NORTHERN AVENUE

LOOP 101 TO 67TH AVENUE

DRAINAGE REPORT
70% PLAN SUBMITTAL

MARICOPA COUNTY
DEPARTMENT OF TRANSPORTATION

Work Order No. 68915
Contract No. CY 1996-58

July 1998

Stanley Consultants INC.
A Stanley Group Company
Engineering, Environmental and Construction Services - Worldwide

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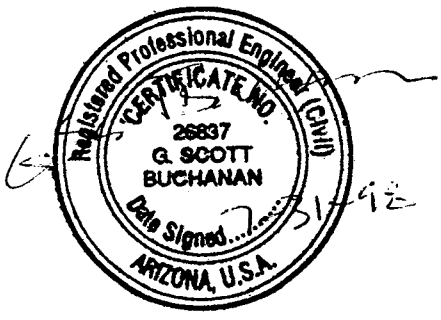

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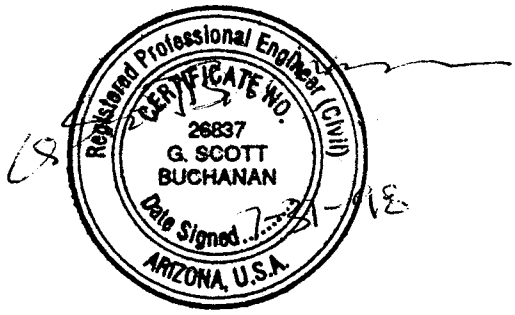

Introduction and Background

Regional drainage for the area surrounding the Maricopa County Department of Transportation (MCDOT) Northern Avenue project limits has been analyzed by consultant Wood/Patel Associates for the Flood Control District of Maricopa County (MCFCD). This analysis is part of the Northern/Orangewood Storm Drain Project which is located in the Cities of Glendale and Peoria as well as Unincorporated Maricopa County. The purpose of the Northern/Orangewood Storm Drain Study is to establish hydrology, preliminary hydraulics, concept routing and pipe sizing for a regional storm drainage system. The Wood/Patel Associates study is a refinement and finalization of the MCFCD Glendale - Peoria Area Drainage Master Plan done by Camp Dresser & McKee, Inc. and James M. Montgomery Consulting Engineers, Inc. in 1987.

Construction of the Northern/Orangewood Storm Drain System will be funded by MCFCD, MCDOT and the Cities of Glendale and Peoria. The outfall for the Northern/Orangewood Storm Drain System will be the existing Arizona Department of Transportation Agua Fria Freeway Channel which is located at the west limit of the MCDOT Northern Avenue project. As part of the Northern/Orangewood Storm Drain System, detention of storm runoff will be provided in proposed basins that will be connected to the storm drains. These basins will attenuate the discharges carried by the storm drain pipe. A copy of the Wood/Patel Associates Plate 11-3A, Northern/Orangewood Storm Drain Project, Selected Alignments has been included in Appendix A.

Wood/Patel Associates has utilized two different design storm criteria in sizing the Northern/Orangewood Storm Drain System. This criteria is based on Glendale and Peoria design standards. These standards each differ from the other. That portion of the system within the City of Glendale is designed using the 10-year, 6-hour storm. Facilities lying within the City of Peoria will be designed using the 2-year, 6-hour storm. The MCDOT Northern Avenue project currently lies within Unincorporated Maricopa County right-of-way. To the north is Peoria and to the south is Glendale. The design storm used by Wood/Patel Associates for the Northern Avenue portion of the storm drain system is the 2-year, 6-hour storm as mutually agreed among the principal parties.

In addition to the dual storm criteria, Wood/Patel Associates has also considered both existing and future developed conditions in the contributing watershed. Although stormwater detention is required of development in both Peoria and Glendale, future condition discharges were found to be greater than present conditions, primarily because of shorter concentration times. The design storm for the Northern Avenue storm drain trunk line, then, is the 2-year, 6-hour future watershed condition storm, assuming that both right-of-way and offsite areas contribute. Also, in sizing the Northern Avenue trunk line, it has been assumed that design discharges are not restricted to enter the system by catch basins, laterals and other connecting storm drain pipe.

Wood/Patel Associates has indicated the locations of concentration points and anticipated inflow to the storm drain system on their Exhibit A, HEC-1 Schematic Diagram. A reduced copy of this schematic is included in Appendix A along with a summary table (Table 4) of discharges from the Wood/Patel Associates HEC-1 Model which corresponds to the schematic diagram. These concentration points are adequate from a regional modeling standpoint. However, they are not necessarily intended to serve as catch basin inlet locations for roadway drainage design. Actual catch basin sizing and location, sizing of laterals and design of a portion of the storm drain trunk line will be done by Stanley Consultants as part of the roadway design process.

Design Criteria

In accordance with the MCDOT/Stanley Consultants Consultant Services Contract, Maricopa County design criteria and various verbal and written directives from MCDOT, the following summarizes the major applicable drainage design criteria and considerations for this project:

1. Plans, drainage report and calculations shall be in metric format;

2. Design of roadway catch basins, laterals, and flow spread shall be based on a 10-year storm using only the road right-of-way as contributing area;

3. One dry 3.6m lane in each direction shall be provided based on the above design storm (4.6m maximum flow spread);

4. The design of storm drain trunk line shall be based on the 2-year, 6-hour discharges from the Wood/Patel HEC-1 model;

5. The roadway shall be designed so that drainage follows historical paths and does not create offsite flooding or adverse ponding within the right-of-way;

6. The 100-year runoff shall be contained below finished floors of adjacent buildings;

7. The maximum flow velocity in the roadway section shall not exceed 3m/s and the maximum discharge shall not exceed 2.8 cms based on a 100-year storm;

8. Runoff crossing dip sections or topping the roadway at any location shall be no deeper than 152mm at the roadway crown for a 100-year storm;

9. Hydrology for the roadway drainage design will be based on the Rational method as presented in the MCFCD Drainage Design Manual, Volume 1, Hydrology;

10. The maximum allowable spacing for new storm drain manholes is 100 m for storm drain pipe 760mm and smaller and 200m for storm drain pipe larger than 760mm;

11. The maximum spacing for catch basin inlets is 200m;

12. Catch basin capture efficiency is assumed to be 80% for either on-grade or sump catch basins;

13. Storm drain laterals entering a manhole should be designed with a vertical offset whenever possible. The invert of one lateral should be at the same elevation or higher than the soffit of the other lateral;

14. Storm drain laterals may enter the trunk line directly via pre-fabricated connections. Opposing laterals should be offset a minimum of 1.5 meters where they connect to the trunk line;

15. Storm drain lateral connections made to existing trunk line (from Loop 101 to 91st Avenue) will be achieved by MAG Standard Detail 524;

16. The minimum pipe size for storm drain trunk line is 610mm and for storm drain laterals is 380mm.

There are no parallel roadside ditches, open channels, culverts or retention facilities necessary as part of the roadway drainage design for this project. Therefore, design criteria normally associated with these features will not be applicable.

Existing and Proposed Storm Drain Trunk Lines

A portion of the Northern Avenue storm drain has already been constructed. An existing 1520mm diameter concrete pipe runs from the Agua Fria Freeway channel outfall east to 91st Avenue. In addition, storm drain trunk line stubs have been provided to the north and east from the Northern/91st Avenue intersection. The stub to the north is approximately 79m of 1220mm concrete pipe and the stub to the east is approximately 91m of 1520mm concrete pipe. The ends of these stubs are capped. A storm drain stub to the south is not needed at 91st Avenue because 91st Avenue drains to the south from the intersection.

The segment of Northern Avenue storm drain from 91st Avenue to 83rd Avenue has been designed by Wood/Patel Associates for MCFCD. The Wood/Patel design is complete and approved by MCFCD. The Northern Avenue storm drain improvements included in the Wood/Patel plans will be constructed at the same time as the Stanley Consultants Northern Avenue roadway improvements. Associated with the Wood/Patel design is a regional stormwater detention basin (called the Peoria Basin) and a secondary storm drain pipe. These features are located north of Northern Avenue between the 87th Avenue alignment and 83rd Avenue.

The secondary pipe intercepts runoff from 83rd Avenue at a point about 400m north of Northern Avenue and conveys it to the Peoria Basin from the northeasterly direction. According to current Wood/Patel plans, the storm drain trunk line in Northern Avenue from 83rd Avenue to the 85th Avenue alignment is 1830mm diameter. At 85th Avenue, this pipe turns north and discharges into the Peoria Basin.

Because the Peoria Basin attenuates the hydrograph peak from its two contributing storm drain pipes, the Northern Avenue storm drain downstream from the basin is much smaller than the pipe upstream from the basin. According to current Wood/Patel design, the Northern Avenue storm drain from the Peoria Basin is 610mm diameter at 85th Avenue. This pipe increases to 760mm diameter at 89th Avenue and connects to the existing 1520mm storm drain stub just east of 91st Avenue.

From 83rd Avenue downstream, the trunk line was originally intended to carry only storm runoff and bleedoff from the Peoria basin. However, subsequent to the Northern Avenue 40% plan submittal, the Salt River Project (SRP) has suggested a design alternative that would involve draining irrigation tailwater into the trunk line. This concept is presently under consideration by MCDOT and MCDFC.

Stanley Consultants' Northern Avenue storm drain design will begin just west of 83rd Avenue where Wood/Patel's design ends. The storm drain pipe going east through the intersection will be 1830mm diameter. Within the 83rd Avenue intersection, a reinforced concrete transition structure will be required to avoid profile conflict with an existing 610mm gravity sewer pipe. This transition structure will provide a cross section that is wider and flatter than the 1830mm storm drain pipe where it passes under the existing sewer pipe. It will have the same or larger hydraulic cross section than the 1830mm storm drain.

