CANDIDATE ASSESSMENT REPORT

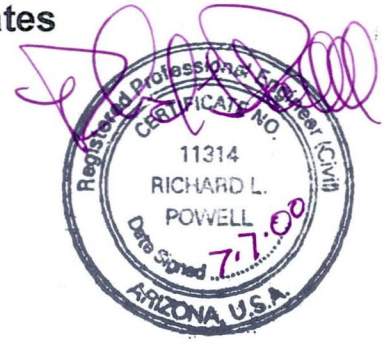
ELLSWORTH ROAD DITCH STUDY

SOUTHERN AVENUE TO APACHE TRAIL

Final Report

PREPARED BY: RITOCH POWELL and Associates
3120 North 19th Avenue
Phoenix, Arizona 85015

RPA Job Number 2005
July 2000



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I. Introduction

Along Ellsworth Road from Southern Avenue north to Apache Trail, several concrete lined ditches exist between the main roadway and the frontage roads. These ditches with their steep side slopes and proximity to the roadway pose a hazard to the traffic. MCDOT is interested in studying these ditches with the goal being to improve the safety of the traveling public along this roadway.

RPA has been asked to prepare a three-part report. Phase I will identify the existing conditions. Phase 2 will discuss alternate solutions. Phase 3 will summarize the findings and recommend a final solution.

II. Existing Conditions

Existing drainage in the vicinity of the project is from the northeast to the southwest. There are three separate ditches within the project limits. Ditch No. 1 is a small concrete lined ditch just north of Broadway Road on the west side of Ellsworth Road. It starts just north of the Broadway intersection and ends approximately 100 feet to the north from where it drains via a 24 inch pipe to a defined drainage way that passes flood water under Ellsworth Road in a large concrete box culvert.

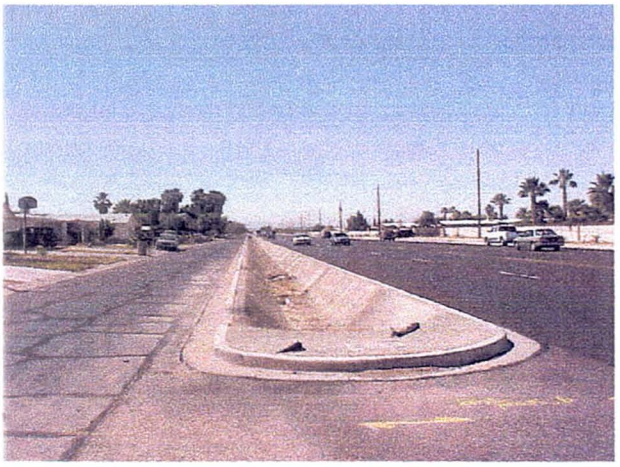
Ditch No. 1 Looking North

Ditch No. 2 is a concrete lined ditch on the east side of Ellsworth Road that begins on the north side of Corabell Avenue and ends at a multiple pipe culvert that passes the water under Ellsworth Road to the west side to an existing ditch which then drains west away from Ellsworth Road. An existing dirt ditch along the north side of Corabell Avenue drains water from the east to a CBC under Corabell Avenue into Ditch No. 2.

Ditch No. 2 - Looking South Across Corabell Ave.

Ditch No. 2 At South End

Ditch No. 3 is also a concrete lined ditch on the east side of Ellsworth Road and begins on the south side of Pueblo Avenue and extends south to Sunland Drive. It then passes under Sunland Drive in a CBC to a ditch that continues south along the west side of Ellsworth Road. There is no frontage road south of Sunland Drive.



Ditch No. 3 North End

Ditch No. 3 Looking South Across Sunland Dr.

The Central Arizona Project Canal is located approximately a mile to the northeast of the project. Drainage across the canal is concentrated at the locations where it crosses the canal. There are two such crossings upstream from the project area. One crosses the CAP just north of Apache Trail at Crismon Road. (see Drainage Area Maps)The water from this crossing flows in existing washes and channels south across Apache Trail and then west to the CBC that crosses Ellsworth Road just north of Broadway Road. This is the crossing that Ditch No. 1 is connected to. The next crossing of the CAP is east of Crismon Road at Broadway Road. This concentration of flow drains to the southwest to an existing ditch along the east side of Crismon Road and then south. Neither of these CAP crossings effects Ditches No. 2 or 3.

The project area is covered by the East Mesa Area Drainage Master Plan; October 1998 prepared by the Flood Control District of Maricopa County. A portion of the Northern Area Topographic Subbasin Boundary Map is included in the Appendix of this report. Ditches No. 1, 2, and 3 have been added to this map for clarification. As can be seen from this map, the drainage areas for the project are wholly contained in sub basin No. 30. This map also shows that concentrated flows crossing the CAP are diverted elsewhere as discussed above.

A copy of sheet 16 of the Maricopa County boundary map is also attached. The drainage areas contributing to the project do not include any of the area in the City of Mesa.

III. Original Design Flows

No As-Built plans could be located for Ditch No. 1. The As-Built plans for the construction of Ellsworth Road from Southern Avenue to University Drive were located. This project was As-Built in May, 1992. This project constructed the main roadway and Ditches No. 2 and 3 and the culverts associated with these ditches. An effort to locate a drainage report for this project was made and none could be found. The consultant who prepared the plans is no longer in the engineering business and had no records of the project.

The design plans did have some design flow information shown on them. This is summarized below:

Culvert No. 1: 6' x 3' x 108' CBC
Ditch No. 2: concrete lined ditch, bottom width = 4' with 1:1 side slopes
Culvert No. 2: 4 – 35" x 24" x 111' CSP Arch
Drainage Area = 0.188 Sq. Mi. (120 Acres)
Q (25) = 94 cfs

Ditch No. 3: concrete lined ditch, Bottom width – 4' with 1:1 side slopes
Culvert No. 3: 6' x 3' x 92' CBC
Drainage Area = 0.405 Sq. Mi. (260 Acres)
Q (25) = 214 cfs

V. Drainage Areas and Design Flows

The drainage areas for this project are in areas fully developed with single family residences. An effort was made to locate As-Built grading or paving plans for these subdivisions. Since they were almost all developed in the 1960's or 1970's, no plans were available. The drainage areas were determined by field observations that were supplemented with levels where needed.

The design flows were calculated using the procedures outlined in the Drainage Design Manual for Maricopa County, Volume I, Hydrology. Since the drainage areas are urban in nature and under 160 Acres, the rational method was used to establish the design flows, or more specifically, the computer program RATIONAL. EXE was used.

Drainage Area No. 1:

Drainage Area No. 1 was found to be very small and consisting of only about 300 feet of the frontage road and 500 feet of the adjacent half of Ellsworth Road. The calculated design flows were: Q(10) = 3 cfs, Q(100) = 5 cfs.

Drainage Area No. 2:

This area is bounded on the north by Broadway Road. Flows north of Broadway Road find their way into the box culvert that crosses under Ellsworth just north of Broadway Road. Crismon Road diverts any flow from the east. An existing dirt ditch extends east from Ellsworth along the north side of Corabell to 96th Street. This collects flows from north of Corabell to Culvert No. 1. In the southeast corner of Ellsworth and Broadway Road is a Fry's Market and the Wynstone Subdivision. Both are recent developments and have on-site retention. These areas will not contribute to the drainage area. Drainage Area No. 2 is summarized as follows:

Drainage Area = 124 Acres (0.194 Sq. Mi.)
- Q(2) = 84 cfs
- Q(5) = 124 cfs
- Q(10) = 162 cfs
- Q(25) = 231 cfs
- Q(100) = 354 cfs

The area compares well with that used in the existing design, but the flows are much larger than the ones used for the design. This is probably due to the different hydrologic methods used at the time of the original design.

Drainage Area No 3:

This area is bounded on the north by DA No. 2. Flows east of the centerline of 96th Street go south in 96th Street. Flows south of the centerline of Pueblo Avenue flow south through the subdivisions to Sunland Avenue where it then flows west and enters the ditch south of Sunland Avenue. Drainage Area No 2 is summarized as follows:

Drainage Area = 82 Acres (0.128 Sq. Mi.)
Q(2) = 69 cfs
Q(5) = 98 cfs
Q(10) = 124 cfs
Q(25) = 171 cfs
Q(100) = 266 cfs

This is a much smaller area than the 0.405 Sq. Mi. shown on the As-Built plans.

V. Capacity of Existing Structures

The computer program FHWA Culvert Analysis, HY8, Version 6.1 was used to analyze the capacity of the existing culverts. This program follows the design methods described in HDS No. 5, Hydraulic Design of Highway Culverts, Sept. 1985, FHWA. This is the basis for the procedures found in the Drainage Design Manual for Maricopa County, Volume II, Hydraulics.

Ditch No. 2:

Ditch No. 2 begins at Culvert No. 1, a 6' x 3' x 108' CBC under Corabell Avenue. It then flows south in a concrete lined ditch between Ellsworth Road and the frontage road to Culvert No. 2, a 4 – 35" x 24" x 111' CSP Arch that crosses under Ellsworth Road. For this report, the capacity of a culvert was considered the flow achieved when the headwater is at the top of the roadway curb. Any additional flow would flow over the curb into the street.

The capacity of Culvert No. 1 was found to be 120 cfs. This would be approximately equivalent to a 5-year storm flow. The ditch itself will carry 250 cfs. Culvert No. 2 has a capacity of 108 cfs. This is approximately a 4-year storm flow.

If the capacity of Culvert No. 1 is exceeded, the additional flow will cross Corabell Avenue to the south in a valley gutter and flow back into Ditch No. 2. If the capacity of Culvert No. 2 is exceeded, the excess will pond in the east half of Ellsworth Road up to a point where it will cross the crown in Ellsworth and eventually find it's way back into the ditch on the west side of Ellsworth Road.

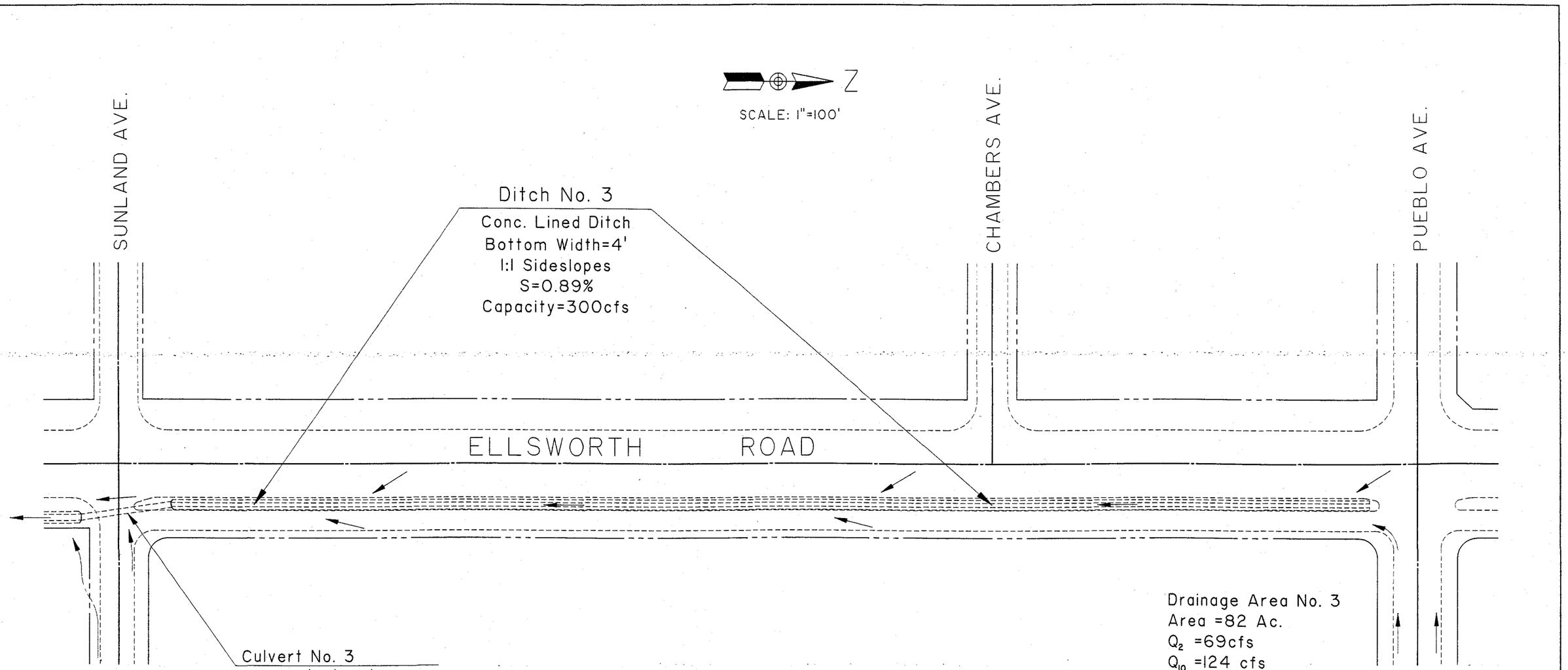
Ditch No 3:

Ditch No. 3 begins just south of Pueblo Avenue between Ellsworth and the Frontage Road and flows south in a concrete lined ditch to Culvert No. 3. Culvert No. 3 is a 6' x 3' x 92' CBC which crosses under Sunland Drive to a larger ditch that continues to the south. There is no frontage road south of Sunland Drive. This ditch eventually drains to an ADOT detention basin at Ellsworth and US-60.

Ditch No. 3 has a capacity of 298 cfs. Culvert No. 3 has a capacity of 120 cfs. This too is approximately a 5-year storm frequency.

If this flow is exceeded, the overflow will cross Sunland Drive in a concrete valley gutter and back into the existing ditch to the south.

SITE MAPS



ELLSWORTH ROAD DITCH STUDY
SOUTHERN AVENUE TO APACHE TRAIL
CANDIDATE ASSESSMENT REPORT

SITE MAP

RITOCHE-POWELL & Associates
Consulting Engineers, Inc.

DESIGN: R.L.P.	DRAWN: T.E.B.	CHECKED: J.M.R.	SHEET 1 OF 4
DATE: 5/00	DATE: 5/00	DATE: 5/00	

N

SCALE: 1"=100'

PUEBLO AVE.

WIER AVE.

Ditch No. 2
Conc. Lined Ditch
Bottom Width=4'
1:1 Sideslopes
S=0.63%
Capacity=250cfs

ELLSWORTH ROAD

Culvert No. 2
Exist.4-35"x 24"x 111' CSP Arch
Capacity=108cfs

Drainage Area No. 2
Area =124 Ac.
Q_2 =84cfs
Q_{10} =162 cfs
Q_{100}=354 cfs

Culvert No. 1
Exist. 6'x3'x108' C.B.C.
Capacity=120cfs

CORALBELL AVE.

ELLSWORTH ROAD DITCH STUDY
SOUTHERN AVENUE TO APACHE TRAIL
CANDIDATE ASSESSMENT REPORT

SITE MAP

RITOCH-POWELL & Associates
Consulting Engineers, Inc.

DESIGN: R.L.P.	DRAWN: T.E.B	CHECKED: J.M.R.	SHEET 2 OF 4
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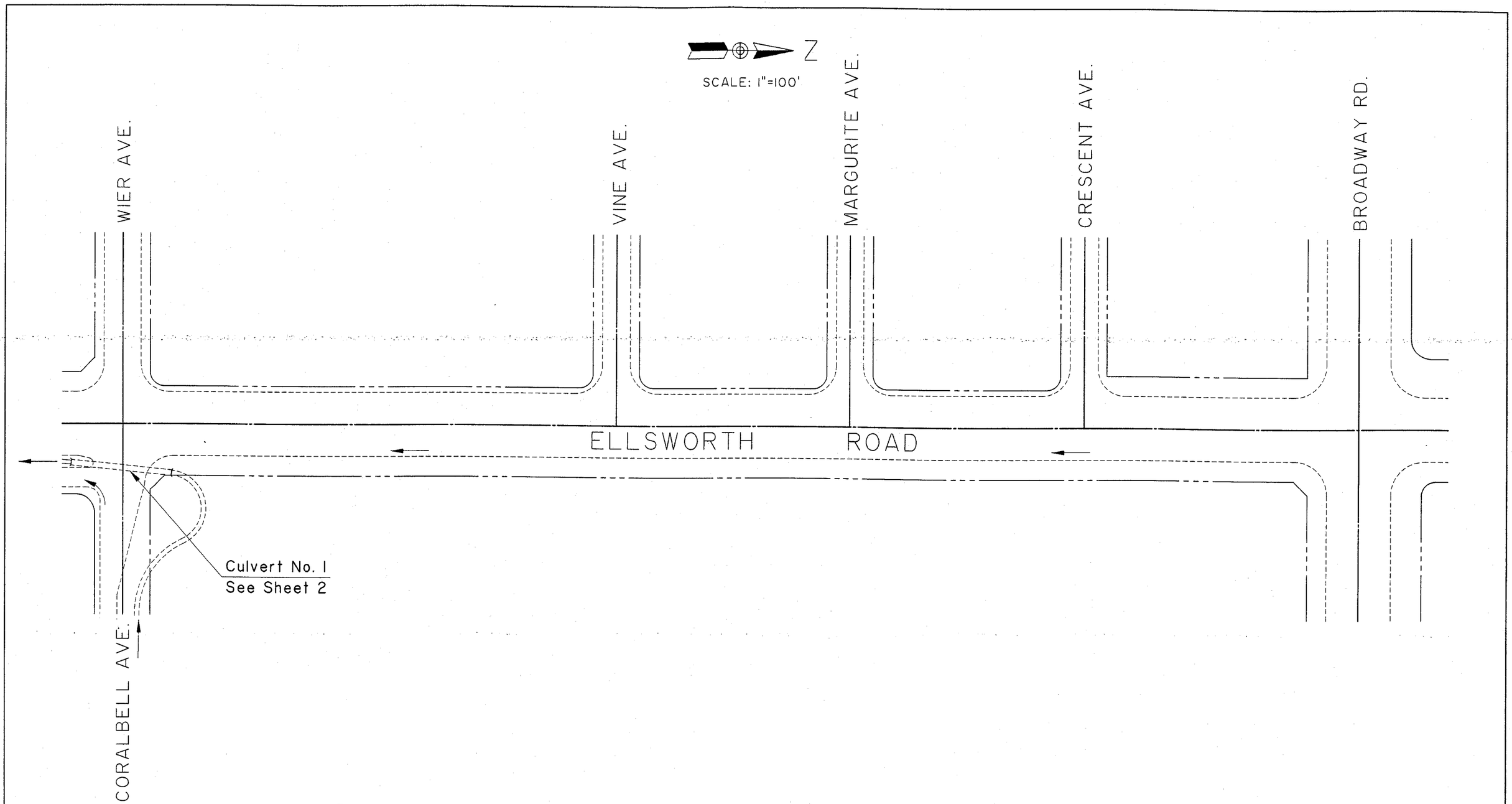


ELLSWORTH ROAD DITCH STUDY
SOUTHERN AVENUE TO APACHE TRAIL
CANDIDATE ASSESSMENT REPORT

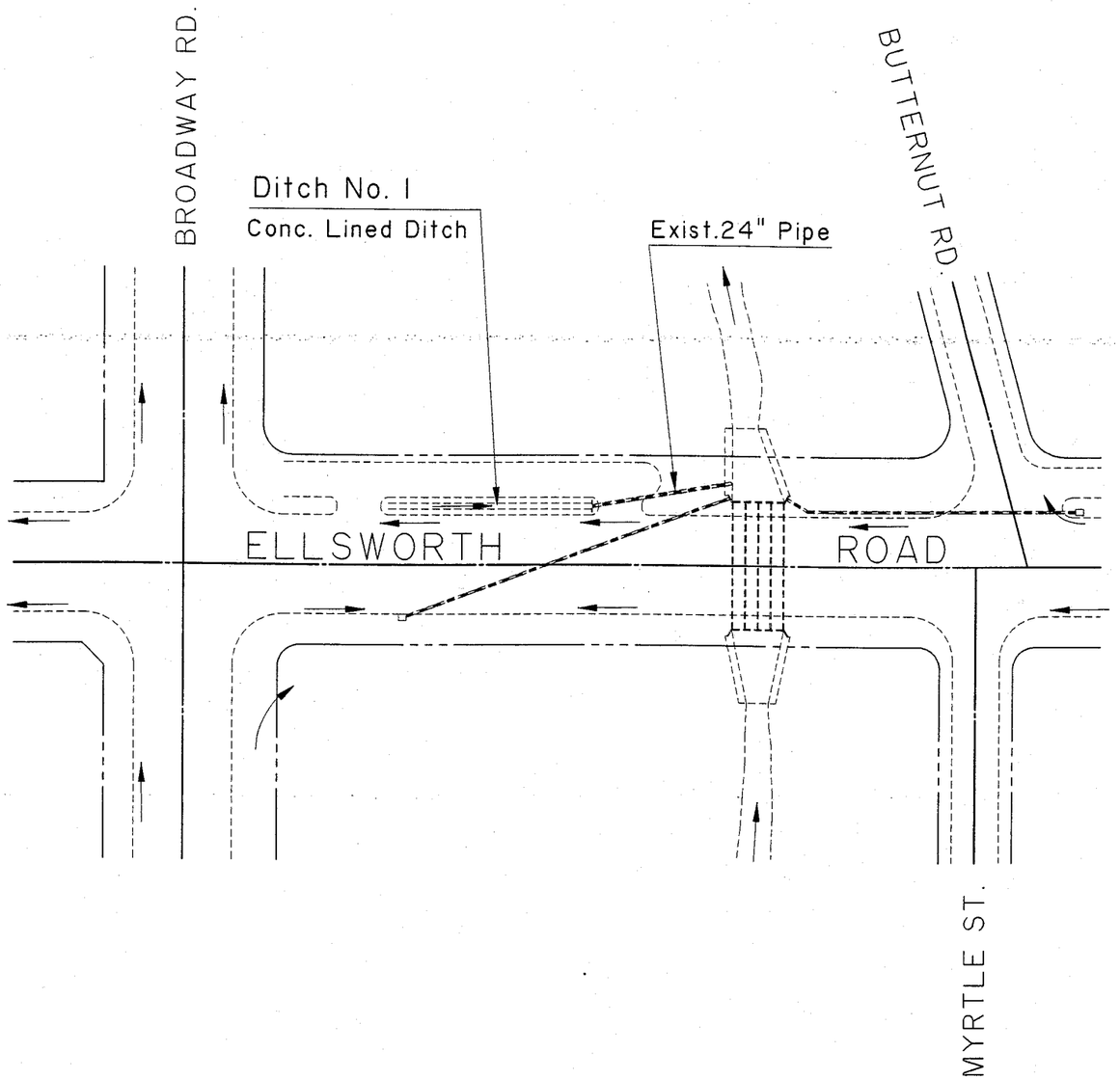
SITE MAP

RITOCH-POWELL & Associates
Consulting Engineers, Inc

DESIGN: R.L.P.	DRAWN: T.E.B.	CHECKED: J.M.R.	SHEET 3 OF 4
DATE: 5/00	DATE: 5/00	DATE: 5/00	

Z

SCALE: 1"=100'



ELLSWORTH ROAD DITCH STUDY
SOUTHERN AVENUE TO APACHE TRAIL
CANDIDATE ASSESSMENT REPORT

SITE MAP

RITOCH-POWELL & Associates
Consulting Engineers, Inc.

