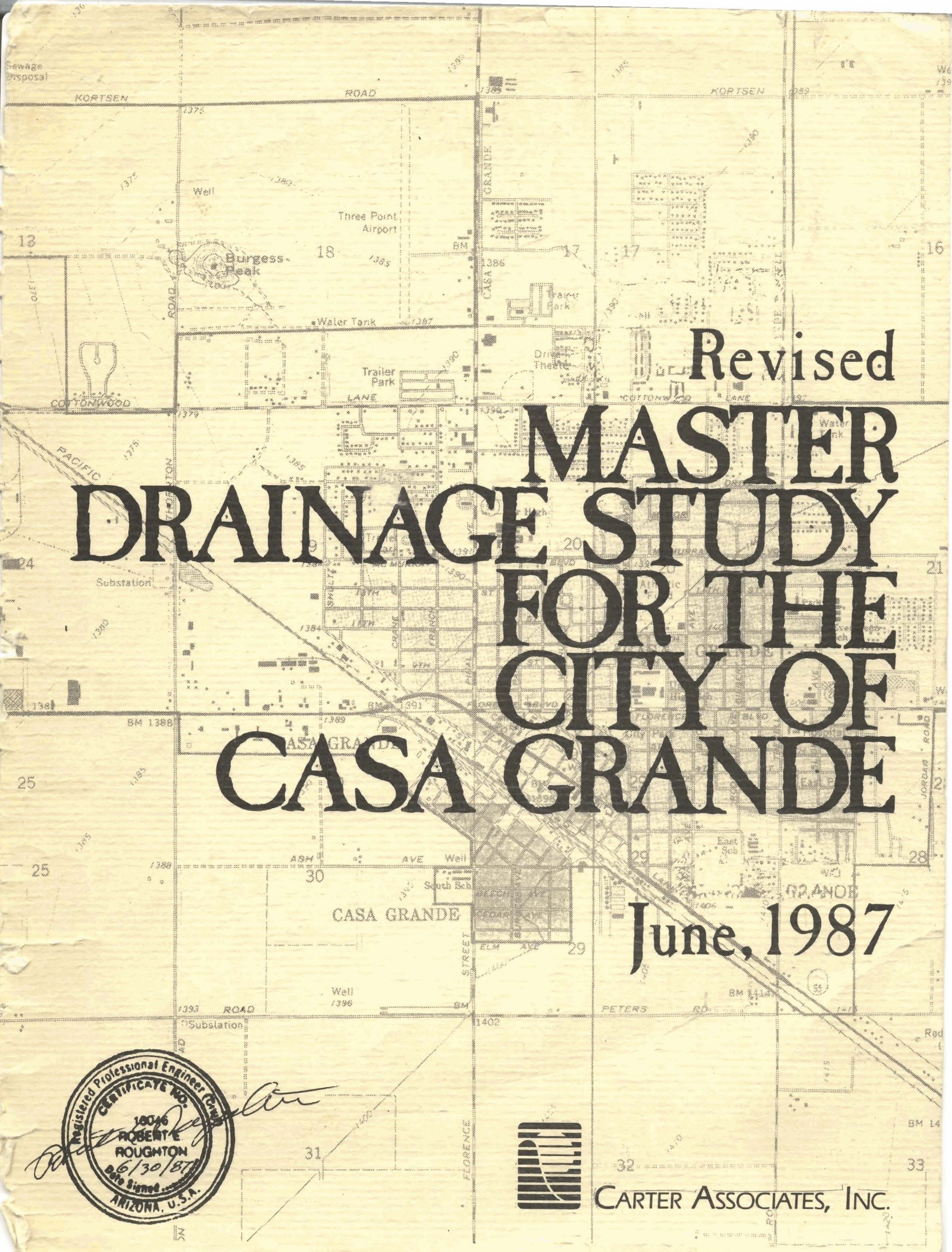

Revised

MASTER DRAINAGE STUDY FOR THE CITY OF CASA GRANDE

June, 1987

Registered Professional Engineer (Civil)
Certificate No.
10046
ROBERT E.
ROUGHTON
6/30/87
Date Signed
ARIZONA, U.S.A.

CARTER ASSOCIATES, INC.

PHASE I drainage improvement recommendations include obtaining all major drainage floodway easements and providing drainage channels and structures for all the developed areas north and south of the North Branch of the Santa Cruz Wash. See "Drainage Easements, Channels and Structure Summary Map", in the map pocket of this report along with the cost estimate breakdowns in the report. The total cost estimate for Phase I improvements is $12,592,004.

PHASE II drainage improvement recommendations would be to provide major drainage structures at points identified on the "Drainage Easements, Channels and Structure Summary Map". These areas are currently undeveloped, some falling outside of the current city limits. The total cost estimate for Phase II improvements is $399,800.

PHASE III drainage recommendations consist of street improvements, minor drainage channeling and a retention basis for the area identified as the Southside neighborhood. This area is defined on Plate 6 of this report. The total cost estimate for Phase III improvements is $684.965. The retention basin design has two alternate cost estimate items; drywells at a cost of $24,000 or pump cost at $23,838.

The total cost of all three phases is $13,015,804 plus the cost of one of the Phase III alternates say $24,000. Rounding these figures to an estimated Grand Total of $13,040,000.

INTRODUCTION

The purpose of this report is to evaluate the potential 100 year event (Q_{100}) storm water runoff in the City of Casa Grande and the contributing drainage areas outside of the city limits. Flooding problem areas were determined from site visits, including one during a rainstorm, and by discussions with city staff and local residents. Recommendations to control flooding are intended to provide a maximum of relief, yet not exceed the financial capabilities of the city.

This report first evaluates the runoff to the North Branch of the Santa Cruz Wash and identifies composited peak runoffs at six concentration points shown on the Master Drainage Map (see Map Pocket of this report). Recommendations for sizing of drainage channels, structures, and drainage easements are made after existing runoff conditions for the six concentration points are discussed.

The report then evaluates Casa Grande's urbanized areas north of the Southern Pacific Railroad tracks up to the North Branch of the Santa Cruz Wash. Also covered are the rural and semi-developed areas bordered by Peart Road and Cox Road from west to east and State Route 84 and 93 from the south up to the North Branch of the Santa Cruz Wash. Recommendations are made in this section after each existing condition is described in the narrative.

The third section of this report deals with the urbanized areas south of the Southern Pacific Railroad and is identified as the Southside Neighborhood. Existing conditions are first covered, then recommendations are made for each of the problems identified.

The last section of the narrative is a suggested Drainage Ordinance and a summary of all recommendations made in this report along with cost estimates for each recommendation.

All calculation sheets, tables, and maps are included in the appendix of this report.

METHODOLOGY

The Soil Conservation Service (SCS) methodology was used to compute the peak discharge for drainage areas north of the North Branch of the Santa Cruz Wash, and for farmlands and undeveloped desert land falling east of Peart Road to Overfield Road. The Rational Method was used to compute the peak discharge for the urban, rural, and semi-developed areas in and around Casa Grande.

Formulas, tables, and other required data were based on "Hydrology Design for Highway Drainage in Arizona" by the Arizona Highway Department, Bridge Division, dated December 1, 1968 and revised in 1975, the ADOT report titled: "Hydrologic and Hydraulic Training Session", dated October 16-18, 1972, revised December, 1973, and "Hydraulic Engineering Circular No. 5" by the U. S. Department of Commerce, Bureau Public Roads. Drainage areas are delineated on the Master Drainage Map, which is a composite of U. S. Geological Survey Quadrangle Maps titled: "Casa Grande West" and "Casa Grande East". The drainage areas were also verified by site visits and discussions with city staff and local residents.

EXISTING RUNOFF CONDITIONS TO THE NORTH BRANCH OF THE SANTA CRUZ WASH

Refer to the Master Drainage Map (in the Map Pocket of the Report) for drainage areas, flow patterns, and peak runoff quantities described in this narrative.

The existing North Branch of the Santa Cruz Wash, hereinafter referred to as the North Branch, intercepts runoff from the following major areas: runoff from the top of the Sacaton Mountains, defined as Drainage Areas A and B, flows south to the North Branch; and runoff from east of I-10, bordered approximately by the Casa Grande Canal to the south and Overland Road to the east, flows in a generalized northwest direction to the North Branch having to cross under I-10 at various existing outlet points (identified on the Master Drainage Map).

This runoff from east of I-10 eventually combines with runoff from the Sacaton Mountains (Drainage Areas A and B) at a concentration point in the existing North Branch identified as Concentration Point 1. The total composite Q_{100} peak runoff equals 2,000 cfs at this point. As this runoff continues west down the North Branch, additional runoff is intercepted from the north and south sides of the wash. Drainage Areas C and D from the north combine at Concentration Point 2 with the drainage areas from the south side bordered between I-10 and Peart Road, east to west, and by State Route 84 and 93 to the south. The total composite Q_{100} peak runoff equals 3,500 cfs at Concentration Point 2.

The runoff passing concentration Point 2 is conveyed by a drainage channel to Trekell Road and passes through an existing 5-8'x4' concrete box culvert. The current alignment of the North Branch of the Santa Cruz Wash, as shown on the Drainage Map, is to be bypassed. A new channel has been located by city forces approximately 1,100 feet to the south. This new alignment closely matches the historic confluences of the North Branch. Minimum channel geometrics and structure size under Trekell Road are covered in the "Recommendations" section of this report.

The new channel location at Trekell Road is identified as Concentration Point 3. Runoff from Concentration Point 2 will be channeled to the new alignment. Minor runoff areas E-1, E-2 and EA-7 fall between Concentration Points 2 and 3 flow down the North Branch before the composite peak runoff arrives; therefore, the total composited Q_{100} peak runoff equals 3,500 cfs at Concentration Point 3. Continuing west and downstream from Concentration Point 3, Drainage Areas F1, F2, and H contribute runoff from the north to the North Branch (see Master Drainage Map). Runoff from the upper city portion of Casa Grande contributes runoff from the south to the North Branch. A more detailed description of the flow patterns from the upper city portion falling between Peart Road and Pinal Avenue, from the east to the west, is covered later on in this report.

The total composited Q_{100} peak runoff for Concentration Point 4, located at the inlet of the existing bridge under Pinal Avenue, equals 4,400 cfs. Calculations show the existing bridge to have an effective capacity of 3,090 cfs. From Concentration Point 4, drainage is conveyed west in the North Branch approximately 10,400 feet to Concentration Point 5. Between Concentration Points 4 and 5, the North Branch intercepts runoff from Drainage Areas 1G, 2G, J, K, L, S-1, S-2 and S-3. The total composited Q_{100} peak runoff from Concentration Point 5 equals 9,800 cfs.

From Concentration Point 5, drainage is conveyed to the southwest for approximately 7,600 feet to Concentration Point 6. Between Concentration Points 5 and 6, the North Branch intercepts runoff from the mid-city portion of Casa Grande and Drainage Areas N and P. The total composited Q_{100} peak runoff for Concentration Point 6 equals 11,500 cfs. Runoff at Concentration Point 6 passes under the Southern Pacific Railroad in a northwesterly direction to eventually combine with the Santa Cruz Wash. Runoff calculations along with the composited peak hydrographs can be found in the appendix section of this report.

RECOMMENDATIONS

Minimum wash geometrics and easement widths required for each concentration point identified along the North Branch have been calculated and are shown on Plates 1 and 2 in the appendix. Only channel improvements are recommended between Concentration Points 1 and 2 which fall outside the city limits. From Concentration Point 2 to 3, it is recommended that a 250-foot wide drainage easement be obtained to convey the runoff to Concentration Point 3 along the realignment of the North Branch. The North Branch will be realigned to match closely its historic confluence. This realignment will require a new 15-10'x4' concrete box culvert under Trekell Road at Concentration Point 3.

It is recommended that the existing 5-8'x4' concrete box culvert at Trekell Road and a segment of the old existing channel alignment of the North Branch between Concentration Points 2 and 3 be removed to allow for future development. Drainage channels would be extended from the north where they intersect the old alignment to the recommended new alignment of the North Branch.

To drain the area falling between the old and recommended new North Branch alignment between Concentration Points 2 and 3, it is recommended a drainage channel and easement along the east side of Trekell Road be allowed for the flow south across Bisnaga Street and Yucca Street to the new alignment. The existing dip section in Trekell Road between Bisnaga and Yucca Streets should be eliminated by raising the grade of Trekell Road at this location. This would help keep runoff from an existing subdivision from flowing west across Trekell Road and divert it by channel to the new alignment of the North Branch directly south of the subdivision.

Runoff from drainage areas E-1 and E-2 drain south in existing channels to the old North Branch alignment. It is recommended new channels and easements be acquired. The easements with channels would be south of Rodeo Road and Colorado Street to the new alignment of the North Branch and south of Rodeo Road and Pueblo Drive to the new alignment of the North Branch (see Drainage Map 10). It is recommended that 3-33" C.M.P.'s be located under Rodeo Road east of Colorado Street.

On the west side of Trekell Road, between Rodeo Road and the old North Branch, the existing drainage channel and dike should be retained and continued south down to the new alignment of the North Branch. It is recommended that the new channel not flow directly into the wash at a right angle, but be diverted by dike to flow into the North Branch at approximately a 45 degree skew and outlet downstream of the existing trailer park on the south bank of the realigned North Branch.

Existing washes north and south of Rodeo Road, located between Trekell Road and Pinal Avenue, would be required to have drainage easements with minimum channel geometrics recommended on the "Easement, Channels and Structure Summary Map" (see Map Pocket).

It is recommended that the drainage area north of Val Vista Boulevard, identified on the Master Drainage Map as 1G, be diverted from flowing directly south to the North Branch. The Q_{100} peak runoff of 1,540 cfs from Drainage Area 1G would be intercepted at Val Vista Boulevard and conveyed west by a new drainage channel approximately 5,000 feet in length requiring a 60-foot wide drainage easement. This diverted runoff flows to an existing drainage channel and continues west combining with runoff from Drainage Area 2G to an existing 5-10'x7' concrete box culvert under State Route 387 (Pinal Avenue). Calculations show the structure to be of adequate capacity to handle the combined Q_{100} runoff from Drainage Areas 1G and 2G. Calculations for channel sizing and existing structure capacity are in the appendix section of this report. It is anticipated that Trekell Road will be extended north across Val Vista Boulevard across the new drainage channel. When development of the area warrants it a new 5-10'x5'x60'$\pm$ concrete box culvert should be located under Trekell Road at the new drainage channel alignment.

The proposed routing of drainage area 1G will convey a significant amount of runoff away from the developing areas directly south of Rodeo Road and future development south of Val Vista Boulevard. The runoff continues from the existing structure under State Route 387, south through an existing drainage canal to the North Branch of the Santa Cruz Wash. The canal outlets at Concentration Point 5, a wider downstream section in the North Branch, and away from the heavier developed areas east of State Route 387 (Pinal Avenue).

CASA GRANDE
DRAINAGE STUDY
CASA GRANDE, ARIZONA

CARTER ASSOCIATES, INC.
5080 North 40th Street, Suite 300
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Revised June, 1987

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EXECUTIVE SUMMARY

This summary is to provide an overview of the key points covered in the Casa Grande Drainage Study. Major drainage areas are defined on the "Master Drainage Map" (in the map pocket of this report). Drainage easements, channels and structure locations and sizes are identified on the "Drainage Easements, Channels and Structure Summary Map" (also in the map pocket of this report). Drainage channels and structures are sized to handle a 100 year storm event but due to extremely flat grades street flooding will still occur. Drainage channels have been located to provide relief from major street flooding and ponding.

A suggested drainage ordinance has been recommended in this report for the City of Casa Grande. This ordinance would require future developing areas within the city limits to maintain total on-site detention. On-site runoff would not be allowed to combine with any peak runoff occurring. It is also recommended that a drainage ordinance agreement be submitted to Pinal County officials requiring the areas falling outside of Casa Grande's city limits but contributing runoff to the North Branch of the Santa Cruz Wash develop and enforce an on-site detention policy so as not to increase or adversely divert the runoff by development of the land outside of the city limits. If both the city and county develop and enforce their drainage ordinances, future developments will detain the Q_{100} design runoff and decrease the peak runoffs to the North Branch.

The overall effect of the drainage ordinance would cause existing runoffs from each new developed area to be intercepted and detained during a rainstorm. This detention would take away from the existing total runoff amounts downstream of the developments and reduce the amount of runoff in the streets, drainage channels and structures. If a drainage ordinance is not developed and enforced by the city, future developments would cause increased site runoff and would overcapacitate the proposed drainage channels and structures recommended in this report.

Recommendations to control flooding are intented to provide a maximum of relief yet not exceed the financial capabilities of the city. The cost estimates in this report break the total drainage improvement cost down to three recommended phases of implementation.

The total composited Q_{100} peak runoff flowing in the North Branch between Concentration Points 3 and 4 equals 4,400 cfs. This volume requires a minimum drainage easement 250-foot wide at Trekell Road, for a 4-foot deep channel and 250 feet wide at Concentration Point 4 (Pinal Avenue). The existing bridge structure's effective capacity was figured to be only 3,090 cfs, a difference of 1,310 cfs.

It is recommended that, as undeveloped areas contributing runoff to the North Branch become developed, the city require by drainage ordinance those areas within city limits to maintain total on-site detention which will not be allowed to combine with any peak runoff occurring. It is also recommended that a drainage ordinance agreement be submitted to Pinal County officials requiring the areas falling outside of Casa Grande's city limits but contributing runoff to the North Branch develop and enforce an on-site detention policy so as not to increase or adversely divert the runoff by development of the land outside of the city limits. If both the city and county develop and enforce their drainage ordinances, future developments will detain the Q_{100} design runoff and decrease the peak runoffs to the North Branch. A proposed drainage ordinance is presented later on in the report.

The time involved for the surrounding land to become developed under drainage ordinance criteria and reduce the composited Q_{100} peak runoff to the existing bridge at concentration Point 4 by a minimum of 1,310 cfs would have to be evaluated by the City of Casa Grande officials. If the city chooses this method, the North Branch channel between Concentration Points 3 and 4 would require a minimum drainage easement of 250 feet for a 4-foot deep channel with an additional one foot for freeboard.

If the city chooses to have a channel and bridge structure capable of handling the current total composited Q_{100} peak runoff of 4,400 cfs, the following criteria must be met. First, a drainage easement of 220-foot width at Concentration Point 3 (Trekell Road) tapering uniformly out to a 250-foot width at Concentration Point 4 (Pinal Avenue) be acquired. Second, it is recommended the two end barrels of the existing bridge at Pinal Avenue be cleaned out to increase the effective opening from 568 square feet to 700 square feet. This will increase the existing bridge's capacity from 3,090 cfs to 4,203 cfs. However, this capacity is still insufficient to pass the 4,400 cfs from the 100-year event and may cause slight overtopping of the structure. The final improvement at this location would be to protect the inlet side of the bridge with riprap bank protection transitioning the 250-foot wide channel down to the 140 feet of effective bridge width.

The section of the North Branch between Concentration Points 4 and 5 requires a large amount of clearing and grubbing of existing vegetation which currently restricts the flow. The North Branch alignment parallels the golf course and is just north of the city limits between Concentration Points 4 and 5. It is recommended that a drainage easement 400 feet wide be obtained for 6,000 feet, then widened uniformly out to 700 feet as the flow passes Concentration Point 5. The composited Q_{100} peak runoff for Concentration Point 5 equals 9,800 cfs.

Runoff from drainage areas S-1, S-2 and S-3 flows north to the North Branch between Concentration Points 4 and 5. A dip section exists across Kortsen Road approximately 2100 feet west of Pinal Avenue. It is recommended that as this area between the golf course and Three-Point Airport developes a 2-10'x3'x60$\pm$ concrete box culvert under Kortsen Road at the dip section be constructed along with a drainage easement and channel down to the North Branch (see Drainage Map 9).

The last section of the North Branch to be analyzed in this report falls between Concentration Points 5 and 6. No easement or revised channel geometrics are recommended for this section. Flow from Concentration Point 5 would be allowed to combine with the existing channel flow which widens out to approximately 1,500 feet. The total composited Q_{100} peak runoff for Concentration Point 6 equals 11,500 cfs.

EXISTING UPPER CITY RUNOFF TO THE NORTH BRANCH WITH RECOMMENDATIONS

Starting with Drainage Area U-8, runoff begins to pond in Pueblo Drive beside the existing K-Mart store. The ponding spreads to the vacant field behind K-Mart when flow tops the existing curb. This area should be considered as a possible detention site if the property is available. The runoff is then conveyed north down Pueblo Drive to the intersection with McMurray Boulevard where additional ponding occurs. The alley at this intersection has a depressed driveway which acts as a barrier to the natural flow pattern causing ponding to back up Pueblo Drive. The depressed driveway to the alley needs to be lowered or totally removed, closed to traffic as it is now, and maintained as a drainageway for storm runoff. The runoff flows through the alleyway along Pueblo Drive to its junction with Manor Drive. It is then conveyed north by an existing V-ditch. Ponding occurs in the existing V-ditch when flow reaches Cottonwood Lane. Ponding in this area also occurs along Cottonwood Lane, on both shoulders of the roadway east to Peart Road and west to the intersection with Trekell Road. It is recommended that the existing V-ditch be widened to a 60-foot channel and the existing grades on both sides of Cottonwood Lane be improved to allow runoff to flow down to Trekell Road. It is recommended that either a roadway ford or a drainage structure be located at a point where the new drainage channel meets Cottonwood Lane (see Drainage Map 1) to convey runoff to north side of Cottonwood Lane then west in an improved drainage channel to an existing ditch running north along the east side of Trekell Road.

Runoff from Drainage Area U-9 is conveyed by an existing V-ditch down to Cottonwood Lane where it ponds and eventually flows down to Trekell Road. It is recommended that the existing V-ditch be widened as shown on Drainage Map 1 and a 60-foot wide drainage easement be obtained for the new channel. A roadway ford or drainage structure is also recommended where the drainage channel intersects Cottonwood Lane. Channel and structure sizes are shown on Drainage Map 1.

The existing drainage ditch running north along the east side of Trekell Road combines the runoff from Drainage Areas U-7, U-8, and U-9. This runoff moves very slowly due to extremely flat channel grade to the next outfall at the intersection with Kortsen Road. The existing channel geometrics need to be improved to handle the Q_{50} or Q_{100} runoff. The minimum required channel geometrics are shown in the appendix. The existing two 18-inch CMP crossings under the intersection of Trekell Road and Kortsen Road are undersized for a Q_{50} or Q_{100} runoff. If the existing two 18-inch CMP's are retained, a detention site is recommended to sufficiently retard the flow keeping it from crossing over the intersection while it outflows through the existing two 18-inch CMP's. It is recommended that four 10x3-foot concrete box culverts be installed in place of the existing two 18-inch CMP's to convey the drainage west along Kortsen Road. It is recommended at this point that the drainage area identified as EA-7 on the Master Drainage Map be required to provide minimal on-site retention until it is developed. Development would also require a more extensive on-site detention design.

For now, it is recommended that the runoff be detained with two 2x2500-foot berms (see Drainage Map 2). One berm would be located starting approximately at the intersection of Trekell Road and Kortsen Road, runs 2,500 feet to the east along the south side of Kortsen Road right-of-way. The other berm runs approximately 2,500 feet to the north along the new drainage channel by Trekell Road. This berm would intersect the berm running east along the right-of-way line of Kortsen Road at the intersection of Trekell Road and Kortsen Road. A 12-inch diameter pipe would be located at the intersection point of berms to drain the detained runoff to the new 4-10'x3' concrete box culverts outletting into the drainage channel along the north side of Kortsen Road (see Drainage Map 2). Current grading for the drainage ditch along Kortsen Road is inadequate and does not carry flow without ponding and crossing the road at several locations. It is recommended that a drainage easement along the north side of Kortsen Road be obtained to allow for a 60-foot wide channel approximately 4,000 feet in length to convey the runoff west to a point approximately 100 feet east of Center Avenue and away from any utility easements (see Drainage Map 2). From this point, drainage would be channeled north to the North Branch. This would require a 150-foot wide drainage easement approximately 2,600 feet in length (see Drainage Map 3).

Runoff from Drainage Area U-6 flows north down Kadota Avenue to combine with Drainage Area U-2. It continues down Kadota Avenue to O'Neil Drive where it flows to the west to Casa Grande Avenue, then to the north down Casa Grande Avenue (see Drainage Map 2) to Racine Place, west across from Racine Place to an existing V-ditch channel flowing west then north to Kortsen Road where the flow ponds west to eventually flow to the State ditch along Pinal Avenue. It is recommended the existing V-ditch channel be widened to a 50-foot channel and a drainage easement be obtained for this area. See Drainage Map 2 for recommended new channel alignment and size. It is further recommended that a drainage structure, 3-10'x3 1/2' concrete box culvert, be located under Kortsen Road as shown on Drainage Map 3 to convey the runoff north in a new drainage channel to the North Branch.

Runoff from Drainage Area U-5 combines with Drainage Area U-2 flowing down Casa Grande Avenue to enter an existing V-ditch across from Racine Place. It was infeasible to recommend a storm drain system with catch basins for Casa Grande Avenue due to the extremely flat grades. The storm drain mainline could not be outletted to a wash with minimal drainage slope. A new drainage easement and channel along the north side of O'Neil Drive is recommended to intercept runoff from O'Neil Drive flowing west across Casa Grande Avenue and to intercept overflows from Casa Grande Avenue. The runoff would be conveyed west approximately 1,100 feet from the intersection of Casa Grande Avenue and O'Neil Drive then north approximately 2,600 feet to combine with additional runoff from Racine Place and Casa Grande Avenue. This combined runoff is conveyed approximately 1,300 feet north to Kortsen Road through a previously recommended 3-10'x3 1/2' concrete box culvert and drainage channel to the North Branch (see Drainage Map 2 and 3).

Runoff from Drainage Area U-3 collects up at Park Avenue and flows north to cross Cottonwood Lane at a dip section combining with runoff from U-1 and conveyed by existing V-ditches to flow into a concrete-lined State ditch (see Drainage Map 2). It is recommended a new drainage easement 26 foot wide with channel be provided for between Cottonwood Lane and O'Neil Drive in drainage area U-1 (see Drainage Map 2). This new channel will also convey the runoff from drainage area U-3 to the State ditch. The State ditch carries the runoff to the North Branch. The State ditch currently is sized to handle a runoff of approximately 146 cfs. If a Q_{100} design capacity is to be carried, the channel will have to be widened an additional four feet.

All calculations for drainage channels and structure sizes are to be found in the appendix section of this report (see the Easements, Channels and Structure Summary sheet).

EXISTING MID-CITY RUNOFF WITH RECOMMENDATIONS

Starting with the Drainage Area M-2, runoff flows from the intersection of Peart Road and State Route 84, 93 in a northwesterly direction, combining with runoff flows from city side streets flowing to the north and northwest, and finally outlets at an existing 2-6'x3'x180' concrete box culvert under the Gila Bend Highway just east of the underpass under the Southern Pacific Railroad. Runoff from Drainage Area M-3 is also conveyed down Florence Boulevard to outlet at the same box culvert. The composited peak Q_{100} runoff for Drainage Areas M-2 and M-3 equals 346 cfs at the existing box culvert. The capacity of this culvert, assuming a flow velocity of 5 fps, is only 180 cfs. It is recommended three additional barrels be added to the existing culvert making it a 5-6'x3'x180' concrete box culvert.

Runoff in Drainage Area M-3 is partially stored in Peart Park. The park has a retention capacity of approximately ten-acre feet. The stored water is pumped into the park area by pumps of 1,000 and 1,500 gpm capacity and allowed to overflow the Park onto Florence Boulevard after the rain storm peak has passed. It is recommended that a storm drain system starting at Peart Park be located down Florence Boulevard (see Drainage Map 4). This system would be sized to intercept approximately 100 cfs. The Q_{100} peak runoff for Drainage Area M-3 is 140 cfs. The remaining 40 cfs would be carried down Florence Boulevard without flooding the street. The maximum size of mainline pipe required to convey 100 cfs at approximately a 0.25 percent slope would be 54 inches at the final catch basin intercept point. The storm drain mainline approximately 3,000 feet in length would have catch basins located along Florence Boulevard to intercept runoff from Peart Park (after the rain storm) at North Florence Street, Fourth Street, North Sacaton Street, and North Maricopa Street. The storm drainage mainline would outlet at the existing 2-6'x3'x180' concrete box culvert under the Gila Bend Highway. A schematic detail showing mainline pipe sizes and lengths is in the appendix section of this report (see Plate 4). Continuing on from the outlet end of the proposed modified structure (4-6'x3' concrete box culvert), the composited Q_{100} peak runoff from Drainage Areas M-2 and M-3 would be conveyed northwest down First Street. At the intersection of First Street with Shultz Street, the runoff from Drainage Area M-1 being conveyed down the existing streets is composited with Drainage

Areas M-2 and M-3. The total composited peak Q_{100} runoff at this point equals 610 cfs. It is recommended at this point a drainage channel and easement 60 feet wide be obtained to convey the runoff down to Thornton Road. There are currently two existing 36-inch CMP's under Thornton Road. It is recommended they be replaced with 3-10'x4' concrete box culverts to adequately pass the runoff under Thornton Road. The existing channel on the west side of Thornton Road would need to be improved to at least match the 60-foot wide channel proposed between First Street and Thornton Road (see Drainage Map 5). The improved channel would be continued northwesterly along the north side of the Southern Pacific Railroad to outlet at Concentration Point 6 in the North Branch. Before the improved channel outlets at Concentration Point 6 in the North Branch an existing railroad spur blocks the normal flow path, diverts it north along the spur to the Maricopa Highway where it turns back to the west under the railroad spur through an undersized opening approximately 32 foot wide by one and one-half foot high. It is recommended a 3-10'x4'x50' concrete box culvert be located under the spur back at the point where the natural wash flow is diverted north, approximately 260 feet south of the Maricopa Highway (see Drainage Map 6). The existing structure under the railroad spur would be retained to handle minor runoffs from the fields to the east and the diversion channel along the spur would be filled in to realign the wash with the new recommended structure.

All calculations for drainage channels and structure sizing are to be found in the appendix section of this report (see the Easements, Channels and Structure Summary Map).

EXISTING VIP BLVD. RUNOFF CONDITIONS WITH RECOMMENDATIONS

Existing Conditions: Referring to Drainage Map 6 for the VIP Boulevard area in the appendix, existing irrigation canals in areas V-1 and V-3 divert flows from the east, in a northerly direction, to an existing ditch that flows northwesterly along the south side of the Southern Pacific Railroad tracks. This ditch which outlets to the North Branch wash has an approximate capacity of 500 cfs and will require increased capacity to adequately convey the peak flow from subareas V-1, V-2 and V-3 (see Drainage Map 6). The existing berms and cultivated fields to the east presently create long lag times which reduces the peaking effect from combined tributary areas.

Recommendations: A new 10'x3'x100' concrete box culvert is recommended to be located under the Gila Bend Highway at the northwest corner of the Meridith/Burda Western Plant along the east side of an existing irrigation canal. It is recommended a new drainage channel be located approximately one-half mile to the north of this structure to intercept runoff from drainage area V-1a. North of the Gila Bend Highway a new drainage channel is recommended to convey the runoff from drainage area V-1a north to a new 3-10'x3'x60' C.B.C. located under the Old Maricopa Highway. This section of new drainage channel will also intercept runoff from drainage area V-1b (see Drainage Map 6). Runoff is then conveyed to the northwest under an existing railroad spur through a recommended 3-10'x3'x60' C.B.C. Runoff would continue to the northwest in an improved drainage channel running along the north side of the Old Maricopa Highway to the North Branch.

To drain tributary area V-2 a drainage easement and channel located approximately 400 feet west of VIP Boulevard beginning at the Gila Bend Highway will convey runoff northerly to the existing south side railroad ditch. Runoff from area V-3 may be conveyed in a similar channel along the east side of Burris Road starting approximately 1,100 feet north of the Gila Bend Highway (S.R. 287), flowing northerly and combining with eastern flows in the existing railroad ditch. Recommended future drainage structure locations are shown on Drainage Map 6 along with channels. For recommended sizes see "Easements, Channels and Structure Summary Map". It is imperative to enforce on site detention for any future developments to the east in order to minimize costly accomodations for downstream areas.

EXISTING RUNOFF FOR RURAL AND SEMI-DEVELOPED AREAS WITH RECOMMENDATIONS

A large portion of the land falling between Peart Road and Cox Road is currently farmland and beyond the city limits. Storm water runoff from cultivated fields is very low and is trapped by small berms around the lower end (the northwest corners). Farmers should be encouraged to continue the practice of berming their fields (to at least one foot high) to prevent runoff during peak storms and to provide a detaining action to the runoff. It is recommended that as the farmlands and surrounding undeveloped desert areas become developed, thereby increasing the runoff, the city will require those areas falling within the city limits to maintain total on-site detention which will not be allowed to combine with any peak runoff occurring. It is further recommended that a drainage ordinance agreement be made with Pinal County officials. This agreement should require that all land outside of Casa Grande's city limits that contribute runoff to the North Branch, maintain an on-site detention design so as not to increase or adversely divert the runoff. Also, that any future developments be required to submit a drainage study to the county and city reflecting the pre- and post-development conditions and the proposed drainage design conforming to the drainage ordinance of the city and/or county for approval.

It is recommended that a drainage easement with channel be placed to the east side of the future alignment of Peart Road between Florence Boulevard and Storey Road (Cottonwood Lane). Field investigation revealed an existing dike, perhaps from past farming use, was located along this alignment and that it is almost totally eroded away. To insure that future runoff does not divert west into developed areas of Casa Grande the new ditch and dike would continue conveying the flow north to Storey Road where it would match into an existing maintained ditch running north along existing Peart Road to empty into the North Branch.

Runoff from Drainage Areas EA-4 and EA-5 that is not detained in cultivated fields flows north to pond against Florence Boulevard (see Drainage Map 7). During peak flows the ponding will flow to the west across Peart Road along Florence Boulevard and combine with Drainage Area U-8. To prevent this, it is recommended a relief structure of 2-10'x3'x100±' concrete box culvert be located under Florence Boulevard on the east side of Peart Road. This would aid as a future relief point when and if existing farmlands become developed.

At the intersection of Earley Road with Peart Road, it is recommended that the roadway grading be such as to insure that runoff continues flowing north along Peart Road and does not combine with drainage areas to the west by turning west onto Earley Road. New drainage easement with channel is recommended along the east side of Peart Road between Earley Road and Florence Boulevard (see Drainage Map 7). South of the intersection of Hermosa Road with Florence Boulevard, it is recommended that the 2-24" C.M.P.s with concrete "L" headwall under Florence Boulevard be removed and replaced with 2-8'x3'x100'± concrete box culvert. This structure will provide an effective outlet for drainage area EA-3 (see Drainage Map 7). It is recommended a berm three foot in height by approximately 500 feet in length be located between drainage areas EA-5 and EA-3 along the west side of the recommended 2-8'x3'x100' concrete box culvert to prevent runoff from flowing west and combining with drainage area EA-5 (see Drainage Map 7).

At the structure's outlet end north of Florence Boulevard it is recommended the runoff be conveyed by a new drainage channel north to Cottonwood Lane (Storey Road). It is recommended at this time a dip section in Cottonwood Lane be located at the intersection with Hermosa Road. When future development warrants, a new 2-8'x3'x60' concrete box culvert would replace the dip section at Cottonwood Lane. Runoff would then be conveyed to the west in a new drainage channel along the north side of Cottonwood Lane to the intersection with Peart Road and then to the north along the east side of Peart Road in a new improved drainage channel to the intersection with Kortsen Road (see Drainage Map 8). At this time it is recommended a dip section in Kortsen Road be located at the intersection with Peart Road. When future development warrants, a new 4-10'x4'x80' concrete box culvert is recommended under Kortsen Road aligned with the new drainage channel. From the structure at Korsten Road runoff is conveyed by a new drainage channel to the North Branch. See "Easements, Channels and Structure Summary Map" for easement and channel sizing.

EXISTING RUNOFF CONDITIONS FOR THE SOUTHSIDE NEIGHBORHOOD

Carter Associates, in line with our agreement, considered a 50-year event for rainfall in the southside neighborhood. In order to analyze various solutions we considered both a one hour and a 24 hour storm. The effects of these two 50-year events will be discussed later in this section.

At first it was assumed that the runoff effecting the southside was being generated by the entire drainage basin shown in Plate No. 5. As the investigation continued it was found that the drainage contributing to flooding is restricted to a much smaller area as shown in Plate No. 6. The effective drainage area is basically limited to urbanized areas noted A, B, C, and D on Plate No. 6.

The influence of runoff from outside the city limits, during a 50-year event, is limited to Florence Street between the city limits and Peters Road. Drainage from areas south and east of the city is being either diverted into existing drainageways or held behind berms and roadways. No drainage enters the southside neighborhood from northeast of the railroad tracks as they form a barrier to flow from that direction.

One critical area is the drainage ditch along the south side of Peters Road and the culverts that pass water under Florence Street. This ditch seems to be adequate to direct runoff from a 50-year event on toward the west past the city but maintenance of the ditch and culverts is critical as even partial pluggage could cause water to overtop the ditch and flow north along Florence Street into the southside neighborhood.

Storm water from the local area as shown in Plate No. 6, flows generally northwest. 50-year storm runoff from fields surrounding the southside neighborhood will have little or no impact on flooding within the city limits. Storm water runoff from cultivated fields is very low and is trapped by small berms which existed around the lower end of all fields at the time of this study. Farmers should be encourged to continue the practice of berming their fields (to at least one foot high) to prevent runoff from entering the city. Flows from industrial areas and from the railroad tracks also has little or no impact as each general drainage path is cut off by roads or structures creating many small retention basins.

Storm water runoff from rural areas was estimated by Soil Conservation Service methods while runoff from the urbanized area was estimated using the rational method and assigning values of runoff coefficients, "C", consistant with the ADOT manual "Hydrologic Design for Highway Drainage in Arizona". In general, runoff from area D, Plate No. 6, makes its way to Florence Street flowing north to a scupper on the west side of Florence Street just north of Ash and along a small ditch on the south side of Third Avenue to Mercedes Street. Flow from areas B and C will generally join flow from area D along Mercedes Street. Area A runoff may be split between First Avenue and Main Avenue. Flows from all areas join together at Main and Mercedes and then pond in an area bounded by the crown of Main Avenue, the area around Mercedes Street and an access road into an industrial site at the curve in the west end of Main near its intesection with State Highway 84. This ponding is identified as a 100-year flood zone by the Federal Insurance Administration on their Flood Insurance Rate Map (FIRM) for Casa Grande. Interviews with local residents indicate that flooding does occur in an area approximately outlined on the FIRM map. Mr. Dewey Powell, operator of a feed store at the southeastern end of the flood zone, noted to the study team that his store has been totally surrounded by water but maximum high water to date has been about 3-4 inches below the floor level. This flood elevation inundates a portion of the intersection of Mercedes Street and Main Avenue and totally submerges a portion of Mercedes and First Avenue.

Alternatives Investigation. At this time all storm water runoff from the southside neighborhood is carried in the streets or in street side ditches or depressions. As runoff approaches the ponding area northwest of the intersection of Mercedes Street and Main Avenue it is carried in Mercedes Street, First Avenue and along a depression on the south side of Main Avenue.

Area D from Plate No. 6 can carry 50-year one-hour or 24-hour event runoff in existing improved streets. Existing streets in areas A, B, and C are not adequate to carry any 50-year storm. Various alternatives were analyzed to reduce or prevent these streets from submerging including: storm drains; improved streets, both standard and inverted crowns; and different flow paths through drainage channels.

Storm drains, if selected, would be required along Main Avenue, First, Second and Third Avenues, and Florence and Mercedes Streets. To provide a minimum drainage outfall, a large and deep (10 to 15 feet) retention basin would be needed.

If runoff is to be carried within the streets then all streets northwest of Florence Street will require improvement with a combination of standard and inverted crown sections.

The runoff loading on storm drains or streets could be minimized by routing some water through new channels. Runoff from area D might be routed along the south side of Third Avenue or in an inverted crown of Third Avenue, and channeled across a farm lot northwest of Mercedes and into the existing ponding area or to a new retention basin. An alternate route would be to reconstruct a portion of Ash Street west of Florence Street to allow water from area D to bypass the City by eventually flowing into the road ditch along the south side of State Route 84. this alternate would require more construction but would reduce the size of the required rentenion basin. Runoff travelling northwest along Second Avenue could also be directed across Mercedes Street, through a channel along the northeast end of the same farm lot and into an existing or new holding area.

Disposal of runoff was considered by construction of a new retention basin near the existing ponding area (see Plate No. 6). Ultimate disposal of water by way of dry wells and evaporation, by inverted siphon to downstream areas, and by pumping was considered.

Alternatives Analysis. The use of storm drains was rejected early in the study process due to the very flat slopes found in the southside neighborhood. Storm drains would be very expensive and would require a very deep retention basin to allow an outfall deep enough to give the conduits adequate slope.

Standard crown streets 32 feet wide with 4-inch roll curbs would handle runoff in the higher portions of areas A, B, and C, but would be submerged at least by Sacaton. If 7-inch vertical curbs were used, submergence would still occur by about Katherine Street. Inverted crown sections along First, Second and Third Avenues and Mercedes Street would carry a 50-year event but submergence would still occur along Mercedes near the intersection of First and Main Avenues.

Routing runoff from area D, either along Third Avenue, across the southwest side of an existing farm lot and into a retention area, or along a reconstructed Ash Street west of Florence Street, would relieve Mercedes Street and Main Avenue of a great deal of their runoff load, and would allow the construction of standard street sections in all but Mercedes Street and First Avenue. Directing water from Second Avenue across Mercedes Street and into a drainage channel crossing an existing farm lot would further lessen the impact of runoff on the intersection of Mercedes and Main, but as Mercedes is capable of handling area A, B, and C runoff as an inverted crown section this additional channel offers little added advantage.

As no easy drainage outlet from the southside neighborhood exists the construction of a retention basin to reduce ponding along Main Avenue and Mercedes Street is needed. Ultimate drainage from this basin can be accomplished in two ways: dry wells plus evaporation or pumping. The use of inverted syphons was considered but there is no reasonable outlet due to the flatness of the area. For this reason, an inverted syphon was rejected.

The remaining methods were evaluated for both cost and convenience.

A pumping system will empty the retention basin more quickly than dry wells but has two disadvantages. If water from the southside is pumped under the railroad tracks to the main part of town it will have to be pumped slowly to avoid increasing the peak runoff and possible flooding on the north side. Disposing of storm water in this manner would require only a small pump but tunneling under the railroad would be fairly expensive. Obtaining permits to tunnel under the railroad will also be a long process requiring 6 to 9 months before construction could begin. Discharging water to other areas such as the road ditch along State Highway 84 or to the Highway 84 railroad underpass would require the approval of ADOT plus the underpass pumps were designed for a certain volume of runoff and may not be capable of handling additional water. Tunneling under the railroad and possibly south Main Avenue, depending on the pipeline route selected, would also be required for disposal to either location.

The use of dry wells will allow the disposal of storm water without moving it to another location, requires little maintenance and is about the same price as a pumping system. Disadvantages associated with dry wells are that they are fairly slow in draining retention basins, they may eventually plug requiring reconstruction and require permits from the Department of Health Services (ADHS) to install. The permitting process may be completed in about three months following submission of a complete application. One possible problem with the dry well permitting process is the existence of industrial or agricultural businesses in the area. ADHS will not allow disposal by dry well if hazardous materials may be present in storm water runoff. Requirements for proper protection of the dry wells may be instituted by the City, but recommendations for such protections are beyond the scope of this study.

Southside Neighborhood Recommendations. Based on the analysis of alternatives the following recommendations are made.

As the reconstruction of some streets in the southside neighborhood is planned we recommend that water from area D be directed along it's existing path as far as Mercedes Street and then through a new channel to the proposed retention area. To allow smooth flow and to minimize pluggage we recommend that the existing scupper along the west side of Florence Street be removed and a depressed sidewalk be constructed. This work could be accomplished by City crews at minimal cost.

An inverted crown section (see sketch in appendix) should be utilized when Third Avenue is rebuilt. The estimated cost to reconstruct Third Avenue from Florence to Mercedes, as a 32-foot wide, inverted crown street with vertical curb and gutter is $112,300.

Conversations with City staff indicates there are no plans to reconstruct Main Avenue at this time. To reduce the amount of water flowing along Main, it is recommended that First Avenue and Second Avenue be constructed as inverted crown streets and that Washington, Sacaton and Katherine Streets be reconstructed as standard crown streets and be graded, as much as topography will allow, to flow toward First or Second Avenue.

As Mercedes is, and will continue to be, a major drainage way, it also should be reconstructed as an inverted crown street. The estimate of probable cost for the reconstruction of all streets mentioned above, except Third Avenue, is $465,300.