At 83rd Avenue, a storm drain stub will be provided to the north for roadway drainage from 83rd Avenue. A storm drain pipe in 83rd Avenue north of the intersection is not reflected on the Wood/Patel selected Alignment Plate 11-3A or in their HEC-1 model as a pipe routing reach. However, this stub has been sized by Stanley as a 460mm pipe on the Northern Avenue 70% plans. In addition, a 460mm diameter pipe is provided in 83rd Avenue to the south of the intersection because about 100m of 83rd Avenue drains north toward the intersection.

From 83rd Avenue, the storm drain will run east to 75th Avenue as shown in the Wood/Patel Selected Alignment Plate 11-3A. According to the Wood/Patel HEC-1 model, the size of pipe in this segment is 1830mm from 83rd Avenue to just west of 79th Avenue and 1520mm from 79th Avenue to 75th Avenue. This is what has been reflected in the Northern Avenue 70% plans.

At 75th Avenue, there will be a connection provided to a storm drain trunk line which has been designed by ASL Sierra Consulting Engineers. This trunk line is part of MCDOT Roadway Improvement Project 68843, 75th Avenue, Glendale Avenue to Olive Avenue. The 75th Avenue project will be constructed prior to Northern Avenue improvements. According to ASL Sierra design, their 75th Avenue trunk line will be 910mm in diameter approaching Northern Avenue from the north. Currently, it is designed to convey drainage from the future 75th Avenue roadway improvements north of Northern Avenue. It is designed only for runoff from the 75th Avenue right-of-way and not for offsite runoff. This pipe is not reflected on the Wood/Patel Selected Alignments

Plate 11-3A or in their HEC-1 model as a pipe routing reach. However, from a hydrologic standpoint, this is probably not significant.

The ASL Sierra plans indicate a 1520mm stub extending west from 75th Avenue approximately 85m. Stanley's Northern Avenue storm drain will connect to this stub. A storm drain stub to the south is not needed at 75th Avenue because 75th Avenue drains to the south from the intersection.

A storm drain trunk line will need to be extended east in Northern Avenue from 75th Avenue to 71st Avenue. This will be done as part of Stanley Consultants' Northern Avenue design and is necessary to provide outfall for catch basins in this segment. The ASL Sierra plans indicate a storm drain stub with a diameter of 1070mm extending east in Northern Avenue approximately 70m from 75th Avenue. This pipe will be extended at the same diameter east from the intersection approximately 240 meters to the first Northern Avenue catch basins and then will reduce in size to 910mm from that location to 71st Avenue.

This trunk line is not shown on the Wood/Patel Selected Alignments Plate 11-3A. However, it is reflected as a 1220mm routing reach pipe in the Wood/Patel HEC-1 model. The cost of the trunk line from 75th Avenue to 71st Avenue will be cost shared 50/50 between Peoria and MCDOT. The cost of catch basins and laterals in this segment will be paid for by MCDOT.

Existing and Proposed Catch Basins and Laterals

Existing roadway design grades for Northern Avenue have been set and range from about 0.001m/m to about 0.010m/m. The proposed roadway profile is generally on grade. However, there are a few very localized sumps in the gutter profiles. The overall grade of the project is from east to west and is on the order of 0.003 m/m. Table 1 is a summary of the storm water conveyance capacity for the typical Northern Avenue roadway section assuming a longitudinal grade of 0.003m/m and a Manning "n" of 0.015. Table 1 velocity and capacity were calculated using procedures from HEC-12. Refer to Appendix A for the typical roadway section.

TABLE 1

REPRESENTATIVE ROADWAY DRAINAGE CONVEYANCE
(@ s = 0.003 m/m)

Depth @ Gutter	Flow Spread (m)	Avg. Flow Velocity (m/s)	Carrying Capacity (cms)
109mm - dry lane flow spread	4.6	0.57	0.12
152mm - top of curb	6.8	0.73	0.34
223mm - crown of road	10.3	0.97	1.03
375mm - crown plus 152mm	10.3	1.39	4.47

City of Phoenix Standard Detail Type "M" catch basins will be used to intercept roadway drainage where required to meet flow spread criteria and satisfy other design conditions. This catch basin has a curb opening with a maintenance basin of 0.91m in length and optional one or two wing basins with lengths of 0.91m, 1.83m, 3.05m and 5.18m each. There is no surface inlet grate associated with this basin. Nearly all catch basins will be on grade but a few will be in sump condition. A Type "M" catch basin will work both on grade or in sump.

Table 2 is a summary of intercept lengths for a Type "M" catch basin on grade based on the typical roadway hydraulics represented in Table 1. Table 2 capture and bypass were calculated using procedures from HEC-12 assuming a catch basin on grade and 80% efficiency. Refer to Appendix A for the City of Phoenix Type "M" catch basin standard detail.

TABLE 2

REPRESENTATIVE CURB OPENING INTERCEPT LENGTHS
(@ s = 0.003 m/m)

Depth @ Gutter	Discharge in Roadway (cms)	Length of Opening (m)	Capture (cms)	Bypass (cms)
109mm	0.12	0.94	0.04	0.08
(dry lane flow spread)		2.01	0.08	0.04
		2.92	0.11	0.01
		4.14	0.12	0.00
152mm	0.34	0.94	0.07	0.27
(top of curb)		2.01	0.14	0.20
		2.92	0.19	0.15
		4.14	0.25	0.09
		6.27	0.32	0.02
223mm	1.03	0.94	0.11	0.92
(crown of road)		2.01	0.23	0.80
		2.92	0.33	0.70
		4.14	0.45	0.58
		6.27	0.64	0.39

Design discharges for catch basins and laterals were calculated using the Rational Method from the Flood Control District of Maricopa County Drainage Design Manual. In this methodology, discharges are influenced by watershed area, length, slope, resistance coefficient, runoff coefficient and rainfall intensity. Table 3 represents discharges estimated using the Rational Method assuming a length of 200m (corresponding to the maximum catch basin spacing), one-half the total right-of-way width (16.76m), resistance coefficient (Kb) of 0.040 and weighted runoff coefficient (C) of 0.68. Because the FCDMC Rational Method does not have a metric version, rainfall intensities and discharges are calculated in English units, then converted to metric.

TABLE 3

REPRESENTATIVE 10-YEAR DISCHARGES

S(m/m)	i_{10}(in/hr)	Q_{10} (cfs)	Q_{10} (cms)
0.001	3.3	1.86	0.053
0.002	3.7	2.09	0.059
0.003	4.0	2.25	0.064
0.004	4.1	2.31	0.065
0.005	4.3	2.43	0.069
0.006	4.4	2.48	0.070
0.007	4.5	2.54	0.072
0.008	4.6	2.60	0.074
0.009	4.7	2.65	0.075
0.010	4.8	2.71	0.077
0.011	4.8	2.71	0.077
0.012	4.9	2.77	0.078
0.013	5.0	2.82	0.080
0.014	5.0	2.82	0.080
0.015	5.1	2.88	0.082

Based on Tables 1 and 3, the typical 100-year discharge for 200m of half-width right-of-way is only about half of the flow spread conveyance capacity at the overall representative roadway grade. In fact, at any given slope, the calculated 10-year discharge never exceeds the flow spread conveyance capacity. Based on Tables 1, 2 and 3, the typical catch basin on grade at 200m spacing assuming 80% efficiency and 100% intercept will be a single wing Type "M" basin with a wing length of 1.83m and a total length of 2.74m.

Existing catch basins and laterals along Northern Avenue between Loop 101 and 91st Avenue appear to have been spaced at about 1/4 mile intervals (or about 400m). Many of the existing catch basins do not match the proposed roadway plan and profile and will require replacement. Where catch basin replacement is required, existing laterals will be utilized as much as possible. Additional catch basins will be required in this segment to meet the 200m maximum spacing.

At the 91st Avenue intersection, catch basins will be located on both sides of Northern Avenue just east of the intersection, both sides of 91st Avenue just north of the intersection and on the north side of Northern Avenue just west of the intersection. The Northern Avenue catch basins just east of 91st Avenue will need to intercept 100% of the drainage from the east. Catch basins will not be needed on 91st Avenue south of the intersection because the roadway drains to the south from the curb returns.

An interim drainage condition may occur downstream from the Northern/91st Avenue intersection until roadway and drainage improvements are completed in 91st Avenue north of Northern. The intercept capacity of the two existing catch basins on 91st Avenue just north of Northern will probably be exceeded until such time as the future trunk line and catch basins to the north are constructed. This condition may result in Northern Avenue flow spread being exceeded west of 91st Avenue. The existing catch basin on the north side of Northern just west of 91st Avenue would normally not be required. However since it is existing, it will be retained in place and it will mitigate the interim flow-by condition mentioned above.

At the Northern/83rd Avenue intersection, catch basins will be located on both sides of 83rd Avenue both north and south of Northern and on both sides of Northern Avenue just east of 83rd Avenue. The 83rd Avenue catch basins south of Northern will be sized to intercept 100% of the future ultimate roadway improvement drainage from the south. The Northern Avenue catch basins will also be sized for 100% intercept of drainage from the east.

Regarding the 83rd Avenue catch basins north of Northern, an interim exceedance condition may occur similar to the one at 91st Avenue mentioned previously. These catch basins are designed as part of a system involving future ultimate roadway and drainage improvements to the north. They will be temporarily undersized, thus allowing flow-by to enter the intersection. This situation will no longer occur after the future improvements in 83rd Avenue are completed to the north. These improvements will include extension of the small diameter trunk line and another pair of catch basins approximately 200m north of the intersection.