DESIGN: R.L.P.	DRAWN: T.E.B.	CHECKED: J.M.R.	SHEET 4 OF 4
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VI. Ditch No. 1 Alternatives

On the surface, this ditch could easily be eliminated with the addition of two catch basins connected to the existing 24 inch pipe that connects to the floodway channel just to the north. Mr. Chuck Feuquay of the Maricopa County Flood Control District who is familiar with the flood history in this area was contacted. He related the following:

Drainage from the north collects in a swale along the north side of Broadway Road and flows west to Ellsworth Road. A defined ditch was built from the northeast corner of this intersection north to the box culvert under Ellsworth Road. Apparently, some of this flow does not make the turn to the north and crosses the crown in Ellsworth Road into the area of Ditch No. 1. It then ponds in the northwest corner of the intersection and floods one business and several residences along the frontage road. The present ditch was installed to drain this ponded water, but it does not handle the flood flows crossing Ellsworth Road. The ditch to the north on the east side of Ellsworth Road has since been concrete lined to increase it's effectiveness, but Mr. Feuquay was not sure this will alleviate the situation.

To replace this ditch at this time with catch basins, and another flood occurred, the County could be perceived as contributing to an increase in the flood height by eliminating the ditch. Until such time as the drainage problem on the east side of Ellsworth Road is solved so that no flows cross Ellsworth Road, it is recommended that Ditch No. 1 be left as is. It is shallow and not that bad of a hazard.

VII. Ditch No. 2 Alternates

In order to evaluate alternative ways of protecting traffic from Ditch No. 2, the affects of the 100 year flood flow were analyzed. (see drawing for Alternate No. I, Existing Conditions)

As previously discussed, the 100 year flows will exceed the capacity of both Culvert No. 1, on the north end of Ditch No. 2, and Culvert No. 3, on the south end. As a result, 100 year flows will back up at the culvert inlets to an elevation where the excess will flow by the culverts and continue downstream. These high water elevations were calculated for each of the culverts.

Culvert No. 1 will cause a 100 year high water elevation in the intersection of Ellsworth Road and Corabell Avenue of 1504.13. This was compared to the finished floor elevation of the adjacent residence, which is 1504.16. From this, it is obvious that whatever alternates are considered, no constriction of the flows downstream from Culvert No. 1 can be allowed. Any such constriction could increase the high water elevation upstream from Culvert No. 1. In fact, during the design of these facilities, regrading of the pavement in this intersection should be considered to reduce the 100 year high water elevation for Culvert No. 1.

A similar evaluation of Culvert No. 2 shows a 100 year high water elevation of 1499.10. This overflow crosses Ellsworth Road to the west in a sag in the roadway profile producing a depth of approximately 6 inches at the crown of the street. The adjacent finished floor is 1499.72, approximately 7.5 inches above the 100 year high water.

Three alternates were considered for Ditch No. 2. The first would be to do nothing.

Alternate No. II

This alternate would be to extend Culvert No. 1 along the ditch alignment south to Culvert No. 2 and then pave over the median area remaining. Catch basins would be spaced along both the Ellsworth Road side and the frontage road side to collect flows generated in the streets. Since the capacity of Culvert No. 2 is less than Culvert No. 1, a direct connection from the extended Culvert No. 1 to Culvert No. 2 cannot be made without constricting flows upstream of Culvert No. 1. Therefore a grate should be provided at the connection. This will also provide maintenance access for both culverts. Analysis of this extended Culvert No. 1 at the 100 year flow and using the headwater elevation of Culvert No. 2 as a tail-water elevation, shows that the high-water upstream from Culvert No. 1 does not increase from the existing conditions.

At present, part of the overflow from Culver No. 1 returns to the existing ditch until it reaches Culvert No. 2, although the ditch will not carry all of the 100 year flow. If Alternate No. II is built, this overflow from Culvert No. 1, not being able to get back into the ditch, will flow south to Culvert No. 2 in the frontage road and Ellsworth Road. This will be the only perceived change to the drainage pattern in the area.

Estimated Cost: $340,000

Alternate No. III

This alternate would be to protect the ditch from traffic using standard guard rail. In order to protect traffic in Ellsworth Road from impalement on the ends of this guard rail, a tangent extruder type end treatment should be provided on each end of the installation (length = 50'). On the north end, Culvert No. 1 will need to be extended 50 feet to accommodate this end treatment. On the south end, the end treatment can be extended beyond the entrance to Culvert No. 2.

Guard rail is normally offset 2 feet from the edge of the traveled lane or in the case of a curb and gutter situation, an extra 2 feet of lane width is provided to the adjacent lane. In this case, the additional 2 feet cannot be provided. This will tend to make the traffic in the outside northbound lane of Ellsworth Road feel constricted because of the proximity of the guard rail. Alternate No. III will not affect the drainage patterns in the area.

Estimated Cost: $120,000

PUEBLO AVE.

Ditch No. 2
Conc. Lined Ditch
Bottom Width=4'
1:1 Sideslopes
S=0.63%
To Remain

SCALE: 1"=100' HORIZ.
1"=5' VERT.

CORALBELL AVE.
(WIER AVE.)

95+00

100+00

105+00

ELLSWORTH ROAD

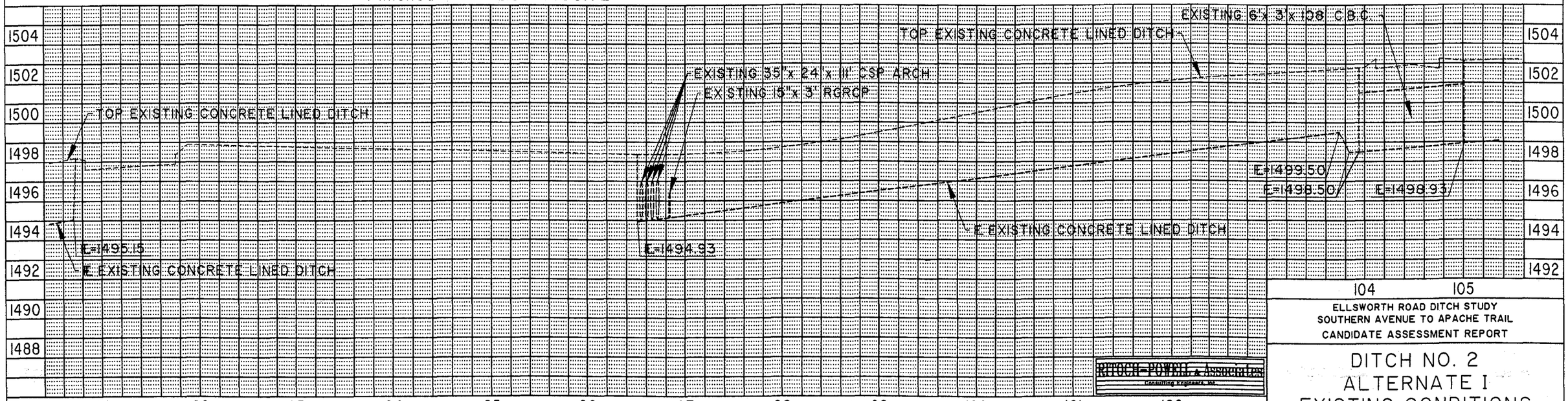
Culvert No. 2
Exist.4-35"x 24"x 111' CSP Arch
To Remain
High Water Elev. at
Q100=1499.10

Drainage Area No. 2
Area =124 Ac.
Q_2 =84cfs
Q_{10} =162 cfs
Q_{100}=354 cfs

Culvert No. 1
Exist. 6'x3'x108' C.B.C.
To Remain
High Water Elev. at
Q100=1504.13

Finished Floor Elev.=1499.72

Finished Floor Elev.=1504.16



ELLSWORTH ROAD DITCH STUDY
SOUTHERN AVENUE TO APACHE TRAIL
CANDIDATE ASSESSMENT REPORT

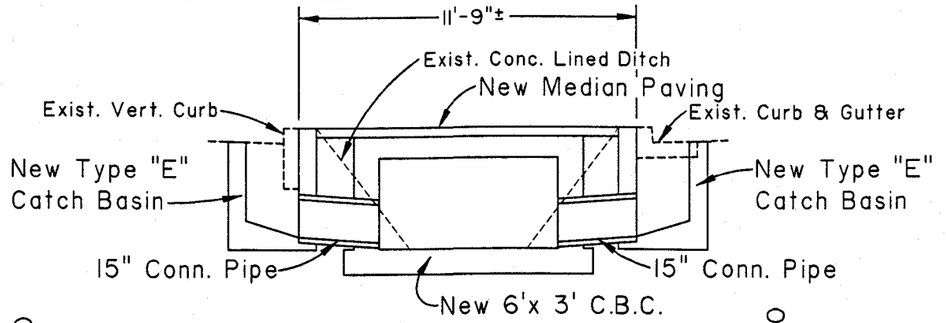
RITOCH-POWELL & Associates
Consulting Engineers, Inc.

DITCH NO. 2
ALTERNATE I
EXISTING CONDITIONS

(1) New Type "E" Catch Basin.Connect To New 6'x 3' C.B.C.

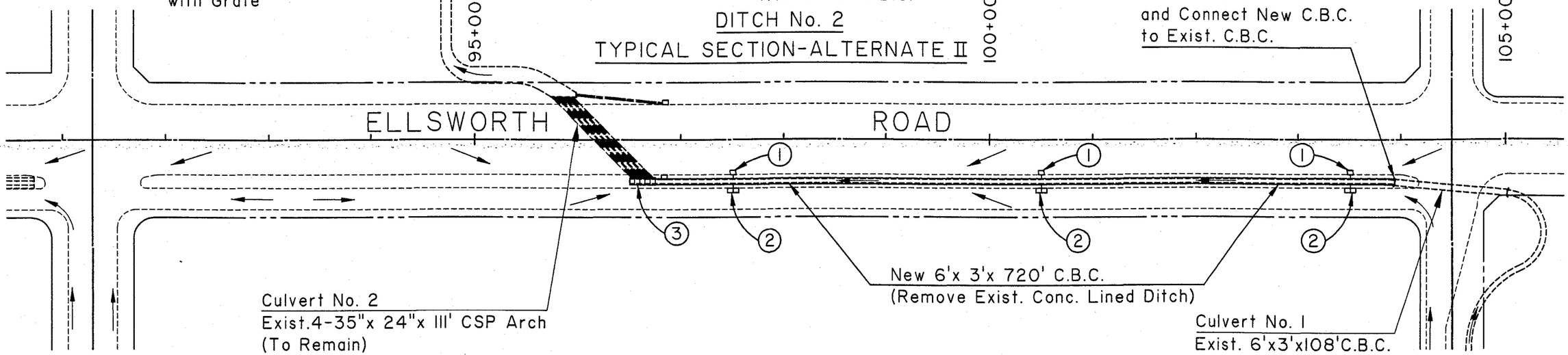
(2) New Type "E" Double Catch Basin. Connect To New 6'x 3' C.B.C.

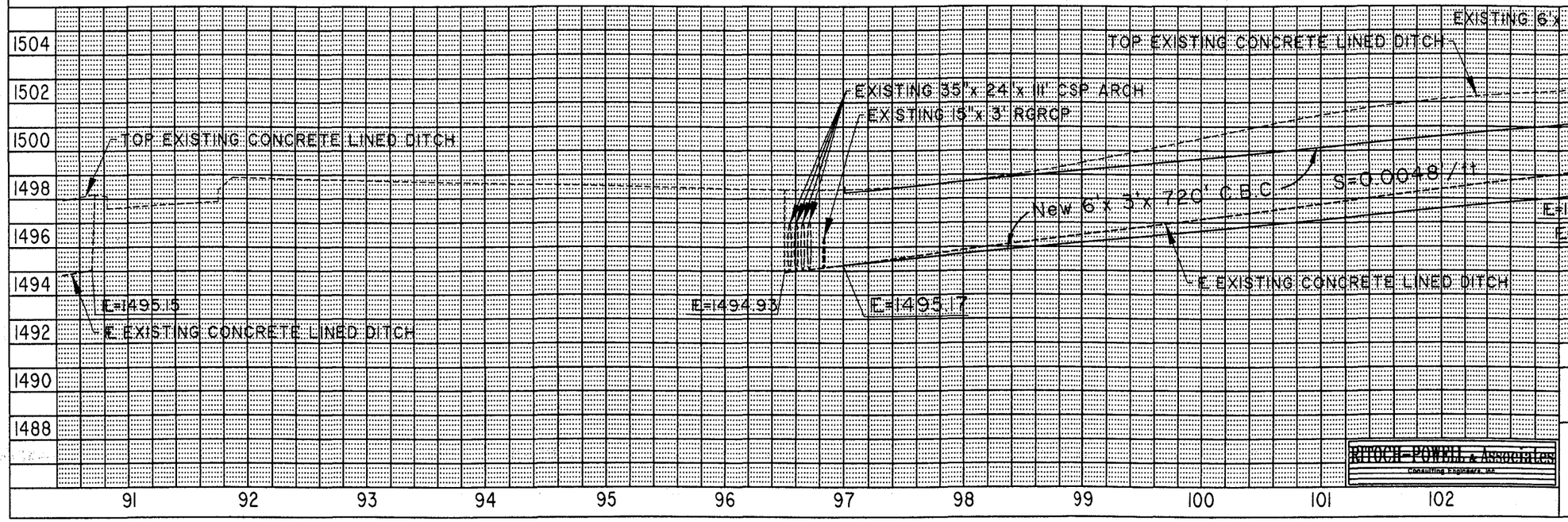
(3) New 25'x 6' Drop Inlet with Grate



DITCH No. 2
TYPICAL SECTION-ALTERNATE II

SCALE: 1"=100' HORIZ.
1"=5' VERT.





ELLSWORTH ROAD DITCH STUDY
SOUTHERN AVENUE TO APACHE TRAIL
CANDIDATE ASSESSMENT REPORT

DITCH No. 2
ALTERNATE II
EXTEND CULVERT NO. 1 TO CULVERT NO. 2

BITOOH-POWELL & Associates
Consulting Engineers, Inc.

New Guard Rail
ADOT C-10 Series

Exist. Curb & Gutter
To Remain

Exist. Curb
To Remain

Exist. Concrete Lined Ditch
Remove & Replace

Ditch No. 2
Concrete Lined Ditch
Remove Exist. Concrete
Lining and Replace after
New Guard Rail is in place.

SCALE: 1"=100' HORIZ.
1"=5' VERT.

PUEBLO AVE.

CORALBELL AVE.
(WIER AVE.)

95+00

100+00

105+00

DITCH No. 2
TYPICAL SECTION-ALTERNATE III

700 L.F. New Guard Rail
50' Tangent End Treatment
each end

ELLSWORTH ROAD

Culvert No. 2
Exist.4-35"x 24"x 111' CSP Arch
To Remain

700 L.F. New Guard Rail
Flared End Treatment
each End

Drainage Area No. 2
Area =124 Ac.
Q_2 =84cfs
Q_{10} =162 cfs
Q_{100}=354 cfs

Culvert No. 1
Exist. 6'x3'x108' C.B.C.
Extend to South 50'

EXISTING 6'x 3'x108' C.B.C.
TOP EXISTING CONCRETE LINED DITCH
EXISTING 35"x 24"x 111" CSP ARCH
EXISTING 15"x 3" RCRCP
TOP EXISTING CONCRETE LINED DITCH
E=1499.50
E=1498.50
E=1498.93
E=1495.15
E EXISTING CONCRETE LINED DITCH
E=1494.93
E EXISTING CONCRETE LINED DITCH

1504 1502 1500 1498 1496 1494 1492 1490 1488

91 92 93 94 95 96 97 98 99 100 101 102 103 104 105

ELLSWORTH ROAD DITCH STUDY
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DITCH NO. 2
ALTERNATE III
GUARD RAIL PROTECTION

STOCH-POWELL & Associates
Consulting Engineers, Inc.

VII. Ditch No. 3 Alternates

Again, as in Ditch No. 2, the 100 year high water elevation at Culvert No. 3 was evaluated. The capacity of Culvert No. 3 is approximately 120 cfs while the 100 year flow is 266 cfs. This high water was calculated to be 1489.63. The finished floor elevation of the adjacent residence is 1491.40, approximately 1 ft. 9 In. above the 100 year ponded elevation.

Also, for evaluation purposes, the 100 year water surface elevation was estimated at the north end of Ditch No. 3, just south of Pueblo Avenue and again about half way along Ditch No. 3. To see the affect of changes in the existing ditch, this was done as if the lined ditch was not there. To estimate this, the east half of Ellsworth Road and the frontage road were considered an open channel and the normal depth of the 100 year flow calculated. As shown in the attach drawing for Alternate No. I, the high water elevation at the north end for the 100 year flow with no ditch is 1498.89 and the adjacent finished floor is 1500.62. The 100 year high water about half way south is 1493.96 and the adjacent finished floor elevation is 1495.76. This means that alternates can be considered that reduce the capacity of or eliminates the existing concrete lined ditch.

Four alternates were considered for Ditch No. 3. The first alternate was to do nothing.

Alternate No. II

This alternate would be to eliminate the existing ditch by extending Culvert No. 3 north along the ditch alignment to a point just south of Pueblo Avenue. This will require a rather large grated drop inlet at the north end of the culvert to pick up a similar flow as the existing culvert is picking up at the south end. This inlet needs to be about 110 ft. long by 6 ft. wide. Catch basins would need to be spaced along each side of the box to pick up minor flows generated in Ellsworth Road and the frontage road.

The existing lined ditch has the capacity to carry all of the flow from the 100 year storm. Extending Culvert No. 3 to eliminate the ditch will have the affect of increasing the flow in Ellsworth Road and the frontage road by forcing the overflow water at the inlet out of the ditch and into the street. But as can be seen by the analysis of the flow elevations with no ditch present, this alternate will not affect the adjacent residential finished floors. This overflow will continue to flow across Sunland Avenue to the existing ditch to the south.

Estimated Cost: **$590,000**

Alternate No. III

This alternate would be to add a grated drop inlet to the north end of Culvert No. 3 (110 ft. x 6 ft.) and replace the existing lined ditch with what is considered a traversable and smaller ditch.

A 4 to 1 slope is generally thought of as a traversable slope. Therefore a vee shaped concrete lined ditch with 4:1 slopes (depth = 1.3 ft.) was analyzed. The capacity of the ditch is approximately 46 cfs when flowing at a depth even with the adjacent gutters. This would be slightly less than a 2 year storm. Existing curb depressions will allow low flows into the ditch.

As has been previously discussed, the larger ditch is not needed to keep the 100 year storm below the adjacent finished floors, but this alternate would put flows that are now carried by the ditch into Ellsworth Road and the frontage road.

Estimated Cost: $200,000

Alternate No. IV

This alternate would protect the existing ditch with guard rail. As with Ditch No. 2, the ends of this guard rail would have to be protected with tangent extruder end treatments. To provide this, about 50 feet of the north end of the ditch would have to be filled and Culvert No. 3 (6' x 3' CBC) would have to be extended 50 feet to the north. The existing concrete lining would have to be removed and replaced after the guard rail is in place. As discussed in regards to Ditch No. 2, this alternate would have the same constricting effect on the outside northbound lane of Ellsworth Road.

Estimated Cost: $180,000

Cost Summary:

Ditch No. 2	
Alternate No. I	$0
Alternate No. II	$340,000
Alternate No. III	$120,000

Ditch No. 3	
Alternate No. I	$0
Alternate No. II	$590,000
Alternate No. III	$200,000
Alternate No. IV	$180,000

Sta. 85+50 with Ditch Removed,
Calculated Normal Depth in
Half Street at Q100=.91ft
Water Surface Elev.=1493.96

Sta. 90+50 with Ditch Removed,
Calculated Normal Depth in
Half Street at Q100=.89ft
Water Surface Elev.=1498.89

SCALE: 1"=100' HORIZ.
1"=5' VERT.

SUNLAND AVE.

Ditch No. 3
Conc. Lined Ditch
Bottom Width=4'
1:1 Sideslopes
S=0.89%
To Remain

CHAMBERS AVE.

PUEBLO AVE.

