



DEVELOPMENT MANUAL Volume II - DESIGN CRITERIA

RIO RANCHO, NEW MEXICO

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II. INTRODUCTION

The City of Rio Rancho's Development Manual is comprised of two separate, but related, volumes. Volume I – Process contains development-related policies and procedures routinely used by the City of Rio Rancho. Development Manual Volume II – Design Criteria provides design standards and criteria for the physical development of the City of Rio Rancho. Together, these procedures and design criteria provide for the orderly development of the community, assuring the public health, safety, and general welfare.

For the purpose of monitoring, evaluating and revising both Volumes of the Development Manual, an interdisciplinary team of city and community individuals shall convene on, at a minimum, a quarterly basis to consider revisions to improve and refine either Volume. Thereby assuring a continued effort to seek improvement in their usefulness, accuracy and effectiveness. The Executive Review Committee shall consist of nine (9) members; five (5) City department representatives and four (4) community group representatives.

Chapter II.1

RECORDABLE AND DEVELOPMENT DOCUMENTS

1. INTRODUCTION

This chapter presents detailed specifications for the preparation of significant development related documents which ultimately are filed or "recorded" with the Sandoval County Clerk.

The major and most significant document discussed is the Final Plat as required by the current Subdivision Ordinance of the City of Rio Rancho. The preparation of a preliminary plat is also discussed in detail since the preliminary plat, when approved by the Planning and Zoning Board, becomes the basis for preparation of the Final Plat.

Examples of appropriate dedication statements on plats and formats for grants of easement by separate instrument for certain purposes, are also included.

The other major types of documents discussed are Construction Plans, including but not limited to; Site Development Plans, Grading and Drainage Plans and Landscaping Plans, Traffic Impact Analysis, Geotech Report, Drainage Master Plan, Drainage Implementation Plan, and a Water and Waste Water Availability Statement. Detailed criteria for these three types of plans have been developed to assure that information may be consistently found on the plans and that no information is lost due to illegibility when the documents are scanned for record.

2. PLAT REQUIREMENTS

A. Governing Regulations

Subdivision Ordinance (Chapter 155-Subdivisions)

This ordinance is the primary regulation governing plat preparation for subdivided land within the jurisdiction of the City of Rio Rancho planning and zoning. Additional requirements related to processing and recording are promulgated by the Sandoval County Clerk.

B. General Requirements for all Plats

"Plat" means, for the purposes of this section, a formal graphic presentation of subdivided land prepared in the manner specified herein and containing required descriptions of subdivided land, acknowledgment by owners of consent to subdivision, dedications, and certification by the plat preparer. This section covers requirements for (1) Preliminary Plats which are required as a step toward Final Plat preparation and approval; (2) plats intended for abbreviated procedure called Summary Plats [generally Final Plats involving minor subdivisions with no increase in the number of lots, a decrease in the number of lots, minor boundary changes, or are for a limited special purpose and which by their nature are appropriate for abbreviated processing; (City of Rio Rancho Ordinance Chapter 155.26)] and (3) Final Plats of proposed subdivisions submitted for approval to the Planning and Zoning Board.

The following are requirements for all plats (detailed requirements for specific types of plats are given in subsequent subsections):

1. Title of Plat

The name of the subdivision or legal description created by the plat should be placed near the upper right hand corner of each plat sheet and should be the boldest lettering on the sheet.

2. Subtitle of Plat

Immediately below the Title of Plat and in the form of a brief statement is the subtitle of the Plat. Examples are "Replat of (lands being replatted)...to... (new name)" or "Subdivision Plat" or "Annexation Plat".

3. Date of Plat

The month and year in which the plat is prepared should be placed immediately below the Subtitle of the plat on each sheet.

4. Location Map

A reduced scale vicinity map showing the relationship of the lands of the plat to well known principal landmarks and municipal boundaries should be placed in the upper left hand corner of the plat sheet or "first sheet" if a multiple sheet plat.

5. Scale and North Arrow

Drawing scale must be shown as both equivalent scale and graphic scale, preferably immediately below the north arrow which must be shown in proper orientation with respect to the plat lines on each plat sheet. A north arrow must also be provided to orient the location map.

6. Purpose of Plat

The purpose of plat statement is a description of the intent of the platting action application. This should delineate at a minimum 1) what is being created by the plat, 2) all dedications of Right-of-Way, 3) easements granted and 4) any vacations of Rights-of-Way or easements.

7. Plat Boundary Lines

Plat boundary lines must be shown as the boldest lines on the plat sheet and must be properly oriented and annotated giving the bearings of all lines in degrees, minutes, and seconds and the basis for such bearings. The distances of all lines must be drawn to correct scale and dimensioned in feet correct to hundredths or other functional reference system.

8. Tie to Permanent Survey Monuments

Tie to Permanent Survey Monuments from the plat boundary lines must be shown giving monument identification, New Mexico State Plane, Central Meridian Datum Coordinates, , and bearings and distances of courses establishing ties; bearings in degrees, minutes and seconds, and distances in feet and hundredths. (See Chapter II.6, Surveys and Permanent Monumentation of the DPM, City of Rio Rancho ordinances; Chapter 155.24, (C), (3), (a), and Chapter 155.25, (C), (5) for more information)

9. Existing Easements

Existing easements within, along, or intersecting the plat boundaries must be shown giving correct location, dimensions, and purpose or nature of right of easement. Existing easements which are to remain in the Final Plat should be drawn in light lines or dashed lines and clearly labeled. Easements intended to be abandoned or vacated by Final Plat approval should be shown as ghost lines, easily distinguished from lines for easements to remain, and must be clearly labeled including the intent to abandon or vacate. Vacation of easements will require additional documentation; see subsection D of this chapter.

10. Existing Public Right-of-Way

Existing public right-of-way along or intersecting the plat boundary or boundary streets of the plat must be shown giving correct locations and dimensions, purpose or nature, and name, if applicable.

11. Total Area of Plat

Total area of plat within the plat boundaries must be shown in acres, rounded to four decimal places for the type of plat being prepared.

12. Monument Description and Location

Monument description and location must be shown for all found monuments and for all monuments set or, if a Preliminary Plat, intended to be set within or related to the plat boundary and ties thereto. Monument description must include the registration number of the surveyor who set the monument or the number which appears on found monuments. Reference DPM Chapter II.6- Surveys and Permanent Monumentation

13. Disclosure Statement

A disclosure statement is required of all plats packages with the exception of abbreviated process plats [City of Rio Rancho Ordinance Chapter 155.26 (A)]. The preliminary and final plat shall be accompanied by a disclosure statement in accordance with the standardized format provided in **Appendix 2.1.2** of this chapter. The purpose of the disclosure statement is to permit the prospective purchaser, lessee, or other person acquiring an interest in the subdivided land to make an informed decision about the purchase, lease, or other conveyance of the land.

14. Signature Blocks

The signature block will conform to the sample provided per section 21, C., 7, d, on page 19 -21 of this chapter.

15. Registered Surveyor Certification

Certification by the registered land surveyor who performed the surveys for the plat and who prepared the plat certifying the accuracy of the surveys and the plat and that the surveys were either performed by the surveyor or under his supervision and that the plat was prepared by the surveyor or under his supervision. If the plat is prepared from record documents only, the certification should so state.

Note: Plats which do not contain clearly identified ties to permanent survey monuments by either record or existing found monuments will not be accepted.

16. Jurisdictional affidavit

Jurisdictional affidavit by surveyor stating the subject property is within the platting jurisdiction of the City of Rio Rancho.

Preliminary Plat Requirements

Reference City of Rio Rancho, Chapter 155: Subdivisions, for subdivision procedures. The following requirements for Preliminary Plats are general requirements:

1. Scale

Must be 1" = 200', or larger (1" = 100' preferable)

2. Additional Data Required – Construction Plans

a. Proposed Monumentation

- (1) Proposed bench mark locations
- (2) Proposed Permanent Survey Monument(s) location and method of tie to plat boundary
- (3) Proposed subdivision control monuments location and type

b. Existing Conditions

- (1) Type and width of paving on existing streets intersecting, along, or within 150' of the plat boundary
- (2) Existing utilities within and adjacent to plat
 - (a) Location and size of:
 - water wells
 - water reservoirs
 - water lines
 - sanitary sewers
 - storm drains, channels and other facilities
 - (b) Location of:
 - gas lines
 - fire hydrants
 - power lines and poles
 - telephone lines and poles
 - street light

- existing structures
- (c) If not on or immediately adjacent to site, direction to, distance to, and size of:
- nearest water lines
 - nearest sanitary sewers with invert elevation
- (3) Ground elevation and site based on mean sea level as established by the National Geodetic Survey North American Vertical Datum, 1988 (NAVD, '88):
- (a) For land having slopes less than 1%:
- by contour lines at intervals of not more than 1' and spot elevations not more than 100' apart at selected locations sufficient to define all breaks in grade and drainage features.
- (b) For lands sloping between 1% and 5%:
- contour lines at intervals not to exceed 2'
- (c) For lands sloping more than 5%:
- by contour lines at intervals not to exceed 5'
- (4) Existing property lines to be eliminated
- by light dashed lines clearly annotated to indicate elimination intent

3. Proposal Elements – Preliminary Plat

- a. Plat boundary gross area in acres to the nearest tenth of an acre
- b. Proposed public right-of-way locations and widths, street widths, and street names
- c. Proposed private way, locations and widths and street widths
- d. Proposed easements of any nature, locations, dimensions, nature or purpose, ownership and any limitations thereto
- e. Proposed block and lot lines with number or letter identification of each block and lot to be created. Lot fronts must be designated on any double fronting residential lots by placement of a one-foot No Vehicular Access Easement on one

of the frontages. Access and addressing must be from the minor street. Areas of all lots in acreage or square feet must be shown on the plat.

- f. Locations, dimensions, and approximate area of reserved or dedicated public lands.
- g. Proposed ground elevations presented as specified in C.2.b.3. of this section.
- h. Locations, dimensions, and approximate areas of proposed multi- family or non-residential areas
- i. Proposed locations of any planned water wells, reservoirs
- j. Any significant topographic features or conditions on-site
- k. Zoning of properties abutting and adjacent to the site
- l. City of Rio Rancho Plat Book & Page numbers and Sandoval County Clerk recordation for all abutting or adjacent properties

D. Final Plat Detailed Requirements

The following detailed requirements for Final Plats are in addition to the general requirements for all plats given in subsection B.

1. Scale

Must be either 1" = 100', or 1" = 50' (1" =50' preferable, when practical)

2. Additional Data Required – Construction Plans

a. Monuments

(1) Permanent Survey Monuments:

The location, description, and the registration number of the surveyor setting permanent survey monuments must be shown. Ties from Permanent Survey Monuments to the City of Rio Rancho control survey network must be shown. Site location must be determined in the New Mexico State Plane, Central Meridian Datum Coordinate System, or applicable ground distance and bearing , must be shown from any Permanent Monument with New Mexico State Plain Central Meridian Coordinates. The New Mexico State Plane Central Meridian Datum Coordinate delta alpha, and the combined sea level and scale factor (grid factor) must be shown at least one (1) of the Permanent

Survey Monuments or, the same data must be shown for the centroid of the area within the plat boundary. The point referenced must be clearly labeled.

(2) Subdivision Control Monuments:

All subdivision control monuments set must be accurately and completely described and shown on the plat giving the nature of the monument and the registration number of the surveyor who set it. If monumentation is to be deferred, proposed monument locations, descriptions and surveyors' registration numbers must be shown on the plat as prescribed above for set monuments, except that symbols for deferred monuments shall be different than those used for set or found monuments.

Additionally, a legend identifying the deferred monuments symbol must be provided labeled with the following statement:

"Deferred monumentation should be set no later than (two) 2 years after the date of filing of this plat with the Sandoval County Clerk."

Reference DPM Chapter II.6 Surveys and Permanent Monumentation.

(3) Bench Marks:

Reference DPM Chapter II.6 Surveys and Permanent Monumentation.

(4) Existing Monumentation:

All existing monumentation, including found property corners, must be shown on the plat, giving accurate description, location and registration number of surveyor who set the monument, if available. Reference DPM Chapter II.6 Surveys and Permanent Monumentation.

b. Plat Boundary:

In addition to the boundary items required by Subsection B, both record and measured distances and bearings must be shown and identified for all courses in the plat boundary on Final Plats.

c. Plat Area:

The total gross area expressed to four decimal places within the plat boundary must be shown on the Final Plat located on the plat as specified in the Subsection B.

d. Planning and Platting Jurisdiction:

Final Plats must contain a jurisdictional statement indicating that the plat either does or does not lie with the municipal boundaries at the time of submission for final City approval. If the plat does not lie within the municipal boundaries, the plat must contain a statement that the plat either does or does not lie within the planning and platting jurisdiction of the City of Rio Rancho.

e. Interior Data:

The following additional data must be shown within the plat boundary of all Final Plats.

(1) All existing public rights-of-ways which will remain and those to be created by the plat. Required information includes the following:

(a) Names of streets

(b) Right-of-way widths and locations

(c) Right-of-way data including the length, central angle, and radius of all curves in right-of-way lines; and

(d) Centerline data including the length, central angle, and radius of all curves.

(2) All easements, both existing and those to be created by the plat giving the following information:

(a) Location and dimensions by bearing and distance

(b) Purpose

(c) Limitations (if any)

(3) Any easements intended to be abandoned, identified as "to be abandoned or vacated by this plat"

Note: Easements may only be vacated by this means if legal consent of all those holding legal interest in the easement is provided on the Final Plat. If vacated by separate procedure or instrument, the approved document must be identified by title and Sandoval County Clerk recordation identification.

(4) All block and lot lines giving the following information:

(a) Location and dimensions of all lot lines by bearing and distance;

(b) Areas of all lots in acreage or square feet;

- (c) Number or letter identification, in progression, for each lot and each block. No lot identification may be duplicated within a single block and no block identification may be duplicated within a plat boundary; and
 - (d) Corner lot fronts must be designated by an “F” for all single-family residential lots.
- (5) Any lots dedicated or reserved for public use must be identified giving location and dimensions by bearing and distance, area in acres or square feet, and the intended purposes. If dedicated by a separate instrument, the document identification and County Clerk recordation information is to be included.

f. Exterior Data:

The following information concerning elements exterior to the plat boundary must be shown on the Final Plat:

- (1) Identification of lands adjoining the platted land, giving the identity of recorded subdivision plats, including the County Clerk recordation information, and City of Rio Rancho Plat Book and Page numbers. Other parcels of land with other types of legal descriptions shall use the most accurate identification available.
- (2) All streets on adjacent lands which intersect the boundary or boundary streets of the plat must be shown giving the location, dimensions of right-of-way and name. Private ways which intersect the plat boundary or boundary streets must be shown similarly.

g. Subdivision Data:

The following additional general information must be shown on the Final Plat:

- (1) The total miles of full-width streets and the total miles of half-width streets, as well as the total miles of all streets created by the plat;
- (2) The total number of lots and or tracts created by the plat;
- (3) The case number of the plat as assigned by the City Development Services Department; and
- (4) The date, including at least the month and year, of the survey

3. *Metes and bounds description*

A metes and bounds description, of the exterior boundary of the platted land must be given on the Final Plat. The caption portion of the description must include reference to the most recent recorded identification of the lands being subdivided or platted and the County recordation information therein. The description is to be located within the central one third of the area of the first sheet of the Final Plat, beginning near the upper margin.

4. *Consent and dedication statements*

a. A statement or statements must be on the Final Plat clearly stating that the proposed plat represents the desires of the owners and that all dedications, grants of easements and other public features of the plat are given for public use in perpetuity with the knowledge and free consent of the owners. Separate clauses of such statements may be necessary for specific special purpose features such as drainage easements. Unless otherwise approved by the planning authority, all grants of easements to the City must generally allow use for other purposes (e.g., drainage easements must also allow for installation of underground sanitary sewer and water lines). The granting of easements shall not obligate the City of Rio Rancho to maintain natural arroyos, drainage channels, or facilities that do not meet the standards of the City Engineer for design and construction , nor shall this granting require the protection of property lying outside of the easements granted.

b. All lands dedicated for public rights-of-way are to be dedicated in fee simple and the dedication statement must so state.

c. If lands are to be dedicated as parks within or associated with the plat,. the dedicated park land must be clearly indicated on the plat, as described herein for public areas.. A separate deed for the dedicated land is required to be provided to the City after the plat to complete the land transfer.

d. If the plat includes any private ways, there must be a statement on the plat establishing the permanent legal character of such private ways, and the statement must be acknowledged by the owners. The statement must indicate the permanent owners of the rights granted in the private ways. A typical form of such statement might read:

"Private ways (streets) shown hereon are hereby granted as permanent access easements to be indivisibly and privately and collectively owned by the owners of the individual properties which the easements serve."

Similar statements must be provided if other ownerships are intended; however, the permanence of access rights to individual properties must be indicated.

If any private way on the plat serves more than one (1) lot and is not to be paved prior to request for plat approval, a bond assuring required paving must be posted with the City.

- e. All owners' signatures on the plat must be acknowledged in the manner required for acknowledgment of deeds.

5. Certifications/ Signatures:

The following certifications/signatures are required to be on the Final Plat:

- a. Certification by the registered land surveyor who performed the surveys for the plat and who prepared the plat certifying the accuracy of the surveys and the plat and that the surveys were either performed by the surveyor or under his supervision and that the plat was prepared by the surveyor or under his supervision. If the plat is prepared from record documents only, the certification should so state. Reference DPM Chapter II.6 Surveys and Permanent Monumentation.

Note: Plats which do not contain clearly identified ties to permanent survey by either record or existing found monuments will not be accepted.

- b. Jurisdictional affidavit by surveyor stating the subject property is within the platting jurisdiction of the City of Rio Rancho.
- c. Certification by utilities that respective needs, if reasonable, are met by the plat. Cable One, Qwest Communications, PNM Electric Services and New Mexico Gas Services are the firms currently providing local service which should make such certification by authorized representatives.
- d. Certification by the City Engineer or his/ her designee that:
 - 1) The requirements of the Department of Public Works, Utility Division have been met;
 - 2) Required monumentation is in place or that satisfactory arrangements for deferred monumentation have been made, including financial security and that surveys have been found in compliance with design standards;
 - 3) Water courses and storm drainage provisions are approved; and
 - 4) Street and alley configuration, right-of-way width, street width, and any private ways are approved.

- e. Certification of the Planning and Zoning Board Chairman noting the date that the plat was approved by the Planning and Zoning Board and acceptance of all dedications and/or vacations (if applicable)
- f. Certification of the City Clerk noting the date that the plat was approved by the Planning and Zoning Board
- g. Certification of the Sandoval County Treasurer that all current and previous property taxes have been paid in full
- h. Certification of the Sandoval County Clerk noting the date, time and recording information
- i. Certification by the Southern Sandoval County Arroyo Flood Control Authority (SSCAFCA) that its needs have been met. Either the SSCAFCA Chairman of the Board or the City Engineer can provide more detailed limits for questionable cases.

Note: The requirement for SSCAFCA approval applies only to plats lying generally east of the north and south diversion channels constructed under SSCAFCA auspices and west of the Middle Rio Grande Conservancy District channels on the west side of the Rio Grande.

- j. Certification by the Park Recreation and Community Services Department Director or his/her designee that park dedication requirements have been met.
- k. Certification by the Development Services Department Director or his/her designee that requirements have been met for change in City of Rio Rancho ownership or rights, involving any rights-of-way, grants of easement, or public lands to be altered by the plat.
- l. Certification by the Planning and Zoning Board Chairman of plat approval noting date and time of the Planning and Zoning Board approval.
- m. Certification of the City Clerk of the date the plat was approved either by the Planning and Zoning Board or administratively by the Development Services Department Director.
- n. Certification by the Mayor of conditional acceptance of all dedications and grants of easement for public use. This certification must be accompanied by a statement on the plat indicating such approval and acceptance. An acceptable form of such statement is shown in subsection 7 of this chapter.

<p><i>Note: Street names must not contain more than 13 letters and spaces. In order to assure that street names will receive approval, the Department of Development</i></p>
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Services, Planning Division should be contacted to review proposed for possible conflicts with existing street names. See Chapter 12 for street naming

- o. If lot lines are changed from existing locations and public infrastructure such as water systems, and sanitary sewer systems are in place prior to the proposed platting, the owners of the lands being replatted or seeking such lot line change must certify acceptance of responsibility for any necessary relocation of water or sanitary sewer services to the lots affected by the lot line change.

6. Graphic standards

a. Materials

- (1) Preliminary Plats must be drawn on stable reproducible transparent material.
- (2) Final Plats must be drawn in permanent black ink on stable reproducible, polyester, transparent material or produced by other means resulting in a permanent, stable, and reproducible transparency. All signatures must be original, not reproduced. Plat sheet size for single sheet plats may be any of the following sizes currently accepted by the County Clerk: a (8 ½" x 14"), b (12" x 18") c (18" x 24"). The maximum acceptable sheet size for any plat is 24"X 36". The sheet size chosen must accommodate adequately all required data at the required scale. Multiple sheets may be required for large or complex plats. Sheet size for multiple sheet plats must be at least 18" x 24".
Spliced plat sheets are not acceptable.
- (3) Adhesive materials or notes may not be used for line work or dimensions bearings of lines, or notes on Final Plats. Signatures must be original. Plats assembled with adhesive materials are not be considered acceptable.

b. Drafting Standards

The following standards provide minimums required to achieve satisfactory microfilm reduction and reproduction with current methods. Use of larger sizes of lines and letters is encouraged, providing relative size relationships are maintained.

(1) Lines (See Appendix 2.1.1)

Plat boundary lines must be the most outstanding lines on the plat and must be clearly distinguished solid lines.

Interior property lines must be solid lines if created by the plat or distinctively dashed lines if existing and to remain or existing and to be changed by the plat. The lines must be less bold than the plat boundary. Dashed lines used for existing property must be distinguished by either pattern or notation to

identify clearly, whether they are to remain, relocated or eliminated by the plat.

Easement lines must be dashed lines of a pattern distinctively different from that used for existing property lines. Easement lines to be created by the plat must be clearly distinguished from existing easement lines by either pattern of dashing or notation. Existing easement lines to remain must be similarly and further distinguished from existing easement lines which are to be altered by the plat.

Public right-of-way lines, other than coincident with plat boundaries must be solid lines if created by the plat or if existing and to remain. Existing public right-of-way lines must be dashed if they are to be altered by the plat. Notation must be provided to distinguish existing lines of public right-of-way which are to remain clearly from lines of public right-of-way to be created by the plat.

Border lines must be provided on plat sheets, drawn as a solid line.

(2) Lettering Standards

Plat title or subdivision name lettering must be the boldest lettering on the sheet.

Plat subtitle or purpose lettering must be at least 6.3 mm high.

Plat boundary dimensions and bearings of lines must be of font size lettering at least 10 point.

The minimum height of freehand lettering for any information on the plat must be no smaller than 1/4 inch tall.

The minimum height of mechanical/font size lettering must be no smaller than 12 point.

Typed lettering must be of a clear, vertical type style. Gothic or elite is preferred. Italic type styles are acceptable for notable elements only on the plat. Typed material must be smear-proofed by a suitable fixative spray. Typed material which does not provide for satisfactory reduction and reproduction by current methods employed by the City and the County will not be acceptable.

***Note:** Adhesive or pressure applied lettering will not be acceptable. Subject to the requirements for permanency and smear proofing all changes to final plats either added or erased by hand must be done and initialed by the Surveyor of Record.*

7. Acceptable forms of language

In general, the plat must be in common English. The following are examples of acceptable forms of language for generally required plat elements. The persons preparing the plat and those who are signatory to any aspect of the plat are cautioned that it is their responsibility to assure that the statements they make or certify to on the plat express clearly their desired intent, and that they have the legal right and authority to certify, consent, or dedicate as their signature indicates.

a. Surveyor's Certification

"I, _____, a registered professional land surveyor under the laws of the State of New Mexico, do hereby certify that this plat was prepared by me or under my supervision, and meets the minimum requirements of monumentation and surveys of the City of Rio Rancho Subdivision Ordinance Chapter 155, and that it is true and correct to the best of my knowledge and belief.

John Q. Surveyor
NMS No. 0000

Date

Note: Title reports, when used, must be current as of the dates of the plat.

b. Jurisdictional Affidavit

"I, _____, New Mexico Professional Surveyor Number _____ hereby affirm that the property described does lie within the platting and extra-territorial subdivision jurisdiction of the City of Rio Rancho.

John Q. Surveyor
NMLS No. 0000

Date

c. Free consent and dedication

"The subdivision hereon described is with the free consent and in accordance with the desires of the undersigned owner(s) and/or proprietor(s) thereof and said owner(s) and/or proprietor(s) do hereby dedicate all streets and public right-of-way shown hereon to the City of Rio Rancho (Sandoval County) in fee simple with warranty covenants and do hereby grant all utility easements shown hereon to the public use forever including the rights of ingress and egress (both surface and subsurface). The undersigned owner(s) and/or proprietor(s) also grant to the City of Rio Rancho in perpetuity all sanitary sewer, water line, and drainage easements shown hereon including the right to construct, operate, inspect, and maintain sanitary sewers, water lines, and drainage facilities therein. Unless specifically limited elsewhere on this plat, all easements granted to the City of Rio Rancho may be used for any or all of the purposes of sanitary sewer, water line, or drainage facility even though only one of these purposes is stated on the easement as drawn on the plat."

Note: Any special easements, private ways, reverter clauses, or other qualifying statements should be inserted in the body of this declaration prior to the concluding statement and signatures. If park land is dedicated, a separate deed is also needed and the County recordation information of such deed should be referenced. If cash in lieu of dedication is provided, the fact must be noted on the plat.

"The undersigned owner(s) and/or proprietor(s) do hereby freely consent to all the foregoing and do hereby represent that I/we am/are authorized to so act."

Owner/Proprietor name typed or printed

Owner/Proprietor's Signature

Date

If there are other holders of equitable interest in the property being platted or subdivided, the following statement should be added to the consent and dedication material:

"The undersigned holder of an equitable interest (either by reason of a mortgage, deed of trust, purchase contract, or option contract) in some or all of the real property included in the (plat or subdivision) herein described, hereby ratifies that (plat or subdivision) and subordinates (his, her, etc.) interest in the property to that (plat or subdivision).

Equitable Interest Holder's Name Typed or Printed

Equitable Interest Holder's Holder
of Equitable Interest Signature

Date

Note: Each owner/proprietor's or interest holder's signature must be acknowledged as required for a deed (i.e., notarized). If the owner(s)/proprietor(s) is a corporation, the signatory on behalf of such corporation must be empowered to bind the corporation in this manner and the signatory's office in the corporation must be

d. Sample Signature Block for Plats (applicable signatures vary with the complexity of the plat)

Subdivision Case Number _____ Date _____

Utilities Approvals:

Cable One _____ Date _____

Public Service Company of New Mexico _____ Date _____

Qwest Communications _____ Date _____

New Mexico Gas Company _____ Date _____

Note: The utility companies may require additional language stating that the Public Utility Easements are granted for their common and joint use. Contact should be made with these companies prior to submittal of the initial plat to clarify their requirements.

City Approvals:

Department of Public Works _____ Date _____

Parks, Recreation & Community Services Dept. Dir. _____ Date _____

Development Services Department Director _____ Date _____

For Subdivisions:

RIO RANCHO PLANNING AND ZONING BOARD

Approved the _____ day of _____, 20__

By PZB chairperson's name _____ Chairman _____ Date _____

County Clerk and Recorder

Date

Southern Sandoval County Arroyo Flood Control Authority

Chair of the Board, Southern Sandoval Arroyo
Flood Control Authority (SSCAFCA)

Date

NOTE: SSCAFCA's signature block will vary depending on the plat. Contact SSCAFCA for the correct wording.

*Dry Utilities, then SSCAFCA's signature should be obtained prior to the City Engineer. When these are complete, Development Services Department will route for Planning & Zoning Board Chairman's signature or Department Director signature and City Clerk. Other signatures may be obtained in any order most convenient to the applicant/agent.

8. *Disclosure Statement*

A disclosure statement is required of all plats with the exception of summary plats. [City of Rio Rancho Ordinance Chapter 155.26 (A)]. Plats shall be accompanied by a disclosure statement in accordance with the standardized format provided in **Appendix 2.1.2** of this chapter. A disclosure statement shall be required for all subdivisions. The purpose of the disclosure statement is to permit the prospective purchaser, lessee, or other person acquiring an interest in the subdivided land to make an informed decision about the purchase, lease, or other conveyance of the land.

CHECKLIST FOR SUBMITTAL OF PRELIMINARY/BULK PLATS

Yes No

- Letter of authorization from the property owner if application is to be managed by another representative. Letter must include name of subdivision, agent and signature of property owner.

Preliminary Plat – 7 paper copies (folded) *NOTE: An additional 15 copies will need to be provided after staff has reviewed and the plat is scheduled for PZ Board hearing.*

Yes No

- Title of Plat
- Subtitle of Plat
- Date of Plat
- Location map with major roads labeled
- North arrow
- Scale of at least 1 inch to 200 feet in standard engineering increments (100 feet is preferable)
- Statement noting purpose of plat
- Plat boundary (boldest lines on plat) annotated with bearings in degrees, minutes and seconds, with basis for bearings noted or shown and dimensions in feet to the nearest hundredth foot (0.00)
- Location and description of all monuments found or set within the plat area and tie to State Plane Coordinate System, Central New Mexico Zone
- Easements (existing) including location, dimensions, type and party receiving easement
- Easements (proposed) including location, dimensions, type and party receiving easement
- Right-of-way (existing along or intersecting plat boundary) including name, location, dimensions and purpose or nature
- Right-of-way (proposed) including name, location, dimensions, purpose or nature and ownership (public or private)

Yes No

- Monument Description and Location
- Disclosure Statement
- Legal description, County recording information (date of recordation and all applicable volume, folio and document numbers) and City of Rio Rancho book and page number for the subject property and abutting properties
- Signature Blocks for Utilities, City departments, County Treasurer, County Clerk and, if necessary, Southern Sandoval County Flood Control Authority.
- Registered New Mexico Surveyor Certification
- Jurisdictional Affidavit
- Name and address of applicant and agent
- Zoning of subject property
- Area of plat to the nearest ten-thousandth (0.0000) acre
- Area (in acres) and mileage of street right-of way created
- Area (in acres) and mileage of street right-of way vacated
- Lot, tract (land reserved by applicant for future subdivision or development ancillary to the subdivision, e.g. landscaped area, utility corridor) and parcel (land dedicated to the City or other public agency) boundaries
- Numbers or letters to identify each lot and block (contiguous grouping of lots)
- Letters to identify each tract or parcel
- Purpose of tracts and parcels
- Boundaries of vacated right-of-way, easements or lot lines

Preliminary Construction Plans – 7 copies

Yes No

- Preliminary construction plans drafted to the standards noted in the Development Process Manual. Preliminary construction plans typically include overall grading, drainage, roadway, utility and landscaping sheets that clearly depict on-site and off-site infrastructure necessary to provide an adequate level service to the subdivision. One hundred percent complete construction plans may also be submitted, but applicant does so at their own risk.

Drainage Report – 3 copies

Yes No

- Drainage report drafted to the standards noted in the Development Process Manual.

Soils Analysis – 3 copies

Yes No

- Soils analysis (geotechnical report) drafted to the standards noted in the Development Process Manual.

Traffic Impact Analysis – 3 copies

Yes No

- Traffic impact analysis drafted to the standards noted in the Development Process Manual.
- Documentation of New Mexico Department of Transportation (NMDOT) approval of access to state highway.

Recreational Facilities Analysis – 3 copies

Yes No

- Provide a report on what recreational facilities are available within a quarter-mile of proposed platted area.

School Impact Analysis – 3 copies

Yes No

- Estimate of number of students by formula (dwelling units x .71)
- Identify which schools will service this platted area

Water and Wastewater Availability Statement – 2 copies

Yes No

- Statement of water and wastewater availability issued by the Department of Public Works noting approval by the Utilities Commission. NOTE: This should be received prior to submittal of Preliminary Plat.

Infrastructure List – 7 copies

Yes No

- List of all proposed onsite and offsite infrastructure improvements within public right-of-way or publically-held easements, including, but not limited to roads (street name, description of improvement, point of beginning and end), drainage (proposed legal description, description of improvement, location), and water and wastewater lines (line size, point of beginning and end).

Financial Guarantee Statement – 2 copies

Yes No

- Statement describing the means of financial guarantee for proposed infrastructure improvements per Chapter 155.27 (not applicable if infrastructure is installed and accepted prior to final plat approval)

Signature

I have reviewed the Preliminary/Bulk Plat Application and find it complete.

Name (Print): _____ Applicant Agent

Signature: _____ Date: _____

RESERVED FOR CITY STAFF USE:

CHECKED BY _____ DATE _____

____ ACCEPTABLE

____ UNACCEPTABLE

____ ADDITIONAL INFORMATION REQUESTED

CHECKLIST FOR SUBMITTAL OF FINAL PLATS

Required Documentation

The application will not be accepted for review until the documentation listed below is provided and deemed complete. "Yes" indicates that the information is provided and complete. "No" indicates the information was not provided and is not applicable. All "No" responses shall be clarified in writing by the applicant or agent.

Letter of Authorization – 1 copy

Yes No

- Letter of authorization from applicant if application is to be managed by another representative. Letter must include name of subdivision, agent and signature of applicant.

Findings of Fact – 7 copies

Yes No

- Copy of Findings of Fact noting conditions of preliminary plat approval.

Final Plat – 7 paper copies (folded) NOTE: An additional 15 copies will need to be provided after staff has reviewed and the plat is scheduled for PZ Board hearing.

Yes No

A. IDENTIFICATION

- Subdivision name
- Date of Plat
- Scale (1 inch to 200 feet, preferably 1 inch to 100 feet), Equivalent and Graphic
- North Arrow
- Location Map, Scale, North Arrow & Reference to Zoning Atlas Page #
- Reference To:
- (A) Federal Section
- (B) Projected Section
- (C) Land Grant
- (D) County and City Control Systems

Yes No

Disclosure Statement

B. MONUMENTS

Subdivision Control Monuments

(A) Centerline Monumentation

(B) Block Control with Surveyor's Registration Number

(C) Type of Corners Found or Set

(D) Bond

Permanent Survey Monuments

(A) Type of Monuments

(B) Monuments, Existing or Set

(C) X and Y Coordinates (N.M.S.P.)

(D) Reference Zone

(E) Delta Alpha

(F) Combined Ground to Grid Factor

(G) Bond

Bench Marks

(A) Location Found or Set

(B) Bond

C. PERIMETER

Written Description, Metes & Bounds

Bearing in Degrees, Minutes & Seconds

Distances in Feet & Hundredths

Record Distances & Bearings

Yes No

- Measured Distances & Bearings
- Basis for Bearings Shall Be Grid or Rotation Factor to Grid
- Total Gross Acreage of Subdivision
- Property Corners Found or Set
- Property Lines Eliminated Shown as Dashed Line

D. BLOCK AND LOT

- Block Identification
- Lot Identification
- Bearing on Non-Radial Lines
- Bearing on Non-Perpendicular Lines
- Distances Lot Perimeter

E. ADJACENT LAND

- The Location and Dimension of Streets that Intersect the Boundary or Boundary Streets of the Subject Subdivision
- Reference to Recorded Subdivision Plats or Adjoining Lands by Recorded Name File, Date and City Book and Page Number
- Graphic Presentation, by Dashes, Lines or Lots Contiguous to Boundary of Subdivision

F. STREET RIGHT-OF-WAY

- Name of Streets (Ensure No Duplication)
- Right-of-Way Width Noted
- Centerline Data, Tangent Distances & Bearings
- Centerline Data, Curves, Radius, Central Angles, Arc
- Mileage of Streets Created: Total, Full-Width, Half-Width
- Street Vacation Application Number

Yes No

- Private Streets or Access Easements so Designated
- Identify Private Way or Street Documentation Addressing Lots Serviced and Maintenance Responsibility

G. EASEMENTS

- All Easements of Record or Apparent are Shown
- Location by Distance & Bearing
- Dimension
- Purpose
- Proposed Shown in Dashed Lines and Labeled
- Existing Shown in Dashed Lines and Labeled with Recordation Data
- Vacated Shown in Ghost Lines and Labeled
- Apparent Shown and Labeled
- Limitations

H. DRAINAGE RIGHT-OF-WAY

- Location
- Dimension

I. PUBLIC AREAS

- Location
- Dimension
- Purpose

J. FREE CONSENT

- Statement that the subdivision is with free consent and in accordance with the desires of the subdivider

Yes No

K. CERTIFICATIONS

- Jurisdictional Affidavit
- Certification and seal of surveyor that plat was prepared in accordance with the Minimum Standards for Surveying in New Mexico and the City of Rio Rancho subdivision ordinance
- Jurisdictional affidavit by surveyor stating that the subject property is within the platting jurisdiction of the City of Rio Rancho
- Certification by either the Planning and Zoning Board Chairman (if plat approved at a Planning and Zoning Board hearing) or by the Development Services Department Director (if approved administratively as a summary plat)
- Certification of City Clerk noting date plat was approved by the Planning and Zoning Board or by the Development Services Department Director (whichever is applicable)
- Certification of franchised utility companies (Cable One, Qwest, PNM) and Department of Public Works
- Certification of County Treasurer that all current and previous property taxes have been paid in full
- Certification of County Clerk noting date, time and recording information

L. DEDICATION

- Signed statement by the subdivider dedicating street and drainage right-of-way and other appropriate lands for public use in fee simple and granting all required easement for public use
- Notary signature

M. ACKNOWLEDGMENT

- Acknowledged in the manner required for the acknowledgment of deeds
- Notary signature

N. SURVEY

- Certification by land surveyor meeting the minimum requirements for monuments and surveys of Chapter II.6 of the City of Rio Rancho Design Process Manual

Yes No

- Digital submittals are required and must contain a minimum of the following:
Coordinate system
 - (A) Data shall be ground coordinates tied to the New Mexico State Plane,
Central Meridian: Datum, NAD83
 - (B) The submittal shall disclose the coordinate system and datum
- Content
 - (A) A single drawing in model space showing only parcel lines, street center
lines, and easement lines
 - (B) Only Final Plat data will be provided
 - (C) Parcel lines shall be in one separate layer
 - (D) Street center lines shall be in one separate layer
 - (D) Access easement lines and all other easements that are 20 feet wide or
greater shall be in a second separate layer
 - (E) All other easement lines shall be in a third separate layer
- File format
 - (A) DXF files in ASCII format. Other formats directly compatible with
Arc/Info GIS may be accepted (i.e. shapefiles, coverage export files)
 - (B) Files may be transmitted as PDF attachments to e-mail, Flash Drive or
CD-ROM
 - (C) One hard copy of the final plat shall accompany the electronic submittal
- File names
 - (A) <DSD Project#>.dxf used as a standard naming convention
- Quality assurance
 - (A) DXF file submitted shall be validated by a Records and GIS Section
designee as a condition to final sign-off
 - (B) Validation review will be performed in a timely manner

Final Construction Plans – 7 copies

Yes No

- Final construction plans (100% complete) drafted to the standards noted in the Development Process Manual and revised to address any comments from preliminary plat review.

Drainage Report – 3 copies

Yes No

- Drainage Report drafted to the standards noted in the Development Process Manual and revised to address any comments from preliminary plat review.

Soils Analysis – 3 copies

Yes No

- Soils analysis (geotechnical report) drafted to the standards noted in the Development Process Manual and revised to address any comments from preliminary plat review.

Traffic Impact Analysis – 3 copies

Yes No

- Traffic impact analysis drafted to the standards noted in the Development Process Manual and revised to address any comments from the preliminary plat review.
- Documentation of New Mexico Department of Transportation (NMDOT) approval of access to state highway.

Infrastructure List – 7 copies

Yes No

- List of all proposed onsite and offsite infrastructure improvements within public right-of-way or publically-held easements, including, but not limited to roads (street name, description of improvement, point of beginning and end), drainage (proposed legal description, description of improvement, location), and water and wastewater lines (line size, point of beginning and end).

Engineer's Opinion of Probable Cost – 2 copies

Yes No

- List of costs of proposed infrastructure improvements (onsite and offsite) drafted to the standards noted in the Development Process Manual. This cost estimate will form the basis of the financial guarantee (if applicable).

Development Agreement – 3 copies

Yes No

Development Agreement drafted to the standards noted in the Development Process Manual (if applicable).

Covenants – 3 copies

Yes No

Draft of covenants that notes private improvements to be maintained by association and dues to be paid by association members if proposing privately owned and maintained infrastructure typically dedicated to and maintained by the City (if applicable)

Signature

I have reviewed the Final Plat Application and find it complete.

Name (Print): _____ Applicant Agent

Signature: _____ Date: _____

For Office Use Only

I have reviewed the Final Plat Application and find it complete incomplete.

Name (Print): _____ Title: _____

Signature: _____ Date: _____

Case No.: _____

If incomplete, date that application was brought into compliance: _____

3. GRANT OF DRAINAGE EASEMENT

This easement grant is made and executed this _____ day of _____ 20____, by and between _____, hereinafter called the "Grantor" and the City of Rio Rancho, New Mexico, a municipal corporation, hereinafter called the "City".

1. The Grantor is the owner of the following described real property within the City of Rio Rancho Unit Block Lot .
- 2 For good and valuable consideration, the receipt of which is hereby acknowledged, Grantor does hereby grant and deliver to the City of Rio Rancho a perpetual easement over and across a portion of Grantor's property for the purpose of permitting the flow, conveyance, and discharge of storm water runoff. [For the purpose of constructing and maintaining a storm water detention facility].
3. The land affected by the grant of this easement and right-of-way is more particularly described as follows:
- 4 A perpetual easement on the areas designated on this plat as "drainage easement" ["detention area"] is hereby dedicated to the City of Rio Rancho for the purpose of permitting the conveyance of storm water runoff and for the purpose of constructing, maintaining, operating, removing, and replacing storm water drainage facilities, either above or below ground. No fence, wall, planting, building, or other obstruction may be placed or maintained in said easement area and there shall be no alteration of the grades or contours in said dedicated area without the approval of said City Engineer or his/ her designee of the City of Rio Rancho. No obstructions may be placed in said easement area which would prevent ingress and egress to same by maintenance vehicles or which would prevent said vehicles traveling on said drainage way for maintenance purposes.
5. No fence, wall, planting, building or other obstruction may be placed or maintained in the easement without the written approval of the City Engineer of the City of Rio Rancho, and there shall be no alteration of the grades or contours in said easement after the drainage facilities are constructed without the written approval of the City Engineer or his/ her designee. Any violation of this provision will be promptly corrected upon receipt of notice from the City, or the City shall have the right to remove or otherwise eliminate such violation and assess the cost to the property owner.
6. Said easement is intended to be permanent in nature for the uses end purposes recited above to the City, it successors and assigns, until such time as the City releases said easement in writing.

7. The obligation of the Grantor set forth herein shall be binding upon the Grantor, his heirs, and assigns, and the property of the Grantor as described herein and will run with said property until released by the City.
8. The City shall not be liable for any damages to the Grantor resulting from its construction, modification, or maintenance of said facilities.

Required Indemnification Note:

The Grantor agrees to defend, indemnify, and hold harmless, the City, its officials, agents and employees from and against any and all claims, actions, suits, or proceedings of any kind brought against said parties for or on account of any matter arising from the drainage facility provided for herein or the Grantor's failure to construct, maintain, or modify the drainage facility under this covenant.

9. The written notice provided for herein shall be accomplished by mailing same to:

The Grantor may change said address by written notice, certified mail, return receipt requested to the City Engineer, Rio Rancho City Hall, 3200 City Center Circle NE, Rio Rancho, New Mexico 87144.

IN WITNESS WHEREOF, the parties have set their hands and seals this _____ day of _____ 20____,

GRANTOR

By: _____

Title: _____

REVIEWED BY THE CITY OF RIO RANCHO LEGAL DEPARTMENT

City Manager

ACKNOWLEDGMENTS

STATE OF NEW MEXICO)

) SS.

COUNTY OF SANDOVAL)

The foregoing instrument was acknowledged before me this ____ day of _____, 20____, by _____

(Name of Grantor)

Notary Public

My Commission Expires:

Appendix 2.1.1

CAD STANDARDS AND NAMING CONVENTIONS FOR DIGITAL PLAN & PLAT SUBMITTALS

All drawing entities must reside on their own respective layers with specified layer names, colors, line types and text styles (if applicable) assigned to each entity **BY LAYER**. All symbols and line types must follow City of Rio Rancho design standards specifications where applicable. All digital plans submitted shall be referenced to at least two known existing section monuments with the basis of bearing clearly stated including bearings and distances. This will assist us in projecting the data to the City of Rio Rancho control grid standard (New Mexico State Plane Coordinate System, NAD 83, US Feet).

LAYER GROUP	LAYER NAME	COLOR	LINETYPE TEXTSTYLE	LAYER DESCRIPTION
ROADWAY R-O-W	C-RW	CYAN	CONTINUOUS	ROADWAY RIGHT-OF-WAY LINES
	C-RW-ABND	8(GRAY)	DOT2	ABANDONED RIGHT-OF-WAY
	C-RW-DIM 33(LT BROWN)	135(DRK CYAN) 33(LT BROWN)	DOT2	R.O.W. WIDTH, DISTANCE, etc. - DIMENSIONS FUTURE/PROPOSED RIGHT-OF-WAY
ROADWAY CENTERLINES	C-RW-PTS	WHITE		POINTS OF CURVATURE & TANGENCY (TIC MARKS)
	C-RW-CL	YELLOW	CENTER2	ROADWAY CENTERLINES
	C-RW-CL-DIM	53(DRK YELLOW)		CENTERLINE BEARING, DISTANCE, & CURVE DIM.'S
	C-RW-CL-MON	RED		UNPAVED ROADWAY CENTERLINE
	C-RW-CL-NMS	BLUE		ROADWAY NAMES
	C-RW-CL-PTS	WHITE		POINTS OF CURVATURE & TANGENCY (TIC MARKS)
ARROYO & RAILROAD R.O.W. & C.L	C-RW-CL-UNP	33(LT BROWN)	DASHED	UNPAVED STREET CENTERLINE
	C-RWAR	150(BLUE)	PHANTOM2 (ROW2)	ARROYO RIGHT-OF-WAY
	C-RWRR	12(DRK RED)	PHANTOM2	RAILROAD RIGHT-OF-WAY
	C-RWAR-CL	141	DIVIDE	ARROYO CENTERLINE
	C-RWRR-CL	YELLOW	TRACKS	RAILROAD CENTERLINE
	C-RWAR/RR-DIM	135		ARROYO OR RAILROAD R.O.W. WIDTH DIMENSION
	C-RWAR/RR-CL-DIM	MAGENTA		BEARING, DISTANCE, & CURVE DIM.'S
	C-RWAR/RR-CL-MON	RED		CENTERLINE MONUMENTS
	C-RWAR/RR-CL-NMS	130(CYAN)		ARROYO OR RAILROAD NAMES
	C-RWPV	WHITE	PHANTOM2	PRIVATE RIGHT-OF-WAY LINES
PRIVATE STREET R.O.W.	C-RWPV-ABND		DOT2	ABANDONED PRIVATE RIGHT-OF-WAY
	C-RWPV-DIM			PRIV. R.O.W. WIDTH, DISTANCE, etc. - DIMENSIONS
	C-RWPV-FUTR		DOT2	FUTURE/PROPOSED PRIVATE RIGHT-OF-WAY
	C-RWPV-PTS			CURVATURE & TANGENCY POINTS (TIC MARKS)
PRIVATE STREET CENTERLINES	C-RWPV-CL		CENTER2	PRIVATE STREET CENTERLINES
	C-RWPV-CL-DIM	MAGENTA		BEARING, DISTANCE, WIDTH, & CURVE DIM.'S
	C-RWPV-CL-MON	RED		PRIVATE CENTERLINE MONUMENTS
	C-RWPV-CL-NMS	BLUE		PRIVATE STREET NAMES
	C-RWPV-CL-PTS	WHITE		CURVATURE & TANGENCY POINTS (TIC MARKS)
PARCELS	C-PL	WHITE	CONTINUOUS	PROPERTY LINES (& PARCEL BOUNDARIES)
	C-PL-AC	MAGENTA		PROPERTY ACREAGES (LOTS & TRACTS)
	C-PL-DTL	143		PROPERTY LINE DETAILS & ATTRIBUTES
	C-PL-DIM	254(LT GRAY)		PROPRTY LINE BEARINGS & CURVE DIM.'S
	C-PL-NUM	201(LT MGNTA)	SIMPLEX	LOT NUMBERS & TRACTS
	C-PL-PTS	WHITE		POINTS OF CURVATURE & TANGENCY (TIC MARKS)
SECTIONS	C-SEC	254	CONTINUOUS	SECTION LINES
	C-SEC-DIM	252(GRAY)		SECTION LINE BEARINGS, DISTANCES, etc.
	C-SEC-MID	50(YELLOW)	DASHED	SECTION MID-LINES
	C-SEC-MON	RED		SECTION (SURVEY) MONUMENTS
CITY LIMIT BOUNDARIES SUBDIVISION BOUNDARIES	C-BOUN-CITY	30(ORANGE)	PHANTOM	CITY LIMIT LINES
	C-BOUN-SUB	204(DRK MGNTA)	CONTINUOUS	SUBDIVISION BOUNDARY
	C-BOUN-SUB-DIM			SUBDIVISION BOUNDARY BEARINGS, DIM'S, etc.
	C-BOUN-SUB-MON	RED		SUBDIVISION BOUNDARY MONUMENTS
	C-BOUN-SUB-NMS	9		SUBDIVISION PHASE/UNIT/PARCEL NAMES/NO.'S
SITE/PROPERTY BOUNDARIES	C-BOUN-SUB-PTS	204(DRK MGNTA)		
	C-BOUN-SITE	204(DRK MGNTA)	CONTINUOUS	SITE BOUNDARY
	C-BOUN-SITE-DIM			SITE BOUNDARY BEARINGS, DIM'S, etc
	C-BOUN-SITE-MON	RED		SITE BOUNDARY MONUMENTS
	C-BOUN-SITE-PTS	204(DRK MGNTA)		SITE BOUNDARY TIC MARKS

Appendix 2.1.2

DISCLOSURE STATEMENTS- Subdivisions

Disclosure statements

Prior to selling, leasing or otherwise conveying any land in a subdivision, the subdivider shall disclose in writing such information as the City of Rio Rancho requires by regulation, to permit the prospective purchaser, lessee, or other person(s) acquiring an interest in the subdivider's land, to make an informed decision about the purchase, lease or other conveyance of the land.

