Sta 19+53 to 23+00 See Plans
- Distances and Cross-Slope Varies Sta 21+62.73 to 21+90± See Plans

TRAPEZOIDAL CHANNEL SECTION
CONCRETE CHANNEL LINING
East Tributary Channel
Sta 0+43± to 21+90

SECTION B3

N.T.S.



CONCRETE LOW FLOW CHANNEL

SECTION B4

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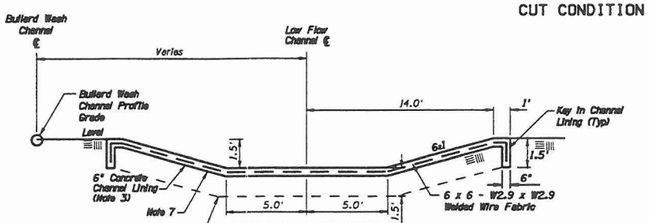
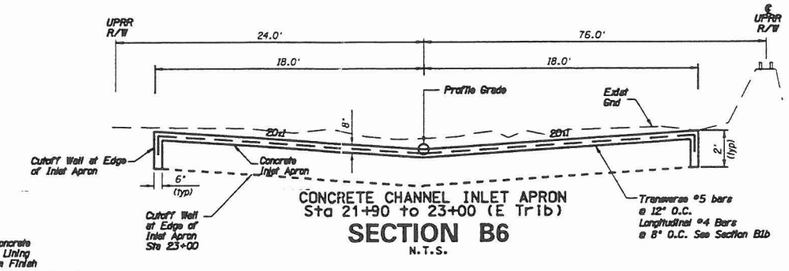


LOW FLOW CHANNEL
DIP CROSSING

SECTION B5

N.T.S.



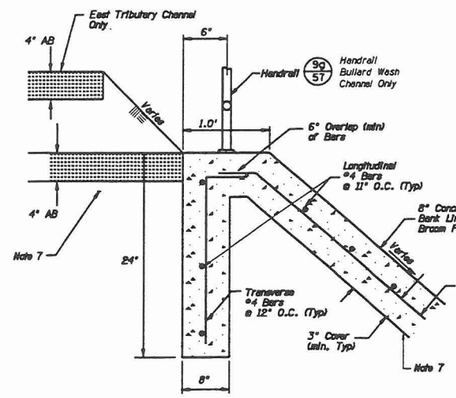
CONCRETE CHANNEL INLET APRON
Sta 21+90 to 23+00 (E Trib)

SECTION B6

N.T.S.

NOTES

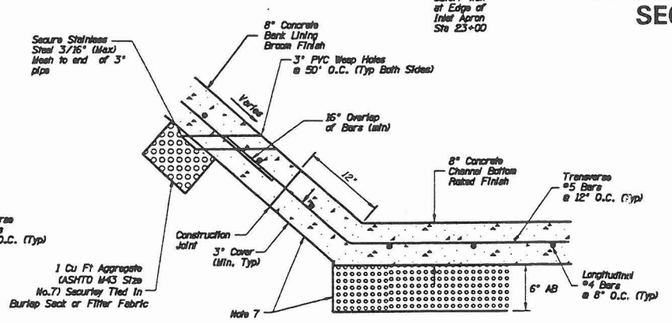
1) Channel bottom shall be roughened with raked finish, and sideslopes with heavy broom finish.
2) Maintenance path is lowered beneath channel bottom only under new UPRR bridge. Station Limits are 75+09 to 75+59, 31.00' Lt See Section J2, Sht 13 and Sht 20 for location.
3) Channel bottom and sideslopes shall have heavy broom finish.
4) Chain link fence (MAG Std 160) is to be installed along airport R/W. See Plans for Location.
5) Install handrail on top of channel bank lining. See Detail 9g, Sht57, Sht55, & Plans for Location.
6) Backfill over gabions and compact to 85%. Compact base under low flow channel to 95%.
7) Compact subgrade under concrete lining, bank fill, and O & M road to 95%. Compact AB to 95%.
8) Remove chain link fence and replace with 4-wire fence @ R/W Line Sta 0+40 to 19+53. See special provisions. Remove chain link fence Sta 19+53 to 23+50.
9) Half Width Varies 35' to 40' Sta 32+66.30 to 33+30±. See detail 1 sht 49 for channel bottom elevations and transition.
10) Bank Height reduces to 7.5' under MC 85 bridge and to 6.0' under UPRR bridge. See Typ Sec J1 and J2 Sht 13.
11) Cover Sideslope with gravel mulch on sideslope 2:1 or steeper.
12) 4-Wire fence installed on top of channel bank. See sht 55 and plans for locations.
13) See plans for location of farm roads and irrigation dirt ditch within TCE. See Section H3, Sht 12.
14) Install 4" thick AB to all operation & maintenance roads. Compact AB to 95%.
15) Construct cutoff wall at Sta 81+50 6" thick x 18" deep across entire dip crossing.
16) Construct cutoff wall at 500 foot intervals starting at Sta 83+00, 6" thick x 18" deep across entire dip crossing.



TYPICAL KEY-IN

SECTION B1a

N.T.S.



CONSTRUCTION JOINT

SECTION B1b

N.T.S.

NO.	REVISION	BY	DATE
3			
2			
1			

FLOOD CONTROL DISTRICT
OF MARICOPA COUNTY
ENGINEERING DIVISION

BULLARD WASH
CHANNEL IMPROVEMENTS PROJECT
PROJECT NO. 4700731

PRELIMINARY
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DESIGNED	D. STOUGH	8/25/98
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CHECKED	R. MILES/B. OLBERT	9/08/98

Sverdrup
CORPORATION

CHANNEL TYPICAL SECTIONS
B1, B2, B3, B4, B5, and B6

SHEET 8 OF 81

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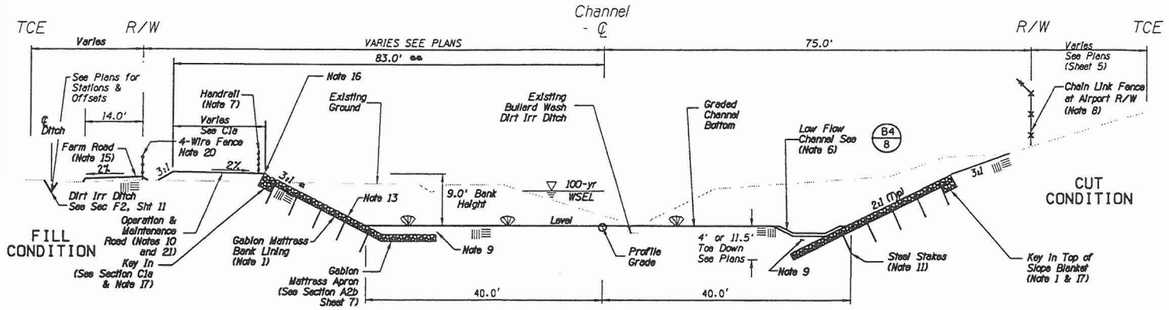
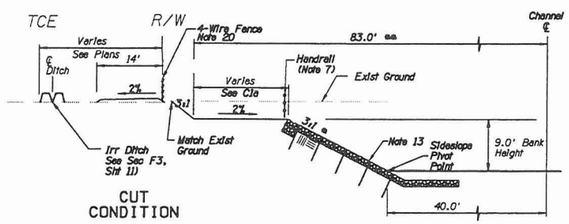


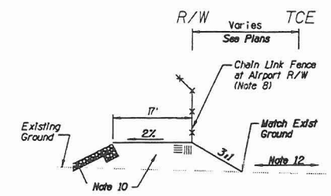


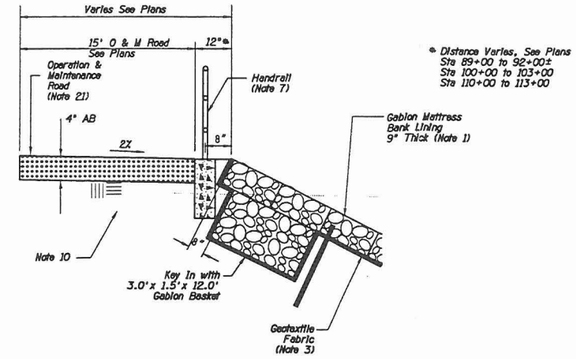
GABION MATTRESS BANK LINING
Sta 81+01 to 117+35

SECTION C1

N.T.S.

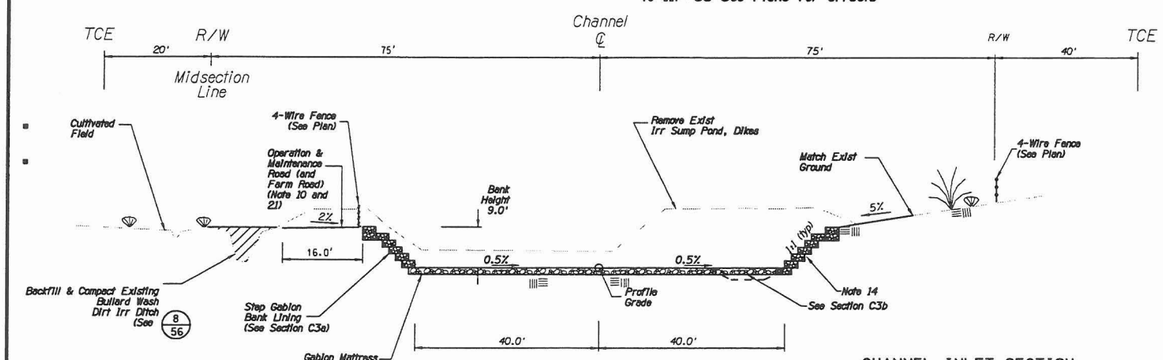
- Sideslopes Vary Sta 89+00 to 93+71.91
  Sta 100+00 to 103+00
  Sta 110+00 to 113+00
  Sta 115+50 to 117+35
- Dimension Varies
  Sta 90+79.92 to 93+71.91 & Sta 115+00 to 117+35 See Plans for offsets





FOR SECTION C1 & C2

SECTION C1a



CHANNEL INLET SECTION
STEP GABION BANK LINING
Sta 119+43 to 121+95

SECTION C3

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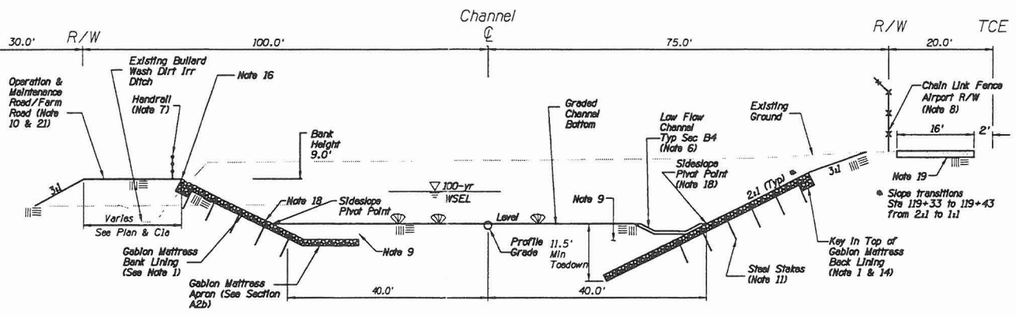


Sta 117+35 to 119+43 (Typical)

SECTION C2

N.T.S.

NOTES

1) Riprap Filled, Gabion Mattress Bank Lining with, 9" x 6' x 12' basket size. Key in top of slope mattress gabions with 3.0' x 1.5' x 12' gabion baskets; filled w/rounded river rock See Specifications.

2) All edges of gabions are connected to adjacent gabion baskets.

3) Geotextile fabric to be installed under all slope mattress gabions and aprons. Fabric shall be installed behind and under step gabion baskets See special provisions for burst strength, permeability and burst strength.

4) Banks lined with riprap filled gabion baskets, stacked with 50-percent overlap, 18" x 36" x 12' basket size (except upper course), on geotextile fabric. (See Sec C3a)

5) Channel bottom lined with 2 layers of 9" x 6' x 12' gabion mattress; filled w/rounded river rock D =4.5 inches

6) Low flow channel lined with, 6-inch thick concrete. See Sec B4, Sht 8.

7) Handrail will be installed 8" behind channel lining left bank only. See Detail 9 sht 57 and Detail 7c sht 55 for locations.

8) Chain link fence (MAG Std 160) is to be installed along airport R/W only. Barbed wire top angled away from airport. See Detail 7c sht 55 for locations.

9) Overexcavate to base of apron, gabion mattress or gabion basket. Backfill over apron to channel invert, compact to 85%. Compact base under low flow channel to 95%

10) Backfill behind each course of gabion baskets, compact to 95%. Compact O & M road subgrade to 95%. Compact Embankments to 95%

11) Steel stakes are 1-inch outer diameter, 4-foot long, galvanized steel pipe. See Detail 5g.

12) Stockpile locations on Airport property to be arranged by Contractor. Contact Shawn Arena, with Phoenix Goodyear Airport.

13) Section C1 includes transitions which vary from 2:1 to 3:1 sideslopes, see plan for locations.

14) Install counterfort Sta 119+43 (Lt & Rt) See Detail 5a, sht 53.

15) Construct Farm Road Sta 91+10 to 117+40 only.

16) Area between O & M Road and gabions varies in width (see section C1 & C2).

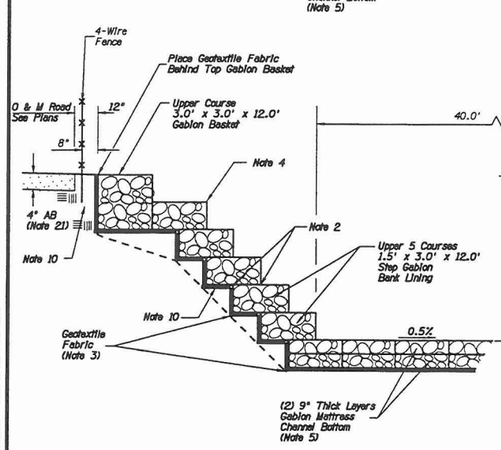
17) Install counterforts at Sta 81+01 Lt & Rt, See Detail 5c, Sht 53.

18) Section C2 includes sideslope transitions which vary from 2:1 to 1:1 Sta 119+33 to 119+43 (See Plans).

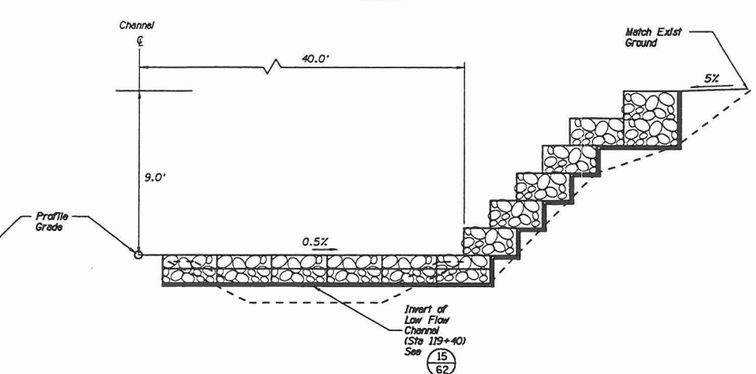
19) Construct new 4" AB, 16' wide airport perimeter road Sta 116+68 to 119+16± Compact AB and subgrade to 95%.

20) Install 4-wire fence, sta 90+95± to 119+33.

21) Install 4" thick AB over all operation & maintenance roads. Compact AB to 95%



SECTION C3a



SECTION C3b

NO.	REVISION	BY	DATE
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FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
ENGINEERING DIVISION

BULLARD WASH
CHANNEL IMPROVEMENTS PROJECT
PROJECT NO. 4700731

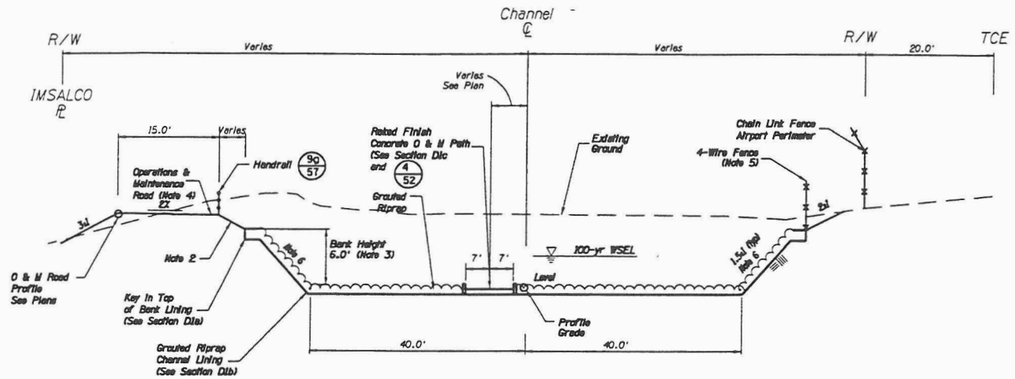
		BY	DATE
PRELIMINARY NOT FOR CONSTRUCTION	DESIGNED	D. STOUGH	8/25/98
	DRAWN	B. EDGAR	9/08/98
	CHECKED	R. MILES/B. OLBERT	9/08/98

Sverdrup CORPORATION

CHANNEL TYPICAL SECTIONS
C1, C2 and C3

SHEET 9 OF 81

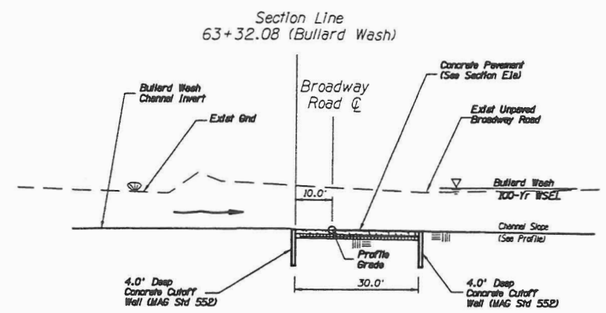
Filename: p:\01384\4700\01\00xxx04\02civil\4702dcp\M63941\s3.dgn
Plotted By: edgarbe Date: 08-SEP-1998 13:57



TRAPEZOIDAL CHANNEL SECTION
GROUTED RIPRAP LINING
Sta 77+00 to 81+00

SECTION D1

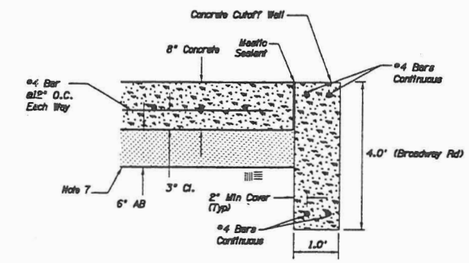
N.T.S.



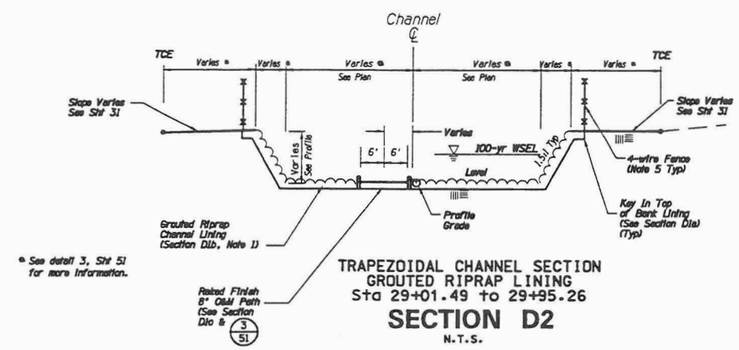
CONCRETE FORD CROSSING
Sta 41+65 to 43+25 Broadway Road

SECTION E1

N.T.S.



SECTION E1a

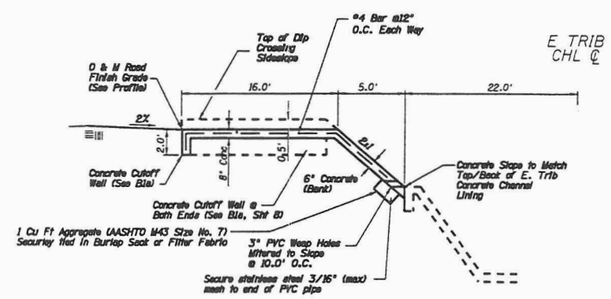


* See detail 3, Sht 51 for more information.

TRAPEZOIDAL CHANNEL SECTION
GROUTED RIPRAP LINING
Sta 29+01.49 to 29+95.26

SECTION D2

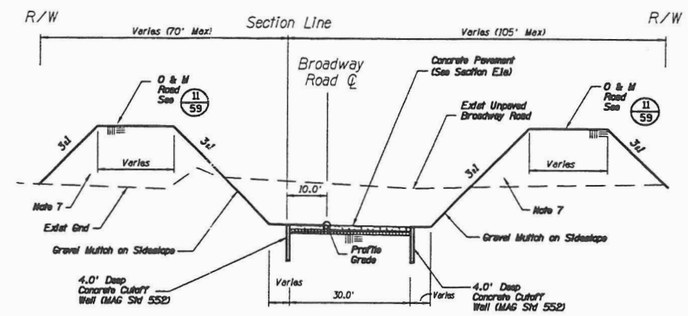
N.T.S.



EAST TRIBUTARY CHANNEL
CONCRETE O & M ROAD DIP CROSSING
Sta 6+40 to 7+20 (East Tributary)

SECTION E4

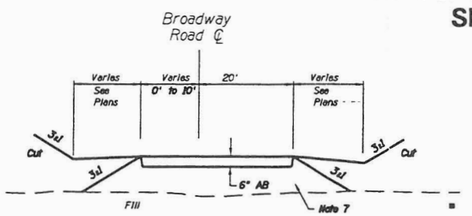
N.T.S.



CONCRETE FORD CROSSING w/SIDESLOPES
Sta 41+01 to 41+65± and
Sta 43+25 to 43+81 Broadway Road

SECTION E2

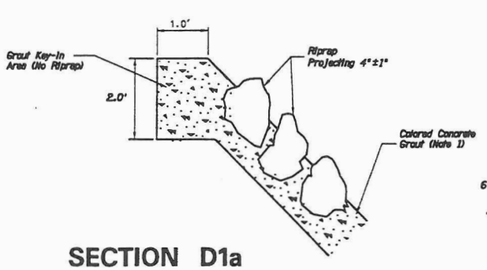
N.T.S.



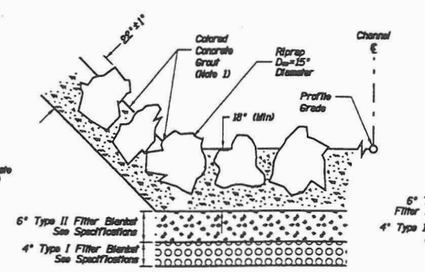
Sta 39+10 to 41+01
Sta 43+81 to 45+54

SECTION E3

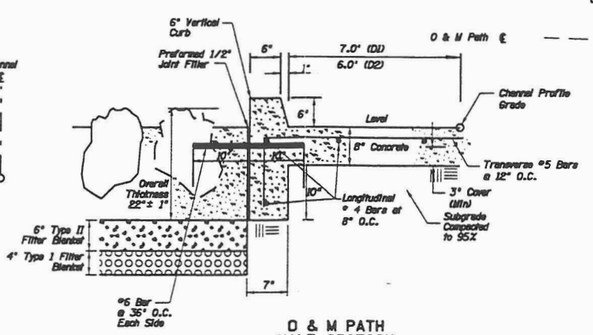
N.T.S.



SECTION D1a



SECTION D1b



O & M PATH
HALF SECTION

SECTION D1c

NOTES

1) Colored grout. See special provisions.
2) Gravel Mulch on Sideslopes 2:1 or Steeper
3) Bank Height Varies 9' to 6' Sta 77+00 to 77+70± and 6' to 9' Sta 80+80 to 81+00
4) See stations and offsets on sheet 20 for location of O & M path.
5) Install 4-wire fence 8' behind key-in of grouted riprap lining, unless shown otherwise on plans
6) Sideslope transitions (Left side)
from 1.27:1 to 1.68:1, Sta 77+00 to Sta 77+48.31 Lt
and from 1.68:1 to 1.5:1, Sta 77+48.31 to Sta 77+71.64 Lt.
Sideslope transition (Right Side)
from 1.5:1 to 2:1 Sta 80+80 to 81+00 Rt.
Sideslope transition (Left Side)
1.5:1 to 3:1, Sta 80+80 to 81+00 Lt.
7) Compact embankments, O & M roads, and Broadway Road to 95%

NO.	REVISION	BY	DATE
1			
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FLOOD CONTROL DISTRICT
OF MARICOPA COUNTY
ENGINEERING DIVISION

BULLARD WASH
CHANNEL IMPROVEMENTS PROJECT
PROJECT NO. 4700731

PRELIMINARY NOT FOR CONSTRUCTION		BY	DATE
	DESIGNED	D. STOUGH	8/25/98
	DRAWN	B. EDGAR	9/08/98
	CHECKED	R. MILES/B. OLBERT	9/08/98

Swerdrup CORPORATION

CHANNEL TYPICAL SECTIONS
D1, D2, E1, E2 and E3

SHEET 10 OF 81

Filename: p:\01384\02000\100xxx\01\02\civil\01\02dgn\8391\1s4.dgn
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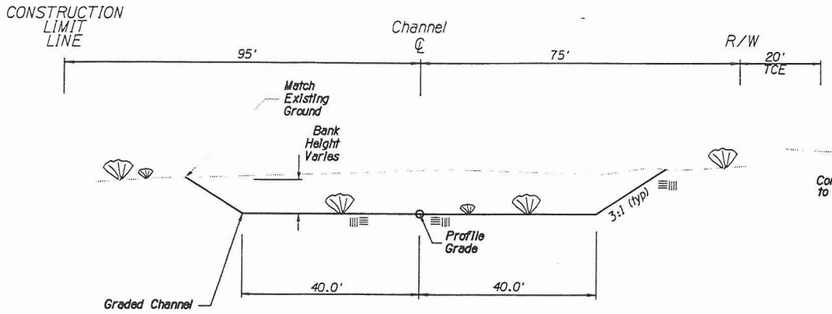
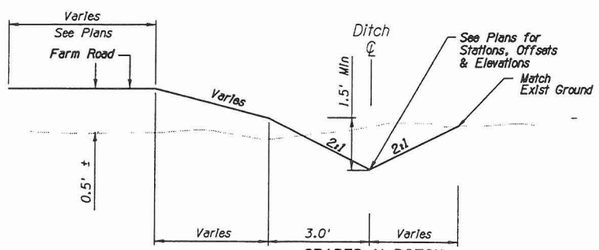


GRADED CHANNEL SECTION
(UNLINED CHANNEL)
Sta 18+12± to 24+00

SECTION F1

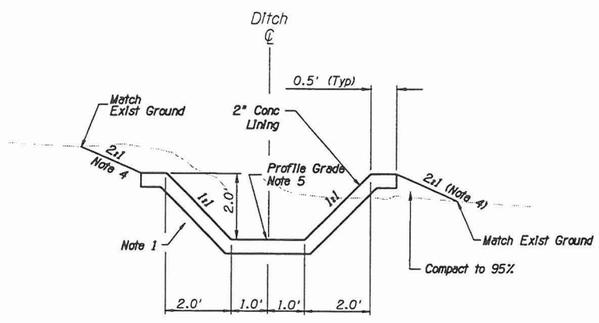
N.T.S.



GRADED V-DITCH

SECTION F2

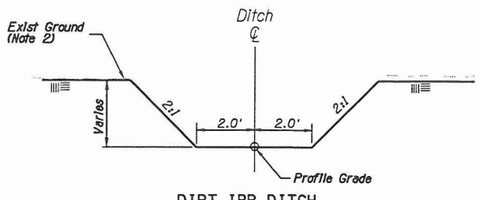
N.T.S.



CONCRETE LINED DITCH

SECTION F3

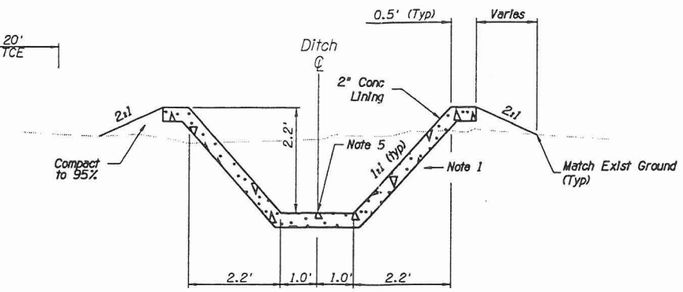
N.T.S.



DIRT IRR DITCH
Sta 123+55± Lt to 124+15 Lt
Sta 70+80± LT to 71+57.50 Lt
Sta 74+23.24 to 74+78.23 Lt

SECTION F4

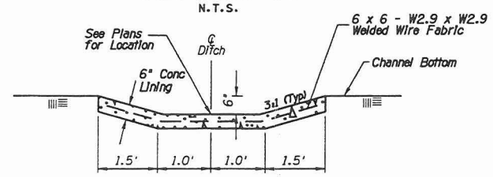
N.T.S.



DEEP CONCRETE LINED DITCH

SECTION F5

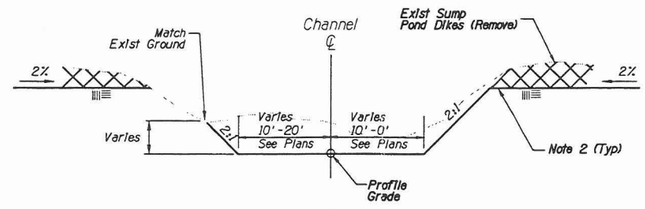
N.T.S.



SHALLOW CONCRETE LINED DITCH
Sta 103+51 and 107+50

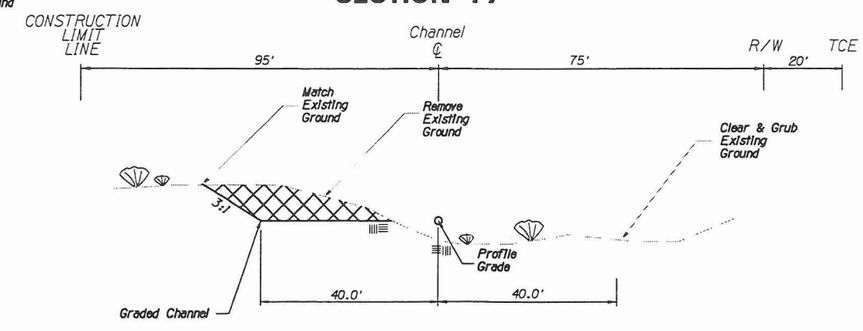
SECTION F6

N.T.S.



DIRT INLET CHANNEL
Sta 123+45 to 123+90±

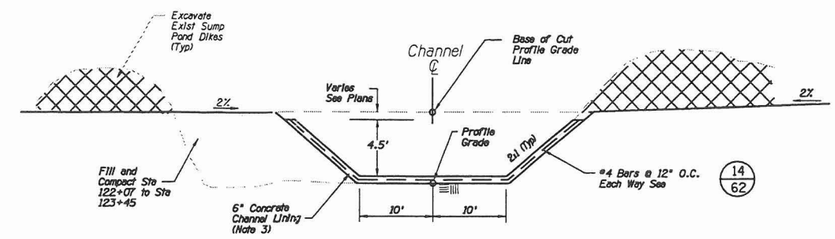
SECTION F7



GRADED CHANNEL SECTION
(UNLINED CHANNEL)
Sta 24+00 to 25+00

SECTION F8

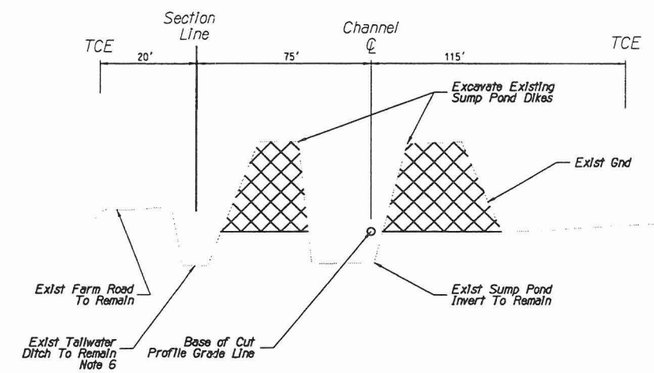
N.T.S.



CONCRETE INLET CHANNEL
Sta 122+07 to 123+45

SECTION G1

N.T.S.



DIKE REMOVAL
BULLARD WASH
Sta 123+90± to 132+61.25

SECTION G2

N.T.S.

14
62

Notes

1) Compact soil under O & M road or concrete channel/ditch lining to 95%.

2) Section F4 and F7 Top of slope is existing ground or base of cut profile grade line elevation (See Typ Sec G2).

3) Channel bottom shall have broom finish Portland cement concrete cast in place 6" thick.

4) Sideslope varies (2:1 max) when adjacent farm road.

5) For ditch grades see plans for stations offsets, and elevations

6) Maintain ditch in operation condition. Keep soil from falling into ditch.

NO.	REVISION	BY	DATE
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FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
ENGINEERING DIVISION

BULLARD WASH
CHANNEL IMPROVEMENTS PROJECT
PROJECT NO. 4700731

PRELIMINARY NOT FOR CONSTRUCTION

	BY	DATE
DESIGNED	D. STOUGH	8/25/98
DRAWN	B. EDGAR	9/08/98
CHECKED	R. MILES/B. OLBERT	9/08/98

Sverdrup CORPORATION

CHANNEL TYPICAL SECTIONS
F1, F2, F3, F4, F5, F6, F7, F8, G1, and G2

SHEET 11 OF 81

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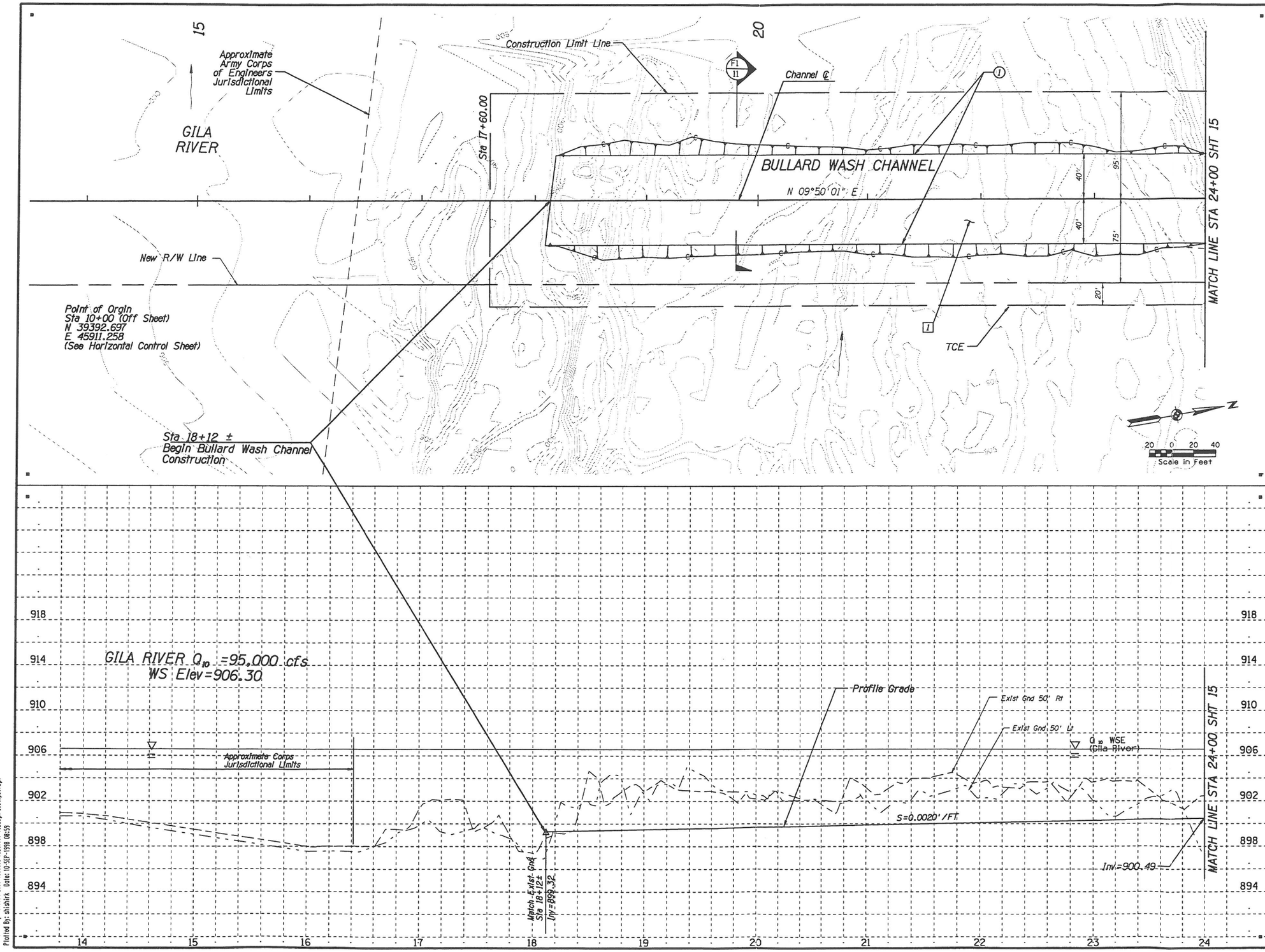

REMOVAL/RELOCATE

1 Clear and Grub (20 trees exceeding 6"ø) Sta 18+00 to Sta 24+00, 75' Lt & Rt (2 Acres)

CONSTRUCTION

1 Grade Channel Bottom and Sideslopes to Daylight. See F1/11

NO.	REVISION	BY	DATE
3			
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FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
ENGINEERING DIVISION

BULLARD WASH
CHANNEL IMPROVEMENTS PROJECT
PROJECT NO. 4700731

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DESIGNED	D. STOUGH	8/25/98
DRAWN	B. EDGAR	9/08/98
CHECKED	R. MILES/B. OLBERT	9/08/98

Sverdrup CORPORATION

PLAN AND PROFILE
STA 14+00.00 TO STA 24+00.00

SHEET 14 OF 81

Filename: p:\013841\2000\100cadd\100civ\11\100cgnd6941pl1.dgn
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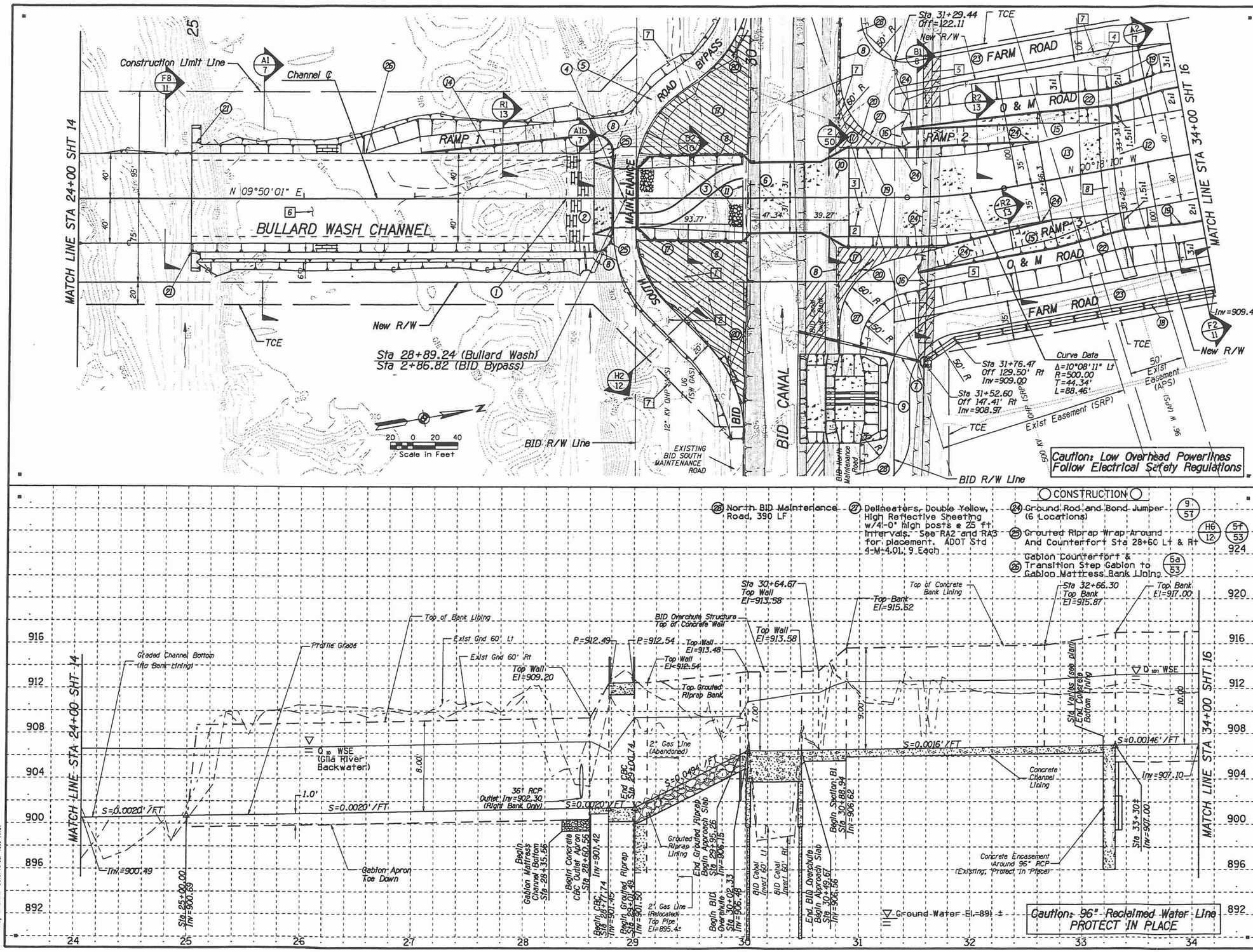

REMOVAL/RELOCATE

1. Relocate 2" Gas (Buried) by SW Gas
2. Relocate Service Pole & Overhead Service Line (APS)
3. Relocate UG Service Line (by APS)
4. Protect In Place Manhole Structure (APS)
5. Fill & Compact Exist Dirt Irr Ditch
6. Clear & Grub Existing Underbrush Sta 24+00 to 29+00, 75' Lt & Rt (1.72 Acres)
7. Protect In Place O/H Power Poles & U/G Services
8. Protect In Place Exist Conc. Pipe Encasement for 96" Pipeline (APS)

CONSTRUCTION

1. New Gabion Mattress Channel Bottom See A1b/7 A2c/7
2. New 36" RGRCP 24 LF with Hdwl, See P1/38 (MAG Std Det 501-4)
3. New Grouted Riprap Grade Control Structure # 1 496 CY and Concrete O & M Path 104 LF, See 3/51
4. New (4) 12'x10' CBC, See BC1/38
5. New 20' Wide BID Bypass Road, See See Also Sheet 31 Plan & Profile H2/12
6. New BID Canal Overchute Structure, See Plan Sheet 73
7. New 24" DIP, 112 LF, with Headwall, See P2/39 (MAG Std Det 501-5)
8. New 4-Wire Fence 520 LF See Detail for Locations 7a/55
9. New (3) 24" RGRCP 45 LF (Ea) and Concrete Spillway, 715 SY P12/39
10. New Concrete Approach Slab, See 2/50
11. New Concrete Cutoff wall See 3a/51
12. Existing Concrete Pipe Encasement (Protect In Place, APS) and Gabion Erosion Apron 1/49
13. Trans Sec B1 to Sec A2, Sta 32+66.3 to 33+80 Lt & Rt. See Det 1 Sheet 49.
14. New Maintenance Ramp #1, See See Plan & Profile, Sheet 32 R1/13 and RA1/32
15. New Maintenance Ramp #2 & 3, See See Plan & Profile Sheet 32 & 33 R2/13 RA2/32 RA3/33
16. New Access Gate, Sta 31+36, 60.0' Lt, 62.7' Lt; Sta 31+50, 65.6' Rt & 69.0' Rt ; see 6/54
17. Regrade Infield Area (NPI) See Sheet 31 and 50.
18. New Graded V-Ditch 600 LF @ Rt F2/11
19. New Handrail 516' LF @ Lt, 447 LF @ Rt, See 7b/55
20. New Barricade, 55 LF @ Lt, 55 LF @ Rt, see MAG Std Dtl 130, Type "B"
21. Step Gabion Bank Lining Terminus 10a/58
22. 15' O & M Road 350 LF @ Lt & 350 LF @ Rt, W/ 4" AB
23. New 20' Farm Road 271 LF @ Lt, 409 LF @ Rt Also See Sec. B1, Sheet 8. A2/7

CONSTRUCTION

24. Ground Rod and Bond Jumper (6 Locations) 9/57
25. Grouted Riprap Wrap Around And Counterfort Sta 28+60 Lt & Rt H6/12 5f/53
26. Gabion Counterfort & Transition Step Gabion to Gabion Mattress Bank Lining 5a/53
27. Delineators, Double Yellow, High Reflective Sheeting w/4'-0" high posts @ 25 ft. Intervals. See RA2 and RA3 for placement. ADOT Std 4-M-4.01. 9 Each
28. North BID Maintenance Road, 390 LF

NO.	REVISION	BY	DATE
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FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
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Sverdrup CORPORATION

PLAN AND PROFILE
STA 24+00.00 TO STA 34+00.00

SHEET 15 OF 81

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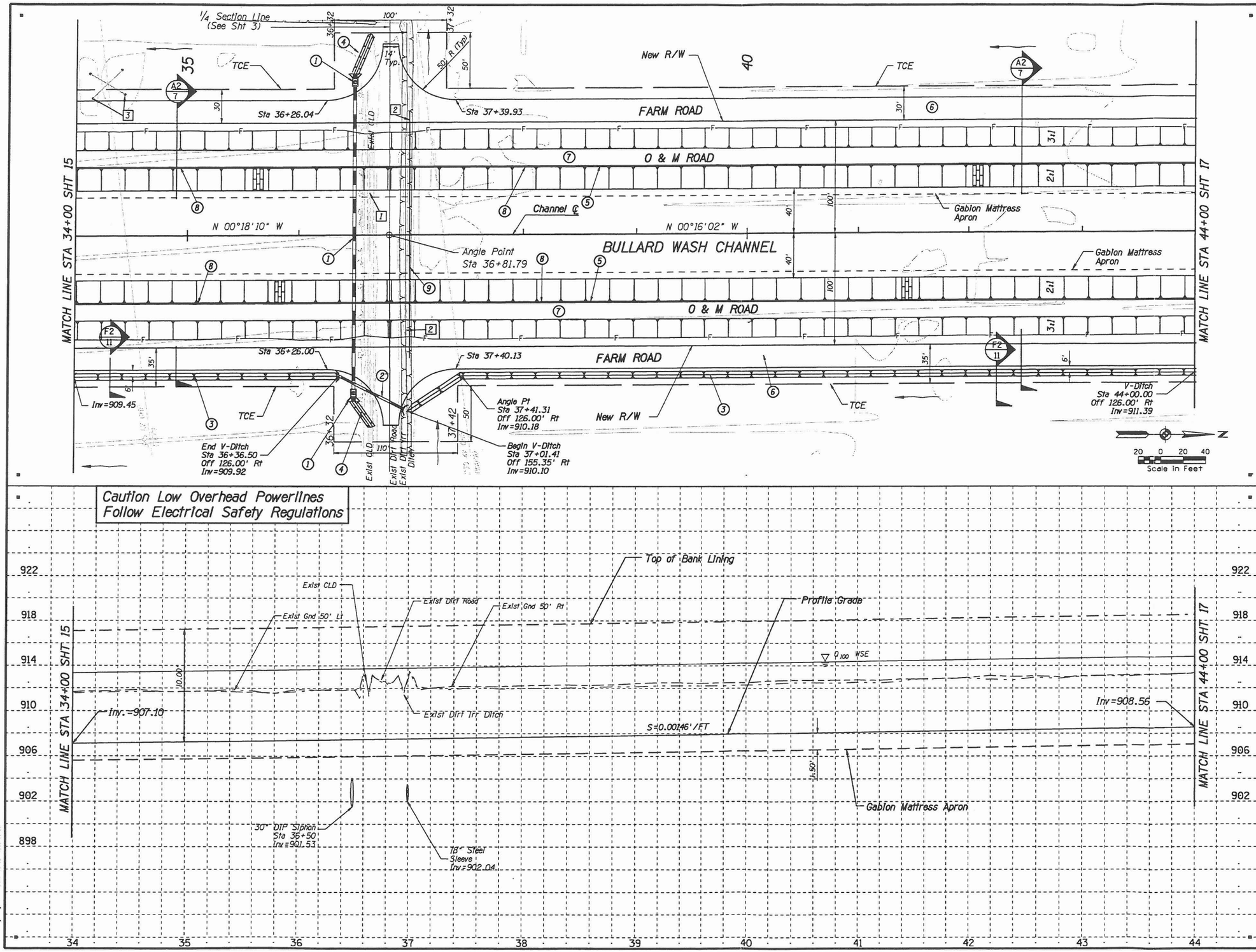

Caution Low Overhead Powerlines
Follow Electrical Safety Regulations

REMOVAL/RELOCATE

1. Remove Exist CLD 350 LF, Fill and Compact
2. Fill & Compact Exist Dirt Ditch
3. Protect In Place Exist OHP Tower Structure (Tucson Electric Power)

CONSTRUCTION

1. New 30" DIP 271 LF, Sta 36+50 Siphon & Irr Siphon Manholes, See S1/45 12/60
2. New 24" RGRCP 65 LF & Hdwls; See P3/45 (MAG Std Det 501-1)
3. New Graded V-Ditch 935 LF @ Rt F2/11
4. New CLD 36 LF @ Lt, 26 LF @ Rt For Location and Grade; See S1/45
5. New 42" Handrail 1000 LF @ Lt & 1000 LF @ Rt; see 7b/55
6. New Graded 20' Farm Road 1050 LF @ Lt, 1050 LF @ Rt; see A2/7
7. 15' O & M Road W/ 4" AB 1000 LF @ Lt, 1000 LF @ Rt
8. Ground Rod and Bond Jumper (4 Locations) 9/57
9. New 18" Steel Sleeve, Sta 36+99.79, Off 110' Lt to 110' Rt, 220 LF, Plug Ends

NO.	REVISION	BY	DATE
3			
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FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
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Sverdrup CORPORATION

PLAN AND PROFILE
STA 34+00.00 TO STA 44+00.00

SHEET 16 OF 81

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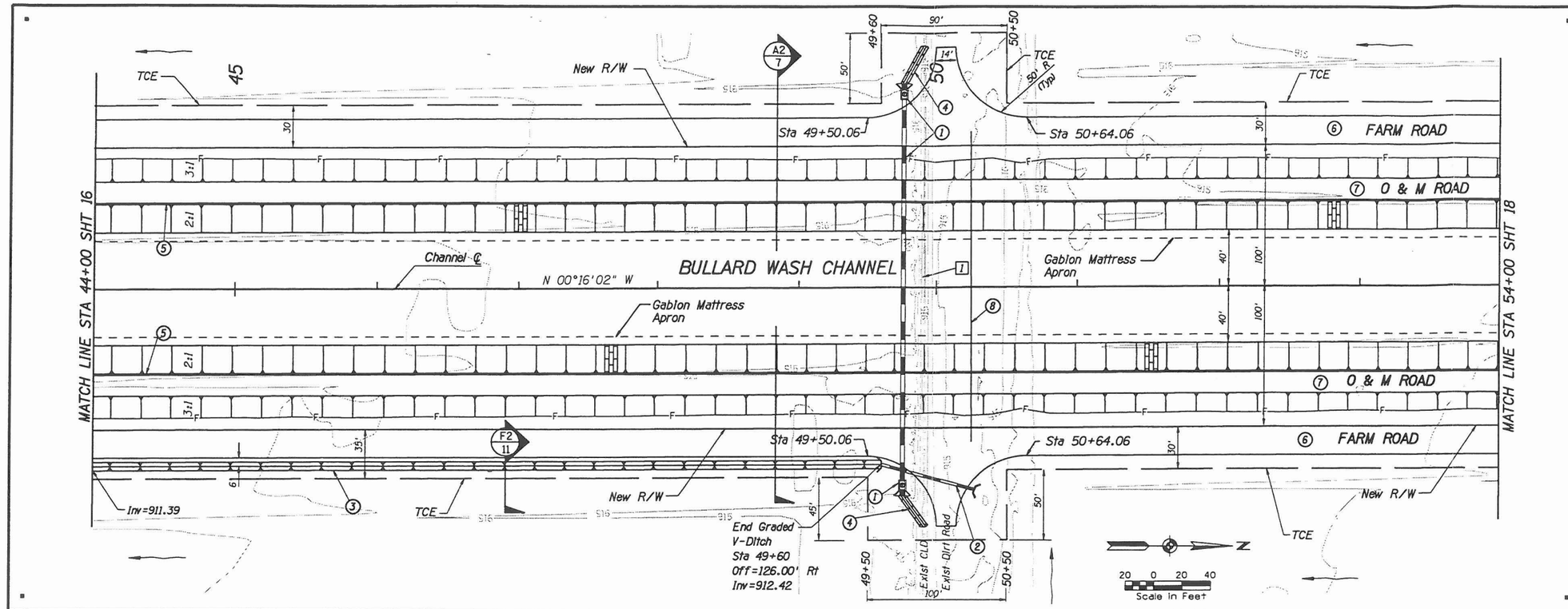

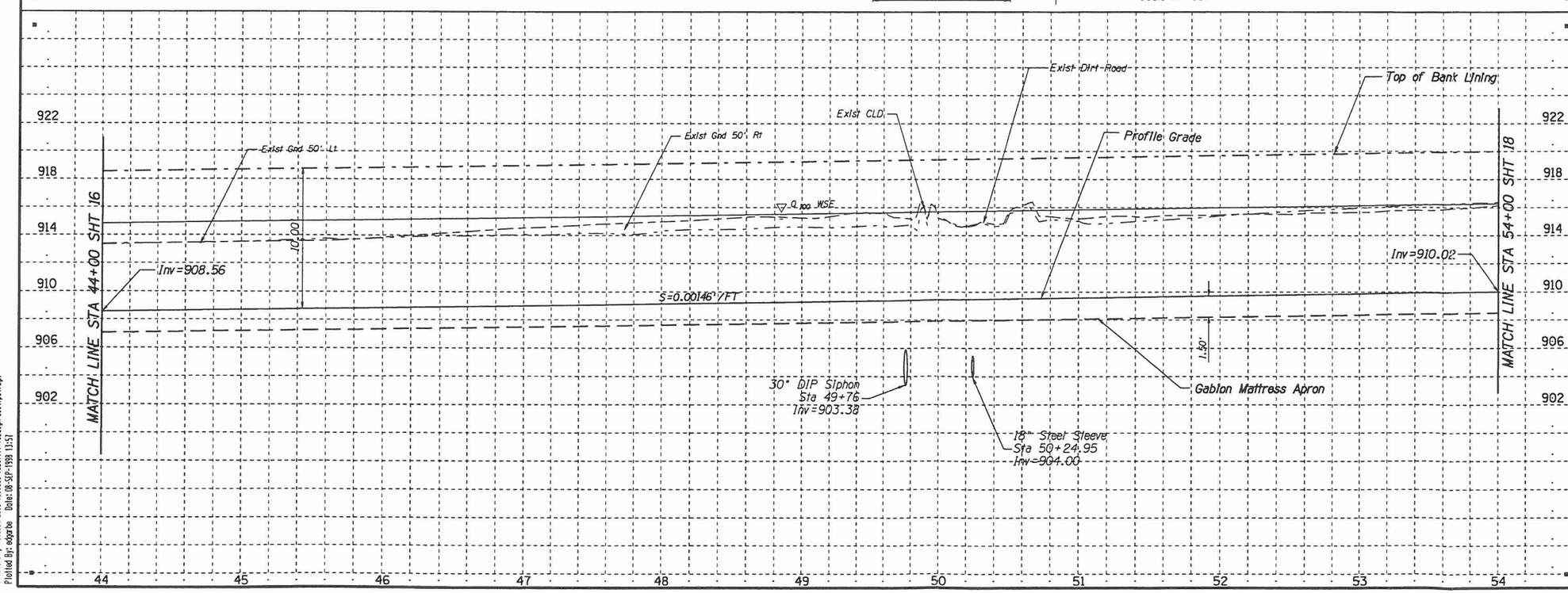

REMOVAL/RELOCATE

1. Remove Exist CLD 340 LF; Fill and Compact

CONSTRUCTION

1. New 30" DIP 272 LF Siphon & Irr Siphon Manholes See (S2/46) and (12/60), Sta 49+76.40
2. New 24" RGRCP 67 LF & Hdwls (MAG Std Det 501-1 & 501-5) For Location & Grade, See (P4/46)
3. New Graded V-Ditch 560 LF @ Rt, See (F2/11)
4. New CLD 39 LF @ Lt, 27 LF @ Rt For Location/Grade see (S2/46)
5. New 42" Handrail; 1000 LF @ Lt, 1000 LF @ Rt see (7b/55)
6. New Graded 20' Farm Road 1050 LF @ LT, 1050 LF @ Rt (A2/7)
7. 15' O & M Road W/ 4" AB 1000 LF @ Lt, 1000 LF @ Rt
8. New 18' Steel Sleeve, Sta 50+24.95, Offset 110' Lt and 110' Rt, 220 LF

NO.	REVISION	BY	DATE
3			
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1			

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
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Sverdrup CORPORATION

PLAN AND PROFILE
STA 44+00.00 TO STA 54+00.00

SHEET 17 OF 81

Filename: p:\013884\2000\100\dd\01\02civil\11\02dgn\6384fl04.dgn
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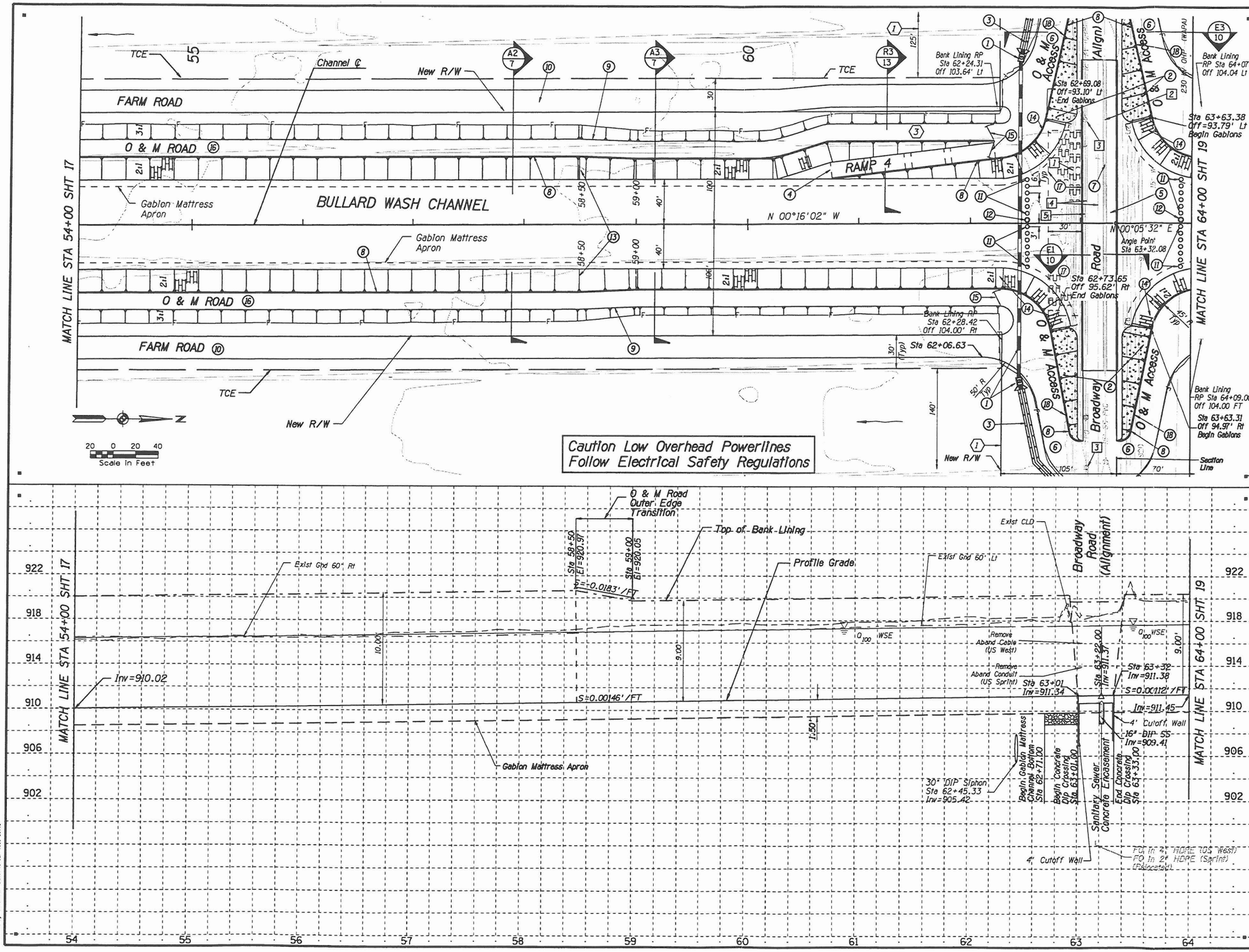

REMOVAL/RELOCATE

1. Remove Exist CLD 518 LF, See (11/59)
2. Remove 15" PVC San Swr 440 LF See (11/59)
3. Relocate 12 Kv OHP & Wood Poles (by APS) (2 Ea)
4. Relocate Tel Cable (by US West)
5. Relocate FO Cable (by US Sprint)

1. See Detail 11, Sheet 59 for TCE & R/W Dimensions in Broadway Rd Area and O & M Access Road Geometry.
2. See Detail Sheet DIP Crossing/ SS Encasement for Location of Utilities in Broadway Road (Align) (11/59)
3. See Detail RA4, Sheet 33 for O & M Road Geometry Around Ramp 4.

CONSTRUCTION

1. New 30" DIP Siphon 284 LF & Irr Siphon Manholes Sta 62+45.33; See (S3/47) (12/60)
2. New Gravel Mulch, 635 SY
3. New CLD 112 LF Lt & 120 LF Rt For Location & Grade, See (S3/47)
4. New Maintenance Ramp #4, Sta 60+26.45 to 62+29.68 (Section R3, Lt Bank Only) (RA4/33) (R3/13)
5. New Concrete Dip Crossing 934 SY, See (11/59) and (2) 4' Cutoff Walls
6. New 24' O & M Road Access w/ 4" AB, (For Location/Offsets) See (11/59)
7. New 16" DIP San Swr 440 LF w/ Concrete Encasement 140 LF, See (11/59)
8. New Handrail, 1,211 LF Lt, 1,211 LF Rt for Locations See Table 7b (9/57) (7b/55)
9. 50' Transition O & M Road Section A2 to A3 Sta 58+50 to 59+00 @ Lt
10. New 20' Farm Road 826 LF Lt & 826 LF Rt (A2/7) (A3/7)
11. New Safety Posts (Flxed) at Sta 62+52 and 63+90 9' Lt @ 6' O.C (6 Ea), and 3' Rt @ 6' OC (7 Ea); See MAG Std Det 140
12. New Removeable Safety Post Sta 62+52, 3' Lt and Sta 63+90, 3' Lt (17/63)
13. Bank Transition, Sec A2 to Sec A3 Sta 58+50 to 59+00 (Lt and Rt) (A2/7) (A3/7)
14. Gabion Mattress Bank Lining 40' Radius Bends (Typ), See and Plan for Rad Pt Locations (A2/7)
15. New Access Gate, Sta 62+20, Off 71.0' Lt, 75.0 Lt and Sta 62+27, Off 73.0' Rt (6/54)
16. 15' O & M Road w/ 4" AB 1166 LF @ Lt and 1166 LF @ Rt
17. Gabion Mattress Channel Bottom Sta 62+71.00 to 63+01.00, See (A2c/7)
18. Ground Rod and Bond Jumper (4 Locations) (9/57)

NO.	REVISION	BY	DATE
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FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
ENGINEERING DIVISION

BULLARD WASH
CHANNEL IMPROVEMENTS PROJECT
PROJECT NO. 4700731

		BY	DATE
PRELIMINARY NOT FOR CONSTRUCTION	DESIGNED	D. STOUGH	8/25/98
	DRAWN	B. EDGAR	9/08/98
	CHECKED	R. MILES/B. OLBERT	9/08/98

Sverdrup CORPORATION

PLAN AND PROFILE
STA 54+00.00 TO STA 64+00.00

SHEET 18 OF 81

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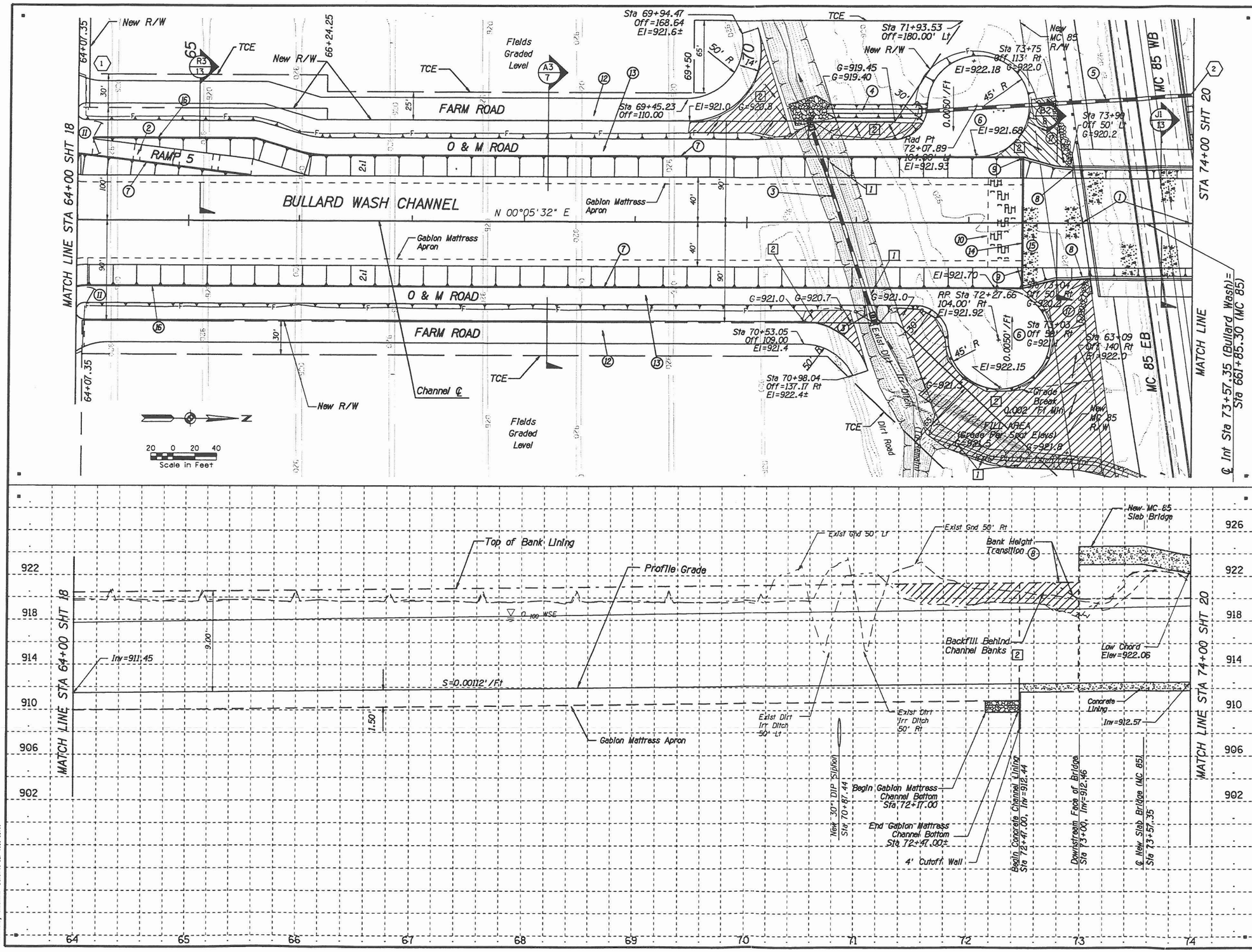

REMOVAL/RELOCATE

1. Fill and Compact Exist Dirt Irr Ditch 380 CY
2. Fill area to Limits and Spot Elevations Shown.

1. See Detail 11, Sheet 59 for TCE & R/W Dimensions In Broadway Road Area
2. Pipe 5 Inlet HW (MAG Std Det 501-4) and Pipe Shown on Sht 20 are Accounted for on this Sheet

CONSTRUCTION

1. New Slab Bridge, MC 85 See Estrella Parkway Roadway Plans, Shts 106-118
2. New Maintenance Ramp, #5, See Sta 64+02.19 to 66+10.64 (Lt Bank Only) (RA5/34) (R3/13)
3. New 30" DIP 174 LF Siphon & Irr Siphon Manholes Dumped Riprap at Outlet (26 Cu Yd) (S4/48) (12/60)
4. New Dirt Irr Ditch 85 LF, See (P5/40) and (F4/11) (Location & Grade)
5. New 36" RGRCP (Pipe 5), 266 LF w/ 2 Headwalls,(MAG Std Det 501-4) see (P5/40)
6. Backfill and Compact Cul-de-sac to Spot Elevations Shown with 4" AB
7. New Handrail 1036 LF Lt, 899 LF Rt, For Location See Table 7b, and see (9/57) (7b/55)
8. Bank Height Transition, 9' to 7.5' Height See (J1a/13)
9. End Gabion Mattress Bank Lining, Sta 72+47, Begin Concrete Channel Lining, Trans 2:1 SS to 1:1 SS at Sta 72+76.65 (Both Banks) (B2/8)
10. Begin Gabion Mattress Channel Bottom, Sta 72+17.00, 89 Cu Yd, See (A2c/7)
11. New Access Gate, Sta 64+14, Off 71.1' Lt and 75.0' Lt, and Sta 64+09, Off 73.3' Rt; see (6/54)
12. New 20' Farm Road 626 LF Lt, 702 LF Rt, See (A3/7)
13. 15' O & M Road W/4" AB 740 LF @ Lt, 755 LF Rt
14. Concrete Cutoff Wall, 118 LF (5d/53) (5b/53)
15. New Concrete Lined Channel (B2/8)
16. Ground Rod and Bond Jumper (2 Locations) (9/57)
17. Dumped Riprap, 12" T x 5' W x 60 LF Lt & 40 LF Rt D50=6", 19 Cu Yd, Place Against Roadway Fill Slope

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Sverdrup CORPORATION

PLAN AND PROFILE
STA 64+00.00 TO STA 74+00.00

SHEET 19 OF 81

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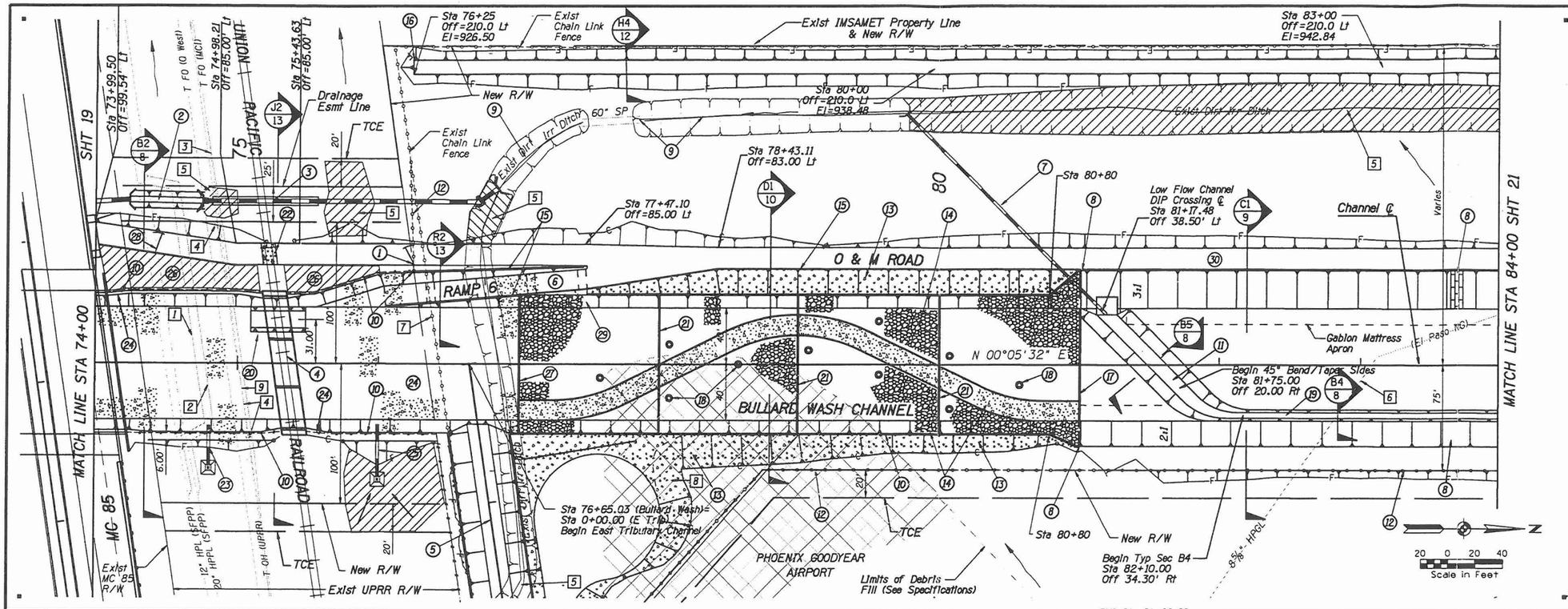

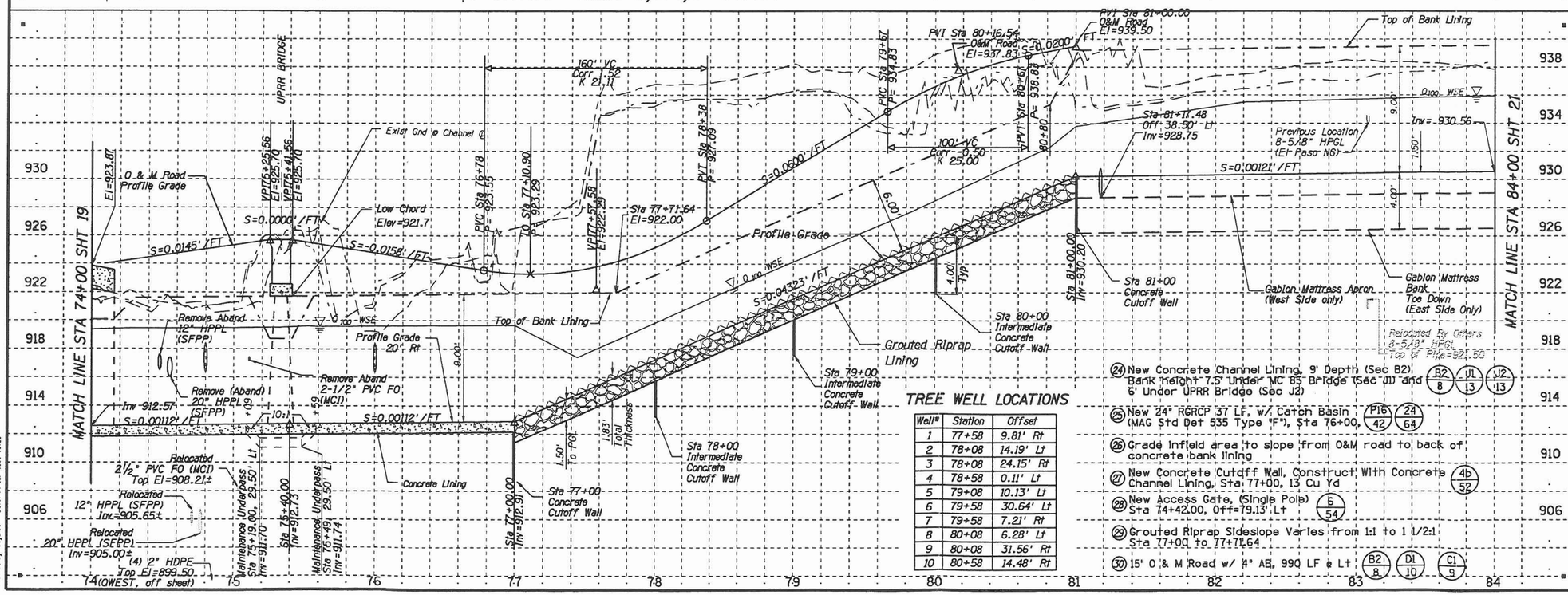

TREE WELL LOCATIONS

Well#	Station	Offset
1	77+58	9.81' Rt
2	78+08	14.19' Lt
3	78+08	24.15' Rt
4	78+58	0.11' Lt
5	79+08	10.13' Lt
6	79+58	30.64' Lt
7	79+58	7.21' Rt
8	80+08	6.28' Lt
9	80+08	31.56' Rt
10	80+58	14.48' Rt

REMOVAL/RELOCATE

1. Relocated 12" HP Petroleum Pipeline (by SFPP) Protect In Place
2. Relocated 20" HP Petroleum Pipeline (by SFPP) Protect In Place
3. Relocated Tel FO Cable (by MCI) Protect In Place
4. Relocated Railroad Switching OH Lines (UPRR) Protect In Place
5. Fill and Compact Dirt Irr Ditch.
6. Relocate 8⅝" HP Gas Pipeline (by El Paso NG)
7. Remove Existing Chain Link Fence 145 LF @ Lt & 50 LF @ Rt of Channel ℄
8. Remove Buried Construction Materials 1500 Tons
9. Remove Abandoned 2" Conduit (MCI)

CONSTRUCTION

1. New 12' Access Gate, Chain Link Fence Sta 76+24.7, Off=71.00' Lt (MAG Std Det 160)
2. New Dirt Irr Ditch 55 LF @ Lt, See P6/40 F4/11
3. New 30" RGRCP (Pipe 6) 209 LF, w/ Sleeve Jacked Under RR 75 LF w/ 1 Hdwl (MAG Std Det 501-4) and 1 Hdwl (MAG Std Det 501-5) P6/40 23/64
4. New 3-Span Precast Concrete Railroad Bridge (By UPRR)
5. New Concrete Lined E Trib Chl, See Sht 26, & B3/8
6. New Concrete Maintenance Ramp, Sta 75+55.72 to 77+43.03 (Lt Bank); see RA6/34 R2/13
7. New 24" RGRCP (Pipe 7), 201 LF Headwall in Bank Lining (Inlet), Outlet Headwall (MAG Std Det 501-4); See P7/41 25/64
8. Begin Gabion Mattress Bank Lining (Sec C1), 3:1 SS, Sta 81+00, See C1/9
9. Clean Out 60" Steel Pipe & Reshape Ditch to Accomodate New Headwall (Pipe 7), see F4/11
10. New 4-Wire Fence 200 LF @ Lt, 608 LF @ Rt, See 7a/55
11. New Low Flow Channel DIP Crossing, See B5/8
12. New Chain Link Fence, (MAG Std Det 160) 524 LF @ Rt, See Table 7c for Locations 7c/55
13. New Gravel Mulch, 1210 SY
14. New Grouted Riprap Channel Lining 2351 CY and O & M Path 425 LF Sta 77+00 to 81+00, 4/52 D1/10
15. New Handrail 617 LF @ Lt, See 7b/55
16. Begin New Landscaping Berm, Sta 76+25, Off=210' Lt, 1636 CY, See H4/12
17. New Concrete Cutoff Wall 20 CY, & Gabion Counterfort, Sta 81+00 3C/51 5c/53
18. New Tree Well 10 Ea, (For Locations See Table This Sheet) 21/63 B4/8
19. New 4' BW Concrete Low Flow Channel, Sta 82+10, 300 LF
20. New 12' Wide Maintenance Underpass Under UPRR Bridge, See K/13
21. New Intermediate Concrete Cutoff Wall; 28 CY Sta 78+00, 79+00, 80+00; See 4a/52
22. New Concrete RR At-Grade Crossing by UPRR
23. New 24" RGRCP 28 LF, w/ Catch Basin (MAG Std Det 535 Type "F"), Sta 74+80, P14/44 24/64
24. New Concrete Channel Lining, 9' Depth (Sec B2) Bank height 7.5' Under MC 85 Bridge (Sec J1) and 6' Under UPRR Bridge (Sec J2) B2/8 J1/13 J2/13
25. New 24" RGRCP 37 LF, w/ Catch Basin (MAG Std Det 535 Type "F"), Sta 76+00, P16/42 24/64
26. Grade Infield area to slope from O&M road to back of concrete bank lining
27. New Concrete Cutoff Wall, Construct With Concrete Channel Lining, Sta 77+00, 13 Cu Yd 4b/52
28. New Access Gate, (Single Pole) Sta 74+42.00, Off=79.13' Lt 6/54
29. Grouted Riprap Sideslope Varies from 1:1 to 1 1/2:1 Sta 77+00 to 77+71.64
30. 15' O & M Road w/ 4" AB, 990 LF @ Lt B2/8 D1/10 C1/9

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FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
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Sverdrup CORPORATION

PLAN AND PROFILE
STA 74+00.00 TO STA 84+00.00

SHEET 20 OF 81

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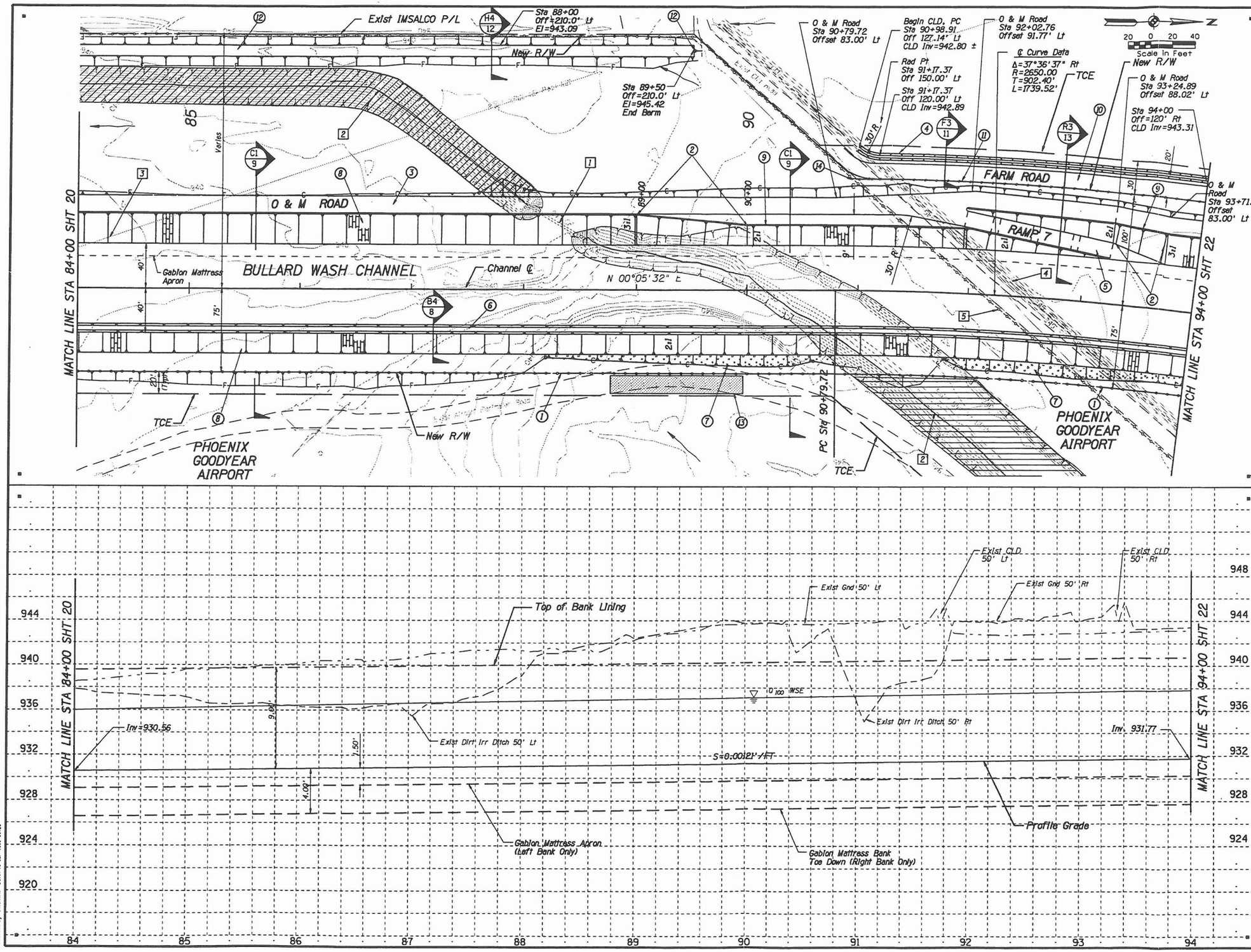

REMOVAL/RELOCATE

1. Remove Exist 24" CP 60 LF
2. Fill & Compact Exist Dirt Irr Ditch See Sheet 5
3. Relocate Exist HPGL (by El Paso NG)
4. Remove Exist CLD 380 LF Sta 90+99 Off=127.1' Lt to Sta 93+57, Off=80' Rt, Fill & Compact As Reqd.
5. Remove Exist Chain Link Fence 385 LF, Sta 90+90, Off 100' Lt to Sta 93+15, Off 75' Rt

CONSTRUCTION

1. New Chain Link Fence 1000 LF @ Rt (MAG Std Det 160), See Table 7c For Location (7c/55)
2. New 100' Channel (Left Bank) Transition Sideslope Varies from 3:1 to 2:1; Sta 89+00 to 90+00 Varies from 2:1 to 3:1, Sta 93+25 to 93+72
3. 15' O & M Road w/ 4" AB, 1000 LF @ Lt (C1/9)
4. New CLD 300 LF, See (F3/11)
5. New Maintenance Ramp # 7 Sta 92+00.00 to 93+72.24; See (RA7/35) (R3/13)
6. New Low Flow Channel 1000 LF (B4/8)
7. New Gravel Mulch, 480 SY
8. New Gabion Mattress Bank Lining, 3:1 SS Lt Bank, (Sta 84+00 to 89+00 & 93+72 to 94+00) 2:1 SS Rt Bank (C1/9)
9. New Handrail 606 LF, See (7b/55)
10. New 14' Wide Graded Farm Road 330 LF See (H3/12)
11. New 4-Wire Fence 300 LF, See (7a/55)
12. New Landscaping Berm, 1162 CY, See End at Sta 89+50, Off=210.00' Lt (H4/12)
13. New 20' Airport Perimeter Road, w/ 4" AB Sta 88+70 to 90+02, Off=85' Rt
14. At Sta 90+95± Lt Set Corner Post for Chain Link Fence and Tie South End of 4-Wire Fence to Corner Post

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FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
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Sverdrup CORPORATION

PLAN AND PROFILE
STA 84+00.00 TO STA 94+00.00

SHEET 21 OF 81

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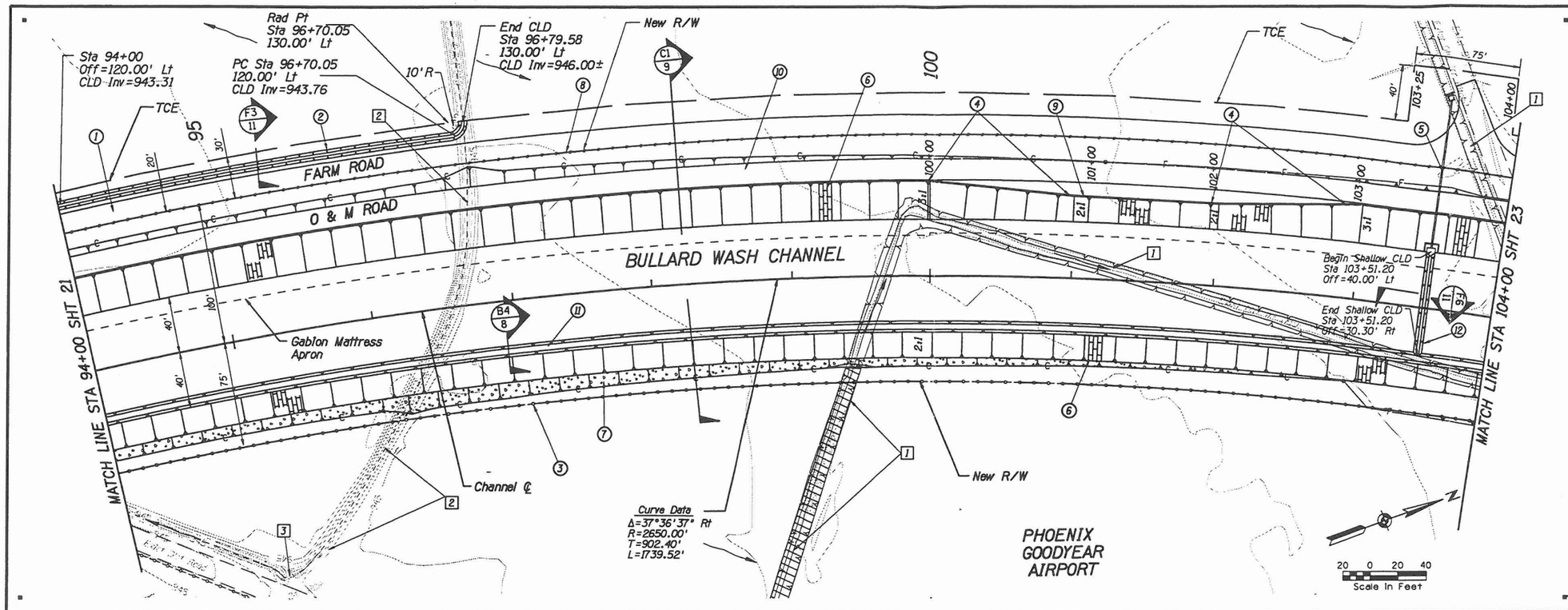

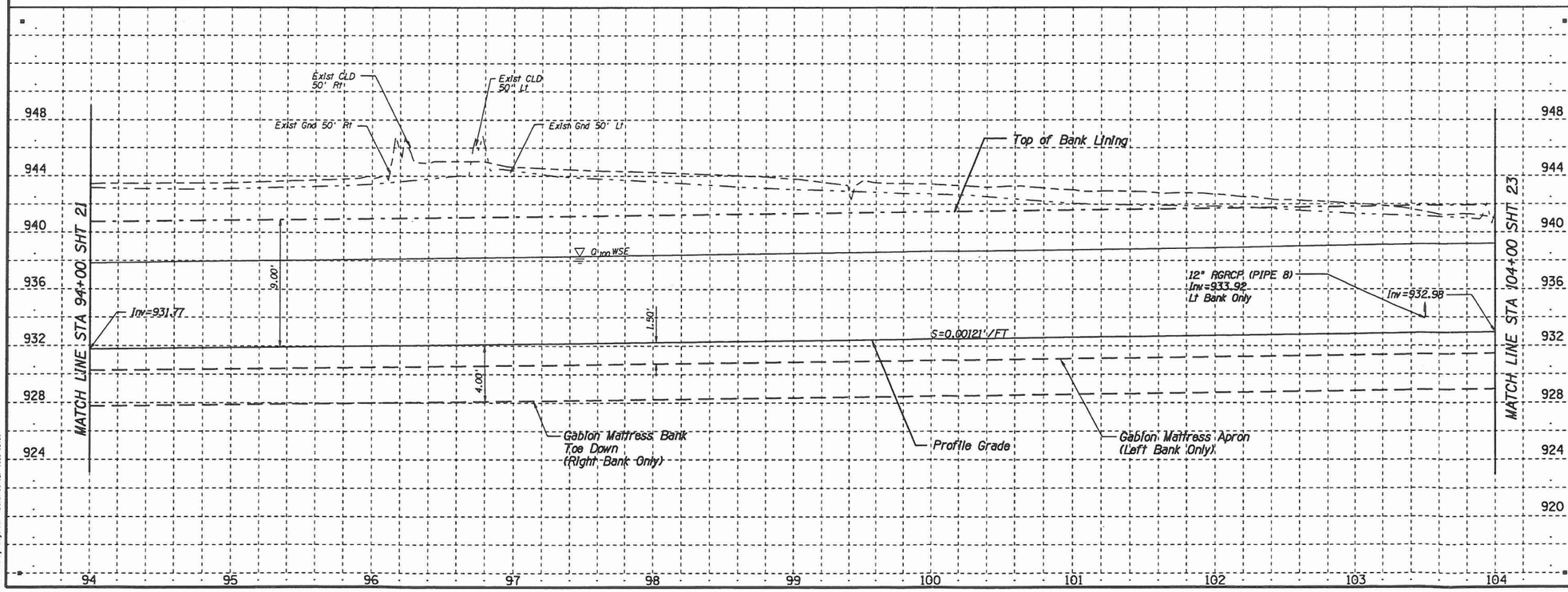

REMOVAL/RELOCATE

1. Fill & Compact Exist Dirt Irr Ditch. See Sheet 5
2. Remove Existing CLD 483 LF, Fill and Compact As Required
3. Remove Exist 24" RCP

CONSTRUCTION

1. New 14' Wide Graded Farm Road, 1000 LF Lt See H3/12
2. New CLD 290 LF Lt, See F3/11
3. New Chain Link Fence 1000 LF @ Rt (MAG Std Dtl 160), See Table 7c for Locations 7c/55
4. New 100' Channel (Left Bank) Transition Sideslope Varies from 3:1 to 2:1; Sta 100+00 to 101+00 Varies from 2:1 to 3:1, Sta 102+00 to 103+00
5. New 12" RGRCP 105 LF & Headwall w/ Trash Rack (MAG Std Dtl 502-1) P8/41 25/64
6. New Gabion Mattress Bank Lining, 3:1SS Lt Bank Sta 94+00 to 99+00, and 103+00 to 104+00 2:1 SS Lt Bank, Sta 101+00 to 102+00, 2:1 SS Rt Bank C1/9
7. New Gravel Mulch 700 SY @ Rt
8. New 4-Wire Fence, 1000 LF @ Lt, See Table 7a For Locations 7a/55 16/63
9. New Handrail, 300 LF @ LT, See and See Table 7b For Locations 9/57 7b/55
10. 15' O & M Road w/4" AB, 1000 LF @ Lt
11. New Low Flow Channel 1000 LF B4/8
12. Shallow Concrete Lined Ditch 71 LF Sta 103+51.20 F6/11

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FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
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Sverdrup CORPORATION

PLAN AND PROFILE
STA 94+00.00 TO STA 104+00.00

SHEET 22 OF 81

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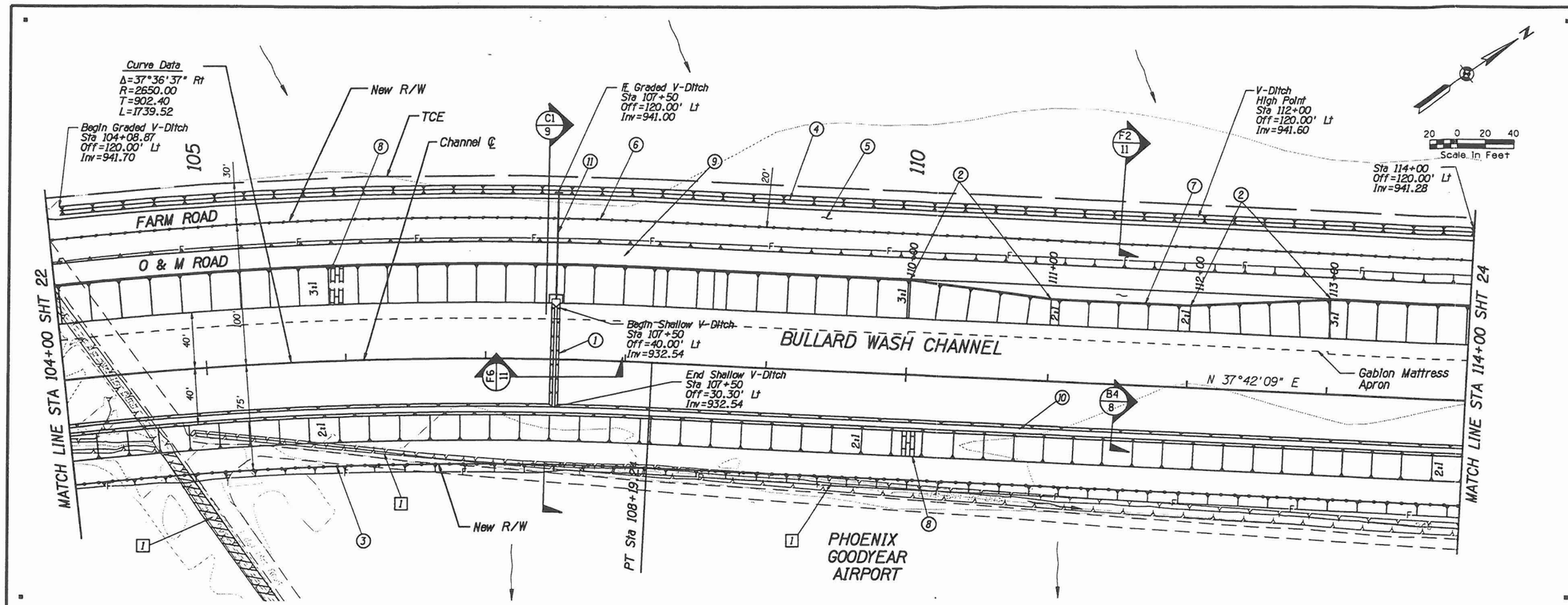

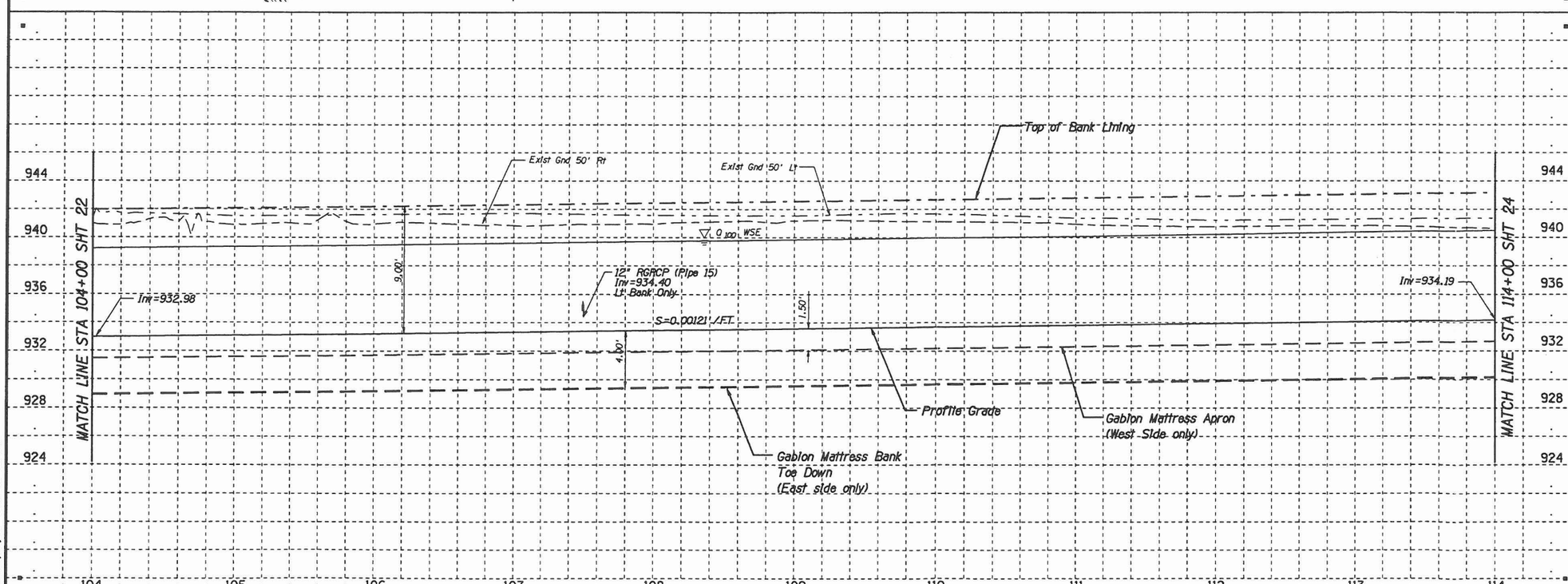

REMOVAL/RELOCATE

1. Fill & Compact Dirt Irr Ditch See Sheet 5

CONSTRUCTION

1. New Shallow CLD, 71 LF See F6/11
2. New 100' Channel (Left Bank) Transition Sideslope Varies from 3:1 to 2:1; Sta 110+00 to 111+00 Varies from 2:1 to 3:1, Sta 112+00 to 113+00
3. New Chain Link Fence 1000 LF per MAG Std Dtl 160 See 7c/55
4. New Graded V-Ditch 991 LF F2/11
5. New 14' Graded Wide Farm Road 991 LF, See H3/12
6. New 4-Wire Fence 1000 LF, See 7a/55
7. New Handrail 300 LF @ Lt, See Table 7b For Locations, and 7b/55 9/57
8. New Slope Blanket Gabions, 3:1SS and 2:1SS C1/9
9. 15' O & M Road 1000 LF W/4" AB
10. New Low Flow Channel 1000 LF B4/8
11. New 12" RGRCP 73 LF & Headwall In Bank Lining w/Trash Rack (MAG Std 502-1) See P15/44 25/64

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Sverdrup CORPORATION

PLAN AND PROFILE
STA 104+00.00 TO STA 114+00.00

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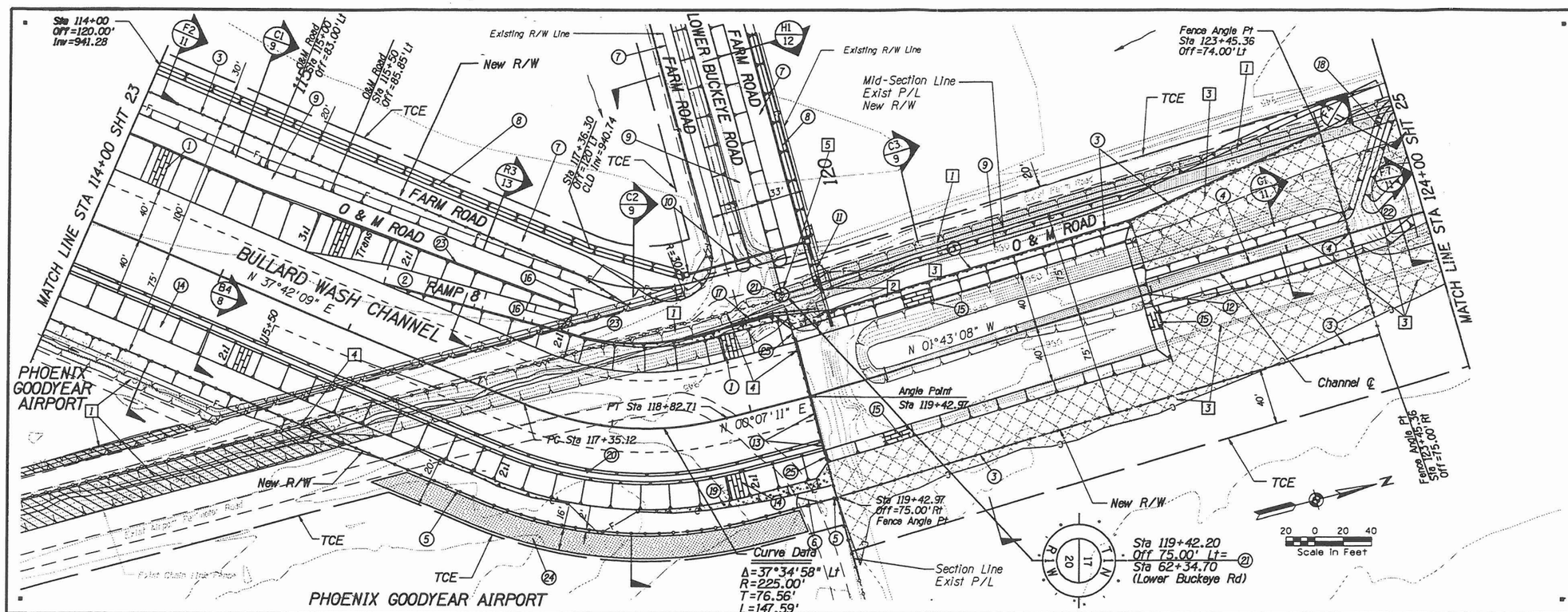

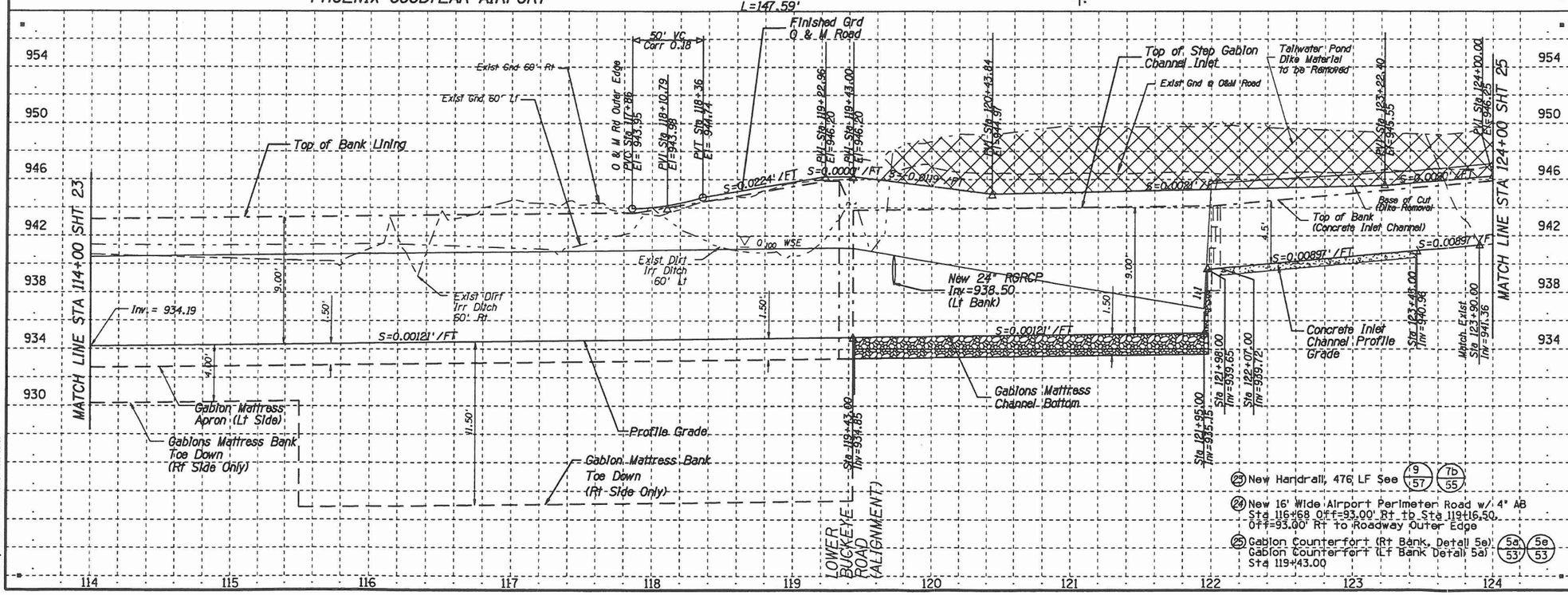

REMOVAL/RELOCATE

1. Fill and Compact Exist Dirt Irr Ditch, See Sheet 5
2. Remove Rubble, Trash, Debris; Fill and Compact See Special Provisions 2 Tons
3. Excavate and Remove Exist Pond Dikes to Base of Cut line in Profile.
4. Remove Exist Chain Link Fence, Sta 115+95, Off=75.00' Rt, Through Sta 119+43, Off=75.00 Lt to Sta 119+43, Off=75.00 Rt
5. Remove Exist 24" Irr Pipe

CONSTRUCTION

1. Gabion Mattress Bank Lining, Left Bank, See Section C1 Sta 114+00 to 115+50 Section C2 Sta 117+35 to 119+43 (C1/9) (C2/9)
2. New Maintenance Ramp, Gabion Mattress Bank Lining, Lt Bank Transition 3:1 to 2:1 SS Sta 115+50 to 116+00 2:1 SS Sta 116+00 to 117+35 (RA8/35) (R3/13)
3. New 4-Wire Fence 1365 LF, See (7a/55) See Detail for Location
4. New 20' BW Concrete Inlet Channel 138 LF Sta 122+07 to Sta 123+45 (G1/11) (14/62)
5. New Chain Link Fence 545 LF Rt per MAG Std Dtl 160 Along Rt R/W Line (7c/55)
6. New 12' Wide Gate, Chain Link Fence MAG Std Dtl 160 Sta 119+29.6, Off=74.5' Rt (North Post)
7. New 14' Wide Graded Farm Road 414 LF Lt, See (H3/12)
8. New Graded V-Ditch, 475 LF @ Lt, see (F2/11)
9. New 15' O & M Road w/4" AB, 1000 LF @ Lt
10. New 12" RGRCP 90 LF & Headwall (MAG Std Dtl 502-1), See (P13/42)
11. New 24" RGRCP 62 LF & Trash Rack Headwall (MAG Std Dtl 502-1) See (P9/42) and (10a/58)
12. New Step Gabion Grade Control Structure, See (8/56) and (14/62)
13. Concrete Cutoff Wall Sta 119+42.97 (Perpendicular to Bearing South of Section Line), 86 LF and Low Flow Channel Inlet, see (15/62)
14. Gabion Mattress Bank Lining, Rt Bank 2:1 SS, Sec C1, Sta 114+00 to 115+50 Sec C2, Sta 115+50 to 119+42.97, (Extended Toedown) (C1/9) (C2/9)
15. New Step Gabion Bank Lining, Sta 119+43 to 122+07 (Both Banks and End of Channel) (C3/9)
16. New Access Gates, Sta 117+45, Off 71.7' Lt and 77.5' Lt, See (6/54)
17. New Barricade, MAG Std Dtl 130 type "B" (See Barricade Location Table 7d) 60 LF (7d/55)
18. New 4' BW Dirt Irr Ditch, 90 LF Sta 123+52, Off 10.00' Lt To Sta 124+12.00, Off 78.00' Lt, See End on Sh 25 (F4/11)
19. New Gravel Mulch, 192 SY
20. New Low Flow Channel, 543 LF, see (B4/8)
21. New Survey Monument (MAG Std Dtl 120), Type A
22. New Dirt Inlet Channel, Sta 123+45 to 123+90
23. New Handrail, 476 LF See (9/57) (7b/55)
24. New 16' Wide Airport Perimeter Road w/ 4" AB Sta 116+68 Off=93.00' Rt to Sta 119+16.50, Off=93.00' Rt to Roadway Outer Edge
25. Gabion Counterfort (Rt Bank, Detail 5e) (5a/53) (5e/53) Gabion Counterfort (Lt Bank Detail 5a) Sta 119+43.00

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Sverdrup CORPORATION

PLAN AND PROFILE
STA 114+00.00 TO STA 124+00.00

SHEET 24 OF 81

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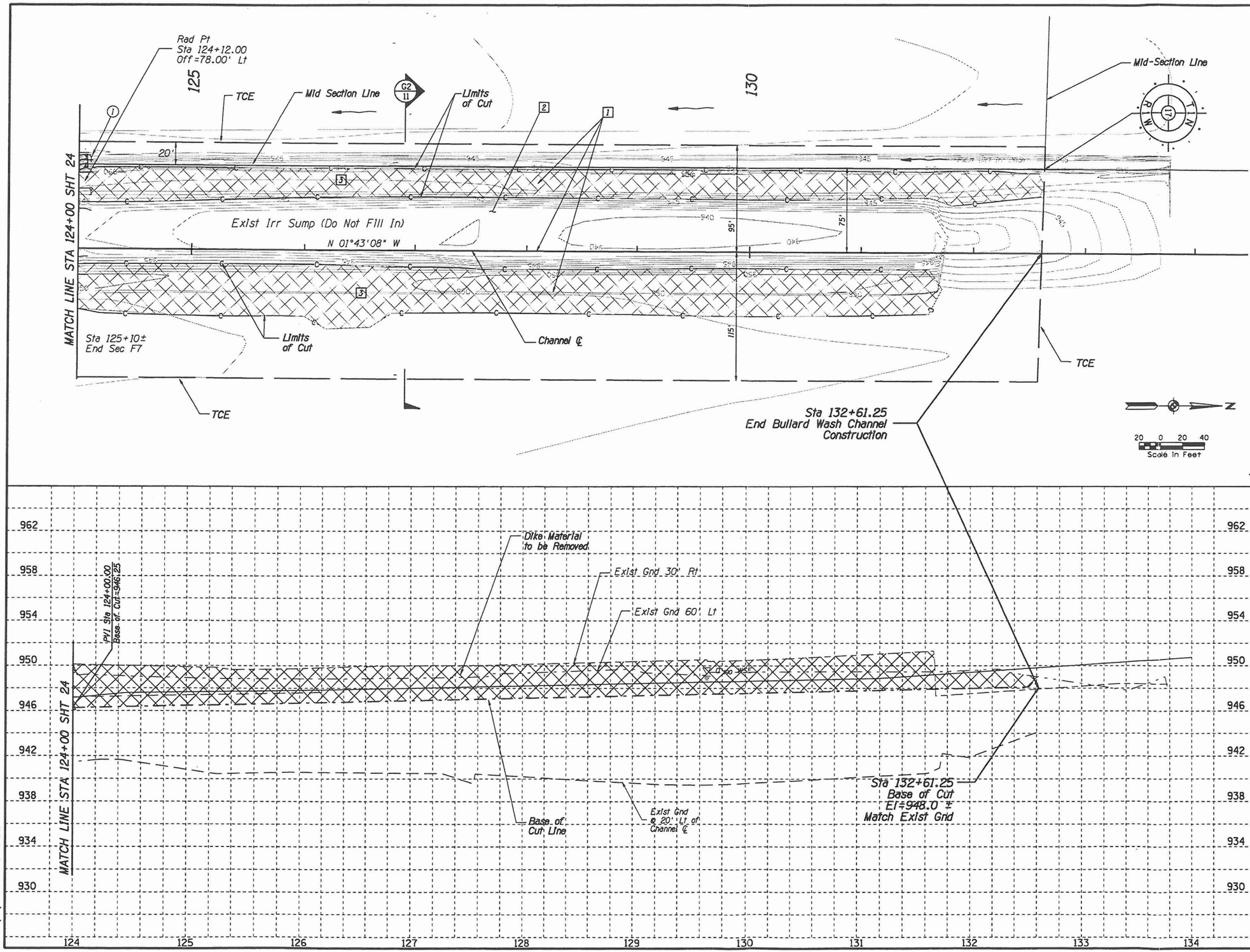

REMOVAL/RELOCATE

1. Excavate Exist Pond Dikes Do Not Fill In Low Area of Sump. Do Not Cause Dirt to Fall Into and/or Clog the Exist Dirt Irrigation Ditch (G2 / 11)
2. Clear and Grub Existing Underbrush, 3 Ac
3. Rubble & Debris Removal, 10 tons

CONSTRUCTION

1. New 4' BW Dirt Irr Ditch 7 LF End Sta 124+12, Off 78.00' Lt, See (F4 / 11)

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STA 124+00.00 TO STA 134+00.00

SHEET 25 OF 81

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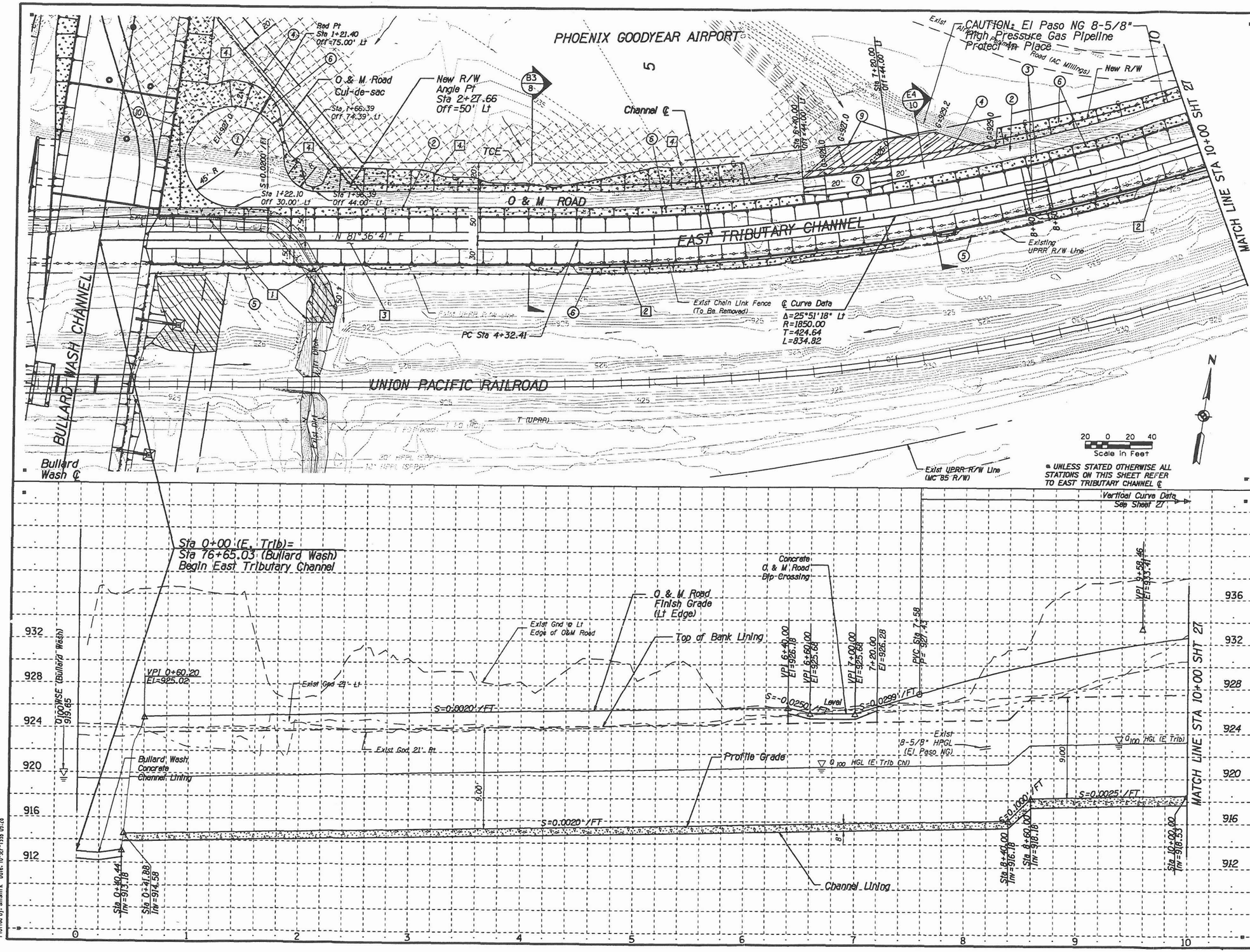

REMOVAL/RELOCATE

1. Fill In and Compact Exist Dirt Irr Ditch, See Sht 5
2. Remove Existing Chain Link Fence Sta 0+45 to 10+00 Rt, (E. Trib Channel) (955 LF This Sheet)
3. Clear and Grub Exist Underbrush (N.P.I.)
4. Remove Buried Construction Materials. 1360 Tons See Special Provisions

CONSTRUCTION

1. New 45' Radius Cul-de-sac w/ 4" AB
2. 14' O & M Road w/ 4" AB, 800 LF
3. New Concrete Grade Control Structure, Maintain 9.0' High, 1.5:1 SS Banks, Earth Sideslope Above Bank Varies
4. New Chain Link Fence, 964 LF @ Lt R/W Line (MAG Std Det 160), See Table 7c For Locations (7c/55)
5. New 4-Wire Fence, 954 LF @ Rt, on P/L See Table 7a For Locations (7a/55) (16/63)
6. New Gravel Mulch, 2426 SY
7. New Concrete O & M Road Dip Crossing Sta 6+40.00 Off=44.00' Lt to Sta 7+20.00, Off=44.00' Lt, 196 SY (E4/10)
8. New Concrete Channel Lining, 15' Bottom Width (East Tributary Channel) (B3/8)
9. Grade Area Between TCE and Bank Lining to Drain Into Concrete O&M Road Dip Crossing
10. New Barricade 80 LF @ Lt (MAG Std Det 130, Type "B" See (7d/55)

NO.	REVISION	BY	DATE
3			
2			
1			

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
ENGINEERING DIVISION

BULLARD WASH
CHANNEL IMPROVEMENTS PROJECT
PROJECT NO. 4700731

		BY	DATE
PRELIMINARY NOT FOR CONSTRUCTION	DESIGNED	D. STOUGH	8/25/98
	DRAWN	B. EDGAR	9/08/98
	CHECKED	R. MILES/B. OLBERT	9/08/98

Sverdrup CORPORATION

PLAN AND PROFILE: (EAST TRIBUTARY)
STA 0+00.00 TO STA 10+00.00

SHEET 26 OF 81

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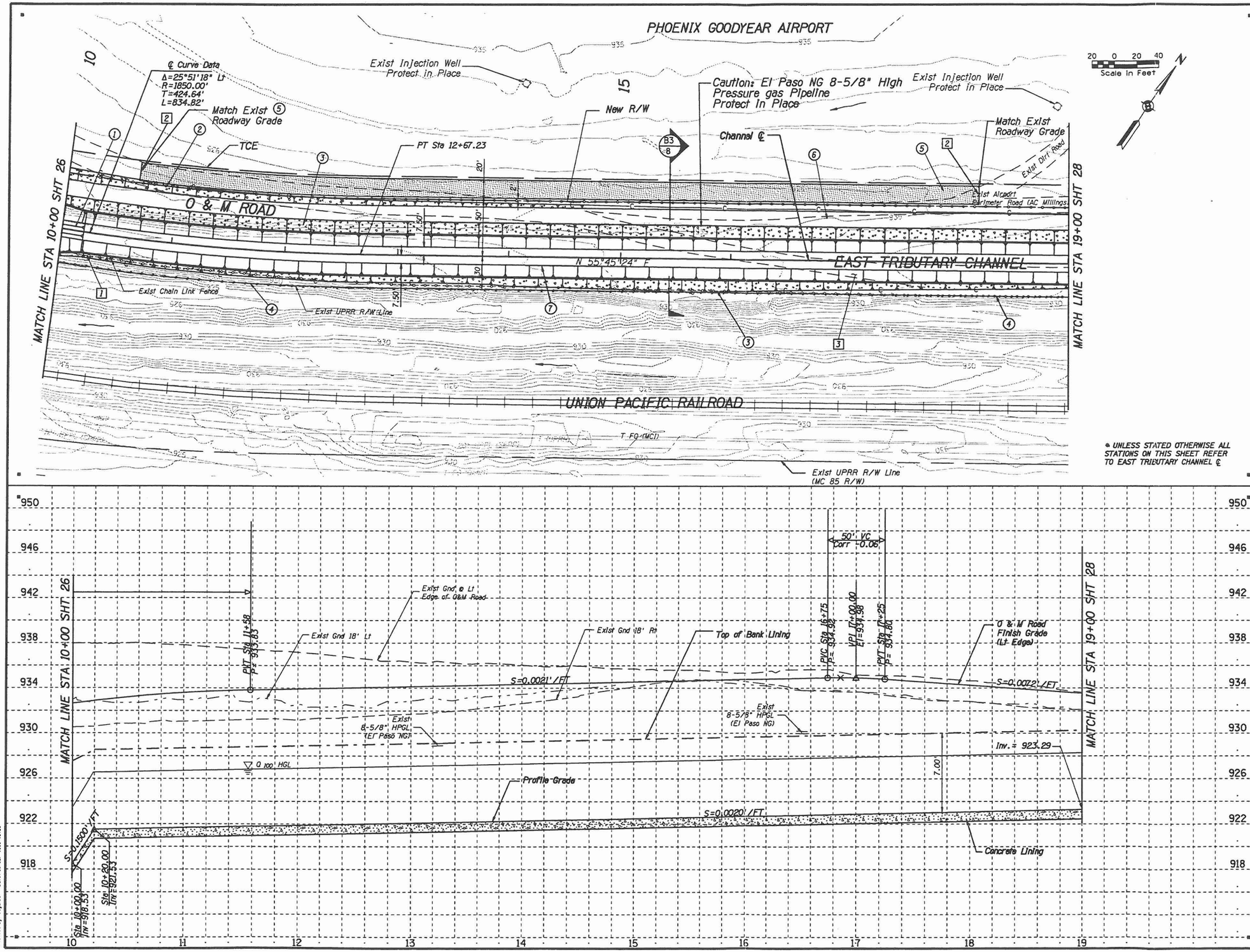

REMOVAL/RELOCATE

1. Remove Existing Chain Link Fence, 900 LF Sta 10+00 Rt to 19+00 Rt.
2. Remove 14' Wide Existing Airport Perimeter Road; Sta 10+65 to 18+20, approx 60' Lt
3. Clear and Grub Existing Underbrush (N.P.I.)