80+00

85+00

90+00

ELLSWORTH ROAD

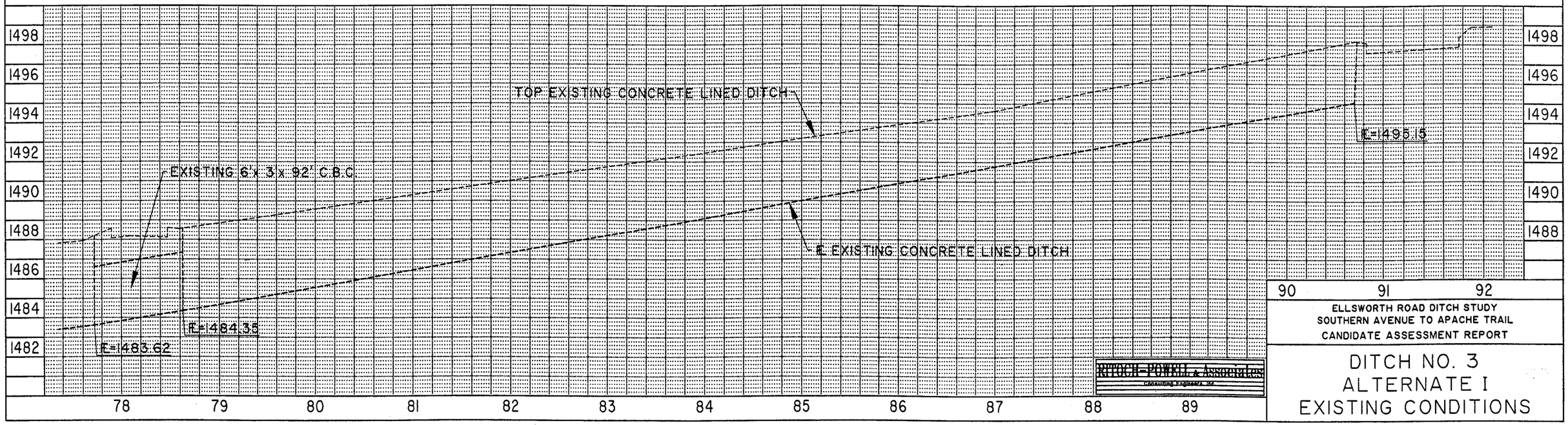
Culvert No. 3
Exist. 6'x3'x92' C.B.C.
To Remain
High Water Elev. at
Q100=1489.63

Finished Floor Elev.=1491.40

Finished Floor Elev.=1495.76

Drainage Area No. 3
Area =82 Ac.
Q =69cfs
Q =124 cfs
Q =266 cfs

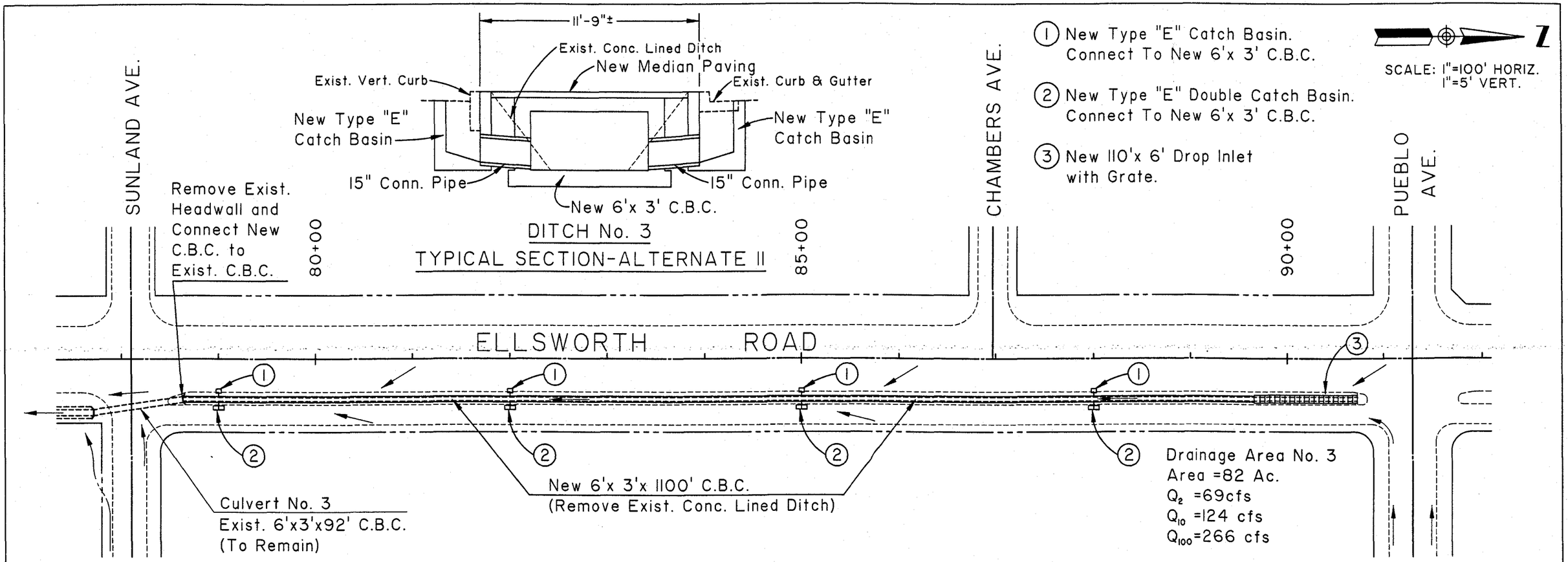
Finished Floor Elev.=1500.62

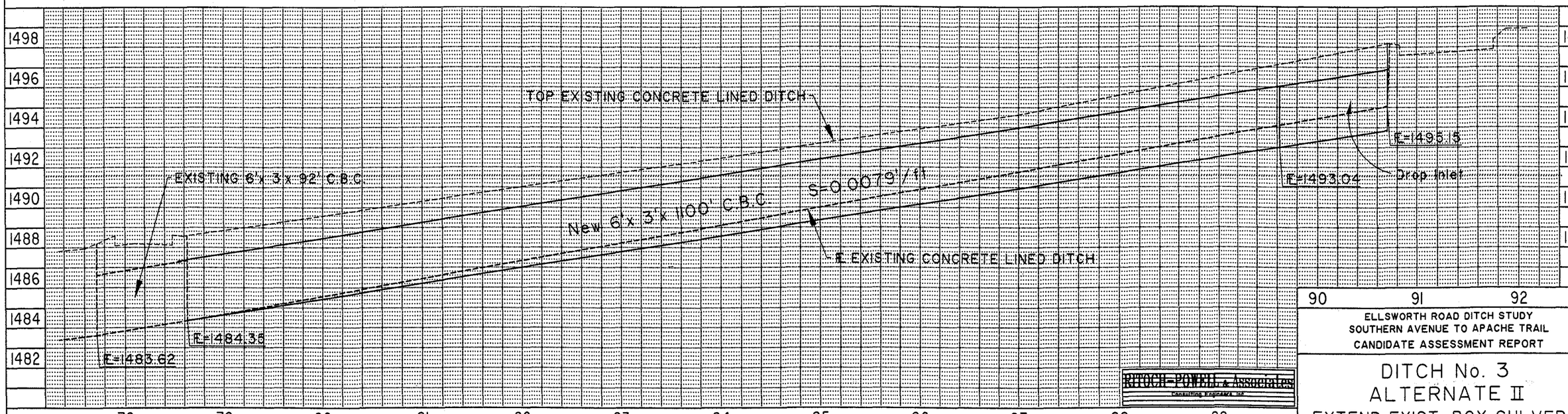


ELLSWORTH ROAD DITCH STUDY
SOUTHERN AVENUE TO APACHE TRAIL
CANDIDATE ASSESSMENT REPORT

RITOCH-POWELL & Associates
Consulting Engineers, Inc.

DITCH NO. 3
ALTERNATE I
EXISTING CONDITIONS

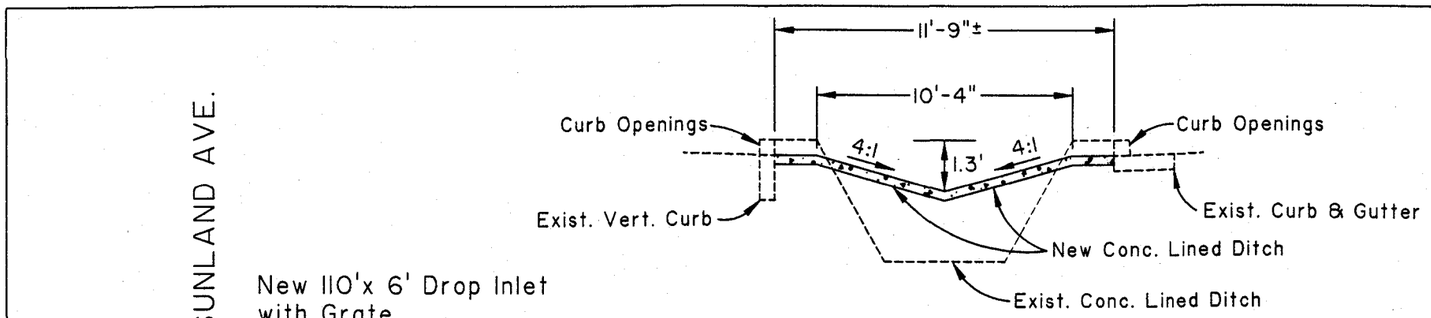




ELLSWORTH ROAD DITCH STUDY
SOUTHERN AVENUE TO APACHE TRAIL
CANDIDATE ASSESSMENT REPORT

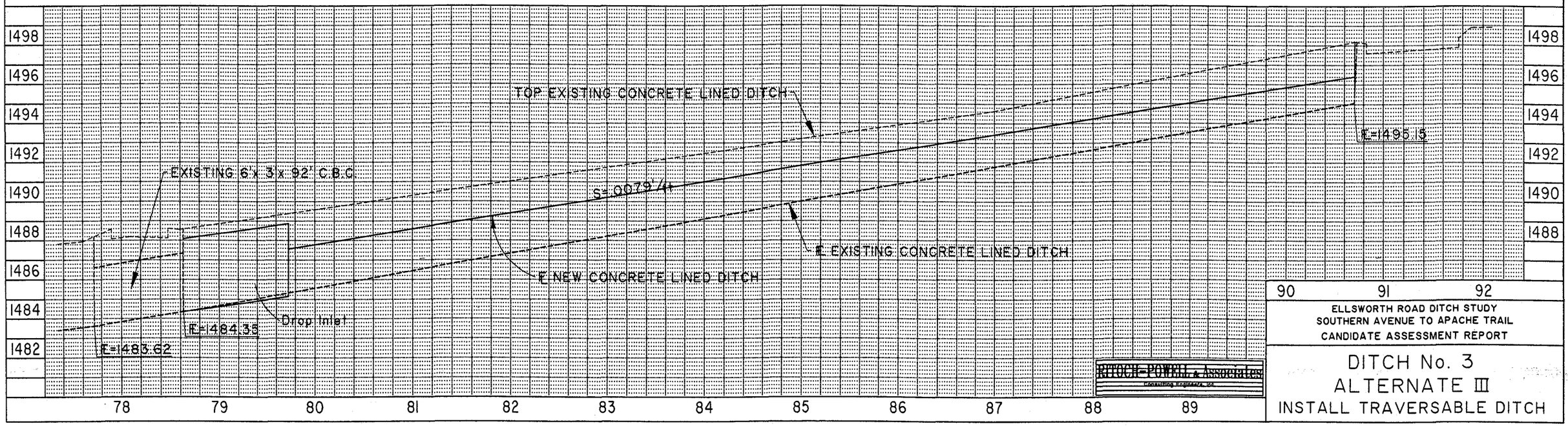
DITCH No. 3
ALTERNATE II
EXTEND EXIST. BOX CULVERT

PITOCH-POWELL & Associates
Consulting Engineers Inc.



DITCH No. 3
TYPICAL SECTION-ALTERNATE III

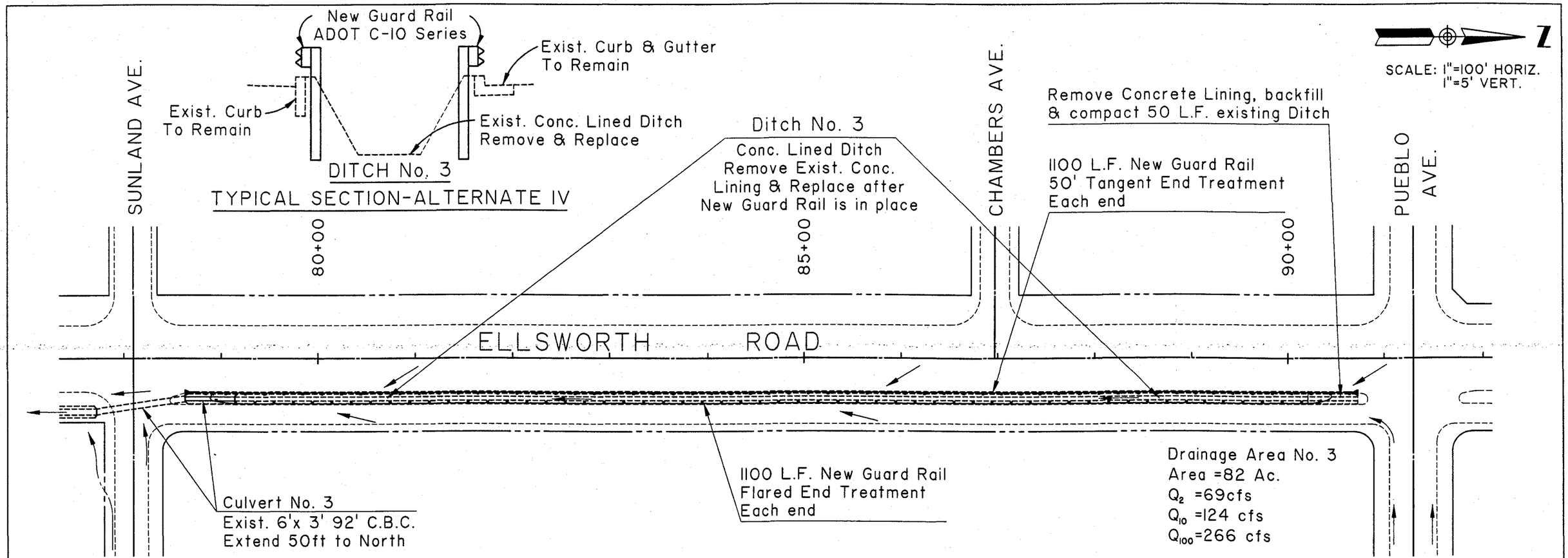
SCALE: 1"=100' HORIZ.
1"=5' VERT.

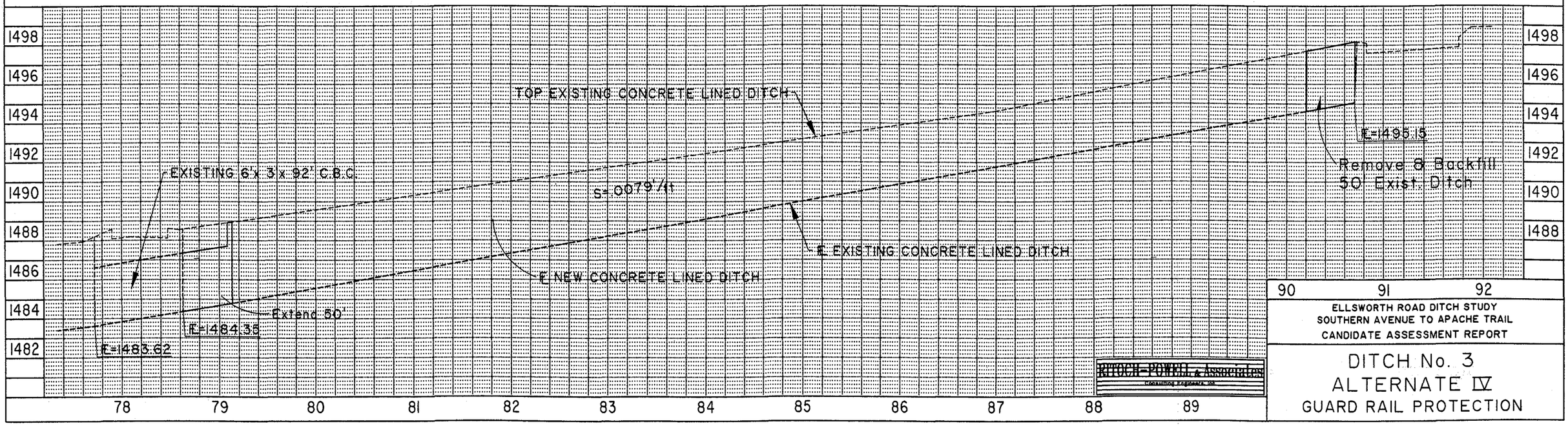


ELLSWORTH ROAD DITCH STUDY
SOUTHERN AVENUE TO APACHE TRAIL
CANDIDATE ASSESSMENT REPORT

DITCH No. 3
ALTERNATE III
INSTALL TRAVERSABLE DITCH

BUTCH-POWELL & Associates
Consulting Engineers, PC





ELLSWORTH ROAD DITCH STUDY
SOUTHERN AVENUE TO APACHE TRAIL
CANDIDATE ASSESSMENT REPORT

DITCH No. 3
ALTERNATE IV
GUARD RAIL PROTECTION

KITCH-POWELL & Associates
Consulting Engineers, Inc.

VIII. Recommendations

Ditch No. 1

It is recommended at this time to leave this small ditch as it is. Until the problem with the runoff crossing Ellsworth Road and ponding in the area of Ditch No. 1 is fixed, any effort to remove Ditch No. 1 could only increase the County's liability.

Ditch No. 2

Alternate No. II is recommended. Alternate No. I, Do Nothing, would be unsatisfactory in that the hazard would still be present. Alternate No. III, Guard Rail, is an economical solution. But guard rail is a hazard in itself. Guard rail would be in effect trading one hazard for another.

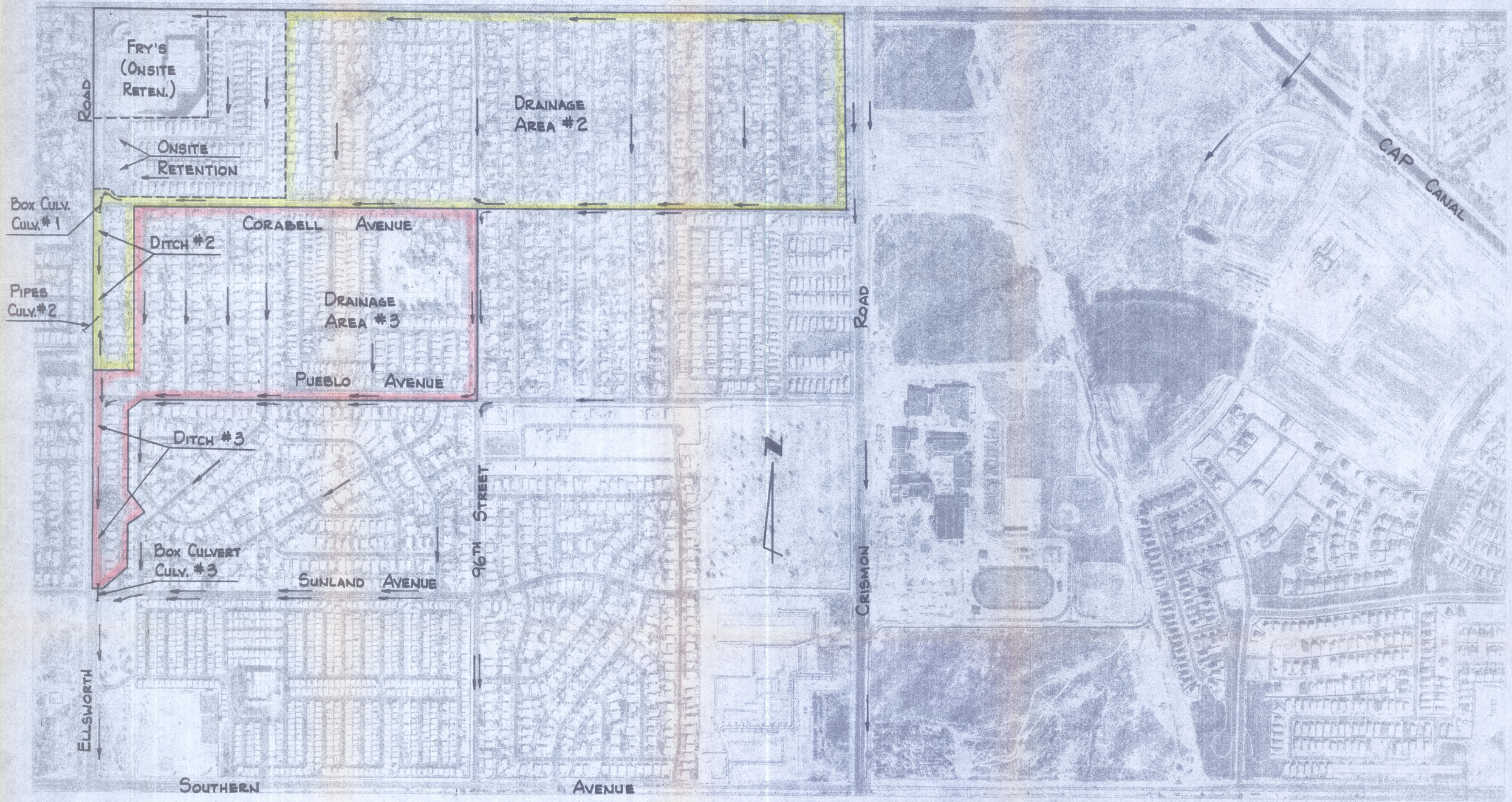
Alternate No. II, although costly, would remove the hazard and not adversely affect drainage in the area. The box culvert extension will not adversely affect the headwater for Culvert No. 1 or the headwater at Culvert No. 2. It will put more of large storm flows into the frontage road and Ellsworth Road. It is also strongly recommended that the possibility of regrading the Ellsworth / Corabell intersection to reduce the 100 year headwater to Culvert No. 1.

Ditch No. 3

Alternate No. III is recommended. Alternate No. I, Do Nothing, does not remove the hazard. Alternate No. IV, Guard Rail, again, would be trading one hazard for another.

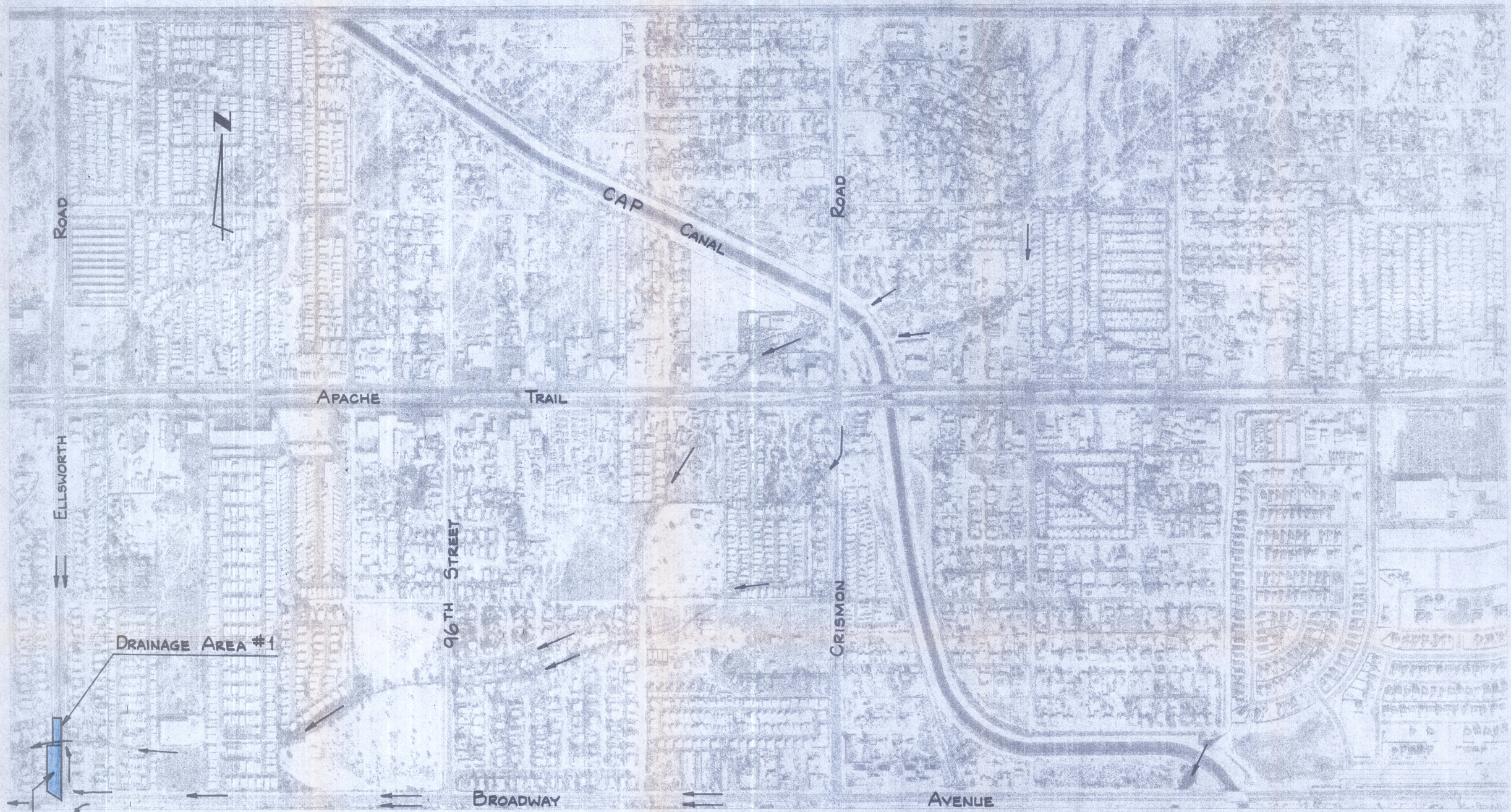
Alternates No. II and III both remove the hazard, although No. III would leave a small but traversable ditch. Both alternates would cause more of the 100 year flow to inundate the frontage road and Ellsworth Road, but neither will threaten the adjacent finished floors. Therefore, since Alternate No. III would cost about one third the cost of Alternate No. II, Alternate No. III is recommended.

