Appendix F

Hydromodification Exemption Analysis for Select Carlsbad Watersheds

HYDROMODIFICATION EXEMPTION ANALYSES FOR SELECT CARLSBAD WATERSHEDS

September 17, 2015

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City of Carlsbad
Report accepted by:

Jason Geldert, City Engineer
PE# 63912 Exp 9/30/16

September 22, 2015
Date

EXECUTIVE SUMMARY

In accordance with Order No. R9-2013-0001, issued by the California Regional Water Quality Control Board (Municipal Permit), projects that are subject to Priority Development Project requirements must incorporate: 1) Treatment control best management practices, and 2) Flow-control requirements to address potential hydromodification impacts to downstream natural (non-hardened) channels.

However, certain improved/hardened drainage systems are not impacted by channel erosion. For these cases, the Municipal Permit includes provisions where a local agency may provide exemptions from hydromodification:

> *Each Copermittee has the discretion to exempt a Priority Development Project from hydromodification management BMP performance requirements of Provisions E.3.c.(2) where the project discharges water runoff to:*
>
> *(i) Existing underground storm drains discharging directly to water storage reservoirs, lakes, enclosed embayments, or the Pacific Ocean.*
>
> *ii) Conveyance channels whose bed and bank are concrete lined all the way from the point of discharge to water storage reservoirs, lakes, enclosed embayments, or the Pacific Ocean;*

Having development/redevelopment projects explore HMP exemption criteria could require an individual project proponent to undertake significant engineering analyses and evaluation of downstream drainage facilities and conditions within a watershed area. Consequently, the City of Carlsbad's Land Development Engineering Division commissioned this hydromodification exemption study.

This report focuses on certain watershed areas tributary to the Agua Hedionda Lagoon, Batiquitos Lagoon, and Buena Vista Lagoon. All three Lagoons are located within the Carlsbad Watershed area and are considered enclosed embayments per the Municipal Permit.

The study limits focus on select areas draining to the lagoons that are highly-developed and are served by improved existing paved streets that collect and convey runoff via reinforced concrete pipes (hardened systems) that are not subject to erosion potential. For each storm drain network discharging to the lagoon, the discharge locations were evaluated to ensure they qualify as a 'direct discharge'. To qualify as a direct discharge, field visits were performed at each outlet location to verify properly sized energy dissipation and, by a review of record drawings, that the discharge locations are below the 100-year flood elevation of the lagoon (consistent with Watershed Management Area Analysis (WMAA) for the San Diego River). Pictures of the outlet locations are at the end of this study.

The HMP Exemption Exhibit in the map pocket at the back of this report includes the limits of the study areas. For those projects located within a hatched area, they are considered exempt from hydromodification requirements either under current conditions or with some future

improvements. In accordance with the Municipal Permit, projects that are exempt from hydromodification must still satisfy all other applicable storm water standards (i.e.: site design, source control measures, treatment control best management practices, low impact development, etc.).

Although several watershed areas were evaluated, not all drainage areas qualified for exemption from hydromodifcation requirements. These reasons why they did not qualify will be explained further in the study and are, therefore, not included as exempt areas in the HMP Exemption Exhibit.

INTRODUCTION

In accordance with the Municipal Permit, development and redevelopment projects are subject to either: 1) Standard Stormwater or 2) Priority Development Project (PDP) requirements, which are more rigorous. The City's "Storm Water Standards Questionnaire E-34" (see Figure 11) is used to determine whether a project must meet Standard Stormwater or PDP requirements. The questionnaire, using criteria from the Municipal Permit, provides specific thresholds under which these new development/redevelopment projects trigger PDP requirements.

Among other things, projects subject to PDP requirements must include treatment control best management practices (BMPs) and are required to incorporate hydromodification BMPs. Hydromodification provides requirements to control post-development storm water runoff rates, velocities, and durations in order to maintain or reduce pre-development downstream erosion, sediment pollutant generation, and protect beneficial uses and stream habitat.

For this study, a focus was made to look at the three lagoons within the city (Buena Vista, Agua Hedionda, and Batiquitos Lagoon) and explore applicable HMP exemptions. This study assesses the lagoons and seven (7) major drainage areas contributing to the lagoons to determine whether they meet hydromodification exemption criteria. The seven major drainage areas are tributary to one of the seven following storm drain outlets into Buena Vista, Agua Hedionda, or Batiquitos Lagoon (see the Study Area Exhibits and HMP Exemption Exhibit in the map pocket):

Buena Vista Lagoon

- 48" and 66" outlets on the east side of Carlsbad Boulevard into the south side of the lagoon
- 48" outlet on the west side of Interstate 5 into the south side of the lagoon
- 66" outlet on the west side of Jefferson Street into the south side of the lagoon

Agua Hedionda Lagoon

- 18" outlet on the west end of Date Avenue into the north side of the lagoon
- 84" outlet on the east side of the railroad tracks into the north side of the lagoon
- 60" outlet near the south end of Marina Drive into the north side of the lagoon

Batiquitos Lagoon

- 84" outlet on the east side of Carlsbad Boulevard into the north side of the lagoon

With the exception of one area, the studied tributary areas do not include natural (non-hardened) channels directly to a lagoon. Each of these major drainage areas is served by a network of improved (hardened) public drainage facilities that outlet into a lagoon. The majority of the public facilities are underground storm drain systems or paved streets. Some facilities are also lined (concrete, gunite, etc.) drainage ditches or swales. Provided runoff from the study area discharges into a non-erodible drainage network that is continuous with a direct discharge to a lagoon, it is potentially eligible for a hydromodification exemption. Based on record drawing research and field reconnaissance, the Study Area Exhibits identify the improved (hardened) drainage networks. The exhibits demonstrate that each major drainage area, except the 48" outlet

towards Buena Vista Lagoon on the west side of Interstate 5, contains a continuously improved non-erodible network that serves the drainage area; therefore MS4's draining directly into the lagoons are not subject to potential impacts from hydromodification. The discharge points must be below the 100-year water surface elevations in the lagoon (consistent with Watershed Management Area Analysis (WMAA) for the San Diego River).

Areas Draining to Buena Vista Lagoon

Using rational method analyses from the 2003 County *Hydrology Manual* and as-built (record drawing) research, the existing storm drain network collecting run-off for all of the Buena Vista Lagoon drainage areas (Major Drainage Basins 100, 200, and 300 as shown on the Study Area Exhibits) analyzed in this report have been shown to be adequate to convey the Q_{10} runoff, which is the upper range for hydromodification as described the Municipal Permit. Each outlet structure was observed to ensure they include adequate energy dissipation to address erosion potential. For details of how these each of these criteria where satisfied, refer to the Appendices of this study. The select areas draining to the Buena Vista Lagoon from Major Drainage Basins 100 and 300, which are determined to be exempt from HMP are shown in the HMP Exemption Exhibit.

Although Major Drainage Basin 200 includes an improved non-erosive (hardened) storm drain system, the existing 48" outlet is not directly adjacent to the waters edge of Buena Vista Lagoon; therefore, does not qualify as a direct discharge to an exempt water body. In order for Major Drainage Basin 200 to qualify for an exemption a non-erodible drainage facility capable of conveying at least the 10-year flow will need to be constructed from the existing 48" outlet to the 100-year floodplain in the receiving lagoon.

Areas Draining to Agua Hedionda Lagoon and Batiquitos Lagoon

Certain drainage areas that drain to these lagoons were selected (Major Drainage Basin 400, 500, 600, and 700 as shown on the Study Area Exhibits). The existing storm drain network for each drainage area was also evaluated against their ability to carry the Q10. As provided in the Technical Appendices, the storm drain system for each drainage areas has the capacity to carry the Q10. The outlet for each storm drain system was also observed to ensure they include adequate energy dissipation to address erosion potential. For details of how these each of these criteria where satisfied, refer to the Appendices of this study. Based on these findings, the select areas draining to Agua Hedionda Lagoon and Batiquitos Lagoon are shall be considered exempt from HMP. These exempt areas are shown in the HMP Exemption Exhibit.

There are two isolated areas within Major Drainage Basin 600 that direct storm runoff over the natural ground surface west of the railroad tracks. Without further analysis using erosion potential (or equivalent), the naturally-lined swales are not considered exempt from hydromodification. Therefore, these areas were excluded from the exemption area in HMP Exemption Exhibit and from further analysis.

OUTLET CONDITIONS

Since the storm drain networks considered in this report are continuously non-erodible to one of the three lagoons (except from Major Drainage Basin 200 and a portion of 600), the energy dissipation to be studied are at the lagoon outlets. As-built drawings were reviewed and a site visit was performed to determine the conditions at each outlet. The following describes the findings for each outlet. In addition, the Lagoon Assessment section contained next in this report confirms that each outlet is below the 100-year water surface elevation. This effort confirms the storm drain network (MS4's) qualifies as a 'direct discharge' to an exempt water body.

Buena Vista Lagoon 48" and 66" Outlets

These are adjacent reinforced concrete pipe outlets that discharge into the south edge of Buena Vista Lagoon immediately east of the merge of State Street and Carlsbad Boulevard. During the site visit, the lagoon water level was at the invert of the 48" outlet and just above the invert of the 66" outlet (see Figure 1 after this report text). Riprap energy dissipation was not observed below the outlets nor was there evidence of erosion below the outlets (see Figure 2).

Drawing No. 215-9 shows that the invert elevation of the 66" reinforced concrete pipe outlet is at 6.0 feet NGVD 29 (the reference drawings are included on the compact disc in the map pocket). The 48" outlet is shown on Drawing 153-9, but the plan does not identify the vertical datum. Based on the site visit, the 48" outlet invert is approximately 6 inches higher than the 66" outlet invert. Buena Vista Lagoon contains a weir structure near the Pacific Ocean that controls the water surface in the lagoon. A field survey by Algert Engineering revealed that the top of the weir structure is at 7.6 feet NAVD 88 or 5.5 feet NGVD 29. Therefore, the water level in the lagoon will be within at least 6 to 12 inches of the outlets. During most periods, the water level should be higher than 5.5 feet due to natural sand build-up above the weir crest caused by littoral processes as well as backwater in the lagoon. Since ponded water is an effective energy dissipater, the 48" and 66" outlets contain proper energy dissipation. This is further evidenced by the absence of erosion below the outlets even though they have been in place since at least the mid-1980's.

Buena Vista Lagoon 48" Outlet

This 48" reinforced concrete pipe is a Caltrans facility whose outlet discharges towards, but not directly into, the south edge of Buena Vista Lagoon immediately west of Interstate 5. The as-built plans (Document No. 40002483) show that the outlet is at elevation 22.0 feet and was designed with "rock slope protection." During the site visit, riprap was observed below the 48" outlet (see Figure 3). The typical riprap diameter was over 12 inches, which is consistent with the sizing proposed on the design plans. Tall grasses obscured some of the riprap, but the grass indicates that the energy dissipation is effective. However, since this outlet is not a 'direct' discharge to the lagoon (see Lagoon Assessment section), no further analysis is provided.

Buena Vista Lagoon 66" Outlet

This 66" reinforced concrete pipe discharges into the south edge of Buena Vista Lagoon immediately west of Jefferson Street. The as-built plans (Drawing No. 182-10) show that the outlet invert is at elevation 5.3 feet NGVD 29 and contains ¼-ton riprap. The outlet invert was just below the lagoon water level (see Figure 4) during the site visit, which is consistent with the

weir-controlled lagoon water level. Riprap was not observed at the outlet during the site visit due to the difficulty in accessing the outlet through the dense vegetation. However, the fact that the water level will be at or above the outlet invert indicates that this outlet has appropriate energy dissipation.

Agua Hedionda Lagoon 18" Outlet

This 18" corrugated metal pipe discharges onto a riprap-lined revetment protecting the northeast bank of Agua Hedionda Lagoon immediately west of the intersection of Date Avenue with Garfield Street (see Figure 5). Storm runoff flows a short distance down the revetment and into the lagoon. As-built plans (Drawing No. 133-3) show that the outlet invert is at elevation 5.36 feet and that energy dissipation has been designed below the outlet. In addition, the tributary drainage area covers approximately 5.2 acres, so the pipe flows will be relatively small.

Agua Hedionda Lagoon 84" Outlet

This 84" reinforced concrete pipe discharges into the north edge of Agua Hedionda Lagoon just east of the railroad tracks. The engineering plans (Drawing No. 360-5) were as-built in 2006, so this is a relatively recent system. The plans show that the storm drain system and its grouted riprap energy dissipater were designed for the 100-year storm flow in accordance with current engineering criteria. A site visit confirmed that the grouted riprap energy dissipater exists and is in substantial conformance with the plans (see Figure 6).

Agua Hedionda Lagoon 60" Outlet

This 60" reinforced concrete pipe discharges directly into the north edge of Agua Hedionda Lagoon just west of Marina Drive. The as-built plans (Drawing No. 152-3) show that the outlet invert elevation is -1.75 feet NGVD 29. This elevation is lower than mean sea level, so the lagoon water level will serve as appropriate energy dissipation for the outflow. A site visit confirmed that the invert is lower than the lagoon water level (see Figure 8).

Batiquitos Lagoon 84" Outlet

This 84" reinforced concrete pipe discharges into the north edge of Batiquitos Lagoon just east of Carlsbad Boulevard and west of the railroad tracks. The as-built drawings (Drawing No. 337-9) show that the storm drain system and its energy dissipater (1-ton riprap and concrete sill) were designed for the 100-year storm flow in accordance with current engineering criteria. A site visit confirmed that the energy dissipater exists in substantial conformance with the plans (see Figure 9).

Summary

For those outlets that qualify as direct discharges, the above information confirms that proper energy dissipation currently exists at each of the storm drain outlet locations for the drainage areas. The dissipation is provided by either riprap or the water level in a lagoon.

DISCHARGE TO LAGOONS

The October 3, 2014, *San Diego River Watershed Management Area Analysis,* states that "to qualify for the potential [hydromodification] exemption, the outlet elevation must be between the river bottom elevation and the 100-year floodplain elevation and properly designed energy dissipation must be provided." Proper energy dissipation was verified in the prior section. This section discusses the 100-year floodplain elevations. Research was performed to determine the 100-year water surface elevations in each of the three lagoons. FEMA provides 100-year floodplain information for many waterbodies. FEMA defines a 100-year floodplain for the lagoons, but does not provide the necessary water surface elevations. However, Dokken Engineering (Dokken) performed detailed HEC-RAS hydraulic analyses of each lagoon as part of their December 2008, *Interstate 5 North Coast Floodplain Studies,* for Caltrans. Relevant excerpts from the Dokken studies are included in the Appendices. Table 1 summarizes the outlet elevations of each discharge point from the as-built drawings (discussed in the prior section) and the associated 100-year floodplain elevation from the Dokken studies. The as-built drawings are either identified as being on NGVD 29 datum or were prepared prior to 1988, so by default should be on NGVD 29. On the other hand, the Dokken studies are on NAVD 88 datum. Corpscon is provided by the US Army Corps of Engineers for coordinate conversions, and shows that 2.2 feet is added to the NGVD 29 elevations to convert to NAVD 88 elevations.

Major Drainage Basin	Description	Outlet Elevation, feet[1]	Lagoon 100-Year Water Surface Elevation, feet[2]
100	Buena Vista Lagoon 48" and 66" Outlets	6.00	13.93
200	Buena Vista Lagoon 48" Outlet	22.00	13.89
300	Buena Vista Lagoon 66" Outlet	5.30	15.75
400	Agua Hedionda Lagoon 60" Outlet	-1.75	12.33
500	Agua Hedionda Lagoon 18" Outlet	5.36	11.68
600	Agua Hedionda Lagoon 84" Outlet	7.95	12.21
700	Batiquitos Lagoon 84" Outlet	6.27	8.90

[1]Elevations are on NGVD 29 (add 2.2 feet to convert to NAVD 88)
[2]Elevations are on NAVD 88

Table 1. Summary of Storm Drain Outlet Elevations and Lagoon Elevations

Table 1 shows that all of the storm drain outlets (with the conversion applied) except at Major Drainage Basin 200 are below the 100-year water surface elevation in the associated lagoon. Therefore, the hydromodification exemption requirement to have the outlet elevation below the 100-year floodplain elevation is met except at Major Drainage Basin 200.

Summary
The four drainage areas (Major Drainage Basins 400, 500, 600, 700) tributary to the Agua Hedionda Lagoon and Batiquitos Lagoon are served by an improved (non-erosive) street and underground storm drains system and have capacity to convey the 10-year rain event condition. The storm drain outlets for these drainage areas to the lagoon are considered direct discharges. Therefore, these areas are considered exempt from hydromodification.

The easterly and westerly drainage areas (Major Dainage Basins 100 and 300) tributary to and outletting directly into Buena Vista Lagoon are served by an improved (non-erosive) street and underground storm drains system and have capacity to convey the 10-year rain event condition. The storm drain outlets for these drainage areas to the lagoon are considered direct discharges. Therefore, these areas are also considered exempt from hydromodification.

The westerly drainage areas (Major Drainage Basin 200) tributary to and outletting adjacent to the Buena Vista Lagoon west of Interstate 15 is served by an improved (non-erosive) street and underground storm drains system and have capacity to convey the 10-year rain event condition. However, this outlet is not considered a direct discharge. In order to create a direct discharge, drainage improvements will need to be constructed that are capable of conveying the 10-year flow to the lagoon. The new outlet must have proper energy dissipation and extend below the 100-year water surface elevation. If such improvements are constructed in the future, this area can be considered as exempt from hydromodification.

HYDROLOGIC AND HYDRAULIC ANALYSES

As mentioned in the Introduction, hydromodification applies to flows up to the 10-year event. Consequently, the drainage network (storm drain pipes, streets, etc.) within each major drainage area are required to convey the 10-year flow in order to qualify for an exemption. All of the available as-built plans for the public storm drain systems in the seven major drainage areas were obtained and reviewed. Several of the more recent as-built plans list 10- or 100-year flow rates in the pipes and/or hydraulic grade lines on the storm drain profiles. These systems have been identified on the Study Area Exhibits and further analyses were not required since the systems have been designed to convey the 10-year or greater flow rates. Therefore, development within these areas is exempt from HMP.

Hydrologic and hydraulic analyses have been performed for the remaining systems whose plans do not contain the flow or hydraulic grade line data. The hydrologic analyses were performed to determine the ultimate condition 10-year flow rates. The County of San Diego's 2003 *Hydrology Manual* rational method procedure was used for the 10-year hydrologic analyses. The rational method input parameters are summarized below and the supporting data is included in Appendix B:

- Precipitation: The 10-year, 6- and 24-hour precipitation values are 1.7 and 3.1 inches, respectively, for the drainage areas tributary to Buena Vista and Agua Hedionda Lagoon. The 10-year, 6- and 24-hour precipitation values are 1.7 and 2.9 inches, respectively, for the drainage areas tributary to Batiquitos Lagoon.

- Drainage subbasin: The drainage subbasins were delineated from the City's 2005 2-foot contour interval topographic mapping, the City's GIS storm drain network, available as-built plans, and a site investigation. See the Study Area Exhibits in the map pocket for the major and subbasin boundaries, rational method node numbers, and subbasin areas.

- Hydrologic soil groups: The hydrologic soil groups were determined from the *San Diego County Soils Interpretation Study* maps for Encinitas and Rancho Santa Fe. The soil group in the study area is primarily A with some pockets of C and D.

- Runoff coefficients: The runoff coefficients were assigned based on the underlying land uses and soil groups. The land uses range from undisturbed areas to commercial/industrial development. The land uses were determined from a 2009 aerial photograph from the City and 2010 Google Earth aerials as well as a site investigation. For undeveloped areas that could be subject to development, a developed condition was assumed. Therefore, the hydrologic analyses essentially model a fully built-out condition. This approach is similar to what would be done for a storm water master plan.

- Flow lengths and elevations: The flow lengths and elevations were obtained from the topographic mapping and engineering plans.

The 10-year rational method analyses were performed using CivilDesign's San Diego County Rational Hydrology Program and the results are included in Appendix B. Separate analyses were performed for the major drainage areas and are labeled as follows:

Buena Vista Lagoon

- Major Basin 100 is tributary to the 48" and 66" outlet on the east side of Carlsbad Boulevard
- Major Basin 200 is tributary to the 48" outlet on the west side of Interstate 5
- Major Basin 300 is tributary to the 66" outlet on the west side of Jefferson Street

Agua Hedionda Lagoon

- Major Basin 400 is tributary to the 60" outlet at the south end of Marina Drive
- Major Basin 500 is tributary to the 18" outlet at the west end of Date Avenue
- Analyses were not performed for the 84" outlet on the east side of the railroad tracks because flow rates and hydraulic grade lines were provided on the majority of the as-built plans.

Batiquitos Lagoon

- Analyses were not performed for the 84" outlet on the east side of Carlsbad Boulevard because flow rates and hydraulic grade lines were provided on the majority of the as-built plans.

The CivilDesign rational method analyses include pipeflow routines for modeling flow in circular pipes. The upstream and downstream invert elevations and pipe length are entered in the model for each storm drain segment. The program then determines the required normal depth pipe size based on the calculated 10-year flow rate, longitudinal slope, and roughness coefficient. The pipeflow routines were used to assess the adequacy of the existing pipes. Invert elevations were selected so that the longitudinal slope from the as-built plans was accurately modeled in the analyses. The longitudinal slope of each storm drain segment was determined from a review of all relevant as-built plans. Some storm drain segments contain varying or multiple slopes. In this case, the flattest slope was used because it will result in the most conservative sizing. A few segments were missing elevations on the as-built plans. For these segments, the average street slope was used. The pipe size from the hydraulic analyses were then compared to the size from the as-built plans to identify pipes with adequate capacity and those with deficiencies.

Since the rational method program determines the minimum required pipe size to convey the 10-year flow in each specific segment, it is possible that program will show the required size increasing or decreasing in adjacent segments of the overall storm drain system. For instance, if the same flow rate is conveyed in two adjacent segments, but the downstream segment has a steeper longitudinal slope, the results can show that the downstream pipe is smaller. Engineering design criteria typically does not allow subsequent segments in a storm drain system to be smaller. However, since the rational method results are merely used as a comparison with the sizes from the as-built plans, any usual telescoping effects are not relevant.

The pipes have been categorized based on their capacity and identified on the Study Area Exhibits per their category. The first category represents pipes in which the as-built plans contain flow rate or hydraulic grade line information indicating that the pipes can convey the 10-year runoff. As mentioned above, analyses were not specifically performed for these systems since detailed information is contained on the as-built plans. The second category represents pipes in which the rational method analyses show that the existing size can convey the 10-year flow rate. The third category represents pipes in which the rational method analyses show that the existing pipes need to be upsized by at most one pipe size (6 inches) to convey the 10-year flow. The fourth category represents pipes in which the rational method analyses show that the existing pipes need to be upsized by more than one pipe size to convey the 10-year flow.

The first and second categories represent no major deficiencies in capacity. The third category indicates that the existing pipe is slightly undersized. However, if pressure flow and street capacity are considered, these systems will be capable of conveying the 10-year flows since the additional flow associated with an at most 6 inch increase in pipe size can be conveyed under pressure or within the adjacent street. This was confirmed by comparing the 10-year flow rates with a street flow capacity chart. For a given pipe segment, the street flow capacity chart indicated that the associated street can convey the required flow. Therefore, the drainage systems within the first three categories have capacity for the 10-year flow.

Existing pipes under the fourth category require additional review to determine whether the 10-year flow can be conveyed. Additional review resulted in the following assessment of the storm drain systems within the fourth category.

Major Basin 100

There are four storm drain segments in Major Basin 100 that fall within the fourth category. The segments are between rational method nodes 105 to 109, 135 to 136, 137 to 138, and 138 to 141. The following assesses the pipe and street capacity of each of these four segments.

The existing pipe from nodes 105 to 109 has an 18” diameter with a normal depth capacity of approximately 10 cubic feet per second (cfs). However, the rational method results show that the 10-year flow rate is 37 cfs, and the pipe size needed to convey 37 cfs varies from 30” to 33”. The corridor along the street between these nodes has capacity for the additional 27 cfs (37 – 10 = 27 cfs) needed beyond the pipe capacity. Therefore, the combined pipe and street in this area can convey the 10-year flow.

A similar assessment is made for the other three segments. The existing pipe from nodes 135 to 136 is a 24” reinforced concrete pipe (RCP), while the analyses show that a 33” RCP is needed. The existing pipe from nodes 137 to 138 is a 36” RCP while the analyses show that a 45” RCP is needed. The existing pipe from nodes 138 to 141 is a 12” RCP while the analyses show that a 30” RCP is needed. For each of these deficient segments, the associated streets can handle the additional capacity needs. In addition, the adjacent upstream and downstream pipe segments are not deficient. Therefore, the overall drainage systems along these nodes can convey the 10-year flow.

Major Basin 300

There are two storm drain segments in Major Basin 300 that fall within the fourth category. The segments are between rational method nodes 309 to 316 and nodes 340 to 343. The existing pipes from nodes 309 to 316 are 24" RCPs, while the required pipe varies from 36" to 39". The existing pipes from nodes 340 to 343 are 66" RCPs, while the required size varies from 78" to 81". For both of these areas, the associated streets can handle the additional capacity needs, so these areas can convey the 10-year flow.

Major Basin 400

There are two storm drain segments in Major Basin 400 that fall within the fourth category. The segments are between rational method nodes 408 to 409 and 418 to 420. The existing pipe between nodes 408 and 409 is an 18" RCP, while a 30" RCP is needed. This pipe crosses a sump in the street. The excess stormwater will pond in the street until it drains through the 18" RCP. Therefore, the 10-year flow will be detained in this area. In addition, there are no natural streams in the vicinity that would be subject to HMP requirements.

The existing pipe between nodes 418 and 420 is a 60" RCP that outlets into Agua Hedionda Lagoon, while the analyses show that a 72" RCP is required. However, a 60" bypass structure near the upper end of this segment can divert a portion of the runoff to a second outlet that discharges to a cove connecting to Agua Hedionda Lagoon. The as-built plans (Drawing No. 152-3) show that the bypass is controlled by stop logs. If the bypass is open, then the pipe capacity below the bypass will be sufficient for the 10-year flow. The City of Carlsbad's Utilities Operations staff has a "Weir Wall Removal Procedure," so the stop logs will be removed during high flow events to ensure 10-year flow capacity. Therefore, this area conveys the 10-year runoff to Agua Hedionda Lagoon.

CONCLUSION

The City of Carlsbad's final HMP outlines conditions under which a Priority Development Project can be exempt from hydromodification requirements. The purpose of this study is to explore HMP exemptions based on the January 2011 Carlsbad SUSMP and Order No. R9-2013-0001 adopted by the Regional Water Quality Control Board. In particular, this study examines the criteria necessary for HMP exemptions for 1) enclosed embayments (lagoons) and 2) stabilized conveyances to exempt systems.

These analyses have been performed for seven major drainage areas selected by the City of Carlsbad and are summarized below based on the two primary criteria that were investigated. Additional criteria must be met in addition to the primary criteria to achieve an exemption. The additional criteria is also summarized below.

Stabilized Conveyances with Energy Dissipation

The hydrologic and hydraulic analyses show that the 10-year flow is conveyed by the underground storm drain alone in most areas, and the combination of the underground storm drain and improved public streets in the remaining areas. In addition, each storm drain outlet into

a lagoon has proper energy dissipation. Therefore, each study area contains an underground storm drain or conveyance channel that discharges directly to an enclosed conveyance.

Lagoon Floodplains

A comparison of as-built drawings with a recent detailed HEC-RAS analysis of each lagoon confirmed that each outlet is below the 100-year floodplain except in Major Drainage Basin 200. Each outlet is also at or above the associated lagoon floor. Therefore, each outlet except in Major Drainage Basin 200 meets the floodplain criteria for a hydromodification exemption. Major Drainage Basin 200 can meet the criteria if its non-erodible drainage system is extended to the lagoon.

Future Projects

Based on the findings in this report, future projects within one of the studied drainage areas (except Major Drainage Basin 200) qualify for an exemption if their storm runoff is directed to a public drainage facility included in this report without being conveyed over a natural drainage course.

However, future projects in certain locations within the study area will be required to perform additional analyses prior to receiving a hydromodification exemption. These exceptions are outlined below.

The major drainage area tributary to the 84” outlet into Agua Hedionda Lagoon is bisected along its westerly side by the existing railroad tracks. Storm runoff from two areas west of the tracks will be directed to naturally-lined swales near the tracks. Since naturally-lined swales prevent a hydromodification exemption, development west of the tracks may need to replace a natural swale with a non-erodible conveyance. It will be the responsibility for a future development project west of the tracks to assess this situation in detail and propose a solution, as needed. The HMP Exemption Exhibit delineates the two non-exempt areas for reference. Hydrologic analyses have not been performed for these two areas.

Figure 1. Outlet of 48” and 66” RCPs into Buena Vista Lagoon

Figure 2. Downstream of 48” and 66” RCPs showing no Erosion

Figure 3. Outlet of Caltrans' 48"RCP Tributary to Buena Vista Lagoon

Figure 4. Outlet of 66" RCP into Buena Vista Lagoon West of Jefferson Street (left of reeds)

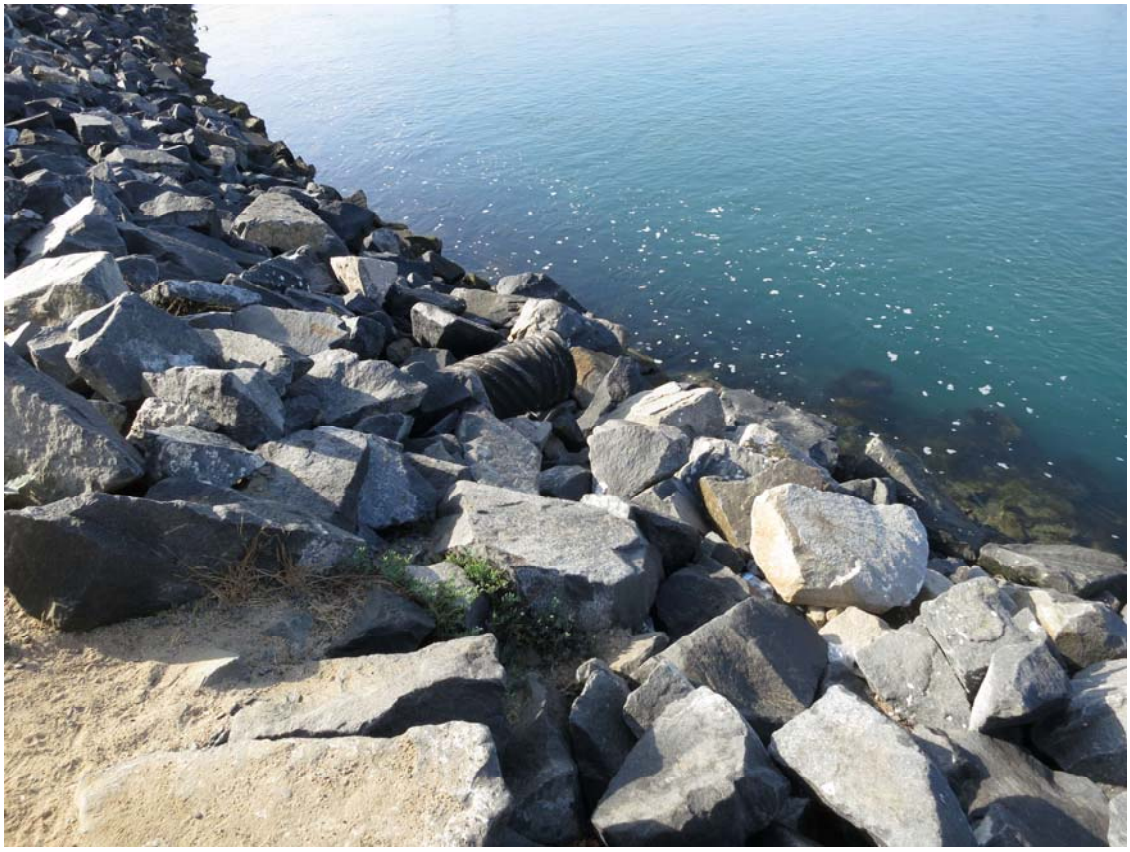


Figure 5. Outlet of 18” RCP into Agua Hedionda Lagoon

Figure 6. Outlet of 84” RCP into Agua Hedionda Lagoon

Figure 7. Open Water Adjacent to Energy Dissipater at 84” RCP into Agua Hedionda Lagoon

Figure 8. Outlet of 60” RCP into Agua Hedionda Lagoon

Figure 9. Outlet of 84" RCP into Batiquitos Lagoon

Figure 10. Sand Flat below Outlet of 84" RCP into Batiquitos Lagoon

STORM WATER STANDARDS QUESTIONNAIRE E-34

Development Services
Land Development Engineering
1635 Faraday Avenue
760-602-2750
www.carlsbadca.gov

INSTRUCTIONS:

To address post-development pollutants that may be generated from development projects, the City requires that new development and significant redevelopment priority projects incorporate Permanent Storm Water Best Management Practices (BMP's) into the project design per the City's Standard Urban Stormwater Management Plan (SUSMP). To view the SUSMP, refer to the Engineering Standards (Volume 4, Chapter 2) at www.carlsbadca.gov/standards.

Initially this questionnaire must be completed by the applicant in advance of submitting for a development application (subdivision, discretionary permits and/or construction permits). The results of the questionnaire determine the level of storm water standards that must be applied to a proposed development or redevelopment project. Depending on the outcome, your project will either be subject to 'Standard Stormwater Requirements' or be subject to additional criteria called 'Priority Development Project Requirements'. Many aspects of project site design are dependent upon the storm water standards applied to a project.

Your responses to the questionnaire represent an initial assessment of the proposed project conditions and impacts. City staff has responsibility for making the final assessment after submission of the development application. If staff determines that the questionnaire was incorrectly filled out and is subject to more stringent storm water standards than initially assessed by you, this will result in the return of the development application as incomplete. In this case, please make the changes to the questionnaire and resubmit to the City.

If you are unsure about the meaning of a question or need help in determining how to respond to one or more of the questions, please seek assistance from Land Development Engineering staff.

A separate completed and signed questionnaire must be submitted for each new development application submission. Only one completed and signed questionnaire is required when multiple development applications for the same project are submitted concurrently. In addition to this questionnaire, you must also complete, sign and submit a Project Threat Assessment Form with construction permits for the project.

Please start by completing Section 1 and follow the instructions. When completed, sign the form at the end and submit this with your application to the city.

SECTION 1 NEW DEVELOPMENT

Does your project meet one or more of the following criteria:	YES	NO
1. ***Housing subdivisions of 10 or more dwelling units***. Examples: single family homes, multi-family homes, condominium and apartments		
2. ***Commercial – greater than 1-acre***. Any development other than heavy industry or residential. Examples: hospitals; laboratories and other medical facilities; educational institutions; recreational facilities; municipal facilities; commercial nurseries; multi-apartment buildings; car wash facilities; mini-malls and other business complexes; shopping malls; hotels; office buildings; public warehouses; automotive dealerships; airfields; and other light industrial facilities.		
3. ***Heavy Industrial / Industry- greater than 1 acre***. Examples: manufacturing plants, food processing plants, metal working facilities, printing plants, and fleet storage areas (bus, truck, etc.).		
4. ***Automotive repair shop***. A facility categorized in any one of Standard Industrial Classification (SIC) codes 5013, 5014, 5541, 7532-7534, and 7536-7539		
5. ***Restaurants***. Any facility that sells prepared foods and drinks for consumption, including stationary lunch counters and refreshment stands selling prepared foods and drinks for immediate consumption (SIC code 5812), where the land area for development is greater than 5,000 square feet. Restaurants where land development is less than 5,000 square feet shall meet all SUSMP requirements except for structural treatment BMP and numeric sizing criteria requirements and hydromodification requirements.		

Figure 11

6.	***Hillside development.*** Any development that creates more than 5,000 square feet of impervious surface and is located in an area with known erosive soil conditions, where the development will grade on any natural slope that is twenty-five percent (25%) or greater.		
7.	***Environmentally Sensitive Area (ESA)***[1]. All development located within or directly adjacent[2] to or discharging directly[3] to an ESA (where discharges from the development or redevelopment will enter receiving waters within the ESA), which either creates 2,500 square feet or more of impervious surface on a proposed project site or increases the area of imperviousness of a proposed project site 10% or more of its naturally occurring condition.		
8.	***Parking lot.*** Area of 5,000 square feet or more, or with 15 or more parking spaces, and potentially exposed to urban runoff		
9.	***Streets, roads, highways, and freeways.*** Any paved surface that is 5,000 square feet or greater used for the transportation of automobiles, trucks, motorcycles, and other vehicles		
10.	***Retail Gasoline Outlets.*** Serving more than 100 vehicles per day and greater than 5,000 square feet		
11.	***Coastal Development Zone.*** Any project located within 200 feet of the Pacific Ocean and (1) creates more than 2500 square feet of impervious surface or (2) increases impervious surface on property by more than 10%.		
12.	***More than 1-acre of disturbance.*** Project results in the disturbance of 1-acre or more of land and is considered a Pollutant-generating Development Project[4].		

1 Environmentally Sensitive Areas include but are not limited to all Clean Water Act Section 303(d) impaired water bodies; areas designated as Areas of Special Biological Significance by the State Water Resources Control Board (Water Quality Control Plan for the San Diego Basin (1994) and amendments); water bodies designated with the RARE beneficial use by the State Water Resources Control Board (Water Quality Control Plan for the San Diego Basin (1994) and amendments); areas designated as preserves or their equivalent under the Multi Species Conservation Program within the Cities and County of San Diego; and any other equivalent environmentally sensitive areas which have been identified by the Copermittees.

2 "Directly adjacent" means situated within 200 feet of the Environmentally Sensitive Area.

3 "Discharging directly to" means outflow from a drainage conveyance system that is composed entirely of flows from the subject development or redevelopment site, and not commingled with flow from adjacent lands.

4 Pollutant-generating Development Projects are those projects that generate pollutants at levels greater than background levels. In general, these include all projects that contribute to an exceedance to an impaired water body or which create new impervious surfaces greater than 5000 square feet and/or introduce new landscaping areas that require routine use of fertilizers and pesticides. In most cases linear pathway projects that are for infrequent vehicle use, such as emergency or maintenance access, or for pedestrian or bicycle use, are not considered Pollutant-generating Development Projects if they are built with pervious surfaces or if they sheet flow to surrounding pervious surfaces.

INSTRUCTIONS:

Section 1 Results:
If you answered **YES** to **ANY** of the questions above, your project is subject to **Priority Development Project** requirements. Skip Section 2 and please proceed to Section 3. Check the "meets PRIORITY DEVELOPMENT PROJECT requirements" box in Section 3. Additional storm water requirements will apply per the SUSMP.

If you answered **NO** to **ALL** of the questions above, then please proceed to Section 2 and follow the instructions.

Figure 11

STORM WATER STANDARDS QUESTIONNAIRE E-34

CITY OF CARLSBAD

Development Services
Land Development Engineering
1635 Faraday Avenue
760-602-2750
www.carlsbadca.gov

SECTION 2	SIGNIFICANT REDEVELOPMENT		
INSTRUCTIONS: Complete the questions below regarding your project		**YES**	**NO**
1. Project results in the disturbance of 1-acre or more of land and is considered a Pollutant-generating Development Project *?			
INSTRUCTIONS: If you answered **NO**, please proceed to question 2. If you answered **YES**, then you **ARE** a significant redevelopment and you **ARE** subject to **PRIORITY DEVELOPMENT PROJECT** requirements. Please check the "meets PRIORITY DEVELOPMENT PROJECT requirements" box in Section 3 below.			
2. Is the project redeveloping an existing priority project type? (Priority projects are defined in Section 1)			
INSTRUCTIONS: If you answered **YES**, please proceed to question 3. If you answered **NO**, then you **ARE NOT a** significant redevelopment and your project is subject to **STANDARD STORMWATER REQUIREMENTS**. Please check the "does not meet PDP requirements" box in Section 3 below.			
3. Is the work limited to trenching and resurfacing associated with utility work; resurfacing and reconfiguring surface parking lots and existing roadways; new sidewalk; bike lane on existing road and/or routine maintenance of damaged pavement such as pothole repair? Resurfacing/reconfiguring parking lots is where the work does not expose underlying soil during construction.			
INSTRUCTIONS: If you answered **NO**, then proceed to question 4. If you answered **YES,** then you **ARE NOT** a significant redevelopment and your project is subject to **STANDARD STORMWATER REQUIREMENTS**. Please check the "does not meet PDP requirements" box in Section 3 below.			
4. Will your redevelopment project create, replace, or add at least 5,000 square feet of impervious surfaces on existing developed property **or** will your project be located within 200 feet of the Pacific Ocean and (1) create 2500 square feet or more of impervious surface or (2) increases impervious surface on the property by more than 10%? Replacement of existing impervious surfaces includes any activity that is not part of routine maintenance where impervious material(s) are removed, exposing underlying soil during construction.			
INSTRUCTIONS: If you answered **YES**, you **ARE** a significant redevelopment, and you **ARE** subject to **PRIORITY DEVELOPMENT PROJECT** requirements. Please check the "meets PRIORITY DEVELOPMENT PROJECT requirements" box in Section 3 below. Review SUSMP to find out if SUSMP requirements apply to your project envelope or the entire project site. If you answered **NO**, then you **ARE NOT a** significant redevelopment and your project is subject to **STANDARD STORMWATER REQUIREMENTS**. Please check the "does not meet PDP requirements" box in Section 3 below.			

