# SR 51 DRAINAGE ASSESSMENT

## INDIAN SCHOOL ROAD TO BETHANY HOME ROAD

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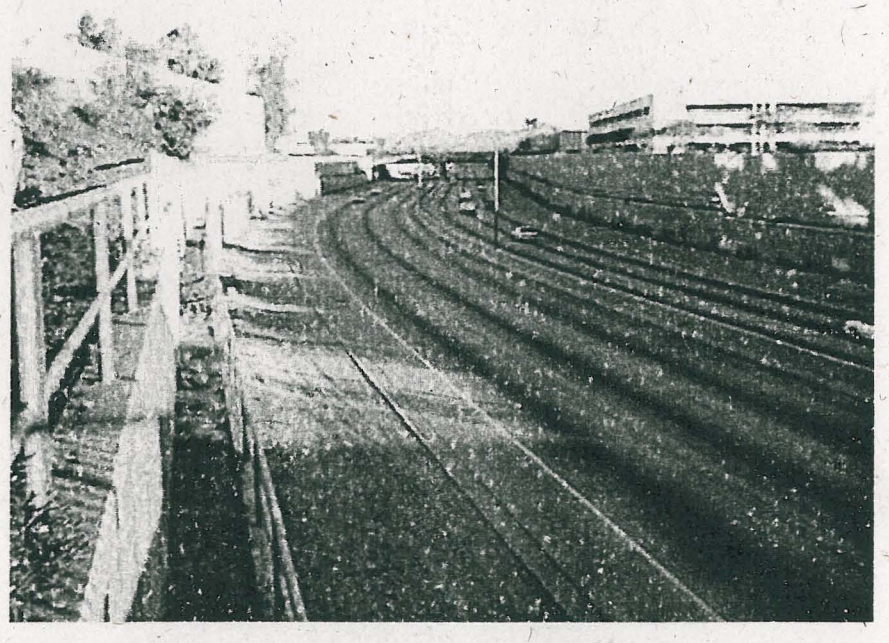
# INITIAL DRAINAGE REPORT

**November 1998**



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# EXECUTIVE SUMMARY

## STUDY PURPOSE

The purpose of this study is to evaluate the drainage facilities of the Squaw Peak Parkway from Indian School Road to Bethany Home Road. The facility has been analyzed for existing conditions and for conditions with proposed HOV lanes. The study describes the drainage performance of the existing facilities with respect to stormwater conveyance, detention capacity and encroachment by off-site flows.

## REPORT PURPOSE

The purpose of this report is to document the Alternative Selection Report and to provide further study of the alternatives/solutions recommended. This report and its Appendices contain calculations and technical information used in the analysis of the Squaw Peak Parkway on-site storm drain, the 18th Street Trunk Line, on-site and off-site hydrology, and the Highland Avenue Pump Station. This report builds upon, and reiterates relevant sections of the Final Alternative Selection Report so that the study process is fully documented in this one volume. A Drainage Project Assessment has been submitted for review concurrently with this report.

## PROBLEMS IDENTIFIED

The following problems were identified in the Final Alternative Selection Report :

### 1. Encroachment by Off-Site Stormwater

Off-site stormwater encroaches the on-site storm drain system via openings provided in the sound wall at Campbell Avenue, Turney Avenue and Glenrosa Avenue and the northbound on-ramp at Highland Avenue.

### 2. 18th Street Trunk Line

The 18th Street Trunk Line does not have sufficient capacity to convey the 10-year storm between Highland Avenue and Indian School Road. The trunk line was designed to convey a 2-year storm south of Highland Avenue. Even if additional capacity were added to the trunk line, the outfall would not be able to accept more runoff.

### 3. On-site Storm Drain

The on-site storm drain has sufficient capacity to convey the existing condition 10-year storm. Current ADOT criteria specifies a 50-year design for depressed roadways.

### 4. Pump Station

The wet well in the pump station lacks storage capacity. Lack of storage will cause excessive cycling of the pumps. The existing pumps have the capacity to discharge about a 10-year

flow without affecting the on-site storm drain; however the pumps discharge into the 18th Street Trunk Line which lacks capacity.

### 5. Colter Street Detention Basin

The Colter Street Junction Structure allows runoff to bypass the Colter Street Detention Basin during a storm, occupying capacity in the trunk line.

## RECOMMENDED SOLUTIONS/ALTERNATIVES

Of the twenty-two Alternatives investigated in the Final Alternative Selection Report, the following are recommended for construction:

**Alternative 3:** Provide inlets at Turney Avenue and Glenrosa Avenue to collect the runoff before it enters the Parkway through the sound wall holes. The inlets would be ineffective in storms larger than about the about 10-year unless off-site detention basins are constructed.

**Alternative 4:** Install a restriction plate across the trunk line outlet pipe in the Colter Street Junction Structure to allow additional flow into the Colter Street Detention Basin.

**Alternative 5B:** Remove runoff from the 18$^{th}$ Street Trunk Line by discharging the pump station flow into a small detention basin at the southeast corner of Highland Avenue and 18$^{th}$ Street, adjacent to the Highland Avenue Pump Station.

**Alternative 6:** Increase the capacity of the on-site storm drain to convey the peak flow from the 25-year storm by detaining the flows which exceed the peak flow of the 10-year storm. Underground detention vaults are proposed to detain the runoff. This would have the effect of increasing the capacity of the on-site storm drain system including the pump station.

**Alternative 7:** Increase size of on-site lateral at the pump station sag to reduce standing water in the southbound lanes.

**Alternative 8:** Adjust pump-on/pump-off switches to reduce excessive cycling of main pumps in Highland Pump Station.

**Alternative 9:** Provide a larger nuisance pump to help reduce the cycling of the main pumps.

**Alternative 10A:** Add manholes with flap gates to 3 on-site catch basins at the downstream ends of both of the Highland Avenue ramps.

**Alternative 11:** Replacement of the 18th Street Trunk Line from Maryland Avenue to Rancho Road

The costs of the Alternatives are found in Section 6.3 of this Report. Funding for these projects has not been programmed.

# 1.0 INTRODUCTION

## 1.1 Location

The Squaw Peak Parkway is a principal north south corridor through east central Phoenix from I-10 on the south to Shea Boulevard on the north (see Figure 1, Vicinity Map). The Parkway is being extended north and will ultimately extend to Beardsley Road (the future Pima Freeway alignment). The Parkway roughly parallels the alignment of 18th Street from I-10 to Northern Avenue. The limits of this study are from Indian School Road to Bethany Home Road. Most of this section of roadway is depressed below the grade of the adjacent local streets. Concurrent with this study, ADOT is also evaluating the addition of high occupancy vehicle (HOV) lanes on the Parkway between I-10 and Shea Boulevard.

## 1.2 History

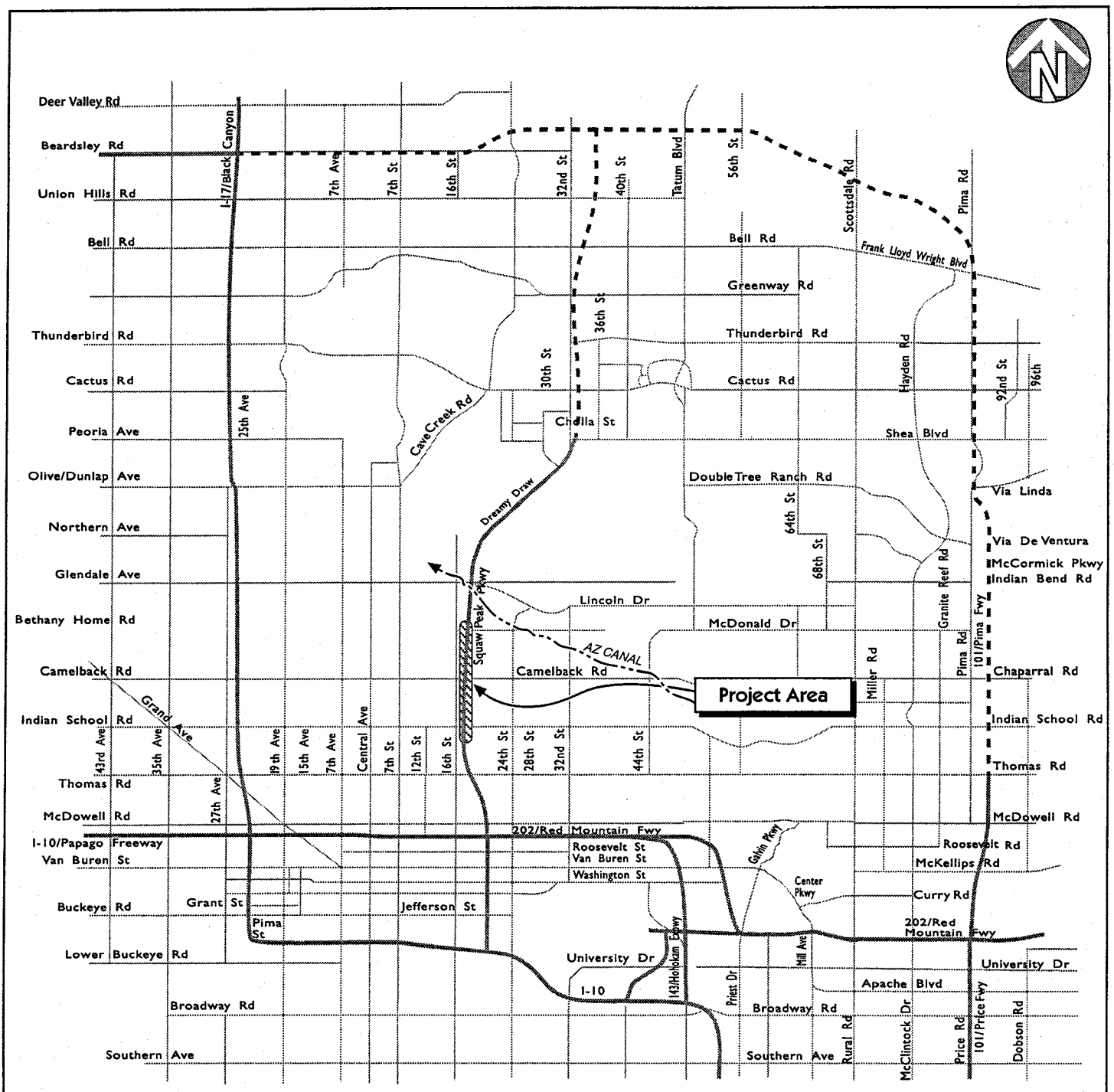
The Squaw Peak Parkway was originally designed, constructed and operated by the City of Phoenix from McDowell Road to Glendale Avenue. The Parkway was extended from Glendale Avenue to Shea Boulevard by ADOT. The facility was maintained by the City until 1992. At that time, ADOT accepted responsibility for the operation and maintenance of the existing portions of roadway. The details of the agreement between ADOT and the City are specified in an intergovernmental agreement (IGA). The City of Phoenix retains liability for the portions of the Parkway that were not designed in accordance with the criteria in ADOT's *1990 Urban Highways Design Manual.* The IGA specifies that the State will maintain the facilities within the sound walls and the City will maintain the facilities outside of the sound walls. However, drainage facilities are located on both sides of the sound walls, complicating the division of responsibility for the facilities.

South of Glendale Avenue the Parkway was designed and constructed to criteria set forth by the City. Many aspects of the roadway and drainage design criteria used vary from that used by ADOT. In general, the City's design criteria was less stringent than ADOT's. Consequently, the on-site storm drainage system appears to be operating at a lower design frequency than that used by ADOT and off-site flows are encroaching onto the Parkway during relatively low frequency events.

There have been two instances of severe flooding reported within the Parkway. The first flood occurred shortly after construction of the facility. It was reportedly caused by lack of fuel in the Highland Avenue Pump Station rather than under performance of the drainage system. The second instance of flooding, in 1993, was attributed to clogged catch basin inlets.

## 1.3 Study Purpose

The purpose of this study is to evaluate the drainage facilities of the Squaw Peak Parkway from Indian School Road to Bethany Home Road. The facility was analyzed for existing conditions and with the proposed HOV lanes in place. The study quantifies the drainage performance of the existing facilities with respect to stormwater conveyance, detention capacity and encroachment by off-site flows. The results of the analysis have been compared to current ADOT drainage design criteria. Deficiencies within the system have been identified. As specific problems were identified, flood mitigation alternatives were




ADOT PRE-DESIGN ON-CALL

# SR51; Indian School to Bethany Home Drainage Project Assessment

## Figure 1, Vicinity Map

proposed to improve the level of performance of the overall drainage system. A range of alternatives has been studied, from those needed to maximize the performance of existing drainage facilities in a cost effective manner to those providing facilities needed to meet current ADOT criteria.

Reasonable alternatives, which have been deemed worthy of further study have been identified and are examined in detail in this report. Quantitative detailed cost analyses are included for these alternatives based upon the technical findings.

A specific return interval was not established for the proposed improvements. It may not be cost effective to improve a facility to point that it meets current ADOT drainage criteria. The final selection of design alternatives considers factors such as cost, expected disruption of Parkway service during construction, impact to surrounding neighborhoods, constructibility issues, and compatibility of future expansion of the parkway. The final selection of solutions/alternatives is based on a consensus.

## 1.4 Study Process

This report is the second in a series of three reports associated with the assessment of the Squaw Peak Parkway drainage between Indian School Road and Bethany Home Road. The Initial Drainage Report builds upon, and reiterates relevant sections of the first report, *SR 51 Drainage Assessment, Final Alternative Selection Report, March 18, 1998,* so that the study process is fully documented in this one volume. This report provides technical documentation of the information presented in the first report. It also provides further study and cost analysis of the solutions/alternatives that were previously recommended. For discussion of alternatives which were initially considered, but were not carried forward, the reader is referred to the *Final Alternative Selection Report.*

The third report, the Drainage Project Assessment, is a project development tool used to program the project. The Drainage Project Assessment has been submitted for review concurrently with this report. It identifies the personnel and agencies involved in the consensus building, defines the scope of the project, design features, development schedule, and construction budgets.

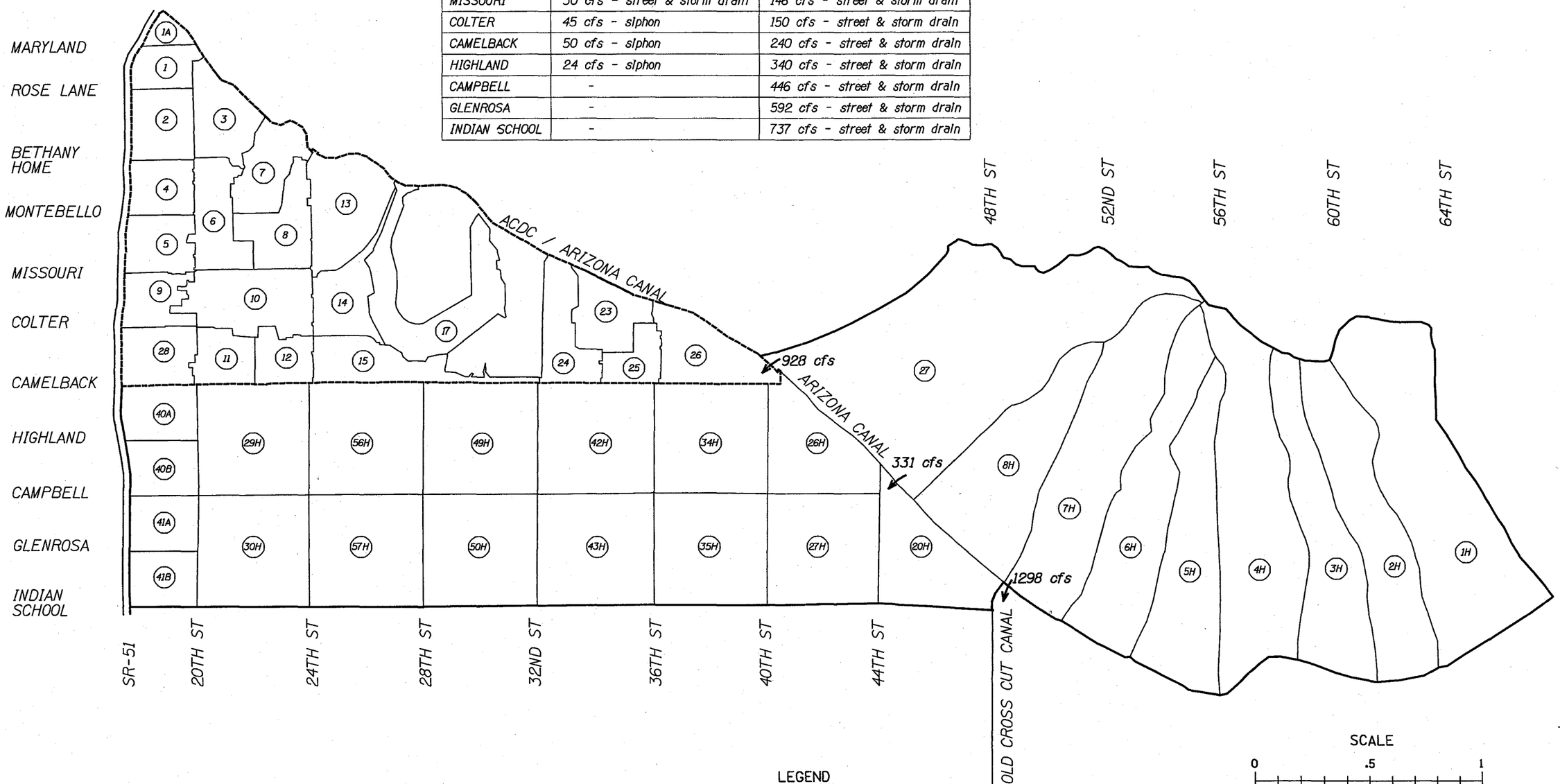
# 2.0 EXISTING CONDITIONS

## 2.1 Introduction

The overall drainage pattern in this area is from northeast to southwest. The upper portion of the watershed is defined by the south slope of Camelback Mountain. The watershed extends east to 40$^{th}$ Street (see Figure 2). Runoff is generally conveyed along city streets, with flows splitting south and west at major intersections. Section 3 of this report discusses previous hydrology studies which determined the watershed boundaries.

Off-site runoff impacts the east side of the Squaw Peak Parkway Corridor. Sound walls along both sides of the Squaw Peak Corridor create a physical barrier, which prevents stormwater from continuing westerly along minor streets. Accumulations of off-site stormwater along the

| FLOW DATA AT SR-51 | | |
|---|---|---|
| STREET | WEST FLOW - TYPE | SOUTH FLOW - TYPE |
| MARYLAND | 24 cfs - siphon | - |
| ROSE LANE | 10 cfs - siphon | 26 cfs - street & storm drain |
| BETHANY HOME | 50 cfs - siphon | 48 cfs - street & storm drain |
| MONTEBELLO | - | 70 cfs - street & storm drain |
| MISSOURI | 30 cfs - street & storm drain | 146 cfs - street & storm drain |
| COLTER | 45 cfs - siphon | 150 cfs - street & storm drain |
| CAMELBACK | 50 cfs - siphon | 240 cfs - street & storm drain |
| HIGHLAND | 24 cfs - siphon | 340 cfs - street & storm drain |
| CAMPBELL | - | 446 cfs - street & storm drain |
| GLENROSA | - | 592 cfs - street & storm drain |
| INDIAN SCHOOL | - | 737 cfs - street & storm drain |




LEGEND

(41A) Sub-basin

Burgess & Niple Drainage Area

HNTB Drainage Area

← 331 Flow (cfs)

50-YR 24-HR DISCHARGE VALUES

| | NAME | DATE |
|---|---|---|
| DESIGN | HNA | 12/18/97 |
| DRAWN | JMC | 12/18/97 |
| CHECKED | JJH | 12/18/97 |

PREMIER

SR-51 INDIAN SCHOOL ROAD TO BETHANY HOME ROAD

DRAINAGE AREA MAP

FIGURE 2

east side of the Parkway are drained by three methods (i.e., the 18th Street Trunk Line, siphons under the Parkway, and street flow on existing bridges).

A major storm drain trunk line is located along the east side of the Squaw Peak right-of-way. The trunk line begins at the Arizona Canal and conveys the runoff to the south, ultimately discharging into the I-10 drainage system. Its principal function is to collect 2-year street flows from 18th Street along the east side of the Parkway.

Runoff is conveyed west under the Squaw Peak Parkway by five stormwater siphons. The siphons are located at Maryland Avenue, Rose Lane, Bethany Home Road, Colter Street and Camelback Road. With the exception of the Colter Street Siphon, the siphons collect runoff on the east side of the Parkway and discharge to the street on the west side of the Parkway. The Colter Street Siphon discharges to the Colter Street Detention Basin. This siphon and basin remove stormwater from the 18th Street Trunk Line so that it can accept pumped flows from the Highland Pump Station.

Runoff is conveyed over the Parkway by bridges at Missouri Avenue, Camelback Road and Highland Avenue. The bridges at Colter Street and Bethany Home Road convey little, if any, runoff over the Parkway. These conveyance systems prevent off-site runoff from lower frequency storms from flowing onto the Parkway. However, off-site runoff is able to enter the Parkway through openings in the sound walls and down the northbound off-ramp at Highland Avenue. Openings have been provided through the east sound wall at Campbell Avenue, Turney Avenue and Glenrosa Avenue to allow off-site runoff to enter the Parkway and reduce flooding of the neighborhoods along the east side of the Parkway.

***Drainage openings in east sound wall. Taken from 18th Street and Glenrosa Avenue looking west.***

ADOT personnel have observed runoff flowing down the northbound off-ramp at Highland Avenue. The runoff was produced by one of the relatively large storms which caused severe flooding on the Parkway.

Within the study limits, the Squaw Peak Parkway is a depressed roadway from just south of Highland Avenue to just south of Bethany Home Road. Roadway runoff in the depressed section is collected by an on-site storm drain that conveys it to the pump station located at Highland Avenue. The pump station discharges into the 18th Street Trunk Line.

## 2.2 Off-site Drainage

### *18th Street Trunk Line*

***Overview*** - The 18th Street Trunk Line is located along the eastern right-of-way of the Squaw Peak Corridor (see Figure 3). Horizontally, the trunk line is located near the eastern sound wall along the Parkway. The trunk line crosses under the wall in several locations. Some reaches are east of the sound wall, others are west of the sound wall. Typically, the invert is about 10 to 20 feet below the existing ground along 18th Street. Depressed sections of the Parkway do not drain directly into the trunk line. Runoff from the depressed section is drained by a separate storm drain and enters the trunk line via the Highland Pump Station.

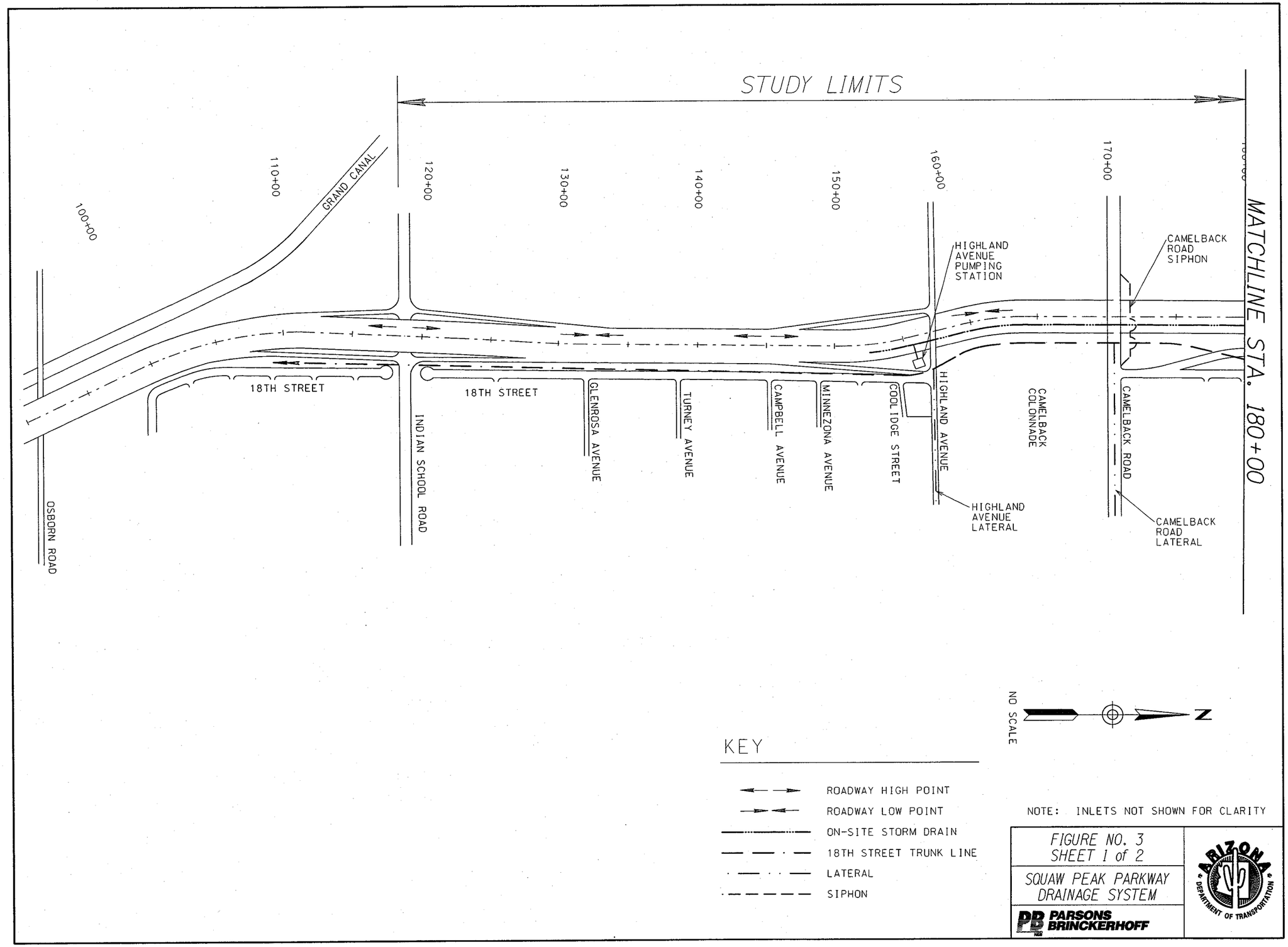
The upstream end of the trunk line, near the Arizona Canal, is north of the study area. The trunk line drains to the south along the Parkway. Between the Arizona Canal and Indian School Road, the trunk line collects on-site runoff from non-depressed areas of the Parkway and from 18th Street.

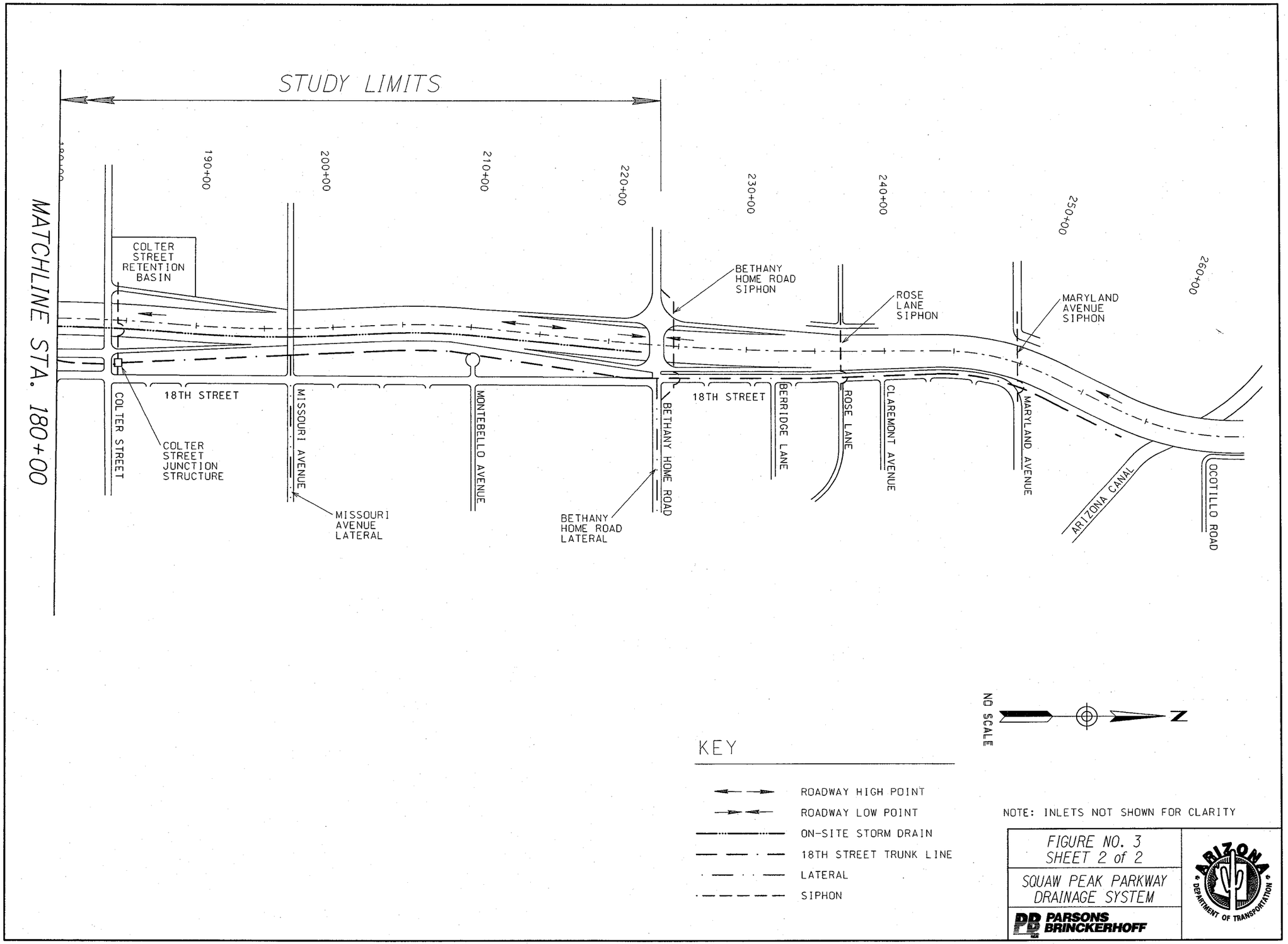
Within the study area, the trunk line has 4 lateral systems, which collect flows from local east-west streets. These laterals are located on Bethany Home Road, Missouri Avenue, Camelback Road and Highland Avenue. The laterals collect runoff which would otherwise flow westerly along the local streets.

Analysis of the 18th Street Trunk Line indicates that it is possible to discuss the trunk line operation in general terms, but there are too many inflow variables to precisely identify a level of operation in terms of an exact design storm frequency. Inflow variables include the flow split within the Colter Street Junction Structure, inflows from the major laterals, pump station discharges and the hydraulic grade line in the storm drain south of Indian School Road. The conveyance capacity of the trunk line varies as shown in Figure 4.

The trunk line was modeled using Winstorm software. Winstorm was developed by the Texas Department of Transportation. It is a Windows version of their THYSYS software and is discussed in detail in Section 4.2 of this report. The conveyance capacity of the trunk line was modeled in two sections, from the Arizona Canal to the Colter Street Junction Structure and from the junction structure to Indian School Road. Pipe and node diagrams for the models are included in the Appendix.

Inlet capacities for the trunk line catch basins were modeled using HEC-12 methods in a spreadsheet. The spreadsheet used peak flows generated by the off-site hydrologic model to estimate the inlet capacities. Spread conditions in the off-site gutters were not analyzed as part of this study. Spread conditions for on-site inlets which drain to the trunk line were not analyzed due to the limited capacity of the trunk line. Two sections of the Parkway are drained by the 18th Street Trunk Line. These sections are located north of Berridge Lane and south of Campbell Avenue. These reaches of the trunk line are only capable of conveying the 2 to 10-year storm, so flows which exceed these levels will be expected to bypass the inlets entirely and pond in mainline sags. The spread criteria for non-depressed roadways is to limit encroachment to half of the outside lane. Therefore, spread calculations for these on-site inlets are generally superfluous.


