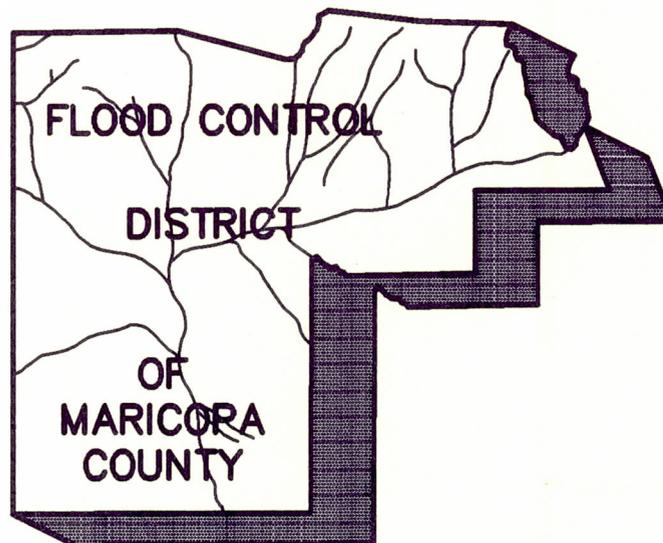


# 500' SWATH/INTERSECTION DRAINAGE PLAN

VOLUME 2.2

ARIZONA CANAL DIVERSION CHANNEL  
AREA DRAINAGE MASTER STUDY

ACDC/ADMS PHASE 1



DRAINAGE INVENTORY & ANALYSIS

ACDC/ADMS PHASE 1

JULY 23, 1993

**KAMINSKI  
HUBBARD**  
engineering, inc.

SURVEYING \* CIVIL \* HYDROLOGY

500' SWATH/INTERSECTION  
DRAINAGE PLAN

Volume 2:2

Arizona Canal Diversion Channel  
Area Drainage Master Study  
ACDC/ADMS Phase I

DRAINAGE INVENTORY & ANALYSIS

July 23, 1993



Prepared For:

Flood Control District of Maricopa County  
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ACDC/ADMS PHASE I  
 500' SWATH/INTERSECTION DRAINAGE PLAN  
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## ACDC Drainage Inventory And Analysis

The construction of the Arizona Canal Diversion Channel (ACDC) brought to light local flooding problems at various areas adjacent to the new ACDC. The Corps of Engineer's (COE) construction plans for the ACDC attempted to address several of these areas and proposed designs to convey these off-site flows into the structure.

The following analysis examines the entire length of the ACDC, Reaches 1 thru 4 for: (1) construction compliance with the design plans for the areas completed or near completion where flood problems were identified through field reconnaissance; (2) effectiveness and efficiency of the COE designs within the flood problem areas to convey off-site local flows into the channel; and (3) to identify additional flood problem areas adjacent to the ACDC that were not addressed within the construction documents or subsequent addendums.

The first task is to analyze the locations where roadway structures cross the ACDC. These locations are the major street crossings identified in the Scope of Work. For each location, an analysis of the post construction off-site drainage condition is performed, making reference to any potential flood problems. If potential flood problems do exist, a solution incorporating at least one alternative and respective cost estimates is included. In addition, a comparison is made to the Corps of Engineer's construction documents with respect to adequately providing storm water conveyance to the ACDC for each major street crossing.

The second task is to identify all potential local flooding areas along the entire length of the ACDC. A 500' wide swath uphill of the channel will be studied to discuss any ponding areas that do not have an outlet into the ACDC. A feasible solution, incorporating at least one alternative and respective cost estimates, is then summarized for the flood problems discussed within the analysis.



## TASK 1: REACH 1 - MAJOR INTERSECTIONS

### 67TH AVENUE

#### Analysis

The intersection of 67th Avenue with the ACDC is located approximately a quarter mile south of 67th Avenue's intersection with Greenway Road. The concentration points for this analysis are located north from the ACDC centerline. Point 1 is 300 feet for the east side and Point 2 is 350 feet for the west side of 67th Avenue (See Exhibit 1).

The concentration points are impacted by storm water runoff from the north conveyed within 67th Avenue which consists of a crowned roadway section without curb and gutter. The existing roadway section conveys the storm water runoff to the ACDC outfall points within the shoulder areas of the roadway prism. The contributing watershed comprises mainly of low-density residential development.

There currently exists a City of Glendale storm drain plan for 67th Avenue. The planned system encompasses the drainage area north of the ACDC and incorporates a storm drain pipe that conveys the intercepted runoff to its concentration point at the intersection of 67th Avenue with the ACDC. The storm drain outfall, located west of the 67th Avenue bridge, is an 84-inch diameter pipe (Point 3). The constructed portion of the 67th Avenue storm drain plan consists of a line that extends from the 84-inch diameter pipe outfall into the ACDC to just north of the intersection of Greenway Road with 67th Avenue.

Until this storm drain system is fully implemented, the majority of the storm water runoff will concentrate itself as surface runoff within the shoulder areas of 67th Avenue, as previously described. This runoff is then conveyed to the Concentration Points (Points 1 & 2) at the ACDC intersection with 67th Avenue. Concentration Point 1 conveys the storm water runoff from the 67th Avenue shoulder area down the ACDC concrete sidewalk (Point 4) to a grouted riprap spillway (Point 5). This system adequately conveys runoff to the ACDC except for the area where runoff is conveyed down the sidewalk (Point 4). The runoff cannot be confined within the limits of the sidewalk and therefore erodes the natural ground and landscaping that borders the sidewalk. This creates a continual maintenance problem.

The storm water runoff concentrated at Point 2 is conveyed into the ACDC via the conveyance described for concentration Point 1. Runoff contributing to Point 2 ponds until it overtops the roadway crown of 67th Avenue and is conveyed into the ACDC by the concrete sidewalk (Point 4) and the grouted riprap spillway (Point 5). This conveyance works well except for the fact that the storm water runoff from Point 2 is crossing 67th Avenue. In addition, for smaller runoff events or the tail end of larger storms, nuisance ponding will occur at Point 2 when headwaters can no longer overtop the 67th Avenue roadway crown.

### **Solution**

To eliminate the erosion adjacent to the sidewalk (Point 4) for Concentration Point 1, the sidewalk would have to be expanded and bordered with monolithic curb on the north side. This would simulate a spillway containing the runoff within the sidewalk areas. To eliminate the ponding at Concentration Point 2 and to reduce the storm water runoff crossing 67th Avenue to Point 1, a double catch basin would have to be constructed at this low point (Point 6) and a connector pipe constructed to tie into the existing 84" storm drain (Point 7).

### **COE Documents**

The ACDC plans did make provisions to convey off-site runoff into the ACDC. However, modifications need to be made to these locations to reduce maintenance and increase efficiency.

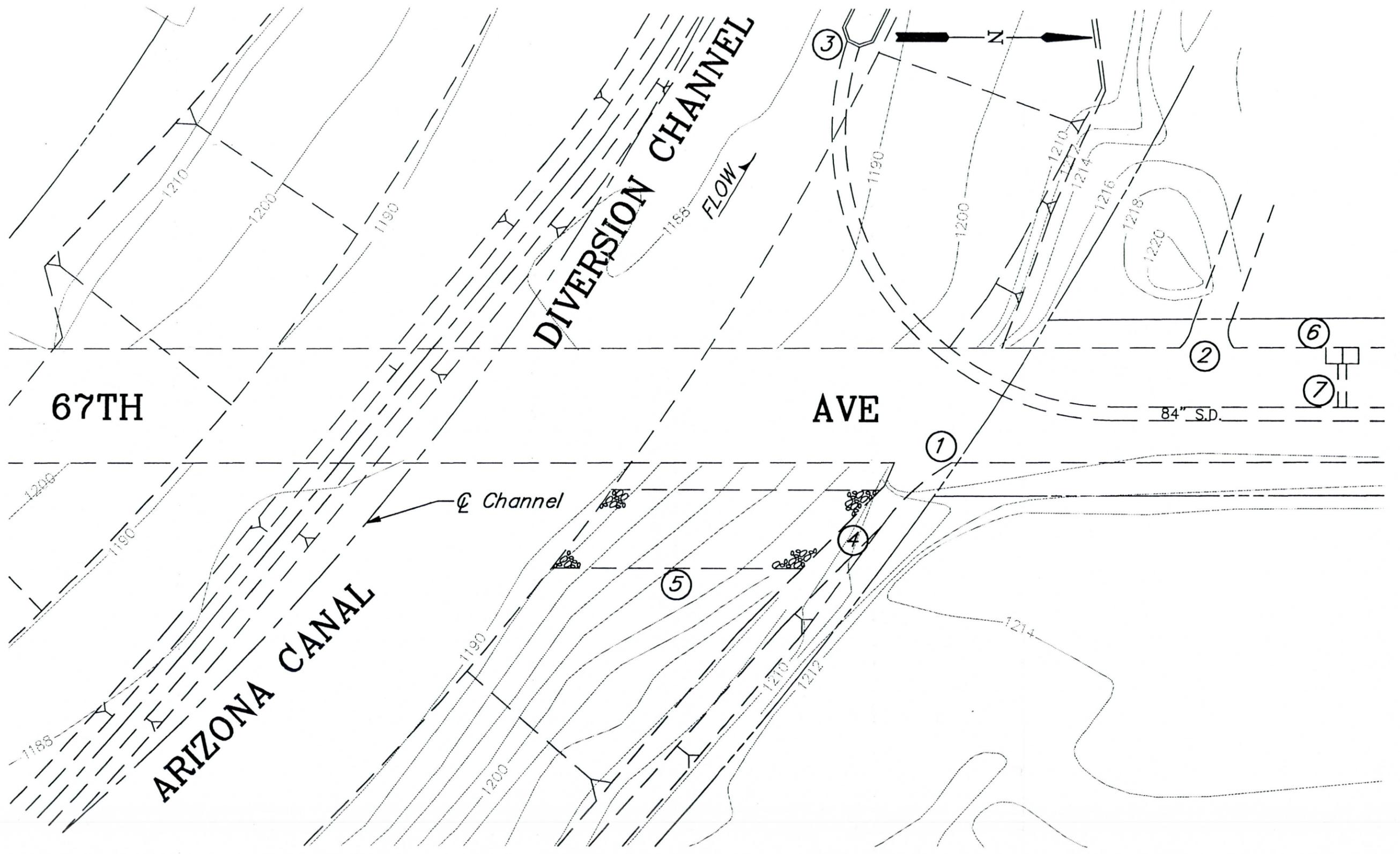
## COST ESTIMATE

### Concentration Point 1 - Convert Existing Sidewalk To Function As A Spillway

Item	Description	Unit	Quantity	Unit Price	Total
1	6" Concrete Sidewalk/Spillway	S.F.	406	\$ 2.00	\$ 812.00
2	Asphalt Concrete	S.Y.	20	8.00	160.00
3	Earthwork & Landscape Reconstruction	L.S.	1	1,000.00	<u>1,000.00</u>
Sub-Total					\$ 1,972.00
15% Contingency					\$ <u>296.00</u>
<b>TOTAL</b>					<b>\$ 2,268.00</b>

### Concentration Point 2 - New Catch Basin

Item	Description	Unit	Quantity	Unit Price	Total
1	New Double Combination Catch Basin	EA.	1	\$ 4,000.00	\$ 4,000.00
2	24" RGRCP	L.F.	50	75.00	3,750.00
3	24" x 84" Diameter Pipe Connection	L.S.	1	1,200.00	1,200.00
4	Asphalt Pavement Replacement	S.Y.	25	10.00	250.00
5	Remove Existing Curb & Gutter	L.F.	15	5.00	<u>75.00</u>
Sub-Total					\$ 9,275.00
15% Contingency					\$ <u>1,349.00</u>
<b>TOTAL</b>					<b>\$ 10,666.00</b>



GREENWAY ROAD

16  
17

15.2 x

20.3 x

LEGEND:  
PONDING AREA



17.4 x

17.6 x

88.9 x

1210

17.0

1190

1200

ARIZONA CANAL DIVERSION CHANNEL

1210

1200

1190

ARIZONA CANAL

14.9 x

17.0

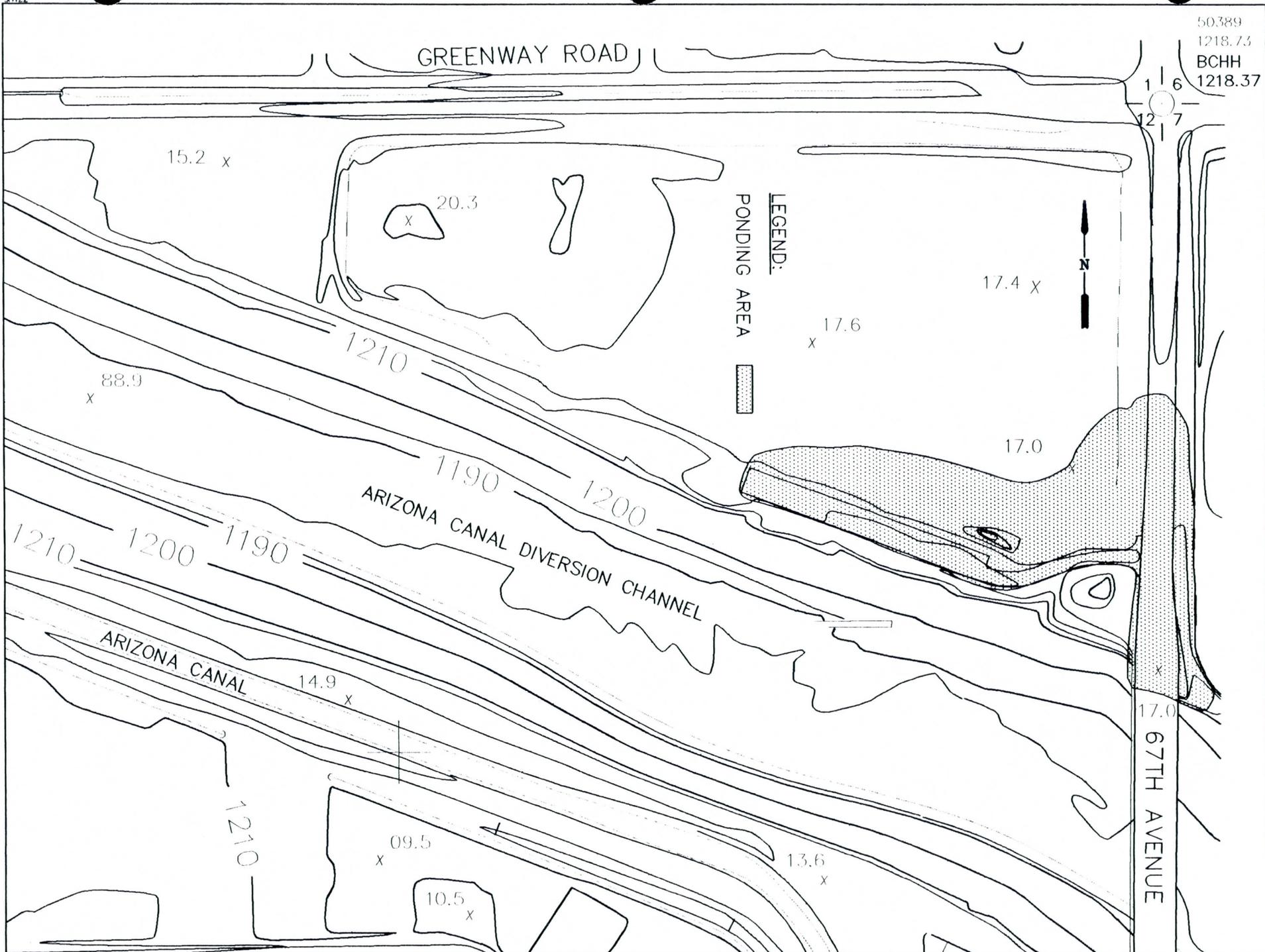
67TH AVENUE

09.5 x

13.6 x

10.5 x

1210



## **THUNDERBIRD ROAD**

### **Analysis**

The intersection of Thunderbird Road with the ACDC is located west of Thunderbird Road's intersection with 59th Avenue (Point 1). The concentration point is the low point in Thunderbird Road located approximately 250 feet east of the ACDC. At this low point there are two existing curb-opening inlets (Points 2 & 3). These inlets are impacted by storm water runoff from the east conveyed in Thunderbird Road.

The storm water runoff conveyed in Thunderbird Road is intercepted by a storm drain system and conveyed into the ACDC via a 96" diameter storm drain pipe (Point 4). The intercepted runoff from the two curb-opening inlets in the sump condition (Points 2 & 3) are also conveyed into the ACDC via the Thunderbird Road storm drain pipe.

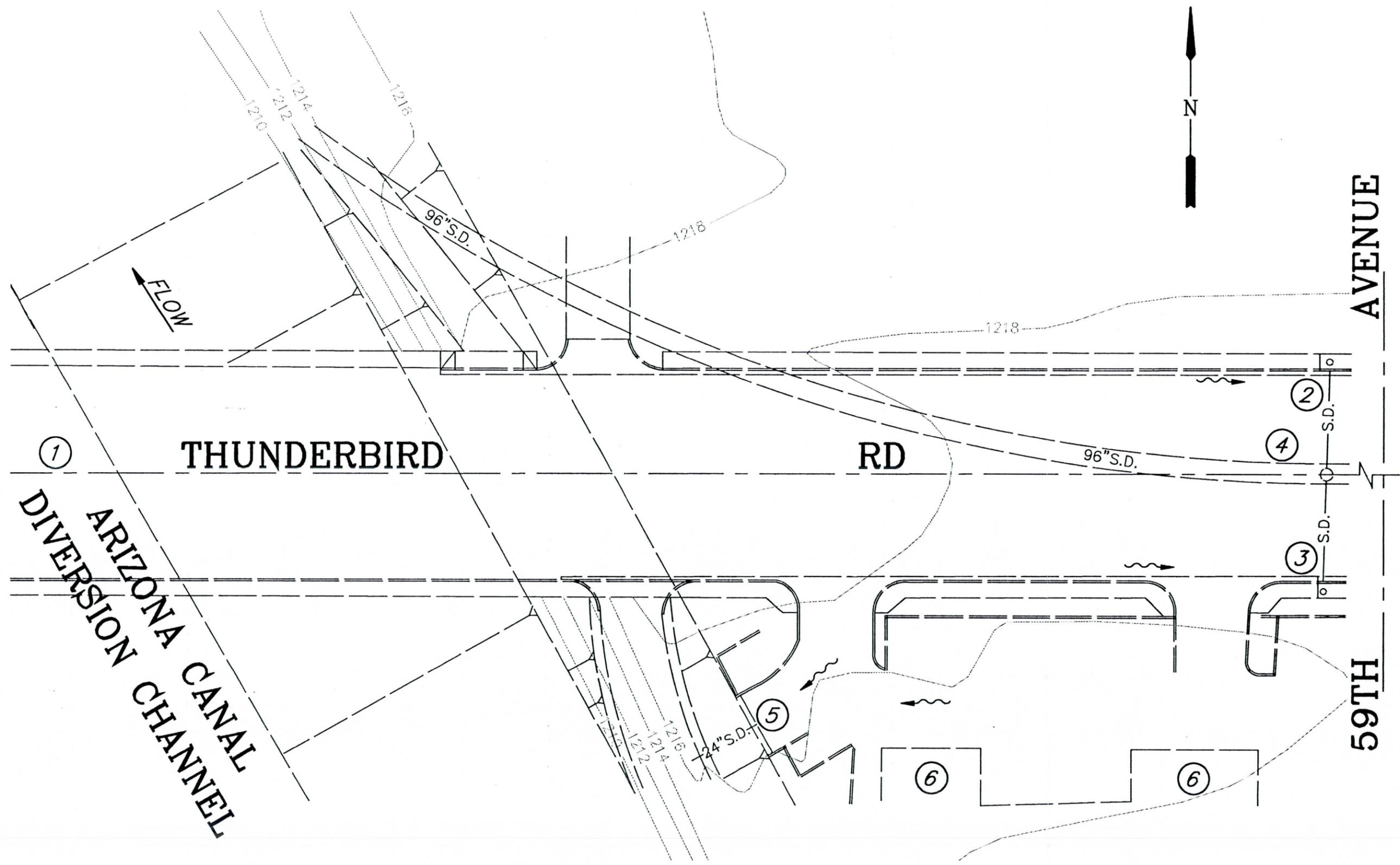
If the existing inlets are deluged by debris, their efficiency is reduced and the overflow storm water runoff is then conveyed into the ACDC by a spillway with a 24" diameter pipe culvert (Point 5). This combination spillway and pipe culvert is located at the southeast corner of the intersection of the ACDC with Thunderbird Road and functions both as an outlet for the adjacent commercial business (Point 6) and overflow spillway for Thunderbird Road.

### **Solution**

As stated in the analysis, the COE design has adequately provided for the conveyance of off-site flows into the ACDC.

### **COE Documents**

The ACDC plans did make provisions for local flows to enter the channel.



①  
 ARIZONA CANAL  
 DIVERSION CHANNEL

THUNDERBIRD

RD

AVENUE

59TH



FLOW

②

④

③

⑤

⑥

⑥

S.D.  
 S.D.  
 S.D.

96" S.D.

96" S.D.

24" S.D.

## **59TH AVENUE**

### **Analysis**

The intersection of 59th Avenue with the ACDC is located just south of 59th Avenue's intersection with Eugie Avenue (Point 1). Eugie Avenue is located one block south of Thunderbird Road and is the concentration point for this analysis at its intersection with 59th Avenue. The concentration point is impacted by contributing watersheds from the north conveyed in 59th Avenue and from the east conveyed in Eugie Avenue.

The runoff in 59th Avenue consists of its own pavement drainage but primarily comprises of overflow runoff from the Thunderbird Road drainage system. The combined runoff in 59th Avenue is intercepted by two curb-opening inlets in a sump condition at 59th Avenue's intersection with Eugie Avenue (Points 2 & 3). The runoff intercepted by these inlets is conveyed north by a 21-inch diameter storm drain pipe (Point 4) to the 96-inch diameter Thunderbird Road storm drain pipe (Point 5). The 96-inch diameter pipe then conveys the combined runoff into the ACDC at a location north of the Thunderbird Road bridge.

The runoff in Eugie Avenue consists of pavement drainage from the east. The storm water runoff is intercepted by two combination inlets in a sump condition that are located in Eugie Avenue just east of 59th Avenue (Points 6 & 7). The runoff intercepted by these inlets is conveyed south by a 21" diameter storm drain pipe to an outfall located at the northeast corner of the intersection of 59th Avenue with the ACDC (Point 8).

The four inlets at the intersection of 59th Avenue with Eugie Avenue work together for substantial storm events but convey the runoff to the ACDC via two separate pipe systems. If the existing inlets are deluged by debris, their efficiency is reduced and there is no alternative or design overflow conveyance into the ACDC. In the event this were to occur, the existing positive drainage to the ACDC is across the vacant lot at Point 9.

### **Solution**

Obtain a drainage easement and construct an overflow spillway within the easement adjacent to the west curb-opening inlet in 59th Avenue (Point 2) to the ACDC (Point 9). The property needed for the easement is currently vacant. This would provide relief and eliminate the flooding in the event the inlets are deluged by debris and their efficiency is reduced.

### **COE Documents**

The ACDC plans made no provisions to convey overflow runoff from 59th and Eugie Avenues.

## COST ESTIMATE

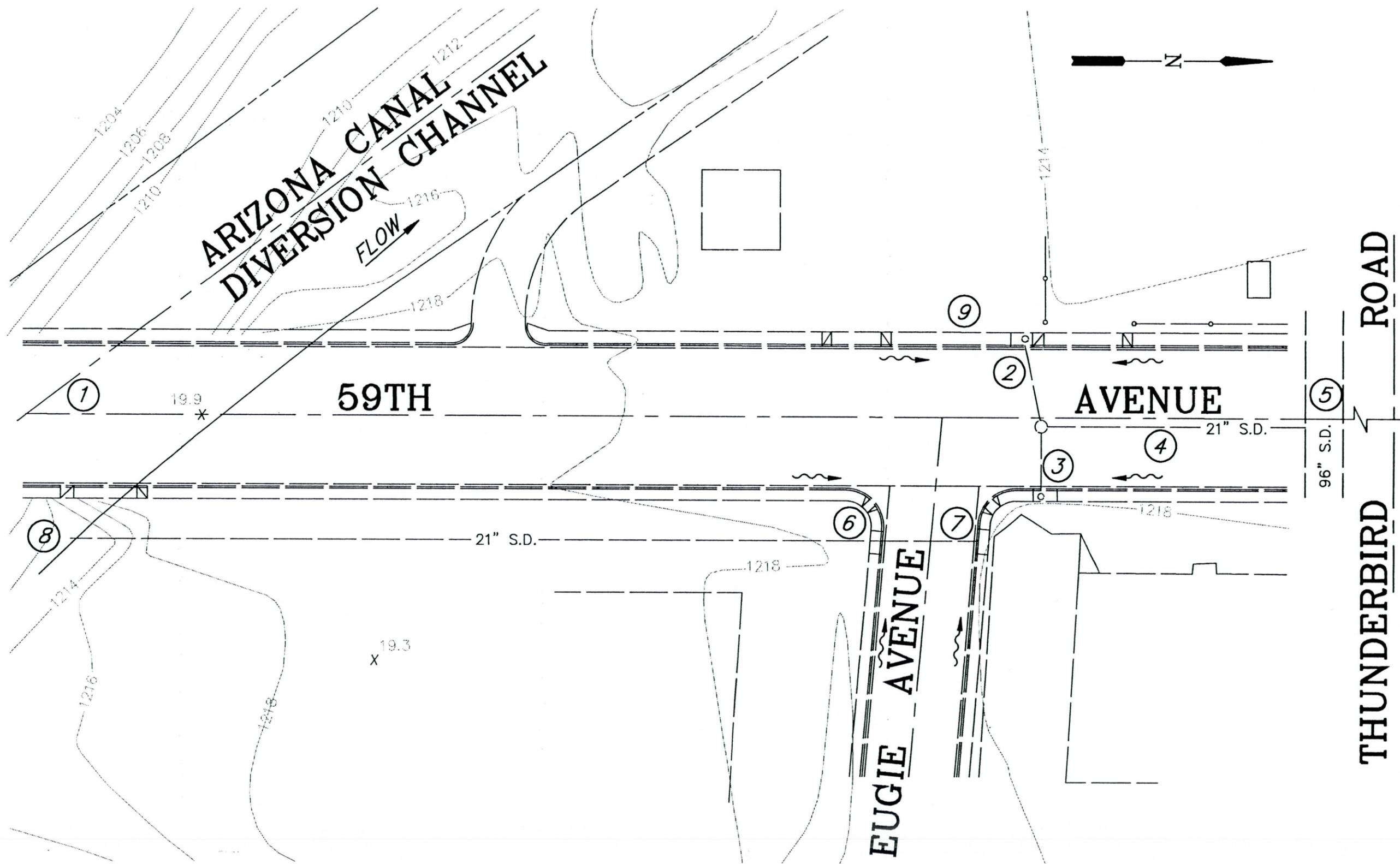
### Open Concrete Lined Channel w/2:1 Side Slopes

Item	Description	Unit	Quantity	Unit Price	Total
1	6" Concrete-Lined Channel	S.Y.	325	\$ 25.00	\$ 8,125.00
2	Clear & Grub	S.Y.	400	3.00	1,200.00
3	Landscaping	L.S.	1	1,500.00	1,500.00
4	Right-Of-Way	S.F.	2,400	5.00	<u>12,000.00</u>