DRAINAGE AREA MAPS



DRAINAGE AREA MAP
ELLSWORTH ROAD DITCH STUDY
SOUTHERN AVENUE TO APACHE TRAIL

RPA # 2005



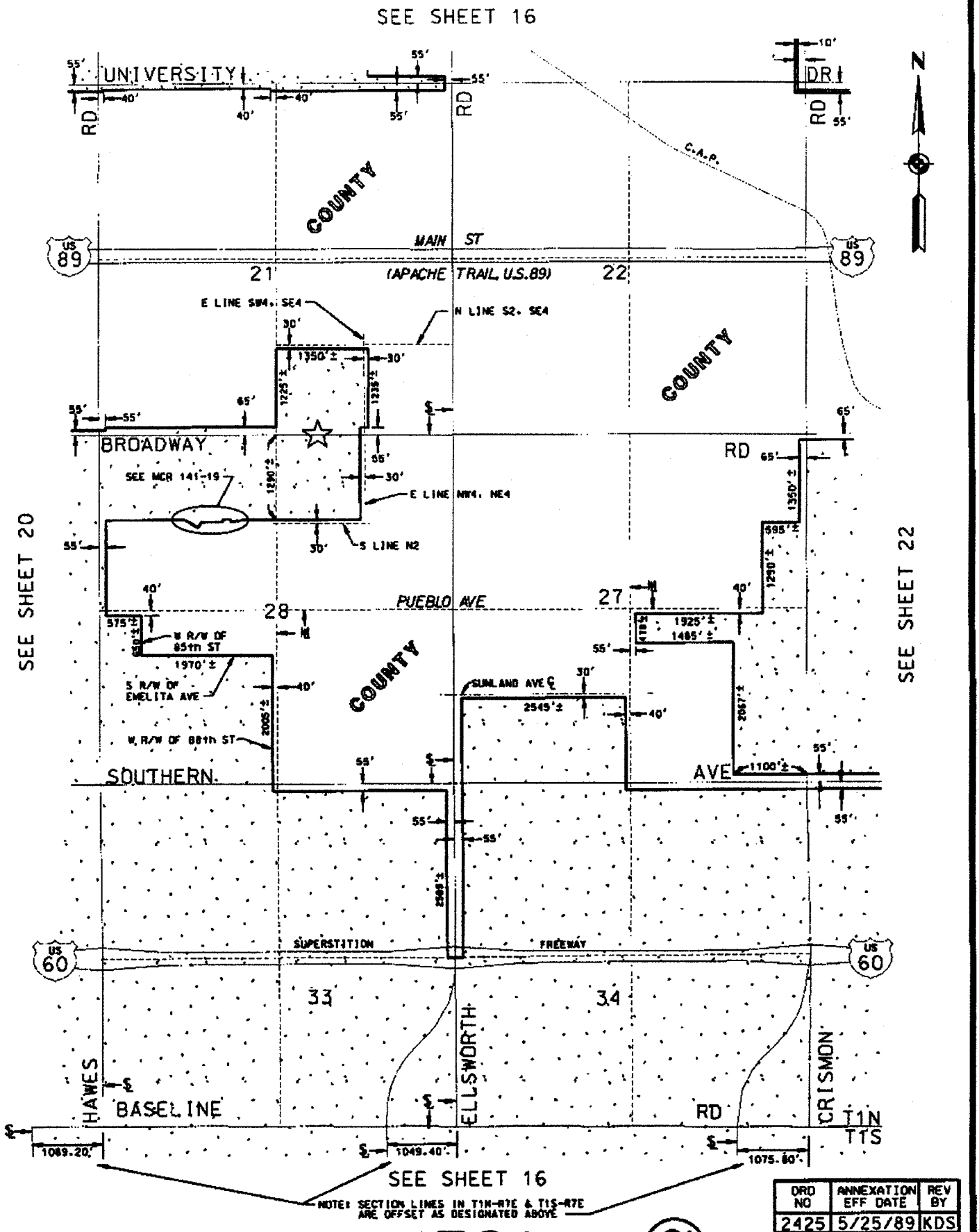
DRAINAGE AREA MAP

ELLSWORTH ROAD DITCH STUDY
SOUTHERN AVENUE TO APACHE TRAIL

RPA # 2005

APPENDIX

MARICOPA COUNTY BOUNDARY MAP



ORD NO	ANNEXATION EFF DATE	REV BY
2425	5/25/89	KDS
2679	5/6/92	JL
2855	1/20/94	JL
2996	3/24/95	AEL
3694	9/30/99	DKG

THIS CITY LIMIT SHEET IS TO BE USED AS A GUIDE ONLY! MARICOPA COUNTY WILL NOT BE RESPONSIBLE FOR ERRORS OR OMISSIONS THAT MIGHT OCCUR.

MESA

T1N-R7E

21

Topographic Subbasin Boundary Map
Northern Area
East Mesa Area Drainage Master Study

Northern Area
East Mesa Area Drainage Master Study
Topographic Subbasin Boundary Map

CALCULATIONS

Design Flow Calculations

RITOCH-POWELL
associates
consulting engineers, inc.
3120 N. 19th Ave-Suite 200-Phoenix, AZ-85015 (602) 263-1177

DATE 5-8-00	BY RLP	CHK.	PROJ. NO. 2005	PAGE 1 of

I. Design Flows:

A. Drainage Area #1

Use RATIONAL.EXE

1. Length = 500'
2. elev. at top = 1509.72 (from As-Builts)
3. elev. at bottom = 1507.86
4. Area = $75' \times 380' + 40' \times 150' = 34{,}500\ ft^2$
   $= 0.8\ Ac$
5. 10-year Runoff Coef. Table 3.2
   Paved Roadway. Table 3.2
   Use C = 0.80
6. k_b Table 3.1
   $k_b = m \log A + b$ Type A
   $m = .00625$ $b = .04$
   $k_b = -.00625 \log .8 + .04 = .041$
7. 10 yr. - 6hr. rainfall = 1.9 in (Fig 2.4)

Flood Control District of Maricopa County
Hydrologic Design Manual Rational Method

Computed by: Rick Powell Date: 05-08-2000

Candidate Assessment Report
Ellsworth Road Ditch Study
Southern Avenue to Apache Trail
RPA No. 2005

LOCATION DATA

Location: Ditch No. 1

Project Name: Ellsworth Road Subarea id: 1

Drainage Area Cover: Residential

DESIGN DATA

Drainage Area	0.80 acres
Watercourse Length	500.0 feet
Top Elevation	1509.7 feet
Bottom Elevation	1507.9 feet
Slope	.00372 feet/feet
Roughness Coefficient (Kb)	.04100
10-Year, 6-Hour Rainfall	1.90 inches

Hydrological Summary Table

Parameter	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
Q (cfs)	2	2	3	4	5	5
C	0.800	0.800	0.800	0.880	0.950	0.950
Tc (min)	11.1	9.8	9.3	8.3	7.9	7.5
i (in/hr)	2.6	3.6	4.1	5.4	6.2	7.2

RITOCH-POWELL
associates
consulting engineers, inc.
3120 N. 19th Ave-Suite 200-Phoenix, AZ-85015 (602) 263-1177

DATE 5-9-00	BY RLP	CHK.	PROJ. NO. 2005	PAGE of

I. Design Flows (cont.)

B. Drainage Area No 2

1. Length = 6,400 ft.
2. Top elev. = 1550 (Quad. Map)
3. Bottom elev. = 1503 (As-builts)
4. Drainage Area =

Area = 1300 ft. x 3850 = 115 Ac.
+ 1300 ft x 60 ft = 2 Ac
+ 270 ft. x 1130 ft = 7 Ac.
Total = 124 Ac.

5. 10 year runoff coef = 0.50 (Residential)
6. $K_b = -.00625 \log 124 + 0.04$
$= .027$
7. 10 yr - 6hr rainfall = 1.9 in

of

Flood Control District of Maricopa County
Hydrologic Design Manual Rational Method

Computed by: Rick Powell

Date: 05-09-2000

Candidate Assessment Report
Ellsworth Road Ditch Study
Southern Avenue to Apache Trail
RPA No. 2005

LOCATION DATA

Location: Ditch No. 2

Project Name: Ellsworth Road Subarea id: 2

Drainage Area Cover: Residential

DESIGN DATA

Drainage Area	124.00	acres = .19 Mi^2
Watercourse Length	6400.0	feet
Top Elevation	1550.0	feet
Bottom Elevation	1503.0	feet
Slope	.00734	feet/feet
Roughness Coefficient (Kb)	.02700	
10-Year, 6-Hour Rainfall	1.90	inches

Hydrological Summary Table

Parameter	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
Q (cfs)	84	124	162	231	295	354
C	0.500	0.500	0.500	0.550	0.600	0.625
Tc (min)	33.0	28.5	25.7	23.3	22.0	20.8
i (in/hr)	1.4	2.0	2.6	3.4	4.0	4.6

RITOCH-POWELL
associates
consulting engineers, inc.
3120 N. 19th Ave-Suite 200-Phoenix, AZ-85015 (602) 263-1177

DATE 5-8-00	BY RJP	CHK.	PROJ. NO. 2005	PAGE 6 of 7

I. Design Flows (cont.)

C. Drainage Area No. 3

1. Length = 3,900 ft.
2. elev. at Top = 1514 (Quad. Map)
3. elev. at bottom = 1,488 (As-builts)
4. Area: 1330' x 2380' = 73 Ac.
   + 260' x 1480' = 9 Ac
   Total = 82 Ac.
5. 10 year runoff coef = 0.50 (Residential)
6. k_b = -0.00625 log 82 + 0.04
   = .028
7. 10 yr. - 6hr rainfall = 1.9 in

Flood Control District of Maricopa County
Hydrologic Design Manual Rational Method

Computed by: Rick Powell Date: 05-09-2000

Candidate Assessment Report
Ellsworth Road Ditch Study
Southern Avenue to Apache Trail
RPA No. 2005

LOCATION DATA

Location: Ditch No. 3

Project Name: Ellsworth Road Subarea id: 3

Drainage Area Cover: Residential

DESIGN DATA

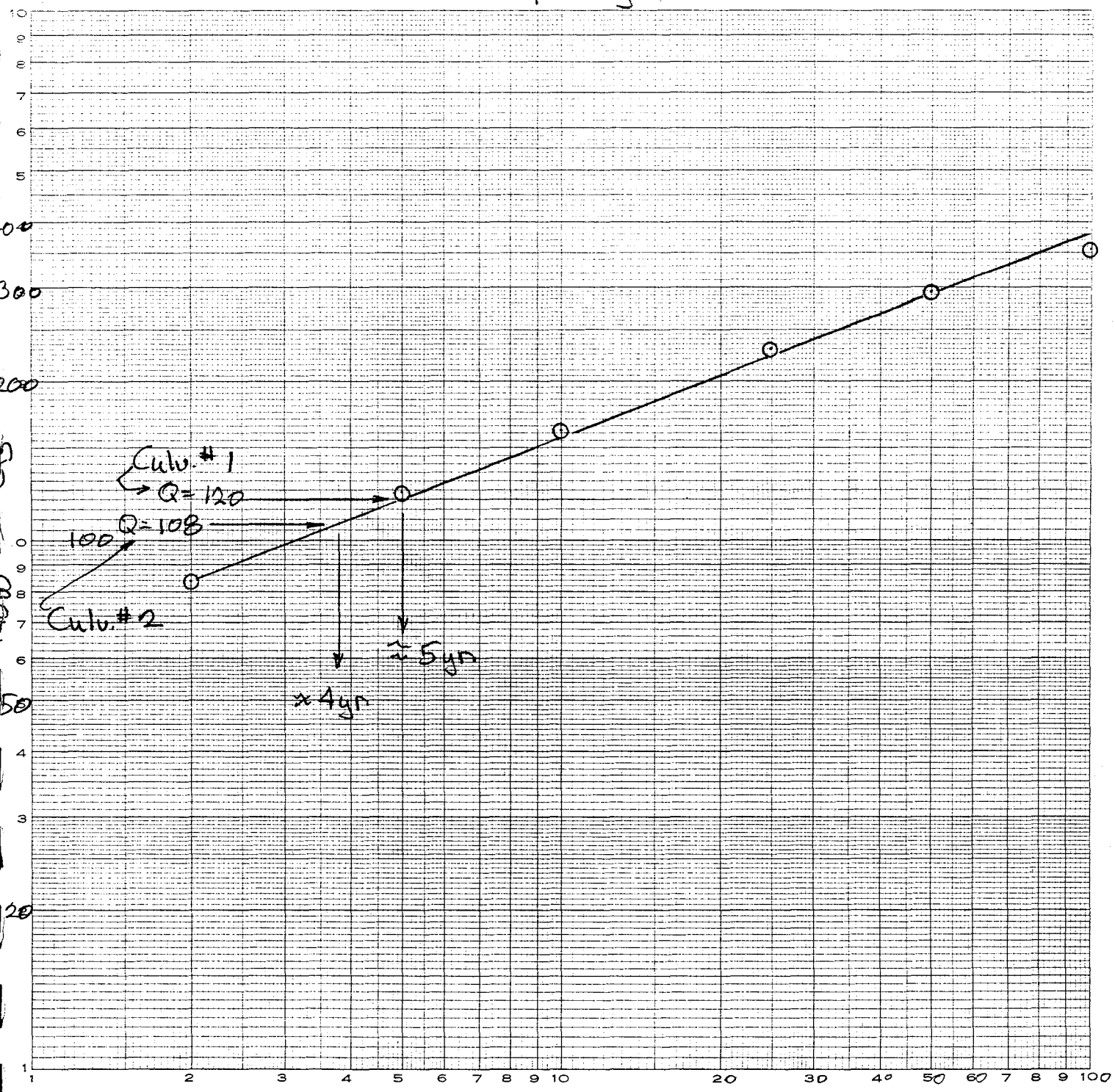
Drainage Area	82.00	acres
Watercourse Length	3900.0	feet
Top Elevation	1514.0	feet
Bottom Elevation	1488.0	feet
Slope	.00667	feet/feet
Roughness Coefficient (Kb)	.02800	
10-Year, 6-Hour Rainfall	1.90	inches

Hydrological Summary Table

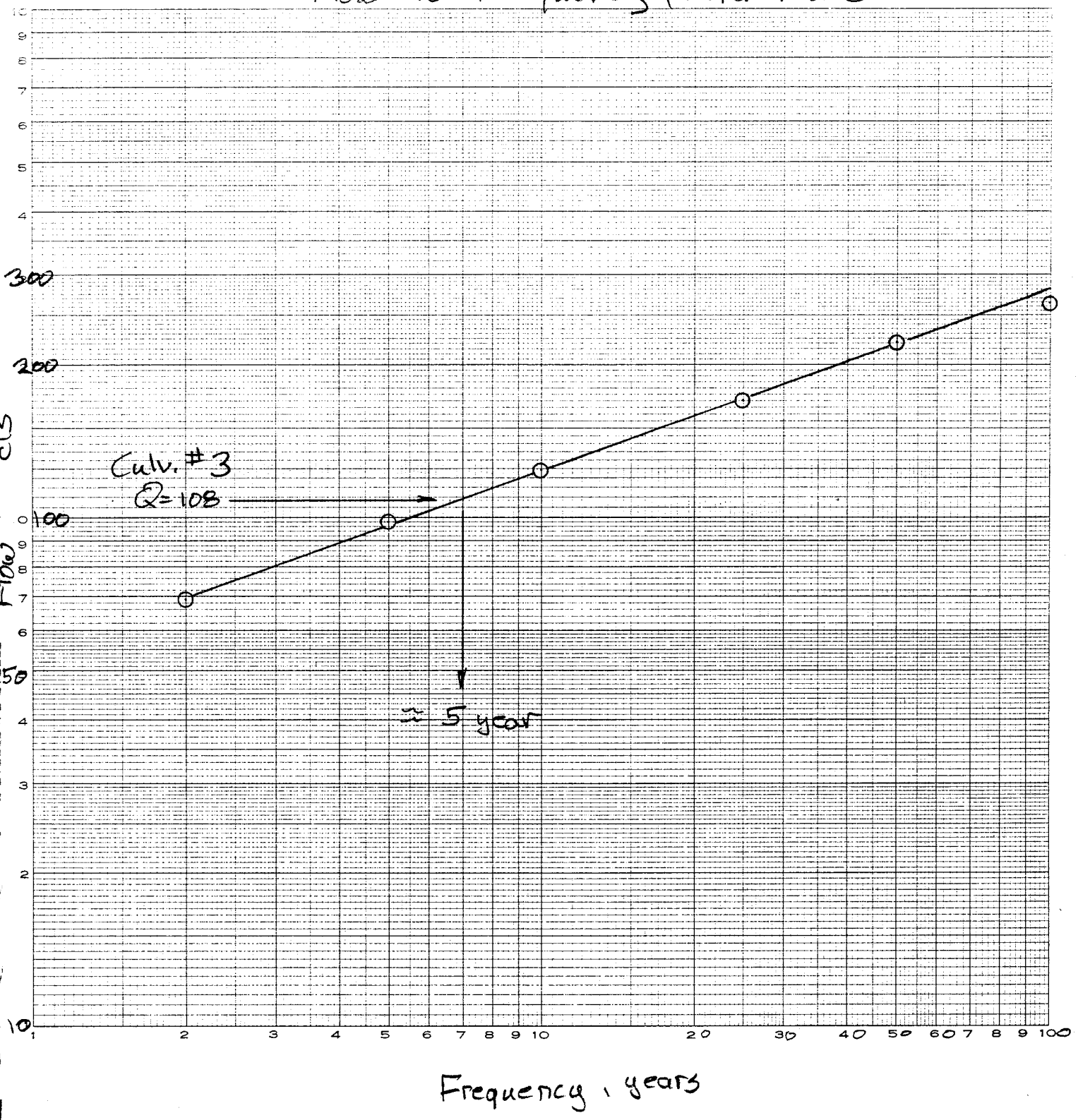
Parameter	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
Q (cfs)	69	98	124	171	220	266
C	0.500	0.500	0.500	0.550	0.600	0.625
Tc (min)	24.9	21.8	20.0	18.3	17.2	16.2
i (in/hr)	1.7	2.4	3.0	3.8	4.5	5.2

of

Flow vs. Frequency, Ditch No. 2



Candidate Assessment Report
Ellsworth Road Ditch Study
Southern Avenue to Apache Trail
RPA No. 2005



Ditch 2 Calculations

Existing Conditions – Ditch 2

Culvert No. 1 - Ditch 2

RITOCH-POWELL
associates
consulting engineers, inc.
3120 N. 19th Ave-Suite 200-Phoenix, AZ-85015 (602) 263-1177

DATE 5-9-00	BY RLP	CHK.	PROJ. NO. 2005	PAGE of

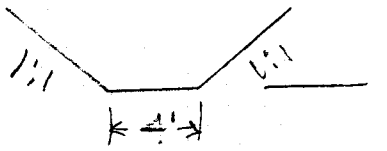
II. Calculate Capacity of Box Culvert @ Coralbell Ave

Ditch No. 2. Culvert No. 1

Exist. 6'×3'×108' CBC

Tail water is a trap. ditch one foot above the box culvert. Concrete lined $n = .014$

$S = .0063'/'$



Inv. elev. = 1499.5

From print-out, the following can be seen:

1. Capacity of the exist. CBC with HW at the top of curb ≅ 120 cfs, HW= 4.27'
   This is somewhat less than the 5 year flow.
2. A 2 year flow causes a HW= 3.12', elev. 1502.05,
   Q= 84 cfs
3. The outlet ditch flow ≈ 2' Deep at Q= 120 cfs

Figure 4.42
Culvert Design Form

Candidate Assessment Report
Ellsworth Road Ditch Study
Southern Avenue to Apache Trail
RPA No. 2005

Ditch 2, Culvert #1, Existing

Project: Ellsworth Rd. CAR Southern Ave to Apache Trail	**Station:** Corabell Ave. **Sheet** _____ **of** _____	**CULVERT DESIGN FORM** **Designer/Date:** RLP / 5-9-00 **Reviewer/Date:** _____ / _____

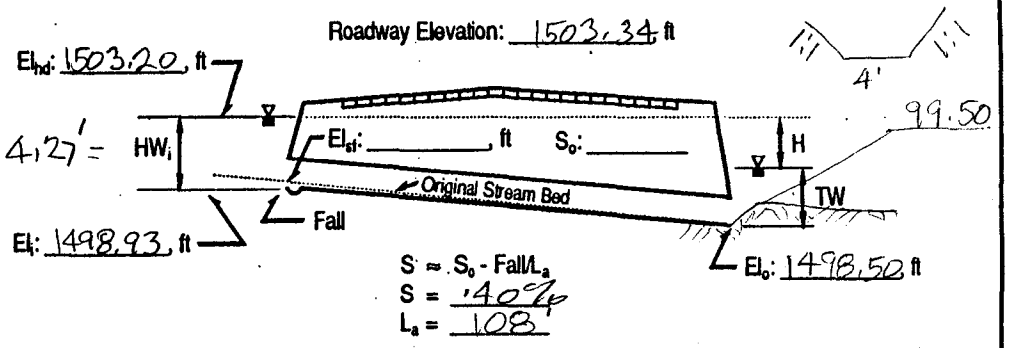
Hydrological Data

See Add'l shts

- ☐ **Method:** _____
- ☐ **Drainage Area:** _____ ☐ **Stream Slope:** _____
- ☐ **Channel Shape:** _____
- ☐ **Routing:** _____ ☐ **Other:** _____