STUDY LIMITS
MATCHLINE STA. 180+00
100+00
110+00
120+00
130+00
140+00
150+00
160+00
170+00
GRAND CANAL
OSBORN ROAD
18TH STREET
18TH STREET
INDIAN SCHOOL ROAD
GLENROSA AVENUE
TURNEY AVENUE
CAMPBELL AVENUE
MINNEZONA AVENUE
COOLIDGE STREET
HIGHLAND AVENUE
HIGHLAND AVENUE PUMPING STATION
HIGHLAND AVENUE LATERAL
CAMELBACK COLONNADE
CAMELBACK ROAD
CAMELBACK ROAD SIPHON
CAMELBACK ROAD LATERAL
NO SCALE
N
KEY
ROADWAY HIGH POINT
ROADWAY LOW POINT
ON-SITE STORM DRAIN
18TH STREET TRUNK LINE
LATERAL
SIPHON
NOTE: INLETS NOT SHOWN FOR CLARITY
FIGURE NO. 3
SHEET 1 of 2
SQUAW PEAK PARKWAY
DRAINAGE SYSTEM
PARSONS BRINCKERHOFF
ARIZONA DEPARTMENT OF TRANSPORTATION


STUDY LIMITS
MATCHLINE STA. 180+00
190+00
200+00
210+00
220+00
230+00
240+00
250+00
260+00
COLTER STREET RETENTION BASIN
COLTER STREET JUNCTION STRUCTURE
BETHANY HOME ROAD SIPHON
ROSE LANE SIPHON
MARYLAND AVENUE SIPHON
18TH STREET
COLTER STREET
MISSOURI AVENUE
MISSOURI AVENUE LATERAL
MONTEBELLO AVENUE
BETHANY HOME ROAD
BETHANY HOME ROAD LATERAL
18TH STREET
BERRIDGE LANE
ROSE LANE
CLAREMONT AVENUE
MARYLAND AVENUE
ARIZONA CANAL
OCOTILLO ROAD
NO SCALE
N
KEY
ROADWAY HIGH POINT
ROADWAY LOW POINT
ON-SITE STORM DRAIN
18TH STREET TRUNK LINE
LATERAL
SIPHON
NOTE: INLETS NOT SHOWN FOR CLARITY
FIGURE NO. 3
SHEET 2 of 2
SQUAW PEAK PARKWAY
DRAINAGE SYSTEM
PARSONS BRINCKERHOFF
ARIZONA DEPARTMENT OF TRANSPORTATION

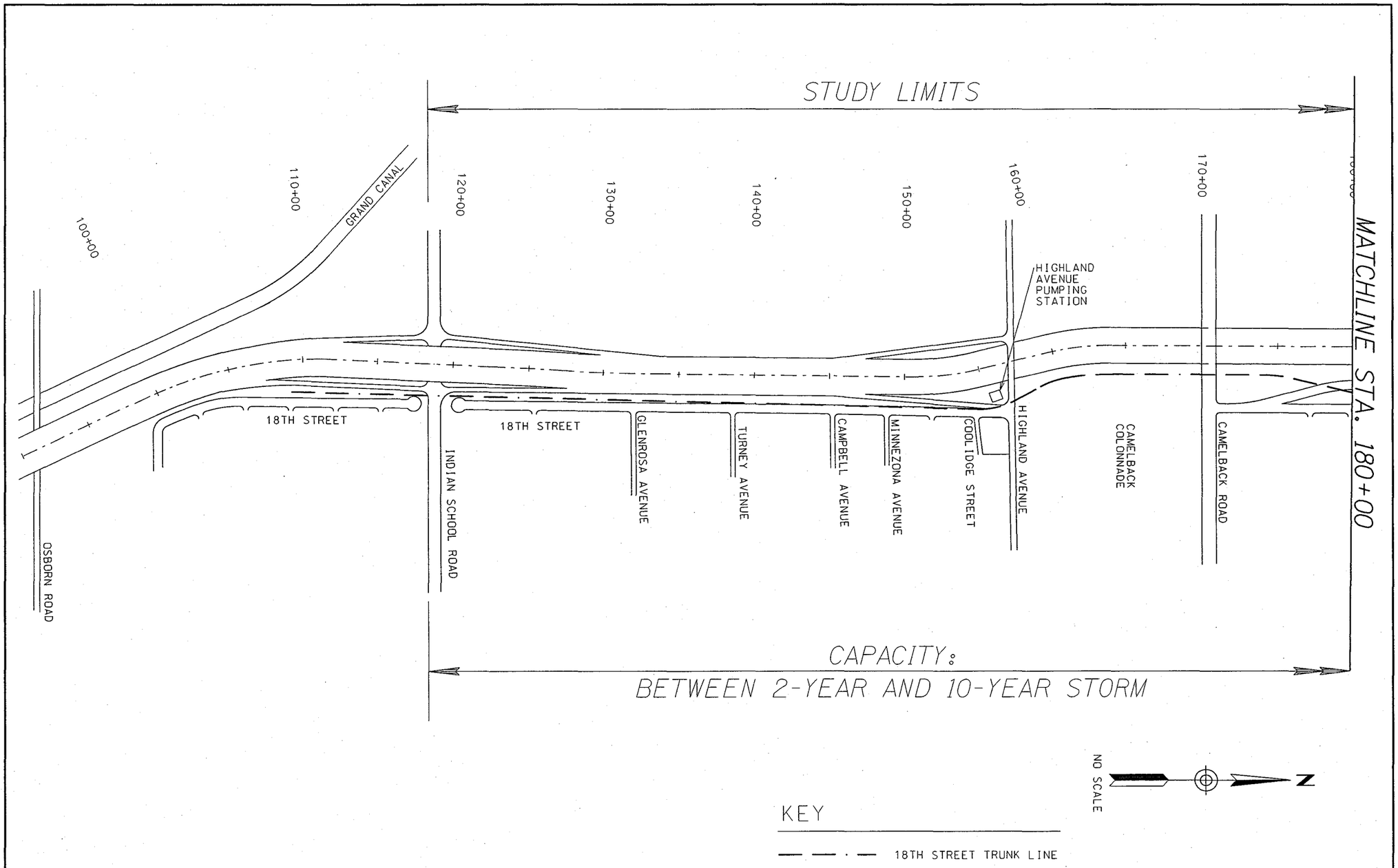
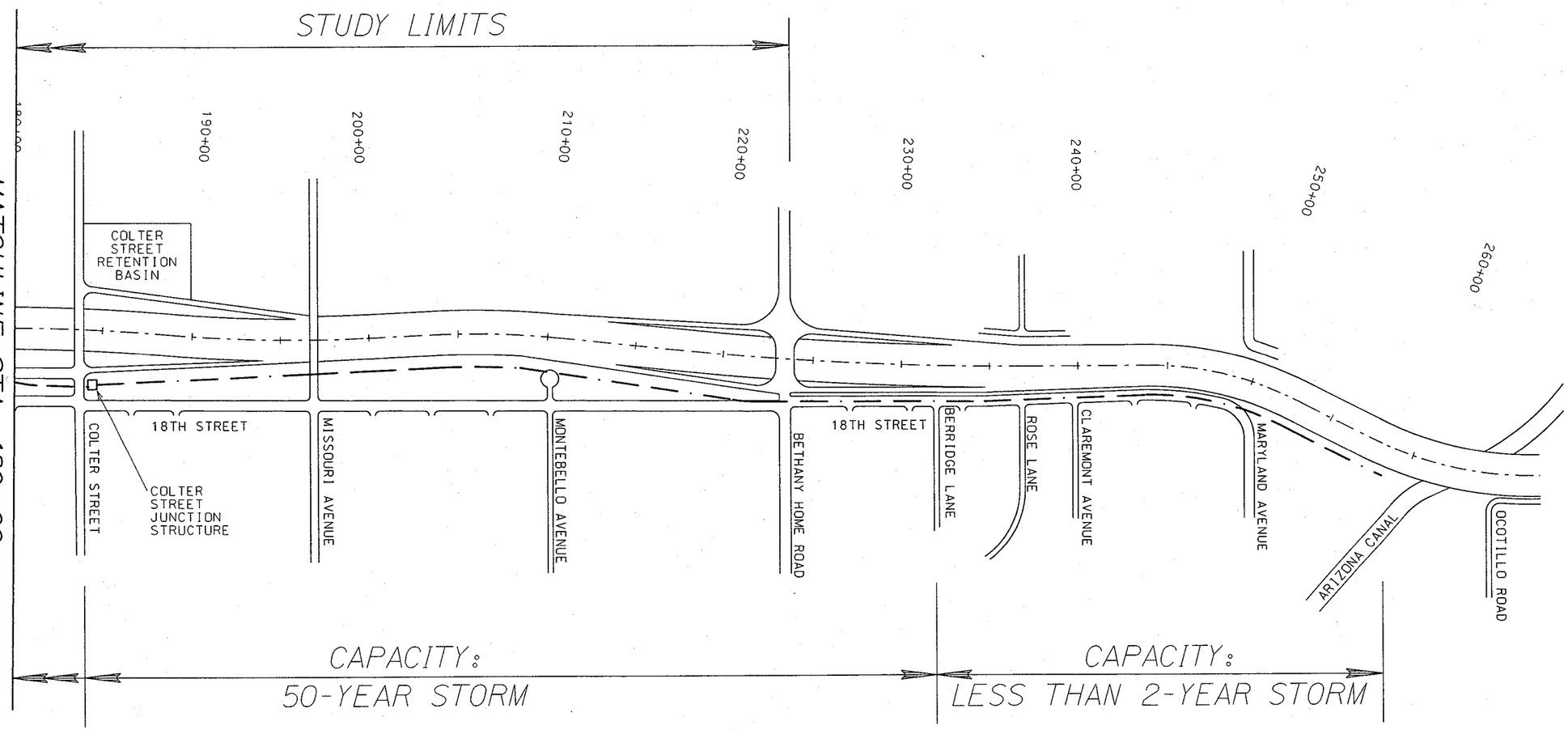



FIGURE NO. 4
SHEET 1 of 2

18th STREET TRUNK LINE
EXISTING CAPACITY

PARSONS BRINCKERHOFF

ARIZONA DEPARTMENT OF TRANSPORTATION




NO SCALE

N

KEY

— — · — 18TH STREET TRUNK LINE

NOTE: INLETS NOT SHOWN FOR CLARITY

FIGURE NO. 4
SHEET 2 of 2

18th STREET TRUNK LINE
EXISTING CAPACITY

PB PARSONS BRINCKERHOFF

ARIZONA DEPARTMENT OF TRANSPORTATION

The conveyance capacities of the laterals in Bethany Home Road, Missouri Avenue, Camelback Road and Highland Avenue were also analyzed using Winstorm. The HEC-12 spreadsheets were used to estimate the intake capacity of the lateral inlets. Pipe and node diagrams and model outputs are included in the Appendix.

***Arizona Canal to Berridge Lane*** -The inlets in this reach are capable of collecting more runoff than the storm drain can convey. This will result in runoff bypassing the Parkway on-site inlets and the 18th Street inlets north of Berridge Lane. Bypass will occur in this area even during the 2-year storm.

***Berridge Lane to Colter Street Junction Structure*** -The trunk line is connected to the Colter Street Siphon by a junction structure located on the east side of the Parkway just south of Colter Street. The junction structure divides incoming flow between the trunk line to the south and to the Colter Street Detention Basin. The detention basin provides on-line storage for the runoff in the trunk line. As long as the HGL of the trunk line is above the water surface in the basin, runoff is diverted to the basin for storage. As the storm passes and the HGL in the trunk line drops the detained runoff flows out of the basin into the trunk line. The Colter Street Detention Basin provides sufficient storage to allow flows to be diverted at anytime during the rising limb of the storm hydrograph. Therefore, the HGL downstream from the structure has little effect on the trunk line upstream from the structure.

The junction structure is configured so that the outlet to the Colter Street Detention Basin is 6 inches lower than the outlet to the trunk line to the south. This diverts low flows into the detention basin during the beginning of the storm. However, there is very little detention storage below the invert of the trunk line outlet in the junction structure. This volume is quickly filled and subsequent inflows to the junction structure are divided between the detention basin and the trunk line.

From Berridge Lane to the Colter Street Junction Structure, the trunk line can convey the 50-year storm.

***Colter Street Junction Structure to Highland Avenue*** - There are few inlets draining directly into the trunk line in this reach, but major laterals tie in at Camelback Road and Highland Avenue and the pump station discharges to the trunk line at Highland Avenue. These tie-ins have a major influence the HGL in the trunk line south of the Colter Street Junction Structure.

***Highland Avenue to Indian School Road*** - The trunk line south of Highland Avenue was designed to convey the peak flow from the 2-year design storm. The as-built construction plans for the 18th Street Trunk Line at Indian School Road shows the design HGL at elevation 1124.25. The inlet grate elevation at this location is at 1133.95. Analysis of the trunk line shows that its capacity within the study area is highly dependent on the actual HGL elevation at Indian School Road.

The analysis of the 2-year design storm within the trunk line is based on the HGL (from the "As-Built" Plans) at Indian School Road being at elevation 1124.25. During the 2-year design storm, runoff enters the trunk line from the cross street laterals, the Colter Street Junction Structure and from inlets located along 18th Street and the undepressed sections of the Parkway. The trunk line is capable of conveying the peak flow from the 2-year design storm from Berridge Lane to Indian School Road.

During storms that exceed the 2-year event, the operation of the system is somewhat indeterminate. The hydraulic grade line in the trunk line will rise and fall with time, affecting the inflow from the laterals and from the Colter Street Junction Structure. The HGL in the trunk line south of Indian School Road will also rise and fall with time, affecting the system's ability to receive runoff from the study area. The HGL at Indian School controls the capacity of the 18th Street Trunk Line from Indian School Road to the Colter Street Junction Structure. Just south of Highland Avenue, the capacity of the trunk line is about 126 cfs during the 10-year storm (HGL at Indian School Road assumed to be near gutter elevation, 1133.5). Examination of the 10-year inflows to the trunk line south of Highland Avenue yields:

1) 110 cfs peak outflow from the Highland Pump Station
2) About 43 cfs from the Highland Lateral (combined street and storm drain )
3) About 43 cfs from the Camelback Lateral
4) About 113 cfs available at the Colter Street Junction Structure

While the peak flows are not concurrent, they will be relatively close together. When inflows from these four sources exceed about 126 cfs, overflow will continue east down Highland Avenue and Camelback Road and south down 18th Street. Overflow on 18th Street and Highland Avenue is expected to impact the Parkway through drainage openings in the sound walls and down the northbound off-ramp. The on-site catch basins at the Highland Avenue ramps are also expected to overflow onto the Parkway. Between Highland Avenue and Indian School Road, the trunk line will not remove on-site runoff during storms in access of about the 2-year storm.

### *Siphons*

Runoff is conveyed west under the Squaw Peak Parkway by five stormwater siphons. The siphons are located at Maryland Avenue, Rose Lane, Bethany Home Road, Colter Street and Camelback Road. With the exception of the Colter Street Siphon, the siphons collect runoff on the east side of the Parkway and discharge through street catch basins on the west side. Inlets for the siphons are located on 18th Street and/or on the cross street. The Colter Street Siphon discharges to the Colter Street Detention Basin.

Siphon capacity calculations are included in the Appendix. The following table summarizes the siphon sizes and their capacities:

**Cross-Parkway Siphons**

| *Location* | *Pipe Size* | *Peak Capacity* |
|---|---|---|
| Maryland Avenue | 27-inch | 24 cfs |
| Rose Lane | 21-inch | 10 cfs |
| Bethany Home Road | 54-inch | 60 cfs |
| Colter Street | 72-inch | 100 cfs |
| Camelback Road | 60-inch | 50 cfs |

The Colter Street Siphon is connected to the 18th Street Trunk Line at the Colter Street Junction Structure as shown in Figure 5. The 100 cfs capacity shown in the table above

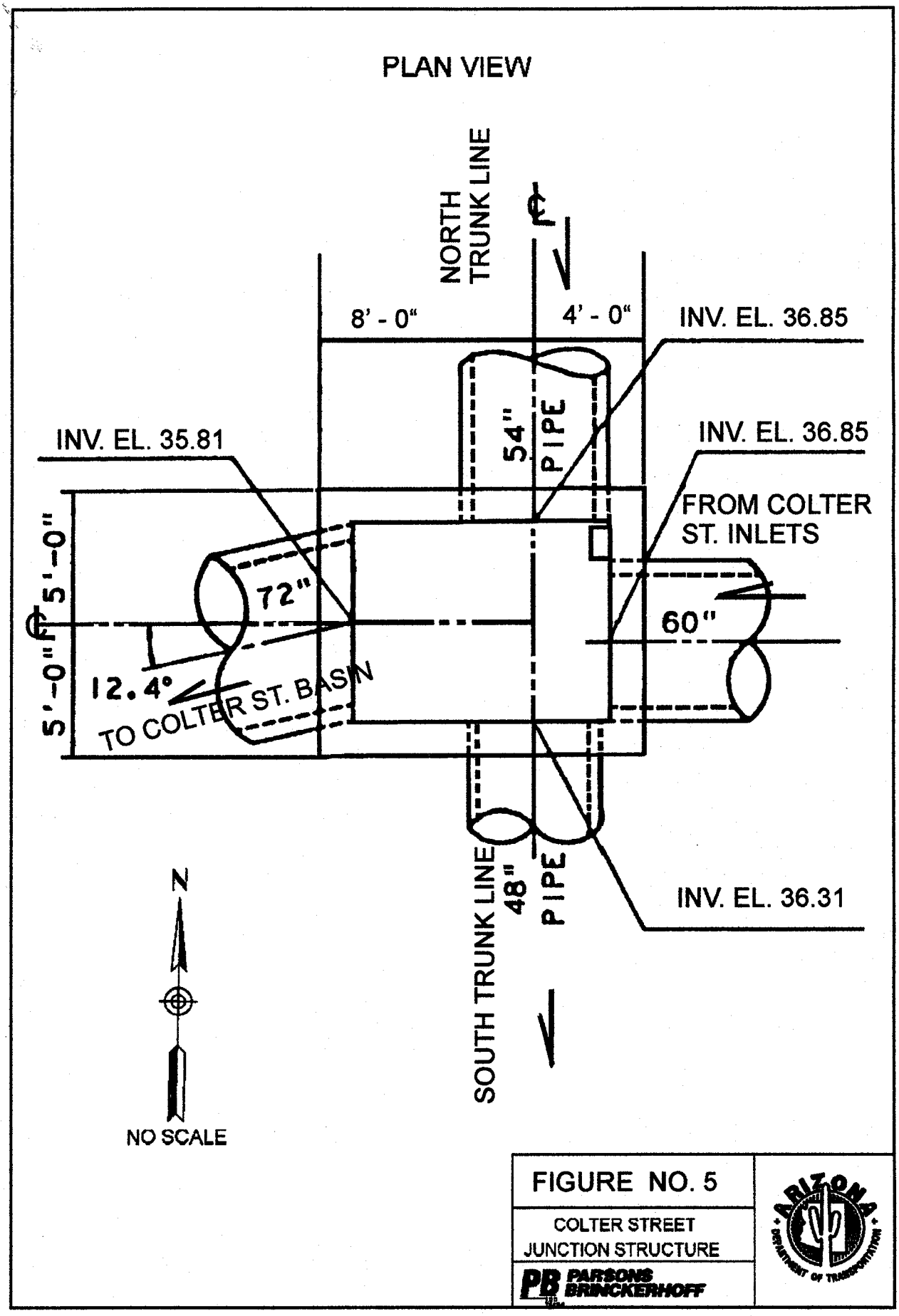



FIGURE NO. 5

COLTER STREET JUNCTION STRUCTURE

PB PARSONS BRINCKERHOFF

reflects the capacity of inlets on Colter Street (ie via the 60-inch storm drain) during the 50-year storm. The 72-inch siphon pipe can deliver approximately 150 cfs (supplied by the 54-inch north trunk line and the 60-inch storm drain) to the Colter Street Detention Basin during the 50-year storm.

The Maryland Avenue, Rose Lane, Colter Street, and Camelback Road siphons are drained by a 6-inch bleed-off pipe to the 18th Street Trunk Line after the storm.

Unlike the other siphons, Bethany Home Road siphon pipe is not completely drained after the storm. The 18th Street Trunk Line passes over the siphon at this location, so it is not possible to drain the siphon below elevation 1155.3. The invert of the lowest manhole within the siphon is at elevation 1148.2. Therefore, approximately 7 feet of water will pond in the manhole.

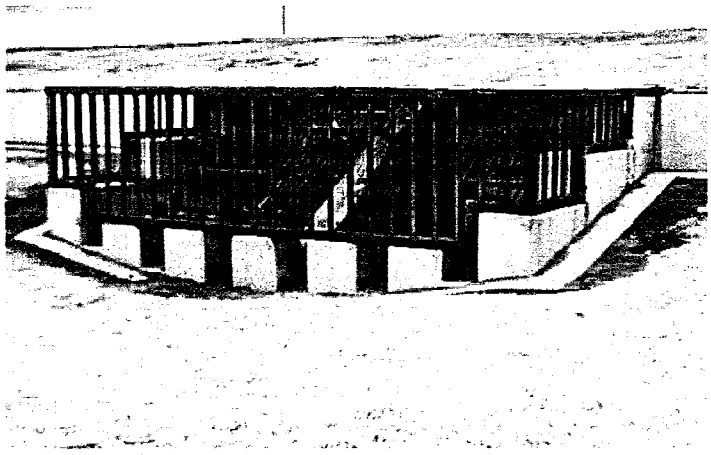
### *Colter Street Detention Basin*

The Colter Street Detention Basin is a City of Phoenix drainage facility. The basin is located in Desert Storm Park, north of Colter Street at 16th Street and occupies virtually the entire park. The bottom of the basin is at elevation 1135, the top is at elevation 1154. In the event that the basin is filled beyond capacity, runoff will overflow into Colter Street. The detention capacity of the basin, when filled to elevation 1153, is estimated at 31 acre feet. Detention capacity calculations are included in the Appendix.

*Colter Basin. Taken from the southern end of the basin looking to the north.*

Runoff is diverted to the basin by the junction structure shown in Figure 5, which connects the 18th Street Trunk Line to the Colter Street Siphon. The junction structure is located east of the northbound on-ramp at Colter Street, within the Parkway sound walls. The 18th Street Trunk Line enters the structure from the north in a 54-inch pipe. A 60-inch storm drain from Colter Street enters the east side of the structure. There are two outlets from the junction structure.

The 18th Street Trunk Line exits to the south in a 48-inch pipe, the siphon continues west in a 72-inch pipe. At elevation 1136.3, the invert to the 48-inch trunk line pipe is 6 inches higher than the invert to the 72-inch pipe.



***Outlet of the Colter Siphon in the Colter Basin. Taken from the center of the basin looking east.***

There are no weirs or other flow diversion devices in the junction structure. The differential head available for each outflow pipe controls flow diversion within the structure. As a storm progresses, the detention basin fills creating backwater effects within the junction structure. However, the hydraulic grade line in the 18th Street Trunk Line also rises as a storm progresses, causing another backwater effect in the structure.

Runoff from the 50-year storm was routed through the structure at 2-minute time steps. Routing calculations are shown in the Appendix. Inflows into the junction structure were distributed between the trunk line to the south and the siphon pipe to the detention basin to the west. The distribution was determined by the estimated tailwater conditions in the discharge pipes. As the water level in the detention basin rises, the tail water condition in the west siphon pipe rises. As runoff is contributed to the trunk line from the Camelback Road lateral and the Highland Avenue lateral, the tail water in the south trunk line pipe rises. The graphs included in the Appendix were used to determine the division of inflow between the detention basin and the trunk line to the south. The analysis included a cumulative tally of the runoff in the detention basin.

The routing quickly showed that the limited capacity of the trunk line south of the junction structure diverts most of the runoff into the basin. A second routing was performed to evaluate the effect of removing the pump station discharge from the trunk line. Removing the pump station discharge slightly prolongs the time period in which the trunk line has capacity to accept runoff from the junction structure.

In the existing condition, it appears that approximately 21 acre feet of runoff are diverted to the detention basin during a 50-year design storm. The 50-year design storm is expected to produce approximately 22 acre feet of runoff. Therefore, the system is retaining about 95% of the runoff. The 100-year design storm (existing condition) is also expected to allow about 1

acre foot of runoff to bypass the detention basin. The 100-year storm produces 25 acre feet of runoff, of which 24 acre feet are detained at a water surface elevation of 1151.4.

As a storm event passes, the hydraulic grade line within the junction structure eventually drops below the water surface elevation in the detention basin. Detained water then flows back through the siphon pipe to the junction structure, continuing down the 18th Street Trunk Line. This continues until the water surface elevation in the basin reaches 1136.3. At that elevation, the water surface is at the invert of the 48-inch trunk line pipe within the junction structure. The remaining water within the siphon pipe and the last 1.4 feet in the basin will drain into the on-site storm drain via a 6-inch bleed pipe. The effects of this drain line were ignored during the analysis of the siphon pipe and the on-site storm drain.

## 2.3 On-site Drainage

### *Interconnections of On-site Storm Drain With Off-site Runoff*

The on-site storm drain is impacted by off-site runoff in three locations. The first is through openings in the east sound wall. Openings have been provided in the base of the sound wall at Campbell Avenue. The openings allow runoff to enter the depressed section of the Parkway, reducing flooding of the houses in the vicinity. There is a landscaped area between the wall openings and the west gutter on 18th Street. Runoff from 18th Street and Campbell Avenue enters the landscaped area via a 50-foot section of depressed curb. An inlet located in the landscaped area collects approximately 5 cfs. The inlet drains to the 18th Street Trunk Line. Bypass flows from this inlet will drain into the Parkway via the openings in the sound wall. The runoff flows north to the sag at Highland Avenue and must be pumped out .

The second encroachment by off-site flows occurs at the northbound off-ramp at Highland Avenue. ADOT personnel have observed runoff flowing down the northbound on-ramp and into the sag at Highland Avenue. This encroachment is not likely intentional, since any runoff entering the sag has to be pumped out.

The northbound off-ramp also receives off-site flow from on-site inlets at the bottom of the ramp. These are the first inlets to overflow when the HGL in the trunk line begins to rise. Off-site flows, which discharge from the ramp inlets, will flow onto the Parkway and into the pump station. Discharge is expected from these inlets in storms larger than a 2-year frequency.

### *On-site Storm Drain*

The majority of the roadway in the study area is depressed. There is no gravity drainage outfall for the depressed section. A pump station located near the northbound Highland Avenue off-ramp removes stormwater runoff. The on-site storm drain conveys the runoff to the pump station. Three mainline roadway crests and two roadway sags define the major on-site subbasins located within the study boundaries. These crests and sags are shown on Figure 3. The northern on-site watershed boundary is a crest located about 800 feet south of Bethany Home Road. Runoff falling south of this flows south to be collected by the on-site storm drain and conveyed to the pump station at Highland Avenue. The low point of the sag is about 120 feet north of Highland Avenue. South of the sag, the roadway rises to a crest 1/4

mile south of Highland Avenue. This crest is the southern boundary of the watershed contributing to the on-site storm drain system. There is a second sag located about 1/2 mile south of Highland. A third crest, at the top of the Indian School Bridge, is the southern watershed boundary of the study area.

There is a sag north of the study area between Bethany Home Road and Glendale Avenue. Although the sag is not in the study area, drainage in the sag is related to the on-site storm drain system. Some of the runoff from the north end of the sag is collected by inlets and laterals from the 18th Street Trunk Line. Analysis of the trunk line indicates that these laterals will not collect all the on-site runoff produced during a 2-year design storm. Runoff from the north side of the sag, which bypasses the inlets and the runoff from the south side of the sag is collected and detained in an underground storage vault located south of the Arizona Canal Bridge. The vault consists of 12, 6-foot by 6-foot box culverts about 200 feet long. The total detention volume is 2 acre feet. The vault is drained into the on-site storm drain via a 15-inch pipe. There is a 6-inch diameter restriction pipe between the vault and the 15-inch drainpipe to reduce the outflow from the vault. Due to the 6-inch restriction, vault outflow was not considered to impact the peak flows in the on-site storm drain.

The on-site storm drain collects runoff generated from the pavement and landscaped areas between the Squaw Peak Parkway sound walls. The trunk line is located along the east edge of the northbound lanes. Laterals convey runoff from the southbound lanes and the median to the trunk line. The laterals are all 15-inch diameter concrete pipes.

The on-site storm drain was analyzed using Winstorm. Inlet capacities and gutter spread of runoff for the on-site catch basins were modeled using HEC-12 methods in a spreadsheet. The spreadsheet was used to model worst case spread conditions in the gutter and inlet capacities as the flow moves downstream in the storm drain. Worst case spread conditions occur with a 10-minute time of concentration at each inlet. Inlet capacities were modeled using the time of concentration at the inlet that corresponds with the time of concentration of the flows within the storm drain. Bypass flows from one catch basin to the next were accounted for in both models. Pipe and node diagrams of the system and printouts of the spreadsheets from the 10, 25, and 50-year storms are included in the Appendix. The following table summarizes the peak on-site flows expected:

**Peak Flows in On-site Storm Drain**

| *Design Storm* | *Existing Condition* |
|---|---|
| 10-year Storm | 117 cfs |
| 25-year Storm | 155 cfs |
| 50-year Storm | 182 cfs |

A hydraulic analysis of the existing on-site storm drain indicates that the system can convey a peak discharge of almost 117 cfs, which is close to the peak flows produced by the 10-year storm for both the existing condition and the condition with HOV lanes. See Section 7.2 of this report for discussion of HOV lanes. At higher flows, runoff will bypass the catch basins and flow to the Highland Avenue sag along the gutter. The trunk line does not have enough

capacity to convey larger peaks. The hydraulic grade line of the trunk line exceeds the gutter elevation in several locations during the 10-year storm.

The analysis indicates that the existing inlets are adequate to prevent excessive stormwater encroachment of the traveled lanes during a 10-year storm. The original mainline roadway was designed with a 2-foot gutter, an 8 to 10-foot shoulder and three, 12-foot lanes. In accordance with ADOT criteria, the allowable spread width in the outside gutter for this section is 14 to 16 feet for the 10-year storm. The inside lanes have a 7-foot shoulder. In superelevated sections, the allowable spread in the inside lane is limited to 7 feet (the edge of the shoulder). The calculated spread for the 10-year storm generally does not exceed the spread criteria. However, some localized encroachment is expected at the end of the southbound Bethany Home Road on-ramp and in the southbound lanes near Highland Avenue. These inlets are all in superelevation transitions and the excessive spread is caused more by flat cross slopes than by excessive runoff. The effected inlets are I706, I714 and I755. The spread is less than 1.5 feet over allowable near Highland Avenue at inlets I706 and I714. Inlet I755 is at the bottom of the southbound on-ramp at Bethany Home Road, so the flooding occurs on the ramp, not on the mainline. These encroachments should be considered minor in nature. Improvements required to reduce the flooded width of pavement would not be cost effective unless performed as part of the work associated with adding HOV lanes.

A check of the spread widths for the 50-year storm shows that the system could theoretically collect the 50-year storm with less than 22 feet of encroachment. If the trunk line were able to convey the runoff, the spread would be expected to exceed 17 feet in only two locations during the 50-year storm.

### *Highland Avenue Pump Station*

The floor of the pump station and generator building are approximately two feet higher than the adjacent gutter elevations in 18th Street.

***Highland Pump Station. Taken from NE corner of Highland Avenue and 18th Street looking to the SW.***

The station has a total of six pumps. There are five main pumps. They are 200-hp Flygt submersible pumps. Four pumps may operate at once with the fifth pump provided for redundancy. A 5-hp nuisance pump is used to drain the wet well after the main pumps shut down. The main pumps have a peak output of about 31 cfs (13,500 gpm) each for a total of

123 cfs from the station. This is approximately equal to the capacity of the on-site storm drain system.

The pumps are currently set so that the first pump begins pumping when the water level in the wet well reaches elevation 1111.0. Subsequent pumps begin to pump at elevations 1112.0, 1113.5 and 1113.67. The high water alarm is set at elevation 1118.0. Therefore, the working volume of the wet well is the volume of water between elevations 1118.0 and 1111.0, or approximately 6,200 cubic feet.

# 3.0 PREVIOUS STUDIES

## 3.1 Off-site Drainage

### *Hydrology*

A number of reports and studies have been prepared for the project area. The following three reports helped establish the criteria for the design of the major existing drainage components for the I-10 and Squaw Peak Freeway.

- Hydrology and Hydraulic Design Concepts, Arthur Beard Engineers, Inc., October 1983.
- Evaluation of Value Engineering Alternatives, Interstate 10 Phoenix-Casa Grande Highway, Inner Loop Drain Tunnels, Howard Needles, Tammen, & Bergendoff, October 1983.
- 50-year Drainage Study for Squaw Peak Parkway, Segment Va, Highland Avenue to Bethany Home Road, Project P-856336, Burgess & Niple Engineers and Architects, May 1987.

The purpose of the original study by Arthur Beard Engineers, Inc. (ABE) was to determine the offsite hydrologic characteristics of the contributing watershed and to develop conceptual designs for the I-10 Inner Loop Storm Drain System. The hydrologic portion of the study resulted in the establishment of a detailed mathematical model of the watershed using the Soil Conservation Service (SCS) TR-20 computer program. This model determined flow parameters for the storm sewer and surface flow at each of the major ½ mile streets for the 50-year design storm.

During review of the ABE report, it became apparent that the calculated storm drainage flows combined with the depressed I-10 freeway alignment created a very unusual and difficult design and construction problem. The magnitude of the problem was demonstrated in the ABE report by high estimated construction costs, large drainage structures and major impacts on traffic and existing utilities. ADOT selected Howard, Needles, Tammen & Bergendoff (HNTB) to perform a Value Engineering (VE) Study to identify, develop and evaluate additional conceptual approaches toward solution of the off-site drainage problem. As part of the VE Study, HNTB refined the ABE TR-20 model. The drainage area was expanded to the east and south to include the southern slope of Camelback Mountain and most of the area north of the Salt River between 20th Street and the New Cross Cut Canal. Results of the VE Study are

summarized in the HNTB report. The HNTB TR-20 model reduced the typical basin size from ½ square mile (ABE) to ¼ square mile.

At the time the HNTB model was formulated, the Squaw Peak Parkway was in the conceptual planning stages, and was envisioned to be an at-grade roadway with a two-year capacity storm drain system (per standard City of Phoenix practice). As the planning process progressed the design concept was modified from an at-grade facility to a depressed facility from Highland Avenue to Glendale Avenue.

Burgess and Niple Engineers and Architects (BN) was retained by the City of Phoenix to evaluate the offsite drainage system for the Squaw Peak Parkway Section Va - Highland Avenue to Bethany Home Road. BN reviewed/refined the HNTB report for the area bounded on the west by the Squaw Peak Parkway, on the south by Camelback Road, on the north by the Arizona Canal, and on the east by 40$^{th}$ Street (includes flow from the south slope of Camelback Mountain). BN conducted field visits and developed a detailed hydrologic model based on numerous hydrologic parameters rather than a ½ street grid. BN identified several areas of concern along the corridor and developed five conceptual drainage design alternatives for this section of the Squaw Peak Parkway. The City of Phoenix implemented several of the design alternatives during construction of the Squaw Peak Parkway.

The City of Phoenix did not require a final drainage report to be prepared for this section of the Squaw Peak Parkway. Therefore, engineering reports documenting the drainage system for this section of the Squaw Peak Freeway do not exist. The PB design team utilized a combination of as-built plans, engineering reports and personnel observations to document the hydrologic/hydraulic operation of this section of the Parkway.

ADOT Pre-Design Section retained Stanley Consultants to evaluate the feasibility of constructing High Occupancy Vehicle (HOV) lanes on the Squaw Peak Freeway. ADOT Pre-Design Section retained Parsons, Brinckerhoff, Quade, & Douglas (PB) to evaluate and recommend improvements to the existing drainage system (onsite and offsite) for the Squaw Peak Freeway from Indian School Road to Bethany Home Road. It is anticipated that the drainage improvements will be constructed prior to or during the HOV construction.

The PB team met with ADOT personnel to discuss the off-site hydrologic models for the project area. The consensus was that the focus of this study should not be on refinement of the offsite hydrologic models, but rather on the development of solutions to the drainage concerns.

## 3.2 On-site Drainage

### *Hydrology*

There are no previous studies available which specifically address on-site hydrology for the Parkway as constructed. Components of the on-site storm drain system were discussed in "*50-Year Drainage Study for Squaw Peak Parkway Segment Va, Highland Avenue to Bethany Home Road*" by Burgess and Niple, 1987. The BN study was an alternative selection report for flood mitigation alternatives for the Squaw Peak Parkway within the present study area.

### *Hydraulics*

There are no previous studies available which specifically address on-site hydraulics.

# 4.0 METHODS OF ANALYSIS

## 4.1 Off-Site Drainage

### *Hydrology*

In order for the PB team to develop effective drainage design alternatives, offsite storm water runoff must first be quantified. Team members reviewed existing hydrologic reports from HNTB and BN. It was determined that the BN model would be utilized for the area north of Camelback Road and the HNTB model would be utilized for the area south of Camelback Road. The contributing watershed was originally modeled with the Soil Conservation Service (SCS) TR-20 computer model. Team members converted the existing TR-20 models to HEC-1 to more closely conform to current ADOT criteria and to allow evaluation of several design alternatives. The following paragraphs describe procedures and methodologies originally utilized as well as modifications made by the PB team.

During the conversion of the hydrologic model to HEC-1, the goal of the PB team was to duplicate the previously approved models. In a few locations, the PB model peak discharge values varied by more than 10 percent from the original TR-20 model. The hydrologic parameters at these locations were adjusted until the peak discharge values conformed with the TR-20 values. Comment cards in the HEC-1 model identify locations where modifications were made by PB team members. Refer to the Appendix for a HEC-1 Routing Schematic, HEC-1 summary output files (printed) and HEC-1 input files (electronic data).

### *Description of Drainage Area*

The project drainage area was bounded on the west by the Squaw Peak Freeway, on the north by the Arizona Canal, on the south by Indian School Road, and on the east by the Old Cross Cut Canal. In addition, a large portion of the south slope of Camelback Mountain flows south to the Arizona Canal, then west into the project area.

The watershed slopes gently toward the southwest, with slopes generally less than one percent. The streets are generally arranged in a north-south, east-west grid pattern. Street widths range from 24 to 100 feet.

Development in the area ranges from urban single family residential to high rise commercial. Many of the property owners in the areas zoned for single-family residential development flood irrigate their yards. These homes generate little runoff due to small irrigation berms bordering their yards. In addition, some areas zoned for multi-family residential, commercial and office development are required by zoning ordinances to retain the 100-year 2-hour storm event.

Storm water runoff within the study area is conveyed by City of Phoenix storm drain systems or by surface runoff along city streets. The major existing City of Phoenix storm drains are located in 18th Street, 24th Street, 32nd Street and Camelback Road. The City of Phoenix storm drain system was generally designed for the 2-year event.

### *Arizona Canal Crossings*

There are three locations near the project area where storm water can cross the Arizona Canal and flow into the study area:

1) The Old Cross Cut Canal
2) Pipes near 44th Street
3) Natural spillway at 39th Street

The first outlet is the large SRP diversion structure at the confluence of the Arizona Canal and the Old Cross Cut Canal. During large storm events SRP may divert over 1000 cfs of flow from the Arizona Canal to the Old Cross Cut Canal at 48th Street. The second outlet is a pipe siphon located near 44th Street. Offsite storm water collects along north side of the Arizona Canal embankment near 44th Street and flows under the canal via a pipe network (approximately 331 cfs per HNTB). The third outlet is the natural spillway (spillway No. 2) near 39th Street. When the canal is full, water in the canal downstream (west) of 48th Street may outlet at spillway No. 2. Downstream (west) of spillway No. 2, offsite runoff will be intercepted by the Arizona Canal Diversion Channel.

BN determined the effect of Spillway No. 2 on the study area by use of the theoretical maximum flow from the spillway before flow in the canal overtops its banks. The depth of flow at the spillway for this condition was assumed to be 18 inches. Based on the formula for a broad crested weir, the theoretical capacity of the spillway was determined to be 928 cfs. This BN value of 928 cfs was utilized in the HEC-1 model for the project.

### *Biltmore Golf Course*

The BN and HNTB reports differ in the way that they address the Biltmore Golf Course area. HNTB's report shows a value of 501 cfs being generated by the golf course area. BN interviewed golf course personnel regarding drainage within the course. According to Biltmore personnel, the golf course areas were designed to completely retain the 100-year storm event. BN checked basins 18 – 22 to verify that the 50-year volume would be completely retained. Existing retention surface areas were determined from the 100 scale quarter section photographs, the basin spillway and existing water surface elevations were determined by field survey, and volumes were then estimated. Assuming there is an average of 1.9 feet of freeboard in the retention basins, there is sufficient volume to completely retain the 50-year runoff volume. Runoff from basins 16 and 18 – 22 were not included in the flows routed to Camelback Road. BN's hydrologic assumptions were utilized for these basins in the HEC-1 model.

### *Rainfall Data*

Rainfall depths for the project drainage area were developed using the isopluvial maps and regression equations presented in the Precipitation-Frequency Atlas of the Western United States, Volume VIII – Arizona, 1975. The SCS Type II storm distribution was utilized for the project because it was used in the original TR-20 models.

### *Interception/Infiltration Losses*

Precipitation losses due to interception and infiltration were modeled using the SCS curve number option in HEC-1. Selection of curve numbers was based on soil characteristics, antecedent moisture content, and land-use.

Soils information is needed in order to model the infiltration characteristics of the watershed. Such information is generally available from soil-survey reports published by the Soil Conservation Service (SCS).