As an inverted crown street 32 feet wide, Mercedes would be capable of carrying a 50-year, one-hour storm. Since Main Avenue will not be reconstructed at this time, however, water flowing down Mercedes will be forced to turn west at Main. A 50-year, 24-hour event flowing from areas A, B, C and D could cause a problem at that intersection. To minimize this, we recommend that a drainage easement be obtained and a channel constructed to carry water westward from the intersection of Third Avenue and Mercedes along the edge of an existing field, turning north and emptying into a proposed retention basin as shown in Plate No. 6.

The present ponding around the intersection of Main and Mercedes and along Main Avenue westward can be eliminated during a 50-year, one-hour event and minimized during 50-year, 24-hour and greater events by the construction of a retention basin on what is now vacant land, as shown in Plate No. 6. A basin with gradually sloping sides and a maximum water depth of about five feet retaining a 50-year, one-hour event would cost about $107,500. This basin would be capable of retaining about 12 acre-feet of water and would fit within the boundary of the existing vacant land north of Mercedes and west of Main Avenue. A 50-year, 24-hour event would require about 22 acre-feet of storage necessitating either a much deeper basin, which is not recommended, or considerably more land area, which may not be readily available.

As Main Avenue is not scheduled for improvement it is recommended that a well defined channel be provided along the south side of Main from Mercedes to the recommended retention basin and between Mercedes and Sacaton, to as great an extent as possible, to maintain an unobstructed flow path for water flowing toward the recommended basin.

Ultimate disposal of water from the proposed retention basin by way of dry wells is recommended. A 50-year, one-hour event can be drained away in 48 hours or less by the use of five 50-foot deep dry wells. The estimated cost for the dry wells is $24,000, compared to about $23,800 for a pumping system. To minimize rapid plugging of a system of dry wells, it is recommended that the proposed retention basin be seeded to help trap silt and organic materials.

The total cost for all recommended improvements to the Southside Neighborhood Drainage System is $709,100, which includes a 20 percent contingency to cover unknown variables, engineering, and administrative costs. Land acquisition costs are not included.

SUGGESTED DRAINAGE ORDINANCE FOR CITY OF CASA GRANDE

The following amendments and additions are recommended to be added to Ordinance No. 609.1, an ordinance of the Council of the City of Casa Grande, Arizona, pertaining to Flood Damage Prevention.

It is recommended Chapter 17, Flood Damage Prevention be amended to include under Article 17-2 Definitions, the following additions:

"Base flood water surface elevation" means the following:

1. In Regulatory Floodways that lie within areas designated on the FIRM's as Flood Hazard Zones AH and A1 through A30, the base flood water surface elevations shall be those elevations shown on the FIRM's for the floodways; however, when the City determines that it has more accurate base flood water surface elevation data than the data shown on the FIRM's, the more accurate data shall be used.

2. In a Regulatory Floodway outside the areas identified as Flood Hazard Zones AH and A1 through A30, the base flood water surface elevations shall be those determined by floodplain delineation accomplished in accordance with criteria established by the Arizona State Director of Water Resources.

3. For those areas of the City which are not within a Regulatory Floodway, the base flood water surface elevations shall be those which are established by a drainage report submitted in accordance with the City's requirements.

To the definition of "Base Flood" worded:

"Base flood" means the flood having a one percent chance of being equalled or exceeded in any given year.

add the sentence: This is also called a "one-hundred year flood".

Add after the definition for Flood Insurance Rate Map (FIRM) the following additional definitions addressing the various flood hazard zones:

"Flood Hazard Zones A, AO, AH, or A1 through A30" are the areas on a FIRM which the Federal Government has determined will be inundated during a one-hundred-year flood. These areas are called, collectively, "Special Flood Hazard Areas."

"Flood Hazard Zone B" is an area on a FIRM which is outside the special flood hazard areas, but is subject to inundation during a five-hundred-year flood.

"Flood Hazard Zone C" is an area on a FIRM which is outside both the special flood hazard areas and the Zone B areas. It is described as an area of minimal flood hazard.

"Flood Hazard Zone D" is an area on a FIRM which has undetermined but possible flooding hazards.

It is recommended Article 17-3 General Provisions add a section identified as Section 17-3-11 Intergovernmental Agreements. This would require renumbering the existing Section 17-3-11 Severability to be identified as Section 17-3-12 Severability.

The suggested wording for the new Section 17-3-11 Intergovernmental Agreements would be:

Section 17-3-11 Intergovernmental Agreements

With the concurrence of the City Council, the Mayor shall be authorized to enter into agreements between the City and other political subdivisions, county, and State agencies to coordinate floodplain management.

It is recommended Article 17-4 Establishment of Development Permit, modify Section 17-4-1 to be expanded as follows:

Section 17-4-1 Establishment of Development Permit

A development Permit shall be obtained before construction or development begins within any area of special flood hazard established in Subsection 17-3.2. Applications for a Development Permit shall be made on forms furnished by the Floodplain Administrator and may include, but not be limited to: plans in duplicate drawn to scale showing the nature, location, dimensions, and elevation of the area in question; existing or proposed structures, fill, storage of materials, drainage facilities, and the location of the foregoing.

Reports, construction plans, and other data submitted in support of an application for a permit shall comply with the following criteria:

1. DRAINAGE REPORTS

When a drainage report is required, it must be prepared and sealed by a civil engineer registered as a professional engineer in the State of Arizona, and it must be prepared in accordance with the criteria established by the City. The purpose of the report is to analyze the effect that a proposed development would have upon the rainfall runoff in the vicinity of the development, to provide data to insure that the development is designed to be protected from flooding, and to provide data supporting the design of facilities to be constructed for the management of rainfall runoff. Each drainage report must consider rainfall runoff from storms with a return frequency up to and and including a 100-year storm. The complexity of the report depends upon the nature of the development and the site on which the development will occur. A drainage report shall be submitted by an applicant requesting one of the following:

a. Approval of a subdivision plat or a horizontal regime.

b. A permit for grading, unless the requirement is waived by the Floodplain Administrator.

c. A permit to construct right-of-way improvements.

d. A permit to construct any structure.

2. DRAINAGE PATTERNS

Rainfall runoff from storms of all return frequencies should enter and depart from property after its development in substantially the same manner as under pre-development conditions. Any proposals to modify drainage patterns must be fully justified by engineering data which shall demonstrate to the Floodplain Administrator that hazards to life and property will not be increased by the proposed modifications. Proposed modifications are as such that they will not alter a Floodway in a manner which will raise the estimated base flood water surface elevation or will increase flooding hazards upstream or downstream of the altered portion of the floodway.

3. STREET CROSSINGS AT NATURAL OR MAN-MADE DRAINAGE CHANNELS

a. The crossing structure requirements listed below will normally apply; however, the engineer may depart from these requirements if he can demonstrate to the Floodplain Administrator's satisfaction that they are inappropriate because of the type of development or the nature of the terrain or natural area development requirements would be violated. In extreme cases, it may be necessary to allow for the entire channel flow to pass over the road.

(1) Local and minor collector streets shall have a culvert or bridge which is capable of carrying all of the peak flow of runoff from a two-year-frequency storm beneath the roadway and which is also capable of carrying enough of the peak flow of runoff from a ten-year-frequency storm beneath the roads so that the portion of the flow over the road is no more than six inches deep.

(2) Major collector and major or minor arterial streets shall have a culvert or bridge which is capable of carrying all of the peak flow of runoff from a 10-year-frequency storm beneath the roadway and which is also capable of carrying enough of the peak flow of runoff from a 25-year-frequency storm so that the portion of the flow over the road is no more than six inches deep.

(3) Watercourse crossings for roads shall be designed so that all lots and structures within a development will be accessible from the boundary of

that development by at least one route during the period of peak flow of runoff from a 100-year-frequency storm. The boundary shall include any adjacent street or streets. Accessibility will be considered to exist if it can be demonstrated by the engineer that at the time of the peak flow the depth of flow over the road will be no greater than one foot.

b. Regardless of the size of the culvert or bridge, the street crossing should be designed to convey the 100-year storm runoff flow under and/or over the road to the area downstream of the crossing to which the flow would have gone in the absence of the street crossing. The construction of a channel crossing must not cause the diversion of drainage flows except when that diversion is part of an approved plan for modification of drainage patterns.

4. STREETS AS WATER CARRIERS

It is expected that streets will carry water from adjacent property and from local areas, but they are not to be used as major water carriers in lieu of natural washes or man-made channels. The maximum depth for water flowing in any street shall be 8 inches during the peak runoff from a 100-year-frequency storm. The above requirements imply that in some cases water may flow deeper than a normal vertical curb height and may flow for a short distance over sidewalk or other back-of-curb areas, but the flow of the water shall always be confined to the road right-of-way or to drainage easements. Particular care must be taken in street sag locations to insure that these requirements are met. Catch basins, scuppers, or similar facilities, together with the necessary channels, must be provided at appropriate locations to remove water flowing in the streets so as not to exceed the above described depth limit.

5. DESIGN PROCEDURES AND CRITERIA

The design procedures and criteria to be used shall be in accordance with those prepared and published by the City of Casa Grande.

6. LOWEST FLOOR ELEVATIONS IN RESIDENTIAL STRUCTURES

a. In Regulatory Floodways and in Flood Hazard Zone A, a new residential structure or the substantial improvement of an existing residential structure shall have its lowest floor constructed at an elevation which is at least one foot above the base flood water surface elevation in the vicinity of the proposed construction site.

b. In Flood Hazard Zone AO, a new residential structure or the substantial improvement of an existing residential structure shall have its lowest floor constructed at an elevation which is at least one foot above the elevation determined by finding the elevation of the highest natural ground adjacent to where the structure will be located and adding to that elevation the depth number specified on the FIRM for that AO Zone.

c. In areas designated as Flood Hazard Zones B, C, and D on the FIRM's which are not in a Regulatory Floodway, a new residential structure (single- or multi-family) shall be constructed according to one of the two following requirements, except when the conditions in subparagraph e., below, apply:

(1) The lowest floor shall be constructed at an elevation which is at or above the base flood water surface elevation.

(2) The lowest floor may be constructed below the base flood water surface elevation, but flood proofing shall be provided for the structure to an elevation which is at least one foot above the base flood water surface elevation.

d. In Flood Hazard Zones B, C, and D, those single-family residential structures which are to be built without a basement and located at a site which the Floodplain Administrator has determined will not be in the vicinity of a watercourse in which the flow of rainfall runoff might be hazardous to the structure or its occupants, the elevation of the lowest floor may be established by one of the methods described in the following subparagraphs.

(1) If the structure is to be located in Flood Hazard Zone B, the lowest floor may be set at an elevation which is 14 inches above the high point of

the natural ground within the area bound by a 10-foot perimeter offset from the structure.

(2) If the structure is to be located in Flood Hazard Zone C or D, the lowest floor may be set at an elevation which is 12 inches above the high point of the natural ground within the area bound by a 10-foot perimeter offset from the structure.

(3) The floor elevation(s) chosen for the residence may be indicated on a topographic plan of the building site parcel which shows the construction pad site and any grading proposed on the parcel. This plan must be prepared and sealed by a civil engineer or architect registered as a professional engineer or architect in the State of Arizona. The floor elevation(s) indicated on the plan are to be elevations considered by the engineer or architect sufficiently high to provide protection in the event of flooding caused by a 100-year storm.

e. A residential structure to be built adjacent to but not within a Regulatory Floodway that will have its lowest floor at an elevation lower than one foot above the base flood water surface elevation in the adjacent Regulatory Floodway must be flood proofed to an elevation at least 2.5 feet above the base flood water surface elevation.

f. In Regulatory Floodways and in Flood Hazard Zones AO and A, a depressed floor area shall be the lowest floor unless there is an area in the structure with a lower floor, such as a basement.

g. In areas designated as Flood Hazard Zones B, C, or D on the FIRM's which are not in a Regulatory Floodway, a depressed floor area does not have to be considered as the lowest floor if there is no door opening directly to the outside which could admit flood water into the depressed floor area and if the depressed area walls and floor are sealed to prevent the infiltration of water into the depressed area.

7. LOWEST FLOOR ELEVATIONS IN NON-RESIDENTIAL STRUCTURES

a. In Regulatory Floodways and in Flood Hazard Zone A, a new nonresidential structure or the substantial improvement of an existing non-residential structure shall be constructed according to one of the two following requirements:

(1) The lowest floor shall be constructed at an elevation which is at least one foot above the base flood water surface elevation in the vicinity of the proposed construction site.

(2) The lowest floor may be constructed below an elevation which is one foot above the base flood water surface elevation, but flood proofing shall be provided for the structure to an elevation which is at least one foot above the base flood water surface elevation.

b. In Flood Hazard Zone AO, a new non-residential structure or the substantial improvement of an existing non-residential structure shall be constructed according to one of the two following requirements:

(1) The lowest floor shall be constructed at an elevation which is at least one foot above the elevation determined by finding the elevation of the highest natural ground adjacent to where the structure will be located and adding to that elevation the depth number specified on the FIRM for that AO Zone.

(2) The lowest floor may be constructed below the minimum lowest floor elevation specified in subparagraph (1), above, but floodproofing shall be provided for the structure to an elevation which is at least as high as the minimum lowest floor elevation determined by the method in subparagraph (1), above.

c. In areas designated as Flood Hazard Zones B, C, and D on the FIRM's which are not in a Regulatory Floodway, a new non-residential structure or the substantial improvement of an existing non-residential structure shall be constructed according to one of the two following requirements:

(1) The lowest floor shall be constructed at an elevation which is at or above the base flood water surface elevation.

(2) The lowest floor may be constructed below the elevation of the base flood water surface elevation but floodproofing shall be provided for the structure to an elevation which is at least as high as the base flood water surface elevation.

8. MOBILE HOMES AND MOBILE HOME PARKS

a. The new installation of a mobile home in an area other than a mobile home park, the construction of a new mobile home park, or the enlargement of an existing mobile home park within a Regulatory Floodway is prohibited.

b. The new installation of a mobile home or the replacement of an existing mobile home outside the Special Flood Hazard Areas must be done in a manner that assures that the mobile home is anchored to the earth so as to prevent flotation, collapse, or lateral movement in the event of flooding.

c. A mobile home to be installed in a new location or as a replacement for an existing mobile home in Flood Hazard Zones A and AO, and a mobile home to be installed as a replacement for an existing mobile home located within a Regulatory Floodway shall be anchored to resist flotation, collapse, or lateral movement by providing over-the-top and frame ties to ground anchors. The following specific requirements must be met:

(1) Over-the-top ties must be provided at each of the four corners of the mobile home. Mobile homes 50 feet or more in length must have two additional over-the-top ties per side at intermediate locations, and mobile homes less than 50 feet in length require only one additional over-the-top tie per side.

(2) Frame ties must be provided at each of the four corners of the mobile home. Mobile homes 50 feet or more in length must have five additional frame ties per side, and mobile homes less than 50 feet in length must have four additional frame ties per side.

(3) All components of the anchoring system must be capable of resisting forces of at least 4,800 pounds.

(4) Any additions to a mobile home must be similarly anchored.

d. The owners of mobile home parks that are located within Special Flood Hazard Areas shall have evacuation plans prepared indicating alternate vehicular access and escape routes. These plans shall be filed with the State Disaster Preparedness Office and with the City's Field Services Director.

e. If an existing mobile home park with a Regulatory Floodway must undergo repair, reconstruction, or improvement of the streets, utility systems and pads at a cost which equals or exceeds 50% of the value of the streets, utility systems and pads before the repair, reconstructions, or improvement has commenced, the following requirements must be met:

(1) The stands or lots must be elevated on compacted fill or on pilings so that the lowest floor of each mobile home will be at or above an elevation which is one foot above the base flood water surface elevation.

(2) Adequate surface drainage and access for a hauler must be provided.

(3) If the stands are elevated on pilings, the lots must be large enough to permit steps, the pilings must have foundations on stable soil and be no more than 10 feet apart, and reinforcement must be provided for pilings more than 6 feet above the ground.

f. A mobile home which is located in a Regulatory Floodway or in Flood Hazard Zones A or AO may be replaced by another mobile home only if:

(1) The mobile home which is to be replaced was not damaged by a flood to more than fifty percent of its value before the flood.

(2) The replacement mobile home is elevated so that the bottom of the structural frame or the lowest point of any attached appliances, whichever is

lower, is at or above an elevation which is one foot above the base flood water surface elevation.

9. REFERENCE TO BASE FLOOD WATER SURFACE ELEVATIONS ON DEVELOPMENT PLANS

The grading and drainage plans for any development adjacent to a Regulatory Floodway and the grading and drainage plans for any development which proposes to modify an existing Regulatory Floodway as a part of the development must indicate the base flood water surface elevations.

10. INFORMATION PERTAINING TO FLOOD PROTECTION TO BE PLACED ON BUILDING PLANS

The following subparagraphs describe requirements for information which shall be placed on building plans for both residential and non-residential structures. Depending upon the type of structure and its location, one or more of the subparagraphs will apply:

a. The proposed elevation of the lowest floor must be shown, regardless of the type of structure or its location.

b. If the structure is to be built in a Regulatory Floodway or in Flood Hazard Zone A, the base flood water surface elevation must be shown.

c. If the structure is to be built in Flood Hazard Zone AO, the elevation of the highest ground adjacent to the structure and the depth number for the AO Zone must be shown.

d. If the lowest floor is to be established by the use of subparagraphs B.6.d.(1) or (2) of section 17-4-1, the elevation of the highest point of the natural ground within the area bound by a 10-foot perimeter offset from the structure must be shown.

11. MINIMIZING THE POTENTIAL FOR FLOOD DAMAGE

Within any area of the City where the Floodplain Administrator determines that the land is subject to flooding, including but not limited to the Special Flood Hazard Areas, all development, including substantial improvements to structures, must meet the following requirements:

a. All structures shall be anchored to their foundations to prevent flotation, collapse, or lateral movement.

b. Building construction materials and utility system equipment shall be resistant to flood damage.

c. The construction methods and practices shall be those which minimize flood damage.

d. Multiple occupancy developments such as subdivisions, shopping centers, etc. shall have their public utility systems such as sewer, water, gas and electric lines and their associated facilities located and constructed in a manner to minimize or eliminate the potential for flood damage. The developments must be constructed with drainage systems which will minimize the exposure to flood damage.

e. New and replacement water supply systems shall be designed and constructed to minimize or eliminate infiltration of flood waters into the systems and the discharge of sewage into the flood waters.

f. New and replacement sanitary sewage systems shall be designed and constructed to minimize or eliminate infiltration of flood waters into the systems and the discharge of sewage into the flood waters.

12. STORM WATER DETENTION OR RETENTION

a. Except as noted below, the development of land within the City must include provisions for the management of storm water runoff from the property which is to be developed. This management shall consist of the construction of storm water detention systems or retention basins. Storm water detention systems must provide peak rates of outlet flow from the developed property onto downstream property which are no greater than the peak rates of runoff flow from the same property under natural conditions with no development. If a suitable outlet for a detention system is not available or if engineering analysis indicates that available outlet systems would be overtaxed by a detention system outflow, a storm water retention basin shall be construction in lieu of a detention system. The requirement for construction of a detention system or a retention basin is waived in the following cases:

(1) An application for a building permit to construct a single-family residential structure.

(2) Development adjacent to a floodway or a drainage channel which has been determined by the City's Project Review Manager to have been designed and constructed to handle the additional runoff flow without increasing the potential for flood damage on downstream property.

(3) Development of a parcel under one-half acre in an area where it can be demonstrated that no significant increase in the potential for flood damage will be created by the development.

b. Storm water detention and retention facilities shall be designed and constructed according to the procedures and criteria established by the City. No detention or retention basin shall retain standing water longer than 36 hours if the basin has not been designed and constructed to be a permanent body of water with appropriate health, safety, and water quality measures for such a body of water.

This concludes the suggested amendments to ordinance No. 609.1.

A proposed retention-detention Policy for the City of Casa Grande is recommended as follows:

CITY OF CASA GRANDE
RETENTION, DETENTION POLICY

Purpose

The relatively flat topography and lack of defined drainage patterns necessitates special attention for controlling storm water collection and retention. Regulatory controls and measures are identified in this chapter to minimize storm water problems.

Sec. 1 Conceptual Drainage Plan.

A conceptual storm water collection and retention plan shall be submitted with a preliminary plat or site development plan and approved prior to the approval of such plat or plan. In the design of the development, every effort shall be made to utilize the natural slope of the land for the storm water collection system. Sub-surface drainage systems shall be discouraged wherever possible. The plan shall include but not be limited to the following:

a. Method of collection (surface and/or sub-surface).

b. Depth, side slopes and area of retention.

c. Calculations of volume held and required.

d. High water elevation and invert of pipes.

e. Method of disposal of water within 36 hours.

f. Areas tributary to each retention basin.

g. Any other data to form a complete plan.

Sec. 2 Subdivisions.

a. All water which falls within the subdivisions (including the respective one-half (1/2) of all abutting streets to the subdivision) from a one-hundred (100) year storm of a one hour duration. (approximately 2.39 inches) as established by the Arizona Highway Department Hydrological Design and Revised Precipitation Maps, must be retained within the boundaries of the subdivison. The method of collection and retention shall be approved by the Department of Public Works. The method of retention calculation, drainage flows and dry wells shall conform to Section 4.

b. Two or more developers may join together to provide a common retention facility. A letter of agreement signed by all developers participating in the common retention must be presented to the Department of Public Works and recorded plat shall indicate that the retention area is a joint facility. The joint retention area must meet all criteria as a single area.

c. All retention basins shall have a design capacity to preclude a water depth in excess of three (3) feet resulting from a one-hundred (100) years, one hour storm. The depth of retention shall be measured from nearest adjacent top of curb. Side slopes shall be hinged to conform to the following slope-depth ratio:

BASIN DEPTH (measured from top)		STEEPEST SLOPE horizontal:vertical
First	3 feet	4:1
From 3 feet to	6 feet	8:1

Exceptions to minimum slope requirements will be considered when innovative and esthetically pleasing design features are presented and public safety is not compromised.

In no event shall storm water stand in the retention basins longer than thirty-six (36) hours. Where possible, basins may be drained by pumping or controlled gravity flow into existing storm drainage lines or irrigation ditches when approved by the controlling agency. With the permission of the City Engineer the right-of-way area from one (1) foot in back of sidewalk may be used for the retention basin. The location and slope of retention basins shall conform to the Zoning Code and Development Policy.

d. All retention basins that will be controlled by the City shall be improved by the developer per City of Casa Grande guidelines for retention basin development and installed prior to the City's acceptance of the retention. The landscape plan shall be submitted with the engineering plans. Retention basins, when not privately maintained, shall be dedicated to the City in fee title as storm water retention basins or drainage rights-of-way. In the case where private retention basins receive water, other than that which falls upon the property and adjacent streets and/or alleys, the areas shall be designated as easement areas for retention purposes and shall have a recorded restrictive covenant requiring perpetual maintenance.

e. On-lot retention is permissible only in single family developments where the lots contain not less than 18,000 square feet and are fully irrigated. The lot shall be depressed to contain the indicated design storm, including that of street run-off.

f. Curbed streets shall be designed and constructed to carry the storm water run-off from a 10 year storm between curbs. When peak flows from the designed storm exceed the street capacity, a sub-surface storm drainage system shall be designed to carry the excess storm water. Local and secondary collector streets serving one acre or larger lots designed for on-lot retention may be constructed with a ribbon curb. Local streets, serving lots of 18,000 square feet to 1 acre in size designed for on-lot retention, may be designed with eighteen (18) inch curb depressions at each lot to permit street run-off to flow into the depressed lots.

g. Peak flows from a fifty (50) year storm shall be carried within the cross section between buildings (front yards and streets). The finish floor elevation of all buildings shall be above the one hundred (100) year storm.

h. All storm drain pipe installed in alleys or streets under curb, gutter and pavement shall be constructed of rubber gasket reinforced concrete pipe capable of withstanding H-22 highway loads.

i. Lakes or ponds used for storm water collection will be required to meet all retention basin requirements specified herein except for water depth, drainage time and side slopes below the normal water level.

j. Commercial/industrial and single lot multi-family (duplex, triplex, etc.) subdivisions may provide either community retention basins or on-site retention for each lot including street run-off, providing the retention area over one (1) foot deep does not exceed fifty percent (50%) of unpaved open space on the site.

Sec. 3 Non-Subdivision Developments.

a. All storm water from a one hundred (100) year storm of one hour duration, (approximately 2.39 inches) as established by the Arizona Highway Department Hydrological Design and Revised Precipitation Maps, shall be retained on site. All storm water within the right-of-way adjacent to said site shall be retained within the site unless other means of disposal of the water (i.e., storm drain, irrigation ditch, or drainage way) is designed and constructed to handle that water.

b. A maximum of fifty percent (50%) of the required retention can be held upon asphalt, concrete or other hard surface except in a special situation and with permission of the City Engineer.

c. The City of Casa Grande shall not be responsible for the design, performance, operation or maintenance of the retention basin.

d. The retention basin shall conform to Section 2(c) and calculations, drainage flows and dry wells shall conform to Section 4.

e. Changes or additions to sites which require approval of a site development plan will be required to address drainage on the entire site and meet storm drainage requirements as set forth in this chapter for the complete site.

Sec. 4 Retention Calculations, Drainage Flows and Dry Wells.

a. Retention calculations shall be submitted as follows:

$$Vr = \frac{D}{12}(A)(Cw)$$

A = Area (square feet or acres)

Vr = Volume required to be retained (cubic feet or acre feet)

D = 100 year - one hour rainfall (inches) = 2.39

Cw = Run-off factor for tributary areas (weighted factors may be required for multiple retention areas and/or special conditions as determined by the City Engineer):

Typical run-off factors:

Pavement (asphalt, concrete, brick, etc.)	0.95
Roofs	0.95
Grass lawn (average slope 0 - 7%)	0.20
Grass lawn (steep slope 7% and greater)	0.35
Desert lawn or rock lawn	0.70
Farm land	0.10
Bare ground (vacant lots)	0.25
Undeveloped desert	0.40

Commercial, industrial area:	0.80
Residential area:	
Range areas 18,000 sq. feet or larger	0.35
Single family areas less than 18,000 square feet	0.40
Multi-unit area:	
Townhouses, pati homes, mobile home parks	0.50
Apartments	0.60

Note:

The weighted 'C' is obtained from the total summated "C" areas divided by the total area or subareas being developed.

b. The point or points in which natural drainage flows from a property prior to development shall remain the same after the property has been altered for the development.

c. Shallow pit percolation tests shall be performed in retention areas to determine natural percolation. Test results shall be submitted to the City Engineer prior to approval of drainage plans. Dry wells are permitted to drain surface retention areas only when no other means of disposal is available. Infiltration into the dry well cannot be considered to reduce the size of the retention area. The property owner of record shall be responsible for the design, performance, operation or maintenance of dry wells used with on-site retention. A percolation test must be carried out on the dry well before acceptance. The percolation test results are to be filed with the City Engineer.

Section 5 Right of City to Drain Basin

It shall be unlawful for any person owning or controlling a retention basin to permit storm water to stand therein longer than thirty-six (36) hours. In addition to any penalty provided by law, should the person owning or controlling any privately owned and maintained basin fail, neglect or refuse to drain said retention basin within thirty-six (36) hours, as required in Sec. 2(c) hereof, it shall be the right to the City, upon the authorization of the Director of Public Works, or his appointed agent, to enter upon the privately owned retention basin property and take such action as may reasonably be necessary to drain said basin. The draining of said basin shall be at the expense of the owners or person controlling such basin.

Section 6 Assessment of Costs for Drainage.

Upon completion of the work, the Director of Public Works shall prepare or cause to be prepared, a verified statement of account of the actual cost of draining of said basin, the date the work was completed, and the street address and the legal description of the property on which said work was done, including five percent (5%) for inspection and other incidental costs in connection therewith and shall serve a duplicate copy of such verified statment upn the person owning or controlling such property in the manner prescribed in Sec. 8 hereof.

Sec. 7 Appeal to Council.

The owner or person controlling such property shall have thirty (30) days from the date of service upon him of the assessment to appeal in writing to the Council from the amount of the assessment as contained in the verified statement. If an appeal is not filed with the City Council within such thirty (30) day period, then the amount of the assessment as determined by the Director of Public Works, shall become final and binding. If an appeal is taken, the Council shall, at its next regular meeting, hear and determine the appeal and may affirm the amount of the assessment, modify the amount thereof, or determine that no assessment at all shall be made. The decision of the Council shall be final and binding on all persons.

Sec. 8 Service of Notice.

Notice shall be personally served on the owner or person controlling such property, by an officer of the Casa Grande Police Department, in the manner provided in Rule 4(d) of the Arizona Rules of Civil Procedure, or mailed to the owner or person controlling such property at his last known address by Certified or Registered Mail, or the address to which the tax bills for the property were last mailed, If the owner does not reside on such property, a duplicate notice shall also be sent to him by Certified or Registered Mail at his last known address.

Sec. 9 Lien for Drainage of Basin

If no appeal is taken from the amount of the assessment, or if an appeal is taken and the Council has affirmed or modified the amount of the assessment, the original assessment or the assessment as so modified shall be recorded in the Office of the County Recorder and from the date of its recording, shall be a lien on said lot or tract of land until paid. Such liens shall be subject and inferior to the lien for general taxes and to all prior recorded mortgages and encumbrances. of record. A sale of the property to satisfy a lien obtained under the provisions of this section shall be made upon judgment of foreclosure or order of sale. The City of Casa Grande shall have the right to bring an action to enforce the lien in a court of competent jurisdiction at any time after the recording of the assessment, but failure to enforce the lien by such action shall not affect its validity. The recorded assessment shall be prima facie evidence of the truth of all matters recited therof. A prior assessment for the purposes provided in this section shall not be a bar to a subsequent assessment or assessments for such purposes, and any number of liens on the same lot or tract of land may be enforced in the same action.

SUMMARY OF ALL REPORT RECOMMENDATIONS AND COST ESTIMATES

COST ESTIMATE

ITEM No.	DESCRIPTION	ESTIMATED QUANTITY	UNIT	UNIT COST	TOTAL COST
1.	16-10'x4'x120' C.B.C.	Cost in Place	L.S.		444,933
2.	2-10'x3'x100' C.B.C.	"	L.S.		54,700
3.	4-10'x4'x60' C.B.C.	"	L.S.		60,000
4.	2-8'x3'x100' C.B.C.	"	L.S.		38,500
5.	3-8'x3'x100' C.B.C.	"	L.S.		51,000
6.	4-10'x3'x150' C.B.C.	"	L.S.		144,000
7.	4-10'x3'x100' C.B.C.	"	L.S.		94,000
8.	2-10'x3'x60' C.B.C.	"	L.S.		29,000
9.	3-33"x70' C.M.P.	"	L.S.		13,650
10a.	42"x1000' R.C.P.R.G. Mainline	"	L.F.	90.00	90,000
b.	48"x1000' R.C.P.R.G. Mainline	"	L.F.	120.00	120,000
c.	52"x1000' R.C.P.R.G. Mainline	"	L.F.	140.00	140,000
d.	10 Catch Basins & 6 Manholes	"	ea.	3000.00	48,000
e.	18"x300' R.C.P.R.G. laterals	"	L.F.	50.00	15,000
11.	Add 3-6'x3'x180' C.B.C. to exist. 2-6'x3'x180' C.B.C.	"	L.S.		108,000
12.	3-10'x4'x100' C.B.C.	"	L.S.		76,100
13.	3-10'x4'x50' C.B.C.	"	L.S.		38,100
14.	10'x3'x100' C.B.C.	"	L.S.		31,400
15.	3-10'x3'x60' C.B.C.	"	L.S.		42,400
16.	3-10'x3'x60' C.B.C.	"	L.S.		42,400

$521,000

CARTER ASSOCIATES, INC.
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Prepared by____ Preliminary/ Cost Estimate
Checked by____ Client____
Reviewed by____ Tract No./Project____
Date____ Job No.____

COST ESTIMATE

ITEM No.	DESCRIPTION	ESTIMATED QUANTITY	UNIT	UNIT COST	TOTAL COST
17.	10'x3'x100' C.B.C.	Cost in Place	L.S.		31,400
18.	2-10'x3'x60' C.B.C.	"	L.S.		29,000
19.	3-8'x3'x60' C.B.C.	"	L.S.		30,300
20.	3-8'x3'x60' C.B.C.	"	L.S.		30,300
21.	3-8'x3'x80' C.B.C.	"	L.S.		39,700
22.	2-8'x3'x60' C.B.C.	"	L.S.		22,100
23.	2-8'x3'x80' C.B.C.	"	L.S.		31,100
	Phase 1 Structure Cost			Subtotal=	1,895,283
24.	4-10'x4'x80' C.B.C.	Cost in Place	L.S.		75,100
25.	4-10'x3'x100' C.B.C.	"	L.S.		74,500
26.	3-8'x3'x100' C.B.C.	"	L.S.		51,200
27.	3-8'x3'x56' C.B.C.	"	L.S.		28,800
28.	4-8'x3'x56' C.B.C.	"	L.S.		37,000
29.	2-8'x3'x100' C.B.C.	"	L.S.		38,500
30.	2-8'x3'x60' C.B.C.	"	L.S.		22,100
31.	5-10'x5'x60' C.B.C.	"	L.S.		72,600
	Phase II Structure Cost			Subtotal=	399,800
	PHASE II			TOTAL	399,800

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Prepared by______ Preliminary/ Cost Estimate
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Reviewed by______ Tract No./Project______
Date______ Job No.______

COST ESTIMATE

ITEM No.	DESCRIPTION Drainage Easements (Phase I)	ESTIMATED QUANTITY	UNIT	UNIT COST	TOTAL COST
1	None		Ac.		
2	225'x4600'	23.76	Ac.	5,000	118,802
3	250'x400'x5280' (Flare)	48.48	Ac.	5,000	242,424
4a	400'x6000'	55.10	Ac.	5,000	275,482
4b	700'x4400'	70.71	Ac.	5,000	353,535
5	40'x5280'	4.85	Ac.	5,000	24,250
6	70'x5200'	8.48	Ac.	5,000	42,400
7a	90'x5500'	11.36	Ac.	5,000	56,800
7b	95'x2800'	6.11	Ac.	5,000	30,550
8	35'x2500'	2.01	Ac.	25,000	50,250
9	50'x2500'	2.87	Ac.	25,000	71,750
10abc	35'x4000'	3.21	Ac.	25,000	80,250
11	45'x5200'	5.37	Ac.	25,000	134,250
12	45'x3700'	3.82	Ac.	25,000	95,558
13	45'x1050'	1.08	Ac.	25,000	27,000
14	40'x3600'	3.31	Ac.	25,000	87,750
15	50'x1300'	1.49	Ac.	25,000	37,250
16	150'x2700	9.30	Ac.	25,000	232,500
17	40'x3900'	3.58	Ac.	25,000	89,500

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Prepared by M.T. **Preliminary/ Cost Estimate**
Checked by R.E.R. **Client** Casa Grande
Reviewed by ______ **Tract No./Project** ______
Date ______ **Job No.** 83314

COST ESTIMATE

ITEM No.	DESCRIPTION Drainage Easements (Phase I)	ESTIMATED QUANTITY	UNIT	UNIT COST	TOTAL COST
18	50'x2700'	3.10	Ac.	25,000	77,500
19	26'x2100'	1.25	Ac.	25,000	31,250
20ab	60'x17600'	24.24	Ac.	5,000	121,200
21	30'x2500'	1.72	Ac.	5,000	8,600
22	50'x4500'	5.16	Ac.	5,000	23,800
23	35'x4300'	3.46	Ac.	5,000	17,300
24ab	40'x4000'	3.67	Ac.	5,000	18,350
24c	45'x1400'	1.45	Ac.	5,000	7,250
25	30'x5500'	3.79	Ac.	5,000	18,950
26	55'x7000'	8.84	Ac.	5,000	44,200
28	20'x1400'	0.64	Ac.	5,000	3,200
29	25'x2500'	1.43	Ac.	5,000	7,150
30	25'x2500'	1.43	Ac.	5,000	7,150
31a	30'x7900'	5.44	Ac.	5,000	27,200
31b	35'x2300'	1.85	Ac.	5,000	9,250
32ab	35'x5800'	4.66	Ac.	5,000	23,300
33	90'x2900'	5.99	Ac.	5,000	29,950
34ab	60'x5400'	7.44	Ac.	5,000	37,200
35	60'x800'	1.10	Ac.	5,000	5,500

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Prepared by______
Checked by______
Reviewed by______
Date______

Preliminary/~~Final~~ Cost Estimate
Client______
Tract No./Project______
Job No. 83314

COST ESTIMATE

ITEM No.	DESCRIPTION Drainage Easement (Phase I)	ESTIMATED QUANTITY	UNIT	UNIT COST	TOTAL COST
37	35'x5280'	4.24	Ac.	5000	21,200
38	40'x5280'	4.85	Ac.	5000	24,250
39	40'x5280'	4.85	Ac.	5000	24,250
40	60'x5000'	6.89	Ac.	5000	34,450
		Drainage Easement Total =			2,669,751.00
					18%

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Prepared by______ Preliminary/ Cost Estimate
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Reviewed by______ Tract No./Project ______
Date ______ Job No. ______

COST ESTIMATE

ITEM No.	DESCRIPTION Channel Excavation (Phase I)	ESTIMATED QUANTITY	UNIT	UNIT COST	TOTAL COST
1	See "Drainage Easements, Channels and Structure Summary Map"	99,259	C.Y.	5.00	
2		110,400	C.Y.	5.00	
3		89,128	C.Y.	5.00	
4a		232,960	C.Y.	5.00	
4b		367,572	C.Y.	5.00	
5		16,427	C.Y.	5.00	
6		34,027	C.Y.	5.00	
7a		60,296	C.Y.	5.00	
7b		32,770	C.Y.	5.00	
8		6,389	C.Y.	5.00	
9		10,566	C.Y.	5.00	
10abc		16,889	C.Y.	5.00	
11		28,100	C.Y.	5.00	
12		20,085	C.Y.	5.00	
13		3,850	C.Y.	5.00	
14		11,200	C.Y.	5.00	
15		5,489	C.Y.	5.00	
16		28,400	C.Y.	5.00	
17		12,133	C.Y.	5.00	

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Prepared by M.A.T. **Preliminary/ Cost Estimate**
Checked by R.E.R. **Client** Casa Grande
Reviewed by ____ **Tract No./Project** ____
Date ____ **Job No.** 83314

COST ESTIMATE

ITEM No.	DESCRIPTION Channel Excavation (Phase I)	ESTIMATED QUANTITY	UNIT	UNIT COST	TOTAL COST
18		11,400	C.Y.	5.00	
19		2,800	C.Y.	5.00	
20ab		104,296	C.Y.	5.00	
21		5,000	C.Y.	5.00	
22		19,000	C.Y.	5.00	
23		10,989	C.Y.	5.00	
24ab		12,444	C.Y.	5.00	
24c		5,133	C.Y.	5.00	
25		11,000	C.Y.	5.00	
26		40,444	C.Y.	5.00	
27	No 27	N/A	C.Y.	5.00	
28		1,244	C.Y.	5.00	
29		3,148	C.Y.	5.00	
30		3,148	C.Y.	5.00	
31a		15,800	C.Y.	5.00	
31b		5,878	C.Y.	5.00	
32ab		14,822	C.Y.	5.00	
33		25,133	C.Y.	5.00	
34ab		28,800	C.Y.	5.00	

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Prepared by M.A.T. Preliminary ~~Final~~ Cost Estimate
Checked by R.E.R Client Casa Grande
Reviewed by ______ Tract No./Project ______
Date ______ Job No. 83314

COST ESTIMATE

ITEM No.	DESCRIPTION Channel Excavation (Phase I)	ESTIMATED QUANTITY	UNIT	UNIT COST	TOTAL COST
35		4,267	C.Y.	5.00	
36	No 36	N/A	C.Y.	5.00	
37		16,427	C.Y.	5.00	
38		16,427	C.Y.	5.00	
39		16,427	C.Y.	5.00	
40		37,037	C.Y.	5.00	
	Total Channel Excavation =	1,597,094	C.Y.	5.00	$7,985,470

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Prepared by______ Preliminary/~~Final~~ Cost Estimate
Checked by______ Client
Reviewed by______ Tract No./Project
Date______ Job No. 83314

COST ESTIMATE

ITEM No.	DESCRIPTION Miscellaneous Items (Phase I)	ESTIMATED QUANTITY	UNIT	UNIT COST	TOTAL COST
	Rail Bank Protection @ Pinal Bridge STD. G17.10 Type 1 (A.D.O.T. STD.)	200	L.F.	150.00	30,000
	Berms 2'x5000'	5000	L.F.	2.00	10,000
	Berms 3'x500'	500	L.F.	3.00	1,500
	Miscellaneous Phase I Total				41,500
	Phase I Summary				
	Total Structure Cost				1,895,283
	Total Easement Cost				2,669,751
	Total Drainage Excavation Cost				7,985,470
	Total Miscellaneous Cost				41,500
	TOTAL PHASE I COST				$12,592,004

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Prepared by M.A.I. Preliminary/ Cost Estimate
Checked by ______ Client ______
Reviewed by ______ Tract No./Project ______
Date ______ Job No. 83314

COST ESTIMATE

ITEM No.	DESCRIPTION	ESTIMATED QUANTITY	UNIT	UNIT COST	TOTAL COST
	Southside Streets (Phase III)				
	Subgrade Prep	27,790	S.Y.	3.00	83,370
	Subbase 6"	27,790	S.Y.	2.50	69,475
	Base Course 4"	27,790	S.Y.	1.85	51,412
	2 1/4" Asph. Conc.	27,790	S.Y.	5.00	138,950
	3/4" A.C. Top Course	27,790	S.Y.	1.75	48,632
	Curb & Gutter	14,900	L.F.	6.00	89,400
	Sub-Total				$481,239
	20% Contingency				96,248
	Sub-Total				$577,487
	NOTE: (Cost/L.F. of 32' Street	7,820	L.F.	73.85	
	NOTE: Includes 1st, 2nd & 3rd Avenues				
	Mercedes, Katherine, Sacaton &				
	Washington Streets only, All				
	assumed 32 feet wide.				