*for definition see Footnote 4 on page 2

SECTION 3 QUESTIONNAIRE RESULTS

❑ My project meets **PRIORITY DEVELOPMENT PROJECT (PDP)** requirements and must comply with additional stormwater criteria per the SUSMP and I understand I must prepare a Storm Water Management Plan for submittal at time of application**.** I understand flow control (hydromodification) requirements may apply to my project. Refer to SUSMP for details.

❑ My project **does not meet PDP** requirements and must only comply with **STANDARD STORMWATER REQUIREMENTS** per the SUSMP. As part of these requirements, I will incorporate low impact development strategies throughout my project.

Applicant Information and Signature Box

Address:	Assessor's Parcel Number(s):
Applicant Name:	Applicant Title:
Applicant Signature:	Date:

This Box for City Use Only

City Concurrence:	YES	NO
By:		
Date:		
Project ID:		

Figure 11

APPENDIX A

DOKKEN ENGINEERING'S HEC-RAS ANALYSES

SECTION 9

Buena Vista Lagoon Location Hydraulic Study

regions with velocities close or equal to zero, were used in the model near the constriction points. The entire 100-year flow passes through the lagoon at a slow, almost stagnant rate.

9.3.4 Discharge

Based on FIS data, *Table 4 – Summary of Discharge: Buena Vista Creek – Upstream of Interstate Highway 5*, 8,500 cfs was selected as the 100-year flood discharge.

9.4 HEC-RAS OUTPUT

The water surface elevations, which are displayed in the appendices and output of this study, are based on flooding that would occur during a 100-year storm. Appendix B contains water surface elevations, channel velocities, top widths, Froude Numbers, and bottom elevations for each cross section. Water surface elevations decreased immediately after the I-5 Bridge due to the sudden contraction and expansion formed in the lagoon by the existing I-5 Bridge. Since Buena Vista Lagoon is a fairly flat waterway, the water surface elevations remain uniform upstream and downstream of the bridge. In effect, the lagoon's flat bottom lacks the change in elevation to achieve higher flow velocities and thus produces a level water surface profile. As shown in Table A, no significant increase to the existing 100-year floodplain would occur from the I-5 bridge replacement. The replacement bridge would result in a lowering of the floodplain upstream the I-5 Bridge by approximately 6 inches.

Table A: Floodplain Comparison

River Station	Q Total	Existing W.S. Elevation	Proposed W.S. Elevation	Change in Elevation	Existing Top Width	Proposed Top Width	Change in Width
	(cfs)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)
7947	8500	15.75	15.26	-0.49	934.46	912.6	-21.86
7865	8500	15.76	15.28	-0.48	1205.4	1193.87	-11.53
7697	8500	15.77	15.29	-0.48	1208.66	1200.76	-7.90
7483	8500	15.76	15.28	-0.48	1260.07	1255.28	-4.79
7282	8500	15.76	15.28	-0.48	1415.89	1406.2	-9.69
7136	8500	15.76	15.28	-0.48	1554.97	1544.01	-10.96
6964	8500	15.76	15.28	-0.48	1585.09	1582.05	-3.04
6803	8500	15.76	15.28	-0.48	1610.37	1585.69	-24.68
6648	8500	15.76	15.28	-0.48	1686.39	1677.56	-8.83
6511	8500	15.76	15.28	-0.48	1655.38	1639.75	-15.63
6381	8500	15.76	15.28	-0.48	1608.53	1594.83	-13.70
6279	8500	15.76	15.28	-0.48	1595.29	1562.22	-33.07
6168	8500	15.76	15.28	-0.48	1547.69	1544.9	-2.79
6060	8500	15.76	15.28	-0.48	1562.11	1559.88	-2.23
5939	8500	15.76	15.28	-0.48	1561.86	1559.71	-2.15
5816	8500	15.76	15.28	-0.48	1559.09	1557.32	-1.77
5670	8500	15.76	15.28	-0.48	1519.46	1513.41	-6.05
5522	8500	15.76	15.28	-0.48	1489.76	1487.18	-2.58
5368	8500	15.76	15.28	-0.48	1460.43	1457.99	-2.44
5244	8500	15.76	15.28	-0.48	1314.36	1311.03	-3.33

5089	8500	15.76	15.27	**-0.49**	1237.75	1234.37	**-3.38**
4974	8500	15.75	15.26	**-0.49**	1114.1	1110.44	**-3.66**
4887	8500	15.18	14.64	**-0.54**	924.71	905.96	**-18.75**
4867*	8500	14.81	N/A	**N/A**	913.65	N/A	**N/A**
4700	8500	**I-5 Bridge**					
4607	8500	12.95	13.13	**0.18**	560.83	568.41	**7.58**
4529	8500	13.89	13.89	**0.00**	789.07	789.07	**0.00**
4400	8500	13.92	13.92	**0.00**	887.72	887.72	**0.00**
4288	8500	13.93	13.93	**0.00**	1261.72	1261.72	**0.00**
4110	8500	13.93	13.93	**0.00**	1199.97	1199.97	**0.00**
3872	8500	13.93	13.93	**0.00**	1359.49	1359.49	**0.00**
3623	8500	13.93	13.93	**0.00**	1442.3	1442.3	**0.00**
3420	8500	13.93	13.93	**0.00**	1682.14	1682.14	**0.00**
3149	8500	13.93	13.93	**0.00**	1789.06	1789.06	**0.00**
2862	8500	13.93	13.93	**0.00**	1816.98	1816.98	**0.00**
2630	8500	13.93	13.93	**0.00**	1782.09	1782.09	**0.00**
2447	8500	13.93	13.93	**0.00**	1745.88	1745.88	**0.00**
2292	8500	13.93	13.93	**0.00**	1668.46	1668.46	**0.00**
2123	8500	13.93	13.93	**0.00**	1695.11	1695.11	**0.00**
2005	8500	13.93	13.93	**0.00**	1892.59	1892.59	**0.00**
1859	8500	13.93	13.93	**0.00**	1815.9	1815.9	**0.00**
1780	8500	13.93	13.93	**0.00**	1755.61	1755.61	**0.00**
1681	8500	13.92	13.92	**0.00**	1737.24	1737.24	**0.00**
1647	8500	13.82	13.82	**0.00**	1677.12	1677.12	**0.00**
1600	8500	**Carlsbad Boulevard Culvert Bridge**					
1580	8500	13.74	13.74	**0.00**	1740.14	1740.14	**0.00**
1311	8500	13.79	13.79	**0.00**	1742.06	1742.06	**0.00**
1078	8500	13.69	13.69	**0.00**	408.41	408.41	**0.00**
1050	8500	**NCTD Railroad Bridge**					
1039	8500	13.69	13.69	**0.00**	383.33	383.33	**0.00**
726	8500	13.73	13.73	**0.00**	1667.25	1667.25	**0.00**
397	8500	13.42	13.42	**0.00**	1528.37	1528.37	**0.00**
180	8500	12.00	12.00	**0.00**	568.21	568.21	**0.00**
0	8500	11.19	11.19	**0.00**	1429.65	1429.65	**0.00**

* Cross section only in existing model

9.4.1 Warning Messages

Warning messages encountered during the proposed model include the following:

The velocity head has changed by more than 0.5 ft (0.15 m). This may indicate the need for additional cross sections, displayed at cross sections #180, #397, #4607, #4700, and #4974. This message is common at constrictions such as bridges and additional cross sections are not normally added.

The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4. This may indicate the need for additional cross sections, displayed at cross sections #180, #397, #726, #1039, #1050, #1078, #1311, #1580, #1681,

NOTES: -e indicates cross section only in existing model

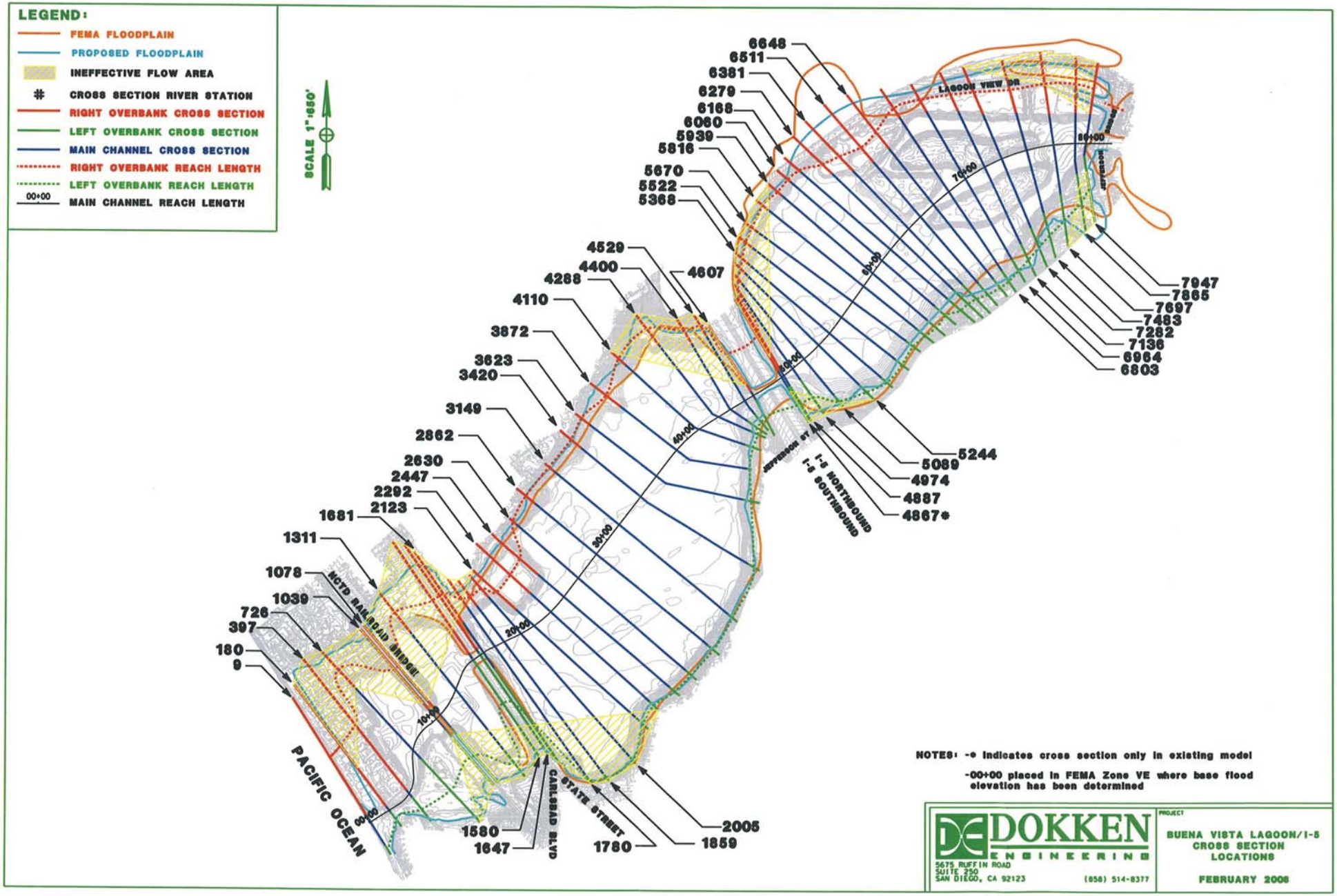
-00+00 placed in FEMA Zone VE where base flood elevation has been determined

DOKKEN ENGINEERING
5675 RUFFIN ROAD
SUITE 250
SAN DIEGO, CA 92123
(858) 514-8377

PROJECT

BUENA VISTA LAGOON/I-5 CROSS SECTION LOCATIONS

FEBRUARY 2008


LEGEND:
FEMA FLOODPLAIN
PROPOSED FLOODPLAIN
INEFFECTIVE FLOW AREA
CROSS SECTION RIVER STATION
RIGHT OVERBANK CROSS SECTION
LEFT OVERBANK CROSS SECTION
MAIN CHANNEL CROSS SECTION
RIGHT OVERBANK REACH LENGTH
LEFT OVERBANK REACH LENGTH
00+00 MAIN CHANNEL REACH LENGTH
SCALE 1" =650'
6648
6511
6381
6279
6168
6060
5939
5816
5670
5522
5368
4529
4400
4288
4110
3872
3623
3420
3149
2862
2630
2447
2292
2123
1681
1311
1078
1039
726
397
180
9
4607
7947
7865
7697
7483
7282
7136
6964
6803
5244
5089
4974
4887
4867*
1580
1647
1780
2005
1859
LAGOON VIEW DR
JEFFERSON ST
I-5 NORTHBOUND
I-5 SOUTHBOUND
NCTD RAILROAD
CARLSBAD BLVD
STATE STREET
PACIFIC OCEAN
10+00
20+00
30+00
40+00
50+00
60+00
70+00
80+00
90+00
NOTES: -e indicates cross section only in existing model
-00+00 placed in FEMA Zone VE where base flood elevation has been determined
DOKKEN ENGINEERING
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SUITE 250
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(858) 514-8377
PROJECT
BUENA VISTA LAGOON/I-5
CROSS SECTION
LOCATIONS
FEBRUARY 2006

HEC-RAS Plan: ExistingBV River: Existing Reach: Buena Vista Profile: Flow1

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Buena Vista	7947	Flow1	8500.00	0.00	15.75	4.12	15.79	0.000038	1.72	5028.66	934.46	0.08
Buena Vista	7865	Flow1	8500.00	-2.00	15.76	1.50	15.78	0.000016	1.19	7315.54	1205.40	0.05
Buena Vista	7697	Flow1	8500.00	-4.00	15.77	0.56	15.78	0.000006	0.79	12049.31	1208.66	0.03
Buena Vista	7483	Flow1	8500.00	1.00	15.76	3.73	15.78	0.000013	0.87	10529.84	1260.07	0.05
Buena Vista	7282	Flow1	8500.00	1.00	15.76		15.77	0.000010	0.76	12255.38	1415.89	0.04
Buena Vista	7136	Flow1	8500.00	0.00	15.76		15.77	0.000007	0.64	14270.92	1554.97	0.03
Buena Vista	6964	Flow1	8500.00	1.00	15.76		15.77	0.000006	0.59	14985.79	1585.09	0.03
Buena Vista	6803	Flow1	8500.00	0.00	15.76		15.77	0.000004	0.51	17030.76	1610.37	0.03
Buena Vista	6648	Flow1	8500.00	0.00	15.76		15.77	0.000004	0.52	17427.74	1686.39	0.03
Buena Vista	6511	Flow1	8500.00	1.00	15.76		15.77	0.000004	0.51	17746.60	1655.38	0.03
Buena Vista	6381	Flow1	8500.00	0.00	15.76		15.77	0.000003	0.48	19045.38	1608.53	0.02
Buena Vista	6279	Flow1	8500.00	0.00	15.76		15.77	0.000002	0.42	21452.93	1595.29	0.02
Buena Vista	6168	Flow1	8500.00	0.00	15.76		15.77	0.000002	0.38	22629.76	1547.69	0.02
Buena Vista	6060	Flow1	8500.00	0.00	15.76		15.77	0.000002	0.38	22710.90	1562.11	0.02
Buena Vista	5939	Flow1	8500.00	0.00	15.76		15.77	0.000002	0.38	22700.15	1561.86	0.02
Buena Vista	5816	Flow1	8500.00	0.00	15.76		15.77	0.000002	0.37	22956.98	1559.09	0.02
Buena Vista	5670	Flow1	8500.00	0.00	15.76		15.76	0.000002	0.38	22445.93	1519.46	0.02
Buena Vista	5522	Flow1	8500.00	0.00	15.76		15.76	0.000002	0.39	21750.33	1489.76	0.02
Buena Vista	5368	Flow1	8500.00	0.00	15.76	1.18	15.76	0.000002	0.41	20945.81	1460.43	0.02
Buena Vista	5244	Flow1	8500.00	0.00	15.76	1.50	15.76	0.000002	0.48	17839.00	1314.36	0.02
Buena Vista	5089	Flow1	8500.00	0.00	15.76	1.64	15.76	0.000004	0.60	14413.73	1237.75	0.03
Buena Vista	4974	Flow1	8500.00	0.00	15.75	2.66	15.76	0.000012	1.04	8721.34	1114.10	0.05
Buena Vista	4887	Flow1	8500.00	1.00	15.18	9.13	15.71	0.000567	5.82	1460.17	924.71	0.31
Buena Vista	4867	Flow1	8500.00	1.00	14.81	9.24	15.61	0.000823	7.18	1184.18	913.65	0.37
Buena Vista	4700		Bridge									
Buena Vista	4607	Flow1	8500.00	0.00	12.95	10.29	14.62	0.002103	10.80	909.32	560.83	0.57
Buena Vista	4529	Flow1	8500.00	-7.00	13.89	2.28	13.97	0.000066	2.19	3975.31	789.07	0.11
Buena Vista	4400	Flow1	8500.00	-1.00	13.92	1.75	13.95	0.000024	1.36	6320.95	887.72	0.07
Buena Vista	4288	Flow1	8500.00	-2.00	13.93	0.12	13.94	0.000007	0.76	11273.59	1261.72	0.03
Buena Vista	4110	Flow1	8500.00	-2.00	13.93		13.94	0.000003	0.49	17378.68	1199.97	0.02
Buena Vista	3872	Flow1	8500.00	-2.00	13.93		13.94	0.000003	0.49	18241.63	1359.49	0.02
Buena Vista	3623	Flow1	8500.00	-2.00	13.93		13.94	0.000002	0.42	20622.91	1442.30	0.02
Buena Vista	3420	Flow1	8500.00	-2.00	13.93		13.94	0.000001	0.36	23988.75	1682.14	0.02
Buena Vista	3149	Flow1	8500.00	-1.00	13.93		13.94	0.000001	0.33	25674.53	1789.06	0.02
Buena Vista	2862	Flow1	8500.00	-2.00	13.93		13.94	0.000001	0.32	26544.78	1816.98	0.01
Buena Vista	2630	Flow1	8500.00	-3.00	13.93		13.94	0.000001	0.32	26648.20	1782.09	0.01
Buena Vista	2447	Flow1	8500.00	-2.00	13.93		13.93	0.000002	0.40	22623.41	1745.88	0.02
Buena Vista	2292	Flow1	8500.00	-2.00	13.93		13.93	0.000002	0.42	21576.38	1668.46	0.02
Buena Vista	2123	Flow1	8500.00	-1.00	13.93	0.22	13.93	0.000002	0.45	20302.66	1695.11	0.02
Buena Vista	2005	Flow1	8500.00	-1.00	13.93	0.31	13.93	0.000002	0.46	19173.12	1892.59	0.02
Buena Vista	1859	Flow1	8500.00	-1.00	13.93	0.77	13.93	0.000003	0.53	16430.98	1815.90	0.02
Buena Vista	1780	Flow1	8500.00	-1.00	13.93	0.85	13.93	0.000004	0.55	15549.74	1755.61	0.03
Buena Vista	1681	Flow1	8500.00	-3.00	13.92	4.36	13.93	0.000012	0.88	10962.95	1737.24	0.05
Buena Vista	1647	Flow1	8500.00	-3.00	13.82	11.60	13.92	0.000258	4.02	4273.20	1677.12	0.20
Buena Vista	1600		Bridge									
Buena Vista	1580	Flow1	8500.00	-3.00	13.74	11.45	13.86	0.000265	4.17	4020.62	1740.14	0.20
Buena Vista	1311	Flow1	8500.00	-4.00	13.79	0.67	13.80	0.000010	0.93	9126.33	1742.06	0.04
Buena Vista	1078	Flow1	8500.00	-1.00	13.69	2.92	13.79	0.000076	2.55	3557.91	408.41	0.12
Buena Vista	1050		Bridge									
Buena Vista	1039	Flow1	8500.00	-1.00	13.69	2.86	13.78	0.000073	2.45	3601.48	383.33	0.12
Buena Vista	726	Flow1	8500.00	-1.00	13.73	2.55	13.75	0.000011	0.87	10474.23	1667.25	0.04
Buena Vista	397	Flow1	8500.00	0.00	13.42	9.69	13.71	0.000566	5.41	2902.33	1528.37	0.30
Buena Vista	180	Flow1	8500.00	-1.00	12.00	12.00	13.39	0.002352	10.76	1351.05	568.21	0.59
Buena Vista	0	Flow1	8500.00	2.00	11.19	8.16	11.23	0.000137	1.98	6152.88	1429.65	0.14

SECTION 8

Agua Hedionda Lagoon Location Hydraulic Study

8.3.3 Starting Water Elevation

The Agua Hedionda Lagoon was run under a subcritical flow regime. The downstream segment of the lagoon flowing into the Pacific Ocean is categorized as a FEMA Zone AE, which has a determined base flood elevation. The downstream starting water surface elevation was input as 11.18 ft (NAVD 88).

8.3.4 Discharge

For the purposes of the floodplain analysis, 9,850 cfs was identified as the peak 100-year storm discharge. Discharge information was obtained from the *Federal Emergency Management Agency Flood Insurance Study, San Diego County, California, Volume 1 of 7 (July 2002)*, at El Camino Real.

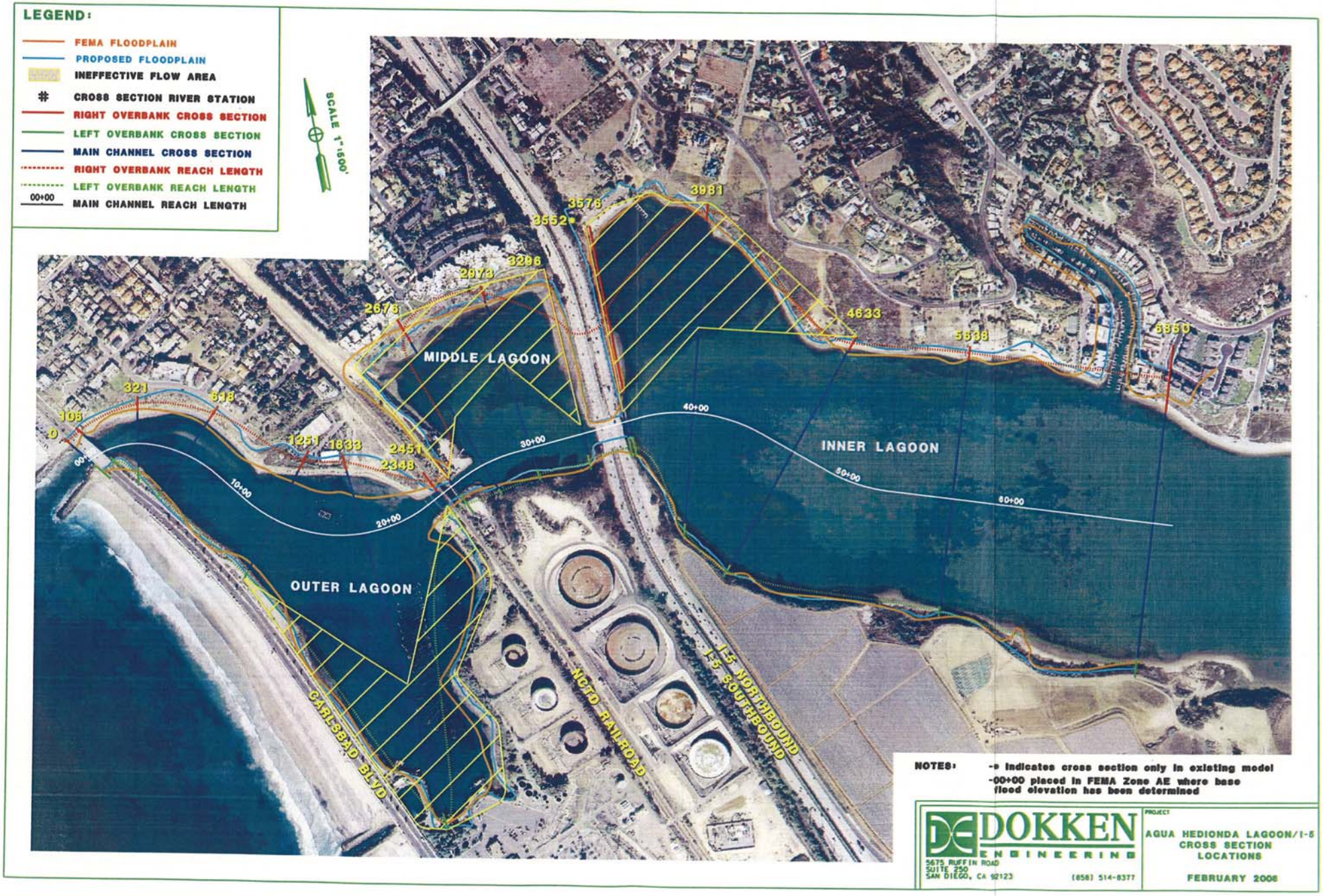
8.4 HEC-RAS OUTPUT

The water surface elevations which, are displayed in the appendices and output of this study, are based on flooding that would occur during a 100-year storm. Appendix B contains water surface elevations, channel velocity, top width, flow regime, and bottom elevations for each cross section. As shown in Table A, no significant changes to the existing 100-year floodplain would occur from the I-5 Bridge replacement.

TABLE A: Floodplain Comparison

River Station	Q Total	Existing W.S. Elev.	Proposed W.S. Elev.	Change in Elevation	Existing Top Width	Proposed Top Width	Change in Width
	(cfs)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)
6860	9850	12.27	12.33	0.06	1811.56	1813.23	1.67
5638	9850	12.26	12.33	0.07	1578.85	1579.24	0.39
4633	9850	12.26	12.33	0.07	1564.59	1564.85	0.26
3981	9850	12.26	12.33	0.07	1863.25	1863.75	0.50
3576	9850	12.22	12.28	0.06	1048.38	1049.38	1.00
3552*	9850	12.21	N/A	N/A	1024.99	N/A	N/A
3400	9850	I-5 Bridge					
3296	9850	12.12	12.12	0.00	1118.88	1118.88	0.00
2973	9850	12.13	12.13	0.00	1081.45	1081.45	0.00
2676	9850	12.13	12.13	0.00	1059.03	1059.03	0.00
2451	9850	11.87	11.87	0.00	151.95	151.95	0.00
2400	9850	NCTD Railroad Trestle Bridge					
2348	9850	11.51	11.51	0.00	151.09	151.09	0.00
1833	9850	11.68	11.68	0.00	2321.18	2321.18	0.00
1251	9850	11.68	11.68	0.00	825.89	825.89	0.00
618	9850	11.67	11.67	0.00	629.02	629.02	0.00
321	9850	11.66	11.66	0.00	516.98	516.98	0.00
106	9850	11.26	11.26	0.00	251.27	251.27	0.00
75	9850	Carlsbad Boulevard Bridge					
0	9850	11.18	11.18	0.00	249.21	249.21	0.00

* Cross section only in existing model



NOTES:
- indicates cross section only in existing model
-00+00 placed in FEMA Zone AE where base flood elevation has been determined

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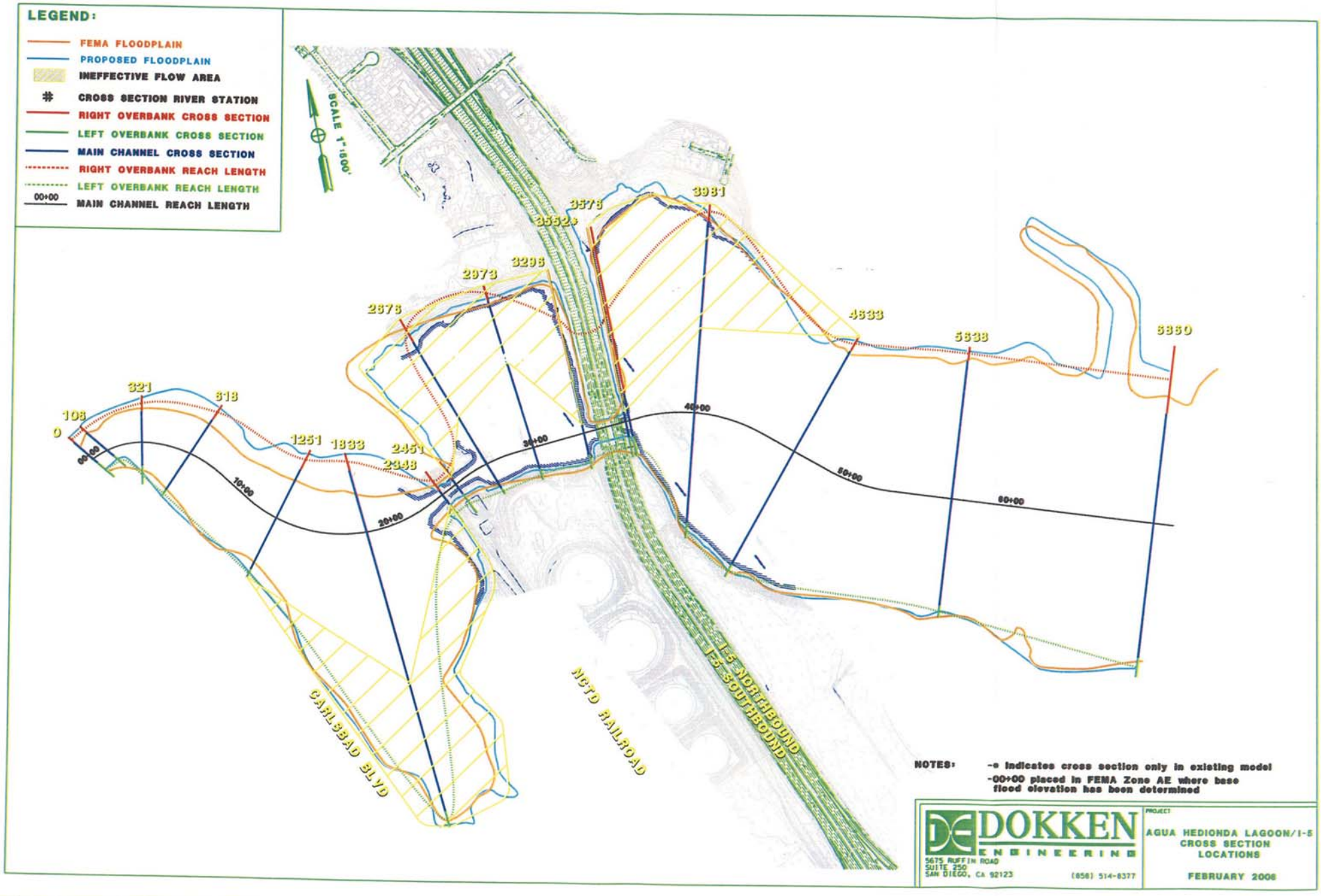
PROJECT
AGUA HEDIONDA LAGOON/I-5
CROSS SECTION
LOCATIONS

FEBRUARY 2008



NOTES:
- o indicates cross section only in existing model
- 00+00 placed in FEMA Zone AE where base flood elevation has been determined

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CROSS SECTION
LOCATIONS

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HEC-RAS Plan: ExistingAHL River: Agua Hedionda Reach: 1 Profile: PF 1

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
1	6860	PF 1	9850.00	-6.81	12.27		12.27	0.000001	0.36	28390.56	1811.56	0.02
1	5638	PF 1	9850.00	-7.81	12.26		12.27	0.000001	0.38	26405.65	1578.85	0.02
1	4633	PF 1	9850.00	-6.81	12.26		12.27	0.000001	0.38	26392.34	1564.59	0.02
1	3981	PF 1	9850.00	-10.81	12.26	-5.39	12.26	0.000002	0.45	22283.34	1863.25	0.02
1	3576	PF 1	9850.00	-25.80	12.22	-16.75	12.26	0.000014	1.69	5984.83	1048.38	0.05
1	3552	PF 1	9850.00	-25.80	12.21	-17.74	12.26	0.000015	1.70	5908.30	1024.99	0.06
1	3400		Bridge									
1	3296	PF 1	9850.00	-25.80	12.12	-15.63	12.15	0.000010	1.36	7332.46	1118.88	0.05
1	2973	PF 1	9850.00	-11.81	12.13	-7.61	12.14	0.000005	0.77	12844.06	1081.45	0.03
1	2676	PF 1	9850.00	-25.81	12.13	-14.57	12.14	0.000006	0.97	10297.05	1059.03	0.04
1	2451	PF 1	9850.00	-9.81	11.87	-2.28	12.11	0.000128	3.98	2551.94	151.95	0.16
1	2400		Bridge									
1	2348	PF 1	9850.00	-9.81	11.51	-2.28	11.76	0.000135	4.04	2519.91	151.09	0.16
1	1833	PF 1	9850.00	-17.81	11.68	-15.35	11.69	0.000000	0.28	35315.71	2321.18	0.01
1	1251	PF 1	9850.00	-17.81	11.68		11.68	0.000003	0.63	16014.37	825.89	0.02
1	618	PF 1	9850.00	-19.81	11.67		11.68	0.000007	0.92	10960.75	629.02	0.04
1	321	PF 1	9850.00	-17.81	11.66		11.68	0.000012	1.24	8471.83	516.98	0.05
1	106	PF 1	9850.00	-3.81	11.26	4.10	11.64	0.000365	5.24	2237.35	251.27	0.26
1	75		Bridge									
1	0	PF 1	9850.00	-3.81	11.18	4.11	11.56	0.000374	5.28	2216.26	249.21	0.26

SECTION 7

Batiquitos Lagoon Location Hydraulic Study

undergone major development and this value was estimated to be low. The Hydrologic Summary in the *San Marcos Creek Bridge at West Carlsbad Blvd (1994)* as-builts, was used to establish the 100-year flood through the lagoon. According to the report, the 100-year base flood flow at the Carlsbad Boulevard Bridge is 12,000 cfs.

7.4 HEC-RAS OUTPUT

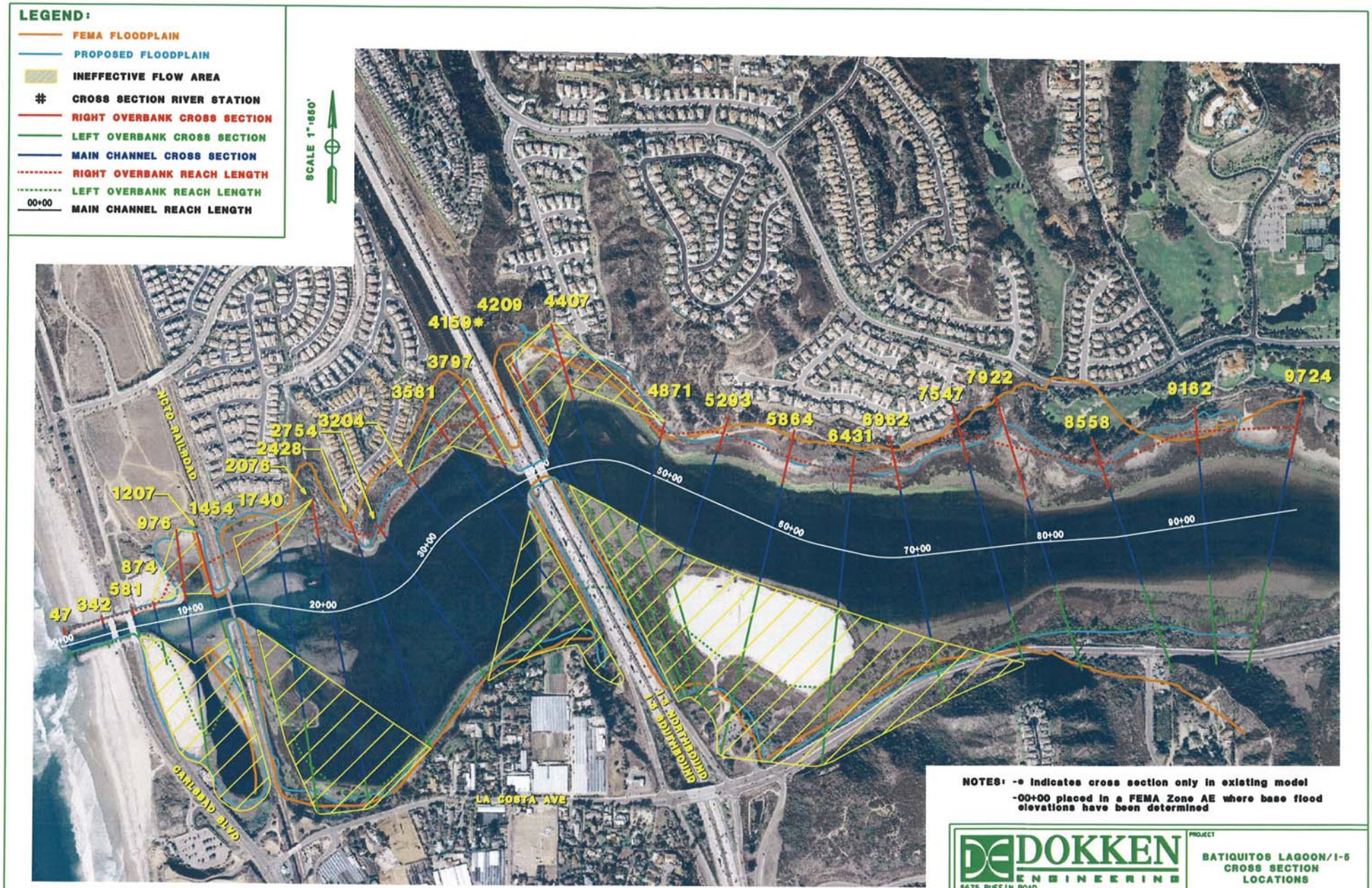
The water surface elevations displayed in the appendices and output of this study are based on flooding that would occur during a 100-year storm. Appendix B contains water surface elevations, channel velocities, top widths, Froude Numbers, and bottom elevations for each cross section list in Table A.

Table A: Floodplain Comparison

River Station	Existing W.S. Elevation (ft)	Proposed W.S. Elevation (ft)	Change in Elevation (ft)	Existing Top Width (ft)	Proposed Top Width (ft)	Change in Top Width (ft)
9724	11.37	10.53	-0.84	1526.92	1482.77	-44.15
9162	11.36	10.52	-0.84	1665.57	1644	-21.57
8558	11.33	10.48	-0.85	1298.03	1246.88	-51.15
7922	11.32	10.46	-0.86	1719.03	1648.06	-70.97
7547	11.32	10.46	-0.86	1528.84	1506.62	-22.22
6962	11.31	10.46	-0.85	1572.21	1548.45	-23.76
6431	11.3	10.45	-0.85	1967	1945.4	-21.6
5864	11.29	10.43	-0.86	1911.35	1886.7	-24.65
5293	11.29	10.42	-0.87	1993.45	1591.98	-401.47
4871	11.28	10.41	-0.87	2173.11	2167.86	-5.25
4407	11.27	10.41	-0.86	2898.08	2780.56	-117.52
4209	11.23	10.19	-1.04	3055.56	3016.29	-39.27
4159*	10.96	N/A	N/A	3067.71	N/A	N/A
4000	I-5 Bridge					
3797	9.64	9.67	0.03	2200.43	2201.92	1.49
3581	9.8	9.8	0.00	1907.17	1907.17	0
3204	9.8	9.8	0.00	1594.47	1594.47	0
2754	9.8	9.8	0.00	1270.86	1270.87	0.01
2428	9.8	9.8	0.00	1657.88	1657.88	0
2076	9.8	9.8	0.00	2099.63	2099.64	0.01
1740	9.78	9.78	0.00	2060.58	2060.58	0
1454	9.46	9.46	0.00	239.8	239.8	0
1300	NCTD Railroad Bridge					
1207	8.76	8.76	0.00	278.54	278.54	0
976	8.9	8.9	0.00	1636.29	1636.29	0
874	8.72	8.72	0.00	456.59	456.59	0
581	8.26	8.26	0.00	232.83	232.83	0
400	Carlsbad Boulevard Bridge					
342	7.39	7.39	0.00	220.55	220.55	0
47	7.17	7.17	0.00	170.28	170.28	0

*Indicates cross section only in existing model

The lagoon bottom elevations are fairly flat and the flow velocities within the lagoon are less than 2 ft/s. The velocity increases at the three bridges where the flow contracts under the crossings and then slows down again as the flow expands into the next downstream section of the lagoon. Table A indicates that the proposed I-5 Bridge would reduce the flow constriction at the



NOTES: -* indicates cross section only in existing model

-00+00 placed in a FEMA Zone AE where base flood elevations have been determined

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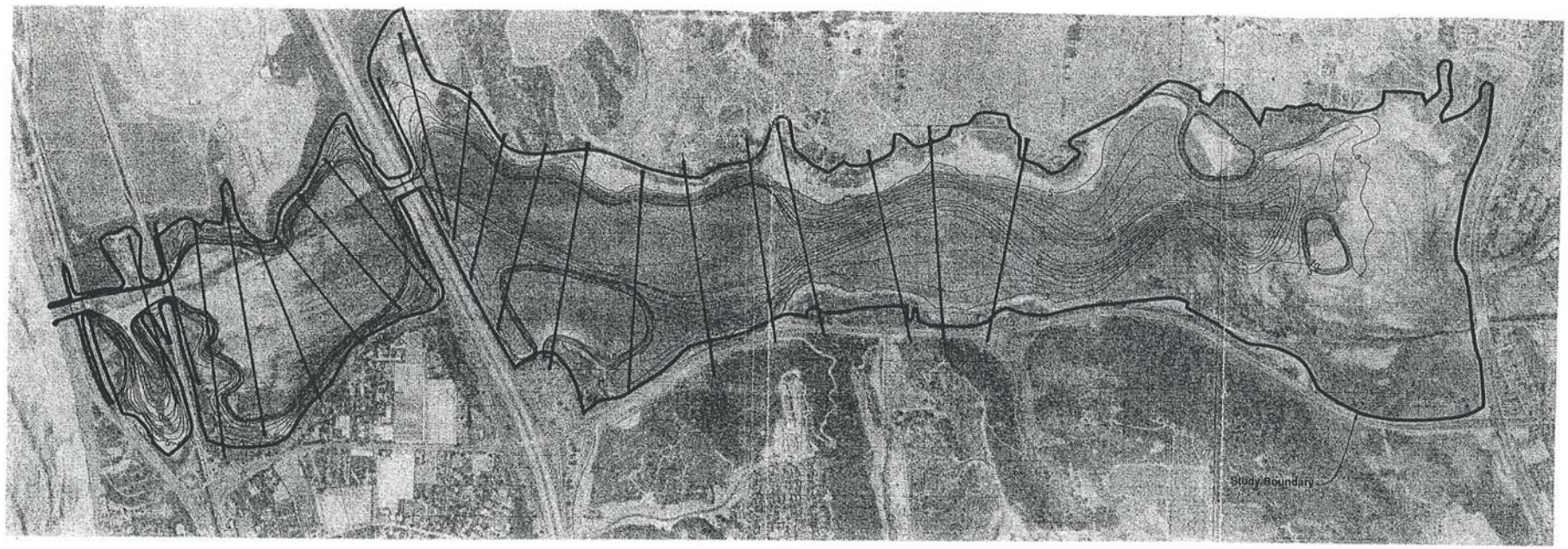
PROJECT

BATIQUITOS LAGOON/I-5
CROSS SECTION
LOCATIONS

FEBRUARY 2008



0 400' 1200'

Legend

ft MLLW

Aerial base maps by Photo Geodesic, June 21, 1968.
Date Compiled May 1990.

