DESIGN DATA REPORT
for the
CACTUS ROAD STORM DRAIN
(67th Avenue to the Agua Fria Freeway)

Prepared for the

FLOOD CONTROL DISTRICT
of
Maricopa County

• CITY of PEORIA

• CITY of GLENDALE

November 1992

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DESIGN DATA REPORT SUMMARY

This report is merely a combination of appendices, each established to define a portion of the design. Appendix A contains the Alternate Conduit Section and Materials Comparison Report. This report reviews the alternative conduit materials and recommends reinforced concrete pipe at the point in time the report was written.

The supporting data for the Glendale-Peoria Drainage Master Plan could not be located. Therefore, SFC Engineering Company performed a new hydrologic study using the Flood Control District of Maricopa County Hydrologic Design Manual (September 1990). Appendix B contains a summary of this work. A complete report with calculations has been submitted separately and only the summary is included here.

Appendices C, D, and E are tied together. Appendix C presents the background information for calculating the hydraulic profile and sizing criteria for the storm drain. The computer runs from the "STORM" computer program used to generate the hydraulic profile are located in appendix E. Appendix C also provides a sketch of the final hydraulic grade line based on data from the STORM program and additional background information required to design the catchbasins. Appendix D contains all the calculations for: 1) sizing the Q (flow) for each catchbasin, and 2) sizing the catchbasin based on that flow. Appendices D and E are composed almost entirely of calculations with the explanation for those calculations found in appendix C.

Appendix F includes all the comments and responses for the 65 percent and the 95 percent submittals.

DESIGN DATA REPORT
for the

CACTUS ROAD STORM DRAIN

(67th Avenue to the Agua Fria Freeway)

APPENDIX A-
Alternate Conduit Section & Materials Comparison Report

CACTUS ROAD STORM DRAIN

ALTERNATE CONDUIT SECTION & MATERIAL COMPARISON REPORT

FOR

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

JUNE 1992

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CACTUS ROAD STORM DRAIN
ALTERNATIVE CONDUIT SECTION AND
MATERIAL EVALUATION REPORT

1. INTRODUCTION

The Cactus Road Storm Drain project consists of constructing a storm drain trunkline along Cactus Road from 67th Avenue to the Agua Fria Outer Loop Freeway (figure 1) capable of handling the 10-year storm event. As a portion of the design services to be performed, various conduit materials and sections have been evaluated to determine those that would be most suitable for this particular installation.

Final design flows, established using the Flood Control District of Maricopa County Hydrologic Design Manual, vary from 213 cfs at the upstream end (67th Avenue) to 1,000 cfs at the downstream end (Agua Fria Outer Loop). Corresponding pipe diameters, for a pipe flowing full but with nominal hydraulic pressure, will vary from 78 to 120 inch. Comparable box conduit sizes would vary from 7 ft x 5 ft to 10 ft x 9 ft.

Final alignment of the storm drain, both horizontally and vertically, is affected by the existing utilities in Cactus Road. However, a minimum 4-foot cover will be maintained with total trench depth for the 78- to 120-inch diameter pipe varying from about 11 to 20 ft. The variety of utilities located in and crossing Cactus Road include natural gas lines, sanitary sewer service lines, 18 and 30 inch sanitary sewer collection lines, water distribution and service lines, cable television lines, Salt River Project irrigation pipelines, telephone service lines, electric service lines, and a 7.2 kV electric line. All effort to avoid these utilities will be made. However, the mere existence of significant numbers of utilities has an impact on the selection of precast versus cast-in-place conduit materials.

Soil samples have been taken along the storm drain alignment and analyzed. A soils report has been prepared defining the types and nature of the soils along the storm drain alignment. Based on soils data, certain conduit materials may be deemed unsuitable. Section 4 presents the basic soils data and the potential impact on the conduit alternatives.

2. STORM DRAIN CONDUIT ALTERNATIVES

The basic design criteria for the storm drain include:

- 10-year return period storm.
- 75- to 100-year life of conduit material.
- Ability to carry flow rates varying from 213 to 1,000 cfs.
- Full flowing pipe at full capacity.
- Hydraulic grade line must be maintained below road elevation and elevation required to drain local catch basins.
- Minimize traffic interference.
- Reasonable construction time frame.

Based on this criteria, five conduit materials have been deemed suitable for evaluation as possible construction alternatives:

- Reinforced Concrete Pipe (RCP).
- Concrete-Lined Corrugated Metal Pipe (CLCMP).
- Precast Box.
- Cast-In-Place Pipe (CIPP).
- Cast-In-Place Box (CIP Box).

3. EVALUATION OF STORM DRAIN CONDUIT ALTERNATIVES

In this section, the five conduit material alternatives will be evaluated on the design criteria listed above.

3.1 Reinforced Concrete Pipe (RCP)

Of the five conduit materials RCP is by far the most common material for installations that require the shortest construction time with the greatest flexibility to be routed around utilities. This material has an excellent track record for durability and minimal long-term maintenance, particularly in these diameters. RCP manufacturers claim that for all practical purposes, their material will last forever; not technically true, but with proper construction and installation, the life of the pipe far exceeds a 75- to 100-year life. Good quality control during construction of the pipeline material itself can be maintained without strict field inspection because the pipe is constructed in a factory and not on-site. In addition, the pipe is a rigid structure and the backfill requirements can be much less stringent than for other conduit materials, further easing field inspection requirements. Other advantages include: (1) a wide variety of local manufacturers providing good availability with a fair amount of competition between manufacturer's prices; (2) relatively fast installation and therefore reduced traffic control problems; and (3) invert erosion in high-sediment conditions is seldom a problem.

The greatest disadvantage to RCP is associated with the rigid nature of the pipe and the resulting installation considerations. To achieve the rigid structure of RCP, large quantities of rebar and concrete are used that make the pipe heavy and hard to handle. To provide reasonable manageability, pipe segments are kept short. In these diameters (78 to 120 inches) the pipe lengths are kept between 6 and 12 ft depending on the equipment and weight capacity of the particular job and contractor. Even with the reduced pipe segment lengths, each piece of pipe is relatively heavy requiring the use of one or two large cranes for installation. The delivery costs are also increased due to the reduced number of pipe segments that can be delivered to the job site at one time. Table 1 further evaluates the weight considerations of RCP in relationship to other conduit materials. Section 5 fully evaluates the cost comparison of RCP to other conduit materials in terms of material cost (including delivery to the job site), installation cost and long-term Operation and Maintenance (O&M) cost.

3.2 Concrete-Lined Corrugated Metal Pipe (CLCMP)

3.2.1 Introduction to CLCMP. Corrugated Metal Pipe (CMP) is a conduit material that has been used extensively in short road crossing culvert situations that have not required an extremely long design life nor stringent hydraulic requirements. Relatively recent design changes or improvements have led to the use of CMP for longer storm drains and for locations that require a longer life. These improvements include use of aluminized coating and lining for corrosion protection and concrete lining for improved hydraulic performance in a given diameter.

Traditionally, CMP was constructed with no coating/lining, an asphalt coating/lining or a galvanized coating/lining. The life of the pipe is extended with coatings and linings, but neither asphalt nor galvanizing has allowed the CMP to be functional for more than 50 years in many installations. Aluminized coatings/linings appear to greatly extend metal life and reduce replacement requirements. G.E. Morris and L. Bednar prepared an evaluation of aluminized versus galvanized coatings for Armco, the predecessor to Contech Construction Products, Inc. (Contech) and the largest distributor of CLCMP in the area (appendix A1). The evaluation was based on 30-year field tests of drainage pipelines protected by aluminized and galvanized coatings, located and exposed together, in 54 sites and originally installed in 1952. The aluminized coating far out-performed the galvanized coating both on the interior and the exterior in all moisture conditions (extremely wet, moderate and dry climates) and in all soil conditions (moderately corrosive to severely corrosive). Aluminized coatings showed no attack or only minor localized coating loss with associated slight substrate penetration on the soil side. These studies helped provide guidelines for the suitability of aluminized coatings in various soil and drainage water conditions. Aluminized CMP is still not recommended for highly corrosive soils; resistivities below 1,500 ohm-cm and a pH range of 5 to 9. (It is already recognized that galvanized protection performs better than asphalt and aluminized coatings are also more durable than asphalt coatings. Aluminized coatings also perform better than asphalt coatings with the second improvement discussed below.)

The second improvement to CMP was the use of a concrete lining to improve hydraulic characteristics. The most modern method of applying the concrete lining is to apply the concrete from a revolving head moving inside the stationary metal pipe. Mechanical trowels immediately follow the spray head to provide a smooth finish. This equipment can also be used for applying linings in-situ. The concrete lining is added to a corrugated metal pipe (usually with aluminized coatings, but asphalt or galvanized can be used) with an inside diameter equivalent to the required diameter. The concrete lining is usually 3/8- to 3/4-inch thick at the crest of the interior corrugation and fills the corrugations.

CLCMP is designed as plain corrugated metal pipe with no allowance for structural contribution from the lining. The function of the lining is only to improve the hydraulic characteristics of the CMP and the lining is not intended to adhere to the metal pipe interior. Therefore, cracks or spalls in the lining do not create any structural integrity problems. The only concern is the hydraulic integrity if a large number of cracks or spalls are exhibited in the pipe (and a large number of these would be required to affect the hydraulic efficiency).

Hairline stress cracks are a common characteristic of CLCMP because the metal portion of the pipe is flexible and the concrete portion is rigid. As the concrete lining dries and as the pipe flexes during handling and installation, these cracks are formed. However, most are "healed" when the pipe is filled with water, according to the manufacturer and some studies.

CLCMP is a flexible rather than a rigid conduit. Rigid conduits, such as RCP, cannot deflect more than about 0.1 percent of their diameter without damage. Therefore, the rigid pipeline must be designed to carry the soil loads above and the arching soil load beside the pipe. Flexible conduits, however, may deflect as much as 5 percent under load without damage. In deflecting, these pipes transfer part of the vertical load into a horizontal thrust which is carried by the passive resistance of the soil beside the pipe. The reduction in forces leads to a reduction in steel requirements to offset the load. Aluminized coatings should not crack under the 5% deflection. Beyond that point, cracking and resultant corrosion are possible and likely.

In summary:

- Aluminized coatings and linings are superior to the more familiar galvanized or asphalt coatings and linings. Data is still limited to the 30-year installations studied by Armco and discussed above. That study provided guidelines for aluminized coated and lined CMP based on stormwater quality and soil resistivity. However, these guidelines provided for a 50-year life for 16-gauge CMP only. No guidelines were provided for 75- to 100-year life. Contech (the local supplier of CLCMP) estimates that if galvanized will last 50 to 55 years, then aluminized will last 80 to 100 years based on the comparison of performance between aluminized and galvanized coatings and linings in this 30-year study.

- Concrete lining of CMP improves the hydraulic characteristics to a comparable level with RCP. In addition, concrete lining further reduces or eliminates concern that the sediment load of stormwater will cause erosion of the pipe invert or that poor water quality will cause corrosion of the pipe interior.

- The number of local installations has increased in the Phoenix area over the last 10 years. Field inspection and data from pipelines ranging in size up to 96 inches is available. No significant deflection, spalling or failure of CLCMP has been reported. However, there are no local installations over 96 inches and few 120-inch diameter installations in the country. This project calls for 2 1/4 miles of pipe 108 inches and larger.

3.2.2 Evaluation of CLCMP. CLCMP has many advantages based on its flexible structure. Table 1 compares CLCMP with RCP in terms of weight and delivery lengths. CLCMP is significantly lighter than RCP and therefore can come in much longer lengths (20 ft). Even in the longer lengths, the pipe segments are still much lighter than the comparable RCP segments; therefore much smaller lighter equipment is required for placing the pipe in the trench. In addition, more pipe can be delivered at a time, not only because more segments can be delivered at a time, but also because each length is longer. The longer lengths also lead to fewer joints and reduced leakage potential.

CLCMP has several other advantages. High material quality control can be maintained because the pipeline is manufactured in the factory, not in the field. Second, the installation is relatively fast because the pipe is delivered at the site ready for installation and backfill. The trench can be closed as soon as the pipe has been installed. Third, the concrete lining provides similar hydraulic characteristics to RCP, therefore, diameters of the pipe are similar to those of RCP. Finally, CLCMP is relatively thin and the outside diameter (OD) is only 2 inches larger than the inside diameter of 120-inch CLCMP (OD=122 inches). RCP, on the other hand, can range from 8 to 11 inches thick; for 120 inch class III RCP, the OD is 142 inches. In areas with a lot of utilities, 20 inches can be a significant addition to the pipeline OD and required trench width.

Several disadvantages also result from the flexible nature of CLCMP. First, backfill and compaction requirements must be much more stringent to prevent pipeline deflections from exceeding the allowable 5 percent. Both RCP and CLCMP will be backfilled and compacted in thin layers to 1 ft above the top of the pipe. However, CLCMP relies more heavily on proper backfill and compaction to handle and resist the loads than does RCP. In addition, if the backfill and compaction is not handled properly, and additional pipeline deflection is created beyond the allowable 5 percent, then the CLCMP concrete lining can be cracked, reducing the hydraulic ability of the pipeline; but worse yet, the aluminized coating can be cracked longitudinally, allowing corrosion attack from the soil side of the pipe. The life of the pipeline is greatly reduced if the aluminized coating is cracked.

CLCMP has several other disadvantages. First, CLCMP is a metal pipe and although the aluminized coating greatly extends the life of the steel, CLCMP is still not suitable for highly corrosive soil environments. The Cactus Road soils data for two borings showed evidence of slightly corrosive soils. The areas appeared to be localized but could be a problem (see discussion in section 4). Second, concrete lining cannot be used in an arched CMP except for very short segments where the coating is applied in-situ, by hand. Arched CMP is sometimes desirable for extreme loads or more efficient hydraulic characteristics. Third, there is still some concern in the industry about the lack of bond between the steel and concrete. This does not appear to be a problem either from a corrosion or hydraulic concern based on the studies performed to date.

A final significant concern about CLCMP is the anticipated life of the product. Studies have shown that the aluminized coatings worked well in nearly all soils and moisture conditions for at least 30 years. Due to minimal effects caused by corrosion on the 30-year old installations, it would not be unreasonable to expect the materials to last at least twice as long as that. However, the aluminized coating is too new to automatically assume it will last from 75 to 100 years. Once corrosion begins, it can be a very rapid process. Many local agencies have expressed concern about the life of the product. The Arizona Department of Transportation (ADOT) has restricted the use of CLCMP based on concerns about the life of the product. ADOT requires a material life of 75 years on storm drains in freeways and primary roads. The material life for secondary and minor roads are 50 and 25 years, respectively. ADOT does not feel there is sufficient data at this time to show that CLCMP will provide a 75-year life. Therefore, CLCMP is not allowed for freeway or primary road storm drains in lengths over 1,000 ft. CLCMP is allowed for installations that only require a 50-year life.

Many cities in the valley have allowed CLCMP in limited locations, but only in smaller diameters and shorter installations. The largest CLCMP installed in the valley is 96 inches. None of the local CLCMP installations are over 10 years old, which is too soon to tell how local conditions will affect the conduit material.

3.3 Precast Box

Precast box conduits offer similar advantages as RCP and CLCMP in terms of high quality control and relatively rapid installation because the conduit material is prefabricated. Precast box conduits are also similar in nature to RCP in that the box is a rigid conduit and requires thin-layer compaction only to the top of the box in trench conditions. The design of the conduit itself withstands the soil loads above and adjacent to the box and does not require optimum trench backfill to resist deflection.

A precast box conduit has two major disadvantages. First, a good gasket was not available for the box joints until recently; therefore, leakage could be a problem in some installations. A few precast box conduits have been installed in the Phoenix area using a new gasket and leakage appears to no longer be a problem. Second, precast box conduits require more materials (rebar and concrete) per flow area in the smaller sizes than RCP. The increased material requirements leads to short lengths (due to weight), increased material cost, increased delivery cost and increased leakage potential due to frequent joints. However, precast box conduits are easier to install. Compaction of the haunches of a circular pipe is more difficult than the haunches of a square box. According to local manufacturers and contractors, the break-even point is about the 10 ft x 9 ft box or 120-inch diameter pipe; precast box conduits are competitive with RCP in the larger sizes but not in the smaller sizes.

3.4 Cast-In-Place (CIPP)

CIPP has been used extensively in the valley for smaller diameter applications and where utility interference has been negligible. CIPP is cast in trench using the trench walls and floor as part of the form and a special piece of equipment which places the (inside diameter split-ring forms) and pours the concrete. After sufficient drying, the forms are removed from the inside and the interior troweled smooth where necessary. This type of conduit is highly cost-effective and many contractors in the area have experience installing the smaller diameters. The nature of the pipe construction virtually eliminates pipe joints reducing leakage potential. With quick-setting concrete mixes, open trench times have been reduced and the trench can be backfilled within 24 to 48 hours.

The most significant disadvantage to CIPP is that the conduit is constructed in the trench in the field. Optimum field conditions and a reliable contractor along with rigid, careful specification and inspection are required to maintain quality control of the conduit construction. Soil conditions must be adequate to provide a good form for the bottom and sides of the conduit. If a soil is cobbley or unstable, wall thickness will vary and may not meet specification requirements or greatly increase material requirements and increase costs. The City of Phoenix will no longer allow installation of CIPP if the bedding is unsuitable without overexcavation and backfill to form the floor and walls of the trench. Soil conditions for Cactus Road indicate that significant cobbles may be encountered in the lower depths (over 15 ft) and therefore CIPP would not be a suitable conduit. Additional discussion can be found in section 4.

A second disadvantage, despite the use of quick-setting concrete, is the open trench installation time. CIPP can be installed at a similar rate to precast pipe when installing in areas with few utility interferences and few external connections. However, Cactus Road contains many utility crossings that will reduce the lengths of run and cause delays in construction and may require the use of precast conduits in these areas. There is also some concern about the structural integrity of large diameter CIPP. ADOT and the City of Phoenix, among other valley agencies, will not allow CIPP in diameters over 96 inches. Over half of the Cactus Road Storm Drain is larger than 114 inches.

3.5 Cast-In-Place Box (CIP Box)

CIP box conduits provide good structural characteristics and are used extensively as road crossings where strength is required or cover is minimal (e.g., freeways commonly use box culverts). CIP box construction follows several steps: the trench is excavated, the floor rebar cage is constructed, the floor poured, the wall and roof rebar cage is constructed, the forms are constructed for the walls and roof, and the walls and roof poured. Even with quick-setting concrete, it is still a tedious job to construct a CIP box culvert.

A 4,500-foot CIP box storm drain was recently constructed parallel to Interstate 10 in the City of Tempe. The upstream portion was 12 ft x 8 ft and the downstream portion was 16 ft x 8 ft (somewhat larger than the largest portion of the Cactus Road Storm Drain). The trench path was parallel to the freeway and unobstructed by all but a few utilities. Construction of this box culvert was very successful because of the large size (paddle wheel scrapers were used very economically to excavate the trench), 1/2 mile reaches could be opened at one time, there was no interference with either traffic patterns or existing utilities, the soils were suitable to support a box, and shoring was not required for trench walls. A quick-setting concrete mix was used for the walls and roof, which sped up construction to a 24-hour period and made construction almost like a slip-form operation. Wall and roof forms were set up in the morning with concrete poured at 2:00 p.m. and allowed to cure to the next morning, when the forms were moved to the next reach. The use of paddle wheel scrapers, long open reaches and quick-setting concrete all reduced construction time. However, construction still took 6 months for 4,500 ft. If the same techniques and subsequent construction time frame could be used on the Cactus Road storm drain, construction would take up to 2 years to complete; far longer than any of the other methods.

As stated above, CIP box conduits have good structural characteristics and, as in the case of CIPP, CIP box conduits are continuous with relatively little leakage problem. Quick-setting concrete mixes have reduced installation times over previously used concrete mixes but the installation time is still a drawback for high traffic areas. CIP box conduits are also constructed in the trench. Soil conditions affect quality control and a good contractor along with rigid specifications with strict field supervision is required to insure a quality conduit.

4. SOILS REPORT RECOMMENDATIONS AND IMPACT ON STORM DRAIN CONDUIT ALTERNATIVES

The field soils investigation included a site reconnaissance, subsurface exploration, and field resistivity testing. Thirty-five test borings were drilled to depths of 11 to 26 feet below the pavement section, with refusal encountered at some locations. Additional information about the field investigations and detailed information about each boring location has been published in the Thomas-Hartig and Associates, Inc. geotechnical report and distributed to the Flood Control District of Maricopa County, the City of Peoria and the City of Glendale. The following is only a summary of the results of that report as the findings impact the storm drain conduit alternatives.

Granular deposits were encountered at and above invert elevations in a majority of test borings. These granular deposits contain gravel and some cobbles and boulders and clean sand layers. Because of the coarse granular materials and potential for caving in, a shaped excavation for cast-in-place pipe may be difficult to impossible to construct. This soil property should not affect the other storm drain alternatives.

Existing surface soils are sandy clays and clayey sands, predominantly of medium plasticity. Undisturbed soils will demonstrate moderately low potentials for expansion. However, compaction of these soils could create high expansive pressures. Imported granular soils exhibiting low expansive potentials or granular site soils are recommended for all backfills along the sides of the storm drain pipe.

The soil along the alignment is fairly strong and the drain will be lighter than the soil it replaces. Low settlements (less than 1/4 inch) due to the construction related disturbance are anticipated and an allowable bearing capacity of 5,000 psf afforded structures and manholes.

Lateral earth pressures are 60 psf/ft for current groundwater conditions and 95 psf/ft for rising groundwater or trench flooded backfill conditions. Walls should be suitably braced during backfilling to prevent damage and excessive deflection.

All excavations should be braced or sloped to provide personnel safety and satisfy local safety code regulations. Maximum temporary cut slopes of 1/4 H:1V in sandy clay/clay clayey sand and 1H:1V in the granular soils are recommended.

Backfill compaction should be accomplished by mechanical methods. Water jetting or flooding of loose, dumped backfill must be prohibited.

Soluble salts, soluble sulfates, soluble chloride, pH and resistivity tests were conducted at various boring locations. The corrosion potential to concrete is low; Type II cement should be used for concrete in contact with soils. Relatively low resistivities (high conductivities) were encountered in only two test borings (sta. 89+00 and 99+00 approximately). The resistivity for sta. 89+00 was 1840 ohm-cm for 0-15 ft and 2630 ohm-cm for 0-25 ft. The resistivity of 1840 ohm-cm is close to, but above, the minimum 1500 ohm-cm for CLCMP and therefore may not be a problem. The resistivity for sta. 99+00 was 1520 ohm-cm for 0-15 ft and 1150 ohm-cm for 0-25 ft with a pH of 8.2 The resistivities are low for this site but the pH is acceptable for aluminized coatings on CLCMP. In addition, a moderate potential for corrosion of buried unprotected metal conduits is indicated in areas where soil moisture content is high. Experienced corrosion specialists should review data for recommendations on metal conduits.

5. COST COMPARISON OF STORM DRAIN CONDUIT ALTERNATIVES

5.1 Conduit Construction Cost

Local suppliers and contractors were contacted to determine an estimated cost for RCP, CLCMP, Precast Box and CIPP. The current edition of The Richardson Rapid System General Construction Estimating Standards was used to determine cost of earthwork and installation of precast conduits. It was not possible to exactly determine the quantity of concrete, rebar and labor required to construct a CIP Box, therefore, prorated costs for these items were used from the City of Tempe box culvert discussed in section 3.5 above. Table 2 lists the estimated total cost and the estimated cost per lineal foot for each type of conduit. These costs do not include the cost of the numerous fittings/structures that will be required to connect the Cactus Road storm drain to collector basins and stubouts to future storm drain laterals. These costs also do not include the cost of rerouting or accommodating the existing utilities or the traffic control problems.

At this point, the CIPP alternative is the least expensive followed in order by CLCMP, RCP, CIP Box and Precast Box. As stated in section 3.4 and 3.5, utilities and numerous specially constructed inlets will greatly affect the cost of the cast-in-place conduits and raise their unit prices. In addition, these conduits are constructed in the field and special features will increase the construction time. Special structures affect the cost of RCP, CLCMP, and Precast Box conduits, but not as much. Secondly, construction time to install prefabricated special fittings is much faster than construction and installation of cast-in-place special fittings because the construction takes place in the factory and only installation is required in the field.

5.2 Conduit Operation and Maintenance Cost

Small conduits are subject to occasional plugging that would require occasional maintenance. The Cactus Road storm drain is a very large diameter conduit and plugging is not likely to be a problem. However, sediment load can accumulate in large conduits affecting the hydraulic characteristics and the ability of the pipeline to carry the water it was designed for. This can be accommodated in the design analysis and, if necessary, slightly oversize the conduit. The greater impact to the conduit would be the material life, if the sediment load were to erode the invert of the pipeline. In the Phoenix area, the sediment load of storm drains is not a significant problem, either in terms of quantity of sediment deposition or invert erosion. In addition, the Cactus Road storm drain is not a steeply-sloped conduit which is a leading cause of invert erosion problems. However, the storm drain has been sized for a minimum velocity of 5 fps during the 10-year storm to provide a flushing action and reduce any sediment build up.

Periodic inspection would be suggested for large diameter pipelines to insure that the interior of the pipeline is in good condition. These inspections should be more frequent (e.g., annual inspection) during the early years for the flexible CLCMP conduit and for CIPP to insure that these pipelines were properly installed and backfilled. CLCMP deflections should be monitored both when the pipe is first installed and during the periodic inspections. The inside diameter measurements of CIPP should be taken after construction prior to acceptance of the conduit by the Cities of Peoria and Glendale, and the Flood Control District of Maricopa County to insure proper installation of the conduit.

Costs for O&M have not been calculated because the cost of annual inspections is relatively nominal and no other maintenance is anticipated to be required for the main storm drain. Some maintenance of the catch basins may be required but the cost of this maintenance will be equal for all alternatives and therefore catch basin maintenance has not been estimated or included.

6. PRELIMINARY DESIGN RECOMMENDATIONS

Table 3 summarizes the information on each of the alternatives in tabular form.

Reinforced concrete pipe is obviously suitable for the Cactus Road storm drain and it is not the most expensive conduit. There are sufficient companies in the area to ensure competitive bidding and a reasonably good price.

Competitive bidding is improved, however, if other alternatives can be allowed. CLCMP offers many of the same advantages of RCP with a potential, substantial cost-savings. However, the design criteria calls for a 75- to 100-year conduit material life and CLCMP has not been shown to have an extended product life. In addition, CLCMP is a flexible pipeline which will require excellent field quality control for backfill and compaction. To verify that this is accomplished, a thorough inspection and testing program will be required. If the pipeline deflection is not kept below 5 percent, then the aluminized coating will likely crack resulting in corrosion and probable shortening of the pipeline life. CLCMP has not been installed anywhere in the valley in this size and quantity, and rarely installed anywhere in the 120-inch diameter. Major agencies, including ADOT, limit the use of CLCMP. Installation of CLCMP in this size and quantity is a risk as compared to more proven alternatives. We do not recommend that this project be a "test case" for large diameter CLCMP.

The precast box conduit was the most expensive alternative; however, the earthwork costs for the precast box were the lowest of all of the alternatives. It is not anticipated that lower earthwork costs can bring the precast box into competitive bidding for this size conduit at this time, particularly if cement slurry or other slurry backfills are used.

CIPP and CIP box are also not considered viable alternatives. CIPP is not recommended by other local agencies in sizes over 96 inches. But more importantly, the soils report does not recommend CIPP in any size due to the cobbley, unstable nature of the trench form. CIP box is not recommended because of the extensive time requirements to construct and the resulting traffic difficulties.

Only RCP appears to meet all the design criteria and soils recommendations, yet still be cost-competitive due to the number of local suppliers. RCP is a proven material and can be relied on to perform well.

TABLE 1
Conduit Material Physical Characteristic Comparison
Cactus Road Storm Drain - Flood Control District of Maricopa County
November 1992

	84-Inch				120-Inch			
	RCP Class III[a]	RCP Ameron[b]	CLCMP 5 x 1 14 ga[c]	Precast Box 7'x6'[d]	RCP Class III[a]	RCP Ameron[b]	CLCMP 5 x 1 14 ga[c]	Precast Box 10' x 9'[d]
Pipe Length, ft	6	12	20	7.5	6	12	20	7.5
Approx Weight, lb/ft	2,409	2,090	318	3,066	4,716	4,830	542	5,520
Approx Weight per Piece, lb	14,454	25,080	6,360	22,995	28,296	57,960	10,840	41,400
Outside Diameter, in	100	100	86	8.33' x 7.33'	142	142	122	11.67' x 10.67'
Maximum Allowable Fill, ft	17	N/A	45	N/A	18	N/A	54	N/A
Truckloads per 1,000 ft of Pipe	50	N/A	25	N/A	99	N/A	25	N/A
Joints per 1,000 ft of Pipe	166	N/A	49	N/A	166	N/A	49	N/A

[a]information provided by Contech Construction Products, Inc.
[b]Information provided by Ameron
[c]Information provided by Contech Construction Products, Inc.
[d]Information provided by Gifford-Hill

N/A = Information not available or not provided

Source: SFC Engineering Company, June 1992

TABLE 2
Alternative Conduit and Section Material Cost Estimate
Cactus Road Storm Drain - Flood Control District of Maricopa County
November 1992

	Reinforced Concrete Pipe	Concrete Lined Corrugated Metal Pipe	Precast Box	Cast-In-Place Pipe	Cast-In-Place Box
Total Cost ($)	6,222,000	5,032,000	7,599,000	4,743,000	6,273,000
Unit Cost ($/lin ft)	366	296	447	279	369

Source: SFC Engineering Company, June 1992

TABLE 3 (Page 1)
Summary of Alternative Conduit Section and Material Advantages and Disadvantages
Cactus Road Storm Drain - Flood Control District of Maricopa County
November 1992

ADVANTAGES	DISADVANTAGES
REINFORCED CONCRETE PIPE (RCP)	
Excellent prior history	Short lengths (approximately 6 ft in 120-inch diameter)
Precast, good quality control	Special fabrications expensive
Many local manufacturers, good availability	Third highest material cost
Long Life	Heaviest pipe weight of other precast materials; large heavy equipment required to install the pipe
Relatively fast installation	
Invert erosion seldom a problem	
CONCRETE LINED CORRUGATED METAL PIPE - (CLCMP)	
CMPCL has similar hydraulic properties as RCP	Unproven life of material
Comes in longer lengths, fewer joints	Deflections can cause cracks in concrete lining
Lighter pipe, lower shipping, delivery, and installation equipment costs	Backfill/bedding is critical for structural stability
Lower cost for special fabrications	Not suitable for corrosive or unstable soils
Prefabricated, good quality control	Cannot arch concrete lined CMP
Relatively fast installation	Industry still has some concerns about lack of bond between steel and concrete
Smaller outside diameter, smaller trench width	
Second lowest material cost	

TABLE 3 (Page 2)
Summary of Alternative Conduit Section and Material Advantages and Disadvantages
Cactus Road Storm Drain - Flood Control District of Maricopa County
November 1992

ADVANTAGES	DISADVANTAGES
PRECAST BOX	
Prefabricated, good quality control Structurally sound Relatively fast installation	Gasket and leakage problems at higher heads Most expensive material cost
CAST-IN-PLACE PIPE (CIPP)	
Lowest material cost	Trench is open a long time (pour 300 to 600 ft/day and backfill 24 to 48 hours after pour) Field manufacture can lead to a lack of quality control in field Cannot be used in all soil conditions (rocky or unstable soil) and CIPP is not recommended for many areas of the Cactus Road storm drain Utility conflicts cause forming problems
CAST-IN-PLACE BOX	
Good structural characteristics	Field manufacture can lead to lack of quality control in field Trench is open a long time (longer than CIPP) Fourth most expensive construction cost Heavy demand for field supervision and inspection to control reinforcing installation, etc.

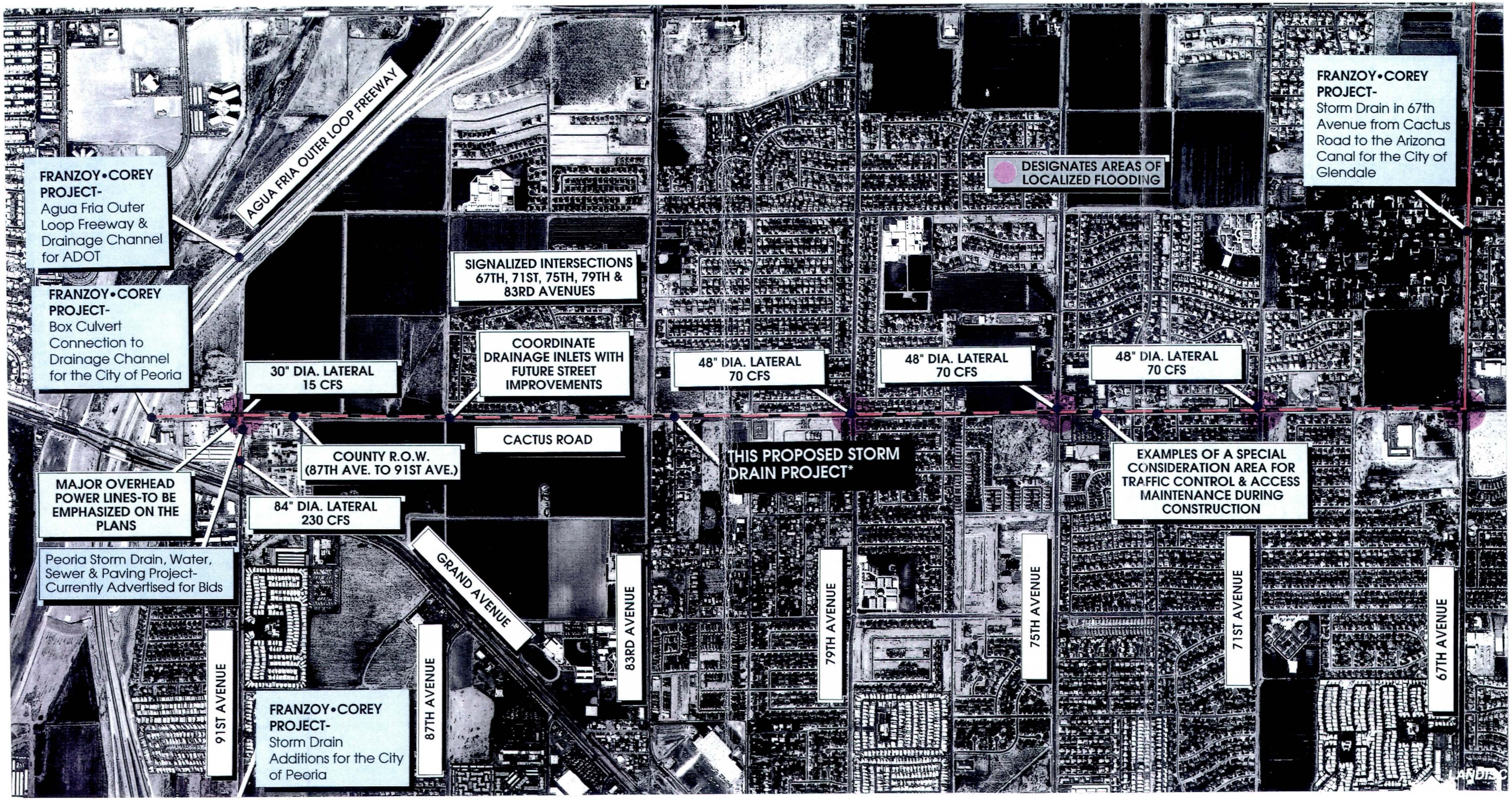
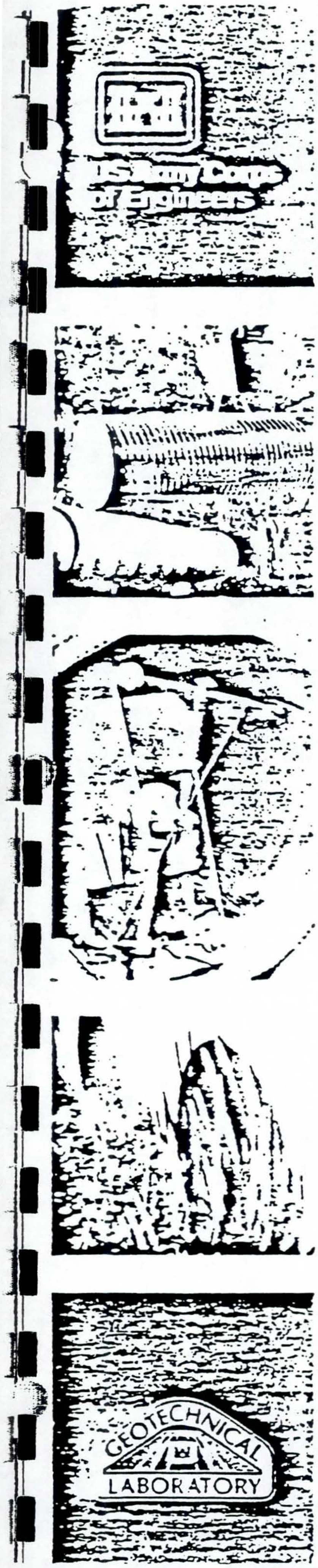


FIGURE 1
CACTUS ROAD STORM DRAIN ALIGNMENT

SFC ENGINEERING COMPANY

APPENDIX A1

EXCERPTS FROM THE PHOENIX REPORT PROVIDED BY CONTECH, INC.



MISCELLANEOUS PAPER GL-86-33

EVALUATION OF BURIED, CONCRETE-LINED CORRUGATED METAL PIPE

by

John C. Potter

Geotechnical Laboratory

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Waterways Experiment Station, Corps of Engineers
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November 1986

Final Report

Approved For Public Release; Distribution Unlimited

Prepared for DEPARTMENT OF THE ARMY
US Army Corps of Engineers
Washington, DC 20314-1000

Unclassified
SECURITY CLASSIFICATION OF THIS PAGE

REPORT DOCUMENTATION PAGE

Form Approved
OMB No 0704-0188
Exp Date Jun 30 1986

1a REPORT SECURITY CLASSIFICATION Unclassified	1b RESTRICTIVE MARKINGS
2a SECURITY CLASSIFICATION AUTHORITY	3. DISTRIBUTION/AVAILABILITY OF REPORT Approved for public release; distribution unlimited
2b DECLASSIFICATION/DOWNGRADING SCHEDULE	
4 PERFORMING ORGANIZATION REPORT NUMBER(S) Miscellaneous Paper GL-86-33	5. MONITORING ORGANIZATION REPORT NUMBER(S)
6a NAME OF PERFORMING ORGANIZATION USAEWES Geotechnical Laboratory; 6b OFFICE SYMBOL (If applicable) WESGP-EC	7a. NAME OF MONITORING ORGANIZATION
6c. ADDRESS (City, State, and ZIP Code) PO Box 631, Vicksburg, MS 39180-0631	7b ADDRESS (City, State, and ZIP Code)
8a. NAME OF FUNDING/SPONSORING ORGANIZATION US Army Corps of Engineers; 8b OFFICE SYMBOL (If applicable) DAEN-ECE-G	9. PROCUREMENT INSTRUMENT IDENTIFICATION NUMBER
8c. ADDRESS (City, State, and ZIP Code) Washington, DC 20314-1000	10 SOURCE OF FUNDING NUMBERS PROGRAM ELEMENT NO. / PROJECT NO. / TASK NO. / WORK UNIT ACCESSION NO

11. TITLE (Include Security Classification)

Evaluation of Buried Concrete-Lined, Corrugated Metal Pipe

12 PERSONAL AUTHOR(S)
Potter, John C.

13a TYPE OF REPORT	13b TIME COVERED	14 DATE OF REPORT (Year, Month, Day)	15 PAGE COUNT
Final report	FROM 1985 TO 1986	November 1986	14

16 SUPPLEMENTARY NOTATION
Available from National Technical Information Service, 5285 Port Royal Road, Springfield, Virginia 22161.

17. COSATI CODES

FIELD	GROUP	SUB-GROUP

18. SUBJECT TERMS (Continue on reverse if necessary and identify by block number)
Concrete coatings (LC) Drainage pipes (LC)
Culverts (LC) Pipe, Concrete (LC)

19. ABSTRACT (Continue on reverse if necessary and identify by block number)

A field study was conducted to evaluate the performance of concrete-lined, corrugated metal pipe for use as an alternative to reinforced concrete pipe. Over 2 miles of concrete-lined pipe were inspected. A 26-year-old concrete lining, installed in an existing corrugated metal pipe as a rehabilitation measure, was also inspected. Based on this field study, concrete-lined, corrugated metal pipe appears to be an acceptable drainage product when proper production and installation quality controls are used.

20 DISTRIBUTION/AVAILABILITY OF ABSTRACT ☒ UNCLASSIFIED/UNLIMITED ☐ SAME AS RPT ☐ DTIC USERS	21 ABSTRACT SECURITY CLASSIFICATION Unclassified
22a. NAME OF RESPONSIBLE INDIVIDUAL	22b TELEPHONE (Include Area Code) / 22c. OFFICE SYMBOL

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83 APR edition may be used until exhausted
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SECURITY CLASSIFICATION OF THIS PAGE
Unclassified

Preface

This evaluation was conducted by the Geotechnical Laboratory (GL), US Army Engineer Waterways Experiment Station (WES), during the period January 1985 through June 1986. The evaluation was sponsored by the Office, Chief of Engineers, US Army, under the work effort "Construction Support," of the Facilities Investigation and Studies Program.

The evaluation was conducted under the general supervision of Dr. W. F. Marcuson III, Chief, GL; Mr. H. H. Ulery, Jr., Chief, Pavement Systems Division (PSD); Mr. H. L. Green, Chief, Engineering Analysis Group; and Mr. D. M. Ladd, Chief, Criteria Development Unit. The evaluation was conducted and the report was prepared by Dr. J. C. Potter, PSD.

COL Allen F. Grum, USA, was the previous Director of WES. COL Dwayne G. Lee, CE, is the present Commander and Director. Dr. Robert W. Whalin is Technical Director.

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Conversion Factors, Non-SI to SI (Metric) Units of Measurement

Non-SI units of measurement used in this report can be converted to SI (metric) units as follows:

Multiply	By	To Obtain
feet	0.3048	metres
inches	2.54	centimetres
pounds (mass)	0.4535924	kilograms

Background

1. In May 1982, a new drainage product called concrete-lined, corrugated metal pipe (CLCMP) was introduced. The manufacturer claimed that this product offered the hydraulic efficiency of concrete pipe and the structural efficiency (economy) of corrugated metal pipe. Hence, the use of this product might result in significant savings to the US Army Corps of Engineers (CE). This evaluation was undertaken to verify the manufacturer's claims and to appraise the durability of the concrete lining, thus determining the acceptability of CLCMP as a construction alternative on CE projects.

Product Description

2. The CLCMP studied in this evaluation is a relatively new generation of concrete-lined pipe, called HEL-COR CL. It is manufactured by the Construction Products Division of Armco, Inc. This product has been under development since 1964 and was first marketed in May 1982. Neither the product nor the process is patented; however, Armco is currently the only manufacturer of CLCMP.

3. HEL-COR CL is fabricated by applying a concrete lining to a conventional, corrugated metal pipe. The metal pipe is usually helically corrugated galvanized steel or aluminized steel (Type 2), although other base materials such as asphalt-coated galvanized steel or asphalt-coated, asbestos-bonded sheets can be used. Diameters range from 24 to 120 in.*, and metal thicknesses range from 0.064 in. (16 gage) to 0.168 in. (8 gage). Standard corrugations are 2-2/3 by 1/2 in., 3 by 1 in., and 5 by 1 in.

4. The concrete lining is applied by a revolving head moving inside the stationary metal pipe (Figure 1). Mechanical trowels immediately following the spray head provide a smooth finish. This equipment is widely used for lining entire pipelines in situ. A minimum concrete thickness of 3/8 in. over the crests of the corrugations is specified, but the actual minimum thickness

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* A table of factors for converting non-SI units of measurement to SI (metric) units is presented on page 3.

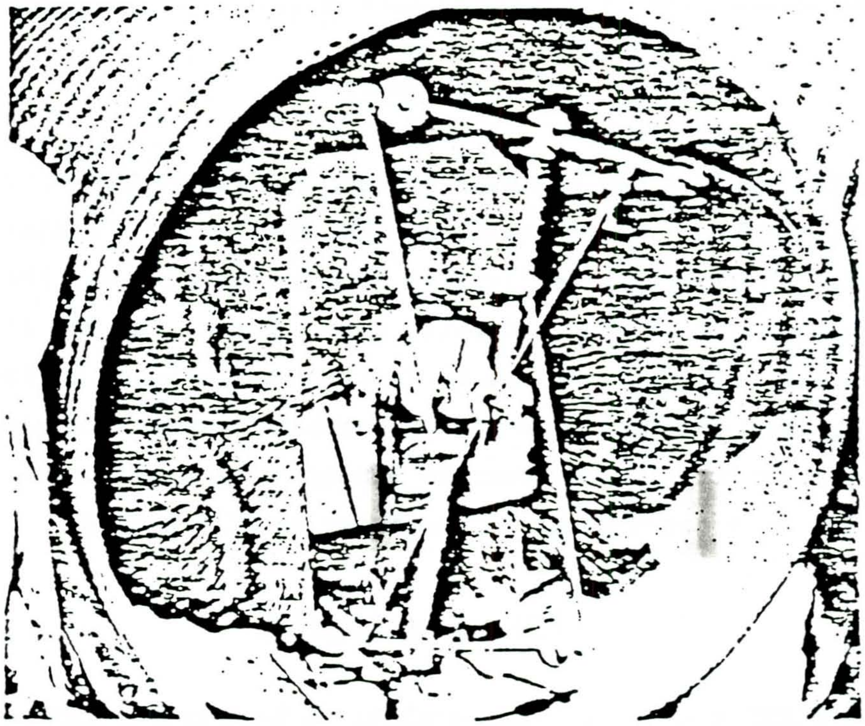


Figure 1. Concrete lining being applied by a revolving head (Construction Products Division of Armco, Inc.)

is usually about 3/4 in. This method of application appears to provide a more uniform, less segregated lining than that produced by spinning the pipe, as shown in Figure 2.

5. The CLCMPS's are designed as plain corrugated metal pipes with no allowance for structural contribution from the lining. The lining functions only to increase the hydraulic efficiency of the corrugated pipe. Damage to the lining, in the form of cracks and spalls, is thus a hydraulic concern rather than a structural concern. Hence, cracks and spalls become significant only when they are extensive enough to degrade the hydraulic efficiency of the pipe or to threaten the integrity of the lining.

6. Table 1 compares CLCMP with Class III reinforced concrete pipe (RCP). The CLCMP offers some intriguing advantages in terms of maximum cover, weight per foot, and joints per 1,000 ft. The lighter weight suggests a less-expensive pipe and lower installation costs. Fewer joints suggest the potential for reduced installation costs and reduced leakage. The CLCMP achieves these advantages by behaving as a flexible rather than a rigid conduit. Rigid conduits, such as RCP, cannot deflect more than about 0.1 percent of their diameter without damage. Therefore, they must be designed to carry the load

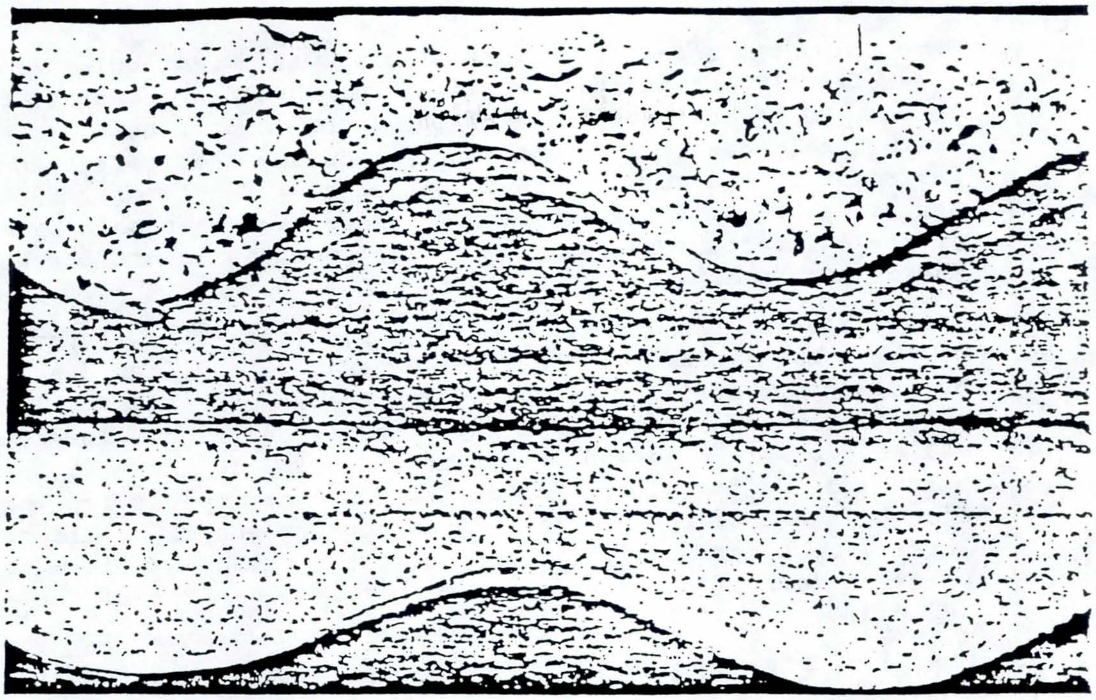


Figure 2. The upper section of the concrete lining was made by spinning the pipe; the lower section was made with the pipe stationary (Construction Products Division of Armco, Inc.)

of the soil above the pipe including negative arching loads from the soil adjacent to that directly above the pipe. Flexible conduits, however, may deflect as much as 5 percent under load without damage. In deflecting, these pipes transfer part of the vertical load into a horizontal thrust which is carried by the passive resistance of the soil at the sides of the pipe. This movement also eliminates or even reverses soil arching above the pipe, reducing the total vertical load on the pipe.

Field Inspections

7. A field study of CLCMP was conducted during the period January 1985 - March 1986. A total of almost 12,000 ft of pipe was surveyed, as summarized in Table 2. All were relatively new Armco installations (less than 2 years old), and the structural design was generally governed by handling stiffness. Exceptions are noted in the remarks column of Table 2.

8. The condition of the installed pipe was consistent throughout the systems surveyed; the following observations apply to all sites and pipe sizes:

a. Some chipping or spalling of the lining was noted, but the metal pipe directly behind the damaged lining showed evidence of blows to the end or to the outside of the pipe. Hence, this damage was probably caused by rough handling during transportation or installation and not by in-service loads or conditions. Satisfactory repairs of these types of damage have been made by most of the contractors by applying a rich grout in accordance with the manufacturer's recommendations.

b. Deflections of the installed pipe ranged from -1 to +6 percent of the nominal diameter, but were generally less than 3 percent. No popping or spalling resulted from these deflections. The characteristic, randomly spaced, circumferential and longitudinal cracks were observed in uninstalled pipe joints at both the plant and the job sites, indicating that they result from plastic shrinkage of the concrete during curing and/or handling. These cracks remain tightly closed in the installed pipe except when the deflection exceeds approximately 5 percent of the nominal diameter.

9. In June 1986, five concrete-lined, corrugated metal culverts in San Mateo County, California, were inspected. Asphalt-coated, galvanized steel culverts were originally installed at these locations in the 1950's. The culvert inverts were found to be extensively damaged after only a few years, and these five culverts were repaired in June 1960 by in situ concrete lining. The process used to apply the concrete lining is very similar to the Armco process except that trowels were not used on the 15-in.-diam culvert.

10. The culverts inspected ranged from 15 to 42 in. in diameter and were all about 200 ft long. In general, the concrete lining showed little sign of deterioration. One steel culvert outlet was sufficiently deteriorated to expose large portions of the lining to the exterior. However, the lining was still intact and serviceable. One culvert showed some invert wear, probably due to bed load. The drainage channel was steep and rocky with evidence of occasional high flows. Two pipes exhibited localized minor spalling, which exposed the additional reinforcement placed during the repair to support the new invert. The original pipe was not exposed from the inside anywhere.

Conclusions

11. Some chipping or spalling of the lining was noted during the inspections, but the steel pipe directly behind the damaged lining showed evidence of blows from sharp objects. Hence, this damage was probably caused by

rough handling during transportation or installation and not by in-service loads or conditions.

12. One section investigated had a measured deflection of 6 percent that resulted in a crack in the lining along the crown but no popping or spalling. Hence, this type of pipe should perform satisfactorily in any installations adhering to the 5-percent-deflection limit generally accepted for flexible conduits.

13. Based on this field study, CLCMP appears to be an acceptable drainage product when proper production and installation quality controls are used and when damage to the lining during construction is repaired according to manufacturer's recommendations. Pop-outs and spalls must be patched in accordance with the manufacturer's recommendations to provide a lasting, high hydraulic efficiency. Small cracks in the lining are acceptable since they have no significant effect on the hydraulic efficiency. Armco's repair procedure is outlined in Appendix A of this report.

14. Based on the performance of the 26-year-old linings on the San Mateo County culverts, it appears that CLCMP will remain serviceable as long as the metal pipe remains structurally sufficient. Except in cases of extremely aggressive effluents or severely abrasive bed loads where this product may not be appropriate, the service life may be estimated by calculating the service life of the unlined pipe (including protective coatings) subjected only to external corrosion.

Table 1

Comparison of Class III RCP with CLCMP

	Pipe diameter, in.									
	24		36		48		60		72	
	RCP Class III	CLCMP 2-2/3 × 1/2 16 gage	RCP Class III	CLCMP 2-2/3 × 1/2 16 gage	RCP Class III	CLCMP 2-2/3 × 1/2 16 gage	RCP Class III	CLCMP 3 × 1 16 gage	RCP Class III	CLCMP 3 × 1 16 gage
Pipe length, ft	8	20	8	20	8	20	6	20	6	20
Approx. weight per ft, lb/ft	264	65	524	98	867	130	1,295	215	1,811	258
Approx. weight per piece, lb	2,112	1,300	4,192	1,960	6,936	2,600	7,770	4,300	10,866	5,160
Outside diam., in.	30	25	44	37	58	49	72	62	86	74
Max. allowable fill, ft	13	124	16	83	16	62	16	50	16	42
Truck loads per 1,000 ft of pipe	6	2	11	5	18	7	27	25	38	25
Joints per 1,000 ft of pipe	124	49	124	49	124	49	166	49	166	49

	Pipe diameter, in.							
	84		96		108		120	
	RCP Class III	CLCMP 3 × 1 16 gage	RCP Class III	CLCMP 3 × 1 16 gage	RCP Class III	CLCMP 3 × 1 14 gage	RCP Class III	CLCMP 3 × 1 12 gage
Pipe length, ft	6	20	6	20	6	20	6	20
Approx. weight per ft, lb/ft	2,409	301	3,090	343	3,865	406	4,716	493
Approx. weight per piece, lb	14,454	6,020	18,540	6,860	23,190	8,120	28,296	9,860
Outside diam., in.	100	86	114	98	128	110	142	122
Max. allowable fill, ft	17	36	17	31	17	35	18	41
Truck loads per 1,000 ft of pipe	50	25	65	25	81	25	99	25
Joints per 1,000 ft of pipe	166	49	166	49	166	49	166	49

Appendix A: HEL-COR CL Repair Procedure

Preparation of Surface

1. The area to be patched shall be thoroughly cleaned of all dirt, dust, or other foreign materials by the use of water, air under pressure, or such other methods as are necessary to secure satisfactory results. The surface shall then be thoroughly wetted with water. All free-standing water shall be removed prior to the liberal painting of the surface to be patched with a cement grout made up of a mixture of cement and water having the consistency of thick paint.

Patching with Mortar

2. The mortar-patching material shall be mixed with a minimum amount of water that will produce a workable mix and shall be placed before the grout coat (as described above) has set or dried out and while the grout coat is in a moist or tacky condition. The mortar shall be mixed in the proportion of one part (by weight) of Type 2 cement with two parts washed, dry concrete sand. The mortar shall be applied as a "plaster coat" overfilling the cavity slightly and bringing to a surface slightly higher than required for the finished patch. It shall then be left undisturbed for a period from 1 to 2 hr to permit initial shrinkage, then struck off with a straightedge spanning the patch. A wooden float may be used to give the exposed surfaces a finish similar to the surrounding concrete, but it must be used lightly so as not to disturb the mortar for an appreciable depth.

3. On surfaces above the springline of the pipe, it may be necessary to build up the proper lining thickness by several mortar plaster applications. Successive coatings of mortar, however, shall be placed before the preceding mortar coating has dried appreciably.

Curing

4. Immediately after finishing the surface of a patch, the area shall either be sprayed with a curing compound or maintained in a thoroughly wetted condition for a minimum of 3 days.

Table 2

Armco Installations Inspected*

Site	Date	Diameter in.	Gage	Corrugation	Length ft	Remarks
Fort Bragg, N.C.	1/31/85	48	16	2-2/3 × 1/2	479	
		54	14	2-2/3 × 1/2	441	
		60	16	5 × 1	731	
North Little Rock, Ark.	3/15/85	84	12	5 × 1	1,100	E-80 live load
Missouri City, Tex.	4/8/85	66	12	2-2/3 × 1/2	1,294	
Turkey Creek, Tex.	4/8/85	108	12	5 × 1	250	High fill ∿ 30-ft cover
College Station, Tex.	4/8/85	60	16	5 × 1	380	
		72	16	5 × 1	585	
San Antonio, Tex.	4/9/85	78	16	5 × 1	240	
		78	12	5 × 1	70	Deep trench ∿ 30-ft cover
		84	16	5 × 1	420	
		96	10	5 × 1	499	E-80 live load
		102	10	5 × 1	520	E-80 live load
Durham, N.C.	4/9/85	102	16	5 × 1	280	
		96	16	5 × 1	3,000	
Ridgeland, Miss.	3/13/86	108	10	5 × 1	480	Cover < 1 ft
		84	14	5 × 1	940	Cover < 2 ft

* All are new CLCMP installations (less than 2 years old), and the structural design was governed by handling stiffness unless otherwise noted.

COMPREHENSIVE EVALUATION OF ALUMINIZED STEEL TYPE 2 PIPE FIELD PERFORMANCE

BY

G. E. Morris and L. Bednar

ABSTRACT

Results of 30-year field tests in 14 states, conducted by Armco on ALUMINIZED STEEL(TM) Type 2, and galvanized steel culvert pipe showed the consistent and pronounced superiority of aluminized.

Armco located and evaluated pipes of the two materials, exposed together, at 54 sites where climatic conditions ranged from very wet to very dry.

Comparison of the field performance of the two materials revealed considerable differences in the basic coating corrosion-control mechanism. The aluminized coating imparted significantly better resistance to general corrosion and localized perforation.

Analyses of pipe condition and environmental factors at every site resulted in usage guidelines for both materials. Aluminized showed tolerance for substantially more severe environmental conditions.

The technique by which the guidelines were derived shows promise in predicting service life for the two materials as well.

INTRODUCTION

ALUMINIZED STEEL Type 2 (for convenience, referred to as aluminized) is a recently introduced new material for drainage pipe applications, but it has a long history of field testing which began in 1952.

There were two separate test programs:

1. Full-length pipes were installed at numerous culvert sites by state and county highway departments in 20 states.
2. Armco Research program joined very short lengths of pipe in long strings and installed them at a limited number of selected sites of various environmental types.

In all field testing, the primary goal was the comparison of performance between aluminized and galvanized steel, which is the standard accepted metallic pipe material. Aluminized displayed a pronounced superiority over galvanized in a series of inspections conducted at various times.

In 1982, a comprehensive evaluation began of all 30-year-old pipes in the highway department program. The results have shown significant, long-term superiority of aluminized -- consistent in a wide variety of exposure conditions.

This report deals mainly with this evaluation. It covers studies on basic corrosion behavior, pipe material performance, and pipe material environmental limitations.

ALUMINIZED/GALVANIZED COMPARATIVE BASIC CORROSION BEHAVIOR

The reasons for the superiority of aluminized in field tests became evident during studies on pipe behavior and environmental conditions, as well as from published literature on basic aluminum and zinc corrosion behavior. The superiority of aluminized arises from differences in the manner by which durability is achieved.

Zinc vs. Aluminum

Inherently, zinc coatings are highly corrodible in water and wetter soils; fortunately, in most of these environments, galvanized performs well because corrosion is greatly retarded by formation of protective-barrier scales, produced mainly by deposits of calcium and magnesium hardness salts.[1,2,3]

Zinc corrosion products contribute to scale formation. Durability problems, which sometimes arise, are all associated with conditions that hinder barrier-scale development. Among the more significant of these are:

1. Softer, non-scaling waters, which also contain corrosive-free acidity (CO_2 and organic acids);
2. Water or soil with excessive amounts of corrosion-accelerating salts (Cl^-, SO_4^{-2}, NO_3^-), which interfere with scale formation;

3. Turbulent, aerated waters which erode barrier scales and provide plentiful dissolved O_2, which accelerates corrosion; and

4. Moving, abrasive bed load which wears away scale and uncorroded metal.

Aluminum coatings are more durable than zinc. This is due to the formation of a thin, passive aluminum oxide film which is more protective than the scale on zinc.[4,5] The film forms in both hard and soft water and is resistant to corrosion by SO_4^{-2}, NO_3^-, CO_2, O_2, and organic acids.

The film also is resistant to erosion by turbulent water. Additionally, if the film is damaged or removed by intermittent harsh abrasive or chemical influences, it is immediately repaired or reformed after the disappearance of these influences.

Aluminized Coating Behavior

The aluminized coating is a two-layer, metallurgically bonded composite with advantageous composite corrosion behavior. It consists of a protective layer of aluminum and an underlying layer of aluminum/iron alloy (see Figure 1).

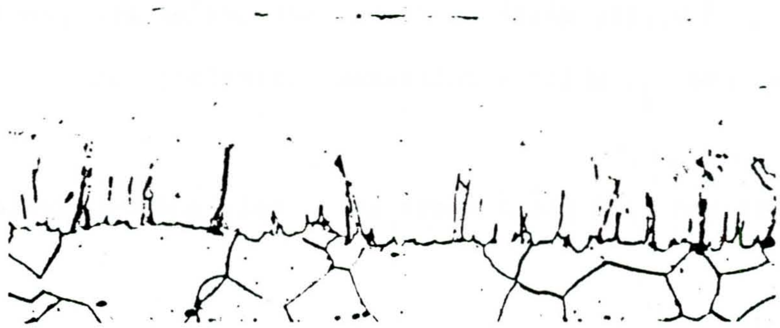


Fig. 1 - Modern aluminized microstructure - Mag. = 500X.

The aluminum layer exhibits all of the aluminum corrosion-resistant characteristics noted above.

Although the aluminum layer is subject to slow pitting corrosion, it is retarded by the alloy layer where it tends to grow laterally (see Figure 2).

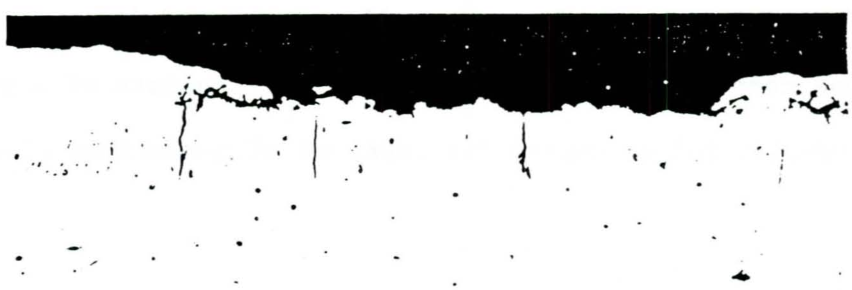


Fig. 2 - Arresting of pitting at alloy layer on pipe in service for 30 years - Mag. = 300X.

The alloy possesses high corrosion resistance and acts as a second line of defense against general corrosion in addition to acting as a pit arrestor. Upon initial exposure at an aluminum layer pit, the alloy layer generates a protective, rust-colored scale which can stain the surrounding aluminum surface and give a false negative impression of coating condition (see Figure 3).

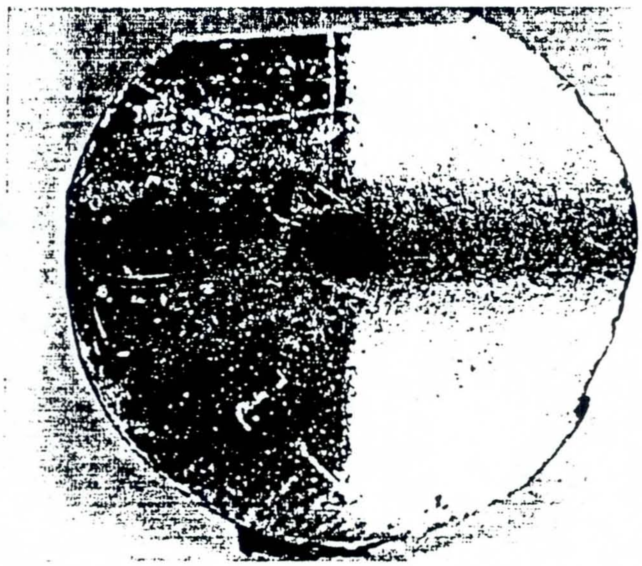
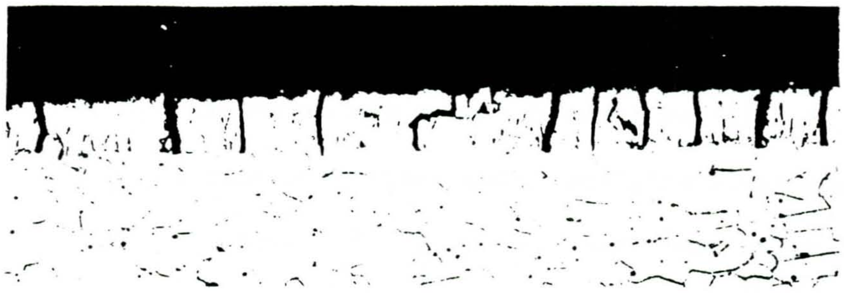


Fig. 3 - Aluminized coating intact beneath rust-stained invert surface.

The alloy is very hard and imparts enhanced abrasion resistance under mildly or moderately abrasive conditions. Fabrication cracks that occur in the alloy layer are plugged and sealed by an initial reaction with the environment , so that substrate corrosion at crack bases is greatly retarded (see Figure 4).



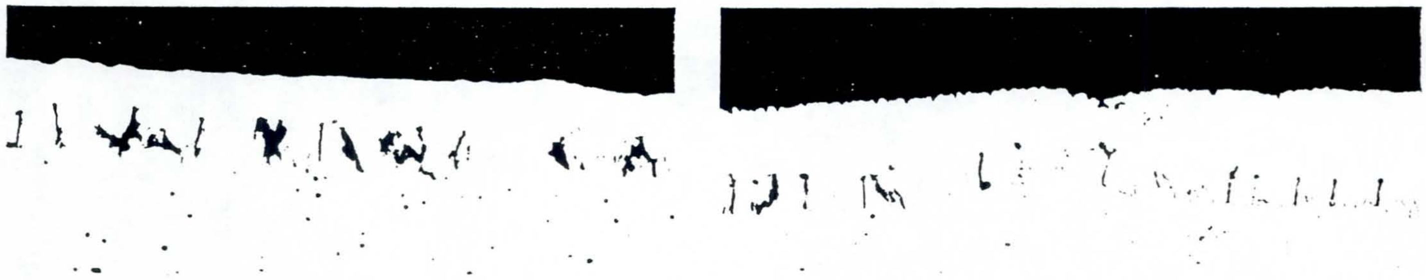
30-year-old material at a site where the aluminum layer has been removed exposing the alloy layer. Although cracks are uncovered, there is no steel substrate corrosion. Mag. = 200X.

Steel substrate protection is the result of crack plugging with alloy-reaction products. The crack on the right and the central crack are sealed and still dormant, while the crack on the left has begun to permit slow substrate corrosion. Mag. = 1500X.

Fig. 4 - Protection of the steel substrate by the cracked alloy layer on 30-year-old, field-exposed material.

Eventually, the alloy will be undermined and deteriorated at coating pit sites, but the time required is considerably greater than that required for total loss of galvanized coatings.

Alloy cracking has only a minor effect on coating performance, judging by field test results. The 30-year-old, field-tested material showed pronounced alloy cracking during corrugating -- especially in corrugation valleys where lateral cracking occurred (see Figure 5).



30-year-old aluminized modern aluminized
Alloy Cracking on Corrugation Crests

30-year-old aluminized modern aluminized
Alloy Cracking in Corrugation Valleys

Fig. 5 - Comparative alloy condition at corrugations on old and modern aluminized. Mag. = 200X.

The superiority of the old material over galvanized was achieved despite such cracking. A residual skin of alloy remained fully bonded to the substrate even if lateral cracking caused spalling of the upper alloy portion (see Figure 6).

Modern aluminized has improved coating ductility and shows less cracking overall.

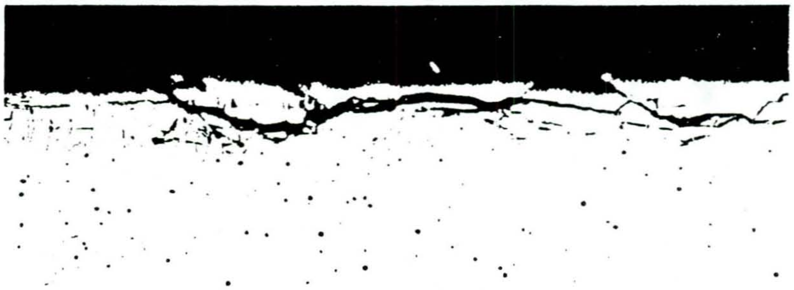


Fig. 6 - Protection of the steel substrate by alloy layer with lateral cracking. Thirty-year-old material at a site where the aluminum layer has been removed locally is illustrated. Although cracks are uncovered over a substantial area, there is no alloy layer spalling and no steel substrate corrosion.

Aluminized/Galvanized Galvanic Protection

The aluminized coating affords more effective protection for exposed steel substrate than galvanized does, judging by the behavior of uncoated edges in 30-year field tests.

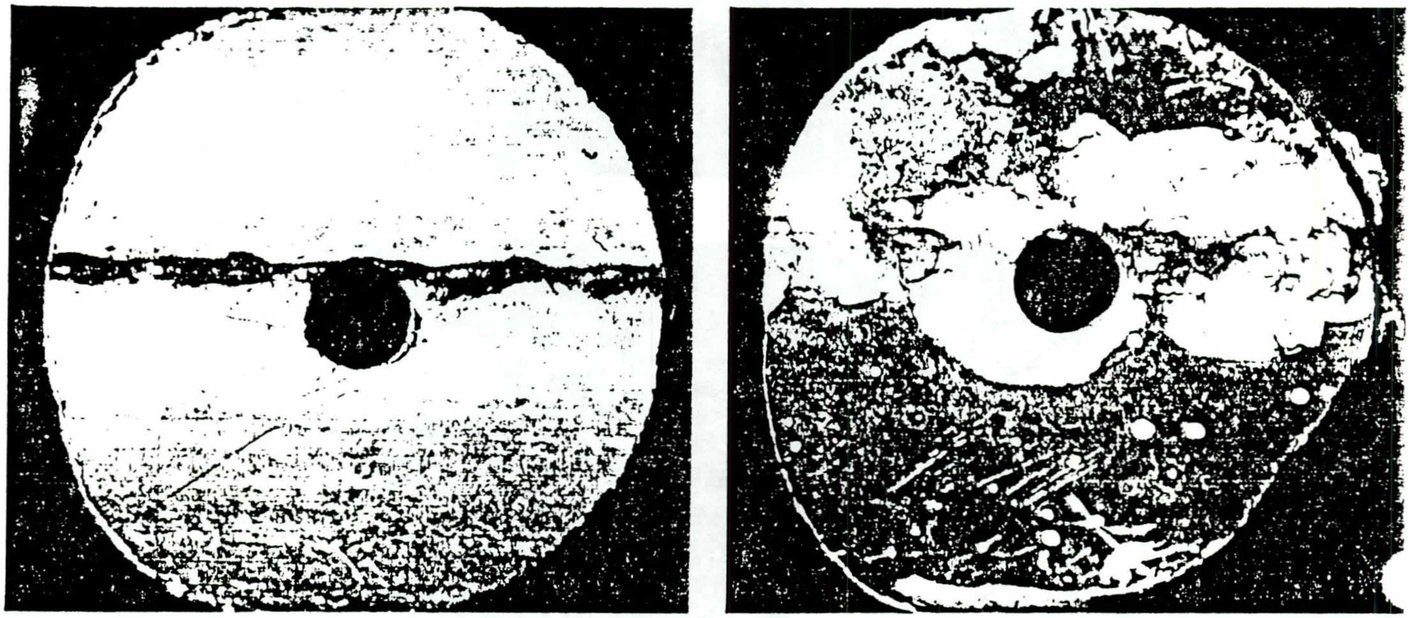
Under conditions in which galvanized pipe edges and zinc-coated inverts have been destroyed, aluminized edges showed very little corrosion damage after 30 years (see Figure 7).

Furthermore, on modern welded-seam HEL-COR(R) the weld seams on aluminized showed superior performance to that of galvanized weld seams, especially in more corrosive waters of lower scaling tendency (see Figure 8).

30-year-old aluminized uncoated edge on a triangular notch cut from invert. The undeteriorated edge is indicated by the arrow.

Galvanized invert

Fig. 7 - Condition of uncoated edge on aluminized invert after a 30-year exposure in a severe waterside environment that caused severe deterioration of a zinc-coated galvanized pipe invert at the same site.



Aluminized Galvanized

Fig. 8 - Comparative weld-seam condition in the inverts of aluminized and galvanized pipe, exposed in the State of Maine. The pipes are connected in series. Inverts constantly are exposed to severely corrosive nonscaling water. The aluminized shows no discernible deterioration of the weld or of the coated surface. The galvanized pipe shows loss of the zinc coating throughout the invert and scattered pitting in the substrate. The extruded weld metal on galvanized is attacked and the substrate attack around the weld is due to earlier coating loss.

The basic limitation on performance of sacrificial zinc coatings is that in environments of lower-scaling tendency, there is little restraint of coating corrosion. Galvanic protection is high, but coating life is shortened so that exposed base metal is soon deprived of all protection. Coating loss occurs first around bare areas because corrosion there is accelerated by galvanic protection (see Figure 8). However, in recommended environments for galvanized, coating corrosion is suppressed by formation of protective barrier scales.[7,8] In such environments, galvanic protection of the steel substrate is achieved at very low coating-corrosion rates.

FIELD TEST PERFORMANCE

Program Background

In 1952, Armco supplied riveted pipe for installation at 137 culvert sites on secondary roads in 20 states for the highway department program. In most cases, galvanized and aluminized pipe lengths were installed in series simultaneously.

In 1982, Armco initiated a thorough program of locating and evaluating pipes from all of those sites which were still functioning. By November, 1983, a total of 58 sites had been located in California, Colorado, Idaho, Illinois, Iowa, Kansas, Michigan, Mississippi, Missouri, New Mexico, Ohio, Oklahoma, Texas, Utah and Washington.

The other sites were lost due to urbanization, abandonment, or new construction.

Of the 58 located sites, four have not been evaluated fully because of accessibility problems.

A wide variety of environmental conditions, ranging from very wet to very dry, were represented. Some pipes are located in wet climates where there is rainfall in excess of 50 in./yr. (i.e., western Washington; northern Mississippi and eastern Texas). Others are located in very dry climates where there is less than 15 in./yr. of rainfall (i.e., Colorado, Utah and New Mexico). Many are located in more typical, intermediate climates (Missouri, Illinois and Iowa).

At several sites, pipes were continuously or generally wet in the invert, while several were generally dry. A few sites were characterized by swampy, mucky conditions including persistently stagnant water, and many were characterized by continuous or nearly continuous water flow. Some were wet only during each rainfall or for a day or so afterward.

There were several sites which had soft, acidic, high-resistivity water, known to be quite corrosive to plain galvanized steel pipe. Also, there were several with slightly alkaline, intermediate-resistivity water, and a few with corrosive, higher-salt, lower-resistivity water.

Some pipes were subject to pronounced silting; others showed very little or none.

There were widely varying pipe and terrain slopes. At some sites, abrasion varying from mild to very severe was observed. Site soils included loamy, clayey and sandy types.

A list of water and soil pH and resistivity values obtained during the evaluation is given in the appendix.

Our evaluation included an assessment of environmental conditions through analyses of water and soil specimens. Environments were classified as severe, moderate, or mild in accordance with their effect on galvanized.

At a small number of sites where no galvanized pipe was installed, resistivity and pH -- along with other supplementary analytical parameters -- were utilized to characterize the severity of the environment.

Pipe evaluation included cleaning, visual inspection and photography of inverts. One-and-a-half- to two-inch-diameter metal trepan specimens were taken from the invert at or near the six o'clock position, and near the pipe ends in both aluminized and galvanized pipes.

In certain cases, trepans were taken near the junction on compound aluminized/galvanized pipe lengths. Where possible, pipe ends were uncovered at the crown, and then cleaned and photographed to permit evaluation of soilside performance. Additional information about soilside performance was obtained by acquiring trepans from the three or nine o'clock positions on aluminized and galvanized at locations remote from pipe ends.

At three sites, pipes were excavated due to special circumstances and a complete evaluation of soilside behavior was possible.

EVALUATION RESULTS

Aluminized was considerably superior to galvanized -- in resistance to both overall attack and localized corrosion on both the invert and the soilside at every evaluated site where no extreme conditions existed. Below, all results are summarized generally. In the attached appendix, they are summarized more specifically in pictorial form.

A table listing soil and water pH and resistivity values obtained for each site is also included in the appendix.

Invert Behavior

Severe environments

At sites with severely corrosive water, galvanized pipe inverts were destroyed or thinned to the point of extensive perforation. By contrast, aluminized at these sites showed only mild attack in the form of small coating pits. In some cases, these pits extended into the steel substrate to a minor degree. Aluminized inverts sometimes showed general rust-colored stain.

which may suggest general coating loss. However, invert cleaning and microscopic examination showed that the coating was intact overall, as previously shown in Figure 3.

A total of 18 sites were designated severe. Thirteen of these had aluminized and galvanized pipes; five had only aluminized.

Moderate or mild environments

At sites with moderately or mildly corrosive waters, galvanized inverts typically showed overall loss of coating and penetration of the steel substrate. These ranged from a few mils in milder environments to 10 to 30 mils in moderate environments. By contrast, after 30 years, aluminized typically showed nothing other than pitting of the aluminum layer arrested at the alloy layer. Invert rust staining occurred in some cases, but several inverts were essentially free of staining.

Abrasive environments

Several sites had obvious abrasive conditions; attack occurred primarily on corrugation crests and upstream sides. Abrasion was mild at most of these, but was moderate at one site and very severe at one other.

In all but the one case involving very severe conditions, aluminized exhibited superior invert abrasion resistance when compared to galvanized. Aluminized superiority was always associated with the hard alloy layer.

The soft aluminum layer was preferentially removed over large areas on corrugation crests, while the underlying hard alloy layer was intact and unaffected.

Galvanized showed total coating loss and significant substrate penetration on corrugation crests at milder abrasive sites, while aluminized showed only loss of the aluminum layer portion of the coating.

At the one moderate site, galvanized showed invert destruction in one section and severe overall thinning and localized perforation on the upstream side of corrugation crests elsewhere. Aluminized at the same site showed loss of the aluminum and alloy coating layers, but only slight substrate penetration.

At the one very severe site, both galvanized and aluminized showed destruction of corrugation crests in the inverts.

Soilside Behavior

No sites had severe soilside influences on galvanized or aluminized, but aluminized behavior was superior in every case where galvanized showed some soilside corrosion.

Typically, in soilside areas above the waterline, galvanized showed only loss of the coating; there was no substantial penetration of the steel substrate.

Below the waterline, there was a tendency toward more severe soilside corrosion of galvanized.

It was possible to make comparisons of aluminized and galvanized lower soilside areas with invert trepans.

Aluminized was substantially superior to galvanized on soilside areas on all invert trepans, including a few where its earth contact is uncertain. Usually, it showed no attack or only minor localized coating loss with associated slight substrate penetration. By comparison, galvanized often showed general coating loss and substantial, though not important, substrate penetration.

At two locations where there were no galvanized pipes for comparison, aluminized showed more significant substrate penetration at small coating pit sites. These pits were about 10 mils deep in one case, and 18 mils deep in the other.

Sites With Interference Complications

There were four sites where aluminized performance was not typical because of complicating interference conditions.

At one of these sites, poor coating quality, in the form of very severe lateral alloy layer cracking, caused widespread spalling of the coating.

At two sites, evidence indicates severe intermittent chemical contamination. At the fourth site, there was severe abrasion.

PERFORMANCE OF MODERN ALUMINIZED AND GALVANIZED PIPE

Helically corrugated aluminized steel pipe, in service for over seven years, is already showing pronounced superiority over galvanized in the more severe environments of lower scaling tendency (see Figure 10 in the appendix). The superiority of the aluminized weld-seam behavior has already been noted.

EFFECT OF ENVIRONMENTAL PARAMETERS ON ALUMINIZED/GALVANIZED DURABILITY

Field test results led to a determination of pipe material performance as a function of controlling environmental parameters. This is highly desirable from the standpoint of comparing the environmental limitations of different materials and predicting material performance.

The problem is the identification of controlling environmental parameters and their interrelationships. Armco simplified the matter by utilizing primary parameters only. Armco investigators then determined whether a realistic, highly consistent result could be attained.

The primary simplification is the assumption that any corrosion problems will result mainly from waterside conditions in the invert. Studies by Armco and various highway departments, among others, show that this is generally the case for galvanized.[10-16] The results indicate that corrosion affecting galvanized structural integrity is likely to occur sooner on the invert than on the soilside. There are certain exceptions, the most significant being cases involving high-salinity soils in dry climates. However, most earlier corrosion problems are the result of waterside corrosion, and Armco concentrated on defining the conditions that give rise to such problems.

Of course, soil parameters do control water parameters, but it is best to concentrate on water because soils are highly heterogeneous. Local soil chemistry is often vastly different from water chemistry, since the water traverses a variety of soil conditions over a watershed of any significant size.

Corrosion of zinc and steel in water is known to be primarily a function of the amounts of corrosion-inhibiting (scaling) and corrosion-accelerating ions.[2,16]

Dissolved O_2 usually is necessary for significant corrosion to occur; it accelerates corrosion in direct proportion to its concentration up to a point. A certain minimum amount of inhibiting salt ions (including Ca^{+2}, Mg^{+2}, HCO_3^-, and to a lesser extent SiO_3^{-2}) is needed to form protective barrier scales, or corrosion at higher O_2 levels will be severe.

Thus, soft high-resistivity surface water is usually quite corrosive to galvanized. Dissolved CO_2 and other sources of H^+ (above certain levels) accelerate corrosion by retarding scale formation and by lowering the pH. Above certain maximum levels, certain salt ions, including Cl^-, SO_4^{-2}, NO_3^-, Na^+ & K^+, interfer with scale formation and accelerate corrosion.

At higher levels of inhibitors, increased levels of all accelerators can be tolerated. Low resistivity water also will be low in corrosiveness when inhibitors are predominant, and high in corrosiveness when accelerators are predominant.

Of course it is necessary to know the prevalent water chemistry at a pipe site in order to classify site corrosiveness. Chemistry changes somewhat throughout the year, but a degree of stability exists as a result of stable prevalent climatic conditions and soil strata composition.

These two predominant factors determine whether surface water will be hard or soft, saline or nonsaline, and alkaline or acidic.

The time of sampling is very important with regard to rainfall. Dilution of ground water discharge with softer surface runoff occurs during and shortly after rainfall periods. The prevalent water chemistry at normally wet sites can be obtained only by sampling at least a few days after the last rainfall.

Some galvanized inverts are exposed to more severe conditions near the high water mark because of contact with well aerated and diluted softer mixtures of runoff with ground water. This is true, even though the time of water contact above the low waterline is usually much less than that below.

Time of contact is usually of lesser importance in the lowest invert areas, which are subject to continuous or prolonged contact with undiluted groundwater, which is usually scale forming. Protective scale in this area tends to persist through periods of rainfall dilution.

Sometimes, in wet climates, pipes that are wet only during and shortly after rainfall periods, show severe corrosion -- despite limited contact time. This is because of the relatively severe conditions produced by aerated, softer runoff with relatively little groundwater input.

Once a suitable water specimen is obtained, concentrations of the necessary ions can be determined reasonably well by a few simple quick titration and meter tests. A total hardness titration gives $Ca^{+2} + Mg^{+2}$, and a total alkalinity titration gives HCO_3^- and some of the SiO_3^{-2}. A pH measurement gives H^+ which, in conjunction with total alkalinity, gives excess or free CO_2, which is usually more useful. A conductivity measurement gives an approximate measure of the total dissolved salt content which, in conjunction with the total inhibitor content (total alkalinity + total hardness), gives an idea of the total accelerator salt content.

The total scaling tendency of a water is established reasonably well by a determination of alkalinity, hardness, and H^+.[17] By adding alkalinity and hardness values and subtrating free CO_2 (usually the primary source of H^+), the scaling tendency is quantified in a relative sense.

Plotting the result on one axis of a graph and conductivity (or resistivity) on the other axis, permits graphing of pipe performance as a function of the primary water parameters. Thus, zones of satisfactory and unsatisfactory performance can be determined.

By utilizing this approach on sites in the two aluminized/galvanized field test programs and sites from other galvanized - only field inspection programs, Armco constructed Figure 9 on performance guidelines.

One-time water samplings, taken at least two days after the last rainfall at normally wet sites, were used from 81 sites in 16 states.

Satisfactory performance was designated as less than 30 mils penetration over sizeable invert areas after exposure for 30 years. This would be expected to result in a minimum service life of 50 years for 16-gage material.

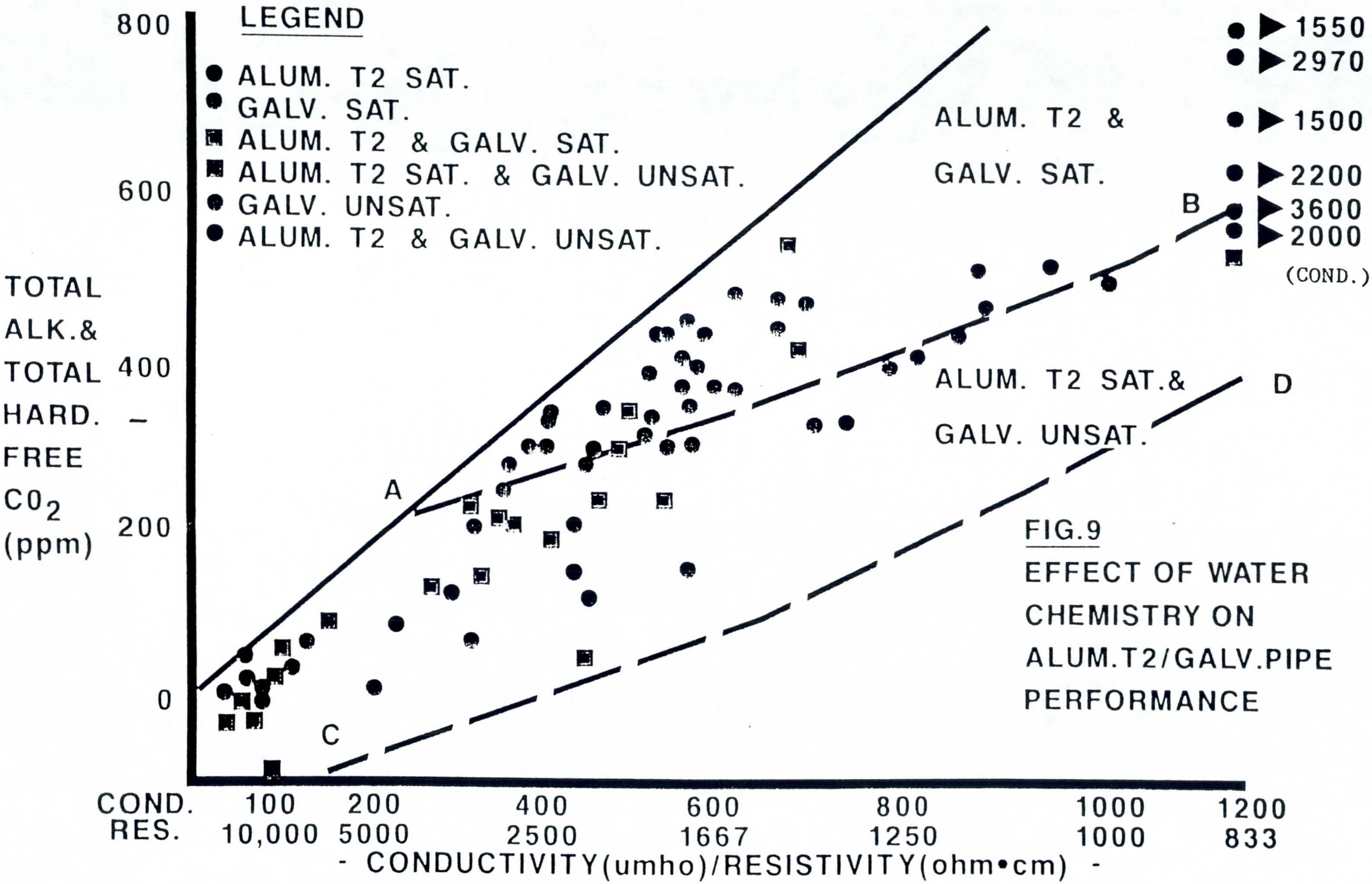


FIG.9

EFFECT OF WATER CHEMISTRY ON ALUM.T2/GALV.PIPE PERFORMANCE

The line AB in Figure 9 marks the limit of increasingly severe conditions that galvanized normally can tolerate while providing satisfactory performance. Increasing severity is encountered from top to bottom and from left to right, and crossing AB in either direction results in encountering problematic conditions.

Transversing the graph from left to right shows the effect of constantly increasing corrosion accelerator salt concentrations (Cl^-, SO_4^{-2}, etc.) at a fixed level of total inhibitors and free CO_2; AB marks the limit of accelerator salt tolerance at this inhibitor/CO_2 level for galvanized. Traversing the graph from top to bottom shows the effect of decreasing inhibitor and increasing free CO_2 at a fixed accelerator salt level, and AB marks the limit of inhibitor decrease or CO_2 increase tolerable at this accelerator level for galvanized.

Consistent results with a rather well-defined boundary between satisfactory and unsatisfactory performance for galvanized were found. There was some overlap at the boundary, most likely due to somewhat nonrepresentative water chemistry in a few cases, but the results are useful and realistic in defining galvanized suitability.

The anticipated detrimental effects of water softness, acidity and corrosion accelerators on galvanized are evident. The superior tolerance of aluminized for more severe conditions is also evident. Superior tolerance for soft acidic water is very evident and well defined. Superior tolerance for higher corrosion accelerator salt concentrations is suggested, as would be anticipated, but the number of pertinent data points is small at present and additional sites with high-conductivity water must be studied to help establish this.

The position of the limiting line for satisfactory aluminized performance (CD) is only tentative at present, but it is evident that the limit is considerably beyond AB in the directions of increasing severity.

Aluminized deterioration was only minor at all sites with compound aluminized/galvanized pipe lengths where galvanized performed poorly. Thus, considerably more severe conditions than these would be necessary to produce the same degree of deterioration on aluminized in the same exposure time, and CD must be located well beyond AB. However, its location cannot be known accurately until the material exhibits considerable deterioration.

Aluminized did show substantial localized attack with a few tiny pit perforations at one severe site in the research test program, but even there, overall deterioration was modest.

At one other site, aluminized showed severe overall deterioration due to very high salinity but accelerator salt content there was far too high to be useful in locating CD.

Four test sites, where aluminized performance was not typical because of unusual complicating conditions, cannot be used to help locate CD. One of these cases involves severe abrasion; another, poor coating quality, while the other two apparently involve severe intermittent chemical conditions far beyond CD.

Obviously, the designation of zones of satisfactory and unsatisfactory pipe durability, based on water chemistry, affords the prospect of predicting pipe life. In its present form, the graph provides a useful guideline for pipe performance although it is expected to be conservative. It is very conservative for drier climates since the graph is based on data from wetter climates. It is also conservative in that the worst portion of a pipe length was used to designate the pipe condition. Additionally, it is conservative for stagnant water sites since lower dissolved oxygen contents in such water produce lower overall corrosion loss (when acidity is not extreme); most of our wet sites had flowing water. It is very conservative for material thicker than 16 gage and for situations that do not require 50 years maintenance-free life for 16 gage material.

In conclusion, the results of 30 years of testing conclusively demonstrate the consistent and pronounced superiority of ALUMINIZED STEEL Type 2.

L. Bednar - Sr, Research Engineer

G. E. Morris - Sr. Product Engineer

APPENDIX

Minimum Resistivity and pH Data and Photographs
of Representative Invert and Soilside Pipe Performance

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17. Reference 1, pp. 62-65.

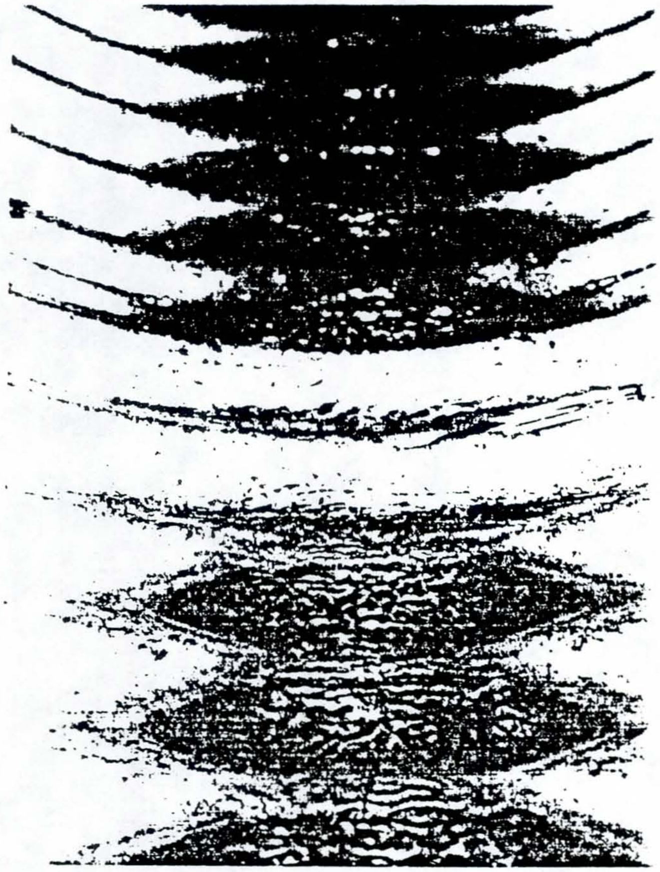
18. Reference 1, pp. 29-34.

Minimum Resistivity and pH Values

	Soil		Water	
	Resistivity	pH	Resistivity	pH
Illinois				
Morgan Co. (1)	2500	6.75	2700	7.94
Sangamon Co. (2)	2200	6.95	6570	7.04
Morgan Co. (3)	2500	7.27	1540	8.10
Greene Co. (4)	3600	7.39	260	7.90
Adams Co. (6)	2600	7.10	3300	7.24
Kansas				
Decatur Co. (7)	2550	7.56	--	--
Dickinson Co. (10)	1500	6.95	--	--
Pratt Co. (11)	3600	5.34	--	--
Iowa				
Marshall Co. (13)	2300	7.24	1885	7.15
" (14)	2800	7.29	--	--
" (15)	2300	7.32	--	--
" (16)	1800	7.14	--	--
" (17)	2800	7.11	--	--
" (18)	2300	7.12	1470	7.73
" (19)	2900	7.17	1370	7.15
" (20)	2400	7.56	1450	7.02
Jefferson Co.	2350	7.48	1020	7.70
Colorado				
Fairplay Co. (23)	7100	7.41	--	--
Mesa Co. (24)	1150	7.06	245	7.30
Weld Co. (26)	1050	7.21	--	--
California				
Napa Co. (34)	1600	5.90	3030	6.97
El Dorado Co. (37)	18000	5.60	--	--
Placer Co. (45)	27000	4.85	1560	6.25
San Benito Co. (46)	3300	5.20	2440	7.27
Marin Co. (48)	2600	6.70	2175	6.50
Utah				
Piute Co. (57)	8106	7.90	--	--
Michigan				
Van Buren Co. (63)	1250	7.52	2000	7.38
Ohio				
Delaware Co. (70)	1800	7.46	2270	7.40
Mississippi				
Tate Co. (81)	4700	5.15	11110	5.55
Benton Co. (82)	5600	4.25	--	--
De Soto Co. (93)	7700	4.65	--	--

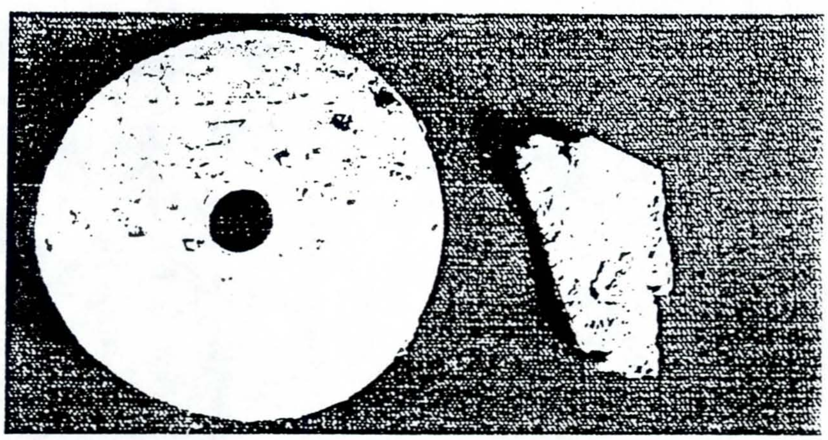
	Soil Resistivity	Soil pH	Water Resistivity	Water pH
Texas				
Montgomery Co. (96)	6000	4.90	3450	7.18
Oklahoma				
Oklahoma Co. (103)	4700	7.39	--	--
" (104)	4600	7.31	--	--
" (105)	4600	6.96	--	--
" (106)	11400	7.34	--	--
" (107)	4500	8.29	--	--
Missouri				
Carter Co. (108)	2900	7.62	2630	--
" (109)	4400	6.54	--	--
Livingston Co. (110)	1900	7.42	830	7.01
"	1750	7.34	2000	7.09
Lafayette Co. (112)	1700	7.26	2440	7.38
" (113)	2150	6.52	3075	7.11
Nodaway Co. (114)	2100	7.49	1850	6.52
" (115)	1100	6.95	4255	6.55
" (116)	2000	7.48	2040	6.82
" (117)	2400	7.36	2630	7.10
" (118)	1500	7.12	2060	6.70
" (119)	1500	7.04	1540	6.80
Washington				
Clallum Co.	17000	4.70	43500	4.60
Snohomish Co.	1850	4.00	11110	6.60
*San Juan Co. (1)	--	6.0	--	--
(Waldron Island) (2)	1400	5.7	1600	7.1
(3)	700	6.0	1300	7.0
(4)	1600	6.2	1750	6.7
New Mexico				
Bemilillo Co. (29)	3200	7.65	--	--

*Taken from Washington DOT Report No. 173 - September, 1981.