At the Northern/75th Avenue intersection, catch basins have been designed as part of the ASL Sierra 75th Avenue roadway improvement plans. Three catch basins are associated with this intersection; one on the south side of Northern just east of 75th Avenue and one on each side of 75th Avenue just north of Northern. The catch basin on the east side of 75th Avenue is on a continuous grade from Northern around the return to the north and receives drainage primarily from Northern Avenue. It is assumed for now that the other two ASL Sierra catch basins are designed for 100% intercept and will not allow flow-by into the intersection. This assumption will be confirmed upon final design.

The ASL Sierra 75th Avenue catch basins should reflect ultimate roadway improvements and are part of a storm drain system that will be constructed prior to Northern Avenue improvements. Therefore, an interim drainage condition like the ones that occur at 91st and 83rd Avenues (mentioned previously) should not occur at 75th Avenue. Catch basins will not be needed on 75th Avenue south of Northern because the roadway drains to the south from the curb returns.

At 71st Avenue, the Northern Avenue storm drain trunk line will end and catch basins will be provided on both sides of Northern to intercept roadway drainage generated from right-of-way extending approximately 800m east to Grand Avenue. Since no storm drain or catch basins will be provided east of 71st Avenue, the discharge approaching this location will be relatively large. Catch basins at this location will require a correspondingly large intercept capacity if it is desired to meet flow spread criteria to the west. However, for now, only standard catch basins have been included on 70% plans.

All storm drain laterals proposed with the Stanley Northern Avenue 70% improvements ar sized at 380mm diameter except where existing stubs west of 91st Avenue need to be extended. These laterals will be 460mm diameter to match the existing pipes. Because of the storm drain trunk line alignment which was necessary in some portions of the project to avoid utilities, many of the lateral pipes will be very steep in slope. At this point in design, utility pothole information has not been completed and potential conflict between storm drain laterals and utilities has not been evaluated very extensively. Approximate utility depths below grade have been estimated for 70% design. Many laterals will require breaks in pipe grade to avoid utility conflicts. Pothole information will be available prior to the next design phase.

Spreadsheet Tables 5 and 6 in Appendix A have been developed to serve as the basis for 70% design of proposed catch basins associated with the Northern Avenue project. Table 5 contains the hydrologic data and estimated design discharge for each catch basin location. Design discharges range from 1.6 cfs (0.044 cms) to 2.8 cfs (0.080 cms). Table 6 contains the roadway hydraulic data, flow spread and catch basin capture and bypass results.

Hydraulic Grade Line

Hydraulic grade lines have been estimated using standard friction loss equations. Minor losses at standard junctions and manholes have also been included. The storm drain system has been designed so that the hydraulic grade line is no higher than 300mm below each catch basin inlet flow line. Haestad Methods' StormCAD software was used to analyze hydraulic grade line for the proposed trunk line. The results of this analysis are included in Appendix A.

Based on preliminary calculations, the 10-year discharge from right-of-way only is significantly less in magnitude than the 2-year, 6-hour future condition offsite discharges from the Wood/Patel Associates Northern/Orangewood Storm Drain study. Therefore, the storm drain trunk line has more than adequate capacity for the 10-year right-of-way only design storm as well as a very favorable hydraulic grade line with regard to that storm.

Hydraulic grade line analysis for the existing Northern Avenue trunk line from Loop 101 to 91st Avenue and for the proposed Wood/Patel trunk line from 91st Avenue to just west of 83rd Avenue has been performed by Wood/Patel. This hydraulic grade line analysis assumes a starting hydraulic grade equal to the inside top of pipe where the existing storm drain discharges to the Loop 101 drainage channel.

The Wood/Patel hydraulic grade line is based on discharges from their PEO0214A.DAT HEC-1 model. Because this is a hydrograph model, it accounts for the concurrence in time between contributing flows. Therefore, the hydraulic grade line and associated storm drain pipe downstream from the Peoria Detention Basin reflects the concurrence of bleedoff discharge from the Peoria Basin with local downstream flow based on a single event 2-year, 6-hour storm. Stanley Consultants has used the Wood/Patel hydraulic grade line from Loop 101 to just west of 83rd Avenue where the Wood/Patel trunk line ends. The Wood/Patel discharges used for the hydraulic grade line analysis do not consider any of the proposed SRP tailwater flows mentioned previously.

When ASL Sierra designed their 75th Avenue storm drain improvements, they used the Wood/Patel hydraulic grade line at 83rd Avenue as their starting hydraulic grade. From there, they extended the hydraulic grade line east toward their project assuming pipe sizes and discharges from the Wood/Patel Northern/Orangewood Storm Drain Study. This established an estimated starting hydraulic grade at their downstream limit just west of 75th Avenue.

The preliminary hydraulic grade line for the trunk line from 83rd Avenue to 75th Avenue was reviewed in relation to the hydraulic grade line from the ASL Sierra 75th Avenue design. With an adjustment for the difference in vertical datum considered, it appears that the hydraulic grade elevation at the manhole at the intersection of 75th Avenue and Northern based on current design may be as much as 1m higher in elevation than the hydraulic grade elevation estimated by ASL Sierra.

This difference in hydraulic grade line is due primarily to the Stanley and Wood/Patel hydraulic grade line analysis consideration of minor losses along the trunk line. ASL Sierra's hydraulic grade line estimate was based on very preliminary downstream design and did not consider minor losses. ASL Sierra's hydraulic grade line for 75th Avenue north of Northern Avenue ranges from about 1 to 2m below proposed finish grade. Therefore, if their starting hydraulic grade was actually 1m higher than estimated, their hydraulic grade line upstream may be very close to gutter flow line for a portion of their project.

Offsite Flow Considerations

There has been some initial concern by Wood/Patel on behalf of MCFCD regarding use of the 10-year right-of-way only storm for designing roadway catch basins, laterals and secondary trunk line. The concern is that these features, being designed for flows significantly less in magnitude than the Northern Avenue trunk line flows, may restrict the Wood/Patel design flows from entering the trunk line system. This would potentially negate a portion of the trunk line's benefit. Although a detailed analysis of this is difficult, it has been considered using a simple approach as follows.

Catch basins will be sized and spaced to intercept flows to meet dry lane and maximum spacing criteria. However, the roadway section is capable of conveying a much larger flow than the flow used to meet spread criteria. If a larger design storm were considered, (for example, the 2-year, 6-hour offsite storm), the water surface may reach roadway crown height on westbound lanes and top of curb height on eastbound lanes. In this scenario, the roadway capacity, based on Table 1, would be 1.03 cms (westbound) + 0.34 (eastbound) = 1.37 cms.

The roadway, then, is capable of directing a much larger flow than the dry lane criteria flow to each catch basin. The typical catch basin intercept that would correspond to this larger roadway capacity and depth is significantly greater than the intercept associated with the dry lane criteria flow depth. For example, based on Table 2, a 2.74m long curb opening catch basin which is capable of intercepting a flow of 0.064 cms at a depth corresponding to 200m catch basin spacing is capable of intercepting a flow of 0.18 cms at a depth of flow corresponding to top of curb and 0.31 cms at a depth corresponding to crown of road. And, based on preliminary pipe hydraulics, typical storm drain laterals at either 380 or 460mm diameter will be capable of conveying larger flows of these magnitude.

A detailed analysis using the 2-year, 6-hour offsite storm would be required to conclude that there is no restriction on intercept. However, this is considered beyond Stanley Consultants' present scope of work and, based on the above results, would be unnecessary.

There are a number of residential structures located along both sides of Northern Avenue within the project limits. Some of these structures have floor elevations that may be at or below the existing Northern Avenue roadway profile. Particular care will need to be exercised in designing the new roadway profile with regard to drainage where these structures exist.

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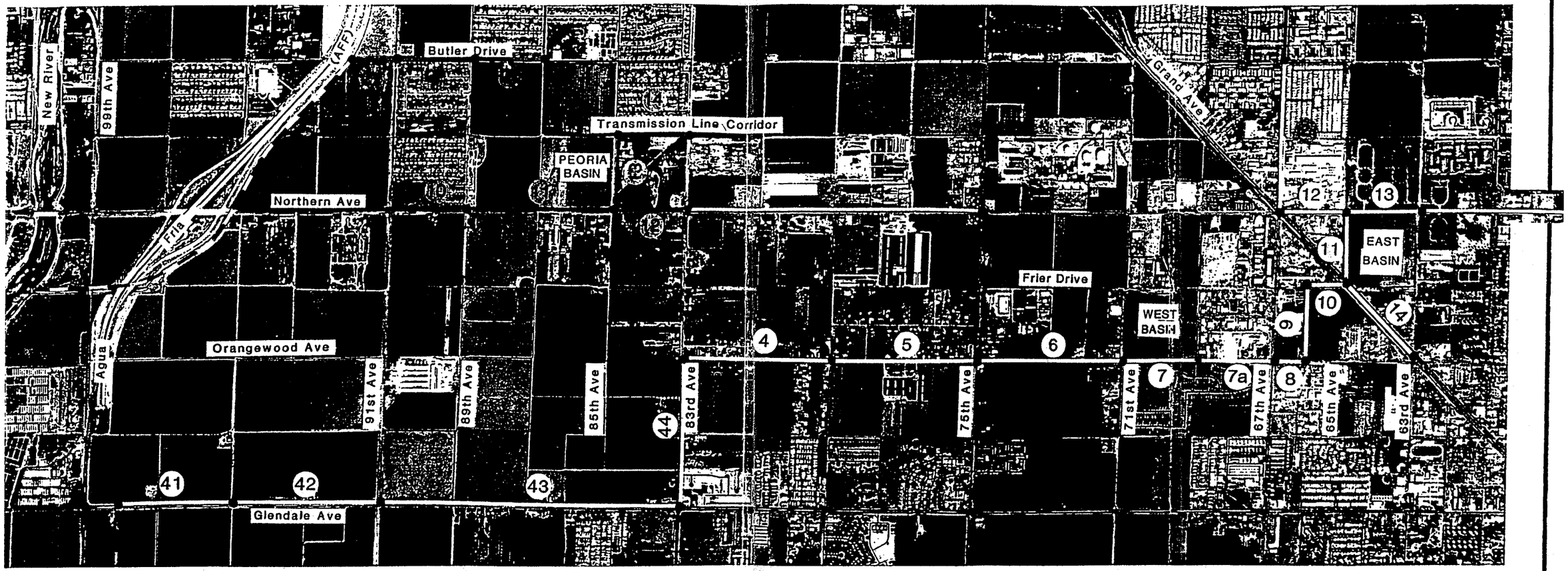
APPENDIX A