FIGURE D-4
Grading Plan for Mitigated Alternative B

BATIQUITOS LAGOON
ENHANCEMENT PROJECT EIR/EIS

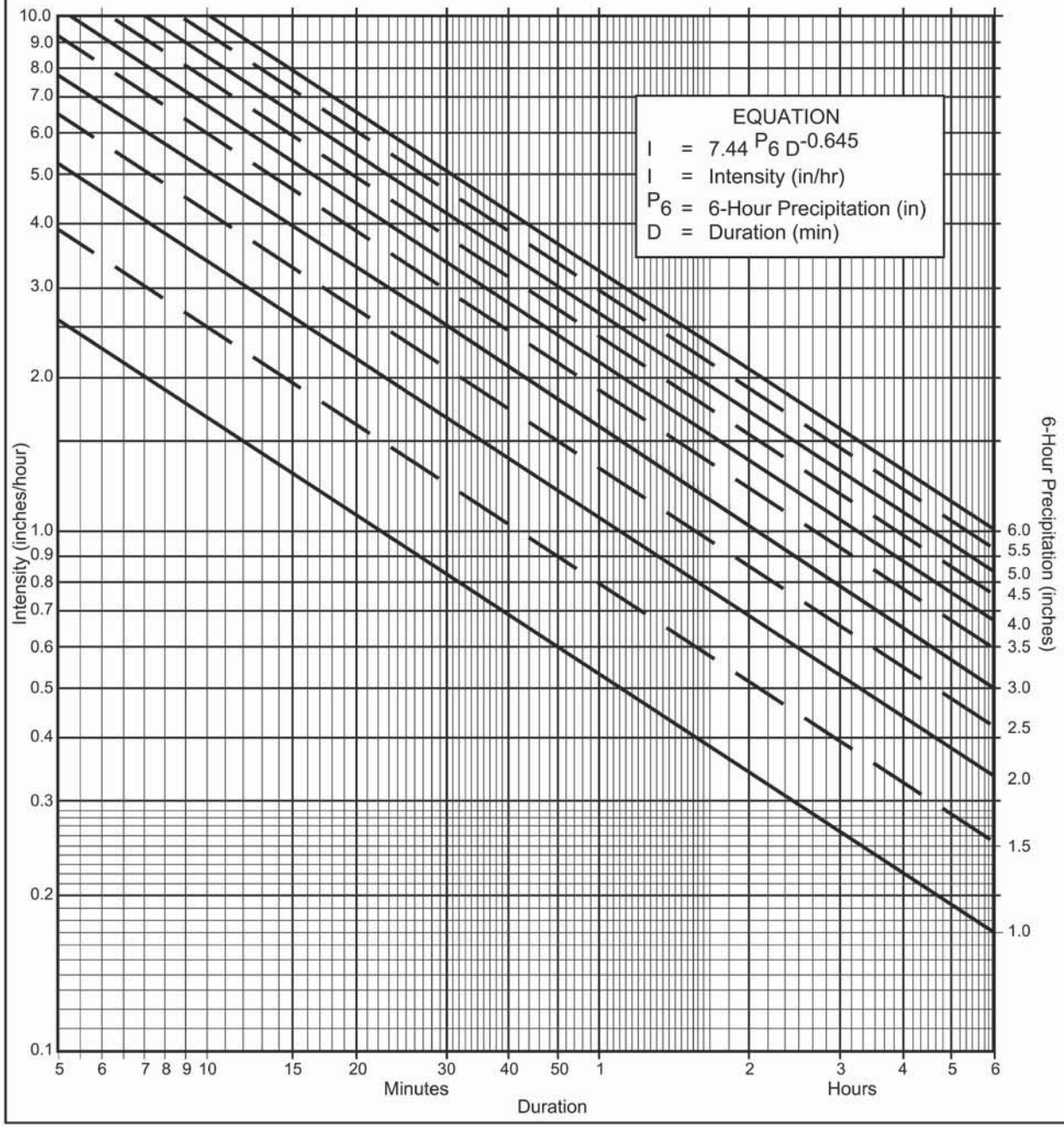
City of Carlsbad
U.S. Army Corps of Engineers

HEC-RAS Plan: BL_Exist River: Batiquitos Reach: 1 Profile: PF 1

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
1	9724	PF 1	12000.00	-2.18	11.37		11.38	0.000024	1.12	12231.76	1526.92	0.06
1	9162	PF 1	12000.00	-2.18	11.36		11.37	0.000019	1.02	13538.79	1665.57	0.06
1	8558	PF 1	12000.00	-2.18	11.33		11.36	0.000035	1.36	9973.96	1298.03	0.08
1	7922	PF 1	12000.00	-2.18	11.32		11.34	0.000024	1.22	12244.24	1719.03	0.06
1	7547	PF 1	12000.00	-2.18	11.32		11.33	0.000008	0.76	16745.06	1528.84	0.04
1	6962	PF 1	12000.00	-3.18	11.31	-0.82	11.32	0.000008	0.79	15734.69	1572.21	0.04
1	6431	PF 1	12000.00	-3.18	11.30	-0.93	11.32	0.000011	0.94	13387.49	1967.00	0.05
1	5864	PF 1	12000.00	-3.18	11.29	-0.78	11.31	0.000015	1.10	11637.82	1911.35	0.05
1	5293	PF 1	12000.00	-3.18	11.29	-0.69	11.30	0.000014	0.98	12758.45	1993.45	0.05
1	4871	PF 1	12000.00	-3.18	11.28	-0.25	11.29	0.000015	1.04	12614.78	2173.11	0.05
1	4407	PF 1	12000.00	-4.18	11.27	-1.54	11.29	0.000010	0.92	13579.51	2898.08	0.04
1	4209	PF 1	12000.00	-4.18	11.23	0.85	11.28	0.000049	1.82	6582.54	3055.56	0.09
1	4159	PF 1	12000.00	-4.18	10.96	2.86	11.25	0.001048	4.34	2765.97	3067.71	0.22
1	4000		Bridge									
1	3797	PF 1	12000.00	-4.18	9.64	0.74	9.90	0.000213	4.08	2941.05	2200.43	0.20
1	3581	PF 1	12000.00	-5.18	9.80	-3.30	9.82	0.000010	0.95	12574.48	1907.17	0.04
1	3204	PF 1	12000.00	-5.00	9.80	-3.41	9.81	0.000006	0.74	16485.04	1594.47	0.03
1	2754	PF 1	12000.00	-5.18	9.80	-3.51	9.81	0.000007	0.73	16536.97	1270.86	0.03
1	2428	PF 1	12000.00	-5.18	9.80		9.81	0.000003	0.55	22514.18	1657.88	0.03
1	2076	PF 1	12000.00	-5.18	9.80	-3.65	9.81	0.000005	0.68	17987.88	2099.63	0.03
1	1740	PF 1	12000.00	-5.18	9.78	-2.73	9.80	0.000020	1.19	10060.15	2060.58	0.06
1	1454	PF 1	12000.00	-5.18	9.46	1.42	9.76	0.000321	4.42	2715.52	239.80	0.23
1	1300		Bridge									
1	1207	PF 1	12000.00	-5.18	8.76		9.04	0.000269	4.46	2978.39	278.54	0.22
1	976	PF 1	12000.00	-5.18	8.90	-2.33	8.95	0.000041	1.83	6710.87	1636.29	0.09
1	874	PF 1	12000.00	-5.18	8.72	-0.63	8.92	0.000162	3.60	3480.47	456.59	0.17
1	581	PF 1	12000.00	-5.18	8.26	1.86	8.82	0.002188	6.27	2123.91	232.83	0.31
1	400		Bridge									
1	342	PF 1	12000.00	-5.18	7.39		8.08	0.000736	6.93	1926.47	220.55	0.35
1	47	PF 1	12000.00	-5.83	7.17	0.79	7.87	0.000652	6.99	1881.59	170.28	0.34

APPENDIX B

10-YEAR RATIONAL METHOD ANALYSES



Directions for Application:

(1) From precipitation maps determine 6 hr and 24 hr amounts for the selected frequency. These maps are included in the County Hydrology Manual (10, 50, and 100 yr maps included in the Design and Procedure Manual).

(2) Adjust 6 hr precipitation (if necessary) so that it is within the range of 45% to 65% of the 24 hr precipitation (not applicaple to Desert).

(3) Plot 6 hr precipitation on the right side of the chart.

(4) Draw a line through the point parallel to the plotted lines.

(5) This line is the intensity-duration curve for the location being analyzed.

Application Form: **Northerly Basins**

(a) Selected frequency 100 year

(b) P_6 = 1.7 in., P_{24} = 3.1, $\frac{P_6}{P_{24}}$ = 55 %(2)

(c) Adjusted P_6(2) = 1.7 in.

(d) t_x = _____ min.

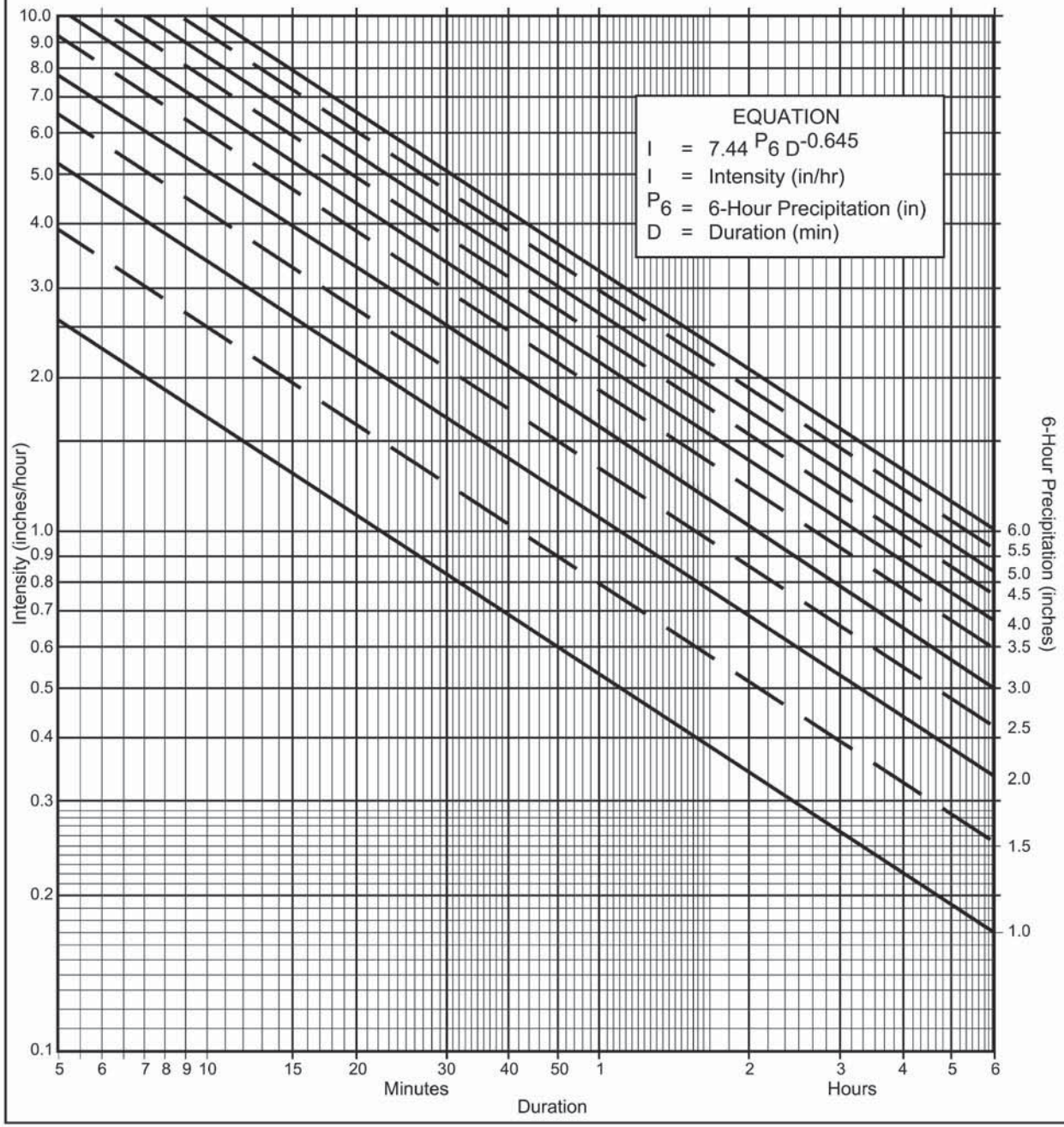
(e) I = _____ in./hr.

Note: This chart replaces the Intensity-Duration-Frequency curves used since 1965.

P6	1	1.5	2	2.5	3	3.5	4	4.5	5	5.5	6
Duration	I	I	I	I	I	I	I	I	I	I	I
5	2.63	3.95	5.27	6.59	7.90	9.22	10.54	11.86	13.17	14.49	15.81
7	2.12	3.18	4.24	5.30	6.36	7.42	8.48	9.54	10.60	11.66	12.72
10	1.68	2.53	3.37	4.21	5.05	5.90	6.74	7.58	8.42	9.27	10.11
15	1.30	1.95	2.59	3.24	3.89	4.54	5.19	5.84	6.49	7.13	7.78
20	1.08	1.62	2.15	2.69	3.23	3.77	4.31	4.85	5.39	5.93	6.46
25	0.93	1.40	1.87	2.33	2.80	3.27	3.73	4.20	4.67	5.13	5.60
30	0.83	1.24	1.66	2.07	2.49	2.90	3.32	3.73	4.15	4.56	4.98
40	0.69	1.03	1.38	1.72	2.07	2.41	2.76	3.10	3.45	3.79	4.13
50	0.60	0.90	1.19	1.49	1.79	2.09	2.39	2.69	2.98	3.28	3.58
60	0.53	0.80	1.06	1.33	1.59	1.86	2.12	2.39	2.65	2.92	3.18
90	0.41	0.61	0.82	1.02	1.23	1.43	1.63	1.84	2.04	2.25	2.45
120	0.34	0.51	0.68	0.85	1.02	1.19	1.36	1.53	1.70	1.87	2.04
150	0.29	0.44	0.59	0.73	0.88	1.03	1.18	1.32	1.47	1.62	1.76
180	0.26	0.39	0.52	0.65	0.78	0.91	1.04	1.18	1.31	1.44	1.57
240	0.22	0.33	0.43	0.54	0.65	0.76	0.87	0.98	1.08	1.19	1.30
300	0.19	0.28	0.38	0.47	0.56	0.66	0.75	0.85	0.94	1.03	1.13
360	0.17	0.25	0.33	0.42	0.50	0.58	0.67	0.75	0.84	0.92	1.00

Intensity-Duration Design Chart - Template

FIGURE 3-1



Directions for Application:

(1) From precipitation maps determine 6 hr and 24 hr amounts for the selected frequency. These maps are included in the County Hydrology Manual (10, 50, and 100 yr maps included in the Design and Procedure Manual).

(2) Adjust 6 hr precipitation (if necessary) so that it is within the range of 45% to 65% of the 24 hr precipitation (not applicaple to Desert).

(3) Plot 6 hr precipitation on the right side of the chart.

(4) Draw a line through the point parallel to the plotted lines.

(5) This line is the intensity-duration curve for the location being analyzed.

Application Form: **Southerly Basins**

(a) Selected frequency 100 year

(b) P_6 = 1.7 in., P_{24} = 2.9, $\frac{P_6}{P_{24}}$ = 59 %(2)

(c) Adjusted P_6(2) = 1.7 in.

(d) t_x = _____ min.

(e) I = _____ in./hr.

Note: This chart replaces the Intensity-Duration-Frequency curves used since 1965.

P6	1	1.5	2	2.5	3	3.5	4	4.5	5	5.5	6
Duration	I	I	I	I	I	I	I	I	I	I	I
5	2.63	3.95	5.27	6.59	7.90	9.22	10.54	11.86	13.17	14.49	15.81
7	2.12	3.18	4.24	5.30	6.36	7.42	8.48	9.54	10.60	11.66	12.72
10	1.68	2.53	3.37	4.21	5.05	5.90	6.74	7.58	8.42	9.27	10.11
15	1.30	1.95	2.59	3.24	3.89	4.54	5.19	5.84	6.49	7.13	7.78
20	1.08	1.62	2.15	2.69	3.23	3.77	4.31	4.85	5.39	5.93	6.46
25	0.93	1.40	1.87	2.33	2.80	3.27	3.73	4.20	4.67	5.13	5.60
30	0.83	1.24	1.66	2.07	2.49	2.90	3.32	3.73	4.15	4.56	4.98
40	0.69	1.03	1.38	1.72	2.07	2.41	2.76	3.10	3.45	3.79	4.13
50	0.60	0.90	1.19	1.49	1.79	2.09	2.39	2.69	2.98	3.28	3.58
60	0.53	0.80	1.06	1.33	1.59	1.86	2.12	2.39	2.65	2.92	3.18
90	0.41	0.61	0.82	1.02	1.23	1.43	1.63	1.84	2.04	2.25	2.45
120	0.34	0.51	0.68	0.85	1.02	1.19	1.36	1.53	1.70	1.87	2.04
150	0.29	0.44	0.59	0.73	0.88	1.03	1.18	1.32	1.47	1.62	1.76
180	0.26	0.39	0.52	0.65	0.78	0.91	1.04	1.18	1.31	1.44	1.57
240	0.22	0.33	0.43	0.54	0.65	0.76	0.87	0.98	1.08	1.19	1.30
300	0.19	0.28	0.38	0.47	0.56	0.66	0.75	0.85	0.94	1.03	1.13
360	0.17	0.25	0.33	0.42	0.50	0.58	0.67	0.75	0.84	0.92	1.00

Intensity-Duration Design Chart - Template

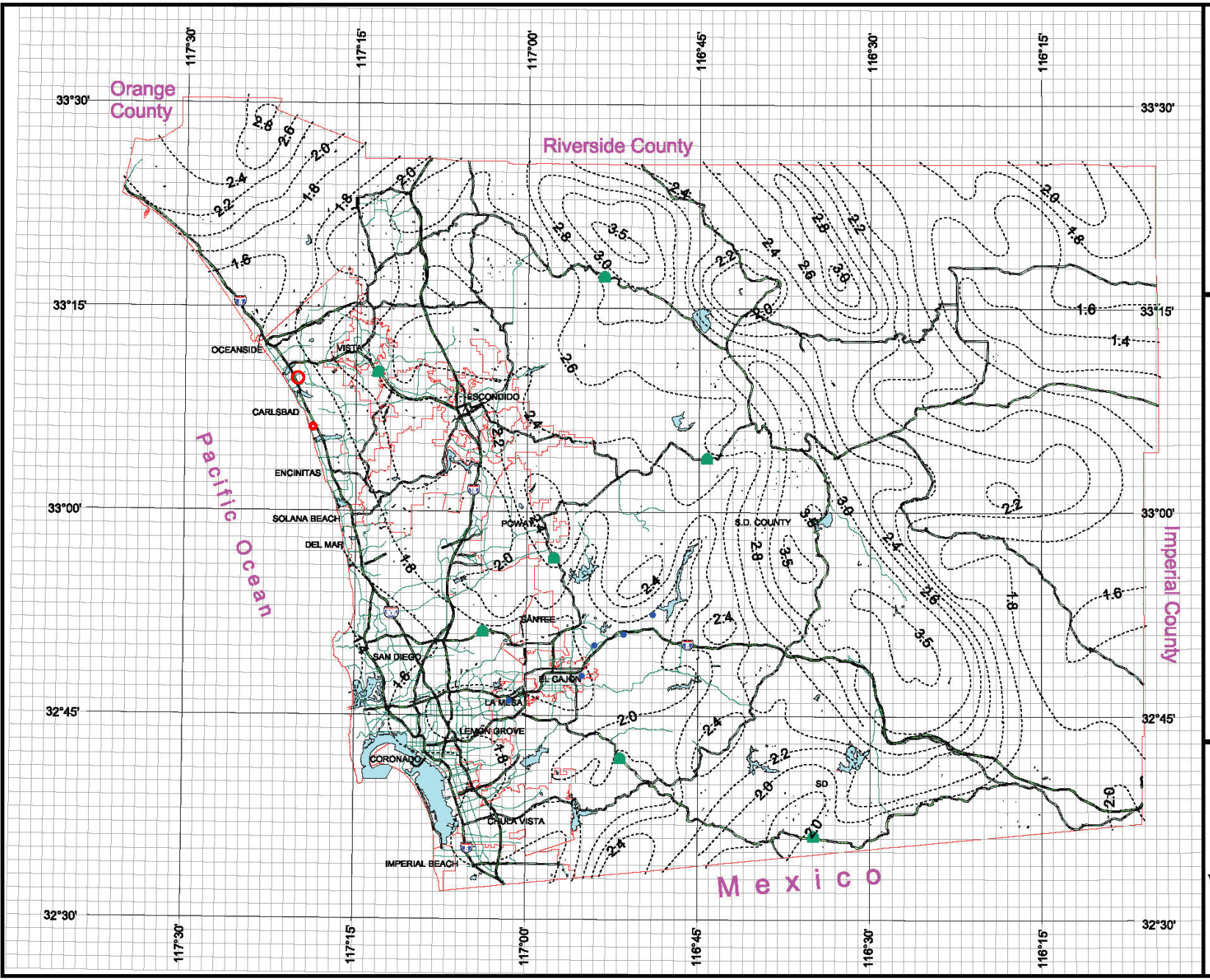
FIGURE 3-1

County of San Diego Hydrology Manual

Rainfall Isopluvials

10 Year Rainfall Event - 6 Hours

Isopluvial (inches)



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County of San Diego Hydrology Manual

Rainfall Isopluvials

10 Year Rainfall Event - 24 Hours

Isopluvial (inches)

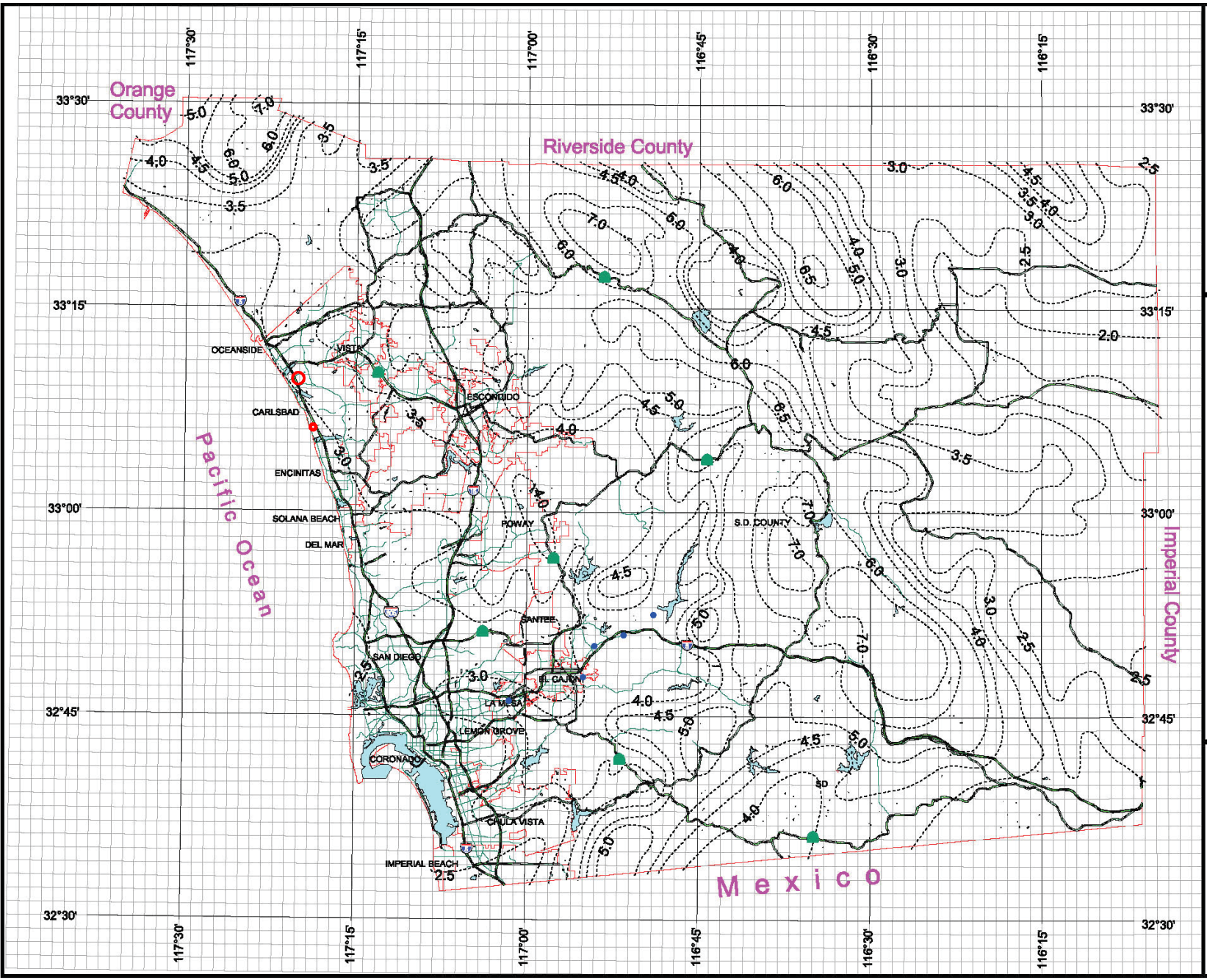

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Table 3-1
RUNOFF COEFFICIENTS FOR URBAN AREAS

Land Use		Runoff Coefficient "C"				
			Soil Type			
NRCS Elements	County Elements	% IMPER.	A	B	C	D
Undisturbed Natural Terrain (Natural)	Permanent Open Space	0*	0.20	0.25	0.30	0.35
Low Density Residential (LDR)	Residential, 1.0 DU/A or less	10	0.27	0.32	0.36	0.41
Low Density Residential (LDR)	Residential, 2.0 DU/A or less	20	0.34	0.38	0.42	0.46
Low Density Residential (LDR)	Residential, 2.9 DU/A or less	25	0.38	0.41	0.45	0.49
Medium Density Residential (MDR)	Residential, 4.3 DU/A or less	30	0.41	0.45	0.48	0.52
Medium Density Residential (MDR)	Residential, 7.3 DU/A or less	40	0.48	0.51	0.54	0.57
Medium Density Residential (MDR)	Residential, 10.9 DU/A or less	45	0.52	0.54	0.57	0.60
Medium Density Residential (MDR)	Residential, 14.5 DU/A or less	50	0.55	0.58	0.60	0.63
High Density Residential (HDR)	Residential, 24.0 DU/A or less	65	0.66	0.67	0.69	0.71
High Density Residential (HDR)	Residential, 43.0 DU/A or less	80	0.76	0.77	0.78	0.79
Commercial/Industrial (N. Com)	Neighborhood Commercial	80	0.76	0.77	0.78	0.79
Commercial/Industrial (G. Com)	General Commercial	85	0.80	0.80	0.81	0.82
Commercial/Industrial (O.P. Com)	Office Professional/Commercial	90	0.83	0.84	0.84	0.85
Commercial/Industrial (Limited I.)	Limited Industrial	90	0.83	0.84	0.84	0.85
Commercial/Industrial (General I.)	General Industrial	95	0.87	0.87	0.87	0.87

*The values associated with 0% impervious may be used for direct calculation of the runoff coefficient as described in Section 3.1.2 (representing the pervious runoff coefficient, Cp, for the soil type), or for areas that will remain undisturbed in perpetuity. Justification must be given that the area will remain natural forever (e.g., the area is located in Cleveland National Forest).
DU/A = dwelling units per acre
NRCS = National Resources Conservation Service

Note that the Initial Time of Concentration should be reflective of the general land-use at the upstream end of a drainage basin. A single lot with an area of two or less acres does not have a significant effect where the drainage basin area is 20 to 600 acres.

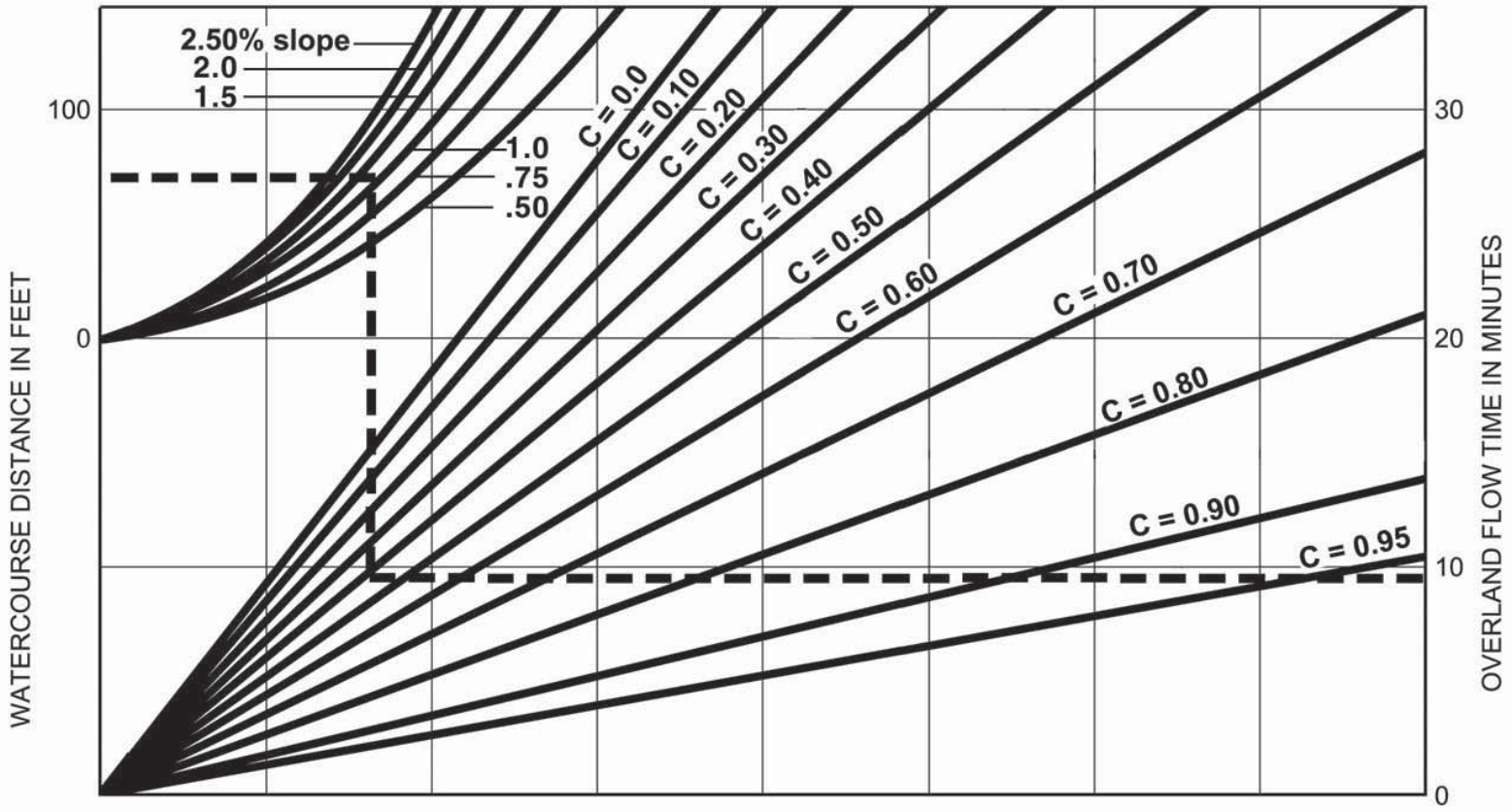
Table 3-2 provides limits of the length (Maximum Length (L_M)) of sheet flow to be used in hydrology studies. Initial T_i values based on average C values for the Land Use Element are also included. These values can be used in planning and design applications as described below. Exceptions may be approved by the "Regulating Agency" when submitted with a detailed study.

Table 3-2

MAXIMUM OVERLAND FLOW LENGTH (L_M) & INITIAL TIME OF CONCENTRATION (T_i)

Element*	DU/ Acre	.5%		1%		2%		3%		5%		10%	
		L_M	T_i	L_M	T_i	L_M	T_i	L_M	T_i	L_M	T_i	L_M	T_i
Natural		50	13.2	70	12.5	85	10.9	100	10.3	100	8.7	100	6.9
LDR	1	50	12.2	70	11.5	85	10.0	100	9.5	100	8.0	100	6.4
LDR	2	50	11.3	70	10.5	85	9.2	100	8.8	100	7.4	100	5.8
LDR	2.9	50	10.7	70	10.0	85	8.8	95	8.1	100	7.0	100	5.6
MDR	4.3	50	10.2	70	9.6	80	8.1	95	7.8	100	6.7	100	5.3
MDR	7.3	50	9.2	65	8.4	80	7.4	95	7.0	100	6.0	100	4.8
MDR	10.9	50	8.7	65	7.9	80	6.9	90	6.4	100	5.7	100	4.5
MDR	14.5	50	8.2	65	7.4	80	6.5	90	6.0	100	5.4	100	4.3
HDR	24	50	6.7	65	6.1	75	5.1	90	4.9	95	4.3	100	3.5
HDR	43	50	5.3	65	4.7	75	4.0	85	3.8	95	3.4	100	2.7
N. Com		50	5.3	60	4.5	75	4.0	85	3.8	95	3.4	100	2.7
G. Com		50	4.7	60	4.1	75	3.6	85	3.4	90	2.9	100	2.4
O.P./Com		50	4.2	60	3.7	70	3.1	80	2.9	90	2.6	100	2.2
Limited I.		50	4.2	60	3.7	70	3.1	80	2.9	90	2.6	100	2.2
General I.		50	3.7	60	3.2	70	2.7	80	2.6	90	2.3	100	1.9

*See Table 3-1 for more detailed description



EXAMPLE:

Given: Watercourse Distance (D) = 70 Feet
Slope (s) = 1.3%
Runoff Coefficient (C) = 0.41
Overland Flow Time (T) = 9.5 Minutes

$$T = \frac{1.8\,(1.1-C)\sqrt{D}}{\sqrt[3]{s}}$$

SOURCE: Airport Drainage, Federal Aviation Administration, 1965

FIGURE 3-3

Rational Formula - Overland Time of Flow Nomograph

San Diego County Rational Hydrology Program

CIVILCADD/CIVILDESIGN Engineering Software,(c)1991-2009 Version 7.8

Rational method hydrology program based on
San Diego County Flood Control Division 2003 hydrology manual
Rational Hydrology Study Date: 12/08/12

City of Carlsbad
Hydromodification Exemption Study
Major Basin 100
10-Year Flow Rate

********* Hydrology Study Control Information **********

Program License Serial Number 4028

Rational hydrology study storm event year is 10.0
English (in-lb) input data Units used

Map data precipitation entered:
6 hour, precipitation(inches) = 1.700
24 hour precipitation(inches) = 3.100
P6/P24 = 54.8%
San Diego hydrology manual 'C' values used

++
Process from Point/Station 100.000 to Point/Station 101.000
**** INITIAL AREA EVALUATION ****