CONSTRUCTION

1. New Concrete Grade Control Structure, Transition Bank Height from 9.0' to 7.0' and maintain 1.5:1 sideslopes. Sideslopes Above Bank Lining Vary
2. New Chain Link Fence, 900 LF @ Lt R/W Line, (MAG Std Det 160), See Table 7c For Locations (7c/55)
3. New Gravel Mulch, 2850 SY
4. New 4-Wire Fence, 900 LF @ Rt, Sta 10+00 to 19+00 See Table 7a For Locations, and see (16/63) (7a/55)
5. New 4' AB, 16' Wide Airport Perimeter Road Sta 10+65 to 18+20, Off 68.00' Lt (E Trib ℄ to Road Outer Edge)
6. 14' O & M Road w/ 4" AB, 900 LF @ Lt
7. New Concrete channel lining 15' Bottom Width, 7.0' Blank Height with 1.5:1 Sideslopes

NO.	REVISION	BY	DATE
3			
2			
1			

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
ENGINEERING DIVISION

BULLARD WASH
CHANNEL IMPROVEMENTS PROJECT
PROJECT NO. 4700731

	BY	DATE
DESIGNED	D. STOUGH	8/25/98
DRAWN	B. EDGAR	9/08/98
CHECKED	R. MILES/B. OLBERT	9/08/98

PRELIMINARY NOT FOR CONSTRUCTION

Sverdrup CORPORATION

PLAN AND PROFILE (EAST TRIBUTARY) STA 10+00.00 TO STA 19+00.00

SHEET 27 OF 81

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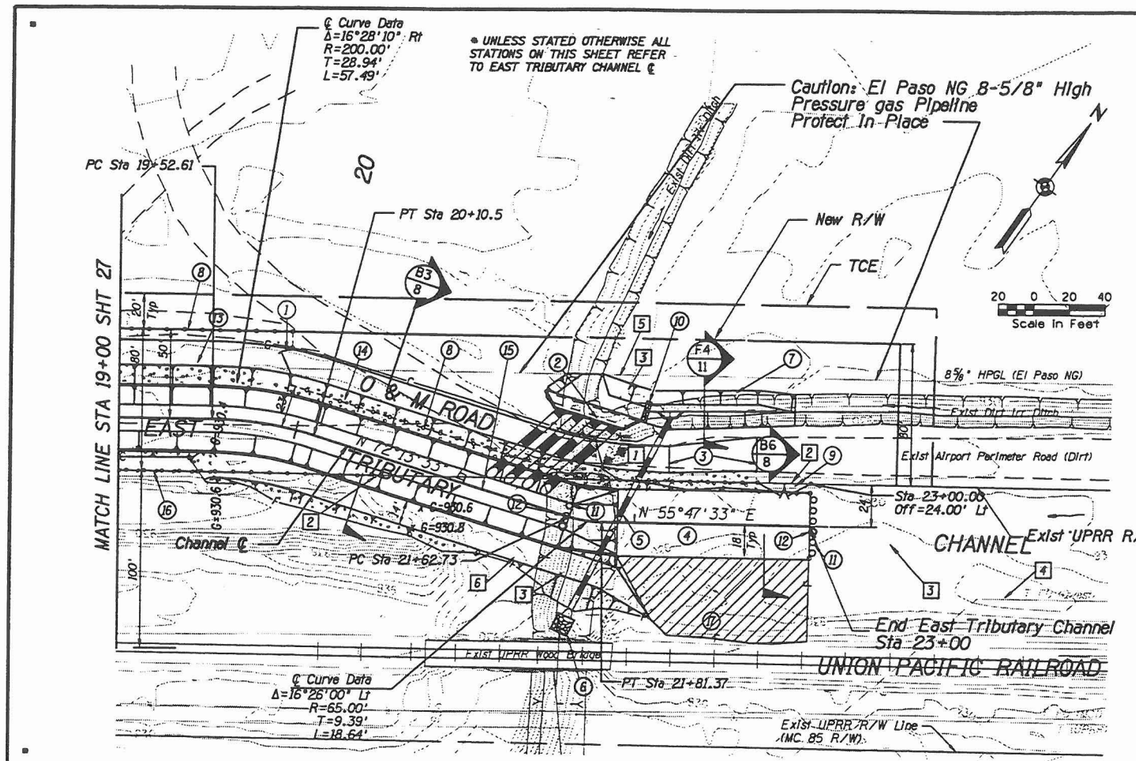
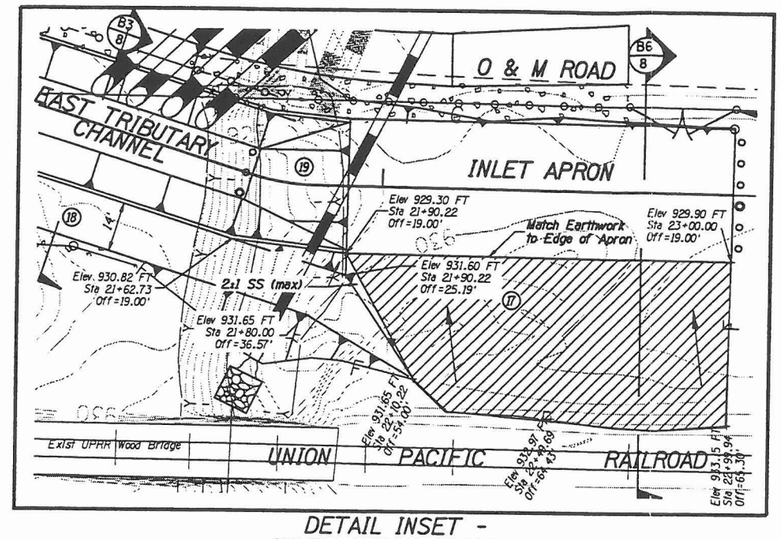
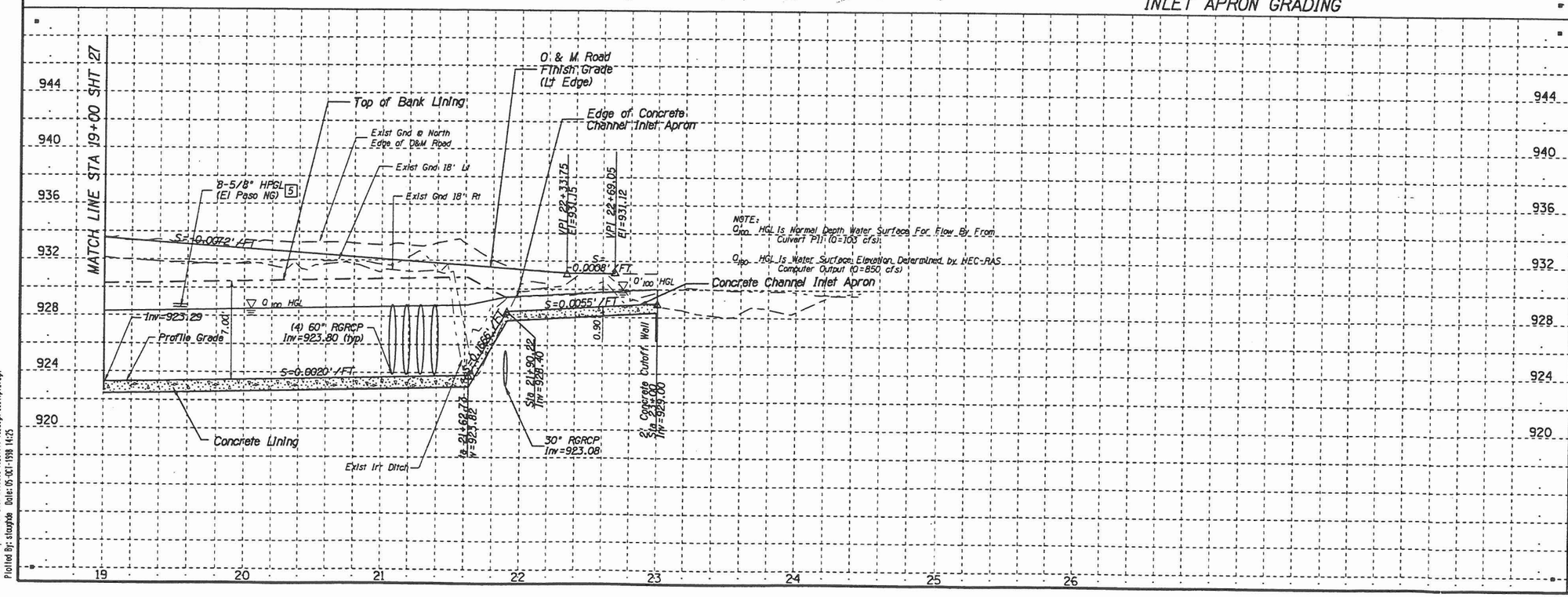




DETAIL INSET -
INLET APRON GRADING



☐ REMOVAL/RELOCATE ☐

1. Remove Exist 60" Steel Pipe 27 LF x 5 ea (Lump Sum)
2. Remove Exist Chain Link Fence Sta 19+00 @ Rt to Sta 23+50 @ Lt, 400 LF
3. Clear and Grub, 0.6 Ac
4. Exist Tel-FO Cable (Protect In Place)
5. Exist 8-5/8" High Pressure Gas Line Protect In Place (El Paso NG)
6. Rubble & Debris Removal, 10 Tons

◯ CONSTRUCTION ◯

1. New 12' Wide (Single) Access Gate, Chain Link Fence (MAG Std Det 160) Sta 19+90, 30.7' Lt
2. New (4) 60" RGRCP x 58 LF (232 LF) @ Lt and Inlet & Outlet Headwalls Detail 13 & 22 (P11/43)
3. 50' Roadway Transition, Match Exist Airport Perimeter Road, Sta 22+19.06, Off=44.66' Lt to Sta 22+69.05, Off=49.64'
4. New Concrete Channel Inlet Apron, See (B6/8)
5. New 30" RGRCP 122 LF with Outlet End Section w/ Drop Inlet Headwall (MAG Std Det 501-5) (P10/43)
6. New Dumped Riprap Outlet Protection, 4 CY (11/12) (P10/43)
7. New 4' BW Dirt Irr Ditch, 83 LF, see Sta 22+07.25, Off 66.00' Lt to Sta 22+90.00, Off 66.00' Lt; See (F4/11) (P10/43)
8. New Chain Link Fence 422 LF @ Lt, (MAG Std Det 160), See Table 7c For Locations (7c/55)
9. New 24' Wide (Double 12') Access Gate, Chain Link Fence (MAG Std Det 160) East Pole at Sta 23+00, Off=24.00' Lt
10. New Gabion Basket Wire, 12 LF Sta 22+03.44, Off=56.97' Rt to Sta 22+06.84, Off=68.48' Rt (13c/61)
11. New Safety Posts (Fixed) (7 ea) at Sta 23+00 Off 3' Lt, 9' Lt, 15' Lt, 9' Rt, and 15' Rt and Sta 21+60, Off 0' Lt and 6' Lt.
12. New Removeable Safety Post, 2 ea at Sta 23+00, Off 3' Rt and Sta 21+60, Off 6' Rt; see (17/63)
13. 15' O & M Road w/ 4" AB; 370 LF @ Lt
14. New Gravel Mulch, 233 SY
15. New Concrete Channel Lining 15' Bottom Width (East of Tributary Channel) (B3/8)
16. New 4-Wire Fence, 50 LF @ Rt Sta 19+00 to Sta 19+50, see Table 7a for Locations (7a/55) (16/63)
17. Fill In and Compact to 95% See Inset Detail For Spot Elevations
18. Compact Embankment to 95%, See (B3/8)
19. Channel Transition, Sec B3 to B6, Sta 21+62.73 to Sta 21+90.22

NO.	REVISION	BY	DATE
3			
2			
1			

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
ENGINEERING DIVISION

BULLARD WASH
CHANNEL IMPROVEMENTS PROJECT
PROJECT NO. 4700731

PRELIMINARY NOT FOR CONSTRUCTION

	BY	DATE
DESIGNED	D. STOUGH	10/05/98
DRAWN	B. EDGAR	10/05/98
CHECKED	R. MILES/B. OLBERT	10/05/98

Sverdrup CORPORATION

PLAN AND PROFILE (EAST TRIBUTARY)
STA 20+00.00 TO STA 23+00.00

SHEET 28 OF 81

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Plotted By: stoughde Date: 05-OCT-1998 14:25

AVERY

TESTHOLE S[illegible]MARY REPORT

REGISTERED LAND SURVEYOR
CERTIFICATE NO.
11751
DAVID SCOTT
HUSCHER
Date Signed 10/31/97
ARIZONA, U.S.A.

PREPARED BY:
Geotrack, Inc.
11219 N. 23rd Ave.
Phoenix, AZ 85029
(602) 331-3225

DATE: October 31, 1997
PROJECT NAME: Bullard Wash Channel
CONTRACT NO: FCD 95 - 39

Geotrack Project Number: 17047

UTILITY LOCATION REQUESTS					ACTUAL FIELD RECORDS					
TH #	Street	Coordinates (Actual)		Anticipated Utility	Date	Ground Elevation	Top Elevation	Bottom Elevation	Material Type Outside Diameter	Depth of Cover
		Northing	Easting							
1	N/A	47068.89	46130.96	8" HP Gas	10-24-97	935.46	928.22	N/A	9" Wrapped Steel	7.24'
2	N/A	46772.86	46232.81	8" HP Gas	10-24-97	939.03	934.04	N/A	9" Wrapped Steel	4.99'
3	N/A	46668.49	46272.64	8" HP Gas	10-24-97	938.80	934.79	N/A	9" Wrapped Steel	4.01'
4	N/A	46640.63	46312.60	8" HP Gas	10-24-97	939.55	934.69	N/A	9" Wrapped Steel	4.86'
5	N/A	46210.78	47064.02	8" HP Gas	10-24-97	927.05	922.30	N/A	9" Wrapped Steel	4.75'
6	N/A	46928.54	48209.96	8" HP Gas	- - -	- - -	- - -	- - -	Attempted-Not Found Due To Concrete Debris in Embankment	- - -
7	MC 85	45810.32	46231.45	20" HP Petroleum	10-23-97	921.33	917.36	N/A	21" Coated Steel	3.97'
8	MC 85	45821.96	46311.28	20" HP Petroleum	10-23-97	920.98	917.06	N/A	21" Coated Steel	3.92'
9	MC 85	45802.95	46231.25	12" HP Petroleum	10-23-97	920.74	917.70	N/A	13" Coated Steel	3.04'
10	MC 85	45814.38	46311.27	12" HP Petroleum	10-23-97	921.47	917.49	N/A	13" Coated Steel	3.98'
11	MC 85	45867.53	46271.35	Telephone F.O.	10-23-97	921.27	917.41	N/A	2 ½" Plastic Conduit	3.86'
12	Broadway Rd	44683.09	46269.51	15" San. Sewer	10-23-97	918.56	910.72	N/A	15" Plastic	7.84'
13	Broadway Rd	44668.39	46269.58	Telephone	10-23-97	918.52	916.03	N/A	0.5" Direct Buried Cable	2.49'

TESTHOLE S MARY REPORT

REGISTERED LAND SURVEYOR
CERTIFICATE NO.
11751
DAVID SCOTT
HUSCHER
Date Signed 10/31/97
ARIZONA, U.S.A.

PREPARED BY:
Geotrack, Inc.
11219 N. 23rd Ave.
Phoenix, AZ 85029
(602) 331-3225

DATE: October 31, 1997
PROJECT NAME: Bullard Wash Channel
CONTRACT NO: FCD 95 - 39

Geotrack Project Number: 17047

UTILITY LOCATION REQUESTS					*ACTUAL FIELD RECORDS*					
TH #	Street	Coordinates (Actual)		Anticipated Utility	Date	Ground Elevation	Top Elevation	Bottom Elevation	Material Type Outside Diameter	Depth of Cover
		Northing	Easting							
14	Broadway Rd	44665.09	46269.77	Telephone F.O.	10-24-97	918.53	913.83	N/A	4 ½" Steel Conduit	4.70'
15	N/A	41305.10	46242.68	2" Gas	10-23-97	908.53	905.89	N/A	2 ½" Coated Steel	2.64'

UTILITY LOCATION REPORT

Geotrack, Inc.
SURVEYORS • UTILITY LOCATORS
11219 N. 23rd Avenue Phoenix, Arizona 85029
(602) 331-3225 FAX (602) 331-8837

CREW CHIEF TORTORELLI
CREW MEMBERS SANCHEZ, POPOV
CHECKED BY: DK

GEOTRACK PROJECT NO. 17047
CUSTOMER PROJECT NO. FCD-95-39
TEST HOLE NO. 1
DATE DUG 10-24-97

GENERAL LOCATION GOODYEAR-PHOENIX AIRPORT @ BULLARD WASH ALIGNMENT
SIZE/TYPE/MATERIAL ANTICIPATED 8" H.P. GAS LINE
PAVING CONDITION BEFORE WORK DIRT WASH W/ WATER
JURISDICTION CITY OF GOODYEAR, AZ

ELEVATION B.M. 939.03 DESCRIPTION TBM #62: 200d NAIL APPX. 150' EAST OF P.H. #1
ROD READING (+) 7.03
H.I. (=) 946.06 B.M. GIVEN/ASSUMED/SURVEYED BY GEOTRACK
(-) 10.60 ROD READING AT SURFACE
(=) 935.46 ELEVATION AT SURFACE
(-) 17.84 ROD READING TOP UTILITY
(=) 928.22 ELEVATION TOP UTILITY
(-) ROD READING BOTTOM UTILITY
(=) ELEVATION BOTTOM UTILITY

PK/HUB/ST PIN/CHSLD "X"/OTHER

CHECK BACK TO B.M. (BREAK SET-UP)
SURFACE ELEV. 935.46
ROD READING (+) 11.20
H.I. (=) 946.66
ROD READING B.M. (-) 7.60
B.M. ELEV CHECK (=) 939.06

ACCURACY CHECK
DEPTH (MEASURED) 7.20'
DEPTH (SURVEYED) 7.24'
DIFFERENCE 0.04'
BOTTOM (MEASURED)
BOTTOM (SURVEYED)
DIFFERENCE

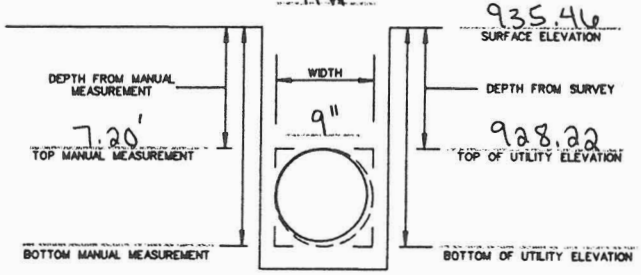
R/W = RIGHT OF WAY
NTS = NOT TO SCALE
PL = PROPERTY LINE
B/C = BACK OF CURB
BW = BUILDING WALL
℄ = CENTER LINE
EP = EDGE OF PAVMENT
PC = POINT OF CURVATURE
S/W = SIDEWALK
D/W = DRIVEWAY
BM = BENCHMARK
CB = CATCH BASIN
○ = MANHOLE
● = TEST HOLE
◇ = FIRE HYDRANT
Ø = POLE

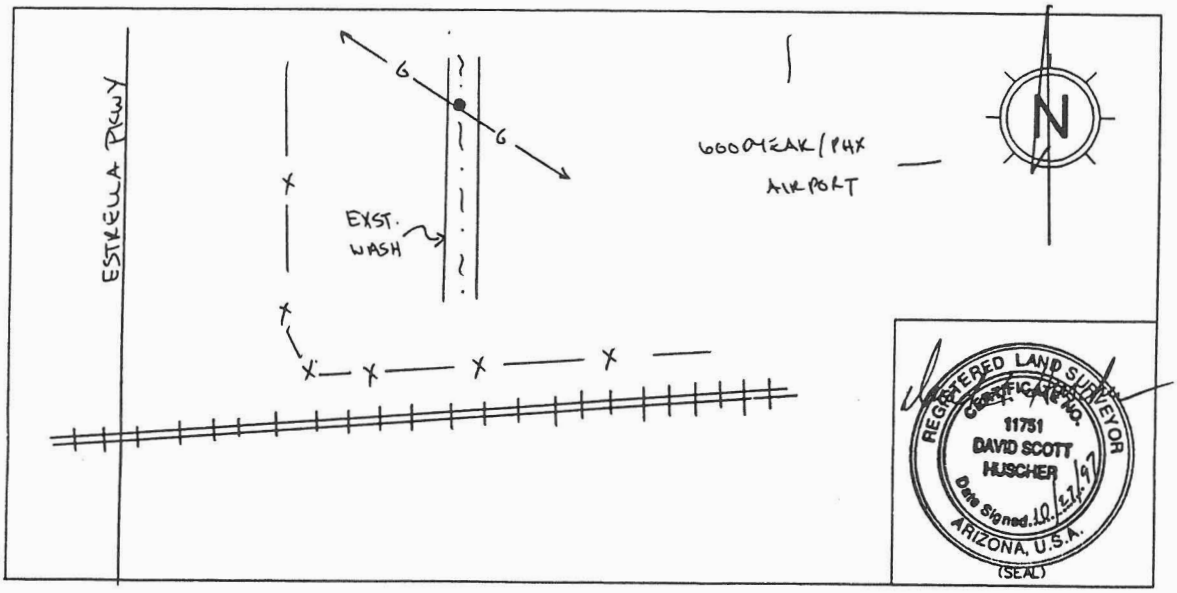
CROSS SECTIONAL VIEW
NOT TO SCALE

FACING NW

PK/HUB/ST PIN/CHSLD "X"/OTHER SET AT ℄ UTILITY

COLOR RIBBON YELLOW





T.H. DUG ____' RT LT OF ____ DESC ℄ ____ ℄ STATION ____ N/A STREET NAME

WAS REQUESTED UTILITY FOUND? YES NO O.D./TYPE 9" W/STL. GAS LINE
PAVING THICKNESS & TYPE N/A SOIL TYPE WET, SOFT
REMARKS:

T.H. COORDINATES N. 47068.89
E. 46130.96

UTILITY LOCATION REPORT

CREW CHIEF MOSS
CREW MEMBERS CRUZ
SANCHEZ
CHECKED BY: DH

Geotrack, Inc.
SURVEYORS • UTILITY LOCATORS
11219 N. 23rd Avenue (602) 331-3225
Phoenix, Arizona 85029 FAX (602) 331-8837

GEOTRACK PROJECT NO. 17047
CUSTOMER PROJECT NO. FCD 95-39
TEST HOLE NO. 2
DATE DUG 10-24-97

GENERAL LOCATION GOODYEAR - PHOENIX AIRPORT @ BULLARD WASH ALIGNMENT
SIZE/TYPE/MATERIAL ANTICIPATED 8" H.P. GAS LINE
PAVING CONDITION BEFORE WORK DIRT FIELD
JURISDICTION CITY OF GOODYEAR, AZ

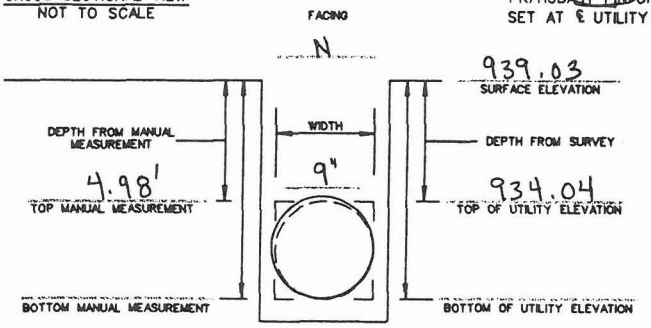
ELEVATION B.M. 939.03 DESCRIPTION TBM 62: 200d NAIL, APPX. 150' EAST OF
ROD READING (+) 7.03 P.H. #1
H.I. (=) 946.06 B.M. GIVEN/ASSUMED/SURVEYED BY GEOTRACK
(-) 7.03 ROD READING AT SURFACE
(=) 939.03 ELEVATION AT SURFACE PK/HUB/ST PIN/CHSLD "X"/OTHER
(-) 12.02 ROD READING TOP UTILITY
(=) 934.04 ELEVATION TOP UTILITY
(-) ROD READING BOTTOM UTILITY
(=) ELEVATION BOTTOM UTILITY

CHECK BACK TO B.M. (BREAK SET-UP)
SURFACE ELEV. 939.03
ROD READING (+) 7.60
H.I. (=) 946.63
ROD READING B.M. (-) 7.60
B.M. ELEV CHECK (=) 939.03

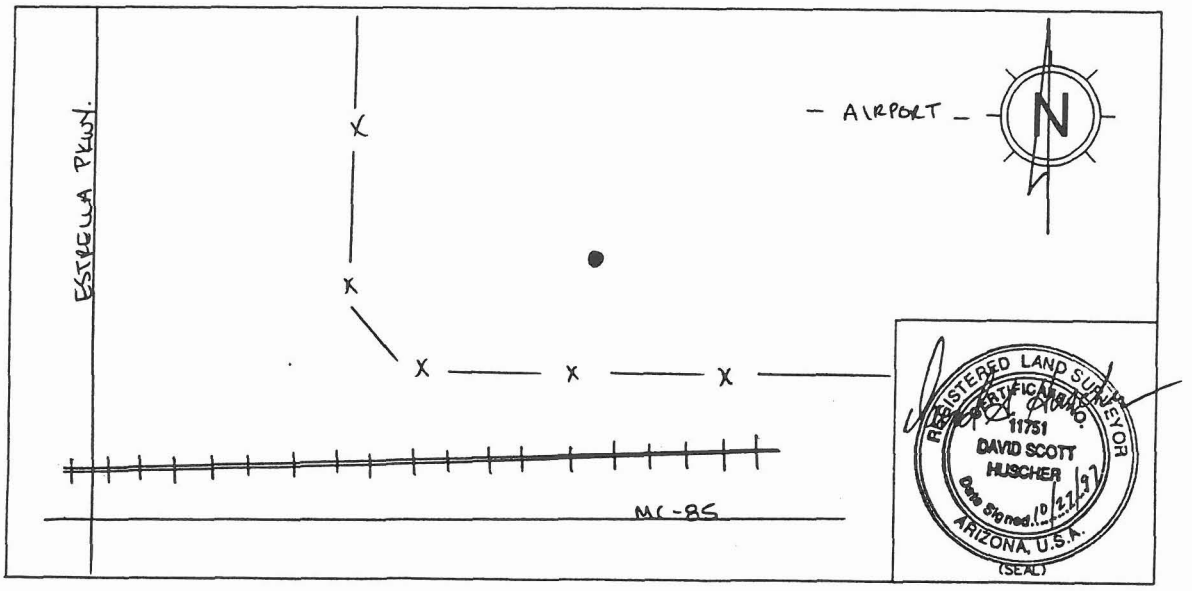
ACCURACY CHECK
DEPTH (MEASURED) 4.98'
DEPTH (SURVEYED) 4.99'
DIFFERENCE 0.01'
BOTTOM (MEASURED)
BOTTOM (SURVEYED)
DIFFERENCE

R/W = RIGHT OF WAY
NTS = NOT TO SCALE
PL = PROPERTY LINE
B/C = BACK OF CURB
BW = BUILDING WALL
℄ = CENTER LINE
EP = EDGE OF PAVMENT
PC = POINT OF CURVATURE
S/W = SIDEWALK
D/W = DRIVEWAY
BM = BENCHMARK
CB = CATCH BASIN
○ = MANHOLE
● = TEST HOLE
◇ = FIRE HYDRANT
Ø = POLE

CROSS SECTIONAL VIEW
NOT TO SCALE



PK/HUB/ST PIN/CHSLD "X"/OTHER
SET AT ℄ UTILITY
COLOR RIBBON YELLOW



T.H. DUG ____' RT LT OF ____ DESC ℄ ____ ℄ STATION ____ N/A STREET NAME

WAS REQUESTED UTILITY FOUND? YES NO O.D./TYPE 9" W/STL. GAS LINE
PAVING THICKNESS & TYPE N/A SOIL TYPE DRY, SOFT
REMARKS:
T.H. COORDINATES: N. 46772.86
E. 46232.81

UTILITY LOCATION REPORT

CREW CHIEF MOSS
CREW MEMBERS SANCHEZ, CRUZ
CHECKED BY: DH

Geotrack, Inc.
SURVEYORS • UTILITY LOCATORS
11219 N. 23rd Avenue Phoenix, Arizona 85029
(602) 331-3225 FAX (602) 331-8837

GEOTRACK PROJECT NO. 17047
CUSTOMER PROJECT NO. FCD 95-39
TEST HOLE NO. 3
DATE DUG 10-24-97

GENERAL LOCATION GOODYEAR - PHOENIX AIRPORT @ BULLARD WASH ALIGNMENT
SIZE/TYPE/MATERIAL ANTICIPATED 8" H.P. GAS LINE
PAVING CONDITION BEFORE WORK DIRT FIELD
JURISDICTION GOODYEAR, AZ

ELEVATION B.M. 938.02 DESCRIPTION TBM #61: N.W. CORN CONC. VAULT APPX. 300' SE OF P.H.'S #2, 3 & 4.
ROD READING (+) 5.88
H.I. (=) 943.90 B.M. GIVEN/ASSUMED/SURVEYED BY GEOTRACK
(-) 5.10 ROD READING AT SURFACE
(=) 938.80 ELEVATION AT SURFACE PK/HUB/ST PIN/CHSLD "X"/OTHER
(-) 9.11 ROD READING TOP UTILITY
(=) 934.79 ELEVATION TOP UTILITY
(-) ROD READING BOTTOM UTILITY
(=) ELEVATION BOTTOM UTILITY

CHECK BACK TO B.M. (BREAK SET-UP)
SURFACE ELEV. 938.80
ROD READING (+) 5.28
H.I. (=) 944.08
ROD READING B.M. (-) 6.07
B.M. ELEV CHECK (=) 938.01

ACCURACY CHECK
DEPTH (MEASURED) 4.04'
DEPTH (SURVEYED) 4.01'
DIFFERENCE 0.03'
BOTTOM (MEASURED)
BOTTOM (SURVEYED)
DIFFERENCE

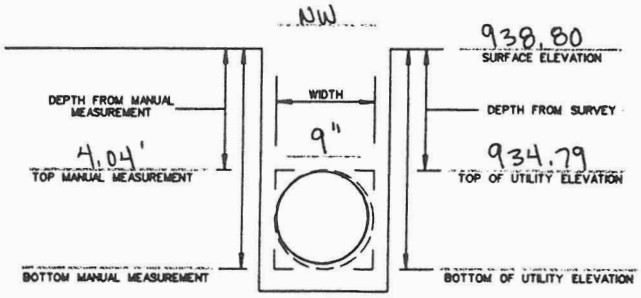
R/W = RIGHT OF WAY
NTS = NOT TO SCALE
PL = PROPERTY LINE
B/C = BACK OF CURB
BW = BUILDING WALL
℄ = CENTER LINE
EP = EDGE OF PAVMENT
PC = POINT OF CURVATURE
S/W = SIDEWALK
D/W = DRIVEWAY
BM = BENCHMARK
CB = CATCH BASIN
○ = MANHOLE
● = TEST HOLE
◇ = FIRE HYDRANT
Ø = POLE

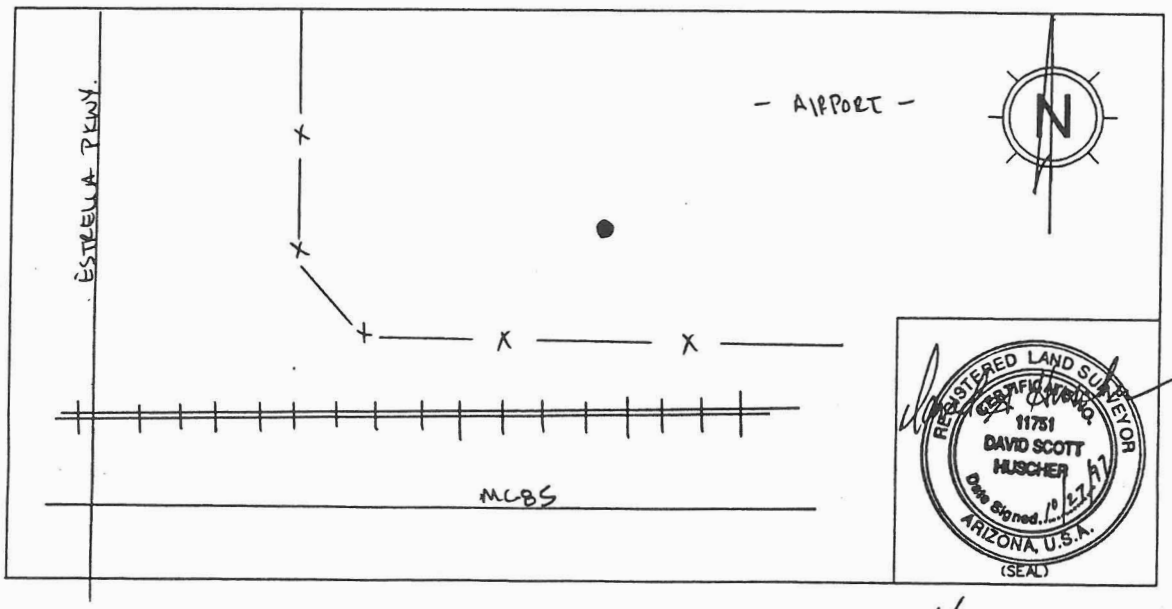
CROSS SECTIONAL VIEW
NOT TO SCALE

FACING NW

PK/HUB/ST PIN/CHSLD "X"/OTHER
SET AT ℄ UTILITY

COLOR RIBBON YELLOW





T.H. DUG ____' RT LT OF ____ DESC ℄ ____ ℄ STATION N/A STREET NAME

WAS REQUESTED UTILITY FOUND? YES NO O.D./TYPE 9" W/STL. GAS LINE
PAVING THICKNESS & TYPE N/A SOIL TYPE DRY, SOFT
REMARKS:
T.H. COORDINATES: N. 46668.49
E. 46272.64

UTILITY LOCATION REPORT

CREW CHIEF MOSS
CREW MEMBERS CRUZ
CHECKED BY: DH

Geotrack, Inc.
SURVEYORS • UTILITY LOCATORS
11219 N. 23rd Avenue (602) 331-3225
Phoenix, Arizona 85029 FAX (602) 331-8837

GEOTRACK PROJECT NO. 17047
CUSTOMER PROJECT NO. FCD 95-39
TEST HOLE NO. 4
DATE DUG 10-24-97

GENERAL LOCATION GOODYEAR-PHOENIX AIRPORT AT BULLARD WASH ALIGNMENT
SIZE/TYPE/MATERIAL ANTICIPATED 8" H.P. GAS LINE
PAVING CONDITION BEFORE WORK DIRT FIELD
JURISDICTION CITY OF GOODYEAR, AZ

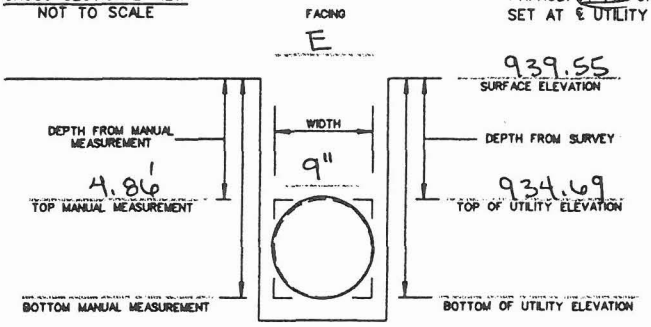
ELEVATION B.M. 938.02 DESCRIPTION TBM #61: NW CORN. CONC. VAULT APPROX. 300' SEAST OF P.H.'s # 2, 3 AND 4
ROD READING (+) 6.07
H.I. (=) 944.09 B.M. GIVEN/ASSUMED/SURVEYED BY GEOTRACK
(-) 4.54 ROD READING AT SURFACE
(=) 939.55 ELEVATION AT SURFACE PK/HUB/ST PIN/CHSLD "X"/OTHER
(-) 9.40 ROD READING TOP UTILITY
(=) 934.69 ELEVATION TOP UTILITY
(-) ROD READING BOTTOM UTILITY
(=) ELEVATION BOTTOM UTILITY

CHECK BACK TO B.M. (BREAK SET-UP)
SURFACE ELEV. 939.55
ROD READING (+) 5.00
H.I. (=) 944.55
ROD READING B.M. (-) 6.52
B.M. ELEV CHECK (=) 938.03

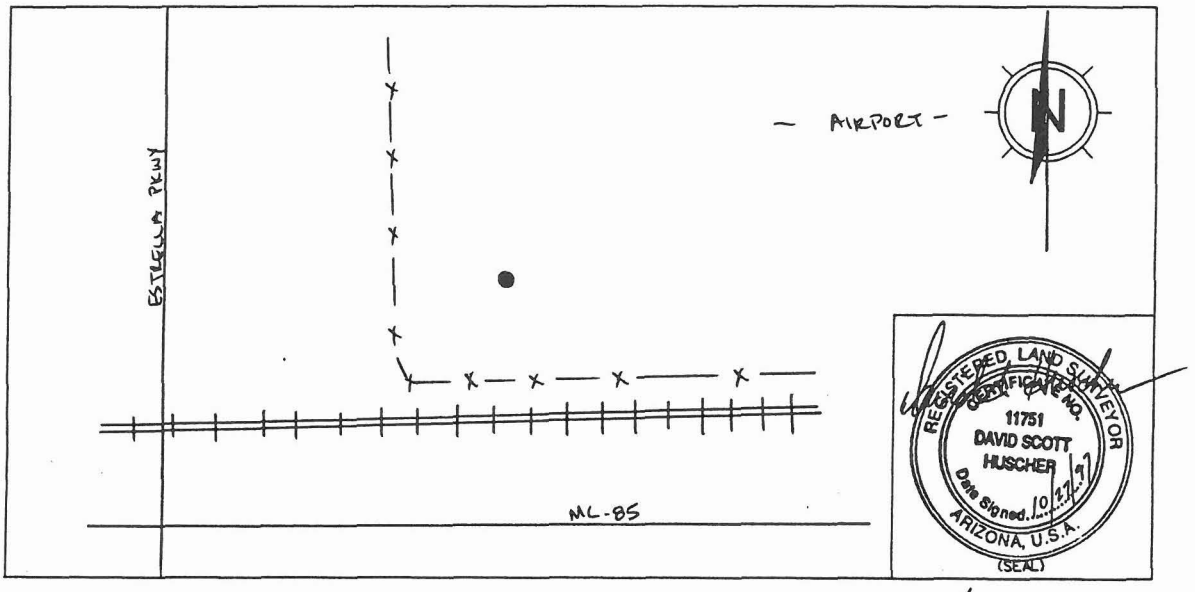
ACCURACY CHECK
DEPTH (MEASURED) 4.86'
DEPTH (SURVEYED) 4.86'
DIFFERENCE 0.00'
BOTTOM (MEASURED)
BOTTOM (SURVEYED)
DIFFERENCE

R/W = RIGHT OF WAY
NTS = NOT TO SCALE
PL = PROPERTY LINE
B/C = BACK OF CURB
BW = BUILDING WALL
℄ = CENTER LINE
EP = EDGE OF PAVMENT
PC = POINT OF CURVATURE
S/W = SIDEWALK
D/W = DRIVEWAY
BM = BENCHMARK
CB = CATCH BASIN
○ = MANHOLE
● = TEST HOLE
◇ = FIRE HYDRANT
Ø = POLE

CROSS SECTIONAL VIEW
NOT TO SCALE



PK/HUB/ST PIN/CHSLD "X"/OTHER
SET AT ℄ UTILITY
COLOR RIBBON YELLOW



T.H. DUG ____' RT LT OF ____ ℄ ____ N/A
DESC ℄ STATION STREET NAME

WAS REQUESTED UTILITY FOUND? (YES) NO O.D./TYPE 9" W/STL GAS LINE
PAVING THICKNESS & TYPE N/A SOIL TYPE HARD, DRY
REMARKS:
T.H. COORDINATES: N. 46640.63
E. 46312.60

UTILITY LOCATION REPORT

CREW CHIEF TORTORELLI
CREW MEMBERS CRUZ
POPOV
CHECKED BY: DH

Geotrack, Inc.
SURVEYORS • UTILITY LOCATORS
11219 N. 23rd Avenue (602) 331-3225
Phoenix, Arizona 85029 FAX (602) 331-8837

GEOTRACK PROJECT NO. 17047
CUSTOMER PROJECT NO. FCD 95-39
TEST HOLE NO. 5
DATE DUG 10-24-97

GENERAL LOCATION GOODYEAR-PHOENIX AIRPORT ~~E~~ N. OF R.R. TRACKS
SIZE/TYPE/MATERIAL ANTICIPATED 8" H.P. GAS LINE
PAVING CONDITION BEFORE WORK DIRT RDWY / FIELD
JURISDICTION CITY OF GOODYEAR, AZ
ELEVATION B.M. 924.63 DESCRIPTION TBM#59: 1/2" REBAR APPROX. 10' N. OF FENCE AND 300' W. OF P.H. #5.

ROD READING	(+) 6.76		
H.I.	(=) 931.39	B.M. GIVEN/ASSUMED/SURVEYED BY GEOTRACK	
	(-) 4.34	ROD READING AT SURFACE	
	(=) 927.05	ELEVATION AT SURFACE	PK/HUB/ST PIN/CHSLD "X"/OTHER
	(-) 9.09	ROD READING TOP UTILITY	
	(=) 922.30	ELEVATION TOP UTILITY	
	(-)	ROD READING BOTTOM UTILITY	
	(=)	ELEVATION BOTTOM UTILITY	

CHECK BACK TO B.M. (BREAK SET-UP)

SURFACE ELEV.		927.05
ROD READING	(+)	3.82
H.I.	(=)	930.87
ROD READING B.M.	(-)	6.26
B.M. ELEV CHECK	(=)	924.61

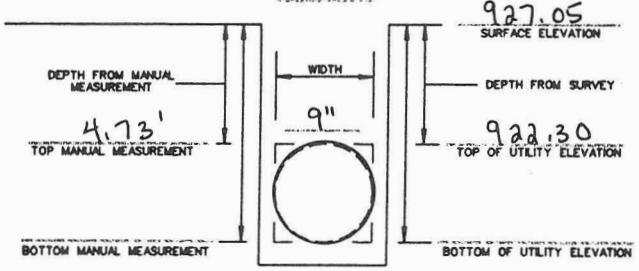
ACCURACY CHECK

DEPTH (MEASURED)	4.73'
DEPTH (SURVEYED)	4.75'
DIFFERENCE	0.02'
BOTTOM (MEASURED)	
BOTTOM (SURVEYED)	
DIFFERENCE	

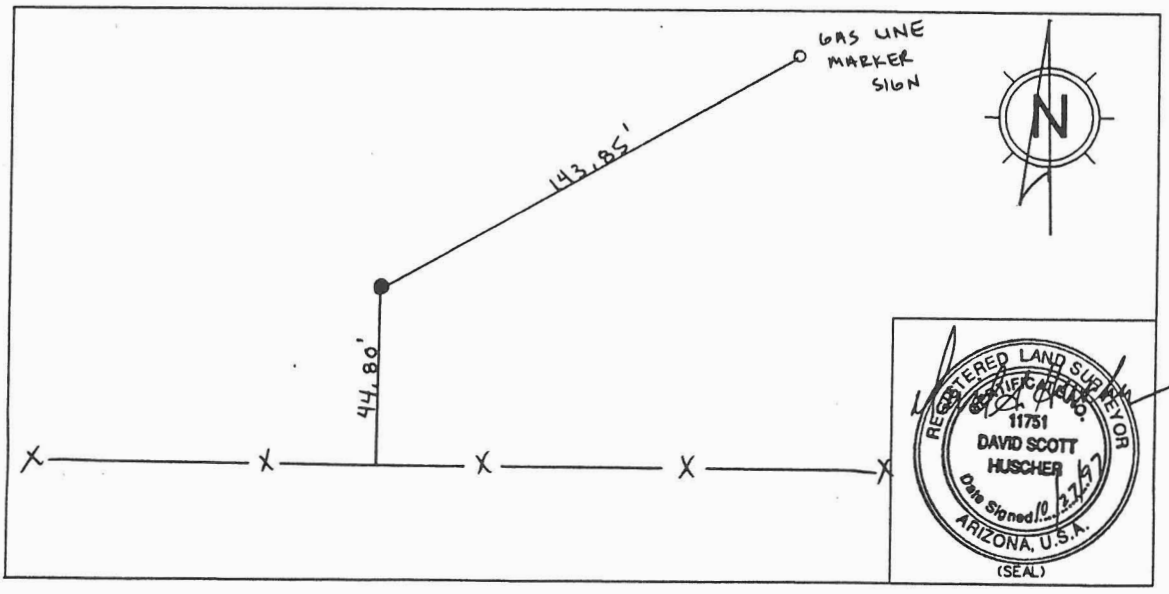
R/W = RIGHT OF WAY
NTS = NOT TO SCALE
PL = PROPERTY LINE
B/C = BACK OF CURB
BW = BUILDING WALL
℄ = CENTER LINE
EP = EDGE OF PAVMENT
PC = POINT OF CURVATURE
S/W = SIDEWALK
D/W = DRIVEWAY
BM = BENCHMARK
CB = CATCH BASIN
○ = MANHOLE
● = TEST HOLE
◇ = FIRE HYDRANT
Ø = POLE

CROSS SECTIONAL VIEW
NOT TO SCALE

FACING NW



PK/HUB/ST PIN/CHSLD "X"/OTHER
SET AT ℄ UTILITY
COLOR RIBBON YELLOW



T.H. DUG ____' RT LT OF ____ DESC ℄ ____ ℄ STATION N/A STREET NAME

WAS REQUESTED UTILITY FOUND? YES NO O.D./TYPE 9" W/STL. GAS LINE
PAVING THICKNESS & TYPE N/A SOIL TYPE HARD, DRY
REMARKS:

T.H. COORDINATES: N. 46210.78
E. 47064.02

UTILITY LOCATION REPORT

CREW CHIEF TORTORELLI
CREW MEMBERS SANCHEZ
MUÑOZ
CHECKED BY: DH

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Phoenix, Arizona 85029 FAX (602) 331-8837

GEOTRACK PROJECT NO. 17047
CUSTOMER PROJECT NO. FCD 95-39
TEST HOLE NO. 7
DATE DUG 10-23-97

GENERAL LOCATION N. SIDE MC 85, ± 1,000' EAST OF ESTRELLA PKWY.
SIZE/TYPE/MATERIAL ANTICIPATED 20" PETROLEUM PIPELINE
PAVING CONDITION BEFORE WORK DIRT R.O.W.
JURISDICTION CITY OF GOODYEAR, AZ
ELEVATION B.M. 923.12 DESCRIPTION TBM #58: B.C. ON H.W., SOUTH SIDE MC 85
ROD READING (+) 4.46
H.I. (=) 927.58 B.M. GIVEN/ASSUMED/SURVEYED BY GEOTRACK
(-) 6.25 ROD READING AT SURFACE
(=) 921.33 ELEVATION AT SURFACE PK/HUB/ST PIN/CHSLD "X"/OTHER
(-) 10.22 ROD READING TOP UTILITY
(=) 917.36 ELEVATION TOP UTILITY
(-) ROD READING BOTTOM UTILITY
(=) ELEVATION BOTTOM UTILITY

CHECK BACK TO B.M. (BREAK SET-UP)
SURFACE ELEV. 921.33
ROD READING (+) 6.44
H.I. (=) 927.77
ROD READING B.M. (-) 4.65
B.M. ELEV CHECK (=) 923.12

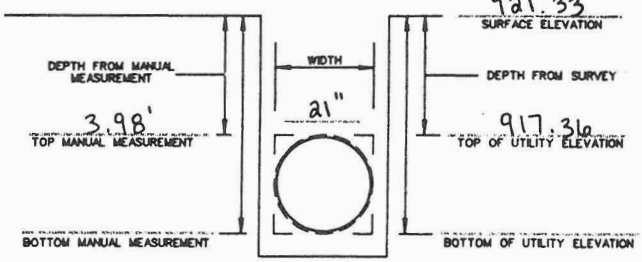
ACCURACY CHECK
DEPTH (MEASURED) 3.98'
DEPTH (SURVEYED) 3.97'
DIFFERENCE 0.01'
BOTTOM (MEASURED)
BOTTOM (SURVEYED)
DIFFERENCE

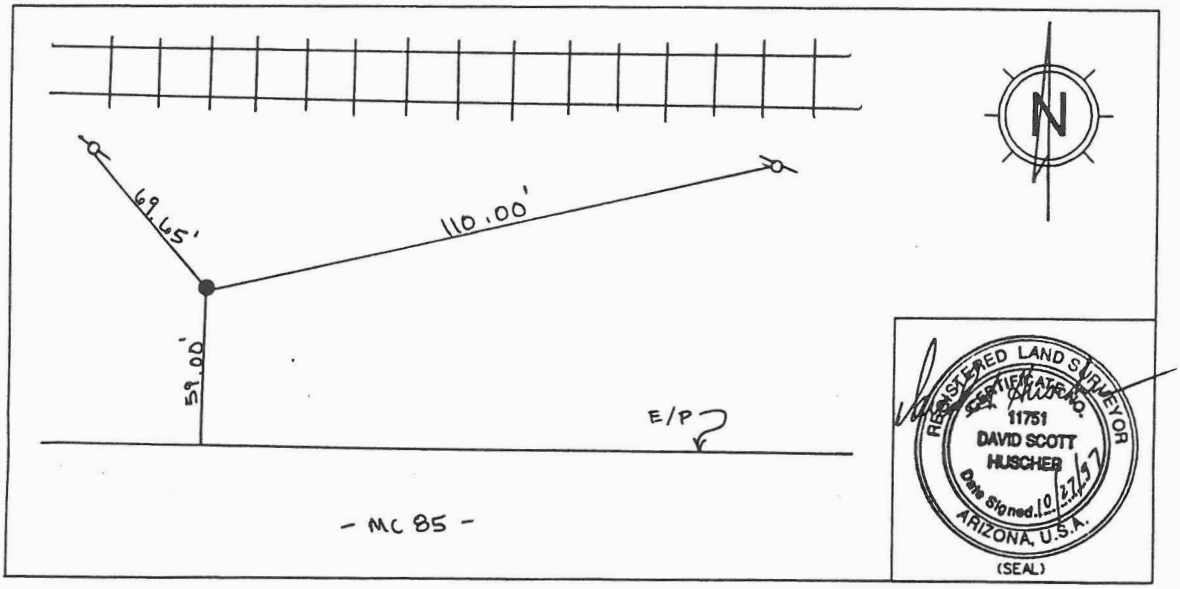
R/W = RIGHT OF WAY
NTS = NOT TO SCALE
PL = PROPERTY LINE
B/C = BACK OF CURB
BW = BUILDING WALL
℄ = CENTER LINE
EP = EDGE OF PAVMENT
PC = POINT OF CURVATURE
S/W = SIDEWALK
D/W = DRIVEWAY
BM = BENCHMARK
CB = CATCH BASIN
○ = MANHOLE
● = TEST HOLE
◇ = FIRE HYDRANT
Ø = POLE

CROSS SECTIONAL VIEW
NOT TO SCALE

FACING EAST

PK/HUB/ST PIN/CHSLD "X"/OTHER
SET AT ℄ UTILITY
COLOR RIBBON YELLOW





REGISTERED LAND SURVEYOR
CERTIFICATE NO. 11751
DAVID SCOTT HUSCHER
Date Signed 10/27/97
ARIZONA, U.S.A.
(SEAL)

T.H. DUG ____' RT LT OF ____ DESC ℄ ____ ℄ STATION ____ MC 85 STREET NAME

WAS REQUESTED UTILITY FOUND? (YES) NO O.D./TYPE 21" COATED STEEL PETROLEUM LINE
PAVING THICKNESS & TYPE N/A SOIL TYPE HARD, DRY
REMARKS:
T.H. COORDINATES: N. 45810.32
E. 46231.45

UTILITY LOCATION REPORT

CREW CHIEF MOSS
CREW MEMBERS CRUZ
TORTORELLI
CHECKED BY: DH

Geotrack, Inc.
SURVEYORS • UTILITY LOCATORS
11219 N. 23rd Avenue (602) 331-3225
Phoenix, Arizona 85029 FAX (602) 331-8837

GEOTRACK PROJECT NO. 17047
CUSTOMER PROJECT NO. FCD 95-39
TEST HOLE NO. 8
DATE DUG 10-23-97

GENERAL LOCATION N. SIDE MC 85, ± 1300' EAST OF ESTRELLA PKWY.
SIZE/TYPE/MATERIAL ANTICIPATED 20" PETROLEUM PIPELINE
PAVING CONDITION BEFORE WORK DIRT R.O.W.
JURISDICTION CITY OF GOODYEAR, AZ

ELEVATION B.M.	923.12	DESCRIPTION	TBM 58: B.C. ON H.W. - S. SIDE MC 85
ROD READING	(+) 4.46		
H.I.	(=) 927.58	B.M. ~~GIVEN~~/ASSUMED/SURVEYED BY GEOTRACK	
	(-) 6.60	ROD READING AT SURFACE	
	(=) 920.98	ELEVATION AT SURFACE	PK/HUB/ST PIN/CHSLD "X"/OTHER
	(-) 10.52	ROD READING TOP UTILITY	
	(=) 917.06	ELEVATION TOP UTILITY	
	(-)	ROD READING BOTTOM UTILITY	
	(=)	ELEVATION BOTTOM UTILITY	

CHECK BACK TO B.M. (BREAK SET-UP)

SURFACE ELEV.		920.98
ROD READING	(+)	6.77
H.I.	(=)	927.75
ROD READING B.M.	(-)	4.65
B.M. ELEV CHECK	(=)	923.10

ACCURACY CHECK

DEPTH (MEASURED)	3.92'
DEPTH (SURVEYED)	3.92'
DIFFERENCE	0.00'
BOTTOM (MEASURED)	
BOTTOM (SURVEYED)	
DIFFERENCE	

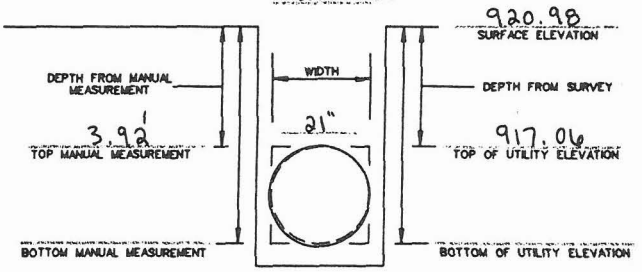
R/W = RIGHT OF WAY
NTS = NOT TO SCALE
PL = PROPERTY LINE
B/C = BACK OF CURB
BW = BUILDING WALL
℄ = CENTER LINE
EP = EDGE OF PAVMENT
PC = POINT OF CURVATURE
S/W = SIDEWALK
D/W = DRIVEWAY
BM = BENCHMARK
CB = CATCH BASIN
○ = MANHOLE
● = TEST HOLE
◇ = FIRE HYDRANT
Ø = POLE

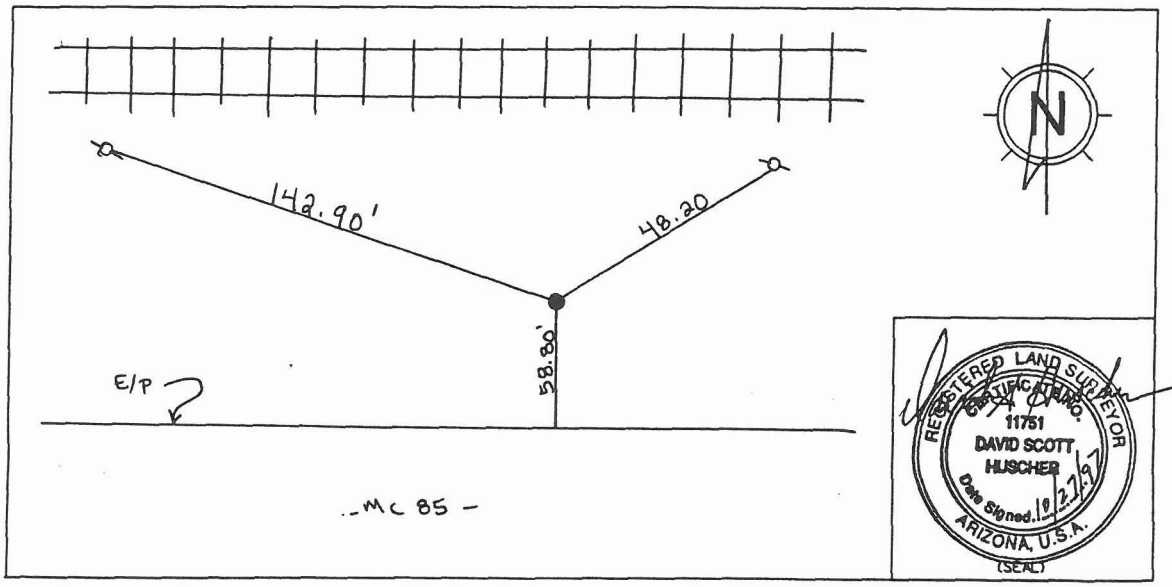
CROSS SECTIONAL VIEW
NOT TO SCALE

FACING
21" EAST

PK/HUB/ST PIN/CHSLD "X"/OTHER
SET AT ℄ UTILITY

COLOR RIBBON YELLOW





REGISTERED LAND SURVEYOR
CERTIFICATE NO.
11751
DAVID SCOTT HUSCHER
Date Signed 10/27/97
ARIZONA, U.S.A.
(SEAL)

T.H. DUG ____' RT LT OF ____ ℄ ____ MC 85
DESC ℄ STATION STREET NAME

WAS REQUESTED UTILITY FOUND? YES NO O.D./TYPE 21" COATED STEEL PETROLEUM PIPELINE
PAVING THICKNESS & TYPE N/A SOIL TYPE HARD, DRY
REMARKS:

T.H. COORDINATES: N. 45821.96
E. 46311.28

UTILITY LOCATION REPORT

Geotrack, Inc.
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11219 N. 23rd Avenue (602) 331-3225
Phoenix, Arizona 85029 FAX (602) 331-8837

CREW CHIEF TORTORELLI
CREW MEMBERS SANCHEZ, MUÑOZ
CHECKED BY: DH

GEOTRACK PROJECT NO. 17047
CUSTOMER PROJECT NO. FCD 95-39
TEST HOLE NO. 9
DATE DUG 10-23-97

GENERAL LOCATION N. SIDE MC85, ± 1200' EAST OF ESTRELLA PKWY.
SIZE/TYPE/MATERIAL ANTICIPATED 12" PETROLEUM PIPELINE
PAVING CONDITION BEFORE WORK DIRT R.O.W.
JURISDICTION CITY OF GOODYEAR, AZ

ELEVATION B.M. 923.12 DESCRIPTION TBM #58: B.C. IN H.W., S. SIDE MC85

ROD READING	(+)	4.46
H.I.	(=)	927.58
	(-)	6.84
	(=)	920.74
	(-)	9.88
	(=)	917.70
	(-)	
	(=)	

B.M. GIVEN/ASSUMED/SURVEYED BY GEOTRACK

ROD READING AT SURFACE
ELEVATION AT SURFACE
ROD READING TOP UTILITY
ELEVATION TOP UTILITY
ROD READING BOTTOM UTILITY
ELEVATION BOTTOM UTILITY

PK/HUB/ST PIN/CHSLD "X"/OTHER

CHECK BACK TO B.M. (BREAK SET-UP)

SURFACE ELEV.		920.74
ROD READING	(+)	7.02
H.I.	(=)	927.76
ROD READING B.M.	(-)	4.65
B.M. ELEV CHECK	(=)	923.11

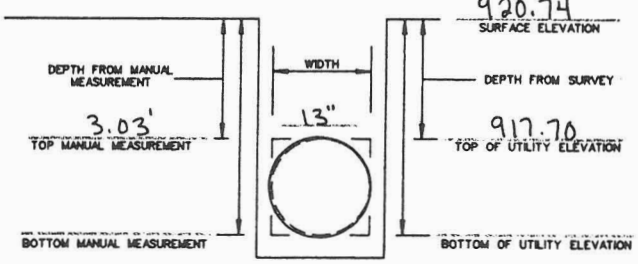
ACCURACY CHECK

DEPTH (MEASURED)	3.03'
DEPTH (SURVEYED)	3.04'
DIFFERENCE	.01'
BOTTOM (MEASURED)	
BOTTOM (SURVEYED)	
DIFFERENCE	

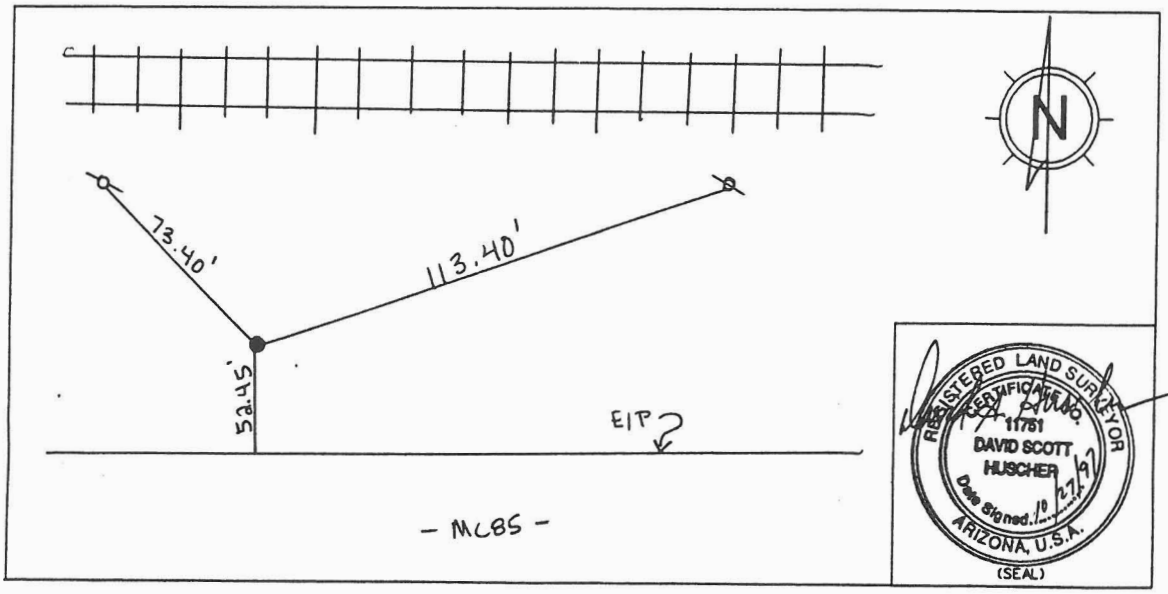
R/W = RIGHT OF WAY
NTS = NOT TO SCALE
PL = PROPERTY LINE
B/C = BACK OF CURB
BW = BUILDING WALL
℄ = CENTER LINE
EP = EDGE OF PAVMENT
PC = POINT OF CURVATURE
S/W = SIDEWALK
D/W = DRIVEWAY
BM = BENCHMARK
CB = CATCH BASIN
○ = MANHOLE
● = TEST HOLE
◇ = FIRE HYDRANT
Ø = POLE

CROSS SECTIONAL VIEW
NOT TO SCALE

FACING EAST



PK/HUB/ST PIN/CHSLD "X"/OTHER
SET AT ℄ UTILITY
COLOR RIBBON YELLOW



REGISTERED LAND SURVEYOR
CERTIFICATE NO. 11751
DAVID SCOTT HUSCHER
Date Signed 10/27/97
ARIZONA, U.S.A.
(SEAL)

T.H. DUG ____' RT LT OF ____ ℄ ____ MC 85
DESC ℄ STATION STREET NAME

WAS REQUESTED UTILITY FOUND? (YES) NO O.D./TYPE 13" COATED STEEL PETROLEUM LINE
PAVING THICKNESS & TYPE N/A SOIL TYPE HARD, DRY
REMARKS:

T.H. COORDINATES: N. 45802.95
E. 46231.25

UTILITY LOCATION REPORT

Geotrack, Inc.
SURVEYORS • UTILITY LOCATORS
11219 N. 23rd Avenue Phoenix, Arizona 85029
(602) 331-3225 FAX (602) 331-8837

CREW CHIEF: MOSS
CREW MEMBERS: CRUZ, TORTORELLI
CHECKED BY: DH

GEOTRACK PROJECT NO. 17047
CUSTOMER PROJECT NO. FCD 95-39
TEST HOLE NO. 10
DATE DUG 10-23-97

GENERAL LOCATION: N. SIDE MC85 ± 1300' EAST OF ESTRELLA PKWY
SIZE/TYPE/MATERIAL ANTICIPATED: 12" PETROLEUM PIPELINE
PAVING CONDITION BEFORE WORK: DIRT R.O.W.
JURISDICTION: CITY OF GOODYEAR, AZ

ELEVATION B.M. 923.12 DESCRIPTION: TBM #581 B.C. ON H.W. - S. SIDE MC85

ROD READING	(+) 4.46		
H.I.	(=) 927.58	B.M. GIVEN/ASSUMED/SURVEYED BY GEOTRACK	
	(-) 6.11	ROD READING AT SURFACE	
	(=) 921.47	ELEVATION AT SURFACE	PK/HUB/ST PIN/CHSLD "X"/OTHER
	(-) 10.09	ROD READING TOP UTILITY	
	(=) 917.49	ELEVATION TOP UTILITY	
	(-)	ROD READING BOTTOM UTILITY	
	(=)	ELEVATION BOTTOM UTILITY	

CHECK BACK TO B.M. (BREAK SET-UP)

SURFACE ELEV.		921.47
ROD READING	(+)	6.30
H.I.	(=)	927.77
ROD READING B.M.	(-)	4.65
B.M. ELEV CHECK	(=)	923.12

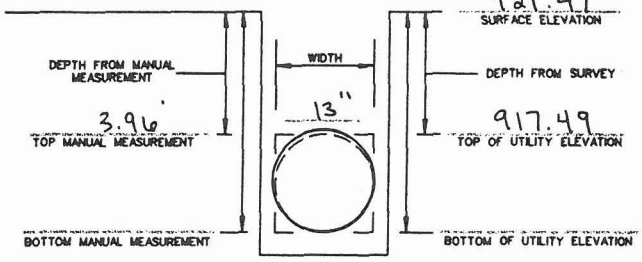
ACCURACY CHECK

DEPTH (MEASURED)	3.96'
DEPTH (SURVEYED)	3.98'
DIFFERENCE	0.02'
BOTTOM (MEASURED)	
BOTTOM (SURVEYED)	
DIFFERENCE	

R/W = RIGHT OF WAY
NTS = NOT TO SCALE
PL = PROPERTY LINE
B/C = BACK OF CURB
BW = BUILDING WALL
℄ = CENTER LINE
EP = EDGE OF PAVMENT
PC = POINT OF CURVATURE
S/W = SIDEWALK
D/W = DRIVEWAY
BM = BENCHMARK
CB = CATCH BASIN
○ = MANHOLE
● = TEST HOLE
◇ = FIRE HYDRANT
Ø = POLE

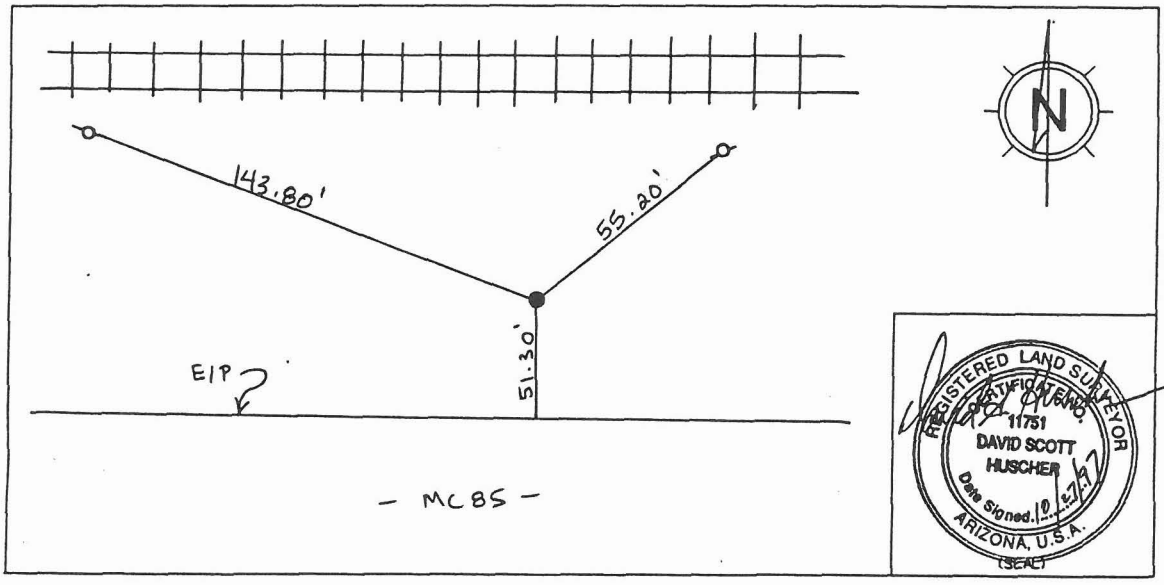
CROSS SECTIONAL VIEW
NOT TO SCALE

FACING: EAST



PK/HUB/ST PIN/CHSLD "X"/OTHER SET AT ℄ UTILITY

COLOR RIBBON: YELLOW



REGISTERED LAND SURVEYOR
CERTIFICATE NO. 11751
DAVID SCOTT HUSCHER
Date Signed 10-27-97
ARIZONA, U.S.A.
(SEAL)

T.H. DUG ____' RT LT OF ____ ℄ ____ MC 85
DESC ℄ STATION STREET NAME

WAS REQUESTED UTILITY FOUND? (YES) NO O.D./TYPE 13" COATED STEEL PETROLEUM LINE
PAVING THICKNESS & TYPE N/A SOIL TYPE HARD, DRY
REMARKS:

T.H. COORDINATES: N. 45814.38
E. 46311.27

UTILITY LOCATION REPORT

CREW CHIEF TORTORELLI
CREW MEMBERS SANCHEZ
MUÑOZ
CHECKED BY: DH

Geotrack, Inc.
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11219 N. 23rd Avenue (602) 331-3225
Phoenix, Arizona 85029 FAX (602) 331-8837

GEOTRACK PROJECT NO. 17047
CUSTOMER PROJECT NO. FCD 95-39
TEST HOLE NO. 11
DATE DUG 10-23-97

GENERAL LOCATION N. SIDE MC85, ± 1200' EAST OF ESTRELLA PKWY.
SIZE/TYPE/MATERIAL ANTICIPATED UNK. SIZE MCI - FIBER OPTIC TELEPHONE LINE
PAVING CONDITION BEFORE WORK DIRT R.O.W.
JURISDICTION CITY OF GOODYEAR

ELEVATION B.M. 923.12 DESCRIPTION TB.M 58 : B.C. ON H.W. SOUTH SIDE MC85.
ROD READING (+) 4.35
H.I. (=) 927.47 B.M. GIVEN/ASSUMED/SURVEYED BY GEOTRACK
(-) 6.20 ROD READING AT SURFACE
(=) 921.27 ELEVATION AT SURFACE PK/HUB/ST PIN/CHSLD "X"/OTHER
(-) 10.06 ROD READING TOP UTILITY
(=) 917.41 ELEVATION TOP UTILITY
(-) ROD READING BOTTOM UTILITY
(=) ELEVATION BOTTOM UTILITY

CHECK BACK TO B.M. (BREAK SET-UP)
SURFACE ELEV. 921.27
ROD READING (+) 6.06
H.I. (=) 927.33
ROD READING B.M. (-) 4.21
B.M. ELEV CHECK (=) 923.12

ACCURACY CHECK
DEPTH (MEASURED) 3.91'
DEPTH (SURVEYED) 3.86'
DIFFERENCE 0.05'
BOTTOM (MEASURED)
BOTTOM (SURVEYED)
DIFFERENCE

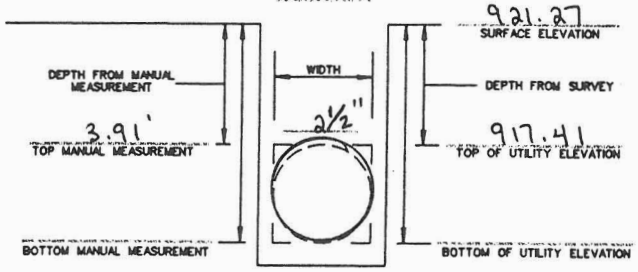
R/W = RIGHT OF WAY
NTS = NOT TO SCALE
PL = PROPERTY LINE
B/C = BACK OF CURB
BW = BUILDING WALL
℄ = CENTER LINE
EP = EDGE OF PAVMENT
PC = POINT OF CURVATURE
S/W = SIDEWALK
D/W = DRIVEWAY
BM = BENCHMARK
CB = CATCH BASIN
○ = MANHOLE
● = TEST HOLE
◇ = FIRE HYDRANT
Ø = POLE

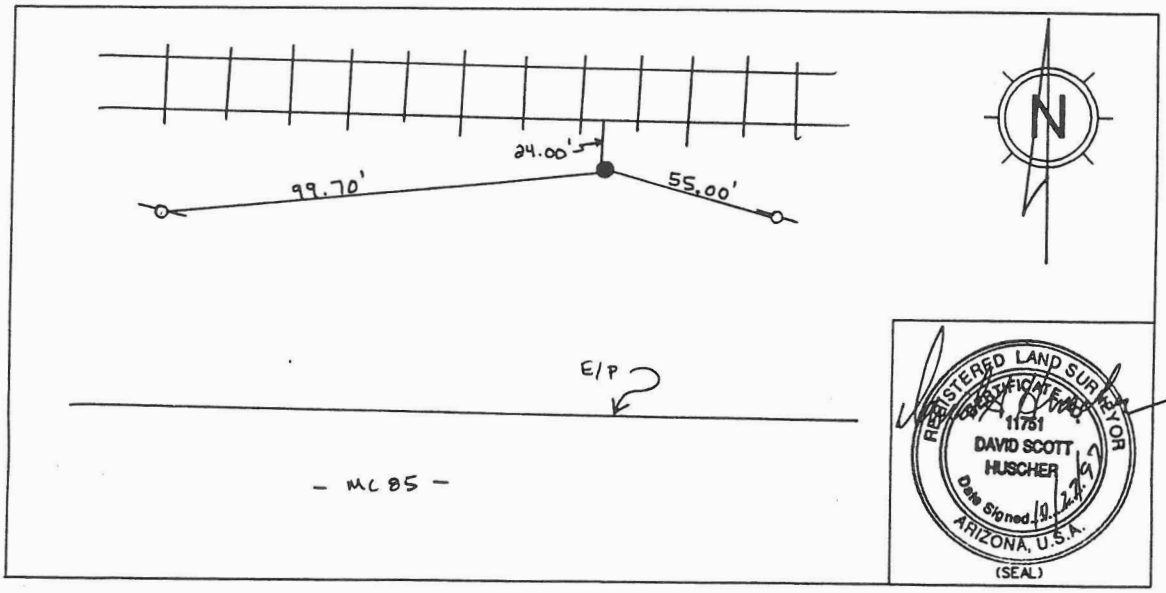
CROSS SECTIONAL VIEW
NOT TO SCALE

FACING EAST

PK/HUB/ST PIN/CHSLD "X"/OTHER
SET AT ℄ UTILITY

COLOR RIBBON ORANGE





T.H. DUG ____' RT LT OF ____ DESC ℄ ____ ℄ STATION MC 85 STREET NAME

WAS REQUESTED UTILITY FOUND? YES NO O.D./TYPE 2½" PLASTIC TELE. CONDUIT
PAVING THICKNESS & TYPE N/A SOIL TYPE HARD, DRY
REMARKS:
T.H. COORDINATES: N. 45867.53
E. 46271.35

UTILITY LOCATION REPORT

CREW CHIEF MOSS
CREW MEMBERS CRUZ
CHECKED BY: DK

Geotrack, Inc.
SURVEYORS • UTILITY LOCATORS
11219 N. 23rd Avenue (602) 331-3225
Phoenix, Arizona 85029 FAX (602) 331-8837

GEOTRACK PROJECT NO. 17047
CUSTOMER PROJECT NO. FCD 95-39
TEST HOLE NO. 12
DATE DUG 10-23-97

GENERAL LOCATION BROADWAY RD, ± 1200' EAST OF ESTRELLA PKWY.
SIZE/TYPE/MATERIAL ANTICIPATED 15" SANITARY SEWER LINE
PAVING CONDITION BEFORE WORK DIRT, GRAVEL ROADWAY
JURISDICTION CITY OF GOODYEAR, AZ

ELEVATION B.M. 918.83 DESCRIPTION TRAV. PNT. #110: 200d NAIL IN BROADWAY RD. AT BULLARD WASH ALIGNMENT
ROD READING (+) 4.91
H.I. (=) 923.74 B.M. GIVEN/ASSUMED/SURVEYED BY GEOTRACK
(-) 5.18 ROD READING AT SURFACE
(=) 918.56 ELEVATION AT SURFACE PK/HUB/ST PIN/CHSLD "X"/OTHER
(-) 13.02 ROD READING TOP UTILITY
(=) 910.72 ELEVATION TOP UTILITY
(-) ROD READING BOTTOM UTILITY
(=) ELEVATION BOTTOM UTILITY

CHECK BACK TO B.M. (BREAK SET-UP)
SURFACE ELEV. 918.56
ROD READING (+) 5.41
H.I. (=) 923.97
ROD READING B.M. (-) 5.14
B.M. ELEV CHECK (=) 918.83

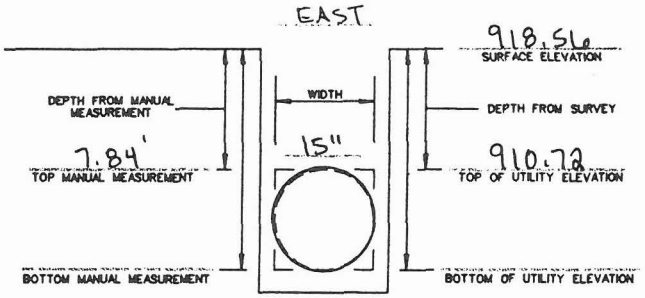
ACCURACY CHECK
DEPTH (MEASURED) 7.84'
DEPTH (SURVEYED) 7.84'
DIFFERENCE 0.00'
BOTTOM (MEASURED)
BOTTOM (SURVEYED)
DIFFERENCE

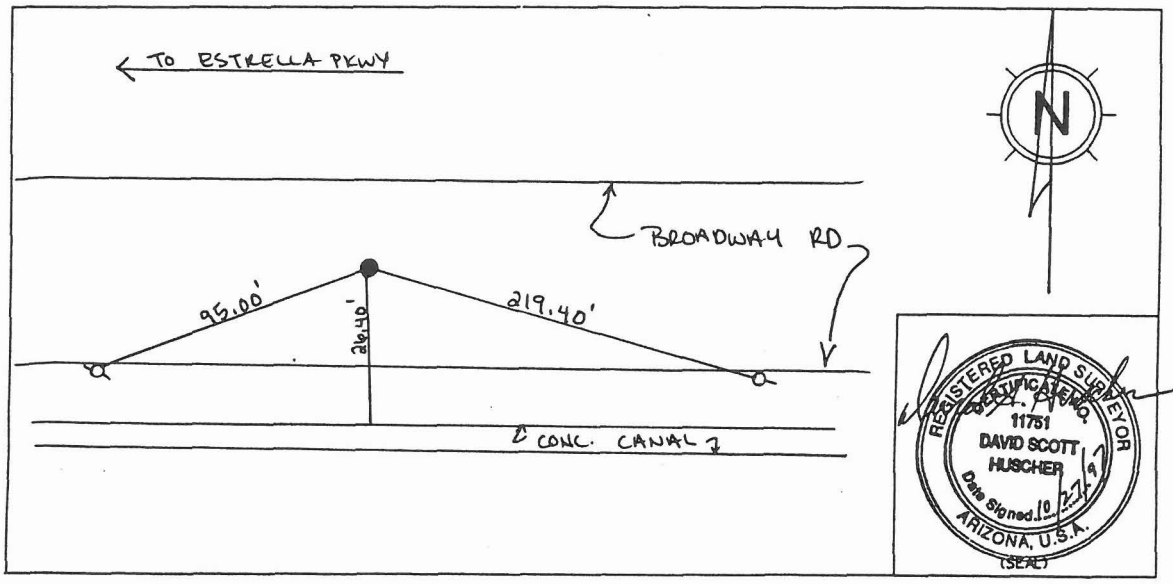
R/W = RIGHT OF WAY
NTS = NOT TO SCALE
PL = PROPERTY LINE
B/C = BACK OF CURB
BW = BUILDING WALL
℄ = CENTER LINE
EP = EDGE OF PAVMENT
PC = POINT OF CURVATURE
S/W = SIDEWALK
D/W = DRIVEWAY
BM = BENCHMARK
CB = CATCH BASIN
○ = MANHOLE
⊕ = TEST HOLE
◇ = FIRE HYDRANT
Ø = POLE

CROSS SECTIONAL VIEW
NOT TO SCALE

FACING EAST

PK/HUB/ST PIN/CHSLD "X"/OTHER
SET AT ℄ UTILITY
COLOR RIBBON GREEN





T.H. DUG ____' RT LT OF ____ DESC ℄ ____ STATION BROADWAY RD. STREET NAME

WAS REQUESTED UTILITY FOUND? YES NO O.D./TYPE 15" PLASTIC SANITARY SEWER
PAVING THICKNESS & TYPE N/A SOIL TYPE DRY, HARD
REMARKS:

T.H. COORDINATES: N. 44683.09
E. 46269.51

UTILITY LOCATION REPORT

CREW CHIEF MOSS
CREW MEMBERS CRUZ
CHECKED BY: DH

Geotrack, Inc.
SURVEYORS • UTILITY LOCATORS
11219 N. 23rd Avenue Phoenix, Arizona 85029
(602) 331-3225 FAX (602) 331-8837

GEOTRACK PROJECT NO. 17047
CUSTOMER PROJECT NO. FCD 95-39
TEST HOLE NO. 13
DATE DUG 10-23-97

GENERAL LOCATION BROADWAY RD. ± 1200' EAST OF ESTRELLA PKWY.
SIZE/TYPE/MATERIAL ANTICIPATED UNK. SIZE TELEPHONE LINE
PAVING CONDITION BEFORE WORK DIRT / GRAVEL RDWY.
JURISDICTION CITY OF GOODYEAR, AZ

ELEVATION B.M. 918.83
DESCRIPTION TRAN. PNT. #10: 200d NAIL IN BROADWAY RD AT BULLARD WASH ALIGNMENT
B.M. GIVEN/ASSUMED/SURVEYED BY GEOTRACK

ROD READING	(+)	4.91
H.I.	(=)	923.74
	(-)	5.22
	(=)	918.52
	(-)	7.71
	(=)	916.03
	(-)	
	(=)	

ROD READING AT SURFACE
ELEVATION AT SURFACE
ROD READING TOP UTILITY
ELEVATION TOP UTILITY
ROD READING BOTTOM UTILITY
ELEVATION BOTTOM UTILITY

PK/HUB/ST PIN/CHSLD "X"/OTHER

CHECK BACK TO B.M. (BREAK SET-UP)

SURFACE ELEV.		918.52
ROD READING	(+)	5.45
H.I.	(=)	923.97
ROD READING B.M.	(-)	5.14
B.M. ELEV CHECK	(=)	918.83

ACCURACY CHECK

DEPTH (MEASURED)	2.49'
DEPTH (SURVEYED)	2.49'
DIFFERENCE	0.00'
BOTTOM (MEASURED)	
BOTTOM (SURVEYED)	
DIFFERENCE	

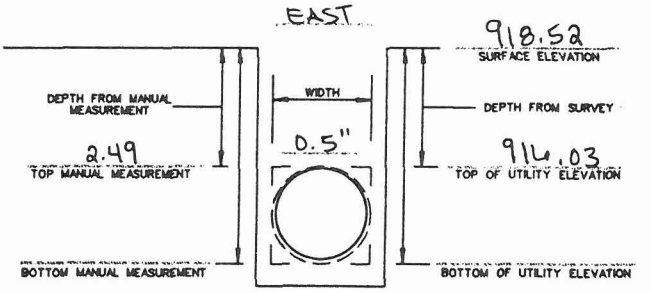
R/W = RIGHT OF WAY
NTS = NOT TO SCALE
PL = PROPERTY LINE
B/C = BACK OF CURB
BW = BUILDING WALL
℄ = CENTER LINE
EP = EDGE OF PAVMENT
PC = POINT OF CURVATURE
S/W = SIDEWALK
D/W = DRIVEWAY
BM = BENCHMARK
CB = CATCH BASIN
○ = MANHOLE
● = TEST HOLE
◇ = FIRE HYDRANT
Ø = POLE

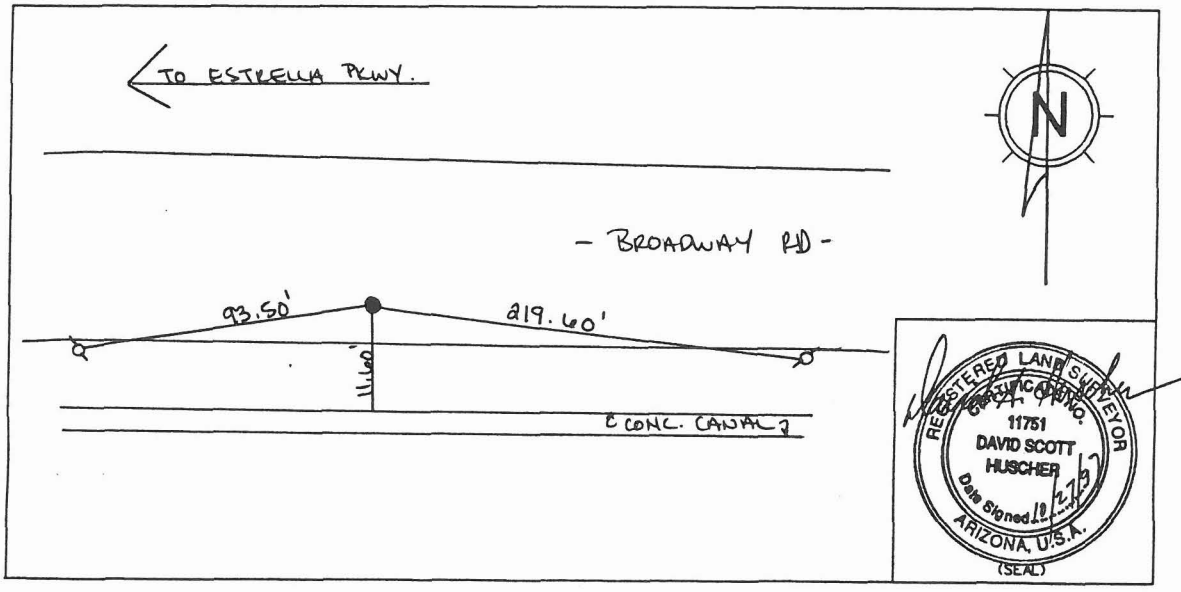
CROSS SECTIONAL VIEW
NOT TO SCALE

FACING EAST

PK/HUB/ST PIN/CHSLD "X"/OTHER
SET AT ℄ UTILITY

COLOR RIBBON ORANGE





T.H. DUG ____' RT LT OF ____ DESC ℄ ____ ℄ STATION BROADWAY RD STREET NAME

WAS REQUESTED UTILITY FOUND? YES NO O.D./TYPE 0.5" DIRECT BURIED TELE. CABLE
PAVING THICKNESS & TYPE N/A SOIL TYPE DRY, HARD
REMARKS:

T.H. COORDINATES: N. 44668.39
E. 46269.58

UTILITY LOCATION REPORT

CREW CHIEF MOSS
CREW MEMBERS CRUZ
CHECKED BY: DH

Geotrack, Inc.
SURVEYORS • UTILITY LOCATORS
11219 N. 23rd Avenue (602) 331-3225
Phoenix, Arizona 85029 FAX (602) 331-8837

GEOTRACK PROJECT NO. 17047
CUSTOMER PROJECT NO. FCD 95-39
TEST HOLE NO. 14
DATE DUG 10-24-97

GENERAL LOCATION BROADWAY RD. AT BULLARD WASH ALIGNMENT
SIZE/TYPE/MATERIAL ANTICIPATED UNK. SIZE FIBER OPTIC TELEPHONE LINE
PAVING CONDITION BEFORE WORK DIRT ROADWAY
JURISDICTION CITY OF GOODYEAR, AZ

ELEVATION B.M. 918.83 DESCRIPTION TRAV. PNT # 110: 200d NAIL IN BROADWAY RD. @ BULLARD WASH ALIGNMENT
ROD READING (+) 4.90
H.I. (=) 923.73 B.M. GIVEN/ASSUMED/SURVEYED BY GEOTRACK
(-) 5.20 ROD READING AT SURFACE
(=) 918.53 ELEVATION AT SURFACE PK/HUB/ST PIN/CHSLD "X"/OTHER
(-) 9.90 ROD READING TOP UTILITY
(=) 913.83 ELEVATION TOP UTILITY
(-) ROD READING BOTTOM UTILITY
(=) ELEVATION BOTTOM UTILITY

CHECK BACK TO B.M. (BREAK SET-UP)
SURFACE ELEV. 918.53
ROD READING (+) 5.01
H.I. (=) 923.54
ROD READING B.M. (-) 4.70
B.M. ELEV CHECK (=) 918.84

ACCURACY CHECK
DEPTH (MEASURED) 4.70'
DEPTH (SURVEYED) 4.70'
DIFFERENCE 0.00'
BOTTOM (MEASURED)
BOTTOM (SURVEYED)
DIFFERENCE

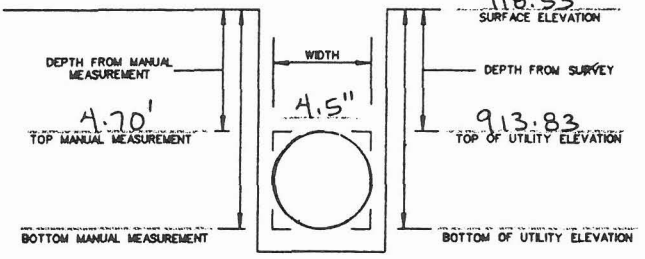
R/W = RIGHT OF WAY
NTS = NOT TO SCALE
PL = PROPERTY LINE
B/C = BACK OF CURB
BW = BUILDING WALL
℄ = CENTER LINE
EP = EDGE OF PAVMENT
PC = POINT OF CURVATURE
S/W = SIDEWALK
D/W = DRIVEWAY
BM = BENCHMARK
CB = CATCH BASIN
○ = MANHOLE
● = TEST HOLE
◇ = FIRE HYDRANT
Ø = POLE

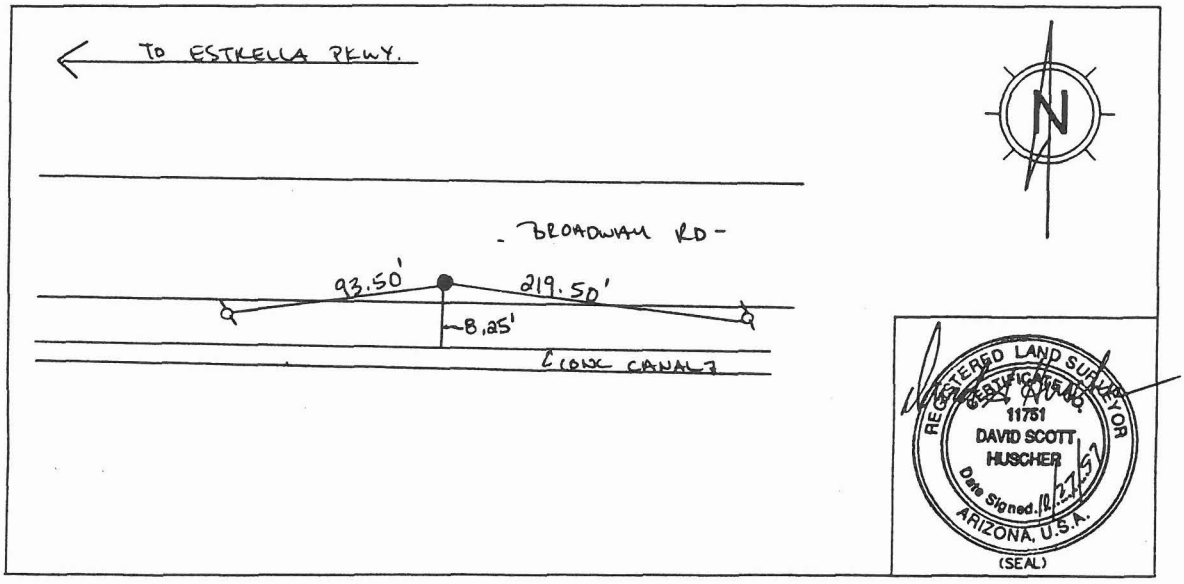
CROSS SECTIONAL VIEW
NOT TO SCALE

FACING W

PK/HUB/ST PIN/CHSLD "X"/OTHER
SET AT ℄ UTILITY

COLOR RIBBON ORANGE





REGISTERED LAND SURVEYOR
CERTIFICATE NO.
11751
DAVID SCOTT HUSCHER
Date Signed 12-27-97
ARIZONA, U.S.A.
(SEAL)

T.H. DUG ____' RT LT OF ____ ℄ ____ BROADWAY RD.
DESC ℄ STATION STREET NAME

WAS REQUESTED UTILITY FOUND? YES NO O.D./TYPE 4.5" STEEL CONDUIT FOR TELE. LINE
PAVING THICKNESS & TYPE N/A SOIL TYPE HARD, DRY
REMARKS:

T.H. COORDINATES: N. 44665.09
E. 46269.77

UTILITY LOCATION REPORT

CREW CHIEF MOSS
CREW MEMBERS SANCHEZ
MUÑOZ
CHECKED BY: DH

Geotrack, Inc.
SURVEYORS • UTILITY LOCATORS
11219 N. 23rd Avenue (602) 331-3225
Phoenix, Arizona 85029 FAX (602) 331-8837

GEOTRACK PROJECT NO. 17047
CUSTOMER PROJECT NO. FCD 95-39
TEST HOLE NO. 15
DATE DUG 10-23-97

GENERAL LOCATION S. SIDE BUCKEYE CANAL @ BULLARD WASH ALIGNMENT
SIZE/TYPE/MATERIAL ANTICIPATED 2" GAS LINE
PAVING CONDITION BEFORE WORK DIRT R.O.W.
JURISDICTION CITY OF GOODYEAR, AZ
ELEVATION B.M. 912.20 DESCRIPTION TBM 63: 60d NAIL - NORTH SIDE P.P. APPX. 100' E OF P.H. #15

ROD READING	(+)	3.00
H.I.	(=)	915.20
	(-)	6.67
	(=)	908.53
	(-)	9.31
	(=)	905.89
	(-)	
	(=)	

B.M. GIVEN/ASSUMED/SURVEYED BY GEOTRACK
ROD READING AT SURFACE
ELEVATION AT SURFACE
ROD READING TOP UTILITY
ELEVATION TOP UTILITY
ROD READING BOTTOM UTILITY
ELEVATION BOTTOM UTILITY

PK/HUB/ST PIN/CHSLD "X"/OTHER

CHECK BACK TO B.M. (BREAK SET-UP)

SURFACE ELEV.		908.53
ROD READING	(+)	6.40
H.I.	(=)	915.13
ROD READING B.M.	(-)	2.94
B.M. ELEV CHECK	(=)	912.19

ACCURACY CHECK

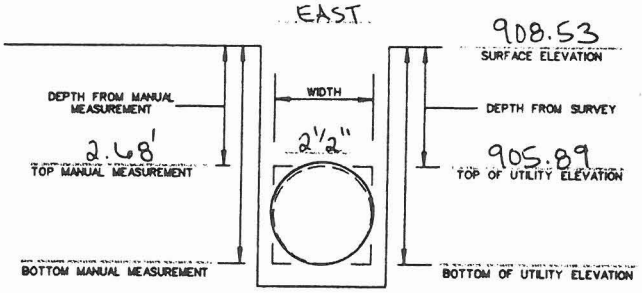
DEPTH (MEASURED)	2.68'
DEPTH (SURVEYED)	2.64'
DIFFERENCE	0.04'
BOTTOM (MEASURED)	
BOTTOM (SURVEYED)	
DIFFERENCE	

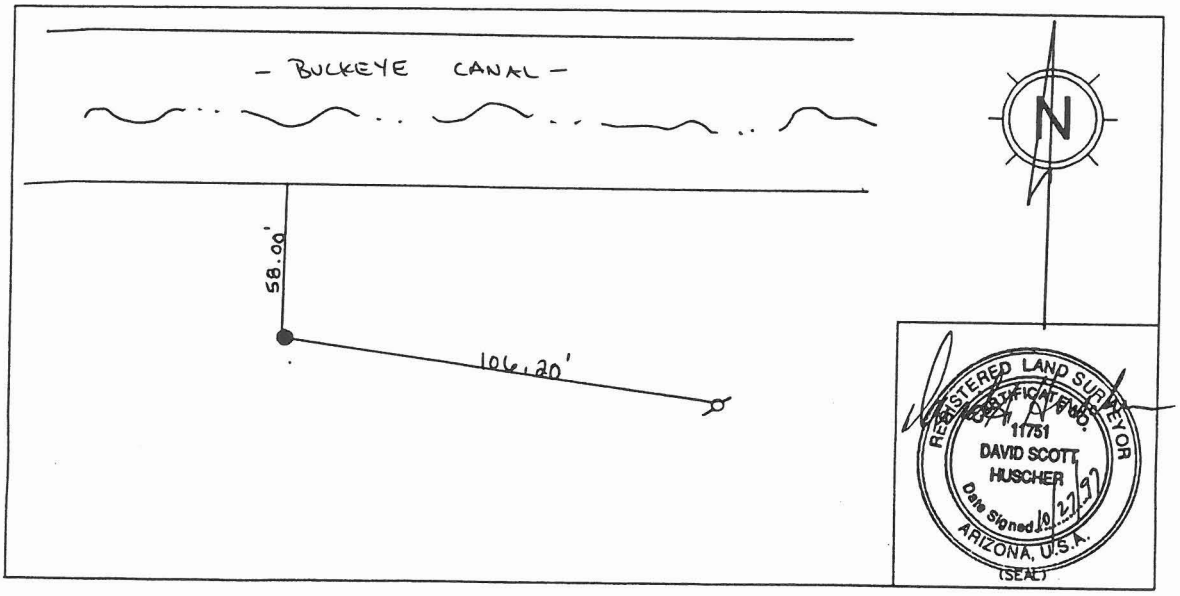
R/W = RIGHT OF WAY
NTS = NOT TO SCALE
PL = PROPERTY LINE
B/C = BACK OF CURB
BW = BUILDING WALL
℄ = CENTER LINE
EP = EDGE OF PAVMENT
PC = POINT OF CURVATURE
S/W = SIDEWALK
D/W = DRIVEWAY
BM = BENCHMARK
CB = CATCH BASIN
○ = MANHOLE
● = TEST HOLE
◇ = FIRE HYDRANT
Ø = POLE

CROSS SECTIONAL VIEW
NOT TO SCALE

FACING EAST

PK/HUB/ST PIN/CHSLD "X"/OTHER
SET AT ℄ UTILITY
COLOR RIBBON YELLOW





T.H. DUG ____' RT LT OF ____ DESC ℄ ____ ℄ STATION ____ N/A STREET NAME

WAS REQUESTED UTILITY FOUND? YES NO O.D./TYPE 2½" COATED STEEL GAS LINE
PAVING THICKNESS & TYPE N/A SOIL TYPE DRY, HARD
REMARKS:
T.H. COORDINATES: N. 41305.10
E. 46242.68

FLOOD CONTROL DISTRICT
OF MARICOPA COUNTY

2801 W. Durango, Phoenix, Arizona 85009
Fax: (602) 506-8561
Office: (602) 506-4074

E-mail: _____

Date: August 4, 1998

COVER SHEET

To: Brad Olbert Fax No. 303-9899

_____ Fax No. _____

From: Olin Sutton

Number of pages being sent including Cover Sheet: 5

SUBJECT: _____

Comments:

TESTH[illegible] SUMMARY REPORT

REGISTERED LAND SURVEYOR
CERTIFICATE NO.
11751
DAVID SCOTT
HUSCHER
Date Signed 7/21/98
ARIZONA, U.S.A.

PREPARED BY:
Geotrack, Inc.
11219 N. 23rd Ave.
Phoenix, AZ 85029
(602) 331-3225

DATE: July 21, 1998
PROJECT NAME: Bullard Wash
CONTRACT NO: FCD 96-11

Geotrack Project Number: 18052

UTILITY LOCATION REQUESTS					ACTUAL FIELD RECORDS					
TH #	Street	Station (Actual)	Offset RT/LT Feet (Actual)	Anticipated Utility	Date	Ground Elevation	Top Elevation	Bottom Elevation	Material Type Outside Diameter	De o Co
1	M.C. 85	660+69.57	RT 11.94	IXC/MCI F.O.	7-13-98	920.99	916.43	N/A	Abandoned 2" Plastic Conduit	4.5
2	M.C. 85	660+89.57	RT 12.17	IXC/MCI F.O.	7-13-98	920.97	916.33	N/A	Abandoned 2" Plastic Conduit	4.6
3	M.C. 85	661+09.45	RT 12.08	IXC/MCI F.O.	7-13-98	921.01	916.45	N/A	Abandoned 2" Plastic Conduit	4.5
4	M.C. 85	660+89.57	RT 12.17	IXC/MCI F.O.	7-15-98	- - -	- - -	- - -	Excavated to 15' Deep Below Abandoned Line - New Bored Facility Not Found	- -

UTILITY LOCATION REPORT

Geotrack, Inc.
SURVEYORS • UTILITY LOCATORS
11219 N. 23rd Avenue (602) 331-3225
Phoenix, Arizona 85029 FAX (602) 331-8837

CREW CHIEF T. MOSS
CREW MEMBERS R. SANCHEZ, J. ESSAM
CHECKED BY: DJH

GEOTRACK PROJECT NO. 18052
CUSTOMER PROJECT NO. FCD 96-11
TEST HOLE NO. 3
DATE DUG 7-13-98

GENERAL LOCATION SOUTH SIDE MC-85, ± 1400' EAST OF ESTRELLA PKWY.
SIZE/TYPE/MATERIAL ANTICIPATED 1XC/NCI FIBER OPTIC
PAVING CONDITION BEFORE WORK EARTH
JURISDICTION CITY OF GOODYEAR, AZ

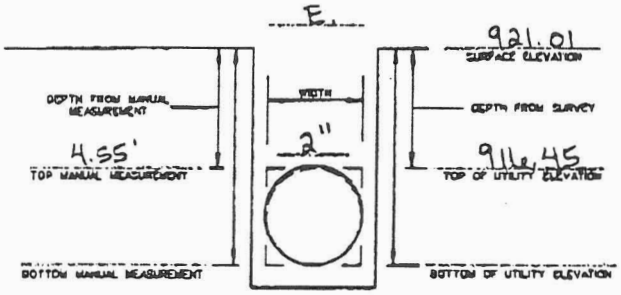
ELEVATION B.M. 923.12 DESCRIPTION TBM #58: B.C. ON H/W S. SIDE MC-85 ± 1800' E. OF ESTRELLA PKWY.
ROD READING (+) 3.35
H.I. (=) 926.47 B.M. GIVEN/ASSUMED/SURVEYED BY GEOTRACK
(-) 5.46 ROD READING AT SURFACE
(=) 921.01 ELEVATION AT SURFACE PK/HUB/ST.PIN/CHSLD "X"/OTHER
(-) 10.02 ROD READING TOP UTILITY
(=) 916.45 ELEVATION TOP UTILITY
(-) ROD READING BOTTOM UTILITY
(=) ELEVATION BOTTOM UTILITY

CHECK BACK TO B.M. (BREAK SET-UP)
SURFACE ELEV. 921.01
ROD READING (-) 5.23
H.I. (=) 926.24
ROD READING B.M.(-) 3.12
B.M. ELEV CHECK (=) 923.12

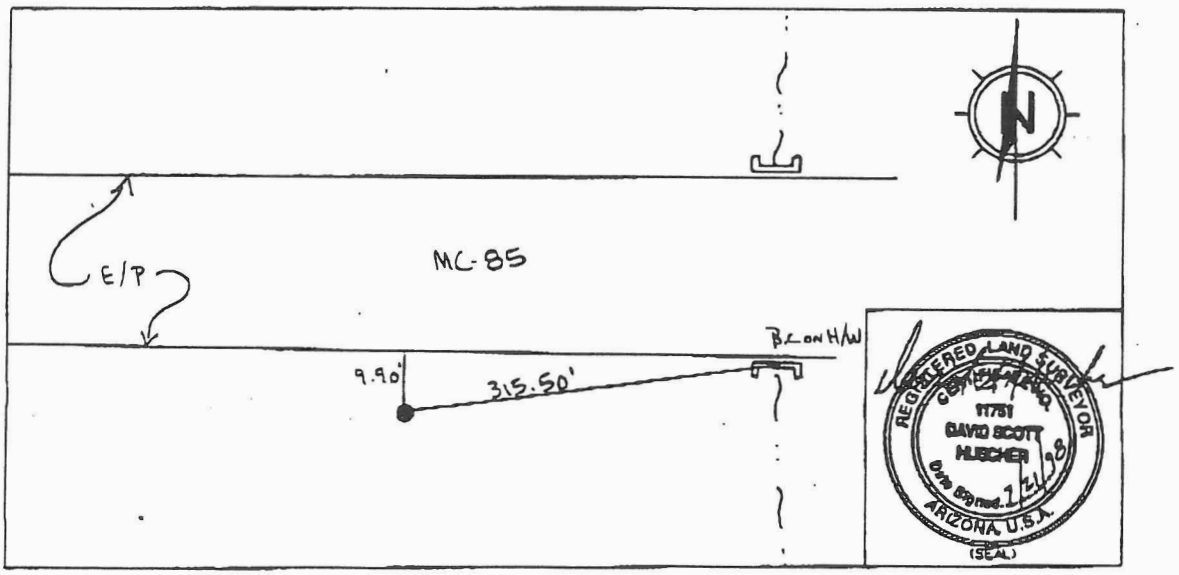
ACCURACY CHECK
DEPTH (MEASURED) 4.55'
DEPTH (SURVEYED) 4.56'
DIFFERENCE 0.01'
BOTTOM (MEASURED)
BOTTOM (SURVEYED)
DIFFERENCE

R/W - RIGHT OF WAY
NTS - NOT TO SCALE
PL - PROPERTY LINE
B/C - BACK OF CURB
BW - BUILDING WALL
℄ - CENTER LINE
EP - EDGE OF PAVEMENT
PC - POINT OF CURVATURE
S/W - SIDEWALK
D/W - DRIVEWAY
BM - BENCHMARK
CB - CATCH BASIN
○ - MANHOLE
● - TEST HOLE
◇ - FIRE HYDRANT
Ø - POLE

CROSS SECTIONAL VIEW
NOT TO SCALE



PK/HUB/ST PIN/CHSLD "X"/OTHER
SET AT ℄ UTILITY
COLOR RIBBON ORANGE



T.H. DUG 12 08 (RT) LT OF ℄ 1661+09.45 MC-85
DESC ℄ STATION STREET NAME

WAS REQUESTED UTILITY FOUND? (YES) NO O.D./TYPE 2" PLASTIC CONDUIT - ABAN.
PAVING THICKNESS & TYPE N/A SOIL TYPE DRY
REMARKS:

UTILITY LOCATION REPORT

Geotrack, Inc.
SURVEYORS • UTILITY LOCATORS
11219 N. 23rd Avenue (602) 331-3225
Phoenix, Arizona 85029 FAX (602) 331-8837

CREW CHIEF T. MOSS
CREW MEMBERS B. SANCHEZ
J. ESSAM
CHECKED BY: DH

GEOTRACK PROJECT NO. 18052
CUSTOMER PROJECT NO. ECD 96-11
TEST HOLE NO. 2
DATE DUG 7-13-98

GENERAL LOCATION SOUTH SIDE MC-85, ±1400' EAST OF ESTRELLA PKWY.
SIZE/TYPE/MATERIAL ANTICIPATED 1XC / MCI FIBER OPTIC
PAVING CONDITION BEFORE WORK EARTH
JURISDICTION CITY OF GOODYEAR, AZ

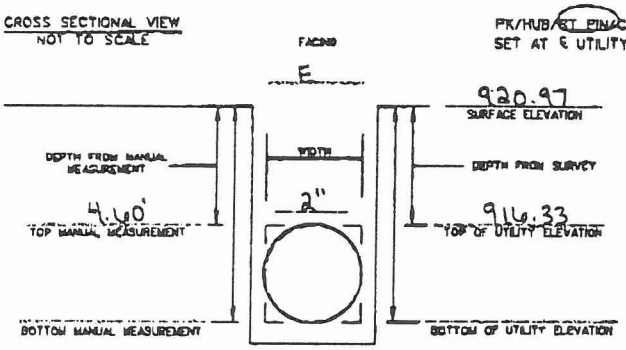
ELEVATION B.M. 923.12 DESCRIPTION TBM#58: B.C. ON N/W S. SIDE MC-85, ±1800' E. OF ESTRELLA PKWY.
ROD READING (-) 3.35
H.I. (=) 926.47 B.M. GIVEN/ASSUMED SURVEYED BY GEOTRACK
(-) 5.50 ROD READING AT SURFACE
(=) 920.97 ELEVATION AT SURFACE PK/HUB ST PIN CHSLD "X"/OTHER
(-) 10.14 ROD READING TOP UTILITY
(=) 916.33 ELEVATION TOP UTILITY
(-) ROD READING BOTTOM UTILITY
(=) ELEVATION BOTTOM UTILITY

CHECK BACK TO B.M. (BREAK SET-UP)
SURFACE ELEV. 920.97
ROD READING (+) 5.28
H.I. (=) 926.25
ROD READING B.M. (-) 3.12
B.M. ELEV CHECK (=) 923.13

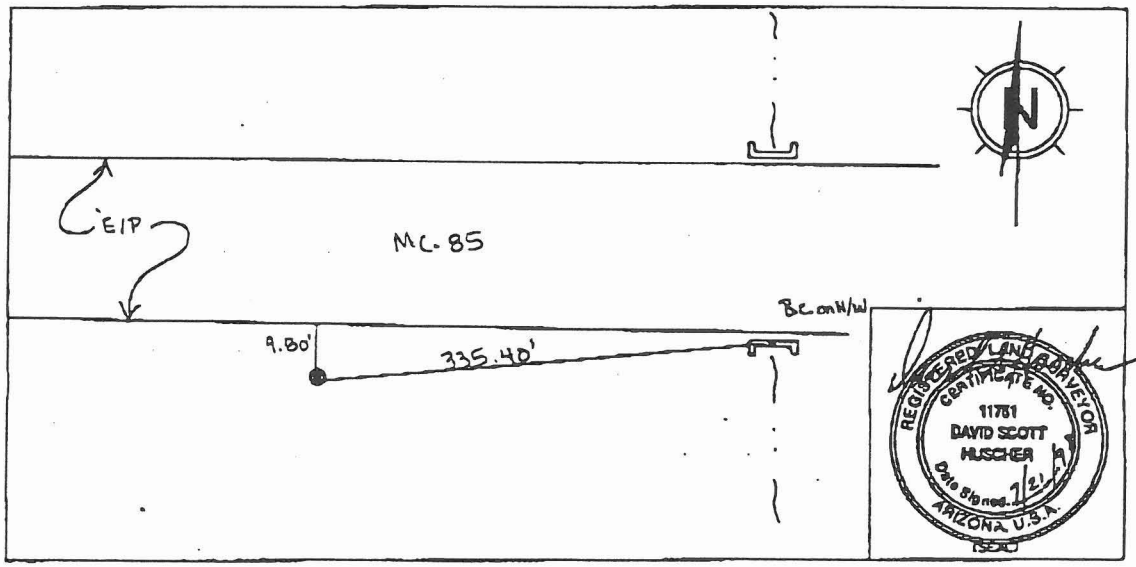
ACCURACY CHECK
DEPTH (MEASURED) 4.60'
DEPTH (SURVEYED) 4.64'
DIFFERENCE 0.04'
BOTTOM (MEASURED)
BOTTOM (SURVEYED)
DIFFERENCE

R/W - RIGHT OF WAY
NTS - NOT TO SCALE
PL - PROPERTY LINE
B/C - BACK OF CURB
BW - BUILDING WALL
℄ - CENTER LINE
EP - EDGE OF PAVEMENT
PC - POINT OF CURVATURE
S/W - SIDEWALK
D/W - DRIVEWAY
BM - BENCHMARK
CB - CATCH BASIN
○ - MANHOLE
⊕ - TEST HOLE
◇ - FIRE HYDRANT
Ø - POLE

CROSS SECTIONAL VIEW
NOT TO SCALE



PK/HUB ST PIN CHSLD "X"/OTHER
SET AT ℄ UTILITY
COLOR RIBBON ORANGE



REGISTERED LAND SURVEYOR
CERTIFICATE NO. 11751
DAVID SCOTT HUSCHER
Date Sig'ned 7/21/98
ARIZONA, U.S.A.
(SEAL)

T.H. DUG 12 17 (RT) LT OF DESC ℄ ℄ 660+89.57 STATION MC 85 STREET NAME

WAS REQUESTED UTILITY FOUND? (YES) NO O.D./TYPE 2" PLASTIC CONDUIT - ABAN.
PAVING THICKNESS & TYPE N/A SOIL TYPE DRY
REMARKS:

UTILITY LOCATION REPORT

Geotrack, Inc.
SURVEYORS • UTILITY LOCATORS
11219 N. 23rd Avenue (602) 331-3225
Phoenix, Arizona 85029 FAX (602) 331-8837

CREW CHIEF T. MOSS
CREW MEMBERS R. SANCHEZ
J. ESSAM
CHECKED BY: DA

GEOTRACK PROJECT NO. 18052
CUSTOMER PROJECT NO. ECD 96-11
TEST HOLE NO. 1
DATE DUG 7-13-98

GENERAL LOCATION SOUTH SIDE MC 85, ±1400' EAST OF ESTRELLA PKWY.
SIZE/TYPE/MATERIAL ANTICIPATED 1XC / MCI FIBER OPTIC
PAVING CONDITION BEFORE WORK EARTH
JURISDICTION CITY OF GOODYEAR, AZ

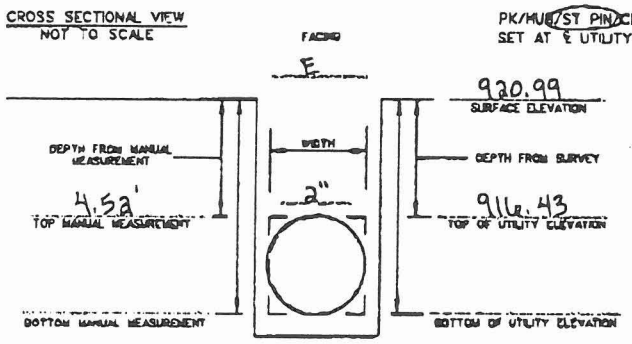
ELEVATION B.M. 923.12 DESCRIPTION TBM#58: B.C. ON H/W SOUTH SIDE MC-85, ±1,800' E. OF ESTRELLA PKWY.
ROD READING (+) 3.35
H.I. (=) 926.47
B.M. GIVEN/ASSUMED/SURVEYED BY GEOTRACK
(-) 5.48 ROD READING AT SURFACE
(=) 920.99 ELEVATION AT SURFACE
PK/HUB/ST PIN/CHSLD "X"/OTHER
(-) 10.04 ROD READING TOP UTILITY
(=) 916.43 ELEVATION TOP UTILITY
(-) ROD READING BOTTOM UTILITY
(=) ELEVATION BOTTOM UTILITY

CHECK BACK TO B.M. (BREAK SET-UP)
SURFACE ELEV. 920.99
ROD READING (+) 5.26
H.I. (=) 926.25
ROD READING B.M. (-) 3.12
B.M. ELEV CHECK (=) 923.13

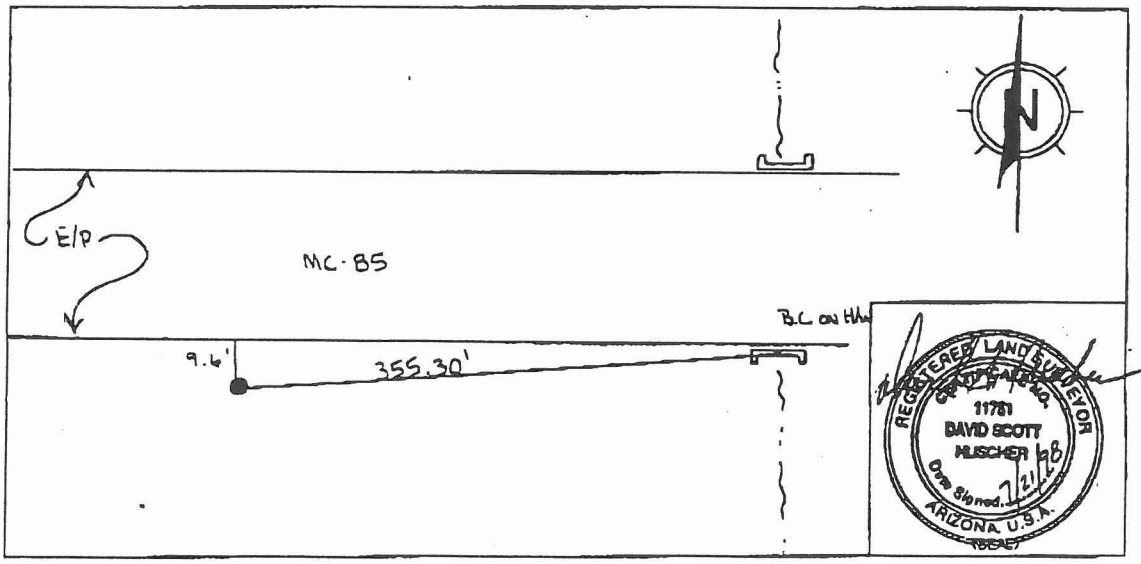
ACCURACY CHECK
DEPTH (MEASURED) 4.52'
DEPTH (SURVEYED) 4.56'
DIFFERENCE 0.04'
BOTTOM (MEASURED)
BOTTOM (SURVEYED)
DIFFERENCE

R/W - RIGHT OF WAY
NTS - NOT TO SCALE
PL - PROPERTY LINE
B/C - BACK OF CURB
BW - BUILDING WALL
℄ - CENTER LINE
EP - EDGE OF PAVEMENT
PC - POINT OF CURVATURE
S/W - SIDEWALK
D/W - DRIVEWAY
BM - BENCHMARK
CB - CATCH BASIN
○ - MANHOLE
● - TEST HOLE
⊙ - FIRE HYDRANT
Ø - POLE

CROSS SECTIONAL VIEW
NOT TO SCALE



PK/HUB/ST PIN/CHSLD "X"/OTHER
SET AT ℄ UTILITY
COLOR RIBBON ORANGE



T.M. DUG 11.94 (RT) LT OF ℄ 660 + 69.57 MC-85
DESC ℄ STATION STREET NAME

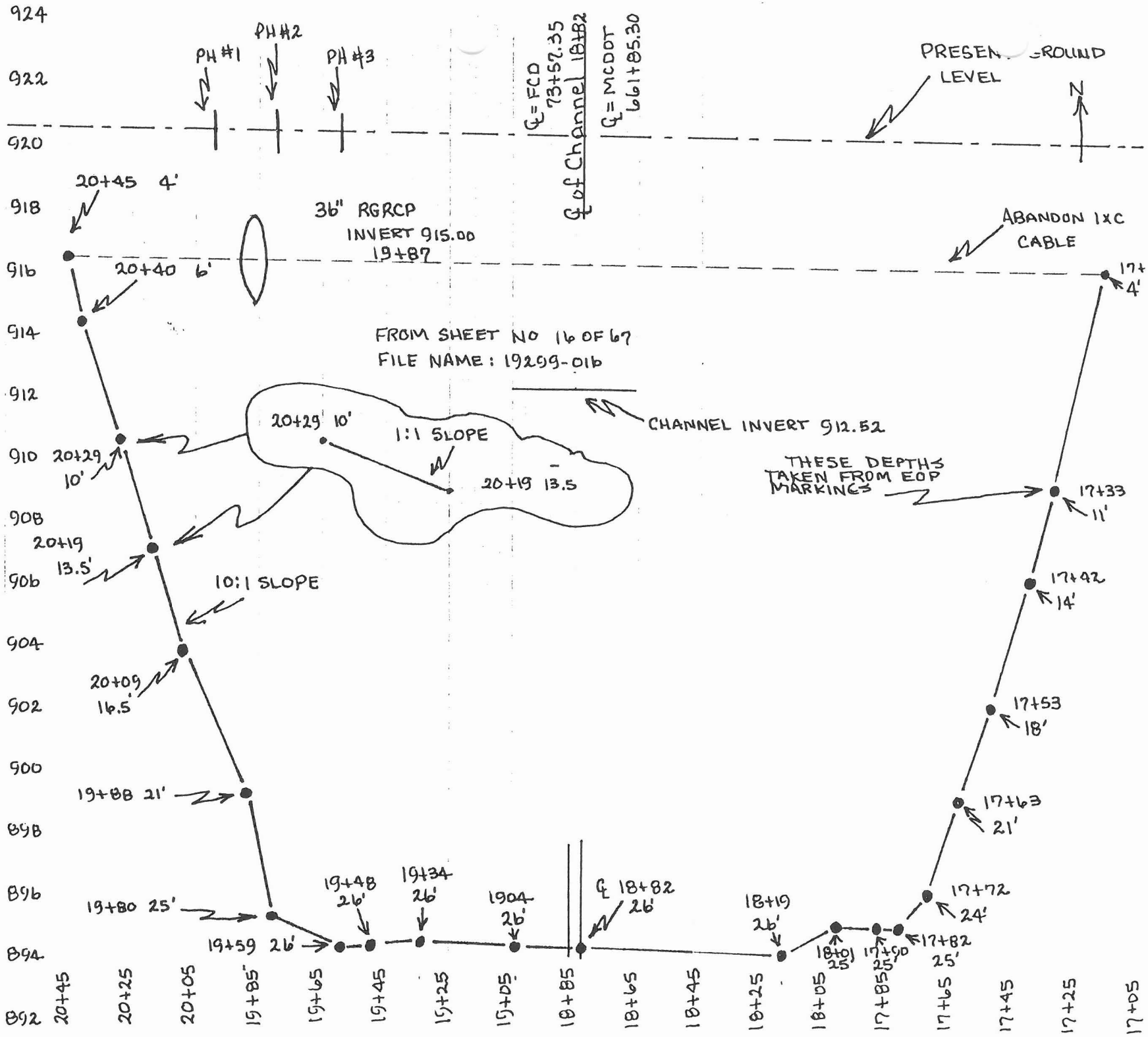
WAS REQUESTED UTILITY FOUND? (YES) NO O.D./TYPE 2" PLASTIC CONDUIT - ABAN.
PAVING THICKNESS & TYPE N/A SOIL TYPE DRY
REMARKS:

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

PROJECT Bullard Wash Channel Improvements PAGE ____ OF ____

DETAIL Olin Sutton 372-6110 FAX 506-8561 COMPUTED ____ DATE ____

CHECKED BY ____ DATE ____

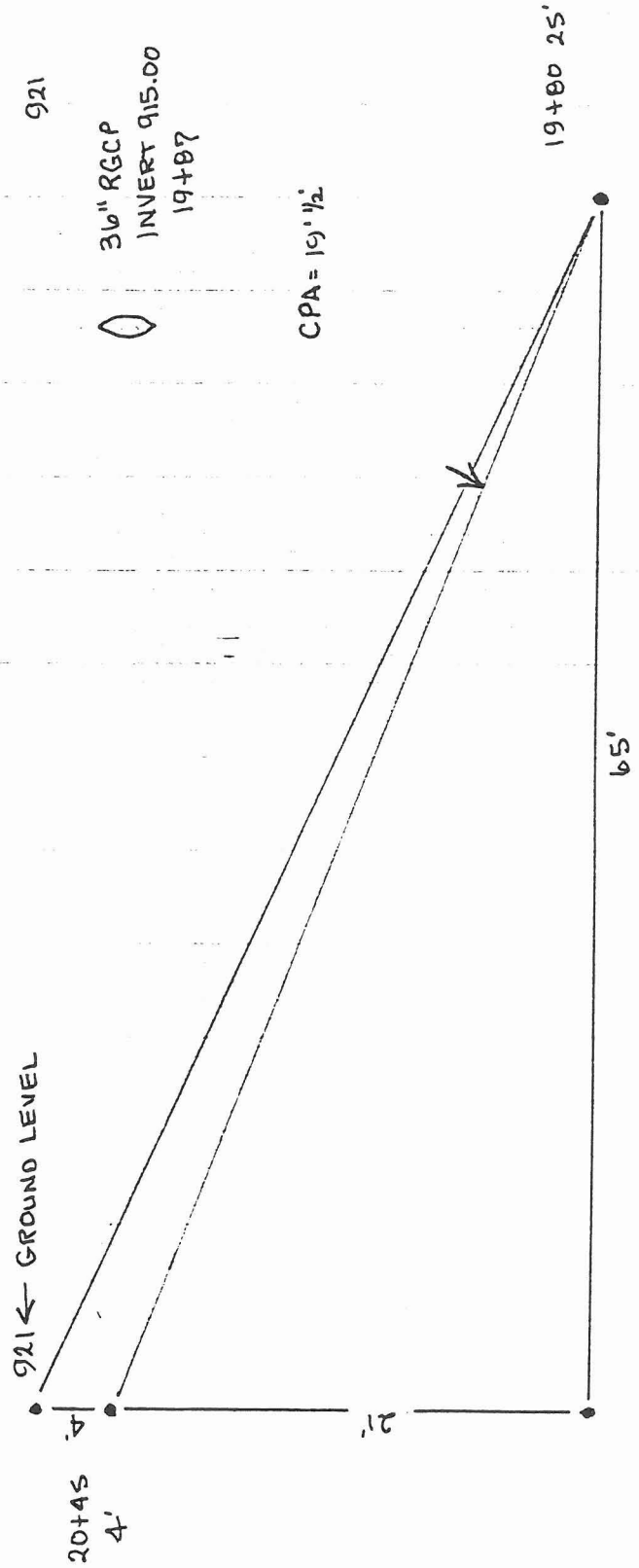


FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

PROJECT _____ PAGE ____ OF ____

DETAIL _____ COMPUTED _____ DATE ____

_____ CHECKED BY _____ DATE ____



AVERY

Requirements for Public and Private Access to Bullard Wash and East Tributary Channels

Access to Bullard Wash and East Tributary Channels is controlled with the use of Access Gates and Safety Posts to prohibit access into the channel bottom and along the channel bank by the general public. Access to the channel bottom (Maintenance Ramps) and along the channel bank (Operation & Maintenance Roads [O & M Roads]) is for operation and maintenance purposes. Farm Roads have been incorporated into the project to provide uninterrupted access to adjacent farm fields that existed prior to the construction of this project. At certain points along the project O & M Roads and the Farm Roads have been combined into a joint use roadway (i.e. Broadway Road alignment and north of Lower Buckeye Road). Private access over or through the bottom of Bullard Wash Channel has been allowed at the Buckeye Irrigation South Maintenance Road and at the Broadway Road alignment. Below is a listing of the stations for access points along the channel, and the station limits for Farm Roads that parallel the channel.