Design Flows/Tailwater

R.I., years	Flow, cfs	TW, ft



Culvert Description: Material - Shape - Size - Entrance	Total Flow Q, cfs	Flow Per Barrel Q/N (1)	Headwater Calculations: Inlet Control HW_i/D (2)	HW_i	Fall (3)	EL_hi (4)	Outlet Control TW (5)	d_c	(d_c + D)/2	h_o (6)	k_e	H (7)	EL_ho (8)	Control Headwater Elevation	Outlet Velocity	Comments
6'x3'x108' CBC, HW	120	120												1503.2		

Technical Footnotes:

(1) Use Q/NB for box culverts.
(2) HW_i/D = HW /D or HW_i/D from design charts
(3) FALL = $HW_i - (EL_{hd} - EL_{sf})$; Fall is zero for culverts on grade.
(4) $EL_{hi} = HW_i + EL_i$ (invert of inlet control section)
(5) TW based on downstream control or flow depth in channel.
(6) h_o = TW or $(d_c + D)/2$ (whichever is greater).
(7) $H = \left[1 + k_e + (29n^2L)/R^{1.33}\right] V^2/2g$
(8) $EL_{ho} = EL_o + H + h_o$

Subscript Definitions:

a. approximate
f. culvert fact
hd. Design Headwater
hj. Headwater in inlet control
he. Headwater in outlet control
i. inlet control section
o. Outlet
sf. Streambed at culvert face
TW. Tailwater

Comments / Discussion:

Culvert Barrel Selected:

Size: _____
Shape: _____
Material: _____ **n:** _____
Entrance: _____

of

CURRENT DATE: 06-15-2000 FILE DATE: 06-15-2000
CURRENT TIME: 09:36:41 FILE NAME: 2005CL-1

Culvert #1 Existing

FHWA CULVERT ANALYSIS
HY-8, VERSION 6.1

SITE DATA

INLET ELEV. (ft)	OUTLET ELEV. (ft)	CULVERT LENGTH (ft)
1498.93	1498.50	108.00

CULVERT SHAPE, MATERIAL, INLET

BARRELS	SHAPE	SPAN (ft)	RISE (ft)	MANNING n	INLET TYPE
1 RCB	MATERIAL	6.00	3.00	.012	CONVENTIONAL

SUMMARY OF CULVERT FLOWS (cfs) FILE: 2005CL-1 DATE: 06-15-2000

ELEV (ft)	TOTAL	1	2	3	4	5	6	ROADWAY	ITR
1499.50	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	1
1500.65	35.4	35.4	0.0	0.0	0.0	0.0	0.0	0.00	1
1501.67	70.8	70.8	0.0	0.0	0.0	0.0	0.0	0.00	1
1502.05	84.0	84.0	0.0	0.0	0.0	0.0	0.0	0.00	1
1503.41	141.6	125.7	0.0	0.0	0.0	0.0	0.0	14.65	8
1503.64	177.0	124.9	0.0	0.0	0.0	0.0	0.0	50.86	6
1503.79	212.4	121.1	0.0	0.0	0.0	0.0	0.0	89.25	5
1503.92	247.8	116.9	0.0	0.0	0.0	0.0	0.0	129.46	5
1504.03	283.2	112.3	0.0	0.0	0.0	0.0	0.0	167.85	7
1504.06	318.6	141.6	0.0	0.0	0.0	0.0	0.0	179.60	5
1504.13	354.0	141.6	0.0	0.0	0.0	0.0	0.0	210.90	4
1503.20	119.8	119.8	0.0	0.0	0.0	0.0	0.0	OVERTOPPING	

SUMMARY OF ITERATIVE SOLUTION ERRORS FILE: 2005CL-1 DATE: 06-15-2000

HEAD ELEV (ft)	HEAD ERROR (ft)	TOTAL FLOW (cfs)	FLOW ERROR (cfs)	% FLOW ERROR
1499.50	0.000	0.00	0.00	0.00
1500.65	0.000	35.40	0.00	0.00
1501.67	0.000	70.80	0.00	0.00
1502.05	0.000	84.00	0.00	0.00
1503.41	-0.009	141.60	1.23	0.87
1503.64	-0.007	177.00	1.21	0.68
1503.79	-0.009	212.40	2.04	0.96
1503.92	-0.006	247.80	1.45	0.59
1504.03	0.000	283.20	3.05	1.08
1504.06	0.002	318.60	-2.60	-0.82
1504.13	-0.006	354.00	1.50	0.42

<1> TOLERANCE (ft) = 0.010 <2> TOLERANCE (%) = 1.000

CURRENT DATE: 06-15-2000 FILE DATE: 06-15-2000
CURRENT TIME: 09:36:41 FILE NAME: 2005CL-1

PERFORMANCE CURVE FOR CULVERT 1 - 1(6.00 (ft) BY 3.00 (ft)) RCB

DISCHARGE FLOW (cfs)	HEADWATER ELEV. (ft)	INLET CONTROL DEPTH (ft)	OUTLET CONTROL DEPTH (ft)	FLOW TYPE <F4>	NORMAL DEPTH (ft)	CRIT. DEPTH (ft)	OUTLET DEPTH (ft)	TW DEPTH (ft)	OUTLET VEL. (fps)	TW VEL. (fps)
0.00	1499.50	0.00	0.57	0-NF	0.00	0.00	0.00	1.00	0.00	0.00
35.40	1500.65	1.72	1.72	1-S2n	0.94	1.03	0.83	2.03	7.12	6.80
70.80	1501.67	2.74	2.74	1-S2n	1.50	1.63	1.43	2.54	8.24	8.32
84.00	1502.05	3.12	3.12	5-S2n	1.69	1.83	1.63	2.69	8.59	8.74
125.72	1503.41	4.48	4.45	4-FFt	2.25	2.39	2.25	3.25	9.29	10.08
124.93	1503.64	4.45	4.71	4-FFt	2.24	2.38	3.00	3.53	6.94	10.69
121.11	1503.80	4.31	4.87	4-FFt	2.19	2.34	3.00	3.79	6.73	11.22
116.89	1503.93	4.16	5.00	4-FFt	2.14	2.28	3.00	4.02	6.49	11.67
112.30	1504.04	4.01	5.11	4-FFt	2.08	2.22	3.00	4.24	6.24	12.08
141.60	1505.00	5.10	6.07	4-FFt	2.46	2.59	3.00	4.44	7.87	12.45
141.60	1505.19	5.10	6.26	4-FFt	2.46	2.59	3.00	4.63	7.87	12.79

El. inlet face invert 1498.93 ft El. outlet invert 1498.50 ft
El. inlet throat invert 0.00 ft El. inlet crest 0.00 ft

***** SITE DATA ***** CULVERT INVERT **********

INLET STATION	0.00 ft
INLET ELEVATION	1498.93 ft
OUTLET STATION	108.00 ft
OUTLET ELEVATION	1498.50 ft
NUMBER OF BARRELS	1
SLOPE (V/H)	0.0040
CULVERT LENGTH ALONG SLOPE	108.00 ft

***** CULVERT DATA SUMMARY **********

BARREL SHAPE	BOX
BARREL SPAN	6.00 ft
BARREL RISE	3.00 ft
BARREL MATERIAL	CONCRETE
BARREL MANNING'S n	0.012
INLET TYPE	CONVENTIONAL
INLET EDGE AND WALL	SQUARE EDGE (0 DEG. FLARE)
INLET DEPRESSION	NONE

RRENT DATE: 06-15-2000 FILE DATE: 06-15-2000
RRENT TIME: 09:36:41 FILE NAME: 2005CL-1

DDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDD
DDDDDDDDDDDDDDDDDDDDDDDDDD TAILWATER DDDDDDDDDDDDDDDDDDDDDDDDDD
DDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDD

****** REGULAR CHANNEL CROSS SECTION ****************

BOTTOM WIDTH	4.00 ft
SIDE SLOPE H/V (X:1)	1.0
CHANNEL SLOPE V/H (ft/ft)	0.006
MANNING'S n (.01-0.1)	0.014
CHANNEL INVERT ELEVATION	1499.50 ft
CULVERT NO.1 OUTLET INVERT ELEVATION	1498.50 ft

****** UNIFORM FLOW RATING CURVE FOR DOWNSTREAM CHANNEL

FLOW (cfs)	W.S.E. (ft)	FROUDE NUMBER	DEPTH (ft)	VEL. (f/s)	SHEAR (psf)
0.00	1499.50	0.000	0.00	0.00	0.00
35.40	1500.53	1.178	1.03	6.80	0.39
70.80	1501.04	1.183	1.54	8.32	0.57
84.00	1501.19	1.184	1.69	8.74	0.63
141.60	1501.75	1.184	2.25	10.08	0.84
177.00	1502.03	1.184	2.53	10.69	0.95
212.40	1502.29	1.183	2.79	11.22	1.04
247.80	1502.52	1.183	3.02	11.67	1.13
283.20	1502.74	1.183	3.24	12.08	1.21
318.60	1502.94	1.183	3.44	12.45	1.29
354.00	1503.13	1.184	3.63	12.79	1.36

DDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDD
DDDDDDDDDDDDDDDDDDDDDDDDDD ROADWAY OVERTOPPING DATA DDDDDDDDDDDDDDDDDDDDDDDDDD
DDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDD

ROADWAY SURFACE	PAVED
EMBANKMENT TOP WIDTH	50.00 ft

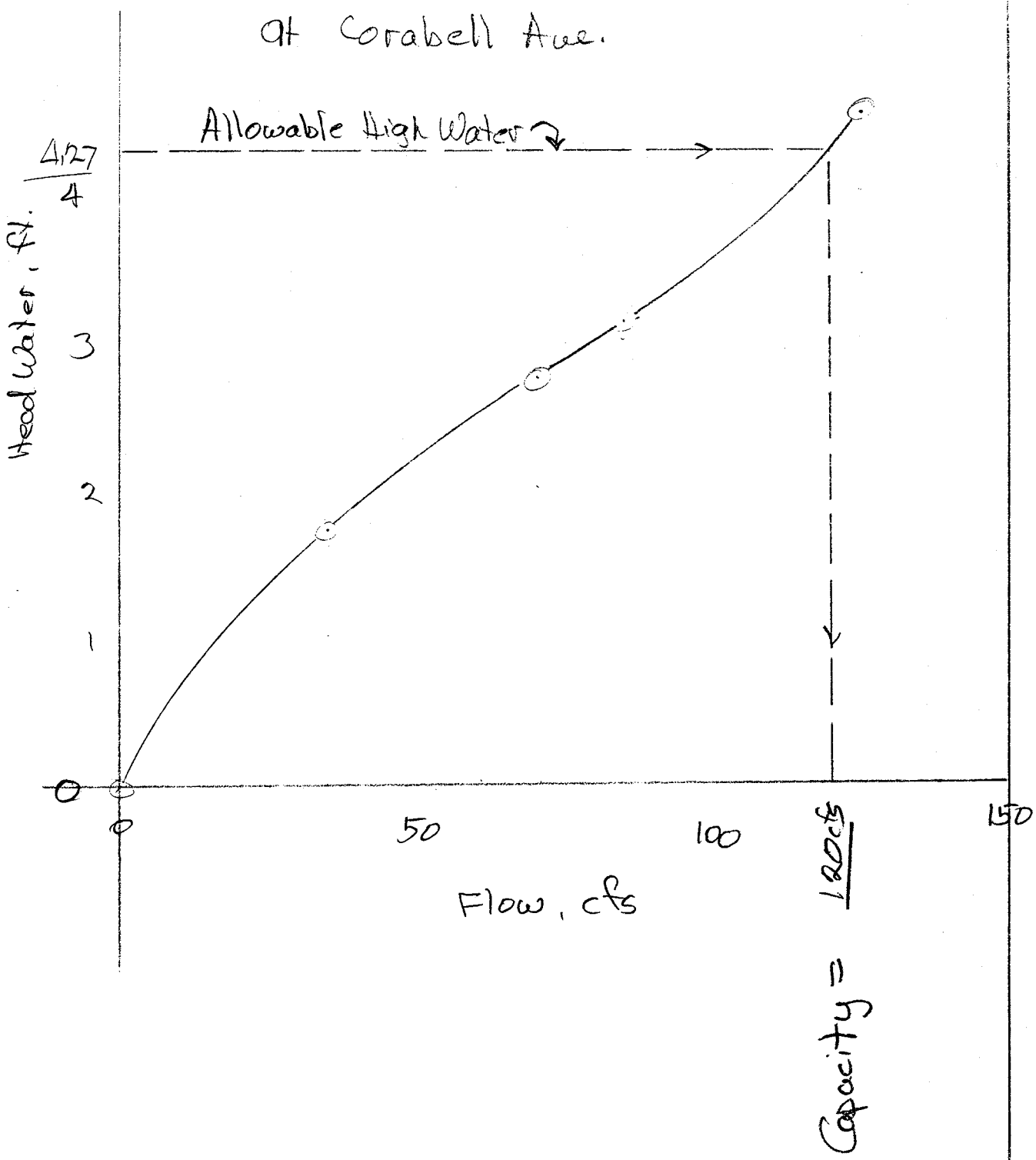
**** USER DEFINED ROADWAY PROFILE

CROSS-SECTION COORD. NO.	X ft	Y ft
1	0.00	1508.00
2	0.00	1504.20
3	66.00	1503.20
4	108.00	1503.20
5	180.00	1504.90
6	180.00	1508.00

DDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDD

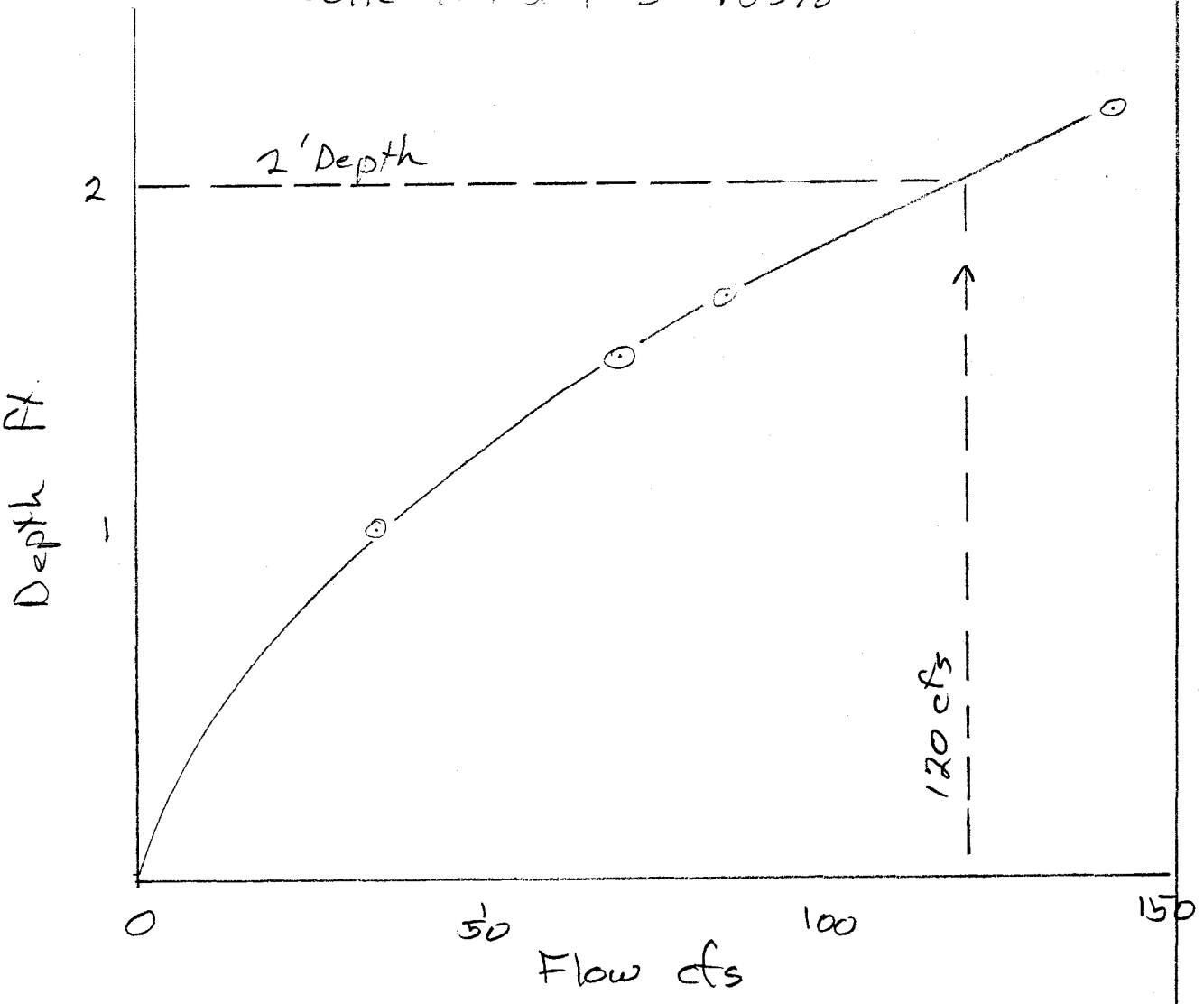
Candidate Assessment Report
Ellsworth Road Ditch Study
Southern Avenue to Apache Trail
RPA No. 2005

Culvert #1 6'x3'x108' CIBC.
at Corabell Ave.



Outlet Ditch south of Corabell

Conc. lined, S = .63%



Culvert No. 2 – Ditch 2

RITOCH-POWELL
associates
consulting engineers, inc.
3120 N. 19th Ave-Suite 200-Phoenix, AZ-85015 (602) 263-1177

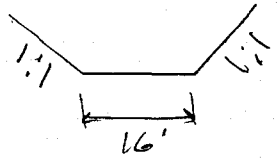
DATE 5-10-00	BY RLP	CHK.	PROJ. NO. 2005	PAGE of

III. Calculate capacity of pipe crossing south of Corobell

Ditch No-2 Culvert #2

Exist. 4 - 35"x24"x 111' CSP Arch.

Outlet chan.:



S = .28%

n = .014 (conc)

From the printout, the following can be seen.

1. Capacity of exist. culverts with the headwater at the top of curb ≅ 108 cfs HW = 3.57'

2. a 2 year flow causes a HW = 2.54' Elev. 1497.47

Q = 84 cfs

Figure 4.42
Culvert Design Form

Candidate Assessment Report
Ellsworth Road Ditch Study
Southern Avenue to Apache Trail
RPA No. 2005

Project: Ellsworth Rd. CAR
Southern Ave. to Apache Trail

Station: South of Corabell
Sheet _____ **of** _____

CULVERT DESIGN FORM
Designer/Date: RLP / 5-10-00
Reviewer/Date: _____ / _____

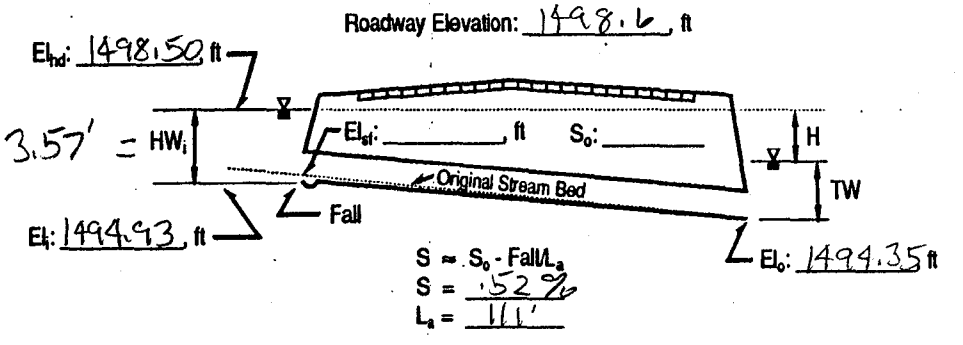
Hydrological Data

See Add'l shts

- ☐ **Method:** _____
- ☐ **Drainage Area:** _____ ☐ **Stream Slope:** _____
- ☐ **Channel Shape:** _____
- ☐ **Routing:** _____ ☐ **Other:** _____

Design Flows/Tailwater

R.I., years	Flow, cfs	TW, ft



Culvert Description: Material - Shape - Size - Entrance	Total Flow Q, cfs	Flow Per Barrel Q/N (1)	Headwater Calculations: Inlet Control HW_i/D (2)	HW_i	Fall (3)	EL_hi (4)	Outlet Control TW (5)	d_c	(d_c + D)/2	h_o (6)	k_e	H (7)	EL_ho (8)	Control Headwater Elevation	Outlet Velocity	Comments
4-35"x24"x111' CSP	108	27												1498.5		

Technical Footnotes:

(1) Use Q/NB for box culverts.
(2) HW_i/D = HW /D or HW_i/D from design charts
(3) FALL = $HW_i - (EL_{hd} - EL_{sf})$; Fall is zero for culverts on grade.
(4) $EL_{hi} = HW_i + EL_i$ (invert of inlet control section)
(5) TW based on downstream control or flow depth in channel.
(6) h_o = TW or $(d_c + D)/2$ (whichever is greater).
(7) $H = \left[1 + k_e + (29n^2L)/R^{1.33}\right] V^2/2g$
(8) $EL_{ho} = EL_o + H + h_o$

Subscript Definitions:

a. approximate
f. culvert fact
hd. Design Headwater
hj. Headwater in inlet control
he. Headwater in outlet control
i. inlet control section
o. Outlet
sf. Streambed at culvert face
TW. Tailwater

Comments / Discussion:

Culvert Barrel Selected:
Size: _____
Shape: _____
Material: _____ **n:** _____
Entrance: _____