The project watershed is included in the Soil Survey of Maricopa County, Arizona, Central Part. Using the standard SCS hydrologic soil classification system, an estimate can be made of the runoff potential of the soils within any given sub-basin in the project watershed. The soils within the project area were determined to be hydrologic soil group "B" as described in the "Soil Survey of Maricopa County, Arizona, Central Part".

SCS hydrologic soil cover complexes (curve numbers) have been determined for all City zoning designations and soil classifications by the City of Phoenix. Each sub-basin in the hydrologic model was divided by zoning type and soil classification. The curve number was then determined for each division. The results were averaged to obtain the sub-area composite curve number. Undeveloped parcels were treated as fully developed in accordance with their particular zoning designation. Flood irrigated areas were excluded from the curve number weighting calculations.

### *Retention Basins*

In 1988, new commercial and industrial developments were required by ordinance to provide retention volume on-site for runoff from a 10-year event. The City of Phoenix currently requires new developments to retain/detain the 100-year 2-hour storm event.

Commercial and industrial developments constructed prior to 1987 were identified and recorded by HNTB and BN during field investigations. It was assumed for each commercial and industrial zoning classification that the required retention would affect a specific percentage of the total lot area, with street rights-of-ways and lot fringe areas draining away from the retained areas. These percentages vary by zoning classification. Where the presence of 10-year retention was verified, the gross lot area was multiplied by the percentage affected by retention. This number was then multiplied by the 10-year runoff depth to produce a volume of retained runoff that could be subtracted from sub-area runoff volume totals for storms of greater than 10-year return periods.

For sub-areas with multi-family, commercial, or industrial 10-year runoff retention, the total volume of runoff from the 50-year storm was calculated using the sub-area composite curve number, the 50-year rainfall depth, and the net contributing area within the sub-area. The retention volume (described above) was then subtracted from the 50-year runoff volume, to produce the total net volume of 50-year runoff actually contributed by the sub-area. This net volume of 50-year runoff was applied over the sub-area net contributing area to compute a Modified curve number for the 50-year storm to be used in the hydrologic model. The PB team did not revise the detention/retention basin procedure.

Peak flows generated through use of the modified curve numbers are equal to or lower than peak flows generated by the original sub-area composite curve number, with any reduction of peak reflecting the effects of the 10-year runoff retention.

### *Unit Hydrograph*

The SCS dimensionless unit hydrograph approach is selected to generate the runoff calculations for each sub-basin in the HEC-1 model. This method requires that lag time be computed for each sub-basin.

When used with the SCS unit hydrograph method, lag time is defined as the time from the center of mass of excess rainfall to the time to peak of a unit hydrograph (NEH-4, chapter 16, SCS). Using SCS procedures, lag time is generally computed as 60 percent of the time of concentration ($T_c$) of a sub-basin.

The time of concentration for a sub-basin was the time required for runoff from the most remote part of the sub-area to reach the concentration point. This was generally determined for the model by finding the maximum distance of flow along City streets within the sub-area, and dividing that distance by the average full gutter flow velocity. The average full gutter velocity was determined by using the standard City of Phoenix Gutter Flow Chart in conjunction with the average slope along the maximum distance of flow.

### *Hydrograph Routing Method*

Manning's equation was utilized to develop cross section rating curves for each reach of street between concentration points. A Manning's "n" of 0.016 and the average street slopes were used in combination with typical field cross sections taken at the top-of-curb, gutter flow line and pavement crown of both sides of the street. The remainder of the right-of-way was assumed to be at the same elevation as the top-of-curb and able to convey flow.

The divert sub-routine was used to split the routed hydrograph at each intersection based on relative conveyance of the two cross sections. Pipe flows were also diverted and routed appropriately assuming a pipe full capacity.

The PB team utilized the HEC-1 eight-point normal depth routing methodology to route street flow. Pipe flows were routed with the Muskingum-Cunge HEC-1 routing procedure. The primary focus of the HEC-1 routing procedures was to match discharge values from the BN and HNTB reports. Therefore, a few sub-basin modeling parameters may not conform exactly to physical parameters within the watershed.

## 4.2 On-site Drainage

### *Hydrology*

Hydrologic analysis was based on the Rational Method as described by the Highway Drainage Design Manual, Hydrology, ADOT, 1993. First, a series of site specific intensity-duration-frequency (IDF) curves were developed for the study area. The curves are included in the Appendix. The minimum time of concentration used to calculate runoff was 10 minutes.

Runoff coefficients for the on-site drainage areas were as follows:

**On-site Runoff Coefficients**

| | *2-yr Storm* | *10-yr Storm* | *25-yr Storm* | *50-yr Storm* |
|---|---|---|---|---|
| Paved Areas | 0.95 | 0.95 | 0.95 | 0.95 |
| Landscaped Areas | 0.65 | 0.70 | 0.75 | 0.75 |

### *Hydraulics*

The hydraulic model of on-site stormwater was developed using Winstorm software by the Texas Department of Transportation. The software uses the Rational Method to calculate the peak flow from the drainage subareas and uses the peak flow to calculate the elevation of the hydraulic grade line throughout the system. Changes in hydraulic grade line elevations are calculated using the friction slope in pipes and minor losses at junctions. The minor losses are based on K factors times the velocity head. The K factors were selected based on the momentum equation:

$$Hj=\frac{(QoVo)-(QiVi)-(QiVicosP)}{0.5g(Ao+Ai)} + hi - ho$$

Separate models were developed for the 10, 25 and 50-year design storms in the existing condition and the design storms with the addition of HOV lanes throughout the study area.

### *Inlet Capacity*

Inlet capacity and gutter flows were modeled using the methods in HEC-12. The calculations were performed using a spreadsheet. Gutter configuration, inlet configuration and the results of the model for the 10-year and 50-year storms are included in Section 2.3 of the Appendix.

### *Pump Station*

Runoff from the on-site storm drain was routed through the Highland Avenue Pump Station to estimate the capacity of the station and to predict the impact on the 18th Street Trunk Line. In order to route the flows; the runoff from the pump station had to be represented as a hydrograph. HEC-1 was used to develop SCS hydrographs for the runoff from the various storm frequencies studied. An SCS hydrograph was used because of its close correlation to

the results obtained by the Rational Method. Single-basin hydrographs were produced for 2-year and 10-year storms for the existing condition and for the 25 and 50-year storms with HOV lanes. The HEC-1 on-site models are provided in the Appendix.

The hydrographs were routed through the pump station using a basic language program based upon SCS flood routing techniques and the Storage Indication Method which compares inflow, outflow and storage at specific time steps using the certified pump curves for the four main pumps. The flow through the 5 Hp nuisance pump is negligible and was not included in the analysis. Routing documentation and a pump curve with superimposed system curves are included in the Appendix.

# 5.0 PROBLEMS IDENTIFIED

## 5.1 Off-site Problems Identified

### *18th Street Trunk Line Capacity, General*

The drainage outfall from the study area is the 18th Street Trunk Line. South of Highland Avenue, the trunk line was designed to convey the runoff produced by a 2-year storm. Analysis shows that it will convey the 2-year storm, but cannot convey the peak flow from the 10-year storm.

The trunk line, in turn, discharges to the I-10 drainage system which has a limited capacity. The I-10 system cannot except higher peak flows from the 18th Street Trunk Line. Even if the entire 18th Street Trunk Line was improved to convey a larger storm, the hydraulics of the existing outfall would restrict discharges from the trunk line to that of a 2-year storm.

As a result, flows in excess of the 2-year storm causes flooding along 18th Street and causes off-site runoff to flow onto the Parkway. With no existing off-site conveyance system in place, the excess flows must be collected and detained to prevent flooding of the Parkway.

### *18th Street Trunk Line Capacity, North End*

As shown in Figure 4, a short section of the trunk line between Maryland Avenue and Rancho Drive is lacking capacity and causes on-site inlets to flood in storms less than the 2-year. The trunk line downstream from this reach has sufficient capacity to convey the runoff from the 50-year storm. Analysis of the inlet capacity show that the inlets are able to meet ADOT collection criteria for the 10-year storm .

In the existing condition, the lack of capacity in the trunk line causes the on-site inlets to flood, resulting in by-pass flows which collect in the sag at Bethany Home Road. This segment of Parkway is drained by storing the runoff in underground vaults which slowly bleed the runoff to the on-site storm drain. The by-pass flows occupy significant storage in the vaults. Without the by-pass flows, the vaults have sufficient capacity to store the excess runoff from the 100-year storm. The by-pass flows reduce the vault capacity to approximately a 10-year storm.

### *Project Location*

The study limits are in a dense, rapidly developing section of Phoenix. There is no vacant land adjacent to the Parkway within the study limits. Any detention will require the acquisition of rights-of-way and the removal of structures.

### *Colter Street Detention Basin*

The Colter Street Junction Structure allows runoff to bypass the Colter Street Detention Basin during a storm, occupying capacity in the trunk line. The amount of runoff that bypasses to the south is a function of the amount of runoff which enters the trunk line from the laterals at Camelback Road and Highland Avenue and the pump station. Runoff entering the trunk line south of the junction structure rises the HGL at the junction structure. As the HGL rises, flow is diverted to the detention basin. The trunk line backs up quickly during the 50-year storm, but a high percentage of the runoff from a small storm would be expected to flow south in the trunk line. The end result is that a peak flow of 20 cfs is able to bypass the Colter Street Detention Basin during the 50-year storm. This is 20 cfs of runoff that could be removed from Camelback Road and Highland Avenue by the lateral storm drains.

### *Encroachment by Off-Site Stormwater*

Off-site stormwater encroaches onto the Parkway pavement at several locations. Openings have been provided in the sound wall at Campbell Avenue, Turney Avenue and Glenrosa Avenue to allow off-site water to enter the Parkway. These openings were intentionally provided during design and must remain. Campbell Avenue drains to an off-site inlet on the east side of the sound wall. Excess runoff bypasses the inlet and enters the Parkway via the openings. Runoff entering at Campbell Avenue flows north to the Highland Avenue Pump station. Glenrosa Avenue and Turney Avenue do not have off-site inlets east of the sound wall. At these locations, runoff from 18$^{th}$ Street flows over a depressed curb and through the openings down the Parkway embankment, damaging the side slopes. If the trunk line has excess capacity at these locations, on-site storm drains will collect the runoff. If not, the runoff will pond in the on-site sag at Between Indian School Road and Campbell Avenue.

Another area experiencing encroachment is the northbound on ramps at Highland Avenue. ADOT personnel report runoff has overtopped the crest in the ramp, allowing off-site runoff from Highland Avenue to enter the Parkway. This occurred during one of the larger storms which caused on-site flooding of the Parkway.

Offsite runoff is also discharged from the catch basins at the bottom of the Highland Avenue northbound on ramp. As the HGL rises in the 18$^{th}$ Street Trunk Line, this inlet is among the first to back up and discharge stormwater.

## 5.2 On-site Problems Identified

### *Storm Drain Capacity*

The on-site storm drain has sufficient capacity to convey the existing condition 10-year storm that would fall on-site. Typical ADOT design criteria for this facility is the 50-year storm. The

on-site system cannot convey the 50-year storm. The problem appears to be limited to conveyance capacity of the main storm drain. There appears to be enough inlets in the system to collect the runoff from the 50-year design storm with limited areas exceeding the ADOT flooded width criteria.

Encroachment by off-site runoff aggravates on-site drainage problems as discussed previously.

### Pump Station

The wet well in the pump station lacks storage capacity. The inlet pipe into the station is only 4 feet in diameter and flows under pressure during the 10-year storm. It provides little or no additional storage for peak flows produced by storms larger than the 2-year event. The 10-year storm hydrograph was routed through the pump station to check the theoretical performance of the station. During the analysis, it became apparent that there is excessive cycling of the pumps. The pump station routing calculations are included in the Appendix. This is caused by a relatively small working volume in the wet well and short vertical distances between the pump-on switches. One vertical foot of the wet well holds 890 cubic feet of water. During the rising limb of the 10-year inflow hydrograph the number one pump would be started 28 times in 15 minutes. The results of the pump station routing are shown in the Appendix. The manufacturer of the pumps indicated that they are rated for 10 starts per hour. This theoretical storm hydrograph results in a higher number of cycles than ADOT pump maintenance personnel have reported to date. However, lack of storage creates the potential for excessive pump cycling.

The existing pumps have the capacity to discharge about a 10-year flow without affecting the on-site storm drain. However, the pumps discharge into the 18th Street Trunk Line, which lacks capacity. The combination of flows from the pump station, the Colter Street Junction Structure, and the Camelback Road and Highland Avenue laterals is expected to contribute more flow than the 18th Street Trunk Line can accept, causing flooding in 18th Street. Storm water from 18th Street will enter the Parkway via the Highland Avenue off-ramp, through the openings in the sound wall, or through the inlets connected directly to the trunk line. The water that gets onto the Parkway will collect in the mainline sag and be re-pumped into the surcharged 18th Street Trunk Line. This process will be repeated until the storm subsides and the HGL in the trunk line will allow the water to be conveyed to the south.

### Flooding of Southbound Lanes

On-site storm drain laterals convey runoff from the west side of the Parkway to the mainline on the east side of the Parkway. These laterals are all 15 inches in diameter. There is a centerline barrier at the sag adjacent to the pump station. The barrier prevents runoff from crossing the centerline. Runoff west of the barrier must drain to the main line through a single, 15-inch lateral. The small diameter lateral is expected to cause a restriction, flooding the southbound lanes.

# 6.0 SOLUTIONS/ALTERNATIVES

The proposed Solutions/Alternatives have been approved for further study by a consensus of interested parties. For the purposes of preliminary design and cost estimation, it is assumed that HOV lanes will be constructed on the Squaw Peak Parkway. Increases in peak flows and runoff volumes have been calculated based on estimated quantities and locations of additional pavement. Unless otherwise stated, cost estimates assume the projects will be constructed independently of each other and independently of HOV construction.

## 6.1 Off-site Solutions/Alternatives

### *Alternatives 1A and 1B*
### *18th Street Detention Basins- Parks or Walled Basins*

Large off-site peak flows will occur at Highland Avenue and on 18th Street, south of Highland Avenue. These flows will impact the Parkway via drainage openings in the sound wall and, in larger events, via the northbound off-ramp at Highland Avenue. Large discharges are expected for return intervals in excess of 2 years (10, 25 and 50-year storms). The majority of the runoff from the 2-year storm will be collected by City of Phoenix storm drains

A series of detention basins are proposed along 18th Street between Highland Avenue and Indian School Road. The basins would collect runoff from local streets and 18th Street. The basins would be located along the east side of 18th Street. Basins are proposed to be located south of Highland Avenue, Campbell Avenue and Glenrosa Avenue. Existing houses now occupy this land. The basins could be multi-use facilities similar to the Colter Street Detention Basin or designed as walled facilities with no public access. Multi-use basins would require approval of the City of Phoenix Parks Department.

The required storage volumes are shown below: Refer to the Appendix for the detention basin volume calculations and methodologies.

**18th Street Runoff Volumes**

| *Location* | *50-yr Vol* |
|---|---|
| Highland Avenue. | 19.3 af |
| Campbell Ave. | 10.2 af |
| Glenrosa Ave. | 14.3 af |

The amount of land required to detain the runoff volumes will vary with the configuration of the basins. For the purpose of this report, basins to be approved as City of Phoenix parks are assumed to have a maximum depth of 4 feet (3 feet of ponded water) and 4:1 maximum side slopes. Basins to be walled off without public access are assumed to be a maximum of 15 feet deep (14 feet of ponded water), have 3:1 side slopes and have no retaining walls. Walled basin configurations assume all existing streets will remain in place and existing alley access will be maintained. Multi-use basins will require the removal of residential streets and alleys due to the large land area required. Street realignment will be addressed during the final design process. ADOT and the City of Phoenix may consider realignment/closure of Coolidge Street to improve the flow of traffic.

The following table shows the estimated amount of land required to detain the runoff from the 50-year storm. The land area required reflects parcels taken as whole residential lots.

**Land Requirements for Off-site Detention Basins**

| | 50-Year Storm | | | |
|---|---|---|---|---|
| **Location** | **Park** | **Houses Removed** | **Walled Basin** | **Houses Removed** |
| Highland Avenue. | 14.3 ac | 50 | 5.2ac | 9 |
| Campbell Ave. | 8.3 ac | 39 | 2.1 ac | 9 |
| Glenrosa Ave. | 8.3 ac | 40 | 2.5 ac | 12 |
| **Totals** | **30.9 ac** | **129** | **9.8 ac** | **30** |

Collection/conveyance systems are needed to bring the runoff into the proposed off-site detention basins. The size, location and cost of the basins is dependent on the final configuration of the basins. Figures 6 and 7 show the proposed detention basin configuration for the project.

***Due to the high cost of construction and the impact on the neighborhood, these alternatives are not recommended candidates for construction.***

### *Alternatives 2A and 2B*
### *Walled Detention Basin on Highland Avenue*

During construction of the Parkway, the row of houses along the south side of Highland Avenue was removed between the northbound off-ramp and 20th Street. The land was converted to a landscaped buffer zone. Funding for the project was supplied by mitigation funds. The buffer zone is currently maintained by the City of Phoenix Parks Department.

An offsite storm water detention basin is proposed for this site. It would collect and detain runoff from Highland Avenue and 18th Street, reducing the amount of runoff which would potentially flow down the northbound off-ramp. The basin would be walled off from public access and be as deep as feasible. The basin design criteria is to maximize the detention capacity rather than try to provide protection against a predetermined design storm frequency.

Two options were considered for the sizing of this basin. The first option is a basin using 3:1 side slopes. The second option is a basin with 3:1 side slopes on the north side and a retaining wall on the south side. The addition of the retaining wall increases the volume detained, but also increases project costs. The following table identifies the estimated storage volume and approximate return period provided by the two options discussed.

Several design alternatives were considered for the Highland Avenue Detention Basin. The project team attempted to provide ADOT with the flexibility to increase the level of service of the drainage facility in the future. The following two scenarios were proposed. First the Highland Avenue basin may be constructed as stand alone project that is capable of

## LEGEND

| | Proposed | Existing | Modified |
|---|---|---|---|
| Curb Inlet | ■ | □ | ◪ |
| Storm Sewer | ▬▬ | ---- | |
| Special Inlet | ⊠ | | |
| Junction Manhole | ● | ○ | |

N

N.T.S.

| | NAME | DATE |
|---|---|---|
| DESIGN | M. Luecker | 4/14/98 |
| DRAWN | J. Carlile | 4/14/98 |
| CHECKED | J. Holtzmeister | 4/14/98 |

PREMIER

SR51 DRAINAGE ASSESSMENT

HIGHLAND BASIN - PARK
ALTERNATIVE 1A - SHEET 1

FIGURE
6

## LEGEND

| | Proposed | Existing |
|---|---|---|
| Curb Opening Inlet | ■ | □ |
| Storm Sewer | ▬▬ | - - - - |
| Junction Manhole | ● | ○ |

N

N.T.S.

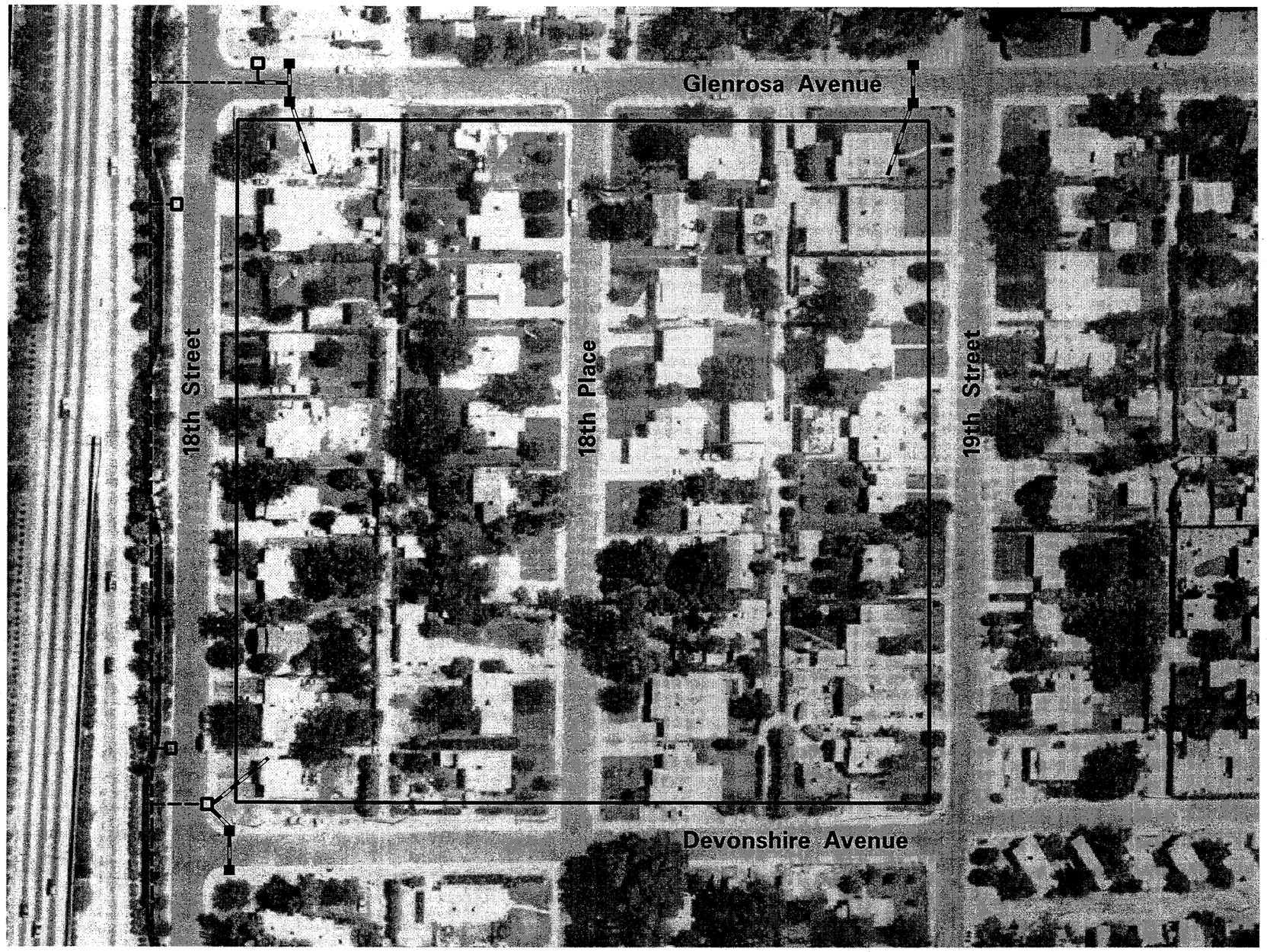
| | NAME | DATE |
|---|---|---|
| DESIGN | M. Luecker | 4/14/98 |
| DRAWN | J. Carillo | 4/14/98 |
| CHECKED | J. Holtzmeister | 4/14/98 |

PREMIER

SR51 DRAINAGE ASSESSMENT

CAMPBELL BASIN - PARK
ALTERNATIVE 1A - SHEET 2

FIGURE
6




## LEGEND

| | Proposed | Existing |
|---|---|---|
| Curb Opening Inlet | ■ | □ |
| Storm Sewer | ——— | - - - - |

N

N.T.S.

| | NAME | DATE |
|---|---|---|
| DESIGN | M. Luecker | 4/14/98 |
| DRAWN | J. Carlile | 4/14/98 |
| CHECKED | J. Hoffzmeister | 4/14/98 |

PREMIER

SR51 DRAINAGE ASSESSMENT

GLENROSA BASIN - PARK
ALTERNATIVE 1A - SHEET 3

FIGURE
6

## LEGEND

| | Proposed | Existing | Modified |
|---|---|---|---|
| Curb Inlet | ■ | □ | ◪ |
| Storm Sewer | ▬▬ | ---- | |
| Special Inlet | ⊠ | | |
| Junction Manhole | ● | ○ | |

N

N.T.S.

| | NAME | DATE |
|---|---|---|
| DESIGN | M. Luecker | 4/14/98 |
| DRAWN | J. Carlile | 4/14/98 |
| CHECKED | J. Holtzmeister | 4/14/98 |

PREMIER

SR51 DRAINAGE ASSESSMENT

HIGHLAND BASIN - WALLED
ALTERNATIVE 1B - SHEET 1

FIGURE
7

## LEGEND

| | Proposed | Existing |
|---|---|---|
| Curb Opening Inlet | ■ | □ |
| Storm Sewer | ▬▬ | - - - - |
| Junction Manhole | ● | ○ |

N

N.T.S.

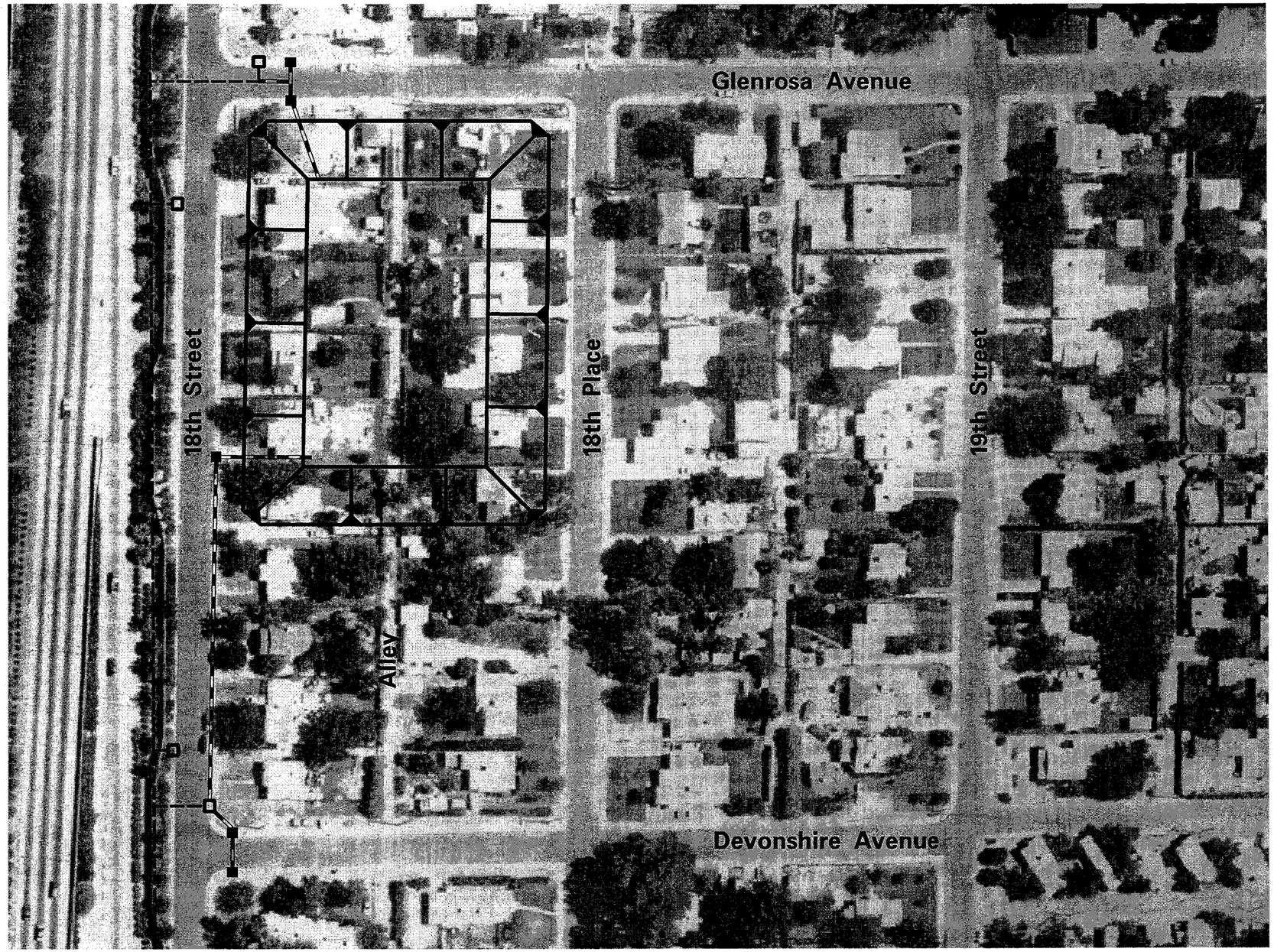
| | NAME | DATE |
|---|---|---|
| DESIGN | M. Luecker | 4/14/98 |
| DRAWN | J. Carlile | 4/14/98 |
| CHECKED | J. Holtzmeister | 4/14/98 |

PREMIER

SR51 DRAINAGE ASSESSMENT

CAMPBELL BASIN - WALLED
ALTERNATIVE 1B - SHEET 2

FIGURE
7




## LEGEND

| | Proposed | Existing |
|---|---|---|
| Curb Opening Inlet | ■ | □ |
| Storm Sewer | ▬▬ | ---- |

N

N.T.S.

| | NAME | DATE |
|---|---|---|
| DESIGN | M. Luecker | 4/14/98 |
| DRAWN | J. Carlile | 4/14/98 |
| CHECKED | J. Holtzmeister | 4/14/98 |

PREMIER

SR51 DRAINAGE ASSESSMENT

GLENROSA BASIN - WALLED
ALTERNATIVE 1B - SHEET 3

FIGURE
7

providing a 14-year to 20-year level of protection for the freeway at Highland Avenue. The freeway may still be flooded at other locations (i.e., at Campbell Avenue and Glenrosa Avenue). Second. The Highland Avenue Basin may also be designed as the first phase of the 18th Street detention basin system. The Highland Avenue basin, the on-site pump station basin, and a third basin (Coolidge Street) would be combined to form the 50-year detention system (19.3 ac-ft) described in the previous paragraph.

The retaining wall option allows the Highland Avenue detention basin storage volume to be maximized and will reduce the amount of homes required for the ultimate (50-year) detention basin. The basin will function in any of the proposed scenarios with or without retaining walls.

**Detention Volumes Provided in Highland Buffer Zone**

| *Basin Type* | *Storage Provided* | *Approximate Return Period Provided* |
|---|---|---|
| 3:1 Side Slopes. | 5.3 ac-ft | 14 years |
| Retaining Wall- South Side | 8.3 ac-ft | 20 years |

It is recommended that the existing Highland Avenue lateral be left in place to allow low flows to be removed by the 18th Street Trunk Line. The collection system for the proposed basin should be designed to take full advantage of any available capacity in the trunk line. By allowing the low flows to bypass the basin when the trunk line has available capacity, storage is reserved for higher frequency events.

The flow split between the trunk line and the basin could be accomplished at the inlets. The existing inlets need to be modified to divert low flows to the trunk line when there is conveyance capacity in the trunk line. A weir in the inlet would be utilized to divert higher frequency flows to a parallel storm drain as the HGL rises in the trunk line. The parallel storm drain would discharge to the basin. The parallel storm drain would be relatively short, connecting three inlets on the north side of Highland Avenue and crossing the road in only one location. Figures 8 and 9 show the Highland Avenue Detention Basin configurations and the proposed collection system.

The storm drain system from the Colonnade Mall also discharges to the Highland Avenue lateral near the northbound off-ramp. The feasibility of discharging the Colonnade Mall storm drain to the basin was examined. The Colonnade Mall storm drain should remain connected to the Highland Avenue lateral, allowing low flows to be removed by the 18th Street Trunk Line. Runoff which bypasses the Colonnade Mall storm drain and enters Highland Avenue would be collected by the proposed collection system.

***This alternative is not a recommended candidate for construction.***

## LEGEND

| | Proposed | Existing | Modified |
|---|---|---|---|
| Curb Inlet | ■ | □ | ▨ |
| Storm Sewer | ——— | - - - - | |
| Special Inlet | ⊠ | | |
| Junction Manhole | ● | ○ | |

N

N.T.S.

| | NAME | DATE |
|---|---|---|
| DESIGN | M. Luecker | 4/14/98 |
| DRAWN | J. Carlile | 4/14/98 |
| CHECKED | J. Holtzmeister | 4/14/98 |

PREMIER

SR51 DRAINAGE ASSESSMENT

HIGHLAND BASIN - WALLED WITH RETAINING WALLS ALTERNATIVE 2A

FIGURE 8

## LEGEND

| | Proposed | Existing | Modified |
|---|---|---|---|
| Curb Inlet | ■ | □ | ◪ |
| Storm Sewer | ▬▬ | - - - - | |
| Special Inlet | ⊠ | | |
| Junction Manhole | ● | ○ | |

N

N.T.S.

| | NAME | DATE |
|---|---|---|
| DESIGN | M. Luecker | 4/14/98 |
| DRAWN | J. Carlile | 4/14/98 |
| CHECKED | J. Holtzmeister | 4/14/98 |

PREMIER

SR51 DRAINAGE ASSESSMENT

HIGHLAND BASIN - WALLED
WITHOUT RETAINING WALLS
ALTERNATIVE 2B

FIGURE
9

### *Alternative 3*
### *Additional Inlets at Turney Ave. and Glenrosa Ave.*

Off-site stormwater flows onto the Parkway via openings in the sound wall and down the on-ramp at Highland Avenue. The openings have been provided in the sound wall at Campbell Avenue, Turney Avenue and Glenrosa Avenue to allow off-site water to enter the Parkway.

The impact of the runoff coming through the openings could be reduced by providing inlets at Turney Avenue and Glenrosa Avenue to collect the runoff before it enters the Parkway through the sound wall holes (similar to the inlet at Campbell Avenue). The proposed inlets would be located east of the sound wall, in front of the openings. They would collect low flows and discharge them to the 18th Street Trunk Line. The inlets would be ineffectual in storms much larger than the 2-year unless off-site detention basins are constructed. In the existing condition, storms much in excess of the 2-year are expected to fill the trunk line to capacity.

A diagram of the proposed inlets is shown in Figure 10.

***This alternative is a recommended candidate for construction.***

### *Alternative 4*
### *Restriction Plate in the Colter Street Junction Structure*

It is proposed that a restriction plate be installed across the 48-inch trunk line outlet pipe in the Colter Street Junction Structure. The plate would be installed to block the top of the pipe as shown in Figure 11. The plate position shown in the figure leaves an opening in the 48-inch pipe with an area equal to the area of a 24-inch storm drain pipe. The plate would divert virtually all runoff entering the junction structure to the detention basin. The bottom of the pipe would remain unobstructed to allow the Colter Street Detention Basin to drain after the storm passes.

Diverting the runoff to the detention basin will lower the HGL in the trunk line at Highland Avenue and Camelback Road, allowing the laterals to collect more runoff. This will reduce the amount of runoff in Highland Avenue. Less street runoff in Highland Avenue will reduce the potential for off-site encroachment of stormwater on the northbound off-ramp at Highland Avenue and from the openings in the sound wall south of Highland Avenue.

In the existing condition, the HGL at the junction structure rises fairly quickly during the 50-year storm. The high HGL causes the trunk line to back up and divert runoff to the detention basin. A restriction plate would simply create this condition more quickly, capturing the rising limb of the hydrograph for detention. In the existing condition, virtually all flow from the latter part of the 50-year storm is expected to be diverted to the detention basin. This diversion is expected to remain unchanged by the installation of the plate.