ALUMINIZED STEEL TYPE 2
(30 years old)

GALVANIZED
(30 years old)



Trepan specimens from inverts at six o'clock position

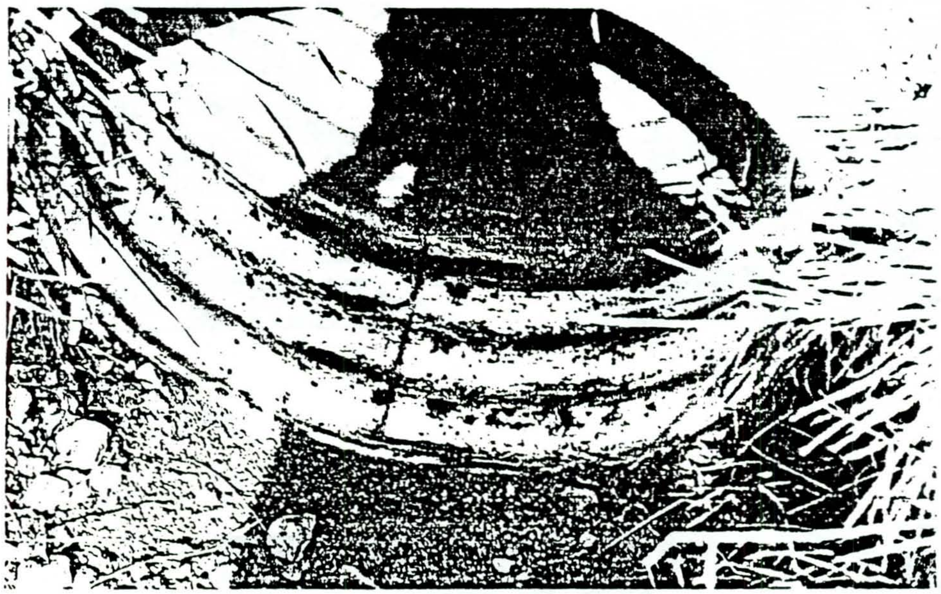
ALUMINIZED STEEL TYPE 2

GALVANIZED
(Fragment from high waterline)

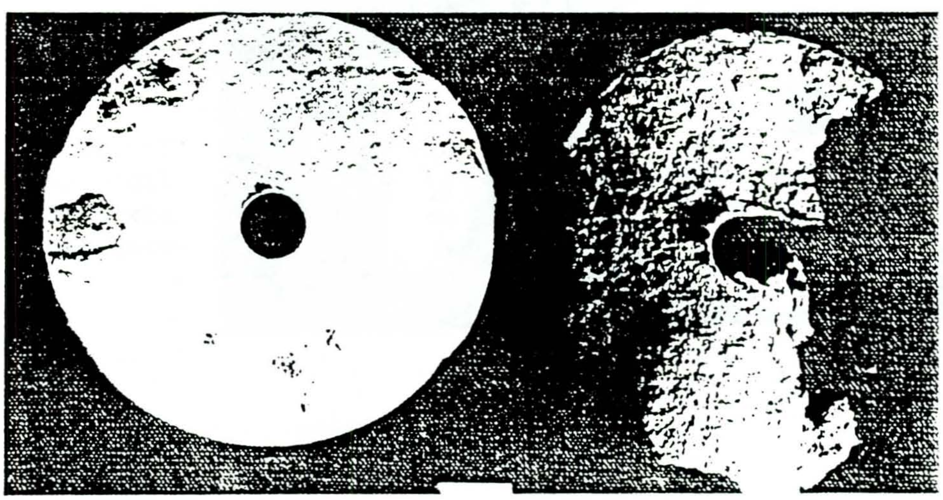
FIGURE 1: Severe Environment, Livingston Co., Missouri

INVERT BEHAVIOR

GALVANIZED
(30 years old)



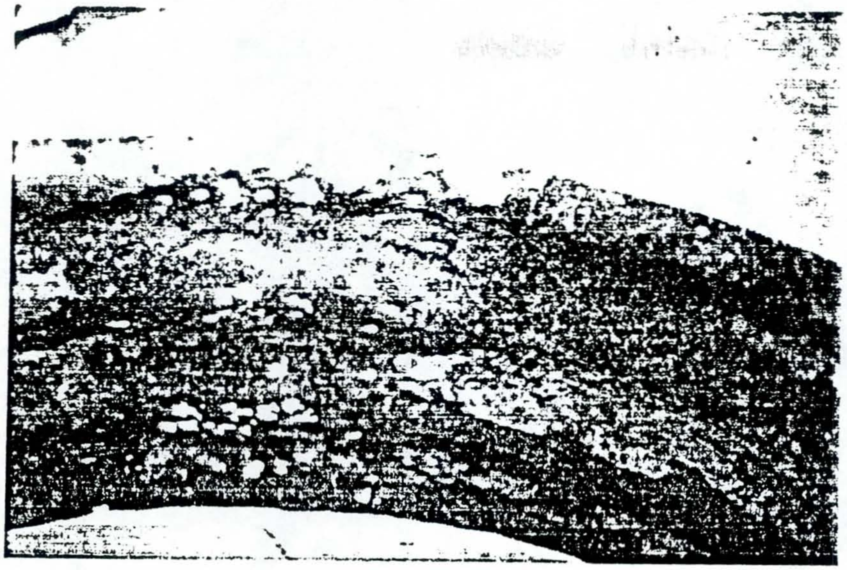
ALUMINIZED
STEEL TYPE 2
(30 years old)



Trepan specimens from inverts at six o'clock position

ALUMINIZED STEEL TYPE 2 GALVANIZED

FIGURE 2: Severe Environment, DeSoto Co., Mississippi



GALVANIZED
(30 years old)

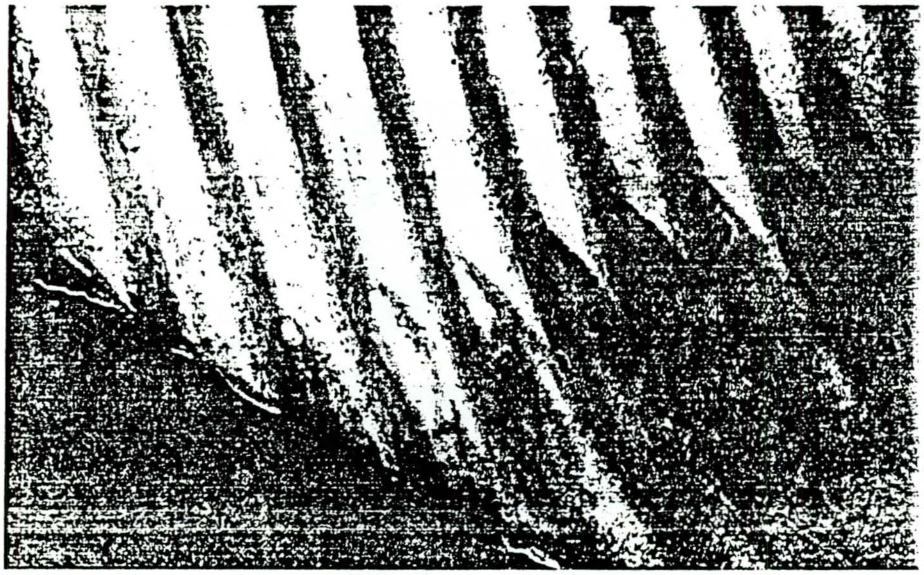
Section of galvanized pipe length showing perforations and severe general rusting. Section is a ring cut from pipe length.

ALUMINIZED STEEL TYPE 2
(30 years old)

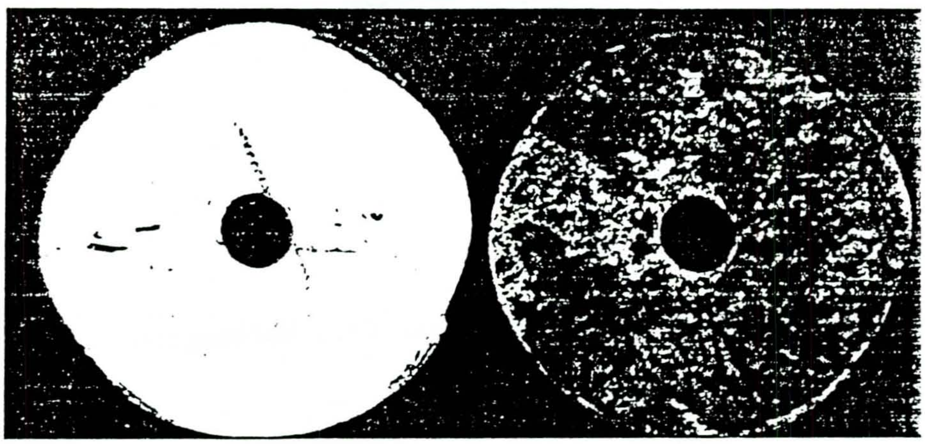
Section of aluminized pipe length showing coating intact generally and pits near uncoated edge. Rusty corroded rivets are also visible.

FIGURE 3: Severe Environment, Snohomish Co., Washington

GALVANIZED
(30 years old)



ALUMINIZED STEEL TYPE 2
(30 years old)

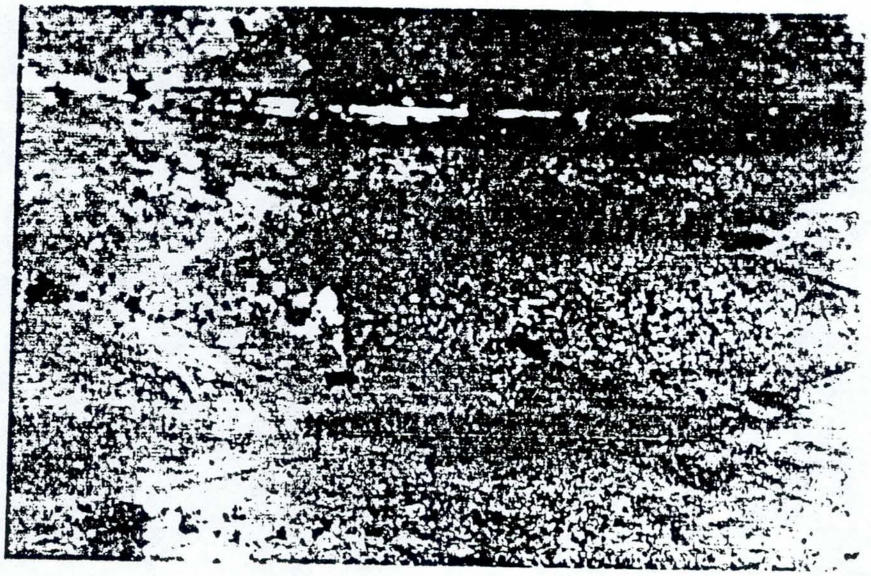


Trepan specimens from inverts at six o'clock position.

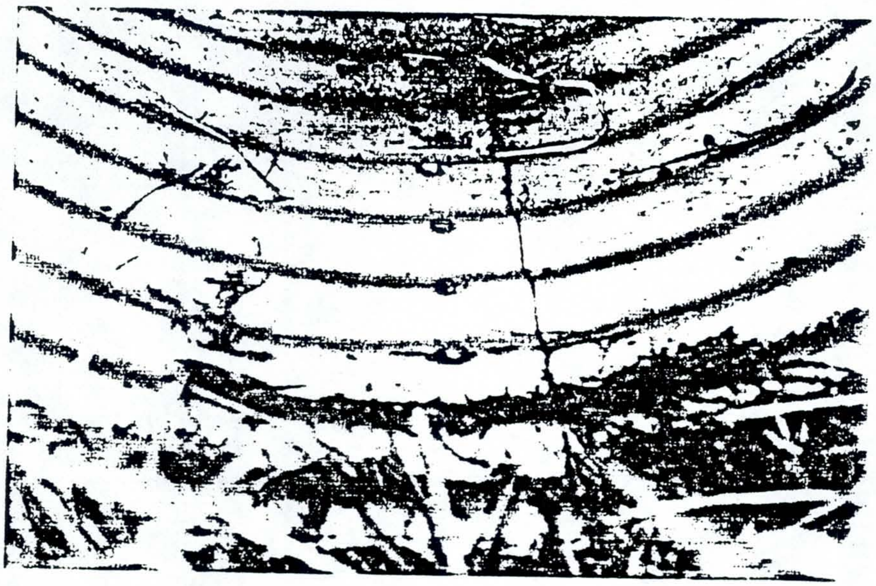
ALUMINIZED STEEL TYPE 2 GALVANIZED

FIGURE 4: Moderate Environment, Morgan Co., Illinois

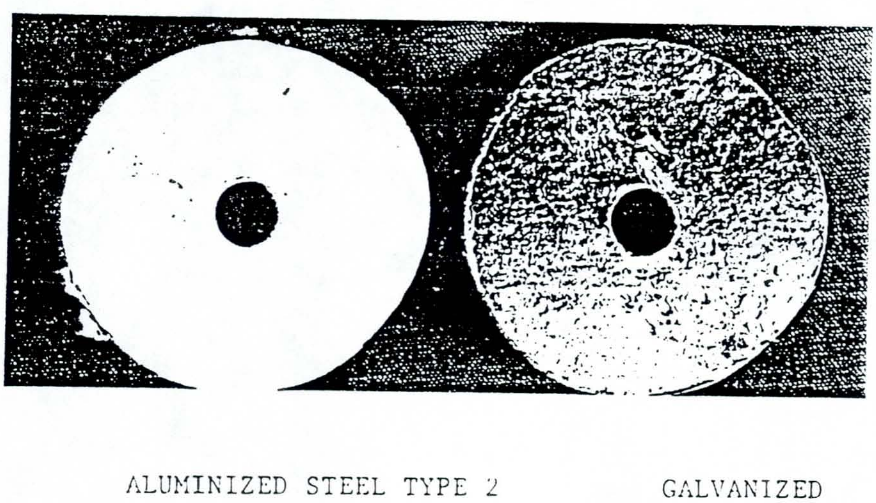
INVERT BEHAVIOR



GALVANIZED
(30 years old)



ALUMINIZED STEEL TYPE 2
(30 years old)

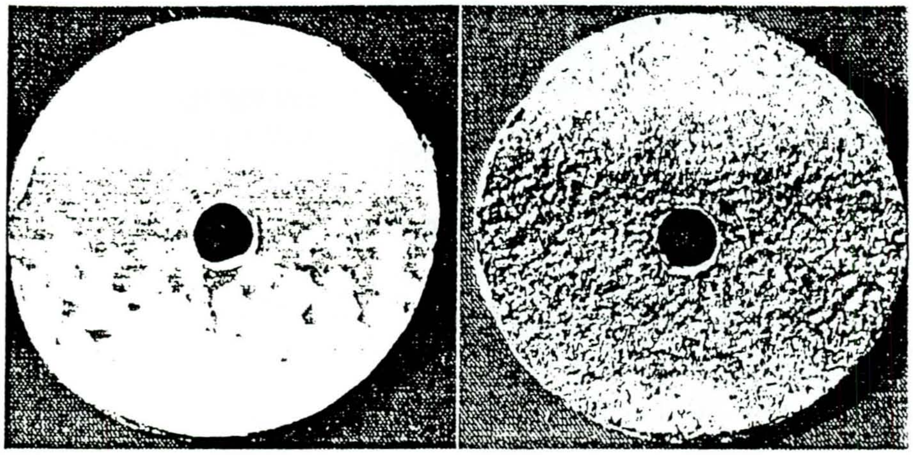


Trepan specimens from inverts at six o'clock position.

ALUMINIZED STEEL TYPE 2 GALVANIZED

FIGURE 5: Mild Environment, Marshall Co., Iowa

INVERT BEHAVIOR

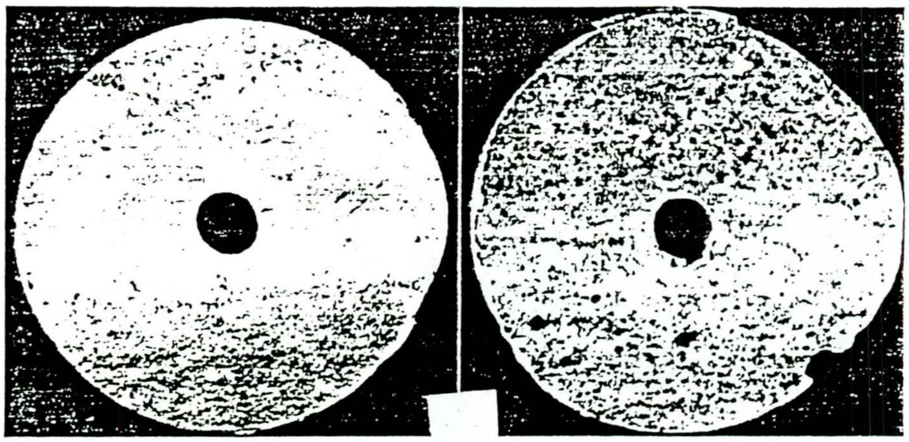


Mildly abrasive site in Oklahoma Co., Oklahoma. Aluminized alloy layer is intact, while galvanized has lost all coating and shows minor substrate penetration.

ALUMINIZED STEEL TYPE 2
(30 years old)

GALVANIZED
(30 years old)

Moderately abrasive site in Placer Co., California. Aluminized has lost all coating on upstream sides of corrugations but shows little substrate penetration. Galvanized shows loss of all coating and about 75 percent penetration of the substrate generally, plus some localized small perforations. There was one section in which galvanized shows invert destruction. Galvanized is about seven years younger than aluminized at this site.

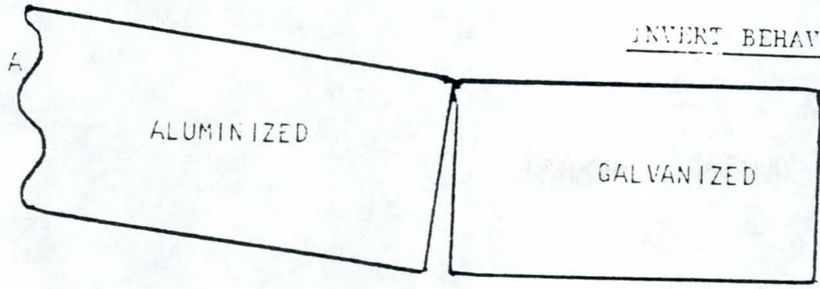


ALUMINIZED STEEL TYPE 2
(30 years old)

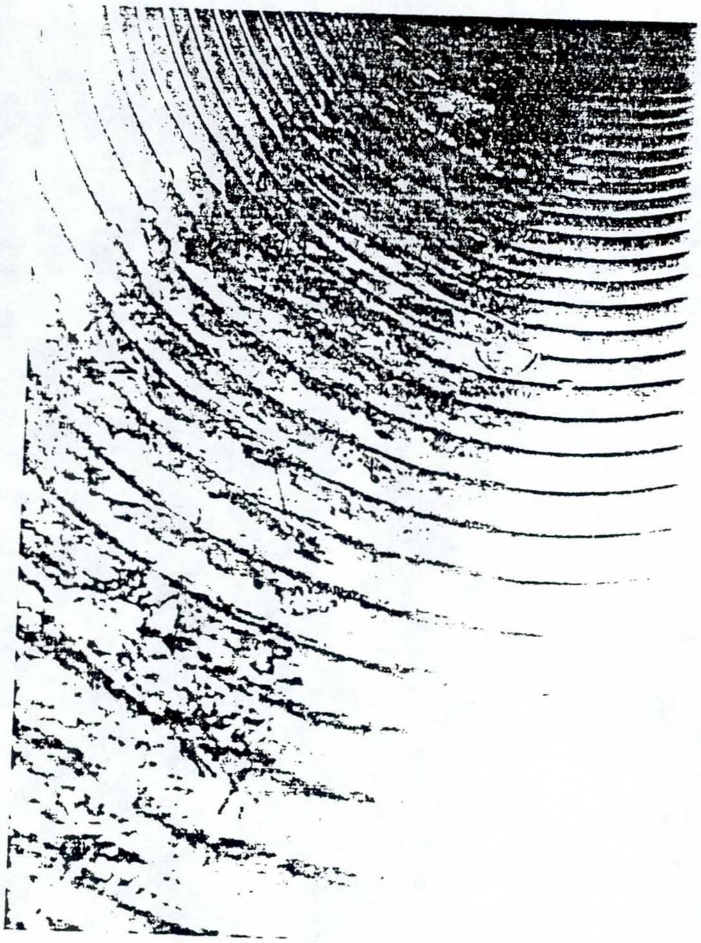
GALVANIZED
(30 years old)

FIGURE 6: Abrasive Environments - Trepan specimens from inverts at six o'clock position illustrated.

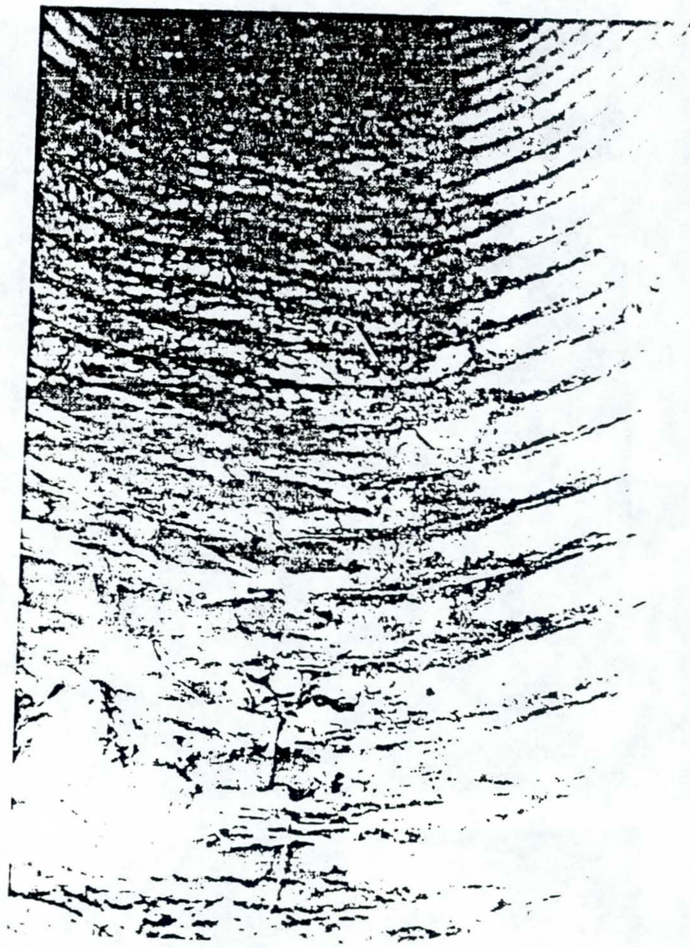
INVERT BEHAVIOR



Short length of galvanized is connected in series with and downstream from aluminized. Aluminized has 5 - 6° slope while galvanized has zero slope (poor junction).



ALUMINIZED STEEL TYPE 2
(30 years old)

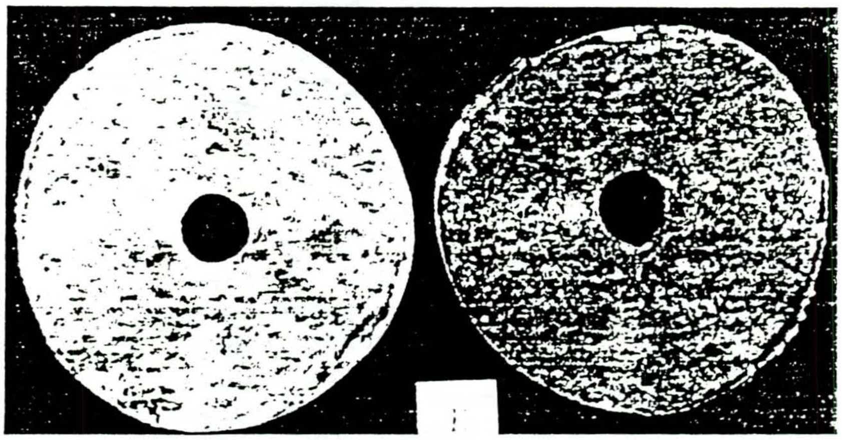


GALVANIZED
(30 years old)

FIGURE 7: Severely abrasive site, Napa Co., California. Perforation was the result of abrasion, as can be seen by the concentration of attack at crests and upstream sides of corrugations. Observation indicates that attack at corrugation crests on the galvanized section, downstream of the aluminized, changes in severity with a change in slope. The first seven or eight galvanized corrugations from the junction show severe crest deterioration. This deterioration diminishes abruptly most likely because of a reduction in velocity with loss of slope. The galvanized section is about ten years younger than the 30-year-old aluminized at this site.

GALVANIZED
(30 years old)

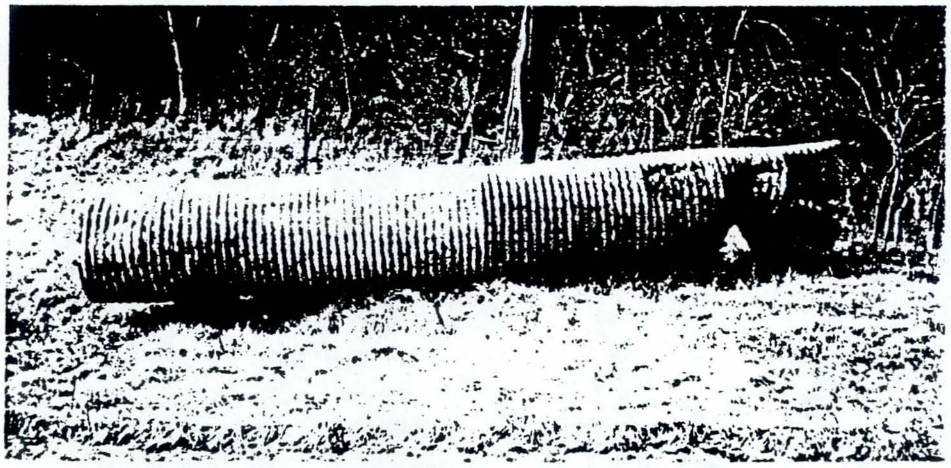
ALUMINIZED STEEL TYPE 2
(30 years old)



Soilside surfaces of trepan specimens from nine o'clock pipe position.

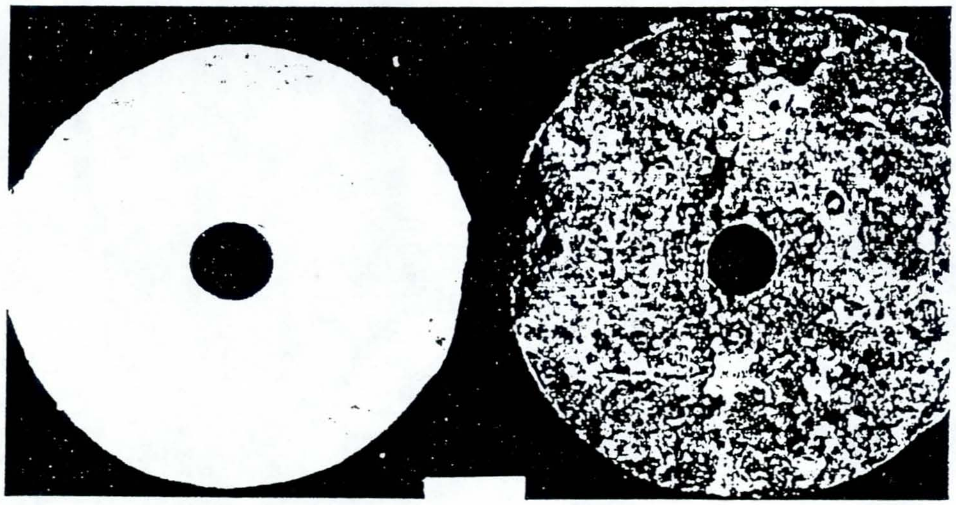
ALUMINIZED STEEL TYPE 2 (30 years old) GALVANIZED (30 years old)

FIGURE: 8: Significant but minor galvanized soilside attack occasionally found above waterline level (Pratt Co., Kansas). Galvanized shows loss of coating and minor general substrate penetration. Aluminized shows spotty loss of aluminum layer and some pinpoint substrate corrosion in spots of exposed alloy.



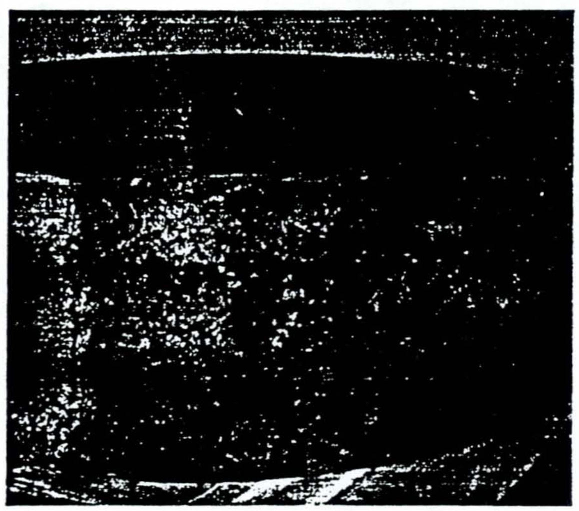
Adams Co., Illinois
(30 years old)

ALUMINIZED STEEL TYPE 2   GALVANIZED



De Soto Co., Mississippi
(30 years old)

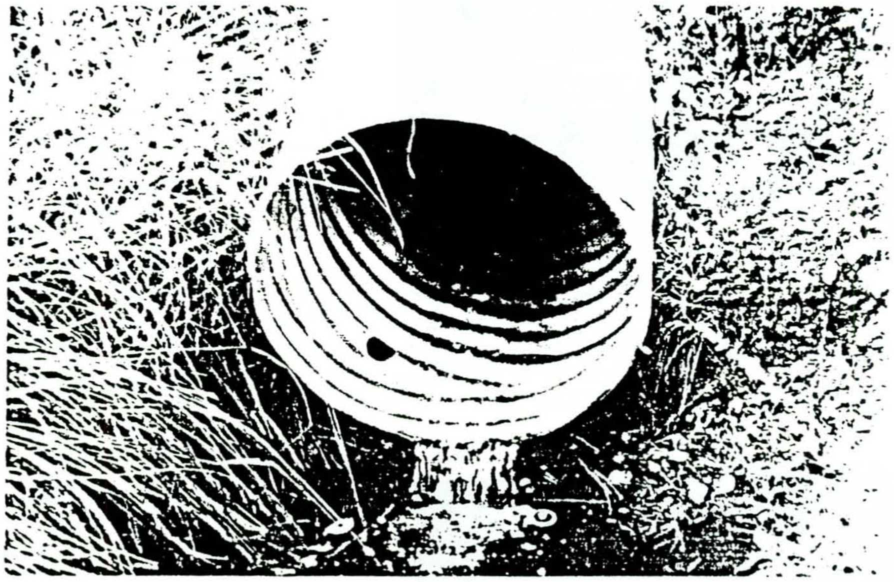
ALUMINIZED STEEL TYPE 2   GALVANIZED



Snohomish Co., Washington

ALUMINIZED STEEL TYPE 2   GALVANIZED

FIGURE 9: Moderate galvanized soilside corrosion below the waterline. The galvanized pipe shows loss of coating and moderate general substrate penetration, while aluminized shows no, or spotty coating attack and mild substrate corrosion. (The Illinois pipe in the top photo was removed due to failure of the galvanized half.)



ALUMINIZED STEEL TYPE 2 invert after cleaning to remove dark stain.

Galvanized invert after cleaning.

FIGURE 10: Relative invert condition of modern helically corrugated weld-seam aluminized and galvanized pipe at the same severe non-scaling water site in Maine. Lengths of aluminized and galvanized pipe are joined together in series at this site. The aluminized is unattacked while the galvanized has lost the zinc coating and shows deep substrate pitting throughout the invert. See Figure 8 in text for close-up of invert trepan specimens. Trepan holes shown here were made in an earlier inspection.

DESIGN DATA REPORT
for the
CACTUS ROAD STORM DRAIN
(67th Avenue to the Agua Fria Freeway)

APPENDIX B-
Hydrology Report/Summary

CACTUS ROAD STORM DRAIN HYDROLOGY SUMMARY

Prepared for the
FLOOD CONTROL DISTRICT
of
MARICOPA COUNTY

Prepared by
SFC Engineering Company

September 3, 1992

CACTUS ROAD STORM DRAIN
INTERIM HYDROLOGY SUMMARY

1. PURPOSE

The purpose of this report is to summarize results of the hydrological studies conducted for the Cactus Road Storm Drain Project. The backup documentation of the hydrological model developed for the Glendale-Peoria Drainage Master Plan, developed by Camp Dresser & Mckee and James M. Montgomery Consulting Engineers, was not available to perform a detailed evaluation of the project drainage area. The hydrological model used in the Master Plan was the Storm Water Management Model (SWMM) developed by the Environmental Protection Agency. After consulting with the Flood Control District of Maricopa County (FCDMC) it was determined that a model should be developed using procedures outlined by the FCDMC in their Hydrologic Design Manual.

This report is an interim report to present a summary of the hydrologic data only and does not present detail on the methodologies and parameters used in the study. Additional detail will be included in the final hydrology report.

2. APPROACH

The hydrologic analysis performed for the design of the Cactus Road Storm Drain Project is subject to the review and approval of the FCDMC. The FCDMC recently adopted procedures to be used on all studies and designs for projects within its

jurisdiction. These methods and procedures are published by the FCDMC in the Hydrologic Design Manual (Sept. 1990).
The U.S. Army Corps of Engineers HEC1 computer program was used to model the project drainage area and was developed in accordance with the FCDMC Hydrologic Design Manual.

The current City of Peoria drainage code requires that all new developments provide on-site storage for runoff from the 10-year 2-hour storm, and that additional runoff be conveyed safely off-site to the nearest major mile street. Based upon retention requirements by the City of Peoria for new developments, runoff resulting from a 10-yr 2-hour storm, was modeled as retention in the hydrologic model for undeveloped areas. The land use assumed for this study were future conditions, based on ultimate development with the current city land use plans. Consistent with the approach of the previously adopted Glendale-Peoria Area Drainage Master Plan, no retention was modeled for existing developments.

3. HEC-1 MODEL DEVELOPMENT

The project drainage area is located primarily in the City of Peoria, with contributions from a small area in the City of Glendale. These drainage basins, shown in figure 1, are delineated into sub-basins to compute future flows for main trunk line and catch basin design.

The basin parameters for each sub-basin were determined from the contour map supplied with the Master Plan, Peoria and Glendale zoning maps, SCS soil survey maps, and drainage regulations from the City of Peoria. HEC-1 cards were prepared utilizing the FCDMC's computer program MCUHP1. The MCUHP1 program generates HEC1 data cards which are consistent with the guidelines established in the Hydrologic Design Manual. The HEC-1 model produced flood hydrographs at concentration points for all sub-basins located in the project area. The criteria used for the HEC-1 model was a 10-yr 6-hour storm with 10-yr 2-hour retention for all undeveloped areas. Retention was removed from the model by reducing contributing areas for undeveloped sub-basins. Two HEC-1 models were created in computing the retention requirements, a 10-yr 6-hour and a 10-yr 2-hr without any retention. A ratio was determined from the difference in runoff from the two models. This ratio was used to reduce contributing areas. Table 2 shows the procedure in developing the reduced areas for all on-site retention. All runoff from the 10-year storm from existing developed areas was considered to enter the combined Glendale-Peoria trunk drains.

4. RESULTS

Table 1 reflects the comparison from the Master Plan to HEC-1 peak flows at various locations within the project area. The HEC-1 model produced smaller flows from 67th Avenue through 83rd Avenue and larger flows from 87th Avenue to 91st Avenue. The triangle area south of Cactus between 83rd Avenue and the Outer Loop drainage channel also showed reduced flows compared to the Master Plan.

Their are several differences between the Master Plan and the HEC-1 model. The Master plan utilized SWMM methodologies and kinematic wave hydrograph and routing procedures. Whereas the HEC-1 model was created using Clark hydrographs and kinematic wave routing procedures. Retention for undeveloped areas in the Master Plan were based upon the difference between 10-year and 2-year storms. The HEC-1 model used Peoria retention regulations of on-site retention for a 10-yr 2-hr storm.

TABLE 1
COMPARISON OF GLENDALE-PEORIA MASTER PLAN
AND SFC HEC-1 HYDROLOGICAL MODEL
SEPTEMBER 3, 1991

MASTER PLAN PIPE #	MASTER PLAN (CFS)	SFC HEC-1 (CFS)	DIFFERENCE (CFS)	LOCATION
178	340	218	-122	GLENDALE AREA
651	470	281	-189	CACTUS & 71st
653	600	495	-105	CACTUS & 75th
655	780	707	-73	CACTUS & 79th
656	860	823	-37	CACTUS & 83rd
657	880	887	7	CACTUS & 87th
659	970	914	-56	CACTUS & 91st
634	120	42	-78	TRIANGLE AREA
635	230	87	-143	TRIANGLE AREA

BLE 2
MPUTATION OF AREA REDUCTION TO ACCOUNT
R 10YR-2HR ON-SITE RETENTION
/02/91

CATION	BASIN (ACRES)	10YR-6HR BASIN OUTFLOW (NO RETENTION) AC-FT	CFS	INCHES	10YR-2HR BASIN OUTFLOW (NO RETENTION) AC-FT	CFS	INCHES	DIFFERENCE (INCHES)	FACTOR	REDUCED BASIN SIZE (SQ-MI)	REDUCED BASIN SIZE (ACRES)
-AQ	128	12	172	1.126	11	317	1.029	0.097	0.086	0.017	11.03 ACRE DEV. RETAIN 10-2
	102	10	104	1.186	9	150	1.064	0.122	0.103	0.016	10.49 ACRE DEV. RETAIN 10-2
-AV	41	5	38	1.448	4	55	1.260	0.188	0.130	0.008	5.32 UNDEVELOPED
	8	1	9	1.350	1	13	1.174	0.176	0.130	0.005	3.13 70% UNDEVELOPED
	33	4	37	1.449	3	55	1.244	0.205	0.141	0.007	4.67 DEV.-TOTAL AREA USED
	3	0	4	1.350	0	6	1.174	0.176	0.130	0.001	0.39 DEV.-TOTAL AREA USED
	76	9	85	1.411	8	123	1.218	0.193	0.137	0.016	10.40 DEV.-TOTAL AREA USED
-AJ	15	2	15	1.407	1	23	1.216	0.191	0.136	0.003	2.04 DEV.-TOTAL AREA USED
-AE	160	22	187	1.626	18	276	1.383	0.243	0.149	0.059	37.52 90% UNDEVELOPED
	41	4	41	1.102	3	68	1.018	0.084	0.076	0.005	3.13 DEV.-TOTAL AREA USED
	15	2	18	1.410	1	30	1.218	0.192	0.136	0.003	2.04 DEV.-TOTAL AREA USED
	9	1	12	1.815	1	19	1.510	0.305	0.168	0.002	1.51 DEV.-TOTAL AREA USED
	33	5	40	1.843	4	60	1.528	0.315	0.171	0.009	5.64 UNDEVELOPED
	79	9	92	1.403	8	135	1.213	0.190	0.135	0.070	44.85 50% UNDEVELOPED
	81	9	93	1.294	8	143	1.140	0.154	0.119	0.071	45.32 50% UNDEVELOPED
	6	1	7	1.409	1	11	1.218	0.191	0.136	0.001	0.81 DEV.-TOTAL AREA USED
	31	3	31	1.203	3	48	1.083	0.120	0.100	0.005	3.09 DEV.-TOTAL AREA USED
	46	5	49	1.274	4	73	1.125	0.149	0.117	0.040	25.69 50% UNDEVELOPED
	14	2	18	1.409	1	29	1.218	0.191	0.136	0.003	1.90 DEV.-TOTAL AREA USED
AB	31	3	31	1.330	3	46	1.162	0.168	0.126	0.006	3.92 DEV.-TOTAL AREA USED
R	88	8	73	1.057	7	102	0.986	0.071	0.067	0.009	5.91 DEV.-TOTAL AREA USED
	49	5	49	1.135	4	77	1.045	0.090	0.079	0.006	3.89 DEV.-TOTAL AREA USED
N	111	14	126	1.488	12	194	1.290	0.198	0.133	0.068	43.64 70% UNDEVELOPED
	34	3	34	1.097	3	58	1.019	0.078	0.071	0.004	2.42 DEV.-TOTAL AREA USED

BLE 2
MPUTATION OF AREA REDUCTION TO ACCOUNT
R 10YR-2HR ON-SITE RETENTION
/02/91

CATION	BASIN (ACRES)	10YR-6HR BASIN OUTFLOW (NO RETENTION)			10YR-2HR BASIN OUTFLOW (NO RETENTION)			DIFFERENCE (INCHES)	FACTOR	REDUCED BASIN SIZE (SQ-MI)	REDUCED BASIN SIZE (ACRES)
		AC-FT	CFS	INCHES	AC-FT	CFS	INCHES				
	15	1	15	1.135	1	25	1.046	0.089	0.078	0.002	1.18 DEV.-TOTAL AREA USED
	24	4	36	1.773	3	62	1.485	0.288	0.162	0.006	3.90 UNDEVELOPED
	12	2	18	1.776	2	32	1.486	0.290	0.163	0.003	1.96 UNDEVELOPED
	66	5	50	0.969	5	75	0.934	0.035	0.036	0.053	34.19 50% UNDEVELOPED
J	46	6	54	1.477	5	89	1.282	0.195	0.132	0.041	26.04 50% UNDEVELOPED
F	69	9	71	1.647	8	98	1.398	0.249	0.151	0.062	39.72 50% UNDEVELOPED
	32	4	41	1.602	4	69	1.370	0.232	0.145	0.007	4.63 UNDEVELOPED
1	12	2	14	1.640	1	23	1.392	0.248	0.151	0.003	1.81 UNDEVELOPED
	49	4	38	0.991	4	62	0.949	0.042	0.042	0.003	2.08 DEV.-TOTAL AREA USED
	42	6	56	1.755	5	92	1.470	0.285	0.162	0.011	6.82 UNDEVELOPED
	30	3	26	1.073	2	30	0.909	0.164	0.153	0.007	4.59 UNDEVELOPED
	99	15	124	1.757	12	185	1.472	0.285	0.162	0.025	16.06 UNDEVELOPED
	28	4	36	1.750	3	58	1.469	0.281	0.161	0.007	4.50 UNDEVELOPED
	69	7	73	1.204	6	110	1.082	0.122	0.101	0.011	6.99 UNDEVELOPED
	12	1	15	1.312	1	20	1.035	0.277	0.211	0.011	7.27 50% UNDEVELOPED
	5	1	8	1.814	1	13	1.511	0.303	0.167	0.001	0.84 UNDEVELOPED
	3	0	5	1.736	0	9	1.454	0.282	0.162	0.001	0.49 UNDEVELOPED
	20	3	28	1.787	2	45	1.491	0.296	0.166	0.005	3.31 UNDEVELOPED-GRAND AV.
	74	10	94	1.634	9	147	1.379	0.255	0.156	0.018	11.55 UNDEVELOPED
	14	2	15	1.726	2	23	1.452	0.274	0.159	0.004	2.22 UNDEVELOPED-GRAND AV.
	23	3	26	1.593	3	42	1.363	0.230	0.144	0.005	3.32 DEV.-TOTAL AREA USED
	18	2	17	1.485	2	28	1.306	0.179	0.121	0.003	2.17 DEV.-TOTAL AREA USED
	23	3	27	1.601	3	45	1.370	0.231	0.144	0.018	11.19 60% UNDEVELOPED

BLE 3
CTUS ROAD STORM DRAIN
C-1 PARAMETERS FOR COMBINED SUB-BASINS
PTEMBER 3, 1991

CATION	% TOTAL AREA	GREEN/AMP SOIL LOSSES IA	DTHETA	PSIF	XKSAT	RTIMP	BASIN AREA (AC)	BASIN AREA (SQ. MI)	FLOW LENGTH (MI)	M	b	Kb	SLOPE (ft/mi)
	48% 52%	0.2	0.14	6.1	0.13	73	69	0.108	0.8	-0.00625	0.04	0.0285	18.5
	13% 87%	0.2	0.22	4.3	0.21	64	46	0.072	0.44	-0.00625	0.04	0.0296	18.5
	34% 66%	0.2	0.22	4.1	0.22	65	111	0.173	0.7	-0.00625	0.04	0.0272	20
	7% 93%	0.2	0.18	6.8	0.14	25	88	0.138	0.75	-0.00693	0.044	0.0305	20
	77% 23%	0.2	0.11	9.8	0.05	25	31	0.048	0.51	-0.00625	0.04	0.0307	20
	78% 22%	0.2	0.15	7.4	0.12	72	160	0.250	0.96	-0.00625	0.04	0.0262	24
	27% 73%	0.2	0.11	10	0.03	25	15	0.023	0.4	-0.00625	0.04	0.0326	24
	44% 12% 5% 9% 30%	0.23	0.13	7.7	0.11	23	128	0.200	0.4	-0.00693	0.044	0.0294	24
	17% 32% 51%	0.2	0.15	6.2	0.13	55	41	0.064	0.66	-0.00693	0.044	0.0328	24

BLE 3
CTUS ROAD STORM DRAIN
C-1 PARAMETERS FOR ALL SUB-BASINS
PTEMBER 3, 1991

CATION	SOIL TYPE	GREEN/AMP SOIL LOSSES IA	DTHETA	PSIF	XKSAT	RTIMP	BASIN AREA (AC)	BASIN AREA (SQ. MI)	FLOW LENGTH (MI)	M	b	Kb	SLOPE (ft/mi)
	LOAM	0.2	0.25	3.5	0.25	75	23	0.036	0.39	-0.00625	0.04	0.0315	25
	60% LOAM 40% CLAY LOAM	0.2	0.17	5.4	0.17	85	99	0.155	0.7	-0.00625	0.04	0.0275	18.5
	50% LOAM 25% CLAY 25% CLAY LOAM	0.2	0.18	6.9	0.14	85	42	0.066	0.42	-0.00625	0.04	0.0299	18.5
	60% LOAM 40% CLAY LOAM	0.5	0	5.4	0.17	0	30	0.047	0.4	-0.01375	0.08	0.0597	18.5
1	60% LOAM 40% CLAY LOAM	0.2	0.17	5.4	0.17	75	12	0.019	0.3	-0.00625	0.04	0.0333	18.5
	60% CLAY LOAM 40% LOAM	0.2	0.12	6.3	0.12	85	33	0.052	0.5	-0.00625	0.04	0.0305	18.5
	50% LOAM 50% CLAY LOAM	0.2	0.15	5.9	0.15	60	36	0.056	0.4	-0.00625	0.04	0.0303	18.5
	LOAM	0.2	0.25	3.5	0.25	75	32	0.050	0.35	-0.00625	0.04	0.0306	18.5
	80% LOAM 20% CLAY LOAM	0.2	0.21	4.4	0.21	25	49	0.077	0.46	-0.00625	0.04	0.0294	18.5
	LOAM	0.2	0.25	3.5	0.25	85	6	0.009	0.14	-0.00625	0.04	0.0351	18.5
	80% LOAM 20% CLAY LOAM	0.2	0.21	4.4	0.21	60	40	0.063	0.36	-0.00625	0.04	0.0300	18.5
	80% LOAM 10 CLAY LOAM 10% CLAY	0.2	0.21	4.9	0.21	25	66	0.103	0.66	-0.00625	0.04	0.0286	18.5
	40% CLAY 30% LOAM 30% CLAY LOAM	0.2	0.16	8.5	0.09	85	12	0.019	0.19	-0.00625	0.04	0.0333	18.5
	80% LOAM 20% CLAY LOAM	0.2	0.21	4.4	0.21	85	73	0.114	0.4	-0.00625	0.04	0.0284	20
	LOAM	0.2	0.25	3.5	0.25	25	38	0.059	0.45	-0.00625	0.04	0.0301	20
	50% LOAM 50% CLAY LOAM	0.2	0.15	5.9	0.15	25	34	0.053	0.4	-0.00625	0.04	0.0304	20
	50% LOAM 50% CLAY	0.2	0.15	5.9	0.13	25	15	0.023	0.3	-0.00625	0.04	0.0326	20

BLE 3
CTUS ROAD STORM DRAIN
C-1 PARAMETERS FOR ALL SUB-BASINS
PTEMBER 3, 1991

CATION	SOIL TYPE	GREEN/AMP SOIL LOSSES IA	DTHETA	PSIF	XKSAT	RTIMP	BASIN AREA (AC)	BASIN AREA (SQ. MI)	FLOW LENGTH (MI)	M	b	Kb	SLOPE (ft/mi)
	50% LOAM 50% CLAY	0.2	0.15	5.9	0.13	85	24	0.038	0.27	-0.00625	0.04	0.0314	20
	50% LOAM 50% CLAY	0.2	0.15	5.9	0.13	25	6	0.009	0.17	-0.00625	0.04	0.0351	20
	50% LOAM 50% CLAY	0.2	0.15	5.9	0.13	25	49	0.077	0.51	-0.00625	0.04	0.0294	20
	50% LOAM 25% CLAY 25% CLAY LOAM	0.2	0.18	6.9	0.14	25	82	0.128	0.72	-0.00625	0.04	0.0280	20
	60% CLAY 20% LOAM 20% CLAY LOAM	0.2	0.11	9.8	0.06	25	81	0.127	0.6	-0.00625	0.04	0.0281	20
	60% CLAY LOAM 40% CLAY	0.2	0.11	9.9	0.03	25	6	0.009	0.21	-0.00625	0.04	0.0351	20
	60% CLAY LOAM 40% CLAY	0.2	0.11	9.9	0.03	25	14	0.022	0.27	-0.00625	0.04	0.0328	20
	60% CLAY 30% CLAY LOAM 10% LOAM	0.2	0.1	10.3	0.04	25	24	0.038	0.34	-0.00625	0.04	0.0314	20
	70% CLAY LOAM 30% CLAY	0.2	0.12	9.5	0.03	25	79	0.123	0.65	-0.00625	0.04	0.0281	20
	80% CLAY LOAM 20% LOAM	0.2	0.17	7.3	0.08	25	31	0.048	0.45	-0.00625	0.04	0.0307	20
	80% CLAY LOAM 10% LOAM 10% CLAY	0.2	0.15	8.15	0.06	25	46	0.072	0.53	-0.00625	0.04	0.0296	20
	80% CLAY LOAM 10% CLAY 10% GRAV. LOAM	0.2	0.15	8.2	0.07	25	7	0.011	0.26	-0.00625	0.04	0.0347	20
	60% CLAY 40% CLAY LOAM	0.2	0.09	10.7	0.02	85	33	0.052	0.52	-0.00625	0.04	0.0305	20
	40% LOAM 40% CLAY 20% CLAY LOAM	0.2	0.15	8	0.11	85	124	0.194	0.7	-0.00625	0.04	0.0269	24

BLE 3
CTUS ROAD STORM DRAIN
C-1 PARAMETERS FOR ALL SUB-BASINS
PTEMBER 3, 1991

CATION	SOIL TYPE	GREEN/AMP SOIL LOSSES IA	DTHETA	PSIF	XKSAT	RTIMP	BASIN AREA (AC)	BASIN AREA (SQ. MI)	FLOW LENGTH (MI)	M	b	Kb	SLOPE (ft/mi)
	60% LOAM 40% CLAY LOAM	0.2	0.17	5.4	0.17	25	36	0.056	0.46	-0.00625	0.04	0.0303	24
	40% LOAM 40% CLAY LOAM 20% CLAY	0.2	0.15	8	0.12	25	41	0.064	0.47	-0.00625	0.04	0.0299	24
	60% CLAY LOAM 40% CLAY	0.2	0.11	9.8	0.03	25	15	0.023	0.3	-0.00625	0.04	0.0326	24
	CLAY LOAM	0.2	0.15	8.2	0.04	85	9	0.014	0.26	-0.00625	0.04	0.0340	24
	CLAY LOAM	0.2	0.15	8.2	0.04	25	4	0.006	0.13	-0.00625	0.04	0.0362	24
	60% CLAY 40% CLAY LOAM	0.2	0.09	10.7	0.02	25	11	0.017	0.34	-0.00625	0.04	0.0335	24
	60% CLAY LOAM 40% CLAY	0.2	0.11	9.8	0.03	25	76	0.119	0.74	-0.00625	0.04	0.0282	24
	CLAY LOAM	0.2	0.15	8.2	0.04	25	3	0.005	0.17	-0.00625	0.04	0.0370	24
	80% LOAM 20% CLAY LOAM	0.2	0.21	4.4	0.21	18	56	0.088	0.82	-0.00625	0.04	0.0291	24
	60% CLAY LOAM 40% CLAY	0.2	0.11	9.8	0.03	85	15	0.023	0.36	-0.00625	0.04	0.0326	24
	CLAY	0.2	0.05	12.4	0.01	18	7	0.011	0.2	-0.00625	0.04	0.0347	24
	50% CLAY LOAM 50% LOAM	0.5	0	5.9	0.15	0	12	0.019	0.3	-0.01375	0.08	0.0652	24
	80% CLAY 20% CLAY LOAM	0.2	0.07	11.6	0.02	15	38	0.059	0.38	-0.00625	0.04	0.0301	24
	80% CLAY LOAM 10% LOAM 10% CLAY	0.2	0.15	8.15	0.06	15	102	0.159	0.8	-0.00625	0.04	0.0274	24
	80% CLAY LOAM 20% CLAY	0.2	0.07	11.6	0.03	25	33	0.052	0.53	-0.00625	0.04	0.0305	24
	CLAY LOAM	0.2	0.15	8.2	0.04	20	7	0.011	0.3	-0.00625	0.04	0.0347	24
	60% CLAY LOAM 40% LOAM	0.2	0.12	6.3	0.12	25	13	0.020	0.3	-0.00625	0.04	0.0330	24
	60% LOAM												

BLE 3
CTUS ROAD STORM DRAIN
C-1 PARAMETERS FOR ALL SUB-BASINS
PTEMBER 3, 1991

		GREEN/AMP SOIL LOSSES											
CATION	SOIL TYPE	IA	DTHETA	PSIF	XKSAT	RTIMP	BASIN AREA (AC)	BASIN AREA (SQ. MI)	FLOW LENGTH (MI)	M	b	Kb	SLOPE (ft/mi)
	40% CLAY LOAM	0.2	0.17	5.4	0.17	85	21	0.033	0.41	-0.00625	0.04	0.0317	24
	CLAY LOAM	0.2	0.15	8.2	0.04	25	8	0.013	0.3	-0.00625	0.04	0.0344	24
	60% LOAM 20% CLAY LOAM 20% CLAY	0.2	0.19	6.2	0.16	85	28	0.044	0.4	-0.00625	0.04	0.0310	21
	80% CLAY LOAM 20% LOAM	0.2	0.17	7.3	0.08	25	69	0.108	0.6	-0.00625	0.04	0.0285	21
	CLAY LOAM	0.5	0	8.2	0.04	0	12	0.019	0.2	-0.01375	0.08	0.0652	21
	CLAY LOAM	0.2	0.15	8.3	0.04	85	5	0.008	0.15	-0.00625	0.04	0.0356	21
	CLAY LOAM	0.2	0.15	8.3	0.04	75	3	0.005	0.1	-0.00625	0.04	0.0370	21
	60% CLAY LOAM 20% CLAY 20% LOAM	0.2	0.15	8.1	0.08	85	20	0.031	0.3	-0.00625	0.04	0.0319	21
	60% CLAY 30% CLAY LOAM 10% LOAM	0.2	0.1	10.3	0.04	60	74	0.116	0.6	-0.00625	0.04	0.0283	21
	50% LOAM 25% CLAY LOAM 25% GRAV. LOAM	0.2	0.23	4.9	0.24	85	14	0.022	0.4	-0.00625	0.04	0.0328	21
	50% LOAM 25% CLAY 25% GRAV. LOAM	0.2	0.23	4.9	0.23	75	23	0.036	0.4	-0.00625	0.04	0.0315	21
	60% LOAM 40% LOAMY SAND	0.2	0.27	3.1	0.63	75	18	0.028	0.4	-0.00625	0.04	0.0322	21
ENDALE AREA CONTRIBUTING TO CACTUS TRUNKLINE													
	60% LOAM 40% CLAY LOAM	0.05	0.17	5.4	0.17	100	6	0.009	0.3	-0.00625	0.04	0.0351	21
	60% CLAY LOAM 40% LOAM	0.2	0.12	6.3	0.12	20	26	0.041	0.55	-0.00625	0.04	0.0312	21
	60% CLAY 40% CLAY LOAM	0.05	0.09	10.7	0.02	100	7	0.011	0.5	-0.00625	0.04	0.0347	21

BLE 3
CTUS ROAD STORM DRAIN
C-1 PARAMETERS FOR ALL SUB-BASINS
PTEMBER 3, 1991

CATION	SOIL TYPE	GREEN/AMP SOIL LOSSES IA	DTHETA	PSIF	XKSAT	RTIMP	BASIN AREA (AC)	BASIN AREA (SQ. MI)	FLOW LENGTH (MI)	M	b	Kb	SLOPE (ft/mi)
	80% LOAM 20% CLAY LOAM	0.2	0.21	4.4	0.21	40	67	0.105	0.5	-0.00625	0.04	0.0286	21
	70% LOAM 30% GRAV. LOAM	0.2	0.25	3.7	0.30	20	17	0.027	0.67	-0.00625	0.04	0.0323	21
	50% LOAM 50% CLAY LOAM	0.2	0.15	5.9	0.15	20	11	0.017	0.5	-0.00625	0.04	0.0335	21
	80% LOAM 20% CLAY LOAM	0.2	0.21	4.4	0.21	40	72	0.113	0.7	-0.00625	0.04	0.0284	21
0	80% LOAM 20% CLAY LOAM	0.2	0.21	4.4	0.21	40	9	0.014	0.4	-0.00625	0.04	0.0340	21
1	80% CLAY LOAM 10% LOAM 10% CLAY	0.2	0.15	8.15	0.06	40	26	0.041	0.4	-0.00625	0.04	0.0312	21

[illegible]ABLE 4
[illegible]CTUS ROAD STORM DRAIN
[illegible]EC-1 ROUTING PARAMETERS
[illegible]INEMATIC WAVE ROUTING
SEPTEMBER 3, 1991

[illegible]OUTING	LENGTH (FT)	SLOPE (FT/FT)	BOTTOM WIDTH (FT)
[illegible]-2	1700	0.003	60
2-3	1250	0.003	60
[illegible]-3A	1350	0.0027	84" pipe
3B-7A	1360	0.002	96" pipe
[illegible]-9A	1360	0.0021	110
[illegible]2-11	1250	0.0027	110
11-9B	1400	0.0027	110
[illegible]-19	1330	0.0023	110
19-20	1400	0.0027	114" pipe
[illegible]3-14	1420	0.0021	60
[illegible]4-18A	1400	0.002	110
18-20	1340	0.001	110
[illegible]6-17	1300	0.002	50
20-27	1360	0.0027	114" pipe
[illegible]7-22	1340	0.0016	110
[illegible]6-25	1320	0.0019	110
25-24	1300	0.001	60
[illegible]4-22A	1400	0.001	60
22-29A	1360	0.0016	120" pipe
[illegible]9-33	1420	0.0016	120" pipe
[illegible]-31	1320	0.0018	80

ABLE 4
CTUS ROAD STORM DRAIN
EC-1 ROUTING PARAMETERS
INEMATIC WAVE ROUTING
SEPTEMBER 3, 1991

OUTING	LENGTH (FT)	SLOPE (FT/FT)	BOTTOM WIDTH (FT)
1-32	1320	0.0019	50
32-33	1320	0.0019	50
6-35	1200	0.0017	50
35-37	1330	0.0024	120" pipe
7-38	1300	0.002	120" pipe
3-35	1360	0.0024	120" pipe
44-46	1500	0.0013	84" pipe
-48	1600	0.0013	84" pipe

DESIGN DATA REPORT
for the

CACTUS ROAD STORM DRAIN

(67th Avenue to the Agua Fria Freeway)

APPENDIX C-
Hydraulic Design

SFC ENGINEERING COMPANY

Subject PRELIMINARY HYDRAULIC DESIGN
Project CACTUS ROAD
File Number 35902.00
Computed MKB Checked MAL Date 10/1/91 Page 1 of 2 Pages

The predesign hydraulic gradeline was prepared (& used @ 30%) based on flows from the Master Plan. One of the first phases of this project was to review that Master Plan & the flow data. However recovery of that data proved impossible & it was agreed to change the scope of the Hydrology & run new models using the new version of the Flood Control District Hydrologic Manual & the Corps of Engineer's HEC programs. This portion of the Design Data Report has been reviewed & accepted by the Flood Control District & was therefore used for the flows for the Final Hydraulic design of the Cactus Road Storm Drain. (See Runoff summary & attached Drainage Subarea Map).

Design Data for the Agua Fria Outer Loop Freeway indicates that the drainage channel was designed for a 100-year storm with a channel elevation of 1132.68. This elevation does not allow for any freeboard in the channel. Typically freeboard will be a minimum of 2 to 3 ft for this size of channel. This type of channel is also typically sized for a 25 or 50-year storm with sufficient freeboard to carry the 100-yr storm without freeboard.

The Cactus Road Storm Drain has been designed to carry the 10 year storm, not the 25 or 100 year storm. In addition, a lateral has been added at 91st Ave to carry additional flow from the south. This flow alters the amout of flow entering @ 91st & the elevations of the Cactus Road Storm Drain

Initial hydraulic calculations for the storm drain used the 100-yr HGL for the Agua Fria Channel (1132.68). It had been hoped that the 10-year storm volume of flow would still drain in a 100-year event. But, although the hydraulic gradeline is below the ground surface, there is insufficient head to drain catch basins up to a minimum of 1¼ miles & more like 2 miles u/s without upsizing the lower 2 miles of pipeline (which is already 114" & 120" Dia pipe). It is not the intent of this project to design for the 100-yr event. (See HGL on the 24"X36" sheet labled PREL C-1 & Appendix E Analysis #1).

By lowering the Agua Fria Channel hydraulic gradeline to 1130.68, & providing a minimal 2-ft freeboard in the channel, there will be sufficient head available to drain all catch basins & collect the additional flow at 91st Avenue w/o upsizing the Cactus Road Storm Drain. This design seemed more reasonable for the 10-year event & should allow for maximum drainage of the area in the 10-year event

SFC ENGINEERING COMPANY

Subject: PRELIMINARY HDRAULIC DESIGN
Project: CACTUS ROAD
File Number: 35902.00
Computed: MJB Checked: ML Date: 10/7/91 Page 2 of 2 Pages

SEE Appendix E Analysis #2 for these results).

It should also be noted that the u/s reaches of the stormdrain should be reduced. The diameters used in the preliminary design are too large to meet the criteria of "full pipe flow at Q max". See Hydraulic Design discussion on next page & Appendix E - Final Designs.

SFC ENGINEERING COMPANY

Subject: HYDRAULIC DESIGN — Project: CACTUS RD — File Number: 3590[illegible].00

Computed: HVM — Checked: [illegible] — Date: 10/7/91 — Page ___ of ___ Pages

BASED ON THE FLOWS AND DOWNSTREAM CONTROL WATER ~~SERVICE~~ SURFACE ELEV, FROM THE PRELIMINARY CONCEPTUAL PROFILE, THE HGL IS INSIDE THE STORM DRAIN PIPE ALONG CACTUS RD. BETWEEN 71st AVE AND 67th AVE. THE PURPOSE OF THIS HYDRAULIC DESIGN IS TO MAINTAIN THE STORM DRAIN PIPE FLOW FULL, THE HGL WILL BE DESIGNED ABOVE THE TOP OF THE PIPE. THE MAIN LINE PIPE HAS BEEN REDUCED FROM 79th AVE TO 67th AVE.

- 79th AVE – 75th AVE ; FROM 114" DIA TO 108" DIA
- 75th AVE – 71st AVE ; FROM 96" DIA TO 84" DIA
- 71st AVE – 67th AVE ; FROM 84" DIA TO 78" DIA

ALSO, 3 LATERALS/STORM DRAIN PIPES ~~HAS~~ HAVE BEEN CHANGED.

- [illegible] AVE : FROM 48" DIA TO 66" DIA
- 75th AVE : FROM 48" DIA TO 42" DIA
- [illegible] AVE : FROM [illegible]" DIA TO 30" DIA

THE FINAL PROFILE HGL OF MAIN LINE AND LATERALS AS SHOWN ON SHEET C-1 BASED ON DOWNSTREAM HGL=1130.68 AND n = 0.012.

FOR COMPUTER REPORT - SEE APPENDIX E.

1 sq mi = 640 ac

RUNOFF SUMMARY
FLOW IN CUBIC FEET PER SECOND
TIME IN HOURS, AREA IN SQUARE MILES

	OPERATION	STATION a/	PEAK FLOW	TIME OF PEAK	AVERAGE FLOW FOR MAXIMUM PERIOD 6-HOUR	24-HOUR	72-HOUR	BASIN AREA	MAXIMUM STAGE	TIME OF MAX STAGE
	HYDROGRAPH AT	AM-AQ	15.	4.08	2.	1.	1.	.02		
	ROUTED TO	R1-2	14.	4.25	2.	1.	1.	.02		
	HYDROGRAPH AT	AR	10.	4.25	2.	1.	1.	.02		
	2 COMBINED AT	C2	25.	4.25	4.	1.	1.	.03		
	ROUTED TO	R2-3	25.	4.33	4.	1.	1.	.03		
	HYDROGRAPH AT	G1	6.	4.25	2.	1.	1.	.01		
	HYDROGRAPH AT	G2	22.	4.33	5.	1.	1.	.04		
	2 COMBINED AT	CG2	28.	4.33	7.	2.	2.	.05		
	HYDROGRAPH AT	G3	6.	4.42	2.	1.	1.	.01		
	2 COMBINED AT	CG3	34.	4.33	9.	3.	3.	.06		
	ROUTED TO	RGSW	33.	4.42	9.	3.	3.	.06		
	HYDROGRAPH AT	G7	7.	4.42	2.	1.	1.	.02		
	2 COMBINED AT	CG4	40.	4.42	11.	3.	3.	.08		
	HYDROGRAPH AT	G5	70.	4.17	13.	4.	4.	.10		
	ROUTED TO	RG5	70.	4.25	13.	4.	4.	.10		
	HYDROGRAPH AT	G6	7.	4.50	2.	1.	1.	.03		
	3 COMBINED AT	CG6	115.	4.33	26.	8.	8.	.21		
	ROUTED TO	RG67	115.	4.33	26.	8.	8.	.21		
	HYDROGRAPH AT	G11	30.	4.17	6.	2.	2.	.04		
	2 COMBINED AT	CG11	143.	4.33	32.	10.	10.	.25		
	HYDROGRAPH AT	G9	64.	4.33	14.	4.	4.	.11		
	ROUTED TO	RG9	63.	4.42	14.	4.	4.	.11		
	HYDROGRAPH AT	G10	6.	4.33	2.	1.	1.	.01		
	3 COMBINED AT	CG10	213.	4.33	48.	14.	14.	.38		
5	HYDROGRAPH AT	AT-AV	5.	4.33	1.	0.	0.	.01		
	2 COMBINED AT	CGALL	218.	4.33	49.	15.	15.	.39		
	ROUTED TO	R5-3A	217.	4.33	49.	15.	15.	.39		
4	HYDROGRAPH AT	AW	3.	4.25	1.	0.	0.	.00		
	2 COMBINED AT	C3A	220.	4.33	50.	15.	15.	.39		

a/ see attached map for Location of contributing Area

R1-2 = Route flow from Location 1 to 2.

C2 = Combined flow of R1-2 w/ recent inlet (in this case AR)

(G1 through CG10:) GLENDALE CONTRIBUTING AREA

Underlined Q's used for Hydraulic Design & Catch Basin Design

[redacted]

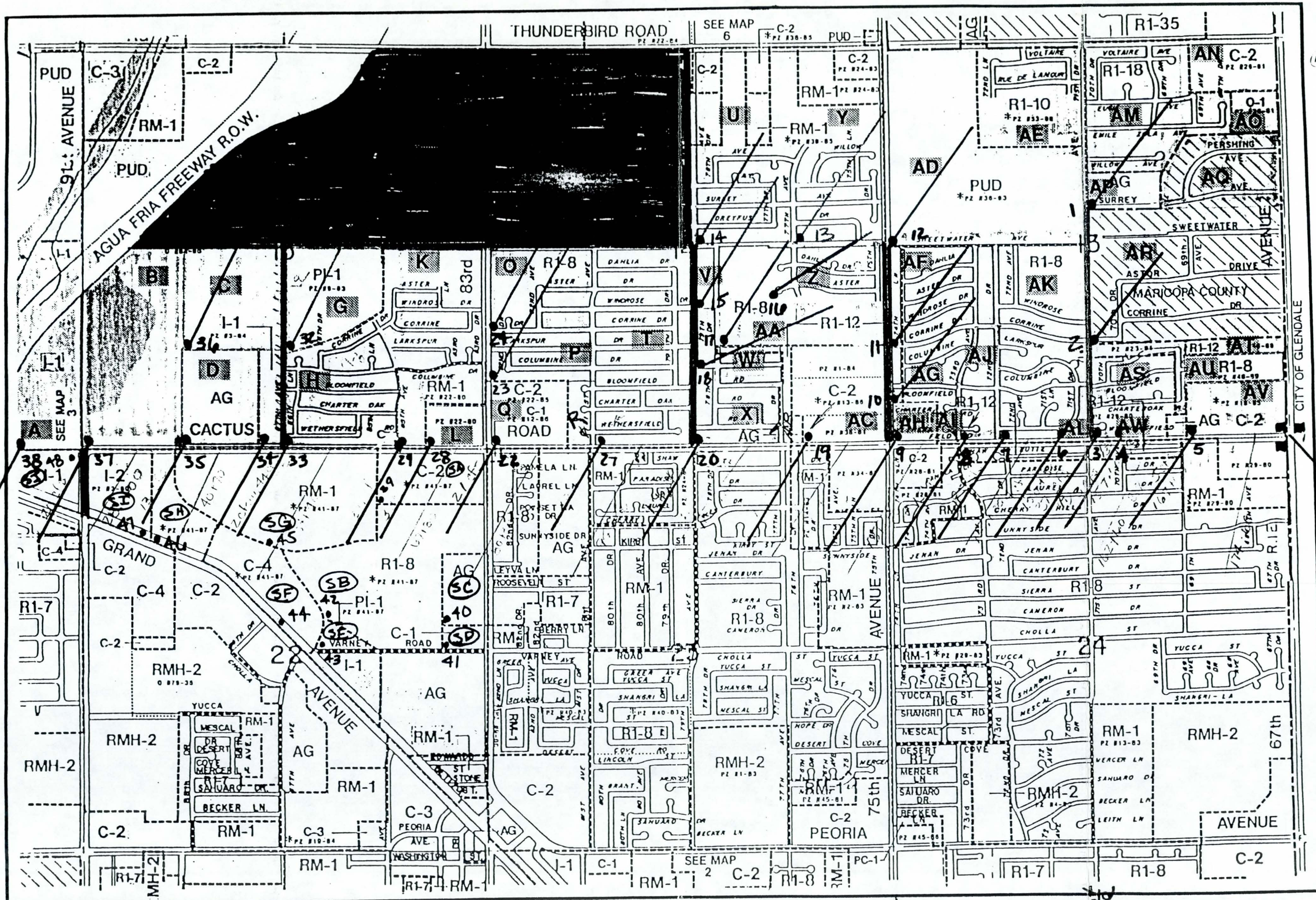
3	HYDROGRAPH AT	AS	37.	4.25	8.	2.	2.	.05
	3 COMBINED AT	C3	281.	4.33	62.	18.	18.	.48
U	HYDROGRAPH AT	AL	4.	4.17	1.	0.	0.	.00
	2 COMBINED AT	C3B	285.	4.33	63.	19.	19.	.48
	ROUTED TO	R3B-7	283.	4.33	63.	19.	19.	.48
7	HYDROGRAPH AT	AK	85.	4.25	18.	5.	5.	.12
	2 COMBINED AT	C7	367.	4.33	81.	24.	24.	.60
	ROUTED TO	R7-9A	365.	4.42	81.	24.	24.	.60
8	HYDROGRAPH AT	AI-AJ	15.	4.25	3.	1.	1.	.02
	2 COMBINED AT	C9A	379.	4.42	84.	25.	25.	.62
	HYDROGRAPH AT	AD-AE	44.	4.25	10.	3.	3.	.06
	ROUTED TO	R12-11	44.	4.33	10.	3.	3.	.06
	HYDROGRAPH AT	AF	41.	4.25	8.	2.	2.	.06
	2 COMBINED AT	C11	84.	4.25	18.	5.	5.	.12
	ROUTED TO	R11-9B	84.	4.33	18.	5.	5.	.12
9	HYDROGRAPH AT	AG	18.	4.17	3.	1.	1.	.02
	2 COMBINED AT	C9B	101.	4.33	21.	6.	6.	.15
9	HYDROGRAPH AT	AH	12.	4.17	3.	1.	1.	.01
	3 COMBINED AT	C9	489.	4.33	108.	32.	32.	.78
	ROUTED TO	R9-19	489.	4.42	108.	32.	32.	.78
19	HYDROGRAPH AT	AC	7.	4.25	2.	1.	1.	.01
	2 COMBINED AT	C19	495.	4.42	110.	32.	32.	.79
	ROUTED TO	R19-20	494.	4.42	110.	32.	32.	.79
	HYDROGRAPH AT	Y	53.	4.25	11.	3.	3.	.07
	ROUTED TO	R13-14	52.	4.33	11.	3.	3.	.07
	HYDROGRAPH AT	U	52.	4.25	10.	3.	3.	.07
	2 COMBINED AT	C14	104.	4.25	20.	6.	6.	.14
	ROUTED TO	14-18A	104.	4.33	20.	6.	6.	.14
	HYDROGRAPH AT	V	7.	4.17	1.	0.	0.	.01
	2 COMBINED AT	C18A	110.	4.33	22.	6.	6.	.15
	HYDROGRAPH AT	Z	32.	4.25	6.	2.	2.	.05
	ROUTED TO	R16-17	31.	4.33	6.	2.	2.	.05
	HYDROGRAPH AT	AA	27.	4.25	5.	2.	2.	.04

Assume 5.0 for AJ & 2.5 for AI

Combined for 30cfs
Assume street flooded

	2 COMBINED AT	C17	58.	4.33	12.	3.	3.	.09		
20	HYDROGRAPH AT	W	18.	4.17	3.	1.	1.	.02		
	3 COMBINED AT	C18	185.	4.33	37.	11.	11.	.26		Combined for 49 cfs Assume street flooded
	ROUTED TO	R18-20	183.	4.33	37.	11.	11.	.26		
20	HYDROGRAPH AT	X-AB	31.	4.25	7.	2.	2.	.05		
	3 COMBINED AT	C20	707.	4.42	153.	45.	45.	1.10		
	ROUTED TO	R20-27	705.	4.42	153.	45.	45.	1.10		
27	HYDROGRAPH AT	T-R	73.	4.33	16.	5.	5.	.14		Assume street flooded.
	2 COMBINED AT	C27	777.	4.42	169.	50.	50.	1.24		
	ROUTED TO	R27-22	772.	4.42	169.	50.	50.	1.24		
	HYDROGRAPH AT	O	34.	4.17	6.	2.	2.	.05		
	ROUTED TO	24-22A	34.	4.33	6.	2.	2.	.05		
22	HYDROGRAPH AT	P	15.	4.17	3.	1.	1.	.02		
	~~3 COMBINED AT~~	~~C22A~~	~~49.~~	~~4.25~~	~~9.~~	~~3.~~	~~3.~~	~~.08~~		Combined for 21 cfs Assume street flooded.
22	HYDROGRAPH AT	Q	6.	4.08	1.	0.	0.	.01		
	3 COMBINED AT	C22	823.	4.42	179.	52.	52.	1.32		
	ROUTED TO	22-29A	817.	4.42	179.	52.	52.	1.32		
28	HYDROGRAPH AT	L	3.	4.08	1.	0.	0.	.00		
	2 COMBINED AT	C29A	819.	4.42	179.	53.	53.	1.32		
29	HYDROGRAPH AT	K	26.	4.33	5.	2.	2.	.05		
	2 COMBINED AT	C29	845.	4.42	185.	54.	54.	1.38		
	ROUTED TO	R29-33	842.	4.50	185.	54.	54.	1.38		
	HYDROGRAPH AT	G	6.	4.17	1.	0.	0.	.01		
33E	ROUTED TO	R32-33	6.	4.33	1.	0.	0.	.01		combined for 46 cfs (D-1 actually flows from west side but this flow will probably flood entire road
33W	HYDROGRAPH AT	D-1	2.	4.17	1.	0.	0.	.00		
33E	HYDROGRAPH AT	H	38.	4.42	8.	2.	2.	.08		
	4 COMBINED AT	C33	887.	4.50	195.	57.	57.	1.46		
	ROUTED TO	R33-35	886.	4.50	195.	57.	57.	1.46		
	HYDROGRAPH AT	C	9.	4.17	2.	1.	1.	.01		
35	ROUTED TO	R36-35	9.	4.25	2.	1.	1.	.01		combined for 13 cfs
35	HYDROGRAPH AT	D	4.	4.42	1.	0.	0.	.01		
	3 COMBINED AT	C35	898.	4.50	198.	58.	58.	1.48		
	ROUTED TO	R35-37	897.	4.50	198.	58.	58.	1.48		

37	HYDROGRAPH AT	B	20.	4.25	5.	1.	1.	.03
	2 COMBINED AT	C37	914.	4.50	202.	59.	59.	1.51
	HYDROGRAPH AT	SA	6.	4.17	1.	0.	0.	.01
	HYDROGRAPH AT	SB	7.	4.25	1.	0.	0.	.01
	HYDROGRAPH AT	SC	9.	4.25	2.	0.	0.	.01
	HYDROGRAPH AT	SD	1.	4.08	0.	0.	0.	.00
	HYDROGRAPH AT	SE	1.	4.08	0.	0.	0.	.00
	HYDROGRAPH AT	SF	4.	4.17	1.	0.	0.	.00
	HYDROGRAPH AT	SG	15.	4.17	3.	1.	1.	.02
	7 COMBINED AT	C44	42.	4.17	9.	3.	3.	.05
	ROUTED TO	R44-46	42.	4.25	9.	3.	3.	.05
	HYDROGRAPH AT	SH	3.	4.25	1.	0.	0.	.00
	HYDROGRAPH AT	SI	26.	4.25	6.	2.	2.	.04
	3 COMBINED AT	C47	71.	4.25	16.	5.	5.	.09
	ROUTED TO	R47-48	70.	4.25	16.	5.	5.	.09
	HYDROGRAPH AT	SJ	17.	4.25	4.	1.	1.	.03
	2 COMBINED AT	C48	87.	4.25	20.	6.	6.	.12
	2 COMBINED AT	C37A	991.	4.50	222.	65.	65.	1.63
	ROUTED TO	R37-38	990.	4.50	222.	65.	65.	1.63
38	HYDROGRAPH AT	A	14.	4.17	3.	1.	1.	.02
	2 COMBINED AT	C38	1000.	4.50	225.	66.	66.	1.65



91st AVE
87th AVE
83rd AVE
79th AVE
75th AVE
71st AVE

@/ Lateral does not exist & is not planned.

- • HEC NODES
- ■ CATCH BASINS
- — FUTURE LATERALS

FIGURE 1
CACTUS ROAD STORM DRAIN DRAINAGE SUBAREAS

ENGINEERING COMPANY

SFC ENGINEERING COMPANY

Subject Street Flow for Catch Basin Design	Project Cactus Road	
	File Number 35902.00	
Computed mjB Checked	Date 10/7/91	Page 1 of 1 Pages

Design of the Cactus Road Storm Drain does not include Roadway & Pavement design. Therefore the following flow calculations based on existing cross-sections were generated to help evaluate flow conditions on the roads.

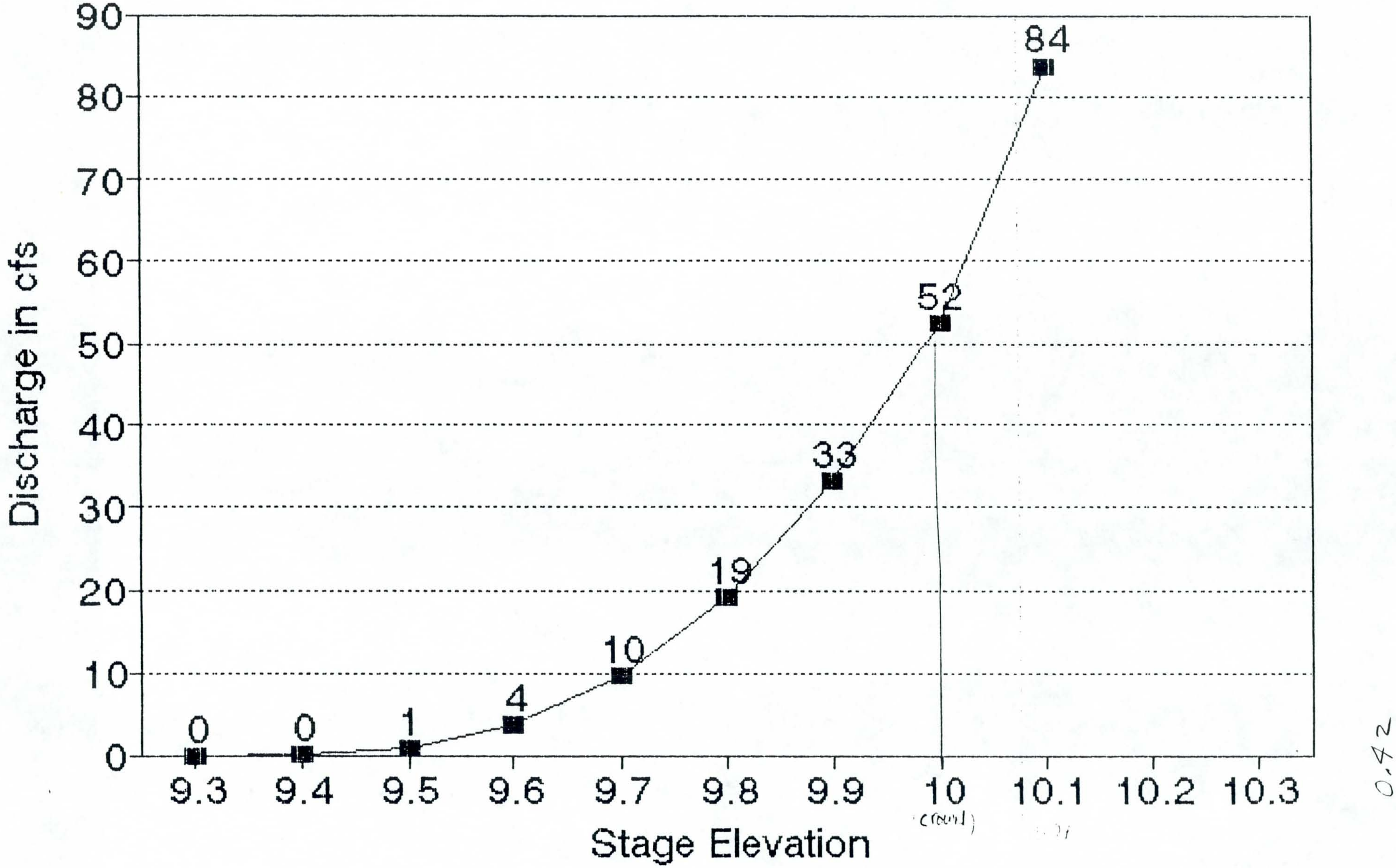
Appendix D contains all the Catch Basin design based the results of the STORM program (Hraulic Gradeline Profile in pocket), the preceding flows from the runoff summary and the following information. The City of Phoenix Storm Drain manual should be referenced for any procedural questions.

SUMMARY OF STREET CAPACITY
CACTUS ROAD
AUGUST 1991

STATION	CROWN ELEVATION	CAPACITY OF NORTH SIDE (CFS)	CAPACITY OF FULL SECTION (CFS)
[illegible]9+00	82.85	70	N.A.
155+00	76.95	47	154
1[illegible]3+00	76.1	62	321
[illegible]2+75	71.5	33	330
141+25	71	12	546
[illegible]8+25	70.1	29	517
1[illegible]6+75	69.7	13	226
1[illegible]8+50	68.2	23	72
[illegible]6+75	67.25	18	66
101+50	59.45	53	376
[illegible]+60	58.8	34	225
88+10	56.2	8	239
[illegible]+00	55.9	17	48
[illegible]+00	52.8	4	60
48+50	45.15	49	77
[illegible]+50	44.4	21	67
[illegible]+50	38.6	N.A.	83
[illegible]+00	37	N.A.	49
[illegible]+00	34	N.A.	16

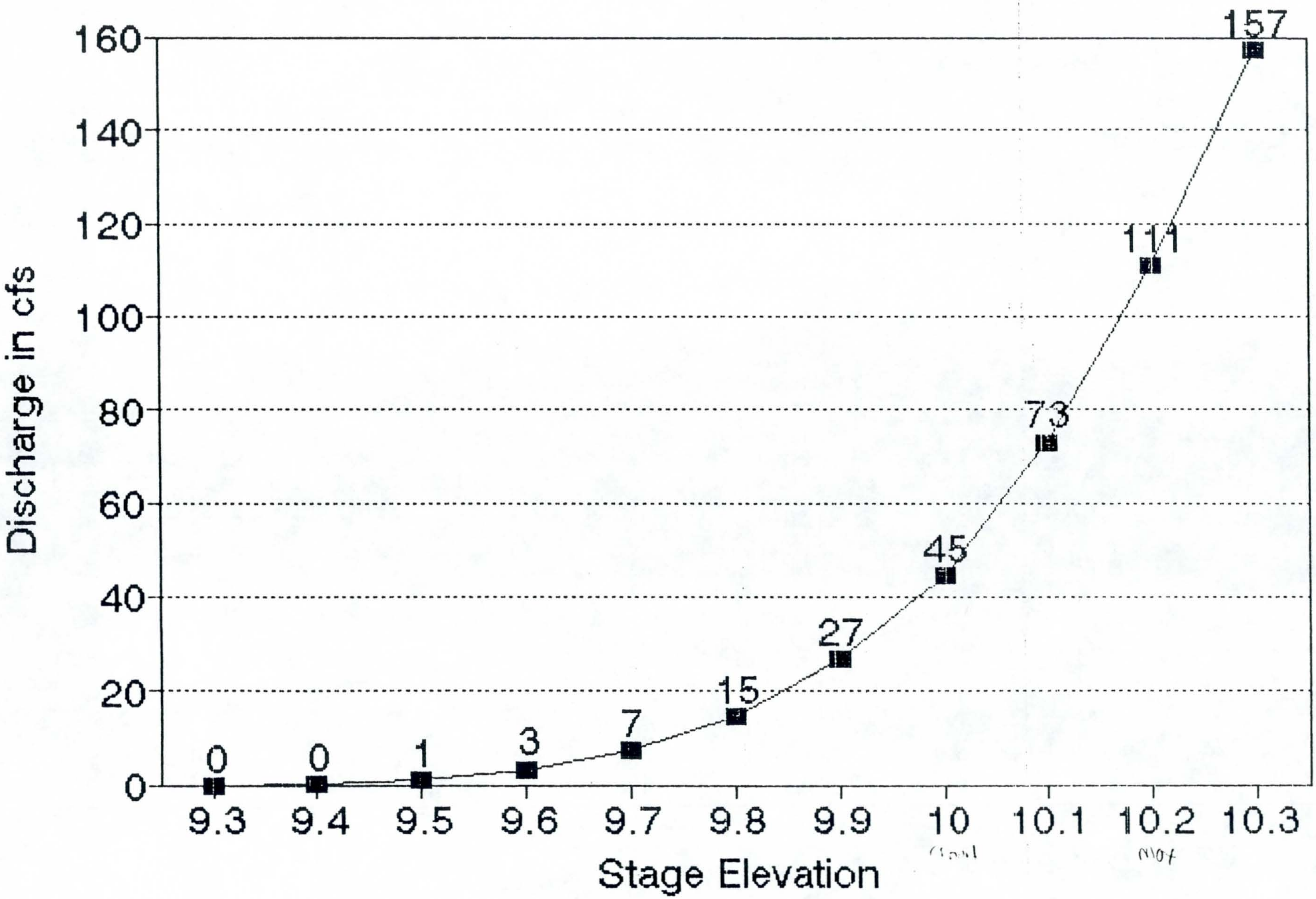
STAGE-DISCHARGE CURVE

71st Av.



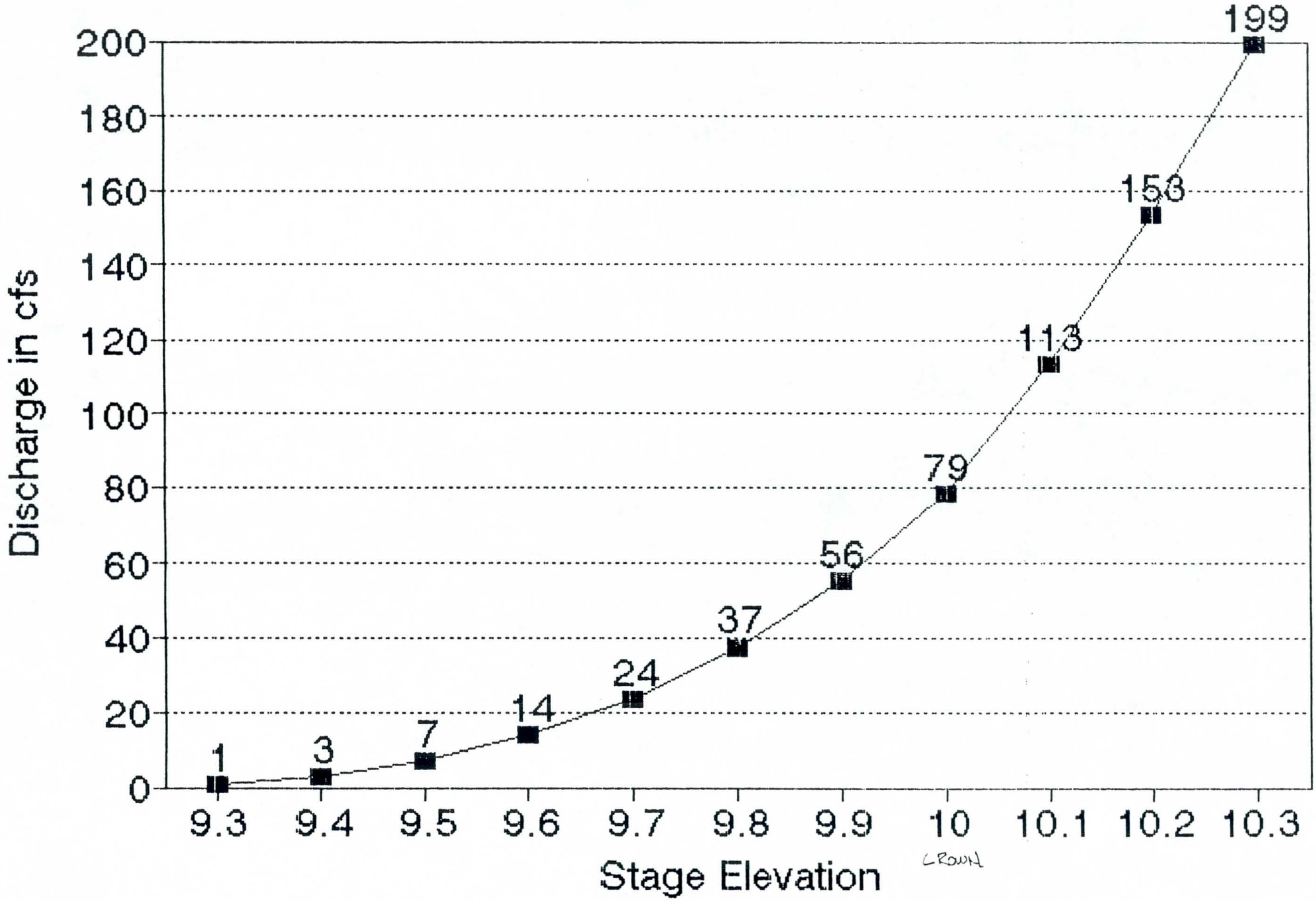
STAGE-DISCHARGE CURVE

75th Av.



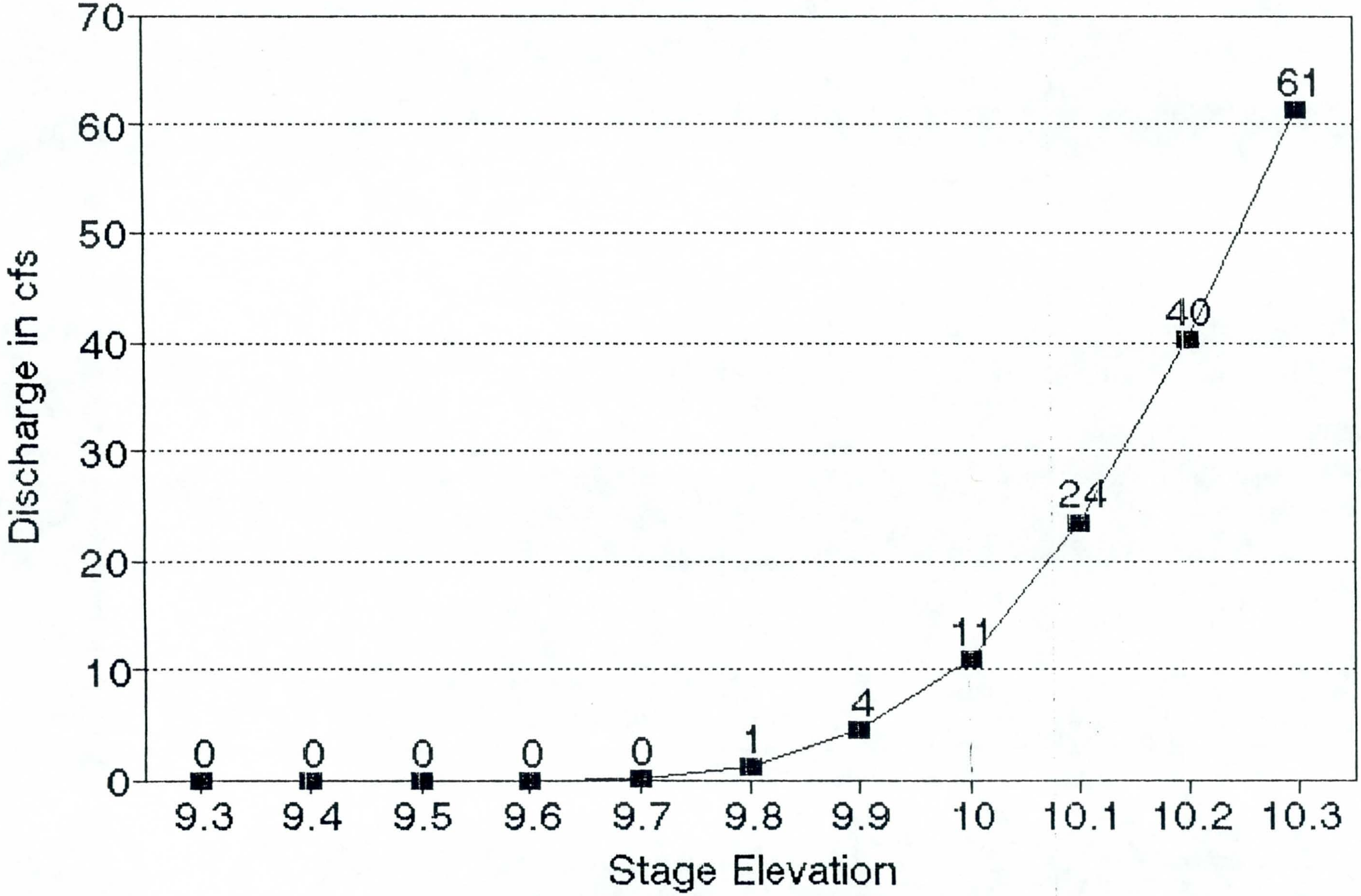
STAGE-DISCHARGE CURVE

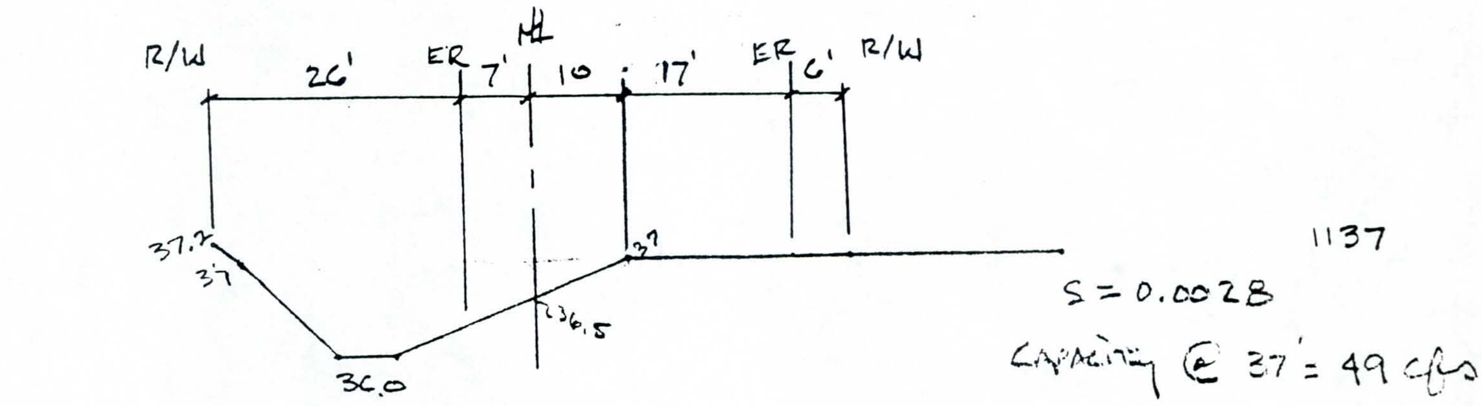
79th Av.