CARTER ASSOCIATES, INC.
1550 E. MEADOWBROOK AVE.
PHOENIX, AZ 85014
602 • 265-1744

Prepared by RER **Preliminary** ~~Final~~ **Cost Estimate**
Checked by ______ **Client** City of Casa Grande
Reviewed by ______ **Tract No./Project** Drainage
Date 5/85 **Job No.** 83314

COST ESTIMATE

ITEM No.	DESCRIPTION Southside Neighborhood (Phase III)	ESTIMATED QUANTITY	UNIT	UNIT COST	TOTAL COST
1	10 HP. Pump	1	ea.	2500.00	2,500
2	Pump Installation	1	L.S.	2500.00	2,500
3	Check & Gate Valves 3"	1	2	250.00	500
4	Piping 3" PVC Schd. 40	350	Ft.	3.30	1,155
5	Direct Bury Install	230	Ft.	5.00	1,150
6	Bore & Jack Casing 6"	120	Ft.	100.00	12,000
7	Install Pipe in Casing	120	Ft.	0.50	60
	Sub-Total				$ 19,865
	20% Contingency				3,973
	Pump "Alternate" Total				$ 23,838
	Drywell	5	ea.	4000.00	20,000
	20% Contingency				4,000
	Drywell Alternate Total				$ 24,000
	Retention Basin	19,590	C.Y.	3.50	68,565
	Reseeding	210,000	S.F.	0.10	21,000
	Sub-Total				89,565
	20% Contingency				17,913
	Retention Basin Total				$107,478
	Total Phase III Cost (without alternate cost)				$684,965

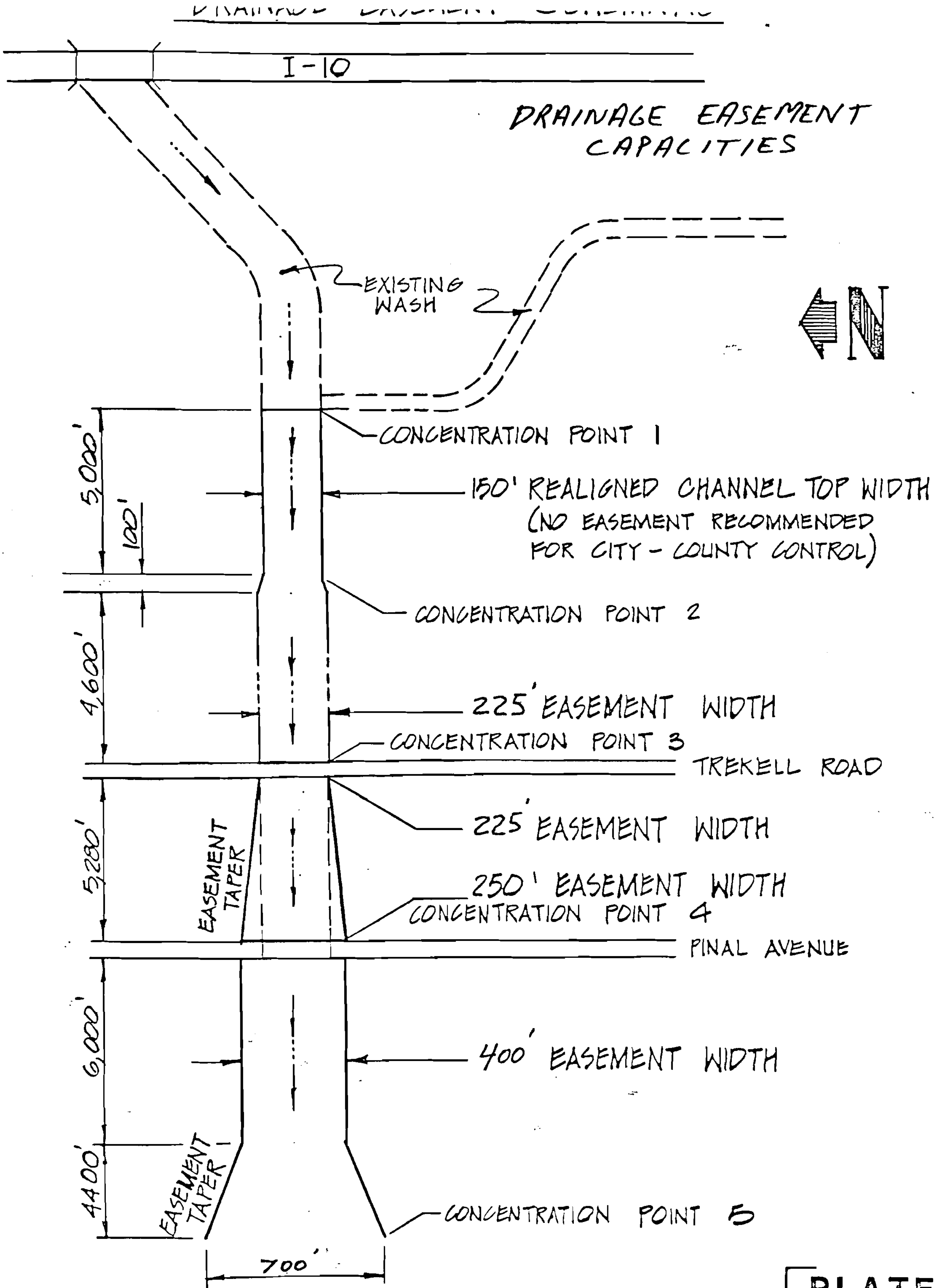
CARTER ASSOCIATES, INC.
1550 E. MEADOWBROOK AVE.
PHOENIX, AZ 85014
602 • 265-1744

Prepared by R.E.R.
Checked by ______
Reviewed by ______
Date 5/85

Preliminary/~~Final~~ Cost Estimate
Client Casa Grande
Tract No./Project ______
Job No. 83314

APPENDIX

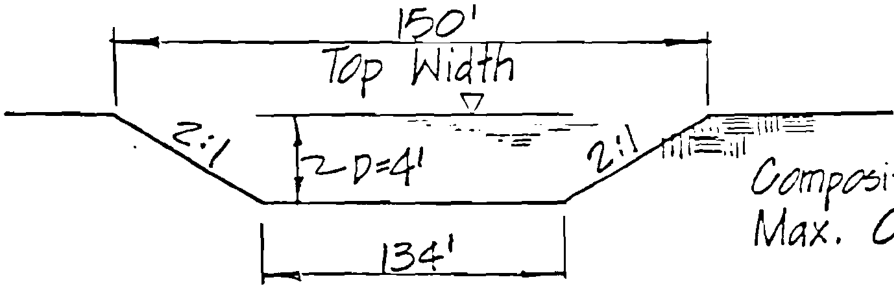
Item	Description
Tables	Hydrology Tables, Rainfall Data Base, "C" Values
Plate No. 1	Drainage Easement Schematic for the North Branch
Plate No. 2	Recommended Channel Geometrics for the North Branch
Plate No. 3	Recommended Bridge Improvements at Pinal Avenue and the North Branch
Plate No. 4	Florence Boulevard Storm Drain Schematic
Plate No. 5	Southside Neighborhood General Drainage Map
Plate No. 6	Southside Neighborhood Drainage Areas
Maps	Drainage Maps 1 thru 10
	Casa Grande Mid and Upper City Drainage Maps
Section 1	Hydrology Calculation Sheets for Casa Grande and Surrounding Areas
	Hydraulic Calculation Sheets with Recommended Drainage Structures
	Hydraulic Calculation Sheets with Recommended drainage Easements and Channels
Section 2	Hydrology and Hydraulic Calculation Sheets for the Southside Neighborhood
Form	Drywell Notice of Disposal Forms
Map Pocket	Master Drainage Map for Casa Grande
	Drainage Easements, Channels and Structure Summary Map



I-10
DRAINAGE EASEMENT CAPACITIES
EXISTING WASH
CONCENTRATION POINT 1
5,000'
100'
150' REALIGNED CHANNEL TOP WIDTH (NO EASEMENT RECOMMENDED FOR CITY - COUNTY CONTROL)
CONCENTRATION POINT 2
4,600'
225' EASEMENT WIDTH
CONCENTRATION POINT 3
TREKELL ROAD
5,280'
EASEMENT TAPER
225' EASEMENT WIDTH
250' EASEMENT WIDTH
CONCENTRATION POINT 4
PINAL AVENUE
6,000'
400' EASEMENT WIDTH
4400'
EASEMENT TAPER
CONCENTRATION POINT 5
700'

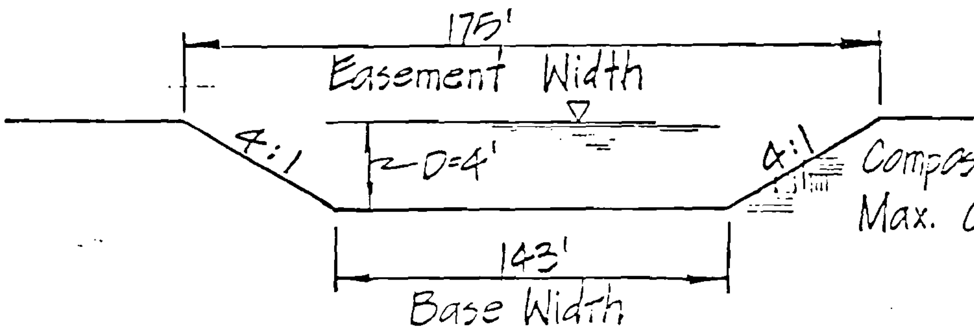
PLATE 1

RECOMMENDED GEOMETRICS



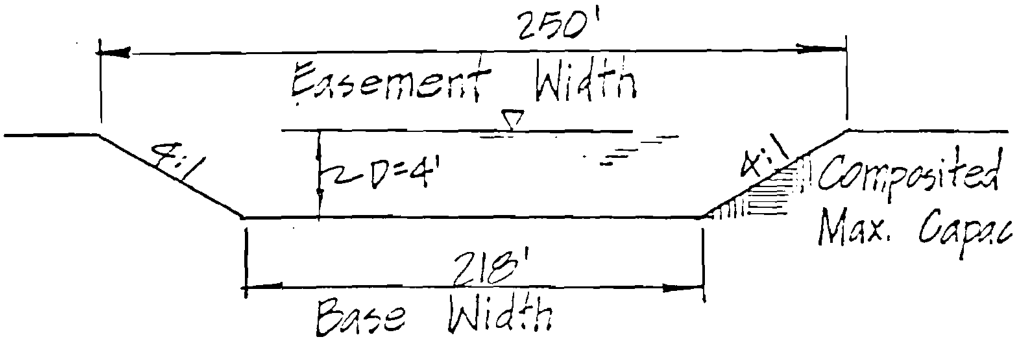
Composited Q100 = 2100 c.f.s.
Max. Capacity Q = 2,580 c.f.s.

CONCENTRATION POINT 1



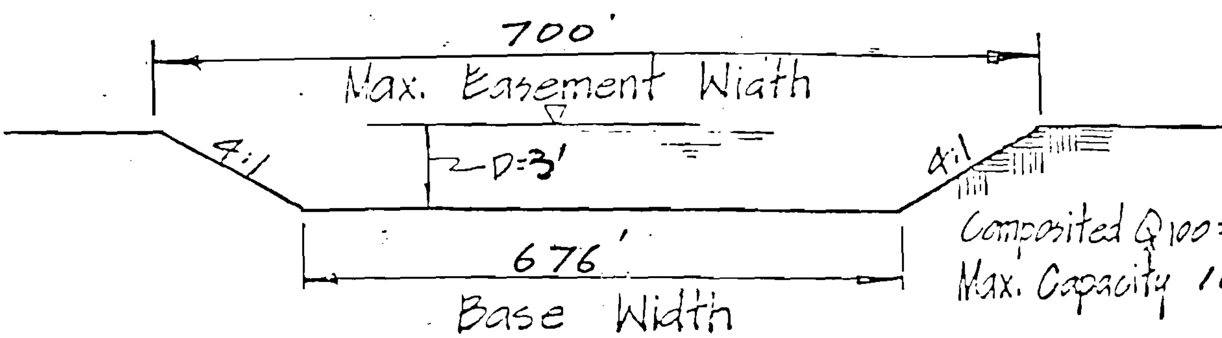
Composited Q100 = 3500 c.f.s.
Max. Capacity Q = 3,220 c.f.s.

CONCENTRATION POINT 2 & 3



Composited Q100 = 4400 c.f.s.
Max. Capacity Q = 4,839 c.f.s.

CONCENTRATION POINT 4



Composited Q100 = 9800 cfs
Max. Capacity 10,100 cfs

CONCENTRATION POINT 5

PLATE 2

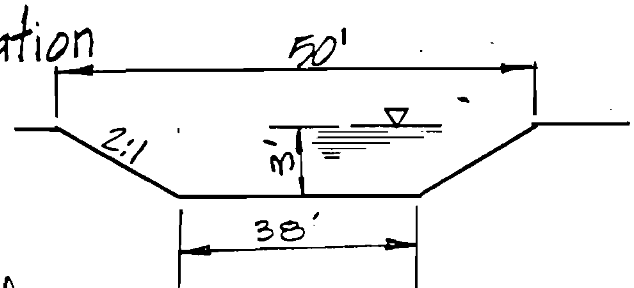
CARTER ASSOCIATES, INC.

Project No. 83314
Project Name Casa Grande Drain. Struct
Sheet No. ______ of ______
Calculated by JK/MT Date 9-13-85
Checked by MT Date 10-1-85

EXISTING CONDITIONS

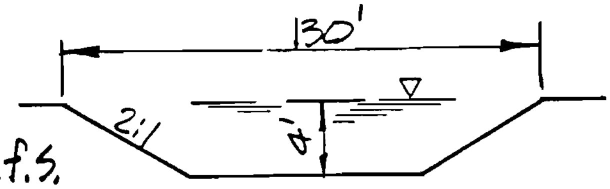
North Branch Wash

Existing Capacities @ Concentration Point 3.



Upstream Of Trekell:

$S \approx 0.0011$ '/ft.
Velocity = 3.7 '/sec.
Existing Capacity = 489 c.f.s.



Downstream Of Trekell:

$S \approx 0.0011$ '/ft.
Velocity = 4.7 '/sec.
Existing Capacity = 2309 c.f.s.

Estimates Based On Mannings n = 0.025

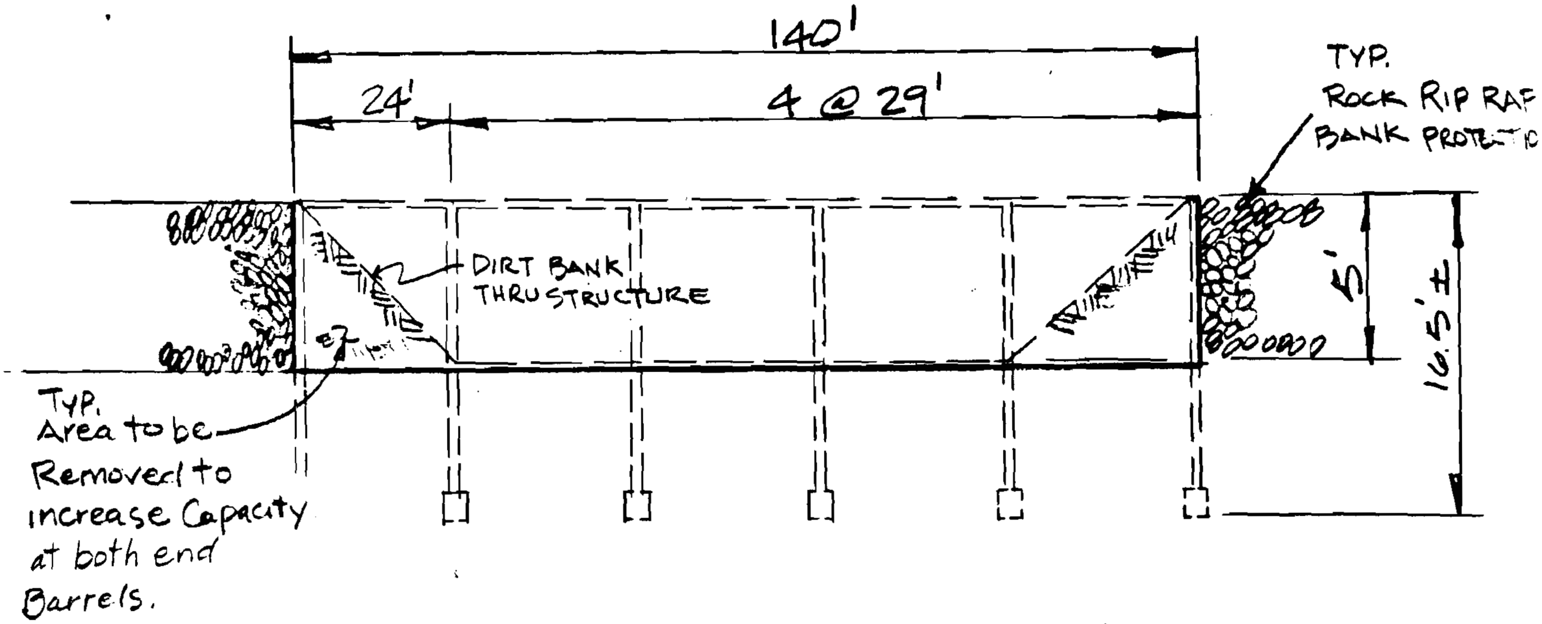
Note: No Existing Structure Under Trekell Road
Q_{100} = 3500 c.f.s.

1550 EAST MEADOWBROOK AVE. • PHOENIX, ARIZONA 85014 • (602) 265-1774

CARTER ASSOCIATES, INC.

Project No. 83314
Project Name Casa Grande Drainage Struc
Sheet No. ____ of ____
Calculated by J.F.K. Date 13 NOV
Checked by M.T Date ____

Existing Carrying Capacity Of North Branch Bridge @ Pinal Avenue "Downstream Section".



Given : Average Slope = 0.0013 1/ft.

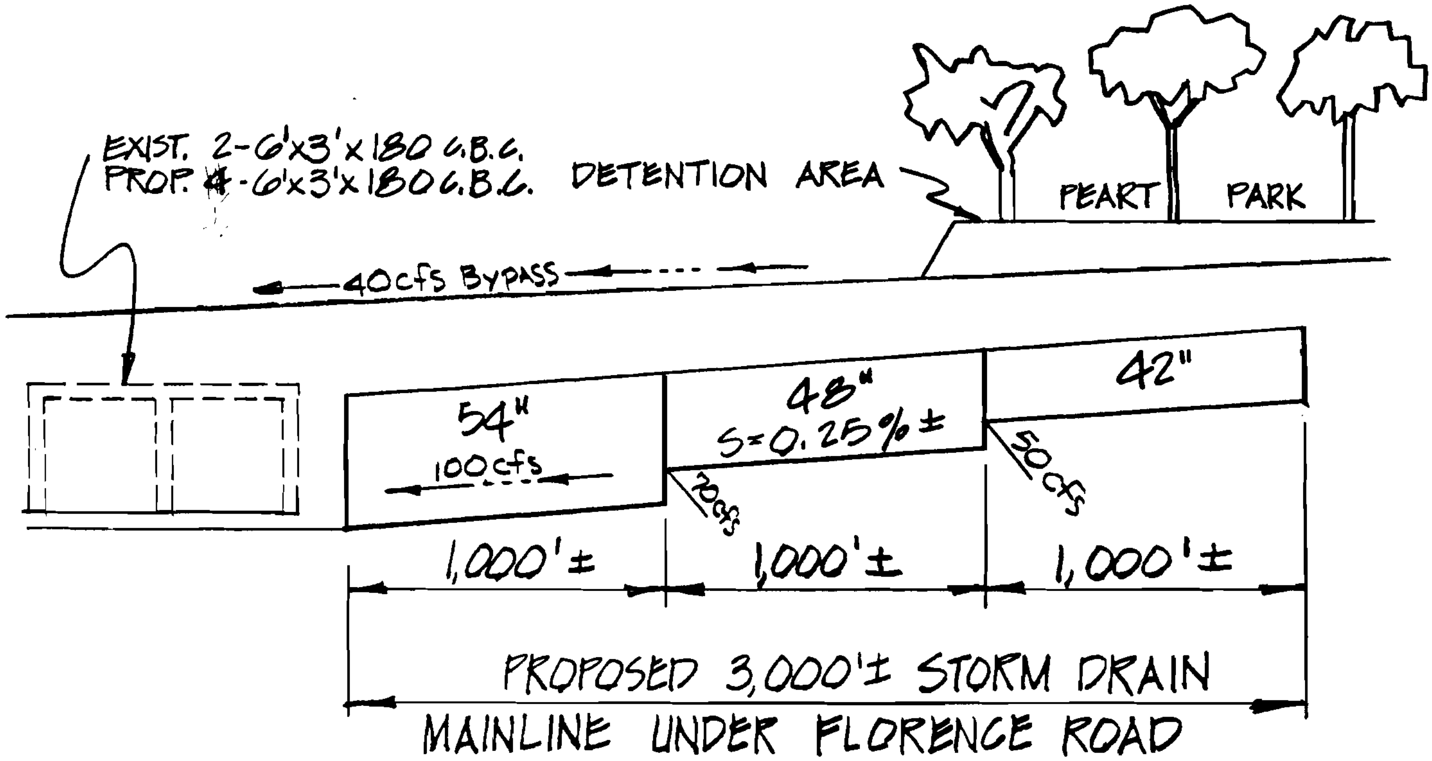
Mannings "n" = 0.025

Wetted Area "A" = 60 ft² + 435 ft² + 73 ft.²
"A" = 568 ft²

Wetted Perimeter "P" = 24.5 ft. + 87 ft + 29.4 ft.
"P" = 141 ft

Q EXISTING = 3092 c.f.s.
Improved Q = 4203 c.f.s. (with end barrels cleaned out)
Requires 250' Easement

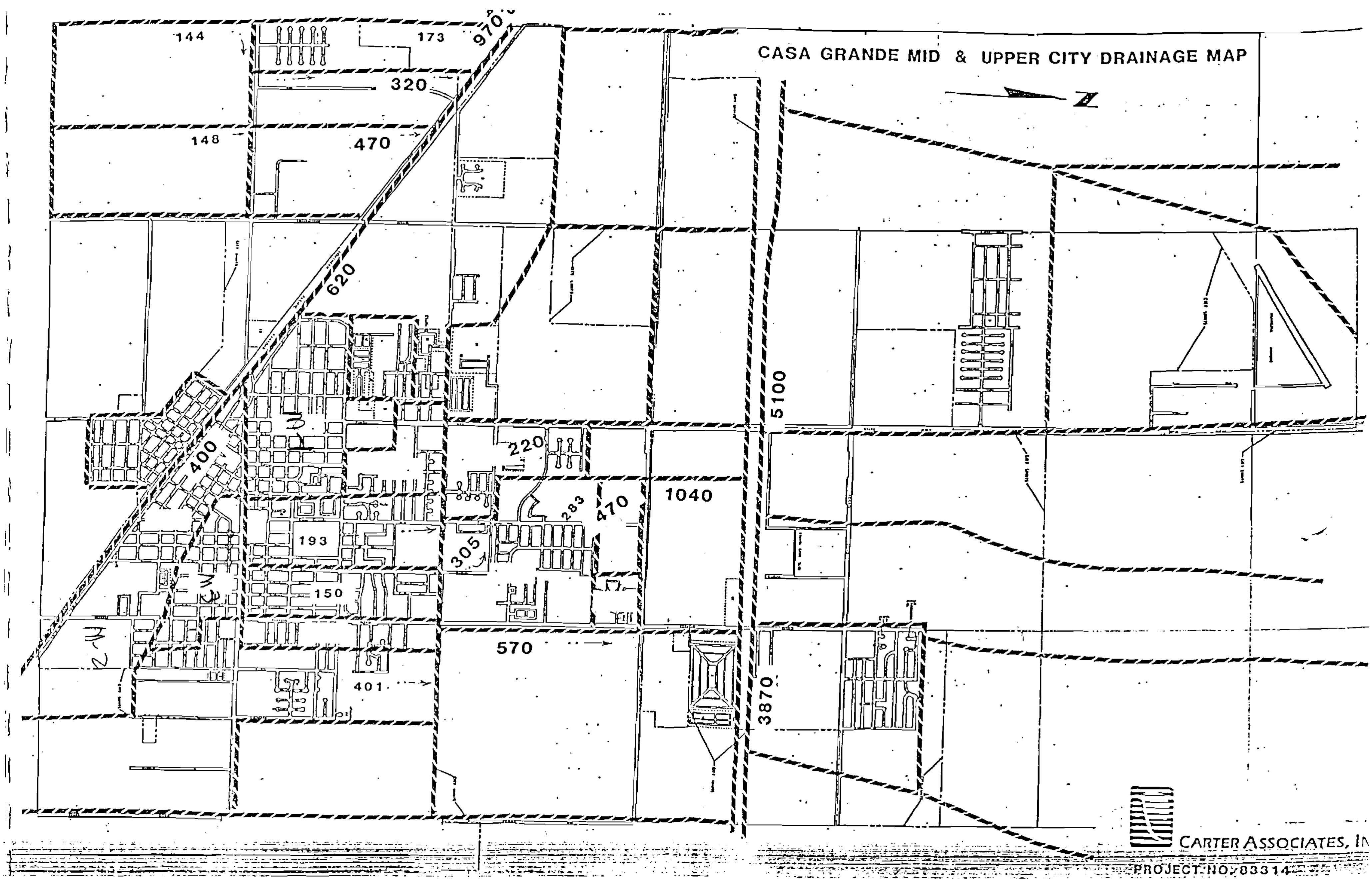
PLATE 3

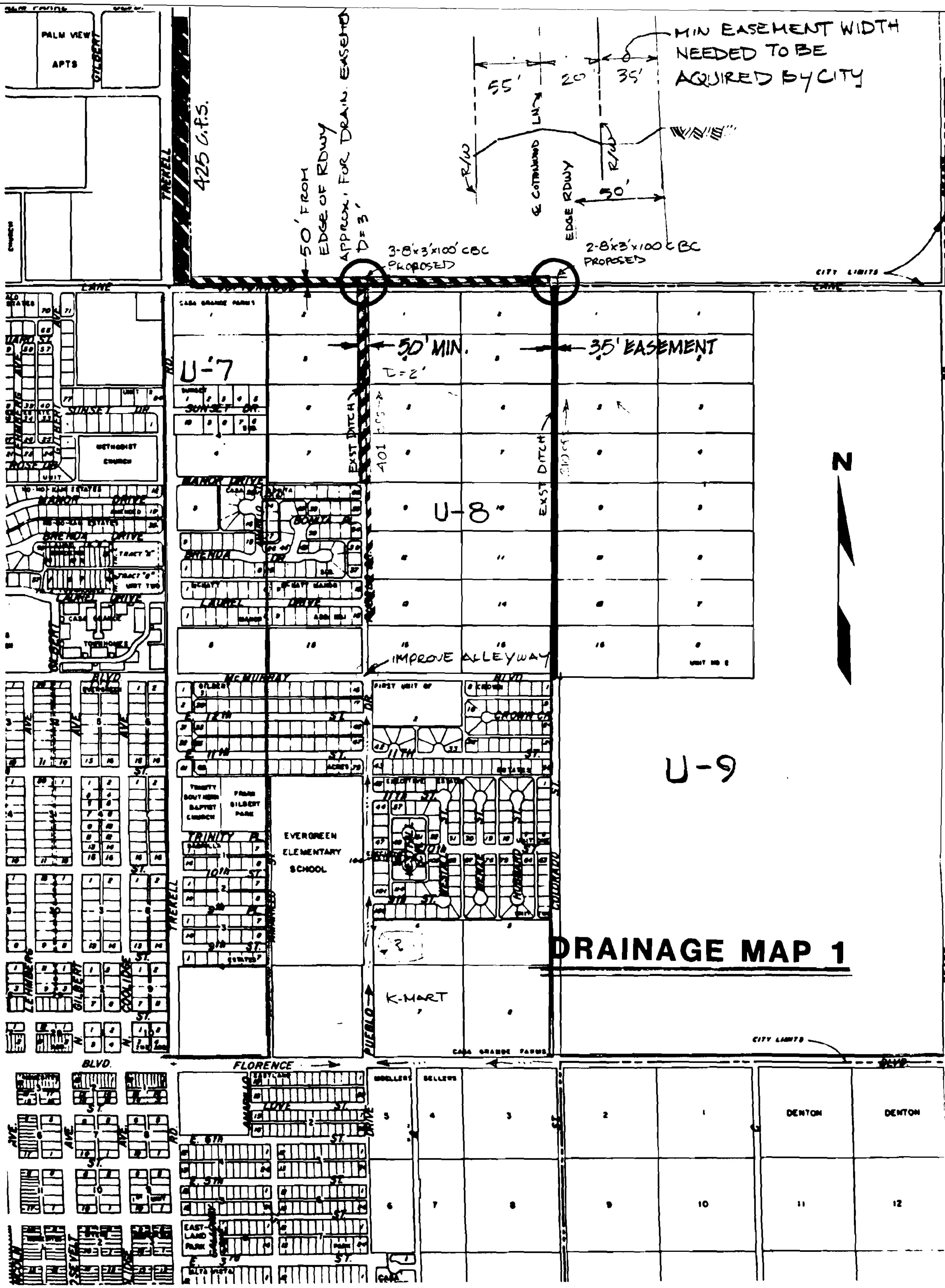


FLORENCE BLVD.

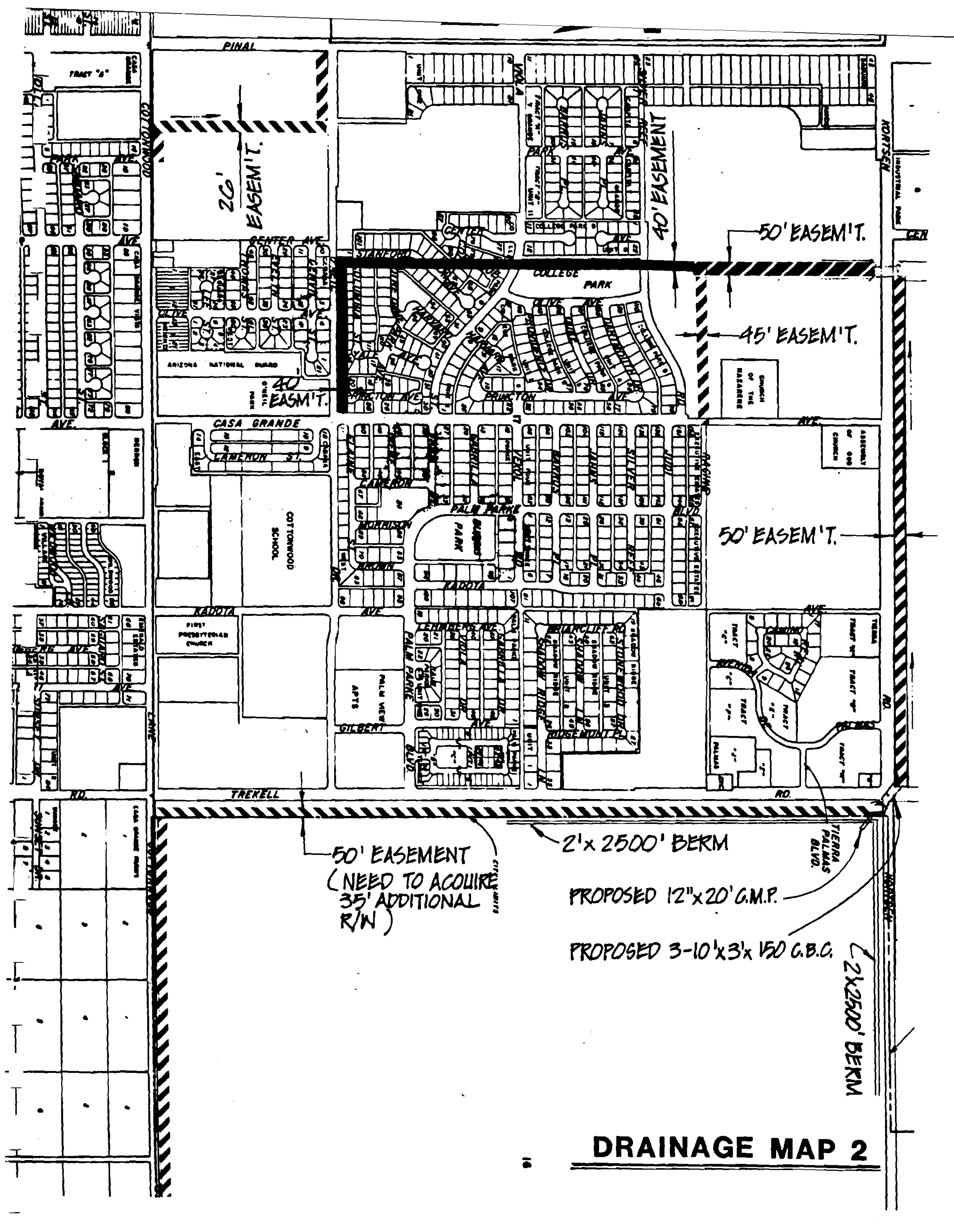
STORM DRAIN SCHEMATIC

PLATE 4

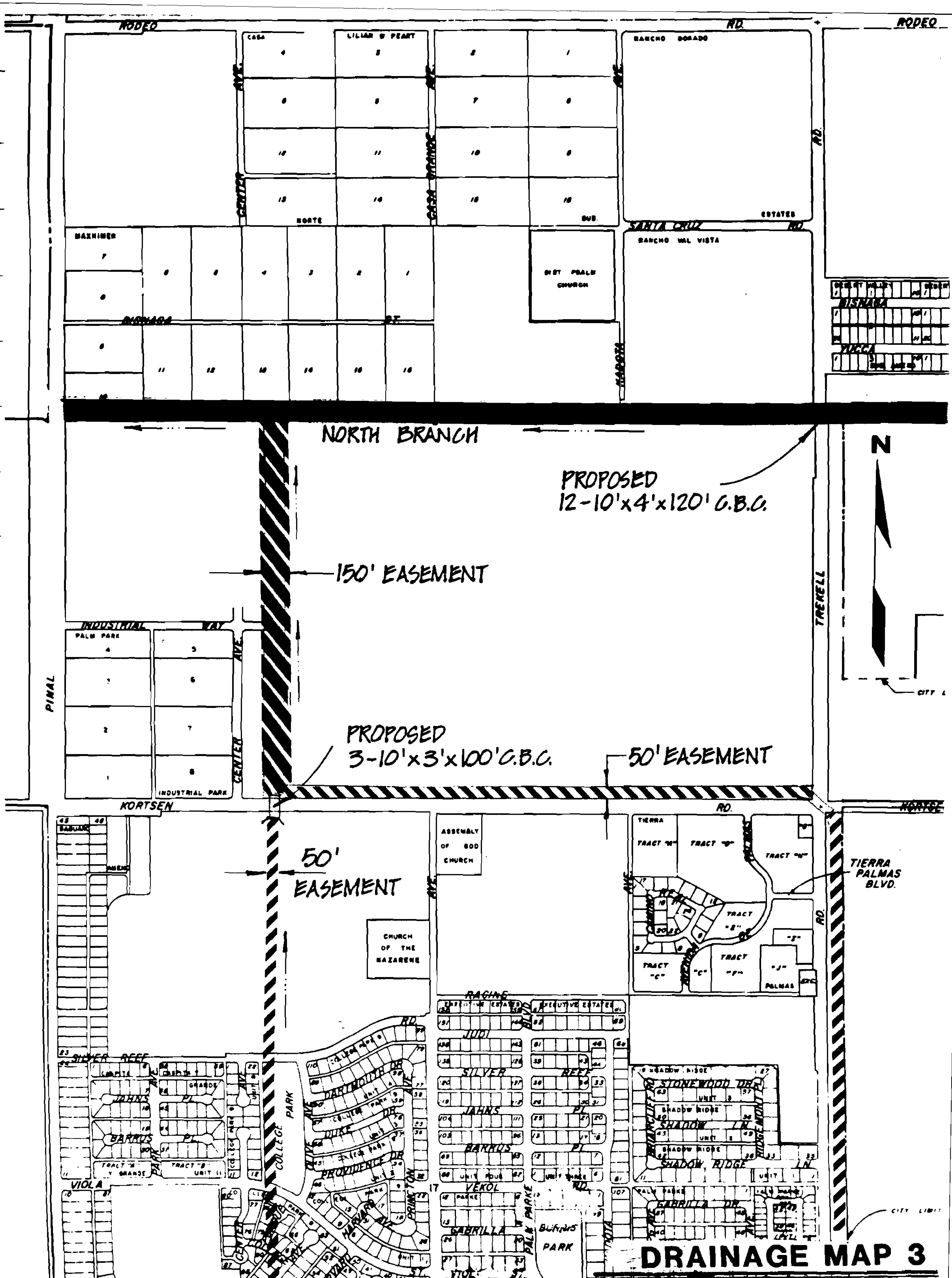

CASA GRANDE MID & UPPER CITY DRAINAGE MAP
N
144
173
970
320
148
470
620
400
193
150
220
283
470
1040
305
5100
570
401
3870
CARTER ASSOCIATES, IN
PROJECT NO. 83314



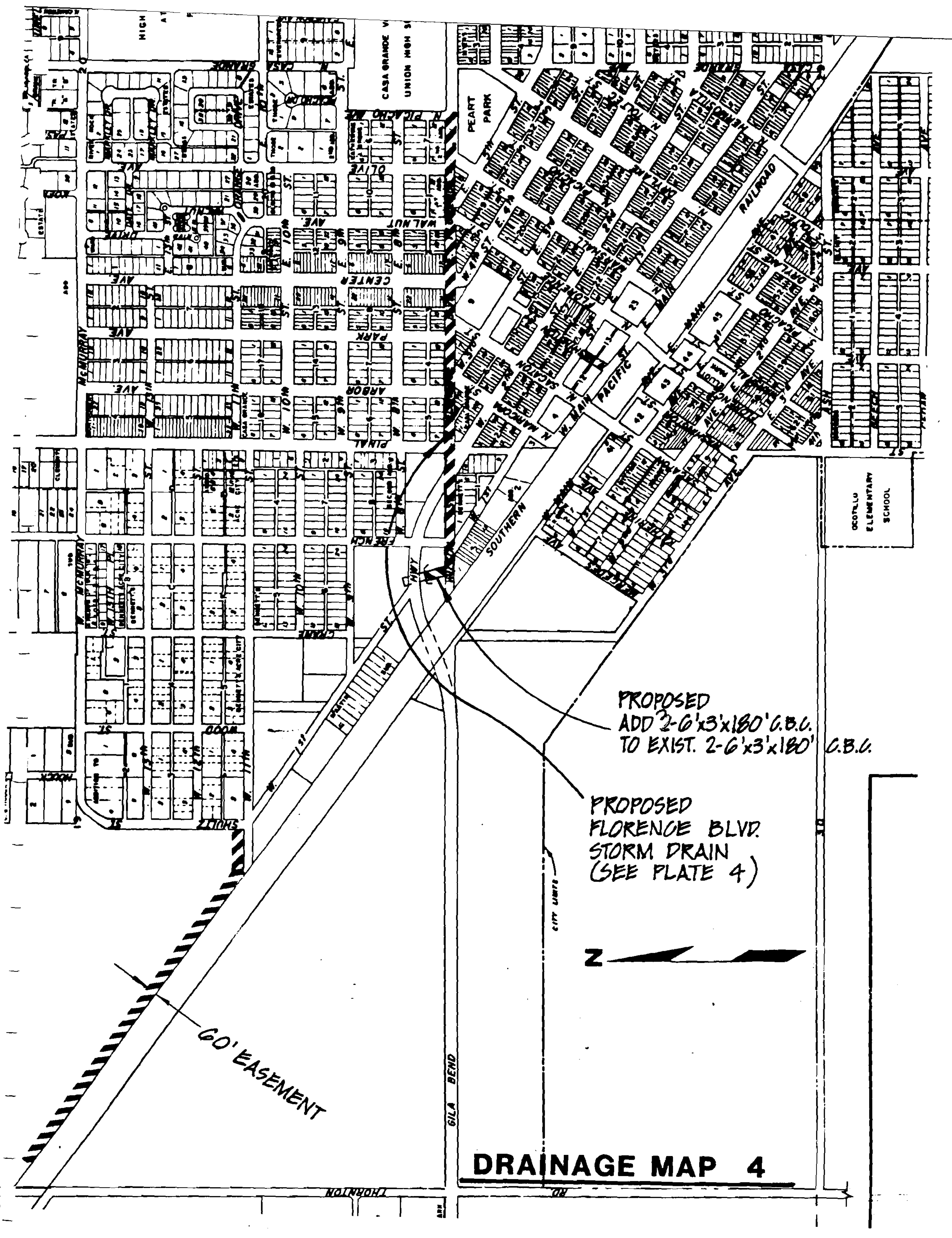
MIN EASEMENT WIDTH NEEDED TO BE AQUIRED BY CITY
55'
20'
35'
R/W
℄ COTTONWOOD LN
EDGE RDWY
50'
50' FROM EDGE OF RDWY APPROX. FOR DRAIN. EASEMT D=3'
425 C.F.S.
3-8'x3'x100' CBC PROPOSED
2-8'x3'x100' CBC PROPOSED
CITY LIMITS
LANE
PALM VIEW APTS
GILBERT
TRERELL
50' MIN.
35' EASEMENT
D=2'
U-7
U-8
U-9
EXST DITCH
401
EXST DITCH
METHODIST CHURCH
SUNSET DR.
MANOR DRIVE
BRENDA DRIVE
LAUREL DRIVE
IMPROVE ALLEYWAY
McMURRAY BLVD
N
EVERGREEN ELEMENTARY SCHOOL
TRINITY SOUTHERN BAPTIST CHURCH
FRANK GILBERT PARK
K-MART
FLORENCE BLVD
PUEBLO
DRAINAGE MAP 1
DENTON
DENTON