SUPPORTING EXHIBITS, TABLES AND CALCULATIONS

NORTHERN/ORANGEWOOD STORM DRAIN PROJECT

CONCEPT/ROUTING STUDY

Contract FCD 94-12



LEGEND

Existing

- Storm Drain Pipe
- AFF Outlet Channel

NOTE: See Pertinent Table II for Pipe #'s, Sizes and Flows.

Proposed

- Storm Drain Pipe
- Detention/Surge Basin
- Future Outfall Channel
- Butler Drive Storm Drain Pipe #
- Northern Avenue Storm Drain Pipe #
- 44 Glendale Avenue Storm Drain Pipe #

Additional alignments added 6/14/96

N

½ Mile

SELECTED ALIGNMENTS

BUTLER AVENUE, NORTHERN AVENUE AND GLENDALE AVENUE ALIGNMENTS

Wood, Patel & Associates, Inc.

PLATE II-3A

UPDATED: 6/14/96

AVE

33

9

NORTHERN AVE

CANAL

LAMY HOME RD

NOTE: HEC-1 OPERATIONS 95DIV, 85DIV & 115DIV APPLY ONLY TO MODEL GLFUNUKN.DAT

RECEIVED
MAR 25 1997
STANLEY CONSULTANTS

N

Revised 11/2/95

LEGEND

- SUB-BASIN BOUNDARY
- (240) SUB-BASIN
- 45R CHANNEL OR PIPE ROUTE
- ●110C COMBINE HYDROGRAPHS
- 115D DIVERSION HYDROGRAPH
- 115DIV DIVERTED HYDROGRAPH
- EXISTING CONDITION SUB-BASIN BOUNDARY

NORTHERN-ORANGEWOOD STORM DRAIN PROJECT

HEC-1 SCHEMATIC DIAGRAM

WOOD/PATEL ASSOCIATES
Civil Engineers
Hydrologists
Land Surveyors
(602) 234-1344

SCALE 1"=1000' | Exhibit A
DATE 2/96 | JOB NO. 9615B
DESIGN ADR | DRAWN ACC
CHECKED JB

NORTHERN AVENUE - LOOP 101 TO 67TH AVENUE
DRAINAGE REPORT - 70% PLAN SUBMITTAL

TABLE 4

Summary of 2-year, 6-hour future condition discharges at selected locations along Northern Avenue from Wood/Patel Associates Northern/Orangewood Storm Drain Project HEC-1 model PEO0214A.DAT, October 1995.

Concentration Point	Description	Discharge (cfs)	Discharge (m^3/s)	Time of Peak (hrs)
30CC	Northern @ 71st Avenue	18	0.501	4.47
30CR	Route 30CC in future Northern Ave 4' SD	18	0.501	4.53
20AR	Route 20AC South on 75th Ave	72	2.035	4.37
40A	Local Sub-basin	76	2.148	4.03
40AC	Combine 30CR, 20AR, 40A	132	3.731	4.13
40AR	Route 40AC in future Northern Ave 5' SD	132	3.731	4.17
40E	Local Sub-basin	21	0.594	4.03
40EC	Combine 40AR, 40E	151	4.268	4.13
40ER	Route 40EC in future Northern Ave 5' SD	151	4.268	4.13
70AR	Route 70AS South along local street	4	0.113	4.43
40D	Local Sub-basin	2	0.057	4.07
40DC	Combine 40ER, 40EC, 40D	155	4.381	4.17
40DR	Route 40 DC in future Northern Ave 5' SD	155	4.381	4.17
90AR	Route 90AC South along future 79th Ave	34	0.961	4.13
90F	Local Sub-basin	1	0.028	4.03
90FC	Combine 40DR, 90AR, 90F	190	5.370	4.17
90FR	Route 90FC in future Northern Ave 6' SD	189	5.342	4.17
90B	Local Sub-basin	4	0.113	4.23
90BC	Combine 90FR, 90B	193	5.455	4.17
90BR	Route 90BC in future Northern Ave 6' SD	193	5.455	4.20
90C	Local Sub-basin	6	0.170	4.03

Concentration Point	Description	Discharge (cfs)	Discharge (m^3/s)	Time of Peak (hrs)
90CC	Combine 90BR, 90C	197	5.568	4.17
90CR	Route 90CC in future Northern Ave 6' SD	197	5.568	4.20
80BR	Route 80BD South on 83rd Ave	0	0	4.63
90E	Local Sub-basin	17	0.480	4.10
90EC	Combine 80BR, 90E	17	0.480	4.10
90ER	Route 90EC South on 83rd Ave	17	0.480	4.13
90D	Local Sub-basin	1	0.028	4.10
90DC2	Combine 90CR, 90ER, 90D	214	6.049	4.20
90DR	Route 90DC2 in future Northern Ave 6' SD	214	6.049	4.23
120	Local Sub-basin	14	0.396	4.13
91C	Combine 90DR, 120	281	7.942	4.23
91DIV	Divert all but 12cfs into surge basin	269	7.603	2.10
91D	Remaining flow	12	0.339	2.10
91R	Route 91D in future Northern Ave 3.5' SD	12	0.339	2.17
140CDV	Divert flow in excess of 2-yr storm drain capacity and northern ave street capacity south on 87th Ave	0	0	2.17
160AR	Route remaining flow in proposed Northern Ave 3.5' SD	12	0.339	2.27
160AR2	Local Sub-basin	4	0.113	4.40
160B	Combine 160AR, 160AR2, 160B	8	0.226	4.47
160BC	Route 160BC in proposed Northern Ave 4' SD	23	0.650	4.43
160BR	Route 160BC in proposed Northern Ave 4' SD	23	0.650	4.47
200AC	Combine 180R, 200A	12	0.339	4.20
200AR	Route 200AC south in future 91st Ave 4' SD	12	0.339	4.23
200B	Local Sub-basin	2	0.057	4.13
200BC	Combine 160BR, 200AR, 200B	35	0.989	4.27

Concentration Point	Description	Discharge (cfs)	Discharge (m^3/s)	Time of Peak (hrs)
200BDV	Divert flow in excess of exist Northern Ave SD and street capacity south on 91st Ave	0	0	4.27
200BR	Route 200BC in exist Northern Ave 5' SD	35	0.989	4.30
210A	Local Sub-basin	4	0.113	4.20
210AC	Combine 200BR, 210A	39	1.102	4.30
210AR	Route 210AC in exist Northern Ave 5' SD	39	1.102	4.33
210B	Local Sub-basin	6	0.170	4.50
210BC	Combine 210AR, 210B @ Loop 101	44	1.244	4.33

*** O U T P U T D A T A ***

REVISED JUNE 1988 TO UPDATE COMPUTATION OF SHORT-DURATION VALUES

PRECIPITATION FREQUENCY VALUES FOR NORTHERN AVE 13459PRE
PRIMARY ZONE NUMBER= 7
SHORT-DURATION ZONE NUMBER= 8

LATITUDE 33.50N LONGITUDE 112.20W ELEVATION 1100 FEET

POINT VALUES

DURATION	RETURN PERIOD 2-YR	5-YR	10-YR	25-YR	50-YR	100-YR	500-YR	
5-MIN	.33	.41	.47	.55	.62	.68	.84	5-MIN
10-MIN	.49	.62	.71	.85	.95	1.05	1.29	10-MIN
15-MIN	.59	.78	.90	1.07	1.21	1.35	1.66	15-MIN
30-MIN	.79	1.04	1.21	1.45	1.64	1.83	2.26	30-MIN
1-HR	.96	1.28	1.50	1.81	2.05	2.28	2.83	1-HR
2-HR	1.04	1.40	1.65	2.00	2.26	2.53	3.14	2-HR
3-HR	1.10	1.49	1.75	2.12	2.41	2.69	3.35	3-HR
6-HR	1.20	1.64	1.94	2.36	2.68	3.00	3.74	6-HR
12-HR	1.30	1.82	2.17	2.66	3.03	3.40	4.26	12-HR
24-HR	1.40	2.00	2.40	2.95	3.38	3.80	4.78	24-HR

* IF YOUR SITE IS IN ARIZONA OR NEW MEXICO, PLEASE CONSULT THE FOLLOWING PAPER FOR REVISED DEPTH-AREA VALUES:
DEPTH-AREA RATIOS IN THE SEMI-ARID SOUTHWEST UNITED STATES
NOAA TECHNICAL MEMORANDUM NWS HYDRO-40
ZEHR AND MYERS
AUGUST 1984