During a 100-year storm, 25 acre feet of runoff is expected to pass through the junction structure. A check of the Colter Street Detention Basin shows that it has the capacity to detain 25 acre feet of stormwater and still have approximately 2 feet of freeboard. In the

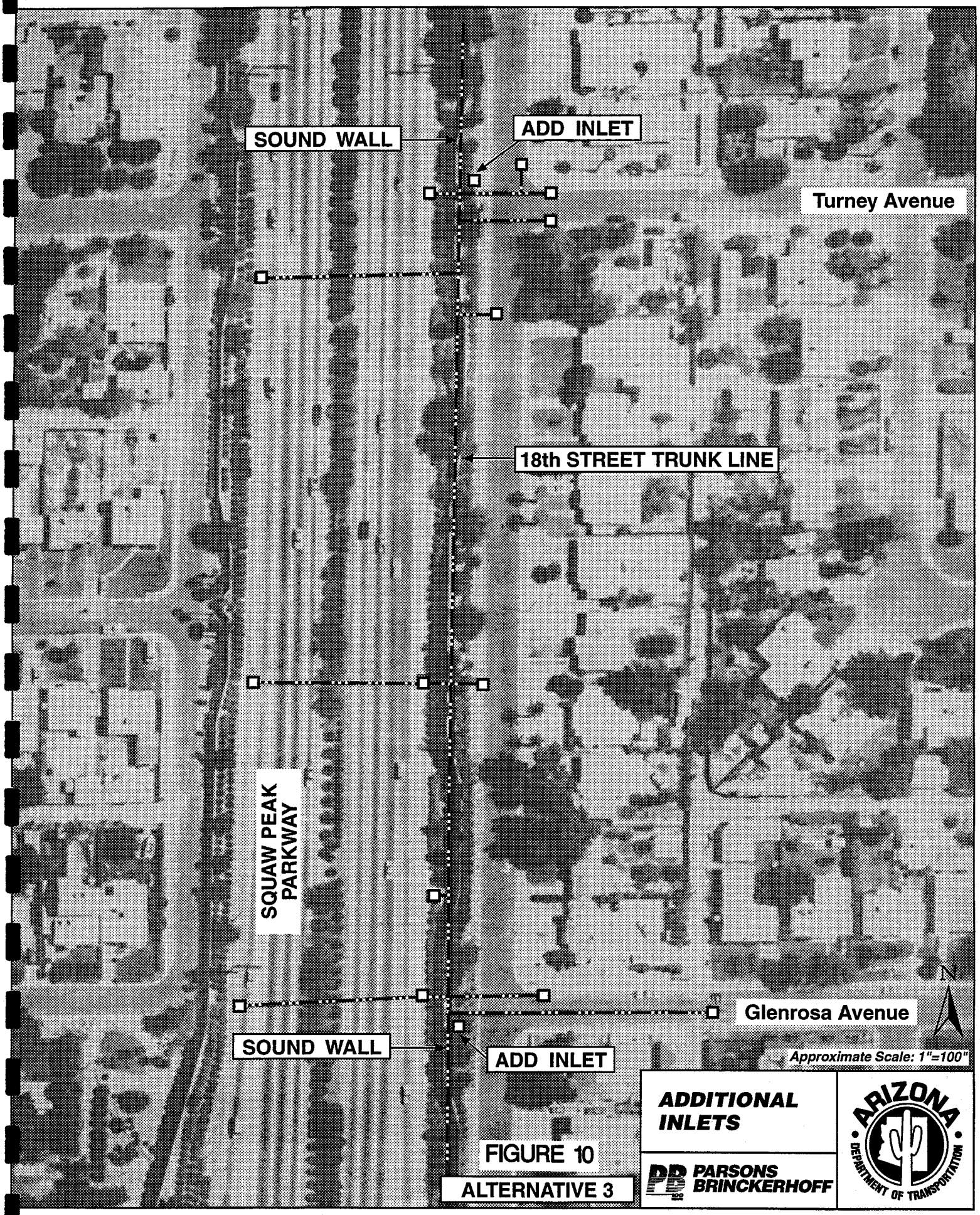
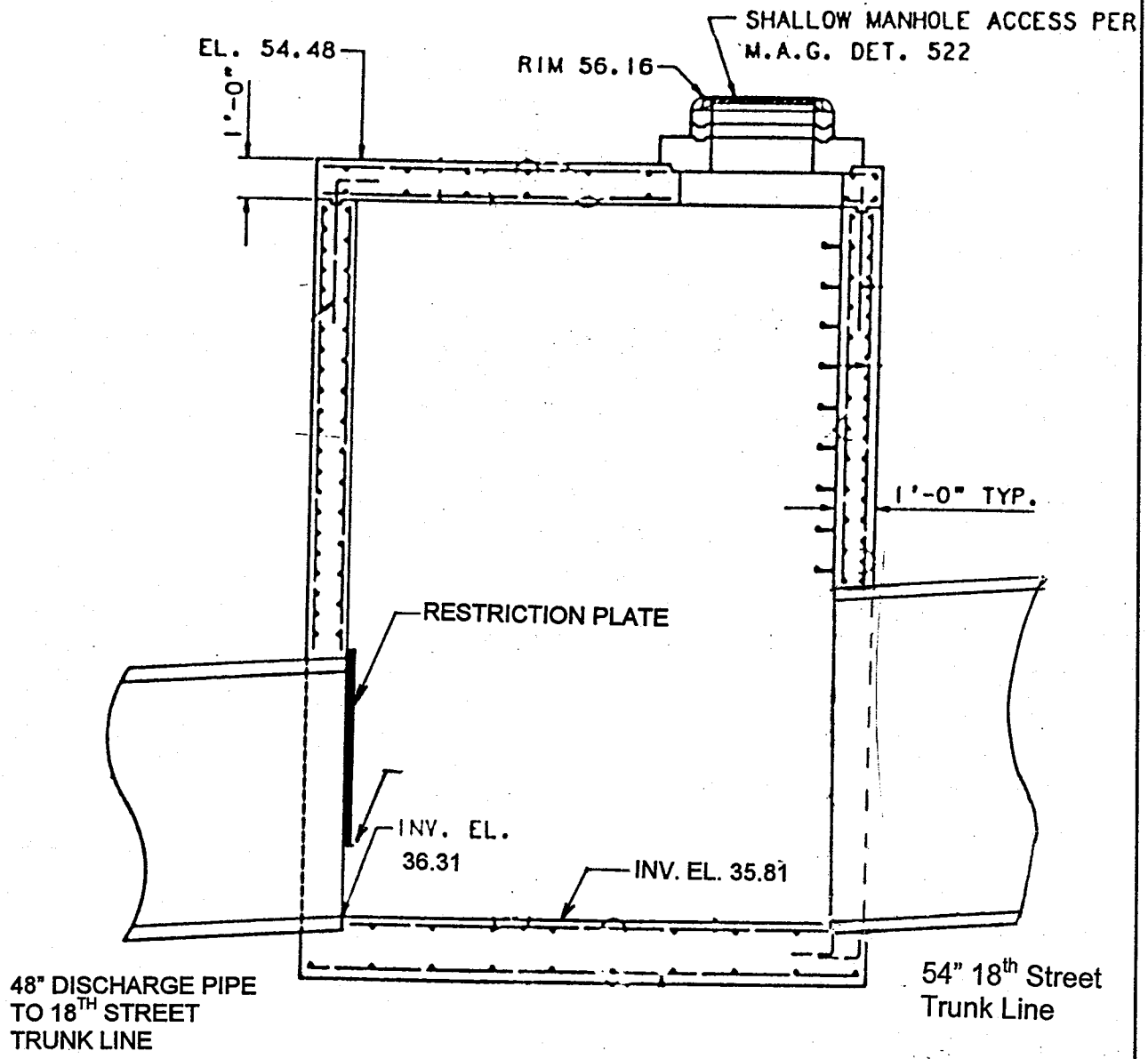



FIGURE 10

ALTERNATIVE 3




# COLTER STREET SIPHON PLAN

ADAPTED FROM AS-BUILT PLANS

| | |
|---|---|
| COLTER STREET JUNCTION STRUCTURE | |
| **ALTERNATIVE NO. 4** | |
| PARSONS BRINCKERHOFF | |

FIGURE 11

existing condition, the junction structure is expected to divert 23 acre feet to the detention basin. It is estimated the basin will drain in less than 36 hours via the 18th Street Trunk Line with the restriction plate in place.

Calculations of the proposed restriction plate are shown in the Appendix.

***This alternative is a recommended candidate for construction.***

## 6.2 On-site Solutions/Alternatives

### *Alternatives 5A and 5B*
### *Small Detention Basin for Pump Station Discharge*

Below Highland Avenue, the trunk line was designed to convey the peak flow from the 2-year storm. Analysis shows that the trunk line is capable of conveying a storm whose magnitude is between that of a 2-year and 10-year design storm. Removing runoff from the 18th Street Trunk Line in the vicinity of Highland Avenue would allow the trunk line to collect and convey more downstream runoff than it does in the existing condition. This would reduce local street flooding and reduce off-site stormwater flowing into Parkway. Removing the pump station discharge from the trunk line allows more flow to enter the trunk line via the laterals at Camelback Road and Highland Avenue and the inlets along 18th Street south of Highland Avenue. This would reduce the off-site inflow onto the Parkway from the openings at Campbell Avenue, Turney Avenue, Glenrosa Avenue and the northbound on-ramp at Highland Avenue.

One option is to detain the runoff discharged from the pump station in a proposed basin at the southeast corner of Highland Avenue and 18th Street, directly in front of the Highland Avenue Pump Station. There is a 1.3 acre residential parcel at this corner, which is currently for sale.

It is proposed to reconfigure the discharge piping from the Highland Avenue Pump Station so that flows would directly drain to the proposed basin. This would remove a substantial flow from the trunk line. In order to detain the runoff from an existing condition, 10-year, 24-hour storm over the entire area tributary to the pump station, the basin would need a capacity of approximately 6.9 acre feet. If 10.5 acre feet of capacity were provided, the basin could detain the runoff expected from the 50-year, 24-hour storm with HOV lanes in place. Calculations are included in the Appendix.

A preliminary check of the grading of the parcel suggests that it will be possible to detain 6.4 acre feet of runoff without use of retaining walls. The basin will have to be a deep, walled facility without public access if it is to have sufficient volume to detain the runoff from a 50-year storm. City of Phoenix rights-of-way will not be required for a basin located at this site. Conceptual grading for this configuration of the site is shown in Figure 12. Calculations are included in the Appendix.

Since the initial right-of-way costs are expected to be high, 13-foot retaining walls were considered on three sides. The basin detains approximately 8.6 acre feet in this configuration. The conceptual grading for this configuration is shown in Figure 13.

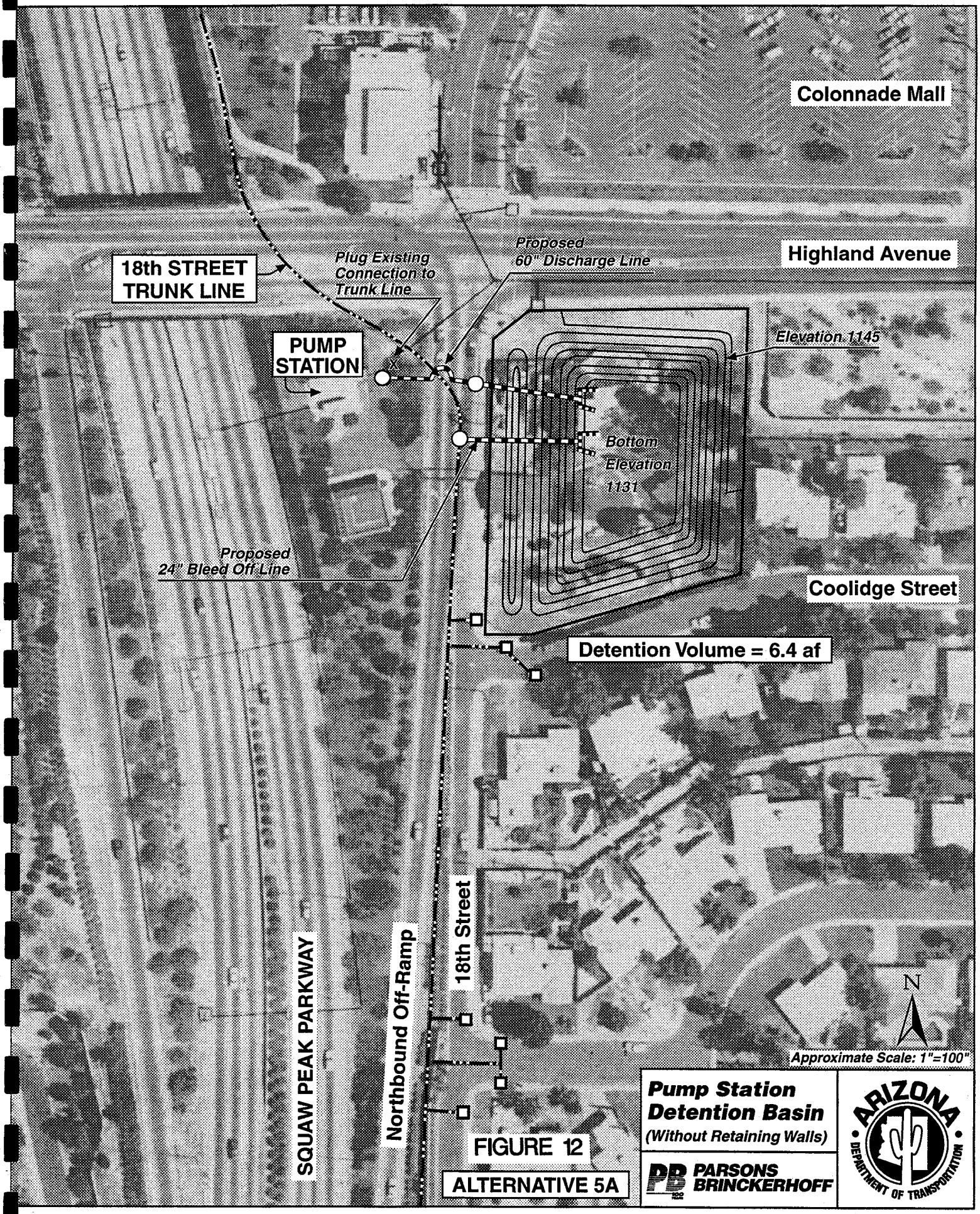



FIGURE 12

ALTERNATIVE 5A

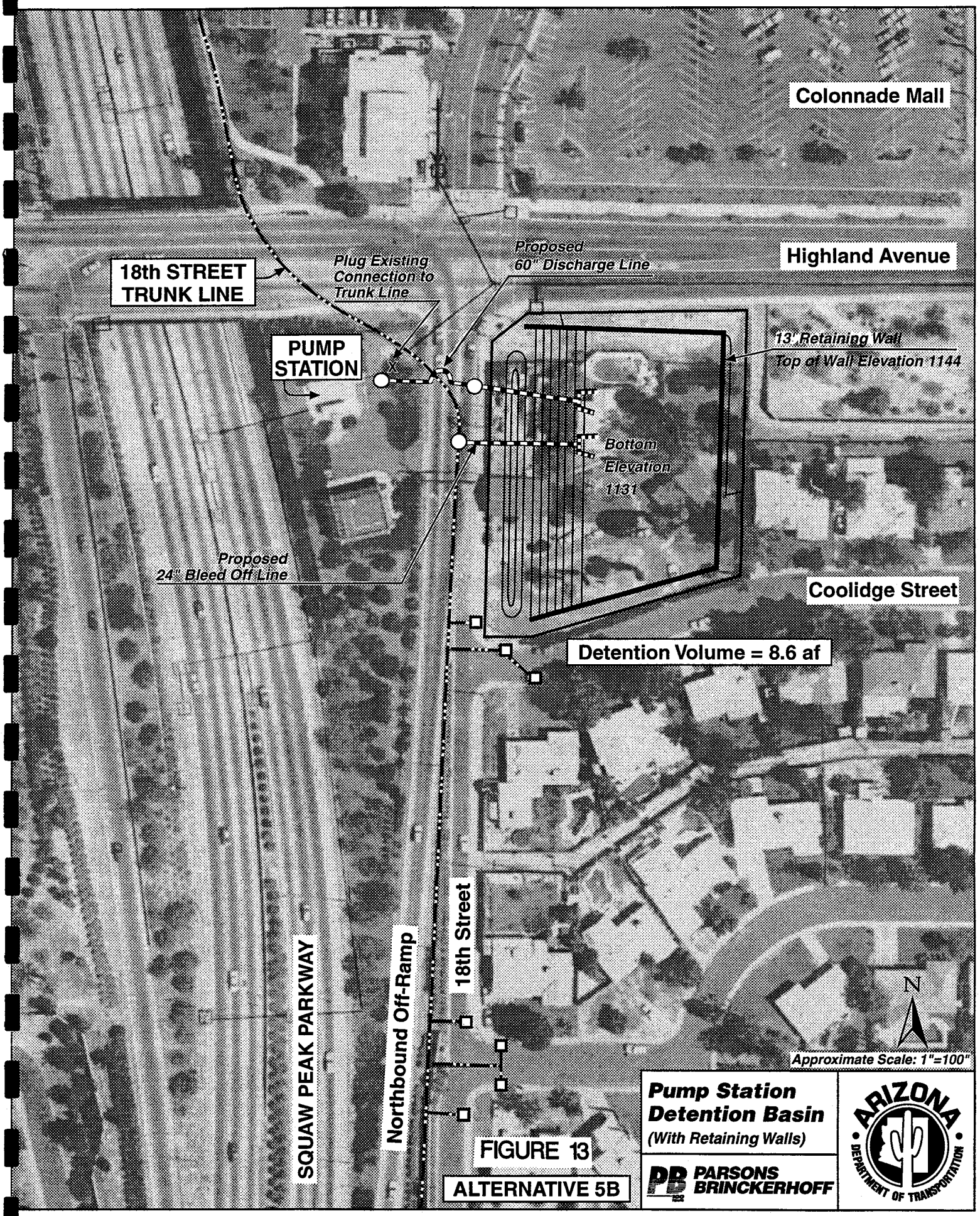



FIGURE 13

ALTERNATIVE 5B

In either configuration, the basin would have a discharge pipe which conveys the detained runoff to the trunk line after the storm passes. The outlet would require a flap gate to prevent the basin from filling with off-site stormwater from the 18th Street Trunk Line.

***This alternative, with the use of retaining walls (5B), is a recommended candidate for construction.***

### *Alternative 6*
### *Detention Vaults to Provide 25-yr On-site Conveyance Capacity*

The conveyance capacity of the on-site storm drain is sufficient to convey the peak flow from the 10-year on-site storm. The capacity of the storm drain could be increased to convey the peak flow from the 25-year storm by replacing all the connector pipes with larger pipe, installing a parallel storm drain system or detaining the difference between the peak flow from the 10-year and 25-year storms.

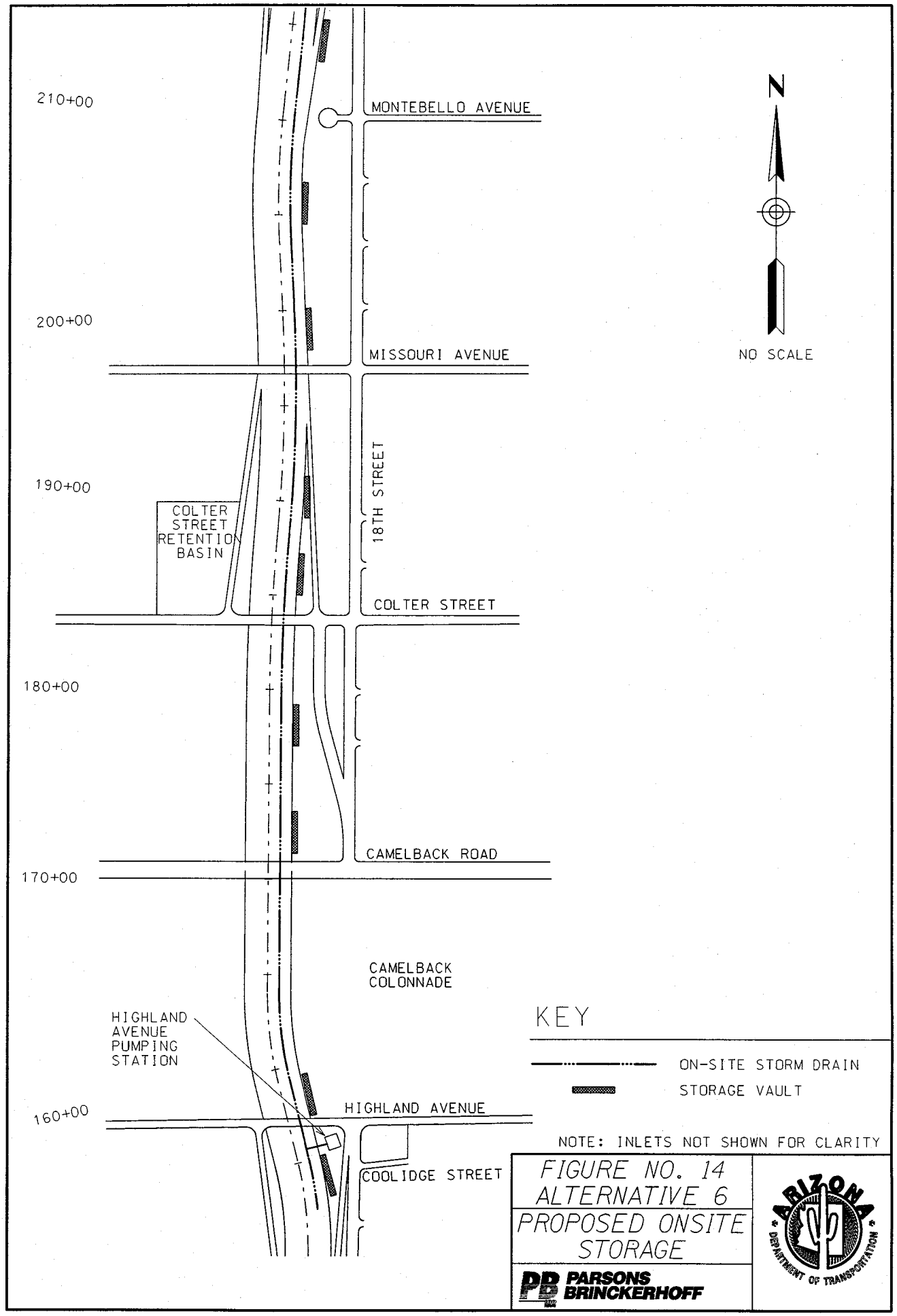
The first two options would have very high installation costs and cause prolonged interruption of service of the Parkway. Providing numerous, small detention basins (vaults) are a feasible option for increasing the level of service of the on-site storm drain.

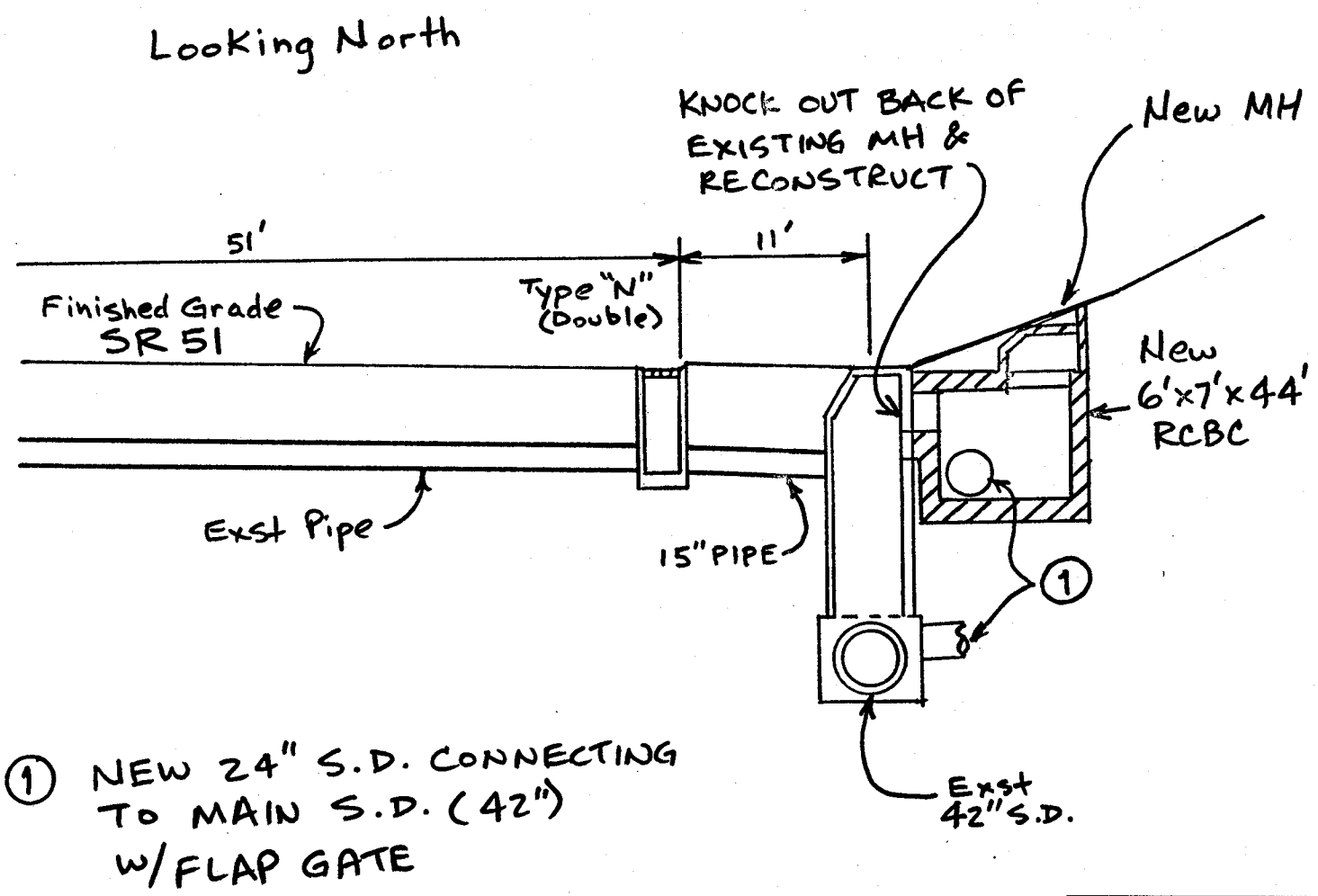
Detaining the difference in peak flows would require approximately 0.21 acre feet of detention distributed evenly along the on-site storm drain system. It is proposed to construct 9 underground box culverts to act as detention vaults at the locations shown on Figure 14. The culverts would be approximately 6 feet by 7 feet by 49 feet. The total storage volume would be 0.42 acre feet. Inflow to these structures is dependent on:

1) the HGL of the mainline storm drain,
2) the amount of runoff removed from upstream storage vaults,
3) the amount of inflow between vaults,
4) the amount of runoff removed from the mainline as a function of height above the vault inlet structure and
5) the actual capability of the roadside inlets to collect the flows produced by the design storm.

While all of these variables can be estimated, it is difficult to accurately estimate the combined effect of all the variables working in conjunction.

Figure 15 shows a generic configuration for the detention vault. Each installation would require two manholes on the main storm drain to act as inlet/outlet structures. A raised inlet into the detention vault would be provided to allow low flows to bypass, but higher flows would spill over and be stored until the storm passes. In some locations it may be possible to utilize an existing manhole as the inlet structure. To the greatest extent possible, the detention vaults would be located behind the existing curb in existing landscaped areas to minimize cost, reduce encroachment of the Parkway during construction, and reduce time required for construction. It is anticipated that at least two of the vaults would be located beneath existing pavement due to lack of available open space. The detention vaults would drain to the on-site storm drain by gravity after the storm passes.


210+00
200+00
190+00
180+00
170+00
160+00
MONTEBELLO AVENUE
MISSOURI AVENUE
18TH STREET
COLTER STREET
CAMELBACK ROAD
CAMELBACK COLONNADE
HIGHLAND AVENUE
COOLIDGE STREET
COLTER STREET RETENTION BASIN
HIGHLAND AVENUE PUMPING STATION
N
NO SCALE
KEY
ON-SITE STORM DRAIN
STORAGE VAULT
NOTE: INLETS NOT SHOWN FOR CLARITY
FIGURE NO. 14
ALTERNATIVE 6
PROPOSED ONSITE STORAGE
PARSONS BRINCKERHOFF
ARIZONA DEPARTMENT OF TRANSPORTATION




1 NEW 24" S.D. CONNECTING TO MAIN S.D. (42") W/FLAP GATE

FIGURE 15

ALTERNATIVE 6

ON-SITE DETENTION VAULT

PARSONS BRINCKERHOFF

ARIZONA DEPARTMENT OF TRANSPORTATION

Adding detention vaults to the on-site storm drain system has the virtual benefit of increasing the capacity of the pump station. With no additional cost, the pump station can now remove the runoff from the 25-year storm from the Parkway. The pumps will operate for a longer period of time during the 25-year storm than they would during the 10-year storm, but the peak flow is reduced to match the capability of the pump station. See the Appendix for routing of flows through the pump station with detention vaults in place.

***This alternative is a recommended candidate for construction.***

### *Alternative 7*
### *Increase Lateral Size at Pump Station Sag*

A larger storm drain lateral is recommended at the on-site sag just north of Highland Avenue. In the existing condition, the center barrier isolates flow on the west side of the Parkway. The existing lateral is only 15 inches in diameter and it is expected to cause a flow restriction, flooding the southbound lanes. It is recommended that the lateral be replaced with a 30-inch diameter pipe. The location of the lateral is shown in Figure 16.

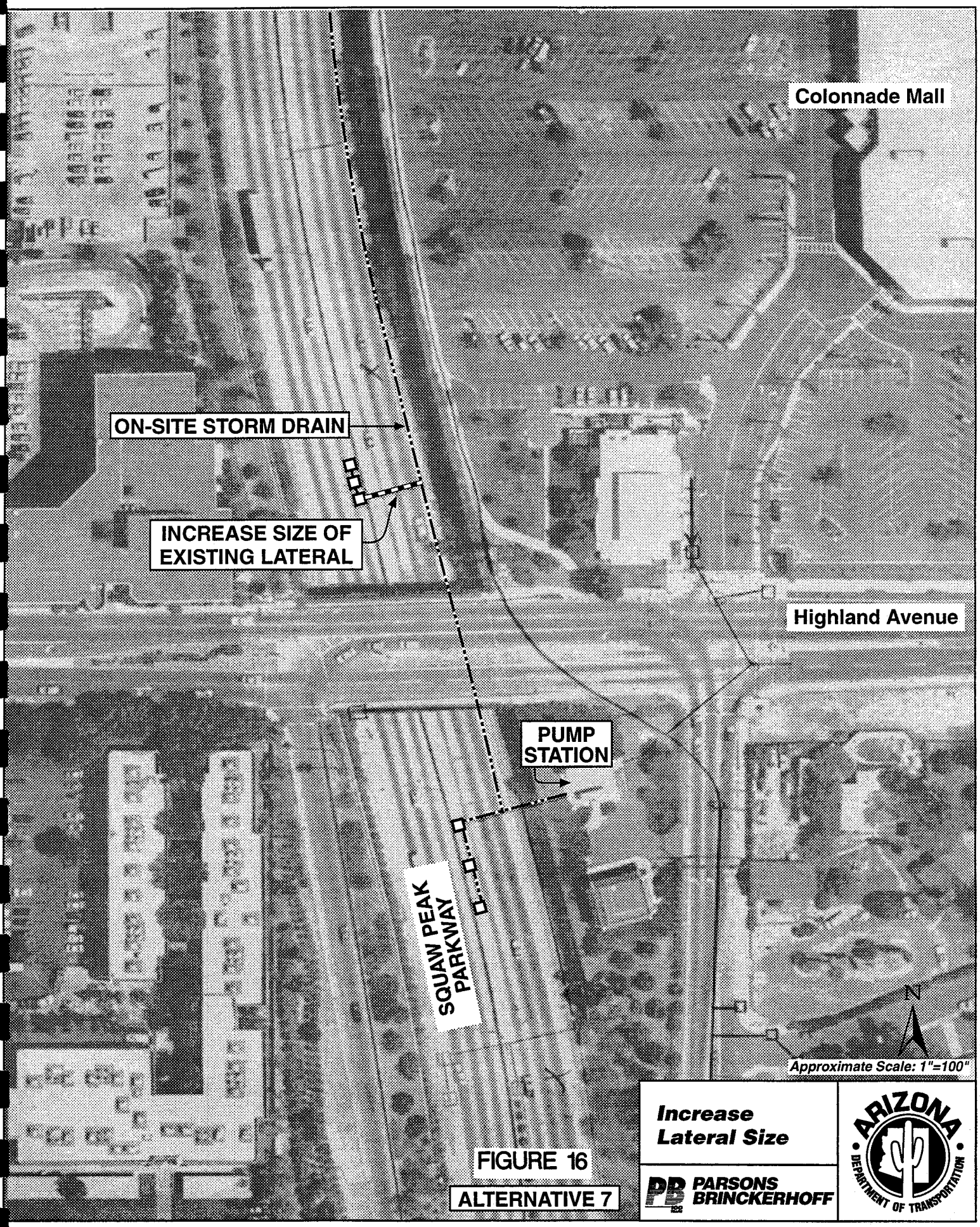
### *Alternative 8*
### *Optimize Pump On/Off Settings*

The lack of storage in the existing wet well and inlet pipe causes excessive cycling of the pumps. Minor modifications to the operation of the pumps would reduce the cycling. The first modification would be to lower the first pump-on elevation and raise the last pump-on elevation. The first pump-on switch should be as low as practical to maximize the storage volume between the pump-on elevations. This will prolong the run time of the first pump and decrease the number of cycles per hour during low flow situations. The disadvantage to raising the last pump-on switch is that it will minimize the freeboard between last pump-on and the alarm level. Also, it would be beneficial to lower the elevation of the lowest pump-off switch. At present, the pump-off switch is set at 1111.0, as shown in Figure 17. This is 13.5 feet from the bottom of the wet well. The pump-off switch could safely be lowered to about 3 feet above the top of the volute, which is about 9 feet from the floor at elevation 1106.0.

**Recommended Pump ON/OFF Settings**

| *Pump Number* | *On Elevation* | *Off Elevation* |
|---|---|---|
| One | 1108.0 | 1106.0 |
| Two | 1110.0 | 1108.0 |
| Three | 1112.0 | 1110.0 |
| Four | 1114.0 | 1112.0 |

Even though the pump cycling computations contained in the Appendix indicate the number one pump may cycle 10 times per hour when the above pump on/off settings are used; a second modification to reduce pump cycling by allowing the switching of the lead/lag position of each pump during a storm event is also recommended. Once a pump starts and stops, it automatically moves to the end of the lag pump queue, prolonging the amount of time each pump is off. This automatic switching should occur even if there are pumps which continue to




**Increase Lateral Size**

PARSONS BRINCKERHOFF

ARIZONA DEPARTMENT OF TRANSPORTATION

FIGURE 16

ALTERNATIVE 7

# HIGHLAND AVE. PUMP STATION

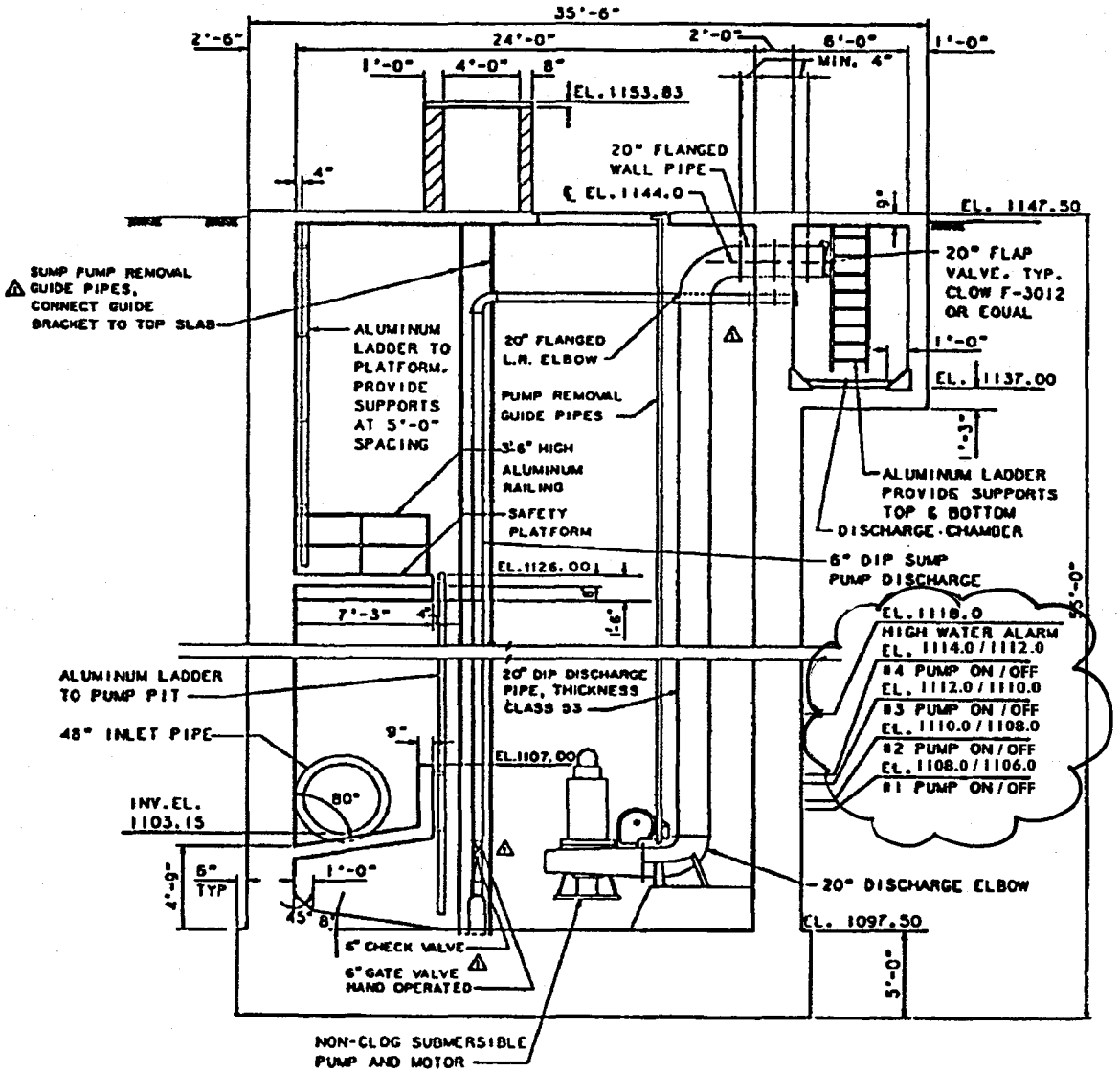



FIGURE 17

ALTERNATIVE NO. 8

REVISED PUMP ON / OFF ELEVATIONS

PB PARSONS BRINCKERHOFF

ARIZONA DEPARTMENT OF TRANSPORTATION

**ADAPTED FROM "AS-BUILT" PLANS**

run without shutting down. The switching should not have to wait until all pumps shut down. This allows all pumps, which are not running continually to move to the end of the queue each time they stop. Since there is a redundant pump, there will always be at least two pumps in the queue after a pump shuts down. These operational modifications require reprogramming of the existing Programmable Logic Computer (PLC).