Maintenance Ramp locations

Ramp 1 – Station 26+55± Lt.
Ramp 2 – Station 33+34± Lt.
Ramp 3 – Station 33+28± Rt.
Ramp 4 – Station 60+26± Lt.
Ramp 5 – Station 66+10± Lt.
Ramp 6 – Station 75+55± Lt.
Ramp 7 – Station 93+72± Lt.
Ramp 8 – Station 116+00 Lt.

Farm Road Limits

Station 31+30± to 62+30± Lt. & Rt.
Station 64+00± to 69+45± Lt.
Station 64+00± to 70+50± Rt.
Station 91+10± to 123+90± Lt.

BID South Maintenance Road Crossing

Station 28+89±

Broadway Road alignment Crossing

Station 63+32±

AVERY

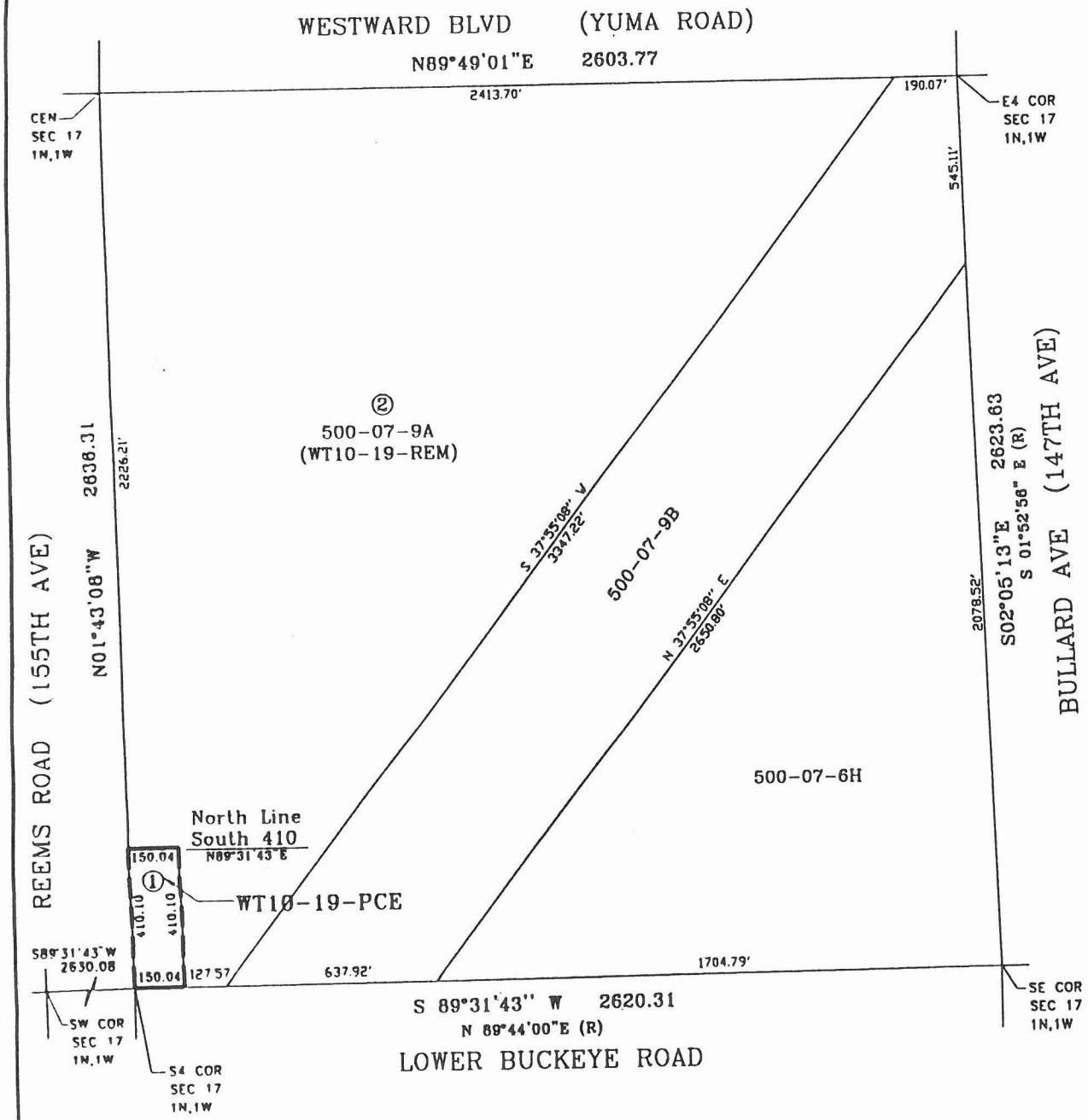
BULLARD WASH OUTFALL PROJECT
WT10-19-PCE; 500-07-9A
SUNCHASE ESTRELLA LIMITED
Partnership

A 150 foot wide Permanent Channel Easement being the West 150 feet of the South 410 feet of the Southeast quarter of Section 17 – T1n, R1W of the G&SRB&M, Maricopa County, Arizona.

Containing 61,514 square feet 1.4122 acres more or less.

Flood Control District of Maricopa County, Arizona			
PRELIM: 3-13-98	CHK: GEO 3-16-98	APR: [illegible] 3-16-98	
REV:		FINAL:	

WT10-19-PCE



SCALE 1" = 500

		SQ.FT.	ACRES
WT10-19-PCE	①	61,514	1.4122
WT10-19-REM	②	3,483,128	79.9616
500-07-9A	① ②	3,544,642	81.3738

FLOOD CONTROL DISTRICT
OF MARICOPA COUNTY-ARIZONA

BULLARD WASH OUTFALL PROJECT

PT SE4 SECTION 17 - T1N,R1W

WT10-19-PCE; 500-07-9A
SUNCHASE ESTRELLA LIMITED
PARTNERSHIP

PRELIMINARY: 3-12-98 JLS

REVISED:

FINAL:

WT10-19PCE-PLOT

BULLARD WASH OUTFALL PROJECT
WT10-19-TCE; 500-07-9A
SUNCHASE ESTRELLA LIMITED
Partnership

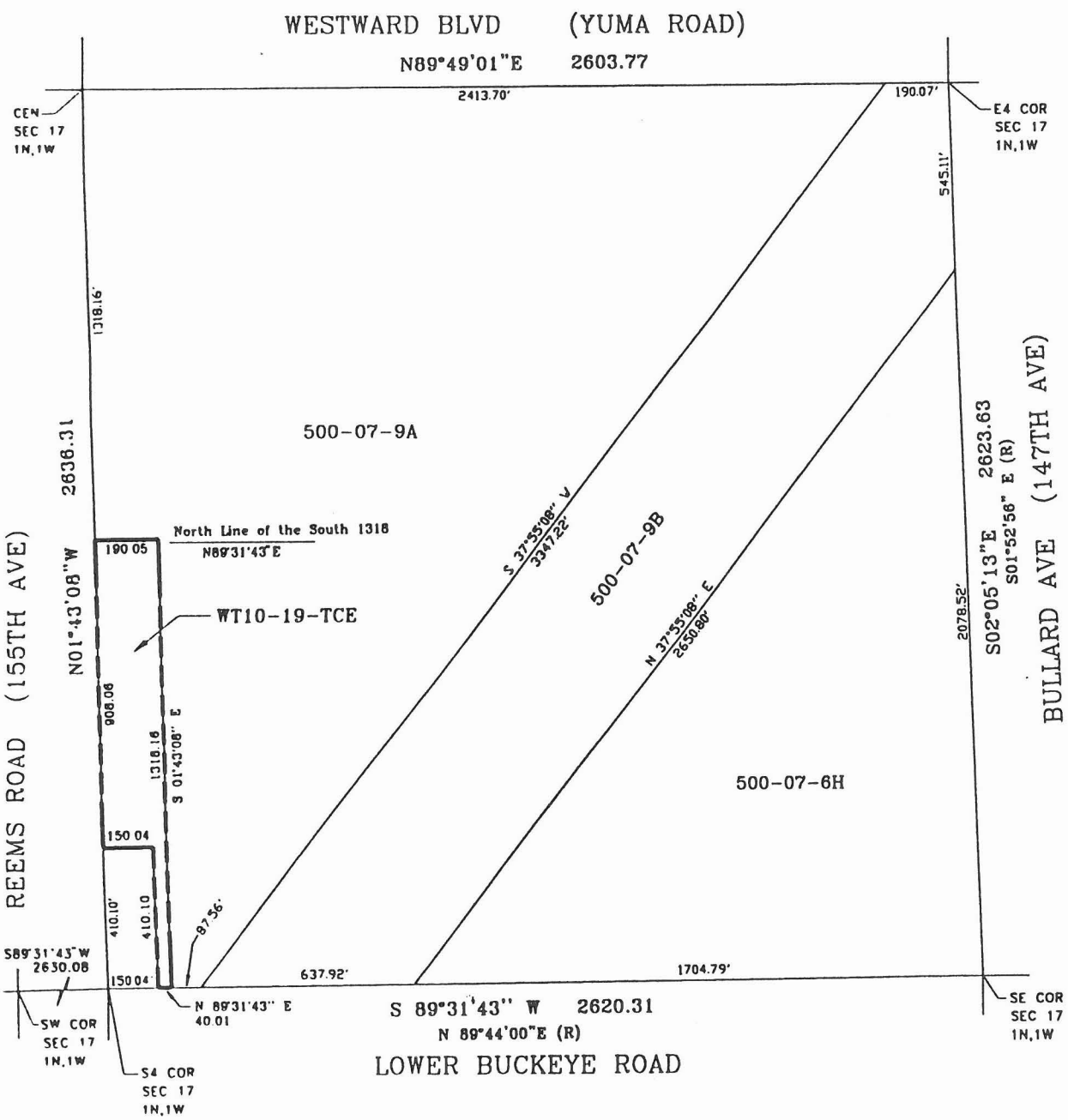
A 190 foot wide Temporary Construction Easement being the West 190 feet of the South 1318 feet of the Southeast quarter of Section 17 – T1n, R1W of the G&SRB&M, Maricopa County, Arizona.

EXCEPT the West 150 feet of the South 410 feet thereof..

Containing 188,934 square feet 4.3373 acres more or less.

Flood Control District of Maricopa County, Arizona			
PRELIM: 3-13-98	CHK: 4-7-98	APR:	
REV:		FINAL:	

WT10-19-TCE



	SQ.FT.	ACRES
WT10-19-TCE	188,934	4.3373

FLOOD CONTROL DISTRICT
OF MARICOPA COUNTY-ARIZONA

BULLARD WASH OUTFALL PROJECT

PT SE4 SECTION 17 - T1N, R1W

WT10-19-TCE; 500-07-9A

SUNCHASE ESTRELLA LIMITED PARTNERSHIP

PRELIMINARY: 3-12-98 JLS

REVISED:

FINAL:

WT10-19-TCE

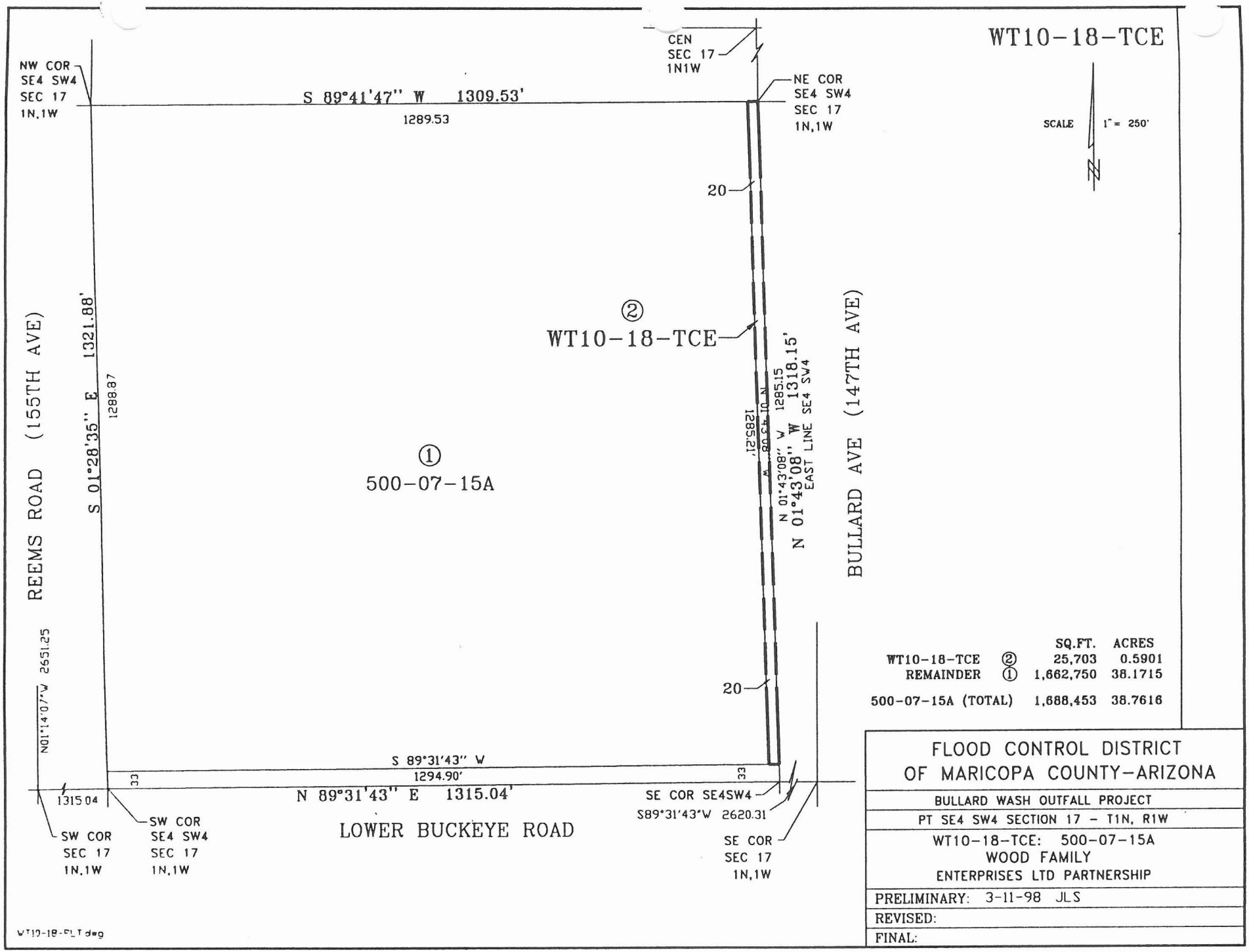
BULLARD WASH OUTFALL PROJECT
WT10-18-TCE; 500-07-15A
WOOD FAMILY
Enterprises Ltd. Partnership

A 20 foot wide Temporary Construction Easement being the East 20 feet of the Southeast quarter of the Southwest quarter (SE4SW4) of Section 17 – T1n, R1W of the G&SRB&M, Maricopa County, Arizona.

EXCEPT the South 33 feeT of said SE4SW4.

Containing 25,703 square feet 0.5901 acres more or less.

Flood Control District of Maricopa County, Arizona			
PRELIM: 3-12-98	CHK: JTG 4-7-98	APR: 4-7-98	
REV:		FINAL:	



		SQ.FT.	ACRES
WT10-18-TCE	②	25,703	0.5901
REMAINDER	①	1,662,750	38.1715
500-07-15A (TOTAL)		1,688,453	38.7616

FLOOD CONTROL DISTRICT
OF MARICOPA COUNTY-ARIZONA

BULLARD WASH OUTFALL PROJECT

PT SE4 SW4 SECTION 17 - T1N, R1W

WT10-18-TCE: 500-07-15A
WOOD FAMILY
ENTERPRISES LTD PARTNERSHIP

PRELIMINARY: 3-11-98 JLS

REVISED:

FINAL:

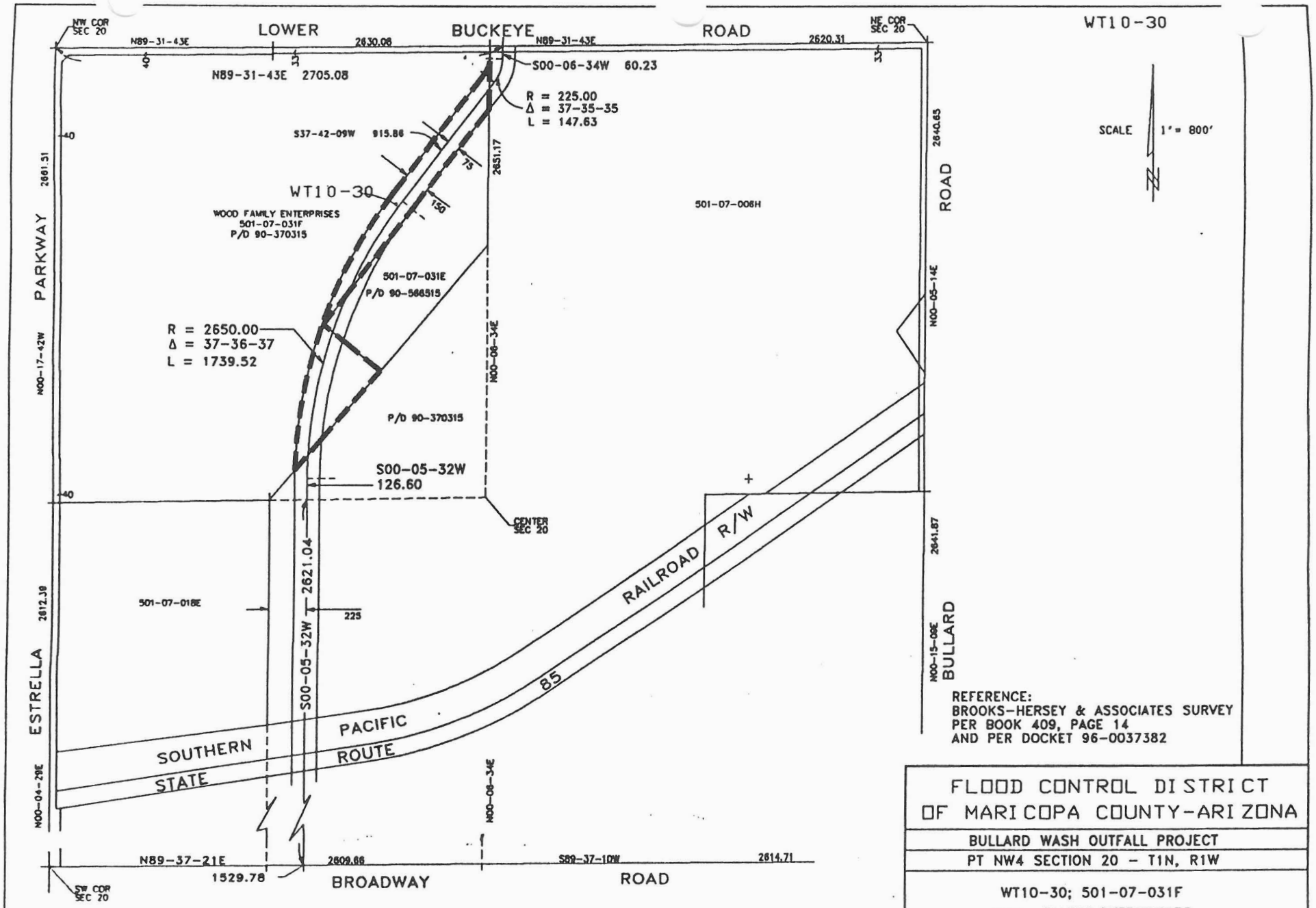
BULLARD WASH OUTFALL PROJECT
WT10-30; 500-07-031F
WOOD FAMILY ENTERPRISES

That part of that certain parcel of land recorded at Record Number 90-370315 in the office of the Recorder, which lies Southeasterly of the Northwest line of a portion of the West half (W2) of Section 20 - T1N, R1W, G&SRB&M, Maricopa County, Arizona, said portion being a strip of land 150' wide, 75' each side of the following described centerline:

BEGINNING said centerline at a point on the North line of said Section 20, which bears North 89°31'43" East 2705.08' from the Northwest corner of said section; thence South 00°06'34" West 60.23'; thence 147.63' along a tangent curve to the right, having a radius of 225' and a central angle of 37°35'35"; thence South 37°42'09" West, along a line 75' Northwest of and parallel with the Northwest line of that certain property according to Document 90-566515, a distance of 915.86'; thence 1739.52' along a tangent curve to the left, having a radius of 2650' and a central angle of 37°36'37"; thence South 00°05'32" West 126.60' to the East-West mid-section line of said Section 20; thence South 00°05'32" West along a line 225' East of and parallel with the West line of the East half of the West half of said Section 20, a distance of 2621.04' to a point on the South line of said section which bears North 89°37'21" East 1529.78' from the Southwest corner of said section 20; said point being the terminus of the herein described centerline.

The above parcel of lands contains a total of 415,200 square feet or 9.5317 acres, more or less.

Flood Control District of Maricopa County, Arizona			WT10-30
PRELIM: 02-27-96	Chk: JTS 11-27-96	Apr: [illegible] 11-27-96	
Rev: 11-19-96		FINAL:	



REFERENCE:
BROOKS-HERSEY & ASSOCIATES SURVEY
PER BOOK 409, PAGE 14
AND PER DOCKET 96-0037382

	SQ. FT.	ACRES
WT10-30	415,199	9.5317

FLOOD CONTROL DISTRICT
OF MARICOPA COUNTY-ARIZONA

BULLARD WASH OUTFALL PROJECT

PT NW4 SECTION 20 - T1N, R1W

WT10-30; 501-07-031F
WOOD FAMILY ENTERPRISES

PRELIMINARY: 1-17-96 MS
REVISED: 2-27-96 MS 11-19-96
FINAL:

BULLARD WASH OUTFALL PROJECT
WT10-30-1 ; 500-07-031F
WOOD FAMILY ENTERPRISES

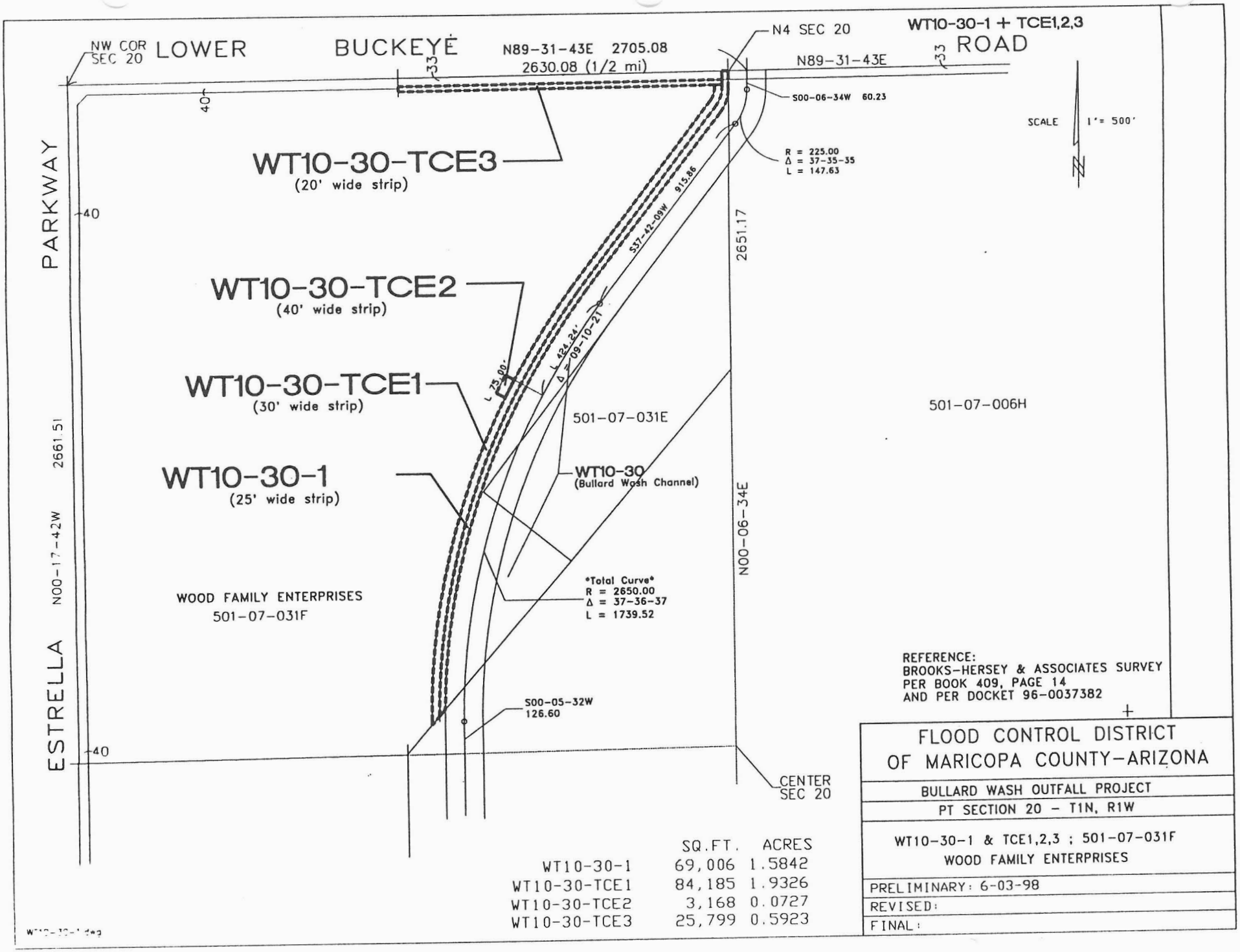
That portion of that certain parcel of land recorded at Record Number 90-370315 in the office of the Recorder, lying within the West half (W2) of Section 20 - T1N, R1W, G&SRB&M, Maricopa County, Arizona, and which portion lies within a strip of land 25' wide, the Southeasterly line of which is 75 feet Northwesterly of and parallel with the following described line:

Line Description

BEGINNING at a point on the North line of said Section 20, which bears North 89°31'43" East 2705.08 feet from the Northwest corner of said section; thence South 00°06'34" West 60.23 feet; thence 147.63 feet along a tangent curve to the right, having a radius of 225 feet and a central angle of 37°35'35"; thence South 37°42'09" West, along a line 75 feet Northwest of and parallel with the Northwest line of that certain property according to Document 90-566515, a distance of 915.86 feet; thence 1739.52 feet along a tangent curve to the left, having a radius of 2650 feet and a central angle of 37°36'37"; thence South 00°05'32" West 126.60 feet to the East-West mid-section line of said Section 20 and the terminus of said described line.

The above parcel of lands contains a total of 69,006 square feet or 1.5842 acres, more or less.

Flood Control District of Maricopa County, Arizona			
PRELIM: 6-03-98	Chk: 6-4-98	Apr: 6-4-98	
Rev:		FINAL:	



REFERENCE:
BROOKS-HERSEY & ASSOCIATES SURVEY
PER BOOK 409, PAGE 14
AND PER DOCKET 96-0037382

	SQ.FT.	ACRES
WT10-30-1	69,006	1.5842
WT10-30-TCE1	84,185	1.9326
WT10-30-TCE2	3,168	0.0727
WT10-30-TCE3	25,799	0.5923

FLOOD CONTROL DISTRICT
OF MARICOPA COUNTY-ARIZONA

BULLARD WASH OUTFALL PROJECT

PT SECTION 20 - T1N, R1W

WT10-30-1 & TCE1,2,3 ; 501-07-031F
WOOD FAMILY ENTERPRISES

PRELIMINARY: 6-03-98

REVISED:

FINAL:

BULLARD WASH OUTFALL PROJECT
WT10-30-TCE1 ; 500-07-031F
WOOD FAMILY ENTERPRISES

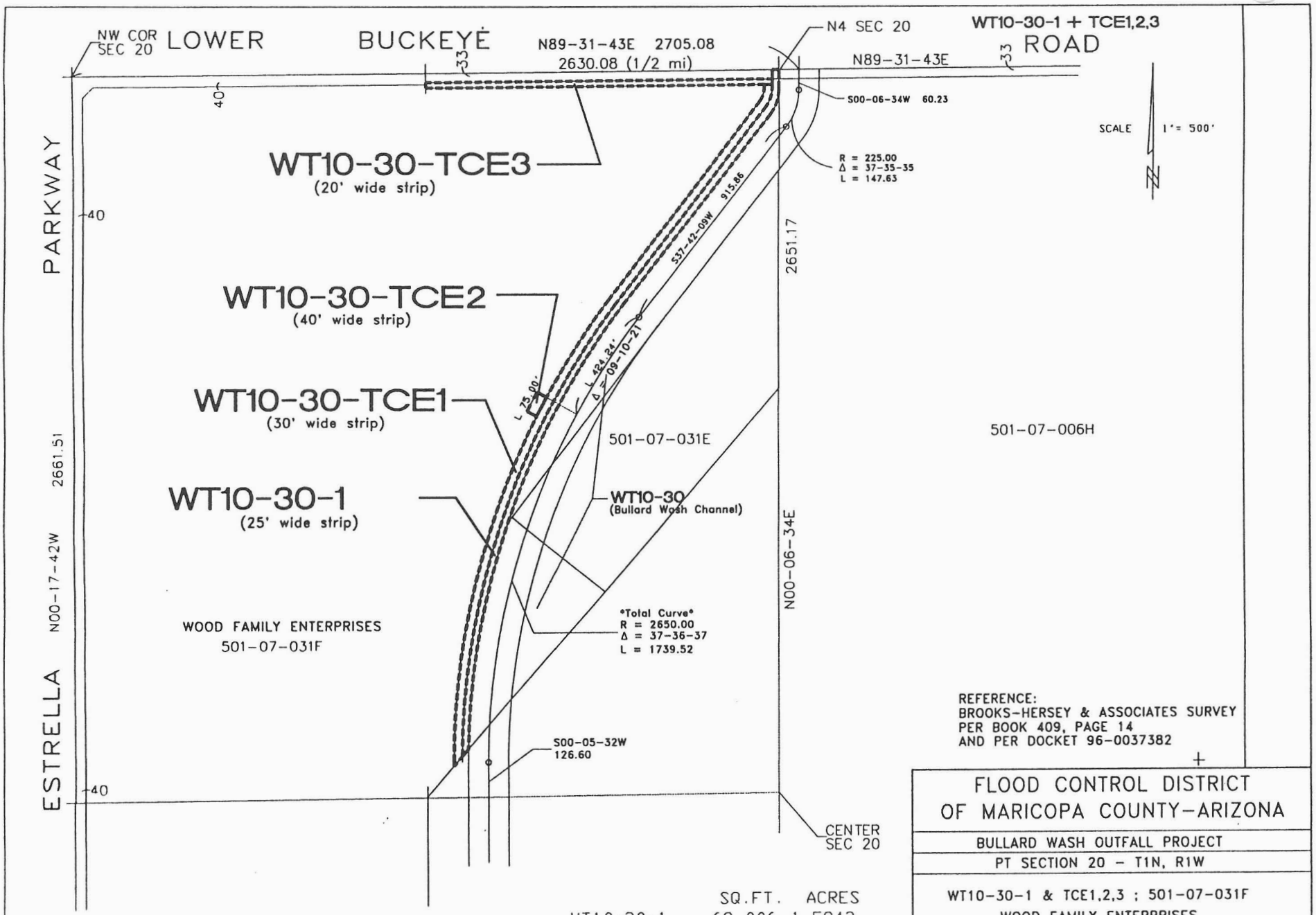
That portion of that certain parcel of land recorded at Record Number 90-370315 in the office of the Recorder, lying within the West half (W2) of Section 20 - T1N, R1W, G&SRB&M, Maricopa County, Arizona, and which portion lies within a strip of land 30' wide, the Southeasterly line of which is 100 feet Northwesterly of and parallel with the following described line:

Line Description

BEGINNING at a point on the North line of said Section 20, which bears North 89°31'43" East 2705.08 feet from the Northwest corner of said section; thence South 00°06'34" West 60.23 feet; thence 147.63 feet along a tangent curve to the right, having a radius of 225 feet and a central angle of 37°35'35"; thence South 37°42'09" West, along a line 75 feet Northwest of and parallel with the Northwest line of that certain property according to Document 90-566515, a distance of 915.86 feet; thence 1739.52 feet along a tangent curve to the left, having a radius of 2650 feet and a central angle of 37°36'37"; thence South 00°05'32" West 126.60 feet to the East-West mid-section line of said Section 20 and the terminus of said described line.

The above parcel of lands contains a total of 84,185 square feet or 1.9326 acres, more or less.

Flood Control District of Maricopa County, Arizona			
PRELIM: 6-03-98	Chk: Mek 6-3-98	Apr: [illegible] 6-3-98	
Rev:		FINAL:	



REFERENCE:
BROOKS-HERSEY & ASSOCIATES SURVEY
PER BOOK 409, PAGE 14
AND PER DOCKET 96-0037382

	SQ.FT.	ACRES
WT10-30-1	69,006	1.5842
WT10-30-TCE1	84,185	1.9326
WT10-30-TCE2	3,168	0.0727
WT10-30-TCE3	25,799	0.5923

FLOOD CONTROL DISTRICT
OF MARICOPA COUNTY-ARIZONA

BULLARD WASH OUTFALL PROJECT

PT SECTION 20 - T1N, R1W

WT10-30-1 & TCE1,2,3 ; 501-07-031F
WOOD FAMILY ENTERPRISES

PRELIMINARY: 6-03-98

REVISED:

FINAL:

BULLARD WASH OUTFALL PROJECT
WT10-30-TCE2 ; 500-07-031F
WOOD FAMILY ENTERPRISES

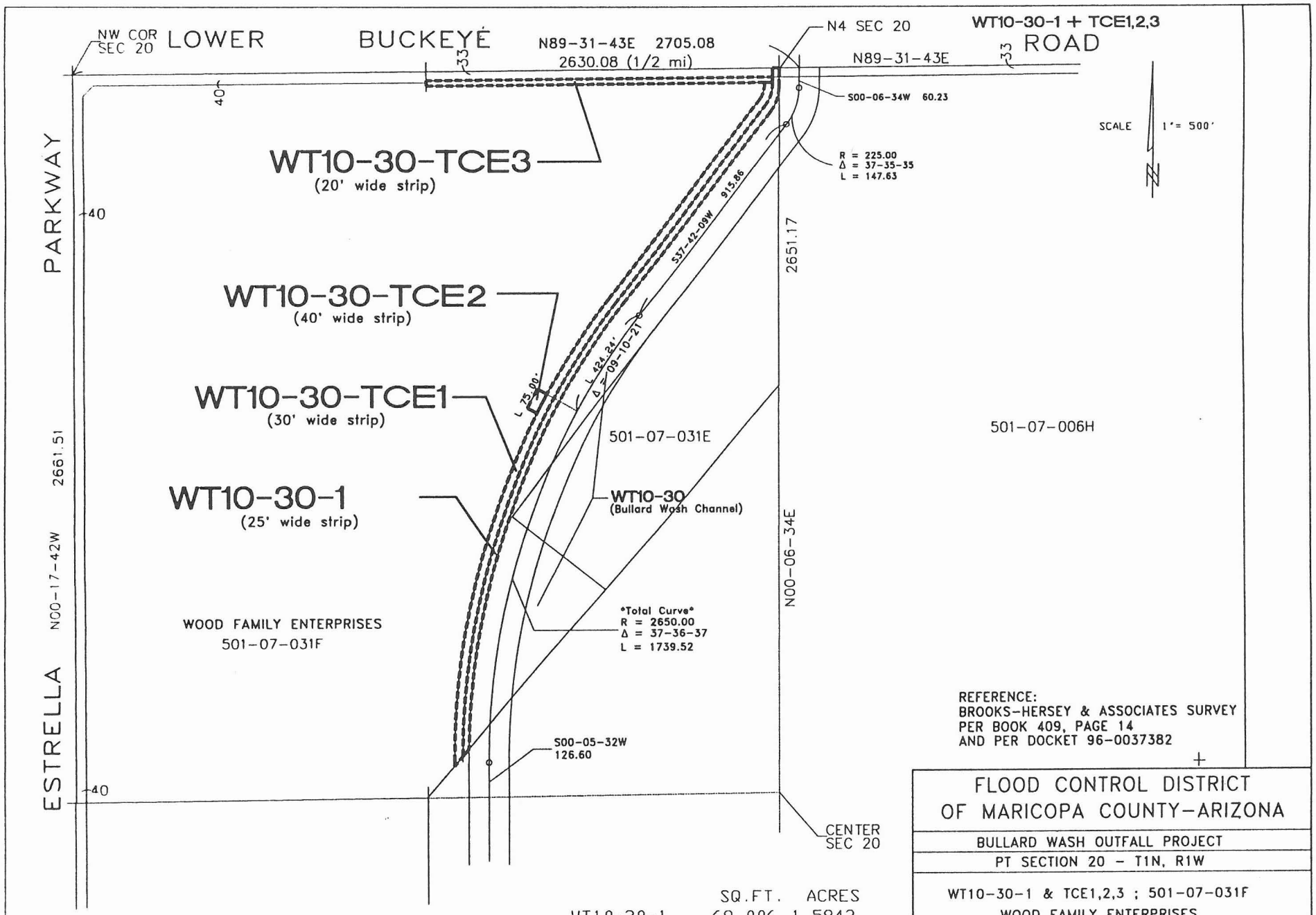
That portion of that certain parcel of land recorded at Record Number 90-370315 in the office of the Recorder, lying within the West half (W2) of Section 20 - T1N, R1W, G&SRB&M, Maricopa County, Arizona, said portion being a strip of land 40' wide, the Southeasterly line of which is 130 feet Northwesterly of and parallel with the following described line:

Line Description

BEGINNING at a point on the North line of said Section 20, which bears North 89°31'43" East 2705.08 feet from the Northwest corner of said section; thence South 00°06'34" West 60.23 feet; thence 147.63 feet along a tangent curve to the right, having a radius of 225 feet and a central angle of 37°35'35"; thence South 37°42'09" West, along a line 75 feet Northwest of and parallel with the Northwest line of that certain property according to Document 90-566515, a distance of 915.86 feet; thence 424.24 feet feet along a tangent curve to the left, having a radius of 2650 feet and a central angle of 09°10'21" to the **POINT OF BEGINNING**; thence, continuing along said curve a distance of 75.00 feet to the terminus of said described line.

The above parcel of lands contains a total of 3,168 square feet or 0.0727 acres, more or less.

Flood Control District of Maricopa County, Arizona			
PRELIM: 6-03-98	Chk: Mek 6-3-98	Apr: [illegible] 6-4-98	
Rev:		FINAL:	



REFERENCE:
BROOKS-HERSEY & ASSOCIATES SURVEY
PER BOOK 409, PAGE 14
AND PER DOCKET 96-0037382

	SQ.FT.	ACRES
WT10-30-1	69,006	1.5842
WT10-30-TCE1	84,185	1.9326
WT10-30-TCE2	3,168	0.0727
WT10-30-TCE3	25,799	0.5923

FLOOD CONTROL DISTRICT
OF MARICOPA COUNTY-ARIZONA

BULLARD WASH OUTFALL PROJECT

PT SECTION 20 - T1N, R1W

WT10-30-1 & TCE1,2,3 ; 501-07-031F
WOOD FAMILY ENTERPRISES

PRELIMINARY: 6-03-98

REVISED:

FINAL:

WT10-30-1.dwg

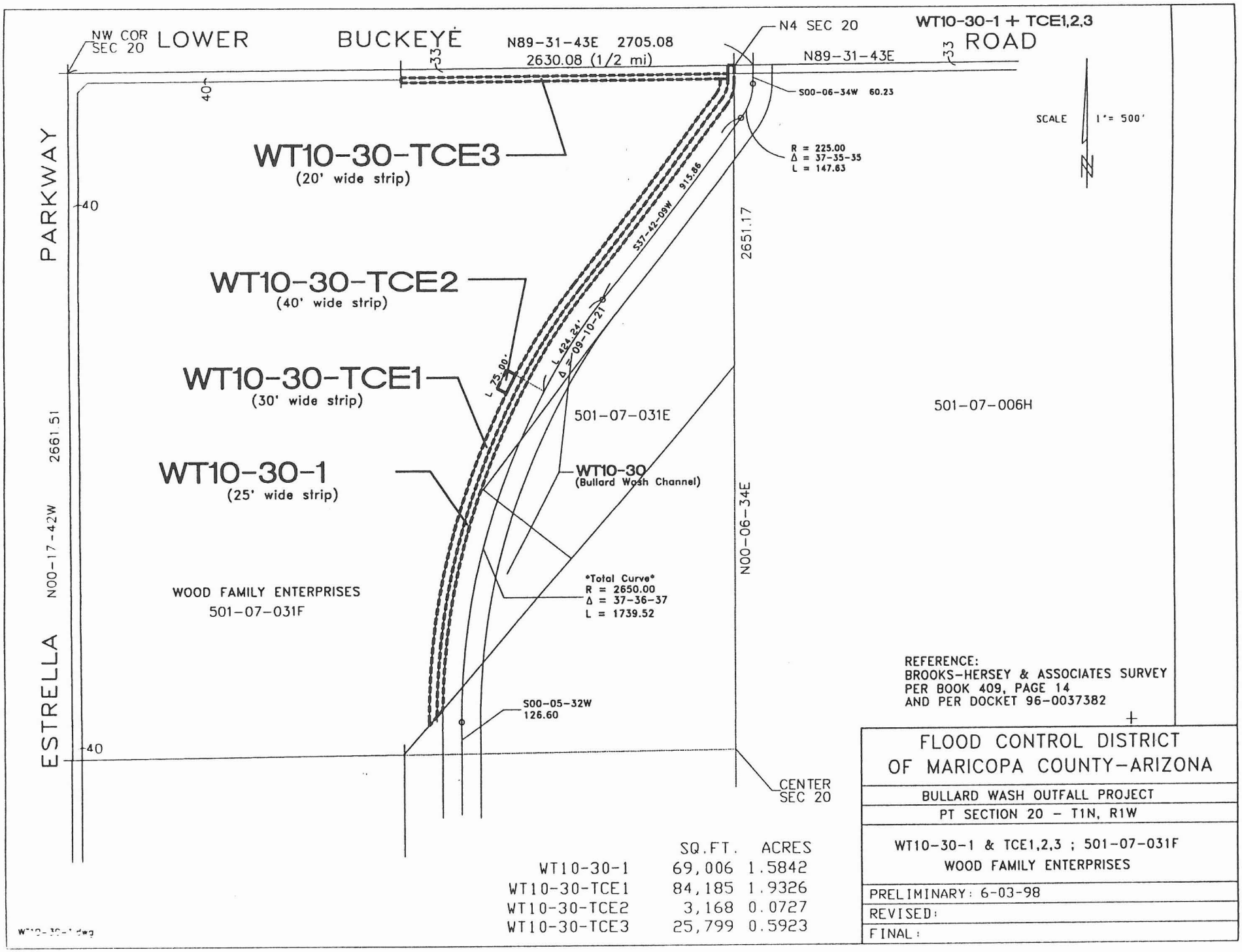
BULLARD WASH OUTFALL PROJECT
WT10-30-TCE3 ; 500-07-031F
WOOD FAMILY ENTERPRISES

A portion of that certain parcel of land recorded at Record Number 90-370315 in the office of the Recorder, lying within the West half (W2) of Section 20 - T1N, R1W, G&SRB&M, Maricopa County, Arizona, described as follows:

The South 20 feet of the North 53 feet of the East half of the West half of said Section 20; EXCEPT the East 25 feet thereof.

The above parcel of lands contains a total of 25,799 square feet or 0.5923 acres, more or less.

Flood Control District of Maricopa County, Arizona		
PRELIM: 6-03-98	Chk: Mek 6-3-98	Apr: 6-03-98
Rev:		FINAL:



	SQ.FT.	ACRES
WT10-30-1	69,006	1.5842
WT10-30-TCE1	84,185	1.9326
WT10-30-TCE2	3,168	0.0727
WT10-30-TCE3	25,799	0.5923

BULLARD WASH OUTFALL PROJECT
WT10-20; 500-07-006H, 31E
CITY OF PHOENIX

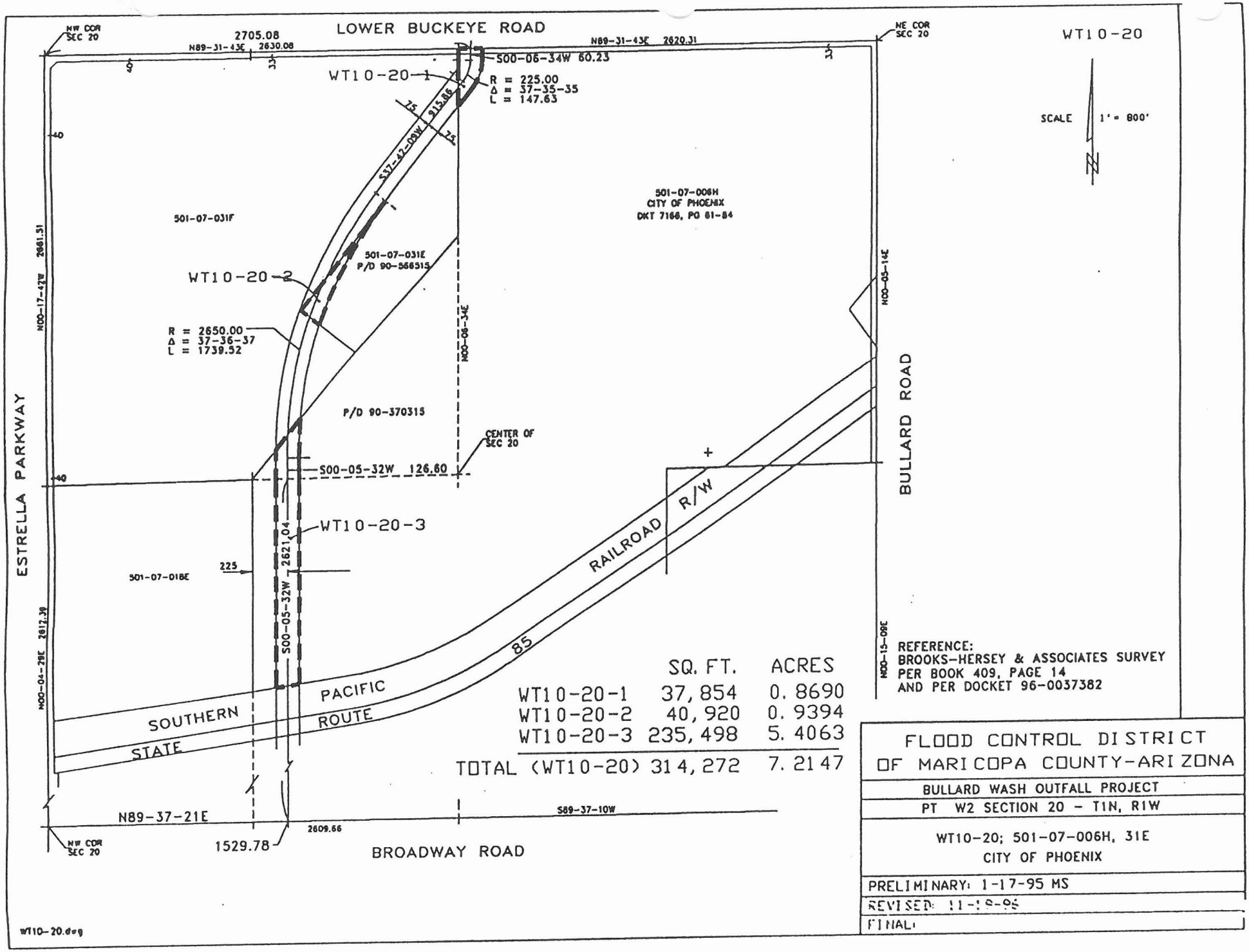
That part of those certain parcels of land recorded at Record Number 90-370315, 90-566515 and Dkt 7166, Page 61-84, in the office of the Recorder, which lies within the following described parcel of land:

PARCEL DESCRIPTION:

A portion of the Northeast quarter (NE4) and the West half (W2) of Section 20 - T1N, R1W, G&SRB&M, Maricopa County, Arizona, being a strip of land 150' wide, 75' each side of the following described centerline: BEGINNING said centerline at a point on the North line of said Section 20, which bears North 89°31'43" East 2705.08' from the Northwest corner of said section; thence South 00°06'34" West 60.23'; thence 147.63' along a tangent curve to the right, having a radius of 225' and a central angle of 37°35'35"; thence South 37°42'09" West, along a line 75' Northwest of and parallel with the Northwest line of that certain property according to Document 90-566515, a distance of 915.86'; thence 1739.52' along a tangent curve to the left, having a radius of 2650' and a central angle of 37°36'37"; thence South 00°05'32" West 126.60' to the East-West mid-section line of said Section 20; thence South 00°05'32" West along a line 225' East of and parallel with the West line of the East half of the West half of said Section 20, a distance of 2621.04' to a point on the South line of said section which bears North 89°37'21" East 1529.78' from the Southwest corner of said section 20; said point being the terminus of the herein described centerline.

The above described parcels combined contains 314,272 square feet or 7.2147 acres more or less

Flood Control District of Maricopa County, Arizona			WT10-20
PRELIM: 01-30-96	Chk: JTS 11-26-96	Apr: [illegible] 11-26-96	
Rev:11-19-96		FINAL:	



	SQ. FT.	ACRES
WT10-20-1	37,854	0.8690
WT10-20-2	40,920	0.9394
WT10-20-3	235,498	5.4063
TOTAL (WT10-20)	314,272	7.2147

REFERENCE:
BROOKS-HERSEY & ASSOCIATES SURVEY
PER BOOK 409, PAGE 14
AND PER DOCKET 96-0037382

FLOOD CONTROL DISTRICT
OF MARICOPA COUNTY-ARIZONA

BULLARD WASH OUTFALL PROJECT

PT W2 SECTION 20 - T1N, R1W

WT10-20; 501-07-006H, 31E
CITY OF PHOENIX

PRELIMINARY: 1-17-95 MS

REVISED: 11-19-95

FINAL:

WT10-20.dwg

BULLARD WASH OUTFALL PROJECT
WT10-20-4; 500-07-6H
CITY OF PHOENIX

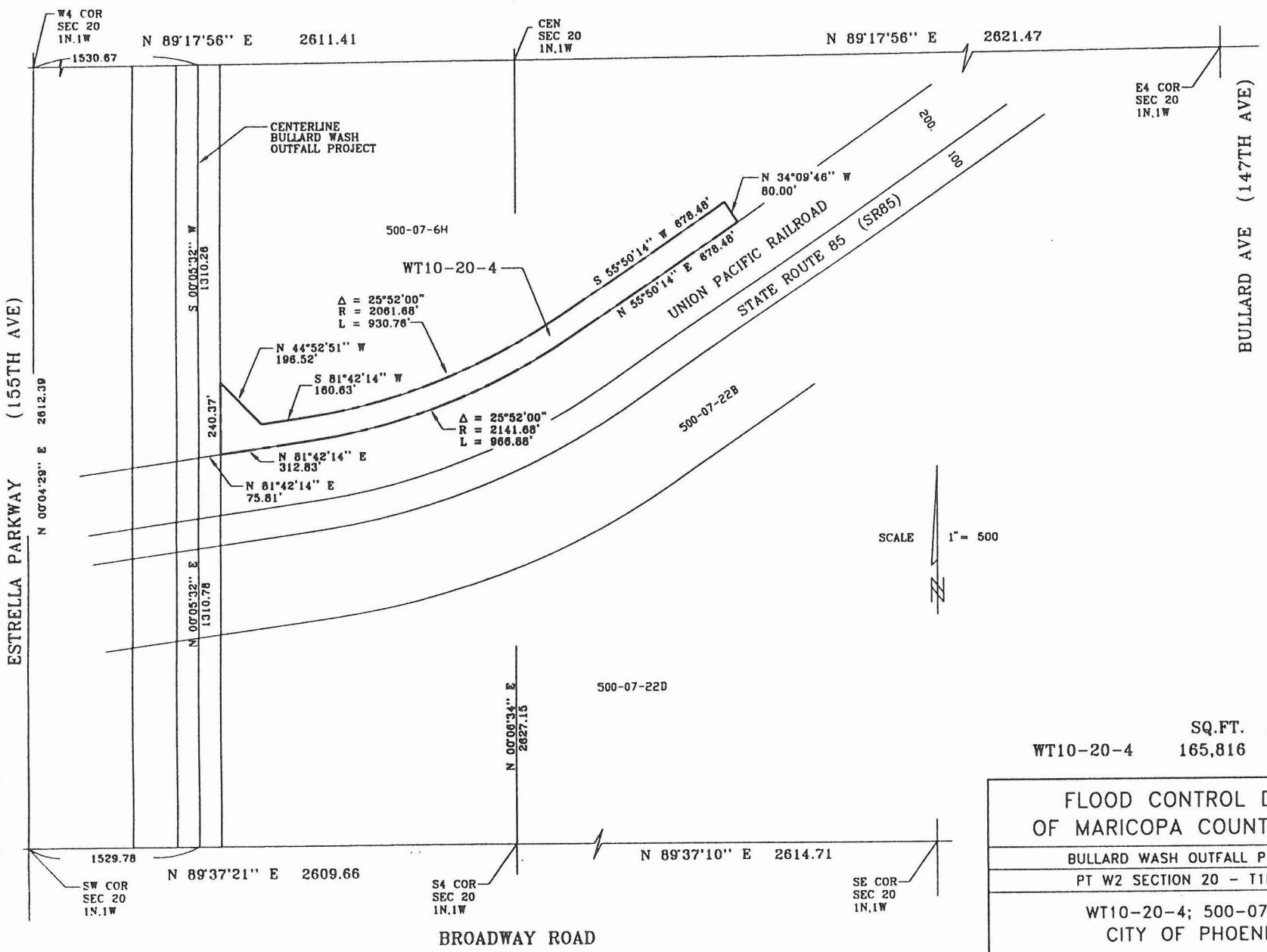
A portion of a parcel of land lying North of the Northwesterly right of way line of the Southern Pacific Railroad, now known as Union Pacific Railroad, and East of the Easterly right of way line of the "Bullard Wash Outfall Project, lying within the South half (S2) of Section 20, T1N, R1W, G&SRB&M, Maricopa County, Arizona, said parcel being also a part of that certain parcel of land recorded at Dkt 7166, Page 61-84 as recorded in the office of the Recorder of said County, said portion is more particularly described as follows:

COMMENCING at the West quarter corner of said Section 20; thence North 89°17'56" East 1530.67 feet to a point on the centerline of said "Bullard Wash Outfall Project"; thence along said centerline, South 00°05'32" West 1310.26 feet to the a point on the Southerly line of said parcel as recorded at "Dkt 7166, Page 61-84", said point is also a point on the Northwesterly right of way line of the Union Pacific Railroad; thence along said Northwesterly line, North 81°42'14" East 75.81 feet to the Easterly right of way line of said "Bullard Wash Outfall Project" and the **POINT OF BEGINNING** ; thence continuing along said Northwesterly right of way line, North 81°42'14" East 312.83 feet to a tangent curve to the left, having a radius of 2141.68 feet and a central angle of 25°52'00" a distance of 966.88 feet; thence North 55°50'14" East 678.48 feet; thence leaving said Northwesterly line, North 34°09'46" West 80.00 feet; thence along a line 80 feet Northwest of and parallel with the Northwesterly right of way line of said Union Pacific Railroad, South 55°50'14" West 678.48 feet to a tangent curve to the right, having a radius of 2061.68 feet and a central angle of 25°52'00" a distance of 930.76 feet; thence South 81°42'14" West 160.63 feet; thence leaving said parallel line, North 44°52'51" West to a point on the Easterly right of way line of said "Bullard Wash Outfall Project", a distance of 196.52 feet; thence along said Easterly line, South 00°05'32" West 240.37 feet to the **POINT OF BEGINNING.**

The above described parcels contains 165,816 square feet or 3.8066 acres more or less

Flood Control District of Maricopa County, Arizona			
PELIM: 4-28-98	CHK: 5-29-98	APR: 6-1-98	
REV: 5-29-98		FINAL:	

WT10-20-4



	SQ.FT.	ACRES
WT10-20-4	165,816	3.8066

FLOOD CONTROL DISTRICT
OF MARICOPA COUNTY-ARIZONA

BULLARD WASH OUTFALL PROJECT

PT W2 SECTION 20 - T1N,R1W

WT10-20-4; 500-07-6H
CITY OF PHOENIX

PRELIMINARY: 4-28-98 JLS

REVISED: 5-29-98

FINAL:

WT10-20-4PLT

BULLARD WASH OUTFALL PROJECT
WT10-20-5; 501-07-6H
CITY OF PHOENIX

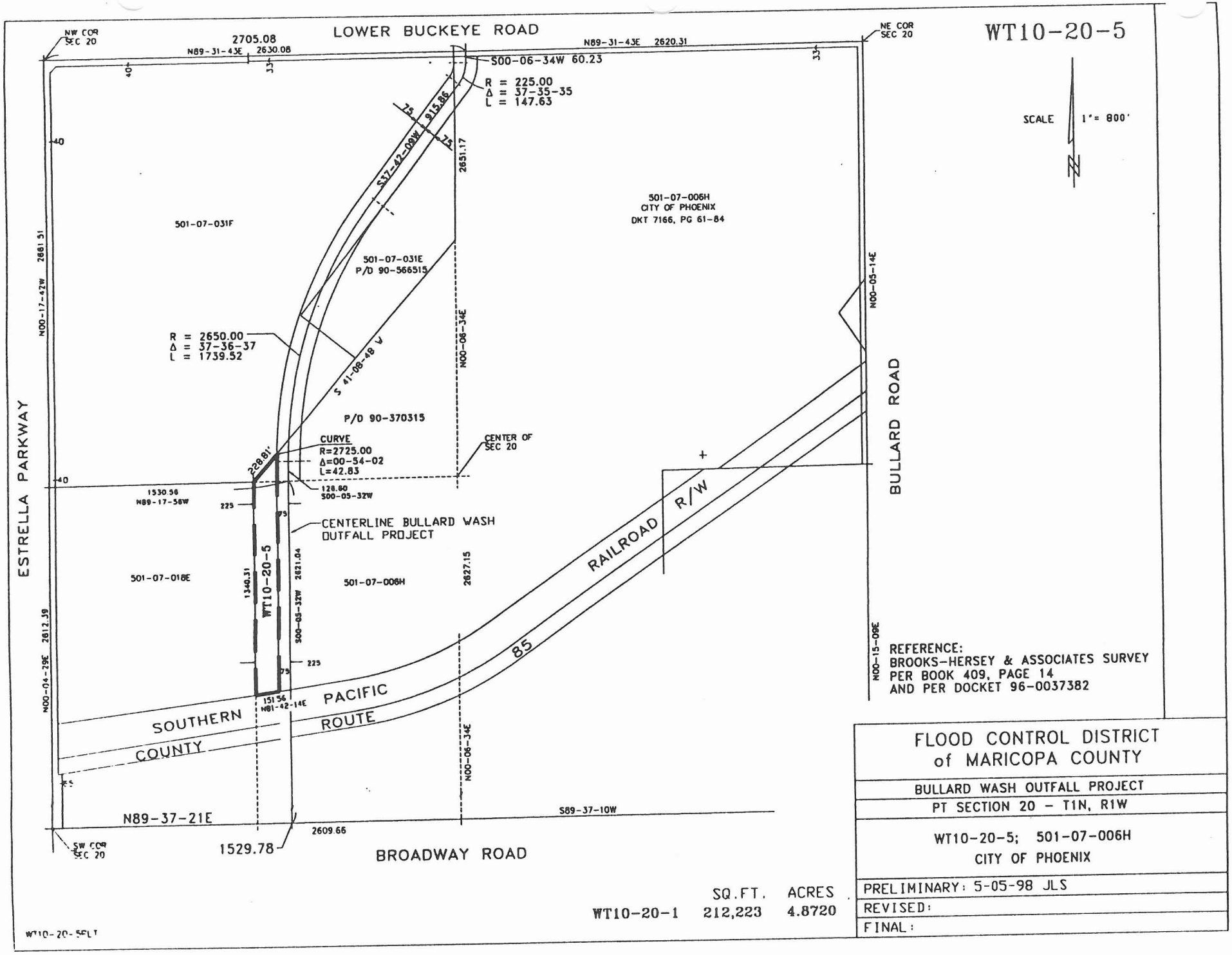
That part of a certain parcel of land recorded at Dkt 7166, Page 61-84, in the office of the Recorder, which lies West of the following described parcel of land:

PARCEL DESCRIPTION:

A portion of the West half (W2) of Section 20 - T1N, R1W, G&SRB&M, Maricopa County, Arizona, being a strip of land 150 feet wide, 75 feet each side of the following described centerline: **BEGINNING** said centerline at a point on the North line of said Section 20, which bears North 89°31'43" East 2705.08' from the Northwest corner of said section; thence South 00°06'34" West 60.23'; thence 147.63' along a tangent curve to the right, having a radius of 225' and a central angle of 37°35'35"; thence South 37°42'09" West, along a line 75' Northwest of and parallel with the Northwest line of that certain property according to Document 90-566515, a distance of 915.86'; thence 1739.52' along a tangent curve to the left, having a radius of 2650' and a central angle of 37°36'37"; thence South 00°05'32" West 126.60' to the East-West mid-section line of said Section 20; thence South 00°05'32" West along a line 225' East of and parallel with the West line of the East half of the West half of said Section 20, a distance of 2621.04' to a point on the South line of said section which bears North 89°37'21" East 1529.78' from the Southwest corner of said section 20; said point being the terminus of the herein described centerline.

The above described parcels combined contains 212,223 square feet or 4.8720 acres more or less

Flood Control District of Maricopa County, Arizona		
PELIM: 5-05-98	CHK: 5-05-98	APR:
REV		FINAL:


WT10-20-5
LOWER BUCKEYE ROAD
NW COR SEC 20
NE COR SEC 20
2705.08
N89-31-43E 2630.08
N89-31-43E 2620.31
S00-06-34W 60.23
R = 225.00
Δ = 37-35-35
L = 147.63
S37-42-09W 915.86
2651.17
501-07-031F
501-07-031E
P/D 90-566515
501-07-006H
CITY OF PHOENIX
DKT 7166, PG 61-84
R = 2650.00
Δ = 37-36-37
L = 1739.52
S 41-08-48 W
N00-06-34E
P/D 90-370315
CURVE
R=2725.00
Δ=00-54-02
L=42.83
228.81'
CENTER OF SEC 20
128.80
S00-05-32W
1530.56
N89-17-56W
CENTERLINE BULLARD WASH
OUTFALL PROJECT
501-07-018E
1349.31
WT10-20-5
2821.04
S00-05-32W
501-07-006H
2827.15
RAILROAD R/W
85
PACIFIC
ROUTE
SOUTHERN
COUNTY
151.56
N81-42-14E
ESTRELLA PARKWAY
BULLARD ROAD
N00-17-42W 2681.51
N00-04-29E 2812.39
N00-05-14E
N00-15-09E
N89-37-21E
S89-37-10W
2609.66
1529.78
SW COR SEC 20
BROADWAY ROAD
SCALE 1" = 800'
REFERENCE:
BROOKS-HERSEY & ASSOCIATES SURVEY
PER BOOK 409, PAGE 14
AND PER DOCKET 96-0037382
FLOOD CONTROL DISTRICT
of MARICOPA COUNTY
BULLARD WASH OUTFALL PROJECT
PT SECTION 20 - T1N, R1W
WT10-20-5; 501-07-006H
CITY OF PHOENIX
PRELIMINARY: 5-05-98 JLS
REVISED:
FINAL:
SQ.FT. ACRES
WT10-20-1 212,223 4.8720
WT10-20-5PLT

BULLARD WASH OUTFALL PROJECT
WT10-20-PCE; 500-07-6H
CITY OF PHOENIX

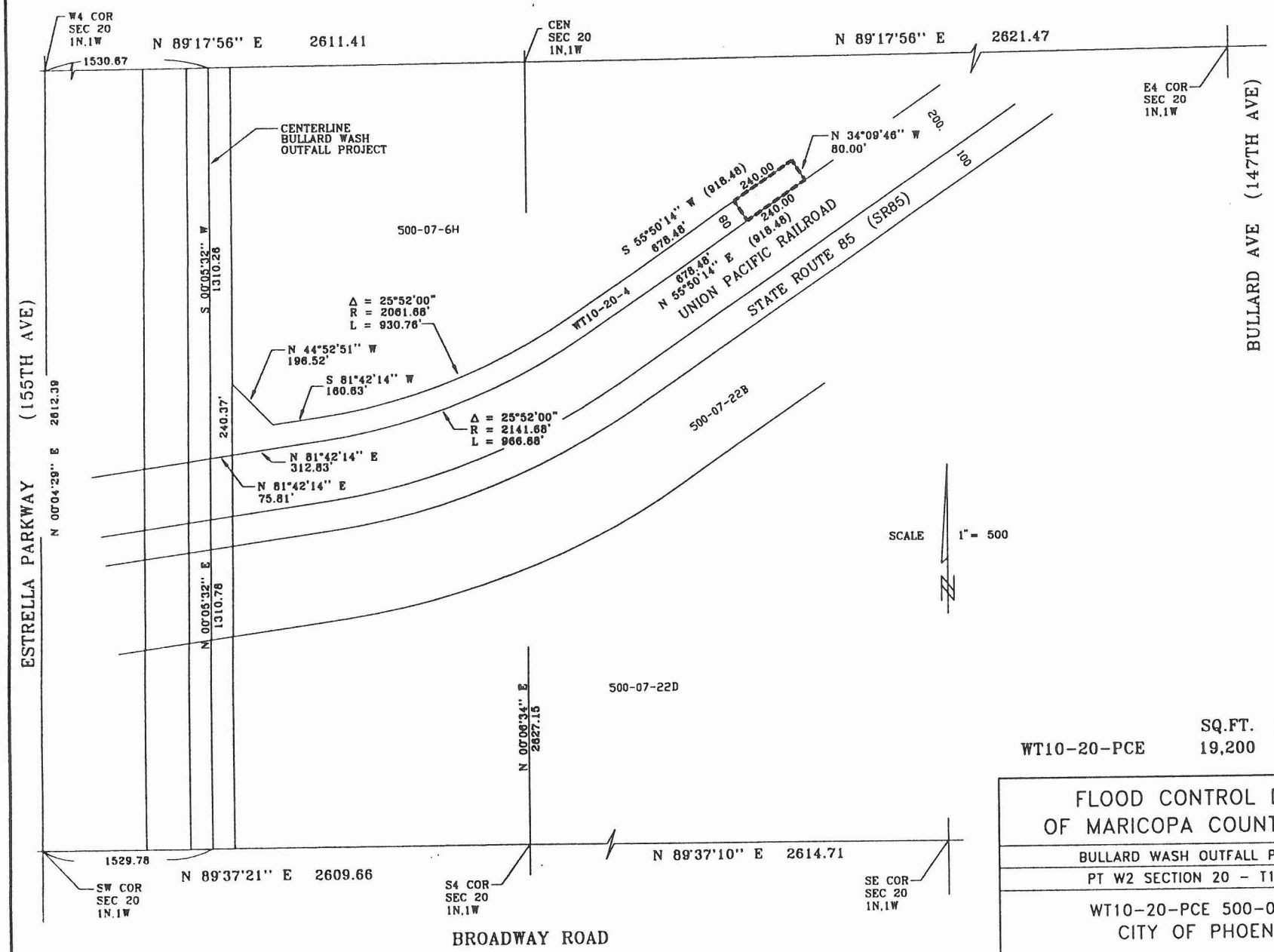
A 80 foot strip of land being a portion of a parcel of land lying North of the Northwesterly right of way line of the Southern Pacific Railroad, now known as Union Pacific Railroad, lying within the South half (S2) of Section 20, T1N, R1W, G&SRB&M, Maricopa County, Arizona, said strip of land being also a part of that certain parcel of land recorded at Dkt 7166, Page 61-84 as recorded in the office of the Recorder of said County, said 80 foot strip is more particularly described as follows:

COMMENCING at the West quarter corner of said Section 20; thence North 89°17'56" East 1530.67 feet to a point on the centerline of said "Bullard Wash Outfall Project"; thence along said centerline, South 00°05'32" West 1310.26 feet to the a point on the Southerly line of said parcel as recorded at "Dkt 7166, Page 61-84", said point is also a point on the Northwesterly right of way line of the Union Pacific Railroad; thence along said Northwesterly line, North 81°42'14" East 75.81 feet to the Easterly right of way line of said "Bullard Wash Outfall Project"; thence continuing along said Northwesterly right of way line, North 81°42'14" East 312.83 feet to a tangent curve to the left, having a radius of 2141.68 feet and a central angle of 25°52'00" a distance of 966.88 feet; thence North 55°50'14" East 678.48 feet to the **POINT OF BEGINNING** of the Southeasterly line of said 80 foot strip; thence continuing along said Northwesterly right of way line, North 55°50'14" East 240.00 feet to the **POINT OF TERMINUS**.

The above described parcels contains 19,200 square feet or 0.4408 acres more or less

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY		
prelim: 4-29-98	chk: 5-29-98	appr: 6-1-98
revised: 5-12-98; 5-29-98		final:
Maricopa County Public Works Land and Right of Way Division		Titles and Right of Way

WT10-20-PCE



	SQ.FT.	ACRES
WT10-20-PCE	19,200	0.4408

FLOOD CONTROL DISTRICT
OF MARICOPA COUNTY-ARIZONA

BULLARD WASH OUTFALL PROJECT

PT W2 SECTION 20 - T1N,R1W

WT10-20-PCE 500-07-6H
CITY OF PHOENIX

PRELIMINARY: 4-29-98 JLS

REVISED:

FINAL:

WT10-20-PCE-PLT

BULLARD WASH OUTFALL PROJECT
WT10-20-TCE1; 501-07-6H
CITY OF PHOENIX

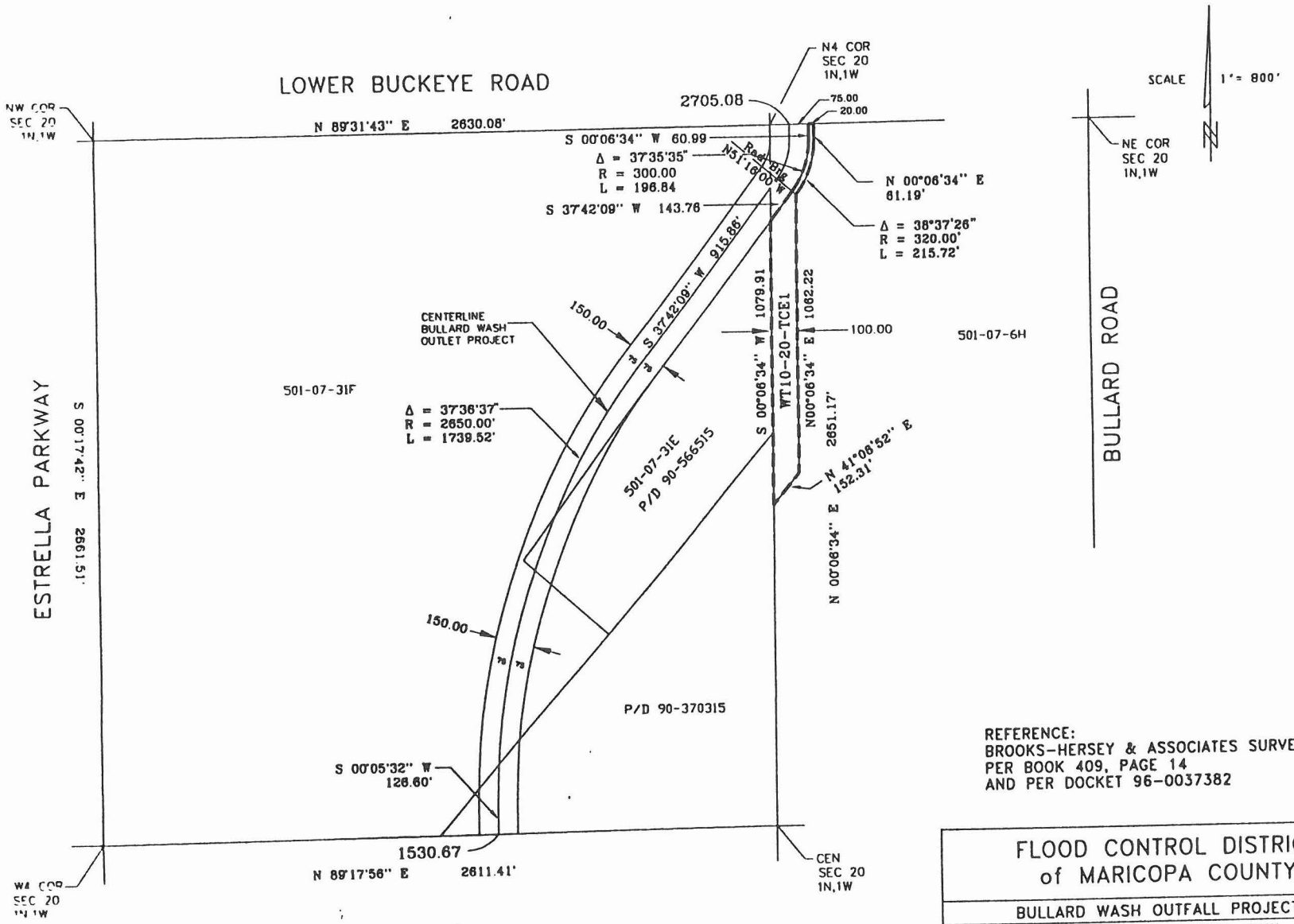
A Temporary Construction Easement being a part of that certain parcel of land recorded at Dkt 7166, Page 61-84, in the office of the Recorder, lying within the Northeast quarter of Section 20 - T1N, R1W, G&SRB&M, Maricopa County, Arizona, said easement is more particularly described as follows:

BEGINNING at a point on the North line of said Section 20, which bears North 89°31'43" East 2780.08 feet from the Northwest corner of said section, said point is also a point on the Easterly right of way line of the " Bullard Wash Outfall Project"; thence along said East line, South 00°06'34" West 60.99 feet to a tangent curve to the right, having a radius of 300.00 feet and a central angle of 37°35'35" a distance of 196.84 feet; thence South 37°42'09" West to the North-South mid-section line of said section 20, a distance of 143.76 feet; thence along said North-South line, South 00°06'34" West 1079.91 feet; thence North 41°08'52" East 152.31; thence along a line 100 feet East of and parallel with the North-South mid-section line of said section 20, North 00°06'34" East 1062.22 feet to a point on non-tangent curve concave to the Northwest from which a radial bears North 51°16'00" West; thence Northeasterly, along said curve through a central angle of 38°37'26", an arc length of 215.72 feet, with a radius of 320.00 feet; thence North 00°06'34" East to a point on the the North line of said section, a distance of 61.19; thence along said North line South 89°31'43" West 20.00 feet to the **POINT OF BEGINNING.**

The above described parcels contains 113,887 square feet or 2.6145 acres more or less

Flood Control District of Maricopa County, Arizona			
PELIM: 5-06-98	CHK: 5-07-98	APR: 5-08-98	
REV:		FINAL:	

WT10-20-TCE1



REFERENCE:
BROOKS-HERSEY & ASSOCIATES SURVEY
PER BOOK 409, PAGE 14
AND PER DOCKET 96-0037382

	SQ.FT.	ACRES
WT10-20-TCE1	113,887	2.6145

FLOOD CONTROL DISTRICT
of MARICOPA COUNTY

BULLARD WASH OUTFALL PROJECT

PT SECTION 20 - T1N, R1W

WT10-20-TCE1; 501-07-6H
CITY OF PHOENIX

PRELIMINARY: 5-06-98 JLS
REVISED:
FINAL:

BULLARD WASH OUTFALL PROJECT
WT10-20-TCE-2; 501-07-6H, 31E
CITY OF PHOENIX

Those portions of land recorded at Documents 90-370315 and 90-566515 in the office of the Recorder, lying in the Northwest quarter of Section 20 - T1N, R1W, G&SRB&M, Maricopa County, Arizona, which lies West the following described line:

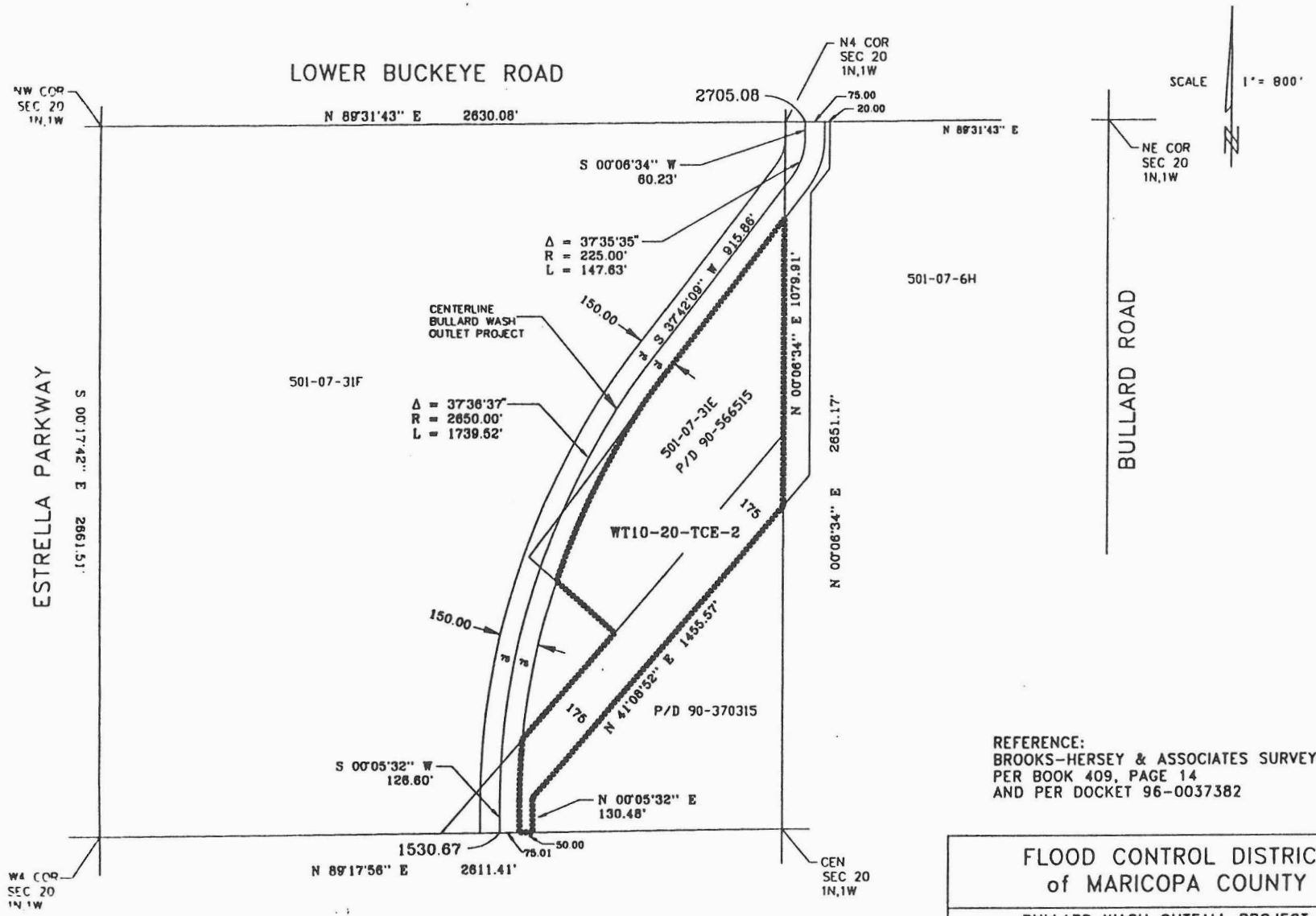
COMMENCING at the centerline of the "Bullard Wash Outlet Project", said centerline is a point on the North line of said Section 20, which bears North 89°31'43" East 2705.08 feet from the Northwest corner of said section; thence South 00°06'34" West 60.23 feet; thence 147.63 feet, along a tangent curve to the right, having a radius of 225 feet and a central angle of 37°35'35"; thence South 37°42'09" West, along a line 75 feet Northwest of and parallel with the Northwest line of said Document 90-566515, a distance of 915.86 feet; thence 1739.52 feet along a tangent curve to the left, having a radius of 2650 feet and a central angle of 37°36'37"; thence South 00°05'32" West 126.60 feet to the East-West mid-section line of said Section 20; thence along said East-West mid-section line, North 89°17'56" East a distance of 125.01 to the **POINT OF BEGINNING**; thence North 00°05'32" East along a line 125 feet East of and parallel with said "Bullard Wash Outlet Project" a distance of 130.48 feet; thence North 41°08'52" East along a line 175 Southeast of and parallel with the Northwest line of said Document 90-370315, to a point on the North-South mid-section line of said section 20, a distance of 1455.57 feet; thence along said North-South line, North 00°06'34" East 1079.91 feet to the terminus of said described line.

EXCEPT any portion of land lying West of the East line of said "Bullard Wash Outfall Project.

The above described parcels combined contains 846,651 square feet or 19.4364 acres more or less

Flood Control District of Maricopa County, Arizona			
PELIM: 5-05-98	CHK: GTS 5-08-98	APR: [illegible] 5-5-98	
REV:		FINAL:	

WT10-20-TCE-2



REFERENCE:
BROOKS-HERSEY & ASSOCIATES SURVEY
PER BOOK 409, PAGE 14
AND PER DOCKET 96-0037382

	SQ.FT.	ACRES
WT10-20-TCE-2	846,651	19.4364

FLOOD CONTROL DISTRICT
of MARICOPA COUNTY

BULLARD WASH OUTFALL PROJECT

PT SECTION 20 - T1N, R1W

WT10-20-TCE-2; 501-07-006H, 31E
CITY OF PHOENIX

PRELIMINARY: 5-05-98 JLS
REVISED:
FINAL:

BULLARD WASH OUTFALL PROJECT
WT10-20-TCE3; 501-07-6H
CITY OF PHOENIX

A 20 foot wide Temporary Construction Easement lying East of and parallel to the "Bullard Wash Outfall Project", and 80 feet Northwest of and parallel to the Southern Pacific Railroad right of way, now known as Union Pacific Railroad, said 20 foot easement is part of that certain parcel of land recorded at Dkt 7166, Page 61-84, in the office of the Recorder, lying within the South half (S2) of Section 20 - T1N, R1W, G&SRB&M, Maricopa County, Arizona. The Westerly and Southerly line of said easement is more particularly described as follows:

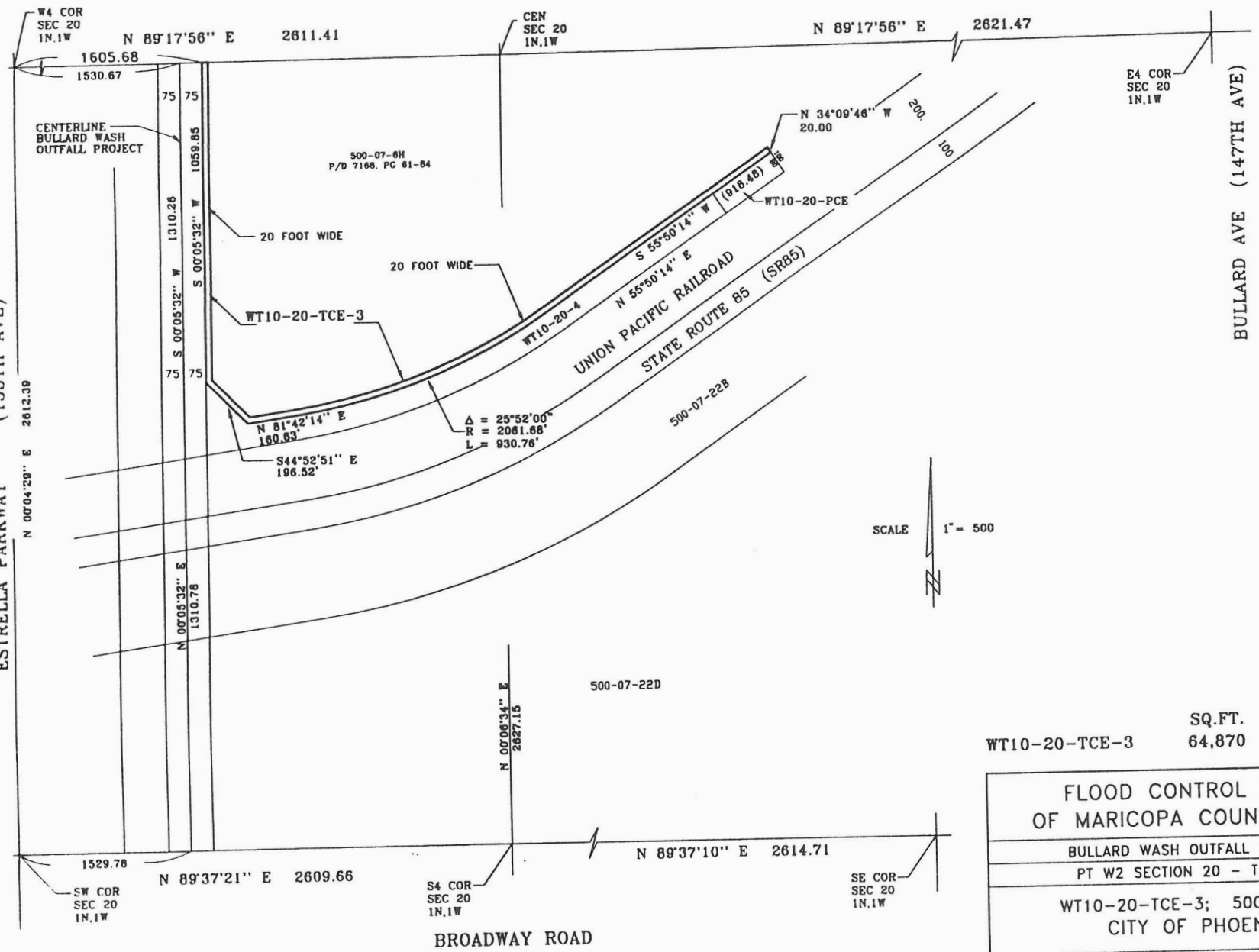
LINE DESCRIPTION:

BEGINNING at a point on the East-West mid-section line of said Section 20, which bears North 89°17'56" East 1605.68 feet from the West quarter corner of said section, said point is also a point on the Easterly right of way line of said Bullard Wash Outfall Project; thence along said East line, South 00°05'32" West 1059.85 feet; thence leaving said East line, South 44°52'51" East 196.52 feet to a point on a line parallel to and 80 feet Northwest of the North right of way line of said Railroad; thence along said parallel line, North 81°42'14" East 160.63 feet to a tangent curve to the left, having a radius of 2061.68 feet and a central angle of 25°52'00" a distance of 930.76 feet; thence North 55°50'14" East 918.48 feet to the **POINT OF TERMINUS** of said descrobed line.

The above described parcels contains 64,870 square feet or 1.4892 acres more or less

Flood Control District of Maricopa County, Arizona			
PELIM: 5-05-98	CHK: TRS 5-29-98	APR: MFT 6-1-98	
REV: 5-29-98		FINAL:	

WT10-20-TCE-3



	SQ.FT.	ACRES
WT10-20-TCE-3	64,870	1.4892

FLOOD CONTROL DISTRICT
OF MARICOPA COUNTY-ARIZONA

BULLARD WASH OUTFALL PROJECT

PT W2 SECTION 20 - T1N,R1W

WT10-20-TCE-3; 500-07-6H
CITY OF PHOENIX

PRELIMINARY: 5-05-98 JLS

REVISED: 5-29-98

FINAL:

WT10-20TCE-3PLT

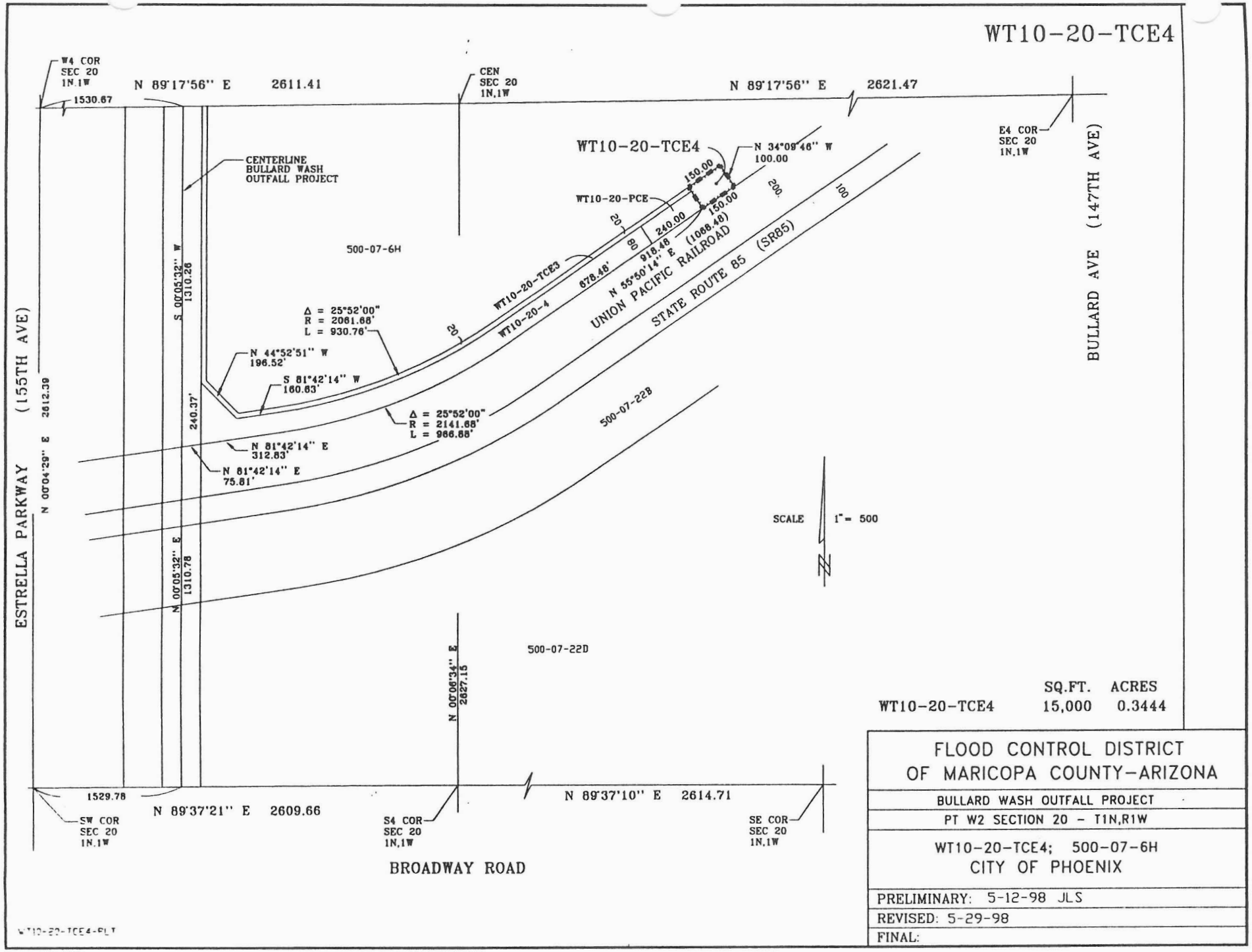
BULLARD WASH OUTFALL PROJECT
WT10-20-TCE4; 500-07-6H
CITY OF PHOENIX

A 100 foot strip of land being a portion of a parcel of land lying North of the Northwesterly right of way line of the Southern Pacific Railroad, now known as Union Pacific Railroad, lying within the South half (S2) of Section 20, T1N, R1W, G&SRB&M, Maricopa County, Arizona, said strip of land being also a part of that certain parcel of land recorded at Dkt 7166, Page 61-84 as recorded in the office of the Recorder of said County, which the Southeasterly line of said 100 foot strip is more particularly described as follows:

COMMENCING at the West quarter corner of said Section 20; thence North 89°17'56" East 1530.67 feet to a point on the centerline of said "Bullard Wash Outfall Project"; thence along said centerline, South 00°05'32" West 1310.26 feet to the a point on the Southerly line of said parcel as recorded at "Dkt 7166, Page 61-84", said point is also a point on the Northwesterly right of way line of the Union Pacific Railroad; thence along said Northwesterly line, North 81°42'14" East 75.81 feet to the Easterly right of way line of said "Bullard Wash Outfall Project"; thence continuing along said Northwesterly right of way line, North 81°42'14" East 312.83 feet to a tangent curve to the left, having a radius of 2141.68 feet and a central angle of 25°52'00" a distance of 966.88 feet; thence North 55°50'14" East 918.48 feet to the **POINT OF BEGINNING** of the Southeasterly line of said 100 foot strip; thence continuing along said Northwesterly right of way line, North 55°50'14" East 150.00 feet to the **POINT OF TERMINUS**.

The above described parcels contains 15,000 square feet or 0.3444 acres more or less

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY		
prelim: 5-12-98	chk: [illegible] 6-1-98	appr: [illegible] 6-1-98
revised: 5-29-98		final:
Maricopa County Public Works Land and Right of Way Division		Titles and Right of Way



	SQ.FT.	ACRES
WT10-20-TCE4	15,000	0.3444

FLOOD CONTROL DISTRICT
OF MARICOPA COUNTY-ARIZONA

BULLARD WASH OUTFALL PROJECT

PT W2 SECTION 20 - T1N,R1W

WT10-20-TCE4; 500-07-6H
CITY OF PHOENIX

PRELIMINARY: 5-12-98 JLS

REVISED: 5-29-98

FINAL:

WT10-20-TCE4-PLT

BULLARD WASH OUTFALL PROJECT
WT10-22-PCE1; 500-07-00
UNION PACIFIC RAILROAD

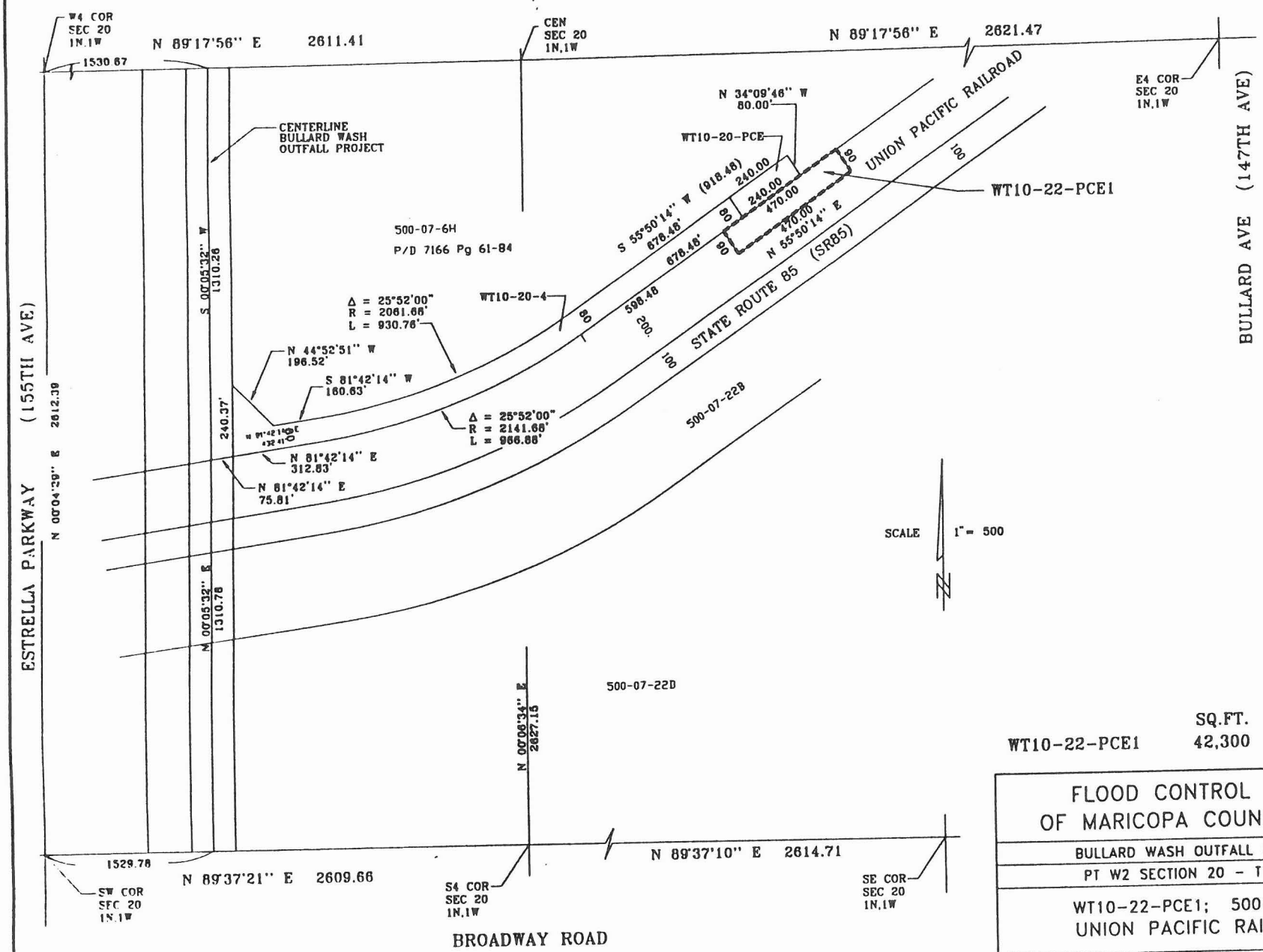
A 90 foot strip of land being a portion of the right of way of the Southern Pacific Railroad, now known as Union Pacific Railroad, lying South of the Northwesterly right of way line of the Union Pacific Railroad and also lying within the South half (S2) of Section 20, T1N, R1W, G&SRB&M, Maricopa County, Arizona. The Northwesterly line of said 90 foot strip is more particularly described as follows:

COMMENCING at the West quarter corner of said Section 20; thence North 89°17'56" East 1530.67 feet to a point on the centerline of said "Bullard Wash Outfall Project"; thence along said centerline, South 00°05'32" West 1310.26 feet to the a point on the Southerly line of said parcel as recorded at "Dkt 7166, Page 61-84", said point is also a point on the Northwesterly right of way line of said Union Pacific Railroad; thence along said Northwesterly line, North 81°42'14" East 75.81 feet to the Easterly right of way line of said "Bullard Wash Outfall Project"; thence continuing along said Northwesterly right of way line, North 81°42'14" East 312.83 feet to a tangent curve to the left, having a radius of 2141.68 feet and a central angle of 25°52'00" a distance of 966.88 feet; thence North 55°50'14" East 598.48 feet to the **POINT OF BEGINNING** of the Northwesterly line of said 90 foot strip; thence continuing along said Northwesterly right of way line, North 55°50'14" East 470.00 feet to the **POINT OF TERMINUS**.

The above described parcels contains 42,300 square feet or 0.9711 acres more or less

Flood Control District of Maricopa County, Arizona		
PELIM: 4-29-98	CHK: Mak 6-1-98	APR: 6-1-98
REV: 5-29-98		FINAL:

WT10-22-PCE1



	SQ.FT.	ACRES
WT10-22-PCE1	42,300	0.9711

FLOOD CONTROL DISTRICT
OF MARICOPA COUNTY-ARIZONA

BULLARD WASH OUTFALL PROJECT

PT W2 SECTION 20 - T1N,R1W

WT10-22-PCE1; 500-07-00
UNION PACIFIC RAILROAD

PRELIMINARY: 4-29-98 JLS

REVISED: 5-29-98

FINAL:

BULLARD WASH OUTFALL PROJECT
WT10-22-PCE2; 500-07-000
UNION PACIFIC RAILROAD

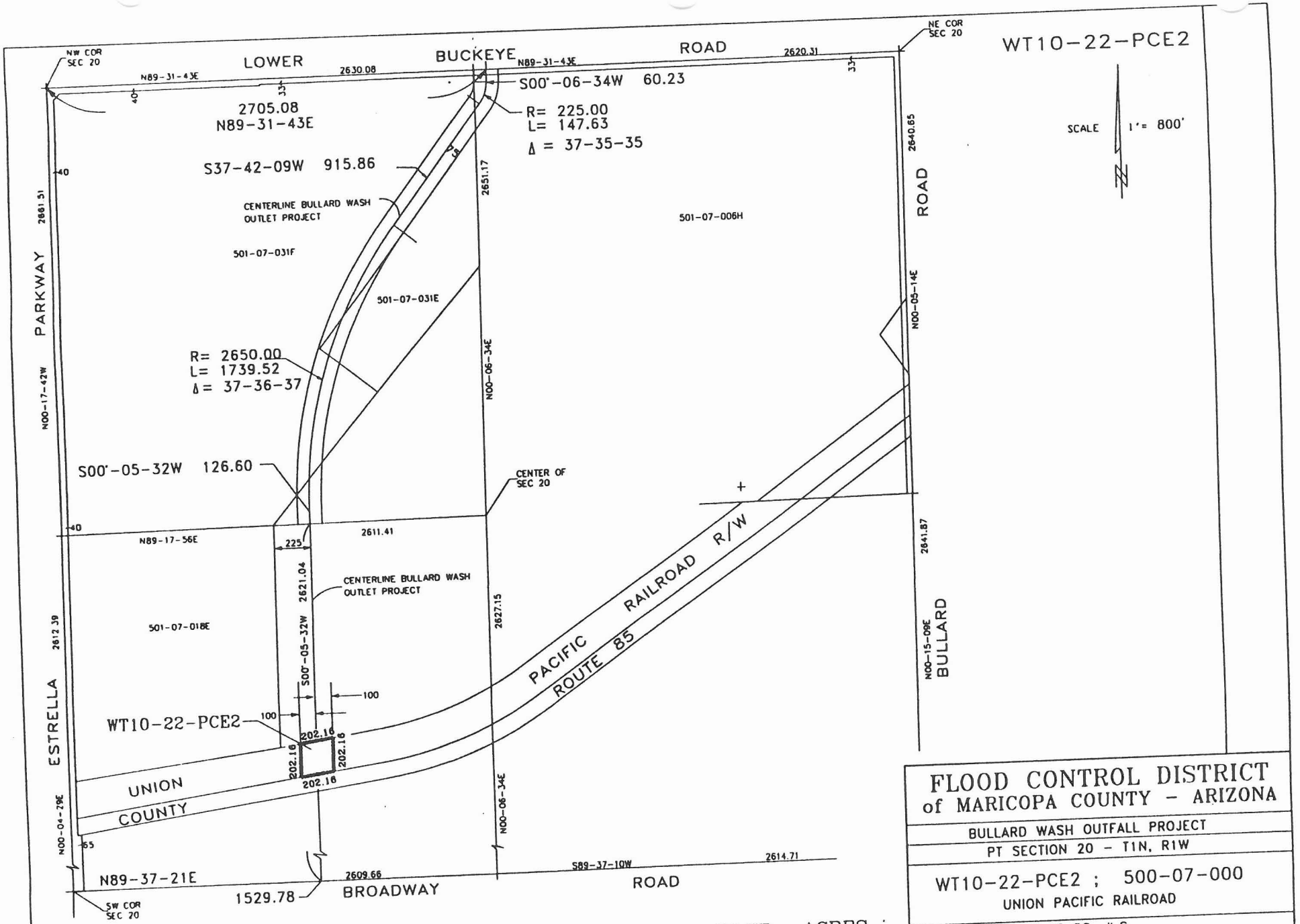
A strip of land 200 feet wide, 100 feet each side of the "Bullard Wash Outlet Project" centerline which lies within the right of way of the Southern Pacific Railroad, now known as Union Pacific Railroad, said centerline is more particularly described as follows:

CENTERLINE DESCRIPTION:

That portion of the Northeast quarter (NE4) and the West half (W2) of Section 20 - T1N, R1W, G&SRB&M, Maricopa County, Arizona. **BEGINNING** said centerline at a point on the North line of said Section 20, which bears North 89°31'43" East 2705.08 feet from the Northwest corner of said section; thence South 00°06'34" West 60.23 feet; thence 147.63 feet, along a tangent curve to the right, having a radius of 225 feet and a central angle of 37°35'35"; thence South 37°42'09" West, along a line 75 feet Northwest of and parallel with the Northwest line of that certain property according to Document 90-566515, a distance of 915.86 feet; thence 1739.52 feet along a tangent curve to the left, having a radius of 2650 feet and a central angle of 37°36'37"; thence South 00°05'32" West 126.60 feet to the East-West mid-section line of said Section 20; thence South 00° 05'32" West along a line 225 feet East of and parallel with the West line of the East half of the West half of said Section 20, a distance of 2621.04 feet to a point on the South line of said section which bears North 89°37'21" East 1529.78 feet from the Southwest corner of said section 20; said point being the terminus of the herein described centerline.

The above described parcel contains 40,432 square feet or 0.9282 acres more or less.

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY		
prelim: 1-30-96	chk: 6-4-98	appr: 6-4-98
revised: 11-19-96; 10-27-97; 5-12-98; 5-29-98		final:
Maricopa County Public Works Land and Right of Way Division		Titles and Right of Way



SQ.FT.	ACRES
40,432	0.9282

WT10-22-PCE2

FLOOD CONTROL DISTRICT of MARICOPA COUNTY - ARIZONA

BULLARD WASH OUTFALL PROJECT

PT SECTION 20 - T1N, R1W

WT10-22-PCE2 ; 500-07-000

UNION PACIFIC RAILROAD

PRELIMINARY: 5-15-98 JLS

REVISED: 5-29-98

FINAL:

WT10-22-PCE2-PLT

BULLARD WASH OUTFALL PROJECT
WT10-22-PCE3; 500-07-000
UNION PACIFIC RAILROAD

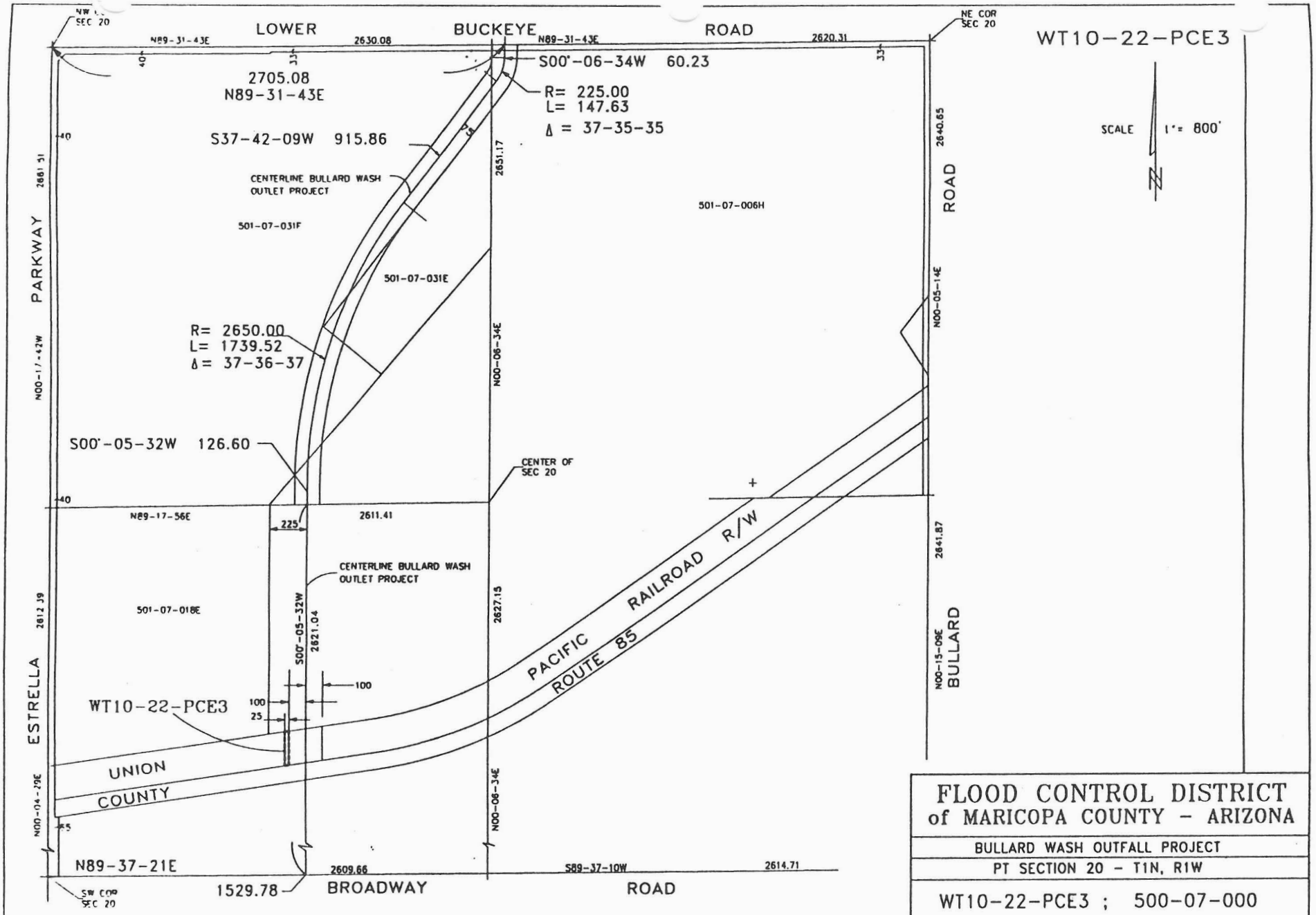
A strip of land 25 feet wide, Which the East line of said 25 foot strip lies 100 feet West of the "Bullard Wash Outlet Project" centerline which lies within the right of way of the Southern Pacific Railroad, now known as Union Pacific Railroad, said centerline is more particularly described as follows:

CENTERLINE DESCRIPTION:

That portion of the Northeast quarter (NE4) and the West half (W2) of Section 20 - T1N, R1W, G&SRB&M, Maricopa County, Arizona. **BEGINNING** said centerline at a point on the North line of said Section 20, which bears North 89°31'43" East 2705.08 feet from the Northwest corner of said section; thence South 00°06'34" West 60.23 feet; thence 147.63 feet, along a tangent curve to the right, having a radius of 225 feet and a central angle of 37°35'35"; thence South 37°42'09" West, along a line 75 feet Northwest of and parallel with the Northwest line of that certain property according to Document 90-566515, a distance of 915.86 feet; thence 1739.52 feet along a tangent curve to the left, having a radius of 2650 feet and a central angle of 37°36'37"; thence South 00°05'32" West 126.60 feet to the East-West mid-section line of said Section 20; thence South 00° 05'32" West along a line 225 feet East of and parallel with the West line of the East half of the West half of said Section 20, a distance of 2621.04 feet to a point on the South line of said section which bears North 89°37'21" East 1529.78 feet from the Southwest corner of said section 20; said point being the terminus of the herein described centerline.

The above described parcel contains 5,055 square feet or 0.1160 acres more or less.

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY		
prelim: 5-29-98	chk: 6-4-98	appr: 6-4-98
revised:		final:
Maricopa County Public Works Land and Right of Way Division		Titles and Right of Way



SQ.FT.	ACRES
5,055	0.1160

WT10-22-PCE3

FLOOD CONTROL DISTRICT of MARICOPA COUNTY - ARIZONA

BULLARD WASH OUTFALL PROJECT

PT SECTION 20 - T1N, R1W

WT10-22-PCE3 ; 500-07-000

UNION PACIFIC RAILROAD

PRELIMINARY: 5-29-98 JLS

REVISED:

FINAL:

BULLARD WASH OUTFALL PROJECT
WT10-22-TCE1 ; 500-07-000
UNION PACIFIC RAILROAD

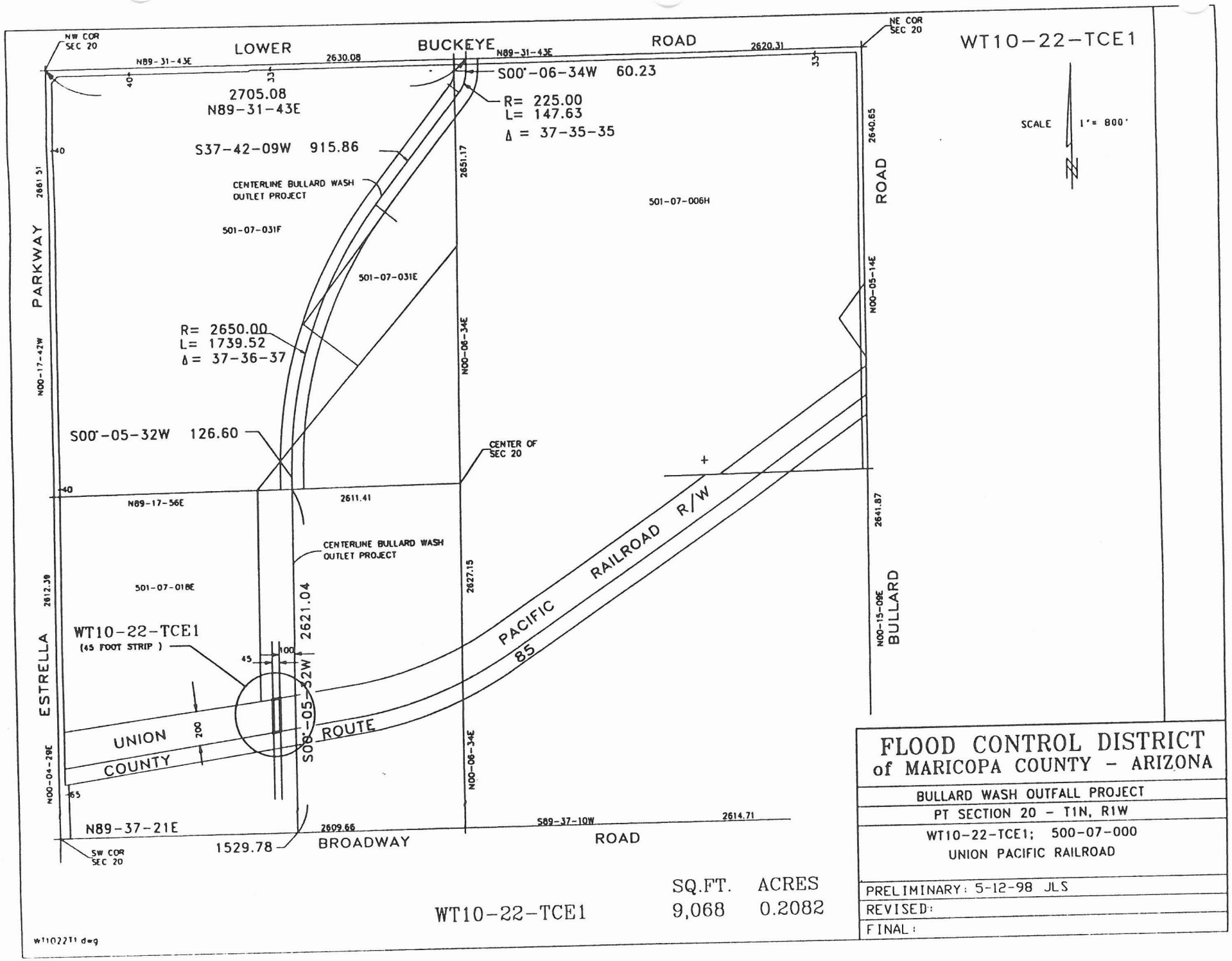
That portion of the Southern Pacific Railroad, now known as Union Pacific Railroad, which lies within a 45 foot strip of land the East line of which lies 100 feet West of and parallel with the following described line:

LINE DESCRIPTION:

That portion of the Northeast quarter (NE4) and the West half (W2) of Section 20 - T1N, R1W, G&SRB&M, Maricopa County, Arizona: BEGINNING said line at a point on the North line of said Section 20, which bears North 89°31'43" East 2705.08 feet from the Northwest corner of said section; thence South 00°06'34" West 60.23 feet; thence 147.63 feet, along a tangent curve to the right, having a radius of 225 feet and a central angle of 37°35'35"; thence South 37°42'09" West, along a line 75 feet Northwest of and parallel with the Northwest line of that certain property according to Document 90-566515, a distance of 915.86 feet; thence 1739.52 feet along a tangent curve to the left, having a radius of 2650 feet and a central angle of 37°36'37"; thence South 00°05'32" West 126.60 feet to the East-West mid-section line of said Section 20; thence South 00° 05'32" West along a line 225 feet East of and parallel with the West line of the East half of the West half of said Section 20, a distance of 2621.04 feet to a point on the South line of said section which bears North 89°37'21" East 1529.78 feet from the Southwest corner of said section 20; said point being the terminus of the herein described centerline.

The above described parcel contains 9,068 square feet or 0.2082 acres more or less.

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY		
prelim: 5-12-98	chk: 6-4-98	appr: 6-04-98
revised: 6-04-98		final:
Maricopa County Public Works Land and Right of Way Division		Titles and Right of Way



SQ.FT.	ACRES
9,068	0.2082

WT10-22-TCE1

FLOOD CONTROL DISTRICT
of MARICOPA COUNTY - ARIZONA

BULLARD WASH OUTFALL PROJECT

PT SECTION 20 - T1N, R1W

WT10-22-TCE1; 500-07-000

UNION PACIFIC RAILROAD

PRELIMINARY: 5-12-98 JLS

REVISED:

FINAL:

wt10221 dwg

BULLARD WASH OUTFALL PROJECT
WT10-22-TCE2 ; 500-07-000
UNION PACIFIC RAILROAD

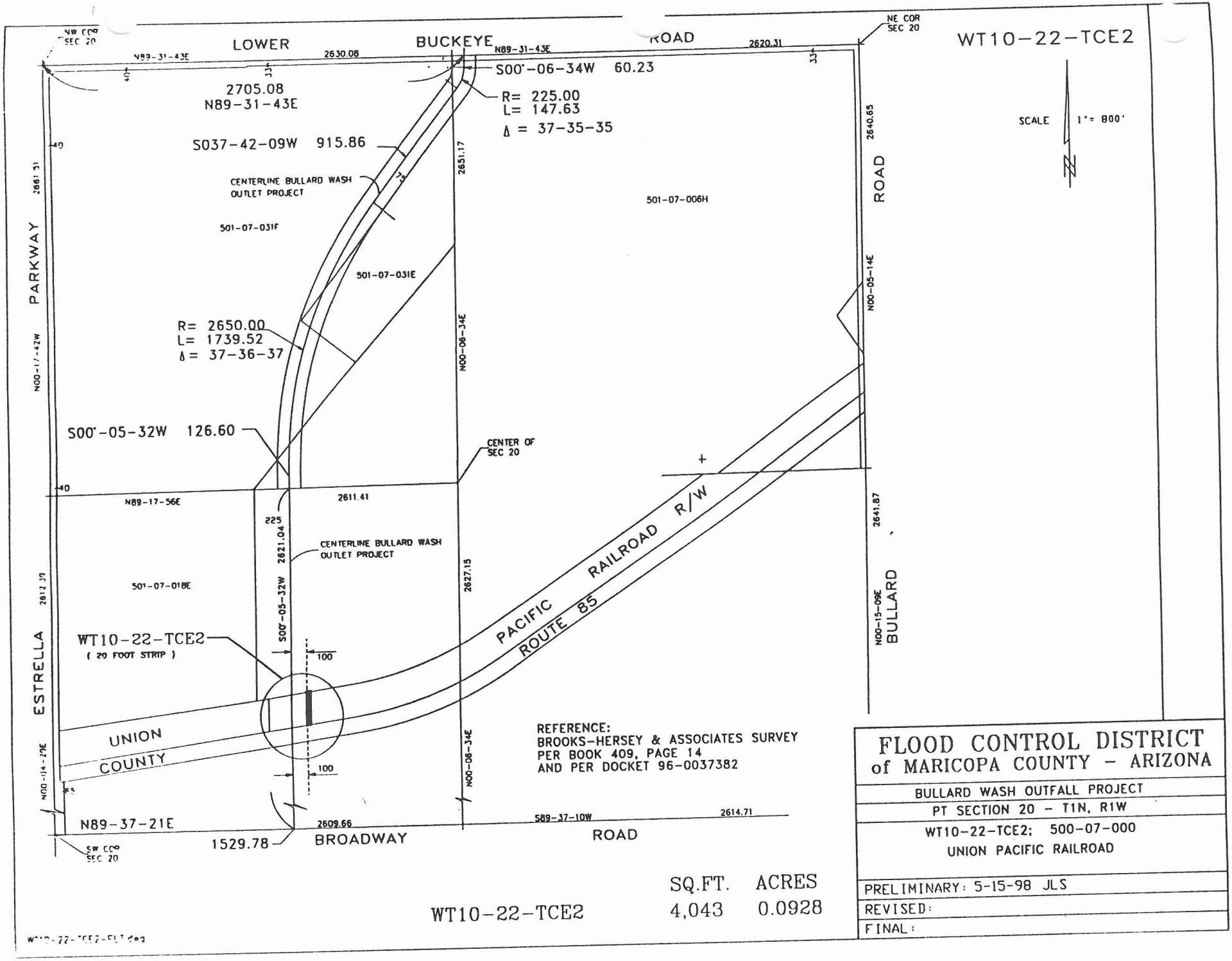
A 20 foot Temporary Construction Easement lying within the right of way of the Southern Pacific Railroad, now known as Union Pacific Railroad. The West line of said easement lies 100 feet East of and parallel with the following described line:

LINE DESCRIPTION:

That portion of the Northeast quarter (NE4) and the West half (W2) of Section 20 - T1N, R1W, G&SRB&M, Maricopa County, Arizona, BEGINNING at a point on the North line of said Section 20, which bears North 89°31'43" East 2705.08 feet from the Northwest corner of said section; thence South 00°06'34" West 60.23 feet; thence 147.63 feet, along a tangent curve to the right, having a radius of 225 feet and a central angle of 37°35'35"; thence South 37°42'09" West, along a line 75 feet Northwest of and parallel with the Northwest line of that certain property according to Document 90-566515, a distance of 915.86 feet; thence 1739.52 feet along a tangent curve to the left, having a radius of 2650 feet and a central angle of 37°36'37"; thence South 00°05'32" West 126.60 feet to the East-West mid-section line of said Section 20; thence South 00° 05'32" West along a line 225 feet East of and parallel with the West line of the East half of the West half of said Section 20, a distance of 2621.04 feet to a point on the South line of said section which bears North 89°37'21" East 1529.78 feet from the Southwest corner of said section 20; said point being the terminus of the herein described line.

The above described parcel contains 4,043 square feet or 0.0928 acres more or less.