INPUT DATA

PROJECT NAME=NORTHERN AVE 13459PRE
ZONE= 7 SHORT-DURATION ZONE= 8
LATITUDE= 33.50 LONGITUDE= 112.20 ELEVATION= 1100
2-YR, 6-HR PCPN= 1.20 100-YR, 6-HR PCPN=.3.00
2-YR, 24-HR PCPN= 1.40 100-YR, 24-HR PCPN= 3.80

Table 5. Catch Basin Hydrology

Basin Location	Contributing Area*		Drainage Length**		High Elevation		Low Elevation		Average Slope	C	Kb	i	10 year Q	
	(ac)	(ha)	(ft)	(m)	(ft)	(m)	(ft)	(m)	(m/m)			(in/hr)	(cfs)	(cms)
Northern Sta 0+211.318 Lt - Sta 0+213.318 Rt	0.848	0.343	671.53	204.682	1090.61	332.419	1088.61	331.809	0.0030	0.68	0.0404	4.0	2.3	0.065
Northern Sta 0+416.000 Lt - Sta 0+414.000 Rt	0.840	0.340	665.07	202.714	1092.57	333.016	1090.59	332.413	0.0030	0.68	0.0405	4.0	2.3	0.065
Northern Sta 0+616.974 Lt - Sta 0+616.714 Rt	0.681	0.275	539.00	164.286	1094.18	333.507	1092.57	333.016	0.0030	0.68	0.0410	4.3	2.0	0.056
Northern Sta 0+779.000 Lt - Sta 0+781.000 Rt	0.915	0.370	725.07	221.000	1096.02	334.068	1094.17	333.502	0.0026	0.68	0.0402	3.8	2.4	0.067
Northern Sta 1+022.561 Rt	0.920	0.372	706.82	215.439	1096.34	334.164	1095.08	333.780	0.0018	0.68	0.0402	3.6	2.3	0.064
Northern Sta 1+249.000 Lt - Sta 1+238.000 Rt	0.899	0.364	711.94	217.000	1098.94	334.957	1096.34	334.164	0.0037	0.68	0.0403	4.1	2.5	0.071
Northern Sta 1+632.000 Lt - Sta 1+630.000 Rt	0.733	0.297	580.71	177.000	1098.94	334.958	1098.06	334.690	0.0015	0.68	0.0408	3.7	1.8	0.052
Northern Sta 1+780.000 Lt - Sta 1+782.000 Rt	0.630	0.255	498.69	152.000	1098.07	334.693	1097.32	334.463	0.0015	0.68	0.0413	3.9	1.7	0.047
Northern Sta 1+980.000 Lt - Sta 1+980.000 Rt	1.193	0.483	744.76	227.004	1097.46	334.505	1096.34	334.164	0.0015	0.68	0.0395	3.5	2.8	0.080
Northern Sta 2+207.004 Lt - Sta 2+205.000 Rt	0.849	0.344	672.57	205.000	1098.45	334.809	1097.45	334.502	0.0015	0.68	0.0404	3.6	2.1	0.059
Northern Sta 2+410.000 Lt - Sta 2+410.000 Rt	0.780	0.315	617.41	188.187	1102.92	336.170	1098.45	334.809	0.0072	0.68	0.0407	4.7	2.5	0.071
Northern Sta 2+620.457 Lt - Sta 2+620.457 Rt	0.855	0.346	654.67	199.543	1104.56	336.669	1102.58	336.065	0.0030	0.68	0.0404	4.1	2.4	0.067
Northern Sta 2+820.000 Lt - Sta 2+820.000 Rt	0.828	0.335	656.17	200.000	1107.06	337.432	1104.55	336.667	0.0038	0.68	0.0405	4.2	2.4	0.067
Northern Sta 3+020.000 Lt - Sta 3+011.000 Rt	0.907	0.367	718.50	219.000	1110.16	338.376	1107.06	337.432	0.0043	0.68	0.0403	4.2	2.6	0.073
Northern Sta 3+230.000 Lt - Sta 3+230.000 Rt	0.828	0.335	656.17	200.000	1113.11	339.275	1110.16	338.376	0.0045	0.68	0.0405	4.3	2.4	0.069
Northern Sta 3+430.000 Lt - Sta 3+430.000 Rt	0.870	0.352	688.98	210.000	1116.20	340.219	1113.11	339.275	0.0045	0.68	0.0404	4.3	2.5	0.072
Northern Sta 3+640.000 Lt - Sta 3+640.000 Rt	0.870	0.352	688.98	210.000	1119.30	341.163	1116.20	340.219	0.0045	0.68	0.0404	4.3	2.5	0.072
Northern Sta 3+850.000 Lt - Sta 3+850.000 Rt	0.828	0.335	656.17	200.000	1122.25	342.062	1119.30	341.163	0.0045	0.68	0.0405	4.3	2.4	0.069
Northern Sta 4+050.000 Lt - Sta 4+050.000 Rt	0.814	0.329	644.69	196.500	1127.71	343.727	1122.25	342.062	0.0085	0.68	0.0406	4.8	2.7	0.075
Northern Sta 4+430.000 Lt - Sta 4+430.000 Rt	0.746	0.302	590.55	180.000	1131.43	344.861	1130.04	344.436	0.0024	0.68	0.0408	4.0	2.0	0.057
Northern Sta 4+610.000 Lt - Sta 4+610.000 Rt	0.725	0.293	574.15	175.000	1132.77	345.269	1131.43	344.861	0.0023	0.68	0.0409	4.0	2.0	0.056
Northern Sta 4+785.000 Lt - Sta 4+785.000 Rt	0.882	0.357	698.82	213.000	1134.42	345.770	1132.77	345.269	0.0024	0.68	0.0403	3.8	2.3	0.065
Northern Sta 4+998.000 Lt - Sta 4+998.000 Rt	0.828	0.335	656.17	200.000	1135.73	346.170	1134.42	345.770	0.0020	0.68	0.0405	3.8	2.1	0.061
Northern Sta 5+035.000 Lt	0.828	0.335	656.17	200.000	1135.70	346.162	1134.39	345.762	0.0020	0.68	0.0405	3.8	2.1	0.061
83rd Ave. Sta 9+977.781 Lt - Sta 9+977.781 Rt	0.301	0.122	328.08	100.000	1121.23	341.752	1102.36	335.998	0.0575	0.68	0.0433	5.6	1.1	0.032
83rd Ave. Sta 10+022.868 Lt - Sta 10+022.868 Rt	0.603	0.244	656.17	200.000	1111.41	338.759	1102.36	335.999	0.0138	0.68	0.0414	5.1	2.1	0.059
89th Ave. Sta 10+020.388 Lt - Sta 10+020.388 Rt	0.603	0.244	656.17	200.000	1099.66	335.176	1098.28	334.756	0.0021	0.68	0.0414	3.8	1.6	0.044

* Based on length @ ½ width of R/W (16.67 m for Northern Avenue and 12.19 m for 83rd and 89th Avenue)

** Distance from the current catch basins to the catch basins immediately upstream, or
from the current catch basins to the future upstream catch basins, or
from the current catch basins to the upstream limit of contributing area