Disclosure statement format

- (1) All subdivisions shall be required to file a disclosure statement that substantially complies with the following requirements and formats:**
- a. Name of subdivision.
 - b. Name and address of subdivider.
 - c. Condition of title.
 - d. Statement of all restrictions or reservations of record that subject the subdivided land to any conditions effecting its use or occupancy.
 - e. Description of utilities being provided by the developer.
(name of entity providing electricity, if available); and
(name of entity providing gas service, if applicable); and
(name of entity providing water, if available); and
(name of entity providing telephone, if available); and
(name of entity providing wastewater disposal, if available); and
(name of entity providing solid waste disposal, if available).
 - f. Water and Wastewater availability
 - g. Liquid waste disposal method
 - h. Solid waste disposal method
 - i. A statement of terrain management.
 - j. A statement of private access maintenance (describe what measures will be taken to ensure private road maintenance).

- (2) Disclosure statements for Major subdivisions containing six to 99 lots shall include the following information:**

DISCLOSURE STATEMENT

PLEASE REVIEW PRIOR TO THE PURCHASE OF PROPERTY LOCATED WITHIN THE SUBDIVISION

This disclosure statement is intended to provide you with information to make an informed decision on the purchase or lease of the property described in this statement. You should read carefully all the information contained in this statement before you decide to buy or lease the described property. Various public

agencies may have issued opinions on both the subdivision proposal and the information contained in this disclosure statement. Summaries of these opinions are contained in this disclosure statement. They may be favorable or unfavorable. You should read them closely.

The City of Rio Rancho has reviewed this disclosure statement to determine whether the subdivider can fulfill the conditions that the subdivider claims in the disclosure statement. However, the City of Rio Rancho does not vouch for the accuracy of what is said in the disclosure statement. In addition, this disclosure statement is not a recommendation or endorsement of the subdivision by either the City or the State. It is informative only.

The City of Rio Rancho recommends that you inspect the property before buying, leasing, or otherwise acquiring it. If you have not inspected the parcel before purchasing, leasing or otherwise acquiring it, you have six (6) months from the time of purchase, lease or other acquisition, to inspect the property in person. After inspecting the parcel within the six (6) month period, you have three (3) days to rescind the transaction and receive all your money back from the subdivider when merchantable title is revested in the subdivider. To rescind the transaction you must give the subdivider written notice of your intent to rescind within three (3) days after the date of your inspection of the property.

County regulations require that any deed, real estate contract, lease, or other instrument conveying an interest in a parcel in the subdivision, be recorded with the County Clerk.

Building permits, wastewater permits or other use permits must be issued by State or City officials before improvements are constructed. You should investigate the availability of such permits before you purchase, lease, or otherwise acquire an interest in the property. You should also determine whether such permits are required for construction of additional improvements before you occupy the property.

1. NAME OF SUBDIVISION

(name of subdivision)

2. NAME AND ADDRESS OF SUBDIVIDER

(name of subdivider)

(address of subdivider)

3. CONDITION OF TITLE

Include the following information (where applicable):

(name of mortgages)

(name and address of each mortgagee)

(balance owing on each mortgage)

(summary of release provisions of each mortgage)

(number of real estate contracts on the subdivided land for which the subdivider is making payments as a purchaser)

(name and address of each person holding a real estate contract as owner of the subdivided land for which the subdivider is making payments as a purchaser)

(balance owing on each real estate contract)

- (summary of default provisions of each real estate contract)
- (summary of release provisions of each real estate contract)
- (statement of any other encumbrances on the land)
- (statement of any other conditions relevant to the state of title)

4. STATEMENT OF ALL RESTRICTIONS OR RESERVATIONS OF RECORD THAT SUBJECT THE SUBDIVIDED LAND TO ANY CONDITIONS AFFECTING ITS USE OR OCCUPANCY
(statement of all deed and plat restrictions affecting the subdivided land)
5. UTILITIES (estimated cost per lot)

TABLE INSET:

(name of entity providing electricity, if available)	(estimated cost)
(name of entity providing gas service, if available)	(estimated cost)
(name of entity providing water, if available)	(estimated cost)
(name of entity providing telephone, if available)	(estimated cost)
(name of entity providing wastewater disposal, if available)	(estimated cost)
(name of entity providing solid waste disposal, if available)	(estimated cost)

6. INSTALLATION OF UTILITIES

TABLE INSET:

(electricity)	(date)
(gas)	(date)
(water)	(date)
(phone)	(date)
(sewer)	(date)
(solid waste disposal)	(date)

7. UTILITY LOCATION

(if all utilities are to be provided to each parcel in the subdivision, please state here)

(if all utilities are to be provided to some but not all parcels in the subdivision, state which utilities will be provided to each parcel)

(state whether each utility will be above ground or underground)

8. WATER and WASTEWATER AVAILABILITY

(describe the maximum annual water requirements of the subdivision including water for indoor and outdoor domestic uses)

(describe the availability and sources of water to meet the subdivision's maximum annual water requirements)

(describe the means of water delivery within the subdivision)

(describe any limitations and restrictions on water use in the subdivision)

(summarize the provisions of any covenants or other restrictions requiring the use of water saving fixtures and other water conservation measures)

(describe what measures, if any, will be employed to monitor or restrict water use in the subdivision)

9. FOR SUBDIVISIONS WITH COMMUNITY WASTEWATER SYSTEMS

(if applicable)

(name and address of entity providing wastewater disposal)

(statement that individual or clustered wastewater systems are prohibited, if such is the case)

(identify, by lot and block number within the subdivision, which lots will be served by which community wastewater system)

(if the wastewater systems within the subdivision have not been accepted for maintenance by the City, state how the wastewater systems will be maintained and describe the lot owner's responsibilities and obligations with respect to maintenance of the wastewater systems)

10. FOR SUBDIVISIONS WITH INDIVIDUAL OR CLUSTERED WASTEWATER SYSTEMS (if applicable)

(state whether wastewater will be provided by the subdivider or by the prospective purchaser/lessee/conveyee)

(if the wastewater systems are provided by purchaser/lessee/conveyee, state the estimated cost of a complete wastewater system, including installation costs)

(if wastewater systems are provided by the subdivider, state the cost, if any, to the purchaser/lessee/conveyee)

(identify, by lot and block number within the subdivision, which lots will be served by which cluster wastewater systems)

(state how the wastewater systems will be maintained and describe the lot owner's responsibilities and obligations with respect to maintenance of the wastewater systems)

11. FOR SUBDIVISIONS WITH COMMUNITY WATER SYSTEMS (if applicable)
(name and address of entity providing water)
(source of water and means of delivery)
(summary of any legal restrictions on either indoor or outdoor usage)
(statement that individual wells are prohibited, if such is the case)
(State of New Mexico drinking water permit number)
12. FOR SUBDIVISIONS WITH INDIVIDUAL DOMESTIC WELLS OR MULTIPLE HOUSEHOLD WELLS (if applicable)
(define whether wells will be provided by the subdivider or by the prospective purchaser/lessee/conveyee)
(if wells are provided by purchaser/lessee/conveyee, state the estimated cost to complete a domestic well, including drilling, pressure tank, control devices, storage and treatment facilities)
(if wells are provided by the subdivider, state the cost, if any, to the purchaser/lessee/conveyee)
(summary of legal restrictions on either indoor or outdoor usage)
(average depth to groundwater and the minimum and maximum well depths to be reasonably expected)
(recommend total depth of well)
(estimated yield in gallons per minute of wells completed to recommended total depth)
13. LIFE EXPECTANCY OF THE WATER SUPPLY
(state the life expectancy of each source of water supply for the subdivision under full development of the subdivision)
12. WATER QUALITY
(describe the quality of water in the subdivision available for human consumption)
(describe any quality that would make the water unsuitable for use within the subdivision)
(state the name, the contaminant level, the maximum contaminant level, the expected adverse effects of the contaminant for domestic use, and the recommended treatment method to reduce the contaminant level to or below the maximum contaminant level for any contaminants which exceed the maximum contaminant levels listed in the current State of New Mexico Drinking Water Bureau Regulations (Title 20, Chapter 7, Part 1))
13. SEWER SYSTEMS
(describe the performance standards that must be obtained, design flow and any other conditions affecting the wastewater systems that are proposed and that have been approved by the City for use within the subdivision)

NOTE: NO SEWER SYSTEM MAY BE USED IN THIS SUBDIVISION OTHER THAN A SYSTEM THAT MEETS THE PERFORMANCE STANDARDS APPROVED BY CITY OF RIO RANCHO DEPARTMENT OF PUBLIC WORKS.

14. SOLID WASTE DISPOSAL

(describe the means of solid waste disposal that is proposed for use within the subdivision)

15. TERRAIN MANAGEMENT (Also known as a grading and drainage report, or plan)

(describe the suitability for residential use of the soils in the subdivision as defined in the Natural Resource Conservation District's Soil Survey for Sandoval County)

(describe any measures necessary for overcoming soil and topographic limitations, and who will be responsible for implementing these measures) (identify by lot and block numbers all parcels within the subdivision that are subject to flooding)

(identify by lot and block number all parcels within the subdivision located in whole or in part on slopes in excess of 8%)

(describe the surface drainage for all lots in the subdivision)

(describe the subsurface drainage for all lots in the subdivision)

(describe the nature, location and completion dates of all storm drainage systems and structures constructed or required to be constructed in the subdivision, and identify the entity which is responsible for construction)

16. SUBDIVISION ACCESS

(names of town nearest to subdivision)

(distance from nearest town to subdivision and the route over which that distance is computed)

(describe access roads to subdivision)

(state whether the subdivision is accessible by conventional vehicle)

(state whether or not subdivision is ordinarily accessible at all times of the year and under all weather conditions)

(describe the width and surfacing of all roads within the subdivision)

(state whether the roads within the subdivision have been accepted for maintenance by the City)

(if the roads within the subdivision have not been accepted for maintenance by the City, state how the roads will be maintained and describe lot owners responsibilities and obligations with respect to road maintenance)

17. MAINTENANCE

(state whether the roads and other improvements within the subdivision will be maintained by the City, the subdivider or an association of lot owner(s), and what measures have been taken to make sure that maintenance takes place)

18. CONSTRUCTION GUARANTEES (if applicable)

(describe any proposed roads, drainage structures, water or wastewater treatment facilities or other improvements that will not be completed before parcels in the subdivision are offered for sale)

19. ADVERSE OR UNUSUAL CONDITIONS

(state any activities or conditions adjacent to or nearby the subdivision, such as feed lots, dairies, cement plants or airports, that would subject the subdivided land to anything unusual affecting its use or occupancy)

20. FIRE PROTECTION

(distance to nearest fire station from subdivision)
(route over which that distance is computed)
(state whether the fire department is full-time or semi-staffed)

21. POLICE PROTECTION

List the various police units that patrol the subdivision.
(sheriff's department, if applicable)
(municipal police, if applicable)
(state police, if applicable)

22. PUBLIC SCHOOLS

(name of and distance to nearest public elementary school serving the subdivision)
(name of and distance to nearest public junior high or middle school serving the subdivision)
(name of and distance to nearest public high school serving the subdivision)

(3) All Major subdivisions containing one hundred (100) or more lots shall be required to file a disclosure statement that substantially complies with the following requirements and formats for subdivision.

DISCLOSURE STATEMENT

PLEASE REVIEW PRIOR TO THE PURCHASE OF PROPERTY LOCATED
WITHIN THE SUBDIVISION

This disclosure statement is intended to provide you with information to make an informed decision on the purchase or lease of the property described in this statement. You should read carefully all the information contained in this statement before you decide to buy or lease the described property.

Various public agencies may have issued opinions on both the subdivision proposal and the information contained in this disclosure statement. Summaries of these opinions are contained in this disclosure statement. They may be favorable or unfavorable. You should read them closely.

The City of Rio Rancho has examined this disclosure statement to determine whether the subdivider can fulfill the conditions that the subdivider claims in the disclosure statement. However, the City of Rio Rancho does not vouch for the accuracy of what is said in the disclosure statement. In addition, the disclosure statement is not a recommendation or endorsement of the subdivision by the City. It is informative only.

The City of Rio Rancho recommends that you inspect the property before buying, leasing or otherwise acquiring it. If you have not inspected the parcel before purchasing, leasing or otherwise acquiring it, you have six (6) months from the time of purchase, lease or other acquisition, to inspect the property in person. After inspecting the parcel within the six (6) month period, you have three (3) days to rescind the transaction and receive all your money back from the subdivider when merchantable title is revested in the subdivider. To rescind the transaction you must give the subdivider written notice of your intent to rescind within three (3) days after the date of your inspection of the property.

County regulations require that any deed, real estate contract, lease, or other instrument conveying an interest in a parcel in the subdivision, be recorded with the County Clerk.

Building permits, wastewater permits or other use permits must be issued City officials before improvements are constructed. You should investigate the availability of such permits before you purchase, lease, or otherwise acquire an interest in the property. You should also determine whether such permits are required for construction of additional improvements before you occupy the property.

1. NAME OF SUBDIVISION
(name of subdivision)
2. NAME AND ADDRESS OF SUBDIVIDER
(name of subdivider)
(address of subdivider)
3. NAME AND ADDRESS OF PERSON IN CHARGE OF SALES, LEASING OR OTHER CONVEYANCE IN NEW MEXICO (optional)
(name of person in charge of sales, leasing or other conveyance)
(address of person in charge of sales, leasing or other conveyance)
(telephone number of person in charge of sales, leasing or other conveyance)
4. SIZE OF SUBDIVISION BOTH PRESENT AND ANTICIPATED

TABLE INSET:

Present	Anticipated
(number of parcels)	(number of parcels)
(number of acres in subdivision)	(number of acres in subdivision)

5. SIZE OF LARGEST PARCEL OFFERED FOR SALE OR LEASE WITHIN THE SUBDIVISION
(size of largest parcel in acres)
6. SIZE OF SMALLEST PARCEL OFFERED FOR SALE OR LEASE WITHIN THE SUBDIVISION
(size of smallest parcel in acres)
7. PROPOSED RANGE OF SELLING OR LEASING PRICES (optional)

TABLE INSET:

(\$ = lowest amount)	(size of parcels sold, leased or conveyed)
(\$ = highest amount)	(size of parcels sold, leased or conveyed)

8. FINANCING TERMS (optional)
 - (interest terms)
 - (term of loan or contract)
 - (minimum down payment)
 - (service charges and/or escrow fees)
 - (premium for credit life or other insurance if it is a condition for giving credit)
 - (closing costs)
9. NAME AND ADDRESS OF HOLDER OF LEGAL TITLE
 - (name of person who is recorded as having legal title)
 - (address of person who is recorded as having legal title)

NOTE: IF ANY OF THE HOLDERS OF EQUITABLE TITLE NAMED ABOVE IS A CORPORATION, LIST THE NAMES AND ADDRESSES OF ALL OFFICERS OF THAT CORPORATION.

10. NAME AND ADDRESS OF PERSONS HAVING EQUITABLE TITLE
 - (name of person who is recording as having equitable title)
 - (address of person who is recording as having equitable title)

NOTE: IF ANY OF THE HOLDERS OF EQUITABLE TITLE NAMED ABOVE IS A CORPORATION, LIST THE NAMES AND ADDRESS OF ALL OFFICERS OF THAT CORPORATION.

11. CONDITION OF TITLE
 - Include here the following information (where applicable)
 - (number of mortgages)
 - (name and address of each mortgage)
 - (balance owing on each mortgage)
 - (summary of the release provisions of each mortgage)
 - (number of all real estate contracts on the subdivided land for which the subdivider is making payments as a purchaser)
 - (name and address of each person holding a real estate contract as owner of the subdivided land for which the subdivider is making payments as a purchaser)
 - (balance owing on each real estate contract)
 - (summary of default provisions of each real estate contract)
 - (statement of any other encumbrances on the land)
 - (statement of any other conditions relevant to the state of the title)
12. STATEMENT OF ALL RESTRICTIONS OR RESERVATIONS OF RECORD THAT SUBJECT THE SUBDIVIDED LAND TO ANY CONDITIONS AFFECTING ITS USE OR OCCUPANCY
 - (state here all deed and plat restrictions affecting the subdivided land)
13. ESCROW AGENT
 - (name of escrow agent)

(address of escrow agent)
 (statement of whether or not the subdivider has any interest in or financial ties to the escrow agent)

14. UTILITIES (estimated cost per lot)

TABLE INSET:

(name of entity providing electricity, if available)	(estimated cost)
(name of entity providing gas service, if available)	(estimated cost)
(name of entity providing water, if available)	(estimated cost)
(name of entity providing telephone, if available)	(estimated cost)
(name of entity providing wastewater disposal disposal, if available)	(estimated cost)
(name of entity providing solid waste disposal, if available)	(estimated cost)

15. INSTALLATION OF UTILITIES

TABLE INSET:

(electricity)	(date)
(gas)	(date)
(water)	(date)
(phone)	(date)
(wastewater disposal)	(date)
(solid waste disposal)	(date)

16. UTILITY LOCATION

(if all utilities are to be provided to each parcel in the subdivision, please state here)

(if all utilities are to be provided to some but not all parcels in the subdivision, state which utilities will be provided to each parcel)

(state whether each utility will be above ground or underground)

17. **WATER AND WASTEWATER AVAILABILITY**
 (describe the maximum annual water requirements of the subdivision including water for indoor and outdoor domestic uses)
 (describe the availability and sources of water to meet the subdivision's maximum annual water requirements)
 (describe the means of water delivery within the subdivision)
 (describe any limitations and restrictions on water use in the subdivision)
 (summarize the provisions of any covenants or other restrictions requiring the use of water saving fixtures and other water conservation measures)
 (describe what measures, if any, will be employed to monitor or restrict water use in the subdivision)
18. **FOR SUBDIVISIONS WITH COMMUNITY WATER SYSTEMS**
 (name and address of entity providing water)
 (source of water and means of delivery)
 (summary of any legal restrictions on either indoor or outdoor usage)
 (statement that individual wells are prohibited, if such is the case)
 (State of New Mexico Drinking Water Bureau's number)
19. **FOR SUBDIVISIONS WITH INDIVIDUAL DOMESTIC WELLS OR MULTIPLE HOUSEHOLD WELLS**
 (define whether wells will be provided by the subdivider or by the prospective purchaser/lessee/conveyee)
 (if wells are provided by purchaser/lessee/conveyee, state the estimated cost to complete a domestic well, including drilling, pressure tank, control devices, storage and treatment facilities)
 (if wells are provided by the subdivider, state the cost, if any, to the purchaser/lessee/ conveyee)
 (summary of legal restrictions on either indoor or outdoor usage)
 (average depth to groundwater and the minimum and maximum well depths to be reasonably expected)
 (recommend total depth of well)
 (estimated yield in gallons per minute of wells completed to recommended total depth)
 (State of New Mexico wells shall be permitted by the State Engineer's Office.)
20. **LIFE EXPECTANCY OF THE WATER SUPPLY**
 (state the life expectancy of each source of water supply for the subdivision under full development of the subdivision)
21. **SURFACE WATER***
 *Not applicable where subdivider intends to provide water for domestic use.
 (provide a detailed statement of the source and yield of the surface water supply and any restrictions to which the surface water supply is subject)
22. **NEW MEXICO STATE ENGINEER'S OPINION ON WATER AVAILABILITY**
 Include here the approved summary of the opinion received by the City from the New Mexico State Engineer regarding:

(whether or not the subdivider can furnish water sufficient in quantity to fulfill the maximum annual water requirements of the subdivision, including water for indoor and outdoor domestic uses)

(whether or not the subdivider can fulfill the proposals in this disclosure statement concerning water, excepting water quality)

23. WATER QUALITY

(describe the quality of water in the subdivision available for human consumption)

(describe any quality that would make the water unsuitable for use within the subdivision)

(state the name, the contaminant level, the maximum contaminant level, the expected adverse effects of the contaminant for domestic use, and the recommended treatment method to reduce the contaminant level to or below the maximum contaminant level for any contaminants which exceed the maximum contaminant levels established by the Water Quality Control Commission or the New Mexico Environment Department, Drinking Water Quality Bureau)

24. NEW MEXICO ENVIRONMENT DEPARTMENT'S OPINION ON WATER QUALITY

Include here the approved summary of the opinion received by the City of Rio Rancho from the New Mexico Environment Department on:

(whether or not the subdivider can furnish water of an acceptable quality for human consumption and measures to protect the water supply from contamination in conformity with state regulations)

(whether or not the subdivider can fulfill the water quality proposal made in this disclosure statement)

(whether or not the subdivider's proposal for water quality conforms to the City water quality regulations)

25. WASTEWATER SYSTEMS

(describe the performance standards that must be obtained, design flow and any other conditions affecting the wastewater systems that are proposed and that has been approved by the City for use within the subdivision)

26. THE NEW MEXICO ENVIRONMENT DEPARTMENT GROUND WATER QUALITY BUREAU OPINION ON WASTEWATER SYSTEMS

Include here the approved summary of the New Mexico Environment Department, Ground Water Quality Bureau on:

(whether there are sufficient wastewater facilities to fulfill the requirements of the subdivision in conformity with state and City ordinance/regulations)

(whether or not the subdivider can fulfill the wastewater proposals made in this disclosure statement)

(whether or not the subdivider's proposal for wastewater disposal conforms to the City's wastewater ordinance/regulations)

27. SOLID WASTE DISPOSAL

(describe the means of solid waste disposal that is proposed for use within the subdivision)

28. NEW MEXICO ENVIRONMENT DEPARTMENT'S OPINION ON SOLID WASTE DISPOSAL

Include here the approved summary of the opinion received from the New Mexico Environment Department on:

(whether or not there are sufficient solid waste disposal facilities to fulfill the needs of the subdivision in conformity with state regulations)

(whether or not the subdivider can fulfill the solid waste proposals made in this disclosure statement)

(whether or not the subdivider's proposal for solid waste disposal conforms to the City's regulations on solid waste disposal)

29. TERRAIN MANAGEMENT (Also known as grading and drainage plan or report)

(describe the suitability for residential use of the soils in the subdivision

(describe any measures necessary for overcoming soil and topographic limitations, and who will be responsible for implementing these measures)

(identify by lot and block numbers all parcels within the subdivision that are subject to flooding)

(identify by lot and block number all parcels within the subdivision located in whole or in part on slopes in excess of 8%)

(describe the surface drainage for all lots in the subdivision)

(describe the subsurface drainage for all lots in the subdivision)

(describe the nature, location and completion dates of all storm drainage systems and structures constructed or required to be constructed in the subdivision, and identify the entity which is responsible for construction)

30. NATURAL RESOURCES CONSERVATION DISTRICT'S OPINION ON TERRAIN MANAGEMENT

Include here the approved summary of the opinion received by the City from the Soil & Water Conservation District on:

(whether or not the subdivider can furnish sufficient terrain management to protect against flooding, inadequate drainage and soil erosion)

(whether or not the subdivider can satisfy the terrain management proposals made in this disclosure statement)

(whether or not the subdivider's terrain management proposals conform to the City regulations on terrain management)

31. SUBDIVISION ACCESS

(state whether or not subdivision is accessible by conventional vehicle)

(state whether or not subdivision is ordinarily accessible at all times of the year and under all weather conditions)

(describe the width and surfacing of all roads within the subdivision)

(state whether the roads within the subdivision have been accepted for maintenance by the City)

(if the roads within the subdivision have not been accepted for maintenance by the City, state how the roads will be maintained and describe lot owners responsibilities and obligations with respect to road maintenance)

32. NEW MEXICO DEPARTMENT OF TRANSPORTATION'S OPINION ON ACCESS

Include here the approved summary of the opinion received by City Department of Public Works from the New Mexico Department of Transportation on:

- (whether or not the subdivider can fulfill the state-highway access requirements for the subdivision in conformity with state regulations)
- (whether or not the subdivider can satisfy the access proposal made in this disclosure statement)
- (whether or not the subdivider's access proposals conform to the City's regulations on access)
33. **CONSTRUCTION GUARANTEES**
(describe any proposed roads, drainage structures, water treatment facilities or other improvements that will not be completed before parcels in the subdivision are offered for sale)
34. **ADVERSE OR UNUSUAL CONDITIONS**
(state any activities or conditions adjacent to or nearby the subdivision, such as feed lots, dairies, cement plants or airports, that would subject the subdivided land to anything unusual affecting its use or occupancy)
35. **RECREATIONAL FACILITIES**
(describe all recreational facilities, actual and proposed in the subdivision)
(state the estimated date of completion of each proposed recreational facility)
(state whether or not there are any bonds, letters of credit or other collateral securing the construction of each proposed recreational facility and describe any such bond, letter of credit or other collateral)
36. **FIRE PROTECTION**
(distance to nearest fire station from subdivision)
(route over which that distance is computed)
(state whether the fire department is full-time or semi-staffed)
37. **POLICE PROTECTION**
(sheriff's department, if applicable)
(municipal police, if applicable) (state police, if applicable)
38. **PUBLIC SCHOOLS**
(name of and distance to nearest public elementary school serving the subdivision)
(name of and distance to nearest public junior high or middle school serving the subdivision)
(Name of and distance to nearest public high school serving the subdivision)
39. **HOSPITALS**
(Name of nearest hospital)
40. **PUBLIC TRANSPORTATION**
Describe all public transportation that serves the subdivision on a regular basis
-

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NOTICE

This document was a collective effort by several individuals and, while every effort was made to provide a superior product, some errors or inconsistencies may exist. Please assist us by reporting every error or inconsistency that you find. Corrections will be made periodically and each page will be updated and corrections logged in an internal tracking system. The official office copy and the web site version will have all of the latest changes and it is recommended that you check either of these sources when periodically and starting a new project.

Chapter II.2

DRAINAGE, FLOOD CONTROL AND EROSION CONTROL

Section 1. INTENT & SUPPORT DOCUMENTS

The standards, guidelines and criteria presented herein are provided in order to facilitate the planning, design, construction and operation of both public and private drainage control, flood control and erosion control facilities within the community. The criteria are not intended as a substitute for good engineering judgment; imagination and ingenuity are encouraged. The thrust of these criteria is toward generalization in order to provide guidance for a large majority of design circumstances, but it must be understood that situations will arise in which these criteria are not appropriate. The SSCAFCA Executive Engineer or City Engineer, may, in specific cases, require more stringent criteria or allow relaxation of these criteria based on his judgment and sound engineering practice. The letter and intent of the approved goals, Mission Statement and Vision Statement are listed below included in this document to insure compliance with the Board's direction and to add value to this document.

A.Goals, Mission Statement and Vision Statement

1. *Original Goals and Commitments*

- To provide flood protection up to the 100 year storm for the public health, safety and welfare of residents and properties within our boundaries.
- To recognize the value of land purchased or controlled for floodways as areas with multi-use potential.
- To assist in the coordination of flood control with other entities for the common good of the public.

2. *Mission Statement*

Protect citizens and property by implementing proven flood control solutions that:

- **Manage** our watersheds prudently for future generations
- **Enhance** the quality of life
- **Create** the most appealing multi-use facilities
- **Set an Example** of quality, integrity, leadership and professionalism
- **Educate** the public concerning flood hazards
- **Administer** public funds prudently

3. *Vision Statement*

Flood control today – for a safer tomorrow.

B. Summary of Documents Relating to Drainage, Flood Control and Erosion Control

1. City of Rio Rancho Ordinances and Policies

- a. Flood Hazard Prevention Ordinance (Chapter 152)
- b. Erosion Control; Storm Drainage (Chapter 153)
- c. Planning and Zoning (Chapter 154)
- d. Subdivision Ordinance (Chapter 155)

2. SSCAFCA Regulations and Policies

- a. Greenbelt Concept Resolution 1992-8
- b. Drainage Policy Resolution 1994-08
- c. Drainage Policy Resolution 2001-6
(Drainage Design Criteria for Roadway Projects)
- d. Guidelines for Allowable Velocities in Piping Systems approved
June 14, 2001
- e. Drainage Policy Amendment 2004-1
- f. Drainage Policy Amendment 2004-2
- g. Drainage Policy Adopted June 20, 2008
- h. Sediment and Erosion Design Guide November 2008
- i. Sediment and Erosion Design Guide Power Point Presentation

Section 2. HYDROLOGY

A. PREFACE

Southern Sandoval County Flood Control Authority (SSCAFCA) was created in 1990 (first official day was June 1, 1990) by the New Mexico Legislature with specific responsibilities to address flooding problems in greater Sandoval County. SSCAFCA's goals, Mission Statements and Vision Statement were developed by staff and adopted by the Board. They are listed below to insure that the letter and intent guide development. With these purposes in mind and the urgency to adopt drainage criteria, SSCAFCA unofficially adopted Chapter II.2 of the City of Albuquerque Development Process Manual.

In 2007, in an effort to adopt drainage criteria that is more representative of the desires of the SSCAFCA Board, the Board authorized the Executive Engineer to adapt the City of Albuquerque DPM Chapter II.2 to meet its needs and desires. With this authorization, SSCAFCA joined with the City of Rio Rancho in establishing drainage criteria that is mutually agreeable to both jurisdictions. SSCAFCA volunteered to take the lead in the creation of Chapter II.2 for Southern Sandoval County by establishing a Subcommittee that met weekly. In conjunction with this update, Bohannan-Huston was charged with the task to prepare for adoption changes to the City of Albuquerque DPM and the AMAFCA Sediment and Erosion Design Guide to supplement the work of the Subcommittee and WHPacific and Stantec investigated public domain hydrology models for inclusion in the DPM. The USACE HEC-HMS model was selected and changes prepared to incorporate this public domain model into the document for use in SSCAFCA's jurisdiction

On July 31, 2009 SSCAFCA adopted the revised Chapter II.2 as an allowable procedure for hydrologic analysis and design of flood control structures.

The City of Rio Rancho is in the process of adopting the revised Chapter II.2 (re-numbered as Chapter II.2.2) as an allowable procedure for hydrologic analysis and design of flood control structures.

SSCAFCA and the City of Rio Rancho wish to acknowledge the assistance of the committee members listed below who helped prepare and/or reviewed the document:

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B. INTRODUCTION

There have been many methods used in the City of Rio Rancho's and SSCAFCA's jurisdiction to compute runoff volumes, peak flow rates and runoff hydrographs from drainage basins. Any methodology used should be based on measurable conditions, be as simple as possible and produce accurate, reproducible results. The methods, graphs, and tables which follow will be used by the City of Rio Rancho and SSCAFCA staff in the review and evaluation of development plans and drainage management plans.

Three basic methods of analysis are presented herein:

- **Rational Method** - describes a simplified procedure for smaller watersheds based on the Rational Method. The procedure is applicable to watersheds up to 40 acres in size.
- **Rainfall-runoff modeling with AHYMO** - describes procedures for rainfall-runoff modeling using the AHYMO computer program. AHYMO is a version of the U.S.D.A. Agricultural Research Service HYMO computer program, modified to utilize initial abstraction/uniform infiltration precipitation losses. Rainfall-runoff modeling using AHYMO is applicable for drainage areas between 40 and 320 acres in size.
- **Rainfall-runoff modeling with HEC-HMS**- describes procedures for rainfall-runoff modeling using the U.S. Army Corps of Engineers HEC-HMS software. Rainfall-runoff modeling using HEC-HMS is applicable for drainage areas greater than 40 acres in size.

C. SYMBOLS AND DEFINITIONS

When evaluating equations use the following order of precedence: 1) parentheses, 2) functions (i.e., SIN or LOG), 3) power or square root, 4) multiplication or division, 5) addition or subtraction.

A_A	.....	area in land treatment A
A_B	.....	area in land treatment B
A_C	.....	area in land treatment C
A_D	.....	area in land treatment D
A_T	.....	total area in sub-basin
Ac Ft	.....	acre feet
C	.....	Rational Method coefficient
C_A	.....	Rational Method coefficient for treatment A
C_B	.....	Rational Method coefficient for treatment B
C_C	.....	Rational Method coefficient for treatment C
C_D	.....	Rational Method coefficient for treatment D
cfs	.....	cubic feet per second
CN	.....	SCS Curve Number
D	.....	duration in days
e	.....	base of natural logarithm system = 2.71828
E	.....	excess precipitation
E_A	.....	excess precipitation for treatment A
E_B	.....	excess precipitation for treatment B
E_C	.....	excess precipitation for treatment C
E_D	.....	excess precipitation for treatment D

EA	elevation adjustment factor for PMP ₆₀
Elev	elevation (feet)
Ft	feet
hr	hour
I	Rational Method intensity (inches/hour)
IA	initial abstraction (inches)
INF	infiltration (inches/hour)
K	conveyance factor for SCS Upland Method
k	recession coefficient for AHYMO program
K _N	basin factor for lag time equation
K _X	conveyance factor for watershed subreach
k/t _{pA}	k divided by t _p for treatment A
k/t _{pB}	k divided by t _p for treatment B
k/t _{pC}	k divided by t _p for treatment C
k/t _{pD}	k divided by t _p for treatment D
k/t _{p40}	k divided by t _p for 40 acres or smaller area
k/t _{p200}	k divided by t _p for 200 acres or larger area
L	length of subreach (feet)
L _{CA}	distance to centroid of drainage basin (feet)
L _G	lag time (hours)
L _X	length of watershed subreach
In	natural logarithm (base e)
log ₁₀	base 10 logarithm

mi^2	.....	square mile(s)
n	.....	Manning's roughness coefficient
P_{12}	.....	12-minute precipitation
P_{60}	.....	60-minute precipitation at 100-year storm
P_{60-2}	.....	60-minute precipitation at 2-year storm
$P_{60-year}$	.....	60-minute precipitation at "year" storm
P_{360}	.....	360-minute precipitation at 100-year storm
P_{360-2}	.....	360-minute precipitation at 2-year storm
P_{360-10}	.....	360-minute precipitation at 10-year storm
P_{1440}	.....	1440-minute (24-hr) precipitation, 100-year storm
P_{1440-2}	.....	1440-minute (24-hr) precipitation at 2-year storm
P_D	.....	precipitation for "D"-days duration
P_{N-100}	.....	"n"-minute precipitation at 100-year storm
P_{N-YEAR}	.....	"n"-minute precipitation at "year" storm
P_T	.....	precipitation at any time, t
PMF	.....	Probable Maximum Flood
$1/2PMF$	.....	one-half of the Probable Maximum Flood
PMP_{15}	.....	15-minute Probable Maximum Precipitation
PMP_{60}	.....	60-minute Probable Maximum Precipitation
PMP_{360}	.....	360-minute Probable Maximum Precipitation
PMP_T	.....	Probable Maximum Precipitation at anytime, t
Q_P	.....	peak discharge (cfs)
Q_{PA}	.....	peak discharge rate (cfs/acre) for treatment A

Q_{PB} peak discharge rate (cfs/acre) for treatment B
 Q_{PC} peak discharge rate (cfs/acre) for treatment C
 Q_{PD} peak discharge rate (cfs/acre) for treatment D
 s slope of subreach in foot per foot
 t time in minutes
 t_B base time for small watershed hydrograph
 T_C time of concentration (hours)
 R storage coefficient (hours)
 t_p time to peak (hours)
 v velocity of flow in watershed (feet/sec)
 v_x velocity of flow in watershed subreach
 V_{360} runoff volume for 360-minute storm
 V_{1440} runoff volume for 1440-minute storm
 V_{4days} runoff volume for 4-day storm
 V_{10days} runoff volume for 10-day storm
 y^x y to the x power
 $+$ addition operator
 $-$ subtraction operator
 $*$ multiplication operator
 $/$ division operator
 $\sqrt{\quad}$ square root operator

DEFINITIONS

100-year Design Storm - means a storm as defined by the Drainage Ordinance and DPM.

ADA – Americans with Disabilities Act.

Amendment - Change to an effective FEMA map resulting in the exclusion of an individual structure or a legally described parcel of undeveloped land that was inadvertently included in the SFHA.

Amenities – Improvements that may enhance the citizens’ enjoyment of the outdoors including, but not limited to, trails, view points with benches, wildlife and plant habitat, educational/informational signage, and trailheads.

Applicant - means any Developer seeking to construct drainage facilities under this Procedure.
Base Flood Elevation (BFE) - Elevation of the 100-year (1-percent annual chance) flood, in feet, referenced to the National Geodetic Vertical Datum.

Benefit - means, for the purpose of this Procedure, the provision of a drainage outfall or flood control facility that serves the property.

Benefited Area - means the tracts or parcels of land within a drainage basin benefited by the proposed drainage or flood control facilities.

BMP - Best Management Practice.

Certificate of Completion and Acceptance - means a document issued by the City/SSCAFCA in a format prescribed in the Development Process Manual which certifies that the public infrastructure improvements required for a development have been satisfactorily completed by the developer and are accepted by the City, for maintenance and public use.

City/County Floodplain Administrator - Public official who is designated by the community to coordinate the community's participation in the National Flood Insurance Program.

Consulting Engineer - means a professional engineer competent in surface water hydrology and hydraulics duly licensed under the laws of the State of New Mexico who is under contract with an Applicant or the City/SSCAFCA to design drainage facilities.

Cost Allocation - means a cost allocated to new development in order to fund and/or recoup the costs of drainage facilities necessitated by and attributable to the new development.

Cost Allocation Table - means the list or roll of all tracts or parcels of property within the benefited area and the amount to be allocated against each tract or parcel as determined in accordance with this Procedure.

Critical Facility – Shall include hospitals, schools and other buildings used for emergency shelter, support facilities/utilities for aforementioned facilities, and access routes to the aforementioned facilities.

Dams – Storm water retention/detention structures approved and controlled by the Office of the State Engineer (i.e., containing a storage volume equal to or greater than 50 acre feet and/or a berm height of 25’ or greater).

Depth of Bury – the vertical distance between the top of the utility line and the bottom of the arroyo, whether the utility is in the arroyo or adjacent to the arroyo, at the time of consideration.

Detention Pond – A ponding structure designed with a physical means by which water is released in a controlled manner.

Developer - means any individual, estate, trust, receiver, cooperative association, club, corporation, company, firm, partnership, joint venture, syndicate, political subdivision or other public or private entity engaging in the platting, subdivision, filling, grading, excavating, or construction of structures.

DEVEX – the runoff with existing platting, full development, unpaved streets, and drainage conveyance. If available, DEVEX flows shall be taken from SSCAFCA approved WMP’s.

DPM – Development Process Manual.

Drainage Basin - means the land area from which storm water shall drain to an acceptable outfall.

Drainage Facilities - means public facilities used for conducting storm waters to, through and from a drainage basin to the point of final destination, and any related improvements, as defined in the Allocation Plan including, but not limited to, any or all of the following: bridges, pipes, conduits, culverts, crossing structures, arroyos, waterways, inlets, swales, ditches, gulches, channels, temporary or permanent retention and detention areas, water quality features, lateral Erosion line and stability measures removal and/or replacement of existing facilities, as well as easements and rights-of-way necessary to accommodate the same.

Encroachment - Construction, placement of fill, or similar alteration of topography in the flood plain that reduces the area available to convey flood waters.

Federal Emergency Management Agency (FEMA) - Government Agency that regulates FIRM maps.

Floodway - Channel of a stream or other watercourse, plus any adjacent flood plain areas that must be kept free of encroachment so that the 100-year flood discharge can be conveyed without cumulatively increasing the elevation of the 100-year flood more than zero feet.

Floodway Fringe - Portion of the 100-year flood plain that is not within the floodway and in which development and other forms of encroachment are allowed.

Flood Boundary and Floodway Map (FBFM) - Flood plain management map issued by FEMA that depicts, based on detailed analyses, the boundaries of the 100- and 500-year floods and the limits of the 100-year floodway. Replaced by FIRM.

Flood Insurance Rate Map (FIRM) - Insurance and flood plain management map issued by FEMA that, based on detailed analyses, identifies areas of 100-year flood hazard in a community. Also shown are BFEs, actuarial insurance rate zones, delineations of the 100- and 500-year flood boundaries, and, on some FIRMS, the 100-year floodway. The Flood Insurance Rate Map enables the community to enter the Regulatory Phase of the National Flood Insurance Program.

Floodplain - Any land area susceptible to being inundated by water from any source, or areas adjacent to a watercourse or other body of water that are subject to inundation by flood waters.

Floodplain Development – Any earthwork, storage, or construction activity (permanent or temporary).

Gross Pollutants - litter, vegetation, coarse sediment and floatable debris. For the local Municipal Separate Storm Sewer System (MS4), the gross pollutant treatment size is defined as 1-3/4" and larger.

HDPE – High Density Polyethylene.

Infrastructure Allocation Drainage Management Plan or Allocation Plan - means a comprehensive analysis of the discharge rate volume, frequency, and course of stormwaters within one or more drainage basins or watershed resulting from a new development and used to identify required drainage facilities so that an equitable cost distribution for drainage facilities may be allocated against benefited properties. The Allocation Plan shall be prepared in accordance with this Procedure.

LEE – Lateral Erosion Envelope.

Letter of Map Amendment (LOMA) - Official determination by FEMA that a specific structure or portion of a property is not within a 100-year flood zone; amends the effective FIRM map.

Letter of Map Revision (LOMR) - Official determination by FEMA that revises Base Flood Elevations, flood insurance rate zones, flood boundaries, or floodways as shown on an effective FIRM map.

National Flood Insurance Program (NFIP) - Federal regulatory program under which flood-prone areas are identified and flood insurance is provided to the owners of property in flood-prone areas.

New Development - means the proposed subdivision of land, reconstruction, redevelopment, conversion, structural alteration, relocation or enlargement of any structure; or any proposed use or extension of the use of land affecting drainage within the benefited area, including but not limited to proposed buildings or other structures, site plan requests, grading, paving, filling, or excavation.

NPDES - National Pollutant Discharge Elimination System.

Open Space - means publicly owned or controlled lands set aside for Open Space purposes.

Ponds – Smaller storm water retention/detention structures not approved or controlled by the Office the State Engineer (i.e., containing a storage volume less than 50 acre feet and/or a berm height of less than 25’.

Retention Pond – A ponding structure without a physical means by which water is released in a controlled manner. This includes ponds whose evacuation is dependent upon infiltration and/or evaporation.

Revision - Change to any of the information that is depicted on an effective NFIP map, which is accomplished by a LOMR or by a Physical map revision.

SAS ECZ – Sanitary Sewer Line Erosion Control Zone, the Depth of Scour for the 100-year DEVEX event.

Scour Depth – Cumulative scour depth including consideration of contraction scour and local scour as defined in Sections 3.4 and 3.5 of the Sediment and Erosion Design Guide.

Special Flood Hazard Area (SFHA) - Area inundated by the base (100-year) flood, which carries any of several A or V zone designations.

SSCAFCA – Southern Sandoval County Arroyo Flood Control Authority.

Storm Water Quality Constituents - dissolved and suspended nutrients, metals, oils, greases, biological agents, etc.

Storm Water Quality Treatment Rate (SWQR) - the peak rate of flow from the water quality storm event.

Storm Water Quality Treatment Volume (SWQV) - the treatment volume from the water quality storm event.

Temporary Drainage Facility - means a nonpermanent drainage control, flood control or erosion control facility constructed as part of a phased project or to serve until such time as a permanent facility is in place, including, but not limited to, desilting ponds, berms, diversions, channels, detention ponds, bank protection and channel stabilization measures.

Water Quality Storm Event - 0.6 inches of precipitation within a six-hour period. This is approximately equivalent to the average annual precipitation event and represents the 80th percentile rainfall event (i.e., approximately 80% of the total annual rainfall occurs in storm events with 0.6" or smaller precipitation depth).

Watershed Park – A comprehensive, connected system of joint use amenities along the arroyos in Southern Sandoval County.

Witness Post – A post identifying the location and depth of the utility that will remain in its location through a storm event.

WMP's – Watershed Management Plans.

STORM DRAINAGE RELEASE RATE

Unless restricted by downstream or specific infrastructure limitations, the maximum discharge permitted from a developed property in the event of a 100 year 6 hour storm shall be the amount of the historic or pre-developed runoff in all watersheds of the City of Rio Rancho. However, as a result of infrastructure limitations, developed properties in the watershed area intercepted by the 7-Bar Channel adjacent to NM 528 south of High Resort Boulevard shall have discharge limited to 0.5 cfs per acre. Release rates may be allowed to be higher if it is shown via a drainage report that an existing flood control facility immediately down stream of the discharge is designed to accept such a flow.

D. RATIONAL METHOD

D.1 INTRODUCTION

The Rational Method formula is a commonly used, simplified method of estimating peak discharge for small uniform drainage areas. This method is typically used to size drainage structures for the peak discharge of a given return period. Extensions of this method can be used to estimate runoff volume and the shape of the runoff hydrograph to design drainage facilities and / or design a drainage structure that requires routing of the hydrograph through the structure.

The Rational Equation is expressed as follows:

$$Q = CiA \tag{D-1}$$

where: Q = maximum rate of runoff, in cfs
C = runoff coefficient
i = average rainfall intensity, in inches / hour
A = drainage area, in acres

D.2 ASSUMPTIONS

The following assumptions are inherent when using the Rational Equation:

1. The peak flow occurs when the entire watershed is contributing to the flow,
2. The rainfall intensity is the same over the entire watershed,
3. The rainfall intensity is uniform over a duration equal to the time of concentration, and
4. The frequency of the computed peak flow is the same as that of the rainfall intensity (e.g. the 25-year rainfall intensity is assumed to produce the 25-year peak flow).