***This alternative is a recommended candidate for construction.***

### *Alternative 9*
### *Increase Size of Nuisance Pump*

Current practice in ADOT pump stations is to provide a low flow pump of about half the capacity of the main pumps and eliminate the redundant main pump. It is proposed to provide a larger sump pump to help reduce the cycling of the main pumps. A pump capable of moving approximately 6 to 10 cfs would help reduce cycling of the larger pumps during small storms. A schematic of the proposed pump is shown in Figure 18. Increasing the output of the sump pump to this extent will require installation of new discharge piping, new electrical wiring and motor starter equipment. A 10 cfs pump would require a 100 Hp pump. The existing generators are capable of running 4 of the main pumps plus the little sump pump. The equipment would not be capable of running the proposed 100 Hp pump and the existing pumps at the same time. Controls would have to be provided to shut down the 100 Hp pump just before the third main pump starts.

If an off-site detention basin is constructed to store the runoff from a 50-year storm, it would be recommended that the pump station generators be replaced with equipment capable of running all 5 of the main pumps and the 100 Hp pump at once. This would provide approximately 160 cfs of pumping capacity. In conjunction with on-site storage vaults discussed above, there would enough capacity to remove the 50-year storm from the Parkway. The storm drain system would only have a 25-year capacity, so significant quantities of runoff would arrive at the Highland Avenue sag as gutter flow. Additional inlets would be needed in the sag to collect the flow, but the depth of flow would be reduced to the point that emergency vehicles could access the Parkway. An enlarged discharge pipe is needed to convey the flow from the pump station to the detention basin. It is proposed that the enlarged pipe be installed as part of Alternative 5A or 5B, even if the nuisance pump is not replaced at this time.

***Alternative 9, Increase Size of Nuisance Pump, is a recommended candidate for construction.***

### *Alternative 10*
### *Prevent Backflow Into On-Site Catch Basins*

The catch basins at the bottom of both of the Highland Avenue ramps (inlets I14, I15, I16 and I17 on the node diagram shown in Section 2.2 of the Appendix) are expected to discharge off-site runoff onto the Parkway when the hydraulic grade line rises in the 18$^{th}$ Street Trunk Line. This is likely to occur during a 2-year storm. Backflow from the catch basins could be prevented by adding sealed manholes with flap gates to the laterals in pipes #34, #36 and

# HIGHLAND AVE. PUMP STATION

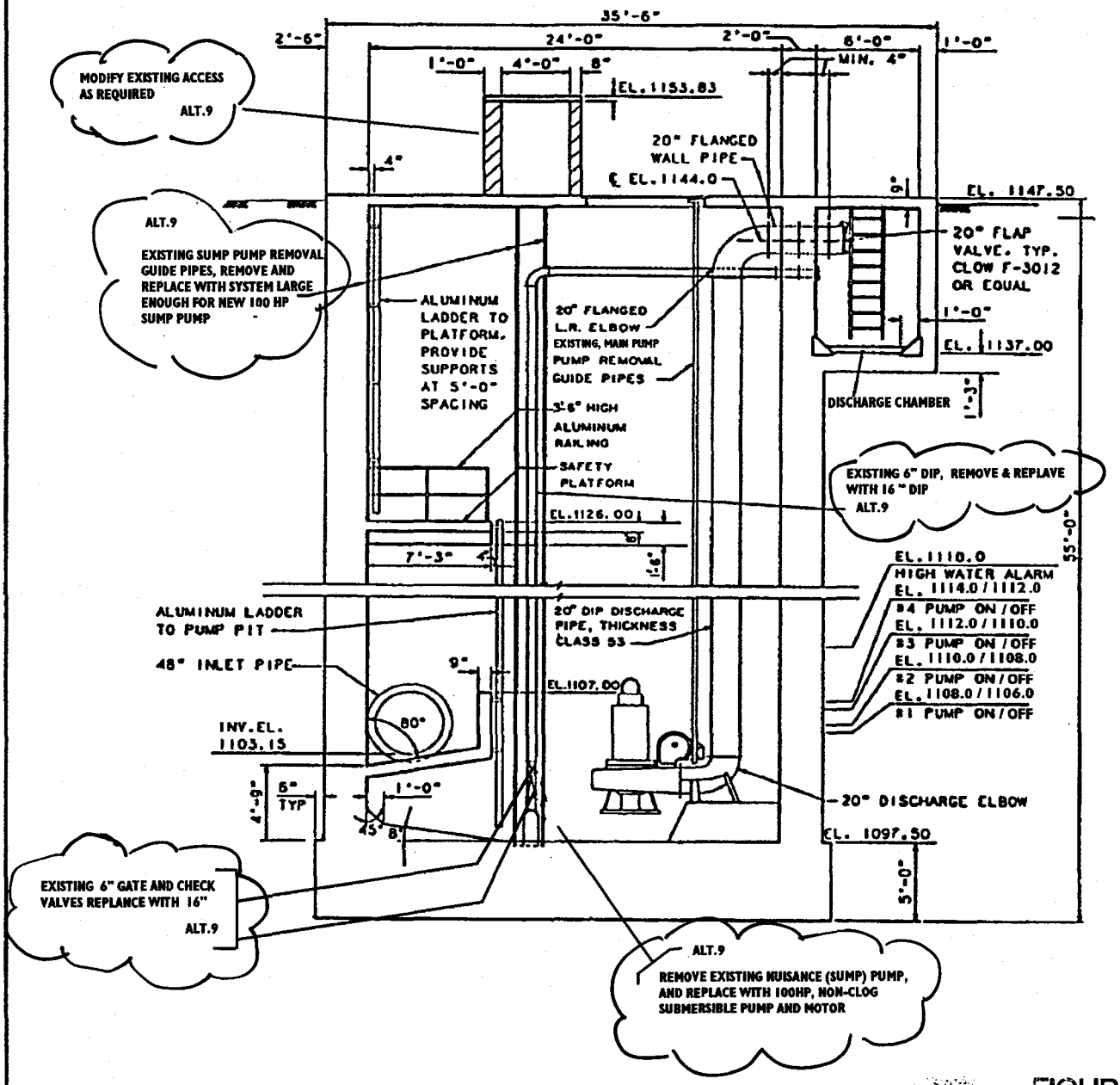



FIGURE 18

ALTERNATIVE NO. 9

LARGER NUISANCE PUMP

PB PARSONS BRINCKERHOFF

ARIZONA DEPARTMENT OF TRANSPORTATION

**ADAPTED FROM "AS-BUILT" PLANS**

#38. The manholes would be between the inlets and the trunk line. Three manholes would be required, as shown in Figure 19.

An alternative solution to the problem would be to repipe the inlets so that they are connected to the on-site storm drain as shown in Figure 20. It will be possible to repipe inlets I14 through I16, but inlet I17 is lower than the tie-in manhole in the on-site storm drain. Inlet I17 would still have to be isolated using a manhole with a flap gate. Connecting these inlets to the on-site storm drain will affect the hydraulics of the on-site storm drain system.

Repiping the inlets does not appear to be cost effective as a stand alone project, but it may be feasible as part of the HOV lane construction. Increasing the size of pipes #702 and #705 to 24-inch is also recommended if the work is done as part of the HOV project.

Hydraulic calculations for repiping the inlets are included in the Appendix.

***Alternative 10B, repiping the inlets into the on-site storm drain, is a recommended candidate for construction.***

### *Alternative 11*
### *18th Street Trunk Line Replacement- Maryland Avenue to Rancho Drive*

The existing 18th Street Trunk Line lacks sufficient capacity to convey a storm greater than the 2-year between Maryland Avenue and Rancho Road. On-site inlets on the Squaw Peak Parkway and inlets on 18th Street are expected to overflow in most storms. Replacement of the trunk line from Maryland Avenue to Rancho Road is recommended. Increasing pipe sizes from 6 inches to 1 foot will provide sufficient capacity to convey the 10-year peak flow. This section of 18th Street is narrow with many transverse and longitudinal utilities. As-built plans show utilities crossing over the existing storm drain, but the plans show sufficient clearance to accommodate the proposed trunk line. Actual utility locations require verification during final design. Parallel utilities present conflicts in several areas. Therefore, removal of the existing trunk line is recommended over the installation of a parallel storm drain. The approximate alignment of the proposed replacement storm drain are shown on Figure 21.

Hydraulic calculations for the replacement storm drain are included in the Appendix.

***Alternative 11, Replacement of 18th Street Trunk Line - Maryland Avenue to Rancho Drive, is a recommended candidate for construction.***

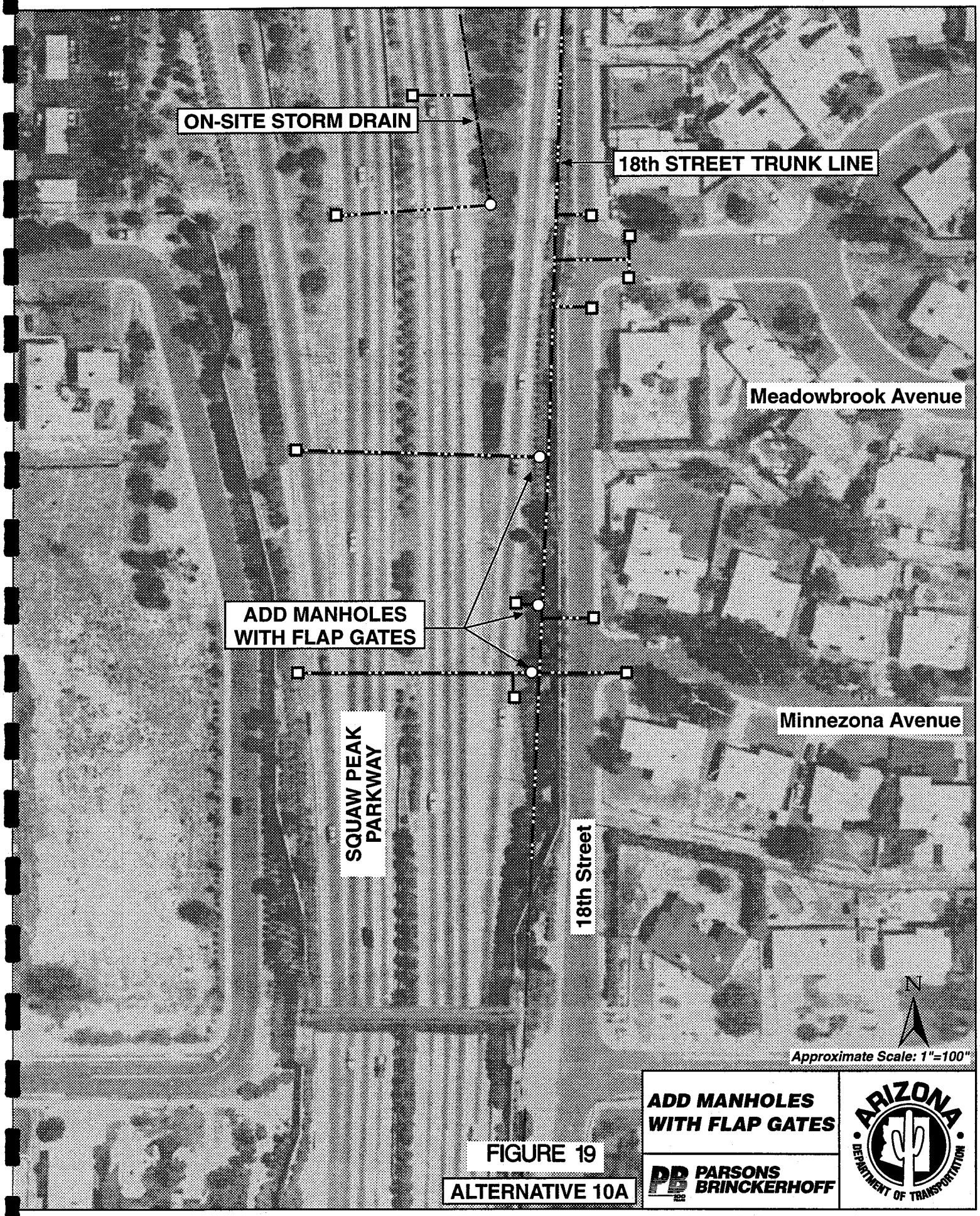



FIGURE 19

ALTERNATIVE 10A

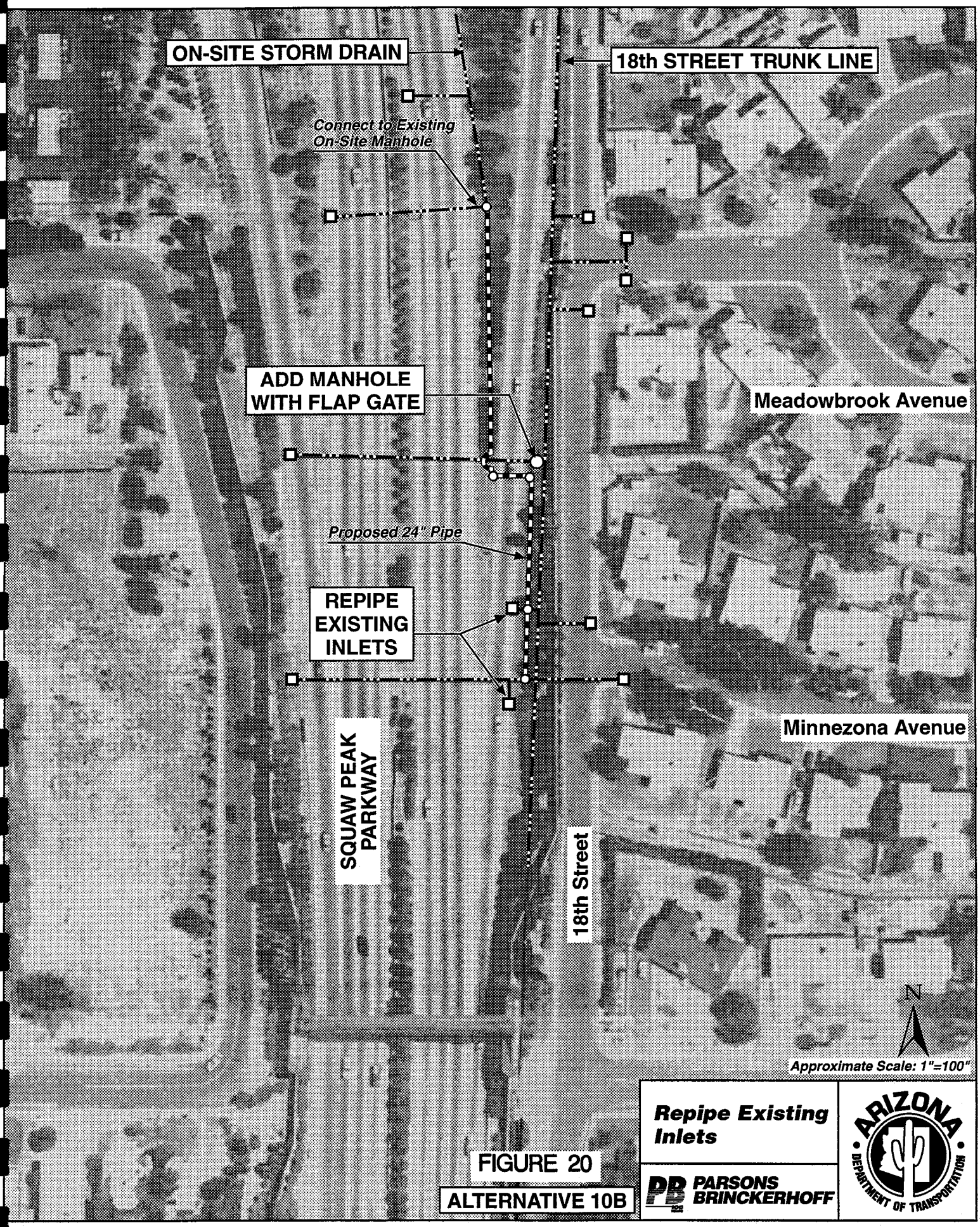
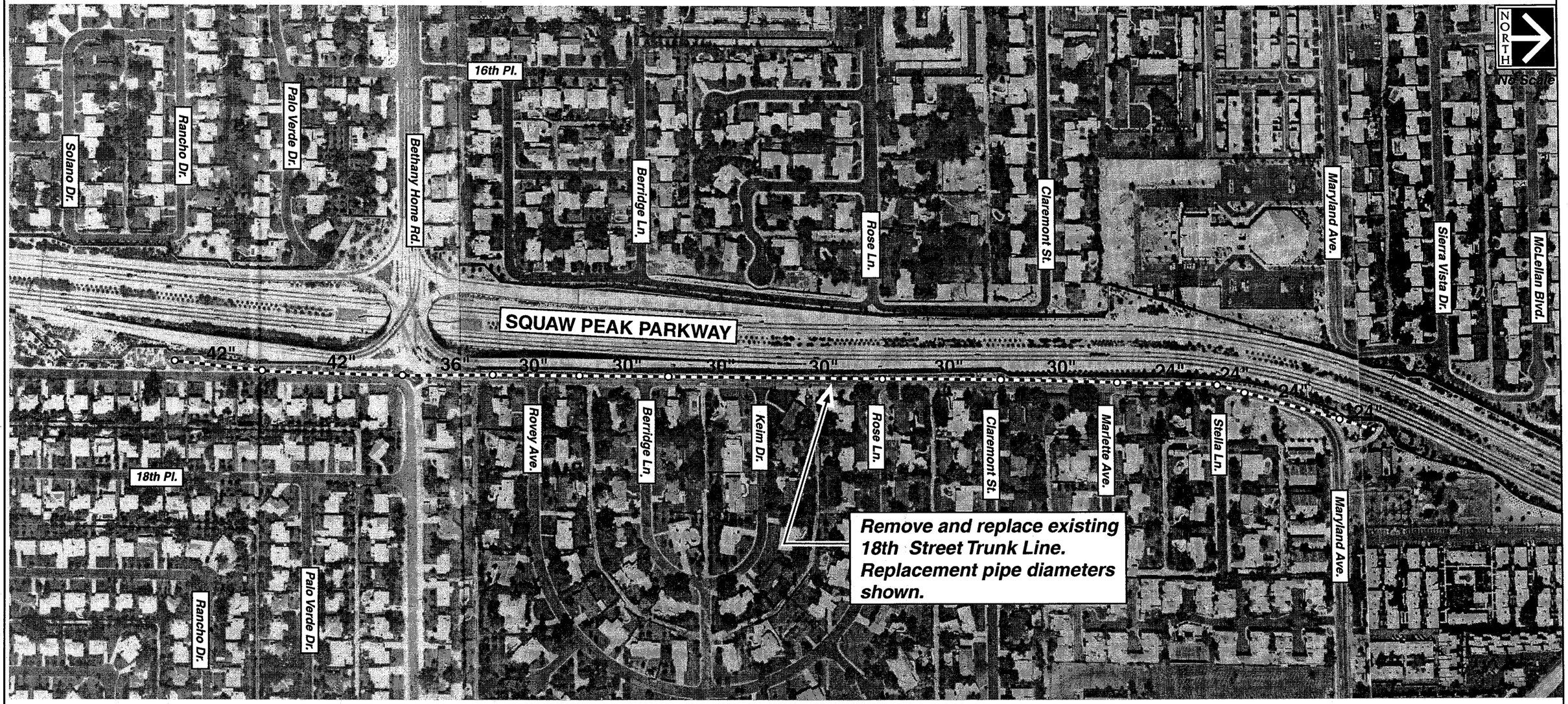



FIGURE 20

ALTERNATIVE 10B




**18th Street Trunk Line Replacement**

PARSONS BRINCKERHOFF

**FIGURE 21**

## 6.3 Summary

The Solutions/Alternatives discussed in this Section are summarized in the matrix on the next page. Alternatives which are Recommended Candidates for Construction are shown in the final column of the matrix. Each solution/alternative is rated against the criteria shown across the top of the matrix.

Most of the rankings used in the matrix are subjective. The following explanations discuss the reasoning used to rank the solutions/alternatives under each criteria considered. Cost estimates in this Report reflect the cost to perform each task as part of a larger project. The recommended alternatives have been grouped into two projects. Project 1 includes projects which are located off-site. Project 2 alternatives are on-site and require disruption of traffic to construct. Project 2 alternatives will be constructed in conjunction with High Occupancy Vehicle Lane improvements. The last column in the matrix shows recommended project groupings. Overall project costs are calculated based on project groupings.

### *Construction/ROW Costs*

Detailed cost estimates were prepared for this report. The cost shown in the matrix is the engineer's estimate of probable construction costs. Detailed cost analysis spreadsheets follow the matrix.

### *Disruption of Parkway Service During Construction*

The proposed solutions/alternatives were rated based on:

VH- Work expected to cause continuous closure of one lane and frequent closure of a second lane. Complete closure of the facility is expected for some tasks. Location of the closures may change during the duration of the project.

H- Work expected to cause continuous closure of one lane with the possibility that more than one lane may be closed on an intermittent basis. Location of the closures may change during the duration of the project.

M- Work expected to cause continuous closure of one lane. Location of the closure may change during the duration of the project.

L- Work is expected to cause intermittent closure of one lane. Closures would be relatively brief.

VL- Work is expected to be done within landscaped areas. Lane closures are not anticipated, but delays may occur due to motorist curiosity.

### *Temporary Community Impacts*

Temporary community impacts are considered to be construction related disruptions of utilities, local street closures, traffic rerouting, and noise and dust caused by construction. The ratings below show the basis of the matrix rankings:

VH- Work is expected to encompass areas measured in square blocks. Numerous intersection closures would be required, Traffic rerouting from 20th Street through the

# Solution/Alternative - Matrix

| | Alternatives | Construction/ROW Cost | Disruption of Parkway Service During Construction | Temporary Community Impacts | Permanent Community Impacts | Operation & Maintenance Costs | Design Effort and Cost | Utility Conflicts | Level of Coordination with City of Phoenix | Constructibility Issues | Compatibility with Addition of HOV Lanes | New ROW- Number of Houses/Acres | Design Frequency | Recommended Candidate for Construction | Recommended Implementation Plan |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1A | 18th Street Detention Basin, 50-yr Storm, Park | $26,918,600 | Nil | VH | H | VL | VH | M | VH | H | VH | 129/30.9 | 50 | No | NA |
| 1B | 18th Street Detention Basin, 50-yr Storm, With Retaining Walls | $10,156,700 | Nil | VH | VH | M | H | M | M | H | VH | 30/9.8 | 50 | No | NA |
| 2A | Walled Detention Basin on Highland Avenue, With Retaining Walls | $2,837,200 | Nil | M | VL | L | M | M | M | L | H | 0/2.1 | 20 | No | NA |
| 2B | Walled Detention Basin on Highland Avenue, Without Retaining Walls | $2,544,600 | Nil | M | VL | L | M | M | M | L | H | 0/2.1 | 14 | No | NA |
| 3 | Additional Inlets at Turney Avenue and Glenrosa Avenue | $20,200 | Nil | L | Nil | VL | VL | VL | M | L | H | NA | 2 | Yes | Project 1 |
| 4 | Add Restriction Plate to Colter Street Junction Structure | $4,400 | VL | Nil | Nil | L | VL | VL | H | VL | H | NA | 100 | Yes | Project 1 |
| 5A | Detention Basin for Pump Station Discharge, Without Retaining Walls | $166,900 | L | M | M | M | M | L | M | M | VH | 1/1.3 | 25 | No | NA |
| 5B | Detention Basin for Pump Station Discharge, With Retaining Walls | $1,902,800 | L | M | M | M | M | L | M | M | VH | 1/1.3 | 25 | Yes | Project 1 |
| 6 | Detention Vaults to Provide 25-yr On-site Conveyance Capacity | $469,700 | M | L | Nil | M | L | L | VL | M | VH | NA | 25 | Yes | Project 2 |
| 7 | Increase On-site Lateral Size at Pump Station Sump | $28,000 | M | Nil | Nil | VL | L | VL | VL | H | VH | NA | 25 | Yes | Project 2 |
| 8 | Optimize Pump On/Off Settings | $11,400 | VL | VL | Nil | Nil | VL | Nil | Nil | VL | VH | NA | 10 | Yes | Project 1 |
| 9 | Increase Size of Nuisance Pump | $100,400 | VL | VL | Nil | L | M | VL | Nil | L | H | NA | 10 | Yes | Project 1 |
| 10A | Prevent Backflow Into On-Site Catch Basins- Manholes with Flap Gates | $15,400 | VL | VL | VL | L | VL | VL | Nil | VL | H | NA | 2 | No | NA |
| 10B | Prevent Backflow Into On-Site Catch Basins- Repipe Inlets | $79,200 | VL | VL | VL | L | VL | VL | Nil | VL | H | NA | 2 | Yes | Project 2 |
| 11 | 18th Street Trunk Line Replacement- Maryland Avenue to Rancho Drive | $447,600 | VL | H | VL | L | M | M | H | M | NA | NA | 10 | Yes | Project 1 |

**Project 1 Subtotal $2,486,800**
**Project 2 Subtotal $576,900**

**Legend**

VH- Very High

H- High

M- Medium

L- Low

VL- Very Low

Nil- None or Negligible

Project 1- Construct as Drainage Improvements

Project 2- Construct with HOV Improvements

PREMIER
ENGINEERING CORPORATION

**Engineers' Preliminary Opinion of Probable Project Costs**

| | | | |
|---|---|---|---|
| Project: | SR51 | By: | Mike Luecker |
| Project No. | 051 MA 2 H 4585 | Date: | 4/14/98 |
| | | Checked: | Jeff Holzmeister |
| | | Premier Project No.: | 9714 |

## ALTERNATIVE 1A
## 18th Street Detention Basin, 50-yr Storm, Park

| | ITEM NO | ITEM DESCRIPTION | UNIT | QUANTITY | UNIT PRICE | AMOUNT |
|---|---|---|---|---|---|---|
| **PART A: BASIN CONSTRUCTION** | | | | | | |
| 1 | 2010011 | CLEARING, GRUBBING AND TREE REMOVAL | ACRE | 0 | $ 5,000.00 | $ - |
| 2 | 2020048 | REMOVAL OF BUILDINGS | EACH | 131 | $ 5,000.00 | $ 655,000.00 |
| 3 | 2020025 | REMOVAL OF CONC. SIDEWALKS, DRIVEWAYS & SLABS | SF | 32400 | $ 2.00 | $ 64,800.00 |
| 4 | 2020031 | REMOVAL OF PORTLAND CEMENT CONC. PAVEMENT | SY | 7900 | $ 15.00 | $ 118,500.00 |
| 5 | 2030201 | DRAINAGE EXCAVATION & HAUL FROM SITE | CY | 137000 | $ 10.00 | $ 1,370,000.00 |
| 6 | 4010012 | PORTLAND CEMENT CONC. PAVEMENT (12") | SY | 300 | $ 45.00 | $ 13,500.00 |
| 7 | 5011023 | PIPE, REINFORCED CONCRETE, CLASS III, 24" | LF | 750 | $ 70.00 | $ 52,500.00 |
| 8 | 5011043 | PIPE, REINFORCED CONCRETE, CLASS III, 36" | LF | 500 | $ 100.00 | $ 50,000.00 |
| 9 | 5011053 | PIPE, REINFORCED CONCRETE, CLASS III, 48" | LF | 600 | $ 250.00 | $ 150,000.00 |
| 10 | 5030043 | CONC. CATCH BASIN (C-15.20), ONE 10' WING, H<10' | EACH | 21 | $ 3,000.00 | $ 63,000.00 |
| 11 | | CONC. CATCH BASIN GRATE INLET - SPECIAL | EACH | 1 | $ 20,000.00 | $ 20,000.00 |
| 12 | 8050071 | BERMUDA GRASS SOD | SY | 149000 | $ 5.00 | $ 745,000.00 |
| 13 | 8060001 | PLANTING TREES, SHRUBS AND PLANTS | LS | 1 | $ 1,343,000.00 | $ 1,343,000.00 |
| 14 | 8080001 | LANDSCAPE IRRIGATION SYSTEM | LS | 1 | $ 470,000.00 | $ 470,000.00 |
| 15 | 9140113 | WALL (BLOCK) | SF | 0 | $ 12.00 | $ - |
| 16 | 9140144 | STEEL FENCE, COLORED PICKET (72") | LF | 0 | $ 35.00 | $ - |
| 17 | 9140153 | RETAINING WALL (REINFORCED CONCRETE) | SF | 0 | $ 25.00 | $ - |
| | | | | | | |
| | | **SUBTOTAL A1** | | | | $ 5,115,300.00 |
| | | | | | | |
| 18 | 2030855 | EROSION CONTROL (1%) | %*SUB | 0.01 | | $ 51,153.00 |
| 19 | 7010001 | MAINTENANCE/PROTECTION OF TRAFFIC (10%) | %*SUB | 0.10 | | $ 511,530.00 |
| 20 | 9010001 | MOBILIZATION (7%) | %*SUB | 0.07 | | $ 358,071.00 |
| 21 | 9240170 | QUALITY CONTROL (2%) | %*SUB | 0.02 | | $ 102,306.00 |
| 22 | 9300142 | WATER SUPPLY / DUST POLLUTION (2%) | %*SUB | 0.02 | | $ 102,306.00 |
| 23 | | CONSTRUCTION SURVEY (1%) | %*SUB | 0.01 | | $ 51,153.00 |
| 24 | | CONSTRUCTION ENGINEERING AND | %*SUB | 0.30 | | $ 1,534,590.00 |
| | | CONTINGENCIES (30%) | | | | |
| | | | | | | |
| | | **SUBTOTAL A2** | | | | $ 2,711,109.00 |
| | | | | | | |
| | | | | | | |
| **PART B: RIGHT-OF-WAY** | | | | | | |
| | | PURCHASE OF HOMES | EACH | 128 | $ 140,000.00 | $ 17,920,000.00 |
| | | R/W FOR PUMP STATION BASIN (SEE OPTION 5B) | LS | 1 | $ 1,019,304.00 | $ 1,019,304.00 |
| | | CONTENGENCIES FOR PUMP STATION BASIN (15%) | | 0.15 | | $ 152,895.60 |
| | | | | | | |
| | | | | | | |
| | | **SUBTOTAL B1** | | | | $ 19,092,199.60 |
| | | | | | | |
| **PROJECT TOTAL(ROUNDED)*** | | | | | | **$ 26,918,600** |

*** Utility relocation not included in project total. Utility costs to be determined during final design.**

PREMIER
ENGINEERING CORPORATION

**Engineers' Preliminary Opinion of Probable Project Costs**

| | | | |
|---|---|---|---|
| Project: | SR51 | By: | Mike Luecker |
| Project No. | 051 MA 2 H 4585 | Date: | 4/14/98 |
| | | Checked: | Jeff Holzmeister |
| | | Premier Project No.: | 9714 |

# ALTERNATIVE 1B
## 18th Street Detention Basin, 50-yr Storm, Walls

| | ITEM NO | ITEM DESCRIPTION | UNIT | QUANTITY | UNIT PRICE | AMOUNT |
|---|---|---|---|---|---|---|
| **PART A: BASIN CONSTRUCTION** | | | | | | |
| 1 | 2020011 | CLEARING, GRUBBING AND TREE REMOVAL | ACRE | 2 | $ 5,000.00 | $ 10,000.00 |
| 2 | 2020048 | REMOVAL OF BUILDINGS | EACH | 32 | $ 5,000.00 | $ 160,000.00 |
| 3 | 2020025 | REMOVAL OF CONC. SIDEWALKS, DRIVEWAYS & SLABS | SF | 12000 | $ 2.00 | $ 24,000.00 |
| 4 | 2020031 | REMOVAL OF PORTLAND CEMENT CONC. PAVEMENT | SY | 390 | $ 15.00 | $ 5,850.00 |
| 5 | 2030201 | DRAINAGE EXCAVATION & HAUL FROM SITE | CY | 116875 | $ 10.00 | $ 1,168,750.00 |
| 6 | 4010012 | PORTLAND CEMENT CONC. PAVEMENT (12") | SY | 1240 | $ 45.00 | $ 55,800.00 |
| 7 | 5011023 | PIPE, REINFORCED CONCRETE, CLASS III, 24" | LF | 825 | $ 70.00 | $ 57,750.00 |
| 8 | 5011043 | PIPE, REINFORCED CONCRETE, CLASS III, 36" | LF | 260 | $ 100.00 | $ 26,000.00 |
| 9 | 5011053 | PIPE, REINFORCED CONCRETE, CLASS III, 48" | LF | 1925 | $ 250.00 | $ 481,250.00 |
| 10 | 5050031 | MANHOLE (C-18.10)(NO. 3) (FOR PIPES 6" TO 36") | EACH | 1 | $ 2,500.00 | $ 2,500.00 |
| 11 | 5050032 | MANHOLE (C-18.10)(NO. 3) (FOR PIPES 6" TO 36") | EACH | 1 | $ 3,500.00 | $ 3,500.00 |
| 12 | 5030043 | CONC. CATCH BASIN (C-15.20), ONE 10' WING, H<10' | EACH | 21 | $ 3,000.00 | $ 63,000.00 |
| 13 | | CONC. CATCH BASIN GRATE INLET - SPECIAL | EACH | 1 | $ 20,000.00 | $ 20,000.00 |
| 14 | 6016089 | ENERGY DISSIPATOR (48" CONCRETE PIPE | EACH | 1 | $ 3,500.00 | $ 3,500.00 |
| 15 | 8030103 | DECOMPOSED GRANITE | SY | 35532 | $ 3.60 | $ 127,915.20 |
| 16 | 8060001 | PLANTING TREES, SHRUBS AND PLANTS | LS | 1 | $ 331,000.00 | $ 331,000.00 |
| 17 | 8080001 | LANDSCAPE IRRIGATION SYSTEM | LS | 1 | $ 116,707.00 | $ 116,707.00 |
| 18 | 9080241 | CONCRETE SIDEWALK (MAG DET. 230 & 231) | SF | 1800 | $ 3.00 | $ 5,400.00 |
| 19 | 9140113 | WALL (BLOCK) | SF | 10920 | $ 12.00 | $ 131,040.00 |
| 20 | 9140144 | STEEL FENCE, COLORED PICKET (72") | LF | 3410 | $ 35.00 | $ 119,350.00 |
| 21 | 9140153 | RETAINING WALL (REINFORCED CONCRETE) | SF | 12010 | $ 25.00 | $ 300,250.00 |
| 22 | XXXXXXX | MISC ITEMS (REMOVE CURB AND GUTTER, FLAP GATE, | LS | 1 | $ 5,095.00 | $ 5,095.00 |
| | | HEADWALL, PIPE PLUG, CONCRETE. CURB, RIP RAP | | | | |
| | AND RAMP CLOSURE - SEE OPTION 5B FOR DETAILS OF MISC ITEMS) | | | | | |
| | | | | | | |
| | | **SUBTOTAL A1** | | | | $ 3,218,657.20 |
| | | | | | | |
| 23 | 2030855 | EROSION CONTROL (1%) | %*SUB | 0.01 | | $ 32,186.57 |
| 24 | 7010001 | MAINTENANCE/PROTECTION OF TRAFFIC (10%) | %*SUB | 0.10 | | $ 321,865.72 |
| 25 | 9010001 | MOBILIZATION (7%) | %*SUB | 0.07 | | $ 225,306.00 |
| 26 | 9240170 | QUALITY CONTROL (2%) | %*SUB | 0.02 | | $ 64,373.14 |
| 27 | 9300142 | WATER SUPPLY / DUST POLLUTION (2%) | %*SUB | 0.02 | | $ 64,373.14 |
| 28 | | CONSTRUCTION SURVEY (1%) | %*SUB | 0.01 | | $ 32,186.57 |
| 29 | | CONSTRUCTION ENGINEERING AND | %*SUB | 0.30 | | $ 965,597.16 |
| | | CONTINGENCIES (30%) | | | | |
| | | | | | | |
| | | **SUBTOTAL A2** | | | | $ 1,705,888.32 |
| **PART B: RIGHT-OF-WAY** | | | | | | |
| | | PURCHASE OF HOMES | EACH | 29 | $ 140,000.00 | $ 4,060,000.00 |
| | | R/W FOR PUMP STATION BASIN (SEE OPTION 5B) | LS | 1 | $1,019,304.00 | $ 1,019,304.00 |
| | | CONTENGENCIES FOR PUMP STATION BASIN (15%) | | 0.15 | | $ 152,895.60 |
| | | | | | | |
| | | **SUBTOTAL B1** | | | | $ 5,232,199.60 |
| **PROJECT TOTAL(ROUNDED)*** | | | | | | **$ 10,156,700** |