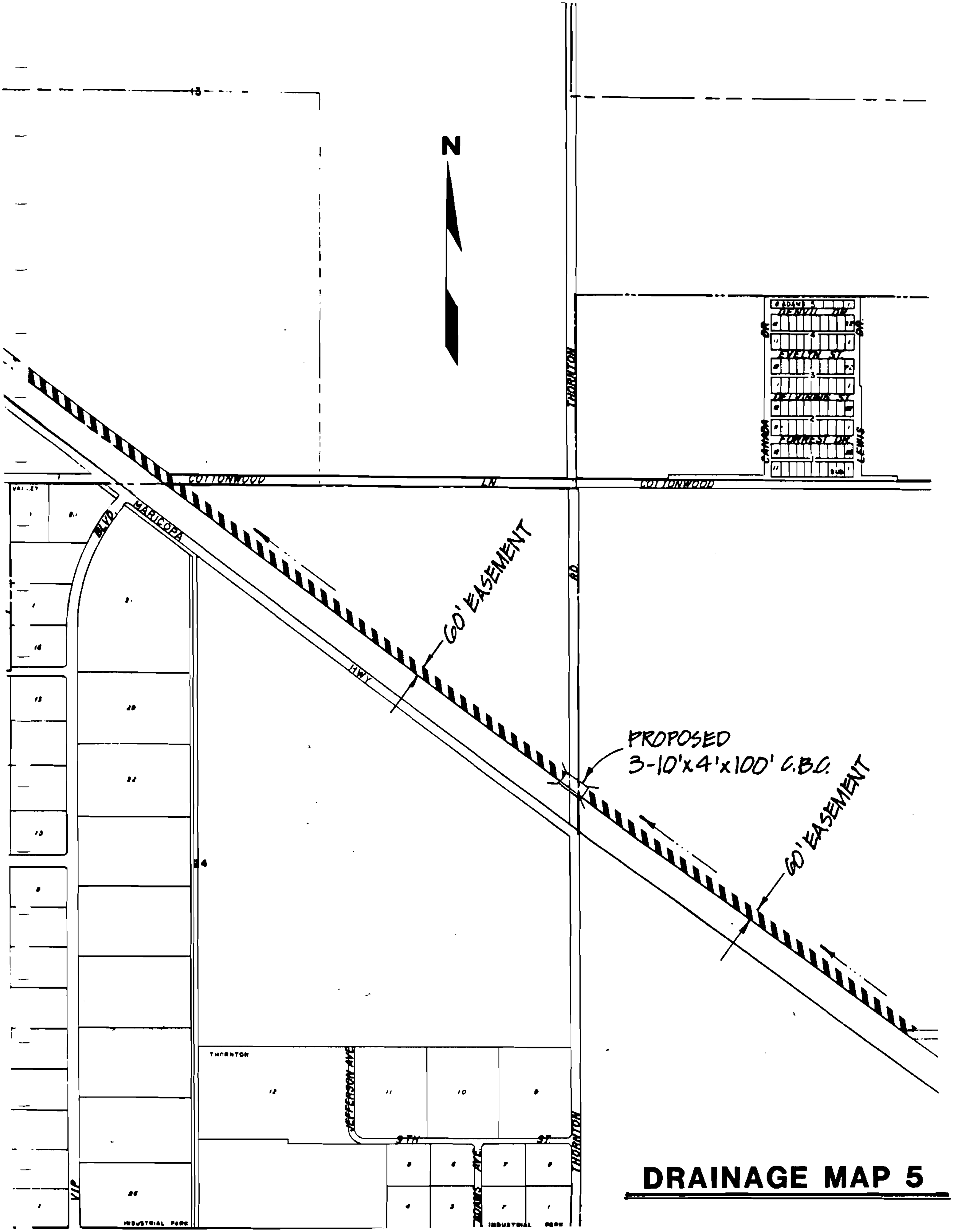


DRAINAGE MAP 2

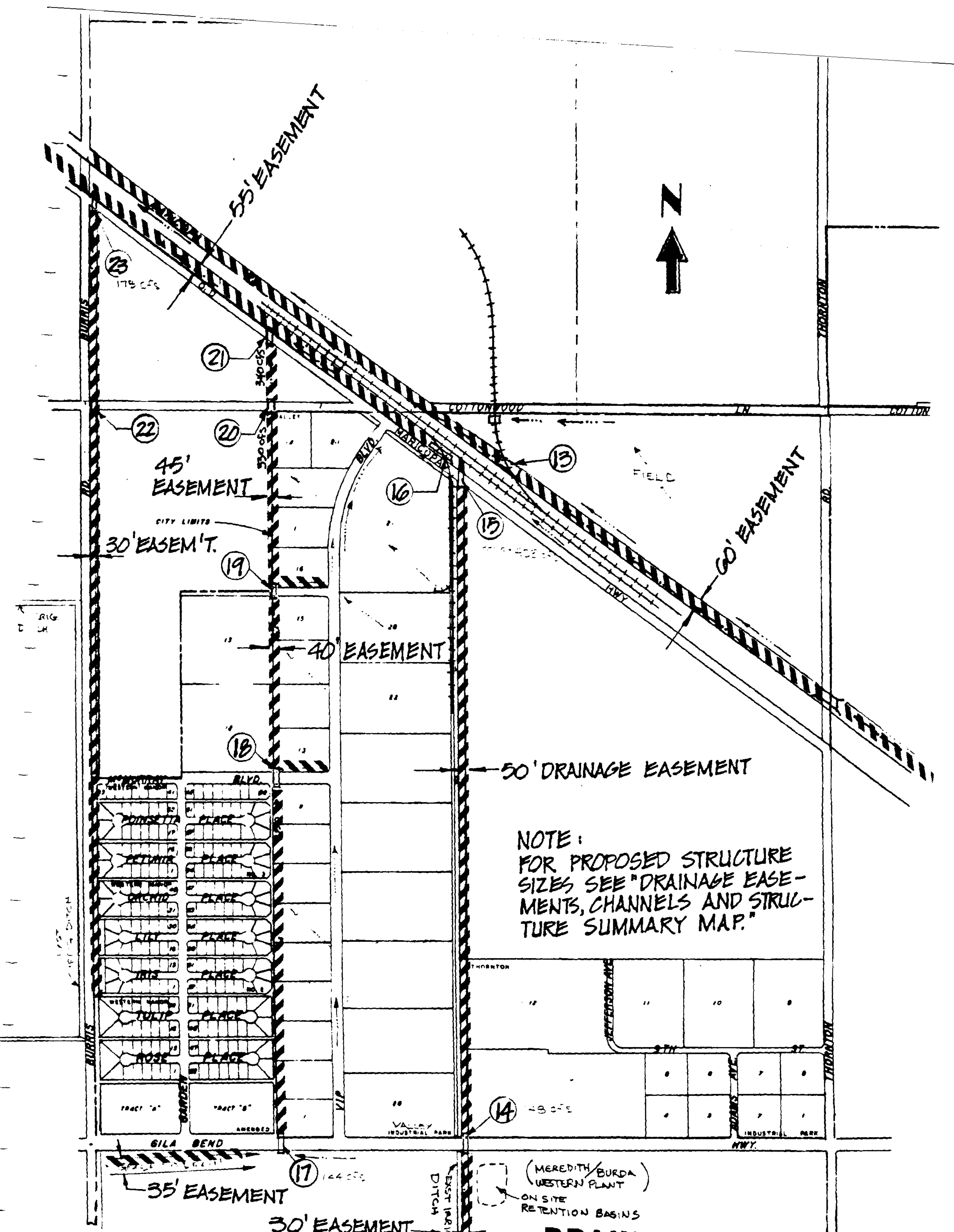


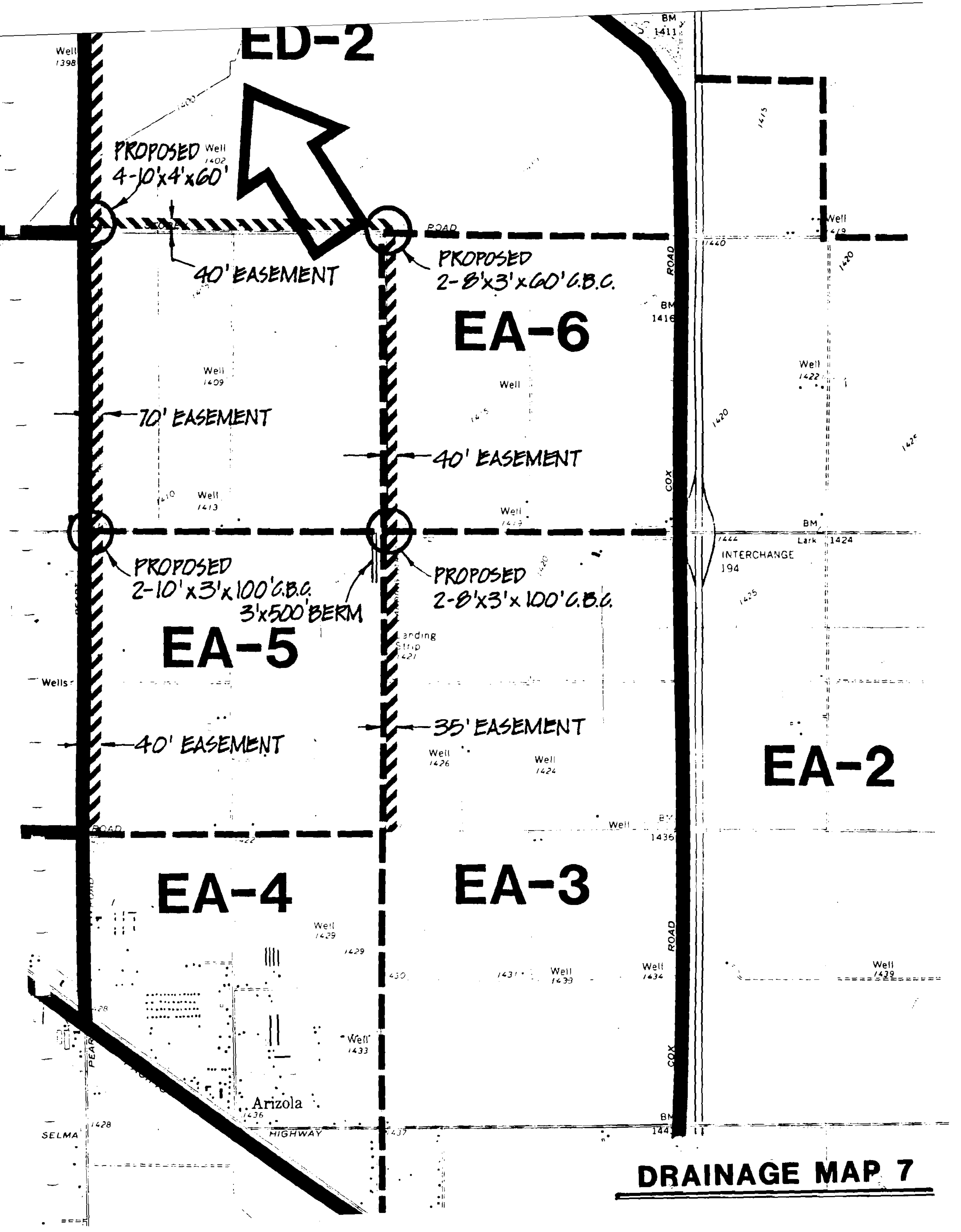
DRAINAGE MAP 3


PROPOSED
ADD 2-6'x3'x180' C.B.C.
TO EXIST. 2-6'x3'x180' C.B.C.
PROPOSED
FLORENCE BLVD.
STORM DRAIN
(SEE PLATE 4)
60' EASEMENT
Z
DRAINAGE MAP 4
PEART PARK
CASA GRANDE UNION HIGH SCHOOL
OCOTILLO ELEMENTARY SCHOOL
RAILROAD
SOUTHERN
PACIFIC
GILA BEND
THORNTON
RD.
CITY LIMITS
WALNUT
CENTER
PARK
ARBOR
PINAL
OLIVE
FRENCH
MCMURRAY
SACATON
MARICOPA
CRANE
WOOD
SCHULTZ

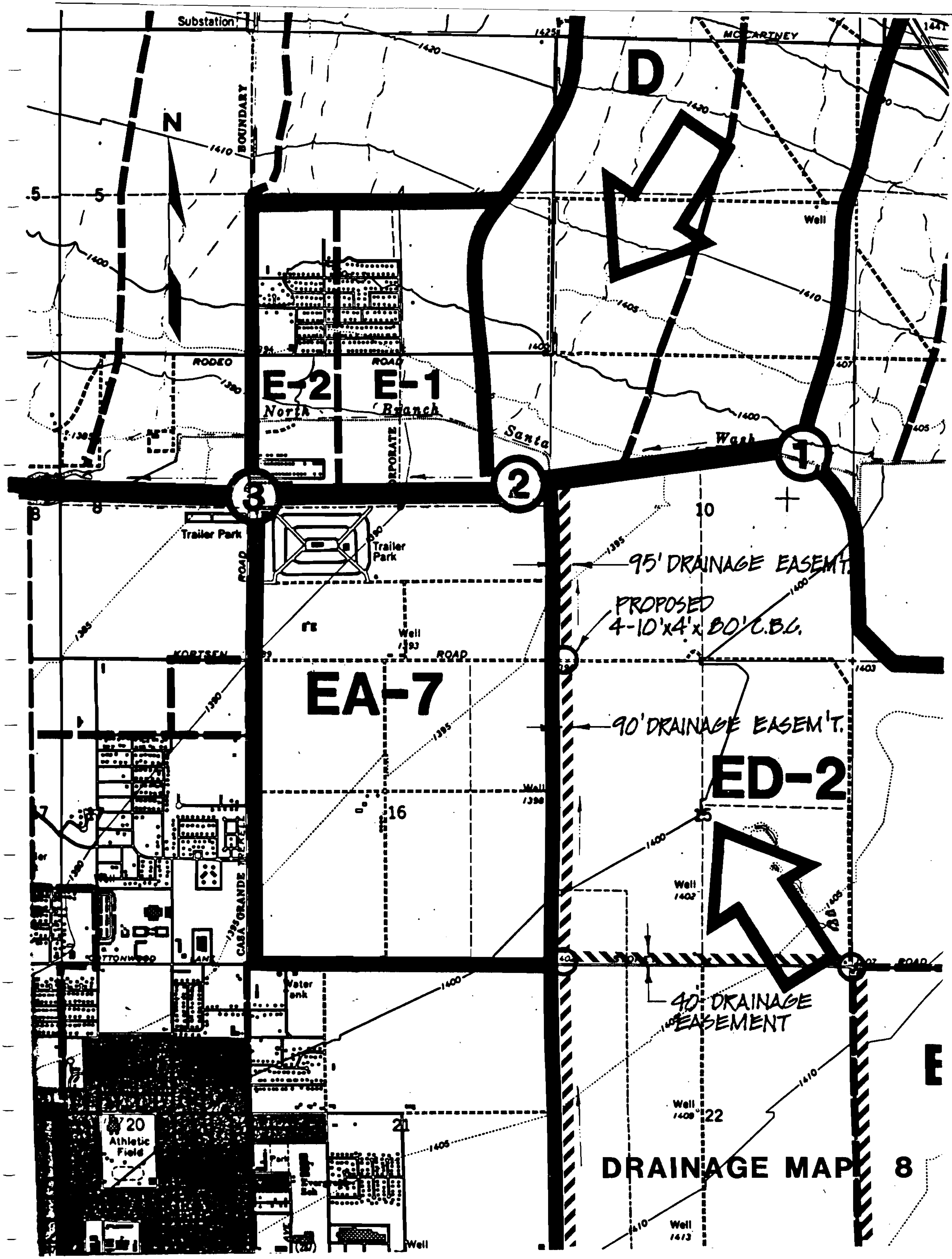


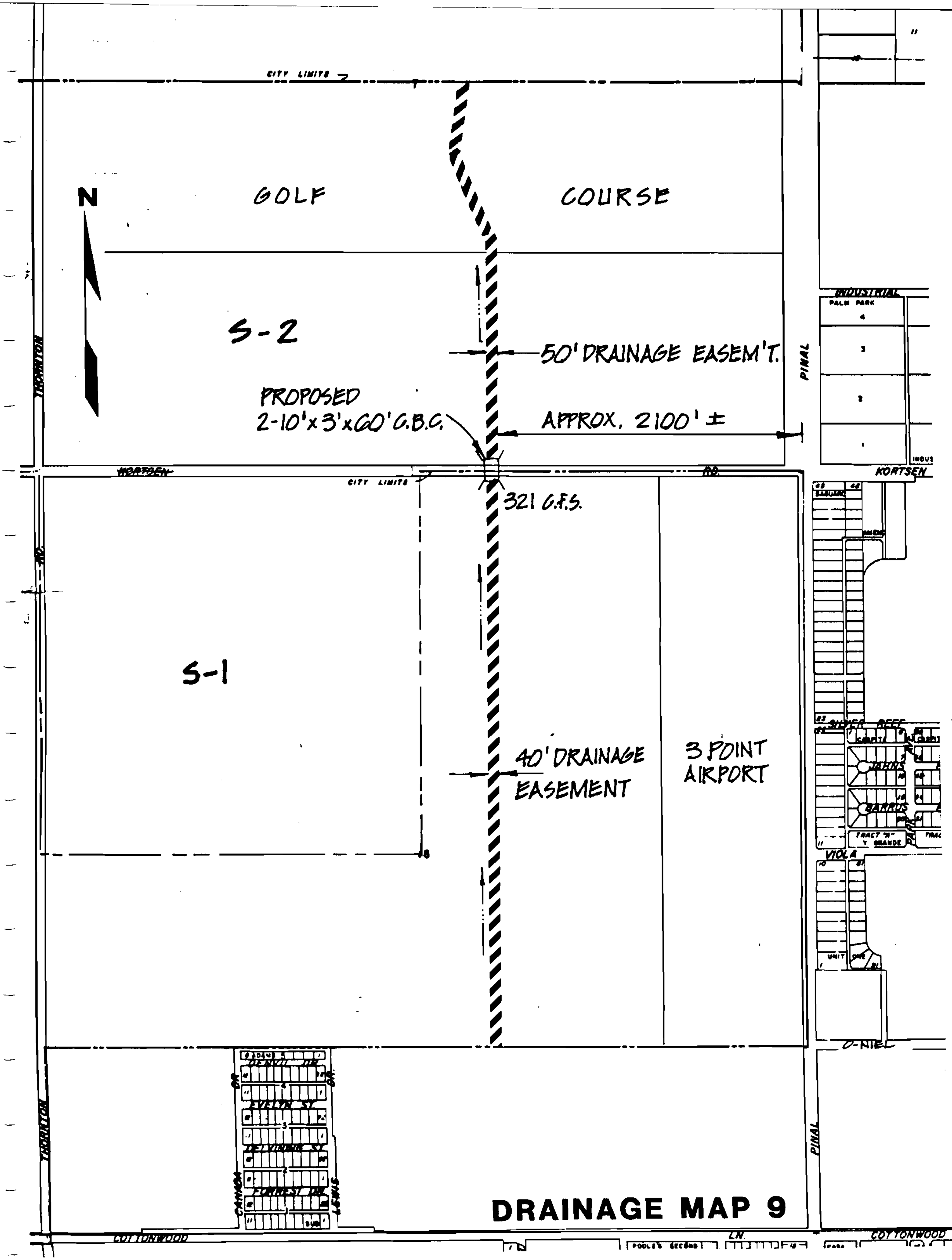
DRAINAGE MAP 5


55' EASEMENT
N
23
175 CFS
21
340 CFS
22
20
330 CFS
45' EASEMENT
CITY LIMITS
30' EASEM'T.
19
40' EASEMENT
18
COTTONWOOD
LN.
COTTON
MARICOPA
BLVD.
16
15
13
FIELD
HWY
60' EASEMENT
50' DRAINAGE EASEMENT
NOTE:
FOR PROPOSED STRUCTURE SIZES SEE "DRAINAGE EASEMENTS, CHANNELS AND STRUCTURE SUMMARY MAP."
BURRIS RD.
THORNTON RD.
POINSETTIA PLACE
PETUNIA PLACE
ORCHID PLACE
LILY PLACE
IRIS PLACE
TULIP PLACE
ROSE PLACE
GARDEN
VIP
THORNTON
JEFFERSON AVE
9TH ST.
VALLEY INDUSTRIAL PARK
INDUSTRIAL PARK
GILA BEND
HWY.
14
17
35' EASEMENT
30' EASEMENT
EAST IRRIG. DITCH
(MEREDITH/BURDA WESTERN PLANT)
ON SITE RETENTION BASINS

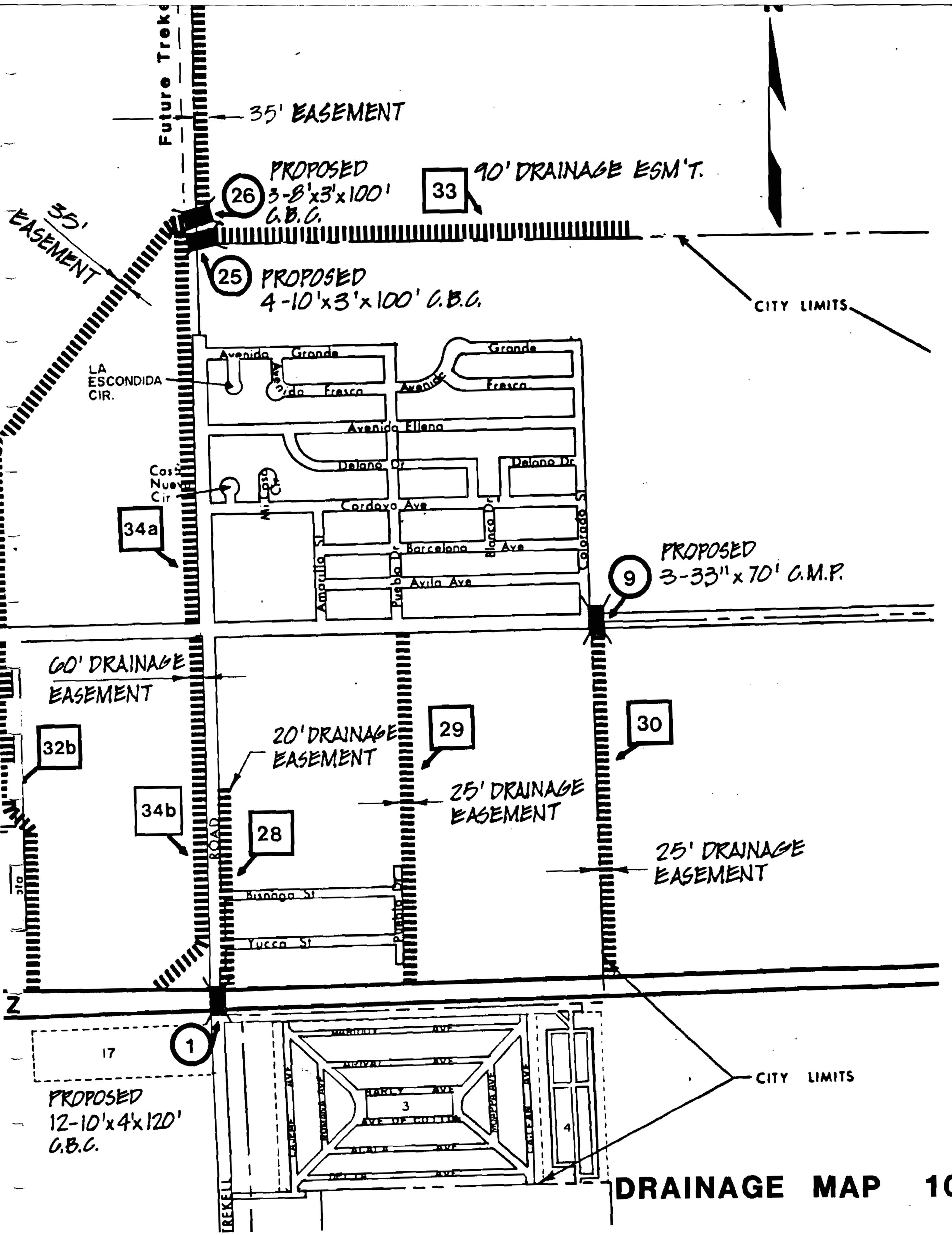


DRAINAGE MAP 7


Substation
McCARTNEY
D
N
BOUNDARY
RODEO
ROAD
E-2
E-1
North Branch Santa Wash
CORPORATE
Trailer Park
Trailer Park
ROAD
95' DRAINAGE EASEM'T.
PROPOSED
4-10'x4'x 80' C.B.C.
Well
KORTSEN
ROAD
EA-7
90' DRAINAGE EASEM'T.
ED-2
Well
CASA GRANDE
COTTONWOOD
ROAD
Water Tank
40' DRAINAGE EASEMENT
E
Athletic Field
Well
DRAINAGE MAP 8
Well



DRAINAGE MAP 9



DRAINAGE MAP 10

HYDROLOGICAL STUDY FOR

CASA GRANDE

DRYWELL NOTICE OF DISPOSAL FORMS

BY

CARTER ASSOCIATES, INC.

1550 E. MEADOWBROOK AVENUE

PHOENIX, ARIZONA 85015

09/13/85

INSTRUCTIONS FOR COMPLETING

DRYWELL NOTICE OF DISPOSAL

1. Indicate in the upper right hand corner of the form whether the facility is new or existing. If the drywells were in existence prior to July 20, 1984, check existing.

2. I.A.-Provide a name by which the facility may be referred to in all correspondence between involved entities. The location address should be a street address or descriptive in relation to major streets, e.g., ¼ mile east of Major St. on Minor Rd.

3. I.B.-Indicate the owner of the facility whenever possible. In any case supply the party responsible for causing the wells to be drilled.

4. I.C.-The contact person should be a person of responsibility with which the Department can deal during and after the permitting process. More than one person may be provided.

5. I.D.-Give the location of the facility (not each drywell) in the township, range format. Break the section down to a ten acre parcel if possible (¼,¼,¼).

6. I.E.-Briefly describe the nature of the activity conducted at the facility. If it is a subdivision or apartment complex, so state.

7. II.A.-Provide the total number of drywells at this facility, and include construction details.

8. II.B.-Give the total drainage area that will feed into the drywells. Describe what those areas are, e.g., roofs and parking lots only, or air conditioning condensate, etc.

9. II.C.-Obtain the most recent water table depth available. Give source of the data whether direct well measurement, driller's information, or an agency such as the Department of Water Resources (DWR). DWR is probably the best source in most cases. If the measurement is of a perched water table, so indicate. Include the date of the measurement when possible.

10. Include a site plan of the facility, sign the signature page, and mail or deliver the form to:

    Arizona Department of Health Services
    Water Permits Unit, Room 300
    2005 N. Central Ave.
    Phoenix, Arizona 85004

11. Any questions concerning this form may be directed to the above address or to (602) 257-2270.

ARIZONA DEPARTMENT OF HEALTH SERVICES
NOTICE OF DISPOSAL
FOR
STORM WATER DRYWELLS

New Facility ___
Existing Fac ___

I. Facility Information

A. Facility/Project Name ______________________________

Location Address ______________________________

______________________ Zip Code __________

B. Owner/Developer ______________________________

Mailing Address ______________________________

______________________ Zip Code __________

Telephone Number ______________________
(Area Code)

C. Contact Person ______________________ Title __________

Telephone Number ______________________
(Area Code)

D. Physical Location: Township __________, Range __________
Section ____, ____¼, ____¼, ____¼

E. Nature of Business ______________________________

____

____

II. Disposal Information

A. Number of Drywells __________ Overall Depth(s) ______________

B. Total Drainage Area __________

Drainage Area Description ______________________________

____

C. Depth to Groundwater ____________ Date of Measurement __________

Source of Data ______________________________
(Give well locations if applicable)

D. Include site plan and vicinity map showing the locations of the drywells, delineation of the drainage areas, locations of any production wells. Also show calculations used in designing for rainfall events.

III. Minimum Construction Requirements

All drywells of this type must be constructed in accordance with the following criteria:

A. Shall be set back at least 100 feet from any surrounding water production wells.

B. Shall not penetrate any saturated zones.

C. Shall be completed at least 10 feet above any groundwater.

IV. Certification:

"I certify that under penalty of law that I have personally examined and am familiar with the information submitted in this document and all attachments and that, based on my inquiry of those individuals immediately responsible for obtaining the information, I believe that the information is true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment."

Printed Name of Applicant	Title
Date Application Signed	Signature of Applicant

HYDROLOGICAL STUDY FOR

CASA GRANDE

HYDROLOGY TABLES

BY

CARTER ASSOCIATES, INC.

1550 E. MEADOWBROOK AVENUE

PHOENIX, ARIZONA 85015

11/18/85

CARTER ASSOCIATES, INC.
PHOENIX, ARIZONA
09/11/85

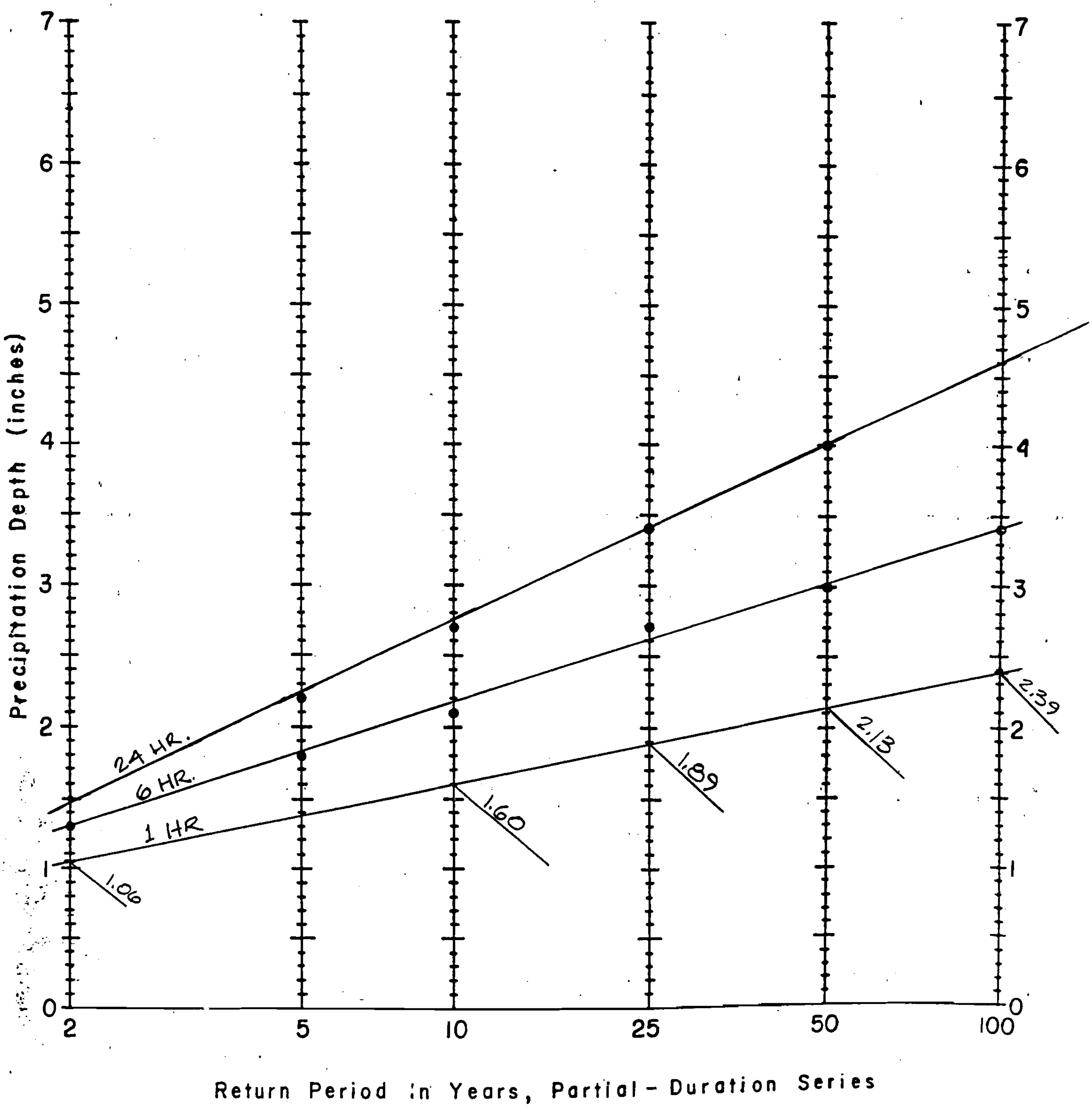
CASA RAINFALL DATA BASE

RAINFALL INTENSITY (Inches/Hour)

TIME (Min)	STORM FREQUENCY (Years) 2	5	10	25	50	100
5.0	3.69	4.80	5.57	6.58	7.41	8.32
6.0	3.52	4.59	5.32	6.28	7.08	7.95
7.0	3.36	4.37	5.07	5.99	6.75	7.57
8.0	3.19	4.15	4.82	5.67	6.42	7.20
9.0	3.03	3.94	4.57	5.40	6.09	6.82
10.0	2.86	3.72	4.32	5.10	5.75	6.45
11.0	2.77	3.61	4.19	4.94	5.57	6.25
12.0	2.68	3.49	4.05	4.79	5.39	6.05
13.0	2.60	3.38	3.92	4.63	5.20	5.84
14.0	2.51	3.26	3.78	4.48	5.02	5.64
15.0	2.42	3.15	3.65	4.32	4.86	5.44
20.0	2.14	2.77	3.23	3.76	4.27	4.74
25.0	1.86	2.43	2.83	3.33	3.77	4.19
30.0	1.67	2.18	2.53	3.05	3.37	3.78
40.0	1.35	1.78	2.08	2.44	2.75	3.09
50.0	1.18	1.53	1.80	2.09	2.37	2.69
60.0	1.06	1.38	1.60	1.89	2.13	2.39
120.0	0.57	0.77	0.90	1.07	1.22	1.37
180.0	0.40	0.54	0.65	0.76	0.88	0.99
240.0	0.30	0.41	0.50	0.62	0.68	0.77
300.0	0.24	0.33	0.41	0.50	0.56	0.65
360.0	0.22	0.30	0.36	0.43	0.50	0.57
480.0	0.17	0.24	0.29	0.35	0.40	0.46
600.0	0.14	0.20	0.25	0.29	0.33	0.39
720.0	0.12	0.17	0.21	0.25	0.29	0.33
1080.0	0.09	0.13	0.14	0.18	0.20	0.25
1440.0	0.06	0.09	0.11	0.14	0.17	0.19

Project No. 83314 Station ______

CASA GRANDE



Precipitation Depth Versus Return Period for Partial - Duration Series

TABLE 1

Return Period (Years)	Precipitation Values (inches)			
	6 hour duration		24 hour duration	
	Map Value	Corrected Value	Map Value	Corrected Value
2	1.3	1.30	1.5	1.48
5	1.8	1.82	2.2	2.24
10	2.1	2.19	2.7	2.77
25	2.7	2.60	3.4	3.42
50	3.0	3.02	4.0	4.01
100	3.4	3.40	4.6	4.60

1 HR. PREC.

$$Y_2 = -0.011 + \left[0.942\left(1.3^2/1.48\right)\right] = 1.06$$

$$Y_{100} = 0.494 + \left[0.755\left(3.4^2/4.6\right)\right] = 2.39$$

RATIONAL METHOD

'C' VALUES

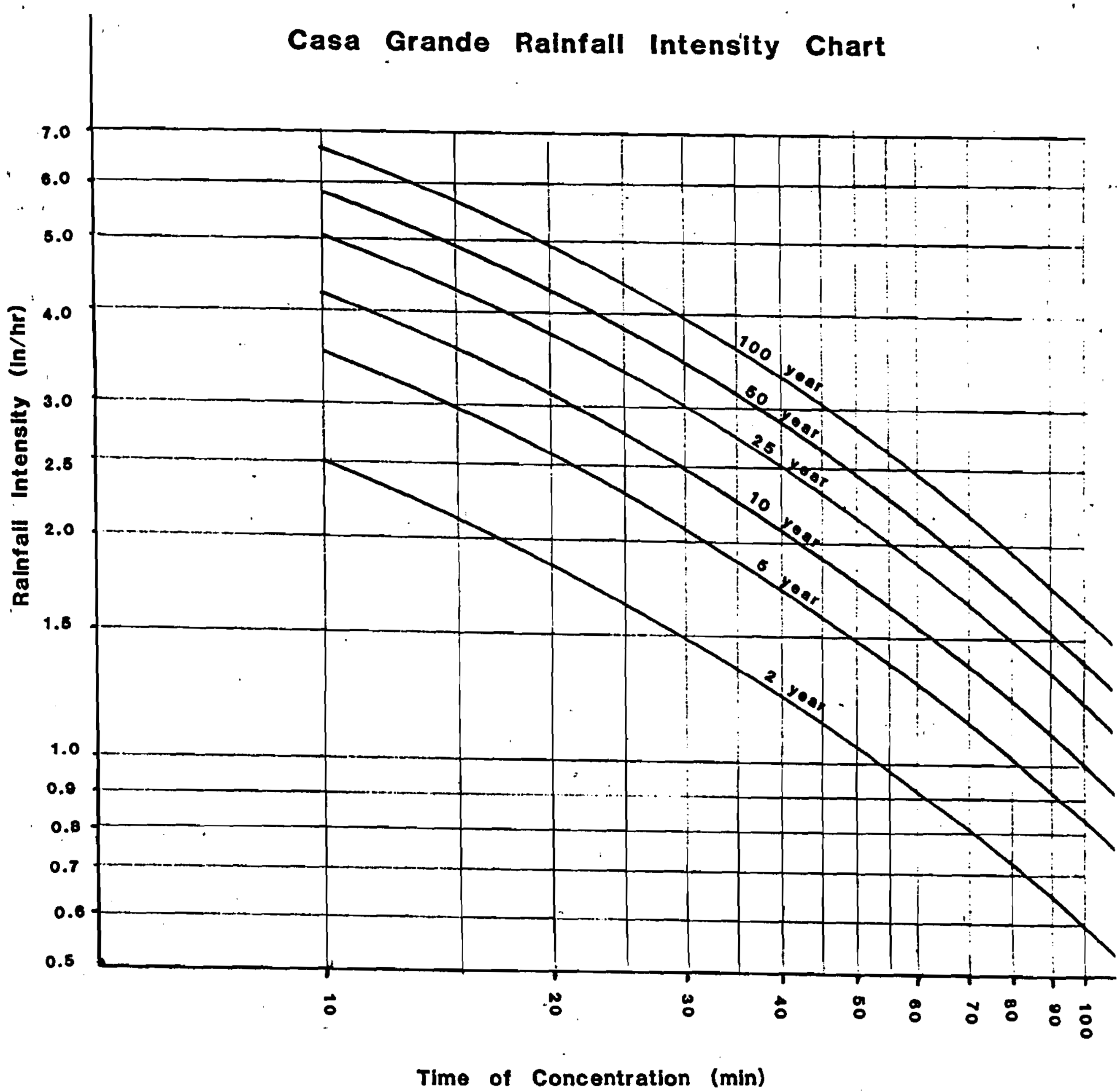
Streets	
Asphaltic	0.70 - 0.95
Concrete	0.80 - 0.95
Gravel roadways & shoulders	0.40 - 0.60
Industrial Areas	
Flat commercial - about 90% of area impervious	0.80
Heavy areas	0.60 - 0.90
Light areas	0.50 - 0.80
Business Areas	
Downtown areas	0.70 - 0.95
Neighborhood areas	0.50 - 0.70
Residential Areas	
Lawns - flat	0.05 - 0.15
- steep	0.15 - 0.35
Suburban areas	0.25 - 0.40
Single family areas	0.30 - 0.50
Multi-unit areas	0.40 - 0.60
Apartment areas	0.50 - 0.70
Parks, Cemeteries	0.10 - 0.25
Playgrounds	0.20 - 0.35

Fig. 3-3

VALUES OF RUNOFF COEFFICIENT C

Values for Runoff Coefficients in Formula Q=CiA

Area Type	"C"Factor Selected
Residential 4+ d.u. /ac	0.43
Residential 1 to 4 d.u. / ac.	0.39
Mobile Home Parks	0.51
High Density Dwellings (Apartments)	0.51
Industrial and Commercial	0.80
Parks	0.20
Agricultural	0.12


Casa Grande Rainfall Intensity Chart
Rainfall Intensity (in/hr)
7.0
6.0
5.0
4.0
3.0
2.5
2.0
1.5
1.0
0.9
0.8
0.7
0.6
0.5
100 year
50 year
25 year
10 year
5 year
2 year
10
20
30
40
50
60
70
80
90
100
Time of Concentration (min)

HYDROLOGIC DESIGN DATA SHEET
S C S Method: Part I

Design Frequency 50 / 100 year storm.

AREA I.D.	Area (SQMI)	Area (Acres)	Length (ft)	Height (ft)	Slope %	AVG. Width (ft)	Width factor Wf	Time of Conc (Hrs)	Time to Peak (Hrs)	Peak Runoff Q50 (CFS)	Q100 (CFS)
A	4.35	2784	31200	674	*	3887	SEE fig. 2-7	3.68	3.68	658	801
B	3.01	1926	33400	1360	*	2512	"	3.47	3.47	483	588
C	2.54	1626	33600	1260	*	2107	"	3.40	3.40	416	506
D	1.67	1069	18700	135	*	2490	"	2.34	2.34	397	484
E-1	0.27	173	5000	15	0.30	1505	1.0	1.54	1.54	98	119
E-2	0.32	205	5000	18	0.36	1784	1.0	1.60	1.60	111	136
F-1	5.08	3251	40200	590	*	3523	fig. 2-7	4.26	4.26	664	808
F-2	1.36	870	18800	112	0.6	2017	"	1.78	1.78	425	518
G-1	4.25	2720	20950	1176	*	5656	"	1.87	1.87	1265	1540
G-2	3.69	2362	19200	323	*	5358	"	2.08	2.08	987	1202
H	2.45	1568	19200	112	0.58	3557	0.89	2.20	1.96	696	847
J	6.43	4115	21700	621	*	8261	fig. 2-7	2.17	2.17	1649	2008
K	1.74	1115	13200	75	0.6	3675	0.89	1.92	1.71	566	689
L	2.03	1299	7000	43	0.6	8085	0.89	1.98	1.76	642	782

* SLOPE VARIES, SEE TRAVEL TIME CALCULATION SHEETS.

Vegetation type DESERT BRUSH

Density 15%

Soil Group C

Curve Number 89

Runoff Q = 1.15 / 1.40 In. (50YR / 100YR)

Precipitation

6 Hr. 3.0 / 3.42

24 Hr. 4.0 / 4.56

1 Hr. 2.13 / 2.39

Computed by: M.A.T.

Checked by: J. F. K.

Date: 11-29-85

Location SEE MASTER DRAINAGE MAP

Job No. 83314

SHEET 1 OF 4

HYDROLOGIC DESIGN DATA SHEET
S C S Method: Part I

Design Frequency 50/100 year storm.

AREA I.D.	Area	Area	Length	Height	Slope	AVG. Width	Width factor	Time of Conc	Time to Peak	Peak Runoff Q50	Q100
	(SQMI)	(Acres)	(ft)	(ft)	%	(ft)	Wf	(Hrs)	(Hrs)	(CFS)	(CFS)
N	1.79	1146	18000	39	0.2	2772	0.89	2.52	2.25	443	539
P	6.78	4339	36800	892	*	5136	fig. 2-7	3.55	3.55	1063	1294
R	11.03	7057	28350	929	*	10847	SCS II	2.69	2.61	2655	3268
↖ SEE SCS METHOD II CALC. SHEET 4 OF 4											
S-1	0.80	512	5300	13	0.25	4208	0.89	1.90	1.69	263	321
S-2	0.44	282	2600	7	0.27	4718	0.89	1.68	1.50	163	199
S-3	0.90	576	7300	35	0.48	3437	0.89	1.74	1.55	323	393

* SLOPE VARIES, SEE TRAVEL TIME CALCULATION SHEETS.

Computed by: M.A.T.

Checked by: J.F.K.

Date: 11-26-85

Vegetation type: DESERT BRUSH

Density: 15%

Soil Group: C

Curve Number: 89

Runoff Q = 1.15/1.4 In.

Precipitation

6 Hr. 3.0/3.42

24 Hr. 4.0/4.56

1 Hr. 2.13/2.39

Location: SEE MASTER DRAINAGE MAP

Job No. 83314

HYDROLOGIC DESIGN DATA SHEET
SCS Method: Part I

Design Frequency 50 / 100 year storm..

	AREA I.D.	Area (SQMI)	Area (Acres)	Length (ft)	Height (ft)	Slope %	AVG. Width (ft)	Width Factor Wf	Time of Conc (Hrs)	Time to Peak (Hrs)	Q50 Peak Runoff (CFS)	Q100 (CFS)
CULTIVATED FIELDS	EA-1	3.6	2304	20000	31	0.16	5018	0.89	3.1	2.8	187	249
	EA-2	3.9	2496	24000	36	0.15	4530	0.89	3.6	3.2	177	236
	EA-3	2.8	1763	17000	36	0.21	4517	0.89	2.4	2.2	185	246
	EA-4	0.92	588	8500	20	0.24	3017	0.89	1.4	1.2	111	148
	EA-5	1.0	640	7500	13	0.17	3717	0.89	1.4	1.2	121	161
	EA-6	1.0	640	7500	15	0.20	3717	0.89	1.3	1.2	121	161
	EA-7	1.5	973	9500	15	0.16	4461	0.89	1.7	1.5	145	194
UNDEV. DESERT	ED-1	2.1	1344	15000	12	0.08	3903	0.89	3.2	2.9	403	491
	ED-2	3.4	2176	17000	22	0.13	5576	0.89	2.9	2.6	728	886

Vegetation type CULV. FIELD / UNDEV. DESERT

Density 80% / 20%

Soil Group B / C

Curve Number 71 (FIELD) / 89 (DESERT)

Runoff Q_{50} = 0.3 / 1.15 In.

Runoff Q_{100} = 0.4 / 1.40 In.

Precipitation

6 Hr. 3.0 / 3.42

24 Hr. 4.0 / 4.56

1 Hr. 2.13 / 2.39

Computed by: J.F.K.

Checked by: M.T.

Date: 11-26-85

Location SEE MASTER DRAINAGE MAP

Job No. 83314

SHEET 3 OF 4

ARIZONA HIGHWAY DEPARTMENT
BRIDGE DIVISION

HYDROLOGIC DESIGN DATA SHEET
SCS METHOD: PART II

LOCATION DATA:

Highway ______ County PINAL
Location NW OF CASA GRANDE (SEE DRAINAGE MAP)
Project No. 83314 Station ______
Name of Stream AREA 'R' TO NO BRANCH SANTA CRUZ WASH

DESIGN DATA:

Design Frequency: 50/100 years
Drainage Area: 11.03 square miles
Drainage Length: 28350 feet
Elevation
- Top of Drainage area: ≈ 2239 feet
- At Structure: ≈ 1310 feet

Drainage Area Slope: VARIES %
Vegetative Cover Type: DESERT BRUSH
Vegetative Cover Density: 15 %
Soil Group: C
Precipitation
- P = 6 hour = 3.0 / 3.42 inches
- P = 24 hour = 4.0/4.56 inches

DESIGN COMPUTATION:

Curve Number: 89
Time of Concentration: 2.69 hours
Peak Design Discharge

$$Qp = \frac{484AQ}{\frac{D}{2} + .6Tc} =$$ 2655 / 3268 cfs

Storm Duration		Point Precipitation	Areal Reduction	Areal Precipitation	Direct Runoff	Peak Discharge	
1 hour	50YR	2.13	0.94	2.00	1.05	2652	
	100YR.	2.39		2.25	1.25	3156	
2 hour		2.44	0.95	2.32	1.30	2655	USE
		2.74		2.60	1.60	3268	
3 hour		2.64	0.97	2.56	1.50	2572	
		2.97		2.88	1.85	3172	
6 hour		3.00	0.98	2.94	1.90	2198	
		3.42		3.35	2.25	2603	

Computed by: M.A.T Date 9-2-85

PROJECT: 33314

DESIGNER: M.A.T.

* EXIST. 5-10'x7'x300' CBC [illegible] Vista Blvd

DATE: 9-10-85

HYDROLOGIC AND CHANNEL INFORMATION

* EXISTING STRUCTURE

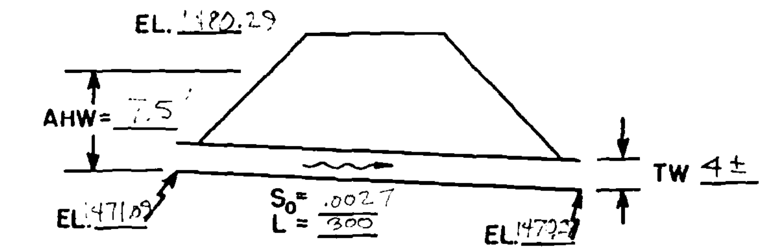
50yr Q_1 = 2752 cfs TW$_1$ = ______

100yr Q_2 = 2742 cfs TW$_2$ = ______

(Q_1 = DESIGN DISCHARGE, SAY Q_{25}
Q_2 = CHECK DISCHARGE, SAY Q_{50} OR Q_{100})

SKETCH

STATION: ______



MEAN STREAM VELOCITY = ______
MAX. STREAM VELOCITY = ______

CULVERT DESCRIPTION (ENTRANCE TYPE)	Q	SIZE	HEADWATER COMPUTATION: INLET CONT. HW/D	INLET CONT. HW	OUTLET CONTROL HW=H+h_o−LS_o: K_e	H	d_c	$\frac{d_c+D}{2}$	TW	h_o	LS_o	HW	CONTROLLING HW	OUTLET VELOCITY	COST	COMMENTS
5-10'x7'x300'	450	10x7	0.87	6.09	.02	1.1	4	5.5	4	5.5	0.81	5.79	6.09	3.3		INLET CONTROL Q50
"	548	10x7	1.02	7.14	0.2	1.67	4.5	5.75	4±	5.75	0.81	6.61	7.14	3.15		INLET CONTROL Q100

SUMMARY & RECOMMENDATIONS:

TOTAL RUNOFF FROM DRAINAGE AREA 1G combined with 2G
EXISTING STRUCTURE (5-10'x7'x300' CBC) IS ADEQUATE TO HANDLE ADDED RUNOFF FROM D.A. 1G.