Sub-Total \$ 22,825.00

15% Contingency \$ 3,424.00

**TOTAL \$ 26,249.00**



80123  
1218.33  
BCHH  
1217.778

THUNDERBIRD ROAD

ARIZONA CANAL

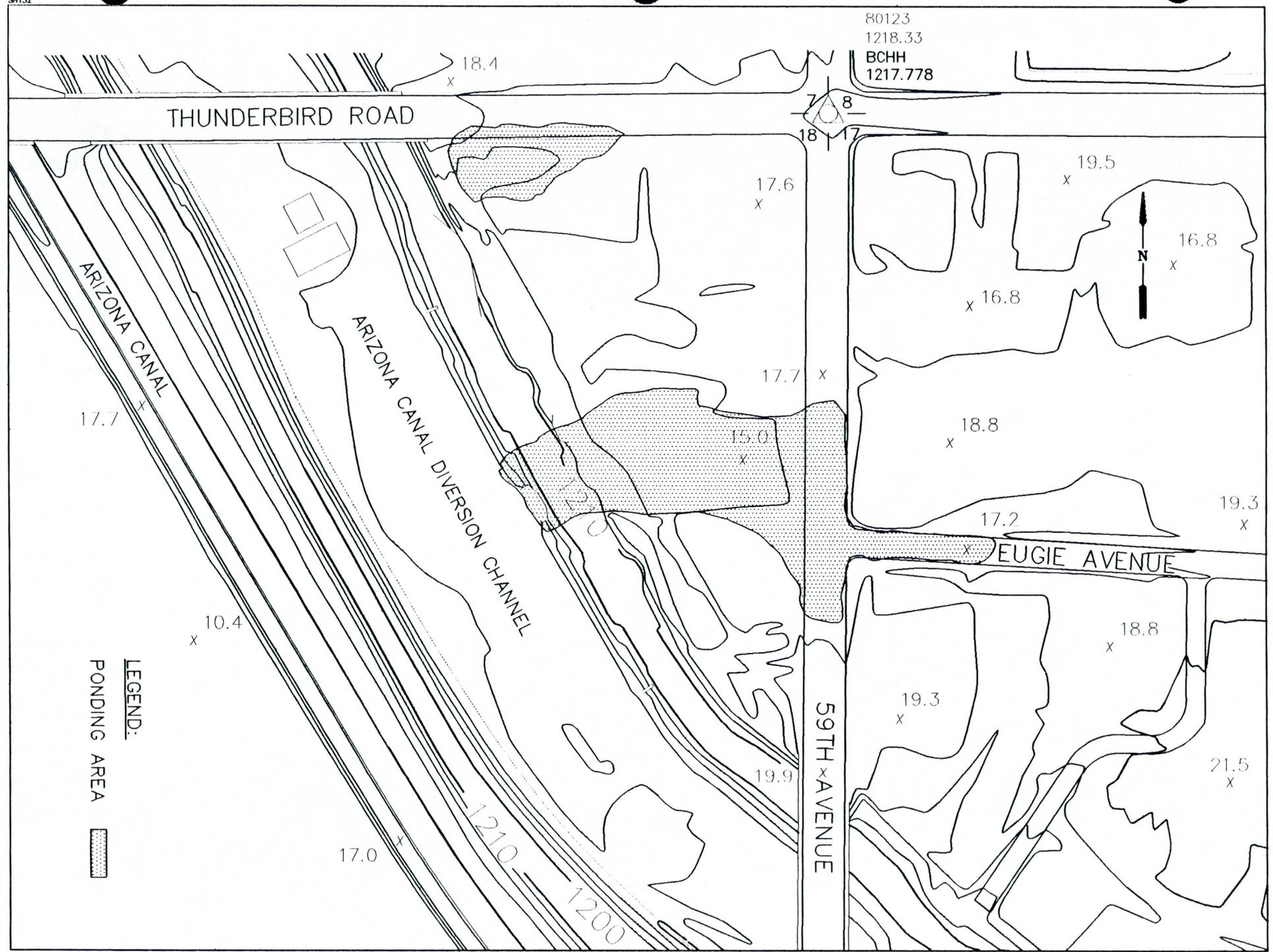
ARIZONA CANAL DIVERSION CHANNEL

EUGIE AVENUE

59TH AVENUE



LEGEND:  
PONDING AREA



## **TASK 1: REACH 2A - MAJOR INTERSECTIONS**

### **CACTUS/51ST AVENUE**

#### **Analysis**

The intersection of the ACDC with 51st Avenue (Point 1) and also Cactus Road (Point 2) will be analyzed together since the ACDC is south and west of the intersection of 51st Avenue and Cactus Road respectively. The concentration point for this analysis is located in Cactus Road approximately 250 feet east of 51st Avenue's intersection with Cactus Road (Points 3 and 4). This concentration point is the low point in Cactus Road which is impacted by storm water runoff from the north conveyed in 51st Avenue and by storm water runoff from the east conveyed in Cactus Road.

The runoff conveyed within 51st Avenue is intercepted by a series of inlets on a continuous grade and two curb-opening inlets (Points 5 & 6) in a sump condition located approximately 125 feet north of Cactus Road. The overflow runoff from these inlets continues around the northeast curb return (Point 7) and flows east in Cactus Road to the low/concentration point (Point 3). This overflow runoff combines with the contributing area conveyed in Cactus Road. The runoff intercepted by the inlets in 51st Avenue and in Cactus Road is conveyed in a 78-inch diameter storm drain pipe to the ACDC (Point 8).

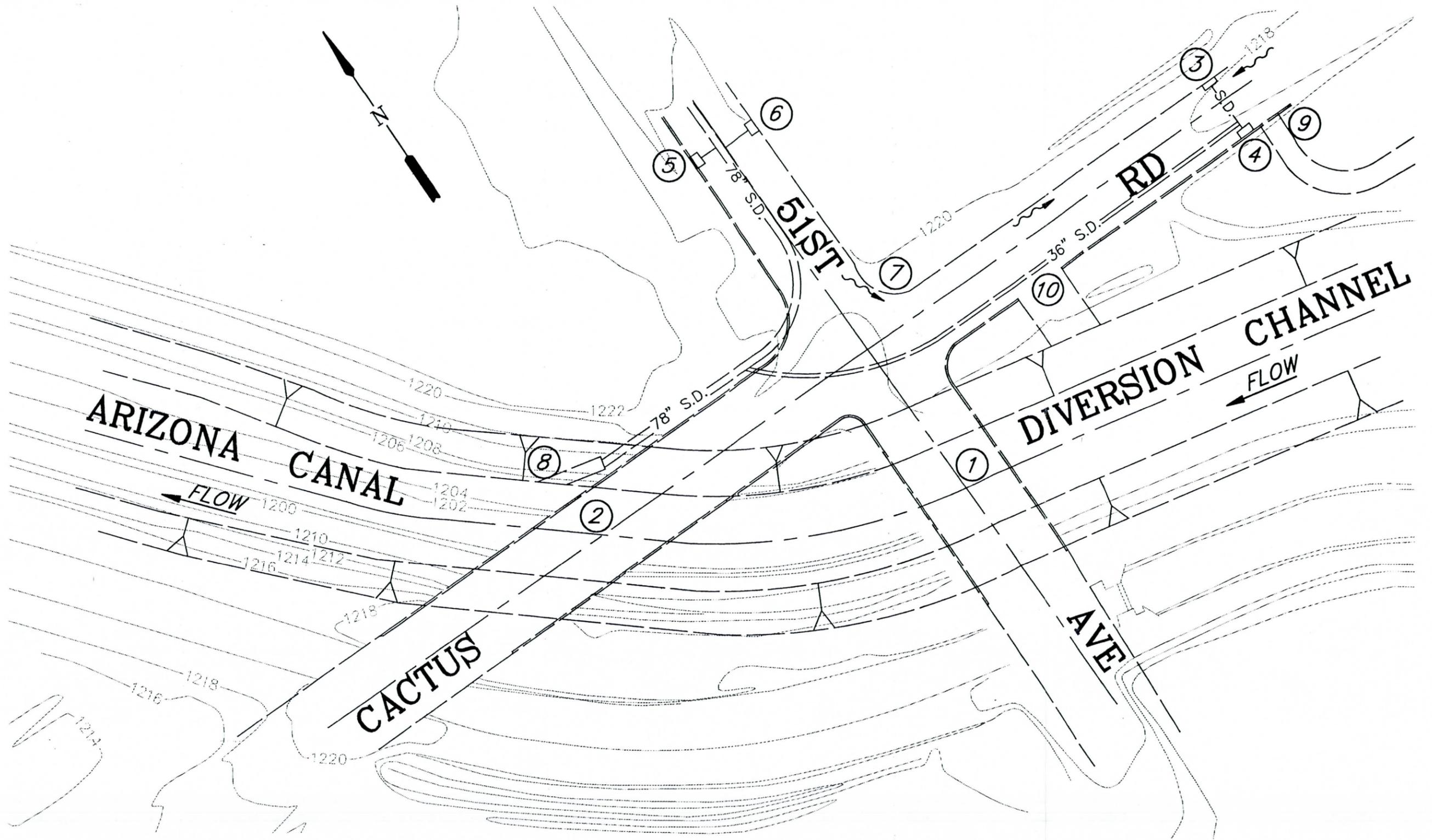
If the curb opening inlet at Point 3 is deluged with debris and its efficiency reduced, the additional runoff will overtop the roadway crown and flow to the curb opening inlet in the south half of Cactus Road (Point 4). When the design capacity of this inlet is exceeded, the storm water is conveyed to the ACDC via two overflow outfalls, (1) an access ramp and maintenance road (Point 9) that is designed to function as a spillway and (2) an overflow spillway just east of the southeast curb return of the Cactus Road and 51st Avenue intersection (Point 10).

#### **Solution**

As stated in the analysis, the COE design has adequately provided for the conveyance of off-site flows into the ACDC.

#### **COE Contract Documents**

The ACDC plans did make provisions for local flows to enter the channel.



## **TASK I: REACH 2B - MAJOR INTERSECTIONS**

### **43RD AVENUE**

#### **Analysis**

The intersection of 43rd Avenue with the ACDC is located approximately 200-feet north of Peoria Avenue (Point 1) and is bordered on the west by a strip plaza (Point 2) and on the east by a small shopping plaza (Point 3).

Contributing storm water runoff is conveyed from the north in 43rd Avenue to its low point approximately 50 feet north of the ACDC. The runoff is intercepted in 43rd Avenue by a series of inlets and conveyed to the ACDC via a 90-inch storm drain pipe (Point 4). At 43rd Avenue's low point, there exists a curb-opening inlet on the east side (Point 5) and a combination inlet on the west side of 43rd Avenue (Point 6). If the existing inlets are deluged by debris, the inlets efficiency will be reduced thereby producing overflow from the inlets at Points 5 & 6.

For the strip plaza bordering the west side of 43rd Avenue (Point 2), the COE provided spillway drains leading into the ACDC. However, the shopping plaza that borders the east side of 43rd Avenue (Point 3) and the north side of the ACDC is approximately twice the size of the strip plaza, and has no positive drainage outfalls into the ACDC. A sizeable storm event will flood the parking lot.

#### **Solution**

Construct a depressed driveway entrance for the ACDC northwest access ramp (Point 7) to intercept overflow runoff from the sump inlets in 43rd Avenue (Points 5 & 6). This runoff will then be discharged into the ACDC via the access ramp.

Construct a spillway (Point 8) from the shopping plaza (Point 3) to provide for positive drainage into the ACDC from the parking lot.

#### **COE Contract Documents**

The ACDC plans made no provisions to convey overflow runoff from the sump inlets within 43rd Avenue. While the ACDC plans provided for the conveyance of storm water runoff from the strip plaza into the ACDC, they did not provide the same conveyance for the shopping plaza to the east of 43rd Avenue.

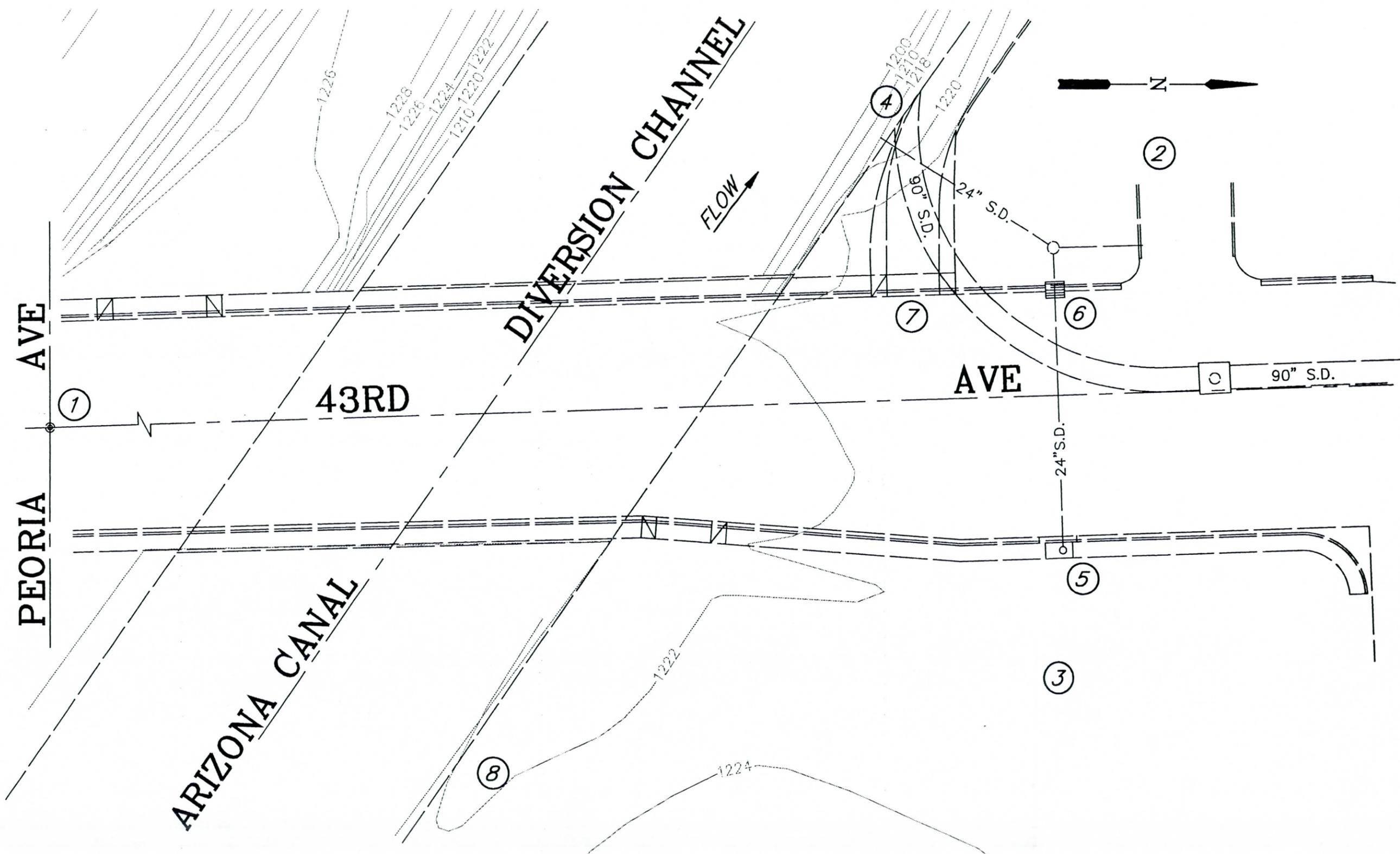
## COST ESTIMATE

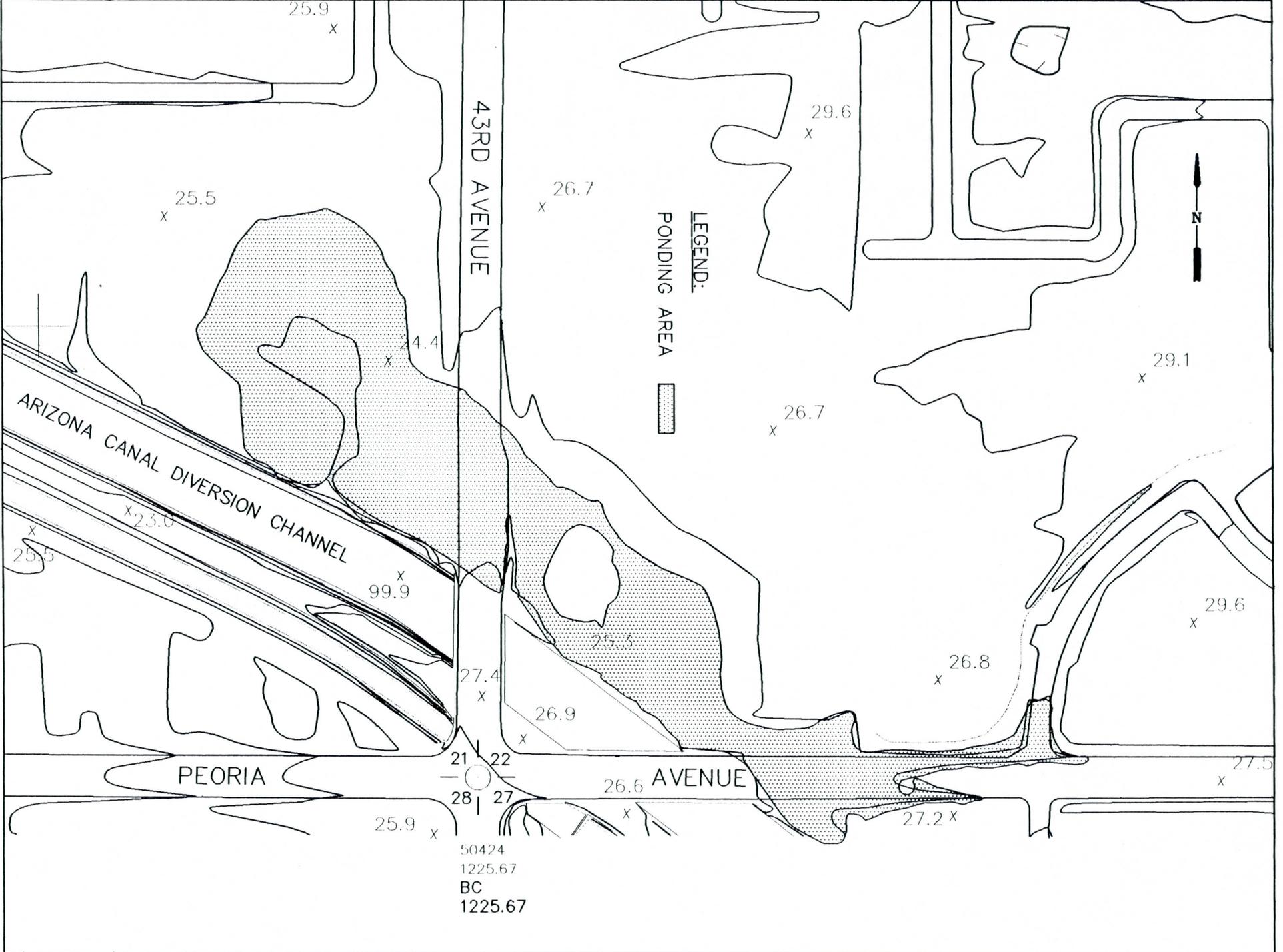
### Construct Depressed Driveway Entrance

Item	Description	Unit	Quantity	Unit Price	Total
1	Concrete Driveway (Remove & Reconstruct)	S.F.	125 \$	4.00 \$	500.00
2	Concrete Curb & Gutter (Remove & Replace)	L.F.	25	8.00	200.00
3	Reconstruction Access Ramp Asphalt Pavement	S.Y.	16	10.00	160.00
4	Landscape Reconstruction	L.S.	1	200.00	<u>200.00</u>
				Sub-Total \$	1,060.00
				15% Contingency \$	<u>159.00</u>
				<b>TOTAL \$</b>	<b>1,219.00</b>

### Construct A Spillway From The Shopping Plaza

Item	Description	Unit	Quantity	Unit Price	Total
1	6" Concrete-Lined Spillway	EA.	1 \$	400.00 \$	400.00
2	Concrete Single Curb (Remove & Replace)	L.F.	20	9.00	180.00
3	Reconstruct Parking Lot Asphalt Pavement	S.Y.	65	8.00	520.00
4	Landscaping Reconstruction	L.S.	1	300.00	<u>300.00</u>
				Sub-Total \$	1,400.00
				15% Contingency \$	<u>210.00</u>
				<b>TOTAL \$</b>	<b>1,610.00</b>





50424  
 1225.67  
 BC  
 1225.67

## **PEORIA AVENUE**

### **Analysis**

The intersection of the ACDC with Peoria Avenue is located approximately 300 feet east of the intersection of Peoria Avenue with 43rd Avenue (Point 1). Peoria Avenue's intersection with the ACDC is impacted by storm water runoff from the northeast and east that is conveyed within Peoria Avenue from the adjacent subdivisions. The storm water runoff is intercepted by a series of inlets in Peoria Avenue and conveyed to the ACDC by a 42-inch storm drain pipe (Point 2). The low point in Peoria Avenue is located approximately 240 feet east of the ACDC with two existing curb-opening inlets (Points 3 & 4) on both the north and south sides of Peoria Avenue.

If these inlets are deluged by debris, their efficiencies will be reduced thereby producing overflow runoff in a sump condition. When this occurs, the runoff will overtop the curb and gutter. The ACDC design provided for an access ramp and maintenance road at the southeast corner of the ACDC's intersection with Peoria Avenue (Point 5). The access ramp cannot convey runoff from Peoria Avenue into the ACDC since it has a standard driveway entrance that is not depressed to function as a spillway (Point 6). In addition, a majority of the storm water runoff is contained in the north half of Peoria Avenue due to the crowned roadway section. The existing roadway section is such that the pavement elevation at the roadway centerline is approximately the same elevation as the top-of-curb. Therefore, in the event there is overflow runoff, the storm water will be overtopping the north top-of-curb (Point 7) in Peoria Avenue at the same time it is overtopping the roadway crown to travel to a potential outfall point at the access ramp (Point 5).

### **Solutions**

Reconstruct the access ramp at the southeast corner of Peoria Avenue's intersection with the ACDC to a depressed driveway entrance with a spillway conveyance into the channel. This will enable the access ramp to function as a spillway to relieve the overflow runoff with the exception of the crowned roadway section at Peoria Avenue's low point. To alleviate this problem, the degree of the crowned section should be reduced by approximately two to three-tenths of a foot below the top-of-curb elevation. This, in combination with the conversion of the access ramp to function as a spillway, will relieve the overflow storm water runoff at this concentration point.

### **COE Contract Documents**

The ACDC plans made no provisions to convey additional runoff.

## COST ESTIMATE

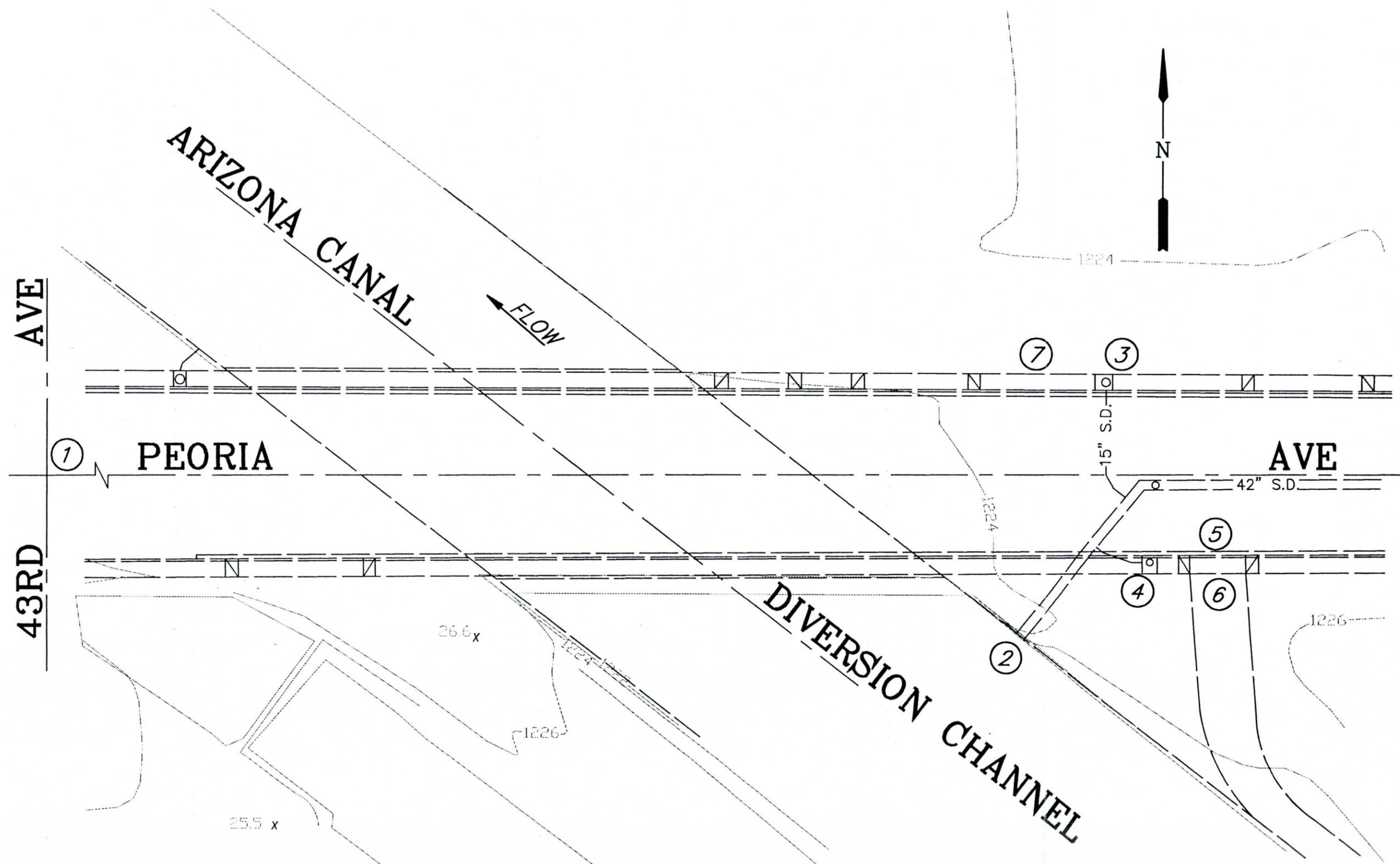
### Construct Depressed Driveway Entrance & Reconstruct the Roadway Crown

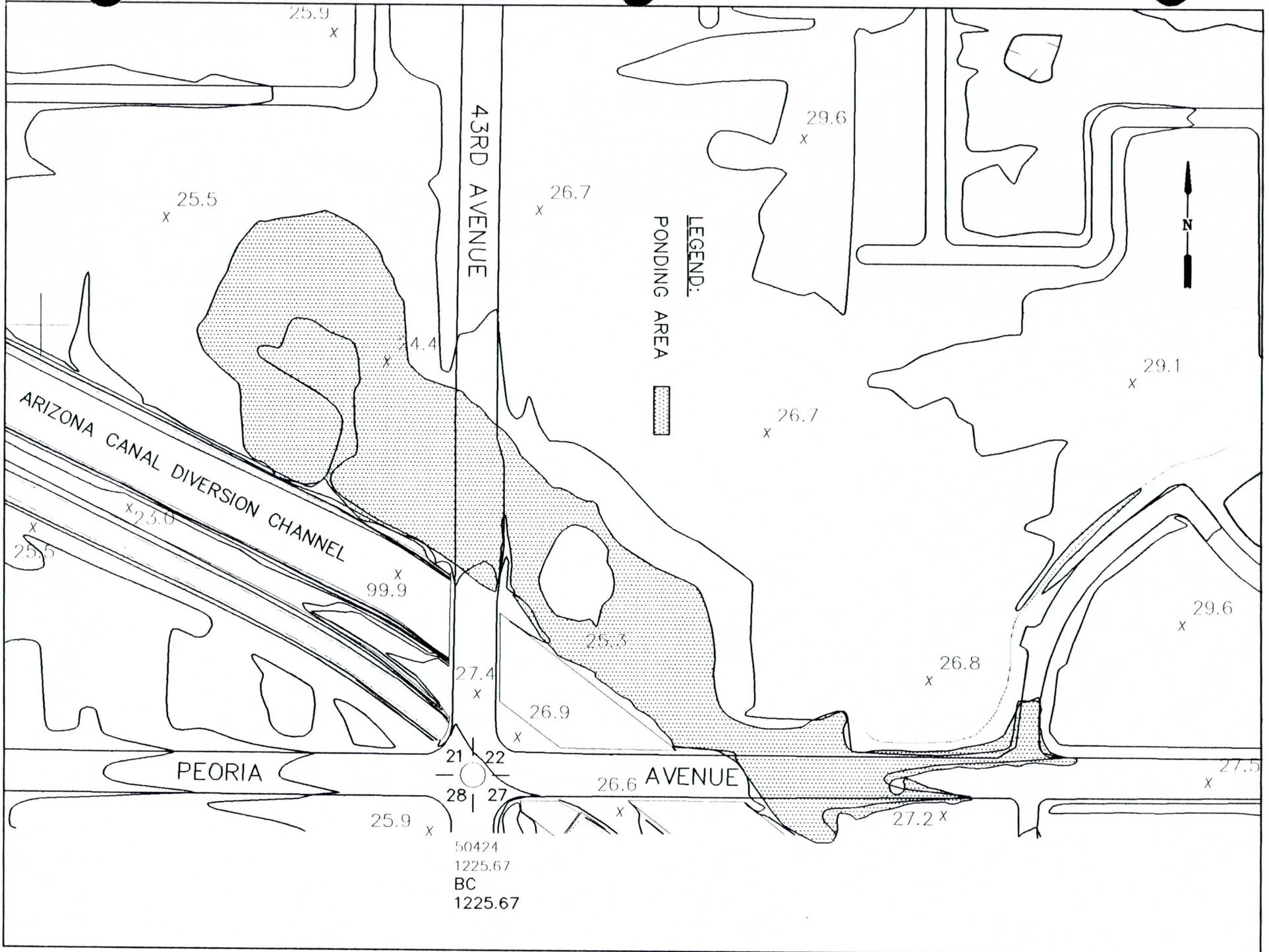
Item	Description	Unit	Quantity	Unit Price	Total
1	Concrete Driveway (Remove & Reconstruct)	S.F.	125	\$ 4.00	\$ 500.00
2	Concrete Curb & Gutter (Remove & Replace)	L.F.	25	8.00	200.00
3	Reconstruction Roadway Crown & Access Ramp Asphalt Pavement	S.Y.	850	10.00	8,500.00
4	Landscape Reconstruction	L.S.	1	200.00	<u>200.00</u>

Sub-Total \$ 9,400.00

15% Contingency \$ 1,410.00

**TOTAL \$ 10,810.00**





## **35TH AVENUE**

### **Analysis**

The intersection of 35th Avenue with the ACDC is located just south of 35th Avenue's intersection with Vogel Avenue (Point 1). This intersection with the ACDC is impacted by storm water runoff from the north and northeast conveyed in 35th Avenue from the adjacent subdivisions. The storm water runoff is intercepted by a series of inlets in 35th Avenue and conveyed to the ACDC by a 96-inch diameter storm drain pipe (Point 2). The low point of 35th Avenue is at its intersection with Vogel Avenue. Curb opening inlets are located at all four corners of this intersection to intercept flows (Points 3, 4, 5 & 6).