Table 6. Catch Basin Hydraulics

Basin Location	By-pass Q (cms)	Design Q (cms)	Roadway Slope* (m/m)	Actual Depth (mm)	Flow Spread (m)	Average Velocity (m/s)	Basin Condition	Length of Opening (m)	Flow Captured (cms)	Flow By-passed (cms)	Catch Basin Specifications
Northern Sta 0+211.318 Lt - Sta 0+213.318 Rt	0.000	0.065	0.00298	88.6	3.590	0.490	On-Grade	2.743	0.065	0.000	C.O.P Detail P-1569, Type M-1, L=1.829 m
Northern Sta 0+416.000 Lt - Sta 0+414.000 Rt	0.000	0.065	0.00298	88.6	3.590	0.490	On-Grade	2.743	0.065	0.000	C.O.P Detail P-1569, Type M-1, L=1.829 m
Northern Sta 0+616.974 Lt - Sta 0+616.714 Rt	0.000	0.056	0.00298	84.5	3.386	0.474	On-Grade	2.743	0.056	0.000	C.O.P Detail P-1569, Type M-1, L=1.829 m
Northern Sta 0+779.000 Lt - Sta 0+781.000 Rt	0.000	0.067	0.00298	89.5	3.633	0.494	On-Grade	2.743	0.067	0.000	C.O.P Detail P-1569, Type M-1, L=1.829 m
Northern Sta 1+022.561 Rt	0.000	0.064	N/A	66.2	0.374	N/A	Sump	2.743	0.064	0.000	C.O.P Detail P-1569, Type M-1, L=1.829 m
Northern Sta 1+249.000 Lt - Sta 1+238.000 Rt	0.000	0.071	0.00365	88.2	3.572	0.541	On-Grade	2.743	0.071	0.000	C.O.P Detail P-1569, Type M-1, L=1.829 m
Northern Sta 1+632.000 Lt - Sta 1+630.000 Rt	0.000	0.052	0.00151	92.0	3.759	0.359	On-Grade	2.743	0.052	0.000	C.O.P Detail P-1569, Type M-1, L=1.829 m
Northern Sta 1+780.000 Lt - Sta 1+782.000 Rt	0.000	0.047	0.00151	89.1	3.613	0.350	On-Grade	2.743	0.047	0.000	C.O.P Detail P-1569, Type M-1, L=1.829 m
Northern Sta 1+980.000 Lt - Sta 1+980.000 Rt	0.000	0.080	N/A	76.8	0.462	N/A	Sump	2.743	0.080	0.000	C.O.P Detail P-1569, Type M-1, L=1.829 m
Northern Sta 2+207.004 Lt - Sta 2+205.000 Rt	0.000	0.059	0.00150	95.9	3.953	0.369	On-Grade	2.743	0.059	0.000	C.O.P Detail P-1569, Type M-1, L=1.829 m
Northern Sta 2+410.000 Lt - Sta 2+410.000 Rt	0.000	0.071	0.00150	101.8	4.248	0.386	On-Grade	2.743	0.071	0.000	C.O.P Detail P-1569, Type M-1, L=1.829 m
Northern Sta 2+620.457 Lt - Sta 2+620.457 Rt	0.000	0.067	0.00304	89.2	3.619	0.498	On-Grade	2.743	0.067	0.000	C.O.P Detail P-1569, Type M-1, L=1.829 m
Northern Sta 2+820.000 Lt - Sta 2+820.000 Rt	0.002	0.069	0.00304	90.0	3.661	0.501	On-Grade	2.743	0.069	0.000	C.O.P Detail P-1569, Type M-1, L=1.829 m
Northern Sta 3+020.000 Lt - Sta 3+011.000 Rt	0.001	0.074	0.00450	86.5	3.484	0.592	On-Grade	2.743	0.072	0.002	C.O.P Detail P-1569, Type M-1, L=1.829 m
Northern Sta 3+230.000 Lt - Sta 3+230.000 Rt	0.002	0.071	0.00450	85.4	3.428	0.586	On-Grade	2.743	0.070	0.001	C.O.P Detail P-1569, Type M-1, L=1.829 m
Northern Sta 3+430.000 Lt - Sta 3+430.000 Rt	0.002	0.074	0.00450	86.5	3.484	0.592	On-Grade	2.743	0.072	0.002	C.O.P Detail P-1569, Type M-1, L=1.829 m
Northern Sta 3+640.000 Lt - Sta 3+640.000 Rt	0.002	0.074	0.00450	86.5	3.484	0.592	On-Grade	2.743	0.072	0.002	C.O.P Detail P-1569, Type M-1, L=1.829 m
Northern Sta 3+850.000 Lt - Sta 3+850.000 Rt	0.006	0.075	0.00450	86.9	3.503	0.594	On-Grade	2.743	0.073	0.002	C.O.P Detail P-1569, Type M-1, L=1.829 m
Northern Sta 4+050.000 Lt - Sta 4+050.000 Rt	0.000	0.075	0.00975	76.8	3.001	0.801	On-Grade	2.743	0.069	0.006	C.O.P Detail P-1569, Type M-1, L=1.829 m
Northern Sta 4+430.000 Lt - Sta 4+430.000 Rt	0.000	0.057	0.00235	88.0	3.558	0.438	On-Grade	2.743	0.057	0.000	C.O.P Detail P-1569, Type M-1, L=1.829 m
Northern Sta 4+610.000 Lt - Sta 4+610.000 Rt	0.000	0.056	0.00235	87.5	3.533	0.436	On-Grade	2.743	0.056	0.000	C.O.P Detail P-1569, Type M-1, L=1.829 m
Northern Sta 4+785.000 Lt - Sta 4+785.000 Rt	0.000	0.065	0.00235	91.7	3.746	0.452	On-Grade	2.743	0.065	0.000	C.O.P Detail P-1569, Type M-1, L=1.829 m
Northern Sta 4+998.000 Lt - Sta 4+998.000 Rt	0.000	0.061	0.00235	89.9	3.654	0.445	On-Grade	2.743	0.061	0.000	C.O.P Detail P-1569, Type M-1, L=1.829 m
Northern Sta 5+035.000 Lt	0.000	0.061	0.00222	91.0	3.710	0.432	On-Grade	2.743	0.061	0.000	C.O.P Detail P-1569, Type M-1, L=1.829 m
83rd Ave. Sta 9+977.781 Lt - Sta 9+977.781 Rt	0.000	0.032	N/A	41.7	0.236	N/A	Sump	2.743	0.032	0.000	C.O.P Detail P-1569, Type M-1, L=1.829 m
83rd Ave. Sta 10+022.868 Lt - Sta 10+022.868 Rt	0.000	0.059	N/A	62.7	0.355	N/A	Sump	2.743	0.059	0.000	C.O.P Detail P-1569, Type M-1, L=1.829 m
89th Ave. Sta 10+020.388 Lt - Sta 10+020.388 Rt	0.000	0.044	0.00210	82.8	3.298	0.391	On-Grade	2.743	0.044	0.000	C.O.P Detail P-1569, Type M-1, L=1.829 m

* Slope @ catch basin

Assume:
1. Cross section geometry per typical road section
2. n=0.015
3. local gutter depression of 50.8 mm (2 inches)
4. 80% efficiency

ARIZONA DEPARTMENT OF TRANSPORTATION
BRIDGE DRAINAGE SECTION

01-22-1998

PROJECT NAME- NORTHERN AVENUE TRACS NO.-
HIGHWAY NAME- " " DESIGNER - GSB
LOCATION - LOOP 101 — 67TH AVENUE CHECKER -
METRIC VER 1.02 January 1996

CURB OPENING INLET -- ON GRADE

GUTTER FLOW HYDRAULICS
GUTTER DESCRIPTION

Roadway Grade-% Per cent--G	=	0.10
Roadway Cross-Slope--m/m--Sx	=	0.020
Shoulder Width--m--	=	1.000
Shoulder Slope--m/m--Ss	=	0.020
Gutter Width--m--W	=	0.431
Gutter Slope--m/m--Sw	=	0.059
Gutter Depression-millimeter--	=	25.4
Manning's 'N	=	0.015
Flow-m^3/s--Q	=	0.0712
SPREAD--m--T	=	4.600
Average Velocity--m/s--V	=	0.331
FLOW in Gutter-m^3/s--	=	0.0185
% Flow in Gutter-	=	26.0
Velocity of Flow in Gutter-m/s	=	0.446
Depth at Curb Line--mm--d	=	108.8

CURB OPENING--ADOT STD. C-15.20

Capture Ratio -- CURB OPENING	=	0.80
Local Gutter Depression-mm--	=	50.8
Flow-m^3/s--Q	=	0.0712
Gutter Velocity at INLET-m/s	=	0.516
Gutter FLOW at INLET-m^3/s--	=	0.0260
Depth at INLET Curb Line-mm--d	=	154.8
Length of opening: TOTAL Intercept--m	=	2.449

LENGTH	Efficiency	Q(Captured)	Q(By-Pass)
0.940	0.582	0.0414	0.0298
2.007	0.954	0.0679	0.0033
2.921	1.000	0.0712	0.0000
4.140	1.000	0.0712	0.0000
6.274	1.000	0.0712	0.0000

ARIZONA DEPARTMENT OF TRANSPORTATION
BRIDGE DRAINAGE SECTION

01-22-1998

PROJECT NAME- NORTHERN AVENUE TRACS NO.- _____
HIGHWAY NAME- " " DESIGNER - GSB
LOCATION - LOOP 101 TO 67TH AVENUE CHECKER - _____
METRIC VER 1.02 January 1996

CURB OPENING INLET -- ON GRADE

GUTTER FLOW HYDRAULICS
GUTTER DESCRIPTION

Roadway Grade-% Per cent--G	=	0.30
Roadway Cross-Slope--m/m--Sx	=	0.020
Shoulder Width--m--	=	1.000
Shoulder Slope--m/m--Ss	=	0.020
Gutter Width--m--W	=	0.431
Gutter Slope--m/m--Sw	=	0.059
Gutter Depression-millimeter--	=	25.4
Manning's 'N	=	0.015
Flow-m^3/s--Q	=	0.1233
SPREAD--m--T	=	4.600
Average Velocity--m/s--V	=	0.573
FLOW in Gutter-m^3/s--	=	0.0320
% Flow in Gutter-	=	26.0
Velocity of Flow in Gutter-m/s	=	0.772
Depth at Curb Line--mm--d	=	108.8

CURB OPENING--ADOT STD. C-15.20

Capture Ratio -- CURB OPENING	=	0.80
Local Gutter Depression-mm--	=	50.8
Flow-m^3/s--Q	=	0.1233
Gutter Velocity at INLET-m/s	=	0.894
Gutter FLOW at INLET-m^3/s--	=	0.0450
Depth at INLET Curb Line-mm--d	=	154.9
Length of opening: TOTAL Intercept--m	=	4.289

LENGTH	Efficiency	Q(Captured)	Q(By-Pass)
0.940	0.359	0.0443	0.0790
2.007	0.679	0.0837	0.0396
2.921	0.872	0.1075	0.0158
4.140	0.998	0.1230	0.0003
6.274	1.000	0.1233	0.0000

ARIZONA DEPARTMENT OF TRANSPORTATION
BRIDGE DRAINAGE SECTION

01-27-1998

PROJECT NAME- NORTHERN AVENUE TRACS NO.- _____
HIGHWAY NAME- " " DESIGNER - GSS
LOCATION - LOOP 101 TO 67TH AVENUE CHECKER - _____
METRIC VER 1.02 January 1996