DRAINAGE AREA TRAVEL TIME CALCULATIONS

TRAVEL TIME SUM = TIME OF CONCENTRATION

FIG 2-7

LONG & NARROW D.A. (A)

LONG & NARROW D.A. (B)

DRAIN AREA	LENGTH SLOPE RUN	ELEV - ELEV	HEIGHT	SLOPE %	TIME CONC. (HR)
A	2200	2077 - 1650	427'	19.4%	0.09
	2000	1650 - 1600	50'	2.5%	0.18
	4000	1600 - 1550	50'	1.25%	0.41
	5300	1550 - 1500	50'	0.94%	0.56
	6700	1500 - 1450	50'	0.75%	0.74
	7000	1450 - 1410	40'	0.57%	0.84
	4000	1410 - 1403	7'	0.18%	0.86
A	31200'			Σ Tc =	3.68
B	1000'	2755 - 2280	475	47.5%	0.04
	1500'	2280 - 1800	480'	32.0%	0.06
	600'	1800 - 1750	50'	8.33%	0.05
	1,500'	1750 - 1700	50'	3.33%	0.13
	2000'	1700 - 1650	50'	2.50%	0.18
	3100	1650 - 1600	50'	1.61%	0.30
	3300	1600 - 1550	50'	1.52%	0.33
	4900	1550 - 1500	50'	1.02%	0.51
	6200	1500 - 1450	50'	0.81%	0.67
	2300	1450 - 1430	20'	0.87%	0.31
B	7000'	1430 - 1395	35'	0.50%	0.89
	33400'			Σ Tc =	3.47

$T_c = \frac{L^{1.15}}{7700\,H^{.38}}$

DRAINAGE AREA TRAVEL TIME CALCULATIONS

FIG 2-7

DRAIN. AREA	LENGTH SLOPE RUN	ELEV - ELEV	HEIGHT	SLOPE %	TIME CONC.
C	1000'	2655 - 2000	655'	65.5%	0.03
	700	2000 - 1800	200'	28.6%	0.03
	800	1800 - 1750	50'	6.25%	0.06
	1200	1750 - 1700	50'	4.17%	0.10
	2500	1700 - 1650	50'	2.0%	0.24
	3200	1650 - 1600	50'	1.56%	0.32
	3500	1600 - 1550	50'	1.43%	0.35
	4700	1550 - 1500	50'	1.06%	0.49
	6000	1500 - 1450	50'	0.83%	0.65
C	10,000	1450 - 1395	55'	0.55%	1.13
	33600'			ΣTc =	3.40

LONG & NARROW D.A.

DRAIN. AREA	LENGTH SLOPE RUN	ELEV - ELEV	HEIGHT	SLOPE %	TIME CONC.
D	2400	1525 - 1500	25'	1.04%	0.29
	3900	1500 - 1465	35'	0.90%	0.45
	2300	1465 - 1450	15'	0.65%	0.34
	8100	1450 - 1400	50'	0.62%	0.92
D	2000	1400 - 1390	10'	0.50%	0.34
	18700			ΣTc =	2.34

LONG & NARROW D.A.

DRAINAGE AREA TRAVEL TIME CALCULATIONS

Fig 2-7

DRAIN AREA	LENGTH SLOPE RUN	ELEV	- ELEV	HEIGHT	SLOPE %	TIME CONC.
F-1	1500	2676	2000	676	45.07	0.05
	2200	2000	1800	200	9.09	0.12
	300	1800	1750	50	16.67	0.02
	1300	1750	1700	50	3.85	0.11
	2600	1700	1650	50	1.92	0.25
	3200	1650	1600	50	1.56	0.32
	4600	1600	1550	50	1.09	0.48
	5400	1550	1500	50	0.93	0.58
	6500	1500	1450	50	0.77	0.71
	7200	1450	1410	40	0.56	0.87
F-1	5400	1410	1385	25	0.46	0.75
	40200				ΣT_c =	4.26

LONG & NARROW D.A.

DRAINAGE AREA TRAVEL TIME CALCULATIONS

DRAIN AREA	LENGTH SLOPE RUN	ELEV - ELEV	HEIGHT	SLOPE %	FIG 2-7 TIME CONC.
1G	800	2676 - 2250	426	53.25	0.03
	2900	2250 - 1800	450	15.52	0.12
	750	1800 - 1750	50	6.67	0.06
	1700	1750 - 1700	50	2.94	0.15
	2500	1700 - 1650	50	2.00	0.24
	3200	1650 - 1600	50	1.56	0.32
	3900	1600 - 1550	50	1.28	0.40
1G	5200	1550 - 1500	50	0.96	0.55
	20950			$\Sigma T_c =$	1.87

DRAINAGE AREA TRAVEL TIME CALCULATIONS

$$T_c = \frac{L^{1.15}}{7700 H^{.38}}$$

FIG 2-7

DRAIN AREA	LENGTH SLOPE RUN	ELEV - ELEV	HEIGHT	SLOPE %	TIME CONC.
2G	700	1798 - 1700	98	14.0	0.04
	1800	1700 - 1650	50	2.78	0.16
	2100	1650 - 1600	50	2.38	0.19
	2800	1600 - 1550	50	1.79	0.27
	7300	1550 - 1500	50	0.68	0.81
2G	4500	1500 - 1475	25	0.56	0.61
	19200'			Σ Tc =	2.08
H	5400	1492 - 1450	42	0.78	0.62
	9000	1450 - 1400	50	0.56	1.04
H	4800	1400 - 1380	20	0.42	0.71
	19200'	(USE AVG SLOPE = 0.58%)		Σ Tc =	2.37
J	800	2041 - 1750	291	36.38	0.03
	700	1750 - 1700	50	7.14	0.05
	1800	1700 - 1650	50	2.78	0.16
	2800	1650 - 1600	50	1.79	0.27
	3300	1600 - 1550	50	1.52	0.33
	4100	1550 - 1500	50	1.22	0.42
	4700	1500 - 1450	50	1.06	0.49
J	3500	1450 - 1420	30	0.86	0.42
	21700'			Σ Tc =	2.17

DRAINAGE AREA TRAVEL TIME CALCULATIONS

$Tc = \frac{L^{1.15}}{7700 H^{.38}}$

FIG 2-7

DRAIN AREA	LENGTH SLOPE RUN	ELEV - ELEV	HEIGHT	SLOPE %	TIME CONC.
"P"	1600	2239 - 1800	439	27.44	0.06
	3400	1800 - 1700	100	2.94	0.26
	5000	1700 - 1600	100	2.00	0.40
	2800	1600 - 1550	50	1.79	0.27
	3700	1550 - 1500	50	1.35	0.37
	4200	1500 - 1450	50	1.19	0.43
	5600	1450 - 1400	50	0.89	0.60
"P"	10,500	1400 - 1347	59	0.56	1.16
	36,800			ΣTc =	3.55
R	1400	2239 - 1750	489	34.93	0.05
	550	1750 - 1700	50	9.09	0.04
	1100	1700 - 1650	50	4.55	0.09
	1600	1650 - 1600	50	3.13	0.14
	1700	1600 - 1550	50	2.94	0.15
	2700	1550 - 1500	50	1.85	0.26
	8300	1500 - 1400	100	1.20	0.73
	5400	1400 - 1350	50	0.93	0.58
R	5600	1350 - 1310	40	0.71	0.65
	28,350		929'	ΣTc =	2.69
			130 AVG.H.	AVG 0.46%	

CONTINUATION OF RUNOFF CALCULATION SHEET

Concen. Point & Elevation	Combine Areas	Upper Elevation	Channel Length	Average Slope	CHANNEL Width	Depth	Vel.	Q	Time	CT & TP	Lag Time	Composite Peak Runoff
		ft	ft	ft/ft	ft	ft	fps	cfs	min	min	min	cfs
Point 1 ± 1398	EA-1	1423	22840	.0011	40	3	3.2	269	118	286	81	
	EA-2	1413	15000	.001	40	3	3.1	257	81	273	68	
	ED-1	1407	7000	.0013	60	3	3.8	550	31	205	0	
	A	1400	1600	.0013	80	3	4.0	813	7	228	23	
	B	1398	0							208	3	~~2000~~
Point 2 ± 1393												
	FROM PT 1	1398	5000	.001	150	4	4.4	2352	19	260	120	
	EA 3,4,5,6 ED 2									140	0	
	C	1395	2700	.0007	75	3	2.9	548	16	220	80	
	D									140	0	~~2800~~
Point 3 ± 1387												
	FROM PT 1	1398	9800	.0011	175	4	4.7	2462	35	275	180	
	EA 3,4,5,6 ED 2	1393	4800	.0013	175	4	5.1	3220	16	156	60	
	C	1395	7500	.0011	175	4	4.7	2962	27	229	133	
	D	1393	4800	.0013	175	4	5.1	3220	16	156	60	
	EA-7									96	0	~~2800~~
Point 4 ± 1376												
	U-2...9	1384	4500	.0018	250	4	6.1	5694	12	152	99	
	U-1...3	1384	4800	.0017	250	4	6.0	5534	13	53	0	
	E	1385	7000	.0013	250	4	5.2	4839	22	116	63	
	F-1	1407	6000	.0052	75	2	6.3	844	16	272	219	
	F-2	1383	3500	.002	50	3	4.6	521	13	120	67	
	H	1376							127	74		~~4420~~
Point 5 ± 1357												
	FROM PT 4	1376	10500	.0017	300	3	5.0	4310	35	335	219	
	J	1420	11000	.0055	300	2	6.9	4037	26	156	40	
	K	1405	9000	.0051	300	2	6.6	3876	23	138	22	
	L									118	2	
	M									116	0	
	G-1	1490	28300	.0046	300	2	6.3	3689	74	186	70	
	G-2	1475	23000	.005	300	2	6.6	3834	58	183	67	~~6000~~
Point 6 ± 1340												
	FROM PT 5	1357	7500	.0023	1000	2	4.5	8953	28	178	43	
	FROM MID CITY	1384	19000	.0023	60	3	5.1	732	62	142	7	
	N									135	0	
	P									213	78	~~7200~~

CT = Channel Time
TP = Time to Peak

Estimates based on mannings n=.025 for grass lined channels with side slopes = 4:1

CONTINUATION OF RUN OFF CALCULATION SHEET

Concen. Point & Elev.	Combine Areas	Upper Elev.	Channel Length	Average Slope	Channel Width & Depth / Velocity	Channel Time	Channel Time & Time to Peak	Lag Time	Composite Peak Runoff
		Ft.	Ft.	Ft/Ft.	Ft / fps	min	min	min	cfs
NORTH BRANCH Point 5 el. ± 1357	S-1	1375	11000	0.0016	50 × 3 / 4.1	45	146	53	
	S-2	1365	4500	0.0018	425 × 3 / 5.2	14	104	11	
	S-3						93	0	
									730 ~~725~~

Estimates based on Mannings n=.025 for grass lined channels with side slopes = 4:1

CONTINUATION OF RUN OFF CALCULATION SHEET

Concen. Point & Elev.	Combine Areas	Upper Elev.	Channel Length	Average Slope	Channel Width & Depth / Velocity	Channel Time	Channel Time & Time to Peak	Lag Time	Composite Peak Runoff
		Ft.	Ft.	Ft/Ft.	Ft / fps	min	min	min	cfs
Storey Rd & Hermosa Rd elev ± 1407	EA-3	1416	5280	.0017	35 x 3 / 3.8	23	155	83	
	EA-6						72	0	
									230 ~~246~~

Estimates based on Mannings n=.025 for grass lined channels with side slopes = 4:1

CONTINUATION OF RUN OFF CALCULATION SHEET

Concen. Point & Elev.	Combine Areas	Upper Elev.	Channel Length	Average Slope	Channel Width & Depth / Velocity	Channel Time	Channel Time & Time to Peak	Lag Time	Composite Peak Runoff
		Ft.	Ft.	Ft/Ft.	Ft / fps	min	min	min	cfs
Florence Blvd & Peart Rd elev 1411	EA-4	-	-	-	-	-	72	0	
	EA-5	1422	5280	.002	30'x3' / 3.9	23	95	23	SAME 280

Estimates based on Mannings n=.025 for grass lined channels with side slopes = 4:1

CONTINUATION OF RUN OFF CALCULATION SHEET

Concen. Point & Elev.	Combine Areas	Upper Elev.	Channel Length	Average Slope	Channel Width & Depth / Velocity	Channel Time	Channel Time & Time to Peak	Lag Time	Composite Peak Runoff
		Ft.	Ft.	Ft/Ft.	Ft / fps	min	min	min	cfs
Storey Rd	EA-4	1421	10560	0.0018	30 x 3 / 3.7	48	120	43	
& Peart Rd	EA-5	1411	5280	0.0017	40 x 3 / 4.0	22	94	17	
el± 1402	ED-2a						77	0	
upstream of recc. Structure									700 ~~720~~

Estimates based on Mannings n=.025 for grass lined channels with side slopes = 4:1

CONTINUATION OF RUN OFF CALCULATION SHEET

Concen. Point & Elev.	Combine Areas	Upper Elev.	Channel Length	Average Slope	Channel Width & Depth / Velocity	Channel Time	Channel Time & Time to Peak	Lag Time	Composite Peak Runoff
		Ft.	Ft.	Ft/Ft.	Ft / fps	min	min	min	cfs
STOREY Rd	EA-3	1416	10560	.0013	40×3 / 3.5	50	182	105	
⋮	EA-4	1421	10560	.0018	30×3 / 3.7	48	120	43	
Peart Rd	EA-5	1411	5280	.0017	40×3 / 4.0	22	94	17	
elev ± 1402	EA-6	1407	5280	.0009	35×3 / 2.8	31	103	26	
	ED-2a						77	0	
									865

Estimates based on Mannings n=.025 for grass lined channels with side slopes = 4:1

CONTINUATION OF THE RUNOFF CALCULATION SHEET

Concen. Point	Combine Areas	Upper Elev. / Channel Length	Avg. Slope / Avg. Velocity*	Channel Time	Channel Time & Time to Peak	Lag Time	Composite Peak Runoff
		ft / ft	/ fps	min	min	min	cfs
Pt #2 elev. ±1393	EA-3	1415 / 20,000	0.001 / 1.9	175	307	151	
	EA-4	1421 / 20,000	0.0013 / 2.1	156	228	72	
NORTH BRANCH & PEART Rd.	EA-5	1412 / 14,000	0.0012 / 2.1	111	183	27	
	EA-6	1407 / 14,000	0.0009 / 1.7	134	206	50	
	ED-2	—	—	—	156	0	1140 ~~1300~~

* Estimated using the Manning equation: n = .017 for paved areas
n = .025 for undeveloped areas

ARIZONA HIGHWAY DEPARTMENT
STRUCTURES SECTION
HYDRAULICS BRANCH

RUNOFF CALCULATION SHEET

LOCATION DATA

Highway: CITY STREETS
Location: CASA G. UPPER CITY
Project No.: 83314

DESIGN DATA

Frequency: 100 years
P_6 = 3.42 in. P_{24} = 4.56 in. P_1 = 2.39 in.

RUNOFF CALCULATIONS

Drainage Area			Pav't.			Comm.			Resid.			PARKS			FUT. DEV. "ROS"				Tc	I	Q
No.	OUTLET	Acre	C	A	CA	C	A	CA	C	A	CA	C	A	CA	C	A	CA	ΣCA	min.	in./hr.	cfs
U-1	STATE DITCH	123	.85	5	4.3	.7	26	18.2	.43	32	13.8	.20	4	.8	.20	75	15.0	52.1	45	2.89	151
U-2	CASA G. AVE. & CITY DITCH	258	"	27	23.0	"	17	11.9	"	127	54.6	"	10	.2	"	77	15.4	105.1	50	2.69	283
U-3	STATE DITCH	53	"	6	5.1	"	4	2.8	"	25	10.8	-	-	-	"	18	3.6	23	30	3.78	87
U-4	KORTSEN Rd.	37	"	5	4.3	-	-	-	"	21	9.0	-	-	-	"	11	2.2	15	17	5.16	77
U-5	CASA G. AVE.	189	"	23	19.6	.7	6	4.2	"	106	45.6	"	28	5.6	"	26	5.2	81	60	2.39	193
U-6	KODOTA AVE	128	"	24	20.4	"	7	4.9	"	90	38.7	-	-	-	"	7	1.4	65	65	2.31	150
U-7	TREKELL Rd.	62	"	8	6.8	"	3	2.1	"	42	18.1	-	-	-	"	9	1.8	29	37	3.30	96
U-8	PUEBLO DITCH	521	"	26	22.1	"	56	39.2	"	108	46.1	"	7	1.4	"	324	64.8	173.6	65	2.31	401
U-9	COLORADO DITCH	300	-	-	-	-	-	-	"	5	2.2	-	-	-	"	295	59	61.2	35	3.44	210
			"			-	-	-	"			-	-	-	-	-	-				
FR-1	North B & PINAL	119	-	-	-	.7	5	3.5	-	-	-	-	-	-	.2	114	22.8	26.3	37	3.30	87
FR-2	No. Br. East of Cen.	203	-	-	-	"	-	-	-	-	-	-	-	-	.2	203	40.6	40.6	37	3.30	134
FR-3	KORTSEN & E. of Cen	77	-	-	-	"	2	1.4	-	-	-	-	-	-	.2	75	15.0	16.4	20	4.90	80

Computed by: J.K. Checked by: M.T. Date: 9-11-85

ARIZONA HIGHWAY DEPARTMENT
STRUCTURES SECTION
HYDRAULICS BRANCH

RUNOFF CALCULATION SHEET

LOCATION DATA

Highway: CITY STREETS
Location: CASA G. MID CITY
Project No.: 83314

DESIGN DATA

Frequency: 100 years
P_6 = 3.42 in. P_{24} = 4.56 in. P_1 = 2.39 in.
P_1 = 1.89 Q25
P_1 = 1.60 Q10

RUNOFF CALCULATIONS

Drainage Area			Pav't.			Comm.			Resid.			PARKS			FUT. DEV 'ROS'				Tc	I	Q
No.	Station - Station	Acre	C	A	CA	C	A	CA	C	A	CA	C	A	CA	C	A	CA	ΣCA	min.	in./hr.	cfs
M-1	11th St & R.R.	241	.85	45	38.2	.7	3	2.1	.43	179	76.9	-	-	-	.2	14	2.8	120	70	2.22	266
M-2	1st St & French	322	"	28	23.8	"	45	31.5	"	112	48.2	-	-	-	"	137	27.4	131	70	2.22	291
M-3	PEART PARK	125	"	20	17.0	"	13	9.1	"	78	33.5	.2	6	1.2	."	8	1.6	62	68	2.25	140
M-3	25 YEAR FREQ																	62		1.8	112
M-3	10 YEAR FREQ																	62		1.5	93

Computed by: JK Checked by: M.T. Date: 9-11-85

(SEE DRAINAGE MAP 6)

$$T_c = \frac{0.04593\, L^{.77}}{S^{.385}}$$

RUNOFF CALCULATION SHEET

LOCATION DATA

Highway: V.I.P. BLVD AREA

Location:

Project No.: 83314

DESIGN DATA

Frequency: 100 years

P_6 = 3.42 in. P_{24} = 4.56 in. P_1 = 2.39 in.

RUNOFF CALCULATIONS

Drainage Area			FIELDS			INDUSTRIAL			RESID.										Tc	I	Q
No.	Station - Station	Acre	C	A	CA	C	A	CA	C	A	CA	C	A	CA	C	A	CA	ΣCA	min.	in./hr.	cfs
V-1a		320	.2	300	60	.7	20	14										74	85	2.0	148
V-1b		242				.7	242	169										169	57	2.5	423
V-2a		320	.2	320	64													64	70	2.25	144
V-2b		168				.7	168	118										118	72	2.20	260
V-3		188							.4	188	75							75	67	2.3	173

Computed by: M.A.T. Checked by: ______ Date: 12-9-85

ARIZONA HIGHWAY DEPARTMENT
STRUCTURES SECTION
HYDRAULICS BRANCH

RUNOFF CALCULATION SHEET

LOCATION DATA

Highway: CITY STREETS
Location: CASA G. UPPER CITY
Project No.: 83314

DESIGN DATA

Frequency: 50 years
P_6 = 3.0 in. P_{24} = 4.0 in. P_1 = 2.13 in.

RUNOFF CALCULATIONS

Drainage Area		Acre	Pav't.			Comm.			Resid.			PARKS			FUT. DEV. "ROS"				Tc	I	Q
No.	OUTLET		C	A	CA	C	A	CA	C	A	CA	C	A	CA	C	A	CA	ΣCA	min.	in./hr.	cfs
U-1	STATE DITCH	123	.85	5	4.3	.7	26	18.2	.43	32	13.8	.20	4	.8	.20	75	15.0	52.1	45	2.60	135
U-2	CASA G. AVE. & CITY DITCH	258	"	27	23.0	"	17	11.9	"	127	54.6	"	10	.2	"	77	15.4	105.1	50	2.45	257
U-3	STATE DITCH	53	"	6	5.1	"	4	2.8	"	25	10.8	-	-	-	"	18	3.6	23	30	3.50	81
U-4	KORTSEN Rd.	37	"	5	4.3	-	-	-	"	21	9.0	-	-	-	"	11	2.2	15	17	4.50	68
U-5	CASA G. AVE.	189	"	23	19.6	.7	6	4.2	"	106	45.6	"	28	5.6	"	26	5.2	81	60	2.15	174
U-6	KODOTA AVE	128	"	24	20.4	"	7	4.9	"	90	38.7	-	-	-	"	7	1.4	65	65	2.0	130
U-7	TREKELL Rd.	62	"	8	6.8	"	3	2.1	"	42	18.1	-	-	-	"	9	1.8	29	37	3.0	87
U-8	PUEBLO DITCH	521	"	26	22.1	"	56	39.2	"	108	46.1	"	7	1.4	"	324	64.8	173.6	65	2.0	347
U-9	COLORADO DITCH	300	-	-	-	-	-	-	"	5	2.2	-	-	-	"	295	59	61.2	35	3.1	190
			"			-	-	-	"			-	-	-	"	-	-				
FR-1	North B & PINAL	119	-	-	-	.7	5	3.5	-	-	-	-	-	-	.2	114	22.8	26.3	37	3.0	79
FR-2	No. Br. East of Cen.	203	-	-	-	"	-	-	-	-	-	-	-	-	.2	203	40.6	40.6	37	3.0	122
FR-3	KORTSEN & E. of Cen	77	-	-	-	"	2	1.4	-	-	-	-	-	-	.2	75	15.0	16.4	20	4.3	71

Computed by: J.K.   Checked by: M.T.   Date: 9-11-85

CONTINUATION OF THE RUNOFF CALCULATION SHEET

Concen. Point	Combine Areas	Upper Elev. (ft)	Channel Length (ft)	Avg. Slope	* Avg. Velocity (fps)	Channel Time (min)	Channel Time & Time to Peak (min)	Lag Time (min)	Composite Peak Runoff (cfs)
N:E of Cottonwood & Trekell int. ELEV. 1397	U-7	-	-	-	-	-	37	0	
	U-8	1398	1400	0.001	3.2	7	72	35	
	U-9	1399	2800	0.001	3.2	15	50	13	570 ~~425~~

* Estimated using the Manning equation: n = .017 for paved areas
n = .025 for undeveloped areas

CONTINUATION OF THE RUNOFF CALCULATION SHEET

Concen. Point	Combine Areas	Upper Elev.	Channel Length	Avg. Slope	* Avg. Velocity	Channel Time	Channel Time & Time to Peak	Lag Time	Composite Peak Runoff
		ft	ft		fps	min	min	min	cfs
NORTH SIDE OF PROPOSED COLLEGE PARK ELEV. 1387	U-2	-	-	-	-	-	50	0	
	U-5	1392	4000	0.0013	2.6	26	86	36	
	U-6	1393	5200	0.0012	2.5	35	100	50	470 ~~420~~

* Estimated using the Manning equation: n = .017 for paved areas
n = .025 for undeveloped areas

CONTINUATION OF THE RUNOFF CALCULATION SHEET

Concen. Point	Combine Areas	Upper Elev. / Channel Length	Avg. Slope / * Avg. Velocity	Channel Time	Channel Time & Time to Peak	Lag Time	Composite Peak Runoff
		ft / ft	/ fps	min	min	min	cfs
FRENCH ST & W. 1ST ST. "Near 5 points" ELEV. 1393	M-2	- / -	- / -	-	70	0	400 ~~346~~
	M-3	1400 / 2800	0.0025 / 2.3	20	88	18	

* Estimated using the Manning equation: n = .017 for paved areas
n = .025 for undeveloped areas

CONTINUATION OF THE RUNOFF CALCULATION SHEET

Concen. Point	Combine Areas	Upper Elev.	Channel Length	Avg. Slope	* Avg. Velocity	Channel Time	Channel Time & Time to Peak	Lag Time	Composite Peak Runoff
		ft	ft		fps	min	min	min	cfs
SHULTZ & 11TH ST. ELEV. 1384	M-1	–	–	–	–	–	70	0	
	M-2	1393	3000	0.003	2.5	20	90	20	
	M-3	1400	5800	0.0028	2.4	40	108	38	620 ~~610~~

* Estimated using the Manning equation: n ≐ .017 for paved areas
n = .025 for undeveloped areas

CONTINUATION OF THE RUNOFF CALCULATION SHEET

Concen. Point	Combine Areas	Upper Elev. / Channel Length	Avg. Slope / * Avg. Velocity	Channel Time	Channel Time & Time to Peak	Lag Time	Composite Peak Runoff
		ft / ft	/ fps	min	min	min	cfs
STATE DITCH ALONG PINAL AVE & SILVER REEF Rd. ELEV. 1384	U-1	– / –	– / –	–	45	0	
	U-3	1390 / 3600	0.0017 / 2.4	25	55	10	215 ~~220~~

* Estimated using the Manning equation: n = .017 for paved areas
n = .025 for undeveloped areas

CONTINUATION OF THE RUNOFF CALCULATION SHEET

Concen. Point	Combine Areas	Upper Elev.	Channel Length	Avg. Slope	* Avg. Velocity	Channel Time	Channel Time & Time to Peak	Lag Time	Composite Peak Runoff
		ft	ft		fps	min	min	min	cfs
NORTH of KORTSEN Rd. East of Center Ave. ELEV. 1384	U-2	1387	2000	0.0015	3.7	9	59	32	
	U-4	1388	2500	0.0016	4.1	10	27	0	
	U-5	1392	6000	0.0013	2.6	38	98	71	
	U-6	1393	7200	0.0013	2.6	46	111	84	
	U-7	1397	9200	0.0014	3.6	43	80	53	
	U-8	1398	10,600	0.0013	3.4	52	117	90	
	U-9	1399	12,000	0.0013	3.4	60	95	68	1040 ~~750~~

* Estimated using the Manning equation: n = .017 for paved areas
n = .025 for undeveloped areas

CONTINUATION OF RUN OFF CALCULATION SHEET

Concen. Point & Elev.	Combine Areas	Upper Elev.	Channel Length	Average Slope	Channel Width & Depth / Velocity	Channel Time	Channel Time & Time to Peak	Lag Time	Composite Peak Runoff
		Ft.	Ft.	Ft/Ft.	Ft / fps	min	min	min	cfs
V-1a	V-1a	1382	6000	.0017	27 × 3 / 3.4	29	114	57	
& V-1b	V-1b	1393	5500	–	–	–	57	0	
el 1372									470 ~~423~~

Estimates based on Mannings n=.025 for grass lined channels with side slopes = 4:1

CONTINUATION OF RUN OFF CALCULATION SHEET

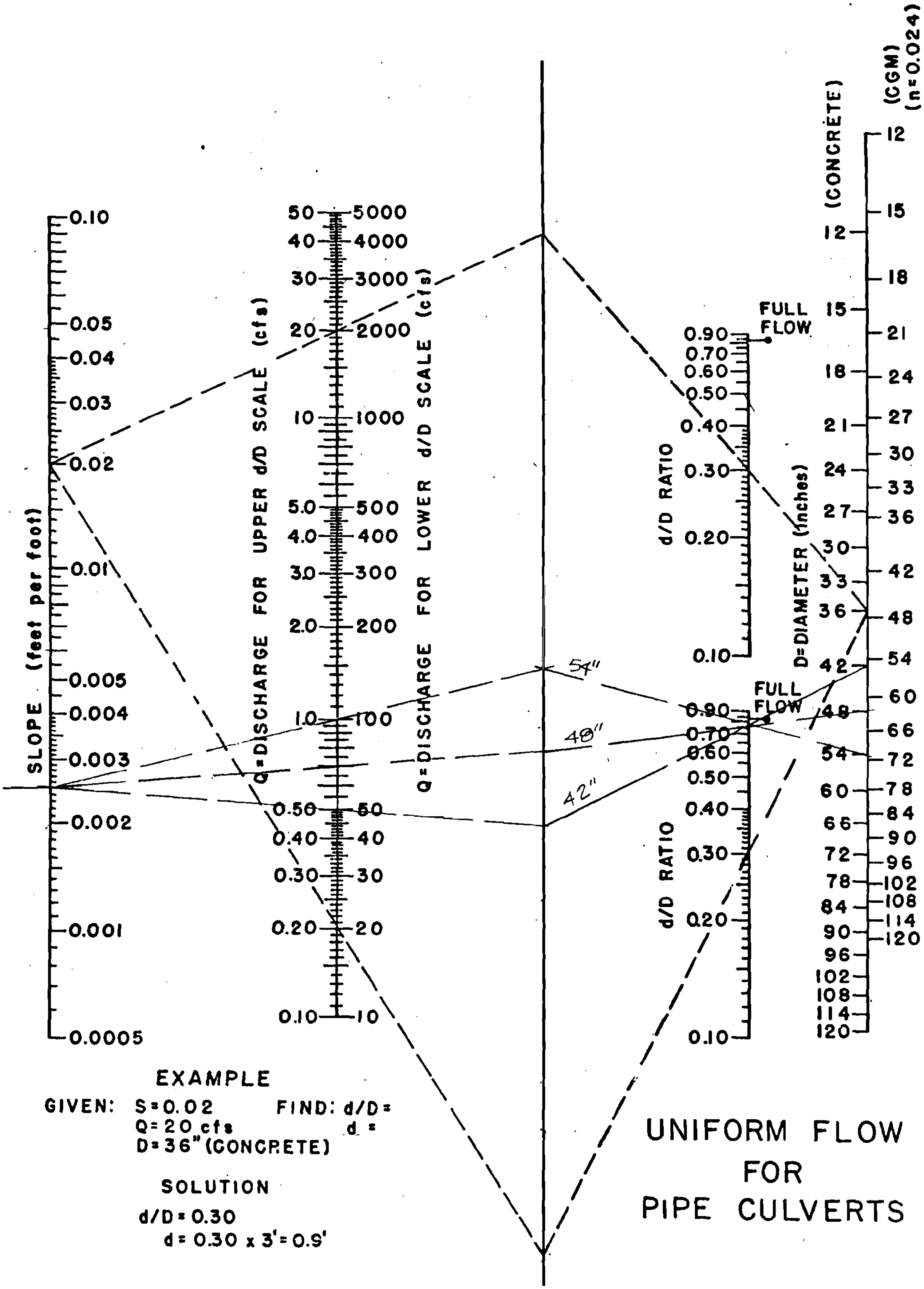
Concen. Point & Elev.	Combine Areas	Upper Elev.	Channel Length	Average Slope	Channel Width & Depth	Channel Velocity	Channel Time	Channel Time & Time to Peak	Lag Time	Composite Peak Runoff
		Ft.	Ft.	Ft/Ft.	Ft	fps	min	min	min	cfs
Burris Rd	V-1a	1382	7900	.0024	30×3	4.3	31	116 148	49	
&	V-1b	1372	3400	.0026	50×3	5.2	11	68 423	1	
RR	V-2a	1375	8200	.0015	30×3	3.4	40	110 144	43	
1363	V-2b	1368	1900	.0025	35×3	4.6	7	79 260	12	
	V-3	-	-					67 173	0	
										970 [illegible] ~~820~~

Estimates based on Mannings n=.025 for grass lined channels with side slopes = 4:1

CONTINUATION OF RUN OFF CALCULATION SHEET

Concen. Point & Elev.	Combine Areas	Upper Elev.	Channel Length	Average Slope	Channel: Width & Depth / Velocity	Channel Time	Channel Time & Time to Peak	Lag Time	Composite Peak Runoff
		Ft.	Ft.	Ft/Ft.	Ft / fps	min	min	min	cfs
VIP – RR 1370	V-2a	1375	6500	0.0008	30x3 / 2.5	43	113 144	41	~~340~~ 320
	V-2b						72 260	0	

Estimates based on Mannings n=.025 for grass lined channels with side slopes = 4:1



EXAMPLE

GIVEN: S=0.02
Q=20 cfs
D=36" (CONCRETE)

FIND: d/D=
d =

SOLUTION

d/D=0.30
d=0.30 x 3'=0.9'

UNIFORM FLOW FOR PIPE CULVERTS

AHD
Structures Section
Hydraulics Branch
10-15-72

Chart 15

FLORENCE BLVD STORM DRAIN

(SEE PLATE 4)

PROJECT: 83314

DESIGNER: M.A.T.

CHECKED:

DATE: 12-12-85

RECOMMENDED DRAINAGE STRUCTURES

HYDROLOGIC AND CHANNEL INFORMATION			No	AHW	So	No	AHW	So	No	AHW	So
Q_{19} = 290 cfs	Q_{25} = 808 cfs	Q_{31} = 1540	19	3′	.002	25	4′	.006	31	5′	.003
Q_{20} = 330 cfs	Q_{26} = 282 cfs		20	3′	.002	26	3′	.006			
Q_{21} = 340 cfs	Q_{27} = 267 cfs		21	3′	.002	27	3′	.006			
Q_{22} = 173 cfs	Q_{28} = 466 cfs		22	3′	.002	28	3′	.006			
Q_{23} = 173 cfs	Q_{29} = 246 cfs		23	3′	.002	29	3′	.002			
Q_{24} = 865 cfs	Q_{30} = 246 cfs		24	4′	.0015	30	3′	.002			

CULVERT DESCRIPTION (ENTRANCE TYPE) W/APPROX. LENGTHS	Q	SIZE	HEADWATER COMPUTATION: INLET CONT.		OUTLET CONTROL $HW = H + h_o - LS_o$								CONTROLLING HW	OUTLET VELOCITY	COST	LOCATION No.
			$\frac{HW}{D}$	HW	K_e	H	d_c	$\frac{d_c+D}{2}$	TW	h_o	LS_o	HW				
3-8′x3′x60′±	97	8′x3′	0.85	2.55	.40	.45	1.7	2.35	2.35	2.35	0.12	2.68	2.68			19
3-8′x3′x60′±	110	8x3	0.94	2.82	.40	.55	1.85	2.43	2.35	2.43	0.12	2.86	2.86			20
3-8′x3′x80′±	113	8x3	0.95	2.85	.40	.61	1.85	2.43	2.43	2.43	0.16	2.88	2.88			21
2-8′x3x60′	87	8x3	0.8	2.40	.40	.35	1.52	2.26	2	2.26	0.12	2.49	2.49			22
2-8′x3′x80′	87	8x3	0.8	2.40	.40	.40	1.52	2.26	2.26	2.26	.16	2.5	2.50			23
4-10′x4′x80′±	216	10x4	0.95	2.85	.40	.74	2.5	3.25	3	3.25	0.12	3.87	3.87			24
4-10x3x100′±	162	8′x3′	1.27	3.81	0.4	1.2	2.35	2.68	2.5	2.68	0.6	3.28	3.81			25
3-8′x3′x100′±	94	8′x3′	0.84	2.52	0.4	.44	1.6	2.3	2	2.3	0.6	2.14	2.52			26
3-8′x3′x50′±	89	8′x3′	0.8	2.4	0.4	0.4	1.55	2.3	2	2.3	0.34	2.36	2.40			27
4-8′x3x56′±	117	8′x3′	0.98	2.94	0.4	.64	1.85	2.43	2	2.43	0.34	2.73	2.94			28
2-8′x3′x100′±	123	8′x3′	1.02	3.06	0.4	.77	2.0	2.5	2.2	2.5	0.2	3.07	3.07			29
2-8′x3′x60′±	123	8′x3′	1.02	3.06	0.4	.70	2.0	2.5	2.5	2.5	0.12	3.08	3.08			30
5-10′x5′x60′±	308	10′x5′	0.95	4.75	0.4	0.9	3.1	3.55	3.5	3.55	0.18	4.27	4.75			31

PROJECT: 83314 DESIGNER: M.A.T.

RECOMMENDED DRAINAGE STRUCTURES

DATE: 12/85

HYDROLOGIC AND CHANNEL INFORMATION			No.	AHW	So	No.	AHW	So	No.	AHW	So
Q_1 = ~~2800~~ 3870 cfs.	Q_7 = ~~420~~ 470 cfs	Q_{13} = 610 cfs	1	4'	0.005	7	3'	.0015	13	4.5'	.0015 '/FT
Q_2 = 280 cfs.	Q_8 = 321 cfs	Q_{14} = 148 cfs	2	3'	0.002	8	3.5'	.0015	14	3'	.002
Q_3 = 720 cfs.	Q_9 = 71 cfs	Q_{15} = 423 cfs	3	4'	0.002	9	2'	.003	15	3'	.002
Q_4 = 210 cfs	Q_{10} = 140 cfs	Q_{16} = 423 cfs	4	3'	.0015	10	N/A	.0025	16	3'	.002
Q_5 = 401 cfs	Q_{11} = ~~346~~ 400 *	Q_{17} = 144 cfs	5	3.3'	.0015	11	3'	.003	17	3'	.002
Q_6 = ~~425~~ ~~[illegible]~~ 570 cfs	Q_{12} = 610 cfs	Q_{18} = 250 cfs	6	3'	.0013	12	4.5'	.0015	18	3'	.002

CULVERT DESCRIPTION (ENTRANCE TYPE) W/APPRO. LENGTHS	Q	SIZE	HEADWATER COMPUTATION: INLET CONT. HW/D	HW	OUTLET CONTROL HW=H+h_o−LS_o: K_e	H	d_c	$\frac{d_c+D}{2}$	TW	h_o	LS_o	HW	CONTROLLING HW	OUTLET VELOCITY	COST	LOCATION No.
CONC. BOX CULV. 12-10'x4'x120'±	233	10'x4'	1.0	4.0	0.4	.85	2.6	3.3	3	3.3	0.6	3.55	4.0			1 *
2-10'x3'x100'	140	10'x3'	0.94	2.82	0.4	.56	1.8	2.4	2.0	2.4	0.2	2.76	2.82			2
4-10'x4'x60'±	180	10x4	0.84	2.52	0.4	.50	2.2	3.1	3.0	3.1	0.12	3.48	3.48			3
C.B.C. 2-8'x3'x100±'	105	8'x3'	0.9	2.7	0.4	.55	1.7	2.35	2	2.35	0.15	2.75	2.75			4
C.B.C. 3-8'x3'x100±'	134	8'x3'	1.09	3.27	0.4	0.9	2.1	2.55	2	2.55	0.15	3.3	3.3			5
C.B.C. 3-10'x3'x150±'	142	10'x3'	0.95	2.85	0.4	.65	1.8	2.4	2	2.4	0.2	2.85	2.85			6 *
C.B.C. 3-10x3x100'±	140	10'x3'	0.95	2.85	0.4	.57	1.8	2.4	2	2.4	0.15	2.82	2.85			7 *
2-10'x3'x60'±	161	10'x3'	1.05	3.15	0.4	.76	2.0	2.5	2	2.5	0.15	3.11	3.15			8
3-33"x70' CMP	24	33"	0.88	2.42	0.5	1.02	1.7	2.23	2	2.23	0.21	3.04	3.04			9
FL[illegible] BLVD STORM DRAIN	100	*	SEE	PLATE 4												10
EXIST 2-6x3x180 ADD 2-6'x3'x180	87	6'x3'	0.96	2.88	0.4	0.77	1.8	2.4	2	2.4	0.54	2.61	2.88			11 *
3-10x4x100±	203	10x4	0.9	3.6	0.4	.62	2.3	3.15	3	3.15	0.15	3.62	3.62			12
3-10x4x50±	203	10x4	0.9	3.6	0.4	.61	2.3	3.15	3	3.15	0.15	3.61	3.61			13
10'x3'x100±	148	10x3	0.99	2.97	0.4	.65	1.9	2.45	2	2.45	0.2	2.9	2.97			14
3-10'x3'x60±	141	10x3	0.95	285	0.4	.55	1.8	24	2	2.4	0.12	2.83	2.85			15
3-10'x3'x60±	141	10x3	0.95	2.85	0.4	.55	1.8	2.4	2	2.4	0.12	2.83	2.85			16
10'x3'x100'	143	10x3	0.97	2.91	0.4	.61	1.8	2.4	2	2.40	0.2	2.81	2.91			17
2-10'x3'x60±'	125	10x3	0.87	2.61	0.4	.45	1.7	2.35	2	2.35	0.12	2.68	2.68			18

Project No. 83314

Project Name

Sheet No. ______ of ______

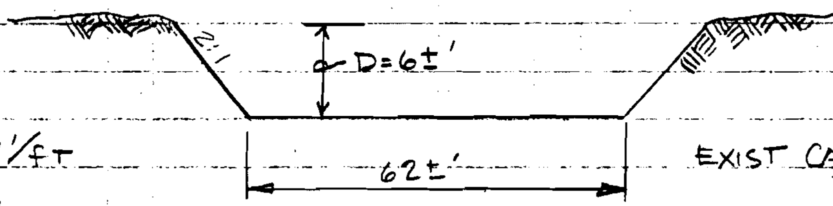
Calculated by J.K. Date 9-13-85

Checked by M.T. Date 10-1-85

CARTER ASSOCIATES, INC.

PROBLEM SECTION #1

EXISTING GEOMETRICS OF DRAINAGE CHANNEL AT VAL VISTA BLVD & S.R. 387, RUNS SOUTHWEST TO NORTH BRANCH OF SANTA CRUZ WASH.



GIVEN:

S = 0.0017'/ft

n = 0.025

A = 444 SQ FT.

WP = 88.8 FT.

EXIST CAPACITY = 3192 cfs.

Q_{100} = 2742 cfs at S.R. 387 INTERSECTION W/ VAL VISTA BLVD.

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Project No. 83314

Project Name CASA GRANDE DRAIN. STUDY

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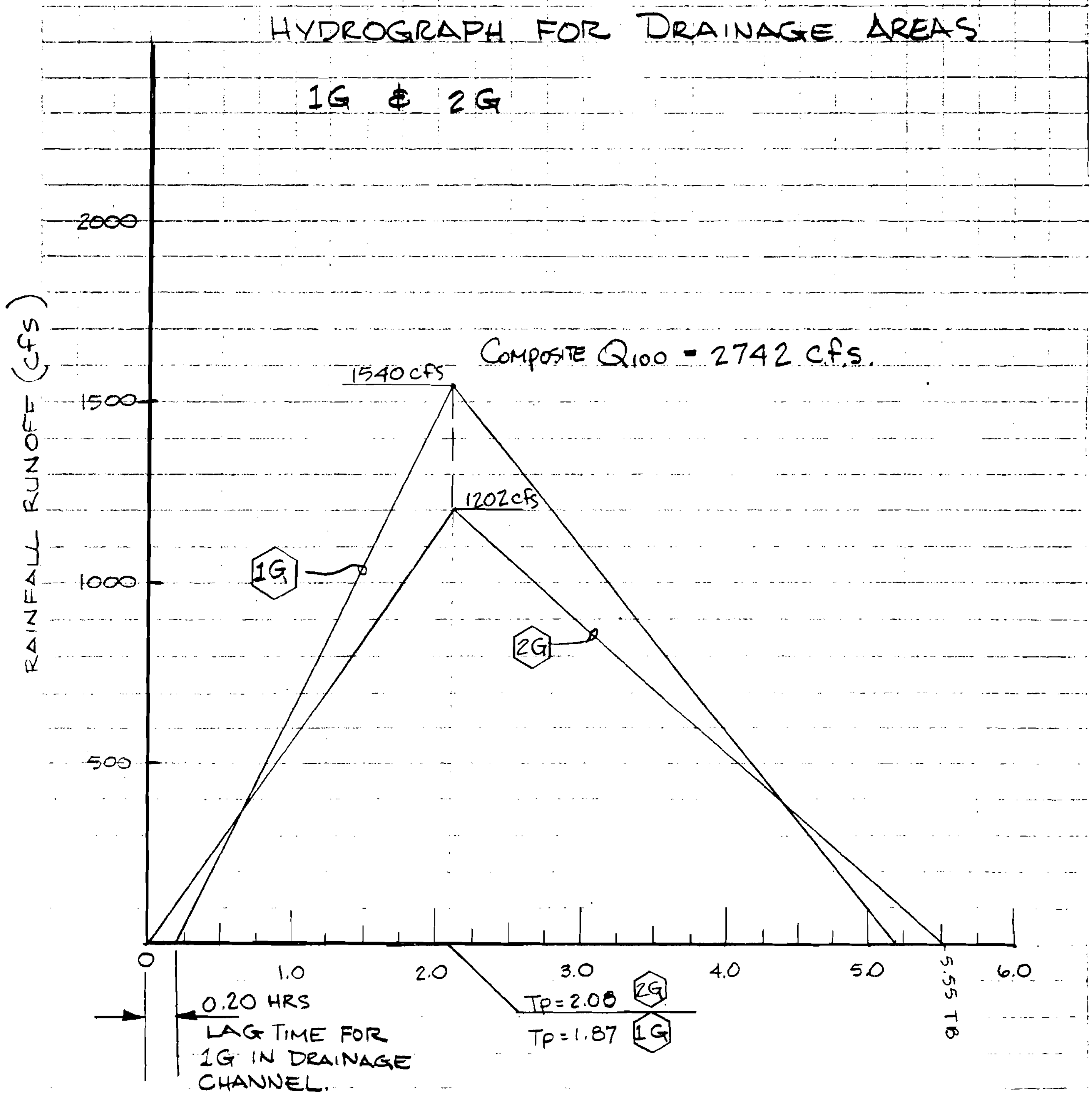
Calculated by ______ Date ______

Checked by ______ Date ______

CARTER ASSOCIATES, INC.