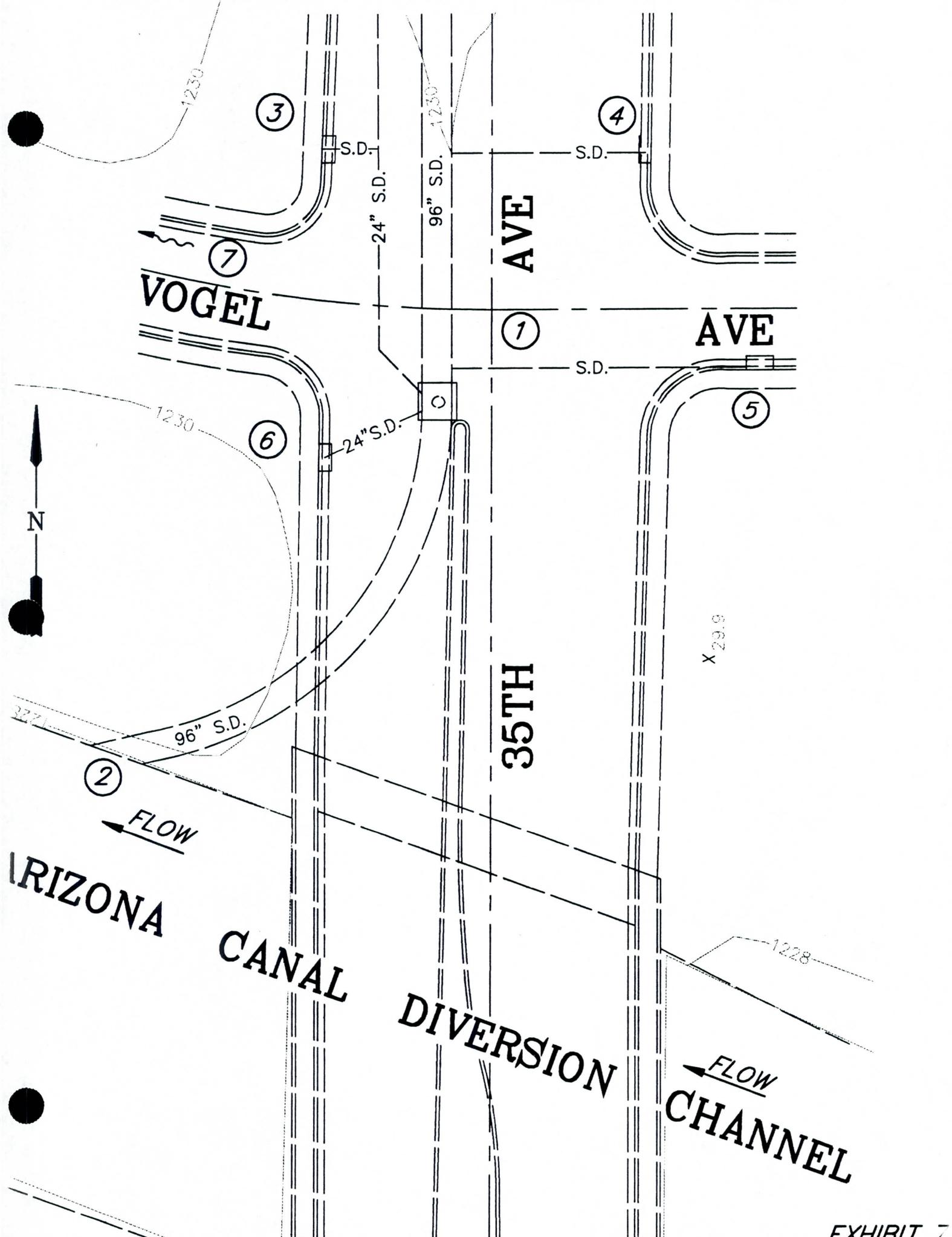
Should the existing inlets be deluged with debris and their efficiencies reduced, the overflow runoff will continue west in Vogel Avenue (Point 7). The overflow runoff will then discharge into the ACDC from Vogel Avenue via a spillway located approximately 700 feet west of 35th Avenue.

### **Solution**

As stated in the analysis, the constructed design by COE appears to be adequate to convey off-site flows into the ACDC without flooding the adjacent properties.

### **COE Contract Documents**

The ACDC plans did make provisions for local flows to enter the channel.



ARIZONA

CANAL

DIVERSION

CHANNEL

AVE

AVE

35TH

VOGEL

②

⑥

⑦

③

④

⑤

①

FLOW

FLOW

S.D.

S.D.

S.D.

24" S.D.

96" S.D.

96" S.D.

1230

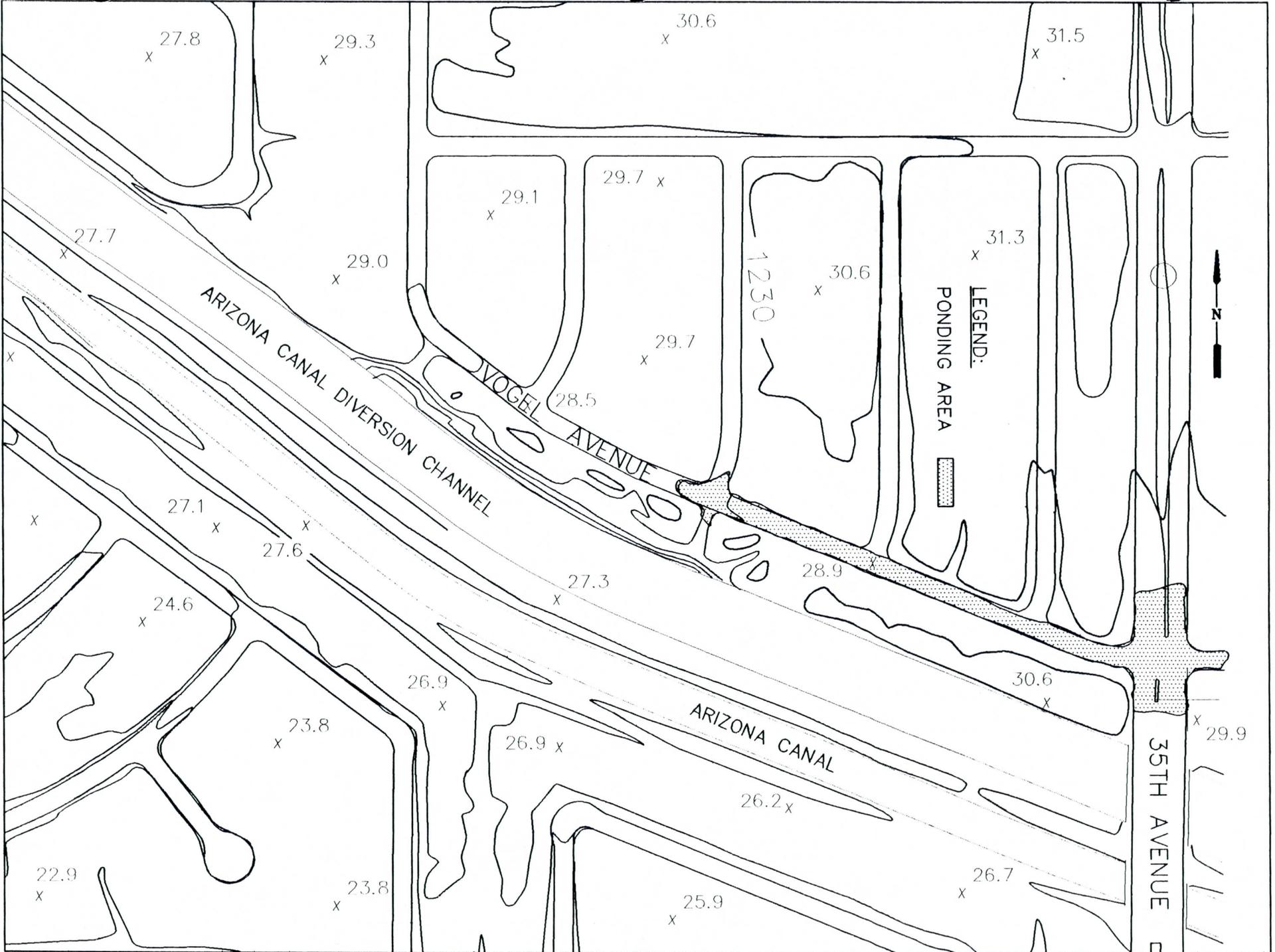
1230

1230

3271

X 29.9

1228



## **TASK 1: REACH 2C - MAJOR INTERSECTIONS**

### **25TH AVENUE**

#### **Analysis**

25th Avenue's intersection with the ACDC occurs between Dunlap Avenue and Mountain View Road (Point 1). The intersection is impacted by storm water runoff from the North conveyed in 25th Avenue with the contributing watershed comprising mostly of business/commercial developments.

The storm water in 25th Avenue is intercepted by two curb opening inlets (Points 3 & 4) located at the low point in the roadway approximately 250 feet north of the ACDC. The inlets, one on the west side and the other on the east side of 25th Avenue, intercept the runoff at this low point and convey the storm water to the ACDC via a 12-inch ductile iron storm drain pipe (Point 5). There are no other designed outfalls into the ACDC for 25th Avenue. In the event the existing inlets are deluged with debris and their efficiencies reduced, there is no existing positive outfall into the ACDC for this overflow runoff.

#### **Solution**

Construct a spillway in the east curb and gutter approximately 70 feet south of the low point inlet (Point 6). The spillway opening would be approximately four-tenths of a foot higher than the inlet opening thereby relieving the overflow runoff to an off-site concentration point before it overtops the curb and gutter and floods adjacent properties. The off-site concentration point is a spillway into the ACDC located approximately 300 feet east of 25th Avenue. The contributing area for this spillway incorporates the area bordered by 25th Avenue on the west and the Cave Creek Wash on the east, which is essentially the City of Phoenix Cave Creek Sports Complex.

#### **COE Contract Documents**

The ACDC plans made no provisions to convey runoff.

## COST ESTIMATE

### Construct A Spillway In The East Curb & Gutter

Item	Description	Unit	Quantity	Unit Price	Total
1	6" Concrete-Lined Channel	S.Y.	135	\$ 25.00	\$ 3,375.00
2	Clear & Grub	S.Y.	175	3.00	525.00
3	Landscaping	L.S.	1	700.00	700.00
4	Right-Of-Way	S.F.	1,500	3.00	4,500.00
5	Concrete Curb & Gutter (Remove & Replace)	L.F.	20	8.00	<u>160.00</u>

Sub-Total \$ 9,260.00

15% Contingency \$ 1,389.00

**TOTAL \$ 10,649.00**

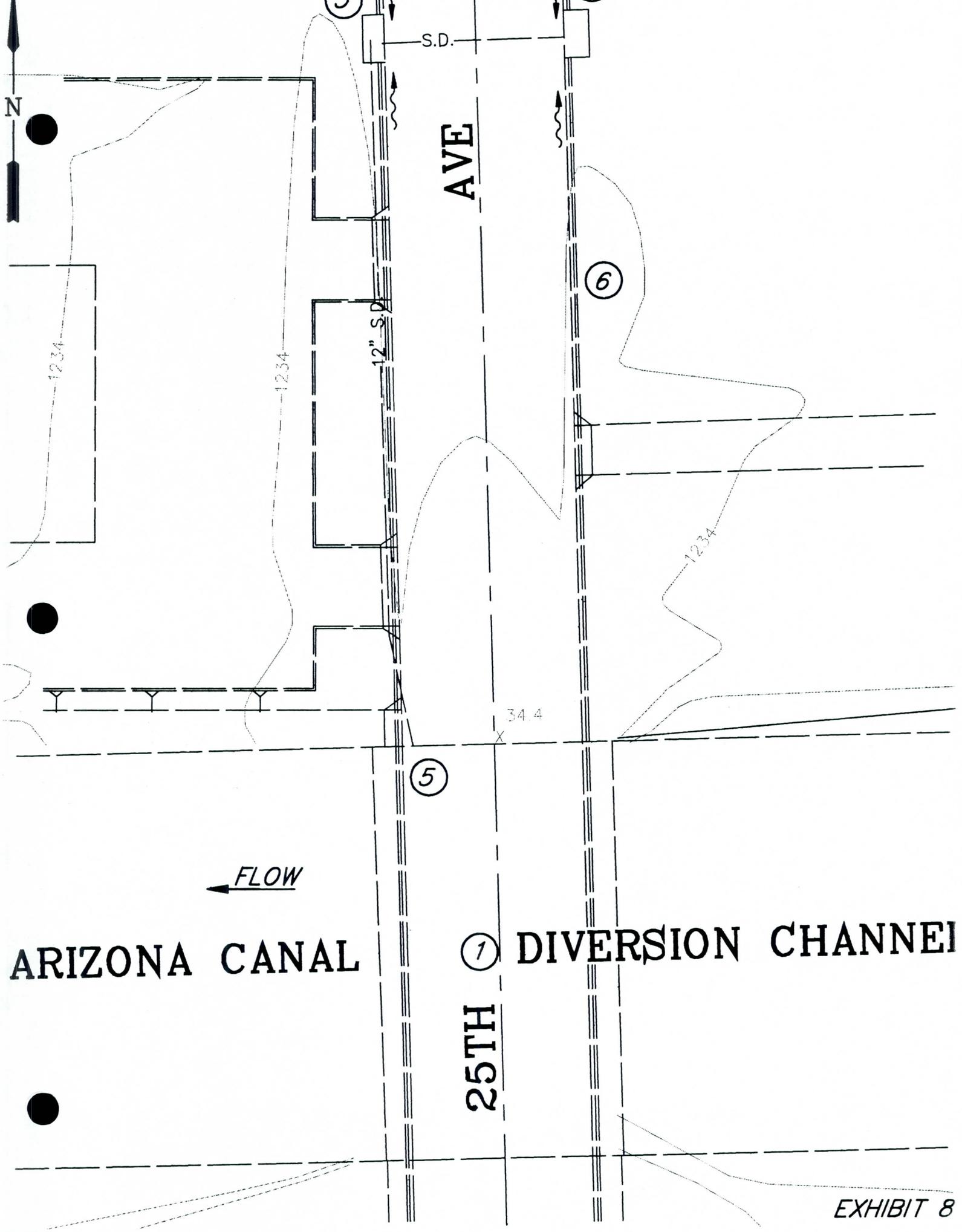
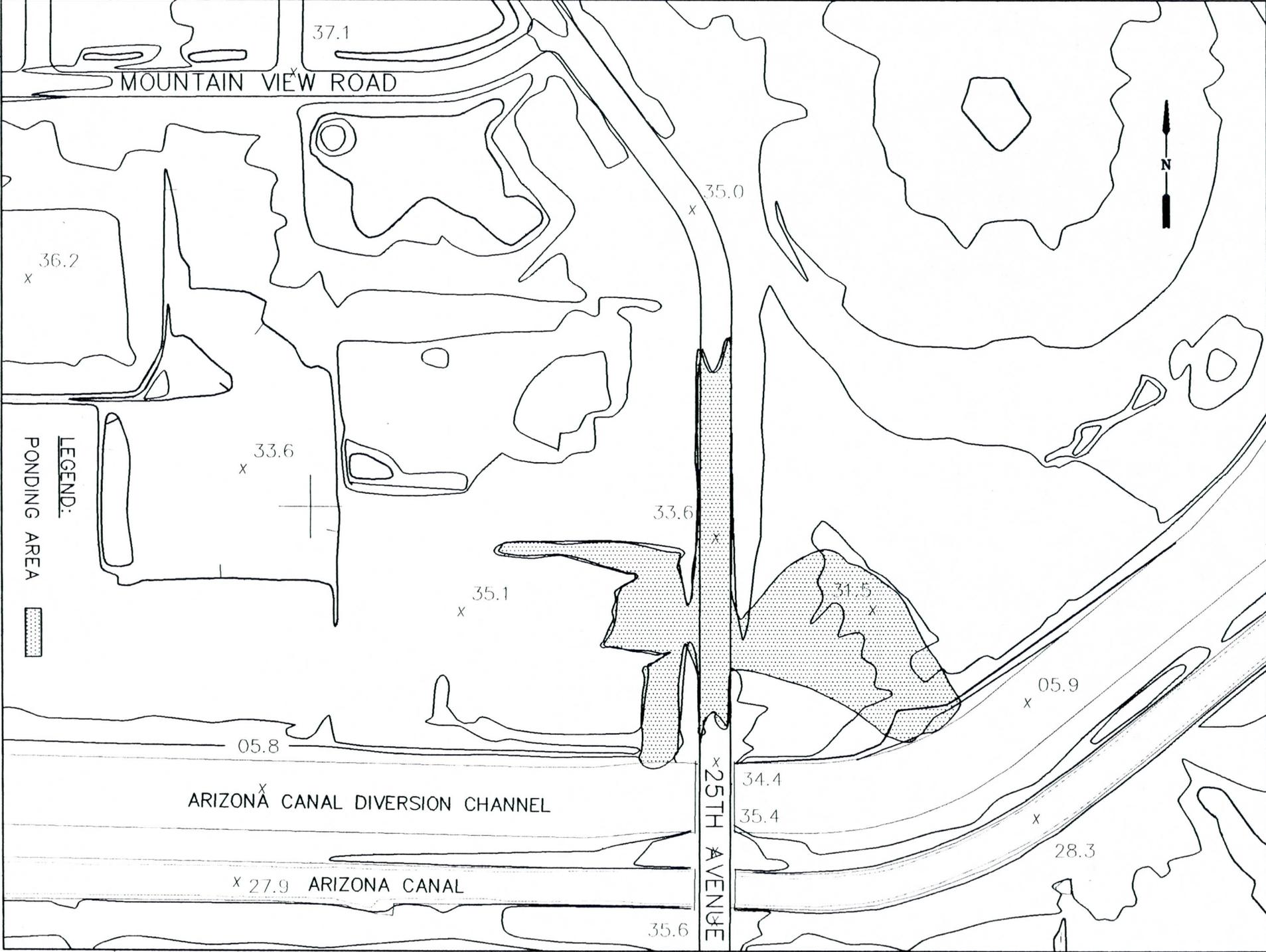


EXHIBIT 8



## **TASK 1: REACH 3 - MAJOR INTERSECTIONS**

### **19TH AVENUE**

#### **Analysis**

Storm runoff flows south on 19th Avenue until reaching Hatcher Road (Point 1). Runoff in the west curb and gutter of 19th Avenue will be intercepted by an existing catch basin, with major flows overtopping the roadway crown and flowing east on Hatcher Road (Point 2). Runoff in the east curb and gutter will turn the corner and flow east on Hatcher Road (Point 3). Flows in Hatcher Road will combine with overflow runoff from the north from Carol Street (Point 4). The culmination of these flows are intercepted at a low point by a curb opening catch basin in the south curb line of Hatcher Road, ACDC Station 612+00, which then discharges into an 18-inch storm drain line east on Hatcher Road (Point 5).

In the event the existing curb opening inlet is deluged with debris and its efficiency reduced, the overflow runoff will overtop the curb and gutter and flow into the landscaped area between Hatcher Road and the ACDC.

#### **Solution**

Construct a typical 12-foot wide overflow spillway into the ACDC. The spillway should be located east of the low point in Hatcher Road making the difference in inlet elevations of the existing curb opening catch basin and the proposed spillway 0.2 feet.

#### **COE Contract Documents**

The ACDC plans made no provision to convey overflow runoff.

## COST ESTIMATE

### Construct An Overflow Spillway

Item	Description	Unit	Quantity	Unit Price	Total
1	6" Concrete-Lined Channel	S.Y.	40 \$	25.00 \$	1,000.00
2	Concrete Curb & Gutter (Remove & Replace)	L.F.	35	8.00	280.00
3	Reconstruct ACDC Maintenance Road	S.Y.	30	4.00	120.00
4	Reconstruct ACDC Channel Wall For Spillway Outlet	L.F.	14	500.00	7,000.00
5	Picket Fence	L.F.	16	25.00	400.00
6	Landscape Reconstruction	L.S.	1	500.00	<u>500.00</u>

Sub-Total \$ 9,300.00

15% Contingency \$ 1,395.00

**TOTAL \$ 10,695.00**

# HATCHER ROAD

# ARIZONA CANAL DIVERSION CHANNEL

# 19TH AVENUE

← FLOW

N

45" S.D.

07.6 x

40.9 X

1232

1232

1230

1228

1234

1238

1240

1232

1230

1230

1232

1236

3

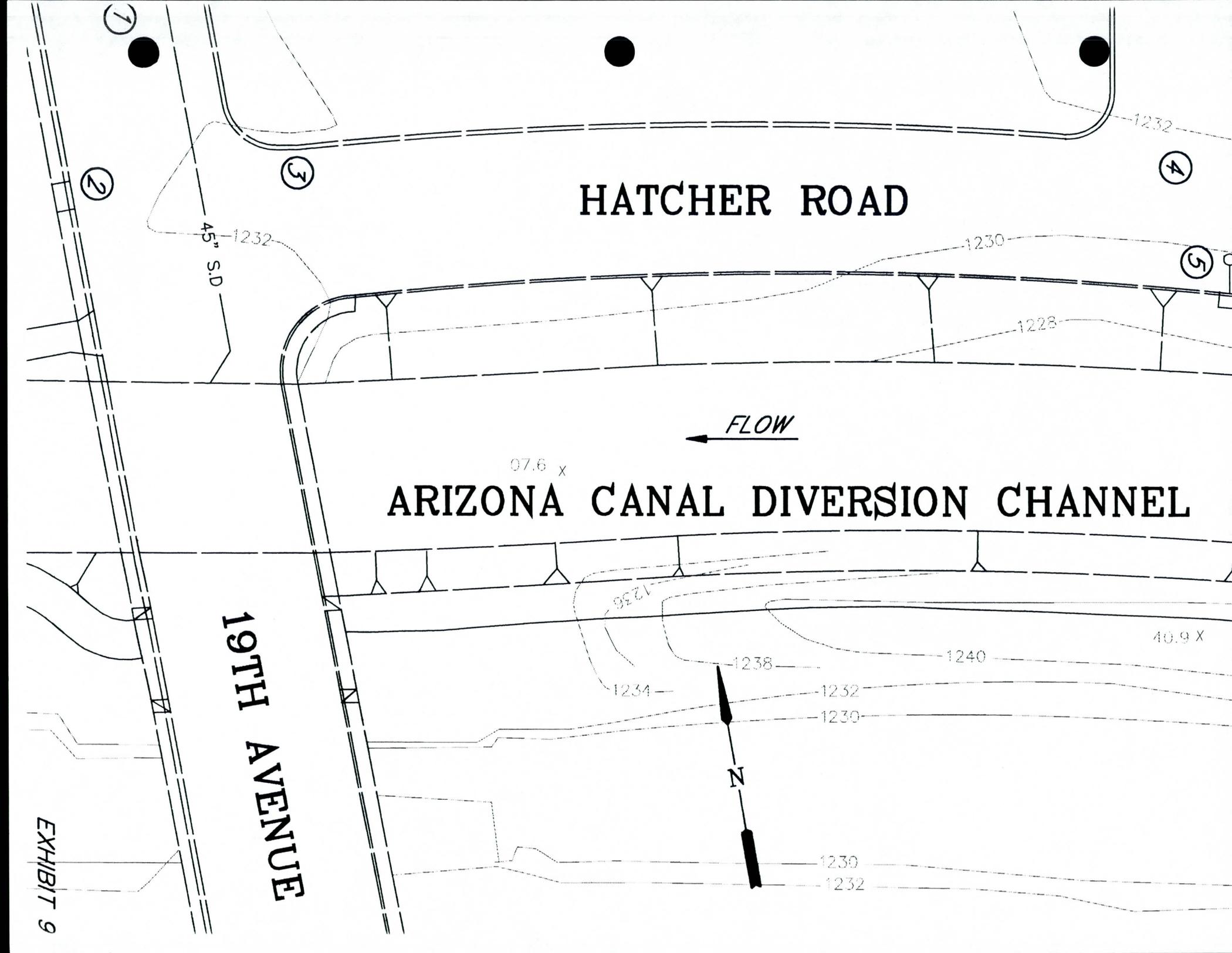
4

5

2

1

EXHIBIT 9



## 7TH AVENUE

### **Analysis**

The intersection of 7th Avenue with the ACDC is a concentration point for a considerably large drainage area north of the channel. The segment of 7th Avenue from the ACDC to Hatcher Road does not have any curb and gutter to channel the storm water runoff. To convey the runoff into the ACDC there exists two grate-inlet catch basins (Points 1 & 2) on the north side of the channel. Both inlets are located just outside of the 7th Avenue roadway prism on the west and east sides of the roadway. The inlet structures are depressed and are constructed with asphaltic concrete aprons to increase their hydraulic performance. Once collected by the inlet structures, the storm water is discharged into the ACDC via a 15-inch concrete pipe (Point 3).