CURB OPENING INLET -- ON GRADE

GUTTER FLOW HYDRAULICS
GUTTER DESCRIPTION

Roadway Grade-% Per cent--G	=	0.30
Roadway Cross-Slope--m/m--Sx	=	0.020
Shoulder Width--m--	=	1.000
Shoulder Slope--m/m--Ss	=	0.020
Gutter Width--m--W	=	0.431
Gutter Slope--m/m--Sw	=	0.059
Gutter Depression-millimeter--	=	25.4
Manning's 'N	=	0.015
Flow-m^3/s--Q	=	0.0640
SPREAD--m--T	=	3.564
Average Velocity--m/s--V	=	0.490
FLOW in Gutter-m^3/s--	=	0.0214
% Flow in Gutter-	=	33.4
Velocity of Flow in Gutter-m/s	=	0.658
Depth at Curb Line--mm--d	=	88.0

CURB OPENING--ADOT STD. C-15.20

Capture Ratio -- CURB OPENING	=	0.80
Local Gutter Depression-mm--	=	50.8
Flow-m^3/s--Q	=	0.0640
Gutter Velocity at INLET-m/s	=	0.784
Gutter FLOW at INLET-m^3/s--	=	0.0319
Depth at INLET Curb Line-mm--d	=	132.5
Length of opening: TOTAL Intercept--m	=	2.820

LENGTH	Efficiency	Q(Captured)	Q(By-Pass)
0.940	0.518	0.0331	0.0309
2.007	0.893	0.0572	0.0068
2.921	1.000	0.0640	0.0000
4.140	1.000	0.0640	0.0000
6.274	1.000	0.0640	0.0000

ARIZONA DEPARTMENT OF TRANSPORTATION
BRIDGE DRAINAGE SECTION

01-22-1998

PROJECT NAME- NORTHERN AVENUE TRACS NO.- _____
HIGHWAY NAME- " " DESIGNER - GSB
LOCATION - LOOP 101 TO 67TH AVENUE CHECKER - _____
METRIC VER 1.02 January 1996

CURB OPENING INLET -- ON GRADE

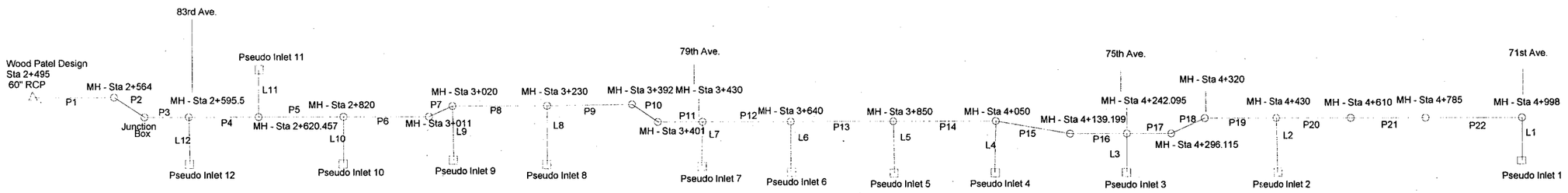
GUTTER FLOW HYDRAULICS
GUTTER DESCRIPTION

Roadway Grade-% Per cent--G	=	1.50
Roadway Cross-Slope--m/m--Sx	=	0.020
Shoulder Width--m--	=	1.000
Shoulder Slope--m/m--Ss	=	0.020
Gutter Width--m--W	=	0.431
Gutter Slope--m/m--Sw	=	0.059
Gutter Depression-millimeter--	=	25.4
Manning's 'N	=	0.015
Flow-m^3/s--Q	=	0.2757
SPREAD--m--T	=	4.600
Average Velocity--m/s--V	=	1.281
FLOW in Gutter-m^3/s--	=	0.0716
% Flow in Gutter-	=	26.0
Velocity of Flow in Gutter-m/s	=	1.727
Depth at Curb Line--mm--d	=	108.8

CURB OPENING--ADOT STD. C-15.20

Capture Ratio -- CURB OPENING	=	0.80
Local Gutter Depression-mm--	=	50.8
Flow-m^3/s--Q	=	0.2757
Gutter Velocity at INLET-m/s	=	1.999
Gutter FLOW at INLET-m^3/s--	=	0.1007
Depth at INLET Curb Line-mm--d	=	154.9
Length of opening: TOTAL Intercept--m	=	9.745

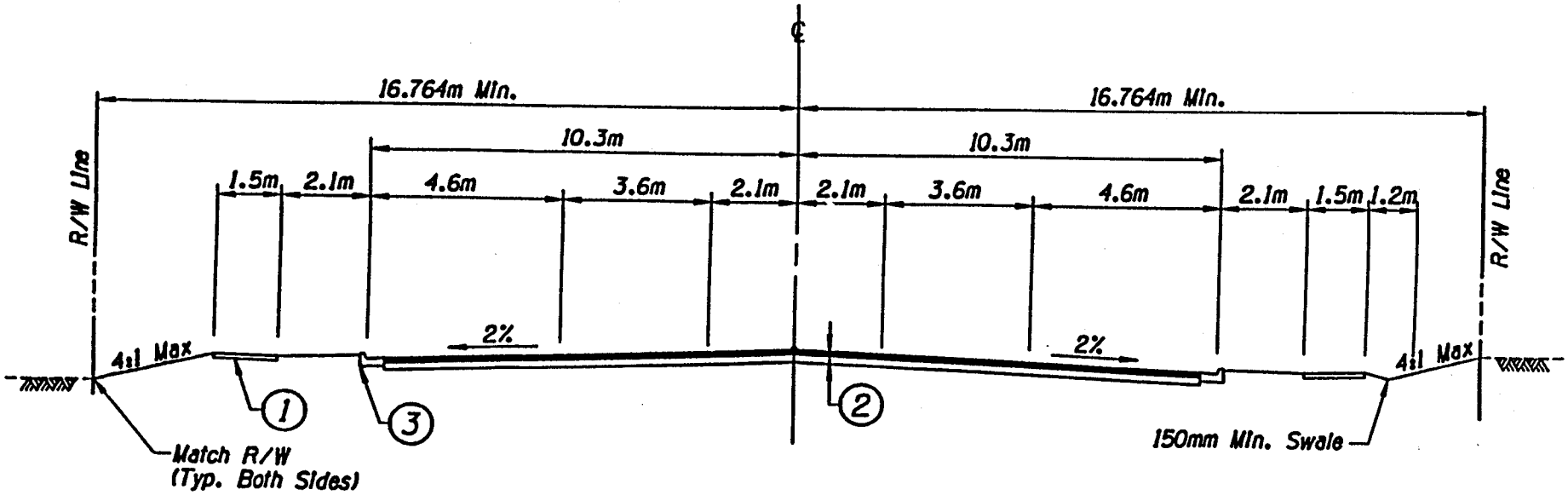
LENGTH	Efficiency	Q(Captured)	Q(By-Pass)
0.940	0.167	0.0460	0.2297
2.007	0.340	0.0936	0.1820
2.921	0.473	0.1305	0.1452
4.140	0.630	0.1738	0.1019
6.274	0.844	0.2327	0.0430