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY		
prelim: 5-15-98	chk: Mk 5-12-98	appr: [illegible] 5-12-98
revised:		final:
Maricopa County Public Works Land and Right of Way Division		Titles and Right of Way


WT10-22-TCE2
SCALE 1"= 800'
NW COR SEC 20
NE COR SEC 20
SW COR SEC 20
LOWER BUCKEYE ROAD
N89-31-43E
2630.08
2620.31
S00°-06-34W 60.23
2705.08
N89-31-43E
R= 225.00
L= 147.63
Δ = 37-35-35
S037-42-09W 915.86
CENTERLINE BULLARD WASH OUTLET PROJECT
501-07-031F
501-07-031E
501-07-006H
2651.17
2640.65
ROAD
PARKWAY
ESTRELLA
BULLARD
N00-17-42W
N00-06-34E
N00-05-14E
N00-15-09E
R= 2650.00
L= 1739.52
Δ = 37-36-37
S00°-05-32W 126.60
CENTER OF SEC 20
N89-17-56E
2611.41
225
2621.04
S00°-05-32W
CENTERLINE BULLARD WASH OUTLET PROJECT
501-07-018E
2627.15
2641.87
PACIFIC RAILROAD R/W
ROUTE 85
WT10-22-TCE2
(20 FOOT STRIP)
100
UNION COUNTY
REFERENCE:
BROOKS-HERSEY & ASSOCIATES SURVEY
PER BOOK 409, PAGE 14
AND PER DOCKET 96-0037382
N89-37-21E
2609.66
S89-37-10W
2614.71
1529.78
BROADWAY ROAD
SQ.FT. ACRES
WT10-22-TCE2 4,043 0.0928
FLOOD CONTROL DISTRICT
of MARICOPA COUNTY - ARIZONA
BULLARD WASH OUTFALL PROJECT
PT SECTION 20 - T1N, R1W
WT10-22-TCE2; 500-07-000
UNION PACIFIC RAILROAD
PRELIMINARY: 5-15-98 JLS
REVISED:
FINAL:

BULLARD WASH OUTFALL PROJECT
WT10-23; 500-07-000
Maricopa County Route 85 (MC-85)

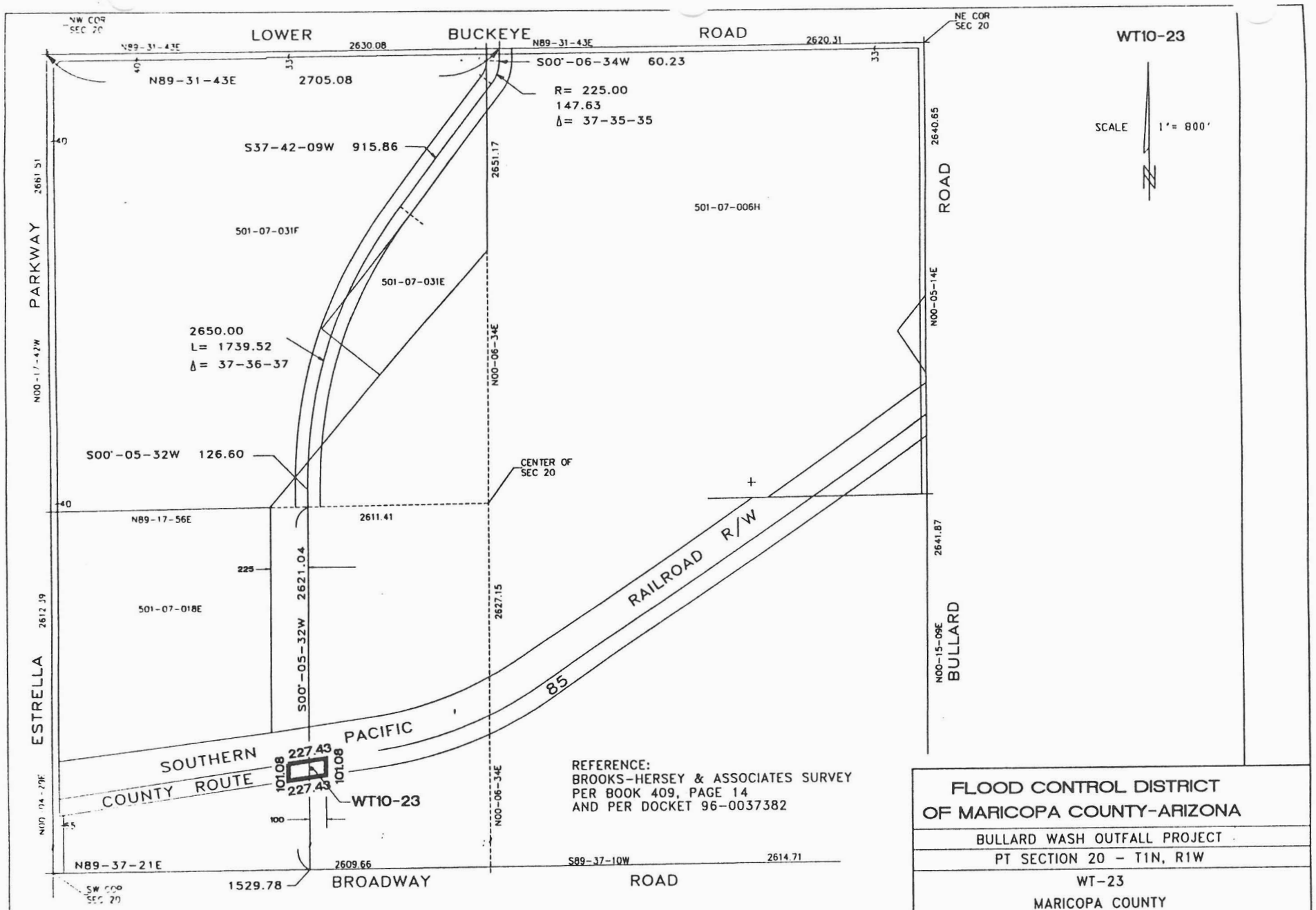
That portion of Maricopa County Route 85 (MC-85), being a strip of land 225 feet wide, the East line of which lies 100 feet East of the "Bullard Wash Outfall Project" The centerline of said Bullard Wash Outfall Project is described as follows:

CENTERLINE DESCRIPTION:

That portion of the Northeast quarter (NE4) and the West half (W2) of Section 20 - T1N, R1W, G&SRB&M, Maricopa County, Arizona. **BEGINNING** said centerline at a point on the North line of said Section 20, which bears North 89°31'43" East 2705.08 feet from the Northwest corner of said section; thence South 00°06'34" West 60.23 feet; thence 147.63 feet, along a tangent curve to the right, having a radius of 225 feet and a central angle of 37°35'35"; thence South 37°42'09" West, along a line 75 feet Northwest of and parallel with the Northwest line of that certain property according to Document 90-566515, a distance of 915.86 feet; thence 1739.52 feet along a tangent curve to the left, having a radius of 2650 feet and a central angle of 37°36'37"; thence South 00°05'32" West 126.60 feet to the East-West mid-section line of said Section 20; thence South 00° 05'32" West along a line 225 feet East of and parallel with the West line of the East half of the West half of said Section 20, a distance of 2621.04 feet to a point on the South line of said section which bears North 89°37'21" East 1529.78 feet from the Southwest corner of said section 20; said point being the terminus of the herein described centerline.

The above described parcel contains 22,743 square feet or 0.5221 acres more or less.

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY		
prelim: 1-17-95	chk: 7-28-98	appr:
revised: 11-19-96; 7-10-98		final:
Maricopa County Public Works Land and Right of Way Division		Titles and Right of Way



	SQ.FT.	ACRES
WT10-23	22,743	0.5221

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY-ARIZONA

BULLARD WASH OUTFALL PROJECT

PT SECTION 20 - T1N, R1W

WT-23

MARICOPA COUNTY DEPARTMENT OF TRANSPORTATION

PRELIMINARY: 1-17-95 MS

REVISED: 11-19-96 7-10-98

FINAL:

BULLARD WASH OUTFALL PROJECT
WT10-25; 500-81-4E, 6J, 500-07-22B, 22D
EQUITABLE VARIABLE LIFE INSURANCE COMPANY

That part of that certain parcel of land recorded at Record Number 94-781427 in the office of the Recorder, which lies within a portion of the Southwest quarter (SW4) of Section 20 and the West half (W2) of Section 29, all in T1N, R1W, G&SRB&M, Maricopa County, Arizona, said portion is more particularly described as follows:

COMMENCING at the common corner of the Southwest corner of said Section 20 and the Northwest corner of said section 29; thence along the common line of said sections, North 89°37'21" East 1184.78 feet to the **POINT OF BEGINNING:**

thence North 00°05'32" East 10.00 to the North line of the South 10 feet of the SW4 of said section 20;

thence along the North line of the South 10 feet of the SW4 of said section 20, North 89°37'21" East 105.00 feet;

thence North 00°05'32" East 70.00 feet;

thence North 89°37'21" East 140.00 feet;

thence along a line 100 feet West of and parallel to the centerline of the Bullard Wash Outfall Project, North 00°05'32" East 215.01 feet;

thence North 89°37'21" East 10.00 feet;

thence along a line 90 feet West of and parallel to the centerline of said Bullard Wash, North 00°05'32" East 509.78 feet;

thence North 53°45'20" West 111.46 feet;

thence South 81°42'14" West 152.38 feet;

thence North 08°17'46" West 50.00 feet;

thence North 81°42'14" East 215.35 feet;

(cont'd)

thence North 00°05'32" East 60.65 feet to a point on the Southerly right of way line of Maricopa County Route 85 (MC-85);
thence along the Southerly right of way line of said MC-85, North 81°42'14" East 126.35 feet to a point on the centerline of said Bullard Wash Outfall Project;
thence continuing along said Southerly right of way, North 81°42'14" East 101.08;
thence along a line lying 100 East of, and parallel to the centerline of said Bullard Wash, South 00°05'32" West 70.76 feet; thence North 81°42'14" East 141.94 feet;
thence South 42°16'30" West 224.01 feet;
thence along a line lying 90 feet East of and parallel to the centerline of said Bullard Wash, South 00°05'32" West 735.50 feet to the North line of the South 70 feet of the SW4 of said section 20;
thence along the North line of said South 70 feet, North 89°37'21" East 160.01 feet;
thence South 00°05'32" West 60.00 feet to the North line of the South 10 feet of the SW4 of said section 20;
thence along the North line of said South 10 feet, North 89°37'21" East 70.00 feet;
thence South 00°05'32" West 10.00 feet to a point on the South line of the SW4 of said section 20;
thence South 00°16'02 East 50.00 feet to the South line of the North 50 feet of the West half of said section 29;
thence along the South line of said North 50 feet, South 89°37'21" West 70.00 feet;
thence South 00°16'02" East 55.00 feet to the South line of the North 105 feet;
thence along the South line of said North 105 feet, South 89°37'21" West 150.00 feet;

(cont'd)

thence along a line 100 feet East of and parallel to the centerline of said Bullard Wash, South 00°16'02" East 2545.53 feet to a point on the East-West mid section line of said section 29.

thence continuing along a line 100 feet East of and parallel to the centerline line of said Bullard Wash, South 00°18'10" East 563.55 feet to a point on the Northerly right-of-way line of the Buckeye Water Conservation and Drainage District "White Tanks Canal" as described in Docket 10480, Page 1438 Recorder's Office, Maricopa County;

thence along said Canal right of way, North 80°24'44" West 110.19 to a point of intersection with the centerline of said Bullard Wash, said point for a tie, lies North 09°50'01" East 2136.52 feet from a point on the South line of the West half of said section 29, which bears North 89°54'41" East 1150.85 feet from the Southwest corner of said section 29;

thence continuing along said Canal right of way, North 80°24'44" West 92.83 feet;

thence North 00°18'10" West 528.92 to a point of intersection with the East-West mid section line of said section 29;

thence along a line lying 100 feet West of and parallel to the centerline of said Bullard Wash, North 00°16'02 West 2545.04 feet to a point on the South line of the North 105 feet;

thence along the South line of the North 105.00 feet of the West half of said section 29, South 89°37'21" West 150.00 feet;

BULLARD WASH OUTFALL PROJECT
WT10-25; 500-81-4E, 6J, 500-07-22B, 22D
EQUITABLE VARIABLE LIFE INSURANCE COMPANY

(cont'd)

thence North 00°16'02" West 65.00 feet to the a point on the South line of the North 40 feet;
thence along the South line of said North 40 feet, South 89°37'21" West 95.00 feet;
thence North 00°16'02" West 40.00 feet to a point on the North line of said section 29 and the **POINT OF BEGINNING.**

Containing 916,117 feet or 21.0312 acres more or less.

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY		
prelim: 01-30-96	chk: JCA 8-27-98	appr: MHT 8-27-98
Revised: 11-19-96, 07-01-98; 8-26-98		final:
Maricopa County Public Works Land and Right of Way Division		Titles and Right of Way

WT10-25

W4 COR SEC 20 1N,1W

1530.67 N 89°17'56" E (2611.41')

CEN SEC 20 1N,1W

SPRR

N 87°42'14" E 126.35

N 87°42'14" E 101.08

S 00°05'32" W 70.76

N 00°05'32" E 60.65

N 87°42'14" E 141.94

MC-86

N 87°42'14" E 215.35

500-07-22B

N 08°17'46" W 50.00

S 42°16'30" W 224.01

S 87°42'14" W 152.38

N 53°45'20" E 111.46

90 90

500-07-22D

N 00°04'28" E 1320.00'

509.78'

S 00°05'32" W 2621.04

735.50

N 00°06'34" E 2627.15

N 89°37'21" E 10.00

N 00°05'32" E 215.01

N 89°37'21" E 160.01

500-07-22D

N 89°37'21" E 140.00

S 00°05'32" W 60.00

N 00°05'32" E 70.00

N 89°37'21" E 70.00

N 89°37'21" E 105.00

S 00°05'32" W 10.00

100 90

S4 COR SEC 20 1N,1W

SE4 COR SEC 20 1N,1W

SW COR SEC 20 1N,1W

S 00°05'32" W 10.00

N89°37'21"E (2609.66)

N89°37'10"E 2614.71

1184.78

N 89°37'21" E 1529.78 TO Centerline Project

S 00°16'02" E 50.00

NW COR SEC 29 1N,1W

N4 COR SEC 29 1N,1W

NE4 COR SEC 29 1N,1W

S 89°37'21" W 70.00

N 00°16'02" W 40.00

S 00°16'02" E 55.00

S 89°37'21" W 95.00

100 100

N 00°16'02" W 65.00

S 89°37'21" W 150.00

S 89°37'21" W 150.00

ESTRELLA PARKWAY

BULLARD AVE

N 00°11'18" W 2646.51

2545.04'

S 00°16'02" E 2650.29

2545.53'

500-81-6J

N 00°20'45" W 2652.96'

500-81-6J

100 100

W4 COR SEC 29 1N,1W

CEN SEC 29 1N,1W

E4 COR SEC 29 1N,1W

N 89°45'50" E (2616.92)

1533.42

S 00°18'10" E 476.94'

500-81-4E

500-81-4E

Δ= 10°08'11"
R = 225.00
L = 39.81

528.92'

563.55'

100 100

Buckeye

N 00°15'35" W 2645.40'

N 80°24'44" W 92.83'

N 80°24'44" W 110.19'

Canal

S 09°50'01" W 2165.17 2136.52

S4 COR SEC 29 1N,1W

S4 COR SEC 29 1N,1W

1150.85

N89°54'41"E (2620.94)

SOUTHERN AVE

PLOT SCALE = 535

Scale 1" = 100'

	SQ.FT.	ACRES
WT10-25	916,117	21.0312

FLOOD CONTROL DISTRICT
OF MARICOPA COUNTY-ARIZONA

BULLARD WASH OUTFALL PROJECT

PT SW4 SECTION 20 & W2 SECTION 29 - T1N,R1W

WT10-25; 500-07, 22B, 22D, 500-81-4E, 6J

EQUITABLE VARIBLE
LIFE INSURANCE

PRELIMINARY: 3-27-98 JLS

REVISED: 11-19-96; 7-01-98 8-26-98

FINAL:

WT10-25-PLT

BULLARD WASH OUTFALL PROJECT
WT10-25-TCE1; 500-81-6J
EQUITABLE VARIABLE LIFE INSURANCE COMPANY

A 20 foot wide Temporary Construction Easement lying within a portion of that certain parcel of land recorded at Record Number 94-781427 in the office of the Recorder, said easement is the South 20 feet of the North 30 feet of the West 1184.79 feet of the West half (W2) of Section 29, T1N, R1W, G&SRB&M, Maricopa County, Arizona,

Containing 23,696 square feet or 0.5440 acres more or less.

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY		
prelim: 7-02-98	chk: 8-25-98	appr: 8-25-98
revised: 8-17-98		final:
Maricopa County Public Works Land and Right of Way Division		Titles and Right of Way

BULLARD WASH OUTFALL PROJECT
WT10-25-TCE2; 500-07-22B, 22D
EQUITABLE VARIABLE LIFE INSURANCE COMPANY

A Temporary Construction Easement lying within a portion of that certain parcel of land recorded at Record Number 94-781427 in the office of the Recorder, said easement lies within the Southwest quarter of Section 20, T1N, R1W, G&SRB&M, Maricopa County, Arizona, and is more particularly described as follows:

COMMENCING at the common corner of the Southwest corner of said Section 20 and the Northwest corner of said section 29; thence along the South line of said section 20, North 89°37'21" East 1529.78 feet to point of intersection of the South line of said section 20 and the centerline of the "Bullard Wash Outfall Project"; thence along the centerline of said Bullard Wash, North 00°05'32" East 80 feet to the North line of the South 80 feet of the Southwest quarter of section 20; thence South 89°37'21" West 100 feet to the West right of way line of said Bullard Wash and the **POINT OF BEGINNING**; thence along said West right of way line, North 00°05'32" East 215.01 feet; thence North 89°37'21" East 10.00 feet,; thence North 00°05'32" East 509.78 feet; thence North 53°45'20" West 111.46 feet; thence South 00°05'32" West 248.52 feet; thence North 89°54'28" East 65.00 feet; thence South 00°05'32" West 327.22 feet; thence South 89°37'21" West 15.00 feet; thence South 00°05'32" West 215.00 feet to the North line of the South 80 feet of the Southwest quarter of said section 20; thence along said North line, North 89°37'21" East 30.00 feet to the **POINT OF BEGINNING**

Containing 34,035 square feet or 0.7814 acres more or less.

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY		
prelim: 7-02-98	chk: 8-27-98	appr: 8-27-98
revised: 8-26-98		final:
Maricopa County Public Works Land and Right of Way Division		Titles and Right of Way

BULLARD WASH OUTFALL PROJECT
WT10-25-TCE3; 500-07-22B, 22D
EQUITABLE VARIABLE LIFE INSURANCE COMPANY

A Temporary Construction Easement lying within a portion of that certain parcel of land recorded at Record Number 94-781427 in the office of the Recorder, said easement lies within the Southwest quarter of Section 20, T1N, R1W, G&SRB&M, Maricopa County, Arizona, and is more particularly described as follows:

COMMENCING at the common corner of the Southwest corner of said Section 20 and the Northwest corner of said section 29; thence along the South line of said section 20, North 89°37'21" East 1529.78 feet to point of intersection of the South line of said section 20 and the centerline of the "Bullard Wash Outfall Project"; thence along the centerline of said Bullard Wash, North 00°05'32" East 70 feet to the North line of the South 70 feet of the SW4 of said section 20; thence North 89°37'21" East 90 feet to the East right of way line of said Bullard Wash and the **POINT OF BEGINNING**; thence along said East right of way line, North 00°05'32" East 735.50 feet; thence North 42°16'30" East 224.01 feet: thence North 81°42'14" East 94.47 feet; thence South 42°16'30" West 318.52 feet to a point on a line lying 30 feet East of and parallel to the East right of way line of said Bullard Wash; thence South 00°05'32" West 679.01 feet to a point on the North line of the South 70 feet of the SW4 of said section 20; thence South 89°37'21" West 30.00 feet to the **POINT OF BEGINNING.**

Containing 37,493 square feet or 0.8607 acres more or less.

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY		
prelim: 7-02-98	chk: GRS 8-27-98	appr: [illegible] 8-27-98
revised: 8-26-98		final:
Maricopa County Public Works Land and Right of Way Division		Titles and Right of Way

BULLARD WASH OUTFALL PROJECT
WT10-25-TCE4; 500-81-6J
EQUITABLE VARIABLE LIFE INSURANCE COMPANY

A Temporary Construction Easement lying within a portion of that certain parcel of land recorded at Record Number 94-781427 in the office of the Recorder, said easement lies within the West half of Section 29, T1N, R1W, G&SRB&M, Maricopa County, Arizona, and is more particularly described as follows:

COMMENCING at the common corner of the Southwest corner of said Section 20 and the Northwest corner of said section 29; thence along the North line of said section 29, North 89°37'21" East 1529.78 feet to point of intersection of the North line of said section 29 and the centerline of the "Bullard Wash Outfall Project"; thence along the centerline of said Bullard Wash, South 00°16'02" East 105 feet to the South line of the North 105 feet of the W2 of said section 29; thence North 89°37'21" East 100 feet to the East right of way line of said Bullard Wash and the **POINT OF BEGINNING**; thence along said East right of way line, South 00°16'02" East 2545.53 feet to a point on the East-West mid section line of said section 29; thence along said mid section line, North 89°45'50" East 85.00 feet; thence North 00°16'02" West 60.00 feet; thence South 89°45'50" West 50.00 feet; thence along a line 35 feet East of and parallel to the East right of way line of said Bullard Wash, North 00°16'02" West 1208.40 feet; thence North 89°37'21" East 50.00 feet ; thence North 00°16'02" West 100.00 feet; thence South 89°37'21" West 55.00 feet; thence along a line 30 feet East of and parallel to the East right of way line of said Bullard Wash, North 00°16'02" West 1177.22 feet to a point on the South line of the North 105 feet of the W2 of said section 29; thence along said South line, South 89°37'21" West 30.00 feet to the **POINT OF BEGINNING.**

Containing 91,209 square feet or 2.0939 acres more or less.

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY		
prelim: 7-02-98	chk: CES 8-21-98	appr: [illegible]
revised: 8-17-98		final:
Maricopa County Public Works Land and Right of Way Division		Titles and Right of Way

BULLARD WASH OUTFALL PROJECT
WT10-25-TCE5; 500-81-4E
EQUITABLE VARIABLE LIFE INSURANCE COMPANY

A Temporary Construction Easement lying within a portion of that certain parcel of land recorded at Record Number 94-781427 in the office of the Recorder, said easement lies within the South half of the West half of Section 29, T1N, R1W, G&SRB&M, Maricopa County, Arizona, and is more particularly described as follows:

COMMENCING at the West quarter corner of said section 29; thence along the East–West mid section line, North 89°45'50" East 1533.42 feet to point of intersection of the East-West mid section line of said section 29 and the centerline of the "Bullard Wash Outfall Project"; thence continuing along said East-West line, North 89°45'50" East 100 feet to the East right of way line of said Bullard Wash and the **POINT OF BEGINNING**; thence along the East line of said right of way, South 00°18'10" East 563.55 feet to a point on the Northerly right-of-way line of the Buckeye Water Conservation and Drainage District "White Tanks Canal" as described in Docket 10480, Page 1438, Recorder's Office, Maricopa County; thence along said Canal right of way line, South 80°24'44" East 178.81 feet; thence leaving the North line of said canal right of way, North 09°35'16" East 50.00 feet; thence North 80°24'44" West 152.00 feet; thence along a line 35 feet East of and parallel to the East right of way line of said Bullard Wash, North 00°18'10" West 468.86 feet to a point on the South line of the North 50.00 feet of the S2W2 of said section 29; thence along said South line, North 89°45'50" East 50.00 feet; thence North 00°18'10" West 50.00 feet to a point on the East- West mid section line of said section 29; thence along said mid section line, South 89°45'50" West 85.00 feet to the **POINT OF BEGINNING.**

Containing 29,713 square feet or 0.6821 acres more or less.

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY		
prelim: 7-02-98	chk: 8-21-98	appr:
revised: 8-17-98		final:
Maricopa County Public Works Land and Right of Way Division		Titles and Right of Way

BULLARD WASH OUTFALL PROJECT
WT10-25-TCE6; 500-81-4E
EQUITABLE VARIABLE LIFE INSURANCE COMPANY

A Temporary Construction Easement lying within a portion of that certain parcel of land recorded at Record Number 94-781427 in the office of the Recorder, said easement lies within the South half of the West half of Section 29, T1N, R1W, G&SRB&M, Maricopa County, Arizona, and is more particularly described as follows:

COMMENCING at the West quarter corner of said section 29; thence along the East – West mid section line, North 89°45'50" East 1533.42 feet to point of intersection of the East-West mid section line of said section 29 and the centerline of the "Bullard Wash Outfall Project"; thence along said East-West line, South 89°45'50" West 100 feet to the West right of way line of said Bullard Wash and the **POINT OF BEGINNING**; thence along the West line of said right of way line, South 00°18'10" East 528.92 to a point on the Northerly right-of-way line of the Buckeye Water Conservation and Drainage District "Buckeye Canal" as described in Docket 10480, Page 1438, Recorder's Office, Maricopa County; thence along said Canal right of way, North 80°24'44" West 30.45 feet; thence leaving the North line of said canal and along a line 30 feet West of and parallel to the West right of way line of said Bullard Wash, North 00°18'10" West 473.72 feet to a point on the South line of the North 50.00 feet of the S2W2 of said section 29; thence along said South line, South 89°45'50" West 50.00 feet; thence North 00°18'10" West 50.00 feet to a point on the East- West mid section line of said section 29; thence along said mid section line, North 89°45'50" East 80.00 feet to the **POINT OF BEGINNING.**

Containing 18,290 square feet or 0.4199 acres more or less.

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY		
prelim: 7-02-98	chk: 8-21-98	appr:
revised: 8-17-98		final:
Maricopa County Public Works Land and Right of Way Division		Titles and Right of Way

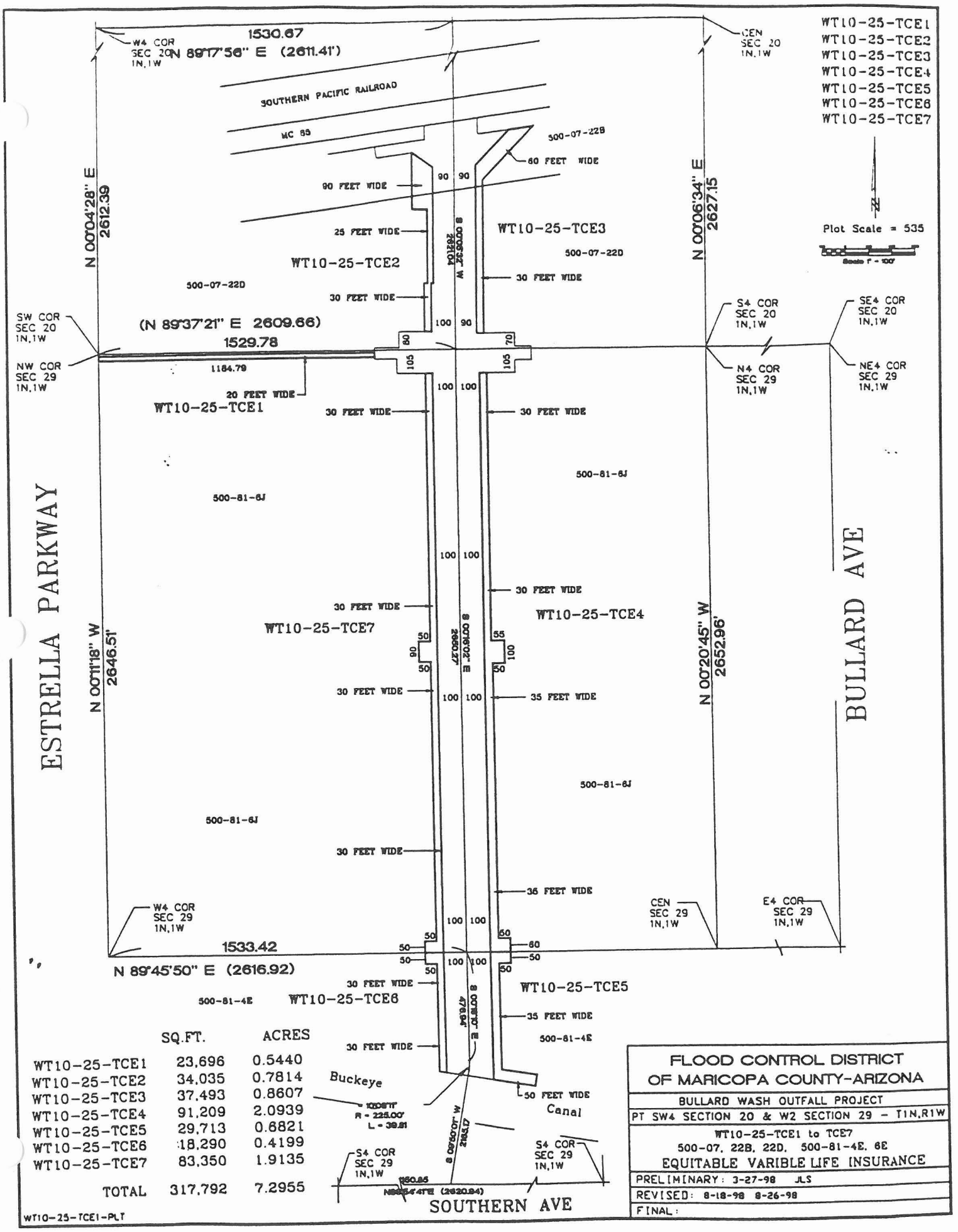
BULLARD WASH OUTFALL PROJECT
WT10-25-TCE7; 500-81-6J
EQUITABLE VARIABLE LIFE INSURANCE COMPANY

A Temporary Construction Easement lying within a portion of that certain parcel of land recorded at Record Number 94-781427 in the office of the Recorder, said easement lies within the West half of Section 29, T1N, R1W, G&SRB&M, Maricopa County, Arizona, and is more particularly described as follows:

COMMENCING at the common corner of the Southwest corner of said Section 20 and the Northwest corner of said section 29; thence along the North line of said section 29, North 89°37'21" East 1529.78 feet to point of intersection of the North line of said section 29 and the centerline of the "Bullard Wash Outfall Project"; thence along the centerline of said Bullard Wash, South 00°16'02" East 105 feet to the South line of the North 105 feet of the W2 of said section 29; thence South 89°37'21" West 100 feet to the West right of way line of said Bullard Wash and the **POINT OF BEGINNING**; thence along said West right of way line, South 00°16'02" East 2545.04 feet to a point on the East-West mid section line of said section 29; thence along said mid section line, South 89°45'50" West 80.00 feet; thence North 00°16'02" West 50.00 feet; thence North 89°45'50" East 50.00 feet; thence along a line 30 feet West of and parallel to the West right of way line of said Bullard Wash, North 00°16'02" West 1227.74 feet; thence South 89°37'21" West 50.00 feet ; thence North 00°16'02" West 90.00 feet; thence North 89°37'21" East 50.00 feet; thence along a line 30 feet West of and parallel to the East right of way line of said Bullard Wash, North 00°16'02" West 1177.22 feet to a point on the South line of the North 105 feet of the W2 of said section 29; thence along said South line, North 89°37'21" East 30.00 feet to the **POINT OF BEGINNING.**

Containing 83,350 square feet or 1.9135 acres more or less.

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY		
prelim: 7-02-98	chk: 8-21-98	appr: 8-21-98
revised: 8-17-98		final:
Maricopa County Public Works Land and Right of Way Division		Titles and Right of Way



	SQ.FT.	ACRES
WT10-25-TCE1	23,696	0.5440
WT10-25-TCE2	34,035	0.7814
WT10-25-TCE3	37,493	0.8607
WT10-25-TCE4	91,209	2.0939
WT10-25-TCE5	29,713	0.6821
WT10-25-TCE6	18,290	0.4199
WT10-25-TCE7	83,350	1.9135
TOTAL	317,792	7.2955

FLOOD CONTROL DISTRICT
OF MARICOPA COUNTY-ARIZONA

BULLARD WASH OUTFALL PROJECT

PT SW4 SECTION 20 & W2 SECTION 29 - T1N,R1W

WT10-25-TCE1 to TCE7
500-07, 22B, 22D, 500-81-4E, 6E

EQUITABLE VARIBLE LIFE INSURANCE

PRELIMINARY: 3-27-98 JLS

REVISED: 8-18-98 8-26-98

FINAL:

WT10-25-TCE1-PLT

THIS DESCRIPTION AMENDS THAT CERTAIN DOCUMENT
98-0497126
MARICOPA COUNTY RECORDER

BULLARD WASH OUTFALL PROJECT
WT10-40 ; 500-81-004J
BUCKEYE WATER CONSERVATION AND DRAINAGE DISTRICT

A portion of the Southwest quarter (SW4) of Section 29, T1N, R1W, G&SRB&M, Maricopa County, Arizona, said portion being that part of that certain parcel of land recorded at Book 412 of Deeds, Page 160 in the office of the Recorder of said County, which lies West of a line parallel with and 75' East of the following described line:

LINE DESCRIPTION

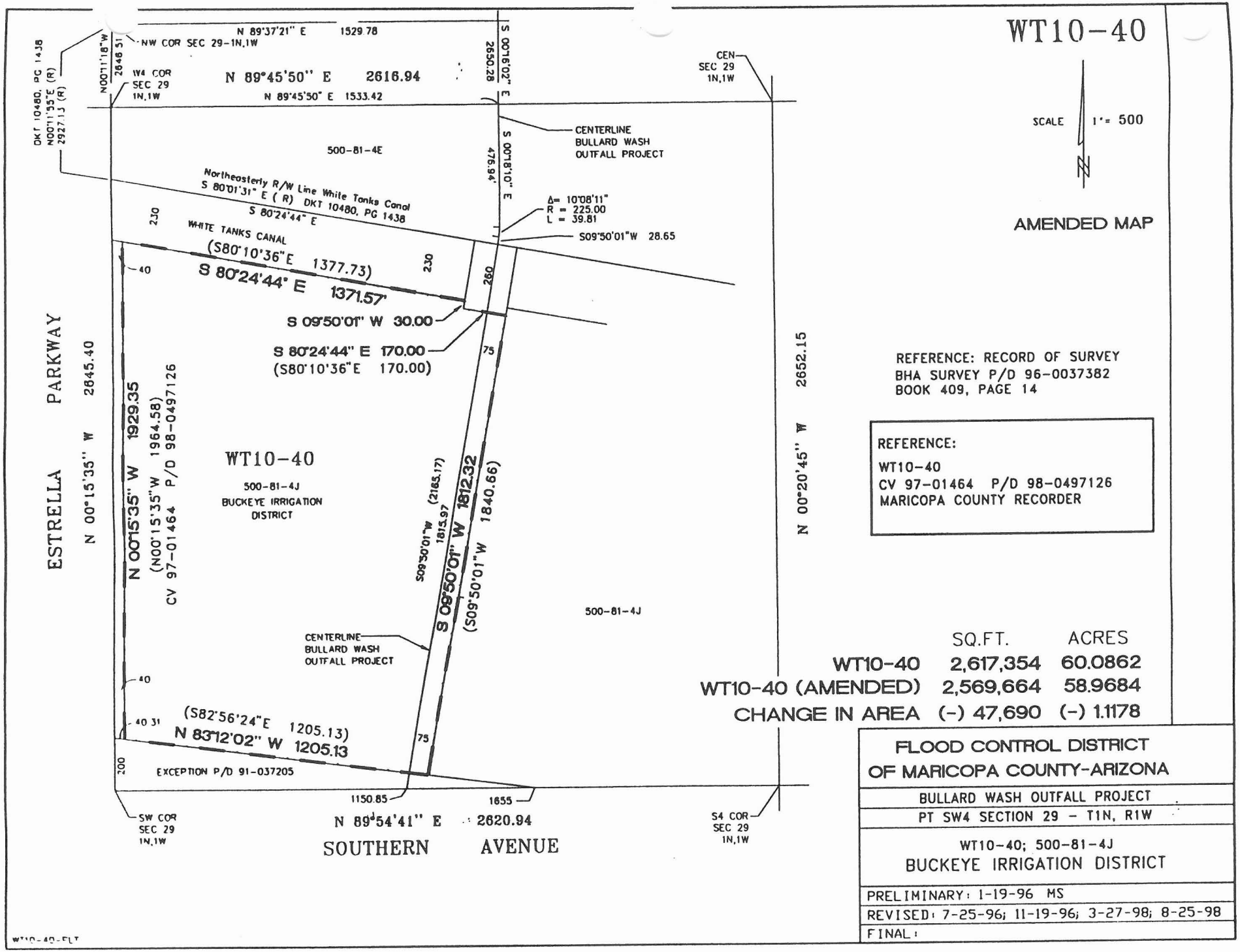
COMMENCING at the West quarter corner of said Section 29; thence along the East West mid-section line, North 89°45'50" East 1533.42 feet; thence along a line 225 feet East of the West line of the East half of the Southwest quarter, South 00°18'10" East 476.94 feet; thence 39.81 feet along a tangent curve to the right having a radius of 225 feet and a central angle of 10°08'11"; thence South 9°50'01" West 28.65 feet to a point on the Northerly right of way line of the "Buckeye Irrigation District Canal" (Docket 10480, Page 1438) of said recorder's office, and the **POINT OF BEGINNING**; thence South 9°50'01" West 2136.52 feet to a point on the South line of said Section 29 which bears North 89°54'41" East 1150.85 feet from the Southwest corner of said Section 29; said point being the terminus of the herein described line.

EXCEPT the West 40 feet thereof; and
EXCEPT the North 230 feet thereof; and
EXCEPT the South 30' of the North 260 feet of the East 170 feet thereof; and
EXCEPT any portion of the property described in Record Document 91-037205.

The above described parcel contains 2,569,664 square feet or 58.9684 acres more or less.

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY		
prelim: 01-30-96	chk: RLS 8-27-98	appr: [illegible]
revised: 7-25-96; 11-19-96; 3-27-98; 8-25-98		final:
Maricopa County Public Works Land and Right of Way Division		Titles and Right of Way

WT10-40



	SQ.FT.	ACRES
WT10-40	2,617,354	60.0862
WT10-40 (AMENDED)	2,569,664	58.9684
CHANGE IN AREA	(-) 47,690	(-) 1.1178

FLOOD CONTROL DISTRICT
OF MARICOPA COUNTY-ARIZONA

BULLARD WASH OUTFALL PROJECT

PT SW4 SECTION 29 - T1N, R1W

WT10-40; 500-81-4J
BUCKEYE IRRIGATION DISTRICT

PRELIMINARY: 1-19-96 MS

REVISED: 7-25-96; 11-19-96; 3-27-98; 8-25-98

FINAL:

WT10-40-FLT

THIS DESCRIPTION AMENDS THAT CERTAIN DOCUMENT
98-0497126
MARICOPA COUNTY RECORDER

BULLARD WASH OUTFALL PROJECT
WT10-40-IE; 500-81-004J
BUCKEYE WATER CONSERVATION AND DRAINAGE DISTRICT

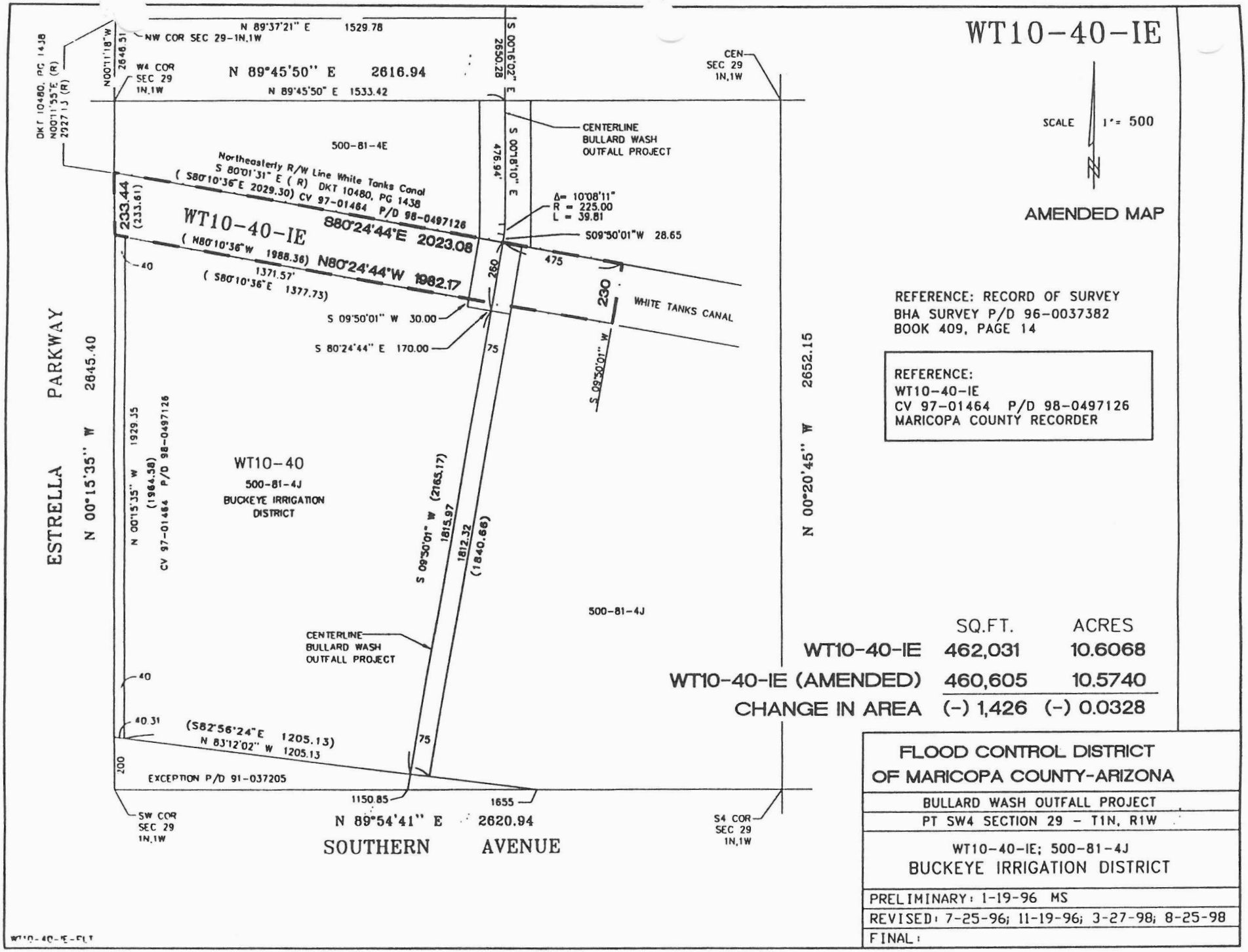
The Northerly 230 feet of that certain parcel of land recorded at Book 412 of Deeds, Page 160 as recorded in the office of the Recorder of said County, lying within the Southwest quarter (SW4) of Section 29, T1N, R1W, G&SRB&M, Maricopa County, Arizona, lying West of the following described line:

COMMENCING at the West quarter corner of said Section 29; thence along the East-West mid-section line, North 89°45'50" East 1533.42 feet; thence along a line 225 feet East of and parallel with the West line of the East half of said Southwest quarter, South 00°18'10" East 476.94 feet; thence 39.81 feet along a tangent curve to the right having a radius of 225 feet and a central angle of 10°08'11"; thence South 09°50'01" West 28.65 feet to a point on the Northerly right of way line of the "Buckeye Irrigation District Canal (Docket 10480, Page 1438) of said recorder's offce; thence along the Northerly line of said canal, South 80°24'44" East 475 feet to the **POINT OF BEGINNING**; thence 09°50'01" West to a point on the Southerly line of the North 230 of the parcel of land according Book 412, of Deeds, Page 160 and the terminus of said line.

The above described parcel contains 460,605 square feet or 10.5740 acres more or less.

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY		
prelim: 3-27-98	chk: 8-27-98	appr: 8-27-98
revised: 8-25-98		final:
Maricopa County Public Works Land and Right of Way Division		Titles and Right of Way

WT10-40-IE



SCALE 1" = 500

AMENDED MAP

REFERENCE: RECORD OF SURVEY
BHA SURVEY P/D 96-0037382
BOOK 409, PAGE 14

REFERENCE:
WT10-40-IE
CV 97-01464 P/D 98-0497126
MARICOPA COUNTY RECORDER

	SQ.FT.	ACRES
WT10-40-IE	462,031	10.6068
WT10-40-IE (AMENDED)	460,605	10.5740
CHANGE IN AREA	(-) 1,426	(-) 0.0328

FLOOD CONTROL DISTRICT
OF MARICOPA COUNTY-ARIZONA

BULLARD WASH OUTFALL PROJECT

PT SW4 SECTION 29 - T1N, R1W

WT10-40-IE; 500-81-4J
BUCKEYE IRRIGATION DISTRICT

PRELIMINARY: 1-19-96 MS

REVISED: 7-25-96; 11-19-96; 3-27-98; 8-25-98

FINAL:

WT10-40-IE-FLT

THIS DESCRIPTION AMENDS THAT CERTAIN DOCUMENT
98-0497126
MARICOPA COUNTY RECORDER

BULLARD WASH OUTFALL PROJECT
WT10-40-PCE; 500-81-004J
BUCKEYE WATER CONSERVATION AND DRAINAGE DISTRICT

The East 170' of the North 260' of the following described property:

A portion of the Southwest quarter (SW4) of Section 29, T1N, R1W, G&SRB&M, Maricopa County, Arizona, said portion being that part of that certain parcel of land recorded at Book 412 of Deeds, Page 160 as recorded in the office of the Recorder of said County which lies West of a line parallel with and 75' East of the following described line:

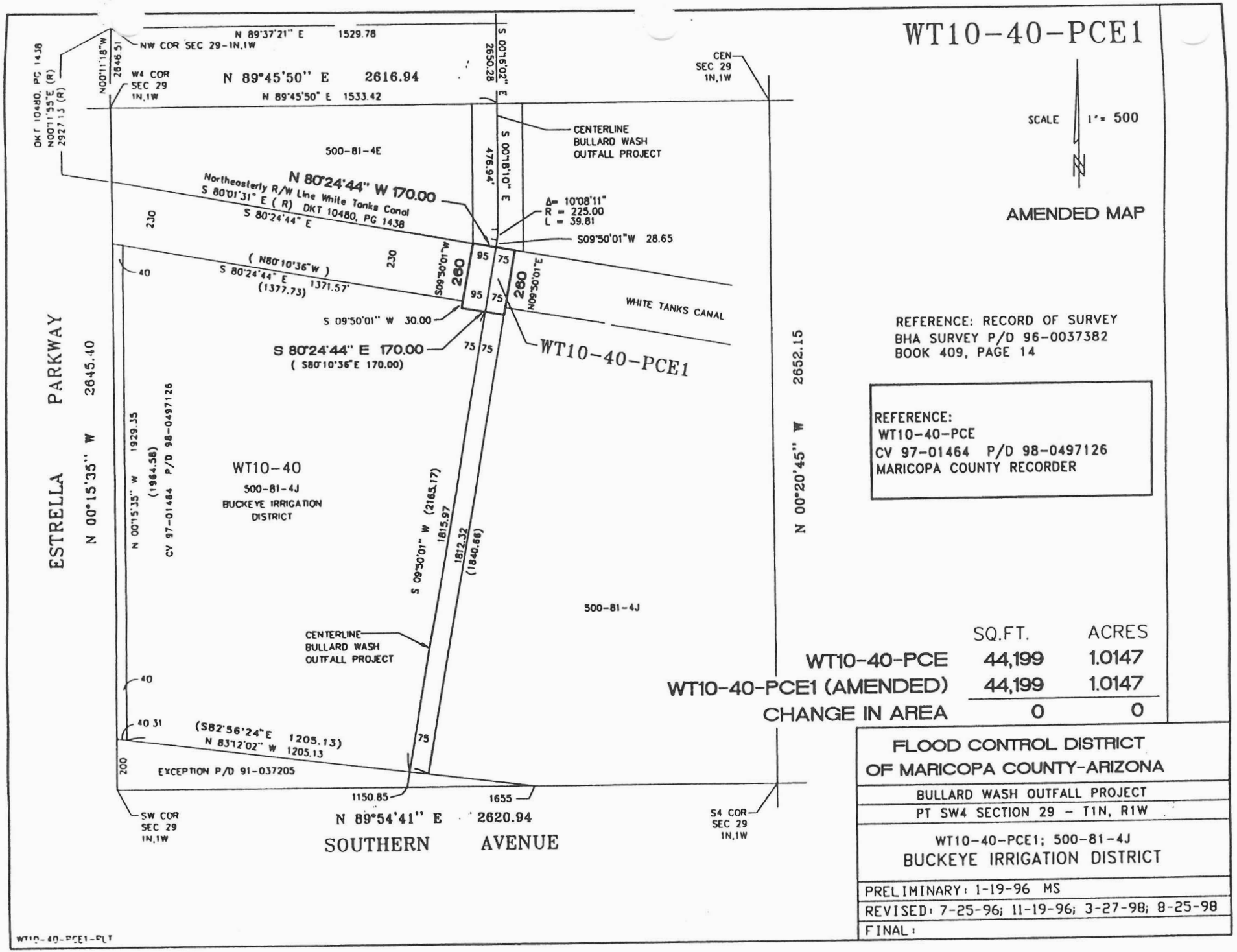
LINE DESCRIPTION

COMMENCING at the West quarter corner of said Section 29; thence along the East-West mid-section line, North 89°45'50" East 1533.42 feet; thence along a line 225 feet East of and parallel with the West line of the East half of said Southwest quarter, South 00°18'10" East 476.94 feet; thence 39.81 feet along a tangent curve to the right having a radius of 225 feet and a central angle of 10°08'11"; thence South 09°50'01" West 28.65 to the **POINT OF BEGINNING**; thence South 9°50'01" West 2136.52 feet to a point on the South line of said Section 29 which bears North 89°54'41" East 1150.85 feet from the Southwest corner of said Section 29; said point being the terminus of the herein described line.

The above described parcel contains 44,200 square feet or 1.0147 acres more or less.

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY		
prelim: 1-30-96	chk: JTS 8-27-98	appr: [illegible]
revised: 7-25-96; 11-19-96; 3-25-98; 8-25-98		final:
Maricopa County Public Works Land and Right of Way Division		Titles and Right of Way

WT10-40-PCE1



SCALE 1" = 500

AMENDED MAP

REFERENCE: RECORD OF SURVEY
BHA SURVEY P/D 96-0037382
BOOK 409, PAGE 14

REFERENCE:
WT10-40-PCE
CV 97-01464 P/D 98-0497126
MARICOPA COUNTY RECORDER

	SQ.FT.	ACRES
WT10-40-PCE	44,199	1.0147
WT10-40-PCE1 (AMENDED)	44,199	1.0147
CHANGE IN AREA	0	0

FLOOD CONTROL DISTRICT
OF MARICOPA COUNTY-ARIZONA

BULLARD WASH OUTFALL PROJECT

PT SW4 SECTION 29 - T1N, R1W

WT10-40-PCE1; 500-81-4J
BUCKEYE IRRIGATION DISTRICT

PRELIMINARY: 1-19-96 MS

REVISED: 7-25-96; 11-19-96; 3-27-98; 8-25-98

FINAL:

WT10-40-PCE1-PLT

THIS DESCRIPTION AMENDS THAT CERTAIN DOCUMENT
98-0497126
MARICOPA COUNTY RECORDER

BULLARD WASH OUTFALL PROJECT
WT10-40-PCE2; 500-81-004J
BUCKEYE WATER CONSERVATION AND DRAINAGE DISTRICT
(BASIN)

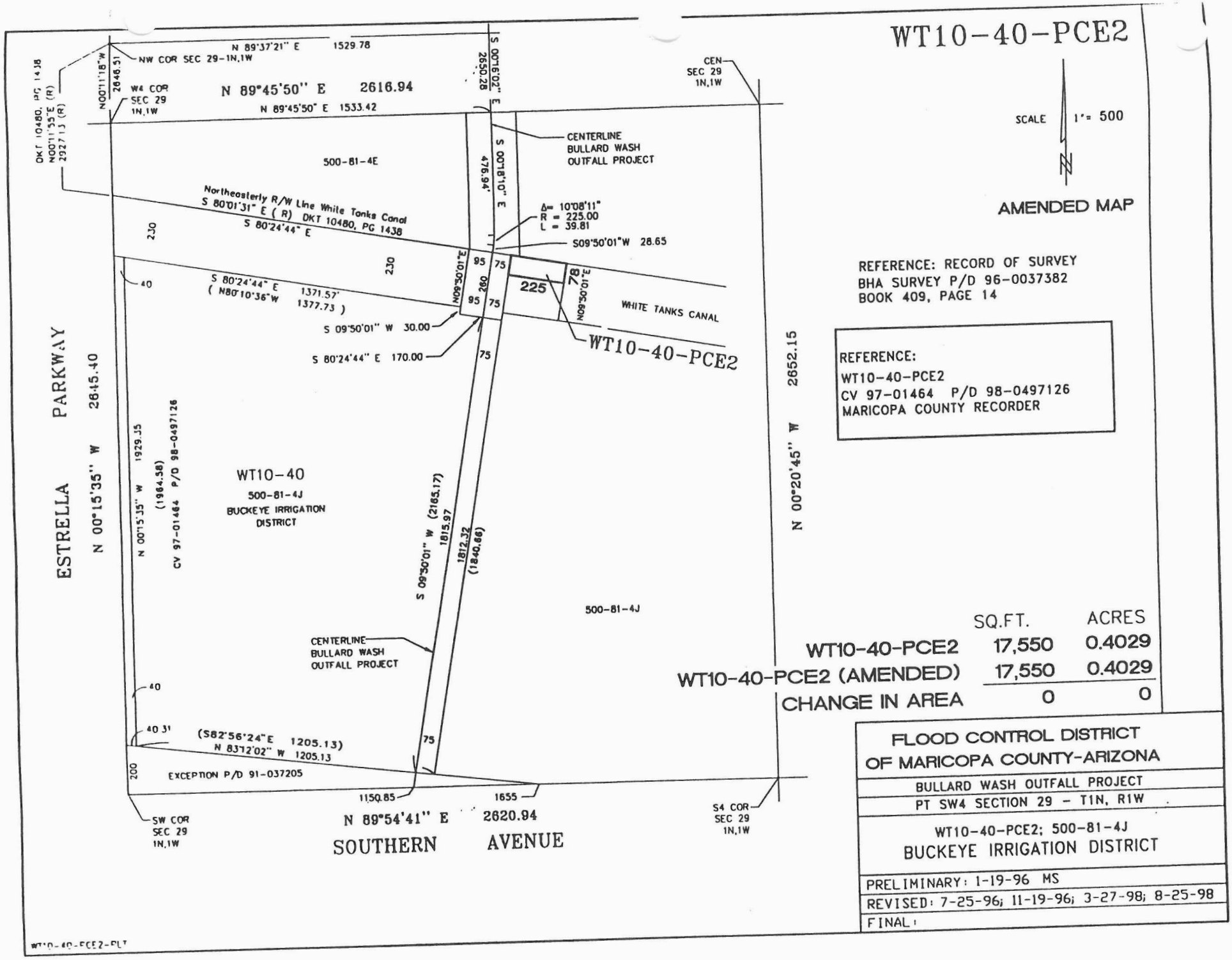
A parcel of land, lying South of and parallel to the Northeasterly right of way line of the Buckeye Irrigation District Canal per Docket 10480, Page 1438, and lying within the Southwest quarter (SW4) of Section 29, T1N, R1W, G&SRB&M, Maricopa County, Arizona, said parcel being also a part of that certain parcel of land recorded at Book 412 of Deeds, Page 160 as recorded in the office of the Recorder of said County, and is more particularly described as follows:

COMMENCING at the West quarter corner of said Section 29; thence along the East-West mid-section line, North 89°45'50" East 1533.42 feet; thence along a line 225 feet East of and parallel with the West line of the East half of said Southwest quarter, South 00°18'10" East 476.94 feet; thence 39.81 feet along a tangent curve to the right having a radius of 225 feet and a central angle of 10°08'11"; thence South 09°50'01" West 28.65 to a point on the Northeasterly right of way line of said canal; thence, South 80°24'44" East along said canal 75 feet to the Easterly right of way line of the "Bullard Wash Outfall Project" and the **POINT OF BEGINNING**; thence South 80°24'44" East 225.00 feet; thence South 09°50'01" West 78.00 feet; thence North 80°24'44" West 225.00 feet to a point on the Easterly right of way line of said "Bullard Wash Outfall Project; thence along the Easterly line of said right of way, North 09°50'01" East 78.00 feet to the **POINT OF BEGINNING.**

The above described parcel contains 17,550 square feet or 0.4029 acres more or less.

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY		
prelim: 3-25-98	chk: JTG 8-27-98	appr: [illegible]
revised: 4-03-98; 8-25-98		final:
Maricopa County Public Works Land and Right of Way Division		Titles and Right of Way

WT10-40-PCE2



	SQ.FT.	ACRES
WT10-40-PCE2	17,550	0.4029
WT10-40-PCE2 (AMENDED)	17,550	0.4029
CHANGE IN AREA	0	0

FLOOD CONTROL DISTRICT
OF MARICOPA COUNTY-ARIZONA

BULLARD WASH OUTFALL PROJECT

PT SW4 SECTION 29 - T1N, R1W

WT10-40-PCE2; 500-81-4J
BUCKEYE IRRIGATION DISTRICT

PRELIMINARY: 1-19-96 MS
REVISED: 7-25-96; 11-19-96; 3-27-98; 8-25-98
FINAL:

WT10-40-PCE2-PLT

THIS DESCRIPTION AMENDS THAT CERTAIN DOCUMENT
98-0497126
MARICOPA COUNTY RECORDER

BULLARD WASH OUTFALL PROJECT
WT10-40-TCE1; 500-81-004J
BUCKEYE WATER CONSERVATION AND DRAINAGE DISTRICT

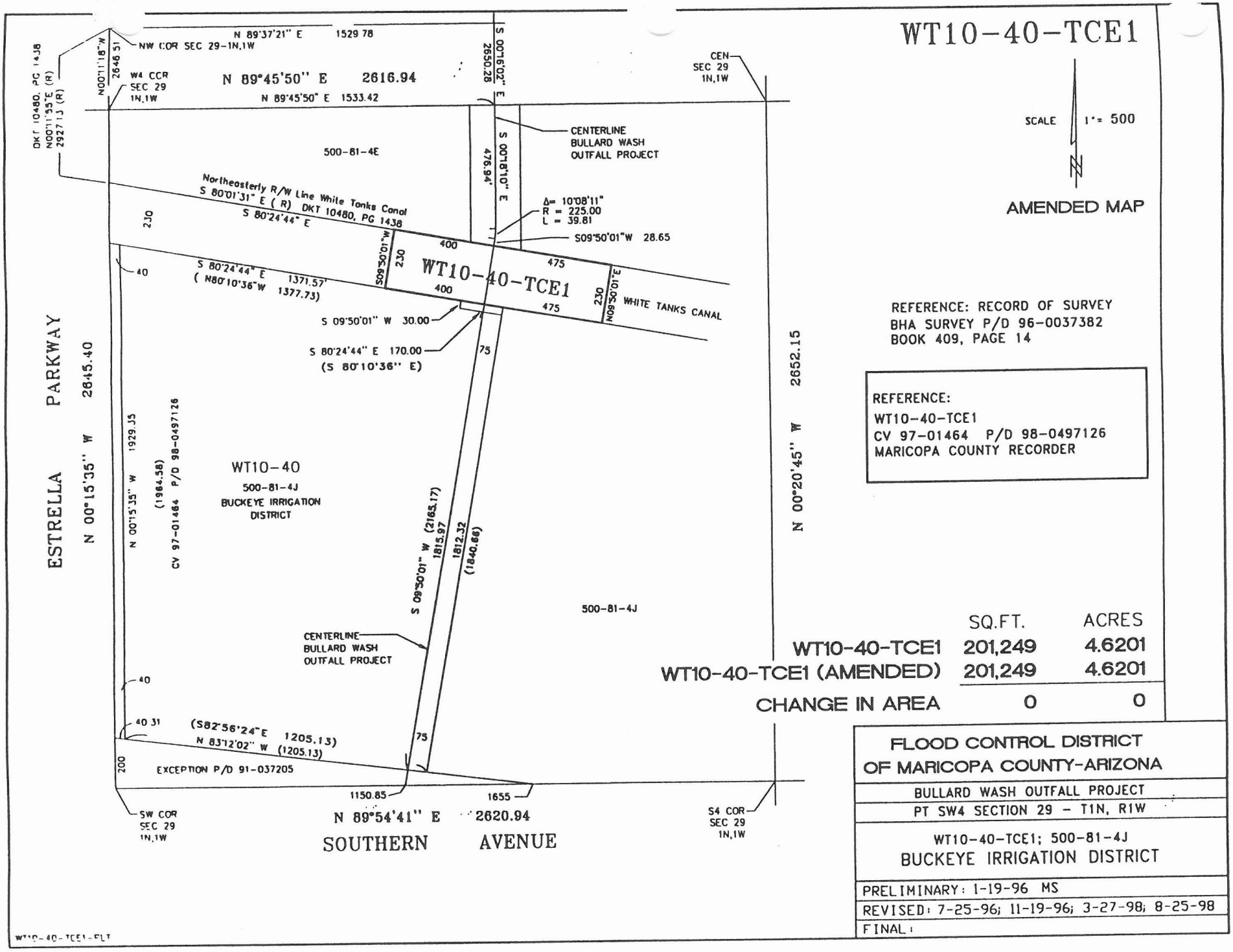
A portion of The Northerly 230 feet of that certain parcel of land recorded at Book 412 of Deeds, Page 160 as recorded in the office of the Recorder of said County, lying within the Southwest quarter (SW4) of Section 29, T1N, R1W, G&SRB&M, Maricopa County, Arizona, the Northerly line of said portion is more particularly described as follows:

COMMENCING at the West quarter corner of said Section 29; thence along the East-West mid-section line, North 89°45'50" East 1533.42 feet; thence along a line 225 feet East of and parallel with the West line of the East half of said Southwest quarter, South 00°18'10" East 476.94 feet; thence 39.81 feet along a tangent curve to the right having a radius of 225 feet and a central angle of 10°08'11" ; thence South 09°50'01" West 28.65 feet to a point on the Northerly right of way line the "Buckeye Irrigation District Canal (Docket 10480, Page 1438); thence along the Northerly line of said canal, South 80°24'44" East 475 feet to the **POINT OF BEGINNING**; thence along the Northerly line of said canal, North 80°24'44" West 875.00 feet to the point of terminus.

The above described parcel contains 201,251 square feet or 4.6201 acres more or less.

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY		
prelim: 3-27-98	chk: 8-27-98	appr: 8-27-98
revised: 8-25-98		final:
Maricopa County Public Works Land and Right of Way Division		Titles and Right of Way

WT10-40-TCE1


N 89°37'21" E 1529.78
NW COR SEC 29-1N,1W
N00°11'18"W 2646.51
W4 COR SEC 29 1N,1W
N 89°45'50" E 2616.94
N 89°45'50" E 1533.42
S 00°16'02" E 2650.28
CEN SEC 29 1N,1W
DKT 10480, PG 1438
N00°11'55"E (R) 2927.13 (R)
500-81-4E
CENTERLINE BULLARD WASH OUTFALL PROJECT
S 00°18'10" E 476.94'
Northeasterly R/W Line White Tanks Canal
S 80°01'31" E (R) DKT 10480, PG 1438
S 80°24'44" E
Δ= 10°08'11"
R = 225.00
L = 39.81
S09°50'01"W 28.65
230
400
475
S09°50'01"W
WT10-40-TCE1
N09°50'01"E
WHITE TANKS CANAL
40
S 80°24'44" E 1371.57'
(N80°10'36"W 1377.73)
S 09°50'01" W 30.00
S 80°24'44" E 170.00
(S 80°10'36" E)
75
ESTRELLA PARKWAY
N 00°15'35" W 2645.40
N 00°15'35" W 1929.35
(1984.58)
CV 97-01464 P/D 98-0497126
WT10-40
500-81-4J
BUCKEYE IRRIGATION DISTRICT
S 09°50'01" W (2165.17)
1815.97
1812.32
(1840.68)
N 00°20'45" W 2652.15
500-81-4J
CENTERLINE BULLARD WASH OUTFALL PROJECT
40
40.31
(S82°56'24"E 1205.13)
N 83°12'02" W (1205.13)
200
EXCEPTION P/D 91-037205
1150.85
1655
SW COR SEC 29 1N,1W
N 89°54'41" E 2620.94
SOUTHERN AVENUE
S4 COR SEC 29 1N,1W
SCALE 1" = 500
AMENDED MAP
REFERENCE: RECORD OF SURVEY
BHA SURVEY P/D 96-0037382
BOOK 409, PAGE 14
REFERENCE:
WT10-40-TCE1
CV 97-01464 P/D 98-0497126
MARICOPA COUNTY RECORDER
SQ.FT. ACRES
WT10-40-TCE1 201,249 4.6201
WT10-40-TCE1 (AMENDED) 201,249 4.6201
CHANGE IN AREA 0 0
FLOOD CONTROL DISTRICT
OF MARICOPA COUNTY-ARIZONA
BULLARD WASH OUTFALL PROJECT
PT SW4 SECTION 29 - T1N, R1W
WT10-40-TCE1; 500-81-4J
BUCKEYE IRRIGATION DISTRICT
PRELIMINARY: 1-19-96 MS
REVISED: 7-25-96; 11-19-96; 3-27-98; 8-25-98
FINAL:
WT10-40-TCE1-FLT

THIS DESCRIPTION AMENDS THAT CERTAIN DOCUMENT
98-0497126
MARICOPA COUNTY RECORDER

BULLARD WASH OUTFALL PROJECT
WT10-40-TCE2; 500-81-004J
BUCKEYE WATER CONSERVATION AND DRAINAGE DISTRICT

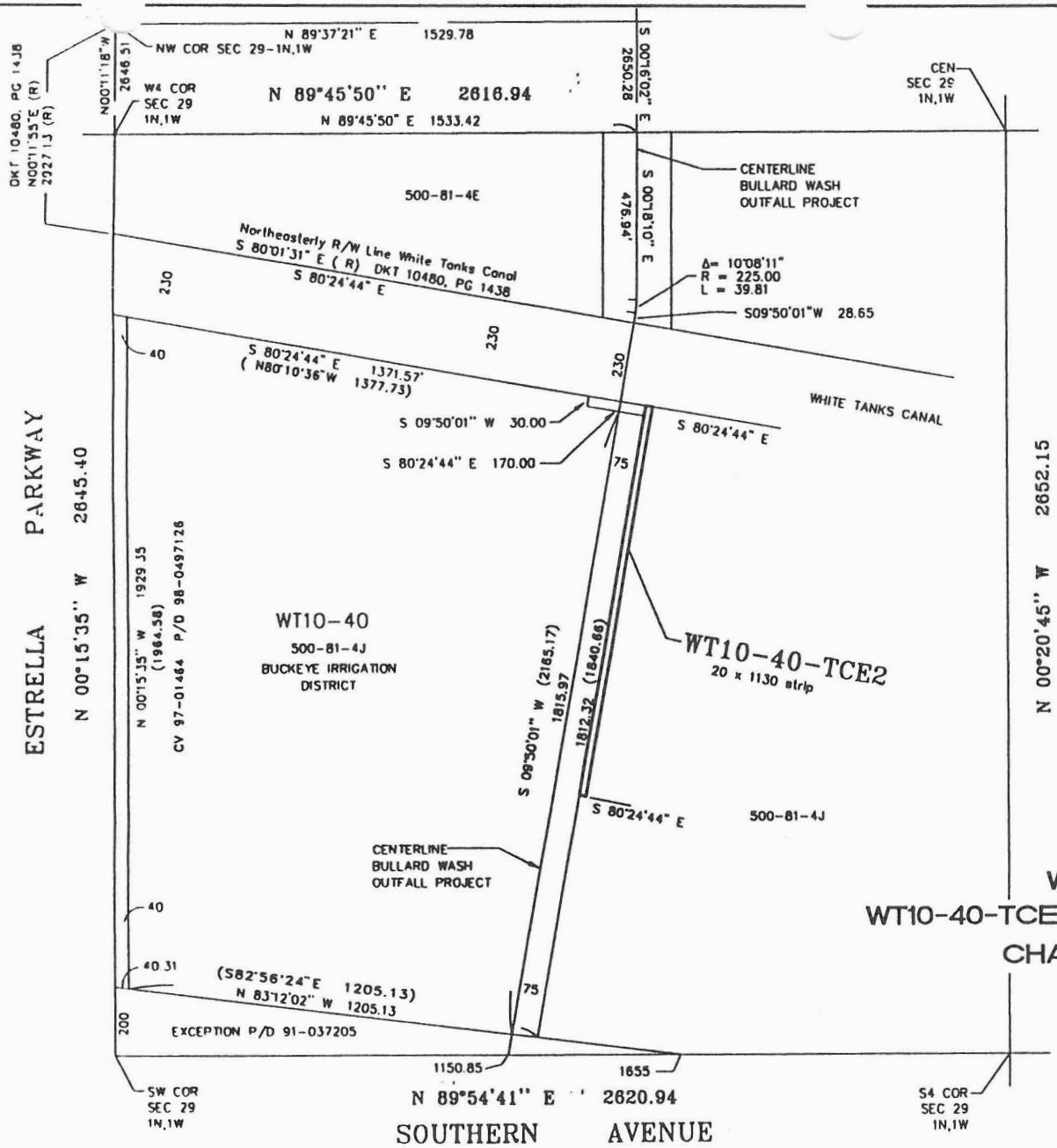
A 20 foot wide parcel of land lying South of the Southerly right of way line of the Buckeye Irrigation District Canal as described in Docket 10480, Page 1438 as recorded in the office of the Recorder, Maricopa County, lying within the Southwest quarter (SW4) of Section 29, T1N, R1W, G&SRB&M, Maricopa County, Arizona, said parcel being also a part of that certain parcel of land recorded at Book 412 of Deeds, Page 160 as recorded in the office of said Recorder, the Westerly line of which lies East of a line parallel with and 75' East of the following described line:

COMMENCING at the West quarter corner of said Section 29; thence along the East-West mid-section line, North 89°45'50" East 1533.42 feet; thence along a line 225 feet East of and parallel with the West line of the East half of said Southwest quarter, South 00°18'10" East 476.94 feet; thence 39.81 feet along a tangent curve to the right having a radius of 225 feet and a central angle of 10°08'11"; thence South 09°50'01" West 28.65 feet to a point on the Northeasterly right of way line of said canal; thence, South 09°50'01" West to a Point on the Southerly right of line of said canal a distance of 230.00 feet and the **POINT OF BEGINNING**; thence South 09°50'01" West 1130.00 feet to the terminus of said line.

The above described parcel contains 22,601 square feet or 0.5188 acres more or less.

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY		
prelim: 3-25-98	chk: [illegible] 8-27-98	appr: [illegible] 8-27-98
revised: 8-25-98		final:
Maricopa County Public Works Land and Right of Way Division		Titles and Right of Way

WT10-40-TCE2



SCALE 1" = 500

AMENDED MAP

REFERENCE: RECORD OF SURVEY
BHA SURVEY P/D 96-0037382
BOOK 409, PAGE 14

REFERENCE:
WT10-40-TCE2
CV 97-01464 P/D 98-0497126
MARICOPA COUNTY RECORDER

	SQ.FT.	ACRES
WT10-40-TCE2	22,600	0.5188
WT10-40-TCE2 (AMENDED)	22,600	0.5188
CHANGE IN AREA	0	0

FLOOD CONTROL DISTRICT
OF MARICOPA COUNTY-ARIZONA

BULLARD WASH OUTFALL PROJECT

PT SW4 SECTION 29 - T1N, R1W

WT10-40-TCE2; 500-81-4J
BUCKEYE IRRIGATION DISTRICT

PRELIMINARY: 1-19-96 MS

REVISED: 7-25-96; 11-19-96; 3-27-98; 8-25-98

FINAL:

WT10-40-TCE2-FLT

AVERY

FLOOD CONTROL DISTRICT
of
Maricopa County

2801 West Durango Street • Phoenix, Arizona 85009-6399
Telephone (602) 506-1501
Fax (602) 506-4601
TT (602) 506-5897

BOARD OF DIRECTORS
Jan Brewer
Fulton Brock
Andrew Kunasek
Don Stapley
Mary Rose Garrido Wilcox

August 3, 1998

Ms. Cynthia Parker, Environmental Coordinator
Aviation Environmental Department
City of Phoenix Aviation
3400 Sky Harbor Boulevard
Phoenix, Arizona 85034

Subject: Bullard Wash Channel Improvements Project – Phoenix Goodyear Airport Debris Dump

Dear Ms. Parker:

As you know the Flood Control District of Maricopa County and the City of Goodyear are working together to design and construct the subject channel improvements project. The alignment of the channel crosses through the southwest corner of the Phoenix Goodyear Airport. Airport staff notified the District of the existence of an old construction debris landfill located in this area of the airport.

We appreciate the information you have provided us about the landfill, including a copy of the characterization report completed for you by SCS Engineers, dated June 4, 1998. The report is comprehensive and includes data on numerous test trenches. In a recent telephone conversation, you stated that you "felt very good about the material in the landfill" and that "you had retrieved all of the waste oil bowsers" attributed to be in the landfill. The characterization done by SCS plus previous historical information you provided indicates that no hazardous or other substances requiring special handling are present within the landfill.

You have also provided to us information regarding the fact that the airport is within a superfund site. The FAX included suggested language to be included in our specifications.

I have coordinated all this information with District Environmental staff and with District General Counsel. We have incorporated this information into our project specifications, and we will address the construction debris landfill as follows:

1. The specifications include the superfund site information language you recommended.

2. The specifications direct the contractor on how to excavate within the limits of the landfill. This includes having either District Environmental staff or one of our on-call environmental consultants on site at all times during such excavation.

3. Any material exposed during excavation which requires special handling will be handled by District staff and our on-call consultant services, which are experienced in removing and disposing of such material. Work by the contractor would cease in the area of the exposed special material until it was mitigated.

4. Where construction debris remains exposed at the face of excavation limits as required for the project, a minimal amount of over-excavation will be done to remove the exposed debris, and the area will then be backfilled and compacted with approximately three feet of clean dirt. This will create a more acceptable finished surface of the dump at such locations.

5. Debris, stained soils and other similar materials will be removed to the limits required for the project, plus any over-excavation as described above. We will not "chase" any debris or stains beyond the required limits of the project beyond the over-excavation limits as described above. Should our contractor cause a substance to leak and stain the soil, the District would remove this soil.

You have been provided with the 90% plans for the project, and we will be happy to provide you with a set of the final plans and specifications when available. You are also welcome to attend the project construction pre-bid meeting, which will be held at District offices sometime in October. The District will notify you of the date and time of the meeting. This will provide you an opportunity to make any comments to the potential contractors bidding on the project.

If you should have any other questions or need additional information from us, or if you have any additional information that would be helpful to us, please do not hesitate to call me at 506-4878. Thank you again for your assistance on this project.

Sincerely,

Donald J. Reriek, P.E.
Project Manager

Copies to: Shawn Arena, Phoenix Goodyear Airport
Jack Shelter, City of Phoenix Aviation Department
Brad Olbert, Sverdrup Civil, Inc.

City of Phoenix

June 16, 1998

Theresa Hoff
Maricopa County Flood Control District
Property Planning Management
2801 West Durango Street
Phoenix AZ 85009

RE: Bullard Wash Project, Phoenix Goodyear Airport

Ms. Hoff:

The City's characterization report for Phoenix Goodyear Airport's southern debris fill is sent with this letter. The City's characterization was not different from the County's study showing construction debris, with the exception of the locating of a few metal containers (hot water heaters or empty steel tanks) which were removed and were not located in the County's proposed construction area.

I have sent you a copy of the City's disclaimer of conditions at Phoenix Goodyear Airport, dated March 1998, attached again for your reference.

I believe that our only unfinished item is to develop a land exchange document incorporating the conditions of the exchange.

Please call me at 273-2730 if I can further assist.

Sincerely,

C Parker

Cynthia Parker
Environmental Coordinator

FLOOD CONTROL DISTRICT
RECEIVED
JUN 22 1998
CHENG
P/O
P & PM
ADMIN
C & M
REMARKS

R:\ADMIN\ENVIRON\CORR\4053.DOC

WORKER PROTECTION

a. Contractor understands and acknowledges that the Phoenix Goodyear Airport, at which the Contractor is to perform a portion of the work, is listed on the National Priorities List pursuant to Section 105 of the Comprehensive Environmental Compensation and Liability Act, 42 U.S.C. 9605, because of the presence of regulated substances at the facility. For this work, the contractor will be in an area that has been studied, and has been found not to have soils concentrations for trichloroethylene above the EPA cleanup standards (by VLEACH Modeling).

Regulated Substances means those substances (including petroleum), included within the definitions of hazardous substance, hazardous chemical, hazardous material, regulated or toxic substance, or hazardous, solid or special waste under federal, state, and local laws presently in effect or that may be enacted, promulgated or adopted in the future or may be amended from time to time, including but not limited to the following:

Resource Conservation and Recovery Act of 1976, 42 U.S.C. 6901, et seq., as amended (RCRA); Toxic Substances Control Act, 15 U.S.C. 2601 et seq., as amended; Occupational Safety and Health Act of 1970, as amended, and Arizona Occupational Safety and Health Act, A.R.S. 23-401, et seq., as amended (OSHA); Comprehensive Environmental Response, Compensation and Liability Act, as amended by the Superfund Amendments and Reauthorization Act, 42 U.S. C. 9601 et seq., as amended. Insecticide, Fungicide, and Rodenticide Act, 7 U.S.C. 13, et seq., as amended; The Arizona Environmental Quality Act, A.R.S. § 49-101, as amended.

b. Contractor further understands and acknowledges that the work could expose its employees and subcontractors to Regulated Substances. Therefore, it shall be the responsibility of the Contractor to conduct reasonable inquiry of the County to ascertain whether the work will affect or disturb any regulated substances, or may result in any potential employee exposure that is known to be present at the job site where the Work is to be performed.

c. The County informs the Contractor that an old U.S. Navy Dump may reside in the work area. Exact boundaries are not known, but it is believed that the fill is predominately construction debris that could possibly include asbestos, considering the dates of use. No direct evidence supports this belief.

d. If during the performance of the work, any unforeseen Regulated Substances are encountered, Contractor shall immediately notify the County of the encounter and shall not recommence work until implementation of the Contractor's Health and Safety Plan and upon direction of the County. Depending on the nature of the Regulated Substances encountered, the County may (i) direct the Contractor

to complete the original scope of work after employee safety concerns have been resolved (ii), agree with the Contractor to modify the scope or (iii) terminate the contract and pay Contractor for work performed.

e. Contractor shall furnish its Subcontractors with a copy of this section of the Contract and shall ensure that its subcontractors comply with the requirements of this section. The Subcontractor will acknowledge its understanding of appropriate health and safety plans by signing and dating the plans.

Environmental Consultants

2702 North 44th Street
Suite 105B
Phoenix, Arizona 85008-1583

602 840-2596
FAX 602 224-0572

SCS ENGINEERS

June 4, 1998
File No. 10.97018.08

Ms. Cynthia Parker
City of Phoenix
Aviation Department
3400 Sky Harbor Boulevard
Phoenix, AZ 85034-4420

Subject: Characterization of Solid Waste Disposal Area
Southwest Portion of Phoenix-Goodyear Airport
Goodyear, Arizona

Dear Cynthia:

Pursuant to your request, SCS Engineers (SCS) is pleased to provide this letter report describing the methodology and findings of our characterization of the solid waste disposal area which exists at the southwest end of the runway at the Phoenix-Goodyear Airport in Goodyear, Arizona.

If you have any questions, please contact either of the undersigned at (602) 840-2596.

Sincerely,

Stephen B. Smith, P.E.
Project Director

Bradley F. Johnston, P.G.
Vice President
SCS ENGINEERS

Registered Professional Engineer (Civil)
CERTIFICATE NO.
23413
STEPHEN B.
SMITH
Date Signed 6-4-98
Arizona U.S.A.

Attachments

SS/BJ:cj
\\SCS_PHX\SYS\DATA\PROJECTS\9701808\9701808pga lf rpt1.doc

SUBSURFACE INVESTIGATION OF SOLID WASTE DISPOSAL AREA SOUTHWEST PORTION OF PHOENIX-GOODYEAR AIRPORT

JUNE 4, 1998
FILE NO. 10.97018.08

BACKGROUND

A solid waste disposal area was identified at the southwest end of the Phoenix-Goodyear Airport (PGA). Based on a review of historical aerial photographs dated 1958, 1964, 1970, 1977, 1980, 1986, 1992, and 1994, dumping and/or excavation in the area appears to have begun between 1964 and 1970, and ceased between 1992 and 1994. Verbal reports indicate that the disposal area was active in 1968, and was covered with soil in 1994.

The Maricopa County Flood Control District (MCFCD) is planning to disturb a portion of the disposal area in order to construct a drainage canal which will pass through the area. At the present time, it is anticipated that approximately one-third of the disposal area would be located within the planned MCFCD channel.

SCS was retained to perform a characterization of the disposal area in order to evaluate the nature and extent of disposed materials. The characterization included the following:

- Preparation of a site-specific health and safety plan;
- A preliminary site visit with PGA operations personnel;
- Clearance for underground utilities by Arizona Blue Stake;
- Excavation of 12 backhoe test pits to visually identify the nature and extent of buried waste;

- Surveying of test pit locations; and

- Preparation of an AutoCAD map of the disposal area and this report.

Since visual observations did not identify the presence of apparent contamination, no soil samples were collected for laboratory analysis.

METHODOLOGY

A CAT 320 track excavator was used to excavate the test pits. Due to concerns regarding generation of dust near the end of the runway, a water truck was used to wet the excavation area and stockpiled soil during excavation activities. This item was not included in the original proposal, but SCS notified Cynthia Parker of COP Aviation via facsimile regarding this change in scope. Following excavation of the test pits, the track excavator and a front end loader were used to backfill the excavations to original grade. The front end loader was not included in the original proposal, but SCS notified Mr. Bill Bown of COP Aviation regarding this change in scope. There was significantly more lineal feet of trench opened during the excavation than anticipated, and the addition of the front end loader for backfilling reduced total field time by at least one day.

In general, the test pits were started outside the apparent limits of the burial area, and were extended into the suspected burial area. Depth of the test pits ranged from approximately eight to 21 feet below ground surface, penetrating at least four feet into native soil beneath visible waste materials. Waste materials removed from the test pits were visually characterized to evaluate the types of waste in the disposal area. Information regarding each test pit, including test pit depth and location, nature of waste, and depth of waste is included in Table 1.

Following excavation of test pits, the test pit locations were surveyed for mapping onto the site map. After test pits were logged and surveyed, they were backfilled. With the exception of a waste oil tank, oil bowser, and three smaller tanks or pressure vessels, any debris that had been excavated was placed back into the excavation, followed by at least two feet of soil to preserve the cover over buried materials. The waste oil tank

and bowser were not replaced into the excavated area, and have reportedly been emptied and disposed of under the supervision of COP Aviation. The smaller tanks or pressure vessels were also disposed of under the supervision of COP Aviation.

FINDINGS

Nature Of Waste Materials

As shown in Table 1, waste materials observed in the test pits included the following:

- Concrete
- Asphaltic concrete
- Rocks
- Soil
- Plastic sheeting
- Wood
- Shingles
- A propane tank
- A metal waste oil tank
- Empty metal drums
- Cable, pipe, and other scrap metal
- A concrete oil "bowser"
- Apparent boiler tanks
- Fiberglass insulation
- Tires
- Brick and clay pipe
- Vegetative debris

One piece of transite (asbestos-containing concrete) piping was observed on the sideslope of the disposal area.

Field indications (odors or visible staining) of contamination were not observed in the test pits.

Extent Of Waste Materials

Buried waste materials were generally not observed outside the suspected disposal area, which is visible in the field as a topographically elevated area west of the underground gas pipeline, bounded by slopes ranging up to 15 feet high. One test pit was excavated on the east (runway) side of the gas pipeline, but the only materials observed were inert materials including rocks, concrete, and asphalt.

Distribution of waste materials was not consistent in terms of depth or lateral extent. Based on this investigation, it appears that waste materials were disposed of by dumping over the edge of former embankments, resulting in discontinuous lenses of waste materials. The maximum depth of buried materials observed in the test pits was approximately eight to nine feet below ground surface, and in most cases waste was covered by at least two feet of soil at the surface. In some cases, waste was visible in the sideslopes of the disposal area.

Waste material observed in the test pits appeared in discontinuous lenses of waste mixed with soil, with soil comprising from 30 to 70 percent of the waste deposits. There was no apparent trend in orientation of these lenses, although the largest concentration of waste materials appeared to be in the western end of the disposal area, in the vicinity of test pit TP3.

CONCLUSIONS

Based on the findings of this investigation, buried waste materials are not limited to inert materials as defined by Arizona Revised Statutes 49-701.16. Although soil or groundwater contamination is not suspected based on visible observation of the test pits, there is the potential that containers of regulated materials (such as the waste oil tank and bowser, which were removed) may be buried in the area.

The distribution of waste materials is not consistent and the waste deposits generally include a significant portion of soil. However, it appears that the largest concentration of waste materials is in the western end of the disposal area.

TABLE

Table 1. Test Pit Locations and Depths, Depth of Waste and Nature of Waste

TEST PIT NUMBER	TEST PIT LOCATION	DEPTH INTERVAL OF WASTE/DEBRIS	NATURE OF WASTE/DEBRIS	COMMENTS
TP1	Starting northwest of suspected area, extending southeast to approximate center of suspected area.	Maximum thickness between 2-6 feet bgs, at 160 feet south of the edge of slope near center of test pit. Minor amount at edge of slope.	Asphalt, concrete, palm fronds, plastic sheeting	Maximum depth of test pit 21 feet
TP2	Starting south of suspected area, extending north into suspected area.	Maximum thickness between 2-4 feet bgs, at approximate edge of slope, thinning toward center of suspected area.	Concrete, metal cable, rocks	Maximum depth of test pit 12 feet
TP3	Starting south of suspected area, extending north into suspected area.	Maximum thickness between 2.5-7 feet bgs, at approximate center of test pit.	Metal pipe, wood, fiberglass insulation, 2 tires, propane tank, 2 empty 55-gallon drums labeled silicone sealant, plastic sheeting, waste oil tank, oil bowser	Maximum depth of test pit 18 feet
TP4	Starting northwest of suspected area, extending southeast into suspected area.	Maximum thickness between 1-3 feet bgs, at approximate edge of slope.	Wood, plastic sheeting	Maximum depth of test pit 7 feet
TP5	Starting northwest of suspected area, extending southeast into suspected area.	Limited amount, maximum thickness between 2-4 feet bgs, at approximate edge of slope.	Wood, plastic sheeting	Maximum depth of test pit 8 feet
TP6	Starting and ending in northwest portion of suspected area.	No waste or debris encountered	No waste or debris encountered	Maximum depth of test pit 14 feet
TP7	Starting south of suspected	Maximum thickness between 3-8 feet	Concrete, rebar, scrap	Maximum

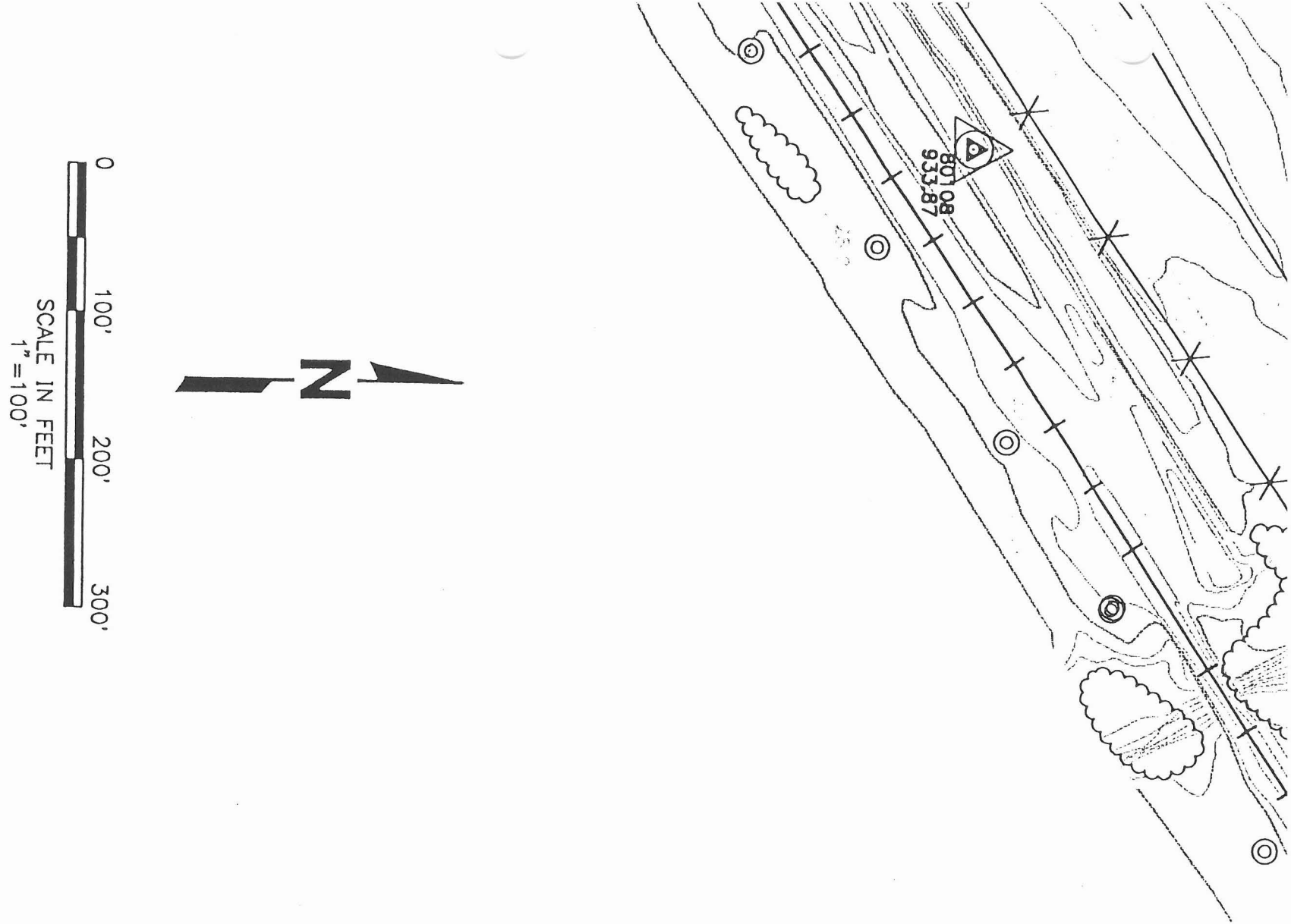
TEST PIT NUMBER	TEST PIT LOCATION	DEPTH INTERVAL OF WASTE/DEBRIS	NATURE OF WASTE/DEBRIS	COMMENTS
	area, extending north to north portion of suspected area.	bgs, at 10 feet north of the edge of slope.	metal, drums, metal pipe, asphalt, palm fronds, 3 boiler tanks	depth of test pit 14 feet
TP8	Starting south of suspected area, extending north into center of eastern portion of suspected area.	Maximum thickness between 4-8 feet bgs, from break in slope to approximately 35 feet north of slope, thinning to north.	Concrete, asphalt, shingles, metal pipe	Maximum depth of test pit 12 feet
TP9	Starting south of suspected area, extending north into center of eastern portion of suspected area.	Maximum thickness between 2-9 feet bgs, at approximately 30 feet north of slope.	Concrete, scrap metal, burned material, metal pipe	Maximum depth of test pit 12 feet
TP10	Starting at northeast edge of slope (near gas line), extending southwest north into center of eastern portion of suspected area.	Maximum thickness between 4-8 feet bgs, thinning to south.	Asphalt, brick, clay pipe	Maximum depth of test pit 13.5 feet
TP11	Starting at northeast edge of slope (near gas line), extending southwest north into center of eastern portion of suspected area.	Maximum thickness between 4-8 feet bgs, at south end of test pit. Asphalt present at northern end of test pit.	Asphalt, concrete, cable, metal pipe	Maximum depth of test pit 14.5 feet
TP12	East side of gas line, extending toward runway	Maximum thickness from ground surface to 6 feet bgs, thinning rapidly to east	Asphalt, concrete, rocks	Maximum depth of test pit 10 feet

EXPLORATION TRENCH LOCATION MAP

2 Foot Contour Interval

LEGEND

	TREE		RUNWAY END INDICATOR LIGHT
	PALM		UTILITY POLE W/SIGHT LIGHT
	SIGN		GUIDANCE SIGN
	HORIZ. & VERT. CONTROL		UTILITY POLE
	STORM DRAIN MANHOLE		WALL MOUNTED LIGHT
	CATCH BASIN		VISUAL APPROACH SLOPE INDICATOR
	CATCH BASIN W/APRON		UTILITY TRANSFORMER
	SEWER MANHOLE		PARKING LOT LIGHT
	CLEANOUT		TELEPHONE HANDHOLE
	SAND–OIL TRAP		TELEPHONE BOOTH
FD	FLOOR DRAIN		TELEPHONE PEDESTAL
	TRENCH DRAIN		UNDER GROUND FUEL STORAGE TANK
	FIRE HYDRANT		ABOVE GROUND FUEL STORAGE TANK
	WATER VALVE		COMPRESSED AIR & FUEL PIT
	WATER METER	GV	GAS VALVE
	ELECTRIC HANDHOLE		EXTRACTION WELL
	FAA LIGHT		INJECTION WELL
	RUNWAY LIGHT		MONITORING WELL
	TAXIWAY LIGHT		OBSERVATION WELL
	INSET TAXIWAY LIGHT		VALVE VAULT
	DIRT ROAD	H	BURIED CABLE MARKER



SCS ENGINEERS
STEARNS, CONRAD AND SCHMIDT
CONSULTING ENGINEERS
2702 N 44TH ST SUITE 105B PHOENIX, AZ 85008
PH. (602) 840-2596 FAX (602) 224-0572

PROJ. NO. 1097018.08	DWN. BY: JCB	Q/A RVW BY: SBS
DSN. BY: SBS	CHK. BY: SBS	APP. BY: SBS

CADD FILE: 970108A
DATE: 06/04/98
SCALE: AS SHOWN
DRAWING NO. 1 of 1

CLIENT

CITY OF PHOENIX
AVIATION DEPARTMENT
PLANNING AND
DEVELOPMENT

SHEET TITLE
EXPLOR

PROJECT TITLE
CITY
PHOEN

PELINE (APPROXIMATE LOCATION)
TP1
TP2
TP3
TP3A
TP4
TP5
TP6
TP7
TP8
TP10
TP11
TP12
940
930
920
70002
924.85
E 57000
N 77000
E 59000

AVERY

Bullard Wash Channel Improvements
Contract No. 95-39
Flood Control District of Maricopa County

Construction Time Calculations - 60% Submittal

Description	Time (Days)	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180	190	200	210	220	230	240
REMOVAL TOTAL	20.0																								
PIPEWORK TOTAL	60.0																								
EARTHWORK TOTAL	100.0																								
CONCRETE TOTAL	80.0																								
MC 85 BRIDGE	60.0																								
RIPRAP/GABIONS	100.0																								
FENCING	30.0																							230	
		Nov		Dec		Jan		Feb		March		April		May		June		July		Aug		Sept			

Month	Working Days	Cumulative Work Days	Calandar Days	Cumulative Cal Days
November (NTP: 11/2/98)	19	19	30	30
December	22	41	31	61
January	19	60	31	92
February	19	79	27	119
March	23	102	31	150
April	22	124	30	180
May	20	144	31	211
June	22	166	30	241
July	21	187	31	272
August	22	209	31	303
September	21	230	30	333
October (Completion Date: 10/1/99)	21			

Bullard Wash Channel Improvements
Contract No. 95-39
Flood Control District of Maricopa County

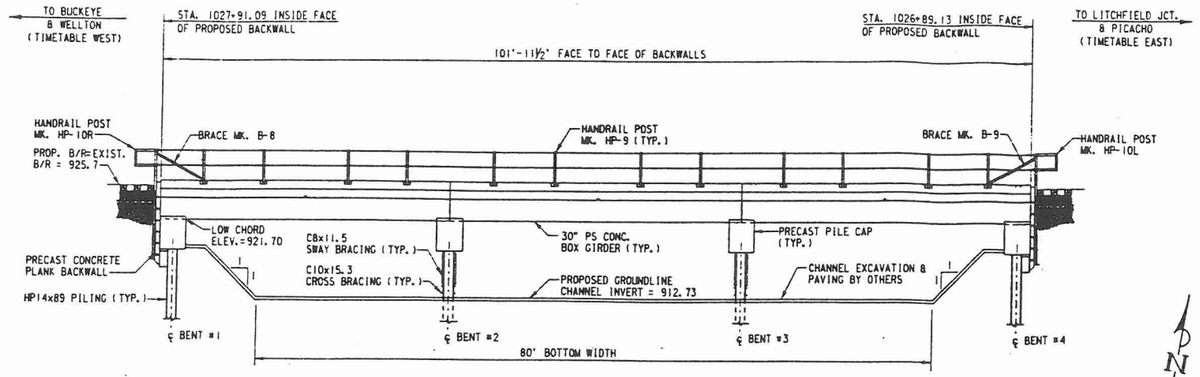
Construction Time Calculations - 60% Submittal

Item Description	ADOT Rate	Unit	Means Rate	Unit	Quantity	Avg Rate	Rate to Use	Crews	Time (Days)
Clear & Grub	1	mi/Day	1	acre/Day	61	1	5		12.2
Fence Removal	-	-	310	LF/Day	2,250	310	300		7.5
Pipe Removal	-	-	120	LF/Day	665	120	120		5.5
Conc Ditch Removal	-	-	-	-	550	-	400		1.4
REMOVAL TOTAL									26.6
USE									**20.0**
24" RGRCP, Class III	300	LF/Day	88	LF/Day	355	194	200		1.8
30" RGRCP, Class III	250	LF/Day	60	LF/Day	191	155	175		1.1
36" RGRCP, Class III	200	LF/Day	60	LF/Day	25	130	150		0.2
60" RGRCP, Class III	30	LF/Day	35	LF/Day	232	33	35		6.6
36" Jacking	-	LF/Day	7	LF/Day	65	-	7		10.0
16" DIP Culvert		LF/Day	38	LF/Day	436	38	75		5.8
24" DIP Culvert		LF/Day	36	LF/Day	800	36	50		16.0
30" DIP Culvert		LF/Day	-	LF/Day	601	-	40		15.0
48" DIP Culvert		LF/Day	-	LF/Day	336	-	30		11.2
Concrete Slip Form Irrigation Ditch (1' Bottom)	300	LF/Day	-	LF/Day	520	-	300		1.7
PIPEWORK TOTAL									69.4
USE									**60.0**
Channel Excavation	650	CY/Day	800	CY/Day	320,000	725	800	4	100.0
Landfill Excavation	500	CY/Day	760	CY/Day	300	630	600	1	0.5
Aggregate Base Course (ABC)	2000	CY/Day	3,000	CY/Day	3,800	2,500	2500		1.5
EARTHWORK TOTAL									102.0
USE									**100.0**
Structural Conc	25	CY/Day	100	CY/Day	5,537	63	50	2	55.4
Reinforcing Steel	25000	CY/Day	-	CY/Day	448,984	-	20000	2	11.2
Precast-Prestressed Concrete Members	50	LF/Day	-	LF/Day	736	-	50	1	14.7
30" Drilled Shaft	140	LF/Day	150	LF/Day	350	145	150	1	2.3
CONCRETE WORK									83.6
USE									**80.0**

Bullard Wash Channel Improvements
Contract No. 95-39
Flood Control District of Maricopa County

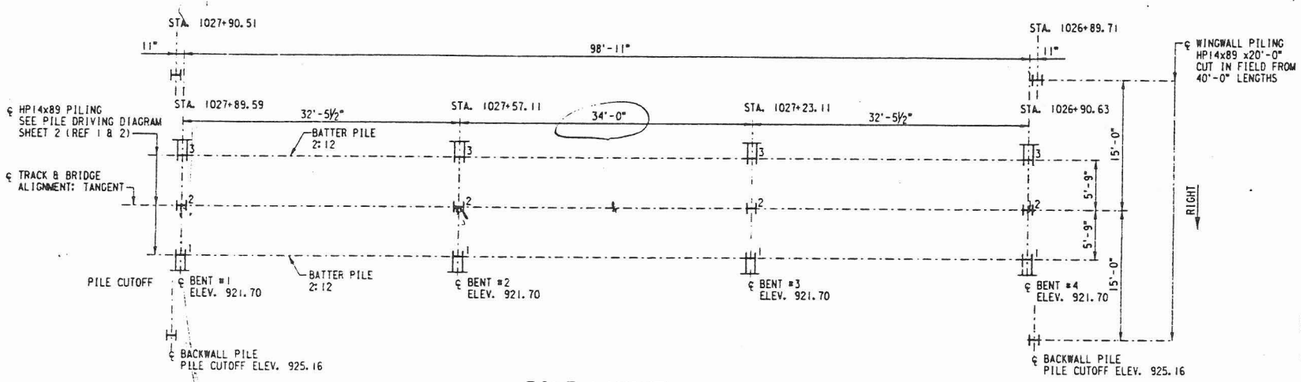
Construction Time Calculations - 60% Submittal

Item Description	ADOT Rate	Unit	Means Rate	Unit	Quantity	Avg Rate	Rate to Use	Crews	Time (Days)
36" Drilled Shaft Bridge Foundations	140	LF/Day		LF/Day	420		140		3.0
Steel Reinforcement (Bridge)	4,000	Lb/Day		Lb/Day	226,050		4,000	2	28.3
Portland Cement Concrete (Bridge), Class A	25	CY/Day		CY/Day	170		25	2	3.4
Portland Cement Concrete (Bridge), Class AA	25	CY/Day		CY/Day	940		25	2	18.8
BRIDGE									53.5
USE									**60.0**
Grouted Riprap	75	CY/Day	62	CY/Day	1,162	69	70	1	16.6
Gabion Baskets	-	SY/Day	80	SY/Day	23,880	-	80	4	74.6
Gabion Matress	-	SY/Day	163	SY/Day	8,320	-	170	4	12.2
RIPRAP/GABIONS									103.5
USE									**100.0**
Chain Link Fencing	1200	LF/Day	260	LF/Day	6,280	730	750		8.4
3-Wire Fencing	2000	LF/Day	4,000	LF/Day	3,415	3,000	3000	1	1.1
Access Gates	-	Ea/Day	35	Ea/Day	8	-	30		0.3
Handrail	-	LF/Day	500	LF/Day	14,065	-	500	1	28.1
FENCING									37.9
USE									**30.0**



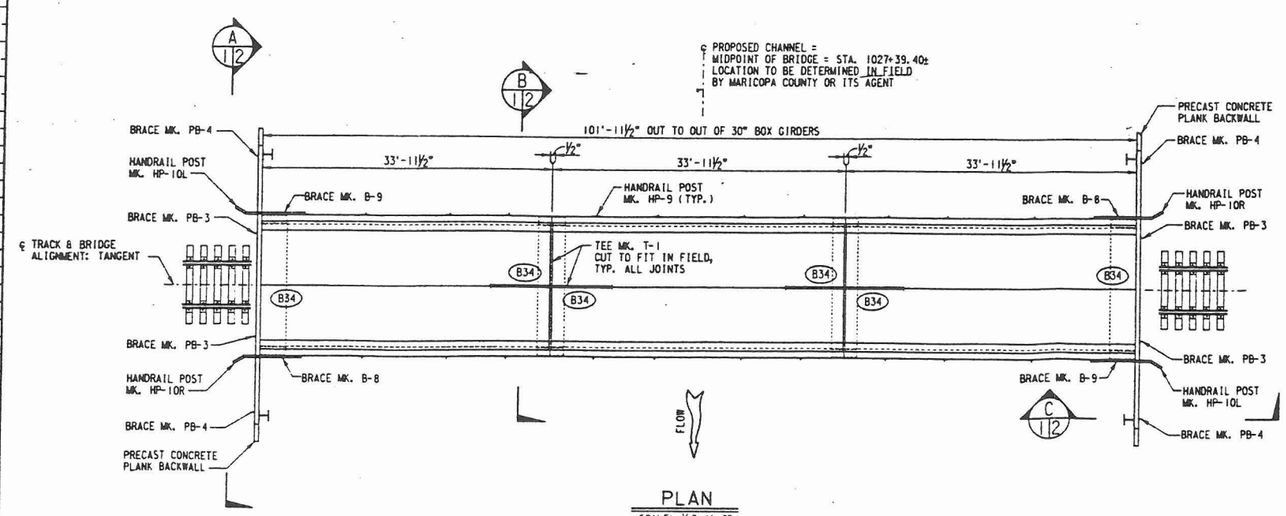
ELEVATION

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



PILE LAYOUT

SCALE: 1/8"=1'-0"
(AT PILE CUTOFF ELEVATION)



PLAN

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

BILL OF MATERIAL

	REQ'D	UNIT	DESCRIPTION	STORE ITEM NO.	ORDERED BY
PRECAST CONCRETE	6	EA.	30"X33'-11½" PRESTRESSED CONCRETE BOX GIRDER MK. B34, TYPE I W/ CURB, WITH 65 ½" DIA. 270 KSI STRANDS (REF. 3 & 4)	511-0141	MANAGER STRUCTURAL PROJECTS
	3	EA.	3'-0"X3'-6"X16'-0" PRECAST CONCRETE PILE CAP (REF. 5)	511-0475	
	4	EA.	6"X1'-10"X 8'-6" PRECAST CONCRETE BACKALL PLANK (REF. 6)	511-0206	
	4	EA.	6"X1'-4"X 12'-0" PRECAST CONCRETE BACKALL PLANK (REF. 6)	511-0202	
	4	EA.	6"X1'-4"X 16'-0" PRECAST CONCRETE BACKALL PLANK (REF. 6)	511-0204	
PILING	26	EA.	HP14X89X40'-0" STEEL PILING (PLAIN, REF. 1 & 2)	510-7556	
	12	EA.	PILE SPLICER FOR HP14X89 STEEL PILE, PER DETAIL SHEET NO. 1	510-8051	
STEEL BRACING	4	EA.	C8X11.5X13'-0" SWAY BRACE (A36, PLAIN)	247-6367	
	4	EA.	C10X15.3X13'-6" CROSS BRACE (A36, PLAIN)	247-6649	
	24	EA.	HANDRAIL POST MK. HP-9 (GALV., PER DETAIL, REF. 8)	513-2020	
	2	EA.	HANDRAIL POST MK. HP-10L (GALV., PER DETAIL, REF. 7)	513-2040	
	2	EA.	HANDRAIL POST MK. HP-10R (GALV., PER DETAIL, REF. 7)	513-2050	
	2	EA.	BRACE MK. PB-3 (GALV., PER DETAIL, REF. 10)	513-0600	
	2	EA.	BRACE MK. PB-4 (GALV., PER DETAIL, REF. 10)	513-0610	
	2	EA.	BRACE MK. B-8 (GALV., PER DETAIL, REF. 9)	513-0540	
	2	EA.	BRACE MK. B-9 (GALV., PER DETAIL, REF. 9)	513-0550	
MISC. STEEL, WIRE ROPE & FASTENERS	9	EA.	¾" DIA. X 1¾" A325 HVY. HEX BOLT, TYPE 1 W/ HVY. HEX NUT (A563, LUBRICATED) AND FLAT CIRCULAR WASHER (F436), EACH COMPONENT HOT DIP OR MECHANICALLY ZINC COATED	513-1168	
	50	EA.	¾" DIA. X 11" A307 HVY. HEX GRADE A BOLT, W/ HVY. HEX ELASTIC LOCKNUT (MIL-N-25027) & FLAT CIRCULAR WASHER (F436), EA. COMPONENT HOT DIP OR MECHANICALLY ZINC COATED	134-6585	
	9	EA.	¾" DIA. X 8" A307 HVY. HEX GRADE A BOLT, W/ HVY. HEX ELASTIC LOCKNUT (MIL-N-25027) & FLAT CIRCULAR WASHER (F436), EA. COMPONENT HOT DIP OR MECHANICALLY ZINC COATED	134-6552	
	5	EA.	¾" DIA. X 9" A307 HVY. HEX GRADE A BOLT, W/ HVY. HEX ELASTIC LOCKNUT (MIL-N-25027) & FLAT CIRCULAR WASHER (F436), EA. COMPONENT HOT DIP OR MECHANICALLY ZINC COATED	134-6554	
	424	LIN. FT.	⅜" NOMINAL DIAMETER WIRE ROPE, 7 WIRE, GALV. STEEL STRAND, SIEMENS MARTINS GRADE, A-COATING (4 - 106' LENGTHS)	050-5394	
	70	EA.	GALV. MALLEABLE IRON U-BOLT W/ 2 ELASTIC LOCKNUTS (MIL-N-250271, ZINC PLATED, FOR ⅜" DIA WIRE ROPE	050-6370	
	8	EA.	HEAVY PATTERN - HEAVY DUTY GALV. CARBON STEEL WIRE ROPE THIMBLE (ZINC PLATED) FOR ⅜" DIA. WIRE ROPE	050-7821	
	8	EA.	½" DIA. EYEBOLT, 2" LONG SHANK WITH 1" I.D. EYE, PLAIN PATTERN, GALV., DROP FORGED STEEL (A489), WITH ZINC PLATED HEX NUT (A563) & ZINC PLATED FLAT CIRCULAR WASHER (F436)	130-0370	
	15	EA.	STEEL TEE MK. T-1 (GALV., PER DETAIL, REF. 10) ASTM A569	513-6000	
	8	EA.	½"X4"X3'-0" ELASTOMERIC BEARING PAD (50 DUROMETER)	510-3640	
	12	EA.	½"X8"X6'-8" ELASTOMERIC BEARING PAD (50 DUROMETER)	510-3645	
	2	EA.	BRIDGE MARKER PER ENGINEERING STANDARDS DRAWING NO. 0507	513-0955	

EST. WT. OF PILING = 92,560 LB.
EST. WT. OF MISC. STEEL (NOT INCL. BOLTS CLIPS & WIRE ROPE) = 1,480 LB.
EST. WT. OF CROSS & SWAY BRACING = 1,425 LB.

DRAWING SCHEDULE

	SHEET NO.	DESCRIPTION
THIS SET	1	GENERAL ARRANGEMENT & BILL OF MATERIAL
	2	MISCELLANEOUS SECTIONS, DETAILS & TOP OF RAIL PROFILE

	NO.	DWG. NO.	SHEET NO.	REV. NO.	DESCRIPTION
REF.	1	104537	-	-	HP14x89 STEEL PILE
	2	104552	-	-	HP14x89 STEEL TEMPLATE DETAILS
	3	114915	1	-	30" DP. PRESTRESSED CONC. DBL. BOX GIRDER
	4	114915	2	-	30" DP. PRESTRESSED CONC. DBL. BOX GIRDER
	5	104258	3	3	STEEL PILE PRECAST ABUT. FOR 30" BOX GIRDERS
	6	114258	8	2	STEEL PILE PRECAST CAP FOR 30" BOX GIRDERS
	7	114268	1	1	END HANDRAIL POST DETAILS
	8	114268	2	3	INTERIOR HANDRAIL POST DETAILS
	9	114268	3	3	HANDRAIL POST BRACING DETAILS
	10	114268	5	4	MISCELLANEOUS STEEL DETAILS

CONSTRUCTION NOTES

GENERAL:

Field verify all dimensions, stations and elevations prior to start of construction.

For information on, and relocation of, fiber optic cable call 1-800-336-9193.

SITE LAYOUT INFORMATION:

Rail raise: No change in mainline elevation.

Track Alignment: Field verify prior to start of construction

Elevations taken from drawings Titled "BULLARD WASH CHANNEL, FINAL: DESIGN" as prepared by Sverdrup Corporation 2-5-98.

Rail stationing based on stationing of the west backwall of Bridge no. 887.39 as shown on the UPRR Right-Of-Way And Track Map. (Sta. 1025+34.6)

Right Of Way: 100' Right of track centerline
100' Left of track centerline

PILE DRIVING:

All numbered pile shall be driven to 120 ton capacity. If any numbered pile cannot be driven to this capacity the Office Of Chief Engineer Structures must be notified.

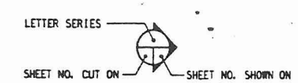
FIELD WELDING:

Welding must be accomplished with the SMAW Process.
Welding must be in compliance with the requirements specified in AWS D1.5-95, except ⅜ in. fillet welds may be made with a single pass.
Welding electrodes must be E7018.
Welders must possess valid certification.

DESIGN NOTES

This structure was designed for Cooper E80 Live Load with 30" ballast and impact.

Design Pile Load: End Bent = 77 Ton
Interior Bent = 120 Ton



SECTION DESIGNATION

EST. WT. OF CONC. BOX GIRDER
MK. B-34 = 38,500 LBS (19.3 TONS)

NO.	DATE	REVISIONS
	/ /	
	/ /	
	/ /	
	/ /	

SP ROUTE SYMBOL R

UNION PACIFIC RAILROAD — OFFICE OF CHIEF ENGINEER DESIGN

LOCATION: BRIDGE 887.34 — GILA (PHEONIX) SUB.
2.0 MILES WEST OF LITCHFIELD, AZ.

FACILITY: 3 SPAN 34' x 30" DEEP DOUBLE BOX GIRDER B.D.

DWG TITLE: GENERAL ARRANGEMENT & BILL OF MATERIAL

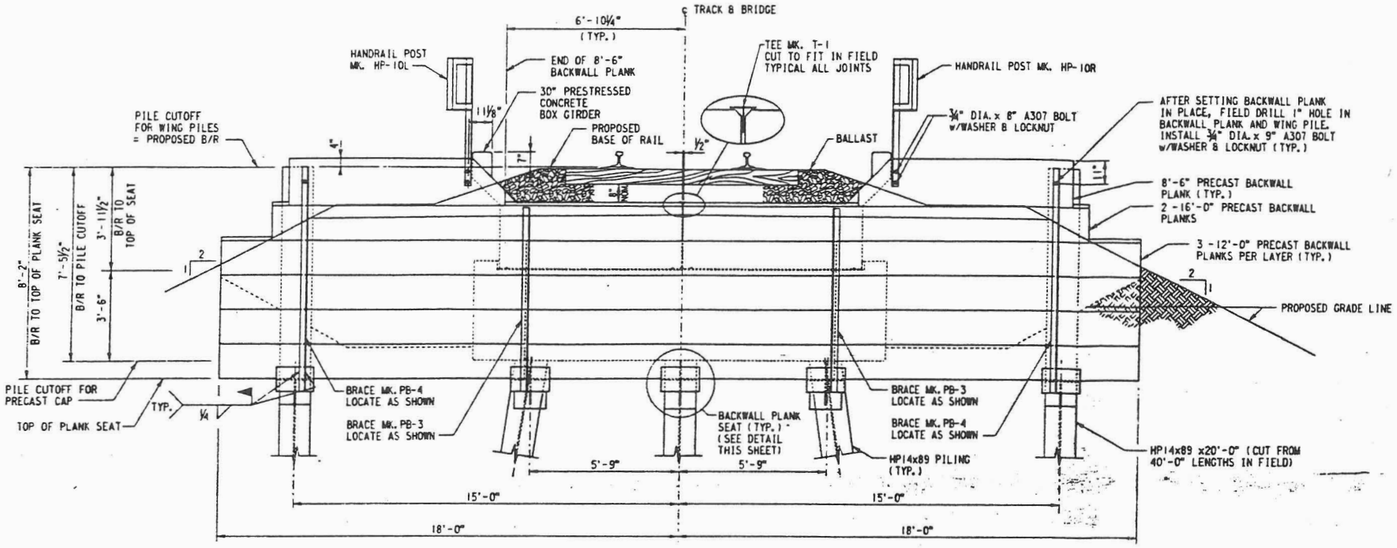
WORK ORDER: 29264
ENGR JOB NO: 001
DESIGN BY: GEV
CHECKED BY: GEV
DRAWN BY: RDK
CHECKED BY: GEV
SCALE: 1/8"=1'-0" AS SHOWN

DWG. SEQUENCE: 1 of 2
C.C. NUMBER: 115073

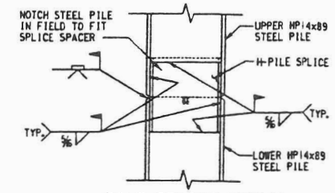
APPROVED
FOR CHIEF ENGINEER DESIGN — 16 June 1998 DATE

FILE NAME: u:\bullard\dgn\115073.bmc

PLOTTED: 16-JUN-1998 11:3



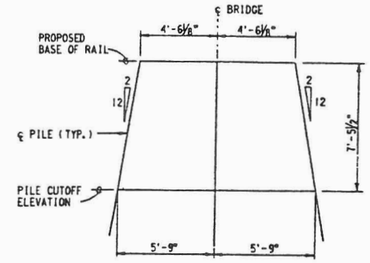
SECTION A 1/2
SCALE: ⅜" = 1'-0"



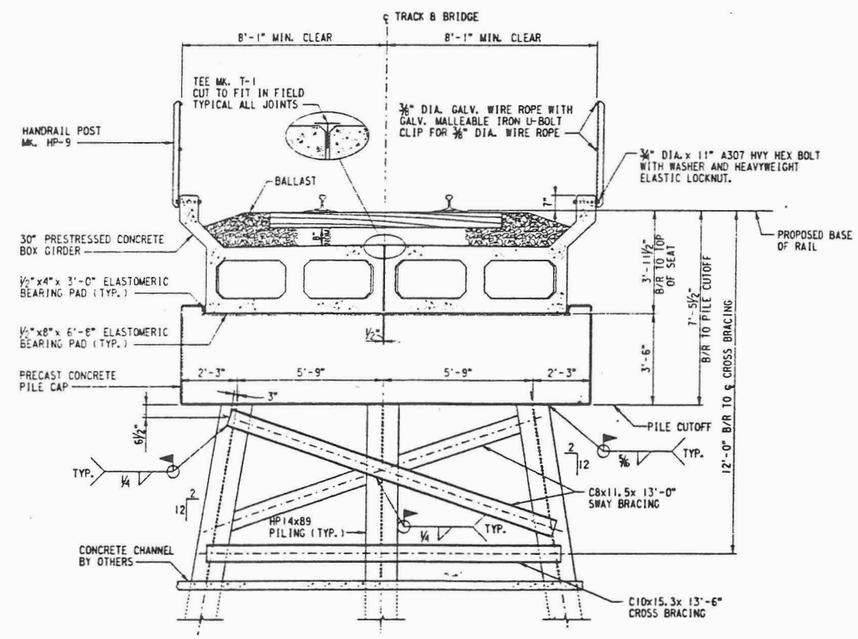
PILE SPLICE DETAIL
SCALE: ⅜" = 1'-0"

PILE SPLICING:
PILE SPLICE FOR HP14X89 INSTALLATION INSTRUCTIONS:

1. NOTCH THE END OF UPPER LENGTH OF H-PILE (TO ACCOMODATE THE SPACER BAR).
2. FIT SPLICE OVER NOTCHED END OF UPPER H-PILE, AND WELD IN PLACE.
3. PLACE THE UPPER SECTION INTO POSITION ON THE LOWER SECTION.
4. TO COMPLETE THE SPLICE, WELD SPLICE TO LOWER H-PILE AND WELD FLANGES AS SHOWN.



3 PILE DRIVING DIAGRAM
BENTS # 1 THRU # 4
NO SCALE



SECTION B 1/2
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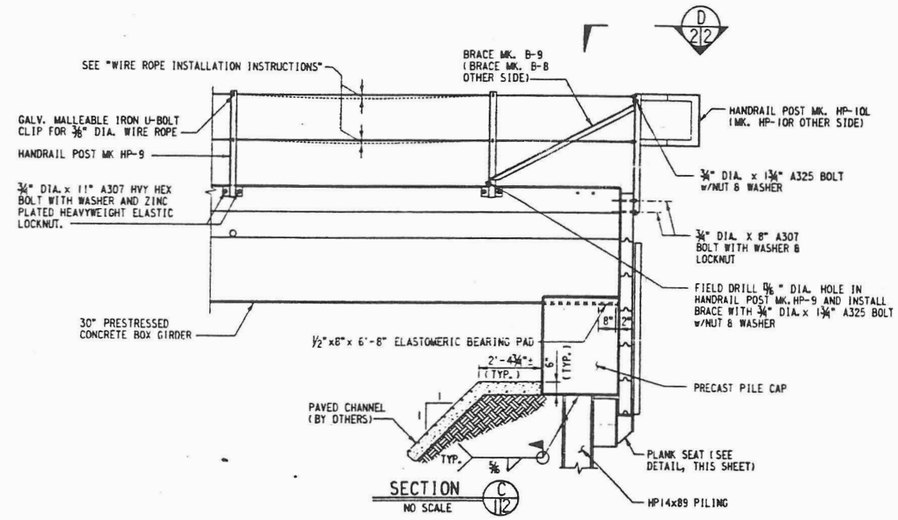
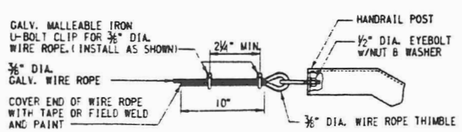


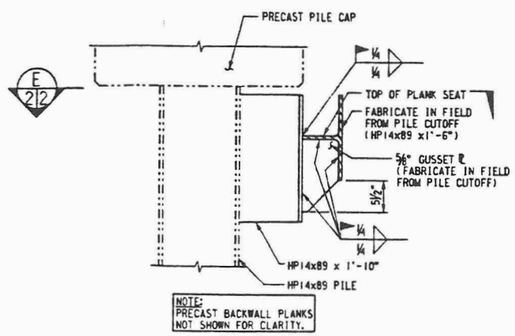
SECTION C 1/2
NO SCALE



VIEW D 2/2
SCALE: 1½" = 1'-0"

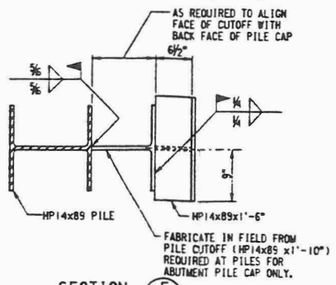
WIRE ROPE INSTALLATION INSTRUCTIONS:

1. THREAD WIRE ROPE THROUGH ALL CLIPS AND TIGHTEN CLIPS AND EYEBOLTS ON ONE END HANDRAIL POST.
2. AFTER INSTALLING BRACES, STRETCH WIRE ROPE, HANG A MINIMUM OF 10 LBS. ON CABLE BETWEEN TWO POSTS, AND REMOVE ALL SAG TO A MAXIMUM OF 2 INCHES.
3. TIGHTEN CLIPS & EYEBOLTS AT REMAINING END HANDRAIL POST.
4. REMOVE WEIGHTS.
5. TIGHTEN CLIPS AT INTERMEDIATE POSTS.



NOTE:
PRECAST BACKWALL PLANKS NOT SHOWN FOR CLARITY.

PLANK SEAT DETAIL
NO SCALE



SECTION E 2/2
NO SCALE

APPROVED
FOR CHIEF ENGINEER DESIGN — 16 June 1998 DATE

NO.	DATE	REVISIONS
	/ /	
	/ /	
	/ /	
	/ /	

SP ROUTE SYMBOL R

UNION PACIFIC RAILROAD — OFFICE OF CHIEF ENGINEER DESIGN

LOCATION: BRIDGE 887.34 — GILA (PHOENIX) SUB. 2.0 MILES WEST OF LITCHFIELD, AZ.

FACILITY: 3 SPAN 34' x 30" DEEP DOUBLE BOX GIRDER B.D.

DWG. TITLE: MISCELLANEOUS SECTIONS AND DETAILS

WORK ORDER: 29264		
ENGR. JOB NO: 001		
DESIGN BY: GEV		
CHECKED BY: GEV		
DRAWN BY: KDS	DWG. SEQUENCE	C. E. NUMBER
CHECKED BY: GEV	2 of 2	115073
SCALE: AS SHOWN		

AVERY

ATL, INC.

CONSTRUCTION QUALITY CONTROL
GEOTECHNICAL CONSULTANTS

BULLARD WASH - CHANNEL
CONTRACT FCD 95-39
GOODYEAR, ARIZONA
ATL JOB NO. 196020-3

ATL Job No. 196020-3

November 22, 1997

GEOTECHNICAL INVESTIGATION

REPORT FOR

SVERDRUP CIVIL, INC.

PROJECT

BULLARD WASH - CHANNEL
CONTRACT FCD 95-39
GOODYEAR, ARIZONA
ATL JOB NO. 196020-3

Reviewed by:

Registered Professional Engineer (Civil)
CERTIFICATE NO.
22719
David Preston
Hayes
Date Signed 11/25/97
ARIZONA U.S.A.

David P. Hayes, P.E.
Executive Vice President

Prepared by:

Ammi Osorio
Project Engineer

ATL, INC.
CONSTRUCTION QUALITY CONTROL
GEOTECHNICAL CONSULTANTS

November 22, 1997

Mr. Bradford D. Olbert, P.E.
Sverdrup, Civil, Inc.
432 N. 44th Street, Ste. 250
Phoenix, AZ 85008

Re: Geotechnical Investigation
Bullard Wash - Channel
Contract FCD 95-39
Goodyear, Arizona
ATL Job No. 196020-3

Dear Mr. Olbert:

This report summarizes the results of a geotechnical investigation conducted at the proposed Bullard Wash Outfall Channel site, including the East Tributary Channel. The purpose of this project is to improve the capacity and re-align the Bullard Wash Channel to contain the 100-year flood flows while maintaining a stable channel. Field exploration, laboratory tests, and engineering analysis are included, along with boring logs and laboratory results.

ATL drilled a total of twenty-six (26) borings, each to depths of 15 feet below existing grade. Five (5) of these borings were drilled at the location of the proposed East Tributary Channel and seven (7) were drilled in the landfill area at the end of the Goodyear Airport runway.

The soil encountered at the proposed site consisted of various types of sandy and clayey materials. The Plasticity Indices of the materials tested ranged from NP to 15. Percent Swell tests revealed a 2% expansion under a 100 psf surcharge for cohesive material. The soil resistivity results indicated that the soil along the alignment is potentially corrosive. Refer to Appendix B for laboratory test results.

ATL has appreciated the opportunity to be of service to Sverdrup Civil, Inc. on this project and looks forward to a continued association on future projects. Should any questions arise, please do not hesitate to contact us at your earliest convenience.

Very truly yours,

Registered Professional Engineer (Civil) CERTIFICATE NO. 22719 David Preston Hayes Date Signed 11/25/97 ARIZONA, U.S.A.