Decimal fraction soil group A = 1.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 0.000
Decimal fraction soil group D = 0.000
[LOW DENSITY RESIDENTIAL]
(1.0 DU/A or Less)
Impervious value, Ai = 0.100
Sub-Area C Value = 0.270
Initial subarea total flow distance = 244.000(Ft.)
Highest elevation = 182.000(Ft.)
Lowest elevation = 162.000(Ft.)
Elevation difference = 20.000(Ft.) Slope = 8.197 %
INITIAL AREA TIME OF CONCENTRATION CALCULATIONS:
The maximum overland flow distance is 100.00 (Ft)
for the top area slope value of 8.20 %, in a development type of
1.0 DU/A or Less
In Accordance With Figure 3-3

```
Initial Area Time of Concentration =   7.41 minutes
TC = [1.8*(1.1-C)*distance(Ft.)^.5)/(% slope^(1/3)]
TC = [1.8*(1.1-0.2700)*( 100.000^.5)/(   8.197^(1/3)]=   7.41
The initial area total distance of  244.00 (Ft.) entered leaves a
remaining distance of  144.00 (Ft.)
Using Figure 3-4, the travel time for this distance is   0.94 minutes
for a distance of 144.00 (Ft.) and a slope of  8.20 %
with an elevation difference of  11.80(Ft.) from the end of the top area
Tt = [11.9*length(Mi)^3)/(elevation change(Ft.))]^.385 *60(min/hr)
 =    0.939 Minutes
Tt=[(11.9*0.0273^3)/( 11.80)]^.385=  0.94
Total initial area Ti =   7.41 minutes from Figure 3-3 formula plus
  0.94 minutes from the Figure 3-4 formula =   8.35 minutes
Rainfall intensity (I) =      3.218(In/Hr) for a    10.0 year storm
Effective runoff coefficient used for area (Q=KCIA) is C = 0.270
Subarea runoff =      0.747(CFS)
Total initial stream area =        0.860(Ac.)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      101.000 to Point/Station      102.000
**** STREET FLOW TRAVEL TIME + SUBAREA FLOW ADDITION ****
________________________________________________________________________
Top of street segment elevation =   162.000(Ft.)
End of street segment elevation =   161.000(Ft.)
Length of street segment  =   171.000(Ft.)
Height of curb above gutter flowline  =    6.0(In.)
Width of half street (curb to crown)  =  18.000(Ft.)
Distance from crown to crossfall grade break  =   8.000(Ft.)
Slope from gutter to grade break (v/hz) =   0.020
Slope from grade break to crown (v/hz)  =   0.020
Street flow is on [1] side(s) of the street
Distance from curb to property line  =  10.000(Ft.)
Slope from curb to property line (v/hz) =   0.020
Gutter width =   1.500(Ft.)
Gutter hike from flowline =  1.500(In.)
 Manning's N in gutter =  0.0150
 Manning's N from gutter to grade break =  0.0180
 Manning's N from grade break to crown =  0.0180
Estimated mean flow rate at midpoint of street =      2.106(CFS)
Depth of flow =   0.322(Ft.), Average velocity =   1.544(Ft/s)
Streetflow hydraulics at midpoint of street travel:
Halfstreet flow width =  11.370(Ft.)
Flow velocity =   1.54(Ft/s)
Travel time =    1.85 min.     TC =   10.19  min.
 Adding area flow to street
Rainfall intensity (I) =      2.829(In/Hr) for a    10.0 year storm
Decimal fraction soil group A = 1.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 0.000
Decimal fraction soil group D = 0.000
[LOW DENSITY RESIDENTIAL                    ]
```

```
(2.0 DU/A or Less       )
Impervious value, Ai = 0.200
Sub-Area C Value = 0.340
Rainfall intensity =      2.829(In/Hr) for a    10.0 year storm
Effective runoff coefficient used for total area
(Q=KCIA) is C = 0.324  CA =      1.259
Subarea runoff =      2.814(CFS) for      3.020(Ac.)
Total runoff =      3.562(CFS)   Total area =       3.880(Ac.)
Street flow at end of street =      3.562(CFS)
Half street flow at end of street =      3.562(CFS)
Depth of flow =   0.375(Ft.), Average velocity =   1.749(Ft/s)
Flow width (from curb towards crown)=  14.019(Ft.)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      102.000 to Point/Station      103.000
**** STREET FLOW TRAVEL TIME + SUBAREA FLOW ADDITION ****
________________________________________________________________________
Top of street segment elevation =   161.000(Ft.)
End of street segment elevation =    73.000(Ft.)
Length of street segment  =  1802.000(Ft.)
Height of curb above gutter flowline  =    6.0(In.)
Width of half street (curb to crown)  =  18.000(Ft.)
Distance from crown to crossfall grade break  =   8.000(Ft.)
Slope from gutter to grade break (v/hz) =   0.020
Slope from grade break to crown (v/hz)  =   0.020
Street flow is on [1] side(s) of the street
Distance from curb to property line  =  10.000(Ft.)
Slope from curb to property line (v/hz) =   0.020
Gutter width =   1.500(Ft.)
Gutter hike from flowline =  1.500(In.)
 Manning's N in gutter =  0.0150
 Manning's N from gutter to grade break =  0.0180
 Manning's N from grade break to crown =  0.0180
Estimated mean flow rate at midpoint of street =     15.814(CFS)
Depth of flow =   0.427(Ft.), Average velocity =   5.604(Ft/s)
Streetflow hydraulics at midpoint of street travel:
Halfstreet flow width =  16.585(Ft.)
Flow velocity =   5.60(Ft/s)
Travel time =    5.36 min.     TC =   15.55  min.
 Adding area flow to street
Rainfall intensity (I) =      2.154(In/Hr) for a    10.0 year storm
Decimal fraction soil group A = 0.700
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 0.000
Decimal fraction soil group D = 0.300
[COMMERCIAL area type                         ]
(Neighborhod Commercial )
Impervious value, Ai = 0.800
Sub-Area C Value = 0.769
Rainfall intensity =      2.154(In/Hr) for a    10.0 year storm
Effective runoff coefficient used for total area
```

```
(Q=KCIA) is C = 0.679  CA =     13.055
Subarea runoff =     24.562(CFS) for     15.340(Ac.)
Total runoff =     28.124(CFS)   Total area =      19.220(Ac.)
Street flow at end of street =     28.124(CFS)
Half street flow at end of street =     28.124(CFS)
Depth of flow =   0.500(Ft.), Average velocity =   6.818(Ft/s)
Warning: depth of flow exceeds top of curb
Note:  depth of flow exceeds top of street crown.
Distance that curb overflow reaches into property =    0.01(Ft.)
Flow width (from curb towards crown)=  18.000(Ft.)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      103.000 to Point/Station      104.000
**** PIPEFLOW TRAVEL TIME (Program estimated size) ****
______________________________________________________________________________
Upstream point/station elevation =    73.000(Ft.)
Downstream point/station elevation =    42.000(Ft.)
Pipe length  =  2380.00(Ft.) Slope =   0.0130  Manning's N = 0.013
No. of pipes = 1  Required pipe flow  =    28.124(CFS)
Nearest computed pipe diameter  =     27.00(In.)
Calculated individual pipe flow  =    28.124(CFS)
Normal flow depth in pipe =   18.19(In.)
Flow top width inside pipe =   25.32(In.)
Critical Depth =   22.13(In.)
Pipe flow velocity =      9.87(Ft/s)
Travel time through pipe =    4.02 min.
Time of concentration (TC) =    19.57 min.


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      103.000 to Point/Station      104.000
**** SUBAREA FLOW ADDITION ****
______________________________________________________________________________
Rainfall intensity (I) =      1.857(In/Hr) for a    10.0 year storm
Decimal fraction soil group A = 1.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 0.000
Decimal fraction soil group D = 0.000
[COMMERCIAL area type                         ]
(Neighborhod Commercial )
Impervious value, Ai = 0.800
Sub-Area C Value = 0.760
Time of concentration =    19.57 min.
Rainfall intensity =      1.857(In/Hr) for a    10.0 year storm
Effective runoff coefficient used for total area
(Q=KCIA) is C = 0.717  CA =     25.907
Subarea runoff =     19.993(CFS) for     16.910(Ac.)
Total runoff =     48.117(CFS)   Total area =      36.130(Ac.)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
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```
Process from Point/Station      104.000 to Point/Station      105.000
**** PIPEFLOW TRAVEL TIME (Program estimated size) ****
------------------------------------------------------------------------
Upstream point/station elevation =    42.000(Ft.)
Downstream point/station elevation =    39.890(Ft.)
Pipe length  =   450.00(Ft.) Slope =   0.0047  Manning's N = 0.013
No. of pipes = 2  Required pipe flow  =    48.117(CFS)
Nearest computed pipe diameter  =     30.00(In.)
Calculated individual pipe flow  =    24.058(CFS)
Normal flow depth in pipe =   21.38(In.)
Flow top width inside pipe =   27.16(In.)
Critical Depth =   20.04(In.)
Pipe flow velocity =      6.43(Ft/s)
Travel time through pipe =    1.17 min.
Time of concentration (TC) =    20.74 min.


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      104.000 to Point/Station      105.000
**** CONFLUENCE OF MINOR STREAMS ****
------------------------------------------------------------------------
Along Main Stream number: 1 in normal stream number 1
Stream flow area =     36.130(Ac.)
Runoff from this stream =     48.117(CFS)
Time of concentration =   20.74 min.
Rainfall intensity =     1.789(In/Hr)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      106.000 to Point/Station      107.000
**** INITIAL AREA EVALUATION ****
------------------------------------------------------------------------
Decimal fraction soil group A = 1.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 0.000
Decimal fraction soil group D = 0.000
[COMMERCIAL area type                        ]
(General Commercial    )
Impervious value, Ai = 0.850
Sub-Area C Value = 0.800
Initial subarea total flow distance  =  249.000(Ft.)
Highest elevation =   86.500(Ft.)
Lowest elevation =   72.000(Ft.)
Elevation difference =   14.500(Ft.) Slope =  5.823 %
INITIAL AREA TIME OF CONCENTRATION CALCULATIONS:
The maximum overland flow distance is 90.00 (Ft)
for the top area slope value of   5.82 %, in a development type of
 General Commercial
In Accordance With Figure 3-3
Initial Area Time of Concentration =   2.85 minutes
TC = [1.8*(1.1-C)*distance(Ft.)^.5)/(% slope^(1/3)]
TC = [1.8*(1.1-0.8000)*(  90.000^.5)/(   5.823^(1/3)]=   2.85
```

```
The initial area total distance of  249.00 (Ft.) entered leaves a
remaining distance of  159.00 (Ft.)
Using Figure 3-4, the travel time for this distance is   1.16 minutes
for a distance of 159.00 (Ft.) and a slope of  5.82 %
with an elevation difference of   9.26(Ft.) from the end of the top area
Tt = [11.9*length(Mi)^3)/(elevation change(Ft.))]^.385 *60(min/hr)
 =    1.156 Minutes
Tt=[(11.9*0.0301^3)/(  9.26)]^.385=  1.16
Total initial area Ti =   2.85 minutes from Figure 3-3 formula plus
  1.16 minutes from the Figure 3-4 formula =   4.00 minutes
Calculated TC of    4.004 minutes is less than 5 minutes,
 resetting TC to 5.0 minutes for rainfall intensity calculations
Rainfall intensity (I) =      4.479(In/Hr) for a    10.0 year storm
Effective runoff coefficient used for area (Q=KCIA) is C = 0.800
Subarea runoff =      4.945(CFS)
Total initial stream area =        1.380(Ac.)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      107.000 to Point/Station      108.000
**** STREET FLOW TRAVEL TIME + SUBAREA FLOW ADDITION ****
________________________________________________________________________
Top of street segment elevation =    72.000(Ft.)
End of street segment elevation =    52.000(Ft.)
Length of street segment  =  1260.000(Ft.)
Height of curb above gutter flowline  =    6.0(In.)
Width of half street (curb to crown)  =  18.000(Ft.)
Distance from crown to crossfall grade break  =   8.000(Ft.)
Slope from gutter to grade break (v/hz) =   0.020
Slope from grade break to crown (v/hz)  =   0.020
Street flow is on [1] side(s) of the street
Distance from curb to property line  =  10.000(Ft.)
Slope from curb to property line (v/hz) =   0.020
Gutter width =   1.500(Ft.)
Gutter hike from flowline =  1.500(In.)
 Manning's N in gutter =  0.0150
 Manning's N from gutter to grade break =  0.0180
 Manning's N from grade break to crown =  0.0180
Estimated mean flow rate at midpoint of street =     18.830(CFS)
Depth of flow =   0.528(Ft.), Average velocity =   4.050(Ft/s)
Warning: depth of flow exceeds top of curb
Note:  depth of flow exceeds top of street crown.
Distance that curb overflow reaches into property =    1.41(Ft.)
Streetflow hydraulics at midpoint of street travel:
Halfstreet flow width =  18.000(Ft.)
Flow velocity =   4.05(Ft/s)
Travel time =    5.18 min.     TC =    9.19  min.
 Adding area flow to street
Rainfall intensity (I) =      3.025(In/Hr) for a    10.0 year storm
Decimal fraction soil group A = 1.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 0.000
```

```
Decimal fraction soil group D = 0.000
[HIGH DENSITY RESIDENTIAL                    ]
(43.0 DU/A or Less      )
Impervious value, Ai = 0.800
Sub-Area C Value = 0.760
Rainfall intensity =      3.025(In/Hr) for a    10.0 year storm
Effective runoff coefficient used for total area
(Q=KCIA) is C = 0.764  CA =     10.794
Subarea runoff =     27.707(CFS) for     12.750(Ac.)
Total runoff =     32.652(CFS)   Total area =      14.130(Ac.)
Street flow at end of street =     32.652(CFS)
Half street flow at end of street =     32.652(CFS)
Depth of flow =   0.634(Ft.), Average velocity =   4.674(Ft/s)
Warning: depth of flow exceeds top of curb
Note:  depth of flow exceeds top of street crown.
Distance that curb overflow reaches into property =    6.71(Ft.)
Flow width (from curb towards crown)=  18.000(Ft.)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      108.000 to Point/Station      109.000
**** PIPEFLOW TRAVEL TIME (Program estimated size) ****
------------------------------------------------------------------------
Upstream point/station elevation =    52.000(Ft.)
Downstream point/station elevation =    48.000(Ft.)
Pipe length  =   456.00(Ft.) Slope =   0.0088  Manning's N = 0.013
No. of pipes = 1  Required pipe flow  =    32.652(CFS)
Nearest computed pipe diameter  =     30.00(In.)
Calculated individual pipe flow  =    32.652(CFS)
Normal flow depth in pipe =   21.23(In.)
Flow top width inside pipe =   27.29(In.)
Critical Depth =   23.34(In.)
Pipe flow velocity =      8.78(Ft/s)
Travel time through pipe =    0.87 min.
Time of concentration (TC) =    10.05 min.


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      108.000 to Point/Station      109.000
**** SUBAREA FLOW ADDITION ****
------------------------------------------------------------------------
Rainfall intensity (I) =      2.854(In/Hr) for a    10.0 year storm
Decimal fraction soil group A = 1.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 0.000
Decimal fraction soil group D = 0.000
[COMMERCIAL area type                        ]
(General Commercial    )
Impervious value, Ai = 0.850
Sub-Area C Value = 0.800
Time of concentration =    10.05 min.
Rainfall intensity =      2.854(In/Hr) for a    10.0 year storm
```

```
Effective runoff coefficient used for total area
(Q=KCIA) is C = 0.770  CA =     13.010
Subarea runoff =      4.484(CFS) for      2.770(Ac.)
Total runoff =     37.136(CFS)   Total area =      16.900(Ac.)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      109.000 to Point/Station      105.000
**** PIPEFLOW TRAVEL TIME (Program estimated size) ****
________________________________________________________________________
Upstream point/station elevation =    48.000(Ft.)
Downstream point/station elevation =    44.000(Ft.)
Pipe length  =   490.00(Ft.) Slope =   0.0082  Manning's N = 0.013
No. of pipes = 1  Required pipe flow  =    37.136(CFS)
Nearest computed pipe diameter  =     33.00(In.)
Calculated individual pipe flow  =    37.136(CFS)
Normal flow depth in pipe =   21.87(In.)
Flow top width inside pipe =   31.21(In.)
Critical Depth =   24.34(In.)
Pipe flow velocity =      8.89(Ft/s)
Travel time through pipe =    0.92 min.
Time of concentration (TC) =    10.97 min.


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      109.000 to Point/Station      105.000
**** CONFLUENCE OF MINOR STREAMS ****
________________________________________________________________________
Along Main Stream number: 1 in normal stream number 2
Stream flow area =     16.900(Ac.)
Runoff from this stream =     37.136(CFS)
Time of concentration =   10.97 min.
Rainfall intensity =     2.698(In/Hr)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      110.000 to Point/Station      111.000
**** INITIAL AREA EVALUATION ****
________________________________________________________________________
Decimal fraction soil group A = 1.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 0.000
Decimal fraction soil group D = 0.000
[COMMERCIAL area type                         ]
(General Commercial    )
Impervious value, Ai = 0.850
Sub-Area C Value = 0.800
Initial subarea total flow distance  =  740.000(Ft.)
Highest elevation =   58.200(Ft.)
Lowest elevation =   44.000(Ft.)
Elevation difference =   14.200(Ft.) Slope =  1.919 %
INITIAL AREA TIME OF CONCENTRATION CALCULATIONS:
```

```
The maximum overland flow distance is 75.00 (Ft)
for the top area slope value of   1.92 %, in a development type of
 General Commercial
In Accordance With Figure 3-3
Initial Area Time of Concentration =   3.76 minutes
TC = [1.8*(1.1-C)*distance(Ft.)^.5)/(% slope^(1/3)]
TC = [1.8*(1.1-0.8000)*(  75.000^.5)/(   1.919^(1/3)]=   3.76
The initial area total distance of  740.00 (Ft.) entered leaves a
remaining distance of  665.00 (Ft.)
Using Figure 3-4, the travel time for this distance is   5.34 minutes
for a distance of 665.00 (Ft.) and a slope of  1.92 %
with an elevation difference of  12.76(Ft.) from the end of the top area
Tt = [11.9*length(Mi)^3)/(elevation change(Ft.))]^.385 *60(min/hr)
 =    5.336 Minutes
Tt=[(11.9*0.1259^3)/( 12.76)]^.385=  5.34
Total initial area Ti =   3.76 minutes from Figure 3-3 formula plus
  5.34 minutes from the Figure 3-4 formula =   9.10 minutes
Rainfall intensity (I) =      3.044(In/Hr) for a    10.0 year storm
Effective runoff coefficient used for area (Q=KCIA) is C = 0.800
Subarea runoff =     13.395(CFS)
Total initial stream area =        5.500(Ac.)


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Process from Point/Station      111.000 to Point/Station      112.000
**** PIPEFLOW TRAVEL TIME (Program estimated size) ****
________________________________________________________________________
Upstream point/station elevation =    44.000(Ft.)
Downstream point/station elevation =    42.100(Ft.)
Pipe length  =   380.00(Ft.) Slope =   0.0050  Manning's N = 0.013
No. of pipes = 1  Required pipe flow  =    13.395(CFS)
Nearest computed pipe diameter  =     24.00(In.)
Calculated individual pipe flow  =    13.395(CFS)
Normal flow depth in pipe =   16.80(In.)
Flow top width inside pipe =   21.99(In.)
Critical Depth =   15.81(In.)
Pipe flow velocity =      5.70(Ft/s)
Travel time through pipe =    1.11 min.
Time of concentration (TC) =    10.21 min.


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      111.000 to Point/Station      112.000
**** SUBAREA FLOW ADDITION ****
________________________________________________________________________
Rainfall intensity (I) =      2.826(In/Hr) for a    10.0 year storm
Decimal fraction soil group A = 1.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 0.000
Decimal fraction soil group D = 0.000
[COMMERCIAL area type                        ]
(General Commercial    )
```

```
Impervious value, Ai = 0.850
Sub-Area C Value = 0.800
Time of concentration =    10.21 min.
Rainfall intensity =      2.826(In/Hr) for a    10.0 year storm
Effective runoff coefficient used for total area
(Q=KCIA) is C = 0.800  CA =      8.704
Subarea runoff =     11.205(CFS) for      5.380(Ac.)
Total runoff =     24.600(CFS)   Total area =      10.880(Ac.)


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Process from Point/Station      112.000 to Point/Station      105.000
**** PIPEFLOW TRAVEL TIME (Program estimated size) ****
________________________________________________________________________
Upstream point/station elevation =    44.000(Ft.)
Downstream point/station elevation =    42.550(Ft.)
Pipe length  =   290.00(Ft.) Slope =   0.0050  Manning's N = 0.013
No. of pipes = 1  Required pipe flow  =    24.600(CFS)
Nearest computed pipe diameter  =     30.00(In.)
Calculated individual pipe flow  =    24.600(CFS)
Normal flow depth in pipe =   21.21(In.)
Flow top width inside pipe =   27.31(In.)
Critical Depth =   20.27(In.)
Pipe flow velocity =      6.63(Ft/s)
Travel time through pipe =    0.73 min.
Time of concentration (TC) =    10.94 min.


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      112.000 to Point/Station      105.000
**** CONFLUENCE OF MINOR STREAMS ****
________________________________________________________________________
Along Main Stream number: 1 in normal stream number 3
Stream flow area =     10.880(Ac.)
Runoff from this stream =     24.600(CFS)
Time of concentration =   10.94 min.
Rainfall intensity =     2.703(In/Hr)
Summary of stream data:

Stream   Flow rate      TC            Rainfall Intensity
 No.       (CFS)       (min)                (In/Hr)


1       48.117     20.74            1.789
2       37.136     10.97            2.698
3       24.600     10.94            2.703
Qmax(1) =
         1.000 *    1.000 *    48.117) +
         0.663 *    1.000 *    37.136) +
         0.662 *    1.000 *    24.600) + =      89.027
Qmax(2) =
         1.000 *    0.529 *    48.117) +
```

```
        1.000 *    1.000 *    37.136) +
        0.998 *    1.000 *    24.600) + =      87.141
Qmax(3) =
        1.000 *    0.527 *    48.117) +
        1.000 *    0.997 *    37.136) +
        1.000 *    1.000 *    24.600) + =      86.997

Total of 3 streams to confluence:
Flow rates before confluence point:
      48.117      37.136      24.600
Maximum flow rates at confluence using above data:
       89.027       87.141       86.997
Area of streams before confluence:
       36.130       16.900       10.880
Results of confluence:
Total flow rate =     89.027(CFS)
Time of concentration =    20.741 min.
Effective stream area after confluence =     63.910(Ac.)


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Process from Point/Station      105.000 to Point/Station      105.000
**** SUBAREA FLOW ADDITION ****
________________________________________________________________________
Rainfall intensity (I) =      1.789(In/Hr) for a    10.0 year storm
Decimal fraction soil group A = 1.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 0.000
Decimal fraction soil group D = 0.000
[COMMERCIAL area type                          ]
(General Commercial    )
Impervious value, Ai = 0.850
Sub-Area C Value = 0.800
Time of concentration =    20.74 min.
Rainfall intensity =      1.789(In/Hr) for a    10.0 year storm
Effective runoff coefficient used for total area
(Q=KCIA) is C = 0.748  CA =     50.877
Subarea runoff =      2.004(CFS) for      4.070(Ac.)
Total runoff =     91.031(CFS)   Total area =      67.980(Ac.)


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Process from Point/Station      105.000 to Point/Station      113.000
**** PIPEFLOW TRAVEL TIME (Program estimated size) ****
________________________________________________________________________
Upstream point/station elevation =    44.000(Ft.)
Downstream point/station elevation =    39.770(Ft.)
Pipe length  =   900.00(Ft.) Slope =   0.0047  Manning's N = 0.013
No. of pipes = 1  Required pipe flow  =    91.031(CFS)
Nearest computed pipe diameter  =     48.00(In.)
Calculated individual pipe flow  =    91.031(CFS)
Normal flow depth in pipe =   36.42(In.)
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Flow top width inside pipe =   41.07(In.)
Critical Depth =   34.69(In.)
Pipe flow velocity =      8.90(Ft/s)
Travel time through pipe =    1.69 min.
Time of concentration (TC) =    22.43 min.


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Process from Point/Station      105.000 to Point/Station      113.000
**** SUBAREA FLOW ADDITION ****
________________________________________________________________________
Rainfall intensity (I) =      1.701(In/Hr) for a    10.0 year storm
Decimal fraction soil group A = 1.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 0.000
Decimal fraction soil group D = 0.000
[COMMERCIAL area type                          ]
(General Commercial    )
Impervious value, Ai = 0.850
Sub-Area C Value = 0.800
Time of concentration =    22.43 min.
Rainfall intensity =      1.701(In/Hr) for a    10.0 year storm
Effective runoff coefficient used for total area
(Q=KCIA) is C = 0.753  CA =     56.629
Subarea runoff =      5.310(CFS) for      7.190(Ac.)
Total runoff =     96.341(CFS)   Total area =      75.170(Ac.)


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Process from Point/Station      113.000 to Point/Station      114.000
**** PIPEFLOW TRAVEL TIME (Program estimated size) ****
________________________________________________________________________
Upstream point/station elevation =    36.000(Ft.)
Downstream point/station elevation =    34.970(Ft.)
Pipe length  =   220.00(Ft.) Slope =   0.0047  Manning's N = 0.013
No. of pipes = 1  Required pipe flow  =    96.341(CFS)
Nearest computed pipe diameter  =     48.00(In.)
Calculated individual pipe flow  =    96.341(CFS)
Normal flow depth in pipe =   38.53(In.)
Flow top width inside pipe =   38.20(In.)
Critical Depth =   35.70(In.)
Pipe flow velocity =      8.92(Ft/s)
Travel time through pipe =    0.41 min.
Time of concentration (TC) =    22.84 min.


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Process from Point/Station      113.000 to Point/Station      114.000
**** CONFLUENCE OF MINOR STREAMS ****
________________________________________________________________________
Along Main Stream number: 1 in normal stream number 1
Stream flow area =     75.170(Ac.)
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Runoff from this stream =     96.341(CFS)
Time of concentration =   22.84 min.
Rainfall intensity =     1.681(In/Hr)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      115.000 to Point/Station      116.000
**** INITIAL AREA EVALUATION ****
________________________________________________________________________
Decimal fraction soil group A = 1.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 0.000
Decimal fraction soil group D = 0.000
[COMMERCIAL area type                          ]
(General Commercial    )
Impervious value, Ai = 0.850
Sub-Area C Value = 0.800
Initial subarea total flow distance  =  760.000(Ft.)
Highest elevation =   52.000(Ft.)
Lowest elevation =   43.700(Ft.)
Elevation difference =    8.300(Ft.) Slope =  1.092 %
INITIAL AREA TIME OF CONCENTRATION CALCULATIONS:
The maximum overland flow distance is 60.00 (Ft)
for the top area slope value of   1.09 %, in a development type of
 General Commercial
In Accordance With Figure 3-3
Initial Area Time of Concentration =   4.06 minutes
TC = [1.8*(1.1-C)*distance(Ft.)^.5)/(% slope^(1/3)]
TC = [1.8*(1.1-0.8000)*(  60.000^.5)/(   1.092^(1/3)]=   4.06
The initial area total distance of  760.00 (Ft.) entered leaves a
remaining distance of  700.00 (Ft.)
Using Figure 3-4, the travel time for this distance is   6.90 minutes
for a distance of 700.00 (Ft.) and a slope of  1.09 %
with an elevation difference of   7.64(Ft.) from the end of the top area
Tt = [11.9*length(Mi)^3)/(elevation change(Ft.))]^.385 *60(min/hr)
 =    6.896 Minutes
Tt=[(11.9*0.1326^3)/(  7.64)]^.385=  6.90
Total initial area Ti =   4.06 minutes from Figure 3-3 formula plus
  6.90 minutes from the Figure 3-4 formula =  10.96 minutes
Rainfall intensity (I) =      2.700(In/Hr) for a    10.0 year storm
Effective runoff coefficient used for area (Q=KCIA) is C = 0.800
Subarea runoff =      3.197(CFS)
Total initial stream area =        1.480(Ac.)


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Process from Point/Station      116.000 to Point/Station      117.000
**** STREET FLOW TRAVEL TIME + SUBAREA FLOW ADDITION ****
________________________________________________________________________
Top of street segment elevation =    43.700(Ft.)
End of street segment elevation =    38.000(Ft.)
Length of street segment  =   663.000(Ft.)
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Height of curb above gutter flowline  =    6.0(In.)
Width of half street (curb to crown)  =  18.000(Ft.)
Distance from crown to crossfall grade break  =   8.000(Ft.)
Slope from gutter to grade break (v/hz) =   0.020
Slope from grade break to crown (v/hz)  =   0.020
Street flow is on [1] side(s) of the street
Distance from curb to property line  =  10.000(Ft.)
Slope from curb to property line (v/hz) =   0.020
Gutter width =   1.500(Ft.)
Gutter hike from flowline =  1.500(In.)
 Manning's N in gutter =  0.0150
 Manning's N from gutter to grade break =  0.0180
 Manning's N from grade break to crown =  0.0180
Estimated mean flow rate at midpoint of street =      8.366(CFS)
Depth of flow =   0.457(Ft.), Average velocity =   2.495(Ft/s)
Note:  depth of flow exceeds top of street crown.
Streetflow hydraulics at midpoint of street travel:
Halfstreet flow width =  18.000(Ft.)
Flow velocity =   2.50(Ft/s)
Travel time =    4.43 min.     TC =   15.39  min.
 Adding area flow to street
Rainfall intensity (I) =      2.169(In/Hr) for a    10.0 year storm
Decimal fraction soil group A = 1.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 0.000
Decimal fraction soil group D = 0.000
[COMMERCIAL area type                          ]
(General Commercial    )
Impervious value, Ai = 0.850
Sub-Area C Value = 0.800
Rainfall intensity =      2.169(In/Hr) for a    10.0 year storm
Effective runoff coefficient used for total area
(Q=KCIA) is C = 0.800  CA =      6.208
Subarea runoff =     10.270(CFS) for      6.280(Ac.)
Total runoff =     13.467(CFS)   Total area =       7.760(Ac.)
Street flow at end of street =     13.467(CFS)
Half street flow at end of street =     13.467(CFS)
Depth of flow =   0.523(Ft.), Average velocity =   2.959(Ft/s)
Warning: depth of flow exceeds top of curb
Note:  depth of flow exceeds top of street crown.
Distance that curb overflow reaches into property =    1.16(Ft.)
Flow width (from curb towards crown)=  18.000(Ft.)


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Process from Point/Station      117.000 to Point/Station      118.000
**** PIPEFLOW TRAVEL TIME (Program estimated size) ****
________________________________________________________________________
Upstream point/station elevation =    38.000(Ft.)
Downstream point/station elevation =    37.000(Ft.)
Pipe length  =   200.00(Ft.) Slope =   0.0050  Manning's N = 0.013
No. of pipes = 1  Required pipe flow  =    13.467(CFS)
```

```
Nearest computed pipe diameter  =     24.00(In.)
Calculated individual pipe flow  =    13.467(CFS)
Normal flow depth in pipe =   16.88(In.)
Flow top width inside pipe =   21.93(In.)
Critical Depth =   15.84(In.)
Pipe flow velocity =      5.71(Ft/s)
Travel time through pipe =    0.58 min.
Time of concentration (TC) =    15.97 min.


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      117.000 to Point/Station      118.000
**** SUBAREA FLOW ADDITION ****
______________________________________________________________________________
Rainfall intensity (I) =      2.118(In/Hr) for a    10.0 year storm
Decimal fraction soil group A = 1.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 0.000
Decimal fraction soil group D = 0.000
[COMMERCIAL area type                         ]
(General Commercial    )
Impervious value, Ai = 0.850
Sub-Area C Value = 0.800
Time of concentration =    15.97 min.
Rainfall intensity =      2.118(In/Hr) for a    10.0 year storm
Effective runoff coefficient used for total area
(Q=KCIA) is C = 0.800  CA =     11.320
Subarea runoff =     10.506(CFS) for      6.390(Ac.)
Total runoff =     23.973(CFS)   Total area =      14.150(Ac.)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      118.000 to Point/Station      114.000
**** PIPEFLOW TRAVEL TIME (Program estimated size) ****
______________________________________________________________________________
Upstream point/station elevation =    38.000(Ft.)
Downstream point/station elevation =    35.950(Ft.)
Pipe length  =   410.00(Ft.) Slope =   0.0050  Manning's N = 0.013
No. of pipes = 1  Required pipe flow  =    23.973(CFS)
Nearest computed pipe diameter  =     30.00(In.)
Calculated individual pipe flow  =    23.973(CFS)
Normal flow depth in pipe =   20.79(In.)
Flow top width inside pipe =   27.68(In.)
Critical Depth =   19.99(In.)
Pipe flow velocity =      6.60(Ft/s)
Travel time through pipe =    1.04 min.
Time of concentration (TC) =    17.01 min.


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      118.000 to Point/Station      114.000
**** CONFLUENCE OF MINOR STREAMS ****
```

```
Along Main Stream number: 1 in normal stream number 2
Stream flow area =     14.150(Ac.)
Runoff from this stream =     23.973(CFS)
Time of concentration =   17.01 min.
Rainfall intensity =     2.034(In/Hr)
Summary of stream data:

Stream   Flow rate      TC            Rainfall Intensity
 No.       (CFS)       (min)                 (In/Hr)


1       96.341     22.84            1.681
2       23.973     17.01            2.034
Qmax(1) =
        1.000 *    1.000 *    96.341) +
        0.827 *    1.000 *    23.973) + =     116.161
Qmax(2) =
        1.000 *    0.745 *    96.341) +
        1.000 *    1.000 *    23.973) + =      95.708

Total of 2 streams to confluence:
Flow rates before confluence point:
      96.341      23.973
Maximum flow rates at confluence using above data:
      116.161       95.708
Area of streams before confluence:
       75.170       14.150
Results of confluence:
Total flow rate =    116.161(CFS)
Time of concentration =    22.839 min.
Effective stream area after confluence =     89.320(Ac.)


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Process from Point/Station      114.000 to Point/Station      119.000
**** PIPEFLOW TRAVEL TIME (Program estimated size) ****
------------------------------------------------------------------------
Upstream point/station elevation =    38.000(Ft.)
Downstream point/station elevation =    35.520(Ft.)
Pipe length  =   460.00(Ft.) Slope =   0.0054  Manning's N = 0.013
No. of pipes = 1  Required pipe flow  =   116.161(CFS)
Nearest computed pipe diameter  =     51.00(In.)
Calculated individual pipe flow  =   116.161(CFS)
Normal flow depth in pipe =   39.19(In.)
Flow top width inside pipe =   43.03(In.)
Critical Depth =   38.61(In.)
Pipe flow velocity =      9.93(Ft/s)
Travel time through pipe =    0.77 min.
Time of concentration (TC) =    23.61 min.
```

```
++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      114.000 to Point/Station      119.000
**** SUBAREA FLOW ADDITION ****
------------------------------------------------------------------------
Rainfall intensity (I) =      1.646(In/Hr) for a    10.0 year storm
Decimal fraction soil group A = 1.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 0.000
Decimal fraction soil group D = 0.000
[COMMERCIAL area type                         ]
(General Commercial    )
Impervious value, Ai = 0.850
Sub-Area C Value = 0.800
The area added to the existing stream causes a
a lower flow rate of Q =    114.515(CFS)
therefore the upstream flow rate of Q =    116.161(CFS) is being used
Time of concentration =    23.61 min.
Rainfall intensity =      1.646(In/Hr) for a    10.0 year storm
Effective runoff coefficient used for total area
(Q=KCIA) is C = 0.762  CA =     69.581
Subarea runoff =      0.000(CFS) for      2.040(Ac.)
Total runoff =    116.161(CFS)   Total area =      91.360(Ac.)


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Process from Point/Station      119.000 to Point/Station      120.000
**** PIPEFLOW TRAVEL TIME (Program estimated size) ****
------------------------------------------------------------------------
Upstream point/station elevation =    36.000(Ft.)
Downstream point/station elevation =    33.460(Ft.)
Pipe length  =   470.00(Ft.) Slope =   0.0054  Manning's N = 0.013
No. of pipes = 1  Required pipe flow  =   116.161(CFS)
Nearest computed pipe diameter  =     51.00(In.)
Calculated individual pipe flow  =   116.161(CFS)
Normal flow depth in pipe =   39.14(In.)
Flow top width inside pipe =   43.09(In.)
Critical Depth =   38.61(In.)
Pipe flow velocity =      9.94(Ft/s)
Travel time through pipe =    0.79 min.
Time of concentration (TC) =    24.40 min.


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      119.000 to Point/Station      120.000
**** SUBAREA FLOW ADDITION ****
------------------------------------------------------------------------
Rainfall intensity (I) =      1.611(In/Hr) for a    10.0 year storm
Decimal fraction soil group A = 1.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 0.000
Decimal fraction soil group D = 0.000
[COMMERCIAL area type                         ]
```

```
(General Commercial    )
Impervious value, Ai = 0.850
Sub-Area C Value = 0.800
The area added to the existing stream causes a
a lower flow rate of Q =    113.134(CFS)
therefore the upstream flow rate of Q =    116.161(CFS) is being used
Time of concentration =    24.40 min.
Rainfall intensity =      1.611(In/Hr) for a    10.0 year storm
Effective runoff coefficient used for total area
(Q=KCIA) is C = 0.762  CA =     70.213
Subarea runoff =      0.000(CFS) for      0.790(Ac.)
Total runoff =    116.161(CFS)   Total area =      92.150(Ac.)


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Process from Point/Station      120.000 to Point/Station      121.000
**** PIPEFLOW TRAVEL TIME (Program estimated size) ****
________________________________________________________________________
Upstream point/station elevation =    38.000(Ft.)
Downstream point/station elevation =    23.440(Ft.)
Pipe length  =   350.00(Ft.) Slope =   0.0416  Manning's N = 0.013
No. of pipes = 1  Required pipe flow  =   116.161(CFS)
Nearest computed pipe diameter  =     36.00(In.)
Calculated individual pipe flow  =   116.161(CFS)
Normal flow depth in pipe =   25.59(In.)
Flow top width inside pipe =   32.64(In.)
Critical depth could not be calculated.
Pipe flow velocity =     21.62(Ft/s)
Travel time through pipe =    0.27 min.
Time of concentration (TC) =    24.67 min.


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      120.000 to Point/Station      121.000
**** CONFLUENCE OF MAIN STREAMS ****
________________________________________________________________________
The following data inside Main Stream is listed:
In Main Stream number: 1
Stream flow area =     92.150(Ac.)
Runoff from this stream =    116.161(CFS)
Time of concentration =   24.67 min.
Rainfall intensity =     1.600(In/Hr)
Program is now starting with Main Stream No. 2


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      130.000 to Point/Station      131.000
**** INITIAL AREA EVALUATION ****
________________________________________________________________________
Decimal fraction soil group A = 1.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 0.000
```

```
Decimal fraction soil group D = 0.000
[LOW DENSITY RESIDENTIAL                     ]
(1.0 DU/A or Less       )
Impervious value, Ai = 0.100
Sub-Area C Value = 0.270
Initial subarea total flow distance  =  290.000(Ft.)
Highest elevation =  183.000(Ft.)
Lowest elevation =  161.000(Ft.)
Elevation difference =   22.000(Ft.) Slope =  7.586 %
INITIAL AREA TIME OF CONCENTRATION CALCULATIONS:
The maximum overland flow distance is 100.00 (Ft)
for the top area slope value of   7.59 %, in a development type of
 1.0 DU/A or Less
In Accordance With Figure 3-3
Initial Area Time of Concentration =   7.60 minutes
TC = [1.8*(1.1-C)*distance(Ft.)^.5)/(% slope^(1/3)]
TC = [1.8*(1.1-0.2700)*( 100.000^.5)/(   7.586^(1/3)]=   7.60
The initial area total distance of  290.00 (Ft.) entered leaves a
remaining distance of  190.00 (Ft.)
Using Figure 3-4, the travel time for this distance is   1.20 minutes
for a distance of 190.00 (Ft.) and a slope of  7.59 %
with an elevation difference of  14.41(Ft.) from the end of the top area
Tt = [11.9*length(Mi)^3)/(elevation change(Ft.))]^.385 *60(min/hr)
 =    1.198 Minutes
Tt=[(11.9*0.0360^3)/( 14.41)]^.385=  1.20
Total initial area Ti =   7.60 minutes from Figure 3-3 formula plus
  1.20 minutes from the Figure 3-4 formula =   8.80 minutes
Rainfall intensity (I) =      3.110(In/Hr) for a    10.0 year storm
Effective runoff coefficient used for area (Q=KCIA) is C = 0.270
Subarea runoff =      0.983(CFS)
Total initial stream area =        1.170(Ac.)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      131.000 to Point/Station      132.000
**** STREET FLOW TRAVEL TIME + SUBAREA FLOW ADDITION ****
________________________________________________________________________
Top of street segment elevation =   161.000(Ft.)
End of street segment elevation =    86.000(Ft.)
Length of street segment  =  2618.000(Ft.)
Height of curb above gutter flowline  =    6.0(In.)
Width of half street (curb to crown)  =  18.000(Ft.)
Distance from crown to crossfall grade break  =   8.000(Ft.)
Slope from gutter to grade break (v/hz) =   0.020
Slope from grade break to crown (v/hz)  =   0.020
Street flow is on [1] side(s) of the street
Distance from curb to property line  =  10.000(Ft.)
Slope from curb to property line (v/hz) =   0.020
Gutter width =   1.500(Ft.)
Gutter hike from flowline =  1.500(In.)
 Manning's N in gutter =  0.0150
 Manning's N from gutter to grade break =  0.0180
```

```
 Manning's N from grade break to crown =  0.0180
Estimated mean flow rate at midpoint of street =      6.350(CFS)
Depth of flow =   0.352(Ft.), Average velocity =   3.676(Ft/s)
Streetflow hydraulics at midpoint of street travel:
Halfstreet flow width =  12.869(Ft.)
Flow velocity =   3.68(Ft/s)
Travel time =   11.87 min.     TC =   20.67  min.
 Adding area flow to street
Rainfall intensity (I) =      1.793(In/Hr) for a    10.0 year storm
Decimal fraction soil group A = 0.550
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 0.000
Decimal fraction soil group D = 0.450
[LOW DENSITY RESIDENTIAL                     ]
(2.9 DU/A or Less       )
Impervious value, Ai = 0.250
Sub-Area C Value = 0.429
Rainfall intensity =      1.793(In/Hr) for a    10.0 year storm
Effective runoff coefficient used for total area
(Q=KCIA) is C = 0.418  CA =      6.501
Subarea runoff =     10.674(CFS) for     14.400(Ac.)
Total runoff =     11.657(CFS)   Total area =      15.570(Ac.)
Street flow at end of street =     11.657(CFS)
Half street flow at end of street =     11.657(CFS)
Depth of flow =   0.422(Ft.), Average velocity =   4.253(Ft/s)
Flow width (from curb towards crown)=  16.340(Ft.)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      132.000 to Point/Station      133.000
**** PIPEFLOW TRAVEL TIME (Program estimated size) ****
____________________________________________________________________________
Upstream point/station elevation =    86.000(Ft.)
Downstream point/station elevation =    80.000(Ft.)
Pipe length  =   370.00(Ft.) Slope =   0.0162  Manning's N = 0.013
No. of pipes = 1  Required pipe flow  =    11.657(CFS)
Nearest computed pipe diameter  =     18.00(In.)
Calculated individual pipe flow  =    11.657(CFS)
Normal flow depth in pipe =   13.01(In.)
Flow top width inside pipe =   16.12(In.)
Critical Depth =   15.60(In.)
Pipe flow velocity =      8.53(Ft/s)
Travel time through pipe =    0.72 min.
Time of concentration (TC) =    21.39 min.


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      134.000 to Point/Station      133.000
**** SUBAREA FLOW ADDITION ****
____________________________________________________________________________
Rainfall intensity (I) =      1.754(In/Hr) for a    10.0 year storm
Decimal fraction soil group A = 0.150
```

```
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 0.000
Decimal fraction soil group D = 0.850
[COMMERCIAL area type                        ]
(Neighborhod Commercial )
Impervious value, Ai = 0.800
Sub-Area C Value = 0.785
Time of concentration =    21.39 min.
Rainfall intensity =      1.754(In/Hr) for a    10.0 year storm
Effective runoff coefficient used for total area
(Q=KCIA) is C = 0.498  CA =      9.918
Subarea runoff =      5.737(CFS) for      4.350(Ac.)
Total runoff =     17.394(CFS)   Total area =      19.920(Ac.)


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Process from Point/Station      133.000 to Point/Station      135.000
**** PIPEFLOW TRAVEL TIME (Program estimated size) ****
________________________________________________________________________
Upstream point/station elevation =    80.000(Ft.)
Downstream point/station elevation =    65.210(Ft.)
Pipe length  =   850.00(Ft.) Slope =   0.0174  Manning's N = 0.013
No. of pipes = 1  Required pipe flow  =    17.394(CFS)
Nearest computed pipe diameter  =     21.00(In.)
Calculated individual pipe flow  =    17.394(CFS)
Normal flow depth in pipe =   14.63(In.)
Flow top width inside pipe =   19.31(In.)
Critical Depth =   18.29(In.)
Pipe flow velocity =      9.72(Ft/s)
Travel time through pipe =    1.46 min.
Time of concentration (TC) =    22.85 min.


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      133.000 to Point/Station      135.000
**** SUBAREA FLOW ADDITION ****
________________________________________________________________________
Rainfall intensity (I) =      1.681(In/Hr) for a    10.0 year storm
Decimal fraction soil group A = 1.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 0.000
Decimal fraction soil group D = 0.000
[MEDIUM DENSITY RESIDENTIAL                  ]
(14.5 DU/A or Less      )
Impervious value, Ai = 0.500
Sub-Area C Value = 0.550
Time of concentration =    22.85 min.
Rainfall intensity =      1.681(In/Hr) for a    10.0 year storm
Effective runoff coefficient used for total area
(Q=KCIA) is C = 0.521  CA =     18.773
Subarea runoff =     14.160(CFS) for     16.100(Ac.)
Total runoff =     31.553(CFS)   Total area =      36.020(Ac.)
```

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++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      135.000 to Point/Station      136.000
**** PIPEFLOW TRAVEL TIME (Program estimated size) ****
----------------------------------------------------------------------
Upstream point/station elevation =    61.000(Ft.)
Downstream point/station elevation =    58.640(Ft.)
Pipe length  =   550.00(Ft.) Slope =   0.0043  Manning's N = 0.013
No. of pipes = 1  Required pipe flow  =    31.553(CFS)
Nearest computed pipe diameter  =     33.00(In.)
Calculated individual pipe flow  =    31.553(CFS)
Normal flow depth in pipe =   24.73(In.)
Flow top width inside pipe =   28.61(In.)
Critical Depth =   22.40(In.)
Pipe flow velocity =      6.61(Ft/s)
Travel time through pipe =    1.39 min.
Time of concentration (TC) =    24.24 min.