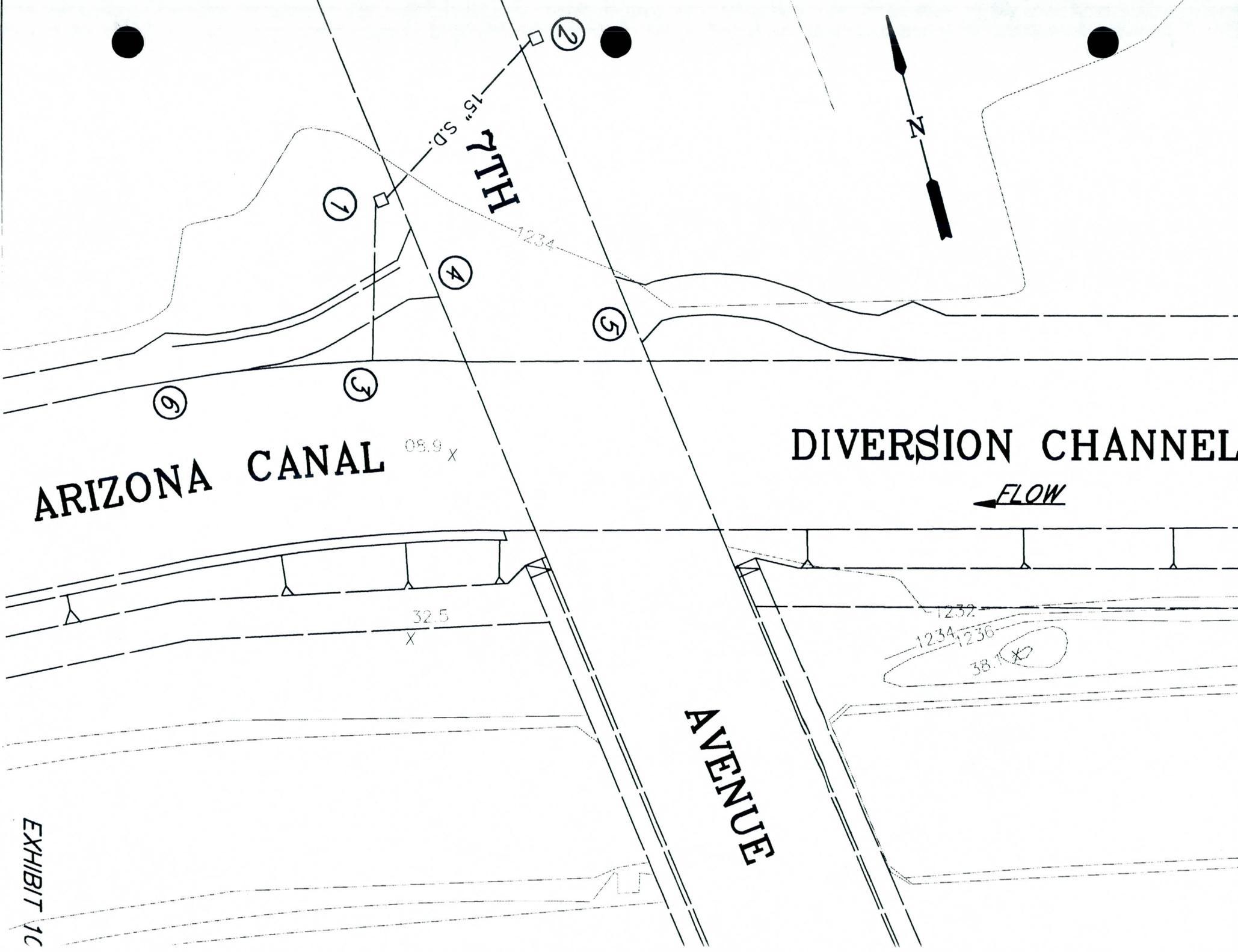
In the event the existing inlets are deluged with debris and their efficiencies reduced the storm water overflow will be conveyed into the ACDC by access ramps and maintenance roads located at the respective sides of the grate-inlet structures (Points 4 & 5) shown in the COE construction documents. The access ramps are similar to a depressed driveway entrance in that the back of the ramp is approximately two inches below the gutter elevation. The access ramps convey the storm runoff onto the maintenance roads which in turn discharges the flows over the top of the channel wall (Point 6).

### **Solution**

As stated in the analysis, the proposed design appears to be adequate to convey off-site flows into the ACDC without creating problem flooding.

### **COE Contract Documents**

The ACDC plans did make provisions for local flows to enter the channel.



**ARIZONA CANAL**

08.9 X

**DIVERSION CHANNEL**

**FLOW**

**AVENUE**

**EXHIBIT 1C**

## **DUNLAP AVENUE**

### **Analysis**

The intersection of Dunlap Avenue with the ACDC is impacted by off-site flows from drainage areas extending east and north of the intersection. Runoff is conveyed to this concentration point from the east on Dunlap Avenue (Point 1), but the majority of the stormwater runoff is generated from the drainage area north of the intersection and conveyed south on Third Avenue (Point 2). The designed low points (Points 3 & 4) are located at both the north and south curb lines of Dunlap Avenue at the intersection of Dunlap Avenue with Third Avenue. These low points have been constructed with grate-inlet catch basins to intercept the off-site runoff. The catch basins are interconnected with two 18-inch storm drain pipes with a 36-inch storm drain pipe that discharges the runoff into the ACDC.

The COE construction plans show a proposed access ramp and maintenance road which begin on Third Avenue just north of Dunlap Avenue (Point 5). The plans show the design of this access ramp is typical of a standard driveway entrance which will not allow storm water runoff to be conveyed from Third Avenue to the ACDC.

During construction, homes bordering Caron Street and Third Avenue adjacent to the ACDC experienced extensive flooding after a sizeable storm event (Point 6). At that time the existing catch basins had not been constructed which simulates the grate-inlets becoming deluged with debris thereby reducing their efficiencies and creating overflow runoff. This illustrates the need for an overflow spillway to convey major flows into the ACDC and alleviate the flooding problem.

### **Solution**

Change the typical driveway entrance for the access ramp (Point 5) to a depressed driveway entrance and add single curb to the north side of the access ramp (Point 6) to contain the storm water runoff. This change would allow the storm water overflows to be conveyed from Third Avenue to the ACDC via the access ramp/ maintenance road. Adequate slope for the access ramp would have to be provided along with minor paving modifications within Third Avenue to channel runoff to the outfall along the access ramp.

### **COE Contract Documents**

The ACDC plans made no provisions for an overflow spillway to convey additional runoff.

## COST ESTIMATE

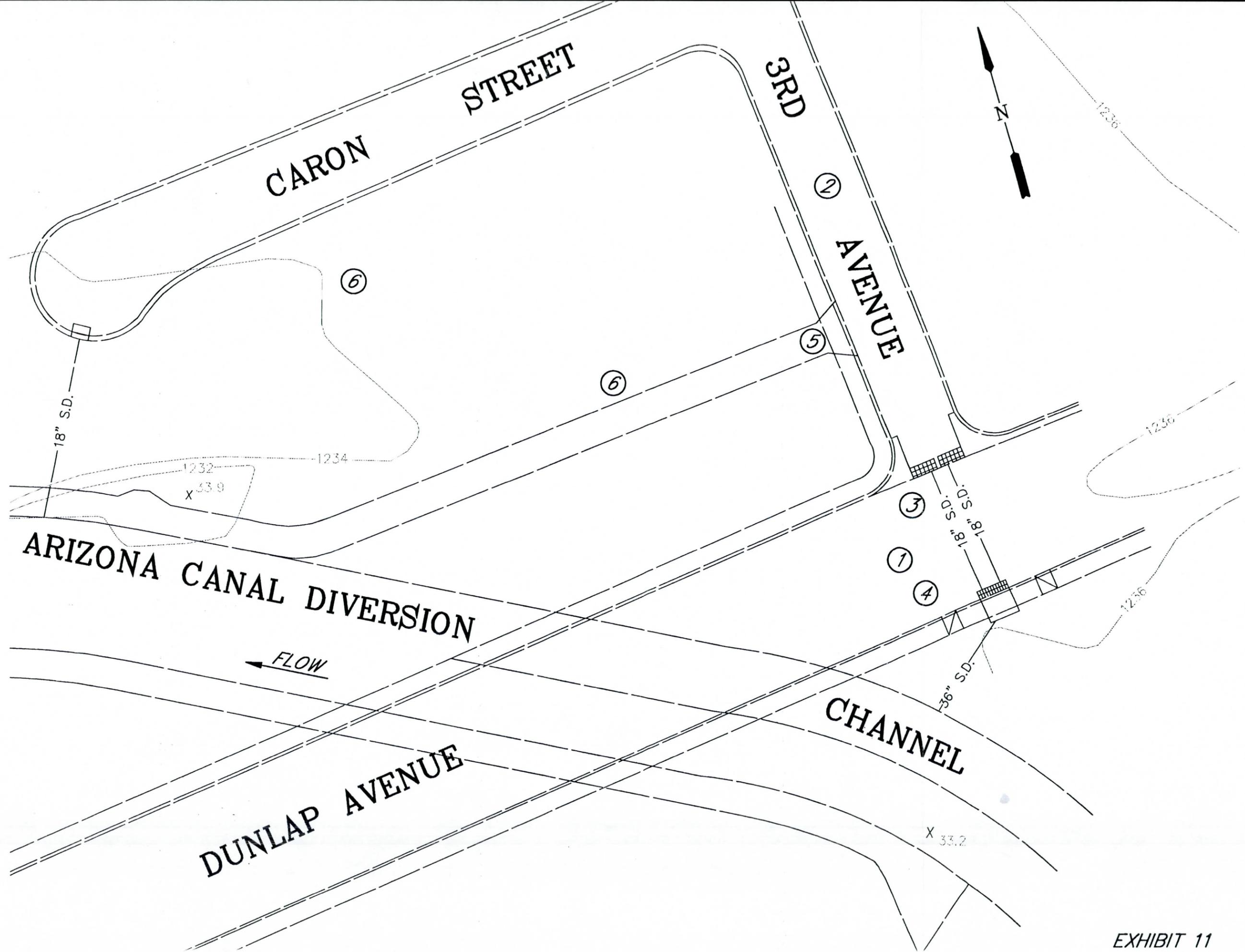
### Depress Driveway Entrance & Reconstruct Access Ramp

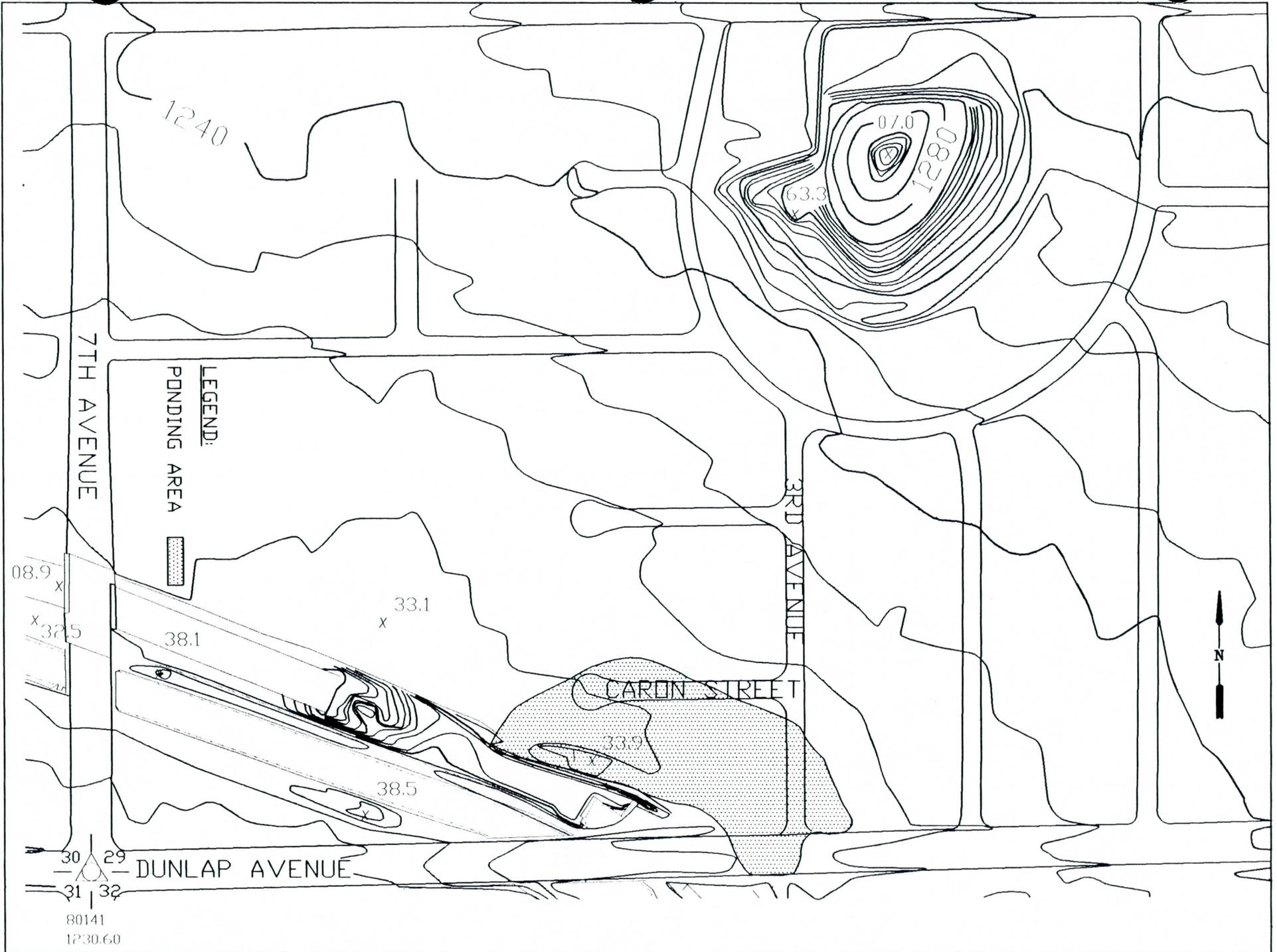
Item	Description	Unit	Quantity	Unit Price	Total
1	Concrete Driveway (Remove & Reconstruct)	S.F.	50	\$ 4.00	\$ 200.00
2	Concrete Single Curb	L.F.	280	9.00	2,520.00
3	Reconstruct Access Ramp Asphalt Pavement	S.Y.	145	4.00	580.00
4	Reconstruct 3rd Avenue Asphalt Pavement	S.Y.	135	10.00	1,350.00
5	Landscape Reconstruction	L.S.	1	1,000.00	<u>1,000.00</u>

Sub-Total \$ 5,650.00

15% Contingency \$ 848.00

**TOTAL \$ 6,498.00**





## CENTRAL AVENUE

### **Analysis**

The intersection of Central Avenue with the ACDC is impacted by off-site runoff generated from drainage areas to the northeast conveyed on Ruth Avenue (Point 1) and from drainage areas to the north conveyed on Central Avenue (Point 2). The ACDC is an open channel structure upstream of Central Avenue to a point just east of Central Avenue's east right-of-way line. From there, and continuing west under Central Avenue to Dunlap Avenue, the ACDC is a covered "box" structure (Point 3).

As shown in the COE construction documents, runoff that flows west on Ruth Avenue is intercepted and conveyed to the ACDC open channel section by a depressed driveway access ramp. The access ramp is located at a low point in the south curb line of Ruth Avenue (Point 4). The runoff is then discharged into the ACDC via the maintenance road.

Runoff that flows south toward the ACDC structure in Central Avenue is intercepted by a series of existing curb-opening catch basins that discharge into an 84-inch storm drain pipe (Point 5). The storm drain line discharges the intercepted storm water runoff into the covered ACDC structure west of Central Avenue. Construction of the ACDC at Central Avenue has created a low point immediately north of the channel. Storm water runoff is intercepted in these areas by four curb opening catch basins, two on each side of the roadway median (Point 6) and one each in the outside curb & gutter (Point 7).

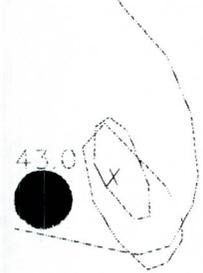
When these curb opening inlets, located at the low points in Central Avenue, are deluged with debris and their efficiencies reduced, the overflow runoff will pond and sheet flow to the maintenance road outfall in Ruth Avenue at Point 4.

### **Solution**

As stated in the analysis, the COE design has adequately provided for the conveyance of off-site flows into the ACDC.

### **COE Contract Documents**

The ACDC plans did make provisions for local flows to enter the channel.



1238

ARIZONA CANAL

DIVERSION CHANNEL

AVENUE

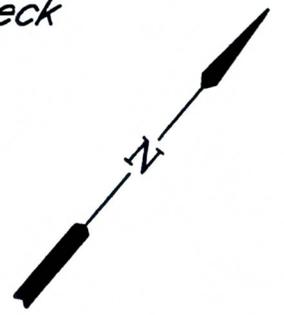
84" S.D.

CENTRAL

☉ of Covered Deck

RUTH AVENUE

FLOW



5

2

6

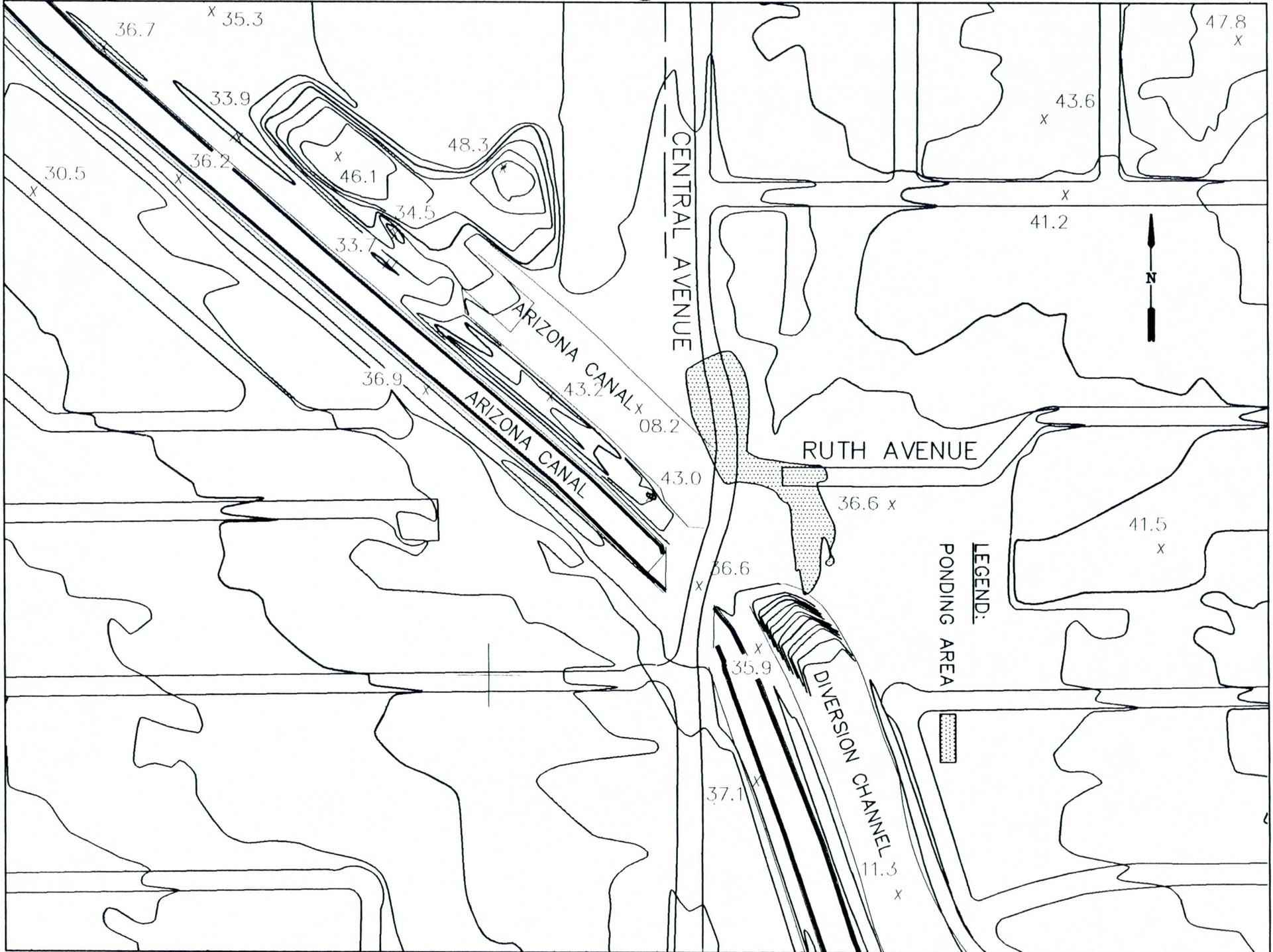
7

7

3

4

1



## **7TH STREET**

### **Analysis**

The intersection of 7th Street with the ACDC is impacted by off-site flows generated from the north and northeast that are conveyed predominantly in 7th Street. The runoff is carried by both the east and west curb and gutters of 7th Street to the local street just north of the ACDC, Las Palmaritas Drive (Point 1). At this intersection, there is a low point in 7th Street where the runoff in the east gutter turns and continues east along Las Palmaritas Drive (Point 2). This flow is discharged into the ACDC via another collector street and spillway into the channel.

The runoff in the west gutter turns and continues west along Las Palmaritas Drive approximately 200 feet to a low point (Point 3). At this low point there are two existing grate-inlet catch basins. The runoff intercepted by these inlets is then discharged into the ACDC by a 12-inch concrete pipe (Point 4).

If the inlets are deluged by debris, their efficiencies will be reduced and thereby produce overflow runoff. The runoff will pond and eventually sheet flow to the spillway at Point 5 and discharged into the ACDC. This spillway is located at the southwest corner of the intersection of 7th Street with Las Palmaritas Drive (Point 5) and will convey the overflow runoff to the ACDC.

### **Solution**

As stated in the analysis, the proposed design appears to be adequate to convey off-site flows into the ACDC without creating problem flooding. Runoff that has exceeded the inlet capacities in the sump in Las Palmaritas Drive (Point 3) is conveyed into the ACDC via the spillway at the southwest corner of the intersection of 7th Street and Las Palmaritas Drive (Point 5). The spillway is approximately 200-feet east of the low point, therefore causing ponding prior to the water reaching the overflow spillway. To minimize maintenance of the ACDC landscaping damaged during this ponding, an additional spillway located closer to the sump in Las Palmaritas Drive (Point 3) is recommended but not necessary.

### **COE Contract Documents**

The ACDC plans did make provisions to convey off-site runoff.

## COST ESTIMATE

### Construct An Overflow Spillway

Item	Description	Unit	Quantity	Unit Price	Total
1	6" Concrete-Lined Channel	S.Y.	55	\$ 25.00	\$ 1,375.00
2	Concrete Roll Curb & Gutter (Remove & Replace)	L.F.	16	8.00	128.00
3	Reconstruct Maintenance Road	S.Y.	15	4.00	60.00
4	Reconstruct ACDC Channel Wall For Spillway Outlet	L.F.	6	500.00	3,000.00
5	Picket Fence	L.F.	8	25.00	200.00
6	Landscape Reconstruction	L.S.	1	750.00	<u>750.00</u>

Sub-Total \$ 5,513.00

15% Contingency \$ 827.00

**TOTAL \$ 6,340.00**

**ARIZONA CANAL DIVERSION CHANNE**

**LAS PALMARITAS DRIVE**

**7TH STREET**

**FLOW** →

12" S.D. (4)

(3)

(5)

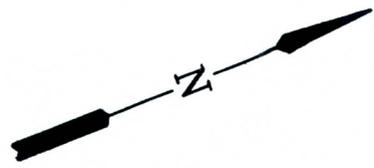
(1)

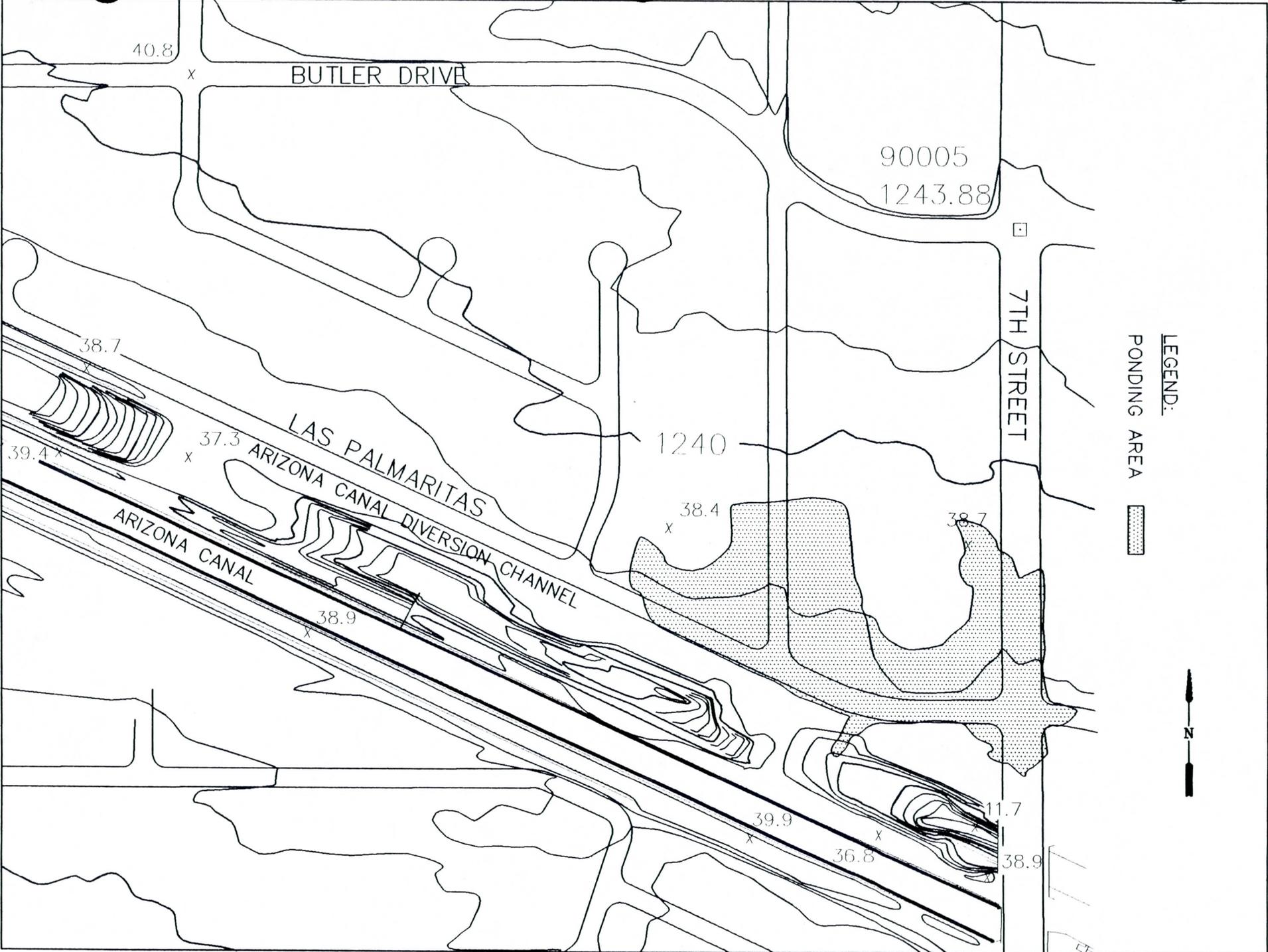
(2)

36.8 X

38.9 X

1220  
1218  
1216  
1214  
1212  
1230  
1232  
1234  
1236





LEGEND:  
PONDING AREA



## NORTHERN AVENUE

### **Analysis**

The intersection of Northern Avenue with the ACDC is impacted by off-site flows from the north and northeast. These flows are conveyed predominantly by Northern Avenue which slopes from east to west and consists of a crowned roadway section. The runoff is carried by the north and south curb and gutters to a low point in the north curb line just east of the ACDC on Northern Avenue (Point 1). At this location, the crowned roadway section has been transitioned to a continuous cross-slope that drains to the north curb line low point.