David P. Hayes, P.E.
Executive Vice President

DPH/brc

2912 W. CLARENDON
PHOENIX, AZ 85017
TELEPHONE (602) 241-1097
FAX (602) 277-1306

820 E. 47TH STREET, SUITE B-1
TUCSON, AZ 85713
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GLOBE, AZ 85502
TELEPHONE (520) 425-8999
FAX (520) 425-9597

1855 W. KAIBAB LANE SUITE 6
FLAGSTAFF, AZ 86001
TELEPHONE (520) 773-9614
FAX (520) 773-9522

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PLATE NO. 3 VICINITY MAP

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APPENDIX B LABORATORY TEST RESULTS

TABULATION OF INDEX TEST RESULTS

GRAIN-SIZE DISTRIBUTION CURVES

STANDARD PROCTOR TESTS

pH AND RESISTIVITY TESTS

SWELL TESTS

GEOTECHNICAL INVESTIGATION

REPORT FOR

SVERDRUP CIVIL, INC.

PROJECT

BULLARD WASH - CHANNEL
CONTRACT FCD 95-39
GOODYEAR, ARIZONA

1.0 PROJECT DESCRIPTION

As part of the Bullard Wash Project for the Flood Control District of Maricopa County (FCD), a new 10,500-foot long channel, approximately six (6) feet in depth, will be constructed. The purpose of this project is to increase the capacity of the Bullard Wash Channel to contain 100-year flood flows within a stable channel. The channel will begin south of Lower Buckeye Road and east of Estrella Parkway. It will continue under the Santa Fe Railroad, under MC-85 through Broadway Road, over the Buckeye Irrigation District (BID) Canal, under the BID service road through a box culvert, ending at Southern Avenue, east of Estrella Parkway. Also included is the construction of a 2,000-foot long

Tributary Channel parallel to the Southern Pacific Railroad (SPRR) and MC-85. This tributary will drain into the new Bullard Wash Channel and extend eastward to the existing Bullard Wash Bridge north of MC-85.

2.0 LOCATION AND SITE DESCRIPTION

The project is located in the western Salt River Valley, a broad basin filled with alluvium of varying grain sizes. The fill deposits are composed of a Lower Conglomerate Unit consisting of cemented sand, gravel, silt, and clay. The fills Upper Alluvial Unit consisting primarily of sands and gravels with clay with silt lenses. Groundwater flows northwesterly north of Yuma Road and southwesterly, south of Yuma Road. Depths of flow range between 40 and 120 feet below land surface.

3.0 SCOPE OF WORK

ATL's responsibility was to drill and sample sub-surface material in order to develop design data for the outfall channel and the east tributary channel. Soil borings were spaced at 500-foot intervals and were drilled to depths of 15 feet below existing grade. Soil testing included the determinations of the basic physical properties in order to classify the individual soil types along with structural support tests appropriate for developing channel design parameters. Resistivity and pH data was also obtained in order to evaluate corrosivity potential of the subsoils.

Field and laboratory data were used in the development of recommendations that address the following issues:

1) Allowable Bearing Capacity and Limiting Settlements
2) Foundation Recommendations for the Channel.
3) Grain-Size distribution of Native Materials with the Channel Bed.
4) Re-use of Native Material.
5) Lateral Pressures

4.0 DRILLING AND SAMPLING PROCEDURES

A total of twenty-six (26) borings were drilled for this portion of the project. Five (5) of these borings were drilled on the east tributary channel proposed alignment. Seven (7) were drilled in the landfill area at the end of the Goodyear Airport runway. All borings were drilled to depths of fifteen (15) feet below existing grade.

A Mobile B-50 drill rig, using 6-inch outside hollow stem continuous flight augers, performed the drilling and sampling of the subsurface soils. A 140-pound hammer dropping 30-inches was used to drive the split-spoon sampler that collected drive samples. Bulk samples were obtained continuously off the auger flights during the drilling operation.

Upon completion of each day's drilling, boreholes were backfilled with excess cuttings from the holes. All samples were transported to ATL's Phoenix Laboratory for analysis. Upon delivery to the laboratory, soil samples were checked by the Project Engineer and the following laboratory tests assigned:

- Sieve Analysis
- Swell Test
- pH and Resistivity
- Plasticity Index
- Moisture Content
- Standard Proctor

5.0 LABORATORY TESTING

Sieve Analysis and Atterberg Limit tests, were conducted on representative samples in order to classify the soils in accordance with the Unified Soils Classification System. Moisture Content tests were performed to determine the amount of water present in the soil at the time of sampling. Standard Proctor tests were performed to determine the maximum dry density and optimum moisture content relationship of each material. The pH and Resistivity Tests were performed to determine the potential corrosivity of soil. In addition, Percent Swell tests were performed to determine the expansion tendencies of the material under various surcharge loads when water is added. Consolidation testing was not performed since other reports addressed that issue.

The following table lists the types and quantities of tests performed to provide the project design information:

TEST	QUANTITY
Sieve Analysis	19
Atterberg Limit	19
Moisture Content	19
Standard Proctor	3
Percent Swell	2
pH and Resistivity	3

All laboratory tests were conducted in accordance with ASTM or AASHTO published procedures. The soils presented on the edited boring logs in Appendix A were classified using the Unified Soils Classifications System (USCS).

6.0 SUMMARY OF EXISTING SUBSURFACE CONDITIONS

The soiled encountered at the proposed site consisted of a wide range of sandy and clayey materials. The clayey materials were classified as CL, CL-ML, and ML and the sandy materials were classified as SM, SP-SM, and SC. Modules of strong cementation was observed in several SM and ML layers. See the detailed boring logs presented in Appendix A.

Minus #200 contents for CL, CL-ML, and ML materials ranged from 52.2% to 94.2%. For the SM, SP-SM, and SC materials, the minus #200 contents ranged from 6.6% to 43.7%. The Plasticity Indices for all soils tested ranged from NP to 15. Standard Proctor analyses were performed on the SM, ML, and CL materials. For the SM material 10 feet below grade in Boring No. 26, the maximum dry density was 118.3 pcf at an optimum moisture content of 14.1%. For the ML material 11 feet below grade in Boring No. 19, the maximum dry density was 115.0 pcf at an optimum moisture content of 15.3%. For the CL material 10 feet below grade in Boring No. 11, the maximum dry density was 111.3 pcf at an optimum moisture content of 15.7%.

Soil resistivity and pH tests were also performed on material used for the above testing. The soil resistivity results ranged from 520 to 991 ohm/cm^3 with pH levels ranging from 7.8 to 8.2. Percent Swell tests were performed on CL material from Boring No. 11

and from Boring No. 19. A 2% swell was measured for both borings under a surcharge of 100 psf.

7.0 DISCUSSIONS AND RECOMMENDATIONS

As indicated in Section 1.0, the main channel will be 10,500 feet in length with the open section approximately six (6) feet deep. In open areas, the channel slopes will be protected by either loose riprap, grouted riprap, gabions or shotcrete. Shotcrete and grouted riprap should not be required for this project unless the projected velocities are high enough to warrant their consideration. The bottom of the channel will be natural ground in the open areas. As the channel alignment approaches roadways, the bottom will transition to concrete, particularly under a new bridge to allow MC 85 to pass over the channel and through an "overchute" structure that will allow the channel water to pass over the Buckeye Irrigation District (BID)Canal. After the channel passes over the BID Canal, it will pass through box culvert sections under the BID Canal southern service road. The concrete bottom will terminate as the channel section is ended at the outfall end of the alignment.

An "eastern" tributary approximately 2500 feet long, will be constructed north of MC 85 and south of the Goodyear airport and will outlet into the main channel north of proposed MC 85 bridge. The pH and Resistivity tests indicate that the soil is corrosive, suggesting that encapsulated metal or concrete pipe should be used to achieve the desired life of the system.

The following sections provide soil analysis in the main channel alignment, the east tributary alignment, and the box culvert under the BID Canal service road. The bridge structures have been addressed in another report prepared by ATL.

7.1 Main Channel

ATL's borings revealed that the subsoil from the northern end of the main channel to the MC 85 bridge is generally a silty clay with sand. Strong cementation was observed at depths greater than 6 feet below greater, with weak to moderate cementation encountered nearer the surface. For acceptability as fill material for roadway widening or behind structures, the material between Boring Nos. 12 and 15 appears to be a higher

quality and is the preferred source for use as a roadway subgrade or structural backfill. It is possible that all the material between Boring Nos. 12 and 17 could be mixed and used throughout the project. Ground water was not encountered in any of these borings.

As the main channel passes under MC 85 and continues to the BID Canal, a wide variance in material types was encountered. Sandy- silty material encountered in Boring Nos. 22, 25 and 26. The material in Boring Nos. 24 and 27 also contains sufficient sand to use in a mix with SP, SM or SC material that could be acceptable subgrade fill.

Side slopes should be cut no steeper than 2 H: 1V even though some areas should be able to sustain slopes as steep as 1H:1V. Prior to placing slope protection, the subgrade should be proof-rolled to a density of no less than 90% of the maximum dry density as determined by ASTM D 698. In areas where concrete is placed, the subgrade must be proof-rolled to a density of no less than 95% of the maximum dry density as determined by ASTM D 698 prior to placing no less than 6 inches of aggregate base course, compacted to the same specification (See Section 8.0 of this Report). The concrete should conform to MAG requirements as re-stated in Section 8.0 of this Report. The transition between a natural bottom and the concrete slab is susceptible to increased scour. A turn-downed concrete edge, extending to a depth of at least two (2) feet below the channel invert is suggested. The depth of this edge should depend on local scour calculations.

7.2 Tributary Channel

The tributary channel alignment was investigated by drilling Boring Nos. 23 through 27. Within the top 10 feet, the material exhibited a weak to strong cementation matrix within the silts, sandy silts and clays encountered. No groundwater was encountered by moisture generally increased as depth below grade increased. Side slopes should not be placed steeper than 2 H:1V and the excavated materials may be re-used elsewhere as roadway subgrade or structural backfill.

The outlet end of this channel will empty into the main channel, north of the proposed MC 85 bridge. Compaction of the side slopes and channel bottom should be performed in an identical manner as recommended in Section 7.2 for the main channel. ATL suggests that the outlet end by constructed of stable material such as shotcrete, or

portland cement concrete in order to reduce erosion. Energy dissipaters may also be required to reduce scour potential.

During drilling, it was observed that a fill of unknown depth existed near the end of a Goodyear runway. ATL drilled seven (7) borings, Nos. 28 through 34, to determine the partial nature of the fill and its depth. Fill varied from 6 to 18 feet, averaging 15 feet in depth. "Chunks" of asphaltic concrete and portland cement concrete were encountered, along with plastic sheets, electrical wire, tree limbs and processed gravel. The fill soil was predominately a silty clay.

7.3 BID Box Culvert

This box culvert is being constructed in order for the water transported by the overchute structure will pass under the southern service road. It is anticipated that the box culvert will be constructed prior to the construction of the overchute structure so that the service road may be re-routed over the box culvert during construction of the overchute. The soil present in the area of the box culvert is represented by Boring Nos. 21 and 22. The overlying layer is silt, varying in depth from 12 feet to 6 feet over a distance of 560 feet. It is anticipated that the foundation for the box will set on the poorly grade sand and gravel layer underlying the silt strata. The following foundation parameters are provided for this structure:

Allowable Bearing Capacity	-	3500 psf
Total and Differential Settlement	-	1 inch maximum
Founding Material	-	Poorly Graded Sand
Coefficient of Friction	-	0.40

We anticipate that the material excavated for the construction of the box culvert will be used to backfill behind the side walls, over which the service road will be constructed. ATL does not recommend use of the silt material. The sand and gravel may be used, however, and the following equivalent fluid pressures are presented for this material using an insitu unit weight of 120 pcf:

Active	-	26 psf
At Rest	-	43 psf
Passive	-	552 psf

The roadway surface should be six inches of ABC compacted in place as per recommendations of Section 8.0 of this report.

8.0 GENERAL CONSTRUCTION RECOMMENDATIONS

8.1 Structural Excavation and Backfill

Along the channel alignment, a significant amount of material will be excavated. Some of this material is suitable for re-use as compacted subgrade for the reconstruction of Estrella Parkway and the portion of MC 85 that lies within the project limits. The silts and clays with minus #200 values exceeding 55% are **not** acceptable for re-use.

The acceptable material should be compacted in layers as specified in Section 8.2 and meet the minimum maximum density and optimum moisture content requirements.

8.2 Compaction

MAG Section's 211 and 215 should be followed, using either AASHTO T-99 or ASTM D698 procedures for obtaining the laboratory proctor maximum dry density and optimum moisture content. This report provides several proctor values but the contractor should confirm these during actual construction. For both soils and aggregate base course materials, compaction should be no less than 95% of the applicable maximum dry density at moisture contents within 2% of optimum for the material being tested. One-point proctors may be used to confirm the laboratory values.

8.3 Borrow

It is not anticipated that imported borrow will be required. If requested, it should meet the following requirements for material placed within 2-feet of the base course.

Sieve Size	Percent Passing
3"	100
3/4"	55 - 80
No. 4	35 - 60
No. 40	5 - 20
No. 200	0 - 12

Plasticity Index $\leq$ 10

In addition, the borrow shall contain no "chunks" of clay, organic matter, tree limbs, excess moisture and stones larger than 3 inches.

8.4 Aggregate Base Course

The aggregate base course (ABC) material used under pavement sections should conform to Section 702 of MAG as follows:

Sieve Size	Percent Passing
1 1/8	100
No. 4	38 - 65
No. 8	25 - 60
No. 30	10 - 40
No. 200	3 - 12

Plasticity Index ≤ 5

8.5 Portland Cement Concrete

The portland cement concrete for the box culvert and channel should conform to MAG Class A as detailed in MAG Section 725. Placement should conform to MAG Section 505.

8.6 Gabions

One method of slope protection is the use of gabions and mattresses. These are typically galvanized metal "baskets" that contain single-sized stone from 4" to 8" in diameter. Connecting wires and ties, also constructed of galvanized metal, are used to establish unity from basket to basket. Gabions may be constructed vertically, as well as on a slope. Several manufacturers supply this material, including Macaffari and Terra Aqua.

8.7 Riprap

If riprap is used to protect the slopes, it should conform to the applicable provisions of MAG Section 703.

9.0 ADDITIONAL SERVICES

It is recommended that the Geotechnical Engineer be retained to provide a general review of final design plans and specifications in order to confirm that the recommendations from this report have been interpreted correctly and implemented in the proper context. In the event that any changes of the proposed project are planned, the conclusions and recommendations contained in this report should be reviewed and the report modified or supplemented as necessary.

The Geotechnical Engineer should also be retained to provide testing services during excavation, grading, and channel construction phases of the work. Construction testing should be performed to determine whether applicable project specifications have been met. ATL's staff consists of certified technicians with several years in this business and have completed many similar FCD, City of Phoenix, and City of Flagstaff projects over the past ten years.

The analyses and recommendations in this report are based in part upon data obtained from the field exploration. The nature and extent of variations beyond the location of test borings may not become evident until construction. If variations then appear evident, it may be necessary to re-evaluate the recommendations of this report.

Our professional services were performed using that degree of care and skill ordinarily exercised, under similar circumstances, by reputable geotechnical engineers practicing in this or similar localities. No warranty, express or implied, is made. We prepared the report as an aid in design of the proposed project. The reader of this report must draw his own conclusions regarding site conditions and specific construction techniques to be used on this project.

This report is for the exclusive purpose of providing geotechnical engineering and/or testing information and recommendations. The scope of services for this project does not include, either specifically or by implication, any environmental assessment of the site or identification of contaminated or hazardous materials or conditions. If the owner is concerned about the potential for such contamination, other studies should be undertaken.

PLATES

GUIDELINES IN THE USE AND INTERPRETATION

OF THIS GEOTECHNICAL REPORT

ATL Job No.196020-3

Our professional services were performed, our findings obtained, and our recommendations prepared in accordance with generally accepted engineering principles and practices. This warranty is in lieu of all other warranties, either expressed or implied.

The geotechnical report was prepared for the use of the Owner in the design of the subject facility and should be made available to potential contractors and/or the Contractor for information on factual data only. This report should not be used for contractual purposes as a warranty of interpreted subsurface conditions such as those indicated by the interpretive boring and test pit logs, cross sections, or discussion of subsurface conditions contained herein.

The analyses, conclusions and recommendations contained in the report are based on site conditions as they presently exist and assume that the exploratory borings, test pits, and/or probes are representative of the subsurface conditions of the site. If, during construction, subsurface conditions are found which are significantly different from those observed in the exploratory borings and test pits, or assumed to exist in the excavations, we should be advised at once so that we can review these conditions and reconsider our recommendations where necessary. If there is a substantial lapse of time between the submission of this report and the start of work at the site, or if conditions have changed due to natural causes or construction operations at or adjacent to the site, this report should be reviewed to determine the applicability of the conclusions and recommendations considering the changed conditions and time lapse.

The Summary Boring Logs are our opinion of the subsurface conditions revealed by periodic sampling of the ground as the borings progressed. The soil descriptions and interfaces between strata are interpretive and actual changes may be gradual.

The boring logs and related information depict subsurface conditions only at these specific locations and at the particular time designated on the logs. Soil conditions at other locations may differ from conditions occurring at these boring locations. Also, the passage of time may result in a change in the soil conditions at these boring locations.

Groundwater levels often vary seasonally. Groundwater levels reported on the boring logs or in the body of the report are factual data only for the dates shown.

Unanticipated soil conditions are commonly encountered on construction sites and cannot be fully anticipated by merely taking soil samples, borings or test pits. Such unexpected conditions frequently require that additional expenditures be made to attain a properly constructed project. It is recommended that the Owner consider providing a contingency fund to accommodate such potential extra costs.

This firm cannot be responsible for any deviation from the intent of this report including, but not restricted to, any changes to the scheduled time of construction, the nature of the project or the specific construction methods or means indicated in this report; nor can our firm be responsible for any construction activity on sites other than the specific site referred to in this report.

SOIL CLASSIFICATION & TERMINOLOGY

GRAPHIC SYMBOL	GROUP SYMBOL	TYPICAL NAMES
	GW	Well graded gravels, gravel - sand mixtures, or sand - gravel - cobble mixtures.
	GP	Poorly graded gravels, gravel - sand mixtures, or sand - gravel - cobble mixtures.
	GM	Silty gravels, gravel - sand - silt mixtures.
	GC	Clayey gravels, gravel - sand - clay mixtures.
	SW	Well graded sands, gravelly sands.
	SP	Poorly graded sands, gravelly sands.
	SM	Silty sands, sand - silt mixtures
	SC	Clayey sands, sand - clay mixtures
	ML	Inorganic silts, clayey silts with slight plasticity
	MH	Inorganic silts, micaceous or diatomaceous silty soils, elastic silts.
	CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays.
	CH	Inorganic clays of high plasticity, fat clays, sandy clays of high plasticity.

DEFINITIONS OF SOIL FRACTIONS

SOIL COMPONENT	PARTICLE SIZE RANGE
Cobbles	Above 3 inches
Gravel	3 inches to No. 4 sieve
Coarse gravel	3 inches to 3/4 inch
Fine gravel	3/4 inch to No. 4 sieve
Sand	No. 4 sieve to No. 200
Coarse	No. 4 sieve to No. 10
Medium	No. 10 sieve to No. 40
Fine	No. 40 sieve to No. 200
Fines (silt or clay)	Below No. 200 sieve

1. Relative Density. Terms for description of relative density of cohesionless, uncemented sands and sand - gravel mixtures,

N	Relative Density
0 - 4	Very loose
5 - 10	Loose
11 - 30	Medium dense
31 - 50	Dense
50	Very dense

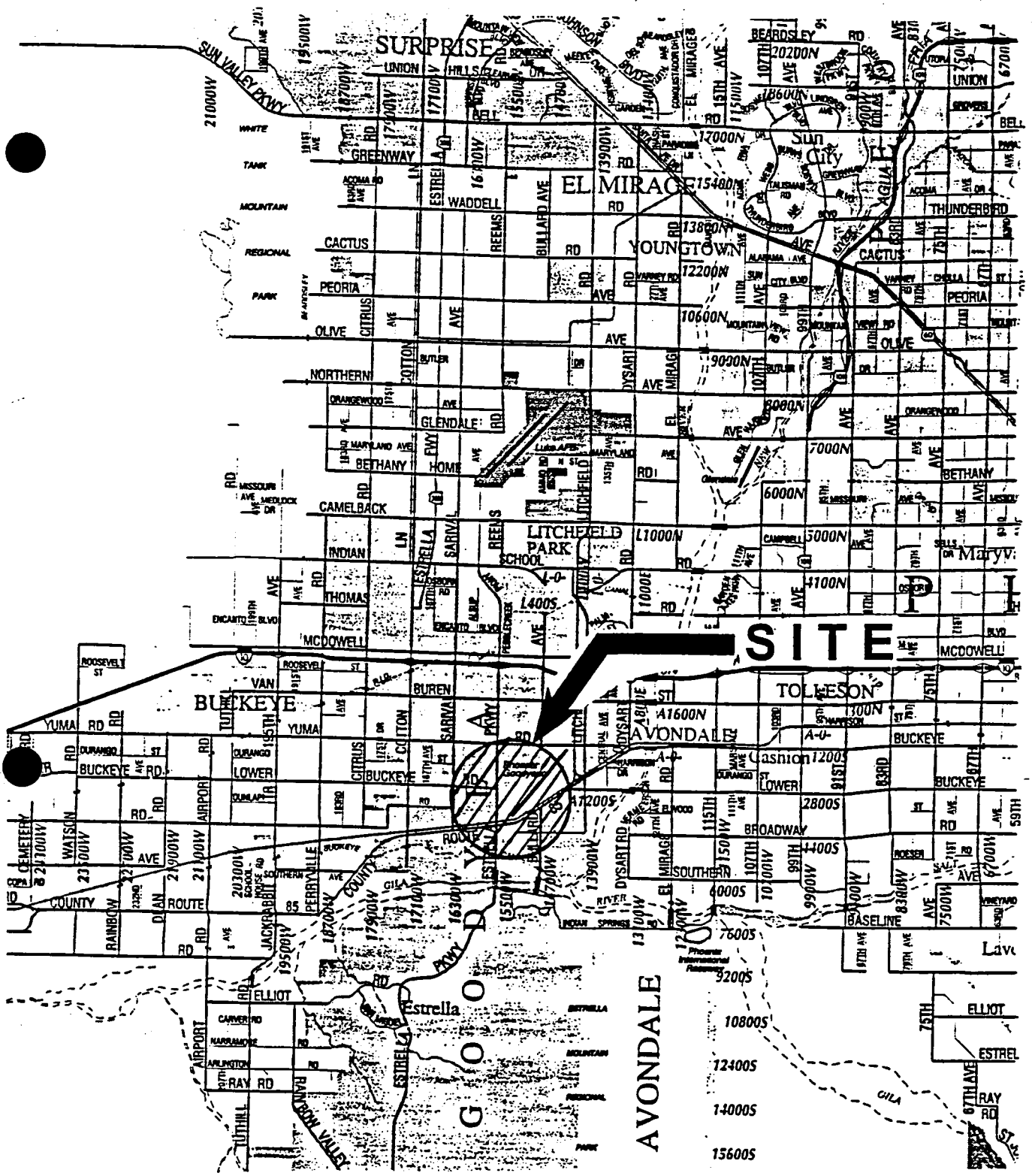
2. Relative Consistency. Terms for description of clays which are saturated or near saturation.

N	Relative Consistency	Remarks
0 - 4	Very soft	Easily penetrated several inches with fist.
3 - 4	Soft	Easily penetrated several inches with thumb.
5 - 8	Medium stiff	Can be penetrated several inches with thumb with moderate effort.
9 - 15	Stiff	Readily indented with thumb but penetrated only with great effort.
16 - 30	Very stiff	Readily indented with thumbnail.
30 +	Hard	Indented only with difficulty by thumbnail.

3. Relative Firmness. Terms for description of partially saturated and / or cemented soils which commonly occur in the Southwest including clays, cemented granular materials, silts and silty and clayey granular soils.

N	Relative Firmness
0 - 4	Very soft
5 - 8	Soft
9 - 15	Moderately firm
16 - 30	Firm
31 - 50	Very firm
50 +	Hard

4. Standard Penetration Tests (SPT) =



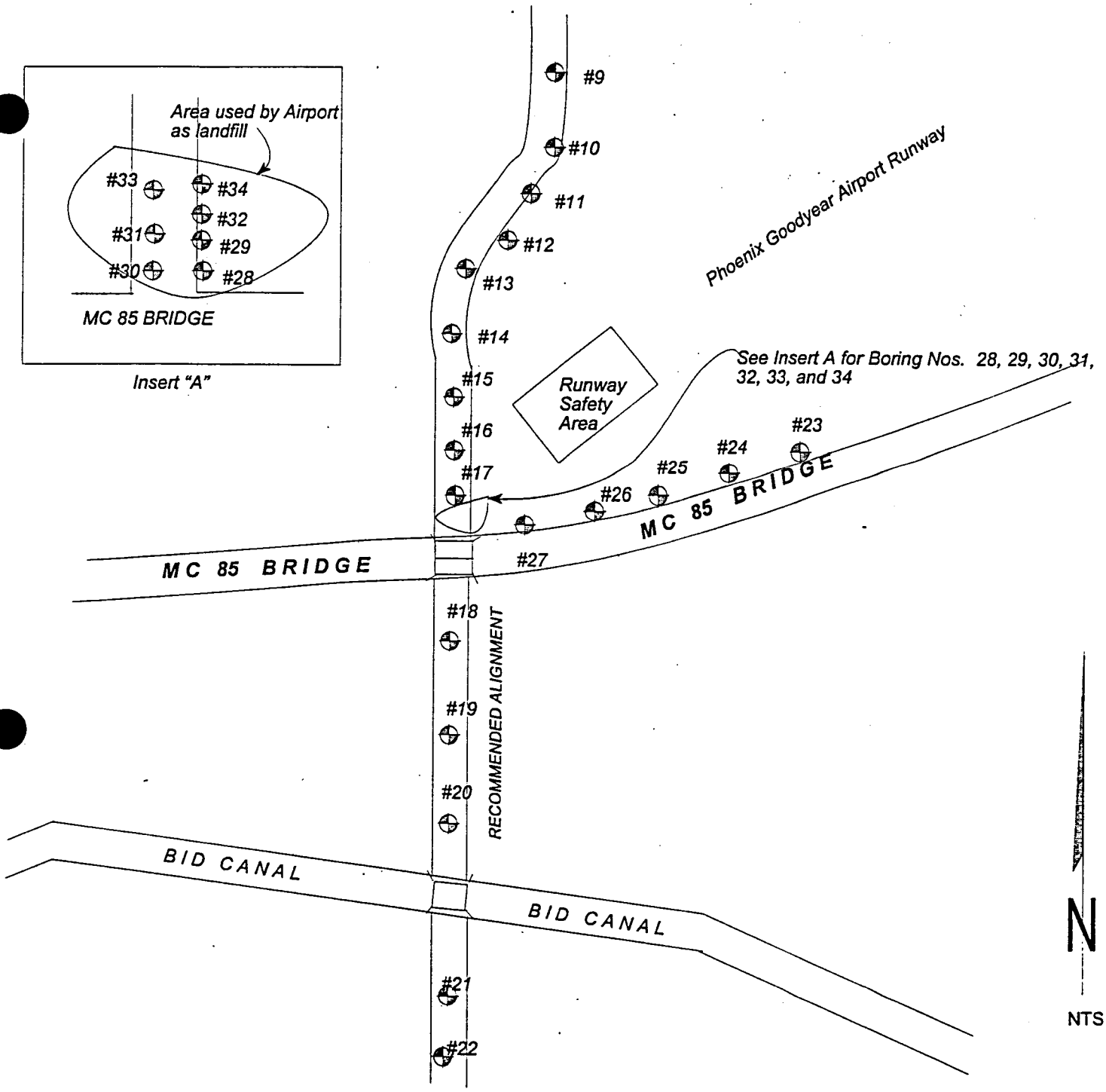
VICINITY MAP

BULLARD WASH - CHANNEL

Goodyear, Arizona

ATL JOB NO. 196020-3

PLATE 3



BORING LOCATIONS

BORING LOCATIONS
BULLARD WASH - CHANNEL
Goodyear, Arizona

ATL JOB NO. 196020-3

PLATE 4

APPENDIX A

BORING LOGS

BULLARD WASH - MAIN CHANNEL
Goodyear, Arizona

ATL Job No. 196020-3

Boring No.: 9

Boring Location: *Centerline, Sta 119+57*

Boring Equipment: *Mobile B-50 with 6 - Inch diameter hollow stem auger*

Date of Boring: *9-29-97* **Elevation of Boring:** *948.0*

Driller: *J. Cowell* **Logger:** *J. Cowell* **Reviewed By:** *A. Osorio*

Graphical Log	Depth (Feet)	SOIL DESCRIPTION	SPT Blows/ft	Ring Blows/ft	% Passing No. 200	Plasticity Index
		Brown, lean CLAY(CL), Moist				
		Brown, silty CLAY(CL-ML) with sand			78.3	7
	5	*Weak cementation*				
	10	*Brown, lean CLAY(CL), damp*				
	15	*(Bottom of boring at 15 feet)*				
	20					
	25					

Boring Stopped at 15 Feet below Existing Grade

Groundwater	Initial Depth	Hour	24 Hour Depth
	None		

NOTE: THE ABOVE DATA FOR DESIGN PURPOSES ONLY.

BULLARD WASH - MAIN CHANNEL
Goodyear, Arizona

ATL Job No. 196020-3

Boring No.: 10

Boring Location: *100' Right Station 116+00, 5' West of airport fence*

Boring Equipment: *Mobile B-50 with 6 - Inch diameter hollow stem auger*

Date of Boring: *9-30-97* **Elevation of Boring:** *943.0*

Driller: *J. Cowell* **Logger:** *J. Cowell* **Reviewed By:** *A. Osorio*

Graphical Log	Depth (Feet)	SOIL DESCRIPTION	SPT Blows/ft	Ring Blows/ft	% Passing No. 200	Plasticity Index
		Brown, silty CLAY(CL-ML), Moist			*74.6*	*5*
	5					
	10	*Moisture increases to wet*				
		Gray-tan, Poorly graded SAND(SP-SM) with silt and gravel				
	15	*(Bottom of boring at 15 feet)*				
	20					
	25					

Boring Stopped at 15 Feet below Existing Grade

Groundwater	Initial Depth	Hour	24 Hour Depth
	None		

NOTE: THE ABOVE DATA FOR DESIGN PURPOSES ONLY.

BULLARD WASH - MAIN CHANNEL
Goodyear, Arizona

ATL Job No. 196020-3

Boring No.:11

Boring Location: *100' Right Station 111+00*

Boring Equipment: *Mobile B-50 with 6 - Inch diameter hollow stem auger*

Date of Boring: *9-30-97* **Elevation of Boring:** *941.0*

Driller: *J. Cowell* **Logger:** *J. Cowell* **Reviewed By:** *A. Osorio*

Graphical Log	Depth (Feet)	SOIL DESCRIPTION	SPT Blows/ft	Ring Blows/ft	% Passing No. 200	Plasticity Index
		Brown, lean CLAY(CL), Moist				
	5	*Moisture increases to wet*			94.2	11
	10	*Gray-tan, Poorly graded SAND(SP-SM) with silt and gravel*				
		Brown, lean CLAY(CL), very moist				
	15	*(Bottom of boring at 15 feet)*				
	20					
	25					

Boring Stopped at 15 Feet below Existing Grade

Groundwater	Initial Depth	Hour	24 Hour Depth
	None		

NOTE: THE ABOVE DATA FOR DESIGN PURPOSES ONLY.

BULLARD WASH - MAIN CHANNEL
Goodyear, Arizona

ATL Job No. 196020-3

Boring No.: 12

Boring Location: *100' Right Station 106+00*

Boring Equipment: *Mobile B-50 with 6 - Inch diameter hollow stem auger*

Date of Boring: *9-30-97* **Elevation of Boring:** *941.0*

Driller: *J. Cowell* **Logger:** *J. Cowell* **Reviewed By:** *A. Osorio*

Graphical Log	Depth (Feet)	SOIL DESCRIPTION	SPT Blows/ft	Ring Blows/ft	% Passing No. 200	Plasticity Index
		Brown, lean CLAY(CL), Moist				
		Tan, clayey SAND(SC), Moist *Weak to moderate cementation*			*41.9*	*15*
	5					
		Cementation increase to strong to moderate				
	10	*Brown, silty CLAY(CL-ML) with sand, very moist*				
	15	*(Bottom of boring at 15 feet)*				
	20					
	25					

Boring Stopped at 15 Feet below Existing Grade	Groundwater	Initial Depth	Hour	24 Hour Depth
		None		

NOTE: THE ABOVE DATA FOR DESIGN PURPOSES ONLY.

BULLARD WASH - MAIN CHANNEL
Goodyear, Arizona

ATL Job No. 196020-3

Boring No.:13

Boring Location: *Centerline right Sta 101+00*

Boring Equipment: *Mobile B-50 with 6 - Inch diameter hollow stem auger*

Date of Boring: *9-30-97* **Elevation of Boring:** *942.8*

Driller: *J. Cowell* **Logger:** *J. Cowell* **Reviewed By:** *A. Osorio*

Graphical Log	Depth (Feet)	SOIL DESCRIPTION	SPT Blows/ft	Ring Blows/ft	% Passing No. 200	Plasticity Index
		Brown, lean CLAY (CL) with sand, Moist				
		Light brown, sandy lean CLAY(CL)			52.2	15
		Strong cemented strata				
	5	*Moderate to strong cementation*				
		Cementation increase to strong to moderate				
	10	*Brown, silty CLAY(CL-ML) with sand, Moist*				
	15	*(Bottom of boring at 15 feet)*				
	20					
	25					

Boring Stopped at 15 Feet below Existing Grade

Groundwater	Initial Depth	Hour	24 Hour Depth
	None		

NOTE: THE ABOVE DATA FOR DESIGN PURPOSES ONLY.

BULLARD WASH - MAIN CHANNEL
Goodyear, Arizona

ATL Job No. 196020-3

Boring No.:14

Boring Location: *Channel centerline, Station 91+90*

Boring Equipment: *Mobile B-50 with 6 - Inch diameter hollow stem auger*

Date of Boring: *9-25-97* **Elevation of Boring:** *944.1*

Driller: *J. Cowell* **Logger:** *J. Cowell* **Reviewed By:** *A. Osorio*

Graphical Log	Depth (Feet)	SOIL DESCRIPTION	SPT Blows/ft	Ring Blows/ft	% Passing No. 200	Plasticity Index
		Brown, lean CLAY(CL) with sand, damp			*77.0*	*12*
	5					
		Brown, sandy SILT(ML), damp with nodules of strong cementation				
	10	*- Moisture increases to moist*				
	15	*(Bottom of boring at 15 feet)*				
	20					
	25					

Boring Stopped at 15 Feet below Existing Grade

Groundwater	Initial Depth	Hour	24 Hour Depth
	None		

NOTE: THE ABOVE DATA FOR DESIGN PURPOSES ONLY.

BULLARD WASH - MAIN CHANNEL
Goodyear, Arizona

ATL Job No. 196020-3

Boring No.:15

Location: *Channel centerline, Station 86+40*

Boring Equipment; *Mobile B-50 with 6 - Inch diameter hollow stem auger*

Date of Boring: *9-25-97* **Elevation of Boring:** *941.5*

Driller: *J. Cowell* **Logger:** *J. Cowell* **Reviewed By:** *A. Osorio*

Graphical Log	Depth (Feet)	SOIL DESCRIPTION	SPT Blows/ft	Ring Blows/ft	% Passing No. 200	Plasticity Index
		Brown, sandy SILT(ML) with nodules and strong cementation, damp (Fill)				
		Brown, silty SAND(SM) with fine gravel, nodules of strong cementation, damp			33.1	NP
	5					
	10	*Increases in nodules percent and size to 1"*				
	15	*(Bottom of boring at 15 feet)*				
	20					
	25					

Boring Stopped at 15 Feet below Existing Grade

Groundwater	Initial Depth	Hour	24 Hour Depth
	None		

NOTE: THE ABOVE DATA FOR DESIGN PURPOSES ONLY.

BULLARD WASH - MAIN CHANNEL
Goodyear, Arizona

ATL Job No. 196020-3

Boring No.: 16

Boring Location: *Channel centerline, Station 82+50*

Boring Equipment: *Mobile B-50 with 6 - Inch diameter hollow stem auger*

Date of Boring: *9-25-97* **Elevation of Boring:** *942.50*

Driller: *J. Cowell* **Logger:** *J. Cowell* **Reviewed By:** *A. Osorio*

Graphical Log	Depth (Feet)	SOIL DESCRIPTION	SPT Blows/ft	Ring Blows/ft	% Passing No. 200	Plasticity Index
		Brown, lean CLAY(CL) with sand, damp				
		(Bottom of Fill at 4 feet)				
	5	*Brown, sandy SILT(ML), with nodules of strong cementation, damp*			63.6	7
	10	*Brown, lean CLAY(CL) with sand, damp*				
	15	*(Bottom of boring at 15 feet)*				
	20					
	25					

Boring Stopped at 15 Feet below Existing Grade

Groundwater	Initial Depth	Hour	24 Hour Depth
	None		

NOTE: THE ABOVE DATA FOR DESIGN PURPOSES ONLY.

BULLARD WASH - MAIN CHANNEL
Goodyear, Arizona

ATL Job No. 196020-3

Boring No.: 17

Boring Location: *Channel centerline, Station 78+50*

Boring Equipment: *Mobile B-50 with 6 - Inch diameter hollow stem auger*

Date of Boring: *9-25-97* **Elevation of Boring:** *936.5*

Driller: *J. Cowell* **Logger:** *J. Cowell* **Reviewed By:** *A. Osorio*

Graphical Log	Depth (Feet)	SOIL DESCRIPTION	SPT Blows/ft	Ring Blows/ft	% Passing No. 200	Plasticity Index
		Brown, silty CLAY(CL-ML) with sand, damp			*71.8*	*5*
	5					
		(Bottom of fill at 8 feet)				
		Brown, silty SAND(SM) with trace of gravel				
		Brown, lean CLAY(CL) with sand, damp				
	10					
	15	*(Bottom of boring at 15 feet)*				
	20					
	25					

Boring Stopped at 15 Feet below Existing Grade

Groundwater	Initial Depth	Hour	24 Hour Depth
	None		

NOTE: THE ABOVE DATA FOR DESIGN PURPOSES ONLY.

BULLARD WASH - MAIN CHANNEL
Goodyear, Arizona

ATL Job No. 196020-3

Boring No.:18

Boring Location: *Channel centerline, Station 63+35*

Boring Equipment: *Mobile B-50 with 6 - Inch diameter hollow stem auger*

Date of Boring: *9-22-97* **Elevation of Boring:** *918.5*

Driller: *J. Cowell* **Logger:** *J. Cowell* **Reviewed By:** *A. Osorio*

Graphical Log	Depth (Feet)	SOIL DESCRIPTION	SPT Blows/ft	Ring Blows/ft	% Passing No. 200	Plasticity Index
		Brown, SILT(ML) with sand, Moist			*74.1*	*3*
	5					
		Brown, silty CLAY(CL-ML) with sand, Moist				
	10					
		Brown, sandy SILT(ML) with nodule of strong cementation, Moist				
		Brown, silty CLAY(CL-ML) with sand, Moist				
	15	*(Bottom of boring at 15 feet)*				
	20					
	25					

Boring Stopped at 15 Feet below Existing Grade

Groundwater	Initial Depth	Hour	24 Hour Depth
	None		

NOTE: THE ABOVE DATA FOR DESIGN PURPOSES ONLY.

BULLARD WASH - MAIN CHANNEL
Goodyear, Arizona

ATL Job No. 196020-3

Boring No.:19

Boring Location: *Channel centerline, Station 50+14*

Boring Equipment: *Mobile B-50 with 6 - Inch diameter hollow stem auger*

Date of Boring: *9-22-97* **Elevation of Boring:** *915.0*

Driller: *J. Cowell* **Logger:** *J. Cowell* **Reviewed By:** *A. Osorio*

Graphical Log	Depth (Feet)	SOIL DESCRIPTION	SPT Blows/ft	Ring Blows/ft	% Passing No. 200	Plasticity Index
		Brown, SILT(ML) with sand, Moist			79.7	3
	5					
	10					
		Brown, silty SAND(SM), Moist with nodules of strong cementation, Moist				
	15	*(Bottom of boring at 15 feet)*				
	20					
	25					

Boring Stopped at 15 Feet below Existing Grade

Groundwater	Initial Depth	Hour	24 Hour Depth
	None		

NOTE: THE ABOVE DATA FOR DESIGN PURPOSES ONLY.

BULLARD WASH - MAIN CHANNEL
Goodyear, Arizona

ATL Job No. 196020-3

Boring No.:20

Boring Location: *Channel centerline, Station 36+71*

Boring Equipment: *Mobile B-50 with 6 - Inch diameter hollow stem auger*

Date of Boring: *9-22-97* **Elevation of Boring:** *912.5*

Driller: *J. Cowell* **Logger:** *J. Cowell* **Reviewed By:** *A. Osorio*

Graphical Log	Depth (Feet)	SOIL DESCRIPTION	SPT Blows/ft	Ring Blows/ft	% Passing No. 200	Plasticity Index
		Brown, silty CLAY(CL-ML), Moist				
	5					
		Brown, SILT(ML) with sand, very moist			83.0	6
	10					
	15	*(Bottom of boring at 15 feet)*				
	20					
	25					

Boring Stopped at 15 Feet below Existing Grade

Groundwater	Initial Depth	Hour	24 Hour Depth
	None		

NOTE: THE ABOVE DATA FOR DESIGN PURPOSES ONLY.

BULLARD WASH - MAIN CHANNEL
Goodyear, Arizona

ATL Job No. 196020-3

Boring No.:21

Boring Location: *10 feet left centerline, Sta 25+60*

Boring Equipment: *Mobile B-50 with 6 - Inch diameter hollow stem auger*

Date of Boring: *9-30-97* **Elevation of Boring:** *909.8*

Driller: *J. Cowell* **Logger:** *J. Cowell* **Reviewed By:** *A. Osorio*

Graphical Log	Depth (Feet)	SOIL DESCRIPTION	SPT Blows/ft	Ring Blows/ft	% Passing No. 200	Plasticity Index
		Brown, SILT(ML), Moist			*86.9*	*5*
	5					
	10					
		Gray-Tan, Poorly graded SAND(SP-SM) with silt and gravel				
	15	*(Bottom of boring at 15 feet)*				
	20					
	25					

Boring Stopped at 15 Feet below Existing Grade

Groundwater	Initial Depth	Hour	24 Hour Depth
	None		

NOTE: THE ABOVE DATA FOR DESIGN PURPOSES ONLY.

BULLARD WASH - MAIN CHANNEL
Goodyear, Arizona

ATL Job No. 196020-3

Boring No.:22

Boring Location: *Centerline at Station 20+10*

Boring Equipment: *Hand dug*

Date of Boring: *9-30-97* **Elevation of Boring:** *902.0*

Driller: *J. Cowell* **Logger:** *J. Cowell* **Reviewed By:** *A. Osorio*

Graphical Log	Depth (Feet)	SOIL DESCRIPTION	SPT Blows/ft	Ring Blows/ft	% Passing No. 200	Plasticity Index
		Brown, SILT(ML), damp				
	5	*Gray, Poorly graded SAND(SP-SM) with silt and gravel*			6.6	NP
		(Bottom of boring at 6 feet)				
	10					
	15					
	20					
	25					

Boring Stopped at 6 Feet below Existing Grade	Groundwater	Initial Depth	Hour	24 Hour Depth
		None		

NOTE: THE ABOVE DATA FOR DESIGN PURPOSES ONLY.

BULLARD WASH - EAST TRIBUTARY CHANNEL

Goodyear, Arizona

ATL Job No. 196020-3

Boring No.:23

Boring Location: *5 feet Right Channel centerline at Station 35+00*

Boring Equipment: *Mobile B-50 with 6" diameter hollow stem auger*

Date of Boring: *9-25-97* **Elevation of Boring:** *Existing*

Driller: *J. Cowell* **Logger:** *J. Cowell* **Reviewed By:** *A. Osorio*

Graphical Log	Depth (Feet)	SOIL DESCRIPTION	SPT Blows/ft	Ring Blows/ft	% Passing No. 200	Plasticity Index
		Brown, SILT(ML), damp				
	5	*Brown, sandy, silty CLAY(CL-ML), Moist*			68.7	4
	10					
		Gray-tan, gravelly SAND(SP), Moist				
		Brown, SILT(ML), Moist				
	15	*(Bottom of boring at 15 feet)*				
	20					
	25					

Boring Stopped at 15 Feet below Existing Grade

Groundwater	Initial Depth	Hour	24 Hour Depth
	None		

NOTE: THE ABOVE DATA FOR DESIGN PURPOSES ONLY.

BULLARD WASH - EAST TRIBUTARY CHANNEL

Goodyear, Arizona

ATL Job No. 196020-3

Boring No.:24

Boring Location: *Channel centerline - Station 30+00 (35 feet North of South airport fence)*

Boring Equipment: *Mobile B-50 with 6" diameter hollow stem auger*

Date of Boring: 9-29-97 **Elevation of Boring:** *Existing*

Driller: *J. Cowell* **Logger:** *J. Cowell* **Reviewed By:** *A. Osorio*

Graphical Log	Depth (Feet)	SOIL DESCRIPTION	SPT Blows/ft	Ring Blows/ft	% Passing No. 200	Plasticity Index
		Light brown, sandy lean CLAY(CL), damp weak cementation			54.4	9
	5					
		Gray-tan, SILT(ML) with gravel, damp with cementation, hard, 9' - 10'				
	10					
	15	*(Bottom of boring at 15 feet)*				
	20					
	25					

Boring Stopped at 15 Feet below Existing Grade	Groundwater	Initial Depth	Hour	24 Hour Depth
		None		

NOTE: THE ABOVE DATA FOR DESIGN PURPOSES ONLY.

BULLARD WASH - EAST TRIBUTARY CHANNEL

Goodyear, Arizona

ATL Job No. 196020-3

Boring No.: 25

Boring Location: *Channel centerline - Station 25+00 (35 feet North of South airport fence)*

Boring Equipment: *Mobile B-50 with 6" diameter hollow stem auger*

Date of Boring: *9-25-97* **Elevation of Boring:** *934.0*

Driller: *J. Cowell* **Logger:** *J. Cowell* **Reviewed By:** *A. Osorio*

Graphical Log	Depth (Feet)	SOIL DESCRIPTION	SPT Blows/ft	Ring Blows/ft	% Passing No. 200	Plasticity Index
		Light brown, sandy SILT(ML), damp weak cementation with nodules of strong cementation				
	5					
		Gray-tan, SILT(ML) with gravel, damp			10.0	NP
	10					
	15	*(Bottom of boring at 15 feet)*				
	20					
	25					

Boring Stopped at 15 Feet below Existing Grade

Groundwater	Initial Depth	Hour	24 Hour Depth
	None		

NOTE: THE ABOVE DATA FOR DESIGN PURPOSES ONLY.

BULLARD WASH - EAST TRIBUTARY CHANNEL

Goodyear, Arizona

ATL Job No. 196020-3

Boring No.:26

Boring Location: *Channel centerline - Station 20+00 (35 feet North of South airport fence)*

Boring Equipment: *Mobile B-50 with 6" diameter hollow stem auger*

Date of Boring: *9-25-97* **Elevation of Boring:** *931.0*

Driller: *J. Cowell* **Logger:** *J. Cowell* **Reviewed By:** *A. Osorio*

Graphical Log	Depth (Feet)	SOIL DESCRIPTION	SPT Blows/ft	Ring Blows/ft	% Passing No. 200	Plasticity Index
		Brown, silty SAND(SM), with gravel with nodules of strong cementation			43.7	3
	5					
	10	*Gray-tan, gravelly SAND(SP), Moist*				
	15	*(Bottom of boring at 15 feet)*				
	20					
	25					

Boring Stopped at 15 Feet below Existing Grade

Groundwater	Initial Depth	Hour	24 Hour Depth
	None		

NOTE: THE ABOVE DATA FOR DESIGN PURPOSES ONLY.

BULLARD WASH - EAST TRIBUTARY CHANNEL

Goodyear, Arizona

ATL Job No. 196020-3

Boring No.:27

Boring Location: *Channel centerline - Station 15+00 (35 feet North of airport fence)*

Boring Equipment: *Mobile B-50 with 6" diameter hollow stem auger*

Date of Boring: *9-25-97* **Elevation of Boring:** *924.5*

Driller: *J. Cowell* **Logger:** *J. Cowell* **Reviewed By:** *A. Osorio*

Graphical Log	Depth (Feet)	SOIL DESCRIPTION	SPT Blows/ft	Ring Blows/ft	% Passing No. 200	Plasticity Index
		Brown, sandy SILT(ML), damp			*54.0*	*1*
	5					
		Moisture increases to moist				
	10					
		Brown, silty SAND(SM) with trace of gravel				
	15	*(Bottom of boring at 15 feet)*				
	20					
	25					

Boring Stopped at 15 Feet below Existing Grade

Groundwater	Initial Depth	Hour	24 Hour Depth
	None		

NOTE: THE ABOVE DATA FOR DESIGN PURPOSES ONLY.

BULLARD WASH - MAIN CHANNEL
Goodyear, Arizona

ATL Job No. 196020-3

Boring No.:28

ring Location: *40 feet Right (East) , Channel Station 77+70*

Boring Equipment: *Mobile B-50 with 6" diameter hollow stem auger*

Date of Boring: *9-25-97* Elevation of Boring: *937.2*

Driller: *J. Cowell* Logger: *J. Cowell* Reviewed By: *A. Osorio*

Graphical Log	Depth (Feet)	SOIL DESCRIPTION	SPT Blows/ft	Ring Blows/ft	% Passing No. 200	Plasticity Index
		Light brown, silty CLAY(CL-ML), damp with broken asphaltic concrete from 0 to 3 ft				
		Light brown, silty CLAY(CL-ML), damp				
	5					
	10	*(Bottom of fill at 10 feet)*				
		Light brown, silty CLAY(CL-ML), moist				
	15					
		Gray-tan, Poorly graded SAND(SP-SM) with silt and gravel				
	20					
		(Bottom of boring at 22 feet)				
	25					

Boring Stopped at 22 Feet below Existing Grade

Groundwater	Initial Depth	Hour	24 Hour Depth
	None		

NOTE: THE ABOVE DATA FOR DESIGN PURPOSES ONLY.

BULLARD WASH - MAIN CHANNEL
Goodyear, Arizona

ATL Job No. 196020-3

Boring No.:29

ing Location: *40 feet Right (East) , Channel Station 78+20*

Boring Equipment: *Mobile B-50 with 6" diameter hollow stem auger*

Date of Boring: *10/14/97* **Elevation of Boring:** *938.0*

Driller: *J. Cowell* **Logger:** *J. Cowell* **Reviewed By:** *A. Osorio*

Graphical Log	Depth (Feet)	SOIL DESCRIPTION	SPT Blows/ft	Ring Blows/ft	% Passing No. 200	Plasticity Index
		Light brown, silty CLAY(CL-ML), damp				
		Light brown, silty CLAY(CL-ML), with gravel and small pieces of broken concrete from 2' to 5' below grade				
	5	*(Bottom of fill at 6 feet)*				
		Light brown, silty SAND(SM), with nodules of strong cementation				
	10					
	15	*(Bottom of boring at 15 feet)*				
	20					
	25					

Boring Stopped at 15 Feet below Existing Grade

Groundwater	Initial Depth	Hour	24 Hour Depth
	None		

NOTE: THE ABOVE DATA FOR DESIGN PURPOSES ONLY.

BULLARD WASH - MAIN CHANNEL
Goodyear, Arizona

ATL Job No. 196020-3

Boring No.:30

ng Location: *10 feet Left(west) of Channel Station 77+95*

Boring Equipment: *Mobile B-50 with 6" diameter hollow stem auger*

Date of Boring: *10/14/97* **Elevation of Boring:** *937.2*

Driller: *J. Cowell* **Logger:** *J. Cowell* **Reviewed By:** *A. Osorio*

Graphical Log	Depth (Feet)	SOIL DESCRIPTION	SPT Blows/ft	Ring Blows/ft	% Passing No. 200	Plasticity Index
		Light brown, silty CLAY(CL-ML) with sand, damp				
		Light brown, silty CLAY(CL-ML), damp with broken asphaltic concrete from 1' to 3 ½' below grade				
	5					
		(Bottom of fill at 9 feet)				
		Light brown, silty CLAY(CL-ML) with sand, damp				
	10	*Increase in moisture to moist*				
	15	*(Bottom of boring at 15 feet)*				
	20					
	25					

Boring Stopped at 15 Feet below Existing Grade

Groundwater	Initial Depth	Hour	24 Hour Depth
	None		

NOTE: THE ABOVE DATA FOR DESIGN PURPOSES ONLY.

A30

BULLARD WASH - MAIN CHANNEL
Goodyear, Arizona

ATL Job No. 196020-3

Boring No.: 31

ng Location: *Channel centerline Station 79+20*

Boring Equipment: *Mobile B-50 with 6" diameter hollow stem auger*

Date of Boring: *10/14/97* **Elevation of Boring:** *937.0*

Driller: *J. Cowell* **Logger:** *J. Cowell* **Reviewed By:** *A. Osorio*

Graphical Log	Depth (Feet)	SOIL DESCRIPTION	SPT Blows/ft	Ring Blows/ft	% Passing No. 200	Plasticity Index
		Light brown, silty CLAY(CL-ML), damp				
		Light brown, silty CLAY(CL-ML) with gravel and black plastic sheeting from 1' to 3 ½' below grade				
	5	*(Bottom of fill at 6 feet)*				
		Light brown, silty SAND(SM), Moist				
	10					
	15	*(Bottom of boring at 15 feet)*				
	20					
	25					

Boring Stopped at 15 Feet below Existing Grade

Groundwater	Initial Depth	Hour	24 Hour Depth
	None		

NOTE: THE ABOVE DATA FOR DESIGN PURPOSES ONLY.

BULLARD WASH - MAIN CHANNEL
Goodyear, Arizona

ATL Job No. 196020-3

Boring No.: 32

ing Location: *50 feet East centerline of Station 79+20*

Boring Equipment: *Mobile B-50 with 6" diameter hollow stem auger*

Date of Boring: *10/14/97* **Elevation of Boring:** *937.5*

Driller: *J. Cowell* **Logger:** *J. Cowell* **Reviewed By:** *A. Osorio*

Graphical Log	Depth (Feet)	SOIL DESCRIPTION	SPT Blows/ft	Ring Blows/ft	% Passing No. 200	Plasticity Index
		Light brown, silty CLAY(CL-ML), damp				
		Light brown, silty CLAY(CL-ML) with broken concrete from 1' to 3 ½' below grade				
		(Bottom of fill at 3½ feet)				
		Light brown, silty CLAY(CL-ML), damp				
	5					
	10					
	15	*(Bottom of boring at 15 feet)*				
	20					
	25					

Boring Stopped at 15 Feet below Existing Grade

Groundwater	Initial Depth	Hour	24 Hour Depth
	None		

NOTE: THE ABOVE DATA FOR DESIGN PURPOSES ONLY.

BULLARD WASH - MAIN CHANNEL
Goodyear, Arizona

ATL Job No. 196020-3

Boring No.: 33

Boring Location: *Channel centerline at Station 80+00*

Boring Equipment: *Mobile B-50 with 6" diameter hollow stem auger*

Date of Boring: *10/14/97* **Elevation of Boring:** *938.00*

Driller: *J. Cowell* **Logger:** *J. Cowell* **Reviewed By:** *A. Osorio*

Graphical Log	Depth (Feet)	SOIL DESCRIPTION	SPT Blows/ft	Ring Blows/ft	% Passing No. 200	Plasticity Index
		Light brown, silty CLAY(CL-ML), damp				
		Light brown, silty CLAY(CL-ML) with broken concrete and piece of electrical wire from 2' to 6' below grade				
	5	*(Bottom of fill at 6 feet)*				
		Light brown, silty CLAY(CL-ML), moist				
	10					
	15	*(Bottom of boring at 15 feet)*				
	20					
	25					

Boring Stopped at 15 Feet below Existing Grade

Groundwater	Initial Depth	Hour	24 Hour Depth
	None		

NOTE: THE ABOVE DATA FOR DESIGN PURPOSES ONLY.

BULLARD WASH - MAIN CHANNEL
Goodyear, Arizona

ATL Job No. 196020-3

Boring No.: 34

Boring Location: *50 feet East Channel centerline at Station 80+00*

Boring Equipment: *Mobile B-50 with 6" diameter hollow stem auger*

Date of Boring: *10/14/97* **Elevation of Boring:** *938.5*

Driller: *J. Cowell* **Logger:** *J. Cowell* **Reviewed By:** *A. Osorio*

Graphical Log	Depth (Feet)	SOIL DESCRIPTION	SPT Blows/ft	Ring Blows/ft	% Passing No. 200	Plasticity Index
		Light brown, silty CLAY(CL-ML), damp (Fill) with broken concrete and pieces of tire limbs from 0 to 6' below grade				
	5	*(Bottom of Fill at 6 feet)*				
		Light brown, silty CLAY(CL-ML), damp with trace 0f gravel				
	10					
	15	*(Bottom of boring at 15 feet)*				
	20					
	25					

Boring Stopped at 15 Feet below Existing Grade

Groundwater	Initial Depth	Hour	24 Hour Depth
	None		

NOTE: THE ABOVE DATA FOR DESIGN PURPOSES ONLY.

APPENDIX B

LABORATORY TEST RESULTS

SUMMARY OF LABORATORY ANALYSIS

CLIENT: SVERDRUP CIVIL, INC. DATE: 11/18/97

PROJECT: BULLARD WASH - CHANNEL

LOCATION: GOODYEAR, ARIZONA

MATERIAL: See Below SAMPLING DATE: 09/25/97

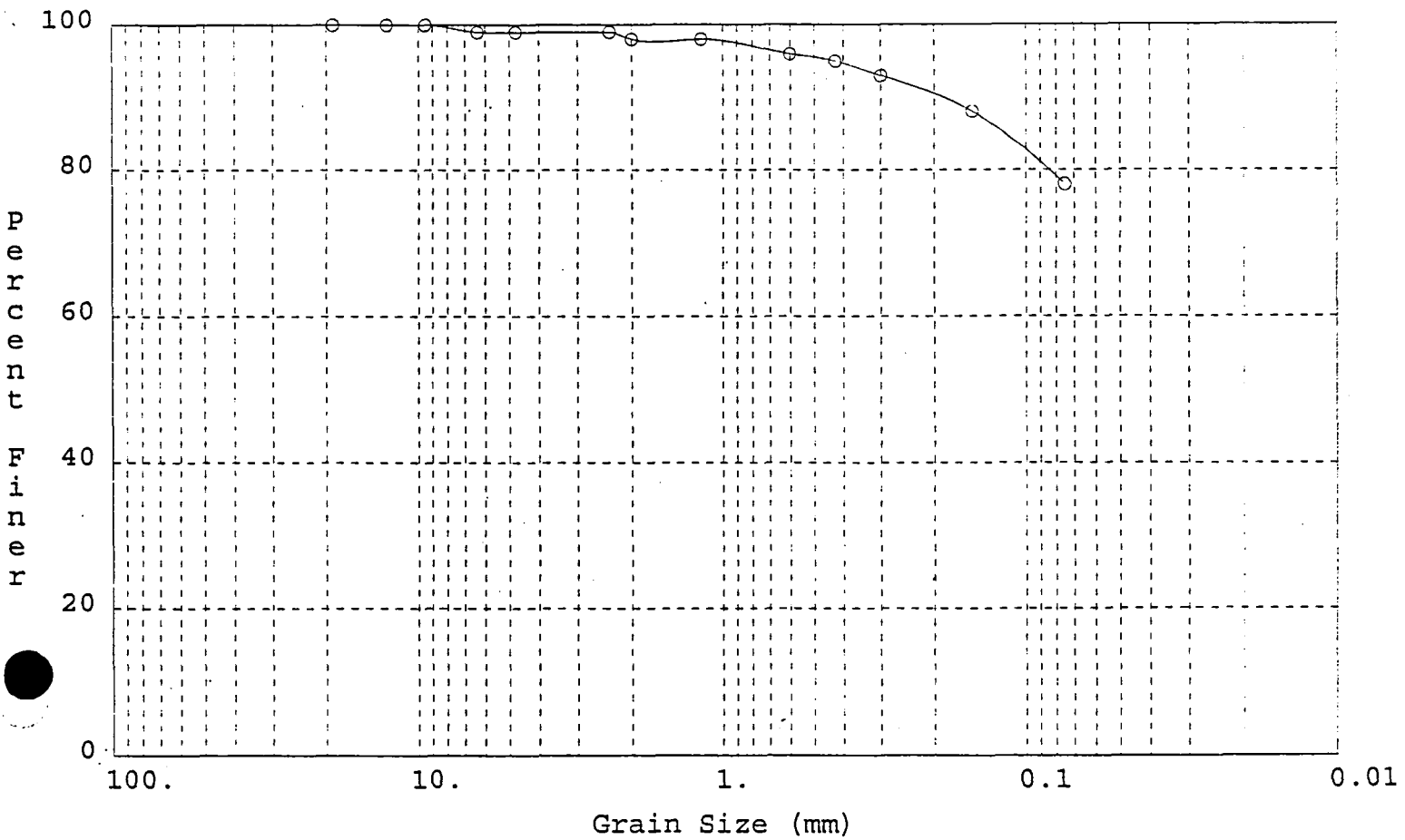
REQUESTED BY: David Hayes ATL JOB NO: 196020-3

BORING No.	DEPTH (FT)	MOIST (%)	USCS	LL	PI	SIEVE ANALYSIS - PERCENT PASSING											
						#200	100	50	40	30	16	10	4	3/8	3/4	1.5	2
9	3 - 9	6.3	CL - ML	28	7	78.3	88	93	95	96	98	98	99	100	-	-	-
10	0 - 11	12.2	CL - ML	24	5	74.6	88	95	96	97	98	99	99	100	-	-	-
11	5 - 10	2.2	CL	30	11	94.2	98	100	-	-	-	-	-	-	-	-	-
12	2 - 10	19.7	SC	40	15	41.9	49	54	56	59	65	72	81	89	96	100	-
13	2 ½ - 11	19.9	CL	38	15	52.2	61	66	69	71	76	82	87	94	98	100	-
14	0 - 8	7.2	CL	32	12	77.0	84	89	91	93	95	96	98	99	100	-	-
15	2 - 15	4.9	SM	-	NP	33.1	43	63	73	79	84	88	92	96	99	99	100
16	4 - 10	7.1	ML	31	7	63.6	77	85	88	91	93	95	98	100	-	-	-
17	0 - 8	10.2	CL - ML	26	5	71.8	80	85	88	90	92	93	95	97	99	100	-
18	0 - 6	10.0	ML	22	3	74.1	89	96	98	99	100	-	-	-	-	-	-
19	0 - 11	13.6	ML	25	3	79.7	94	98	99	99	100	-	-	-	-	-	-
20	8 - 15	24.4	ML	32	6	83.0	92	93	94	95	96	97	100	-	-	-	-
21	0 - 11 ½	10.5	ML	29	5	86.9	98	99	99	100	-	-	-	-	-	-	-
22	4 - 6	1.5	SP - SM	-	NP	6.6	11	38	62	76	84	88	90	92	96	100	-
23	3 - 11 ½	12.8	CL - ML	25	4	68.7	87	97	99	99	100	-	-	-	-	-	-
24	0 - 8	7.4	CL	29	9	54.4	66	77	82	86	90	92	95	99	100	-	-
25	6 - 15	3.1	ML	-	NP	10.0	12	16	19	24	32	40	52	63	71	94	100
26	0 - 10	5.7	SM	26	3	43.7	54	64	70	74	79	82	85	91	97	100	-
27	0 - 12 ½	4.9	ML	22	1	54.0	71	87	91	94	97	98	99	99	100	-	-

Project Number = 196020-3 Client: Sverdrup Civil , Inc.
Location = Bullard Wash, Channel
Date = 10/4/97
Tested By = D. Johnson
Boring Number = 9
Depth = 3' - 9'
Sample Number = 97-0794
Description = Brown, silty CLAY(CL-ML) with sand
Dry Sample Weight (g) = 1000

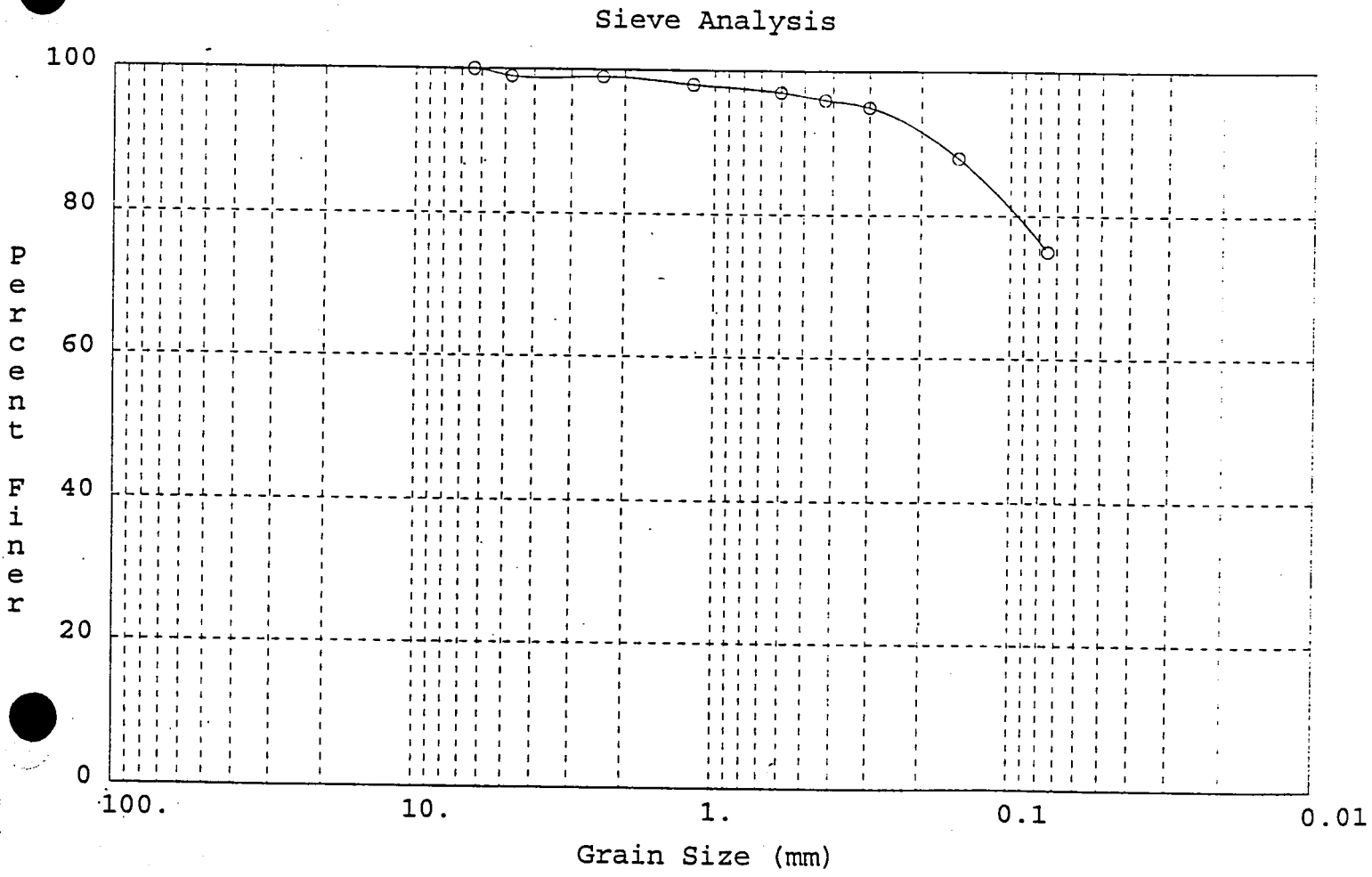
SIEVE NUMBER	SIEVE OPENING (mm)	RETAINED WEIGHT (g)	PERCENT OF WEIGHT RETAINED	CUMULATIVE PERCENT RETAINED	PERCENT FINER (%)
3/4"	19.050	0.00	0.00	0.00	100.00
1/2"	12.700	0.00	0.00	0.00	100.00
3/8"	9.500	0.00	0.00	0.00	100.00
1/4"	6.350	10.00	1.00	1.00	99.00
#4	4.750	0.00	0.00	1.00	99.00
#8	2.360	0.00	0.00	1.00	99.00
#10	2.000	10.00	1.00	2.00	98.00
#16	1.180	0.00	0.00	2.00	98.00
#30	0.600	20.00	2.00	4.00	96.00
#40	0.425	10.00	1.00	5.00	95.00
#50	0.300	20.00	2.00	7.00	93.00
#100	0.150	50.00	5.00	12.00	88.00
#200	0.075	100.00	10.00	22.00	78.00
Pan	0.000	0.00	0.00	22.00	78.00

Sieve Analysis



Project Number = 196020-3 Client: Sverdrup Civil , Inc.
Location = Bullard Wash, Channel
Date = 10/6/97
Tested By = D. Johnson
Boring Number = 10
Depth = 0 - 11'
Sample Number = 97-811
Description = Brown, Silty CLAY(CL-ML)
Dry Sample Weight (g) = 1000

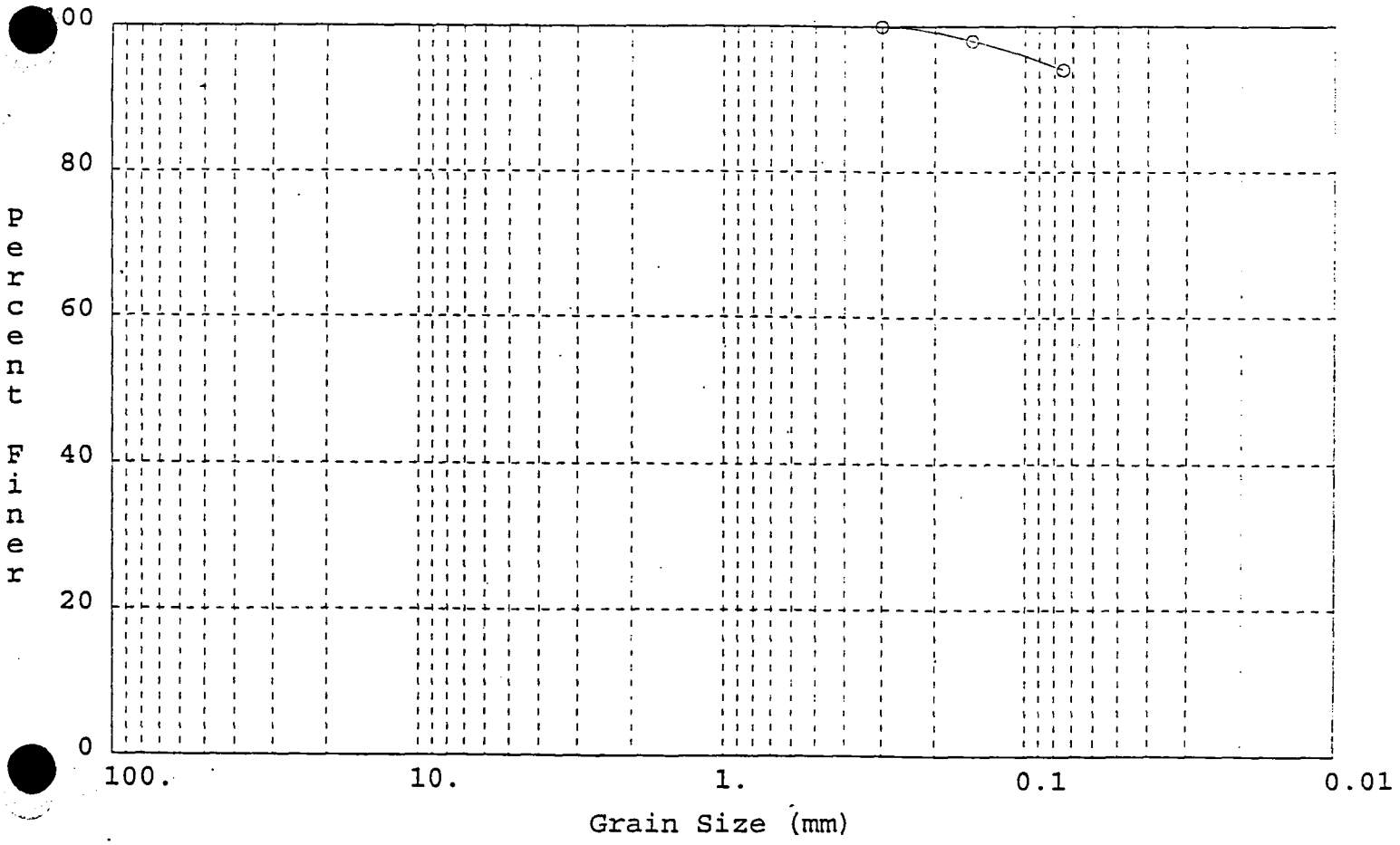
SIEVE NUMBER	SIEVE OPENING (mm)	RETAINED WEIGHT (g)	PERCENT OF WEIGHT RETAINED	CUMULATIVE PERCENT RETAINED	PERCENT FINER (%)
1/4"	6.350	0.00	0.00	0.00	100.00
#4	4.750	10.00	1.00	1.00	99.00
#8	2.360	0.00	0.00	1.00	99.00
#16	1.180	10.00	1.00	2.00	98.00
#30	0.600	10.00	1.00	3.00	97.00
#40	0.425	10.00	1.00	4.00	96.00
#50	0.300	10.00	1.00	5.00	95.00
#100	0.150	70.00	7.00	12.00	88.00
#200	0.075	130.00	13.00	25.00	75.00
Pan	0.000	0.00	0.00	25.00	75.00



Project Number = 196020-3 Client: Sverdrup Civil , Inc.
Location = Bullard Wash, Channel
Date = 10/9/97
Tested By = M. Blalock
Boring Number = 11
Depth = 5' - 10'
Sample Number = 97-0812
Description = Brown, lean CLAY(CL)
Dry Sample Weight (g) = 1000

SIEVE NUMBER	SIEVE OPENING (mm)	RETAINED WEIGHT (g)	PERCENT OF WEIGHT RETAINED	CUMULATIVE PERCENT RETAINED	PERCENT FINER (%)
#50	0.300	0.00	0.00	0.00	100.00
#100	0.150	20.00	2.00	2.00	98.00
#200	0.075	40.00	4.00	6.00	94.00
Pan	0.000	0.00	0.00	6.00	94.00

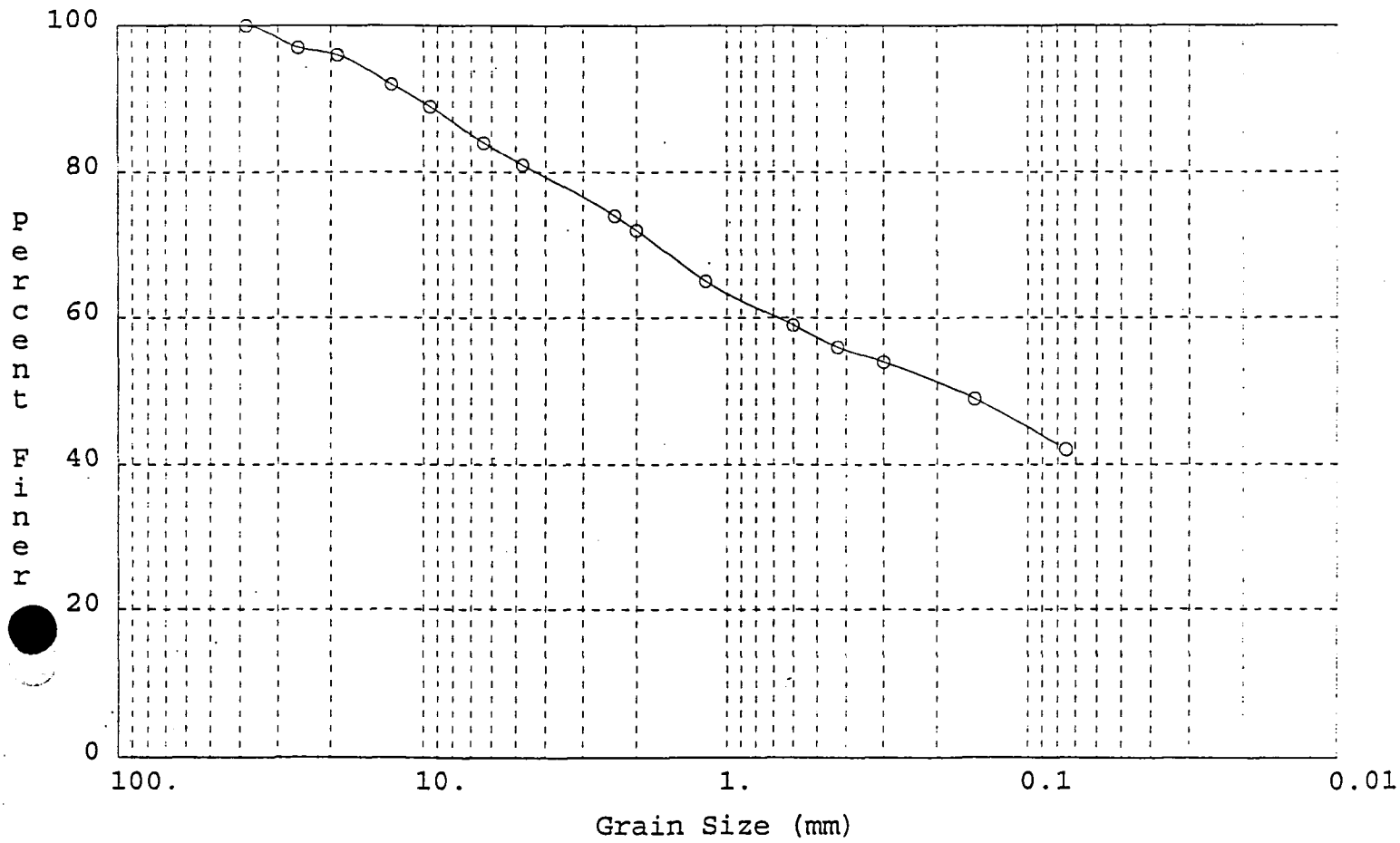
Sieve Analysis



Project Number = 196020-3 Client: Sverdrup Civil , Inc.
Location = Bullard Wash, Channel
Date = 10/4/97
Tested By = D. Johnson
Boring Number = 12
Depth = 2' - 10'
Sample Number = 97-0814
Description = Tan, Clayey SAND(SC)
Dry Sample Weight (g) = 1000

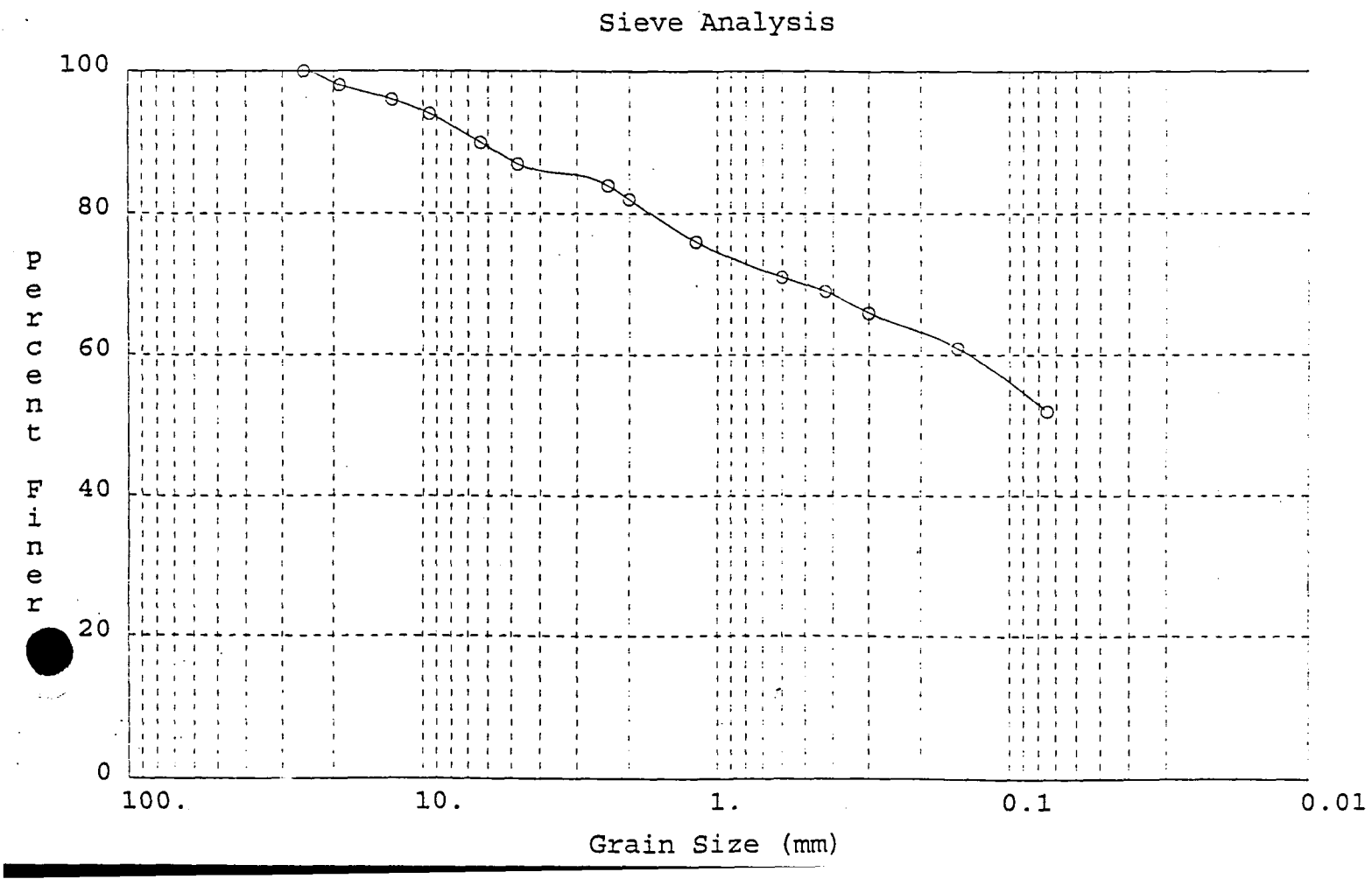
SIEVE NUMBER	SIEVE OPENING (mm)	RETAINED WEIGHT (g)	PERCENT OF WEIGHT RETAINED	CUMULATIVE PERCENT RETAINED	PERCENT FINER (%)
1 1/2"	38.100	0.00	0.00	0.00	100.00
1"	25.700	30.00	3.00	3.00	97.00
3/4"	19.050	10.00	1.00	4.00	96.00
1/2"	12.700	40.00	4.00	8.00	92.00
3/8"	9.500	30.00	3.00	11.00	89.00
1/4"	6.350	50.00	5.00	16.00	84.00
#4	4.750	30.00	3.00	19.00	81.00
#8	2.360	70.00	7.00	26.00	74.00
#10	2.000	20.00	2.00	28.00	72.00
#16	1.180	70.00	7.00	35.00	65.00
#30	0.600	60.00	6.00	41.00	59.00
#40	0.425	30.00	3.00	44.00	56.00
#50	0.300	20.00	2.00	46.00	54.00
#100	0.150	50.00	5.00	51.00	49.00
[illegible]0	0.075	70.00	7.00	58.00	42.00
[illegible]	0.000	0.00	0.00	58.00	42.00

Sieve Analysis



Project Number = 196020-3 Client: Sverdrup Civil , Inc.
Location = Bullard Wash, Channel
Date = 10/4/97
Tested By = D. Johnson
Boring Number = 13
Depth = 2 1/2' - 11'
Sample Number = 97-0815
Description = Light brown, Sandy lean CLAY(CL)
Dry Sample Weight (g) = 1000

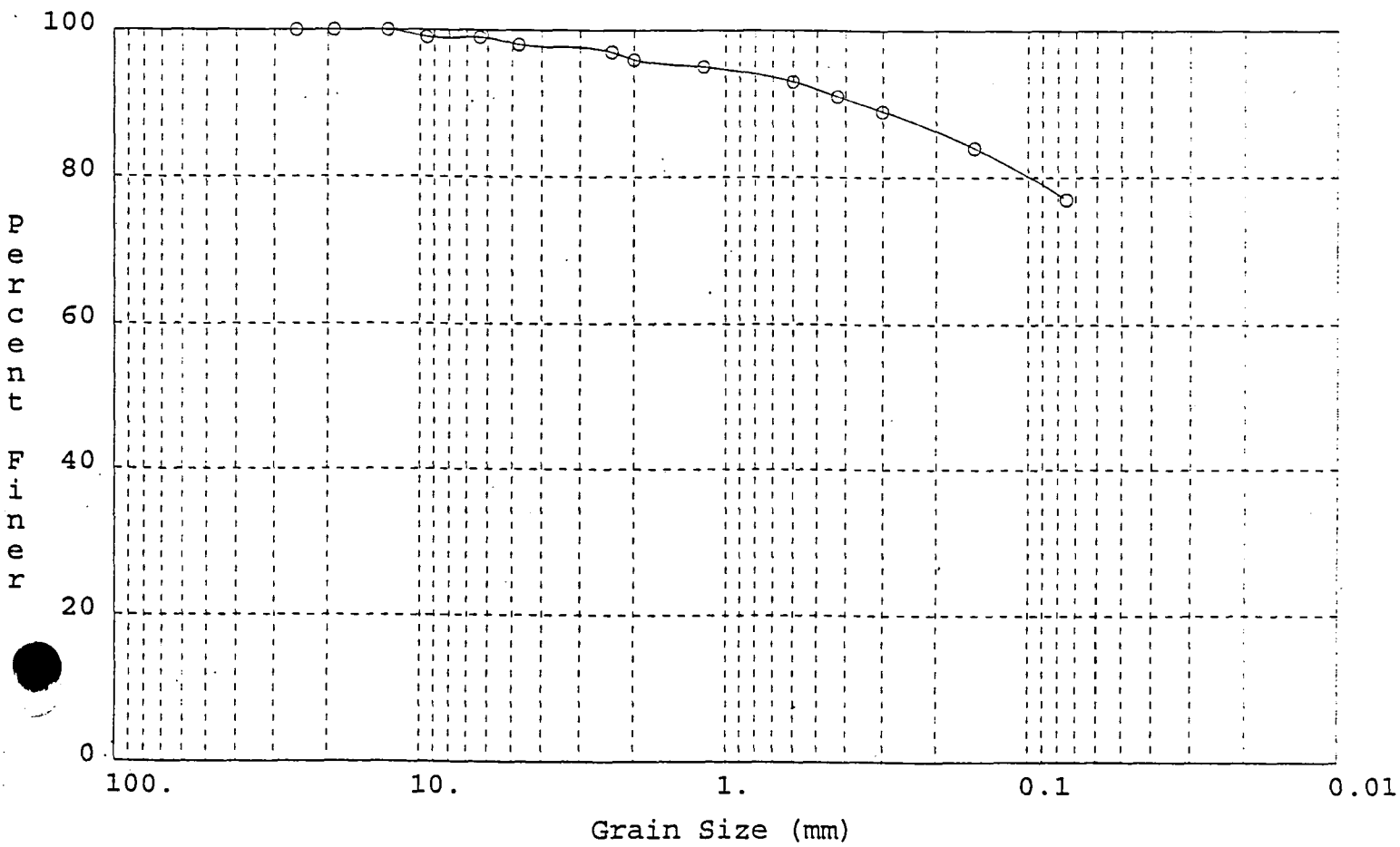
SIEVE NUMBER	SIEVE OPENING (mm)	RETAINED WEIGHT (g)	PERCENT OF WEIGHT RETAINED	CUMULATIVE PERCENT RETAINED	PERCENT FINER (%)
1"	25.400	0.00	0.00	0.00	100.00
3/4"	19.050	20.00	2.00	2.00	98.00
1/2"	12.700	20.00	2.00	4.00	96.00
3/8"	9.500	20.00	2.00	6.00	94.00
1/4"	6.350	40.00	4.00	10.00	90.00
#4	4.750	30.00	3.00	13.00	87.00
#8	2.360	30.00	3.00	16.00	84.00
#10	2.000	20.00	2.00	18.00	82.00
#16	1.180	60.00	6.00	24.00	76.00
#30	0.600	50.00	5.00	29.00	71.00
#40	0.425	20.00	2.00	31.00	69.00
#50	0.300	30.00	3.00	34.00	66.00
#100	0.150	50.00	5.00	39.00	61.00
#200	0.075	90.00	9.00	48.00	52.00
Pan	0.000	0.00	0.00	48.00	52.00



Project Number = 196020-3 Client: Sverdrup Civil , Inc.
Location = Bullard Wash, Channel
Date = 10/4/97
Tested By = D. Johnson
Boring Number = 14
Depth = 0' - 8'
Sample Number = 97-0795
Description = Brown, lean CLAY(CL) with sand
Dry Sample Weight (g) = 1000

SIEVE NUMBER	SIEVE OPENING (mm)	RETAINED WEIGHT (g)	PERCENT OF WEIGHT RETAINED	CUMULATIVE PERCENT RETAINED	PERCENT FINER (%)
1"	25.400	0.00	0.00	0.00	100.00
3/4"	19.050	0.00	0.00	0.00	100.00
1/2"	12.700	0.00	0.00	0.00	100.00
3/8"	9.500	10.00	1.00	1.00	99.00
1/4"	6.350	0.00	0.00	1.00	99.00
#4	4.750	10.00	1.00	2.00	98.00
#8	2.360	10.00	1.00	3.00	97.00
#10	2.000	10.00	1.00	4.00	96.00
#16	1.180	10.00	1.00	5.00	95.00
#30	0.600	20.00	2.00	7.00	93.00
#40	0.425	20.00	2.00	9.00	91.00
#50	0.300	20.00	2.00	11.00	89.00
#100	0.150	50.00	5.00	16.00	84.00
#200	0.075	70.00	7.00	23.00	77.00
Pan	0.000	0.00	0.00	23.00	77.00

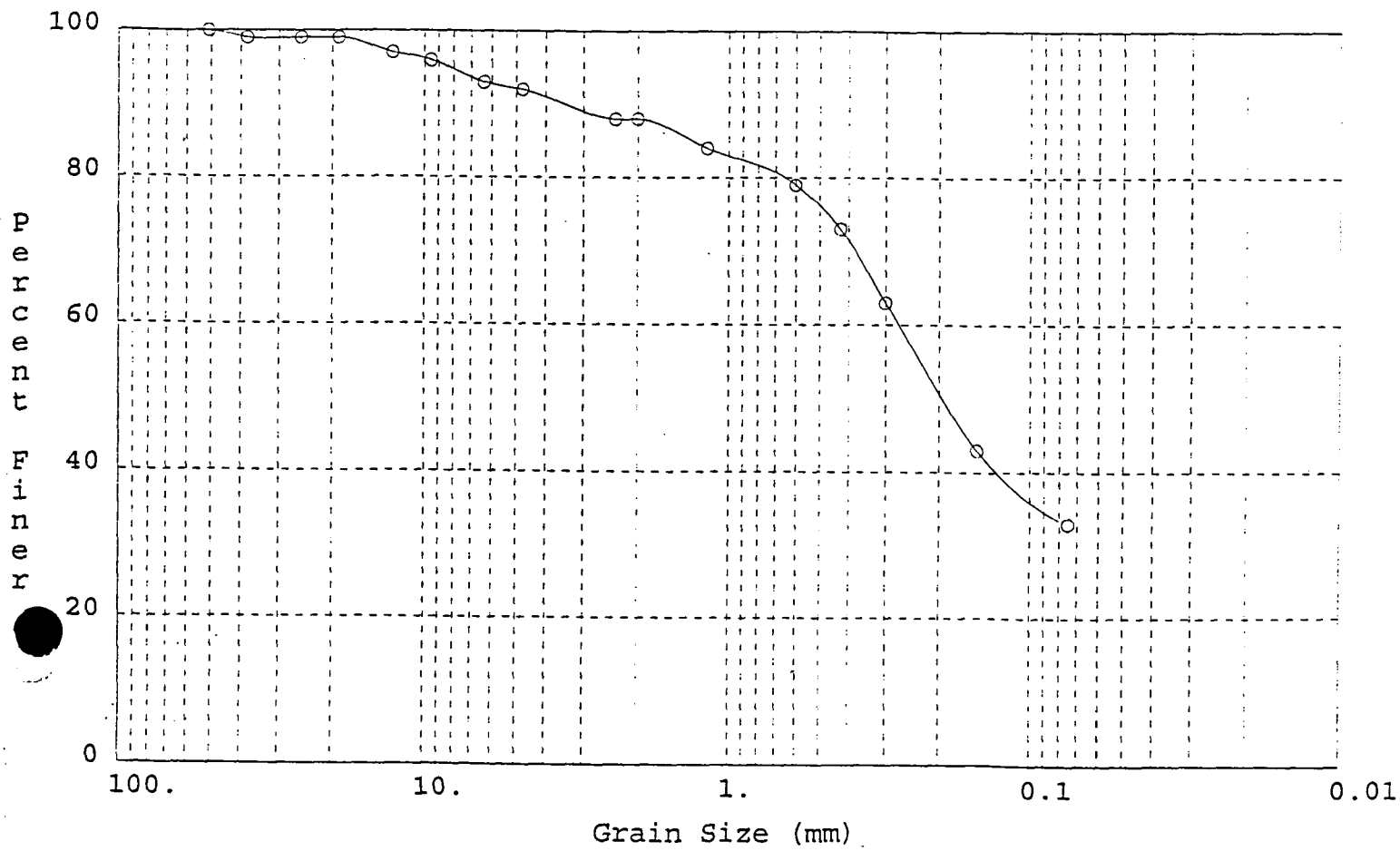
Sieve Analysis



Project Number = 196020-3 Client: Sverdrup Civil , Inc.
Location = Bullard Wash, Channel
Date = 10/1/97
Tested By = D. Johnson
Boring Number = 15
Depth = 2' - 15'
Sample Number = 97-0798
Description = Brown, silty SAND(SM)
Dry Sample Weight (g) = 1000

SIEVE NUMBER	SIEVE OPENING (mm)	RETAINED WEIGHT (g)	PERCENT OF WEIGHT RETAINED	CUMULATIVE PERCENT RETAINED	PERCENT FINER (%)
2"	50.800	0.00	0.00	0.00	100.00
1 1/2"	38.100	10.00	1.00	1.00	99.00
1"	25.400	0.00	0.00	1.00	99.00
3/4"	19.050	0.00	0.00	1.00	99.00
1/2"	12.700	20.00	2.00	3.00	97.00
3/8"	9.500	10.00	1.00	4.00	96.00
1/4"	6.350	30.00	3.00	7.00	93.00
#4	4.750	10.00	1.00	8.00	92.00
#8	2.360	40.00	4.00	12.00	88.00
#10	2.000	0.00	0.00	12.00	88.00
#16	1.180	40.00	4.00	16.00	84.00
#30	0.600	50.00	5.00	21.00	79.00
#40	0.425	60.00	6.00	27.00	73.00
#50	0.300	100.00	10.00	37.00	63.00
#100	0.150	200.00	20.00	57.00	43.00
#200	0.075	100.00	10.00	67.00	33.00
Pan	0.000	0.00	0.00	67.00	33.00

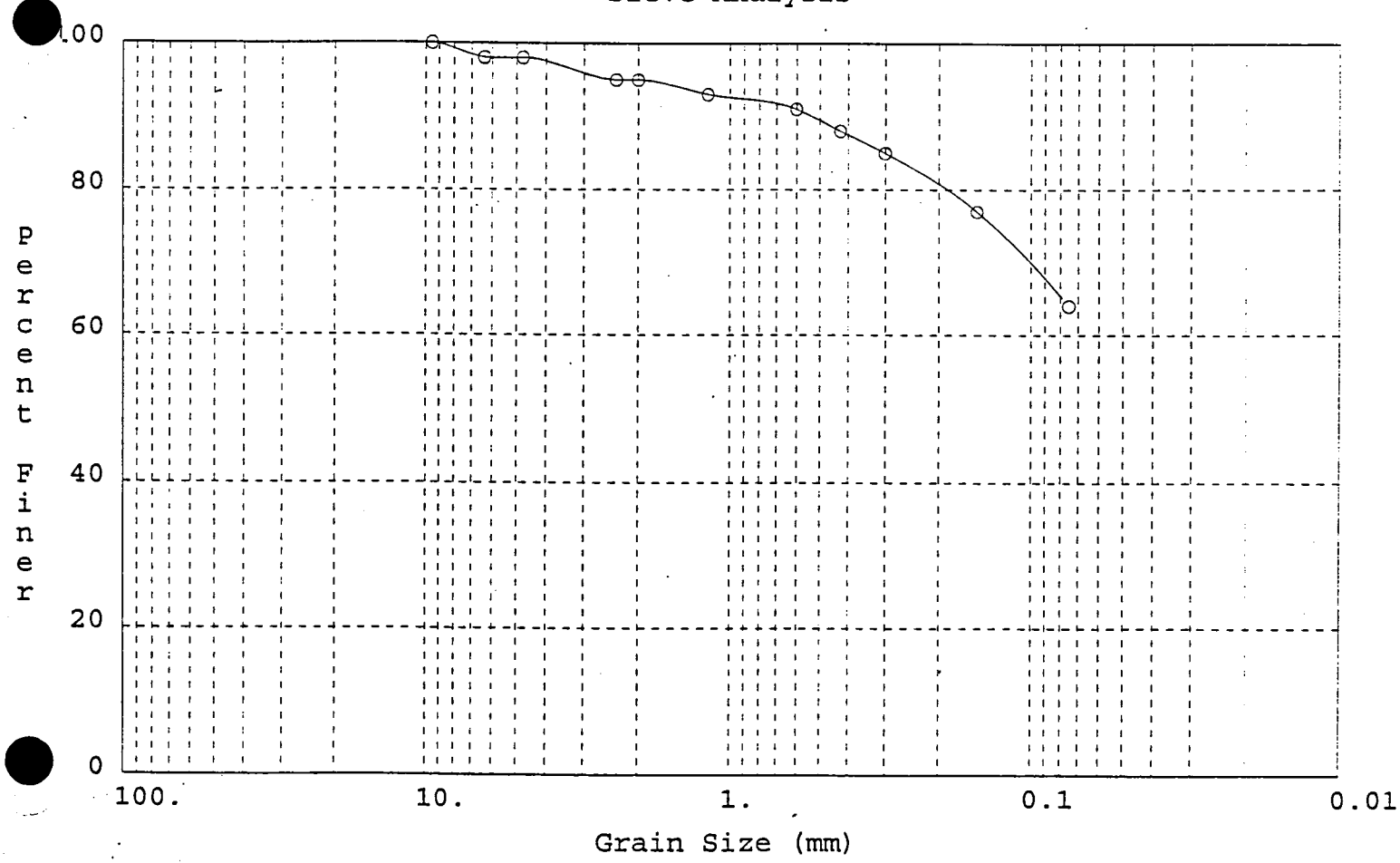
Sieve Analysis



Project Number = 196020-3 Client: Sverdrup Civil , Inc.
Location = Bullard Wash, Channel
Date = 10/1/97
Tested By = D. Johnson
Boring Number = 16
Depth = 4' - 10'
Sample Number = 97-0799
Description = Brown, sandy SILT(ML)
Dry Sample Weight (g) = 1000

SIEVE NUMBER	SIEVE OPENING (mm)	RETAINED WEIGHT (g)	PERCENT OF WEIGHT RETAINED	CUMULATIVE PERCENT RETAINED	PERCENT FINER (%)
3/8"	9.500	0.00	0.00	0.00	100.00
1/4"	6.350	20.00	2.00	2.00	98.00
#4	4.750	0.00	0.00	2.00	98.00
#8	2.360	30.00	3.00	5.00	95.00
#10	2.000	0.00	0.00	5.00	95.00
#16	1.180	20.00	2.00	7.00	93.00
#30	0.600	20.00	2.00	9.00	91.00
#40	0.425	30.00	3.00	12.00	88.00
#50	0.300	30.00	3.00	15.00	85.00
#100	0.150	80.00	8.00	23.00	77.00
#200	0.075	130.00	13.00	36.00	64.00
Pan	0.000	0.00	0.00	36.00	64.00

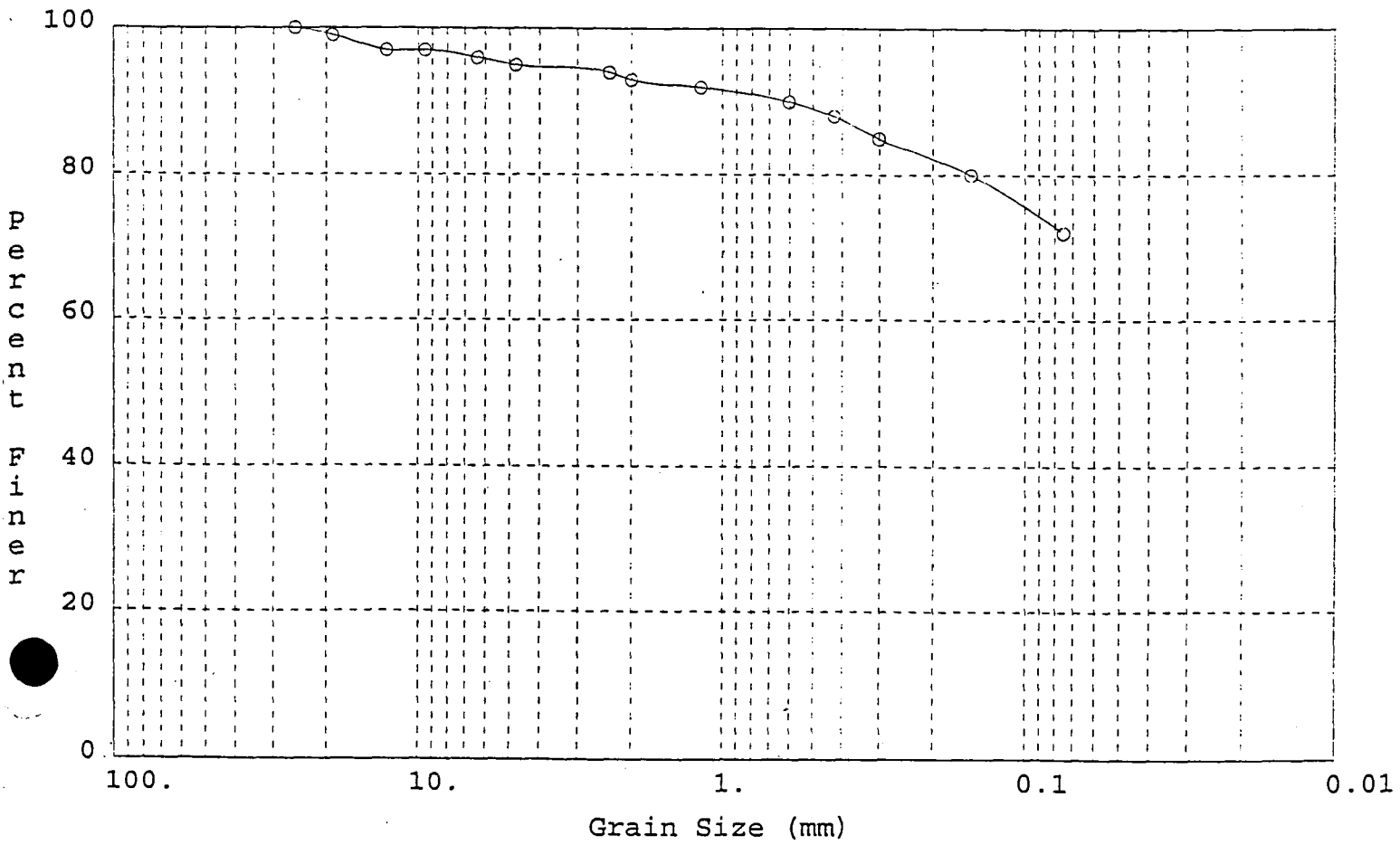
Sieve Analysis



Project Number = 196020-3 Client: Sverdrup Civil , Inc.
Location = Bullard Wash, Channel
Date = 10/1/97
Tested By = D. Johnson
Boring Number = 17
Depth = 0 - 8'
Sample Number = 97-0800
Description = Brown, silty CLAY(CL-ML) with sand
Dry Sample Weight (g) = 1000

SIEVE NUMBER	SIEVE OPENING (mm)	RETAINED WEIGHT (g)	PERCENT OF WEIGHT RETAINED	CUMULATIVE PERCENT RETAINED	PERCENT FINER (%)
1"	25.400	0.00	0.00	0.00	100.00
3/4"	19.050	10.00	1.00	1.00	99.00
1/2"	12.700	20.00	2.00	3.00	97.00
3/8"	9.500	0.00	0.00	3.00	97.00
1/4"	6.350	10.00	1.00	4.00	96.00
#4	4.750	10.00	1.00	5.00	95.00
#8	2.360	10.00	1.00	6.00	94.00
#10	2.000	10.00	1.00	7.00	93.00
#16	1.180	10.00	1.00	8.00	92.00
#30	0.600	20.00	2.00	10.00	90.00
#40	0.425	20.00	2.00	12.00	88.00
#50	0.300	30.00	3.00	15.00	85.00
#100	0.150	50.00	5.00	20.00	80.00
#200	0.075	80.00	8.00	28.00	72.00
[illegible]	0.000	0.00	0.00	28.00	72.00

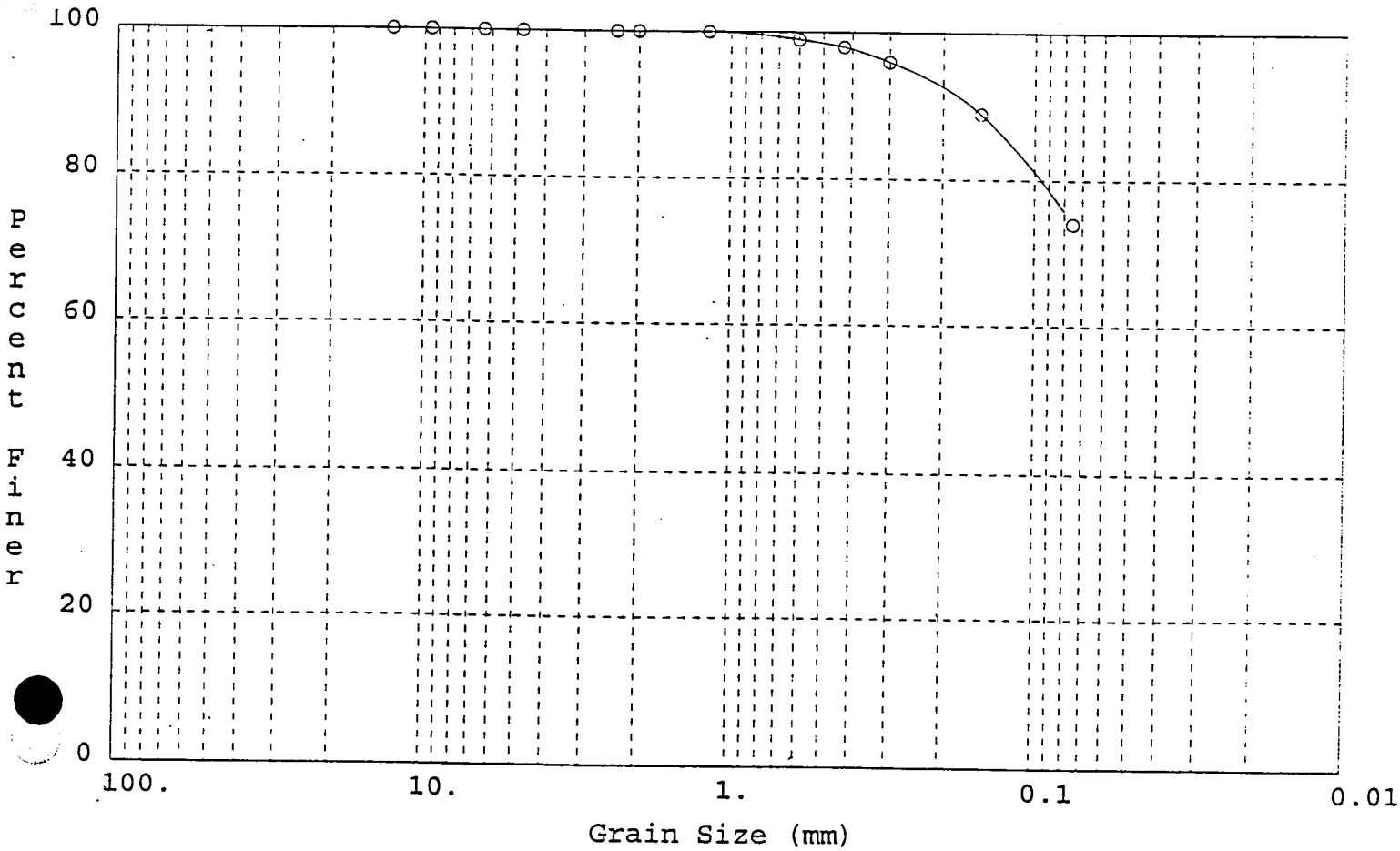
Sieve Analysis



Project Number = 196020-3 Client: Sverdrup Civil , Inc.
Location = Bullard Wash, Channel
Date = 9/29/97
Tested By = M. Blalock
Pooling Number = 18
Depth = 0 - 6'
Sample Number = 97-0778
Description = Brown, SILT(ML) with sand
Dry Sample Weight (g) = 1000

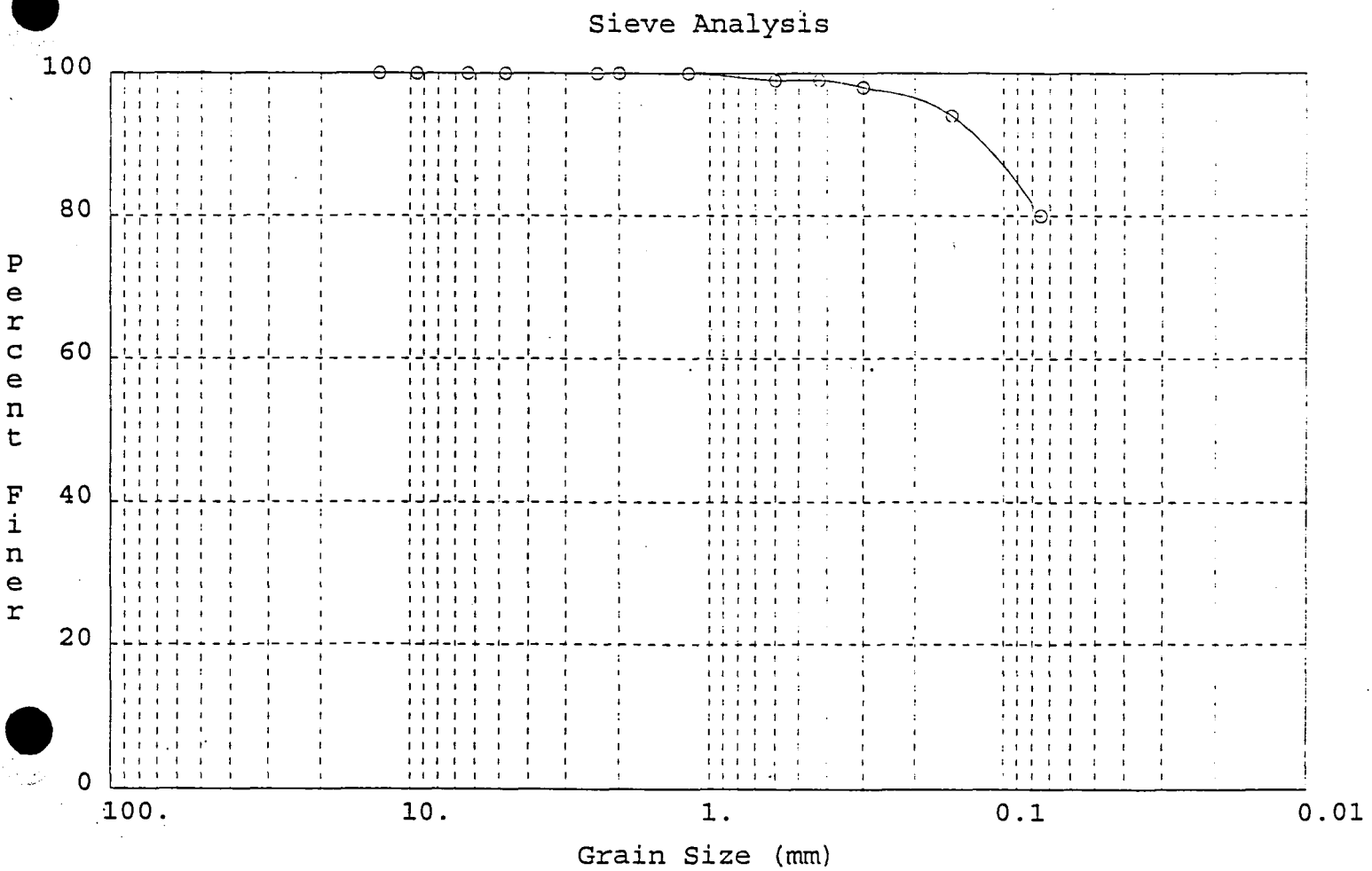
SIEVE NUMBER	SIEVE OPENING (mm)	RETAINED WEIGHT (g)	PERCENT OF WEIGHT RETAINED	CUMULATIVE PERCENT RETAINED	PERCENT FINER (%)
1/2"	12.700	0.00	0.00	0.00	100.00
3/8"	9.500	0.00	0.00	0.00	100.00
1/4"	6.350	0.00	0.00	0.00	100.00
#4	4.750	0.00	0.00	0.00	100.00
#8	2.360	0.00	0.00	0.00	100.00
#10	2.000	0.00	0.00	0.00	100.00
#16	1.180	0.00	0.00	0.00	100.00
#30	0.600	10.00	1.00	1.00	99.00
#40	0.425	10.00	1.00	2.00	98.00
#50	0.300	20.00	2.00	4.00	96.00
#100	0.150	70.00	7.00	11.00	89.00
#200	0.075	150.00	15.00	26.00	74.00
Pan	0.000	0.00	0.00	26.00	74.00

Sieve Analysis



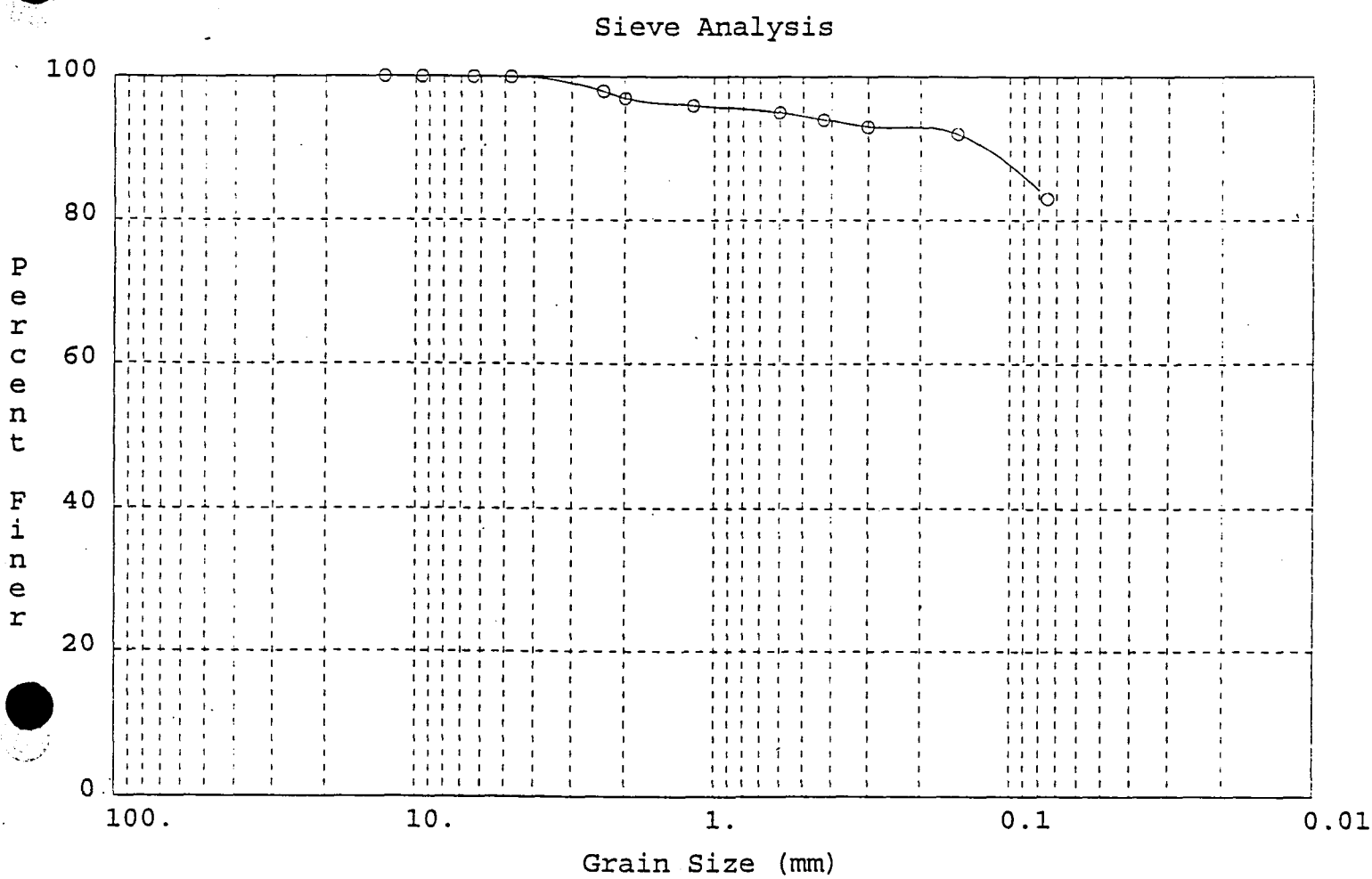
Project Number = 196020-3 Client: Sverdrup Civil , Inc.
Location = Bullard Wash, Channel
Date = 9/29/97
Tested By = M. Blalock
Boring Number = 19
Depth = 0 - 11'
Sample Number = 97-0779
Description = Brown, SILT(ML) with sand
Dry Sample Weight (g) = 1000

SIEVE NUMBER	SIEVE OPENING (mm)	RETAINED WEIGHT (g)	PERCENT OF WEIGHT RETAINED	CUMULATIVE PERCENT RETAINED	PERCENT FINER (%)
1/2"	12.700	0.00	0.00	0.00	100.00
3/8"	9.500	0.00	0.00	0.00	100.00
1/4"	6.350	0.00	0.00	0.00	100.00
#4	4.750	0.00	0.00	0.00	100.00
#8	2.360	0.00	0.00	0.00	100.00
#10	2.000	0.00	0.00	0.00	100.00
#16	1.180	0.00	0.00	0.00	100.00
#30	0.600	10.00	1.00	1.00	99.00
#40	0.425	0.00	0.00	1.00	99.00
#50	0.300	10.00	1.00	2.00	98.00
#100	0.150	40.00	4.00	6.00	94.00
#200	0.075	140.00	14.00	20.00	80.00
Pan	0.000	0.00	0.00	20.00	80.00



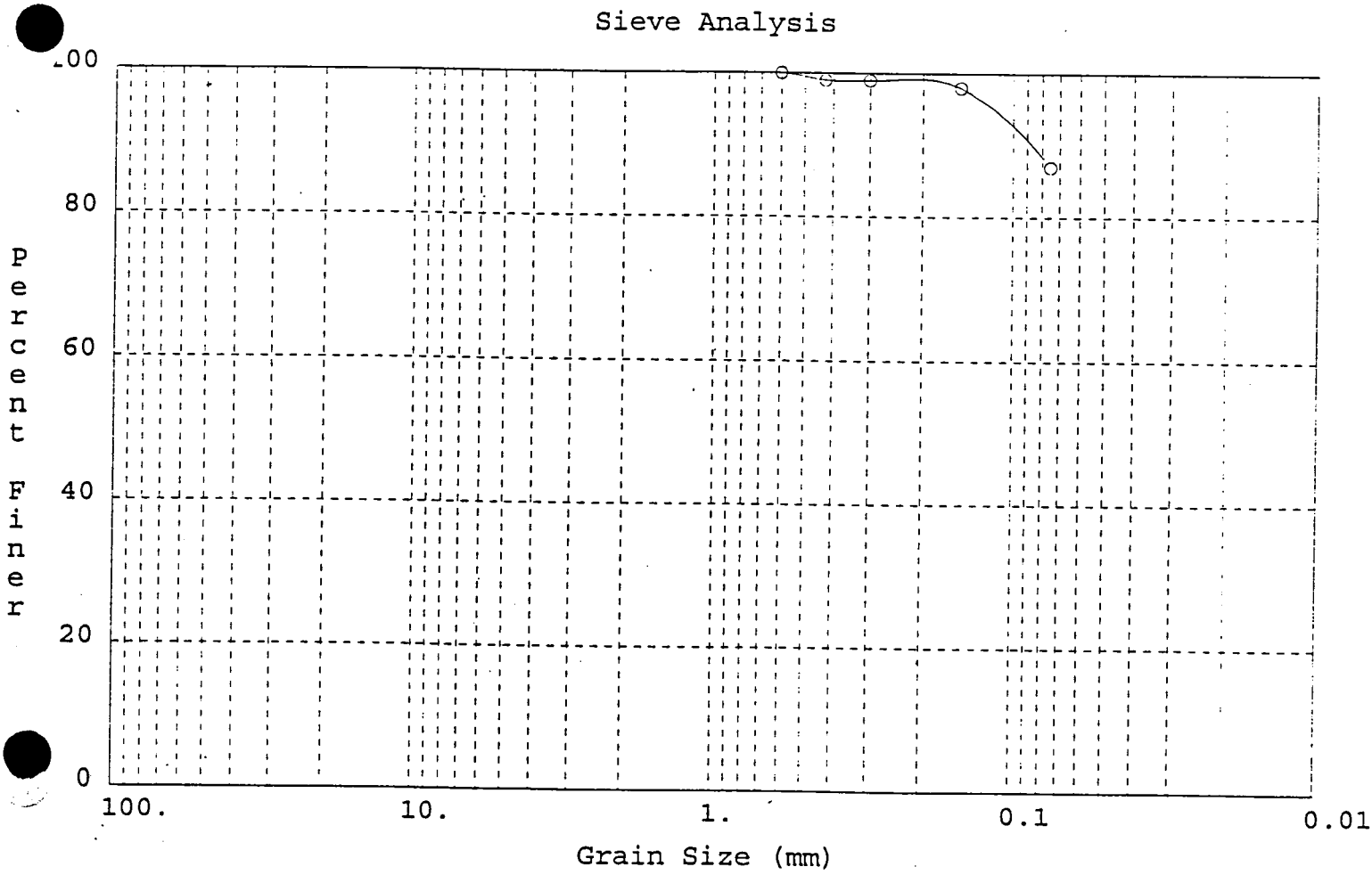
Project Number = 196020-3 Client: Sverdrup Civil , Inc.
Location = Bullard Wash, Channel
Date = 9/29/97
Tested By = M. Blalock
Boring Number = 20
Depth = 8' - 15'
Sample Number = 97-0780
Description = Brown, SILT(ML) with sand
Dry Sample Weight (g) = 1000

SIEVE NUMBER	SIEVE OPENING (mm)	RETAINED WEIGHT (g)	PERCENT OF WEIGHT RETAINED	CUMULATIVE PERCENT RETAINED	PERCENT FINER (%)
1/2"	12.700	0.00	0.00	0.00	100.00
3/8"	9.500	0.00	0.00	0.00	100.00
1/4"	6.350	0.00	0.00	0.00	100.00
#4	4.750	0.00	0.00	0.00	100.00
#8	2.360	20.00	2.00	2.00	98.00
#10	2.000	10.00	1.00	3.00	97.00
#16	1.180	10.00	1.00	4.00	96.00
#30	0.600	10.00	1.00	5.00	95.00
#40	0.425	10.00	1.00	6.00	94.00
#50	0.300	10.00	1.00	7.00	93.00
#100	0.150	10.00	1.00	8.00	92.00
#200	0.075	90.00	9.00	17.00	83.00
Pan	0.000	0.00	0.00	17.00	83.00



Project Number = 196020-1 Client: Sverdrup Civil , Inc.
Location = Bullard Wash, Channel
Date = 10/4/97
Tested By = D. Johnson
Boring Number = 21
Depth = 0 - 11 1/2'
Sample Number = 97-0816
Description = Brown, SILT (ML)
Dry Sample Weight (g) = 1000