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      135.000 to Point/Station      136.000
**** SUBAREA FLOW ADDITION ****
----------------------------------------------------------------------
Rainfall intensity (I) =      1.618(In/Hr) for a    10.0 year storm
Decimal fraction soil group A = 1.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 0.000
Decimal fraction soil group D = 0.000
[MEDIUM DENSITY RESIDENTIAL                 ]
(7.3 DU/A or Less       )
Impervious value, Ai = 0.400
Sub-Area C Value = 0.480
Time of concentration =    24.24 min.
Rainfall intensity =      1.618(In/Hr) for a    10.0 year storm
Effective runoff coefficient used for total area
(Q=KCIA) is C = 0.501  CA =     35.136
Subarea runoff =     25.301(CFS) for     34.090(Ac.)
Total runoff =     56.855(CFS)   Total area =      70.110(Ac.)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      136.000 to Point/Station      137.000
**** PIPEFLOW TRAVEL TIME (Program estimated size) ****
----------------------------------------------------------------------
Upstream point/station elevation =    58.000(Ft.)
Downstream point/station elevation =    41.370(Ft.)
Pipe length  =   660.00(Ft.) Slope =   0.0252  Manning's N = 0.013
No. of pipes = 1  Required pipe flow  =    56.855(CFS)
Nearest computed pipe diameter  =     30.00(In.)
Calculated individual pipe flow  =    56.855(CFS)
Normal flow depth in pipe =   21.70(In.)
```

```
Flow top width inside pipe =   26.84(In.)
Critical Depth =   28.43(In.)
Pipe flow velocity =     14.95(Ft/s)
Travel time through pipe =    0.74 min.
Time of concentration (TC) =    24.97 min.


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      136.000 to Point/Station      137.000
**** SUBAREA FLOW ADDITION ****
________________________________________________________________________
Rainfall intensity (I) =      1.587(In/Hr) for a    10.0 year storm
Decimal fraction soil group A = 1.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 0.000
Decimal fraction soil group D = 0.000
[MEDIUM DENSITY RESIDENTIAL                  ]
(14.5 DU/A or Less      )
Impervious value, Ai = 0.500
Sub-Area C Value = 0.550
Time of concentration =    24.97 min.
Rainfall intensity =      1.587(In/Hr) for a    10.0 year storm
Effective runoff coefficient used for total area
(Q=KCIA) is C = 0.519  CA =     57.603
Subarea runoff =     34.575(CFS) for     40.850(Ac.)
Total runoff =     91.430(CFS)   Total area =     110.960(Ac.)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      137.000 to Point/Station      138.000
**** PIPEFLOW TRAVEL TIME (Program estimated size) ****
________________________________________________________________________
Upstream point/station elevation =    42.000(Ft.)
Downstream point/station elevation =    38.960(Ft.)
Pipe length  =   400.00(Ft.) Slope =   0.0076  Manning's N = 0.013
No. of pipes = 1  Required pipe flow  =    91.430(CFS)
Nearest computed pipe diameter  =     45.00(In.)
Calculated individual pipe flow  =    91.430(CFS)
Normal flow depth in pipe =   32.39(In.)
Flow top width inside pipe =   40.42(In.)
Critical Depth =   35.26(In.)
Pipe flow velocity =     10.75(Ft/s)
Travel time through pipe =    0.62 min.
Time of concentration (TC) =    25.59 min.


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      137.000 to Point/Station      138.000
**** CONFLUENCE OF MINOR STREAMS ****
________________________________________________________________________
Along Main Stream number: 2 in normal stream number 1
Stream flow area =    110.960(Ac.)
```

```
Runoff from this stream =     91.430(CFS)
Time of concentration =   25.59 min.
Rainfall intensity =     1.562(In/Hr)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      139.000 to Point/Station      140.000
**** INITIAL AREA EVALUATION ****
________________________________________________________________________
Decimal fraction soil group A = 1.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 0.000
Decimal fraction soil group D = 0.000
[COMMERCIAL area type                          ]
(General Commercial    )
Impervious value, Ai = 0.850
Sub-Area C Value = 0.800
Initial subarea total flow distance  =  350.000(Ft.)
Highest elevation =   51.000(Ft.)
Lowest elevation =   49.000(Ft.)
Elevation difference =    2.000(Ft.) Slope =  0.571 %
INITIAL AREA TIME OF CONCENTRATION CALCULATIONS:
The maximum overland flow distance is 50.00 (Ft)
for the top area slope value of   0.57 %, in a development type of
 General Commercial
In Accordance With Figure 3-3
Initial Area Time of Concentration =   4.60 minutes
TC = [1.8*(1.1-C)*distance(Ft.)^.5)/(% slope^(1/3)]
TC = [1.8*(1.1-0.8000)*(  50.000^.5)/(   0.571^(1/3)]=   4.60
The initial area total distance of  350.00 (Ft.) entered leaves a
remaining distance of  300.00 (Ft.)
Using Figure 3-4, the travel time for this distance is   4.61 minutes
for a distance of 300.00 (Ft.) and a slope of  0.57 %
with an elevation difference of   1.71(Ft.) from the end of the top area
Tt = [11.9*length(Mi)^3)/(elevation change(Ft.))]^.385 *60(min/hr)
 =    4.610 Minutes
Tt=[(11.9*0.0568^3)/(  1.71)]^.385=  4.61
Total initial area Ti =   4.60 minutes from Figure 3-3 formula plus
  4.61 minutes from the Figure 3-4 formula =   9.21 minutes
Rainfall intensity (I) =      3.020(In/Hr) for a    10.0 year storm
Effective runoff coefficient used for area (Q=KCIA) is C = 0.800
Subarea runoff =      2.996(CFS)
Total initial stream area =        1.240(Ac.)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      140.000 to Point/Station      141.000
**** STREET FLOW TRAVEL TIME + SUBAREA FLOW ADDITION ****
________________________________________________________________________
Top of street segment elevation =    49.000(Ft.)
End of street segment elevation =    41.000(Ft.)
Length of street segment  =   941.000(Ft.)
```

```
Height of curb above gutter flowline  =    6.0(In.)
Width of half street (curb to crown)  =  18.000(Ft.)
Distance from crown to crossfall grade break  =   8.000(Ft.)
Slope from gutter to grade break (v/hz) =   0.020
Slope from grade break to crown (v/hz)  =   0.020
Street flow is on [1] side(s) of the street
Distance from curb to property line  =  10.000(Ft.)
Slope from curb to property line (v/hz) =   0.020
Gutter width =   1.500(Ft.)
Gutter hike from flowline =  1.500(In.)
 Manning's N in gutter =  0.0150
 Manning's N from gutter to grade break =  0.0180
 Manning's N from grade break to crown =  0.0180
Estimated mean flow rate at midpoint of street =     10.559(CFS)
Depth of flow =   0.486(Ft.), Average velocity =   2.728(Ft/s)
Note:  depth of flow exceeds top of street crown.
Streetflow hydraulics at midpoint of street travel:
Halfstreet flow width =  18.000(Ft.)
Flow velocity =   2.73(Ft/s)
Travel time =    5.75 min.     TC =   14.96  min.
 Adding area flow to street
Rainfall intensity (I) =      2.209(In/Hr) for a    10.0 year storm
Decimal fraction soil group A = 1.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 0.000
Decimal fraction soil group D = 0.000
[COMMERCIAL area type                         ]
(General Commercial    )
Impervious value, Ai = 0.850
Sub-Area C Value = 0.800
Rainfall intensity =      2.209(In/Hr) for a    10.0 year storm
Effective runoff coefficient used for total area
(Q=KCIA) is C = 0.800  CA =      8.168
Subarea runoff =     15.047(CFS) for      8.970(Ac.)
Total runoff =     18.042(CFS)   Total area =      10.210(Ac.)
Street flow at end of street =     18.042(CFS)
Half street flow at end of street =     18.042(CFS)
Depth of flow =   0.578(Ft.), Average velocity =   3.178(Ft/s)
Warning: depth of flow exceeds top of curb
Note:  depth of flow exceeds top of street crown.
Distance that curb overflow reaches into property =    3.90(Ft.)
Flow width (from curb towards crown)=  18.000(Ft.)


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Process from Point/Station      141.000 to Point/Station      138.000
**** PIPEFLOW TRAVEL TIME (Program estimated size) ****
----------------------------------------------------------------------
Upstream point/station elevation =    41.000(Ft.)
Downstream point/station elevation =    39.670(Ft.)
Pipe length  =   555.00(Ft.) Slope =   0.0024  Manning's N = 0.013
No. of pipes = 1  Required pipe flow  =    18.042(CFS)
```

```
Nearest computed pipe diameter  =     30.00(In.)
Calculated individual pipe flow  =    18.042(CFS)
Normal flow depth in pipe =   22.22(In.)
Flow top width inside pipe =   26.30(In.)
Critical Depth =   17.27(In.)
Pipe flow velocity =      4.63(Ft/s)
Travel time through pipe =    2.00 min.
Time of concentration (TC) =    16.96 min.


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      141.000 to Point/Station      138.000
**** CONFLUENCE OF MINOR STREAMS ****
________________________________________________________________________
Along Main Stream number: 2 in normal stream number 2
Stream flow area =     10.210(Ac.)
Runoff from this stream =     18.042(CFS)
Time of concentration =   16.96 min.
Rainfall intensity =     2.037(In/Hr)
Summary of stream data:

Stream   Flow rate      TC            Rainfall Intensity
 No.       (CFS)       (min)                 (In/Hr)


1       91.430     25.59            1.562
2       18.042     16.96            2.037
Qmax(1) =
        1.000 *    1.000 *    91.430) +
        0.767 *    1.000 *    18.042) + =     105.266
Qmax(2) =
        1.000 *    0.663 *    91.430) +
        1.000 *    1.000 *    18.042) + =      78.625

Total of 2 streams to confluence:
Flow rates before confluence point:
      91.430      18.042
Maximum flow rates at confluence using above data:
      105.266       78.625
Area of streams before confluence:
      110.960       10.210
Results of confluence:
Total flow rate =    105.266(CFS)
Time of concentration =    25.594 min.
Effective stream area after confluence =    121.170(Ac.)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      138.000 to Point/Station      121.000
**** PIPEFLOW TRAVEL TIME (Program estimated size) ****
________________________________________________________________________
Upstream point/station elevation =    48.000(Ft.)
```

```
Downstream point/station elevation =    26.170(Ft.)
Pipe length  =   740.00(Ft.) Slope =   0.0295  Manning's N = 0.013
No. of pipes = 1  Required pipe flow  =   105.266(CFS)
Nearest computed pipe diameter  =     36.00(In.)
Calculated individual pipe flow  =   105.266(CFS)
Normal flow depth in pipe =   27.19(In.)
Flow top width inside pipe =   30.96(In.)
Critical depth could not be calculated.
Pipe flow velocity =     18.39(Ft/s)
Travel time through pipe =    0.67 min.
Time of concentration (TC) =    26.27 min.


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      138.000 to Point/Station      121.000
**** CONFLUENCE OF MAIN STREAMS ****
________________________________________________________________________
The following data inside Main Stream is listed:
In Main Stream number: 2
Stream flow area =    121.170(Ac.)
Runoff from this stream =    105.266(CFS)
Time of concentration =   26.27 min.
Rainfall intensity =     1.536(In/Hr)
Summary of stream data:

Stream   Flow rate      TC            Rainfall Intensity
 No.       (CFS)       (min)                 (In/Hr)


1      116.161     24.67            1.600
2      105.266     26.27            1.536
Qmax(1) =
         1.000 *    1.000 *   116.161) +
         1.000 *    0.939 *   105.266) + =     215.025
Qmax(2) =
         0.960 *    1.000 *   116.161) +
         1.000 *    1.000 *   105.266) + =     216.820

Total of 2 main streams to confluence:
Flow rates before confluence point:
     116.161     105.266
Maximum flow rates at confluence using above data:
      215.025      216.820
Area of streams before confluence:
       92.150      121.170


Results of confluence:
Total flow rate =    216.820(CFS)
Time of concentration =    26.265 min.
Effective stream area after confluence  =    213.320(Ac.)
```

```
++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      121.000 to Point/Station      121.000
**** SUBAREA FLOW ADDITION ****
________________________________________________________________________
Rainfall intensity (I) =      1.536(In/Hr) for a    10.0 year storm
Decimal fraction soil group A = 1.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 0.000
Decimal fraction soil group D = 0.000
[HIGH DENSITY RESIDENTIAL                    ]
(43.0 DU/A or Less      )
Impervious value, Ai = 0.800
Sub-Area C Value = 0.760
The area added to the existing stream causes a
a lower flow rate of Q =    212.041(CFS)
therefore the upstream flow rate of Q =    216.820(CFS) is being used
Time of concentration =    26.27 min.
Rainfall intensity =      1.536(In/Hr) for a    10.0 year storm
Effective runoff coefficient used for total area
(Q=KCIA) is C = 0.639  CA =    138.006
Subarea runoff =      0.000(CFS) for      2.660(Ac.)
Total runoff =    216.820(CFS)   Total area =     215.980(Ac.)
End of computations, total study area =         215.980 (Ac.)
```

San Diego County Rational Hydrology Program

CIVILCADD/CIVILDESIGN Engineering Software,(c)1991-2009 Version 7.8

Rational method hydrology program based on
San Diego County Flood Control Division 2003 hydrology manual
Rational Hydrology Study Date: 12/08/12

City of Carlsbad
Hydromodification Exemption Study
Major Basin 200
10-Year Flow Rate

********* Hydrology Study Control Information **********

Program License Serial Number 4028

Rational hydrology study storm event year is 10.0
English (in-lb) input data Units used

Map data precipitation entered:
6 hour, precipitation(inches) = 1.700
24 hour precipitation(inches) = 3.100
P6/P24 = 54.8%
San Diego hydrology manual 'C' values used

++
Process from Point/Station 200.000 to Point/Station 201.000
**** INITIAL AREA EVALUATION ****

Decimal fraction soil group A = 1.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 0.000
Decimal fraction soil group D = 0.000
[COMMERCIAL area type]
(Office Professional)
Impervious value, Ai = 0.900
Sub-Area C Value = 0.830
Initial subarea total flow distance = 740.000(Ft.)
Highest elevation = 95.000(Ft.)
Lowest elevation = 88.000(Ft.)
Elevation difference = 7.000(Ft.) Slope = 0.946 %
INITIAL AREA TIME OF CONCENTRATION CALCULATIONS:
The maximum overland flow distance is 60.00 (Ft)
for the top area slope value of 0.95 %, in a development type of
Office Professional
In Accordance With Figure 3-3

```
Initial Area Time of Concentration =   3.83 minutes
TC = [1.8*(1.1-C)*distance(Ft.)^.5)/(% slope^(1/3)]
TC = [1.8*(1.1-0.8300)*(  60.000^.5)/(   0.946^(1/3)]=   3.83
The initial area total distance of  740.00 (Ft.) entered leaves a
remaining distance of  680.00 (Ft.)
Using Figure 3-4, the travel time for this distance is   7.13 minutes
for a distance of 680.00 (Ft.) and a slope of  0.95 %
with an elevation difference of   6.43(Ft.) from the end of the top area
Tt = [11.9*length(Mi)^3)/(elevation change(Ft.))]^.385 *60(min/hr)
 =    7.127 Minutes
Tt=[(11.9*0.1288^3)/(  6.43)]^.385=  7.13
Total initial area Ti =   3.83 minutes from Figure 3-3 formula plus
  7.13 minutes from the Figure 3-4 formula =  10.96 minutes
Rainfall intensity (I) =      2.700(In/Hr) for a    10.0 year storm
Effective runoff coefficient used for area (Q=KCIA) is C = 0.830
Subarea runoff =      7.529(CFS)
Total initial stream area =        3.360(Ac.)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      201.000 to Point/Station      202.000
**** IMPROVED CHANNEL TRAVEL TIME ****
________________________________________________________________________
Upstream point elevation =    88.000(Ft.)
Downstream point elevation =    84.100(Ft.)
Channel length thru subarea  =   692.000(Ft.)
Channel base width    =    3.000(Ft.)
Slope or 'Z' of left channel bank =   4.000
Slope or 'Z' of right channel bank =   4.000
Estimated mean flow rate at midpoint of channel =      9.490(CFS)
Manning's 'N'    = 0.040
Maximum depth of channel  =    3.000(Ft.)
Flow(q) thru subarea =      9.490(CFS)
Depth of flow =   0.825(Ft.), Average velocity =   1.827(Ft/s)
Channel flow top width =    9.598(Ft.)
Flow Velocity =    1.83(Ft/s)
Travel time  =    6.31 min.
Time of concentration =   17.28 min.
Critical depth =      0.531(Ft.)
 Adding area flow to channel
Rainfall intensity (I) =      2.013(In/Hr) for a    10.0 year storm
Decimal fraction soil group A = 1.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 0.000
Decimal fraction soil group D = 0.000
[COMMERCIAL area type                         ]
(Office Professional    )
Impervious value, Ai = 0.900
Sub-Area C Value = 0.830
Rainfall intensity =      2.013(In/Hr) for a    10.0 year storm
Effective runoff coefficient used for total area
(Q=KCIA) is C = 0.830  CA =      5.652
```

```
Subarea runoff =      3.850(CFS) for      3.450(Ac.)
Total runoff =     11.379(CFS)   Total area =       6.810(Ac.)
Depth of flow =   0.900(Ft.), Average velocity =   1.917(Ft/s)
Critical depth =      0.586(Ft.)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      201.000 to Point/Station      202.000
**** CONFLUENCE OF MINOR STREAMS ****
________________________________________________________________________
Along Main Stream number: 1 in normal stream number 1
Stream flow area =      6.810(Ac.)
Runoff from this stream =     11.379(CFS)
Time of concentration =   17.28 min.
Rainfall intensity =     2.013(In/Hr)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      203.000 to Point/Station      204.000
**** INITIAL AREA EVALUATION ****
________________________________________________________________________
Decimal fraction soil group A = 0.500
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 0.000
Decimal fraction soil group D = 0.500
[MEDIUM DENSITY RESIDENTIAL                  ]
(4.3 DU/A or Less       )
Impervious value, Ai = 0.300
Sub-Area C Value = 0.465
Initial subarea total flow distance  =  950.000(Ft.)
Highest elevation =  167.000(Ft.)
Lowest elevation =  130.000(Ft.)
Elevation difference =   37.000(Ft.) Slope =  3.895 %
INITIAL AREA TIME OF CONCENTRATION CALCULATIONS:
The maximum overland flow distance is 95.00 (Ft)
for the top area slope value of   3.90 %, in a development type of
 4.3 DU/A or Less
In Accordance With Figure 3-3
Initial Area Time of Concentration =   7.08 minutes
TC = [1.8*(1.1-C)*distance(Ft.)^.5)/(% slope^(1/3)]
TC = [1.8*(1.1-0.4650)*(  95.000^.5)/(   3.895^(1/3)]=   7.08
The initial area total distance of  950.00 (Ft.) entered leaves a
remaining distance of  855.00 (Ft.)
Using Figure 3-4, the travel time for this distance is   4.93 minutes
for a distance of 855.00 (Ft.) and a slope of  3.90 %
with an elevation difference of  33.30(Ft.) from the end of the top area
Tt = [11.9*length(Mi)^3)/(elevation change(Ft.))]^.385 *60(min/hr)
 =    4.930 Minutes
Tt=[(11.9*0.1619^3)/( 33.30)]^.385=  4.93
Total initial area Ti =   7.08 minutes from Figure 3-3 formula plus
  4.93 minutes from the Figure 3-4 formula =  12.01 minutes
Rainfall intensity (I) =      2.545(In/Hr) for a    10.0 year storm
```

```
Effective runoff coefficient used for area (Q=KCIA) is C = 0.465
Subarea runoff =      1.988(CFS)
Total initial stream area =        1.680(Ac.)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      204.000 to Point/Station      205.000
**** STREET FLOW TRAVEL TIME + SUBAREA FLOW ADDITION ****
________________________________________________________________________
Top of street segment elevation =   130.000(Ft.)
End of street segment elevation =    86.000(Ft.)
Length of street segment  =   875.000(Ft.)
Height of curb above gutter flowline  =    6.0(In.)
Width of half street (curb to crown)  =  18.000(Ft.)
Distance from crown to crossfall grade break  =   8.000(Ft.)
Slope from gutter to grade break (v/hz) =   0.020
Slope from grade break to crown (v/hz)  =   0.020
Street flow is on [1] side(s) of the street
Distance from curb to property line  =  10.000(Ft.)
Slope from curb to property line (v/hz) =   0.020
Gutter width =   1.500(Ft.)
Gutter hike from flowline =  1.500(In.)
 Manning's N in gutter =  0.0150
 Manning's N from gutter to grade break =  0.0180
 Manning's N from grade break to crown =  0.0180
Estimated mean flow rate at midpoint of street =      4.708(CFS)
Depth of flow =   0.299(Ft.), Average velocity =   4.250(Ft/s)
Streetflow hydraulics at midpoint of street travel:
Halfstreet flow width =  10.180(Ft.)
Flow velocity =   4.25(Ft/s)
Travel time =    3.43 min.     TC =   15.44  min.
 Adding area flow to street
Rainfall intensity (I) =      2.164(In/Hr) for a    10.0 year storm
Decimal fraction soil group A = 0.100
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 0.000
Decimal fraction soil group D = 0.900
[MEDIUM DENSITY RESIDENTIAL                  ]
(7.3 DU/A or Less       )
Impervious value, Ai = 0.400
Sub-Area C Value = 0.561
Rainfall intensity =      2.164(In/Hr) for a    10.0 year storm
Effective runoff coefficient used for total area
(Q=KCIA) is C = 0.536  CA =      3.395
Subarea runoff =      5.360(CFS) for      4.660(Ac.)
Total runoff =      7.349(CFS)   Total area =       6.340(Ac.)
Street flow at end of street =      7.349(CFS)
Half street flow at end of street =      7.349(CFS)
Depth of flow =   0.339(Ft.), Average velocity =   4.717(Ft/s)
Flow width (from curb towards crown)=  12.193(Ft.)
```

```
++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      205.000 to Point/Station      205.000
**** SUBAREA FLOW ADDITION ****
------------------------------------------------------------------------
Rainfall intensity (I) =      2.164(In/Hr) for a    10.0 year storm
Decimal fraction soil group A = 0.150
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 0.000
Decimal fraction soil group D = 0.850
[MEDIUM DENSITY RESIDENTIAL                 ]
(7.3 DU/A or Less       )
Impervious value, Ai = 0.400
Sub-Area C Value = 0.556
Time of concentration =    15.44 min.
Rainfall intensity =      2.164(In/Hr) for a    10.0 year storm
Effective runoff coefficient used for total area
(Q=KCIA) is C = 0.549  CA =      9.395
Subarea runoff =     12.983(CFS) for     10.780(Ac.)
Total runoff =     20.332(CFS)   Total area =      17.120(Ac.)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      205.000 to Point/Station      205.000
**** SUBAREA FLOW ADDITION ****
------------------------------------------------------------------------
Rainfall intensity (I) =      2.164(In/Hr) for a    10.0 year storm
Decimal fraction soil group A = 1.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 0.000
Decimal fraction soil group D = 0.000
[COMMERCIAL area type                       ]
(Office Professional    )
Impervious value, Ai = 0.900
Sub-Area C Value = 0.830
Time of concentration =    15.44 min.
Rainfall intensity =      2.164(In/Hr) for a    10.0 year storm
Effective runoff coefficient used for total area
(Q=KCIA) is C = 0.558  CA =      9.859
Subarea runoff =      1.006(CFS) for      0.560(Ac.)
Total runoff =     21.338(CFS)   Total area =      17.680(Ac.)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      205.000 to Point/Station      202.000
**** PIPEFLOW TRAVEL TIME (Program estimated size) ****
------------------------------------------------------------------------
Upstream point/station elevation =    86.000(Ft.)
Downstream point/station elevation =    84.100(Ft.)
Pipe length  =   170.00(Ft.) Slope =   0.0112  Manning's N = 0.013
No. of pipes = 1  Required pipe flow  =    21.338(CFS)
Nearest computed pipe diameter  =     24.00(In.)
Calculated individual pipe flow  =    21.338(CFS)
```

```
Normal flow depth in pipe =   17.67(In.)
Flow top width inside pipe =   21.15(In.)
Critical Depth =   19.84(In.)
Pipe flow velocity =      8.61(Ft/s)
Travel time through pipe =    0.33 min.
Time of concentration (TC) =    15.77 min.


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      205.000 to Point/Station      202.000
**** CONFLUENCE OF MINOR STREAMS ****
________________________________________________________________________
Along Main Stream number: 1 in normal stream number 2
Stream flow area =     17.680(Ac.)
Runoff from this stream =     21.338(CFS)
Time of concentration =   15.77 min.
Rainfall intensity =     2.135(In/Hr)
Summary of stream data:

Stream   Flow rate      TC            Rainfall Intensity
 No.       (CFS)       (min)                (In/Hr)


1       11.379     17.28            2.013
2       21.338     15.77            2.135
Qmax(1) =
        1.000 *    1.000 *    11.379) +
        0.943 *    1.000 *    21.338) + =      31.499
Qmax(2) =
        1.000 *    0.913 *    11.379) +
        1.000 *    1.000 *    21.338) + =      31.726

Total of 2 streams to confluence:
Flow rates before confluence point:
      11.379      21.338
Maximum flow rates at confluence using above data:
       31.499       31.726
Area of streams before confluence:
        6.810       17.680
Results of confluence:
Total flow rate =     31.726(CFS)
Time of concentration =    15.771 min.
Effective stream area after confluence =     24.490(Ac.)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      202.000 to Point/Station      206.000
**** PIPEFLOW TRAVEL TIME (Program estimated size) ****
________________________________________________________________________
Upstream point/station elevation =    84.100(Ft.)
Downstream point/station elevation =    82.900(Ft.)
Pipe length  =   240.00(Ft.) Slope =   0.0050  Manning's N = 0.013
```

```
No. of pipes = 1  Required pipe flow  =    31.726(CFS)
Nearest computed pipe diameter  =     33.00(In.)
Calculated individual pipe flow  =    31.726(CFS)
Normal flow depth in pipe =   23.34(In.)
Flow top width inside pipe =   30.03(In.)
Critical Depth =   22.48(In.)
Pipe flow velocity =      7.07(Ft/s)
Travel time through pipe =    0.57 min.
Time of concentration (TC) =    16.34 min.


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      202.000 to Point/Station      206.000
**** SUBAREA FLOW ADDITION ****
________________________________________________________________________
Rainfall intensity (I) =      2.087(In/Hr) for a    10.0 year storm
Decimal fraction soil group A = 1.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 0.000
Decimal fraction soil group D = 0.000
[COMMERCIAL area type                        ]
(Office Professional    )
Impervious value, Ai = 0.900
Sub-Area C Value = 0.830
Time of concentration =    16.34 min.
Rainfall intensity =      2.087(In/Hr) for a    10.0 year storm
Effective runoff coefficient used for total area
(Q=KCIA) is C = 0.640  CA =     16.167
Subarea runoff =      2.015(CFS) for      0.790(Ac.)
Total runoff =     33.741(CFS)   Total area =      25.280(Ac.)


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Process from Point/Station      202.000 to Point/Station      206.000
**** SUBAREA FLOW ADDITION ****
________________________________________________________________________
Rainfall intensity (I) =      2.087(In/Hr) for a    10.0 year storm
Decimal fraction soil group A = 0.200
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 0.000
Decimal fraction soil group D = 0.800
[MEDIUM DENSITY RESIDENTIAL                  ]
(7.3 DU/A or Less       )
Impervious value, Ai = 0.400
Sub-Area C Value = 0.552
Time of concentration =    16.34 min.
Rainfall intensity =      2.087(In/Hr) for a    10.0 year storm
Effective runoff coefficient used for total area
(Q=KCIA) is C = 0.617  CA =     20.948
Subarea runoff =      9.976(CFS) for      8.660(Ac.)
Total runoff =     43.717(CFS)   Total area =      33.940(Ac.)
```

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Process from Point/Station      206.000 to Point/Station      207.000
**** PIPEFLOW TRAVEL TIME (Program estimated size) ****
------------------------------------------------------------------------
Upstream point/station elevation =    82.900(Ft.)
Downstream point/station elevation =    71.380(Ft.)
Pipe length  =   758.00(Ft.) Slope =   0.0152  Manning's N = 0.013
No. of pipes = 1  Required pipe flow  =    43.717(CFS)
Nearest computed pipe diameter  =     30.00(In.)
Calculated individual pipe flow  =    43.717(CFS)
Normal flow depth in pipe =   21.52(In.)
Flow top width inside pipe =   27.02(In.)
Critical Depth =   26.44(In.)
Pipe flow velocity =     11.59(Ft/s)
Travel time through pipe =    1.09 min.
Time of concentration (TC) =    17.43 min.


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      206.000 to Point/Station      207.000
**** SUBAREA FLOW ADDITION ****
------------------------------------------------------------------------
Rainfall intensity (I) =      2.002(In/Hr) for a    10.0 year storm
Decimal fraction soil group A = 1.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 0.000
Decimal fraction soil group D = 0.000
[COMMERCIAL area type                        ]
(Office Professional    )
Impervious value, Ai = 0.900
Sub-Area C Value = 0.830
Time of concentration =    17.43 min.
Rainfall intensity =      2.002(In/Hr) for a    10.0 year storm
Effective runoff coefficient used for total area
(Q=KCIA) is C = 0.648  CA =     25.695
Subarea runoff =      7.720(CFS) for      5.720(Ac.)
Total runoff =     51.437(CFS)   Total area =      39.660(Ac.)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      207.000 to Point/Station      207.000
**** SUBAREA FLOW ADDITION ****
------------------------------------------------------------------------
Rainfall intensity (I) =      2.002(In/Hr) for a    10.0 year storm
Decimal fraction soil group A = 0.450
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 0.000
Decimal fraction soil group D = 0.550
[MEDIUM DENSITY RESIDENTIAL                  ]
(7.3 DU/A or Less       )
Impervious value, Ai = 0.400
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```
Sub-Area C Value = 0.529
Time of concentration =    17.43 min.
Rainfall intensity =      2.002(In/Hr) for a    10.0 year storm
Effective runoff coefficient used for total area
(Q=KCIA) is C = 0.604  CA =     38.181
Subarea runoff =     24.994(CFS) for     23.580(Ac.)
Total runoff =     76.431(CFS)   Total area =      63.240(Ac.)


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Process from Point/Station      207.000 to Point/Station      208.000
**** PIPEFLOW TRAVEL TIME (Program estimated size) ****
________________________________________________________________________
Upstream point/station elevation =    70.000(Ft.)
Downstream point/station elevation =    39.000(Ft.)
Pipe length  =  1320.00(Ft.) Slope =   0.0235  Manning's N = 0.013
No. of pipes = 1  Required pipe flow  =    76.431(CFS)
Nearest computed pipe diameter  =     33.00(In.)
Calculated individual pipe flow  =    76.431(CFS)
Normal flow depth in pipe =   25.50(In.)
Flow top width inside pipe =   27.66(In.)
Critical depth could not be calculated.
Pipe flow velocity =     15.52(Ft/s)
Travel time through pipe =    1.42 min.
Time of concentration (TC) =    18.85 min.


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      207.000 to Point/Station      208.000
**** SUBAREA FLOW ADDITION ****
________________________________________________________________________
Rainfall intensity (I) =      1.903(In/Hr) for a    10.0 year storm
Decimal fraction soil group A = 1.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 0.000
Decimal fraction soil group D = 0.000
[MEDIUM DENSITY RESIDENTIAL                 ]
(14.5 DU/A or Less      )
Impervious value, Ai = 0.500
Sub-Area C Value = 0.550
Time of concentration =    18.85 min.
Rainfall intensity =      1.903(In/Hr) for a    10.0 year storm
Effective runoff coefficient used for total area
(Q=KCIA) is C = 0.596  CA =     43.851
Subarea runoff =      7.033(CFS) for     10.310(Ac.)
Total runoff =     83.465(CFS)   Total area =      73.550(Ac.)


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Process from Point/Station      208.000 to Point/Station      209.000
**** PIPEFLOW TRAVEL TIME (Program estimated size) ****
________________________________________________________________________
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```
Upstream point/station elevation =    39.000(Ft.)
Downstream point/station elevation =    30.110(Ft.)
Pipe length  =   440.00(Ft.) Slope =   0.0202  Manning's N = 0.013
No. of pipes = 1  Required pipe flow  =    83.465(CFS)
Nearest computed pipe diameter  =     36.00(In.)
Calculated individual pipe flow  =    83.465(CFS)
Normal flow depth in pipe =   26.20(In.)
Flow top width inside pipe =   32.04(In.)
Critical Depth =   33.61(In.)
Pipe flow velocity =     15.13(Ft/s)
Travel time through pipe =    0.48 min.
Time of concentration (TC) =    19.33 min.
End of computations, total study area =          73.550 (Ac.)
```

San Diego County Rational Hydrology Program

CIVILCADD/CIVILDESIGN Engineering Software,(c)1991-2009 Version 7.8

Rational method hydrology program based on
San Diego County Flood Control Division 2003 hydrology manual
Rational Hydrology Study Date: 12/08/12

City of Carlsbad
Hydromodification Exemption Study
Major Basin 300
10-Year Flow Rate

********* Hydrology Study Control Information **********

Program License Serial Number 4028

Rational hydrology study storm event year is 10.0
English (in-lb) input data Units used

Map data precipitation entered:
6 hour, precipitation(inches) = 1.700
24 hour precipitation(inches) = 3.100
P6/P24 = 54.8%
San Diego hydrology manual 'C' values used

++
Process from Point/Station 300.000 to Point/Station 301.000
**** INITIAL AREA EVALUATION ****