An existing catch basin at the low point has been replaced by the COE plans with an access ramp that has been constructed with a depressed driveway entrance section. The access ramp conveys the storm runoff onto the maintenance road which in turn discharges the flow over the top of the channel wall into the ACDC (Point 2).

### **Solution**

As stated in the analysis, the proposed design appears to be adequate to convey off-site flows into the ACDC without creating problem flooding.

### **COE Contract Documents**

The ACDC plans did make provisions for local flows to enter the channel.



X 35.6

CHANNEL FLOW



DIVERSION

12.3 X

NORTHERN

CANAL

AVENUE

②

③

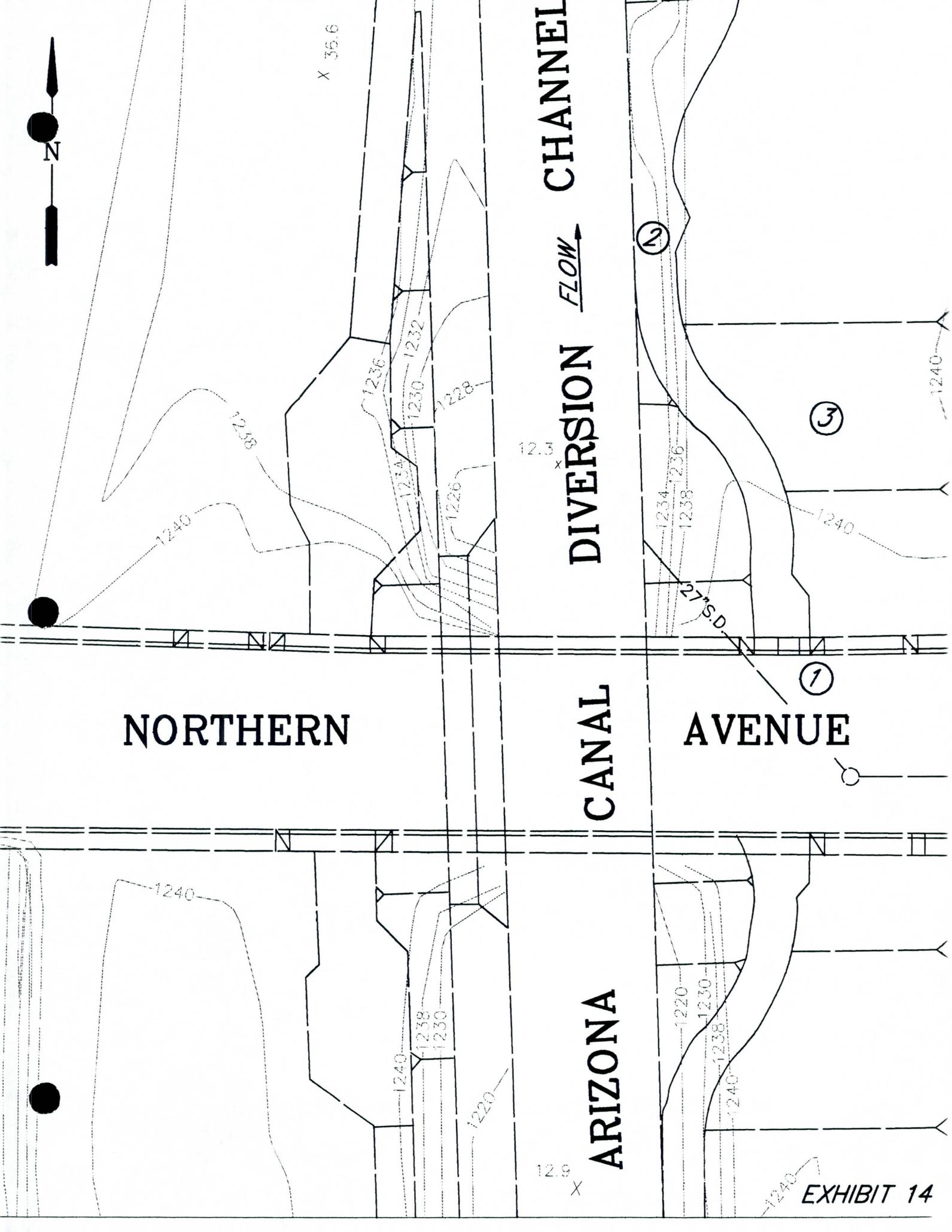
①

27° S.D.

ARIZONA

12.9 X

EXHIBIT 14



## **TASK 1: REACH 4 - MAJOR INTERSECTIONS**

### **12TH STREET**

#### **Analysis**

The intersection of 12th Street with the ACDC is located just south of 12th Street's intersection with the Dreamy Draw Wash (Point 1). The ACDC intersection is impacted by storm water runoff generated from the drainage area to the east and by floodwaters from the Dreamy Draw Wash. If a sizeable storm event occurs that exceeds the capacity of the Dreamy Draw Wash, the overflow floodwaters are diverted south along 12th Street to its intersection with the ACDC (Point 2).

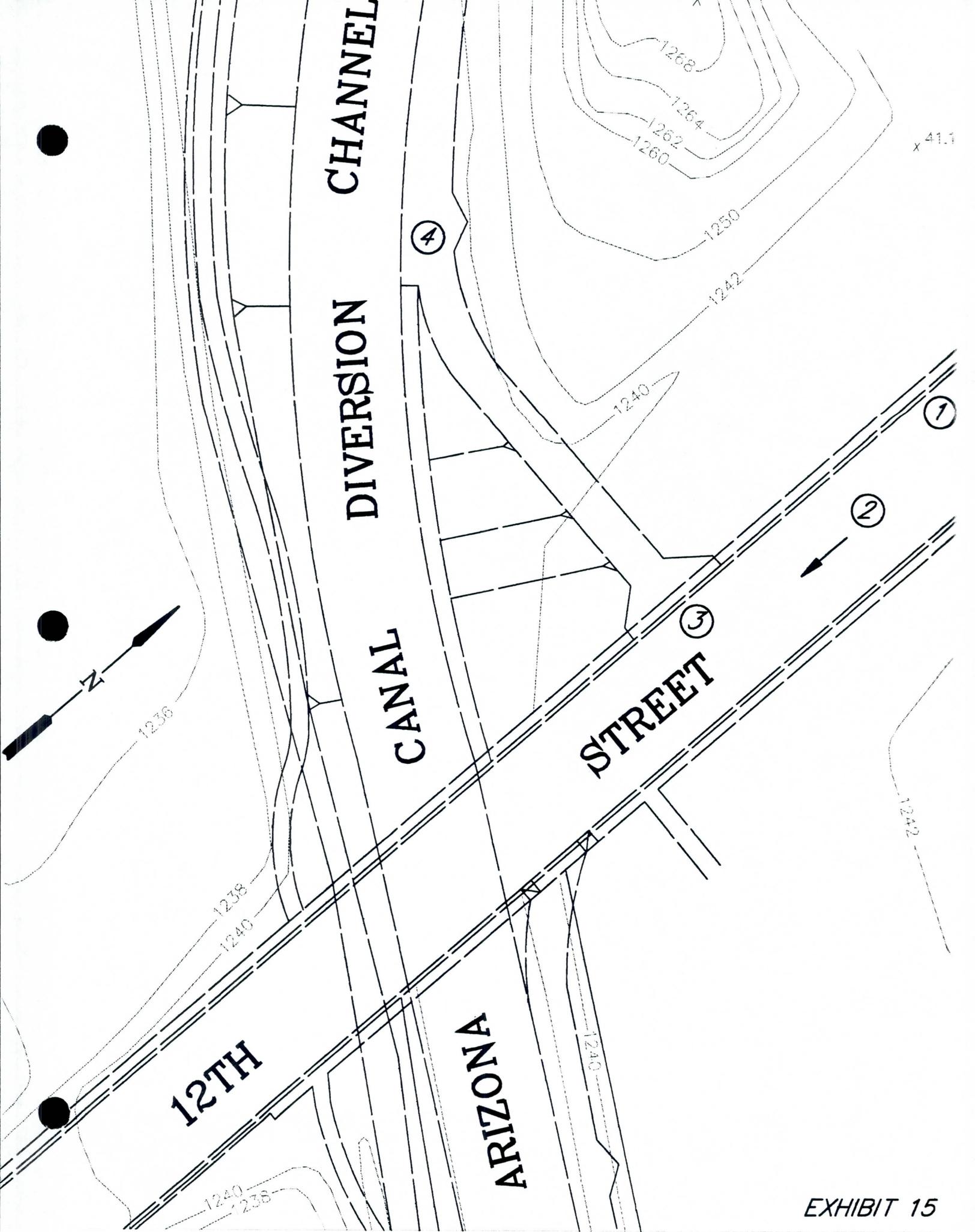
These flows are concentrated at a low point located at the northwest corner of the intersection of 12th Street with the ACDC (Point 3). The storm water runoff, as shown on the COE plans, is conveyed into the ACDC by an access ramp and maintenance road located at this low point. The access ramp is designed as a depressed driveway entrance and conveys the runoff onto the maintenance road which discharges the flows over the top of the channel wall (Point 4).

#### **Solution**

As stated in the analysis, the proposed design appears to be adequate to convey off-site flows into the ACDC without creating problem flooding. The ACDC construction of this intersection has not yet been fully completed. The northwest access ramp has been constructed but the maintenance roads and overall channel construction have yet to begin. Therefore, construction implementation of the design plans must be monitored to ensure proper drainage hydraulics.

#### **COE Contract Documents**

The ACDC plans did make provisions for local flows to enter the channel.



## **16TH STREET**

### **Analysis**

16th Street's intersection with the ACDC is impacted by storm water runoff generated from a small drainage area in 16th Street to the north (Point 1) and predominantly from flows conveyed from the northeast and east by the Myrtle Avenue Wash (Point 2). The Myrtle Avenue Wash crosses 16th Street just north of the ACDC's intersection with 16th Street. The majority of runoff in 16th Street north of the ACDC generally flows to the dipped roadway crossing at the Myrtle Avenue Wash. The small amount of runoff generated by the area that borders the ACDC in 16th Street, as shown on the COE plans, is conveyed into the channel by the use of access ramps and maintenance roads located at both the east and west sides of 16th Street north of the ACDC (Points 3 & 4).

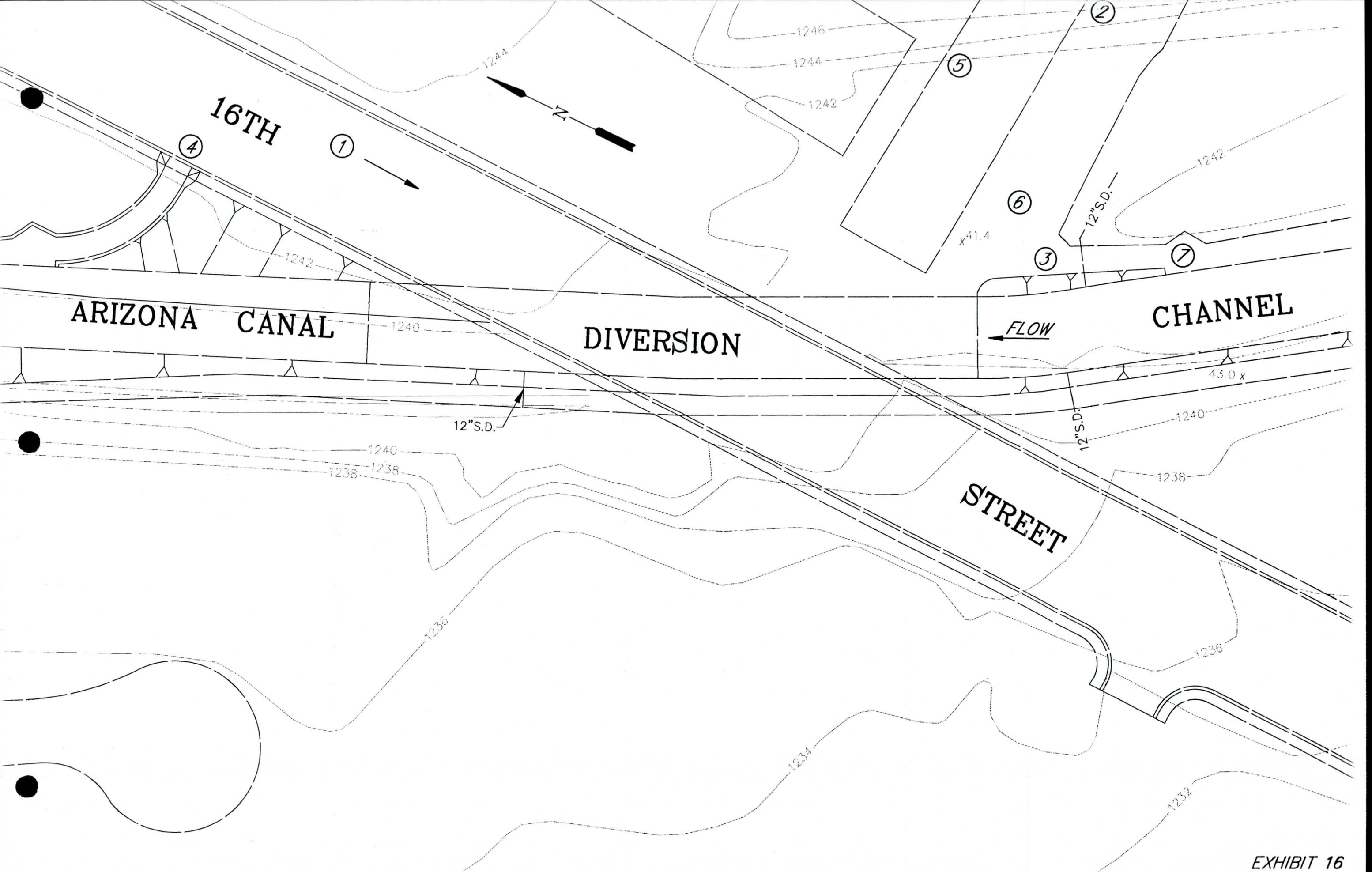
The Myrtle Avenue Wash upstream of its crossing with 16th Street incorporates a diversion of flows at the intersection of Myrtle Avenue with 17th Street. The natural course of the wash from its intersection with 17th Street is to continue west along Myrtle Avenue, but a portion of the runoff is diverted to the southwest at this intersection. The diverted flows continue southwest until they reach the east boundary of an apartment complex that is located at the northeast corner of the intersection of 16th Street with the ACDC (Point 5). The runoff is then conveyed around the apartment complex, via a parking lot, to the northeast corner of the intersection of 16th Street with the ACDC (Point 6). The COE plans show an access ramp to be constructed at this location which would convey diverted Myrtle Avenue Wash flows from the parking lot of the apartment complex into the ACDC (Point 7).

### **Solution**

As stated in the analysis, the proposed design appears to be adequate to convey storm water runoff into the ACDC without creating problem flooding. Runoff generated from 16th Street in itself will be minor compared to the diverted flow from the Myrtle Avenue Wash. The ACDC construction of this intersection has not been completed. Therefore construction implementation of the design plans must be monitored to ensure proper drainage hydraulics. A particular area of concern is the access ramp and maintenance road at the northeast corner of the intersection (Point 7). Proper grading and bank protection must be established to ensure that the diverted flow from the Myrtle Avenue Wash is safely conveyed to the access ramp.

### **COE Contract Documents**

The ACDC plans did make provisions for local flows to enter the channel.



## MARYLAND AVENUE

### **Analysis**

The intersection of Maryland Avenue with the ACDC is impacted by off-site flows generated from drainage areas east of this site. These contributing flows are conveyed to the ACDC through the adjacent City of Phoenix Granada Park, (Point 1) and Maryland Avenue (Point 2).

The storm water runoff discharged from the Granada Park crosses 20th Street at two existing dipped roadway crossings (Points 3 & 4). The runoff then follows its existing flow path to the ACDC where it is discharged into the channel via a spillway (Point 5) or over the channel wall (Point 6) as shown on the COE plans.

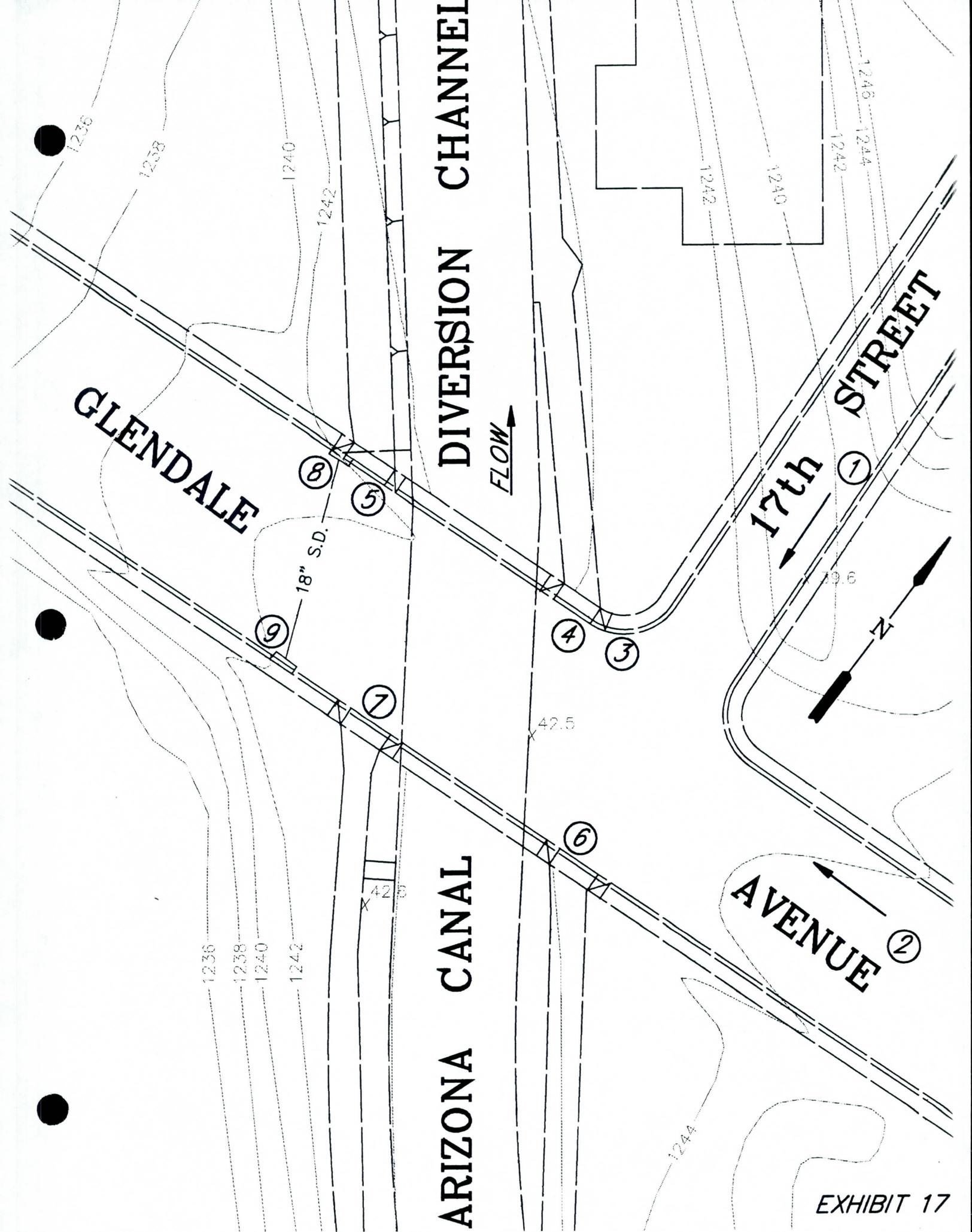
The storm water runoff conveyed by Maryland Avenue flows from the east to its intersection with the ACDC. Maryland Avenue's longitudinal slope is at a continuous grade as it crosses the ACDC, thereby creating a flow-by condition. The COE plans show this runoff to be intercepted with the access ramps that use the existing depressed driveway sections (Points 7, 8 & 9). The flows intercepted by the access ramps are conveyed onto the maintenance roads and discharged into the ACDC over the channel wall or by spillways. The flow-by continues west along Maryland Avenue.

### **Solution**

As stated in the analysis, the proposed design appears to be adequate to convey off-site flows into the ACDC without creating problem flooding. The construction of this intersection has not been completed. Therefore, construction implementation of the design plans must be monitored to ensure proper drainage hydraulics.

### **COE Contract Documents**

The ACDC plans did make provisions for local flows to enter the channel.



ARIZONA CANAL

ARIZONA CANAL

GLENDALE

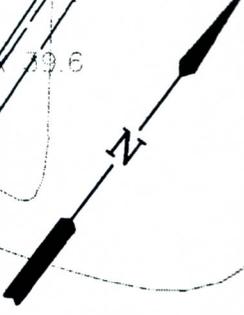
DIVERSION CHANNEL

17th STREET

AVENUE

18" S.D.

FLOW



## **GLENDALE AVENUE**

### **Analysis**

The intersection of Glendale Avenue with the ACDC is impacted by off-site flows from drainage areas extending both north and east of the intersection. Runoff generated from these drainage areas are conveyed within the roadway section southerly on 17th Street (Point 1) and westerly on Glendale Avenue (Point 2). The culmination of flows from the two drainage areas is at the intersection of 17th Street and Glendale Avenue, which is also the northeast corner of the intersection of Glendale Avenue with the ACDC (Point 3).

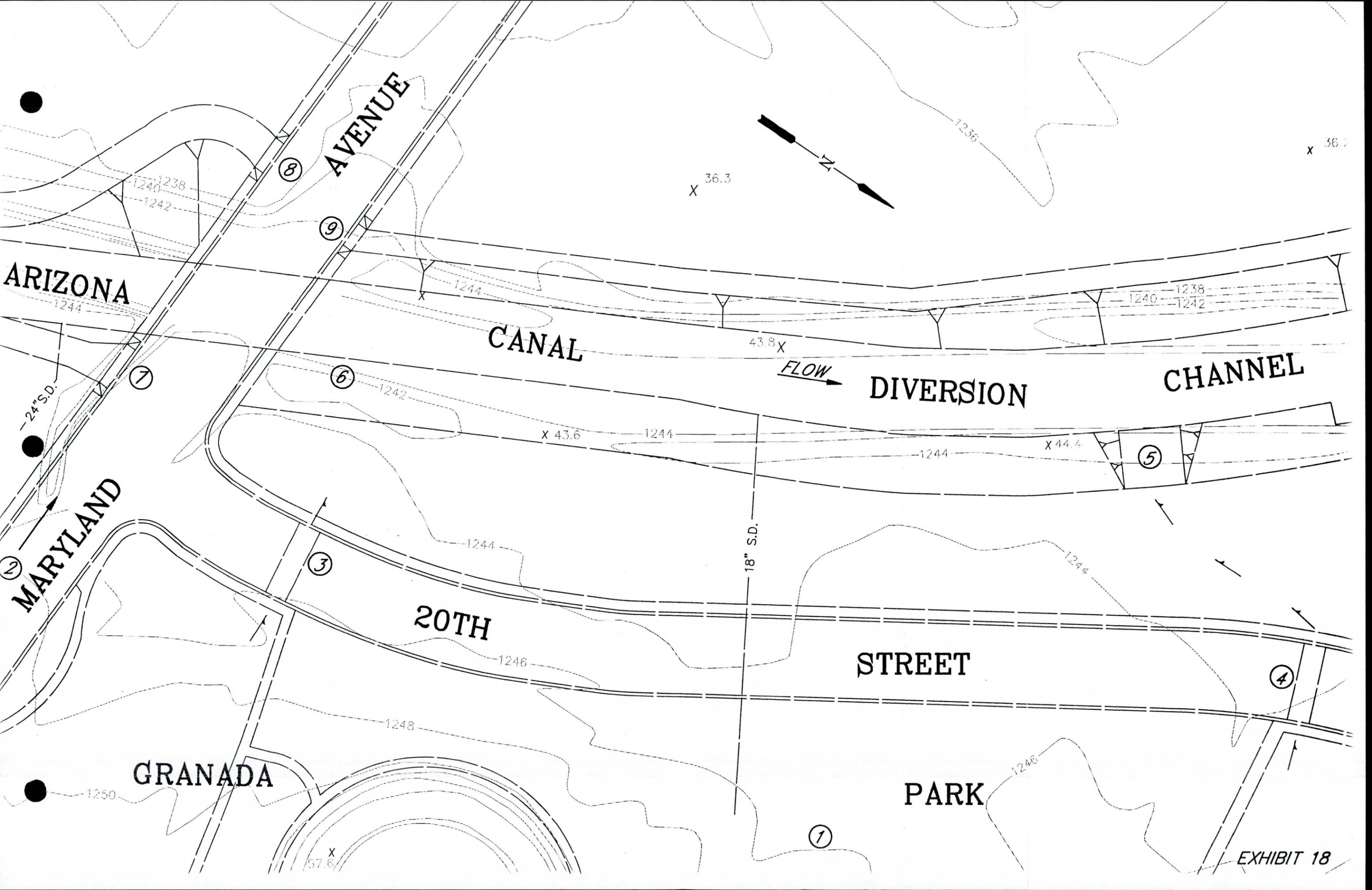
Glendale Avenue's longitudinal grade is a continuous slope as it crosses the ACDC, thereby creating a flow-by condition for the contributing runoff. The COE plans attempt to convey the runoff on Glendale Avenue into the ACDC by the use of four access ramps, located at each corner of the intersection of Glendale Avenue with the ACDC (Points 4, 5, 6 & 7), and with two existing catch basins that are located between the ACDC and the Arizona Canal (Points 8 & 9). The access ramps are all designed as depressed driveway entrances that convey the runoff onto the maintenance roads which then discharge the runoff into the ACDC over the channel wall or by spillways. Storm water runoff that is not intercepted and conveyed into the ACDC will continue to flow west on Glendale Avenue.

### **Solution**

As stated in the analysis, the proposed design appears to be adequate to convey off-site flows into the ACDC without creating problem flooding. The construction of this intersection has not been completed. Therefore, construction implementation of the design plans must be monitored to ensure proper drainage hydraulics and grading within the ACDC right-of-way.

### **COE Contract Documents**

The ACDC plans did make provisions for local flows to enter the channel.



x 36.3

x 36.3

1238  
1240  
1242

CANAL

43.8x

FLOW

DIVERSION

CHANNEL

x 43.6

1244

1244

x 44.4

24" S.D.

18" S.D.