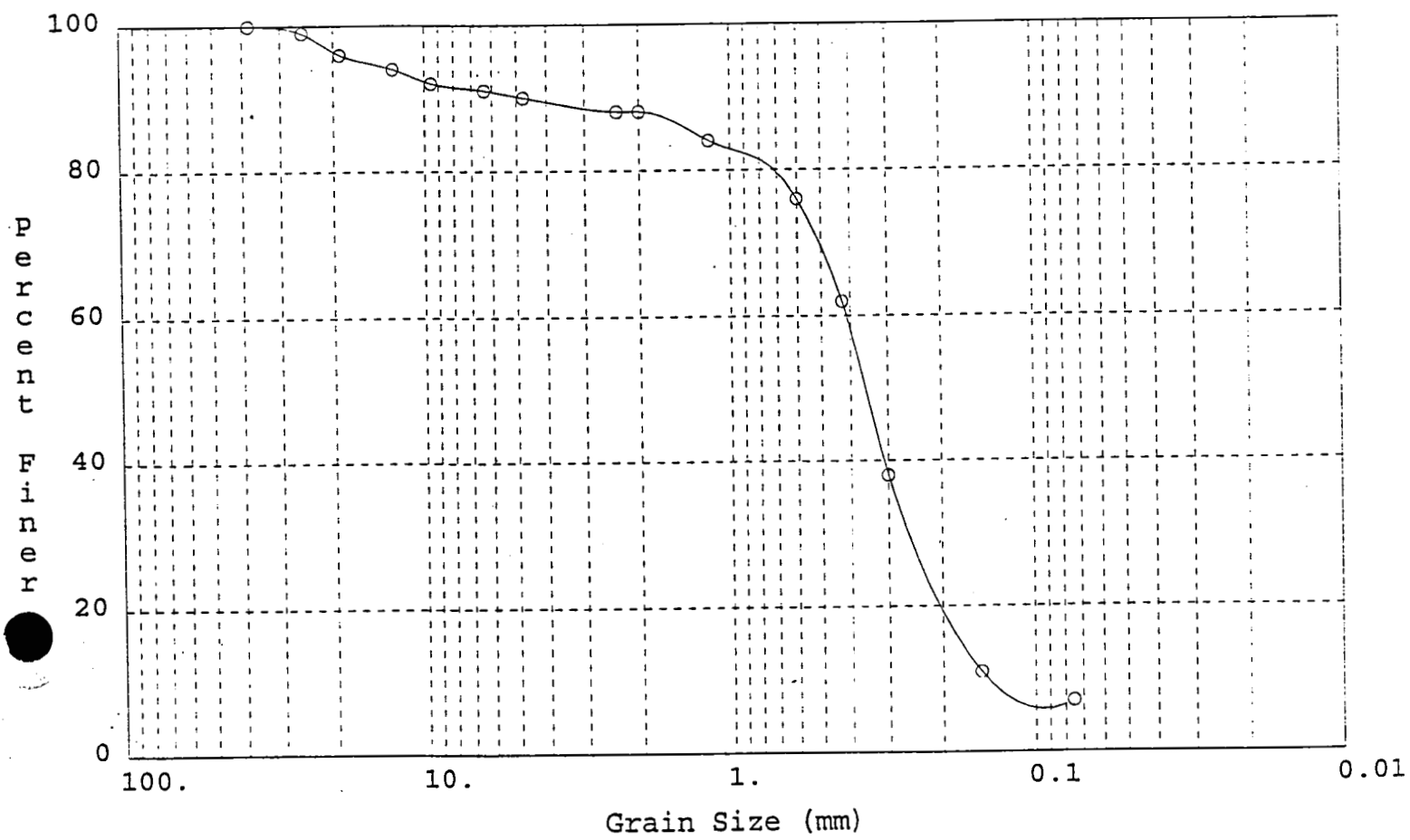
SIEVE NUMBER	SIEVE OPENING (mm)	RETAINED WEIGHT (g)	PERCENT OF WEIGHT RETAINED	CUMULATIVE PERCENT RETAINED	PERCENT FINER (%)
#30	0.600	0.00	0.00	0.00	100.00
#40	0.425	10.00	1.00	1.00	99.00
#50	0.300	0.00	0.00	1.00	99.00
#100	0.150	10.00	1.00	2.00	98.00
#200	0.075	110.00	11.00	13.00	87.00
Pan	0.000	0.00	0.00	13.00	87.00



Project Number = 196020-3 Client: Sverdrup Civil , Inc.
Location = Bullard Wash, Channel
Date = 10/4/97
Tested By = D. Johnson
Boring Number = 22
Depth = 4' - 6'
Sample Number = 97-0817
Description = Gray, Poorly graded SAND(SP-SM) with silt and gravel
Dry Sample Weight (g) = 1000

SIEVE NUMBER	SIEVE OPENING (mm)	RETAINED WEIGHT (g)	PERCENT OF WEIGHT RETAINED	CUMULATIVE PERCENT RETAINED	PERCENT FINER (%)
1 1/2"	38.100	0.00	0.00	0.00	100.00
1"	25.400	10.00	1.00	1.00	99.00
3/4"	19.050	30.00	3.00	4.00	96.00
1/2"	12.700	20.00	2.00	6.00	94.00
3/8"	9.500	20.00	2.00	8.00	92.00
1/4"	6.350	10.00	1.00	9.00	91.00
#4	4.750	10.00	1.00	10.00	90.00
#8	2.360	20.00	2.00	12.00	88.00
#10	2.000	0.00	0.00	12.00	88.00
#16	1.180	40.00	4.00	16.00	84.00
#30	0.600	80.00	8.00	24.00	76.00
#40	0.425	140.00	14.00	38.00	62.00
#50	0.300	240.00	24.00	62.00	38.00
#100	0.150	270.00	27.00	89.00	11.00
#200	0.075	40.00	4.00	93.00	7.00
Pan	0.000	0.00	0.00	93.00	7.00

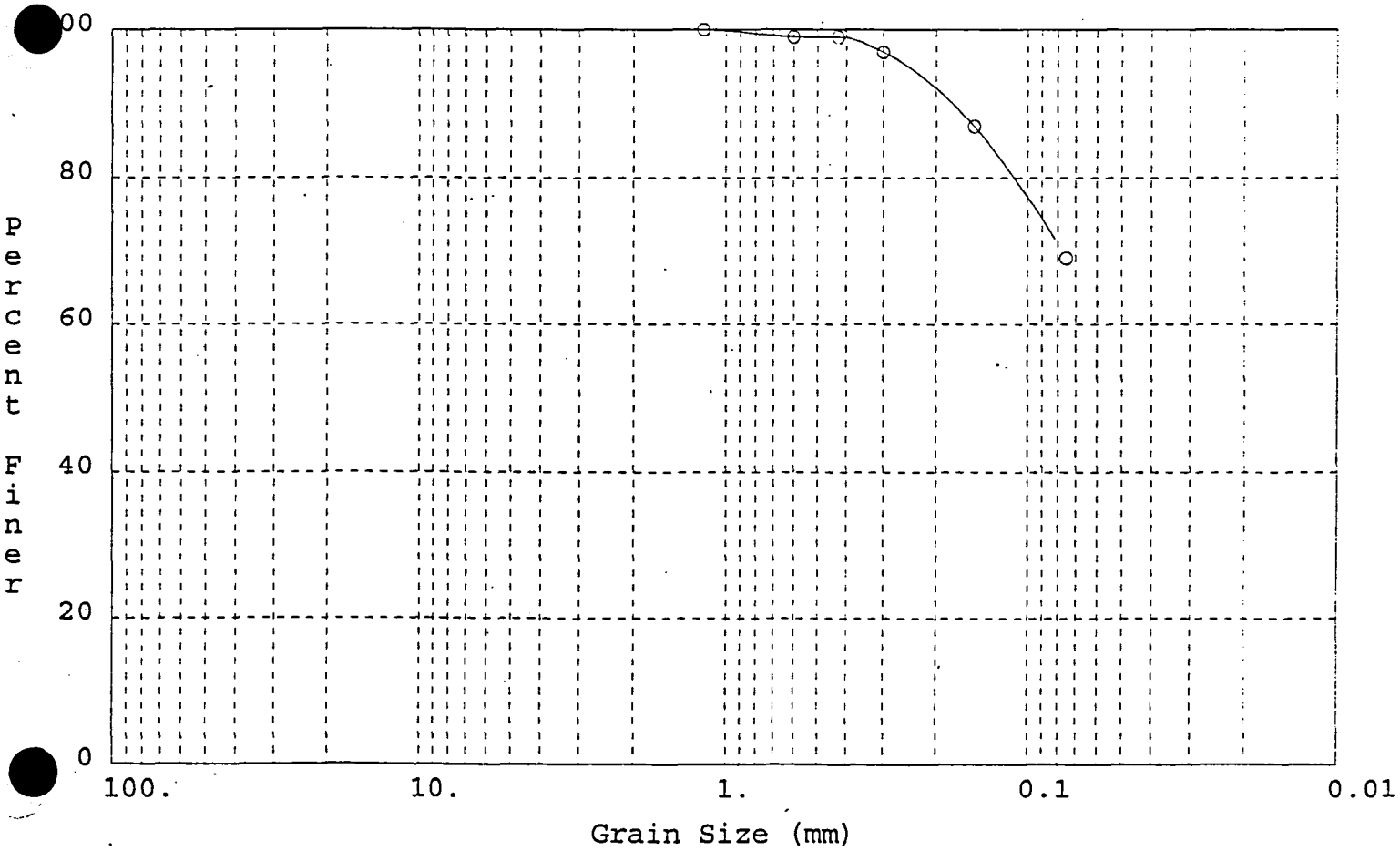
Sieve Analysis



Project Number = 196020-3 Client: Sverdrup Civil , Inc.
Location = Bullard Wash, East Tributary Channel
Date = 10/1/97
Tested By = D. Johnson
Trenching Number = 23
Depth = 3' - 11 1/2'
Sample Number = 97-0801
Description = Brown, sandy, silty CLAY(CL-ML)
Dry Sample Weight (g) = 1000

SIEVE NUMBER	SIEVE OPENING (mm)	RETAINED WEIGHT (g)	PERCENT OF WEIGHT RETAINED	CUMULATIVE PERCENT RETAINED	PERCENT FINER (%)
#16	1.180	0.00	0.00	0.00	100.00
#30	0.600	10.00	1.00	1.00	99.00
#40	0.425	0.00	0.00	1.00	99.00
#50	0.300	20.00	2.00	3.00	97.00
#100	0.150	100.00	10.00	13.00	87.00
#200	0.075	180.00	18.00	31.00	69.00
Pan	0.000	0.00	0.00	31.00	69.00

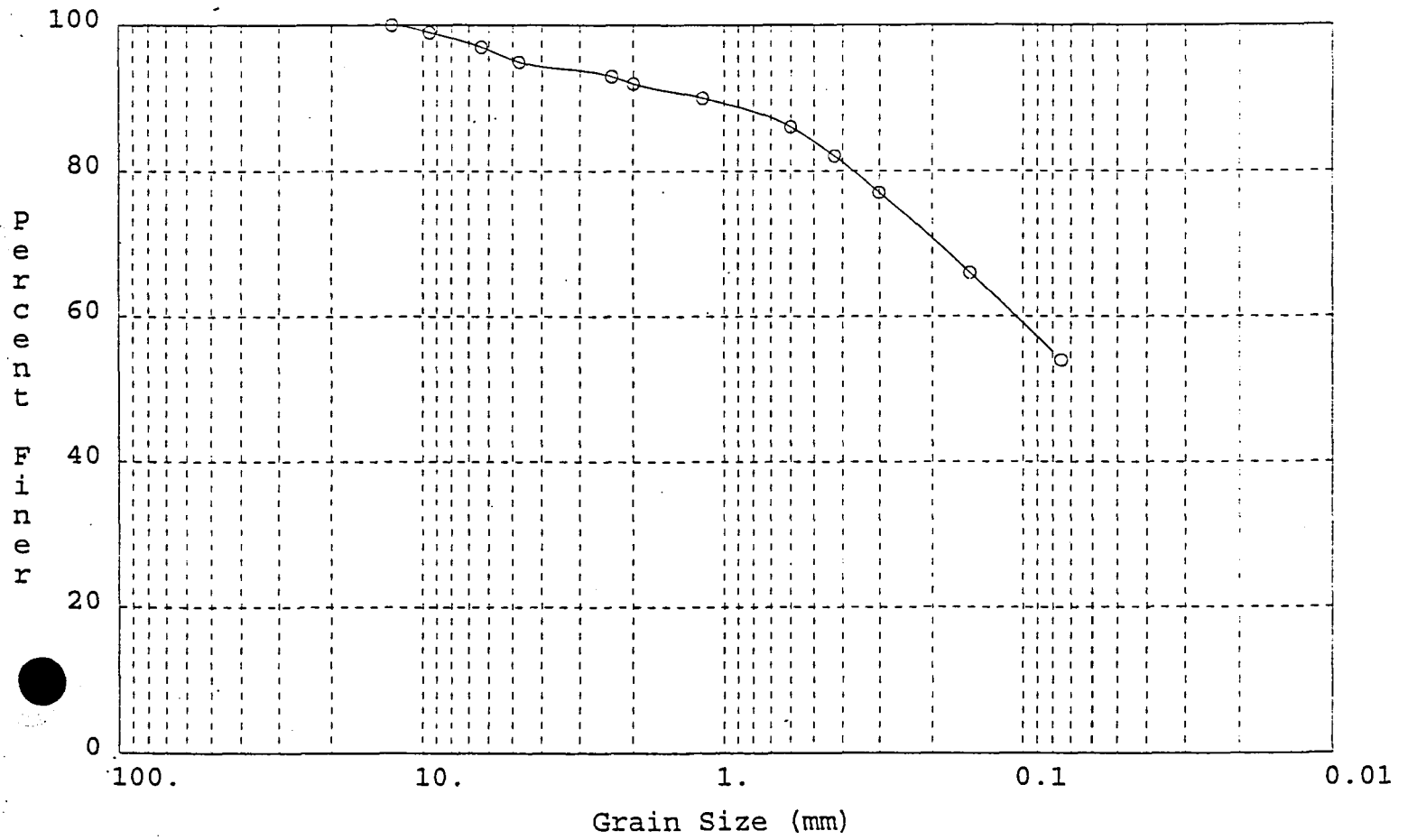
Sieve Analysis



Project Number = 196020-3 Client: Sverdrup Civil , Inc.
Location = Bullard Wash, East Tributary Channel
Date = 10/1/97
Tested By = L. Gitner
Boring Number = 24
Depth = 0 - 8'
Sample Number = 97-0802
Description = Brown, sandy lean CLAY(CL)
Dry Sample Weight (g) = 1000

SIEVE NUMBER	SIEVE OPENING (mm)	RETAINED WEIGHT (g)	PERCENT OF WEIGHT RETAINED	CUMULATIVE PERCENT RETAINED	PERCENT FINER (%)
1/2"	12.700	0.00	0.00	0.00	100.00
3/8"	9.500	10.00	1.00	1.00	99.00
1/4"	6.350	20.00	2.00	3.00	97.00
#4	4.750	20.00	2.00	5.00	95.00
#8	2.360	20.00	2.00	7.00	93.00
#10	2.000	10.00	1.00	8.00	92.00
#16	1.180	20.00	2.00	10.00	90.00
#30	0.600	40.00	4.00	14.00	86.00
#40	0.425	40.00	4.00	18.00	82.00
#50	0.300	50.00	5.00	23.00	77.00
#100	0.150	110.00	11.00	34.00	66.00
#200	0.075	120.00	12.00	46.00	54.00
Pan	0.000	0.00	0.00	46.00	54.00

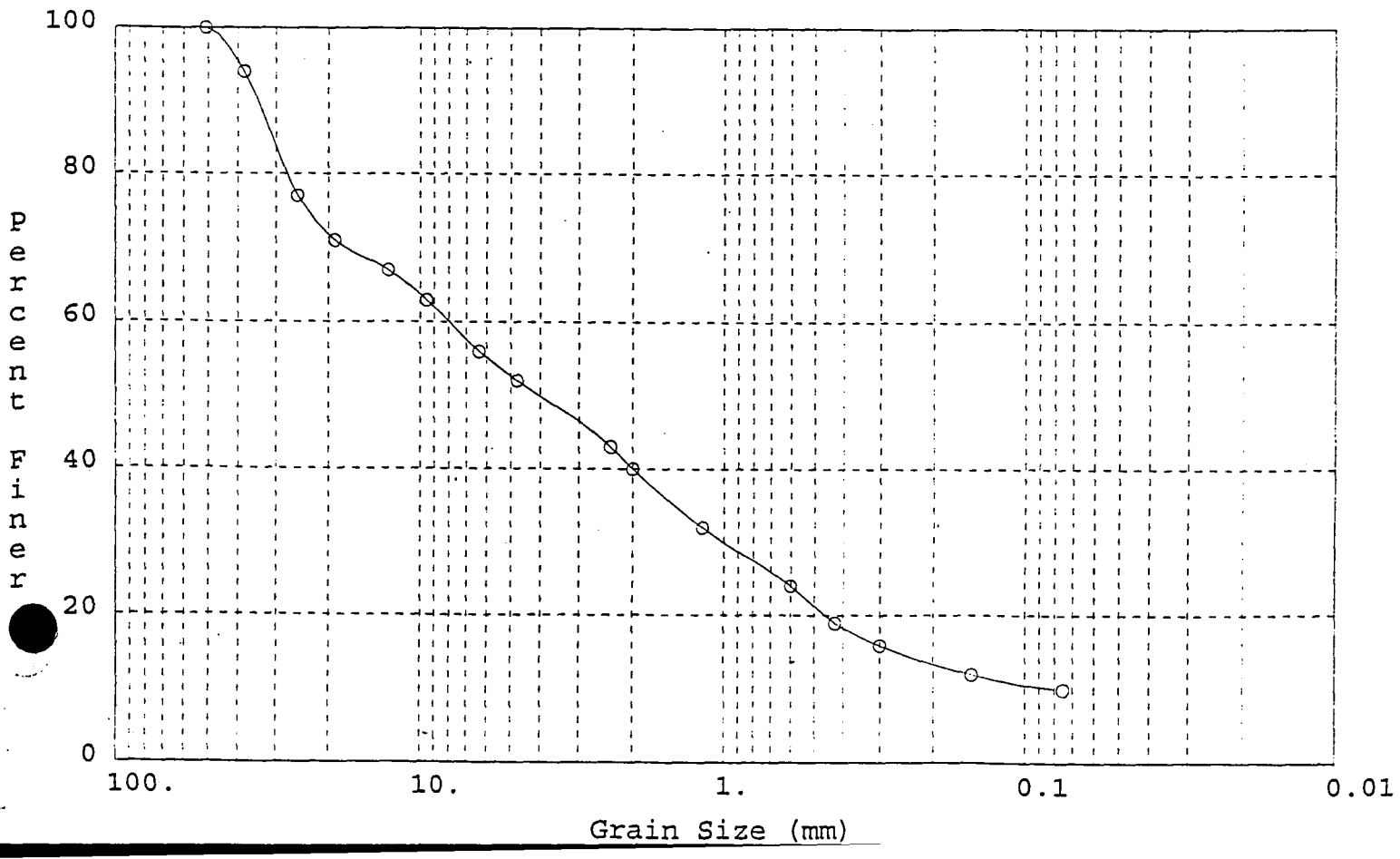
Sieve Analysis



Project Number = 196020-3 Client: Sverdrup Civil , Inc.
Location = Bullard Wash, East Tributary Channel
Date = 10/1/97
Tested By = D. Johnson
Boring Number = 25
Depth = 6'- 15'
Sample Number = 97-0803
Description = Gray-tan, SILT(ML)
Dry Sample Weight (g) = 1000

SIEVE NUMBER	SIEVE OPENING (mm)	RETAINED WEIGHT (g)	PERCENT OF WEIGHT RETAINED	CUMULATIVE PERCENT RETAINED	PERCENT FINER (%)
2"	50.800	0.00	0.00	0.00	100.00
1 1/2"	38.100	60.00	6.00	6.00	94.00
1"	25.400	170.00	17.00	23.00	77.00
3/4"	19.050	60.00	6.00	29.00	71.00
1/2"	12.700	40.00	4.00	33.00	67.00
3/8"	9.500	40.00	4.00	37.00	63.00
1/4"	6.350	70.00	7.00	44.00	56.00
#4	4.750	40.00	4.00	48.00	52.00
#8	2.360	90.00	9.00	57.00	43.00
#10	2.000	30.00	3.00	60.00	40.00
#16	1.180	80.00	8.00	68.00	32.00
#30	0.600	80.00	8.00	76.00	24.00
#40	0.425	50.00	5.00	81.00	19.00
#50	0.300	30.00	3.00	84.00	16.00
#100	0.150	40.00	4.00	88.00	12.00
#200	0.075	20.00	2.00	90.00	10.00
Pan	0.000	0.00	0.00	90.00	10.00

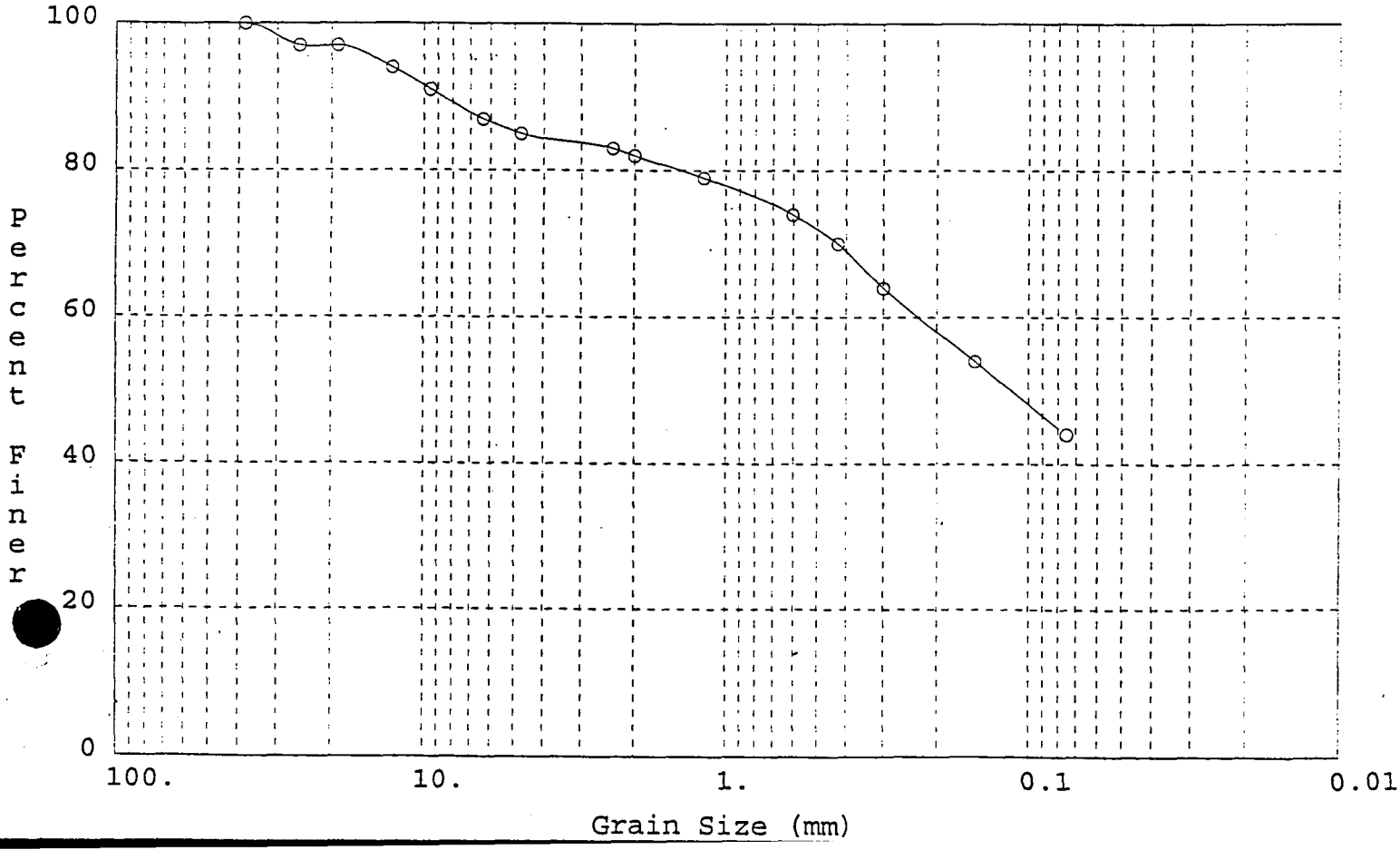
Sieve Analysis



Project Number = 196020-3 Client: Sverdrup Civil , Inc.
Location = Bullard Wash, East Tributary Channel
Date = 10/11/97
Tested By = D. Johnson
Boring Number = 26
Depth = 0 - 10'
Sample Number = 97-0804
Description = Brown, silty SAND(SM) with gravel
Dry Sample Weight (g) = 1000

SIEVE NUMBER	SIEVE OPENING (mm)	RETAINED WEIGHT (g)	PERCENT OF WEIGHT RETAINED	CUMULATIVE PERCENT RETAINED	PERCENT FINER (%)
1 1/2"	38.100	0.00	0.00	0.00	100.00
1"	25.400	30.00	3.00	3.00	97.00
3/4"	19.050	0.00	0.00	3.00	97.00
1/2"	12.700	30.00	3.00	6.00	94.00
3/8"	9.500	30.00	3.00	9.00	91.00
1/4"	6.350	40.00	4.00	13.00	87.00
#4	4.750	20.00	2.00	15.00	85.00
#8	2.360	20.00	2.00	17.00	83.00
#10	2.000	10.00	1.00	18.00	82.00
#16	1.180	30.00	3.00	21.00	79.00
#30	0.600	50.00	5.00	26.00	74.00
#40	0.425	40.00	4.00	30.00	70.00
#50	0.300	60.00	6.00	36.00	64.00
#100	0.150	100.00	10.00	46.00	54.00
#200	0.075	100.00	10.00	56.00	44.00
Pan	0.000	0.00	0.00	56.00	44.00

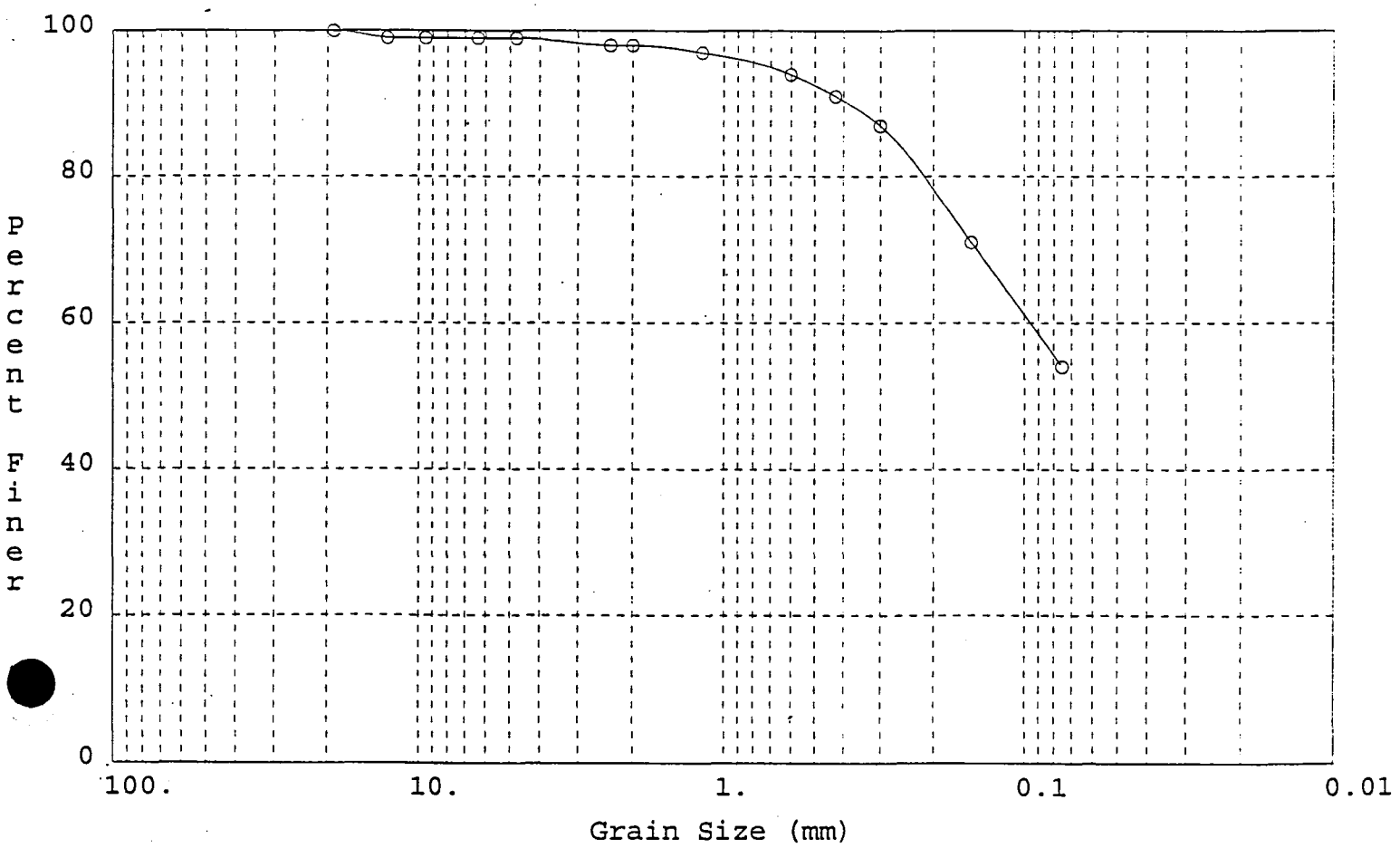
Sieve Analysis



Project Number = 196020-3 Client: Sverdrup Civil , Inc.
Location = Bullard Wash, East Tributary Channel
Date = 10/1/97
Tested By = D. Johnson
Boring Number = 27
Depth = 0 - 12 1/2'
Sample Number = 97-0806
Description = Brown, sandy SILT(ML)
Dry Sample Weight (g) = 1000

SIEVE NUMBER	SIEVE OPENING (mm)	RETAINED WEIGHT (g)	PERCENT OF WEIGHT RETAINED	CUMULATIVE PERCENT RETAINED	PERCENT FINER (%)
3/4"	19.050	0.00	0.00	0.00	100.00
1/2"	12.700	10.00	1.00	1.00	99.00
3/8"	9.500	0.00	0.00	1.00	99.00
1/4"	6.350	0.00	0.00	1.00	99.00
#4	4.750	0.00	0.00	1.00	99.00
#8	2.360	10.00	1.00	2.00	98.00
#10	2.000	0.00	0.00	2.00	98.00
#16	1.180	10.00	1.00	3.00	97.00
#30	0.600	30.00	3.00	6.00	94.00
#40	0.425	30.00	3.00	9.00	91.00
#50	0.300	40.00	4.00	13.00	87.00
#100	0.150	160.00	16.00	29.00	71.00
#200	0.075	170.00	17.00	46.00	54.00
Pan	0.000	0.00	0.00	46.00	54.00

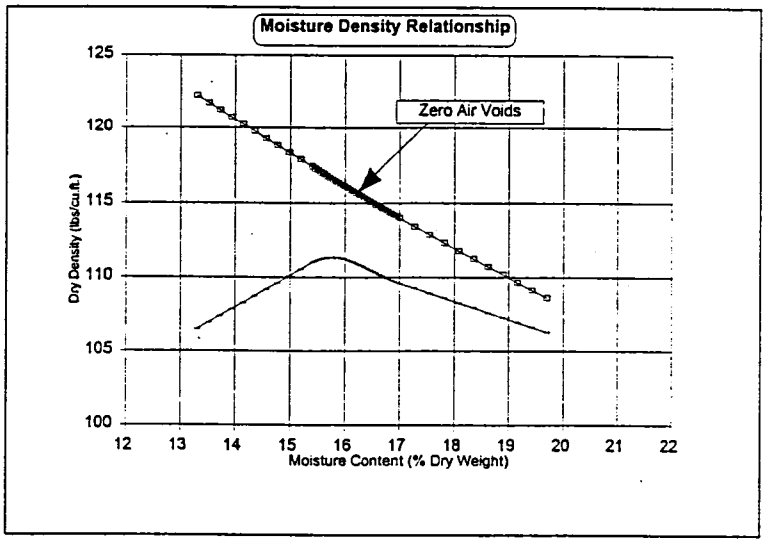
Sieve Analysis



ATL, INC.
CONSTRUCTION QUALITY CONTROL
GEOTECHNICAL CONSULTANTS

Summary of Moisture Density Relationship Tests

Client:	Sverdrup Civil 432 N. 44th Street, Ste 250 Phoenix, Az 85008	**Job No.**	196020-3
		Lab No.	97-0813
		Type of Rammer:	Manual
		Test Date:	10/07/97
Project:	Bullard Wash - Channel		
Test Designation:	ASTM D-698	**Material Description:**	Brown, lean CLAY(CL)
Test Method:	A	**Sample Source:**	Boring No. 11 Depth: 5' - 10'



Specific Gravity Used For Zero Air Voids Curve: 2.65

Test No.	1	2	3	4
Dry Density (lbs/cu.ft.)	106.5	111.0	109.6	106.3
Moisture Content (%)	13.3	15.4	17.0	19.7

Maximum Dry Density (lbs/cu.ft.): **111.3**
Optimum Moisture Content (% of Dry Weight): **15.7**

Remarks:

Respectfully Submitted:

Robert Rivera
Laboratory Supervisor

Reviewed By:
Input By: MC

2912 W. CLARENDON
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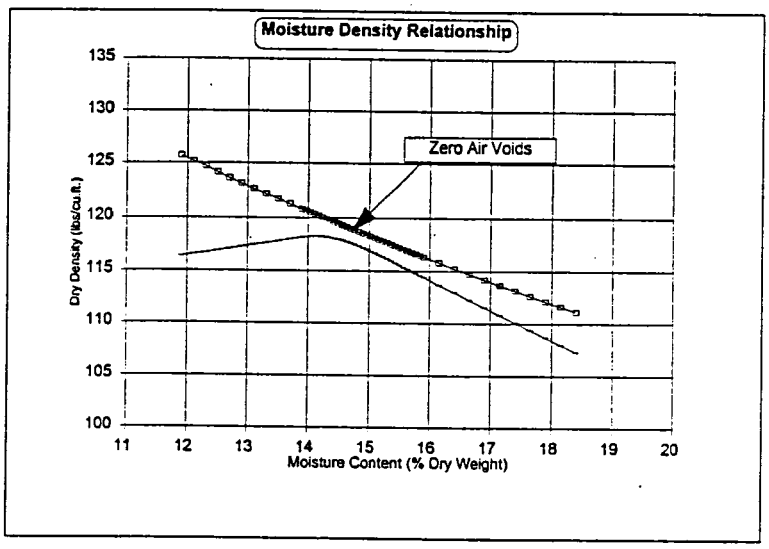
ATL, INC.
CONSTRUCTION QUALITY CONTROL
GEOTECHNICAL CONSULTANTS

Summary of Moisture Density Relationship Tests

Client:	Sverdrup Civil 432 N. 44th Street, Ste 250 Phoenix, Az 85008	**Job No.**	196020-3
		Lab No.	97-0805
		Type of Rammer:	Manual
		Test Date:	10/07/97
Project:	Bullard Wash - Channel		
Test Designation:	ASTM D-698	**Material Description:**	Brown, silty SAND (SM) with gravel
Test Method:	A	**Sample Source:**	Boring No. 26 Depth: 0-10'



Specific Gravity Used For Zero Air Voids Curve: 2.65

Test No.	1	2	3	4
Dry Density (lbs/cu.ft.)	116.4	118.2	114.4	107.3
Moisture Content (%)	11.9	13.9	15.9	18.4

Maximum Dry Density (lbs/cu.ft.): **118.3**
Optimum Moisture Content (% of Dry Weight): **14.1**

Remarks:

Respectfully Submitted:

Robert Rivera
Laboratory Supervisor

Reviewed By:
Input By: MC

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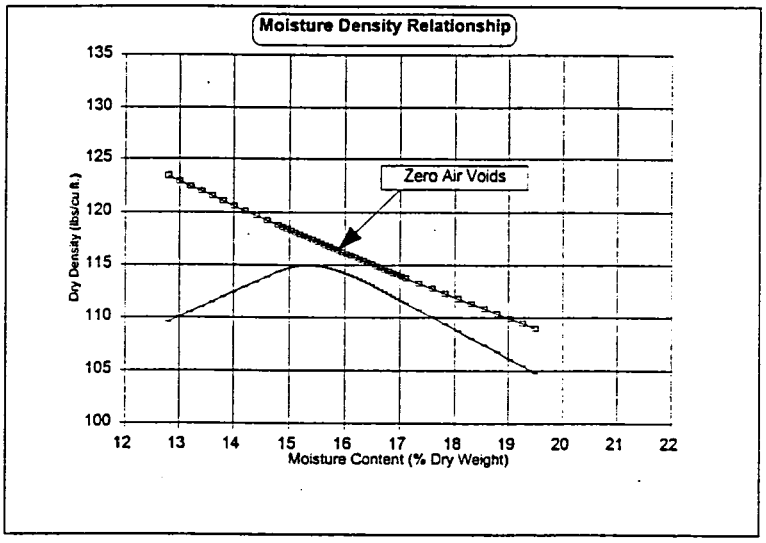
ATL, INC.
CONSTRUCTION QUALITY CONTROL
GEOTECHNICAL CONSULTANTS

Summary of Moisture Density Relationship Tests

Client:	Sverdrup Civil 432 N. 44th Street, Ste 250 Phoenix, Az 85008	**Job No.**	196020-3
		Lab No.	97-0779
		Type of Rammer:	Manual
		Test Date:	10/07/97
Project:	Bullard Wash - Channel		
Test Designation:	ASTM D-698	**Material Description:**	Brown, SILT(ML) with sand
Test Method:	A	**Sample Source:**	Boring No.:19 Depth: 0-11'



Specific Gravity Used For Zero Air Voids Curve: 2.65

Test No.	1	2	3	4
Dry Density (lbs/cu.ft.)	109.6	114.4	111.4	104.8
Moisture Content (%)	12.8	14.8	17.1	19.5

Maximum Dry Density (lbs/cu.ft.): **115.0**
Optimum Moisture Content (% of Dry Weight): **15.3**

Remarks:

Respectfully Submitted:

Robert Rivera
Laboratory Supervisor

Reviewed By:
Input By: MC

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BULLARD WASH - CHANNEL
GOODYEAR, ARIZONA
ATL JOB NO. 196020-3

PERCENT SWELL TEST
(Surcharge = 100psf)

Boring No.	Sample Depth (ft)	USCS	Percent Swell	Dry Density (pcf)	Saturation Moisture (%)
11	5 - 10	CL	1.9	102.4	25.3
19	0 - 11	ML	1.9	105.5	24.4

BULLARD WASH - CHANNEL
GOODYEAR, ARIZONA
ATL JOB NO. 196020-3

pH AND RESISTIVITY TESTS

Boring No.	Depth (Ft)	USCS	pH	Average Soil Resistivity (Ohms /cm^3)
11	5 - 10	CL	7.8	520
19	0 - 11	ML	8.2	991
26	0 - 10	SM	7.8	734

ATL, INC.
CONSTRUCTION QUALITY CONTROL
GEOTECHNICAL CONSULTANTS

March 4, 1998

Mr. Bradford D. Olbert, P.E.
Sverdrup Civil, Inc.
432 North 44th Street, Suite 250
Phoenix, Arizona 85008

Re: Addendum No. 1
Landfill Treatment
Bullard Wash Channel Report
Contract FCD 95-39
Goodyear, Arizona
ATL Job No. 196020-3

Dear Mr. Olbert:

For this contract, Boring Nos. 28 through 34 were drilled to determine the depth and type of fill at this location. The material encountered during drilling included soil, old asphaltic concrete, portland cement concrete, plastic sheeting, electrical wire, and tree limbs. The following addendum should be **added** to Section 8.1 of the subject report and addresses methods of separating the debris from the soil so that the soil may be reused elsewhere on the project.

Section 8.1 - Structural Excavation and Backfill Addendum

In order to re-use the soil excavated for the channel construction in the area represented by Boring Nos 28 through 34, a "grizzly" with a 3-inch sieve or similar screening equipment should be utilized to separate the construction debris. The contractor should also be informed that some debris could pass a 3-inch screen and will require removal by hand. The debris should be disposed of off-site.

There is no accurate way to determine what percentage of the fill is re-usable. For estimating purposes, from 10% to 20% of the volume is probably unusable.

Very truly yours,

Registered Professional Engineer (Civil) CERTIFICATE NO. 22719 David Preston Hayes Date Signed 3/4/98 ARIZONA, U.S.A.

David P. Hayes, P.E.
Executive Vice President

DPH/brc

ATL, INC.

CONSTRUCTION QUALITY CONTROL
GEOTECHNICAL CONSULTANTS

BULLARD WASH
LEVEES AND EMBANKMENTS
FCD PROJECT NO. 95-39
ATL JOB NO. 198013

ATL Job No. 198013 *June 8, 1998*

GEOTECHNICAL INVESTIGATION

REPORT FOR

SVERDRUP CIVIL, INC.

PROJECT

BULLARD WASH
LEVEES AND EMBANKMENTS
FCD PROJECT NO. 95-39
ATL JOB NO. 198013

Reviewed by:

Registered Professional Engineer (Civil) CERTIFICATE NO. 22719 David Preston Hayes Date Signed 6-8-98 ARIZONA U.S.A.

David P. Hayes, P.E.
Executive Vice President

Prepared by:

Ammi Osorio
Project Engineer

ATL, INC.
CONSTRUCTION QUALITY CONTROL
GEOTECHNICAL CONSULTANTS

PHOENIX – CORPORATE OFFICE
2912 W. Clarendon • Phoenix, AZ 85017
(602) 241-1097 • Fax (602) 277-1306

June 8, 1998

Mr. Brad Olbert, P.E.
Sverdrup Civil, Inc.
637 South 48th Street, Suite 101
Tempe, AZ 85281

Re: Geotechnical Investigation Report
Bullard Wash
Levees and Embankments
FCD Project No. 95-39
ATL Job No. 198013

Dear Mr. Olbert:

This report presents the results of a geotechnical investigation for the proposed construction of a roadway embankment along Lower Buckeye Road, and a levee embankment on both sides of the proposed canal, between Broadway Road and the BID Canal, in Goodyear, Arizona. Field exploration, laboratory tests, and engineering analysis are included along with boring logs and laboratory results. ATL's work was performed in accordance with ATL Revised Proposal No. P97348 dated December 17, 1997.

ATL drilled and sampled nine (9) boreholes to depths of approximately 11½ feet below grade. The roadway embankment slopes should not be steeper than 2H:1V and the levee slopes should match the channel slopes on the front side and 1H:1V on the backside. A non-woven geotextile will be placed between the stepped gabion baskets and the soil embankment in the channel section.

ATL has appreciated the opportunity to be of service to Sverdrup Civil, Inc. on this project and looks forward to a continued association on future projects. Should any questions arise, please do not hesitate to contact us at your earliest convenience.

Very truly yours,

Registered Professional Engineer (Civil)
CERTIFICATE NO.
22719
David Preston
Hayes
Date Signed 6/8/98
ARIZONA, U.S.A.

David P. Hayes, P.E.
Executive Vice President

DPH/brc

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GEOTECHNICAL INVESTIGATION

REPORT FOR

SVERDRUP CIVIL, INC.

PROJECT

BULLARD WASH
LEVEES AND EMBANKMENTS
FCD PROJECT NO. 95-39
ATL JOB NO. 198013

1.0 PROJECT DESCRIPTION

The Flood Control District of Maricopa County is intending to construct embankments in two areas along the Bullard Wash Channel. One area involves both sides of the Bullard Wash Channel from Broadway Road, south of the BID Canal and result in the construction of levees as an extension of the channel side slopes. The other area is located at the northern end of the channel at Lower Buckeye Road. The embankment that will be constructed near the northern end of the Channel will function as a roadway embankment for the extension of Lower Buckeye Road and will be oriented perpendicular to the new channel. This will require a northerly extension of the proposed Bullard Wash channel and the raising of Lower Buckeye Road. Farm roads will be constructed on either side of Lower Buckeye Road.

2.0 LOCATION AND SITE DESCRIPTION

The project site is located south of Interstate 10 Freeway (I-10), west of Litchfield Road, and east of Sarival Avenue. It is situated in a predominantly farm area in Goodyear, Arizona.

The project area is located in the western Salt River Valley, a broad basin filled with alluvium of varying grain-sizes. The fill deposits are composed of a Lower Conglomerate Unit consisting of cemented sand, gravel, silt, and clay but design considerations interested in materials found in the Upper Alluvial Unit, which consist primarily of sands and gravels with clay and silt lenses. Groundwater flows to the northwest, north of Yuma road and to the southwest, south of Yuma Road at depths between 40 and 120 feet below land surface.

3.0 SCOPE OF WORK

ATL's responsibility was to drill and sample sub-surface material in order to develop design data for the construction of the levee embankments.

Field and Laboratory testing were performed to appraise the ability of the in-situ soils to support the proposed embankments. The following issues were addressed as a result of the investigation:

1) Recommendations for the levee and embankment construction.
2) Settlements and Rapid Draw-down effects and Lateral Pressures on the proposed Levees and Embankment.
3) Earth Fill Stability.

4.0 DRILLING AND SAMPLING PROCEDURES

A total of nine (9) borings were drilled for this project, each to a depth of 11½ feet below grade. Six (6) of these borings were drilled, along the Bullard Wash Channel alignment, from Broadway Road south, to the BID Canal. The remaining borings were drilled along the alignment of the proposed roadway embankment at Lower Buckeye Road.

A Mobile B-50 drill rig, with 6-inch outside diameter auger, was utilized in the drilling and sampling of the boreholes. SPT values were obtained at 10 feet below grade using a split-spoon sampler driven by a 140-pound hammer dropping 30-inches until the sampler penetrated 18-inches into the soil in accordance with ASTM D1586 standards. Ring samples were also obtained near the surface. Bulk samples of the existing native material were selectively sampled from the auger flights as drilling proceeded.

Upon completion, each borehole was backfilled with excess cuttings. All samples were transported to ATL's Phoenix Laboratory for analysis. Upon delivery to the laboratory, soil samples were checked by the Project Engineer and the following ASTM tests assigned:

- Sieve Analysis
- Plasticity Index
- Moisture Content
- Direct Shear Test
- Standard Proctor Analysis
- Consolidation Test
- Percent Swell Test

5.0 LABORATORY TESTING

Bulk samples of the subgrade were collected off the auger flights throughout the depth of each boring. Visual field classifications noted on the field boring logs were modified by the results of index tests such as Sieve Analysis and Atterberg Limits. The resulting Unified Soils Classification presented on the edited logs in Appendix A. Moisture Content tests were performed to determine the amount of water present in the soil at the time of sampling. Standard Proctor Analysis were completed on the subgrade material to determine the relationship between the maximum dry density and optimum moisture content. A Consolidation Test was conducted to determine the amount of vertical movement a sample would experience under specific loading and moisture conditions. A Percent Swell Test was performed to determine the expansion tendencies of the material under given surcharge load when water is added. A Direct Shear Test was also performed to provide parameters that were used in determining equivalent fluid pressures that potentially will be acting against the proposed levee embankment.

All laboratory tests were conducted in accordance with ASTM published standards and are summarized in Appendix B, "Laboratory Test Results". The soils described on the edited boring logs were classified using the Unified Soils Classification System (USCS). The following table summarizes the type and quantities of laboratory tests completed for this project.

TEST	QUANTITY
Sieve Analysis	9
Atterberg Limit	9
Moisture Content	9
Standard Proctor	2
Consolidation	1
Direct Shear	1
Percent Swell	1

6.0 SUMMARY OF EXISTING CONDITIONS

Classification data for the soils sampled from the borings suggests the following soil profile variation. Refer to Appendix A for detailed boring information.

a) At Lower Buckeye Road, the subgrade, to a depth of 11½ feet, consisted primarily of a **lean CLAY (CL)** with sand. In some areas a **clayey SAND (SC)** or a **sandy fat CLAY (CH)** with gravel were observed.

b) The channel alignment, south of Broadway Road, revealed **lean CLAY (CL)** to a depth of 11½ feet.

c) The *N* values obtained at 10 feet below grade revealed the CL materials as "Stiff" to "Hard". The SC material was observed to be "very firm" as revealed by the *N* values obtained; moderate cementation was observed from Boring No. 3 starting at 8 feet below grade and extended to approximately 10 feet below grade.

The minus No. 200 results ranged from 63% to 95%. The Plasticity Indices ranged from 9 to 30. The SC material tested contained a minus #200 content of 39% with a Plasticity Index of 8. The CH material tested contained a minus #200 of 55% with a Plasticity Index of 32.

Standard Proctor Analyses were performed from Boring No. 2 and from Boring No. 7, which were both classified as CL material. The CL material from Boring No. 2, at the depth of 0 to 5 feet below grade, yielded a maximum dry density of 120.4 pcf at an optimum moisture content of 12.3%. The CL material from Boring No. 7, at the depth of 2½ to 5 feet below grade, yielded a maximum dry density of 103.5 pcf at an optimum moisture content of 21.0%.

A Consolidation Test was performed on a CL material from Boring No. 7, at a depth of 2½ to 3 feet below grade. A total consolidation of 2% was observed when the sample was 100% saturated with water under a stress of 2,280 psf.

A Percent Swell Test was also performed on a CL material from Boring No. 7, at a depth of 2½ to 3 feet below grade. The material swelled 1.1% under a surcharge of 100 psf.

A friction angle of 38° was obtained when a Direct Shear Test was performed on CL material from Boring No. 7.

7.0 DISCUSSIONS AND RECOMMENDATIONS

The sampling of the subsurface materials was performed on May 14 & 15, 1998. Groundwater was not encountered during drilling. Variances in groundwater levels should not effect the construction of the levees. Surface water, however, could effect the project construction sequence, particularly if a flood occurs prior to the beginning of construction.

7.1 Lower Buckeye Roadway Embankment

The roadway embankment will be constructed on Lower Buckeye Road extended, from Estrella Parkway, east to the proposed location of the Bullard Wash Channel. The embankment height will range from 3 to 5 feet above existing grade to an elevation of 948.0, will be 16 feet wide, and will serve as a roadway subgrade for the eastern

extension of Lower Buckeye Road. Farm roads are planned on either side of the embankment to allow for local access.

In ATL's geotechnical report for the new channel **"Bullard Wash - Channel"**, dated November 22, 1997, it was recommended that some of the material excavated from the channel be mixed specifically with the granular material excavated between ATL Boring Nos. 12 and 17. The northern end of the channel was represented by Boring Nos 9 through 11 and the material was a cohesive lean clay with some silt. While the plasticity was less than 10 for this material, the minus No. 200 amounts exceeded 70%. Thus, this cohesive material should be mixed with excavated granular material before being used as roadway embankment.

Placement and compaction should be performed in accordance with the recommendations contained in Section 8. The roadway embankment construction will require that the existing ground be scarified and compacted to a depth of 12 inches below grade. The embankment should be placed in 10 inch compacted layers to the requirements presented in Section 8.0 of this report. Al layers will be placed horizontally and the slopes trimmed to the specified angle. This will insure uniform compaction throughout the fill.

The slope of the levee, which should not exceed 2H:1V, will be protected from possible erosion by providing stabilizing treatments such as spraying with clear lignosufinites, applying seed mixes, or gravel mulch. It is also important to provide drainage along the intersection of the slope and the farm road surface to carry water away from the embankment toe. We suggest that this ditch be paved or otherwise sealed and the farm road sloped transversely away from the embankment.

In preparing the subgrade for the levee fill, we anticipate that due to scarification and compaction, that the resulting elevation will be less than that of the original ground. The difference is the "Ground Compaction Factor". For this project, that estimated value is:

Ground Compaction Factor = 0.2 feet

A shrinkage factor has been computed for the difference between the in-situ density and the compacted density of the channel material in the aforementioned ATL report. That estimated value is:

Shrinkage Factor = 15%

During a flood, the roadway embankment will function as a levee, providing a barrier for the water and directing it to the new Bullard Wash Channel. It should be noted that this levee embankment is not a dam designed to constrain a given volume of water for the life of the structure. In addition, our embankment is not sealed from the infiltration of water on the face that will be exposed to the flood waters. While the effects of rapid draw down are consideration with this fine-grained soils, because of the short height of the embankment we don not anticipate that they will influence the structures performance as much as the potential harm that saturation could cause.

7.2 Bullard Wash Channel Levee

A levee is proposed to be constructed on either side of the Bullard Wash Channel from Broadway Road south to the BID Canal. The front face of the channel slope and levee will be protected with stepped gabions and a geotextile fabric bank lining. The height from the channel invert to the top of the levee is 10 feet. Between Stations 33+30 to 63+01, the back face of the levee embankment will also be protected by the gabions.

Since the gabions for the levee will be an extension of the channel slope protection, the material and installation requirements for the rock will be identical. The geotextile fabric will function as a barrier and an impermeable layer between the embankment material and the gabion baskets. Backfill behind each course of gabion baskets should be compacted to 95%.

The top of each levee will be utilized as an unpaved operations and maintenance road, 15 feet wide. A handrail will be constructed between the road edge and the back of the gabion baskets. A four inch compacted layer of aggregate base course will be placed as a wearing surface for these roads. Specifications of compaction are presented in Section 8.

7.3 Material Source

The material excavated from the Bullard Wash Channel will be used to build up the Levee on all areas. As indicated in ATL's Channel Report, some blending of the excavated materials might be required. Placement and compaction requirements will conform to appropriate item in Section 8.0 of this report.

8.0 CONSTRUCTION RECOMMENDATIONS

ATL recommends that MAG Standards be used as a guideline for the development of construction specifications. The following sub-sections provide specific references to MAG, as well as containing additional recommendations specific to this project.

8.1 Site Preparation

Stripping of organic soil, small bushes and grass will be required prior to excavating the native subsoil for subsequent use in the roadway and levee embankments. The stripped materials should be disposed of off-site.

The native ground should be scarified a depth of 12 inches and compacted as required in 8.4. Moisture might have to be added in order to reach the acceptable range of water content during compaction.

8.2 Excavation and Backfill

Excavation is not required for this part of the project. Material excavated from the channel construction will be used as backfill for the roadway and levee embankment construction. Backfilling operations should be conducted in accordance with Section 206 of MAG. The contractor may need to prepare an area to mix the excavated materials to create an acceptable embankment material.

The following specifications are suggested for the material used as embankment in the levee whether it is mixed or sole sourced:

Sieve Size	Percent Passing by Weight
2"	100
No. 40	30 - 75
No. 200	10 - 60

$5 \leq$ Plasticity Index ≥ 12

8.3 Borrow

The only anticipated use for borrow or imported material is to either mix with the existing granular material or use solely as embankment for the construction of the Levee. No specification is presented in this section, since Section 8.2 provides the grading allowance for the **final** product, mixed or not. The Contractor will submit a borrow source, along with recent gradations and Atterberg Limit data. If mixed, the Contractor will also be required to provide a mixing procedure.

8.4 Placement and Compaction

Structural backfill for the levee and roadway embankments should be placed in 12-inch compacted layers. The lifts will be compacted to within 95% of the maximum laboratory dry density and within ±2% of the optimum moisture content as determined by ASTM D698, Standard Proctor. All layers will be placed horizontally and slopes trimmed after placement to conform to the plan requirements. Recompaction of the native subsoil material is also required and it shall be compacted to 95% of ASTM D698 and within 2% of the optimum moisture content.

8.5 Geotextile

The geotextile fabric is utilized under the gabions baskets and relieves the hydrostatic pressure and prevents the embankment soils from sloughing, and reduces water penetration to the subgrade during a flood. ATL suggests the following specifications as a minimum for this non-woven product, utilizing ISO 9002 certified production facilities:

Mullen Burst Strength	475 psi - Min
Permeability	0.48 cm/sec - MAX
Apparent Opening Size	150 μm - MAX
UV Resistence	70% Retained in 100 hrs. - MIN

9.0 LIMIT OF SERVICES

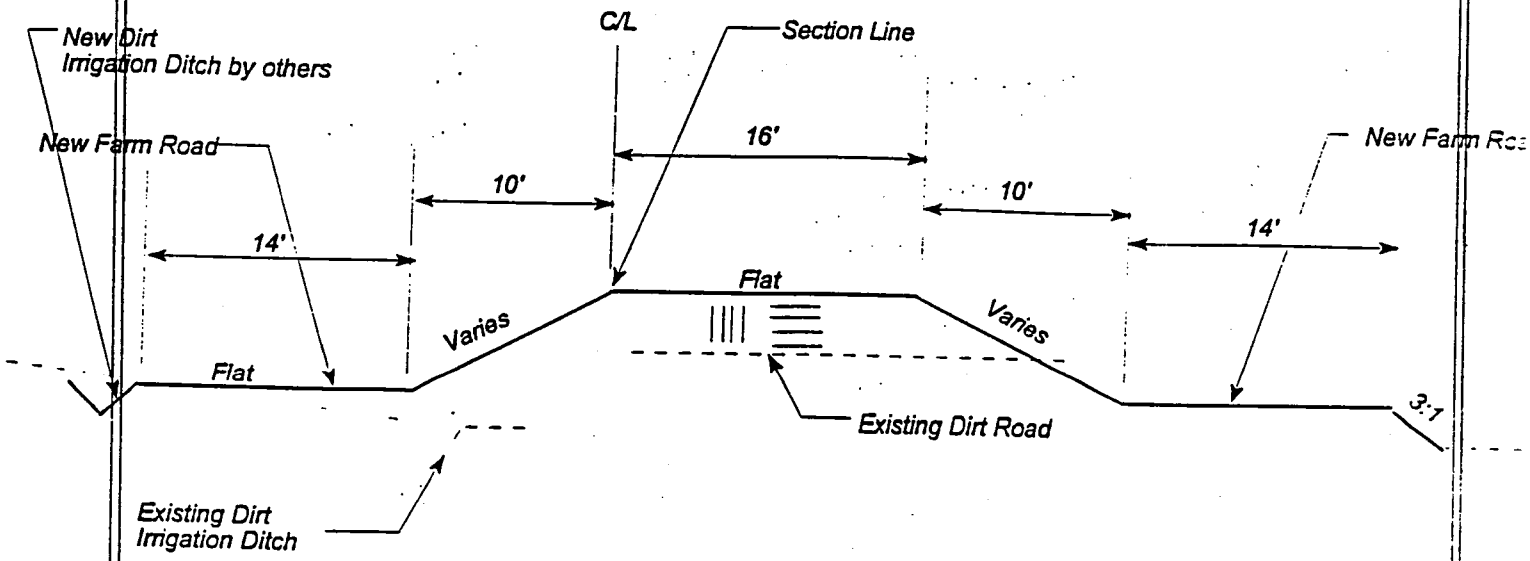
The Geotechnical Engineer may also be retained to provide testing services during excavation, backfill, and grading, and levee construction phases of the work. Construction testing, including field and laboratory evaluation of backfill should be performed by a competent; certified laboratory to determine whether applicable project requirements have been met. ATL, Inc. is highly qualified to provide these additional services.

The analyses and recommendations in this report are based in part upon data obtained from field exploration. The nature and extent of variations beyond the location of test borings may not become evident until construction. If variations then appear evident, it may be necessary to reevaluate the recommendations of this report.

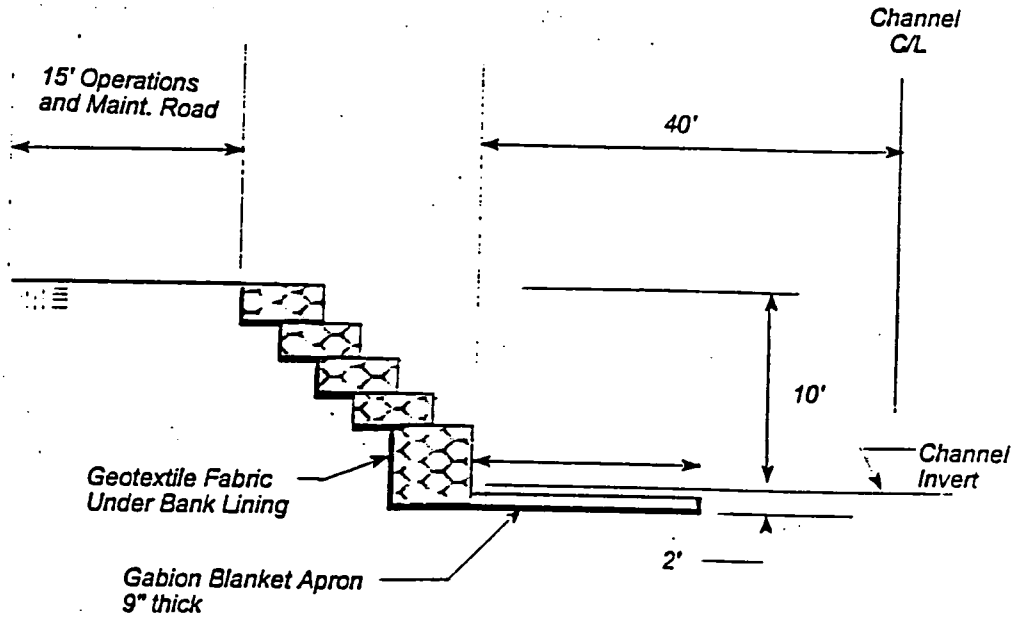
Our professional services were performed using that degree of care and skill ordinarily exercised, under similar circumstances, by reputable geotechnical engineers practicing in this or similar localities. No warranty, express or implied, is made. We prepared the report as an aid in design of the proposed project. This report is for the exclusive purpose of providing geotechnical engineering and/or testing information and recommendations. The scope of services for this project does not include, either specifically or by implication, and environmental assessment of the site or identification of contaminated or hazardous materials or conditions.

10.0 REFERENCES

- ***Uniform Standard Specifications for Public Works Construction***, Maricopa Association of Governments, 1992
- ***Roadside Geology of Arizona***, Holka Chronic, 1995
- Arizona Department of Water Resources, ***Hydrologic Map Series, Report No. 12***, Sheet 1, 1983.
- Lambe and Whitman, ***Soil Mechanics***, 1969.
- ***GeoCal for Windows***, Geotechnical Software by DataSurge.
- ***Geosynthetics Specifications***, GSI Construction Products.



LOWER BUCKEYE ROAD
Typical Section



STEPPED GABION BANK LINING
Typical Section

PLATES

GUIDELINES IN THE USE AND INTERPRETATION

OF THIS GEOTECHNICAL REPORT

ATL Job No. 198013

Our professional services were performed, our findings obtained, and our recommendations prepared in accordance with generally accepted engineering principles and practices. This warranty is in lieu of all other warranties, either expressed or implied.

The geotechnical report was prepared for the use of the Owner in the design of the subject facility and should be made available to potential contractors and/or the Contractor for information on factual data only. This report should not be used for contractual purposes as a warranty of interpreted subsurface conditions such as those indicated by the interpretive boring and test pit logs, cross sections, or discussion of subsurface conditions contained herein.

The analyses, conclusions and recommendations contained in the report are based on site conditions as they presently exist and assume that the exploratory borings, test pits, and/or probes are representative of the subsurface conditions of the site. If, during construction, subsurface conditions are found which are significantly different from those observed in the exploratory borings and test pits, or assumed to exist in the excavations, we should be advised at once so that we can review these conditions and reconsider our recommendations where necessary. If there is a substantial lapse of time between the submission of this report and the start of work at the site, or if conditions have changed due to natural causes or construction operations at or adjacent to the site, this report should be reviewed to determine the applicability of the conclusions and recommendations considering the changed conditions and time lapse.

The Summary Boring Logs are our opinion of the subsurface conditions revealed by periodic sampling of the ground as the borings progressed. The soil descriptions and interfaces between strata are interpretive and actual changes may be gradual.

The boring logs and related information depict subsurface conditions only at these specific locations and at the particular time designated on the logs. Soil conditions at other locations may differ from conditions occurring at these boring locations. Also, the passage of time may result in a change in the soil conditions at these boring locations.

Groundwater levels often vary seasonally. Groundwater levels reported on the boring logs or in the body of the report are factual data only for the dates shown.

Unanticipated soil conditions are commonly encountered on construction sites and cannot be fully anticipated by merely taking soil samples, borings or test pits. Such unexpected conditions frequently require that additional expenditures be made to attain a properly constructed project. It is recommended that the Owner consider providing a contingency fund to accommodate such potential extra costs.

This firm cannot be responsible for any deviation from the intent of this report including, but not restricted to, any changes to the scheduled time of construction, the nature of the project or the specific construction methods or means indicated in this report; nor can our firm be responsible for any construction activity on sites other than the specific site referred to in this report.

SOIL CLASSIFICATION & TERMINOLOGY

GRAPHIC SYMBOL	GROUP SYMBOL	TYPICAL NAMES
	GW	Well graded gravels, gravel - sand mixtures, or sand - gravel - cobble mixtures.
	GP	Poorly graded gravels, gravel - sand mixtures, or sand - gravel - cobble mixtures.
	GM	Silty gravels, gravel - sand - silt mixtures.
	GC	Clayey gravels, gravel - sand - clay mixtures.
	SW	Well graded sands, gravelly sands.
	SP	Poorly graded sands, gravelly sands.
	SM	Silty sands, sand - silt mixtures
	SC	Clayey sands, sand - clay mixtures
	ML	Inorganic silts, clayey silts with slight plasticity
	MH	Inorganic silts, micaceous or diatomaceous silty soils, elastic silts.
	CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays.
	CH	Inorganic clays of high plasticity, fat clays, sandy clays of high plasticity.

1. Relative Density. Terms for description of relative density of cohesionless, uncemented sands and sand - gravel mixtures,

N	Relative Density
0 - 4	Very loose
5 - 10	Loose
11 - 30	Medium dense
31 - 50	Dense
50	Very dense

2. Relative Consistency. Terms for description of clays which are saturated or near saturation.

N	Relative Consistency	Remarks
0 - 4	Very soft	Easily penetrated several inches with fist.
3 - 4	Soft	Easily penetrated several inches with thumb.
5 - 8	Medium stiff	Can be penetrated several inches with thumb with moderate effort.
9 - 15	Stiff	Readily indented with thumb but penetrated only with great effort.
16 - 30	Very stiff	Readily indented with thumb nail.
30 +	Hard	Indented only with difficulty by thumbnail.

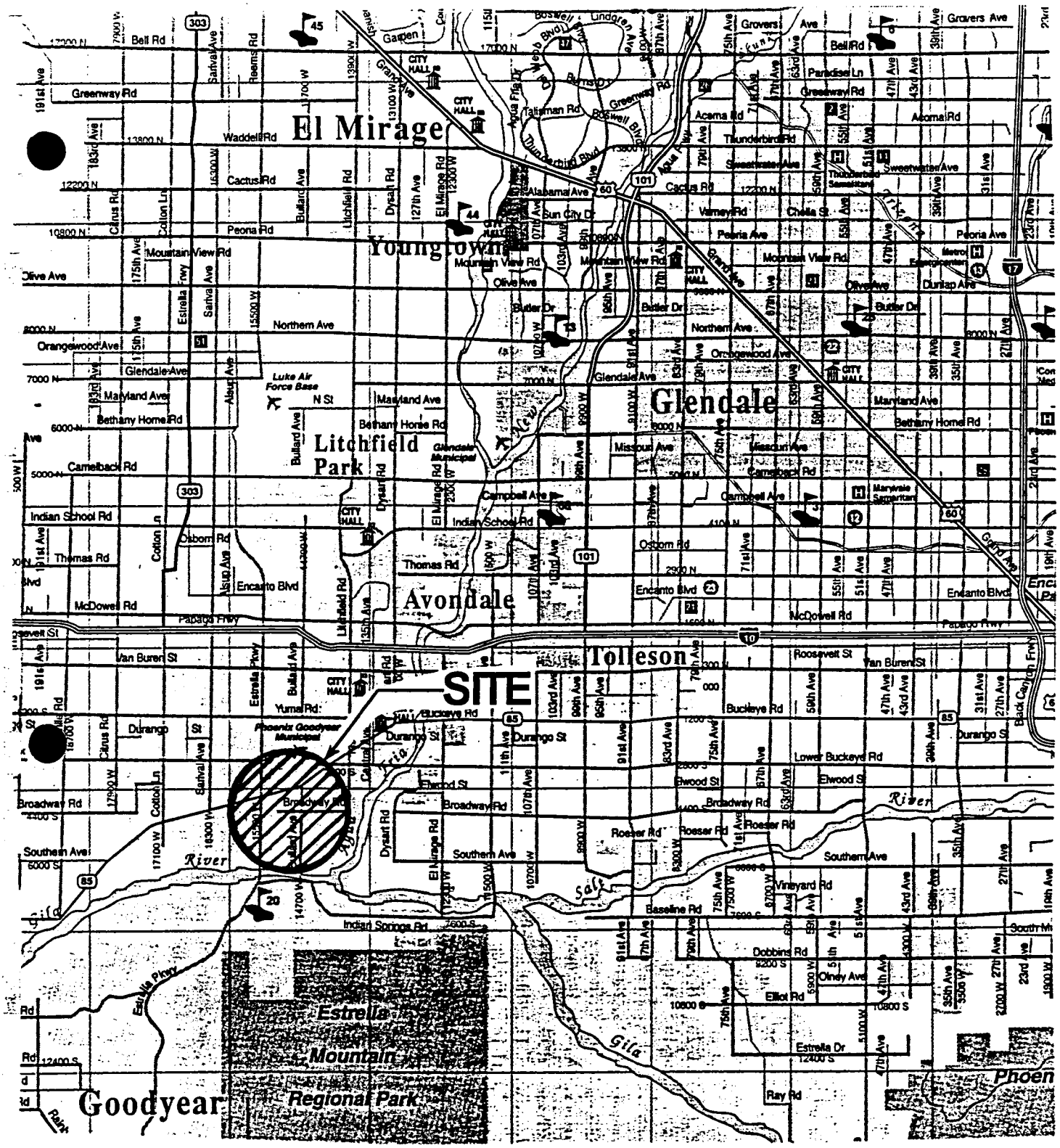
3. Relative Firmness. Terms for description of partially saturated and / or cemented soils which commonly occur in the Southwest including clays, cemented granular materials, silts and silty and clayey granular soils.

N	Relative Firmness
0 - 4	Very soft
5 - 8	Soft
9 - 15	Moderately firm
16 - 30	Firm
31 - 50	Very firm
50 +	Hard

4. Standard Penetration Tests (SPT) =

DEFINITIONS OF SOIL FRACTIONS

SOIL COMPONENT	PARTICLE SIZE RANGE
Cobbles	Above 3 inches
Gravel	3 inches to No. 4 sieve
Coarse gravel	3 inches to 3/4 inch
Fine gravel	3/4 inch to No. 4 sieve
Sand	No. 4 sieve to No. 200
Coarse	No. 4 sieve to No. 10
Medium	No. 10 sieve to No. 40
Fine	No. 40 sieve to No. 200
Fines (silt or clay)	Below No. 200 sieve



VICINITY MAP

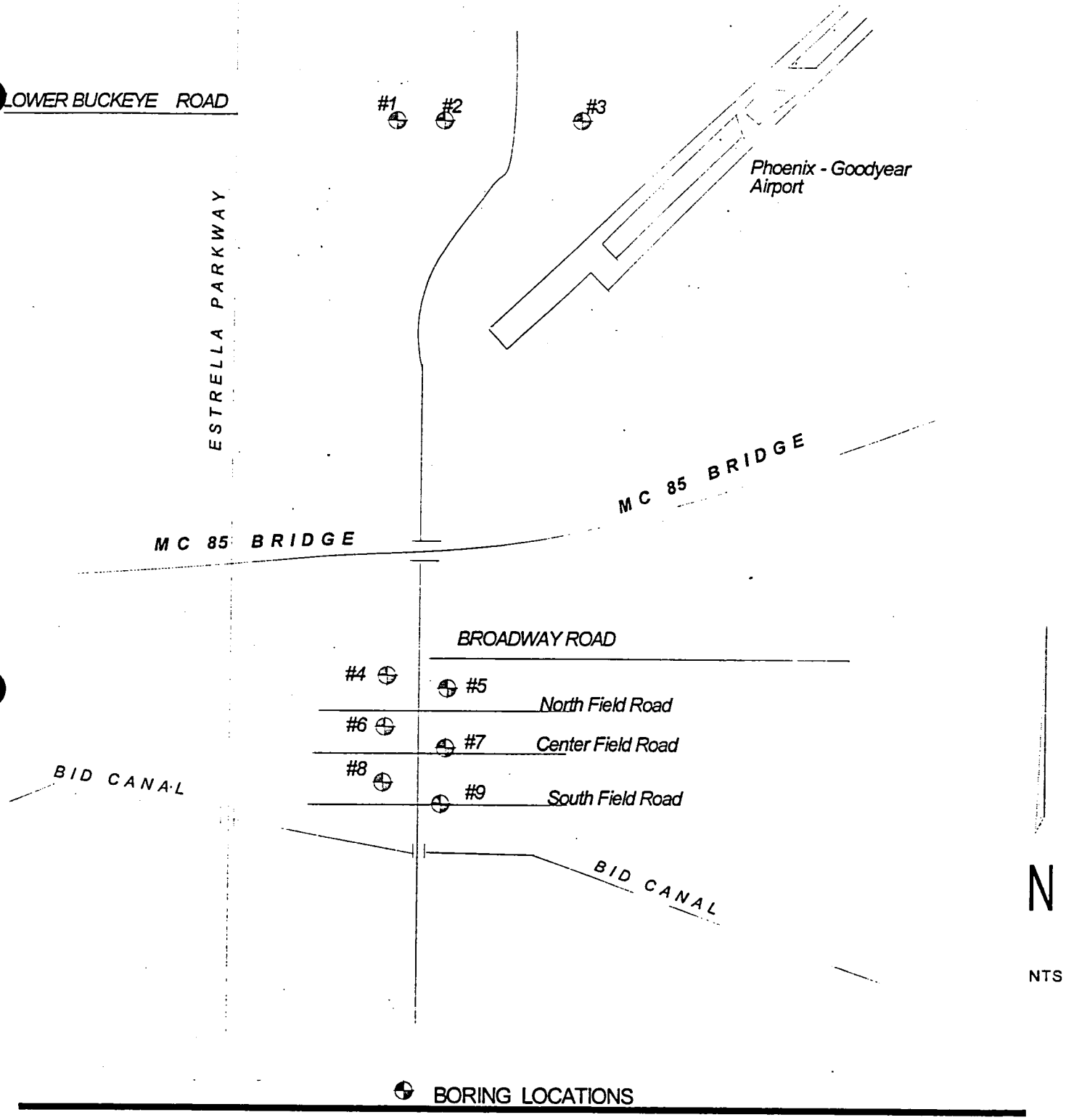
BULLARD WASH - LEVEES

Lower Buckeye Road, Broadway Road and BID Canal

Goodyear, Arizona

ATL JOB NO. 198013

PLATE 3



BORING LOCATIONS

BORING LOCATIONS

BULLARD WASH - LEVEES

Lower Buckeye Road, Broadway Road and BID Canal
Goodyear, Arizona

ATL JOB NO. 198013

PLATE 4

APPENDIX A

BORING LOGS

BULLARD WASH - LEVEES
Lower Buckeye Road, Broadway Road and BID Canal

ATL Job No. 198013

Boring No.: 1

Boring Location: *300 west of Channel centerline*
Southern edge of Lower Buckeye Road

Boring Equipment: *Mobile B-50 with 6 - Inch diameter hollow stem auger*

Date of Boring: *5/15/98* **Elevation of Boring:** *Existing*

Driller: *K. Phillips* **Logger:** *K. Phillips* **Reviewed By:** *A. Osorio*

Graphical Log	Depth (Feet)	SOIL DESCRIPTION	SPT Blows/ft	Ring Blows/ft	% Passing No. 200	Plasticity Index
		Dark brown, clayey SAND(SC), slightly moist				
	5	*Gravel was observed at 5 feet below grade, in a moist condition*				
	10		32			
		(Bottom of Boring at 11 ½ feet)				
	15					
	20					
	25					

Boring Stopped at 11 ½ Feet below Existing Grade

Groundwater Initial Depth ____ Hour ____ 24 Hour Depth ____

NOTE: THE ABOVE DATA FOR DESIGN PURPOSES ONLY.

A1

BULLARD WASH - LEVEES

Lower Buckeye Road, Broadway Road and BID Canal

ATL Job No. *198013*

Boring No.: 2

Boring Location: *200 west of Channel centerline*
Southern edge of Lower Buckeye Road

Boring Equipment: *Mobile B-50 with 6 - Inch diameter hollow stem auger*

Date of Boring: *5/15/98* **Elevation of Boring:** *Existing*

Driller: *K. Phillips* **Logger:** *K. Phillips* **Reviewed By:** *A. Osorio*

Graphical Log	Depth (Feet)	SOIL DESCRIPTION	SPT Blows/ft	Ring Blows/ft	% Passing No. 200	Plasticity Index
		Dark brown, sandy lean CLAY(CL), moist				
	5			32		
		Small lenses of clay was observed starting at 7 feet below grade				
	10		11			
		(Bottom of Boring at 11 ½ feet)				
	15					
	20					
	25					

Boring Stopped at 11 ½ Feet below Existing Grade

Groundwater — Initial Depth — Hour — 24 Hour Depth

NOTE: THE ABOVE DATA FOR DESIGN PURPOSES ONLY.

A2

BULLARD WASH - LEVEES
Lower Buckeye Road, Broadway Road and BID Canal

ATL Job No. 198013

Boring No.: 3

Boring Location: *225 east of Channel centerline*
Southern edge of Lower Buckeye Road

Boring Equipment: *Mobile B-50 with 6 - Inch diameter hollow stem auger*

Date of Boring: *5/15/98* **Elevation of Boring:** *Existing*

Driller: *K. Phillips* **Logger:** *K. Phillips* **Reviewed By:** *A. Osorio*

Graphical Log	Depth (Feet)	SOIL DESCRIPTION	SPT Blows/ft	Ring Blows/ft	% Passing No. 200	Plasticity Index
		Dark brown, sandy lean CLAY(CL), slightly moist				
		White, sandy fat CLAY(CH), with gravel, slightly moist				
	5	*Light brown, sandy lean CLAY(CL) with gravel, moist*				
		Observed Moderate cementation at 8 to 10 feet below grade				
	10		*88 / 7"*			
		(Bottom of Boring at 11 feet and 1 inch)				
	15					
	20					
	25					

Boring Stopped at 11'-1" below Existing Grade

Groundwater Initial Depth Hour 24 Hour Depth

NOTE: THE ABOVE DATA FOR DESIGN PURPOSES ONLY.

BULLARD WASH - LEVEES
Lower Buckeye Road, Broadway Road and BID Canal

ATL Job No. 198013

Boring No.: 4

Boring Location: *75 feet west of centerline*
25 feet south of Broadway Road

Boring Equipment: *Mobile B-50 with 6 - Inch diameter hollow stem auger*

Date of Boring: *5/14/98* **Elevation of Boring:** *Existing*

Driller: *K. Phillips* **Logger:** *K. Phillips* **Reviewed By:** *A. Osorio*

Graphical Log	Depth (Feet)	SOIL DESCRIPTION	SPT Blows/ft	Ring Blows/ft	% Passing No. 200	Plasticity Index
		Dark brown, lean CLAY(CL) with sand, moist				
	5					
	10		41			
		(Bottom of Boring at 11 ½ feet)				
	15					
	20					
	25					

Boring Stopped at 11 ½ Feet below Existing Grade

Groundwater	Initial Depth	Hour	24 Hour Depth

NOTE: THE ABOVE DATA FOR DESIGN PURPOSES ONLY.

BULLARD WASH - LEVEES
Lower Buckeye Road, Broadway Road and BID Canal

ATL Job No. 198013
Boring No.: 5

Boring Location: *75 feet east of centerline*
59 feet north of north field road

Boring Equipment: *Mobile B-50 with 6 - Inch diameter hollow stem auger*

Date of Boring: *5/14/98* **Elevation of Boring:** *Existing*

Driller: *K. Phillips* **Logger:** *K. Phillips* **Reviewed By:** *A. Osorio*

Graphical Log	Depth (Feet)	SOIL DESCRIPTION	SPT Blows/ft	Ring Blows/ft	% Passing No. 200	Plasticity Index
		Dark brown, lean CLAY(CL), moist				
		Percentage of sand was observed at 1 to 10 feet below grade				
	5					
	10					
			38			
		(Bottom of Boring at 11 ½ feet)				
	15					
	20					
	25					

Boring Stopped at 11 ½ Feet below Existing Grade

Groundwater _____ Initial Depth _____ Hour _____ 24 Hour Depth

NOTE: THE ABOVE DATA FOR DESIGN PURPOSES ONLY.

BULLARD WASH - LEVEES
Lower Buckeye Road, Broadway Road and BID Canal

ATL Job No. 198013
Boring No.: 6

Boring Location: *75 feet west of centerline*
25 feet south of north field road

Boring Equipment: *Mobile B-50 with 6 - Inch diameter hollow stem auger*

Date of Boring: *5/14/98* **Elevation of Boring:** *Existing*

Driller: *K. Phillips* **Logger:** *K. Phillips* **Reviewed By:** *A. Osorio*

Graphical Log	Depth (Feet)	SOIL DESCRIPTION	SPT Blows/ft	Ring Blows/ft	% Passing No. 200	Plasticity Index
		Dark brown, lean CLAY(CL), moist				
	5					
	10					
			24			
		(Bottom of Boring at 11 ½ feet)				
	15					
	20					
	25					

Boring Stopped at 11 ½ Feet below Existing Grade

Groundwater Initial Depth Hour 24 Hour Depth

NOTE: THE ABOVE DATA FOR DESIGN PURPOSES ONLY.

BULLARD WASH - LEVEES
Lower Buckeye Road, Broadway Road and BID Canal

ATL Job No. 198013

Boring No.: 7

Boring Location: *75 feet east of centerline*
Center of field road north shoulder

Boring Equipment: *Mobile B-50 with 6 - Inch diameter hollow stem auger*

Date of Boring: *5/14/98* **Elevation of Boring:** *Existing*

Driller: *K. Phillips* **Logger:** *K. Phillips* **Reviewed By:** *A. Osorio*

Graphical Log	Depth (Feet)	SOIL DESCRIPTION	SPT Blows/ft	Ring Blows/ft	% Passing No. 200	Plasticity Index
		Black, lean CLAY(CL), slightly moist				
		Changed color to Dark brown, in a moist condition starting at 2 ½ feet below grade		27		
	5	*Changed color to Light brown at 5 feet below grade*				
	10		14			
		(Bottom of Boring at 11 ½ feet)				
	15					
	20					
	25					

Boring Stopped at 11 ½ Feet below Existing Grade

Groundwater _____ Initial Depth _____ Hour _____ 24 Hour Depth

NOTE: THE ABOVE DATA FOR DESIGN PURPOSES ONLY.

BULLARD WASH - LEVEES
Lower Buckeye Road, Broadway Road and BID Canal

ATL Job No. 198013
Boring No.: 8

Boring Location: *60 feet south of center field road*
75 feet west of centerline

Boring Equipment: *Mobile B-50 with 6 - Inch diameter hollow stem auger*

Date of Boring: *5/15/98* **Elevation of Boring:** *Existing*

Driller: *K. Phillips* **Logger:** *K. Phillips* **Reviewed By:** *A. Osorio*

Graphical Log	Depth (Feet)	SOIL DESCRIPTION	SPT Blows/ft	Ring Blows/ft	% Passing No. 200	Plasticity Index
		Black, lean CLAY(CL), moist				
		Changed color to Dark brown at 3 feet below grade				
	5					
	10		24			
		(Bottom of Boring at 11 ½ feet)				
	15					
	20					
	25					

Boring Stopped at 11 ½ Feet below Existing Grade

Groundwater — Initial Depth — Hour — 24 Hour Depth

NOTE: THE ABOVE DATA FOR DESIGN PURPOSES ONLY.

BULLARD WASH - LEVEES
Lower Buckeye Road, Broadway Road and BID Canal

ATL Job No. 198013
Boring No.: 9

Boring Location: *75 feet east of centerline South field road*

Boring Equipment: *Mobile B-50 with 6 - Inch diameter hollow stem auger*

Date of Boring: *5/15/98* **Elevation of Boring:** *Existing*

Driller: *K. Phillips* **Logger:** *K. Phillips* **Reviewed By:** *A. Osorio*

Graphical Log	Depth (Feet)	SOIL DESCRIPTION	SPT Blows/ft	Ring Blows/ft	% Passing No. 200	Plasticity Index
		Black, lean CLAY(CL), moist				
		Changed color to Dark brown at 3 feet below grade				
	5					
	10		36			
		(Bottom of Boring at 11 ½ feet)				
	15					
	20					
	25					

Boring Stopped at 11 ½ Feet below Existing Grade

Groundwater	Initial Depth	Hour	24 Hour Depth

NOTE: THE ABOVE DATA FOR DESIGN PURPOSES ONLY.

APPENDIX B

LABORATORY TEST RESULTS

SUMMARY OF LABORATORY ANALYSIS

CLIENT: SVERDRUP CIVIL, INC. DATE: 05/29/98

PROJECT: BULLARD WASH LEVEES

LOCATION: LOWER BUCKEYE ROAD, BROADWAY ROAD AND BID CANAL , GOODYEAR, ARIZONA

MATERIAL: See Below SAMPLING DATE: 05/15/98

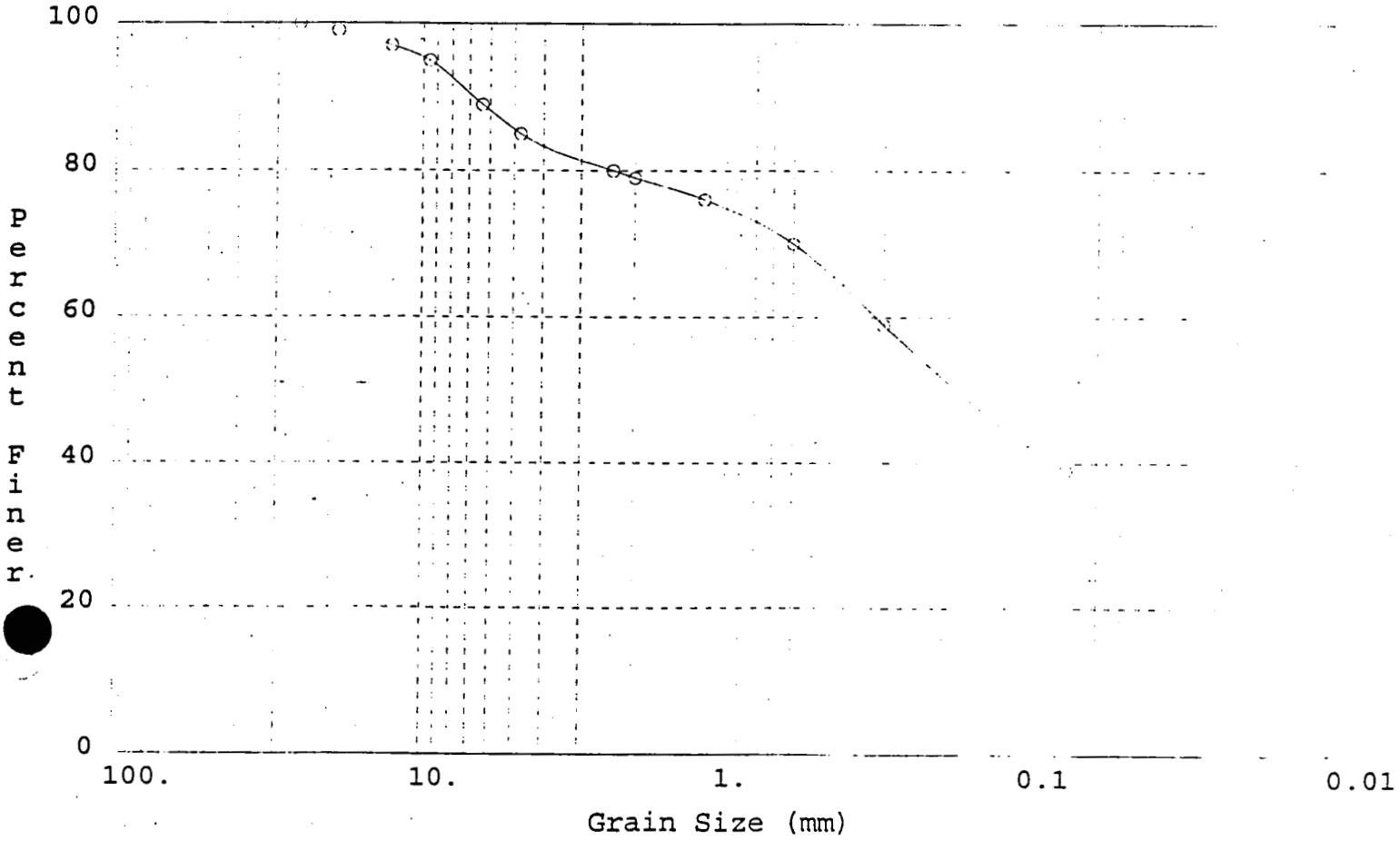
REQUESTED BY: David Hayes ATL JOB NO: 198013

BORING No.	DEPTH (Feet)	MOIST %	USCS	LL	PI	SIEVE ANALYSIS - PERCENT PASSING											
						#200	#100	#50	#40	#30	#16	#10	#4	3/8	3/4	1.0	3
1	5 - 10	8.8	SC	27	8	39.3	48	59	65	70	76	79	85	95	99	100	-
2	0 - 10	9.0	CL	47	30	63.0	79	95	98	99	100	-	-	-	-	-	-
3	3 - 5	15.2	CH	54	32	55.2	60	65	68	71	77	82	88	95	99	100	-
4	0- 7	14.8	CL	48	30	74.8	91	99	100	-	-	-	-	-	-	-	-
5	1 - 5	20.6	CL	32	13	82.7	96	99	100	-	-	-	-	-	-	-	-
6	0 - 10	17.9	CL	30	9	88.0	98	100	-	-	-	-	-	-	-	-	-
7	2 1/2 - 5	20.9	CL	38	18	95.0	99	100	-	-	-	-	-	-	-	-	-
8	3 - 10	22.9	CL	36	17	92.3	98	98	98	99	99	100	-	-	-	-	-
9	5 - 10	21.7	CL	34	10	93.3	97	98	98	98	99	99	100	-	-	-	-

Project Number = 198013 Client: Sverdrup, Inc.
Location = Bullard Wash Levees, Lower Buckeye Road
Date = 5/20/98
Tested By = M. Castillo
Boring Number = 1
Depth = 5' - 10'
Sample Number = 98-0519
Description = Dark brown, clayey SAND(SC) with gravel
Dry Sample Weight (g) = 1000

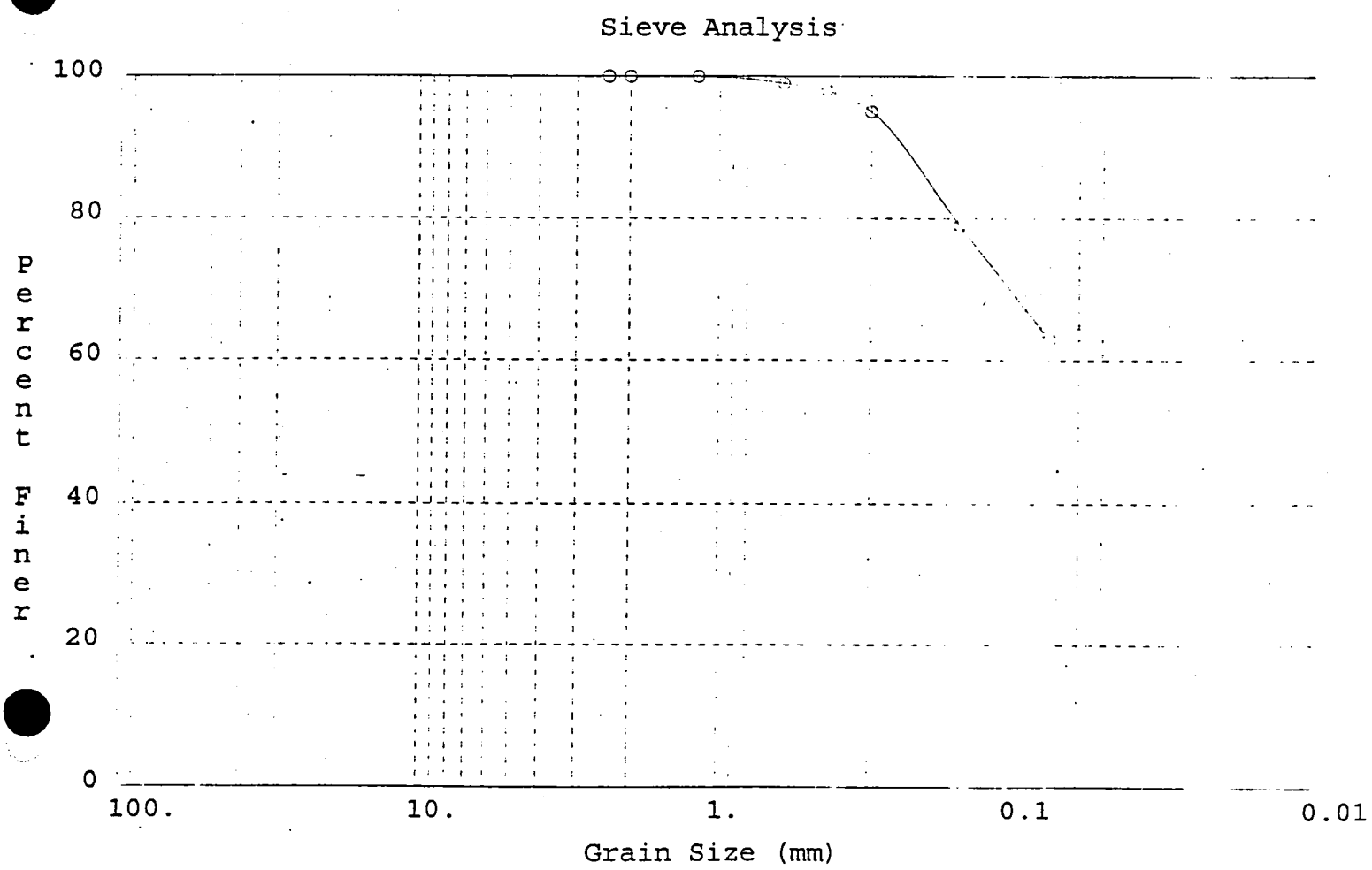
SIEVE NUMBER	SIEVE OPENING (mm)	RETAINED WEIGHT (g)	PERCENT OF WEIGHT RETAINED	CUMULATIVE PERCENT RETAINED	PERCENT FINER (%)
1"	25.400	0.00	0.00	0.00	100.00
3/4"	19.050	10.00	1.00	1.00	99.00
1/2"	12.700	20.00	2.00	3.00	97.00
3/8"	9.500	20.00	2.00	5.00	95.00
1/4"	6.350	60.00	6.00	11.00	89.00
#4	4.750	40.00	4.00	15.00	85.00
#8	2.360	50.00	5.00	20.00	80.00
#10	2.000	10.00	1.00	21.00	79.00
#16	1.180	30.00	3.00	24.00	76.00
#30	0.600	60.00	6.00	30.00	70.00
#40	0.425	50.00	5.00	35.00	65.00
#50	0.300	60.00	6.00	41.00	59.00
#100	0.150	110.00	11.00	52.00	48.00
#200	0.075	90.00	9.00	61.00	39.00
Pan	0.000	0.00	0.00	61.00	39.00

Sieve Analysis



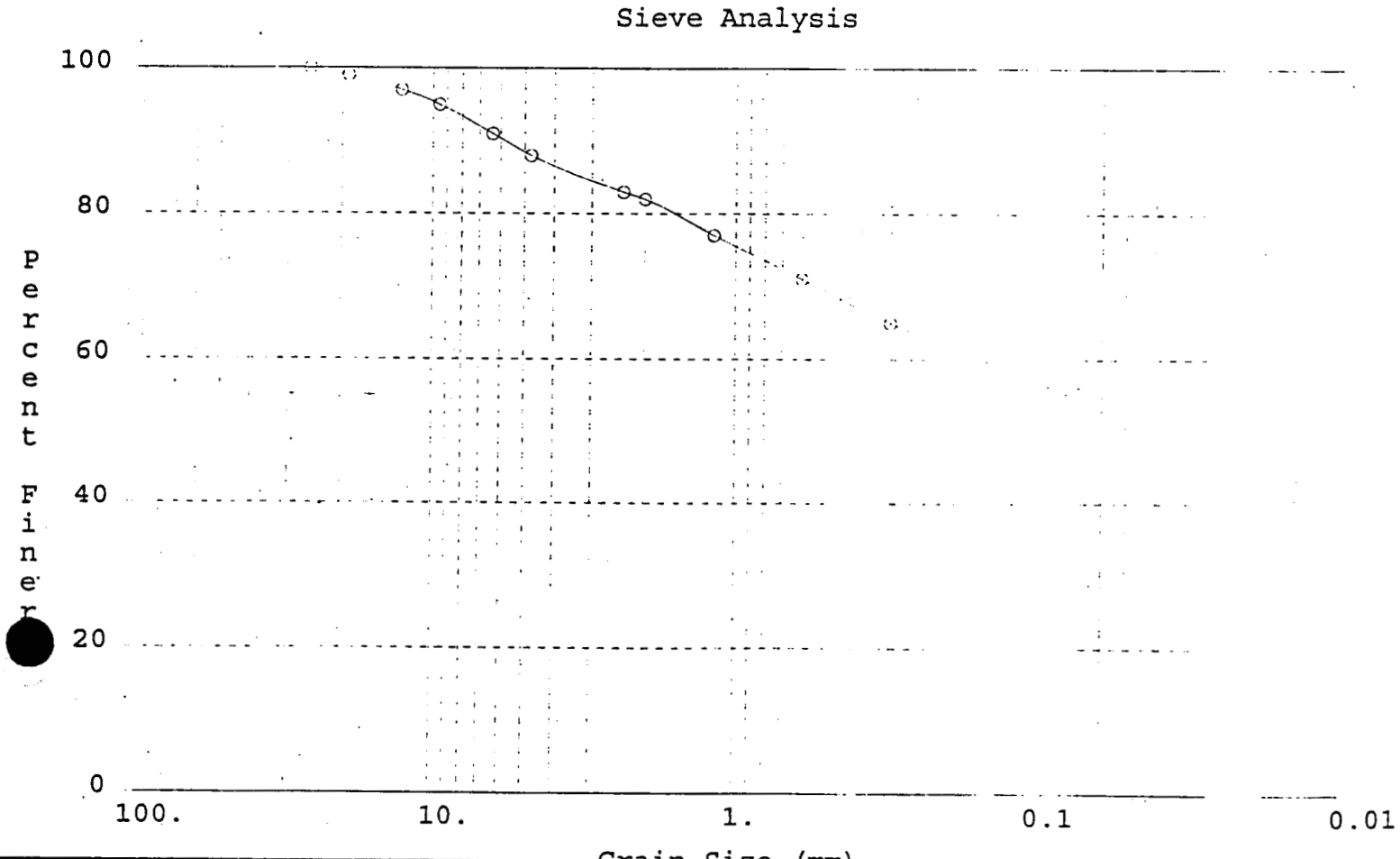
Project Number = 198013 Client: Sverdrup, Inc.
Location = Bullard Wash Levees, Lower Buckeye Road
Date = 5/20/98
Tested By = M. Castillo
Boring Number = 2
Depth = 0 - 10'
Sample Number = 98-0520
Description = Dark brown, sandy lean CLAY(CL)
Dry Sample Weight (g) = 1000

SIEVE NUMBER	SIEVE OPENING (mm)	RETAINED WEIGHT (g)	PERCENT OF WEIGHT RETAINED	CUMULATIVE PERCENT RETAINED	PERCENT FINER (%)
#8	2.360	0.00	0.00	0.00	100.00
#10	2.000	0.00	0.00	0.00	100.00
#16	1.180	0.00	0.00	0.00	100.00
#30	0.600	10.00	1.00	1.00	99.00
#40	0.425	10.00	I.00	2.00	98.00
#50	0.300	30.00	3.00	5.00	95.00
#100	0.150	160.00	16.00	21.00	79.00
#200	0.075	160.00	16.00	37.00	63.00
Pan	0.000	0.00	0.00	37.00	63.00



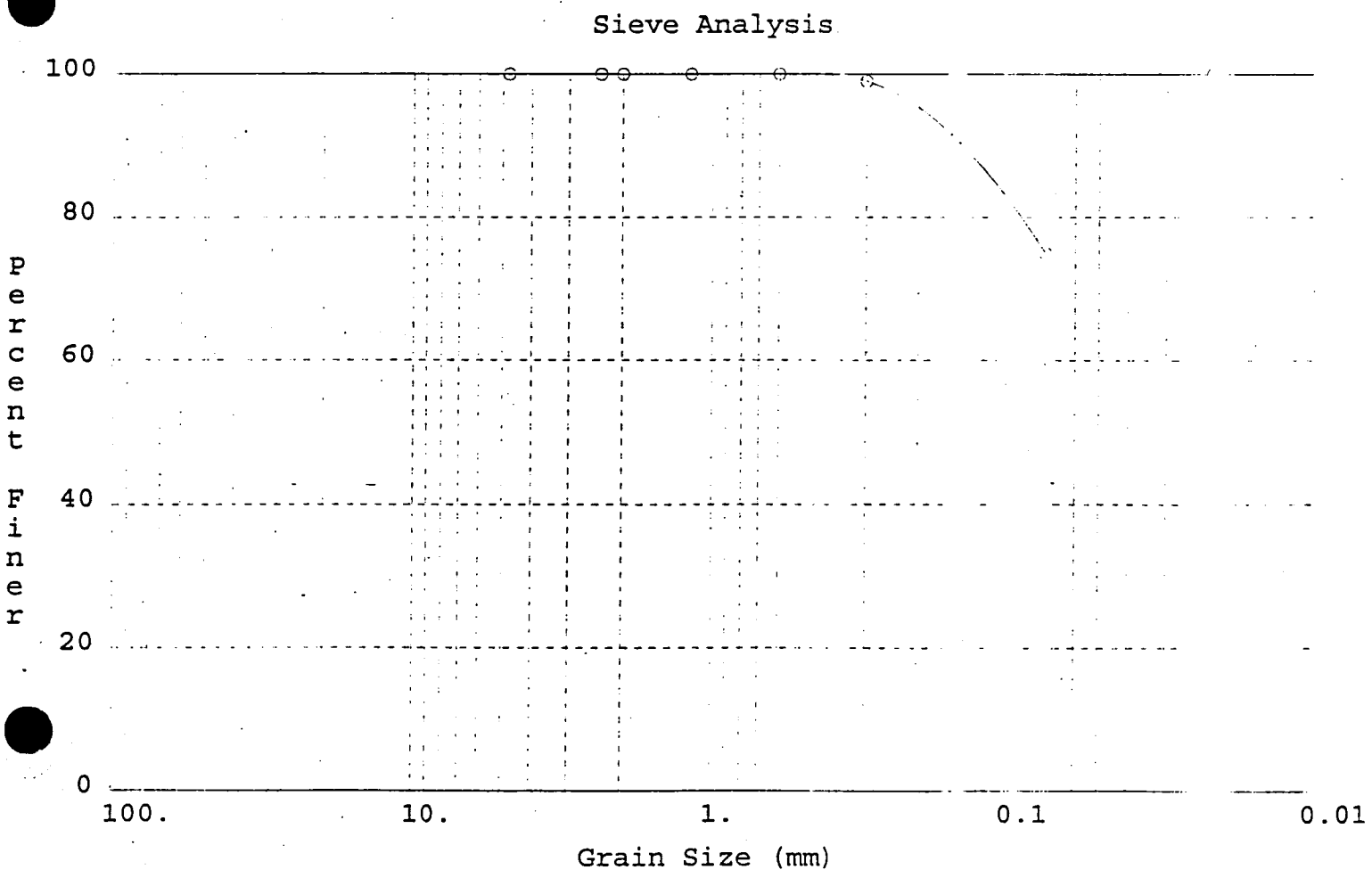
Project Number = 198013 Client: Sverdrup, Inc.
Location = Bullard Wash Levees, Lower Buckeye Road
Date = 5/20/98
Tested By = M. Castillo
Boring Number = 3
Depth = 3' - 5'
Sample Number = 98-0522
Description = Tan, sandy fat CLAY(CH)
Dry Sample Weight (g) = 1000

SIEVE NUMBER	SIEVE OPENING (mm)	RETAINED WEIGHT (g)	PERCENT OF WEIGHT RETAINED	CUMULATIVE PERCENT RETAINED	PERCENT FINER (%)
1"	25.400	0.00	0.00	0.00	100.00
3/4"	19.050	10.00	1.00	1.00	99.00
1/2"	12.700	20.00	2.00	3.00	97.00
3/8"	9.500	20.00	2.00	5.00	95.00
1/4"	6.350	40.00	4.00	9.00	91.00
#4	4.750	30.00	3.00	12.00	88.00
#8	2.360	50.00	5.00	17.00	83.00
#10	2.000	10.00	1.00	18.00	82.00
#16	1.180	50.00	5.00	23.00	77.00
#30	0.600	60.00	6.00	29.00	71.00
#40	0.425	30.00	3.00	32.00	68.00
#50	0.300	30.00	3.00	35.00	65.00
#100	0.150	50.00	5.00	40.00	60.00
#200	0.075	50.00	5.00	45.00	55.00
Pan	0.000	0.00	0.00	45.00	55.00



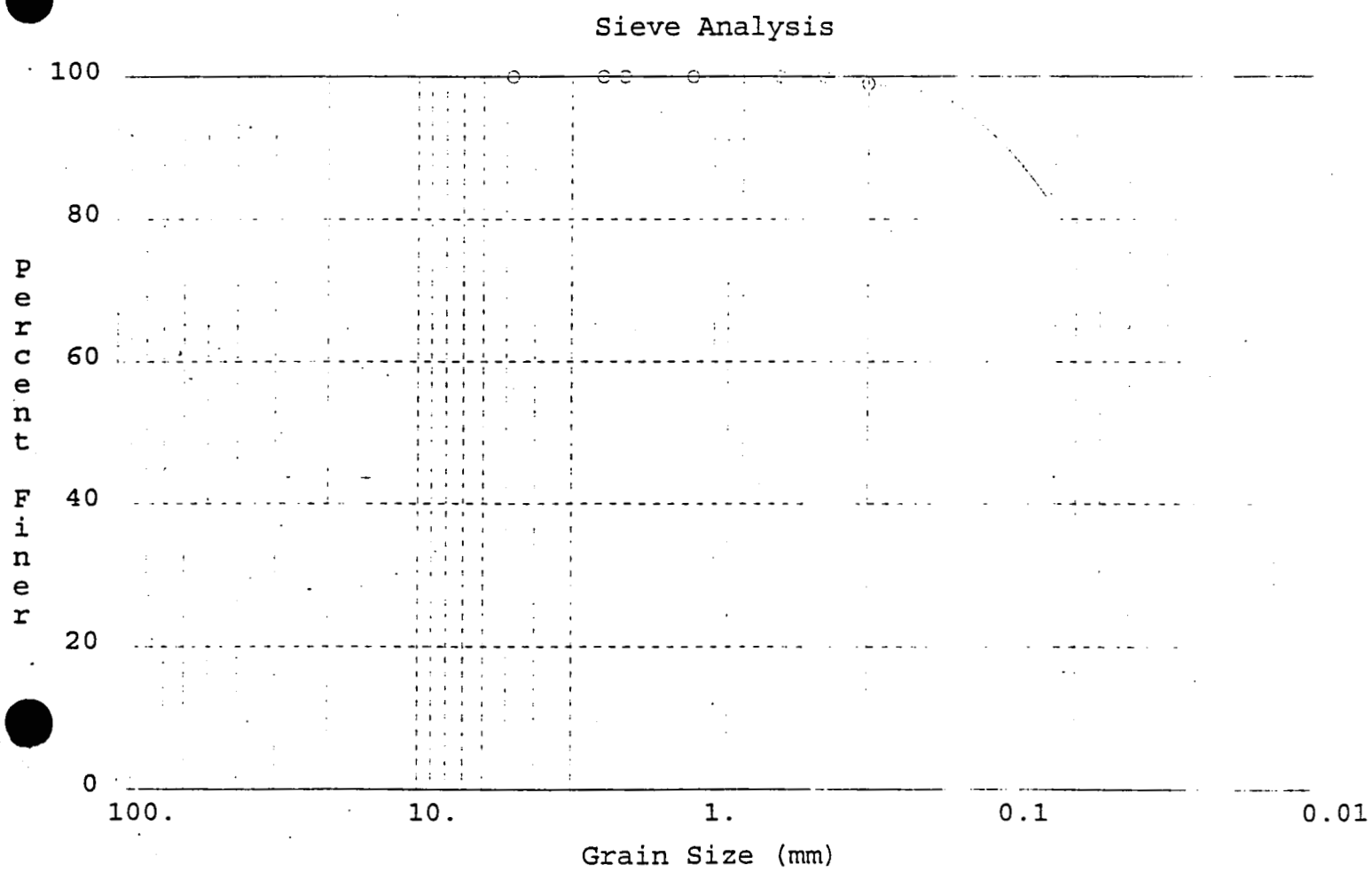
Project Number = 198013 Client: Sverdrup, Inc.
Location = Bullard Wash Levees, Lower Buckeye Road
Date = 5/20/98
Tested By = M. Castillo
Boring Number = 4
Depth = 0 - 7'
Sample Number = 98-0523
Description = Dark brown, lean CLAY(CL) with sand
Dry Sample Weight (g) = 1000

SIEVE NUMBER	SIEVE OPENING (mm)	RETAINED WEIGHT (g)	PERCENT OF WEIGHT RETAINED	CUMULATIVE PERCENT RETAINED	PERCENT FINER (%)
#4	4.750	0.00	0.00	0.00	100.00
#8	2.360	0.00	0.00	0.00	100.00
#10	2.000	0.00	0.00	0.00	100.00
#16	1.180	0.00	0.00	0.00	100.00
#30	0.600	0.00	0.00	0.00	100.00
#40	0.425	0.00	0.00	0.00	100.00
#50	0.300	10.00	1.00	1.00	99.00
#100	0.150	80.00	8.00	9.00	91.00
#200	0.075	160.00	16.00	25.00	75.00
Pan	0.000	0.00	0.00	25.00	75.00



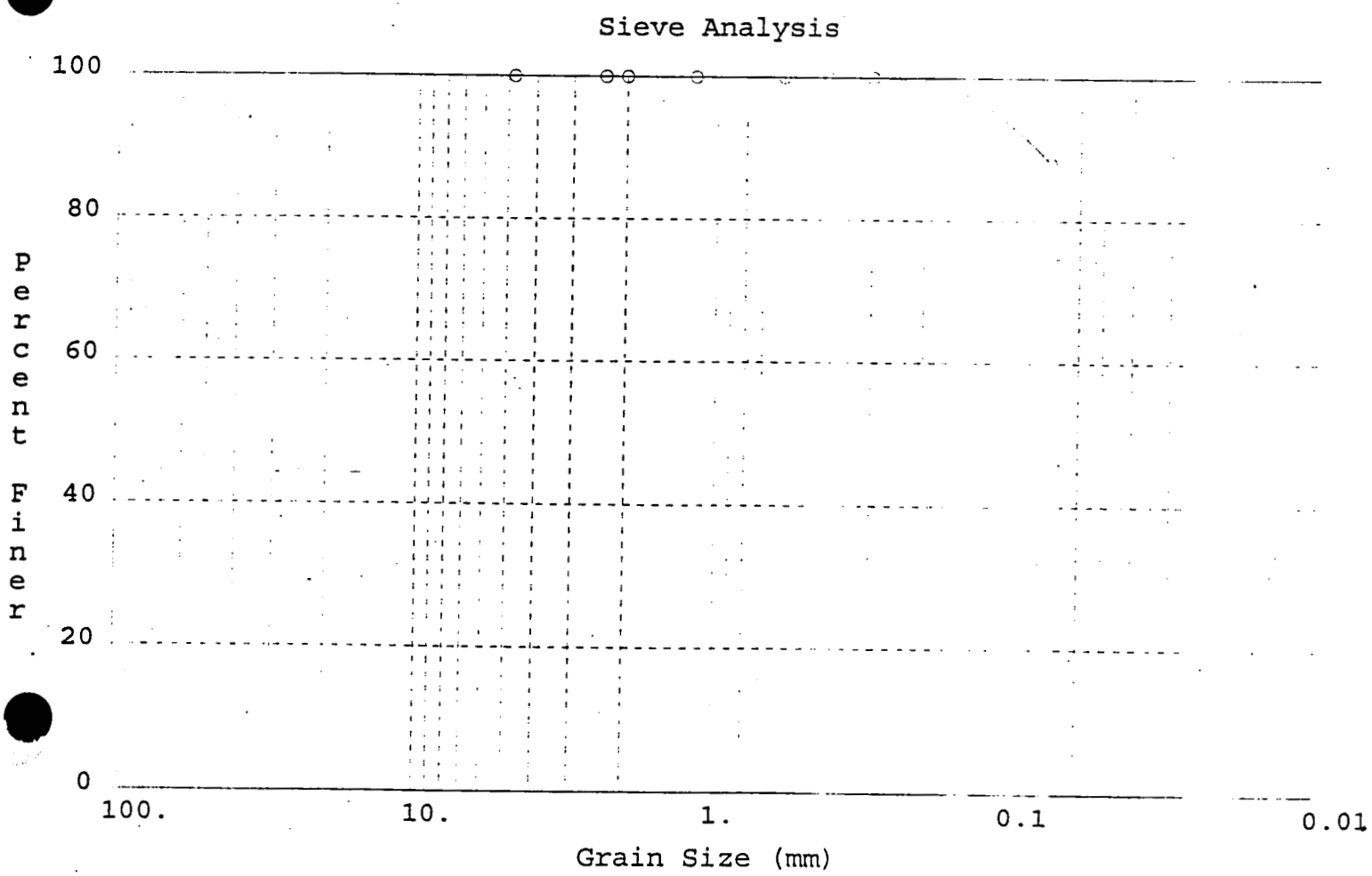
Project Number = 198013 Client: Sverdrup, Inc.
Location = Bullard Wash Levees, Lower Buckeye Road
Date = 5/26/98
Tested By = M.Blalock
Boring Number = 5
Depth = 1 - 5'
Sample Number = 98-0524
Description = Dark brown, lean CLAY(CL) with sand
Dry Sample Weight (g) = 1000

SIEVE NUMBER	SIEVE OPENING (mm)	RETAINED WEIGHT (g)	PERCENT OF WEIGHT RETAINED	CUMULATIVE PERCENT RETAINED	PERCENT FINER (%)
#4	4.750	0.00	0.00	0.00	100.00
#8	2.360	0.00	0.00	0.00	100.00
#10	2.000	0.00	0.00	0.00	100.00
#16	1.180	0.00	0.00	0.00	100.00
#30	0.600	0.00	0.00	0.00	100.00
#40	0.425	0.00	0.00	0.00	100.00
#50	0.300	10.00	1.00	1.00	99.00
#100	0.150	30.00	3.00	4.00	96.00
#200	0.075	130.00	13.00	17.00	83.00
Pan	0.000	0.00	0.00	17.00	83.00



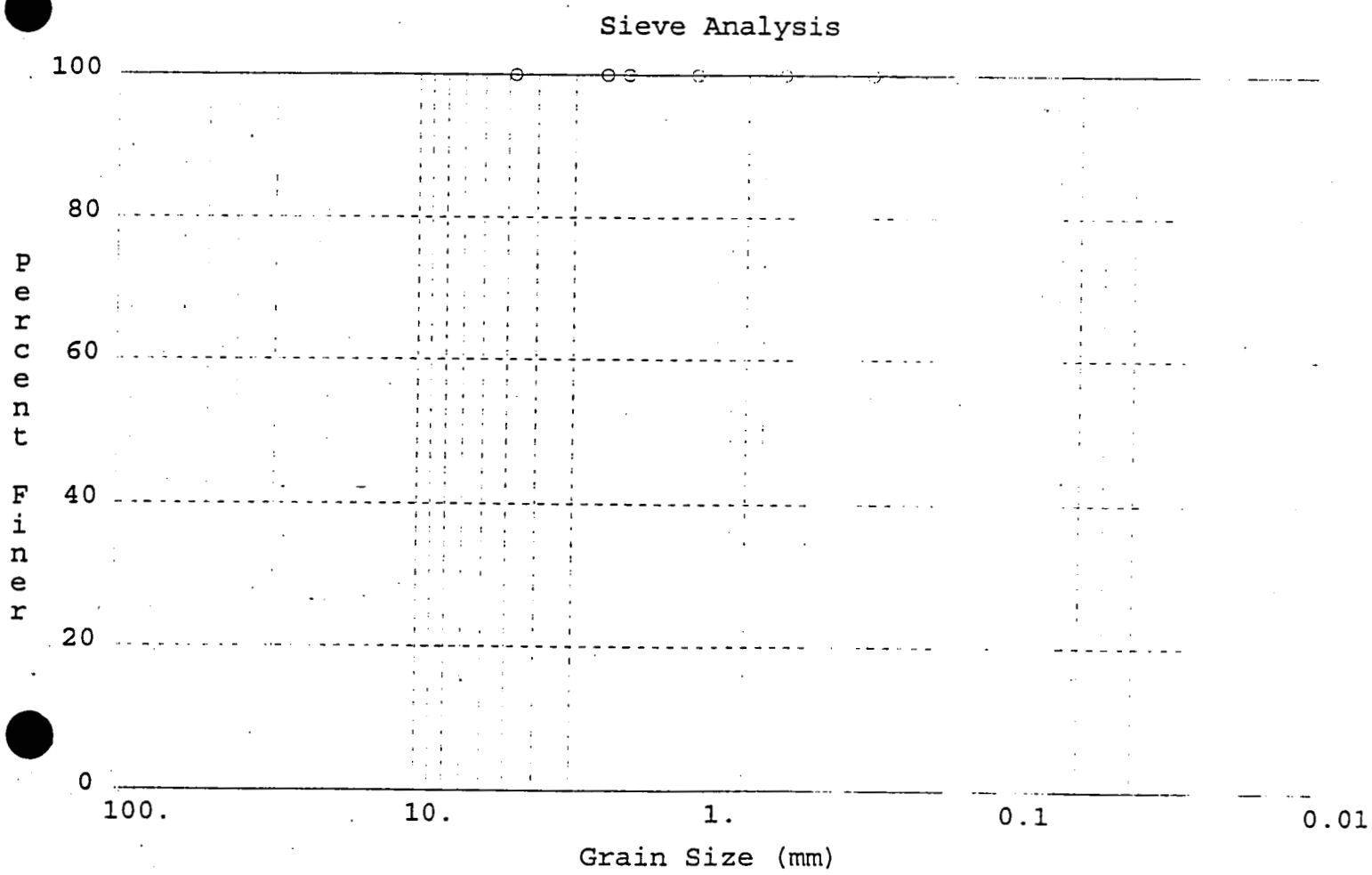
Project Number = 198013 Client: Sverdrup, Inc.
Location = Bullard Wash Levees, Lower Buckeye Road
Date = 5/20/98
Tested By = M. Castillo
Boring Number = 6
Depth = 0 - 10'
Sample Number = 98-0525
Description = Dark brown, lean CLAY(CL)
Dry Sample Weight (g) = 1000

SIEVE NUMBER	SIEVE OPENING (mm)	RETAINED WEIGHT (g)	PERCENT OF WEIGHT RETAINED	CUMULATIVE PERCENT RETAINED	PERCENT FINER (%)
#4	4.750	0.00	0.00	0.00	100.00
#8	2.360	0.00	0.00	0.00	100.00
#10	2.000	0.00	0.00	0.00	100.00
#16	1.180	0.00	0.00	0.00	100.00
#30	0.600	0.00	0.00	0.00	100.00
#40	0.425	0.00	0.00	0.00	100.00
#50	0.300	0.00	0.00	0.00	100.00
#100	0.150	20.00	2.00	2.00	98.00
#200	0.075	100.00	10.00	12.00	88.00
Pan	0.000	0.00	0.00	12.00	88.00



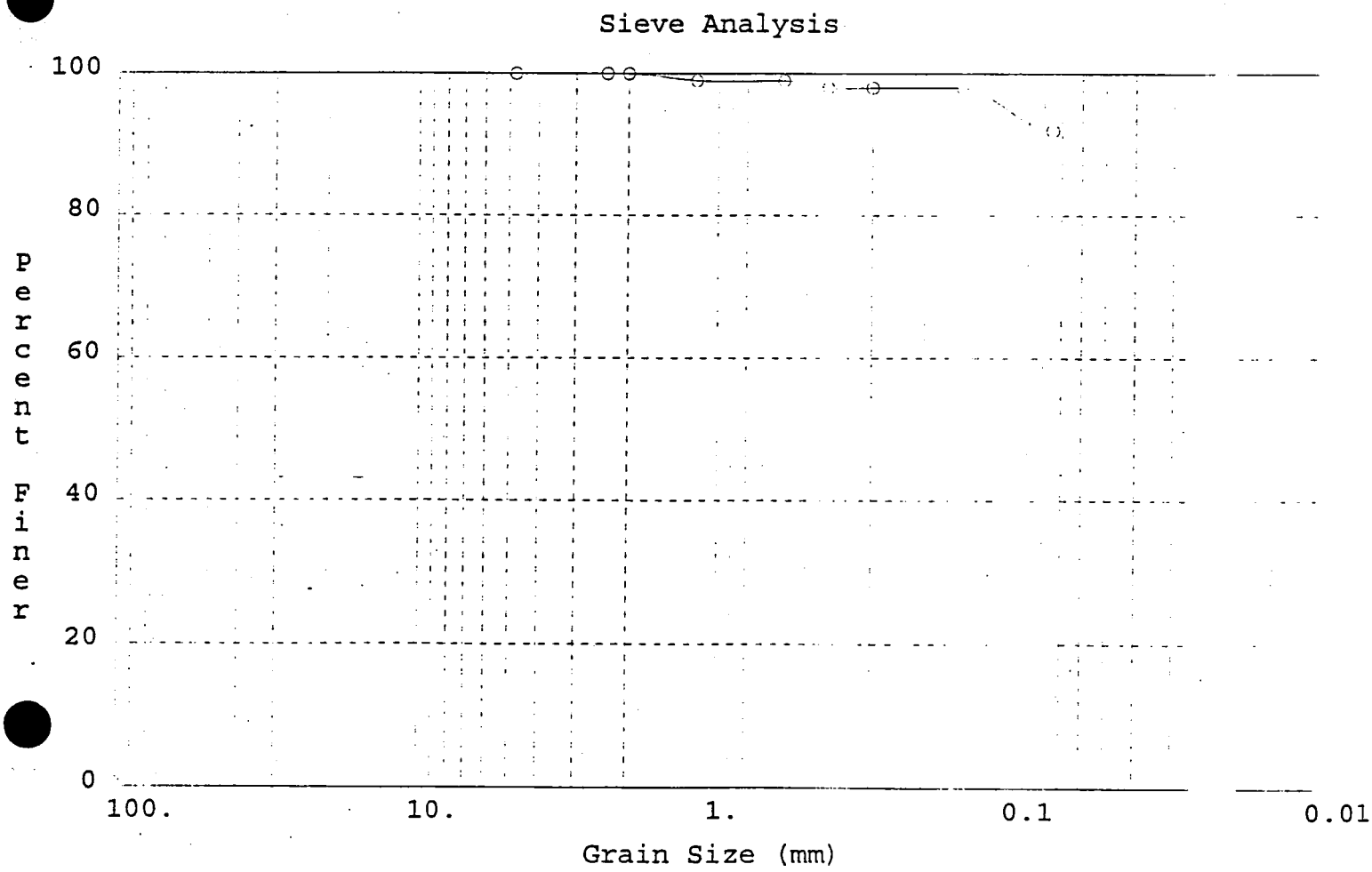
Project Number = 198013 Client: Sverdrup, Inc.
Location = Bullard Wash Levees, Lower Buckeye Road
Date = 5/20/98
Tested By = M. Castillo
Boring Number = 7
Depth = 2 1/2' - 5'
Sample Number = 98-0526
Description = Dark brown, lean CLAY(CL)
Dry Sample Weight (g) = 1000

SIEVE NUMBER	SIEVE OPENING (mm)	RETAINED WEIGHT (g)	PERCENT OF WEIGHT RETAINED	CUMULATIVE PERCENT RETAINED	PERCENT FINER (%)
#4	4.750	0.00	0.00	0.00	100.00
#8	2.360	0.00	0.00	0.00	100.00
#10	2.000	0.00	0.00	0.00	100.00
#16	1.180	0.00	0.00	0.00	100.00
#30	0.600	0.00	0.00	0.00	100.00
#40	0.425	0.00	0.00	0.00	100.00
#50	0.300	0.00	0.00	0.00	100.00
#100	0.150	10.00	1.00	1.00	99.00
#200	0.075	40.00	4.00	5.00	95.00
Pan	0.000	0.00	0.00	5.00	95.00



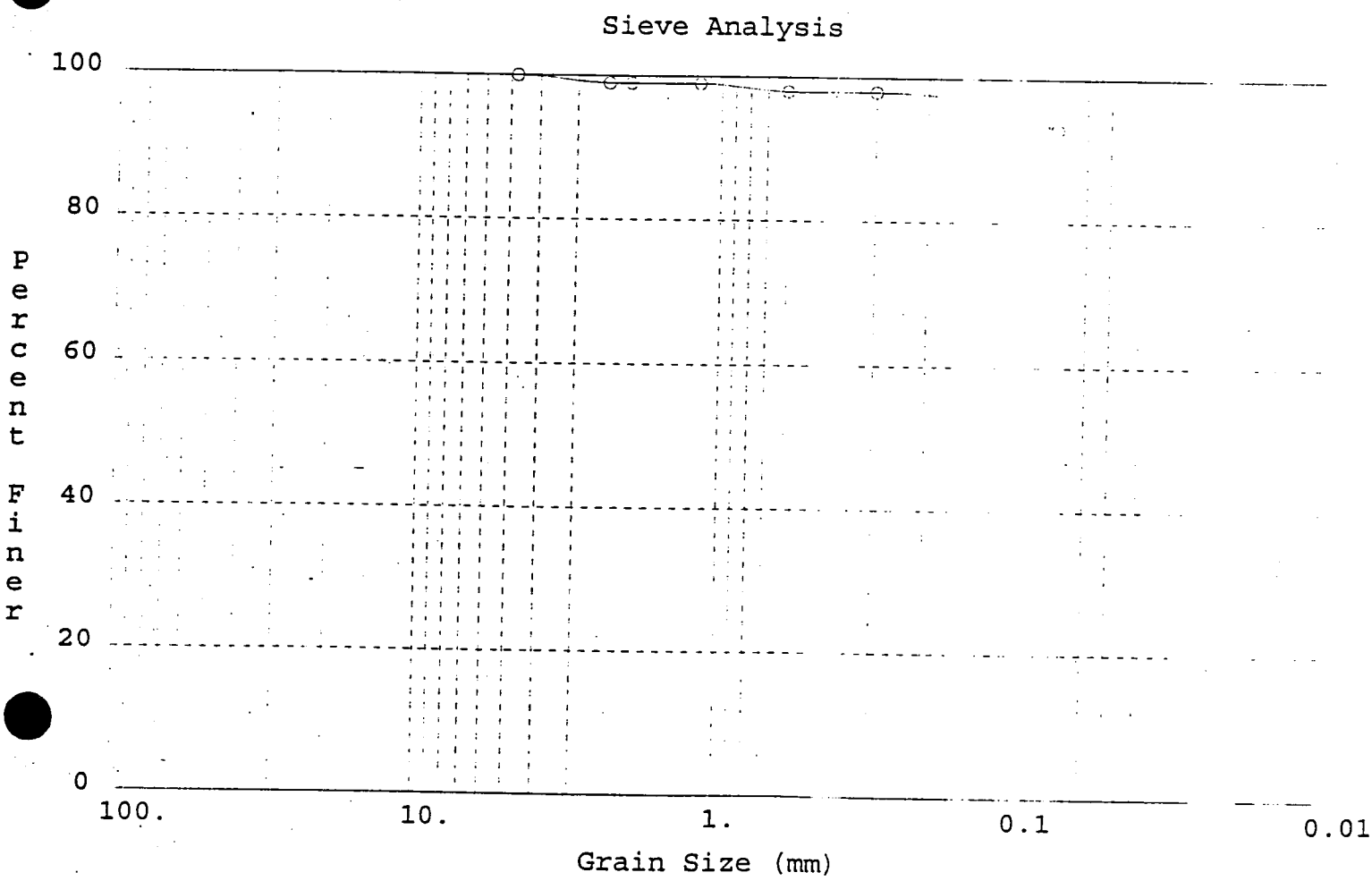
Project Number = 198013 Client: Sverdrup, Inc.
Location = Bullard Wash Levees, Lower Buckeye Road
Date = 5/26/98
Tested By = M. Blalock
Boring Number = 8
Depth = 3' - 10'
Sample Number = 98-0529
Description = Dark brown, lean CLAY(CL)
Dry Sample Weight (g) = 1000

SIEVE NUMBER	SIEVE OPENING (mm)	RETAINED WEIGHT (g)	PERCENT OF WEIGHT RETAINED	CUMULATIVE PERCENT RETAINED	PERCENT FINER (%)
#4	4.750	0.00	0.00	0.00	100.00
#8	2.360	0.00	0.00	0.00	100.00
#10	2.000	0.00	0.00	0.00	100.00
#16	1.180	10.00	1.00	1.00	99.00
#30	0.600	0.00	0.00	1.00	99.00
#40	0.425	10.00	1.00	2.00	98.00
#50	0.300	0.00	0.00	2.00	98.00
#100	0.150	0.00	0.00	2.00	98.00
#200	0.075	60.00	6.00	8.00	92.00
Pan	0.000	0.00	0.00	8.00	92.00



Project Number = 198013 Client: Sverdrup, Inc.
Location = Bullard Wash Levees, Lower Buckeye Road
Date = 5/26/98
Tested By = M. Blalock
Boring Number = 9
Depth = 5' - 10'
Sample Number = 98-0530
Description = Dark brown, lean CLAY(CL)
Dry Sample Weight (g) = 1000

SIEVE NUMBER	SIEVE OPENING (mm)	RETAINED WEIGHT (g)	PERCENT OF WEIGHT RETAINED	CUMULATIVE PERCENT RETAINED	PERCENT FINER (%)
#4	4.750	0.00	0.00	0.00	100.00
#8	2.360	10.00	1.00	1.00	99.00
#10	2.000	0.00	0.00	1.00	99.00
#16	1.180	0.00	0.00	1.00	99.00
#30	0.600	10.00	1.00	2.00	98.00
#40	0.425	0.00	0.00	2.00	98.00
#50	0.300	0.00	0.00	2.00	98.00
#100	0.150	10.00	1.00	3.00	97.00
#200	0.075	40.00	4.00	7.00	93.00
Pan	0.000	0.00	0.00	7.00	93.00

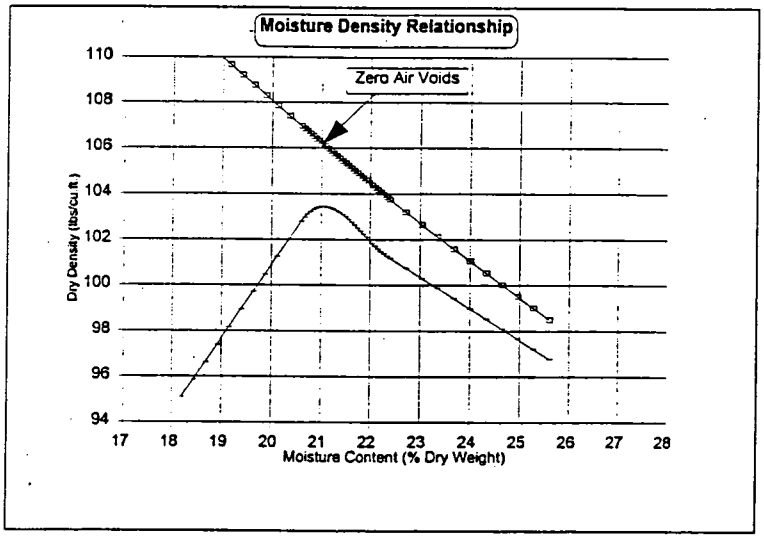


ATL, INC.
CONSTRUCTION QUALITY CONTROL
GEOTECHNICAL CONSULTANTS

PHOENIX – CORPORATE OFFICE
2912 W. Clarendon • Phoenix, AZ 85017
(602) 241-1097 • Fax (602) 277-1306

Summary of Moisture Density Relationship Tests

Client:	Sverdrup, Inc. 637 South 48th St. Ste 101 Tempe, AZ 85281	**Job No.**	198013
		Lab No.	98-0528
		Type of Rammer:	Manual
Project:	Bullard Wash Levees, Lower Buckeye Rd. Goodyear, AZ	**Test Date:**	05/22/98
		Material Description:	Dark brown, sandy lean CLAY(CL)
Test Designation:	ASTM D-698		
Test Method:	A	**Sample Source:**	Boring No.: 7 ; Depth: 2 1/2' - 5'



Specific Gravity Used For Zero Air Voids Curve: 2.65

Test No.	1	2	3	4
Dry Density (lbs/cu.ft.)	95.1	102.8	101.2	96.8
Moisture Content (%)	18.2	20.6	22.4	25.6

Maximum Dry Density (lbs/cu.ft.): **103.5**
Optimum Moisture Content (% of Dry Weight): **21.0**

Remarks:

Reviewed By:
Input By: AO

Respectfully Submitted:

Joseph B. Lopez, SET
Laboratory Supervisor

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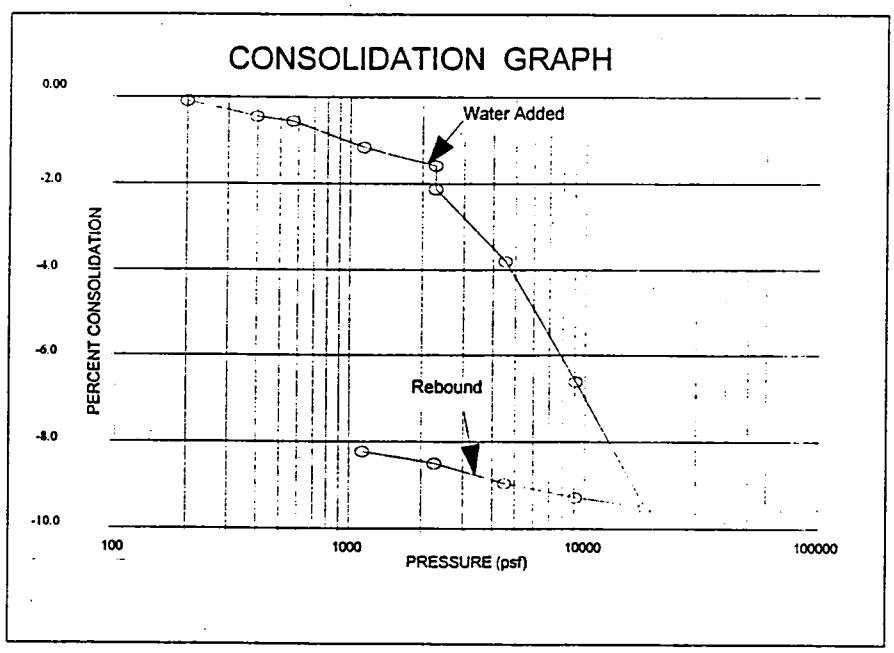
CONSOLIDATION TEST
(ASTM D-2435)

Client:	Sverdrup Civil, Inc.	**Lab No.:**	98-0527
Project Name :	Bullard Wash-Levees, Goodyear, AZ	**Test Date:**	05/19/98
Project No. :	198013	**Sample Location:**	Boring No.: 7
Initial Reading:	0.2000		Depth:2 1/2' - 3'
Dry Density:	96.5 pcf	**Soil Description:**	Dark brown, lean CLAY(CL)
Moisture Content:	Before: 21.8% After: 24.4%		

LOAD (tsf)	LOAD (psf)	DIAL READING	PERCENT CONSOLIDATION
0.05	100	0.2001	-0.01
0.10	200	0.2009	-0.09
0.20	400	0.2044	-0.44
0.29	570	0.2055	-0.55
0.57	1140	0.2116	-1.16
1.14	2280	0.2158	-1.58
1.14	2280	0.2212	-2.12
2.28	4560	0.2379	-3.79
4.56	9120	0.2661	-6.61
9.12	18240	0.2950	-9.50
4.56	9120	0.2928	-9.28
2.28	4560	0.2895	-8.95
1.14	2280	0.2849	-8.49
0.57	1140	0.2822	-8.22



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BULLARD WASH LEVEES
LOWER BUCKEYE ROAD
BROADWAY ROAD & BID CANAL
GOODYEAR, ARIZONA
ATL JOB NO. 198013

PERCENT SWELL TEST
(Surcharge = 100psf)

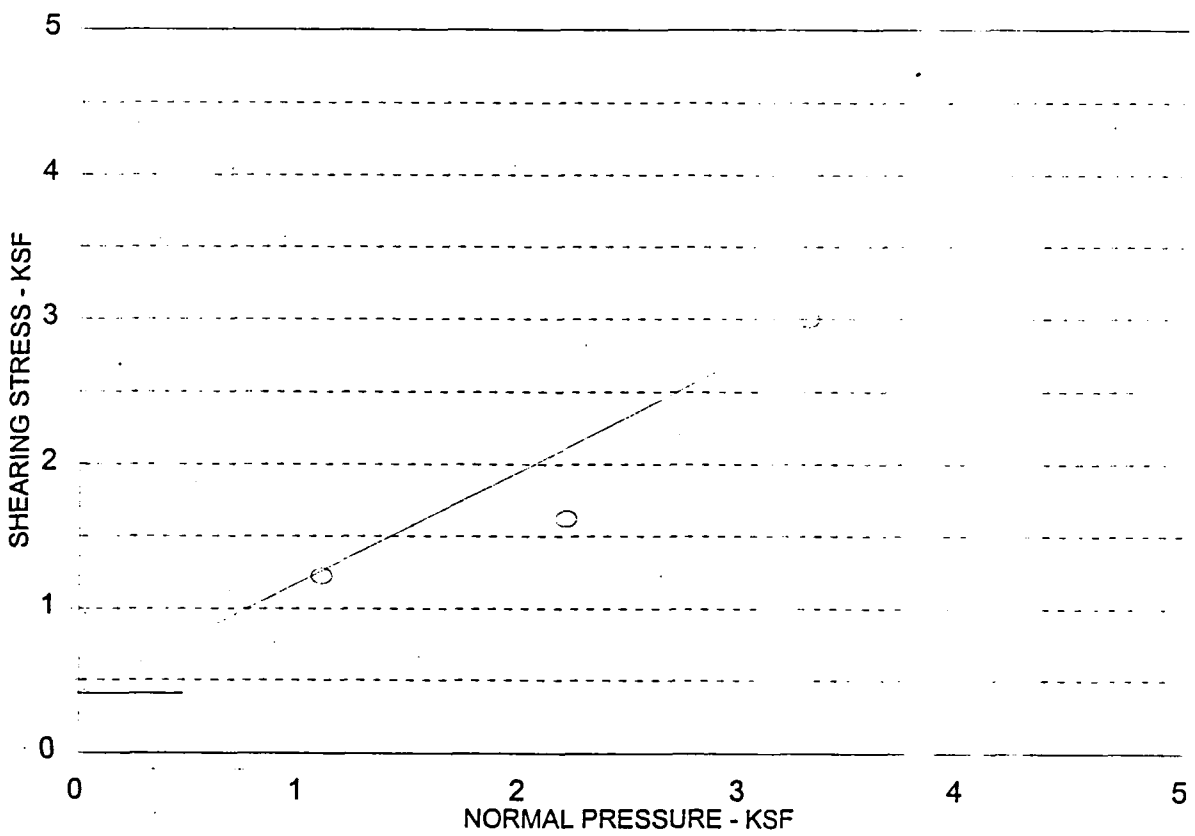
Boring No. No.	Sample Depth (ft)	USCS	Percent Swell	Dry Density (pcf)	Saturation Moisture (%)
7	2 ½ - 3	CL	1.1	89.2	33.1

RESULTS OF DIRECT SHEAR TESTS

Client: Sverdrup Civil, Inc. **Date:** 27-May-98
Project Name: Bullard Wash-Levees, Goodyear, AZ
Sample Source: Boring No.: 7 Depth: 2 1/2' - 3'
Type: Driven Ring; Dry Density: 97.7 pcf; Moisture Content: 25.8%
Material: Dark brown, lean CLAY(CL)
Sampled By: K. Phillips
Lab. No.: 98-0527
TESTED: ASTM D3080; Samples soaked.