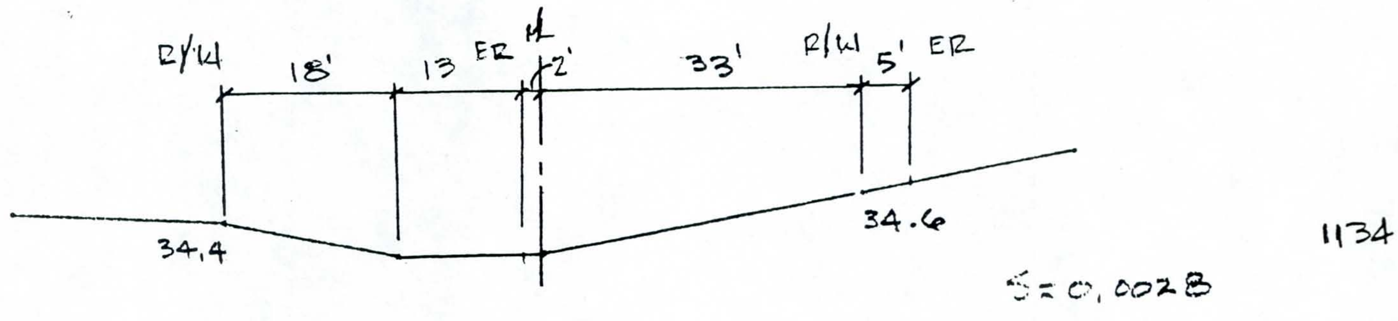
STAGE-DISCHARGE CURVE

83rd Av.





20+00
(tot 49 cfs)

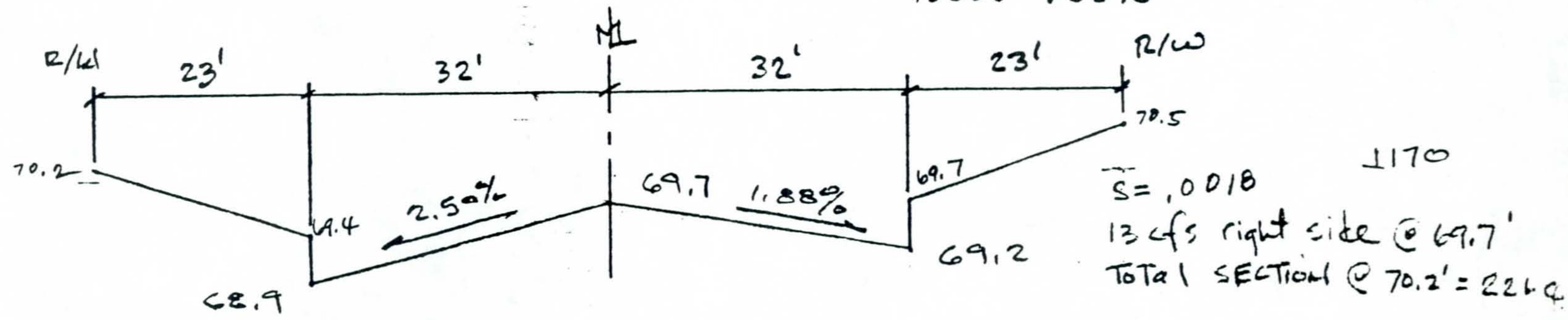


11+00
(tot 16 cfs)

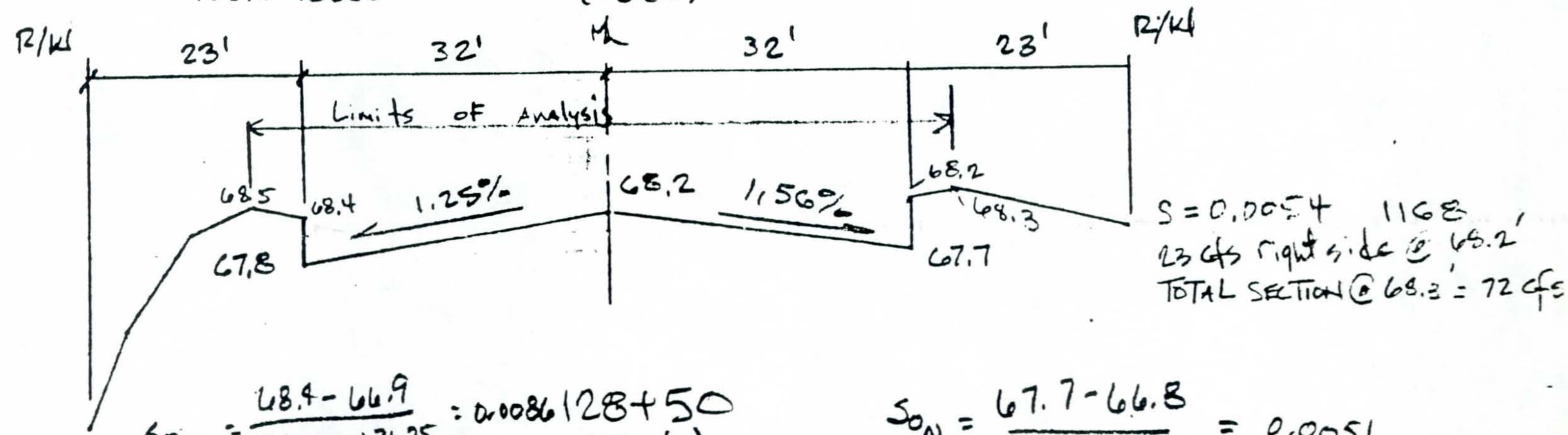
H: 1" = 20'
V: 1" = 2'

NOTE:
SECTIONS ARE
LOOKING DOWNSTREAM

$S_{o_S} = \frac{69.4 - 68.9}{150} = 0.0033$ $S_{o_N} = \frac{69.4 - 69.2}{13825 - 13675} = 0.0013$

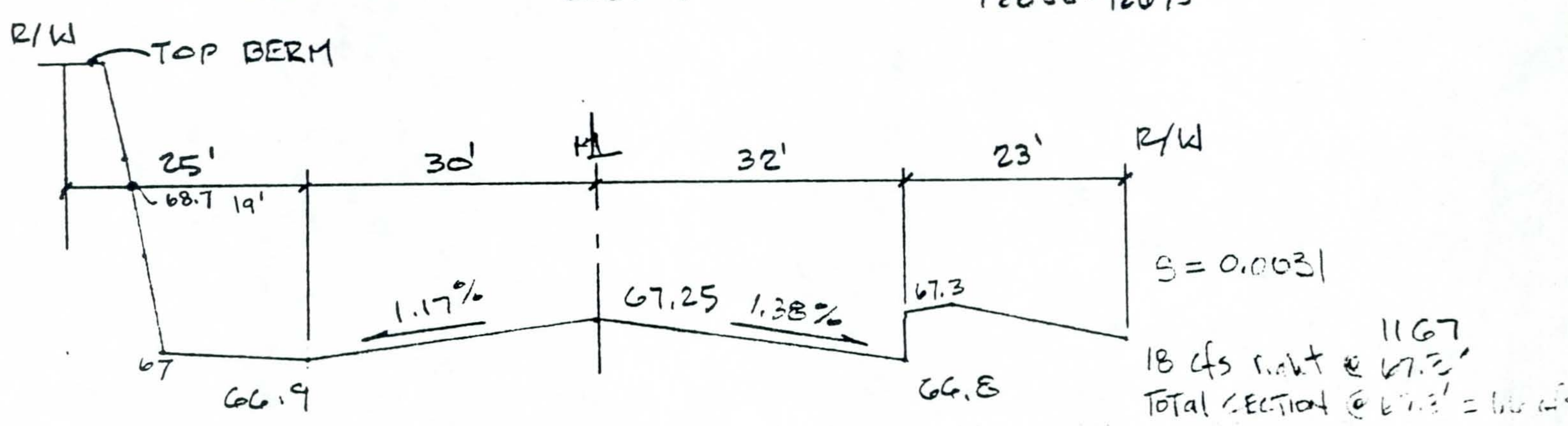


$S_{o_S} = \frac{68.9 - 67.8}{13675 - 12850} = 0.0013$ 136+75 (13 cfs) $S_{o_N} = \frac{69.2 - 67.7}{13675 - 12850} = 0.0018$



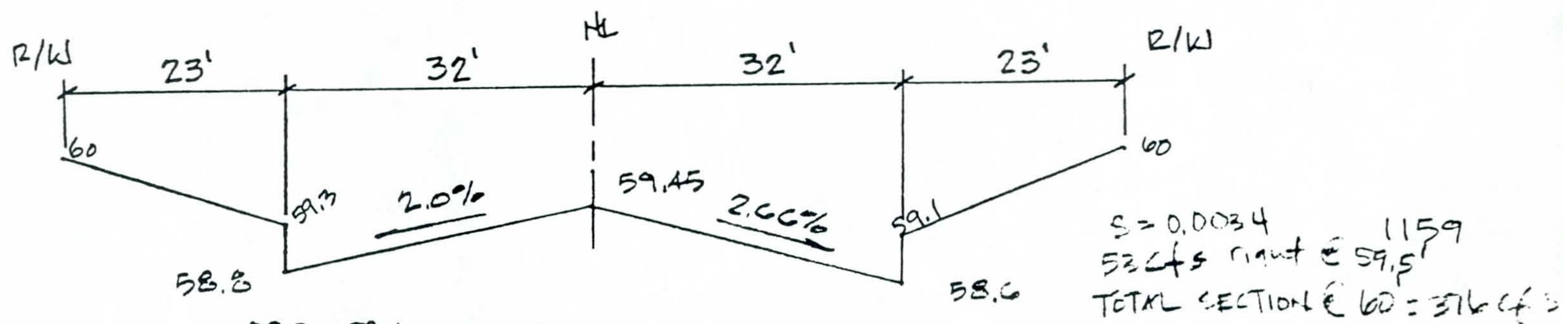
$S_{o_S} = \frac{68.4 - 66.9}{12850 - 12675} = 0.0086$ 128+50 (23 cfs) $S_{o_N} = \frac{67.7 - 66.8}{12850 - 12675} = 0.0051$

1169

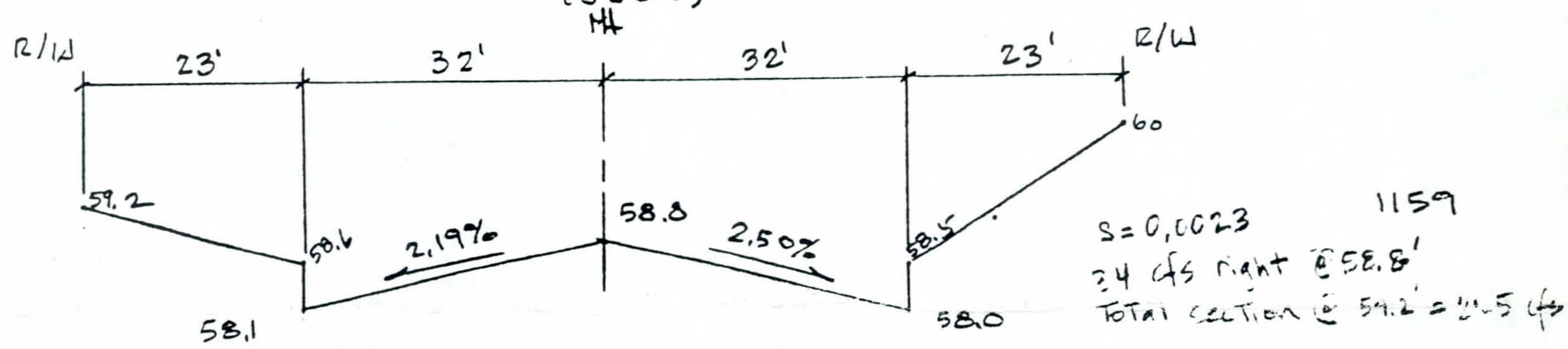


$S_{o_S} = \frac{66.9 - 58.8}{12675 - 10150} = 0.0032$ 126+75 (18 cfs) $S_{o_N} = \frac{66.8 - 58.6}{12675 - 10150} = 0.0032$

S = -0.0005 -0.0005

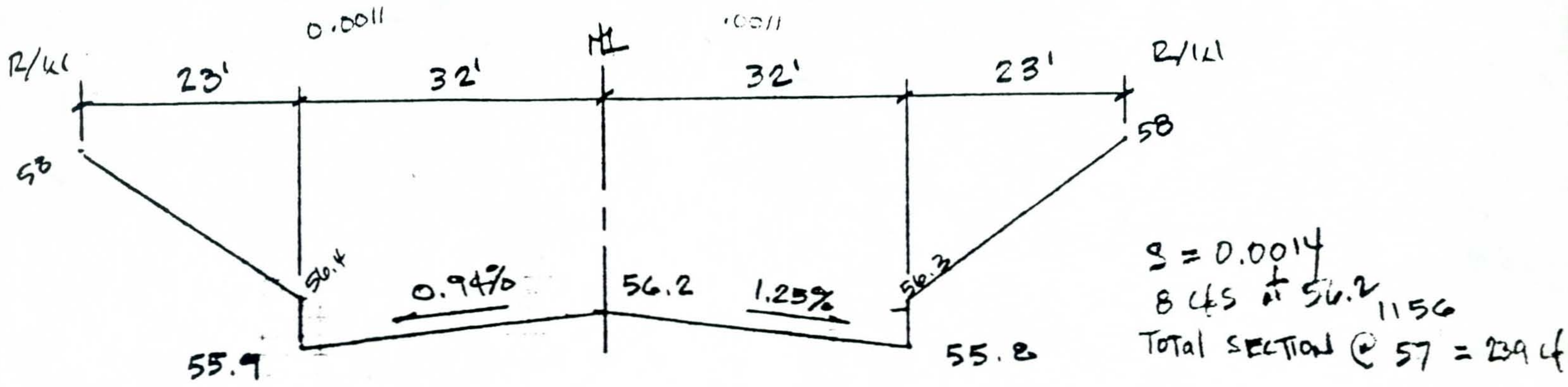


$S_{o_S} = \frac{58.8 - 58.1}{10150 - 9960} = 0.0037$ 101+50 (53 cfs) $S_{o_N} = \frac{58.6 - 58.0}{10150 - 9960} = 0.0032$



$S_{o_S} = \frac{58.1 - 55.9}{9960 - 8810} = 0.0019$ 99+60 (34 cfs) $S_{o_N} = \frac{58.0 - 55.8}{9960 - 8810} = 0.0019$

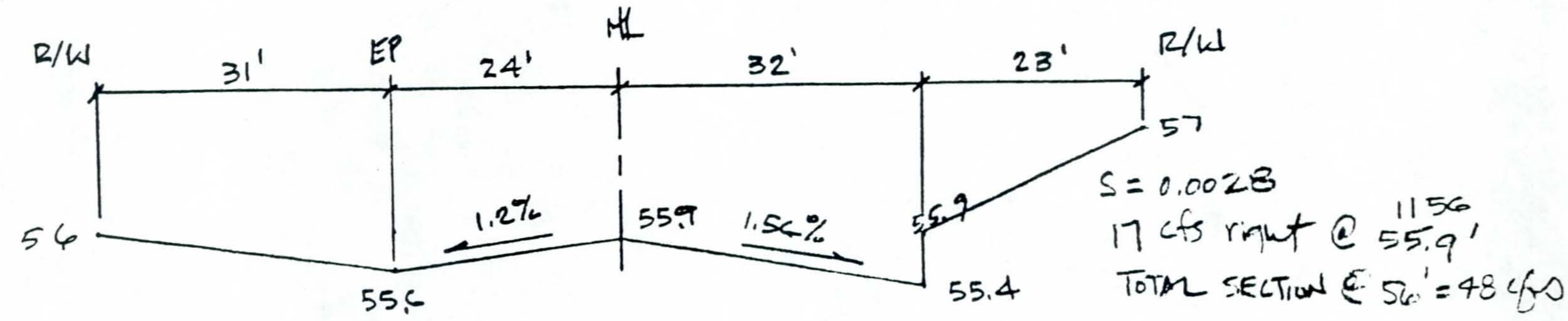
0.0011 0.0011



H: 1" = 20'
V: 1" = 2'

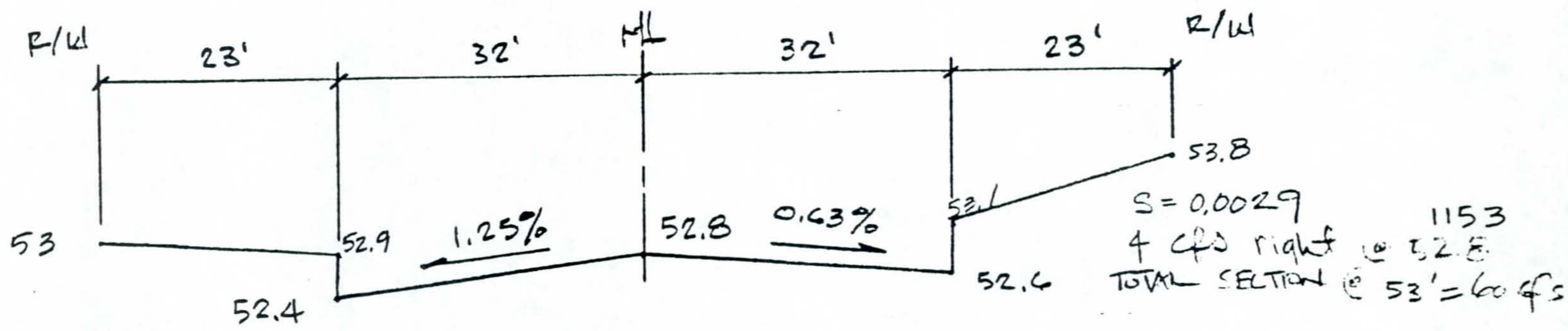
NOTE:
SECTIONS ARE

$S_{o_S} = \frac{55.9 - 55.6}{8810 - 8600} = 0.0014$ 88+10 (8 cfs) $S_{o_N} = \frac{55.8 - 55.4}{8810 - 8600} = 0.0019$



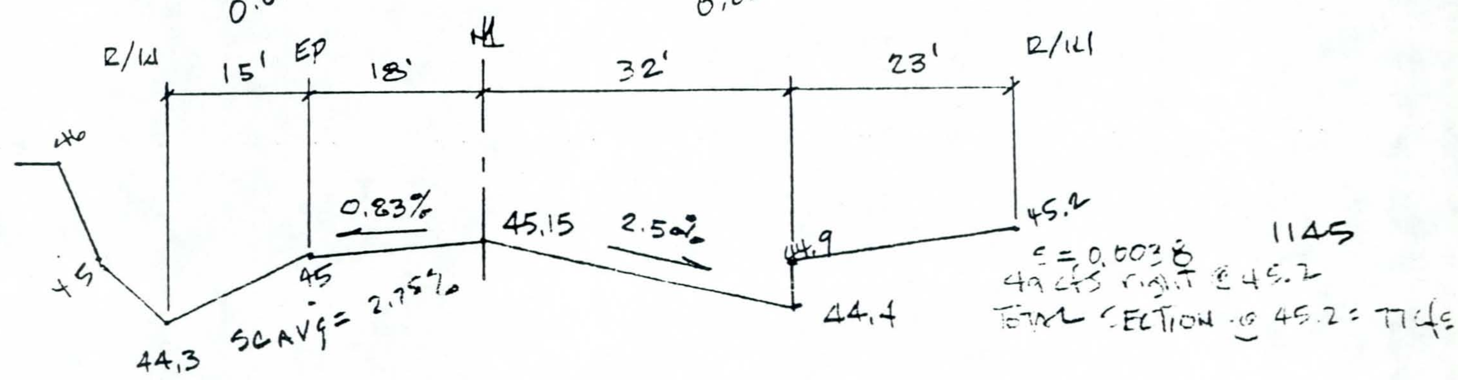
$S_{o_S} = \frac{55.6-52.4}{1100} = 0.0029$ 86+00 (17cfs) $S_{o_N} = \frac{55.4-52.6}{8600-7500} = 0.0025$

.0001 -0.0008

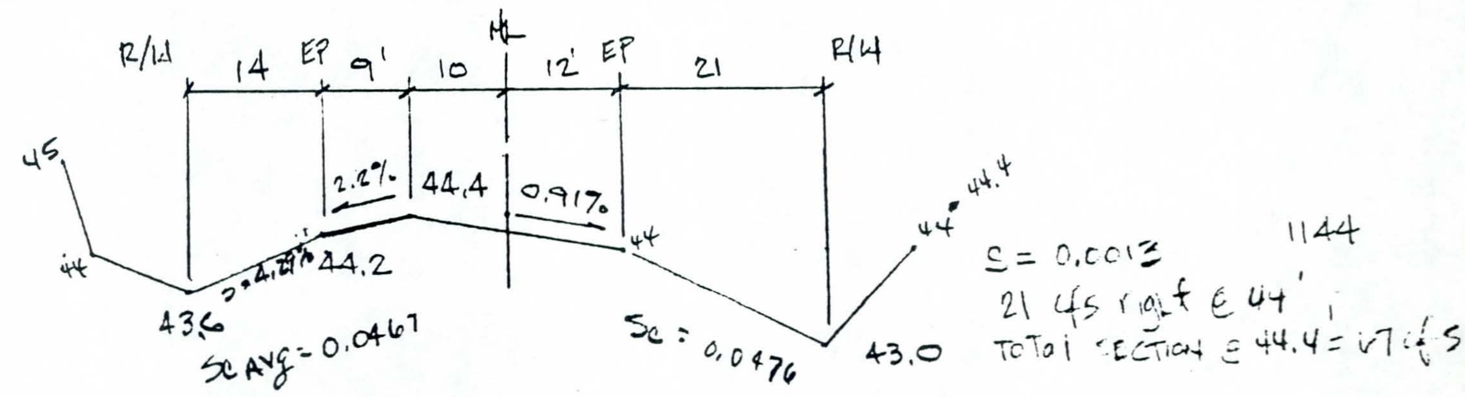


$S_{o_S} = \frac{52.4-44.3}{7500-4850} = 0.0030$ 75+00 (4cfs) $S_{o_N} = \frac{52.6-44.4}{7500-4850} = 0.0031$

0.0006 0.0007

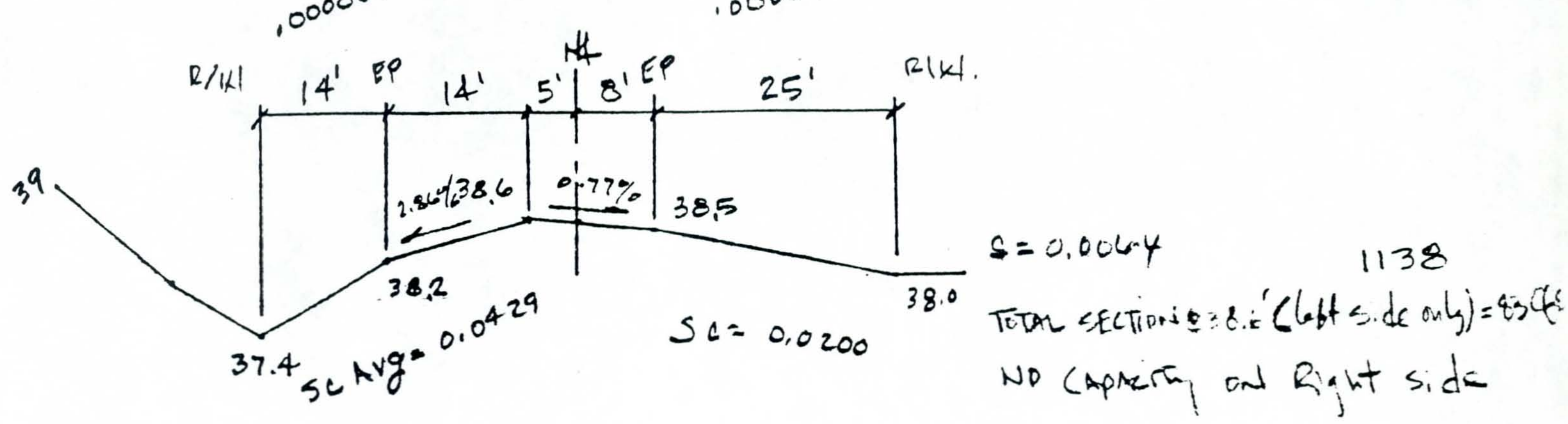


$S_{o_S} = \frac{44.3-43.6}{4850-4650} = 0.0035$ 48+50 (149cfs)



$S_{o_S} = \frac{43.6-37.4}{4650-2250} = 0.0026$ 46+50 (21cfs) $S_{o_N} = \frac{43-38}{4650-2250} = 0.0021$

.00000156² .0000115

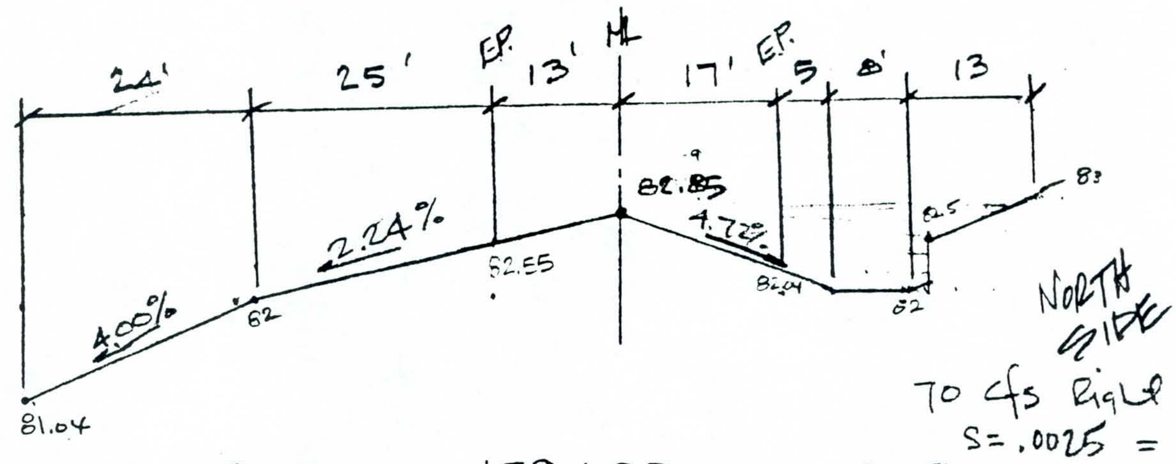


H: 1" = 20'
V: 1" = 2'

22+50
(tot 83cfs)

NOTE.
SECTIONS ARE
LOOKING DOWNSTREAM

n = .015 ASPALT
.013 CONCRETE
.025 Earth



1182
1181

70 cfs Right side
S = .0025 = 82.85 − 76.95

S_ong = (82 − 76.5) / 2400 = 0.0023

179+00
(70 cfs)

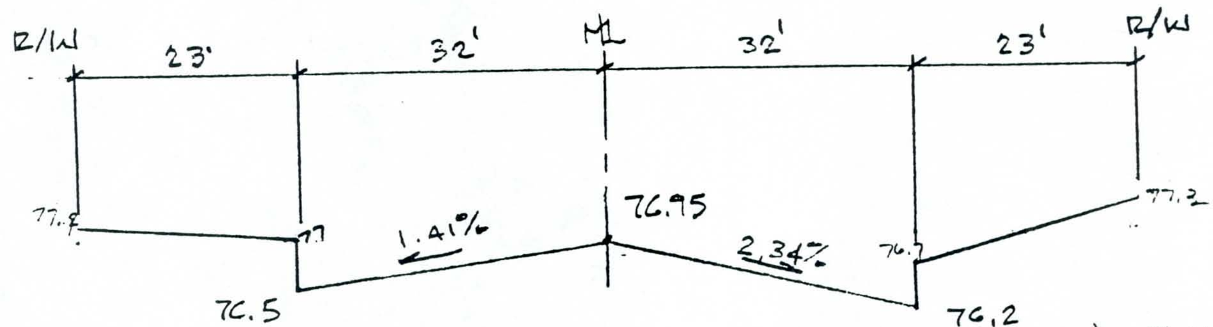
S_ON = (82 − 76.7) / 2400 = 0.0022

.0010

Sc @ 161+60 (4.72 − 2.34) / (17900 − 15500) = (4.72 − S) / (17900 − 1616

Sc = 2.99%

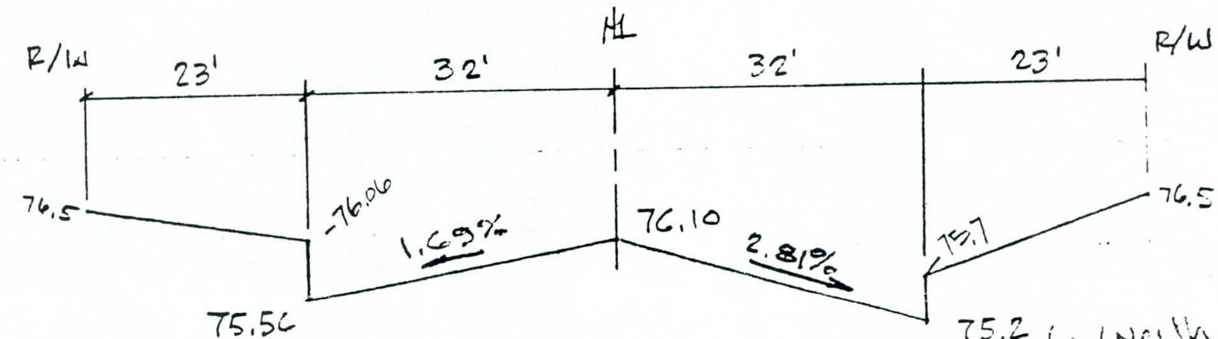
R/W Sc @ 176+60 = 4.48



1177

47 cfs (north only) ELEV. 77'
TOTAL SECTION 154 cfs at 77.2'
S = .0043

155+00
(47cfs)

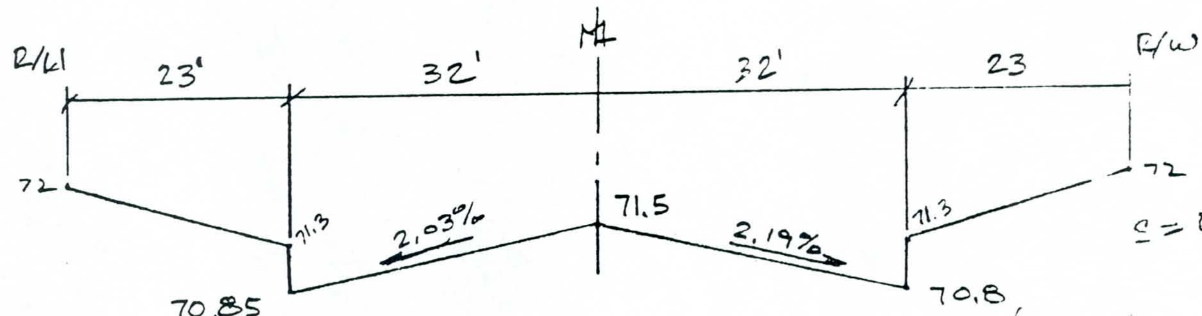


1176

62 cfs (North side @ 76.1)
TOTAL SECTION 221 cfs @ 76.5'
S = .0045

S_cons. = (75.56 − 70.85) / (15300 − 14275) = 0.0046

153+00
(62cfs)

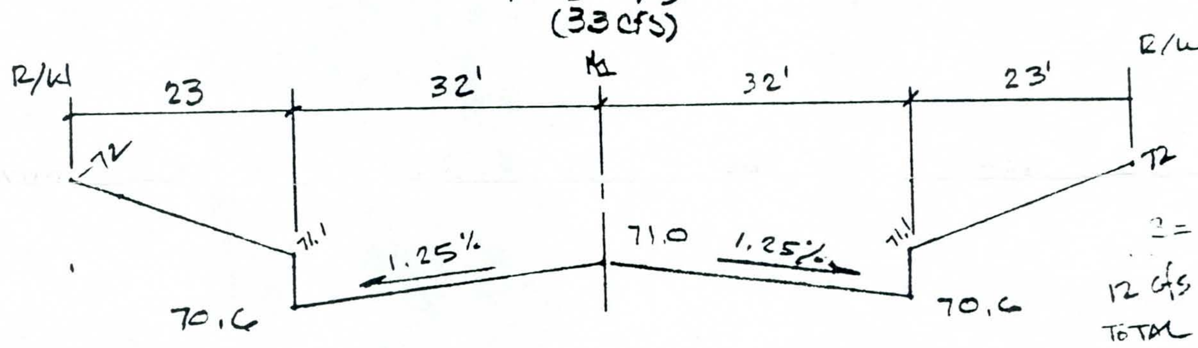


S = 0.0033

1171

33 cfs North @ 71.5'
Total SECTION @ 72' 330 cfs

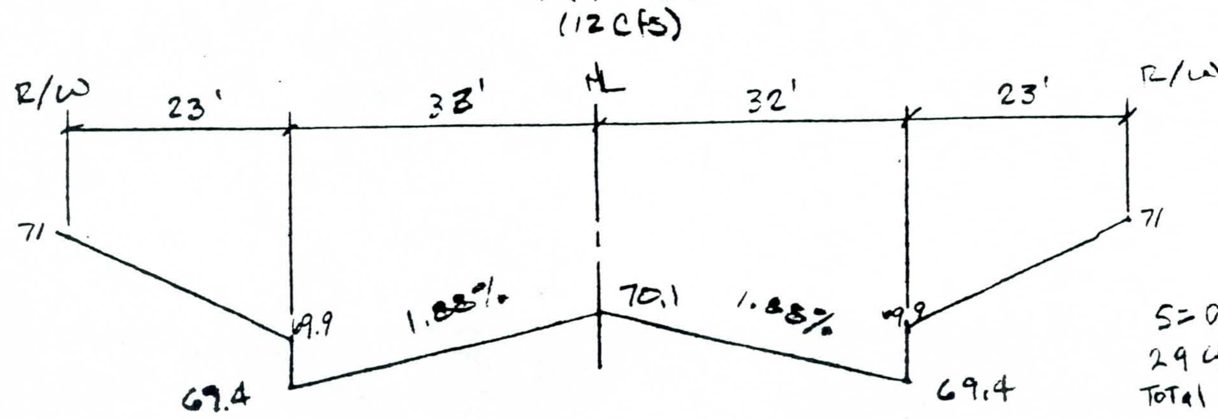
142+75
(33 cfs)



S = .003
1171
12 cfs NORTH side @ 71'
TOTAL SECTION @ 72 546 cfs

141+25
(12 CFS)

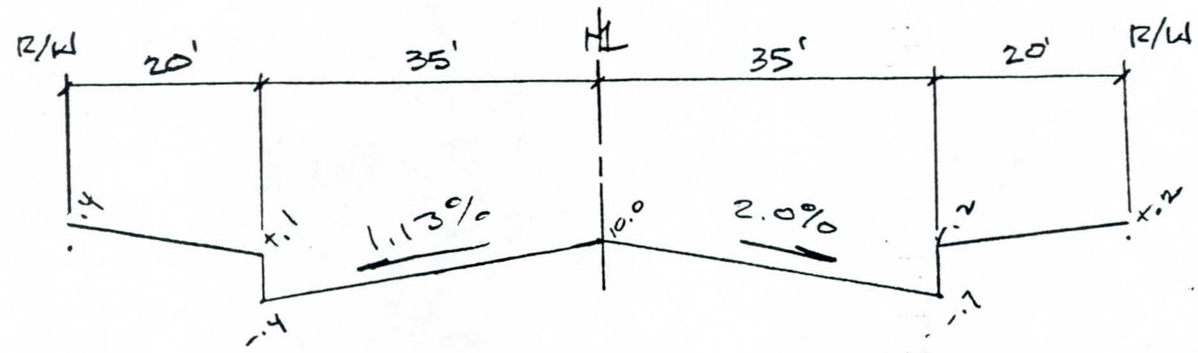
H = 1" = 20'
V = 1" = 2'



S = 0.0027
1170
29 cfs right @ 70.1'
Total SECTION @ 71 577 cfs

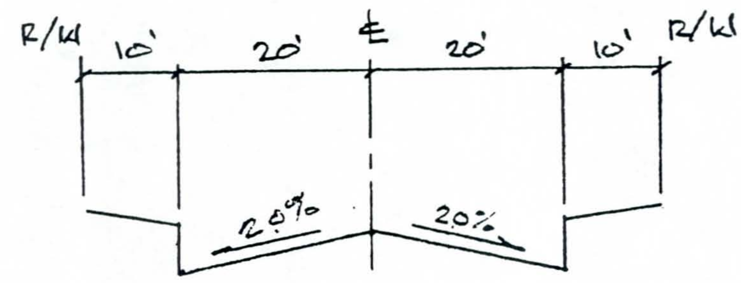
NOTE:
SECTIONS ARE
LOOKING DOWNSTREAM

138+25



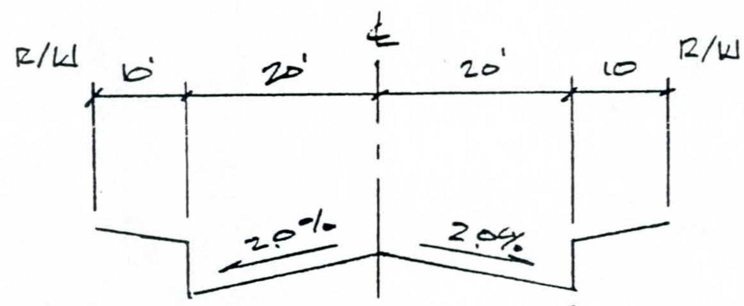
75th Av.

S ≅ 0.0027
Q_{HEC} = 30cfs
$Q_{E\,max}$ = 45cfs



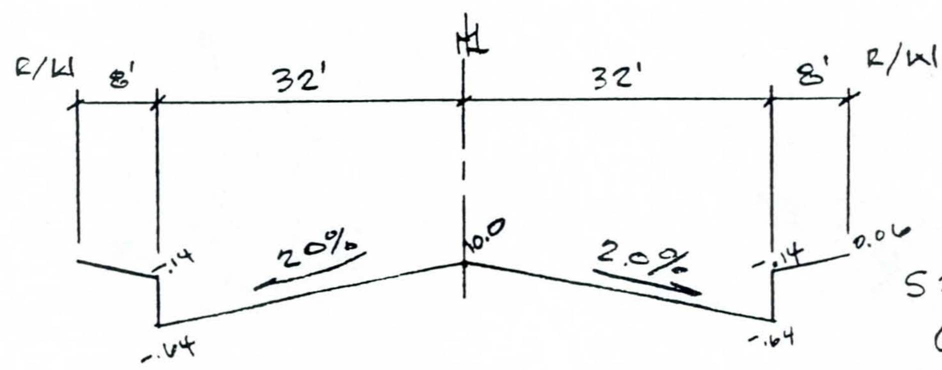
73rd Av.

S ≅ 0.003
Q = 15cfs
Use 71st SD as guide
(20/32)(52) = 32.5 cfs max
$Q_{MAX\ East}$ =
(y = 0.4')



72nd Dr.

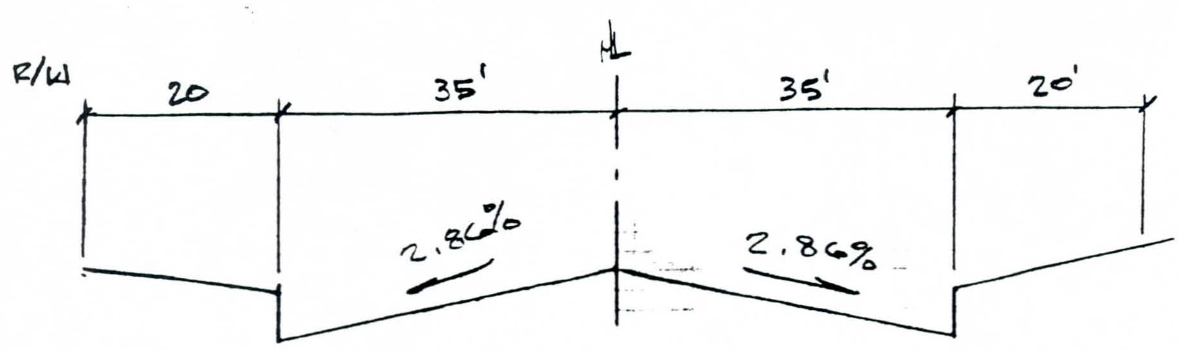
S ≅ 0.003
Q = 85
use 71st SD as guide



71st Av.

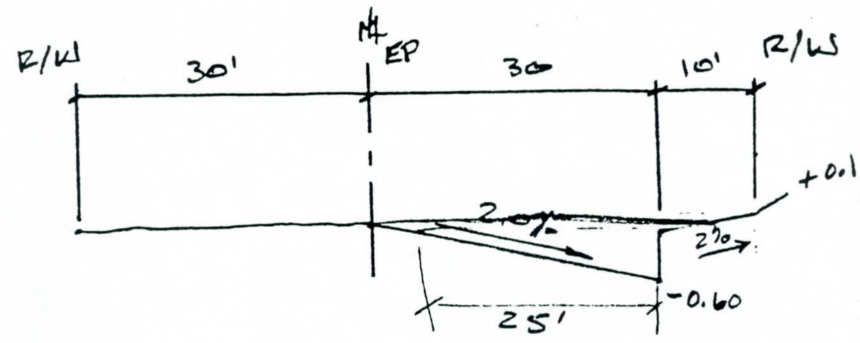
S ≅ 0.003
Q = 37cfs

H: 1" = 20'
V: 1" = 2'



67th Av.

NOTE:
SECTIONS ARE
LOOKING NORTH



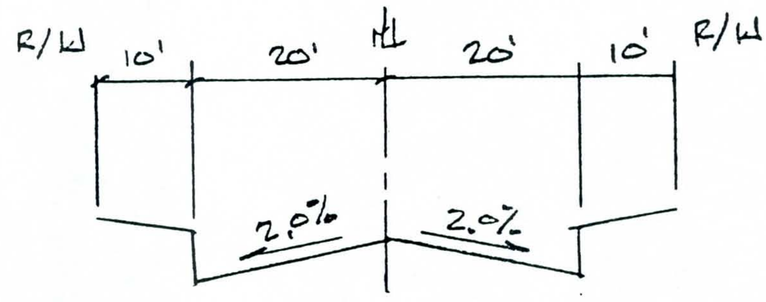
$S \cong 0.0019$

$Q_{HEC} = 46$ cfs

$Q_E = 15$ cfs $y = 0.5, A = 6.25$

$Q_{E\,max} = 21.6$ cfs $y = 0.6, A = 6.75$

87th Av.



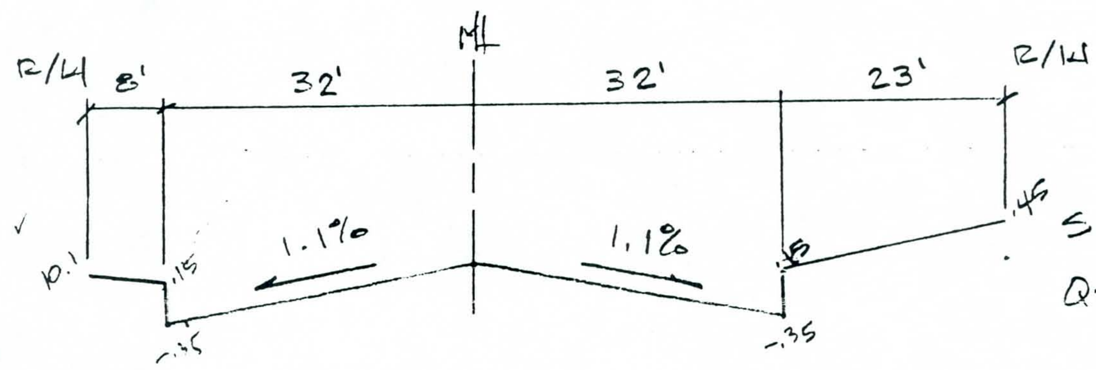
$S \simeq 0.0019$

$Q = 26$ cfs

Use 71st S.D.E. as guide

$20/32 (52) = 32.5$

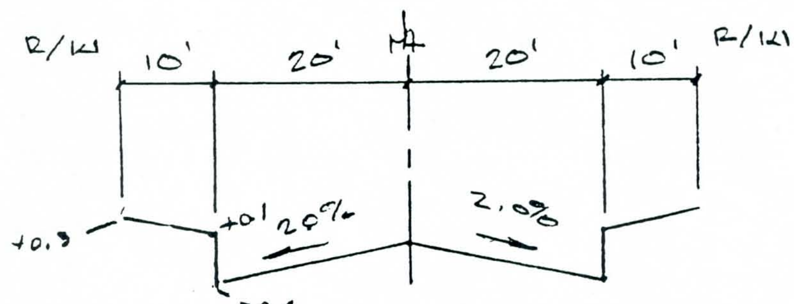
85th Av.



$S \cong 0.001$

$Q = 21$ cfs

83rd Av.



$S \simeq 0.001$

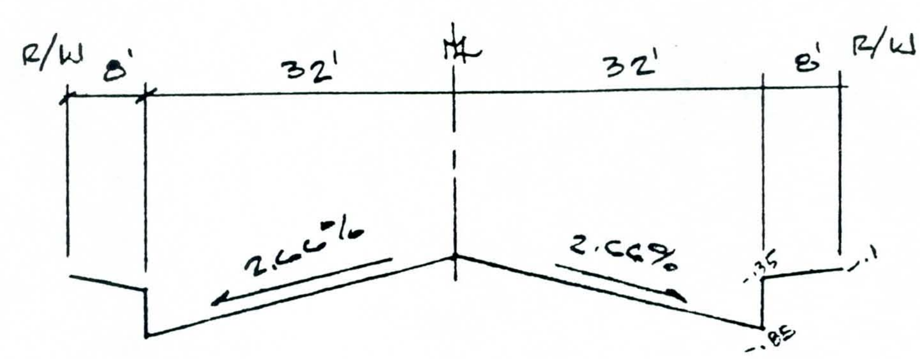
$Q = 73$ cfs

$Q_{E\,max} = 6.6$ cfs, $y = 0.4$ $A = 4$ ft

$Q_{street} = 20.0$ cfs, $y = 0.5$, $A = 10$ ft

$Q_{ROW} = 30.0$ cfs, $y = 0.7$, $A = 12$ ft

81st Av.



$S \cong 0.001$

$Q = 49$ cfs

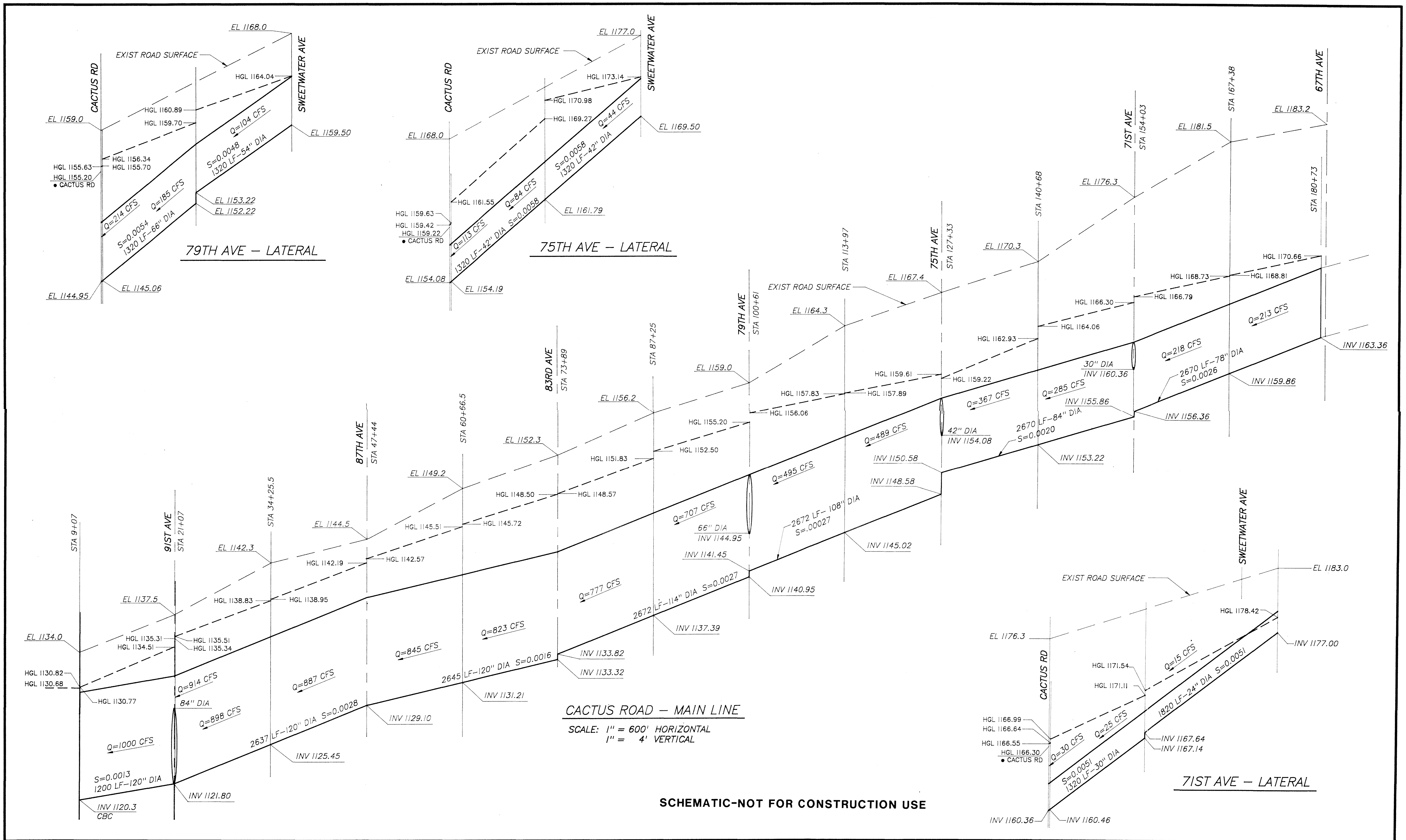
$Q_{crown} = 79$ cfs

79th Av.

H: 1" = 20'

V: 1" = 2'

NOTE:
SECTIONS ARE
LOOKING NORTH



CACTUS_CONCEP.DWG

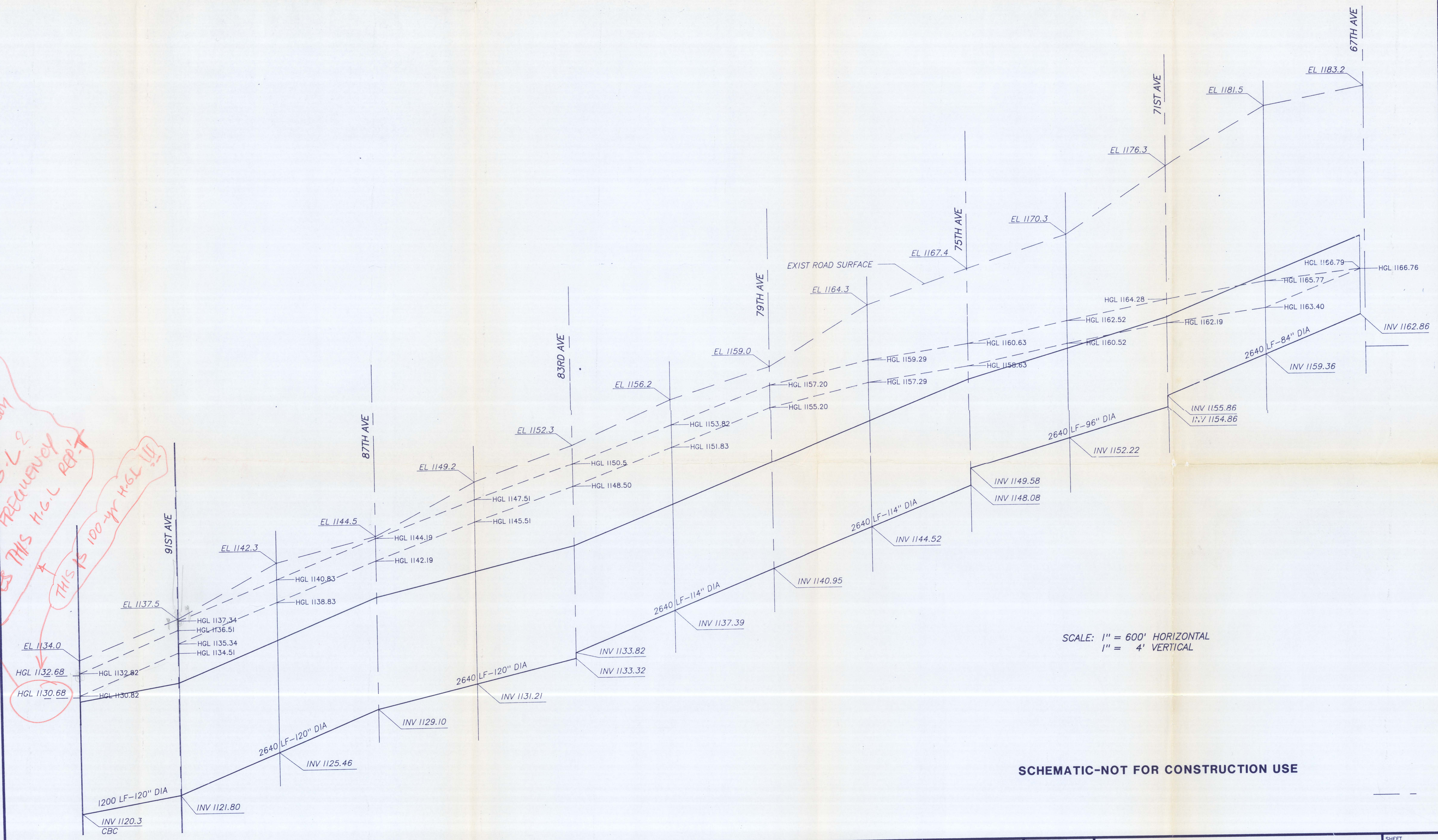
NO.	DATE	REVISION	BY	APPD.

Date ______
Designed ______
Drawn ______
Checked ______

SFC ENGINEERING COMPANY
7776 Pointe Parkway West
Suite 290
Phoenix, Arizona 85044
(602) 438-2200

CACTUS ROAD DRAIN CONCEPTUAL PROFILE

SHEET C-1
PROJECT NO.
DWG. NO. 1



SCALE: 1" = 600' HORIZONTAL
1" = 4' VERTICAL

SCHEMATIC-NOT FOR CONSTRUCTION USE

NO.	DATE	REVISION	BY	APPD.

Date
Designed
Drawn
Checked

SFC ENGINEERING COMPANY
7776 Pointe Parkway West
Suite 290
Phoenix, Arizona 85044
(602) 438-2200

CACTUS ROAD DRAIN CONCEPTUAL PROFILE

SHEET C-1
PROJECT NO. PREL. DSN.
DWG. NO. 1

CACTUS_CONCEP.DWG

DESIGN DATA REPORT
for the

CACTUS ROAD STORM DRAIN

(67th Avenue to the Agua Fria Freeway)

APPENDIX D-
Catch Basin Design

SFC ENGINEERING COMPANY

Subject: Preliminary Layout of Catch Basins | Project: CACTUS ROAD
File Number: 35902.00
Computed: MJB | Checked: | Date: 10/7/91 | Page 1 of Pages

1) Design Criteria
2) Calculator Programs used for Design
3) Graphs & charts used for Design
4) Preliminary Catch Basin Layout Map
5) Hydrologic Design Computations for each Catch Basin (52 pages)
6) Inlet Design Computations for each Catch Basin (94 pages)
7) Roadway Replacement from 87th to 91st for Catch Basin Inlet Elevations

Note: All calculations based on:

STORM DRAIN DESIGN MANUAL by the CITY OF PHOENIX.

Please see this manual for procedural questions.

SFC ENGINEERING COMPANY

Subject: Basic Design Criteria for the Catch Basins | Project: Cactus Road
File Number: 35902.00
Computed: myB | Checked: | Date: 9/20/91 | Page 1 of ___ Pages

1) Assumed that storm drain design would include design of inlets at 67th Ave from Southbound 67th Ave & westbound Cactus. Therefore also assumed design should include catching the flow from the basin closest to the 67th-Cactus intersection on Glendale's side.

2) HEC models calculated flow to points along Cactus Road including Roadway drainage. For catch basins located every 660 ft, used the Rational method to calculate roadway flows & the 10yr Rainfall Intensity from the Hydrologic Design Manual for Maricopa County. (The HEC models all used the 10yr storm so it was used here as well). Also, assumed 100% impervious because the future roadway will be a 5-lane road w/ curb & gutter. This assumption will result in slight over design of the catch basins but should not be substantial. Also did not calculate a separate flow for N. side of roadway when flow came from the HEC model (because HEC model included this flow). Nor did I calculate a separate Roadway drainage for S. side when the HEC flow topped the Crown.

3) At 71st Ave & Cactus Road:

- Cross-slope on 71st Ave is nearly 0% therefore assumed entire Q coming across entire width of 71st Avenue (37cfs).

- Try two M-Is on 71st & if necessary one M-IIs on north half of Cactus West of intersection & one M-Is on north half of Cactus East of intersection.

SFC ENGINEERING COMPANY

Subject: INLET DESIGN COMPUTATION. Project: CACTUS RD

File Number: 35902.00

Computed ______ Checked ______ Date ______ Page ___ of ___ Pages

```
01♦LBL "VG"
02 "SC=?"
03 PROMPT
04 STO 01
05 "SO=?"
06 PROMPT
07 STO 02
08 1.288
09 ENTER↑
10 3
11 ENTER↑
12 RCL 01
13 *
14 .25
15 Y↑X
16 *
17 RCL 02
18 .375
19 Y↑X
20 *
21 .0429
22 /
23 "VG ="
24 ARCL X
25 AVIEW
26 END
```

```
01♦LBL "Y"
02 "Q(CFS)=?"
03 PROMPT
04 STO 01
05 "SC=?"
06 PROMPT
07 1/X
08 STO 02
09 "SO=?"
10 PROMPT
11 STO 03
12 RCL 01
13 .56
14 ENTER↑
15 RCL 02
16 .015
17 /
18 STO 04
19 *
20 RCL 03
21 SQRT
22 *
23 /
24 .375
25 Y↑X
26 "Y="
27 ARCL X
28 AVIEW
29 STOP
30 "Z="
31 ARCL 02
32 AVIEW
33 STOP
34 "Z/N="
35 ARCL 04
36 AVIEW
37 END
```

```
01♦LBL "LA"
02 "QA=?"
03 PROMPT
04 STO 01
05 "A=?"
06 PROMPT
07 STO 02
08 "Y=?"
09 PROMPT
10 STO 03
11 RCL 02
12 RCL 03
13 +
14 1.5
15 Y↑X
16 .7
17 *
18 RCL 02
19 RCL 03
20 +
21 1/X
22 RCL 03
23 *
24 CHS
25 1
26 +
27 2.5
28 Y↑X
29 CHS
30 1
31 +
32 *
33 1/X
34 RCL 01
35 *
36 END
```

```
01♦LBL "Q"
02 "A=?"
03 PROMPT
04 STO 01
05 "Y=?"
06 PROMPT
07 STO 02
08 "L=?"
09 PROMPT
10 STO 03
11 "LA=?"
12 PROMPT
13 STO 04
14 "QA=?"
15 PROMPT
16 STO 05
17 RCL 03
18 RCL 04
19 /
20 CHS
21 1
22 +
23 RCL 01
24 RCL 02
25 /
26 +
27 2.5
28 Y↑X
29 CHS
30 RCL 01
31 RCL 02
32 /
33 1
34 +
35 2.5
36 Y↑X
37 +
38 RCL 05
39 *
40 RCL 01
41 RCL 02
42 /
43 2.5
44 Y↑X
45 CHS
46 RCL 01
47 RCL 02
48 /
49 1
50 +
51 2.5
52 Y↑X
53 +
54 /
55 .8
56 *
57 END
```

IN-HOUSE HP 41CX PROGRAMS USED TO CALCULATE VG (VELOCITY IN GUTTER)

Y (Yg DEPTH AT CURB)

LA (REQUIRED LENGTH)

Q (Allow flow)

} TYPE N

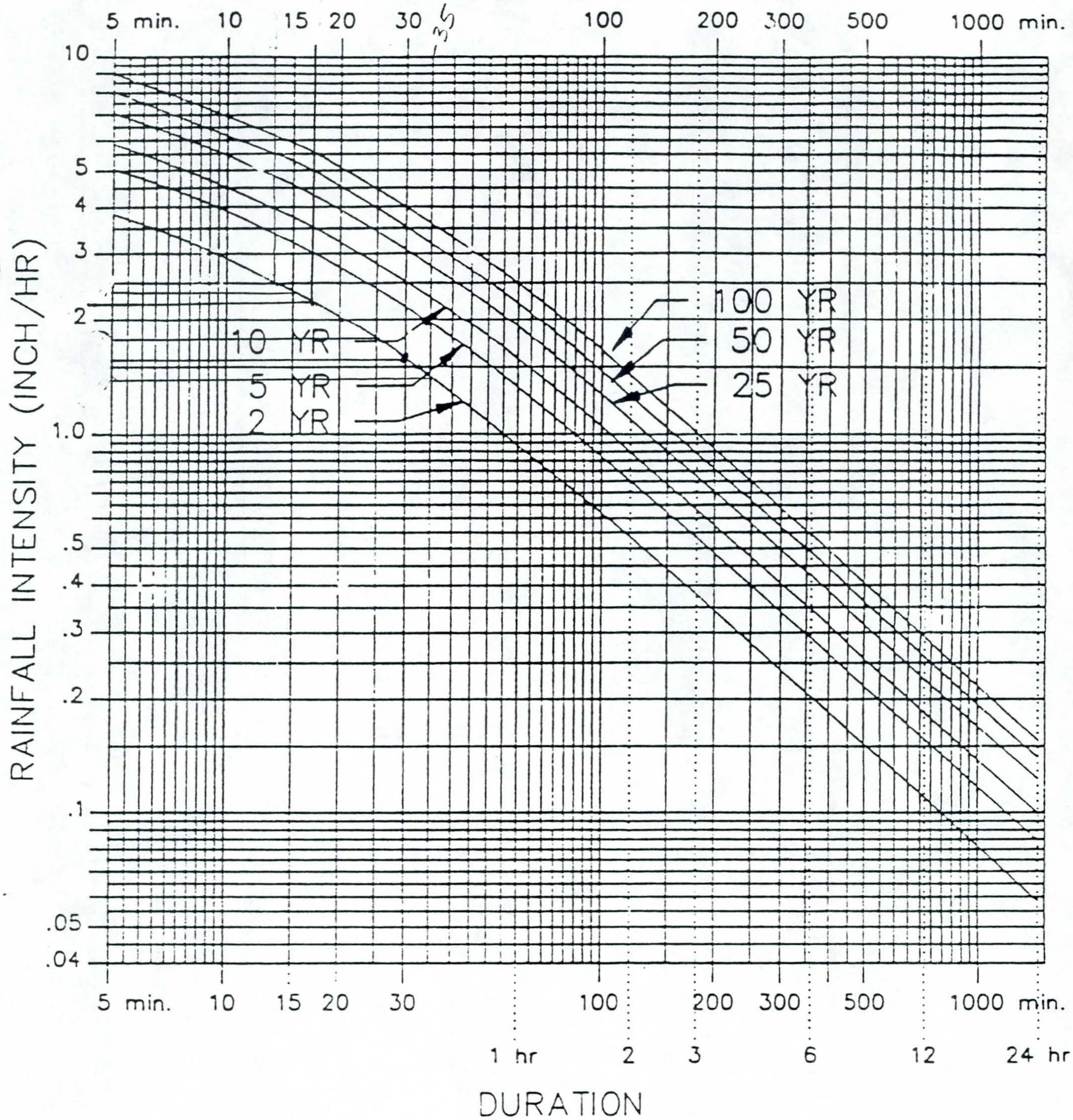
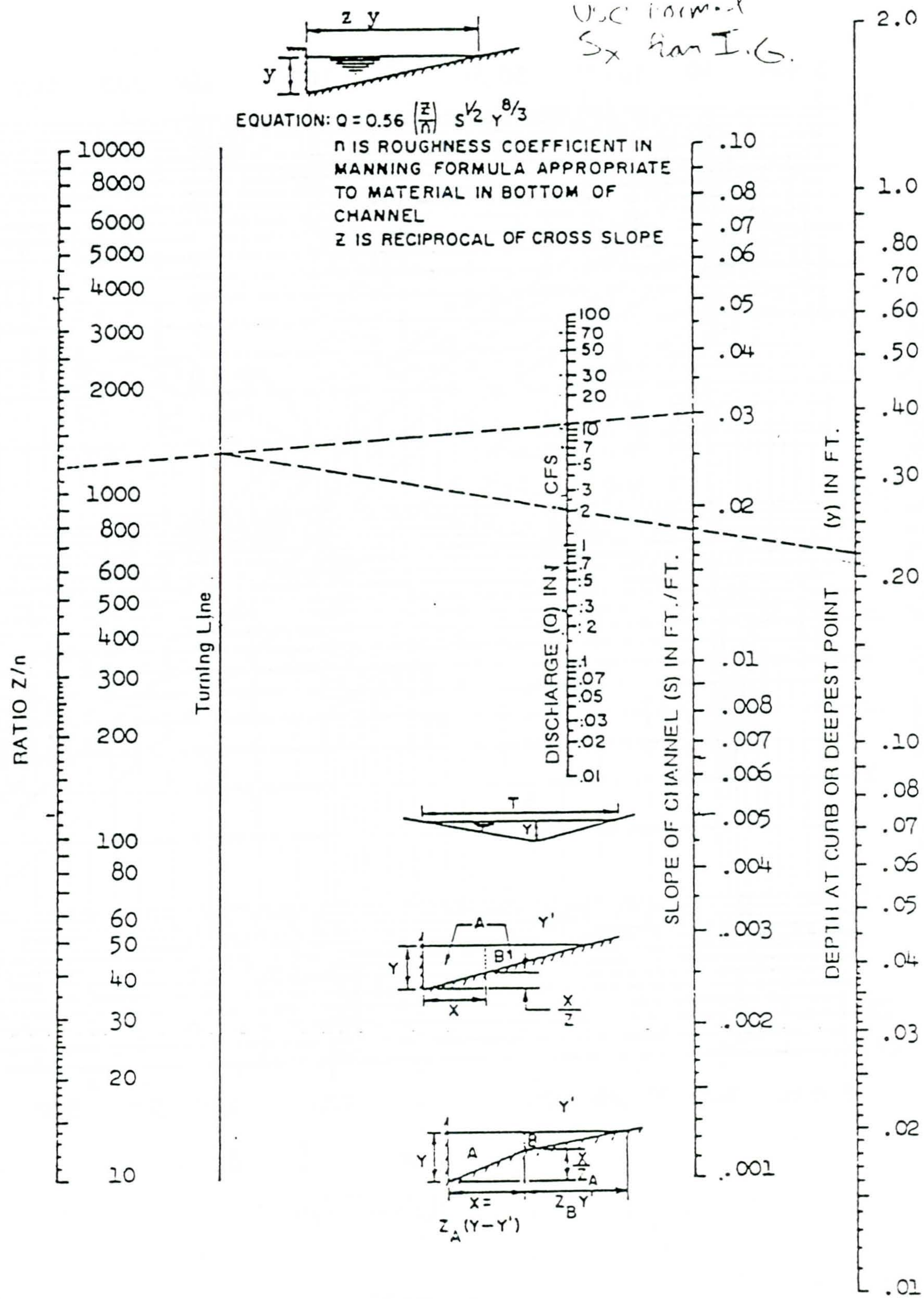


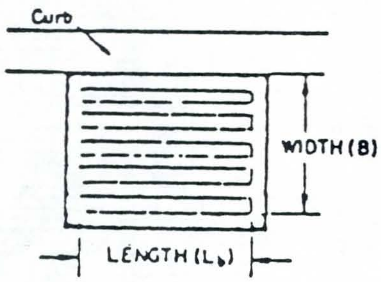
Figure 3.2
Rainfall Intensity-Duration-Frequency Relation
(Phoenix Metro Area)

Use normal S_x than I.G.



$$Y = \left[\frac{Q}{.56 \frac{Z}{N} S^{1/2}} \right]^{3/8}$$

line from Z/N to S
line from turningline to Q → Y;

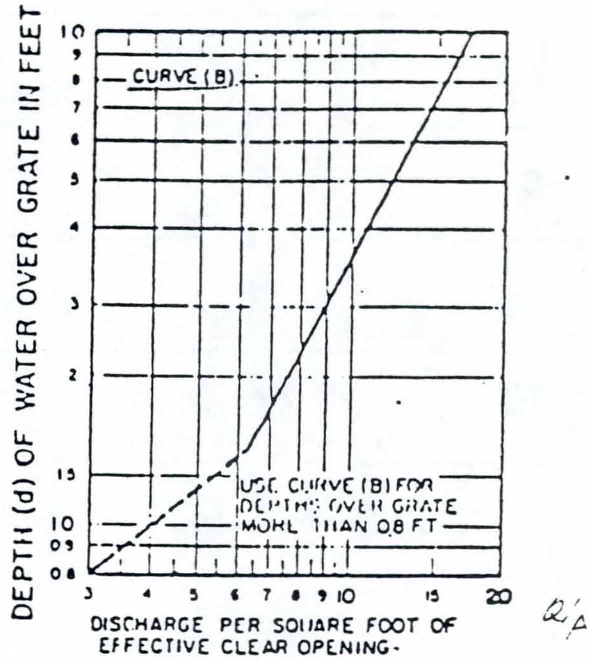


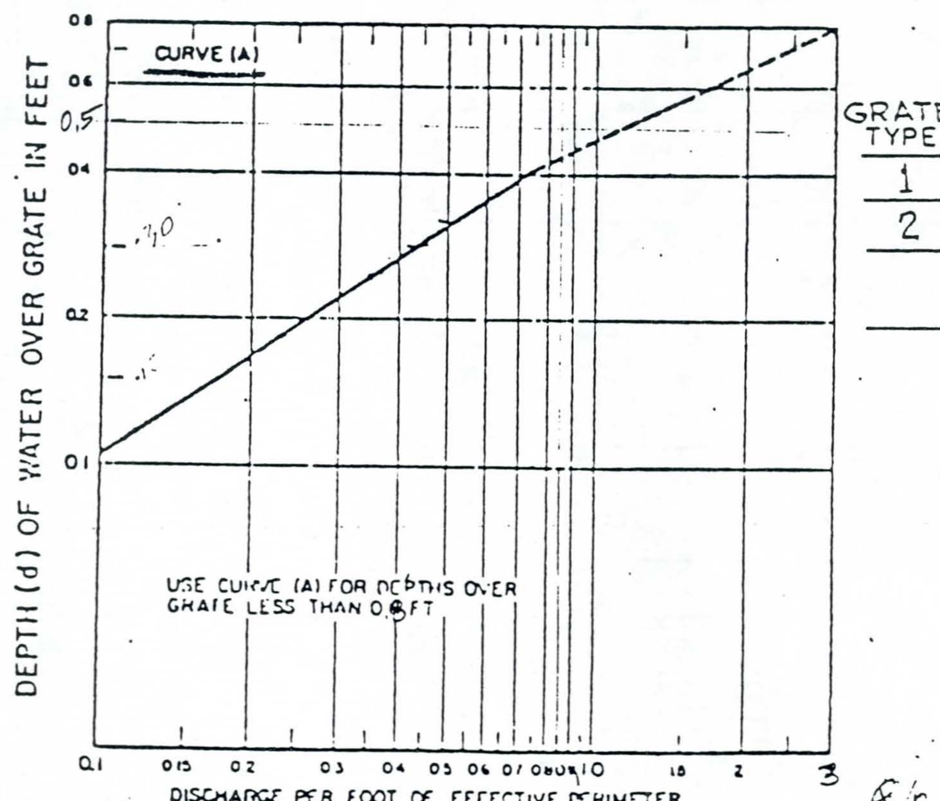
$P = 2B + L_b$

A = AREA OF CLEAR OPENING IN GRATE

TO ALLOW FOR CLOGGING DIVIDE P OR A BY 2 BEFORE OBTAINING d.

WITHOUT CURB $P = 2(B + L_b)$





GRATE TYPE	AREA	P
1	3.78	10.66
2	2.56	9.41

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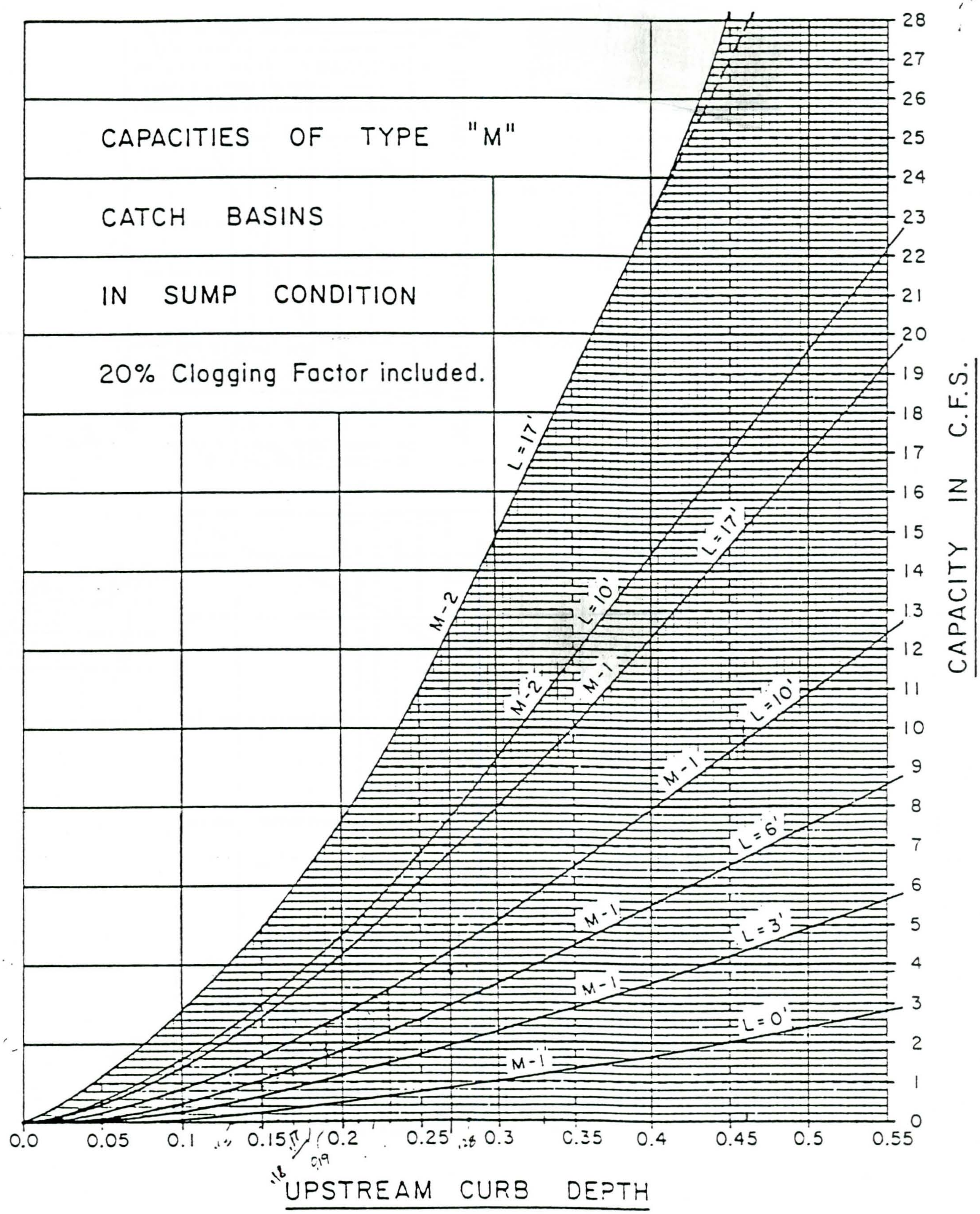
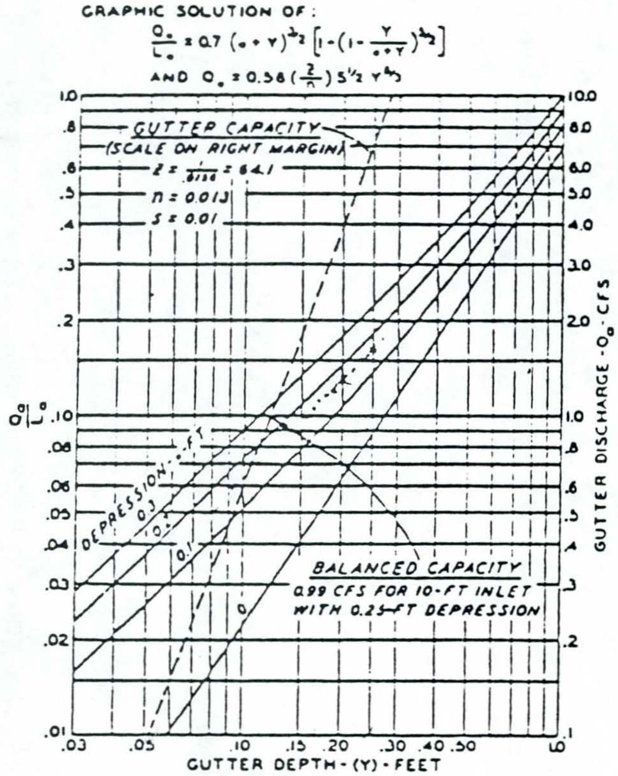
REV. AUG. 1968

HYDRAULIC CAPACITY OF GRATE INLET IN SUMP

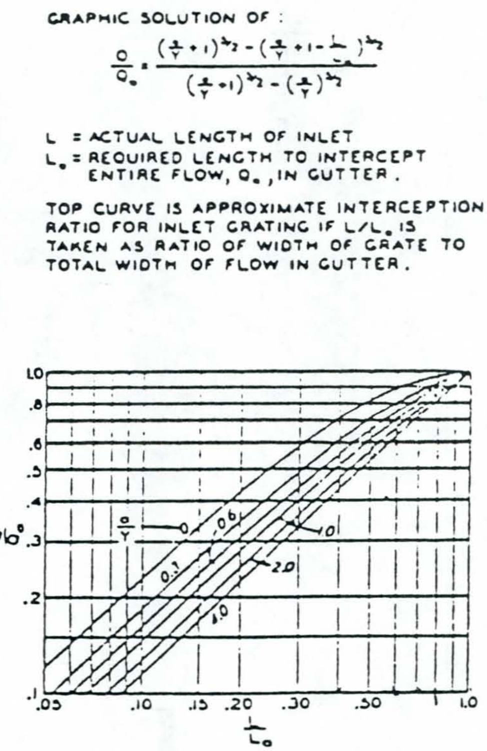


CAPACITIES OF TYPE "M"
CATCH BASINS
IN SUMP CONDITION
20% Clogging Factor included.
L=17'
M-2
L=10'
M-2
L=17'
M-1
L=10'
M-1
L=6'
M-1
L=3'
M-1
L=0'
M-1
0.0
0.05
0.1
0.15
0.2
0.25
0.3
0.35
0.4
0.45
0.5
0.55
UPSTREAM CURB DEPTH
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
CAPACITY IN C.F.S.

Continuous flow

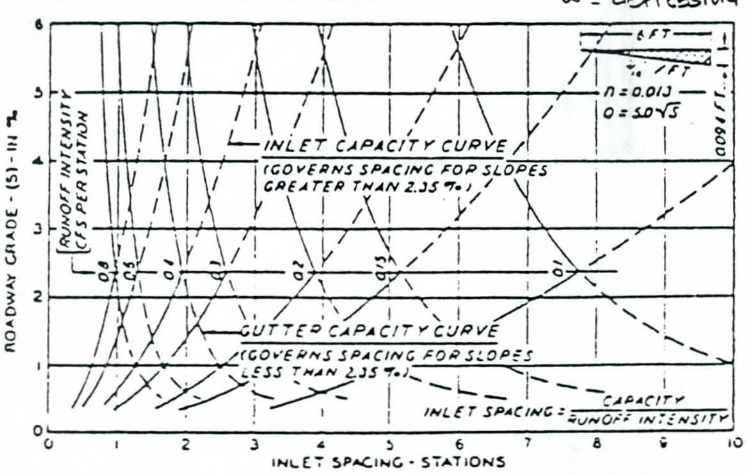


a.-CAPACITY OF CURB OPENING INLET IN CUBIC FEET PER SECOND PER FOOT OF LENGTH, DEPENDING UPON DEPTH IN APPROACH GUTTER (Y) IN FEET, AND DEPRESSION OF GUTTER FLOW LINE (a) IN FEET WHEN INTERCEPTING 100% OF GUTTER FLOW.



b.- PARTIAL INTERCEPTION RATIO FOR CURB OPENING INLETS.

a = depression



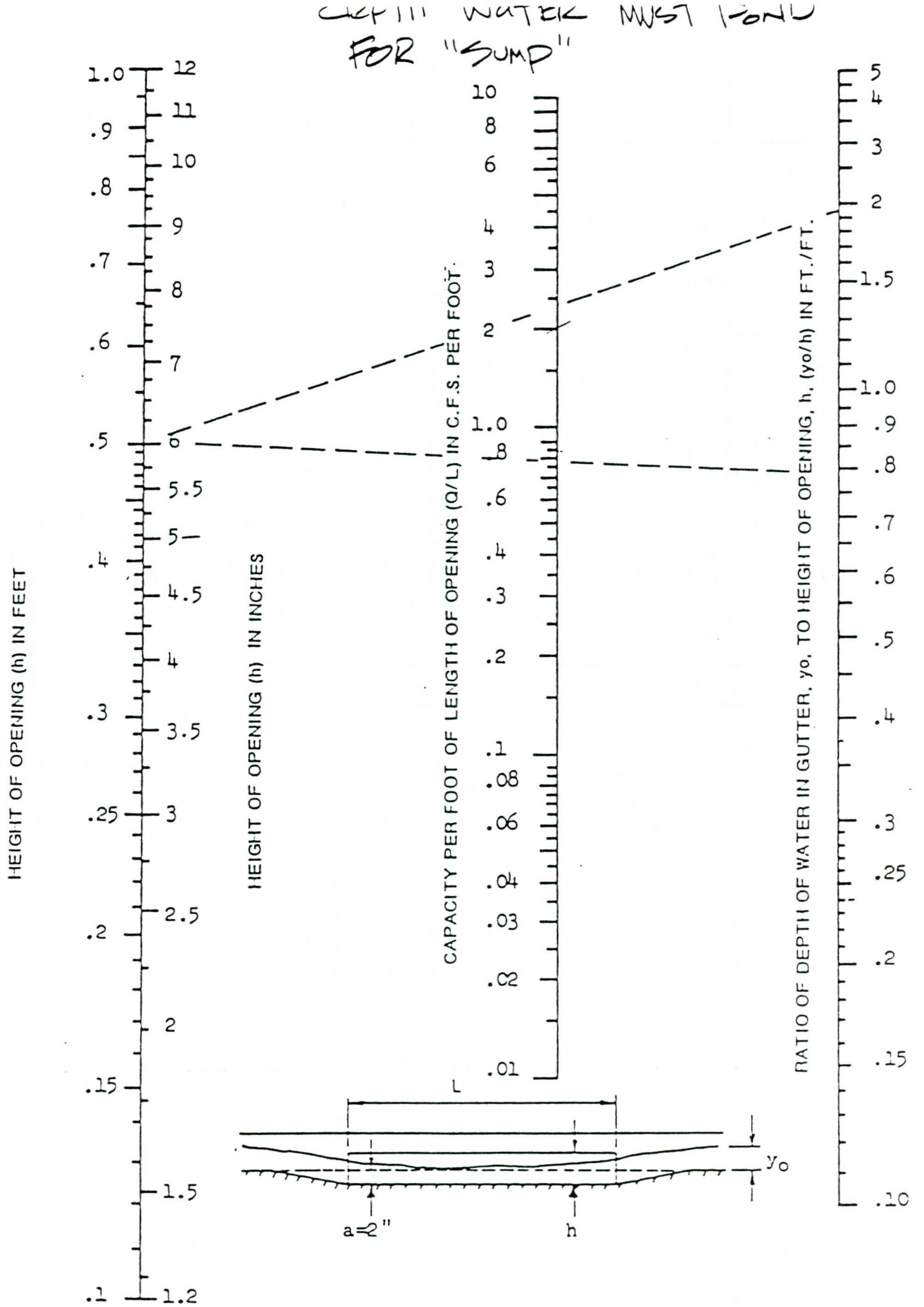
C.- SAMPLE DESIGN CHART FOR INLET SPACING ON VARIOUS GRADES (CHART IS APPLICABLE ONLY TO A 10-FT INLET WITH A 0.25-FT DEPRESSION AND GUTTER CROSS SECTION AS INDICATED).

PREPARED BY
BUREAU OF PUBLIC ROADS

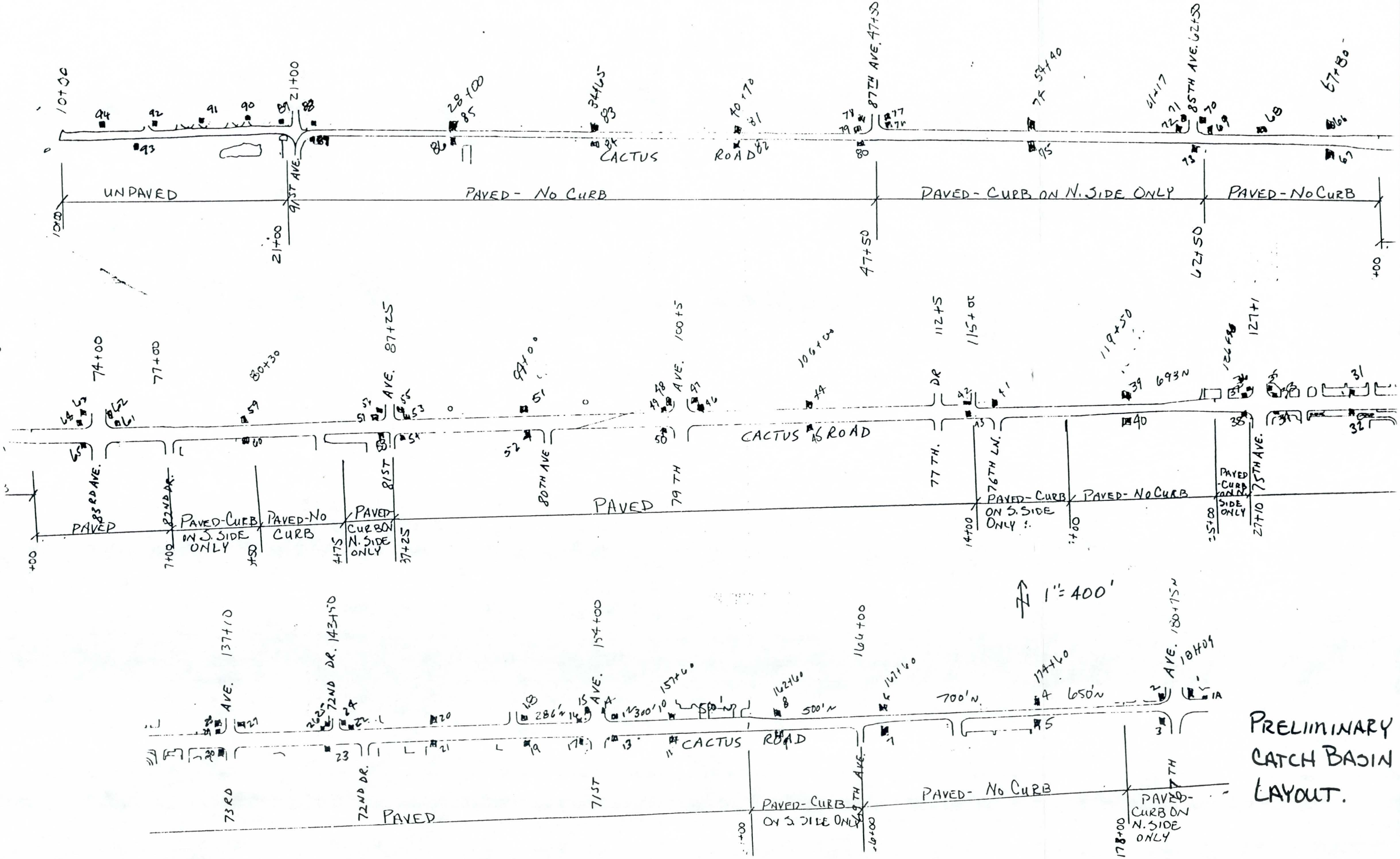
CURB INLETS
DESIGN CHARTS

Figure 12

GPO 811-330-4



NOMOGRAPH FOR CAPACITY OF CURB OPENING INLETS IN SUMPS, DEPRESSION DEPTH 2"



PRELIMINARY CATCH BASIN LAYOUT.

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EXIST C.B. M-1, L=3 & 15" PIPE

DRAINAGE AREA 1A

LOCATION: NE COR OF 67TH AVE & CACTUS -

ZONING: —

L = ______ = ______ FT

$T_C = \frac{L}{60V_g}$ = ______
= 10 MINUTES (MIN)

Ai = $\frac{\_\_\_\_ x \_\_\_\_}{43560}$ = ______ AC

Sc = CROSS SLOPE = ______

I = from IDF curve = 4.5 IN/HR

So = GUTTER SLOPE = ______

Q = 0.9 (4.5 - 0.2) ______

n = 0.015 FOR ASPHALT

= ______ CFS

V_g = 30.05 (3X______)$^{0.25}$ (______)$^{0.375}$

= ______ FT/SEC

DRAINAGE AREA ______

LOCATION: ______

ZONING: ______

L = ______ = ______ FT

$T_C = \frac{L}{60V_g}$ = ______
= 10 MINUTES (MIN)

Ai = $\frac{\_\_\_\_ x \_\_\_\_}{43560}$ = ______ AC

Sc = CROSS SLOPE = ______

I = from IDF curve = 4.5 IN/HR

So = GUTTER SLOPE = ______

Q = 0.9 (4.5 - 0.2) ______

n = 0.015 FOR ASPHALT

= ______ CFS

V_g = 30.05 (3X______)$^{0.25}$ (______)$^{0.375}$

= ______ FT/SEC

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DRAINAGE AREA (1)

LOCATION: NE SEC OF GLENDALE - BASIN G 10

ZONING: ~~100% IMPERVIOUS~~ See hydrology report

~~L = ___ = ___ FT~~

~~$T_c = \frac{L}{60V_g}$ = ___~~

~~= 10 MINUTES (MIN)~~

~~$Ai = \frac{\_\_ x \_\_}{43560}$ = ___ AC~~

~~Sc = CROSS SLOPE = ___~~

~~I = from IDF curve = 4.5 IN/HR~~

~~So = GUTTER SLOPE = ___~~

~~Q = 0.9 (4.5 - 0.2) ___~~

~~= ___ CFS~~

~~n = 0.015 FOR ASPHALT~~

~~$V_g = 30.05\,(3X\_\_)^{0.25}\,(\_\_)^{0.375}$~~

~~= ___ FT/SEC~~

Q= 6 CFS From HEC model (SEE ATTACHED TABLE)

DRAINAGE AREA (2)

LOCATION: NW ROW OF 67th AVE & CACTUS RD

ZONING: 100% IMPERVIOUS

179+87 TO 180+73

L = 43+15 = 58 FT

$T_c = \frac{L}{60V_g} = \frac{58}{60 \times 1.69} = 0.57$ MIN

= 10 MINUTES (MIN)

$Ai = \frac{58 \times 55}{43560}$ = 0.07 AC

Sc = CROSS SLOPE = 0.0167

I = from IDF curve = 4.5 IN/HR

So = GUTTER SLOPE = 0.0034

Q = 0.9 (4.5 - 0.2) 0.07

= 0.27 CFS

n = 0.015 FOR ASPHALT

$V_g = 30.05\,(3X.0167)^{0.25}\,(0.0034)^{0.375}$

= 1.69 FT/SEC

DRAINAGE AREA (3)

LOCATION: SW ROW OF 67th AVE & CACTUS RD

ZONING: 100% IMPERVIOUS

179+87 TO 180+73

L = 43+15 = 58 FT

$T_c = \frac{L}{60V_g} = \frac{58}{60 \times 1.57} = 0.62$ MIN

= 10 MINUTES (MIN)

$Ai = \frac{58 \times 55}{43560} = 0.07$ AC

Sc = CROSS SLOPE = 0.0224

I = from IDF curve = 4.5 IN/HR

So = GUTTER SLOPE = 0.0023

Q = 0.9 (4.5 - 0.2) 0.07

= 0.27 CFS

n = 0.015 FOR ASPHALT

$V_g = 30.05\ (3X.0224)^{0.25}\ (.0023)^{0.375}$

= 1.57 FT/SEC

DRAINAGE AREA (2A)

LOCATION: SE ROW of 67th Ave & Cactus Road

ZONING: ___

L = ___ = ___ FT

$T_c = \frac{L}{60V_g}$ = ___

= 10 MINUTES (MIN)

$Ai = \frac{\_\_ \times \_\_}{43560}$ = ___ AC

Sc = CROSS SLOPE = ___

I = from IDF curve = 4.5 IN/HR

So = GUTTER SLOPE = ___

Q = 0.9 (4.5 - 0.2) ___

= ___ CFS

n = 0.015 FOR ASPHALT

$V_g = 30.05\ (3X\_\_)^{0.25}\ (\_\_)^{0.375}$

= ___ FT/SEC

Requested by C.O.G. for nuisance flow.