*** Utility relocation not included in project total. Utility costs to be determined during final design.**



Quantity
12/1/98

PREMIER
ENGINEERING CORPORATION

**Engineers' Preliminary Opinion of Probable Project Costs**

| | | | |
|---|---|---|---|
| Project: | SR51 | By: | Mike Luecker |
| Project No. | 051 MA 2 H 4585 | Date: | 11/20/98 |
| | | Checked: | Jeff Holzmeister |
| | | Premier Project No.: | 9714 |

## ALTERNATIVE 2A
## Walled Detention Basin on Highland Avenue, With Retaining Walls

| | ITEM NO | ITEM DESCRIPTION | UNIT | QUANTITY | UNIT PRICE | AMOUNT |
|---|---|---|---|---|---|---|
| **PART A: BASIN CONSTRUCTION** | | | | | | |
| 1 | 2020011 | CLEARING, GRUBBING AND TREE REMOVAL | ACRE | 2 | $ 5,000.00 | $ 10,000.00 |
| 2 | 2020048 | REMOVAL OF BUILDINGS | EACH | 0 | $ 5,000.00 | $ - |
| 3 | 2020025 | REMOVAL OF CONC. SIDEWALKS, DRIVEWAYS & SLABS | SF | 12000 | $ 2.00 | $ 24,000.00 |
| 4 | 2020031 | REMOVAL OF PORTLAND CEMENT CONC. PAVEMENT | SY | 70 | $ 15.00 | $ 1,050.00 |
| 5 | 2030201 | DRAINAGE EXCAVATION & HAUL FROM SITE | CY | 23000 | $ 10.00 | $ 230,000.00 |
| 6 | 4010012 | PORTLAND CEMENT CONC. PAVEMENT (12") | SY | 70 | $ 45.00 | $ 3,150.00 |
| 7 | 5011023 | PIPE, REINFORCED CONCRETE, CLASS III, 24" | LF | 450 | $ 70.00 | $ 31,500.00 |
| 8 | 5011043 | PIPE, REINFORCED CONCRETE, CLASS III, 36" | LF | 60 | $ 100.00 | $ 6,000.00 |
| 9 | 5011053 | PIPE, REINFORCED CONCRETE, CLASS III, 48" | LF | 500 | $ 250.00 | $ 125,000.00 |
| 10 | 5030043 | CONC. CATCH BASIN (C-15.20), ONE 10' WING, H<10' | EACH | 6 | $ 3,000.00 | $ 18,000.00 |
| 11 | | CONC. CATCH BASIN GRATE INLET - SPECIAL | EACH | 1 | $ 20,000.00 | $ 20,000.00 |
| 12 | 8030103 | DECOMPOSED GRANITE | SY | 10000 | $ 3.60 | $ 36,000.00 |
| 13 | 8060001 | PLANTING TREES, SHRUBS AND PLANTS | LS | 1 | $ 90,000.00 | $ 90,000.00 |
| 14 | 8080001 | LANDSCAPE IRRIGATION SYSTEM | LS | 1 | $ 31,500.00 | $ 31,500.00 |
| 15 | 9140113 | WALL (BLOCK) | SF | 0 | $ 12.00 | $ - |
| 16 | 9140144 | STEEL FENCE, COLORED PICKET (72") | LF | 900 | $ 35.00 | $ 31,500.00 |
| 17 | 9140153 | RETAINING WALL (REINFORCED CONCRETE) | SF | 5250 | $ 25.00 | $ 131,250.00 |
| | | | | | | |
| | | **SUBTOTAL A1** | | | | $ 788,950.00 |
| | | | | | | |
| 18 | 2030855 | EROSION CONTROL (1%) | %*SUB | 0.01 | | $ 7,889.50 |
| 19 | 7010001 | MAINTENANCE/PROTECTION OF TRAFFIC (10%) | %*SUB | 0.10 | | $ 78,895.00 |
| 20 | 9010001 | MOBILIZATION (7%) | %*SUB | 0.07 | | $ 55,226.50 |
| 21 | 9240170 | QUALITY CONTROL (2%) | %*SUB | 0.02 | | $ 15,779.00 |
| 22 | 9300142 | WATER SUPPLY / DUST POLLUTION (2%) | %*SUB | 0.02 | | $ 15,779.00 |
| 23 | | CONSTRUCTION SURVEY (1%) | %*SUB | 0.01 | | $ 7,889.50 |
| 24 | | CONSTRUCTION ENGINEERING AND | %*SUB | 0.30 | | $ 236,685.00 |
| | | CONTINGENCIES (30%) | | | | |
| | | | | | | |
| | | **SUBTOTAL A2** | | | | $ 418,143.50 |
| | | | | | | |
| | | | | | | |
| **PART B: RIGHT-OF-WAY** | | | | | | |
| | | PURCHASE OF BUFFER ZONE | LS | 1 | $1,417,500.00 | $ 1,417,500.00 |
| | | CONTINGENCIES (15%) | LS | 1 | $ 212,625.00 | $ 212,625.00 |
| | | **SUBTOTAL B1** | | | | $ 1,630,125.00 |
| | | | | | | |
| **PROJECT TOTAL(ROUNDED)*** | | | | | | **$ 2,837,200** |

*** Utility relocation not included in project total. Utility costs to be determined during final design.**

PREMIER
ENGINEERING CORPORATION

## *Engineers' Preliminary Opinion of Probable Project Costs*

| | | | |
|---|---|---|---|
| Project: | SR51 | By: | Mike Luecker |
| Project No. | 051 MA 2 H 4585 | Date: | 11/20/98 |
| | | Checked: | Jeff Holzmeister |
| | | Premier Project No.: | 9714 |

# ALTERNATIVE 2B
## Walled Detention Basin on Highland Avenue, Without Retaining Walls

| | ITEM NO | ITEM DESCRIPTION | UNIT | QUANTITY | UNIT PRICE | AMOUNT |
|---|---|---|---|---|---|---|
| **PART A: BASIN CONSTRUCTION** | | | | | | |
| 1 | 2020011 | CLEARING, GRUBBING AND TREE REMOVAL | ACRE | 2 | $ 5,000.00 | $ 10,000.00 |
| 2 | 2020048 | REMOVAL OF BUILDINGS | EACH | 0 | $ 5,000.00 | $ - |
| 3 | 2020025 | REMOVAL OF CONC. SIDEWALKS, DRIVEWAYS & SLABS | SF | 12000 | $ 2.00 | $ 24,000.00 |
| 4 | 2020031 | REMOVAL OF PORTLAND CEMENT CONC. PAVEMENT | SY | 70 | $ 15.00 | $ 1,050.00 |
| 5 | 2030201 | DRAINAGE EXCAVATION & HAUL FROM SITE | CY | 17000 | $ 10.00 | $ 170,000.00 |
| 6 | 4010012 | PORTLAND CEMENT CONC. PAVEMENT (12") | SY | 70 | $ 45.00 | $ 3,150.00 |
| 7 | 5011023 | PIPE, REINFORCED CONCRETE, CLASS III, 24" | LF | 450 | $ 70.00 | $ 31,500.00 |
| 8 | 5011043 | PIPE, REINFORCED CONCRETE, CLASS III, 36" | LF | 60 | $ 100.00 | $ 6,000.00 |
| 9 | 5011053 | PIPE, REINFORCED CONCRETE, CLASS III, 48" | LF | 500 | $ 250.00 | $ 125,000.00 |
| 10 | 5030043 | CONC. CATCH BASIN (C-15.20), ONE 10' WING, H<10' | EACH | 6 | $ 3,000.00 | $ 18,000.00 |
| 11 | | CONC. CATCH BASIN GRATE INLET - SPECIAL | EACH | 1 | $ 20,000.00 | $ 20,000.00 |
| 12 | 8030103 | DECOMPOSED GRANITE | SY | 10000 | $ 3.60 | $ 36,000.00 |
| 13 | 8060001 | PLANTING TREES, SHRUBS AND PLANTS | LS | 1 | $ 90,000.00 | $ 90,000.00 |
| 14 | 8080001 | LANDSCAPE IRRIGATION SYSTEM | LS | 1 | $ 31,500.00 | $ 31,500.00 |
| 15 | 9140113 | WALL (BLOCK) | SF | 0 | $ 12.00 | $ - |
| 16 | 9140144 | STEEL FENCE, COLORED PICKET (72") | LF | 900 | $ 35.00 | $ 31,500.00 |
| 17 | 9140153 | RETAINING WALL (REINFORCED CONCRETE) | SF | 0 | $ 25.00 | $ - |
| | | | | | | |
| | | **SUBTOTAL A1** | | | | $ 597,700.00 |
| | | | | | | |
| 18 | 2030855 | EROSION CONTROL (1%) | %*SUB | 0.01 | | $ 5,977.00 |
| 19 | 7010001 | MAINTENANCE/PROTECTION OF TRAFFIC (10%) | %*SUB | 0.10 | | $ 59,770.00 |
| 20 | 9010001 | MOBILIZATION (7%) | %*SUB | 0.07 | | $ 41,839.00 |
| 21 | 9240170 | QUALITY CONTROL (2%) | %*SUB | 0.02 | | $ 11,954.00 |
| 22 | 9300142 | WATER SUPPLY / DUST POLLUTION (2%) | %*SUB | 0.02 | | $ 11,954.00 |
| 23 | | CONSTRUCTION SURVEY (1%) | %*SUB | 0.01 | | $ 5,977.00 |
| 24 | | CONSTRUCTION ENGINEERING AND | %*SUB | 0.30 | | $ 179,310.00 |
| | | CONTINGENCIES (30%) | | | | |
| | | | | | | |
| | | **SUBTOTAL A2** | | | | $ 316,781.00 |
| | | | | | | |
| | | | | | | |
| **PART B: RIGHT-OF-WAY** | | | | | | |
| | | PURCHASE OF BUFFER ZONE | LS | 1 | $1,417,500.00 | $ 1,417,500.00 |
| | | CONTINGENCIES (15%) | LS | 1 | $ 212,625.00 | $ 212,625.00 |
| | | **SUBTOTAL B1** | | | | $ 1,630,125.00 |
| | | | | | | |
| **PROJECT TOTAL (ROUNDED)*** | | | | | | **$ 2,544,600** |

*** Utility relocation not included in project total. Utility costs to be determined during final design.**

## *CONSTRUCTION COST ESTIMATE*

11/30/98

**PROJECT NUMBER: 051 MA 2 H 4585 01L** **ROUTE: SR 51**

**ALTERNATIVE 3**

**LOCATION: INLETS- TURNEY AVENUE & GLENROSA AVENUE**

| *Item No.* | *Description* | *Unit* | *Quantity* | *Unit Cost* | *Total* |
|---|---|---|---|---|---|
| 5011023 | Pipe, Reinforced Concrete, Class III, 24" | L.FT. | 20 | $70 | $1,400 |
| 5030142 | Concrete Catch Basin (Median) (C-15.80, Modified, Double Inlet) | EACH | 2 | $5,000 | $10,000 |
| 8030103 | Decomposed Granite | SQ.YD. | 100 | $4 | $400 |
| 8060001 | Planting Trees, Shrubs And Plants | L.SUM | 1 | $1,000 | $1,000 |
| | | | | | |
| | **Subtotal A1** | | | | **$12,800** |
| | | | | | |
| 2030855 | Erosion Control (1%) | | | | $128 |
| 9240170 | Quality Control (2%) | | | | $256 |
| 9300142 | Water Supply/Dust Palliative (2%) | | | | $256 |
| 7010001 | Maintenance/Protection of Traffic (10%) | | | | $1,280 |
| 9010001 | Mobilization | | | | $1,500 |
| | Construction Survey (1%) | | | | $128 |
| | Construction Engineering & Contingencies (30%) | | | | $3,840 |
| | | | | | |
| | **Subtotal A2** | | | | **$7,388** |

**PROJECT TOTAL (ROUNDED)** **$20,200**

## *CONSTRUCTION COST ESTIMATE*

11/30/98

**PROJECT NUMBER: 051 MA 2 H 4585 01L** **ROUTE: SR 51**

**ALTERNATIVE 4**

**LOCATION: COLTER STREET JUNCTION STRUCTURE**

| *Item No.* | *Description* | *Unit* | *Quantity* | *Unit Cost* | *Total* |
|---|---|---|---|---|---|
| 503XXXX | Restriction Plate | L.SUM | 1 | $2,000 | $2,000 |
| | | | | | |
| | **Subtotal A1** | | | | **$2,000** |
| | | | | | |
| 2030855 | Erosion Control (1%) | | | | $20 |
| 9240170 | Quality Control (2%) | | | | $40 |
| 9300142 | Water Supply/Dust Palliative (2%) | | | | $40 |
| 7010001 | Maintenance/Protection of Traffic (10%) | | | | $200 |
| 9010001 | Mobilization | | | | $1,500 |
| | Construction Survey (1%) | | | | $20 |
| | Construction Engineering & Contingencies (30%) | | | | $600 |
| | | | | | |
| | **Subtotal A2** | | | | **$2,420** |

**PROJECT TOTAL (ROUNDED)** **$4,400**

## *CONSTRUCTION COST ESTIMATE*

12/1/98

**PROJECT NUMBER: 051 MA 2 H 4585 01L** **ROUTE: SR 51**

**ALTERNATIVE 5A**

**LOCATION: RETENTION BASIN AT HIGHLAND AVENUE PUMP STATION WITHOUT RETAINING WALLS- CAPACITY = 6.4 AF**

### *PART A: BASIN CONSTRUCTION*

| *Item No.* | *Description* | *Unit* | *Quantity* | *Unit Cost* | *Total* |
|---|---|---|---|---|---|
| 2020011 | Removal of Buildings | EACH | 3 | $5,000 | $15,000 |
| 2020021 | Removal of Concrete Curb and Gutter | L.FT. | 60 | $3 | $180 |
| 2020031 | Removal of Portland Concrete Cement Pavement | SQ.YD. | 150 | $15 | $2,250 |
| 2030201 | Excavation( ) | CU.YD. | 10,325 | $10 | $103,253 |
| 4010012 | Portland Concrete Cement Pavement (12") | SQ.YD. | 150 | $45 | $6,750 |
| 5011023 | Pipe, Reinforced Concrete, Class III, 24" | L.FT. | 75 | $70 | $5,250 |
| 5011053 | Pipe, Reinforced Concrete, Class III, 48" | L.FT. | 125 | $250 | $31,250 |
| 5015124 | Flap Gate, (24") | EACH | 1 | $300 | $300 |
| 5050031 | Manhole (C-18.10) (No. 3) (For Pipes 6" to 36") | EACH | 1 | $2,500 | $2,500 |
| 5050032 | Manhole (C-18.10) (No. 3) (For Pipes Over 36") | EACH | 1 | $3,500 | $3,500 |
| 6016088 | Headwall (24" Concrete Pipe) | EACH | 1 | $800 | $800 |
| 6016089 | Energy Dissipator (48" Concrete Pipe) | EACH | 1 | $3,500 | $3,500 |
| 8030103 | Decomposed Granite | SQ.YD. | 2,095 | $4 | $8,380 |
| 8060001 | Planting Trees, Shrubs And Plants | L.SUM | 1 | $50,000 | $50,000 |
| 8080001 | Landscape Irrigation System | L.SUM | 1 | $19,820 | $19,820 |
| 8080696 | Concrete Pipe Plug (48") | EACH | 1 | $150 | $150 |
| 9080041 | Concrete Curb (Phoenix Mountable Curb) | L.FT. | 60 | $12 | $720 |
| 9080241 | Concrete Sidewalk (MAG Det. 230 & 231) | SQ.FT. | 1,800 | $3 | $5,400 |
| 9130001 | Erosion Control (Riprap)($D_{50}$ = 12") | CU.YD. | 25 | $65 | $1,625 |
| 9140113 | Wall (Block) | SQ.FT. | 4,640 | $12 | $55,680 |
| 9140144 | Steel Fence, Colored Picket (72") | L.FT. | 240 | $35 | $8,400 |
| | | | | | |
| | **Subtotal A1** | | | | **$324,708** |
| | | | | | |
| 2030855 | Erosion Control (1%) | | | | $3,247 |
| 9240170 | Quality Control (2%) | | | | $6,494 |
| 9300142 | Water Supply/Dust Palliative (2%) | | | | $6,494 |
| 7010001 | Maintenance/Protection of Traffic (10%) | | | | $32,471 |
| 9010001 | Mobilization (7%) | | | | $22,730 |
| | Construction Survey (1%) | | | | $3,247 |
| | Construction Engineering & Contingencies (30%) | | | | $97,412 |
| | | | | | |
| | **Subtotal A2** | | | | **$172,095** |

### *PART B: RIGHT-OF-WAY*

| *Item No.* | *Description* | *Unit* | *Quantity* | *Unit Cost* | *Total* |
|---|---|---|---|---|---|
| | Right-of-Way | L.SUM | 1 | $1,019,304.00 | $1,019,304 |
| | Contingencies (15%) | | | | $152,896 |
| | | | | | |
| | **Subtotal B1** | | | | **$1,172,200** |

**PROJECT TOTAL (ROUNDED)** **$1,669,000**

## *CONSTRUCTION COST ESTIMATE*

12/1/98

**PROJECT NUMBER: 051 MA 2 H 4585 01L** **ROUTE: SR 51**

**ALTERNATIVE 5B**

**LOCATION: RETENTION BASIN AT HIGHLAND AVENUE PUMP STATION WITH 13' RETAINING WALLS- CAPACITY = 8.6 AF**

### *PART A: BASIN CONSTRUCTION*

| *Item No.* | *Description* | *Unit* | *Quantity* | *Unit Cost* | *Total* |
|---|---|---|---|---|---|
| 2020011 | Removal of Buildings | EACH | 3 | $5,000 | $15,000 |
| 2020021 | Removal of Concrete Curb and Gutter | L.FT. | 60 | $3 | $180 |
| 2020031 | Removal of Portland Concrete Cement Pavement | SQ.YD. | 150 | $15 | $2,250 |
| 2030201 | Excavation( ) | CU.YD. | 13,875 | $10 | $138,747 |
| 4010012 | Portland Concrete Cement Pavement (12") | SQ.YD. | 150 | $45 | $6,750 |
| 5011023 | Pipe, Reinforced Concrete, Class III, 24" | L.FT. | 75 | $70 | $5,250 |
| 5011053 | Pipe, Reinforced Concrete, Class III, 48" | L.FT. | 125 | $250 | $31,250 |
| 5015124 | Flap Gate, (24") | EACH | 1 | $300 | $300 |
| 5050031 | Manhole (C-18.10) (No. 3) (For Pipes 6" to 36") | EACH | 1 | $2,500 | $2,500 |
| 5050032 | Manhole (C-18.10) (No. 3) (For Pipes Over 36") | EACH | 1 | $3,500 | $3,500 |
| 6016088 | Headwall (24" Concrete Pipe) | EACH | 1 | $800 | $800 |
| 6016089 | Energy Dissipator (48" Concrete Pipe) | EACH | 1 | $3,500 | $3,500 |
| 8030103 | Decomposed Granite | SQ.YD. | 732 | $4 | $2,927 |
| 8060001 | Planting Trees, Shrubs And Plants | L.SUM | 1 | $17,000 | $17,000 |
| 8080001 | Landscape Irrigation System | L.SUM | 1 | $6,607 | $6,607 |
| 8080696 | Concrete Pipe Plug (48") | EACH | 1 | $150 | $150 |
| 9080041 | Concrete Curb (Phoenix Mountable Curb) | L.FT. | 60 | $12 | $720 |
| 9080241 | Concrete Sidewalk (MAG Det. 230 & 231) | SQ.FT. | 1,800 | $3 | $5,400 |
| 9130001 | Erosion Control (Riprap)($D_{50}$ = 12") | CU.YD. | 25 | $65 | $1,625 |
| 9140113 | Wall (Block) | SQ.FT. | 4,640 | $12 | $55,680 |
| 9140121 | Retaining Wall (Reinforced Concrete) | SQ.FT. | 6,760 | $25 | $169,000 |
| 9140144 | Steel Fence, Colored Picket (72") | L.FT. | 240 | $35 | $8,400 |
| | **Subtotal A1** | | | | **$477,535** |
| | | | | | |
| 2030855 | Erosion Control (1%) | | | | $4,775 |
| 9240170 | Quality Control (2%) | | | | $9,551 |
| 9300142 | Water Supply/Dust Palliative (2%) | | | | $9,551 |
| 7010001 | Maintenance/Protection of Traffic (10%) | | | | $47,754 |
| 9010001 | Mobilization (7%) | | | | $33,427 |
| | Construction Survey (1%) | | | | $4,775 |
| | Construction Engineering & Contingencies (30%) | | | | $143,261 |
| | **Subtotal A2** | | | | **$253,094** |
| | | | | | |
| | ***TOTAL A1+ A2 (ROUNDED)*** | | | | ***$730,600*** |

### *PART B: RIGHT-OF-WAY*

| *Item No.* | *Description* | *Unit* | *Quantity* | *Unit Cost* | *Total* |
|---|---|---|---|---|---|
| | Right-of-Way | L.SUM | 1 | $1,019,304 | $1,019,304 |
| | Contingencies (15%) | | | | $152,896 |
| | | | | | |
| | **Subtotal B (ROUNDED)** | | | | **$1,172,200** |

**PROJECT TOTAL (ROUNDED)** **$1,902,800**

## *CONSTRUCTION COST ESTIMATE*

11/30/98

**PROJECT NUMBER: 051 MA 2 H 4585 01L** **ROUTE: SR 51**

**ALTERNATIVE 6**

**LOCATION: ON-SITE DETENTION VAULTS**

| *Item No.* | *Description* | *Unit* | *Quantity* | *Unit Cost* | *Total* |
|---|---|---|---|---|---|
| 2020021 | Removal of Concrete Curb and Gutter | L.FT. | 100 | $3.00 | $300.00 |
| 2020031 | Removal of Portland Concrete Cement Pavement | SQ.YD. | 12 | $15.00 | $180.00 |
| 2030502 | Structural Excavation (Box Culvert) | CU.YD. | 1,200 | $15.00 | $18,000.00 |
| 2030508 | Structure Backfill | CU.YD. | 1,200 | $30.00 | $36,000.00 |
| 4010012 | Portland Concrete Cement Pavement (12") | SQ.YD. | 120 | $45.00 | $5,400.00 |
| 5011023 | Pipe, Reinforced Concrete, Class III, 24" | L.FT. | 400 | $70.00 | $28,000.00 |
| 5015124 | Flap Gate, (24") | EACH | 10 | $300.00 | $3,000.00 |
| 5050031 | Manhole (C-18.10) (NO. 3) (For Pipes 6" to 36") | EACH | 10 | $2,500.00 | $25,000.00 |
| 5050032 | Manhole (C-18.10) (NO. 3) (For Pipes Over 36") | EACH | 10 | $3,500.00 | $35,000.00 |
| 6018101 | Reinforced Box Culvert (B-02.10, 6X7) | L.FT. | 440 | $300.00 | $132,000.00 |
| 601XXXX | Reinforced Concrete End Wall for 6X7 Box Culvert | EACH | 20 | $500.00 | $10,000.00 |
| 8030103 | Decomposed Granite | SQ.YD. | 2,200 | $3.60 | $7,920.00 |
| 8060001 | Planting Trees, Shrubs And Plants | L.SUM | 1 | $5,000.00 | $5,000.00 |
| 9080041 | Concrete Curb (Phoenix Mountable Curb) | L.FT. | 100 | $12.00 | $1,200.00 |
| | | | | | |
| | **Subtotal A1** | | | | **$307,000.00** |
| | | | | | |
| 2030855 | Erosion Control (1%) | | | | $3,070.00 |
| 9240170 | Quality Control (2%) | | | | $6,140.00 |
| 9300142 | Water Supply/Dust Palliative (2%) | | | | $6,140.00 |
| 7010001 | Maintenance/Protection of Traffic (10%) | | | | $30,700.00 |
| 9010001 | Mobilization (7%) | | | | $21,490.00 |
| | Construction Survey (1%) | | | | $3,070.00 |
| | Construction Engineering & Contingencies (30%) | | | | $92,100.00 |
| | | | | | |
| | **Subtotal A2** | | | | **$162,710.00** |

**PROJECT TOTAL (ROUNDED)** **$469,700**

## *CONSTRUCTION COST ESTIMATE*

11/30/98

**PROJECT NUMBER: 051 MA 2 H 4585 01L** **ROUTE: SR 51**

**ALTERNATIVE 7**

**LOCATION: LATERAL AT HIGHLAND AVENUE SUMP**

| *Item No.* | *Description* | *Unit* | *Quantity* | *Unit Cost* | *Total* |
|---|---|---|---|---|---|
| 2020021 | Removal of Concrete Curb and Gutter | L.FT. | 15 | $3.00 | $45.00 |
| 2020023 | Remove Existing Concrete Barrier | L.FT. | 15 | $50.00 | $750.00 |
| 2020031 | Removal of Portland Concrete Cement Pavement | SQ.YD. | 85 | $15.00 | $1,275.00 |
| 2020041 | Removal of Pipe | L.FT. | 50 | $10.00 | $500.00 |
| 4010012 | Portland Concrete Cement Pavement (12") | SQ.YD. | 85 | $50.00 | $4,250.00 |
| 5011033 | Pipe, Reinforced Concrete, Class III, 30" | L.FT. | 50 | $80.00 | $4,000.00 |
| 8030103 | Decomposed Granite | SQ.YD. | 20 | $3.60 | $72.00 |
| 9080041 | Concrete Curb (Phoenix Mountable Curb) | L.FT. | 15 | $12.00 | $180.00 |
| 9100011 | Reconstruct Concrete Barrier | L.FT. | 15 | $120.00 | $1,800.00 |
| | | | | | |
| | **Subtotal A1** | | | | **$12,872.00** |
| | | | | | |
| 2030855 | Erosion Control (1%) | | | | $128.72 |
| 9240170 | Quality Control (2%) | | | | $257.44 |
| 9300142 | Water Supply/Dust Palliative (2%) | | | | $257.44 |
| 7010001 | Maintenance/Protection of Traffic | | | | $9,000.00 |
| 9010001 | Mobilization | | | | $1,500.00 |
| | Construction Survey (1%) | | | | $128.72 |
| | Construction Engineering & Contingencies (30%) | | | | $3,861.60 |
| | | | | | |
| | **Subtotal A2** | | | | **$15,133.92** |

**PROJECT TOTAL (ROUNDED)** **$28,000**

## *CONSTRUCTION COST ESTIMATE*

11/30/98

**PROJECT NUMBER: 051 MA 2 H 4585 01L** **ROUTE: SR 51**

**ALTERNATIVE 8**

**LOCATION: OPTIMIZE PUMP STATION CONTROLS**

| *Item No.* | *Description* | *Unit* | *Quantity* | *Unit Cost* | *Total* |
|---|---|---|---|---|---|
| XXXXXXX | Reprogram Existing Programable Logic Computer | L.SUM | 1 | $5,000 | $5,000 |
| XXXXXXX | Adjust Float Swith Levels | L.SUM | 1 | $2,500 | $2,500 |
| | | | | | |
| | **Subtotal A1** | | | | **$7,500** |
| | | | | | |
| ~~2030855~~ | ~~Erosion Control (1%)~~ | | | | ~~$0~~ |
| 9240170 | Quality Control (2%) | | | | $150 |
| ~~9300142~~ | ~~Water Supply/Dust Palliative (2%)~~ | | | | ~~$0~~ |
| ~~7010001~~ | ~~Maintenance/Protection of Traffic (10%)~~ | | | | ~~$0~~ |
| 9010001 | Mobilization | | | | $1,500 |
| | ~~Construction Survey (1%)~~ | | | | ~~$0~~ |
| | Construction Engineering & Contingencies (30%) | | | | $2,250 |
| | | | | | |
| | **Subtotal A2** | | | | **$3,900** |

**PROJECT TOTAL (ROUNDED)** **$11,400**

## *CONSTRUCTION COST ESTIMATE*

11/30/98

**PROJECT NUMBER: 051 MA 2 H 4585 01L** **ROUTE: SR 51**

**ALTERNATIVE 9**

**LOCATION: PUMP STATION NUISANCE PUMP**

| *Item No.* | *Description* | *Unit* | *Quantity* | *Unit Cost* | *Total* |
|---|---|---|---|---|---|
| 2020053 | Remove (Existing Pump and Discharge Piping) | EACH | 1 | $2,500 | $2,500 |
| 5060400 | 16" Discharge Piping and Piping Accessories | L.SUM | 1 | $3,700 | $3,700 |
| 5060500 | Pump Station Electrical System | EACH | 1 | $22,500 | $22,500 |
| 8080662 | Pumps, Electric Motors and Related Equipment | L.SUM | 1 | $38,500 | $38,500 |
| XXXXXXX | Pump Hatch and Cover | L.SUM | 1 | $5,000 | $5,000 |
| | | | | | |
| | **Subtotal A1** | | | | **$72,200** |
| | | | | | |
| ~~2030855~~ | ~~Erosion Control (1%)~~ | | | | ~~$0~~ |
| 9240170 | Quality Control (2%) | | | | $1,444 |
| ~~9300142~~ | ~~Water Supply/Dust Palliative (2%)~~ | | | | ~~$0~~ |
| ~~7010001~~ | ~~Maintenance/Protection of Traffic (10%)~~ | | | | ~~$0~~ |
| 9010001 | Mobilization (7%) | | | | $5,054 |
| | ~~Construction Survey (1%)~~ | | | | ~~$0~~ |
| | Construction Engineering & Contingencies (30%) | | | | $21,660 |
| | | | | | |
| | **Subtotal A2** | | | | **$28,158** |

**PROJECT TOTAL (ROUNDED)** **$100,400**

## *CONSTRUCTION COST ESTIMATE*

11/30/98

**PROJECT NUMBER: 051 MA 2 H 4585 01L** **ROUTE: SR 51**

**ALTERNATIVE 10A**

**LOCATION: HIGHLAND AVENUE RAMP INLETS**

**ADD MANHOLES WITH FLAP GATES**

| *Item No.* | *Description* | *Unit* | *Quantity* | *Unit Cost* | *Total* |
|---|---|---|---|---|---|
| 5015115 | Flap Gate, (15") | EACH | 3 | $300.00 | $900.00 |
| 5050031 | Manhole (C-18.10) (NO. 3) (For Pipes 6" to 36") | EACH | 3 | $2,500.00 | $7,500.00 |
| 8030103 | Decomposed Granite | SQ.YD. | 30 | $3.60 | $108.00 |
| 8060001 | Planting Trees, Shrubs And Plants | L.SUM | 1 | $1,000.00 | $1,000.00 |
| | | | | | |
| | **Subtotal A1** | | | | **$9,508.00** |
| | | | | | |
| 2030855 | Erosion Control (1%) | | | | $95.08 |
| 9240170 | Quality Control (2%) | | | | $190.16 |
| 9300142 | Water Supply/Dust Palliative (2%) | | | | $190.16 |
| 7010001 | Maintenance/Protection of Traffic (10%) | | | | $950.80 |
| 9010001 | Mobilization | | | | $1,500.00 |
| | Construction Survey (1%) | | | | $95.08 |
| | Construction Engineering & Contingencies (30%) | | | | $2,852.40 |
| | | | | | |
| | **Subtotal A2** | | | | **$5,873.68** |

**PROJECT TOTAL (ROUNDED)** **$15,400**

## *CONSTRUCTION COST ESTIMATE*

11/30/98

**PROJECT NUMBER: 051 MA 2 H 4585 01L** **ROUTE: SR 51**

**ALTERNATIVE 10B**

**LOCATION: HIGHLAND AVENUE RAMP INLETS**

**CONNECT INLETS TO ON-SITE STORM DRAIN**

| *Item No.* | *Description* | *Unit* | *Quantity* | *Unit Cost* | *Total* |
|---|---|---|---|---|---|
| 5011023 | Pipe, Reinforced Concrete, Class III, 24" | L.FT. | 460 | $65.00 | $29,900.00 |
| 5015115 | Flap Gate, (15") | EACH | 1 | $300.00 | $300.00 |
| 5050031 | Manhole (C-18.10) (NO. 3) (For Pipes 6" to 36") | EACH | 5 | $2,500.00 | $12,500.00 |
| 8030103 | Decomposed Granite | SQ.YD. | 790 | $3.60 | $2,844.00 |
| 8060001 | Planting Trees, Shrubs And Plants | L.SUM | 1 | $5,000.00 | $5,000.00 |
| XXXXXXX | Ramp Closure | L.SUM | 1 | $1,200.00 | $1,200.00 |
| | | | | | |
| | **Subtotal A1** | | | | **$51,744.00** |
| | | | | | |
| 2030855 | Erosion Control (1%) | | | | $517.44 |
| 9240170 | Quality Control (2%) | | | | $1,034.88 |
| 9300142 | Water Supply/Dust Palliative (2%) | | | | $1,034.88 |
| 7010001 | Maintenance/Protection of Traffic (10%) | | | | $5,174.40 |
| 9010001 | Mobilization (7%) | | | | $3,622.08 |
| | Construction Survey (1%) | | | | $517.44 |
| | Construction Engineering & Contingencies (30%) | | | | $15,523.20 |
| | | | | | |
| | **Subtotal A2** | | | | **$27,424.32** |

**PROJECT TOTAL (ROUNDED)** **$79,200**

## *CONSTRUCTION COST ESTIMATE*

12/1/98

**PROJECT NUMBER: 051 MA 2 H 4585 01L** **ROUTE: SR 51**

**ALTERNATIVE 11**

**LOCATION: 18th STREET TRUNK LINE REPLACEMENT**

**MARYLAND AVENUE TO RANCHO DRIVE**

| *Item No.* | *Description* | *Unit* | *Quantity* | *Unit Cost* | *Total* |
|---|---|---|---|---|---|
| 2020021 | Removal of Concrete Curb and Gutter | L.FT. | 145 | $3.00 | $435 |
| 2020029 | Removal of Asphaltic Concrete Pavement | SQ.YD. | 1,404 | $3.00 | $4,212 |
| 2020041 | Removal of Pipe | L.FT. | 3,331 | $2.00 | $6,662 |
| 4061001 | Pavement Replacement (Mag Det. 200) (Type A) | SQ.YD. | 1,166 | $20.00 | $23,320 |
| 4061002 | Pavement Replacement (Mag Det. 200) (Type B) | SQ.YD. | 238 | $23.00 | $5,474 |
| 5011024 | Pipe, Reinforced Concrete, Class IV, 24" | L.FT. | 799 | $50.00 | $39,950 |
| 5011034 | Pipe, Reinforced Concrete, Class IV, 30" | L.FT. | 1,785 | $65.00 | $116,025 |
| 5011044 | Pipe, Reinforced Concrete, Class IV, 36" | L.FT. | 97 | $110.00 | $10,670 |
| 5011050 | Pipe, Reinforced Concrete, Class IV, 42" | L.FT. | 650 | $120.00 | $78,000 |
| 5050221 | Reconstruct Manhole | EACH | 13 | $500.00 | $6,500 |
| 9080103 | Concrete Curb And Gutter, Type C (Mag Det. 220) | L.FT. | 145 | $9.00 | $1,305 |
| | | | | | |
| | **Subtotal A1** | | | | **$292,553.00** |
| | | | | | |
| 2030855 | Erosion Control (1%) | | | | $2,925.53 |
| 9240170 | Quality Control (2%) | | | | $5,851.06 |
| 9300142 | Water Supply/Dust Palliative (2%) | | | | $5,851.06 |
| 7010001 | Maintenance/Protection of Traffic (10%) | | | | $29,255.30 |
| 9010001 | Mobilization (7%) | | | | $20,478.71 |
| | Construction Survey (1%) | | | | $2,925.53 |
| | Construction Engineering & Contingencies (30%) | | | | $87,765.90 |
| | | | | | |
| | **Subtotal A2** | | | | **$155,053.09** |

**PROJECT TOTAL (ROUNDED)** **$447,600**

community would be expected. Interruptions in utility service would be common. Work would take longer than 2 to 3 months to complete.

H- Work is expected to encompass areas larger than a block long. Intersection closures would be required, Traffic rerouting within the community would be common. Interruptions in utility service would be common. Work would be completed in approximately 2 months or less.

M- Work is expected to involve sections of the community up to a block long. Traffic and utility interruptions are more wide spread and of longer duration than a project considered to be Low impact. Work would be completed in a month or less.

L- Work is expected to be limited to small areas. Traffic and utility interruptions are localized and of short duration. Work would be completed in several days or less.

VL- Little or no construction in adjacent communities.