Decimal fraction soil group A = 1.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 0.000
Decimal fraction soil group D = 0.000
[MEDIUM DENSITY RESIDENTIAL]
(7.3 DU/A or Less)
Impervious value, Ai = 0.400
Sub-Area C Value = 0.480
Initial subarea total flow distance = 280.000(Ft.)
Highest elevation = 341.000(Ft.)
Lowest elevation = 329.000(Ft.)
Elevation difference = 12.000(Ft.) Slope = 4.286 %
INITIAL AREA TIME OF CONCENTRATION CALCULATIONS:
The maximum overland flow distance is 100.00 (Ft)
for the top area slope value of 4.29 %, in a development type of
7.3 DU/A or Less
In Accordance With Figure 3-3

```
Initial Area Time of Concentration =   6.87 minutes
TC = [1.8*(1.1-C)*distance(Ft.)^.5)/(% slope^(1/3)]
TC = [1.8*(1.1-0.4800)*( 100.000^.5)/(   4.286^(1/3)]=   6.87
The initial area total distance of  280.00 (Ft.) entered leaves a
remaining distance of  180.00 (Ft.)
Using Figure 3-4, the travel time for this distance is   1.43 minutes
for a distance of 180.00 (Ft.) and a slope of  4.29 %
with an elevation difference of   7.71(Ft.) from the end of the top area
Tt = [11.9*length(Mi)^3)/(elevation change(Ft.))]^.385 *60(min/hr)
 =    1.432 Minutes
Tt=[(11.9*0.0341^3)/(  7.71)]^.385=  1.43
Total initial area Ti =   6.87 minutes from Figure 3-3 formula plus
  1.43 minutes from the Figure 3-4 formula =   8.30 minutes
Rainfall intensity (I) =      3.230(In/Hr) for a    10.0 year storm
Effective runoff coefficient used for area (Q=KCIA) is C = 0.480
Subarea runoff =      2.139(CFS)
Total initial stream area =        1.380(Ac.)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      301.000 to Point/Station      302.000
**** PIPEFLOW TRAVEL TIME (Program estimated size) ****
________________________________________________________________________
Upstream point/station elevation =   329.000(Ft.)
Downstream point/station elevation =   327.200(Ft.)
Pipe length  =   360.00(Ft.) Slope =   0.0050  Manning's N = 0.013
No. of pipes = 1  Required pipe flow  =     2.139(CFS)
Nearest computed pipe diameter  =     12.00(In.)
Calculated individual pipe flow  =     2.139(CFS)
Normal flow depth in pipe =    8.50(In.)
Flow top width inside pipe =   10.91(In.)
Critical Depth =    7.50(In.)
Pipe flow velocity =      3.60(Ft/s)
Travel time through pipe =    1.67 min.
Time of concentration (TC) =     9.97 min.


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      302.000 to Point/Station      303.000
**** STREET FLOW TRAVEL TIME + SUBAREA FLOW ADDITION ****
________________________________________________________________________
Top of street segment elevation =   306.000(Ft.)
End of street segment elevation =   230.000(Ft.)
Length of street segment  =   987.000(Ft.)
Height of curb above gutter flowline  =    6.0(In.)
Width of half street (curb to crown)  =  18.000(Ft.)
Distance from crown to crossfall grade break  =   8.000(Ft.)
Slope from gutter to grade break (v/hz) =   0.020
Slope from grade break to crown (v/hz)  =   0.020
Street flow is on [1] side(s) of the street
Distance from curb to property line  =  10.000(Ft.)
Slope from curb to property line (v/hz) =   0.020
```

```
Gutter width =   1.500(Ft.)
Gutter hike from flowline =  1.500(In.)
 Manning's N in gutter =  0.0150
 Manning's N from gutter to grade break =  0.0180
 Manning's N from grade break to crown =  0.0180
Estimated mean flow rate at midpoint of street =     10.444(CFS)
Depth of flow =   0.353(Ft.), Average velocity =   6.031(Ft/s)
Streetflow hydraulics at midpoint of street travel:
Halfstreet flow width =  12.885(Ft.)
Flow velocity =   6.03(Ft/s)
Travel time =    2.73 min.     TC =   12.70  min.
 Adding area flow to street
Rainfall intensity (I) =      2.456(In/Hr) for a    10.0 year storm
Decimal fraction soil group A = 1.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 0.000
Decimal fraction soil group D = 0.000
[MEDIUM DENSITY RESIDENTIAL                  ]
(7.3 DU/A or Less       )
Impervious value, Ai = 0.400
Sub-Area C Value = 0.480
Rainfall intensity =      2.456(In/Hr) for a    10.0 year storm
Effective runoff coefficient used for total area
(Q=KCIA) is C = 0.480  CA =      7.613
Subarea runoff =     16.555(CFS) for     14.480(Ac.)
Total runoff =     18.694(CFS)   Total area =      15.860(Ac.)
Street flow at end of street =     18.694(CFS)
Half street flow at end of street =     18.694(CFS)
Depth of flow =   0.419(Ft.), Average velocity =   6.935(Ft/s)
Flow width (from curb towards crown)=  16.200(Ft.)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      303.000 to Point/Station      304.000
**** PIPEFLOW TRAVEL TIME (Program estimated size) ****
________________________________________________________________________
Upstream point/station elevation =   230.000(Ft.)
Downstream point/station elevation =   219.970(Ft.)
Pipe length  =   660.00(Ft.) Slope =   0.0152  Manning's N = 0.013
No. of pipes = 1  Required pipe flow  =    18.694(CFS)
Nearest computed pipe diameter  =     21.00(In.)
Calculated individual pipe flow  =    18.694(CFS)
Normal flow depth in pipe =   16.45(In.)
Flow top width inside pipe =   17.30(In.)
Critical Depth =   18.79(In.)
Pipe flow velocity =      9.25(Ft/s)
Travel time through pipe =    1.19 min.
Time of concentration (TC) =    13.89 min.


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Process from Point/Station      303.000 to Point/Station      304.000
```

```
**** CONFLUENCE OF MINOR STREAMS ****
____________________________________________________________________________
Along Main Stream number: 1 in normal stream number 1
Stream flow area =     15.860(Ac.)
Runoff from this stream =     18.694(CFS)
Time of concentration =   13.89 min.
Rainfall intensity =     2.318(In/Hr)


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Process from Point/Station      305.000 to Point/Station      306.000
**** INITIAL AREA EVALUATION ****
____________________________________________________________________________
Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 1.000
Decimal fraction soil group D = 0.000
[MEDIUM DENSITY RESIDENTIAL                  ]
(7.3 DU/A or Less       )
Impervious value, Ai = 0.400
Sub-Area C Value = 0.540
Initial subarea total flow distance  =  130.000(Ft.)
Highest elevation =  344.000(Ft.)
Lowest elevation =  335.000(Ft.)
Elevation difference =    9.000(Ft.) Slope =  6.923 %
INITIAL AREA TIME OF CONCENTRATION CALCULATIONS:
The maximum overland flow distance is 100.00 (Ft)
for the top area slope value of   6.92 %, in a development type of
 7.3 DU/A or Less
In Accordance With Figure 3-3
Initial Area Time of Concentration =   5.29 minutes
TC = [1.8*(1.1-C)*distance(Ft.)^.5)/(% slope^(1/3)]
TC = [1.8*(1.1-0.5400)*( 100.000^.5)/(   6.923^(1/3)]=   5.29
The initial area total distance of  130.00 (Ft.) entered leaves a
remaining distance of   30.00 (Ft.)
Using Figure 3-4, the travel time for this distance is   0.30 minutes
for a distance of  30.00 (Ft.) and a slope of  6.92 %
with an elevation difference of   2.08(Ft.) from the end of the top area
Tt = [11.9*length(Mi)^3)/(elevation change(Ft.))]^.385 *60(min/hr)
 =    0.300 Minutes
Tt=[(11.9*0.0057^3)/(  2.08)]^.385=  0.30
Total initial area Ti =   5.29 minutes from Figure 3-3 formula plus
  0.30 minutes from the Figure 3-4 formula =   5.59 minutes
Rainfall intensity (I) =      4.169(In/Hr) for a    10.0 year storm
Effective runoff coefficient used for area (Q=KCIA) is C = 0.540
Subarea runoff =      1.216(CFS)
Total initial stream area =        0.540(Ac.)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      306.000 to Point/Station      307.000
**** STREET FLOW TRAVEL TIME + SUBAREA FLOW ADDITION ****
```

```
Top of street segment elevation =   335.000(Ft.)
End of street segment elevation =   280.000(Ft.)
Length of street segment  =  1260.000(Ft.)
Height of curb above gutter flowline  =    6.0(In.)
Width of half street (curb to crown)  =  18.000(Ft.)
Distance from crown to crossfall grade break  =   8.000(Ft.)
Slope from gutter to grade break (v/hz) =   0.020
Slope from grade break to crown (v/hz)  =   0.020
Street flow is on [1] side(s) of the street
Distance from curb to property line  =  10.000(Ft.)
Slope from curb to property line (v/hz) =   0.020
Gutter width =   1.500(Ft.)
Gutter hike from flowline =  1.500(In.)
 Manning's N in gutter =  0.0150
 Manning's N from gutter to grade break =  0.0180
 Manning's N from grade break to crown =  0.0180
Estimated mean flow rate at midpoint of street =      8.573(CFS)
Depth of flow =   0.362(Ft.), Average velocity =   4.635(Ft/s)
Streetflow hydraulics at midpoint of street travel:
Halfstreet flow width =  13.335(Ft.)
Flow velocity =   4.64(Ft/s)
Travel time =    4.53 min.     TC =   10.12  min.
 Adding area flow to street
Rainfall intensity (I) =      2.843(In/Hr) for a    10.0 year storm
Decimal fraction soil group A = 0.250
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 0.750
Decimal fraction soil group D = 0.000
[MEDIUM DENSITY RESIDENTIAL                  ]
(7.3 DU/A or Less       )
Impervious value, Ai = 0.400
Sub-Area C Value = 0.525
Rainfall intensity =      2.843(In/Hr) for a    10.0 year storm
Effective runoff coefficient used for total area
(Q=KCIA) is C = 0.526  CA =      5.573
Subarea runoff =     14.627(CFS) for     10.060(Ac.)
Total runoff =     15.842(CFS)   Total area =      10.600(Ac.)
Street flow at end of street =     15.842(CFS)
Half street flow at end of street =     15.842(CFS)
Depth of flow =   0.434(Ft.), Average velocity =   5.373(Ft/s)
Flow width (from curb towards crown)=  16.962(Ft.)


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Process from Point/Station      307.000 to Point/Station      308.000
**** PIPEFLOW TRAVEL TIME (Program estimated size) ****
------------------------------------------------------------------------------
Upstream point/station elevation =   280.000(Ft.)
Downstream point/station elevation =   275.260(Ft.)
Pipe length  =   375.00(Ft.) Slope =   0.0126  Manning's N = 0.013
No. of pipes = 1  Required pipe flow  =    15.842(CFS)
```

```
Nearest computed pipe diameter  =     21.00(In.)
Calculated individual pipe flow  =    15.842(CFS)
Normal flow depth in pipe =   15.42(In.)
Flow top width inside pipe =   18.55(In.)
Critical Depth =   17.64(In.)
Pipe flow velocity =      8.37(Ft/s)
Travel time through pipe =    0.75 min.
Time of concentration (TC) =    10.87 min.


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      307.000 to Point/Station      308.000
**** SUBAREA FLOW ADDITION ****
------------------------------------------------------------------------------
Rainfall intensity (I) =      2.715(In/Hr) for a    10.0 year storm
Decimal fraction soil group A = 1.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 0.000
Decimal fraction soil group D = 0.000
[MEDIUM DENSITY RESIDENTIAL                 ]
(7.3 DU/A or Less       )
Impervious value, Ai = 0.400
Sub-Area C Value = 0.480
Time of concentration =    10.87 min.
Rainfall intensity =      2.715(In/Hr) for a    10.0 year storm
Effective runoff coefficient used for total area
(Q=KCIA) is C = 0.518  CA =      6.653
Subarea runoff =      2.221(CFS) for      2.250(Ac.)
Total runoff =     18.063(CFS)   Total area =      12.850(Ac.)


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Process from Point/Station      308.000 to Point/Station      304.000
**** PIPEFLOW TRAVEL TIME (Program estimated size) ****
------------------------------------------------------------------------------
Upstream point/station elevation =   253.000(Ft.)
Downstream point/station elevation =   219.110(Ft.)
Pipe length  =   480.00(Ft.) Slope =   0.0706  Manning's N = 0.013
No. of pipes = 1  Required pipe flow  =    18.063(CFS)
Nearest computed pipe diameter  =     18.00(In.)
Calculated individual pipe flow  =    18.063(CFS)
Normal flow depth in pipe =   10.55(In.)
Flow top width inside pipe =   17.73(In.)
Critical depth could not be calculated.
Pipe flow velocity =     16.80(Ft/s)
Travel time through pipe =    0.48 min.
Time of concentration (TC) =    11.34 min.


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Process from Point/Station      308.000 to Point/Station      304.000
**** CONFLUENCE OF MINOR STREAMS ****
```

```
Along Main Stream number: 1 in normal stream number 2
Stream flow area =     12.850(Ac.)
Runoff from this stream =     18.063(CFS)
Time of concentration =   11.34 min.
Rainfall intensity =     2.641(In/Hr)
Summary of stream data:

Stream   Flow rate      TC            Rainfall Intensity
 No.       (CFS)       (min)                 (In/Hr)


1       18.694     13.89            2.318
2       18.063     11.34            2.641
Qmax(1) =
        1.000 *    1.000 *    18.694) +
        0.878 *    1.000 *    18.063) + =      34.547
Qmax(2) =
        1.000 *    0.817 *    18.694) +
        1.000 *    1.000 *    18.063) + =      33.332

Total of 2 streams to confluence:
Flow rates before confluence point:
      18.694      18.063
Maximum flow rates at confluence using above data:
       34.547       33.332
Area of streams before confluence:
       15.860       12.850
Results of confluence:
Total flow rate =     34.547(CFS)
Time of concentration =    13.886 min.
Effective stream area after confluence =     28.710(Ac.)


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Process from Point/Station      304.000 to Point/Station      309.000
**** PIPEFLOW TRAVEL TIME (Program estimated size) ****
------------------------------------------------------------------------
Upstream point/station elevation =   220.000(Ft.)
Downstream point/station elevation =   214.080(Ft.)
Pipe length  =   296.00(Ft.) Slope =   0.0200  Manning's N = 0.013
No. of pipes = 1  Required pipe flow  =    34.547(CFS)
Nearest computed pipe diameter  =     27.00(In.)
Calculated individual pipe flow  =    34.547(CFS)
Normal flow depth in pipe =   18.09(In.)
Flow top width inside pipe =   25.39(In.)
Critical Depth =   24.03(In.)
Pipe flow velocity =     12.21(Ft/s)
Travel time through pipe =    0.40 min.
Time of concentration (TC) =    14.29 min.
```

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Process from Point/Station      304.000 to Point/Station      309.000
**** CONFLUENCE OF MINOR STREAMS ****
------------------------------------------------------------------------
Along Main Stream number: 1 in normal stream number 1
Stream flow area =     28.710(Ac.)
Runoff from this stream =     34.547(CFS)
Time of concentration =   14.29 min.
Rainfall intensity =     2.275(In/Hr)


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Process from Point/Station      310.000 to Point/Station      311.000
**** INITIAL AREA EVALUATION ****
------------------------------------------------------------------------
Decimal fraction soil group A = 1.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 0.000
Decimal fraction soil group D = 0.000
[MEDIUM DENSITY RESIDENTIAL                 ]
(7.3 DU/A or Less       )
Impervious value, Ai = 0.400
Sub-Area C Value = 0.480
Initial subarea total flow distance  =  382.000(Ft.)
Highest elevation =  296.000(Ft.)
Lowest elevation =  264.000(Ft.)
Elevation difference =   32.000(Ft.) Slope =  8.377 %
INITIAL AREA TIME OF CONCENTRATION CALCULATIONS:
The maximum overland flow distance is 100.00 (Ft)
for the top area slope value of   8.38 %, in a development type of
 7.3 DU/A or Less
In Accordance With Figure 3-3
Initial Area Time of Concentration =   5.50 minutes
TC = [1.8*(1.1-C)*distance(Ft.)^.5)/(% slope^(1/3)]
TC = [1.8*(1.1-0.4800)*( 100.000^.5)/(   8.377^(1/3)]=   5.50
The initial area total distance of  382.00 (Ft.) entered leaves a
remaining distance of  282.00 (Ft.)
Using Figure 3-4, the travel time for this distance is   1.56 minutes
for a distance of 282.00 (Ft.) and a slope of  8.38 %
with an elevation difference of  23.62(Ft.) from the end of the top area
Tt = [11.9*length(Mi)^3)/(elevation change(Ft.))]^.385 *60(min/hr)
 =    1.563 Minutes
Tt=[(11.9*0.0534^3)/( 23.62)]^.385=  1.56
Total initial area Ti =   5.50 minutes from Figure 3-3 formula plus
  1.56 minutes from the Figure 3-4 formula =   7.06 minutes
Rainfall intensity (I) =      3.586(In/Hr) for a    10.0 year storm
Effective runoff coefficient used for area (Q=KCIA) is C = 0.480
Subarea runoff =      2.754(CFS)
Total initial stream area =        1.600(Ac.)


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Process from Point/Station      311.000 to Point/Station      312.000
**** IMPROVED CHANNEL TRAVEL TIME ****
------------------------------------------------------------------------
Upstream point elevation =   264.000(Ft.)
Downstream point elevation =   255.500(Ft.)
Channel length thru subarea  =   132.000(Ft.)
Channel base width    =    0.500(Ft.)
Slope or 'Z' of left channel bank =   2.000
Slope or 'Z' of right channel bank =   2.000
Manning's 'N'    = 0.015
Maximum depth of channel  =    1.000(Ft.)
Flow(q) thru subarea =      2.754(CFS)
Depth of flow =   0.306(Ft.), Average velocity =   8.081(Ft/s)
Channel flow top width =    1.725(Ft.)
Flow Velocity =    8.08(Ft/s)
Travel time  =    0.27 min.
Time of concentration =    7.33 min.
Critical depth =      0.539(Ft.)


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Process from Point/Station      312.000 to Point/Station      313.000
**** STREET FLOW TRAVEL TIME + SUBAREA FLOW ADDITION ****
------------------------------------------------------------------------
Top of street segment elevation =   255.500(Ft.)
End of street segment elevation =   218.000(Ft.)
Length of street segment  =   724.000(Ft.)
Height of curb above gutter flowline  =    6.0(In.)
Width of half street (curb to crown)  =  18.000(Ft.)
Distance from crown to crossfall grade break  =   8.000(Ft.)
Slope from gutter to grade break (v/hz) =   0.020
Slope from grade break to crown (v/hz)  =   0.020
Street flow is on [1] side(s) of the street
Distance from curb to property line  =  10.000(Ft.)
Slope from curb to property line (v/hz) =   0.020
Gutter width =   1.500(Ft.)
Gutter hike from flowline =  1.500(In.)
 Manning's N in gutter =  0.0150
 Manning's N from gutter to grade break =  0.0180
 Manning's N from grade break to crown =  0.0180
Estimated mean flow rate at midpoint of street =      8.242(CFS)
Depth of flow =   0.349(Ft.), Average velocity =   4.902(Ft/s)
Streetflow hydraulics at midpoint of street travel:
Halfstreet flow width =  12.690(Ft.)
Flow velocity =   4.90(Ft/s)
Travel time =    2.46 min.     TC =    9.79  min.
 Adding area flow to street
Rainfall intensity (I) =      2.903(In/Hr) for a    10.0 year storm
Decimal fraction soil group A = 1.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 0.000
Decimal fraction soil group D = 0.000
```

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[MEDIUM DENSITY RESIDENTIAL                 ]
(7.3 DU/A or Less       )
Impervious value, Ai = 0.400
Sub-Area C Value = 0.480
Rainfall intensity =      2.903(In/Hr) for a    10.0 year storm
Effective runoff coefficient used for total area
(Q=KCIA) is C = 0.480  CA =      4.709
Subarea runoff =     10.918(CFS) for      8.210(Ac.)
Total runoff =     13.672(CFS)   Total area =       9.810(Ac.)
Street flow at end of street =     13.672(CFS)
Half street flow at end of street =     13.672(CFS)
Depth of flow =   0.405(Ft.), Average velocity =   5.533(Ft/s)
Flow width (from curb towards crown)=  15.492(Ft.)


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Process from Point/Station      313.000 to Point/Station      309.000
**** PIPEFLOW TRAVEL TIME (Program estimated size) ****
________________________________________________________________________
Upstream point/station elevation =   218.000(Ft.)
Downstream point/station elevation =   212.960(Ft.)
Pipe length  =   970.00(Ft.) Slope =   0.0052  Manning's N = 0.013
No. of pipes = 1  Required pipe flow  =    13.672(CFS)
Nearest computed pipe diameter  =     24.00(In.)
Calculated individual pipe flow  =    13.672(CFS)
Normal flow depth in pipe =   16.83(In.)
Flow top width inside pipe =   21.97(In.)
Critical Depth =   15.98(In.)
Pipe flow velocity =      5.81(Ft/s)
Travel time through pipe =    2.78 min.
Time of concentration (TC) =    12.57 min.


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Process from Point/Station      313.000 to Point/Station      309.000
**** CONFLUENCE OF MINOR STREAMS ****
________________________________________________________________________
Along Main Stream number: 1 in normal stream number 2
Stream flow area =      9.810(Ac.)
Runoff from this stream =     13.672(CFS)
Time of concentration =   12.57 min.
Rainfall intensity =     2.471(In/Hr)
Summary of stream data:

Stream   Flow rate      TC            Rainfall Intensity
 No.       (CFS)       (min)                 (In/Hr)


1       34.547     14.29            2.275
2       13.672     12.57            2.471
Qmax(1) =
        1.000 *    1.000 *    34.547) +
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        0.921 *    1.000 *    13.672) + =      47.135
Qmax(2) =
        1.000 *    0.880 *    34.547) +
        1.000 *    1.000 *    13.672) + =      44.067

Total of 2 streams to confluence:
Flow rates before confluence point:
      34.547      13.672
Maximum flow rates at confluence using above data:
       47.135       44.067
Area of streams before confluence:
       28.710        9.810
Results of confluence:
Total flow rate =     47.135(CFS)
Time of concentration =    14.290 min.
Effective stream area after confluence =     38.520(Ac.)


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Process from Point/Station      309.000 to Point/Station      309.000
**** SUBAREA FLOW ADDITION ****
________________________________________________________________________
Rainfall intensity (I) =      2.275(In/Hr) for a    10.0 year storm
Decimal fraction soil group A = 1.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 0.000
Decimal fraction soil group D = 0.000
[MEDIUM DENSITY RESIDENTIAL                  ]
(7.3 DU/A or Less       )
Impervious value, Ai = 0.400
Sub-Area C Value = 0.480
Time of concentration =    14.29 min.
Rainfall intensity =      2.275(In/Hr) for a    10.0 year storm
Effective runoff coefficient used for total area
(Q=KCIA) is C = 0.490  CA =     24.802
Subarea runoff =      9.296(CFS) for     12.140(Ac.)
Total runoff =     56.431(CFS)   Total area =      50.660(Ac.)


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Process from Point/Station      309.000 to Point/Station      314.000
**** PIPEFLOW TRAVEL TIME (Program estimated size) ****
________________________________________________________________________
Upstream point/station elevation =   210.000(Ft.)
Downstream point/station elevation =   202.530(Ft.)
Pipe length  =   725.00(Ft.) Slope =   0.0103  Manning's N = 0.013
No. of pipes = 1  Required pipe flow  =    56.431(CFS)
Nearest computed pipe diameter  =     36.00(In.)
Calculated individual pipe flow  =    56.431(CFS)
Normal flow depth in pipe =   25.13(In.)
Flow top width inside pipe =   33.06(In.)
Critical Depth =   29.22(In.)
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Pipe flow velocity =     10.72(Ft/s)
Travel time through pipe =    1.13 min.
Time of concentration (TC) =    15.42 min.


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Process from Point/Station      309.000 to Point/Station      314.000
**** SUBAREA FLOW ADDITION ****
________________________________________________________________________
Rainfall intensity (I) =      2.167(In/Hr) for a    10.0 year storm
Decimal fraction soil group A = 0.670
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 0.330
Decimal fraction soil group D = 0.000
[MEDIUM DENSITY RESIDENTIAL                 ]
(7.3 DU/A or Less       )
Impervious value, Ai = 0.400
Sub-Area C Value = 0.500
Time of concentration =    15.42 min.
Rainfall intensity =      2.167(In/Hr) for a    10.0 year storm
Effective runoff coefficient used for total area
(Q=KCIA) is C = 0.494  CA =     46.588
Subarea runoff =     44.503(CFS) for     43.590(Ac.)
Total runoff =    100.934(CFS)   Total area =      94.250(Ac.)


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Process from Point/Station      314.000 to Point/Station      315.000
**** PIPEFLOW TRAVEL TIME (Program estimated size) ****
________________________________________________________________________
Upstream point/station elevation =   206.000(Ft.)
Downstream point/station elevation =   200.500(Ft.)
Pipe length  =   235.00(Ft.) Slope =   0.0234  Manning's N = 0.013
No. of pipes = 1  Required pipe flow  =   100.934(CFS)
Nearest computed pipe diameter  =     36.00(In.)
Calculated individual pipe flow  =   100.934(CFS)
Normal flow depth in pipe =   29.16(In.)
Flow top width inside pipe =   28.25(In.)
Critical depth could not be calculated.
Pipe flow velocity =     16.46(Ft/s)
Travel time through pipe =    0.24 min.
Time of concentration (TC) =    15.65 min.


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Process from Point/Station      314.000 to Point/Station      315.000
**** SUBAREA FLOW ADDITION ****
________________________________________________________________________
Rainfall intensity (I) =      2.145(In/Hr) for a    10.0 year storm
Decimal fraction soil group A = 1.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 0.000
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```
Decimal fraction soil group D = 0.000
[LOW DENSITY RESIDENTIAL                    ]
(2.9 DU/A or Less       )
Impervious value, Ai = 0.250
Sub-Area C Value = 0.380
Time of concentration =    15.65 min.
Rainfall intensity =      2.145(In/Hr) for a    10.0 year storm
Effective runoff coefficient used for total area
(Q=KCIA) is C = 0.489  CA =     48.401
Subarea runoff =      2.896(CFS) for      4.770(Ac.)
Total runoff =    103.830(CFS)   Total area =      99.020(Ac.)


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Process from Point/Station      315.000 to Point/Station      316.000
**** PIPEFLOW TRAVEL TIME (Program estimated size) ****
________________________________________________________________________
Upstream point/station elevation =   197.000(Ft.)
Downstream point/station elevation =   176.530(Ft.)
Pipe length  =   890.00(Ft.) Slope =   0.0230  Manning's N = 0.013
No. of pipes = 1  Required pipe flow  =   103.830(CFS)
Nearest computed pipe diameter  =     39.00(In.)
Calculated individual pipe flow  =   103.830(CFS)
Normal flow depth in pipe =   27.09(In.)
Flow top width inside pipe =   35.92(In.)
Critical Depth =   36.53(In.)
Pipe flow velocity =     16.87(Ft/s)
Travel time through pipe =    0.88 min.
Time of concentration (TC) =    16.53 min.


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      315.000 to Point/Station      316.000
**** SUBAREA FLOW ADDITION ****
________________________________________________________________________
Rainfall intensity (I) =      2.071(In/Hr) for a    10.0 year storm
Decimal fraction soil group A = 1.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 0.000
Decimal fraction soil group D = 0.000
[MEDIUM DENSITY RESIDENTIAL                 ]
(7.3 DU/A or Less       )
Impervious value, Ai = 0.400
Sub-Area C Value = 0.480
Time of concentration =    16.53 min.
Rainfall intensity =      2.071(In/Hr) for a    10.0 year storm
Effective runoff coefficient used for total area
(Q=KCIA) is C = 0.488  CA =     55.937
Subarea runoff =     12.012(CFS) for     15.700(Ac.)
Total runoff =    115.842(CFS)   Total area =     114.720(Ac.)
```

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Process from Point/Station      316.000 to Point/Station      317.000
**** PIPEFLOW TRAVEL TIME (Program estimated size) ****
________________________________________________________________________
Upstream point/station elevation =   158.000(Ft.)
Downstream point/station elevation =   154.720(Ft.)
Pipe length  =   205.00(Ft.) Slope =   0.0160  Manning's N = 0.013
No. of pipes = 1  Required pipe flow  =   115.842(CFS)
Nearest computed pipe diameter  =     42.00(In.)
Calculated individual pipe flow  =   115.842(CFS)
Normal flow depth in pipe =   31.45(In.)
Flow top width inside pipe =   36.43(In.)
Critical Depth =   38.62(In.)
Pipe flow velocity =     14.99(Ft/s)
Travel time through pipe =    0.23 min.
Time of concentration (TC) =    16.76 min.


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Process from Point/Station      316.000 to Point/Station      317.000
**** SUBAREA FLOW ADDITION ****
________________________________________________________________________
Rainfall intensity (I) =      2.053(In/Hr) for a    10.0 year storm
Decimal fraction soil group A = 1.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 0.000
Decimal fraction soil group D = 0.000
[MEDIUM DENSITY RESIDENTIAL                 ]
(7.3 DU/A or Less       )
Impervious value, Ai = 0.400
Sub-Area C Value = 0.480
Time of concentration =    16.76 min.
Rainfall intensity =      2.053(In/Hr) for a    10.0 year storm
Effective runoff coefficient used for total area
(Q=KCIA) is C = 0.487  CA =     56.950
Subarea runoff =      1.061(CFS) for      2.110(Ac.)
Total runoff =    116.902(CFS)   Total area =     116.830(Ac.)


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Process from Point/Station      317.000 to Point/Station      318.000
**** PIPEFLOW TRAVEL TIME (Program estimated size) ****
________________________________________________________________________
Upstream point/station elevation =   154.000(Ft.)
Downstream point/station elevation =   148.210(Ft.)
Pipe length  =   362.00(Ft.) Slope =   0.0160  Manning's N = 0.013
No. of pipes = 1  Required pipe flow  =   116.902(CFS)
Nearest computed pipe diameter  =     42.00(In.)
Calculated individual pipe flow  =   116.902(CFS)
Normal flow depth in pipe =   31.69(In.)
Flow top width inside pipe =   36.15(In.)
Critical Depth =   38.72(In.)
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Pipe flow velocity =     15.00(Ft/s)
Travel time through pipe =    0.40 min.
Time of concentration (TC) =    17.16 min.


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Process from Point/Station      317.000 to Point/Station      318.000
**** CONFLUENCE OF MINOR STREAMS ****
________________________________________________________________________
Along Main Stream number: 1 in normal stream number 1
Stream flow area =    116.830(Ac.)
Runoff from this stream =    116.902(CFS)
Time of concentration =   17.16 min.
Rainfall intensity =     2.022(In/Hr)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      320.000 to Point/Station      321.000
**** INITIAL AREA EVALUATION ****
________________________________________________________________________
Decimal fraction soil group A = 1.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 0.000
Decimal fraction soil group D = 0.000
[MEDIUM DENSITY RESIDENTIAL                 ]
(7.3 DU/A or Less       )
Impervious value, Ai = 0.400
Sub-Area C Value = 0.480
Initial subarea total flow distance  =  155.000(Ft.)
Highest elevation =  186.000(Ft.)
Lowest elevation =  183.000(Ft.)
Elevation difference =    3.000(Ft.) Slope =  1.935 %
INITIAL AREA TIME OF CONCENTRATION CALCULATIONS:
The maximum overland flow distance is 80.00 (Ft)
for the top area slope value of   1.94 %, in a development type of
 7.3 DU/A or Less
In Accordance With Figure 3-3
Initial Area Time of Concentration =   8.01 minutes
TC = [1.8*(1.1-C)*distance(Ft.)^.5)/(% slope^(1/3)]
TC = [1.8*(1.1-0.4800)*(  80.000^.5)/(   1.935^(1/3)]=   8.01
The initial area total distance of  155.00 (Ft.) entered leaves a
remaining distance of   75.00 (Ft.)
Using Figure 3-4, the travel time for this distance is   0.99 minutes
for a distance of  75.00 (Ft.) and a slope of  1.94 %
with an elevation difference of   1.45(Ft.) from the end of the top area
Tt = [11.9*length(Mi)^3)/(elevation change(Ft.))]^.385 *60(min/hr)
 =    0.991 Minutes
Tt=[(11.9*0.0142^3)/(  1.45)]^.385=  0.99
Total initial area Ti =   8.01 minutes from Figure 3-3 formula plus
  0.99 minutes from the Figure 3-4 formula =   9.00 minutes
Rainfall intensity (I) =      3.065(In/Hr) for a    10.0 year storm
Effective runoff coefficient used for area (Q=KCIA) is C = 0.480
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```
Subarea runoff =      0.368(CFS)
Total initial stream area =        0.250(Ac.)


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Process from Point/Station      321.000 to Point/Station      322.000
**** STREET FLOW TRAVEL TIME + SUBAREA FLOW ADDITION ****
________________________________________________________________________
Top of street segment elevation =   183.000(Ft.)
End of street segment elevation =   165.000(Ft.)
Length of street segment  =   855.000(Ft.)
Height of curb above gutter flowline  =    6.0(In.)
Width of half street (curb to crown)  =  18.000(Ft.)
Distance from crown to crossfall grade break  =   8.000(Ft.)
Slope from gutter to grade break (v/hz) =   0.020
Slope from grade break to crown (v/hz)  =   0.020
Street flow is on [1] side(s) of the street
Distance from curb to property line  =  10.000(Ft.)
Slope from curb to property line (v/hz) =   0.020
Gutter width =   1.500(Ft.)
Gutter hike from flowline =  1.500(In.)
 Manning's N in gutter =  0.0150
 Manning's N from gutter to grade break =  0.0180
 Manning's N from grade break to crown =  0.0180
Estimated mean flow rate at midpoint of street =      4.894(CFS)
Depth of flow =   0.342(Ft.), Average velocity =   3.073(Ft/s)
Streetflow hydraulics at midpoint of street travel:
Halfstreet flow width =  12.335(Ft.)
Flow velocity =   3.07(Ft/s)
Travel time =    4.64 min.     TC =   13.64  min.
 Adding area flow to street
Rainfall intensity (I) =      2.345(In/Hr) for a    10.0 year storm
Decimal fraction soil group A = 1.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 0.000
Decimal fraction soil group D = 0.000
[MEDIUM DENSITY RESIDENTIAL                  ]
(7.3 DU/A or Less       )
Impervious value, Ai = 0.400
Sub-Area C Value = 0.480
Rainfall intensity =      2.345(In/Hr) for a    10.0 year storm
Effective runoff coefficient used for total area
(Q=KCIA) is C = 0.480  CA =      3.994
Subarea runoff =      8.996(CFS) for      8.070(Ac.)
Total runoff =      9.364(CFS)   Total area =       8.320(Ac.)
Street flow at end of street =      9.364(CFS)
Half street flow at end of street =      9.364(CFS)
Depth of flow =   0.414(Ft.), Average velocity =   3.589(Ft/s)
Flow width (from curb towards crown)=  15.931(Ft.)


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Process from Point/Station      322.000 to Point/Station      323.000
**** PIPEFLOW TRAVEL TIME (Program estimated size) ****
------------------------------------------------------------------------
Upstream point/station elevation =   165.000(Ft.)
Downstream point/station elevation =   158.300(Ft.)
Pipe length  =   410.00(Ft.) Slope =   0.0163  Manning's N = 0.013
No. of pipes = 1  Required pipe flow  =     9.364(CFS)
Nearest computed pipe diameter  =     18.00(In.)
Calculated individual pipe flow  =     9.364(CFS)
Normal flow depth in pipe =   11.06(In.)
Flow top width inside pipe =   17.52(In.)
Critical Depth =   14.19(In.)
Pipe flow velocity =      8.21(Ft/s)
Travel time through pipe =    0.83 min.
Time of concentration (TC) =    14.47 min.


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      323.000 to Point/Station      324.000
**** STREET FLOW TRAVEL TIME + SUBAREA FLOW ADDITION ****
------------------------------------------------------------------------
Top of street segment elevation =   158.300(Ft.)
End of street segment elevation =   156.000(Ft.)
Length of street segment  =   506.000(Ft.)
Height of curb above gutter flowline  =    6.0(In.)
Width of half street (curb to crown)  =  18.000(Ft.)
Distance from crown to crossfall grade break  =   8.000(Ft.)
Slope from gutter to grade break (v/hz) =   0.020
Slope from grade break to crown (v/hz)  =   0.020
Street flow is on [1] side(s) of the street
Distance from curb to property line  =  10.000(Ft.)
Slope from curb to property line (v/hz) =   0.020
Gutter width =   1.500(Ft.)
Gutter hike from flowline =  1.500(In.)
 Manning's N in gutter =  0.0150
 Manning's N from gutter to grade break =  0.0180
 Manning's N from grade break to crown =  0.0180
Estimated mean flow rate at midpoint of street =     15.683(CFS)
Depth of flow =   0.612(Ft.), Average velocity =   2.431(Ft/s)
Warning: depth of flow exceeds top of curb
Note:  depth of flow exceeds top of street crown.
Distance that curb overflow reaches into property =    5.60(Ft.)
Streetflow hydraulics at midpoint of street travel:
Halfstreet flow width =  18.000(Ft.)
Flow velocity =   2.43(Ft/s)
Travel time =    3.47 min.     TC =   17.94  min.
 Adding area flow to street
Rainfall intensity (I) =      1.965(In/Hr) for a    10.0 year storm
Decimal fraction soil group A = 0.600
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 0.000
Decimal fraction soil group D = 0.400
```

```
[MEDIUM DENSITY RESIDENTIAL                  ]
(7.3 DU/A or Less       )
Impervious value, Ai = 0.400
Sub-Area C Value = 0.516
Rainfall intensity =      1.965(In/Hr) for a    10.0 year storm
Effective runoff coefficient used for total area
(Q=KCIA) is C = 0.503  CA =     11.171
Subarea runoff =     12.585(CFS) for     13.910(Ac.)
Total runoff =     21.949(CFS)   Total area =      22.230(Ac.)
Street flow at end of street =     21.949(CFS)
Half street flow at end of street =     21.949(CFS)
Depth of flow =   0.683(Ft.), Average velocity =   2.656(Ft/s)
Warning: depth of flow exceeds top of curb
Note:  depth of flow exceeds top of street crown.
Distance that curb overflow reaches into property =    9.17(Ft.)
Flow width (from curb towards crown)=  18.000(Ft.)


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Process from Point/Station      324.000 to Point/Station      325.000
**** PIPEFLOW TRAVEL TIME (Program estimated size) ****
________________________________________________________________________
Upstream point/station elevation =   156.000(Ft.)
Downstream point/station elevation =   154.710(Ft.)
Pipe length  =   430.00(Ft.) Slope =   0.0030  Manning's N = 0.013
No. of pipes = 1  Required pipe flow  =    21.949(CFS)
Nearest computed pipe diameter  =     30.00(In.)
Calculated individual pipe flow  =    21.949(CFS)
Normal flow depth in pipe =   24.00(In.)
Flow top width inside pipe =   24.00(In.)
Critical Depth =   19.10(In.)
Pipe flow velocity =      5.22(Ft/s)
Travel time through pipe =    1.37 min.
Time of concentration (TC) =    19.31 min.


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      324.000 to Point/Station      325.000
**** SUBAREA FLOW ADDITION ****
________________________________________________________________________
Rainfall intensity (I) =      1.873(In/Hr) for a    10.0 year storm
Decimal fraction soil group A = 0.600
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 0.000
Decimal fraction soil group D = 0.400
[MEDIUM DENSITY RESIDENTIAL                  ]
(7.3 DU/A or Less       )
Impervious value, Ai = 0.400
Sub-Area C Value = 0.516
Time of concentration =    19.31 min.
Rainfall intensity =      1.873(In/Hr) for a    10.0 year storm
Effective runoff coefficient used for total area
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(Q=KCIA) is C = 0.507  CA =     16.476
Subarea runoff =      8.918(CFS) for     10.280(Ac.)
Total runoff =     30.867(CFS)   Total area =      32.510(Ac.)


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Process from Point/Station      325.000 to Point/Station      326.000
**** PIPEFLOW TRAVEL TIME (Program estimated size) ****
________________________________________________________________________
Upstream point/station elevation =   158.000(Ft.)
Downstream point/station elevation =   156.110(Ft.)
Pipe length  =   315.00(Ft.) Slope =   0.0060  Manning's N = 0.013
No. of pipes = 1  Required pipe flow  =    30.867(CFS)
Nearest computed pipe diameter  =     30.00(In.)
Calculated individual pipe flow  =    30.867(CFS)
Normal flow depth in pipe =   23.86(In.)
Flow top width inside pipe =   24.21(In.)
Critical Depth =   22.71(In.)
Pipe flow velocity =      7.38(Ft/s)
Travel time through pipe =    0.71 min.
Time of concentration (TC) =    20.03 min.


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Process from Point/Station      325.000 to Point/Station      326.000
**** SUBAREA FLOW ADDITION ****
________________________________________________________________________
Rainfall intensity (I) =      1.830(In/Hr) for a    10.0 year storm
Decimal fraction soil group A = 0.400
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 0.000
Decimal fraction soil group D = 0.600
[MEDIUM DENSITY RESIDENTIAL                 ]
(7.3 DU/A or Less       )
Impervious value, Ai = 0.400
Sub-Area C Value = 0.534
Time of concentration =    20.03 min.
Rainfall intensity =      1.830(In/Hr) for a    10.0 year storm
Effective runoff coefficient used for total area
(Q=KCIA) is C = 0.511  CA =     20.064
Subarea runoff =      5.856(CFS) for      6.720(Ac.)
Total runoff =     36.722(CFS)   Total area =      39.230(Ac.)


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Process from Point/Station      326.000 to Point/Station      327.000
**** PIPEFLOW TRAVEL TIME (Program estimated size) ****
________________________________________________________________________
Upstream point/station elevation =   156.000(Ft.)
Downstream point/station elevation =   154.860(Ft.)
Pipe length  =   190.00(Ft.) Slope =   0.0060  Manning's N = 0.013
No. of pipes = 1  Required pipe flow  =    36.722(CFS)
```

```
Nearest computed pipe diameter  =     33.00(In.)
Calculated individual pipe flow  =    36.722(CFS)
Normal flow depth in pipe =   24.38(In.)
Flow top width inside pipe =   29.00(In.)
Critical Depth =   24.21(In.)
Pipe flow velocity =      7.80(Ft/s)
Travel time through pipe =    0.41 min.
Time of concentration (TC) =    20.43 min.


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      327.000 to Point/Station      327.000
**** SUBAREA FLOW ADDITION ****
________________________________________________________________________
Rainfall intensity (I) =      1.807(In/Hr) for a    10.0 year storm
Decimal fraction soil group A = 0.400
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 0.400
Decimal fraction soil group D = 0.200
[LOW DENSITY RESIDENTIAL                    ]
(2.0 DU/A or Less       )
Impervious value, Ai = 0.200
Sub-Area C Value = 0.396
Time of concentration =    20.43 min.
Rainfall intensity =      1.807(In/Hr) for a    10.0 year storm
Effective runoff coefficient used for total area
(Q=KCIA) is C = 0.487  CA =     24.175
Subarea runoff =      6.954(CFS) for     10.380(Ac.)
Total runoff =     43.676(CFS)   Total area =      49.610(Ac.)