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DRAINAGE AREA (4)

LOCATION: N½ OF ROW FROM 179+87 – 174+60

ZONING: 100% IMPERVIOUS

L = 179+87 – 174+60 = 527 FT

$T_c = \frac{L}{60V_g} = \frac{527}{60 \times 1.83} = 4.79$ MIN

= 10 MINUTES (MIN)

$Ai = \frac{527 \times 55}{43560} = 0.67$ AC

Sc = CROSS SLOPE = 0.0448

I = from IDF curve = 4.5 IN/HR

So = GUTTER SLOPE = 0.0022

Q = 0.9 (4.5 - 0.2) 0.67

= 2.59 CFS

n = 0.015 FOR ASPHALT

$V_g = 30.05\,(3X.0448)^{0.25}\,(.0022)^{0.375}$

= 1.83 FT/SEC

DRAINAGE AREA (5)

LOCATION: S½ OF ROW FROM 179+87 – 174+60

ZONING: 100% IMPERVIOUS

L = 179+87 – 174+60 = 527 FT

$T_c = \frac{L}{60V_g} = \frac{527}{60 \times 1.54} = 5.70$ MIN

= 10 MINUTES (MIN)

$Ai = \frac{527 \times 55}{43560} = 0.67$ AC

Sc = CROSS SLOPE = 0.0209

I = from IDF curve = 4.5 IN/HR

So = GUTTER SLOPE = 0.0023

Q = 0.9 (4.5 - 0.2) 0.67

= 2.59 CFS

n = 0.015 FOR ASPHALT

$V_g = 30.05\,(3X.0209)^{0.25}\,(.0023)^{0.375}$

= 1.54 FT/SEC

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DRAINAGE AREA (6) LOCATION: N½ OF ROW & BASINS AT AU & AY

ZONING: ~~100% IMPERVIOUS~~ see Hydrology Report

~~L = ___ = ___ FT~~ ~~$T_c = \frac{L}{60V_g}$ = ___~~

~~= 10 MINUTES (MIN)~~

~~Ai = ___ x ___ / 43560 = ___ AC~~

~~Sc = CROSS SLOPE = ___~~ ~~I = from IDF curve = 4.5 IN/HR~~

~~So = GUTTER SLOPE = ___~~ ~~Q = 0.9 (4.5 - 0.2) ___~~

~~n = 0.015 FOR ASPHALT~~ ~~= ___ CFS~~

$V_g = 30.05 (3X\_\_\_)^{0.25} (\_\_\_)^{0.375}$

= ___ FT/SEC

Q = 5 CFS FROM HEC MODEL (SEE ATTACHED TABLE)

DRAINAGE AREA (7) LOCATION: S½ OF ROW FROM 174+60 - 167+60

ZONING: 100% IMPERVIOUS

L = 174+60 - 167+60 = 700 FT $T_c = \frac{L}{60V_g} = \frac{700}{60 \times 1.50} = 7.78$ MIN

= 10 MINUTES (MIN)

$Ai = \frac{700 \times 55}{43560}$ = 0.88 AC

Sc = CROSS SLOPE = 0.0190 I = from IDF curve = 4.5 IN/HR

So = GUTTER SLOPE = 0.0023 Q = 0.9 (4.5 - 0.2) 0.88

n = 0.015 FOR ASPHALT = 3.41 CFS

$V_g = 30.05 (3X.0190)^{0.25} (.0023)^{0.375}$

= 1.50 FT/SEC

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DRAINAGE AREA (8)

LOCATION: N 1/2 OF ROW FROM 167+60 - 162+60

ZONING: 100% IMPERVIOUS

L = 167+60 - 162+60 = 500 FT

$T_c = \frac{L}{60V_g} = \frac{500}{60 \times 1.67} = 4.99$ MIN

= 10 MINUTES (MIN)

$A_i = \frac{500 \times 55}{43560} = 0.63$ AC

Sc = CROSS SLOPE = 0.0309

I = from IDF curve = 4.5 IN/HR

So = GUTTER SLOPE = 0.0022

Q = 0.9 (4.5 - 0.2) 0.63

n = 0.015 FOR ASPHALT

= 2.44 CFS

$V_g = 30.05\,(3X.0309)^{0.25}\,(0.0022)^{0.375}$

= 1.67 FT/SEC

DRAINAGE AREA (9)

LOCATION: S 1/2 OF ROW FROM 167+60 - 162+60

ZONING: 100% IMPERVIOUS

L = 167+60 - 162+60 = 500 FT

$T_c = \frac{L}{60V_g} = \frac{500}{60 \times 1.46} = 5.72$ MIN

= 10 MINUTES (MIN)

$A_i = \frac{500 \times 55}{43560} = 0.63$ AC

Sc = CROSS SLOPE = 0.0167

I = from IDF curve = 4.5 IN/HR

So = GUTTER SLOPE = 0.0023

Q = 0.9 (4.5 - 0.2) 0.63

n = 0.015 FOR ASPHALT

= 2.44 CFS

$V_g = 30.05\,(3X.0167)^{0.25}\,(.0023)^{0.375}$

= 1.46 FT/SEC

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DRAINAGE AREA (10) LOCATION: N½ OF ROW & BASIN AW @ 157+60

ZONING: ~~100% IMPERVIOUS~~ See Hydrology Report

~~L = = ___ FT $T_c = \frac{L}{60V_g}$ = ___~~

~~= 10 MINUTES (MIN)~~

~~Ai = ___ x ___ / 43560 = ___ AC~~

~~Sc = CROSS SLOPE = ___ I = from IDF curve = 4.5 IN/HR~~

~~So = GUTTER SLOPE = ___ Q = 0.9 (4.5 - 0.2) ___~~

~~n = 0.015 FOR ASPHALT = ___ CFS~~

~~$V_g = 30.05\,(3X\_\_\_)^{0.25}\,(\_\_\_)^{0.375}$~~

~~= ___ FT/SEC~~

Q = 3CFS FROM HEC MODEL (SEE ATTACHED TABLE)

DRAINAGE AREA (11) LOCATION: S½ ROW FROM 162+60 - 157+60

ZONING: 100% IMPERVIOUS

L = 162+60 - 157+60 = 500 FT $T_c = \frac{L}{60V_g} = \frac{500}{60 \times 1.42} = 5.88$ MIN

= 10 MINUTES (MIN)

Ai = $\frac{500 \times 55}{43560}$ = 0.63 AC

Sc = CROSS SLOPE = 0.0150 I = from IDF curve = 4.5 IN/HR

So = GUTTER SLOPE = 0.0023 Q = 0.9 (4.5 - 0.2) 0.63

n = 0.015 FOR ASPHALT = 2.44 CFS

$V_g = 30.05\,(3X.0150)^{0.25}\,(.0023)^{0.375}$

= 1.42 FT/SEC

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DRAINAGE AREA (12) LOCATION: N 1/2 OF ROW FROM 157+60 - 154+70

ZONING: 100% IMPERVIOUS

L = 157+60 - 154+70 = 290 FT

$T_c = \frac{L}{60V_g} = \frac{290}{60 \times 1.40} = 3.45$ MIN = 10 MINUTES (MIN)

$Ai = \frac{290 \times 55}{43560} = 0.37$ AC

Sc = CROSS SLOPE = 0.0141

I = from IDF curve = 4.5 IN/HR

So = GUTTER SLOPE = 0.0023

Q = 0.9 (4.5 - 0.2) 0.37 = 1.42 CFS

n = 0.015 FOR ASPHALT

$V_g = 30.05\,(3X.0141)^{0.25}\,(0.0023)^{0.375}$

= 1.40 FT/SEC

DRAINAGE AREA (13) LOCATION: S 1/2 OF ROW 157+60 - 154+70

ZONING: 100% IMPERVIOUS

L = 157+60 - 154+70 = 290 FT

$T_c = \frac{L}{60V_g} = \frac{290}{60 \times 1.56} = 3.10$ MIN = 10 MINUTES (MIN)

$Ai = \frac{290 \times 55}{43560} = 0.37$ AC

Sc = CROSS SLOPE = 0.0234

I = from IDF curve = 4.5 IN/HR

So = GUTTER SLOPE = 0.0022

Q = 0.9 (4.5 - 0.2) 0.37 = 1.42 CFS

n = 0.015 FOR ASPHALT

$V_g = 30.05\,(3X.0234)^{0.25}\,(.0022)^{0.375}$

= 1.56 FT/SEC

DRAINAGE AREA (14) LOCATION: 1/2 OF BASIN AS

ZONING: ~~100% IMPERVIOUS~~ See Hydrology Report

L = = ______ FT $T_C = \frac{L}{60V_g}$ = ______

= 10 MINUTES (MIN)

Ai = $\frac{\_\_\_ x \_\_\_}{43560}$ = ______ AC

Sc = CROSS SLOPE = ______ I = from IDF curve = 4.5 IN/HR

So = GUTTER SLOPE = ______ Q = 0.9 (4.5 - 0.2) ______

n = 0.015 FOR ASPHALT = ______ CFS

V_g = 30.05 (3X____)$^{0.25}$ (______)$^{0.375}$

= ______ FT/SEC

Q = 37 CFS/2 = 18.5 CFS FROM HEC MODEL (SEE ATTACHED TABLE)

DRAINAGE AREA (15) LOCATION: 1/2 OF BASIN AS

ZONING: ~~100% IMPERVIOUS~~ See Hydrology Report

L = = ______ FT $T_C = \frac{L}{60V_g}$ = ______

= 10 MINUTES (MIN)

Ai = $\frac{\_\_\_ x \_\_\_}{43560}$ = ______ AC

Sc = CROSS SLOPE = ______ I = from IDF curve = 4.5 IN/HR

So = GUTTER SLOPE = ______ Q = 0.9 (4.5 - 0.2) ______

n = 0.015 FOR ASPHALT = ______ CFS

V_g = 30.05 (3X____)$^{0.25}$ (______)$^{0.375}$

= ______ FT/SEC

Q = 18.5 CFS FROM HEC MODEL (SEE ATTACHED TABLE)

DRAINAGE AREA (16) LOCATION: INTERSECTION OF 71st & CACTUS (N½)

ZONING: 100% IMPERVIOUS

L = ______ = ______ FT

A1 = 43 x 35/43560 = 0.03 AC

Ai = (85 x 39) / 43560 = 0.08 AC

Σ = 0.11 AC

$T_c = \frac{L}{60V_g} = \frac{43+85}{60 \times 1.40} = 1.52$ MIN

= 10 MINUTES (MIN)

Sc = CROSS SLOPE = 0.0141

So = GUTTER SLOPE = 0.0023

n = 0.015 FOR ASPHALT

$V_g = 30.05\,(3X .0141)^{0.25}\,(.0023)^{0.375}$

= 1.40 FT/SEC

I = from IDF curve = 4.5 IN/HR

Q = 0.9 (4.5 - 0.2) 0.11

= 0.43 CFS

DRAINAGE AREA (17) LOCATION: INTERSECTION OF 71st & CACTUS (S½)

ZONING: 100% IMPERVIOUS

L = ______ = ______ FT

Ai = (___ x ___) / 43560 = 0.11 AC (SEE (16))

$T_c = \frac{L}{60V_g} = \frac{43+85}{60 \times 1.56} = 1.37$ MIN

= 10 MINUTES (MIN)

Sc = CROSS SLOPE = 0.0234

So = GUTTER SLOPE = 0.0022

n = 0.015 FOR ASPHALT

$V_g = 30.05\,(3X .0234)^{0.25}\,(.0022)^{0.375}$

= 1.56 FT/SEC

I = from IDF curve = 4.5 IN/HR

Q = 0.9 (4.5 - 0.2) 0.11

= 0.43 CFS

DRAINAGE AREA (18) LOCATION: N½ OF ROW & BASIN AL

ZONING: ~~100% IMPERVIOUS~~ See Hydrology Report

~~L = ___ = ___ FT~~

~~$T_c = \frac{L}{60V_g}$ = ___~~

~~= 10 MINUTES (MIN)~~

~~Ai = $\frac{\_\_\_ \times \_\_\_}{43560}$ = ___ AC~~

~~Sc = CROSS SLOPE = ___~~

~~I = from IDF curve = 4.5 IN/HR~~

~~So = GUTTER SLOPE = ___~~

~~Q = 0.9 (4.5 - 0.2) ___~~

~~n = 0.015 FOR ASPHALT~~

~~= ___ CFS~~

~~$V_g = 30.05\ (3X\_\_\_)^{0.25}\ (\_\_\_)^{0.375}$~~

~~= ___ FT/SEC~~

Q= 4CFS FROM HEC MODEL (SEE ATTACHED TABLE)

DRAINAGE AREA (19) LOCATION: S½ OF ROW 153+37–150+51

ZONING: 100% IMPERVIOUS

L = 153+37 - 150+51 = 286 FT

$T_c = \frac{L}{60V_g} = \frac{286}{60 \times 1.92} = 2.48$ MIN

= 10 MINUTES (MIN)

Ai = $\frac{286 \times 55}{43560}$ = 0.36 AC

Sc = CROSS SLOPE = 0.0177

I = from IDF curve = 4.5 IN/HR

So = GUTTER SLOPE = 0.0046

Q = 0.9 (4.5 - 0.2) 0.36

n = 0.015 FOR ASPHALT

= 1.40 CFS

$V_g = 30.05\ (3X.0177)^{0.25}\ (.0046)^{0.375}$

= 1.92 FT/SEC

DRAINAGE AREA (20) — LOCATION: N½ OF ROW 150+51 TO 146+20

ZONING: 100% IMPERVIOUS

L = 150+51 − 146+20 = 431 FT — $T_c = \frac{L}{60V_g} = \frac{431}{60 \times 1.86} = 3.86$ MIN = 10 MINUTES (MIN)

Ai = $\frac{431 \times 55}{43560}$ = 0.54 AC

Sc = CROSS SLOPE = 0.0219 — I = from IDF curve = 4.5 IN/HR

So = GUTTER SLOPE = 0.0037 — Q = 0.9 (4.5 - 0.2) 0.54 = 2.11 CFS

n = 0.015 FOR ASPHALT

$V_g = 30.05\,(3X.0219)^{0.25}\,(.0037)^{0.375}$

= 1.86 FT/SEC

DRAINAGE AREA (21) — LOCATION: S½ OF ROW 150+51 − 146+20

ZONING: 100% IMPERVIOUS

L = 150+51 − 146+20 = 431 FT — $T_c = \frac{L}{60V_g} = \frac{431}{60 \times 1.99} = 3.61$ MIN = 10 MINUTES (MIN)

Ai = $\frac{431 \times 55}{43560}$ = 0.54 AC

Sc = CROSS SLOPE = 0.0235 — I = from IDF curve = 4.5 IN/HR

So = GUTTER SLOPE = 0.0042 — Q = 0.9 (4.5 - 0.2) 0.54 = 2.11 CFS

n = 0.015 FOR ASPHALT

$V_g = 30.05\,(3X.0235)^{0.25}\,(.0042)^{0.375}$

= 1.99 FT/SEC

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DRAINAGE AREA (22)

LOCATION: N½ OF ROW 146+20 – 142+41

ZONING: 100% IMPERVIOUS

L = 146+20 − 142+41 = 379 FT

$T_c = \frac{L}{60V_g} = \frac{379}{60 \times 1.70} = 3.72$ MIN

= 10 MINUTES (MIN)

$Ai = \frac{379 \times 55}{43560} = 0.48$ AC

Sc = CROSS SLOPE = 0.0313

I = from IDF curve = 4.5 IN/HR

So = GUTTER SLOPE = 0.0023

Q = 0.9 (4.5 - 0.2) 0.48

= 1.85 CFS

n = 0.015 FOR ASPHALT

$V_g = 30.05\,(3 \times .0313)^{0.25}\,(.0023)^{0.375}$

= 1.70 FT/SEC

DRAINAGE AREA (23)

LOCATION: S½ OF ROW 146+20 – 142+04

ZONING: 100% IMPERVIOUS

L = 146+20 − 142+04 = 416 FT

$T_c = \frac{L}{60V_g} = \frac{416}{60 \times 1.86} = 3.7$ MIN

= 10 MINUTES (MIN)

$Ai = \frac{416 \times 55}{43560} = 0.53$ AC

Sc = CROSS SLOPE = 0.0313

I = from IDF curve = 4.5 IN/HR

So = GUTTER SLOPE = 0.0029

Q = 0.9 (4.5 - 0.2) 0.53

= 2.03 CFS

n = 0.015 FOR ASPHALT

$V_g = 30.05\,(3 \times .0313)^{0.25}\,(.0029)^{0.375}$

= 1.86 FT/SEC

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DRAINAGE AREA (24) LOCATION: 1/2 OF BASIN AK

ZONING: ~~100% IMPERVIOUS~~ See Hydrology Report

L = ______ = ______ FT $T_C = \frac{L}{60V_g}$ = ______

= 10 MINUTES (MIN)

Ai = $\frac{\_\_\_ x \_\_\_}{43560}$ = ______ AC

Sc = CROSS SLOPE = ______ I = from IDF curve = 4.5 IN/HR

So = GUTTER SLOPE = ______ Q = 0.9 (4.5 - 0.2) ______

n = 0.015 FOR ASPHALT = ______ CFS

V_g = 30.05 (3X____)$^{0.25}$ (______)$^{0.375}$

= ______ FT/SEC

Q= 85 CFS/2 = 42.5 CFS FROM HEC MODEL (SEE ATTACHED TABLE)

DRAINAGE AREA (25) LOCATION: 1/2 OF BASIN AK

ZONING: ~~100% IMPERVIOUS~~ See Hydrology Report

L = ______ = ______ FT $T_C = \frac{L}{60V_g}$ = ______

= 10 MINUTES (MIN)

Ai = $\frac{\_\_\_ x \_\_\_}{43560}$ = ______ AC

Sc = CROSS SLOPE = ______ I = from IDF curve = 4.5 IN/HR

So = GUTTER SLOPE = ______ Q = 0.9 (4.5 - 0.2) ______

n = 0.015 FOR ASPHALT = ______ CFS

V_g = 30.05 (3X____)$^{0.25}$ (______)$^{0.375}$

= ______ FT/SEC

Q= 42.5 CFS FROM HEC MODEL (SEE ATTACHED TABLE)

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DRAINAGE AREA (26)

LOCATION: N½ OF 72nd DR & CACTUS INTERSECT

ZONING: 100% IMPERVIOUS

L = ______ = ______ FT

$T_c = \frac{L}{60V_g}$ = ______

= 10 MINUTES (MIN)

Ai = ______ x ______ / 43560 = ______ AC

Sc = CROSS SLOPE = ______

I = from IDF curve = 4.5 IN/HR

So = GUTTER SLOPE = ______

Q = 0.9 (4.5 - 0.2) ______

n = 0.015 FOR ASPHALT

= ______ CFS

$V_g = 30.05\,(3X\_\_\_\_)^{0.25}\,(\_\_\_\_)^{0.375}$

= ______ FT/SEC

ASSUME Q = 1 CFS BECAUSE ROW DRAINAGE AREA IS SO SMALL

DRAINAGE AREA ______

LOCATION: ______

ZONING: ______

L = ______ = ______ FT

$T_c = \frac{L}{60V_g}$ = ______

= 10 MINUTES (MIN)

Ai = ______ x ______ / 43560 = ______ AC

Sc = CROSS SLOPE = ______

I = from IDF curve = 4.5 IN/HR

So = GUTTER SLOPE = ______

Q = 0.9 (4.5 - 0.2) ______

n = 0.015 FOR ASPHALT

= ______ CFS

$V_g = 30.05\,(3X\_\_\_\_)^{0.25}\,(\_\_\_\_)^{0.375}$

= ______ FT/SEC

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DRAINAGE AREA (27) LOCATION: BASIN AJ

ZONING: ~~100% IMPERVIOUS~~ See Hydrology Report

L = = ______ FT $T_C = \frac{L}{60V_g}$ = ______

= 10 MINUTES (MIN)

Ai = $\frac{\_\_\_ x \_\_\_}{43560}$ = ______ AC

Sc = CROSS SLOPE = ______ I = from IDF curve = 4.5 IN/HR

So = GUTTER SLOPE = ______ Q = 0.9 (4.5 - 0.2) ______

n = 0.015 FOR ASPHALT = ______ CFS

V_g = 30.05 (3X____)$^{0.25}$ (______)$^{0.375}$

= ______ FT/SEC

Q = 15CFS/2 = 7.5CFS From HEC MODEL (SEE ATTACHED TABLE)

(ASSUME FLOW ALONG 73rd IS AQUALLY SPLIT SINCE CROWN IS ONLY 0.2' ABOVE GUTTER)

DRAINAGE AREA (28) LOCATION: BASIN AJ

ZONING: ~~100% IMPERVIOUS~~ See Hydrology Report

L = = ______ FT $T_C = \frac{L}{60V_g}$ = ______

= 10 MINUTES (MIN)

Ai = $\frac{\_\_\_ x \_\_\_}{43560}$ = ______ AC

Sc = CROSS SLOPE = ______ I = from IDF curve = 4.5 IN/HR

So = GUTTER SLOPE = ______ Q = 0.9 (4.5 - 0.2) ______

n = 0.015 FOR ASPHALT = ______ CFS

V_g = 30.05 (3X____)$^{0.25}$ (______)$^{0.375}$

= ______ FT/SEC

Q = 15CFS/2 = 7.5CFS FROM HEC MODEL (SEE ATTACHED TABLE)

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DRAINAGE AREA (29)

LOCATION: N½ OF ROW 141+55 – 136+74

ZONING: 100% IMPERVIOUS

L = 141+55 – 136+74 = 481 FT

$T_c = \frac{L}{60V_g} = \frac{481}{60 \times 1.21} = 6.63$ MIN
= 10 MINUTES (MIN)

$Ai = \frac{481 \times 55}{43560} = 0.61$ AC

Sc = CROSS SLOPE = 0.0188

I = from IDF curve = 4.5 IN/HR

So = GUTTER SLOPE = 0.0013

Q = 0.9 (4.5 - 0.2) 0.61
= 2.35 CFS

n = 0.015 FOR ASPHALT

$V_g = 30.05\ (3X.0188)^{0.25}\ (.0013)^{0.375}$
= 1.21 FT/SEC

DRAINAGE AREA (30)

LOCATION: S½ OF ROW 142+04 – 136+68

ZONING: 100% IMPERVIOUS

L = 142+04 – 136+68 = 536 FT

$T_c = \frac{L}{60V_g} = \frac{536}{60 \times 1.84} = 4.85$ MIN
= 10 MINUTES (MIN)

$Ai = \frac{536 \times 55}{43560} = 0.68$ AC

Sc = CROSS SLOPE = 0.0250

I = from IDF curve = 4.5 IN/HR

So = GUTTER SLOPE = 0.0033

Q = 0.9 (4.5 - 0.2) 0.68
= 2.62 CFS

n = 0.015 FOR ASPHALT

$V_g = 30.05\ (3X.0250)^{0.25}\ (.0033)^{0.375}$
= 1.84 FT/SEC

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DRAINAGE AREA (31)

LOCATION: N 1/2 OF ROW 136+74 - 131+50

ZONING: 100% IMPERVIOUS

L = 136+74 - 131+50 = 524 FT

$T_c = \frac{L}{60V_g} = \frac{524}{60 \times 1.33} = 6.6$ MIN

= 10 MINUTES (MIN)

$Ai = \frac{524 \times 55}{43560} = 0.66$ AC

Sc = CROSS SLOPE = 0.0167

So = GUTTER SLOPE = 0.0018

n = 0.015 FOR ASPHALT

$V_g = 30.05\ (3X\ .0167)^{0.25}\ (.0018)^{0.375}$

= 1.33 FT/SEC

I = from IDF curve = 4.5 IN/HR

Q = 0.9 (4.5 - 0.2) 0.66

= 2.56 CFS

DRAINAGE AREA (32)

LOCATION: S 1/2 OF ROW 136+68 - 131+50

ZONING: 100% IMPERVIOUS

L = 136+68 - 131+50 = 518 FT

$T_c = \frac{L}{60V_g} = \frac{518}{60 \times 1.18} = 7.31$ MIN

= 10 MINUTES (MIN)

$Ai = \frac{518 \times 55}{43560} = 0.65$ AC

Sc = CROSS SLOPE = 0.0170

So = GUTTER SLOPE = 0.0013

n = 0.015 FOR ASPHALT

$V_g = 30.05\ (3X\ .0170)^{0.25}\ (.0013)^{0.375}$

= 1.18 FT/SEC

I = from IDF curve = 4.5 IN/HR

Q = 0.9 (4.5 - 0.2) 0.65

= 2.53 CFS

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DRAINAGE AREA (33)

LOCATION: N½ OF ROW 131+30 - 128+10

ZONING: 100% IMPERVIOUS

L = 131+30 - 128+10 = 320 FT

$T_c = \frac{L}{60V_g} = \frac{320}{60 \times 1.93} = 2.76$ MIN

= 10 MINUTES (MIN)

$Ai = \frac{320 \times 55}{43560} = 0.40$ AC

Sc = CROSS SLOPE = 0.0156

I = from IDF curve = 4.5 IN/HR

So = GUTTER SLOPE = 0.0051

Q = 0.9 (4.5 - 0.2) 0.40

= 1.56 CFS

n = 0.015 FOR ASPHALT

$V_g = 30.05\,(3X.0156)^{0.25}\,(.0051)^{0.375}$

= 1.93 FT/SEC

DRAINAGE AREA (34)

LOCATION: S½ OF ROW 131+30 - 128+10

ZONING: 100% IMPERVIOUS

L = 131+30 - 128+10 = 320 FT

$T_c = \frac{L}{60V_g} = \frac{320}{60 \times 2.22}$

= 10 MINUTES (MIN)

$Ai = \frac{320 \times 55}{43560} = 0.40$ AC

Sc = CROSS SLOPE = 0.0125

I = from IDF curve = 4.5 IN/HR

So = GUTTER SLOPE = 0.0086

Q = 0.9 (4.5 - 0.2) 0.40

= 1.56 CFS

n = 0.015 FOR ASPHALT

$V_g = 30.05\,(3X.0125)^{0.25}\,(.0086)^{0.375}$

= 2.22 FT/SEC

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DRAINAGE AREA (35) LOCATION: 1/2 BASIN AH & AG

ZONING: ~~100% IMPERVIOUS~~ See Hydrology Report

~~L = ___ = ___ FT~~ ~~$T_c = \frac{L}{60V_g}$ = ___ = 10 MINUTES (MIN)~~

~~$Ai = \frac{\_\_\_ x \_\_\_}{43560}$ = ___ AC~~

~~Sc = CROSS SLOPE = ___~~ ~~I = from IDF curve = 4.5 IN/HR~~

~~So = GUTTER SLOPE = ___~~ ~~Q = 0.9 (4.5 - 0.2) ___ = ___ CFS~~

~~n = 0.015 FOR ASPHALT~~

~~$V_g = 30.05\ (3X\_\_\_)^{0.25}\ (\_\_\_)^{0.375}$ = ___ FT/SEC~~

Q = 30 CFS From HEC MODEL (SEE ATTACHED TABLE)

DRAINAGE AREA (36) LOCATION: 1/2 BASIN AH & AG

ZONING: ~~100% IMPERVIOUS~~ See Hydrology Report

~~L = ___ = ___ FT~~ ~~$T_c = \frac{L}{60V_g}$ = ___ = 10 MINUTES (MIN)~~

~~$Ai = \frac{\_\_\_ x \_\_\_}{43560}$ = ___ AC~~

~~Sc = CROSS SLOPE = ___~~ ~~I = from IDF curve = 4.5 IN/HR~~

~~So = GUTTER SLOPE = ___~~ ~~Q = 0.9 (4.5 - 0.2) ___ = ___ CFS~~

~~n = 0.015 FOR ASPHALT~~

~~$V_g = 30.05\ (3X\_\_\_)^{0.25}\ (\_\_\_)^{0.375}$ = ___ FT/SEC~~

Q = 0.0 CFS @ THIS TIME.

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DRAINAGE AREA (37)

LOCATION: N 1/2 OF ROW @ INTER OF 75th & CACTUS

ZONING: 100% IMPERVIOUS

L = ________ = ________ FT

$T_c = \frac{L}{60V_g}$ = ________

= 10 MINUTES (MIN)

Ai = $\frac{\_\_\_\_ x \_\_\_\_}{43560}$ = ________ AC

Sc = CROSS SLOPE = ________

I = from IDF curve = 4.5 IN/HR

So = GUTTER SLOPE = ________

Q = 0.9 (4.5 - 0.2) ________

n = 0.015 FOR ASPHALT

= ________ CFS

V_g = 30.05 (3X____)$^{0.25}$ (________)$^{0.375}$

= ________ FT/SEC

ASSUMED Q = 1.0 CFS BECAUSE AREA OF DRAINAGE SO SMALL

DRAINAGE AREA (38)

LOCATION: S 1/2 OF ROW @ INTER OF 75th & CACTUS

ZONING: 100% IMPERVIOUS

L = ________ = ________ FT

$T_c = \frac{L}{60V_g}$ = ________

= 10 MINUTES (MIN)

Ai = $\frac{\_\_\_\_ x \_\_\_\_}{43560}$ = ________ AC

Sc = CROSS SLOPE = ________

I = from IDF curve = 4.5 IN/HR

So = GUTTER SLOPE = ________

Q = 0.9 (4.5 - 0.2) ________

n = 0.015 FOR ASPHALT

= ________ CFS

V_g = 30.05 (3X____)$^{0.25}$ (________)$^{0.375}$

= ________ FT/SEC

ASSUMED Q = 1.0 CFS BECAUSE DRAINAGE AREA IS SO SMALL.

DRAINAGE AREA (39)

LOCATION: N½ OF ROW 126+48 - 119+50

ZONING: 100% IMPERVIOUS

L = 126+48 - 119+50 = 698 FT

$T_c = \frac{L}{60V_g} = \frac{698}{60 \times 1.65} = 7.05$ MIN

= 10 MINUTES (MIN)

$Ai = \frac{698 \times 55}{43560} = 0.88$ AC

Sc = CROSS SLOPE = 0.0169

I = from IDF curve = 4.5 IN/HR

So = GUTTER SLOPE = 0.0032

Q = 0.9 (4.5 - 0.2) 0.88

= 3.41 CFS

n = 0.015 FOR ASPHALT

$V_g = 30.05\,(3 \times .0169)^{0.25}\,(.0032)^{0.375}$

= 1.65 FT/SEC

DRAINAGE AREA (40)

LOCATION: S½ OF ROW 126+48 - 119+50

ZONING: 100% IMPERVIOUS

L = 126+48 - 119+50 = 698 FT

$T_c = \frac{L}{60V_g} = \frac{698}{60 \times 1.57} = 7.4$ MIN

= 10 MINUTES (MIN)

$Ai = \frac{698 \times 55}{43560} = 0.88$ AC

Sc = CROSS SLOPE = 0.0137

I = from IDF curve = 4.5 IN/HR

So = GUTTER SLOPE = 0.0032

Q = 0.9 (4.5 - 0.2) 0.88

= 3.41 CFS

n = 0.015 FOR ASPHALT

$V_g = 30.05\,(3 \times .0137)^{0.25}\,(.0032)^{0.375}$

= 1.57 FT/SEC

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DRAINAGE AREA (41) LOCATION: N 1/2 ROW OF BASIN AC

ZONING: ~~100% IMPERVIOUS~~ See Hydrology Report

L = ______ = ______ FT $T_c = \frac{L}{60V_g}$ = ______

= 10 MINUTES (MIN)

Ai = ______ x ______ / 43560 = ______ AC

Sc = CROSS SLOPE = ______ I = from IDF curve = 4.5 IN/HR

So = GUTTER SLOPE = ______ Q = 0.9 (4.5 - 0.2) ______

n = 0.015 FOR ASPHALT = ______ CFS

$V_g = 30.05 (3X\_\_\_)^{0.25} (\_\_\_)^{0.375}$

= ______ FT/SEC

Q = 7 CFS From HEC MODEL (SEE ATTACHED TABLE)

DRAINAGE AREA (42) LOCATION: N 1/2 Row 115+58 – 112+00

ZONING: 100% IMPERVIOUS

L = 115+58 – 112+00 = 358 FT $T_c = \frac{L}{60V_g} = \frac{358}{60 \times 1.85}$ = 3.23 MIN

= 10 MINUTES (MIN)

Ai = 358 x 55 / 43560 = 0.45 AC

Sc = CROSS SLOPE = 0.0212 I = from IDF curve = 4.5 IN/HR

So = GUTTER SLOPE = 0.0032 Q = 0.9 (4.5 - 0.2) 0.45

n = 0.015 FOR ASPHALT = 1.75 CFS

$V_g = 30.05 (3X.0212)^{0.25} (.0032)^{0.375}$

= 1.85 FT/SEC

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DRAINAGE AREA (43)

LOCATION: S 1/2 OF ROW 119+50 – 112+00

ZONING: 100% IMPERVIOUS

L = 119+50 – 112+00 = 750 FT

$T_C = \frac{L}{60V_g} = \frac{750}{60 \times 1.69} = 7.4$ MIN

= 10 MINUTES (MIN)

$Ai = \frac{750 \times 55}{43560} = 0.95$ AC

Sc = CROSS SLOPE = 0.0182

I = from IDF curve = 4.5 IN/HR

So = GUTTER SLOPE = 0.0032

Q = 0.9 (4.5 - 0.2) 0.95

= 3.66 CFS

n = 0.015 FOR ASPHALT

$V_g = 30.05\,(3X.0182)^{0.25}\,(.0032)^{0.375}$

= 1.69 FT/SEC

DRAINAGE AREA ______

LOCATION: ______

ZONING: ______

L = ______ = ______ FT

$T_C = \frac{L}{60V_g} =$ ______

= 10 MINUTES (MIN)

$Ai = \frac{\_\_\_ \times \_\_\_}{43560} =$ ______ AC

Sc = CROSS SLOPE = ______

I = from IDF curve = 4.5 IN/HR

So = GUTTER SLOPE = ______

Q = 0.9 (4.5 - 0.2) ______

= ______ CFS

n = 0.015 FOR ASPHALT

$V_g = 30.05\,(3X\_\_\_)^{0.25}\,(\_\_\_)^{0.375}$

= ______ FT/SEC

DRAINAGE AREA (44)

LOCATION: N1/2 OF ROW 112+04 – 106+00

ZONING: 100% IMPERVIOUS

$L = 112{+}04 - 106{+}00 = 604$ FT

$Ai = \frac{604 \times 55}{43560} = 0.76$ AC

Sc = CROSS SLOPE = 0.0242

So = GUTTER SLOPE = 0.0032

n = 0.015 FOR ASPHALT

$V_g = 30.05\,(3 \times .0242)^{0.25}\,(.0032)^{0.375}$

$= 1.81$ FT/SEC

$T_c = \frac{L}{60V_g} = \frac{604}{60 \times 1.81} = 5.6$ MIN

= 10 MINUTES (MIN)

I = from IDF curve = 4.5 IN/HR

$Q = 0.9\,(4.5 - 0.2)\ 0.76$

$= 2.95$ CFS

DRAINAGE AREA (45)

LOCATION: S1/2 OF ROW 112+04 – 106+00

ZONING: 100% IMPERVIOUS

$L = 112{+}04 - 106{+}00 = 604$ FT

$Ai = \frac{604 \times 55}{43560} = 0.76$ AC

Sc = CROSS SLOPE = 0.0179

So = GUTTER SLOPE = 0.0032

n = 0.015 FOR ASPHALT

$V_g = 30.05\,(3 \times .0179)^{0.25}\,(.0032)^{0.375}$

$= 1.68$ FT/SEC

$T_c = \frac{L}{60V_g} = \frac{604}{60 \times 1.68}$

= 10 MINUTES (MIN)

I = from IDF curve = 4.5 IN/HR

$Q = 0.9\,(4.5 - 0.2)\ 0.76$

$= 2.95$ CFS

DRAINAGE AREA (46) LOCATION: N1/2 OF ROW 106+00-101+30

ZONING: 100% IMPERVIOUS

L = 106+00-101+30 = 470 FT

$T_c = \frac{L}{60V_g} = \frac{470}{60 \times 1.85} = 4.23$ MIN

= 10 MINUTES (MIN)

Ai = $\frac{470 \times 55}{43560}$ = 0.59 AC

Sc = CROSS SLOPE = 0.0266

I = from IDF curve = 4.5 IN/HR

So = GUTTER SLOPE = 0.0032

Q = 0.9 (4.5 - 0.2) 0.59

= 2.3 CFS

n = 0.015 FOR ASPHALT

$V_g = 30.05\ (3X.0266)^{0.25}\ (.0032)^{0.375}$

= 1.85 FT/SEC

DRAINAGE AREA (47) LOCATION: 1/2 OF BASIN X

ZONING: ~~100% IMPERVIOUS~~ see Hydrology Report

L = = ______ FT

$T_c = \frac{L}{60V_g}$ = ______

= 10 MINUTES (MIN)

Ai = $\frac{\_\_\_ \times \_\_\_}{43560}$ = ______ AC

Sc = CROSS SLOPE = ______

I = from IDF curve = 4.5 IN/HR

So = GUTTER SLOPE = ______

Q = 0.9 (4.5 - 0.2) ______

= ______ CFS

n = 0.015 FOR ASPHALT

$V_g = 30.05\ (3X\_\_\_)^{0.25}\ (\_\_\_)^{0.375}$

= ______ FT/SEC

Q = 49/2 CFS = 24.5 CFS From HEC MODEL (SEE ATTACHED TABLE)

DRAINAGE AREA (48)   LOCATION: 1/2 OF BASIN X

ZONING: ~~100% IMPERVIOUS~~ See Hydrologic Report

L = ___ = ___ FT $T_c = \frac{L}{60V_g}$ = ___

= 10 MINUTES (MIN)

Ai = $\frac{\_\_\_ x \_\_\_}{43560}$ = ___ AC

Sc = CROSS SLOPE = ___   I = from IDF curve = 4.5 IN/HR

So = GUTTER SLOPE = ___   Q = 0.9 (4.5 - 0.2) ___

n = 0.015 FOR ASPHALT   = ___ CFS

V_g = 30.05 (3X___)$^{0.25}$ (___)$^{0.375}$

= ___ FT/SEC

Q = 49/2 CFS = 24.5 CFS From HEC MODEL (SEE ATTACHED TABLE)

DRAINAGE AREA (49)   LOCATION: N1/2 OF 79th & CACTUS INTERSECTION

ZONING: 100% IMPERVIOUS

L = ___ = ___ FT $T_c = \frac{L}{60V_g}$ = ___

= 10 MINUTES (MIN)

Ai = $\frac{\_\_\_ x \_\_\_}{43560}$ = ___ AC

Sc = CROSS SLOPE = ___   I = from IDF curve = 4.5 IN/HR

So = GUTTER SLOPE = ___   Q = 0.9 (4.5 - 0.2) ___

n = 0.015 FOR ASPHALT   = ___ CFS

V_g = 30.05 (3X___)$^{0.25}$ (___)$^{0.375}$

= ___ FT/SEC

ASSUME Q = 1.0 CFS BECAUSE BASIN IS SO SMALL.

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DRAINAGE AREA (50)

LOCATION: S 1/2 OF ROW 106+00 - 99+78

ZONING: 100% IMPERVIOUS

L = 106+00 - 99+78 = 622 FT

$T_c = \frac{L}{60V_g} = \frac{622}{60 \times 1.82} = 5.7$ MIN

= 10 MINUTES (MIN)

Ai = $\frac{622 \times 55}{43560}$ = 0.79 AC

Sc = CROSS SLOPE = 0.0200

I = from IDF curve = 4.5 IN/HR

So = GUTTER SLOPE = 0.0037

Q = 0.9 (4.5 - 0.2) 0.79

= 3.04 CFS

n = 0.015 FOR ASPHALT

$V_g = 30.05\,(3X.0200)^{0.25}\,(.0037)^{0.375}$

= 1.82 FT/SEC

DRAINAGE AREA ( )

LOCATION: ______

ZONING: ______

L = ______ = ______ FT

$T_c = \frac{L}{60V_g}$ = ______

= 10 MINUTES (MIN)

Ai = $\frac{\_\_\_ \times \_\_\_}{43560}$ = ______ AC

Sc = CROSS SLOPE = ______

I = from IDF curve = 4.5 IN/HR

So = GUTTER SLOPE = ______

Q = 0.9 (4.5 - 0.2) ______

= ______ CFS

n = 0.015 FOR ASPHALT

$V_g = 30.05\,(3X\_\_\_)^{0.25}\,(\_\_\_)^{0.375}$

= ______ FT/SEC

DRAINAGE AREA (51) LOCATION: N½ OF ROW 99+78 - 94+00

ZONING: 100% IMPERVIOUS

L = 99+78 - 94+00 = 578 FT

$T_c = \frac{L}{60V_g} = \frac{578}{60 \times 1.40}$ = 10 MINUTES (MIN)

Ai = $\frac{578 \times 55}{43560}$ = 0.73 AC

Sc = CROSS SLOPE = 0.0189

So = GUTTER SLOPE = 0.0019

n = 0.015 FOR ASPHALT

I = from IDF curve = 4.5 IN/HR

Q = 0.9 (4.5 - 0.2) 0.73 = 2.82 CFS

$V_g = 30.05\ (3X.0189)^{0.25}\ (.0019)^{0.375}$ = 1.40 FT/SEC

DRAINAGE AREA (52) LOCATION: S½ OF ROW 99+78 - 94+00

ZONING: 100% IMPERVIOUS

L = 99+78 - 94+00 = 578 FT

$T_c = \frac{L}{60V_g} = \frac{578}{60 \times 1.35}$ = 10 MINUTES (MIN)

Ai = $\frac{578 \times 55}{43560}$ = 0.73 AC

Sc = CROSS SLOPE = 0.0158

So = GUTTER SLOPE = 0.0019

n = 0.015 FOR ASPHALT

I = from IDF curve = 4.5 IN/HR

Q = 0.9 (4.5 - 0.2) 0.73 = 2.82 CFS

$V_g = 30.05\ (3X.0158)^{0.25}\ (.0019)^{0.375}$ = 1.35 FT/SEC

DRAINAGE AREA (53)

LOCATION: N 1/2 OF ROW 94+00 – 87+70

ZONING: 100% IMPERVIOUS

$L = 94+00 - 87+70 = 630$ FT

$T_c = \frac{L}{60V_g} = \frac{630}{60 \times 1.28} = 8.2$ MIN

= 10 MINUTES (MIN)

$Ai = \frac{630 \times 55}{43560} = 0.80$ AC

Sc = CROSS SLOPE = 0.0131

I = from IDF curve = 4.5 IN/HR

So = GUTTER SLOPE = 0.0019

Q = 0.9 (4.5 - 0.2) 0.80

= 3.08 CFS

n = 0.015 FOR ASPHALT

$V_g = 30.05\,(3X.0131)^{0.25}\,(.0019)^{0.375}$

= 1.28 FT/SEC

DRAINAGE AREA (54)

LOCATION: S 1/2 OF ROW 94+00 – 87+70

ZONING: 100% IMPERVIOUS

$L = 94+00 - 87+70 = 630$ FT

$T_c = \frac{L}{60V_g} = \frac{630}{60 \times 1.06} = 9.9$ MIN

= 10 MINUTES (MIN)

$Ai = \frac{630 \times 55}{43560} = 0.80$ AC

Sc = CROSS SLOPE = 0.0099

I = from IDF curve = 4.5 IN/HR

So = GUTTER SLOPE = 0.0014

Q = 0.9 (4.5 - 0.2) 0.80

= 3.08 CFS

n = 0.015 FOR ASPHALT

$V_g = 30.05\,(3X.0099)^{0.25}\,(.0014)^{0.375}$

= 1.06 FT/SEC

DRAINAGE AREA (55)   LOCATION: 1/2 OF BASIN T

ZONING: ~~100% IMPERVIOUS~~ See Hydro Report

L = ________ = ________ FT $T_C = \frac{L}{60V_g}$ = ________

= 10 MINUTES (MIN)

Ai = ________ x ________ / 43560 = ________ AC

Sc = CROSS SLOPE = ________   I = from IDF curve = 4.5 IN/HR

So = GUTTER SLOPE = ________   Q = 0.9 (4.5 - 0.2) ________

n = 0.015 FOR ASPHALT   = ________ CFS

V_g = 30.05 (3X____)$^{0.25}$ (________)$^{0.375}$

= ________ FT/SEC

Q= 73/2 CFS = 36.5 CFS From HEC MODEL (SEE ATTACHED TABLE)

DRAINAGE AREA (56)   LOCATION: 1/2 BASIN T

ZONING: ~~100% IMPERVIOUS~~ See Hydrology Report

L = ________ = ________ FT $T_C = \frac{L}{60V_g}$ = ________

= 10 MINUTES (MIN)

Ai = ________ x ________ / 43560 = ________ AC

Sc = CROSS SLOPE = ________   I = from IDF curve = 4.5 IN/HR

So = GUTTER SLOPE = ________   Q = 0.9 (4.5 - 0.2) ________

n = 0.015 FOR ASPHALT   = ________ CFS

V_g = 30.05 (3X____)$^{0.25}$ (________)$^{0.375}$

= ________ FT/SEC

Q=36.5 CFS From HEC MODEL (SEE ATTACHED TABLE)

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DRAINAGE AREA (57)

LOCATION: N 1/2 OF ROW OF 81 St & CACTUS INTERSECT

ZONING: 100% IMPERVIOUS

L = ______ = ______ FT

$T_c = \frac{L}{60V_g}$ = ______

= 10 MINUTES (MIN)

Ai = $\frac{\text{\_\_\_ x \_\_\_}}{43560}$ = ______ AC

Sc = CROSS SLOPE = ______

I = from IDF curve = 4.5 IN/HR

So = GUTTER SLOPE = ______

Q = 0.9 (4.5 - 0.2) ______

n = 0.015 FOR ASPHALT

= ______ CFS

$V_g = 30.05\,(3X\_\_\_)^{0.25}\,(\_\_\_)^{0.375}$

= ______ FT/SEC

Q = 1.0 CFS BECAUSE DRAINAGE AREA IS SO SMALL

DRAINAGE AREA (58)

LOCATION: S 1/2 OF ROW OF 81 St & CACTUS INTERS

ZONING: 100% IMPERVIOUS

L = ______ = ______ FT

$T_c = \frac{L}{60V_g}$ = ______

= 10 MINUTES (MIN)

Ai = $\frac{\text{\_\_\_ x \_\_\_}}{43560}$ = ______ AC

Sc = CROSS SLOPE = ______

I = from IDF curve = 4.5 IN/HR

So = GUTTER SLOPE = ______

Q = 0.9 (4.5 - 0.2) ______

n = 0.015 FOR ASPHALT

= ______ CFS

$V_g = 30.05\,(3X\_\_\_)^{0.25}\,(\_\_\_)^{0.375}$

= ______ FT/SEC

ASSUME Q = 1.0 CFS BECAUSE DRAINAGE AREA IS SO SMALL.

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DRAINAGE AREA (59)

LOCATION: N½ OF ROW 86+67 – 80+30

ZONING: 100% IMPERVIOUS

L = 86+67 – 80+30 = 637 FT

$T_c = \frac{L}{60V_g} = \frac{637}{60 \times 1.35} = 7.8$ MIN

= 10 MINUTES (MIN)

$Ai = \frac{637 \times 55}{43560} = 0.80$ AC

Sc = CROSS SLOPE = 0.0110

I = from IDF curve = 4.5 IN/HR

So = GUTTER SLOPE = 0.0025

Q = 0.9 (4.5 - 0.2) 0.80

= 3.11 CFS

n = 0.015 FOR ASPHALT

$V_g = 30.05\,(3X.0110)^{0.25}\,(.0025)^{0.375}$

= 1.35 FT/SEC

DRAINAGE AREA (60)

LOCATION: S½ OF ROW 86+67 – 80+30

ZONING: 100% IMPERVIOUS

L = 86+67 – 80+30 = 637 FT

$T_c = \frac{L}{60V_g} = \frac{637}{60 \times 1.48} = 7.2$ MIN

= 10 MINUTES (MIN)

$Ai = \frac{637 \times 55}{43560} = 0.80$ AC

Sc = CROSS SLOPE = 0.0127

I = from IDF curve = 4.5 IN/HR

So = GUTTER SLOPE = 0.0029

Q = 0.9 (4.5 - 0.2) 0.80

= 3.11 CFS

n = 0.015 FOR ASPHALT

$V_g = 30.05\,(3X.0127)^{0.25}\,(.0029)^{0.375}$

= 1.48 FT/SEC

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DRAINAGE AREA (61)

LOCATION: N 1/2 OF ROW 80+30 – 74+58

ZONING: 100% IMPERVIOUS

L = 80+30 - 74+58 = 572 FT

$T_c = \frac{L}{60V_g} = \frac{572}{60 \times 1.19} = 8.0$ MIN

= 10 MINUTES (MIN)

Ai = $\frac{572 \times 55}{43560}$ = 0.72 AC

Sc = CROSS SLOPE = 0.0065

So = GUTTER SLOPE = 0.0025

n = 0.015 FOR ASPHALT

I = from IDF curve = 4.5 IN/HR

Q = 0.9 (4.5 - 0.2) 0.72

= 2.80 CFS

$V_g = 30.05\ (3X .0065)^{0.25}\ (.0025)^{0.375}$

= 1.19 FT/SEC

DRAINAGE AREA ( )

LOCATION: ___

ZONING: ___

L = ___ = ___ FT

$T_c = \frac{L}{60V_g}$ = ___

= 10 MINUTES (MIN)

Ai = $\frac{\_\_ \times \_\_}{43560}$ = ___ AC

Sc = CROSS SLOPE = ___

So = GUTTER SLOPE = ___

n = 0.015 FOR ASPHALT

I = from IDF curve = 4.5 IN/HR

Q = 0.9 (4.5 - 0.2) ___

= ___ CFS

$V_g = 30.05\ (3X\_\_)^{0.25}\ (\_\_)^{0.375}$

= ___ FT/SEC

DRAINAGE AREA (62) LOCATION: 1/2 BASIN P & Q

ZONING: ~~100% IMPERVIOUS~~ See Hydrology Report

L = = ______ FT $T_c = \frac{L}{60V_g}$ = ______

= 10 MINUTES (MIN)

Ai = $\frac{\_\_\_ x \_\_\_}{43560}$ = ______ AC

Sc = CROSS SLOPE = ______ I = from IDF curve = 4.5 IN/HR

So = GUTTER SLOPE = ______ Q = 0.9 (4.5 - 0.2) ______

n = 0.015 FOR ASPHALT = ______ CFS

V_g = 30.05 (3X______)$^{0.25}$ (______)$^{0.375}$

= ______ FT/SEC

Q = 21/2 CFS = 10.5 CFS FROM HEC MODEL (SEE ATTACHED TABLE)

DRAINAGE AREA (63) LOCATION: 1/2 BASIN P & Q

ZONING: ~~100% IMPERVIOUS~~ See Hydrology Report

L = = ______ FT $T_c = \frac{L}{60V_g}$ = ______

= 10 MINUTES (MIN)

Ai = $\frac{\_\_\_ x \_\_\_}{43560}$ = ______ AC

Sc = CROSS SLOPE = ______ I = from IDF curve = 4.5 IN/HR

So = GUTTER SLOPE = ______ Q = 0.9 (4.5 - 0.2) ______

n = 0.015 FOR ASPHALT = ______ CFS

V_g = 30.05 (3X______)$^{0.25}$ (______)$^{0.375}$

= ______ FT/SEC

Q = 10.5 CFS FROM HEC MODEL (SEE ATTACHED TABLE)

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DRAINAGE AREA (64)

LOCATION: N½ OF ROW OF 83rd & CACTUS INTER.

ZONING: 100% IMPERVIOUS

L = ____ = ____ FT

$T_c = \frac{L}{60V_g}$ = ____

= 10 MINUTES (MIN)

Ai = ____ x ____ / 43560 = ____ AC

Sc = CROSS SLOPE = ____

I = from IDF curve = 4.5 IN/HR

So = GUTTER SLOPE = ____

Q = 0.9 (4.5 - 0.2) ____

n = 0.015 FOR ASPHALT

= ____ CFS

$V_g = 30.05\,(3X\_\_\_\_)^{0.25}\,(\_\_\_\_)^{0.375}$

= ____ FT/SEC

ASSUME Q = 1.0 CFS BECAUSE DRAINAGE AREA IS SO SMALL

DRAINAGE AREA (65)

LOCATION: S½ OF ROW 80+30 – 73+12

ZONING: ____

L = 80+30 – 73+12 = 718 FT

$T_c = \frac{L}{60V_g} = \frac{718}{60 \times 1.50}$

= 10 MINUTES (MIN)

Ai = 718 x 55 / 43560 = 0.91 AC

Sc = CROSS SLOPE = 0.0133

I = from IDF curve = 4.5 IN/HR

So = GUTTER SLOPE = 0.0029

Q = 0.9 (4.5 - 0.2) 0.91

n = 0.015 FOR ASPHALT

= 3.51 CFS

$V_g = 30.05\,(3X.0133)^{0.25}\,(.0029)^{0.375}$

= 1.50 FT/SEC

DRAINAGE AREA (66)

LOCATION: N 1/2 OF ROW 73+12 – 67+80

ZONING: 100% IMPERVIOUS

L = 73+12 − 67+80 = 532 FT

$T_c = \frac{L}{60V_g} = \frac{532}{60 \times 1.63} = 5.4$ MIN

= 10 MINUTES (MIN)

Ai = $\frac{532 \times 55}{43560}$ = 0.67 AC

Sc = CROSS SLOPE = 0.0168

I = from IDF curve = 4.5 IN/HR

So = GUTTER SLOPE = 0.0031

Q = 0.9 (4.5 - 0.2) 0.67

= 2.60 CFS

n = 0.015 FOR ASPHALT

$V_g = 30.05\,(3X.0168)^{0.25}\,(.0031)^{0.375}$

= 1.63 FT/SEC

DRAINAGE AREA (67)

LOCATION: S 1/2 OF ROW 73+12 – 67+80

ZONING: 100% IMPERVIOUS

L = 73+12 − 67+80 = 532 FT

$T_c = \frac{L}{60V_g} = \frac{532}{60 \times 1.46} = 6.1$ MIN

= 10 MINUTES (MIN)

Ai = $\frac{532 \times 55}{43560}$ = 0.67 AC

Sc = CROSS SLOPE = 0.0113

I = from IDF curve = 4.5 IN/HR

So = GUTTER SLOPE = 0.0030

Q = 0.9 (4.5 - 0.2) 0.67

= 2.60 CFS

n = 0.015 FOR ASPHALT

$V_g = 30.05\,(3X.0113)^{0.25}\,(.0030)^{0.375}$

= 1.46 FT/SEC

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DRAINAGE AREA (68) LOCATION: BASIN L APPROX 65+27

ZONING: ~~100% IMPERVIOUS~~ See Hydrology Report

L = = ______ FT $T_c = \frac{L}{60V_g}$ = ______

= 10 MINUTES (MIN)

Ai = $\frac{\_\_\_ x \_\_\_}{43560}$ = ______ AC

Sc = CROSS SLOPE = ______ I = from IDF curve = 4.5 IN/HR

So = GUTTER SLOPE = ______ Q = 0.9 (4.5 - 0.2) ______

n = 0.015 FOR ASPHALT = ______ CFS

V_g = 30.05 (3X_____)$^{0.25}$ (________)$^{0.375}$

= ______ FT/SEC

Q= 3.0 CFS From HEC MODEL (SEE ATTACHED TABLE)

DRAINAGE AREA ______ LOCATION: ______

ZONING: ______

L = = ______ FT $T_c = \frac{L}{60V_g}$ = ______

= 10 MINUTES (MIN)

Ai = $\frac{\_\_\_ x \_\_\_}{43560}$ = ______ AC

Sc = CROSS SLOPE = ______ I = from IDF curve = 4.5 IN/HR

So = GUTTER SLOPE = ______ Q = 0.9 (4.5 - 0.2) ______

n = 0.015 FOR ASPHALT = ______ CFS

V_g = 30.05 (3X_____)$^{0.25}$ (________)$^{0.375}$

= ______ FT/SEC

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DRAINAGE AREA (69) LOCATION: STA 62+87

ZONING: 100% IMPERVIOUS

L = ______ = ______ FT $T_c = \frac{L}{60V_g}$ = ______

= 10 MINUTES (MIN)

Ai = $\frac{\text{\_\_\_ x \_\_\_}}{43560}$ = ______ AC

Sc = CROSS SLOPE = ______ I = from IDF curve = 4.5 IN/HR

So = GUTTER SLOPE = ______ Q = 0.9 (4.5 - 0.2) ______

n = 0.015 FOR ASPHALT = ______ CFS

$V_g = 30.05\ (3X\_\_\_)^{0.25}\ (\_\_\_)^{0.375}$

= ______ FT/SEC

ASSUME Q = 1.0 CFS

DRAINAGE AREA (70) LOCATION: 1/2 BASIN K

ZONING: See Hydrology Report

L = ______ = ______ FT $T_c = \frac{L}{60V_g}$ = ______

= 10 MINUTES (MIN)

Ai = $\frac{\text{\_\_\_ x \_\_\_}}{43560}$ = ______ AC

Sc = CROSS SLOPE = ______ I = from IDF curve = 4.5 IN/HR

So = GUTTER SLOPE = ______ Q = 0.9 (4.5 - 0.2) ______

n = 0.015 FOR ASPHALT = ______ CFS

$V_g = 30.05\ (3X\_\_\_)^{0.25}\ (\_\_\_)^{0.375}$

= ______ FT/SEC

Q = 21/2 CFS = 10.5 CFS From HEC MODEL (SEE ATTACHED TABLE)

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DRAINAGE AREA (71) LOCATION: 1/2 BASIN K

ZONING: ~~100% IMPERVIOUS~~ See Hydrology Report

L = ______ = ______ FT $T_c = \frac{L}{60V_g}$ = ______

= 10 MINUTES (MIN)

Ai = $\frac{x}{43560}$ = ______ AC

Sc = CROSS SLOPE = ______ I = from IDF curve = 4.5 IN/HR

So = GUTTER SLOPE = ______ Q = 0.9 (4.5 - 0.2) ______

n = 0.015 FOR ASPHALT = ______ CFS

$V_g = 30.05\ (3X\_\_\_)^{0.25}\ (\_\_\_)^{0.375}$

= ______ FT/SEC

Q= 10.5 CFS From HEC MODEL (SEE ATTACHED TABLE)

DRAINAGE AREA (72) LOCATION: N1/2 OF ROW OF 85th & CACTUS

ZONING: 100% IMPERVIOUS

L = ______ = ______ FT $T_c = \frac{L}{60V_g}$ = ______

= 10 MINUTES (MIN)

Ai = $\frac{x}{43560}$ = ______ AC

Sc = CROSS SLOPE = ______ I = from IDF curve = 4.5 IN/HR

So = GUTTER SLOPE = ______ Q = 0.9 (4.5 - 0.2) ______

n = 0.015 FOR ASPHALT = ______ CFS

$V_g = 30.05\ (3X\_\_\_)^{0.25}\ (\_\_\_)^{0.375}$

= ______ FT/SEC

ASSUME Q=1.0 CFS BECAUSE BASIN IS SO SMALL.

DRAINAGE AREA (73)

LOCATION: S½ OF ROW 67+80 – 61+17

ZONING: 100% IMPERVIOUS

L = 67+80 – 61+17 = 663 FT

$T_c = \frac{L}{60V_g} = \frac{663}{60 \times 1.83} = 6.0$ MIN

= 10 MINUTES (MIN)

$Ai = \frac{663 \times 55}{43560} = 0.84$ AC

Sc = CROSS SLOPE = 0.0280

I = from IDF curve = 4.5 IN/HR

So = GUTTER SLOPE = 0.0030

Q = 0.9 (4.5 - 0.2) 0.84

= 3.24 CFS

n = 0.015 FOR ASPHALT

$V_g = 30.05\,(3 \times .0280)^{0.25}\,(.0030)^{0.375}$

= 1.83 FT/SEC

DRAINAGE AREA ______

LOCATION: ______

ZONING: ______

L = ______ = ______ FT

$T_c = \frac{L}{60V_g}$ = ______

= 10 MINUTES (MIN)

$Ai = \frac{\_\_\_ \times \_\_\_}{43560}$ = ______ AC

Sc = CROSS SLOPE = ______

I = from IDF curve = 4.5 IN/HR

So = GUTTER SLOPE = ______

Q = 0.9 (4.5 - 0.2) ______

= ______ CFS

n = 0.015 FOR ASPHALT

$V_g = 30.05\,(3 \times \_\_\_)^{0.25}\,(\_\_\_)^{0.375}$

= ______ FT/SEC

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DRAINAGE AREA (74)

LOCATION: N½ OF ROW 61+17-54+40

ZONING: 100% IMPERVIOUS

L = 61+17-54+40 = 677 FT

$T_c = \frac{L}{60V_g} = \frac{677}{60 \times 1.80} = 6.3$ MIN

= 10 MINUTES (MIN)

$Ai = \frac{677 \times 55}{43560} = 0.85$ AC

Sc = CROSS SLOPE = 0.0249

I = from IDF curve = 4.5 IN/HR

So = GUTTER SLOPE = 0.0031

Q = 0.9 (4.5 - 0.2) 0.85

= 3.31 CFS

n = 0.015 FOR ASPHALT

$V_g = 30.05 (3X.0249)^{0.25} (.0031)^{0.375}$

= 1.80 FT/SEC

DRAINAGE AREA (75)

LOCATION: S½ OF ROW 61+17 TO 54+40

ZONING: 100% IMPERVIOUS

L = 61+17-54+40 = 677 FT

$T_c = \frac{L}{60V_g} = \frac{677}{60 \times 1.70} = 6.6$ MIN

= 10 MINUTES (MIN)

$Ai = \frac{677 \times 55}{43560} = 0.85$ AC

Sc = CROSS SLOPE = 0.0207

I = from IDF curve = 4.5 IN/HR

So = GUTTER SLOPE = 0.0030

Q = 0.9 (4.5 - 0.2) 0.85

= 3.31 CFS

n = 0.015 FOR ASPHALT

$V_g = 30.05 (3X.0207)^{0.25} (.0030)^{0.375}$

= 1.70 FT/SEC

DRAINAGE AREA (76) — LOCATION: N 1/2 ROW 54+40 – 48+14

ZONING: 100% IMPERVIOUS

L = 54+40 − 48+14 = 626 FT

$T_c = \frac{L}{60V_g} = \frac{626}{60 \times 1.80} = 5.8$ MIN

= 10 MINUTES (MIN)

$Ai = \frac{626 \times 55}{43560} = 0.79$ AC

Sc = CROSS SLOPE = 0.0250

I = from IDF curve = 4.5 IN/HR

So = GUTTER SLOPE = 0.0031

Q = 0.9 (4.5 - 0.2) 0.79

= 3.06 CFS

n = 0.015 FOR ASPHALT

$V_g = 30.05\,(3 \times .0250)^{0.25}\,(.0031)^{0.375}$

= 1.80 FT/SEC

DRAINAGE AREA (77) — LOCATION: 1/2 OF BASIN H

ZONING: ~~100% IMPERVIOUS~~ See Hydrology Report

~~L = ___ = ___ FT~~

~~$T_c = \frac{L}{60V_g}$ = ___~~

~~= 10 MINUTES (MIN)~~

~~$Ai = \frac{\_\_ \times \_\_}{43560}$ = ___ AC~~

~~Sc = CROSS SLOPE = ___~~

~~I = from IDF curve = 4.5 IN/HR~~

~~So = GUTTER SLOPE = ___~~

~~Q = 0.9 (4.5 - 0.2) ___~~

~~n = 0.015 FOR ASPHALT~~

~~= ___ CFS~~

~~$V_g = 30.05\,(3X\_\_)^{0.25}\,(\_\_)^{0.375}$~~

~~= ___ FT/SEC~~

$Q = \frac{2(46)}{3}$ CFS = 31 CFS From HEC Model (SEE ATTACHED TABLE)

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DRAINAGE AREA (78)

LOCATION: 1/2 OF BASIN H

ZONING: ~~100% IMPERVIOUS~~ See Hydrology Report

~~L = ___ = ___ FT~~

~~$T_C = \frac{L}{60V_g}$ = ___~~

~~= 10 MINUTES (MIN)~~

~~$Ai = \frac{\_\_\_ x \_\_\_}{43560}$ = ___ AC~~

~~Sc = CROSS SLOPE = ___~~

~~I = from IDF curve = 4.5 IN/HR~~

~~So = GUTTER SLOPE = ___~~

~~Q = 0.9 (4.5 - 0.2) ___~~

~~n = 0.015 FOR ASPHALT~~

~~= ___ CFS~~

~~$V_g = 30.05 (3X\_\_\_)^{0.25} (\_\_\_)^{0.375}$~~

~~= ___ FT/SEC~~

Q = 46/3 CFS = 15 CFS From HEC Model (SEE ATTACHED TABLE)

DRAINAGE AREA (79)

LOCATION: N 1/2 OF ROW OF 87th & CACTUS

ZONING: 100% IMPERVIOUS

~~L = ___ = ___ FT~~

~~$T_C = \frac{L}{60V_g}$ = ___~~

~~= 10 MINUTES (MIN)~~

~~$Ai = \frac{\_\_\_ x \_\_\_}{43560}$ = ___ AC~~

~~Sc = CROSS SLOPE = ___~~

~~I = from IDF curve = 4.5 IN/HR~~

~~So = GUTTER SLOPE = ___~~

~~Q = 0.9 (4.5 - 0.2) ___~~

~~n = 0.015 FOR ASPHALT~~

~~= ___ CFS~~

~~$V_g = 30.05 (3X\_\_\_)^{0.25} (\_\_\_)^{0.375}$~~

~~= ___ FT/SEC~~

ASSUME Q = 1.0 CFS BECAUSE DRAINAGE AREA IS SO SMALL.

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DRAINAGE AREA (80) LOCATION: S1/2 OF ROW 54+40 – 46+75

ZONING: 100% IMPERVIOUS

L = 54+40 – 46+75 = 765 FT

$T_c = \frac{L}{60V_g} = \frac{765}{60 \times 2.2} = 5.8$ MIN

= 10 MINUTES (MIN)

$Ai = \frac{765 \times 55}{43560} = 0.97$ AC

Sc = CROSS SLOPE = 0.0467

I = from IDF curve = 4.5 IN/HR

So = GUTTER SLOPE = 0.0035

Q = 0.9 (4.5 - 0.2) 0.97

= 3.74 CFS

n = 0.015 FOR ASPHALT

$V_g = 30.05\,(3X.0467)^{0.25}\,(.0035)^{0.375}$

= 2.2 FT/SEC

DRAINAGE AREA ( ) LOCATION: ______

ZONING: ______

L = ______ = ______ FT

$T_c = \frac{L}{60V_g}$ = ______

= 10 MINUTES (MIN)

$Ai = \frac{\_\_\_ \times \_\_\_}{43560}$ = ______ AC

Sc = CROSS SLOPE = ______

I = from IDF curve = 4.5 IN/HR

So = GUTTER SLOPE = ______

Q = 0.9 (4.5 - 0.2) ______

= ______ CFS

n = 0.015 FOR ASPHALT

$V_g = 30.05\,(3X\_\_\_)^{0.25}\,(\_\_\_)^{0.375}$

= ______ FT/SEC

DRAINAGE AREA (81)

LOCATION: N 1/2 OF ROW 46+75 - 40+70

ZONING: 100% IMPERVIOUS

L = 46+75 - 40+70 = 605 FT

$T_c = \frac{L}{60V_g} = \frac{605}{60 \times 1.24} = 8.1$ MIN

= 10 MINUTES (MIN)

$Ai = \frac{605 \times 55}{43560} = 0.76$ AC

Sc = CROSS SLOPE = 0.0409

So = GUTTER SLOPE = 0.0021

n = 0.015 FOR ASPHALT

I = from IDF curve = 4.5 IN/HR

Q = 0.9 (4.5 - 0.2) 0.76

= 2.96 CFS

$V_g = 30.05\ (3X.0409)^{0.25}\ (.0021)^{0.375}$

= 1.24 FT/SEC

DRAINAGE AREA (82)

LOCATION: S 1/2 OF ROW 46+75 - 40+70

ZONING: 100% IMPERVIOUS

L = 46+75 - 40+70 = 605 FT

$T_c = \frac{L}{60V_g} = \frac{605}{60 \times 1.38} = 7.3$ MIN

= 10 MINUTES (MIN)

$Ai = \frac{605 \times 55}{43560} = 0.76$ AC

Sc = CROSS SLOPE = 0.0458

So = GUTTER SLOPE = 0.0026

n = 0.015 FOR ASPHALT

I = from IDF curve = 4.5 IN/HR

Q = 0.9 (4.5 - 0.2) 0.76

= 2.96 CFS

$V_g = 30.05\ (3X.0458)^{0.25}\ (.0026)^{0.375}$

= 1.38 FT/SEC

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DRAINAGE AREA: (83) LOCATION: BASIN D

ZONING: ~~100% IMPERVIOUS~~ See Hydrology Report

~~L = ___ = ___ FT~~ ~~$T_c = \frac{L}{60V_g}$ = ___~~

~~= 10 MINUTES (MIN)~~

~~Ai = ___ x ___ / 43560 = ___ AC~~

~~Sc = CROSS SLOPE = ___~~ ~~I = from IDF curve = 4.5 IN/HR~~

~~So = GUTTER SLOPE = ___~~ ~~Q = 0.9 (4.5 - 0.2) ___~~

~~n = 0.015 FOR ASPHALT~~ ~~= ___ CFS~~

~~$V_g = 30.05\,(3X\_\_\_)^{0.25}\,(\_\_\_)^{0.375}$~~

~~= ___ FT/SEC~~

Q= 13CFS From HEC Model (SEE ATTACHED TABLE)

DRAINAGE AREA: (84) LOCATION: S½ OF ROW 40+70 – 34+65

ZONING: 100% IMPERVIOUS

L = 40+70 – 34+65 = 605 FT $T_c = \frac{L}{60V_g} = \frac{605}{60 \times 1.37} = 7.35$ MIN

= 10 MINUTES (MIN)

$Ai = \frac{605 \times 55}{43560}$ = 0.76 AC

Sc = CROSS SLOPE = 0.0448 I = from IDF curve = 4.5 IN/HR

So = GUTTER SLOPE = 0.0026 Q = 0.9 (4.5 - 0.2) 0.76

n = 0.015 FOR ASPHALT = 2.96 CFS

$V_g = 30.05\,(3X.0448)^{0.25}\,(.0026)^{0.375}$

= 1.37 FT/SEC

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DRAINAGE AREA (85)

LOCATION: N½ ROW 34+65 - 28+00

ZONING: 100% IMPERVIOUS

L = 34+65 - 28+00 = 665 FT

$T_c = \frac{L}{60V_g} = \frac{665}{60 \times 1.11} = 9.98$ MIN

= 10 MINUTES (MIN)

$Ai = \frac{665 \times 55}{43560} = 0.84$ AC

Sc = CROSS SLOPE = 0.0263

I = from IDF curve = 4.5 IN/HR

So = GUTTER SLOPE = 0.0021

Q = 0.9 (4.5 - 0.2) 0.84

= 3.25 CFS

n = 0.015 FOR ASPHALT

$V_g = 30.05\,(3X.0263)^{0.25}\,(.0021)^{0.375}$

= 1.11 FT/SEC

DRAINAGE AREA (86)

LOCATION: S½ OF ROW 34+65 - 28+00

ZONING: 100% IMPERVIOUS

L = 34+65 - 28+00 = 665 FT

$T_c = \frac{L}{60V_g} = \frac{665}{60 \times 1.36} = 8.1$ MIN

= 10 MINUTES (MIN)

$Ai = \frac{665 \times 55}{43560} = 0.84$ AC

Sc = CROSS SLOPE = 0.0438

I = from IDF curve = 4.5 IN/HR

So = GUTTER SLOPE = 0.0026

Q = 0.9 (4.5 - 0.2) 0.84

= 3.25 CFS

n = 0.015 FOR ASPHALT

$V_g = 30.05\,(3X.0438)^{0.25}\,(0.0026)^{0.375}$

= 1.36 FT/SEC

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DRAINAGE AREA ~~87~~ LOCATION: BASIN B

ZONING: ~~100% IMPERVIOUS~~ See Hydrology Report

~~L = ___ = ___ FT $T_c = \frac{L}{60V_g}$ = ___~~

~~= 10 MINUTES (MIN)~~

~~$Ai = \frac{\_\_\_ x \_\_\_}{43560}$ = ___ AC~~

~~Sc = CROSS SLOPE = ___ I = from IDF curve = 4.5 IN/HR~~

~~So = GUTTER SLOPE = ___ Q = 0.9 (4.5 - 0.2) ___~~

~~n = 0.015 FOR ASPHALT = ___ CFS~~

~~$V_g = 30.05\ (3X\_\_\_)^{0.25}\ (\_\_\_)^{0.375}$~~

~~= ___ FT/SEC~~

N/ 20cfs is the flow w/Sweetwater Lateral. Due to excessive flows, used 27cfs (the flow w/o sweetwater Lateral).

Q = ~~20~~ 27 cfs CFS From HEC Model (SEE ATTACHED TABLE)

DRAINAGE AREA 87 LOCATION: S½ ROW 28+00 - 21+86

ZONING: 100% IMPERVIOUS

L = 28+00 - 21+86 = 634 FT $T_c = \frac{L}{60V_g} = \frac{634}{60 \times 1.15} = 9.19$ MIN

= 10 MINUTES (MIN)

$Ai = \frac{634 \times 55}{43560}$ = 0.80 AC

Sc = CROSS SLOPE = 0.0200* I = from IDF curve = 4.5 IN/HR

So = GUTTER SLOPE = 0.0028 Q = 0.9 (4.5 - 0.2) 0.80

n = 0.015 FOR ASPHALT = 3.10 CFS

$V_g = 30.05\ (3X.0200)^{0.25}\ (.0028)^{0.375}$

= 1.15 FT/SEC

* ASSUMED 2% X-SLOPE FOR NEW PAVEMENT FOR NOW.

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DRAINAGE AREA (38) LOCATION: BASIN B

ZONING: SEE HYDROLOGY REPORT

L = ___ = ___ FT $T_c = \frac{L}{60V_g}$ = ___

= 10 MINUTES (MIN)

Ai = $\frac{\_\_ \times \_\_}{43560}$ = ___ AC

Sc = CROSS SLOPE = ___ I = from IDF curve = 4.5 IN/HR

So = GUTTER SLOPE = ___ Q = 0.9 (4.5 - 0.2) ___

n = 0.015 FOR ASPHALT = ___ CFS

$V_g = 30.05\,(3X\_\_\_)^{0.25}\,(\_\_\_)^{0.375}$

= ___ FT/SEC

* Area B, concentration point # 37, w/o Sweetwater Lateral, has a flow of 29 CFS.

Q = 29 CFS from HEC model.

DRAINAGE AREA ___ LOCATION: ___

ZONING: ___

L = ___ = ___ FT $T_c = \frac{L}{60V_g}$ = ___

= 10 MINUTES (MIN)

Ai = $\frac{\_\_ \times \_\_}{43560}$ = ___ AC

Sc = CROSS SLOPE = ___ I = from IDF curve = 4.5 IN/HR

So = GUTTER SLOPE = ___ Q = 0.9 (4.5 - 0.2) ___

n = 0.015 FOR ASPHALT = ___ CFS

$V_g = 30.05\,(3X\_\_\_)^{0.25}\,(\_\_\_)^{0.375}$

= ___ FT/SEC

DRAINAGE AREA (89)

LOCATION: N 1/2 OF ROW 21+50 – 20+45, NORTH along 91ST AV.

ZONING: 100% IMPERVIOUS

L = 21+50 to 20+45 + 91ST AREA NORTH = 770 FT

$T_c = \frac{L}{60V_g} = \frac{770}{60 \times 1.15} = 11.16$ MIN

= 10 MINUTES (MIN)

$A_i = \frac{770 \times ~~55~~ 33'}{43560}$ = 0.97 AC

Sc = CROSS SLOPE = 0.0200

I = from IDF curve = ~~4.5~~ 4.4 IN/HR

So = GUTTER SLOPE = 0.0028

Q = 0.9 (~~4.5~~ 4.4 - 0.2) 0.97

n = 0.015 FOR ASPHALT

= 3.67 CFS

V_g = ~~30.05~~ 21.12 $(3X .0200)^{0.25}$ $(.0028)^{0.375}$

= 1.15 FT/SEC

DRAINAGE AREA (90)

LOCATION: N 1/2 OF ROW 18+~~25~~ 34 – 20+45

ZONING: 100 % IMPERVIOUS

L = 20+45 – 18+25 = 220 FT

$T_c = \frac{L}{60V_g} = \frac{220}{60 \times 1.15} = 3.18$ MIN

= 10 MINUTES (MIN)

$A_i = \frac{220 \times 55}{43560}$ = 0.28 AC

Sc = CROSS SLOPE = 0.02

I = from IDF curve = 4.5 IN/HR

So = GUTTER SLOPE = 0.0028

Q = 0.9 (4.5 - 0.2) 0.28

n = 0.015 FOR ASPHALT

= 1.1 CFS

V_g = ~~30.05~~ 21.12 $(3X 0.02)^{0.25}$ $(0.0028)^{0.375}$

= 1.15 FT/SEC

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DRAINAGE AREA (91)

LOCATION: N ½ OF ROW ~~18+25~~ 18+34 - ~~15+80~~ 16+00

ZONING: 100% IMPERVIOUS

L = 18+25 - 15+80 = 245 FT

$T_c = \frac{L}{60V_g} = \frac{245}{60 \times 0.81} = 5.04$ MIN

= 10 MINUTES (MIN)

Ai = $\frac{245 \times 55}{43560}$ (33') = 0.19 AC

Sc = CROSS SLOPE = 0.0114

I = from IDF curve = 4.5 IN/HR

So = GUTTER SLOPE = 0.0016

Q = 0.9 (4.5 - 0.2) 0.19

= 0.7 CFS

n = 0.015 FOR ASPHALT

V_g = ~~30.05~~ 21.12 $(3 \times .0114)^{0.25}$ $(.0016)^{0.375}$

= 0.81 FT/SEC

DRAINAGE AREA (92)

LOCATION: N ½ OF ROW ~~15+80~~ 16+00 - ~~14+35~~ 14+80

ZONING: 100% IMPERVIOUS

L = 15+80 - 14+35 = 235 FT

$T_c = \frac{L}{60V_g} = \frac{235}{60 \times 0.79} = 5$ MIN

= 10 MINUTES (MIN)

Ai = $\frac{235 \times 55}{43560}$ = 0.3 AC

Sc = CROSS SLOPE = 0.0100*

I = from IDF curve = 4.5 IN/HR

So = GUTTER SLOPE = 0.0016

Q = 0.9 (4.5 - 0.2) 0.3

= 1.2 CFS

n = 0.015 FOR ASPHALT

V_g = ~~30.05~~ 21.12 $(3 \times .0100)^{0.25}$ $(.0016)^{0.375}$

= 0.79 FT/SEC

DRAINAGE AREA (93) LOCATION: 13+45, 22' RT

ZONING: 100% IMPERVIOUS

L = 13+45 − 21+86 = 841 FT

$T_c = \frac{L}{60V_g} = \frac{841}{60 \times 0.81} = 17.3$ min

= 10 MINUTES (MIN)

$Ai = \frac{841 \times 55}{43560} = 1.06$ AC

Sc = CROSS SLOPE = .0114

I = from IDF curve = ~~4.5~~ 3.5 IN/HR

So = GUTTER SLOPE = .0016

Q = 0.9 (~~4.5~~ 3.5 - 0.2) 1.06

= 3.2 CFS

n = 0.015 FOR ASPHALT

V_g = ~~30.05~~ 21.12 (3X .0114)$^{0.25}$ (.0016)$^{0.375}$

= 0.81 FT/SEC

DRAINAGE AREA (94) LOCATION: BASIN A

ZONING: ______

L = ______ = ______ FT

$T_c = \frac{L}{60V_g}$ = ______

= 10 MINUTES (MIN)

$Ai = \frac{\_\_\_ x \_\_\_}{43560}$ = ______ AC

Sc = CROSS SLOPE = ______

I = from IDF curve = 4.5 IN/HR

So = GUTTER SLOPE = ______

Q = 0.9 (4.5 - 0.2) ______

= ______ CFS

n = 0.015 FOR ASPHALT

V_g = 30.05 (3X ___)$^{0.25}$ (___)$^{0.375}$

= ______ FT/SEC

Q = 14 cfs (HEC-1 run)

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INLET (1A)

LOCATION: STA EXISTING 181+49 - 34.5 LT

V = EXIST= 6.17 FT

CAL'D RUNOFF = ______ CFS

L = 3.0 FT

FLOW BY ( ) = ______ CFS

PIPE = 15 IN

TOTAL Q = ______ CFS

SUMP = ______ IN

S_0 = AVE GUTTER SLOPE = ______ FT/FT

SPREAD = ______ FT

S_C = X-SLOPE AT BASIN = ______ FT/FT

INLET TYPE: EXIST M-1 L=3'

Z = ______, Z/n = ______

n = 0.015 for asphalt

Note: TIE EXIST INLET (1A) TO 60"⌀ Storm drain. Available head = 10.64' OK

From page 27 Y_g= ______ FT, V_g = ______ FT/SEC

DESIGN OF INLET

From page 40 Y_g = ______ FT, Q = ______ CFS, L = ______ FT

FLOWBY ______

DCB(MIN)=1.17+0.0233(______)^2 + ______ = ______ USE V = ______FT

HEAD

ELEV @ CURB = 82.47

HGL ELEV = 70.66

H = 11.81 - 1.17 = 10.64 FT

SUMP (Page 29)

Q/L = ______ CFS/FT

y_0/h = ______ FT/FT

h = ______ IN

y_0 = ______ IN

PIPE DESIGN

TOTAL H NEEDED = 0.0233(______)^2+(______)

= ______ FT

V(PIPE) = Q/A = ______ FT/SEC

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SF = Friction Slope = ______ FT/FT

SPREAD = Y_g/S_C = ______ = ______ FT

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INLET ⟨1⟩ LOCATION: STA 181+10.5 – 66' LT

V = 6.0 FT CAL'D RUNOFF = 6.0 CFS

L = 10.0 FT FLOW BY ( ) = 0.0 CFS

PIPE = 15 IN TOTAL Q = 6.0 CFS

SUMP = 3.9 IN S_0 = AVE GUTTER SLOPE = 0.0038 FT/FT

SPREAD = 12 FT S_C = X-SLOPE AT BASIN = 0.0333 FT/FT

INLET TYPE: M-1, L=10' Z = 30.03, Z/n = 2002.00

n = 0.015 for asphalt

From page 27 Y_g = 0.40 FT, V_g = 2.09 FT/SEC

DESIGN OF INLET

From page 40 Y_g = 0.40 FT, Q = 7.9 CFS, L = 10.0 FT

FLOWBY ___

DCB(MIN)=1.17+0.0233(4.88)^2 + 1.25 = 2.97' USE V = 6.0 FT

HEAD

ELEV @ CURB = 82.25

HGL ELEV = 70.57

H = 11.68-1.17 = 10.51 FT

SUMP (Page 29)

Q/L = 6/~~10~~ 13 = ~~0.60~~ 0.46 CFS/FT

y_0/h = ~~0.78~~ 0.67 FT/FT

h = 5 IN

y_0 = ~~3.9~~ 3.4 IN = ~~0.33~~ 0.27 ft < 0.40' OK

PIPE DESIGN

TOTAL H NEEDED = 0.0233 (= 1.5/28) (4.88 [V pipe])^2 + (40 x .00731 [(Sf)(Lpipe)]) + V bends = 0.85 FT OK

V(PIPE) = Q/A = 4.88 FT/SEC

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SF = Friction Slope = 0.00731 FT/FT

SPREAD = Y_g/S_C = 0.40 / 0.0333 = 12 FT

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INLET (2A)

V = 4' FT

PIPE = 15 IN

INLET TYPE: TYPE N

SINGLE BASIN

LOCATION STA 181+47, RT

CAL'D RUNOFF = ________ CFS

FLOW BY (____) = ________ CFS

TOTAL Q = ________ CFS

S_C = ________ FT/FT

COMPUTATION OF DEPTH

From Page 30 Curve A

$P = \frac{10.66 \times \_\_\_\_}{2}$ = ______ FT

$\frac{Q}{P}$ = ________

DEPTH = ________ FT

PIPE

TOP OF GRATE = ________

HGL = ________

HEAD(H) = ________ FT

H NEEDED = $\frac{1.5(\_\_\_\_)^2}{64.4}$ + ________

= ________ FT

n = 0.024 for unpaved road area

Sf = ________

DCB = $1.17 + \frac{1.5(\_\_\_\_)^2}{64.4}$ + ________ = V = ________ FT

SPREAD = DEPTH/S_C = ________ = ________ FT

Requested by C.O.G. for nuisance flow.

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INLET (2)

LOCATION: STA 179+87 – 34.5' LT

V = 3.5 FT

CAL'D RUNOFF = 1.0 CFS

L = 6.0 FT

FLOW BY ( ) = 0 CFS

PIPE = 15 IN

TOTAL Q = 1.0 CFS

SUMP = 1.9 IN

S_0 = AVE GUTTER SLOPE = 0.0034 FT/FT

SPREAD = 9.6 FT

S_C = X-SLOPE AT BASIN = 0.0167 FT/FT

INLET TYPE: M-1, L=6'

Z = 59.88, Z/n = 3992.0

n = 0.015 for asphalt

From page 27 Y_g = 0.16 FT, V_g = 1.69 FT/SEC

DESIGN OF INLET

From page 40 Y_g = 0.16 FT, Q = 1.2 CFS, L = 6.0 FT

FLOWBY ——

DCB(MIN)=1.17+0.0233(0.81)^2 + 1.25 = 2.43' USE V = 3.5 FT

HEAD

ELEV @ CURB = 82.76

HGL ELEV = 70.55

H = 12.21 – 1.17 = 11.04 FT

SUMP (Page 29)

Q/L = 1/9 = 0.17 CFS/FT

y_0/h = 0.38 FT/FT

h = 5 IN

y_0 = 1.9 IN = 0.16' = 0.16' OK

OK @ Q/L = 1/9 too

PIPE DESIGN

TOTAL H NEEDED = 0.0233(0.81)^2+(28 X .0020)

= 0.02 FT OK

V(PIPE) = Q/A = 0.81 FT/SEC

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SF = Friction Slope = 0.00020 FT/FT

SPREAD = Y_g/S_C = 0.16 / 0.0167 = 9.6 FT

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INLET (3)

LOCATION: STA 179+87 RT

V = 3.5 FT

CAL'D RUNOFF = 1.0 CFS

L = 3' FT

FLOW BY (   ) = — CFS

PIPE = 15 IN

TOTAL Q = 1.0 CFS

SUMP = 1.7 IN

S_0 = AVE GUTTER SLOPE = 0.0015 FT/FT

SPREAD = 11.2 FT

S_C = X-SLOPE AT BASIN = 0.0169 FT/FT

INLET TYPE: M-1 L=3'

Z = 59.17, Z/n = 3944.77

n = 0.015 for asphalt

From page 27 Y_g = 0.19 FT, V_g = ____ FT/SEC

DESIGN OF INLET

From page 40 Y_g = 0.19 FT, Q = 1.05 CFS, L = 3 FT

FLOWBY —

DCB(MIN)=1.17+0.0233(0.81)^2 + 1.25' = 2.44' USE V = 3.5 FT

HEAD

ELEV @ CURB = 82.97

HGL ELEV = 70.55

H = 12.42−1.17 = 11.25 FT

SUMP (Page 29)

Q/L = 1/6 = 0.17 CFS/FT

y_o/h = 0.34 FT/FT

h = 5 IN

y_0 = 1.7 IN

.14 < .19 OK

PIPE DESIGN

TOTAL H NEEDED = 0.0233(0.81)^2+(36 X .0002)

= 0.02 FT OK

V(PIPE) = Q/A = 1.0 / 1.23 FT/SEC = 0.81 FPS

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SF = Friction Slope = 0.00020 FT/FT

SPREAD = Y_g/S_C = 0.19 / 0.0169 = 11.24 FT

OK

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INLET (4)   LOCATION: STA 174+~~60~~ 50 LT

V = 4.0 FT   CAL'D RUNOFF = 2.58 CFS

L = 10' FT   FLOW BY (   ) = — CFS

PIPE = 15 IN   TOTAL Q_A = 2.58 CFS

SPREAD = 10 FT S_0 = AVE GUTTER SLOPE = 0.0019 FT/FT

INLET TYPE: M-1, L=10' S_C = X-SLOPE AT BASIN = 0.0332 FT/FT

Z = 30.12, Z/n = 2008.03

n = 0.015 for asphalt

From page 27 Y_g = 0.33 FT, V_g = ____ FT/SEC   used Calculator program to calc. LA and Q

DESIGN OF INLET

From page 28 Q_A/L_A = ____ L_A = 11.44 $L/L_A = \frac{13}{11.44}$ = 1.14

$\frac{a}{y} = \frac{.16}{.33}$ $\frac{Q}{Q_A}$ =   Q = (____)(____)0.8 = 2.14 CFS

FLOWBY 2.58 − 2.14 = 0.44 CFS. (4 TO 6)

DCB(MIN)=1.17+0.0233(1.74)² + 1.25 = 2.49' USE V = 4.0 FT

HEAD

ELEV @ CURB = 81.74

HGL ELEV = 69.82

H = 11.92−1.17 = 10.75 FT

PIPE DESIGN

TOTAL H NEEDED = 0.0233(1.74)²+(27 X .00093) + $\frac{V^2}{2g}$ bend loss = 0.14 FT OK

V(PIPE) = Q/A = $\frac{2.14}{1.23}$ FT/SEC = 1.74 FT/SEC.

SF = Friction Slope = 0.00093 FT/FT

SPREAD = Y_g/S_C = $\frac{0.33}{0.0332}$ = 9.94 FT

OK

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INLET: (5) LOCATION: STA 174+50 RT

V = 4.0' FT CAL'D RUNOFF = 2.58 CFS

L = 10' FT FLOW BY ( ) = — CFS

PIPE = 15 IN TOTAL Q_A = 2.58 CFS

SPREAD = 14.2 FT S_0 = AVE GUTTER SLOPE = 0.0015 FT/FT

INLET TYPE: M-1 L=10' S_C = X-SLOPE AT BASIN = 0.0205 FT/FT

Z = ____, Z/n = ____

n = 0.015 for asphalt

From page 27 Y_g = 0.29 FT, V_g = ____ FT/SEC

DESIGN OF INLET

From page 28 Q_A/L_A = ____ L_A = 13.21 $L/L_A = \frac{13}{13.21} = 0.98$

$\frac{a}{y} = \frac{.16}{.29}$ $\frac{Q}{Q_A}$ = Q = (____)(____)0.8 = 2.05 CFS

FLOWBY 2.58 − 2.05 = 0.53 CFS (From #5 to #7)

DCB(MIN) = 1.17 + 0.0233(1.67)² + 1.25 = 2.48' USE V = 4.0 FT

HEAD

ELEV @ CURB = 82.15

HGL ELEV = 69.82

H = 12.33 − 1.17 = 11.16 FT

PIPE DESIGN

TOTAL H NEEDED = 0.0233(1.67)² + (37 X .000)86

= 0.06 FT OK

V(PIPE) = Q/A = $\frac{2.05}{1.23}$ FT/SEC = 1.67 FPS

SF = Friction Slope = 0.00086 FT/FT

SPREAD = Y_g/S_C = $\frac{0.29}{0.0205}$ = 14.15 FT OK

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INLET (6)

LOCATION: STA 167+75 LT

V = 4.0' FT

CAL'D RUNOFF = 5.0 CFS

L = 10' FT

FLOW BY (#4) = 0.44 CFS

PIPE = 15 IN

TOTAL Q_A = 5.44 CFS

SPREAD = 11.7 FT

S_0 = AVE GUTTER SLOPE = 0.0019 FT/FT

INLET TYPE: M-1 L=10'

S_C = X-SLOPE AT BASIN = 0.0412 FT/FT

Z = 24.27, Z/n = 1618.12

n = 0.015 for asphalt

From page 27 Y_g = .48 FT, V_g = ____ FT/SEC

DESIGN OF INLET

From page 28 Q_A/L_A = ____ L_A = 15.67 $L/L_A = \frac{13}{15.67} = .83$

$\frac{a}{y} = \frac{.16}{.48}$ $\frac{Q}{Q_A}$ =

Q = (____)(____)0.8 = 4.10 CFS

FLOWBY 5.44 - 4.10 = 1.34 CFS (From #6 - #8)

DCB(MIN) = $1.17+0.0233(3.33)^2 + 1.25 = 2.68'$ USE V = 4.0 FT

HEAD

ELEV @ CURB = 80.43

HGL ELEV = 68.84

H = 11.59 - 1.17 = 10.42 FT

PIPE DESIGN

TOTAL H NEEDED = $0.0233(3.33)^2 + (27 \times .00341)$ + $\frac{v^2}{2g}$ bend = 0.52 FT OK

V(PIPE) = Q/A = $\frac{4.10}{1.23}$ FT/SEC = 3.33 FT/SEC

SF = Friction Slope = 0.00341 FT/FT

SPREAD = Y_g/S_C = $\frac{0.48}{0.0412}$ = 11.7 FT

OK

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INLET ⟨7⟩ LOCATION: STA 167+75

V = 4.0 FT CAL'D RUNOFF = 3.42 CFS

L = 10.0 FT FLOW BY (#5) = 0.53 CFS

PIPE = 15 IN TOTAL Q_A = 3.95 CFS

SPREAD = 16.8 FT S_0 = AVE GUTTER SLOPE = 0.0015 FT/FT

INLET TYPE: M-1 L=10' S_C = X-SLOPE AT BASIN = 0.0197 FT/FT

Z = 50.76, Z/n = 3384.09

n = 0.015 for asphalt

From page 27 Y_g = 0.33 FT, V_g = _____ FT/SEC

DESIGN OF INLET

From page 28 Q_A/L_A = _____ L_A = 17.52 $L/L_A = \frac{13}{17.52}$ = 0.74

$\frac{a}{y} = \frac{.16}{.33}$ $\frac{Q}{Q_A}$ =

Q = (_____)(_____)0.8 = 2.77 CFS

FLOWBY 3.95 - 2.77 = 1.18 CFS (From 7 To 9)

DCB(MIN)=1.17+0.0233(2.25)² + 1.25 = 2.54' USE V = 4.0 FT

HEAD

ELEV @ CURB = 81.13 ✓

HGL ELEV = 68.84

H = 12.29-1.17 = 11.12 FT

PIPE DESIGN

TOTAL H NEEDED = 0.0233(2.25)²+(37X.00156)

= 0.18 FT OK

V(PIPE) = Q/A = $\frac{2.77}{1.23}$ FT/SEC = 2.25 FT/SEC

SF = Friction Slope = 0.00156 FT/FT

SPREAD = Y_g/S_C = $\frac{.33}{.0197}$ = 16.75 FT

OK

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INLET ⟨8⟩ LOCATION: STA 162+60 LT

V = 4.0 FT CAL'D RUNOFF = 2.44 CFS

L = 10 FT FLOW BY (#6) = 1.34 CFS

PIPE = 15 IN TOTAL Q_A = 3.78 CFS

SPREAD = 20.5 FT S_0 = AVE GUTTER SLOPE = 0.0019 FT/FT

INLET TYPE: M-1 L=10' S_C = X-SLOPE AT BASIN = 0.0132 FT/FT

Z = 75.76, Z/n = 5050.51

n = 0.015 for asphalt

From page 27 Y_g = 0.27 FT, V_g = _____ FT/SEC

DESIGN OF INLET

From page 28 Q_A/L_A = _____ L_A = 20.92' $L/L_A = \frac{13'}{20.92'}$ = 0.62

$\frac{a}{y} = \frac{.16}{.27}$ $\frac{Q}{Q_A}$ =

Q = (_____)(_____)0.8 = 2.34 CFS

FLOWBY 3.78 - 2.34 = 1.44 (Frm #8 TO # 10)

DCB(MIN)=1.17+0.0233(1.90)² + 1.25 = 2.50' USE V = 4.0 FT

HEAD

ELEV @ CURB = 79.43 ✓

HGL ELEV = 68.00

H = 11.44 - 1.17 = 10.26 FT

PIPE DESIGN

TOTAL H NEEDED = 0.0233(1.90)² + (20)(.00111) + $\frac{V^2}{2g}$ bend = 0.17 FT

V(PIPE) = Q/A = $\frac{2.34}{1.23}$ FT/SEC = 1.90 FPS

SF = Friction Slope = 0.00111 FT/FT

SPREAD = Y_g/S_C = $\frac{0.27}{0.0132}$ = 20.45 FT

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INLET (9) LOCATION: STA 162+60 – 34.5' RT

V = 4.0 FT CAL'D RUNOFF = 2.44 CFS

L = 10.0 FT FLOW BY (#7) = 1.18 CFS

PIPE = 15 IN TOTAL Q_a = 3.62 CFS

SPREAD = 16.8 FT S_0 = AVE GUTTER SLOPE = 0.0023 FT/FT

INLET TYPE: M-1, L=10' S_C = X-SLOPE AT BASIN = 0.0167 FT/FT

Z = 59.88, Z/n = 3992.0

n = 0.015 for asphalt

Used Calculator Program to calc L_A & Q

From page 27 Y_g = 0.28 FT, V_g = 1.46 FT/SEC

DESIGN OF INLET

From page 28 $Q_A/L_A = \frac{3.62}{13}$ (2.44 struck out) L_A = 19.25 $L/L_A = \frac{13}{19.25}$ = 0.68

$\frac{a}{y} = \frac{0.16}{0.28}$ $\frac{Q}{Q_A}$ = Q = (Qa)(Q/Qa)0.8 = 2.37 CFS (Clogging factor)

FLOWBY 3.62 CFS – 2.37 CFS (#9 TO #11) = 1.25 CFS

DCB(MIN) = 1.17 + 0.0233(1.93)² + 1.25 = 2.51' USE V = 4.0 FT

("Cf + freeboard" "1.5/2g" "V" "d_{pipe}")

HEAD

ELEV @ CURB = 79.60

HGL ELEV = 68.00

H = 11.60 – 1.17 = 10.43 FT

PIPE DESIGN

TOTAL H NEEDED = 0.0233(1.93)² + (37×.00114)

= 0.13 FT OK

V(PIPE) = Q/A = 1.93 FT/SEC

SF = Friction Slope = 0.00114 FT/FT

SPREAD = $Y_g/S_C = \frac{0.28}{0.0167}$ = 16.8 FT

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INLET ⟨10⟩ LOCATION: STA 157+50 – 34.5' LT

V = 4.0 FT CAL'D RUNOFF = 3.0 CFS

L = 10.0 FT FLOW BY (#8) = 1.44 CFS

PIPE = 15 IN TOTAL Q_A = 4.44 CFS

SPREAD = 13.9 FT S_0 = AVE GUTTER SLOPE = 0.0022 FT/FT

INLET TYPE: M-1, L=10 S_C = X-SLOPE AT BASIN = 0.0260 FT/FT

Z = 38.46 Z/n = 2564

n = 0.015 for asphalt

From page 27 Y_g = 0.36 FT, V_g = 1.60 FT/SEC

DESIGN OF INLET

From page 28 Q_A/L_A = ___ L_A = 17.85' $L/L_A = \frac{13'}{17.85'}$ = 0.73

$\frac{a}{y} = \frac{0.16}{0.36}$ $\frac{Q}{Q_A}$ =

Q = (___)(___)0.8 = 3.10 CFS

FLOWBY (#10 TO #12) = 4.44 CFS – 3.10 CFS = 1.34 CFS

DCB(MIN) = 1.17+0.0233(2.52)² + 1.25 = 2.57 USE V = 4.0 FT

HEAD

ELEV @ CURB = 77.90

HGL ELEV = 67.29

H = 10.61 – 1.17 = 9.44 FT

PIPE DESIGN

TOTAL H NEEDED = 0.0233(2.52)² + (28 X .00195) + bend loss $\frac{v^2}{2g}$ = 0.30 FT OK

V(PIPE) = Q/A = $\frac{3.10}{2.13}$ FT/SEC = 2.52 FT/SEC

SF = Friction Slope = 0.00195 FT/FT

SPREAD = Y_g/S_C = $\frac{0.36}{0.0260}$ = 13.9 FT

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INLET (11) LOCATION: STA 157+50 - 34.5' LT

V = 4.0 FT CAL'D RUNOFF = 2.44 CFS

L = 10.0 FT FLOW BY (#9) = 1.25 CFS

PIPE = 15 IN TOTAL Q_A = 3.69 CFS

SPREAD = 18 FT S_0 = AVE GUTTER SLOPE = 0.0023 FT/FT

INLET TYPE: M-1, L=10 S_C = X-SLOPE AT BASIN = 0.0150 FT/FT

Z = 66.67, Z/n = 4444

n = 0.015 for asphalt

From page 27 Y_g = 0.27 FT, V_g = 1.42 FT/SEC

DESIGN OF INLET

From page 28 Q_A/L_A = ______ L_A = 20.42 $L/L_A = \frac{13}{~~18.52~~\ 20.42}$ = ~~0.70~~ 0.64

$\frac{a}{y} = \frac{0.16}{0.27}$ $\frac{Q}{Q_A}$ = Q = (______)(______)0.8 = ~~2.05~~ 2.32 CFS

FLOWBY (#11 TO #13) = 3.69 CFS - 2.32 CFS = 1.37 CFS

DCB(MIN) = 1.17 + 0.0233(1.89)^2 + 1.25 = 2.50 USE V = 4.0 FT

HEAD

ELEV @ CURB = 77.80

HGL ELEV = 67.29

H = 10.51 - 1.17 = 9.34 FT

PIPE DESIGN

TOTAL H NEEDED = 0.0233(1.89)^2 + (37 X .0011)

= 0.12 FT OK

V(PIPE) = Q/A = 1.89 FT/SEC

SF = Friction Slope = 0.00110 FT/FT

SPREAD = Y_g/S_C = $\frac{0.27}{0.0150}$ = 18 FT

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INLET (12)

LOCATION: STA 154+76 – 34.5' LT

V = 4 FT

CAL'D RUNOFF = 1.42 CFS

L = 10 FT

FLOW BY (#10) = 1.34 CFS

PIPE = 15 IN

TOTAL Q = 2.76 CFS

SUMP = 1.95 IN

S_0 = AVE GUTTER SLOPE = 0.0023 FT/FT

SPREAD = 17 FT

S_C = X-SLOPE AT BASIN = 0.0141 FT/FT

INLET TYPE: M-1, L=10'

Z = 70.92, Z/n = 4728.13

n = 0.015 for asphalt

From page 27 Y_g = 0.24 FT, V_g = 1.40 FT/SEC

DESIGN OF INLET

From page 40 Y_g = 0.24 FT, Q = 3.6 CFS, L = 10 FT

FLOWBY /

DCB(MIN)=1.17+0.0233(2.24)² + 1.25 = 2.53 USE V = 4.0 FT

HEAD

ELEV @ CURB = 76.54

HGL ELEV = 66.90

H = 9.64' – 1.17' = 8.47 FT

PIPE DESIGN

TOTAL H NEEDED = 0.0233(2.24)²+(29 x .00154)

+ bend vs loss 2g = 0.24 FT OK

V(PIPE) = Q/A = 2.24 FT/SEC

SUMP (Page 29)

Q/L = 2.76 / 13 ~~6/9~~ = ~~0.35~~ 0.21 CFS/FT

y_0/h = 0.39 FT/FT

h = 5 IN

y_0 = 1.95 IN = ~~0.23' to 0.22'~~

~~OK @ Q/L = 2.11/9.400~~

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SF = Friction Slope = 0.00154 FT/FT

SPREAD = Y_g/S_C = 0.24 / 0.0141'/' = 17 FT

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INLET ⟨13⟩ LOCATION: STA 154+76 – 34.5' RT

V = 3.5 FT CAL'D RUNOFF = 1.42 CFS

L = 6.0 FT FLOW BY (#11) = 1.37 CFS

PIPE = 15 IN TOTAL Q = 2.79 CFS

SUMP = 2.6 IN S_0 = AVE GUTTER SLOPE = 0.0022 FT/FT

SPREAD = 11.9 FT S_C = X-SLOPE AT BASIN = 0.0234 FT/FT

INLET TYPE: M-1, L=6' Z = 42.74, Z/n = 2,849.0

n = 0.015 for asphalt

From page 27 Y_g = 0.29 FT, V_g = 1.56 FT/SEC

DESIGN OF INLET

From page 40 Y_g = 0.29 FT, Q = 3.3 CFS, L = 6.0 FT

FLOWBY ——

DCB(MIN) = 1.17 + 0.0233(2.27)^2 + 1.25 = 2.54 USE V = 3.5 FT

HEAD

ELEV @ CURB = 76.95

HGL ELEV = 66.90

H = 10.05' − 1.17' = 8.88 FT

SUMP (Page 29)

Q/L = 2.79 / ~~6~~ 9 = ~~0.27~~ ~~0.41~~ .31 ~~0.46~~ CFS/FT

y_0/h = .52 ~~0.62~~ FT/FT

h = 5 IN

y_0 = 2.6 ~~3.1~~ 2.3 IN = 0.26' < 0.28' 0.19'

OK @ L = 9' too

PIPE DESIGN

TOTAL H NEEDED = 0.0233(2.27)^2 + (37 × .00158)

= 0.18 FT OK

V(PIPE) = Q/A = 2.27 FT/SEC

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SF = Friction Slope = 0.00158 FT/FT

SPREAD = Y_g/S_C = 0.28 / 0.0234 = 11.9 FT

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INLET (14)

LOCATION: STA 154+38, 82' LT

V = 4.0 FT

CAL'D RUNOFF = 20.0 CFS

L = 17 FT

FLOW BY ( ) = 0 CFS

PIPE = 24 IN

TOTAL Q = 20.0 CFS

SUMP = 3.75 IN

S_0 = AVE GUTTER SLOPE = 0.0030 FT/FT

SPREAD = 27' FT

S_C = X-SLOPE AT BASIN = 0.0200 FT/FT

INLET TYPE: M-2 L=17'

Z = 50.0, Z/n = 3333.33

n = 0.015 for asphalt

From page 27 Y_g = 0.54 FT, V_g = 1.68 FT/SEC

DESIGN OF INLET

From page 40 Y_g = 0.54 FT, Q = 28 CFS, L = 17 FT

FLOWBY ―

DCB(MIN)=1.17+0.0233(6.37)² + 2.0 = 4.11' USE V = 4.0 FT

HEAD

ELEV @ CURB = 76.50

HGL ELEV = 66.99

H = 9.51 − 1.17 = 8.34 FT

SUMP (Page 29)

Q/L = 20/37 = 0.54 CFS/FT

y_o/h = 0.75 FT/FT

h = 5 IN

y_o = 3.75 IN

PIPE DESIGN

TOTAL H NEEDED = 0.0233(6.37)²+(34×.00666)

= 1.17' FT OK

V(PIPE) = Q/A = 20/3.142 FT/SEC = 6.37 FT/SEC

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SF = Friction Slope = 0.00666 FT/FT

SPREAD = Y_g/S_C = 0.54/0.02 = 27' FT

Note: When C.O.P. installs a lateral, the spread will be reduced.