20TH

1246

STREET

1248

GRANADA

PARK

1250

1246

x 57.6

EXHIBIT 18

## **24th STREET**

### **Analysis**

The intersection of 24th Street with the ACDC is impacted by runoff generated from the drainage area to the north within 24th Street and the drainage area to the northeast of the intersection which is commercially developed. The construction of the ACDC at 24th Street will not create adverse drainage effects, due to the proposed structure being a covered box through this area.

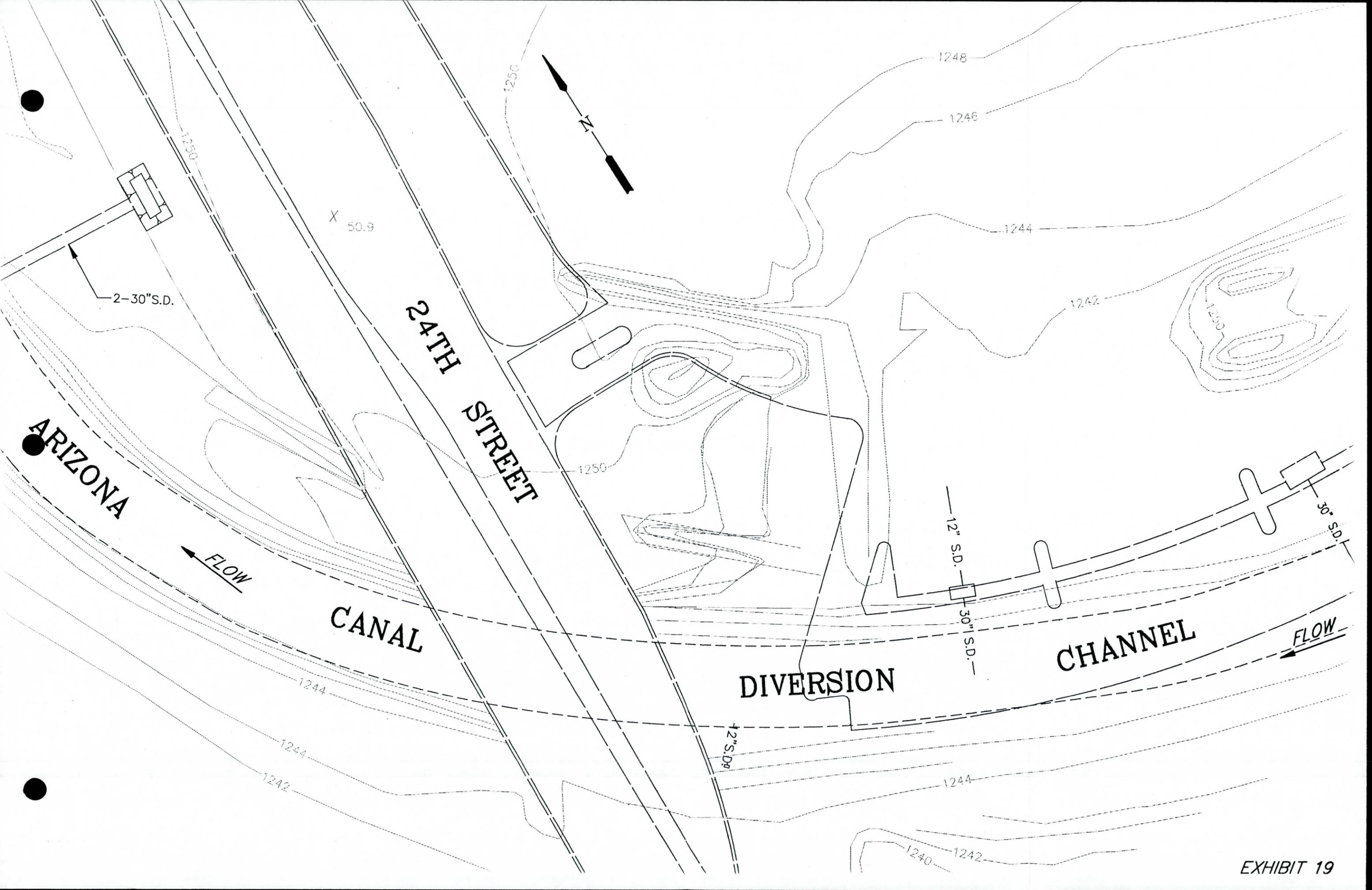
The COE plans show both drainage areas, particularly the commercially developed, exhibit controlled outfalls or low points. At each of the low or controlled outfall points there is either an existing or COE proposed inlet structure that is connected to the ACDC by pipes to convey the storm water runoff to the structure. Since the ACDC is a covered box structure through its intersection with 24th Street, storm water runoff cannot be conveyed into the structure by spillways but only by inlet structures.

### **Solution**

The COE design adequately provided for the conveyance of off-site flows into the ACDC.

### **COE Contract Documents**

The ACDC plans did make provisions to convey off-site flows into the channel.



ARIZONA

24TH STREET

CANAL

DIVERSION

CHANNEL

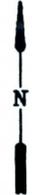
PONDING AREA

LEGEND:



24TH STREET

ARIZONA CANAL



80152  
1248.99

54.6  
x

x 58.3

1280

x 59.6

53.5  
x

50.9

45.6  
x

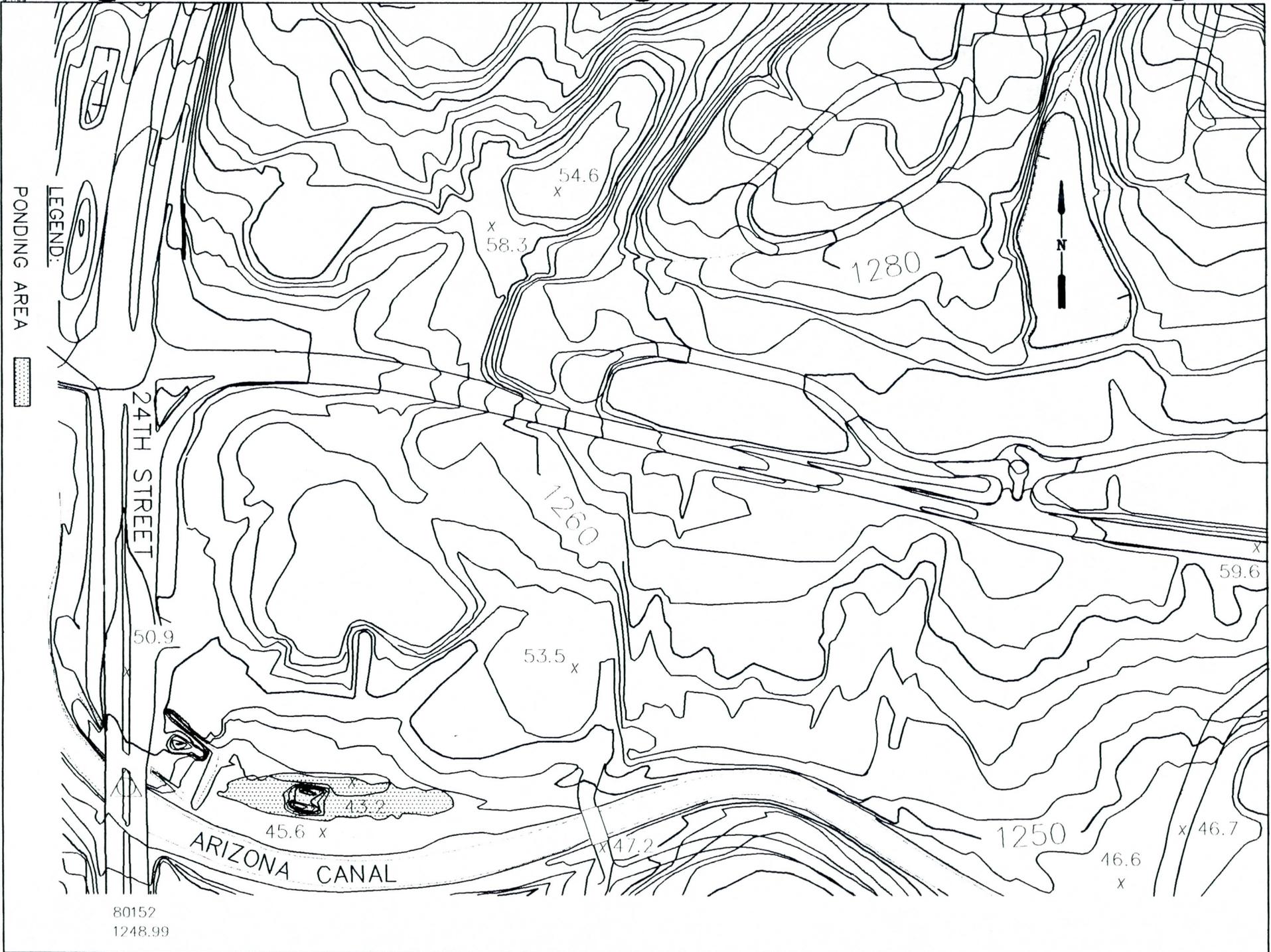
43.2

x 47.2

1250

x 46.7

16.6  
x



## **32ND STREET**

### **Analysis**

The ACDC, as it approaches from the east and crosses under 32nd Street, is a covered box structure (Point 1). As the ACDC continues west from its intersection with 32nd Street, it transitions to a channel structure (Point 2). The intersection of 32nd Street with the ACDC is impacted by off-site flows from the drainage area to the north, specifically 32nd Street.

The COE plans show the contributing storm water runoff to be intercepted by two inlet structures (Points 3 & 4) in 32nd Street just north of the ACDC. The flows are then conveyed into a 30-inch concrete pipe that discharges the runoff into the ACDC (Point 5). 32nd Street's longitudinal slope, as it crosses the ACDC, is at a continuous grade, creating a flow-by condition. Therefore, the additional runoff that the proposed inlets (Points 3 & 4) cannot intercept will continue south on 32nd Street.

### **Solution**

As stated in the analysis, the proposed design appears adequate to convey off-site flows into the ACDC without creating problem flooding, especially since the contributing area is minimal. However, two access ramps (Points 6 & 7) are proposed in the COE plans at the northwest and southwest corners of the intersection of 32nd Street with the ACDC. The proposed access ramps are designed as a typical driveway section which will not allow the conveyance of storm water runoff onto maintenance roads and into the channel. For an added safety factor, it is recommended that both of these access ramps are converted to the depressed driveway section thereby allowing the conveyance of runoff. The ACDC construction of this intersection has not been completed, therefore construction implementation of the design plans and improvements must be monitored to ensure proper drainage hydraulics.

### **COE Contract Documents**

The ACDC plans did make provisions for local flows to enter the channel.

## COST ESTIMATE

### Depress Access Ramp Driveway Entrances

Item	Description	Unit	Quantity	Unit Price	Total
1	Concrete Driveway	S.F.	100 \$	4.00 \$	400.00
2	Concrete Curb & Gutter	L.F.	50	8.00	400.00
3	Access Ramp Asphalt Pavement	S.Y.	45	4.00	<u>180.00</u>
				Sub-Total \$	980.00
				15% Contingency \$	<u>147.00</u>
				<b>TOTAL \$</b>	<b>1,127.00</b>

ARIZONA

32ND

CANAL

① ARIZONA CANAL DIVERSION CHANNEL

STANFORD DRIVE

FLOW

48" S.D.

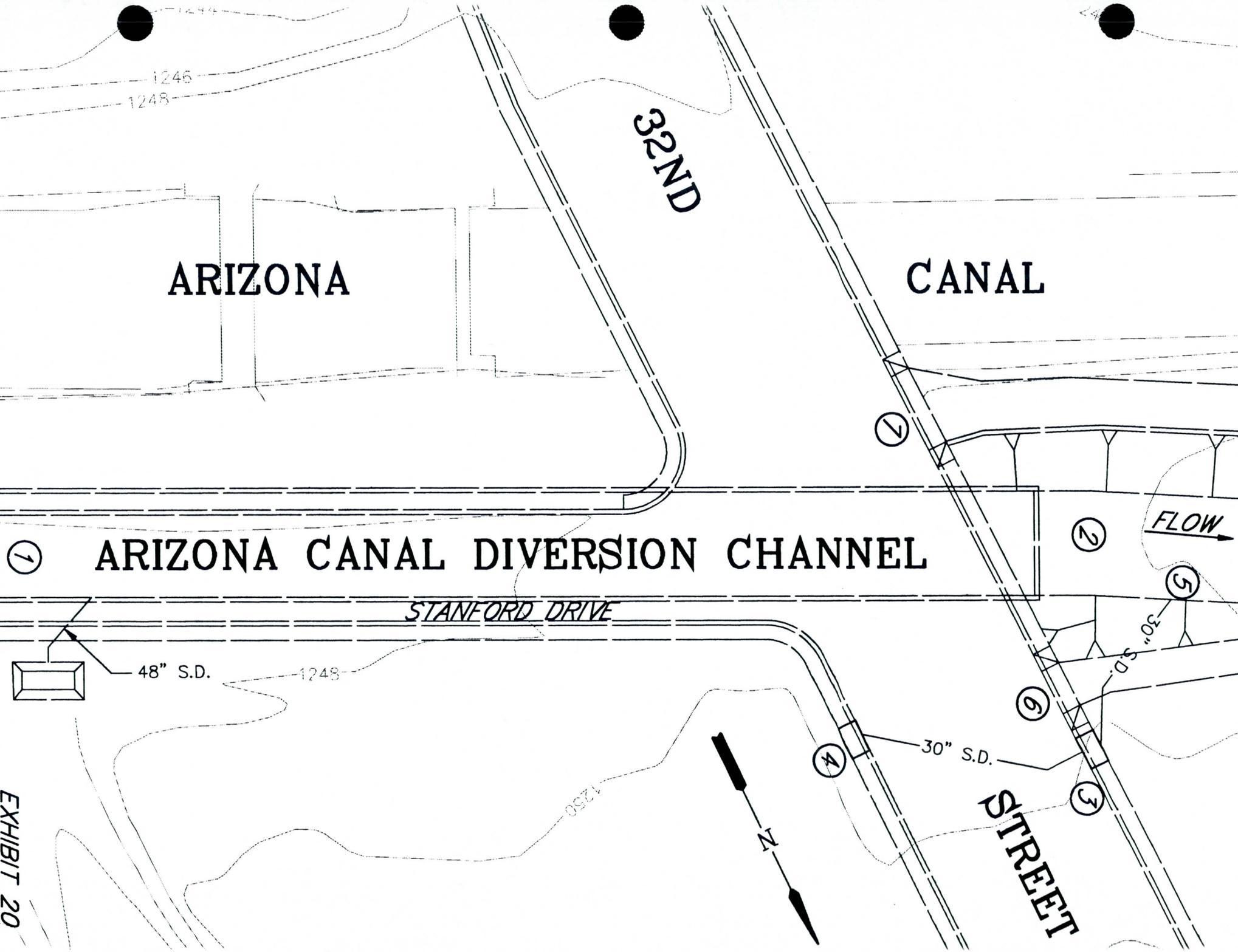
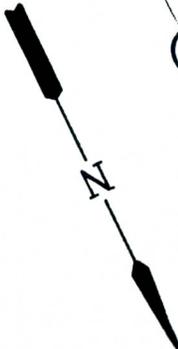
1248

30" S.D.

30" S.D.

STREET

EXHIBIT 20





## TASK 2

Task 2 is an analysis that identifies and examines all drainage problems within a 500' wide swath uphill of the ACDC. The analysis of this swath covers the entire length of the ACDC, less the major street crossings identified and analyzed in Task 1. The analysis also identifies and proposes solutions for the ponding areas and the areas that exhibit a potential for major flooding.

The emphasis of this task is focussed and concentrated primarily on areas of post-construction rather than pre-construction for two reasons. First, existing conditions used for design purposes may change between the time of design and actual construction. Secondly, specific portions of a project are not always constructed exactly as the contract plans illustrate. This, however, does not reflect that portions of the ACDC that have not gone to construction or are currently under construction are less significant in regards to analysis than portions that have been completed. It is merely illustrating that there are (1) more resources available to identify all the problem areas; (2) the information included in the resources are more detailed; and (3) the information documented in the resources can be easily accounted for and verified for post construction rather than pre-construction.

A vast number of references were required for this analysis in order to properly locate and document both the existing and potential problem flooding areas. The references utilized are as follows:

- Field Reconnaissance
- Present Aerial Contour Mapping
- Corps of Engineers Design Contract Plans
- Corps of Engineers Erosion Control, Recreation and Esthetics Contract Plans
- Pre-Construction Contour Mapping
- Maricopa County Flood Control and Corps of Engineers correspondence and post-construction field reviews.

The field reconnaissance is the most valuable and informative of these references. The field reconnaissance incorporated (1) a hands on approach that included photographs and video tapes of before, during and after storm events; (2) interviews with local residents for a before and after effects of construction of the ACDC; and (3) interviews with municipal agencies for information regarding existing and future storm water conveyance systems.

The following is an analysis for each location determined to either have or exhibit a potential for problem flooding. Each analysis will incorporate an exhibit and/or photographs to illustrate the problems and solutions.

## TASK 2: REACH 1 - 500' SWATH

### Station 192+00

#### Analysis

This analysis incorporates the intersection of Greenway Road with 70th and 71st Avenues. The existing condition illustrates storm water runoff flows from the east and the north to a concentration point in 70th Avenue north of its intersection with Greenway Road. At the concentration point there exists two 3.5-foot grate opening inlets (Points 1 & 2 - Picture #1) conveying storm water runoff via a 12-inch diameter pipe to the ACDC. These inlets and the surrounding subdivision are the concentration/low points for the contributing watershed.

A portion of the runoff conveyed in Greenway Road and the frontage road from the east is conveyed in an earthen ditch (Point 3) and intercepted by a headwall structure (Point 4). The runoff is then conveyed to the ACDC via a 36-inch and 48-inch diameter storm drain pipe (Point 5). The remainder of the runoff that is not intercepted continues to the Concentration Points 1 and 2. In addition, a small portion of the runoff from the east is conveyed in a small swale bordering the south side of Greenway Road (Point 6) that discharges into the ACDC via a concrete spillway with a grouted riprap dissipator (Point 7 - Picture #2). The concrete spillway (Point 7 - Picture #3) was not constructed to the back of the existing curb and therefore has created some noticeable scour from the runoff conveyed within the earthen swale. The runoff from the north is conveyed within 70th Avenue from the adjacent subdivision to the Concentration Points 1 and 2.

The existing inlets (Points 1 & 2) and the 12-inch diameter pipe can convey the smaller storm events to the ACDC. In the event the existing inlets are deluged with debris, their efficiencies are reduced and overflow runoff occurs. The overflow concrete spillway (Point 7) is constructed to convey runoff that overtops the south curb of 71st Avenue/Greenway Road into the ACDC. The problem that exists is the roadway is superelevated correctly for the roadway curve but incorrectly for drainage purposes (Picture #4). It is superelevated so that the high side is the south curb line. This prohibits the overflow runoff from entering the ACDC and in turn promotes flooding of the adjacent subdivision, particularly the northeast corner (Point 8) and the northwest corner (Point 9) of the intersection of Greenway Road with 71st Avenue (Pictures #5 & 6). The homeowner at Point 9 discussed in an interview conducted on April 23, 1992, that prior to the construction of the ACDC there were no flooding problems within their neighborhood during significant storm events. After construction, he stated, he has to continually clean debris from the two inlets at (Points 1 & 2) during storm events and that flooding of their neighborhood is a regular occurrence. He stated that during one particular storm event, the flooding and storms were so intense that their family dog drowned. He also stated, that several of his neighbors had at one time banded together and unsuccessfully tried to sue the Flood Control District of Maricopa County, the City and the Army Corps of Engineers.

## **Solution**

There are two probable solutions to remedy this problem flooding location. The first solution is to construct a 2-foot wide transverse catch basin to extend between the existing catch basins at Points 1 & 2. The new transverse catch basins would be a vane grate inlet to maximize efficiency. For runoff from the north, swales bordering 70th Avenue would be constructed to channelize the water to the transverse catch basin between Points 1 and 2. With the new inlet and its increased hydraulic capacity, the 12-inch diameter connector pipe would be replaced with a 24-inch diameter connector pipe.

The second solution entails reconstruction of Greenway Road and 71st Avenue. The proposal is to reconstruct the roadway superelevation in Greenway Road and 71st Avenue to a flat superelevation rather than a superelevation to the south as shown in Picture 4 and reconstruct the spillway entrance to tie into the new roadway gutter. This will allow overflow storm water runoff to naturally enter the ACDC. To flatten the superelevation in the roadway through the curve is contrary to practical roadway design and would possibly require the posted speed limit to be reduced but is a practical solution for the conveyance of the storm water runoff to the ACDC. In addition, this design is currently in place just west of this location at the intersection of 71st Avenue with Mary Jane Lane. There the roadway superelevation is opposite of the practical roadway curve design as shown in Exhibit 22. This allows storm water runoff to naturally enter the ACDC via a concrete scupper and spillway (Pictures #7, 8 and 9).

## **COE Contract Documents**

The ACDC plans made no provisions to convey overflow storm water runoff into the ACDC in the event the existing inlets are deluged with debris.

## COST ESTIMATE

### New Transverse Catch Basins And Drainage Swale

Item	Description	Unit	Quantity	Unit Price	Total
1	New Transverse Catch Basin	EA.	1	\$ 10,000.00	\$ 10,000.00
2	24" RGRC	L.F.	70	75.00	5,250.00
3	Reconstruct 24" Diameter Pipe Connection Into Existing Manhole	L.S.	1	600.00	600.00
4	Asphalt Pavement Replacement	S.Y.	45	10.00	450.00
5	Reconstruct Concrete Valley Gutter	S.F.	38	8.00	304.00
6	Earthwork & Landscape Reconstruction	L.S.	1	2,500.00	2,500.00
7	Concrete Curb & Gutter (Remove & Replace)	L.F.	50	8.00	<u>400.00</u>
				Sub-Total	\$ 19,504.00
				15% Contingency	\$ <u>2,926.00</u>
				<b>TOTAL</b>	<b>\$ 22,430.00</b>

### Reconstruct Roadway Superelevation

Item	Description	Unit	Quantity	Unit Price	Total
1	Reconstruct Intersection Asphalt Pavement	S.Y.	1,170	\$ 10.00	\$ 11,700.00
2	Concrete Curb & Gutter (Remove & Replace)	L.F.	650	8.00	5,200.00
3	Adjust Manhole Frame & Cover	EA.	2	200.00	400.00
4	Reconstruct Existing Spillway To Match New Improvements	L.S.	1	1,200.00	1,200.00
5	Earthwork & Landscape Reconstruction	L.S.	1	1,500.00	1,500.00
6	Concrete Valley Gutter	S.F.	125	8.00	<u>1,000.00</u>
				Sub-Total	\$ 21,000.00
				15% Contingency	\$ <u>3,150.00</u>
				<b>TOTAL</b>	<b>\$ 24,150.00</b>



**Picture #1**

Looking South @ the Intersection of Greenway Road with 70th Avenue.



**Picture #2**

Looking West from the ACDC Maintenance Road at the Concrete Spillway Bordering the South Side of Greenway Road.



**Picture #3**

Looking East Along South Side of Greenway Road from the Concrete Spillway @ the Intersection of Greenway Road with 70th Avenue.



**Picture #4**

Looking West at the superelevation in the Intersection of Greenway Road with 70th Avenue.



**Picture #5**

Looking Northwest @ the Northwest Corner of the Intersection of Greenway Road with 70th Avenue.



**Picture #6**

Looking North at the Intersection of Greenway Road with 70th Avenue.



**Picture #7**

Looking Northeast @ the Superelevation and Concrete Spillway at the Intersection of 71st Avenue with Mary Jane Lane.



**Picture #8**

Looking South at the Concrete Spillway at the Intersection of 71st Avenue with Mary Jane Lane.



**Picture #9**

Looking Southwest at the Concrete Valley Gutter and Spillway at the Intersection of 71st Avenue with Mary Jane Lane.