D.3 LIMITATIONS

The following limitations shall apply to the Rational Method for use in the City/SSCAFCA jurisdiction. Drainage areas that do not meet the following conditions will require the use of an appropriate rainfall-runoff method as outlined in Sections E or F.

1. The total drainage area cannot exceed 40 acres in size,
2. The land treatment within the contributing watershed must be fairly consistent over the entire drainage area and uniformly distributed throughout the area, and
3. The contributing drainage area cannot have drainage structures or other facilities upstream of the point of interest that require flood routing.

D.4 RUNOFF COEFFICIENTS

Perhaps the most important variable in the Rational Method equation is the runoff coefficient. The runoff coefficient represents the fraction of rainfall that appears as surface runoff from a watershed. Thus, the runoff coefficient is, by default, also a measure of the fraction of rainfall lost to depression storage, infiltration and evaporation with infiltration being the primary loss component. This fraction is largely independent of rainfall intensity or volume from impervious areas. However, for pervious areas, the fraction of runoff varies with rainfall intensity and the accumulated volume of runoff. Therefore, the selection of a runoff coefficient that is appropriate for the storm, soil type, land cover and land use conditions is critical.

Runoff coefficients are based on a characterization of the watershed area into land treatment classifications. Four land treatment classifications have been created that typify the conditions in the City/SSCAFCA jurisdiction. Descriptions of the land treatment classifications are provided in Table D-1. Three of the land treatment classifications (A, B and C) are for pervious conditions. The fourth classification (D) is for impervious areas. Runoff coefficients for each land treatment type are listed in Table D-2.

TABLE D-1. LAND TREATMENTS	
Treatment	Land Condition
A	Soil uncompacted by human activity with 0 to 10 percent slopes. Native grasses, weeds and shrubs in typical densities with minimal disturbance to grading, ground cover and infiltration capacity.
B	Irrigated lawns, parks and golf courses with 0 to 10 percent slopes. Native grasses, weeds and shrubs, and soil uncompacted by human activity with slopes greater than 10 percent and less than 20 percent.
C	Soil compacted by human activity. Minimal vegetation. Unpaved parking, roads, trails. Most vacant lots. Gravel or rock on plastic (desert landscaping). Irrigated lawns and parks with slopes greater than 10 percent. Native grasses, weeds and shrubs, and soil uncompacted by human activity with slopes at 20 percent or greater. Native grass, weed and shrub areas with clay or clay loam soils and other soils of very low permeability as classified by SCS Hydrologic Soil Group D.
D	Impervious areas, pavement and roofs.
Most watersheds contain a mixture of land treatments. To determine proportional treatments, measure respective subareas. In lieu of specific measurement for treatment D, the areal percentages in TABLE D-3 may be employed.	

For watersheds with multiple land treatment types present, an area averaged runoff coefficient should be used as input to Equation D-1. The area average can be a simple arithmetic average, as seen in the equation below.

$$C = \frac{A_A C_A + A_B C_B + A_C C_C + A_D C_D}{A_A + A_B + A_C + A_D}$$

TABLE D-2. RATIONAL METHOD RUNOFF COEFFICIENT, C				
Recurrence Interval	Land Treatment			
Years	A	B	C	D
500	0.56	0.62	0.66	0.93
100	0.27	0.43	0.61	0.93
50	0.20	0.35	0.58	0.93
25	0.14	0.31	0.56	0.92
10	0.08	0.24	0.47	0.92
5	0.01	0.10	0.40	0.92
2	0.00	0.02	0.26	0.92
1	0.00	0.00	0.06	0.90

TABLE D-3 SSCAFCA TREATMENT TYPE PERCENTAGE SUMMARY

Parcel Description	Treatments				Methodology/Notes
	A	B	C	D	
1/8 Acre	0%	15%	15%	70%	DPM, Chapter 22.2, Table A-4 for D
1/6 Acre	0%	28%	15%	57%	Northern Meadows Master Plan
1/4 Acre	0%	30%	28%	42%	DPM, and followed SSCAFCA lead on B&C
1/2 Acre	10%	33%	30%	27%	SSCAFCA
1 Acre	43%	20%	20%	17%	SSCAFCA
Single Family Residential N=units/acre, N6					$7*\sqrt{(N*N)} + (5*N)$
Estate Lots (btwn 1- 5ac)	60%	15%	15%	10%	DPM for 2.5 acre lot
M-1 (Light Industrial)	0%	15%	15%	70%	DPM for D, split B & C
Vacant Res./Undevel.	79%	8%	8%	5%	DPM for 5 acre lot
Arroyo	100%	0%	0%	0%	DPM
Major Roads	0%	0%	10%	90%	DPM
School	10%	20%	20%	50%	DPM
Commercial/Industrial	0%	0%	15%	85%	DPM average of Heavy Industrial and Commercial
Open Space	100%	0%	0%	0%	DPM
Parks, Sports and Rec	0%	85%	0%	15%	DPM
Landfill	0%	0%	100%	0%	All disturbed ground
Multi-Family	0%	15%	15%	70%	DPM-Multiple Unit Res. Attached
Northern Meadows	0%	28%	15%	57%	Northern Meadows Master Plan
Drainage Ponds	0%	0%	100%	0%	
County Platted (1)	18.7%	29.5%	27.0%	24.8%	(used Basin P12_104 as typical)
County Unplatted (2)	95%	5%	0%	0%	DPM

NOTES

- County Platted area is defined as the area between CORR boundary and Rio Rancho Estates boundary.
- County Unplatted area is defined as the area outside the city limits and the Rio Rancho Estates limits. It is considered to be existing conditions.
- All roads are assumed to be paved.

D.5 TIME OF CONCENTRATION

Time of concentration is defined as the time it takes for runoff to travel from the hydraulically most distant part of the watershed basin to the basin outlet or point of analysis (concentration point). The units for time of concentration are time, in hours. This implies that the time of concentration flow path may not be the longest physical length, but the length that results in the longest time.

Time of concentration is calculated using the SCS Upland Method. The Upland Method is the summation of flow travel time for the series of unique flow characteristics that occur along the overall basin flow path length. The Upland Method travel time equation is:

$$T_c = \sum_{i=1}^n \left(\frac{L_i}{36,000 * K_i * \sqrt{S_i}} \right) \quad (D-2)$$

Where: T_c = Time of concentration, in hours
 L_i = Length of each unique surface flow conveyance condition, in feet
 K_i = Conveyance factor from Table D-4
 S_i = Slope of the flow path, in feet per foot

TABLE D-4. CONVEYANCE FACTORS	
K	Conveyance Condition
0.7	Turf, landscaped areas and undisturbed natural areas (sheet flow* only).
1	Bare or disturbed soil areas and paved areas (sheet flow* only).
2	Shallow concentrated flow (paved or unpaved).
3	Street flow, storm sewers and natural channels, and that portion of subbasins (without constructed channels) below the upper 2000 feet for subbasins longer than 2000 feet.
4	Constructed channels (for example: riprap, soil cement or concrete lined channels).
* Sheet flow is flow over plane surfaces, with flow depths up to 0.1 feet. Sheet flow applies only to the upper 400 feet (maximum) of a subbasin.	

D.6 INTENSITY

Rainfall intensity, i , in Equation D-1 is estimated in inches/hour for the specified recurrence interval. The rainfall intensity is uniform over a duration equal to the time of concentration for the drainage area.

For most drainage areas less than or equal to 40 acres in size, it can be assumed that the time of concentration for drainage areas up to 40 acres in size will not exceed 15-minutes. Rainfall intensities for time of a time of concentration of 15-minutes are listed in Table D-5. Rainfall intensities listed in Table D-5 are based on precipitation values for the City/SSCAFCA jurisdiction derived from NOAA Atlas 14, Precipitation - Frequency Atlas of the United States, Volume 1: Semiarid Southwest (Arizona, Southeast California, Nevada, New Mexico, Utah).

TABLE D-5. RAINFALL INTENSITY	
Recurrence Interval	Intensity
Years	in/hr
500	5.7
100	4.4
50	3.9
25	3.4
10	2.8
5	2.3
2	1.7
1	1.4

D.7 RUNOFF VOLUME

Runoff volumes for drainage areas less than or equal to 40 acres in size can be estimated using a modified form of the Rational Method Equation. That equation is as follows.

$$V = C \frac{P}{12} A \tag{D-3}$$

- where:
- V = runoff volume, in acre-feet
 - C = weighted runoff coefficient derived from Table D-2
 - P = rainfall depth, in inches from Table D-6
 - A = drainage area, in acres

Rainfall depths for Equation D-3 are listed in Table D-6. The rainfall depths provided in Table D-6 are for multiple recurrence intervals and storm durations. Those values are adapted from NOAA Atlas 14, Precipitation - Frequency Atlas of the United States, Volume 1: Semiarid Southwest (Arizona, Southeast California, Nevada, New Mexico, Utah). For all other recurrence intervals and / or storm durations, point precipitation depths are to be obtained directly from the National Weather Service through the NOAA 14 Precipitation Frequency Data Server web site

found at http://hdsc.nws.noaa.gov/hdsc/pfds/sa/nm_pfds.html. At this web site point precipitation values for frequencies up to 1,000 years and duration up to 60 days can be obtained by entering the latitude and longitude of the watershed of interest.

TABLE D-6. RECURRENCE INTERVAL POINT PRECIPITATION DEPTHS				
Recurrence Interval	Duration			
	15-Minute	1-Hour	6-Hour	24-Hour
500	1.42	2.37	3.01	3.57
100	1.10	1.84	2.37	2.90
50	0.97	1.62	2.11	2.57
25	0.85	1.42	1.86	2.29
10	0.70	1.16	1.54	1.90
5	0.58	0.97	1.31	1.66
2	0.43	0.72	1.02	1.32
1	0.34	0.56	0.81	1.05

D.8 RUNOFF HYDROGRAPH

A runoff hydrograph can be synthesized for drainage areas less than or equal to 40 acres based on the Rational Method. This procedure is to be used where routing of the storm inflow through a drainage structure is desired, such as for the design of a detention basin. The procedure is based on an idealized hydrograph shape, drainage area time of concentration and the Rational Method peak discharge. The shape of the hydrograph is shown in Figure D-1. Equations for deriving the runoff hydrograph shape are as follows:

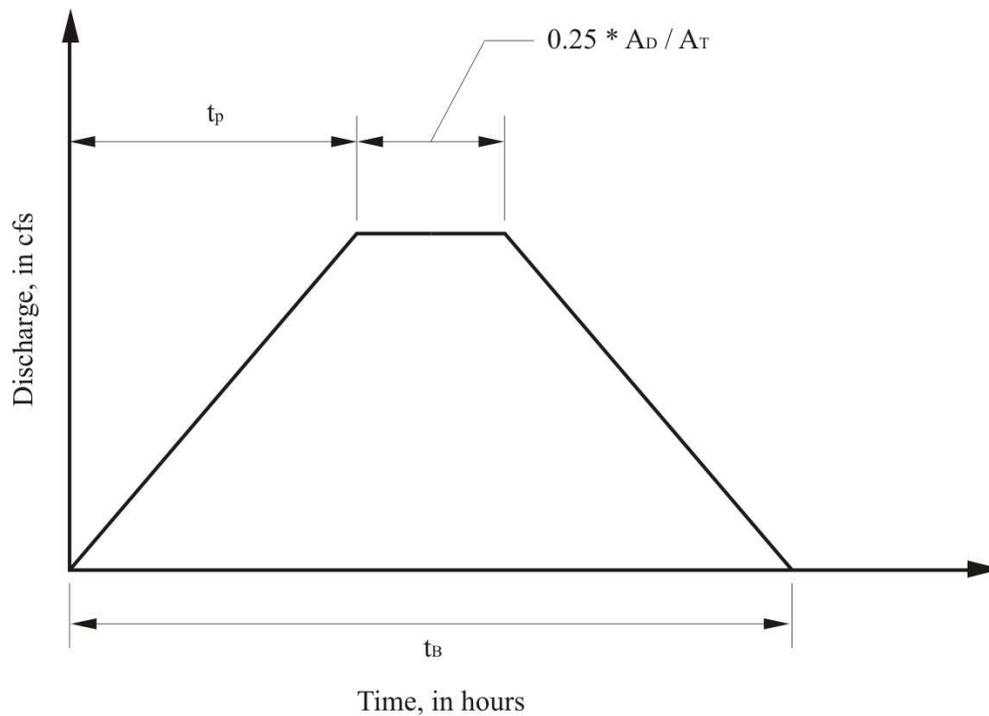
$$t_B = \left(2.017 \frac{C * P * A_T}{Q_P} \right) - \left(0.25 \frac{A_D}{A_T} \right) \quad (D-4)$$

- where:
- t_B = time base, in hours
 - C = runoff coefficient from Table D-2
 - P = rainfall depth, in inches from Table D-6
 - Q_P = Rational Method peak discharge, in cfs
 - A_D = area in land treatment type D, in acres
 - A_T = drainage area, in acres

$$t_p = 0.7 * T_c + \frac{1.6 - A_D / A_T}{12} \quad (D-5)$$

where: t_p = time to peak in hours
 T_c = time of concentration from Eqn. D-2, in hours
 A_D = area in land treatment type D, in acres
 A_T = drainage area, in acres

FIGURE D-1. RATIONAL METHOD RUNOFF HYDROGRAPH SHAPE



D.9 PROCEDURE

A runoff hydrograph can be synthesized for drainage areas less than or equal to 40 acres based on the Rational Method. This procedure is to be used where routing of the storm inflow through a drainage structure is desired, such as for the design of a detention basin.

To estimate peak discharge,

1. Determine the drainage area for the point of interest.
2. Calculate the area of each unique land treatment type or zoning classification.
3. Using the percent area of each land treatment type, calculate the area averaged runoff coefficient using the data from Table D-2.
4. For the desired frequency, select the maximum intensity from Table D-5.
5. Calculate the peak discharge using Equation D-1:

To estimate runoff volume,

1. For the desired storm frequency and duration, select the rainfall depth from Table D-6
2. Calculate the runoff coefficient using the procedures for estimating peak discharge
3. Calculate runoff volume using Equation D-3

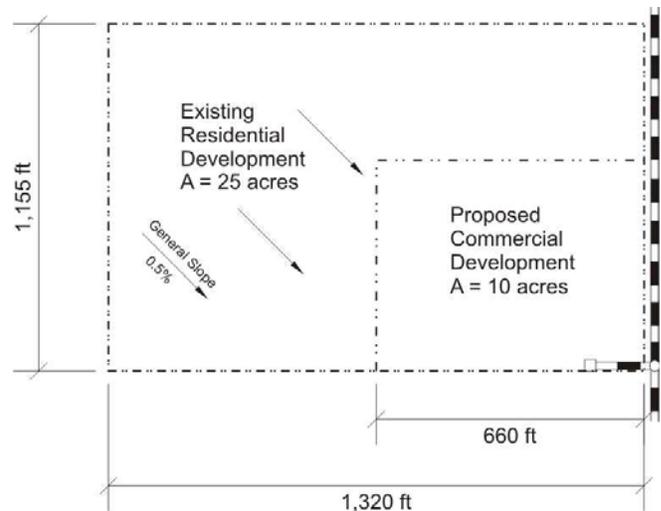
To estimate the Rational Method runoff hydrograph,

1. Calculate the peak discharge using the above procedures
2. From an appropriate map of the drainage area, delineate the time of concentration flow path and measure the length, in feet.
3. Select K from Table D-4
4. Measure the average flow path slope, S
5. Calculate the time of concentration using Equation D-2
6. Calculate the time base of the runoff hydrograph using Equation D-4
7. Calculate the time to peak using Equation D-5
8. Construct the hydrograph starting at time = 0 hours with a discharge of 0 cfs.

D.10 EXAMPLE

Runoff from an existing residential development collects at a roadway intersection. A new storm drain lateral is to be constructed as part of a proposed commercial development (see the following figure). Calculate the following:

1. 10-year peak discharge for the storm drain lateral.
2. Storage volume necessary to temporarily store the entire runoff volume from the 100-year, 6-hour storm.
3. Compute a runoff hydrograph for design of a detention basin to meter the 100-year flow into the storm drain.



Peak Discharge

1. Calculate the weighted runoff coefficient

From Table D-3, Land Treatment Type percentages for the two parcel descriptions are:

Parcel Description	Area acres	Percent of Land Treatment Type			
		A	B	C	D
1/8 Acre	25	0	15	15	70
Commercial / Industrial	10	0	0	15	85

From Table D-2, runoff coefficients for a 10-year frequency storm are:

- $C_B = 0.24$
- $C_C = 0.47$
- $C_D = 0.92$

Area of each Land Treatment Type is calculated as:

- $\text{Area}_B = (0.15)(25) + (0)(10) = 3.75$ acres
 - $\text{Area}_C = (0.15)(25) + (0.15)(10) = 5.25$ acres
 - $\text{Area}_D = (0.70)(25) + (0.80)(10) = \underline{26.0}$ acres
- Total Area = 35.0 acres**

Weighted runoff coefficient (C) is:

$$C = \frac{(3.75)(0.24) + (5.25)(0.47) + (26)(0.92)}{35}$$

$$C = 0.78$$

2. From Table D-5, the rainfall intensity (assuming $T_c \leq 15$ minutes) = 2.8 in/hr
3. Calculate the peak discharge using Equation D-1

$$Q = CiA$$

$$Q = (0.78)(2.8)(35)$$

$$Q = 77 \text{ cfs}$$

Note: It is recommended that all flow rates be rounded up to the nearest single unit (e.g. 76.44 cfs is rounded to 77 cfs).

100-Year, 6-hour Runoff Volume

1. From Table D-6, 100-year, 6-hour rainfall depth = 2.37 inches
2. Calculate the weighted runoff coefficient for the 100-year event

From Table D-3, Land Treatment Type percentages for the two parcel descriptions are:

Parcel Description	Area acres	Percent of Land Treatment Type			
		A	B	C	D
1/8 Acre	25	0	15	15	70
Commercial / Industrial	10	0	0	15	85

From Table D-2, runoff coefficients for a 100-year frequency storm are:

- $C_B = 0.43$
- $C_C = 0.61$
- $C_D = 0.93$

Area of each Land Treatment Type is calculated as:

- $\text{Area}_B = (0.15)(25) + (0)(10) = 3.75$ acres
 - $\text{Area}_C = (0.15)(25) + (0.15)(10) = 5.25$ acres
 - $\text{Area}_D = (0.70)(25) + (0.85)(10) = 26.0$ acres
- Total Area = 35.0 acres**

Weighted runoff coefficient (C) is:

$$C = \frac{(3.75)(0.43) + (5.25)(0.61) + (26)(0.93)}{35}$$
$$C = 0.83$$

3. Calculate the runoff volume using Equation D-3

$$V = C \frac{P}{12} A$$

$$V = (0.83) \left(\frac{2.37}{12} \right) (35)$$

$$V = 5.7 \text{ acre-feet}$$

Runoff Hydrograph

1. Calculate Time of Concentration assuming a total length of 2,475 feet (1,155 + 1,320) and a channel will be constructed to convey runoff along the boundary of the commercial development to the storm drain inlet.

From Table D-4, select conveyance factors for each conveyance condition

- A. $K_1 = 2$ (Shallow concentrated flow within residential area)
- B. $K_2 = 3$ (Street flow, storm sewers and open channels for commercial area)

From Equation D-2, T_c is:

$$T_c = \sum_{i=1}^n \left(\frac{L_i}{36,000 * K_i * \sqrt{S_i}} \right)$$

$$T_c = \left[\frac{(1,155 + 660)}{(36,000)(2)\sqrt{0.005}} + \frac{660}{(36,000)(3)\sqrt{0.005}} \right]$$

$$T_c = (0.36 + 0.09)$$

$$T_c = 0.45 \text{ hours (27 minutes)}$$

Note: assumption of a 15 minute T_c for estimating the 10-year peak discharge is reasonable and conservative based on the 100-year T_c of 27 minutes.

2. Calculate the 100-year peak discharge using Equation D-1 and an intensity of 4.4 in/hr taken from Table D-5

$$Q = CiA$$

$$Q = (0.83)(4.4)(35)$$

$$Q = 128 \text{ cfs}$$

3. Calculate the shape of the runoff hydrograph time base using Equation D-4 and time to peak using Equation D-5

$$t_B = \left(2.017 \frac{C * P * A_T}{Q_p} \right) - \left(0.25 \frac{A_D}{A_T} \right)$$

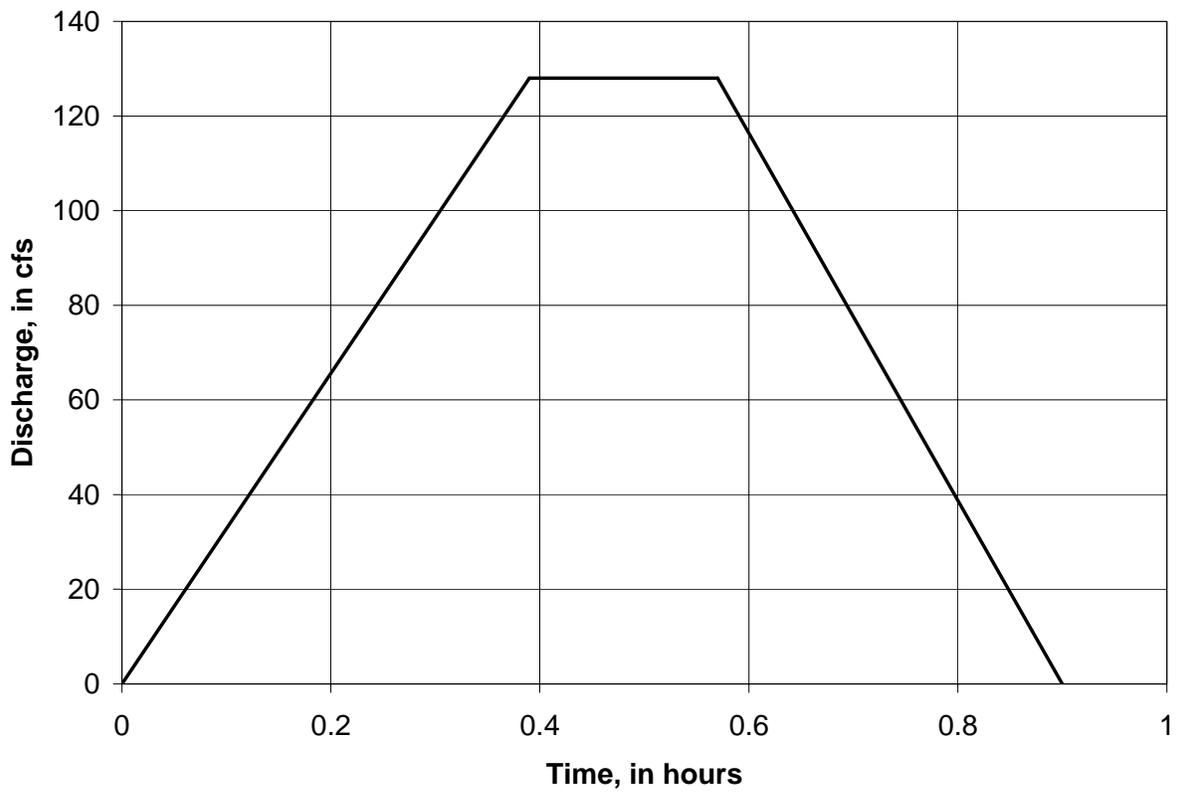
$$t_B = \left(2.017 \frac{(0.83)(2.37)(35)}{128} \right) - \left(0.25 \left(\frac{26}{35} \right) \right)$$

$$t_B = 0.90 \text{ hours}$$

$$t_p = 0.7 * T_c + \frac{1.6 - A_D/A_T}{12}$$

$$t_p = 0.7 \left(\frac{27}{60} \right) + \frac{1.6 - (26/35)}{12}$$

$$t_p = 0.39 \text{ hours}$$



E. RAINFALL-RUNOFF MODELING: AHYMO

E.1 INTRODUCTION

Rainfall-runoff modeling for drainage areas greater 40 acres and less than 320 acres in size may be conducted using the AHYMO computer program. AHYMO is an arid lands hydrologic model based on the HYMO computer program. The HYMO program was developed by Jimmy R. Williams and Roy W. Hann, Jr. in the early 1970's for the USDA Agricultural Research Service in cooperation with the Texas Agricultural Experiment Station, Texas A&M University. During the 1980's, HYMO was reformulated, enhanced and renamed to AHYMO by Cliff Anderson to simulate rainfall-runoff processes characteristic of the Albuquerque area. The current version of the program was issued in 1997.

Rainfall-runoff methodologies encoded into AHYMO are described in the following sections. In addition, techniques and procedures for developing the necessary input to AHYMO are discussed in the following sections.

E.2 DESIGN RAINFALL CRITERIA

For design hydrology, the characteristics of the major flood producing storm are simulated using a synthetic storm. Components of a synthetic storm are basin average rainfall depth and temporal distribution. Information and procedures for developing the design rainfall criteria for storms other than the Probable Maximum Precipitation are provided in the following sections.

E.2.1 Depth

The principal design storm for peak flow determination is the 100-year, 6-hour event. For analysis and design of retention ponds and detention dams, the 100-year, 24-hour storm is to be used. Additional design analysis may be required if the structure falls under the jurisdiction of the New Mexico Office of State Engineer, Dam Safety Bureau. Point precipitation depths for the 100-year storm to be used within the City/SSCAFCA jurisdiction are provided in Table E-1. Those values are adapted from NOAA Atlas 14, Precipitation - Frequency Atlas of the United States, Volume 1: Semiarid Southwest (Arizona, Southeast California, Nevada, New Mexico, Utah).

For determining sediment transport and for analysis of watersheds with complex routing conditions, other storm frequencies and durations may be required. Point precipitation depths for use in the City/SSCAFCA jurisdiction for multiple recurrence intervals and storm durations are listed in Table E-1. For all other recurrence intervals and storm durations, point precipitation depths are to be obtained directly from the National Weather Service through the NOAA 14 Precipitation Frequency Data Server website found at http://hdsc.nws.noaa.gov/hdsc/pfds/sa/nm_pfds.html. At this web site point precipitation values for frequencies up to 1,000 years and duration up to 60 days can be obtained by entering the latitude and longitude of the watershed of interest.

TABLE E-1. RECURRENCE INTERVAL POINT PRECIPITATION DEPTHS				
Recurrence Interval Years	Duration			
	15-Minute	1-Hour	6-Hour	24-Hour
500	1.42	2.37	3.01	3.57
100	1.10	1.84	2.37	2.90
50	0.97	1.62	2.11	2.57
25	0.85	1.42	1.86	2.29
10	0.70	1.16	1.54	1.90
5	0.58	0.97	1.31	1.66
2	0.43	0.72	1.02	1.32
1	0.34	0.56	0.81	1.05

E.2.2 Temporal Distribution

Basin average rainfall for 100-year, 6- and 24-hour storms is distributed temporally using a suite of equations; E-1 through E-6. The equations are a function of the 1-, 6- and 24-hour basin average depths. The design rainfall distribution is front loaded with the peak intensity set at 85.3 minutes (hour 1.42) regardless of storm duration. This distribution results in approximately 80 percent of the total depth occurring in less than one hour. For the 6-hour storm the distribution of rainfall is determined using the first 5 of the 6 equations. For the 24-hour storm, all 6 equations are used. To illustrate the shape of the pattern, the 6-hour storm distribution using the depths from Table E-1 for a 20 square mile watershed is shown in Figure E-2.

$$P_T = 2.334 * (P_{360} - P_{60}) * \left(1.5^A - \left(1.5 - \frac{t}{60} \right)^A \right) \quad \text{For } 0 \leq t \leq 60 \quad \text{(E-1)}$$

$$P_T = P_{T=60} + P_{60} * 0.4754 * \left(0.5^{0.09} - \left(1.5 - \frac{t}{60} \right)^{0.09} \right) \quad \text{For } 60 < t < 67 \quad \text{(E-2)}$$

$$P_T = P_{T=60} + P_{60} * \left(0.0001818182 * (t - 60) + 0.000018338 * (t - 60)^{3.2} \right) \quad \text{For } 67 \leq t < 85.3 \quad \text{(E-3)}$$

$$P_T = P_{T=60} + P_{60} * \left(0.07 * (t - 60) - 1.1886 - 0.0404768 * (t - 85)^{1.0985865} \right) \quad \text{For } 85.3 \leq t < 120 \quad \text{(E-4)}$$

$$P_T = P_{360} + (P_{T=60} + P_{60} - P_{360}) \frac{4.4^{3A} - \left(\frac{t}{60} - 1.6\right)^{3A}}{4.4^{3A} - 0.4^{3A}} \quad \text{For } 120 \leq t \leq 360 \quad (\text{E-5})$$

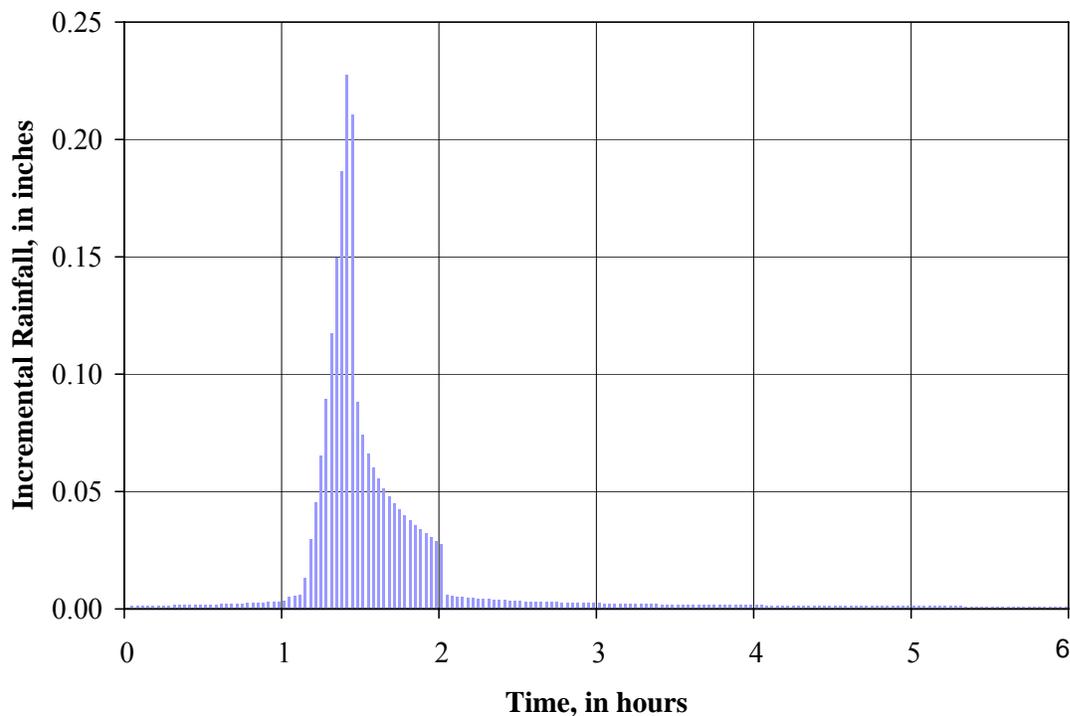
$$P_T = P_{1440} + (P_{360} - P_{1440}) * \frac{30^B - \left(\frac{t}{60} + 6\right)^B}{30^B - 12^B} \quad \text{For } 360 < t < 1440 \quad (\text{E-6})$$

Where: $A = \frac{\text{Log}\left(\frac{P_{360}}{P_{60}}\right)}{\text{Log}(6.0)}$

$$B = \frac{\text{Log}\left(\frac{P_{1440}}{P_{360}}\right)}{\text{Log}(4.0)}$$

These equations are implemented in the AHYMO program by specifying P_{60} , P_{360} , and P_{1440} with the RAINFALL command. See the AHYMO users manual for additional information at www.ahymo.com.

FIGURE E-1. 100-YR 6-HR RAINFALL HYETOGRAPH



E.2.3 Procedure

- A. For design events up to the 500-year and storm durations up to the 24-hour
 - 1. Select the point rainfall depths from Table E-1
 - 2. In AHYMO
 - a. For a 6-hour storm code the RAINFALL command with the following:
 - 1. Distribution type = 1
 - 2. 1-hour rainfall depth from Step 1
 - 3. 6-hour rainfall depth from Step 1
 - 4. Incremental time, DT, of 0.033333 hours
 - b. For a 24-hour storm code the RAINFALL command with the following:
 - 1. Distribution type = 2
 - 2. 1-hour adjusted rainfall depth from Step 1
 - 3. 6-hour adjusted rainfall depth from Step 1
 - 4. 24-hour adjusted rainfall depth from Step 1
 - 5. Incremental time, DT, of 0.05 hours
- B. For design storms with durations other than 6- or 24-hours, submit to SSCAFCA/City Engineer in writing a recommendation for depth-area reduction and time distribution of the rainfall for the selected storm event.

E.3 RAINFALL LOSS

Rainfall losses are generally considered to be the result of evaporation of water from the land surface, interception of rainfall by vegetal cover, depression storage on the land surface and the infiltration of water into the soil matrix. The magnitude of rainfall loss is typically expressed as an equivalent uniform depth in inches. By a mass balance, rainfall minus losses equals rainfall excess. Estimation of rainfall loss is an important element in flood analyses that must be clearly understood and estimated with care.

E.3.1 Land Treatment

Estimation of rainfall losses are based on a characterization of the watershed area into land treatment classifications. Four land treatment classifications have been created that typify the conditions in the City/SSCAFCA jurisdiction. Descriptions of the land treatment classifications are provided in Table E-2. Three of the land treatment classifications (A, B and C) are for pervious conditions. The fourth classification (D) is for impervious areas.

TABLE E-2. LAND TREATMENTS	
Treatment	Land Condition
A	Soil uncompacted by human activity with 0 to 10 percent slopes. Native grasses, weeds and shrubs in typical densities with minimal disturbance to grading, ground cover and infiltration capacity.
B	Irrigated lawns, parks and golf courses with 0 to 10 percent slopes. Native grasses, weeds and shrubs, and soil uncompacted by human activity with slopes greater than 10 percent and less than 20 percent.
C	Soil compacted by human activity. Minimal vegetation. Unpaved parking, roads, trails. Most vacant lots. Gravel or rock on plastic (desert landscaping). Irrigated lawns and parks with slopes greater than 10 percent. Native grasses, weeds and shrubs, and soil uncompacted by human activity with slopes at 20 percent or greater. Native grass, weed and shrub areas with clay or clay loam soils and other soils of very low permeability as classified by SCS Hydrologic Soil Group D.
D	Impervious areas, pavement and roofs.
Most watersheds contain a mix of land treatments. To determine proportional treatments, measure respective subareas. In lieu of specific measurement for treatment D, the areal percentages in Table E-3 may be employed.	

Of the land treatment classifications listed in Table E-2, only treatment type A represents land in its natural, undisturbed state. Land treatment classifications B and C describe conditions that have been impacted by some form of urbanization. Urban areas within a watershed usually contain a mix of the land treatment types. Ideally, the specific area of each land treatment type can be measured from available information. In lieu of specific measurement for each unique land treatment type that occurs within urban areas, generalized percentages based on zoning classifications can be used. Average land treatment type percentages associated with various zoning designations are listed in Table E-3.

TABLE E-3 SSCAFCA TREATMENT TYPE PERCENTAGE SUMMARY

Parcel Description	Treatments				Methodology/Notes
	A	B	C	D	
1/8 Acre	0%	15%	15%	70%	DPM, Chapter 22.2, Table A-4 for D
1/6 Acre	0%	28%	15%	57%	Northern Meadows Master Plan
1/4 Acre	0%	30%	28%	42%	DPM, and followed SSCAFCA lead on B&C
1/2 Acre	10%	33%	30%	27%	SSCAFCA
1 Acre	43%	20%	20%	17%	SSCAFCA
Single Family Residential N=units/acre, N6					$7 * \sqrt{((N * N) + (5 * N))}$
Estate Lots (btwn 1- 5ac)	60%	15%	15%	10%	DPM for 2.5 acre lot
M-1 (Light Industrial)	0%	15%	15%	70%	DPM for D, split B & C
Vacant Res./Undevel.	79%	8%	8%	5%	DPM for 5 acre lot
Arroyo	100%	0%	0%	0%	DPM
Major Roads	0%	0%	10%	90%	DPM
School	10%	20%	20%	50%	DPM
Commercial/Industrial	0%	0%	15%	85%	DPM average of Heavy Industrial and Commercial
Open Space	100%	0%	0%	0%	DPM
Parks, Sports and Rec	0%	85%	0%	15%	DPM
Landfill	0%	0%	100%	0%	All disturbed ground
Multi-Family	0%	15%	15%	70%	DPM-Multiple Unit Res. Attached
Northern Meadows	0%	28%	15%	57%	Northern Meadows Master Plan
Drainage Ponds	0%	0%	100%	0%	
County Platted (1)	18.7%	29.5%	27.0%	24.8%	(used Basin P12_104 as typical)
County Unplatted (2)	95%	5%	0%	0%	DPM

NOTES:

1. County Platted area is defined as the area between CORR boundary and Rio Rancho Estates boundary.
2. County Unplatted area is defined as the area outside the city limits and the Rio Rancho Estates limits. It is considered to be existing conditions.
3. All roads are assumed to be paved.

E.3.2 Initial Abstraction and Infiltration Loss

Simulation of rainfall loss is accomplished using an initial loss coupled with a loss rate. This combined methodology is a two parameter model. The first parameter is the Initial Abstraction (IA). The initial abstraction is the summation of all losses other than infiltration and is applied at the beginning of the storm event. The second parameter is the Infiltration rate (INF) of the soil matrix at saturation. Infiltration losses begin once the initial abstraction is completely satisfied. For pervious conditions, the infiltration rate is constant. For impervious conditions, the infiltration rate is constant up to hour 3 of the design storm. After hour 3 and until hour 6, the infiltration rate is linearly reduced to zero. Beyond hour 6, no infiltration occurs. The constant loss is only applied once the Initial Abstraction is satisfied. An illustration of the application of this method is provided in Figure E-2.

Recommended values for the Initial Abstraction and Infiltration rate are assigned to each land treatment type and are listed in Table E-4. For watersheds and subbasins with multiple, unique land treatment types an arithmetic area averaged value for IA and INF is to be calculated.

FIGURE E-2. Representation of rainfall Loss Methodology

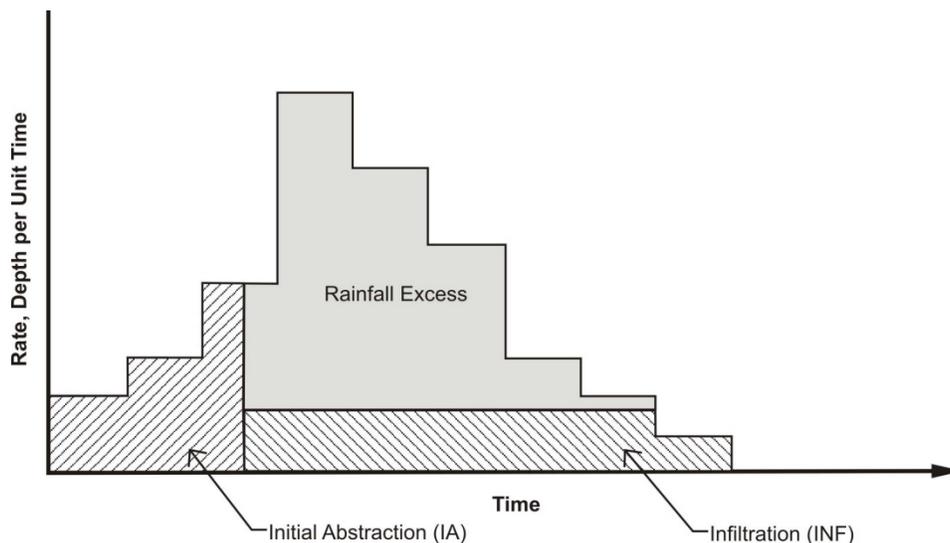


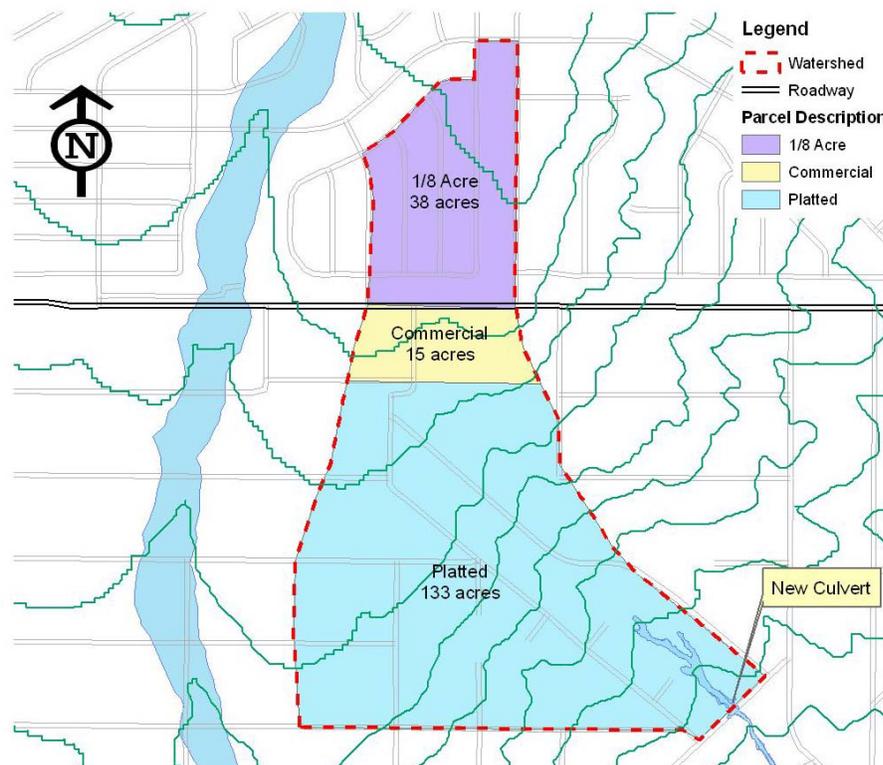
TABLE E-4. INITIAL AND CONSTANT LOSS PARAMETERS		
Land Treatment	Initial Abstraction (inches)	Infiltration (inches/hour)
A	0.65	1.67
B	0.50	1.25
C	0.35	0.83
D	0.10	0.04

E.3.3 Procedure

1. For each subbasin, calculate the area of each unique land treatment type or zoning classification.
2. Calculate the area weighed percentage of each land treatment type.
3. In AHYMO, for each subbasin code in the percent area of each land treatment type in the COMPUTE NM HYD command.(See AHYMO Users Manual)

E.3.4 Example

A new culvert is to be constructed to convey the 100-year, 6-hour storm at the location shown in the following figure. Compute the rainfall loss parameters for the contributing watershed.



- From Table E-3, percentage of Land Treatment Types for each parcel within the watershed are:

Parcel Description	Area acres	Percent of Land Treatment Type			
		A	B	C	D
1/8 Acre	38	0	15	15	70
Commercial / Industrial	15	0	0	15	85
Platted	133	18.7	29.5	27.0	24.8

Area of each Land Treatment Type is calculated as:

- $Area_A = (0)(38) + (0)(15) + (0.187)(133) = 24.9$ acres
 - $Area_B = (0.15)(38) + (0)(15) + (0.295)(133) = 44.9$ acres
 - $Area_C = (0.15)(38) + (0.15)(15) + (0.27)(133) = 43.9$ acres
 - $Area_D = (0.70)(38) + (0.85)(15) + (0.248)(133) = 72.3$ acres
- Total Area = 186.0 acres**

- Using values of IA from Table E-4, calculate the weighted value of IA

$$IA = \frac{(24.9)(0.65) + (44.9)(0.50) + (43.9)(0.35) + (72.3)(0.10)}{(24.9 + 44.9 + 43.9 + 72.3)}$$

$$IA = 0.33 \text{ inches}$$

- Using values of INF from Table E-4, calculate the weighted value of INF.

$$INF = \frac{(24.9)(1.67) + (44.9)(1.25) + (43.9)(0.83) + (72.3)(0.04)}{(24.9 + 44.9 + 43.9 + 72.3)}$$

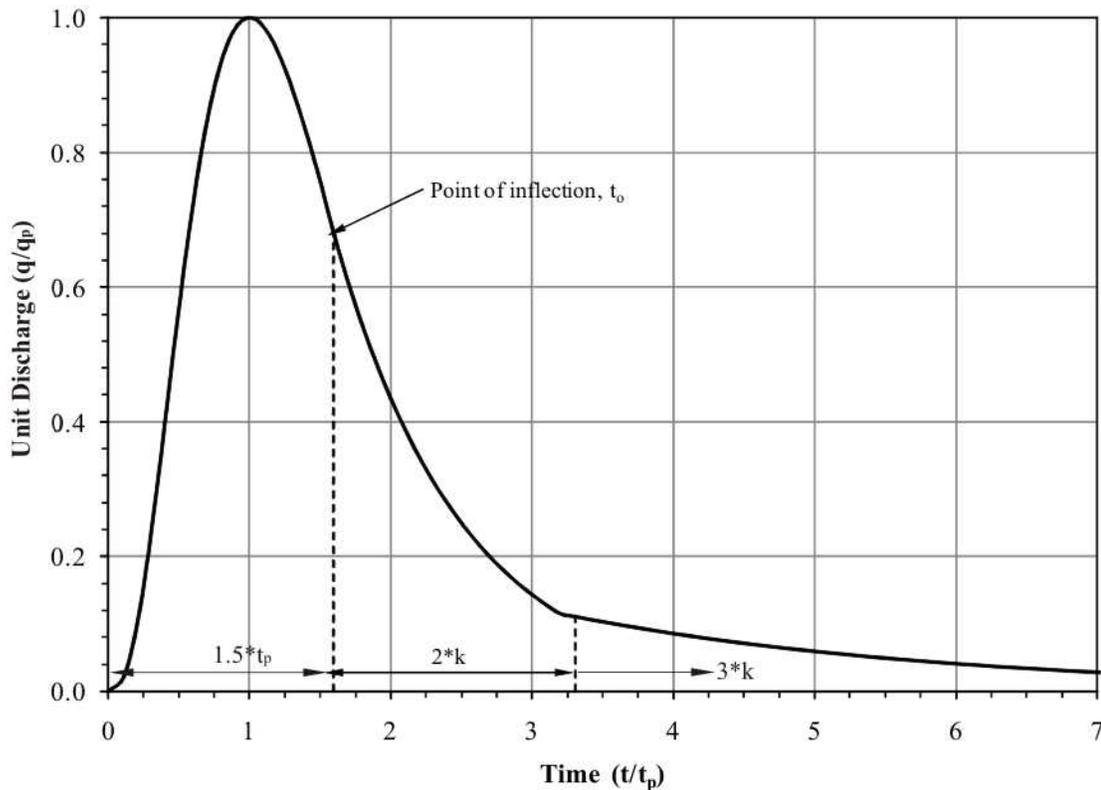
$$INF = 0.74 \text{ in/hr}$$

E.4 UNIT HYDROGRAPH

Rainfall excess generated during a storm event is routed across the basin surface and eventually begins to concentrate at a downstream location (concentration point). The routing process results in the transformation of rainfall excess to a runoff hydrograph. Simulation of rainfall excess transformation is typically accomplished using the concept of a unit hydrograph. A unit hydrograph is defined as the hydrograph of one inch of direct runoff from a storm of a specified duration for a particular basin. Every watershed will have a different unit hydrograph that reflects the topography, land use, and other unique characteristics of the individual watershed. Different unit hydrographs will also be produced for the same watershed for different durations of rainfall excess.

For most watersheds, sufficient data (rainfall and runoff records) does not exist to develop unit hydrographs specific to the watershed. Therefore, indirect methods are used to develop a unit hydrograph. Such unit hydrographs are called synthetic unit hydrographs. The synthetic unit hydrograph encoded in AHYMO is dimensionless and can be defined by two numeric parameters; Time to Peak (t_p) and Recession Constant (k). The shape of the AHYMO dimensionless unit hydrograph is broken into three time segments as illustrated in Figure E-3.