Pseudo inlets are used to adjust flows in the trunk line

Table 7. Northern Avenue Storm Pipe Analysis Results

Pipe	-Node- Upstream Downstream	-Ground- Upstream (m) Downstream (m)	-HGL- Upstream (m) Downstream (m)	-Slope- Energy (m/m) Constructed (m/m)	-Section- Discharge (m³/s) Capacity (m³/s)	-Section- Shape Size	Length (m)	Discharge (m³/s)	Average Velocity (m/s)	Capacity (m³/s)
P22	MH - Sta 4+998	345.964	344.673	0.000728	0.5097	Circular	213.0	0.5097	0.78	1.3349
	MH - Sta 4+785	345.465	344.517	0.004996	1.3349	900 mm				
P21	MH - Sta 4+785	345.465	344.487	0.000728	0.5097	Circular	175.0	0.5097	0.78	1.3354
	MH - Sta 4+610	345.055	344.359	0.005000	1.3354	900 mm				
P20	MH - Sta 4+610	345.055	344.328	0.000728	0.5097	Circular	180.0	0.5097	0.78	1.3354
	MH - Sta 4+430	344.633	344.197	0.005000	1.3354	900 mm				
P19	MH - Sta 4+430	344.633	343.990	0.005707	2.1521	Circular	110.0	2.1521	2.41	1.5627
	MH - Sta 4+320	344.296	343.363	0.003009	1.5627	1050 mm				
P18	MH - Sta 4+320	344.296	343.185	0.005707	2.1521	Circular	25.3	2.1521	2.41	1.5197
	MH - Sta 4+296.115	344.000	343.041	0.002846	1.5197	1050 mm				
P17	MH - Sta 4+296.115	344.000	342.864	0.005707	2.1521	Circular	54.0	2.1521	2.41	1.5601
	MH - Sta 4+242.095	343.800	342.555	0.002999	1.5601	1050 mm				
P16	MH - Sta 4+242.095	343.800	342.341	0.002569	3.7378	Circular	102.9	3.7378	2.05	4.8004
	MH - Sta 4+139.199	343.200	342.077	0.004237	4.8004	1500 mm				
P15	MH - Sta 4+139.199	343.200	341.970	0.002569	3.7378	Circular	89.5	3.7378	2.05	6.7463
	MH - Sta 4+050	342.215	341.740	0.008369	6.7463	1500 mm				
P14	MH - Sta 4+050	342.215	341.582	0.003164	4.1484	Circular	200.0	4.1484	2.27	6.7568
	MH - Sta 3+850	341.316	340.949	0.008395	6.7568	1500 mm				
P13	MH - Sta 3+850	341.316	340.790	0.003822	4.5590	Circular	210.0	4.5590	2.50	6.7550
	MH - Sta 3+640	340.372	339.987	0.008390	6.7550	1500 mm				
P12	MH - Sta 3+640	340.372	339.798	0.004541	4.9696	Circular	210.0	4.9696	2.72	6.7569
	MH - Sta 3+430	339.428	338.844	0.008395	6.7569	1500 mm				
P11	MH - Sta 3+430	339.428	338.622	0.005323	5.3802	Circular	29.0	5.3802	2.95	6.7505
	MH - Sta 3+401	339.297	338.468	0.008379	6.7505	1500 mm				
P10	MH - Sta 3+401	339.297	338.340	0.002013	5.3802	Circular	13.0	5.3802	2.05	1.8217
	MH - Sta 3+392	339.199	338.314	0.000231	1.8217	1800 mm				
P9	MH - Sta 3+392	339.199	338.185	0.002013	5.3802	Circular	162.0	5.3802	2.05	2.6814
	MH - Sta 3+230	338.471	337.859	0.000500	2.6814	1800 mm				
P8	MH - Sta 3+230	338.471	337.747	0.002116	5.5161	Circular	210.0	5.5161	2.10	2.6814
	MH - Sta 3+020	337.527	337.302	0.000500	2.6814	1800 mm				
P7	MH - Sta 3+020	337.527	337.114	0.002221	5.6520	Circular	12.8	5.6520	2.15	2.2233
	MH - Sta 3+011	337.550	337.085	0.000344	2.2233	1800 mm				
P6	MH - Sta 3+011	337.550	336.896	0.002221	5.6520	Circular	191.0	5.6520	2.15	2.6828
	MH - Sta 2+820	336.865	336.472	0.000501	2.6828	1800 mm				
P5	MH - Sta 2+820	336.865	336.349	0.002311	5.7650	Circular	200.0	5.7650	2.19	2.6761
	MH - Sta 2+620.457	336.231	335.887	0.000498	2.6761	1800 mm				
P4	MH - Sta 2+620.457	336.231	335.759	0.002403	5.8780	Circular	24.5	5.8780	2.24	2.6978
	MH - Sta 2+595.5	336.152	335.700	0.000506	2.6978	1800 mm				
P3	MH - Sta 2+595.5	336.152	335.540	0.002515	6.0139	Circular	11.5	6.0139	2.29	2.6931
	Junction Box	336.000	335.511	0.000504	2.6931	1800 mm				
P2	Junction Box	336.000	335.190	0.002515	6.0139	Circular	22.0	6.0139	2.29	2.5567
	MH - Sta 2+564	335.892	335.135	0.000455	2.5567	1800 mm				
P1	MH - Sta 2+564	335.892	334.975	0.002515	6.0139	Circular	69.1	6.0139	2.29	2.6757
	60" RCP	336.000	334.801	0.000498	2.6757	1800 mm				



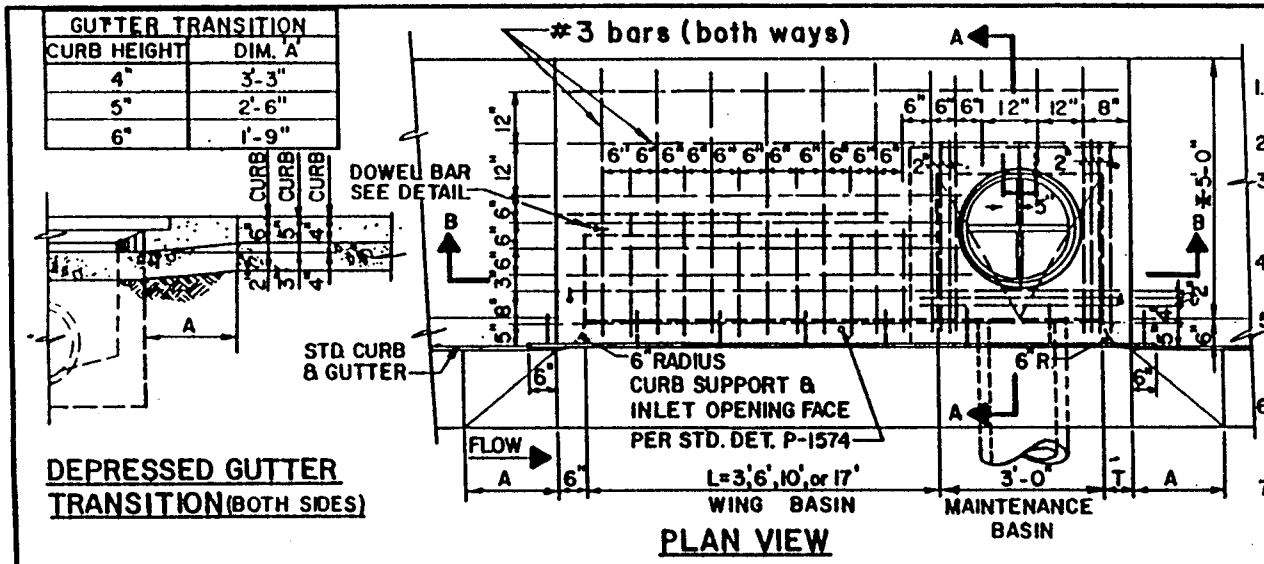
Northern Avenue Typical Section
Urban Minor Arterial Road

(1) Typical Location of Future Sidewalk. Except at Street Intersections (Typ. Both Sides).

(2) 100mm Min. A.C. Over 250mm Min. A.B. or Approved Equivalent.

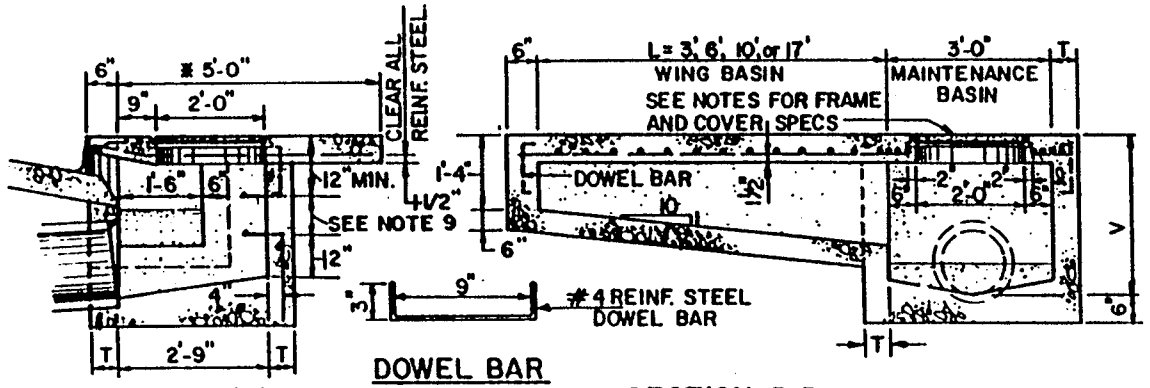
(3) MAG Std. Detail 220, Type A Curb & Gutter (Typ. Both Sides)

GUTTER TRANSITION	
CURB HEIGHT	DIM. 'A'
4"	3'-3"
5"	2'-6"
6"	1'-9"



DEPRESSED GUTTER TRANSITION (BOTH SIDES)

PLAN VIEW



NOTES

1. TYPES ARE DESIGNATED AS FOLLOWS; 'M'- NO WING, 'M-1'- ONE WING, 'M-2'- TWO WINGS.
2. ALL CONCRETE SHALL BE CLASS 'A'.
3. ALL REINFORCING STEEL SHALL BE DEFORMED BARS AND SHALL CONFORM TO A.S.T.M. SPECIFICATION 615.
4. CONNECTOR PIPES SHALL BE PLACED IN THE APPROPRIATE WALL OF THE MAINTENANCE BASIN.
5. FLOOR OF BASIN SHALL BE TROWELLED TO A HARD, SMOOTH SURFACE AND SHALL SLOPE FROM ALL DIRECTIONS TO OUTLET.
6. CONSTRUCTION DRAINS SHALL BE INSTALLED IN ALL INLETS BUILT WITH PAVING PROJECTS. (SEE DET. P-1575.)
7. LOCATE WING BASIN ON UPSTREAM SIDE OF MAINTENANCE BASIN FOR TYPE M-1. WING BASINS FOR TYPE M-2 SHALL BE BOTH SIDES OF MAINTENANCE BASIN.
8. STEPS (M.A.G. DET. 428 POLYPROPYLENE) – V=3' (INCL.), PLACE ONE STEP 12" ABOVE THE FLOOR OF THE BASIN. V OVER 3', PLACE STEPS AT 12" INTERVALS FROM THE FLOOR OF THE BASIN WITH THE TOP STEP AT 12" (MIN.) BELOW THE TOP OF THE GRATE.
9. ACCESS FRAME AND COVER PER DET. P-1561

CATCH BASIN WALL THICKNESS
T=6" IF V=4' OR LESS
T=8" IF V=4' TO 8'
(IF V EXCEEDS 8', SPECIAL DESIGN IS REQUIRED.)
L=0 UNLESS SPECIFIED ON THE PLANS
V=3'-6" MIN. WHEN L=0: 3' OR 6'
V=4'-0" MIN WHEN L=10' OR 17'

* 4'-0" IN LOCATIONS WHERE 4' SIDEWALK IS REQ'D.

DETAIL NO. P-1569	CITY OF PHOENIX STANDARD DETAIL	CATCH BASIN TYPE 'M'	APPROVED CITY ENGINEER 4/8/81 DATE	DETAIL NO. P-1569