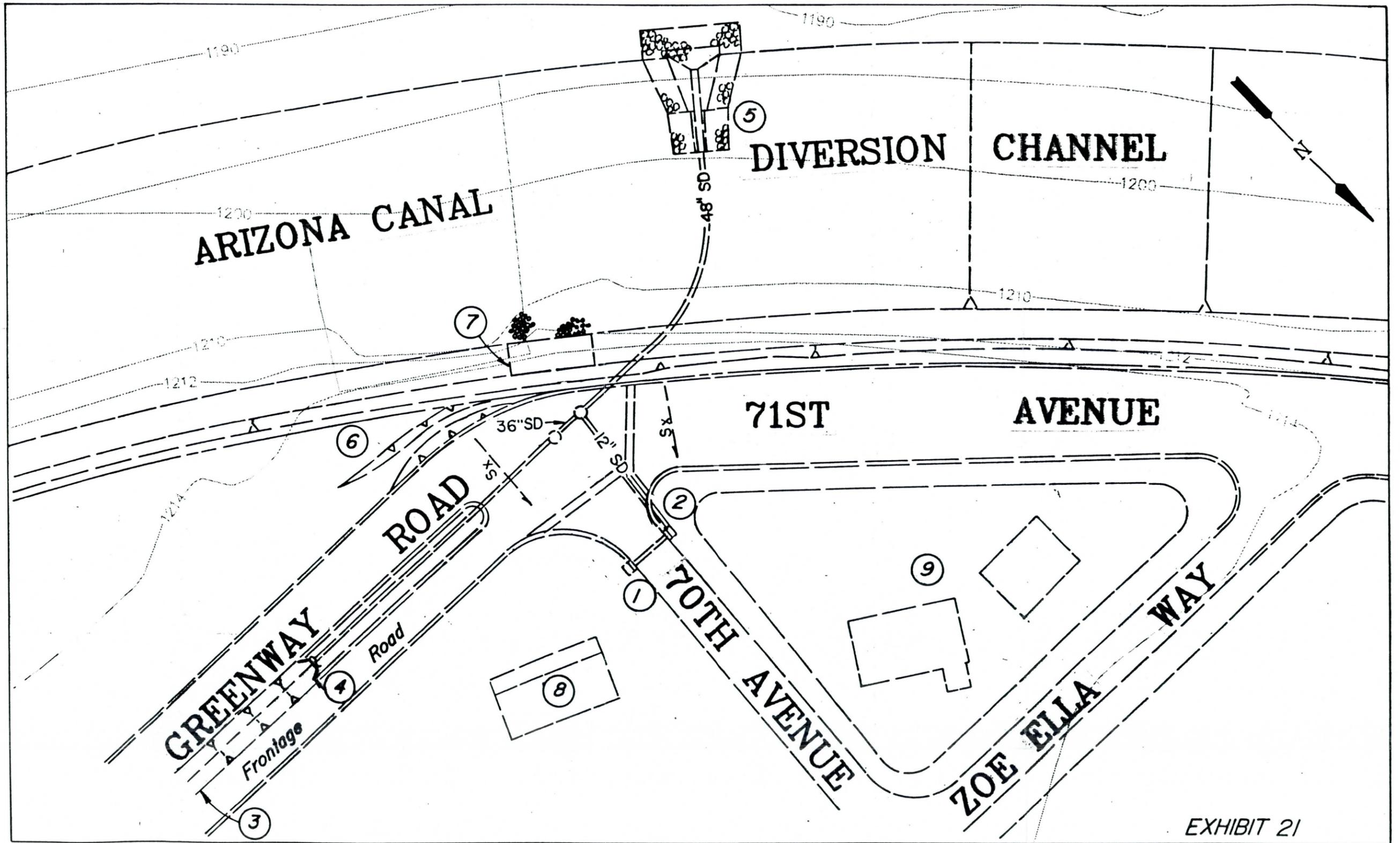
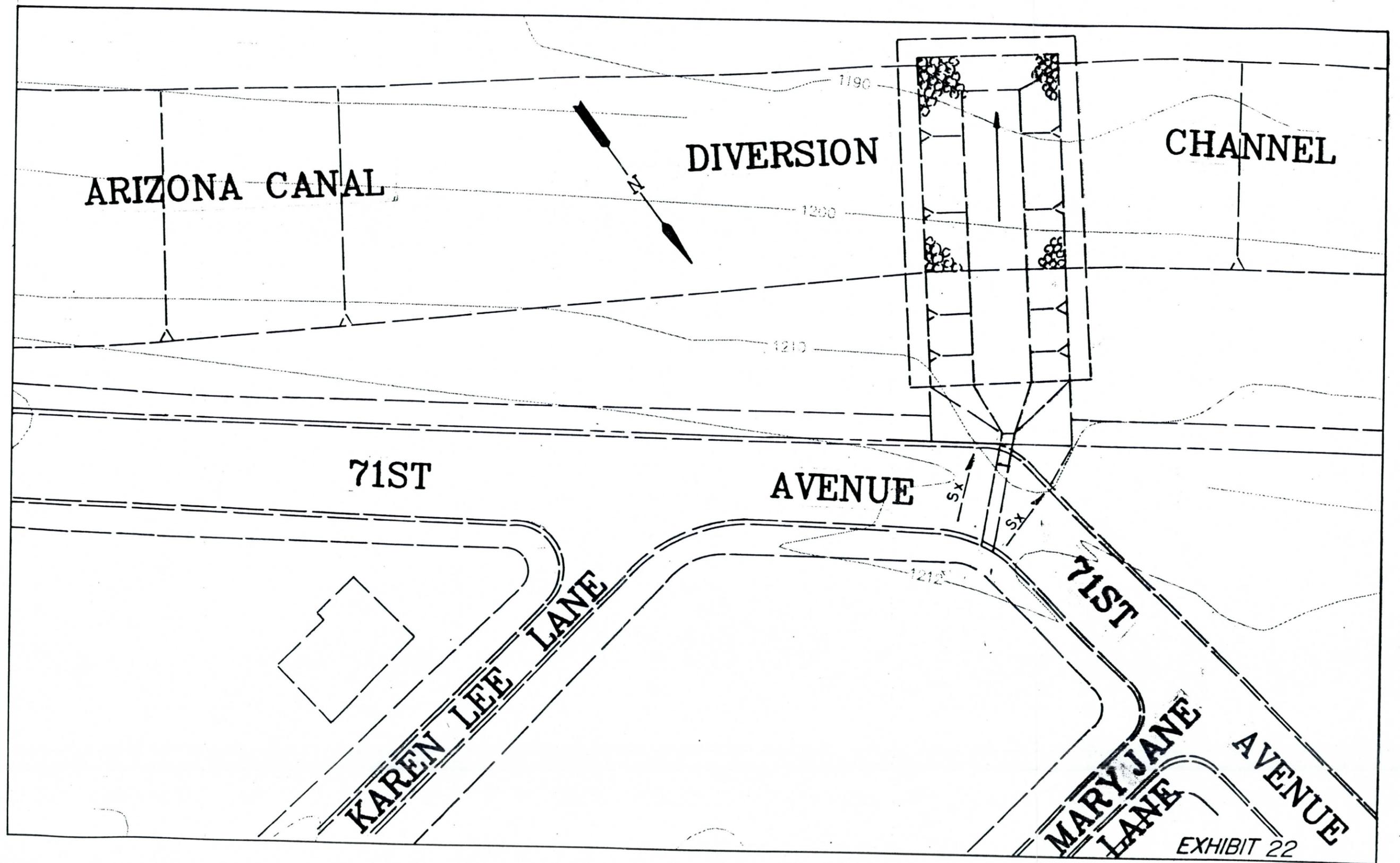
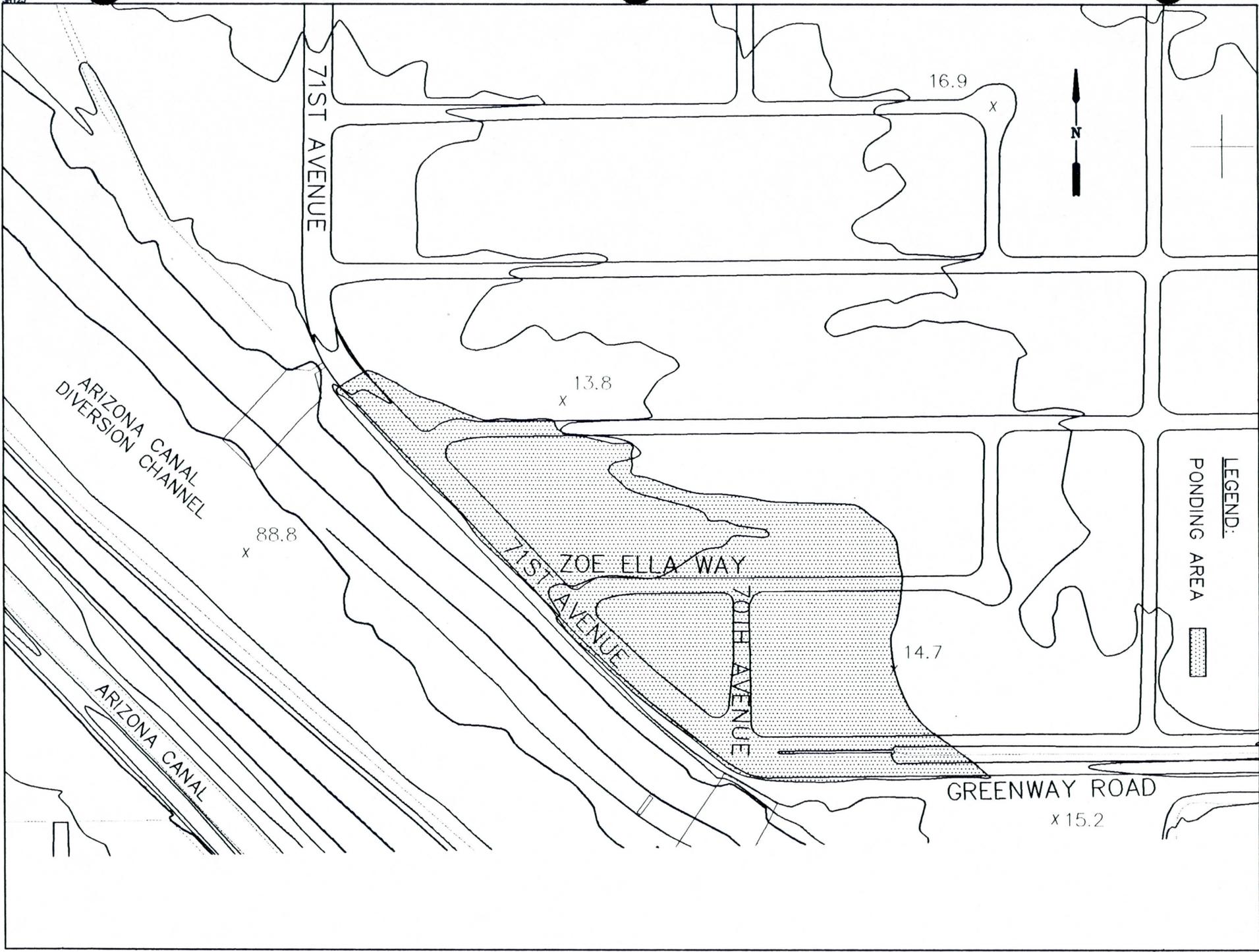


EXHIBIT 21





71ST AVENUE

16.9



13.8

ARIZONA CANAL  
DIVERSION CHANNEL

88.8

ZOE ELLA WAY

71ST AVENUE

70TH AVENUE

14.7

LEGEND:  
PONDING AREA



ARIZONA CANAL

GREENWAY ROAD

x15.2

## TASK 2: REACH 1 - 500' SWATH

### Station 245+00

#### **Analysis**

This analysis incorporates the intersection of the 64th Avenue cul-de-sac with the ACDC (Exhibit 23). The concentration point for this area is at the intersection of 64th Avenue with Banff Lane, just a few hundred feet north of the 64th Avenue cul-de-sac. At this concentration point there exists a standard catch basin that intercepts storm water runoff and discharges into the ACDC via a 48" diameter storm drain pipe (Point 1). Runoff from recent storms have exceeded the capacity of the catch basin which in turn ponds in the cul-de-sac behind the CMU wall (Point 2).

The homeowner at the northwest portion of the cul-de-sac (Point 3) discussed in an interview conducted on April 23, 1992, that during one of the larger storm events the catch basin was partially clogged with debris and its efficiency reduced. In turn, the storm water runoff began ponding in the cul-de-sac since the CMU wall (Point 2) was not allowing the runoff to enter the ACDC. The resident stated that the ponding water began to flood adjacent homes and threaten many others. At that time, the residents began knocking holes in the base of the wall (Point 2 - Pictures #10 & 11). The resident stated that this relieved some of the ponding but soon after, the water pressure knocked out an entire section of the CMU wall (Pictures #10 & 11). Once this occurred the flood waters recessed and caused major erosion of the channel side slopes as it rushed to the opening in the wall. MCFCD has since constructed a spillway on the ACDC side slope to the back side of the CMU wall, also being the right-of-way line. This is shown in Picture 10 also illustrating that the section of wall has not been replaced.

#### **Solution**

As previously stated, the MCFCD has constructed a spillway at the wall opening that extends from the back of the wall, or right-of-way line, down the side slope and into the ACDC. However, as shown in Picture 10, nothing was done to the roll curb or sidewalk to convey the ponding storm water runoff to the spillway and into the channel. Essentially, the storm water runoff must pond within the cul-de-sac before it will overtop the roll curb and sidewalk and discharge into the spillway. Also, in Picture #10, it illustrates that the lip of the spillway is approximately two to three tenths above the upstream natural ground and concrete sidewalk. Because of this ridge at the mouth of the spillway, the storm water runoff that overtops the roll curb and sidewalk may flow to the spillway and begin flowing to the east or west parallel to the right-of-way line. At this point the runoff will find the edges of the spillway and discharge into the ACDC eroding the natural channel banks adjacent to the spillway.

One solution is to depress the roll curb and sidewalk and connect into the existing spillway. An alternative solution is to remove a portion of the roll curb and sidewalk and to construct a concrete scupper and extend the existing spillway to the scupper. Both alternatives satisfy the criteria by safely conveying the overflow runoff to the existing spillway and maintaining it within the drainage improvements thereby eliminating any maintenance due to erosion.

#### **COE Contract Documents**

The ACDC plans made no provisions to convey overflow storm water runoff in the event the existing catch basin is deluged with debris.

## COST ESTIMATE

### Depress the Roll Curb And Sidewalk

Item	Description	Unit	Quantity	Unit Price	Total
1	Roll Curb & Gutter (Remove & Replace)	L.F.	16 \$	8.00 \$	128.00
2	Sidewalk (Remove & Replace)	S.F.	80	4.00	320.00
3	Reconstruct Existing Spillway To Match New Improvements	L.S.	1	900.00	900.00
4	Reconstruct CMU Wall w/Drainage Opening	L.S.	1	500.00	<u>500.00</u>
Sub-Total \$					1,848.00
15% Contingency \$					<u>277.00</u>
<b>TOTAL \$</b>					<b>2,125.00</b>

### Construct A Concrete Scupper

Item	Description	Unit	Quantity	Unit Price	Total
1	Roll Curb & Gutter (Remove)	L.F.	16 \$	8.00 \$	128.00
2	Construct Concrete Curb & Gutter	L.F.	8	8.00	36.00
3	Concrete Sidewalk (Remove)	S.F.	40	2.00	80.00
4	Construct Concrete Scupper	L.S.	1	1,800.00	1,800.00
5	Reconstruct Existing Spillway To Match New Improvements	L.S.	1	900.00	900.00
6	Reconstruct CMU Wall w/Drainage Opening	L.S.	1	500.00	500.00
Sub-Total \$					3,444.00
15% Contingency \$					<u>516.00</u>
<b>TOTAL \$</b>					<b>3,960.00</b>



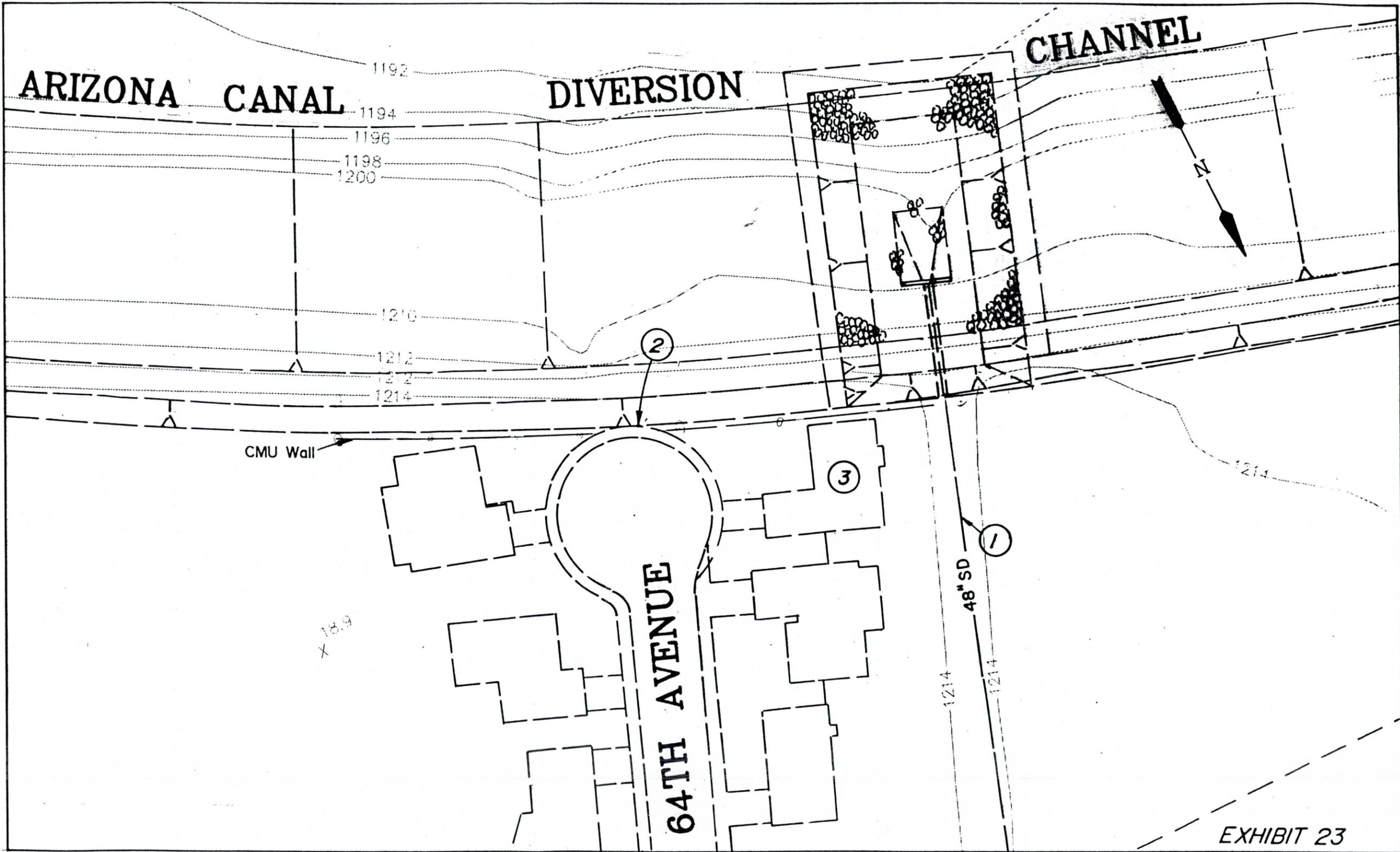
**Picture #10**

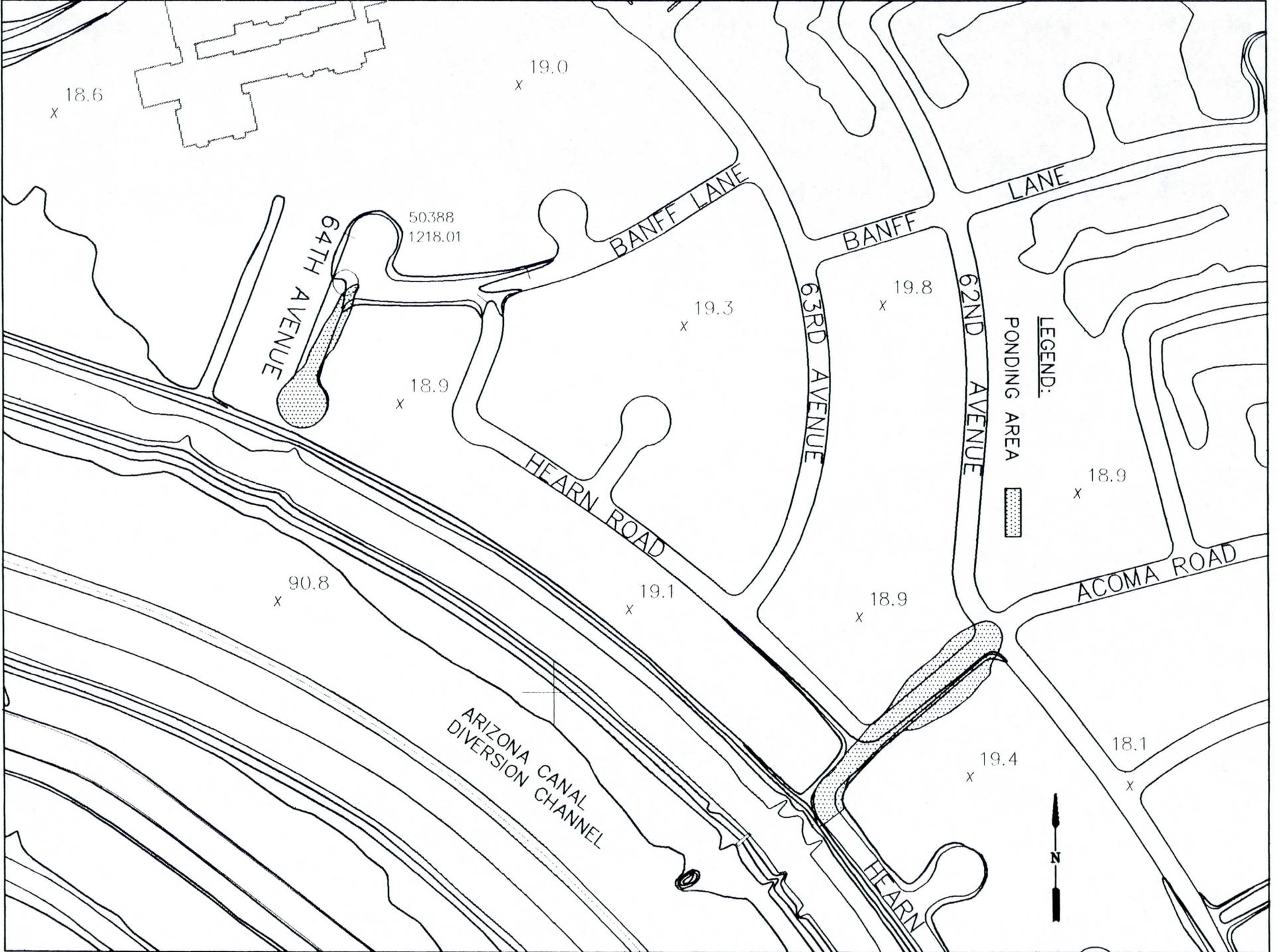
Looking West at the Opening in the CMU Wall at the End of the 64th Avenue Cul-De-Sac.



**Picture #11**

Looking South at the Opening in the CMU Wall at the End of the 64th Avenue Cul-De-Sac.





## TASK 2: REACH 1 - 500' SWATH

### Station 253+75

#### **Analysis**

This analysis incorporates the intersection of Acoma Drive with 62nd Avenue and Hearn Road (Exhibit 24). Prior to the construction of the ACDC, an existing 36" diameter side drain discharged into a retention basin. When the ACDC was constructed, the 36" diameter pipe was extended to the channel (Point 1) and the retention basin was filled. Later, Acoma Drive was extended approximately 150 feet to the channel right-of-way (Point 2). This portion of Acoma Drive extended (Point 2) then became the concentration or low point for the subdivision drainage area.

A series of inlets at the intersection of Acoma Drive with 62nd Avenue and within Acoma Drive itself, (Points 3 - 14 and Pictures #12 - 15), intercept storm water runoff and convey it to the ACDC via the previously discussed 36" diameter pipe. These curb opening inlets work satisfactorily under normal conditions, but their efficiencies are reduced when deluged with debris.

A resident adjacent to Acoma Drive (Point 15), stated in an interview conducted on April 23, 1992, that a year ago during a sizeable storm event the water in Acoma Drive was up to his garage. In addition, at the intersection of the ACDC with Acoma Drive extended, the resident stated that there was significant scour (Point 16). MCFCD has since constructed a spillway on the ACDC side slope to the channel right-of-way.

#### **Solution**

As previously stated, the MCFCD has constructed a spillway at Acoma Drive's outfall into the ACDC. However, the spillway stops short of Acoma Drive and nothing was done to the vertical curb and gutter to convey the runoff to the spillway. During larger storm events the storm water runoff will be conveyed in Acoma Drive to its outfall (Point 16). At this point if the inlets capacity is reduced by debris, the overflow runoff will jump the vertical curb. The runoff then may or may not continue down the spillway since there is native material between the vertical curb and the beginning of the spillway. Thereby allowing the chance for the runoff to flow adjacent to spillway and eroding the natural channel banks.

One solution to this is to depress the vertical curb and sidewalk and connect into the existing spillway. An alternative solution is to remove a portion of the vertical curb and sidewalk and to construct a concrete scupper and extend the existing spillway to the scupper. Both alternatives satisfy the criteria by safely and naturally conveying the overflow runoff to the existing spillway and maintaining it within the drainage improvements thereby eliminating maintenance due to erosion.

## COE Contract Documents

The ACDC plans made no provisions to convey overflow storm water runoff in the event the existing catch basins are deluged with debris.

## COST ESTIMATE

### Depress Concrete Curb & Gutter

Item	Description	Unit	Quantity	Unit Price	Total
1	Concrete & Gutter (Remove)	L.F.	12 \$	2.00 \$	24.00
2	Construct Concrete Ribbon Curb	L.F.	12	8.00	96.00
3	Reconstruct Existing Spillway To Match New Improvements	L.S.	1	1,200.00	<u>1,200.00</u>
Sub-Total \$					1,320.00
15% Contingency \$					<u>198.00</u>
<b>TOTAL \$</b>					<b>1,518.00</b>

### Construct A Concrete Scupper

Item	Description	Unit	Quantity	Unit Price	Total
1	Concrete Curb & Gutter (Remove)	L.F.	12 \$	8.00 \$	24.00
2	Construct Concrete Scupper	L.S.	1	1,600.00	1,600.00
3	Reconstruct Existing Spillway To Match New Improvements	L.S.	1	1,200.00	<u>1,200.00</u>
Sub-Total \$					2,824.00
15% Contingency \$					<u>424.00</u>
<b>TOTAL \$</b>					<b>3,248.00</b>



**Picture #12**

Looking Southwest at the End of Acoma Drive and its Intersection with Both the ACDC and Hearn Road.



**Picture #13**

Looking Southwest at the End of Acoma Drive from resident described at "Point 15".



**Picture #14**

Looking Northeast at the Intersection of Acoma Drive with 62nd Avenue.



**Picture #15**

Looking Northeast at the Intersection of Acoma Drive with 62nd Avenue from resident described at "Point 15".