FIGURE E-3. AHYMO DIMENSIONLESS UNIT HYDROGRAPH



E.4.1 Time to Peak

Time to peak is defined as the time from the beginning of unit rainfall excess to the time of the peak flow of the unit runoff hydrograph. It is assumed to be a constant ratio of the time of concentration as given by Equation E-7. Time of concentration (T_c) is defined as the time it takes for runoff to travel from the hydraulically most distant part of the watershed basin to the basin outlet or point of analysis (concentration point). The units for time of concentration are time, in hours. This implies that the time of concentration flow path may not be the longest physical length, but the length that results in the longest time.

$$t_p = \left(\frac{2}{3}\right) * T_c \quad (E-7)$$

Time of concentration is calculated using one of three equations. Selection of the appropriate equation is based on the time of concentration flow path length (in time). Regardless of the selected equation, time of concentration should not be less than 12 minutes.

For basins with flow path lengths less than 4,000 feet the SCS Upland Method is used. The Upland Method is the summation of flow travel time for the series of unique flow characteristics that occur along the overall basin flow path length. The Upland Method travel time equation is:

$$T_c = \sum_{i=1}^n \left(\frac{L_i}{36,000 * K_i * \sqrt{S_i}} \right) \quad (E-8)$$

Where: T_c = Time of concentration, in hours
 L_i = Length of each unique surface flow conveyance condition, in feet
 K_i = Conveyance factor from Table E-5
 S_i = Slope of the flow path, in feet per foot

TABLE E-5. CONVEYANCE FACTORS	
K	Conveyance Condition
0.7	Turf, landscaped areas and undisturbed natural areas (sheet flow* only).
1	Bare or disturbed soil areas and paved areas (sheet flow* only).
2	Shallow concentrated flow (paved or unpaved).
3	Street flow, storm sewers and natural channels, and that portion of subbasins (without constructed channels) below the upper 2000 feet for subbasins longer than 2000 feet.
4	Constructed channels (for example: riprap, soil cement or concrete lined channels).
* Sheet flow is flow over plane surfaces, with flow depths up to 0.1 feet. Sheet flow applies only to the upper 400 feet (maximum) of a subbasin.	

For basins with flow path lengths longer than 4,000 feet the following equation should be used for calculating time of concentration:

$$T_c = \left(\frac{12,000 - L}{72,000 * K * \sqrt{S}} + \frac{(L - 4,000) * K_n * \left(\frac{L_{ca}}{L} \right)^{0.33}}{552.2 * S^{0.165}} \right) \quad (E-9)$$

Where: L = Flow path length, in feet
 L_{ca} = Distance along L from point of concentration to a point opposite the centroid of the basin, in feet

- K = Conveyance factor from Table E-5
- K_n = Basin factor, from Table E-6
- S = Slope of flow path, in feet per foot

TABLE E-6. LAG EQUATION BASIN FACTORS	
K_n	Basin Condition
0.042	Mountain Brush and Juniper
0.033	Desert Terrain (Desert Brush)
0.025	Low Density Urban (Minimum improvements to watershed channels)
0.021	Medium Density Urban (Flow in streets, storm sewers and improved channels)
0.016	High Density Urban (Concrete and rip-rap lined channels)

Calculation of a basin time of concentration is a function of flow path length and, by extension, basin area. Therefore, basin / subbasin delineation is a key consideration that must be addressed early on in the modeling process as it not only influences unit hydrograph parameter estimation but rainfall loss parameters as well. Wherever possible, subbasin delineation should be based on the best available topographic mapping and, if available, detailed aerial photography. For some areas, field investigation may also be necessary to verify subbasin boundaries particularly in urban or distributary areas. The breakdown of a watershed into subbasins should consider the following:

- The subbasin sizes should be as uniform as possible.
- Subbasins should have fairly homogeneous land use and geographic characteristics. For example: mountain, hillslope and valley areas should be delineated separately where possible.
- Soils, vegetation and land treatment characteristics should be fairly homogeneous.
- Subbasins size should be commensurate with the intended use of the model. For example, if the model is to be used for the evaluation and / or design of drainage infrastructure, the subbasin size should be fairly small so that runoff magnitudes are known at multiple locations within the watershed. For drainage management plans, the subbasin size should in general not be greater than 1.5 mi² or less than 0.1 mi².

E.4.2 Time of Concentration for Steep Slopes and Natural Channels

The equations used to compute time of concentration may result in values that are too small to be sustained for natural channel conditions. In natural channels, flows become unstable when a Froude Number of 1.0 is approached. The equations identified in Section E.4.1 can result in flow velocities for steep slopes that indicate supercritical flow conditions, even though such supercritical flows cannot be sustained for natural channels. For steep slopes, natural channels will likely experience chute and pool conditions with a hydraulic jump occurring at the

downstream end of chute areas; or will experience a series of cascading flows with very steep drops interspersed with flatter channel sections.

For the purposes of this section, steep slopes are defined as those greater than 0.04 foot per foot. The procedures outlined in this section should not be used for the following conditions:

- Slopes flatter than 0.04 foot per foot.
- Channels with irrigated grass, riprap, soil cement, gabion, or concrete lining which cannot be clearly identified as natural or naturalistic.
- The hydraulic design of channels or channel elements. The purpose this section is to define procedures for hydrologic analysis only. The design of facilities adjacent to or within channels with chute and pool conditions cannot be analyzed with the simplified procedures identified herein. It may be necessary to design such facilities for the supercritical flows of chutes (for sediment transport, local scour, stable material size) and for the hydraulic jump of pool conditions (for maximum water surface elevation and flood protection).

The slope of steep natural watercourses should be adjusted to account for the effective slope that can be sustained. The slope adjustment procedures identified in the Denver - Urban Drainage and Flood Control District (UDFCD) Urban Storm Drainage Criteria Manual (Figure 4-1, Runoff chapter, 1990) are applicable for the slope adjustment identified herein. In addition, channel conveyance factors (K) should be checked to make sure that appropriate equivalent Froude Numbers are maintained. The UDFCD Figure 4-1 can be approximated by the following equation:

$$S' = 0.052467 + 0.062627 S - 0.18197 e^{-62.375S} \quad (E-10)$$

Where: S = Measured slope, in feet per foot
 S' = Adjusted slope, in feet per foot

The conveyance factors (K) for the Upland Method should be checked to make sure that appropriate Froude Numbers are maintained. The Basin Factors, K_n , from Table E-6 remain applicable when using equations E-8 and E-9 with the adjusted slope computed by equation E-10. To adjust the conveyance factor (K) it is necessary to estimate the peak flow rate from the watershed. Using estimated conveyance factors (K) from Table E-5 and the Rational Method procedures outlined in Part D, an estimated peak flow rate for the basin (Q_p) can be computed. The following formulas are then used to compute conveyance factor adjustment:

$$K' = 0.302 * S'^{-0.5} * Q_p^{0.18} \quad (E-11)$$

$$K'' = 0.207 * S'^{-0.5} * Q_p^{0.18} \quad (E-12)$$

An adjusted conveyance factor (K) is then obtained based on the following:

- if $K > K'$ then $K = K'$
- if $K' \geq K \geq K''$ then $K = K$ (no adjustment)

- if $K < K''$ then $K = K''$

This is an iterative process that is to be repeated until the computed value of Q_p is within 10 percent of original value of Q_p .

E.4.3 Recession Constant

The recession constant is a function of drainage area, rainfall depth and land cover treatment. A value of k is calculated for each land cover treatment present in the watershed. Two sets of equations are provided for the estimation of k . Selection of the appropriate set is based on basin area.

For drainage basins less than or equal to 40 acres in size, k is calculated separately for each land treatment type using Equations E-13 through E-16. For basins with multiple land cover treatments, an arithmetically area-weighted value is calculated for the pervious areas (land treatment types A, B and C) with a separate calculation for land treatment type D. Regardless of the land treatment type or combinations of land treatment type within the basin, the calculated value of k must be no greater than $1.35t_p$ and no less than $0.545t_p$. The following are equations for calculating land treatment types.

Land Treatment Type A

$$k = \begin{cases} t_p(1.58159 - 0.18912P_{60}) & \text{For } P_{60} < 2.10 \text{ inches} \\ t_p(0.98204 + 0.09638P_{60}) & \text{For } P_{60} \geq 2.10 \text{ inches} \end{cases} \quad (\text{E-13})$$

Land Treatment Type B

$$k = \begin{cases} t_p(1.22953 - 0.132P_{60}) & \text{For } P_{60} < 1.89 \text{ inches} \\ t_p(0.8090 + 0.0905P_{60}) & \text{For } P_{60} \geq 1.89 \text{ inches} \end{cases} \quad (\text{E-14})$$

Land Treatment Type C

$$k = \begin{cases} t_p(0.90392 - 0.07488P_{60}) & \text{For } P_{60} < 1.68 \text{ inches} \\ t_p(0.63596 + 0.08462P_{60}) & \text{For } P_{60} \geq 1.68 \text{ inches} \end{cases} \quad (\text{E-15})$$

Land Treatment Type D

$$k = \begin{cases} 0.5450t_p & \text{For } P_{60} < 1.33 \text{ inches} \\ t_p(0.31048 + 0.7356P_{60}) & \end{cases} \quad (\text{E-16})$$

For $P_{60} \geq 1.33$ inches

For drainage basins greater than or equal to 200 acres in size, k is calculated separately for each land treatment type using Equations E-17 through E-20. For basins with multiple land cover treatments, an arithmetically area-weighted value is calculated for the pervious areas (land treatment types A, B and C) with a separate calculation for land treatment type D. Regardless of the land treatment type or combinations of land treatment type within the basin, the calculated value of k must not be greater than $1.30t_p$.

Land Treatment Type A

$$k = t_p (0.854 + 0.5808 * 4.756828^{1-P_{60}}) \quad (E-17)$$

Land Treatment Type B

$$k = t_p (0.770 + 0.480 * 4.756828^{1-P_{60}}) \quad (E-18)$$

Land Treatment Type C

$$k = t_p (0.686 + 0.3792 * 4.756828^{1-P_{60}}) \quad (E-19)$$

Land Treatment Type D

$$k = t_p (0.528 + 0.1896 * 4.756828^{1-P_{60}}) \quad (E-20)$$

For drainage basins between 40 and 200 acres in size, calculate k using the appropriate equations for drainage area up to 40 acres and for drainage areas greater than or equal to 200 acres in size. The basin specific values of k for pervious and impervious areas are then calculated using linear interpolation.

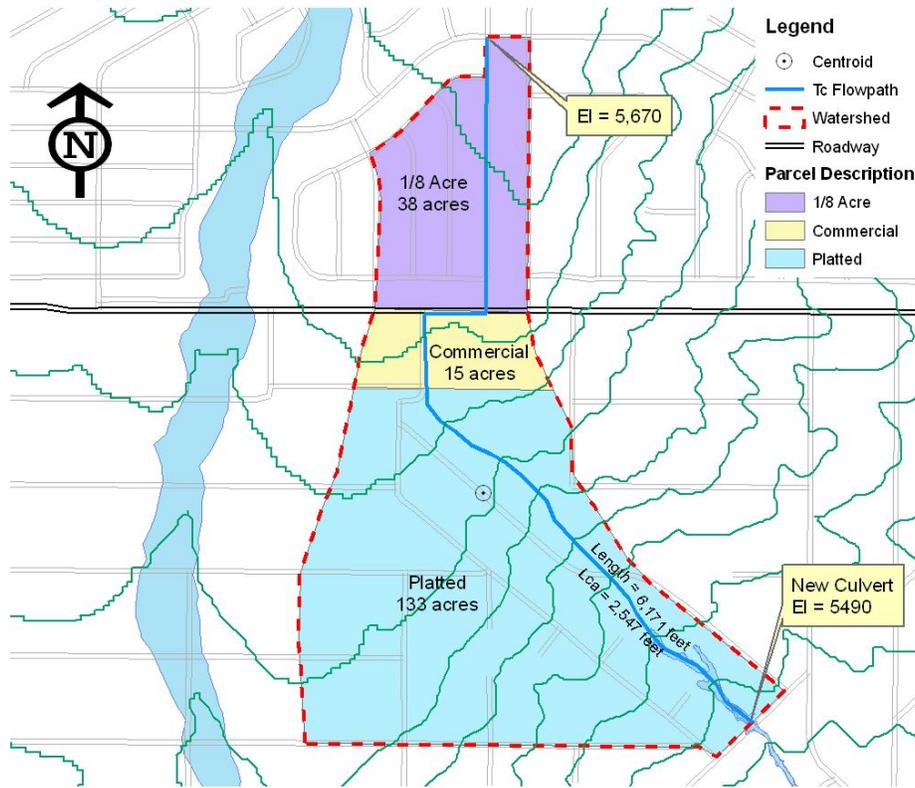
E.4.4 Procedure

1. From an appropriate map of the watershed, delineate the time of concentration flow path for each subbasin and measure the length, in feet.
 - a. If the flow path length is less than 4,000 feet, calculate T_c using Equation E-8 with the following:
 - i. Select K from Table E-5
 - ii. Measure the average flow path slope, S . If the flow path slope is greater than 0.04 feet / foot:
 1. Calculate the adjusted slope using Equation E-10.
 2. Estimate the peak discharge using procedures in Part D
 3. Calculate the conveyance factor adjustment range using Equations E-11 and E-12.
 4. Recalculate the peak discharge using the procedures in Part D and the adjusted slope and conveyance factor.

5. Repeat steps ii3 and ii4 until the calculated peak discharge is within 10 % of the original value.
 - b. If the flow path length is longer than 4,000 feet, calculate T_c using Equation E-9 with the following:
 - i. Measure L_{ca} and S
 - ii. Select appropriate values of K from Table E-5 and K_n from Table E-6
 2. Calculate t_p using Equation E-7
 3. Calculate k based on the drainage area:
 - a. If drainage area is less than or equal to 40 acres in size and contains only one land treatment type, use Equation E-13, E-14 or E-15 as appropriate for the land treatment type present. If multiple land treatment types are present calculate an arithmetically area-weighted value for pervious areas using Equations E-13 through E-15) and also calculate k for impervious area using Equation E-16.
 - b. If drainage area is greater than or equal to 200 acres in size and contains only one land treatment type, use Equation E-17, E-18 or E-19 as appropriate for the land treatment type present. If multiple land treatment types are present calculate an arithmetically area-weighted value for pervious areas using Equations E-17 through E-19) and also calculate k for impervious area using Equation E-20.
 - c. If drainage area is between 40 and 200 acres in size then calculate k according to Step 3a and 3b. Then use linear interpolation to estimate k for the basin drainage area.

E.4.5 Example

A new culvert is to be constructed to convey the 100-year, 6-hour storm at the location shown in the following figure. Compute the unit hydrograph parameters for the contributing watershed.



1. The flow path length is greater than 4,000 feet. Therefore, Equation E-9 is used for the calculating Time of Concentration (T_c). Select K and K_n from Tables E-5 and E-6, respectively.

C. $K = 2$ (Shallow concentrated flow within residential area)

D. $K_n = 0.33$ (Desert terrain)

2. Using Equation E-9, calculate T_c .

$$T_c = \left(\frac{12,000 - 6,171}{72,000 * 2 * \sqrt{0.029}} + \frac{(6,171 - 4,000) * 0.033 * \left(\frac{2,547}{6,171} \right)^{0.33}}{552.2 * 0.029^{0.165}} \right)$$

$$T_c = (0.24 + 0.17)$$

$$T_c = 0.41 \text{ hours}$$

3. Using Equation E-7, calculate t_p .

$$t_p = \left(\frac{2}{3} \right) * T_c$$

$$t_p = \left(\frac{2}{3} \right) * 0.41$$

$$t_p = 0.27 \text{ hours}$$

4. Calculate the recession constant, k, using Equations E-13 through E-20 and the 100-year, 1-hour rainfall depth from Table E-1.

Calculate the k for Land Treatment Type A at 40 and 200 acres

$$k_A^{40} = t_p (1.58159 - 0.18912 P_{60})$$

$$k_A^{40} = 0.27 * (1.58159 - 0.18912 * 1.84)$$

$$k_A^{40} = 0.33 \text{ hours}$$

$$k_A^{200} = t_p (0.854 + 0.5808 * 4.756828^{1-P_{60}})$$

$$k_A^{200} = 0.27 * (0.854 + 0.5808 * 4.756828^{1-1.84})$$

$$k_A^{200} = 0.27 \text{ hours}$$

Calculate the k for Land Treatment Type B at 40 and 200 acres

$$k_B^{40} = t_p (1.22953 - 0.132 P_{60})$$

$$k_B^{40} = 0.27 * (1.22953 - 0.132 * 1.84)$$

$$k_B^{40} = 0.27 \text{ hours}$$

$$k_B^{200} = t_p (0.770 + 0.480 * 4.756828^{1-P_{60}})$$

$$k_B^{200} = 0.27 * (0.770 + 0.480 * 4.756828^{1-1.84})$$

$$k_B^{200} = 0.24 \text{ hours}$$

Calculate the k for Land Treatment Type C at 40 and 200 acres

$$k_C^{40} = t_p (0.63596 + 0.08462 P_{60})$$

$$k_C^{40} = 0.27 * (0.63596 + 0.08462 * 1.84)$$

$$k_C^{40} = 0.21 \text{ hours}$$

$$k_C^{200} = t_p (0.686 + 0.3792 * 4.756828^{1-P_{60}})$$

$$k_C^{200} = 0.27 * (0.686 + 0.3792 * 4.756828^{1-1.84})$$

$$k_C^{200} = 0.21 \text{ hours}$$

Calculate the k for Land Treatment Type D at 40 and 200 acres

$$k_D^{40} = t_p (0.31048 + 0.07356 P_{60})$$

$$k_D^{40} = 0.27 * (0.31048 + 0.07356 * 1.84)$$

$$k_D^{40} = 0.12 \text{ hours}$$

$$k_D^{200} = t_p (0.528 + 0.1896 * 4.756828^{1-P_{60}})$$

$$k_D^{200} = 0.27 * (0.528 + 0.1896 * 4.756828^{1-1.84})$$

$$k_D^{200} = 0.16 \text{ hours}$$

Calculate the weighted k for the pervious area at 40 and 200 acres

$$k_p^{40} = \frac{(24.9)(0.33) + (44.9)(0.27) + (43.9)(0.21)}{(24.9 + 44.9 + 43.9)}$$

$$k_p^{40} = 0.26 \text{ hours}$$

$$k_p^{200} = \frac{(24.9)(0.27) + (44.9)(0.24) + (43.9)(0.21)}{(24.9 + 44.9 + 43.9)}$$

$$k_p^{200} = 0.23 \text{ hours}$$

Calculate the weighted k for the pervious portion of the watershed is calculated using linear interpolation

$$k_p = 0.23 - (0.23 - 0.26) * \left(\frac{200 - 186}{200 - 40} \right)$$

$$k_p = 0.233 \text{ hours}$$

Calculate the weighted k for the impervious portion of the watershed is calculated using linear interpolation

$$k_p = 0.16 - (0.16 - 0.12) * \left(\frac{200 - 186}{200 - 40} \right)$$

$$k_p = 0.157 \text{ hours}$$

E.5 CHANNEL ROUTING

Hydrologic channel routing describes the movement of a floodwave (hydrograph) along a watercourse. For most natural rivers, as a floodwave passes through a given reach, the peak of the outflow hydrograph is attenuated and delayed due to flow resistance in the channel and the storage capacity of the river reach. In urban environments, runoff is often conveyed in manmade features such as roadways, storm drains and engineered channels that minimize hydrograph attenuation.

Channel routing is used in flood hydrology models, such as AHYMO, when the watershed is modeled with multiple subbasins and runoff from the upper subbasins must be translated through a channel or system of channels to the watershed outlet. The channel routing method in AHYMO is the Muskingum-Cunge methodology.

The Muskingum-Cunge channel routing is a physically based methodology that solves the continuity and diffusive form of the momentum equation based on the physical channel properties and the inflow hydrograph. The solution procedure involves the discretization of the equations in both time and space (length). The discretized time and distance step size influence the accuracy and stability of the solution.

E.5.1 Physical Parameters

The physical parameters required for the Musking-Cunge channel routing are; reach length, flow resistance factor, friction slope and the channel geometry. One limitation of this method is that it cannot account for the effects of backwater. Therefore, the friction slope can be approximated using the average bed slope.

The channel reach length and average bed slope should be estimated from the best available mapping. If there are significant changes in the bed slope over the length of the channel routing reach, a weighted average slope should be estimated or multiple reach lengths used. Also, if the channel bed slope exceeds 0.04 feet per foot then the procedures in Section E.4.2 should be followed.

Hydrologic routing calculations are based on a single cross section that describes the average geometry for the entire reach. The representative geometry can be any prismatic open channel configuration, including a circular section, as well as an irregular channel. Typically, the channel geometry is derived from a single location along the reach that is representative of the overall channel geometry. Channel geometry can be estimated using available topographic mapping or from field survey.

E.5.2 Roughness Coefficients

Flow resistance in the channel and overbank flow area is simulated using Manning's roughness coefficients. Flow resistance is affected by many factors including bed material size, bed form, irregularities in the cross section, depth of flow, vegetation, channel alignment, channel shape, obstructions to flow and the quantity of sediment of being transported in

suspension or as bed load. In general, all factors that retard flow and increase turbulent mixing tend to increase Manning’s n-values. Manning’s roughness coefficients appropriate for hydrologic routing are listed in Table E-7 and are, in general, taken from the SSCAFCA Sediment and Erosion Design Guide (MEI, 2008). Use of roughness coefficients other than those listed in Table E-7 must be estimated using the information and procedures in the Sediment and Erosion Design Guide and approved by SSCAFCA.

TABLE E-7. MANNING’S ROUGHNESS COEFFICIENTS	
Channel or Floodplain Type	n-value
Sand bed arroyos	0.055
Tined concrete	0.018
Shotcrete	0.025
Reinforced concrete pipe	0.013
Trowled concrete	0.013
No-joint cast-in-place concrete pipe	0.014
Reinforced concrete box	0.015
Reinforced concrete arch	0.015
Streets	0.017
Flush grouted riprap	0.020
Corrugated metal pipe	0.025
Grass-lined channels (sodded & irrigated)	0.025
Earth-lined channels (smooth)	0.030
Wire-tied riprap	0.040
Medium weight dumped riprap	0.045
Grouted riprap (exposed rock)	0.045
Jetty type riprap (D50 > 24’)	0.050

E.5.3 Procedure

1. From an appropriate map of the watershed, measure the routing reach length in feet and estimate the friction slope as the channel bed slope in feet per foot.
2. Select and cross sectional geometry that represents that average hydraulic conditions of the reach. If a single cross section cannot be identified that represents the average

- hydraulic conditions, break the reach into multiple sections and treat each as a unique element in AHYMO.
3. Conduct a field reconnaissance of the watershed and routing reaches to observe the flow resistance characteristics.
 4. Select an appropriate Manning's roughness coefficient for the channel and overbank flow areas using Table E-7

E.6 SEDIMENT BULKING

Flow bulking occurs when sediment is eroded from the land surface and entrained into the flowing water. Entrained sediment has the effect of increasing the runoff volume and flow rate. Within this jurisdiction there is potential for high sediment yields. For undeveloped watersheds the bulking factor is 18%. Similarly, sediment yield from developed areas shall be 6%. Developed conditions are those areas that have paved roads with curb and gutter. Given the high potential for surface erosion, all watershed models will include flow bulking.

E.6.1 Procedure

In AHYMO, flow bulking for sediment is simulated using a ratio. The ratio is applied to direct runoff estimated for each subbasin. The bulking factor is applied globally using the SEDIMENT BULK Command. The bulking factor specified on this command is used for all subsequent runoff calculation until changed by another SEDIMENT BULK Command.

F. RAINFALL-RUNOFF MODELING: HEC-HMS

F.1 INTRODUCTION

Rainfall-runoff modeling for drainage areas greater than 320 acres in size is to be conducted using the U.S. Army Corps of Engineers HEC-HMS software. HEC-HMS can also be applied to drainage areas between 40 and 320 acres in size. HEC-HMS is the successor to HEC-1 and has been in use since 1998. HEC-HMS is a public domain software that is part of the Hydrologic Engineering Center's Next Generation Software Development Project. Input to HEC-HMS is to be developed using the recommended methodologies, techniques and procedures presented in the following sections.

F.2 DESIGN RAINFALL CRITERIA

For design hydrology, the characteristics of the major flood producing storm are simulated using a synthetic storm. Components of a synthetic storm are basin average rainfall depth and temporal distribution. Information and procedures for developing the design rainfall criteria for storms other than the Probable Maximum Precipitation are provided in the following sections.

F.2.1 Depth

The principal design storm for peak flow determination is the 100-year, 6-hour event. For analysis and design of retention ponds and detention dams, the 100-year, 24-hour storm is to be used unless the structure falls under the jurisdiction of the New Mexico Office of State Engineer, Dam Safety Bureau. Point precipitation depths for the 100-year storm to be used within the City/SSCAFCA jurisdiction are provided in Table F-1. Those values are adapted from NOAA Atlas 14, Precipitation - Frequency Atlas of the United States, Volume 1: Semiarid Southwest (Arizona, Southeast California, Nevada, New Mexico, Utah).

For determining sediment transport and for analysis of watersheds with complex routing conditions, other storm frequencies and durations may be required. Point precipitation depths for use in the City/SSCAFCA jurisdiction for multiple recurrence intervals and storm durations are listed in Table F-1. For all other recurrence intervals and storm durations, point precipitation depths are to be obtained directly from the National Weather Service through the NOAA 14 Precipitation Frequency Data Server web site found at http://hdsc.nws.noaa.gov/hdsc/pfds/sa/nm_pfds.html. At this web site point precipitation values for frequencies up to 1,000 years and duration up to 60 days can be obtained by entering the latitude and longitude of the watershed of interest

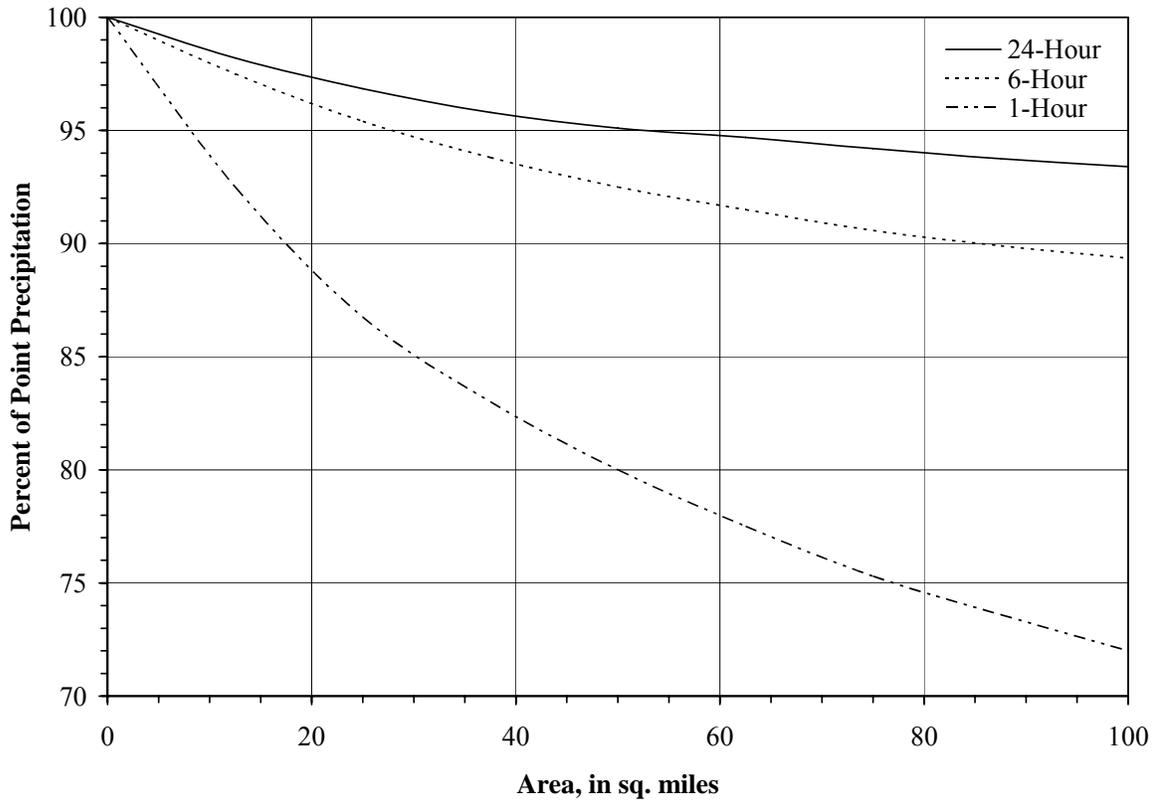
TABLE F-1. RECURRENCE INTERVAL POINT PRECIPITATION DEPTHS				
Recurrence Interval	Duration			
	Years	15-Minute	1-Hour	6-Hour	24-Hour
500	1.42	2.37	3.01	3.57
100	1.10	1.84	2.37	2.90
50	0.97	1.62	2.11	2.57
25	0.85	1.42	1.86	2.29
10	0.70	1.16	1.54	1.90
5	0.58	0.97	1.31	1.66
2	0.43	0.72	1.02	1.32
1	0.34	0.56	0.81	1.05

F.2.2 Depth-Area-Reduction

The rainfall depths listed in Table F-1 or obtained from the NOAA 14 Precipitation Frequency Data Server web site are point rainfall depths for specified durations. This depth is not the areal-averaged rainfall over the basin that would occur during a storm. For uncontrolled watersheds (those areas not controlled by dams, ponds and / or partial diversions), a reduction factor is used to convert the point rainfall to an equivalent uniform depth over the entire watershed. Reduction factors for converting point rainfall depths to basin averaged rainfall are depicted graphically in Figure F-1. That figure is adapted from NOAA Atlas 2 Precipitation-Frequency Atlas of the Western United States, Vol. IV - New Mexico.

The use of Figure F-1 is appropriate for sizing major dams, channels and arroyos but is usually not appropriate for sizing channel inlets, side drainage and storm sewers associated with these major facilities. Use of a single depth-area reduction factor for large drainage studies may cause flows in the upper reaches of the study area to be under estimated. It may be necessary to evaluate major projects with and without area reduction factors and to establish the capacity of intermediate facilities based on a ratio of the values obtained.

FIGURE F-1. 100-YR DEPTH-AREA REDUCTION FACTORS



F.2.3 Temporal Distribution

Basin average rainfall for 100-year, 6- and 24-hour storms is distributed temporally using a suite of equations; F-1 through F-6. The equations are a function of the 1-, 6- and 24-hour basin average depths. The design rainfall distribution is front loaded with the peak intensity set at 85.3 minutes (hour 1.42) regardless of storm duration. This distribution results in approximately 80 percent of the total depth occurring in less than one hour. For the 6-hour storm the distribution of rainfall is determined using the first 5 of the 6 equations. For the 24-hour storm, all 6 equations are used. To illustrate the shape of the pattern, the 6-hour storm distribution using the depths from Table F-1 for a 20 square mile watershed is shown in Figure F-2.

$$P_T = 2.334 * (P_{360} - P_{60}) * \left(1.5^A - \left(1.5 - \frac{t}{60} \right)^A \right) \quad \text{For } 0 \leq t \leq 60 \text{ (F-1)}$$

$$P_T = P_{T=60} + P_{60} * 0.4754 * \left(0.5^{0.09} - \left(1.5 - \frac{t}{60} \right)^{0.09} \right) \quad \text{For } 60 < t < 67 \text{ (F-2)}$$

$$P_T = P_{T=60} + P_{60} * \left(0.0001818182 * (t - 60) + 0.000018338 * (t - 60)^{3.2} \right) \quad \text{For } 67 \leq t < 85.3 \text{ (F-3)}$$

$$P_T = P_{T=60} + P_{60} * \left(0.07 * (t - 60) - 1.1886 - 0.0404768 * (t - 85)^{1.0985865} \right) \quad \text{For } 85.3 \leq t < 120 \text{ (F-4)}$$

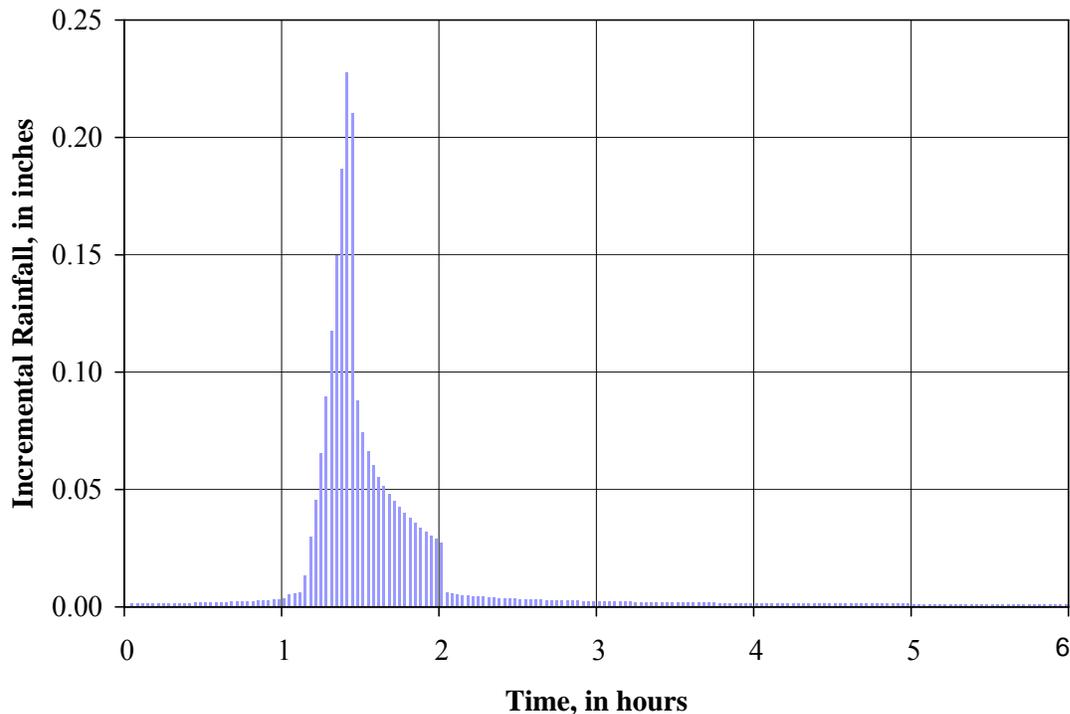
$$P_T = P_{360} + (P_{T=60} + P_{60} - P_{360}) * \frac{4.4^{3A} - \left(\frac{t}{60} - 1.6 \right)^{3A}}{4.4^{3A} - 0.4^{3A}} \quad \text{For } 120 \leq t \leq 360 \text{ (F-5)}$$

$$P_T = P_{1440} + (P_{360} - P_{1440}) * \frac{30^B - \left(\frac{t}{60} + 6 \right)^B}{30^B - 12^B} \quad \text{For } 360 < t < 1440 \text{ (F-6)}$$

Where: $A = \frac{\text{Log}\left(\frac{P_{360}}{P_{60}}\right)}{\text{Log}(6.0)}$

$$B = \frac{\text{Log}\left(\frac{P_{1440}}{P_{360}}\right)}{\text{Log}(4.0)}$$

FIGURE F-2. 100-YR 6-HOUR RAINFALL HYETOGRAPH

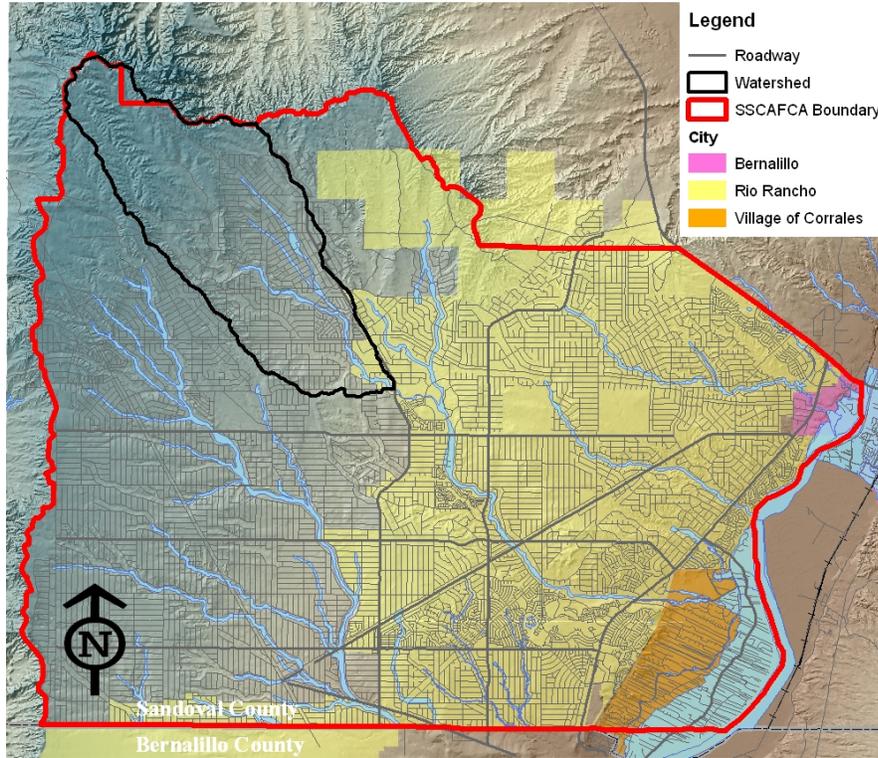


F.2.4 Procedure

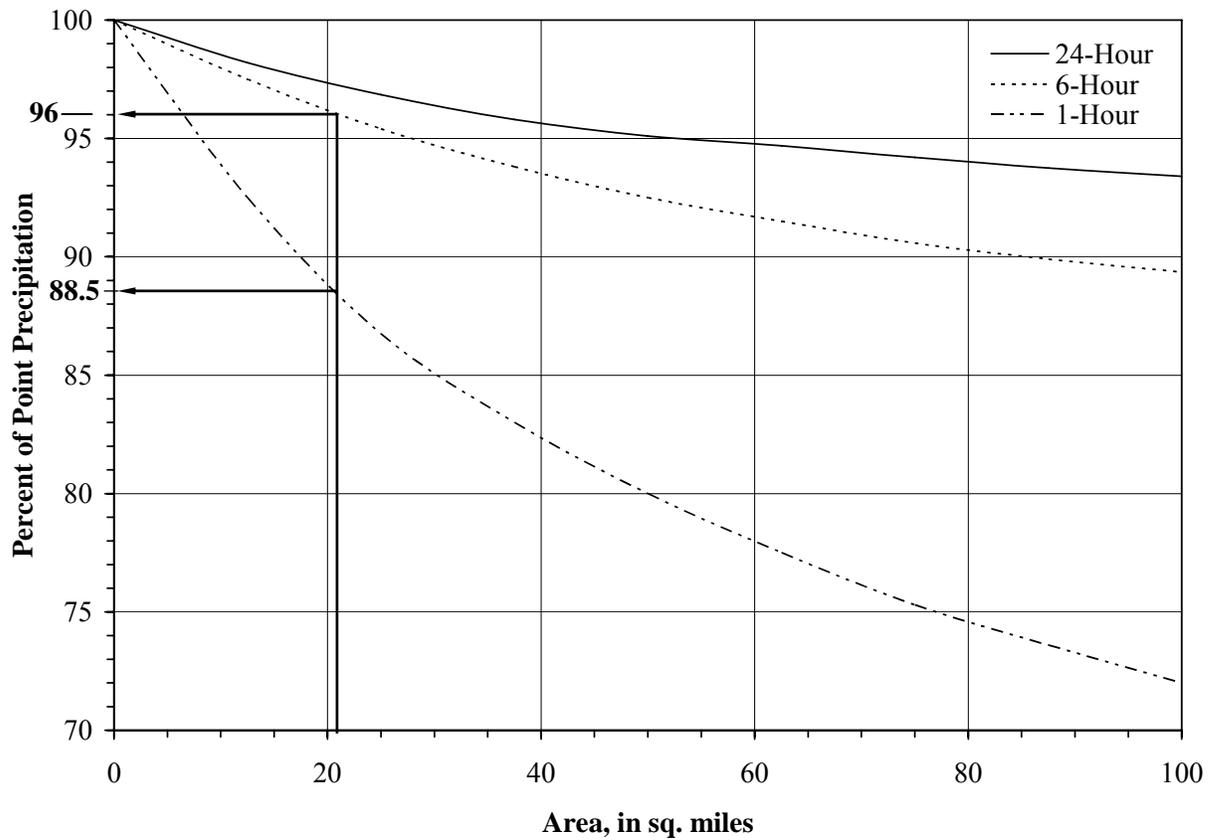
- A. For design events up to the 500-year and storm durations up to the 24-hour
 - 1. Select the point rainfall depths from Table F-1
 - 2. Using Figure F-1, determine the depth-area adjustment factor for each duration using the total watershed area.
 - 3. Reduce the point precipitation depths from Table F-1 using the depth-area adjustment factors from Figure F-1.
 - 4. Obtain the rainfall distribution from SSCAFCA.
 - 5. In HEC-HMS
 - a. Code the distribution in as time distribution data.
 - b. Select the “Specified Hyetograph” as the Meteorological Model
 - c. Select “Yes” to include subbasins
- B. For design storms with durations other than 6- or 24-hours, submit in writing a recommendation to the City/SSCAFCA for depth-area reduction and time distribution of the rainfall for the selected storm event.

F.2.5 Example

Compute the 100-year, 6-hour storm design rainfall data for the watershed shown in following figure. The watershed area is approximately 20.5 square miles



1. 100-year point rainfall depths from Table F-1 are:
 - F. 100-year, 1-hour = 1.84 inches
 - G. 100-year, 6-hour = 2.37 inches
2. Estimate depth-area reduction factors for the watershed area of 20.5 square miles using Figure F-1



3. Calculate the equivalent uniform rainfall depth

$$P_{60}^{100} = (1.84)(0.885) = 1.63 \text{ inches}$$

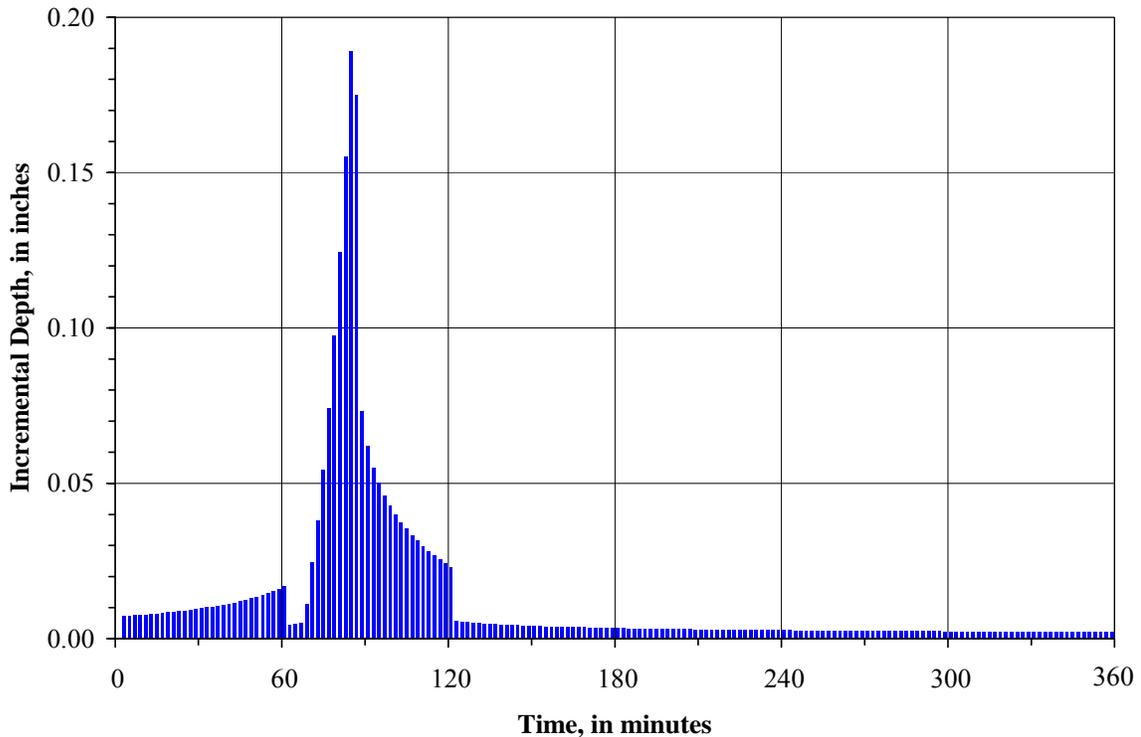
$$P_{360}^{100} = (2.37)(0.960) = 2.28 \text{ inches}$$

4. Calculate the cumulative rainfall mass curve using Equations F-1 through F-5 for the 6-hour storm. The computation time interval is 2 minutes.

Sample – To be obtained directly from SSCAFCA for use in hydrologic modeling.

Time hours	Rainfall inches	Time hours	Rainfall inches	Time hours	Rainfall inches	Time hours	Rainfall inches
0	0.000	92	1.459	184	2.065	276	2.190
2	0.007	94	1.509	186	2.068	278	2.192
4	0.014	96	1.555	188	2.071	280	2.194
6	0.021	98	1.598	190	2.074	282	2.197
8	0.028	100	1.638	192	2.078	284	2.199
10	0.036	102	1.676	194	2.081	286	2.201
12	0.043	104	1.712	196	2.084	288	2.203
14	0.051	106	1.745	198	2.087	290	2.206
16	0.059	108	1.777	200	2.090	292	2.208
18	0.067	110	1.807	202	2.093	294	2.210
20	0.075	112	1.835	204	2.096	296	2.213
22	0.084	114	1.862	206	2.099	298	2.215
24	0.092	116	1.887	208	2.101	300	2.217
26	0.101	118	1.911	210	2.104	302	2.219
28	0.110	120	1.934	212	2.107	304	2.221
30	0.120	122	1.940	214	2.110	306	2.224
32	0.129	124	1.945	216	2.113	308	2.226
34	0.139	126	1.951	218	2.116	310	2.228
36	0.149	128	1.956	220	2.118	312	2.230
38	0.160	130	1.961	222	2.121	314	2.232
40	0.171	132	1.965	224	2.124	316	2.235
42	0.182	134	1.970	226	2.127	318	2.237
44	0.193	136	1.975	228	2.129	320	2.239
46	0.205	138	1.979	230	2.132	322	2.241
48	0.218	140	1.984	232	2.135	324	2.243
50	0.231	142	1.988	234	2.137	326	2.245
52	0.244	144	1.992	236	2.140	328	2.247
54	0.258	146	1.996	238	2.143	330	2.249
56	0.273	148	2.000	240	2.145	332	2.251
58	0.288	150	2.004	242	2.148	334	2.254
60	0.304	152	2.008	244	2.150	336	2.256
62	0.309	154	2.012	246	2.153	338	2.258
64	0.314	156	2.016	248	2.155	340	2.260
66	0.319	158	2.020	250	2.158	342	2.262
68	0.330	160	2.024	252	2.160	344	2.264
70	0.355	162	2.027	254	2.163	346	2.266
72	0.393	164	2.031	256	2.165	348	2.268
74	0.448	166	2.035	258	2.168	350	2.270
76	0.522	168	2.038	260	2.170	352	2.272
78	0.620	170	2.042	262	2.173	354	2.274
80	0.746	172	2.045	264	2.175	356	2.276
82	0.902	174	2.048	266	2.178	358	2.278
84	1.092	176	2.052	268	2.180	360	2.280
86	1.268	178	2.055	270	2.182		
88	1.341	180	2.058	272	2.185		
90	1.403	182	2.062	274	2.187		

100-YR 6-HOUR RAINFALL HYETOGRAPH



F.3 RAINFALL LOSS

Rainfall losses are generally considered to be the result of evaporation of water from the land surface, interception of rainfall by vegetal cover, depression storage on the land surface and the infiltration of water into the soil matrix. The magnitude of rainfall loss is typically expressed as an equivalent uniform depth in inches. By a mass balance, rainfall minus losses equals rainfall excess. Estimation of rainfall loss is an important element in flood analyses that must be clearly understood and estimated with care.