### *Permanent Community Impacts*

Permanent community impacts are considered to be lasting changes to the community such as erection of walls around basins, installation of parks and demolition of homes. Some of the impacts could be viewed as favorable, such as the addition of parks and the reduction of flooding of local streets. Other impacts could be viewed as negative. For the purpose of this matrix, no attempt is made to evaluate the desirability of the impact. The solutions/ alternatives is rated based on the magnitude of the impact:

VH- Improvement requires removal of 25 homes or more and the resulting facility is not accessible to the public for recreation.

H- Improvement requires removal of 10 homes or less and the resulting facility is not accessible to the public for recreation. Or improvement requires removal of 10 to 25 houses and the resulting facility is accessible to the public for recreation.

M- Improvement requires removal of 1 to 2 homes and resulting facility is not accessible to the public for recreation. Or improvement requires removal of less than 10 houses and the resulting facility is accessible to the public for recreation.

L- Improvement requires removal of 1 to 2 homes. Resulting facility is accessible to the public for recreation.

VL- Little or no visible change to the community once construction is completed.

### *Operation and Maintenance Costs*

Potential cost <u>increases</u> are used to rank anticipated maintenance costs based on the type of facility to be maintained. The costs considered here are the additional maintenance, operation and replacement costs associated with the improvement to the facility, not the total cost of maintaining the facility:

VH- Periodic maintenance and inspection required. Potential for high replacement costs. Maintenance is typically difficult and most likely requires the services of a specialized subcontractor.

H- Periodic maintenance and inspection required. Potential for high replacement costs. Specialized subcontractors may be required to perform some of the maintenance. Includes most mechanical installations.

M- Installation requires periodic inspection, with occasional maintenance expected.

L- Periodic inspection required, but little maintenance expected.

VL- No regular maintenance required or expected.

### Design Effort and Cost

Design effort and cost rankings are based on the amount of preliminary data to be gathered, the amount of coordination expected with City of Phoenix staff, the level of public input into the design, the number of specialists expected to be involved in the design, the complexity of the analysis required for design and the complexity of the plans required (i.e., level of detail, sheet count).

VH- Complex plans and analysis required. There may be numerous utility conflicts to resolve, involvement of specialists such as structural or traffic engineers required, high degree of coordination with City of Phoenix staff required and public will have input into the design process.

H- Complex plans and analysis required. There may be utility conflicts to resolve, involvement of specialists such as structural or traffic engineers required, high degree of coordination with City of Phoenix staff expected and public may have some input into the design process.

M- Plans and analysis required. There may be utility conflicts to resolve and some coordination with City of Phoenix staff.

L- Plans and analysis required. No major complications foreseen.

VL- Plan requirements are minimal, possibly none. Analysis is expected to be minimal, possibly none.

### Utility Conflicts

Utility are ranked on the expected degree of difficulty in resolving the conflict:

VH- Numerous conflicts expected. Conflicts expected to be difficult to resolve or require great detail to resolve. Removal and rerouting of utilities expected.

H- Numerous conflicts expected. Conflicts expected to be difficult to resolve or require great detail to resolve.

M- Numerous conflicts expected. Conflicts expected to be readily resolved.

L- Conflicts expected at small number of locations. Conflicts expected to be readily resolved.

VL- No conflicts expected, but the possibility remains that a conflict could occur.

### Level of Coordination with the City of Phoenix

Off-site improvements are a component of many of the recommended solutions/alternatives. The level of coordination with the City is expected to increase as more departments become

involved. Intergovernmental agreements may be required if the City is to maintain detention basins as parks.

VH- Same as the criteria for a High ranking, but involving a significantly larger area.

H- Improvements require construction within or across City right-of-way. Improvements affect City storm drains and local drainage patterns. Improvements may require City of Phoenix acceptance of a detention facility as a park.

M- Improvements require construction within or across City right-of-way. Improvements affect City storm drains and local drainage patterns.

L- Improvements do not require construction within the City right-of-way, but local traffic patterns may be affected by ramp closures and construction traffic.

VL- Minimal involvement with City. Improvements do not require construction within City right-of-way.

### Constructibility Issues

Constructibility is ranked according to the degree of difficulty expected in the construction:

VH- Same as the criteria for a High ranking, but involving highly specialized equipment or extremely constricted working space.

H- Same as the criteria for a Medium ranking, but with a higher degree of specialized equipment or more work to be done in unfavorable conditions.

M- Improvements require use of heavy equipment within a limited space. May require specialty equipment or equipment not expected to be used in the construction of the HOV lanes. Some disruption of traffic or utilities is expected.

L- Modification of an existing facility. Work requires greater degree of modification than a Low rating. Some disruption of traffic or utilities is expected.

VL- Modification of an existing facility. Minimal personnel required, minimum disruption of traffic or utilities expected.

### Compatibility with HOV Lanes

Solutions/alternatives were ranked with respect to their compatibility with the addition of HOV lanes. All improvements were ranked High or Very High. None of the recommended improvements are expected to conflict with the addition of HOV lanes within the study corridor.

VH- Same as the criteria for a High ranking, but improvement removes runoff from on-site gutters.

H- Improvement does not interfere with the construction or operation of HOV lanes, but it may prolong the time required to complete HOV lane construction if work is done concurrently. Improvement benefits parkway drainage by reducing encroachment by off-site storm water.

# 7.0 DRAINAGE IMPACT OF HOV LANES

## 7.1 HOV Overview

Addition of HOV lanes within the project boundaries affects the on-site storm drain and the 18th Street Trunk Line. Runoff generated north of Campbell Avenue is collected and conveyed by the on-site storm drain. Runoff generated between Indian School Road and Campbell Avenue is collected and conveyed by the trunk line. Analysis shows that the addition of HOV lanes will have little effect on the drainage patterns or problems within the study area. Drainage is not expected to control the design of the HOV lanes.

At this time, the report, *Alternatives Selection Report, High Occupancy Vehicle Lane Study, Junction I-10 to Shea Boulevard, State Route 51,* is under review by ADOT. The report recommends two lane configuration concepts for further study. Typical roadway cross sections are shown in the Appendix. Concept No. 1 has the HOV lane next to a median barrier with a 4 to 12-foot inside shoulder. Concept No. 2 has no inside shoulder with a 14 to 15-foot HOV lane next to the median barrier.

Another report, *SR 51 Drainage Evaluation, I-10 to Shea Boulevard, Effects of Adding High Occupancy Vehicle Lanes, Parsons Brinckerhoff, 1998,* is currently under review by ADOT. The report discusses the impact of adding HOV lanes throughout the corridor. The reader is referred to this report for further discussion of the impact of HOV lanes.

## 7.2 Impact on On-site Storm Drain

Adding HOV lanes is expected to cause slight increases in the peak design flows as shown in the table:

**Peak Flows in On-site Storm Drain**

| *Design Storm* | *Existing Condition* | *With HOV Lanes* |
|---|---|---|
| 10-year Storm | 117 cfs | 124 cfs |
| 25-year Storm | 155 cfs | 161 cfs |
| 50-year Storm | 182 cfs | 182 cfs |

Supporting calculations are included in the Appendix.

The roadway design criteria for maximum flooded width of pavement is to keep half of one lane dry during a 10-year storm. The improvements recommended in the report will increase the level of service of the on-site storm drain to convey a 25-year storm. Except for three inlets in the vicinity of superelevation transitions, the flooded width of roadway is expected to meet the drainage design criteria with the existing lane configuration. Adding HOV lanes will alter drainage patterns, causing some areas to receive more runoff than they do in the existing condition. Although the overall peak flow is expected to change very little, some inlets will receive 10 to 30% more runoff than in the existing condition.

Analysis indicates that there are generally sufficient inlets to collect the 10-year storm with HOV lanes without exceeding lane encroachment criteria. However, lane flooding would occur in the Highland Avenue sag. Three median inlets (I704, I707 and I708) in the superelevated section are expected to flood the roadway12 feet from the toe of the barrier. The maximum allowable flooded width is 9.5 feet in Concept No. 1, minimum non-standard configuration or 7 feet in Concept No. 2, minimum non-standard configuration. Two inlets (I706 and I714) in the southbound lane superelevation transitions are expected to flood to 17 and 18 feet. These inlets are in the outside lanes so the allowable encroachment width is 14 feet in either HOV concept. These inlets flooded to 15.3 feet (14 feet allowable) in the existing condition. Calculations are included in the Appendix.

A median barrier in the superelevated section near Montebello Avenue is expected to flood to 10.2 feet (7 to 9.5 feet allowable). Another outside lane inlet is expected to flood to 20.8 feet at the bottom of the southbound on-ramp at Bethany Home Road. This inlet is in a superelevation transition and it is also expected to flood in the existing condition.

It is recommended that inlets or slotted drains be added in the areas identified during construction of the HOV lanes. Inlet spacing throughout the corridor is to be checked during drainage design of the HOV lanes. This analysis was based on preliminary information that may or may not be valid during design of the HOV lanes.

### 7.3 HOV Impact on the 18th Street Trunk Line

The sag between Indian School Road and Campbell Avenue is expected to flood during storms which exceed the magnitude of the 10-year storm. The drainage criteria for the roadway is to limit the lane encroachment to half of the outside lane during the 10-year storm. Since the roadway is expected to flood during the 10-year storm under existing conditions, the addition of HOV lanes is not expected to aggravate the problem to a significant degree. Similar flooding problems on the Parkway are to be expected from Indian School Road to I-10.

A local detention pond to collect runoff from the sag was considered at Glenrosa Avenue, but the alternative was rejected since it would require the removal of 3 houses (25-year storm, walled basin) to 6 houses (50-year storm, detention in a park). However, flooding of the sag could be alleviated if a large detention basin east of 18th Street is constructed. Design of any drainage improvements made should consider the extra pavement and possible narrowing of the shoulders expected with the addition of HOV lanes.

## 8.0 RECOMMENDED SOLUTIONS/ALTERNATIVES

Of the twenty-two Alternatives investigated in the Final Alternative Selection Report, the following are recommended for construction:

**Alternative 3:** Provide inlets at Turney Avenue and Glenrosa Avenue to collect the runoff before it enters the Parkway through the sound wall holes. The inlets would be ineffective in storms larger than about the about 10-year unless off-site detention basins are constructed.

**Alternative 4:** Install a restriction plate across the trunk line outlet pipe in the Colter Street Junction Structure to allow additional flow into the Colter Street Detention Basin.

**Alternative 5B:** Remove runoff from the 18th Street Trunk Line by discharging the pump station flow into a small detention basin at the southeast corner of Highland Avenue and 18th Street, adjacent to the Highland Avenue Pump Station.

**Alternative 6:** Increase the capacity of the on-site storm drain to convey the peak flow from the 25-year storm by detaining the flows which exceed the peak flow of the 10-year storm. Underground detention vaults are proposed to detain the runoff. This would have the effect of increasing the capacity of the on-site storm drain system including the pump station.

**Alternative 7:** Increase size of on-site lateral at the pump station sag to reduce standing water in the southbound lanes.

**Alternative 8:** Adjust pump-on/pump-off switches to reduce excessive cycling of main pumps in Highland Pump Station.

**Alternative 9:** Provide a larger nuisance pump to help reduce the cycling of the main pumps.

**Alternative 10A:** Add manholes with flap gates to 3 on-site catch basins at the downstream ends of both of the Highland Avenue ramps.

**Alternative 11:** Replacement of the 18th Street Trunk Line from Maryland Avenue to Rancho Road

# ARIZONA DEPARTMENT OF TRANSPORTATION

## *OFFICE MEMO*

INTERMODAL TRANSPORTATION DIVISION
January 26, 1999

BILL HIGGINS, HIGHWAY OPERATIONS, 174A
RAY JOHNSON, ELECTRICAL DESIGN, 066R
GEORGE WAY, MATERIALS SECTION, 068R
DOUG ALEXANDER, MATERIALS GEOTECHNICAL, 068R
CLIFTON TAYLOR, MAINTENANCE GROUP, NATURAL RESOURCES SECTION, 176A
HARI KHANNA, PROGRAM & PROJECT MANAGEMENT SECTION, 620E
RICHARD DUARTE, ENVIRONMENTAL PLANNING, 619E
LEROY BRADY, ROADSIDE DEVELOPMENT, 617E
FLOYD ROEHRICH (ACTING), HIGHWAY DEVELOPMENT GROUP, 102A
STEVE HANSEN, RIGHT-OF-WAY SECTION, 612E
PE-SHEN YANG, BRIDGE MANAGEMENT SECTION, 613E
ESTOMIH KOMBE, ARIZONA TRANSPORTATION RESEARCH CENTER, 075R
JOHN PEIN, PRIORITY PROGRAMMING, 320B
BILL BRISCOE, UTILITY & RAILROAD ENGINEERING, 618E
BRITT BOWEN, PHOTOGRAMMETRY & MAPPING, 203P
MARTA RAIFORD, ROADWAY PREDESIGN, 050P (Project File)
CHUCK EATON, DIRECTOR SUPPORT OFFICE, 118A
JAMES ROMERO, PROJECT MANAGER, SPMS, 614E
DAN MACDONALD, ROADWAY DESIGN, 615E
STEVE BRUFLAT, ROADWAY DESIGN, 615E
GEORGE CHIN, (PHOENIX) REGIONAL TRAFFIC ENGINEERING, PM04
ARIF KAZMI, TRAFFIC DESIGN, 063R
DAN LANCE, PHOENIX CONSTRUCTION DISTRICT, E700
JOHN HAUSKINS, PHOENIX MAINTENANCE, PM00
CRAIG CORNWELL, PHOENIX MAINTENANCE, PM65
KENNETH AKOH-ARREY, DRAINAGE SECTION, 634E
BILL VACHON, FHWA (FLAGSTAFF, PHOENIX), 005R
BOB BORTFELD, CITY OF PHOENIX, 200 W WASHINGTON, 5TH FLOOR, PHOENIX, AZ, 85003
DON RERICK, MA CO FLOOD CONTROL DISTRICT, 2801 W DURANGO, PHOENIX, AZ, 85009

FROM: VINCENT LI, ROADWAY PREDESIGN, 050P YWL
THRU: HERMAN MOZART, PREDESIGN PROGRAM MANAGEMENT SECTION, 050P
SUBJECT: 51 MA 2 H458501C
FINAL DRAINAGE STUDY
INDIAN SCHOOL-BETHANY HOME
SQUAW PEAK HIGHWAY
SR 51

The attached Final Report is forwarded to you for your information and files. If you have any questions, please contact me at 255-7453.

RECid: 4038

# ARIZONA DEPARTMENT OF TRANSPORTATION

HIGHWAYS DIVISION

ROADWAY GROUP

# PROJECT DETERMINATION

| Fiscal Year | Project Number | County and District | Project Location and Highway |
|---|---|---|---|
| 0<br>0 indicates project non-programmed | 51 MA 2 H458501C<br>STATE-600-2 | Maricopa County<br>Phoenix (Const) District | INDIAN SCHOOL-BETHANY HOME<br>SQUAW PEAK HIGHWAY |

Description: Drainage study

Existing Program No [X] Program Year: 0 Estimated Cost: $ 1,314,600

Operating Partnership Category: A [ ] B [ ] P [X] N/A [ ] U [ ]

Reports Required: Location and Design Concept Yes [ ] No [X]

Design Concept Report Yes [ ] No [X]

Class I [ ] Class II [X] Class III [ ]

Public Hearing:

In the Highway Development process, at least one public hearing or the opportunity for a hearing will be offered for any project that:

- [ ] requires a significant amount of new right-of-way;
- [ ] substantially changes the layout or function of connecting roadway or the facility being improved;
- [ ] has a significant adverse impact on abutting real property;
- [ ] otherwise has a significant social, economic, environmental or other effect;
- [ ] is controversial on environmental grounds;
- [ ] or has significant floodplain encroachment;
- [X] none of the above conditions apply.

| Recommends: | Yes | No | |
|---|---|---|---|
| | [ ] | [X] | Public Forum |
| | [ ] | [X] | Offer a combined Location/Design Hearing |
| | [ ] | [X] | Offer separate Location/Design Hearings |
| | [ ] | [X] | Hold a Design Public Hearing |

Herman H. Mozart 12/3/98
HERMAN MOZART, MANAGER, PREDESIGN PROGRAM MANAGEMENT SECTION, 050P — Date

FOR: Roland Dy 1/15/99
RICHARD DUARTE, MANAGER, ENVIRONMENTAL PLANNING SECTION, 619E — Date

Comments:

*Concur:*

Jan 15, 99
JAMES ROMERO, PROJECT MANAGER, SPMS, 614E — Date

Dec 7, 1998
DAN LANCE, PHOENIX CONSTRUCTION DISTRICT, E700 — Date

*Approved:*

1-26-99
JOHN LOUIS, ASSISTANT STATE ENGINEER, ROADWAY ENGINEERING GROUP, 611E — Date

12-8-98
JOHN HADSKINS, PHOENIX MAINTENANCE, PM00 — Date

cc: Project Funding, 204B
Resource Administration, 205B

RECid: 4038

**Parsons Brinckerhoff**
1501 W. Fountainhead Parkway
Suite 400
Tempe, AZ 85282-1853
602-966-8295
Fax: 602-966-9234

PROJECT 051 MA 2 H 4585 01C
FEDERAL AID NO. (UNASSIGNED)

**SR 51: INDIAN SCHOOL – BETHANY HOME**
**SQUAW PEAK PARKWAY**

# FINAL DRAINAGE PROJECT ASSESSMENT

December 1998

*Prepared For:*

ARIZONA DEPARTMENT OF TRANSPORTATION

Registered Professional Engineer (Civil)
CERTIFICATE NO. 22905
CATHERINE PRITCHARD HOLLOW
Date Signed 12/3/98
ARIZONA

*Prepared By:*

## A. INTRODUCTION

Project 051 MA 2 H 4585 01C [FED AID NO. UNASSIGNED], SR 51, Indian School to Bethany Home is a major project which is described as modifications to the SR 51 drainage system.

The project is located on SR 51 in Maricopa County, approximately 2 miles north of the junction with Interstate 10. The project limits begin at MP 2.0 and extend north for approximately 2.2 miles.

The project is not programmed. It is assumed the project will be jointly funded. The total estimated cost is $2.6 which includes $1.3 million for construction costs, $1.2 million for right-of-way, and $0.1 million for design.

The purpose of the project is to improve the existing SR 51 drainage systems, both on-site and off-site, to mitigate flooding of the facility.

## B. BACKGROUND DATA

The Squaw Peak Parkway, from Mc Dowell Road to Glendale Avenue, was built by the City of Phoenix in 1988. In 1992, ADOT accepted responsibility for the operation and maintenance of the facility and designated it as State Route 51. For this section, the Parkway drainage system was designed and constructed to criteria set forth by the City, which vary from those used by ADOT. Consequently, the on-site storm drainage system appears to be operating at a lower design frequency than that used by ADOT and off-site flows are encroaching onto the Parkway during relatively low frequency events.

This project addresses the section from Indian School Road to north of Bethany Home Road.

The existing cross section varies within the project limits. As a minimum, it consists of three lanes in each direction and paved shoulders. The existing right-of-way varies through the corridor. The land adjacent to the ADOT right-of-way is private land with some commercial development.

The estimated average daily traffic (ADT) on SR 51 is 150,200 vehicles based on 1996 data. The posted speed limit is 55 mph throughout.

As part of this study process, two previous reports have been prepared. The Final Alternative Selection Report, completed in March 1998, analyzed the existing drainage facilities and evaluated a full range of alternatives to improve the level of performance of the overall drainage system. The Initial Drainage Report documents the complete study process, presents an analysis of the feasible alternatives, and provides recommendations for implementation of the improvements.

The overall drainage pattern for the study area is from northeast to southwest. Runoff in the watershed is generally conveyed along city streets, with flows splitting south and west at major intersections.

Accumulations of off-site storm water along the east side of SR 51 are drained by three methods: the 18th Street Trunk Line, siphons under SR 51, and street flow on existing surface street bridges. For on-site flows, there is a storm drain for the depressed section of SR 51 between Bethany Home Road and Highland Avenue. This on-site storm drain conveys flows to the pump station at Highland Avenue which discharges into the 18th Street Trunk Line. The storm drain system is described in detail in the Initial Drainage Report.

## C. PROJECT SCOPE

Since this project is not programmed, the project limits are established by this Project Assessment Report. Project 051 MA 2 H 4585 01C (SR 51; Indian School – Bethany Home) will begin at MP 2.0 and will end at MP 4.4. The project includes detention basins, additional inlets, a parallel storm drain, and modifications to the pump station to mitigate flooding of the facility. A specific return interval was not established for the improvements.

Specifically, the project tasks are to:

- Install two additional inlets, one at Turney Avenue and one at Glenrosa Avenue between the sound wall and 18th Street. Construct storm sewer line to connect the inlets to the 18th Street trunk line.

- Install a restriction plate across the 48-inch trunk line outlet pipe in the Colter Street Junction Structure. The plate would be positioned to provide an open area equal to the area of a 24-inch pipe.

- Optimize the pump on/off settings at the Highland Pump Station. In addition, the pump settings will be modified to allow the switching of the lead/lag position of each pump during a storm event. These operational modifications require the reprogramming of the existing Programmable Logic Computer (PLC).

- Construct a detention basin (210' by 240') at the southeast corner of Highland Avenue and 18th Street to detain discharge from the pump station. The basin will have 13-foot retaining walls on the north, east, and south sides. An eight-foot high block wall will be installed behind the three retaining walls. A steel fence would be provided on the west side. The basin will be landscaped. The existing pump station connection to the 18th Street trunk line will be plugged. The discharge piping from the pump station would be reconfigured to provide a 60-inch line to the basin. The basin will have a 24" bleed off pipe to convey the detained runoff to the 18th Street trunk line after the storm passes. The outlet will have a flap-gate to prevent trunk line flows from entering the basin.

- Install a larger sump pump in the Highland Avenue Pump Station to reduce the cycling of the main pumps. The proposed pump would be capable of moving approximately 6 to 10 cfs. Install new discharge piping, electrical wiring, and motor starter equipment. Provide controls to shut down the 100 HP pump before the third main pump starts.

- Remove and replace the 18th Street trunk line from Maryland to Rancho Road. The storm drain will consist of approximately 3,331 feet of pipe and include 13 manholes. Approximately 1,404 square yards of pavement will have to removed and replaced. An estimated 3,331 linear feet of existing pipe will have to be removed.
- Seed all disturbed areas.

## D. DEVELOPMENT CONSIDERATIONS

Because less than five acres of land will be disturbed, a NPDES (National Pollutant Discharge Elimination System) Permit will not be required; however, in accordance with Federal Regulation 23 CFR Part 650, Subpart B, construction projects that are federally funded shall provide design features to reduce erosion and minimize sedimentation during and after construction when applicable. This project will be reviewed during design by the Roadside Development Section to determine if a Storm Water Erosion/Sedimentation Plan will be required as part of the project plans.

Other pertinent development considerations are listed below.

- This project is located in an EPA non-attainment area for carbon monoxide, PM-10, and ozone.
- Environmental Planning Section will determine if there are any special environmental or archaeological concerns and prepare the required documentation.

- New right-of-way will be required for the detention basin at the southeast corner of 18th Street and Highland Avenue.
- Since new right-of-way is being acquired at the southeast corner of 18th Street and Highland, potential roadway improvements should be evaluated for the south leg of the intersection during design.
- No major utility conflicts are anticipated; however, ADOT's Utility and Railroad Engineering Section, or a designated consultant, will verify.
- The construction season is not a consideration for this project.
- The project will be designed in English units.
- Coordination with the City of Phoenix will be required for design and construction.
- A location survey will be required for the new detention basins and retaining walls, pipes, and inlets. The project manager will request the survey during the design phase.
- Coordination will be required with the Maricopa County Flood Control District.
- Detailed traffic control plans will be required. Lane closure times for Highland Avenue to be per the City of Phoenix Traffic Barricade Manual. The SR 51 northbound off-ramp closures to be in accordance with ADOT Phoenix Construction District requirements.
- The presence of Camelthorn in the construction area should be determined and herbicide used if needed.
- ADOT will be responsible for obtaining the necessary 404 permit from the US Army Corps of Engineers and Section 401 certification from the Arizona Department of Environmental Quality.

## E. OTHER REQUIREMENTS

Specific funding sources have not been identified at this time. This project will be designed by a consultant. It will be administered under the Operating Partnership Agreement under Category P.

The Preconstruction Engineering "E" Model Schedule (CPS ID is not assigned) should be used for this project. The bid advertising date has not been set.

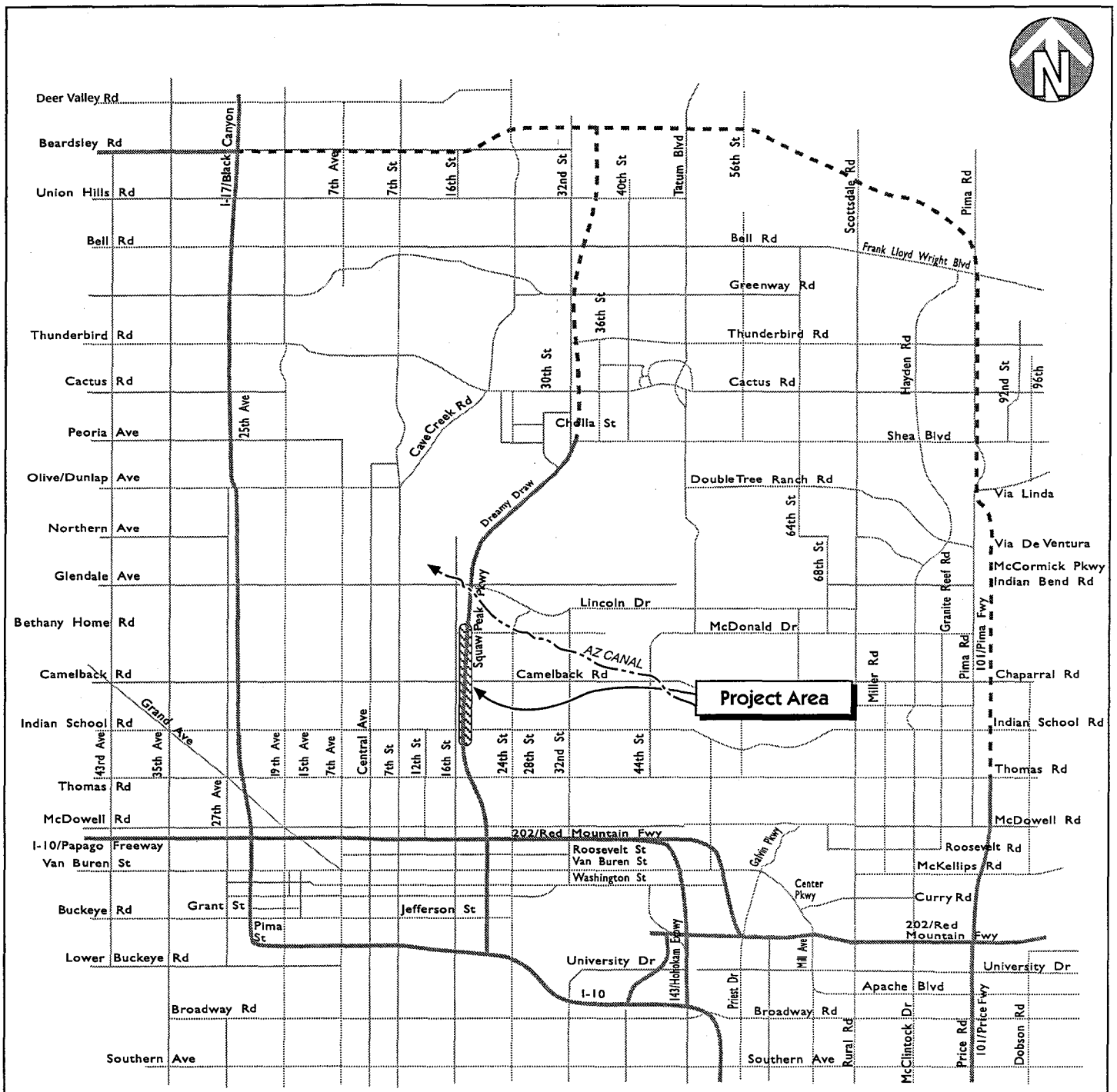
## F. ESTIMATED COST

| | |
|---|---|
| Construction costs | $1,314,600 |
| Right of Way costs | $1,172,200 |
| Subtotal | $2,486,800 |
| Design costs | $105,200 |
| TOTAL COSTS | $2,592,000 |

The cost of this project is based upon unit prices obtained from ADOT's "Construction Costs 1997" and recent bid tabulations for a project in the area. Design costs are estimated at 8% of construction costs.

## G. REQUIRED ACTION BY PRIORITY PLANNING COMMITTEE

Action is required by the Priority Planning Committee to program and fund this project.




ADOT PRE-DESIGN ON-CALL

# SR51; Indian School to Bethany Home Drainage Project Assessment

## Vicinity Map

PROJECT TRACS No.: 051 MA 002 H 4585 01C

# INVOLVEMENT SHEET

| CONTACTED | ATTENDED FIELD REVIEW | ORGANIZATION | INVOLVEMENT | | | | COMMENTS (ISSUES WHICH MAKE INVOLVEMENT SIGNIFICANT OR MINIMAL) |
|---|---|---|---|---|---|---|---|
| | | | SIGNIFICANT | MINIMUM | NONE | UNKNOWN | |
| X | X | PHOENIX DISTRICT | X | | | | Construction Engineering & Administration. |
| X | | SPMS | X | | | | PM: |
| X | | RIGHT-OF-WAY | X | | | | New right of way required. Right-Of-Way Clearance Letter. |
| | | ELECTRICAL DESIGN | | | X | | |
| X | | TRAFFIC DESIGN | | X | | | Review of traffic control. |
| | | TRAFFIC STUDIES | | | X | | |
| X | | BRIDGE DESIGN | X | | | | |
| X | X | DRAINAGE DESIGN | X | | | | Design review |
| X | | PAVEMENT DESIGN | X | | | | Prepare Materials Memo. |
| X | | GEOTECH SECTION | | X | | | Prepare Geotech Report. |
| X | X | ENVIRONMENTAL PLANNING | X | | | | Preparation of Environmental Documentation |
| X | X | ROADWAY DESIGN | X | | | | Roadway plans |
| | | UTILITY & RAILROAD | X | | | | Utility Clearance Letter. |
| | | ENGINEERING SURVEY | X | | | | Survey required for basins, inlets and pipes. |
| | | PHOTOGRAMMETRY & MAPPING | | | X | | |
| X | | ROADSIDE DEVELOPMENT | | X | | | Storm Water Erosion / Sedimentation Prevention Plan (if required) |
| | | CONTRACTS & SPECIFICATIONS | X | | | | PS & E Package. |
| X | | FHWA | | X | | | Federal Funding and Certification Acceptance Process |
| X | | MARICOPA COUNTY FLOOD CONTROL | X | | | | Coordination. |
| X | | CITY OF PHOENIX | X | | | | Coordination. Funding IGA |

## SR 51; Indian School - Bethany Home
## SUMMARY OF PROJECT COSTS

| Alternative | ROW | | Construction | | Total by Alternative |
|---|---|---|---|---|---|
| | | | | | |
| | | | | | |
| 3 - inlets on 18th St. at Turney and Glenrosa | $0 | | $20,200 | | $20,200 |
| | | | | | |
| 4 - Colter Streeet junction structure modification | $0 | | $4,400 | | $4,400 |
| | | | | | |
| 5B - retention basin at 18th St and Highland | $1,172,200 | | $730,600 | | $1,902,800 |
| | | | | | |
| 8 - Optimize pump station controls | $0 | | $11,400 | | $11,400 |
| | | | | | |
| 9 -larger pump station nuisance pump | $0 | | $100,400 | | $100,400 |
| | | | | | |
| 11- replace 18th St. storm drain | $0 | | $447,600 | | $447,600 |
| | | | | | |
| **TOTAL** | **$1,172,200** | | **$1,314,600** | | **$2,486,800** |
| | | | | | |

NOTE: See attached sheets for detailed cost estimate by alternative

## *CONSTRUCTION COST ESTIMATE*

12/1/98

**PROJECT NUMBER: 051 MA 2 H 4585 01L** **ROUTE: SR 51**

**ALTERNATIVE 3**

**LOCATION: INLETS- TURNEY AVENUE & GLENROSA AVENUE**

| *Item No.* | *Description* | *Unit* | *Quantity* | *Unit Cost* | *Total* |
|---|---|---|---|---|---|
| 5011023 | Pipe, Reinforced Concrete, Class III, 24" | L.FT. | 20 | $70 | $1,400 |
| 5030142 | Concrete Catch Basin (Median) (C-15.80, Modified, Double Inlet) | EACH | 2 | $5,000 | $10,000 |
| 8030103 | Decomposed Granite | SQ.YD. | 100 | $4 | $400 |
| 8060001 | Planting Trees, Shrubs And Plants | L.SUM | 1 | $1,000 | $1,000 |
| | | | | | |
| | **Subtotal A1** | | | | **$12,800** |
| | | | | | |
| 2030855 | Erosion Control (1%) | | | | $128 |
| 9240170 | Quality Control (2%) | | | | $256 |
| 9300142 | Water Supply/Dust Palliative (2%) | | | | $256 |
| 7010001 | Maintenance/Protection of Traffic (10%) | | | | $1,280 |
| 9010001 | Mobilization | | | | $1,500 |
| | Construction Survey (1%) | | | | $128 |
| | Construction Engineering & Contingencies (30%) | | | | $3,840 |
| | | | | | |
| | **Subtotal A2** | | | | **$7,388** |

**PROJECT TOTAL (ROUNDED)** **$20,200**

## *CONSTRUCTION COST ESTIMATE*

12/1/98

**PROJECT NUMBER: 051 MA 2 H 4585 01L** **ROUTE: SR 51**

**ALTERNATIVE 4**

**LOCATION: COLTER STREET JUNCTION STRUCTURE**

| *Item No.* | *Description* | *Unit* | *Quantity* | *Unit Cost* | *Total* |
|---|---|---|---|---|---|
| 503XXXX | Restriction Plate | L.SUM | 1 | $2,000 | $2,000 |
| | | | | | |
| | **Subtotal A1** | | | | **$2,000** |
| | | | | | |
| 2030855 | Erosion Control (1%) | | | | $20 |
| 9240170 | Quality Control (2%) | | | | $40 |
| 9300142 | Water Supply/Dust Palliative (2%) | | | | $40 |
| 7010001 | Maintenance/Protection of Traffic (10%) | | | | $200 |
| 9010001 | Mobilization | | | | $1,500 |
| | Construction Survey (1%) | | | | $20 |
| | Construction Engineering & Contingencies (30%) | | | | $600 |
| | | | | | |
| | **Subtotal A2** | | | | **$2,420** |

**PROJECT TOTAL (ROUNDED)** **$4,400**

## *CONSTRUCTION COST ESTIMATE*

12/1/98

**PROJECT NUMBER: 051 MA 2 H 4585 01L** **ROUTE: SR 51**

**ALTERNATIVE 5B**

**LOCATION: RETENTION BASIN AT HIGHLAND AVENUE PUMP STATION WITH 13' RETAINING WALLS- CAPACITY = 8.6 AF**

### *PART A: BASIN CONSTRUCTION*

| *Item No.* | *Description* | *Unit* | *Quantity* | *Unit Cost* | *Total* |
|---|---|---|---|---|---|
| 2020011 | Removal of Buildings | EACH | 3 | $5,000 | $15,000 |
| 2020021 | Removal of Concrete Curb and Gutter | L.FT. | 60 | $3 | $180 |
| 2020031 | Removal of Portland Concrete Cement Pavement | SQ.YD. | 150 | $15 | $2,250 |
| 2030201 | Excavation( ) | CU.YD. | 13,875 | $10 | $138,747 |
| 4010012 | Portland Concrete Cement Pavement (12") | SQ.YD. | 150 | $45 | $6,750 |
| 5011023 | Pipe, Reinforced Concrete, Class III, 24" | L.FT. | 75 | $70 | $5,250 |
| 5011053 | Pipe, Reinforced Concrete, Class III, 48" | L.FT. | 125 | $250 | $31,250 |
| 5015124 | Flap Gate, (24") | EACH | 1 | $300 | $300 |
| 5050031 | Manhole (C-18.10) (No. 3) (For Pipes 6" to 36") | EACH | 1 | $2,500 | $2,500 |
| 5050032 | Manhole (C-18.10) (No. 3) (For Pipes Over 36") | EACH | 1 | $3,500 | $3,500 |
| 6016088 | Headwall (24" Concrete Pipe) | EACH | 1 | $800 | $800 |
| 6016089 | Energy Dissipator (48" Concrete Pipe) | EACH | 1 | $3,500 | $3,500 |
| 8030103 | Decomposed Granite | SQ.YD. | 732 | $4 | $2,927 |
| 8060001 | Planting Trees, Shrubs And Plants | L.SUM | 1 | $17,000 | $17,000 |
| 8080001 | Landscape Irrigation System | L.SUM | 1 | $6,607 | $6,607 |
| 8080696 | Concrete Pipe Plug (48") | EACH | 1 | $150 | $150 |
| 9080041 | Concrete Curb (Phoenix Mountable Curb) | L.FT. | 60 | $12 | $720 |
| 9080241 | Concrete Sidewalk (MAG Det. 230 & 231) | SQ.FT. | 1,800 | $3 | $5,400 |
| 9130001 | Erosion Control (Riprap)($D_{50}$ = 12") | CU.YD. | 25 | $65 | $1,625 |
| 9140113 | Wall (Block) | SQ.FT. | 4,640 | $12 | $55,680 |
| 9140121 | Retaining Wall (Reinforced Concrete) | SQ.FT. | 6,760 | $25 | $169,000 |
| 9140144 | Steel Fence, Colored Picket (72") | L.FT. | 240 | $35 | $8,400 |
| | **Subtotal A1** | | | | **$477,535** |
| | | | | | |
| 2030855 | Erosion Control (1%) | | | | $4,775 |
| 9240170 | Quality Control (2%) | | | | $9,551 |
| 9300142 | Water Supply/Dust Palliative (2%) | | | | $9,551 |
| 7010001 | Maintenance/Protection of Traffic (10%) | | | | $47,754 |
| 9010001 | Mobilization (7%) | | | | $33,427 |
| | Construction Survey (1%) | | | | $4,775 |
| | Construction Engineering & Contingencies (30%) | | | | $143,261 |
| | **Subtotal A2** | | | | **$253,094** |
| | | | | | |
| | ***TOTAL A1+ A2 (ROUNDED)*** | | | | ***$730,600*** |