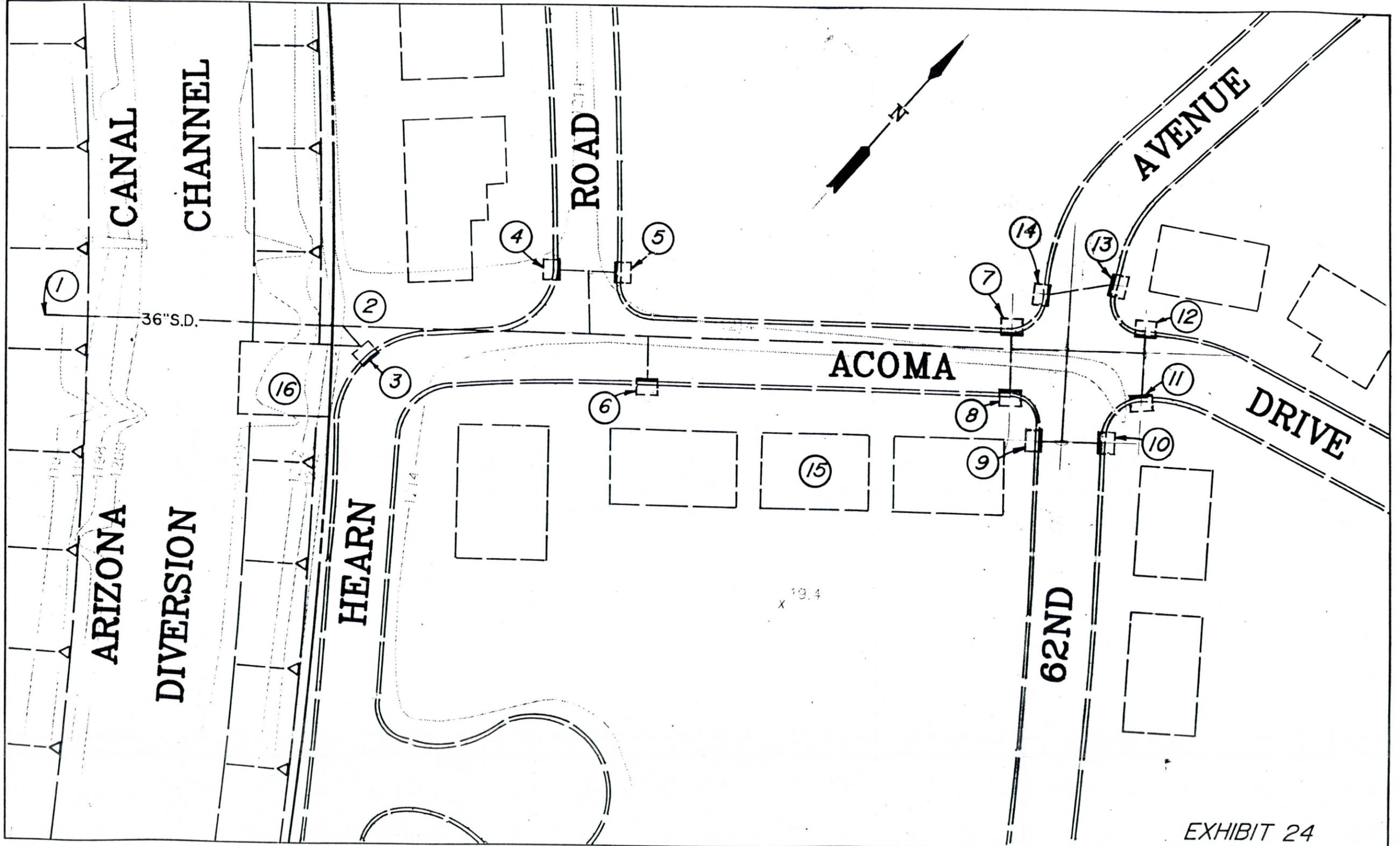
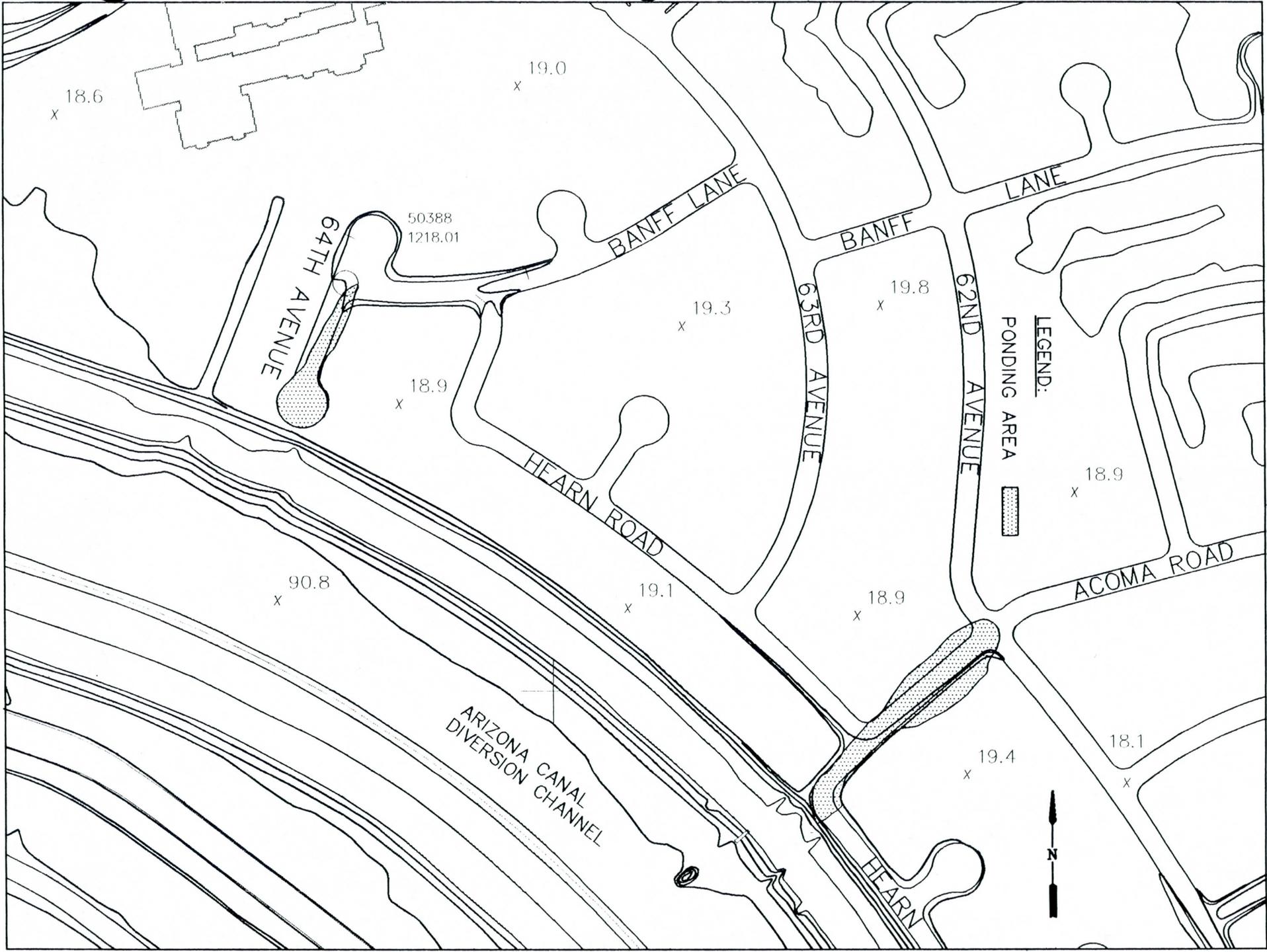


EXHIBIT 24



## **TASK 2: REACH 2A - 500' SWATH**

### **Station 369+25**

#### **Analysis**

This analysis incorporates a location on 49th Drive that is approximately 500 feet south of the intersection of 49th Drive with Cactus Road (Point 1). The existing condition illustrates that runoff contributes from both the north and south to the concentration and low point of the subdivision, which is the point of analysis. There exists two-three foot curb opening inlets (Points 2 & 3) that intercept the subdivision storm water runoff and then discharge into the ACDC through an easement via a 12" diameter storm drain pipe (Point 4).

The two curb opening inlets are sufficient under normal conditions, but in the event the inlets are deluged with debris, their efficiencies are reduced and overflow storm water runoff occurs. Conditions of recent storms have promoted overflow storm water runoff from these inlets causing flooding within the roadway. The existing inlets (Points 2 & 3) are shown in Picture 16.

The homeowner on the west side of 49th Drive adjacent to the existing catch basins (Point 5 - Picture #17) discussed in an interview conducted on April 23, 1992, that during one of the larger storm events the catch basin efficiencies were reduced causing extensive ponding in their area. The resident stated that their home was nearly flooded, even though their (Point 5 - Picture #17) finish floor elevation is quite high. The resident also stated that the flood waters were waist deep and much of their landscaping and their neighbors landscaping had been washed up by the ponding storm water.

#### **Solution**

As illustrated in the analysis, the existing three foot curb opening inlets (Points 2 & 3) are adequate except in the event the inlets are deluged with debris. Therefore, it is recommended to remove these existing inlets and replace them with combination inlets that have increased capacity and reduced clogging potential. In addition, with the increase in efficiency of the catch basins it may be necessary to increase the existing 12" storm drain pipe to an 18" pipe.

#### **COE Contract Documents**

The ACDC plans made no provision to convey runoff overflow storm water in the event the inlets are deluged with debris.

## COST ESTIMATE

### New Catch Basins

Item	Description	Unit	Quantity	Unit Price	Total
1	Concrete Curb & Gutter & Sidewalk (Remove)	L.S.	1	\$ 1,300.00	\$ 1,300.00
2	New Combination Catch Basin	EA.	2	3,200.00	3,200.00
3	Asphalt Pavement Replacement	EA.	30	10.00	300.00
4	18" RGRCP	L.F.	150	60.00	9,750.00
5	Earthwork & Landscape Reconstruction	L.S.	1	2,500.00	2,500.00
6	ACDC Concrete Lining & Outlet Structure Reconstruction	L.S.	1	5,500.00	<u>5,500.00</u>

Sub-Total \$ 22,550.00

15% Contingency \$ 3,382.00

**TOTAL \$ 25,932.00**



**Picture #16**

Looking South in 49th Drive at the Low Point described as "Points 2 & 3".



**Picture #17**

Looking West at Resident on West Side of 49th Drive described as "Point 5".

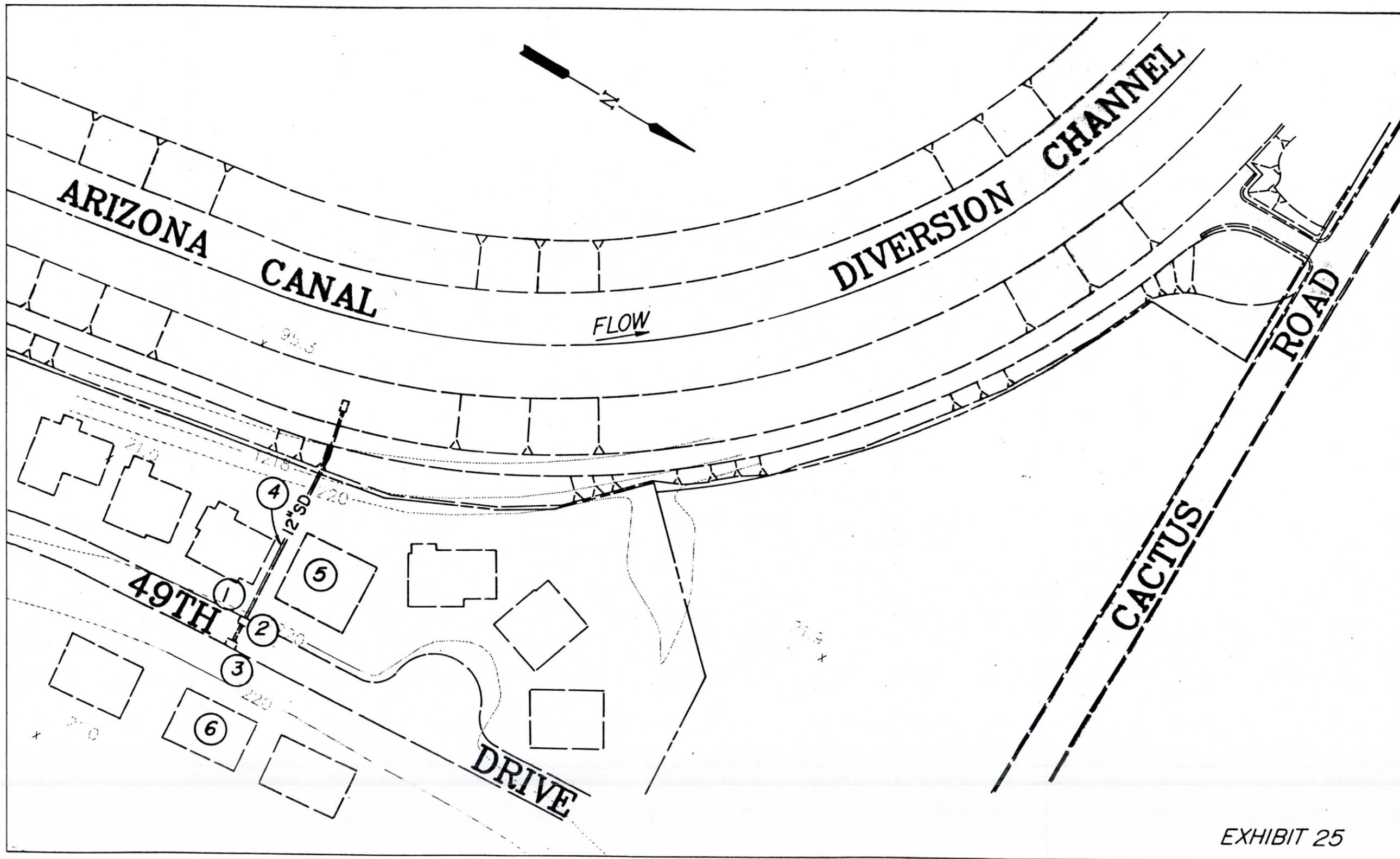
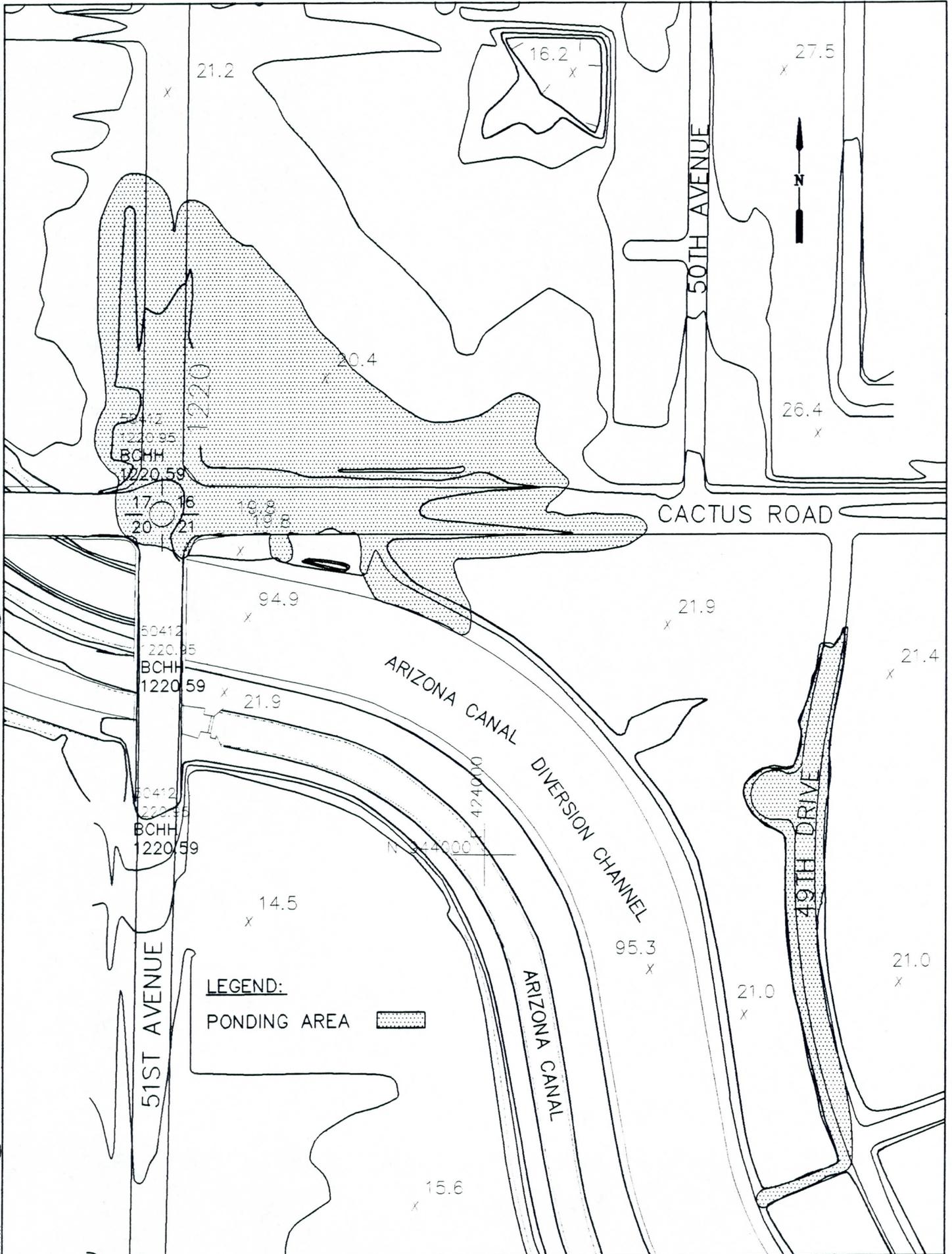


EXHIBIT 25



## **TASK 2: REACH 2B - 500' SWATH**

### **Station 420+00**

#### **Analysis**

This analysis incorporates the intersection of 44th Lane with 46th Avenue (Exhibit 26), in which this location is the concentration point for the contributing subdivision. The contributing runoff is conveyed from the north by 44th Lane and from the west by 46th Avenue.

The MCFCD has constructed an access ramp at the intersections confluence with the ACDC (Point 1). This access ramp is two fold in that it provides for maintenance access to the concrete channel and also functions as a spillway during sizeable storm events. The runoff enters the access ramp after it has overtopped the roll curb and gutter (Point 2 - Picture #18).

The homeowner at the northeast corner of the intersection of 44th Lane with 46th Avenue (Point 3) discussed in an interview conducted on April 23, 1992, that during one of the more recent sizeable storm events, the backwater created from the roll curb and gutter threatened to flood his home and the home at Point 4. He stated that the runoff ponds in the intersection until it can overtop the roll curb. The runoff then discharges into the channel via the access ramp (Point 1) and over the vertical channel wall (Point 5). The resident also stated that the area consisting of natural ground (Point 6 - Picture #18) exhibited significant scour.

#### **Solution**

As previously discussed, a spillway into the ACDC exists at this location to convey storm water runoff from the subdivision into the channel. However, there exists no conveyance from the intersection of 44th Lane with 46th Avenue to the access ramp. The storm water runoff must pond behind the roll curb before it overtops and is discharged into the ACDC via the access ramp or channel wall.

The solution to eliminate the potential for flooding is to remove the roll curb, replace it with ribbon curb and extend the access ramp to the ribbon curb. Essentially by extending the access ramp to the new ribbon curb, the new design would also function as a spillway. This design would eliminate the flooding potential by allowing the storm water runoff to naturally enter the channel. The design would also eliminate any erosion type maintenance by maintaining the runoff within the drainage improvements.

#### **COE Contract Documents**

The ACDC plans made no provisions to convey overflow storm water runoff from the intersection of 44th Lane with 46th Avenue.

## COST ESTIMATE

### Reconstruct Concrete Curb And Access Ramp

Item	Description	Unit	Quantity	Unit Price	Total
1	Concrete Roll Curb & Gutter (Remove)	L.F.	65	\$ 2.00	130.00
2	Construct Concrete Ribbon Curb	L.F.	65	8.00	520.00
3	Reconstruct Access Ramp Asphalt Pavement	S.Y.	200	8.00	<u>1,600.00</u>

Sub-Total \$ 2,250.00

15% Contingency \$ 338.00

**TOTAL \$ 2,588.00**



Picture #18

Looking South at the Southeast Corner of the Intersection of 46th Avenue with 44th Lane.

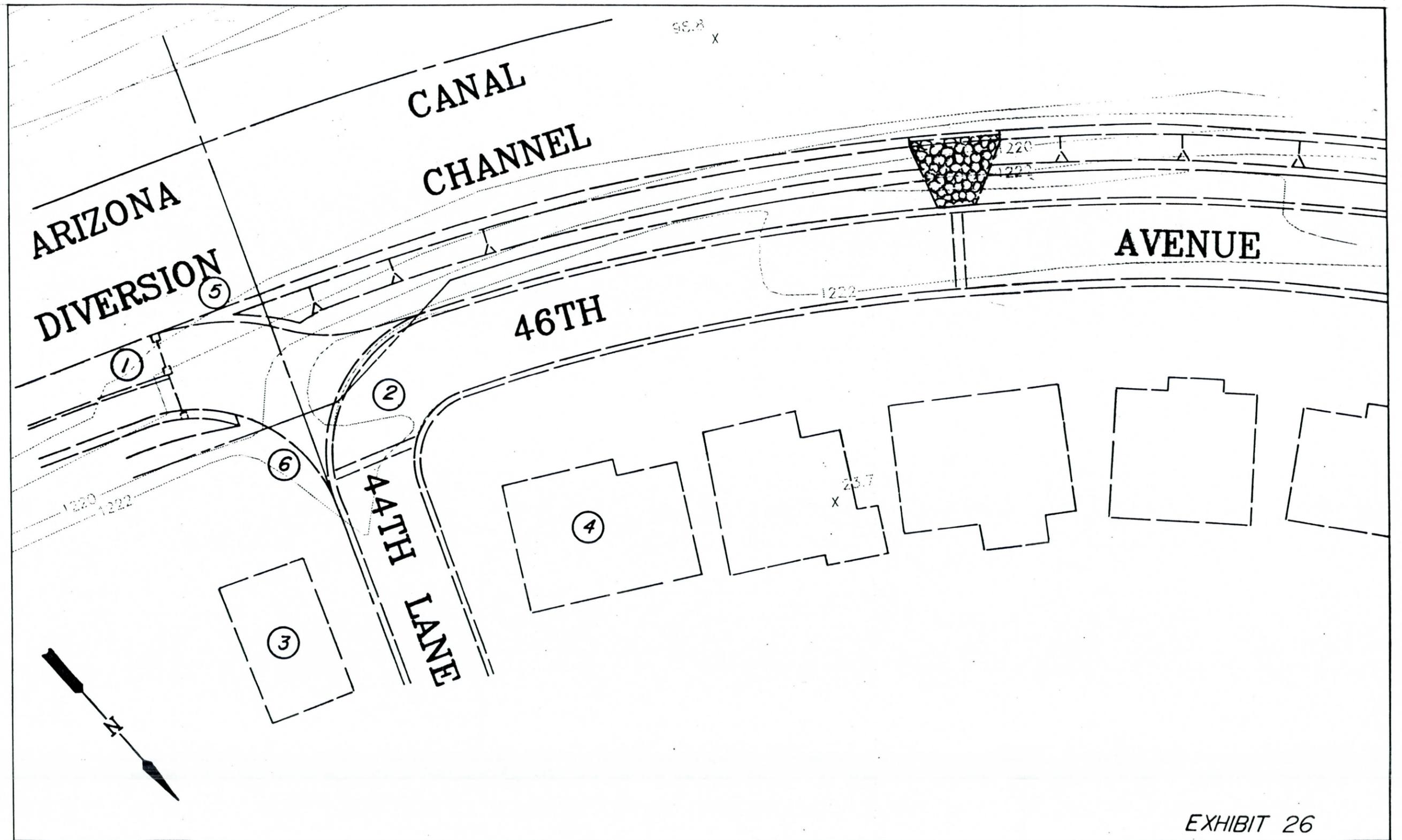
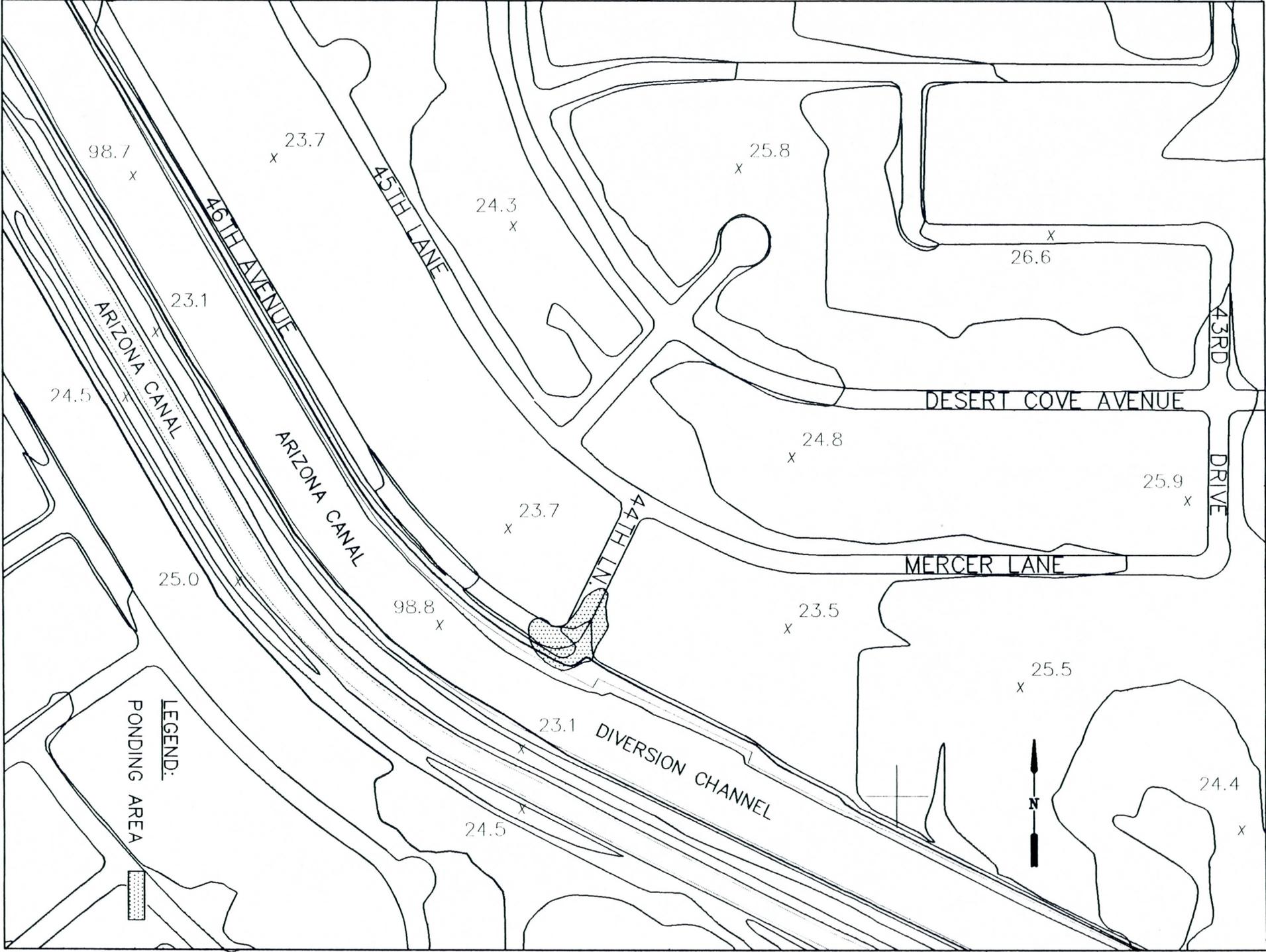


EXHIBIT 26



## **TASK 2: REACH 3 - 500' SWATH**

### **Station 740+00**

#### **Analysis**

This analysis incorporates the intersection of the 10th Street Wash with the ACDC (Point 1) and the intersection of Griswold Road with 9th Street (Point 2). Existing drainage conditions illustrate that the intersection of 9th Street and Griswold Road (Point 2) is a concentration point for the contributing subdivision, specifically 9th Street. Upon construction of the ACDC, an extensive spillway was implemented at the 10th Street Wash outfall into the ACDC as shown in Picture 19. To construct the spillway, the northern bank (Point 3) of the 10th Street Wash was improved to provide a consistent channel section thereby improving the hydraulic performance of the wash. However, when the bank improvements were completed, the top of bank elevation was higher than the adjacent street elevations at the intersection of Griswold Avenue with 9th Street (Point 2). Picture 20 taken at the intersection of 9th Street with Griswold Road (Point 2) looking towards the ACDC and the 10th Street Wash outfall, vividly depicts the elevation differences between the top of bank and the intersection pavement elevations. An existing 18" diameter CMP inlet structure and pipe (Point 4) located at the end of Griswold Road intercepts and conveys the storm water runoff to the 10th Street Wash. However, if the inlet is deluged with debris, its efficiency is reduced and overflow runoff begins to pond.

A homeowner adjacent to 9th Street (Point 5) discussed in an interview conducted on April 23, 1992, that during sizeable storm events the intersection of 9th Street and Griswold Road (Point 2) experiences significant flooding. The storm water runoff from the subdivision ponds in the intersection until at some point the runoff can overtop the earthen bank of the 10th Street Wash. This may cause flooding of the adjacent homes and significant scour of the 10th Street Wash channel banks.

#### **Solution**

There are two probable solutions to remedy this problem flooding. The first solution to resolve the potential flooding at the intersection of 9th Street with Griswold Road is to reverse the elevation differences between the intersection pavement and the 10th Street Wash top of bank. This entails a small area of pavement reconstruction shown in Picture #20 to provide a positive drain from the northwest curb return to the wash. In addition, to eliminate erosion of the wash bank, a concrete spillway from the roadway edge of pavement into the 10th Street Wash (Point 6) should also be constructed to utilize a controlled outfall point. The second solution would be to replace the existing inlet at Point 4 with a double area drain.

#### **COE Contract Documents**

The ACDC plans made no provisions to adequately convey major runoff from the intersection of 9th Street with Griswold Road to the ACDC.

**COST ESTIMATE**

**Reconstruct The Intersection Of 9th Street w/Griswold Road**

Item	Description	Unit	Quantity	Unit Price	Total
1	Reconstruct Asphalt Pavement	S.Y.	250	\$ 10.00	\$ 2,500.00
2	Earthwork	L.S.	1	2,000.00	2,000.00
3	Concrete Spillway	EA.	1	500.00	<u>500.00</u>
Sub-Total					\$ 5,000.00
15% Contingency					\$ <u>750.00</u>
<b>TOTAL</b>					<b>\$ 5,750.00</b>

**New Area Drain**

Item	Description	Unit	Quantity	Unit Price	Total
1	Double Area Drain Catch Basin	EA.	1	\$ 4,500.00	\$ 4,500.00
2	Earthwork & Landscaping Reconstruction	L.S.	1	1,500.00	<u>1,500.00</u>
Sub-Total					\$ 6,000.00
15% Contingency					\$ <u>900.00</u>
<b>TOTAL</b>					<b>\$ 6,900.00</b>



**Picture #19**

Looking East at the 10th Street Wash Concrete Outfall Spillway into the ACDC.



**Picture #20**

Looking West at the 10th Street Wash Outfall into the ACDC and at the End of Griswold Road. Taken from the Intersection of Griswold Road with 9th Street.