F.3.1 Land Treatment

Estimation of rainfall losses are based on a characterization of the watershed area into land treatment classifications. Four land treatment classifications have been created that typify the conditions in the City/SSCAFCA jurisdiction. Descriptions of the land treatment classifications are provided in Table F-2. Three of the land treatment classifications (A, B and C) are for pervious conditions. The fourth classification (D) is for impervious areas.

TABLE F-2. LAND TREATMENTS	
Treatment	Land Condition
A	Soil uncompacted by human activity with 0 to 10 percent slopes. Native grasses, weeds and shrubs in typical densities with minimal disturbance to grading, ground cover and infiltration capacity.
B	Irrigated lawns, parks and golf courses with 0 to 10 percent slopes. Native grasses, weeds and shrubs, and soil uncompacted by human activity with slopes greater than 10 percent and less than 20 percent.
C	Soil compacted by human activity. Minimal vegetation. Unpaved parking, roads, trails. Most vacant lots. Gravel or rock on plastic (desert landscaping). Irrigated lawns and parks with slopes greater than 10 percent. Native grasses, weeds and shrubs, and soil uncompacted by human activity with slopes at 20 percent or greater. Native grass, weed and shrub areas with clay or clay loam soils and other soils of very low permeability as classified by SCS Hydrologic Soil Group D.
D	Impervious areas, pavement and roofs.
Most watersheds contain a mix of land treatments. To determine proportional treatments, measure respective subareas. In lieu of specific measurement for treatment D, the areal percentages in Table F-3 may be employed.	

Of the land treatment classifications listed in Table F-2, only treatment type A represents land in its natural, undisturbed state. Land treatment classifications B and C describe conditions that have been impacted by some form of urbanization. Urban areas within a watershed usually contain a mix of the land treatment types. Ideally, the specific area of each land treatment type can be measured from available information. In lieu of specific measurement for each unique land treatment type that occurs within urban areas, generalized percentages based on zoning classifications can be used. Average land treatment type percentages associated with various zoning designations are listed in Table F-3.

TABLE F-3 SSCAFCA TREATMENT TYPE PERCENTAGE SUMMARY

Parcel Description	Treatments				Methodology/Notes
	A	B	C	D	
1/8 Acre	0%	15%	15%	70%	DPM, Chapter 22.2, Table A-4 for D
1/6 Acre	0%	28%	15%	57%	Northern Meadows Master Plan
1/4 Acre	0%	30%	28%	42%	DPM, and followed SSCAFCA lead on B&C
1/2 Acre	10%	33%	30%	27%	SSCAFCA
1 Acre	43%	20%	20%	17%	SSCAFCA
Single Family Residential N=units/acre, N6					$7 * \sqrt{((N * N) + (5 * N))}$
Estate Lots (btwn 1 - 5ac)	60%	15%	15%	10%	DPM for 2.5 acre lot
M-1 (Light Industrial)	0%	15%	15%	70%	DPM for D, split B & C
Vacant Res./Undevel.	79%	8%	8%	5%	DPM for 5 acre lot
Arroyo	100%	0%	0%	0%	DPM
Major Roads	0%	0%	10%	90%	DPM
School	10%	20%	20%	50%	DPM
Commercial/Industrial	0%	0%	15%	85%	DPM average of Heavy Industrial and Commercial
Open Space	100%	0%	0%	0%	DPM
Parks, Sports and Rec	0%	85%	0%	15%	DPM
Landfill	0%	0%	100%	0%	All disturbed ground
Multi-Family	0%	15%	15%	70%	DPM-Multiple Unit Res. Attached
Northern Meadows	0%	28%	15%	57%	Northern Meadows Master Plan
Drainage Ponds	0%	0%	100%	0%	
County Platted (1)	18.7%	29.5%	27.0%	24.8%	(used Basin P12_104 as typical)
County Unplatted (2)	95%	5%	0%	0%	DPM

NOTES

- County Platted area is defined as the area between CORR boundary and Rio Rancho Estates boundary.
- County Unplatted area is defined as the area outside the city limits and the Rio Rancho Estates limits. It is considered to be existing conditions.
- All roads are assumed to be paved.

F.3.2 Initial and Constant Loss

Simulation of rainfall loss in HEC-HMS is accomplished using the Initial and Constant Loss Method. The Initial and Constant Loss Methodology is a two parameter model. The first parameter is the Initial Abstraction (IA). The initial abstraction is the summation of all losses other than infiltration and is applied at the beginning of the storm event. The second parameter is the constant loss. The constant loss is the Infiltration rate (INF) of the soil matrix at saturation. The constant loss is only applied once the Initial Abstraction is satisfied. An illustration of the application of this method is provided in Figure F-3.

Recommended values for the Initial Abstraction and Infiltration rate are assigned to each pervious land treatment type and are listed in Table F-4. For watersheds and subbasins with multiple unique land treatment types an arithmetic area averaged value for IA and INF is to be calculated.

FIGURE F-3. Representation of the Initial and Constant Loss Methodology

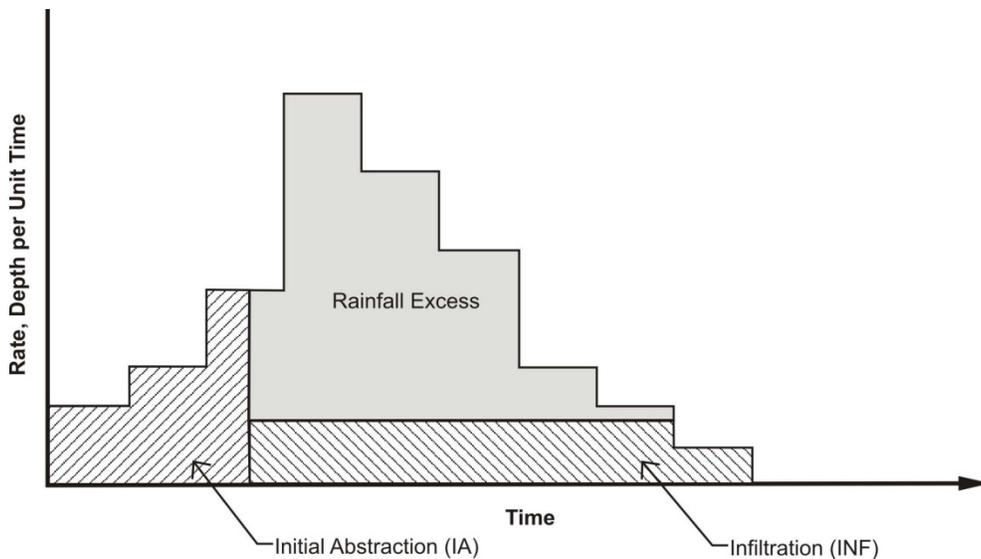


TABLE F-4. INITIAL AND CONSTANT LOSS PARAMETERS		
Land Treatment	Initial Abstraction (inches)	Infiltration (inches/hour)
A	0.65	1.67
B	0.50	1.25
C	0.35	0.83

F.3.3 Impervious Area

For the Initial and Constant Loss Method as employed in HEC-HMS, it is assumed that there are no losses associated with impervious area (land treatment type D) and rainfall over the impervious area is converted directly to rainfall excess. The percentage of rainfall converted directly to excess is the same as the percent area of land treatment type D. Computationally, rainfall to be converted directly to excess occurs prior to any loss calculations for each model time step. The rainfall not converted directly to excess is then available to the loss calculations.

F.3.4 Procedure

1. For each subbasin, calculate the area of each unique land treatment type or zoning classification.
2. Using the percent area of each pervious area land treatment type, calculate the area averaged value of IA and INF using the data from Table F-4 for each subbasin.
3. For each subbasin sum the percent impervious area as the percent area of land treatment type D.
4. In HEC-HMS, for each subbasin within the Basin Model:
 - a. code the subbasin area average value of IA as the Initial Loss.
 - b. code the subbasin area average value of INF as the Constant Rate.
 - c. code the total percent area of land treatment type D as the impervious percentage.

F.3.5 Example

Calculate the rainfall loss parameters for a 20.5 square mile watershed using the following data:

Parcel Description	Area sq. miles
1/8 acre Platted	1.0 11.5
Unplatted	8.0

1. From Table F-3, percentage of Land Treatment Types for each parcel within the watershed are:

Parcel Description	Area acres	Percent of Land Treatment Type			
		A	B	C	D
1/8 Acre Commercial / Industrial Platted	1.0 11.5 8.0	0 18.7 95	15 29.5 5	15 27.0 0	70 24.8 0

Area of each Land Treatment Type is calculated as:

- $\text{Area}_A = (0)(1.0) + (0.187)(11.5) + (0.95)(8.0) = 9.8$ sq. miles
 - $\text{Area}_B = (0.15)(1.0) + (0.295)(11.5) + (0.05)(8.0) = 3.9$ sq. miles
 - $\text{Area}_C = (0.15)(1.0) + (0.270)(11.5) + (0.0)(8.0) = 3.3$ sq. miles
 - $\text{Area}_D = (0.70)(1.0) + (0.248)(11.5) + (0.0)(8.0) = \underline{3.5}$ sq. miles
- Total Area = 20.5 sq. miles

2. Using values of IA from Table F-4, calculate the weighted value of IA

$$IA = \frac{(9.8)(0.65) + (3.9)(0.50) + (3.3)(0.35)}{(9.8 + 3.9 + 3.3)}$$

$$IA = 0.56 \text{ inches}$$

3. Using values of INF from Table E-4, calculate the weighted value of

$$INF = \frac{(9.8)(1.67) + (3.9)(1.25) + (3.3)(0.83)}{(9.8 + 3.9 + 3.3)}$$

$$INF = 1.41 \text{ in/hr}$$

4. Assign the impervious area as the percent area of Land Treatment Type D

$$\text{Percent Impervious} = \left(\frac{3.5}{20.5} \right) = 17.1\%$$

F.4 UNIT HYDROGRAPH

Rainfall excess generated during a storm event is routed across the basin surface and eventually begins to concentrate at a downstream location (concentration point). The routing process results in the transformation of rainfall excess to a runoff hydrograph. Simulation of rainfall excess transformation is typically accomplished using the concept of a unit hydrograph. A unit hydrograph is defined as the hydrograph of one inch of direct runoff from a storm of a specified duration for a particular basin. Every watershed will have a different unit hydrograph that reflects the topography, land use, and other unique characteristics of the individual watershed. Different unit hydrographs will also be produced for the same watershed for different durations of rainfall excess.

For most watersheds, sufficient data (rainfall and runoff records) does not exist to develop unit hydrographs specific to the watershed. Therefore, indirect methods are used to develop a unit hydrograph. Such unit hydrographs are called synthetic unit hydrographs. The synthetic unit hydrograph method in HEC-HMS that is to be used to transform rainfall excess to a runoff hydrograph is the Clark unit hydrograph.

The Clark unit hydrograph is analogous to the routing of an inflow hydrograph through a reservoir. The inflow hydrograph, called the translation hydrograph in the Clark method, is determined from the temporal and spatial distribution of rainfall excess over a basin. The translation hydrograph is then routed by a form of the continuity equation. The Clark method uses two numeric parameters; Time of Concentration (T_c) and Storage Coefficient (R) and a graphical parameter, the time-area relation. The time-area relation defines the relation between the accumulated area of a basin and the time it takes for runoff from that area to reach the basin outlet. In the current version of HEC-HMS, the time-area relation is hard coded and cannot be changed by the user.

F.4.1 Time of Concentration

Time of concentration is defined as the time it takes for runoff to travel from the hydraulically most distant part of the watershed basin to the basin outlet or point of analysis (concentration point). The units for time of concentration are time, in hours. This implies that the time of concentration flow path may not be the longest physical length, but the length that results in the longest time.

Time of concentration is calculated using one of three equations. Selection of the appropriate equation is based on the time of concentration flow path length (in time). Regardless of the selected equation, time of concentration should not be less than 8 minutes.

For basins with flow path lengths less than 4,000 feet the SCS Upland Method is used. The Upland Method is the summation of flow travel time for the series of unique flow characteristics that occur along the overall basin flow path length. The Upland Method travel time equation is:

$$T_c = \frac{2}{3} * \sum_{i=1}^n \left(\frac{L_i}{36,000 * K_i * \sqrt{S_i}} \right) \quad (F-7)$$

Where: T_c = Time of concentration, in hours
 L_i = Length of each unique surface flow conveyance condition, in feet
 K_i = Conveyance factor from Table F-5
 S_i = Slope of the flow path, in feet per foot

TABLE F-5. CONVEYANCE FACTORS	
K	Conveyance Condition
0.7	Turf, landscaped areas and undisturbed natural areas (sheet flow* only).
1	Bare or disturbed soil areas and paved areas (sheet flow* only).
2	Shallow concentrated flow (paved or unpaved).
3	Street flow, storm sewers and natural channels, and that portion of subbasins (without constructed channels) below the upper 2000 feet for subbasins longer than 2000 feet.
4	Constructed channels (for example: riprap, soil cement or concrete lined channels).
* Sheet flow is flow over plane surfaces, with flow depths up to 0.1 feet. Sheet flow applies only to the upper 400 feet (maximum) of a subbasin.	

For basins with flow path lengths greater than 12,000 feet the time of concentration is calculated using a form of the basin lag equation. Coefficients and exponents follow USDI Bureau of Reclamation recommendations.

$$T_c = \frac{8}{9} * 26K_n \left(\frac{L * L_{ca}}{5280^2 * \sqrt{5280 * S}} \right)^{0.33} \quad (F-8)$$

Where: T_c = Time of concentration, in hours
 L = Flow path length, in feet
 L_{ca} = Distance along L from point of concentration to a point opposite the centroid of the basin, in feet
 K_n = Basin factor, from Table F-6
 S = Slope of flow path, in feet per foot

K_n in Equation F-8 is a measure of the hydraulic efficiency of the watershed to convey runoff to the basin outlet. This is analogous to a Manning's roughness coefficient. Selection of K_n should reflect the conditions of all the watercourse in the basin that convey runoff to the outlet.

TABLE F-6. LAG EQUATION BASIN FACTORS	
K_n	Basin Condition
0.042	Mountain Brush and Juniper
0.033	Desert Terrain (Desert Brush)
0.025	Low Density Urban (Minimum improvements to watershed channels)
0.021	Medium Density Urban (Flow in streets, storm sewers and improved channels)
0.016	High Density Urban (Concrete and rip-rap lined channels)

For basins with flow path lengths between 4,000 and 12,000 feet a transition equation is used that is a composite of equations F-7 and F-8. This transition equation is expressed as:

$$T_c = \left(\frac{2}{3} \right) * \left(\frac{12,000 - L}{72,000 * K * \sqrt{S}} + \frac{(L - 4,000) * K_n * \left(\frac{L_{ca}}{L} \right)^{0.33}}{552.2 * S^{0.165}} \right) \quad (F-9)$$

Where: T_c = Time of concentration, in hours
 L = Flow path length, in feet
 L_{ca} = Distance along L from point of concentration to a point opposite the centroid of the basin, in feet
 K = Conveyance factor from Table F-5
 K_n = Basin factor, from Table F-6
 S = Slope of flow path, in feet per foot

Calculation of a basin time of concentration is a function of flow path length and by extension basin area. Therefore, basin / subbasin delineation is a key consideration that must be addressed early on in the modeling process as it not only influences unit hydrograph parameter estimation but rainfall loss parameters as well. Wherever possible, subbasin delineation should be based on the best available topographic mapping and if available detailed aerial photography. For some areas, field investigation may also be necessary to verify subbasin boundaries particularly in urban or distributary areas. The breakdown of a watershed into subbasins should consider the following:

- The subbasin sizes should be as uniform as possible.
- Subbasins should have fairly homogeneous land use and geographic characteristics. For example: mountain, hillslope and valley areas should be separated by subbasin where possible.
- Soils, vegetation and land treatment characteristics should be fairly homogeneous.
- Subbasins size should be commensurate with the intended use of the model. For example, if the model is to be used for the evaluation and / or design of drainage infrastructure, the subbasin size should be fairly small so that runoff magnitudes are known at multiple locations within the watershed. For drainage management plans, the subbasin size shall in general not be greater than 1.5 mi² or less than 0.1 mi².

F.4.2 Time of Concentration for Steep Slopes and Natural Channels

The equations used to compute time of concentration may result in values that are too small to be sustained for natural channel conditions. In natural channels, flows become unstable when a Froude Number of 1.0 is approached. The equations identified in Section A.3.1 can result in flow velocities for steep slopes that indicate supercritical flow conditions, even though such supercritical flows cannot be sustained for natural channels. For steep slopes, natural channels will likely experience chute and pool conditions with a hydraulic jump occurring at the downstream end of chute areas; or will experience a series of cascading flows with very steep drops interspersed with flatter channel sections.

For the purposes of this section, steep slopes are defined as those greater than 0.04 foot per foot. The procedures outlined in this section should not be used for the following conditions:

- Slopes flatter than 0.04 foot per foot.
- Channels with irrigated grass, riprap, soil cement, gabion, or concrete lining which cannot be clearly identified as natural or naturalistic.
- The hydraulic design of channels or channel elements. The purpose of this section is to define procedures for hydrologic analysis only. The design of facilities adjacent to or within channels with chute and pool conditions cannot be analyzed with the simplified procedures identified herein. It may be necessary to design such facilities for the supercritical flows of chutes (for sediment transport, local scour, stable material size) and for the hydraulic jump of pool conditions (for maximum water surface elevation and flood protection).

The slope of steep natural watercourses should be adjusted to account for the effective slope that can be sustained. The slope adjustment procedures identified in the Denver - Urban Drainage and Flood Control District (UDFCD) Urban Storm Drainage Criteria Manual (Figure 4-1, Runoff chapter, 1990) are applicable for the slope adjustment identified herein. In addition, channel conveyance factors (K) should be checked to make sure that appropriate equivalent Froude Numbers are maintained. The UDFCD Figure 4-1 can be approximated by the following equation:

$$S' = 0.052467 + 0.062627 S - 0.18197 e^{-62.375S} \quad (F-10)$$

Where: S = Measured slope, in feet per foot
 S' = Adjusted slope, in feet per foot

The conveyance factors (K) for the Upland Method should be checked to make sure that appropriate Froude Numbers are maintained. The Lag Equation Basin Factors, K_n , from Table F-6 remain applicable when using equations F-8 and F-9 with the adjusted slope computed by equation F-10. To adjust the conveyance factor (K) it is necessary to estimate the peak flow rate from the watershed. Using estimated conveyance factors (K) from Table F-5 and the procedures outlined in Part D, an estimated peak flow rate for the basin (Q_p) can be computed. The following formulas are then used to compute conveyance factor adjustment:

$$K' = 0.302 * S'^{-0.5} * Q_p^{0.18} \quad (F-11)$$

$$K'' = 0.207 * S'^{-0.5} * Q_p^{0.18} \quad (F-12)$$

An adjusted conveyance factor (K) is then obtained based on the following:

- if $K > K'$ then $K = K'$
- if $K' \geq K \geq K''$ then $K = K$ (no adjustment)
- if $K < K''$ then $K = K''$

This is an iterative process that is to be repeated until the computed value of Q_p is within 10 percent of original value of Q_p .

F.4.3 Storage Coefficient

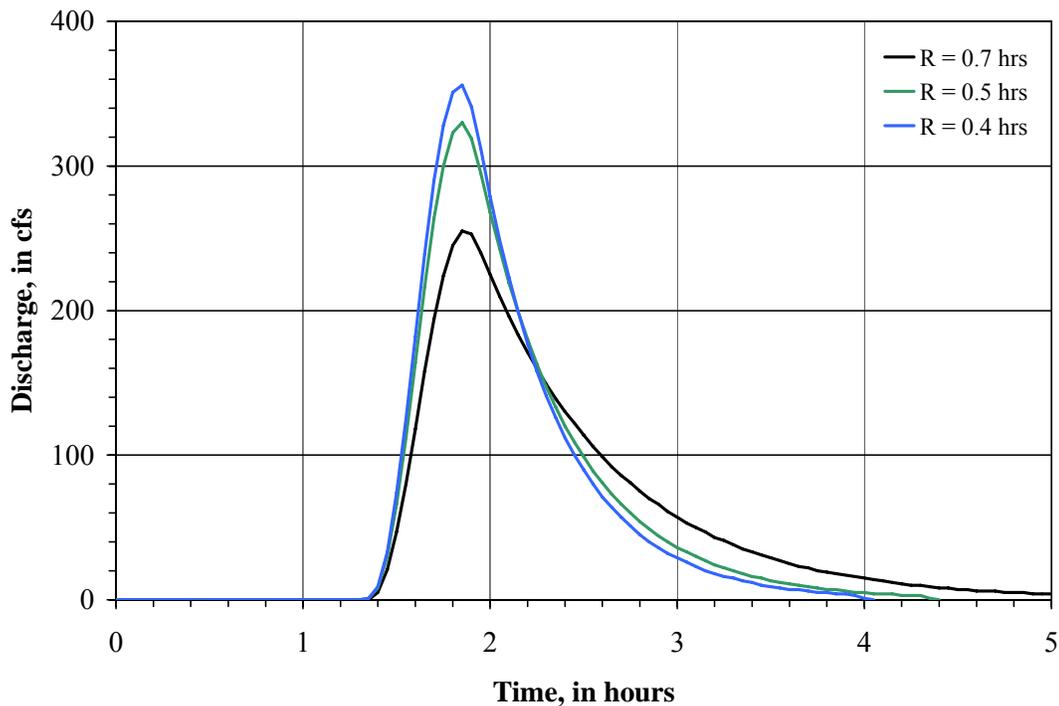
The storage coefficient describes the effect that temporary storage in the basin has on the hydrograph. The storage coefficient has the units of time and is interrelated with time of concentration. The temporary storage potential of runoff for a basin is also influenced by the land treatment conditions present. The equation for estimating the storage coefficient is:

$$R = 1.165 * T_c \left(INF^{0.45} - IA^{1.4} \left(\frac{D}{100} \right)^{0.40} \right) \quad (F-13)$$

- Where:
- R = Storage coefficient, in hours
 - T_c = Time of concentration, in hours (from Eqn. F-7, F-8 or F-9)
 - INF = Infiltration loss rate for the subbasin, in in/hr
 - IA = Initial abstraction for the basin, in inches
 - D = Land treatment type D, expressed in percent

Land treatment conditions (impervious area in particular), influence the storage coefficient in that as the degree of development increases, the storage coefficient decreases. This results in a decrease in the time that runoff is stored in the basin. Thus a greater proportion of runoff volume is conveyed to the basin outlet over a shorter time period, resulting in a higher peak discharge. This is illustrated in Figure F-4. In that figure runoff hydrographs are plotted for a hypothetical basin 1 square mile in size. Reducing the storage coefficient while holding all other parameters constant results in the compression of the time distribution of runoff and thus an increase in peak discharge.

FIGURE F-4. Influence of watershed storage on the runoff hydrograph



F.4.4 Procedure

1. Delineate the time of concentration flow path for each subbasin and measure the length, in feet.
 - a. If the flow path length is less than 4,000 feet, calculate T_c using Equation F-7 with the following:
 - i. Select K from Table F-5
 - ii. Measure the average flow path slope, S. If the flow path slope is greater than 0.04 feet / foot:
 1. Calculate the adjusted slope using Equation F-10.
 2. Estimate the peak discharge using procedures in Part D
 3. Calculate the conveyance factor adjustment range using Equations F-11 and F-12.
 4. Recalculate the peak discharge using the procedures in Part D and the adjusted slope and conveyance factor.
 5. Repeat steps ii3 and ii4 until the calculated peak discharge is within 10 % of the original value.
 - b. If the flow path length is between 4,000 and 12,000 feet, calculate T_c using Equation F-9 with the following:
 - i. Measure L_{ca} and S
 - ii. Select appropriate values of K from Table F-5 and K_n from Table F-6
 - c. If the flow path length is greater than 12,000 feet, calculate T_c using Equation F-8 with the following:
 - i. Measure L_{ca} and S
 - ii. Select appropriate values of K_n from Table F-6
2. Calculate the storage coefficient for each subbasin using Equation F-13
3. In HEC-HMS code in the calculated values for time of concentration and storage coefficient for each subbasin.

F.4.5 Example

Calculate the unit hydrograph parameters for a 20.5 square mile watershed based on the following data. Rainfall loss parameters for the watershed are from the example in Section F.3.5.

- Flow path length, $L = 8.5$ miles
- Length to centroid, $L_{ca} = 4.0$ miles
- Flow path slope, $S = 1.8\%$

1. Calculate T_c

The flow path length is greater than 12,000 feet. Therefore, use Equation F-8 and assume a value for K_n of 0.033.

$$T_c = \frac{8}{9} * 26 K_n \left(\frac{L * L_{ca}}{5280^2 * \sqrt{5280 * S}} \right)^{0.33}$$

$$T_c = \frac{8}{9} * 26 * (0.033) \left(\frac{8.5 * 4.0}{\sqrt{5280 * 0.018}} \right)^{0.33}$$

$$T_c \text{ 1.15 hours}$$

2. Using Equation F-13, calculate the Clark unit hydrograph storage coefficient, R.

$$R = 1.165 * T_c \left(INF^{0.45} - IA^{1.4} \left(\frac{D}{100} \right)^{0.40} \right)$$

$$R = 1.165 * 1.15 * \left(1.41^{0.45} - 0.56^{1.4} \left(\frac{17.1}{100} \right)^{0.40} \right)$$

$$R = 1.27 \text{ hours}$$

F.5 CHANNEL ROUTING

Hydrologic channel routing describes the movement of a floodwave (hydrograph) along a watercourse. For most natural rivers, as a floodwave passes through a given reach, the peak of the outflow hydrograph is attenuated and delayed due to flow resistance in the channel and the storage capacity of the river reach. In urban environments, runoff is often conveyed in man made features such as roadways, storm drains and engineered channels that minimize hydrograph attenuation.

Channel routing is used in flood hydrology models, such as HEC-HMS, when the watershed is modeled with multiple subbasins and runoff from the upper subbasins must be translated through a channel or system of channels to the watershed outlet. The channel routing method to be used in HEC-HMS is the Muskingum-Cunge methodology.

The Muskingum-Cunge channel routing is a physically based methodology that solves the continuity and diffusive form of the momentum equation based on the physical channel properties and the inflow hydrograph. The solution procedure involves the discretization of the equations in both time and space (length). The discretized time and distance step size influence the accuracy and stability of the solution. In HEC-HMS the time and distance step size are calculated internally.

F.5.1 Physical Parameters

The physical parameters required for the Muskingum-Cunge channel routing are: reach length, flow resistance factor, friction slope and the channel geometry. One limitation of this method is that it cannot account for the effects of backwater. Therefore, the friction slope should be approximated using the average bed slope. Channel geometry can be one of the following:

- Circular
- Trapezoidal
- Rectangular
- Triangular
- 8 point irregular cross section

Although a circular section can be simulated, the Muskingum-Cunge solution assumes open channel flow conditions regardless of the geometric constraint. If the inflow to the routing reach results in the flow depth exceeding approximately 77% of the diameter, HEC-HMS will report a warning message and the routing results should be checked for reasonableness. In particular, the results should be checked for volume conservation.

When using the 8-point irregular cross section, the cross section must be exactly 8 points. Additionally, the 3rd and 6th point of the cross section defines the break in Manning's n-values for the overbank and channel areas.

F.5.2 Roughness Coefficients

Flow resistance in the channel and overbank flow area is simulated using Manning's roughness coefficients. Flow resistance is affected by many factors including bed material size, bed form, irregularities in the cross section, depth of flow, vegetation, channel alignment, channel shape, obstructions to flow and the quantity of sediment of being transported in suspension or as bed load. In general, all factors that retard flow and increase turbulent mixing tend to increase Manning's n-values. Manning's roughness coefficients appropriate for hydrologic routing are listed in Table F-7 and are, in general, taken from the SSCAFCA Sediment and Erosion Design Guide (MEI, 2008). Use of roughness coefficients other than those listed in Table E-7 must be estimated using the information and procedures in the Sediment and Erosion Design Guide and approved by SSCAFCA.

TABLE F-7. MANNING'S ROUGHNESS COEFFICIENTS	
Channel or Floodplain Type	n-value
Sand bed arroyos	0.055
Tined concrete	0.018
Shotcrete	0.025
Reinforced concrete pipe	0.013
Trowled concrete	0.013
No-joint cast-in-place concrete pipe	0.014
Reinforced concrete box	0.015
Reinforced concrete arch	0.015
Streets	0.017
Flush grouted riprap	0.020
Corrugated metal pipe	0.025
Grass-lined channels (sodded & irrigated)	0.025
Earth-lined channels (smooth)	0.030
Wire-tied riprap	0.040
Medium weight dumped riprap	0.045
Grouted riprap (exposed rock)	0.045
Jetty type riprap (D50 > 24")	0.050

F.5.3 Procedure

1. From an appropriate map of the watershed, measure the routing reach length in feet and estimate the friction slope as the channel bed slope in feet per foot.
2. Select a cross sectional geometry that represents that average hydraulic conditions of the reach. If a single cross section cannot be identified that represents the average hydraulic conditions, break the reach into multiple sections and treat each as a unique element in HEC-HMS.
3. Conduct a field reconnaissance of the watershed and routing reaches to observe the flow resistance characteristics.
4. Select an appropriate Manning's roughness coefficient for the channel and overbank flow areas using Table F-7

F.6 SEDIMENT BULKING

Flow bulking occurs when sediment is eroded from the land surface and entrained into the flowing water. Entrained sediment has the effect of increasing the runoff volume and flow rate. Within this jurisdiction there is potential for high sediment yields. Studies indicate that the sediment yield from undeveloped watersheds can result in bulking factors up to 18%. Similarly, sediment yield from developed areas can result in bulking factors up to 6% for developed conditions. Developed conditions are those areas that have paved roads with curb and gutter. Given the high potential for surface erosion, all watershed models will include flow bulking.

F.6.1 Procedure

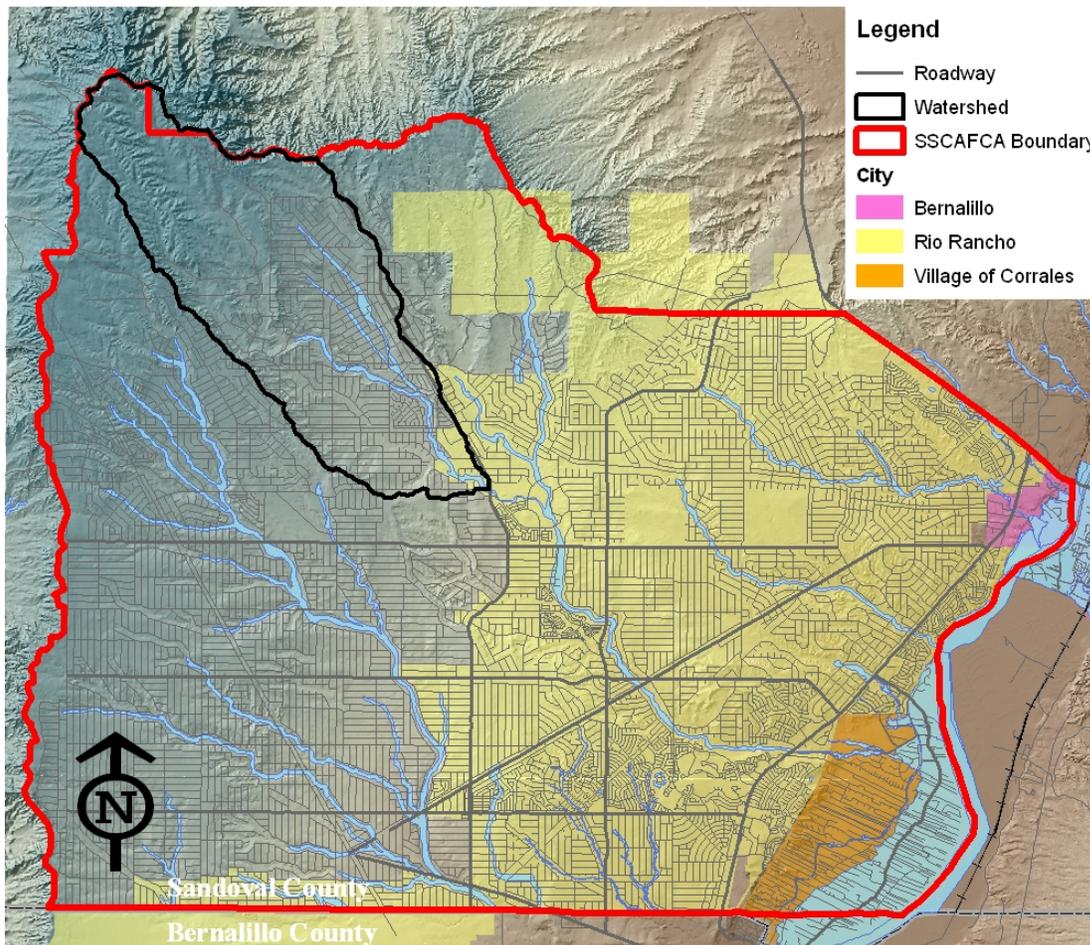
In HEC-HMS, flow bulking for sediment is simulated using a ratio. The ratio is applied to direct runoff estimated for each subbasin. There are two approaches for coding ratios in HEC-HMS. The first is a global assignment. For this option, only one ratio can be applied. Therefore, this option can only be applied to watersheds that are entirely undeveloped or developed. A globally assigned ratio is applied through the computation options for each run.

The second approach for simulating flow bulking due to sediment in HEC-HMS is to apply the appropriate ratio for each subbasin within the watershed. This option is to be used for watersheds with both undeveloped and developed areas.

F.7 HEC-HMS EXAMPLE

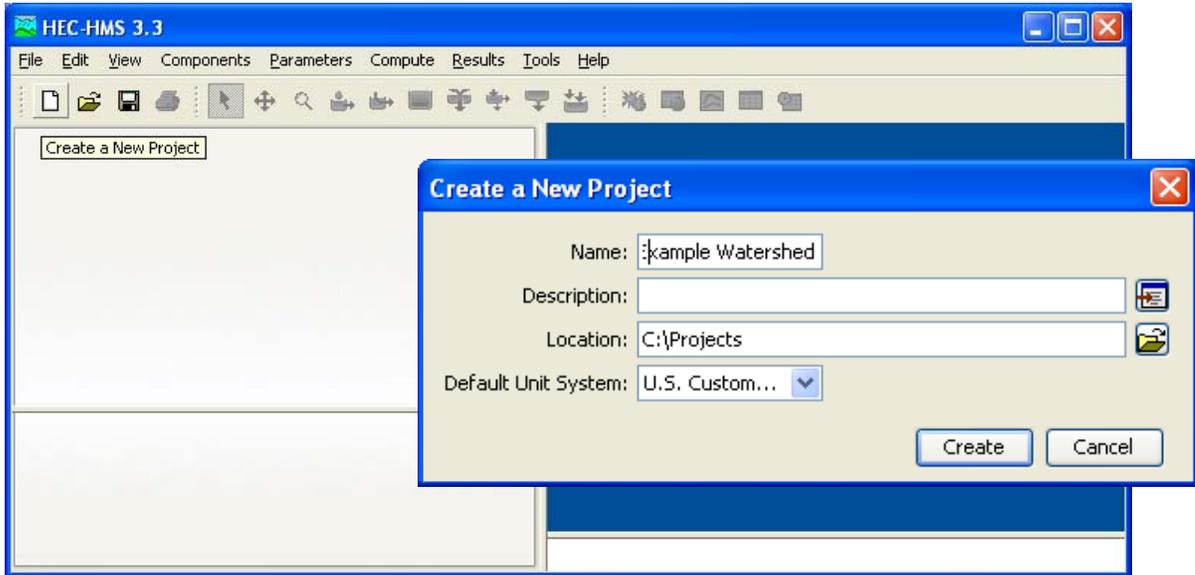
A new roadway crossing is needed for Rainbow Blvd. at Montoyas Arroyo. The new crossing must be designed to convey the 100-year, 6-hour peak flow without overtopping. The contributing drainage area at the roadway crossing is approximately 20.5 square miles. Compute the peak discharge for watershed at Rainbow Blvd.

FIGURE F-5. EXAMPLE WATERSHED MAP

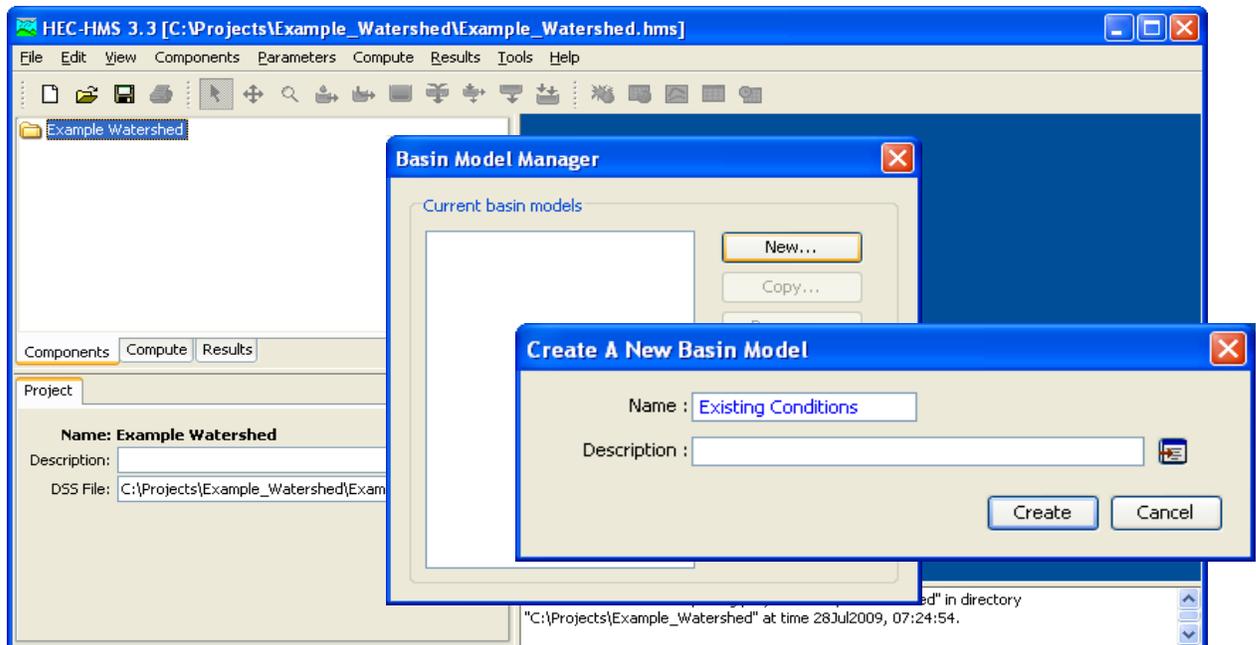


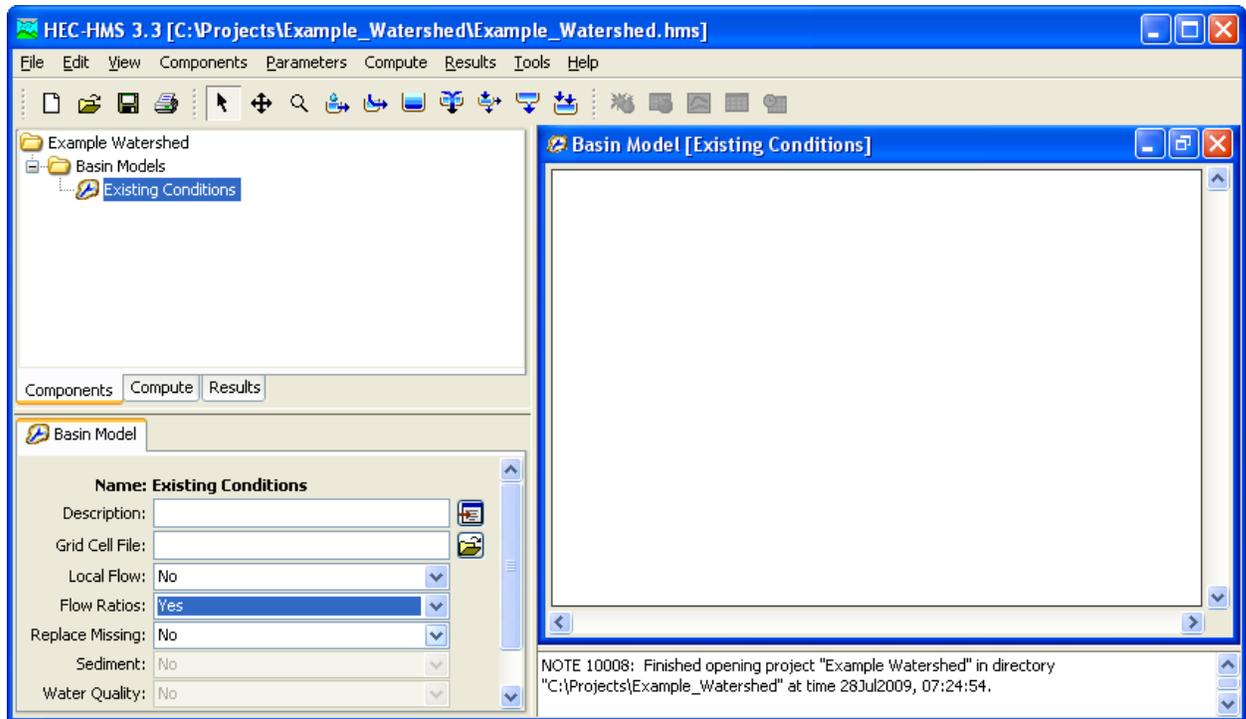
F.8.1 Project Setup

1. Create a new project and provide the following:
 - a. Project name (e.g. Example Watershed)
 - b. Path to model data
 - c. Default system of units

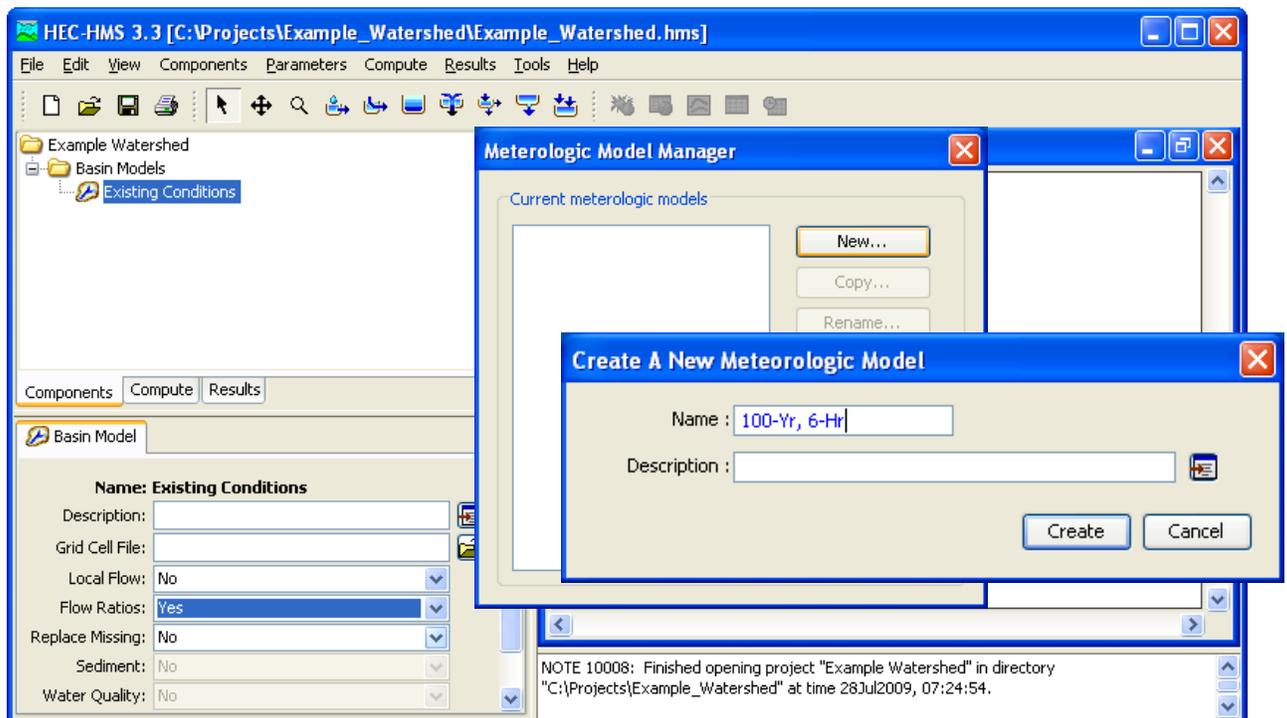


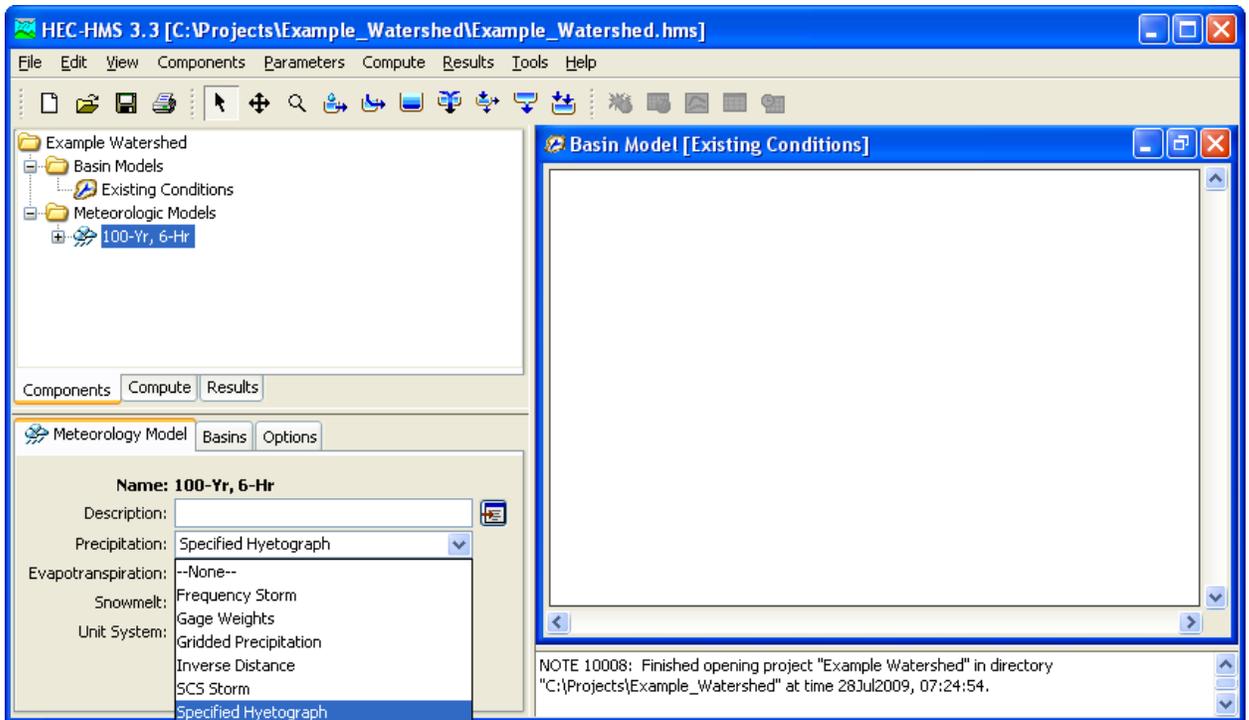
2. Create a Basin Model: From the *Components* pull down menu, select *Basin Model Manager*
 - a. Select *New*
 - b. Enter a name for the basin model (e.g. Existing Conditions)
 - c. In the *Component Editor*, select “Yes” in the *Flow Ratio* list box



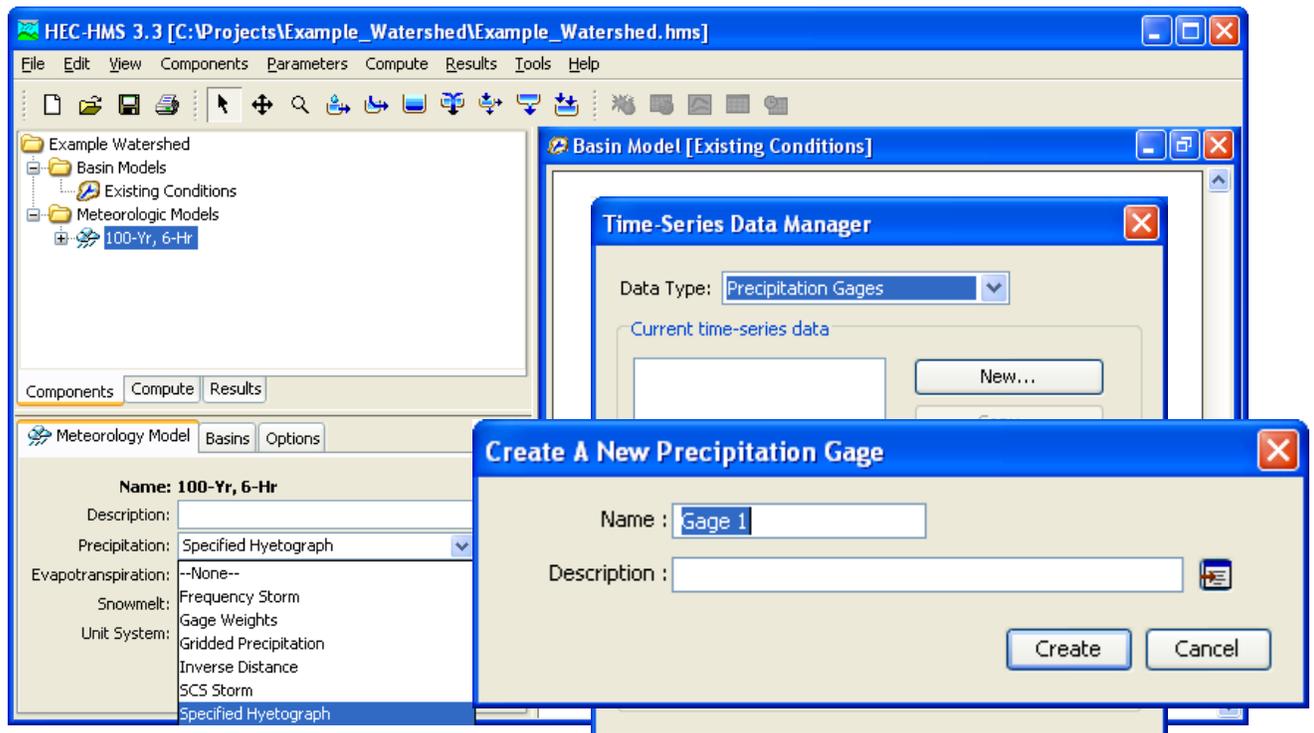


3. Create a Meteorologic Model: From the *Components* pull down menu, select *Meteorologic Model Manager*
 - a. Select *New*
 - b. Enter a name for the meteorologic model (e.g. 100-Yr, 6-Hr)
 - c. In the *Component Editor*, select "Specified Hyetograph" in the *Precipitation* list box





4. Create a precipitation gage: from the *Components* pull down menu, select *Time-Series Data Manager*
 - a. With the *Data Type* set to “Precipitation Gages”, select *New*
 - b. Assign a name for the gage (e.g. Gage-1)

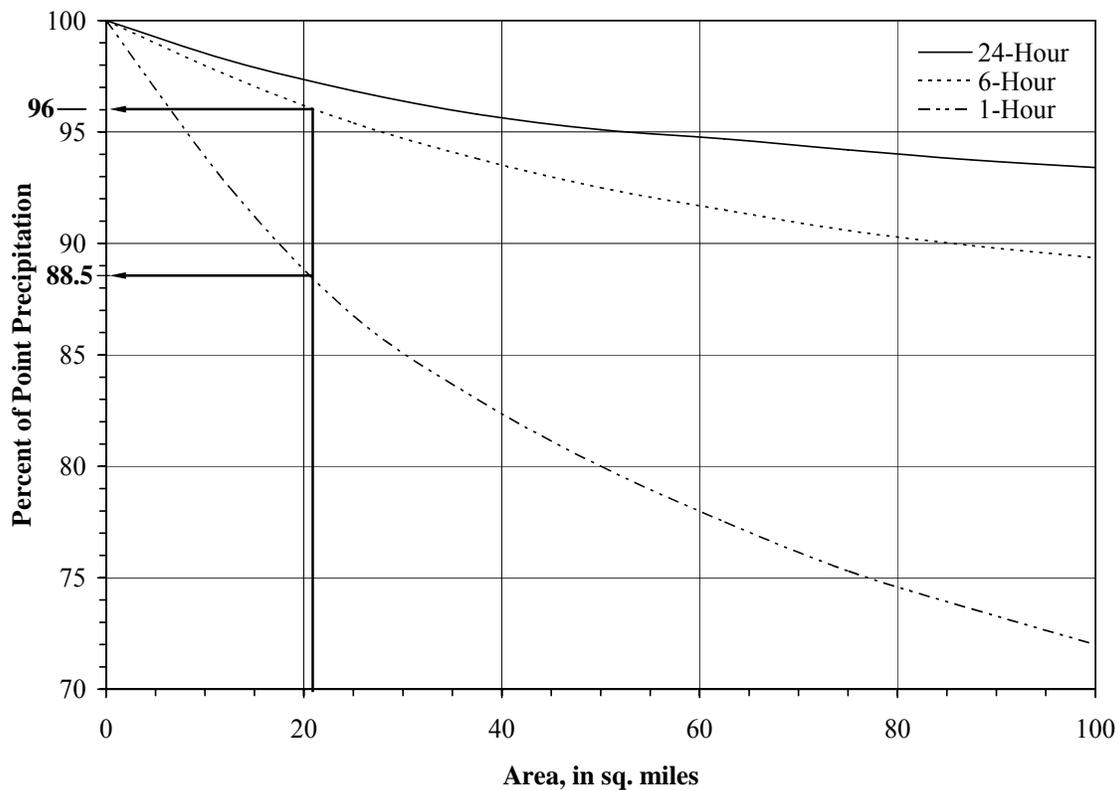


F.8.2 Design Rainfall

Determine the 100-year, 6-hour rainfall data for the watershed, plot the rainfall hyetograph and code the data into the HEC-HMS project.