Ditch #2, Culvert #2, Existing

9

CURRENT DATE: 06-13-2000
CURRENT TIME: 09:39:34

Culvert #2, Existing

FILE DATE: 06-13-2000
FILE NAME: 2005CL-2

FHWA CULVERT ANALYSIS
HY-8, VERSION 6.1

SITE DATA

INLET ELEV. (ft)	OUTLET ELEV. (ft)	CULVERT LENGTH (ft)
1494.93	1494.35	111.00

CULVERT SHAPE, MATERIAL, INLET

BARRELS	SHAPE	SPAN	RISE	MANNING	INLET
	MATERIAL	(ft)	(ft)	n	TYPE
4	CMPA	2.92	2.00	.025	CONVENTIONAL

SUMMARY OF CULVERT FLOWS (cfs) FILE: 2005CL-2 DATE: 06-13-2000

ELEV (ft)	TOTAL	1	2	3	4	5	6	ROADWAY	ITR
1494.93	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	1
1496.23	35.4	35.4	0.0	0.0	0.0	0.0	0.0	0.00	1
1497.09	70.8	70.8	0.0	0.0	0.0	0.0	0.0	0.00	1
1497.47	84.0	84.0	0.0	0.0	0.0	0.0	0.0	0.00	1
1498.85	141.6	103.7	0.0	0.0	0.0	0.0	0.0	36.80	18
1498.93	177.0	105.7	0.0	0.0	0.0	0.0	0.0	69.56	9
1498.98	212.4	105.4	0.0	0.0	0.0	0.0	0.0	105.64	8
1499.03	247.8	102.7	0.0	0.0	0.0	0.0	0.0	143.46	7
1499.07	283.2	100.9	0.0	0.0	0.0	0.0	0.0	180.46	6
1499.07	318.6	141.5	0.0	0.0	0.0	0.0	0.0	180.93	21
1499.10	354.0	141.5	0.0	0.0	0.0	0.0	0.0	210.60	5
1498.62	101.7	101.7	0.0	0.0	0.0	0.0	0.0	OVERTOPPING	

SUMMARY OF ITERATIVE SOLUTION ERRORS FILE: 2005CL-2 DATE: 06-13-2000

HEAD ELEV (ft)	HEAD ERROR (ft)	TOTAL FLOW (cfs)	FLOW ERROR (cfs)	% FLOW ERROR
1494.93	0.000	0.00	0.00	0.00
1496.23	0.000	35.40	0.00	0.00
1497.09	0.000	70.80	0.00	0.00
1497.47	0.000	84.00	0.00	0.00
1498.85	-0.001	141.60	1.14	0.81
1498.93	-0.002	177.00	1.73	0.98
1498.98	-0.001	212.40	1.40	0.66
1499.03	-0.001	247.80	1.67	0.67
1499.07	-0.002	283.20	1.81	0.64
1499.07	0.000	318.60	-3.85	-1.21
1499.10	-0.002	354.00	1.88	0.53

<1> TOLERANCE (ft) = 0.010 <2> TOLERANCE (%) = 1.000

CURRENT DATE: 06-13-2000 FILE DATE: 06-13-2000
CURRENT TIME: 09:39:34 FILE NAME: 2005CL-2

PERFORMANCE CURVE FOR CULVERT 1 - 4(2.92 (ft) BY 2.00 (ft)) CMPA

DISCHARGE FLOW (cfs)	HEADWATER ELEV. (ft)	INLET CONTROL DEPTH (ft)	OUTLET CONTROL DEPTH (ft)	FLOW TYPE <F4>	NORMAL DEPTH (ft)	CRIT. DEPTH (ft)	OUTLET DEPTH (ft)	TW DEPTH (ft)	OUTLET VEL. (fps)	TW VEL. (fps)
0.00	1494.93	0.00	0.00	0-NF	0.00	0.00	0.00	0.00	0.00	0.00
35.40	1496.23	1.19	1.30	2-M2c	1.07	0.76	0.76	0.56	4.62	3.80
70.80	1497.09	1.87	2.16	2-M2c	2.00	1.13	1.13	0.85	5.98	4.93
84.00	1497.47	2.12	2.54	2-M2c	2.00	1.25	1.25	0.95	6.42	5.25
103.66	1498.85	2.55	3.92	2-M2c	2.00	1.41	1.41	1.29	7.06	6.33
105.71	1498.92	2.60	3.99	3-M2t	2.00	1.42	1.48	1.48	6.92	6.85
105.36	1498.98	2.59	4.05	3-M2t	2.00	1.42	1.65	1.65	6.27	7.30
102.68	1499.03	2.53	4.10	3-M2t	2.00	1.40	1.81	1.81	5.75	7.70
100.93	1499.08	2.49	4.15	3-M2t	2.00	1.39	1.96	1.96	5.48	8.06
141.52	1498.54	3.61	3.35	3-M1f	2.00	1.65	2.00	2.10	7.61	8.39
141.52	1498.54	3.61	3.35	3-M1f	2.00	1.65	2.00	2.23	7.61	8.69

El. inlet face invert 1494.93 ft El. outlet invert 1494.35 ft
El. inlet throat invert 0.00 ft El. inlet crest 0.00 ft

***** SITE DATA ***** CULVERT INVERT **********

INLET STATION	0.00 ft
INLET ELEVATION	1494.93 ft
OUTLET STATION	111.00 ft
OUTLET ELEVATION	1494.35 ft
NUMBER OF BARRELS	4
SLOPE (V/H)	0.0052
CULVERT LENGTH ALONG SLOPE	111.00 ft

***** CULVERT DATA SUMMARY **********

BARREL SHAPE	PIPE ARCH
BARREL SPAN	2.92 ft
BARREL RISE	2.00 ft
BARREL MATERIAL	STEEL OR ALUMINUM
BARREL MANNING'S n	0.025
INLET TYPE	CONVENTIONAL
INLET EDGE AND WALL	HEADWALL
INLET DEPRESSION	NONE

CURRENT DATE: 06-13-2000 FILE DATE: 06-13-2000
CURRENT TIME: 09:39:34 FILE NAME: 2005CL-2

DDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDD
DDDDDDDDDDDDDDDDDDDDDDDDDD TAILWATER DDDDDDDDDDDDDDDDDDDDDDDDDDD
DDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDD

******* REGULAR CHANNEL CROSS SECTION ****************

BOTTOM WIDTH	16.00 ft
SIDE SLOPE H/V (X:1)	1.0
CHANNEL SLOPE V/H (ft/ft)	0.003
MANNING'S n (.01-0.1)	0.014
CHANNEL INVERT ELEVATION	1494.35 ft
CULVERT NO.1 OUTLET INVERT ELEVATION	1494.35 ft

******* UNIFORM FLOW RATING CURVE FOR DOWNSTREAM CHANNEL

FLOW (cfs)	W.S.E. (ft)	FROUDE NUMBER	DEPTH (ft)	VEL. (f/s)	SHEAR (psf)
0.00	1494.35	0.000	0.00	0.00	0.00
35.40	1494.91	0.894	0.56	3.80	0.10
70.80	1495.20	0.940	0.85	4.93	0.16
84.00	1495.30	0.951	0.95	5.25	0.18
141.60	1495.64	0.982	1.29	6.33	0.24
177.00	1495.83	0.994	1.48	6.85	0.28
212.40	1496.00	1.002	1.65	7.30	0.31
247.80	1496.16	1.010	1.81	7.70	0.34
283.20	1496.31	1.015	1.96	8.06	0.37
318.60	1496.45	1.020	2.10	8.39	0.39
354.00	1496.58	1.024	2.23	8.69	0.42

DDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDD
DDDDDDDDDDDDDDDDDDDDDDDDDD ROADWAY OVERTOPPING DATA DDDDDDDDDDDDDDDDDDDDDDDDDD
DDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDD

ROADWAY SURFACE	PAVED
EMBANKMENT TOP WIDTH	68.00 ft

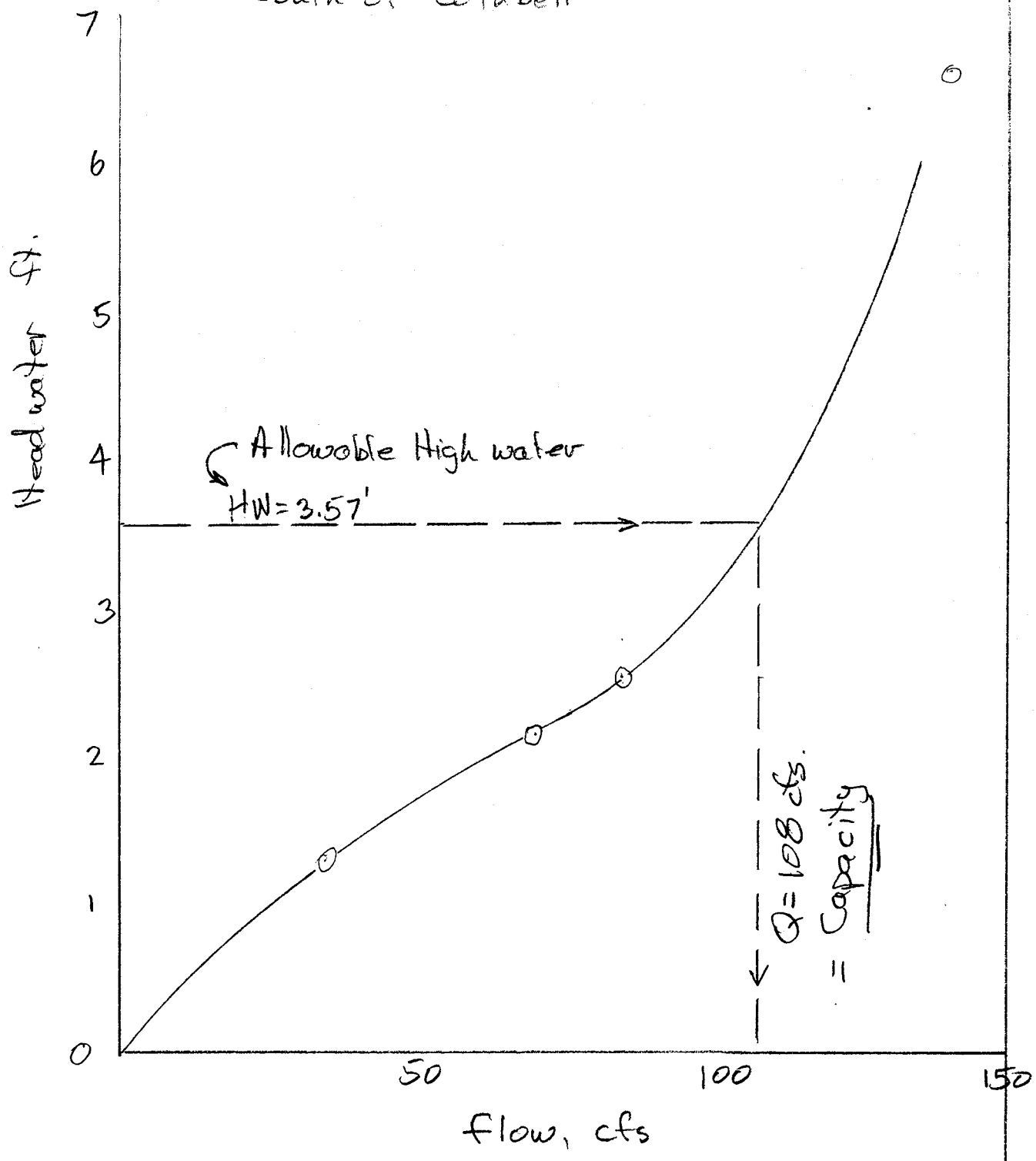
***** USER DEFINED ROADWAY PROFILE

CROSS-SECTION COORD. NO.	X ft	Y ft
1	9300.00	1499.20
2	9400.00	1499.04
3	9500.00	1498.88
4	9600.00	1498.72
5	9700.00	1498.62
6	9800.00	1498.92
7	9900.00	1499.70

DDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDD

Calvert #2 4-35"×24"×111' CMPA

South of Corabell



Ditch 2 – Alternate No. II

Figure 4.42
Culvert Design Form

Ditch No. 2 — Alternate II

Project: Ellsworth Road CAR
Southern Ave to Apache Trail

Station: Ditch No. 2
Sheet _____ of _____

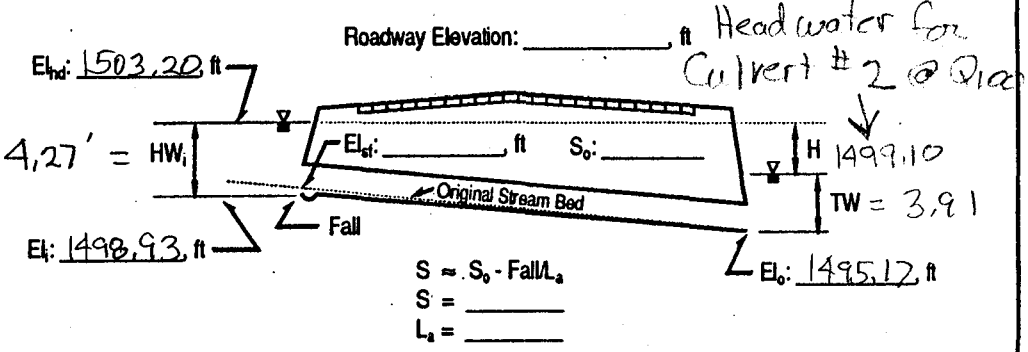
CULVERT DESIGN FORM
Designer/Date: R. Powell II 6-15-00
Reviewer/Date: _____ / _____

Hydrological Data

See Add'l shts
- ☐ Method: _____
- ☐ Drainage Area: _____ ☐ Stream Slope: _____
- ☐ Channel Shape: _____
- ☐ Routing: _____ ☐ Other: _____

Design Flows/Tailwater

R.I., years	Flow, cfs	TW, ft



Culvert Description: Material - Shape - Size - Entrance	Total Flow Q, cfs	Flow Per Barrel Q/N (1)	Headwater Calculations: Inlet Control HW_i/D (2)	HW_i	Fall (3)	EL_hi (4)	Outlet Control TW (5)	d_c	(d_c + D)/2	h_o (6)	k_e	H (7)	EL_ho (8)	Control Headwater Elevation	Outlet Velocity	Comments
6'x3' CBC	120													03.20		

Technical Footnotes:

(1) Use Q/NB for box culverts.
(2) HW_i/D = HW /D or HW_i/D from design charts
(3) FALL = $HW_i - (EL_{hd} - EL_{sf})$; Fall is zero for culverts on grade.
(4) $EL_{hi} = HW_i + EL_i$ (invert of inlet control section)
(5) TW based on downstream control or flow depth in channel.
(6) h_o = TW or $(d_c + D)/2$ (whichever is greater).

(7) $H = \left[1 + k_e + (29n^2L)/R^{1.33}\right] V^2/2g$

(8) $EL_{ho} = EL_o + H + h_o$

Subscript Definitions:

a.	approximate	i.	inlet control section
f.	culvert fact	o.	Outlet
hd.	Design Headwater	sf.	Streambed at culvert face
hj.	Headwater in inlet control	TW.	Tailwater
he.	Headwater in outlet control		

Comments / Discussion:

Culvert Barrel Selected:
Size: _____
Shape: _____
Material: _____ n: _____
Entrance: _____

CURRENT DATE: 06-15-2000
CURRENT TIME: 10:14:14

Ditch #2, Alternate II

FILE DATE: 06-15-2000
FILE NAME: 2005ALT2

FHWA CULVERT ANALYSIS
HY-8, VERSION 6.1

SITE DATA

CULVERT SHAPE, MATERIAL, INLET

	INLET ELEV. (ft)	OUTLET ELEV. (ft)	CULVERT LENGTH (ft)	BARRELS SHAPE MATERIAL	SPAN (ft)	RISE (ft)	MANNING n	INLET TYPE
1	1498.93	1495.17	800.01	1 RCB	6.00	3.00	.012	CONVENTIONAL
2								
3								
4								
5								
6								

SUMMARY OF CULVERT FLOWS (cfs) FILE: 2005ALT2 DATE: 06-15-2000

ELEV (ft)	TOTAL	1	2	3	4	5	6	ROADWAY	ITR
1499.10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	1
1500.65	35.4	35.4	0.0	0.0	0.0	0.0	0.0	0.00	1
1501.67	70.8	70.8	0.0	0.0	0.0	0.0	0.0	0.00	1
1502.05	84.0	84.0	0.0	0.0	0.0	0.0	0.0	0.00	1
1503.41	141.6	125.7	0.0	0.0	0.0	0.0	0.0	14.50	8
1503.61	177.0	131.0	0.0	0.0	0.0	0.0	0.0	44.91	6
1503.74	212.4	134.6	0.0	0.0	0.0	0.0	0.0	76.22	5
1503.86	247.8	137.5	0.0	0.0	0.0	0.0	0.0	109.11	5
1503.96	283.2	139.9	0.0	0.0	0.0	0.0	0.0	141.00	4
1504.05	318.6	141.8	0.0	0.0	0.0	0.0	0.0	174.55	4
1504.13	354.0	143.8	0.0	0.0	0.0	0.0	0.0	208.45	4
1503.20	119.8	119.8	0.0	0.0	0.0	0.0	0.0	OVERTOPPING	

SUMMARY OF ITERATIVE SOLUTION ERRORS FILE: 2005ALT2 DATE: 06-15-2000

HEAD ELEV (ft)	HEAD ERROR (ft)	TOTAL FLOW (cfs)	FLOW ERROR (cfs)	% FLOW ERROR
1499.10	0.000	0.00	0.00	0.00
1500.65	0.000	35.40	0.00	0.00
1501.67	0.000	70.80	0.00	0.00
1502.05	0.000	84.00	0.00	0.00
1503.41	-0.005	141.60	1.39	0.98
1503.61	-0.006	177.00	1.13	0.64
1503.74	-0.007	212.40	1.63	0.77
1503.86	-0.005	247.80	1.19	0.48
1503.96	-0.010	283.20	2.33	0.82
1504.05	-0.009	318.60	2.21	0.69
1504.13	-0.007	354.00	1.80	0.51

<1> TOLERANCE (ft) = 0.010 <2> TOLERANCE (%) = 1.000

CURRENT DATE: 06-15-2000 FILE DATE: 06-15-2000
CURRENT TIME: 10:14:14 FILE NAME: 2005ALT2

PERFORMANCE CURVE FOR CULVERT 1 - 1(6.00 (ft) BY 3.00 (ft)) RCB

DISCHARGE FLOW (cfs)	HEADWATER ELEV. (ft)	INLET CONTROL DEPTH (ft)	OUTLET CONTROL DEPTH (ft)	FLOW TYPE <F4>	NORMAL DEPTH (ft)	CRIT. DEPTH (ft)	OUTLET DEPTH (ft)	TW DEPTH (ft)	OUTLET VEL. (fps)	TW VEL. (fps)
0.00	1499.10	0.00	0.17	0-NF	0.00	0.00	0.00	3.93	0.00	0.00
35.40	1500.65	1.72	1.72	1-S1f	0.89	1.03	1.20	3.93	4.92	0.00
70.80	1501.67	2.74	2.74	1-S1f	1.42	1.63	1.80	3.93	6.56	0.00
84.00	1502.05	3.12	3.12	1-S1f	1.60	1.83	2.00	3.93	7.00	0.00
125.71	1503.41	4.48	3.99	4-FFt	2.13	2.39	2.13	3.93	9.85	0.00
130.96	1503.61	4.68	4.31	4-FFt	2.19	2.46	2.19	3.93	9.96	0.00
134.55	1503.74	4.81	4.54	4-FFt	2.23	2.50	2.23	3.93	10.04	0.00
137.49	1503.86	4.93	4.74	4-FFt	2.27	2.54	2.27	3.93	10.10	0.00
139.87	1503.96	5.03	4.90	4-FFt	2.30	2.57	2.30	3.93	10.15	0.00
141.84	1504.04	5.11	5.03	4-FFt	2.32	2.59	2.32	3.93	10.18	0.00
143.75	1504.12	5.19	5.16	4-FFt	2.34	2.62	2.34	3.93	10.22	0.00

El. inlet face invert 1498.93 ft El. outlet invert 1495.17 ft
El. inlet throat invert 0.00 ft El. inlet crest 0.00 ft

***** SITE DATA ***** CULVERT INVERT **********

INLET STATION	0.00 ft
INLET ELEVATION	1498.93 ft
OUTLET STATION	800.00 ft
OUTLET ELEVATION	1495.17 ft
NUMBER OF BARRELS	1
SLOPE (V/H)	0.0047
CULVERT LENGTH ALONG SLOPE	800.01 ft

***** CULVERT DATA SUMMARY **********

BARREL SHAPE	BOX
BARREL SPAN	6.00 ft
BARREL RISE	3.00 ft
BARREL MATERIAL	CONCRETE
BARREL MANNING'S n	0.012
INLET TYPE	CONVENTIONAL
INLET EDGE AND WALL	SQUARE EDGE (0 DEG. FLARE)
INLET DEPRESSION	NONE

CURRENT DATE: 06-15-2000 FILE DATE: 06-15-2000
CURRENT TIME: 10:14:14 FILE NAME: 2005ALT2

DDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDD
DDDDDDDDDDDDDDDDDDDDDDDDDDD TAILWATER DDDDDDDDDDDDDDDDDDDDDDDDDDD
DDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDD
DDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDD

CONSTANT WATER SURFACE ELEVATION
1499.10

DDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDD
DDDDDDDDDDDDDDDDDDDDDDDDDDD ROADWAY OVERTOPPING DATA DDDDDDDDDDDDDDDDDDDDDDDDDDD
DDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDD

ROADWAY SURFACE PAVED
EMBANKMENT TOP WIDTH 50.00 ft
***** USER DEFINED ROADWAY PROFILE

CROSS-SECTION COORD. NO.	X ft	Y ft
1	0.00	1508.00
2	0.00	1504.20
3	66.00	1503.20
4	108.00	1503.20
5	180.00	1504.90
6	180.00	1508.00

DDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDD

Ditch 3 - Calculations

Ditch 3 – Existing Conditions

Ditch 3 – Culvert No. 3

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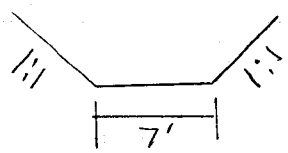
DATE 5-10-00	BY RLP	CHK.	PROJ. NO. 2025	PAGE of

IV. Calculate capacity of CBC at Sunland Ave.

Ditch No. 3 Culvert No. 3

Exist. 6' x 3' x 92' CBC

Outlet channel:



Conc. $n = .014$

$S = .51\%$

From the printout, it can be seen:

1. The capacity of the exist. CBC with the HW at the top of curb $\cong$ 120 cfs., HW = 4.29'

2. A 2 year flow results in HW = 2.69'

$Q = 69$ cfs Elev. = 1487.04

Figure 4.42
Culvert Design Form

Candidate Assessment Report
Ellsworth Road Ditch Study
Southern Avenue to Apache Trail
RPA No. 2005