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INLET (15)

LOCATION: STA 153+68, 82' LT

V = 4.0 FT

CAL'D RUNOFF = 37-20 CFS = 17CFS

L = 17 FT

FLOW BY (   ) = 0 CFS

PIPE = 24 IN

TOTAL Q = 17 CFS

SUMP = 5 IN

S_0 = AVE GUTTER SLOPE = 0.0030 FT/FT

SPREAD = 25.5 FT

S_C = X-SLOPE AT BASIN = 0.020 FT/FT

INLET TYPE: M-1, L=17'

Z = 50.0, Z/n = 3333.33

n = 0.015 for asphalt

From page 27 Y_g = 0.51 FT, V_g = _____ FT/SEC

DESIGN OF INLET

From page 40 Y_g = 0.51 FT, Q = 17.4 CFS, L = 17 FT

FLOWBY ———

DCB(MIN)=1.17+0.0233(5.41)² + 2.0 = 3.85 USE V = 4.0 FT

HEAD

ELEV @ CURB = 76.21

HGL ELEV = 66.99

H = 9.22-1.17 = 8.05 FT

SUMP (Page 29)

Q/L = 17/20 = 0.85 CFS/FT

y_0/h = 1.0 FT/FT

h = 5 IN

y_0 = 5 IN

.42 < .51 OK

PIPE DESIGN

TOTAL H NEEDED = 0.0233(5.41)² + (27)(0.00481)

= 0.81 FT OK

V(PIPE) = Q/A = 17/3.142 FT/SEC = 5.41 FT/SEC

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Page 32

SF = Friction Slope = 0.00481 FT/FT

SPREAD = Y_g/S_C = 0.51/0.02 = 25.5 FT

When C.O.P Installs lateral, the spread will be reduced.

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INLET (16)

LOCATION: STA 153+30 – 34.5' LT

V = 3.5 FT

CAL'D RUNOFF = 1.0 CFS

L = 6.0 FT

FLOW BY ( ) = / CFS

PIPE = 15 IN

TOTAL Q = 1.0 CFS

SUMP = 1.25 IN

S_0 = AVE GUTTER SLOPE = 0.0023 FT/FT

SPREAD = 11.3 FT

S_C = X-SLOPE AT BASIN = 0.0141 FT/FT

INLET TYPE: M-1, L=6'

Z = 70.92, Z/n = 4728.13

n = 0.015 for asphalt

From page 27 Y_g = ~~0.17~~ .16 FT, V_g = 1.40 FT/SEC

DESIGN OF INLET

From page 40 Y_g = ~~0.17~~ .16 FT, Q = 1.2 CFS, L = 6 FT

FLOWBY /

DCB(MIN) = $1.17+0.0233(0.81)^2$ + 1.25 = 2.44 USE V = 3.5 FT

HEAD

ELEV @ CURB = 75.58

HGL ELEV = 66.50

H = 9.08' − 1.17' = 7.91 FT

SUMP (Page 29)

Q/L = 1.0/6 9 = ~~0.18~~ .11 CFS/FT

y_0/h = .25 ~~0.36~~ FT/FT

h = 5 IN

y_0 = 1.25 IN = 0.15' < 0.17'

OK @ L = 9' too

PIPE DESIGN

TOTAL H NEEDED = $0.0233(0.81)^2 + (28 \times .0002)20$

$\frac{v^2}{2g}$ bend = 0.03 FT OK

V(PIPE) = Q/A = 0.81 FT/SEC

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SF = Friction Slope = 0.00020 FT/FT

SPREAD = Y_g/S_C = 0.16' / 0.0141'/1 = 11.3 FT

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INLET ⟨17⟩ LOCATION: STA 153+30 - 34.5' RT

V = 3.5 FT CAL'D RUNOFF = 1.0 CFS

L = 3.0 FT FLOW BY ( ) = — CFS

PIPE = 15 IN TOTAL Q = 1.0 CFS

SUMP = 2.7 IN S_0 = AVE GUTTER SLOPE = 0.0022 FT/FT

SPREAD = 8.6 FT S_C = X-SLOPE AT BASIN = 0.0234 FT/FT

INLET TYPE: M-1, L=3.0' Z = 42.74, Z/n = 2849.0

n = 0.015 for asphalt

From page 27 Y_g = 0.20 FT, V_g = 1.56 FT/SEC

DESIGN OF INLET

From page 40 Y_g = 0.20 FT, Q = 1.20 CFS, L = 3.0 FT

FLOWBY —

DCB(MIN)=1.17+0.0233(0.81)² + 1.25 = 2.44 USE V = 3.5 FT

HEAD

ELEV @ CURB = 76.12

HGL ELEV = 66.50

H = 9.62' - 1.17' = 8.45 FT

SUMP (Page 29)

Q/L = 1/~~3~~ 6 = ~~0.33~~ 0.17 CFS/FT

y_0/h = ~~0.54~~ 0.34 FT/FT

h = 5 IN

y_0 = ~~2.7~~ 1.7 IN = ~~0.23~~ 0.14 < ~~X~~ 0.20

OK

PIPE DESIGN

TOTAL H NEEDED = 0.0233(0.81)²+(37 x .00020)

= 0.03 FT OK

V(PIPE) = Q/A = 0.81 FT/SEC

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SF = Friction Slope = 0.0002 FT/FT

SPREAD = Y_g/S_C = 0.2 / 0.0234 = 8.6 FT

SFC ENGINEERING COMPANY

Subject: INLET DESIGN COMPUTATIONS — SUMP CONDITION
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INLET (18) LOCATION: STA 150+54 – 34.5' LT

V = 8.0 FT CAL'D RUNOFF = 4.0 CFS

L = 10.0 FT FLOW BY ( ) = — CFS

PIPE = 15 IN TOTAL Q = 4.0 CFS

SUMP = 3.0 IN S_0 = AVE GUTTER SLOPE = 0.0046 FT/FT

SPREAD = 14.5 FT S_C = X-SLOPE AT BASIN = 0.0186 FT/FT

INLET TYPE: M-1, L=10' Z = 53.76, Z/n = 3584.23

n = 0.015 for asphalt

From page 27 Y_g = 0.27 FT, V_g = 1.94 FT/SEC

DESIGN OF INLET

From page 40 Y_g = 0.27 FT, Q = 4.4 CFS, L = 10.0 FT

FLOWBY ______

DCB(MIN) = 1.17 + 0.0233(3.25)^2 + 1.25 = 2.67 USE V = 8.0 FT

HEAD

ELEV @ CURB = 74.45

HGL ELEV = 65.73

H = 8.72 − 1.17 = 7.55 FT

SUMP (Page 29)

Q/L = 4/10 (13) = 0.40 CFS/FT

y_0/h = 0.61 FT/FT

h = 5 IN

y_0 = 3.0 IN = 0.25' < 0.27'
OK @ L=13' too

PIPE DESIGN

TOTAL H NEEDED = 0.0233(3.25)^2 + (26 X .00325)

= 0.33 FT OK

V(PIPE) = Q/A = 3.25 FT/SEC

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SF = Friction Slope = 0.00325 FT/FT

SPREAD = Y_g/S_C = 0.27 / 0.0186 = 14.5 FT

SFC ENGINEERING COMPANY

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INLET (19) LOCATION: STA 150+54 — 34.5' RT

V = 3.5 FT CAL'D RUNOFF = 1.40 CFS

L = 6.0 FT FLOW BY ( ) = — CFS

PIPE = 15 IN TOTAL Q_A= 1.40 CFS

SPREAD = 10.2 FT S_0 = AVE GUTTER SLOPE = 0.0046 FT/FT

INLET TYPE: M-1, L=6.0' S_C = X-SLOPE AT BASIN = 0.0177 FT/FT

Z = 56.5, Z/n = 3766.48

n = 0.015 for asphalt

From page 27 Y_g= 0.18 FT, V_g = 1.92 FT/SEC

DESIGN OF INLET

From page 28 Q_A/L_A = ___ L_A = 11.90 $L/L_A = \frac{9.0'}{11.90}$ = 0.76

$\frac{a}{y} = \frac{0.16}{0.18}$ $\frac{Q}{Q_A}$ =

Q = (___)(___)0.8 = 0.95 CFS

FLOWBY (#19 TO #21) = 1.40CFS − 0.95 CFS = 0.45 CFS

DCB(MIN)=1.17+0.0233(0.77)² + 1.25 = 2.43' USE V = 3.5 FT

HEAD

ELEV @ CURB = 74.56

HGL ELEV = 65.73

H = 8.83−1.17= 7.66 FT

PIPE DESIGN

TOTAL H NEEDED = 0.0233(0.77)²+(36x0.00018

= 0.02 FT OK

V(PIPE) = Q/A = 0.77 FT/SEC

SF = Friction Slope = 0.00018 FT/FT

SPREAD = Y_g/S_C = $\frac{0.18'}{0.0177\%}$ = 10.2 FT

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INLET (20) LOCATION: STA 146+20 – 34.5' LT

V = 8.0 FT CAL'D RUNOFF = 2.11 CFS

L = 10.0 FT FLOW BY ( ) = — CFS

PIPE = 15 IN TOTAL Q_A = 2.11 CFS

SPREAD = 10.5 FT S_0 = AVE GUTTER SLOPE = 0.0037 FT/FT

INLET TYPE: M-1, L=10' S_C = X-SLOPE AT BASIN = 0.0219 FT/FT

Z = 45.66, Z/n = 3044.14

n = 0.015 for asphalt

From page 27 Y_g = 0.23 FT, V_g = 1.86 FT/SEC

DESIGN OF INLET

From page 28 Q_A/L_A = ___ L_A = 13.87 $L/L_A = \frac{13}{13.87}$ = 0.94

$\frac{a}{y} = \frac{0.16}{0.23}$ $\frac{Q}{Q_A}$ = Q = (___)(___)0.8 = 1.64 CFS

FLOWBY (#20 TO #22) = 2.11 CFS – 1.64 CFS = 0.47 CFS

DCB(MIN) = 1.17 + 0.0233(1.33)² + 1.25 = 2.46' USE V = 8.0 FT

HEAD

ELEV @ CURB = 72.41

HGL ELEV = 64.99

H = 7.42 – 1.17 = 6.25 FT

PIPE DESIGN

TOTAL H NEEDED = 0.0233(1.33)² + (25 x .00054)

= 0.05 FT OK

V(PIPE) = Q/A = 1.33 FT/SEC

SF = Friction Slope = 0.00054 FT/FT

SPREAD = Y_g/S_C = $\frac{0.23}{0.0219}$ = 10.5 FT

ENGINEERING COMPANY

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INLET (21)

LOCATION: STA 146+20 - 34.5' RT

V = 4.0 FT

CAL'D RUNOFF = 2.11 CFS

L = 10.0' FT

FLOW BY (#19) = 0.45 CFS

PIPE = 15 IN

TOTAL Q_A = 2.56 CFS

SPREAD = 10.64 FT

S_0 = AVE GUTTER SLOPE = 0.0042 FT/FT

INLET TYPE: M-1, L = 10'

S_C = X-SLOPE AT BASIN = 0.0235 FT/FT

Z = 42.55, Z/n = 2836.88

n = 0.015 for asphalt

From page 27 Y_g = 0.25 FT, V_g = 1.99 FT/SEC

DESIGN OF INLET

From page 28 Q_A/L_A = ___ L_A = 15.40 $L/L_A = \frac{13}{15.40}$ = 0.84

$\frac{a}{y} = \frac{0.16}{0.25}$ $\frac{Q}{Q_A}$ =

Q = (____)(____)0.8 = 1.89 CFS

FLOWBY (#21 TO #23) = 2.56 CFS - 1.89 CFS = 0.67 CFS

DCB(MIN) = 1.17 + 0.0233(1.54)² + 1.25 = 2.48 USE V = 4.0 FT

HEAD

ELEV @ CURB = 72.49

HGL ELEV = 64.99

H = 7.50' - 1.17' = 6.33 FT

PIPE DESIGN

TOTAL H NEEDED = 0.0233(1.54)² + (36 x .00073)

= 0.08 FT OK

V(PIPE) = Q/A = 1.54 FT/SEC

SF = Friction Slope = 0.00073 FT/FT

SPREAD = Y_g/S_C = $\frac{0.25}{0.0235}$ = 10.64 FT

SFC ENGINEERING COMPANY

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INLET: 22 LOCATION: STA 142+46 – 34.5' LT

V = 8.0 FT CAL'D RUNOFF = 1.85 CFS

L = 3.0 FT FLOW BY (#20) = 0.47 CFS

PIPE = 15 IN TOTAL Q = 2.32 CFS

SUMP = 4.7 IN S_0 = AVE GUTTER SLOPE = 0.0023 FT/FT

SPREAD = 9.6 FT S_C = X-SLOPE AT BASIN = 0.0313 FT/FT

INLET TYPE: M-1, L=3' Z = 31.95, Z/n = 2129.93

n = 0.015 for asphalt

From page 27 Y_g = 0.30 FT, V_g = 1.70 FT/SEC

DESIGN OF INLET

From page 40 Y_g = 0.30 FT, Q = 2.3 CFS, L = 3.0 FT

FLOWBY (#22 TO #26) = 2.32 – 2.3 = 0.02 CFS

DCB(MIN) = 1.17 + 0.0233(1.89)² + 1.25 = 2.5 USE V = 8.0 FT

HEAD

ELEV @ CURB = 71.04

HGL ELEV = 64.36

H = 6.68 – 1.17 = 5.51 FT

SUMP (Page 29)

Q/L = 2.3/~~3~~ 6 = ~~0.77~~ 0.38 (0.58) CFS/FT

y_0/h = ~~0.94~~ FT/FT

h = 5 IN

y_0 = ~~4.7~~ 2.9 IN = ~~0.39'~~ > 0.30 0.24 < 0.30

OK @ L = 6'

PIPE DESIGN

TOTAL H NEEDED = 0.0233(1.89)² + (25 × .0011)

= 0.11 FT OK

V(PIPE) = Q/A = 1.89 FT/SEC

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SF = Friction Slope = 0.0011 FT/FT

SPREAD = Y_g/S_C = 0.30 / 0.0313 = 9.6 FT

SFC ENGINEERING COMPANY

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INLET (23)

LOCATION: STA 142+01, 34.5' RT

V = 4.0 FT

CAL'D RUNOFF = 2.03 CFS

L = 10 FT

FLOW BY (#21) = 0.67 CFS

PIPE = 15 IN

TOTAL Q_A = 2.70 CFS

SPREAD = 9.6 FT

S_0 = AVE GUTTER SLOPE = 0.0029 FT/FT

INLET TYPE: M-1 L=10'

S_C = X-SLOPE AT BASIN = 0.0313 FT/FT

Z = 31.95, Z/n = 2129.93

n = 0.015 for asphalt

From page 27 Y_g = 0.30 FT, V_g = 1.86 FT/SEC

DESIGN OF INLET

From page 28 Q_A/L_A = ______ L_A = 13.31 $L/L_A = \frac{13}{13.31}$ = 0.98

$\frac{a}{y} = \frac{0.16}{0.30}$ $\frac{Q}{Q_A}$ =

Q = (______)(______)0.8 = 2.14 CFS

FLOWBY = 2.70 − 2.14 = 0.56 CFS (From #23 to #30)

DCB(MIN) = 1.17 + 0.0233(1.74)^2 + 1.25 = 2.49 USE V = 4.0 FT

HEAD

ELEV @ CURB = 71.03

HGL ELEV = 64.28

H = 6.75 − 1.17 = 5.58 FT

PIPE DESIGN

TOTAL H NEEDED = 0.0233(1.74)^2 + (36 × .00093)

= 0.10 FT OK

V(PIPE) = Q/A = $\frac{2.14}{1.23}$ FT/SEC = 1.74 CFS

SF = Friction Slope = 0.00093 FT/FT

SPREAD = Y_g/S_C = $\frac{0.30}{0.0313}$ = 9.6 FT

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INLET (24) LOCATION: STA 142+22, 70' LT

V = 6.0 ~~5.0~~ FT CAL'D RUNOFF = 42.5 CFS

L = 17 FT FLOW BY ( ) = 0 CFS

PIPE = 24 IN TOTAL Q = 42.5 CFS

SUMP = 4.65 IN S_0 = AVE GUTTER SLOPE = 0.0071 FT/FT

SPREAD = 33 FT S_C = X-SLOPE AT BASIN = 0.0176 FT/FT

INLET TYPE: M-2 L=17' Z = 58.82, Z/n = 3787.87

n = 0.015 for asphalt

From page 27 Y_g = 0.58 FT, V_g = 2.25 FT/SEC

DESIGN OF INLET

From page 40 Y_g = 0.45 FT, Q = 28 CFS, L = 17 FT

FLOWBY = 42.5 − 28 = 14.5 CFS (From #24 TO #26 & 26A)

DCB(MIN) = 1.17 + 0.0233(8.91)^2 + 2.0 = 5.02' USE V = 5.0 FT

HEAD

ELEV @ CURB = 70.97

HGL ELEV = 64.32

H = 6.65 − 1.17 = 5.48 FT

SUMP (Page 29)

Q/L = 28/37 = 0.76 CFS/FT

y_0/h = 0.93 FT/FT

h = 5 IN

y_0 = 4.65 IN

PIPE DESIGN

TOTAL H NEEDED = 0.0233(8.91)^2+(12 × .01303)

= 2.00 FT OK

V(PIPE) = Q/A = 28/3.142 FT/SEC = 8.91 FT/SEC

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SF = Friction Slope = 0.01303 FT/FT

SPREAD = Y_g/S_C = 0.58/0.0176 = 33 FT NO CHOICE UNLESS, INSTALL LAT. UPSTREAM.

Lowered to avoid exist. utilities. 11/13/92

INLET (25) LOCATION: STA 141+90, 70' LT

V = 5 FT CAL'D RUNOFF = 42.5 CFS

L = 17 FT FLOW BY ( ) = 0 CFS

PIPE = 24 IN TOTAL Q = 42.5 CFS

SUMP = 4.65 IN S_0 = AVE GUTTER SLOPE = 0.0071 FT/FT

SPREAD = 33 FT S_C = X-SLOPE AT BASIN = 0.0176 FT/FT

INLET TYPE: M-2 L=17' Z = 56.82, Z/n = 3787.88

n = 0.015 for asphalt

From page 27 Y_g = 0.58 FT, V_g = 2.25 FT/SEC

DESIGN OF INLET

From page 40 Y_g = 0.45 FT, Q = 28 CFS, L = 17 FT

FLOWBY 42.5 − 28 = 14.5 (From #25 To #26 and #26A)

DCB(MIN) = 1.17+0.0233(8.91)² + 2.0 = 5.02 USE V = 5.0 FT

HEAD

ELEV @ CURB = 70.91

HGL ELEV = 64.26

H = 6.65 − 1.17 = 5.48 FT

SUMP (Page 29)

Q/L = 28/37 = 0.76 CFS/FT

y_0/h = 0.93 FT/FT

h = 5 IN

y_0 = 4.65 IN

PIPE DESIGN

TOTAL H NEEDED = 0.0233(8.91)² + (18 X .013)03

= 2.08 FT OK

V(PIPE) = Q/A = 28 / 3.142 FT/SEC = 8.91 FT/SEC

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SF = Friction Slope = 0.01303 FT/FT

SPREAD = Y_g/S_C = 0.58 / 0.0176 = 33 FT NO CHOICE, UNLESS, INSTALL LAT. UPSTREAM.

INLET (26) LOCATION: STA 141+58 – 34.5' LT

V = 8.0 FT CAL'D RUNOFF = 1.0 CFS

L = 10 FT FLOW BY (#25) #24 = 29.0 CFS

PIPE = 24 IN TOTAL Q = 30.0 CFS

SUMP = 5.50 IN S_0 = AVE GUTTER SLOPE = 0.0017 FT/FT

SPREAD = 47.2 FT S_C = X-SLOPE AT BASIN = 0.0125 FT/FT

INLET TYPE: M-1 L=10' Z = 80.0, Z/n = 5333.33

n = 0.015 for asphalt

From page 27 Y_g = 0.59 FT, V_g = 1.21 FT/SEC

DESIGN OF INLET

From page 40 Y_g = 0.55 FT, Q = 12.4 CFS, L = 10 FT

FLOWBY = 30 – 12.4 = 17.6 CFS (From #26 to #26A)

DCB(MIN) = 1.17 + 0.0233(3.95)² + 2.0 = 3.53' USE V = 8.0 FT

HEAD

ELEV @ CURB = 70.80

HGL ELEV = 64.19

H = 6.61 – 1.17 = 5.44 FT

SUMP (Page 29)

Q/L = 12.4/13 = 0.95 CFS/FT

y_0/h = 1.10 FT/FT

h = 5 IN

y_0 = 5.50 IN

0.46 < 0.55 OK

PIPE DESIGN

TOTAL H NEEDED = 0.0233(3.95)² + (25 × .00256)

= 0.43 FT OK

V(PIPE) = Q/A = 12.4/3.142 FT/SEC = 3.95 FT/SEC

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SF = Friction Slope = 0.00256 FT/FT

SPREAD = Y_g/S_C = 0.59/0.0125 = 47.2 FT No choice unless install lat. & collects water @ upstream.

Assumed Sump Cond. — not Continuous — Split from #26

NGINEERING COMPANY

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INLET (26)A LOCATION: STA 141+19 – 34.5' LT

V = 8.0 FT CAL'D RUNOFF = 0 CFS

L = 17 FT FLOW BY (#26) = 17.6 CFS

PIPE = 24 IN TOTAL Q = 17.6 CFS

SUMP = 3.75 IN S_0 = AVE GUTTER SLOPE = 0.0017 FT/FT

SPREAD = 32 FT S_C = X-SLOPE AT BASIN = 0.0125 FT/FT

INLET TYPE: M-1, L=17 Z = 80.00, Z/n = 5333.33

n = 0.015 for asphalt

From page 27 Y_g = 0.48 FT, V_g = 1.21 FT/SEC

DESIGN OF INLET

From page 40 Y_g = 0.48 FT, Q = 16.0 CFS, L = 17 FT

FLOWBY 17.6 – 16 = 1.6 CFS (From 26A TO 29)

DCB(MIN) = 1.17 + 0.0233(3.41)² + 2.0 = 3.44 USE V = 8.0 FT

HEAD

ELEV @ CURB = 70.80

HGL ELEV = 64.19

H = 6.61 – 1.17 = 5.44 FT

SUMP (Page 29)

Q/L = 10.7/20 = 0.54 CFS/FT

y_0/h = 0.75 FT/FT

h = 5 IN

y_0 = 3.75 IN

PIPE DESIGN

TOTAL H NEEDED = 0.0233(3.41)² + (25 X .00191)

= 0.32 FT OK

V(PIPE) = Q/A = 10.7/3.142 FT/SEC = 3.41 FT/SEC

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SF = Friction Slope = 0.00191 FT/FT

SPREAD = Y_g/S_C = 0.40/0.0125 = 32 FT No choice, unless install lateral upstream

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INLET (27)

LOCATION: STA 137+40.5 – 56' LT.

V = 4.0 FT

CAL'D RUNOFF = 10 CFS

L = 17 FT

FLOW BY ( ) = 0 CFS

PIPE = 18 IN

TOTAL Q = 10 CFS

SUMP = 3.6 IN

S_0 = AVE GUTTER SLOPE = 0.0030 FT/FT

SPREAD = 21 FT

S_C = X-SLOPE AT BASIN = 0.0200 FT/FT

INLET TYPE: M-1 L=17'

Z = 50.00, Z/n = 3333.33

n = 0.015 for asphalt

From page 27 Y_g = 0.42 FT, V_g = 1.68 FT/SEC

DESIGN OF INLET

From page 40 Y_g = 0.42 FT, Q = 13.2 CFS, L = 17 FT

FLOWBY ———

DCB(MIN) = 1.17+0.0233(5.66)^2 + 1.5 = 3.42' USE V = 4.0 FT

HEAD

ELEV @ CURB = 69.90

HGL ELEV = 62.07

H = 7.83 − 1.17 = 6.66 FT

SUMP (Page 29)

Q/L = 10/20 = 0.5 CFS/FT

y_0/h = 0.72 FT/FT

h = 5 IN

y_0 = 3.6 IN

PIPE DESIGN

TOTAL H NEEDED = 0.0233(5.66)^2+(41X.00772)

= 1.06 FT OK

V(PIPE) = Q/A = 10/1.767 FT/SEC = 5.66 FT/SEC

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SF = Friction Slope = 0.00772 FT/FT

SPREAD = Y_g/S_C = 0.42/0.02 = 21 FT

At Q = 15 cfs ⇒ Y_G = 0.49', Spread = 24.5' ∴ Some flow crests road. Overdesign (27) and let Q=5 for (28)

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INLET (28)

LOCATION: STA 136+94.5 - 56' LT

V = 7.0 FT

CAL'D RUNOFF = 15-10 = 5 CFS

L = 10 FT

FLOW BY ( ) = 0 CFS

PIPE = 24 IN

TOTAL Q = 5 CFS

SUMP = 2.95 IN

S_0 = AVE GUTTER SLOPE = 0.0030 FT/FT

SPREAD = 16 FT

S_C = X-SLOPE AT BASIN = 0.020 FT/FT

INLET TYPE: M-1 L=10'

Z = 50.0, Z/n = 3333.33

n = 0.015 for asphalt

From page 27 Y_g = 0.32 FT, V_g = 1.68 FT/SEC

DESIGN OF INLET

From page 40 Y_g = 0.32 FT, Q = 5.6 CFS, L = 10 FT

FLOWBY ___

DCB(MIN) = 1.17 + 0.0233(4.77 $)^2$ + 2.0 = 3.70 USE V = 7.0 FT

HEAD

ELEV @ CURB = 69.88

HGL ELEV = 61.94

H = 7.94 - 1.17 = 6.77 FT

SUMP (Page 29)

Q/L = 5/13 = 0.38 CFS/FT

y_0/h = 0.59 FT/FT

h = 5 IN

y_0 = 2.95 IN

PIPE DESIGN

TOTAL H NEEDED = 0.0233(4.77 $)^2$ + (49 x .00374

= 0.71 FT

V(PIPE) = Q/A = 15 / 3.142 FT/SEC = 4.77 FT/SEC (#27 #28)

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SF = Friction Slope = 0.00374 FT/FT

SPREAD = Y_g/S_C = 0.32 / 0.02 = 16 FT

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INLET (29)

LOCATION: STA 136+60 – 34.5' LT

V = 3.5 FT

CAL'D RUNOFF = 2.35 CFS

L = 6.0 FT

FLOW BY (#26A) = 1.6 CFS

PIPE = 15 IN

TOTAL Q = 3.95 CFS

SUMP = 3.25 IN

S_0 = AVE GUTTER SLOPE = 0.0013 FT/FT

SPREAD = 18.6 FT

S_C = X-SLOPE AT BASIN = 0.0188 FT/FT

INLET TYPE: M-1, L = 6'

Z = 53.19, Z/n = 3546.1

n = 0.015 for asphalt

From page 27 Y_g = 0.34 FT, V_g = 1.21 FT/SEC

DESIGN OF INLET

From page 40 Y_g = 0.34 FT, Q = 4.2 CFS, L = 6.0 FT

FLOWBY ___

DCB(MIN) = 1.17 + 0.0233(3.21)^2 + 1.25 = 2.66 USE V = 3.5 FT

HEAD

ELEV @ CURB = 69.38

HGL ELEV = 61.85

H = 7.53 − 1.17 = 6.36 FT

SUMP (Page 29)

Q/L = 3.95 / ~~6~~ 9 = ~~0.73~~ ~~0.48~~ .44 CFS/FT (68)

y_o/h = .65 ~~0.90~~ FT/FT

h = 5 IN

y_o = 3.25 ~~4.5~~ 3.4 IN = 0.38' > 0.35' (0.28' < 0.35')

OK @ L = 9'

PIPE DESIGN

TOTAL H NEEDED = 0.0233(3.21)^2 + (26 x .00317)

= 0.32 FT OK

V(PIPE) = Q/A = 3.95 / 1.23 FT/SEC = 3.21 FPS

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SF = Friction Slope = 0.00317 FT/FT

SPREAD = Y_g/S_C = 0.35 / 0.0188 = 18.6 FT

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INLET (30)

LOCATION: STA 136+60 – 34.5' RT

V = 3.5 FT

CAL'D RUNOFF = 2.62 CFS

L = 6.0 FT

FLOW BY ( ) = 0.56 CFS

PIPE = 15 IN

TOTAL Q = 3.18 CFS

SUMP = 3.7 IN

S_0 = AVE GUTTER SLOPE = 0.0033 FT/FT

SPREAD = 11.6 FT

S_C = X-SLOPE AT BASIN = 0.0250 FT/FT

INLET TYPE: M-1, L=6'

Z = 40.0, Z/n = 2667

n = 0.015 for asphalt

From page 27 Y_g = 0.29 FT, V_g = 1.84 FT/SEC

DESIGN OF INLET

From page 40 Y_g = 0.29 FT, Q = 3.3 CFS, L = 6 FT

FLOWBY ___

DCB(MIN) = 1.17 + 0.0233(2.59)² + 1.25 = 2.58' USE V = 3.5 FT

HEAD

ELEV @ CURB = 68.99

HGL ELEV = 61.85

H = 7.14 - 1.17 = 5.97 FT

SUMP (Page 29)

Q/L = 3.18 / ~~6~~ 9 = ~~0.53~~ 0.35 CFS/FT

y_0/h = ~~0.74~~ 0.54 FT/FT

h = 5 IN

y_0 = ~~3.7~~ 2.8 IN = ~~0.31~~ 0.23 < 0.29 ~~< 0.29~~

OK @ L=9'

PIPE DESIGN

TOTAL H NEEDED = 0.0233(2.59)² + (36 × .00205) + bend loss $\frac{V^2}{2g}$ = 0.33 FT OK

V(PIPE) = Q/A = 2.59 FT/SEC

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SF = Friction Slope = 0.00205 FT/FT

SPREAD = Y_g/S_C = 0.29 / 0.0250 = 11.6 FT

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INLET (31) LOCATION: STA 131+50 – 34.5' LT

V = 4.0 FT CAL'D RUNOFF = 2.56 CFS

L = 10.0 FT FLOW BY ( ) = — CFS

PIPE = 15 IN TOTAL Q_A = 2.56 CFS

SPREAD = 15.5 FT S_0 = AVE GUTTER SLOPE = 0.0018 FT/FT

INLET TYPE: M-1, L=10' S_C = X-SLOPE AT BASIN = 0.0167 FT/FT

Z = 59.88 Z/n = 3992

n = 0.015 for asphalt

From page 27 Y_g = 0.26 FT, V_g = 1.33 FT/SEC

DESIGN OF INLET

From page 28 Q_A/L_A = ___ L_A = 14.76 $L/L_A = \frac{13}{14.76}$ = 0.88

$\frac{a}{y} = \frac{0.16}{0.26}$ $\frac{Q}{Q_A}$ =

Q = (___)(___)0.8 = 1.94 CFS

FLOWBY (#31 TO #33) = 2.56 - 1.94 = 0.62 CFS

DCB(MIN) = 1.17 + 0.0233(1.58 $)^2$ + 1.25 = 2.48 USE V = 4.0 FT

HEAD

ELEV @ CURB = 68.54

HGL ELEV = 60.42

H = 8.12 - 1.17 = 6.95 FT

PIPE DESIGN

TOTAL H NEEDED = 0.0233(1.58 $)^2$ + (26 X .00077)

= 0.08 FT OK

V(PIPE) = Q/A = 1.58 FT/SEC

SF = Friction Slope = 0.00077 FT/FT

SPREAD = Y_g/S_C = $\frac{0.26}{0.0167}$ = 15.5 FT

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INLET (32) LOCATION: STA 131+50 – 34.5' RT

V = 4.0 FT CAL'D RUNOFF = 2.53 CFS

L = 10.0 FT FLOW BY ( ) = — CFS

PIPE = 15 IN TOTAL Q_A = 2.53 CFS

SPREAD = 15.9 FT S_0 = AVE GUTTER SLOPE = 0.0013 FT/FT

INLET TYPE: M-1, L=10' S_C = X-SLOPE AT BASIN = 0.0170 FT/FT

Z = 58.82 Z/n = 3922

n = 0.015 for asphalt

From page 27 Y_g = 0.27 FT, V_g = 1.18 FT/SEC

DESIGN OF INLET

From page 28 Q_A/L_A = ___ L_A = 14.0 $L/L_A = \frac{13}{14}$ = 0.93

$\frac{a}{y} = \frac{0.16}{0.27}$ $\frac{Q}{Q_A}$ =

Q = (___)(___)0.8 = 1.96 CFS

FLOWBY (#32 TO #34) = 2.53 – 1.96 = 0.57 CFS

DCB(MIN) = 1.17 + 0.0233(1.59)^2 + 1.25 = 2.48 USE V = 4.0 FT

HEAD

ELEV @ CURB = 68.17

HGL ELEV = 60.42

H = 7.75 – 1.17 = 6.58 FT

PIPE DESIGN

TOTAL H NEEDED = 0.0233(1.59)^2 + (36 x .00078) + bend loss = 0.13 FT OK

V(PIPE) = Q/A = 1.59 FT/SEC

SF = Friction Slope = 0.00078 FT/FT

SPREAD = Y_g/S_C = $\frac{0.27}{0.0170}$ = 15.9 FT

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INLET ⟨33⟩ LOCATION: STA 128+05 - 34.5' LT

V = 4.0 FT CAL'D RUNOFF = 1.56 CFS

L = 10.0 FT FLOW BY (#31) = 0.62 CFS

PIPE = 15 IN TOTAL Q = 2.18 CFS

SUMP = 2 IN S_0 = AVE GUTTER SLOPE = 0.0051 FT/FT

SPREAD = 12.5 FT S_C = X-SLOPE AT BASIN = 0.0156 FT/FT

INLET TYPE: M-1, L=10' Z = 64.10, Z/n = 4274

n = 0.015 for asphalt

From page 27 Y_g = 0.19 FT, V_g = 1.93 FT/SEC

DESIGN OF INLET

From page 40 Y_g = 0.19 FT, Q = 2.5 CFS, L = 10 FT

FLOWBY ______

DCB(MIN)=1.17+0.0233(1.77)^2 + 1.25 = 2.49' USE V = 4.0 FT

HEAD

ELEV @ CURB = 67.89

HGL ELEV = 59.43

H = 8.46-1.17 = 7.29 FT

SUMP (Page 29)

Q/L = $\frac{2.18}{10\ 13}$ = 0.22 CFS/FT

y_0/h = 0.40 FT/FT

h = 5 IN

y_0 = 2 IN = 0.17' < 0.19'

OK @ L=13' too.

PIPE DESIGN

TOTAL H NEEDED = 0.0233(1.77)^2+(26X.00097)

= 0.10 FT OK

V(PIPE) = Q/A = 1.77 FT/SEC

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SF = Friction Slope = 0.00097 FT/FT

SPREAD = Y_g/S_C = $\frac{0.19}{0.0156}$ = 12.5 FT

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INLET (34) LOCATION: STA 128+05- 34.5' RT

V = 4.0 FT CAL'D RUNOFF = 1.56 CFS

L = 10.0 FT FLOW BY (#32) = 0.57 CFS

PIPE = 15 IN TOTAL Q = 2.13 CFS

SUMP = 1.9 IN S_0 = AVE GUTTER SLOPE = 0.0086 FT/FT

SPREAD = 12.8 FT S_C = X-SLOPE AT BASIN = 0.0125 FT/FT

INLET TYPE: M-1, L=10' Z = 80.0, Z/n = 5333

n = 0.015 for asphalt

From page 27 Y_g = 0.16 FT, V_g = 2.22 FT/SEC

DESIGN OF INLET

From page 40 Y_g = 0.16 FT, Q = 1.90 CFS, L = 10 FT

FLOWBY (#34-#38) = 2.13 - 1.90 = 0.23CFS

DCB(MIN)=1.17+0.0233(1.54)² + 1.25 = 2.48 USE V = 4.0 FT

HEAD

ELEV @ CURB = 67.61

HGL ELEV = 59.43

H = 8.18-1.17 = 7.01 FT

SUMP (Page 29)

Q/L = 1.90/10 13 = 0.19 CFS/FT

y_0/h = 0.37 FT/FT

h = 5 IN

y_0 = 1.9 IN = 0.16' = 0.16'

OK @ L = 13' too

PIPE DESIGN

TOTAL H NEEDED = 0.0233(1.54)²+(35×.00073)

= 0.08 FT OK

V(PIPE) = Q/A = 1.54 FT/SEC

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SF = Friction Slope = 0.00073 FT/FT

SPREAD = Y_g/S_C = 0.16 / 0.0125 = 12.8 FT

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INLET (35)   LOCATION: STA 127+69 - 80' LT

V = 4.0 ~~5.0~~ FT   CAL'D RUNOFF = 30 CFS

L = 17.0 FT   FLOW BY ( ) = - CFS

PIPE = 24 IN   TOTAL Q = 30 CFS

SUMP = 4.7 IN S_0 = AVE GUTTER SLOPE = 0.0027 FT/FT

SPREAD = 32.0 FT S_C = X-SLOPE AT BASIN = 0.0200 FT/FT

INLET TYPE: M-2, L=17'   Z = 50, Z/n = 3333

n = 0.015 for asphalt

From page 27 Y_g = 0.64 FT, V_g = 1.62 FT/SEC

DESIGN OF INLET

From page 40 Y_g = 0.45 FT,   Q = 28 CFS,   L = 17 FT

FLOWBY (#35 TO #37) = 30 - 28 = 2 CFS

DCB(MIN) = 1.17 + 0.0233(8.91)^2 + 2.0 = 5.02 USE V = ___ FT

HEAD

ELEV @ CURB = 67.91

HGL ELEV = 59.32

H = 8.59 - 1.17 = 7.42 FT

SUMP (Page 29)

Q/L = 28/37 = 0.76 CFS/FT

y_0/h = 0.94 FT/FT

h = 5 IN

y_0 = 4.7 IN

.39 < .45 OK

PIPE DESIGN

TOTAL H NEEDED = 0.0233(8.91)^2 + (38 X 0.013)03

= 2.34 FT   OK

V(PIPE) = Q/A = 8.91 FT/SEC

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SF = Friction Slope = 0.01303 FT/FT

SPREAD = Y_g/S_C = 0.64 / 0.02 = 32 FT

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INLET (36) LOCATION: STA NOT REQUIRED

V = ______ FT CAL'D RUNOFF = ______ CFS

L = ______ FT FLOW BY (   ) = ______ CFS

PIPE = ______ IN TOTAL Q = ______ CFS

SUMP = ______ IN S_0 = AVE GUTTER SLOPE = ______ FT/FT

SPREAD = ______ FT S_C = X-SLOPE AT BASIN = ______ FT/FT

INLET TYPE: ______ Z = ______, Z/n = ______

n = 0.015 for asphalt

From page 27 Y_g = ______ FT, V_g = ______ FT/SEC

DESIGN OF INLET

From page 40 Y_g = ______ FT, Q = ______ CFS, L = ______ FT

FLOWBY ______

DCB(MIN) = $1.17 + 0.0233(\_\_\_)^2 +$ ______ = ______ USE V = ______ FT

HEAD

ELEV @ CURB = ______

HGL ELEV = ______

H = ______ = ______ FT

SUMP (Page 29)

Q/L = ______ CFS/FT

y_0/h = ______ FT/FT

h = ______ IN

y_0 = ______ IN

PIPE DESIGN

TOTAL H NEEDED = $0.0233(\_\_\_)^2 + (\_\_\_)$

= ______ FT

V(PIPE) = Q/A = ______ FT/SEC

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SF = Friction Slope = ______ FT/FT

SPREAD = Y_g/S_C = ______ = ______ FT

INLET (37) LOCATION: STA 126+45 – 34.5' LT

V = 4.0 FT CAL'D RUNOFF = 1.0 CFS

L = 10.0 FT FLOW BY (#35) = 2.0 CFS

PIPE = 15 IN TOTAL Q = 3.0 CFS

SUMP = 2.5 IN S_0 = AVE GUTTER SLOPE = 0.0051 FT/FT

SPREAD = 15.2 FT S_C = X-SLOPE AT BASIN = 0.0138 FT/FT

INLET TYPE: M-1, L=10' Z = 72.46, Z/n = 4831

n = 0.015 for asphalt

From page 27 Y_g = 0.21 FT, V_g = 1.87 FT/SEC

DESIGN OF INLET

From page 40 Y_g = 0.21 FT, Q = 3.0 CFS, L = 10 FT

FLOWBY ______

DCB(MIN) = 1.17 + 0.0233(2.44)^2 + 1.25 = 2.56 USE V = 4.0 FT

HEAD

ELEV @ CURB = 67.29

HGL ELEV = 59.51

H = 7.78 − 1.17 = 6.61 FT

SUMP (Page 29)

Q/L = 3/10 (13) = 0.30 CFS/FT

y_0/h = 0.50 FT/FT

h = 5 IN

y_0 = 2.5 IN = 0.21' = 0.21'

OK @ L=13' too

PIPE DESIGN

TOTAL H NEEDED = 0.0233(2.44)^2 + (26 × .00183)

= 0.19 FT OK

V(PIPE) = Q/A = 2.44 FT/SEC

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SF = Friction Slope = 0.00183 FT/FT

SPREAD = Y_g/S_C = 0.21 / 0.0138 = 15.2 FT

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INLET 38

LOCATION STA 126+45 – 35' RT

V = 3.0 FT

CAL'D RUNOFF = 1.0 CFS

PIPE = 15 IN

FLOW BY (#34) = 0.23 CFS

INLET TYPE: TYPE N

TOTAL Q = 1.23 CFS

SINGLE BASIN

S_c = 0.0320 FT/FT

COMPUTATION OF DEPTH

From Page 30 Curve A

$P = \frac{10.66 \times 1}{2} = 5.33$ FT

$\frac{Q}{P} = \frac{1.23}{5.33} = 0.23$

DEPTH = 0.18 FT

PIPE

TOP OF GRATE = 66.70

HGL = 59.51

HEAD(H) = 7.19 - 1.17 FT = 6.02 FT

H NEEDED = $\frac{1.5(1.0)^2}{64.4}$ + 36 X 0.00031 + bend loss

= 0.05 FT OK

n = 0.024 for unpaved road area

Sf = 0.00031

DCB = 1.17 + $\frac{1.5(1.0)^2}{64.4}$ + 1.25 = V = 2.44 FT USE V= 3.0 FT

SPREAD = DEPTH/S_c = $\frac{0.18}{0.0320}$ = 5.6 FT OK

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INLET (39) LOCATION STA 119+50 – 29' LT

V = 3.0 FT CAL'D RUNOFF = 3.41 CFS

PIPE = 15 IN FLOW BY (____) = — CFS

INLET TYPE: TYPE N TOTAL Q = 3.41 CFS

DOUBLE BASIN S_C = 0.0169 FT/FT

COMPUTATION OF DEPTH

From Page 30 Curve A

$P = \frac{10.66 \times 2}{2} = 10.66$ FT

$\frac{Q}{P} = \frac{3.41}{10.66} = 0.32$

DEPTH = 0.24 FT

PIPE

TOP OF GRATE = 64.50

HGL = 58.61

HEAD(H) = 5.90 - 1.17 FT = 4.73 FT

H NEEDED = $\frac{1.5(2.77)^2}{64.4}$ + 21 x .00236 + bend loss

= 0.35 FT OK

n = 0.024 for unpaved road area

Sf = 0.00236

DCB = 1.17 + $\frac{1.5(2.77)^2}{64.4}$ + 1.25 = V = 2.60 FT USE V = 3.0 FT

SPREAD = DEPTH/S_C = $\frac{0.24}{0.0169}$ = 14.2 FT

ENGINEERING COMPANY

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INLET (40)

LOCATION STA 119+50 - 43' RT

V = 3.0 FT

CAL'D RUNOFF = 3.41 CFS

PIPE = 15 IN

FLOW BY (______) = — CFS

INLET TYPE: TYPE N

TOTAL Q = 3.41 CFS

DOUBLE BASIN

S_C = 0.0137 FT/FT

COMPUTATION OF DEPTH

From Page 30 Curve A

$P = \frac{10.66 \times 2}{2} = 10.66$ FT

$\frac{Q}{P} = \frac{3.41}{10.66} = 0.32$

DEPTH = 0.24 FT

PIPE

TOP OF GRATE = 64.40

HGL = 58.61

HEAD(H) = 5.79 - 1.17 FT = 4.62 FT

H NEEDED = $\frac{1.5(2.77)^2}{64.4}$ + 45 x .00236 + bend loss

= 0.40 FT OK

n = 0.024 for unpaved road area

Sf = 0.00236

DCB = $1.17 + \frac{1.5(2.77)^2}{64.4} + 1.25$ = V = 2.60 FT USE V = 3.0 FT

SPREAD = DEPTH/S_C = $\frac{0.24}{0.0137}$ = 17.5 FT

SFC ENGINEERING COMPANY

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INLET ⟨41⟩

LOCATION STA 115+55 – 27' LT

V = 3.5 FT

CAL'D RUNOFF = 7.0 CFS

PIPE = 15 IN

FLOW BY (____) = — CFS

INLET TYPE: TYPE N

TOTAL Q = 7.0 CFS

TRIPLE BASIN

S_C = 0.020 FT/FT

COMPUTATION OF DEPTH

From Page 30 Curve A

$P = \frac{10.66 \times 3}{2} = 15.99$ FT

$\frac{Q}{P} = \frac{7.0}{15.99} = 0.44$

DEPTH = 0.30 FT

PIPE

TOP OF GRATE = 64.60

HGL = 58.10

HEAD(H) = 6.50 – 1.17 FT = 5.33 FT

H NEEDED = $\frac{1.5(5.69)^2}{64.4}$ + 20 x .00995

= 0.95 FT OK

n = 0.024 for unpaved road area

Sf = 0.00995

DCB = $1.17 + \frac{1.5(5.69)^2}{64.4} + 1.25$ = V = 3.17 FT USE V=3.5FT

SPREAD = DEPTH/S_C = $\frac{0.30}{0.020}$ = 15 FT

ENGINEERING COMPANY

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INLET (42)   LOCATION: STA 111+96 – 34.5' LT

V = 3.5 FT   CAL'D RUNOFF = 1.75 CFS

L = 6.0 FT   FLOW BY (   ) = — CFS

PIPE = 15 IN   TOTAL Q = 1.75 CFS

SUMP = 2.45 IN S_0 = AVE GUTTER SLOPE = 0.0032 FT/FT

SPREAD = 10.4 FT S_C = X-SLOPE AT BASIN = 0.0212 FT/FT

INLET TYPE: M-1, L=6'   Z = 47.17, Z/n = 3144

n = 0.015 for asphalt

From page 27 Y_g = 0.22 FT, V_g = 1.85 FT/SEC

DESIGN OF INLET

From page 40 Y_g = 0.22 FT,   Q = 2.1 CFS,   L = 6 FT

FLOWBY ——

DCB(MIN) = 1.17 + 0.0233(1.42)^2 + 1.25 = 2.47   USE V = 3.5 FT

HEAD

ELEV @ CURB = 63.84

HGL ELEV = 57.55

H = 6.29 − 1.17 = 5.12 FT

SUMP (Page 29)

Q/L = 1.75 / ~~6~~ 9 = 0.29 CFS/FT

y_0/h = 0.49 FT/FT

h = 5 IN

y_0 = 2.45 IN = 0.20 < 0.22

OK @ L=9' too

PIPE DESIGN

TOTAL H NEEDED = 0.0233(1.42)^2 + (26 x .00062

= 0.06 FT   OK

V(PIPE) = Q/A = 1.42 FT/SEC

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SF = Friction Slope = 0.00062 FT/FT

SPREAD = Y_g/S_C = 0.22 / 0.0212 = 10.4 FT

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INLET: 43 — LOCATION: STA 111+96 – 34.5' RT

V = 4.0 FT — CAL'D RUNOFF = 3.66 CFS

L = 10 FT — FLOW BY ( ) = / CFS

PIPE = 15 IN — TOTAL Q_A = 3.66 CFS

SPREAD = 14.8 FT — S_0 = AVE GUTTER SLOPE = 0.0032 FT/FT

INLET TYPE: M-1, L=10' — S_C = X-SLOPE AT BASIN = 0.0182 FT/FT

Z = 54.95, Z/n = 3663

n = 0.015 for asphalt

From page 27 Y_g = 0.27 FT, V_g = 1.69 FT/SEC

DESIGN OF INLET

From page 28 Q_A/L_A = ___ L_A = 20.25 $L/L_A = \frac{13}{20.25}$ = 0.64

$\frac{a}{y} = \frac{0.16}{0.27}$ $\frac{Q}{Q_A}$ =

Q = (___)(___)0.8 = 2.32 CFS

FLOWBY (#43 TO #45) = 3.66 - 2.32 = 1.34 CFS

DCB(MIN) = 1.17+0.0233(1.89)² + 1.25 = 2.50' USE V = 4.0 FT

HEAD

ELEV @ CURB = 64.00

HGL ELEV = 67.55

H = 64.5 - 1.17 = 5.28 FT

PIPE DESIGN

TOTAL H NEEDED = 0.0233(1.89)² + (35)(.00109) + bend loss = 0.18 FT OK

V(PIPE) = Q/A = 1.89 FT/SEC

SF = Friction Slope = 0.00109 FT/FT

SPREAD = Y_g/S_C = $\frac{0.27}{0.0182}$ = 14.8 FT

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INLET ⟨44⟩ LOCATION: STA 106+00 - 34.5' LT

V = 4.0 FT CAL'D RUNOFF = 2.95 CFS

L = 10.0 FT FLOW BY ( ) = — CFS

PIPE = 15 IN TOTAL Q_A = 2.95 CFS

SPREAD = 11.6 FT S_0 = AVE GUTTER SLOPE = 0.0032 FT/FT

INLET TYPE: M-1, L=10' S_C = X-SLOPE AT BASIN = 0.0242 FT/FT

Z = 41.32, Z/n = 2754.8

n = 0.015 for asphalt

From page 27 Y_g = 0.28 FT, V_g = 1.81 FT/SEC

DESIGN OF INLET

From page 28 Q_A/L_A = ___ L_A = 15.69 $L/L_A = \frac{13}{15.69}$ = 0.83

$\frac{a}{y} = \frac{.016}{0.28}$ $\frac{Q}{Q_A}$ = Q = (___)(___)0.8 = 2.17 CFS

FLOWBY (#44 - #46) = 2.95 - 2.17 = 0.78 CFS

DCB(MIN)=1.17+0.0233(1.76)^2 + 1.25 = 2.49 USE V = 4.0 FT

HEAD

ELEV @ CURB = 61.54

HGL ELEV = 56.78

H = 4.76 - 1.17 = 3.59 FT

PIPE DESIGN

TOTAL H NEEDED = 0.0233(1.76)^2+(26X.000)96

+ bend loss = 0.15 FT OK

V(PIPE) = Q/A = 1.76 FT/SEC

SF = Friction Slope = 0.00096 FT/FT

SPREAD = Y_g/S_C = $\frac{0.28}{0.0242}$ = 11.6 FT

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INLET (45)   LOCATION: STA 106+00 – 34.5' RT

V = 4.0 FT   CAL'D RUNOFF = 2.95 CFS

L = 10.0 FT   FLOW BY (   ) = 1.34 CFS

PIPE = 15 IN   TOTAL Q_A = 4.29 CFS

SPREAD = 16.2 FT S_0 = AVE GUTTER SLOPE = 0.0032 FT/FT

INLET TYPE: M-1, L=10' S_C = X-SLOPE AT BASIN = 0.0179 FT/FT

Z = 55.87 Z/n = 3724.39

n = 0.015 for asphalt

From page 27 Y_g = 0.29 FT, V_g = 1.68 FT/SEC

DESIGN OF INLET

From page 28 Q_A/L_A = ____ L_A = 21.96 $L/L_A = \frac{13}{21.96}$ = 0.59

$\frac{a}{y} = \frac{0.16}{0.29}$ $\frac{Q}{Q_A}$ =

Q = (____)(____)0.8 = 2.60 CFS

FLOWBY (#45 TO #50) = 4.29 – 2.60 = 1.69 CFS

DCB(MIN) = 1.17 + 0.0233(2.11)² + 1.25 = 2.52'   USE V = 4.0 FT

HEAD

ELEV @ CURB = 61.53

HGL ELEV = 56.78

H = 4.75 – 1.17 = 3.58 FT

PIPE DESIGN

TOTAL H NEEDED = 0.0233(2.11)² + (35)(.00137) + bend loss = 0.22 FT   OK

V(PIPE) = Q/A = 2.11 FT/SEC

SF = Friction Slope = 0.00137 FT/FT

SPREAD = Y_g/S_C = $\frac{0.29}{0.0179}$ = 16.2 FT

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INLET (46) LOCATION: STA 101+32 – 34.5' LT

V = 3.5 FT CAL'D RUNOFF = 2.30 CFS

L = 6.0 FT FLOW BY (#44) = 0.78 CFS

PIPE = 15 IN TOTAL Q = 3.08 CFS

SUMP = 2.95 IN S_0 = AVE GUTTER SLOPE = 0.0032 FT/FT

SPREAD = 11.10 FT S_C = X-SLOPE AT BASIN = 0.0266 FT/FT

INLET TYPE: M-1, L=6' Z = 37.59, Z/n = 2506.27

n = 0.015 for asphalt

From page 27 Y_g = 0.30 FT, V_g = 1.85 FT/SEC

DESIGN OF INLET

From page 40 Y_g = 0.30 FT, Q = 3.5 CFS, L = 6.0 FT

FLOWBY ___

DCB(MIN) = 1.17 + 0.0233(2.50)² + 1.25 = 2.57 USE V = 3.5 FT

HEAD

ELEV @ CURB = 59.14

HGL ELEV = 56.16

H = 2.98 − 1.17 = 1.81 FT

SUMP (Page 29)

Q/L = 3.08/6.0 = 0.51 CFS/FT

y_0/h = 0.59 FT/FT

h = 5 IN

y_0 = 2.95 IN = 0.25' < 0.30'

OK @ L=9' too

PIPE DESIGN

TOTAL H NEEDED = 0.0233(2.50)² + (25)(.00193) + bend loss $v^2/2g$ = 0.29 FT OK

V(PIPE) = Q/A = 2.50 FT/SEC

Page 31

Page 32

SF = Friction Slope = 0.00193 FT/FT

SPREAD = Y_g/S_C = 0.30 / 0.0266 = 11.1 FT

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INLET (47) LOCATION: STA 100+98 – 79' LT

V = 4.5 FT CAL'D RUNOFF = 24.5 CFS

L = 10 FT FLOW BY ( ) = — CFS

PIPE = 24 IN TOTAL Q = 24.5 CFS

SUMP = 6.25 IN S_0 = AVE GUTTER SLOPE = 0.0037 FT/FT

SPREAD = 23.7 FT S_C = X-SLOPE AT BASIN = 0.0266 FT/FT

INLET TYPE: M-2, L=10' Z = 37.59, Z/n = 2506.27

n = 0.015 for asphalt

From page 27 Y_g = 0.63 FT, V_g = 1.95 FT/SEC

DESIGN OF INLET

From page 40 Y_g = 0.55 FT, Q = 22.2 CFS, L = 10 FT

FLOWBY (#47–#49) = 24.5 – 22.2 = 2.3 CFS

DCB(MIN)=1.17+0.0233(7.07)^2 + 2.0 = 4.33' USE V = 4.5 FT

HEAD

ELEV @ CURB = 59.18

HGL ELEV = 56.11

H = 3.07–1.17 = 1.90 FT

SUMP (Page 29)

Q/L = 22.2/20 (23) = 1.11 CFS/FT

y_0/h = 1.25 FT/FT

h = 5 IN

y_0 = 6.25 IN = 0.52 < 0.56 (0.55)

OK@ L = 23 too

PIPE DESIGN

TOTAL H NEEDED = 0.0233(7.07)^2+(32x.0082)

= 1.43 FT OK

V(PIPE) = Q/A = 7.07 FT/SEC

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SF = Friction Slope = 0.0082 FT/FT

SPREAD = Y_g/S_C = 0.63 / 0.0266 = 23.7 FT

ENGINEERING COMPANY

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INLET ⟨48⟩ LOCATION: STA 100+29 – 79' LT

V = 4.5 FT CAL'D RUNOFF = 24.5 CFS

L = 10.0 FT FLOW BY ( ) = — CFS

PIPE = 24 IN TOTAL Q = 24.5 CFS

SUMP = 6.25 IN S_0 = AVE GUTTER SLOPE = 0.0037 FT/FT

SPREAD = 23.7 FT S_C = X-SLOPE AT BASIN = 0.0266 FT/FT

INLET TYPE: M-2, L=10' Z = 37.59, Z/n = 2506.27

n = 0.015 for asphalt

From page 27 Y_g = 0.63 FT, V_g = 1.95 FT/SEC

DESIGN OF INLET

From page 40 Y_g = 0.55 FT, Q = 22.2 CFS, L = 10 FT

FLOWBY (#48 TO #49) = 24.5 – 22.2 = 2.3 CFS

DCB(MIN) = 1.17+0.0233(7.07)^2 + 2.0 = 4.33' USE V = 4.5 FT

HEAD

ELEV @ CURB = 59.12

HGL ELEV = 55.03

H = 4.09 – 1.17 = 2.92 FT

SUMP (Page 29)

Q/L = 22.2/~~20~~ 23 = 1.11 CFS/FT

y_0/h = 1.25 FT/FT

h = 5 IN

y_0 = 6.25 IN = 0.52' < ~~0.86~~ 0.55'

OK @ L = 23' too

PIPE DESIGN

TOTAL H NEEDED = 0.0233(7.07)^2+(26X.0082)

= 1.38 FT OK

V(PIPE) = Q/A = 7.07 FT/SEC

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SF = Friction Slope = 0.0082 FT/FT

SPREAD = Y_g/S_C = 0.63 / 0.0266 = 23.7 FT

SFC ENGINEERING COMPANY

Subject **INLET DESIGN COMPUTATIONS** Project **Cactus Rd**

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INLET (49)

LOCATION: STA 99+80 – 34.5' LT

V = 8.0 FT

CAL'D RUNOFF = 1.0 CFS

L = 10 FT

FLOW BY (#47 #48) = 4.6 CFS

PIPE = 15 IN

TOTAL Q = 5.6 CFS

SUMP = 3.8 IN

S_0 = AVE GUTTER SLOPE = 0.0037 FT/FT

SPREAD = 15 FT

S_C = X-SLOPE AT BASIN = 0.0219 FT/FT

INLET TYPE: M-1, L=10'

Z = 45.66, Z/n = 3044

n = 0.015 for asphalt

From page 27 Y_g = 0.33 FT, V_g = 1.86 FT/SEC

DESIGN OF INLET

From page 40 Y_g = 0.33 FT, Q = 6.0 CFS, L = 10 FT

FLOWBY ———

DCB(MIN)=1.17+0.0233(4.55)² + 1.25 = 2.90 USE V = 8.0 FT

HEAD

ELEV @ CURB = 58.68

HGL ELEV = 55.02

H = 3.66-1.17 = 2.49 FT

SUMP (Page 29)

Q/L = 5.6/~~10~~ 13 = 0.56 CFS/FT

y_0/h = 0.76 FT/FT

h = 5 IN

y_0 = 3.8 IN = 0.32' < 0.33'
OK @ L = 13' + 00

PIPE DESIGN

TOTAL H NEEDED = 0.0233(4.55)²+(24X.0064)
+ bend loss v²/2g = 0.96 FT OK

V(PIPE) = Q/A = 4.55 FT/SEC

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SF = Friction Slope = 0.00636 FT/FT

SPREAD = Y_g/S_C = 0.33/0.0219 = 15 FT

ENGINEERING COMPANY

Subject **INLET DESIGN COMPUTATIONS** Project **Cactus Rd**

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INLET (50)

LOCATION: STA 99+80 – 34.5' RT

V = 4.0 FT

CAL'D RUNOFF = 3.04 CFS

L = 10 FT

FLOW BY ( ) = 1.69 CFS

PIPE = 15 IN

TOTAL Q = 4.73 CFS

SUMP = 3.4 IN

S_0 = AVE GUTTER SLOPE = 0.0037 FT/FT

SPREAD = 15 FT

S_C = X-SLOPE AT BASIN = 0.0200 FT/FT

INLET TYPE: M-1, L=10'

Z = 50.0, Z/n = 3333.33

n = 0.015 for asphalt

From page 27 Y_g = 0.30 FT, V_g = 1.82 FT/SEC

DESIGN OF INLET

From page 40 Y_g = 0.30 FT, Q = 5.1 CFS, L = 10 FT

FLOWBY ——

DCB(MIN)=1.17+0.0233(3.85)² + 1.25 = 2.76' USE V = 4.0 FT

HEAD

ELEV @ CURB = 58.55

HGL ELEV = 55.02

H = 3.53−1.17 = 2.36 FT

SUMP (Page 29)

Q/L = 4.73 / 10 (13) = 0.47 CFS/FT

y_0/h = 0.68 FT/FT

h = 5 IN

y_0 = 3.4 IN = 0.28 < 0.30

OK @ L = 13' too

PIPE DESIGN

TOTAL H NEEDED = 0.0233(3.85)²+(35X.00454)

+ bend loss = 0.73 FT OK

V(PIPE) = Q/A = 3.85 FT/SEC

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Page 32

SF = Friction Slope = 0.00454 FT/FT

SPREAD = Y_g/S_C = 0.30 / 0.0200 = 15 FT

SFC ENGINEERING COMPANY

Subject INLET DESIGN COMPUTATIONS Project Cactus Rd

CONTINUOUS CONDITION File Number 35902.00

Computed MYB/Hcm Checked MYB Date 12/10/91 Page 53 of ___ Pages

INLET (51) LOCATION: STA 94+00 - 34.5' LT

V = 5.0 FT CAL'D RUNOFF = 2.82 CFS

L = 10 FT FLOW BY ( ) = — CFS

PIPE = 15 IN TOTAL Q_A = 2.82 CFS

SPREAD = 14.8 FT S_0 = AVE GUTTER SLOPE = 0.0019 FT/FT

INLET TYPE: M-1, L=10 S_C = X-SLOPE AT BASIN = 0.0189 FT/FT

Z = 52.91, Z/n = 3527

n = 0.015 for asphalt

From page 27 Y_g = 0.28 FT, V_g = 1.40 FT/SEC

DESIGN OF INLET

From page 28 Q_A/L_A = ___ L_A = 15.0 L/L_A = $\frac{13}{15}$ = 0.87

$\frac{a}{y} = \frac{0.16}{0.28}$ $\frac{Q}{Q_A}$ = Q = (___)(___)0.8 = 2.12 CFS

FLOWBY (#51 TO #53) = 2.82 - 2.12 = 0.70 CFS

DCB(MIN)=1.17+0.0233(1.72)² + 1.25 = 2.49 USE V = 5.0 FT

HEAD

ELEV @ CURB = 57.46

HGL ELEV = 53.85

H = 3.61-1.17 = 2.44 FT

PIPE DESIGN

TOTAL H NEEDED = 0.0233(1.72)²+(24X.00091) + bend v^2 loss $2g$ = 0.14 FT OK

V(PIPE) = Q/A = 1.72 FT/SEC

SF = Friction Slope = 0.00091 FT/FT

SPREAD = Y_g/S_C = $\frac{0.28}{0.0189}$ = 14.8 FT

SFC ENGINEERING COMPANY

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INLET: (52) | LOCATION: STA 94+00 – 34.5' RT

V = 3.5 FT | CAL'D RUNOFF = 2.82 CFS

L = 6.0 FT | FLOW BY ( ) = — CFS

PIPE = 15 IN | TOTAL Q_A = 2.82 CFS

SPREAD = 16.4 FT | S_0 = AVE GUTTER SLOPE = 0.0019 FT/FT

INLET TYPE: M-1, L=6' | S_C = X-SLOPE AT BASIN = 0.0158 FT/FT

Z = 63.29, Z/n = 4219

n = 0.015 for asphalt

From page 27 Y_g = 0.26 FT, V_g = 1.35 FT/SEC

DESIGN OF INLET

From page 28 Q_A/L_A = ___ L_A = 16.26 $L/L_A = \frac{9}{16.26}$ = 0.55

$\frac{a}{y} = \frac{0.16}{0.26}$ $\frac{Q}{Q_A}$ =

Q = (___)(___)0.8 = 1.61 CFS

FLOWBY (#52 TO #54) = 2.82 – 1.61 = 1.21 CFS

DCB(MIN) = 1.17 + 0.0233(1.31)^2 + 1.25 = 2.46 USE V = 3.5 FT

HEAD

ELEV @ CURB = 57.29

HGL ELEV = 53.85

H = 3.44 – 1.17 = 2.27 FT

PIPE DESIGN

TOTAL H NEEDED = 0.0233(1.31)^2 + (35)(.00053) + bend or loss T_g = 0.09 FT OK

V(PIPE) = Q/A = 1.31 FT/SEC

SF = Friction Slope = 0.00053 FT/FT

SPREAD = Y_g/S_C = $\frac{0.26}{0.0158}$ = 16.4 FT

SFC ENGINEERING COMPANY

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Project: Cactus Rd
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INLET: 53 LOCATION: STA ~~88+06~~ 90+00 – 34.5' LT

V = 4.0 FT CAL'D RUNOFF = 3.08 CFS

L = 10.0 FT FLOW BY ( ) = 0.70 CFS

PIPE = 15 IN TOTAL Q = 3.78 CFS

SUMP = 2.95 IN S_0 = AVE GUTTER SLOPE = 0.0019 FT/FT

SPREAD = 20.6 FT S_C = X-SLOPE AT BASIN = 0.0131 FT/FT

INLET TYPE: M-1, L=10' Z = 76.34, Z/n = 5089

n = 0.015 for asphalt

From page 27 Y_g = 0.27 FT, V_g = 1.28 FT/SEC

DESIGN OF INLET

From page 40 Y_g = 0.27 FT, Q = 4.3 CFS, L = 10 FT

FLOWBY ___

DCB(MIN) = 1.17 + 0.0233(3.07)^2 + 1.25 = 2.64 USE V = 4.0 FT

HEAD

ELEV @ CURB = 56.04

HGL ELEV = 52.59

H = 3.45 – 1.17 = 2.28 FT

SUMP (Page 29)

Q/L = 3.78/10 = 0.38 CFS/FT

y_0/h = 0.59 FT/FT

h = 5 IN

y_0 = 2.95 IN = 0.25 < 0.27

OK @ L = 13' too

PIPE DESIGN

TOTAL H NEEDED = 0.0233(3.07)^2 + (25 X .0029) + bend loss = 0.44 FT OK

V(PIPE) = Q/A = 3.07 FT/SEC

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SF = Friction Slope = 0.0029 FT/FT

SPREAD = Y_g/S_C = 0.27 / 0.0131 = 20.6 FT

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INLET (54)

LOCATION: STA 87+70 - 34.5' RT

V = 4.0 FT

CAL'D RUNOFF = 3.08 CFS

L = 10.0 FT

FLOW BY ( ) = 1.21 CFS

PIPE = 15 IN

TOTAL Q = 4.29 CFS

SUMP = 3.2 IN

S_0 = AVE GUTTER SLOPE = 0.0014 FT/FT

SPREAD = 27.3 FT

S_C = X-SLOPE AT BASIN = 0.0099 FT/FT

INLET TYPE: M-1, L=10'

Z = 101.01, Z/n = 6734

n = 0.015 for asphalt

From page 27 Y_g = 0.27 FT, V_g = 1.1 FT/SEC

DESIGN OF INLET

From page 40 Y_g = 0.27 FT, Q = 4.3 CFS, L = 10 FT

FLOWBY ——

DCB(MIN)=1.17+0.0233(3.49)^2 + 1.25 = 2.70' USE V = 4.0 FT

HEAD

ELEV @ CURB = 56.10

HGL ELEV = 52.59

H = 3.51 − 1.17 = 2.34 FT

SUMP (Page 29)

Q/L = 3.08/13 = 0.24 CFS/FT

y_0/h = 0.42 FT/FT

h = 5 IN

y_0 = 2.1 IN = 0.18' < 0.27'

OK

PIPE DESIGN

TOTAL H NEEDED = 0.0233(3.49)^2+(35X.00)374

+ bend loss $\frac{v^2}{2g}$ = 0.60 FT OK

V(PIPE) = Q/A = 3.49 FT/SEC

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SF = Friction Slope = 0.00374 FT/FT

SPREAD = Y_g/S_C = 0.27 / 0.0099 = 27.3 FT

SFC ENGINEERING COMPANY

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Computed MYB/HVM Checked MYB Date 12/10/91 Page 57 of ___ Pages

INLET (55) LOCATION: STA 87+50 – 71' LT (81st Ave)

V = 5 FT CAL'D RUNOFF = 36.5 CFS

L = 17 FT FLOW BY ( ) = – CFS

PIPE = 24 IN TOTAL Q = 36.5 CFS

SUMP = 4.85 IN S_0 = AVE GUTTER SLOPE = 0.0010 FT/FT

SPREAD = 42 FT S_C = X-SLOPE AT BASIN = 0.0200 FT/FT

INLET TYPE: M-2, L=17' Z = 50.0, Z/n = 3333

n = 0.015 for asphalt

Note: y_g @ Q=73cfs = 1.08' d @ curb = 0.5' Z @ crest = ... No question that flow crests 81st Ave & splitting flow equally is proba. reasonable.

From page 27 Y_g = 0.84 FT, V_g = 1.11 FT/SEC

DESIGN OF INLET

From page 40 Y_g = 0.47 FT, Q = 28 CFS, L = 17 FT

FLOWBY (#55 TO #57) = 36.5 – 28.0 = 8.5 CFS

DCB(MIN) = 1.17 + 0.0233(8.91)² + 2.0 = 5.02 USE V = 5.0 FT

HEAD

ELEV @ CURB = 56.31

HGL ELEV = 52.55

H = 3.76 – 1.17 = 2.59 FT

SUMP (Page 29)

Q/L = ~~28/20~~ 28/37 = ~~0.82~~ 0.76 CFS/FT

y_0/h = ~~0.97~~ 0.94 FT/FT

h = 5 IN

y_0 = ~~4.85~~ 4.7 IN = ~~0.40~~ 0.39 < 0.47

OK

PIPE DESIGN

TOTAL H NEEDED = 0.0233(8.91)² + (22 X .013)04

= 2.14 FT OK

V(PIPE) = Q/A = 8.91 FT/SEC

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SF = Friction Slope = 0.01304 FT/FT

SPREAD = Y_g/S_C = 0.84 / 0.02 = 42 FT – No choice unless install lateral.

This intersection will always flood even when laterals are installed w/ this design.

ENGINEERING COMPANY

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INLET (56) LOCATION: STA 87+05.5 – 71' LT

V = 5 FT CAL'D RUNOFF = 36.5 CFS

L = 17 FT FLOW BY ( ) = — CFS

PIPE = 24 IN TOTAL Q = 36.5 CFS ← See Note on (55)

SUMP = 4.85 IN S_0 = AVE GUTTER SLOPE = 0.0010 FT/FT

SPREAD = 42 FT S_C = X-SLOPE AT BASIN = 0.0200 FT/FT

INLET TYPE: M-2, L=17' Z = 50.00, Z/n = 3333

n = 0.015 for asphalt

From page 27 Y_g = 0.84 FT, V_g = 1.11 FT/SEC

DESIGN OF INLET

From page 40 Y_g = 0.47 FT, Q = 28 CFS, L = 17 FT

FLOWBY (#56 TO #57) = 36.5 - 28.0 = 8.5 CFS

DCB(MIN) = 1.17 + 0.0233(8.91)² + 2.0 = 5.02 USE V = 5.0 FT

HEAD

ELEV @ CURB = 56.32

HGL ELEV = 51.78

H = 4.54 - 1.17 = 3.37 FT

SUMP (Page 29)

Q/L = 28/~~34~~ 37 = ~~.82~~ 0.74 CFS/FT

y_0/h = ~~0.97~~ 0.14 FT/FT

h = 5 IN

y_0 = ~~4.85~~ 4.7 IN = 0.39 < 0.47

OK

PIPE DESIGN

TOTAL H NEEDED = 0.0233(8.91)² + (18X.01304)

= 2.08 FT OK

V(PIPE) = Q/A = 8.91 FT/SEC

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SF = Friction Slope = 0.01304 FT/FT

SPREAD = Y_g/S_C = 0.84 / 0.02 = 42 FT

SFC ENGINEERING COMPANY

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INLET (57) LOCATION: STA 86+74 - 34.5' LT

V = 4.0 FT CAL'D RUNOFF = 1.0 CFS

L = 10 FT FLOW BY ( ) = 17.0 CFS

PIPE = 24 IN TOTAL Q = 18.0 CFS

SUMP = 5.25 IN S_0 = AVE GUTTER SLOPE = 0.0019 FT/FT

SPREAD = 33 FT S_C = X-SLOPE AT BASIN = 0.0156 FT/FT

INLET TYPE: M-2, L=10' Z = 64.10, Z/n = 4274

n = 0.015 for asphalt

From page 27 Y_g = 0.52 FT, V_g = 1.33 FT/SEC

DESIGN OF INLET

From page 40 Y_g = 0.52 FT, Q = 20.6 CFS, L = 10 FT

FLOWBY ___/___

DCB(MIN)=1.17+0.0233(5.73)² + 2.0 = 3.94 USE V = 4.0 FT

HEAD

ELEV @ CURB = 55.92

HGL ELEV = 51.70

H = 4.22-1.17 = 3.05 FT

SUMP (Page 29)

Q/L = 18/20 = 0.90 CFS/FT

y_0/h = 1.05 FT/FT

h = 5 IN

y_0 = 5.25 IN = 0.44 < 0.52

OK @ L=23 too

PIPE DESIGN

TOTAL H NEEDED = 0.0233(5.73)²+(25x.0054) + bend loss $\frac{v^2}{2g}$ = 1.41 FT OK

V(PIPE) = Q/A = 5.73 FT/SEC

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Page 32

SF = Friction Slope = 0.0054 FT/FT

SPREAD = Y_g/S_C = 0.52 / 0.0156 = 33 FT

This intersection will always flood because of the large volume of flow down 81st Ave &

INLET (58)

LOCATION STA 86+74 – 27.5' RT

V = 3.0 FT

CAL'D RUNOFF = 1.0 CFS

PIPE = 15 IN

FLOW BY (#57) = 1.0 CFS

INLET TYPE: TYPE N

TOTAL Q = 2.0 CFS

DOUBLE BASIN

S_C = 0.0120 FT/FT

COMPUTATION OF DEPTH

From Page 30 Curve A

$P = \frac{10.66 \times 2}{2} = 10.66$ FT

$\frac{Q}{P} = \frac{2}{10.66} = 0.19$

DEPTH = 0.17 FT

PIPE

TOP OF GRATE = 55.60

HGL = 51.70

HEAD(H) = 3.90–1.17 FT = 2.73 FT

H NEEDED = $\frac{1.5(1.63)^2}{64.4}$ + 31 X 0.00081 + bend

= 0.13 FT OK

n = 0.024 for unpaved road area

Sf = 0.00081

$DCB = 1.17 + \frac{1.5(1.63)^2}{64.4} + 1.25 = V = 2.48$ FT USE V = 3.0'

SPREAD = DEPTH/S_C = $\frac{0.17}{0.0120}$ = 14 FT OK

SFC ENGINEERING COMPANY

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INLET (59)

LOCATION STA 80+30 - 34' LT

V = 4.0 FT

CAL'D RUNOFF = 3.11 CFS

PIPE = 15 IN

FLOW BY (______) = — CFS

INLET TYPE: TYPE N

TOTAL Q = 3.11 CFS

DOUBLE BASIN

S_C = 0.0110 FT/FT

COMPUTATION OF DEPTH

From Page 30 Curve A

$P = \frac{10.66 \times 2}{2} = 10.66$ FT

$\frac{Q}{P} = \frac{3.11}{10.66} = 0.29$

DEPTH = 0.22 FT

PIPE

TOP OF GRATE = 53.60

HGL = 50.13

HEAD(H) = 3.47 - 1.17 = 2.3 FT

H NEEDED = $\frac{1.5(2.53)^2}{64.4} + 24 \times .00196$

= 0.20 FT OK

n = 0.024 for unpaved road area

Sf = 0.00196

DCB = $1.17 + \frac{1.5(2.53)^2}{64.4} + 1.25$ = V = 2.57 FT USE V = 4.0 FT

SPREAD = DEPTH/S_C = $\frac{0.22}{0.0110}$ = 20 FT OK

INLET (60) LOCATION: STA 80+30 – 34.5' RT

V = 4.0 FT CAL'D RUNOFF = 3.11 CFS

L = 10.0 FT FLOW BY ( ) = — CFS

PIPE = 15 IN TOTAL Q_A = 3.11 CFS

SPREAD = 18.1 FT S_0 = AVE GUTTER SLOPE = 0.0029 FT/FT

INLET TYPE: M-1, L=10' S_C = X-SLOPE AT BASIN = 0.0127 FT/FT

Z = 78.74, Z/n = 5249.34

n = 0.015 for asphalt

From page 27 Y_g = 0.23 FT, V_g = 1.48 FT/SEC

DESIGN OF INLET

From page 28 Q_A/L_A = ___ L_A = 20.45 $L/L_A = \frac{13}{20.45}$ = 0.64

$\frac{a}{y} = \frac{0.16}{0.23}$ $\frac{Q}{Q_A}$ = Q = (___)(___)0.8 = 1.93 CFS

FLOWBY (#60 TO #65) = 3.11 – 1.93 = 1.18 CFS

DCB(MIN)=1.17+0.0233(1.57)^2 + 1.25 = 2.48 USE V = 4.0 FT

HEAD

ELEV @ CURB = 54.26

HGL ELEV = 50.13

H = 4.13 – 1.17 = 2.96 FT

PIPE DESIGN

TOTAL H NEEDED = 0.0233(1.57)^2+(36 X .00076 + bend loss = 0.12 FT OK

V(PIPE) = Q/A = 1.57 FT/SEC

SF = Friction Slope = 0.00076 FT/FT

SPREAD = Y_g/S_C = $\frac{0.23}{0.0127}$ = 18.1 FT

SFC ENGINEERING COMPANY

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INLET ⟨61⟩ LOCATION: STA 74+60 - 34.5' LT

V = 4.0 FT CAL'D RUNOFF = 2.80 CFS

L = 10.0 FT FLOW BY ( ) = — CFS

PIPE = 15 IN TOTAL Q = 2.80 CFS

SUMP = 2.4 IN S_0 = AVE GUTTER SLOPE = 0.0025 FT/FT

SPREAD = 18.4 FT S_C = X-SLOPE AT BASIN = 0.0125 FT/FT

INLET TYPE: M-1, L=10' Z = 80.0, Z/n = 5333.33

n = 0.015 for asphalt

From page 27 Y_g = 0.23 FT, V_g = 1.40 FT/SEC

DESIGN OF INLET

From page 40 Y_g = 0.23 FT, Q = 3.3 CFS, L = 10 FT

FLOWBY —

DCB(MIN)=1.17+0.0233(2.28)² + 1.25 = 2.54 USE V = 4.0 FT

HEAD

ELEV @ CURB = 52.81

HGL ELEV = 48.74

H = 4.07-1.17 = 2.90 FT

SUMP (Page 29)

Q/L = 2.8 / ~~10~~ 13 = .28 CFS/FT

y_0/h = .48 FT/FT

h = 5 IN

y_0 = 2.4 IN = 0.20 < 0.23

OK @ L=13' too

PIPE DESIGN

TOTAL H NEEDED = 0.0233(2.28)²+(24 X .00159)

= 0.16 FT OK

V(PIPE) = Q/A = 2.28 FT/SEC

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SF = Friction Slope = 0.00159 FT/FT

SPREAD = Y_g/S_C = 0.23 / 0.0125 = 18.4 FT

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SFC ENGINEERING COMPANY

INLET (62)

LOCATION: STA 74+27 — 70' LT (83rd Ave)

V = ~~7.0'~~ 4.0 FT

CAL'D RUNOFF = 10.5 CFS

L = 17 FT

FLOW BY ( ) = — CFS

PIPE = 18 IN

TOTAL Q = 10.5 CFS

SUMP = 3.85 IN

S_0 = AVE GUTTER SLOPE = 0.0029 FT/FT

SPREAD = 31 FT

S_C = X-SLOPE AT BASIN = 0.0110 FT/FT

INLET TYPE: M-1, L=17'

Z = 90.91, Z/n = 6060

n = 0.015 for asphalt

Note: y_g @ Q = 21cfs = 0.44'
Z @ crest = 0.35

From page 27 Y_g = 0.34 FT, V_g = 1.43 FT/SEC

DESIGN OF INLET

From page 40 Y_g = 0.34 FT, Q = 9.6 CFS, L = 17 FT

FLOWBY (#62 TO #64) = 10.5 − 9.6 = 0.90 CFS

DCB(MIN) = 1.17 + 0.0233(5.43)² + 1.5 = 3.76' USE V = 4.0 FT

HEAD

ELEV @ CURB = 52.85

HGL ELEV = 48.66

H = 4.19 − 1.17 = 3.02 FT

SUMP (Page 29)

Q/L = 9.6 / ~~17~~ 20 = .56 CFS/FT

y_0/h = 0.77 FT/FT

h = 5 IN

y_0 = 3.85 IN = 0.32' < 0.34'

OK @ L = 20' too

PIPE DESIGN

TOTAL H NEEDED = 0.0233(5.43)² + (66 X .00)71

= 1.16' FT OK

V(PIPE) = Q/A = 5.43 FT/SEC

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SF = Friction Slope = 0.00711 FT/FT

SPREAD = Y_g/S_C = 0.34 / 0.0110 = 31 FT

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INLET ⟨63⟩ LOCATION: STA 73+57 – 70' LT

V = 8.0' ~~5.0~~ FT CAL'D RUNOFF = 10.5 CFS

L = 17 FT FLOW BY ( ) = — CFS

PIPE = 24 IN TOTAL Q = 10.5 CFS ← See Note 0. ⟨L2⟩

SUMP = 3.85 IN S_0 = AVE GUTTER SLOPE = 0.0029 FT/FT

SPREAD = 31 FT S_C = X-SLOPE AT BASIN = 0.0110 FT/FT

INLET TYPE: M-1, L=17' Z = ______, Z/n = ______

n = 0.015 for asphalt

From page 27 Y_g = 0.34 FT, V_g = 1.43 FT/SEC

DESIGN OF INLET

From page 40 Y_g = 0.34 FT, Q = 9.6 CFS, L = 17 FT

FLOWBY (#63 TO #64) = 10.5 – 9.6 = 0.90 CFS

DCB(MIN) = 1.17 + 0.0233(6.11)^2 + 2.0 = 4.04 USE V = 5.0 FT

HEAD

ELEV @ CURB = 52.69

HGL ELEV = 48.43

H = 4.26 - 1.17 = 3.09 FT

SUMP (Page 29)

Q/L = 9.6 / ~~17~~ 20 = 0.56 CFS/FT

y_0/h = 0.77 FT/FT

h = 5 IN

y_0 = 3.85 IN = 0.32' < 0.34'

OK @ L=20' too

PIPE DESIGN

TOTAL H NEEDED = 0.0233(6.11)^2+(58X.00613)

= 1.23 FT OK

V(PIPE) = Q/A = 19.2 / 3.142 FT/SEC = 6.11 FT/SEC

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SF = Friction Slope = 0.00613 FT/FT

SPREAD = Y_g/S_C = 0.34 / 0.0110 = 31 FT

ENGINEERING COMPANY

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INLET (64) LOCATION: STA 73+06 - 34.5' LT

V = 4.0 FT CAL'D RUNOFF = 1.0 CFS

L = 10 FT FLOW BY (#62 #63) = 1.80 CFS

PIPE = 15 IN TOTAL Q = 2.80 CFS

SUMP = 2.35 IN S_0 = AVE GUTTER SLOPE = 0.0030 FT/FT

SPREAD = 17.6 FT S_C = X-SLOPE AT BASIN = 0.0125 FT/FT

INLET TYPE: M-1, L=~~10'~~ 17' Z = 80.0, Z/n = 5333.33

n = 0.015 for asphalt

From page 27 Y_g = 0.22 FT, V_g = ___ FT/SEC

Note: Enlarged Basin from L=10' to L=17' to provide excess capacity to make sure all flow is caught. Q on side street was divided in half & Q on east may actually be larger causing more flowby & therefore requiring a larger basin @ 64.

DESIGN OF INLET

From page 40 Y_g = 0.22 FT, Q = 5.0 CFS, L = ~~10~~ 17 FT

FLOWBY ___

DCB(MIN) = 1.17 + 0.0233(2.28)² + 1.25 = 2.54 USE V = 4.0 FT

HEAD

ELEV @ CURB = 52.55

HGL ELEV = 48.33

H = 4.22 - 1.17 = 3.05 FT

SUMP (Page 29)

Q/L = 2.8 / ~~10~~ 13 = 0.28 CFS/FT

y_0/h = 0.47 FT/FT

h = 5 IN

y_0 = 2.35 IN = 0.20 < 0.22

OK @ L=13' too

PIPE DESIGN

TOTAL H NEEDED = 0.0233(2.28)² + (24 X .00159)

= 0.16 FT OK

V(PIPE) = Q/A = 2.28 FT/SEC

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Page 32

SF = Friction Slope = 0.00159 FT/FT

SPREAD = Y_g/S_C = 0.22 / 0.0125 = 17.6 FT

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INLET (65)

LOCATION: STA 73+06 – 34.5' RT

V = 4.0 FT

CAL'D RUNOFF = 3.51 CFS

L = 10 FT

FLOW BY (#60) = 1.18 CFS

PIPE = 15 IN

TOTAL Q = 4.69 CFS

SUMP = 3.2 IN

S_0 = AVE GUTTER SLOPE = 0.0029 FT/FT

SPREAD = 20.3 FT

S_C = X-SLOPE AT BASIN = 0.0133 FT/FT

INLET TYPE: M-1, L=10'

Z = 75.19, Z/n = 5012

n = 0.015 for asphalt

From page 27 Y_g = 0.27 FT, V_g = _____ FT/SEC

DESIGN OF INLET

From page 40 Y_g = 0.27 FT, Q = 4.3 CFS, L = 10 FT

FLOWBY (#65–#67) = 4.69 – 4.30 = 0.39 CFS

DCB(MIN) = 1.17 + 0.0233(3.5)² + 1.25 = 2.70 USE V = 4.0 FT

HEAD

ELEV @ CURB = 52.51

HGL ELEV = 48.33

H = 4.18 – 1.17 = 3.01 FT

SUMP (Page 29)

Q/L = 4.3/10 (13) = 0.43 CFS/FT

y_0/h = 0.64 FT/FT

h = 5 IN

y_0 = 3.2 IN = 0.27 = 0.27

OK @ L=13' too

PIPE DESIGN

TOTAL H NEEDED = 0.0233(3.5)² + (36 X .003)76

= 0.42 FT OK

V(PIPE) = Q/A = 3.50 FT/SEC

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SF = Friction Slope = 0.00376 FT/FT

SPREAD = Y_g/S_C = 0.27 / 0.0133 = 20.3 FT

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INLET (66)

LOCATION STA 67+80 – 29' LT

V = 3.0 FT

CAL'D RUNOFF = 2.60 CFS

PIPE = 15 IN

FLOW BY ( ) = – CFS

INLET TYPE: TYPE N

TOTAL Q = 2.60 CFS

SINGLE BASIN

S_C = 0.0168 FT/FT

COMPUTATION OF DEPTH

From Page 30 Curve A

$P = \frac{10.66 \times 1}{2} = 5.33$ FT

$\frac{Q}{P} = \frac{2.60}{5.33} = 0.49$

DEPTH = 0.32 FT

PIPE

TOP OF GRATE = 50.90

HGL = 47.22

HEAD(H) = 3.68 – 1.17 FT = 2.51 FT

H NEEDED = $\frac{1.5(2.11)^2}{64.4}$ + 30 × 0.00137 + bend

= 0.21 FT OK

n = 0.024 for unpaved road area

Sf = 0.00137

$DCB = 1.17 + \frac{1.5(2.11)^2}{64.4} + 1.25 = V = 2.52$ FT USE V = 3.0 FT

$SPREAD = DEPTH/S_C = \frac{0.32}{0.0168} = 19'$ FT OK

INLET (67)

LOCATION STA 67+80 – 29' RT

V = 7.0 FT

CAL'D RUNOFF = 2.60 CFS

PIPE = 15 IN

FLOW BY (#65) = 0.39 CFS

INLET TYPE: TYPE N

TOTAL Q = 2.99 CFS

DOUBLE BASIN

S_C = 0.0113 FT/FT

COMPUTATION OF DEPTH

From Page 30 Curve A

$P = \frac{10.66 \times 2}{2} = 10.66$ FT

$\frac{Q}{P} = \frac{2.99}{10.66} = 0.28$

DEPTH = 0.22 FT

PIPE

TOP OF GRATE = 50.30

HGL = 47.22

HEAD(H) = 3.08 – 1.17 = FT 1.91 FT

H NEEDED = $\frac{1.5(2.43)^2}{64.4}$ + 19 X 0.00182

= 0.17 FT OK

n = 0.024 for unpaved road area

Sf = 0.00182

DCB = 1.17 + $\frac{1.5(2.43)^2}{64.4}$ + 1.25 = V = 2.56 FT USE V = 7.0 FT

SPREAD = DEPTH/S_C = $\frac{0.22}{0.0113}$ = 19.5 FT OK

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INLET (68)

LOCATION STA 65+27 – 26' LT

V = 3.0 FT

CAL'D RUNOFF = 3.0 CFS

PIPE = 15 IN

FLOW BY ( ) = – CFS

INLET TYPE: TYPE N

TOTAL Q = 3.0 CFS

DOUBLE BASIN

S_C = 0.0125 FT/FT

COMPUTATION OF DEPTH

From Page 30 Curve A

$P = \frac{10.66 \times 2}{2} = 10.66$ FT

$\frac{Q}{P} = \frac{3.0}{10.66} = 0.28$

DEPTH = 0.22 FT

PIPE

TOP OF GRATE = 50.00

HGL = 46.69

HEAD(H) = 3.31 – 1.17 FT = 2.14 FT

H NEEDED = $\frac{1.5(2.44)^2}{64.4} + 27 \times .00183$

= 0.19 FT OK

n = 0.024 for unpaved road area

Sf = 0.00183

$DCB = 1.17 + \frac{1.5(2.44)^2}{64.4} + 1.25 = V = 2.56$ FT USE V=3.0'

$SPREAD = DEPTH/S_C = \frac{0.22}{0.0125} = 17.6$ FT

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INLET (69)

LOCATION STA 63+01 – 25' LT

V = 3.0 FT

CAL'D RUNOFF = 1.0 CFS

PIPE = 15 IN

FLOW BY (____) = — CFS

INLET TYPE: TYPE N

TOTAL Q = 1.0 CFS

SINGLE BASIN

S_c = 0.0125 FT/FT

COMPUTATION OF DEPTH

From Page 30 Curve A

$P = \frac{10.66 \times 1}{2} = 5.33$ FT

$\frac{Q}{P} = \frac{1.0}{5.33} = 0.19$

DEPTH = 0.16 FT

PIPE

TOP OF GRATE = 50.0

HGL = 46.18

HEAD(H) = 3.82 – 1.17 FT = 2.65 FT

H NEEDED = $\frac{1.5(0.81)^2}{64.4} + 26 \times .00020$

= 0.03 FT OK

n = 0.024 for unpaved road area

Sf = 0.00020

$DCB = 1.17 + \frac{1.5(0.81)^2}{64.4} + 1.25 = V = 2.44$ FT USE V = 3.0 FT

$SPREAD = DEPTH/S_c = \frac{0.16}{0.0125} = 12.8$ FT

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INLET (70)

LOCATION: STA 62+57 – 56' LT (85th Ave)

V = 4.0 FT

CAL'D RUNOFF = 10.5 CFS

L = 10 FT

FLOW BY ( ) = — CFS

PIPE = 18 IN

TOTAL Q = 10.5 CFS

SUMP = 5.6 IN

S_0 = AVE GUTTER SLOPE = 0.0019 FT/FT

SPREAD = 23 FT

S_C = X-SLOPE AT BASIN = 0.0200 FT/FT

INLET TYPE: M-1, L=10'

Z = 50.0, Z/n = 3333.33

n = 0.015 for asphalt

Note: y_g @ Q= 21cfs = 0.60'
Z crest = (SC)(W) = (.02)(20') = 0.04
Cresting begins before Q = 21/2 ∴ assumption of splitting flow is reasonable.