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Process from Point/Station      327.000 to Point/Station      327.000
**** SUBAREA FLOW ADDITION ****
________________________________________________________________________
Rainfall intensity (I) =      1.807(In/Hr) for a    10.0 year storm
Decimal fraction soil group A = 0.600
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 0.200
Decimal fraction soil group D = 0.200
[MEDIUM DENSITY RESIDENTIAL                 ]
(7.3 DU/A or Less       )
Impervious value, Ai = 0.400
Sub-Area C Value = 0.510
Time of concentration =    20.43 min.
Rainfall intensity =      1.807(In/Hr) for a    10.0 year storm
Effective runoff coefficient used for total area
(Q=KCIA) is C = 0.490  CA =     27.627
Subarea runoff =      6.238(CFS) for      6.770(Ac.)
Total runoff =     49.914(CFS)   Total area =      56.380(Ac.)
```

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Process from Point/Station      327.000 to Point/Station      328.000
**** PIPEFLOW TRAVEL TIME (Program estimated size) ****
------------------------------------------------------------------------
Upstream point/station elevation =   159.000(Ft.)
Downstream point/station elevation =   156.500(Ft.)
Pipe length  =   250.00(Ft.) Slope =   0.0100  Manning's N = 0.013
No. of pipes = 1  Required pipe flow  =    49.914(CFS)
Nearest computed pipe diameter  =     33.00(In.)
Calculated individual pipe flow  =    49.914(CFS)
Normal flow depth in pipe =   25.50(In.)
Flow top width inside pipe =   27.66(In.)
Critical Depth =   27.92(In.)
Pipe flow velocity =     10.13(Ft/s)
Travel time through pipe =    0.41 min.
Time of concentration (TC) =    20.84 min.


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Process from Point/Station      327.000 to Point/Station      328.000
**** SUBAREA FLOW ADDITION ****
------------------------------------------------------------------------
Rainfall intensity (I) =      1.784(In/Hr) for a    10.0 year storm
Decimal fraction soil group A = 0.150
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 0.850
Decimal fraction soil group D = 0.000
[MEDIUM DENSITY RESIDENTIAL                 ]
(4.3 DU/A or Less       )
Impervious value, Ai = 0.300
Sub-Area C Value = 0.469
Time of concentration =    20.84 min.
Rainfall intensity =      1.784(In/Hr) for a    10.0 year storm
Effective runoff coefficient used for total area
(Q=KCIA) is C = 0.485  CA =     36.083
Subarea runoff =     14.444(CFS) for     18.010(Ac.)
Total runoff =     64.358(CFS)   Total area =      74.390(Ac.)


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Process from Point/Station      328.000 to Point/Station      318.000
**** PIPEFLOW TRAVEL TIME (Program estimated size) ****
------------------------------------------------------------------------
Upstream point/station elevation =   163.000(Ft.)
Downstream point/station elevation =   153.200(Ft.)
Pipe length  =   980.00(Ft.) Slope =   0.0100  Manning's N = 0.013
No. of pipes = 1  Required pipe flow  =    64.358(CFS)
Nearest computed pipe diameter  =     36.00(In.)
Calculated individual pipe flow  =    64.358(CFS)
Normal flow depth in pipe =   28.41(In.)
Flow top width inside pipe =   29.37(In.)
Critical Depth =   30.91(In.)
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Pipe flow velocity =     10.75(Ft/s)
Travel time through pipe =    1.52 min.
Time of concentration (TC) =    22.36 min.


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Process from Point/Station      328.000 to Point/Station      318.000
**** CONFLUENCE OF MINOR STREAMS ****
________________________________________________________________________
Along Main Stream number: 1 in normal stream number 2
Stream flow area =     74.390(Ac.)
Runoff from this stream =     64.358(CFS)
Time of concentration =   22.36 min.
Rainfall intensity =     1.704(In/Hr)


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Process from Point/Station      329.000 to Point/Station      330.000
**** INITIAL AREA EVALUATION ****
________________________________________________________________________
Decimal fraction soil group A = 1.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 0.000
Decimal fraction soil group D = 0.000
[MEDIUM DENSITY RESIDENTIAL                 ]
(7.3 DU/A or Less       )
Impervious value, Ai = 0.400
Sub-Area C Value = 0.480
Initial subarea total flow distance  =  974.000(Ft.)
Highest elevation =  230.000(Ft.)
Lowest elevation =  210.000(Ft.)
Elevation difference =   20.000(Ft.) Slope =  2.053 %
INITIAL AREA TIME OF CONCENTRATION CALCULATIONS:
The maximum overland flow distance is 80.00 (Ft)
for the top area slope value of   2.05 %, in a development type of
 7.3 DU/A or Less
In Accordance With Figure 3-3
Initial Area Time of Concentration =   7.85 minutes
TC = [1.8*(1.1-C)*distance(Ft.)^.5)/(% slope^(1/3)]
TC = [1.8*(1.1-0.4800)*(  80.000^.5)/(   2.053^(1/3)]=   7.85
The initial area total distance of  974.00 (Ft.) entered leaves a
remaining distance of  894.00 (Ft.)
Using Figure 3-4, the travel time for this distance is   6.53 minutes
for a distance of 894.00 (Ft.) and a slope of  2.05 %
with an elevation difference of  18.35(Ft.) from the end of the top area
Tt = [11.9*length(Mi)^3)/(elevation change(Ft.))]^.385 *60(min/hr)
 =    6.529 Minutes
Tt=[(11.9*0.1693^3)/( 18.35)]^.385=  6.53
Total initial area Ti =   7.85 minutes from Figure 3-3 formula plus
  6.53 minutes from the Figure 3-4 formula =  14.38 minutes
Rainfall intensity (I) =      2.266(In/Hr) for a    10.0 year storm
Effective runoff coefficient used for area (Q=KCIA) is C = 0.480
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Subarea runoff =      2.066(CFS)
Total initial stream area =        1.900(Ac.)


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Process from Point/Station      330.000 to Point/Station      331.000
**** STREET FLOW TRAVEL TIME + SUBAREA FLOW ADDITION ****
________________________________________________________________________
Top of street segment elevation =   210.000(Ft.)
End of street segment elevation =   174.000(Ft.)
Length of street segment  =   625.000(Ft.)
Height of curb above gutter flowline  =    6.0(In.)
Width of half street (curb to crown)  =  18.000(Ft.)
Distance from crown to crossfall grade break  =   8.000(Ft.)
Slope from gutter to grade break (v/hz) =   0.020
Slope from grade break to crown (v/hz)  =   0.020
Street flow is on [1] side(s) of the street
Distance from curb to property line  =  10.000(Ft.)
Slope from curb to property line (v/hz) =   0.020
Gutter width =   1.500(Ft.)
Gutter hike from flowline =  1.500(In.)
 Manning's N in gutter =  0.0150
 Manning's N from gutter to grade break =  0.0180
 Manning's N from grade break to crown =  0.0180
Estimated mean flow rate at midpoint of street =      7.831(CFS)
Depth of flow =   0.338(Ft.), Average velocity =   5.043(Ft/s)
Streetflow hydraulics at midpoint of street travel:
Halfstreet flow width =  12.172(Ft.)
Flow velocity =   5.04(Ft/s)
Travel time =    2.07 min.     TC =   16.45  min.
 Adding area flow to street
Rainfall intensity (I) =      2.078(In/Hr) for a    10.0 year storm
Decimal fraction soil group A = 1.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 0.000
Decimal fraction soil group D = 0.000
[MEDIUM DENSITY RESIDENTIAL                  ]
(7.3 DU/A or Less       )
Impervious value, Ai = 0.400
Sub-Area C Value = 0.480
Rainfall intensity =      2.078(In/Hr) for a    10.0 year storm
Effective runoff coefficient used for total area
(Q=KCIA) is C = 0.480  CA =      6.504
Subarea runoff =     11.448(CFS) for     11.650(Ac.)
Total runoff =     13.515(CFS)   Total area =      13.550(Ac.)
Street flow at end of street =     13.515(CFS)
Half street flow at end of street =     13.515(CFS)
Depth of flow =   0.397(Ft.), Average velocity =   5.744(Ft/s)
Flow width (from curb towards crown)=  15.104(Ft.)


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Process from Point/Station      331.000 to Point/Station      332.000
**** PIPEFLOW TRAVEL TIME (Program estimated size) ****
------------------------------------------------------------------------
Upstream point/station elevation =   174.000(Ft.)
Downstream point/station elevation =   158.000(Ft.)
Pipe length  =   400.00(Ft.) Slope =   0.0400  Manning's N = 0.013
No. of pipes = 1  Required pipe flow  =    13.515(CFS)
Nearest computed pipe diameter  =     18.00(In.)
Calculated individual pipe flow  =    13.515(CFS)
Normal flow depth in pipe =   10.50(In.)
Flow top width inside pipe =   17.75(In.)
Critical Depth =   16.41(In.)
Pipe flow velocity =     12.63(Ft/s)
Travel time through pipe =    0.53 min.
Time of concentration (TC) =    16.98 min.


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Process from Point/Station      332.000 to Point/Station      332.000
**** SUBAREA FLOW ADDITION ****
------------------------------------------------------------------------
Rainfall intensity (I) =      2.036(In/Hr) for a    10.0 year storm
Decimal fraction soil group A = 1.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 0.000
Decimal fraction soil group D = 0.000
[MEDIUM DENSITY RESIDENTIAL                 ]
(7.3 DU/A or Less       )
Impervious value, Ai = 0.400
Sub-Area C Value = 0.480
Time of concentration =    16.98 min.
Rainfall intensity =      2.036(In/Hr) for a    10.0 year storm
Effective runoff coefficient used for total area
(Q=KCIA) is C = 0.480  CA =     17.088
Subarea runoff =     21.276(CFS) for     22.050(Ac.)
Total runoff =     34.790(CFS)   Total area =      35.600(Ac.)


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Process from Point/Station      332.000 to Point/Station      318.000
**** PIPEFLOW TRAVEL TIME (Program estimated size) ****
------------------------------------------------------------------------
Upstream point/station elevation =   164.000(Ft.)
Downstream point/station elevation =   147.830(Ft.)
Pipe length  =    86.00(Ft.) Slope =   0.1880  Manning's N = 0.013
No. of pipes = 1  Required pipe flow  =    34.790(CFS)
Nearest computed pipe diameter  =     18.00(In.)
Calculated individual pipe flow  =    34.790(CFS)
Normal flow depth in pipe =   11.78(In.)
Flow top width inside pipe =   17.12(In.)
Critical depth could not be calculated.
Pipe flow velocity =     28.39(Ft/s)
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Travel time through pipe =    0.05 min.
Time of concentration (TC) =    17.03 min.


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Process from Point/Station      332.000 to Point/Station      318.000
**** CONFLUENCE OF MINOR STREAMS ****
________________________________________________________________________
Along Main Stream number: 1 in normal stream number 3
Stream flow area =     35.600(Ac.)
Runoff from this stream =     34.790(CFS)
Time of concentration =   17.03 min.
Rainfall intensity =     2.032(In/Hr)
Summary of stream data:

Stream   Flow rate      TC            Rainfall Intensity
 No.       (CFS)       (min)                 (In/Hr)


1      116.902     17.16            2.022
2       64.358     22.36            1.704
3       34.790     17.03            2.032
Qmax(1) =
         1.000 *    1.000 *   116.902) +
         1.000 *    0.768 *    64.358) +
         0.995 *    1.000 *    34.790) + =     200.912
Qmax(2) =
         0.843 *    1.000 *   116.902) +
         1.000 *    1.000 *    64.358) +
         0.839 *    1.000 *    34.790) + =     192.104
Qmax(3) =
         1.000 *    0.992 *   116.902) +
         1.000 *    0.761 *    64.358) +
         1.000 *    1.000 *    34.790) + =     199.763

Total of 3 streams to confluence:
Flow rates before confluence point:
     116.902      64.358      34.790
Maximum flow rates at confluence using above data:
      200.912      192.104      199.763
Area of streams before confluence:
      116.830       74.390       35.600
Results of confluence:
Total flow rate =    200.912(CFS)
Time of concentration =    17.164 min.
Effective stream area after confluence =    226.820(Ac.)


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Process from Point/Station      318.000 to Point/Station      333.000
**** PIPEFLOW TRAVEL TIME (Program estimated size) ****
________________________________________________________________________
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Upstream point/station elevation =   162.000(Ft.)
Downstream point/station elevation =   149.490(Ft.)
Pipe length  =   340.00(Ft.) Slope =   0.0368  Manning's N = 0.013
No. of pipes = 1  Required pipe flow  =   200.912(CFS)
Nearest computed pipe diameter  =     45.00(In.)
Calculated individual pipe flow  =   200.912(CFS)
Normal flow depth in pipe =   32.34(In.)
Flow top width inside pipe =   40.46(In.)
Critical depth could not be calculated.
Pipe flow velocity =     23.64(Ft/s)
Travel time through pipe =    0.24 min.
Time of concentration (TC) =    17.40 min.


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      318.000 to Point/Station      333.000
**** SUBAREA FLOW ADDITION ****
________________________________________________________________________
Rainfall intensity (I) =      2.004(In/Hr) for a    10.0 year storm
Decimal fraction soil group A = 1.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 0.000
Decimal fraction soil group D = 0.000
[HIGH DENSITY RESIDENTIAL                    ]
(24.0 DU/A or Less      )
Impervious value, Ai = 0.650
Sub-Area C Value = 0.660
Time of concentration =    17.40 min.
Rainfall intensity =      2.004(In/Hr) for a    10.0 year storm
Effective runoff coefficient used for total area
(Q=KCIA) is C = 0.489  CA =    113.381
Subarea runoff =     26.256(CFS) for      4.940(Ac.)
Total runoff =    227.168(CFS)   Total area =     231.760(Ac.)


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Process from Point/Station      333.000 to Point/Station      334.000
**** PIPEFLOW TRAVEL TIME (Program estimated size) ****
________________________________________________________________________
Upstream point/station elevation =   139.000(Ft.)
Downstream point/station elevation =   131.270(Ft.)
Pipe length  =   210.00(Ft.) Slope =   0.0368  Manning's N = 0.013
No. of pipes = 1  Required pipe flow  =   227.168(CFS)
Nearest computed pipe diameter  =     45.00(In.)
Calculated individual pipe flow  =   227.168(CFS)
Normal flow depth in pipe =   36.09(In.)
Flow top width inside pipe =   35.86(In.)
Critical depth could not be calculated.
Pipe flow velocity =     23.94(Ft/s)
Travel time through pipe =    0.15 min.
Time of concentration (TC) =    17.55 min.
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Process from Point/Station      333.000 to Point/Station      334.000
**** SUBAREA FLOW ADDITION ****
________________________________________________________________________
Rainfall intensity (I) =      1.993(In/Hr) for a    10.0 year storm
Decimal fraction soil group A = 1.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 0.000
Decimal fraction soil group D = 0.000
[MEDIUM DENSITY RESIDENTIAL                  ]
(14.5 DU/A or Less      )
Impervious value, Ai = 0.500
Sub-Area C Value = 0.550
Time of concentration =    17.55 min.
Rainfall intensity =      1.993(In/Hr) for a    10.0 year storm
Effective runoff coefficient used for total area
(Q=KCIA) is C = 0.492  CA =    119.871
Subarea runoff =     11.711(CFS) for     11.800(Ac.)
Total runoff =    238.879(CFS)   Total area =     243.560(Ac.)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      334.000 to Point/Station      335.000
**** PIPEFLOW TRAVEL TIME (Program estimated size) ****
________________________________________________________________________
Upstream point/station elevation =   126.000(Ft.)
Downstream point/station elevation =   108.250(Ft.)
Pipe length  =   355.00(Ft.) Slope =   0.0500  Manning's N = 0.013
No. of pipes = 1  Required pipe flow  =   238.879(CFS)
Nearest computed pipe diameter  =     45.00(In.)
Calculated individual pipe flow  =   238.879(CFS)
Normal flow depth in pipe =   32.86(In.)
Flow top width inside pipe =   39.95(In.)
Critical depth could not be calculated.
Pipe flow velocity =     27.64(Ft/s)
Travel time through pipe =    0.21 min.
Time of concentration (TC) =    17.76 min.


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Process from Point/Station      334.000 to Point/Station      335.000
**** SUBAREA FLOW ADDITION ****
________________________________________________________________________
Rainfall intensity (I) =      1.977(In/Hr) for a    10.0 year storm
Decimal fraction soil group A = 1.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 0.000
Decimal fraction soil group D = 0.000
[MEDIUM DENSITY RESIDENTIAL                  ]
(7.3 DU/A or Less       )
Impervious value, Ai = 0.400
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Sub-Area C Value = 0.480
Time of concentration =    17.76 min.
Rainfall intensity =      1.977(In/Hr) for a    10.0 year storm
Effective runoff coefficient used for total area
(Q=KCIA) is C = 0.491  CA =    129.605
Subarea runoff =     17.387(CFS) for     20.280(Ac.)
Total runoff =    256.266(CFS)   Total area =     263.840(Ac.)


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Process from Point/Station      335.000 to Point/Station      336.000
**** PIPEFLOW TRAVEL TIME (Program estimated size) ****
________________________________________________________________________
Upstream point/station elevation =   108.000(Ft.)
Downstream point/station elevation =    91.750(Ft.)
Pipe length  =   325.00(Ft.) Slope =   0.0500  Manning's N = 0.013
No. of pipes = 1  Required pipe flow  =   256.266(CFS)
Nearest computed pipe diameter  =     45.00(In.)
Calculated individual pipe flow  =   256.266(CFS)
Normal flow depth in pipe =   34.92(In.)
Flow top width inside pipe =   37.52(In.)
Critical depth could not be calculated.
Pipe flow velocity =     27.86(Ft/s)
Travel time through pipe =    0.19 min.
Time of concentration (TC) =    17.96 min.


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Process from Point/Station      335.000 to Point/Station      336.000
**** SUBAREA FLOW ADDITION ****
________________________________________________________________________
Rainfall intensity (I) =      1.963(In/Hr) for a    10.0 year storm
Decimal fraction soil group A = 1.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 0.000
Decimal fraction soil group D = 0.000
[HIGH DENSITY RESIDENTIAL                    ]
(43.0 DU/A or Less      )
Impervious value, Ai = 0.800
Sub-Area C Value = 0.760
Time of concentration =    17.96 min.
Rainfall intensity =      1.963(In/Hr) for a    10.0 year storm
Effective runoff coefficient used for total area
(Q=KCIA) is C = 0.495  CA =    132.258
Subarea runoff =      3.415(CFS) for      3.490(Ac.)
Total runoff =    259.681(CFS)   Total area =     267.330(Ac.)


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Process from Point/Station      335.000 to Point/Station      336.000
**** SUBAREA FLOW ADDITION ****
________________________________________________________________________
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Rainfall intensity (I) =      1.963(In/Hr) for a    10.0 year storm
Decimal fraction soil group A = 1.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 0.000
Decimal fraction soil group D = 0.000
[MEDIUM DENSITY RESIDENTIAL                 ]
(7.3 DU/A or Less       )
Impervious value, Ai = 0.400
Sub-Area C Value = 0.480
Time of concentration =    17.96 min.
Rainfall intensity =      1.963(In/Hr) for a    10.0 year storm
Effective runoff coefficient used for total area
(Q=KCIA) is C = 0.494  CA =    135.191
Subarea runoff =      5.758(CFS) for      6.110(Ac.)
Total runoff =    265.439(CFS)   Total area =     273.440(Ac.)


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Process from Point/Station      336.000 to Point/Station      337.000
**** PIPEFLOW TRAVEL TIME (Program estimated size) ****
________________________________________________________________________
Upstream point/station elevation =    91.000(Ft.)
Downstream point/station elevation =    84.190(Ft.)
Pipe length  =   300.00(Ft.) Slope =   0.0227  Manning's N = 0.013
No. of pipes = 1  Required pipe flow  =   265.439(CFS)
Nearest computed pipe diameter  =     54.00(In.)
Calculated individual pipe flow  =   265.439(CFS)
Normal flow depth in pipe =   39.89(In.)
Flow top width inside pipe =   47.45(In.)
Critical depth could not be calculated.
Pipe flow velocity =     21.07(Ft/s)
Travel time through pipe =    0.24 min.
Time of concentration (TC) =    18.20 min.


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      336.000 to Point/Station      337.000
**** SUBAREA FLOW ADDITION ****
________________________________________________________________________
Rainfall intensity (I) =      1.947(In/Hr) for a    10.0 year storm
Decimal fraction soil group A = 1.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 0.000
Decimal fraction soil group D = 0.000
[MEDIUM DENSITY RESIDENTIAL                 ]
(14.5 DU/A or Less      )
Impervious value, Ai = 0.500
Sub-Area C Value = 0.550
Time of concentration =    18.20 min.
Rainfall intensity =      1.947(In/Hr) for a    10.0 year storm
Effective runoff coefficient used for total area
(Q=KCIA) is C = 0.495  CA =    136.346
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Subarea runoff =      0.011(CFS) for      2.100(Ac.)
Total runoff =    265.450(CFS)   Total area =     275.540(Ac.)


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Process from Point/Station      337.000 to Point/Station      338.000
**** PIPEFLOW TRAVEL TIME (Program estimated size) ****
________________________________________________________________________
Upstream point/station elevation =    83.000(Ft.)
Downstream point/station elevation =    77.070(Ft.)
Pipe length  =   190.00(Ft.) Slope =   0.0312  Manning's N = 0.013
No. of pipes = 1  Required pipe flow  =   265.450(CFS)
Nearest computed pipe diameter  =     51.00(In.)
Calculated individual pipe flow  =   265.450(CFS)
Normal flow depth in pipe =   37.50(In.)
Flow top width inside pipe =   45.00(In.)
Critical depth could not be calculated.
Pipe flow velocity =     23.76(Ft/s)
Travel time through pipe =    0.13 min.
Time of concentration (TC) =    18.33 min.


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Process from Point/Station      337.000 to Point/Station      338.000
**** SUBAREA FLOW ADDITION ****
________________________________________________________________________
Rainfall intensity (I) =      1.938(In/Hr) for a    10.0 year storm
Decimal fraction soil group A = 1.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 0.000
Decimal fraction soil group D = 0.000
[LOW DENSITY RESIDENTIAL                    ]
(2.9 DU/A or Less       )
Impervious value, Ai = 0.250
Sub-Area C Value = 0.380
Time of concentration =    18.33 min.
Rainfall intensity =      1.938(In/Hr) for a    10.0 year storm
Effective runoff coefficient used for total area
(Q=KCIA) is C = 0.491  CA =    139.690
Subarea runoff =      5.233(CFS) for      8.800(Ac.)
Total runoff =    270.683(CFS)   Total area =     284.340(Ac.)


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Process from Point/Station      338.000 to Point/Station      339.000
**** PIPEFLOW TRAVEL TIME (Program estimated size) ****
________________________________________________________________________
Upstream point/station elevation =    78.000(Ft.)
Downstream point/station elevation =    66.120(Ft.)
Pipe length  =   260.00(Ft.) Slope =   0.0457  Manning's N = 0.013
No. of pipes = 1  Required pipe flow  =   270.683(CFS)
Nearest computed pipe diameter  =     48.00(In.)
```

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Calculated individual pipe flow  =   270.683(CFS)
Normal flow depth in pipe =   34.97(In.)
Flow top width inside pipe =   42.69(In.)
Critical depth could not be calculated.
Pipe flow velocity =     27.57(Ft/s)
Travel time through pipe =    0.16 min.
Time of concentration (TC) =    18.49 min.


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      338.000 to Point/Station      339.000
**** SUBAREA FLOW ADDITION ****
________________________________________________________________________
Rainfall intensity (I) =      1.927(In/Hr) for a    10.0 year storm
Decimal fraction soil group A = 1.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 0.000
Decimal fraction soil group D = 0.000
[LOW DENSITY RESIDENTIAL                     ]
(2.0 DU/A or Less       )
Impervious value, Ai = 0.200
Sub-Area C Value = 0.340
Time of concentration =    18.49 min.
Rainfall intensity =      1.927(In/Hr) for a    10.0 year storm
Effective runoff coefficient used for total area
(Q=KCIA) is C = 0.486  CA =    143.345
Subarea runoff =      5.557(CFS) for     10.750(Ac.)
Total runoff =    276.240(CFS)   Total area =     295.090(Ac.)


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Process from Point/Station      339.000 to Point/Station      340.000
**** PIPEFLOW TRAVEL TIME (Program estimated size) ****
________________________________________________________________________
Upstream point/station elevation =    64.000(Ft.)
Downstream point/station elevation =    22.000(Ft.)
Pipe length  =  1110.00(Ft.) Slope =   0.0378  Manning's N = 0.013
No. of pipes = 1  Required pipe flow  =   276.240(CFS)
Nearest computed pipe diameter  =     48.00(In.)
Calculated individual pipe flow  =   276.240(CFS)
Normal flow depth in pipe =   38.86(In.)
Flow top width inside pipe =   37.69(In.)
Critical depth could not be calculated.
Pipe flow velocity =     25.35(Ft/s)
Travel time through pipe =    0.73 min.
Time of concentration (TC) =    19.22 min.


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Process from Point/Station      340.000 to Point/Station      341.000
**** PIPEFLOW TRAVEL TIME (Program estimated size) ****
________________________________________________________________________
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```
Upstream point/station elevation =    22.000(Ft.)
Downstream point/station elevation =    21.090(Ft.)
Pipe length  =   325.00(Ft.) Slope =   0.0028  Manning's N = 0.013
No. of pipes = 1  Required pipe flow  =   276.240(CFS)
Nearest computed pipe diameter  =     78.00(In.)
Calculated individual pipe flow  =   276.240(CFS)
Normal flow depth in pipe =   63.56(In.)
Flow top width inside pipe =   60.59(In.)
Critical Depth =   53.56(In.)
Pipe flow velocity =      9.53(Ft/s)
Travel time through pipe =    0.57 min.
Time of concentration (TC) =    19.78 min.


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Process from Point/Station      340.000 to Point/Station      341.000
**** SUBAREA FLOW ADDITION ****
________________________________________________________________________
Rainfall intensity (I) =      1.845(In/Hr) for a    10.0 year storm
Decimal fraction soil group A = 0.950
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 0.050
Decimal fraction soil group D = 0.000
[LOW DENSITY RESIDENTIAL                     ]
(1.0 DU/A or Less       )
Impervious value, Ai = 0.100
Sub-Area C Value = 0.275
Time of concentration =    19.78 min.
Rainfall intensity =      1.845(In/Hr) for a    10.0 year storm
Effective runoff coefficient used for total area
(Q=KCIA) is C = 0.452  CA =    158.703
Subarea runoff =     16.498(CFS) for     55.950(Ac.)
Total runoff =    292.738(CFS)   Total area =     351.040(Ac.)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      341.000 to Point/Station      342.000
**** PIPEFLOW TRAVEL TIME (Program estimated size) ****
________________________________________________________________________
Upstream point/station elevation =    22.000(Ft.)
Downstream point/station elevation =    18.920(Ft.)
Pipe length  =  1100.00(Ft.) Slope =   0.0028  Manning's N = 0.013
No. of pipes = 1  Required pipe flow  =   292.738(CFS)
Nearest computed pipe diameter  =     81.00(In.)
Calculated individual pipe flow  =   292.738(CFS)
Normal flow depth in pipe =   63.28(In.)
Flow top width inside pipe =   66.97(In.)
Critical Depth =   54.55(In.)
Pipe flow velocity =      9.76(Ft/s)
Travel time through pipe =    1.88 min.
Time of concentration (TC) =    21.66 min.
```

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Process from Point/Station      341.000 to Point/Station      342.000
**** SUBAREA FLOW ADDITION ****
------------------------------------------------------------------------
Rainfall intensity (I) =      1.740(In/Hr) for a    10.0 year storm
Decimal fraction soil group A = 1.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 0.000
Decimal fraction soil group D = 0.000
[INDUSTRIAL area type                         ]
(General Industrial       )
Impervious value, Ai = 0.950
Sub-Area C Value = 0.870
The area added to the existing stream causes a
a lower flow rate of Q =    277.948(CFS)
therefore the upstream flow rate of Q =    292.738(CFS) is being used
Time of concentration =    21.66 min.
Rainfall intensity =      1.740(In/Hr) for a    10.0 year storm
Effective runoff coefficient used for total area
(Q=KCIA) is C = 0.454  CA =    159.764
Subarea runoff =      0.000(CFS) for      1.220(Ac.)
Total runoff =    292.738(CFS)   Total area =     352.260(Ac.)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      342.000 to Point/Station      343.000
**** PIPEFLOW TRAVEL TIME (Program estimated size) ****
------------------------------------------------------------------------
Upstream point/station elevation =    20.000(Ft.)
Downstream point/station elevation =    19.220(Ft.)
Pipe length  =   280.00(Ft.) Slope =   0.0028  Manning's N = 0.013
No. of pipes = 1  Required pipe flow  =   292.738(CFS)
Nearest computed pipe diameter  =     81.00(In.)
Calculated individual pipe flow  =   292.738(CFS)
Normal flow depth in pipe =   63.47(In.)
Flow top width inside pipe =   66.71(In.)
Critical Depth =   54.55(In.)
Pipe flow velocity =      9.74(Ft/s)
Travel time through pipe =    0.48 min.
Time of concentration (TC) =    22.14 min.
End of computations, total study area =         352.260 (Ac.)
```

San Diego County Rational Hydrology Program

CIVILCADD/CIVILDESIGN Engineering Software,(c)1991-2009 Version 7.8

Rational method hydrology program based on
San Diego County Flood Control Division 2003 hydrology manual
Rational Hydrology Study Date: 12/08/12

City of Carlsbad
Hydromodification Exemption Study
Major Basin 400
10-Year Flow Rate

********* Hydrology Study Control Information **********

Program License Serial Number 4028

Rational hydrology study storm event year is 10.0
English (in-lb) input data Units used

Map data precipitation entered:
6 hour, precipitation(inches) = 1.700
24 hour precipitation(inches) = 3.100
P6/P24 = 54.8%
San Diego hydrology manual 'C' values used

++
Process from Point/Station 400.000 to Point/Station 401.000
**** INITIAL AREA EVALUATION ****

Decimal fraction soil group A = 1.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 0.000
Decimal fraction soil group D = 0.000
[MEDIUM DENSITY RESIDENTIAL]
(7.3 DU/A or Less)
Impervious value, Ai = 0.400
Sub-Area C Value = 0.480
Initial subarea total flow distance = 646.000(Ft.)
Highest elevation = 331.000(Ft.)
Lowest elevation = 309.000(Ft.)
Elevation difference = 22.000(Ft.) Slope = 3.406 %
INITIAL AREA TIME OF CONCENTRATION CALCULATIONS:
The maximum overland flow distance is 95.00 (Ft)
for the top area slope value of 3.41 %, in a development type of
7.3 DU/A or Less
In Accordance With Figure 3-3

```
Initial Area Time of Concentration =   7.23 minutes
TC = [1.8*(1.1-C)*distance(Ft.)^.5)/(% slope^(1/3)]
TC = [1.8*(1.1-0.4800)*(  95.000^.5)/(   3.406^(1/3)]=   7.23
The initial area total distance of  646.00 (Ft.) entered leaves a
remaining distance of  551.00 (Ft.)
Using Figure 3-4, the travel time for this distance is   3.70 minutes
for a distance of 551.00 (Ft.) and a slope of  3.41 %
with an elevation difference of  18.77(Ft.) from the end of the top area
Tt = [11.9*length(Mi)^3)/(elevation change(Ft.))]^.385 *60(min/hr)
 =    3.701 Minutes
Tt=[(11.9*0.1044^3)/( 18.77)]^.385=  3.70
Total initial area Ti =   7.23 minutes from Figure 3-3 formula plus
  3.70 minutes from the Figure 3-4 formula =  10.93 minutes
Rainfall intensity (I) =      2.705(In/Hr) for a    10.0 year storm
Effective runoff coefficient used for area (Q=KCIA) is C = 0.480
Subarea runoff =      3.284(CFS)
Total initial stream area =        2.530(Ac.)


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Process from Point/Station      401.000 to Point/Station      402.000
**** STREET FLOW TRAVEL TIME + SUBAREA FLOW ADDITION ****
________________________________________________________________________
Top of street segment elevation =   309.000(Ft.)
End of street segment elevation =   230.000(Ft.)
Length of street segment  =  1121.000(Ft.)
Height of curb above gutter flowline  =    6.0(In.)
Width of half street (curb to crown)  =  18.000(Ft.)
Distance from crown to crossfall grade break  =   8.000(Ft.)
Slope from gutter to grade break (v/hz) =   0.020
Slope from grade break to crown (v/hz)  =   0.020
Street flow is on [1] side(s) of the street
Distance from curb to property line  =  10.000(Ft.)
Slope from curb to property line (v/hz) =   0.020
Gutter width =   1.500(Ft.)
Gutter hike from flowline =  1.500(In.)
 Manning's N in gutter =  0.0150
 Manning's N from gutter to grade break =  0.0180
 Manning's N from grade break to crown =  0.0180
Estimated mean flow rate at midpoint of street =     16.691(CFS)
Depth of flow =   0.410(Ft.), Average velocity =   6.525(Ft/s)
Streetflow hydraulics at midpoint of street travel:
Halfstreet flow width =  15.770(Ft.)
Flow velocity =   6.52(Ft/s)
Travel time =    2.86 min.     TC =   13.79  min.
 Adding area flow to street
Rainfall intensity (I) =      2.328(In/Hr) for a    10.0 year storm
Decimal fraction soil group A = 1.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 0.000
Decimal fraction soil group D = 0.000
[MEDIUM DENSITY RESIDENTIAL                 ]
```

```
(7.3 DU/A or Less       )
Impervious value, Ai = 0.400
Sub-Area C Value = 0.480
Rainfall intensity =      2.328(In/Hr) for a    10.0 year storm
Effective runoff coefficient used for total area
(Q=KCIA) is C = 0.480  CA =     12.893
Subarea runoff =     26.725(CFS) for     24.330(Ac.)
Total runoff =     30.010(CFS)   Total area =      26.860(Ac.)
Street flow at end of street =     30.010(CFS)
Half street flow at end of street =     30.010(CFS)
Depth of flow =   0.484(Ft.), Average velocity =   7.815(Ft/s)
Note:  depth of flow exceeds top of street crown.
Flow width (from curb towards crown)=  18.000(Ft.)


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Process from Point/Station      402.000 to Point/Station      403.000
**** PIPEFLOW TRAVEL TIME (Program estimated size) ****
________________________________________________________________________
Upstream point/station elevation =   230.000(Ft.)
Downstream point/station elevation =   210.280(Ft.)
Pipe length  =   290.00(Ft.) Slope =   0.0680  Manning's N = 0.013
No. of pipes = 1  Required pipe flow  =    30.010(CFS)
Nearest computed pipe diameter  =     21.00(In.)
Calculated individual pipe flow  =    30.010(CFS)
Normal flow depth in pipe =   13.27(In.)
Flow top width inside pipe =   20.26(In.)
Critical depth could not be calculated.
Pipe flow velocity =     18.73(Ft/s)
Travel time through pipe =    0.26 min.
Time of concentration (TC) =    14.05 min.


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Process from Point/Station      402.000 to Point/Station      403.000
**** SUBAREA FLOW ADDITION ****
________________________________________________________________________
Rainfall intensity (I) =      2.300(In/Hr) for a    10.0 year storm
Decimal fraction soil group A = 0.800
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 0.200
Decimal fraction soil group D = 0.000
[MEDIUM DENSITY RESIDENTIAL                  ]
(7.3 DU/A or Less       )
Impervious value, Ai = 0.400
Sub-Area C Value = 0.492
Time of concentration =    14.05 min.
Rainfall intensity =      2.300(In/Hr) for a    10.0 year storm
Effective runoff coefficient used for total area
(Q=KCIA) is C = 0.481  CA =     13.473
Subarea runoff =      0.979(CFS) for      1.180(Ac.)
Total runoff =     30.988(CFS)   Total area =      28.040(Ac.)
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Process from Point/Station      403.000 to Point/Station      404.000
**** PIPEFLOW TRAVEL TIME (Program estimated size) ****
----------------------------------------------------------------------
Upstream point/station elevation =   210.000(Ft.)
Downstream point/station elevation =   181.500(Ft.)
Pipe length  =   475.00(Ft.) Slope =   0.0600  Manning's N = 0.013
No. of pipes = 1  Required pipe flow  =    30.988(CFS)
Nearest computed pipe diameter  =     21.00(In.)
Calculated individual pipe flow  =    30.988(CFS)
Normal flow depth in pipe =   14.18(In.)
Flow top width inside pipe =   19.67(In.)
Critical depth could not be calculated.
Pipe flow velocity =     17.92(Ft/s)
Travel time through pipe =    0.44 min.
Time of concentration (TC) =    14.49 min.


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      403.000 to Point/Station      404.000
**** SUBAREA FLOW ADDITION ****
----------------------------------------------------------------------
Rainfall intensity (I) =      2.254(In/Hr) for a    10.0 year storm
Decimal fraction soil group A = 0.500
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 0.500
Decimal fraction soil group D = 0.000
[MEDIUM DENSITY RESIDENTIAL                 ]
(7.3 DU/A or Less       )
Impervious value, Ai = 0.400
Sub-Area C Value = 0.510
Time of concentration =    14.49 min.
Rainfall intensity =      2.254(In/Hr) for a    10.0 year storm
Effective runoff coefficient used for total area
(Q=KCIA) is C = 0.485  CA =     15.988
Subarea runoff =      5.056(CFS) for      4.930(Ac.)
Total runoff =     36.044(CFS)   Total area =      32.970(Ac.)


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Process from Point/Station      404.000 to Point/Station      405.000
**** PIPEFLOW TRAVEL TIME (Program estimated size) ****
----------------------------------------------------------------------
Upstream point/station elevation =   176.000(Ft.)
Downstream point/station elevation =   164.700(Ft.)
Pipe length  =   565.00(Ft.) Slope =   0.0200  Manning's N = 0.013
No. of pipes = 1  Required pipe flow  =    36.044(CFS)
Nearest computed pipe diameter  =     27.00(In.)
Calculated individual pipe flow  =    36.044(CFS)
Normal flow depth in pipe =   18.66(In.)
```

```
Flow top width inside pipe =   24.95(In.)
Critical Depth =   24.36(In.)
Pipe flow velocity =     12.30(Ft/s)
Travel time through pipe =    0.77 min.
Time of concentration (TC) =    15.26 min.


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Process from Point/Station      404.000 to Point/Station      405.000
**** CONFLUENCE OF MINOR STREAMS ****
________________________________________________________________________
Along Main Stream number: 1 in normal stream number 1
Stream flow area =     32.970(Ac.)
Runoff from this stream =     36.044(CFS)
Time of concentration =   15.26 min.
Rainfall intensity =     2.181(In/Hr)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      406.000 to Point/Station      407.000
**** INITIAL AREA EVALUATION ****
________________________________________________________________________
Decimal fraction soil group A = 1.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 0.000
Decimal fraction soil group D = 0.000
[MEDIUM DENSITY RESIDENTIAL                  ]
(7.3 DU/A or Less       )
Impervious value, Ai = 0.400
Sub-Area C Value = 0.480
Initial subarea total flow distance  =  428.000(Ft.)
Highest elevation =  247.000(Ft.)
Lowest elevation =  219.000(Ft.)
Elevation difference =   28.000(Ft.) Slope =  6.542 %
INITIAL AREA TIME OF CONCENTRATION CALCULATIONS:
The maximum overland flow distance is 100.00 (Ft)
for the top area slope value of   6.54 %, in a development type of
 7.3 DU/A or Less
In Accordance With Figure 3-3
Initial Area Time of Concentration =   5.97 minutes
TC = [1.8*(1.1-C)*distance(Ft.)^.5)/(% slope^(1/3)]
TC = [1.8*(1.1-0.4800)*( 100.000^.5)/(   6.542^(1/3)]=   5.97
The initial area total distance of  428.00 (Ft.) entered leaves a
remaining distance of  328.00 (Ft.)
Using Figure 3-4, the travel time for this distance is   1.93 minutes
for a distance of 328.00 (Ft.) and a slope of  6.54 %
with an elevation difference of  21.46(Ft.) from the end of the top area
Tt = [11.9*length(Mi)^3)/(elevation change(Ft.))]^.385 *60(min/hr)
 =    1.931 Minutes
Tt=[(11.9*0.0621^3)/( 21.46)]^.385=  1.93
Total initial area Ti =   5.97 minutes from Figure 3-3 formula plus
  1.93 minutes from the Figure 3-4 formula =   7.90 minutes
```

```
Rainfall intensity (I) =      3.335(In/Hr) for a    10.0 year storm
Effective runoff coefficient used for area (Q=KCIA) is C = 0.480
Subarea runoff =      2.914(CFS)
Total initial stream area =        1.820(Ac.)


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Process from Point/Station      407.000 to Point/Station      408.000
**** STREET FLOW TRAVEL TIME + SUBAREA FLOW ADDITION ****
________________________________________________________________________
Top of street segment elevation =   219.000(Ft.)
End of street segment elevation =   188.000(Ft.)
Length of street segment  =   731.000(Ft.)
Height of curb above gutter flowline  =    6.0(In.)
Width of half street (curb to crown)  =  18.000(Ft.)
Distance from crown to crossfall grade break  =   8.000(Ft.)
Slope from gutter to grade break (v/hz) =   0.020
Slope from grade break to crown (v/hz)  =   0.020
Street flow is on [1] side(s) of the street
Distance from curb to property line  =  10.000(Ft.)
Slope from curb to property line (v/hz) =   0.020
Gutter width =   1.500(Ft.)
Gutter hike from flowline =  1.500(In.)
 Manning's N in gutter =  0.0150
 Manning's N from gutter to grade break =  0.0180
 Manning's N from grade break to crown =  0.0180
Estimated mean flow rate at midpoint of street =     18.552(CFS)
Depth of flow =   0.457(Ft.), Average velocity =   5.538(Ft/s)
Note:  depth of flow exceeds top of street crown.
Streetflow hydraulics at midpoint of street travel:
Halfstreet flow width =  18.000(Ft.)
Flow velocity =   5.54(Ft/s)
Travel time =    2.20 min.     TC =   10.10  min.
 Adding area flow to street
Rainfall intensity (I) =      2.846(In/Hr) for a    10.0 year storm
Decimal fraction soil group A = 1.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 0.000
Decimal fraction soil group D = 0.000
[MEDIUM DENSITY RESIDENTIAL                  ]
(7.3 DU/A or Less       )
Impervious value, Ai = 0.400
Sub-Area C Value = 0.480
Rainfall intensity =      2.846(In/Hr) for a    10.0 year storm
Effective runoff coefficient used for total area
(Q=KCIA) is C = 0.480  CA =     11.990
Subarea runoff =     31.216(CFS) for     23.160(Ac.)
Total runoff =     34.130(CFS)   Total area =      24.980(Ac.)
Street flow at end of street =     34.130(CFS)
Half street flow at end of street =     34.130(CFS)
Depth of flow =   0.547(Ft.), Average velocity =   6.799(Ft/s)
Warning: depth of flow exceeds top of curb
```

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Note:  depth of flow exceeds top of street crown.
Distance that curb overflow reaches into property =    2.34(Ft.)
Flow width (from curb towards crown)=  18.000(Ft.)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      408.000 to Point/Station      409.000
**** PIPEFLOW TRAVEL TIME (Program estimated size) ****
________________________________________________________________________
Upstream point/station elevation =   188.000(Ft.)
Downstream point/station elevation =   187.440(Ft.)
Pipe length  =    56.00(Ft.) Slope =   0.0100  Manning's N = 0.013
No. of pipes = 1  Required pipe flow  =    34.130(CFS)
Nearest computed pipe diameter  =     30.00(In.)
Calculated individual pipe flow  =    34.130(CFS)
Normal flow depth in pipe =   20.91(In.)
Flow top width inside pipe =   27.58(In.)
Critical Depth =   23.84(In.)
Pipe flow velocity =      9.35(Ft/s)
Travel time through pipe =    0.10 min.
Time of concentration (TC) =    10.20 min.


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Process from Point/Station      408.000 to Point/Station      409.000
**** SUBAREA FLOW ADDITION ****
________________________________________________________________________
Rainfall intensity (I) =      2.828(In/Hr) for a    10.0 year storm
Decimal fraction soil group A = 0.950
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 0.050
Decimal fraction soil group D = 0.000
[MEDIUM DENSITY RESIDENTIAL                 ]
(7.3 DU/A or Less       )
Impervious value, Ai = 0.400
Sub-Area C Value = 0.483
Time of concentration =    10.20 min.
Rainfall intensity =      2.828(In/Hr) for a    10.0 year storm
Effective runoff coefficient used for total area
(Q=KCIA) is C = 0.480  CA =     13.681
Subarea runoff =      4.565(CFS) for      3.500(Ac.)
Total runoff =     38.695(CFS)   Total area =      28.480(Ac.)


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Process from Point/Station      409.000 to Point/Station      410.000
**** PIPEFLOW TRAVEL TIME (Program estimated size) ****
________________________________________________________________________
Upstream point/station elevation =   188.000(Ft.)
Downstream point/station elevation =   175.800(Ft.)
Pipe length  =   610.00(Ft.) Slope =   0.0200  Manning's N = 0.013
No. of pipes = 1  Required pipe flow  =    38.695(CFS)
```

```
Nearest computed pipe diameter  =     27.00(In.)
Calculated individual pipe flow  =    38.695(CFS)
Normal flow depth in pipe =   19.73(In.)
Flow top width inside pipe =   23.95(In.)
Critical Depth =   24.87(In.)
Pipe flow velocity =     12.44(Ft/s)
Travel time through pipe =    0.82 min.
Time of concentration (TC) =    11.02 min.


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Process from Point/Station      409.000 to Point/Station      410.000
**** SUBAREA FLOW ADDITION ****
________________________________________________________________________
Rainfall intensity (I) =      2.691(In/Hr) for a    10.0 year storm
Decimal fraction soil group A = 0.400
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 0.600
Decimal fraction soil group D = 0.000
[MEDIUM DENSITY RESIDENTIAL                 ]
(7.3 DU/A or Less       )
Impervious value, Ai = 0.400
Sub-Area C Value = 0.516
Time of concentration =    11.02 min.
Rainfall intensity =      2.691(In/Hr) for a    10.0 year storm
Effective runoff coefficient used for total area
(Q=KCIA) is C = 0.484  CA =     15.461
Subarea runoff =      2.913(CFS) for      3.450(Ac.)
Total runoff =     41.608(CFS)   Total area =      31.930(Ac.)