### *PART B: RIGHT-OF-WAY*

| *Item No.* | *Description* | *Unit* | *Quantity* | *Unit Cost* | *Total* |
|---|---|---|---|---|---|
| | Right-of-Way | L.SUM | 1 | $1,019,304 | $1,019,304 |
| | Contingencies (15%) | | | | $152,896 |
| | | | | | |
| | **Subtotal B (ROUNDED)** | | | | **$1,172,200** |

**PROJECT TOTAL (ROUNDED)** **$1,902,800**

## *CONSTRUCTION COST ESTIMATE*

12/1/98

**PROJECT NUMBER: 051 MA 2 H 4585 01L** **ROUTE: SR 51**

**ALTERNATIVE 8**

**LOCATION: OPTIMIZE PUMP STATION CONTROLS**

| *Item No.* | *Description* | *Unit* | *Quantity* | *Unit Cost* | *Total* |
|---|---|---|---|---|---|
| XXXXXXX | Reprogram Existing Programable Logic Computer | L.SUM | 1 | $5,000 | $5,000 |
| XXXXXXX | Adjust Float Swith Levels | L.SUM | 1 | $2,500 | $2,500 |
| | | | | | |
| | **Subtotal A1** | | | | **$7,500** |
| | | | | | |
| ~~2030855~~ | ~~Erosion Control (1%)~~ | | | | ~~$0~~ |
| 9240170 | Quality Control (2%) | | | | $150 |
| ~~9300142~~ | ~~Water Supply/Dust Palliative (2%)~~ | | | | ~~$0~~ |
| ~~7010001~~ | ~~Maintenance/Protection of Traffic (10%)~~ | | | | ~~$0~~ |
| 9010001 | Mobilization | | | | $1,500 |
| | ~~Construction Survey (1%)~~ | | | | ~~$0~~ |
| | Construction Engineering & Contingencies (30%) | | | | $2,250 |
| | | | | | |
| | **Subtotal A2** | | | | **$3,900** |

**PROJECT TOTAL (ROUNDED)** **$11,400**

## *CONSTRUCTION COST ESTIMATE*

12/1/98

**PROJECT NUMBER: 051 MA 2 H 4585 01L** **ROUTE: SR 51**

**ALTERNATIVE 9**

**LOCATION: PUMP STATION NUISANCE PUMP**

| *Item No.* | *Description* | *Unit* | *Quantity* | *Unit Cost* | *Total* |
|---|---|---|---|---|---|
| 2020053 | Remove (Existing Pump and Discharge Piping) | EACH | 1 | $2,500 | $2,500 |
| 5060400 | 16" Discharge Piping and Piping Accessories | L.SUM | 1 | $3,700 | $3,700 |
| 5060500 | Pump Station Electrical System | EACH | 1 | $22,500 | $22,500 |
| 8080662 | Pumps, Electric Motors and Related Equipment | L.SUM | 1 | $38,500 | $38,500 |
| XXXXXXX | Pump Hatch and Cover | L.SUM | 1 | $5,000 | $5,000 |
| | | | | | |
| | **Subtotal A1** | | | | **$72,200** |
| | | | | | |
| ~~2030855~~ | ~~Erosion Control (1%)~~ | | | | ~~$0~~ |
| 9240170 | Quality Control (2%) | | | | $1,444 |
| ~~9300142~~ | ~~Water Supply/Dust Palliative (2%)~~ | | | | ~~$0~~ |
| ~~7010001~~ | ~~Maintenance/Protection of Traffic (10%)~~ | | | | ~~$0~~ |
| 9010001 | Mobilization (7%) | | | | $5,054 |
| | ~~Construction Survey (1%)~~ | | | | ~~$0~~ |
| | Construction Engineering & Contingencies (30%) | | | | $21,660 |
| | | | | | |
| | **Subtotal A2** | | | | **$28,158** |

**PROJECT TOTAL (ROUNDED)** **$100,400**

## *CONSTRUCTION COST ESTIMATE*

12/1/98

**PROJECT NUMBER: 051 MA 2 H 4585 01L** **ROUTE: SR 51**

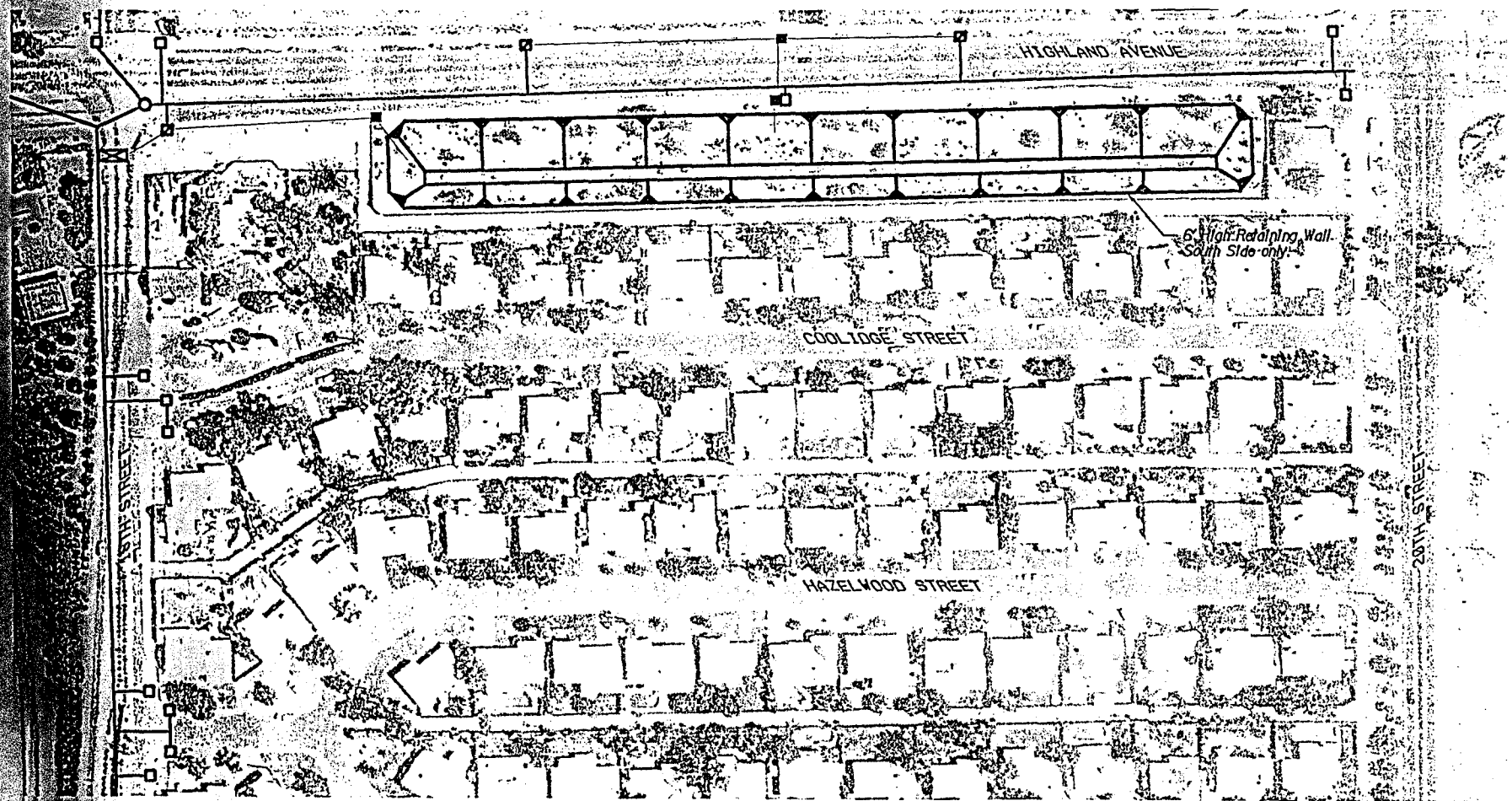
**ALTERNATIVE 11**

**LOCATION: 18th STREET TRUNK LINE REPLACEMENT**

**MARYLAND AVENUE TO RANCHO DRIVE**

| *Item No.* | *Description* | *Unit* | *Quantity* | *Unit Cost* | *Total* |
|---|---|---|---|---|---|
| 2020021 | Removal of Concrete Curb and Gutter | L.FT. | 145 | $3.00 | $435 |
| 2020029 | Removal of Asphaltic Concrete Pavement | SQ.YD. | 1,404 | $3.00 | $4,212 |
| 2020041 | Removal of Pipe | L.FT. | 3,331 | $2.00 | $6,662 |
| 4061001 | Pavement Replacement (Mag Det. 200) (Type A) | SQ.YD. | 1,166 | $20.00 | $23,320 |
| 4061002 | Pavement Replacement (Mag Det. 200) (Type B) | SQ.YD. | 238 | $23.00 | $5,474 |
| 5011024 | Pipe, Reinforced Concrete, Class IV, 24" | L.FT. | 799 | $50.00 | $39,950 |
| 5011034 | Pipe, Reinforced Concrete, Class IV, 30" | L.FT. | 1,785 | $65.00 | $116,025 |
| 5011044 | Pipe, Reinforced Concrete, Class IV, 36" | L.FT. | 97 | $110.00 | $10,670 |
| 5011050 | Pipe, Reinforced Concrete, Class IV, 42" | L.FT. | 650 | $120.00 | $78,000 |
| 5050221 | Reconstruct Manhole | EACH | 13 | $500.00 | $6,500 |
| 9080103 | Concrete Curb And Gutter, Type C (Mag Det. 220) | L.FT. | 145 | $9.00 | $1,305 |
| | | | | | |
| | **Subtotal A1** | | | | **$292,553.00** |
| | | | | | |
| 2030855 | Erosion Control (1%) | | | | $2,925.53 |
| 9240170 | Quality Control (2%) | | | | $5,851.06 |
| 9300142 | Water Supply/Dust Palliative (2%) | | | | $5,851.06 |
| 7010001 | Maintenance/Protection of Traffic (10%) | | | | $29,255.30 |
| 9010001 | Mobilization (7%) | | | | $20,478.71 |
| | Construction Survey (1%) | | | | $2,925.53 |
| | Construction Engineering & Contingencies (30%) | | | | $87,765.90 |
| | | | | | |
| | **Subtotal A2** | | | | **$155,053.09** |

**PROJECT TOTAL (ROUNDED)** **$447,600**




LEGEND

| | Proposed | Existing | Modified |
|---|---|---|---|
| Curb Inlet | ■ | □ | ⊠ |
| Storm Sewer | —— | —— | |
| Special Inlet | ⊠ | | |
| Junction Manhole | ● | ○ | |

N

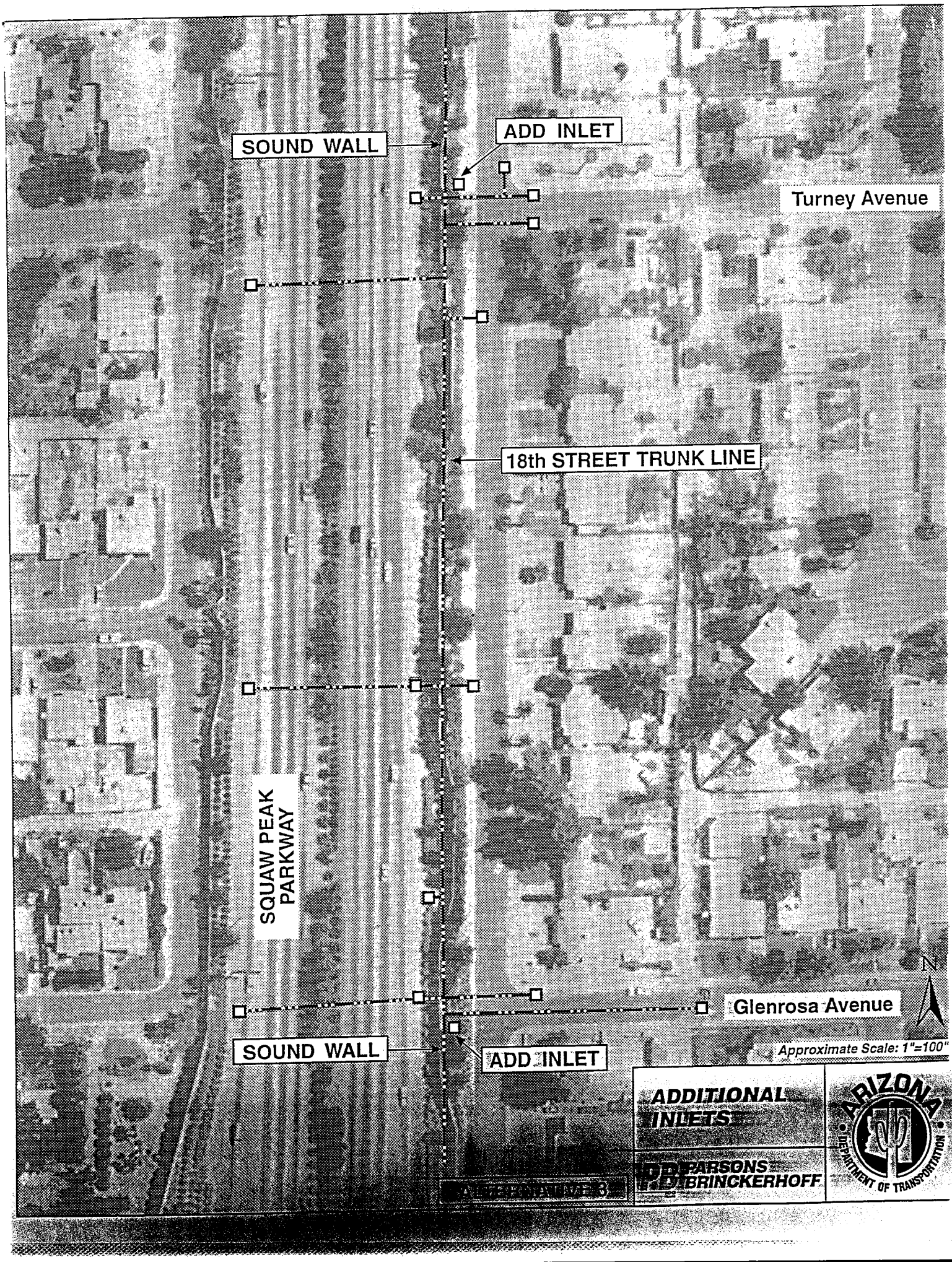
N.T.S.

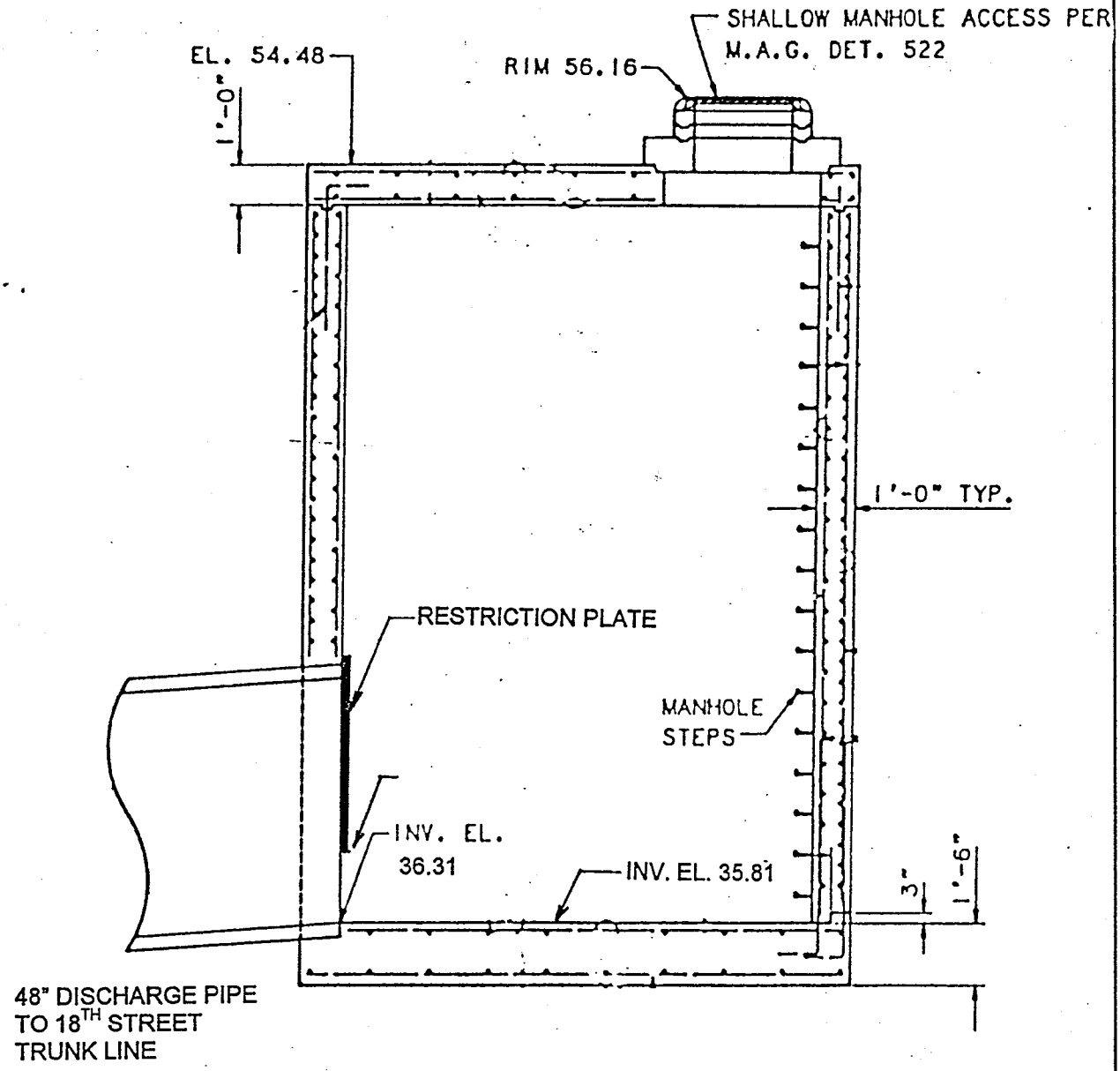
| | NAME | DATE |
|---|---|---|
| DESIGN | N. Lueder | 6/11/96 |
| DRAWN | J. Cirillo | 6/11/96 |
| CHECKED | J. Wallgrundefer | 6/11/96 |

PREMIER

SR51 DRAINAGE ASSESSMENT

HIGHLAND BASIN - WALLED WITH RETAINING WALLS ALTERNATIVE 2A


SOUND WALL
ADD INLET
Turney Avenue
18th STREET TRUNK LINE
SQUAW PEAK PARKWAY
Glenrosa Avenue
SOUND WALL
ADD INLET
N
Approximate Scale: 1"=100'
ADDITIONAL INLETS
PARSONS BRINCKERHOFF
ARIZONA DEPARTMENT OF TRANSPORTATION

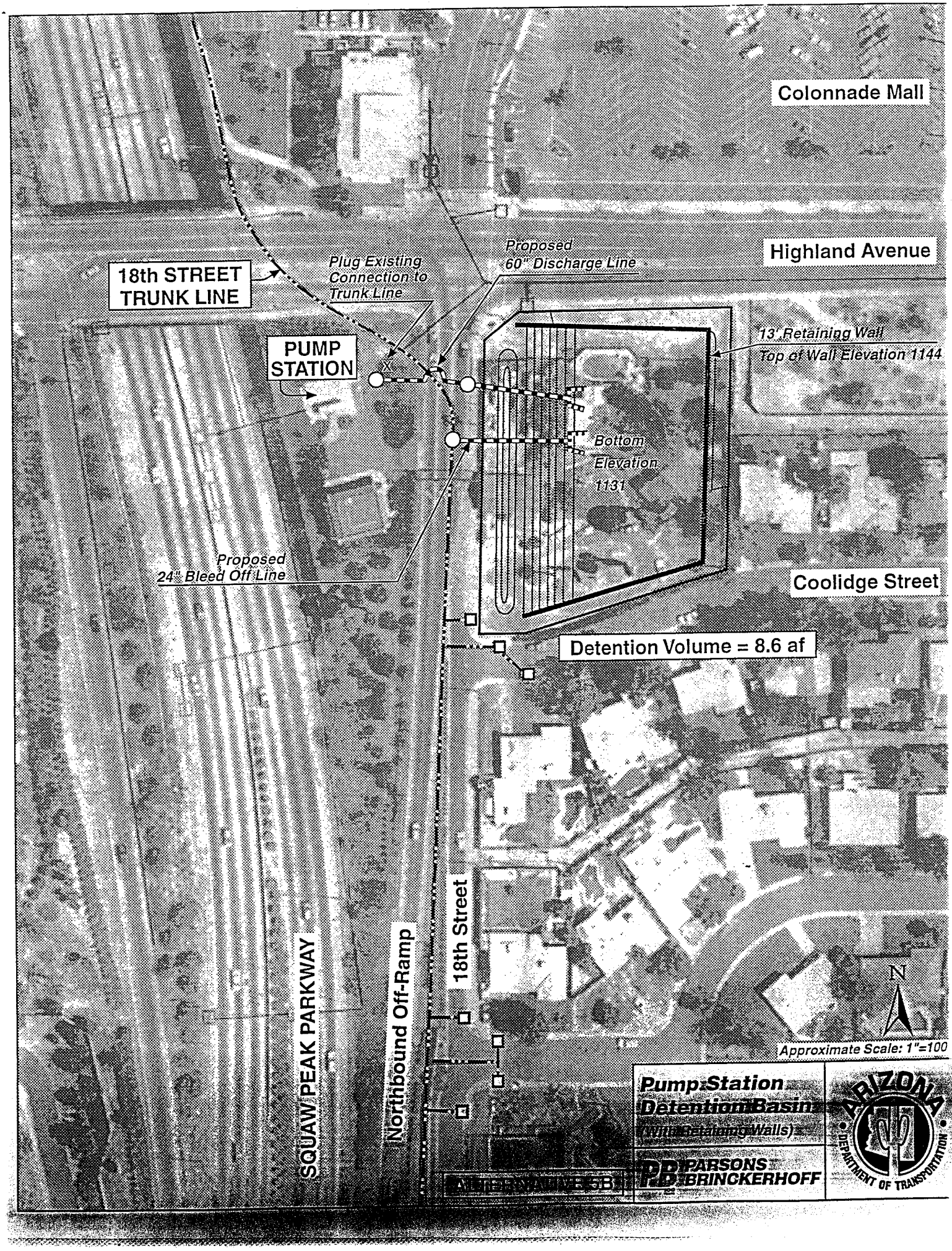



# COLTER STREET

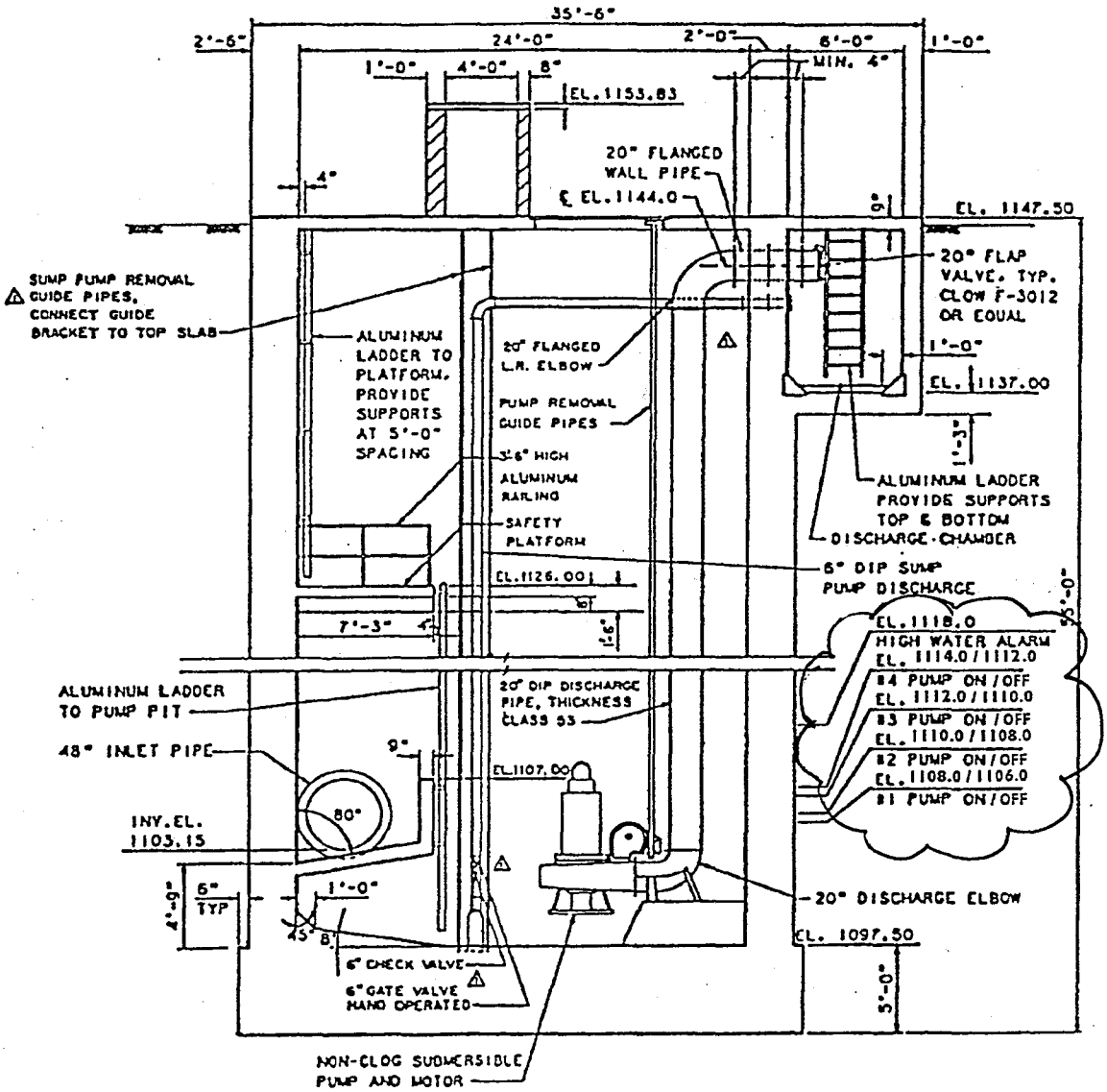
# SIPHON PLAN

ADAPTED FROM AS-BUILT PLANS

| | |
|---|---|
| COLTER STREET JUNCTION STRUCTURE | ARIZONA DEPARTMENT OF TRANSPORTATION |
| ALTERNATIVE NO. 4 | |
| PARSONS BRINCKERHOFF | |


Colonnade Mall
Highland Avenue
18th STREET TRUNK LINE
Plug Existing Connection to Trunk Line
Proposed 60" Discharge Line
PUMP STATION
13' Retaining Wall
Top of Wall Elevation 1144
Bottom Elevation 1131
Proposed 24" Bleed Off Line
Coolidge Street
Detention Volume = 8.6 af
18th Street
Northbound Off-Ramp
SQUAW PEAK PARKWAY
N
Approximate Scale: 1"=100
Pump Station Detention Basin (With Retaining Walls)
PARSONS BRINCKERHOFF
ARIZONA DEPARTMENT OF TRANSPORTATION

# HIGHLAND AVE. PUMP STATION




ALTERNATIVE NO. 8

REVISED PUMP ON/OFF ELEVATIONS

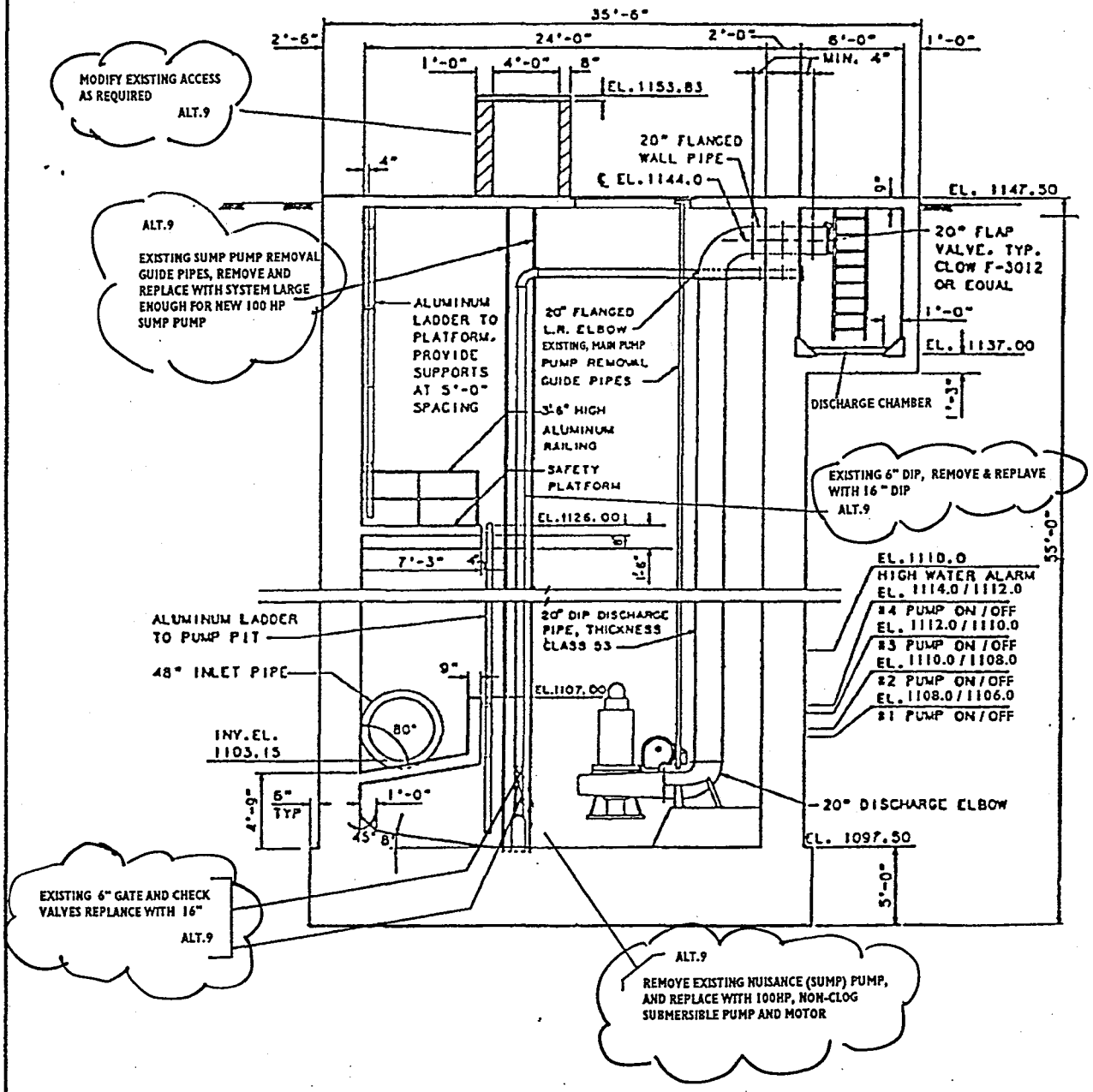
ADAPTED FROM "AS-BUILT" PLANS

PARSONS BRINCKERHOFF

ARIZONA DEPARTMENT OF TRANSPORTATION

SR-51 Drainage Assessment
Indian School Road to Bethany Home Road

# HIGHLAND AVE. PUMP STATION



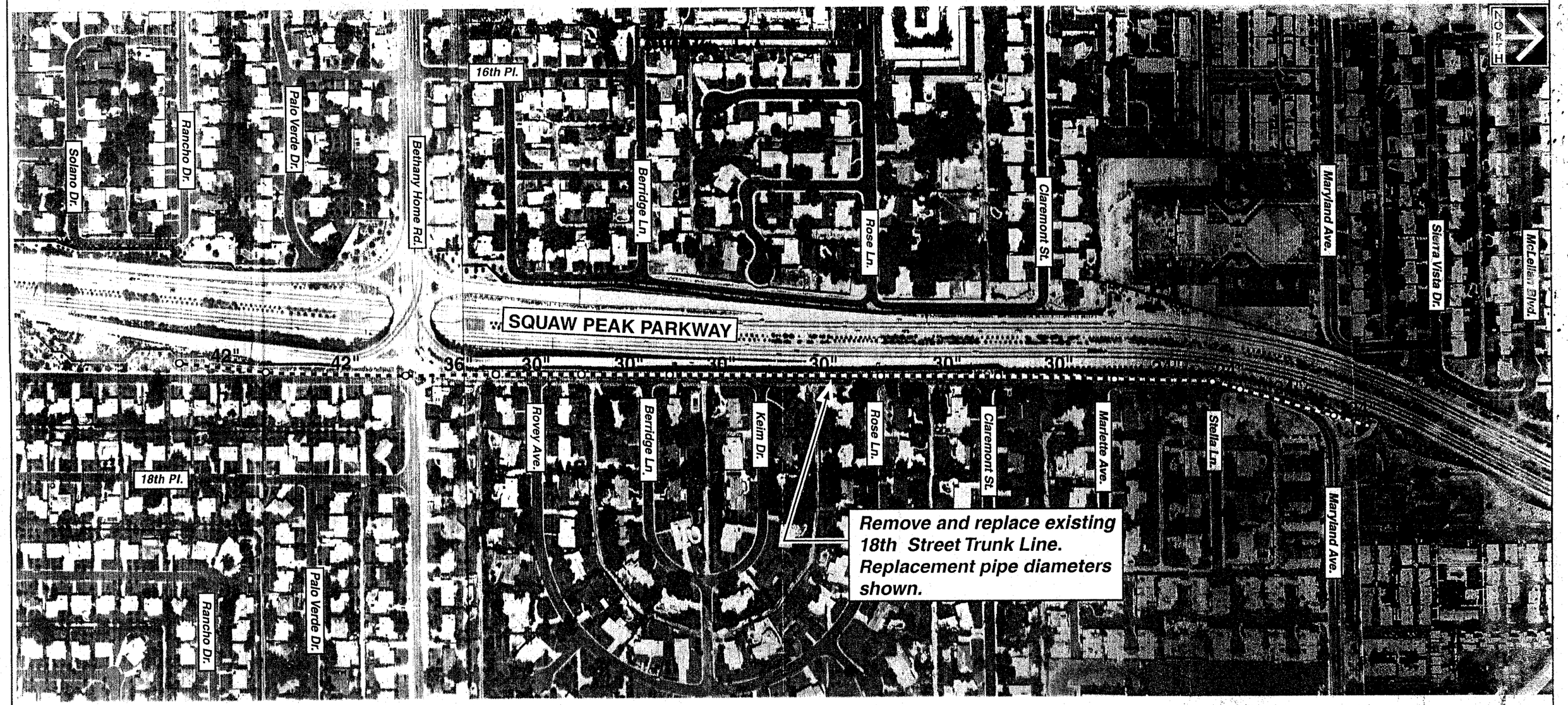

ALTERNATIVE NO. 9

LARGER NUISANCE PUMP

ADAPTED FROM "AS-BUILT" PLANS

PARSONS BRINCKERHOFF

ARIZONA DEPARTMENT OF TRANSPORTATION




ARIZONA DEPARTMENT OF TRANSPORTATION

**18th Street Trunk Line Replacement**

PB PARSONS BRINCKERHOFF