RESULTS:

Friction Angle (phi)= 38 Deg. Cohesion (c) = 0.4 ksf



Project No. 198013

ATL, INC.
CONSTRUCTION QUALITY CONTROL
GEOTECHNICAL CONSULTANTS

PHOENIX – CORPORATE OFFICE
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(602) 241-1097 • Fax (602) 277-1306

July 13, 1998

RECEIVED
AUG 17 1998
Sverdrup
PHOENIX

Mr. Brad Olbert, P.E.
Sverdrup Civil, Inc.
432 North 44th Street
Suite 250
Phoenix, Arizona 85008

Re: Analysis Review
Bullard Wash Levees
Goodyear, Arizona
ATL Job No. 198013

Dear Brad:

In response to your questions in our July 9 meeting and your subsequent memorandum, the following explanation is provided as to why detailed slope stability and rapid draw-down analysis were not performed on the final configuration of levee proposed for a portion of the Bullard Wash Channel.

Lets address rapid drawdown. Rapid drawdown is a sudden lowering in the level of water standing against the slope. For this project, rapid drawdown could occur when the state of the channel flow falls following flood conditions. Unless pore pressures with a slope can adjust immediately to the falling water level, high pore pressures may exist within a slope following a rapid drawdown. The levee in this project is an extension of the channel slope; the front slope of 1v:1h is protected either by gabions or concrete. The back slope is either 1v:1h and protected by gabions or is 1v:3h and seeded. The levees vary in height from 4 to 6 feet, with three feet of that freeboard. Therefore, even if pore water pressure built up, the levee is too shallow, the slopes too flat and protection in place that will not allow slope failures.

The above discussion is also applicable to seepage and slope stability analysis. The levees are inherently too shallow for traditional wedge failures. They are also stabilized by gabions. In many cases they will be part of the maintenance road subgrade, and thus will be compacted in layers. The procedure most amenable to calculation is the sliding wedge method in which the active (or passive) earth pressure theory is employed to determine the side forces. This procedure as been used by the Department of Navy and others. Because the "driving force" is so small due to the minimal amount of soil involved, the factor of safety is very high. This observation is fairly intuitive and thus no other analysis was performed.

When developing the proposal and outlining the anticipated scope of work, the magnitude of the levees was not known. Thus the analysis was included.

If you have further questions, please do not hesitate to contact me.

Very truly yours,

David P. Hayes, P.E.
Executive Vice President

DPH/brc
cc: F. Rivera

AVERY

Sediment Transport & Scour Analysis
BULLARD WASH OUTFALL CHANNEL IMPROVEMENTS
FCD #95-39

Prepared for:

Sverdrup Civil, Inc.
637 South 48th Street
Suite 101
Tempe, AZ 85281
Phone: 303-9799

and

Flood Control District of Maricopa County
2901 West Durango Street
Phoenix, Arizona 85009
Phone: (602) 506-1501

Prepared by:

Wood, Patel & Associates, Inc.
1550 East Missouri, Suite 203
Phoenix, Arizona 85014
Phone: (602) 234-1344
Fax: (602) 234-1322

Registered Professional Engineer (Civil)
CERTIFICATE NO.
10512
ASHOK C. PATEL
Date Signed 4/10/98
ARIZONA, U.S.A.

April 10, 1998
WP #96464

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Bullard Wash Outfall Channel
Sediment Transport & Scour Analysis

1.0 INTRODUCTION

Sediment transport analyses examine the potential for sediment deposition impacts to the design water surface profile and potential undercutting of the natural bank or bank-lining by scour processes. The design of an erosion resistant bank protection system must consider the potential for scour of the channel bed, if the bed is to be left as natural earth. Failure to do so could lead to the toe of the bank protection material being undercut by scour processes that will be induced by flowing water. Should this situation occur, the bank lining material may collapse into the scour hole, thus exposing the bank to erosive velocities and possible lateral movement.

Vertical changes of the channel bed can occur in response to the following six processes:

1. Long-Term Aggradation/Degradation: Aggradation and degradation are defined as the vertical raising and lowering, respectively, of the channel bed over relatively long distances and time periods. Such changes, which are sometimes referred to as gradation changes, can be the result of both natural and man-induced changes in the watershed.

   Long-term gradation change occurs over a long period of time in response to an imbalance between the sediment transport capacity of the channel and the dominant sediment supply to the channel. When such imbalances occur, the channel will naturally adjust its slope to restore equilibrium between the transport capacity and incoming supply of sediment. The sediment continuity concept is the primary principle applied in both qualitative and quantitative analysis of gradation changes. If the transport capacity of the channel exceeds the sediment supply, the channel will flatten its slope (degrade). However, should the sediment supply exceed the transport capacity of the channel, the channel slope will increase (aggrade) in order to generate higher velocities that are capable of moving the sediment inflows.

2. Local Scour: Local scour will occur in response to objects being placed in the path of flowing water. The most common form of local scour is that occurring at bridge

piers and protruding bridge abutments or spur dikes. The procedures and methodology outlined in HEC-18 should be used for local scour analysis.

3. General Scour: General scour process occurs in response to changes in channel geometry from one reach of a channel to the next. As the channel cross-section contracts or expands, its flow velocity (and thus sediment transport capacity) will change. General scour, and/or sediment deposition, is usually quantified with a mobile-boundary sediment routing model such as HEC-6. Such models are capable of predicting scour and deposition patterns as a function of bed-material size, channel geometry, and changes in discharge that occur during passage of a specific flood hydrograph.

4. Bend Scour: The bends associated with meandering channels will induce transverse or "secondary" currents which will scour sediment from the outside of a bend and cause it to be deposited along the inside of the bend. The magnitude of bend scour can be estimated by Zeller's equation (1981), which is based on the assumption of constant stream power through the channel bend.

5. Low Flow Incisement: When large width-depth ratio exists in a channel, it is vulnerable to the formation of low-flow channels. For example, when trapezoidal channels, designed to carry large storm events such as the 100-year flood, are exposed to smaller, more frequent flows (2- to 5-year floods), the wide channel bottom widths may cause a shallow sheetflow condition. Rather than transporting these smaller flows in this manner, the channel will incise a low-flow channel that provides a more hydraulically efficient conveyance for these small discharges. There are no rigorous methodologies available for the prediction of low-flow channel incisement. A field inspection of the study area and engineering judgment are probably the best methods to determine the potential for low flow channel incisement.

6. Bed-Form Troughs: Sand and gravel-bed channels are prone to the development of transitory bedforms, such as dunes and antidunes. Such bedforms create troughs, or depressions, below the natural bed of the channel during a flow event. In order to account for the possibility of these troughs forming adjacent to the toe of the bank, it is prudent to include bedform troughs in the estimate of total scour.

2.0 PURPOSE OF STUDY

This study is a supplement to the Bullard Wash Outfall Channel Improvements, in which a revised channelization concept was agreed upon by Sverdrup, together with the Flood Control District, the City of Goodyear, and MCDOT. The concept addressed the City's requirements on the aesthetics, recreational, and equestrian needs, as well as maintenance issues. As a result, a workable channel cross-section, style of bank protection, and drop structure scheme have been mutually agreed upon for the channelization project.

The purpose of this study is limited to the estimation of the required toe down depths for the bank protection of the two channlized segments in the Bullard Wash. Specifically, the downstream reach is from the upstream face of the BID culvert to the downstream face of the MC85 Bridge (Sta. 29+00 to 73+00), and the middle reach is from Grade Break Top to the Bottom of Drop (Sta. 81+02 to 121+64).

Because the channel segments for the bridge, culverts, and transition areas will be protected using concrete lining, no bridge local scour estimation is necessary for this study. Also the two subject channel segments are quite uniform, so it is assumed that no general scour will occur. However, there is a significant bend near the downstream side of the Lower Buckeye Road.

Therefore, long-term aggradation/degradation, bend scour at the upstream of the middle reach, sill scour near the upstream area of each reach, bed-form troughs, and low flow incisement were analyzed in this study. The following sections present a technical discussion of the engineering assumptions and methodologies used for the estimations of the above mentioned scour components.

3.0 METHODOLOGIES

3.1 Hydrology

The recommended 100-year 24-hour peak flow for the Bullard Wash Outfall Channel Improvements is 3,200 cfs. The estimated 50-year, 25-year, and 10-year flows are 2,680 cfs, 2,020 cfs, and 1,370 cfs respectively. These flows were utilized for evaluating the scour potential in the channel.

3.2 Hydraulics

The hydraulics of the channel were modeled with the Army Corps of Engineers HEC-RAS Hydraulic Modeling Software. The profile summary tables for all return periods and the graphical profiles and cross sections for the 100-year flow are shown in Appendix B.

3.3 Soils

ATL, INC. investigated the soils in the wash in November of 1997. The soil in the upstream was classified as silty clay with sand, and in the downstream reach the soil was classified as a sandy-silty material. D_{16}, D_{50}, and D_{84} values were estimated from the soil sieve analysis curves provided for each of the channel reaches.

3.4 Sediment Transport Capacity Estimation

The Empirical Power Relationship (Zeller and Fullerton, 1983) was used to estimate to sediment transport capacity for each reach of the channel. The supporting calculations are included in Appendix A.

The representative cross sections chosen for the analysis are Sta. 131+20 for the upstream reach, Sta. 108+19 for the middle reach (Sta. 80+00 to 120+00), and Sta. 63+22 for the downstream reach (Sta. 30+00 to 80+00).

3.5 Watershed Load Estimation

In order to estimate the long-term aggradation/degradation trend of the channel, the watershed sediment load into the subject channel should be estimated first. The upstream reach consists of a small tailwater conveyance ditch representing the Bullard Wash thalweg. Based on the existing floodplain delineation, the floodplain

will spread out over a broad area covered by agricultural fields. The velocities through this reach are very slow generally in a range of 1 to 4 fps. There is no physical evidence of any wash instability. For these reasons, it is assumed that the upstream natural wash is in equilibrium and the sediment transport capacity of the wash is equivalent to the watershed sediment supply. Cross section in at Sta. 131+20 represents the upstream natural wash conditions. As a part of the channelization design, a shallow concrete lined ditch is being incorporated into the middle reach channel bottom (Sta. 119+43 to Sta. 81+02). The purpose of the ditch is to convey irrigation tailwater flows (approximately 7 cfs) and its sediment load through this reach to an irrigation outlet structure located at the top of the Grade Break Drop. The ditch will keep tailwater flows to the east side of the channel so that the flows will not block maintenance access to the channel and to reduce contact with occasional recreational users of the channel.

Since the existing wash has a very limited drainage conveyance capacity, ponding occurs at the railroad and highway MC85 bridge structures. The limited conveyance including very poor outfall conditions at the existing bridge locations has resulted in localized sedimentation. With the proposed channel improvements, the drainage conveyance will be enhanced significantly and thereby eliminating the sedimentation concerns.

3.6 Long-Term Aggradation/Degradation - Equilibrium Slope Analysis

Equilibrium slope analysis was utilized to estimate the long-term gradation changes in the Bullard Wash channel. The equilibrium channel slope is defined as the slope at which the channel's sediment transporting capacity is equal to the incoming sediment supply. Under this condition, the channel neither aggrades nor degrades. When the present slope of the channel is greater than the equilibrium slope, the channel will degrade in order to reach its equilibrium slope.

The calculation of the equilibrium slope, which the channel will conform to, is accomplished by using the definition of a channel in equilibrium. That is, $Q_{s\,in} = Q_{s\,out}$, where $Q_{s\,in}$ represents the supply rate of sediment into the channel and $Q_{s\,out}$ represents the sediment transport rate out of the channel.

The procedure begins with a determination of the sediment transport rate into the channel. The upstream sediment supply was assumed to be the watershed sediment load and to be in equilibrium. The hydraulics of the current (designed) channel condition was modeled with the HEC-RAS program. Since a uniform flow condition was assumed to exist in each of the three channel reaches, Manning's equation was used (in an iterative process) to calculate the final equilibrium slope. The individual slopes of the study reaches were varied until the resulting sediment transport capacity equaled the incoming sediment supply for that reach. Once a slope was found at which the incoming sediment supply equaled the sediment load in the channel reach, this slope was assumed to be the equilibrium slope for that reach and the analysis of the next reach was initiated. This procedure was repeated until all reaches had been analyzed. A spreadsheet was developed to perform these calculations and the output is included in Appendix A. The 10-year flow was assumed to be the dominant flow condition.

3.7 Bend Scour Estimation

Zeller's equation (1981) was used to estimate the bend scour magnitude. The input data and calculations were shown in a spreadsheet output and included in Appendix A. The 100-year flow was used in the bend scour calculation. The bend scour was calculated for east bank from station 117+00 to 119+53.

3.8 Sill Scour Estimation

The equation developed by Veronese (1937) was used to estimate the sill scour depth in this study. The input data and calculations were given in a spreadsheet output and included in Appendix A. The 100-year flow was used in the sill scour computation.

3.9 Bed-Form Troughs Estimation

The relationship developed by Kennedy (1963) was used to estimate the depth of antidune troughs (below the existing channel bed) and the equation developed by Simons and Senturk (1977) was applied to compute the dune heights. Whichever is greater was used as the bed-form trough depth. The input data and calculation were shown in Appendix A - Bed-form trough estimation spreadsheet. The 100-year flow was used in the bed-form trough estimation.

4.0 RESULTS AND CONCLUSIONS

The equilibrium slope analysis results were shown in Table 1. For the middle reach of the channel, the equilibrium slope is 0.00091 ft/ft and the change from the present slope (0.001207 ft/ft) is 0.000297 ft/ft. For the downstream reach of the channel, the equilibrium slope is 0.00088 ft/ft and the change from the present slope (0.001365 ft/ft) is 0.000485 ft/ft.

The low flow incisement is assumed to be 15% of the 100-year flow depth which is about 1.0 ft for both middle and downstream reaches.

Based on the sediment transport and scour analysis the following conclusions are made:

4.1 Local Scour

Sill scour is anticipated at the downstream side of the lined grade control structures. This type of scour will be limited to a very localized area and can be significantly reduced or eliminated by providing a gabion mattress. Bend scour also occurs in a local area near the channel bend.

The total depth of local scour at the upper end of Middle Reach at Sta. 119+53 = 2.8 ft. (bend scour) +3.4 ft. (sill scour) = 6.2 ft;

The total depth of local scour at the upper end of Downstream Reach at Sta. 73+00 = 5.5 ft. (sill scour), bend scour not applicable at this location.

4.2 Toe Down Depths

Toe down depth = {long-term degradation + bedform troughs + low flow incisement + local scour (if applicable)} x safety factor

<u>Middle Reach Corridor</u>

Toe down depth = (1.21 + 0.38 + 1.0 + 0.0) x 1.3 = 3.4 ft.

<u>Downstream Reach Corridor</u>

Toe down depth = (2.12 + 0.54 + 1.0 + 0.0) x 1.3 = 4.8 ft.

Middle Reach at Sta. 119 + 53 (localized condition)

Toe down depth = (1.21 + 0.38 + 1.0 + 6.2) x 1.3 = 11.4 ft.

Downstream Reach at Sta. 73 + 00 (localized condition)

Toe down depth = (2.12 + 0.54 + 1.0 + 5.5) x 1.3 = 11.9 ft.

APPENDIX A

Sediment Transport Capacity Estimation

and

Scour Estimation

Sediment Transport Capacity Computation Sheet for Upstream Reach (Sta. 131+20)

Sediment Transport Capacity Computation Sheet for Middle Reach (Sta. 108+19)

Sediment Transport Capacity Computation Sheet for Downstream Reach (Sta. 63+22)

Equilibrium Slope Computation Sheet for Upstream Reach (Sta. 131+20)

Equilibrium Slope Computation Sheet for Upstream Reach (Sta. 108+19)

Equilibrium Slope Computation Sheet for Upstream Reach (Sta. 63+22)

Bed-Form Trough Computation Sheet for Middle Reach (Sta. 108+19)

Bed-Form Trough Computation Sheet for Middle Reach (Sta. 108+19)

Bend Scour Computation Sheet for the Middle Reach

Sill Scour Computation Sheet for Both Middle and Downstream Reaches

APPENDIX B

HEC-RAS Modeling Results

100-Year Flow Profile Table

50-Year Flow Profile Table

25-Year Flow Profile Table

10-Year Flow Profile Table

100-Year Flow Profile Plot

Cross Sections Plots

Table 1

Equilibrium Slope Analysis Results

Return	Sediment Transport Capacity			Capcity Excess		Reach Length		Reach Slope		Equilibrium Slope		Slope Change		Long-Term Scour Depth	
Period (Year)	Upstream (cfs)	Middle (cfs)	Downstream (cfs)	Middle (cfs)	Downstream (cfs)	Middle (ft)	Downstream (ft)	Middle (ft/ft)	Downstream (ft/ft)	Middle (ft/ft)	Downstream (ft/ft)	Middle (ft/ft)	Downstream (ft/ft)	Middle (ft)	Downstream (ft)
10	2.56	3.83	5.20	1.27	1.37	4062	4380	0.001207	0.001365	0.00091	0.00088	0.000297	0.000485	1.21	2.12

APPENDIX A

Sediment Transport Capacity Estimation
and
Scour Estimation

Sediment Transport Capacity Computation Sheet for Upstream Reach (Sta. 131+20)

Sediment Transport Capacity Computation Sheet for Middle Reach (Sta. 108+19)

Sediment Transport Capacity Computation Sheet for Downstream Reach (Sta. 63+22)

Equilibrium Slope Computation Sheet for Upstream Reach (Sta. 131+20)

Equilibrium Slope Computation Sheet for Upstream Reach (Sta. 108+19)

Equilibrium Slope Computation Sheet for Upstream Reach (Sta. 63+22)

Bed-Form Trough Computation Sheet for Middle Reach (Sta. 108+19)

Bed-Form Trough Computation Sheet for Middle Reach (Sta. 108+19)

Bend Scour Computation Sheet for the Middle Reach

Sill Scour Computation Sheet for Both Middle and Downstream Reaches

Sediment Transport Computation Sheet

Reference: ADWR, Design Manual for Engineering Analysis of Fluvial Systems, 1985.

Calculation: Total Bed-Material Discharge. **Application:** Sand-Bed Channels.

Project Name: Bullard Wash **Section Name:** Sta 131+20

Sediment Transport Equation

Zeller and Fullerton (1983) developed the following equation based on the Empirical Power Relationship $qs = aY_h^b V^c$ by Simons, Li, and Fullerton (1981):

$$qs = \frac{0.0064\, n^{1.77} V^{4.32} G^{0.45}}{Y_h^{0.30} D_{50}^{0.61}}$$

Where:		**Range:**
	q_s = bed-material discharge in cfs per unit width;	
	n = Manning's roughness coefficient;	(0.018-0.035)
	V = mean velocity (ft/s);	(3 - 30)
	G = gradation coefficient = $0.5(D_{84}/D_{50}+D_{50}/D_{16})$;	(2 - 5)
	Y_h = hydraulic depth (ft);	(1 - 20)
	D_{50} = median diameter (mm).	

Input Data - 10-year Flow

Q =	1370	(cfs)	D_{50} =	0.03	(mm)
n =	0.03		D_{84} =	0.11	(mm)
Y_h =	1.04	(ft)	D_{16} =	0.01	(mm)
V =	2.03	(ft/s)	G =	3.33	
b =	646.36	(ft)	r_s =	165.4	(lb/ft^3)

Computed Sediment Discharge

q_s =	**0.00396**	**(cfs/ft)**
Q_s =	**2.56**	**(cfs)**
c =	**4934**	**(ppm by weight)**

Sediment Transport Computation Sheet

Reference: ADWR, Design Manual for Engineering Analysis of Fluvial Systems, 1985.

Calculation: Total Bed-Material Discharge. **Application:** Sand-Bed Channels.

Project Name: Bullard Wash **Section Name:** Sta 108+19

Sediment Transport Equation

Zeller and Fullerton (1983) developed the following equation based on the Empirical Power Relationship $qs = aY_h^b V^c$ by Simons, Li, and Fullerton (1981):

$$qs = \frac{0.0064\, n^{1.77} V^{4.32} G^{0.45}}{Y_h^{0.30} D_{50}^{0.61}}$$

Where:		**Range:**
	q_s = bed-material discharge in cfs per unit width;	
	n = Manning's roughness coefficient;	(0.018-0.035)
	V = mean velocity (ft/s);	(3 - 30)
	G = gradation coefficient = $0.5(D_{84}/D_{50}+D_{50}/D_{16})$;	(2 - 5)
	Y_h = hydraulic depth (ft);	(1 - 20)
	D_{50} = median diameter (mm).	

Input Data - 10-year Flow

Q =	1370	(cfs)	D_{50} =	0.06	(mm)
n =	0.0287		D_{84} =	0.31	(mm)
Y_h =	3.42	(ft)	D_{16} =	0.015	(mm)
V =	4.06	(ft/s)	G =	4.58	
b =	98.80	(ft)	r_s =	165.4	(lb/ft^3)

Computed Sediment Discharge

q_s =	**0.03874**	**(cfs/ft)**
Q_s =	**3.83**	**(cfs)**
c =	**7350**	**(ppm by weight)**

Sediment Transport Computation Sheet

Reference: ADWR, Design Manual for Engineering Analysis of Fluvial Systems, 1985.

Calculation: Total Bed-Material Discharge. **Application:** Sand-Bed Channels.

Project Name: Bullard Wash **Section Name:** Sta 63+22

Sediment Transport Equation

Zeller and Fullerton (1983) developed the following equation based on the Empirical Power Relationship $qs = aY_h^b V^c$ by Simons, Li, and Fullerton (1981):

$$qs = \frac{0.0064\, n^{1.77} V^{4.32} G^{0.45}}{Y_h^{0.30} D_{50}^{0.61}}$$

Where:		**Range:**
	q_s = bed-material discharge in cfs per unit width;	
	n = Manning's roughness coefficient;	(0.018-0.035)
	V = mean velocity (ft/s);	(3 - 30)
	G = gradation coefficient = $0.5(D_{84}/D_{50}+D_{50}/D_{16})$;	(2 - 5)
	Y_h = hydraulic depth (ft);	(1 - 20)
	D_{50} = median diameter (mm).	

Input Data - 10-year Flow

Q =	1370	(cfs)	D_{50} =	0.06	(mm)
n =	0.0276		D_{84} =	0.3	(mm)
Y_h =	3.44	(ft)	D_{16} =	0.015	(mm)
V =	4.57	(ft/s)	G =	4.50	
b =	87.17	(ft)	r_s =	165.4	(lb/ft^3)

Computed Sediment Discharge

q_s =	**0.05967**	**(cfs/ft)**
Q_s =	**5.20**	**(cfs)**
c =	**9963**	**(ppm by weight)**

Equilibrium Slope Computation Sheet

Reference: ADWR, Design Manual for Engineering Analysis of Fluvial Systems, 1985.

Calculation: Total Bed-Material Discharge. **Application:** Sand-Bed Channels.

Project Name: Bullard Wash **Section Name:** Sta 131+20

Sediment Transport Equation

Zeller and Fullerton (1983) developed the following equation based on the Empirical Power Relationship $qs = aY_h^b V^c$ by Simons, Li, and Fullerton (1981):

$$qs = \frac{0.0064\, n^{1.77} V^{4.32} G^{0.45}}{Y_h^{0.30} D_{50}^{0.61}}$$

Where:		**Range:**
	q_s = bed-material discharge in cfs per unit width;	
	n = Manning's roughness coefficient;	(0.018-0.035)
	V = mean velocity (ft/s);	(3 - 30)
	G = gradation coefficient = $0.5(D_{84}/D_{50}+D_{50}/D_{16})$;	(2 - 5)
	Y_h = hydraulic depth (ft);	(1 - 20)
	D_{50} = median diameter (mm).	

Input Data - 10-year Flow

Q =	1370	(cfs)	D_{50} =	0.03	(mm)
n =	0.03		D_{84} =	0.11	(mm)
Y_h =	1.04	(ft)	D_{16} =	0.01	(mm)
V =	2.03	(ft/s)	G =	3.33	
b =	646.36	(ft)	r_s =	165.4	(lb/ft^3)

Computed Sediment Discharge

q_s =	**0.00396**	**(cfs/ft)**
Q_s =	**2.56**	**(cfs)**
c =	**4934**	**(ppm by weight)**

Equilibrium Slope Computation Sheet

Reference: ADWR, Design Manual for Engineering Analysis of Fluvial Systems, 1985.

Calculation: Total Bed-Material Discharge. **Application:** Sand-Bed Channels.

Project Name: Bullard Wash **Section Name:** Sta 108+19

Sediment Transport Equation

Zeller and Fullerton (1983) developed the following equation based on the Empirical Power Relationship $qs = aY_h^b V^c$ by Simons, Li, and Fullerton (1981):

$$qs = \frac{0.0064\, n^{1.77} V^{4.32} G^{0.45}}{Y_h^{0.30} D_{50}^{0.61}}$$

		Range:
Where:	q_s = bed-material discharge in cfs per unit width;	
	n = Manning's roughness coefficient;	(0.018-0.035)
	V = mean velocity (ft/s);	(3 - 30)
	G = gradation coefficient = $0.5(D_{84}/D_{50}+D_{50}/D_{16})$;	(2 - 5)
	Y_h = hydraulic depth (ft);	(1 - 20)
	D_{50} = median diameter (mm).	

Input Data - 10-year Flow

Q =	1370	(cfs)	D_{50} =	0.06	(mm)
n =	0.0287		D_{84} =	0.31	(mm)
Y_h =	3.69	(ft)	D_{16} =	0.015	(mm)
V =	3.69	(ft/s)	G =	4.58	
b =	100.55	(ft)	r_s =	165.4	(lb/ft^3)

Computed Sediment Discharge

q_s =	**0.02510**	**(cfs/ft)**
Q_s =	**2.52**	**(cfs)**
c =	**4859**	**(ppm by weight)**

Equilibrium Slope Computation Sheet

Reference: ADWR, Design Manual for Engineering Analysis of Fluvial Systems, 1985.

Calculation: Total Bed-Material Discharge. **Application:** Sand-Bed Channels.

Project Name: Bullard Wash **Section Name:** Sta 63+22

Sediment Transport Equation

Zeller and Fullerton (1983) developed the following equation based on the Empirical Power Relationship $qs = aY_h^b V^c$ by Simons, Li, and Fullerton (1981):

$$qs = \frac{0.0064\, n^{1.77} V^{4.32} G^{0.45}}{Y_h^{0.30} D_{50}^{0.61}}$$

Where:		**Range:**
	q_s = bed-material discharge in cfs per unit width;	
	n = Manning's roughness coefficient;	(0.018-0.035)
	V = mean velocity (ft/s);	(3 - 30)
	G = gradation coefficient = $0.5(D_{84}/D_{50}+D_{50}/D_{16})$;	(2 - 5)
	Y_h = hydraulic depth (ft);	(1 - 20)
	D_{50} = median diameter (mm).	

Input Data - 10-year Flow

Q =	1370	(cfs)	D_{50} =	0.06	(mm)
n =	0.0276		D_{84} =	0.3	(mm)
Y_h =	3.97	(ft)	D_{16} =	0.015	(mm)
V =	3.91	(ft/s)	G =	4.50	
b =	88.34	(ft)	r_s =	165.4	(lb/ft^3)

Computed Sediment Discharge

q_s =	**0.02904**	**(cfs/ft)**
Q_s =	**2.57**	**(cfs)**
c =	**4939**	**(ppm by weight)**

Bed-Form Trough Computation Sheet

Reference: ADWR, Design Manual for Engineering Analysis of Fluvial Systems, 1985.

Project Name: Bullard Wash **Section Name:** Sta 108+19

Depth of Antidune Troughs

Kennedy (1963) developed the following equation based on laboratory flume studies to estimate the maximum depth of antidune troughs (below the existing channel bed)

$$Da = 0.0135v^2$$

Where: Da = depth of antidune trough (ft);
v = mean velocity of the channel (ft/s).

Depth of Dune Height

Simons and Senturk (1977) developed the following relationship to estimate the depth of dune height.

$$\log(Yh) = 0.8271\log(Hd) + 0.8901$$

Where: Hd = depth of dune height (m);
Yh = hydraulic depth (m).

Input Data - 100-year Flow

Q =	3200	(cfs)	v =	5.29	(ft/s)
Yh =	5.42	(ft)			

Computed Depths

Da =	0.38	(ft)
Dd=0.5Hd =	0.25	(ft)

Recomended Value = 0.38 (ft) (greater of Da and Dd)

Bed-Form Trough Computation Sheet

Reference: ADWR, Design Manual for Engineering Analysis of Fluvial Systems, 1985.

Project Name: Bullard Wash **Section Name:** Sta 63+22

Depth of Antidune Troughs

Kennedy (1963) developed the following equation based on laboratory flume studies to estimate the maximum depth of antidune troughs (below the existing channel bed)

$$Da = 0.0135v^2$$

Where: Da = depth of antidune trough (ft);
v = mean velocity of the channel (ft/s).

Depth of Dune Height

Simons and Senturk (1977) developed the following relationship to estimate the depth of dune height.

$$\log(Yh) = 0.8271\log(Hd) + 0.8901$$

Where: Hd = depth of dune height (m);
Yh = hydraulic depth (m).

Input Data - 100-year Flow

Q = 3200 (cfs) v = 6.33 (ft/s)
Yh = 5.51 (ft)

Computed Depths

Da = 0.54 (ft)
Dd=0.5Hd = 0.26 (ft)

Recomended Value = 0.54 (ft) (greater of Da and Dd)

Bend Scour Calculation Sheet

Reference: ADWR, Design Manual for Engineering Analysis of Fluvial Systems, 1985. p5.105-5.110

Scour Depth Equation:

$$Z_{bs} = \frac{0.0685 Y V^{0.8}}{Y_h^{0.4} S_e^{0.3}} \left[2.1 \left(\frac{\sin^2(\alpha/2)}{\cos(\alpha)} \right)^{0.2} - 1 \right]$$

Where Z_{bs} = bend scour component of total scour depth (ft)
V = mean velocity of upstream flow (fps)
Y = maximum depth of upstream flow (ft)
Y_h = hydraulic depth of upstream flow (ft)
S_e = upstream energy slope (bed slope for uniform flow conditions, ft/ft)
a = angle formed by the projection of the channel centerline from the point of curvature to a point which meets a line tangent to the outer bank of the channel (degrees)

Scour Length Equation

$$X = 2.3 \left(\frac{C}{\sqrt{g}} \right) Y$$

Where X = distance from the end of channel curvature (point of tangency, P.T.) to the downstream point at which secondary currents have dissipated (ft)
C = Chezy coefficient = 1.486*R^(1/6)/n
g = gravitational acceleration (32.2 ft/s²)
Y = depth of flow (to be conservative, use maximum depth of flow, exclusive of scour, within the bend) (ft)

Input Data

V =	5.52	(ft/s)	n =	0.0287	
Y =	6.26	(ft)	A =	579.4	(ft²)
Y_h =	5.51	(ft)	P =	108	(ft)
S_e =	0.00121		R =	5.36	(ft)
a =	40	(degree)	C =	68.51	
		Stable bank side slope =		2.5	(H:V)

Computed Scour Values

Scour Depth:		Scour Length:		Scour Width:	
Z_{bs} =	2.82 (ft)	X =	174 (ft)	W =	7.0 (ft)

Sill Scour Computation Sheet

100-year Scour Estimate Downstream of a Sill Structure #1

Methodology from "Computing Degradation and Local Scour" by E. Pemberton and J. Lara, 1984, Technical Guideline for Bureau of Reclamation, pages 40-45, equation type "D"

100-year Discharge =	3,200	cfs				
Total Flow Area =	604.43	ft^2	1.5	ft Long-Term Degradation		
Total Top Width =	111.43	ft	0.0	ft Depth to Top of Soil-Cement		
Mean Flow Depth =	5.42	ft	Existing Bed Elevation		933.46	ft
Discharge per foot =	28.72	cfs/ft	Top of Sill Elevation		933.46	ft

Veronese (1937)

$$d_s = KH_T^{0.225} q^{0.54} - d_m$$

ds = 3.4 ft

d_s =	depth of scour (ft)	
K =	1.32	1.32 inch-pound units
H_T =	1.50	head from U/S to D/S
q =	28.72	discharge per unit width (cfs per ft)
d_m =	5.42	D/S mean water depth

100-year Scour Estimate Downstream of a Sill Structure #2

Methodology from "Computing Degradation and Local Scour" by E. Pemberton and J. Lara, 1984, Technical Guideline for Bureau of Reclamation, pages 40-45, equation type "D"

100-yr Discharge =	3,200	cfs				
Total Flow Area =	505.91	ft^2	2.5	ft Long-Term Degradation		
Total Top Width =	91.78	ft	0	ft Depth to Top of Sill Structure		
Mean Flow Depth =	5.51	ft	Existing Bed Elevation		911.36	ft
Discharge per foot =	34.87	cfs/ft	Top of Floor Elevation		911.36	ft

Veronese (1937)

$$d_s = KH_T^{0.225} q^{0.54} - d_m$$

ds = 5.5 ft

d_s =	depth of scour (ft)	
K =	1.32	1.32 inch-pound units
H_T =	2.5	head from U/S to D/S
q =	34.87	discharge per unit width (cfs per ft)
d_m =	5.51	D/S mean water depth

APPENDIX B

HEC-RAS Modeling Results

100-Year Flow Profile Table

50-Year Flow Profile Table

25-Year Flow Profile Table

10-Year Flow Profile Table

100-Year Flow Profile Plot

Cross Sections Plots

HEC-RAS Plan: 100-Year River: Bullard Wash Out Reach: Bullard Wash

Reach	River Sta	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
		(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Bullard Wash	13700	3200.00	948.50	951.63	951.31	951.96	0.009524	8.39	908.61	666.71	0.97
Bullard Wash	13120	3200.00	947.30	949.90	949.10	950.08	0.002052	3.96	1247.61	822.83	0.46
Bullard Wash	12640	3200.00	945.20	947.67	947.67	948.23	0.008973	7.55	863.65	818.39	0.93
Bullard Wash	12420	3200.00	943.40	947.04	945.85	947.16	0.001090	2.71	1179.13	550.44	0.33
Bullard Wash	12172.42	3200.00	943.10	945.89	945.89	946.49	0.010322	7.82	666.37	544.91	0.83
Bullard Wash	12164.42	3200.00	935.10	936.97	938.92	945.57	0.191243	23.53	136.00	83.08	3.24
Bullard Wash	11963	3200.00	934.86	941.04	938.68	941.65	0.002742	6.23	513.50	92.05	0.46
Bullard Wash	11943	3200.00	934.84	941.10	938.39	941.57	0.001209	5.52	579.40	105.15	0.41
Bullard Wash	11882.84	3200.00	934.76	941.03	938.32	941.50	0.001205	5.52	579.38	104.95	0.41
Bullard Wash	11735.25	3200.00	934.58	940.85	938.13	941.32	0.001204	5.52	579.77	105.01	0.41
Bullard Wash	11550	3200.00	934.36	940.65	937.89	941.09	0.001183	5.32	601.64	111.31	0.40
Bullard Wash	11300	3200.00	934.04	940.36	937.57	940.79	0.001164	5.28	605.93	111.74	0.40
Bullard Wash	11200	3200.00	933.92	940.20	937.48	940.67	0.001195	5.50	581.63	105.18	0.41
Bullard Wash	11100	3200.00	933.80	940.08	937.35	940.55	0.001195	5.50	581.47	105.13	0.41
Bullard Wash	11000	3200.00	933.68	939.99	937.21	940.42	0.001173	5.30	603.73	111.46	0.40
Bullard Wash	10819.37	3200.00	933.46	939.77	936.99	940.21	0.001168	5.29	604.43	111.43	0.40
Bullard Wash	10300	3200.00	932.84	939.18	936.37	939.61	0.001155	5.27	607.63	111.82	0.40
Bullard Wash	10200	3200.00	932.72	939.02	936.27	939.49	0.001185	5.49	583.38	105.25	0.41
Bullard Wash	10100	3200.00	932.60	938.90	936.15	939.37	0.001184	5.49	583.34	105.20	0.41
Bullard Wash	10000	3200.00	932.48	938.81	936.01	939.24	0.001161	5.28	605.84	111.56	0.40
Bullard Wash	9080	3200.00	931.37	937.76	934.90	938.19	0.001122	5.22	613.26	111.86	0.39
Bullard Wash	8102	3200.00	930.20	933.73	933.73	935.35	0.014693	10.21	313.30	97.64	1.00
Bullard Wash	8080	3200.00	929.25	932.25	932.86	934.82	0.027321	12.87	248.58	85.94	1.33
Bullard Wash	7700	3200.00	912.91	914.74	916.68	923.28	0.029552	23.46	136.41	83.12	3.23
Bullard Wash	7553	3200.00	912.74	919.00	916.46	919.57	0.000389	6.04	529.61	92.45	0.44
Bullard Wash	7543	Bridge									
Bullard Wash	7533	3200.00	912.73	918.96	916.46	919.53	0.000396	6.08	526.50	92.37	0.45
Bullard Wash	7500	3200.00	912.69	918.94	916.46	919.51	0.000400	6.10	524.78	92.43	0.45
Bullard Wash	7460	3200.00	912.64	918.93	916.41	919.50	0.000392	6.06	528.21	92.44	0.45
Bullard Wash	7430	3200.00	912.60	918.92	916.36	919.48	0.000385	6.03	531.05	92.45	0.44
Bullard Wash	7357	Bridge									
Bullard Wash	7300	3200.00	912.43	918.64	916.21	919.23	0.000408	6.14	521.50	92.28	0.45
Bullard Wash	7270	3200.00	912.40	918.63	916.01	919.18	0.001258	5.96	537.02	92.46	0.44
Bullard Wash	6322	3200.00	911.36	917.25	914.97	917.87	0.001503	6.33	505.91	91.78	0.47
Bullard Wash	3350	3200.00	907.03	913.42	910.64	913.95	0.001157	5.79	552.57	92.83	0.42
Bullard Wash	3330	3200.00	907.00	913.31	910.83	913.92	0.000415	6.26	510.82	88.00	0.46

HEC-RAS Plan: 100-Year River: Bullard Wash Out Reach: Bullard Wash (Continued)

Reach	River Sta	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
		(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Bullard Wash	3300	3200.00	906.88	913.19	910.91	913.90	0.000489	6.76	473.40	82.00	0.50
Bullard Wash	3130	3200.00	906.20	913.16	910.22	913.73	0.001209	6.07	527.58	82.00	0.42
Bullard Wash	3049	3200.00	905.87	910.90	910.90	913.41	0.002438	12.71	251.69	50.17	1.00
Bullard Wash	3003	3200.00	905.69	910.40	910.71	913.26	0.002990	13.58	235.72	50.15	1.10
Bullard Wash	2980	3200.00	904.65	908.04	909.50	912.89	0.039284	17.66	181.16	56.74	1.74
Bullard Wash	2920	3200.00	901.95	905.25	906.79	910.36	0.042995	18.15	176.31	56.91	1.82
Bullard Wash	2900.42	3200.00	900.25	908.04	905.19	909.04	0.000606	8.03	398.66	51.20	0.51
Bullard Wash	2890.42	Culvert									
Bullard Wash	2880.42	3200.00	900.16	906.04	905.10	907.79	0.001432	10.64	300.88	51.20	0.77
Bullard Wash	2840	3200.00	900.10	906.62	903.71	907.11	0.001084	5.64	567.14	94.00	0.40
Bullard Wash	2520	3200.00	899.44	906.34	903.04	906.78	0.000899	5.31	602.87	94.00	0.37
Bullard Wash	2499.74	3200.00	899.40	906.38	902.92	906.74	0.000582	5.00	748.36	135.07	0.33
Bullard Wash	2400	3200.00	899.20	906.40	902.69	906.66	0.000503	4.32	926.98	196.33	0.29
Bullard Wash	1860	3200.00	898.12	906.15	901.62	906.37	0.000509	3.82	881.08	167.60	0.25
Bullard Wash	1800	3200.00	898.00	906.30	901.56	906.30	0.000021	0.97	8189.77	2346.00	0.06

HEC-RAS Plan: 50-Year River: Bullard Wash Out Reach: Bullard Wash

Reach	River Sta	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
		(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Bullard Wash	13700	2680.00	948.50	951.43	951.16	951.76	0.009965	8.10	784.11	626.27	0.98
Bullard Wash	13120	2680.00	947.30	949.71	948.96	949.87	0.002004	3.70	1096.27	780.07	0.44
Bullard Wash	12640	2680.00	945.20	947.51	947.51	948.04	0.009151	7.21	734.57	767.53	0.93
Bullard Wash	12420	2680.00	943.40	946.84	945.70	946.94	0.001058	2.51	1068.06	548.41	0.32
Bullard Wash	12172.42	2680.00	943.10	945.70	945.70	946.29	0.010513	7.53	567.62	498.64	0.82
Bullard Wash	12164.42	2680.00	935.10	936.71	938.52	945.25	0.236651	23.45	114.29	82.53	3.51
Bullard Wash	11963	2680.00	934.86	940.42	938.28	940.95	0.002783	5.88	456.14	90.74	0.46
Bullard Wash	11943	2680.00	934.84	940.46	938.01	940.88	0.001205	5.22	512.96	102.58	0.41
Bullard Wash	11882.84	2680.00	934.76	940.39	937.93	940.81	0.001200	5.22	513.11	102.40	0.41
Bullard Wash	11735.25	2680.00	934.58	940.21	937.75	940.63	0.001198	5.22	513.55	102.47	0.41
Bullard Wash	11550	2680.00	934.36	940.01	937.51	940.40	0.001182	5.04	531.22	108.11	0.40
Bullard Wash	11300	2680.00	934.04	939.72	937.20	940.11	0.001160	5.01	535.32	108.52	0.40
Bullard Wash	11200	2680.00	933.92	939.57	937.09	939.99	0.001184	5.19	515.89	102.65	0.41
Bullard Wash	11100	2680.00	933.80	939.45	936.97	939.87	0.001183	5.19	515.89	102.60	0.41
Bullard Wash	11000	2680.00	933.68	939.35	936.83	939.74	0.001165	5.02	534.01	108.30	0.40
Bullard Wash	10819.37	2680.00	933.46	939.14	936.61	939.53	0.001158	5.01	534.97	108.29	0.40
Bullard Wash	10300	2680.00	932.84	938.55	936.00	938.93	0.001140	4.97	538.72	108.68	0.39
Bullard Wash	10200	2680.00	932.72	938.41	935.89	938.82	0.001160	5.16	519.59	102.79	0.40
Bullard Wash	10100	2680.00	932.60	938.29	935.77	938.70	0.001157	5.16	519.86	102.76	0.40
Bullard Wash	10000	2680.00	932.48	938.19	935.63	938.58	0.001138	4.98	538.50	108.50	0.39
Bullard Wash	9080	2680.00	931.37	937.19	934.52	937.56	0.001072	4.87	549.85	109.00	0.38
Bullard Wash	8102	2680.00	930.20	933.35	933.35	934.81	0.015197	9.69	276.51	95.73	1.01
Bullard Wash	8080	2680.00	929.25	931.87	932.46	934.25	0.029984	12.39	216.29	85.19	1.37
Bullard Wash	7700	2680.00	912.91	914.55	916.28	922.18	0.030732	22.17	120.90	82.74	3.23
Bullard Wash	7553	2680.00	912.74	918.36	916.06	918.87	0.000393	5.69	471.00	91.14	0.44
Bullard Wash	7543	Bridge									
Bullard Wash	7533	2680.00	912.73	918.32	916.06	918.83	0.000401	5.72	468.17	91.07	0.44
Bullard Wash	7500	2680.00	912.69	918.30	916.06	918.81	0.000405	5.75	466.40	91.10	0.45
Bullard Wash	7460	2680.00	912.64	918.29	916.01	918.80	0.000396	5.70	469.79	91.12	0.44
Bullard Wash	7430	2680.00	912.60	918.28	915.97	918.78	0.000389	5.67	472.62	91.14	0.44
Bullard Wash	7357	Bridge									
Bullard Wash	7300	2680.00	912.43	918.01	915.79	918.53	0.000413	5.78	463.47	90.97	0.45
Bullard Wash	7270	2680.00	912.40	917.99	915.61	918.48	0.001242	5.60	478.83	91.19	0.43
Bullard Wash	6322	2680.00	911.36	916.63	914.57	917.18	0.001505	5.97	449.19	90.54	0.47
Bullard Wash	3350	2680.00	907.03	912.62	910.24	913.11	0.001246	5.60	478.49	91.21	0.43
Bullard Wash	3330	2680.00	907.00	912.51	910.42	913.08	0.000464	6.09	440.11	86.98	0.48

HEC-RAS Plan: 50-Year River: Bullard Wash Out Reach: Bullard Wash (Continued)

Reach	River Sta	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
		(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Bullard Wash	3300	2680.00	906.88	912.39	910.48	913.06	0.000544	6.57	407.98	80.76	0.52
Bullard Wash	3130	2680.00	906.20	912.35	909.79	912.88	0.001276	5.81	461.29	82.00	0.43
Bullard Wash	3049	2680.00	905.87	910.32	910.32	912.57	0.002497	12.02	222.94	50.15	1.00
Bullard Wash	3003	2680.00	905.69	909.89	910.15	912.41	0.002998	12.74	210.31	50.14	1.10
Bullard Wash	2980	2680.00	904.65	907.66	908.98	912.05	0.041272	16.82	159.30	55.97	1.76
Bullard Wash	2920	2680.00	901.95	904.89	906.27	909.46	0.044139	17.16	156.17	56.16	1.81
Bullard Wash	2900.42	2680.00	900.25	907.35	904.64	908.19	0.000562	7.37	363.53	51.20	0.49
Bullard Wash	2890.42	Culvert									
Bullard Wash	2880.42	2680.00	900.16	906.14	904.55	907.33	0.000951	8.75	306.21	51.20	0.63
Bullard Wash	2840	2680.00	900.10	906.52	903.31	906.88	0.000798	4.80	558.04	93.83	0.35
Bullard Wash	2520	2680.00	899.44	906.33	902.65	906.64	0.000634	4.45	601.60	94.00	0.31
Bullard Wash	2499.74	2680.00	899.40	906.36	902.55	906.61	0.000414	4.20	744.80	134.85	0.28
Bullard Wash	2400	2680.00	899.20	906.37	902.34	906.55	0.000359	3.64	920.70	195.67	0.24
Bullard Wash	1860	2680.00	898.12	906.20	901.24	906.35	0.000349	3.18	888.89	168.71	0.21
Bullard Wash	1800	2680.00	898.00	906.30	901.32	906.30	0.000014	0.81	8189.77	2346.00	0.05

HEC-RAS Plan: 25-Year River: Bullard Wash Out Reach: Bullard Wash

Reach	River Sta	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
		(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Bullard Wash	13700	2020.00	948.50	951.15	950.94	951.46	0.010930	7.71	616.07	567.13	1.01
Bullard Wash	13120	2020.00	947.30	949.44	948.77	949.57	0.001919	3.32	894.94	719.25	0.43
Bullard Wash	12640	2020.00	945.20	947.25	947.25	947.76	0.009857	6.78	547.24	687.04	0.94
Bullard Wash	12420	2020.00	943.40	946.54	945.48	946.62	0.001042	2.24	903.23	545.40	0.31
Bullard Wash	12172.42	2020.00	943.10	945.44	945.44	945.98	0.010443	6.98	444.40	434.04	0.81
Bullard Wash	12164.42	2020.00	935.10	936.37	937.97	944.92	0.340595	23.47	86.06	81.81	4.03
Bullard Wash	11963	2020.00	934.86	939.54	937.73	939.98	0.002877	5.36	377.04	88.91	0.46
Bullard Wash	11943	2020.00	934.84	939.56	937.48	939.92	0.001203	4.78	422.68	98.98	0.41
Bullard Wash	11882.84	2020.00	934.76	939.49	937.40	939.84	0.001196	4.78	423.02	98.84	0.41
Bullard Wash	11735.25	2020.00	934.58	939.31	937.22	939.67	0.001194	4.77	423.47	98.90	0.41
Bullard Wash	11550	2020.00	934.36	939.11	936.98	939.44	0.001184	4.63	435.97	103.64	0.40
Bullard Wash	11300	2020.00	934.04	938.82	936.66	939.15	0.001159	4.59	439.69	104.00	0.39
Bullard Wash	11200	2020.00	933.92	938.68	936.56	939.03	0.001172	4.74	426.25	99.08	0.40
Bullard Wash	11100	2020.00	933.80	938.56	936.44	938.91	0.001170	4.74	426.42	99.05	0.40
Bullard Wash	11000	2020.00	933.68	938.46	936.30	938.79	0.001158	4.60	439.45	103.85	0.39
Bullard Wash	10819.37	2020.00	933.46	938.25	936.08	938.58	0.001148	4.58	440.60	103.86	0.39
Bullard Wash	10300	2020.00	932.84	937.67	935.46	937.99	0.001120	4.54	444.92	104.26	0.39
Bullard Wash	10200	2020.00	932.72	937.54	935.36	937.88	0.001129	4.68	431.75	99.31	0.40
Bullard Wash	10100	2020.00	932.60	937.42	935.24	937.76	0.001124	4.67	432.39	99.29	0.39
Bullard Wash	10000	2020.00	932.48	937.33	935.10	937.64	0.001108	4.53	446.22	104.17	0.39
Bullard Wash	9080	2020.00	931.37	936.38	933.99	936.67	0.000997	4.36	462.82	104.94	0.37
Bullard Wash	8102	2020.00	930.20	932.82	932.82	934.05	0.015974	8.89	227.21	93.12	1.00
Bullard Wash	8080	2020.00	929.25	931.37	931.92	933.46	0.034289	11.59	174.22	84.21	1.42
Bullard Wash	7700	2020.00	912.91	914.30	915.73	920.55	0.031719	20.05	100.74	82.24	3.19
Bullard Wash	7553	2020.00	912.74	917.49	915.52	917.90	0.000397	5.15	392.33	89.35	0.43
Bullard Wash	7543	Bridge									
Bullard Wash	7533	2020.00	912.73	917.45	915.51	917.87	0.000405	5.18	389.79	89.28	0.44
Bullard Wash	7500	2020.00	912.69	917.43	915.51	917.85	0.000410	5.21	387.99	89.29	0.44
Bullard Wash	7460	2020.00	912.64	917.42	915.46	917.83	0.000399	5.16	391.34	89.31	0.43
Bullard Wash	7430	2020.00	912.60	917.41	915.42	917.82	0.000390	5.13	394.12	89.34	0.43
Bullard Wash	7357	Bridge									
Bullard Wash	7300	2020.00	912.43	917.15	915.25	917.57	0.000419	5.24	385.52	89.17	0.44
Bullard Wash	7270	2020.00	912.40	917.13	915.07	917.52	0.001208	5.04	400.61	89.46	0.42
Bullard Wash	6322	2020.00	911.36	915.81	914.03	916.26	0.001468	5.38	375.75	88.90	0.46
Bullard Wash	3350	2020.00	907.03	911.52	909.70	911.96	0.001422	5.32	379.78	89.02	0.45
Bullard Wash	3330	2020.00	907.00	911.41	909.86	911.94	0.000563	5.84	345.62	84.70	0.51

HEC-RAS Plan: 25-Year River: Bullard Wash Out Reach: Bullard Wash (Continued)

Reach	River Sta	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
		(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Bullard Wash	3300	2020.00	906.88	911.29	909.88	911.91	0.000657	6.30	320.68	78.55	0.55
Bullard Wash	3130	2020.00	906.20	911.24	909.20	911.70	0.001385	5.44	371.22	80.03	0.45
Bullard Wash	3049	2020.00	905.87	909.56	909.56	911.42	0.002565	10.94	184.70	50.12	1.00
Bullard Wash	3003	2020.00	905.69	909.14	909.38	911.26	0.003165	11.69	172.83	50.11	1.11
Bullard Wash	2980	2020.00	904.65	907.11	908.25	910.91	0.045547	15.64	129.15	54.89	1.80
Bullard Wash	2920	2020.00	901.95	904.41	905.55	908.19	0.045263	15.59	129.57	55.16	1.79
Bullard Wash	2900.42	2020.00	900.25	906.80	903.89	907.36	0.000409	6.02	335.27	51.20	0.41
Bullard Wash	2890.42	Culvert									
Bullard Wash	2880.42	2020.00	900.16	906.22	903.79	906.88	0.000519	6.51	310.28	51.20	0.47
Bullard Wash	2840	2020.00	900.10	906.42	902.76	906.63	0.000476	3.68	548.99	93.62	0.27
Bullard Wash	2520	2020.00	899.44	906.32	902.10	906.49	0.000363	3.36	600.40	94.00	0.23
Bullard Wash	2499.74	2020.00	899.40	906.33	902.02	906.48	0.000238	3.18	741.38	134.65	0.21
Bullard Wash	2400	2020.00	899.20	906.34	901.82	906.44	0.000207	2.75	914.71	195.04	0.18
Bullard Wash	1860	2020.00	898.12	906.24	900.72	906.33	0.000194	2.38	896.62	169.81	0.16
Bullard Wash	1800	2020.00	898.00	906.30	900.91	906.30	0.000008	0.61	8189.77	2346.00	0.04

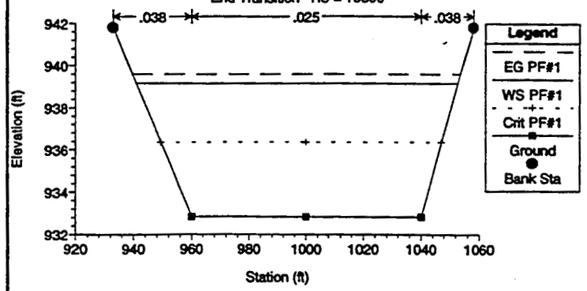
HEC-RAS Plan: 10-Year River: Bullard Wash Out Reach: Bullard Wash

Reach	River Sta	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
		(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Bullard Wash	13700	1370.00	948.50	950.83	950.71	951.11	0.012291	7.19	445.00	499.79	1.03
Bullard Wash	13120	1370.00	947.30	949.12	948.54	949.22	0.001834	2.86	675.14	646.36	0.40
Bullard Wash	12640	1370.00	945.20	946.88	946.88	947.36	0.012162	6.43	356.84	412.55	1.00
Bullard Wash	12420	1370.00	943.40	946.18	945.21	946.24	0.001067	1.93	708.37	541.82	0.30
Bullard Wash	12172.42	1370.00	943.10	945.10	945.10	945.59	0.010513	6.31	312.15	351.73	0.79
Bullard Wash	12164.42	1370.00	935.10	936.03	937.37	944.55	0.559340	23.43	58.47	81.10	4.86
Bullard Wash	11963	1370.00	934.86	938.54	937.13	938.89	0.003060	4.73	289.51	86.83	0.46
Bullard Wash	11943	1370.00	934.84	938.55	936.89	938.83	0.001208	4.22	324.67	94.92	0.40
Bullard Wash	11882.84	1370.00	934.76	938.48	936.81	938.76	0.001200	4.21	325.15	94.81	0.40
Bullard Wash	11735.25	1370.00	934.58	938.30	936.63	938.58	0.001197	4.21	325.48	94.86	0.40
Bullard Wash	11550	1370.00	934.36	938.09	936.40	938.35	0.001195	4.11	333.04	98.57	0.39
Bullard Wash	11300	1370.00	934.04	937.80	936.08	938.06	0.001167	4.08	336.15	98.88	0.39
Bullard Wash	11200	1370.00	933.92	937.67	935.97	937.94	0.001171	4.18	328.04	95.03	0.40
Bullard Wash	11100	1370.00	933.80	937.55	935.85	937.82	0.001168	4.17	328.28	95.01	0.40
Bullard Wash	11000	1370.00	933.68	937.44	935.72	937.70	0.001161	4.07	336.46	98.78	0.39
Bullard Wash	10819.37	1370.00	933.46	937.24	935.50	937.49	0.001149	4.06	337.57	98.80	0.39
Bullard Wash	10300	1370.00	932.84	936.66	934.88	936.91	0.001111	4.01	341.80	99.16	0.38
Bullard Wash	10200	1370.00	932.72	936.53	934.77	936.79	0.001108	4.10	334.11	95.28	0.39
Bullard Wash	10100	1370.00	932.60	936.42	934.65	936.68	0.001099	4.09	334.99	95.29	0.38
Bullard Wash	10000	1370.00	932.48	936.32	934.52	936.57	0.001086	3.98	344.20	99.17	0.38
Bullard Wash	9080	1370.00	931.37	935.43	933.41	935.65	0.000906	3.74	365.98	100.24	0.35
Bullard Wash	8102	1370.00	930.20	932.24	932.24	933.21	0.017218	7.89	173.60	90.20	1.00
Bullard Wash	8080	1370.00	929.25	930.85	931.31	932.56	0.040620	10.52	130.26	83.17	1.48
Bullard Wash	7700	1370.00	912.91	914.05	915.13	918.63	0.031347	17.17	79.80	81.72	3.06
Bullard Wash	7553	1370.00	912.74	916.51	914.92	916.83	0.000400	4.48	306.13	87.35	0.42
Bullard Wash	7543	Bridge									
Bullard Wash	7533	1370.00	912.73	916.48	914.91	916.80	0.000409	4.50	304.15	87.29	0.43
Bullard Wash	7500	1370.00	912.69	916.46	914.91	916.78	0.000416	4.53	302.39	87.26	0.43
Bullard Wash	7460	1370.00	912.64	916.45	914.86	916.76	0.000402	4.48	305.67	87.30	0.42
Bullard Wash	7430	1370.00	912.60	916.44	914.82	916.75	0.000390	4.44	308.40	87.33	0.42
Bullard Wash	7357	Bridge									
Bullard Wash	7300	1370.00	912.43	916.18	914.65	916.50	0.000424	4.56	300.43	87.16	0.43
Bullard Wash	7270	1370.00	912.40	916.16	914.46	916.46	0.001157	4.35	315.15	87.52	0.40
Bullard Wash	6322	1370.00	911.36	914.94	913.42	915.27	0.001353	4.57	299.51	87.17	0.43
Bullard Wash	3350	1370.00	907.03	910.35	909.09	910.73	0.001726	4.95	276.92	86.67	0.49
Bullard Wash	3330	1370.00	907.00	910.22	909.23	910.70	0.000755	5.55	246.77	82.25	0.56

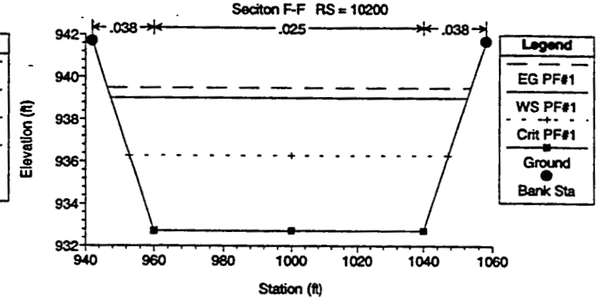
HEC-RAS Plan: 10-Year River: Bullard Wash Out Reach: Bullard Wash (Continued)

Reach	River Sta	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
		(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Bullard Wash	3300	1370.00	906.88	910.11	909.22	910.67	0.000873	5.97	229.36	76.17	0.61
Bullard Wash	3130	1370.00	906.20	910.04	908.54	910.42	0.001556	4.96	276.09	77.54	0.46
Bullard Wash	3049	1370.00	905.87	908.72	908.72	910.15	0.002687	9.61	142.58	50.09	1.00
Bullard Wash	3003	1370.00	905.69	908.32	908.54	910.00	0.003452	10.39	131.84	50.09	1.13
Bullard Wash	2980	1370.00	904.65	906.51	907.45	909.65	0.053530	14.23	96.29	53.69	1.87
Bullard Wash	2920	1370.00	901.95	906.40	904.74	906.89	0.002902	5.63	243.14	59.32	0.49
Bullard Wash	2900.42	1370.00	900.25	906.49	903.05	906.78	0.000218	4.29	319.56	51.20	0.30
Bullard Wash	2890.42	Culvert									
Bullard Wash	2880.42	1370.00	900.16	906.27	902.96	906.56	0.000233	4.38	312.64	51.20	0.31
Bullard Wash	2840	1370.00	900.10	906.36	902.16	906.46	0.000227	2.52	542.68	93.48	0.18
Bullard Wash	2520	1370.00	899.44	906.31	901.50	906.39	0.000167	2.28	599.58	94.00	0.16
Bullard Wash	2499.74	1370.00	899.40	906.31	901.43	906.38	0.000111	2.16	739.06	134.51	0.15
Bullard Wash	2400	1370.00	899.20	906.32	901.24	906.37	0.000096	1.88	910.68	194.62	0.13
Bullard Wash	1860	1370.00	898.12	906.27	900.15	906.31	0.000088	1.61	902.00	170.57	0.11
Bullard Wash	1800	1370.00	898.00	906.30	900.04	906.30	0.000004	0.41	8189.77	2346.00	0.03

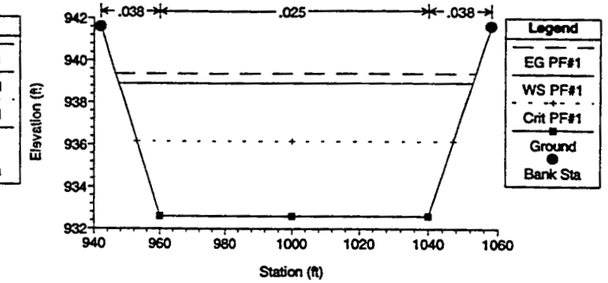
Bullard Wash Improvements Phase I (5FEB98 plans) 16-02-98
Flow: D/S = Gila 10yr
End Transition RS = 10300



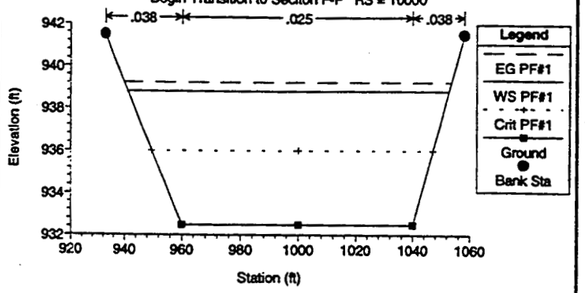
Bullard Wash Improvements Phase I (5FEB98 plans) 16-02-98
Flow: D/S = Gila 10yr
Seciton F-F RS = 10200



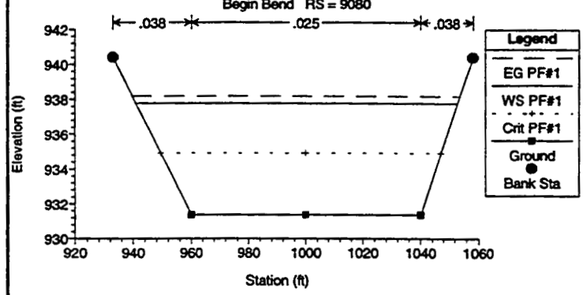
Bullard Wash Improvements Phase I (5FEB98 plans) 16-02-98
Flow: D/S = Gila 10yr
Seciton F-F RS = 10100



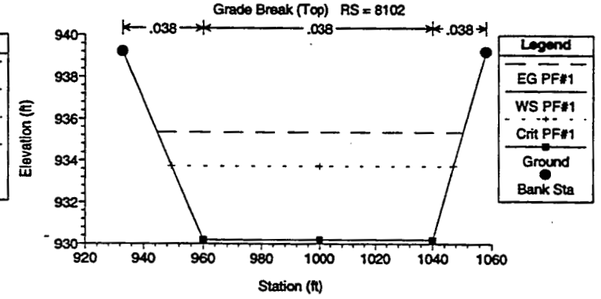
Bullard Wash Improvements Phase I (5FEB98 plans) 16-02-98
Flow: D/S = Gila 10yr
Begin Transition to Seciton F-F RS = 10000



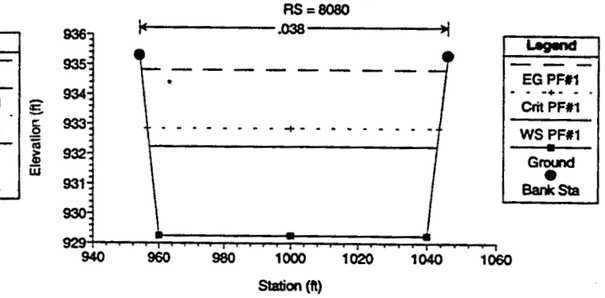
Bullard Wash Improvements Phase I (5FEB98 plans) 16-02-98
Flow: D/S = Gila 10yr
Begin Bend RS = 9080



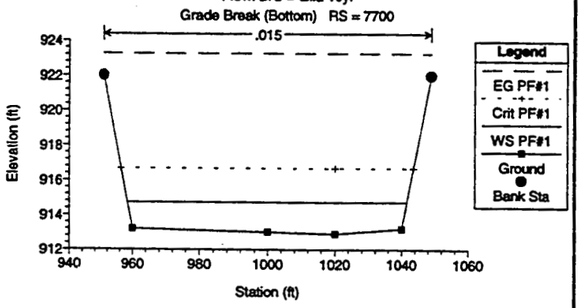
Bullard Wash Improvements Phase I (5FEB98 plans) 16-02-98
Flow: D/S = Gila 10yr
Grade Break (Top) RS = 8102



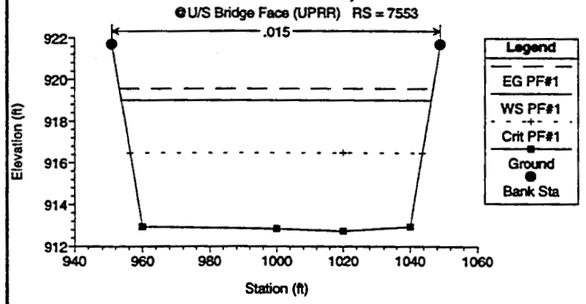
Bullard Wash Improvements Phase I (5FEB98 plans) 16-02-98
Flow: D/S = Gila 10yr
RS = 8080



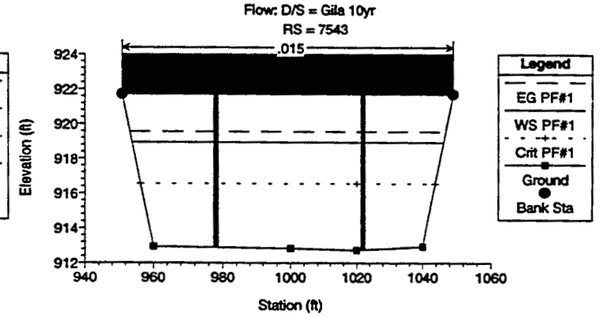
Bullard Wash Improvements Phase I (5FEB98 plans) 16-02-98
Flow: D/S = Gila 10yr
Grade Break (Bottom) RS = 7700



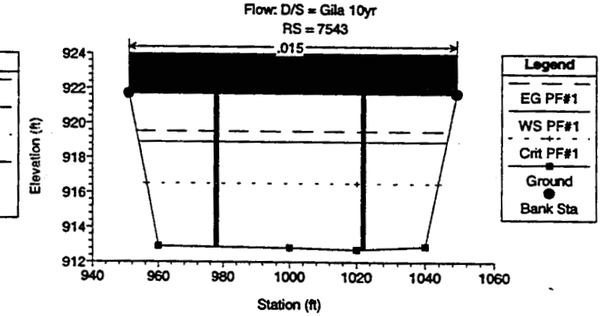
Bullard Wash Improvements Phase I (5FEB98 plans) 16-02-98
Flow: D/S = Gila 10yr
U/S Bridge Face (UPRR) RS = 7553



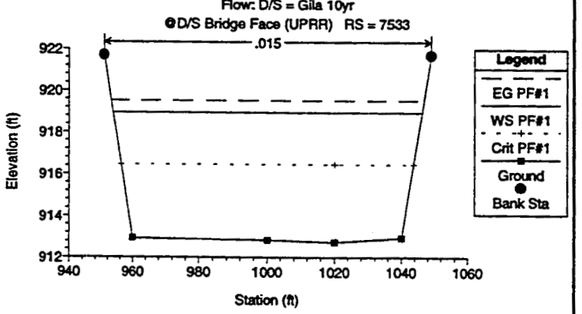
Bullard Wash Improvements Phase I (5FEB98 plans) 16-02-98
Flow: D/S = Gila 10yr
RS = 7543



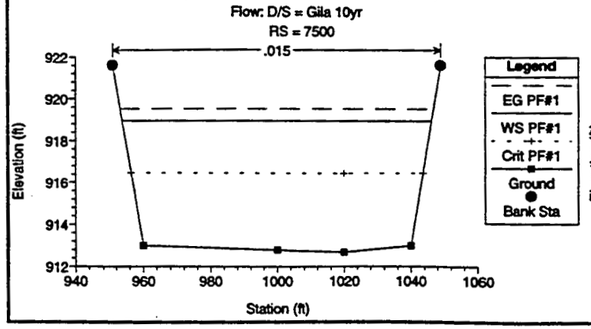
Bullard Wash Improvements Phase I (5FEB98 plans) 16-02-98
Flow: D/S = Gila 10yr
RS = 7543



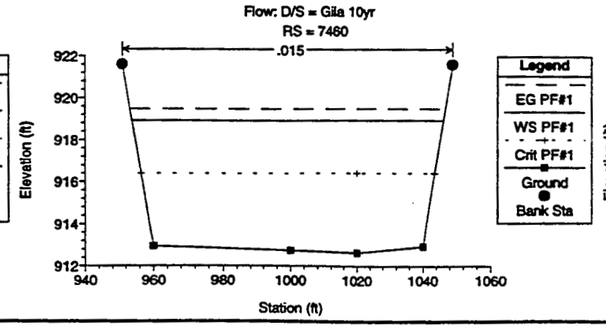
Bullard Wash Improvements Phase I (5FEB98 plans) 16-02-98
Flow: D/S = Gila 10yr
D/S Bridge Face (UPRR) RS = 7533



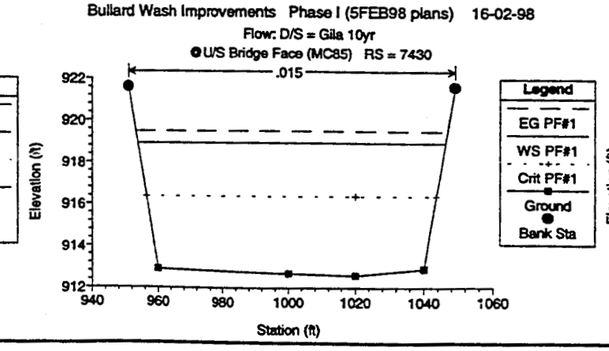
Bullard Wash Improvements Phase I (5FEB98 plans) 16-02-98
Flow: D/S = Gila 10yr
RS = 7500



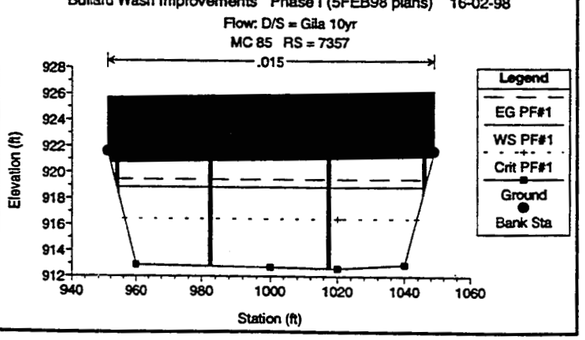
Bullard Wash Improvements Phase I (5FEB98 plans) 16-02-98
Flow: D/S = Gila 10yr
RS = 7460



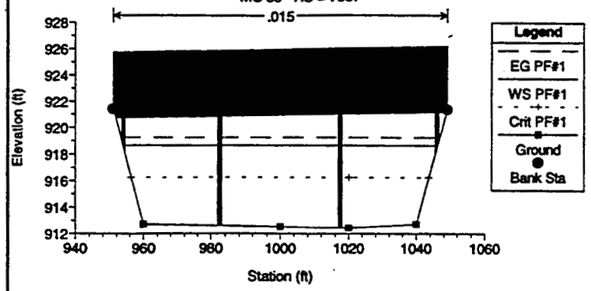
Bullard Wash Improvements Phase I (5FEB98 plans) 16-02-98
Flow: D/S = Gila 10yr
U/S Bridge Face (MC85) RS = 7430



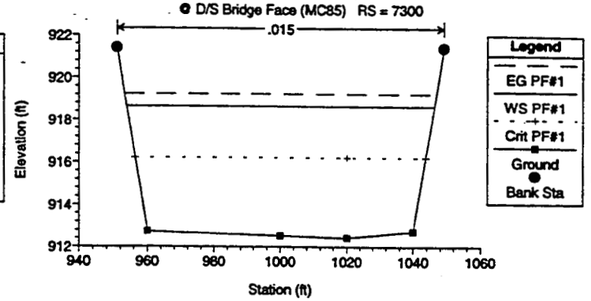
Bullard Wash Improvements Phase I (5FEB98 plans) 16-02-98
Flow: D/S = Gila 10yr
MC 85 RS = 7357



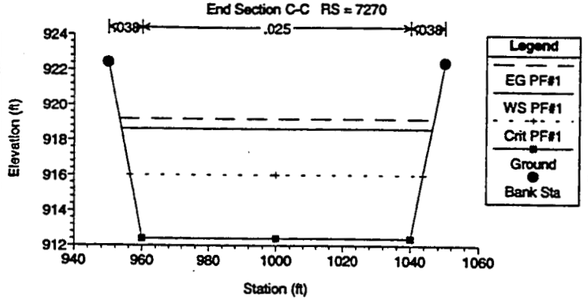
Bullard Wash Improvements Phase I (5FEB98 plans) 16-02-98
Flow: D/S = Gila 10yr
MC 85 RS = 7357



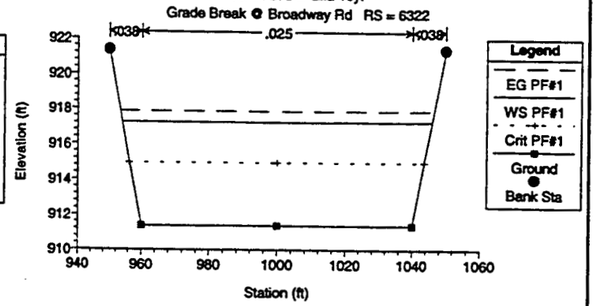
Bullard Wash Improvements Phase I (5FEB98 plans) 16-02-98
Flow: D/S = Gila 10yr
@ D/S Bridge Face (MC85) RS = 7300



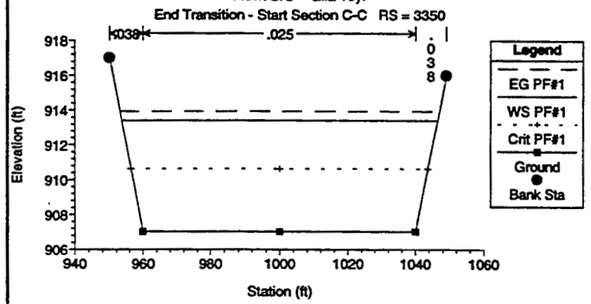
Bullard Wash Improvements Phase I (5FEB98 plans) 16-02-98
Flow: D/S = Gila 10yr
End Section C-C RS = 7270



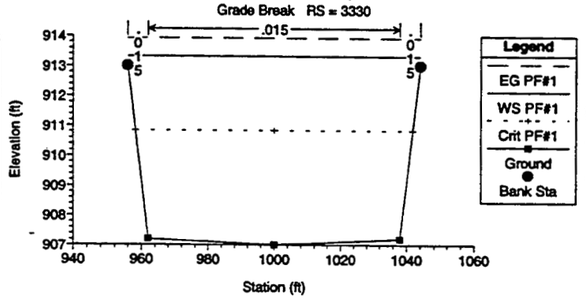
Bullard Wash Improvements Phase I (5FEB98 plans) 16-02-98
Flow: D/S = Gila 10yr
Grade Break @ Broadway Rd RS = 6322



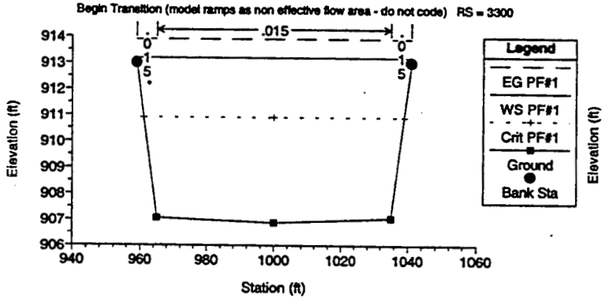
Bullard Wash Improvements Phase I (5FEB98 plans) 16-02-98
Flow: D/S = Gila 10yr
End Transition - Start Section C-C RS = 3350



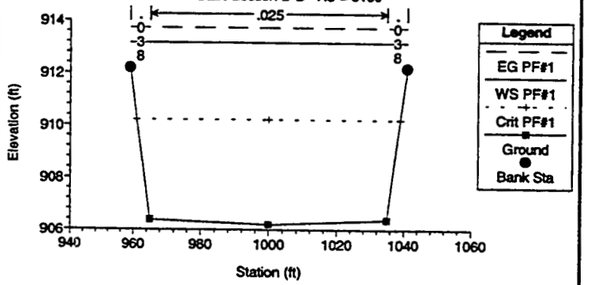
Bullard Wash Improvements Phase I (5FEB98 plans) 16-02-98
Flow: D/S = Gila 10yr
Grade Break RS = 3330



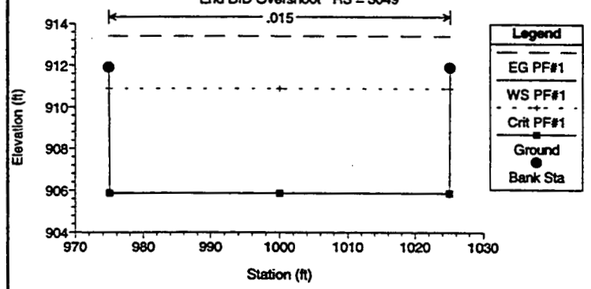
Bullard Wash Improvements Phase I (5FEB98 plans) 16-02-98
Flow: D/S = Gila 10yr
Begin Transition (model ramps as non effective flow area - do not code) RS = 3300



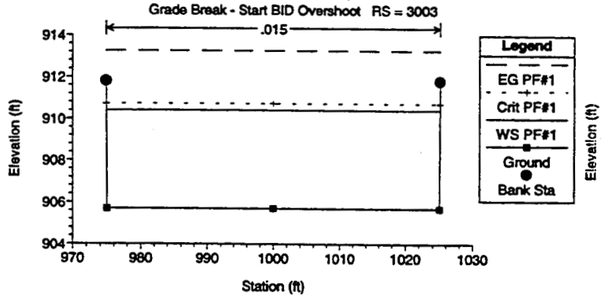
Bullard Wash Improvements Phase I (5FEB98 plans) 16-02-98
Flow: D/S = Gila 10yr
Start Section B-B RS = 3130



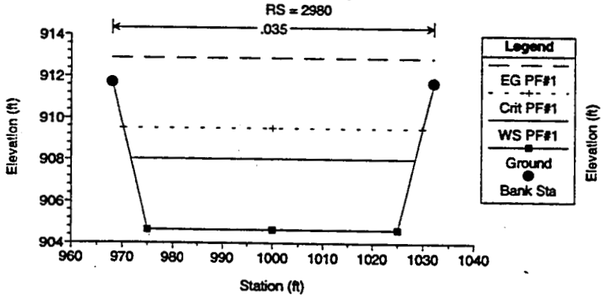
Bullard Wash Improvements Phase I (5FEB98 plans) 16-02-98
Flow: D/S = Gila 10yr
End BID Overshoot RS = 3049



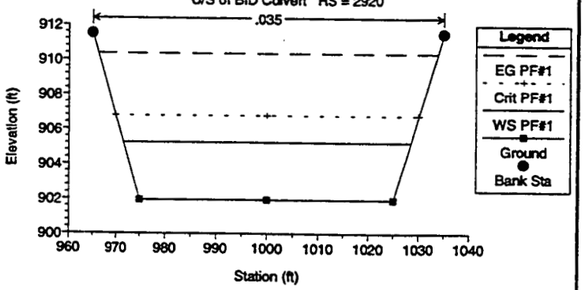
Bullard Wash Improvements Phase I (5FEB98 plans) 16-02-98
Flow: D/S = Gila 10yr
Grade Break - Start BID Overshoot RS = 3003



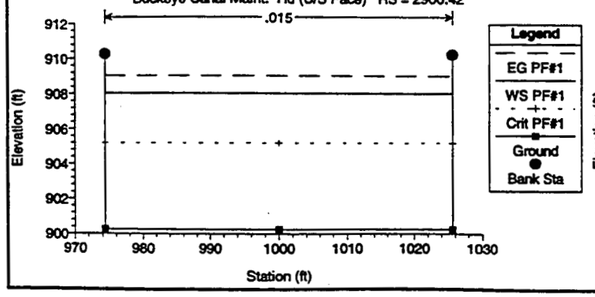
Bullard Wash Improvements Phase I (5FEB98 plans) 16-02-98
Flow: D/S = Gila 10yr
RS = 2980



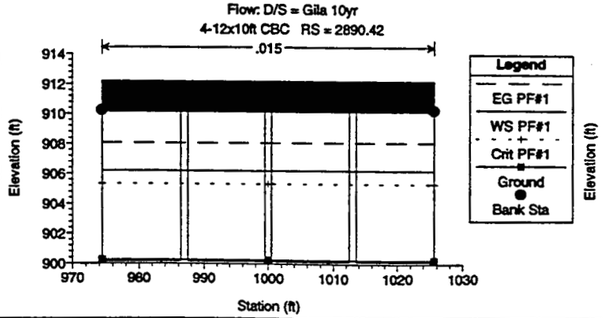
Bullard Wash Improvements Phase I (5FEB98 plans) 16-02-98
Flow: D/S = Gila 10yr
U/S of BID Culvert RS = 2920



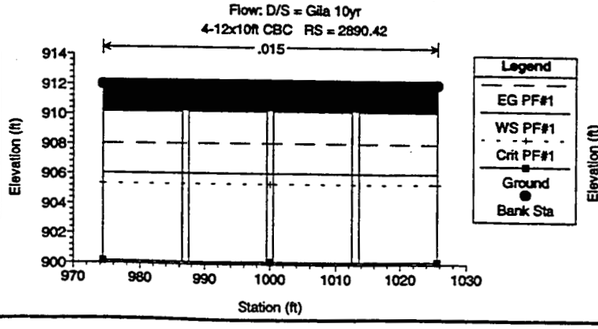
Bullard Wash Improvements Phase I (5FEB98 plans) 16-02-98
Flow: D/S = Gila 10yr
Buckeye Canal Maint. Rd (U/S Face) RS = 2900.42



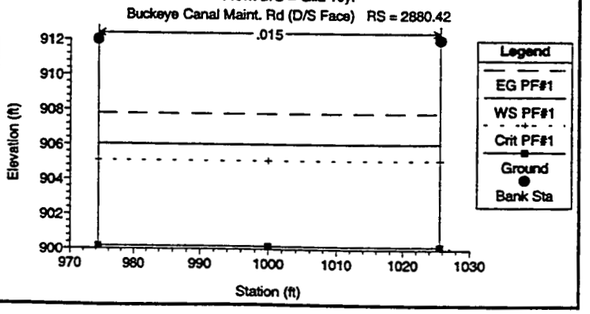
Bullard Wash Improvements Phase I (5FEB98 plans) 16-02-98
Flow: D/S = Gila 10yr
4-12x10ft CBC RS = 2890.42



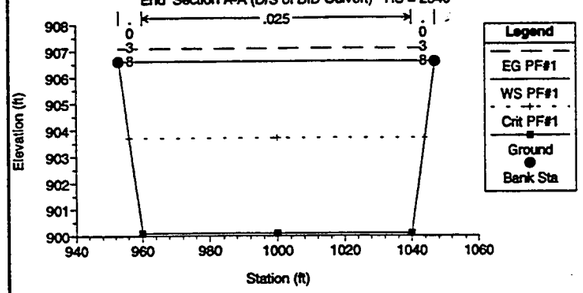
Bullard Wash Improvements Phase I (5FEB98 plans) 16-02-98
Flow: D/S = Gila 10yr
4-12x10ft CBC RS = 2890.42



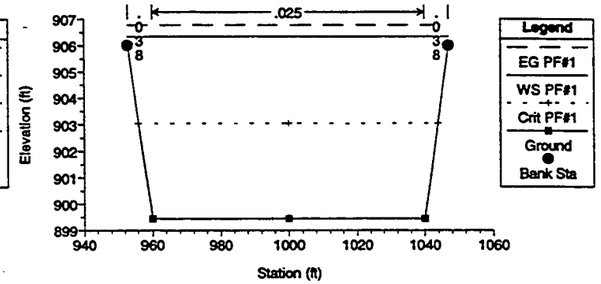
Bullard Wash Improvements Phase I (5FEB98 plans) 16-02-98
Flow: D/S = Gila 10yr
Buckeye Canal Maint. Rd (D/S Face) RS = 2880.42



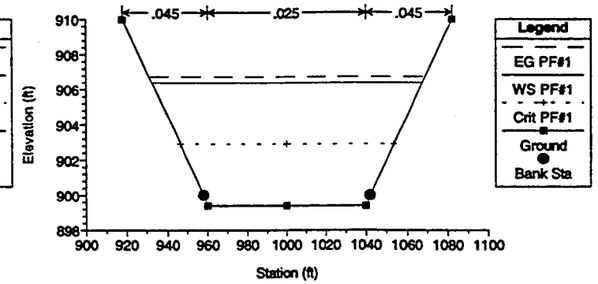
Bullard Wash Improvements Phase I (5FEB98 plans) 16-02-98
Flow: D/S = Gila 10yr
End Section A-A (D/S of BID Culvert) RS = 2840



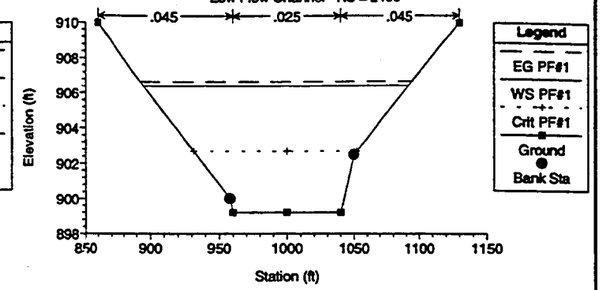
Bullard Wash Improvements Phase I (5FEB98 plans) 16-02-98
Flow: D/S = Gila 10yr
End Transition - Start Section A-A RS = 2520



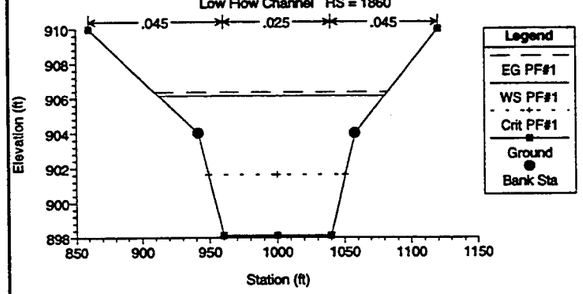
Bullard Wash Improvements Phase I (5FEB98 plans) 16-02-98
Flow: D/S = Gila 10yr
Transition to Seciton A-A RS = 2499.74



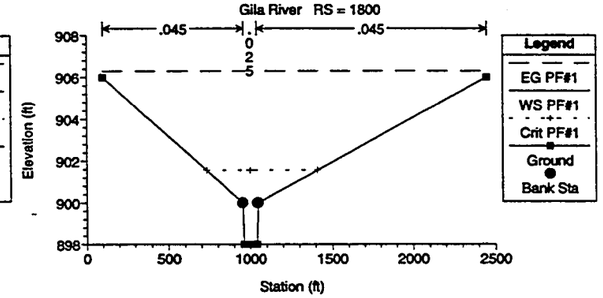
Bullard Wash Improvements Phase I (5FEB98 plans) 16-02-98
Flow: D/S = Gila 10yr
Low Flow Channel RS = 2400



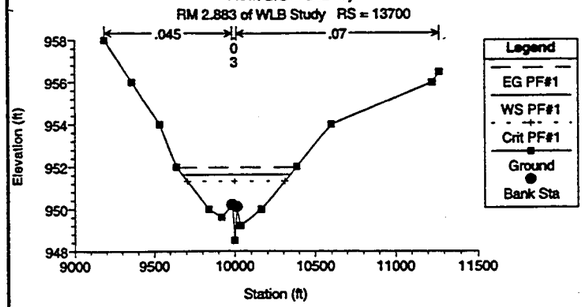
Bullard Wash Improvements Phase I (5FEB98 plans) 16-02-98
Flow: D/S = Gila 10yr
Low Flow Channel RS = 1860



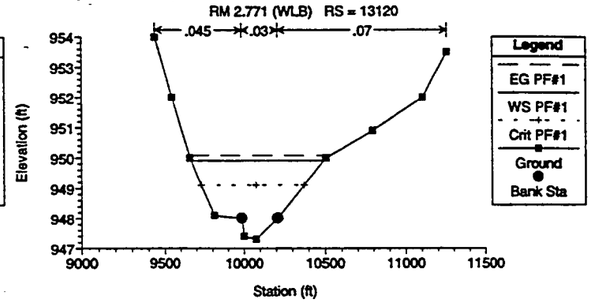
Bullard Wash Improvements Phase I (5FEB98 plans) 16-02-98
Flow: D/S = Gila 10yr
Gila River RS = 1800



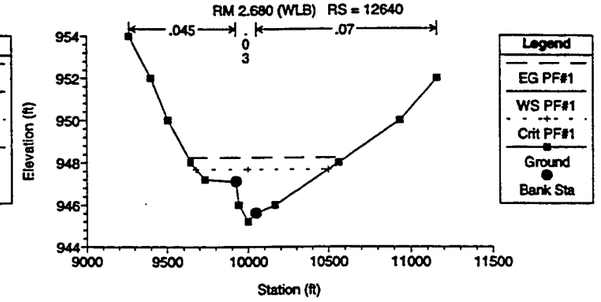
Bullard Wash Improvements Phase I (5FEB98 plans) 16-02-98
Flow: D/S = Gila 10yr
RM 2.883 of WLB Study RS = 13700



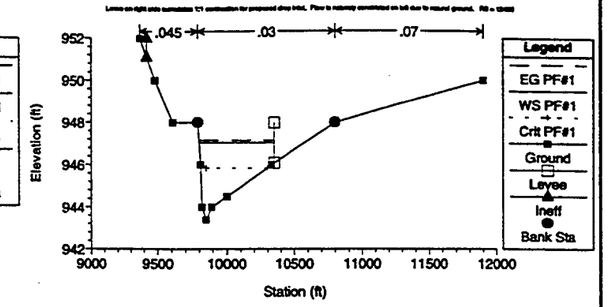
Bullard Wash Improvements Phase I (5FEB98 plans) 16-02-98
Flow: D/S = Gila 10yr
RM 2.771 (WLB) RS = 13120



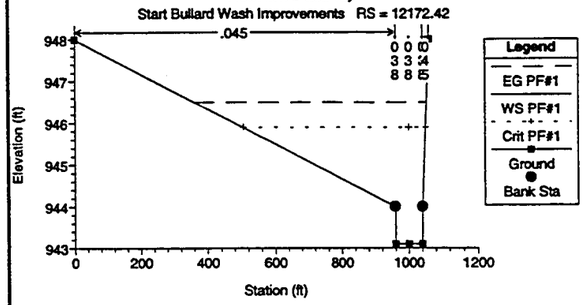
Bullard Wash Improvements Phase I (5FEB98 plans) 16-02-98
Flow: D/S = Gila 10yr
RM 2.680 (WLB) RS = 12640



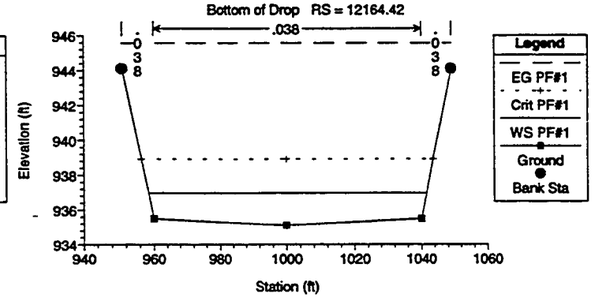
Bullard Wash Improvements Phase I (5FEB98 plans) 16-02-98



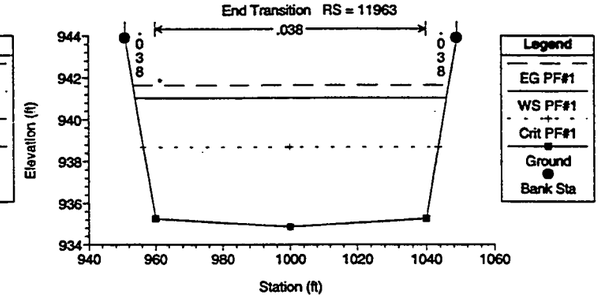
Bullard Wash Improvements Phase I (5FEB98 plans) 16-02-98
Flow: D/S = Gila 10yr
Start Bullard Wash Improvements RS = 12172.42



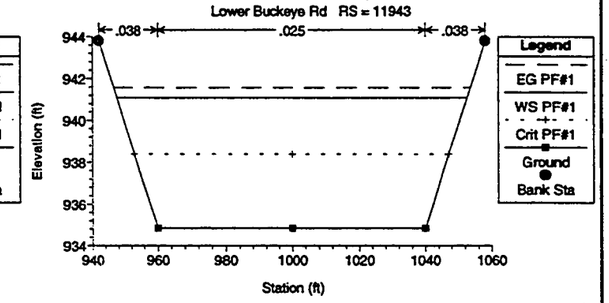
Bullard Wash Improvements Phase I (5FEB98 plans) 16-02-98
Flow: D/S = Gila 10yr
Bottom of Drop RS = 12164.42



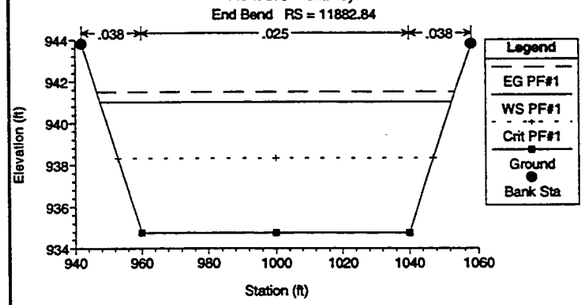
Bullard Wash Improvements Phase I (5FEB98 plans) 16-02-98
Flow: D/S = Gila 10yr
End Transition RS = 11963



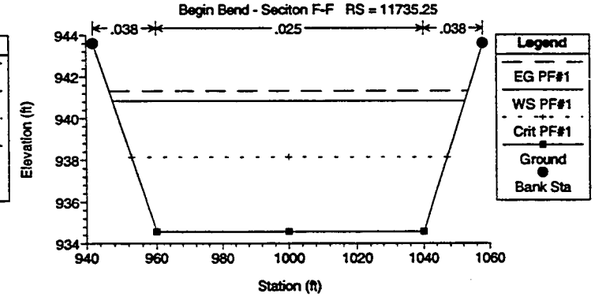
Bullard Wash Improvements Phase I (5FEB98 plans) 16-02-98
Flow: D/S = Gila 10yr
Lower Buckeye Rd RS = 11943



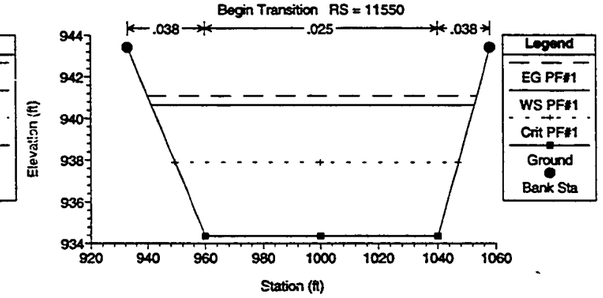
Bullard Wash Improvements Phase I (5FEB98 plans) 16-02-98
Flow: D/S = Gila 10yr
End Bend RS = 11882.84



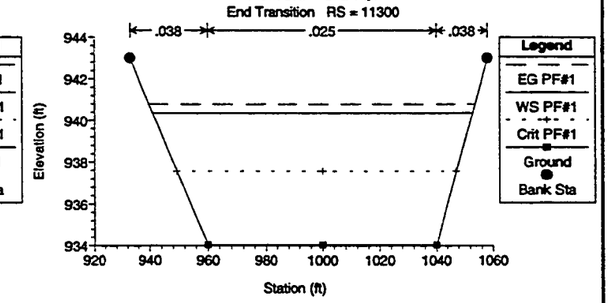
Bullard Wash Improvements Phase I (5FEB98 plans) 16-02-98
Flow: D/S = Gila 10yr
Begin Bend - Seciton F-F RS = 11735.25



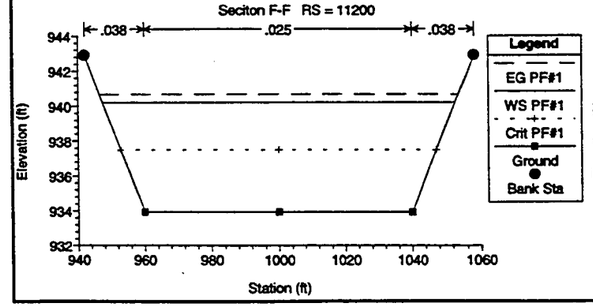
Bullard Wash Improvements Phase I (5FEB98 plans) 16-02-98
Flow: D/S = Gila 10yr
Begin Transition RS = 11550



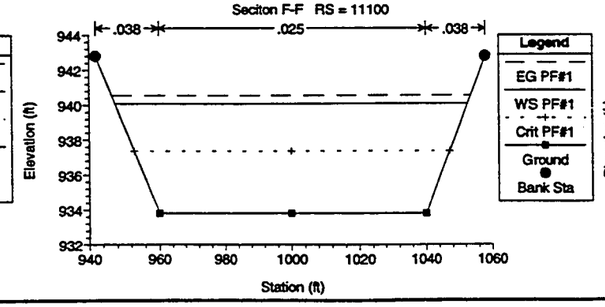
Bullard Wash Improvements Phase I (5FEB98 plans) 16-02-98
Flow: D/S = Gila 10yr
End Transition RS = 11300



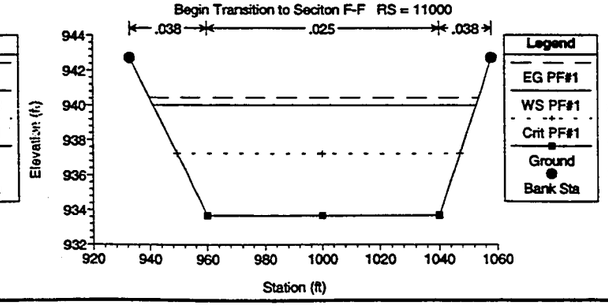
Bullard Wash Improvements Phase I (5FEB98 plans) 16-02-98
Flow: D/S = Gila 10yr
Seciton F-F RS = 11200



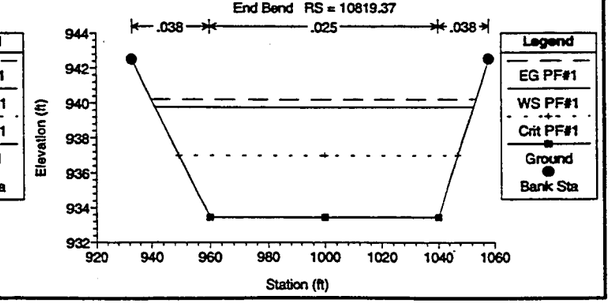
Bullard Wash Improvements Phase I (5FEB98 plans) 16-02-98
Flow: D/S = Gila 10yr
Seciton F-F RS = 11100

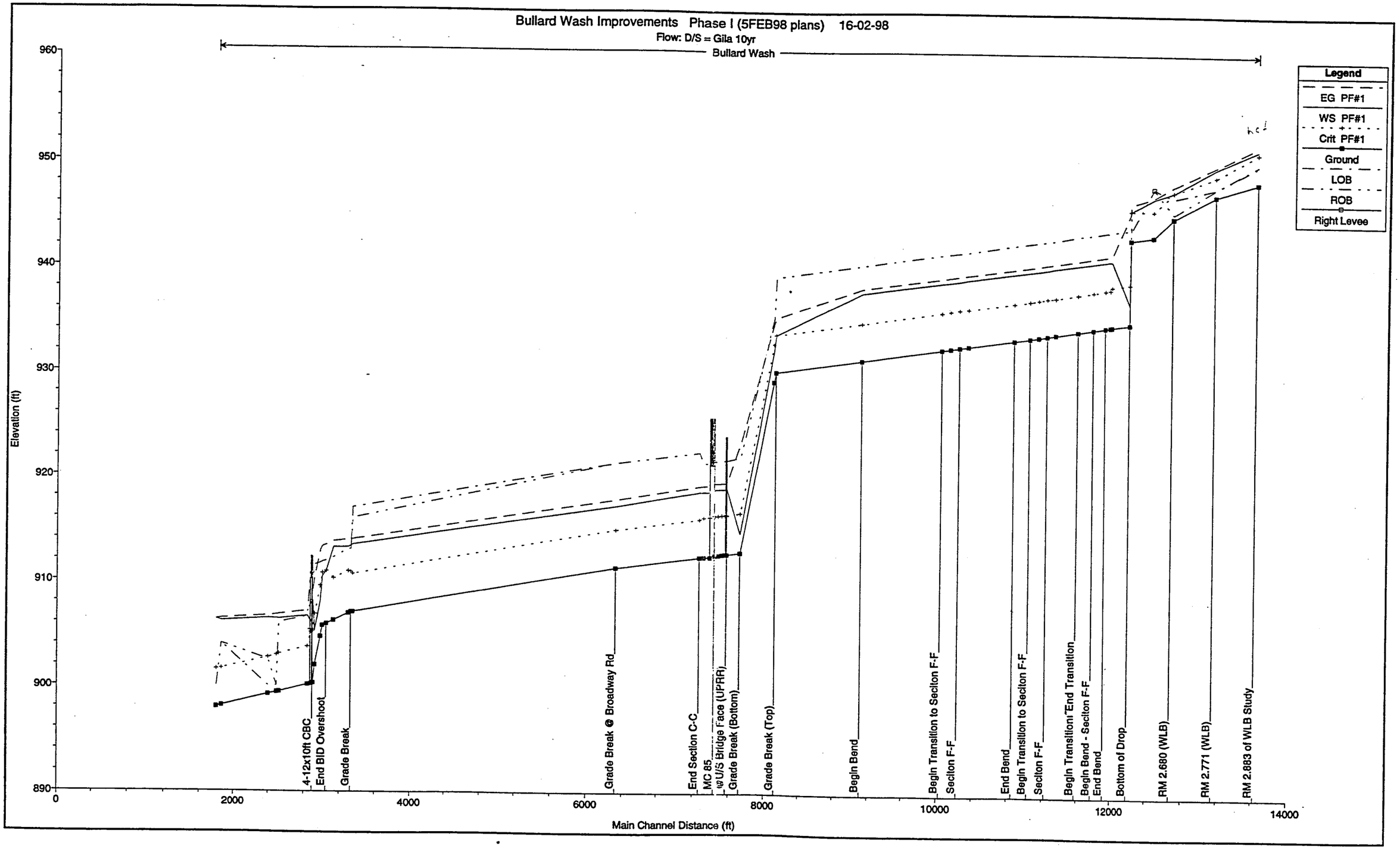


Bullard Wash Improvements Phase I (5FEB98 plans) 16-02-98
Flow: D/S = Gila 10yr
Begin Transition to Seciton F-F RS = 11000



Bullard Wash Improvements Phase I (5FEB98 plans) 16-02-98
Flow: D/S = Gila 10yr
End Bend RS = 10819.37




Bullard Wash Improvements Phase I (5FEB98 plans) 16-02-98
Flow: D/S = Gila 10yr
Bullard Wash
Legend
EG PF#1
WS PF#1
Crit PF#1
Ground
LOB
ROB
Right Levee
Elevation (ft)
960
950
940
930
920
910
900
890
0
2000
4000
6000
8000
10000
12000
14000
Main Channel Distance (ft)
4-12x10ft CBC
End BID Overshoot
Grade Break
Grade Break @ Broadway Rd
End Section C-C
MC 85
w/ U/S Bridge Face (UPRR)
Grade Break (Bottom)
Grade Break (Top)
Begin Bend
Begin Transition to Section F-F
Section F-F
End Bend
Begin Transition to Section F-F
Section F-F
Begin Transition/ End Transition
Begin Bend - Section F-F
End Bend
Bottom of Drop
RM 2.680 (WLB)
RM 2.771 (WLB)
RM 2.883 of WLB Study

AVERY

BULLARD WASH OUTFALL CHANNEL IMPROVEMENTS

SUPPLEMENTAL HYDRAULIC COMPUTATIONS

FCD #95-39

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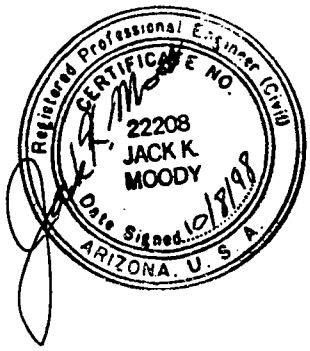

Revised: October 8, 1998
Revised: September 22, 1998
July 7, 1998
WP #96464

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RIPRAP DESIGN

SEEPAGE ANALYSIS

HYDRAULIC JUMP CALCULATIONS

LOCAL SCOUR ESTIMATION

Registered Professional Engineer (Civil)
CERTIFICATE NO.
22208
JACK K.
MOODY
Date Signed 10/8/98
ARIZONA, U.S.A.