From page 27 Y_g = 0.46 FT, V_g = 1.42 FT/SEC

DESIGN OF INLET

From page 40 Y_g = 0.46 FT, Q = 9.7 CFS, L = 10 FT

FLOWBY (#70 TO #72) = 10.5 – 9.7 = 0.8 CFS

DCB(MIN) = 1.17 + 0.0233(5.49)² + 1.5 = 3.37 USE V = 4.0 FT

HEAD

ELEV @ CURB = 49.80

HGL ELEV = 46.03

H = 3.77 – 1.17 = 2.60 FT

SUMP (Page 29)

Q/L = 9.7/10 (13') = 0.97 CFS/FT

y_0/h = 1.12 FT/FT

h = 5 IN

y_0 = 5.6 IN = 0.47 ≅ 0.46

OK @ L=13' too

PIPE DESIGN

TOTAL H NEEDED = 0.0233(5.49)² + (41)(.00726)

= 1.09 FT OK

V(PIPE) = Q/A = 5.49 FT/SEC

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SF = Friction Slope = 0.00726 FT/FT

SPREAD = Y_g/S_C = 0.46/0.020 = 23 FT

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INLET (71) LOCATION: STA 62+12.5 - 56' LT

V = 5.0 FT CAL'D RUNOFF = 10.5 CFS

L = 10 FT FLOW BY ( ) = — CFS

PIPE = 24 IN TOTAL Q = 10.5 CFS ← See Note on (70)

SUMP = 5.6 IN S_0 = AVE GUTTER SLOPE = 0.0019 FT/FT

SPREAD = 23 FT S_C = X-SLOPE AT BASIN = 0.0200 FT/FT

INLET TYPE: M-1, L=10 Z = 50.0, Z/n = 3333.33

n = 0.015 for asphalt

From page 27 Y_g = 0.46 FT, V_g = 1.42 FT/SEC

DESIGN OF INLET

From page 40 Y_g = 0.46 FT, Q = 9.7 CFS, L = 10 FT

FLOWBY (#71 TO #72) = 10.5 − 9.7 = 0.80'

DCB(MIN) = 1.17 + 0.0233(3.09)² + 2.0 = 3.39' USE V = 5.0 FT

HEAD

ELEV @ CURB = 49.74

HGL ELEV = 46.03

H = 3.71 − 1.17 = 2.54 FT

SUMP (Page 29)

Q/L = 9.7/13 = 0.97 CFS/FT (10 crossed out)

y_0/h = 1.12 FT/FT

h = 5 IN

y_0 = 5.6 IN 0.47 ≈ 0.46

OK @ L = 13' too

PIPE DESIGN

TOTAL H NEEDED = 0.0233(6.18)² + (56 x .00626)

= 1.24 FT OK

V(PIPE) = Q/A = 6.18 FT/SEC (Q = 19.4 CFS)

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Page 32

SF = Friction Slope = 0.00626 FT/FT

SPREAD = Y_g/S_C = 0.46 / 0.020 = 23 FT

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INLET 72 | LOCATION: STA 61+82 – 34.5' LT

V = ~~7.0~~ 7.5 FT | CAL'D RUNOFF = 1.0 CFS

L = 10 FT | FLOW BY (#70 #71) = 1.6 CFS

PIPE = 15 IN | TOTAL Q = 2.6 CFS

SUMP = 2.25 IN | S_0 = AVE GUTTER SLOPE = 0.0030 FT/FT

SPREAD = 16.8 FT | S_C = X-SLOPE AT BASIN = 0.0125 FT/FT

INLET TYPE: M-1, L=10' | Z = ________, Z/n = ________

n = 0.015 for asphalt

From page 27 Y_g = 0.21 FT, V_g = 1.50 FT/SEC

DESIGN OF INLET

From page 40 Y_g = 0.21 FT, Q = 2.9 CFS, L = 10 FT

FLOWBY ——

DCB(MIN)=1.17+0.0233(2.11)^2 + 1.25 = 2.52 USE V = 7.0 FT

HEAD

ELEV @ CURB = 49.50

HGL ELEV = 45.96

H = 3.54 − 1.17 = 2.37 FT

SUMP (Page 29)

Q/L = 2.6 / ~~10~~ 13 = 0.26 CFS/FT

y_0/h = 0.45 FT/FT

h = 5 IN

y_0 = 2.25 IN = 0.19 < 0.21

OK @ L=13' too

PIPE DESIGN

TOTAL H NEEDED = 0.0233(2.11)^2+(34)(.00)137

+ bend loss = 0.22 FT OK

V(PIPE) = Q/A = 2.11 FT/SEC

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SF = Friction Slope = 0.00137 FT/FT

SPREAD = Y_g/S_C = 0.21 / 0.0125 = 16.8 FT

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INLET (73)

LOCATION STA 61+17 – 30' RT

V = 7.0 FT

CAL'D RUNOFF = 3.24 CFS

PIPE = 15 IN

FLOW BY (____) = 0 CFS

INLET TYPE: TYPE N

TOTAL Q = 3.24 CFS

DOUBLE BASIN

S_c = 0.0125 FT/FT

COMPUTATION OF DEPTH

From Page 30 Curve A

$P = \frac{10.66 \times 2}{2} = 10.66$ FT

$\frac{Q}{P} = \frac{3.24}{10.66} = 0.30$

DEPTH = 0.23 FT

PIPE

TOP OF GRATE = 48.10

HGL = 44.83

HEAD(H) = 3.27 – 1.17 FT = 2.10 FT

H NEEDED = $\frac{1.5(2.63)^2}{64.4} + 20 \times 0.00213$

= 0.20' FT OK

n = 0.024 for unpaved road area

Sf = 0.00213

DCB = $1.17 + \frac{1.5(2.63)^2}{64.4} + 1.25$ = V = 2.58 FT USE V = 8.0 FT

SPREAD = DEPTH/S_c = $\frac{0.23}{0.0125}$ = 18.4 FT

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INLET (74)   LOCATION: STA 54+40 – 34.5' LT

V = 8.0 FT   CAL'D RUNOFF = 3.31 CFS

L = 10.0 FT   FLOW BY ( ) = / CFS

PIPE = 15 IN   TOTAL Q_A = 3.31 CFS

SPREAD = 12.0 FT S_0 = AVE GUTTER SLOPE = 0.0031 FT/FT

INLET TYPE: M-1, L=10' S_C = X-SLOPE AT BASIN = 0.0249 FT/FT

Z = 40.16, Z/n = 2677

n = 0.015 for asphalt

From page 27 Y_g = 0.30 FT, V_g = 1.80 FT/SEC

DESIGN OF INLET

From page 28 Q_A/L_A = ___ L_A = 16.32 $L/L_A = \frac{13}{16.32}$ = 0.80

$\frac{a}{y} = \frac{0.16}{0.30}$ $\frac{Q}{Q_A}$ =

Q = (___)(___)0.8 = 2.40 CFS

FLOWBY (#74 TO #76) = 3.31 – 2.40 = 0.91 CFS

DCB(MIN) = 1.17+0.0233(1.95)^2 + 1.25 = 2.51 USE V = 8.0 FT

HEAD

ELEV @ CURB = 46.76

HGL ELEV = 44.10

H = 2.66 – 1.17 = 1.49 FT

PIPE DESIGN

TOTAL H NEEDED = 0.0233(1.95)^2+(33 X .0011)?

+ bend loss = 0.19 FT   OK

V(PIPE) = Q/A = 1.95 FT/SEC

SF = Friction Slope = 0.00117 FT/FT

SPREAD = Y_g/S_C = $\frac{0.30}{0.0249}$ = 12.0 FT

INLET 75

LOCATION STA 54+40 – 27' RT

V = 6.0 FT

CAL'D RUNOFF = 3.31 CFS

PIPE = 15 IN

FLOW BY (______) = ─ CFS

INLET TYPE: TYPE N

TOTAL Q = 3.31 CFS

DOUBLE BASIN

S_c = 0.0207 FT/FT

COMPUTATION OF DEPTH

From Page 30 Curve A

$P = \frac{10.66 \times 2}{2} = 10.66$ FT

$\frac{Q}{P} = \frac{3.31}{10.66} = 0.31$

DEPTH = 0.24 FT

PIPE

TOP OF GRATE = 45.60

HGL = 44.10

HEAD(H) = 1.50 – 1.17 FT = 0.33 FT

H NEEDED = $\frac{1.5(2.69)^2}{64.4} + 17 \times 0.00223$

= 0.21 FT OK

n = 0.024 for unpaved road area

Sf = 0.00223

$DCB = 1.17 + \frac{1.5(2.69)^2}{64.4} + 1.25 = V = 2.59$ FT USE V = 6.0 FT

$SPREAD = DEPTH/S_c = \frac{0.24}{0.0207} = 11.6$ FT

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INLET (76) LOCATION: STA 48+14 – 34.5' LT

V = 3.5 FT CAL'D RUNOFF = 3.06 CFS

L = 6.0 FT FLOW BY (#74) = 0.91 CFS

PIPE = 15 IN TOTAL Q = 3.97 CFS

SUMP = 3.1 ~~4.1~~ IN S_0 = AVE GUTTER SLOPE = 0.0031 FT/FT

SPREAD = 12.8 FT S_C = X-SLOPE AT BASIN = 0.0250 FT/FT

INLET TYPE: M-1, L = 6' Z = 40.0, Z/n = 2667

n = 0.015 for asphalt

From page 27 Y_g = 0.32 FT, V_g = 1.80 FT/SEC

DESIGN OF INLET

From page 40 Y_g = 0.32 FT, Q = 3.80 CFS, L = 6 FT

FLOWBY (#76 TO #79) = 3.97 – 3.80 = 0.17 CFS

DCB(MIN) = 1.17 + 0.0233(3.09)² + 1.25 = 2.64 USE V = 3.5 FT

HEAD

ELEV @ CURB = 44.54

HGL ELEV = 42.72

H = 1.82 – 1.17 = 0.65 FT

SUMP (Page 29)

Q/L = 3.8 / ~~6~~ 9 = ~~0.63~~ 0.42 CFS/FT

y_0/h = ~~0.82~~ 0.62 FT/FT

h = 5 IN

y_0 = ~~4.1~~ 3.1 IN = 0.34 > 0.32 0.26 < 0.32

OK

PIPE DESIGN

TOTAL H NEEDED = 0.0233(3.09)² + (33 x .00293)

= 0.32 FT OK

V(PIPE) = Q/A = 3.09 FT/SEC

Page 31

Page 32

SF = Friction Slope = 0.00293 FT/FT

SPREAD = Y_g/S_C = 0.32 / 0.0250 = 12.8 FT

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INLET 77 LOCATION: STA 47+~~63.5~~ 80 – 82' LT

V = 5' FT CAL'D RUNOFF = 31.0 CFS

L = 17 FT FLOW BY ( ) = — CFS

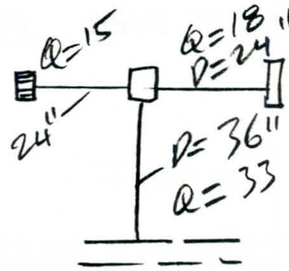
PIPE = 24 IN TOTAL Q = 31.0 CFS

SUMP = 3.7 IN S_0 = AVE GUTTER SLOPE = 0.0019 FT/FT

SPREAD = 35 FT S_C = X-SLOPE AT BASIN = 0.020 FT/FT

INLET TYPE: M-2, L=17' Z = 50, Z/n = 3333

n = 0.015 for asphalt



From page 27 Y_g = 0.70 FT, V_g = _____ FT/SEC

DESIGN OF INLET

From page 40 Y_g = 0.34 FT, Q = 18 CFS, L = 17 FT

FLOWBY (#77 TO #79) = 31.0 – 18.0 = 13.0 CFS

DCB(MIN)=1.17+0.0233(8.91)² + 2.0 = 5.02' USE V = 5.0 FT

HEAD

ELEV @ CURB = 44.62

HGL ELEV = 42.18

H = 2.44 – 0.67 = 1.77 FT

omitted .5' Freeboard. Hun.

SUMP (Page 29)

Q/L = 18/34 = .53 CFS/FT

y_0/h = .74 FT/FT

h = 5 IN

y_0 = 3.7 IN .31 < .34 OK

PIPE DESIGN

TOTAL H NEEDED = 0.0233(5.73)²+(26 X .00539) +0.0233(4.67)² + (80 X .00209)

= 1.58 FT OK

V(PIPE) = Q/A = 18 / 3.142 FT/SEC = 5.73 FPS

Page 31

Page 32

SF = Friction Slope = 0.00539 FT/FT

SPREAD = Y_g/S_C = 0.70 / 0.020 = 35 FT Crested, but no choice.

SFC ENGINEERING COMPANY

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INLET (78)

LOCATION STA 47+28 - 82' LT

V = 4.0 FT

CAL'D RUNOFF = 15 CFS

PIPE = 24 IN

FLOW BY (____) = 0 CFS

INLET TYPE: TYPE N

TOTAL Q = 15 CFS

TRIPLE BASIN

S_C = 0.00 FT/FT

COMPUTATION OF DEPTH

From Page 30 Curve A

$P = \frac{10.66 \times 3}{2} = 15.99$ FT

$\frac{Q}{P} = \frac{15}{15.99} = 0.94$

DEPTH = 0.46 FT

PIPE

$V = \frac{15}{3.142} = 4.77$ FPS -

TOP OF GRATE = 44.0

HGL = 42.18

HEAD(H) = 1.82 FT (omitted .5' Freeboard)

H NEEDED = $\frac{1.5(4.77)^2}{64.4} + 19 \times .00374$
$+ .0233(4.67)^2 + 80(.00209)$
= 1.28 FT OK (see # 77)

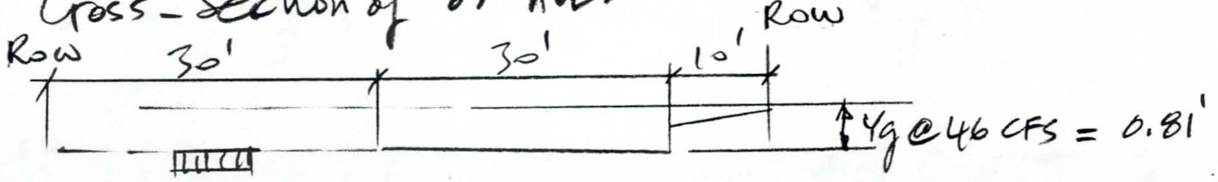
n = 0.024 for unpaved road area

Sf = 0.00374

DCB = $1.17 + \frac{1.5(4.77)^2}{64.4} + 2.0$ = V = 3.70 FT USE V = 4.0'

SPREAD = DEPTH/S_C = ________ = ________ FT

Cross-Section of 87th AVE.



SFC ENGINEERING COMPANY

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INLET (79)

LOCATION STA 46+75 - 25' LT

V = 4.0 FT

CAL'D RUNOFF = 1.0 CFS

PIPE = 24 IN

FLOW BY (#77) = 13.0 CFS

INLET TYPE: TYPE N

TOTAL Q = 14.0 CFS

TRIPLE BASIN

S_C = 0.0476 FT/FT

COMPUTATION OF DEPTH

From Page 30 Curve A

$P = \frac{10.66 \times 3}{2} = 15.99$ FT

$\frac{Q}{P} = \frac{14}{15.99} = 0.88$

DEPTH = 0.43 FT

PIPE

$V = \frac{14}{3.142} = 4.46$ F/S

TOP OF GRATE = 43.50

HGL = 41.99

HEAD(H) = 1.51 - 0.67 FT = 0.84'

H NEEDED = $\frac{1.5(4.46)^2}{64.4} + 25(.00327)$

= 0.54 FT OK

n = 0.024 for unpaved road area

Sf = 0.00327

DCB = $1.17 + \frac{1.5(4.46)^2}{64.4} + 2.0$ = V = 3.63 FT USE V=4.0'

SPREAD = DEPTH/S_C = $\frac{0.43}{0.0476}$ = 9.03 FT

SFC ENGINEERING COMPANY

Subject **INLET DESIGN COMPUTATIONS** Project **Cactus Rd**

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INLET (80)

LOCATION STA 46+75 – 27' RT

V = 8.0 FT

CAL'D RUNOFF = 3.74 CFS

PIPE = 15 IN

FLOW BY (______) = — CFS

INLET TYPE: TYPE N

TOTAL Q = 3.74 CFS

SINGLE BASIN

S_C = 0.0429 FT/FT

COMPUTATION OF DEPTH

From Page 30 Curve A

$P = \frac{10.66 \times 1}{2} = 5.33$ FT

$\frac{Q}{P} = \frac{3.74}{5.33} = 0.70$

DEPTH = 0.39 FT

PIPE

TOP OF GRATE = 43.60

HGL = 41.99

HEAD(H) = 1.61 – 1.17 FT = 0.44

H NEEDED = $\frac{1.5(3.04)^2}{64.4} + 16 \times 0.00284$

= 0.26 FT OK

n = 0.024 for unpaved road area

Sf = 0.00284

$DCB = 1.17 + \frac{1.5(3.04)^2}{64.4} + 1.25 = V = 2.64$ FT USE V = 8.0 FT

$SPREAD = DEPTH/S_C = \frac{0.39}{0.0429} = 9.1$ FT

SFC ENGINEERING COMPANY

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Computed MYB/Hvm Checked MYB Date 12/11/91 Page 83 of ___ Pages

INLET ⟨81⟩

LOCATION STA 40+70 - 23' LT

V = 3.0 FT

CAL'D RUNOFF = 2.96 CFS

PIPE = 15 IN

FLOW BY (______) = — CFS

INLET TYPE: TYPE N

TOTAL Q = 2.96 CFS

SINGLE BASIN

S_C = 0.0409 FT/FT

COMPUTATION OF DEPTH

From Page 30 Curve A

$P = \frac{10.66 \times 1}{2} = 5.33$ FT

$\frac{Q}{P} = \frac{2.96}{5.33} = 0.56$

DEPTH = 0.34 FT

PIPE

TOP OF GRATE = 42.30

HGL = 40.48

HEAD(H) = 1.82 - 1.17 FT = 0.65 FT

H NEEDED = $\frac{1.5(2.41)^2}{64.4} + 23 \times 0.00178$

= 0.18 FT OK

n = 0.024 for unpaved road area

Sf = 0.00178

$DCB = 1.17 + \frac{1.5(2.41)^2}{64.4} + 1.25 = V = 2.56$ FT USE V = 3.0 FT

SPREAD = DEPTH/S_C = $\frac{0.34}{0.0409}$ = 8.3 FT

SFC ENGINEERING COMPANY

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INLET (82)

LOCATION STA 40+70 – 27' RT

V = 8.0 FT

CAL'D RUNOFF = 2.96 CFS

PIPE = 15 IN

FLOW BY (____) = — CFS

INLET TYPE: TYPE N

TOTAL Q = 2.96 CFS

SINGLE BASIN

S_c = 0.0458 FT/FT

COMPUTATION OF DEPTH

From Page 30 Curve A

$P = \frac{10.66 \times 1}{2} = 5.33$ FT

$\frac{Q}{P} = \frac{2.96}{5.33} = 0.56$

DEPTH = 0.34 FT

PIPE

TOP OF GRATE = 42.90

HGL = 40.48

HEAD(H) = 2.43 – 1.17 FT = 1.26 FT

H NEEDED = $\frac{1.5(2.41)^2}{64.4}$ + 16 X 0.00178

= 0.16 FT OK

n = 0.024 for unpaved road area

Sf = 0.00178

DCB = $1.17 + \frac{1.5(2.41)^2}{64.4}$ + 1.25 = V = 2.56 FT USE V = 8.0 FT

SPREAD = DEPTH/S_c = $\frac{0.34}{0.0458}$ = 7.4 FT

SFC ENGINEERING COMPANY

Subject INLET DESIGN COMPUTATIONS TYPE N FOR UNCURBED AREAS	Project Cactus Rd
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INLET (83)

LOCATION STA ~~34+65~~ 33+70 – 23' LT.

V = 4.0 FT

CAL'D RUNOFF = 13.0 CFS

PIPE = 24 IN

FLOW BY (_____) = 0 CFS

INLET TYPE: TYPE N

TOTAL Q = 13.0 CFS

TRIPLE BASIN

S_C = 0.0409 FT/FT

COMPUTATION OF DEPTH

From Page 30 Curve A

$P = \frac{10.66 \times 3}{2} = 15.99$ FT

$\frac{Q}{P} = \frac{13}{15.99} = 0.81$

DEPTH = 0.42 FT

PIPE

$V = \frac{13}{3.142} = 4.14$ FPS

TOP OF GRATE = 41.60

HGL = 39.04

HEAD(H) = 2.56 − 1.17 FT = 1.39'

$H \text{ NEEDED} = \frac{1.5(4.14)^2}{64.4} + 22 \times .00281$

= 0.46 FT OK

n = 0.024 for unpaved road area

Sf = 0.00281

$DCB = 1.17 + \frac{1.5(4.14)^2}{64.4} + 2.0 = V = 3.56$ FT USE V = 4.0'

$SPREAD = DEPTH/S_C = \frac{0.42}{0.0409} = 10.3$ FT

SFC ENGINEERING COMPANY

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INLET (84)

LOCATION STA ~~34+65~~ 33+70 - 27' RT

V = 8.0 FT

CAL'D RUNOFF = 2.96 CFS

PIPE = 15 IN

FLOW BY (____) = — CFS

INLET TYPE: TYPE N

TOTAL Q = 2.96 CFS

SINGLE BASIN

S_C = 0.0448 FT/FT

COMPUTATION OF DEPTH

From Page 30 Curve A

$P = \frac{10.66 \times 1}{2} = 5.33$ FT

$\frac{Q}{P} = \frac{2.96}{5.33} = 0.56$

DEPTH = 0.34 FT

PIPE

TOP OF GRATE = 40.70

HGL = 39.04

HEAD(H) = 1.66 - 1.17 FT = 0.49 FT

H NEEDED = $\frac{1.5(2.41)^2}{64.4}$ + 16 X 0.00178

= 0.16 FT OK

n = 0.024 for unpaved road area

Sf = 0.00178

DCB = $1.17 + \frac{1.5(2.41)^2}{64.4}$ + 1.25 = V = 2.56 FT USE V = 8.0 FT

SPREAD = DEPTH/S_C = $\frac{0.34}{0.0448}$ = 7.6 FT

INLET (85)

LOCATION STA 28+00 – 23' LT

V = 3.0 FT

CAL'D RUNOFF = 3.25 CFS

PIPE = 15 IN

FLOW BY (______) = — CFS

INLET TYPE: TYPE N

TOTAL Q = 3.25 CFS

SINGLE BASIN

S_C = 0.0263 FT/FT

COMPUTATION OF DEPTH

From Page 30 Curve A

$P = \frac{10.66 \times 1}{2} = 5.33$ FT

$\frac{Q}{P} = \frac{3.25}{5.33} = 0.61$

DEPTH = 0.37 FT

PIPE

TOP OF GRATE = 39.80

HGL = 37.25

HEAD(H) = 2.55 − 1.17 FT = 1.38 FT

H NEEDED = $\frac{1.5(2.64)^2}{64.4}$ + 23 x 0.00215

= 0.21 FT OK

n = 0.024 for unpaved road area

Sf = 0.00215

DCB = $1.17 + \frac{1.5(2.64)^2}{64.4}$ + 1.25 = V = 2.58 FT USE V = 3.0 FT

SPREAD = DEPTH/S_C = $\frac{0.37}{0.0263}$ = 14.1 FT

INLET (86)

LOCATION STA 28+00 - 27' RT

V = 8.0 FT

CAL'D RUNOFF = 3.25 CFS

PIPE = 15 IN

FLOW BY (_____) = — CFS

INLET TYPE: TYPE N

TOTAL Q = 3.25 CFS

SINGLE BASIN

S_C = 0.0438 FT/FT

COMPUTATION OF DEPTH

From Page 30 Curve A

$P = \frac{10.66 \times 1}{2} = 5.33$ FT

$\frac{Q}{P} = \frac{3.25}{5.33} = 0.61$

DEPTH = 0.37 FT

PIPE

TOP OF GRATE = 39.60

HGL = 37.25

HEAD(H) = 2.35 - 1.17 FT = 1.18 FT

H NEEDED = $\frac{1.5(2.64)^2}{64.4} + 16 \times 0.00215$

= 0.20 FT OK

n = 0.024 for unpaved road area

Sf = 0.00215

$DCB = 1.17 + \frac{1.5(2.64)^2}{64.4} + 1.25$ = V = 2.58 FT USE V = 8.0 FT

SPREAD = DEPTH/S_C = $\frac{0.37}{0.0438}$ = 8.5 FT

SPC ENGINEERING COMPANY

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INLET 87 — LOCATION STA 2H86 - 27' RT

V = 8 FT — CAL'D RUNOFF = 3.10 CFS

PIPE = 15 IN — FLOW BY (______) = 0 CFS

INLET TYPE: TYPE N — TOTAL Q = 3.10 CFS

DOUBLE BASIN — S_C = 0.0200 FT/FT

COMPUTATION OF DEPTH

From Page 30 Curve A

$P = \frac{10.66 \times 2}{2} = 10.66$ FT

$\frac{Q}{P} = \frac{3.10}{10.66} = 0.29$

DEPTH = 0.23 FT

PIPE

$V = \frac{Q}{A} = 2.52$ FPS

TOP OF GRATE = 36.90

HGL = 35.71

HEAD(H) = 1.19 - 0.67 FT = 0.52 OK

Eliminated the Freeboard.

H NEEDED = $\frac{1.5(2.52)^2}{64.4}$ + 14 X 0.00195

= 0.17 FT OK

n = 0.024 for unpaved road area

Sf = 0.00195

DCB = $1.17 + \frac{1.5(2.52)^2}{64.4} + 1.25$ = V = 2.56' FT USE V = 8.0'

SPREAD = DEPTH/S_C = $\frac{0.23}{0.02}$ = 11.5 FT

HEADWALL, DROP INLET

SFC ENGINEERING COMPANY

Subject	INLET DESIGN COMPUTATIONS	Project	Cactus Rd
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INLET (88)

LOCATION STA 21+46, 20' LT

V = 3.5 FT

CAL'D RUNOFF = 29 CFS

PIPE = 30 IN

FLOW BY (____) = / CFS

INLET TYPE: ~~TYPE N~~ SEE HEADWALL CALC'S / BASIN

TOTAL Q = 29 CFS

S_C = N/A FT/FT

COMPUTATION OF DEPTH

From Page 30 Curve A

$P = \frac{10.66 \times \quad}{2} = $ ____ FT

$\frac{Q}{P}$ = ____

DEPTH = ____ FT

PIPE

TOP OF ~~GRATE~~ water surface = 36.66

HGL = 35.64

HEAD(H) = 1.02' FT

H NEEDED = ~~$\frac{1.5(\quad)^2}{64.4}$~~ + /

= 0.91' FT

See headwall Cal's

n = 0.024 for unpaved road area

Sf = 0.00424

~~$DCB = 1.17 + \frac{1.5(\quad)^2}{64.4}$ + ____ = V = ____ FT~~

~~SPREAD = DEPTH/S_C = ____ = ____ FT~~

SFC ENGINEERING COMPANY

Subject: HEADWALL, DROP INLET @ STA 21+46 (88)
Project: Cactus Rd.
File Number: 35902.00
Computed: Hum Checked: MYB
Date: 6/5/92 Page 2 of 3 Pages

HGL = 35.64
Spg head = 36.66

$H = 1.02'$

– 30" ϕ RCP L = 22' Q = 29 CFS MAX

$V = \frac{Q}{A} = 5.90$ FPS $\frac{v^2}{2g} = .54'$

$S_f = \frac{n^2 v^2}{2.21 R^{1.333}} = \frac{0.012^2 \; 5.90^2}{2.21 \times .625^{1.333}} = .00424$

Head needed $= 1.5 \frac{v^2}{2g} + 0.00424 \times 22$ + trash rack

$= .91' +$ OK USE 30" PIPE

– 24" ϕ RCP $V = \frac{29}{\pi} = 9.23$ $\frac{v^2}{2g} = 1.32$ $S_f = 0.01399$

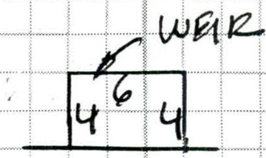
Head needed $= 1.5 \frac{v^2}{2g} + 22(.01399) = 2.29'$ NO

Spg MAX WSL = 37.46 (@ 12' dry lane)

Weir elev = 36.66

$H = 0.8'$

$L = \frac{Q}{3H^{1.5}} = \frac{29}{3 \times .8^{1.5}} = 13.5'$ ⟹



SFC ENGINEERING COMPANY

Subject: STA 21+46- (88)

Project: Cactus Rd -

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Computed: [illegible] Checked: MJB

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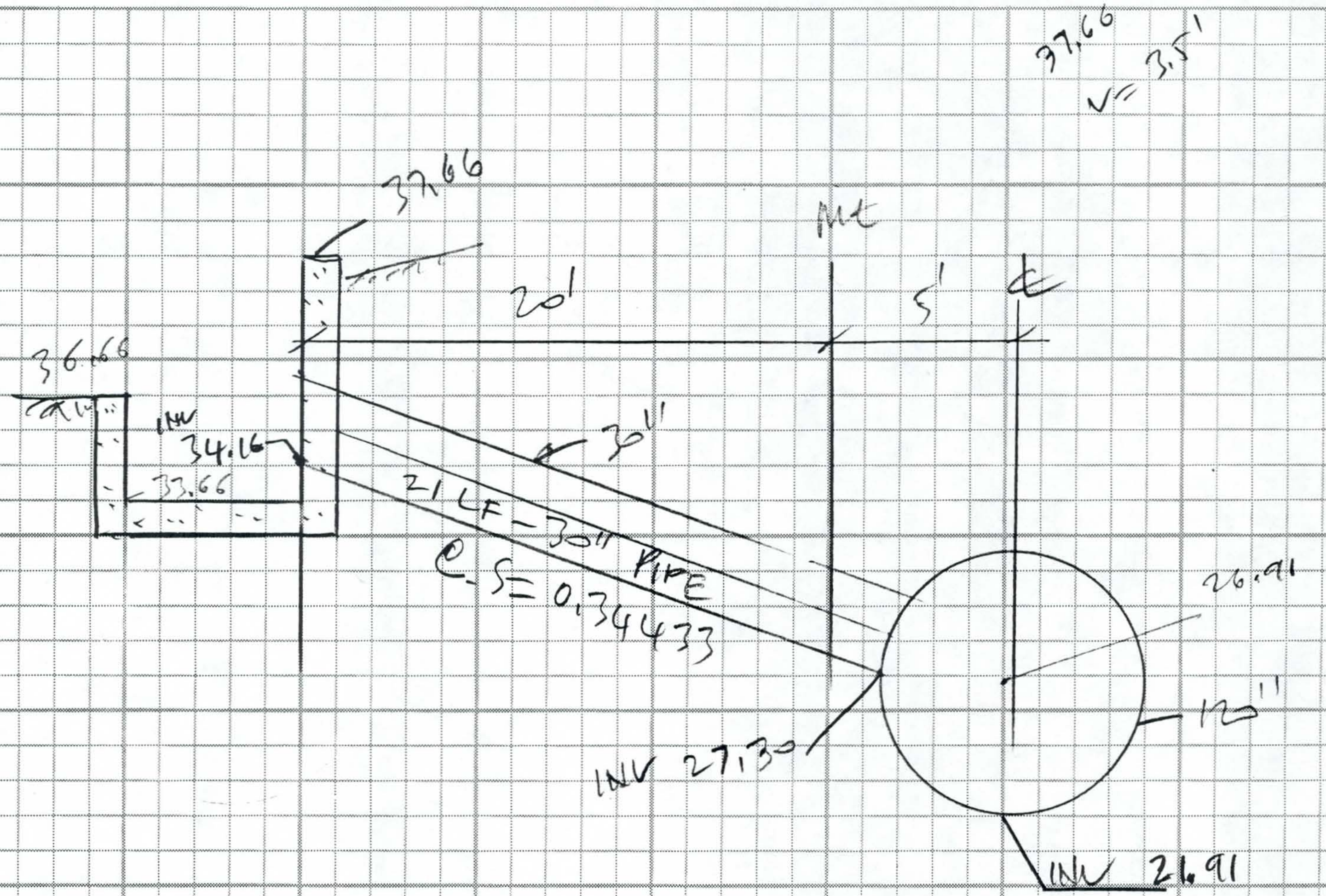

21+46-

ENGINEERING COMPANY

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INLET (89)

LOCATION STA ~~20+45~~ 20+48, 22' left

V = 3 FT

CAL'D RUNOFF = 3.7 CFS

PIPE = 15 IN

FLOW BY (—) = ϕ CFS

INLET TYPE: TYPE N

TOTAL Q = 3.7 CFS

Single BASIN

S_C = N/A FT/FT

COMPUTATION OF DEPTH

From Page 30 Curve A

$P = \frac{10.66 \times 1}{2} = 5.33$ FT

$\frac{Q}{P} = \frac{3.7}{5.33} = 0.69$

DEPTH = 2' FT

single basin Area = 3.78

Q/A = 7.5

Q = 7.5(3.78) ok

PIPE

TOP OF ~~GRATE~~ Water Surface = 1136.40 (Top of Grate = 34.4)

HGL = 1134.45

HEAD(H) = 1.95-1.17 FT

H NEEDED = $\frac{1.5(3.01)^2}{64.4} + 0.0028(20)$

= 0.27 FT ok

n = 0.024 for unpaved road area

Sf = 0.0028

$DCB = 1.17 + \frac{1.5(3.01)^2}{64.4} + 1.25 = V = 3$ FT

SPREAD = DEPTH/S_C = ______ = N/A FT

SFC ENGINEERING COMPANY

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INLET (90)

LOCATION STA ~~18+25~~ 18+34, 22' LT

V = 3 FT

CAL'D RUNOFF = 1.1 CFS

PIPE = 15 IN

FLOW BY (ϕ) = ϕ CFS

INLET TYPE: TYPE N

TOTAL Q = 1.1 CFS

SINGLE BASIN

S_c = N/A FT/FT

COMPUTATION OF DEPTH

From Page 30 Curve A

$P = \frac{10.66 \times 1}{2} = 5.33$ FT

$\frac{Q}{P} = \frac{1.1}{5.33}$

DEPTH = 2' FT

PIPE

TOP OF ~~GRATE~~ WATER SURFACE = 35.87   Top of Grate = 33.87

HGL = 33.66

HEAD(H) = 2.21 - 1.17 FT = 1.04'

H NEEDED = $\frac{1.5(1)^2}{64.4}$ + .0003 (20)

= 0.03 FT ok

n = 0.024 for unpaved road area

Sf = 0.0003

DCB = 1.17 + $\frac{1.5(1)^2}{64.4}$ + 1.25 = V = 3' FT

SPREAD = DEPTH/S_c = N/A = N/A FT

SFC ENGINEERING COMPANY

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INLET 91

LOCATION STA ~~15+86~~ 16+00, 27' LEFT

V = 3 FT

CAL'D RUNOFF = 1.0 CFS

PIPE = 15 IN

FLOW BY (—) = ∅ CFS

INLET TYPE: TYPE N

TOTAL Q = 1.0 CFS

Single BASIN

S_c = N/A FT/FT

COMPUTATION OF DEPTH

From Page 30 Curve A

$P = \frac{10.66 \times 1}{2} = 5.33$ FT

$\frac{Q}{P} = 1.0/5.33$

DEPTH = 2' FT

$\frac{Q}{A} = 7.5$

$Q = 7.5(3.78)$ ok

PIPE

TOP OF ~~GRATE~~ Water Surface = 34.84 (Top of Grate = 32.84)

HGL = 32.80

HEAD(H) = 2.04-1.17 FT = 0.87'

H NEEDED = $\frac{1.5(.85)^2}{64.4}$ + .0002(20)

= 0.1 FT ok

n = 0.024 for unpaved road area

Sf = 0.0002

$DCB = 1.17 + \frac{1.5(.85)^2}{64.4} + 1.25 = V = 3'$ FT

SPREAD = DEPTH/S_c = ______ = N/A FT

SFC ENGINEERING COMPANY

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INLET 92

V = 3 FT

PIPE = 15 IN

INLET TYPE: TYPE N

Single BASIN

LOCATION STA ~~14+23~~ 14+80, 27' LT

CAL'D RUNOFF = 1.2 CFS

FLOW BY (∅) = ∅ CFS

TOTAL Q = 1.2 CFS

S_C = N/A FT/FT

COMPUTATION OF DEPTH

From Page 30 Curve A

$P = \frac{10.66 \times 1}{2} = 5.33$ FT

$\frac{Q}{P} = 1.2 / 5.33$

DEPTH = 2 FT

PIPE

TOP OF ~~GRATE~~ Water Surface = 34.7 Top of Grate = 32.7

HGL = 32.93

HEAD(H) = 1.77 - 1.17 FT = 0.6'

$H\ NEEDED = \frac{1.5(1)^2}{64.4} + .00029(22)$

= 0.03 FT ok

n = 0.024 for unpaved road area

Sf = 0.00029

$DCB = 1.17 + \frac{1.5(1)^2}{64.4} + 1.25 = V = 3$ FT

SPREAD = DEPTH/S_C = N/A = N/A FT

SFC ENGINEERING COMPANY

Subject **INLET DESIGN COMPUTATIONS**		Project **Cactus Rd**	
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INLET 93

LOCATION STA 12+45, 18 RT

V = 3 FT

CAL'D RUNOFF = 3.2 CFS

PIPE = 15 IN

FLOW BY (—) = ϕ CFS

INLET TYPE: TYPE N

TOTAL Q = 3.2 CFS

Single BASIN

S_C = N/A FT/FT

COMPUTATION OF DEPTH

~~From Page 30 Curve A~~

$P = \frac{10.66 \times 1}{2}$ = 5.33 FT

~~$\frac{Q}{P}$ = 3.2/5.33~~

~~DEPTH = 2 FT~~

~~$\frac{Q}{A} = 7.5$~~

~~$Q = 7.5(3/18)$ ok~~

PIPE

TOP OF ~~GRATE~~ water surface = 33.67 (assume 1.5' depth in Earth channel – depth in headwall struct.)

HGL = 32.0

HEAD(H) = 1.67 − 1.17 = 0.5 FT

H NEEDED = $\frac{1.5(2.6)^2}{64.4}$ + 0.0026(12)

= 0.18 FT OK

n = 0.024 for unpaved road area

Sf = 0.0021

~~DCB = 1.17 + $\frac{1.5(3.5)^2}{64.4}$ + 1.25 = V = 3 FT~~

~~SPREAD = DEPTH/S_C = ___ = N/A FT~~

See headwall calc's

SFC ENGINEERING COMPANY

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INLET 94 — LOCATION STA 11+00, 28' LT

V = 4 FT — CAL'D RUNOFF = 14 CFS

PIPE = 24 IN — FLOW BY (—) = ɸ CFS

INLET TYPE: TYPE N — TOTAL Q = 14 CFS

Single BASIN — S_C = N/A FT/FT

COMPUTATION OF DEPTH

From Page 30 Curve A

$P = \frac{10.66 \times 1}{2} = 5.33$ FT

$\frac{Q}{P}$ = 14/5.33 = 2.62

DEPTH = 2' FT

Q/A at 2' = 7.5

Q = 7.5(3.78) = 28

okay

PIPE

TOP OF ~~GRATE~~ Water Surface = 33.46 (Top of Grate = 31.4)

HGL = 31.14

HEAD(H) = 2.32 FT

H NEEDED = $\frac{1.5(4.5)^2}{64.4}$ + 0.0033(25)

Entrance & Exit loss coeff — friction loss

= 0.55 FT ok

n = 0.024 for unpaved road area

Sf = 0.0033

DCB = $1.17 + \frac{1.5(4.5)^2}{64.4}$ + 2 = V = 4 FT

SPREAD = DEPTH/S_C = ___ = N/A FT

RUN VOLUME FOR SURFACE C
CTUS RD PAVEMENT REPLACE

SEVOL SUMMARY LISTING 15 June, 1992 Page 1
2:18 PM

STANLEY FRANZOY COREY Consulting Engineers
7776 Pointe Parkway West, Pheonix, AZ 85044

Volume calculation method = modified end areas

SEQ NO.	NAME	STATION	TRUNC. DIST. LEFT	RIGHT	CUT VOLUME	FILL VOLUME	CUM. CUT	CUM. FILL	FILL - CUT *1.0 *1.0	CUM. FILL - CUT *1.0 *1.0
1		10+00.00	0.00	0.00	0.0	0.0	0.	0.	0.	0.
2		10+50.00	0.00	0.00	86.6	0.0	87.	0.	-87.	-87
3		11+00.00	0.00	0.00	93.0	0.4	180.	0.	-93.	-179
4		11+50.00	0.00	0.00	86.7	0.7	266.	1.	-86.	-265
5		12+00.00	0.00	0.00	83.4	0.6	350.	2.	-83.	-348
6		12+50.00	0.00	0.00	79.5	1.0	429.	3.	-79.	-426
7		13+00.00	0.00	0.00	74.0	1.5	503.	4.	-73.	-499
8		13+45.00	0.00	0.00	74.3	0.9	578.	5.	-73.	-572
9		13+50.00	0.00	0.00	10.7	0.1	588.	5.	-11.	-583
10		14+00.00	0.00	0.00	130.7	1.1	719.	6.	-130.	-713
11		14+50.00	0.00	0.00	142.3	1.5	861.	8.	-141.	-853
12		15+00.00	0.00	0.00	131.3	2.3	993.	10.	-129.	-983
13		15+50.00	0.00	0.00	137.4	3.4	1130.	14.	-134.	-1116
14		16+00.00	0.00	0.00	153.3	4.4	1283.	18.	-149.	-1265
15		16+50.00	0.00	0.00	152.6	4.6	1436.	23.	-148.	-1413
16		17+00.00	0.00	0.00	147.8	4.5	1584.	27.	-143.	-1557
17		17+50.00	0.00	0.00	136.9	5.1	1721.	32.	-132.	-1689
18		18+00.00	0.00	0.00	129.1	5.5	1850.	38.	-124.	-1812
19		18+50.00	0.00	0.00	118.2	6.1	1968.	44.	-112.	-1924
20		19+00.00	0.00	0.00	108.7	6.3	2077.	50.	-102.	-2027
21		19+50.00	0.00	0.00	96.0	5.8	2173.	56.	-90.	-2117
22		20+00.00	0.00	0.00	81.1	4.9	2254.	61.	-76.	-2193
23		20+50.00	0.00	0.00	75.6	4.0	2329.	65.	-72.	-2265
24		21+00.00	0.00	0.00	158.7	0.4	2488.	65.	-158.	-2423
25		21+50.00	0.00	0.00	167.6	0.0	2656.	65.	-168.	-2591
26		22+00.00	0.00	0.00	102.0	0.1	2758.	65.	-102.	-2693
27		22+50.00	0.00	-0.00	117.1	0.0	2875.	65.	-117.	-2810
28		23+00.00	0.00	0.00	109.3	0.0	2984.	65.	-109.	-2919
29		23+50.00	0.00	-0.00	97.8	0.0	3082.	65.	-98.	-3017
30		24+00.00	0.00	0.00	91.6	0.0	3174.	65.	-92.	-3109
31		24+50.00	0.00	0.00	86.7	0.0	3260.	65.	-87.	-3195
32		25+00.00	0.00	0.00	81.6	0.1	3342.	65.	-81.	-3277
33		25+50.00	0.00	0.00	73.4	1.1	3415.	66.	-72.	-3349
34		26+00.00	0.00	0.00	68.6	2.0	3484.	68.	-67.	-3416
35		26+50.00	0.00	0.00	67.5	1.6	3551.	70.	-66.	-3482
36		27+00.00	0.00	0.00	68.4	2.2	3620.	72.	-66.	-3548
37		27+50.00	0.00	0.00	72.5	1.3	3692.	73.	-71.	-3619
38		28+00.00	0.00	0.00	78.9	0.1	3771.	73.	-79.	-3698
39		28+50.00	0.00	0.00	84.1	0.0	3855.	73.	-84.	-3782
40		29+00.00	0.00	0.00	88.6	0.0	3944.	73.	-89.	-3870
41		29+50.00	0.00	0.00	89.0	0.0	4033.	73.	-89.	-3959
42		30+00.00	0.00	0.00	88.0	0.6	4121.	74.	-87.	-4047
43		30+50.00	0.00	0.00	94.4	2.8	4215.	77.	-92.	-4138
44		31+00.00	0.00	0.00	95.8	5.2	4311.	82.	-91.	-4229
45		31+50.00	0.00	0.00	99.1	1.9	4410.	84.	-97.	-4326
46		32+00.00	0.00	0.00	107.4	0.2	4517.	84.	-107.	-4433
47		32+50.00	0.00	0.00	107.8	0.1	4625.	84.	-108.	-4541
48		33+00.00	0.00	0.00	102.3	0.0	4728.	84.	-102.	-4643
49		33+50.00	0.00	-0.00	97.1	0.4	4825.	85.	-97.	-4740
50		34+00.00	0.00	0.00	100.4	0.2	4925.	85.	-100.	-4840

Volume calculation method = modified end areas

SEQ NO.	NAME	STATION	TRUNC. DIST. LEFT	TRUNC. DIST. RIGHT	CUT VOLUME	FILL VOLUME	CUM. CUT	CUM. FILL	FILL - CUT *1.0 *1.0	CUM. FILL - CUT *1.0 *1.0
51		34+50.00	0.00	0.00	103.5	0.0	5028.	85.	-104.	-4944
52		35+00.00	0.00	0.00	104.8	0.0	5133.	85.	-105.	-5048
53		35+50.00	0.00	0.00	105.3	0.0	5239.	85.	-105.	-5154
54		36+00.00	0.00	0.00	106.0	0.0	5345.	85.	-106.	-5260
55		36+50.00	0.00	0.00	110.0	0.0	5455.	85.	-110.	-5370
56		37+00.00	0.00	0.00	114.9	0.0	5570.	85.	-115.	-5485
57		37+50.00	0.00	0.00	120.9	0.0	5690.	85.	-121.	-5606
58		38+00.00	0.00	0.00	128.4	0.0	5819.	85.	-128.	-5734
59		38+50.00	0.00	0.00	134.4	0.0	5953.	85.	-134.	-5868
60		39+00.00	0.00	0.00	136.1	1.7	6089.	87.	-134.	-6003
61		39+50.00	0.00	0.00	138.5	4.1	6228.	91.	-134.	-6137
62		40+00.00	0.00	0.00	131.3	4.3	6359.	95.	-127.	-6264
63		40+50.00	0.00	0.00	122.1	5.4	6481.	100.	-117.	-6381
64		41+00.00	0.00	0.00	122.0	6.9	6603.	107.	-115.	-6496
65		41+50.00	0.00	0.00	121.3	7.8	6725.	115.	-114.	-6610
66		42+00.00	0.00	0.00	109.9	8.2	6835.	123.	-102.	-6711
67		42+50.00	0.00	0.00	96.6	9.2	6931.	132.	-87.	-6799
68		43+00.00	0.00	0.00	89.7	8.2	7021.	141.	-82.	-6880
69		43+50.00	0.00	0.00	86.5	10.0	7107.	151.	-76.	-6957
70		44+00.00	0.00	0.00	86.6	13.3	7194.	164.	-73.	-7030
71		44+50.00	0.00	0.00	84.1	12.5	7278.	176.	-72.	-7102
72		45+00.00	0.00	0.00	78.6	12.3	7357.	189.	-66.	-7168
73		45+50.00	0.00	0.00	75.2	12.5	7432.	201.	-63.	-7231
74		46+00.00	0.00	0.00	73.3	11.8	7505.	213.	-61.	-7292
75		46+50.00	0.00	-1.33	76.7	9.5	7582.	223.	-67.	-7359
76		47+00.00	0.00	0.00	78.2	13.7	7660.	236.	-65.	-7424
77		47+44.30	0.00	0.00	85.2	5.8	7745.	242.	-79.	-7503

DESIGN DATA REPORT
for the
CACTUS ROAD STORM DRAIN
(67th Avenue to the Agua Fria Freeway)

APPENDIX E-
Computer Report

ANALYSIS # 1

- DOWN STREM HGL = 1132.68
- PRELIMANARY PIPE DESIGN SIZES USED

SEE APPENDIX C FOR DISCUSSION

Project : CACTUS ROAD BASED UPON HEC-1 ANALYSIS-includes triangle area Date: 9/25/1991 Time: 11: 6:39

INPUT DATA LISTING

CACTRIAN

CD	L2	MAX Q	ADJ Q	LENGTH	FL 1	FL 2	CTL/TW	D	W	S	KJ	KE	KM	LC	L1	L3	L4	A1	A3	A4	J	N
8	1						1132.68															
2	2	1000.0	1000.0	30.00	1120.29	1120.30	.00	96.	120.	3	.00	.00	.00	1	3	0	0	0.	0.	0.	9.99	.014
2	3	1000.0	1000.0	1200.00	1120.30	1121.80	.00	120.	0.	3	.00	.00	.00	0	4	17	0	0.	45.	0.	9.99	.012
2	4	914.0	914.0	10.00	1121.80	1121.81	.00	120.	0.	3	.00	.00	.00	0	5	0	0	0.	0.	0.	9.99	.012
2	5	898.0	898.0	1320.00	1121.81	1125.46	.00	120.	0.	3	.00	.00	.00	0	6	0	0	0.	0.	0.	9.99	.012
2	6	887.0	887.0	1320.00	1125.46	1129.10	.00	120.	0.	3	.00	.00	.00	0	7	0	0	0.	0.	0.	9.99	.012
2	7	845.0	845.0	1320.00	1129.10	1131.21	.00	120.	0.	3	.00	.00	.00	0	8	0	0	0.	0.	0.	9.99	.012
2	8	823.0	823.0	1320.00	1131.21	1133.32	.00	120.	0.	3	.00	.00	.00	0	9	0	0	0.	0.	0.	9.99	.012
2	9	777.0	777.0	1320.00	1133.82	1137.39	.00	114.	0.	3	.00	.00	.00	0	10	0	0	0.	0.	0.	9.99	.012
2	10	707.0	707.0	1320.00	1137.39	1140.95	.00	114.	0.	3	.00	.00	.00	0	11	18	0	0.	45.	0.	9.99	.012
2	11	495.0	495.0	1320.00	1140.95	1144.52	.00	114.	0.	3	.00	.00	.00	0	12	0	0	0.	0.	0.	8.00	.012
2	12	489.0	489.0	1320.00	1144.52	1148.08	.00	114.	0.	3	.00	.00	.00	0	13	19	0	0.	45.	0.	8.00	.012
2	13	367.0	367.0	1320.00	1149.58	1152.22	.00	96.	0.	3	.00	.00	.00	0	14	0	0	0.	0.	0.	7.00	.012
2	14	285.0	285.0	1320.00	1152.22	1154.86	.00	96.	0.	3	.00	.00	.00	0	15	20	0	0.	45.	0.	7.00	.012
2	15	218.0	218.0	1320.00	1155.86	1159.36	.00	84.	0.	3	.00	.00	.00	0	16	0	0	0.	0.	0.	7.00	.012
2	16	213.0	213.0	1320.00	1159.36	1162.86	.00	84.	0.	1	.00	.00	.00	0	0	0	0	0.	0.	0.	.00	.012
2	17	87.0	87.0	4000.00	1121.80	1126.81	.00	84.	0.	1	.00	.00	.00	4	0	0	0	0.	0.	0.	.00	.012
2	18	183.0	183.0	2640.00	1146.45	1160.00	.00	48.	0.	1	.00	.00	.00	11	0	0	0	0.	0.	0.	.00	.012
2	19	101.0	101.0	2640.00	1153.58	1169.00	.00	48.	0.	1	.00	.00	.00	13	0	0	0	0.	0.	0.	.00	.012
2	20	25.0	25.0	2640.00	1158.86	1175.00	.00	48.	0.	1	.00	.00	.00	15	0	0	0	0.	0.	0.	.00	.012

1Project : CACTUS ROAD BASED UPON HEC-1 ANALYSIS-includes triangle area Date: 9/25/1991 Time: 11: 6:39

STORM DRAIN ANALYSIS RESULTS

Line No	Q (cfs)	D (in)	W (in)	Dn (ft)	Dc (ft)	Flow Type	Sf-full (ft/ft)	V 1 (fps)	V 2 (fps)	FL 1 (ft)	FL 2 (ft)	HG 1 Calc	HG 2 Calc	D 1 (ft)	D 2 (ft)	TW Calc	TW CK
1	Hydraulic grade line control = 1132.68																
2	1000.0	96	120	8.00	6.76	Full	.00478	12.5	12.5	1120.29	1120.30	1132.68	1132.82	12.39	12.52	.00	.00

3	1000.0	120	0	10.00	7.61	Full	.00311	12.7	12.7	1120.30	1121.80	1132.77	1136.51	12.47	14.71	.00	.00	
4	914.0	120	0	10.00	7.28	Full	.00260	11.6	11.6	1121.80	1121.81	1137.31	1137.34	15.51	15.53	.00	.00	
5	898.0	120	0	7.81	7.22	Full	.00251	11.4	11.4	1121.81	1125.46	1137.51	1140.83	15.70	15.37	.00	.00	
6	887.0	120	0	7.74	7.18	Full	.00245	11.3	11.3	1125.46	1129.10	1140.95	1144.19	15.49	15.09	.00	.00	
7	845.0	120	0	10.00	7.01	Full	.00222	10.8	10.8	1129.10	1131.21	1144.57	1147.51	15.47	16.30	.00	.00	
8	823.0	120	0	10.00	6.91	Full	.00211	10.5	10.5	1131.21	1133.32	1147.72	1150.50	16.51	17.18	.00	.00	
9	777.0	114	0	7.44	6.80	Full	.00247	11.0	11.0	1133.82	1137.39	1150.57	1153.83	16.75	16.44	.00	.00	
10	707.0	114	0	6.87	6.48	Full	.00205	10.0	10.0	1137.39	1140.95	1154.50	1157.20	17.11	16.25	.00	.00	
11	495.0	114	0	5.35	5.38	Full	.00100	7.0	7.0	1140.95	1144.52	1157.96	1159.29	17.02	14.77	.00	.00	
12	489.0	114	0	5.32	5.34	Full	.00098	6.9	6.9	1144.52	1148.08	1159.33	1160.63	14.81	12.55	.00	.00	
13	367.0	96	0	5.56	4.86	Full	.00138	7.3	7.3	1149.58	1152.22	1160.70	1162.52	11.12	10.30	.00	.00	
14	285.0	96	0	4.68	4.25	Full	.00083	5.7	5.7	1152.22	1154.86	1163.18	1164.28	10.96	9.42	.00	.00	
15	218.0	84	0	3.96	3.84	Seal	.00099	5.7	5.9	1155.86	1159.36	1164.53	1165.77	8.67	6.41	.00	.00	HJU

X = 1005.46 X(N) = .00

16	213.0	84	0	3.90	3.80	Part	.00095	5.7	9.6	1159.36	1162.86	1165.81	1166.79	6.45	3.93	1168.21	.00

4 Hydraulic grade line control = 1136.91

17	87.0	84	0	2.88	2.39	Full	.00016	2.3	2.3	1121.80	1126.81	1136.91	1137.54	15.11	10.73	1137.62	.00

11 Hydraulic grade line control = 1157.58

18	183.0	48	0	4.00	3.78	Full	.01383	14.6	14.6	1146.45	1160.00	1157.58	1194.09	11.13	34.09	1197.38	.00

1Project : CACTUS ROAD BASED UPON HEC-1 ANALYSIS-includes triangle area Date: 9/25/1991 Time: 11: 6:39

STORM DRAIN ANALYSIS RESULTS

Line No	Q (cfs)	D (in)	W (in)	Dn (ft)	Dc (ft)	Flow Type	Sf-full (ft/ft)	V 1 (fps)	V 2 (fps)	FL 1 (ft)	FL 2 (ft)	HG 1 Calc	HG 2 Calc	D 1 (ft)	D 2 (ft)	TW Calc	TW CK	
13 Hydraulic grade line control = 1160.66																		
19	101.0	48	0	2.83	3.04	Seal	.00421	8.0	9.8	1153.58	1169.00	1160.66	1172.04	7.08	3.04	1173.55	.00	HJ

X = 1891.38 X(N) = 2283.50 X(J) = 2103.79 F(J) = 45.24 D(BJ) = 2.83 D(AJ) = 3.26

15 Hydraulic grade line control = 1164.41

```
20  25.0  48   0  1.23  1.48  Seal   .00026   2.0   5.9  1158.86 1175.00 1164.41 1176.47   5.55   1.47 1177.02     .00 HJ
        X =  263.84  X(N) =  801.76  X(J) =  611.13  F(J) =     7.59  D(BJ) =     1.23  D(AJ) =     1.75
```

1

LIST OF ABBREVIATIONS

```
     V 1, FL 1, D 1 and HG 1  refer to downstream end
0    V 2, FL 2, D 2 and HG 2  refer to upstream end
0    X     - Distance in feet from downstream end to point where HG intersects soffit in seal condition
0    X(N)  - Distance in feet from downstream end to point where water surface reaches normal depth by either drawdown or backwater
0    X(J)  - Distance in feet from downstream end to point where hydraulic jump occurs in line
0    F(J)  - The computed force at the hydraulic jump
0    D(BJ) - Depth of water before the hydraulic jump (upstream side)
0    D(AJ) - Depth of water after the hydraulic jump (downstream side)
0    SEAL indicates flow changes from part to full or from full to part
0    HJ    indicates that flow changes from supercritical to subcritical through a hydraulic jump
0    HJU   indicates that hydraulic jump occurs at the junction at the upstream end of the line
0    HJD   indicates that hydraulic jump occurs at the junction at the downstream end of the line
```

1Project : CACTUS ROAD BASED UPON HEC-1 ANALYSIS-includes triangle area
Date: 9/25/1991 Time: 11: 6:39

PIPE NUMBER 2

COMPOSITE ANALYSIS

Discharge = 1000.00 cfs

	Downstream	Upstream
Velocity	.00 fps	.00 fps
Depth of flow	12.39 ft	12.52 ft
Area of flow	502.66 sf	168.41 sf
HGL	1132.68 ft	1132.82 ft
EGL	1132.68 ft	1132.82 ft
Invert	1120.29 ft	1120.30 ft
Soffit	1128.29 ft	1128.30 ft
Diameter	8.00 ft	
Width	10.00 ft	

PRIMARY ANALYSIS

Channel length	30.00 ft	Normal depth	8.00 ft
Channel slope	.00033 ft/ft	Critical depth	6.76 ft
Friction slope	.00478 ft/ft	Flow condition	Mild
Adjusted Q	1000.00 cfs		
Mannings n	.0140	Loss due to friction	.14 ft
Entrance loss coeff	.00	Minor losses	.00 ft
Junction loss coeff	.00	Length of junction	9.99 ft
Minor loss coeff	.00		
Tailwater control	.00 ft	Structure code	3

STORM DRAIN CONNECTIVITY

Downstream pipe (LC) 1

Upstream pipe	(L1)	3	Angle to d.s. pipe (A1)	.00 deg
Lateral #1	(L3)	0	Angle to d.s. pipe (A3)	.00 deg
Lateral #2	(L4)	0	Angle to d.s. pipe (A4)	.00 deg

CONNECTIVITY DIAGRAM

```
               1         2       3
        ---------0---------0---------   <--- Flow
```

1Project : CACTUS ROAD BASED UPON HEC-1 ANALYSIS-includes triangle area
Date: 9/25/1991 Time: 11: 6:39

PIPE NUMBER 3

COMPOSITE ANALYSIS

Discharge = 1000.00 cfs

	Downstream	Upstream
Velocity	12.73 fps	12.73 fps
Depth of flow	12.47 ft	14.71 ft
Area of flow	502.66 sf	168.41 sf
HGL	1132.77 ft	1136.51 ft
EGL	1135.29 ft	1139.03 ft
Invert	1120.30 ft	1121.80 ft
Soffit	1130.30 ft	1131.80 ft
Diameter	10.00 ft	
Width	.00 ft	

PRIMARY ANALYSIS

Channel length	1200.00 ft	Normal depth	10.00 ft
Channel slope	.00125 ft/ft	Critical depth	7.61 ft
Friction slope	.00311 ft/ft	Flow condition	Mild
Adjusted Q	1000.00 cfs		
Mannings n	.0120	Loss due to friction	3.74 ft
Entrance loss coeff	.00	Minor losses	.00 ft
Junction loss coeff	.00	Length of junction	9.99 ft
Minor loss coeff	.00		
Tailwater control	.00 ft	Structure code	3

STORM DRAIN CONNECTIVITY

Downstream pipe (LC) 0

Upstream pipe	(L1)	4	Angle to d.s. pipe (A1)	.00 deg
Lateral #1	(L3)	17	Angle to d.s. pipe (A3)	45.00 deg
Lateral #2	(L4)	0	Angle to d.s. pipe (A4)	.00 deg

CONNECTIVITY DIAGRAM

```
                           / 17
                          /
                         /
         2         3    /      4
    ---------0---------0/---------     <--- Flow
```

1Project : CACTUS ROAD BASED UPON HEC-1 ANALYSIS-includes triangle area
Date: 9/25/1991   Time: 11: 6:39

PIPE NUMBER 4

COMPOSITE ANALYSIS

Discharge = 914.00 cfs

	Downstream	Upstream
Velocity	11.64 fps	11.64 fps
Depth of flow	15.51 ft	15.53 ft
Area of flow	459.43 sf	153.93 sf
HGL	1137.31 ft	1137.34 ft
EGL	1139.42 ft	1139.44 ft
Invert	1121.80 ft	1121.81 ft
Soffit	1131.80 ft	1131.81 ft
Diameter	10.00 ft	
Width	.00 ft	

PRIMARY ANALYSIS

Channel length	10.00 ft	Normal depth	10.00 ft
Channel slope	.00100 ft/ft	Critical depth	7.28 ft
Friction slope	.00260 ft/ft	Flow condition	Mild
Adjusted Q	914.00 cfs		
Mannings n	.0120	Loss due to friction	.03 ft
Entrance loss coeff	.00	Minor losses	.00 ft
Junction loss coeff	.00	Length of junction	9.99 ft
Minor loss coeff	.00		
Tailwater control	.00 ft	Structure code	3

STORM DRAIN CONNECTIVITY

Downstream pipe	(LC)	0		
Upstream pipe	(L1)	5	Angle to d.s. pipe (A1)	.00 deg
Lateral #1	(L3)	0	Angle to d.s. pipe (A3)	.00 deg
Lateral #2	(L4)	0	Angle to d.s. pipe (A4)	.00 deg

CONNECTIVITY DIAGRAM

```
         3         4      5
    ---------0---------0---------     <--- Flow
```

1Project : CACTUS ROAD BASED UPON HEC-1 ANALYSIS-includes triangle area
Date: 9/25/1991 Time: 11: 6:39

PIPE NUMBER 5

COMPOSITE ANALYSIS

Discharge = 898.00 cfs

	Downstream	Upstream
Velocity	11.43 fps	11.43 fps
Depth of flow	15.70 ft	15.37 ft
Area of flow	451.39 sf	151.23 sf
HGL	1137.51 ft	1140.83 ft
EGL	1139.54 ft	1142.86 ft
Invert	1121.81 ft	1125.46 ft
Soffit	1131.81 ft	1135.46 ft
Diameter	10.00 ft	
Width	.00 ft	

PRIMARY ANALYSIS

Channel length	1320.00 ft	Normal depth	7.81 ft
Channel slope	.00277 ft/ft	Critical depth	7.22 ft
Friction slope	.00251 ft/ft	Flow condition	Mild
Adjusted Q	898.00 cfs		
Mannings n	.0120	Loss due to friction	3.32 ft
Entrance loss coeff	.00	Minor losses	.00 ft
Junction loss coeff	.00	Length of junction	9.99 ft
Minor loss coeff	.00		
Tailwater control	.00 ft	Structure code	3

STORM DRAIN CONNECTIVITY

Downstream pipe	(LC)	0		
Upstream pipe	(L1)	6	Angle to d.s. pipe (A1)	.00 deg
Lateral #1	(L3)	0	Angle to d.s. pipe (A3)	.00 deg
Lateral #2	(L4)	0	Angle to d.s. pipe (A4)	.00 deg

CONNECTIVITY DIAGRAM

```
            4         5         6
   ---------0---------0---------    <--- Flow
```

PIPE NUMBER 6

COMPOSITE ANALYSIS

Discharge = 887.00 cfs

	Downstream	Upstream
Velocity	11.29 fps	11.29 fps
Depth of flow	15.49 ft	15.09 ft
Area of flow	445.86 sf	149.38 sf
HGL	1140.95 ft	1144.19 ft
EGL	1142.93 ft	1146.17 ft
Invert	1125.46 ft	1129.10 ft
Soffit	1135.46 ft	1139.10 ft
Diameter	10.00 ft	
Width	.00 ft	

PRIMARY ANALYSIS

Channel length	1320.00 ft	Normal depth	7.74 ft
Channel slope	.00276 ft/ft	Critical depth	7.18 ft
Friction slope	.00245 ft/ft	Flow condition	Mild
Adjusted Q	887.00 cfs		
Mannings n	.0120	Loss due to friction	3.24 ft
Entrance loss coeff	.00	Minor losses	.00 ft
Junction loss coeff	.00	Length of junction	9.99 ft
Minor loss coeff	.00		
Tailwater control	.00 ft	Structure code	3

STORM DRAIN CONNECTIVITY

Downstream pipe	(LC)	0		
Upstream pipe	(L1)	7	Angle to d.s. pipe (A1)	.00 deg
Lateral #1	(L3)	0	Angle to d.s. pipe (A3)	.00 deg
Lateral #2	(L4)	0	Angle to d.s. pipe (A4)	.00 deg

CONNECTIVITY DIAGRAM

```
            5         6         7
   ---------0---------0---------    <--- Flow
```

1Project : CACTUS ROAD BASED UPON HEC-1 ANALYSIS-includes triangle area
Date: 9/25/1991 Time: 11: 6:39

PIPE NUMBER 7

COMPOSITE ANALYSIS

Discharge = 845.00 cfs

	Downstream	Upstream
Velocity	10.76 fps	10.76 fps
Depth of flow	15.47 ft	16.30 ft
Area of flow	424.74 sf	142.31 sf
HGL	1144.57 ft	1147.51 ft
EGL	1146.37 ft	1149.31 ft
Invert	1129.10 ft	1131.21 ft

Soffit	1139.10 ft	1141.21 ft
Diameter	10.00 ft	
Width	.00 ft	

PRIMARY ANALYSIS

Channel length	1320.00 ft	Normal depth	10.00 ft
Channel slope	.00160 ft/ft	Critical depth	7.01 ft
Friction slope	.00222 ft/ft	Flow condition	Mild
Adjusted Q	845.00 cfs		
Mannings n	.0120	Loss due to friction	2.94 ft
Entrance loss coeff	.00	Minor losses	.00 ft
Junction loss coeff	.00	Length of junction	9.99 ft
Minor loss coeff	.00		
Tailwater control	.00 ft	Structure code	3

STORM DRAIN CONNECTIVITY

Downstream pipe	(LC)	0		
Upstream pipe	(L1)	8	Angle to d.s. pipe (A1)	.00 deg
Lateral #1	(L3)	0	Angle to d.s. pipe (A3)	.00 deg
Lateral #2	(L4)	0	Angle to d.s. pipe (A4)	.00 deg

CONNECTIVITY DIAGRAM

```
              6          7        8
       ---------0---------0---------    <--- Flow
```

1Project : CACTUS ROAD BASED UPON HEC-1 ANALYSIS-includes triangle area
Date: 9/25/1991 Time: 11: 6:39

PIPE NUMBER 8

COMPOSITE ANALYSIS

Discharge = 823.00 cfs

	Downstream	Upstream
Velocity	10.48 fps	10.48 fps
Depth of flow	16.51 ft	17.18 ft
Area of flow	413.69 sf	138.60 sf
HGL	1147.72 ft	1150.50 ft
EGL	1149.42 ft	1152.21 ft
Invert	1131.21 ft	1133.32 ft
Soffit	1141.21 ft	1143.32 ft
Diameter	10.00 ft	
Width	.00 ft	

PRIMARY ANALYSIS

Channel length	1320.00 ft	Normal depth	10.00 ft

Channel slope	.00160 ft/ft	Critical depth	6.91 ft
Friction slope	.00211 ft/ft	Flow condition	Mild
Adjusted Q	823.00 cfs		
Mannings n	.0120	Loss due to friction	2.79 ft
Entrance loss coeff	.00	Minor losses	.00 ft
Junction loss coeff	.00	Length of junction	9.99 ft
Minor loss coeff	.00		
Tailwater control	.00 ft	Structure code	3

STORM DRAIN CONNECTIVITY

Downstream pipe	(LC)	0		
Upstream pipe	(L1)	9	Angle to d.s. pipe (A1)	.00 deg
Lateral #1	(L3)	0	Angle to d.s. pipe (A3)	.00 deg
Lateral #2	(L4)	0	Angle to d.s. pipe (A4)	.00 deg

CONNECTIVITY DIAGRAM

```
          7          8         9
  ---------O---------O---------    <--- Flow
```

1Project : CACTUS ROAD BASED UPON HEC-1 ANALYSIS-includes triangle area
Date: 9/25/1991 Time: 11: 6:39

PIPE NUMBER 9

COMPOSITE ANALYSIS

Discharge = 777.00 cfs

	Downstream	Upstream
Velocity	10.96 fps	10.96 fps
Depth of flow	16.75 ft	16.44 ft
Area of flow	390.56 sf	130.86 sf
HGL	1150.57 ft	1153.83 ft
EGL	1152.44 ft	1155.70 ft
Invert	1133.82 ft	1137.39 ft
Soffit	1143.32 ft	1146.89 ft
Diameter	9.50 ft	
Width	.00 ft	

PRIMARY ANALYSIS

Channel length	1320.00 ft	Normal depth	7.44 ft
Channel slope	.00271 ft/ft	Critical depth	6.80 ft
Friction slope	.00247 ft/ft	Flow condition	Mild
Adjusted Q	777.00 cfs		
Mannings n	.0120	Loss due to friction	3.26 ft
Entrance loss coeff	.00	Minor losses	.00 ft
Junction loss coeff	.00	Length of junction	9.99 ft
Minor loss coeff	.00		
Tailwater control	.00 ft	Structure code	3

STORM DRAIN CONNECTIVITY

Downstream pipe	(LC)	0			
Upstream pipe	(L1)	10	Angle to d.s. pipe	(A1)	.00 deg
Lateral #1	(L3)	0	Angle to d.s. pipe	(A3)	.00 deg
Lateral #2	(L4)	0	Angle to d.s. pipe	(A4)	.00 deg

CONNECTIVITY DIAGRAM

```
        8         9      10
---------0---------0---------    <--- Flow
```

1Project : CACTUS ROAD BASED UPON HEC-1 ANALYSIS-includes triangle area
Date: 9/25/1991 Time: 11: 6:39

PIPE NUMBER 10

COMPOSITE ANALYSIS

Discharge = 707.00 cfs

	Downstream	Upstream
Velocity	9.97 fps	9.97 fps
Depth of flow	17.11 ft	16.25 ft
Area of flow	355.38 sf	119.07 sf
HGL	1154.50 ft	1157.20 ft
EGL	1156.04 ft	1158.75 ft
Invert	1137.39 ft	1140.95 ft
Soffit	1146.89 ft	1150.45 ft
Diameter	9.50 ft	
Width	.00 ft	

PRIMARY ANALYSIS

Channel length	1320.00 ft	Normal depth	6.87 ft
Channel slope	.00270 ft/ft	Critical depth	6.48 ft
Friction slope	.00205 ft/ft	Flow condition	Mild
Adjusted Q	707.00 cfs		
Mannings n	.0120	Loss due to friction	2.70 ft
Entrance loss coeff	.00	Minor losses	.00 ft
Junction loss coeff	.00	Length of junction	9.99 ft
Minor loss coeff	.00		
Tailwater control	.00 ft	Structure code	3

STORM DRAIN CONNECTIVITY

Downstream pipe	(LC)	0			
Upstream pipe	(L1)	11	Angle to d.s. pipe	(A1)	.00 deg
Lateral #1	(L3)	18	Angle to d.s. pipe	(A3)	45.00 deg
Lateral #2	(L4)	0	Angle to d.s. pipe	(A4)	.00 deg

INPUT DATA LISTING

CAZTRIA6.

CD	L2	MAX Q	ADJ Q	LENGTH	FL 1	FL 2	CTL/TW	D	W	S	KJ	KE	KM	LC	L1	L3	L4	A1	A3	A4	J	N
8	1						1130.68															
2	2	1000.0	1000.0	30.00	1120.29	1120.30	.00	96.	120.	3	.00	.00	.00	1	3	0	0	0.	0.	0.	9.99	.014
2	3	1000.0	1000.0	1200.00	1120.30	1121.80	.00	120.	0.	3	.00	.00	.00	0	4	17	0	0.	45.	0.	9.99	.012
2	4	914.0	914.0	10.00	1121.80	1121.81	.00	120.	0.	3	.00	.00	.00	0	5	0	0	0.	0.	0.	9.99	.012
2	5	898.0	898.0	1320.00	1121.81	1125.46	.00	120.	0.	3	.00	.00	.00	0	6	0	0	0.	0.	0.	9.99	.012
2	6	887.0	887.0	1320.00	1125.46	1129.10	.00	120.	0.	3	.00	.00	.00	0	7	0	0	0.	0.	0.	9.99	.012
2	7	845.0	845.0	1320.00	1129.10	1131.21	.00	120.	0.	3	.00	.00	.00	0	8	0	0	0.	0.	0.	9.99	.012
2	8	823.0	823.0	1320.00	1131.21	1133.32	.00	120.	0.	3	.00	.00	.00	0	9	0	0	0.	0.	0.	9.99	.012
2	9	777.0	777.0	1320.00	1133.82	1137.39	.00	114.	0.	3	.00	.00	.00	0	10	0	0	0.	0.	0.	9.99	.012
2	10	707.0	707.0	1320.00	1137.39	1140.95	.00	114.	0.	3	.00	.00	.00	0	11	18	0	0.	45.	0.	9.99	.012
2	11	495.0	495.0	1320.00	1141.45	1145.02	.00	108.	0.	3	.00	.00	.00	0	12	0	0	0.	0.	0.	8.00	.012
2	12	489.0	489.0	1320.00	1145.02	1148.58	.00	108.	0.	3	.00	.00	.00	0	13	21	0	0.	45.	0.	8.00	.012
2	13	367.0	367.0	1320.00	1150.58	1153.22	.00	84.	0.	3	.00	.00	.00	0	14	0	0	0.	0.	0.	7.00	.012
2	14	285.0	285.0	1320.00	1153.22	1155.86	.00	84.	0.	3	.00	.00	.00	0	15	24	0	0.	45.	0.	7.00	.012
2	15	218.0	218.0	1320.00	1156.36	1159.86	.00	78.	0.	3	.00	.00	.00	0	16	0	0	0.	0.	0.	7.00	.012
2	16	213.0	213.0	1320.00	1159.86	1163.36	.00	78.	0.	1	.00	.00	.00	0	0	0	0	0.	0.	0.	.00	.012
2	17	87.0	87.0	4000.00	1121.80	1126.81	.00	84.	0.	1	.00	.00	.00	4	0	0	0	0.	0.	0.	.00	.012
2	18	214.0	214.0	20.00	1144.95	1145.06	.00	66.	0.	3	.00	.00	.00	11	19	0	0	0.	0.	0.	.00	.012
2	19	185.0	185.0	1300.00	1145.06	1152.22	.00	66.	0.	3	.00	.00	.00	0	20	0	0	0.	0.	0.	.00	.012
2	20	104.0	104.0	1320.00	1153.22	1159.50	.00	54.	0.	1	.00	.00	.00	0	0	0	0	0.	0.	0.	.00	.012
2	21	113.0	113.0	20.00	1154.08	1154.19	.00	42.	0.	3	.00	.00	.00	13	22	0	0	0.	0.	0.	.00	.012
2	22	84.0	84.0	1300.00	1154.19	1161.79	.00	42.	0.	3	.00	.00	.00	0	23	0	0	0.	0.	0.	.00	.012
2	23	44.0	44.0	1320.00	1161.79	1169.50	.00	42.	0.	1	.00	.00	.00	0	0	0	0	0.	0.	0.	.00	.012
2	24	30.0	30.0	20.00	1160.36	1160.46	.00	30.	0.	3	.00	.00	.00	15	25	0	0	0.	0.	0.	.00	.012
2	25	25.0	25.0	1300.00	1160.46	1167.14	.00	30.	0.	3	.00	.00	.00	0	26	0	0	0.	0.	0.	.00	.012

Project : CACTUS ROAD BASED UPON HEC-1 ANALYSIS-includes triangle area Date: 9/30/1991 Time: 11:40:55

INPUT DATA LISTING

CD	L2	MAX Q	ADJ Q	LENGTH	FL 1	FL 2	CTL/TW	D	W	S	KJ	KE	KM	LC	L1	L3	L4	A1	A3	A4	J	N
2	26	15.0	15.0	1820.00	1167.64	1177.00	.00	24.	0.	1	.00	.00	.00	0	0	0	0	0.	0.	0.	.00	.012

1Project : CACTUS ROAD BASED UPON HEC-1 ANALYSIS-includes triangle area   Date: 9/30/1991   Time: 11:40:55

STORM DRAIN ANALYSIS RESULTS

Line No	Q (cfs)	D (in)	W (in)	Dn (ft)	Dc (ft)	Flow Type	Sf-full (ft/ft)	V 1 (fps)	V 2 (fps)	FL 1 (ft)	FL 2 (ft)	HG 1 Calc	HG 2 Calc	D 1 (ft)	D 2 (ft)	TW Calc	TW CK
1	Hydraulic grade line control = 1130.68																
2	1000.0	96	120	8.00	6.76	Full	.00478	12.5	12.5	1120.29	1120.30	1130.68	1130.82	10.39	10.52	.00	.00
3	1000.0	120	0	10.00	7.61	Full	.00311	12.7	12.7	1120.30	1121.80	1130.77	1134.51	10.47	12.71	.00	.00
4	914.0	120	0	10.00	7.28	Full	.00260	11.6	11.6	1121.80	1121.81	1135.31	1135.34	13.51	13.53	.00	.00
5	898.0	120	0	7.81	7.22	Full	.00251	11.4	11.4	1121.81	1125.46	1135.51	1138.83	13.70	13.37	.00	.00
6	887.0	120	0	7.74	7.18	Full	.00245	11.3	11.3	1125.46	1129.10	1138.95	1142.19	13.49	13.09	.00	.00
7	845.0	120	0	10.00	7.01	Full	.00222	10.8	10.8	1129.10	1131.21	1142.57	1145.51	13.47	14.30	.00	.00
8	823.0	120	0	10.00	6.91	Full	.00211	10.5	10.5	1131.21	1133.32	1145.72	1148.50	14.51	15.18	.00	.00
9	777.0	114	0	7.44	6.80	Full	.00247	11.0	11.0	1133.82	1137.39	1148.57	1151.83	14.75	14.44	.00	.00
10	707.0	114	0	6.87	6.48	Full	.00205	10.0	10.0	1137.39	1140.95	1152.50	1155.20	15.11	14.25	.00	.00
11	495.0	108	0	5.57	5.48	Full	.00134	7.8	7.8	1141.45	1145.02	1156.06	1157.83	14.61	12.81	.00	.00
12	489.0	108	0	5.53	5.45	Full	.00131	7.7	7.7	1145.02	1148.58	1157.89	1159.61	12.87	11.03	.00	.00
13	367.0	84	0	7.00	5.05	Full	.00281	9.5	9.5	1150.58	1153.22	1159.22	1162.93	8.64	9.71	.00	.00
14	285.0	84	0	5.30	4.42	Full	.00170	7.4	7.4	1153.22	1155.86	1164.06	1166.30	10.84	10.44	.00	.00
15	218.0	78	0	4.19	3.94	Full	.00147	6.6	6.6	1156.36	1159.86	1166.79	1168.73	10.43	8.87	.00	.00
16	213.0	78	0	4.12	3.90	Full	.00141	6.4	6.4	1159.86	1163.36	1168.81	1170.66	8.95	7.30	1171.30	.00
4	Hydraulic grade line control = 1134.91																
17	87.0	84	0	2.88	2.39	Full	.00016	2.3	2.3	1121.80	1126.81	1134.91	1135.54	13.11	8.73	1135.62	.00
11	Hydraulic grade line control = 1155.63																

FINAL DESIGN

- DOWNSTREAM HGL = 1130.68
- DOWNSIZED PIPE SIZES FROM PRELIMINARY DESIGN

CONNECTIVITY DIAGRAM

```
                          / 19
                         /
                        /
         0        12   /      13
    ---------0---------0/---------    <--- Flow
```

1Project : CACTUS ROAD BASED UPON HEC-1 ANALYSIS-includes triangle area
Date: 9/25/1991 Time: 13:51:38

PIPE NUMBER 20

COMPOSITE ANALYSIS

Discharge = 25.00 cfs

	Downstream	Upstream
Velocity	2.16 fps	5.94 fps
Depth of flow	3.47 ft	1.47 ft
Area of flow	11.58 sf	4.21 sf
HGL	1162.33 ft	1176.47 ft
EGL	1162.40 ft	1177.02 ft
Invert	1158.86 ft	1175.00 ft
Soffit	1162.86 ft	1179.00 ft
Diameter	4.00 ft	
Width	.00 ft	

PRIMARY ANALYSIS

Channel length	2640.00 ft	Normal depth	1.23 ft
Channel slope	.00611 ft/ft	Critical depth	1.48 ft
Friction slope	.00026 ft/ft	Flow condition	Steep
Adjusted Q	25.00 cfs		
Mannings n	.0120	Loss due to friction	.68 ft
Entrance loss coeff	.00	Minor losses	.00 ft
Junction loss coeff	.00	Length of junction	.00 ft
Minor loss coeff	.00		
Tailwater control	1177.02 ft	Structure code	1

STORM DRAIN CONNECTIVITY

Downstream pipe (LC) 15

Upstream pipe	(L1)	0	Angle to d.s. pipe (A1)	.00 deg
Lateral #1	(L3)	0	Angle to d.s. pipe (A3)	.00 deg
Lateral #2	(L4)	0	Angle to d.s. pipe (A4)	.00 deg

CONNECTIVITY DIAGRAM

```
                          / 20
                         /
                        /
```

STORM DRAIN CONNECTIVITY

Downstream pipe	(LC)	4		
Upstream pipe	(L1)	0	Angle to d.s. pipe (A1)	.00 deg
Lateral #1	(L3)	0	Angle to d.s. pipe (A3)	.00 deg
Lateral #2	(L4)	0	Angle to d.s. pipe (A4)	.00 deg

CONNECTIVITY DIAGRAM

```
                         / 17
                        /
                       /
         0        3   /      4
  ---------0---------0/---------    <--- Flow
```

1Project : CACTUS ROAD BASED UPON HEC-1 ANALYSIS-includes triangle area
Date: 9/25/1991 Time: 13:51:38

PIPE NUMBER 18

COMPOSITE ANALYSIS

Discharge = 183.00 cfs

	Downstream	Upstream
Velocity	14.56 fps	14.56 fps
Depth of flow	9.13 ft	32.09 ft
Area of flow	84.75 sf	30.82 sf
HGL	1155.58 ft	1192.09 ft
EGL	1158.88 ft	1195.38 ft
Invert	1146.45 ft	1160.00 ft
Soffit	1150.45 ft	1164.00 ft
Diameter	4.00 ft	
Width	.00 ft	

PRIMARY ANALYSIS

Channel length	2640.00 ft	Normal depth	4.00 ft
Channel slope	.00513 ft/ft	Critical depth	3.78 ft
Friction slope	.01383 ft/ft	Flow condition	Mild
Adjusted Q	183.00 cfs		
Mannings n	.0120	Loss due to friction	36.51 ft
Entrance loss coeff	.00	Minor losses	.00 ft
Junction loss coeff	.00	Length of junction	.00 ft
Minor loss coeff	.00		
Tailwater control	1195.38 ft	Structure code	1

STORM DRAIN CONNECTIVITY

Downstream pipe (LC) 11

Upstream pipe	(L1)	0	Angle to d.s. pipe (A1)	.00 deg
Lateral #1	(L3)	0	Angle to d.s. pipe (A3)	.00 deg
Lateral #2	(L4)	0	Angle to d.s. pipe (A4)	.00 deg

CONNECTIVITY DIAGRAM

```
                          /  18
                         /
                        /
          0        10  /     11
     ---------0---------0/---------    <--- Flow
```

1Project : CACTUS ROAD BASED UPON HEC-1 ANALYSIS-includes triangle area
Date: 9/25/1991 Time: 13:51:38

PIPE NUMBER 19

COMPOSITE ANALYSIS

Discharge = 101.00 cfs

	Downstream	Upstream
Velocity	8.04 fps	9.85 fps
Depth of flow	5.08 ft	3.04 ft
Area of flow	46.77 sf	17.01 sf
HGL	1158.66 ft	1172.04 ft
EGL	1159.67 ft	1173.55 ft
Invert	1153.58 ft	1169.00 ft
Soffit	1157.58 ft	1173.00 ft
Diameter	4.00 ft	
Width	.00 ft	

PRIMARY ANALYSIS

Channel length	2640.00 ft	Normal depth	2.83 ft
Channel slope	.00584 ft/ft	Critical depth	3.04 ft
Friction slope	.00421 ft/ft	Flow condition	Steep
Adjusted Q	101.00 cfs		
Mannings n	.0120	Loss due to friction	11.12 ft
Entrance loss coeff	.00	Minor losses	.00 ft
Junction loss coeff	.00	Length of junction	.00 ft
Minor loss coeff	.00		
Tailwater control	1173.55 ft	Structure code	1

STORM DRAIN CONNECTIVITY

Downstream pipe (LC) 13

Upstream pipe	(L1)	0	Angle to d.s. pipe (A1)	.00 deg
Lateral #1	(L3)	0	Angle to d.s. pipe (A3)	.00 deg
Lateral #2	(L4)	0	Angle to d.s. pipe (A4)	.00 deg

Soffit	1162.86 ft	1166.36 ft
Diameter	7.00 ft	
Width	.00 ft	

PRIMARY ANALYSIS

Channel length	1320.00 ft	Normal depth	3.96 ft
Channel slope	.00265 ft/ft	Critical depth	3.84 ft
Friction slope	.00099 ft/ft	Flow condition	Mild
Adjusted Q	218.00 cfs		
Mannings n	.0120	Loss due to friction	1.31 ft
Entrance loss coeff	.00	Minor losses	.00 ft
Junction loss coeff	.00	Length of junction	7.00 ft
Minor loss coeff	.00		
Tailwater control	.00 ft	Structure code	3

STORM DRAIN CONNECTIVITY

Downstream pipe (LC) 0

Upstream pipe	(L1)	16	Angle to d.s. pipe (A1)	.00 deg
Lateral #1	(L3)	0	Angle to d.s. pipe (A3)	.00 deg
Lateral #2	(L4)	0	Angle to d.s. pipe (A4)	.00 deg

CONNECTIVITY DIAGRAM

```
        14         15        16
   ---------0---------0---------    <--- Flow
```

1Project : CACTUS ROAD BASED UPON HEC-1 ANALYSIS-includes triangle area
Date: 9/25/1991 Time: 13:51:38

PIPE NUMBER 16

COMPOSITE ANALYSIS

Discharge = 213.00 cfs

	Downstream	Upstream
Velocity	8.36 fps	9.67 fps
Depth of flow	4.40 ft	3.90 ft
Area of flow	98.64 sf	35.87 sf
HGL	1163.76 ft	1166.76 ft
EGL	1164.85 ft	1168.21 ft
Invert	1159.36 ft	1162.86 ft
Soffit	1166.36 ft	1169.86 ft
Diameter	7.00 ft	
Width	.00 ft	

PRIMARY ANALYSIS

Channel length	1320.00 ft	Normal depth	3.90 ft

Channel slope	.00265 ft/ft	Critical depth	3.80 ft
Friction slope	.00095 ft/ft	Flow condition	Mild
Adjusted Q	213.00 cfs		
Mannings n	.0120	Loss due to friction	1.25 ft
Entrance loss coeff	.00	Minor losses	.00 ft
Junction loss coeff	.00	Length of junction	.00 ft
Minor loss coeff	.00		
Tailwater control	1168.21 ft	Structure code	1

STORM DRAIN CONNECTIVITY

Downstream pipe	(LC)	0		
Upstream pipe	(L1)	0	Angle to d.s. pipe (A1)	.00 deg
Lateral #1	(L3)	0	Angle to d.s. pipe (A3)	.00 deg
Lateral #2	(L4)	0	Angle to d.s. pipe (A4)	.00 deg

CONNECTIVITY DIAGRAM

```
              15        16
       ---------O---------O    <--- Flow
```

1Project : CACTUS ROAD BASED UPON HEC-1 ANALYSIS-includes triangle area
Date: 9/25/1991 Time: 13:51:38

PIPE NUMBER 17

COMPOSITE ANALYSIS

Discharge = 87.00 cfs

	Downstream	Upstream
Velocity	2.26 fps	2.26 fps
Depth of flow	13.11 ft	8.73 ft
Area of flow	40.29 sf	14.65 sf
HGL	1134.91 ft	1135.54 ft
EGL	1134.99 ft	1135.62 ft
Invert	1121.80 ft	1126.81 ft
Soffit	1128.80 ft	1133.81 ft
Diameter	7.00 ft	
Width	.00 ft	

PRIMARY ANALYSIS

Channel length	4000.00 ft	Normal depth	2.88 ft
Channel slope	.00125 ft/ft	Critical depth	2.39 ft
Friction slope	.00016 ft/ft	Flow condition	Mild
Adjusted Q	87.00 cfs		
Mannings n	.0120	Loss due to friction	.63 ft
Entrance loss coeff	.00	Minor losses	.00 ft
Junction loss coeff	.00	Length of junction	.00 ft
Minor loss coeff	.00		
Tailwater control	1135.62 ft	Structure code	1

PIPE NUMBER 13

COMPOSITE ANALYSIS

Discharge = 367.00 cfs

	Downstream	Upstream
Velocity	7.30 fps	7.30 fps
Depth of flow	9.12 ft	8.30 ft
Area of flow	169.96 sf	61.81 sf
HGL	1158.70 ft	1160.52 ft
EGL	1159.53 ft	1161.35 ft
Invert	1149.58 ft	1152.22 ft
Soffit	1157.58 ft	1160.22 ft
Diameter	8.00 ft	
Width	.00 ft	

PRIMARY ANALYSIS

Channel length	1320.00 ft	Normal depth	5.56 ft
Channel slope	.00200 ft/ft	Critical depth	4.86 ft
Friction slope	.00138 ft/ft	Flow condition	Mild
Adjusted Q	367.00 cfs		
Mannings n	.0120	Loss due to friction	1.82 ft
Entrance loss coeff	.00	Minor losses	.00 ft
Junction loss coeff	.00	Length of junction	7.00 ft
Minor loss coeff	.00		
Tailwater control	.00 ft	Structure code	3

STORM DRAIN CONNECTIVITY

Downstream pipe	(LC)	0		
Upstream pipe	(L1)	14	Angle to d.s. pipe (A1)	.00 deg
Lateral #1	(L3)	0	Angle to d.s. pipe (A3)	.00 deg
Lateral #2	(L4)	0	Angle to d.s. pipe (A4)	.00 deg

CONNECTIVITY DIAGRAM

```
              12         13        14
        ---------0---------0---------    <--- Flow
```

1Project : CACTUS ROAD BASED UPON HEC-1 ANALYSIS-includes triangle area
Date: 9/25/1991 Time: 13:51:38

PIPE NUMBER 14

COMPOSITE ANALYSIS

Discharge = 285.00 cfs

	Downstream	Upstream

Velocity	5.67 fps	5.91 fps
Depth of flow	8.96 ft	7.33 ft
Area of flow	131.99 sf	48.00 sf
HGL	1161.18 ft	1162.19 ft
EGL	1161.68 ft	1162.73 ft
Invert	1152.22 ft	1154.86 ft
Soffit	1160.22 ft	1162.86 ft
Diameter	8.00 ft	
Width	.00 ft	

PRIMARY ANALYSIS

Channel length	1320.00 ft	Normal depth	4.68 ft
Channel slope	.00200 ft/ft	Critical depth	4.25 ft
Friction slope	.00083 ft/ft	Flow condition	Mild
Adjusted Q	285.00 cfs		
Mannings n	.0120	Loss due to friction	1.10 ft
Entrance loss coeff	.00	Minor losses	.00 ft
Junction loss coeff	.00	Length of junction	7.00 ft
Minor loss coeff	.00		
Tailwater control	.00 ft	Structure code	3

STORM DRAIN CONNECTIVITY

Downstream pipe	(LC)	0		
Upstream pipe	(L1)	15	Angle to d.s. pipe (A1)	.00 deg
Lateral #1	(L3)	20	Angle to d.s. pipe (A3)	45.00 deg
Lateral #2	(L4)	0	Angle to d.s. pipe (A4)	.00 deg

CONNECTIVITY DIAGRAM

```
                          /  20
                         /
                        /
        13        14   /      15
   ---------0---------0/---------    <--- Flow
```

1Project : CACTUS ROAD BASED UPON HEC-1 ANALYSIS-includes triangle area
Date: 9/25/1991 Time: 13:51:38

PIPE NUMBER 15

COMPOSITE ANALYSIS

Discharge = 218.00 cfs

	Downstream	Upstream
Velocity	5.79 fps	9.48 fps
Depth of flow	6.61 ft	4.04 ft
Area of flow	100.96 sf	36.71 sf
HGL	1162.47 ft	1163.40 ft
EGL	1162.99 ft	1164.79 ft
Invert	1155.86 ft	1159.36 ft

Lateral #2 (L4) 0 Angle to d.s. pipe (A4) .00 deg

CONNECTIVITY DIAGRAM

```
                         / 18
                        /
                       /
         9      10    /     11
    ---------0---------0/---------    <--- Flow
```

1Project : CACTUS ROAD BASED UPON HEC-1 ANALYSIS-includes triangle area
Date: 9/25/1991 Time: 13:51:38

PIPE NUMBER 11

COMPOSITE ANALYSIS

Discharge = 495.00 cfs

	Downstream	Upstream
Velocity	6.98 fps	6.98 fps
Depth of flow	15.02 ft	12.77 ft
Area of flow	229.24 sf	83.36 sf
HGL	1155.96 ft	1157.29 ft
EGL	1156.72 ft	1158.05 ft
Invert	1140.95 ft	1144.52 ft
Soffit	1150.45 ft	1154.02 ft
Diameter	9.50 ft	
Width	.00 ft	

PRIMARY ANALYSIS

Channel length	1320.00 ft	Normal depth	5.35 ft
Channel slope	.00271 ft/ft	Critical depth	5.38 ft
Friction slope	.00100 ft/ft	Flow condition	Steep
Adjusted Q	495.00 cfs		
Mannings n	.0120	Loss due to friction	1.32 ft
Entrance loss coeff	.00	Minor losses	.00 ft
Junction loss coeff	.00	Length of junction	8.00 ft
Minor loss coeff	.00		
Tailwater control	.00 ft	Structure code	3

STORM DRAIN CONNECTIVITY

Downstream pipe (LC) 0

Upstream pipe (L1) 12 Angle to d.s. pipe (A1) .00 deg
Lateral #1 (L3) 0 Angle to d.s. pipe (A3) .00 deg
Lateral #2 (L4) 0 Angle to d.s. pipe (A4) .00 deg

CONNECTIVITY DIAGRAM

```
                 10          11        12
            ---------0---------0---------    <--- Flow
```

PIPE NUMBER 12

COMPOSITE ANALYSIS

Discharge = 489.00 cfs

	Downstream	Upstream
Velocity	6.90 fps	6.90 fps
Depth of flow	12.81 ft	10.55 ft
Area of flow	226.46 sf	82.35 sf
HGL	1157.33 ft	1158.63 ft
EGL	1158.07 ft	1159.37 ft
Invert	1144.52 ft	1148.08 ft
Soffit	1154.02 ft	1157.58 ft
Diameter	9.50 ft	
Width	.00 ft	

PRIMARY ANALYSIS

Channel length	1320.00 ft	Normal depth	5.32 ft
Channel slope	.00270 ft/ft	Critical depth	5.34 ft
Friction slope	.00098 ft/ft	Flow condition	Steep
Adjusted Q	489.00 cfs		
Mannings n	.0120	Loss due to friction	1.29 ft
Entrance loss coeff	.00	Minor losses	.00 ft
Junction loss coeff	.00	Length of junction	8.00 ft
Minor loss coeff	.00		
Tailwater control	.00 ft	Structure code	3

STORM DRAIN CONNECTIVITY

Downstream pipe (LC) 0

Upstream pipe	(L1)	13	Angle to d.s. pipe (A1)	.00 deg
Lateral #1	(L3)	19	Angle to d.s. pipe (A3)	45.00 deg
Lateral #2	(L4)	0	Angle to d.s. pipe (A4)	.00 deg

CONNECTIVITY DIAGRAM

```
                                    / 19
                                   /
                                  /
                 11          12  /      13
            ---------0---------0/---------    <--- Flow
```

Channel length	1320.00 ft	Normal depth	10.00 ft
Channel slope	.00160 ft/ft	Critical depth	6.91 ft
Friction slope	.00211 ft/ft	Flow condition	Mild
Adjusted Q	823.00 cfs		
Mannings n	.0120	Loss due to friction	2.79 ft
Entrance loss coeff	.00	Minor losses	.00 ft
Junction loss coeff	.00	Length of junction	9.99 ft
Minor loss coeff	.00		
Tailwater control	.00 ft	Structure code	3