1. 100-year point rainfall depths taken from Table F-1 are:
 - 100-year, 1-hour = 1.84 inches
 - 100-year, 6-hour = 2.37 inches
2. Estimate depth-area reduction factors for the watershed area of 20.5 square miles using Figure F-1.

FIGURE F-6. EXAMPLE WATERSHED DEPTH-AREA REDUCTION



3. Calculate the equivalent uniform rainfall depth

$$P_1^{100} = (1.84)(0.885) = 1.63 \text{ inches}$$

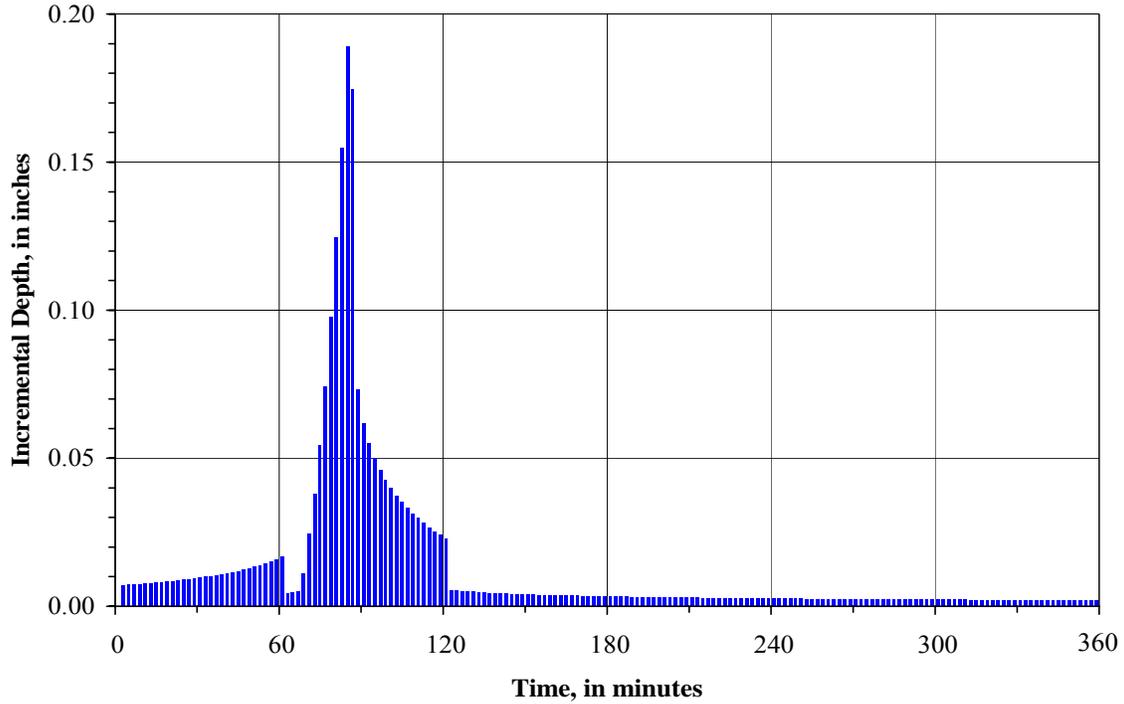
$$P_6^{100} = (2.37)(0.960) = 2.28 \text{ inches}$$

4. Calculate the cumulative rainfall mass curve using Equations F-1 through F-5 for the 6-hour storm. The computation time interval is 2 minutes.

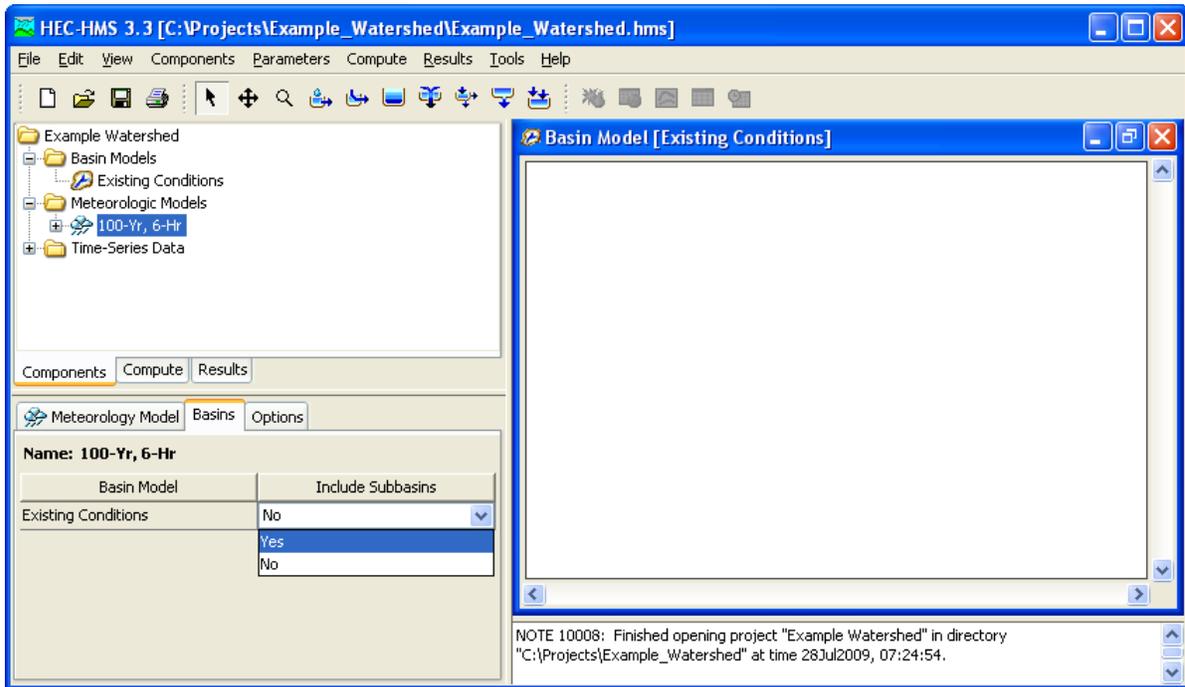
TABLE F-8 CUMULATIVE RAINFALL DISTRIBUTION

Time min	Rainfall inches	Time min	Rainfall inches	Time min	Rainfall inches	Time min	Rainfall inches
0	0.000	92	1.459	184	2.065	276	2.190
2	0.007	94	1.509	186	2.068	278	2.192
4	0.014	96	1.555	188	2.071	280	2.194
6	0.021	98	1.598	190	2.074	282	2.197
8	0.028	100	1.638	192	2.078	284	2.199
10	0.036	102	1.676	194	2.081	286	2.201
12	0.043	104	1.712	196	2.084	288	2.203
14	0.051	106	1.745	198	2.087	290	2.206
16	0.059	108	1.777	200	2.090	292	2.208
18	0.067	110	1.807	202	2.093	294	2.210
20	0.075	112	1.835	204	2.096	296	2.213
22	0.084	114	1.862	206	2.099	298	2.215
24	0.092	116	1.887	208	2.101	300	2.217
26	0.101	118	1.911	210	2.104	302	2.219
28	0.110	120	1.934	212	2.107	304	2.221
30	0.120	122	1.940	214	2.110	306	2.224
32	0.129	124	1.945	216	2.113	308	2.226
34	0.139	126	1.951	218	2.116	310	2.228
36	0.149	128	1.956	220	2.118	312	2.230
38	0.160	130	1.961	222	2.121	314	2.232
40	0.171	132	1.965	224	2.124	316	2.235
42	0.182	134	1.970	226	2.127	318	2.237
44	0.193	136	1.975	228	2.129	320	2.239
46	0.205	138	1.979	230	2.132	322	2.241
48	0.218	140	1.984	232	2.135	324	2.243
50	0.231	142	1.988	234	2.137	326	2.245
52	0.244	144	1.992	236	2.140	328	2.247
54	0.258	146	1.996	238	2.143	330	2.249
56	0.273	148	2.000	240	2.145	332	2.251
58	0.288	150	2.004	242	2.148	334	2.254
60	0.304	152	2.008	244	2.150	336	2.256
62	0.309	154	2.012	246	2.153	338	2.258
64	0.314	156	2.016	248	2.155	340	2.260
66	0.319	158	2.020	250	2.158	342	2.262
68	0.330	160	2.024	252	2.160	344	2.264
70	0.355	162	2.027	254	2.163	346	2.266
72	0.393	164	2.031	256	2.165	348	2.268
74	0.448	166	2.035	258	2.168	350	2.270
76	0.522	168	2.038	260	2.170	352	2.272
78	0.620	170	2.042	262	2.173	354	2.274
80	0.746	172	2.045	264	2.175	356	2.276
82	0.902	174	2.048	266	2.178	358	2.278
84	1.092	176	2.052	268	2.180	360	2.280
86	1.268	178	2.055	270	2.182		
88	1.341	180	2.058	272	2.185		
90	1.403	182	2.062	274	2.187		

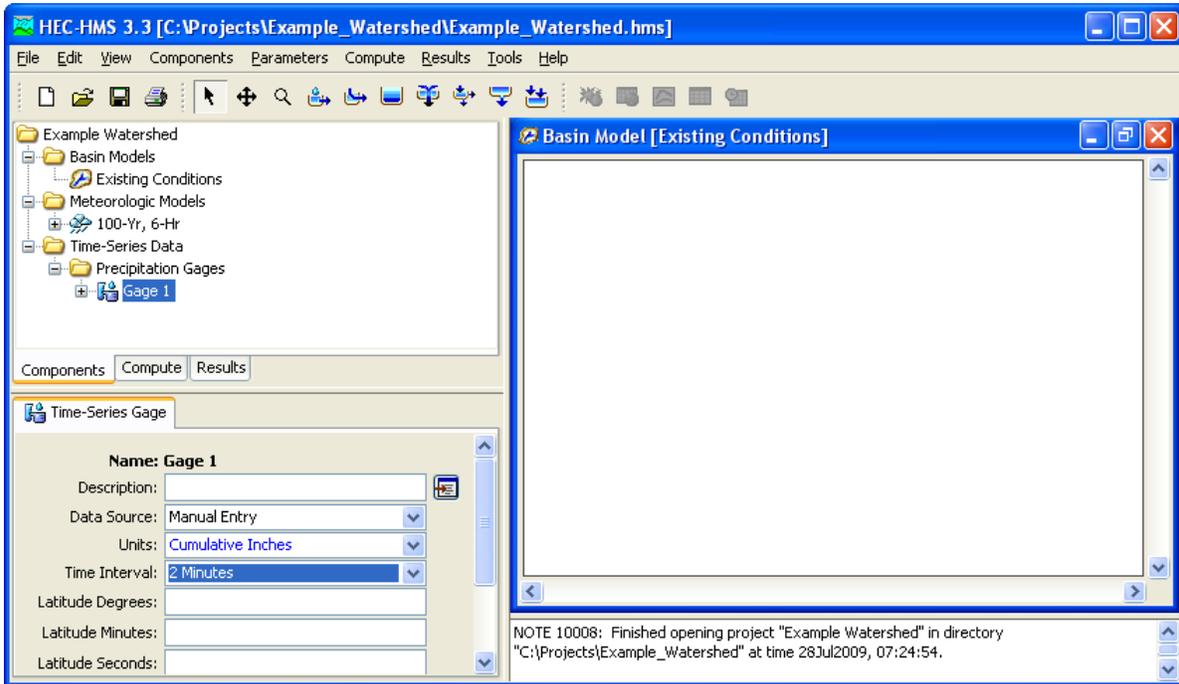
FIGURE F-7. 100-YEAR, 6-HOUR RAINFALL HYETOGRAPH



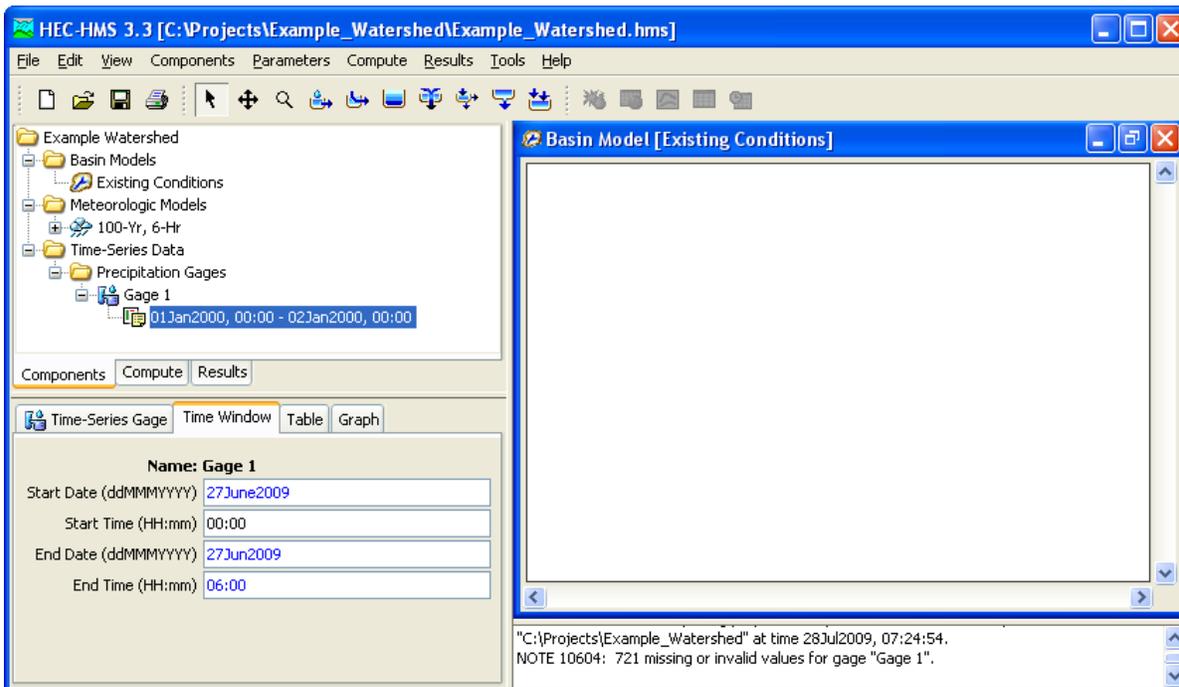
5. Code the cumulative rainfall data into HEC-HMS
 - a. In the *Basin* tab of the *Component Editor* for the “100-Yr, 6-Hr” precipitation model, toggle on the “Include Subbasins” option



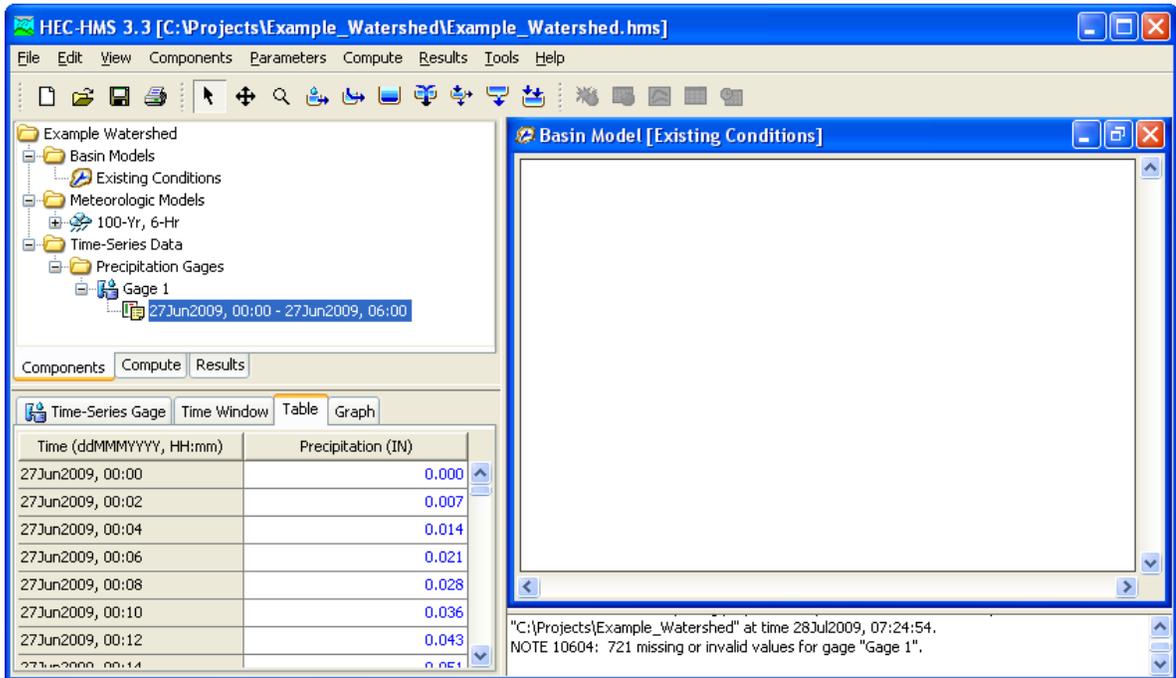
- b. In the *Component Editor* for “Gage-1”, set the following:
 - i. Units = Cumulative Inches
 - ii. Time Interval = 2 Minutes



- c. Set the time duration of rainfall

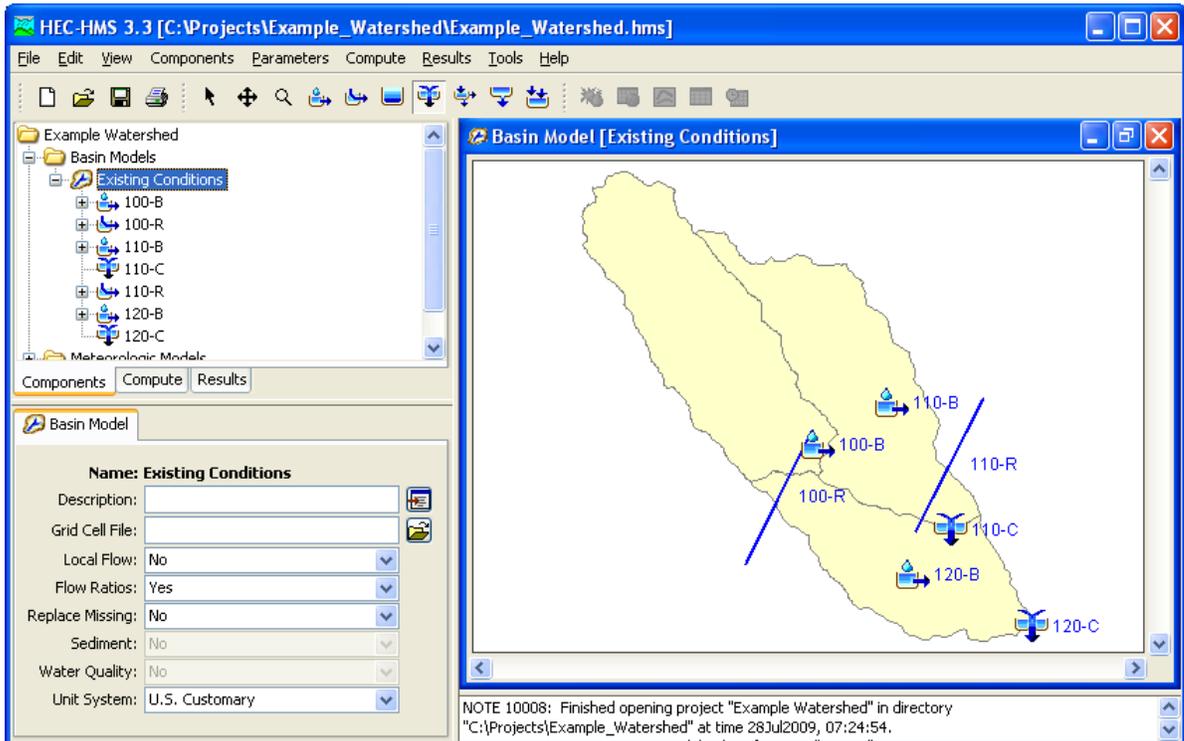


d. Cut and paste the cumulative rainfall data from Table F-8

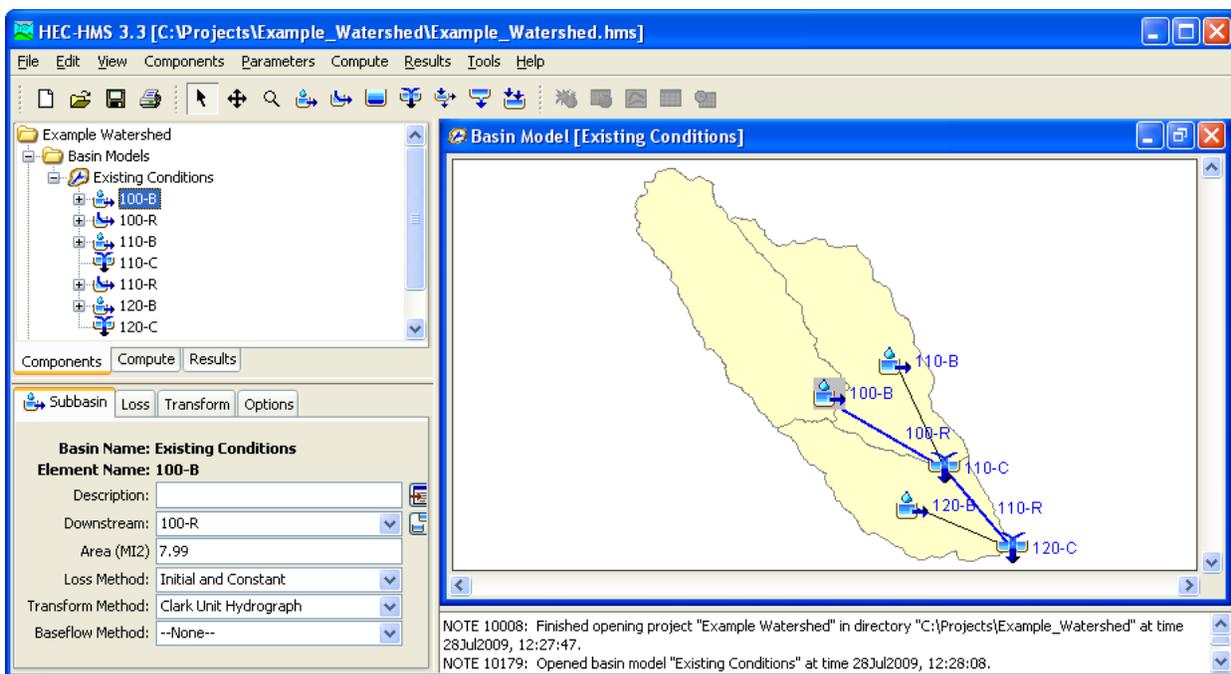


F.8.3 Basin Data

1. Build watershed schematic in the HEC-HMS Desktop using the watershed icons for each element.



2. Set the default methodologies for subbasin and channel routing elements
 - a. From the *Parameters* pull down menu
 - i. Select *Subbasin Methods*
 - Select *Loss* and set the Method to “Initial and Constant”
 - Select *Transform* and set the Method to “Clark Unit Hydrograph”
 - Select *Baseflow* and set the Method to “None”
 - ii. Select *Reach Methods*
 - Select *Routing* and set the Method to “Muskingum-Cunge”
 - Select *Loss/Gain* and set the Method to “None”
3. Code in subbasin areas and set downstream connectivity



F.8.4 Rainfall Loss Parameters

Compute the subbasin average rainfall loss parameters and code the values into the HEC-HMS project for the watershed. Existing condition land use within the watershed is illustrated in Figure F-8. The areas for each unique land use type with each subbasin are listed in the following Table F-9.

FIGURE F-8. EXAMPLE WATESHED LAND USE CONDITIONS

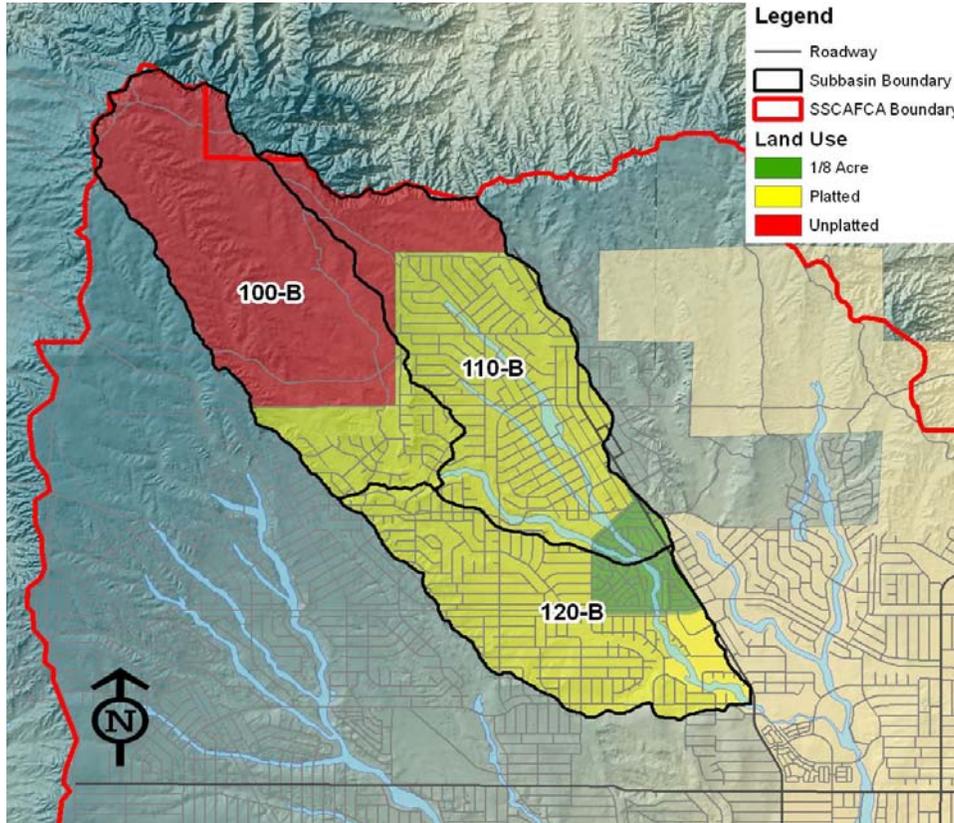


TABLE F-9 EXAMPLE WATERSHED LAND USE DATA

Parcel Description	Area, in sq. miles			Total Area sq. miles
	100-B	110-B	120-B	
1/8 Acre	---	0.38	0.62	1.00
Platted	1.60	4.58	5.69	11.87
Unplatted	6.39	1.24	---	7.63
Total	7.99	6.20	6.31	20.50

- From Table F-3, percentage of Land Treatment Types for each parcel within the watershed are:

Parcel Description	Percent of Land Treatment Type			
	A	B	C	D
1/8 Acre	0	15	15	70
Platted	18.7	29.5	27.0	24.8
Unplatted	95	5	0	0

- Calculate the area of each Land Treatment type within each subbasin by multiplying the area of each parcel type by the percent of Land Treatment type, for example:

For subbasin 100-B, the area of each Land Treatment type is as follows

$$\text{Area}_A = (0)(0\%) + (1.6)(18.7\%) + (6.39)(95\%) = 6.37 \text{ sq. miles}$$

$$\text{Area}_B = (0)(15\%) + (1.6)(29.5\%) + (6.39)(5\%) = 0.79 \text{ sq. miles}$$

$$\text{Area}_C = (0)(15\%) + (1.6)(27.0\%) + (6.39)(0\%) = 0.43 \text{ sq. miles}$$

$$\text{Area}_D = (0)(70\%) + (1.6)(24.8\%) + (6.39)(0\%) = 0.40 \text{ sq. miles}$$

$$\text{Total Area} = 7.99 \text{ sq. miles}$$

Therefore, the area of each Land Treatment type for each subbasin is as follows:

Subbasin ID	Land Treatment Type Area, in sq. miles				Total Area sq. miles
	A	B	C	D	
100-B	6.37	0.79	0.43	0.40	7.99
110-B	2.03	1.47	1.30	1.40	6.20
120-B	1.06	1.77	1.63	1.85	6.31
Total	9.46	4.03	3.36	3.65	20.50

- Using values of IA from Table F-4, calculate the weighted value of IA for each subbasin, for example:

For subbasin 100-B, the area weighted IA is calculated as follows

$$IA = \frac{(6.37)(0.65) + (0.79)(0.50) + (0.43)(0.35)}{6.37 + 0.79 + 0.43} = 0.62$$

Therefore, the area weighed IA for each subbasin is as follows:

Subbasin ID	IA inches
100-B	0.62
110-B	0.52
120-B	0.48

4. Using values of INF from Table F-5, calculate the weighted value of INF for each subbasin, for example:

For subbasin 100-B, the area weighted INF is calculated as follows:

$$IA = \frac{(6.37)(1.67) + (0.79)(1.25) + (0.43)(0.83)}{6.37 + 0.79 + 0.43} = 1.58$$

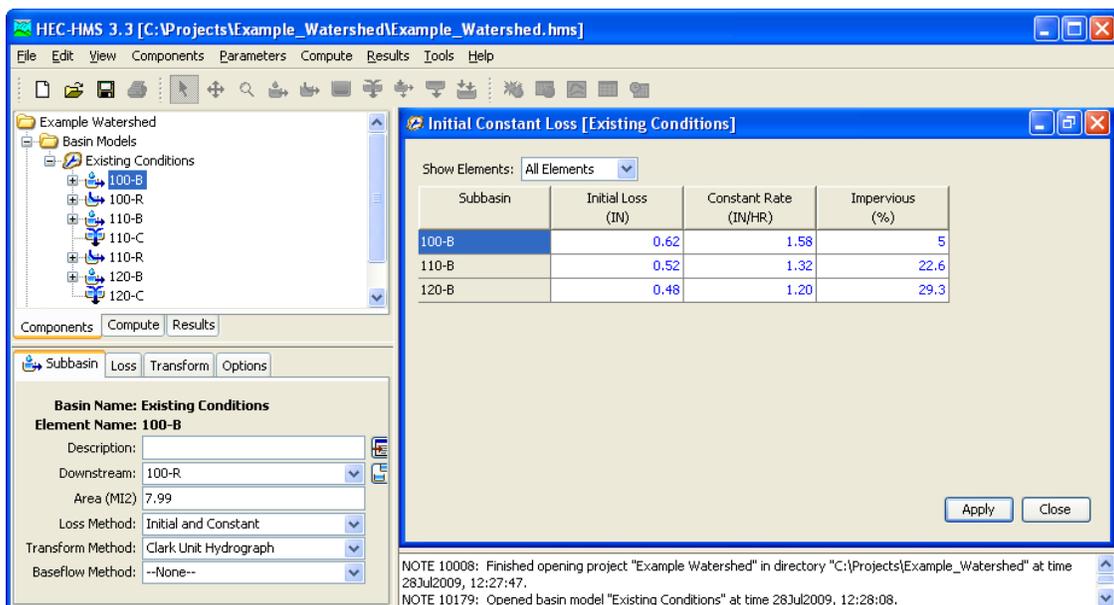
Therefore, the area weighed INF for each subbasin is as follows:

Subbasin ID	INF in/hr
100-B	1.58
110-B	1.32
120-B	1.20

5. Using the area of Land Treatment Type D, compute the impervious area percentage for each subbasin

Subbasin ID	Impervious Area %
100-B	5.0
110-B	22.6
120-B	29.3

6. Code the rainfall loss parameters in HEC-HMS: from the *Parameters* pull down menu
 - a. Select *Loss* and then *Initial and Constant*
 - b. Select “All Elements”
 - c. Code in the rainfall loss parameters for each subbasin



F.8.5 Unit Hydrograph Parameters

Compute the Clark unit hydrograph parameters and code the values into the HEC-HMS project for the watershed. Runoff from each subbasin should account for sediment bulking. Time of Concentration (Tc) flow paths, subbasin centroid locations and Lca flow paths for each subbasin are illustrated in Figure F-9. The physical data for calculation of the Clark unit hydrograph parameters for each subbasin are listed in the Table F-9.

FIGURE F-9. EXAMPLE WATESHED FLOW PATHS

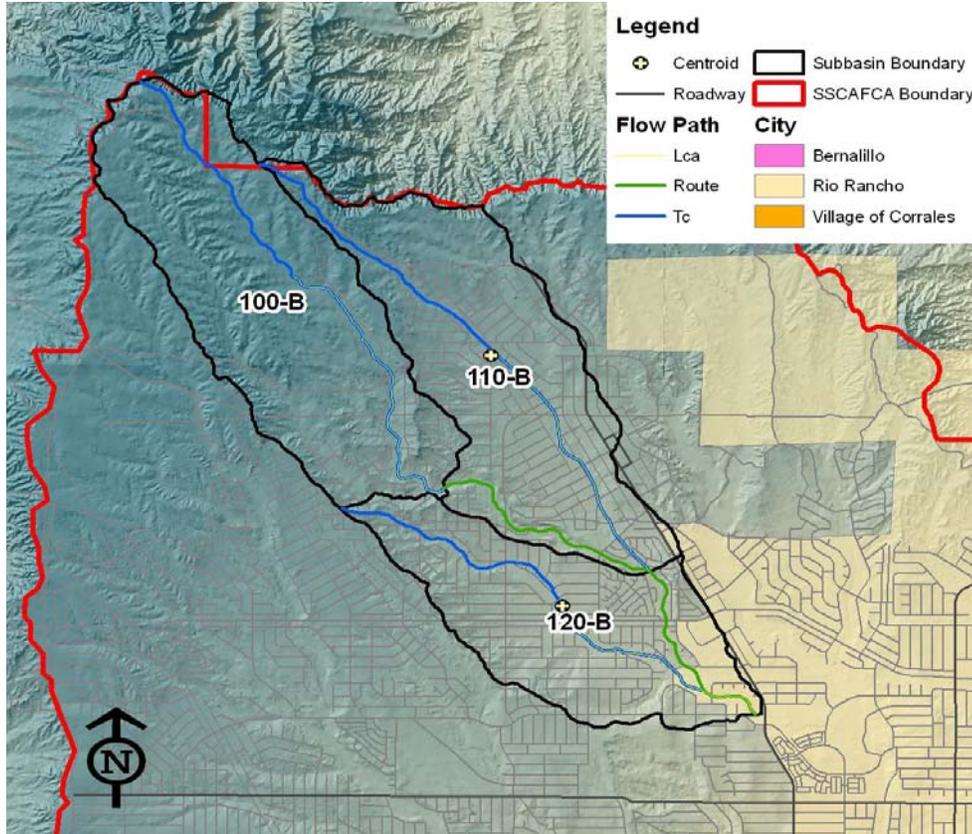


TABLE F-10 EXAMPLE WATERSEHD FLOW PATH DATA

Subbasin ID	Flow Path Length		Slope ft/ft
	L miles	L _{ca} miles	
100-B	5.15	2.71	0.0185
110-B	5.81	2.68	0.0171
120-B	4.92	2.35	0.0165

1. Calculate the T_c for each subbasin

The T_c flow path length is greater than 12,000 feet for all subbasins, therefore use Equation F-8 and select a value of K_n from Table F-6.

The majority of each subbasin is undeveloped land, either platted or unplatted, therefore assume a value of K_n of 0.033 for all subbasins.

Using Equation F-8, T_c for subbasin 100-B is:

$$T_c = \frac{8}{9} * 26(0.033) * \left(\frac{27,192 * 14,309}{5280^2 * \sqrt{5280 * 0.0185}} \right)^{0.33} = 0.855 \text{ hrs}$$

Using Equation F-8, T_c for subbasin 110-B is:

$$T_c = \frac{8}{9} * 26(0.033) * \left(\frac{30,677 * 14,150}{5280^2 * \sqrt{5280 * 0.0171}} \right)^{0.33} = 0.899 \text{ hrs}$$

Using Equation F-8, T_c for subbasin 120-B is:

$$T_c = \frac{8}{9} * 26(0.033) * \left(\frac{25,998 * 12,408}{5280^2 * \sqrt{5280 * 0.0165}} \right)^{0.33} = 0.819 \text{ hrs}$$

2. Calculate the Storage Coefficient (R) for each subbasin using Equation F-13 and the results from Example Problem No. 2

Using Equation F-13, R for subbasin 100-B is:

$$R = 1.165 * 0.855 * \left(1.58^{0.45} - 0.62^{1.4} \left(\frac{5}{100} \right)^{0.40} \right) = 1.070 \text{ hrs}$$

Using Equation F-13, R for subbasin 110-B is:

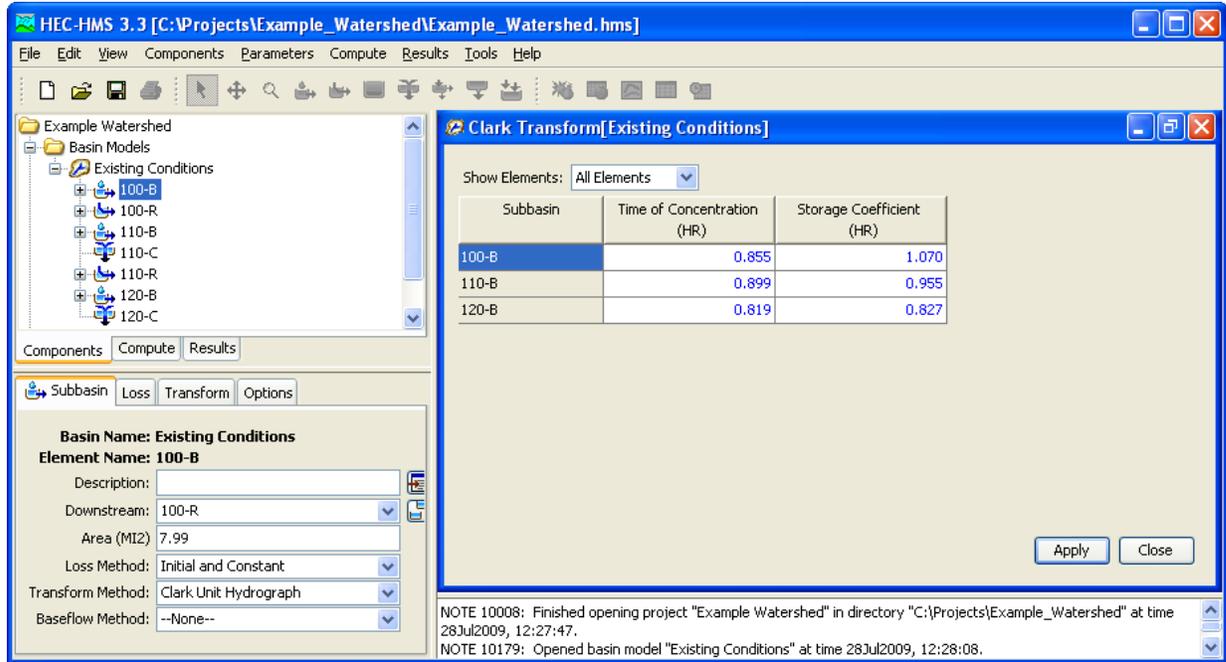
$$R = 1.165 * 0.899 * \left(1.32^{0.45} - 0.52^{1.4} \left(\frac{22.6}{100} \right)^{0.40} \right) = 0.955 \text{ hrs}$$

Using Equation F-13, R for subbasin 120-B is:

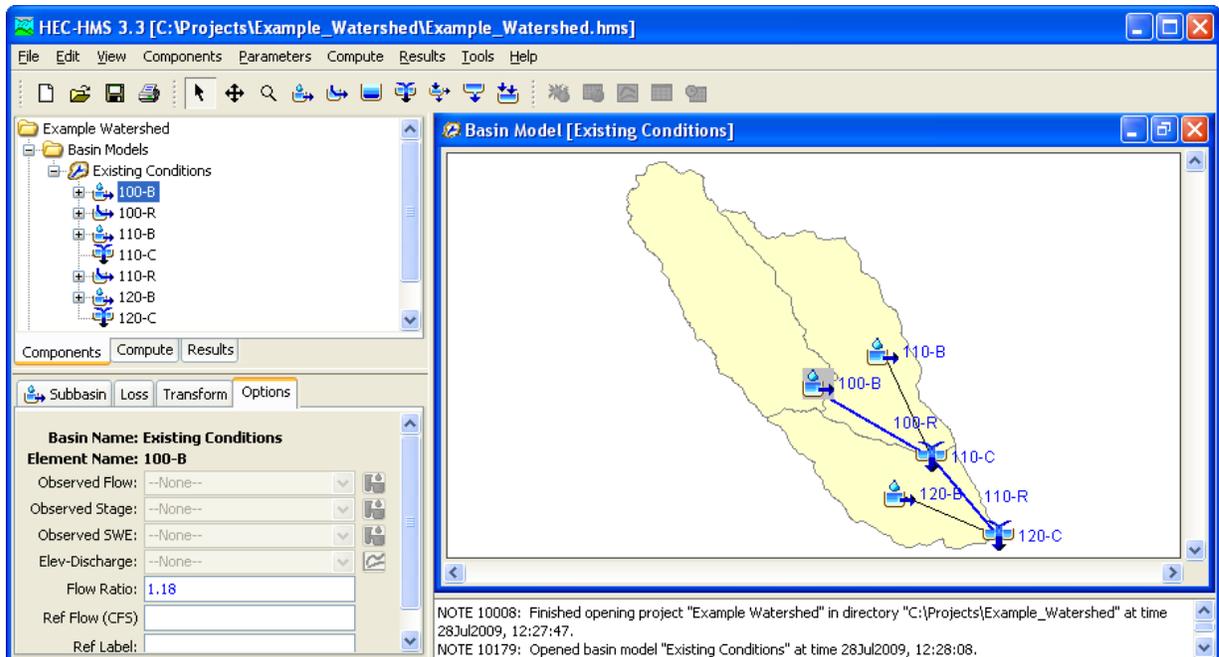
$$R = 1.165 * 0.819 * \left(1.20^{0.45} - 0.48^{1.4} \left(\frac{29.3}{100} \right)^{0.40} \right) = 0.827 \text{ hrs}$$

3. Assign sediment bulking factors for each subbasin based on the guidance in Section F.6. Since the majority of all three subbasins are undeveloped, but platted lands, use a sediment bulking factor of 18% for all subbasins.