SUMMARY OF MANNINGS "n" VALUES

TABLE E1.1
Manning's n-values Used for Each Channel Material

Channel Material	Manning's n-value
Concrete - troweled or float finish	0.015
Concrete - heavy broom or raked finish	0.019
Concrete - form liner finish	0.024
Grouted rip rap	0.038
Vegetated earth	0.032
Gabion basket or mattress	0.030

References: Flood Control District of Maricopa County, Drainage Design Manual - Volume II, Hydraulics, January 1996
Chow, Ven Te, Open-Channel Hydraulics, 1959

TABLE E1.2
Summary of Manning's n-values Used for Bullard Wash

From Station	To Station	Channel Description	Assigned Manning's n-values		
			Left Side	Channel	Right Side
18+00.00	25+00.00	Reach not modeled (earthen section graded into Gila river)	--	--	--
25+00.00	28+60.56	Trap. channel, gabion mattress sides, vegetated earthen bottom.	0.030	0.032	0.030
28+60.56	28+77.74	Box culvert outlet apron, concrete sides (float finish) and bottom (raked).	0.015	0.019	0.015
28+77.74	29+01.49	Box culverts, 4 - 12'x10' CBC (eastern box is raked on bottom).	0.015	0.015	0.015
29+01.49	29+95.26	Trap. channel, grouted rip rap sides and bottom (d50 = 15 inches).	0.038	0.038	0.038
29+95.26	30+02.33	Rect. to trap. channel transition, concrete sides (form liner finish), bottom (raked finish).	0.024	0.019	0.024
30+02.33	30+64.67	Rect. overchute, concrete sides (form liner finish) and bottom (raked).	0.024	0.019	0.024
30+64.67	33+30.00	Trap. channel, concrete Sides (float finish) and bottom (raked finish).	0.015	0.019	0.015
33+30.00	72+47.00	Trap. channel, gabion mattress sides, vegetated earthen bottom.	0.030	0.032	0.030
72+47.00	77+00.00	Trap. channel, concrete Sides (float finish) and bottom (raked finish).	0.015	0.019	0.015
77+00.00	81+00.00	Trap. channel, grouted rip rap sides and bottom (d50 = 15 inches).	0.038	0.038	0.038
81+00.00	119+43.00	Trap. channel, gabion mattress sides, vegetated earthen bottom, concrete trapezoidal low flow channel (n = 0.015).	0.030	0.032	0.030
119+43.00	121+98.00	Channel inlet area, gabion basket sides and bottom apron (n-value in overbanks = 0.045).	0.030	0.030	0.030
121+98.00	122+00.00	Channel inlet area, gabion basket sides, concrete channel @ top of drop (n-value in overbanks = 0.045).	0.030	0.015	0.030
122+00.00	123+45.00	Channel inlet area, vegetated earthen overbanks, concrete channel (n-value in overbanks = 0.045).	0.032	0.015	0.032
123+45.00	124+45.00	Channel inlet area, vegetated earthen channel (n-value in overbanks = 0.045).	0.032	0.032	0.032
124+45.00	131+20.00	Channel inlet area, vegetated earthen channel, undisturbed overbanks per WLB Study.	0.045	0.032	0.070
131+20.00	137+00.00	Bullard Wash, geometry per WLB Study.	0.045	0.032	0.070

TABLE E3
Summary of Expansion and Contraction Coefficients

From Station	To Station	Channel Description	Assigned coefficients Contraction	Assigned coefficients Expansion
137+00.00	126+40.00	Gradual transitions, U/S of inlet area	0.1	0.3
126+40.00	119+32.00	Channel inlet area to Lower Buckeye Road	0.3	0.5
119+32.00	81+00.00	Gradual transitions, Lower Buckeye Rd to U/S of bridges	0.1	0.3
81+00.00	80+80.00	Contraction / transition U/S of sloping drop structure	0.3	0.5
80+80.00	72+80.00	Gradual transitions, sloping drop structure & bridges	0.1	0.3
72+80.00	72+47.00	Expansion / transition D/S of MC 85 bridge	0.3	0.5
72+47.00	30+88.94	Gradual transitions, MC 85 Bridge to Overchute transition	0.1	0.3
30+88.94	30+64.67	Contraction / transition from trap channel to BID overchute	0.3	0.5
30+64.67	30+02.33	Gradual transitions, BID Overchute	0.1	0.3
30+02.33	29+95.26	Expansion / transition from BID overchute to sloping drop	0.3	0.5
29+95.26	29+11.00	Gradual transitions, sloping drop structure	0.1	0.3
29+11.00	28+60.56	4 barrel Box Culvert under BID bypass road	0.3	0.5
28+60.56	25+00.00	Gradual transitions, box culvert outlet to Gila River	0.1	0.3

References: Flood Control District of Maricopa County, Drainage Design Manual - Volume II, Hydraulics, January 1996
US Army Corps of Engineers, HEC-2 Water Surface Profiles User's Manual, September 1990

HEC-RAS OUTPUT

TABLE E5.1
HEC-RAS Output for Bullard Wash Outfall Channel Improvements
Final Hydraulic Profile (100-yr Q) for sub & supercritical flow conditions
Bullard Wash from Gila River to Lower Buckeye Road

Profile Output Table - Standard Table 1
HEC-RAS Plan: Final(9/98) River: Bullard Wash Reach: Outfall Channel Run Date: 24-Sep-98

Reach	River Sta	Q Total (ft/sec)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/sec)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl
Outfall Channel	2500.00	3200.00	900.69	906.58	904.30	907.20	0.002001	6.33	505.71	91.78	0.48
Outfall Channel	2660.00	3200.00	901.02	906.90	904.63	907.52	0.002012	6.34	504.81	91.76	0.48
Outfall Channel	2860.56	3200.00	901.42	907.30	905.03	907.92	0.002008	6.33	505.14	91.76	0.48
Outfall Channel	2877.74	3200.00	901.45	906.45	906.38	908.87	0.003534	12.49	256.13	51.29	0.99
Outfall Channel	2901.4	Culvert									
Outfall Channel	2901.49	3200.00	901.50	909.45	906.43	910.41	0.000565	7.85	407.69	51.34	0.49
Outfall Channel	2911.00	3200.00	901.97	909.93	906.59	910.52	0.002140	6.19	517.19	76.95	0.42
Outfall Channel	2995.26	3200.00	906.15	909.69	910.46	912.71	0.027315	13.95	229.31	70.12	1.36
Outfall Channel	3002.33	3200.00	906.48	910.82	910.82	913.01	0.004132	11.87	269.55	62.12	1.00
Outfall Channel	3049.67	3200.00	906.56	911.59	910.90	913.22	0.002630	10.26	311.95	62.14	0.81
Outfall Channel	3064.67	3200.00	906.58	911.65	910.92	913.25	0.002564	10.17	314.59	62.14	0.80
Outfall Channel	3088.94	3200.00	906.62	912.81	910.65	913.55	0.000767	6.88	464.86	82.29	0.51
Outfall Channel	3141.00	3200.00	906.70	912.84	910.74	913.59	0.000800	6.98	458.73	82.15	0.52
Outfall Channel	3266.00	3200.00	906.90	912.92	910.94	913.71	0.000857	7.13	448.90	81.90	0.54
Outfall Channel	3330.00	3200.00	907.00	913.25	910.70	913.78	0.000544	5.84	547.68	98.51	0.44
Outfall Channel	3372.00	3200.00	907.06	913.35	910.61	913.82	0.001435	5.49	582.76	105.31	0.41
Outfall Channel	3562.61*	3200.00	907.34	913.62	910.89	914.09	0.001440	5.50	582.08	105.28	0.41
Outfall Channel	3753.23*	3200.00	907.62	913.90	911.17	914.37	0.001444	5.50	581.51	105.26	0.41
Outfall Channel	3943.84*	3200.00	907.89	914.17	911.45	914.64	0.001441	5.50	581.89	105.23	0.41
Outfall Channel	4134.46*	3200.00	908.17	914.45	911.72	914.92	0.001445	5.50	581.33	105.21	0.41
Outfall Channel	4325.07*	3200.00	908.45	914.72	912.00	915.19	0.001449	5.51	580.85	105.19	0.41
Outfall Channel	4515.69*	3200.00	908.73	915.00	912.28	915.47	0.001452	5.51	580.45	105.18	0.41
Outfall Channel	4706.30*	3200.00	909.00	915.28	912.56	915.75	0.001447	5.51	580.99	105.15	0.41
Outfall Channel	4896.92*	3200.00	909.28	915.55	912.83	916.02	0.001450	5.51	580.55	105.14	0.41
Outfall Channel	5087.53*	3200.00	909.56	915.83	913.11	916.30	0.001453	5.52	580.18	105.12	0.41
Outfall Channel	5278.15*	3200.00	909.84	916.11	913.39	916.58	0.001456	5.52	579.87	105.11	0.41
Outfall Channel	5468.76*	3200.00	910.11	916.38	913.67	916.85	0.001450	5.51	580.48	105.09	0.41
Outfall Channel	5659.38*	3200.00	910.39	916.66	913.95	917.13	0.001453	5.52	580.11	105.08	0.41
Outfall Channel	5850.00	3200.00	910.67	916.94	914.23	917.41	0.001456	5.52	579.79	105.06	0.41
Outfall Channel	5900.00	3200.00	910.74	917.01	914.30	917.48	0.001453	5.52	580.08	105.07	0.41

TABLE E5.1
HEC-RAS Output for Bullard Wash Outfall Channel Improvements
Final Hydraulic Profile (100-yr Q) for sub & supercritical flow conditions
Bullard Wash from Gila River to Lower Buckeye Road

Profile Output Table - Standard Table 1
HEC-RAS Plan: Final(9/98) River: Bullard Wash Reach: Outfall Channel Run Date: 24-Sep-98

Reach	River Sta	Q Total (ft/sec)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/sec)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl
Outfall Channel	6020.00	3200.00	910.92	917.18	914.48	917.66	0.001458	5.52	579.49	105.05	0.41
Outfall Channel	6220.00	3200.00	911.21	917.47	914.77	917.95	0.001457	5.52	579.65	105.06	0.41
Outfall Channel	6322.00	3200.00	911.36	917.62	914.92	918.10	0.001464	5.53	578.67	105.02	0.42
Outfall Channel	6400.00	3200.00	911.45	917.74	915.00	918.21	0.001434	5.49	582.59	105.17	0.41
Outfall Channel	6510.*	3200.00	911.58	917.90	915.14	918.37	0.001409	5.46	585.99	105.30	0.41
Outfall Channel	6620.00	3200.00	911.70	918.07	915.26	918.52	0.001378	5.42	590.28	105.46	0.40
Outfall Channel	6776.75*	3200.00	911.88	918.29	915.44	918.74	0.001348	5.38	594.59	105.63	0.40
Outfall Channel	6933.5*	3200.00	912.05	918.50	915.61	918.95	0.001314	5.34	599.54	105.81	0.40
Outfall Channel	7090.25*	3200.00	912.23	918.71	915.79	919.15	0.001295	5.31	602.52	105.93	0.39
Outfall Channel	7247.00	3200.00	912.40	918.92	915.96	919.35	0.001269	5.28	606.45	106.07	0.39
Outfall Channel	7280.00	3200.00	912.34	918.90	916.10	919.42	0.000506	5.79	552.83	92.80	0.42
Outfall Channel	7300.00	3200.00	912.36	918.91	916.13	919.43	0.000508	5.79	552.23	92.87	0.42
Outfall Channel	7357	Bridge									
Outfall Channel	7417.00	3200.00	912.49	919.26	916.26	919.75	0.000452	5.59	572.76	93.23	0.40
Outfall Channel	7440.00	3200.00	912.51	919.27	916.27	919.76	0.000454	5.60	571.91	93.22	0.40
Outfall Channel	7500.00	3200.00	912.58	919.30	916.35	919.79	0.000465	5.64	567.47	93.13	0.40
Outfall Channel	7523.00	3200.00	911.82	919.34	916.19	919.80	0.000427	5.49	583.30	93.14	0.39
Outfall Channel	7533	Bridge									
Outfall Channel	7543.00	3200.00	911.84	919.43	916.22	919.89	0.000410	5.42	590.61	93.30	0.38
Outfall Channel	7558.00	3200.00	912.65	919.42	916.43	919.91	0.000453	5.59	572.39	93.23	0.40
Outfall Channel	7605.00	3200.00	912.70	919.44	916.44	919.93	0.000454	5.59	572.13	93.11	0.40
Outfall Channel	7700.00	3200.00	912.81	919.47	916.58	919.98	0.000477	5.69	565.67	106.75	0.41
Outfall Channel	7744.00	3200.00	914.81	917.48	918.40	920.70	0.039657	14.39	222.35	86.61	1.58
Outfall Channel	7771.64	3200.00	916.00	918.71	919.58	921.77	0.037273	14.05	227.82	88.13	1.54
Outfall Channel	7925.82*	3200.00	922.67	925.06	926.25	929.04	0.056647	16.01	199.91	87.18	1.86
Outfall Channel	8080.00	3200.00	929.34	932.41	932.92	934.77	0.024601	12.33	259.54	89.20	1.27
Outfall Channel	8100.00	3200.00	930.20	933.73	933.73	935.35	0.014641	10.20	313.66	97.66	1.00
Outfall Channel	8210.00	3200.00	929.33	935.30	933.80	936.03	0.002797	6.88	464.86	104.83	0.58
Outfall Channel	8348.*	3200.00	929.50	935.74	933.95	936.39	0.002329	6.48	493.77	106.20	0.53
Outfall Channel	8486.*	3200.00	929.66	936.10	934.12	936.70	0.002049	6.21	515.06	107.19	0.50

TABLE E5.1
HEC-RAS Output for Bullard Wash Outfall Channel Improvements
Final Hydraulic Profile (100-yr Q) for sub & supercritical flow conditions
Bullard Wash from Gila River to Lower Buckeye Road

Profile Output Table - Standard Table 1
HEC-RAS Plan: Final(9/98) River: Bullard Wash Reach: Outfall Channel Run Date: 24-Sep-98

Reach	River Sta	Q Total (ft/sec)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/sec)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl
Outfall Channel	8624.*	3200.00	929.83	936.41	934.29	936.97	0.001882	6.04	529.81	107.88	0.48
Outfall Channel	8762.*	3200.00	929.99	936.69	934.45	937.23	0.001750	5.90	542.77	108.48	0.46
Outfall Channel	8900.00	3200.00	930.16	936.94	934.62	937.46	0.001663	5.80	552.02	108.90	0.45
Outfall Channel	9000.00	3200.00	930.29	937.09	934.77	937.64	0.001710	5.96	537.11	103.19	0.46
Outfall Channel	9080.00	3200.00	930.38	937.24	934.86	937.78	0.001653	5.89	543.08	103.42	0.45
Outfall Channel	9200.00	3200.00	930.55	937.44	935.03	937.97	0.001621	5.85	546.60	103.56	0.45
Outfall Channel	9372.00	3200.00	930.74	937.77	935.21	938.24	0.001441	5.53	578.90	110.13	0.42
Outfall Channel	9529.*	3200.00	930.93	938.00	935.38	938.47	0.001407	5.48	583.51	110.34	0.42
Outfall Channel	9686.*	3200.00	931.12	938.22	935.58	938.68	0.001379	5.45	587.44	110.52	0.42
Outfall Channel	9843.*	3200.00	931.31	938.44	935.77	938.90	0.001356	5.42	590.81	110.67	0.41
Outfall Channel	10000.00	3200.00	931.50	938.66	935.96	939.11	0.001337	5.39	593.57	110.80	0.41
Outfall Channel	10100.00	3200.00	931.62	938.77	936.10	939.26	0.001396	5.57	574.10	104.62	0.42
Outfall Channel	10200.00	3200.00	931.74	938.92	936.22	939.39	0.001379	5.55	576.38	104.71	0.42
Outfall Channel	10300.00	3200.00	931.86	939.09	936.33	939.53	0.001283	5.32	601.72	111.16	0.40
Outfall Channel	10430.*	3200.00	932.02	939.26	936.49	939.70	0.001278	5.31	602.47	111.20	0.40
Outfall Channel	10560.*	3200.00	932.17	939.43	936.62	939.86	0.001266	5.29	604.44	111.29	0.40
Outfall Channel	10690.*	3200.00	932.33	939.59	936.79	940.03	0.001263	5.29	604.95	111.31	0.40
Outfall Channel	10820.00	3200.00	932.49	939.76	936.95	940.19	0.001260	5.29	605.42	111.33	0.40
Outfall Channel	11000.00	3200.00	932.71	939.98	937.17	940.42	0.001255	5.28	606.17	111.36	0.40
Outfall Channel	11100.00	3200.00	932.83	940.09	937.31	940.55	0.001318	5.47	585.11	105.04	0.41
Outfall Channel	11200.00	3200.00	932.95	940.22	937.43	940.68	0.001309	5.46	586.48	105.09	0.41
Outfall Channel	11300.00	3200.00	933.07	940.39	937.54	940.81	0.001223	5.23	611.40	111.60	0.39
Outfall Channel	11425.*	3200.00	933.22	940.54	937.69	940.97	0.001221	5.23	611.73	111.61	0.39
Outfall Channel	11550.00	3200.00	933.37	940.70	937.82	941.12	0.001220	5.23	612.02	111.63	0.39
Outfall Channel	11735.00	3200.00	933.60	940.90	938.08	941.36	0.001286	5.43	589.83	105.22	0.40
Outfall Channel	11883.00	3200.00	933.77	941.10	938.25	941.55	0.001271	5.40	592.17	105.31	0.40
Outfall Channel	11932.00	3200.00	933.84	941.16	938.32	941.61	0.001276	5.41	591.35	105.28	0.40
Outfall Channel	11943.00	3200.00	933.85	941.13	938.44	941.67	0.001481	5.89	543.54	92.44	0.43
Outfall Channel	12195.00	3200.00	934.75	936.92	938.76	944.47	0.096977	22.04	145.19	83.52	2.95
Outfall Channel	12198.00	3200.00	939.65	945.82	945.82	946.51	0.004752	7.95	639.60	375.21	0.94

TABLE E5.1
HEC-RAS Output for Bullard Wash Outfall Channel Improvements
Final Hydraulic Profile (100-yr Q) for sub & supercritical flow conditions
Bullard Wash from Gila River to Lower Buckeye Road

Profile Output Table - Standard Table 1
HEC-RAS Plan: Final(9/98) River: Bullard Wash Reach: Outfall Channel Run Date: 24-Sep-98

Reach	River Sta	Q Total (ft/sec)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/sec)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl	
Outfall Channel	12200.00	3200.00	939.68	946.90	946.05	947.22	0.000625	5.41	1105.85	493.50	0.54	b
Outfall Channel	12345.00	3200.00	940.96	946.92	946.61	947.43	0.001100	6.87	1038.34	626.70	0.61	
Outfall Channel	12445.00	3200.00	941.85	947.51	946.86	947.68	0.002032	4.15	1222.28	768.39	0.44	
Outfall Channel	12640.00	3200.00	942.50	947.85	946.69	947.98	0.001103	3.69	1321.56	839.61	0.34	
Outfall Channel	13120.00	4906.00	943.70	948.89	948.87	949.66	0.009993	7.21	784.66	594.41	0.91	
Outfall Channel	13700.00	4906.00	948.50	952.80	951.68	952.97	0.003333	6.13	1818.94	873.00	0.58	c

Notes: * Denotes HEC-RAS Interpolated Cross Section

a) Station 25+00 downstream starting WSEL using slope area method with channel slope = 0.002 ft/ft is 906.58 ft.
10-yr WSEL in Gila River is 906.3 ft per FEMA study of record by Dames & More.
Slope area with channel slope yields 100-yr WSEL in Bullard Wash of 906.58 ft @ STA 25+00.

b) Station 122+00 known WSEL is 946.9 based on uneven weir flow ponding elevation for the drop inlet structure.

c) Station 137+00 (RM 2.883) upstream starting WSEL is known elevation of 952.8 ft per WLB Study.

SUMMARY OF FREEBOARD CONSIDERATIONS

Wood, Patel & Associates, Inc.

TABLE E5.6
Summary of Freeboard Considerations for Bullard Wash

Project: FCDMC: Bullard Wash - CLOMR Submittal
River Reach: Gila River Outfall to Lower Buckeye Road
Date: 24-Sep-98
Reference: FCDMC, Drainage Design Manual, Volume II - Hydraulics, January 1996

Equations Used:

Freeboard: $FB = 0.25 (Y + V^2 / 2g) + dY$ for both subcritical & supercritical flow
Superelevation: $dY = (V^2 * T) / (g * Rc)$ for channel bends
subcritical flow, min FB = 1.0 ft — supercritical flow, min FB = 2.0 ft
Bridges, min FB = 2.0 ft — Levees, min FB = 3.0 ft

Stationing, in feet		Channel Elev., in feet		WSEL	Velocity	Froude	Freeboard, in feet			Background DATA				
										Radius	Top Width	Rc/T	Super Elev	Calculated
2500.00	25+00.00	900.69	908.69	906.58	6.33	0.48	1.63	2.11		none	91.78	--	n/a	1.628
2660.00	26+60.00	901.02	909.02	906.90	6.34	0.48	1.63	2.12		none	91.76	--	n/a	1.626
2860.56	28+60.56	901.42	909.42	907.30	6.33	0.48	1.63	2.12		none	91.76	--	n/a	1.626
2877.74	28+77.74	901.45	909.45	906.45	12.49	0.99	2.00	3.00	a	none	51.29	--	n/a	1.856
2901.40	29+01.40	901.50	912.54						a	4 barrel 10'x12' concrete box culvert				
2901.49	29+01.49	901.50	912.54	909.45	7.85	0.49	2.23	3.09	a	none	51.34	--	n/a	2.227
2911.00	29+11.00	901.97	912.54	909.93	6.19	0.42	2.14	2.61		none	76.95	--	n/a	2.139
2995.26	29+95.26	906.15	913.41	909.69	13.95	1.36	2.00	3.72		none	70.12	--	n/a	1.640
3002.33	30+02.33	906.48	913.48	910.82	11.87	1.00	2.00	2.66		none	62.12	--	n/a	1.632
3049.67	30+49.67	906.56	913.58	911.59	10.26	0.81	1.67	1.99		none	62.14	--	n/a	1.666
3064.67	30+64.67	906.58	913.58	911.65	10.17	0.80	1.67	1.93		none	62.14	--	n/a	1.669
3088.94	30+88.94	906.62	915.62	912.81	6.88	0.51	1.73	2.81		none	82.29	--	n/a	1.731
3141.00	31+41.00	906.70	915.70	912.84	6.98	0.52	1.97	2.86		500	82.15	6.09	0.25	1.724
3266.00	32+66.00	906.90	915.90	912.92	7.13	0.54	1.96	2.98		500	81.90	6.11	0.26	1.702
3330.00	33+30.00	907.00	917.00	913.25	5.84	0.44	3.00	3.75		none	98.51	--	n/a	1.695
3372.00	33+72.00	907.06	917.06	913.35	5.49	0.41	3.00	3.71		none	105.31	--	n/a	1.690
3562.61*	3562.61*	907.34	917.34	913.62	5.50	0.41	3.00	3.72		none	105.28	--	n/a	1.687
3753.23*	3753.23*	907.62	917.62	913.90	5.50	0.41	3.00	3.72		none	105.26	--	n/a	1.687
3943.84*	3943.84*	907.89	917.89	914.17	5.50	0.41	3.00	3.72		none	105.23	--	n/a	1.687
4134.46*	4134.46*	908.17	918.17	914.45	5.50	0.41	3.00	3.72		none	105.21	--	n/a	1.687
4325.07*	4325.07*	908.45	918.45	914.72	5.51	0.41	3.00	3.73		none	105.19	--	n/a	1.685
4515.69*	4515.69*	908.73	918.73	915.00	5.51	0.41	3.00	3.73		none	105.18	--	n/a	1.685
4706.30*	4706.30*	909.00	919.00	915.28	5.51	0.41	3.00	3.72		none	105.15	--	n/a	1.688
4896.92*	4896.92*	909.28	919.28	915.55	5.51	0.41	3.00	3.73		none	105.14	--	n/a	1.685
5087.53*	5087.53*	909.56	919.56	915.83	5.52	0.41	3.00	3.73		none	105.12	--	n/a	1.686
5278.15*	5278.15*	909.84	919.84	916.11	5.52	0.41	3.00	3.73		none	105.11	--	n/a	1.686
5468.76*	5468.76*	910.11	920.11	916.38	5.51	0.41	3.00	3.73		none	105.09	--	n/a	1.685
5659.38*	5659.38*	910.39	920.39	916.66	5.52	0.41	3.00	3.73		none	105.08	--	n/a	1.686
5850.00	58+50.00	910.67	920.67	916.94	5.52	0.41	3.00	3.73		none	105.06	--	n/a	1.686
5900.00	59+00.00	910.74	919.74	917.01	5.52	0.41	1.69	2.73		none	105.07	--	n/a	1.686
6020.00	60+20.00	910.92	919.92	917.18	5.52	0.41	1.68	2.74		none	105.05	--	n/a	1.683
6220.00	62+20.00	911.21	920.21	917.47	5.52	0.41	1.68	2.74		none	105.06	--	n/a	1.683
6322.00	63+22.00	911.36	920.36	917.62	5.53	0.42	1.68	2.74		none	105.02	--	n/a	1.684
6400.00	64+00.00	911.45	920.45	917.74	5.49	0.41	1.69	2.71		none	105.17	--	n/a	1.690
6510.*	6510.*	911.58	920.58	917.90	5.46	0.41	1.70	2.68		none	105.30	--	n/a	1.696
6620.00	66+20.00	911.70	920.70	918.07	5.42	0.40	1.71	2.63		none	105.46	--	n/a	1.707

Wood, Patel & Associates, Inc.

TABLE E5.6
Summary of Freeboard Considerations for Bullard Wash

Project: FCDMC: Bullard Wash - CLOMR Submittal
River Reach: Gila River Outfall to Lower Buckeye Road
Date: 24-Sep-98
Reference: FCDMC, Drainage Design Manual, Volume II - Hydraulics, January 1996

Equations Used:

Freeboard: $FB = 0.25 (Y + V^2 / 2g) + dY$ for both subcritical & supercritical flow
Superelevation: $dY = (V^2 * T) / (g * Rc)$ for channel bends
subcritical flow, min FB = 1.0 ft — supercritical flow, min FB = 2.0 ft
Bridges, min FB = 2.0 ft — Levees, min FB = 3.0 ft

Stationing, in feet		Channel Elev., in feet		WSEL	Velocity	Froude	Freeboard, in feet			Background DATA				
										Radius	Top Width	Rc/T	Super Elev	Calculated
6776.75*	6776.75*	911.88	920.88	918.29	5.38	0.40	1.72	2.59		none	105.63	--	n/a	1.715
6933.5*	6933.5*	912.05	921.05	918.50	5.34	0.40	1.72	2.55		none	105.81	--	n/a	1.723
7090.25*	7090.25*	912.23	921.23	918.71	5.31	0.39	1.73	2.52		none	105.93	--	n/a	1.729
7247.00	72+47.00	912.40	921.40	918.92	5.28	0.39	1.74	2.48		none	106.07	--	n/a	1.738
7280.00	72+80.00	912.34	921.34	918.90	5.79	0.42	1.77	2.44		none	92.80	--	n/a	1.770
7300.00	73+00.00	912.36	922.06	918.91	5.79	0.42	2.00	3.15	b	none	92.87	--	n/a	1.768
7357.00	73+57.00	912.43	922.06						b		MC 85 bridge			
7417.00	74+17.00	912.49	922.06	919.26	5.59	0.40	2.00	2.80	b	none	93.23	--	n/a	1.814
7440.00	74+40.00	912.51	921.51	919.27	5.60	0.40	1.81	2.24		none	93.22	--	n/a	1.812
7500.00	75+00.00	912.58	921.58	919.30	5.64	0.40	1.80	2.28		none	93.13	--	n/a	1.803
7523.00	75+23.00	911.82	921.70	919.34	5.49	0.39	2.00	2.36	c	none	93.14	--	n/a	1.997
7543.00	75+43.00	911.83	921.70						c		UPRR bridge			
7543.00	75+43.00	911.84	921.70	919.43	5.42	0.38	2.01	2.27	c	none	93.30	--	n/a	2.012
7558.00	75+58.00	912.65	921.65	919.42	5.59	0.40	1.81	2.23		none	93.23	--	n/a	1.814
7605.00	76+05.00	912.70	921.70	919.44	5.59	0.40	1.81	2.26		none	93.11	--	n/a	1.806
7700.00	77+00.00	912.81	921.81	919.47	5.69	0.41	1.79	2.34		none	106.75	--	n/a	1.791
7744.00	77+44.00	914.81	921.97	917.48	14.39	1.58	2.00	4.49		none	86.61	--	n/a	1.471
7771.64	77+71.64	916.00	922.00	918.71	14.05	1.54	2.00	3.29		none	88.13	--	n/a	1.444
7925.82*	7925.82*	922.67	928.67	925.06	16.01	1.86	2.00	3.61		none	87.18	--	n/a	1.593
8080.00	80+80.00	929.34	935.34	932.41	12.33	1.27	2.00	2.93		none	89.20	--	n/a	1.358
8100.00	81+00.00	930.20	939.20	933.73	10.20	1.00	2.00	5.47		none	97.66	--	n/a	1.286
8210.00	82+10.00	930.33	939.33	935.30	6.88	0.58	1.43	4.03	d	none	104.83	--	n/a	1.426
8348.*	8348.*	930.50	939.50	935.74	6.48	0.53	1.47	3.76	d	none	106.20	--	n/a	1.473
8486.*	8486.*	930.66	939.66	936.10	6.21	0.50	1.51	3.56	d	none	107.19	--	n/a	1.510
8624.*	8624.*	930.83	939.83	936.41	6.04	0.48	1.54	3.42	d	none	107.88	--	n/a	1.537
8762.*	8762.*	930.99	939.99	936.69	5.90	0.46	1.56	3.30	d	none	108.48	--	n/a	1.560
8900.00	89+00.00	931.16	940.16	936.94	5.80	0.45	1.58	3.22	d	none	108.90	--	n/a	1.576
9000.00	90+00.00	931.29	940.29	937.09	5.96	0.46	1.59	3.20	d	none	103.19	--	n/a	1.588
9080.00	90+80.00	931.38	940.38	937.24	5.89	0.45	1.60	3.14	d	none	103.42	--	n/a	1.600
9200.00	92+00.00	931.55	940.55	937.44	5.85	0.45	1.65	3.11	d	2650	103.56	25.59	0.04	1.605
9372.00	93+72.00	931.74	940.74	937.77	5.53	0.42	1.67	2.97	d	2650	110.13	24.06	0.04	1.626
9529.*	9529.*	931.93	940.93	938.00	5.48	0.42	1.67	2.93	d	2650	110.34	24.02	0.04	1.634
9686.*	9686.*	932.12	941.12	938.22	5.45	0.42	1.68	2.90	d	2650	110.52	23.98	0.04	1.640
9843.*	9843.*	932.31	941.31	938.44	5.42	0.41	1.69	2.87	d	2650	110.67	23.95	0.04	1.647
10000.00	100+00.00	932.50	941.50	938.66	5.39	0.41	1.69	2.84	d	2650	110.80	23.92	0.04	1.653
10100.00	101+00.00	932.62	941.62	938.77	5.57	0.42	1.70	2.85	d	2650	104.62	25.33	0.04	1.658

Wood, Patel & Associates, Inc.

TABLE E5.6
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Project: FCDMC: Bullard Wash - CLOMR Submittal
River Reach: Gila River Outfall to Lower Buckeye Road
Date: 24-Sep-98
Reference: FCDMC, Drainage Design Manual, Volume II - Hydraulics, January 1996

Equations Used:

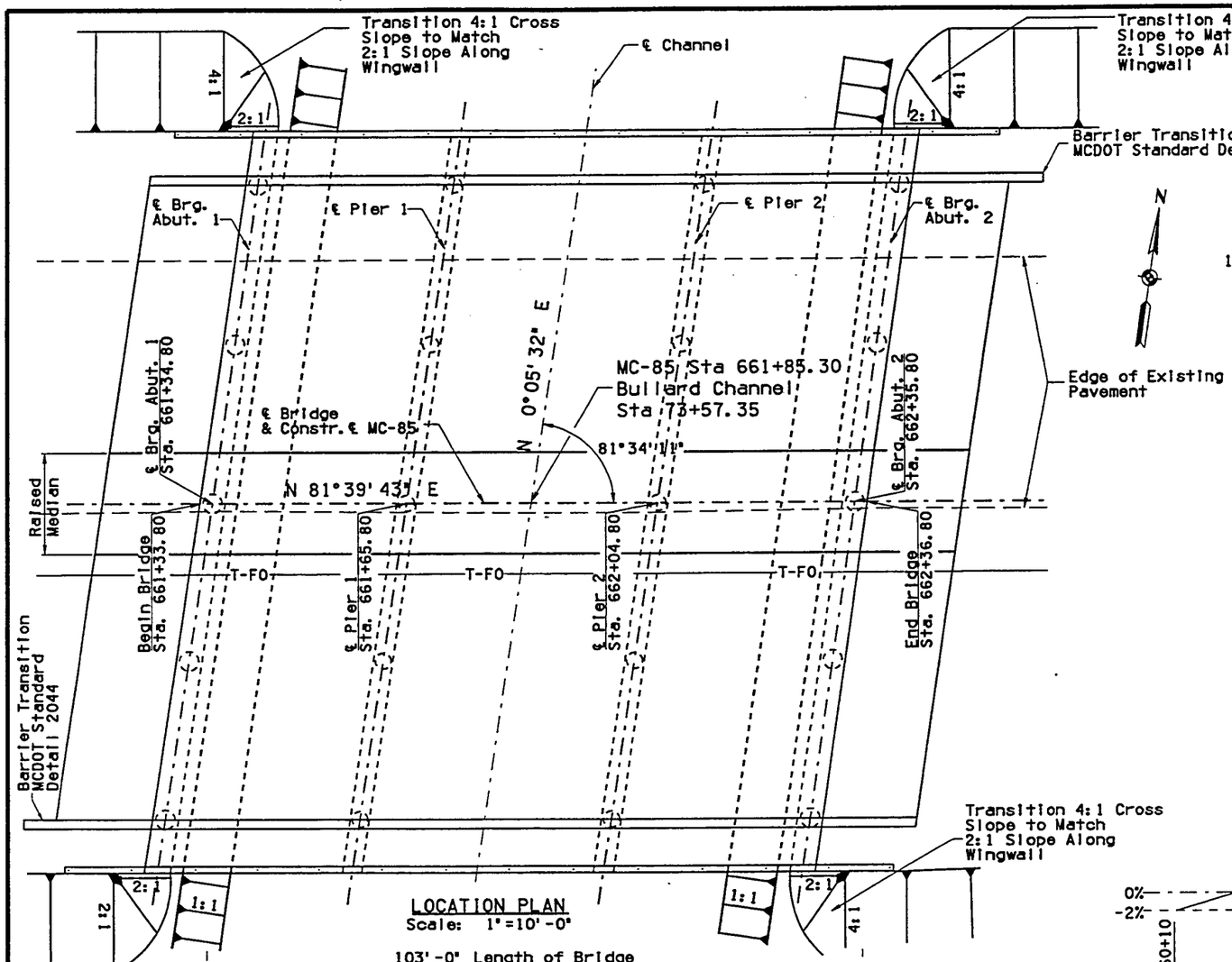
Freeboard: $FB = 0.25 (Y + V^2 / 2g) + dY$ for both subcritical & supercritical flow
Superelevation: $dY = (V^2 * T) / (g * Rc)$ for channel bends
subcritical flow, min FB = 1.0 ft — supercritical flow, min FB = 2.0 ft
Bridges, min FB = 2.0 ft — Levees, min FB = 3.0 ft

Stationing, in feet		Channel Elev., in feet		WSEL	Velocity	Froude	Freeboard, in feet			Background DATA				
										Radius	Top Width	Rc/T	Super Elev	Calculated
10200.00	102+00.00	932.74	941.74	938.92	5.55	0.42	1.70	2.82	d	2650	104.71	25.31	0.04	1.665
10300.00	103+00.00	932.86	941.86	939.09	5.32	0.40	1.70	2.77	d	2650	111.16	23.84	0.04	1.667
10430.*	10430.*	933.02	942.02	939.26	5.31	0.40	1.71	2.76	d	2650	111.20	23.83	0.04	1.669
10560.*	10560.*	933.17	942.17	939.43	5.29	0.40	1.71	2.74	d	2650	111.29	23.81	0.04	1.674
10690.*	10690.*	933.33	942.33	939.59	5.29	0.40	1.71	2.74	d	2650	111.31	23.81	0.04	1.674
10820.00	108+20.00	933.49	942.49	939.76	5.29	0.40	1.71	2.73	d	2650	111.33	23.80	0.04	1.676
11000.00	110+00.00	933.71	942.71	939.98	5.28	0.40	1.68	2.73	d	none	111.36	--	n/a	1.676
11100.00	111+00.00	933.83	942.83	940.09	5.47	0.41	1.68	2.74	d	none	105.04	--	n/a	1.681
11200.00	112+00.00	933.95	942.95	940.22	5.46	0.41	1.68	2.73	d	none	105.09	--	n/a	1.683
11300.00	113+00.00	934.07	943.07	940.39	5.23	0.39	1.69	2.68	d	none	111.60	--	n/a	1.686
11425.*	11425.*	934.22	943.22	940.54	5.23	0.39	1.69	2.68	d	none	111.61	--	n/a	1.686
11550.00	115+50.00	934.37	943.37	940.70	5.23	0.39	1.69	2.67	d	none	111.63	--	n/a	1.689
11735.00	117+35.00	934.60	943.60	940.90	5.43	0.40	2.12	2.70	d	225	105.22	2.14	0.43	1.689
11883.00	118+83.00	934.77	943.77	941.10	5.40	0.40	2.12	2.67	d	225	105.31	2.14	0.42	1.696
11932.00	119+32.00	934.84	943.84	941.16	5.41	0.40	1.69	2.68	d	none	105.28	--	n/a	1.694
11943.00	119+43.00	933.85	942.85	941.13	5.89	0.43	n/a	n/a	e	none	92.44	--	n/a	1.955
12195.00	121+95.00	934.75	943.75	936.92	22.04	2.95	n/a	n/a	e	none	83.52	--	n/a	2.428
12198.00	121+98.00	939.65	944.15	945.82	7.95	0.94	n/a	n/a	e	none	375.21	--	n/a	1.788
12200.00	122+00.00	939.68	944.18	946.90	5.41	0.54	n/a	n/a	e	none	493.50	--	n/a	1.919
12345.00	123+45.00	940.96	945.46	946.92	6.87	0.61	n/a	n/a	e	none	626.70	--	n/a	1.673
12445.00	124+45.00	941.85	946.35	947.51	4.15	0.44	n/a	n/a	e	none	768.39	--	n/a	1.482
12640.00	126+40.00	942.50	947.00	947.85	3.69	0.34	n/a	n/a	e	none	839.61	--	n/a	1.390
13120.00	131+20.00	943.70	948.20	948.89	7.21	0.91	n/a	n/a	e	none	594.41	--	n/a	1.499
13700.00	n/a	948.50	953.00	952.80	6.13	0.58	n/a	n/a	f	none	873.00	--	n/a	1.221

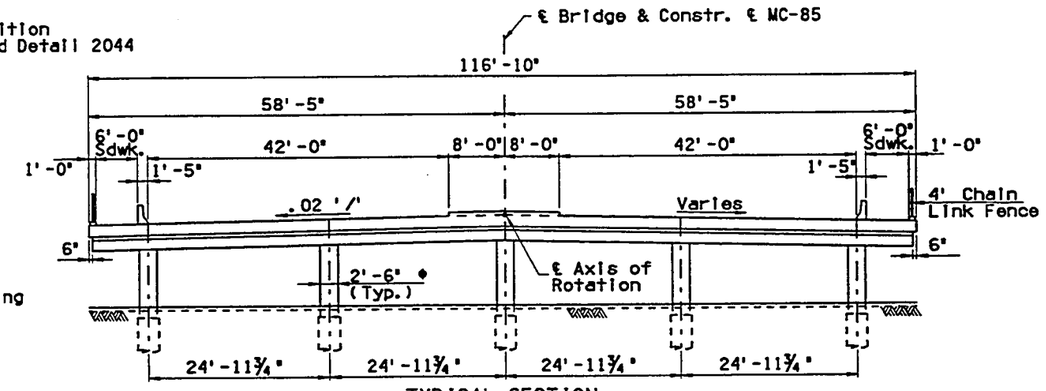
Notes: * Denotes HEC-RAS Interpolated Cross Section
a) STA 28+78.74 to 29+01.49, 4 - 12'x10' concrete box culvert
b) STA 73+00 to 74+30, Maricopa County 85 slab bridge, low chord elevation is 922.06.
c) STA 75+33 to 75+53, UPRR precast bridge, low chord elevation is 921.7, designed by others.
d) STA 82+20 to 119+43, low flow channel invert reported by HEC-RAS, however freeboard calculations based on centerline invert of main channel.
e) Channel Inlet Area - flow is expected to weir over banks into Bullard Wash upstream of Lower Buckeye Road.
f) Tie into existing FEMA regulated floodplain @ RM 2.883

SUPPORTING MC85 AND UPRR BRIDGE DOCUMENTATION

F.H.W.A. REGION	STATE	PROJECT NO.	SHEET NO.	TOTAL SHEETS	RECORD DRAWING
9	AZ.	68877	106	150	·



LOCATION PLAN
Scale: 1"=10'-0"



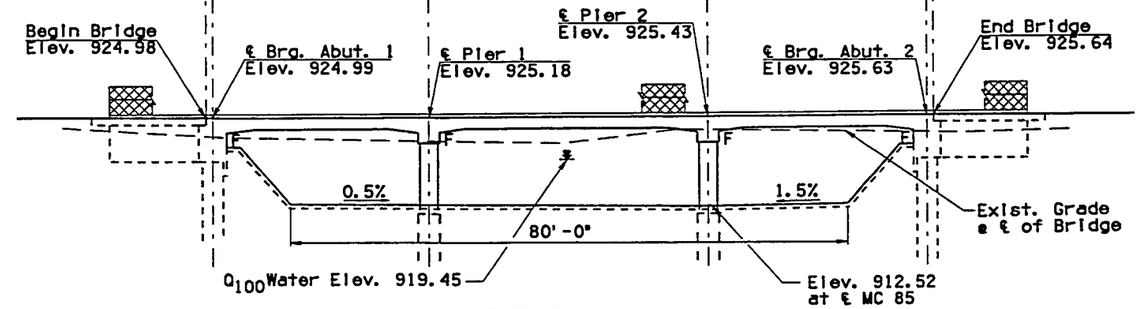
TYPICAL SECTION
Scale: 1"=10'-0"

SHEET LIST

TITLE	NO.
General Plan	106
General Notes, Qtys., Fdtn. Layout	107
Boring Data	108-9
Drilled Shaft & Column Details	110
Abut. #1 Plan & Elev., Wingwall Details	111
Abut. #2 Plan & Elevation	112
Abutment Details	113
Pier Plan & Elevation	114
Pier Details	115
Deck Plan	116
Deck Details	117
Miscellaneous Details	118

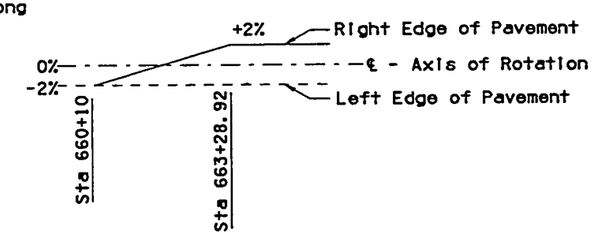
103'-0" Length of Bridge

1'-0" | 31'-0" | 39'-0" | 31'-0" | 1'-0"

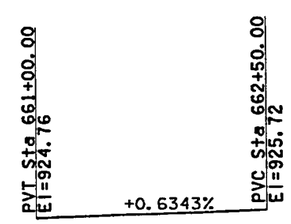


F=Fixed Support

ELEVATION
Scale: 1"=10'-0"
Stations, elevations, and dimensions are measured along ℄ Bridge.



SUPERELEVATION DIAGRAM



PROFILE GRADE

NO.	REVISION	BY	DATE
3	·	·	·
2	·	·	·
1	·	·	·

MARICOPA COUNTY
DEPARTMENT OF TRANSPORTATION
ENGINEERING DIVISION

ESTRELLA PARKWAY
BUCKEYE CANAL TO ELWOOD STREET
PROJECT NO. 68877

PRELIMINARY NOT FOR CONSTRUCTION

	BY	DATE
DESIGNED	C. RODRIGUEZ	8/27/98
DRAWN	R. SHISHIDO	8/27/98
CHECKED	J. FISCHER	8/27/98

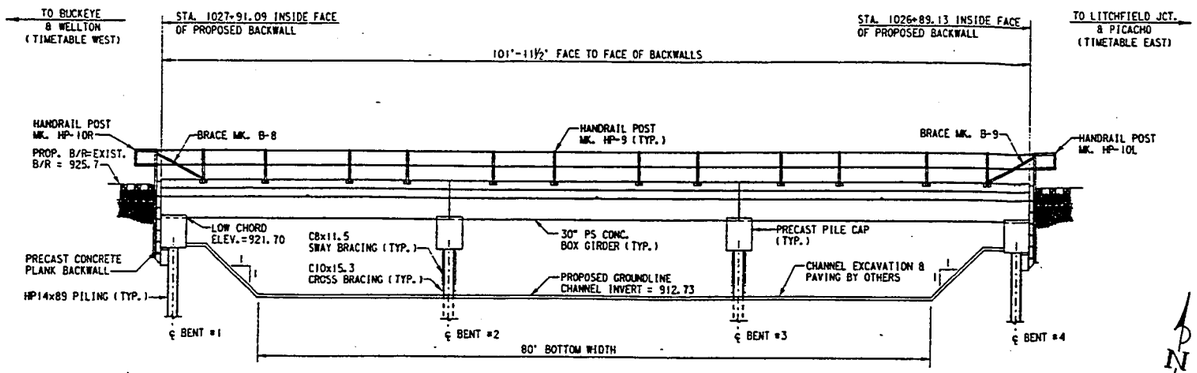
Sverdrup CORPORATION

MC-85 BULLARD WASH BRIDGE
GENERAL PLAN

SHEET OF 106 150

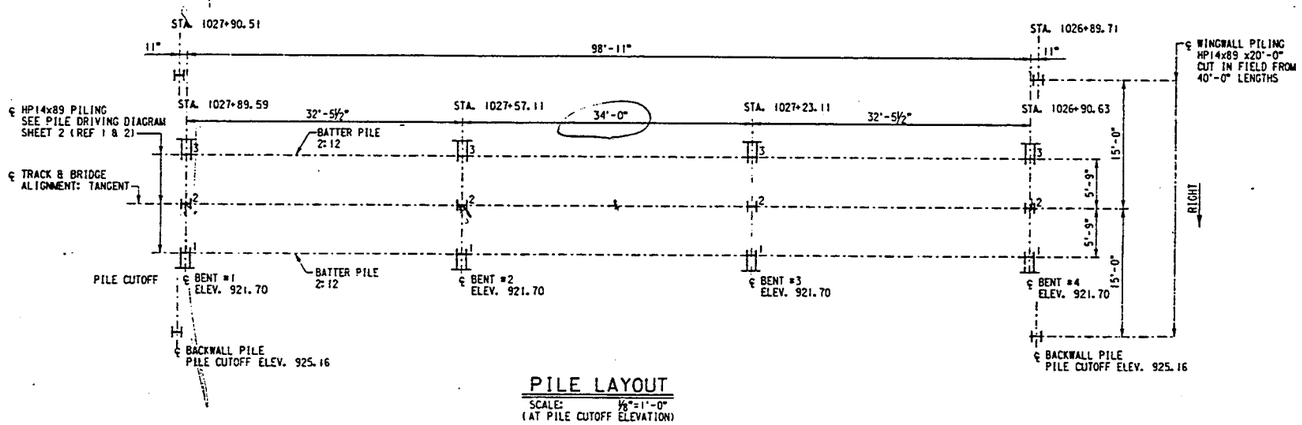
TRACS NO.

FileName: p:\0138H410\00410\cccd\01705\r\01705dgn\68941s1.dgn
Plotted By: shishirk Date: 15-SEP-1998 09:26



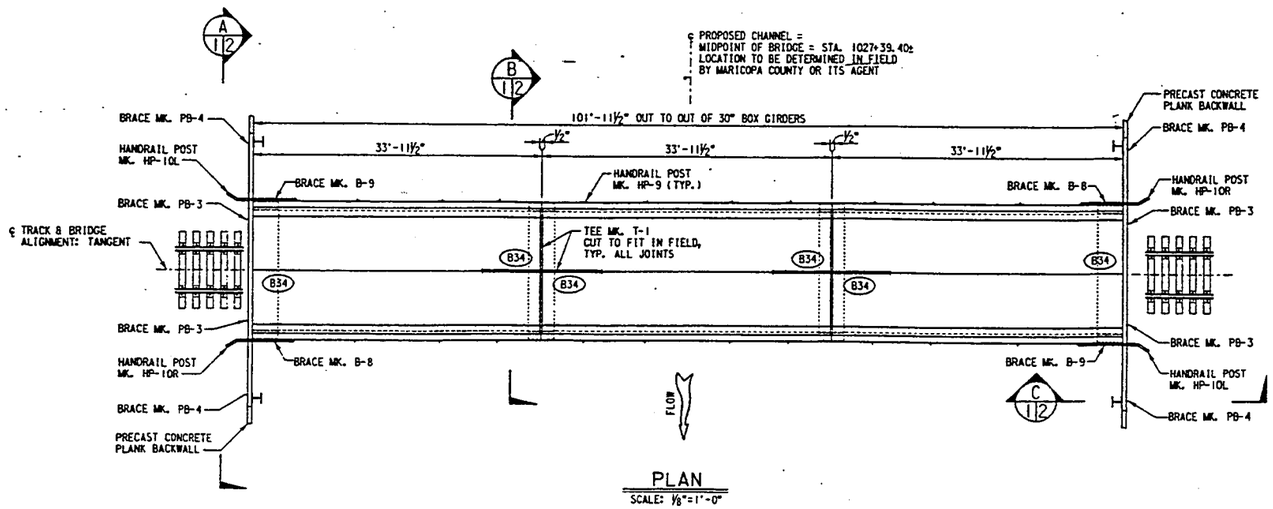
ELEVATION

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



PILE LAYOUT

SCALE: 1/8"=1'-0"
(AT PILE CUTOFF ELEVATION)



PLAN

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

BILL OF MATERIAL

	REQ'D	UNIT	DESCRIPTION	STORE ITEM NO.	ORDERED BY
PRECAST CONCRETE	6	EA.	30"X33'-11½" PRESTRESSED CONCRETE BOX GIRDER MK. B34, TYPE I W/ CURB, WITH 65 ½" DIA. 270 KSI STRANDS (REF. 3 & 4)	511-0141	MANAGER STRUCTURAL PROJECTS
	3	EA.	3'-0"X3'-6"X16'-0" PRECAST CONCRETE PILE CAP (REF. 5)	511-0475	
	4	EA.	6"X1'-10"X 8'-6" PRECAST CONCRETE BACKALL PLANK (REF. 6)	511-0206	
	4	EA.	6"X1'-4"X 12'-0" PRECAST CONCRETE BACKALL PLANK (REF. 6)	511-0202	
	4	EA.	6"X1'-4"X 16'-0" PRECAST CONCRETE BACKALL PLANK (REF. 6)	511-0204	
PILING	26	EA.	HP14X89X40'-0" STEEL PILING (PLAIN, REF. 1 & 2)	510-7556	
	12	EA.	PILE SPLICER FOR HP14X89 STEEL PILE, PER DETAIL SHEET NO. 1	510-8051	
STEEL BRACING	4	EA.	C8X11.5X13'-0" SWAY BRACE (A36, PLAIN)	247-6367	
	4	EA.	C10X15.3X13'-6" CROSS BRACE (A36, PLAIN)	247-6649	
MISC. STEEL, WIRE ROPE & FASTENERS	24	EA.	HANDRAIL POST MK. HP-9 (GALV., PER DETAIL, REF. 8)	513-2020	
	2	EA.	HANDRAIL POST MK. HP-10L (GALV., PER DETAIL, REF. 7)	513-2040	
	2	EA.	HANDRAIL POST MK. HP-10R (GALV., PER DETAIL, REF. 7)	513-2050	
	2	EA.	BRACE MK. PB-3 (GALV., PER DETAIL, REF. 10)	513-0600	
	2	EA.	BRACE MK. PB-4 (GALV., PER DETAIL, REF. 10)	513-0610	
	2	EA.	BRACE MK. B-8 (GALV., PER DETAIL, REF. 9)	513-0540	
	2	EA.	BRACE MK. B-9 (GALV., PER DETAIL, REF. 9)	513-0550	
	9	EA.	¾" DIA. X 1¾" A325 HVY. HEX BOLT, TYPE I W/ HVY. HEX NUT (A563, LUBRICATED) AND FLAT CIRCULAR WASHER (F436), EACH COMPONENT HOT DIP OR MECHANICALLY ZINC COATED	513-1168	
	50	EA.	¾" DIA. X 11" A307 HVY. HEX GRADE A BOLT, W/ HVY. HEX ELASTIC LOCKNUT (MIL-N-25027) & FLAT CIRCULAR WASHER (F436), EA. COMPONENT HOT DIP OR MECHANICALLY ZINC COATED	134-6585	
	9	EA.	¾" DIA. X 8" A307 HVY. HEX GRADE A BOLT, W/ HVY. HEX ELASTIC LOCKNUT (MIL-N-25027) & FLAT CIRCULAR WASHER (F436), EA. COMPONENT HOT DIP OR MECHANICALLY ZINC COATED	134-6552	
	5	EA.	¾" DIA. X 9" A307 HVY. HEX GRADE A BOLT, W/ HVY. HEX ELASTIC LOCKNUT (MIL-N-25027) & FLAT CIRCULAR WASHER (F436), EA. COMPONENT HOT DIP OR MECHANICALLY ZINC COATED	134-6554	
	424	LIN.FT.	3/16" NOMINAL DIAMETER WIRE ROPE, 7 WIRE, GALV. STEEL STRAND, SIEMENS MARTINS GRADE, A-COATING (4 - 106' LENGTHS)	050-5394	
	70	EA.	GALV. MALLEABLE IRON U-BOLT W/ 2 ELASTIC LOCKNUTS (MIL-N-25027), ZINC PLATED, FOR 3/16" DIA WIRE ROPE	050-6370	
	8	EA.	HEAVY PATTERN - HEAVY DUTY GALV. CARBON STEEL WIRE ROPE THIMBLE (ZINC PLATED) FOR 3/16" DIA. WIRE ROPE	050-7821	
	8	EA.	½" DIA. EYEBOLT, 2" LONG SHANK WITH 1" I.D. EYE, PLAIN PATTERN, GALV., DROP FORGED STEEL (A489), WITH ZINC PLATED HEX NUT (A563) & ZINC PLATED FLAT CIRCULAR WASHER (F436)	130-0370	
	15	EA.	STEEL TEE MK. T-1 (GALV., PER DETAIL, REF. 10) ASTM A569	513-6000	
	8	EA.	½"X4"X3'-0" ELASTOMERIC BEARING PAD (50 DUROMETER)	510-3640	
	12	EA.	½"X8"X6'-8" ELASTOMERIC BEARING PAD (50 DUROMETER)	510-3645	
	2	EA.	BRIDGE MARKER PER ENGINEERING STANDARDS DRAWING NO. 0507	513-0955	

EST. WT. OF PILING = 92,560 LB.
EST. WT. OF MISC. STEEL (NOT INCL. BOLTS CLIPS & WIRE ROPE) = 1,480 LB.
EST. WT. OF CROSS & SWAY BRACING = 1,425 LB.

DRAWING SCHEDULE

	SHEET NO.	DESCRIPTION
THIS SET	1	GENERAL ARRANGEMENT & BILL OF MATERIAL
	2	MISCELLANEOUS SECTIONS, DETAILS & TOP OF RAIL PROFILE

	NO.	DWG. NO.	SHEET NO.	REV. NO.	DESCRIPTION
REF.	1	104537	-	-	HP14x89 STEEL PILE
	2	104552	-	-	HP14x89 STEEL TEMPLATE DETAILS
	3	114915	1	-	30" DP. PRESTRESSED CONC. DBL. BOX GIRDER
	4	114915	2	-	30" DP. PRESTRESSED CONC. DBL. BOX GIRDER
	5	104258	3	3	STEEL PILE PRECAST ABUT. FOR 30" BOX GIRDERS
	6	114258	8	2	STEEL PILE PRECAST CAP FOR 30" BOX GIRDERS
	7	114268	1	1	END HANDRAIL POST DETAILS
	8	114268	2	3	INTERIOR HANDRAIL POST DETAILS
	9	114268	3	3	HANDRAIL POST BRACING DETAILS
	10	114268	5	4	MISCELLANEOUS STEEL DETAILS

CONSTRUCTION NOTES

GENERAL:

Field verify all dimensions, stations and elevations prior to start of construction.

For information on, and relocation of, fiber optic cable call 1-800-336-9193.

SITE LAYOUT INFORMATION:

Rail raise: No change in mainline elevation.

Track Alignment: Field verify prior to start of construction

Elevations taken from drawings Titled "BULLARD WASH CHANNEL, FINAL: DESIGN" as prepared by Sverdrup Corporation 2-5-98.

Rail stationing based on stationing of the west backwall of Bridge no. 887.39 as shown on the UPRR Right-Of-Way And Track Map. (Sta. 1025+34.6)

Right Of Way: 100' Right of track centerline
100' Left of track centerline

PILE DRIVING:

All numbered pile shall be driven to 120 ton capacity. If any numbered pile cannot be driven to this capacity the Office Of Chief Engineer Structures must be notified.

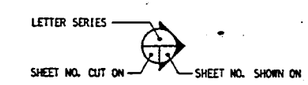
FIELD WELDING:

Welding must be accomplished with the SMAW Process. Welding must be in compliance with the requirements specified in AWS D1.5-95, except 5/16 in. fillet welds may be made with a single pass. Welding electrodes must be E70I8. Welders must possess valid certification.

DESIGN NOTES

This structure was designed for Cooper E80 Live Load with 30" ballast and impact.

Design Pile Load: End Bent = 77 Ton
Interior Bent = 120 Ton



SECTION DESIGNATION

EST. WT. OF CONC. BOX GIRDER
MK. B-34 = 38,500 LBS (19.3 TONS)

NO.	DATE	REVISIONS
	/ /	
	/ /	
	/ /	
	/ /	

SP ROUTE SYMBOL R

UNION PACIFIC RAILROAD
OFFICE OF CHIEF ENGINEER DESIGN

LOCATION: BRIDGE 887.34 GILA (PHOENIX) SUB. 2.0 MILES WEST OF LITCHFIELD, AZ.

FACILITY: 3 SPAN 34' x 30" DEEP DOUBLE BOX GIRDER B.D.

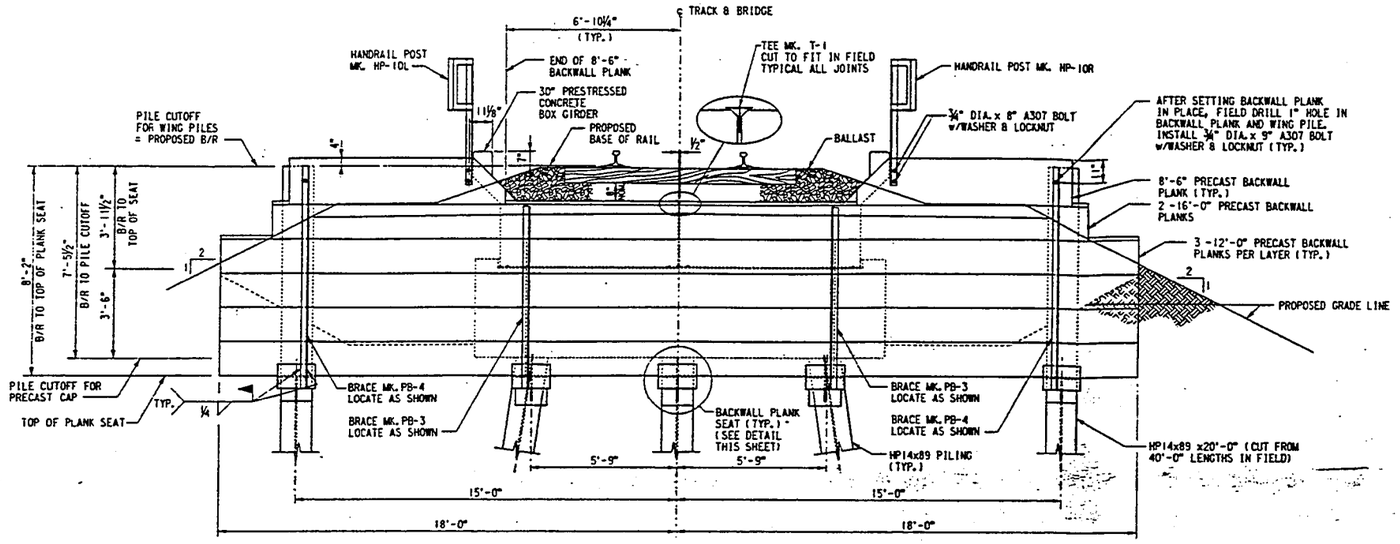
DWG TITLE: GENERAL ARRANGEMENT & BILL OF MATERIAL

WORK ORDER: 29264
ENGR JOB NO: 001
DESIGN BY: GEV
CHECKED BY: GEV
DRAWN BY: RTN
CHECKED BY: GEV
SCALE: 1/8"=1'-0" AS SHOWN

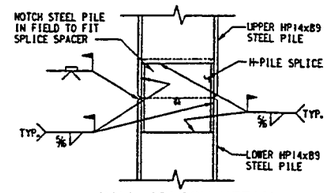
DWG. SEQUENCE: 1 of 2
C.E. NUMBER: 115073

APPROVED FOR CHIEF ENGINEER DESIGN
16 June 1998 DATE

PLOTTED: 16-JUN-1998 11:3



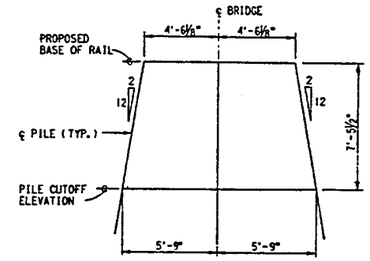
SECTION A/1|2
SCALE: ⅜" = 1'-0"



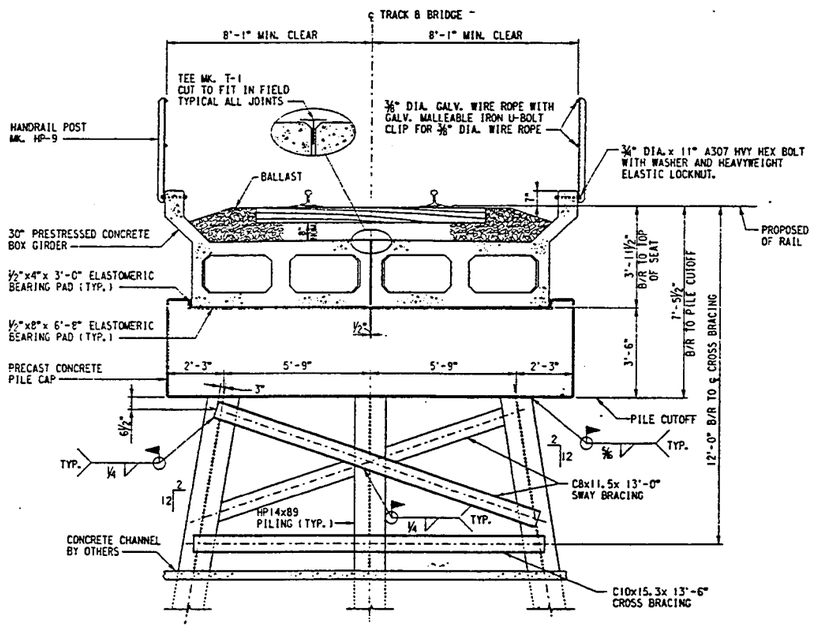
PILE SPLICE DETAIL
SCALE: ⅜" = 1'-0"

PILE SPLICING:
PILE SPLICE FOR HP14X89 INSTALLATION INSTRUCTIONS:

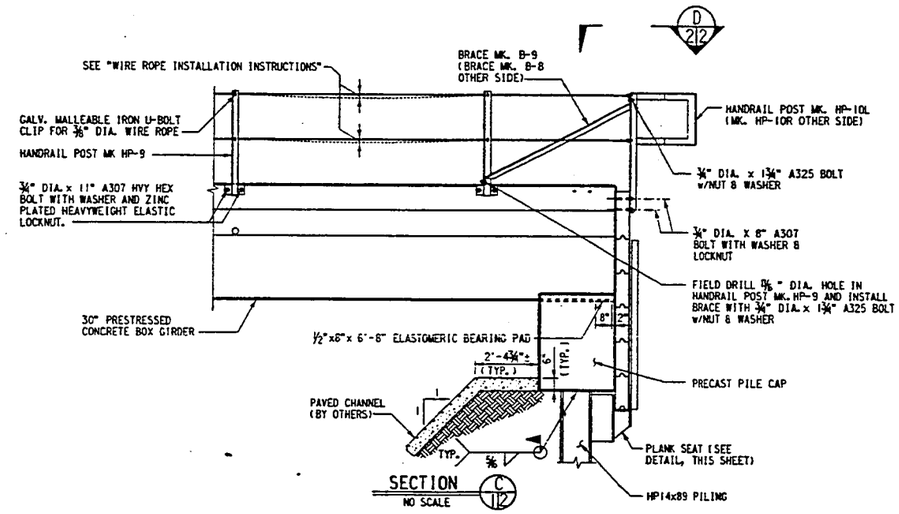
1. NOTCH THE END OF UPPER LENGTH OF H-PILE (TO ACCOMODATE THE SPACER BAR).
2. FIT SPLICE OVER NOTCHED END OF UPPER H-PILE, AND WELD IN PLACE.
3. PLACE THE UPPER SECTION INTO POSITION ON THE LOWER SECTION.
4. TO COMPLETE THE SPLICE, WELD SPLICE TO LOWER H-PILE AND WELD FLANGES AS SHOWN.



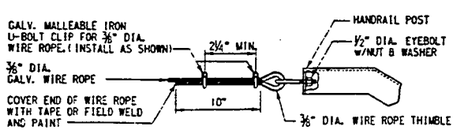
3 PILE DRIVING DIAGRAM
BENTS #1 THRU #4
NO SCALE



SECTION B/1|2
NO SCALE



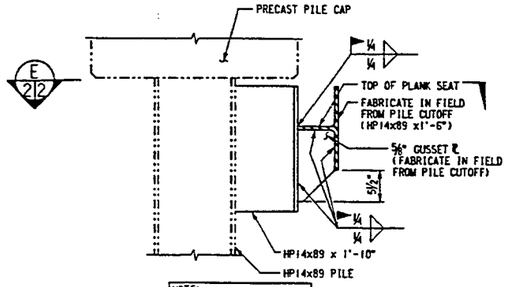
SECTION C/1|2
NO SCALE



VIEW D/2|2
SCALE: 1½"=1'-0"

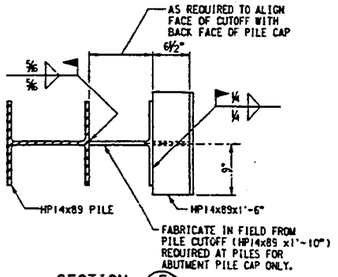
WIRE ROPE INSTALLATION INSTRUCTIONS:

1. THREAD WIRE ROPE THROUGH ALL CLIPS AND TIGHTEN CLIPS AND EYEBOLTS ON ONE END HANDRAIL POST.
2. AFTER INSTALLING BRACES, STRETCH WIRE ROPE, HANG A MINIMUM OF 10 LBS. ON CABLE BETWEEN TWO POSTS, AND REMOVE ALL SAG TO A MAXIMUM OF 2 INCHES.
3. TIGHTEN CLIPS & EYEBOLTS AT REMAINING END HANDRAIL POST.
4. REMOVE WEIGHTS.
5. TIGHTEN CLIPS AT INTERMEDIATE POSTS.



NOTE:
PRECAST BACKWALL PLANKS NOT SHOWN FOR CLARITY.

PLANK SEAT DETAIL
NO SCALE



SECTION E/2|2
NO SCALE

APPROVED
FOR CHIEF ENGINEER DESIGN — 16 June 1998 DATE

NO.	DATE	REVISIONS
	/ /	
	/ /	
	/ /	
	/ /	

SP ROUTE SYMBOL R

UNION PACIFIC RAILROAD — OFFICE OF CHIEF ENGINEER DESIGN

LOCATION: BRIDGE 887.34 — GILA (PHOENIX) SUB. 2.0 MILES WEST OF LITCHFIELD, AZ.

FACILITY: 3 SPAN 34' x 30" DEEP DOUBLE BOX GIRDER B.D.

DWG. TITLE: MISCELLANEOUS SECTIONS AND DETAILS

WORK ORDER: 29264		
ENGR JOB NO: 001		
DESIGN BY: GEV		
CHECKED BY: GEV		
DRAWN BY: FDS	DWG. SEQUENCE	C E NUMBER
CHECKED BY: GEV	2 of 2	115073
SCALE: AS SHOWN		

EAST TRIBUTARY CHANNEL HYDROLOGY

WOOD/PATEL

CIVIL ENGINEERS • HYDROLOGISTS • LAND SURVEYORS

PROJECT Bullard Wash

PROJECT NO. 96464 SHEET NO. 1 OF 1

CALCULATED BY DTP DATE 2 July 98 CHECKED BY JM DATE 7/4/98

East Tributary Channel HYDROLOGY

Reference: FCDMC, Bullard Wash Outfall Feasibility Study (FCD 94-06), Volume 1 of 2

There are three concentration points for the proposed Bullard Wash given in the Feasibility study; and two concentration points for the East Tributairy.

HEC-1 ID	100-YR 24-hr Q (cfs)	Time to Peak (hrs)	Description
CP335	3168	19.67	Bullard Wash N of airport
2I336	3172	19.75	Bullard Wash @ UPRR (East Trib. Confluence)
CP364A	3175	19.92	Bullard Wash @ Outfall to Gila River
1I336	311	13.83	East Tributary ≈ Litchfield & Lower Buckeye Rd
336	552	13.92	Contributing Subbasin to East Tributary

The Feasibility Study did not revise the original WLB ADMS combination order for the proposed East Tributary Channel. However, it is intuitive that the sum of the East Tributairy hydrographs will be 850 cfs (per Feasibility Study) and the time to peak will be 13.9 hrs. This is 5.8 hrs before the peak flow of 3200 cfs arives in Bullard Wash.

CONCLUSION: The peak flow of 850 cfs in the East Tributary Channel will enter and pass through Bullard Wash 5.8 hours before the peak flow of 3200 cfs arrives, thus the peaks do not coincide, and are not modeled by HEC-RAS.

BULLARD WASH GABION INLET HYDRAULICS

WOOD/PATEL

CIVIL ENGINEERS • HYDROLOGISTS • LAND SURVEYORS

PROJECT Bullard Wash

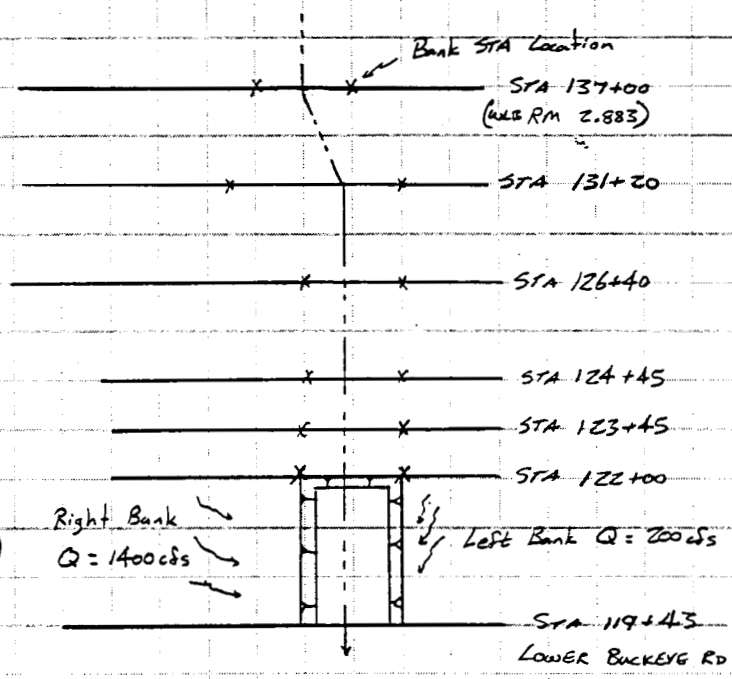
PROJECT NO. 96464 SHEET NO. 1 OF 1

CALCULATED BY DTP DATE 4 SEP 98 CHECKED BY JM DATE 10/1/98

Bullard Wash – Phase 2

Gabion Inlet Hydraulics

Reference: US Army Corps of Engineers Uneven Weir micro computer program Fortran version 1.0



N

N.T.S.

Summary of Flow Distribution

Station	Q_{Left}	Q_{Main}	Q_{Right}	Q_{To}
137+00	2500	640	1770	4906
131+20	200	4610	50	4906
126+40	0	1500	1700	3200
124+45	130	1730	1340	3200
123+45	100	2340	770	3200
122+00	0	2530	670	3200

Note: It seems reasonable that STA 124+45 represents flow distribution approaching gabion drop inlet structure.

Q_{Left} = 130 cfs ⇒ use Q = 200 cfs

Q_{Right} = 1340 cfs ⇒ use Q = 1400 cfs

Uneven Weir Results

Right Bank (West side) Q = 1400 cfs

Ponding EL = 946.9

Left Bank (East Side) Q = 200 cfs

Ponding EL = 944.5

```
*******************************************
    UNEVEN WEIR FLOW PROGRAM
    FORTRAN VERSION 1.0
*******************************************

    PROJECT:  Bullard Wash Outfall Channel          Drop inlet on west side
    ENGINEER:  dtp
    DATE:   9/ 4/1998
    TIME:  11:42. 4

---------------------------------------------
    INPUT PARAMETERS
---------------------------------------------

    STARTING WSEL:        944.90
    MAXIMUM WSEL:         947.70
    STEP SIZE:              0.10
    BREADTH OF WEIR:       20.00

*******************************************
    INPUT ELEVATION/STATION TABLE.
    PROJECT:  Bullard Wash Outfall Channel          Drop inlet on west side
    DATE:   9/ 4/1998
    TIME:  11:42. 4
*******************************************
```

POINT	ELEVATION	STATION
1	950.00	11942.00
2	946.20	11943.00
3	944.97	12043.84
4	945.30	12200.00
5	950.00	12201.00

```
*******************************************
    WEIR COEFFICIENT TABLE
    PROJECT:  Bullard Wash Outfall Channel          Drop inlet on west side
    DATE:   9/ 4/1998
    TIME:  11:42. 4
*******************************************
```

REFERENCE: COE CHART - UPPER CURVE

POINT	HEAD	COEFFICIENT	POINT	HEAD	COEFFICIENT
1	0.00	2.5000	16	1.50	2.7500
2	0.10	2.5167	17	1.60	2.7667
3	0.20	2.5333	18	1.70	2.7833
4	0.30	2.5500	19	1.80	2.8000
5	0.40	2.5667	20	1.90	2.8167
6	0.50	2.5833	21	2.00	2.8333
7	0.60	2.6000	22	2.10	2.8500
8	0.70	2.6167	23	2.20	2.8667
9	0.80	2.6333	24	2.30	2.8833
10	0.90	2.6500	25	2.40	2.9000
11	1.00	2.6667	26	2.50	2.9167
12	1.10	2.6833	27	2.60	2.9333
13	1.20	2.7000	28	2.70	2.9500
14	1.30	2.7167			
15	1.40	2.7333			

```
*******************************************
    UNEVEN WEIR FLOW PROGRAM
    FORTRAN VERSION 1.0
    PROJECT:  Bullard Wash Outfall Channel          Drop inlet on west side
    DATE:   9/ 4/1998
    TIME:  11:42. 4
*******************************************
```

ELEVATION	DISCHARGE (CFS)	ELEVATION	DISCHARGE (CFS)
944.90	0.00	946.40	813.32
945.00	0.09	946.50	928.03
945.10	3.40	946.60	1049.12
945.20	14.19	946.70	1176.45
945.30	35.10	946.80	1309.89
945.40	66.92	946.90	1449.35
945.50	107.48	947.00	1594.76
945.60	155.96	947.10	1746.04
945.70	212.05	947.20	1903.15
945.80	275.60	947.30	2066.03
945.90	346.55	947.40	2234.66
946.00	424.91	947.50	2409.00
946.10	510.71	947.60	2589.03
946.20	604.02		
946.30	705.22		

1400 cfs in right bank (west side) will overtop O'M road @ ELEV = 946.90

```
*********************************************
    UNEVEN WEIR FLOW PROGRAM
    FORTRAN VERSION 1.0
*********************************************

    PROJECT:  Bullard Wash Outfall Channel        Drop inlet weir on east
    ENGINEER:  dtp
    DATE:   9/ 4/1998
    TIME:  11:49.44

---------------------------------------------
    INPUT PARAMETERS
---------------------------------------------

    STARTING WSEL:        943.80
    MAXIMUM WSEL:         946.50
    STEP SIZE:              0.10
    BREADTH OF WEIR:       10.00
```

1

```
*********************************************
    INPUT ELEVATION/STATION TABLE.
    PROJECT:  Bullard Wash Outfall Channel        Drop inlet weir on east
    DATE:   9/ 4/1998
    TIME:  11:49.44
*********************************************
```

POINT	ELEVATION	STATION
1	948.00	11942.00
2	943.85	11943.00
3	944.20	12200.00
4	948.00	12201.00

```
*******************************************
    WEIR COEFFICIENT TABLE
    PROJECT:  Bullard Wash Outfall Channel        Drop inlet weir on east
    DATE:   9/ 4/1998
    TIME:  11:49.44
*******************************************
```

REFERENCE: COE CHART - UPPER CURVE

POINT	HEAD	COEFFICIENT	POINT	HEAD	COEFFICIENT
1	0.00	2.5000	16	1.50	3.0000
2	0.10	2.5333	17	1.60	3.0022
3	0.20	2.5667	18	1.70	3.0044
4	0.30	2.6000	19	1.80	3.0067
5	0.40	2.6333	20	1.90	3.0089
6	0.50	2.6667	21	2.00	3.0111
7	0.60	2.7000	22	2.10	3.0133
8	0.70	2.7333	23	2.20	3.0156
9	0.80	2.7667	24	2.30	3.0178
10	0.90	2.8000	25	2.40	3.0200
11	1.00	2.8333	26	2.50	3.0222
12	1.10	2.8667	27	2.60	3.0244
13	1.20	2.9000	28	2.70	3.0267
14	1.30	2.9333			
15	1.40	2.9667			

```
*******************************************
    UNEVEN WEIR FLOW PROGRAM
    FORTRAN VERSION 1.0
    PROJECT:  Bullard Wash Outfall Channel        Drop inlet weir on east
    DATE:   9/ 4/1998
    TIME:  11:49.44
*******************************************
```

ELEVATION	DISCHARGE (CFS)	ELEVATION	DISCHARGE (CFS)
943.80	0.00	945.30	1085.30
943.90	0.41	945.40	1228.98
944.00	6.46	945.50	1380.57
944.10	23.32	945.60	1528.27
944.20	54.44	945.70	1677.18
944.30	100.96	945.80	1830.83
944.40	159.14	945.90	1989.08
944.50	227.44	946.00	2151.85
944.60	305.11	946.10	2319.02
944.70	391.66	946.20	2490.51
944.80	486.79	946.30	2666.23
944.90	590.28	946.40	2846.10
945.00	701.97	946.50	3030.06
945.10	821.75		
945.20	949.54		

200 cfs in left bank (east side) will overtop gabion inlet structure @ ELEV = 944.5

RIPRAP DESIGN

WOOD/PATEL

CIVIL ENGINEERS • HYDROLOGISTS • LAND SURVEYORS

PROJECT Bullard Wash Outfall channel Improvements

PROJECT NO. FCD #95-39 SHEET NO. 1 OF 8

CALCULATED BY SZ DATE 6-15-98 CHECKED BY [illegible] DATE 6/98

Reference: "Drainage Design manual for Maricopa county, AZ, Vol. I, Hydraulics" Jan. 1996. FCDMC.

Design of Grouted Riprap Lining

1). Channel section near BID canal.

The highest velocity in this area is 16.47 ft/s at station 29+80.

The estimated riprap thickness is 2.1 ft from Figure 6.10, P6-49 of the Reference.

D50 can be calculated by the following Eq.

$$\text{Riprap thickness} = 1.5 \times D_{50}$$

$$D_{50} = \frac{2.1}{1.5} = 1.4 \text{ ft} = 17 \text{ in.}$$

For rock riprap, the Manning "n" value varies with mean stone size as follows (HEC 11, FHWA):

$$n = 0.0395 \times D_{50}^{1/6}$$

$$n = 0.0395 \times 1.4^{1/6} = 0.042$$

Substituting n = 0.042 into the HEC-RAS model gives the new highest flow velocity of 15.14 ft/s in this area.

Repeat the above steps, we have.

Riprap thickness = 1.25 ft = 20 in

D_{50} = 15 in.

n = 0.041.

Substituting n = 0.041 into the HEC-RAS model gives the new highest flow velocity of 15.22 ft/s in this area, which is close to the previous run. Therefore, the final design parameters should be:

Riprap thickness = 22 in. and
D_{50} = 15 in.

2) Channel Section near UPRR

The highest velocity in this area is 16.52 ft/s at station 79+53.

Following the above procedures, the estimated parameters are:

Riprap thickness = 2.1 ft = 25 in

D_{50} = 1.4 ft = 17 in.

n = 0.042.

Substituting n = 0.042 into the HEC-RAS model yields the new highest flow velocity of 15.56 ft/s in this area.

Repeat the above steps. the final design parameters are:

Riprap thickness = 22 in, and

D50 = 15 in.

3) Gradation of Riprap

The median rock size should not exceed 0.67 times the blanket thickness and the largest rock used should not exceed the thickness. Table 6-4 of the Reference can be used as the guideline in preparing the riprap rocks. As a practical matter, the recommended minimum size is one-half of the D50 for (grouted) riprap, i.e. 8 in. for the subject project.

Stone Size Range (in)	percent of Gradation
20 to 22	100
17 to 19	25
14 to 16	50
8 to 10	15

4) Filter Blanket Requirements

A well-graded gravel filter should be placed over the channel bed prior to channel lining with grouted riprap in order to protect the underlying soil from washing away by seepage force and provide a base on which grouted riprap will rest. Equations 6-15a & 6-15b of the Reference can be used to determine the gradation of the filter rocks. For simplicity Tables 6-5 and 6-6 are used for the design of the filter blanket layers. Because the designed thickness of the riprap is about 24", and the channel soil is fine grain, the thickness requirements for gravel bedding are (Table 6-6): Type I: 4", Type II: 6".

The Type I bedding is designed to be the lower layer in a two-layer filter for protecting fine grained soils, and Type II is between the grouted riprap and Type I bedding. Their gradations are shown in Table 6-5.

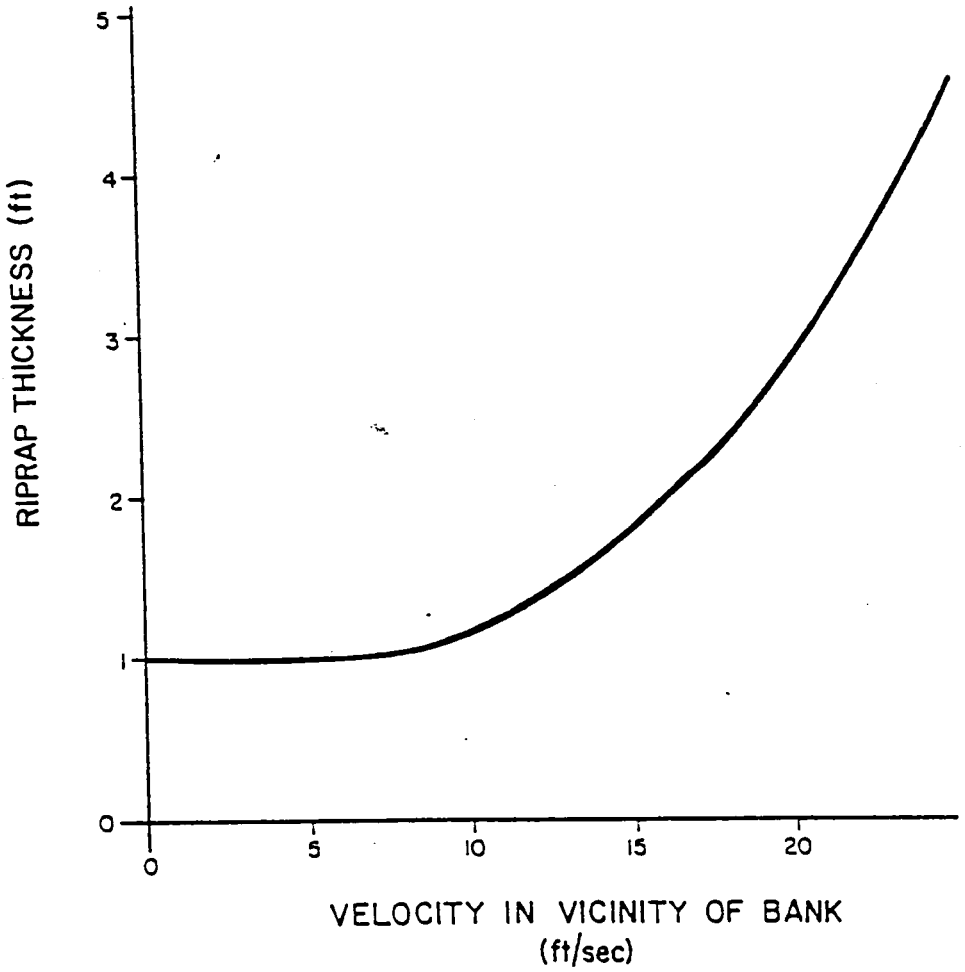


Figure 6.10
Required Blanket Thickness of Grouted Rock
(USDOT, FHWA, HEC-11, 1989)

6.5.5 Wire Enclosed Rock (Gabion Baskets)

6.5.5.1 General: Wire enclosed rock refers to rocks that are confined by a wire basket so that they act as a single unit. The wire mesh enclosed rock units are also known as gabion baskets or gabion mattresses. One of the major advantages of wire enclosed rock is that it provides an alternative in situations where available rock sizes are too small for ordinary riprap. Another advantage is the versatility that results from the regular geometric shapes of wire enclosed rock. The rectangular blocks and mats can be fashioned into almost any shape that can be formed with concrete. The durability of wire enclosed rock is generally limited by the service life of the galvanized binding wire which, under normal conditions, is considered to be about 15 years. Water carrying silt, sand or gravel can reduce the service life of the wire. Also, water which rolls or otherwise moves cobbles and large stones breaks the wire with a hammer and anvil action and considerably shortens the life of the wire. The wire has been found to be susceptible to corrosion by various chemical agents and is particularly affected by high

If the designer has no knowledge of the erodibility of the soil at a particular channel site, a reasonable estimate of d_{max} may be obtained by interpolating half-way between the "erosion resistant" and "erodible" lines of the maximum permissible depth charts (except Chart 27 for rock riprap, where no range is given because the underlying soil has no influence on the erosion resistance of the riprap lining).

Hydraulic Resistance

The flow velocity charts were developed to define the relationship between the hydraulic radius of the channel, R, longitudinal slope of the channel, S_o, and mean channel velocity, V, for a given channel lining. For some linings, such as rock riprap of a given size and fiber glass roving tacked with asphalt, the Manning equation may be used since the n value is essentially constant. For rock riprap, the Manning n value varies with mean stone size, as follows (6):

$$n = 0.0395\ D_{50}^{1/6}$$

Thus, the following n values apply for common stone sizes:

D_{50} (ft.)	n
0.25	0.0314
0.50	0.0352
0.75	0.0377
1.00	0.0395
1.50	0.0423
2.00	0.0443

For fiber glass roving tacked with asphalt, Cox (4) found that the Manning n value was approximately a constant:

	Smooth Rolled Channels	Channels with Clods and Tracks
Single layer	0.030	0.035
Double layer	0.020	0.025

The higher values of n were used in the development of Charts 5 and 6, assuming that most highway channels will be rather rough after seeding and mulching.

Table 6.4
Riprap Gradation Limits
(USDOT, FHWA, HEC-11)

Stone Size Range	Stone Weight Range	Percent of Gradation
1.5 d_{50} to 1.7 d_{50}	3.0 W_{50} to 5.0 W_{50}	100
1.2 d_{50} to 1.4 d_{50}	2.0 W_{50} to 2.75 W_{50}	85
1.0 d_{50} to 1.15 d_{50}	1.0 W_{50} to 1.5 W_{50}	50
0.4 d_{50} to 0.6 d_{50}	0.1 W_{50} to 0.2 W_{50}	15

The gradation coefficient, G, should equal 1.5.

$$G = 0.5(d_{84}/d_{50} + d_{50}/d_{16}) \tag{6.14}$$

Table 6.4 provides design gradations for riprap. As a practical matter, the designer should check with local quarries and suppliers regarding the classes and quality of riprap available near the site.

Thickness: The riprap-layer thickness shall be the greater of 1.0 times the d_{100} value, or 1.5 times the d_{50} value. But the thickness need not exceed twice the d_{100} value. The thickness is measured perpendicular to the slope upon which the riprap is placed.

Filter Blanket Requirements: The purpose of granular filter blankets underlying riprap is two-fold. First, they protect the underlying soil from washing out; and, second, they provide a base on which the riprap will rest. The need for a filter blanket is a function of particle-size ratios between the riprap and the underlying soil which comprise the channel bank. The inequalities that must be satisfied are as follows:

$$\frac{(d_{15})_{filter}}{(d_{85})_{base}} < 5 < \frac{(d_{15})_{filter}}{(d_{15})_{base}} < 40 \tag{6.15a}$$

$$\frac{(d_{50})_{filter}}{(d_{50})_{base}} < 40 \tag{6.15b}$$

Table 6.5
Gradation for Gravel Bedding
(Simons, Li and Associates, 1989)

Standard Sieve Size	Type I (1)	Type II (1)
3 inches	-	90 to 100
1-1/2 inches	-	-
3/4 inch	-	20 to 90
3/8 inch	100	-
#4 (4.75 mm)	95 to 100	0 to 20
#16 (1.18 mm)	45 to 80	-
#50 (0.30 mm)	10 to 30	-
#100 (0.15 mm)	2 to 10	-
#200 (0.075 mm)	0 to 2	0 to 3

(1) Percent passing by weight

Table 6.6
Thickness Requirements for Gravel Bedding

Riprap Classification	Minimum Bedding Thickness, inches		
	Fine Grain Native Soils		Coarse Grain Native Soils
	Type I	Type II	Type III
6", 8"	4	4	6
12"	4	4	6
18"	4	6	8
24"	4	6	8
30"	4	8	10
36"	4	8	10

SEEPAGE ANALYSIS

WOOD/PATEL

CIVIL ENGINEERS • HYDROLOGISTS • LAND SURVEYORS

PROJECT Bullard wash channel Improvements

PROJECT NO. FCD #95-39 SHEET NO. 1 OF 8

CALCULATED BY SZ DATE 6-30 CHECKED BY AK DATE 6/98

Channel Seepage Analysis

Reference: FCDMC, Drainage Design Manual for Maricopa County, AZ, Volume II. Hydraulics, Jan. 28, 1996.

Method: Lane's Weighted-Creep method.

Equation. $$C_w = \frac{(L_H + 3L_V)}{3H_{df}} \qquad (7.5)$$

Where: C_w — weighted-creep head ratio;

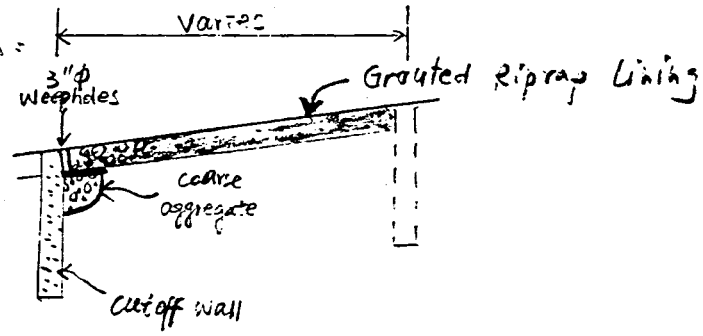
L_H — horizontal creep distance;

L_V — vertical creep distance;

H_{df} — hydraulic head difference.

Critical values of C_w for different soils are shown in Table 7.3. (P7-25)

Typical Section:



Location 1. North of UPRR

Parameters from HEC-RAS model for this location are

Station 77+00, WSEL = 919.79 ft

Station 81+00, WSEL = 933.78 ft

$H_{df} = 933.78 - 919.79 = 13.99$ ft

$L_H = 8160 - 7700 = 400$ ft

Let the cutoff wall depth = 4 ft, and one cutoff wall at station 77+00 ±,

$L_U = 2 \times 4 \times 1 = 8$ ft

$$C_W = \frac{(400 + 3 \times 8)}{3 \times 13.99} = 10.1$$

which is greater than any value shown in Table 7.3.

Conclusion: It is safe to provide one 4' cutoff wall at approximate Station 77+00.

Location 2. South of BID Canal

Parameters from HEC-RAS model for this location are:

Station 28+79.75, WSEL = 906.56 ft

Station 30+02.33, WSEL = 910.82 ft

$L_H = 3002.33 - 2879.75 = 122.56$ ft

$H_{df} = 910.82 - 906.56 = 4.26$ ft

Let the cutoff wall depth = 4 ft, and one cutoff wall at Station 28+79.75

$L_U = 2 \times 4 \times 1 = 8$ ft

$$C_w = \frac{(122.56 + 3\times 8)}{3\times 4.26} = 11.5$$

which is greater than any value shown in Table 7.3.

Conclusion: It is safe to provide one 4' cutoff wall at approximate Station 28+80

Location 3, North of BID Canal.

Parameters from HEC-RAS model for this location are:

Station 30+02.33. WSEL = 910.82 ft.

Station 33+50 WSEL = 913.06 ft

$H_{df} = 913.06 - 910.82 = 2.24$ ft

$L_H = 3350 - 3002.33 = 347.67$ ft

Let the cutoff wall depth = 4 ft. and the cutoff wall at Station 30+02

$L_v = 2\times 4\times 1 = 8$ ft

$$C_w = \frac{(347.67 + 3\times 8)}{3\times 2.24} = 55.3$$

which is much greater than any value shown in Table 7.3.

Conclusion: The cutoff wall is not needed for this section.

Location 4. South of UPRR

Parameters from HEC-RAS model for this location are:

Station 72+90, WSEL = 919.17 ft, Station 77+00, WSEL = 919.79 ft

$H_{df} = 919.79 - 919.17 = 0.62$ ft, $L_H = 7700 - 7290 = 410$ ft

Assume no cutoff wall, $L_V = 0$.

$$C_W = \frac{410}{3 \times 0.62} = 220$$

which is much greater than any value shown in Table 7.3.

Conclusion: The cutoff wall is not needed for this section.

Weepholes:

To enchance drainage, provide 3" ϕ weepholes, 20 ft O.C., immediately upstream of the cutoff wall.

Provide one cubic ft coarse aggregate (AASHTO M43 size NO. 7) securely tied in burlap sack (or filter fabric) at each drain location, underneath the grouted riprap sections. NO weepholes are necessary for concrete slabs.

7.3.2.5 Seepage and Uplift Forces: The most common technique for seepage analysis is that proposed by E.W. Lane (1935), commonly referred to as "Lane's Weighted-Creep Method. The essential elements of this method are paraphrased as follows:

1. The weighted-creep distance of a cross-section of a drop structure is the sum of the vertical creep distances (along contact surfaces steeper than 45 degrees), L_V, plus one-third of the horizontal creep distances (along contact surfaces less than 45 degrees), L_H.

2. The weighted-creep head ratio is defined as:

$$C_w = \frac{(L_H + 3L_v)}{3H_{df}} \tag{7.5}$$

3. Lane's recommended weighted-creep ratios are given for various foundation materials in Table 7.3.

4. Reverse filter drains, weep holes, and pipe drains are aids to provide security from seepage, and recommended safe weighted-creep head ratios may be reduced as much as 10 percent, if used.

5. Care must be exercised to insure that cutoff walls extend laterally into each bank so that flow will not outflank them.

6. The upward pressure to be used in design may be estimated by assuming that the drop in pressure from headwater to tailwater along the contact line of the drop structure and cutoff wall is proportional to the weighted-creep distance.

Seepage is controlled by increasing the seepage length such that C_w is lowered to a conservative value. Soils tests must be taken during design and confirmed during construction. These tests are especially critical for reinforced concrete structures.

An example of this technique can be found in Design of Small Dams (USBR, 1987). An alternative approach is to use a flow net or computerized seepage analysis to estimate subsurface flows and uplift pressures under a structure. Seepage considerations should be included in the design of cutoff walls, wall footings, drains, filters, structural slabs, and grouted masses.

Locating a seepage cutoff wall upstream of the crest of a drop structure and using horizontal impervious blankets can be effective. It is also very important to control lateral seepage around the structure.

Table 7.3
Lane's Weighted-Creep: Recommended Ratios

Material	C_W Ratio
Very fine sand or silt	8.5
Fine sand	7.0
Medium sand	6.0
Coarse sand	5.0
Fine gravel	4.0
Medium gravel	3.5
Coarse gravel including cobbles	3.0
Boulders with some cobbles and gravel	2.5
Soft clay	3.0
Medium clay	2.0
Hard clay	1.8
Very hard clay or hardpan	1.6

7.3.3 Drop Selection

There are four major considerations for the selection of the type of drop structure for a particular application: 1) surface flow hydraulic performance; 2) foundation and seepage control; 3) economic considerations; and 4) construction considerations. Other factors which can affect selection are land uses, aesthetics, safety, maintenance, and anticipated downstream channel degradation.

7.3.3.1 Surface Flow Hydraulic System: The primary consideration for the selection of a drop structure should be functional hydraulic performance. The surface flow hydraulic system combines channel approach and crest hydraulics, sloping or vertical drop hydraulics and downstream tailwater conditions. Hydraulic analysis procedures are presented in Section 7.3.2. Additional guidelines are also contained in Section 7.3.4.

7.3.3.2 Foundation and Seepage Control Systems: Table 7.4 presents some typical foundation conditions and control systems typically used for various drop heights. Table 7.4 is presented only as a guide. The hydraulic engineer must calculate hydraulic loadings which can occur for a variety of conditions such as interim construction conditions, low flow, and flood flow. The soils/foundation engineer couples this information with the on-site soils information. Both work with a structural engineer to establish final loading diagrams, and selection and sizing of structural components. This

Design Q_{100} = 3200 cfs

HEC-RAS Plan: 60%sub(6/98) River: Bullard Wash Out Reach: Bullard Wash

Reach	River Sta	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
		(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Bullard Wash	13700	3200.00	948.50	952.00	951.28	952.19	0.004863	6.22	1174.21	745.53	0.67
Bullard Wash	13120	3200.00	947.30	949.70	949.09	949.92	0.003188	4.36	1086.10	777.11	0.52
Bullard Wash	12640	3200.00	945.20	949.15	947.65	949.22	0.000752	2.94	2374.60	1213.61	0.28
Bullard Wash	12420	3200.00	940.50	948.49	946.00	948.92	0.002086	5.30	607.27	148.00	0.46
Bullard Wash	12328	3200.00	940.32	947.54	947.54	948.69	0.001541	8.58	372.98	162.00	1.00
Bullard Wash	12200	3200.00	940.00	945.28	946.11	948.18	0.005072	13.67	234.10	96.56	1.55
Bullard Wash	12195.13	3200.00	934.74	936.63	938.75	947.36	0.172302	26.29	121.73	82.96	3.82
Bullard Wash	11963	3200.00	934.43	941.13	938.43	941.67	0.001437	5.89	543.15	92.49	0.43
Bullard Wash	11943	3200.00	933.83	941.16	938.31	941.61	0.001268	5.40	592.60	105.32	0.40
Bullard Wash	11883	3200.00	933.76	941.08	938.24	941.54	0.001272	5.41	591.94	105.30	0.40
Bullard Wash	11735	3200.00	933.58	940.90	938.07	941.35	0.001279	5.41	590.96	105.26	0.40
Bullard Wash	11550	3200.00	933.36	940.69	937.83	941.11	0.001219	5.23	612.07	111.63	0.39
Bullard Wash	11300	3200.00	933.06	940.38	937.53	940.81	0.001223	5.23	611.42	111.60	0.39
Bullard Wash	11200	3200.00	932.93	940.22	937.41	940.68	0.001299	5.44	587.84	105.14	0.41
Bullard Wash	11100	3200.00	932.81	940.08	937.29	940.55	0.001308	5.46	586.60	105.09	0.41
Bullard Wash	11000	3200.00	932.69	939.98	937.15	940.41	0.001245	5.26	607.86	111.44	0.40
Bullard Wash	10820	3200.00	932.48	939.75	936.94	940.18	0.001257	5.28	605.92	111.35	0.40
Bullard Wash	10690.*	3200.00	932.32	939.59	936.78	940.02	0.001259	5.28	605.50	111.33	0.40
Bullard Wash	10560.*	3200.00	932.16	939.42	936.61	939.86	0.001262	5.29	605.06	111.31	0.40
Bullard Wash	10430.*	3200.00	932.01	939.26	936.48	939.69	0.001274	5.31	603.15	111.23	0.40
Bullard Wash	10300	3200.00	931.85	939.09	936.32	939.53	0.001278	5.31	602.47	111.20	0.40
Bullard Wash	10200	3200.00	931.73	938.91	936.21	939.39	0.001374	5.54	577.16	104.73	0.42
Bullard Wash	10100	3200.00	931.61	938.77	936.09	939.25	0.001390	5.57	574.96	104.65	0.42
Bullard Wash	10000	3200.00	931.49	938.66	935.95	939.11	0.001330	5.38	594.54	110.84	0.41
Bullard Wash	9642.5*	3200.00	931.30	938.44	935.76	938.90	0.001349	5.41	591.84	110.72	0.41
Bullard Wash	9685.*	3200.00	931.10	938.23	935.56	938.68	0.001360	5.42	590.13	110.64	0.41
Bullard Wash	9527.5*	3200.00	930.91	938.01	935.36	938.47	0.001385	5.46	586.54	110.48	0.42
Bullard Wash	9370	3200.00	930.72	937.78	935.19	938.25	0.001416	5.49	582.36	110.29	0.42
Bullard Wash	9200	3200.00	930.52	937.47	935.00	937.99	0.001568	5.79	552.53	103.79	0.44
Bullard Wash	9080	3200.00	930.38	937.26	934.86	937.80	0.001629	5.86	545.65	103.52	0.45
Bullard Wash	9000	3200.00	930.28	937.12	934.76	937.66	0.001669	5.91	541.39	103.36	0.46
Bullard Wash	8900	3200.00	930.16	936.98	934.62	937.49	0.001629	5.76	555.75	109.08	0.45
Bullard Wash	8730.*	3200.00	929.95	936.67	934.41	937.20	0.001727	5.87	545.15	108.59	0.46
Bullard Wash	8560.*	3200.00	929.74	936.33	934.20	936.90	0.001863	6.02	531.60	107.96	0.48
Bullard Wash	8390.*	3200.00	929.53	935.95	933.98	936.56	0.002068	6.23	513.56	107.12	0.50
Bullard Wash	8220	3200.00	929.32	935.50	933.79	936.17	0.002415	6.56	487.85	105.92	0.54
Bullard Wash	8100	3200.00	930.20	933.78	933.78	935.48	0.014625	10.46	305.82	90.75	1.00
Bullard Wash	8082	3200.00	929.42	932.30	933.00	935.00	0.030395	13.18	242.86	88.64	1.40
Bullard Wash	7979.33*	3200.00	924.98	927.50	928.56	931.06	0.047326	15.13	211.44	87.57	1.72
Bullard Wash	7876.66*	3200.00	920.55	923.18	924.13	926.45	0.041318	14.51	220.60	87.88	1.61
Bullard Wash	7774	3200.00	916.11	918.70	919.69	922.08	0.043604	14.75	216.92	87.76	1.65
Bullard Wash	7744	3200.00	914.81	917.41	918.40	920.80	0.043183	14.78	216.53	86.44	1.65
Bullard Wash	7700	3200.00	912.91	919.79	916.68	920.26	0.000422	5.47	591.09	107.39	0.38
Bullard Wash	7605	3200.00	912.93	919.84	916.36	920.19	0.000295	4.72	678.43	107.63	0.33
Bullard Wash	7558	3200.00	912.88	919.67	916.66	920.16	0.000447	5.57	574.99	93.38	0.40
Bullard Wash	7553	3200.00	911.94	919.71	916.29	920.14	0.000373	5.26	608.61	93.53	0.36
Bullard Wash	7543	Bridge									
Bullard Wash	7533	3200.00	911.92	919.62	916.27	920.05	0.000386	5.32	601.69	93.38	0.37
Bullard Wash	7500	3200.00	912.68	919.56	916.45	920.03	0.000428	5.49	582.70	93.35	0.39
Bullard Wash	7460	3200.00	912.64	919.55	916.40	920.01	0.000423	5.47	584.96	93.38	0.39
Bullard Wash	7430	3200.00	912.60	919.54	916.36	920.00	0.000416	5.44	587.75	93.43	0.38
Bullard Wash	7357	Bridge									
Bullard Wash	7300	3200.00	912.43	919.16	916.21	919.65	0.000461	5.62	569.53	93.35	0.40
Bullard Wash	7290	3200.00	912.40	919.17	916.01	919.63	0.001253	5.45	587.41	93.54	0.38
Bullard Wash	7122.5*	3200.00	912.22	918.95	915.83	919.42	0.001277	5.48	583.84	93.46	0.39
Bullard Wash	6955.*	3200.00	912.05	918.73	915.66	919.20	0.001314	5.53	578.57	93.35	0.39
Bullard Wash	6787.5*	3200.00	911.87	918.49	915.48	918.98	0.001349	5.58	573.73	93.25	0.40
Bullard Wash	6620	3200.00	911.69	918.25	915.30	918.75	0.001391	5.63	568.15	93.13	0.40
Bullard Wash	6400	3200.00	911.45	917.92	915.06	918.43	0.001456	5.72	559.86	92.95	0.41
Bullard Wash	6322	3200.00	911.36	917.80	914.97	918.32	0.001479	5.74	557.07	92.89	0.41
Bullard Wash	6220	3200.00	911.21	917.65	914.82	918.17	0.001479	5.75	556.99	92.89	0.41
Bullard Wash	6020	3200.00	910.92	917.36	914.53	917.87	0.001485	5.75	556.35	92.87	0.41
Bullard Wash	5900	3200.00	910.74	917.18	914.35	917.69	0.001483	5.75	556.53	92.88	0.41
Bullard Wash	5850	3200.00	910.67	917.10	914.28	917.62	0.001487	5.75	556.13	92.87	0.41
Bullard Wash	5671.42*	3200.00	910.41	916.84	914.02	917.35	0.001491	5.76	555.54	92.86	0.42
Bullard Wash	5492.85*	3200.00	910.15	916.57	913.76	917.09	0.001497	5.77	554.85	92.84	0.42
Bullard Wash	5314.28*	3200.00	909.89	916.30	913.50	916.82	0.001504	5.78	554.10	92.84	0.42
Bullard Wash	5135.71*	3200.00	909.63	916.03	913.24	916.55	0.001512	5.79	553.09	92.81	0.42
Bullard Wash	4957.14*	3200.00	909.37	915.76	912.98	916.28	0.001523	5.80	551.89	92.79	0.42
Bullard Wash	4778.57*	3200.00	909.11	915.48	912.72	916.01	0.001535	5.81	550.47	92.76	0.42
Bullard Wash	4600.*	3200.00	908.85	915.20	912.46	915.73	0.001550	5.83	548.79	92.72	0.42
Bullard Wash	4421.42*	3200.00	908.59	914.92	912.20	915.45	0.001567	5.85	546.83	92.69	0.42
Bullard Wash	4242.85*	3200.00	908.33	914.64	911.94	915.17	0.001589	5.88	544.45	92.64	0.43
Bullard Wash	4064.28*	3200.00	908.07	914.34	911.68	914.89	0.001617	5.91	541.41	92.57	0.43

HEC-RAS Plan: 60%sub(6/98) River: Bullard Wash Out Reach: Bullard Wash (Continued)

Reach	River Sta	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
		(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Bullard Wash	3885.71*	3200.00	907.81	914.04	911.42	914.59	0.001652	5.95	537.70	92.49	0.43
Bullard Wash	3707.14*	3200.00	907.55	913.74	911.16	914.29	0.001696	6.00	533.19	92.41	0.44
Bullard Wash	3528.57*	3200.00	907.29	913.41	910.90	913.99	0.001754	6.07	527.54	92.28	0.45
Bullard Wash	3350	3200.00	907.03	913.08	910.64	913.66	0.001830	6.15	520.43	92.13	0.46
Bullard Wash	3330	3200.00	907.00	912.93	910.83	913.63	0.000769	6.71	476.58	87.69	0.51
Bullard Wash	3078.81	3200.00	906.60	912.54	910.65	913.40	0.000957	7.45	429.42	77.03	0.56
Bullard Wash	3064.81	3200.00	906.58	911.80	910.92	913.31	0.002040	9.88	324.04	62.15	0.76
Bullard Wash	3049.67	3200.00	906.55	911.77	910.89	913.28	0.002041	9.88	323.99	62.15	0.76
Bullard Wash	3002.33	3200.00	906.48	910.82	910.82	913.01	0.015484	11.87	269.48	62.12	1.00
Bullard Wash	2995.33	3200.00	906.13	909.59	910.44	912.75	0.029326	14.27	224.22	69.96	1.40
Bullard Wash	2914	3200.00	902.06	909.93	906.68	910.54	0.002232	6.28	509.73	76.62	0.43
Bullard Wash	2902.75	3200.00	901.50	909.47	906.44	910.42	0.000562	7.83	408.79	51.35	0.49
Bullard Wash	2890.42	Culvert									
Bullard Wash	2879.75	3200.00	901.45	906.56	906.38	908.88	0.003533	12.22	261.84	51.30	0.95
Bullard Wash	2871.74	3200.00	901.43	906.85	906.04	908.51	0.006450	10.35	309.12	57.14	0.78
Bullard Wash	2838.75	3200.00	901.37	907.26	904.98	907.88	0.002003	6.33	505.60	91.77	0.48
Bullard Wash	2653.75	3200.00	901.00	906.89	904.81	907.51	0.002003	6.33	505.55	91.77	0.48
Bullard Wash	2499.74	3200.00	900.69	906.58	904.30	907.20	0.002001	6.33	505.71	91.78	0.48

HYDRAULIC JUMP CALCULATIONS

WOOD/PATEL

CIVIL ENGINEERS • HYDROLOGISTS • LAND SURVEYORS

PROJECT Bullard Wash Outfall Channel Improvements

PROJECT NO. FCD #95-39 SHEET NO. 1 OF 2

CALCULATED BY SZ DATE 6-15-98 CHECKED BY AW DATE 6/98

Hydraulic Jump Evaluation

1) Jump Height

For $Fr_1 > 1.7$, $y_2 = \frac{y_1}{2}\left[(1+8Fr_1^2)^{1/2}-1\right]$ (7.2)

For $Fr \le 1.7$, $y_2 = y_1 Fr_1^2$ (7.4)

2) Jump Length

The length of a hydraulic jump can be determined from Figure 7.9 for non-rectangular channels.

Location (1) Hydraulic Jump at upstream of the 4-12x10 CBC near BID Canal.

@ Station 29+95.33

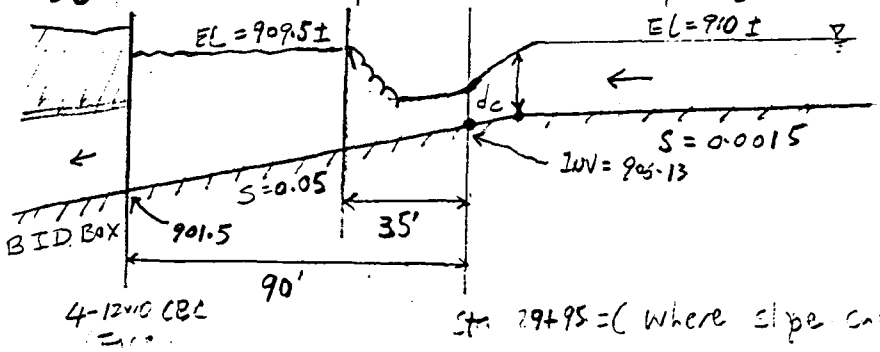
$Fr_1 = 1.40 < 1.7$, $y_1 = 3.46$ ft. $b = 60$ ft, $Z = 1$

$y_2 = 3.46 \times 1.40^2 = 6.78$ ft.

$t = \frac{b}{zy} = \frac{60}{1 \times 3.46} = 17.3$

$L/y_1 = 10$, (Fig. 7.9)

$L = 10 \times 3.46 = 35$ ft. No impact on the 4-12x10 ft CBC.



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PROJECT Bullard wash channel improvements
PROJECT No. FCD # 95-39 SHEET No. 2 OF 2
CALCULATED BY SZ DATE 6-30-98 CHECKED BY MJV DATE 6/98

Location (2) Hydraulic Jump near UPRR

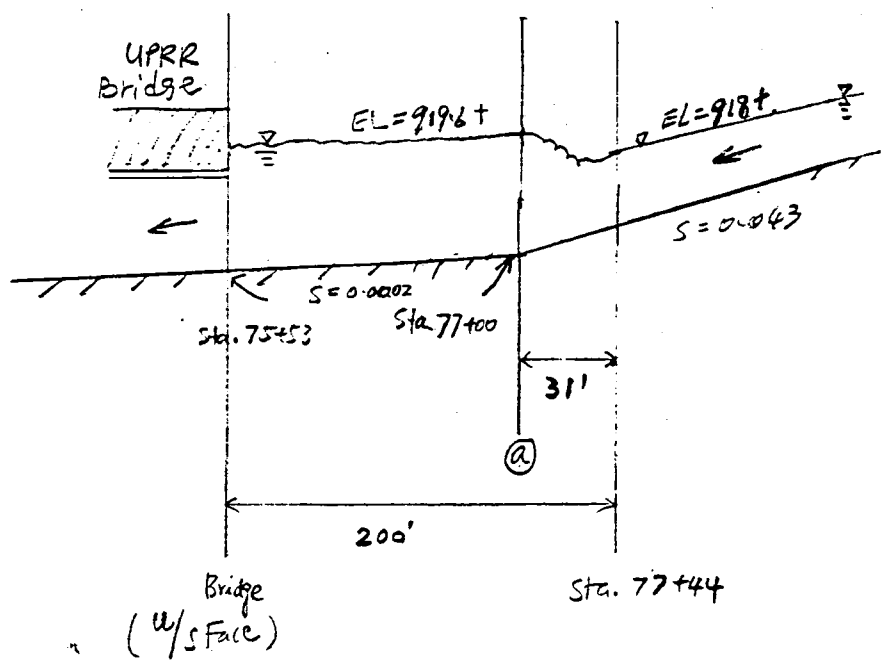
$Fr_1 = 1.65 < 1.7$, $y_1 = 2.6$ ft, $b = 75$ ft, $z = 2$

$y_2 = 2.6 \times 1.65^2 = 7.1$ ft

$t = \frac{b}{zy} = \frac{75}{2 \times 2.6} = 14.4$

$L/y_1 = 12$ (Fig. 7.9)

$L = 12 \times 2.6 = 31$ ft. No impact on the downstream bridge



Profile looking west
NTS

ⓐ Approximate station where TW Elev = Elev. of Jump

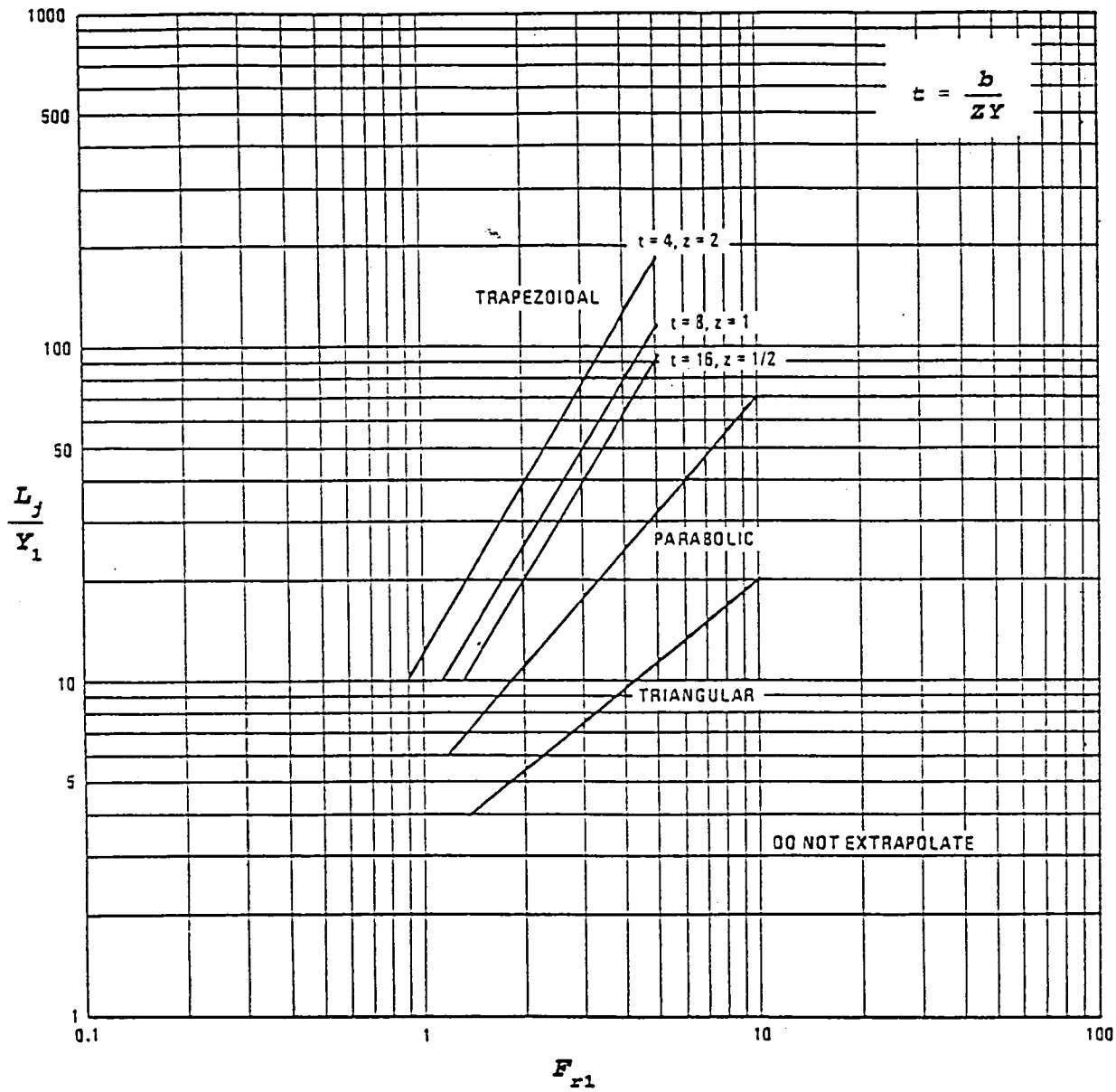


Figure 7.9
Length of a Hydraulic Jump for Non-Rectangular Channels
(USDOT, FHWA, HEC-14, 1983)

LOCAL SCOUR ESTIMATION

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PROJECT Bullard Wash channel.

PROJECT No. FCD # 95-39 SHEET No. 1 OF 2

CALCULATED BY SZ DATE 6-30 CHECKED BY HV DATE 6/98

Local scour Depth at Downstream of Broadway Road

Method: Veronese (1937)

Local scour (sill scour) depth = 4.1 ft (see attached spreadsheet)

From sediment transport and scour analysis report:

Long-term degradation = 2.12 ft.

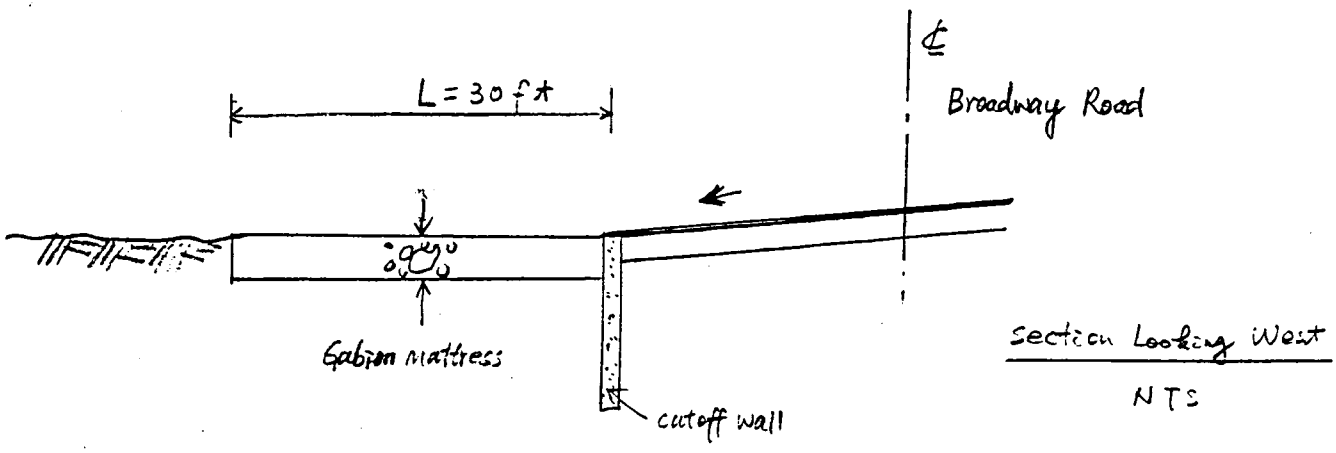
Bedform troughs = 0.54 ft

Low flow incisement = 1.0 ft

Total scour depth at station 63+60 (localized condition)

= { long-term degradation + bedform troughs + low flow incisement + local scour (sill scour) } × safety factor

= { 2.12 + 0.54 + 1.0 + 4.1 } × 1.3 = 10.1 ft



Section Looking West

NTS

In order to stablize the local scour immediately below Broadway Road, a gibion mattress protection anchoring with proposed 4' deep cutoff wall is recommended. The width of the gibion mattress should be the same as the channel bottom width.

Because gibion is flexible, it will adjust to downstream potential scour development.

Sill Scour Computation Sheet

100-year Scour Estimate Downstream of Broadway Road (Sta. 63+22)

Methodology from "Computing Degradation and Local Scour" by E. Pemberton and J. Lara, 1984, Technical Guideline for Bureau of Reclamation, pages 40-45, equation type "D"

100-year discharge =	3,200	cfs	Long-term degradation =	1.60	ft
Total flow area (u/s) =	557.07	ft^2	Total flow area (d/s) =	556.99	ft^2
Total top width (u/s) =	92.89	ft	Total top width (d/s) =	92.89	ft
Mean flow depth (u/s) =	6.00	ft	Mean flow depth (d/s) =	6.00	ft
Discharge per foot =	34.45	cfs/ft	WSEL (u/s) =	917.80	ft
			WSEL (d/s) =	917.65	ft

Veronese (1937)

$$d_s = KH_T^{0.225} q^{0.54} - d_m$$

d_s =	depth of scour (ft)	
K =	1.32	1.32 inch-pound units
H_T =	1.75	head from U/S to D/S
q =	34.45	discharge per unit width (cfs per ft)
d_m =	6.00	D/S mean water depth

ds = 4.1 ft

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PROJECT Ballard wash channel Improvements

PROJECT No. FCD # 95-39 SHEET No. 1 OF 3

CALCULATED BY SZ DATE 6-30 CHECKED BY _____ DATE _____

Local scour depth at downstream of CRC.

method: Veronese (1937)

Local scour (sill scour) depth = 5.0 ft (see attached spreadsheet)

No long-term degradation/aggredation, bedform trough, and low flow incisement are applicable, therefore,

Total scour depth = local scour × safety factor

= 5.0×1.3 = 6.5 ft.

Sill Scour Computation Sheet

100-year Scour Estimate Downstream of 4-12x10 ft CBC (Sta. 28+71.74)

Methodology from "Computing Degradation and Local Scour" by E. Pemberton and J. Lara, 1984, Technical Guideline for Bureau of Reclamation, pages 40-45, equation type "D"

100-year discharge =	3,200	cfs	Long-term degradation =	0.00	ft
Total flow area (u/s) =	309.12	ft^2	Total flow area (d/s) =	505.60	ft^2
Total top width (u/s) =	57.14	ft	Total top width (d/s) =	91.77	ft
Mean flow depth (u/s) =	5.41	ft	Mean flow depth (d/s) =	5.51	ft
Discharge per foot =	56.00	cfs/ft	WSEL (u/s) =	906.85	ft
			WSEL (d/s) =	907.26	ft

Veronese (1937)

$$d_s = KH_T^{0.225} q^{0.54} - d_m$$

ds = 5.0 ft

d_s = depth of scour (ft)

K = 1.32 1.32 inch-pound units

H_T = 0.63 head from U/S to D/S

q = 56.00 discharge per unit width (cfs per ft)

d_m = 5.51 D/S mean water depth

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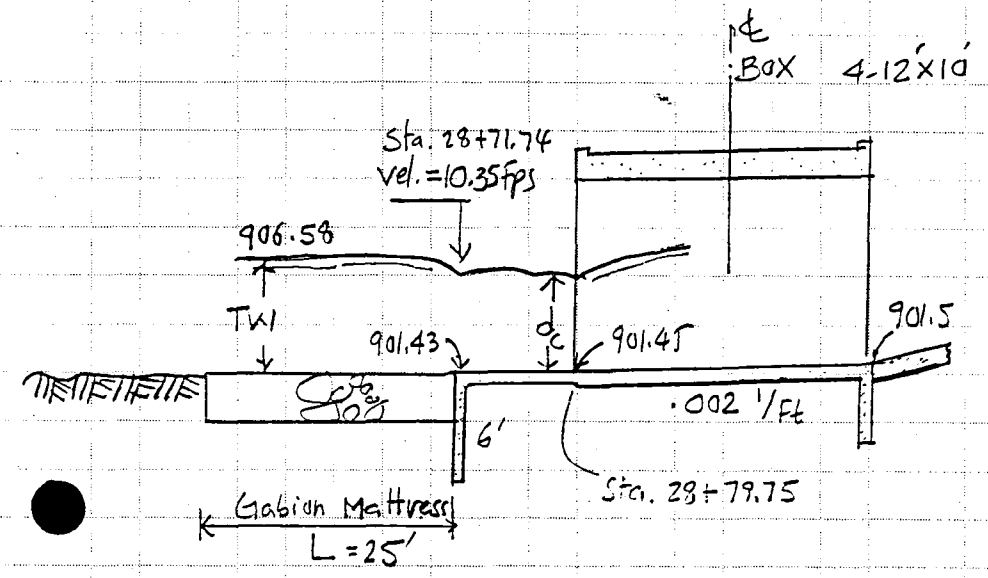
PROJECT Bullard Wash Channel Improvements

PROJECT NO. ZCD #95-39 SHEET NO. 3 OF 3

CALCULATED BY tg DATE 6/98 CHECKED BY SZ DAT 6-30

BID Maintenance Road Box Culvert, Outlet Protection



Profile Looking West

From HEC-RAS, @ 28+79.75
$Y_1 = 5.11$ (d_c)
$V_1 = 12.22$ fps
$F_r = 0.95$ ($\simeq d_c$)

① Tailwater based on Q_{100} in Gila River = 906.3

or, ② " " slope area method for the outfall channel for Q_{100} in Bullard Wash channel = 906.58

∴ Condition ② is controlling, use 906.58 as the SWSEL

Since velocity at the downstream edge of concrete apron is subcritical (10.35 fps per HEC-RAS), a gabion mattress is recommended to stabilize scour.

Provide 25 ft long gabion mattress. The mattress should be anchored to the apron cut-off wall. The mattress should be placed for the full width of channel bottom

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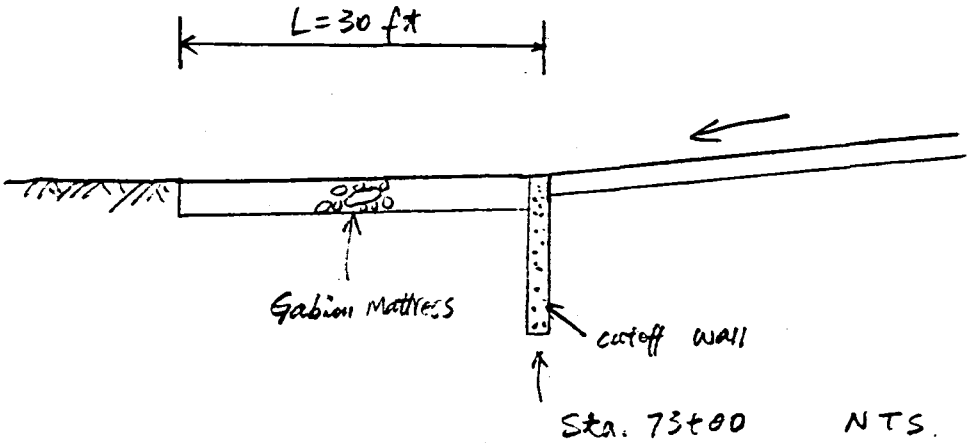
PROJECT Bullard Wash Channel Improvements

PROJECT NO. FCD# 95-39 SHEET NO. 1 OF 1

CALCULATED BY SZ DATE 7-2 CHECKED BY AU DATE 7/98

Local scour Depth at sta. 73+00

The calculated toe down depth from the sediment Transport & scour Analysis Report is 11.9 ft at this location.

It is recommended that a gibion mattress protection anchoring with proposed 4' deep cutoff wall be constructed. The width of the gibion mattress is the same as the channel bottom width.