Project: Ellsworth Road CAR
Southern Ave to Apache Trail

Station: Sunland Dr
Sheet _____ **of** _____

CULVERT DESIGN FORM
Designer/Date: _____ / _____
Reviewer/Date: _____ / _____

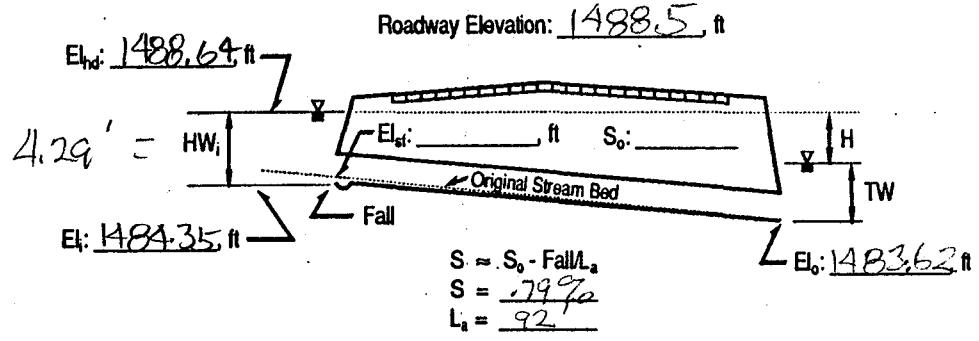
Hydrological Data

See Add'l shts

- ☐ **Method:** _____
- ☐ **Drainage Area:** _____ ☐ **Stream Slope:** _____
- ☐ **Channel Shape:** _____
- ☐ **Routing:** _____ ☐ **Other:** _____

Design Flows/Tailwater

R.I., years	Flow, cfs	TW, ft



Culvert Description: Material - Shape - Size - Entrance	Total Flow Q, cfs	Flow Per Barrel Q/N (1)	Headwater Calculations: Inlet Control HW_i/D (2)	HW_i	Fall (3)	EL_hi (4)	Outlet Control TW (5)	d_c	(d_c + D)/2	h_o (6)	k_e	H (7)	EL_ho (8)	Control Headwater Elevation	Outlet Velocity	Comments
6'x3'x92' CBC	120	120												1488.64		

Technical Footnotes:

(1) Use Q/NB for box culverts.
(2) HW_i/D = HW /D or HW_i/D from design charts
(3) FALL = $HW_i - (EL_{hd} - EL_{sf})$; Fall is zero for culverts on grade.
(4) $EL_{hi} = HW_i + EL_i$ (invert of inlet control section)
(5) TW based on downstream control or flow depth in channel.
(6) h_o = TW or $(d_c + D)/2$ (whichever is greater).
(7) $H = \left[1 + k_e + (29n^2L)/R^{1.33}\right] V^2/2g$
(8) $EL_{ho} = EL_o + H + h_o$

Subscript Definitions:

a. approximate
f. culvert fact
hd. Design Headwater
hj. Headwater in inlet control
he. Headwater in outlet control
i. inlet control section
o. Outlet
sf. Streambed at culvert face
TW. Tailwater

Comments / Discussion:

Culvert Barrel Selected:
Size: _____
Shape: _____
Material: _____ **n:** _____
Entrance: _____

Ditch #3 Culvert #2 Existing

9

CURRENT DATE: 06-13-2000 FILE DATE: 06-13-2000
CURRENT TIME: 13:53:13 FILE NAME: 2005CL-3

Culvert #3, Existing

FHWA CULVERT ANALYSIS
HY-8, VERSION 6.1

SITE DATA

INLET ELEV. (ft)	OUTLET ELEV. (ft)	CULVERT LENGTH (ft)
1484.35	1483.62	92.00

CULVERT SHAPE, MATERIAL, INLET

BARRELS	SHAPE	MATERIAL	SPAN (ft)	RISE (ft)	MANNING n	INLET TYPE
1	RCB		6.00	3.00	.012	CONVENTIONAL

SUMMARY OF CULVERT FLOWS (cfs) FILE: 2005CL-3 DATE: 06-13-2000

ELEV (ft)	TOTAL	1	2	3	4	5	6	ROADWAY	ITR
1484.35	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	1
1485.78	26.6	26.6	0.0	0.0	0.0	0.0	0.0	0.00	1
1486.59	53.2	53.2	0.0	0.0	0.0	0.0	0.0	0.00	1
1487.04	69.0	69.0	0.0	0.0	0.0	0.0	0.0	0.00	1
1488.15	106.4	106.4	0.0	0.0	0.0	0.0	0.0	0.00	1
1488.86	133.0	126.8	0.0	0.0	0.0	0.0	0.0	5.62	5
1489.12	159.6	133.4	0.0	0.0	0.0	0.0	0.0	24.69	5
1489.29	186.2	137.8	0.0	0.0	0.0	0.0	0.0	46.70	4
1489.42	212.8	141.0	0.0	0.0	0.0	0.0	0.0	71.00	4
1489.53	239.4	143.6	0.0	0.0	0.0	0.0	0.0	93.63	3
1489.63	266.0	146.1	0.0	0.0	0.0	0.0	0.0	117.74	3
1488.64	120.6	120.6	0.0	0.0	0.0	0.0	0.0	OVERTOPPING	

SUMMARY OF ITERATIVE SOLUTION ERRORS FILE: 2005CL-3 DATE: 06-13-2000

HEAD ELEV (ft)	HEAD ERROR (ft)	TOTAL FLOW (cfs)	FLOW ERROR (cfs)	% FLOW ERROR
1484.35	0.000	0.00	0.00	0.00
1485.78	0.000	26.60	0.00	0.00
1486.59	0.000	53.20	0.00	0.00
1487.04	0.000	69.00	0.00	0.00
1488.15	0.000	106.40	0.00	0.00
1488.86	-0.006	133.00	0.62	0.47
1489.12	-0.006	159.60	1.49	0.93
1489.29	-0.006	186.20	1.74	0.93
1489.42	-0.009	212.80	0.79	0.37
1489.53	-0.006	239.40	2.16	0.90
1489.63	-0.006	266.00	2.19	0.82

<1> TOLERANCE (ft) = 0.010 <2> TOLERANCE (%) = 1.000

CURRENT DATE: 06-13-2000 FILE DATE: 06-13-2000
CURRENT TIME: 13:53:13 FILE NAME: 2005CL-3

PERFORMANCE CURVE FOR CULVERT 1 - 1(6.00 (ft) BY 3.00 (ft)) RCB

DIS-CHARGE FLOW (cfs)	HEAD-WATER ELEV. (ft)	INLET CONTROL DEPTH (ft)	OUTLET CONTROL DEPTH (ft)	FLOW TYPE <F4>	NORMAL DEPTH (ft)	CRIT. DEPTH (ft)	OUTLET DEPTH (ft)	TW DEPTH (ft)	OUTLET VEL. (fps)	TW VEL. (fps)
0.00	1484.35	0.00	0.00	0-NF	0.00	0.00	0.00	0.00	0.00	0.00
26.60	1485.78	1.43	1.43	1-S2n	0.62	0.85	0.55	0.66	8.06	5.23
53.20	1486.59	2.24	2.24	1-S2n	0.98	1.35	1.02	1.00	8.71	6.62
69.00	1487.04	2.69	2.69	1-S2n	1.17	1.60	1.22	1.17	9.39	7.21
106.40	1488.15	3.80	3.80	5-S2n	1.57	2.14	1.67	1.51	10.61	8.27
126.77	1488.86	4.51	4.51	5-S2n	1.78	2.41	1.90	1.72	11.14	8.86
133.42	1489.11	4.77	4.77	5-S2n	1.84	2.49	1.97	1.91	11.28	9.37
137.76	1489.29	4.94	4.94	5-S2n	1.89	2.54	2.02	2.09	11.34	9.80
141.01	1489.42	5.07	5.07	5-S2n	1.92	2.58	2.05	2.26	11.44	10.19
143.61	1489.53	5.18	5.18	5-S2n	1.94	2.62	2.09	2.41	11.47	10.55
146.07	1489.63	5.28	5.28	5-S2n	1.97	2.65	2.12	2.56	11.51	10.87

El. inlet face invert 1484.35 ft El. outlet invert 1483.62 ft
El. inlet throat invert 0.00 ft El. inlet crest 0.00 ft

***** SITE DATA ***** CULVERT INVERT **********

INLET STATION	0.00 ft
INLET ELEVATION	1484.35 ft
OUTLET STATION	92.00 ft
OUTLET ELEVATION	1483.62 ft
NUMBER OF BARRELS	1
SLOPE (V/H)	0.0079
CULVERT LENGTH ALONG SLOPE	92.00 ft

***** CULVERT DATA SUMMARY **********

BARREL SHAPE	BOX
BARREL SPAN	6.00 ft
BARREL RISE	3.00 ft
BARREL MATERIAL	CONCRETE
BARREL MANNING'S n	0.012
INLET TYPE	CONVENTIONAL
INLET EDGE AND WALL	SQUARE EDGE (0 DEG. FLARE)
INLET DEPRESSION	NONE

CURRENT DATE: 06-13-2000 FILE DATE: 06-13-2000
CURRENT TIME: 13:53:13 FILE NAME: 2005CL-3

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DDDDDDDDDDDDDDDDDDDDDDDDDDD TAILWATER DDDDDDDDDDDDDDDDDDDDDDDDDDDD
DDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDD

****** REGULAR CHANNEL CROSS SECTION ****************

BOTTOM WIDTH	7.00 ft
SIDE SLOPE H/V (X:1)	1.0
CHANNEL SLOPE V/H (ft/ft)	0.005
MANNING'S n (.01-0.1)	0.014
CHANNEL INVERT ELEVATION	1483.62 ft
CULVERT NO.1 OUTLET INVERT ELEVATION	1483.62 ft

******* UNIFORM FLOW RATING CURVE FOR DOWNSTREAM CHANNEL

FLOW (cfs)	W.S.E. (ft)	FROUDE NUMBER	DEPTH (ft)	VEL. (f/s)	SHEAR (psf)
0.00	1483.62	0.000	0.00	0.00	0.00
26.60	1484.28	1.131	0.66	5.23	0.21
53.20	1484.62	1.165	1.00	6.62	0.32
69.00	1484.79	1.174	1.17	7.21	0.37
106.40	1485.13	1.186	1.51	8.27	0.48
133.00	1485.34	1.191	1.72	8.86	0.55
159.60	1485.53	1.194	1.91	9.37	0.61
186.20	1485.71	1.195	2.09	9.80	0.67
212.80	1485.88	1.196	2.26	10.19	0.72
239.40	1486.03	1.197	2.41	10.55	0.77
266.00	1486.18	1.197	2.56	10.87	0.81

DDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDD
DDDDDDDDDDDDDDDDDDDDDDDDDDD ROADWAY OVERTOPPING DATA DDDDDDDDDDDDDDDDDDDDDDDDDDD
DDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDD

ROADWAY SURFACE	PAVED
EMBANKMENT TOP WIDTH	50.00 ft

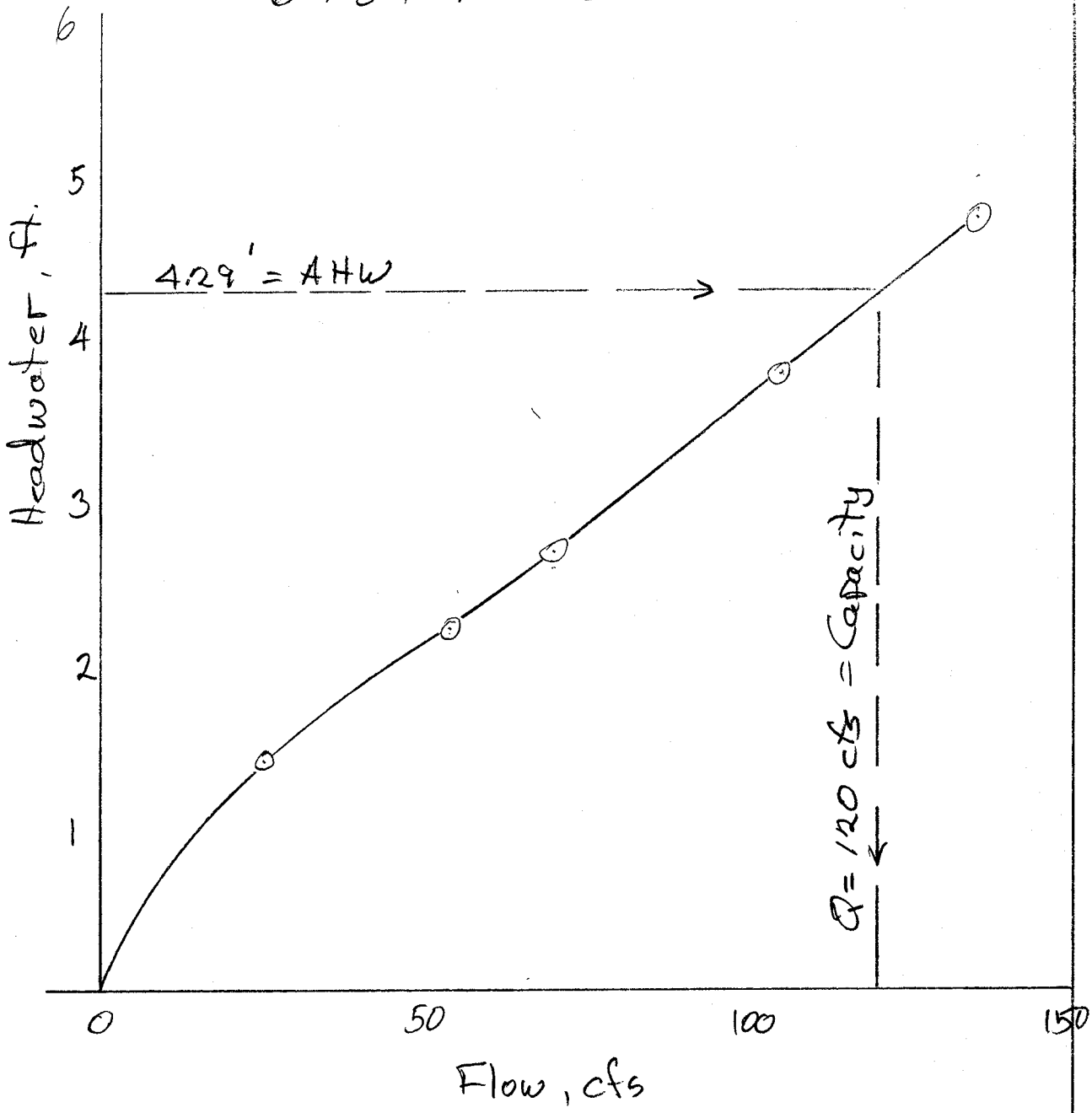
**** USER DEFINED ROADWAY PROFILE

CROSS-SECTION COORD. NO.	X ft	Y ft
1	0.00	1494.00
2	0.00	1491.40
3	50.00	1488.64
4	62.00	1488.64
5	100.00	1489.28
6	100.00	1494.00

DDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDD

Culvert No. 3, @ Sunland Dr.

6' x 3' x 92' CBC



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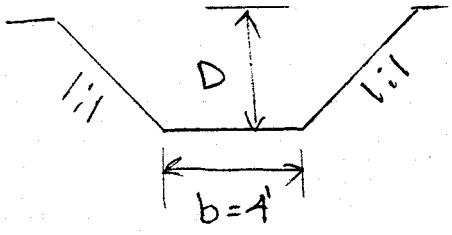
V. Check capacities of existing ditches.

Ditch No. 2:

From Kings "Handbook of Hydraulics" Table 7-11

$$Q = \frac{K'}{n} b^{8/3} S^{1/2}$$

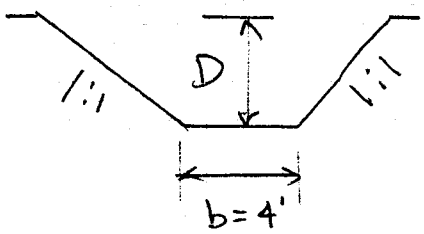


D (minimum) = 3'
$n = .014$
$S = .63\%$

$\frac{D}{b} = \frac{3}{4} = .75 \quad K' = 1.095$

$$Q = \text{capacity} = \frac{1.095}{.014}(4)^{8/3}(.0063)^{1/2} = 250 \text{ cfs}$$

Ditch No. 3:



$D_{min} = 3'$
$n = .014$
$S = .89\%$

$\frac{D}{b} = \frac{3}{4} = .75 \quad K' = 1.095$

$$Q = \frac{1.095}{.014}(4)^{8/3}(.0089)^{1/2} = 298 \text{ cfs}$$

Ditch 3 – High Water with Ditch Removed

CHANNEL DATA Station 90+50

DESIGN FLOW (cfs)	266.0	MANNING'S `n'.....	0.0150
NORMAL DEPTH (ft).....	0.89	SLOPE OF CHANNEL (%)	0.96
AREA OF FLOW (sq. ft.).....	39.25	VELOCITY (fps).....	6.78
WETTED PERIMETER (ft).....	67.26	CRITICAL AREA (sq. ft.)	0.00
CRITICAL DEPTH (ft).....	0.00	CRITICAL VELOCITY (fps)..	% 1.701412E

+

High Water = 1498.89 FF = 1500.62

CROSS SECTION DATA

POINT	OFFSET	ELEVATION
1	0.00	100.62
2	50.00	98.00
3	62.00	98.00
4	100.00	98.68
5	100.00	100.00

FILE NAME -- pueblo
CHANNEL DATA Sta. 85+50

DESIGN FLOW (cfs)	266.0	MANNING'S `n'.....	0.0150
NORMAL DEPTH (ft).....	0.91	SLOPE OF CHANNEL (%)	0.96
AREA OF FLOW (sq. ft.).....	39.18	VELOCITY (fps).....	6.79
WETTED PERIMETER (ft).....	66.97	CRITICAL AREA (sq. ft.)	0.00
CRITICAL DEPTH (ft).....	0.00	CRITICAL VELOCITY (fps)..	% 1.701412E

+

HW = 1493.96 FF = 1495.76

CROSS SECTION DATA

POINT	OFFSET	ELEVATION
1	0.00	95.76
2	50.00	93.05
3	62.00	93.05
4	100.00	93.78
5	100.00	95.00

FILE NAME -- pueblo2

Candidate Assessment Report
Ellsworth Road Ditch Study
Southern Avenue to Apache Trail
RPA No. 2005

Determine depth of flow @ Q_{100} = 266 cfs with existing ditch Removed.

Ditch 3 – Alternate No. II

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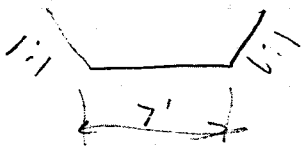
DATE 6-14-00	BY RLP	CHK.	PROJ. NO. 2005	PAGE of

Calculate capacity of Ditch 3, Alt. II.

Alt. II Replace ditch with a 6'x3' CBC

New. 6'x3'x 1230' CBC

Outlet Channel:



conc. $n = .014$
$S = .51\%$

Set AHW the same as the exist. CBC at Sunland Ave. AHW = 4.29'

Capacity (at AHW) = 121 cfs.

Ditch No.3

Figure 4.42
Culvert Design Form

Alternate II

Project: Ellsworth Road CAR Southern Ave to Apache Trail

Station: Ditch No. 3
Sheet _____ **of** _____

CULVERT DESIGN FORM
Designer/Date: _____ / _____
Reviewer/Date: _____ / _____

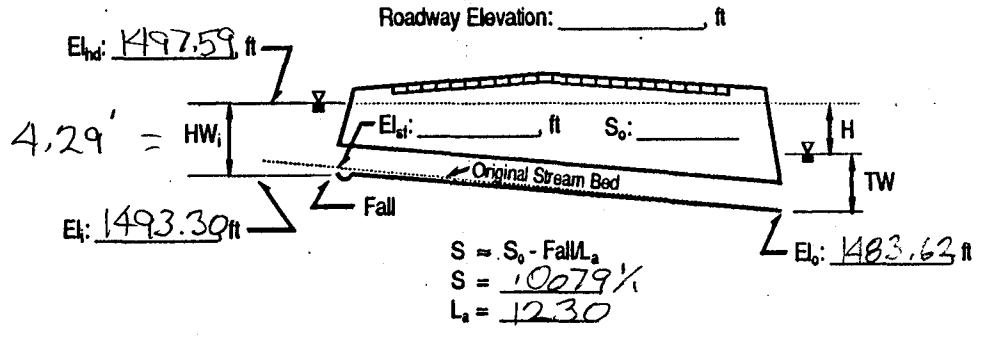
Hydrological Data

See Add'l shts

- ☐ **Method:** _____
- ☐ **Drainage Area:** _____ ☐ **Stream Slope:** _____
- ☐ **Channel Shape:** _____
- ☐ **Routing:** _____ ☐ **Other:** _____

Design Flows/Tailwater

R.I., years	Flow, cfs	TW, ft



Culvert Description: Material - Shape - Size - Entrance	Total Flow Q, cfs	Flow Per Barrel Q/N (1)	Headwater Calculations: Inlet Control HW_i/D (2)	HW_i	Fall (3)	EL_hi (4)	Outlet Control TW (5)	d_c	(d_c + D)/2	h_o (6)	k_e	H (7)	EL_ho (8)	Control Headwater Elevation	Outlet Velocity	Comments
Alternate II																
6'x3' CBC	121													97.59		

Technical Footnotes:

(1) Use Q/NB for box culverts.
(2) HW_i/D = HW /D or HW_i/D from design charts
(3) FALL = $HW_i - (EL_{hd} - EL_{sf})$; Fall is zero for culverts on grade.
(4) $EL_{hi} = HW_i + EL_i$ (invert of inlet control section)
(5) TW based on downstream control or flow depth in channel.
(6) h_o = TW or $(d_c + D)/2$ (whichever is greater).
(7) $H = \left[1 + k_e + (29n^2L)/R^{1.33}\right] V^2/2g$
(8) $EL_{ho} = EL_o + H + h_o$