4. Code the Clark unit hydrograph parameters in HEC-HMS: from the *Parameters* pull down menu
 - a. Select *Transform* and then Clark Unit Hydrograph
 - b. Select “All Elements”
 - c. Code in the rainfall loss parameters for each subbasin



5. Code in the sediment bulking ratio: on the *Options* tab in the *Component Editor* for each subbasin, code in 1.18 as the flow ratio



F.8.6 Channel Routing Parameters

Develop the Muskingum-Cunge channel routing data and code that data into the HEC-HMS project for the watershed, execute the model and summarize the results. Routing reaches for the watershed are illustrated in Figure F-10. The physical data for routing reach is listed in the Table F-11. Cross sections typical of the geometry for each reach are shown in Figures F-11 and F-12 for Routing Reach 100-R and 110-R, respectively.

FIGURE F-10. EXAMPLE WATESHED ROUTING REACHES

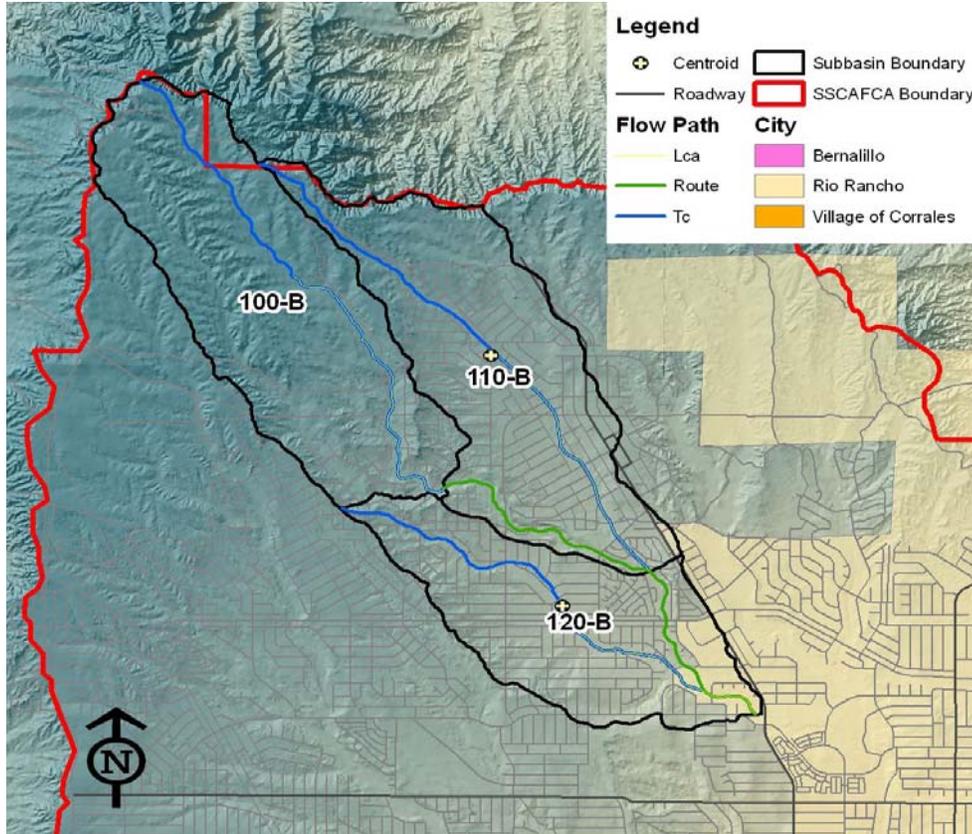


TABLE F-11 EXAMPLE WATERSHED CHANNEL ROUTING DATA

Reach ID	Reach from Subbasin	Length feet	Slope ft/ft
100-R	100-B	11,263	0.0165
110-R	120-B	9,685	0.0158

FIGURE F-11. REACH 100-R CROSS SECTIONAL GEOMETRY

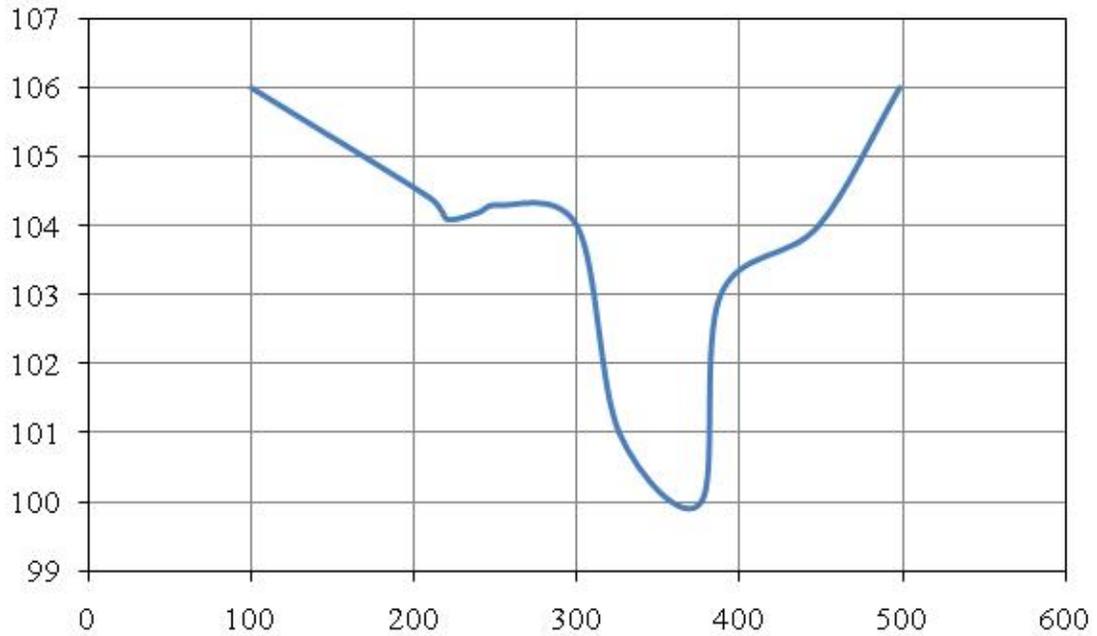
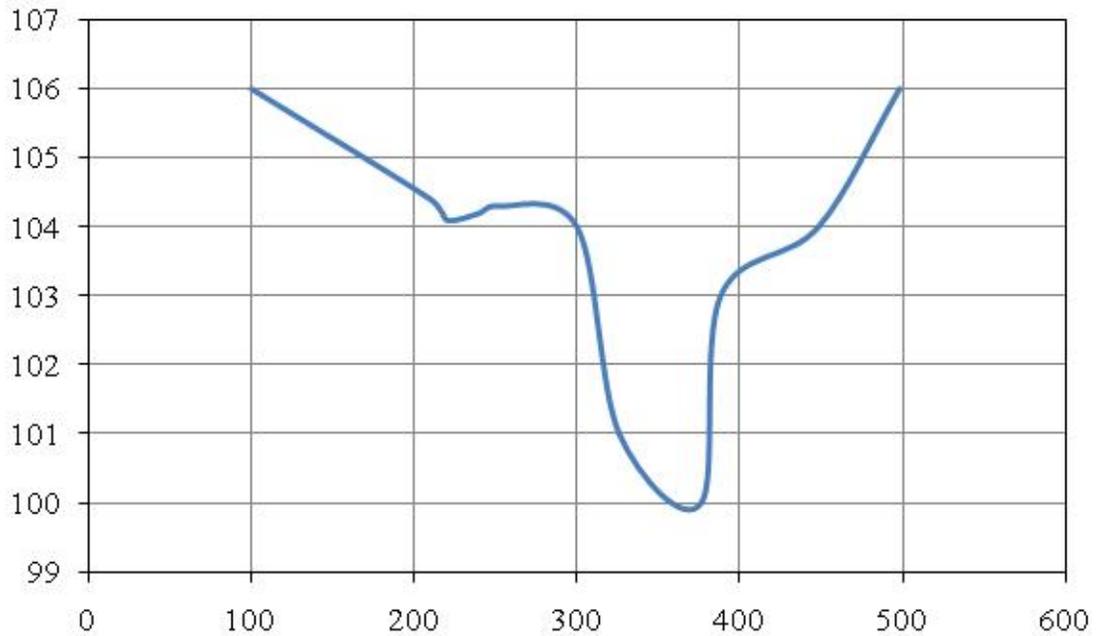
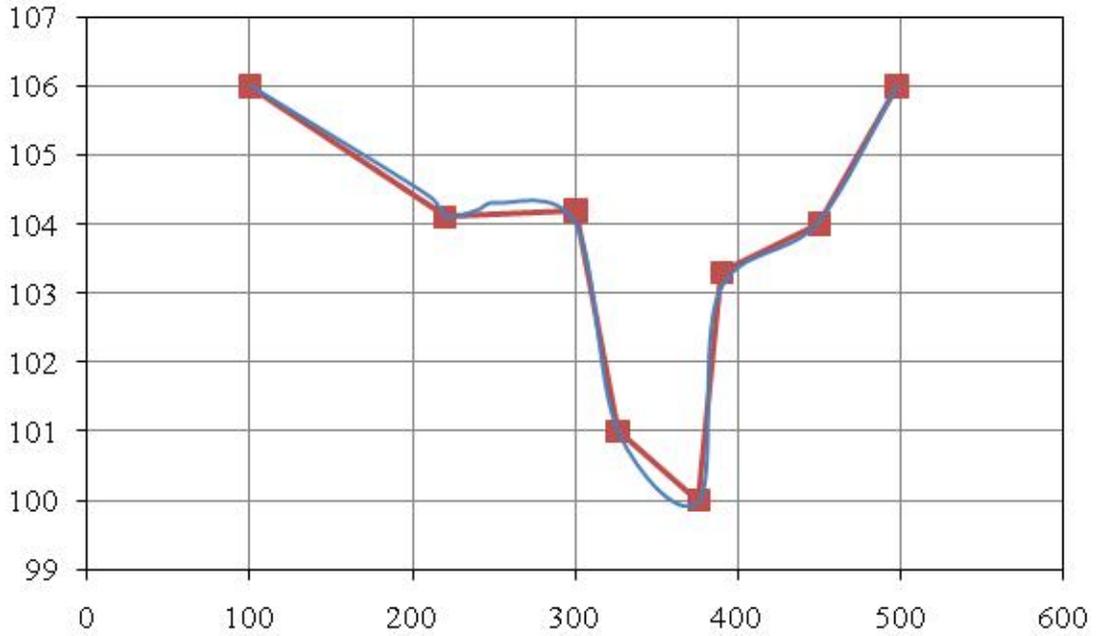


FIGURE F-12. REACH 110-R CROSS SECTIONAL GEOMETRY

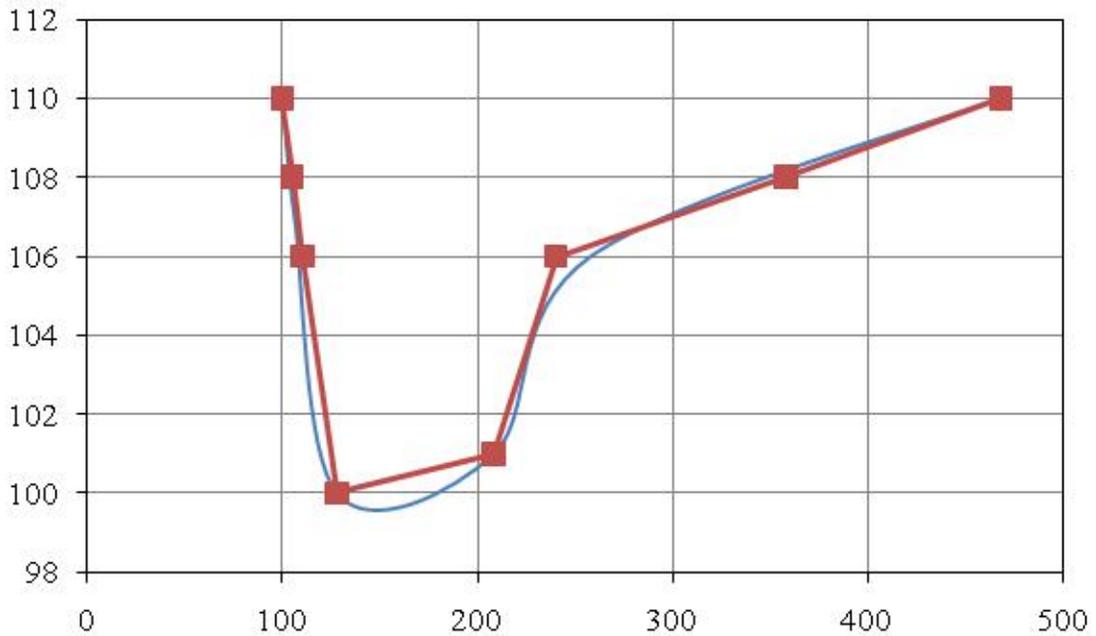


1. Simplify the channel geometry for each reach into an 8-point irregular section.

8-Point Geometry for Reach 100-R



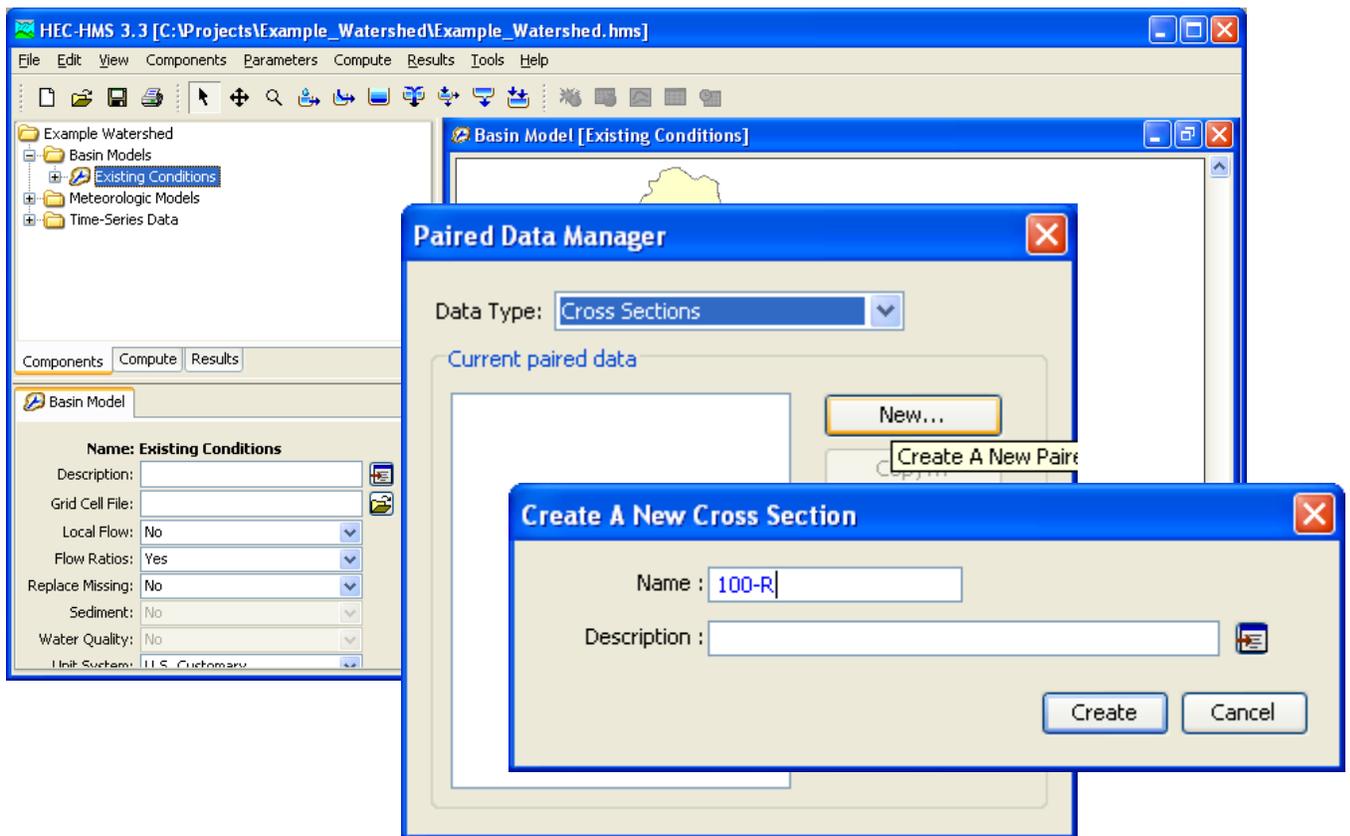
8-Point Geometry for Reach 110-R



2. From Table F-7, select the appropriate Manning's n-value(s) for each reach.

Both routing reaches are natural, sand bed arroyos. From Table F-7 use a Manning's n-value of 0.05 for the entire section.

3. Code the routing data into HEC-HMS
 - a. From the *Components* pull down menu, select *Paired Data Manager*
 - b. Select "Cross Sections" as the *Data Type*
 - c. Select *New* and enter a name for the first cross section (e.g. 100-R)
 - d. Repeat Step 3.c for the second cross section



- On the Table tab in the Component Editor of the Cross Section data, code in the 8-point geometry for each cross section using Figures F-11 and F-12

HEC-HMS 3.3 [C:\Projects\Example_Watershed\Example_Watershed.hms]

File Edit View Components Parameters Compute Results Tools Help

Example Watershed

- Basin Models
 - Existing Conditions
- Meteorologic Models
- Time-Series Data
- Paired Data
 - Cross Sections
 - 100-R
 - 110-R

Components Compute Results

Paired Data Table Graph

Station (FT)	Elevation (FT)
100	106
220	104.1
300	104.2
330	101.0
380	100.0
390	103.3
450	104.0
500	106.0

Basin Model [Existing Conditions]

NOTE 10008: Finished opening project "Example Watershed" in directory "C:\Projects\Example_Watershed" at time 28Jul2009, 12:27:47.
NOTE 10179: Opened basin model "Existing Conditions" at time 28Jul2009, 12:28:08.

HEC-HMS 3.3 [C:\Projects\Example_Watershed\Example_Watershed.hms]

File Edit View Components Parameters Compute Results Tools Help

Example Watershed

- Basin Models
 - Existing Conditions
- Meteorologic Models
- Time-Series Data
- Paired Data
 - Cross Sections
 - 100-R
 - 110-R

Components Compute Results

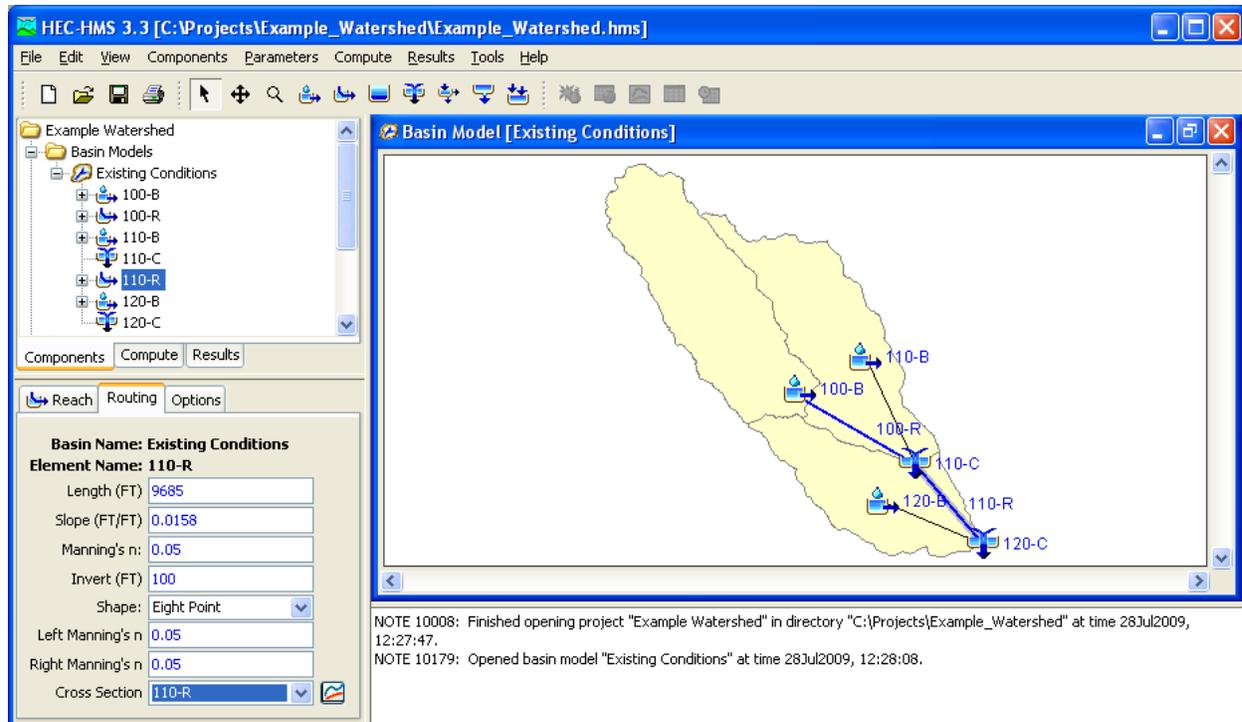
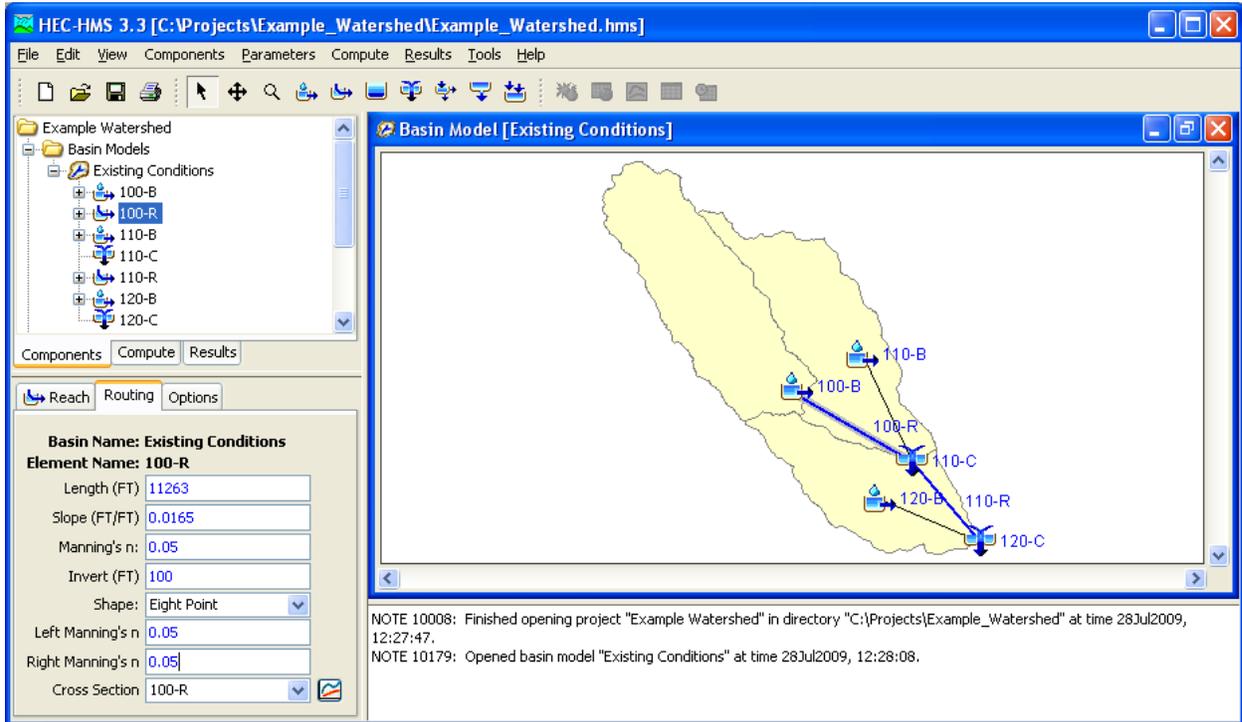
Paired Data Table Graph

Station (FT)	Elevation (FT)
100.0	110.0
110.0	108.0
120.0	106.0
130.0	100.0
210.0	100.5
240.0	106.0
360.0	108.0
470.0	110.0

Basin Model [Existing Conditions]

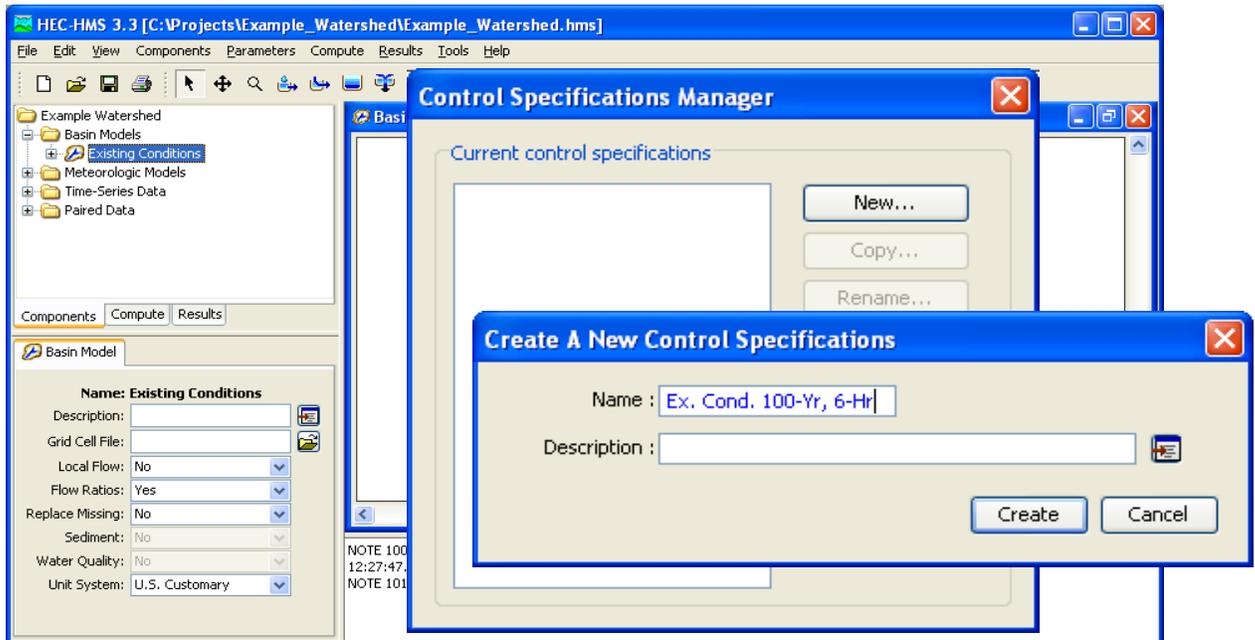
NOTE 10008: Finished opening project "Example Watershed" in directory "C:\Projects\Example_Watershed" at time 28Jul2009, 12:27:47.
NOTE 10179: Opened basin model "Existing Conditions" at time 28Jul2009, 12:28:08.

- On the Routing tab of the Component Editor for each routing reach, code in the physical routing parameters

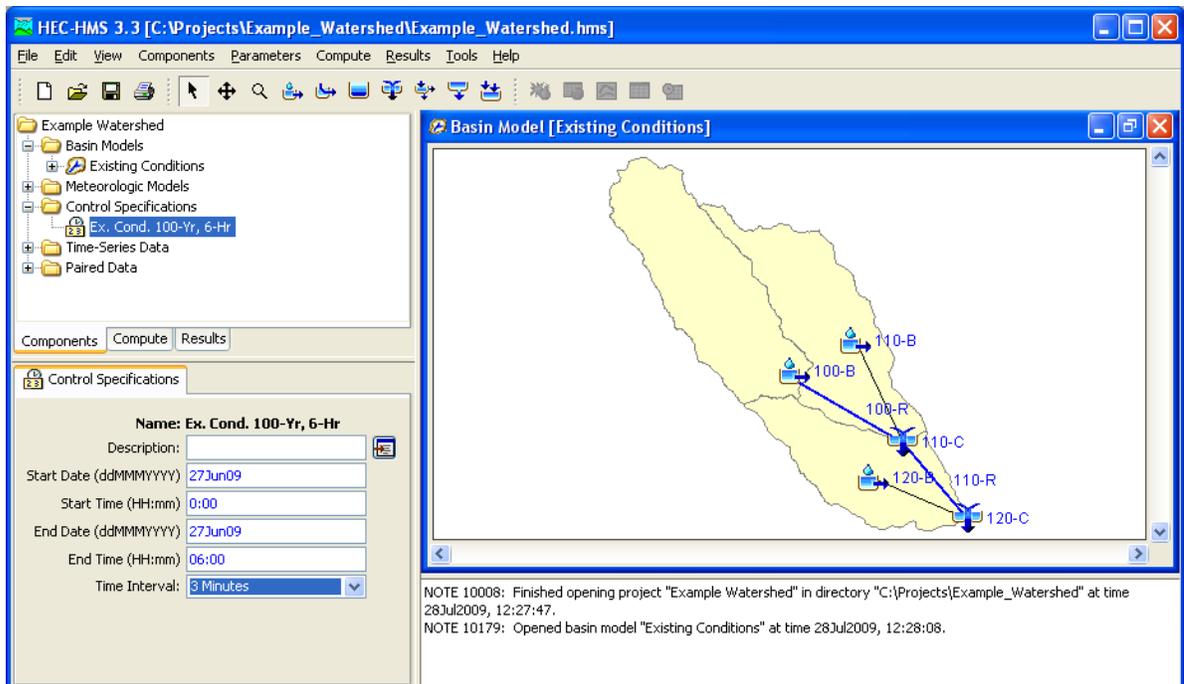


F.8.7 Model Execution

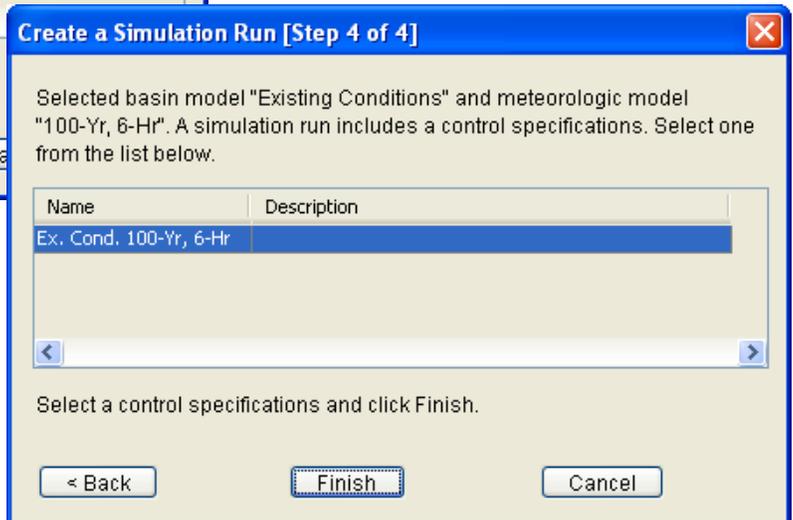
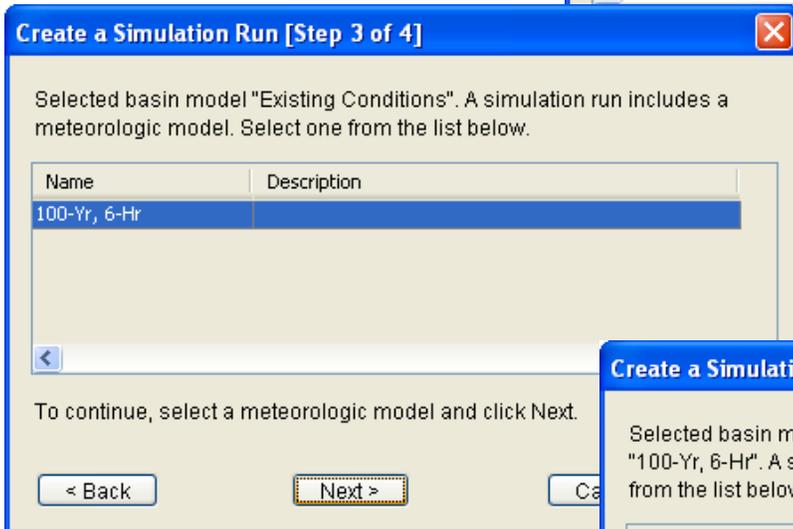
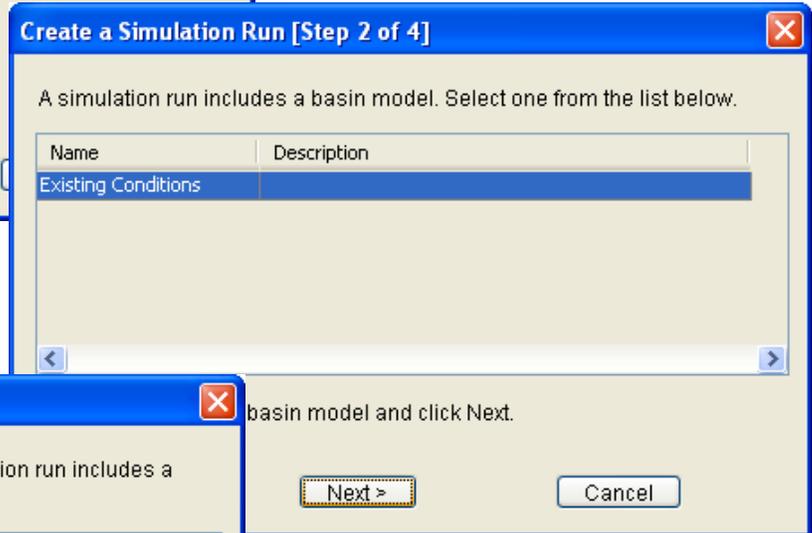
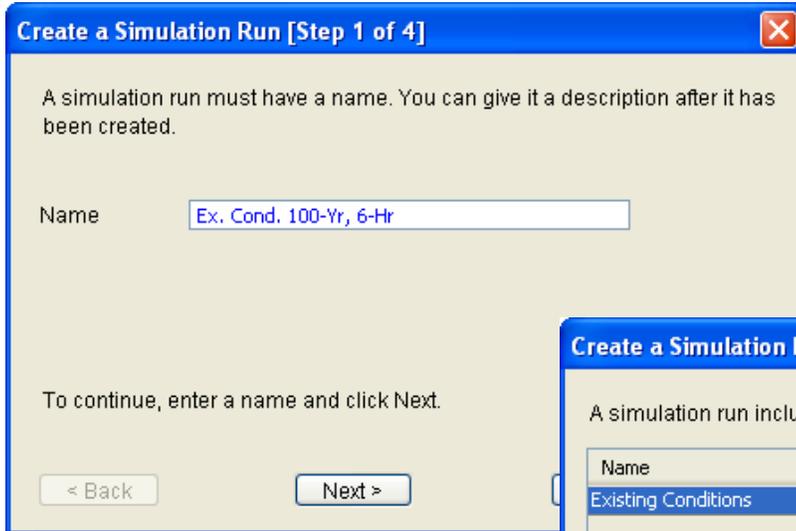
1. Create the Control Mata for model execution: From the *Components* pull down menu, select *Control Specifications Manager*
 - a. Select *New*
 - b. Enter a name for the control model (e.g. Ex. Cond. 100-Yr, 6-Hr)



2. In the Component Editor for the Control Specifications input the model simulation time and the computational interval



3. From the *Compute* pull down menu, select *Create Simulation Run*
 - a. Input a run name (e.g. Ex. Cond. 100-Yr, 6-Hr)
 - b. Select the Basin Model, Meteorologic Model and Component Model



- From the Compute pull down menu, select Compute Run and view the global summary results

The screenshot shows the HEC-HMS 3.3 software interface. The main window displays the 'Global Summary Results for Run "Ex. Cond. 100-Yr, 6-Hr"'. The results window includes the following information:

- Project: Example Watershed
- Simulation Run: Ex. Cond. 100-Yr, 6-Hr
- Start of Run: 27Jun2009, 00:00
- End of Run: 27Jun2009, 06:00
- Compute Time: 28Jul2009, 14:34:04
- Basin Model: Existing Conditions
- Meteorologic Model: 100-Yr, 6-Hr
- Control Specifications: Ex. Cond. 100-Yr, 6-Hr

Volume Units: IN AC-FT

Hydrologic Element	Drainage Area (MI ²)	Peak Discharge (CFS)	Time of Peak	Volume (IN)
100-B	7.99	2058	27Jun2009, 02:09	0.6
100-R	7.99	2040	27Jun2009, 02:36	0.6
110-B	6.20	2225	27Jun2009, 02:12	0.9
110-C	14.19	3894	27Jun2009, 02:27	0.8
110-R	14.19	3887	27Jun2009, 02:39	0.8
120-B	6.31	2861	27Jun2009, 02:09	1.1
120-C	20.50	6013	27Jun2009, 02:27	0.9

Subbasins

Name: 100-Yr, 6-Hr

Subbasin Name	Gage
100-B	Gage 1
110-B	Gage 1
120-B	Gage 1

NOTE 20364: Found no parameter problems in meteorologic model "100-Yr, 6-Hr".
 NOTE 40049: Found no parameter problems in basin model "Existing Conditions".
 NOTE 41054: Routing parameters for reach "100-R": Delta t (sec) 96.4 Delta x (ft) 866.3846
 NOTE 41054: Routing parameters for reach "110-R": Delta t (sec) 97.7 Delta x (ft) 1,076.1111
 NOTE 10185: Finished computing simulation run "Ex. Cond. 100-Yr, 6-Hr" at time 28Jul2009, 14:34:04.

G. PROCEDURE FOR PROBABLE MAXIMUM FLOOD

Computation of the Probable Maximum Flood (PMF), or one-half Probable Maximum Flood ($\frac{1}{2}$ PMF), is typically required for design of dam spillways in high hazard areas. For flood control dams, the PMF is typically used for design of the emergency spillway. The Office of the State Engineer (OSE) should be contacted regarding specific requirements on the use of the PMF.

G.1 JURISDICTION OF THE OFFICE OF THE STATE ENGINEER (OSE) (FACILITIES THAT COME UNDER THE OSE MUST BE COORDINATED WITH THAT JURISDICTION)

The OSE has jurisdiction over the design and construction of non-federal dams. His authority for the safety of dams is contained primarily within Chapter 72, NMSA 1978. All dams must conform to the OSE criteria as demonstrated by correspondence issued by the OSE and provided to the City Engineer/SSCAFCA Before proceeding to design any project requiring a permit for a dam, the Office of the State Engineer should be contacted to obtain guidance on applicable regulations and design criteria. City/SSCAFCA review must occur before submittal to OSE to obtain concurrence on determination of PMP. This includes dams intended for sediment, erosion and flood control

Copies of the Manual of Rules and Regulations Governing the Appropriation and Use of the Surface Waters of the State of New Mexico and the Summary of New Mexico State Engineer Office Procedure on Design Criteria and Safety of Dams are available from the OSE, Santa Fe, New Mexico. Included in the summary is information on the classification of dams, hydrologic evaluation guidelines, probable maximum precipitation (PMP) criteria, and the "Engineering Review Project Check List". Special engineering requirements are required for project design and construction supervision.

The procedures for determination of the PMF must be consistent with the OSE's rules, regulations, procedures and design criteria. The OSE shall make the final determination on the design criteria, safety requirements, alternate specifications/procedures and/or additional requirements.

H. USE OF ALTERNATE PROCEDURES

Hydrology methods other than those specified in Parts A through D may be appropriate for local conditions and may be acceptable to SSCFCA and other reviewing agencies. The use of alternate procedures should be reviewed with the City/SSCAFCA early in the project to establish that such alternate procedures are acceptable and to establish specific parameters.

In general, computer programs which are in the public domain, have available users manuals and established use in the engineering community will most likely be accepted as an alternative. Areas which require special analysis because of unusual terrain conditions, special sediment considerations, unique hydraulic conditions, or extraordinary soil conditions are candidates for alternate procedures. Use of special procedures will be considered when experimental testing and analysis of measured precipitation and runoff conditions indicates that the special procedures will provide more accurate results. The use of proprietary computer programs and programs available only to a small segment of the engineering community will require additional documentation to establish that they are an acceptable alternative. Documentation should include users manuals, discussion of the engineering principals and formulas utilized, and calibration to establish that the methodology is applicable to the local area. The use of an alternate computer program solely on the basis that it gives lower or higher numbers will not be acceptable.

H.1 PROGRAMS FOR ALTERNATE PROCEDURE ACCEPTANCE

Some computer programs which have had previous use in the community and will be considered for alternate procedure acceptance include:

- 1) **SWMM** - Stormwater Management Model, Version 5 by the U.S. Environmental Protection Agency. This is an extremely complex model with an extensive range of capabilities. The program was developed for urban areas with storm sewer systems. Of special interest is the capability to model stormwater quality in addition to water quantity. The EXTRAN module of the SWMM model has been used locally to model flow in irrigation canals and drains because its dynamic flow routing capability can compute backwater profiles in open channels and closed conduits under unsteady flow conditions. Hydrograph input for the EXTRAN application can use hydrographs generated by the HYMO computer program. Specific parameters to calibrate SWMM parameters for local conditions have not been established.
- 2) **TR-20**- Computer Program Project Formulation, Hydrology by the U.S.D.A. Soil Conservation Service. This SCS computer program is widely used throughout the U.S. It is available through independent licensed software vendors and from the National Technical Information Service. The program was initially developed for rural areas with relatively large sub-basins. The "TYPE-II" (24-hour) rainfall distribution commonly used with TR-20 is not applicable for the Albuquerque area. In New Mexico, a TYPE II-a (24-hour) distribution should be used with TR-20. The "a" used in the TYPE II-a distribution refers to the percentage of the one-hour precipitation (P_{60}) to the 24-hour precipitation

(P1440) or, $a = 100 * P60 / P1440$. The value of "a" is rounded to the nearest five percent (i.e.: 60, 65, 70 and 75). Tables of TYPE II-60, II-65, II-70, and II-75 distributions, with a 0.25 hour incremental time, are available from the SCS. SCS CNs should be consistent with TR-55, Chapter II.2 procedures; but should not be less than the values in TABLE E-1, or as computed by equation e-7.

- 3) **TR-48 - Computer Program for Project Formulation - Structure Site Analysis** by the U.S.D.A. Soil Conservation Service. This program has particular application to the analysis and design of dams and therefore may have special application to this area. The program normally uses the sites' storage-discharge capacities to floodroute inflow hydrographs through a potential reservoir. Inflow hydrographs may be input from other models or developed from a storm rainfall distribution. The program will compute runoff by the standard SCS CN procedure or by the initial abstraction-average infiltration method. The program also has limited routing capability for analysis of multiple structures and channels.