PROBLEM SECTION # 1



CARTER ASSOCIATES, INC.

Project No. 83314

Project Name CASA GRANDE DRAIN. STUDY

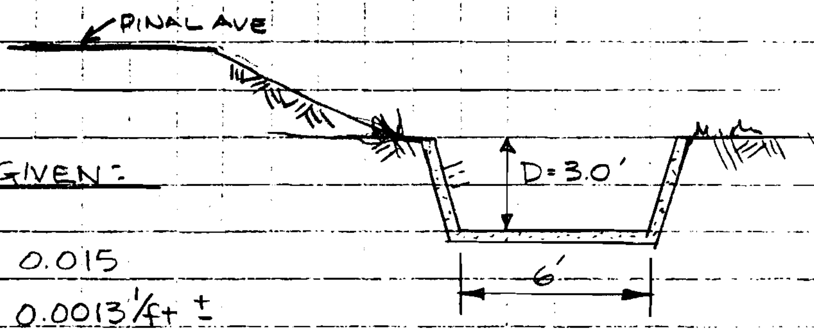
Sheet No. ______ of ______

Calculated by JK/MT Date 9-13-85

Checked by M.T. Date 10-2-85

PROBLEM SECTION #2

EXISTING CAPACITY OF STATE DITCH (CONC. CHANNEL) ALONG EAST SIDE OF PINAL AVE (S.R. 387) FROM KORTSEN RD TO NORTH BRANCH OF SANTA CRUZ WASH.



GIVEN:

n = 0.015

AVG. S = 0.0013'/ft ±

A = 27 SQ. FT.

WP = 14.5 FT.

EXIST. CAPACITY = 146. c.f.s.

Vel. = 5.4 f.p.s.

MINIMUM REQUIRED CHANNEL GEOMETRICS IF Q100 FLOWS ARE TO BE CARRIED IN STATE DITCH

GIVEN:

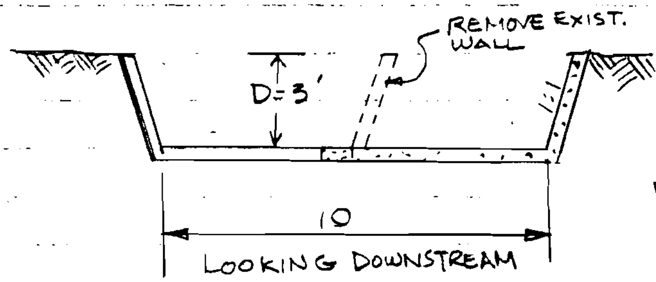
n = 0.015

AVG S = 0.0013'/ft ±

D = 3.0'

MAX. CAPACITY = 229 cfs.

COMPOSITE Q100 = 220 cfs



A = 39 SQ. FT.

WP = 18.49'

Project No. 83314

Project Name

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Calculated by J.K. Date 9-13-85

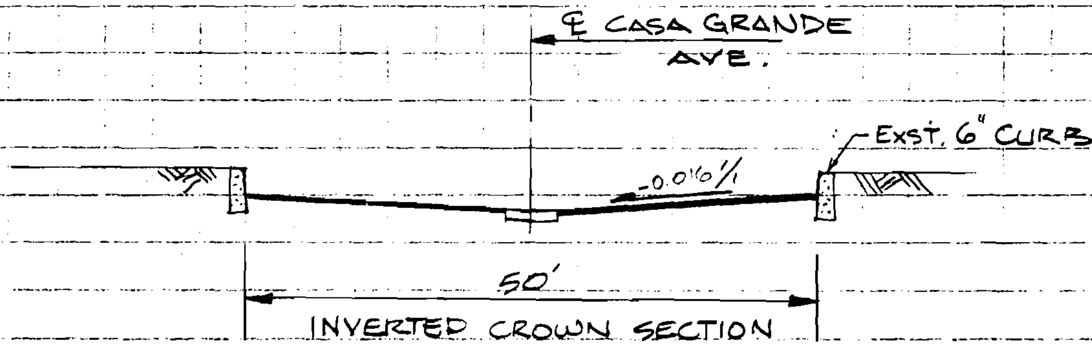
Checked by M.T. Date 10-1-85

CARTER ASSOCIATES, INC.

PROBLEM SECTION # 2

EXISTING X-SECTION OF CASA GRANDE AVE

(TAKEN SOUTH OF VIOLA ST.)



GIVEN:

$n = 0.016$

AVG. $S = 0.0013'/ft$

$A = 35$ SQ. FT

$WP = 51$ FT

EXISTING CAPACITY = 91 c.f.s.

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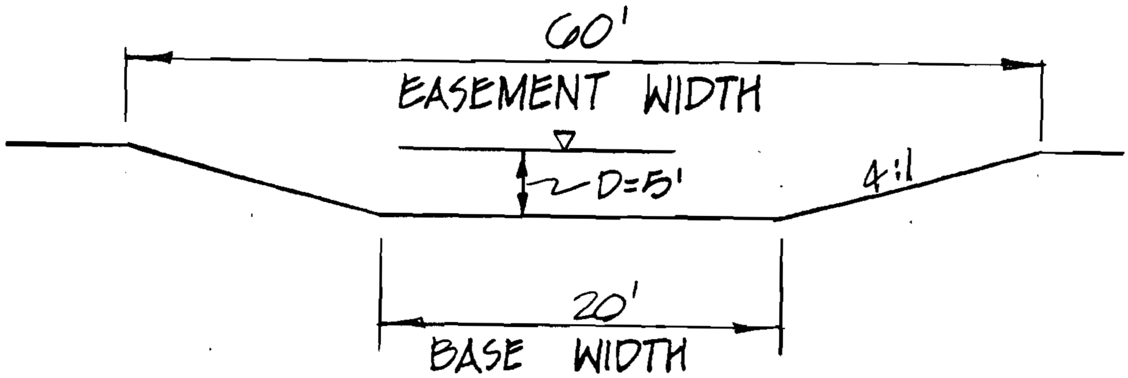

COMPOSITED Q100 = ~~610~~ 620 c.f.s.

DEPTS @ 4' CAPACITY = 603 c.f.s.

5' MAX. CAPACITY = 947 c.f.s.

GIVEN:
S = 0.0013 '/ft. ±
n = 0.025
A = 200 Sq. Ft.
W.P. = 61.23'

Drainage Easement And Channel Geometric
From Junction Of 1st. Street & Shultz Street
To Concentration Point 6.

Channel I.D. Number	Easement Top Width (ft)	Depth (ft)	Approximate Length (ft)	Longitudinal Slope (ft/ft)	Velocity * at Capacity (fps)	Capacity (cfs)	Runoff (cfs)
1	150	4	5000	0.001	4.4	2351	~~2300~~ 2100
2	175	4	4600	0.001	4.4	2824	~~2800~~ 3500
3	175 250	4 4	5280	0.0017	5.8 5.9	3682 4607	~~4120~~ 4400
4	250 425	4 3	6000 4400	0.0016	5.7 5.3	5369 6041	~~6000~~ 9800
5	40	3	5280	0.0017	4.0	334	280
6	70	3	5280	0.0015	4.2	732	720
7a	90	4	5500	0.001	4.2	1225	1150
7b	95	4	2800	0.001	4.2	1319	1300
8	35	3	2500	0.0013	3.3	230	210
9	50	3	2500	0.0013	3.7	420	401
10a	50	3	1600	0.0013	3.7	420	401
10b	50	3	1300	0.0013	3.7	420	401
10c	50	3	1100	0.0014	3.8	436	~~425~~ 570
11	50	3	5200	0.0014	3.8	436	~~425~~ 570
12	50	3	3700	0.0014	3.8	436	~~425~~ 570
13	45	3	1050	0.001	3.2	312	283
14	40	3	3600	0.001	3.1	257	214
15	50	3	1300	0.0014	3.8	436	~~420~~ 470
16	150	2	2700	0.001	2.9	818	~~[illegible]~~ * 1040
17	40	3	3900	0.002	4.3	363	321
18	50	3	2700	0.0013	3.7	420	370
19	26	2	2100	0.0015	2.3	102	102
20a	60	5	2600	0.0013	4.7	947	610
20b	60	5	15000	0.0013	4.7	947	610

* Estimates based on Mannings n=0.025 for grass lined trapezoidal channels with side slopes = 4:1

Channel I.D. Number	Easement Top Width	Depth	Approximate Length (ft)	Longitudinal Slope (ft/ft)	Velocity at Capcity (fps)	Capacity (cfs)	Runoff (cfs)
21	30	3	2500	0.001	2.7	148	148
22	50	3	4500	0.0015	4.0	452	423
23	35	3	4300	0.0005	2.1	143	144
24a	40	3	2500	0.001	3.1	256	250
24b	40	3	1500	0.0014	3.6	303	290
24c	45	3	1400	0.0015	3.9	382	340
25	30	3	5500	0.0018	3.7	199	173
26	55	4	7000	0.002	5.3	824	820
28	20	2	1400	0.001	2.1	50	42
29	25	2	2500	0.003	4.0	135	119
30	25	2	2500	0.0036	4.3	147	138
31a	30	3	7900	0.004	5.5	296	267
31b	35	3	2300	0.0035	5.5	377	282
32a	35	3	3300	0.0035	5.5	377	300
32b	35	3	2500	0.0035	5.5	377	350
33	90	3	2900	0.001	3.5	830	808
34a	60	3	2800	0.003	5.8	836	808
34b	60	3	2600	0.003	5.8	836	808
35	60	3	800	0.003	5.8	836	470
37	35	3	5280	0.0015	3.6	247	246
38	40	3	5280	0.0013	3.6	292	246
39	40	3	5280	0.0013	3.6	292	246
40	60	5	5000	0.002	5.9	1174	1540

* Estimates based on Mannings n=0.025 for grass lined trapezoidal channels with side slopes = 4:1

HYDROLOGICAL STUDY FOR

CASA GRANDE

SOUTHSIDE NEIGHBORHOOD

BY

CARTER ASSOCIATES, INC.

1550 E. MEADOWBROOK AVENUE

PHOENIX, ARIZONA 85015

11/18/95

CARTER ASSOCIATES, INC.

Project No. 83314

Project Name

Sheet No. ______ of ______

Calculated by M.A.T. Date 5-2-85

Checked by ______ Date ______

DRAINAGE AREA (A)

TOTAL AREA = 38.2 AC.

APPROX. AREA IN STREETS

STREET NAME	WIDTH	LENGTH
MAIN AVE	32'	2840'
KATHERINE AVE	32'	200'
SACATON AVE.	32'	200'
WASHINGTON ST.	32'	200'
FLORENCE ST.	32'	200'
S. MARSHALL ST.	32'	830'
S. PICACHO ST	32'	820'
S. DRYLAKE ST	32'	620'
S. TOLTEC ST.	32'	400'
E. 1ST AVE.	32'	990'
E. 2nd AVE.	32'	690'

$32' \times 7990' = \frac{255,680}{43560} = 5.87$ ACRES

TOTAL PAVED STREETS W/FUTURE CURB = 5.9 ACRES

RUNOFF 'C' = 0.85

LIGHT INDUSTRIAL AREA

$2610' \times 170' \div 43560 = 10.2$ AC. RUNOFF 'C' = 0.70

RESIDENTIAL AREA

$486,050^{\square'} \div 43560 = 11.2$ AC. RUNOFF 'C' = 0.43

NOTE 4+DWELLING UNITS PER ACRE USE C = 0.43

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Project No. 83314

Project Name CASA GRANDE DRAIN. STUDY

Sheet No. ______ of ______

Calculated by M.A.T. Date 5-2-85

Checked by ______ Date ______

CARTER ASSOCIATES, INC.

DRAINAGE AREA (A) CONT.

INDUSTRIAL STORAGE AREA

476,800□' ÷ 43560 = 10.95 ACRES RUNOFF 'C' = 0.60 (BARE GROUND)

TIME OF CONCENTRATION (Tc)

$$T_c \text{ OVERLAND} = \frac{0.04593(1880')^{.77}}{0.25^{.385}} = 26.0 \text{ min}$$

$$T_c \text{ PVMT} = \frac{2840}{3.5 \times 60} = 13.5 \text{ min}$$

$\Sigma T_c = 39.5$ min

DRAINAGE AREA (B) TOTAL AREA = 12.0 ACRES

STREET NAME	WIDTH	LENGTH
W. 1ST AVE.	32'	1720'
KATHERINE AVE.	32'	300'
SACATON ST.	32'	300'
WASHINGTON ST.	32'	300'
FLORENCE ST.	32'	300'
	32' ×	2920

$$32' \times 2920 = \frac{93440□'}{43560} = 2.14 \text{ AC.}$$

TOTAL PAVED STREETS W/FUTURE CURB = 2.1 ACRES

RUNOFF 'C' = 0.85

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DRAINAGE AREA (B) CONT.

LIGHT INDUST. (BARE GROUND)

430 x 310 ÷ 43560 = 3.1 ACRES, RUNOFF 'C' = 0.60

RESIDENTIAL

297550□' ÷ 43560 = 6.8 ACRES, RUNOFF 'C' = 0.43

PARK

180' x 300' ÷ 43560 = 1.24 ACRES (RUNOFF RETAIN ON SITE)

TIME OF CONCENTRATION (Tc)

$$Tc.\ OVERLAND = \frac{0.04593\,(393)^{.77}}{0.25^{.385}} = 7.8\ min$$

$$Tc.\ PVMT = \frac{2005'}{35 \times 60} = 9.5\ min$$

$\Sigma Tc = 17.3\ min.$

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DRAINAGE AREA (C)

TOTAL AREA = 19.3 ACRES

AREA IN STREETS

STREET NAME	WIDTH	LENGTH
MERCEDES	32'	700'
KATHERINE AVE	32'	325'
SACATON ST.	32'	320'
WASHINGTON ST.	32'	320'
FLORENCE ST.	32'	490'
3RD AVE.	32'	2200'
2ND AVE.	32'	1520'
MARSHALL ST	32'	300'

$32 \times 6175 = \frac{197600}{43560} = 4.54$ ACRES

TOTAL PAVED STREETS W/FUTURE CURBS = 4.5 ACRES

RUNOFF 'C' = 0.85

RESIDENTIAL AREA

645,650□' ÷ 43560 = 14.8 ACRES, RUNOFF 'C' = 0.43

TIME OF CONCENTRATION (Tc)

$$T_c \text{ OVERLAND} = \frac{0.04593(400)^{.77}}{0.25^{.385}} = 7.9 \text{ min}$$

$$T_c \text{ PVMT} = \frac{2900'}{3.5 \times 60} = 13.8 \text{ min}$$

$\Sigma T_c = 21.7$ min.

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Project No. 83314

Project Name CASA GRANDE DRAIN. STUDY

Sheet No. ______ of ______

Calculated by M.A.T. Date 5-3-85

Checked by ______ Date ______

CARTER ASSOCIATES, INC.

DRAINAGE AREA (D)

TOTAL AREA = 53.0 ACRES

AREA IN STREETS

STREET NAME	WIDTH	LENGTH	AREA SQ. FT.
ASH ST	32'	1630'	52160
BEECH ST.	32'	1630'	52160
CEDAR ST.	32'	1630'	52160
DATE ST.	32'	1630'	52160
ELM ST. (FUTURE)	32'	1630'	52160
FLORENCE ST (URBAN)	40'	1540'	61600
FLORENCE ST (RURAL)	30'±	1300'	39000
BURGESS AVE	32'	1270'	40640
ELLIOT AVE	32'	1270	40640
GREEN AVE (FUTURE)	32'	1270	40640

$\frac{483{,}320 \square'}{43560} = 11.1$ ACRES

TOTAL PAVED STREETS W/CURB = 11.1 ACRES, RUNOFF 'C' = 0.85

RDWY SHOULDERS AREA (FLORENCE ST RURAL)

$91{,}000\square' \div 43560 = 0.5$ ACRES, RUNOFF 'C' = 0.60

RESIDENTIAL AREA

$1{,}801{,}800\square' \div 43560 = 41.4$ ACRES, RUNOFF 'C' = 0.43

TIME OF CONCENTRATION (T_c) NORMAL CROWNS = OVERLAND FLOW

$$T_c = \frac{0.04593(2900)^{.77}}{0.25^{.385}} = 36.30 \text{ min.}$$

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STORM SEWER SYSTEM DESIGN: RUNOFF CALCULATION SHEET

LOCATION DATA

Highway CASA GRANDE STREETS

Location SOUTH SIDE OF R.R. TRACKS

Project No. 83314

DESIGN DATA

Frequency 50/100 years

P_6 = 3.0/3.4 in. P_{24} = 4.0/4.6 in. P_1 = (2.13)/2.39 in.

RUNOFF CALCULATIONS

Drainage Area			Pav't.			Comm. (LIGHT INDUST)			Resid.			INDUSTRIAL (BARE GROUND)			PARK				Tc	I (1 HOUR)	Q (Q_{50})	Wc
No.	Station - Station	Acre	C	A	CA	C	A	CA	C	A	CA	C	A	CA	C	A	CA	ΣCA	min.	in./hr.	cfs	
A	INDUSTRIAL & RES.	38.2	0.85	5.9	5.0	0.70	10.2	7.1	0.43	11.2	4.8	0.60	10.9	6.5				23.4	39.5	2.78	65	0.61
B	INDUSTRIAL & RES	12.0	0.85	2.1	1.8				0.43	6.8	2.9	0.60	3.1	1.9				6.6	17.3	4.59	30	0.55
C	RESIDENTIAL	19.3	0.85	4.5	3.8				0.43	14.8	6.4							10.2	21.7	4.10	42	0.53
											SLOPES											
D	RESIDENTIAL	53.0	0.85	11.1	9.4				0.43	41.4	17.8	0.60	0.5	0.3				27.5	36.3	2.98	82	0.52
	TOTAL ACRES =	122.5																				
																		TOTAL	1 HOUR	Q_{50} =	219	cfs.
	PARK (RETAIN ON SITE)	1.2													0.2	1.2	0.2	N/A				
	FIELD (RETAIN ON SITE)																					

Computed by: M. A. TARR Checked by: ______ Date: ______

CARTER ASSOCIATES, INC.

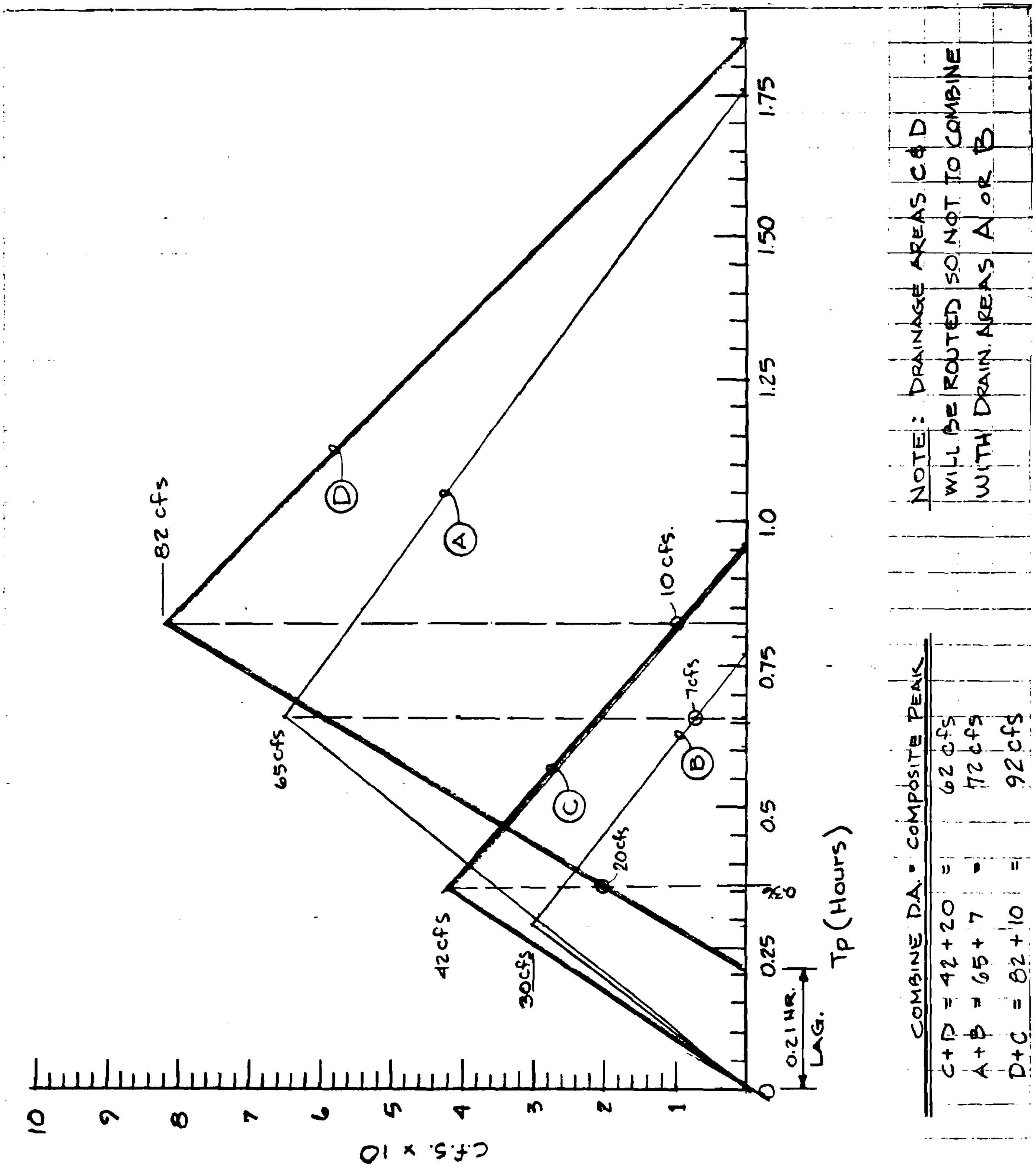
Project No. 83314

Project Name CASA GRANDE DRAIN. STUDY

Sheet No. ____ of ____

Calculated by M.A.T. Date 4/85

Checked by ____ Date ____



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STORM SEWER SYSTEM DESIGN: RUNOFF CALCULATION SHEET

LOCATION DATA

Highway CASA GRANDE STREETS

Location SOUTH SIDE OF R.R. TRACKS

Project No. 83314

DESIGN DATA

Frequency 50/100 years

P_6 = 3.0/3.4 in. P_{24} = (4.0)/4.6 in. P_1 = 2.13/2.39 in.

RUNOFF CALCULATIONS

Drainage Area			Pav't.			Comm. (LIGHT INDUST.)			Resid.			INDUSTRIAL (BARE GROUND)			PARK				Tc	I (24 HOUR)	Q (Q50)	Wc
No.	Station - Station	Acre	C	A	CA	C	A	CA	C	A	CA	C	A	CA	C	A	CA	ΣCA	min.	in./hr.	cfs	
A	INDUSTRIAL & RES.	33.2	0.85	5.9	5.0	0.70	10.2	7.1	0.43	11.2	4.8	0.60	10.9	6.5				23.4	39.5	5.2	122	0.61
B	INDUSTRIAL & RES.	12.0	0.85	2.1	1.8				0.43	6.8	2.9	0.60	3.1	1.9				6.6	17.3	8.5	56	0.55
C	RESIDENTIAL	19.3	0.85	4.5	3.8				0.43	14.8	6.4							10.2	21.7	7.6	78	0.53
											SLOPES							A,B,C	TOTAL	Q50 =	256 CFS	
D	RESIDENTIAL	53.0	0.85	11.1	9.4				0.43	41.4	17.8	0.60	0.5	0.3				27.5	36.3	5.6	154	0.52
	TOTAL ACRES =	122.5																				
	PARK (RETAIN ON SITE)	1.2													0.2	1.2	0.2	N/A				
	FIELD ([illegible])																					

Computed by: M. A. TARR Checked by: ______ Date: ______

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CARTER ASSOCIATES, INC.
PHOENIX, ARIZONA
09/11/85

HYDROLOGIC REPORT FOR

CASA GRANDE

UNIVERSAL RATIONAL HYDROGRAPH

Q(PEAK) = C*I*A
50 YEAR STORM FREQUENCY

BASIN IDENTIFIER   SOUTHSIDE A
DISCHARGES INTO   W.MAIN AVE

BASIN AREA   =   38.20 ACRES
RUNOFF COEFF. =   0.61
RAINFALL INT. =   2.78 IN/HR

TIME (MIN)	RUNOFF (C.F.S.)
0.0	0.0
19.8	1.2
39.5	2.4
59.3	3.4
79.0	4.4
98.8	34.6
118.5	64.8
138.3	42.9
158.0	21.0
177.8	13.9
197.5	6.8
217.3	4.7
237.0	2.5
256.8	2.3
276.5	2.1
296.3	1.6
316.0	1.0
335.8	0.9
355.5	0.7
375.3	0.4
395.0	0.0
414.8	0.0
434.5	0.0
454.3	0.0
474.0	0.0
493.8	0.0
513.5	0.0
533.3	0.0
553.0	0.0
572.8	0.0

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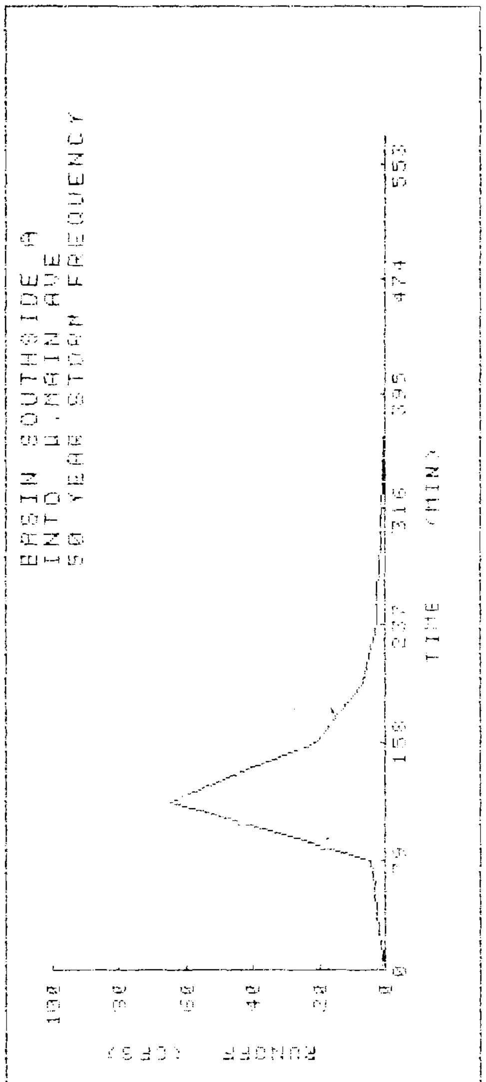
HYDROLOGIC REPORT FOR

CASA GRANDE



CARTER ASSOCIATES, INC.
PHOENIX, ARIZONA
09/11/85

HYDROLOGIC REPORT FOR

CASA GRANDE

UNIVERSAL RATIONAL HYDROGRAPH

Q(PEAK) = C*I*A
50 YEAR STORM FREQUENCY

BASIN IDENTIFIER SOUTHSIDE B
DISCHARGES INTO W.MAIN AVE

BASIN AREA = 12.00 ACRES
RUNOFF COEFF. = 0.55
RAINFALL INT. = 4.59 IN/HR

TIME (MIN)	RUNOFF (C.F.S.)
0.0	0.0
8.7	1.4
17.3	2.8
26.0	4.1
34.6	5.3
43.3	17.8
51.9	30.3
60.6	20.4
69.2	10.4
77.9	8.5
86.5	6.5
95.2	5.5
103.8	4.5
112.5	3.0
121.1	1.5
129.8	1.3
138.4	1.0
147.1	0.5
155.7	0.0
164.4	0.0
173.0	0.0
181.7	0.0
190.3	0.0
199.0	0.0
207.6	0.0
216.3	0.0
224.9	0.0
233.6	0.0
242.2	0.0
250.9	0.0

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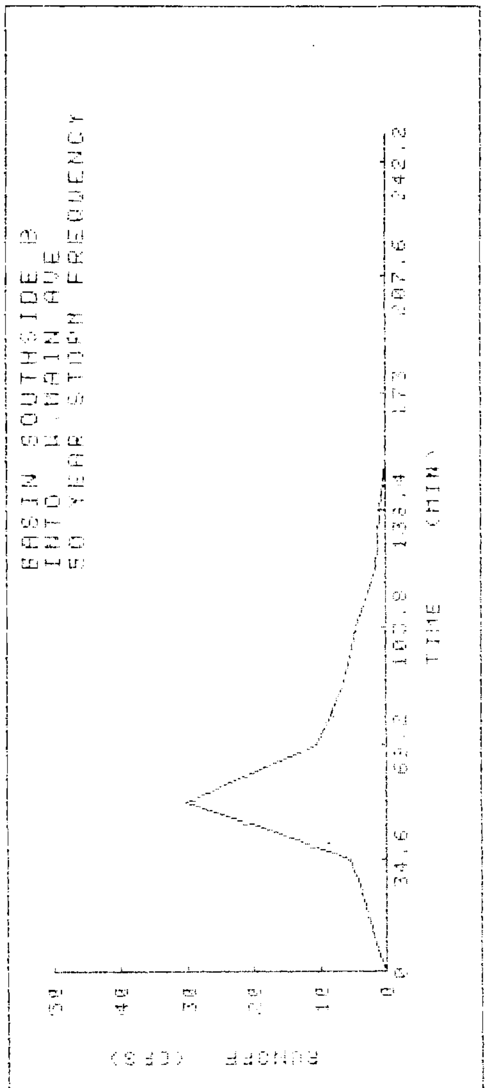
PHOENIX, ARIZONA
09/11/85

HYDROLOGIC REPORT FOR

CASA GRANDE



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HYDROLOGIC REPORT FOR

CASA GRANDE

UNIVERSAL RATIONAL HYDROGRAPH

Q(PEAK) = C*I*A
50 YEAR STORM FREQUENCY

BASIN IDENTIFIER   SOUTHSIDE C
DISCHARGES INTO   W.MAIN AVE

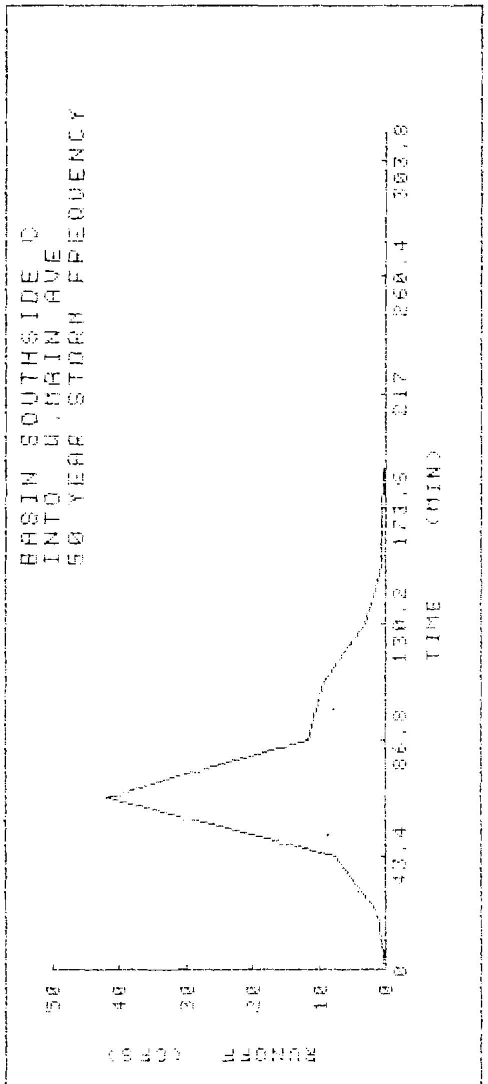
BASIN AREA = 19.30 ACRES
RUNOFF COEFF. = 0.53
RAINFALL INT. = 4.10 IN/HR

TIME (MIN)	RUNOFF (C.F.S.)
0.0	0.0
10.9	0.7
21.7	1.3
32.6	4.4
43.4	7.5
54.3	24.7
65.1	41.9
76.0	26.8
86.8	11.7
97.7	10.5
108.5	9.4
119.4	6.2
130.2	3.1
141.1	1.9
151.9	0.8
162.8	0.7
173.6	0.6
184.5	0.3
195.3	0.0
206.2	0.0
217.0	0.0
227.9	0.0
238.7	0.0
249.6	0.0
260.4	0.0
271.3	0.0
282.1	0.0
293.0	0.0
303.8	0.0
314.7	0.0

PAGE
CARTER ASSOCIATES, INC.
PHOENIX, ARIZONA
09/11/85

HYDROLOGIC REPORT FOR

CASA GRANDE



PAGE
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09/11/85

HYDROLOGIC REPORT FOR

CASA GRANDE

UNIVERSAL RATIONAL HYDROGRAPH

Q(PEAK) = C*I*A
50 YEAR STORM FREQUENCY

BASIN IDENTIFIER   SOUTHSIDE D
DISCHARGES INTO   W.MAIN AVE

BASIN AREA = 53.00 ACRES
RUNOFF COEFF. = 0.52
RAINFALL INT. = 2.98 IN/HR

TIME (MIN)	RUNOFF (C.F.S.)
0.0	0.0
18.2	2.0
36.3	4.0
54.5	4.3
72.6	4.6
90.8	43.3
108.9	82.1
127.1	53.4
145.2	24.8
163.4	16.3
181.5	7.9
199.7	6.0
217.8	4.1
236.0	3.0
254.1	2.0
272.3	1.9
290.4	1.8
308.6	1.4
326.7	1.1
344.9	0.5
363.0	0.0
381.2	0.0
399.3	0.0
417.5	0.0
435.6	0.0
453.8	0.0
471.9	0.0
490.1	0.0
508.2	0.0
526.4	0.0

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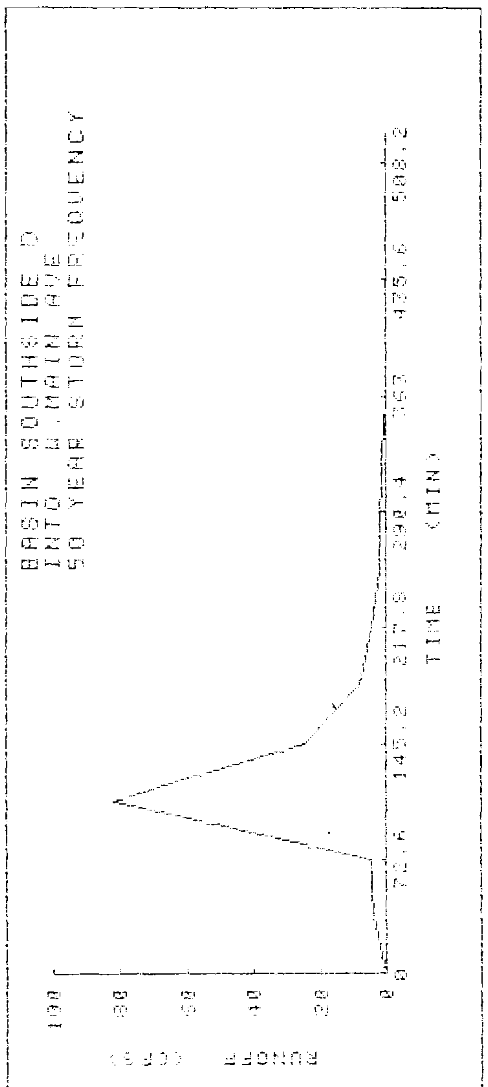
09/11/85

HYDROLOGIC REPORT FOR

CASA GRANDE



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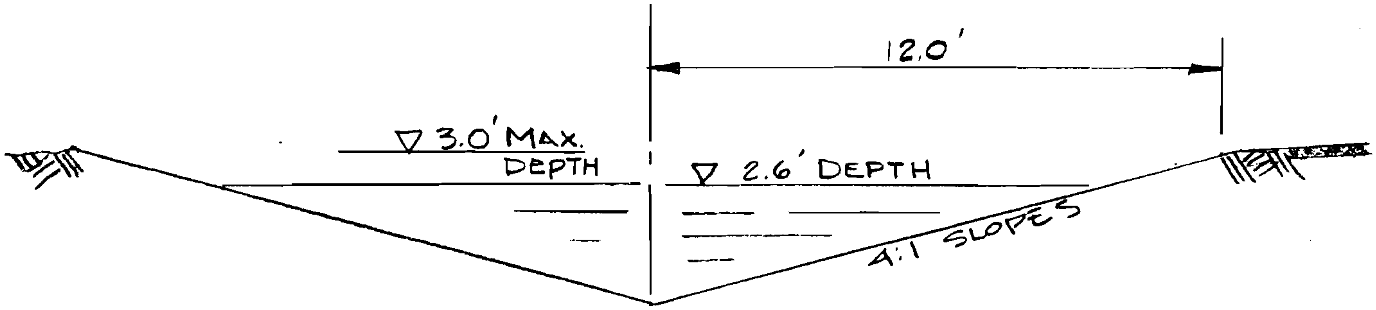
Project No. 83314

Project Name CASA GRANDE DRAIN. STUDY

Sheet No. ______ of ______

Calculated by M.A.T. Date 4-30-85

Checked by ______ Date ______



TYPICAL DRAINAGE CHANNEL
FROM AREA (D)

$d = 3.0'$ MAX.

$V = \frac{1.49}{n}(R)^{2/3}(S)^{1/2}$

GIVEN: $Q_{50} = 80$ c.f.s.

$n = 0.030$

$S = 0.0025'/ft.$ AVG.

$R = \frac{A}{WP} = \frac{36}{24.74} = 1.46$

$V = (49.67)(1.46)^{2/3}(.0025)^{1/2} = \underline{3.2}$ f.p.s.

$Q = AV = (36)(3.2) = \underline{115}$ c.f.s. MAX. CAP.

TRY $d = 2.6'$ $A = 27.04$ sq.ft., $WP = 21.44$, $R = 1.26$

$V = (49.67)(1.26)^{2/3}(.0025)^{1/2} = \underline{2.9}$ f.p.s.

$Q = (27.04)(2.9) = 78.4$ c.f.s. → USE $d = 2.6'$

LAG TIME FROM DRAINAGE AREA (D)

$L = 2200 \pm '$ IN CHANNEL, $Q = 80$ cfs, $V = 2.90$ f.p.s

$\frac{2200}{2.90 \times 60} = 12.6$ minutes $= 0.21$ HOURS LAG TIME (SEE HYDROGRAPH)

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Project No. 83314

Project Name CASA GRANDE DRAIN. STUDY

Sheet No. ______ of ______

Calculated by M.A.T. Date 5-1-85

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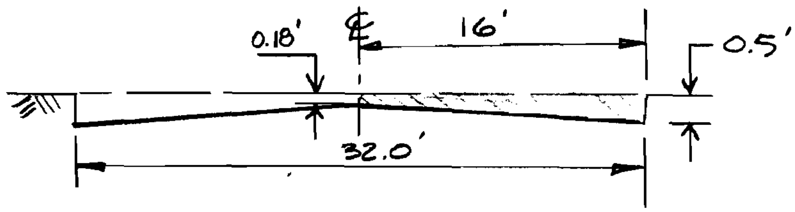

TYPICAL NORMAL CROWN RDWY.

FIG. CAPACITY OF 32' NORMAL CROWN RDWY. WITH 6" VERT. CURBS.

USING MANNING EQUATION: $V = \frac{1.49}{n}(R)^{2/3}(S)^{1/2}$

GIVEN: $n = 0.016$

$S = 0.0025'/\text{ft. AVG.}$

$A = \frac{0.2 + 0.5}{2} \times 16 = \underline{5.6}$ SQ FT (½ SECTION)

$R = \frac{A}{WP} = \frac{5.6}{16.5} = \underline{0.34}$

$V = (93.1)(0.34)^{2/3}(.0025)^{1/2} = 2.27 \rightarrow \underline{2.3}$ f.p.s.

$Q = AV = (5.6)(2.3) = 12.88 \times 2 = \underline{25.76}$ c.f.s. TOTAL RDWY SECT. MAX. CAP. TO TOP OF CURB.

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Sheet No. ______ of ______

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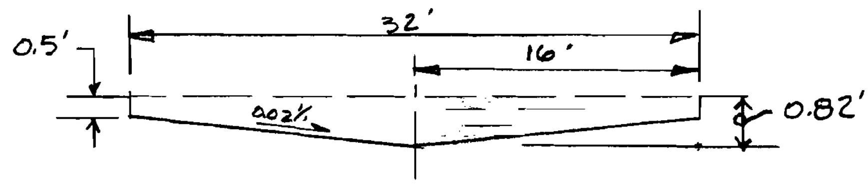

TYPICAL INVERTED CROWN ROADWAY

FIG. CAPACITY OF 32' INV. CROWN RDWY WITH 6" VERT. CURBS.

USING MANNINGS EQUATION: $V = \frac{1.49}{n}(R)^{2/3}(S)^{1/2}$

GIVEN: $n = 0.016$

$S = 0.0025$ '/ft. AVG.

$A = \frac{1.0 + 1.64}{2} \times 16' = \underline{21.12}$ SQ. FT.

$R = \frac{A}{WP} = \frac{21.12}{33} = \underline{0.64}$

$V = (93.1)(0.64)^{2/3}(.0025)^{1/2} = \underline{3.5}$ f.p.s.

$Q = AV = (21.12)(3.5) = \underline{73.9}$ c.f.s. MAX. CAPACITY TO TOP OF CURB (6")

NOTE: TIME OF CONCENTRATION (Tc) FOR PVMT RUNOFF THE MANNING EQUATION & THE CONTINUITY EQUATION ARE USED ALONG WITH THE OVERLAND FLOW EQUATION

$Tc = \frac{LENGTH}{VEL \times 60} = min.$ (FOR STREET RUNOFF)

$Tc = \frac{0.04593\, L^{.77}}{S^{.385}} = min.$ (FOR OVERLAND FLOW)

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Project No. 83314

Project Name CASA GRANDE DRAIN. STUDY

Sheet No. ______ of ______

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Checked by ______ Date ______

RUNOFF RETENTION 1 HR. DURATION

$C_w = \frac{67.7}{122.5} = 0.55$ WEIGHTED RUNOFF 'C'

I = 0.18' (1 HOUR)

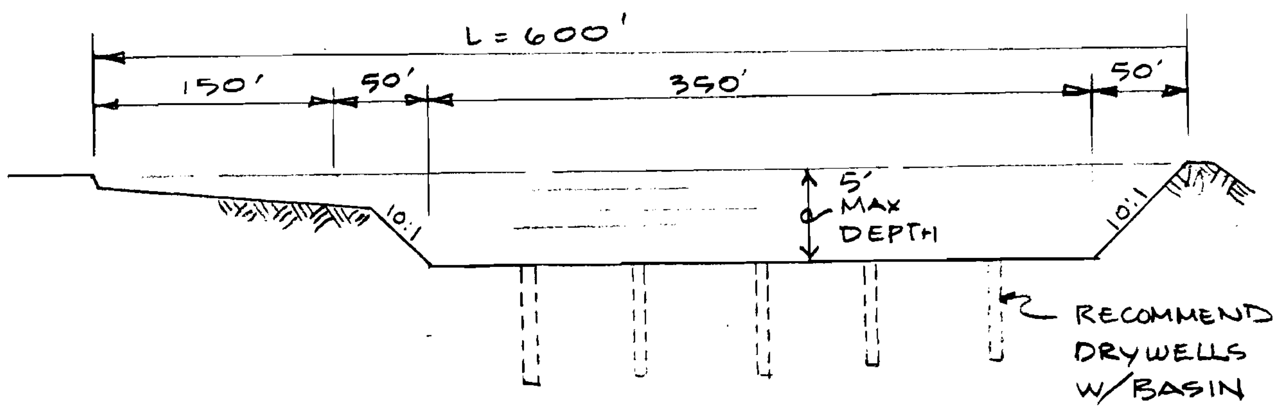
A = 122.5 AC x 43560 = 5,336,100 SQ FT.