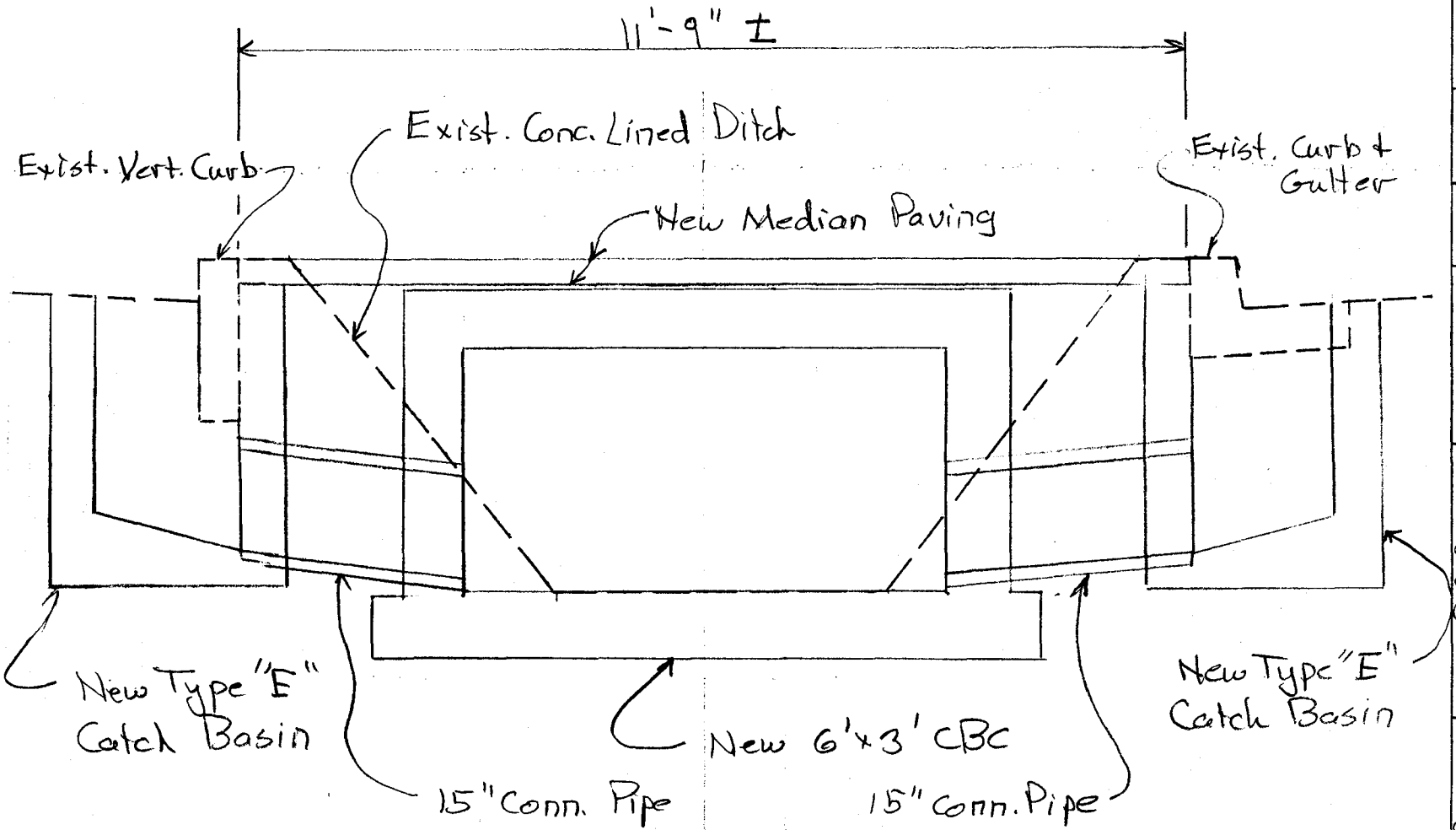
Subscript Definitions:

a.	approximate	i.	inlet control section
f.	culvert fact	o.	Outlet
hd.	Design Headwater	sf.	Streambed at culvert face
hj.	Headwater in inlet control	TW.	Tailwater
he.	Headwater in outlet control		

Comments / Discussion:

Culvert Barrel Selected:
Size: _____
Shape: _____
Material: _____ **n:** _____
Entrance: _____

Ditch No. 3 Typical Section Alternate II



DATE 6-14-00 | BY RLP | CHK. | PROJ. NO. 2005 | PAGE 9

Candidate Assessment Report
Ellsworth Road Ditch Study
Southern Avenue to Apache Trail
RPA No. 2005

RITOCH-POWELL associates
consulting engineers, inc.
3120 N. 19th Ave Suite 200 Phoenix, AZ 85015 (602) 263-1177

URRENT DATE: 06-14-2000 FILE DATE: 06-14-2000
URRENT TIME: 13:50:21 FILE NAME: 2005ALTR

Ditch # 3, Alternate II

FHWA CULVERT ANALYSIS
HY-8, VERSION 6.1

SITE DATA

INLET ELEV. (ft)	OUTLET ELEV. (ft)	CULVERT LENGTH (ft)
1493.30	1483.62	1230.04

CULVERT SHAPE, MATERIAL, INLET

BARRELS	SHAPE MATERIAL	SPAN (ft)	RISE (ft)	MANNING n	INLET TYPE
1	RCB	6.00	3.00	.012	CONVENTIONAL

SUMMARY OF CULVERT FLOWS (cfs) FILE: 2005ALTR DATE: 06-14-2000

ELEV (ft)	TOTAL	1	2	3	4	5	6	ROADWAY	ITR
1493.30	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	1
1494.73	26.6	26.6	0.0	0.0	0.0	0.0	0.0	0.00	1
1495.54	53.2	53.2	0.0	0.0	0.0	0.0	0.0	0.00	1
1495.99	69.0	69.0	0.0	0.0	0.0	0.0	0.0	0.00	1
1497.10	106.4	106.4	0.0	0.0	0.0	0.0	0.0	0.00	1
1497.69	133.0	123.4	0.0	0.0	0.0	0.0	0.0	8.96	9
1497.82	159.6	126.9	0.0	0.0	0.0	0.0	0.0	31.91	5
1497.92	186.2	129.5	0.0	0.0	0.0	0.0	0.0	55.58	4
1498.00	212.8	131.8	0.0	0.0	0.0	0.0	0.0	80.35	4
1498.08	239.4	133.7	0.0	0.0	0.0	0.0	0.0	103.61	3
1498.16	266.0	135.5	0.0	0.0	0.0	0.0	0.0	128.40	3
1497.59	120.6	120.6	0.0	0.0	0.0	0.0	0.0	OVERTOPPING	

SUMMARY OF ITERATIVE SOLUTION ERRORS FILE: 2005ALTR DATE: 06-14-2000

HEAD ELEV (ft)	HEAD ERROR (ft)	TOTAL FLOW (cfs)	FLOW ERROR (cfs)	% FLOW ERROR
1493.30	0.000	0.00	0.00	0.00
1494.73	0.000	26.60	0.00	0.00
1495.54	0.000	53.20	0.00	0.00
1495.99	0.000	69.00	0.00	0.00
1497.10	0.000	106.40	0.00	0.00
1497.69	-0.006	133.00	0.68	0.51
1497.82	-0.005	159.60	0.83	0.52
1497.92	-0.008	186.20	1.10	0.59
1498.00	-0.006	212.80	0.71	0.33
1498.08	-0.004	239.40	2.06	0.86
1498.16	-0.004	266.00	2.11	0.79

<1> TOLERANCE (ft) = 0.010 <2> TOLERANCE (%) = 1.000

CURRENT DATE: 06-14-2000 FILE DATE: 06-14-2000
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PERFORMANCE CURVE FOR CULVERT 1 - 1(6.00 (ft) BY 3.00 (ft)) RCB

DISCHARGE FLOW (cfs)	HEADWATER ELEV. (ft)	INLET CONTROL DEPTH (ft)	OUTLET CONTROL DEPTH (ft)	FLOW TYPE <F4>	NORMAL DEPTH (ft)	CRIT. DEPTH (ft)	OUTLET DEPTH (ft)	TW DEPTH (ft)	OUTLET VEL. (fps)	TW VEL. (fps)
0.00	1493.30	0.00	0.00	0-NF	0.00	0.00	0.00	0.00	0.00	0.00
26.60	1494.73	1.43	1.43	1-S2n	0.62	0.85	0.55	0.66	8.06	5.23
53.20	1495.54	2.24	2.24	1-S2n	0.98	1.35	0.85	1.00	10.44	6.62
69.00	1495.99	2.69	2.69	1-S2n	1.17	1.60	1.10	1.17	10.41	7.21
106.40	1497.10	3.80	3.80	5-S2n	1.57	2.14	1.44	1.51	12.30	8.27
123.36	1497.69	4.39	4.39	5-S2n	1.74	2.36	1.66	1.72	12.36	8.86
126.86	1497.82	4.52	4.52	5-S2n	1.78	2.41	1.71	1.91	12.37	9.37
129.51	1497.92	4.62	4.62	5-S2n	1.81	2.44	1.74	2.09	12.39	9.80
131.75	1498.00	4.70	4.70	5-S2n	1.83	2.47	1.77	2.26	12.41	10.19
133.73	1498.08	4.78	4.78	5-S2n	1.85	2.49	1.79	2.41	12.42	10.55
135.49	1498.15	4.85	4.85	5-S2n	1.86	2.52	1.86	2.56	12.16	10.87

El. inlet face invert 1493.30 ft El. outlet invert 1483.62 ft
El. inlet throat invert 0.00 ft El. inlet crest 0.00 ft

***** SITE DATA ***** CULVERT INVERT **********

INLET STATION	0.00 ft
INLET ELEVATION	1493.30 ft
OUTLET STATION	1230.00 ft
OUTLET ELEVATION	1483.62 ft
NUMBER OF BARRELS	1
SLOPE (V/H)	0.0079
CULVERT LENGTH ALONG SLOPE	1230.04 ft

***** CULVERT DATA SUMMARY **********

BARREL SHAPE	BOX
BARREL SPAN	6.00 ft
BARREL RISE	3.00 ft
BARREL MATERIAL	CONCRETE
BARREL MANNING'S n	0.012
INLET TYPE	CONVENTIONAL
INLET EDGE AND WALL	SQUARE EDGE (0 DEG. FLARE)
INLET DEPRESSION	NONE

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DDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDD
DDDDDDDDDDDDDDDDDDDDDDDDD TAILWATER DDDDDDDDDDDDDDDDDDDDDDDDDD
DDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDD

****** REGULAR CHANNEL CROSS SECTION ****************

BOTTOM WIDTH	7.00 ft
SIDE SLOPE H/V (X:1)	1.0
CHANNEL SLOPE V/H (ft/ft)	0.005
MANNING'S n (.01-0.1)	0.014
CHANNEL INVERT ELEVATION	1483.62 ft
CULVERT NO.1 OUTLET INVERT ELEVATION	1483.62 ft

****** UNIFORM FLOW RATING CURVE FOR DOWNSTREAM CHANNEL

FLOW (cfs)	W.S.E. (ft)	FROUDE NUMBER	DEPTH (ft)	VEL. (f/s)	SHEAR (psf)
0.00	1483.62	0.000	0.00	0.00	0.00
26.60	1484.28	1.131	0.66	5.23	0.21
53.20	1484.62	1.165	1.00	6.62	0.32
69.00	1484.79	1.174	1.17	7.21	0.37
106.40	1485.13	1.186	1.51	8.27	0.48
133.00	1485.34	1.191	1.72	8.86	0.55
159.60	1485.53	1.194	1.91	9.37	0.61
186.20	1485.71	1.195	2.09	9.80	0.67
212.80	1485.88	1.196	2.26	10.19	0.72
239.40	1486.03	1.197	2.41	10.55	0.77
266.00	1486.18	1.197	2.56	10.87	0.81

DDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDD
DDDDDDDDDDDDDDDDDDDDDDDDDD ROADWAY OVERTOPPING DATA DDDDDDDDDDDDDDDDDDDDDDDDDD
DDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDD

ROADWAY SURFACE	PAVED
EMBANKMENT TOP WIDTH	50.00 ft
CREST LENGTH	100.00 ft
OVERTOPPING CREST ELEVATION	1497.59 ft

DDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDD

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Ditch No. 3, Alternate II.

→ Calc. size of grated inlet at north end of the extended 6'×3' CBC

This grate will need to be depressed so that it will perform as a ~~sump~~.

Set the depression at 6" = .5' = d.

The grate will act as a weir.

$Q_i = C_w P d^{1.5}$ $\quad C_w = 3.0$

Q_i = capacity of 6'×3' CBC = 121 cfs

Clogging = 50%

Required perimeter = $P = \frac{Q_i}{C_w d^{1.5}} \times 2$

$$P = \frac{121}{3.0(.5)^{1.5}} \times 2 = 230'$$

If the grate is 6' wide (same as box width)

Length = $\frac{230-12}{2} \simeq 110'$

Drop inlet needs to be 110' × 6'

Ditch 3 – Alternate No. III

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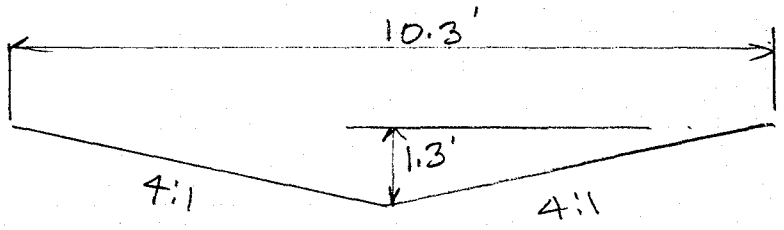
Calculate Capacity of Ditch No. 3, Alt. III



$n = .014$ (conc. lined) $S = .79\%$

CHANNEL DATA

DESIGN FLOW (cfs)	46.5	MANNING'S `n'.....	0.0140
NORMAL DEPTH (ft).....	1.30	SLOPE OF CHANNEL (%)	0.79
AREA OF FLOW (sq. ft.).....	6.72	VELOCITY (fps).....	6.92
WETTED PERIMETER (ft).....	10.69	CRITICAL AREA (sq. ft.)	0.00
CRITICAL DEPTH (ft).....	0.00	CRITICAL VELOCITY (fps)..	% 1.701412E 38

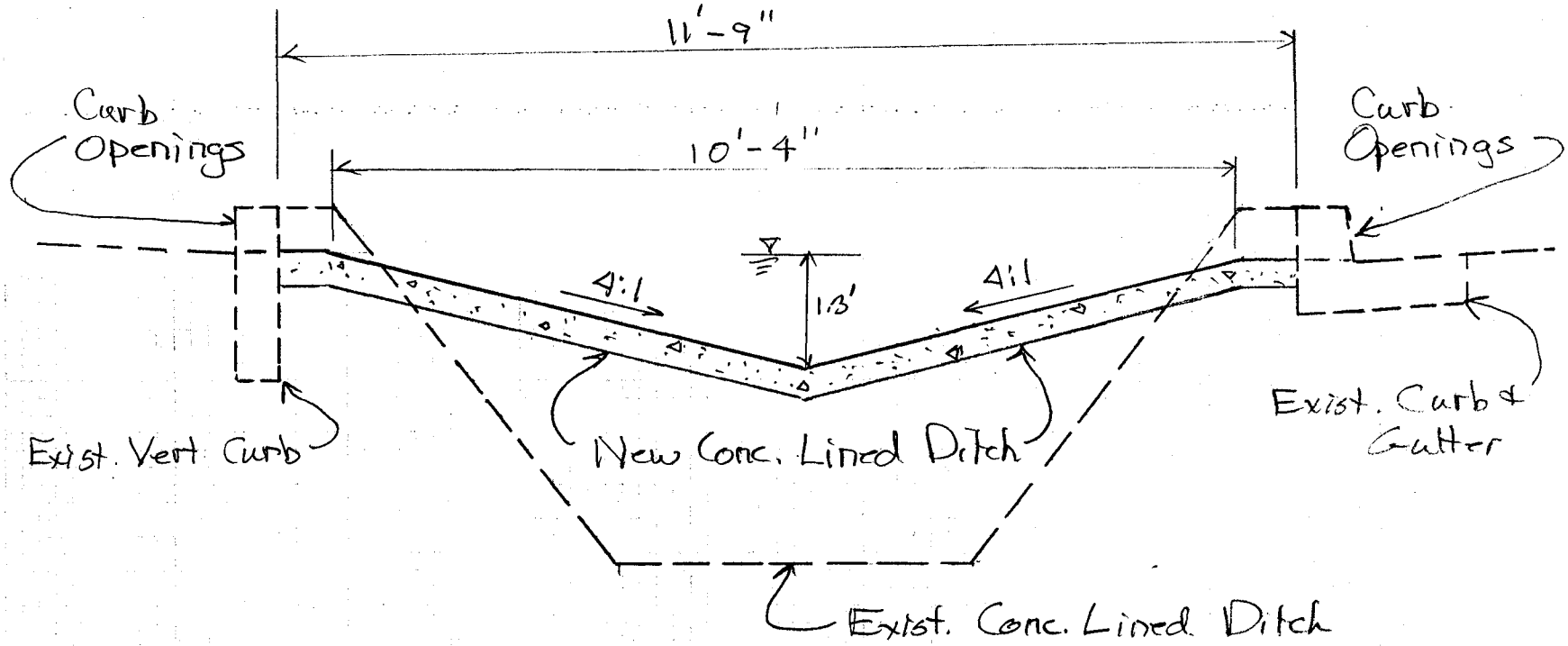
CROSS SECTION DATA

POINT	OFFSET	ELEVATION
1	0.00	10.00
2	5.20	8.70
3	10.40	10.00

FILE NAME -- ellsdith

Capacity = 46 cfs

Ditch No. 3, Typical Section Alternate III



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RITOCH-POWELL associates
consulting engineers, inc.
3120 N. 19th Ave. Suite 200 Phoenix, AZ 85015 (602) 263-1177

Candidate Assessment Report
Ellsworth Road Ditch Study
Southern Avenue to Apache Trail
RPA No. 2005

RITOCH-POWELL
associates
consulting engineers, inc.
3120 N. 19th Ave-Suite 200-Phoenix, AZ-85015 (602) 263-1177

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Ditch No. 3, Alternate III

- Calculate size of grate for drop inlet on the north end of the exist. 6'x3' CBC under Sunland Ave. Sump.

Q_i = 121 cfs. C_w = 3.0

d = ? set top of inlet @ top of exist CBC

= inv. = 1484.35
+ 3.00
+ .79 (9½ in)

Grate = 1488.14

High Water elev. when overtoping begins
= 1488.64

Therefore, depth of water over grate = 1488.64 − 1488.14 = 0.5'

∴ Use the same size inlet as as with Alt. II

110' x 6'

Cost Estimates

Cost Estimates:

A. Ditch No. 2, Alternate II.

New 6'×3'× 720' CBC (ADOT Std)
Catch Basins & Median pavement & Drop Inlet

CBC: from ADOT Structure Stds.

Conc: $720' \times 0.635 \frac{CY}{ft.} = 457$ CY

Steel: $720' \times 90 \frac{lbs}{ft.} = 64,800$ lbs

Remove Conc. lined Ditch = $700' \times 15.3'$
= 10,700 S.F.

25'×6' Drop Inlet with Grate = 1 Ea

Type "E" CB (single) = 3 Ea.

Type "E" CB (Double) = 3 Ea

Median Paving = 694×12 = 8,328 SF

Item	Unit.	Quant.	Unit Price	Cost.
Structural Conc.	CY.	457	$300	$137,100
Reinforcing Steel	lbs.	64,800	1.00	64,800
25'× 6' Drop Inlet	Ea.	1	20,000	20,000
Remove Conc. Ditch	S.F.	10,700	1.50	16,050
Type "E" CB	Ea.	3	2,000	6,000
Type "E" CB (Dbl.)	Ea.	3	3,000	9,000
Median Paving	S.F.	8,328	2.00	16,656
			Total =	$269,606
			25% Contingencies	67,394
			Total =	$337,000

B. Ditch No.2, Alternate III.

New Guard Rail on each side of ditch,
Remove + Replace Conc. Ditch Lining.
Extend 6'x3' CBC by 50 LF

Guard Rail = 2 x 700' = 1400 LF

Remove Exist. Conc. Lining and Replace

750' x 15.3 = 11,475 SF

Guard Rail End Treatment. = 4 Ea.

Item	Unit.	Quant.	Unit Price	Cost
Guard Rail, ADOT C-10 Series	LF	1,400	$13.00	$18,200
Guard Rail End Treat.	Ea.	4	2,500	10,000
Remove Conc. Ditch Lining	S.F	11,500	1.50	17,250
New Conc. Channel Lining	S.F	11,500	3.00	34,500
Extend 6'x3' CBC	LF	50	300	15,000
			Total =	94,950
			25% Contingencies =	23,750
			Total =	$118,700

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C. Ditch No. 3, Alternate II

- New 6'x3'x1100' CBC, Catch Basins and median paving. & 110'x6' Drop Inlet & Grate

CBC: Conc: 1100' x 0.635 C.Y./Ft. = 699 C.Y.

Steel: 1100' x 90 lbs/Ft. = 99,000 lbs.

Remove conc. lined ditch = 1150' x 15.3'
= 17,600 S.F.

Type "E" CB (single) = 4 Ea.

Type "E" CB (Double) = 4 Ea

Med. Paving = 1140' x 12' = 13,680 SF

Item	Unit.	Quant.	Unit Price	Cost
Structural Conc.	C.Y.	699	$300	$209,700
Rein. Steel	lbs.	99,000	1.00	99,000
Remove Conc. Ditch	S.F.	17,600	1.50	26,400
Type "E" CB	Each	4	2,000	8,000
Type "E" CB (Double)	Ea.	4	3,000	12,000
Med. Paving	S.F.	13,680	2.00	27,360
110'x6' Drop Inlet	Ea.	1	90,000	90,000

Total = $472,460

25% Contingencies = 118,140

Total = $590,600

D. Ditch No. 3, Alternate III

- Remove Exist. Conc. Ditch & Replace with Traversable Conc. Ditch., Install New 110'x6' Drop Inlet on exist. CBC

Remove Conc. Lined Ditch = 1200' x 15.3'
= 18,360 SF

New Conc. Lined Ditch = 1100' x 12.3'
= 13,530 SF

110'x6' Drop Inlet = 1 Ea.

Item	Unit	Quant.	Unit Price	Cost
Remove Conc. Ditch Lining	SF	18,360	1.50	$27,540
New Conc. Ditch Lining	SF	13,530	3.00	40,590
110'x6' Drop Inlet	Ea.	1	90,000	90,000

Total = $158,130

25% Contingencies = 39,530

Total = $197,660

E. Ditch No. 3, Alternate IV

- New Guard Rail on each side of ditch,
Remove & Replace Con. Ditch Lining.
Extend 6'x3' CBC 50 ft.

Guard Rail = 2 x 1100' = 2,200 L.F.

Remove & Replace conc. ditch Lining =

15.3' x 1250' = 19,125 SF

Guard Rail End Treatment = 4 Ea.

Extend 6'x3' CBC = 50'

Item	Units	Quant.	Unit Price	Cost
Guard Rail, ADOT C-10 Series	L.F.	2,200	$13	28,600
Guard Rail End Treat.	Ea.	4	2,500	10,000
Remove Ditch Lining	S.F.	19,125	1.50	28,690
New. Conc. Ditch Lining	S.F	19,125	3.00	57,375
6'x3' CBC	LF	50	300	15,000

$139,665

25% Contingencies = 34,915

$174,580