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Process from Point/Station      410.000 to Point/Station      405.000
**** PIPEFLOW TRAVEL TIME (Program estimated size) ****
________________________________________________________________________
Upstream point/station elevation =   162.000(Ft.)
Downstream point/station elevation =   145.200(Ft.)
Pipe length  =   420.00(Ft.) Slope =   0.0400  Manning's N = 0.013
No. of pipes = 1  Required pipe flow  =    41.608(CFS)
Nearest computed pipe diameter  =     24.00(In.)
Calculated individual pipe flow  =    41.608(CFS)
Normal flow depth in pipe =   18.14(In.)
Flow top width inside pipe =   20.62(In.)
Critical depth could not be calculated.
Pipe flow velocity =     16.34(Ft/s)
Travel time through pipe =    0.43 min.
Time of concentration (TC) =    11.44 min.


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Process from Point/Station      410.000 to Point/Station      405.000
**** CONFLUENCE OF MINOR STREAMS ****
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```
Along Main Stream number: 1 in normal stream number 2
Stream flow area =     31.930(Ac.)
Runoff from this stream =     41.608(CFS)
Time of concentration =   11.44 min.
Rainfall intensity =     2.626(In/Hr)
Summary of stream data:

Stream   Flow rate      TC            Rainfall Intensity
 No.       (CFS)       (min)                (In/Hr)


1       36.044     15.26            2.181
2       41.608     11.44            2.626
Qmax(1) =
        1.000 *    1.000 *    36.044) +
        0.831 *    1.000 *    41.608) + =      70.603
Qmax(2) =
        1.000 *    0.750 *    36.044) +
        1.000 *    1.000 *    41.608) + =      68.638

Total of 2 streams to confluence:
Flow rates before confluence point:
      36.044      41.608
Maximum flow rates at confluence using above data:
       70.603       68.638
Area of streams before confluence:
       32.970       31.930
Results of confluence:
Total flow rate =     70.603(CFS)
Time of concentration =    15.260 min.
Effective stream area after confluence =     64.900(Ac.)


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Process from Point/Station      405.000 to Point/Station      405.000
**** SUBAREA FLOW ADDITION ****
------------------------------------------------------------------------
Rainfall intensity (I) =      2.181(In/Hr) for a    10.0 year storm
Decimal fraction soil group A = 0.050
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 0.950
Decimal fraction soil group D = 0.000
[MEDIUM DENSITY RESIDENTIAL                 ]
(7.3 DU/A or Less       )
Impervious value, Ai = 0.400
Sub-Area C Value = 0.537
Time of concentration =    15.26 min.
Rainfall intensity =      2.181(In/Hr) for a    10.0 year storm
Effective runoff coefficient used for total area
(Q=KCIA) is C = 0.491  CA =     36.593
Subarea runoff =      9.202(CFS) for      9.580(Ac.)
```

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Total runoff =     79.805(CFS)   Total area =      74.480(Ac.)


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Process from Point/Station      405.000 to Point/Station      411.000
**** PIPEFLOW TRAVEL TIME (Program estimated size) ****
________________________________________________________________________
Upstream point/station elevation =   146.000(Ft.)
Downstream point/station elevation =   136.320(Ft.)
Pipe length  =   242.00(Ft.) Slope =   0.0400  Manning's N = 0.013
No. of pipes = 1  Required pipe flow  =    79.805(CFS)
Nearest computed pipe diameter  =     30.00(In.)
Calculated individual pipe flow  =    79.805(CFS)
Normal flow depth in pipe =   23.91(In.)
Flow top width inside pipe =   24.14(In.)
Critical depth could not be calculated.
Pipe flow velocity =     19.04(Ft/s)
Travel time through pipe =    0.21 min.
Time of concentration (TC) =    15.47 min.


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      405.000 to Point/Station      411.000
**** SUBAREA FLOW ADDITION ****
________________________________________________________________________
Rainfall intensity (I) =      2.162(In/Hr) for a    10.0 year storm
Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 1.000
Decimal fraction soil group D = 0.000
[MEDIUM DENSITY RESIDENTIAL                 ]
(7.3 DU/A or Less       )
Impervious value, Ai = 0.400
Sub-Area C Value = 0.540
Time of concentration =    15.47 min.
Rainfall intensity =      2.162(In/Hr) for a    10.0 year storm
Effective runoff coefficient used for total area
(Q=KCIA) is C = 0.493  CA =     38.440
Subarea runoff =      3.286(CFS) for      3.420(Ac.)
Total runoff =     83.091(CFS)   Total area =      77.900(Ac.)


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Process from Point/Station      411.000 to Point/Station      412.000
**** PIPEFLOW TRAVEL TIME (Program estimated size) ****
________________________________________________________________________
Upstream point/station elevation =   136.000(Ft.)
Downstream point/station elevation =   117.830(Ft.)
Pipe length  =   395.00(Ft.) Slope =   0.0460  Manning's N = 0.013
No. of pipes = 1  Required pipe flow  =    83.091(CFS)
Nearest computed pipe diameter  =     30.00(In.)
Calculated individual pipe flow  =    83.091(CFS)
```

```
Normal flow depth in pipe =   23.20(In.)
Flow top width inside pipe =   25.12(In.)
Critical depth could not be calculated.
Pipe flow velocity =     20.38(Ft/s)
Travel time through pipe =    0.32 min.
Time of concentration (TC) =    15.79 min.


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      411.000 to Point/Station      412.000
**** SUBAREA FLOW ADDITION ****
________________________________________________________________________
Rainfall intensity (I) =      2.133(In/Hr) for a    10.0 year storm
Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 0.670
Decimal fraction soil group D = 0.330
[MEDIUM DENSITY RESIDENTIAL                  ]
(7.3 DU/A or Less       )
Impervious value, Ai = 0.400
Sub-Area C Value = 0.550
Time of concentration =    15.79 min.
Rainfall intensity =      2.133(In/Hr) for a    10.0 year storm
Effective runoff coefficient used for total area
(Q=KCIA) is C = 0.496  CA =     40.667
Subarea runoff =      3.650(CFS) for      4.050(Ac.)
Total runoff =     86.741(CFS)   Total area =      81.950(Ac.)


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Process from Point/Station      412.000 to Point/Station      413.000
**** PIPEFLOW TRAVEL TIME (Program estimated size) ****
________________________________________________________________________
Upstream point/station elevation =   116.000(Ft.)
Downstream point/station elevation =   107.990(Ft.)
Pipe length  =   176.00(Ft.) Slope =   0.0455  Manning's N = 0.013
No. of pipes = 1  Required pipe flow  =    86.741(CFS)
Nearest computed pipe diameter  =     30.00(In.)
Calculated individual pipe flow  =    86.741(CFS)
Normal flow depth in pipe =   24.38(In.)
Flow top width inside pipe =   23.42(In.)
Critical depth could not be calculated.
Pipe flow velocity =     20.32(Ft/s)
Travel time through pipe =    0.14 min.
Time of concentration (TC) =    15.94 min.


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Process from Point/Station      412.000 to Point/Station      413.000
**** SUBAREA FLOW ADDITION ****
________________________________________________________________________
Rainfall intensity (I) =      2.120(In/Hr) for a    10.0 year storm
```

```
Decimal fraction soil group A = 0.330
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 0.330
Decimal fraction soil group D = 0.340
[MEDIUM DENSITY RESIDENTIAL                 ]
(7.3 DU/A or Less       )
Impervious value, Ai = 0.400
Sub-Area C Value = 0.530
Time of concentration =    15.94 min.
Rainfall intensity =      2.120(In/Hr) for a    10.0 year storm
Effective runoff coefficient used for total area
(Q=KCIA) is C = 0.501  CA =     48.506
Subarea runoff =     16.116(CFS) for     14.780(Ac.)
Total runoff =    102.857(CFS)   Total area =      96.730(Ac.)


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Process from Point/Station      413.000 to Point/Station      414.000
**** PIPEFLOW TRAVEL TIME (Program estimated size) ****
________________________________________________________________________
Upstream point/station elevation =   108.000(Ft.)
Downstream point/station elevation =    87.490(Ft.)
Pipe length  =   260.00(Ft.) Slope =   0.0789  Manning's N = 0.013
No. of pipes = 1  Required pipe flow  =   102.857(CFS)
Nearest computed pipe diameter  =     30.00(In.)
Calculated individual pipe flow  =   102.857(CFS)
Normal flow depth in pipe =   22.10(In.)
Flow top width inside pipe =   26.42(In.)
Critical depth could not be calculated.
Pipe flow velocity =     26.53(Ft/s)
Travel time through pipe =    0.16 min.
Time of concentration (TC) =    16.10 min.


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      413.000 to Point/Station      414.000
**** SUBAREA FLOW ADDITION ****
________________________________________________________________________
Rainfall intensity (I) =      2.107(In/Hr) for a    10.0 year storm
Decimal fraction soil group A = 0.500
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 0.250
Decimal fraction soil group D = 0.250
[MEDIUM DENSITY RESIDENTIAL                 ]
(7.3 DU/A or Less       )
Impervious value, Ai = 0.400
Sub-Area C Value = 0.517
Time of concentration =    16.10 min.
Rainfall intensity =      2.107(In/Hr) for a    10.0 year storm
Effective runoff coefficient used for total area
(Q=KCIA) is C = 0.503  CA =     55.565
Subarea runoff =     14.196(CFS) for     13.640(Ac.)
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```
Total runoff =    117.052(CFS)   Total area =     110.370(Ac.)


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Process from Point/Station      414.000 to Point/Station      415.000
**** PIPEFLOW TRAVEL TIME (Program estimated size) ****
________________________________________________________________________
Upstream point/station elevation =    86.000(Ft.)
Downstream point/station elevation =    85.000(Ft.)
Pipe length  =   100.00(Ft.) Slope =   0.0100  Manning's N = 0.013
No. of pipes = 1  Required pipe flow  =   117.052(CFS)
Nearest computed pipe diameter  =     45.00(In.)
Calculated individual pipe flow  =   117.052(CFS)
Normal flow depth in pipe =   35.63(In.)
Flow top width inside pipe =   36.55(In.)
Critical Depth =   39.23(In.)
Pipe flow velocity =     12.47(Ft/s)
Travel time through pipe =    0.13 min.
Time of concentration (TC) =    16.24 min.


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      414.000 to Point/Station      415.000
**** CONFLUENCE OF MINOR STREAMS ****
________________________________________________________________________
Along Main Stream number: 1 in normal stream number 1
Stream flow area =    110.370(Ac.)
Runoff from this stream =    117.052(CFS)
Time of concentration =   16.24 min.
Rainfall intensity =     2.095(In/Hr)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      415.000 to Point/Station      415.000
**** USER DEFINED FLOW INFORMATION AT A POINT ****
________________________________________________________________________
User specified 'C' value of 0.480 given for subarea
Rainfall intensity (I) =      1.277(In/Hr) for a    10.0 year storm
User specified values are as follows:
TC =  35.00 min.  Rain intensity =       1.28(In/Hr)
Total area =      260.320(Ac.)  Total runoff =   171.000(CFS)


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Process from Point/Station      415.000 to Point/Station      415.000
**** CONFLUENCE OF MINOR STREAMS ****
________________________________________________________________________
Along Main Stream number: 1 in normal stream number 2
Stream flow area =    260.320(Ac.)
Runoff from this stream =    171.000(CFS)
Time of concentration =   35.00 min.
Rainfall intensity =     1.277(In/Hr)
```

```
Summary of stream data:

Stream   Flow rate      TC            Rainfall Intensity
 No.       (CFS)       (min)                (In/Hr)


1      117.052     16.24            2.095
2      171.000     35.00            1.277
Qmax(1) =
        1.000 *    1.000 *   117.052) +
        1.000 *    0.464 *   171.000) + =     196.377
Qmax(2) =
        0.609 *    1.000 *   117.052) +
        1.000 *    1.000 *   171.000) + =     242.321

Total of 2 streams to confluence:
Flow rates before confluence point:
     117.052     171.000
Maximum flow rates at confluence using above data:
      196.377      242.321
Area of streams before confluence:
      110.370      260.320
Results of confluence:
Total flow rate =    242.321(CFS)
Time of concentration =    35.000 min.
Effective stream area after confluence =    370.690(Ac.)


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Process from Point/Station      415.000 to Point/Station      416.000
**** PIPEFLOW TRAVEL TIME (Program estimated size) ****
________________________________________________________________________
Upstream point/station elevation =    67.000(Ft.)
Downstream point/station elevation =    28.750(Ft.)
Pipe length  =   778.00(Ft.) Slope =   0.0492  Manning's N = 0.013
No. of pipes = 1  Required pipe flow  =   242.321(CFS)
Nearest computed pipe diameter  =     45.00(In.)
Calculated individual pipe flow  =   242.321(CFS)
Normal flow depth in pipe =   33.47(In.)
Flow top width inside pipe =   39.29(In.)
Critical depth could not be calculated.
Pipe flow velocity =     27.49(Ft/s)
Travel time through pipe =    0.47 min.
Time of concentration (TC) =    35.47 min.


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      415.000 to Point/Station      416.000
**** CONFLUENCE OF MINOR STREAMS ****
________________________________________________________________________
Along Main Stream number: 1 in normal stream number 1
Stream flow area =    370.690(Ac.)
```

```
Runoff from this stream =    242.321(CFS)
Time of concentration =   35.47 min.
Rainfall intensity =     1.266(In/Hr)


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Process from Point/Station      417.000 to Point/Station      417.000
**** USER DEFINED FLOW INFORMATION AT A POINT ****
________________________________________________________________________
User specified 'C' value of 0.500 given for subarea
Rainfall intensity (I) =      2.205(In/Hr) for a    10.0 year storm
User specified values are as follows:
TC =  15.00 min.  Rain intensity =       2.21(In/Hr)
Total area =       23.750(Ac.)  Total runoff =    26.100(CFS)


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Process from Point/Station      417.000 to Point/Station      417.000
**** SUBAREA FLOW ADDITION ****
________________________________________________________________________
Rainfall intensity (I) =      2.205(In/Hr) for a    10.0 year storm
Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 0.000
Decimal fraction soil group D = 1.000
[MEDIUM DENSITY RESIDENTIAL                 ]
(7.3 DU/A or Less       )
Impervious value, Ai = 0.400
Sub-Area C Value = 0.570
Time of concentration =    15.00 min.
Rainfall intensity =      2.205(In/Hr) for a    10.0 year storm
Effective runoff coefficient used for total area
(Q=KCIA) is C = 0.515  CA =     15.608
Subarea runoff =      8.319(CFS) for      6.550(Ac.)
Total runoff =     34.419(CFS)   Total area =      30.300(Ac.)


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Process from Point/Station      417.000 to Point/Station      416.000
**** PIPEFLOW TRAVEL TIME (Program estimated size) ****
________________________________________________________________________
Upstream point/station elevation =   120.000(Ft.)
Downstream point/station elevation =    68.200(Ft.)
Pipe length  =   740.00(Ft.) Slope =   0.0700  Manning's N = 0.013
No. of pipes = 1  Required pipe flow  =    34.419(CFS)
Nearest computed pipe diameter  =     21.00(In.)
Calculated individual pipe flow  =    34.419(CFS)
Normal flow depth in pipe =   14.48(In.)
Flow top width inside pipe =   19.43(In.)
Critical depth could not be calculated.
Pipe flow velocity =     19.45(Ft/s)
Travel time through pipe =    0.63 min.
```

```
Time of concentration (TC) =    15.63 min.


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      417.000 to Point/Station      416.000
**** CONFLUENCE OF MINOR STREAMS ****
________________________________________________________________________
Along Main Stream number: 1 in normal stream number 2
Stream flow area =     30.300(Ac.)
Runoff from this stream =     34.419(CFS)
Time of concentration =   15.63 min.
Rainfall intensity =     2.147(In/Hr)
Summary of stream data:

Stream   Flow rate      TC            Rainfall Intensity
 No.       (CFS)       (min)                (In/Hr)


1      242.321     35.47            1.266
2       34.419     15.63            2.147
Qmax(1) =
        1.000 *    1.000 *   242.321) +
        0.590 *    1.000 *    34.419) + =     262.612
Qmax(2) =
        1.000 *    0.441 *   242.321) +
        1.000 *    1.000 *    34.419) + =     141.221

Total of 2 streams to confluence:
Flow rates before confluence point:
     242.321      34.419
Maximum flow rates at confluence using above data:
      262.612      141.221
Area of streams before confluence:
      370.690       30.300
Results of confluence:
Total flow rate =    262.612(CFS)
Time of concentration =    35.472 min.
Effective stream area after confluence =    400.990(Ac.)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      416.000 to Point/Station      418.000
**** PIPEFLOW TRAVEL TIME (Program estimated size) ****
________________________________________________________________________
Upstream point/station elevation =    28.750(Ft.)
Downstream point/station elevation =    18.690(Ft.)
Pipe length  =   214.00(Ft.) Slope =   0.0470  Manning's N = 0.013
No. of pipes = 1  Required pipe flow  =   262.612(CFS)
Nearest computed pipe diameter  =     48.00(In.)
Calculated individual pipe flow  =   262.612(CFS)
Normal flow depth in pipe =   33.80(In.)
Flow top width inside pipe =   43.82(In.)
```

```
Critical depth could not be calculated.
Pipe flow velocity =     27.79(Ft/s)
Travel time through pipe =    0.13 min.
Time of concentration (TC) =    35.60 min.


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      416.000 to Point/Station      418.000
**** SUBAREA FLOW ADDITION ****
____________________________________________________________________________
Rainfall intensity (I) =      1.263(In/Hr) for a    10.0 year storm
Decimal fraction soil group A = 0.080
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 0.020
Decimal fraction soil group D = 0.900
[LOW DENSITY RESIDENTIAL                      ]
(1.0 DU/A or Less       )
Impervious value, Ai = 0.100
Sub-Area C Value = 0.398
The area added to the existing stream causes a
a lower flow rate of Q =    258.450(CFS)
therefore the upstream flow rate of Q =    262.612(CFS) is being used
Time of concentration =    35.60 min.
Rainfall intensity =      1.263(In/Hr) for a    10.0 year storm
Effective runoff coefficient used for total area
(Q=KCIA) is C = 0.484  CA =    204.664
Subarea runoff =      0.000(CFS) for     21.460(Ac.)
Total runoff =    262.612(CFS)   Total area =     422.450(Ac.)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      418.000 to Point/Station      419.000
**** PIPEFLOW TRAVEL TIME (Program estimated size) ****
____________________________________________________________________________
Upstream point/station elevation =    28.000(Ft.)
Downstream point/station elevation =    21.600(Ft.)
Pipe length  =  1600.00(Ft.) Slope =   0.0040  Manning's N = 0.013
No. of pipes = 1  Required pipe flow  =   262.612(CFS)
Nearest computed pipe diameter  =     72.00(In.)
Calculated individual pipe flow  =   262.612(CFS)
Normal flow depth in pipe =   57.75(In.)
Flow top width inside pipe =   57.37(In.)
Critical Depth =   53.27(In.)
Pipe flow velocity =     10.80(Ft/s)
Travel time through pipe =    2.47 min.
Time of concentration (TC) =    38.07 min.


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      418.000 to Point/Station      419.000
**** SUBAREA FLOW ADDITION ****
____________________________________________________________________________
```

```
Rainfall intensity (I) =      1.209(In/Hr) for a    10.0 year storm
Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 0.000
Decimal fraction soil group D = 1.000
[MEDIUM DENSITY RESIDENTIAL                  ]
(10.9 DU/A or Less      )
Impervious value, Ai = 0.450
Sub-Area C Value = 0.600
The area added to the existing stream causes a
a lower flow rate of Q =    248.060(CFS)
therefore the upstream flow rate of Q =    262.612(CFS) is being used
Time of concentration =    38.07 min.
Rainfall intensity =      1.209(In/Hr) for a    10.0 year storm
Effective runoff coefficient used for total area
(Q=KCIA) is C = 0.485  CA =    205.120
Subarea runoff =      0.000(CFS) for      0.760(Ac.)
Total runoff =    262.612(CFS)   Total area =     423.210(Ac.)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      419.000 to Point/Station      420.000
**** PIPEFLOW TRAVEL TIME (Program estimated size) ****
----------------------------------------------------------------------
Upstream point/station elevation =    10.000(Ft.)
Downstream point/station elevation =     9.020(Ft.)
Pipe length  =   245.00(Ft.) Slope =   0.0040  Manning's N = 0.013
No. of pipes = 1  Required pipe flow  =   262.612(CFS)
Nearest computed pipe diameter  =     72.00(In.)
Calculated individual pipe flow  =   262.612(CFS)
Normal flow depth in pipe =   57.75(In.)
Flow top width inside pipe =   57.37(In.)
Critical Depth =   53.27(In.)
Pipe flow velocity =     10.80(Ft/s)
Travel time through pipe =    0.38 min.
Time of concentration (TC) =    38.45 min.


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      419.000 to Point/Station      420.000
**** CONFLUENCE OF MAIN STREAMS ****
----------------------------------------------------------------------
The following data inside Main Stream is listed:
In Main Stream number: 1
Stream flow area =    423.210(Ac.)
Runoff from this stream =    262.612(CFS)
Time of concentration =   38.45 min.
Rainfall intensity =     1.202(In/Hr)
Program is now starting with Main Stream No. 2


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
```

```
Process from Point/Station      430.000 to Point/Station      431.000
**** INITIAL AREA EVALUATION ****
----------------------------------------------------------------------
Decimal fraction soil group A = 0.200
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 0.150
Decimal fraction soil group D = 0.650
[MEDIUM DENSITY RESIDENTIAL                  ]
(7.3 DU/A or Less       )
Impervious value, Ai = 0.400
Sub-Area C Value = 0.547
Initial subarea total flow distance  =  665.000(Ft.)
Highest elevation =  134.500(Ft.)
Lowest elevation =   51.000(Ft.)
Elevation difference =   83.500(Ft.) Slope = 12.556 %
INITIAL AREA TIME OF CONCENTRATION CALCULATIONS:
The maximum overland flow distance is 100.00 (Ft)
for the top area slope value of  12.56 %, in a development type of
 7.3 DU/A or Less
In Accordance With Figure 3-3
Initial Area Time of Concentration =   4.28 minutes
TC = [1.8*(1.1-C)*distance(Ft.)^.5)/(% slope^(1/3)]
TC = [1.8*(1.1-0.5475)*( 100.000^.5)/(  12.556^(1/3)]=   4.28
The initial area total distance of  665.00 (Ft.) entered leaves a
remaining distance of  565.00 (Ft.)
Using Figure 3-4, the travel time for this distance is   2.28 minutes
for a distance of 565.00 (Ft.) and a slope of 12.56 %
with an elevation difference of  70.94(Ft.) from the end of the top area
Tt = [11.9*length(Mi)^3)/(elevation change(Ft.))]^.385 *60(min/hr)
 =    2.284 Minutes
Tt=[(11.9*0.1070^3)/( 70.94)]^.385=  2.28
Total initial area Ti =   4.28 minutes from Figure 3-3 formula plus
  2.28 minutes from the Figure 3-4 formula =   6.56 minutes
Rainfall intensity (I) =      3.759(In/Hr) for a    10.0 year storm
Effective runoff coefficient used for area (Q=KCIA) is C = 0.547
Subarea runoff =      6.647(CFS)
Total initial stream area =        3.230(Ac.)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      431.000 to Point/Station      432.000
**** STREET FLOW TRAVEL TIME + SUBAREA FLOW ADDITION ****
----------------------------------------------------------------------
Top of street segment elevation =    51.000(Ft.)
End of street segment elevation =    14.000(Ft.)
Length of street segment  =   830.000(Ft.)
Height of curb above gutter flowline  =    6.0(In.)
Width of half street (curb to crown)  =  18.000(Ft.)
Distance from crown to crossfall grade break  =   8.000(Ft.)
Slope from gutter to grade break (v/hz) =   0.020
Slope from grade break to crown (v/hz)  =   0.020
Street flow is on [1] side(s) of the street
```

```
Distance from curb to property line  =  10.000(Ft.)
Slope from curb to property line (v/hz) =   0.020
Gutter width =   1.500(Ft.)
Gutter hike from flowline =  1.500(In.)
 Manning's N in gutter =  0.0150
 Manning's N from gutter to grade break =  0.0180
 Manning's N from grade break to crown =  0.0180
Estimated mean flow rate at midpoint of street =     25.415(CFS)
Depth of flow =   0.493(Ft.), Average velocity =   6.373(Ft/s)
Note:  depth of flow exceeds top of street crown.
Streetflow hydraulics at midpoint of street travel:
Halfstreet flow width =  18.000(Ft.)
Flow velocity =   6.37(Ft/s)
Travel time =    2.17 min.     TC =    8.73  min.
 Adding area flow to street
Rainfall intensity (I) =      3.126(In/Hr) for a    10.0 year storm
Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 0.300
Decimal fraction soil group D = 0.700
[MEDIUM DENSITY RESIDENTIAL                  ]
(4.3 DU/A or Less       )
Impervious value, Ai = 0.300
Sub-Area C Value = 0.508
Rainfall intensity =      3.126(In/Hr) for a    10.0 year storm
Effective runoff coefficient used for total area
(Q=KCIA) is C = 0.513  CA =     14.113
Subarea runoff =     37.468(CFS) for     24.300(Ac.)
Total runoff =     44.114(CFS)   Total area =      27.530(Ac.)
Street flow at end of street =     44.114(CFS)
Half street flow at end of street =     44.114(CFS)
Depth of flow =   0.591(Ft.), Average velocity =   7.403(Ft/s)
Warning: depth of flow exceeds top of curb
Note:  depth of flow exceeds top of street crown.
Distance that curb overflow reaches into property =    4.53(Ft.)
Flow width (from curb towards crown)=  18.000(Ft.)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      432.000 to Point/Station      433.000
**** PIPEFLOW TRAVEL TIME (Program estimated size) ****
----------------------------------------------------------------------
Upstream point/station elevation =    14.000(Ft.)
Downstream point/station elevation =    12.950(Ft.)
Pipe length  =   150.00(Ft.) Slope =   0.0070  Manning's N = 0.013
No. of pipes = 1  Required pipe flow  =    44.114(CFS)
Nearest computed pipe diameter  =     33.00(In.)
Calculated individual pipe flow  =    44.114(CFS)
Normal flow depth in pipe =   26.95(In.)
Flow top width inside pipe =   25.53(In.)
Critical Depth =   26.43(In.)
Pipe flow velocity =      8.49(Ft/s)
```

```
Travel time through pipe =    0.29 min.
Time of concentration (TC) =     9.03 min.


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      432.000 to Point/Station      433.000
**** CONFLUENCE OF MAIN STREAMS ****
________________________________________________________________________
The following data inside Main Stream is listed:
In Main Stream number: 2
Stream flow area =     27.530(Ac.)
Runoff from this stream =     44.114(CFS)
Time of concentration =    9.03 min.
Rainfall intensity =     3.060(In/Hr)
Summary of stream data:

Stream   Flow rate      TC            Rainfall Intensity
 No.       (CFS)       (min)                 (In/Hr)


1      262.612     38.45            1.202
2       44.114      9.03            3.060
Qmax(1) =
        1.000 *    1.000 *   262.612) +
        0.393 *    1.000 *    44.114) + =     279.937
Qmax(2) =
        1.000 *    0.235 *   262.612) +
        1.000 *    1.000 *    44.114) + =     105.775

Total of 2 main streams to confluence:
Flow rates before confluence point:
     262.612      44.114
Maximum flow rates at confluence using above data:
      279.937      105.775
Area of streams before confluence:
      423.210       27.530


Results of confluence:
Total flow rate =    279.937(CFS)
Time of concentration =    38.448 min.
Effective stream area after confluence  =    450.740(Ac.)
End of computations, total study area =         450.740 (Ac.)
```

San Diego County Rational Hydrology Program

CIVILCADD/CIVILDESIGN Engineering Software,(c)1991-2009 Version 7.8

Rational method hydrology program based on
San Diego County Flood Control Division 2003 hydrology manual
Rational Hydrology Study Date: 12/08/12

City of Carlsbad
Hydromodification Exemption Study
Major Basin 500
10-Year Flow Rate

********* Hydrology Study Control Information **********

Program License Serial Number 4028

Rational hydrology study storm event year is 10.0
English (in-lb) input data Units used

Map data precipitation entered:
6 hour, precipitation(inches) = 1.700
24 hour precipitation(inches) = 3.100
P6/P24 = 54.8%
San Diego hydrology manual 'C' values used

++
Process from Point/Station 500.000 to Point/Station 501.000
**** INITIAL AREA EVALUATION ****

Decimal fraction soil group A = 1.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 0.000
Decimal fraction soil group D = 0.000
[MEDIUM DENSITY RESIDENTIAL]
(7.3 DU/A or Less)
Impervious value, Ai = 0.400
Sub-Area C Value = 0.480
Initial subarea total flow distance = 250.000(Ft.)
Highest elevation = 50.000(Ft.)
Lowest elevation = 48.000(Ft.)
Elevation difference = 2.000(Ft.) Slope = 0.800 %
INITIAL AREA TIME OF CONCENTRATION CALCULATIONS:
The maximum overland flow distance is 65.00 (Ft)
for the top area slope value of 0.80 %, in a development type of
7.3 DU/A or Less
In Accordance With Figure 3-3
Initial Area Time of Concentration = 9.69 minutes
TC = [1.8*(1.1-C)*distance(Ft.)^.5)/(% slope^(1/3)]

```
TC = [1.8*(1.1-0.4800)*(  65.000^.5)/(   0.800^(1/3)]=   9.69
The initial area total distance of  250.00 (Ft.) entered leaves a
remaining distance of  185.00 (Ft.)
Using Figure 3-4, the travel time for this distance is   2.79 minutes
for a distance of 185.00 (Ft.) and a slope of  0.80 %
with an elevation difference of   1.48(Ft.) from the end of the top area
Tt = [11.9*length(Mi)^3)/(elevation change(Ft.))]^.385 *60(min/hr)
 =    2.790 Minutes
Tt=[(11.9*0.0350^3)/(  1.48)]^.385=  2.79
Total initial area Ti =   9.69 minutes from Figure 3-3 formula plus
  2.79 minutes from the Figure 3-4 formula =  12.48 minutes
Rainfall intensity (I) =      2.483(In/Hr) for a    10.0 year storm
Effective runoff coefficient used for area (Q=KCIA) is C = 0.480
Subarea runoff =      1.156(CFS)
Total initial stream area =        0.970(Ac.)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      501.000 to Point/Station      502.000
**** PIPEFLOW TRAVEL TIME (Program estimated size) ****
________________________________________________________________________
Upstream point/station elevation =    48.000(Ft.)
Downstream point/station elevation =    47.100(Ft.)
Pipe length  =   180.00(Ft.) Slope =   0.0050  Manning's N = 0.013
No. of pipes = 1  Required pipe flow  =     1.156(CFS)
Nearest computed pipe diameter  =      9.00(In.)
Calculated individual pipe flow  =     1.156(CFS)
Normal flow depth in pipe =    7.29(In.)
Flow top width inside pipe =    7.06(In.)
Critical Depth =    5.93(In.)
Pipe flow velocity =      3.02(Ft/s)
Travel time through pipe =    0.99 min.
Time of concentration (TC) =    13.48 min.


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      501.000 to Point/Station      502.000
**** SUBAREA FLOW ADDITION ****
________________________________________________________________________
Rainfall intensity (I) =      2.363(In/Hr) for a    10.0 year storm
Decimal fraction soil group A = 1.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 0.000
Decimal fraction soil group D = 0.000
[MEDIUM DENSITY RESIDENTIAL                 ]
(7.3 DU/A or Less       )
Impervious value, Ai = 0.400
Sub-Area C Value = 0.480
Time of concentration =    13.48 min.
Rainfall intensity =      2.363(In/Hr) for a    10.0 year storm
Effective runoff coefficient used for total area
(Q=KCIA) is C = 0.480  CA =      2.491
Subarea runoff =      4.731(CFS) for      4.220(Ac.)
Total runoff =      5.887(CFS)   Total area =       5.190(Ac.)
```

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++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      502.000 to Point/Station      503.000
**** PIPEFLOW TRAVEL TIME (Program estimated size) ****
------------------------------------------------------------------------
Upstream point/station elevation =    47.000(Ft.)
Downstream point/station elevation =    30.000(Ft.)
Pipe length  =    60.00(Ft.) Slope =   0.2833  Manning's N = 0.013
No. of pipes = 1  Required pipe flow  =     5.887(CFS)
Nearest computed pipe diameter  =      9.00(In.)
Calculated individual pipe flow  =     5.887(CFS)
Normal flow depth in pipe =    5.38(In.)
Flow top width inside pipe =    8.83(In.)
Critical depth could not be calculated.
Pipe flow velocity =     21.35(Ft/s)
Travel time through pipe =    0.05 min.
Time of concentration (TC) =    13.52 min.
End of computations, total study area =           5.190 (Ac.)
```

GRAPHIC SCALE

1000 0 500 1000

1 INCH = 500 FEET

LEGEND:

- MAJOR DRAINAGE BASIN BOUNDARY
- NATURAL FLOW PATH
- HYDROMODIFICATION EXEMPT AREA
- HYDROMODIFICATION EXEMPT AREA IF FUTURE DRAINAGE IMPROVEMENTS ARE CONSTRUCTED

HMP EXEMPTION EXHIBIT

PIPE SEGMENT	AS-BUILT DRAWING NO.	EXISTING FACILITY AND MINIMUM SLOPE	10-YEAR FLOW, CFS	10-YEAR FLOW CONTAINED IN PIPE UNDER PRESSURE	EXCESS 10-YEAR FLOW CONTAINED IN STREET	EXCESS 10-YEAR FLOW ENTERS ADJACENT LAGOON
A	287-2	18" RCP AT 0.5%	13	Y		
B	220-8	18" RCP (UNKNOWN SLOPE)	37		Y	
C	462-6	18" RCP AT 0.5%	13	Y		
D	137-3A	12" RCP AT 0.24%	18		Y	
E	133-9	36" RCP AT 0.76%	91		Y	
F	146-8	24" RCP AT 0.43%	57		Y	
G	CALTRANS CONTRACT 11-039724	30" RCP (UNKNOWN SLOPE)	32	Y		
H	182-10, 304-2	66" RCP AT 0.28%	293		Y	
I	166-8, 189-6, 206-2	36" RCP AT 1.60% TO 48" RCP AT 2.27%	116 TO 265	Y		
J	141-3	24" RCP AT 1.03% TO 27" RCP AT 2.30%	56 TO 104		Y	
K	146-3	18" RCP AT 1.52%	19	Y		
L	125-4	18" RCP AT 1.23%	16	Y		
M	158-6	18" RCP AT 1.00%	34		Y	
N	158-6	24" RCP AT 1.00%	39	Y		
O	167-4	24" RCP AT 2.00%	39	Y		
P	167-4	21" RCP AT 10.00% TO 24" RCP AT 2.00%	36	Y		
Q	167-5	42" RCP AT 1.00%	117	Y		
R	152-3	60" RCP AT 0.4%	263			Y

NOTE:
THE STORM DRAIN SEGMENTS IN THIS TABLE ARE ONES IN WHICH THE HYDRAULIC ANALYSES SHOW INSUFFICIENT NORMAL DEPTH CAPACITY TO CONVEY THE 10-YEAR FLOW (YELLOW AND RED LINES ON THE LEGEND). THIS TABLE INDICATES IF THE SEGMENTS HAVE CAPACITY TO CONVEY THE 10-YEAR FLOW UNDER PRESSURE. FOR SYSTEMS THAT CANNOT CONVEY THE 10-YEAR FLOW UNDER PRESSURE, THE TABLE INDICATES IF THE EXCESS FLOW CAN BE CONVEYED IN THE STREET OR WILL DIRECTLY ENTER AN ADJACENT LAGOON. ALL OF THE SEGMENTS MEET ONE OF THESE CRITERIA AND, HENCE, SATISFIES THE HYDROMODIFICATION EXEMPTION REQUIREMENT FOR CONVEYING THE 10-YEAR FLOW.

THE DRAINAGE AREAS ENCOMPASSING SEGMENTS A THROUGH L ARE ON STUDY AREA EXHIBIT SHEET 2. THE DRAINAGE AREAS ENCOMPASSING SEGMENTS M THORUGH R ARE ON STUDY AREA EXHIBIT SHEET 1.

STUDY AREA EXHIBIT
HYDROMODIFICATION EXEMPTION

AGUA HEDIONDA CREEK
DRAINAGE AREAS

SHEET 1 OF 2

DETAIL

GRAPHIC SCALE
300 0 300 600
1 INCH = 300 FEET

MAJOR DRAINAGE BASIN 300

MAJOR DRAINAGE BASIN 200

MAJOR DRAINAGE BASIN 100

MAJOR DRAINAGE BASIN 700

BUENA VISTA LAGOON

MATCHLINE - SEE DETAIL ABOVE

SEE SHEET 1

SEE SHEET 1

SEE SHEET 1

BATIQUITOS LAGOON

BUENA VISTA CREEK DRAINAGE AREAS

PIPE SEGMENT	AS-BUILT DRAWING NO.	EXISTING FACILITY AND MINIMUM SLOPE	10-YEAR FLOW, CFS	10-YEAR FLOW CONTAINED IN PIPE UNDER PRESSURE	EXCESS 10-YEAR FLOW CONTAINED IN STREET	EXCESS 10-YEAR FLOW ENTERS ADJACENT LAGOON
A	287-2	18" RCP AT 0.5%	13	Y		
B	220-8	18" RCP (UNKNOWN SLOPE)	37		Y	
C	462-6	18" RCP AT 0.5%	13	Y		
D	137-3A	12" RCP AT 0.24%	18		Y	
E	133-9	36" RCP AT 0.76%	91		Y	
F	146-8	24" RCP AT 0.43%	57		Y	
G	CALTRANS CONTRACT 11-039724	30" RCP (UNKNOWN SLOPE)	32	Y		
H	182-10, 304-2	66" RCP AT 0.28%	293		Y	
I	166-8, 189-6, 206-2	36" RCP AT 1.60% TO 48" RCP AT 2.27%	116 TO 265	Y		
J	141-3	24" RCP AT 1.03% TO 27" RCP AT 2.30%	56 TO 104		Y	
K	146-3	18" RCP AT 1.52%	19	Y		
L	125-4	18" RCP AT 1.23%	16	Y		
M	158-6	18" RCP AT 1.00%	34		Y	
N	158-6	24" RCP AT 1.00%	39	Y		
O	167-4	24" RCP AT 2.00%	39	Y		
P	167-4	21" RCP AT 10.00% TO 24" RCP AT 2.00%	36	Y		
Q	167-5	42" RCP AT 1.00%	117	Y		
R	152-3	60" RCP AT 0.4%	263			Y

NOTE:
THE STORM DRAIN SEGMENTS IN THIS TABLE ARE ONES IN WHICH THE HYDRAULIC ANALYSES SHOW INSUFFICIENT NORMAL DEPTH CAPACITY TO CONVEY THE 10-YEAR FLOW (YELLOW AND RED LINES ON THE LEGEND). THIS TABLE INDICATES IF THE SEGMENTS HAVE CAPACITY TO CONVEY THE 10-YEAR FLOW UNDER PRESSURE. FOR SYSTEMS THAT CANNOT CONVEY THE 10-YEAR FLOW UNDER PRESSURE, THE TABLE INDICATES IF THE EXCESS FLOW CAN BE CONVEYED IN THE STREET OR WILL DIRECTLY ENTER AN ADJACENT LAGOON. ALL OF THE SEGMENTS MEET ONE OF THESE CRITERIA AND, HENCE, SATISFIES THE HYDROMODIFICATION EXEMPTION REQUIREMENT FOR CONVEYING THE 10-YEAR FLOW.

THE DRAINAGE AREAS ENCOMPASSING SEGMENTS A THROUGH L ARE ON STUDY AREA EXHIBIT SHEET 2. THE DRAINAGE AREAS ENCOMPASSING SEGMENTS M THORUGH R ARE ON STUDY AREA EXHIBIT SHEET 1.

LEGEND:

- MAJOR DRAINAGE BASIN BOUNDARY
- MINOR DRAINAGE BASIN BOUNDARY (SUBBASIN)
- OVERLAND FLOW PATH
- 3.62 AC DRAINAGE BASIN AREA
- [10] RATIONAL METHOD NODE NUMBER
- EXISTING CATCH BASIN OR INLET
- EXISTING DRAINAGE DITCH OR SWALE
- MINOR EXISTING STORM DRAIN PIPE OR LATERAL
- AS-BUILT PLANS SHOWING 10-YEAR OR HIGHER FLOW CONTAINED IN EXISTING PIPE
- NORMAL DEPTH ANALYSIS SHOWING 10-YEAR FLOW CONTAINED IN EXISTING PIPE
- NORMAL DEPTH ANALYSIS SHOWING EXISTING PIPE INCREASED BY ONE PIPE SIZE (6") TO CONTAIN 10-YEAR FLOW (SEE TABLE FOR DETAILS)
- NORMAL DEPTH ANALYSIS SHOWING EXISTING PIPE INCREASED BY MORE THAN ONE PIPE SIZE TO CONTAIN 10-YEAR FLOW (SEE TABLE FOR DETAILS)
- OUTLET INTO LAGOON
- (A) PIPE SEGMENT (SEE TABLE FOR DETAILS)

BATIQUITOS CREEK DRAINAGE AREAS

STUDY AREA EXHIBIT
HYDROMODIFICATION EXEMPTION