(C)(I)(A) = 528,274 CU. FT. (1 HOUR)

TRAPEZOIDAL BASIN

APPROX. GEOMETRICS

600' x 350' DEPTH 1' TO 5'



TYPICAL SECTION
RETENTION BASIN

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JFK

CARTER ASSOCIATES, INC.

April 17, 1987

Mr. Tom Long, P.E.
City Engineer
CITY OF CASA GRANDE

Casa Grande, Arizona

RE: Casa Grande Master Drainage Study
Carter Job Number 83314

Dear Tom:

In response to a concern expressed by Bill Collins of DNA Engineering, we have reevaluated the magnitudes of runoff in the Casa Grande Master Drainage study. We agree that a discrepancy exists in the use of channel time when plotting the composite unit hydrographs for combining tributary areas.

The lag time in this study is defined as the time of peak after the initial subarea peak has subsided. The channel time in this study is defined as the time which the unit hydrograph for the particular subarea "lags" before reaching the concentration point. The original composite hydrographs were incorrectly plotted due to previous confusion between these two definitions.

Enclosed herewith are the revised composite unit hydrographs with a summary of reevaluation for all concentration points. Fortunately, most of the revised composite peaks are similar to the original values. Revised sizes for channels and structures have been determined for those flows which bring about a necessary change.

Please find the enclosed evaluation. Let me know if I can be of further assistance.

Sincerely,

John F. Kraft, Jr.

John F. Kraft, Jr.

JFK:mww
Enclosures

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SUMMARY OF REEVALUATION

Concentration Point	Original Q (cfs)	Revised Q (cfs)	Structure Designation	Channel Designation
No. 1 on North Branch	2,000	2,100**	*	*
No. 2 on North Branch	2,800	3,500**	*	2
No. 3 on North Branch	2,800	3,500**	1	2
No. 4 on North Branch	4,120	4,400**	Pinal Bridge	3
No. 5 on North Branch	6,000	9,800	*	4a
No. 6 on North Branch	7,200	11,500	*	4b
French St. & West 1st St.	346	400	11	*
Shultz & 11th St.	610	620	*	*
State ditch at Silver Reef	220	215	*	*
North of College Park	420	470	7	15
Trekell & Cottonwood	425	570	6	10c & 11 & 12
North of Kortsen E of Center	750	1,040	*	16
Burgess Peak Area	725	730	*	*
Storey and Hermosa	246	298**	*	*
Florence Blvd. and Peart Rd.	280	268**	*	*
Storey and Peart Rd.	720	392**	*	*
Downstream of Storey and Peart	865	900	*	*
Peart Road Outlet	1,300	1,170**	*	*
East VIP Blvd. Area	423	470	*	*
West VIP Blvd. Area	340	320	*	*
VIP Blvd. Area	820	970	*	*

* Structure is nonexistent or revised flow has not significantly changed.

** Runoff quantities revised June, 1987.

REVISED CHANNEL CAPACITIES

Channel Designation	Concentration Point	Original Size (ft.)	Revised[1] Size (ft.)
2	North Branch East of Trekell	175 x 4	225 x 4
3	North Branch East of Pinal	250 x 4	250 x 4
4a	North Branch West of Pinal	250 x 4	400 x 4
4b	North Branch West of Thorton	425 x 3	700 x 3
10c	Trekell and Cottonwood	50 x 3	60 x 3
11	Downstream of Trekell and Cottonwood	50 x 3	60 x 3
12	Downstream of Trekell and Cottonwood	50 x 3	60 x 3
16	North of Kortsen East of Center	150 x 2	150 x 2.5

REVISED STRUCTURE CAPACITIES

Structure Designation	Location	Original Size (ft.)	Revised Size[2] (ft.)
1	North Branch and Trekell	(12) 10 x 4 x 120	(15) 10 x 4 x 120
6	Trekell and Kortsen	(3) 10 x 3 x 150	(4) 10 x 3 x 150
7	Kortsen West of Casa Grande	(3) 10 x 3 x 100	(3) 10 x 3.5 x 100
11	Florence Blvd. and 1st Street	Add (2) 6 x 3 x 180	Add (3) 6 x 3 x 180

1 Based on channel slopes shown on summary map with 4:1 side slopes and Mannings n = 0.025.

2 Based on a 1.0 foot head loss with a loss coefficient K_e = 0.4 and Mannings n = 0.016.

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Project No. 83314

Project Name CASA GRANDE DRAINAGE ST.

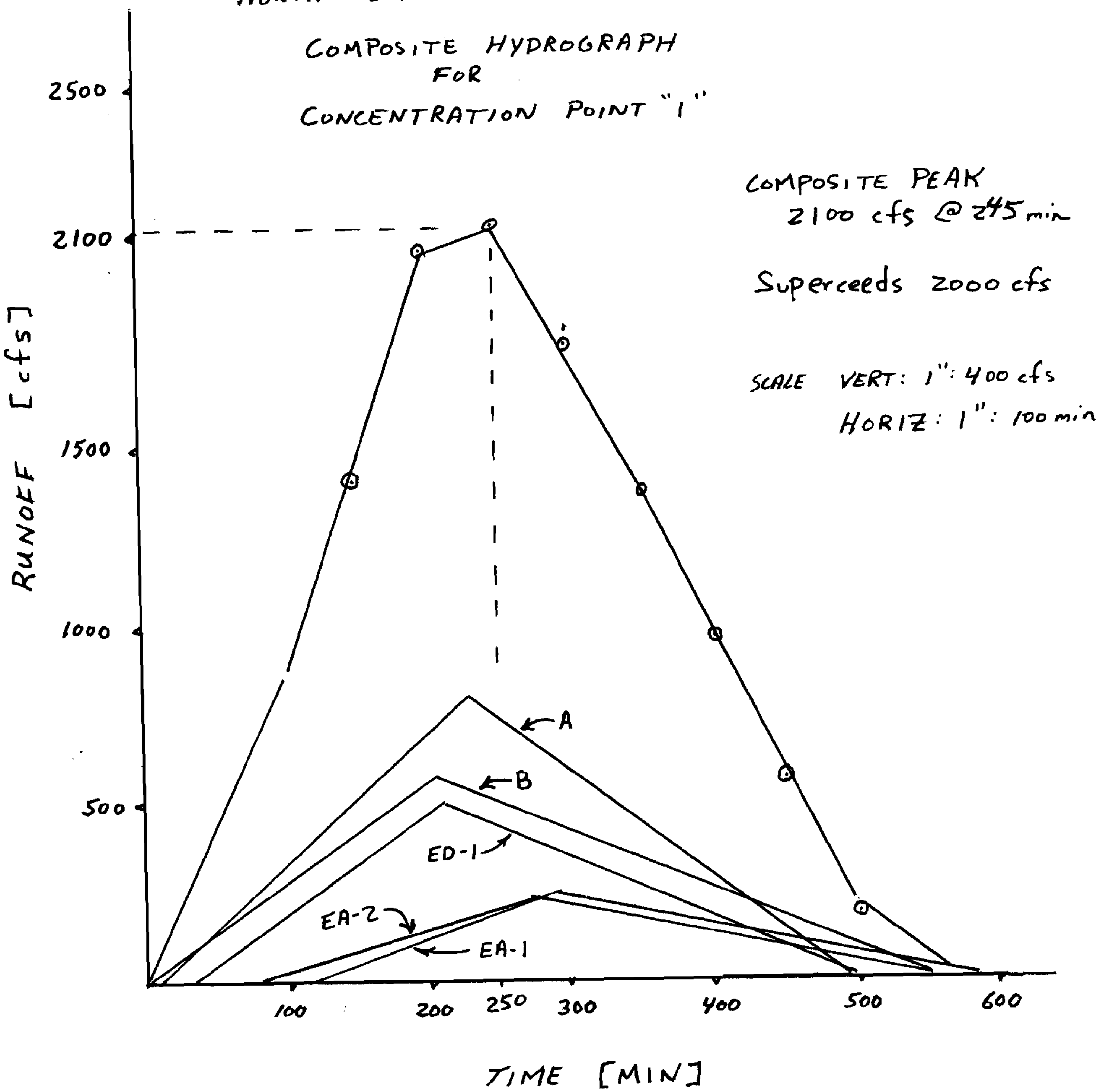
Sheet No. 1 of 21

Calculated by JOHN KRAFT Date 4/8/87

Checked by REK Date 6/29/87

NORTH BRANCH OF THE SANTA CRUZ

COMPOSITE HYDROGRAPH FOR CONCENTRATION POINT "1"



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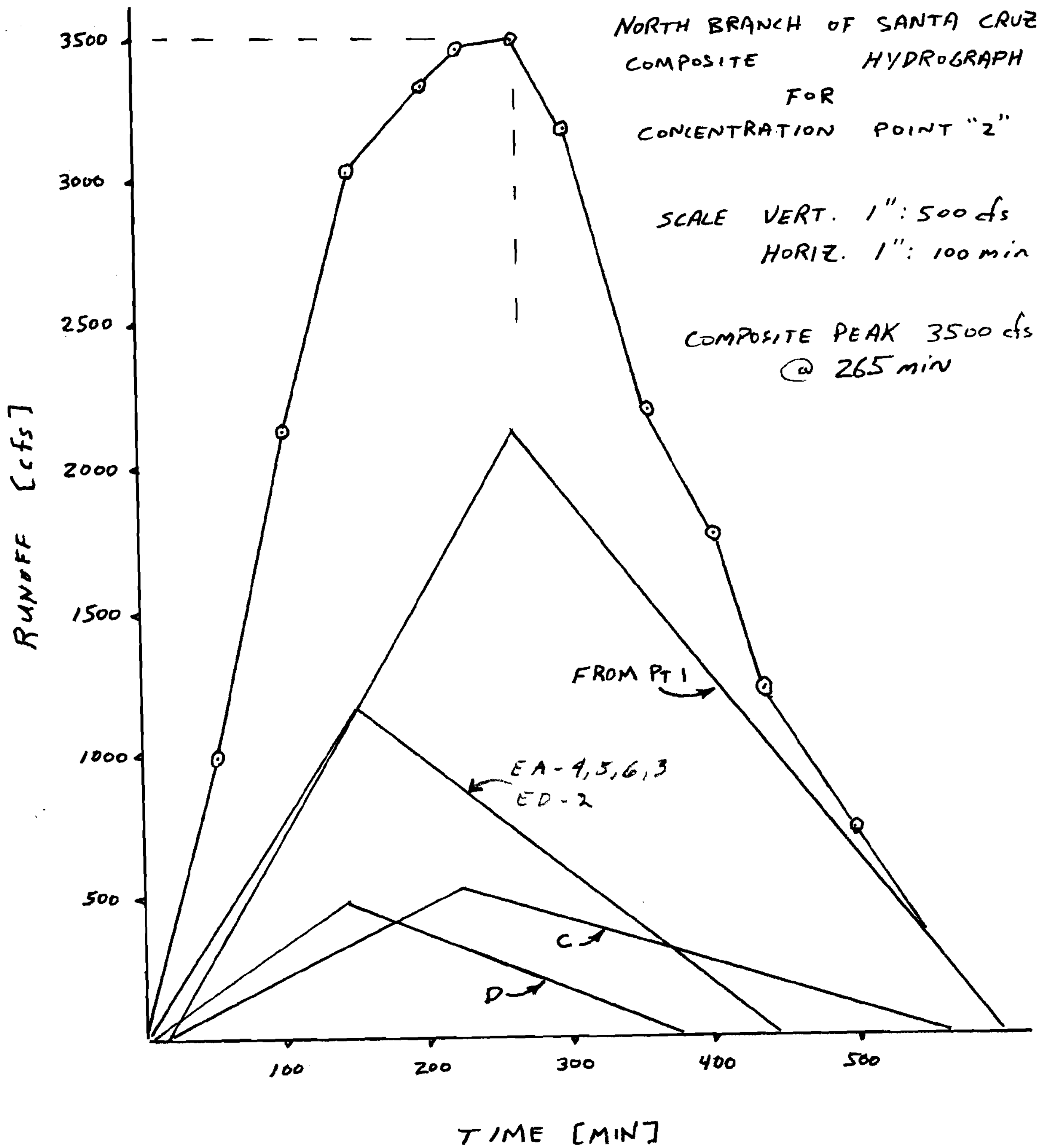
Project No. 83314

Project Name CASA G. DRAINAGE STUDY

Sheet No. 2 of 21

Calculated by JOHN KRAFT Date 4/8/87

Checked by RER Date 6/29/87



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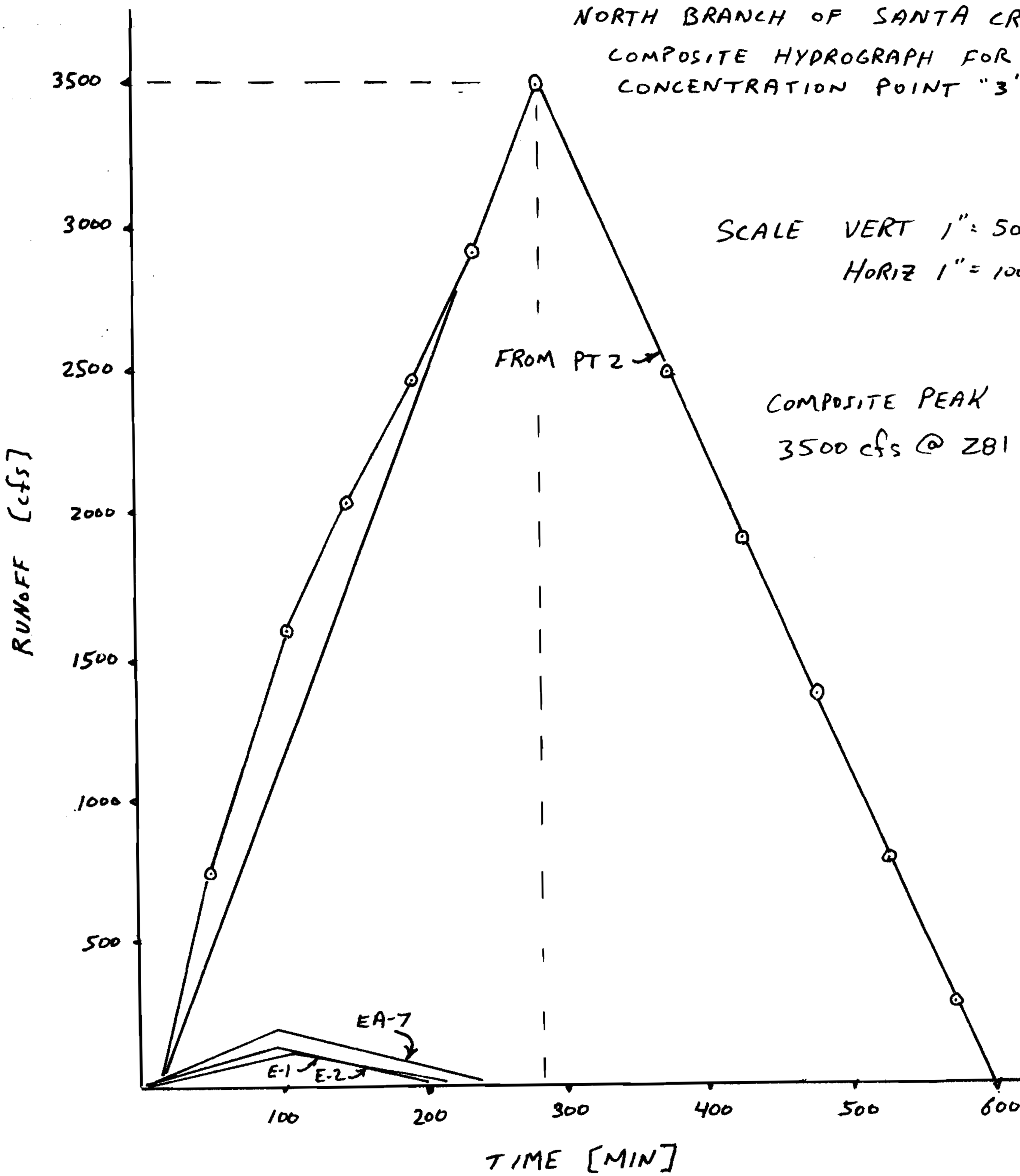
Project No. 83314
Project Name CASA G. DRAINAGE ST.
Sheet No. 3 of 21
Calculated by JFK Date 4/8/87
Checked by RER Date 6/29/87

NORTH BRANCH OF SANTA CRUZ
COMPOSITE HYDROGRAPH FOR
CONCENTRATION POINT "3"



SCALE VERT 1" = 500 cfs
HORIZ 1" = 100 MIN

COMPOSITE PEAK
3500 cfs @ 281 MIN

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Project No. 83314

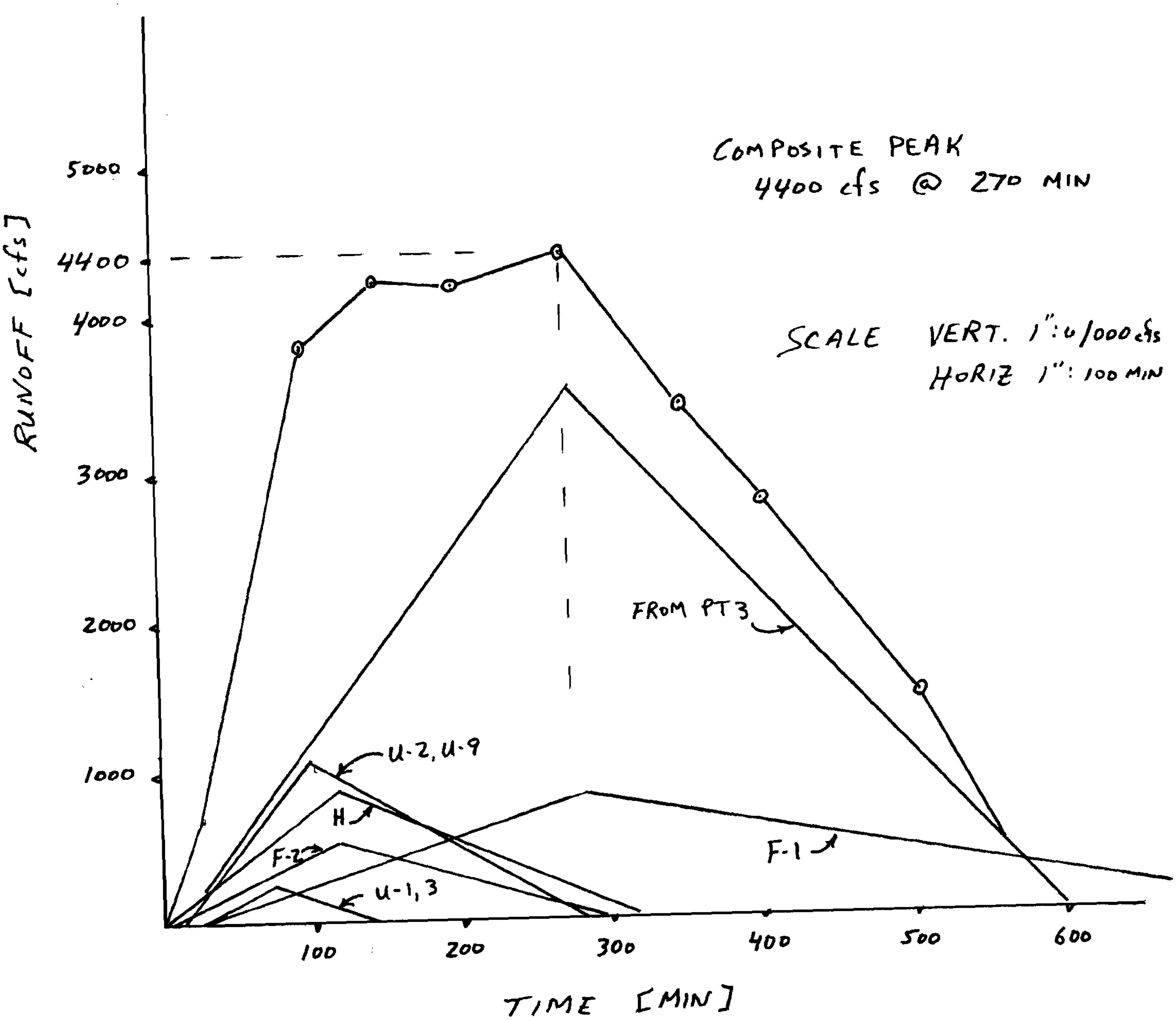
Project Name CASA G. DRAINAGE ST

Sheet No. 4 of 21

Calculated by JOHN KRAFT Date 4/9/87

Checked by RER Date 6/29/87

NORTH BRANCH OF SANTA CRUZ
COMPOSITE HYDROGRAPH FOR
CONCENTRATION POINT "4"
(@ PINAL BRIDGE)



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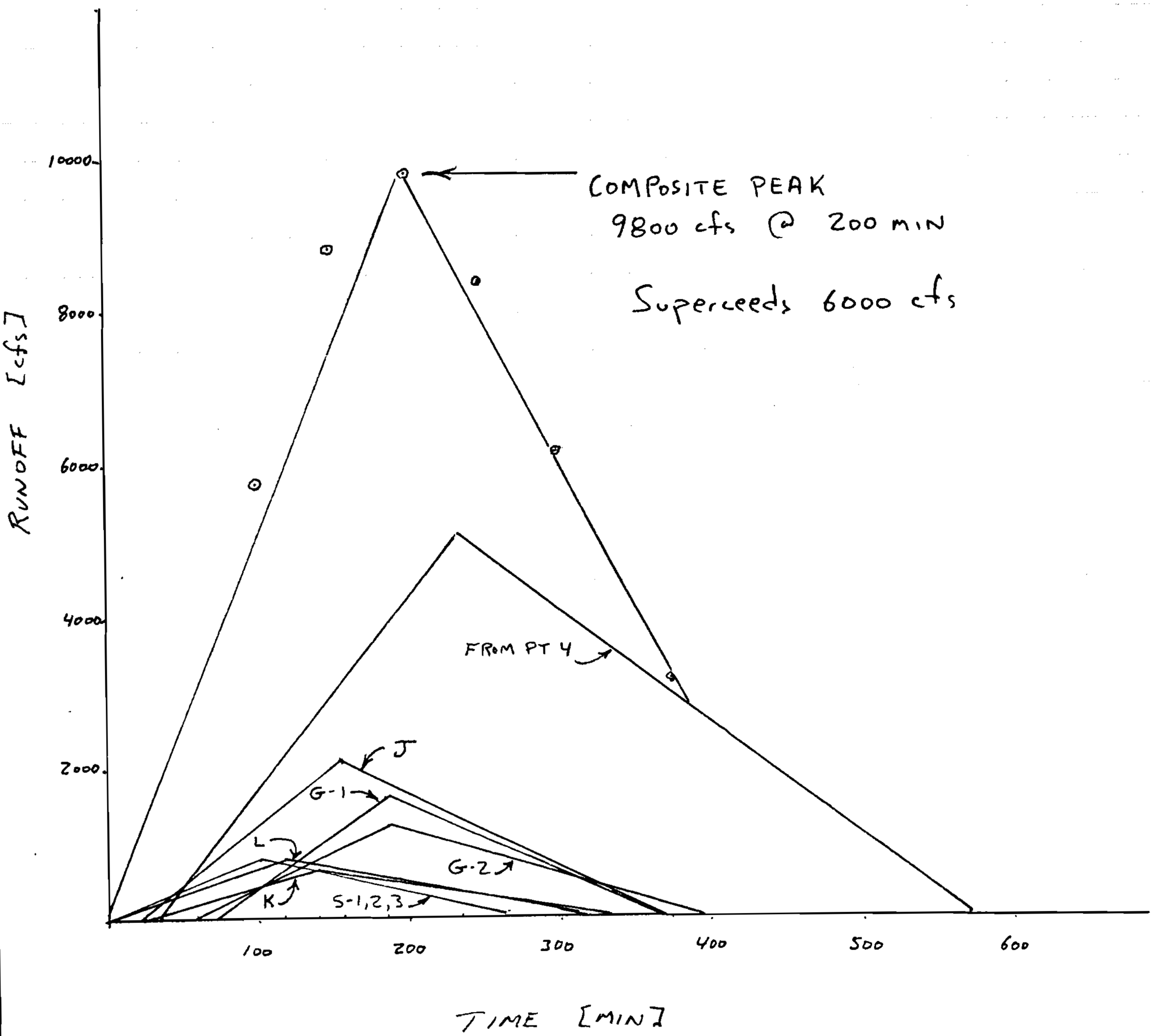
JOB 83314
SHEET NO. 5 OF 21
CALCULATED BY JFK DATE 4/10/87
CHECKED BY RER DATE 6/29/87
SCALE VERT 1": 2000 cfs HORIZ 1": 100 MIN

100 YR 1 HR

COMPOSITE HYDROGRAPH
FOR
CONCENTRATION POINT "5"



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JOB 83314
SHEET NO. 6 OF 21
CALCULATED BY JFK DATE 4/10/87
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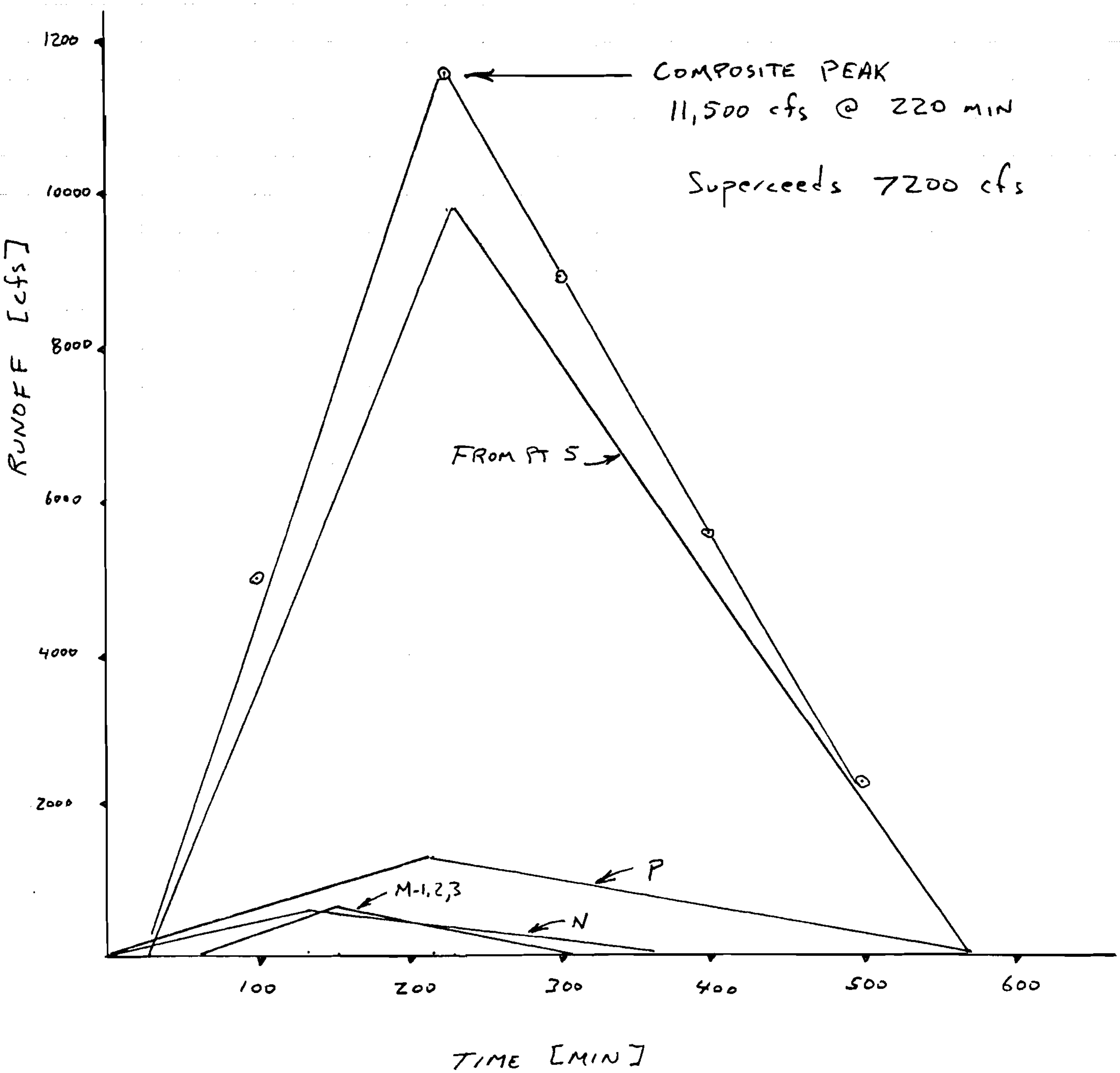
SCALE VERT 1": 2000 cfs HORIZ 1": 100 MIN

100 YR 1 HR

NORTH BRANCH

COMPOSITE HYDROGRAPH
FOR
CONCENTRATION POINT 6



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JOB 83314
SHEET NO. 7 OF 21
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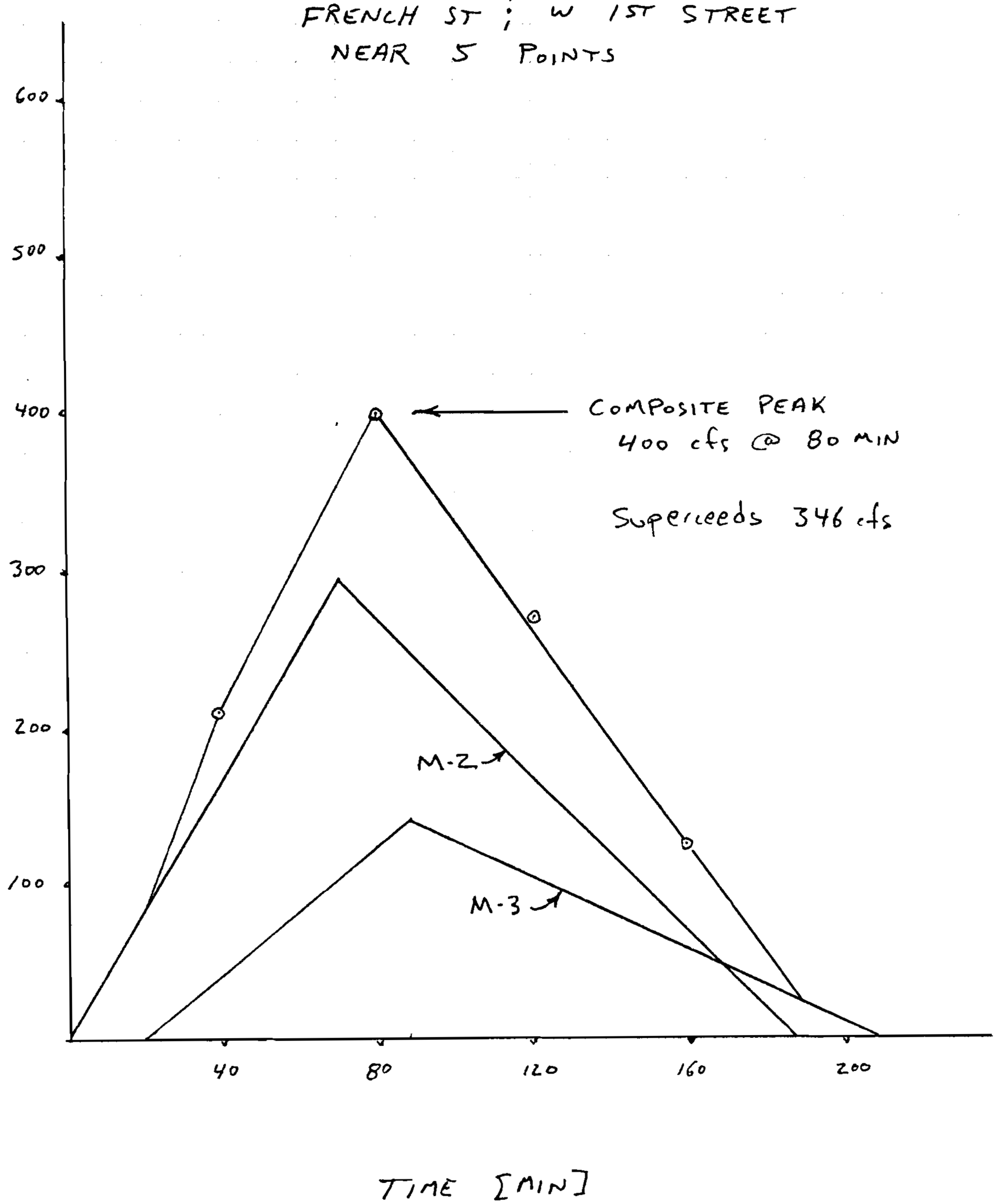
SCALE VERT 1": 100 cfs HORIZ 1": 40 MIN

CONCENTRATION POINT
FRENCH ST ; W 1ST STREET
NEAR 5 POINTS



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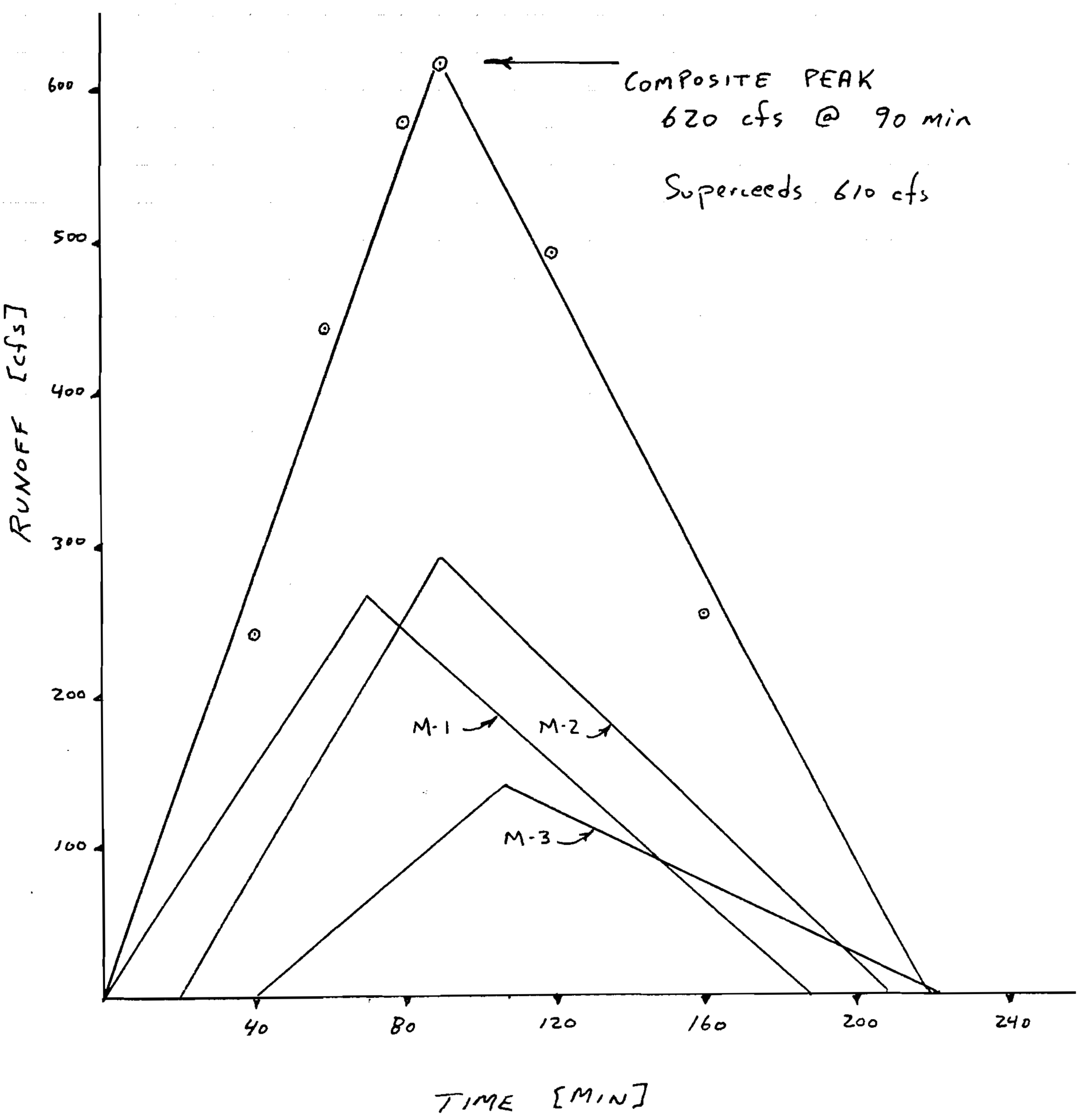
JOB 83314
SHEET NO. 8 OF 21
CALCULATED BY JFK DATE 4/8/87
CHECKED BY RER DATE 6/29/87
SCALE VERT 1": 100 cfs HORIZ 1": 40 MIN

100 YR 1 HR

MID-CITY COMPOSITE HYDROGRAPH



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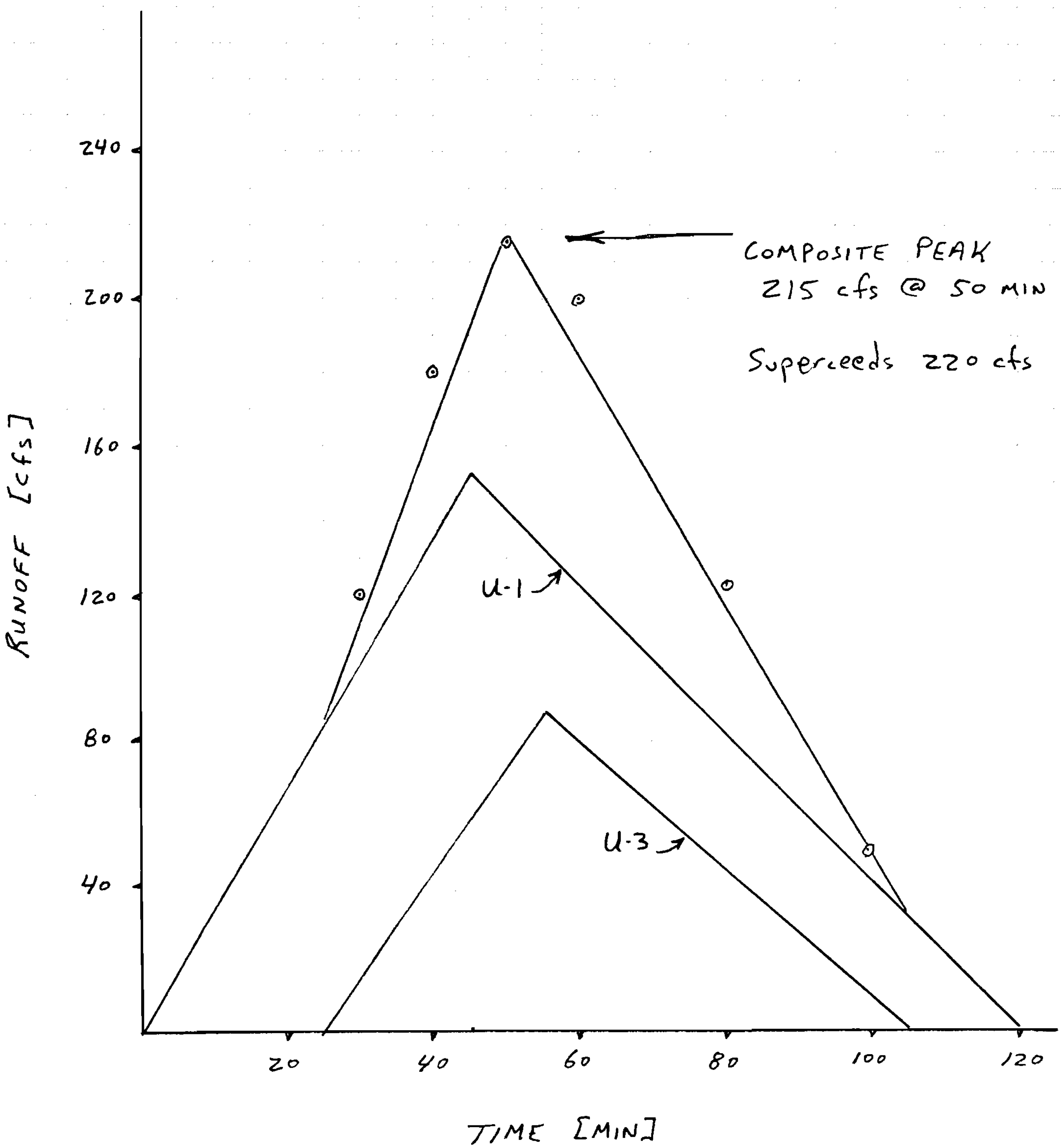
JOB 83314
SHEET NO. 9 OF 21
CALCULATED BY JFK DATE 4/8/87
CHECKED BY RER DATE 6/29/87
SCALE VERT 1": 40 cfs HORIZ 1": 20 MIN

100 YR 1 HR

COMPOSITE HYDROGRAPH FOR STATE DITCH @ SILVER REEF RD



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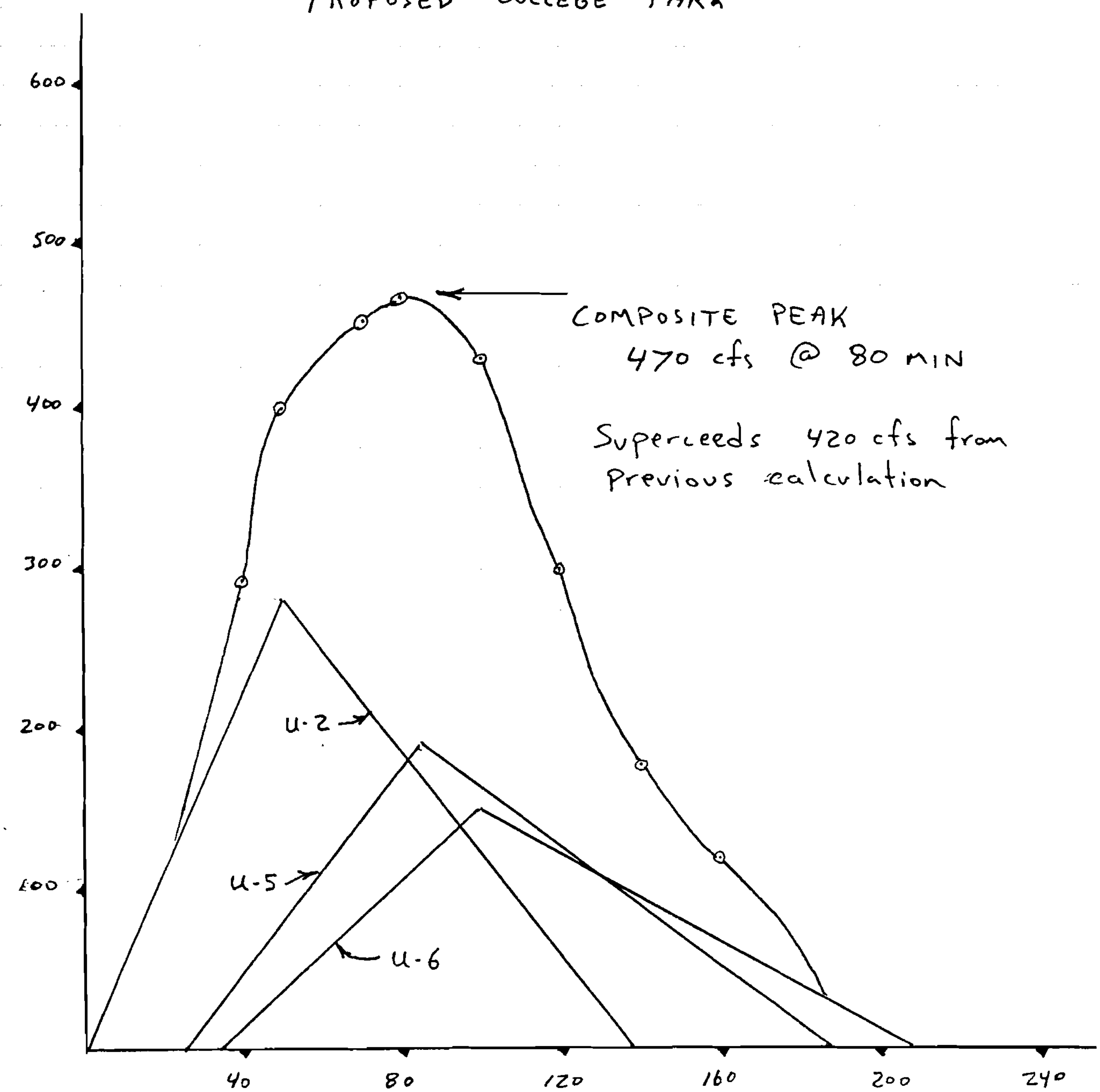
JOB 83314
SHEET NO. 10 OF 21
CALCULATED BY JFK DATE 4/10/87
CHECKED BY RER DATE 6/29/87
SCALE VERT 1": 100 cfs HORIZ 1": 40 MIN