STORM DRAIN CONNECTIVITY

Downstream pipe	(LC)	0		
Upstream pipe	(L1)	9	Angle to d.s. pipe (A1)	.00 deg
Lateral #1	(L3)	0	Angle to d.s. pipe (A3)	.00 deg
Lateral #2	(L4)	0	Angle to d.s. pipe (A4)	.00 deg

CONNECTIVITY DIAGRAM

```
          7         8         9
   ---------0---------0---------    <--- Flow
```

1Project : CACTUS ROAD BASED UPON HEC-1 ANALYSIS-includes triangle area

Date: 9/25/1991 Time: 13:51:38

PIPE NUMBER 9

COMPOSITE ANALYSIS

Discharge = 777.00 cfs

	Downstream	Upstream
Velocity	10.96 fps	10.96 fps
Depth of flow	14.75 ft	14.44 ft
Area of flow	359.83 sf	130.86 sf
HGL	1148.57 ft	1151.83 ft
EGL	1150.44 ft	1153.70 ft
Invert	1133.82 ft	1137.39 ft
Soffit	1143.32 ft	1146.89 ft
Diameter	9.50 ft	
Width	.00 ft	

PRIMARY ANALYSIS

Channel length	1320.00 ft	Normal depth	7.44 ft
Channel slope	.00271 ft/ft	Critical depth	6.80 ft
Friction slope	.00247 ft/ft	Flow condition	Mild
Adjusted Q	777.00 cfs		
Mannings n	.0120	Loss due to friction	3.26 ft
Entrance loss coeff	.00	Minor losses	.00 ft
Junction loss coeff	.00	Length of junction	9.99 ft
Minor loss coeff	.00		
Tailwater control	.00 ft	Structure code	3

STORM DRAIN CONNECTIVITY

Downstream pipe	(LC)	0			
Upstream pipe	(L1)	10	Angle to d.s. pipe	(A1)	.00 deg
Lateral #1	(L3)	0	Angle to d.s. pipe	(A3)	.00 deg
Lateral #2	(L4)	0	Angle to d.s. pipe	(A4)	.00 deg

CONNECTIVITY DIAGRAM

```
          8          9       10
     ---------0---------0---------    <--- Flow
```

1Project : CACTUS ROAD BASED UPON HEC-1 ANALYSIS-includes triangle area
Date: 9/25/1991   Time: 13:51:38

PIPE NUMBER 10

COMPOSITE ANALYSIS

Discharge = 707.00 cfs

	Downstream	Upstream
Velocity	9.97 fps	9.97 fps
Depth of flow	15.11 ft	14.25 ft
Area of flow	327.42 sf	119.07 sf
HGL	1152.50 ft	1155.20 ft
EGL	1154.04 ft	1156.75 ft
Invert	1137.39 ft	1140.95 ft
Soffit	1146.89 ft	1150.45 ft
Diameter	9.50 ft	
Width	.00 ft	

PRIMARY ANALYSIS

Channel length	1320.00 ft	Normal depth	6.87 ft
Channel slope	.00270 ft/ft	Critical depth	6.48 ft
Friction slope	.00205 ft/ft	Flow condition	Mild
Adjusted Q	707.00 cfs		
Mannings n	.0120	Loss due to friction	2.70 ft
Entrance loss coeff	.00	Minor losses	.00 ft
Junction loss coeff	.00	Length of junction	9.99 ft
Minor loss coeff	.00		
Tailwater control	.00 ft	Structure code	3

STORM DRAIN CONNECTIVITY

Downstream pipe	(LC)	0			
Upstream pipe	(L1)	11	Angle to d.s. pipe	(A1)	.00 deg
Lateral #1	(L3)	18	Angle to d.s. pipe	(A3)	45.00 deg

```
15     Hydraulic grade line control =  1162.33

20   25.0  48    0  1.23  1.48  Part   .00026    2.2    5.9  1158.86 1175.00 1162.33 1176.47    3.47    1.47 1177.02       .00 HJ
        X =      .00  X(N) =  418.33  X(J) =  259.13  F(J) =      7.59  D(BJ) =      1.23  D(AJ) =      1.75
```

1 LIST OF ABBREVIATIONS

```
      V 1, FL 1, D 1 and HG 1  refer to downstream end
0     V 2, FL 2, D 2 and HG 2  refer to upstream end
0     X      - Distance in feet from downstream end to point where HG intersects soffit in seal condition
0     X(N)  - Distance in feet from downstream end to point where water surface reaches normal depth by either drawdown or backwater
0     X(J)  - Distance in feet from downstream end to point where hydraulic jump occurs in line
0     F(J)  - The computed force at the hydraulic jump
0     D(BJ) - Depth of water before the hydraulic jump (upstream side)
0     D(AJ) - Depth of water after the hydraulic jump (downstream side)
0     SEAL indicates flow changes from part to full or from full to part
0     HJ    indicates that flow changes from supercritical to subcritical through a hydraulic jump
0     HJU   indicates that hydraulic jump occurs at the junction at the upstream end of the line
0     HJD   indicates that hydraulic jump occurs at the junction at the downstream end of the line
```

1Project : CACTUS ROAD BASED UPON HEC-1 ANALYSIS-includes triangle area
Date: 9/25/1991 Time: 13:51:38

PIPE NUMBER 2

COMPOSITE ANALYSIS

Discharge = 1000.00 cfs

	Downstream	Upstream
Velocity	.00 fps	.00 fps
Depth of flow	10.39 ft	10.52 ft
Area of flow	463.11 sf	168.41 sf
HGL	1130.68 ft	1130.82 ft
EGL	1130.68 ft	1130.82 ft
Invert	1120.29 ft	1120.30 ft
Soffit	1128.29 ft	1128.30 ft
Diameter	8.00 ft	
Width	10.00 ft	

PRIMARY ANALYSIS

Channel length	30.00 ft	Normal depth	8.00 ft
Channel slope	.00033 ft/ft	Critical depth	6.76 ft
Friction slope	.00478 ft/ft	Flow condition	Mild
Adjusted Q	1000.00 cfs		
Mannings n	.0140	Loss due to friction	.14 ft
Entrance loss coeff	.00	Minor losses	.00 ft
Junction loss coeff	.00	Length of junction	9.99 ft
Minor loss coeff	.00		
Tailwater control	.00 ft	Structure code	3

STORM DRAIN CONNECTIVITY

Downstream pipe	(LC)	1		
Upstream pipe	(L1)	3	Angle to d.s. pipe (A1)	.00 deg
Lateral #1	(L3)	0	Angle to d.s. pipe (A3)	.00 deg
Lateral #2	(L4)	0	Angle to d.s. pipe (A4)	.00 deg

CONNECTIVITY DIAGRAM

```
           1          2        3
  ---------0---------0---------    <--- Flow
```

1Project : CACTUS ROAD BASED UPON HEC-1 ANALYSIS-includes triangle area
Date: 9/25/1991 Time: 13:51:38

PIPE NUMBER 3

COMPOSITE ANALYSIS

Discharge = 1000.00 cfs

	Downstream	Upstream
Velocity	12.73 fps	12.73 fps
Depth of flow	10.47 ft	12.71 ft
Area of flow	463.11 sf	168.41 sf
HGL	1130.77 ft	1134.51 ft
EGL	1133.29 ft	1137.03 ft
Invert	1120.30 ft	1121.80 ft
Soffit	1130.30 ft	1131.80 ft
Diameter	10.00 ft	
Width	.00 ft	

PRIMARY ANALYSIS

Channel length	1200.00 ft	Normal depth	10.00 ft
Channel slope	.00125 ft/ft	Critical depth	7.61 ft
Friction slope	.00311 ft/ft	Flow condition	Mild
Adjusted Q	1000.00 cfs		
Mannings n	.0120	Loss due to friction	3.74 ft
Entrance loss coeff	.00	Minor losses	.00 ft
Junction loss coeff	.00	Length of junction	9.99 ft
Minor loss coeff	.00		
Tailwater control	.00 ft	Structure code	3

STORM DRAIN CONNECTIVITY

Downstream pipe	(LC)	0		
Upstream pipe	(L1)	4	Angle to d.s. pipe (A1)	.00 deg
Lateral #1	(L3)	17	Angle to d.s. pipe (A3)	45.00 deg
Lateral #2	(L4)	0	Angle to d.s. pipe (A4)	.00 deg

INPUT DATA LISTING

CACTRIA2

CD	L2	MAX Q	ADJ Q	LENGTH	FL 1	FL 2	CTL/TW	D	W	S	KJ	KE	KM	LC	L1	L3	L4	A1	A3	A4	J	N
8	1						1130.68															
2	2	1000.0	1000.0	30.00	1120.29	1120.30	.00	96.	120.	3	.00	.00	.00	1	3	0	0	0.	0.	0.	9.99	.014
2	3	1000.0	1000.0	1200.00	1120.30	1121.80	.00	120.	0.	3	.00	.00	.00	0	4	17	0	0.	45.	0.	9.99	.012
2	4	914.0	914.0	10.00	1121.80	1121.81	.00	120.	0.	3	.00	.00	.00	0	5	0	0	0.	0.	0.	9.99	.012
2	5	898.0	898.0	1320.00	1121.81	1125.46	.00	120.	0.	3	.00	.00	.00	0	6	0	0	0.	0.	0.	9.99	.012
2	6	887.0	887.0	1320.00	1125.46	1129.10	.00	120.	0.	3	.00	.00	.00	0	7	0	0	0.	0.	0.	9.99	.012
2	7	845.0	845.0	1320.00	1129.10	1131.21	.00	120.	0.	3	.00	.00	.00	0	8	0	0	0.	0.	0.	9.99	.012
2	8	823.0	823.0	1320.00	1131.21	1133.32	.00	120.	0.	3	.00	.00	.00	0	9	0	0	0.	0.	0.	9.99	.012
2	9	777.0	777.0	1320.00	1133.82	1137.39	.00	114.	0.	3	.00	.00	.00	0	10	0	0	0.	0.	0.	9.99	.012
2	10	707.0	707.0	1320.00	1137.39	1140.95	.00	114.	0.	3	.00	.00	.00	0	11	18	0	0.	45.	0.	9.99	.012
2	11	495.0	495.0	1320.00	1140.95	1144.52	.00	114.	0.	3	.00	.00	.00	0	12	0	0	0.	0.	0.	8.00	.012
2	12	489.0	489.0	1320.00	1144.52	1148.08	.00	114.	0.	3	.00	.00	.00	0	13	19	0	0.	45.	0.	8.00	.012
2	13	367.0	367.0	1320.00	1149.58	1152.22	.00	96.	0.	3	.00	.00	.00	0	14	0	0	0.	0.	0.	7.00	.012
2	14	285.0	285.0	1320.00	1152.22	1154.86	.00	96.	0.	3	.00	.00	.00	0	15	20	0	0.	45.	0.	7.00	.012
2	15	218.0	218.0	1320.00	1155.86	1159.36	.00	84.	0.	3	.00	.00	.00	0	16	0	0	0.	0.	0.	7.00	.012
2	16	213.0	213.0	1320.00	1159.36	1162.86	.00	84.	0.	1	.00	.00	.00	0	0	0	0	0.	0.	0.	.00	.012
2	17	87.0	87.0	4000.00	1121.80	1126.81	.00	84.	0.	1	.00	.00	.00	4	0	0	0	0.	0.	0.	.00	.012
2	18	183.0	183.0	2640.00	1146.45	1160.00	.00	48.	0.	1	.00	.00	.00	11	0	0	0	0.	0.	0.	.00	.012
2	19	101.0	101.0	2640.00	1153.58	1169.00	.00	48.	0.	1	.00	.00	.00	13	0	0	0	0.	0.	0.	.00	.012
2	20	25.0	25.0	2640.00	1158.86	1175.00	.00	48.	0.	1	.00	.00	.00	15	0	0	0	0.	0.	0.	.00	.012

STORM DRAIN ANALYSIS RESULTS

Line No	Q (cfs)	D (in)	W (in)	Dn (ft)	Dc (ft)	Flow Type	Sf-full (ft/ft)	V 1 (fps)	V 2 (fps)	FL 1 (ft)	FL 2 (ft)	HG 1 Calc	HG 2 Calc	D 1 (ft)	D 2 (ft)	TW Calc	TW CK
1	Hydraulic grade line control = 1130.68																
2	1000.0	96	120	8.00	6.76	Full	.00478	12.5	12.5	1120.29	1120.30	1130.68	1130.82	10.39	10.52	.00	.00

3	1000.0	120	0	10.00	7.61	Full	.00311	12.7	12.7	1120.30	1121.80	1130.77	1134.51	10.47	12.71	.00	.00
4	914.0	120	0	10.00	7.28	Full	.00260	11.6	11.6	1121.80	1121.81	1135.31	1135.34	13.51	13.53	.00	.00
5	898.0	120	0	7.81	7.22	Full	.00251	11.4	11.4	1121.81	1125.46	1135.51	1138.83	13.70	13.37	.00	.00
6	887.0	120	0	7.74	7.18	Full	.00245	11.3	11.3	1125.46	1129.10	1138.95	1142.19	13.49	13.09	.00	.00
7	845.0	120	0	10.00	7.01	Full	.00222	10.8	10.8	1129.10	1131.21	1142.57	1145.51	13.47	14.30	.00	.00
8	823.0	120	0	10.00	6.91	Full	.00211	10.5	10.5	1131.21	1133.32	1145.72	1148.50	14.51	15.18	.00	.00
9	777.0	114	0	7.44	6.80	Full	.00247	11.0	11.0	1133.82	1137.39	1148.57	1151.83	14.75	14.44	.00	.00
10	707.0	114	0	6.87	6.48	Full	.00205	10.0	10.0	1137.39	1140.95	1152.50	1155.20	15.11	14.25	.00	.00
11	495.0	114	0	5.35	5.38	Full	.00100	7.0	7.0	1140.95	1144.52	1155.96	1157.29	15.02	12.77	.00	.00
12	489.0	114	0	5.32	5.34	Full	.00098	6.9	6.9	1144.52	1148.08	1157.33	1158.63	12.81	10.55	.00	.00
13	367.0	96	0	5.56	4.86	Full	.00138	7.3	7.3	1149.58	1152.22	1158.70	1160.52	9.12	8.30	.00	.00
14	285.0	96	0	4.68	4.25	Seal	.00083	5.7	5.9	1152.22	1154.86	1161.18	1162.19	8.96	7.33	.00	.00

X = 824.50 X(N) = .00

15	218.0	84	0	3.96	3.84	Part	.00099	5.8	9.5	1155.86	1159.36	1162.47	1163.40	6.61	4.04	.00	.00
16	213.0	84	0	3.90	3.80	Part	.00095	8.4	9.7	1159.36	1162.86	1163.76	1166.76	4.40	3.90	1168.21	.00

X = .00 X(N) = 445.58

4 Hydraulic grade line control = 1134.91

17	87.0	84	0	2.88	2.39	Full	.00016	2.3	2.3	1121.80	1126.81	1134.91	1135.54	13.11	8.73	1135.62	.00

11 Hydraulic grade line control = 1155.58

18	183.0	48	0	4.00	3.78	Full	.01383	14.6	14.6	1146.45	1160.00	1155.58	1192.09	9.13	32.09	1195.38	.00

STORM DRAIN ANALYSIS RESULTS

Line No	Q (cfs)	D (in)	W (in)	Dn (ft)	Dc (ft)	Flow Type	Sf-full (ft/ft)	V 1 (fps)	V 2 (fps)	FL 1 (ft)	FL 2 (ft)	HG 1 Calc	HG 2 Calc	D 1 (ft)	D 2 (ft)	TW Calc	TW CK
13 Hydraulic grade line control = 1158.66																	
19	101.0	48	0	2.83	3.04	Seal	.00421	8.0	9.8	1153.58	1169.00	1158.66	1172.04	5.08	3.04	1173.55	.00 HJ

X = 663.63 X(N) = 1053.09 X(J) = 873.38 F(J) = 45.24 D(BJ) = 2.83 D(AJ) = 3.26

ANALYSIS #2

- DOWNSTREAM HGL = 1130.68
- PRELIMINARY PIPE DESIGN SIZES USED

CONNECTIVITY DIAGRAM

```
                                  / 19
                                 /
                                /
              0        12      /      13
    ---------0---------0/---------     <--- Flow
```

1Project : CACTUS ROAD BASED UPON HEC-1 ANALYSIS-includes triangle area
Date: 9/25/1991 Time: 11: 6:39

PIPE NUMBER 20

COMPOSITE ANALYSIS

Discharge = 25.00 cfs

	Downstream	Upstream
Velocity	1.99 fps	5.94 fps
Depth of flow	5.55 ft	1.47 ft
Area of flow	12.57 sf	4.21 sf
HGL	1164.41 ft	1176.47 ft
EGL	1164.47 ft	1177.02 ft
Invert	1158.86 ft	1175.00 ft
Soffit	1162.86 ft	1179.00 ft
Diameter	4.00 ft	
Width	.00 ft	

PRIMARY ANALYSIS

Channel length	2640.00 ft	Normal depth	1.23 ft
Channel slope	.00611 ft/ft	Critical depth	1.48 ft
Friction slope	.00026 ft/ft	Flow condition	Steep
Adjusted Q	25.00 cfs		
Mannings n	.0120	Loss due to friction	.68 ft
Entrance loss coeff	.00	Minor losses	.00 ft
Junction loss coeff	.00	Length of junction	.00 ft
Minor loss coeff	.00		
Tailwater control	1177.02 ft	Structure code	1

STORM DRAIN CONNECTIVITY

Downstream pipe (LC) 15

Upstream pipe	(L1)	0	Angle to d.s. pipe (A1)	.00 deg
Lateral #1	(L3)	0	Angle to d.s. pipe (A3)	.00 deg
Lateral #2	(L4)	0	Angle to d.s. pipe (A4)	.00 deg

CONNECTIVITY DIAGRAM

```
                                  / 20
                                 /
                                /
              0        14      /      15
```

STORM DRAIN CONNECTIVITY

```
Downstream pipe    (LC)  4

Upstream pipe      (L1)  0    Angle to d.s. pipe (A1)    .00 deg
Lateral #1         (L3)  0    Angle to d.s. pipe (A3)    .00 deg
Lateral #2         (L4)  0    Angle to d.s. pipe (A4)    .00 deg
```

CONNECTIVITY DIAGRAM

```
                            / 17
                           /
                          /
          0        3     /     4
   ---------0---------0/---------     <--- Flow
```

1Project : CACTUS ROAD BASED UPON HEC-1 ANALYSIS-includes triangle area
Date: 9/25/1991   Time: 11: 6:39

PIPE NUMBER 18

COMPOSITE ANALYSIS

Discharge = 183.00 cfs

	Downstream	Upstream
Velocity	14.56 fps	14.56 fps
Depth of flow	11.13 ft	34.09 ft
Area of flow	91.99 sf	30.82 sf
HGL	1157.58 ft	1194.09 ft
EGL	1160.88 ft	1197.38 ft
Invert	1146.45 ft	1160.00 ft
Soffit	1150.45 ft	1164.00 ft
Diameter	4.00 ft	
Width	.00 ft	

PRIMARY ANALYSIS

Channel length	2640.00 ft	Normal depth	4.00 ft
Channel slope	.00513 ft/ft	Critical depth	3.78 ft
Friction slope	.01383 ft/ft	Flow condition	Mild
Adjusted Q	183.00 cfs		
Mannings n	.0120	Loss due to friction	36.51 ft
Entrance loss coeff	.00	Minor losses	.00 ft
Junction loss coeff	.00	Length of junction	.00 ft
Minor loss coeff	.00		
Tailwater control	1197.38 ft	Structure code	1

STORM DRAIN CONNECTIVITY

```
Downstream pipe    (LC)  11

Upstream pipe      (L1)  0    Angle to d.s. pipe (A1)    .00 deg
```

Lateral #1	(L3)	0	Angle to d.s. pipe (A3)	.00 deg
Lateral #2	(L4)	0	Angle to d.s. pipe (A4)	.00 deg

CONNECTIVITY DIAGRAM

```
                           / 18
                          /
                         /
       0         10     /      11
---------0---------0/---------    <--- Flow
```

1Project : CACTUS ROAD BASED UPON HEC-1 ANALYSIS-includes triangle area
Date: 9/25/1991 Time: 11: 6:39

PIPE NUMBER 19

COMPOSITE ANALYSIS

Discharge = 101.00 cfs

	Downstream	Upstream
Velocity	8.04 fps	9.85 fps
Depth of flow	7.08 ft	3.04 ft
Area of flow	50.77 sf	17.01 sf
HGL	1160.66 ft	1172.04 ft
EGL	1161.67 ft	1173.55 ft
Invert	1153.58 ft	1169.00 ft
Soffit	1157.58 ft	1173.00 ft
Diameter	4.00 ft	
Width	.00 ft	

PRIMARY ANALYSIS

Channel length	2640.00 ft	Normal depth	2.83 ft
Channel slope	.00584 ft/ft	Critical depth	3.04 ft
Friction slope	.00421 ft/ft	Flow condition	Steep
Adjusted Q	101.00 cfs		
Mannings n	.0120	Loss due to friction	11.12 ft
Entrance loss coeff	.00	Minor losses	.00 ft
Junction loss coeff	.00	Length of junction	.00 ft
Minor loss coeff	.00		
Tailwater control	1173.55 ft	Structure code	1

STORM DRAIN CONNECTIVITY

Downstream pipe (LC) 13

Upstream pipe	(L1)	0	Angle to d.s. pipe (A1)	.00 deg
Lateral #1	(L3)	0	Angle to d.s. pipe (A3)	.00 deg
Lateral #2	(L4)	0	Angle to d.s. pipe (A4)	.00 deg

Diameter	7.00 ft		
Width	.00 ft		

PRIMARY ANALYSIS

Channel length	1320.00 ft	Normal depth	3.96 ft
Channel slope	.00265 ft/ft	Critical depth	3.84 ft
Friction slope	.00099 ft/ft	Flow condition	Mild
Adjusted Q	218.00 cfs		
Mannings n	.0120	Loss due to friction	1.31 ft
Entrance loss coeff	.00	Minor losses	.00 ft
Junction loss coeff	.00	Length of junction	7.00 ft
Minor loss coeff	.00		
Tailwater control	.00 ft	Structure code	3

STORM DRAIN CONNECTIVITY

Downstream pipe (LC) 0

Upstream pipe	(L1)	16	Angle to d.s. pipe (A1)	.00 deg
Lateral #1	(L3)	0	Angle to d.s. pipe (A3)	.00 deg
Lateral #2	(L4)	0	Angle to d.s. pipe (A4)	.00 deg

CONNECTIVITY DIAGRAM

```
          14         15        16
  ---------0---------0---------     <--- Flow
```

1Project : CACTUS ROAD BASED UPON HEC-1 ANALYSIS-includes triangle area
Date: 9/25/1991 Time: 11: 6:39

PIPE NUMBER 16

COMPOSITE ANALYSIS

Discharge = 213.00 cfs

	Downstream	Upstream
Velocity	5.74 fps	9.58 fps
Depth of flow	6.45 ft	3.93 ft
Area of flow	107.07 sf	35.87 sf
HGL	1165.81 ft	1166.79 ft
EGL	1166.33 ft	1168.21 ft
Invert	1159.36 ft	1162.86 ft
Soffit	1166.36 ft	1169.86 ft
Diameter	7.00 ft	
Width	.00 ft	

PRIMARY ANALYSIS

Channel length	1320.00 ft	Normal depth	3.90 ft
Channel slope	.00265 ft/ft	Critical depth	3.80 ft

Friction slope	.00095 ft/ft	Flow condition	Mild
Adjusted Q	213.00 cfs		
Mannings n	.0120	Loss due to friction	1.25 ft
Entrance loss coeff	.00	Minor losses	.00 ft
Junction loss coeff	.00	Length of junction	.00 ft
Minor loss coeff	.00		
Tailwater control	1168.21 ft	Structure code	1

STORM DRAIN CONNECTIVITY

Downstream pipe (LC) 0

Upstream pipe	(L1)	0	Angle to d.s. pipe (A1)	.00 deg
Lateral #1	(L3)	0	Angle to d.s. pipe (A3)	.00 deg
Lateral #2	(L4)	0	Angle to d.s. pipe (A4)	.00 deg

CONNECTIVITY DIAGRAM

```
          15        16
   ---------0---------0    <--- Flow
```

1Project : CACTUS ROAD BASED UPON HEC-1 ANALYSIS-includes triangle area
Date: 9/25/1991 Time: 11: 6:39

PIPE NUMBER 17

COMPOSITE ANALYSIS

Discharge = 87.00 cfs

	Downstream	Upstream
Velocity	2.26 fps	2.26 fps
Depth of flow	15.11 ft	10.73 ft
Area of flow	43.73 sf	14.65 sf
HGL	1136.91 ft	1137.54 ft
EGL	1136.99 ft	1137.62 ft
Invert	1121.80 ft	1126.81 ft
Soffit	1128.80 ft	1133.81 ft
Diameter	7.00 ft	
Width	.00 ft	

PRIMARY ANALYSIS

Channel length	4000.00 ft	Normal depth	2.88 ft
Channel slope	.00125 ft/ft	Critical depth	2.39 ft
Friction slope	.00016 ft/ft	Flow condition	Mild
Adjusted Q	87.00 cfs		
Mannings n	.0120	Loss due to friction	.63 ft
Entrance loss coeff	.00	Minor losses	.00 ft
Junction loss coeff	.00	Length of junction	.00 ft
Minor loss coeff	.00		
Tailwater control	1137.62 ft	Structure code	1

CONNECTIVITY DIAGRAM

```
                          / 18
                         /
                        /
          9        10  /     11
   ---------O---------O/---------    <--- Flow
```

1Project : CACTUS ROAD BASED UPON HEC-1 ANALYSIS-includes triangle area
Date: 9/25/1991 Time: 11: 6:39

PIPE NUMBER 11

COMPOSITE ANALYSIS

Discharge = 495.00 cfs

	Downstream	Upstream
Velocity	6.98 fps	6.98 fps
Depth of flow	17.02 ft	14.77 ft
Area of flow	248.81 sf	83.36 sf
HGL	1157.96 ft	1159.29 ft
EGL	1158.72 ft	1160.05 ft
Invert	1140.95 ft	1144.52 ft
Soffit	1150.45 ft	1154.02 ft
Diameter	9.50 ft	
Width	.00 ft	

PRIMARY ANALYSIS

Channel length	1320.00 ft	Normal depth	5.35 ft
Channel slope	.00271 ft/ft	Critical depth	5.38 ft
Friction slope	.00100 ft/ft	Flow condition	Steep
Adjusted Q	495.00 cfs		
Mannings n	.0120	Loss due to friction	1.32 ft
Entrance loss coeff	.00	Minor losses	.00 ft
Junction loss coeff	.00	Length of junction	8.00 ft
Minor loss coeff	.00		
Tailwater control	.00 ft	Structure code	3

STORM DRAIN CONNECTIVITY

Downstream pipe	(LC)	0		
Upstream pipe	(L1)	12	Angle to d.s. pipe (A1)	.00 deg
Lateral #1	(L3)	0	Angle to d.s. pipe (A3)	.00 deg
Lateral #2	(L4)	0	Angle to d.s. pipe (A4)	.00 deg

CONNECTIVITY DIAGRAM

```
        10        11       12
   ---------0---------0---------    <--- Flow
```

1Project : CACTUS ROAD BASED UPON HEC-1 ANALYSIS-includes triangle area
Date: 9/25/1991 Time: 11: 6:39

PIPE NUMBER 12

COMPOSITE ANALYSIS

Discharge = 489.00 cfs

	Downstream	Upstream
Velocity	6.90 fps	6.90 fps
Depth of flow	14.81 ft	12.55 ft
Area of flow	245.80 sf	82.35 sf
HGL	1159.33 ft	1160.63 ft
EGL	1160.07 ft	1161.37 ft
Invert	1144.52 ft	1148.08 ft
Soffit	1154.02 ft	1157.58 ft
Diameter	9.50 ft	
Width	.00 ft	

PRIMARY ANALYSIS

Channel length	1320.00 ft	Normal depth	5.32 ft
Channel slope	.00270 ft/ft	Critical depth	5.34 ft
Friction slope	.00098 ft/ft	Flow condition	Steep
Adjusted Q	489.00 cfs		
Mannings n	.0120	Loss due to friction	1.29 ft
Entrance loss coeff	.00	Minor losses	.00 ft
Junction loss coeff	.00	Length of junction	8.00 ft
Minor loss coeff	.00		
Tailwater control	.00 ft	Structure code	3

STORM DRAIN CONNECTIVITY

Downstream pipe	(LC)	0		
Upstream pipe	(L1)	13	Angle to d.s. pipe (A1)	.00 deg
Lateral #1	(L3)	19	Angle to d.s. pipe (A3)	45.00 deg
Lateral #2	(L4)	0	Angle to d.s. pipe (A4)	.00 deg

CONNECTIVITY DIAGRAM

```
                          / 19
                         /
                        /
        11         12  /      13
   ---------0---------0/---------    <--- Flow
```

1Project : CACTUS ROAD BASED UPON HEC-1 ANALYSIS-includes triangle area
Date: 9/25/1991 Time: 11: 6:39

CONNECTIVITY DIAGRAM

```
                              / 17
                             /
                            /
            2         3    /      4
     ---------0---------0/---------    <--- Flow
```

1Project : CACTUS ROAD BASED UPON HEC-1 ANALYSIS-includes triangle area
Date: 9/25/1991 Time: 13:51:38

PIPE NUMBER 4

COMPOSITE ANALYSIS

Discharge = 914.00 cfs

	Downstream	Upstream
Velocity	11.64 fps	11.64 fps
Depth of flow	13.51 ft	13.53 ft
Area of flow	423.28 sf	153.93 sf
HGL	1135.31 ft	1135.34 ft
EGL	1137.42 ft	1137.44 ft
Invert	1121.80 ft	1121.81 ft
Soffit	1131.80 ft	1131.81 ft
Diameter	10.00 ft	
Width	.00 ft	

PRIMARY ANALYSIS

Channel length	10.00 ft	Normal depth	10.00 ft
Channel slope	.00100 ft/ft	Critical depth	7.28 ft
Friction slope	.00260 ft/ft	Flow condition	Mild
Adjusted Q	914.00 cfs		
Mannings n	.0120	Loss due to friction	.03 ft
Entrance loss coeff	.00	Minor losses	.00 ft
Junction loss coeff	.00	Length of junction	9.99 ft
Minor loss coeff	.00		
Tailwater control	.00 ft	Structure code	3

STORM DRAIN CONNECTIVITY

Downstream pipe (LC) 0

Upstream pipe	(L1)	5	Angle to d.s. pipe (A1)	.00 deg
Lateral #1	(L3)	0	Angle to d.s. pipe (A3)	.00 deg
Lateral #2	(L4)	0	Angle to d.s. pipe (A4)	.00 deg

CONNECTIVITY DIAGRAM

```
         3         4        5
```

---------0---------0---------   <--- Flow

1Project : CACTUS ROAD BASED UPON HEC-1 ANALYSIS-includes triangle area
Date: 9/25/1991   Time: 13:51:38

PIPE NUMBER 5

COMPOSITE ANALYSIS

Discharge = 898.00 cfs

	Downstream	Upstream
Velocity	11.43 fps	11.43 fps
Depth of flow	13.70 ft	13.37 ft
Area of flow	415.87 sf	151.23 sf
HGL	1135.51 ft	1138.83 ft
EGL	1137.54 ft	1140.86 ft
Invert	1121.81 ft	1125.46 ft
Soffit	1131.81 ft	1135.46 ft
Diameter	10.00 ft	
Width	.00 ft	

PRIMARY ANALYSIS

Channel length	1320.00 ft	Normal depth	7.81 ft
Channel slope	.00277 ft/ft	Critical depth	7.22 ft
Friction slope	.00251 ft/ft	Flow condition	Mild
Adjusted Q	898.00 cfs		
Mannings n	.0120	Loss due to friction	3.32 ft
Entrance loss coeff	.00	Minor losses	.00 ft
Junction loss coeff	.00	Length of junction	9.99 ft
Minor loss coeff	.00		
Tailwater control	.00 ft	Structure code	3

STORM DRAIN CONNECTIVITY

Downstream pipe (LC) 0

Upstream pipe	(L1)	6	Angle to d.s. pipe (A1)	.00 deg
Lateral #1	(L3)	0	Angle to d.s. pipe (A3)	.00 deg
Lateral #2	(L4)	0	Angle to d.s. pipe (A4)	.00 deg

CONNECTIVITY DIAGRAM

4 5 6

---------0---------0---------   <--- Flow

1Project : CACTUS ROAD BASED UPON HEC-1 ANALYSIS-includes triangle area
Date: 9/25/1991   Time: 13:51:38

PIPE NUMBER 6

COMPOSITE ANALYSIS

PIPE NUMBER 13

COMPOSITE ANALYSIS

Discharge = 367.00 cfs

	Downstream	Upstream
Velocity	7.30 fps	7.30 fps
Depth of flow	11.12 ft	10.30 ft
Area of flow	184.47 sf	61.81 sf
HGL	1160.70 ft	1162.52 ft
EGL	1161.53 ft	1163.35 ft
Invert	1149.58 ft	1152.22 ft
Soffit	1157.58 ft	1160.22 ft
Diameter	8.00 ft	
Width	.00 ft	

PRIMARY ANALYSIS

Channel length	1320.00 ft	Normal depth	5.56 ft
Channel slope	.00200 ft/ft	Critical depth	4.86 ft
Friction slope	.00138 ft/ft	Flow condition	Mild
Adjusted Q	367.00 cfs		
Mannings n	.0120	Loss due to friction	1.82 ft
Entrance loss coeff	.00	Minor losses	.00 ft
Junction loss coeff	.00	Length of junction	7.00 ft
Minor loss coeff	.00		
Tailwater control	.00 ft	Structure code	3

STORM DRAIN CONNECTIVITY

Downstream pipe (LC) 0

Upstream pipe	(L1)	14	Angle to d.s. pipe (A1)	.00 deg
Lateral #1	(L3)	0	Angle to d.s. pipe (A3)	.00 deg
Lateral #2	(L4)	0	Angle to d.s. pipe (A4)	.00 deg

CONNECTIVITY DIAGRAM

```
          12         13        14
   ---------O---------O---------    <--- Flow
```

1Project : CACTUS ROAD BASED UPON HEC-1 ANALYSIS-includes triangle area
Date: 9/25/1991 Time: 11: 6:39

PIPE NUMBER 14

COMPOSITE ANALYSIS

Discharge = 285.00 cfs

	Downstream	Upstream
Velocity	5.67 fps	5.67 fps

	Downstream	Upstream
Depth of flow	10.96 ft	5.42 ft
Area of flow	143.26 sf	48.00 sf
HGL	1163.18 ft	1164.28 ft
EGL	1163.68 ft	1164.78 ft
Invert	1152.22 ft	1154.86 ft
Soffit	1160.22 ft	1162.86 ft
Diameter	8.00 ft	
Width	.00 ft	

PRIMARY ANALYSIS

Channel length	1320.00 ft	Normal depth	4.68 ft
Channel slope	.00200 ft/ft	Critical depth	4.25 ft
Friction slope	.00083 ft/ft	Flow condition	Mild
Adjusted Q	285.00 cfs		
Mannings n	.0120	Loss due to friction	1.10 ft
Entrance loss coeff	.00	Minor losses	.00 ft
Junction loss coeff	.00	Length of junction	7.00 ft
Minor loss coeff	.00		
Tailwater control	.00 ft	Structure code	3

STORM DRAIN CONNECTIVITY

Downstream pipe (LC) 0

Upstream pipe	(L1)	15	Angle to d.s. pipe (A1)	.00 deg
Lateral #1	(L3)	20	Angle to d.s. pipe (A3)	45.00 deg
Lateral #2	(L4)	0	Angle to d.s. pipe (A4)	.00 deg

CONNECTIVITY DIAGRAM

```
                         / 20
                        /
                       /
       13         14  /      15
   ---------0---------0/---------     <--- Flow
```

1Project : CACTUS ROAD BASED UPON HEC-1 ANALYSIS-includes triangle area
Date: 9/25/1991 Time: 11: 6:39

PIPE NUMBER 15

COMPOSITE ANALYSIS

Discharge = 218.00 cfs

	Downstream	Upstream
Velocity	5.66 fps	5.90 fps
Depth of flow	8.67 ft	6.41 ft
Area of flow	109.58 sf	36.71 sf
HGL	1164.53 ft	1165.77 ft
EGL	1165.03 ft	1166.32 ft
Invert	1155.86 ft	1159.36 ft
Soffit	1162.86 ft	1166.36 ft

Discharge = 887.00 cfs

	Downstream	Upstream
Velocity	11.29 fps	11.29 fps
Depth of flow	13.49 ft	13.09 ft
Area of flow	410.78 sf	149.38 sf
HGL	1138.95 ft	1142.19 ft
EGL	1140.93 ft	1144.17 ft
Invert	1125.46 ft	1129.10 ft
Soffit	1135.46 ft	1139.10 ft
Diameter	10.00 ft	
Width	.00 ft	

PRIMARY ANALYSIS

Channel length	1320.00 ft	Normal depth	7.74 ft
Channel slope	.00276 ft/ft	Critical depth	7.18 ft
Friction slope	.00245 ft/ft	Flow condition	Mild
Adjusted Q	887.00 cfs		
Mannings n	.0120	Loss due to friction	3.24 ft
Entrance loss coeff	.00	Minor losses	.00 ft
Junction loss coeff	.00	Length of junction	9.99 ft
Minor loss coeff	.00		
Tailwater control	.00 ft	Structure code	3

STORM DRAIN CONNECTIVITY

Downstream pipe	(LC)	0		
Upstream pipe	(L1)	7	Angle to d.s. pipe (A1)	.00 deg
Lateral #1	(L3)	0	Angle to d.s. pipe (A3)	.00 deg
Lateral #2	(L4)	0	Angle to d.s. pipe (A4)	.00 deg

CONNECTIVITY DIAGRAM

```
                5         6        7
        ---------0---------0---------    <--- Flow
```

1Project : CACTUS ROAD BASED UPON HEC-1 ANALYSIS-includes triangle area

Date: 9/25/1991 Time: 13:51:38

PIPE NUMBER 7

COMPOSITE ANALYSIS

Discharge = 845.00 cfs

	Downstream	Upstream
Velocity	10.76 fps	10.76 fps
Depth of flow	13.47 ft	14.30 ft
Area of flow	391.33 sf	142.31 sf
HGL	1142.57 ft	1145.51 ft
EGL	1144.37 ft	1147.31 ft

Invert	1129.10 ft	1131.21 ft
Soffit	1139.10 ft	1141.21 ft
Diameter	10.00 ft	
Width	.00 ft	

PRIMARY ANALYSIS

Channel length	1320.00 ft	Normal depth	10.00 ft
Channel slope	.00160 ft/ft	Critical depth	7.01 ft
Friction slope	.00222 ft/ft	Flow condition	Mild
Adjusted Q	845.00 cfs		
Mannings n	.0120	Loss due to friction	2.94 ft
Entrance loss coeff	.00	Minor losses	.00 ft
Junction loss coeff	.00	Length of junction	9.99 ft
Minor loss coeff	.00		
Tailwater control	.00 ft	Structure code	3

STORM DRAIN CONNECTIVITY

Downstream pipe (LC) 0

Upstream pipe	(L1)	8	Angle to d.s. pipe (A1)	.00 deg
Lateral #1	(L3)	0	Angle to d.s. pipe (A3)	.00 deg
Lateral #2	(L4)	0	Angle to d.s. pipe (A4)	.00 deg

CONNECTIVITY DIAGRAM

```
          6          7        8
    ---------0---------0---------    <--- Flow
```

1Project : CACTUS ROAD BASED UPON HEC-1 ANALYSIS-includes triangle area
Date: 9/25/1991 Time: 13:51:38

PIPE NUMBER 8

COMPOSITE ANALYSIS

Discharge = 823.00 cfs

	Downstream	Upstream
Velocity	10.48 fps	10.48 fps
Depth of flow	14.51 ft	15.18 ft
Area of flow	381.14 sf	138.60 sf
HGL	1145.72 ft	1148.50 ft
EGL	1147.42 ft	1150.21 ft
Invert	1131.21 ft	1133.32 ft
Soffit	1141.21 ft	1143.32 ft
Diameter	10.00 ft	
Width	.00 ft	

PRIMARY ANALYSIS

18	214.0	66	0	3.70	4.09	Full	.00346	9.0	9.0	1144.95	1145.06	1155.63	1155.70	10.68	10.64	.00	.00
19	185.0	66	0	3.35	3.80	Full	.00259	7.8	7.8	1145.06	1152.22	1156.34	1159.70	11.28	7.48	.00	.00
20	104.0	54	0	2.80	2.99	Full	.00238	6.5	6.5	1153.22	1159.50	1160.89	1164.04	7.67	4.54	1164.70	.00

STORM DRAIN ANALYSIS RESULTS

Line No	Q (cfs)	D (in)	W (in)	Dn (ft)	Dc (ft)	Flow Type	Sf-full (ft/ft)	V 1 (fps)	V 2 (fps)	FL 1 (ft)	FL 2 (ft)	HG 1 Calc	HG 2 Calc	D 1 (ft)	D 2 (ft)	TW Calc	TW CK
12	Hydraulic grade line control = 1159.42																
21	113.0	42	0	3.50	3.19	Full	.01075	11.7	11.7	1154.08	1154.19	1159.42	1159.63	5.34	5.44	.00	.00
22	84.0	42	0	3.50	2.85	Full	.00594	8.7	8.7	1154.19	1161.79	1161.55	1169.27	7.36	7.48	.00	.00
23	44.0	42	0	1.81	2.07	Full	.00163	4.6	4.6	1161.79	1169.50	1170.98	1173.14	9.19	3.64	1173.46	.00
15	Hydraulic grade line control = 1166.55																
24	30.0	30	0	1.96	1.87	Full	.00456	6.1	6.1	1160.36	1160.46	1166.55	1166.64	6.19	6.18	.00	.00
25	25.0	30	0	1.67	1.70	Full	.00316	5.1	5.1	1160.46	1167.14	1166.99	1171.11	6.53	3.97	.00	.00
26	15.0	24	0	1.42	1.40	Seal	.00375	4.8	6.3	1167.64	1177.00	1171.54	1178.42	3.90	1.42	1179.04	.00

X = 1357.19 X(N) = 229.84

1 LIST OF ABBREVIATIONS

V 1, FL 1, D 1 and HG 1 refer to downstream end
0 V 2, FL 2, D 2 and HG 2 refer to upstream end
0 X - Distance in feet from downstream end to point where HG intersects soffit in seal condition
0 X(N) - Distance in feet from downstream end to point where water surface reaches normal depth by either drawdown or backwater
0 X(J) - Distance in feet from downstream end to point where hydraulic jump occurs in line
0 F(J) - The computed force at the hydraulic jump
0 D(BJ) - Depth of water before the hydraulic jump (upstream side)
0 D(AJ) - Depth of water after the hydraulic jump (downstream side)
0 SEAL indicates flow changes from part to full or from full to part
0 HJ indicates that flow changes from supercritical to subcritical through a hydraulic jump
0 HJU indicates that hydraulic jump occurs at the junction at the upstream end of the line
0 HJD indicates that hydraulic jump occurs at the junction at the downstream end of the line

PIPE NUMBER 2

COMPOSITE ANALYSIS

Discharge = 1000.00 cfs

	Downstream	Upstream
Velocity	.00 fps	.00 fps
Depth of flow	10.39 ft	10.52 ft
Area of flow	209.44 sf	159.17 sf
HGL	1130.68 ft	1130.82 ft
EGL	1130.68 ft	1130.82 ft
Invert	1120.29 ft	1120.30 ft
Soffit	1128.29 ft	1128.30 ft
Diameter	8.00 ft	
Width	10.00 ft	

PRIMARY ANALYSIS

Channel length	30.00 ft	Normal depth	8.00 ft
Channel slope	.00033 ft/ft	Critical depth	6.76 ft
Friction slope	.00478 ft/ft	Flow condition	Mild
Adjusted Q	1000.00 cfs		
Mannings n	.0140	Loss due to friction	.14 ft
Entrance loss coeff	.00	Minor losses	.00 ft
Junction loss coeff	.00	Length of junction	9.99 ft
Minor loss coeff	.00		
Tailwater control	.00 ft	Structure code	3

STORM DRAIN CONNECTIVITY

Downstream pipe (LC) 1

Upstream pipe	(L1)	3	Angle to d.s. pipe (A1)	.00 deg
Lateral #1	(L3)	0	Angle to d.s. pipe (A3)	.00 deg
Lateral #2	(L4)	0	Angle to d.s. pipe (A4)	.00 deg

CONNECTIVITY DIAGRAM

```
                1          2        3
      ---------0---------0---------    <--- Flow
```

1Project : CACTUS ROAD BASED UPON HEC-1 ANALYSIS-includes triangle area
Date: 9/30/1991 Time: 11:40:55

PIPE NUMBER 3

COMPOSITE ANALYSIS

Discharge = 1000.00 cfs

	Downstream	Upstream
Velocity	12.73 fps	12.73 fps
Depth of flow	10.47 ft	12.71 ft
Area of flow	209.44 sf	159.17 sf
HGL	1130.77 ft	1134.51 ft
EGL	1133.29 ft	1137.03 ft
Invert	1120.30 ft	1121.80 ft
Soffit	1130.30 ft	1131.80 ft

Diameter	10.00 ft
Width	.00 ft

PRIMARY ANALYSIS

Channel length	1200.00 ft	Normal depth	10.00 ft
Channel slope	.00125 ft/ft	Critical depth	7.61 ft
Friction slope	.00311 ft/ft	Flow condition	Mild
Adjusted Q	1000.00 cfs		
Mannings n	.0120	Loss due to friction	3.74 ft
Entrance loss coeff	.00	Minor losses	.00 ft
Junction loss coeff	.00	Length of junction	9.99 ft
Minor loss coeff	.00		
Tailwater control	.00 ft	Structure code	3

STORM DRAIN CONNECTIVITY

Downstream pipe	(LC) 0		
Upstream pipe	(L1) 4	Angle to d.s. pipe (A1)	.00 deg
Lateral #1	(L3) 17	Angle to d.s. pipe (A3)	45.00 deg
Lateral #2	(L4) 0	Angle to d.s. pipe (A4)	.00 deg

CONNECTIVITY DIAGRAM

```
                             / 17
                            /
                           /
        2         3       /      4
   ---------0---------0/---------     <--- Flow
```

1Project : CACTUS ROAD BASED UPON HEC-1 ANALYSIS-includes triangle area
Date: 9/30/1991 Time: 11:40:55

PIPE NUMBER 4

COMPOSITE ANALYSIS

Discharge = 914.00 cfs

	Downstream	Upstream
Velocity	11.64 fps	11.64 fps
Depth of flow	13.51 ft	13.53 ft
Area of flow	191.43 sf	145.48 sf
HGL	1135.31 ft	1135.34 ft
EGL	1137.42 ft	1137.44 ft
Invert	1121.80 ft	1121.81 ft
Soffit	1131.80 ft	1131.81 ft
Diameter	10.00 ft	
Width	.00 ft	

PRIMARY ANALYSIS

Channel length	10.00 ft	Normal depth	10.00 ft
Channel slope	.00100 ft/ft	Critical depth	7.28 ft
Friction slope	.00260 ft/ft	Flow condition	Mild
Adjusted Q	914.00 cfs		
Mannings n	.0120	Loss due to friction	.03 ft
Entrance loss coeff	.00	Minor losses	.00 ft
Junction loss coeff	.00	Length of junction	9.99 ft
Minor loss coeff	.00		
Tailwater control	.00 ft	Structure code	3

STORM DRAIN CONNECTIVITY

Downstream pipe (LC) 0

Upstream pipe	(L1)	5	Angle to d.s. pipe (A1)	.00 deg
Lateral #1	(L3)	0	Angle to d.s. pipe (A3)	.00 deg
Lateral #2	(L4)	0	Angle to d.s. pipe (A4)	.00 deg

CONNECTIVITY DIAGRAM

```
          3          4        5
    ---------0---------0---------    <--- Flow
```

1Project : CACTUS ROAD BASED UPON HEC-1 ANALYSIS-includes triangle area
Date: 9/30/1991 Time: 11:40:55

PIPE NUMBER 5

COMPOSITE ANALYSIS

Discharge = 898.00 cfs

	Downstream	Upstream
Velocity	11.43 fps	11.43 fps
Depth of flow	13.70 ft	13.37 ft
Area of flow	188.08 sf	142.94 sf
HGL	1135.51 ft	1138.83 ft
EGL	1137.54 ft	1140.86 ft
Invert	1121.81 ft	1125.46 ft
Soffit	1131.81 ft	1135.46 ft
Diameter	10.00 ft	
Width	.00 ft	

PRIMARY ANALYSIS

Channel length	1320.00 ft	Normal depth	7.81 ft
Channel slope	.00277 ft/ft	Critical depth	7.22 ft
Friction slope	.00251 ft/ft	Flow condition	Mild
Adjusted Q	898.00 cfs		
Mannings n	.0120	Loss due to friction	3.32 ft
Entrance loss coeff	.00	Minor losses	.00 ft
Junction loss coeff	.00	Length of junction	9.99 ft
Minor loss coeff	.00		

Tailwater control	.00 ft	Structure code	3

STORM DRAIN CONNECTIVITY

Downstream pipe	(LC)	0		
Upstream pipe	(L1)	6	Angle to d.s. pipe (A1)	.00 deg
Lateral #1	(L3)	0	Angle to d.s. pipe (A3)	.00 deg
Lateral #2	(L4)	0	Angle to d.s. pipe (A4)	.00 deg

CONNECTIVITY DIAGRAM

```
            4          5         6
      ---------0---------0---------    <--- Flow
```

1Project : CACTUS ROAD BASED UPON HEC-1 ANALYSIS-includes triangle area
Date: 9/30/1991 Time: 11:40:55

PIPE NUMBER 6

COMPOSITE ANALYSIS

Discharge = 887.00 cfs

	Downstream	Upstream
Velocity	11.29 fps	11.29 fps
Depth of flow	13.49 ft	13.09 ft
Area of flow	185.77 sf	141.19 sf
HGL	1138.95 ft	1142.19 ft
EGL	1140.93 ft	1144.17 ft
Invert	1125.46 ft	1129.10 ft
Soffit	1135.46 ft	1139.10 ft
Diameter	10.00 ft	
Width	.00 ft	

PRIMARY ANALYSIS

Channel length	1320.00 ft	Normal depth	7.74 ft
Channel slope	.00276 ft/ft	Critical depth	7.18 ft
Friction slope	.00245 ft/ft	Flow condition	Mild
Adjusted Q	887.00 cfs		
Mannings n	.0120	Loss due to friction	3.24 ft
Entrance loss coeff	.00	Minor losses	.00 ft
Junction loss coeff	.00	Length of junction	9.99 ft
Minor loss coeff	.00		
Tailwater control	.00 ft	Structure code	3

STORM DRAIN CONNECTIVITY

Downstream pipe	(LC)	0		
Upstream pipe	(L1)	7	Angle to d.s. pipe (A1)	.00 deg

Lateral #1	(L3)	0	Angle to d.s. pipe (A3)	.00 deg
Lateral #2	(L4)	0	Angle to d.s. pipe (A4)	.00 deg

CONNECTIVITY DIAGRAM

```
              5         6        7
     ---------0---------0---------    <--- Flow
```

1Project : CACTUS ROAD BASED UPON HEC-1 ANALYSIS-includes triangle area
Date: 9/30/1991 Time: 11:40:55

PIPE NUMBER 7

COMPOSITE ANALYSIS

Discharge = 845.00 cfs

	Downstream	Upstream
Velocity	10.76 fps	10.76 fps
Depth of flow	13.47 ft	14.30 ft
Area of flow	176.98 sf	134.50 sf
HGL	1142.57 ft	1145.51 ft
EGL	1144.37 ft	1147.31 ft
Invert	1129.10 ft	1131.21 ft
Soffit	1139.10 ft	1141.21 ft
Diameter	10.00 ft	
Width	.00 ft	

PRIMARY ANALYSIS

Channel length	1320.00 ft	Normal depth	10.00 ft
Channel slope	.00160 ft/ft	Critical depth	7.01 ft
Friction slope	.00222 ft/ft	Flow condition	Mild
Adjusted Q	845.00 cfs		
Mannings n	.0120	Loss due to friction	2.94 ft
Entrance loss coeff	.00	Minor losses	.00 ft
Junction loss coeff	.00	Length of junction	9.99 ft
Minor loss coeff	.00		
Tailwater control	.00 ft	Structure code	3

STORM DRAIN CONNECTIVITY

Downstream pipe	(LC)	0		
Upstream pipe	(L1)	8	Angle to d.s. pipe (A1)	.00 deg
Lateral #1	(L3)	0	Angle to d.s. pipe (A3)	.00 deg
Lateral #2	(L4)	0	Angle to d.s. pipe (A4)	.00 deg

CONNECTIVITY DIAGRAM

```
              6         7        8
```

```
          ---------0---------0---------    <--- Flow
1Project : CACTUS ROAD BASED UPON HEC-1 ANALYSIS-includes triangle area
 Date: 9/30/1991        Time: 11:40:55
 --------------------------------------------------------------------------

 PIPE NUMBER    8

                               COMPOSITE ANALYSIS

    Discharge =   823.00 cfs

                    Downstream        Upstream
                    -----------      -----------
    Velocity          10.48 fps        10.48 fps
    Depth of flow     14.51 ft         15.18 ft
    Area of flow     172.37 sf        131.00 sf
    HGL             1145.72 ft       1148.50 ft
    EGL             1147.42 ft       1150.21 ft
    Invert          1131.21 ft       1133.32 ft
    Soffit          1141.21 ft       1143.32 ft
    Diameter          10.00 ft
    Width               .00 ft


                                PRIMARY ANALYSIS

    Channel length         1320.00 ft      Normal depth           10.00 ft
    Channel slope           .00160 ft/ft   Critical depth          6.91 ft
    Friction slope          .00211 ft/ft   Flow condition         Mild
    Adjusted Q              823.00 cfs
    Mannings n               .0120         Loss due to friction    2.79 ft
    Entrance loss coeff        .00         Minor losses             .00 ft
    Junction loss coeff        .00         Length of junction      9.99 ft
    Minor loss coeff           .00
    Tailwater control          .00 ft      Structure code             3


                             STORM DRAIN CONNECTIVITY

    Downstream pipe     (LC)   0

    Upstream pipe       (L1)   9    Angle to d.s. pipe (A1)     .00 deg
    Lateral #1          (L3)   0    Angle to d.s. pipe (A3)     .00 deg
    Lateral #2          (L4)   0    Angle to d.s. pipe (A4)     .00 deg


                              CONNECTIVITY DIAGRAM

                    7          8         9
          ---------0---------0---------    <--- Flow
1Project : CACTUS ROAD BASED UPON HEC-1 ANALYSIS-includes triangle area
 Date: 9/30/1991        Time: 11:40:55
 --------------------------------------------------------------------------

 PIPE NUMBER    9

                               COMPOSITE ANALYSIS
```

Discharge = 777.00 cfs

	Downstream	Upstream
Velocity	10.96 fps	10.96 fps
Depth of flow	14.75 ft	14.44 ft
Area of flow	162.73 sf	123.68 sf
HGL	1148.57 ft	1151.83 ft
EGL	1150.44 ft	1153.70 ft
Invert	1133.82 ft	1137.39 ft
Soffit	1143.32 ft	1146.89 ft
Diameter	9.50 ft	
Width	.00 ft	

PRIMARY ANALYSIS

Channel length	1320.00 ft	Normal depth	7.44 ft
Channel slope	.00271 ft/ft	Critical depth	6.80 ft
Friction slope	.00247 ft/ft	Flow condition	Mild
Adjusted Q	777.00 cfs		
Mannings n	.0120	Loss due to friction	3.26 ft
Entrance loss coeff	.00	Minor losses	.00 ft
Junction loss coeff	.00	Length of junction	9.99 ft
Minor loss coeff	.00		
Tailwater control	.00 ft	Structure code	3

STORM DRAIN CONNECTIVITY

Downstream pipe (LC) 0

Upstream pipe	(L1)	10	Angle to d.s. pipe (A1)	.00 deg
Lateral #1	(L3)	0	Angle to d.s. pipe (A3)	.00 deg
Lateral #2	(L4)	0	Angle to d.s. pipe (A4)	.00 deg

CONNECTIVITY DIAGRAM

```
           8         9       10
   ---------0---------0---------    <--- Flow
```

1Project : CACTUS ROAD BASED UPON HEC-1 ANALYSIS-includes triangle area
Date: 9/30/1991 Time: 11:40:55

PIPE NUMBER 10

COMPOSITE ANALYSIS

Discharge = 707.00 cfs

	Downstream	Upstream
Velocity	9.97 fps	9.97 fps
Depth of flow	15.11 ft	14.25 ft
Area of flow	148.07 sf	112.54 sf
HGL	1152.50 ft	1155.20 ft
EGL	1154.04 ft	1156.75 ft

EGL	1171.89 ft	1179.04 ft
Invert	1167.64 ft	1177.00 ft
Soffit	1169.64 ft	1179.00 ft
Diameter	2.00 ft	
Width	.00 ft	

PRIMARY ANALYSIS

Channel length	1820.00 ft	Normal depth	1.42 ft
Channel slope	.00514 ft/ft	Critical depth	1.40 ft
Friction slope	.00375 ft/ft	Flow condition	Mild
Adjusted Q	15.00 cfs		
Mannings n	.0120	Loss due to friction	6.82 ft
Entrance loss coeff	.00	Minor losses	.00 ft
Junction loss coeff	.00	Length of junction	.00 ft
Minor loss coeff	.00		
Tailwater control	1179.04 ft	Structure code	1

STORM DRAIN CONNECTIVITY

Downstream pipe	(LC)	0		
Upstream pipe	(L1)	0	Angle to d.s. pipe (A1)	.00 deg
Lateral #1	(L3)	0	Angle to d.s. pipe (A3)	.00 deg
Lateral #2	(L4)	0	Angle to d.s. pipe (A4)	.00 deg

CONNECTIVITY DIAGRAM

```
        25         26
---------0---------0    <--- Flow
```

1

Date: 9/30/1991 Time: 11:40:55

PIPE NUMBER 24

COMPOSITE ANALYSIS

Discharge = 30.00 cfs

	Downstream	Upstream
Velocity	6.11 fps	6.11 fps
Depth of flow	6.19 ft	6.18 ft
Area of flow	6.28 sf	4.78 sf
HGL	1166.55 ft	1166.64 ft
EGL	1167.13 ft	1167.22 ft
Invert	1160.36 ft	1160.46 ft
Soffit	1162.86 ft	1162.96 ft
Diameter	2.50 ft	
Width	.00 ft	

PRIMARY ANALYSIS

Channel length	20.00 ft	Normal depth	1.96 ft
Channel slope	.00500 ft/ft	Critical depth	1.87 ft
Friction slope	.00456 ft/ft	Flow condition	Mild
Adjusted Q	30.00 cfs		
Mannings n	.0120	Loss due to friction	.09 ft
Entrance loss coeff	.00	Minor losses	.00 ft
Junction loss coeff	.00	Length of junction	.00 ft
Minor loss coeff	.00		
Tailwater control	.00 ft	Structure code	3

STORM DRAIN CONNECTIVITY

Downstream pipe	(LC)	15		
Upstream pipe	(L1)	25	Angle to d.s. pipe (A1)	.00 deg
Lateral #1	(L3)	0	Angle to d.s. pipe (A3)	.00 deg
Lateral #2	(L4)	0	Angle to d.s. pipe (A4)	.00 deg

CONNECTIVITY DIAGRAM

```
                         / 24
                        /
                       /
       0        14    /     15
  ---------0---------0/---------    <--- Flow
```

1Project : CACTUS ROAD BASED UPON HEC-1 ANALYSIS-includes triangle area
Date: 9/30/1991 Time: 11:40:55

PIPE NUMBER 25

COMPOSITE ANALYSIS

Discharge = 25.00 cfs

	Downstream	Upstream
Velocity	5.09 fps	5.09 fps
Depth of flow	6.53 ft	3.97 ft
Area of flow	5.24 sf	3.98 sf
HGL	1166.99 ft	1171.11 ft
EGL	1167.40 ft	1171.51 ft
Invert	1160.46 ft	1167.14 ft
Soffit	1162.96 ft	1169.64 ft
Diameter	2.50 ft	
Width	.00 ft	

PRIMARY ANALYSIS

Channel length	1300.00 ft	Normal depth	1.67 ft
Channel slope	.00514 ft/ft	Critical depth	1.70 ft
Friction slope	.00316 ft/ft	Flow condition	Steep
Adjusted Q	25.00 cfs		
Mannings n	.0120	Loss due to friction	4.11 ft
Entrance loss coeff	.00	Minor losses	.00 ft
Junction loss coeff	.00	Length of junction	.00 ft
Minor loss coeff	.00		
Tailwater control	.00 ft	Structure code	3

STORM DRAIN CONNECTIVITY

Downstream pipe	(LC)	0		
Upstream pipe	(L1)	26	Angle to d.s. pipe (A1)	.00 deg
Lateral #1	(L3)	0	Angle to d.s. pipe (A3)	.00 deg
Lateral #2	(L4)	0	Angle to d.s. pipe (A4)	.00 deg

CONNECTIVITY DIAGRAM

```
            24        25       26
    ---------0---------0---------    <--- Flow
```

1Project : CACTUS ROAD BASED UPON HEC-1 ANALYSIS-includes triangle area
Date: 9/30/1991 Time: 11:40:55

PIPE NUMBER 26

COMPOSITE ANALYSIS

Discharge = 15.00 cfs

	Downstream	Upstream
Velocity	4.77 fps	6.28 fps
Depth of flow	3.90 ft	1.42 ft
Area of flow	3.14 sf	2.39 sf
HGL	1171.54 ft	1178.42 ft

Downstream pipe	(LC)	12		
Upstream pipe	(L1)	22	Angle to d.s. pipe (A1)	.00 deg
Lateral #1	(L3)	0	Angle to d.s. pipe (A3)	.00 deg
Lateral #2	(L4)	0	Angle to d.s. pipe (A4)	.00 deg

CONNECTIVITY DIAGRAM

```
                          / 21
                         /
                        /
          0        11  /     12
     ---------0---------0/---------    <--- Flow
```

1Project : CACTUS ROAD BASED UPON HEC-1 ANALYSIS-includes triangle area

Date: 9/30/1991 Time: 11:40:55

PIPE NUMBER 22

COMPOSITE ANALYSIS

Discharge = 84.00 cfs

	Downstream	Upstream
Velocity	8.73 fps	8.73 fps
Depth of flow	7.36 ft	7.48 ft
Area of flow	17.59 sf	13.37 sf
HGL	1161.55 ft	1169.27 ft
EGL	1162.73 ft	1170.45 ft
Invert	1154.19 ft	1161.79 ft
Soffit	1157.69 ft	1165.29 ft
Diameter	3.50 ft	
Width	.00 ft	

PRIMARY ANALYSIS

Channel length	1300.00 ft	Normal depth	3.50 ft
Channel slope	.00585 ft/ft	Critical depth	2.85 ft
Friction slope	.00594 ft/ft	Flow condition	Mild
Adjusted Q	84.00 cfs		
Mannings n	.0120	Loss due to friction	7.72 ft
Entrance loss coeff	.00	Minor losses	.00 ft
Junction loss coeff	.00	Length of junction	.00 ft
Minor loss coeff	.00		
Tailwater control	.00 ft	Structure code	3

STORM DRAIN CONNECTIVITY

Downstream pipe	(LC)	0		
Upstream pipe	(L1)	23	Angle to d.s. pipe (A1)	.00 deg
Lateral #1	(L3)	0	Angle to d.s. pipe (A3)	.00 deg
Lateral #2	(L4)	0	Angle to d.s. pipe (A4)	.00 deg

CONNECTIVITY DIAGRAM

```
             21        22       23
        ---------0---------0---------    <--- Flow
```

1Project : CACTUS ROAD BASED UPON HEC-1 ANALYSIS-includes triangle area
Date: 9/30/1991   Time: 11:40:55

PIPE NUMBER 23

COMPOSITE ANALYSIS

Discharge = 44.00 cfs

	Downstream	Upstream
Velocity	4.57 fps	4.57 fps
Depth of flow	9.19 ft	3.64 ft
Area of flow	9.22 sf	7.00 sf
HGL	1170.98 ft	1173.14 ft
EGL	1171.31 ft	1173.46 ft
Invert	1161.79 ft	1169.50 ft
Soffit	1165.29 ft	1173.00 ft
Diameter	3.50 ft	
Width	.00 ft	

PRIMARY ANALYSIS

Channel length	1320.00 ft	Normal depth	1.81 ft
Channel slope	.00584 ft/ft	Critical depth	2.07 ft
Friction slope	.00163 ft/ft	Flow condition	Steep
Adjusted Q	44.00 cfs		
Mannings n	.0120	Loss due to friction	2.15 ft
Entrance loss coeff	.00	Minor losses	.00 ft
Junction loss coeff	.00	Length of junction	.00 ft
Minor loss coeff	.00		
Tailwater control	1173.46 ft	Structure code	1

STORM DRAIN CONNECTIVITY

Downstream pipe (LC) 0

Upstream pipe	(L1)	0	Angle to d.s. pipe (A1)	.00 deg
Lateral #1	(L3)	0	Angle to d.s. pipe (A3)	.00 deg
Lateral #2	(L4)	0	Angle to d.s. pipe (A4)	.00 deg

CONNECTIVITY DIAGRAM

```
             22        23
        ---------0---------0    <--- Flow
```

1Project : CACTUS ROAD BASED UPON HEC-1 ANALYSIS-includes triangle area

PRIMARY ANALYSIS

Channel length	1300.00 ft	Normal depth	3.35 ft
Channel slope	.00551 ft/ft	Critical depth	3.80 ft
Friction slope	.00259 ft/ft	Flow condition	Steep
Adjusted Q	185.00 cfs		
Mannings n	.0120	Loss due to friction	3.36 ft
Entrance loss coeff	.00	Minor losses	.00 ft
Junction loss coeff	.00	Length of junction	.00 ft
Minor loss coeff	.00		
Tailwater control	.00 ft	Structure code	3

STORM DRAIN CONNECTIVITY

Downstream pipe (LC) 0

Upstream pipe	(L1)	20	Angle to d.s. pipe (A1)	.00 deg
Lateral #1	(L3)	0	Angle to d.s. pipe (A3)	.00 deg
Lateral #2	(L4)	0	Angle to d.s. pipe (A4)	.00 deg

CONNECTIVITY DIAGRAM

```
          18        19       20
    ---------0---------0---------    <--- Flow
```

1Project : CACTUS ROAD BASED UPON HEC-1 ANALYSIS-includes triangle area
Date: 9/30/1991 Time: 11:40:55

PIPE NUMBER 20

COMPOSITE ANALYSIS

Discharge = 104.00 cfs

	Downstream	Upstream
Velocity	6.54 fps	6.54 fps
Depth of flow	7.67 ft	4.54 ft
Area of flow	21.78 sf	16.55 sf
HGL	1160.89 ft	1164.04 ft
EGL	1161.56 ft	1164.70 ft
Invert	1153.22 ft	1159.50 ft
Soffit	1157.72 ft	1164.00 ft
Diameter	4.50 ft	
Width	.00 ft	

PRIMARY ANALYSIS

Channel length	1320.00 ft	Normal depth	2.80 ft
Channel slope	.00476 ft/ft	Critical depth	2.99 ft
Friction slope	.00238 ft/ft	Flow condition	Steep
Adjusted Q	104.00 cfs		

Mannings n	.0120	Loss due to friction	3.15 ft
Entrance loss coeff	.00	Minor losses	.00 ft
Junction loss coeff	.00	Length of junction	.00 ft
Minor loss coeff	.00		
Tailwater control	1164.70 ft	Structure code	1

STORM DRAIN CONNECTIVITY

Downstream pipe	(LC)	0		
Upstream pipe	(L1)	0	Angle to d.s. pipe (A1)	.00 deg
Lateral #1	(L3)	0	Angle to d.s. pipe (A3)	.00 deg
Lateral #2	(L4)	0	Angle to d.s. pipe (A4)	.00 deg

CONNECTIVITY DIAGRAM

```
               19        20
          ---------0---------0    <--- Flow
```

1Project : CACTUS ROAD BASED UPON HEC-1 ANALYSIS-includes triangle area
Date: 9/30/1991   Time: 11:40:55

PIPE NUMBER 21

COMPOSITE ANALYSIS

Discharge = 113.00 cfs

	Downstream	Upstream
Velocity	11.74 fps	11.74 fps
Depth of flow	5.34 ft	5.44 ft
Area of flow	23.67 sf	17.99 sf
HGL	1159.42 ft	1159.63 ft
EGL	1161.56 ft	1161.77 ft
Invert	1154.08 ft	1154.19 ft
Soffit	1157.58 ft	1157.69 ft
Diameter	3.50 ft	
Width	.00 ft	

PRIMARY ANALYSIS

Channel length	20.00 ft	Normal depth	3.50 ft
Channel slope	.00550 ft/ft	Critical depth	3.19 ft
Friction slope	.01075 ft/ft	Flow condition	Mild
Adjusted Q	113.00 cfs		
Mannings n	.0120	Loss due to friction	.21 ft
Entrance loss coeff	.00	Minor losses	.00 ft
Junction loss coeff	.00	Length of junction	.00 ft
Minor loss coeff	.00		
Tailwater control	.00 ft	Structure code	3

STORM DRAIN CONNECTIVITY

	Downstream	Upstream
Velocity	2.26 fps	2.26 fps
Depth of flow	13.11 ft	8.73 ft
Area of flow	18.22 sf	13.85 sf
HGL	1134.91 ft	1135.54 ft
EGL	1134.99 ft	1135.62 ft
Invert	1121.80 ft	1126.81 ft
Soffit	1128.80 ft	1133.81 ft
Diameter	7.00 ft	
Width	.00 ft	

PRIMARY ANALYSIS

Channel length	4000.00 ft	Normal depth	2.88 ft
Channel slope	.00125 ft/ft	Critical depth	2.39 ft
Friction slope	.00016 ft/ft	Flow condition	Mild
Adjusted Q	87.00 cfs		
Mannings n	.0120	Loss due to friction	.63 ft
Entrance loss coeff	.00	Minor losses	.00 ft
Junction loss coeff	.00	Length of junction	.00 ft
Minor loss coeff	.00		
Tailwater control	1135.62 ft	Structure code	1

STORM DRAIN CONNECTIVITY

Downstream pipe (LC) 4

Upstream pipe	(L1)	0	Angle to d.s. pipe (A1)	.00 deg
Lateral #1	(L3)	0	Angle to d.s. pipe (A3)	.00 deg
Lateral #2	(L4)	0	Angle to d.s. pipe (A4)	.00 deg

CONNECTIVITY DIAGRAM

```
                          / 17
                         /
                        /
          0         3  /       4
   ---------0---------0/---------    <--- Flow
```

1Project : CACTUS ROAD BASED UPON HEC-1 ANALYSIS-includes triangle area
Date: 9/30/1991 Time: 11:40:55

PIPE NUMBER 18

COMPOSITE ANALYSIS

Discharge = 214.00 cfs

	Downstream	Upstream
Velocity	9.01 fps	9.01 fps
Depth of flow	10.68 ft	10.64 ft
Area of flow	44.82 sf	34.06 sf

HGL	1155.63 ft	1155.70 ft
EGL	1156.89 ft	1156.96 ft
Invert	1144.95 ft	1145.06 ft
Soffit	1150.45 ft	1150.56 ft
Diameter	5.50 ft	
Width	.00 ft	

PRIMARY ANALYSIS

Channel length	20.00 ft	Normal depth	3.70 ft
Channel slope	.00550 ft/ft	Critical depth	4.09 ft
Friction slope	.00346 ft/ft	Flow condition	Steep
Adjusted Q	214.00 cfs		
Mannings n	.0120	Loss due to friction	.07 ft
Entrance loss coeff	.00	Minor losses	.00 ft
Junction loss coeff	.00	Length of junction	.00 ft
Minor loss coeff	.00		
Tailwater control	.00 ft	Structure code	3

STORM DRAIN CONNECTIVITY

Downstream pipe (LC) 11

Upstream pipe	(L1)	19	Angle to d.s. pipe (A1)	.00 deg
Lateral #1	(L3)	0	Angle to d.s. pipe (A3)	.00 deg
Lateral #2	(L4)	0	Angle to d.s. pipe (A4)	.00 deg

CONNECTIVITY DIAGRAM

```
                         / 18
                        /
                       /
        0        10   /     11
   ---------0---------0/---------    <--- Flow
```

1Project : CACTUS ROAD BASED UPON HEC-1 ANALYSIS-includes triangle area
Date: 9/30/1991 Time: 11:40:55

PIPE NUMBER 19

COMPOSITE ANALYSIS

Discharge = 185.00 cfs

	Downstream	Upstream
Velocity	7.79 fps	7.79 fps
Depth of flow	11.28 ft	7.48 ft
Area of flow	38.75 sf	29.45 sf
HGL	1156.34 ft	1159.70 ft
EGL	1157.28 ft	1160.64 ft
Invert	1145.06 ft	1152.22 ft
Soffit	1150.56 ft	1157.72 ft
Diameter	5.50 ft	
Width	.00 ft	

CONNECTIVITY DIAGRAM

```
                              / 24
                             /
                            /
         13        14      /      15
     ---------0---------0/---------   <--- Flow
```

1Project : CACTUS ROAD BASED UPON HEC-1 ANALYSIS-includes triangle area
Date: 9/30/1991 Time: 11:40:55

PIPE NUMBER 15

COMPOSITE ANALYSIS

Discharge = 218.00 cfs

	Downstream	Upstream
Velocity	6.57 fps	6.57 fps
Depth of flow	10.43 ft	8.87 ft
Area of flow	45.66 sf	34.70 sf
HGL	1166.79 ft	1168.73 ft
EGL	1167.46 ft	1169.40 ft
Invert	1156.36 ft	1159.86 ft
Soffit	1162.86 ft	1166.36 ft
Diameter	6.50 ft	
Width	.00 ft	

PRIMARY ANALYSIS

Channel length	1320.00 ft	Normal depth	4.19 ft
Channel slope	.00265 ft/ft	Critical depth	3.94 ft
Friction slope	.00147 ft/ft	Flow condition	Mild
Adjusted Q	218.00 cfs		
Mannings n	.0120	Loss due to friction	1.94 ft
Entrance loss coeff	.00	Minor losses	.00 ft
Junction loss coeff	.00	Length of junction	7.00 ft
Minor loss coeff	.00		
Tailwater control	.00 ft	Structure code	3

STORM DRAIN CONNECTIVITY

Downstream pipe (LC) 0

Upstream pipe	(L1)	16	Angle to d.s. pipe (A1)	.00 deg
Lateral #1	(L3)	0	Angle to d.s. pipe (A3)	.00 deg
Lateral #2	(L4)	0	Angle to d.s. pipe (A4)	.00 deg

CONNECTIVITY DIAGRAM

```
         14        15      16
     ---------0---------0---------   <--- Flow
```

1Project : CACTUS ROAD BASED UPON HEC-1 ANALYSIS-includes triangle area
Date: 9/30/1991 Time: 11:40:55

PIPE NUMBER 16

COMPOSITE ANALYSIS

Discharge = 213.00 cfs

	Downstream	Upstream
Velocity	6.42 fps	6.42 fps
Depth of flow	8.95 ft	7.30 ft
Area of flow	44.61 sf	33.90 sf
HGL	1168.81 ft	1170.66 ft
EGL	1169.45 ft	1171.30 ft
Invert	1159.86 ft	1163.36 ft
Soffit	1166.36 ft	1169.86 ft
Diameter	6.50 ft	
Width	.00 ft	

PRIMARY ANALYSIS

Channel length	1320.00 ft	Normal depth	4.12 ft
Channel slope	.00265 ft/ft	Critical depth	3.90 ft
Friction slope	.00141 ft/ft	Flow condition	Mild
Adjusted Q	213.00 cfs		
Mannings n	.0120	Loss due to friction	1.86 ft
Entrance loss coeff	.00	Minor losses	.00 ft
Junction loss coeff	.00	Length of junction	.00 ft
Minor loss coeff	.00		
Tailwater control	1171.30 ft	Structure code	1

STORM DRAIN CONNECTIVITY

Downstream pipe (LC) 0

Upstream pipe	(L1)	0	Angle to d.s. pipe (A1)	.00 deg
Lateral #1	(L3)	0	Angle to d.s. pipe (A3)	.00 deg
Lateral #2	(L4)	0	Angle to d.s. pipe (A4)	.00 deg

CONNECTIVITY DIAGRAM

```
      15        16
---------0---------0    <--- Flow
```

1Project : CACTUS ROAD BASED UPON HEC-1 ANALYSIS-includes triangle area
Date: 9/30/1991 Time: 11:40:55

PIPE NUMBER 17

COMPOSITE ANALYSIS

Discharge = 87.00 cfs

Junction loss coeff	.00	Length of junction	8.00 ft
Minor loss coeff	.00		
Tailwater control	.00 ft	Structure code	3

STORM DRAIN CONNECTIVITY

Downstream pipe	(LC)	0		
Upstream pipe	(L1)	13	Angle to d.s. pipe (A1)	.00 deg
Lateral #1	(L3)	21	Angle to d.s. pipe (A3)	45.00 deg
Lateral #2	(L4)	0	Angle to d.s. pipe (A4)	.00 deg

CONNECTIVITY DIAGRAM

```
                        / 21
                       /
                      /
     11        12    /    13
---------0---------0/---------    <--- Flow
```

1Project : CACTUS ROAD BASED UPON HEC-1 ANALYSIS-includes triangle area
Date: 9/30/1991 Time: 11:40:55

PIPE NUMBER 13

COMPOSITE ANALYSIS

Discharge = 367.00 cfs

	Downstream	Upstream
Velocity	9.54 fps	9.54 fps
Depth of flow	8.64 ft	9.71 ft
Area of flow	76.86 sf	58.42 sf
HGL	1159.22 ft	1162.93 ft
EGL	1160.63 ft	1164.34 ft
Invert	1150.58 ft	1153.22 ft
Soffit	1157.58 ft	1160.22 ft
Diameter	7.00 ft	
Width	.00 ft	

PRIMARY ANALYSIS

Channel length	1320.00 ft	Normal depth	7.00 ft
Channel slope	.00200 ft/ft	Critical depth	5.05 ft
Friction slope	.00281 ft/ft	Flow condition	Mild
Adjusted Q	367.00 cfs		
Mannings n	.0120	Loss due to friction	3.71 ft
Entrance loss coeff	.00	Minor losses	.00 ft
Junction loss coeff	.00	Length of junction	7.00 ft
Minor loss coeff	.00		
Tailwater control	.00 ft	Structure code	3

STORM DRAIN CONNECTIVITY

Downstream pipe	(LC)	0		
Upstream pipe	(L1)	14	Angle to d.s. pipe (A1)	.00 deg
Lateral #1	(L3)	0	Angle to d.s. pipe (A3)	.00 deg
Lateral #2	(L4)	0	Angle to d.s. pipe (A4)	.00 deg

CONNECTIVITY DIAGRAM

```
            12         13       14
      ---------0---------0---------    <--- Flow
```

1Project : CACTUS ROAD BASED UPON HEC-1 ANALYSIS-includes triangle area
Date: 9/30/1991   Time: 11:40:55

PIPE NUMBER 14

COMPOSITE ANALYSIS

Discharge = 285.00 cfs

	Downstream	Upstream
Velocity	7.41 fps	7.41 fps
Depth of flow	10.84 ft	10.44 ft
Area of flow	59.69 sf	45.36 sf
HGL	1164.06 ft	1166.30 ft
EGL	1164.92 ft	1167.16 ft
Invert	1153.22 ft	1155.86 ft
Soffit	1160.22 ft	1162.86 ft
Diameter	7.00 ft	
Width	.00 ft	

PRIMARY ANALYSIS

Channel length	1320.00 ft	Normal depth	5.30 ft
Channel slope	.00200 ft/ft	Critical depth	4.42 ft
Friction slope	.00170 ft/ft	Flow condition	Mild
Adjusted Q	285.00 cfs		
Mannings n	.0120	Loss due to friction	2.24 ft
Entrance loss coeff	.00	Minor losses	.00 ft
Junction loss coeff	.00	Length of junction	7.00 ft
Minor loss coeff	.00		
Tailwater control	.00 ft	Structure code	3

STORM DRAIN CONNECTIVITY

Downstream pipe	(LC)	0		
Upstream pipe	(L1)	15	Angle to d.s. pipe (A1)	.00 deg
Lateral #1	(L3)	24	Angle to d.s. pipe (A3)	45.00 deg
Lateral #2	(L4)	0	Angle to d.s. pipe (A4)	.00 deg

Invert	1137.39 ft	1140.95 ft
Soffit	1146.89 ft	1150.45 ft
Diameter	9.50 ft	
Width	.00 ft	

PRIMARY ANALYSIS

Channel length	1320.00 ft	Normal depth	6.87 ft
Channel slope	.00270 ft/ft	Critical depth	6.48 ft
Friction slope	.00205 ft/ft	Flow condition	Mild
Adjusted Q	707.00 cfs		
Mannings n	.0120	Loss due to friction	2.70 ft
Entrance loss coeff	.00	Minor losses	.00 ft
Junction loss coeff	.00	Length of junction	9.99 ft
Minor loss coeff	.00		
Tailwater control	.00 ft	Structure code	3

STORM DRAIN CONNECTIVITY

Downstream pipe (LC) 0

Upstream pipe	(L1) 11	Angle to d.s. pipe (A1)	.00 deg
Lateral #1	(L3) 18	Angle to d.s. pipe (A3)	45.00 deg
Lateral #2	(L4) 0	Angle to d.s. pipe (A4)	.00 deg

CONNECTIVITY DIAGRAM

```
                          / 18
                         /
                        /
        9         10   /     11
  ---------0---------0/---------    <--- Flow
```

1Project : CACTUS ROAD BASED UPON HEC-1 ANALYSIS-includes triangle area
Date: 9/30/1991 Time: 11:40:55

PIPE NUMBER 11

COMPOSITE ANALYSIS

Discharge = 495.00 cfs

	Downstream	Upstream
Velocity	7.78 fps	7.78 fps
Depth of flow	14.61 ft	12.81 ft
Area of flow	103.67 sf	78.79 sf
HGL	1156.06 ft	1157.83 ft
EGL	1157.01 ft	1158.77 ft
Invert	1141.45 ft	1145.02 ft
Soffit	1150.45 ft	1154.02 ft
Diameter	9.00 ft	
Width	.00 ft	

PRIMARY ANALYSIS

Channel length	1320.00 ft	Normal depth	5.57 ft
Channel slope	.00271 ft/ft	Critical depth	5.48 ft
Friction slope	.00134 ft/ft	Flow condition	Mild
Adjusted Q	495.00 cfs		
Mannings n	.0120	Loss due to friction	1.77 ft
Entrance loss coeff	.00	Minor losses	.00 ft
Junction loss coeff	.00	Length of junction	8.00 ft
Minor loss coeff	.00		
Tailwater control	.00 ft	Structure code	3

STORM DRAIN CONNECTIVITY

Downstream pipe (LC) 0

Upstream pipe	(L1)	12	Angle to d.s. pipe (A1)	.00 deg
Lateral #1	(L3)	0	Angle to d.s. pipe (A3)	.00 deg
Lateral #2	(L4)	0	Angle to d.s. pipe (A4)	.00 deg

CONNECTIVITY DIAGRAM

```
         10        11       12
      ---------0---------0---------    <--- Flow
```

1Project : CACTUS ROAD BASED UPON HEC-1 ANALYSIS-includes triangle area
Date: 9/30/1991 Time: 11:40:55

PIPE NUMBER 12

COMPOSITE ANALYSIS

Discharge = 489.00 cfs

	Downstream	Upstream
Velocity	7.69 fps	7.69 fps
Depth of flow	12.87 ft	11.03 ft
Area of flow	102.42 sf	77.84 sf
HGL	1157.89 ft	1159.61 ft
EGL	1158.81 ft	1160.53 ft
Invert	1145.02 ft	1148.58 ft
Soffit	1154.02 ft	1157.58 ft
Diameter	9.00 ft	
Width	.00 ft	

PRIMARY ANALYSIS

Channel length	1320.00 ft	Normal depth	5.53 ft
Channel slope	.00270 ft/ft	Critical depth	5.45 ft
Friction slope	.00131 ft/ft	Flow condition	Mild
Adjusted Q	489.00 cfs		
Mannings n	.0120	Loss due to friction	1.72 ft
Entrance loss coeff	.00	Minor losses	.00 ft

DESIGN DATA REPORT
for the
CACTUS ROAD STORM DRAIN
(67th Avenue to the Agua Fria Freeway)

APPENDIX F-
Correspondence

RESPONSES TO THE FLOOD CONTROL DISTRICT OF MARICOPA COUNTY COMMENTS ON THE 60 PERCENT SUBMITTAL FOR THE CACTUS ROAD STORM DRAIN FROM 67TH AVENUE TO THE AGUA FRIA FREEWAY

18 November 1991 Comments from RCS

1. **COMMENT:** According to the Scope of Work, the Construction Special Provision should be submitted for FCD review.

   RESPONSE: Review of the hydrologic data in the Flood Control Master Plan for Cactus Road was substantially delayed last spring and eventually eliminated from the contract because data could not be recovered from the Flood Control District of Maricopa County (FCD). The scope of work was then changed and the hydrology was rerun using the new version of FCD's Hydrologic Manual and the Corps of Engineers' HEC programs. This delay caused delays in preparing the plans and other associated deliverables. In order to expedite the process, only the 60 percent plan and profiles and supporting data were originally submitted. The 60 percent Construction Special Provisions and Preliminary Opinion of Probable Construction Cost were submitted later on 23 December 1991.

2. **COMMENT:** The inlet calculations should be completed.

   RESPONSE: As stated above, FCD's Hydrologic Manual and the HEC programs were used to calculate runoff flows rather than the more traditional Rational method. Flows were generated at approximate 1300-foot intervals. Several assumptions had to be made in order to size intermediate catch basins. It was suggested and agreed to that the catch basins would only be sized (as to type of structure) and located for the 60 percent delivery. Upon review of the assumptions used and approval of the size and location of catch basins then the rest of the design calculations would be completed (depth of catch basins and size of connector pipe). The 95 percent submittal will include design calculations for flow to be collected, type of catch basin, depth of catch basin and size of connector pipeline.

3. **COMMENT:** The entrance losses (Ke) and manhole losses (Km) should be included in the input data listing of "Storm" software.

   RESPONSE: The "storm" program allows for two different methods of calculating entrance headlosses and exit headlosses. One is through the traditional use of Ke and Km and the other is through the use of friction loss of equivalent length of pipe. We chose the friction loss of equivalent length. This should have been explained more clearly in the discussion about the program and will be included in the 95 percent submittal.

4. **COMMENT:** All design drawings and calculations should be stamped by registered engineer and initialed by both designer and checker.

   RESPONSE: There is an ongoing debate within the profession about stamping and signing drawings and calculations that are not final and ready for construction. The stamp implies a level of confidence that is just not there until the final submittal. The 95 percent submittal is substantially complete and therefore stamped.

5. **COMMENT:** The computer generated output should be verified by hand calculations.

   RESPONSE: Hand calculations have been included in the 95 percent submittal.

6. **COMMENT:** The runoff coefficient used with rational formula is 0.9 but according to "City of Phoenix Storm Drain Design Manual" for paved street or parking lot it should be 0.95.

   RESPONSE: The rational equation listed on page 2 of the City of Phoenix Storm Drain Design Manual is:

$$Q=0.8(I-f_c)A^p+0.9(I-0.2)A^i$$

   The first portion is for the pervious area (A^p) and is equal to zero when calculating the flow in the Right of Way for the intermediate basins. On pg 20, a list of the percent impervious is listed for zoning types. Parking (Open) and Parking (Structures) are listed at 0.85 percent; however, these factors apply to the non-Right of Way zone which is listed at 100 percent. Therefore, A^i was multiplied by 100 percent. We did not find a reference in the manual to a 0.95 factor.

7 November 1991 Comments from RCS

1. **COMMENT:** The soils report should not be included with the Construction Special Provisions. The Contractor can review the soils report upon his/her request through the FCD or City of Peoria.

   RESPONSE: Acknowledged.

2. **COMMENT:** Include soils boring sheets in the plans with boring locations shown.

   RESPONSE: Acknowledged.

3. **COMMENT:** Provide the supporting information for eliminating CLCMP and CIP from project alternatives for district review.

RESPONSE: Cast-in-place pipe was eliminated based on the recommendation of the soils report which was submitted to FCD. CLCMP was eliminated based on a variety of reasons most important of which is the reluctance by the City of Peoria to allow this alternative. Contech (the local supplier of CLCMP) provided a report that they call the Phoenix report. The report contains various studies and information collected by Contech. Portions of this report were used to present the test data summarized in the Alternate Conduit Section & Materials Comparison Report. Portions of this report have been included in the Design Data Report.

4. **COMMENT:** Provide the location of manholes, sizes of lateral drains and profile of lateral.

RESPONSE: Manholes, lateral drain sizes and lateral profiles have been included in the 95 percent submittal.

5. **COMMENT:** Provide a vicinity map and index.

RESPONSE: These have been included in the 95 percent submittal.

6. **COMMENT:** Provide "General Construction Notes" regarding the project.

RESPONSE: These have been included in the 95 percent submittal.

7. **COMMENT:** Provide "Construction Notes" on right hand column of sheet showing LF of pipe, # of manholes, # of catch basins and etc....

RESPONSE: See comment 2 from 18 November 1991 comments from RCS above. These have been included in the 95 percent submittal.

8. **COMMENT:** Provide the documentation for the software used to calculate the HGL in order to interpret the input and output data.

RESPONSE: This have been included in the 95 percent submittal.

9. **COMMENT:** Provide sample of hand calculations for junction losses at the laterals and junctions.

RESPONSE: See comment 5 from 18 November 1991 comments from RCS above. This has been included in the 95 percent submittal.

Sta 10+00 to 12+00:

Show transition details for the round pipe to box culvert.

RESPONSE: This has been included in the 95 percent submittal.

Sta 12+00 to 17+00:

COMMENT: 1" WS (?) not shown on profile.

RESPONSE: Small water service lines are not typically shown in profile because they ar enot documented and cover is usually less than 3 ft. Contractors are instructed in MAG about how to relocate them if necessary.

Sta 17+00 to 22+00:

COMMENT: 24" IRR needs to be relocated.

RESPONSE: It is not anticipated that the SRP line requires relocation.

COMMENT: Specify the location of major overhead powerlines.

RESPONSE: There are three locations where overhead lines cross the storm drain trunkline and caution notes have been added.

Sta 47+00 to 52+00:

COMMENT: 12" W needs to be relocated or supported?

RESPONSE: Realignment is required and shown.

Sta 52+00 to 57+00:

COMMENTS: The electrical line (@ Sta. 54+) needs to be relocated.

RESPONSE: It is not anticipated that this electric line needs to be relocated.

Sta 62+00 to 67+00:

COMMENTS: The 8" W needs to be relocated or supported?

RESPONSE: A general note has been included requiring the contractor to protect in-place all utilities unless otherwise directed in the plans. In addition, instructions have been added to specify where and how to encase water lines that are too close to the storm drain.

Sta 67+00 to 72+00:

COMMENTS: At Sta. 71+00, show the horizontal distance to center line of pipe to the right of way line.

RESPONSE: Clarified construction requirements.

Sta 72+00 to 77+00:

COMMENTS: 12" W and 24" W needs to be relocated or supported?

RESPONSE: Twelve inch water line - see comment on station 62+00 and 67+00. Twenty-four inch water line - a permanent pipe support is required and note has been added to that effect.

Sta 92+00 to 97+00:

COMMENTS: The 8" W needs to be relocated or supported"

RESPONSE: See comment on station 62+00 to 67+00.

Sta 97+00 to 102+00

COMMENTS: The slope of 361 LF 114" Dia. pipe should be .0033 ft/ft.

RESPONSE: The length of 114-inch diameter pipe and slope have been readjusted.

COMMENT: The slope of 139 LF 108" dia. pipe should be .0008 ft/ft.

RESPONSE: The length of 108-inch diameter pipe and slope have been readjusted.

Sta 122+00 to 127+00:

COMMENTS: 144" box culvert and 18" SS line needs to be relocated.

RESPONSE: The sanitary sewer line has been relocated. SRP has been contacted and coordination with them to construct the storm drain and trunkline is underway.

Sta 127+00 to 132+00:

COMMENTS: 10" SS, 8" W, 12" W, and 24" IRR needs to be relocated or supported?

RESPONSE: Ten inch S.S. - plugged and removed as necessary. Eight inch W and 12-inch W - require encasement. Twenty-four inch IRR requires permanent pipe support.

COMMENTS: Please show 18" SS line on profile.

RESPONSE: An 18-inch sanitary sewer does not cross the storm drain. A site plan has been used to clarify the construction of the sewer realignment.

Sta 132+00 to 137+00:

COMMENTS: Please show the 12" W (?) on profile. Does it need to be relocated or supported?

RESPONSE: The 12-inch water line does not cross the storm drain and where necessary notes have been added for connector pipe conflicts.

Sta 152+00 to 157+00:

COMMENTS: The 10" W @ 71st Ave. needs to be relocated or supported?

RESPONSE: See comment on sta 62+00 to 67+00.

Sta 167+00 to 172+00:

COMMENTS: At sta 171+, show the electrical line on profile. If it is an overhead line provide a "Caution" sign.

RESPONSE: Line shown in profile added.

COMMENTS: On cross-section @ Sta 170+00 the 24" IRR shown on plan is shown as 30" IRR. Please verify.

RESPONSE: Cross-section corrected to 24-inch IRR.

Sta 177+00 to 182+00:

COMMENTS: Please show the size and invert elevation of pipe coming from north of 67th Ave.

RESPONSE: Acknowledged.

12 November 1991 Comments from Gary H. Shapiro

1. **COMMENT:** As stated in the scope of work all plan sheets must be initialed by the person responsible for the design, the design checking, drawing the plans, and the checking of plans.

   RESPONSE: See comment 4 from 18 November 1991 comments from RCS above.

2. **COMMENT:** The name of the project "Cactus Road Storm Drain" is to be placed in all title blocks.

   RESPONSE: This has been added.

3. **COMMENT:** The construction center line and or the monument line must be identified with a bearing.

   RESPONSE: Data added.

4. **COMMENT:** Information pertaining to the pipe bends and curves shall be identified on the plans.

   RESPONSE: This has been included in the 95 percent submittal (see comment above).

5. **COMMENT:** A detail of the outlet shall be provided in the plans. This is where the 120 inch diameter pipe ties into the existing 10' x 8' box culvert.

RESPONSE: This has been included in the 95 percent submittal (see comment above).

6. **COMMENT:** Manhole locations need to be identified on the plans.

RESPONSE: This has been included in the 95 percent submittal (see comment above).

7. **COMMENT:** Catch basin types and locations have to be identified on the plans.

RESPONSE: See comment 2 from 18 November 1991 comments from RCS above. This will be submitted in the 95 percent submittal.

8. **COMMENT:** Construction notes need to be incorporated into the plans identifying type and quantities of materials per plan sheet.

RESPONSE: This has been included in the 95 percent submittal.

9. **COMMENT:** A general construction notes sheet shall be provided with additional information pertaining to this project.

RESPONSE: This has been included in the 95 percent submittal (see comment above).

10. **COMMENT:** Soil boring logs will be included in the plans.

RESPONSE: See comment 2 from 7 November 1991 comments from RCS above.

11. **COMMENT:** Invert elevations for all the laterals that enter the main storm drain from (91st Ave., 79th Ave., 75th Ave., 71st Ave., and 67th Ave.) shall be shown on the plans. Do not label these as future storm drains. They are part of the project.

RESPONSE: Acknowledged.

12. **COMMENT:** The laterals (84" @ 91st Ave., and the one at 67th Ave.) will extend no farther than the curb returns.

RESPONSE: At 91st Avenue, this project ties into the 84-inch lateral that is already in place and extends beyond the curb return. At 67th Avenue, the extension of the Cactus Road storm drain ends at the eastern curb return. However, unless otherwise directed, the northern lateral will connect to the end of the 66-inch diameter lateral 114 ft north of the monument line.

STA 15+00:

COMMENT: In the cross section show the location of the telephone line on the north side of Cactus Road.

RESPONSE: Added

STA 15+69:

COMMENT: Identify the 1" W.S. line in the profile

RESPONSE: See comment on sta 12+00 to 17+00 from 7 November 1991 comments for RCS.

STA 17+00 - 22+00:

COMMENT: Lengths of pipe segments do not agree with the final HEC 1 analysis (see pipe numbers 3, 4, and 5).

RESPONSE: The HEC1 analysis does not use pipe numbers for routing flow. The HEC1 model was used to determine runoff volumes for basins. This model was built for the best available contour information and all routing lengths are approximate. STORM was then used to generate the HGL based on data from the HEC model. The lengths of pipe used for this program were more accurate and based on stationing of the matching HEC model node locations. STORM was used to size the main trunkline and to provide the worst case HGL at the time of highest concentration. Individual catch basin flows are based on the HEC model and rational method. The basins were sized to allow maximum flow into the main trunkline at the maximum HGL generated in STORM, even though the two times of concentration may not match.

STA 19+00:

COMMENT: In the cross section show the location of the telephone line shown on the profile.

RESPONSE: Acknowledged

STA 25+00:

COMMENT: The right of way in the cross section is different than that shown on the plan view.

RESPONSE: The right-of-way on the north side is 33 ft and on the south side is 55 ft. The cross-section now reflects these rights-of-way.

STA 30+00:

COMMENT: The right of way in the cross section is different than that shown on the plan view.

RESPONSE: See comment on sta 25+00 just above. Southern right-of-way changes to 33 ft at sta 30+45 approximately.

STA 85+00:

COMMENT: In the cross section there is indicated a telephone line south of the monument line. This is not shown on the plan view.