100 YR 1 HR

CONCENTRATION POINT NORTH OF PROPOSED COLLEGE PARK



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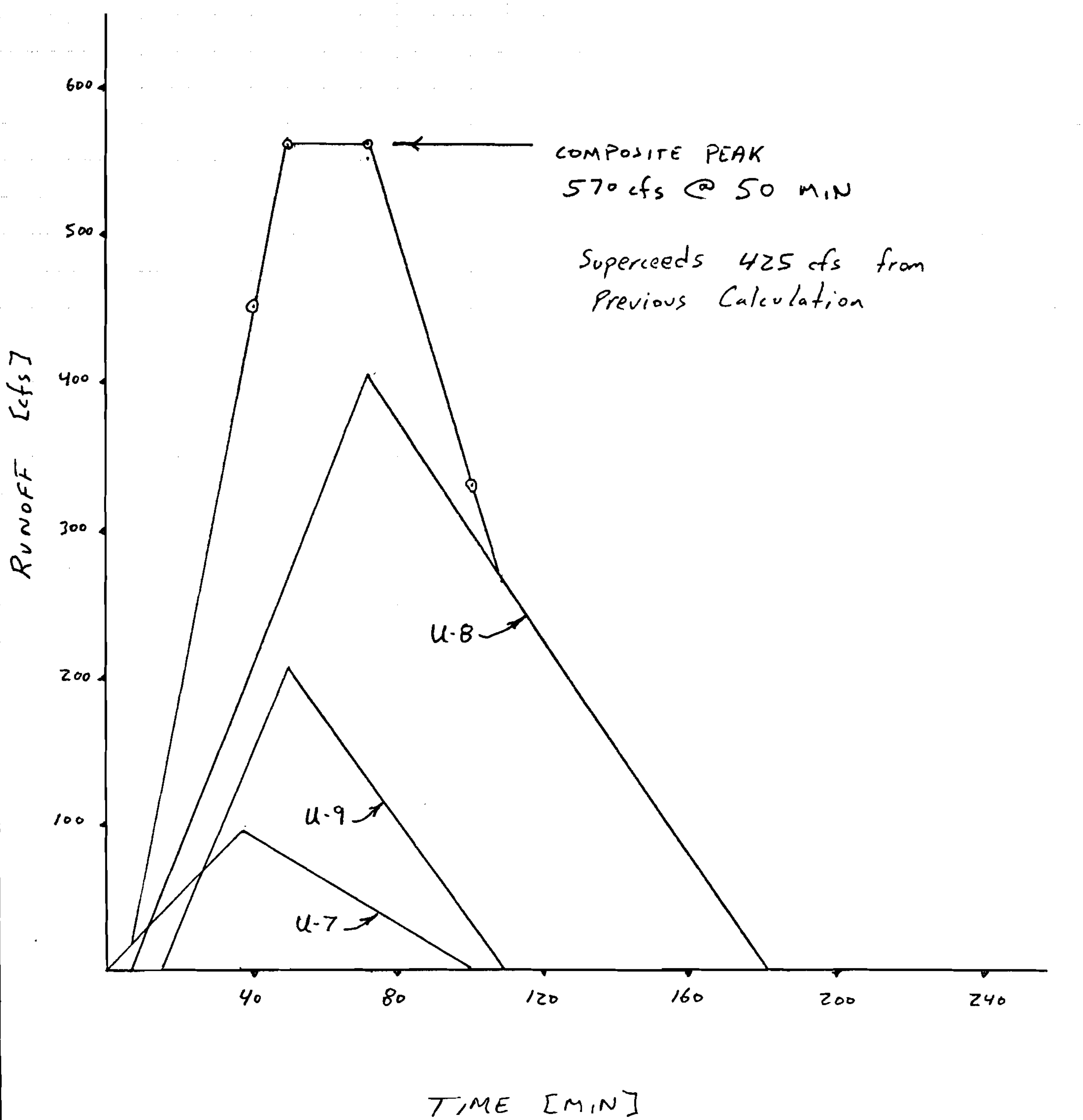
JOB CASA GRANDE DRAINAGE STUDY
SHEET NO. 11 OF 21
CALCULATED BY JOHN KRAFT DATE 4/10/87
CHECKED BY RER DATE 6/29/87
SCALE VERT 1": 100 cfs HORIZ 1": 40 MIN

100 YR 1 HR

CONCENTRATION POINT @ TREKELL & COTTONWOOD



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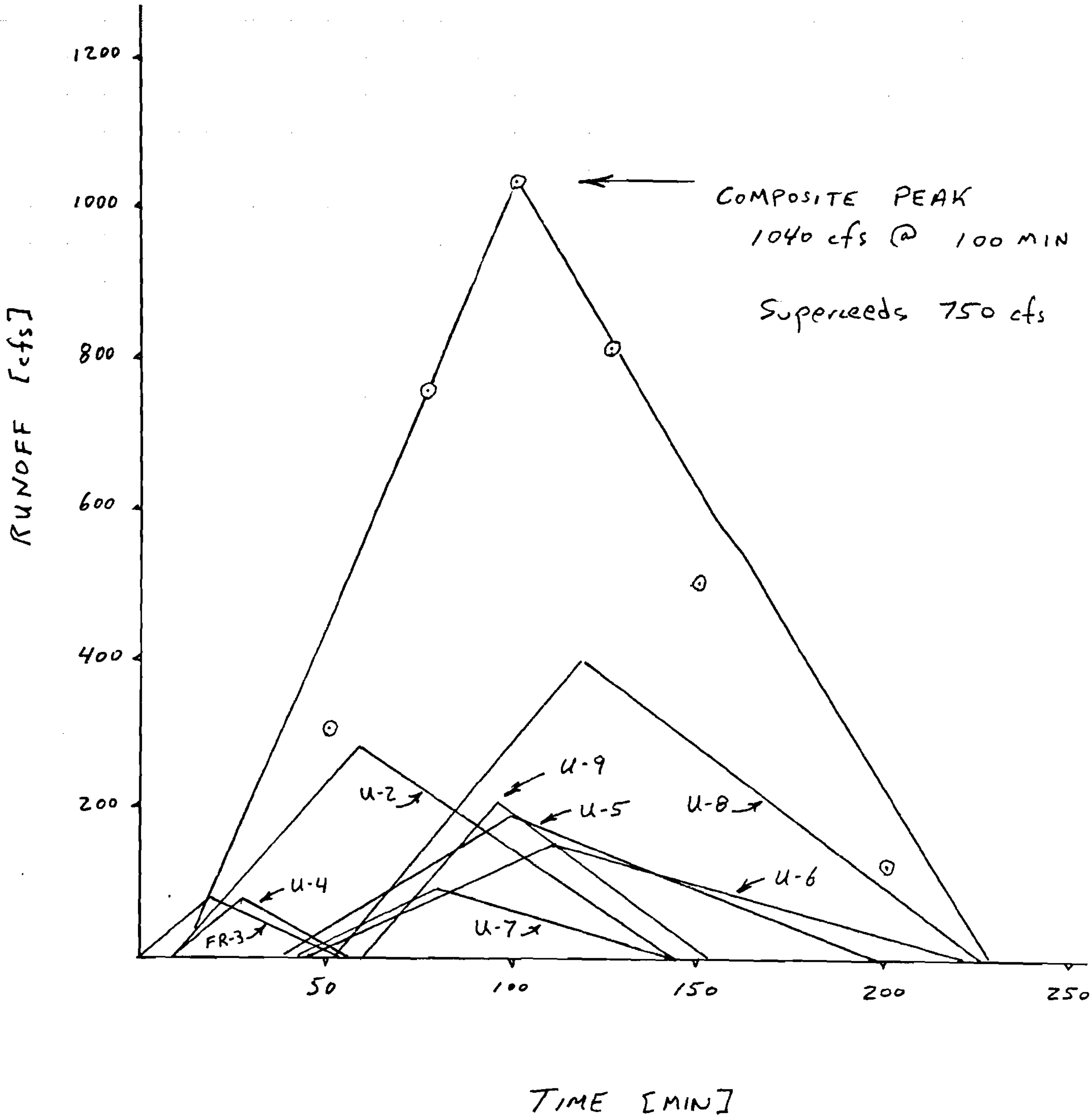
JOB 83314
SHEET NO. 12 OF 21
CALCULATED BY JFK DATE 4/8/87
CHECKED BY RER DATE 6/29/87
SCALE VERT: 1" : 200 cfs HORIZ 1" : 40 MIN

100 YR 1 HR

COMPOSITE HYDROGRAPH
FOR
NORTH OF KORTSEN RD
EAST OF CENTER AVE



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JOB 83314
SHEET NO. 13 OF 21
CALCULATED BY JOHN KRAFT DATE 4/8/87
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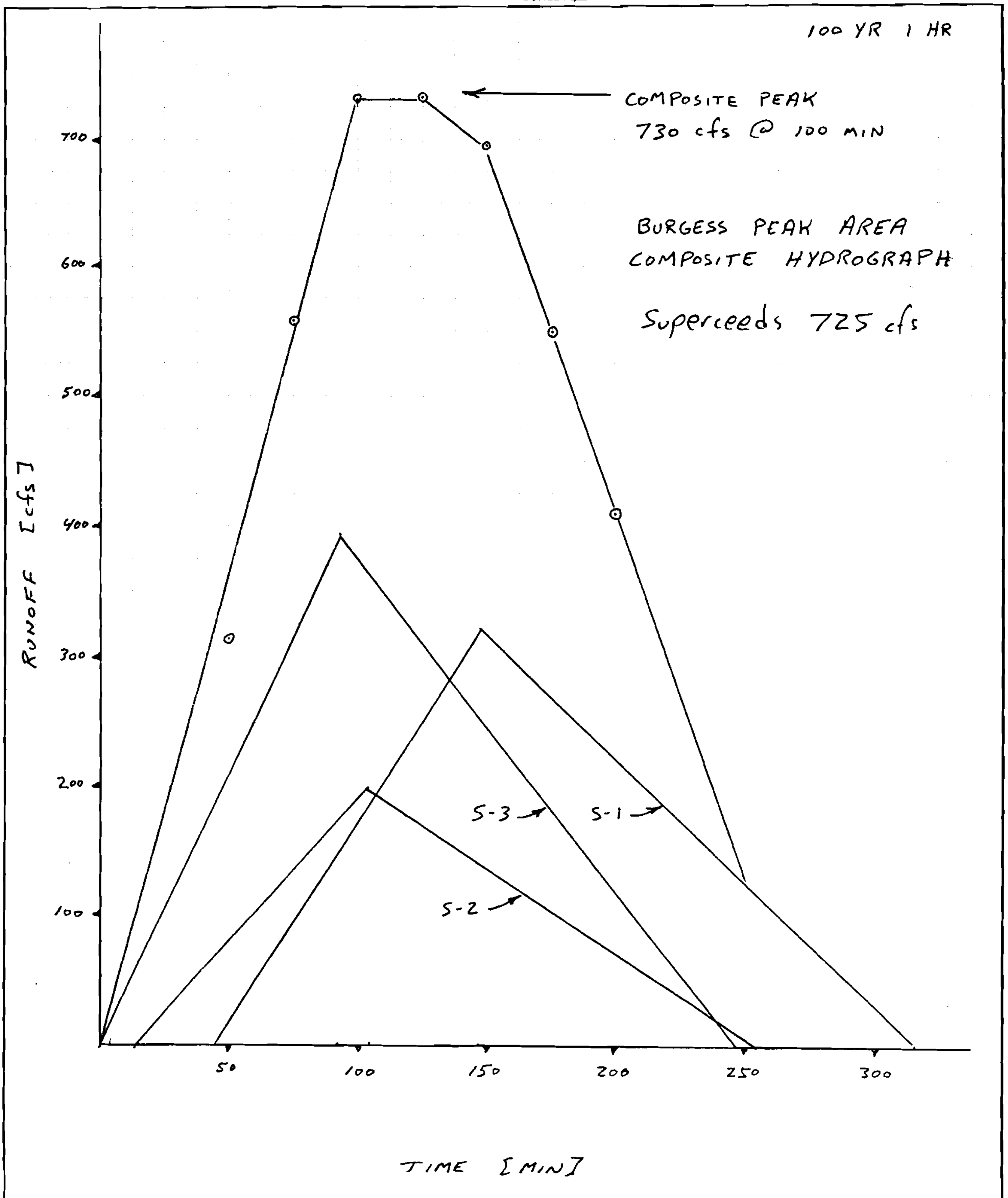
SCALE VERT 1": 100 cfs HORIZ 1": 50 MIN



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Project Name CASA G. DRAINAGE ST
Sheet No. 14 of 21
Calculated by JOHN KRAFT Date 4/15/87
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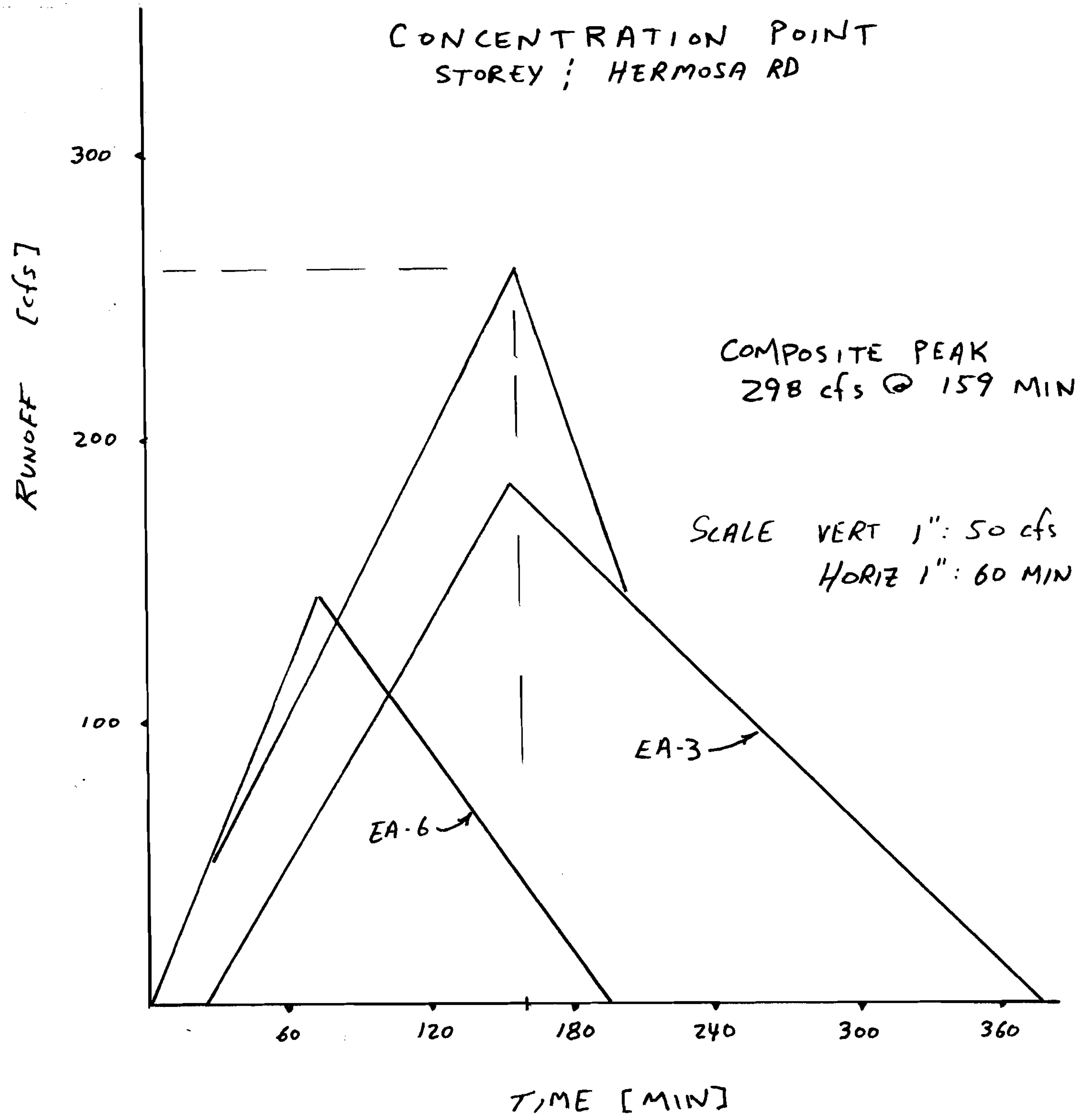

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Project No. 83314
Project Name CASA G. DRAINAGE ST.
Sheet No. 15 of 21
Calculated by JOHN KRAFT Date 4/10/87
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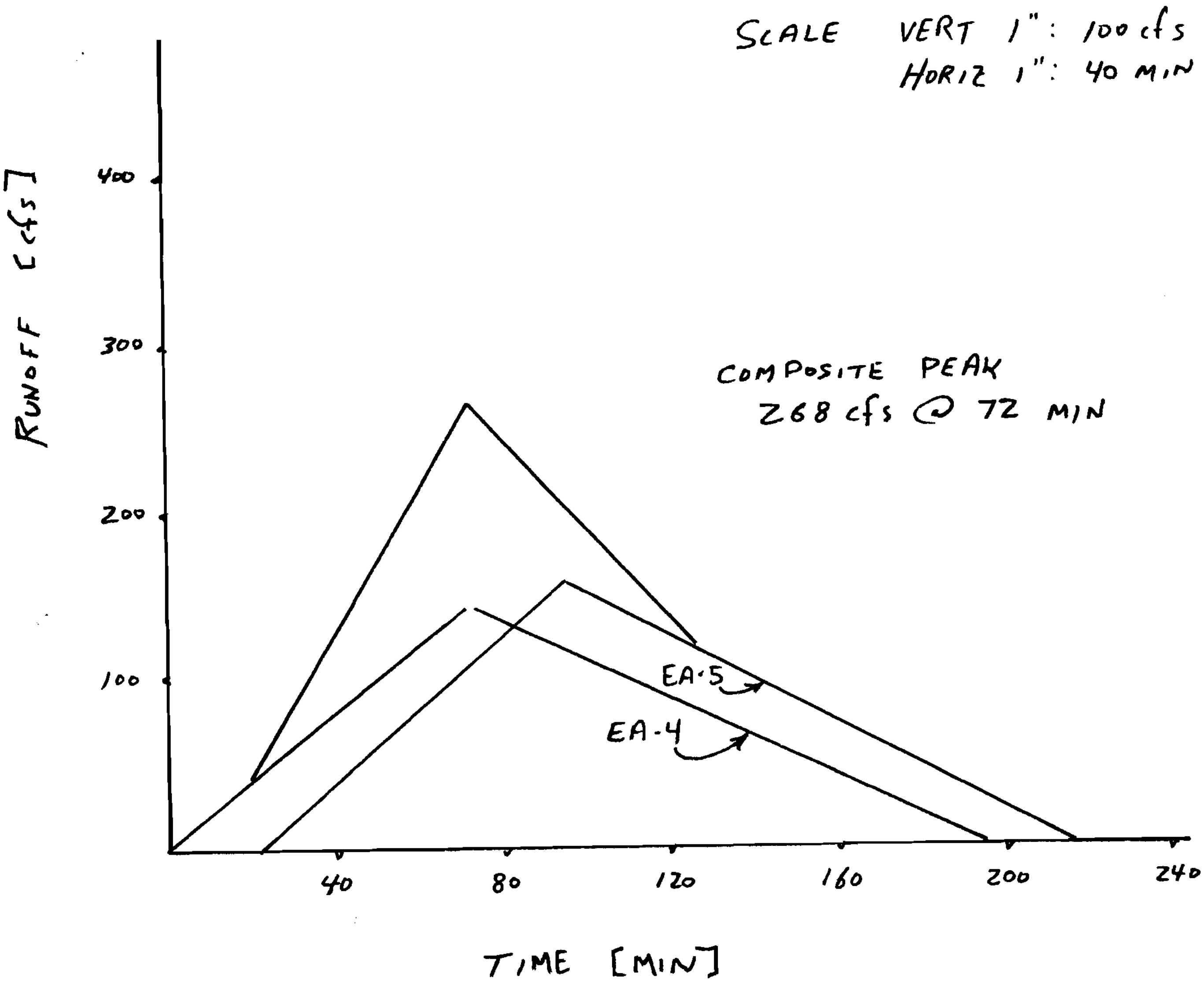
CONCENTRATION POINT @
FLORENCE BLVD ; PEART RD.



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Project No. 83314

Project Name CASA G. DRAINAGE ST

Sheet No. 16 of 21

Calculated by JOHN KRAFT Date 4/15/87

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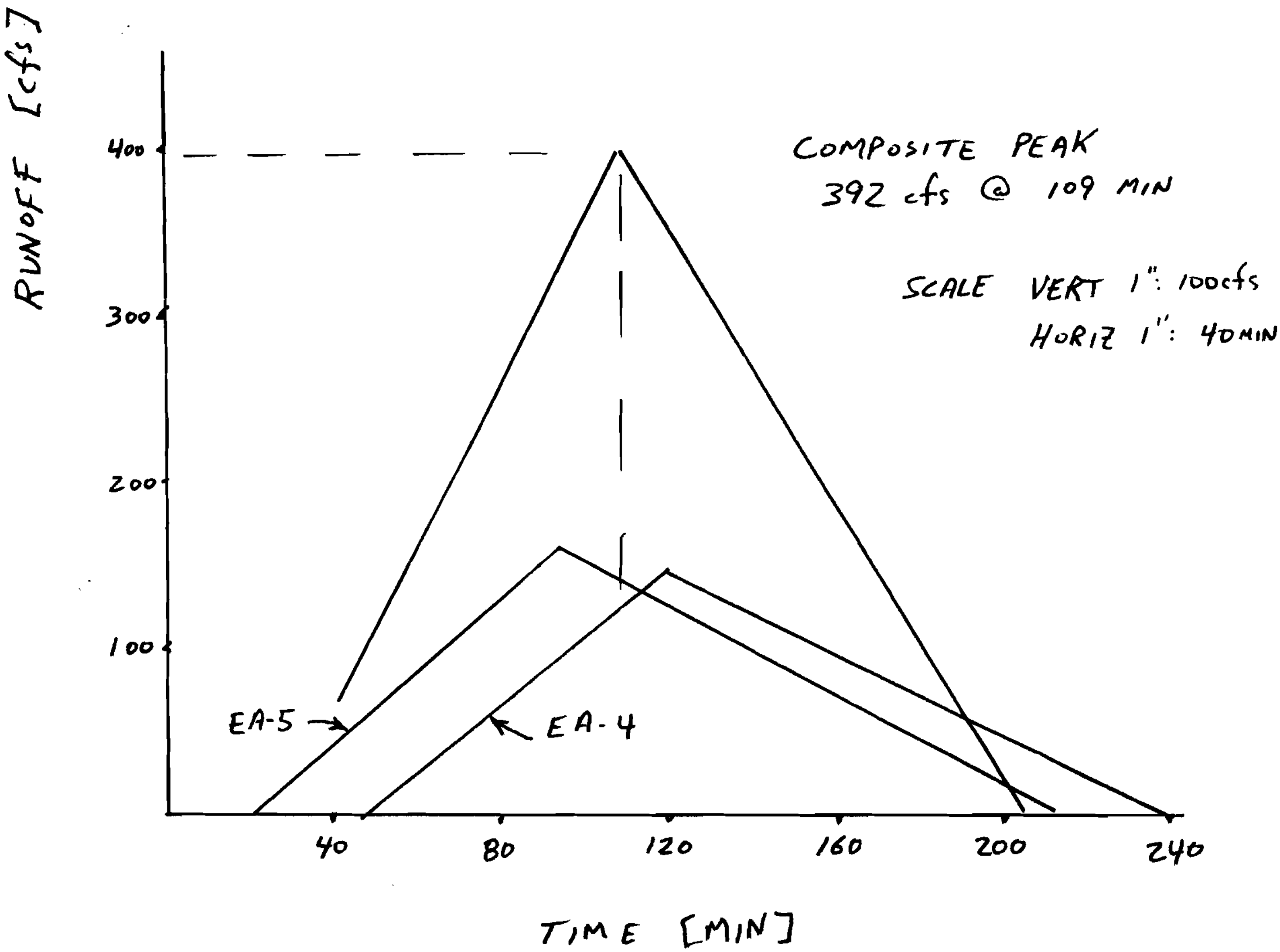
CONCENTRATION POINT

STOREY : PEART Rd



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JOB 83314

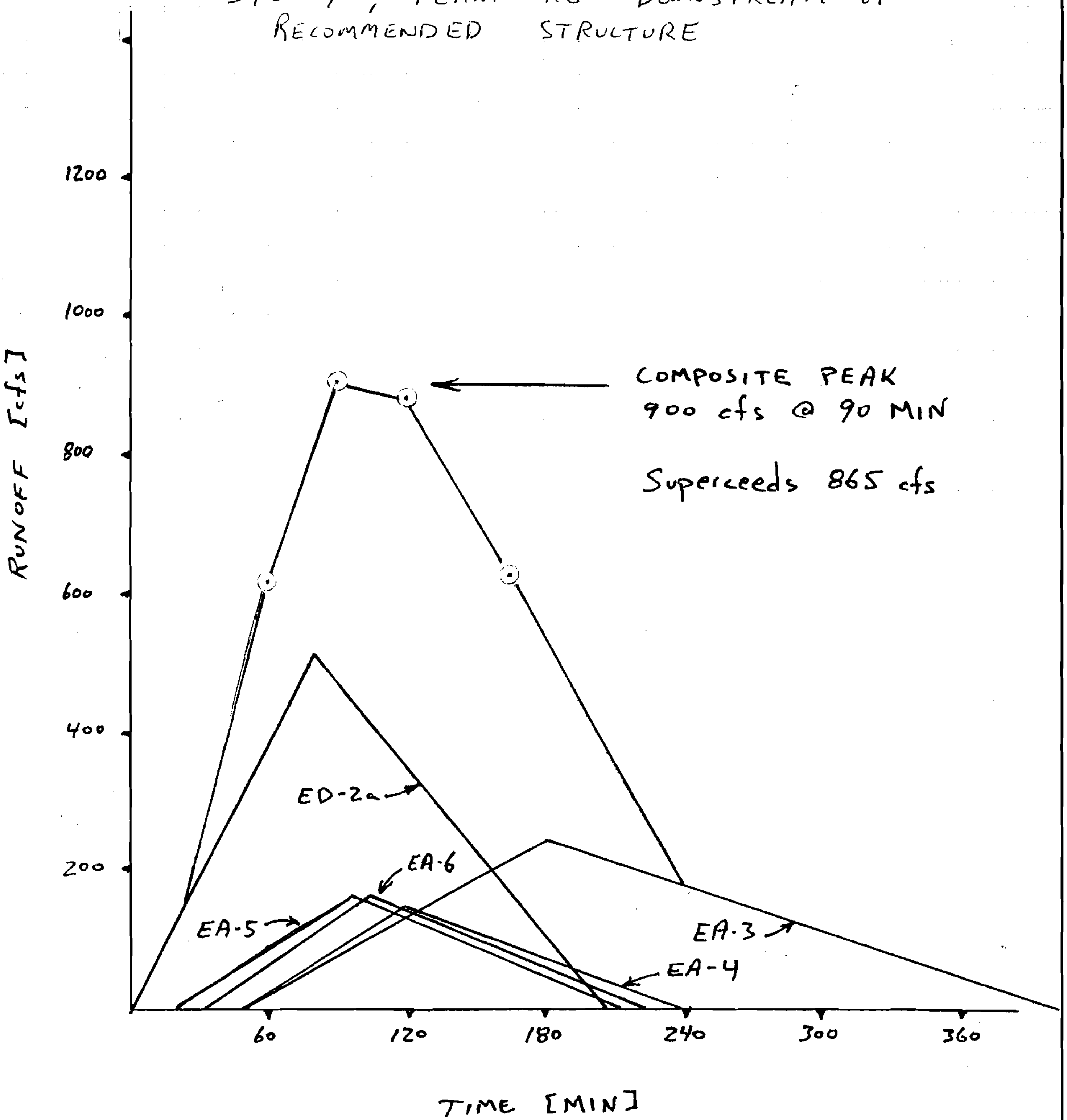
SHEET NO. 17 OF 21

CALCULATED BY JFK DATE 4/15/87

CHECKED BY ______ DATE ______

SCALE VERT 1": 200 cfs 1": 60 MIN

CONCENTRATION POINT
STOREY & PEART Rd - DOWNSTREAM OF
RECOMMENDED STRUCTURE



(602) 955-0900

CARTER ASSOCIATES, INC.

5080 NORTH 40th STREET, SUITE 300, PHOENIX, AZ 85018

Project No. 83314

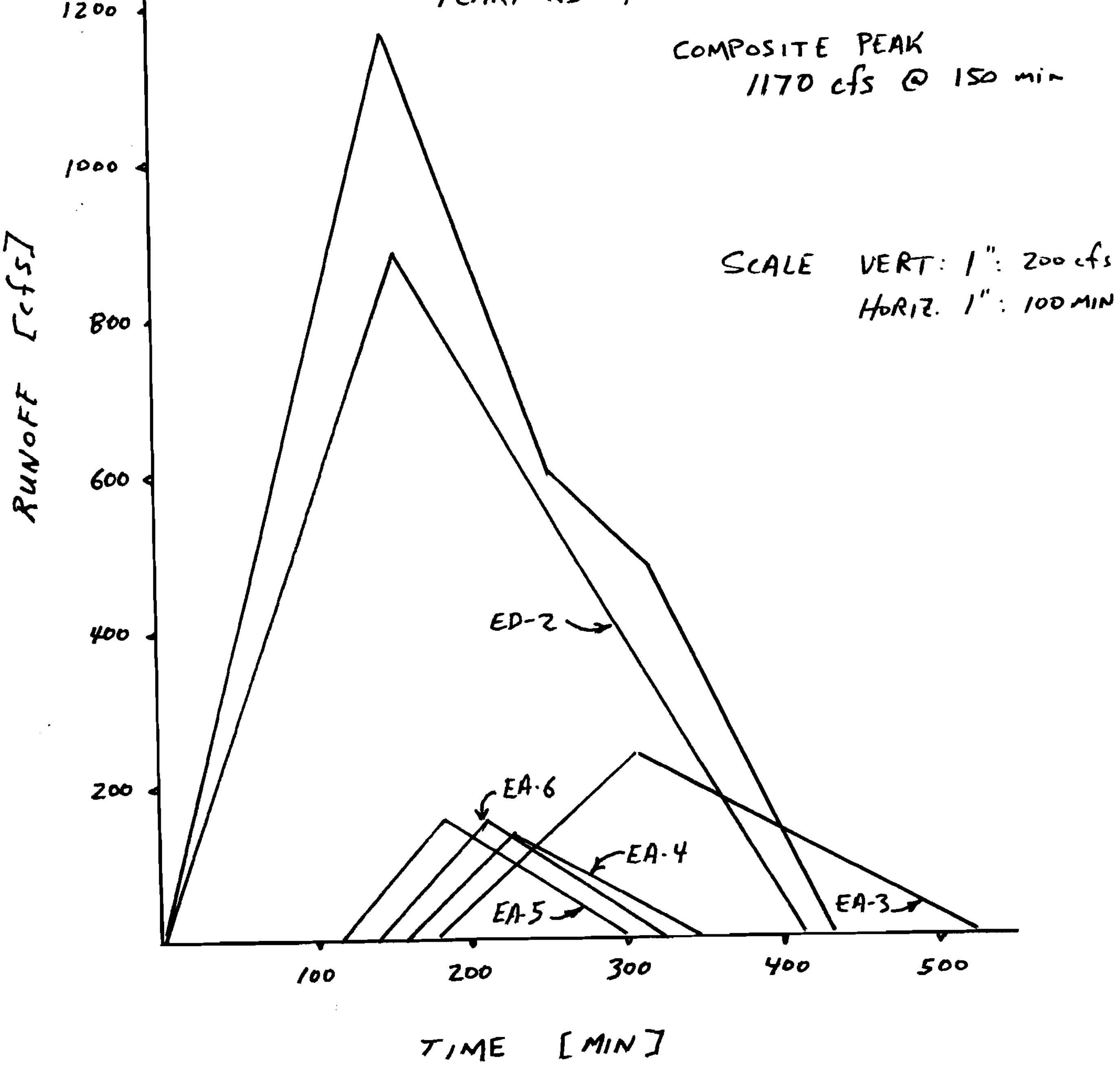
Project Name CASA G. DRAINAGE ST.

Sheet No. 18 of 21

Calculated by JOHN KRAFT Date 4/8/87

Checked by R E C Date 6/29/87

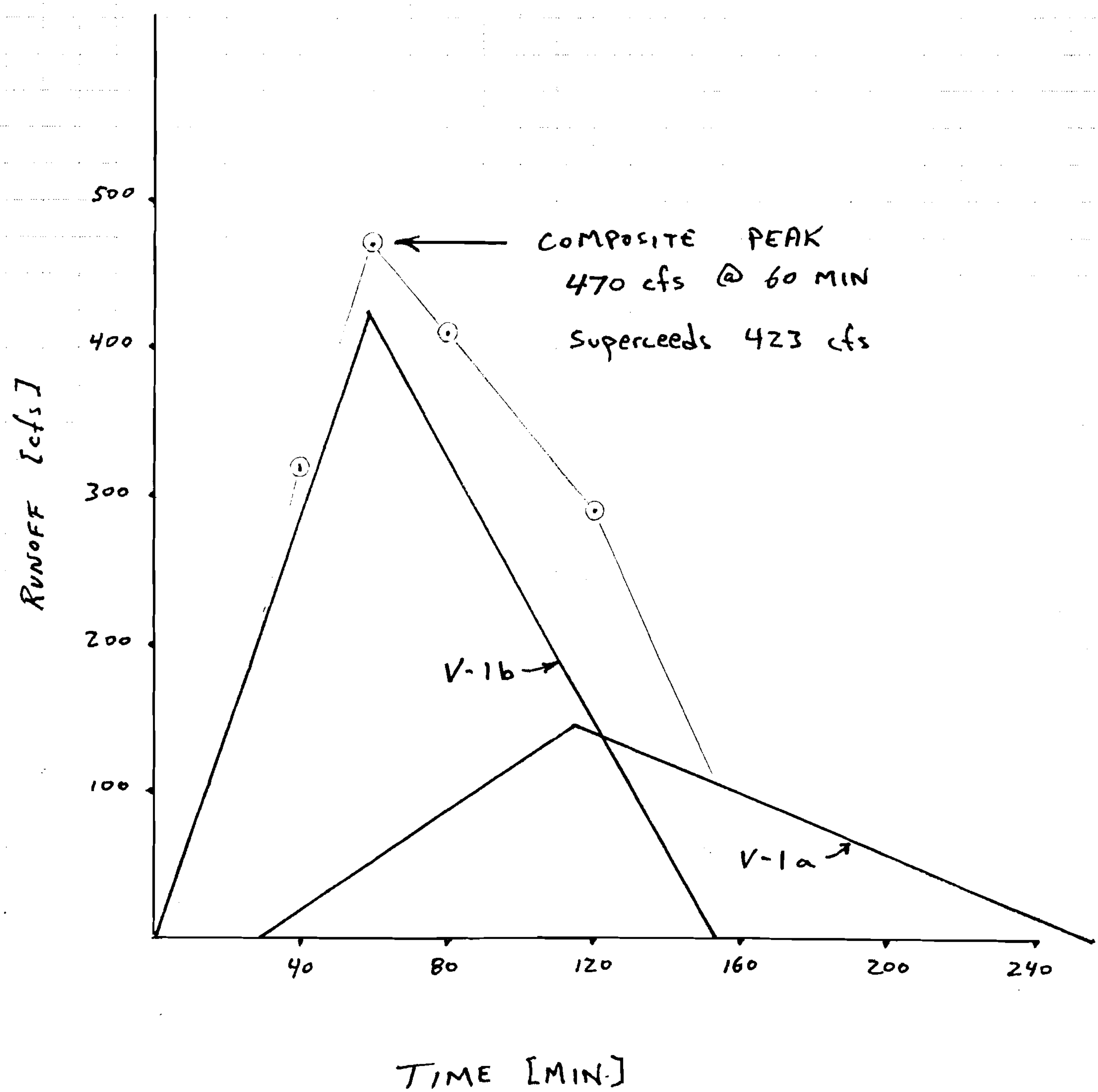
COMPOSITE HYDROGRAPH FOR PEART RD & NORTH BRANCH



CARTER ASSOCIATES
210 N. PARK STREET
FLAGSTAFF, AZ 86001
(602) 779-4505

JOB 83314
SHEET NO. 19 OF 21
CALCULATED BY JFK DATE 4/15/87
CHECKED BY BER DATE 4/?/87
SCALE VERT 1": 100 cfs HORIZ 1": 40 MIN

CONCENTRATION POINT
EAST HALF OF VIP Blvd AREA



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FLAGSTAFF, AZ 86001
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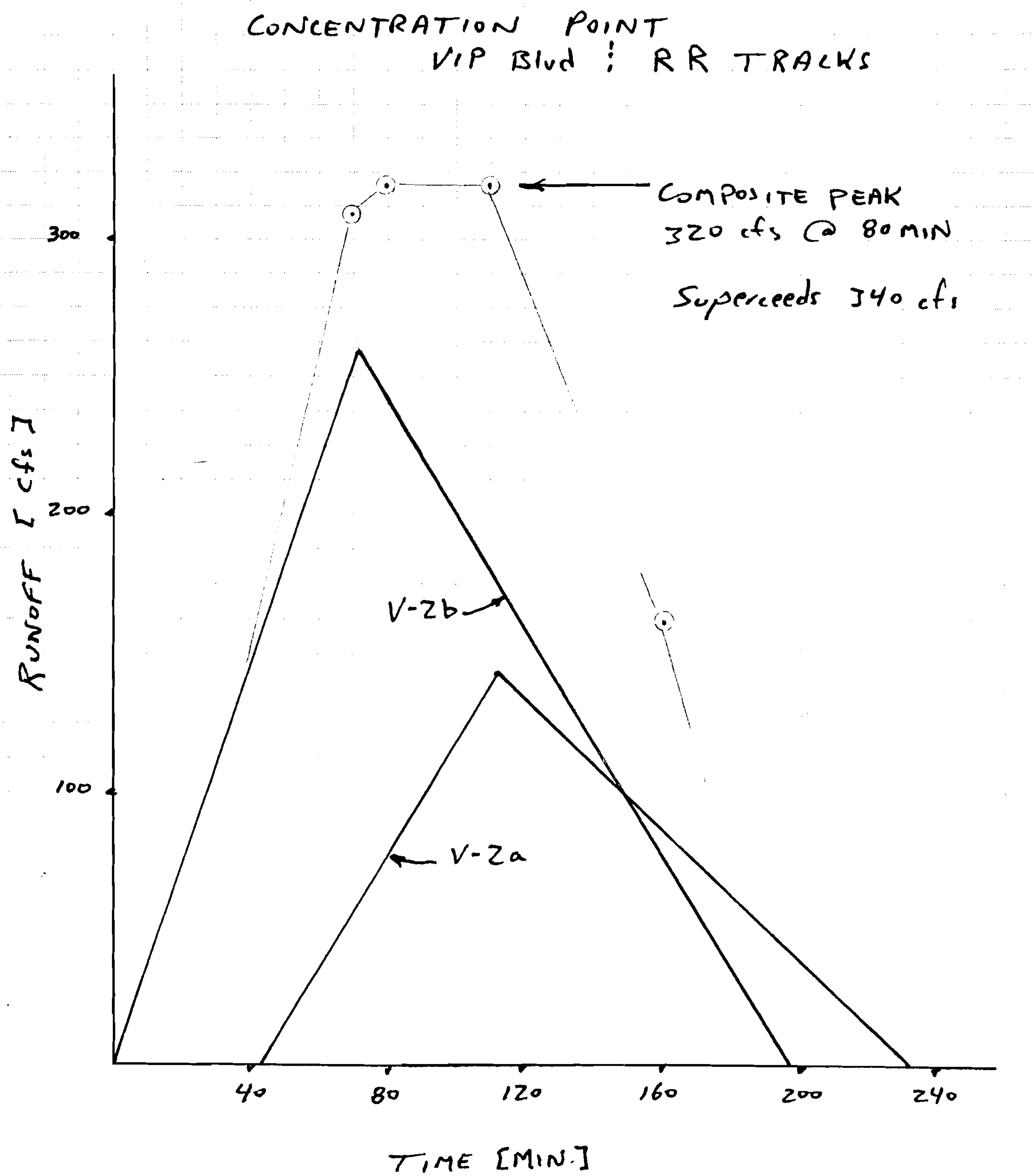
JOB 83314

SHEET NO. 20 OF 21

CALCULATED BY JFK DATE 4/15/87

CHECKED BY RER DATE 6/29/87

SCALE VERT 1": 100 cfs HORIZ 1": 40 MIN



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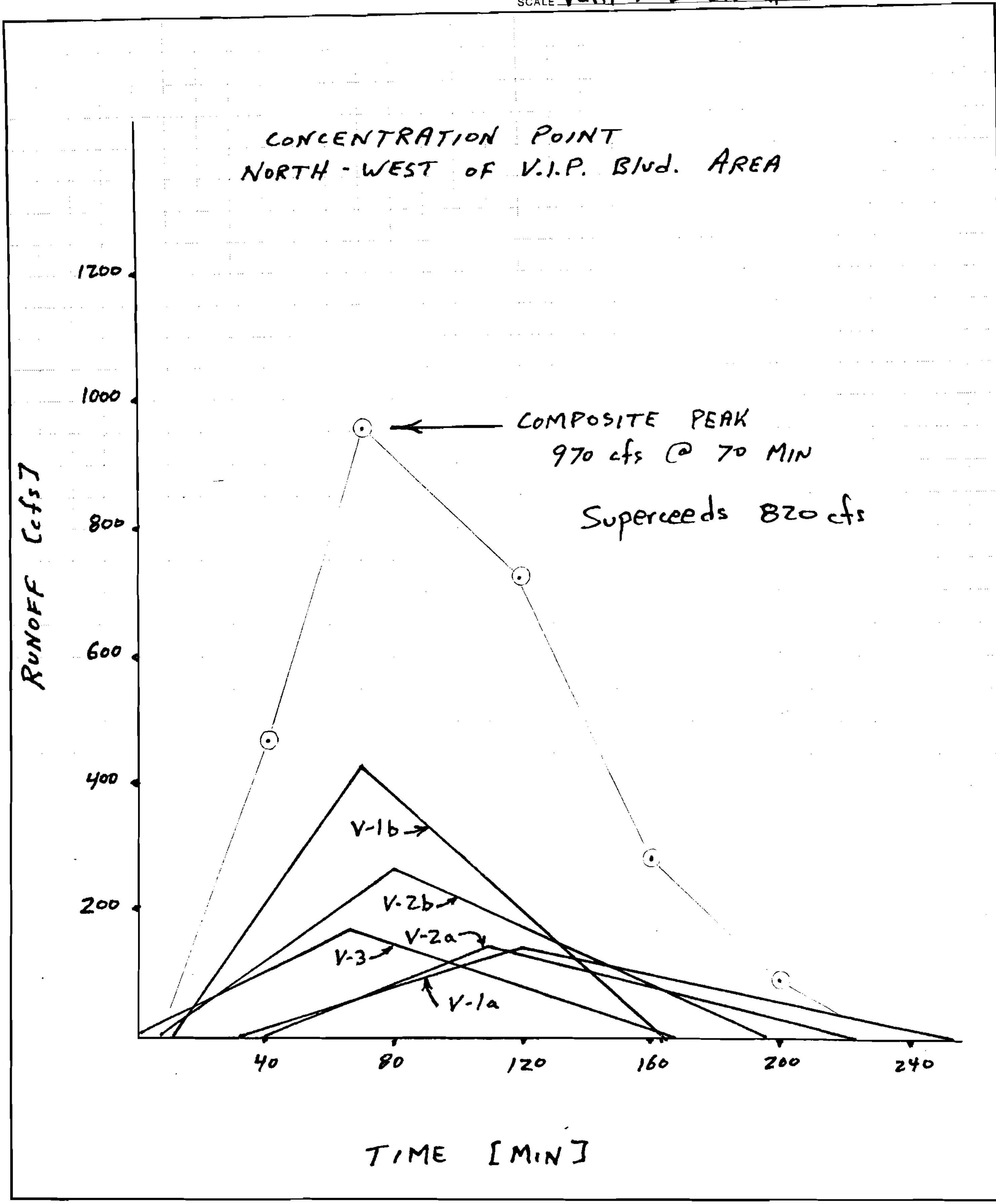
JOB 83314
SHEET NO. 21 OF 21
CALCULATED BY JFK DATE 4/15/87
CHECKED BY RER DATE 4/29/87
SCALE VERT 1": 200 cfs HORIZ 1": 40 MIN



PRODUCT 204-1 Nebs Inc. Groton Mass 01471