RESPONSE: Removed telephone from cross-section.

STA 115+00:

COMMENT: The right of way in the cross section is different than that shown on the plan view. Same for the 18" SRP line. This cross section could have been chosen at a better location.

RESPONSE: Changed cross-section sta to 113+00.

STA 120+00:

COMMENT: In the cross section there are two telephone lines indicated on the north side of Cactus Road which are not shown on the plan view. The telephone and water line on the south side of Cactus are located differently in the plan view and the cross sectional view.

RESPONSE: Telephone lines were removed. The telephone and water line locations were inadvertently reversed.

STA 125+00:

COMMENT: Same as Sta 120+00

RESPONSE: Telephone lines were removed.

STA 130+00:

COMMENT: Identify the location of the 18" Storm Sewer line that crosses the 84" RCP in the profile.

RESPONSE: The S.S. line is a sanitary sewer line and the crossing in reference was new construction recommended for the realignment of the sewer for the City of Peoria to review. All construction notes have now been added to a site plan and pertinent crossing information shown on the storm drain plan and profile.

STA 130+40:

COMMENT: Identify the location of the 12" Water line in the profile.

RESPONSE: See comment on sta 130+00 above.

STA 140+00:

COMMENT: Identify the location of the Electric line on the north side of Cactus Road in the profile. If this is an over head line indicate so with a warning.

RESPONSE: Parallel overhead electric lines do not require warnings. However, this is a buried line.

STA 165+00:

COMMENT: Same as Sta 140+00

RESPONSE: The electric line on the south side is a small service line, outside of the standard maximum 55-foot right-of-way and inside the residential walled area. However, the line was added.

STA 170+00:

COMMENT: The SRP line in the cross section has a different size than that in the plan view.

RESPONSE: Cross-section note corrected (see comment above).

STA 171+60

COMMENT: Show the location of the Electric line in the profile. If this is an overhead line indicate so with a warning.

RESPONSE: Buried line added to profile (see comment above).

STA 175+00:

COMMENT: Same and Sta. 170+00

RESPONSE: Cross-section note corrected.

SITE PLANS

COMMENT: On the site Plan for 83rd Avenue and Cactus Road do not tie the water line to an abandoned telephone line.

RESPONSE: The water line is not being tied into the abandoned telephone line. The dimension line crosses the abandoned telephone line, not the water line.

RESPONSES TO THE CITY OF PEORIA'S COMMENTS ON THE 60 PERCENT SUBMITTAL FOR THE CACTUS ROAD STORM DRAIN FROM 67TH AVENUE TO THE AGUA FRIA FREEWAY

1. **COMMENT:** Station 12+00 to station 17+00, there is an 8-inch sanitary sewer that extends north out of the manhole at station 16+80 to a tee located approximately 9 feet north of the monument line and then extends east and west and is parallel to the existing 18-inch sanitary sewer. The sewer extends west to approximately station 12+80 to a 90° bend and then extends to the south. The sewer line extends east to approximately station 20+40 to 90° bend and then extends to the north. Actual elevations of the 8-inch sanitary sewer are not known and conflicts may exist between the catch basin (91) and the lateral (90). The sewer will also have to be protected in place during construction of the 120-inch storm drain.

   RESPONSE: It was assumed that "9 feet north of the monument line" was to have right-of-way line. Sewer line was added and additional potholing required.

2. **COMMENT:** Staff is concerned that the 8-inch or the 30-inch sanitary sewers may be damaged during construction of the storm drain and strongly recommend that a note be added to the plans notifying the contractor to use extreme caution.

   RESPONSE: Permanent pipe supports are called for at each gravity flow pipe line crossing and a general note was added regarding caution during construction.

3. **COMMENT:** A note should be added to the plans directing the contractor to regrade the swales on the north and south sides of Cactus Road if disturbed during construction.

   RESPONSE: Note was added.

4. **COMMENT:** Station 27+00 to station 32+00, the 16-inch water line may conflict with catch basin (86).

   RESPONSE: No conflict anticipated. However, guidelines for water line realignments have been added to the general notes and special provisions. Guidelines have also been included in the special provisions regarding water line encasement.

5. **COMMENT:** Station 32+00 to station 37+00, the 16-inch water line may conflict with catch basin (84).

   RESPONSE: See comment no. 4.

6. **COMMENT:** Station 37+00 to station 42+00, the 16-inch water line may conflict with catch basin (82).

   RESPONSE: See comment no. 4.

7. **COMMENT:** Station 42+00 to station 47+00, the 16-inch water line may conflict with catch basin at station 46+75.

   RESPONSE: See comment no. 4.

8. **COMMENT:** Station 47+00 to station 52+00, the 12-inch water line will cross the 120-inch diameter storm drain and must be protected in place during construction.

   RESPONSE: Vertical realignment is required for this water line and coordination with the city for temporary shutoff will be required in the special provisions.

9. **COMMENT:** Station 52+00 to station 57+00, the 12-inch water line may conflict with catch basin (75).

   RESPONSE: See comment no. 4.

10. **COMMENT:** Station 57+00 to station 62+00, the 12-inch water line may conflict with catch basin (73).

    RESPONSE: See comment no. 4.

11. **COMMENT:** Station 62+00 to station 67+00, the 8-inch water line extending north on 85th Avenue will cross the 120-inch storm drain and must be protected in place during construction.

    RESPONSE: A general note to protect all utility crossings in place, unless otherwise called out on the plans has been included.

12. **COMMENT:** Station 67+00 to station 72+00, the 12-foot water line may conflict with the catch basin lateral (67). The 6-inch water line will cross the 120-inch storm drain and must be protected in place during construction.

    RESPONSE: Catch basin 67 - see comment 4. Six inch water line crossing - see comment no. 11.

13. **COMMENT:** Station 72+00 to station 77+00, the 12-inch water line that extends north on 83rd Avenue will cross the 114-inch storm drain and must be protected in place during construction.

RESPONSE: See comment no. 11.

14. **COMMENT:** Station 72+00 to station 77+00, the 4-inch water line will cross the 114-inch storm drain and must be protected in place or a section of pipe can be removed during construction and then replaced. All traffic signal facilities damaged during construction must be replaced to City of Peoria standards.

RESPONSE: Four inch water line crossing - see comment no. 8. A general note has been added that traffic signal facilities must be replaced in kind at each signaled intersection.

15. **COMMENT:** Station 77+00 to station 82+00, the 8-inch water line will cross the 114-inch storm drain and must be protected in place or a section of pipe can be removed during construction and then replaced. The 8-inch and 12-inch water lines may conflict with catch basin lateral (60).

RESPONSE: Eight inch water line - see comment no. 11. Catch basin 60 - see comment no. 4. Vertical realignment is required for the 12-inch water line.

16. **COMMENT:** Station 82+00 to station 87+00, the 12-inch water line may conflict with catch basin (58).

RESPONSE: See comment no. 4.

17. **COMMENT:** Station 87+00 to station 92+00, the 8-inch water line may conflict with catch basin (54). The 8-inch water line that extends north on 81st Avenue must be protected in place during construction.

RESPONSE: Catch basin 54 - realignment of the 8-inch water line is required. In addition, the connection between the 12-inch and 8-inch water lines must be readjusted.

18. **COMMENT:** Station 92+00 to station 97+00, the 8-inch and 12-inch water lines may conflict with catch basin laterals (52) and (51) respectively. The 8-inch water line extending south on 80th Avenue must be protected in place during construction.

RESPONSE: Catch basins 52 and 51 - see comment no. 4. Eight inch water line - see comment no. 11.

19. **COMMENT:** Station 97+00 to station 102+00, the 8-inch and 12-inch water lines may conflict with catch basin laterals (49) and (50) respectively. The fire hydrant at the northwest corner of 79th Avenue and Cactus Road may conflict with the catch basin at lateral (49) and may have to be relocated. The 12-inch water line extending north on 79th Avenue will cross the 108-inch storm drain and must be protected in place during construction. All traffic signal facilities damaged during construction must be replaced to City of Peoria standards.

RESPONSE: Catch basin 49 and 50 - see comment no. 4. Fire hydrant - should be missed by catch basin as now designed. Twelve inch water line - see comment no. 11. Traffic signal facilities - see comment no. 14.

20. **COMMENT:** Station 102+00 to station 107+00, the 8-inch water line may conflict with catch basin (45).

RESPONSE: Vertical realignment is required.

21. **COMMENT:** Station 107+00 to station 112+00, the 8-inch water line may conflict with catch basin (43).

RESPONSE: Vertical realignment is required.

22. **COMMENT:** Station 112+00 to station 117+00, the 8-inch water line will cross the 108-inch storm drain and must be protected in place during construction.

RESPONSE: See comment no. 11.

23. **COMMENT:** Station 117+00 to station 122+00, the 8-inch water line may conflict with catch basin (40).

RESPONSE: See comment no. 4.

24. **COMMENT:** Station 122+00 to station 127+00, the 8-inch water line may conflict with catch basin (38). The 6-inch water line will cross the 108-inch storm drain and must be protected during construction.

RESPONSE: Catch basin 38 - see comment no. 4. Six inch water line - see comment no. 11.

25. **COMMENT:** Station 122+00 to station 127+00, all traffic signal facilities damaged during construction must be replaced to City of Peoria Standards.

RESPONSE: See comment no. 14.

26. **COMMENT:** Sta 127+00 to Sta 132+00, the 8-inch and 12-inch water lines that extend north on 75th Avenue will cross the 84-inch storm drain and must be protected in place during construction. The 12-inch water lines on Cactus Road and 75th Avenue may conflict with catch basin laterals (34) and (35) respectively. The 12-inch water line may conflict with catch basin lateral (32).

RESPONSE: Eight inch and 12-inch waterline - see comment no. 11. Catch basin 34 - see comment no. 4. Catch basin 35 - see comment no. 4. Eight inch water line requires vertical realignment. Catch basin 38 and 32 - see comment no. 4.

27. **COMMENT:** Sta 127+00 to Sta 132+00, all traffic signal facilities damaged during construction must be replaced to City of Peoria standards.

RESPONSE: See comment no. 14.

28. **COMMENT:** Sta 132+00 to Sta 137+00, the 8-inch water line and the 6-inch sanitary sewer will cross the 84-inch storm drain and must be protected in place. The 12-inch water line may conflict with catch basin lateral (30).

RESPONSE: Eight inch and 6-inch water lines - see comment no. 11. Catch basin 30 - see comment no. 4.

29. **COMMENT:** Station 137+00 to station 142+00, the 6-inch water line that extends north on 73rd Avenue will cross the 84-inch storm drain and must be protected in place. The fire hydrant located at the north east corner of 73rd Avenue and Cactus Road may conflict with the catch basin and lateral (27) and may have to be relocated. The 12-inch sanitary sewer may conflict with the 84-inch storm drain and must be protected in place.

RESPONSE: Six inch water line - see comment no. 11. Fire hydrant - a construction note has been added to relocate the fire hydrant. Twelve inch sanitary sewer - permanent pipe support is required.

30. **COMMENT:** Station 142+00 to station 147+00, the 12-inch water line may conflict with catch basin laterals (23) and (21). The 8-inch water line that extends north on 72nd Drive will cross the 84-inch storm drain and must be protected in place during construction.

RESPONSE: Catch basin 21 and 23 - see comment no. 4. Eight inch water line - see comment no. 11.

31. **COMMENT:** Station 147+00 to station 152+00, the 12-inch water line may conflict with catch basin lateral (19). The 6-inch water line that extends north on 71st Drive will cross the 84-inch storm drain and must be protected in place during construction. Catch basin 19 - see comment no. 4. Six inch water line - see comment no. 11.

RESPONSE: Catch basin 19: See comment no. 4. 6-Inch water line: See comment no. 11.

32. **COMMENT:** Station 152+00 to station 157+00, the 12-inch water line may conflict with catch basin laterals (17) and (13). The 10-inch water line on 71st Avenue may conflict with catch basin lateral (15). The 12-inch sanitary sewer will cross the 36-inch storm drain and must be protected in-place during construction. The 12-inch water line that extends north on 71st Avenue will cross the 84-inch storm drain and must be protected in place during construction. All traffic signal facilities damaged during construction must be replaced to city of Peoria standards.

RESPONSE: Catch basins 13, 15, and 17 - see comment no. 4. Twelve inch sanitary sewer - the lateral storm drain is a 30-inch diameter pipe. Only a permanent pipe support is required. Twelve inch waterline - see comment no. 11. Traffic signal facilities - see comment no. 14.

33. **COMMENT:** Station 157+00 to station 162+00, the 12-inch sanitary sewer and the 12-inch water line may conflict with catch basin laterals (10) and (11). The 6-inch water line will cross the 78-inch storm drain and must be protected in place during construction.

RESPONSE: Catch basin 10 - a permanent pipe support is required. Catch basin 11 - see comment no. 4. Six inch water line - see comment no. 11.

34. **COMMENT:** Station 162+00 to station 167+00, the 12-inch sanitary sewer line and 12-inch water line may conflict with catch basins (8) and (9).

RESPONSE: Catch basin 8 - see comment no. 33. Catch basin 9 - see comment no. 4.

35. **COMMENT:** Station 167+00 to station 172+00, the 8-inch sanitary sewer line and 12-inch water line may conflict with catch basins (6) and (7).

RESPONSE: Catch basin 33 - see comment no. 7. Catch basin 7 - see comment no. 4.

36. **COMMENT:** Station 172+00 to station 177+00, the 8-inch sanitary sewer line and 12-inch water line may conflict with catch basins (4) and (5).

RESPONSE: Catch basin 4 - see comment no. 33. Catch basin 5 - see comment no. 4.

37. **COMMENT:** Station 177+00 to station 182+00, the 12-inch water line may conflict with catch basins (3). The 12-inch water line that extends north on 67th Avenue will cross the 78-inch storm drain and must be protected in place during construction. All traffic signal facilities damaged during construction must be replaced to City of Glendale standards.

RESPONSE: Catch basin 3 - see comment no. 4. Twelve inch water line - see comment no. 11. Traffic signal facilities - a note has been added requiring in-kind replacement.

RESPONSES TO THE CITY OF GLENDALE'S COMMENTS ON THE 65 PERCENT SUBMITTAL FOR THE CACTUS ROAD STORM DRAIN FROM 67TH AVENUE TO THE AGUA FRIA FREEWAY

1. **COMMENT:** The overall cost of the project will be less if alternate materials ar used. CLCMP could be a viable bid alternate if a PCC slurry around the pipe is used to provide the additional strength and possibly extend the life of the pipe.

   RESPONSE: The biggest structural concern for CLCMP is the backfill operation. There is no question that PCC slurry would eliminate the concern about proper mechanical compaction to keep the pipe in round and support the live and dead loads. It is also agreed that PCC slurry backfill may add to the life of the conduit by reducing the concern about coatings and cracks caused by improper backfill. However, there are no tests or installations that have been conducted that prove this. CLCMP is a relative newcomer to the storm drain world and therefore requires client agreement along with an engineering recommendation prior to use as an alternate.

2. **COMMENT:** The inlet calculations add 0.2 inches per hour to the intensity. Why?

   RESPONSE: The rational equation provided in the Phoenix Storm Drain Design Manual (Revised: July 1987) calls for subtracting the factor 0.2. The equation and inlet calculations have been corrected.

3. **COMMENT:** The areas for the inlet calculations are for 30-foot width and should be the ultimate width of the right-of-way which will be 55 ft minimum.

   RESPONSE: The 30-foot width was changed to 55 ft. However, all road right-of-way flow was accounted for in the flows generated by the HEC model and collected in catch basins located at the intersections. Nor was the size of any of the intermediate catch basins changed due to increasing the width to 55 ft.

4. **COMMENT:** Several of the streets include two inlets with individual connector pipes. These should be combined into one lateral with short connector pipes. Drainage basins 1/2-mile deep may need laterals extended in the streets to pick up a portion of the flow before it reaches the major intersection at Cactus Road.

   RESPONSE: In response to the first part of the comment, we have re-evaluated the layout of connector pipes for 72nd, 73rd, 81st, 83rd, 85th and 87th Avenues. It has been determined that it will probably be cost effective to connect the eastern side-street catch basins to the western side-street catch basins and then connect to the storm drain. It will also be about $2,000 to $3,000 per intersection less to install a 30-inch diameter lateral to two short 24-inch diameter connector pipes for 72nd, 81st and 87th Avenues.

It should be noted that we have recommended a future lateral for 81st Avenue because of the excessive flows arriving on Cactus Road and this intersection will always flood even after the Sweetwater Interceptor and the laterals are all installed. In response to the second half of the comment, the catch basins at 71st, 75th, 79th and 91st Avenue shave all been designed to catch flows generated in the 1/2 mile north of Cactus Road. It was assumed that the remaining flow generated in the 1/2 mile to 1 mile north of Cactus Road will not be collected until the laterals are installed and flooding along Cactus Road will occur. Catch basins at all the remaining intersections and drainage basin outlets have bene designed for the flow generated from the entire 1 mile north of Cactus Road because laterals have not been planned for these side-streets. Finally, laterals would greatly help collect the water before it reaches Cactus Road but they are not part of the current scope of work.

5. **COMMENT:** Why is there a rise in the HGL at station 60+75 with no change in pipe size or quantity of flow?

   RESPONSE: The hydraulic gradeline was generated using the HEC model flow rates and stations. On sheet C-1 in the design data calculations you will find that the quantity of flow changes at station 60+66. This is the station used on the plan and profile sheets although the catch basins are located slightly upstream and are the actual physical locations for the change in flow. The HGL shown on these plans is an approximation of a particular flow condition and is the best approximation of the highest flow conditions anticipated under the design assumptions of the HEC model. Normally the HGL would not be shown because it would be given in the Drainage Master Plan and base don a routing model for approximate inflow locations. In this case, the HGL was calculated by the Engineer and not provided by the client. If showing the HGL and EGL in this manner is confusing, it could be removed and the reviewing agencies could use sheet C-1 to check hydraulic calculations. There is not reason to include it on the construction plans for the contractor.

6. **COMMENT:** Inlets constructed opposite each other should have the connection to the main line offset to allow pre-manufactured tees or install a manhole.

   RESPONSE: Ameron has already acknowledged that prefabricated crosses, as shown, are not a problem. The other major valley RCP supplier, Hydroconduit, will also be contacted to determine whether they can prefabricate these crosses or the catch basins on the south side can be offset as necessary for prefabricated pipe construction.

7. **COMMENT:** The 66-inch drain in 79th Avenue is not future and should be constructed with a manhole and stubout at the end.

RESPONSE: None of the lateral collectors (91st, 79th, 75th and 71st Avenues) as shown on the plan and profiles are future. Only the sections north of the stubouts should be labeled future. The plan and profiles have been changed. Manholes are also going to be included in the 95 percent submittal.

8. **COMMENT:** The connector pipe for inlet 37 is too close to the sanitary sewer manhole and should be constructed with the low end of the inlet at the east end of the inlet to provide clearance.

RESPONSE: Final catch basin locations reflect utility locations and this catch basin has been adjusted to accommodate the existing sewer manhole.

9. **COMMENT:** The 90° bends in the connector pipes in 87th and 72nd Avenues should be eliminated. Laterals in these streets as discussed above would eliminate this problem.

RESPONSE: See comment and response no. 4.

10. **COMMENT:** There is an existing inlet at the east end of the northeast return of 67th Avenue and Cactus Road. This inlet was designed to connect to the storm drain in Cactus Road. A copy of the as-built for this inlet is enclosed and will also be sent to SFC Engineering Company.

RESPONSE: The catch basin connection has been included.

RESPONSES TO COMMENTS FROM
FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
ON THE CACTUS ROAD STORM DRAIN
95% SUBMITTAL

COMMENTS FROM R. W. SHOBE, 5 August 1992:

The 95 percent submittal for the Cactus Road Storm Drain has been reviewed and the following items are to be included and/or corrected for the final submittal:

GENERAL:

Throughout the plans, in the Construction Notes you make reference to Salt River Project Plan for details. Include these details in the plans if they are pertinent to the storm drain project.

Response: Originally, it was thought the SRP plans would be included. It is now thought the work will be done separately. In any event the note was changed and may change again at the final design.

It appears as though you went over board with encasements and pipe supports when crossing with a connector pipe. The 24" clearance is fine for a sewer line but we are installing a storm drain. It might be more practical to just support sewer lines that the connector goes underneath, to support water lines where joints have been exposed or leave it to the discretion of the engineer. Water and sewer line that are below the connector pipe should remain undisturbed unless it conflicts with the construction of the storm drain or connector pipes. Usually it is noted as "protect in place".

Response: All gravity lines that the storm drain goes under require a permanent pipe support per MAG. Those gravity lines that the storm drain goes over the top of within 2 ft call for a pipe support because the contractor often exposes these to verify their location. If they are close to the storm drain and not exposed and proper support is not provided they may collapse. It is better to expose them and support them if we anticipate they are close. All water lines that are within 6 ft of a parallel sewer line or less than 2 ft above a sewer line are required to have protection. Protection being defined as mechanical joints, slip joints with restraint or concrete encasement per the Arizona Administrative Code R9-8-326. We reviewed all pipe supports and encasements to see if we were over cautious and revised pipe supports and encasements as required.

The paving of Cactus Road with drive way improvements seems a bit excessive. If Peoria wants this to be part of this to be part of this project it will have to be a separate pay item that only the City of Peoria is responsible for.

Response: It is not certain what is meant by drive way improvements. No entrances or roads have been improved other than laying a new layer of gravel on the dirt road, which is somewhat graveled now. The road from 91st to 83rd avenues is being replaced because it will almost completely be removed by excavation for the pipeline.

There should be a generic phrase stating that the top of the manhole rims are to match either the new or existing pavement.

Response: Done.

Identify all existing and proposed R/W.

Response All existing right-of-way is shown. Additional proposed right-of-way is not required.

All the catch basins shall be placed such that they can be readily incorporated into future paving jobs without major modifications. For example, it appears that the catch basin on sheet 4 will end up behind the side walk in the future.

Response: Catch Basins west of 91st Avenue have been relocated and, to the extent possible, we have tried to anticipate future location requirements.

It is suggested that the ditch on sheets 4, 5, and 6 be eliminated and to use swale and grade to drain toward the catch basin. This will eliminate the need for culverts at all the driveway entrances and raising the grate elevations 3' +/- in the future when paving occurs.

Response: This area of the project has been subject to excessive flooding and there is a major concern that flooding be eliminated when the storm drain is installed.

The inverts on the plan and profile sheets do not match with the inverts on the connector pipe profiles.

Response: Corrected.

PLANS:

Sheet 01. On the cover sheet provide a place for the approval signatures from both Glendale and Peoria.

Response: Done.

Delete Sagramoso's name since he is no longer with the District. The name of the Chief Engineer and General Manager will be added at the later date.

Response: Done.

Sheet 02. Under the GENERAL NOTES #8 provide the actual telephone number.

Response: Done.

Sheet 03. Check on the following quantities from the plan sheets and the connector pipe profiles there seems to be some discrepancies:

01. Sheet 17, 30, and 33.

Response: Done.

02. Sheet 17, 30, and 33.

Response: Done.

04. Sheet 22, and 28.

Response: Done.

05. Sheet 6.

Response: Done.

06. Sheet 12.

Response: Done.

09. Sheet 38.

Response: Done.

13. Sheet 22.

Response: Done.

14. Sheet 22.

Response: Done.

16. Sheet 8, 9, 10, and 11.

Response: Done.

18. Sheet 9, 11, and 17.

Response: Done.

25. Sheet 33.

Response: Done.

26. Sheet 30, and 33.

Response: Done.

28. Sheet 33.

Response: Done.

29. Sheet 30, and 33.

Response: Done.

30. Sheet 6.

Response: Done.

31. Sheet 6.

Response: Done.

40. Sheet 25.

Response: Done.

63. Sheet 17, 22, 30, 31, 32, 33, 38.

Response: Done.

Item 63, there is no MAG Std. Det. 403, there is a MAG Std. Det. 403-1, and 403-2.

Response: The -1 and -2 are merely page numbers of this detail. Both are needed for the complete details; therefore, we called for 403 in general.

Change the title "Description" to "Estimated Quantities (contractor to verify)".

Response: Done.

Change the title "Storm Drain Summary" to "Quantity Sheet".

Response: Done.

Sheet 04. A portion of connector pipe (94) is shown by dashed lines, please correct.

Response: Moved station #11 over and extended connector pipe to clarify the area.

Three ft or less of cover may not be adequate to protect the storm drain from heavy trucks and equipment.

Response: Checked with local pipe manufacturer's, no problem.

ADOT will need to review these plans since we are entering onto their property. It appears as though some replacement of landscaping and fencing may be needed. Permits from ADOT may be required.

Response: Since the Project will not be built for several years we suggest that coordination take place at final design. Added note for contractor to replace landscape and fence according to ADOT requirements.

Indicate the datum you are using, ADOT's or Peoria's.

Response: We used Brass Caps with the elevations stamped on them. ADOT was used only as a secondary source for unstamped Brass Caps.

Sheet 05. Under the Construction Notes #1, the waterline encasement detail does not appear on sheet 66. Provide the correct sheet number.

Response: Done.

It might be advantageous to relocate the 6" water line upwards about a foot than to relocate it 10' downward.

Response: Insufficient cover for a waterline relocation.

Protect in place the telephone line at Sta. 13+29, and the 1" water line at Sta. 15+60.

Response: Done.

It appears as though the utilities crossing the ditch on the north side of Cactus will be exposed. Provide rectification.

Response: Done.

Sheet 06. The L.F. of the 30" pipe (#3) does not agree with the L.F. shown on the connector pipe profiles, sheet 40.

Response: Corrected.

It appears that a 30" pipe (#88) ties into a tee (120 x 120 x 24) please make the necessary corrections to the appropriate sheets.

Response: Corrected.

The catch basin for pipe (#88) appears to be a safety hazard (open pit) to the public and traffic, please correct.

Response: Added a grate for protection at structure.

Show the invert elevation of pipe (#88) and (#3) on the profile.

Response: Done.

The invert elevation for pipe (#87) as shown on the profile is slightly different than that shown in the connector pipe profiles.

Response: Corrected.

The catch basin for pipe (#89) is different than that shown in the connector pipe profile.

Response: Corrected to Single N-basin.

	Show how the water and telephone lines are to be relocated.
Response:	A note was added to vertically realign waterline under drain channel crossing. Telephone duct should be low enough and most of the single telephone lines are abandoned.
	Show how the signs to be relocated.
Response:	A note was added to the general notes.
	Identify dots. For example, there are two dots on pipe #88.
Response:	These showed up at the time of the aerial survey. They are unknown cable TV connections.
Sheet 07.	There is an object at Sta. 22+00 on the south R/W that needs identification.
Response:	This is an elevation gradeline that was on the wrong layer and not shut off.
Sheet 08.	Compare the L.F., invert elevations, and encasements for pipes (#85) and (#86) with that shown in the connector pipe profiles and make the necessary corrections.
Response:	Corrected Sheet 8.
Sheet 09.	Compare the L.F., and invert elevations for pipes (#84) and (#83) with that shown in the connector pipe profiles and make the necessary corrections.
Response:	Corrected Sheet 9.
Sheet 10.	For pipes (#82) and (#81) the L.F. appears to be incorrect. Compare with connector pipe profiles. For pipe (#81) compare the invert elevation.
Response:	Corrected Sheet 10.
Sheet 11.	For pipe (#80) and (#79) compare L.F., and invert elevations with connector pipe profiles and make the necessary corrections.
Response:	Corrected Sheet 11.
Sheet 12.	For pipe (#2) compare L.F. with that shown in the connector pipe profiles.
Response:	Corrected Sheet 12.

	Check the HGL at Sta. 52+00.
Response:	Corrected HGL.
Sheet 13.	Check the HGL at Sta. 57+00.
Response:	Corrected HGL.
	Compare pipe (#75) with connector pipe profile for encasements and make the necessary corrections.
Response:	Added note regarding waterline encasement.
Sheet 17.	Plan view show a 2"G and the profile shows a 4"G.
Response:	Corrected Profile.
	In the Construction Notes there is no mention of a water line encasement and pipe support for pipe (#62), see connector pipe profiles.
Response:	Revised connector pipe #62 and #63 to drain to manhole in center of 83rd Avenue then to the Storm drain. Waterline encasement is not required because there is a 2-foot clearance between waterline and storm drain.
	Adjust connector pipe (#64) to avoid conflict with the telephone ducts.
Response:	Done.
	Checked quantities under Concrete Removal Required.
Response:	Check quantities and changed circled notes 3, 4, 8, and 9 based on changes to connector pipe design.
	The water line re-routing shows one valve and the site plan shows two valves.
Response:	Corrected, thank you.
	Compare pipe lengths for pipe (#64) with connector pipe profile.
Response:	Done.

The representation of the 4"W seems unreasonable, please verify.

Response: The 4 inch waterline was located based on waterline plans and was not field verified because the valve was covered by asphalt and the potential conflict to the storm drain was not significant enough to require potholing. A note was added that the engineer may not require realignment. It should be noted that the aerials show a valve (which has been field verified) for which waterline plans cannot explain. If there is a north/south line here, it should not cause a conflict. The valve has been left on as an alert.

The sidewalk, apron, curb and gutter quantities are not shown for pipe (#63).

Response: There were included in the catch basin #63 quantities. These have since been edited to reflect the design changes mentioned above.

Sheet 18. Adjust connector pipe (#60) to avoid conflicts with the utilities.

Response: Lowered catchbasin invert to avoid as many utilities as possible.

Sheet 20. Under the Construction Notes, #6, Indicate where this is on the plan view.

Response: Corrected.

The plugs for the 8" X 12" tee may require thrust blocks.

Response: The are no plugs; 8 inch existing lines are connected to a cross and 12 inch lines are new.

Concrete quantities for apron replacement will need to added to the plans.

Response: Not sure what concrete apron is being referred to. Since this sentence follows waterline relocation comments it is assumed that is what is being referenced. All excavation backfill and pavement replacement is included in the cost of the waterline.

Sheet 22. Under New Storm Drain Pipe check the Stationing and L.F. for pipes (#1) and (#2) with sheet 3.

Response: Corrected stationing Sheet 22 and quantities on Sheet 3.

Under the Construction Notes #4, and #7. Indicate that the 24" irrigation line needs to be relocated, and a vertical realignment of waterline, respectfully. See connector pipe profile for pipe (#47) and make the necessary corrections.

Response: Note #4 was changed to show SRP will be relocating. Note #7 was rewritten to include the realignment.

The NOTE states to see sheet 46, yet nothing pertaining to sheet 22 could be found.

Response: Deleted reference to Sheet 46.

Justify the 72" pipe and reducer at 79th Ave.

Response: When we ran the hydraulics on the laterals we found that we need a short section of 72 inch pipe to maintain our design criteria of keeping the upstream hydraulic profile inside the estimated elevation of the lateral. Not including the 72 inch pipe put the hydraulic grade line above the estimated ground surface at the upstream end of the lateral and future catch basins would not drain to the lateral as required.

Inverts to do not match with the computer run "STORM" see pipe #18, 79th Ave.

Response: Concern was raised at the review meeting regarding the final hydraulic analysis versus the actual layout of the plan and profiles. The following explanation will hopefully clarify the purpose and use of the "final" hydraulic profile generated from the STORM program. To design the storm drain, we first ran a HEC analysis to determine flows and locations of these flows for a particular storm at the peak condition. Then we determined a downstream water surface elevation to generate a back water curve from. We also determined the upstream conditions since this project ties into other projects. Then we determined preliminary pipe sizes, approximate locations of these changes in size, approximate size of laterals and approximate elevation of the lateral inverts at the storm drain. This information was plugged into the STORM program, and Hydraulic Grade Lines (HGLs) and Energy Grade Lines (EGLs) were determined. Based on previous design experience, we know that 3 to 4 ft between the ground surface to the hydraulic gradeline is required for good catch basin design, we resized pipelines, laterals, and relocated size changes until the best design possible was determined. Once a good design was achieved, we moved forward with the actual layout of catch basins, connector pipes and laterals using the "final" hydraulic grade line. If a lateral is moved slightly, or if the invert is lowered to miss utilities, or the location of a size change is moved slightly we do not go back to STORM and keep rerunning and coming up with a new HGL and redesigning all impacted catch basins. It would be a never ending process. At each step of the design we have tried to be conservative, but the more conservative the design the more expensive the product; therefore, a balance must be achieved. In this case the invert of the lateral was lowered after "final" hydraulic design was determined to miss existing utilities.

Sheet 24. #3 under New Storm Drain Manholes should be a #2.

Response: Corrected, thank you.

See connector pipe profile for pipe (#43). It is suggested that you adjust the connector pipe to avoid conflicts with utilities.

Response: SRP cannot be avoided. Added realignment and encasement note to 8 inch waterline.

Sheet 25. In the Cross Section: Sta. 113+00 check the 12" waterline and telephone line. It appears as though they are plotted incorrectly. Also make the correction to the main trunk line (108 or 114).

Response: Corrected main storm drain to 108 inches. These cross sections are to provide pictorial information to the contractor about parallel lines. This sheet has a number of parallel line changes and a typical was hard to choose. Everything was shown even though not everything existed at Sta 113+00. Changed station to Sta 114+00 and showed SRP with a note that the SRP line is at STA 113+00.

Sheet 28. There appears to be a conflict between the New 18" sewer line and connector pipe (#33). Compare the elevations of pipe (#33) on sheet 51 with the elevations of the 18" sewer line on sheet 65. At 79th Avenue you show a water valve on the telephone line.

Response: Corrected 18 inch sewer conflict. Water valves are located based on aerial and telephone and waterlines located based on utility maps. To clarify, we moved water valves.

Sheet 29. Under Concrete Removal Required there appears to be some misnumbering of items. 2 t o 3, 3 to 4, 4 to 6, 5 to 7, 6 to 8.

Response: Corrected, thank you.

Sheet 30. Check the quantities under the Concrete Removal Required.

Response: Corrected, Sheet 3.

Include catch basin for pipe (#26) on sheet 2.

Response: Sheet 2 does not reference CB pipe #26 specifically however we did [redacted] sheet 3.

Sheet 33. Check the quantities under Concrete Removal Required.

Response: Changed Sheet No. 3.

Include catch basin for pipes (#13) and (#14) on sheet 2.

Response: Corrected, Sheet 3.

The L.F. for pipe (#3) is different than that shown on the connector pipe profile by 3'.

Response: Corrected.

Sheet 35. In the Cross Section Sta. 165+00 the R/W is plotted differently than in the plan view. Also plot the second telephone line on the north side.

Response: Corrected.

Sheet 36. In the Cross Section Sta. 170+00 the R/W is plotted differently than in the plan view.

Response: Corrected.

At approximately Sta. 171+63 the plan view indicates an electric line, indicate if this is an overhead line or buried.

Response: This is buried. Now shown in profile.

Sheet 37. In the Cross Section Sta. 175+00 the R/W is plotted differently than in the plan view.

Response: Corrected.

Sheet 38. In the Cross Section Sta. 179+00 the R/W is plotted differently than in the plan view.

Response: Corrected.

Sheet 39. For pipe (#89) indicate the size, length, and slope. The catch basin does not agree with that on sheet 6.

Response: Corrected.

For pipe (#94) it appears that the slope might be incorrect, check the length of pipe, difference in elevations, and slope. Using the given slope my calcs show a 15.7' length of pipe.

Response: Corrected.

Sheet 40. The 30" pipe shows a different length that shown on sheet 6.

Response: Corrected.

The special box structure can not be found on sheet 62.

Response: Corrected.

For pipe (#87) the invert is different than that shown on sheet 6.

Response: Corrected.

For pipe (#85) the invert is different than that shown on sheet 8, also check the slope and length of pipe.

Response: Corrected.

For pipe (#86) the invert is different than that shown on sheet 8.

Response: Corrected.

For pipe (#88) there are 2 telephone line missing in the profile, also indicate the new headwall on sheet 71.

Response: Done.

Show the utilities for the 30" pipe (#3).

Response: Done.

Sheet 41. For pipe (#84) the invert is different than that shown on sheet 9.

Response: Corrected.

	For pipe (#83) the invert is different than that shown on sheet 9 and check the pipe length, invert elevations, and slope.
Response:	Corrected.
	For pipe (#82) check the pipe length, invert elevations, and slope.
Response:	Corrected.
	For pipe (#81) the invert is different than that shown on sheet 11.
Response:	Corrected on Sheet 10.
Sheet 42.	For pipe (#79) the invert different than that shown on sheet 11.
Response:	Corrected.
Sheet 45.	Pipe (#64) adjust connector pipe to avoid the relocation of the telephone ducts.
Response:	Telephone duct relocated as of potholing. Redesigned CB #64 to miss duct.
	For pipe (#63) the length is different than that shown on sheet 17.
Response:	This CB connection has been redesigned.
	For pipe (#62) a 4"G line is shown, yet the plan view shows a 2"G line. The 8" sewer and 12" water line may need a pipe support.
Response:	Corrected to 2 inch G line. The CB connection has been redesigned. The sewer line requires a permanent pipe support.
	For pipe (#60) adjust connector pipe to avoid utility conflicts.
Response:	Lowered CB to miss most utilities. However, missing the electrical conduit is more important.
Sheet 46.	For the 36" pipe at Sta. 87+29 LT show the 12" water line.
Response:	Done.
Sheet 48.	For pipe (#3) the special structure cannot be found on sheet 63.
Response:	Corrected.

Sheet 49.	For pipe (#43) indicate that the 8" water line is to be protected in place.
Response:	Vertical realignment is required (2-foot clearance is required by code).
Sheet 50.	For pipe (#39) indicate where the telephone ducts are.
Response:	Done.
	For pipe (#35) it appears as thought the telephone duct and the 6" water line are plotted incorrectly. Also check the slope, invert elevations, and length of pipe.
Response:	No. This is the best information we have regarding the two.
Sheet 51.	For pipe (#33) it appears as though there might be a conflict with the New 18" sewer line, see sheet 28 and 65.
Response:	There was, corrected the design. Thank you.
Sheet 52.	For pipe (#29) show the electrical line with in the R/W.
Response:	Done.
	For pipe (#2) there are 2 telephone line indicated, sheet 31 indicates only 1 telephone line.
Response:	Corrected.
Sheet 53.	Adjust the connector pipe to avoid the 8" water line for pipe (#24).
Response:	Lowered CB #24 by 1 ft.
Sheet 54.	For pipe (#3) indicate the location of the telephone line that is between the 2- 24" irrigation lines.
Response:	Added.
Sheet 56.	For pipe (#8) indicate the location of the 2 telephone lines. One line might need to be relocated.
Response:	Corrected, thank you.
Sheet 57.	For pipe (#7) the special box structure was not found on sheet 64.
Response:	Corrected.

Sheet 58. Provide sheet numbers for #3, and #2.

Response: Done.

For pipe (#92) the grate elevation is different than that shown on the connector pipe profiles.

Response: CB #92 was relocated, the correct elevation should be on both Sheet 58 and 39.

Indicate how the ditch on the south side near the box culvert is to drain.

Response: All flow on the south side generated upstream is to be captured in CB #93 for the 10 year, 2-hour event. Only small flows are anticipated from rain falling in this area. Large events will overtop CB #93 and flow to the river as they do now.

Show the 6" waterline, telephone line, and the electric line in the profile. It appears as though these utilities will be exposed at the ditch locations.

Response: Small service lines are normally lowered as needed and often times are not shown on plans. However, notes have been added to Sheets 4 and 5 specifying what should be done.

Sheet 59. Provide sheet numbers for #3, and #4.

Response: Done.

Provide a 2 for pipe (#87).

Response: Done.

Sheet 60. For pipes (#84) and (#83) the grate elevation is different than that shown on the connector pipe profile.

Response: Corrected.

M should either be identified on the plans or eliminated from the right margin.

Response: M was identified.

The "Edge of Pavement" is pointing to existing not proposed, identify both.

Response: Corrected.

Sheet 61.	M should either be identified on the plans or eliminated from the right margin.
Response:	M identified.
Sheet 62.	S and 1 can not be found in the plan.
Response:	Added S and 1 to plan.
	Provide a 2 for pipe (#76).
Response:	Done.
Sheet 63.	The items such as sewer line and manhole, water line and valves should be part of the quantities, sheet 3.
Response:	Done.
	At 83rd Ave. a 4"G is indicated, Sheet 17 shows a 2"G.
Response:	Corrected.
	The water line is tied to a telephone line.
Response:	We could not find any connections shown between the waterline and telephone line.
	The 12" water line should be installed between the two new tees.
Response:	It was; however, after reviewing area further we changed the reconnection slightly. We also changed the pen weights to clarify the removals versus new installation.
	This area needs clarification.
Response:	It is believed that the "area" in question is the 8 inch waterline connection to the 12 inch waterline. We do not have much information on this area, or what was intended by the original designer, but this is what we know and what we think is going on. The segment between the two north/south tees is a 12 inch line (we potholed the line). We think that the 8 inch line had insufficient capacity to deliver water to the north/south 12 inch line. When the east/west 12 inch waterline was installed a connection was added to the north/south line. We relocated this connection line to eliminate the parallel vertical conflict between the waterline and storm drain.

Sheet 64. The items such as waterline and valves should be part of the quantities, sheet 3.

Response: Done.

Sheet 65. There appears to be a conflict between the 18" sewer line and the connector pipe (#33).

Response: Corrected.

The sewer line and manholes should be part of the quantities, sheet 3.

Response: Corrected.

Sheet 70. The manholes for pipes 120" to 108" have prefabricate tees, these were not included on the quantities sheet 3.

Response: The tees are typically part of the standard details for the manholes in MAG; therefore, they are not called out separately.

Since the driveway culverts are all the same do not dimension the width of the bedding material as D + 3' min, provide a dimension.

Response: It is standard procedure on details that may vary to not specifically dimension in order to allow the same detail to be used for more than one size. This also provides information if changes are made in construction and different sized culverts are then required.

Since all the culverts are the same do not dimension the center of pipe as 1/2 D, provide a dimension in the Type 1 End Section Dimensions.

Response: See previous response.

Sheet 71. For the Headwall Drop Inlet it appears as though there will be 6" of standing water.

Response: Changed design.

In the Headwall Structure dimensions L and M could not be found.

Response: These are dimensions required for trash rack details for MAG Std Det 502-1. These details were not redrawn in these plans, but referenced by note.

Sheet 72. It appears that no one checked the boring logs.

Response: Corrected.

Sheet 73. It appears that no one checked the boring logs.

Response: Corrected.

Sheet 74. Access will need to be maintained on the south side of the storm drain from Agua Fria to 83rd Ave.

Response: The contractor is required to provide access to all driveways even if the main access road is on the north under the City of Phoenix traffic guidelines which he has been instructed to use in the Special Provisions. It is not possible to provide lanes on the south side without additional right-of-way.

SPECIAL PROVISIONS:

The numbering within the specs are to be the same as that of MAG.

Response: Done.

In the Table of Contents change the numbering to match that of MAG.
.01 to 100, .02 to 200, .03 to 300, etc.

Response: Done.

SP-1 Change: "A" to 104, "B" to 108.

Response: Done.

SP-3 Utility Coordination:

Change "D" to 105.

Response: Done.

Ernie Cota is no longer with APS.

Response: Removed Mr. Cota's name. We have not filled in the name at this time since it is likely to change before construction.

Provide contact name and phone number for City of Peoria, and Salt River Project.

Response: Phone number have been filled in, but contact people should be determined at the time of construction.

Include Blue Stake.

Response: Done.

SP-4 Clearing and Grubbing section is not needed.

Response: Removed Section. This section was originally included because of the payment paragraphs, since there are no trees, the payment paragraph in MAG should not be a problem.

Structure Excavation and Backfill section is not needed.

Response: Done.

Riprap Construction:

Change "D" to 220.

Response: Done.

There is no riprap in the bid tab.

Response: Rip Rap was item no. 68 for culvert entrances.

The sentence "The bed for riprap shall be shaped and trimmed to provide even surfaces." is not needed.

Response: There are two sentences in 220.3, only one applies; therefore, we rewrote this section without that sentence. Also labeled items by section to help clarify.

SP-5 Change the "E" to 107. This section Hauling and Grading Permit does not belong in the 200 section.

Response: Done, corrected location.

Watering:

The section is not needed.

Response: Done.

Streets and related work:
Change ".03" to 300.

Response: Done.

The first paragraph is not needed.

Response: We combined most of the paving work into one section to clarify the payment for resurfacing the roadway. Changed to separate sections to accommodate previous request to match MAG spec numbers.

SP-6 The first paragraph is not needed.

Response: See Response above.

The sections "Pavement Matching and Surfacing Replacement", "Concrete Curb, Gutter, Sidewalk, Driveway and Alley Entrance", "Adjusting Frames, Cover, Valve Boxes", "Removal and Existing Improvements" are not needed.

Response: Removed Pavement Matching, etc... and Concrete Curb etc... Sections. No separate payment has been set up for adjusting valve boxes or manhole; therefore, this stays. Removal of Existing Improvements has been included to specify and provide payment for the miscellaneous work at the ADOT fence.

SP-7 Telecommunications Installation and Relocation:
Include that this shall be relocated at their cost and by them. This is not to be a bid item.

Response: There are five locations that we have asked the contractor to lower the telephone line to eliminate cost. All the contractor has to do is make the excavation slightly larger. Changed spec to not a pay item.

Change: ".04" to 400, "A" to 401.

Response: Done.

SP-8 Police Officer Requirements:
The second paragraph is not needed.

Response: Remove the paragraph.

Sequence of Construction does not belong in this section:
Change "D" to 108.

Response: Done.

State that the contractor is to complete X feet before starting the next reach. Refer to 602.2.10.

Response: We checked with the City of Peoria (Dan Nissan). They thought the standard 1320 ft called out in MAG was fine. So there is no change from MAG for the Special Provisions.

Survey Markers is not needed.

Response: Paragraph 2 is not part of MAG Survey Markers (Section 310) and therefore we added this to the special provisions.

SP-9 Change "F" to 420.

Response: Done.

Street Lighting needs MAG number and method of payment.

Response: Removed street lighting.

Concrete Structures:
Change "0.5" to 500, "A" to 505.

Response: Done.

The third paragraph is not needed.

Response: Changed structures to cubic yardage instead of lump sum and removed third paragraph.

Change ".06" to 600.

Response: Done.

Change "A" to 601.

Response: Done.

SP-10 Fill in the blanks.

Response: Done.

SP-11 Change "B" to 610.

Response: Done.

SP-12 The second paragraph should have a section 630.

Response: Corrected waterline section to match MAG section numbering.

SP-13 Sewer Line Relocation:

Change "C' to 615.

Response: Done.

Fill in the blanks in the first paragraph.

Response: Done.

The second paragraph is not needed.

Response: This paragraph is needed to clearly identify what lists will be included in the sewer line bid item.

Storm Drain Construction:

Change "D" to 618.

Response: Done.

The sections "General", "Submittals", are not needed.

Response: Removed.

SP-14 The section "Review" is not needed.

Response: Removed.

SP-15 The sections "Main Line Pipe", "Connecting Pipe" are not needed.

Response: Removed.

SP-16 Corrugated Metal Pipe and Arches not in Bid Tab.

Response: See Item #66.

Change "E" to 621.

Response: Done.

Is the unit price bid per linear foot or each.

Response: Clarified the pipe in line foot and the end sections are each.

Manhole Construction:

Change "F" to 625.

Response: Done.

Your paragraph is not needed.

Response: Revised section, see response below.

Indicate how the Tee's for the manhole will be paid for.

Response: Tee for manholes are part of the manhole cost.

Change "G" to 630.

Response: Done.

Materials is not needed.

Response: Removed.

Do not include the Engineers Estimate (Opinion of Probable cost) with the Special Provisions. This is to be submitted separately in a sealed envelope. The Bid Tab is to be included in the specs with the unit price and amount columns left blank.

Response: The Engineer's Estimate was only bound in the 95 percent specs to simplify review. Bid Tab was changed to format provided at review meeting.

All Item numbers are to coincide with Plans, Specs, Bid Tab, and Engineers Estimate.

Response: Specs have been numbered to match MAG Specifications. The Engineer's Estimate was more detailed than the bid tab so we reorganized it to show summary costs that will match the bid tab.

Pipe excavation, backfill, installation are to be included in the cost of the pipe. It is not to be a separate bid item.

Response: These items were separated in the engineer's estimate to provide more background, but combined on the bid tab. We reorganized the engineer's estimate to match the bid tab.

All catch basins are to be lumped into a quantity of cubic yards of concrete.

Response: Catch Basins are typically done on a per each of a given type.

Tee's, reducers, wyes, etc. are to be lumped into a quantity of cubic yards of concrete.

Response: These are precast items in most cases and are therefore bid on the per each item not total concrete.

The Box Structures are to be in cubic yards of concrete with the rebar incidental to the cost.

Response: Changed Bid Tab.

In the bid tab check the quantity of 30" dia rcp, and the 120"x120"x24" tee.

Response: Done.

A 120"x120"x30" tee is not shown on the plans.

Response: Corrected.

The unlisted items need to be identified.

Response: These are items allowed under MAG, such as fence removal and replacement for example. The quantities sheet now reflects the miscellaneous work on sheet 4.

COMMENTS FROM RAJ SHAH TO R.W. SCHOBE, 30 JUNE 1992

PLANS:

Sheet C-1:

The sheet should be signed by designer and checker and should be stamped by the registered engineer with his/her signature.

Response: Done.

Sheet 6 of 75:

1. At Sta. 21+46, the 30: side inlet is not shown on the profile. Also, the connector tee should be 30" not 24".

Response: Added, corrected.

2. At Sta. 20+80.5, show the 30" side inlet on the profile.

Response: Added.

Sheet 8 of 75:

Please verify the length of connector pipes for catchbasins #85 & #86 with catchbasins details on sheet 41.

Response: Done.

Sheet 9 of 75:

1. Please verify the length of connector pipes for catchbasins #83 & #84 with catchbasins details on sheet 41.

Response: Done.

2. At Sta. 33+70, the 24" connector pipe is shown as 15" on profile. Please change to 24".

Response: Done.

3. The Construction Note #5 should be #6.

Response: Done.

Sheet 10 of 75:

Please verify the length of connector pipes for catchbasins #81 and #82 with catchbasins details on sheet 41.

Response: Done.

Sheet 11 of 75:

1. Please verify the length of connector pipes for catchbasins #79 and #80 with catchbasins details on sheet 41 and 42.

Response: Done.

2. At Sta. 46+75, the 24" connector pipe is shown as 15". Also the invert elevation should be verified with sheet 41 and 42.

Response: Done.

Sheet 12 of 75:

Please verify the length of 36" pipe with sheet 42.

Response: Done.

Sheet 17 of 75:

1. Please provide the "Caution" sign for the electrical line.

Response: Caution Notes have been added to plans where overhead lines cross proposed construction.

2. The 2"G line shown on plan view is shown as 4"G line on profile. Please verify.

Response: Corrected.

3. Construction Note #8 & #9, it should be 70 sf of concrete removal not 170 sf.

Response: These catch basins connector pipes have been redesigned and concrete removals have been changed to reflect the new quantities.

Sheet 20 of 75:

Where is the pipe for Construction Note #6?

Response: Added symbol to plans.

Sheet 29 of 75:

Concrete removal Notes are mislabeled. Please verify.

Response: Corrected.

The catchbasin #25 should be shown on sheet 31 or sheet 30.

Response: Removed symbol on Sheet 31.

Sheet 38 of 75:

Please show the complete drawing north of the main pipe on 67th Ave.

Response: We do not have topography, aerial, or survey for this area. The area is shown in profile on connector pipe for entire reach.

Sheet 40 of 75:

1. At Sta. 21+86 RT, the invert of the pipe is shown as 26.95' on profile. Please verify.

Response: Corrected profile.

2. At Sta. 28+00 LT, the invert of the pipe is shown as 29.99 on profile. Please verify.

Response: Corrected profile.

3. At Sta. 28+00 RT, the invert of the pipe is shown as 29.10 on profile. Please verify.

Response: Corrected profile.

Sheet 41 of 75:

1. At Sta. 33+70 LT & RT, the invert of the pipes as shown as 30.99' and 30.66' on profile. Please verify.

Response: Corrected profile.

2. At Sta. 40+70 LT, the invert of the pipe as shown as 33.31' on profile. Please verify.

Response: Corrected profile.

3. At Sta. 46+75 RT, the invert of the pipe is shown as 33.88 on profile. Please verify.

Response: Corrected profile.

Sheet 42 of 75:

At Sta. 46+75 LT, the invert of the pipe is shown as 34.22' on profile. Please verify.

Sheet 45 of 75: Corrected profile.

At Sta. 73+06, is the conflicting telephone line abandoned?

Response: Catchbasin redesigned based on measure-down location of telephone duct.

Sheet 49 of 75:

At Sta. 111+96 RT, 8"W line needs to be re-aligned and encased in concrete.

Response: Done.

Sheet 55 of 75:

At Sta. 154+38, the 8"S, 2"G and 10"W lines need to be encased in concrete.

Response: Added encasement and pipe support. Removed gas line per Southwest Gas review of plans. Line may have been abandoned in place because in another intersection, Southwest Gas said they did not have a gasline, but we found one on the plans they sent and in the potholing.

Sheet 57 of 75:

At Sta. 180+66, show catchbasin #1 on profile.

Response: Done.

Sheet 58 - 61 of 75:

Are the grates of the catchbasins flush with the bottom of the channel? If yes, the top of grates should match with the channel bottom.

Response: Grate Tops are flush with bottom of channel (see connector pipes).

Sheet 66 - 69 of 75:

1. All the joints at the invert of the junction structure should be made water tight.

Response: Added note clarifying that contractor should cast pipes in-place to the structures.

2. Please provide the purpose of not continuing the bottom steel at the bottom slab of concrete junction structures.

Response: Not required per structural engineer's design.

Sheet 68 of 75:

The MAG detail 522 called out for manhole shaft is only for up to 48" diameter manhole. We have 60" dia. opening. The MAG detail may have to be modified for this condition. Please verify.

Response: MAG Detail 522 references MAG Detail 420 which shows base of 48 inches or 60 inches.

Sheet 71 of 75:

1. Please specify clearly when to use "Type A" encasement and when to use "Type B" encasement.

Response: Please see the Pipe Crossing Notes for this information.

2. On the "Headwall Detail", Sec. C-C, specify the dimension of the inlet apron.

Response: Done.

CONSTRUCTION SPECIAL PROVISION:

According to page 2, Item #4 and #5 of "Scope of Work", the Special Provisions prepared by the Consultant shall be numbered, named, and sequenced in the same order as MAG Specifications Sections. The items in the Engineer's estimate shall conform exactly to the Bidding Schedule Items. Item numbers in the Bidding Schedule shall be the same as MAG Specification Section Numbers.

Response: Changed as requested.

BID TABS:

1. Item #12, "Remove concrete curb & gutter" should be 1364 LF.

Response: Corrected.

2. Item #13, "Remove concrete sidewalk" should be 5280 SF.

Response: Corrected.

3. Item #16, "Conc. CB L=6', Det. 1569" should be 10 each.

Response: Corrected.

4. Item #17, "Conc. CB L=10', Det. 1569" should be 36 each.

Response: Corrected.

5. Item #18, "Conc. CB L=17', Det. 1569" should be 6 each.

Response: Corrected.

6. Item #21, "Conc. CB Type N, Single Basin" should be 13 each.

Response: Corrected.

7. Item #22, "Conc. CB Type N, Double Basin" should be 10 each.

Response: Corrected.

8. Item #39, "108"X108"X15" prefab. tee" should be 2 each.

Response: Corrected.

9. Item #62, 63 & 64, pipe excavation & hauling, pipe backfill, and pipe installation cost respectively should be incidental to pipe cost per linear foot.

Response: Corrected.

10. What are the unlisted items?

Response: Unlisted items are the ADOT fence removal and other items listed in MAG Section 350.

COMMENTS FROM MRD TO R.W. SHOBE, 30 JUNE 1992

DESIGN DATA REPORT:

1. The report should contain introductory or explanatory statements about the contents of the report. As submitted, after the table of contents the appendices follow without the main body of the report.

Response: Done.

2. Appendix A: On page 4, an evaluation report by Morris and Bednar was cited without reference to an appendix. The implied appendix (after Fig. 1) should be numbered as A1 or Aa to avoid appendix number duplication.

Response: Done.

3. Appendix B: It contains only one page with "Hydrology Report previously submitted". The important results and summary should be included in this appendix and the details in a separate hydrology report. As presented, there is no point including it as Appendix B.

Response: Included Final Report

4. Appendix C: The runoff summary computer output should have been included in Appendix B. The design discharges as extracted from the HEC-1 output may be summarized. The Stage-Discharge Curves my be more appropriate in Appendix B, unless they are directly used in hydraulic design. Plan view location of the various cross sections should be included and labelled accordingly.

Response: The runoff summary data is included here to show what information was used from HEC runs. The runoff quantities used from the HEC summary sheet were underlined rather than resummarized to first, save time and second, show where the quantities came from. The Stage-Discharge Curves are for particular locations on the street and generated from Manning equation. They were used to help design catchbasins and are not a part of the Hydrologic Study done. The plan views of these cross-sections correspond to the plans.

5. Appendix D: A brief discussion on methodology used in catch basin design should be included instead of mere enumeration. Also, with the numerous catch basins, a summary table is needed showing drainage area, pipe length, design Q and possible storage potential, if applicable.

Response: Methodology was not discussed in detail since it would be a rehash of the City of Phoenix design manual. Added a note up front to refer the reader to the Design Manual if they are unfamiliar with catchbasin design. A summary table at this juncture (Final Submittal) would serve no purpose. No storage potential was assumed unless it was included in the HEC analysis. The catchbasin design is for the instant in time that the peak flow condition occurs.

6. Appendix E: Explanatory statements are also needed to give background information on the data presented and how they were used in the final design. Basic assumptions in Analysis 1, Analysis 2 and Final Design should be given.

Response: This appendix is referenced from appendix C. The information has been separated to keep massive amounts of data away from explanatory text. Added some brief clarification of the 3 evens and referenced appendix C for discussion.

CONSTRUCTION PLANS:

The indicated pipe sizes and slopes were compared with those presented in the Cactus Road Drain Conceptual Profile and were found consistent, except for slope between Sta 100+61 and Sta 113+97 which was indicated 0.00027 in the conceptual profile, probably a lithographic error (should be 0.0027).

Response: Acknowledged. Slope should be 0.0027.

**RESPONSES TO COMMENTS FROM
THE CITY OF GLENDALE ON
95% SUBMITTAL**

The Cactus Road Storm Drain 95 Percent Submittal:

There is an advantage which should be listed on the CLCMP option which is that the pipe will fit in a smaller space due to the smaller outside diameter.

Response: Added to list.

There are a couple of typos in Tables 2 and 3 (see attached).

Response: Corrected.

Be consistent between CLCMP or CMPCL in tables 1 & 3.

Response: Corrected.

Please add a connector pipe stub and "N" type inlet at sta. 181+53± with the rip-rap per detail sht. 70.

Response: Added the N Basin with the standard concrete apron.

The inlet at 179+87 Lt. is not really needed since the water flows both south and west from that point.

Response: Acknowledged. However, major intersections have catchbasins here for the nuisance flow from the intersection.

The inlet at Sta. 181+49 Lt. needs to have a note added concerning the removal of the plug and bottom of the existing inlet prior to connection to the storm drain. Also need to plug the existing pipe connection to the existing irrigation pipe. This inlet information was provided to SFC but can be resupplied if necessary.

Response: Done.

Is there a plan as to when this storm drain outfall will be constructed and how paid for?

Response: It is our understanding that the construction will be put on hold until such time that funds are available.

RESPONSES TO COMMENTS FROM
THE CITY OF PEORIA
ON 95% SUBMITTAL

The City of Peoria 95 percent submittal:

Comment: Page SP-3. We were not aware that the City is responsible for the hiring of a contractor for the relocation of existing water and sewer lines located within the City's right-of-way. We need to discuss the issue of prior rights.

Response: Separate discussions with Flood Control will be required.

Comment: Page SP-3. Please list Dan Nissen at 412-7212 as the contact for City of Peoria water and sewer.

Response: Done.

Comment: SP-5, E. Contact Mr. Larry Fudurich for information regarding the haul route and permit.

Response: Added.

Comment: Page SP-7, A. The section of Cactus Road from 91st Avenue to 87th Avenue is under the Maricopa County Department of Transportation's jurisdiction.

Response: Added.

Comment: The contractor will be responsible to submit a traffic control plan for restriction or closure of city streets.

Response: Added.

Comment: Page SP-8, B. Local access must be provided as required.

Response: Covered in the City of Phoenix Traffic Manual.

Comment: Page SP-10. The contractor shall take special note of the parallel 18-inch sanitary sewer in addition to the 30-inch sanitary sewer.

Response: Added.

Comment: Page SP-12. All salvaged water line valves from the City of Peoria water distribution system shall be delivered to the City of Peoria.

Response: Done.

Comment: Page SP-12. The City of Peoria has no valve shutdown fees.

Response: Acknowledged.

Comment: Page SP-12. The City of Peoria and the City of Glendale shall be notified prior to any water line shutdown.

Response: Added.

Comment: Page SP-13. The City of Peoria will not be responsible to take the line out of service, provide necessary valve cut-ins, and flush the lines prior to placing it back into service. We need to discuss the issue of prior rights.

Response: Separate discussions with Flood Control will be required.

Comment: Page SP-13. The contractor shall notify the City prior to relocating the 18-inch sanitary sewer.

Response: Added.

RESPONSES TO THE FLOOD CONTROL DISTRICT OF MARICOPA COUNTY COMMENTS ON THE 60 PERCENT SUBMITTAL FOR THE CACTUS ROAD STORM DRAIN FROM 67TH AVENUE TO THE AGUA FRIA FREEWAY

18 November 1991 Comments from RCS

1. **COMMENT:** According to the Scope of Work, the Construction Special Provision should be submitted for FCD review.

   RESPONSE: Review of the hydrologic data in the Flood Control Master Plan for Cactus Road was substantially delayed last spring and eventually eliminated from the contract because data could not be recovered from the Flood Control District of Maricopa County (FCD). The scope of work was then changed and the hydrology was rerun using the new version of FCD's Hydrologic Manual and the Corps of Engineers' HEC programs. This delay caused delays in preparing the plans and other associated deliverables. In order to expedite the process, only the 60 percent plan and profiles and supporting data were originally submitted. The 60 percent Construction Special Provisions and Preliminary Opinion of Probable Construction Cost were submitted later on 23 December 1991.

2. **COMMENT:** The inlet calculations should be completed.

   RESPONSE: As stated above, FCD's Hydrologic Manual and the HEC programs were used to calculate runoff flows rather than the more traditional Rational method. Flows were generated at approximate 1300-foot intervals. Several assumptions had to be made in order to size intermediate catch basins. It was suggested and agreed to that the catch basins would only be sized (as to type of structure) and located for the 60 percent delivery. Upon review of the assumptions used and approval of the size and location of catch basins then the rest of the design calculations would be completed (depth of catch basins and size of connector pipe). The 95 percent submittal will include design calculations for flow to be collected, type of catch basin, depth of catch basin and size of connector pipeline.

3. **COMMENT:** The entrance losses (Ke) and manhole losses (Km) should be included in the input data listing of "Storm" software.

   RESPONSE: The "storm" program allows for two different methods of calculating entrance headlosses and exit headlosses. One is through the traditional use of Ke and Km and the other is through the use of friction loss of equivalent length of pipe. We chose the friction loss of equivalent length. This should have been explained more clearly in the discussion about the program and will be included in the 95 percent submittal.

4. **COMMENT:** All design drawings and calculations should be stamped by registered engineer and initialed by both designer and checker.

   RESPONSE: There is an ongoing debate within the profession about stamping and signing drawings and calculations that are not final and ready for construction. The stamp implies a level of confidence that is just not there until the final submittal. The 95 percent submittal is substantially complete and therefore stamped.

5. **COMMENT:** The computer generated output should be verified by hand calculations.

   RESPONSE: Hand calculations have been included in the 95 percent submittal.

6. **COMMENT:** The runoff coefficient used with rational formula is 0.9 but according to "City of Phoenix Storm Drain Design Manual" for paved street or parking lot it should be 0.95.

   RESPONSE: The rational equation listed on page 2 of the City of Phoenix Storm Drain Design Manual is:

   $$Q=0.8(I-f_c)A^p+0.9(I-0.2)A^i$$

   The first portion is for the pervious area (A^p) and is equal to zero when calculating the flow in the Right of Way for the intermediate basins. On pg 20, a list of the percent impervious is listed for zoning types. Parking (Open) and Parking (Structures) are listed at 0.85 percent; however, these factors apply to the non-Right of Way zone which is listed at 100 percent. Therefore, A^i was multiplied by 100 percent. We did not find a reference in the manual to a 0.95 factor.

7 November 1991 Comments from RCS

1. **COMMENT:** The soils report should not be included with the Construction Special Provisions. The Contractor can review the soils report upon his/her request through the FCD or City of Peoria.

   RESPONSE: Acknowledged.

2. **COMMENT:** Include soils boring sheets in the plans with boring locations shown.

   RESPONSE: Acknowledged.

3. **COMMENT:** Provide the supporting information for eliminating CLCMP and CIP from project alternatives for district review.

RESPONSE: Cast-in-place pipe was eliminated based on the recommendation of the soils report which was submitted to FCD. CLCMP was eliminated based on a variety of reasons most important of which is the reluctance by the City of Peoria to allow this alternative. Contech (the local supplier of CLCMP) provided a report that they call the Phoenix report. The report contains various studies and information collected by Contech. Portions of this report were used to present the test data summarized in the Alternate Conduit Section & Materials Comparison Report. Portions of this report have been included in the Design Data Report.

4. **COMMENT:** Provide the location of manholes, sizes of lateral drains and profile of lateral.

RESPONSE: Manholes, lateral drain sizes and lateral profiles have been included in the 95 percent submittal.

5. **COMMENT:** Provide a vicinity map and index.

RESPONSE: These have been included in the 95 percent submittal.

6. **COMMENT:** Provide "General Construction Notes" regarding the project.

RESPONSE: These have been included in the 95 percent submittal.

7. **COMMENT:** Provide "Construction Notes" on right hand column of sheet showing LF of pipe, # of manholes, # of catch basins and etc....

RESPONSE: See comment 2 from 18 November 1991 comments from RCS above. These have been included in the 95 percent submittal.

8. **COMMENT:** Provide the documentation for the software used to calculate the HGL in order to interpret the input and output data.

RESPONSE: This have been included in the 95 percent submittal.

9. **COMMENT:** Provide sample of hand calculations for junction losses at the laterals and junctions.

RESPONSE: See comment 5 from 18 November 1991 comments from RCS above. This has been included in the 95 percent submittal.

Sta 10+00 to 12+00:

Show transition details for the round pipe to box culvert.

RESPONSE: This has been included in the 95 percent submittal.

Sta 12+00 to 17+00:

COMMENT: 1" WS (?) not shown on profile.

RESPONSE: Small water service lines are not typically shown in profile because they ar enot documented and cover is usually less than 3 ft. Contractors are instructed in MAG about how to relocate them if necessary.

Sta 17+00 to 22+00:

COMMENT: 24" IRR needs to be relocated.

RESPONSE: It is not anticipated that the SRP line requires relocation.

COMMENT: Specify the location of major overhead powerlines.

RESPONSE: There are three locations where overhead lines cross the storm drain trunkline and caution notes have been added.

Sta 47+00 to 52+00:

COMMENT: 12" W needs to be relocated or supported?

RESPONSE: Realignment is required and shown.

Sta 52+00 to 57+00:

COMMENTS: The electrical line (@ Sta. 54+) needs to be relocated.

RESPONSE: It is not anticipated that this electric line needs to be relocated.

Sta 62+00 to 67+00:

COMMENTS: The 8" W needs to be relocated or supported?

RESPONSE: A general note has been included requiring the contractor to protect in-place all utilities unless otherwise directed in the plans. In addition, instructions have been added to specify where and how to encase water lines that are too close to the storm drain.

Sta 67+00 to 72+00:

COMMENTS: At Sta. 71+00, show the horizontal distance to center line of pipe to the right of way line.

RESPONSE: Clarified construction requirements.

Sta 72+00 to 77+00:

COMMENTS: 12" W and 24" W needs to be relocated or supported?

RESPONSE: Twelve inch water line - see comment on station 62+00 and 67+00. Twenty-four inch water line - a permanent pipe support is required and note has been added to that effect.

Sta 92+00 to 97+00:

COMMENTS: The 8" W needs to be relocated or supported"

RESPONSE: See comment on station 62+00 to 67+00.

Sta 97+00 to 102+00

COMMENTS: The slope of 361 LF 114" Dia. pipe should be .0033 ft/ft.

RESPONSE: The length of 114-inch diameter pipe and slope have been readjusted.

COMMENT: The slope of 139 LF 108" dia. pipe should be .0008 ft/ft.

RESPONSE: The length of 108-inch diameter pipe and slope have been readjusted.

Sta 122+00 to 127+00:

COMMENTS: 144" box culvert and 18" SS line needs to be relocated.

RESPONSE: The sanitary sewer line has been relocated. SRP has been contacted and coordination with them to construct the storm drain and trunkline is underway.

Sta 127+00 to 132+00:

COMMENTS: 10" SS, 8" W, 12" W, and 24" IRR needs to be relocated or supported?

RESPONSE: Ten inch S.S. - plugged and removed as necessary. Eight inch W and 12-inch W - require encasement. Twenty-four inch IRR requires permanent pipe support.

COMMENTS: Please show 18" SS line on profile.

RESPONSE: An 18-inch sanitary sewer does not cross the storm drain. A site plan has been used to clarify the construction of the sewer realignment.

Sta 132+00 to 137+00:

COMMENTS: Please show the 12" W (?) on profile. Does it need to be relocated or supported?

RESPONSE: The 12-inch water line does not cross the storm drain and where necessary notes have been added for connector pipe conflicts.

Sta 152+00 to 157+00:

COMMENTS: The 10" W @ 71st Ave. needs to be relocated or supported?

RESPONSE: See comment on sta 62+00 to 67+00.

Sta 167+00 to 172+00:

COMMENTS: At sta 171+, show the electrical line on profile. If it is an overhead line provide a "Caution" sign.

RESPONSE: Line shown in profile added.

COMMENTS: On cross-section @ Sta 170+00 the 24" IRR shown on plan is shown as 30" IRR. Please verify.

RESPONSE: Cross-section corrected to 24-inch IRR.

Sta 177+00 to 182+00:

COMMENTS: Please show the size and invert elevation of pipe coming from north of 67th Ave.

RESPONSE: Acknowledged.

12 November 1991 Comments from Gary H. Shapiro

1. **COMMENT:** As stated in the scope of work all plan sheets must be initialed by the person responsible for the design, the design checking, drawing the plans, and the checking of plans.

   RESPONSE: See comment 4 from 18 November 1991 comments from RCS above.

2. **COMMENT:** The name of the project "Cactus Road Storm Drain" is to be placed in all title blocks.

   RESPONSE: This has been added.

3. **COMMENT:** The construction center line and or the monument line must be identified with a bearing.

   RESPONSE: Data added.

4. **COMMENT:** Information pertaining to the pipe bends and curves shall be identified on the plans.

   RESPONSE: This has been included in the 95 percent submittal (see comment above).

5. **COMMENT:** A detail of the outlet shall be provided in the plans. This is where the 120 inch diameter pipe ties into the existing 10' x 8' box culvert.

   RESPONSE: This has been included in the 95 percent submittal (see comment above).

6. **COMMENT:** Manhole locations need to be identified on the plans.

   RESPONSE: This has been included in the 95 percent submittal (see comment above).

7. **COMMENT:** Catch basin types and locations have to be identified on the plans.

   RESPONSE: See comment 2 from 18 November 1991 comments from RCS above. This will be submitted in the 95 percent submittal.

8. **COMMENT:** Construction notes need to be incorporated into the plans identifying type and quantities of materials per plan sheet.

   RESPONSE: This has been included in the 95 percent submittal.

9. **COMMENT:** A general construction notes sheet shall be provided with additional information pertaining to this project.

   RESPONSE: This has been included in the 95 percent submittal (see comment above).

10. **COMMENT:** Soil boring logs will be included in the plans.

    RESPONSE: See comment 2 from 7 November 1991 comments from RCS above.

11. **COMMENT:** Invert elevations for all the laterals that enter the main storm drain from (91st Ave., 79th Ave., 75th Ave., 71st Ave., and 67th Ave.) shall be shown on the plans. Do not label these as future storm drains. They are part of the project.

    RESPONSE: Acknowledged.

12. **COMMENT:** The laterals (84" @ 91st Ave., and the one at 67th Ave.) will extend no farther than the curb returns.

    RESPONSE: At 91st Avenue, this project ties into the 84-inch lateral that is already in place and extends beyond the curb return. At 67th Avenue, the extension of the Cactus Road storm drain ends at the eastern curb return. However, unless otherwise directed, the northern lateral will connect to the end of the 66-inch diameter lateral 114 ft north of the monument line.

STA 15+00:

COMMENT: In the cross section show the location of the telephone line on the north side of Cactus Road.

RESPONSE: Added

STA 15+69:

COMMENT: Identify the 1" W.S. line in the profile

RESPONSE: See comment on sta 12+00 to 17+00 from 7 November 1991 comments for RCS.

STA 17+00 - 22+00:

COMMENT: Lengths of pipe segments do not agree with the final HEC 1 analysis (see pipe numbers 3, 4, and 5).

RESPONSE: The HEC1 analysis does not use pipe numbers for routing flow. The HEC1 model was used to determine runoff volumes for basins. This model was built for the best available contour information and all routing lengths are approximate. STORM was then used to generate the HGL based on data from the HEC model. The lengths of pipe used for this program were more accurate and based on stationing of the matching HEC model node locations. STORM was used to size the main trunkline and to provide the worst case HGL at the time of highest concentration. Individual catch basin flows are based on the HEC model and rational method. The basins were sized to allow maximum flow into the main trunkline at the maximum HGL generated in STORM, even though the two times of concentration may not match.

STA 19+00:

COMMENT: In the cross section show the location of the telephone line shown on the profile.

RESPONSE: Acknowledged

STA 25+00:

COMMENT: The right of way in the cross section is different than that shown on the plan view.

RESPONSE: The right-of-way on the north side is 33 ft and on the south side is 55 ft. The cross-section now reflects these rights-of-way.

STA 30+00:

COMMENT: The right of way in the cross section is different than that shown on the plan view.

RESPONSE: See comment on sta 25+00 just above. Southern right-of-way changes to 33 ft at sta 30+45 approximately.

STA 85+00:

COMMENT: In the cross section there is indicated a telephone line south of the monument line. This is not shown on the plan view.

RESPONSE: Removed telephone from cross-section.

STA 115+00:

COMMENT: The right of way in the cross section is different than that shown on the plan view. Same for the 18" SRP line. This cross section could have been chosen at a better location.

RESPONSE: Changed cross-section sta to 113+00.

STA 120+00:

COMMENT: In the cross section there are two telephone lines indicated on the north side of Cactus Road which are not shown on the plan view. The telephone and water line on the south side of Cactus are located differently in the plan view and the cross sectional view.

RESPONSE: Telephone lines were removed. The telephone and water line locations were inadvertently reversed.

STA 125+00:

COMMENT: Same as Sta 120+00

RESPONSE: Telephone lines were removed.

STA 130+00:

COMMENT: Identify the location of the 18" Storm Sewer line that crosses the 84" RCP in the profile.

RESPONSE: The S.S. line is a sanitary sewer line and the crossing in reference was new construction recommended for the realignment of the sewer for the City of Peoria to review. All construction notes have now been added to a site plan and pertinent crossing information shown on the storm drain plan and profile.

STA 130+40:

COMMENT: Identify the location of the 12" Water line in the profile.

RESPONSE: See comment on sta 130+00 above.

STA 140+00:

COMMENT: Identify the location of the Electric line on the north side of Cactus Road in the profile. If this is an over head line indicate so with a warning.

RESPONSE: Parallel overhead electric lines do not require warnings. However, this is a buried line.

STA 165+00:

COMMENT: Same as Sta 140+00

RESPONSE: The electric line on the south side is a small service line, outside of the standard maximum 55-foot right-of-way and inside the residential walled area. However, the line was added.

STA 170+00:

COMMENT: The SRP line in the cross section has a different size than that in the plan view.

RESPONSE: Cross-section note corrected (see comment above).

STA 171+60

COMMENT: Show the location of the Electric line in the profile. If this is an overhead line indicate so with a warning.

RESPONSE: Buried line added to profile (see comment above).

STA 175+00:

COMMENT: Same and Sta. 170+00

RESPONSE: Cross-section note corrected.

SITE PLANS

COMMENT: On the site Plan for 83rd Avenue and Cactus Road do not tie the water line to an abandoned telephone line.

RESPONSE: The water line is not being tied into the abandoned telephone line. The dimension line crosses the abandoned telephone line, not the water line.

RESPONSES TO THE CITY OF PEORIA'S COMMENTS ON THE 60 PERCENT SUBMITTAL FOR THE CACTUS ROAD STORM DRAIN FROM 67TH AVENUE TO THE AGUA FRIA FREEWAY

1. **COMMENT:** Station 12+00 to station 17+00, there is an 8-inch sanitary sewer that extends north out of the manhole at station 16+80 to a tee located approximately 9 feet north of the monument line and then extends east and west and is parallel to the existing 18-inch sanitary sewer. The sewer extends west to approximately station 12+80 to a 90° bend and then extends to the south. The sewer line extends east to approximately station 20+40 to 90° bend and then extends to the north. Actual elevations of the 8-inch sanitary sewer are not known and conflicts may exist between the catch basin (91) and the lateral (90). The sewer will also have to be protected in place during construction of the 120-inch storm drain.

   RESPONSE: It was assumed that "9 feet north of the monument line" was to have right-of-way line. Sewer line was added and additional potholing required.

2. **COMMENT:** Staff is concerned that the 8-inch or the 30-inch sanitary sewers may be damaged during construction of the storm drain and strongly recommend that a note be added to the plans notifying the contractor to use extreme caution.

   RESPONSE: Permanent pipe supports are called for at each gravity flow pipe line crossing and a general note was added regarding caution during construction.

3. **COMMENT:** A note should be added to the plans directing the contractor to regrade the swales on the north and south sides of Cactus Road if disturbed during construction.

   RESPONSE: Note was added.

4. **COMMENT:** Station 27+00 to station 32+00, the 16-inch water line may conflict with catch basin (86).

   RESPONSE: No conflict anticipated. However, guidelines for water line realignments have been added to the general notes and special provisions. Guidelines have also been included in the special provisions regarding water line encasement.

5. **COMMENT:** Station 32+00 to station 37+00, the 16-inch water line may conflict with catch basin (84).

   RESPONSE: See comment no. 4.

6. **COMMENT:** Station 37+00 to station 42+00, the 16-inch water line may conflict with catch basin (82).

   RESPONSE: See comment no. 4.

7. **COMMENT:** Station 42+00 to station 47+00, the 16-inch water line may conflict with catch basin at station 46+75.

   RESPONSE: See comment no. 4.

8. **COMMENT:** Station 47+00 to station 52+00, the 12-inch water line will cross the 120-inch diameter storm drain and must be protected in place during construction.

   RESPONSE: Vertical realignment is required for this water line and coordination with the city for temporary shutoff will be required in the special provisions.

9. **COMMENT:** Station 52+00 to station 57+00, the 12-inch water line may conflict with catch basin (75).

   RESPONSE: See comment no. 4.

10. **COMMENT:** Station 57+00 to station 62+00, the 12-inch water line may conflict with catch basin (73).

    RESPONSE: See comment no. 4.

11. **COMMENT:** Station 62+00 to station 67+00, the 8-inch water line extending north on 85th Avenue will cross the 120-inch storm drain and must be protected in place during construction.

    RESPONSE: A general note to protect all utility crossings in place, unless otherwise called out on the plans has been included.

12. **COMMENT:** Station 67+00 to station 72+00, the 12-foot water line may conflict with the catch basin lateral (67). The 6-inch water line will cross the 120-inch storm drain and must be protected in place during construction.

    RESPONSE: Catch basin 67 - see comment 4. Six inch water line crossing - see comment no. 11.

13. **COMMENT:** Station 72+00 to station 77+00, the 12-inch water line that extends north on 83rd Avenue will cross the 114-inch storm drain and must be protected in place during construction.

RESPONSE: See comment no. 11.

14. **COMMENT:** Station 72+00 to station 77+00, the 4-inch water line will cross the 114-inch storm drain and must be protected in place or a section of pipe can be removed during construction and then replaced. All traffic signal facilities damaged during construction must be replaced to City of Peoria standards.

RESPONSE: Four inch water line crossing - see comment no. 8. A general note has been added that traffic signal facilities must be replaced in kind at each signaled intersection.

15. **COMMENT:** Station 77+00 to station 82+00, the 8-inch water line will cross the 114-inch storm drain and must be protected in place or a section of pipe can be removed during construction and then replaced. The 8-inch and 12-inch water lines may conflict with catch basin lateral (60).

RESPONSE: Eight inch water line - see comment no. 11. Catch basin 60 - see comment no. 4. Vertical realignment is required for the 12-inch water line.

16. **COMMENT:** Station 82+00 to station 87+00, the 12-inch water line may conflict with catch basin (58).

RESPONSE: See comment no. 4.

17. **COMMENT:** Station 87+00 to station 92+00, the 8-inch water line may conflict with catch basin (54). The 8-inch water line that extends north on 81st Avenue must be protected in place during construction.

RESPONSE: Catch basin 54 - realignment of the 8-inch water line is required. In addition, the connection between the 12-inch and 8-inch water lines must be readjusted.

18. **COMMENT:** Station 92+00 to station 97+00, the 8-inch and 12-inch water lines may conflict with catch basin laterals (52) and (51) respectively. The 8-inch water line extending south on 80th Avenue must be protected in place during construction.

RESPONSE: Catch basins 52 and 51 - see comment no. 4. Eight inch water line - see comment no. 11.

19. **COMMENT:** Station 97+00 to station 102+00, the 8-inch and 12-inch water lines may conflict with catch basin laterals (49) and (50) respectively. The fire hydrant at the northwest corner of 79th Avenue and Cactus Road may conflict with the catch basin at lateral (49) and may have to be relocated. The 12-inch water line extending north on 79th Avenue will cross the 108-inch storm drain and must be protected in place during construction. All traffic signal facilities damaged during construction must be replaced to City of Peoria standards.

    RESPONSE: Catch basin 49 and 50 - see comment no. 4. Fire hydrant - should be missed by catch basin as now designed. Twelve inch water line - see comment no. 11. Traffic signal facilities - see comment no. 14.

20. **COMMENT:** Station 102+00 to station 107+00, the 8-inch water line may conflict with catch basin (45).

    RESPONSE: Vertical realignment is required.

21. **COMMENT:** Station 107+00 to station 112+00, the 8-inch water line may conflict with catch basin (43).

    RESPONSE: Vertical realignment is required.

22. **COMMENT:** Station 112+00 to station 117+00, the 8-inch water line will cross the 108-inch storm drain and must be protected in place during construction.

    RESPONSE: See comment no. 11.

23. **COMMENT:** Station 117+00 to station 122+00, the 8-inch water line may conflict with catch basin (40).

    RESPONSE: See comment no. 4.

24. **COMMENT:** Station 122+00 to station 127+00, the 8-inch water line may conflict with catch basin (38). The 6-inch water line will cross the 108-inch storm drain and must be protected during construction.

    RESPONSE: Catch basin 38 - see comment no. 4. Six inch water line - see comment no. 11.

25. **COMMENT:** Station 122+00 to station 127+00, all traffic signal facilities damaged during construction must be replaced to City of Peoria Standards.

    RESPONSE: See comment no. 14.

26. **COMMENT:** Sta 127+00 to Sta 132+00, the 8-inch and 12-inch water lines that extend north on 75th Avenue will cross the 84-inch storm drain and must be protected in place during construction. The 12-inch water lines on Cactus Road and 75th Avenue may conflict with catch basin laterals (34) and (35) respectively. The 12-inch water line may conflict with catch basin lateral (32).

    RESPONSE: Eight inch and 12-inch waterline - see comment no. 11. Catch basin 34 - see comment no. 4. Catch basin 35 - see comment no. 4. Eight inch water line requires vertical realignment. Catch basin 38 and 32 - see comment no. 4.

27. **COMMENT:** Sta 127+00 to Sta 132+00, all traffic signal facilities damaged during construction must be replaced to City of Peoria standards.

    RESPONSE: See comment no. 14.

28. **COMMENT:** Sta 132+00 to Sta 137+00, the 8-inch water line and the 6-inch sanitary sewer will cross the 84-inch storm drain and must be protected in place. The 12-inch water line may conflict with catch basin lateral (30).

    RESPONSE: Eight inch and 6-inch water lines - see comment no. 11. Catch basin 30 - see comment no. 4.

29. **COMMENT:** Station 137+00 to station 142+00, the 6-inch water line that extends north on 73rd Avenue will cross the 84-inch storm drain and must be protected in place. The fire hydrant located at the north east corner of 73rd Avenue and Cactus Road may conflict with the catch basin and lateral (27) and may have to be relocated. The 12-inch sanitary sewer may conflict with the 84-inch storm drain and must be protected in place.

    RESPONSE: Six inch water line - see comment no. 11. Fire hydrant - a construction note has been added to relocate the fire hydrant. Twelve inch sanitary sewer - permanent pipe support is required.

30. **COMMENT:** Station 142+00 to station 147+00, the 12-inch water line may conflict with catch basin laterals (23) and (21). The 8-inch water line that extends north on 72nd Drive will cross the 84-inch storm drain and must be protected in place during construction.

    RESPONSE: Catch basin 21 and 23 - see comment no. 4. Eight inch water line - see comment no. 11.

31. **COMMENT:** Station 147+00 to station 152+00, the 12-inch water line may conflict with catch basin lateral (19). The 6-inch water line that extends north on 71st Drive will cross the 84-inch storm drain and must be protected in place during construction. Catch basin 19 - see comment no. 4. Six inch water line - see comment no. 11.

RESPONSE: Catch basin 19: See comment no. 4. 6-Inch water line: See comment no. 11.

32. **COMMENT:** Station 152+00 to station 157+00, the 12-inch water line may conflict with catch basin laterals (17) and (13). The 10-inch water line on 71st Avenue may conflict with catch basin lateral (15). The 12-inch sanitary sewer will cross the 36-inch storm drain and must be protected in-place during construction. The 12-inch water line that extends north on 71st Avenue will cross the 84-inch storm drain and must be protected in place during construction. All traffic signal facilities damaged during construction must be replaced to city of Peoria standards.

RESPONSE: Catch basins 13, 15, and 17 - see comment no. 4. Twelve inch sanitary sewer - the lateral storm drain is a 30-inch diameter pipe. Only a permanent pipe support is required. Twelve inch waterline - see comment no. 11. Traffic signal facilities - see comment no. 14.

33. **COMMENT:** Station 157+00 to station 162+00, the 12-inch sanitary sewer and the 12-inch water line may conflict with catch basin laterals (10) and (11). The 6-inch water line will cross the 78-inch storm drain and must be protected in place during construction.

RESPONSE: Catch basin 10 - a permanent pipe support is required. Catch basin 11 - see comment no. 4. Six inch water line - see comment no. 11.

34. **COMMENT:** Station 162+00 to station 167+00, the 12-inch sanitary sewer line and 12-inch water line may conflict with catch basins (8) and (9).

RESPONSE: Catch basin 8 - see comment no. 33. Catch basin 9 - see comment no. 4.

35. **COMMENT:** Station 167+00 to station 172+00, the 8-inch sanitary sewer line and 12-inch water line may conflict with catch basins (6) and (7).

RESPONSE: Catch basin 33 - see comment no. 7. Catch basin 7 - see comment no. 4.

36. **COMMENT:** Station 172+00 to station 177+00, the 8-inch sanitary sewer line and 12-inch water line may conflict with catch basins (4) and (5).

RESPONSE: Catch basin 4 - see comment no. 33. Catch basin 5 - see comment no. 4.

37. **COMMENT:** Station 177+00 to station 182+00, the 12-inch water line may conflict with catch basins (3). The 12-inch water line that extends north on 67th Avenue will cross the 78-inch storm drain and must be protected in place during construction. All traffic signal facilities damaged during construction must be replaced to City of Glendale standards.

RESPONSE: Catch basin 3 - see comment no. 4. Twelve inch water line - see comment no. 11. Traffic signal facilities - a note has been added requiring in-kind replacement.

RESPONSES TO THE CITY OF GLENDALE'S COMMENTS ON THE 65 PERCENT SUBMITTAL FOR THE CACTUS ROAD STORM DRAIN FROM 67TH AVENUE TO THE AGUA FRIA FREEWAY

1. **COMMENT:** The overall cost of the project will be less if alternate materials ar used. CLCMP could be a viable bid alternate if a PCC slurry around the pipe is used to provide the additional strength and possibly extend the life of the pipe.

   RESPONSE: The biggest structural concern for CLCMP is the backfill operation. There is no question that PCC slurry would eliminate the concern about proper mechanical compaction to keep the pipe in round and support the live and dead loads. It is also agreed that PCC slurry backfill may add to the life of the conduit by reducing the concern about coatings and cracks caused by improper backfill. However, there are no tests or installations that have been conducted that prove this. CLCMP is a relative newcomer to the storm drain world and therefore requires client agreement along with an engineering recommendation prior to use as an alternate.

2. **COMMENT:** The inlet calculations add 0.2 inches per hour to the intensity. Why?

   RESPONSE: The rational equation provided in the Phoenix Storm Drain Design Manual (Revised: July 1987) calls for subtracting the factor 0.2. The equation and inlet calculations have been corrected.

3. **COMMENT:** The areas for the inlet calculations are for 30-foot width and should be the ultimate width of the right-of-way which will be 55 ft minimum.

   RESPONSE: The 30-foot width was changed to 55 ft. However, all road right-of-way flow was accounted for in the flows generated by the HEC model and collected in catch basins located at the intersections. Nor was the size of any of the intermediate catch basins changed due to increasing the width to 55 ft.

4. **COMMENT:** Several of the streets include two inlets with individual connector pipes. These should be combined into one lateral with short connector pipes. Drainage basins 1/2-mile deep may need laterals extended in the streets to pick up a portion of the flow before it reaches the major intersection at Cactus Road.

   RESPONSE: In response to the first part of the comment, we have re-evaluated the layout of connector pipes for 72nd, 73rd, 81st, 83rd, 85th and 87th Avenues. It has been determined that it will probably be cost effective to connect the eastern side-street catch basins to the western side-street catch basins and then connect to the storm drain. It will also be about $2,000 to $3,000 per intersection less to install a 30-inch diameter lateral to two short 24-inch diameter connector pipes for 72nd, 81st and 87th Avenues.

It should be noted that we have recommended a future lateral for 81st Avenue because of the excessive flows arriving on Cactus Road and this intersection will always flood even after the Sweetwater Interceptor and the laterals are all installed. In response to the second half of the comment, the catch basins at 71st, 75th, 79th and 91st Avenue shave all been designed to catch flows generated in the 1/2 mile north of Cactus Road. It was assumed that the remaining flow generated in the 1/2 mile to 1 mile north of Cactus Road will not be collected until the laterals are installed and flooding along Cactus Road will occur. Catch basins at all the remaining intersections and drainage basin outlets have bene designed for the flow generated from the entire 1 mile north of Cactus Road because laterals have not been planned for these side-streets. Finally, laterals would greatly help collect the water before it reaches Cactus Road but they are not part of the current scope of work.

5. **COMMENT:** Why is there a rise in the HGL at station 60+75 with no change in pipe size or quantity of flow?

   RESPONSE: The hydraulic gradeline was generated using the HEC model flow rates and stations. On sheet C-1 in the design data calculations you will find that the quantity of flow changes at station 60+66. This is the station used on the plan and profile sheets although the catch basins are located slightly upstream and are the actual physical locations for the change in flow. The HGL shown on these plans is an approximation of a particular flow condition and is the best approximation of the highest flow conditions anticipated under the design assumptions of the HEC model. Normally the HGL would not be shown because it would be given in the Drainage Master Plan and base don a routing model for approximate inflow locations. In this case, the HGL was calculated by the Engineer and not provided by the client. If showing the HGL and EGL in this manner is confusing, it could be removed and the reviewing agencies could use sheet C-1 to check hydraulic calculations. There is not reason to include it on the construction plans for the contractor.

6. **COMMENT:** Inlets constructed opposite each other should have the connection to the main line offset to allow pre-manufactured tees or install a manhole.

   RESPONSE: Ameron has already acknowledged that prefabricated crosses, as shown, are not a problem. The other major valley RCP supplier, Hydroconduit, will also be contacted to determine whether they can prefabricate these crosses or the catch basins on the south side can be offset as necessary for prefabricated pipe construction.

7. **COMMENT:** The 66-inch drain in 79th Avenue is not future and should be constructed with a manhole and stubout at the end.

RESPONSE: None of the lateral collectors (91st, 79th, 75th and 71st Avenues) as shown on the plan and profiles are future. Only the sections north of the stubouts should be labeled future. The plan and profiles have been changed. Manholes are also going to be included in the 95 percent submittal.

8. **COMMENT:** The connector pipe for inlet 37 is too close to the sanitary sewer manhole and should be constructed with the low end of the inlet at the east end of the inlet to provide clearance.

RESPONSE: Final catch basin locations reflect utility locations and this catch basin has been adjusted to accommodate the existing sewer manhole.

9. **COMMENT:** The 90° bends in the connector pipes in 87th and 72nd Avenues should be eliminated. Laterals in these streets as discussed above would eliminate this problem.

RESPONSE: See comment and response no. 4.

10. **COMMENT:** There is an existing inlet at the east end of the northeast return of 67th Avenue and Cactus Road. This inlet was designed to connect to the storm drain in Cactus Road. A copy of the as-built for this inlet is enclosed and will also be sent to SFC Engineering Company.

RESPONSE: The catch basin connection has been included.

RESPONSES TO COMMENTS FROM
FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
ON THE CACTUS ROAD STORM DRAIN
95% SUBMITTAL

COMMENTS FROM R. W. SHOBE, 5 August 1992:

The 95 percent submittal for the Cactus Road Storm Drain has been reviewed and the following items are to be included and/or corrected for the final submittal:

GENERAL:

Throughout the plans, in the Construction Notes you make reference to Salt River Project Plan for details. Include these details in the plans if they are pertinent to the storm drain project.

Response: Originally, it was thought the SRP plans would be included. It is now thought the work will be done separately. In any event the note was changed and may change again at the final design.

It appears as though you went over board with encasements and pipe supports when crossing with a connector pipe. The 24" clearance is fine for a sewer line but we are installing a storm drain. It might be more practical to just support sewer lines that the connector goes underneath, to support water lines where joints have been exposed or leave it to the discretion of the engineer. Water and sewer line that are below the connector pipe should remain undisturbed unless it conflicts with the construction of the storm drain or connector pipes. Usually it is noted as "protect in place".

Response: All gravity lines that the storm drain goes under require a permanent pipe support per MAG. Those gravity lines that the storm drain goes over the top of within 2 ft call for a pipe support because the contractor often exposes these to verify their location. If they are close to the storm drain and not exposed and proper support is not provided they may collapse. It is better to expose them and support them if we anticipate they are close. All water lines that are within 6 ft of a parallel sewer line or less than 2 ft above a sewer line are required to have protection. Protection being defined as mechanical joints, slip joints with restraint or concrete encasement per the Arizona Administrative Code R9-8-326. We reviewed all pipe supports and encasements to see if we were over cautious and revised pipe supports and encasements as required.

The paving of Cactus Road with drive way improvements seems a bit excessive. If Peoria wants this to be part of this to be part of this project it will have to be a separate pay item that only the City of Peoria is responsible for.

Response: It is not certain what is meant by drive way improvements. No entrances or roads have been improved other than laying a new layer of gravel on the dirt road, which is somewhat graveled now. The road from 91st to 83rd avenues is being replaced because it will almost completely be removed by excavation for the pipeline.

There should be a generic phrase stating that the top of the manhole rims are to match either the new or existing pavement.

Response: Done.

Identify all existing and proposed R/W.

Response All existing right-of-way is shown. Additional proposed right-of-way is not required.

All the catch basins shall be placed such that they can be readily incorporated into future paving jobs without major modifications. For example, it appears that the catch basin on sheet 4 will end up behind the side walk in the future.

Response: Catch Basins west of 91st Avenue have been relocated and, to the extent possible, we have tried to anticipate future location requirements.

It is suggested that the ditch on sheets 4, 5, and 6 be eliminated and to use swale and grade to drain toward the catch basin. This will eliminate the need for culverts at all the driveway entrances and raising the grate elevations 3' +/- in the future when paving occurs.

Response: This area of the project has been subject to excessive flooding and there is a major concern that flooding be eliminated when the storm drain is installed.

The inverts on the plan and profile sheets do not match with the inverts on the connector pipe profiles.

Response: Corrected.

PLANS:

Sheet 01. On the cover sheet provide a place for the approval signatures from both Glendale and Peoria.

Response: Done.

Delete Sagramoso's name since he is no longer with the District.
The name of the Chief Engineer and General Manager will be added at the later date.

Response: Done.

Sheet 02. Under the GENERAL NOTES #8 provide the actual telephone number.

Response: Done.

Sheet 03. Check on the following quantities from the plan sheets and the connector pipe profiles there seems to be some discrepancies:

01. Sheet 17, 30, and 33.

Response: Done.

02. Sheet 17, 30, and 33.

Response: Done.

04. Sheet 22, and 28.

Response: Done.

05. Sheet 6.

Response: Done.

06. Sheet 12.

Response: Done.

09. Sheet 38.

Response: Done.

13. Sheet 22.

Response: Done.

14. Sheet 22.

Response: Done.

16. Sheet 8, 9, 10, and 11.

Response: Done.

18. Sheet 9, 11, and 17.

Response: Done.

25. Sheet 33.

Response: Done.

26. Sheet 30, and 33.

Response: Done.

28. Sheet 33.

Response: Done.

29. Sheet 30, and 33.

Response: Done.

30. Sheet 6.

Response: Done.

31. Sheet 6.

Response: Done.

40. Sheet 25.

Response: Done.