H.2 BIBLIOGRAPHY

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PART G - HYMO INPUT AND OUTPUT

G.1 HYMO INPUT FILE

```
*S FILE:TESTDPM.DAT
START          TIME=0.0      NPU=0          PRINT LINE=0
*S*****COMPUTE HYDROGRAPHS FOR SECTION 2.2.2, HYDROLOGY, DPM

*****
*S EXAMPLE C-2  **
*****

****PERVIOUS PORTION ****

* TREATMENT A, B, C - 100 YEAR STORM
COMPUTE HYD      ID=1  HYD NO=101.1 DT=.033333 HRS  DA=1.2500  SQ MI
                IA=-0.515  INF=1.292      K= -0.263600      TP=-0.292000  RAIN=
.0000      .0017      .0035      .0053      .0071      .0090      .0109
.0128      .0148      .0169      .0190      .0212      .0234      .0257
.0280      .0304      .0329      .0355      .0381      .0409      .0437
.0467      .0497      .0529      .0563      .0597      .0633      .0672
.0712      .0754      .0798      .0850      .0906      .0965      .1093
.1379      .1819      .2450      .3311      .4444      .5887      .7685
.9878      1.1907      1.2756      1.3473      1.4111      1.4691      1.5226
1.5722      1.6185      1.6620      1.7029      1.7414      1.7779      1.8124
1.8450      1.8760      1.9054      1.9333      1.9598      1.9660      1.9719
1.9774      1.9827      1.9877      1.9926      1.9972      2.0017      2.0060
2.0102      2.0143      2.0182      2.0220      2.0257      2.0292      2.0327
2.0361      2.0395      2.0427      2.0459      2.0490      2.0520      2.0550
2.0579      2.0607      2.0635      2.0663      2.0690      2.0716      2.0742
2.0767      2.0793      2.0817      2.0842      2.0865      2.0889      2.0912
2.0935      2.0958      2.0980      2.1002      2.1023      2.1045      2.1066
2.1087      2.1107      2.1127      2.1147      2.1167      2.1187      2.1206
2.1225      2.1244      2.1263      2.1281      2.1299      2.1317      2.1335
2.1353      2.1371      2.1388      2.1405      2.1422      2.1439      2.1456
2.1472      2.1489      2.1505      2.1521      2.1537      2.1553      2.1568
2.1584      2.1599      2.1615      2.1630      2.1645      2.1660      2.1675
2.1689      2.1704      2.1718      2.1733      2.1747      2.1761      2.1775
2.1789      2.1803      2.1816      2.1830      2.1844      2.1857      2.1870
2.1884      2.1897      2.1910      2.1923      2.1936      2.1948      2.1961
2.1974      2.1986      2.1999      2.2011      2.2024      2.2036      2.2048
2.2060      2.2072      2.2084      2.2096      2.2108      2.2120      2.2131
2.2143      2.2154      2.2166      2.2177      2.2189      2.2200
PRINT HYD      ID=1      CODE=1
**** IMPERVIOUS PORTION **** TREATMENT D
COMPUTE HYD      ID=2      HYD NO=101.2      DT=.033333 HRS DA=0.5000 SQ MI
                IA=-0.10  INF=0.04  K=-0.168200 TP= -0.292000      RAIN=-1
PRINT HYD      ID=2      CODE=1
**** COMBINED HYDROGRAPH ****
ADD HYD      ID=2      HYD NO=101.3 ID=1 ID=2
PRINT HYD      ID=2      CODE=1

*****
*S EXAMPLE C-3  **
*****
```

*** PERVIOUS PORTION ***** TREATMENT A, B & C

COMPUTE HYD ID=1 HYD NO=101.1 DT=.033333 HRS DA=0.1250 SQ MI
IA=0.515 INF=-1.292 K=-0.156500 TP=-0.162000 RAIN=-1

PRINT HYD ID=1 CODE=1

*** IMPERVIOUS PORTION ***** TREATMENT D

COMPUTE HYD ID=2 HYD NO=101.2 DT=.033333 HRS DA=0.0500 SQ MI
IA=-0.10 INF=0.04 K=-0.090600 TP=-0.162000 RAIN=-1

PRINT HYD ID=2 CODE=1

***** COMBINED HYDROGRAPH *****

ADD HYD ID=2 HYD NO=101.3 ID=1 ID=2

PRINT HYD ID=2 CODE=1

*S EXAMPLE C 4 **

RAINFALL TYPE=1 RAIN QUARTER=0.0 RAIN ONE=1.88
RAIN SIX=2.22 RAIN DAY=2.68 DT=.033333

COMPUTE NM HYD ID= 2 HYD NO= 101.3 DA=0.175 SQ MI
PER A=21.43 PER B=35.71 PER C=14.29 PER D=28.57
TP= -0.162 MASSRAIN=-1

PRINT HYD ID=2 CODE=1

*S EXAMPLE D-3 **

***** PERVIOUS PORTION ***** TREATMENT A, B & C

COMPUTE HYD	ID=1	HYD NO=101.1	DT=.033333	HRS	DA=1.2500	SQ MI	
	IA=-0.515	INF=-1.292	K=-0.173400	TP=-0.292000	RAIN=		
.0000	.0070	.0142	.0217	.0294	.0375	.0459	
.0547	.0638	.0733	.0832	.0936	.1044	.1156	
.1272	.1394	.1520	.1650	.1786	.1927	.2072	
.2223	.2379	.2540	.2707	.2879	.3056	.3239	
.3428	.3622	.3822	.4028	.4240	.4457	.4681	
.4911	.5146	.5388	.5636	.5890	.6150	.6417	
.6690	.6969	.7255	.7548	.7847	.8152	.8464	
.8783	.9109	.9441	.9780	1.0126	1.0479	1.0838	
1.1205	1.1578	1.1959	1.2347	1.2741	1.7377	2.6322	
3.9411	5.4901	7.0155	8.1916	8.6459	9.0766	9.4890	
9.8382	10.1365	10.3938	10.6181	10.8157	10.9918	11.1507	
11.2957	11.4294	11.5541	11.6715	11.7830	11.8898	11.9928	
12.0928	12.1902	12.2857	12.3795	12.4721	12.5636	12.6542	
12.8014	12.9384	13.0662	13.1855	13.2969	13.4009	13.4983	
13.5894	13.6748	13.7549	13.8301	13.9008	13.9673	14.0300	
14.0892	14.1451	14.1979	14.2480	14.2954	14.3405	14.3834	
14.4243	14.4633	14.5006	14.5363	14.5705	14.6033	14.6349	
14.6654	14.6948	14.7231	14.7506	14.7773	14.8031	14.8283	
14.8527	14.8766	14.8999	14.9227	14.9450	14.9669	14.9883	
15.0094	15.0301	15.0505	15.0706	15.0905	15.1101	15.1294	
15.1485	15.1675	15.1862	15.2048	15.2232	15.2415	15.2596	
15.2777	15.2956	15.3134	15.3311	15.3487	15.3662	15.3837	
15.4011	15.4184	15.4356	15.4528	15.4700	15.4871	15.5042	
15.5212	15.5382	15.5551	15.5720	15.5889	15.6058	15.6226	

```

15.6395 15.6562 15.6730 15.6898 15.7065 15.7232 15.7400
15.7567 15.7733 15.7900 15.8067 15.8233 15.8400
PRINT HYD ID=1 CODE=1
***** IMPERVIOUS PORTION***** TREATMENT D
COMPUTE HYD ID=2 HYD NO.=101.2 DT=.033333 HRS DA=0.5000 SQ MI
IA=-0.10 INF=0.04 K=-0.159700 TP=-0.292000 RAIN=-1
PRINT HYD ID=2 CODE=1
***** COMBINED HYDROGRAPH*****
ADD HYD ID=2 HYD NO.=101.3 ID=1 ID=2
PRINT HYD ID=2 CODE=1

```

```

*****
* S EXAMPLE D-4 **
*****

```

```

RAINFALL TYPE=3 RAIN QUARTER=7.58 RAIN ONE=11.38
RAIN SIX=15.84 RAIN DAY=0.0 DT=.033333
COMPUTE NM HYD ID=2 HYD NO= 101.3 DA=1.750 SQ MI
PER A=240 PER B=400 PER C=160 PER D=320 TP=-0.292
MASSRAIN=1
PRINT HYD ID=2 CODE=1
FINISH

```

```

G.2 HYMO OUTPUT FILE
AHYMO PROGRAM (AHYM0392) AMAFCA VERSION OF HYMO - MARCH, 1992
RUN DATE (MON/DAY/YR) = 01/18/1993
START TIME (HR:MIN:SEC) = 18:32:27 USER NO. - AMAFCA01.491
INPUT FILE = TESTDPM.DAT

```

```

*TEST OF THE DPM EXAMPLES - JANUARY 1993
*S FILE:TESTDPM.DAT
START TIME=0.0 NPU=0 PRINT LINE=0
*S*****COMPUTE HYDROGRAPHS FOR SECTION 22.2, HYDROLOGY, DPM

```

```

*****
*S EXAMPLE C-2 **
*****

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```

***** PERVIOUS PORTION *****

```

```

* TREATMENT A, B & C - 100 YEAR STORM
COMPUTE HYD ID=1 HYD NO=101.1 DT=.033333 HR DA=1.2500 SQ MI
IA=-0.515 INF=-1.292 K=-0.263600 TOP=-0.292000RAIN=
.0000 .0017 .0035 .0053 .0071 .0090 .0109
.0128 .0148 .0169 .0190 .0212 .0234 .0257
.0280 .0304 .0329 .0355 .0381 .0409 .0437
.0467 .0497 .0529 .0563 .0597 .0633 .0672
.0712 .0754 .0798 .0850 .0906 .0965 .1093
.1379 .1819 .2450 .3311 .4444 .5887 .7685
.9878 1.1907 1.2756 1.3473 1.4111 1.4691 1.5226
1.5722 1.6185 1.6620 1.7029 1.7414 1.7779 1.8124
1.8450 1.8760 1.9054 1.9333 1.9598 1.9660 1.9719
1.9774 1.9827 1.9877 1.9926 1.9972 2.0017 2.0060
2.0102 2.0143 2.0182 2.0220 2.0257 2.0292 2.0327
2.0361 2.0395 2.0427 2.0459 2.0490 2.0520 2.0550
2.0579 2.0607 2.0635 2.0663 2.0690 2.0716 2.0742
2.0767 2.0793 2.0817 2.0842 2.0865 2.0889 2.0912
2.0935 2.0958 2.0980 2.1002 2.1023 2.1045 2.1066
2.1087 2.1107 2.1127 2.1147 2.1167 2.1187 2.1206

```

2.1225 2.1244 2.1263 2.1281 2.1299 2.1317 2.1335
 2.1353 2.1371 2.1388 2.1405 2.1422 2.1439 2.1456
 2.1472 2.1489 2.1505 2.1521 2.1537 2.1553 2.1568
 2.1584 2.1599 2.1615 2.1630 2.1645 2.1660 2.1675
 2.1689 2.1704 2.1718 2.1733 2.1747 2.1761 2.1775
 2.1789 2.1803 2.1816 2.1830 2.1844 2.1857 2.1870
 2.1884 2.1897 2.1910 2.1923 2.1936 2.1948 2.1961
 2.1974 2.1986 2.1999 2.2011 2.2024 2.2036 2.2048
 2.2060 2.2072 2.2084 2.2096 2.2108 2.2120 2.2131
 2.2143 2.2154 2.2166 2.2177 2.2189 2.2200

K = .263600HR TP = 29200H SHAPE CONSTANT, N = 3.92515
 UNIT PEAK = 1498.9 CFS UNIT VOLUME = 1.000 B = 350.15

RUNOFF COMPUTED BY INITIAL ABSTRACTION - INFILTRATION METHOD - DT = .033333
 PRINT HYD ID=1 CODE=1

PARTIAL HYDROGRAPH 101.10

RUNOFF VOLUME = .65128 INCHES = 43.4181 ACRE-FEET
 PEAK DISCHARGE RATE = 905.66 CFS AT 1.700 HOURS BASIN AREA = 1.2500 SQ. MI

****IMPERVIOUS PORTION **** TREATMENT D

COMPUTE HYD ID=2 HYD NO=101.2 DT=.033333 HRS DA=0.5000 SQ MI
 IA=-0.10 INF=0.04 K=-0.168200 TP=-0.292000 RAIN=-1
 K = .168200HR TP = .292000HR SHAPE CONSTANT, N = 6.62354
 UNIT PEAK = 861.53 CFS UNIT VOLUME = 1.000 B = 503.13

RUNOFF COMPUTED BY INITIAL ABSTRACTION - INFILTRATION METHOD - DT =
 .033333

PRINT HYD ID=2 CODE=1

PARTIAL HYDROGRHAPH 101.20

RUNOFF VOLUME = 1.98503 INCHES = 52.9338 ACRE-FEET
 PEAK DISCHARGE RATE = 923.75 CFS AT 1.667 HOURS BASIN AREA = .5000 SQ. MI.

*****COMBINED HYDROGRAPH*****

ADD HYD ID=2 HYD NO=101.3 IN=1 ID=2
 PRINT HYD ID=2 CODE=1

PARTIAL HYDROGRAPH 101.30

RUNOFF VOLUME = 1.03235 INCHES = 96.3518 ACRE-FEET
 PEAK DISCHARGE RATE = 1827.79 CFS AT 1.667 HOURS BASIN AREA = 1.7500 SQ.

 *S EXAMPLE C-3 **

**** PERVIOUS PORTION **** TREATMENT A, B & C

COMPUTE HYD ID=1 HYD NO=101.1 DT=.033333 HRS DA=0.1250 SQ.MI
 IA =-0.515 INF=-1.292 K=-0.156500 TP=-0.162000 RAIN=-1
 K = .156500 HR TP = .162000HR SHAPE CONSTANT, N = 3.65682
 UNIT PEAK = 255.86 CFS UNIT VOLUME = 1.000 B = 331.60
 RUNOFF COMPUTED BY INITIAL ABSTRACTION - INFILTRATION METHOD - DT = .033333

PRINT HYD ID=1 CODE=1

PARTIAL HYDROGRAPH 101.10

RUNOFF VOLUME = .65128 INCHES = 4.3418 ACRE-FEET
 PEAK DISCHARGE RATE = 139.88 CFS AT 1.533 HOURS BASIN AREA = .1250 SQ. MI.

*****IMPERVIOUS PORTION*****TREATMENT D

COMPUTE HYD ID=2 HYD NO=101.2 DT=.033333 HRS DA=0.0500 SQ. MI.
 IA=-0.10 INF=0.04 K=-0.090600 TP=-0.162000 RAIN=-1
 K = .090600 HR TP = .162000HR SHAPE CONSTANT, N = 6.87595
 UNIT PEAK = 159.06 CFS UNIT VOLUME = .9999 B = 515.35
 RUNOFF COMPUTED BY INITIAL ABSTRACTION - INFILTRATION METHOD - DT = .033333

PRINT HYD ID=2 CODE=1
 PARTIAL HYDROGRAPH 101.20

RUNOFF VOLUME = 1.98503 INCHES = 5.2934 ACRE-FEET
 PEAK DISCHARGE RATE = 127.85 CFS AT 1.533 HOURS BASIN AREA = .0500 SQ. MI.

*****COMBINED HYDROGRAPH*****

ADD HYD ID=2 HYD NO=1-1.3 ID=1 ID=2
 PRINT HYD ID=2 CODE=1

PARTIAL HYDROGRAPH 101.30

RUNOFF VOLUME = 1.03235 INCHES = 9.6352 ACRE-FEET
 PEAK DISCHARGE RATE = 267.72 CFS AT 1.533 HOURS BASIN AREA = .1750 SQ. MI.

 *S EXAMPLE C-4 **

RAINFALL TYPE=1 RAIN QUARTER=0.0 RAIN ONE-1.88
 RAIN SIX=2.22 RAIN DAY=2.68 DT=.033333
 COMPUTED 6-HOUR RAINFALL DISTRIBUTION BASED ON NOAA ATLAS 2 - PEAK AT 1.40 HR.
 DT= .033333 HOURS END TIME = 5.999940 HOURS

.0000	.0017	.0035	.0053	.0071	.0090	.0109
.0128	.0148	.0169	.0190	.0212	.0234	.0257
.0280	.0304	.0329	.0355	.0381	.0409	.0437
.0467	.0497	.0529	.0563	.0597	.0633	.0672
.0712	.0754	.0798	.0850	.0906	.0965	.1093
.1379	.1819	.2450	.3311	.4444	.5887	.7685
.9878	1.1907	1.2756	1.3473	1.4111	1.4691	1.5226
1.5722	1.6185	1.6620	1.7029	1.7414	1.7779	1.8124
1.8450	1.8760	1.9054	1.9333	1.9598	1.9660	1.9719
1.9774	1.9822	1.9877	1.9926	1.9972	2.0017	2.0060
2.0102	2.0143	2.0182	2.0220	2.0257	2.0292	2.0327
2.0361	2.0395	2.0427	2.0459	2.0490	2.0520	2.0550
2.0579	2.0607	2.0635	2.0663	2.0690	2.0716	2.0742
2.0767	2.0793	2.0817	2.0842	2.0865	2.0889	2.0912
2.0935	2.0958	2.0980	2.1002	2.1023	2.1045	2.1066
2.1087	2.1107	2.1127	2.1147	2.1167	2.1187	2.1206
2.1225	2.1244	2.1263	2.1281	2.1299	2.1317	2.1335
2.1353	2.1371	2.1388	2.1405	2.1422	2.1439	2.1456
2.1472	2.1489	2.1505	2.1521	2.1537	2.1553	2.1568
2.1584	2.1599	2.1615	2.1630	2.1645	2.1660	2.1675
2.1689	2.1704	2.1718	2.1733	2.1747	2.1761	2.1775
2.1789	2.1803	2.1816	2.1830	2.1844	2.1857	2.1870

2.1884	2.1897	2.1910	2.1923	2.1936	2.1948	2.1961
2.1974	2.1986	2.1999	2.2011	2.2024	2.2036	2.2048
2.2060	2.2072	2.2084	2.2096	2.2108	2.2120	2.2131
2.2143	2.2154	2.2166	2.2177	2.2189	2.2200	

COMPUTE NM HYD ID=2 HYD NO.= 101.3 DA=0.175 SQ. MI
 PER A=21.43 PER B=35.71 PERC=14.29 PER D=28.57
 TP= -0.1162 MASSRAIN =-1

K = .090554HR TP = .162000HR K/TP RATIO = .558978 SHAPE CONSTANT, N = 6.880332
 UNIT PEAK = 159.11 CFS UNIT VOLUME = .9999 B = 515.56 P60 = 1.8800
 AREA = .049998 SQ. MI. IA - .1000 INCHES INF = .04000 INCHES PER HOUR
 RUNOFF COMPUTED BY INITIAL ABSTRACTION/INFILTRATION NUMBER METHOD - DT = .033333

K = .156460HR TP = .162000HR K/TP RATIO = .965805 SHAPE CONSTANT, N = 3.657761
 UNIT PEAK = 255.92 CFS UNIT VOLUME = 1.000 B = 331.67 P60 = 1.8800
 AREA = .125003 SQ. MI. IA - .51499 INCHES INF = 1.29198 INCHES PER HOUR
 RUNOFF COMPUTED BY INITIAL ABSTRACTION/INFILTRATION NUMBER METHOD - DT = .033333

PRINT HYD ID=2 CODE=1

PARTIAL HYDROGRAPH 101.30

RUNOFF VOLUME = 1.03234 INCHES = 9.6351 ACRE-FEET
 PEAK DISCHARGE RATE = 267.77 CFS AT 1.533 HOURS BASIN AREA = 1750 SQ. MI

 *S EXAMPLE D-3 **

***** PERVIOUS PORTION ***** TREATMENT A, B & C

COMPUTE HYD	ID=1	HYD NO=101.1	DT=.0333333 HRS	DA=1.2500 SQ. MI		
	IA=-0.515	INF=-1.292	K=-0.173400	TP=-0.292000	RAIN =	
.0000	.0070	.0142	.0217	.0294	.0375	.0459
.0547	.0638	.0733	.0832	.0936	.1044	.1156
.1272	.1394	.1520	.1650	.1786	.1927	.2072
.2223	.2379	.2540	.2707	.2879	.3056	.3239
.3428	.3622	.3822	.4028	.4240	.4457	.4681
.4911	.5146	.5388	.5636	.5890	.6150	.6417
.6690	.6969	.7255	.7548	.7847	.8152	.8464
.8783	.9109	.9441	.9780	1.0126	1.0479	1.0838
1.1205	1.1578	1.1959	1.2347	1.2741	1.7377	2.6322
3.9411	5.4901	7.0155	8.1916	8.6459	9.0766	9.4890
9 8382	10.1365	10.3938	10.6181	10.8157	10.9918	11.1507
11.2957	11.4294	11.5541	11.6715	11.7830	11.8898	11.9928
12.0928	12.1902	12.2857	12.3795	12.4721	12.5636	12.6542
12.8014	12.9384	13.0662	13.1855	13.2969	13.4009	13.4983
13.5894	13.6748	13.7549	13.8301	13.9008	13.9673	14.0300
14.0892	14.1451	14.1979	14.2480	14.2954	14.3405	14.3834
14.4243	14.4633	14.5006	14.5363	14.5705	14.6033	14.6349
14.6654	14.6948	14.7231	14.7506	14.7773	14.8031	14.8283
14.8527	14.8766	14.8999	14.9227	14.9450	14.9669	14.9883
15.0094	15.0301	15.0505	15.0706	15.0905	15.1101	15.1294
15.1485	15.1675	15.1862	15.2048	15.2232	15.2415	15.2596
15.2777	15.2956	15.3134	15.3311	15.3487	15.3662	15.3837

15.4011	15.4184	15.4356	15.4528	15.4700	15.4871	15.5042
15.5212	15.5382	15.5551	15.5720	15.5889	15.6058	15.6226
15.6395	15.6562	15.6730	15.6898	15.7065	15.7232	15.7400
15.7567	15.1733	15.7900	15.8067	15.8233	15.8400	

K = .173400HR TP = .292000HR SHAPE CONSTANT, N = 6.37493
UNIT PEAK = 2101.2 CFS UNIT VOLUME = .9999 B = 490.85
RUNOFF COMPUTED BY INITIAL ABSTRACTION - INFILTRATION METHOD - DT = .033333

PRINT HYD ID=1 CODE=1
PARTIAL HYDROGRAPH 101.10

RUNOFF VOLUME = 10.91309 INCHES = 727.5348 ACRE-FEET
PEAK DISCHARGE RATE = 14586.49 CFS AT 2.433 HOURS BASIN AREA = 1.2500 SQ. MI.

***** IMPERVIOUS PORTION ***** TREATMENT D

COMPUTE HYD ID=2 HYD NO-101.2 DT=.033333 HRS DA=0.50000 SQ MI
IA=-0.10 INF=0.04 K=-0.159700 TP=-0.292000 RAIN=-1

K = 1.59700HR TP = .292000HR SHAPE CONSTANT, N = 7.07453
UNIT PEAK = 898.59 CFS UNIT VOLUME = 1.000 B = 524.78
RUNOFF COMPUTED BY INITIAL ABSTRACTION - INFILTRATION METHOD - DT = .033333

PRINT HYD ID=1 CODE=1
PARTIAL HYDROGRAPH 101.20

RUNOFF VOLUME = 15.57613 INCHES = 415.3609 ACRE-FEET
PEAK DISCHARGE RATE = 6494.75 CFS AT 2.433 HOURS BASIN AREA = .5000 SQ. MI.

***** COMBINED HYDROGRAPH *****

ADD HYD ID=2 HYD NO-101.3 ID=1 ID=2
PRINT HYD ID=2 CODE =1
PARTIAL HYDROGRAPH 101.3
RUNOFF VOLUME = 12.24539 INCHES = 1142.8960 ACRE-FEET
PEAK DISCHARGE RATE = 21081.24 CFS AT 2.433 HOURS BASIN AREA = 1.7500 SQ. MI.

*S EXAMPLE D-4 **

RAINFALL TYPE=3 RAIN QUARTER = 7.58 RAIN ONE=11.38
RAIN SIX=15.84 RAIN DAY=0.0 DT = .033333
COMPUTED P.M.P. 6-HOUR RAINFALL DISTRIBUTION BASED ON H.M.R.-55a
DT = .033333 HOURS END TIME = 5.999940 HOURS

.0000	.0070	.0142	.0217	.0294	.0375	.0459
.0547	.0638	.0733	.0832	.0936	.1044	.1156
.1272	.1394	.1520	.1650	.1786	.1927	.2072
.2223	.2379	.2540	.2707	.2879	.3056	.3239
.3428	.3622	.3822	.4028	.4240	.4457	.4681
.4911	.5146	.5388	.5636	.5890	.6150	.6417
.6690	.6969	.7255	.7548	.7847	.8152	.8464
.8783	.9109	.9441	1.9780	1.0126	1.0479	1.0838
1.1205	1.1578	1.1959	1.2347	1.2741	1.7377	2.6322
3.9411	5.4901	7.0155	8.1916	8.6459	9.0766	9.4890
9.8382	10.1365	10.3938	10.6181	10.8157	10.9918	11.1507
11.2957	11.4294	11.5541	11.6715	11.7830	11.8898	11.9928

12.0928	12.1902	12.2857	12.3795	12.4721	12.5636	12.6542
12.8014	12.9384	13.0662	13.1855	13.2969	13.4009	13.4983
13.5894	13.6748	13.7549	13.8301	13.9008	13.9673	14.0300
14.0892	14.1451	14.1979	14.2480	14.2954	14.3405	14.3834
14.4243	14.4633	14.5006	14.5363	14.5705	14.6033	14.6349
14.6654	14.6948	14.7231	14.7506	14.7773	14.8031	14.8283
14.8527	14.8766	14.8999	14.9227	14.9450	14.9669	14.9883
15.0094	15.0301	15.0505	15.0706	15.0905	15.1101	15.1294
15.1485	15.1675	15.1862	15.2048	15.2232	15.2415	15.2596
15.2777	15.2956	15.3134	15.3311	15.3487	15.3662	15.3837
15.4011	15.4184	15.4356	15.4528	15.4700	15.4871	15.5042
15.5212	15.5382	15.5551	15.5720	15.5889	15.6058	15.6226
15.6395	15.6562	15.6730	15.6898	15.7065	15.7232	15.7400
15.7567	15.7733	15.7900	15.8067	15.8233	15.8400	

COMPUTE NM HYD ID=2 HYD NO= 101.3 DA=1.750 SQ. MI
 PER A=240 PER B=400 PER C=160 PER D=320 TP=-0.292

K = .159697HR TP = .292000HR K/TP RATIO = .546909 SHAPE CONSTANT, N = 7.074674
 UNIT PEAK - 898.60 CFS UNIT VOLUME = 1.000 B = 524.78 P60 = 11.380
 AREA = .500000 SQ MI IA = .10000 INCHES INF = .04000 INCHES PER HOUR
 RUNOFF COMPUTED BY INITIAL ABSTRACTION/INFILTRATION NUMBER METHOD - DT = .033333

K = .173405HR TP = .292000HR K/TP RATIO = .593853 SHAPE CONSTANT, N = 6.374689
 UNIT PEAK - 2101.2 CFS UNIT VOLUME = .9999 B = 490.84 P60 = 11.380
 AREA = 1.250000 SQ MI IA = .51500 INCHES INF = 1.29200 INCHES PER HOUR
 RUNOFF COMPUTED BY INITIAL ABSTRACTION/INFILTRATION NUMBER METHOD - DT = .033333

PRINT HYD ID=2 CODE=1 PARTIAL HYDROGRAPH 101.30

RUNOFF VOLUME = 12.24539 INCHES = 1142.8960 ACRE-FEET
 PEAK DISCHARGE RATE = 21081.04 CFS AT 2.433 HOURS BASIN AREA = 1.7500 SQ. MI

FINISH

NORMAL PROGRAM FINISH END TIME (HR:MIN:SEC) = 18:32:38

Section 3. HYDRAULIC DESIGN

A. Weirs and Orifices

1. Weirs

A weir is a barrier in an open channel, over which water flows. A weir with a sharp upstream corner or edge such that the water springs clear of the crest is a "sharp crested weir". All other weirs are classified as "weirs not sharp crested". Weirs are to be evaluated using the following equation:

$$Q = CLH^{3/2}$$

where:

Q = Discharge in cfs

C = Discharge coefficient from Handbook of Hydraulics, King and Brater, 5th Edition (or comparable)

L = Effective length of crest in feet

H = Depth of flow above elevation of crest in feet (approach velocity shall be disregarded in most applications)

Applications

Weirs are generally used as measuring and hydraulic control devices. Emergency spillways in which critical depth occurs and overflow-type roadway crossings of channels are the most common applications of weirs. Channel drop structures and certain storm drain inlets may also be analyzed as weirs. Special care must be exercised when selecting weir coefficients in the following cases:

- a. Submerged weirs
- b. Broad crested weirs
- c. Weirs with obstructions (i.e., guardrails, piers, etc.)

2. Orifices

An orifice is an submerged opening with a closed perimeter through which water flows. Orifices are analyzed using the following equation:

$$Q = CA \sqrt{2gh}$$

where:

Q = Discharge in cfs

C = Coefficient of discharge from Handbook of Hydraulics, King and Brater, 5th Edition (or comparable)

A = Area of opening in square feet

g = 32.2 ft/sec

h = Depth of water measured from the center of the opening

Approach velocity shall be disregarded in most applications.

Applications

Orifices are generally used as measuring and hydraulic control devices. Orifice hydraulics control the function of many "submerged inlet - free outlet" culverts, primary spillways in detention facilities, manholes in conduit flow, and in storm drain inlets.

B. Criteria for Hydraulic Design: Closed Conduits

1. General Hydraulic Criteria

Closed conduit sections (pipe, box or arch sections) will be designed as flowing full and, whenever possible, under pressure except when the following conditions exist:

- a. In some areas of high sediment potential, there is a possibility of stoppage occurring in drains. In situations where sediment may be expected, the City Engineer/SSCAFCA will use 18% for undeveloped conditions and 6% for developed conditions.
- b. In certain situations, open channel sections upstream of the proposed closed conduit may be adversely affected by backwater.

If the proposed conduit is to be designed for pressure conditions, the hydraulic grade line shall not be higher than the ground or street surface, or encroach on the same in a reach where interception of surface flow is necessary. However, in those reaches where no surface flow will be intercepted, a hydraulic grade line which encroaches on or is slightly higher than the ground or street surface may be acceptable provided that pressure manholes exist or will be constructed.

2. Water Surface Profile Calculations

a. Determination of Control Water Surface Elevation

A conduit to be designed for pressure conditions may discharge into one of the following:

- (1) A body of water such as a detention reservoir
- (2) A natural watercourse or arroyo
- (3) An open channel, either improved or unimproved
- (4) Another closed conduit

The controlling water surface elevation at the point of discharge is commonly referred to as the control and, for pressure flow, is generally located at the downstream end of the conduit.

Two general types of controls are possible for a conduit on a mild slope, which is a physical requirement for pressure flow in discharging conduits.

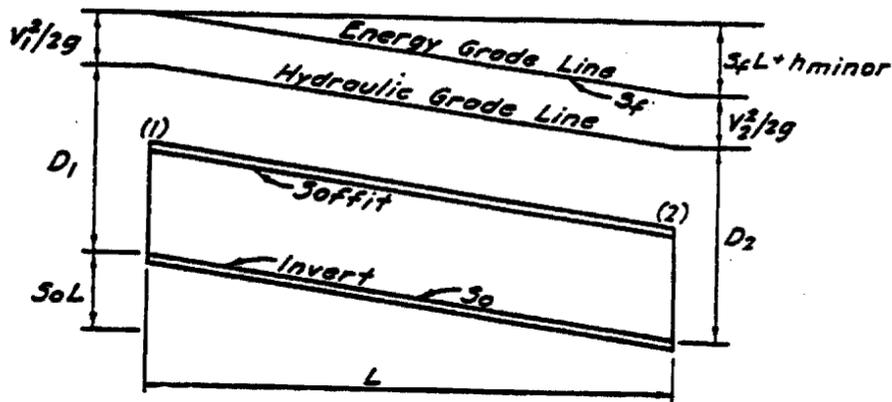
- a. Control elevation above the soffit elevation. In such situations, the control must conform to the following criteria:
 - (1) In the case of a conduit discharging into a detention facility, the control is the 100-year water surface reservoir elevation.
 - (2) In the case of a conduit discharging into an open channel, the control is the 100-year design water surface elevation of the channel.
 - (3) In the case of a conduit discharging into another conduit, the control is the design hydraulic grade line elevation of the outlet conduit immediately upstream of the confluence.

Whenever case (1) or (2) above is used, the possibility of having flow out of manholes or inlets due to discharge elevations at the 100-year level must be investigated and appropriate steps taken to prevent its occurrence.

- b. Control elevation at or below the soffit elevation. The control is the soffit elevation at the point of discharge. This condition may occur in any one of the four situations described above in 2a.
- c. Instructions for Hydraulic Calculations

Most procedures for calculating hydraulic grade line profiles are based on the Bernoulli equation. This equation can be expressed as follows:

$$\frac{V_1^2}{2g} + D_1 + S_0 L = \frac{V_2^2}{2g} + D_2 + S_f L + h_{\text{minor}}$$



- in which
- D = Vertical distance from invert to H.G.L
 - S₀ = Invert slope
 - L = Horizontal projected length of conduit
 - S_g = Average friction slope between Sections 1 and 2
 - V = Average velocity (g/A)
 - h_{minor} = Minor head losses

Minor losses have been included in the Bernoulli equation because of their importance in calculating hydraulic grade line profiles and are assumed to be uniformly distributed in the above figure.

When specific energy (E) is substituted for the quantity $(\frac{V^2}{2g} + D)$ in the above equation and minor losses are ignored and the result rearranged,

$$L = \frac{E_2 - E_1}{S_0 - S_f}$$

The above is a simplification of a more complex equation and is convenient for locating the approximate point where pressure flow may become unsealed.

One format in use at SSCAFCA for calculating hydraulic grade line profiles and considered acceptable is shown on Plate 2.2.8 B-1.

d. Head Losses

(1) Friction Loss

Friction losses for closed conduits carrying storm water, including pump station discharge lines, will be calculated from the Manning equation or a derivation thereof. The Manning equation is commonly expressed as follows:

$$Q = \frac{1.486}{n} AR^{2/3} S_f^{1/2}$$

in which Q = Discharge, in c.f.s.

n = Roughness coefficient

A = Area of water normal to flow in ft.

R = Hydraulic radius

Sf = Friction slope

When rearranged into a more useful form,

in which

$$S_f = \left[\frac{Qn}{1.486AR^{2/3}} \right]^2 = \left[\frac{Q}{K} \right]^2$$

in which:

$$K = \frac{1.486}{n} AR^{2/3}$$

The loss of head due to friction throughout the length of reach (L) is calculated by:

$$h_f = S_f L = \left[\frac{Q}{K} \right]^2 L$$

The value of K is dependent upon only two factors: the geometrical shape of the flow cross section as expressed by the quantity ($AR^{2/3}$), and the roughness coefficient (n). The values of n are shown in Table 2.2.3 B-1.

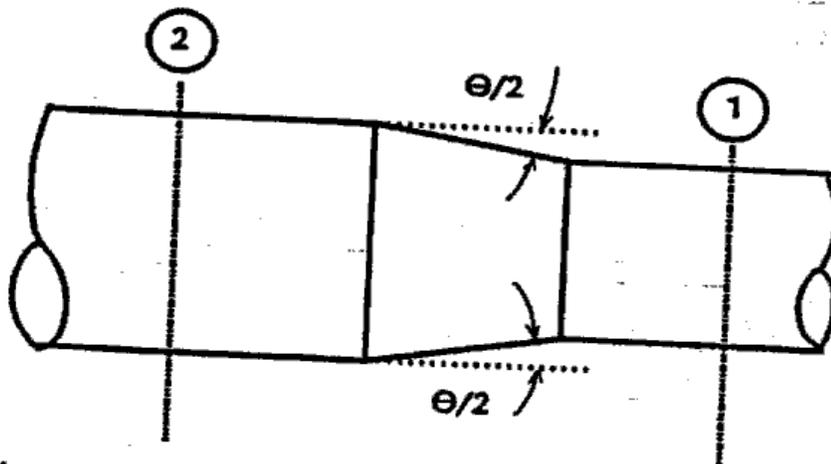
TABLE 2.2.3 B-1
VALUES OF MANNING'S n

	n
Tined Concrete	0.018
Shotcrete	0.025
Reinforce Concrete Pipe	0.013
Troweled Concrete	0.013
No-joint cast in place concrete pipe	0.014
Reinforced Concrete Box	0.015
Reinforced Concrete Arch	0.015
Streets	0.017
Flush Grouted Riprap	0.020
Corrugated Metal Pipe	0.025
Grass Lined Channels (sodded & irrigated)	0.025
Earth Lined Channels (smooth)	0.030
Wire Tied Riprap	0.040
Medium Weight Dumped Riprap	0.045
Grouted Riprap (exposed rock)	0.045
Jetty Type Riprap ($D_{50} > 24"$)	0.050

See SSCAFCA's Sediment and Erosion Design guide for recommended Manning's n values for naturalistic channels. For materials not listed contact City Engineer/SSCAFCA prior to use.

(2) Transition Loss

Transition losses will be calculated from the equations shown below. These equations are applicable when no change in Q occurs and where the horizontal angle of divergence or convergence ($\theta/2$) between the two sections does not exceed 5 degrees 45 minutes.



For increasing velocities in the direction of flow from (2) to (1)

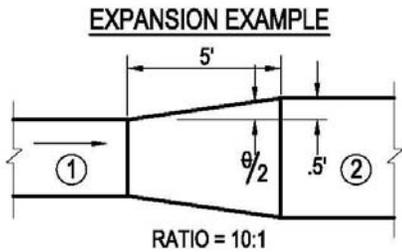
$$h_t = 0.1 \left[\frac{v_1^2}{2g} - \frac{v_2^2}{2g} \right]$$

For decreasing velocities in the direction of flow from (1) to (2)

$$h_t = 0.2 \left[\frac{v_1^2}{2g} - \frac{v_2^2}{2g} \right]$$

Deviations from the above criteria must be approved by the City Engineer/SSCAFCA. When such situations occur, the angle of divergence or convergence ($\theta/2$) may be greater than 5 degrees 45 minutes. However, when it is increased beyond 5 degrees 45 minutes, the above equation will give results for h_t that are too small, and the use of more accurate methods, such as the Gibson method shown Plate 2.2.3 B-2, will be acceptable.

TRANSITION HEAD LOSS



CONTRACTION (INCREASING VELOCITY): $h_t = \frac{K_e}{2} \frac{(V_2 - V_1)^2}{2g}$

EXPANSION (DECREASING VELOCITY): $h_t = K_e \frac{(V_1 - V_2)^2}{2g}$

REFERENCE

GIBSON-ENLARGERS
STANDARD OF THE HYDRAULIC INSTITUTE
 $K_e = 3.50 (\tan \theta/2)^{1.22}$

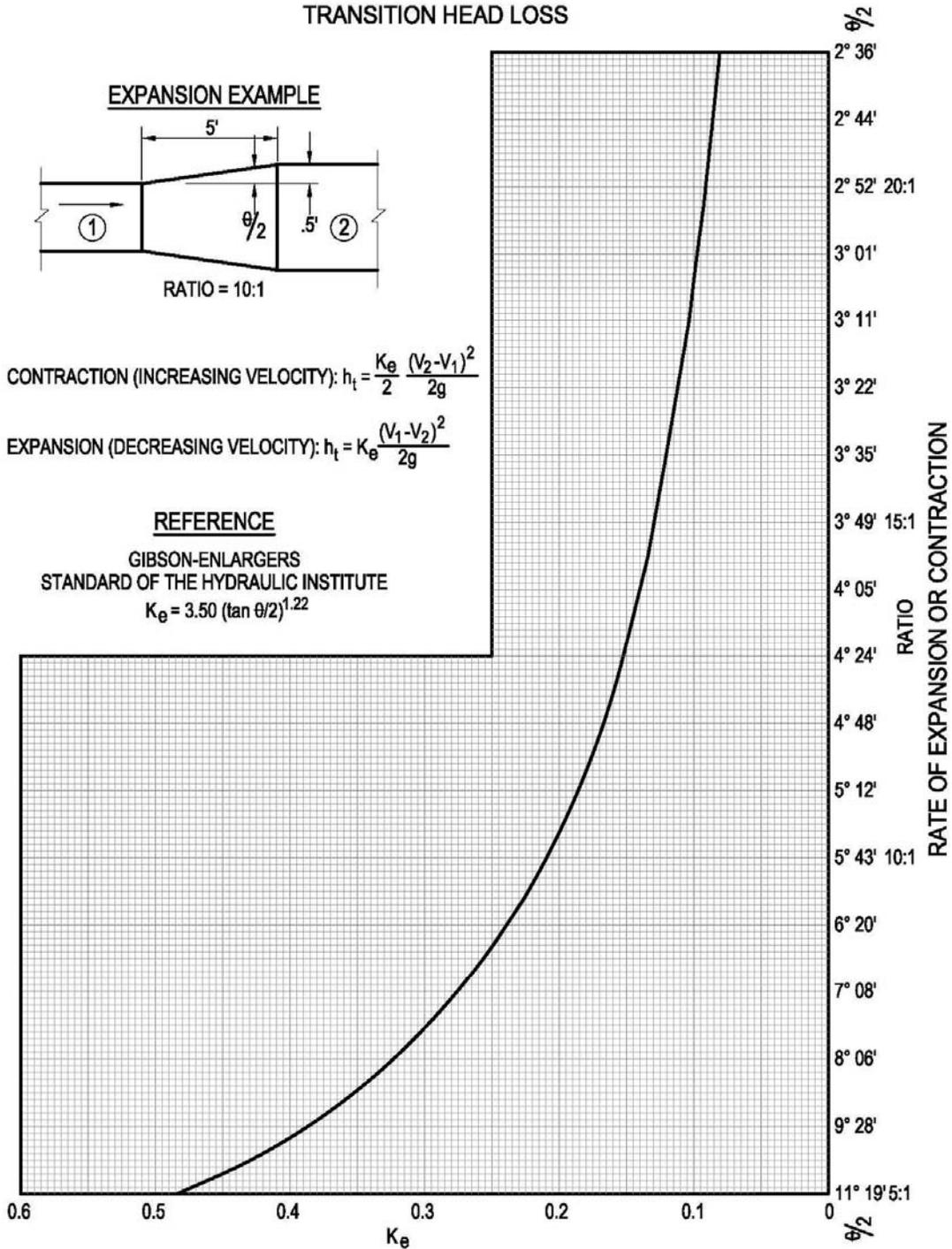
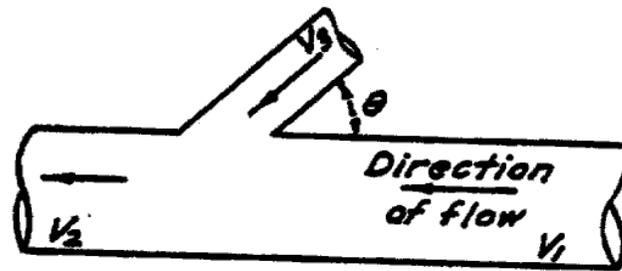


PLATE 22.3 B-2

(3) Junction Losses

In general, junction losses are calculated by equating pressure plus momentum through the confluences under consideration. This can be done by using either the P + M method or the Thompson equation, both of which are shown in Section 2.2, Section 8. Both methods are applicable in all cases for pressure flow and will give the same results.

For the special case of pressure flow with $A_1 = A_2$ and friction neglected,



$$h_j = \frac{V_2^2}{2g} - \frac{V_1^2}{2g} - \frac{2A_2}{A_1} \cdot \frac{V_2^2}{2g} \cdot \cos \theta$$

(4) Manhole Loss

Manhole losses will be calculated from the equation shown below. Where a change in pipe size and/or change in Q occurs, the head loss will be calculated in accordance with Sections (2) and (3), preceding.

$$h_{m.h.} = .05 \left[\frac{V^2}{2g} \right]$$

(5) Bend Loss

Bend losses will be calculated from the following equations:

$$h_b = K_b \left[\frac{V^2}{2g} \right]$$

BEND LOSSES

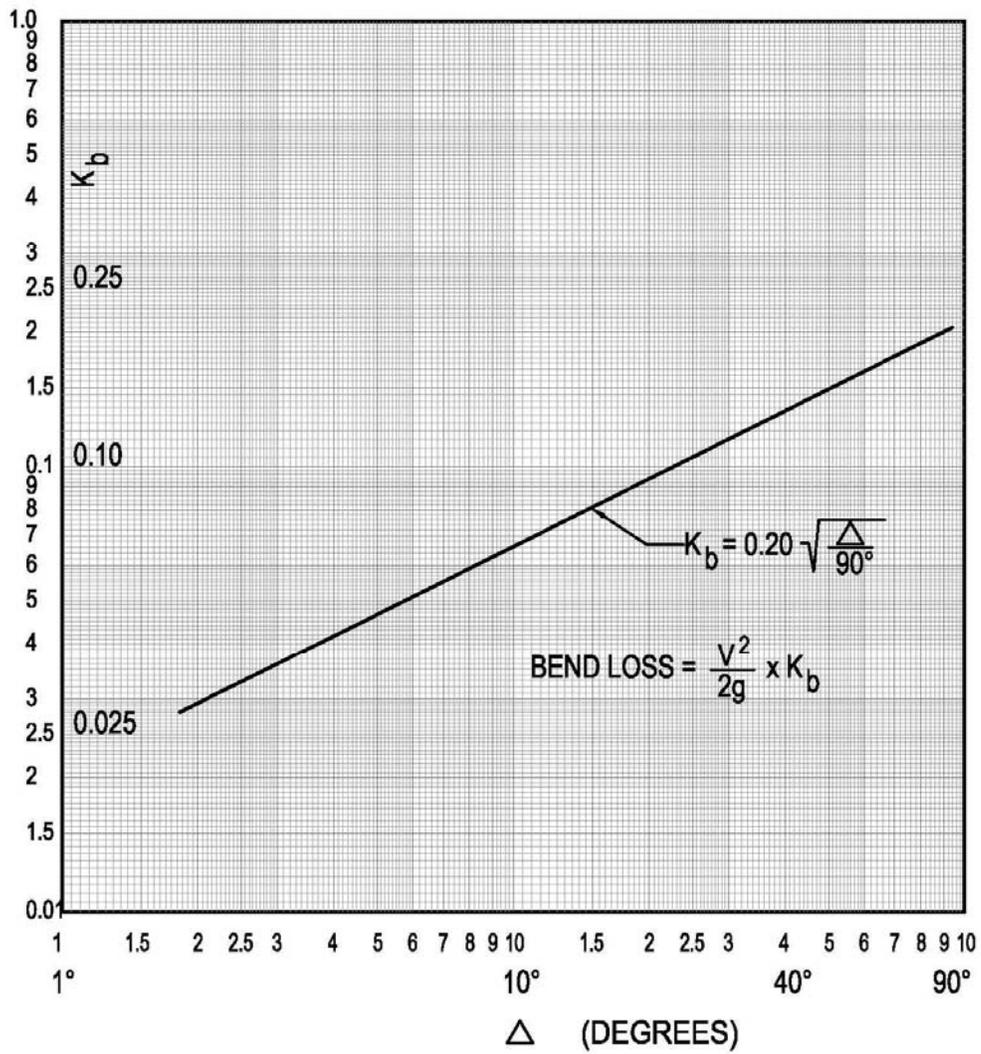


PLATE 22.3 B-3

in which:

$$K_b = 0.20 \sqrt{\frac{\Delta}{90^\circ}}$$

where Δ = Central angle of bend in degrees

K_b may be evaluated graphically from 2.2.3 B-3 for values of Δ not exceeding 90 degrees.

Bend losses should be included for all closed conduits, those flowing partially full as well as those flowing full.

(6) Angle Point Loss

Angle point losses shall be calculated from the following equation:

$$h_{a.pt.} = .0033 \Theta \left[\frac{V^2}{2g} \right]$$

in which Θ = Deflection angle in degrees, not to exceed 6° without prior approval.

3. Special Cases

a. Transition From Large to Small Conduit

As a general rule, storm drains will be designed with sizes increasing in the downstream direction. However, when studies indicate it may be advisable to decrease the size of a downstream section, the conduit may be decreased in size in accordance with the following limitations:

- (1) For slopes of .0025 (.25 percent) or less, conduit sizes may be decreased to a minimum diameter of 72 inches. Each reduction is limited to a maximum of 6 inches.
- (2) For slopes of more than .0025, conduit sizes may be decreased to a minimum diameter of 30 inches. Each reduction is limited to a maximum of 3 inches for pipe 48 inches in diameter or smaller, and to a maximum of 6 inches for pipe larger than 48 inches in diameter. Reductions exceeding the above criteria must have prior City Engineer/SSCAFCA approval.

In any case the reduction in size must result in a more economical system.

Where conduits are to be decreased in size due to a change in grade, the criteria for locating the transition will be as shown on Plate 2.2.3 B-4.

4. Design Requirements for Maintenance and Access

a. Manholes

(1) Spacing

Where the proposed conduit is 60" and larger, manholes should be spaced at intervals of approximately 800 feet to 1000 feet. Where the proposed conduit is less than 60 inches in diameter and the horizontal alignment has numerous bends or angle points, the manhole spacing should be reduced to approximately 500 feet.

The spacing requirements shown above apply regardless of design velocities. Deviations from the above criteria are subject to City Engineer/SSCAFCA approval.

(2) Location

Manholes should be located outside of street intersections wherever possible, especially when one or more streets are heavily traveled.

In situations where the proposed conduit is to be aligned both in easement and in street right-of-way, manholes should be located in street right-of-way, wherever possible.

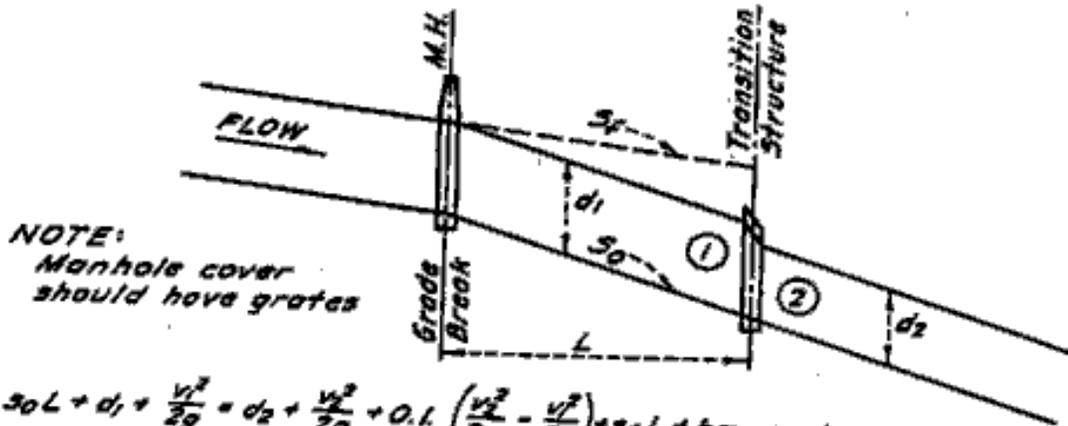
Manholes should be located as close to changes in grade as feasible when the following conditions exist:

- (a) When the upstream conduit has a steeper slope than the downstream conduit and the change in grade is greater than 10 percent, sediment tends to deposit at the point where the change in grade occurs.
- (b) When transitioning to a smaller downstream conduit due to an abruptly steeper slope downstream, sediment tends to accumulate at the point of transition.

(3) Design

When the design flow in a pipe flowing full has a velocity of 20 f.p.s. or greater, or is supercritical in a partially full pipe, the total horizontal angle of divergence or convergence between the walls of the manhole and its center line should not exceed 5°45'.

LOCATION OF TRANSITION
Large to Small Conduit



$$s_0 L + d_1 + \frac{v_1^2}{2g} = d_2 + \frac{v_2^2}{2g} + 0.1 \left(\frac{v_2^2}{2g} - \frac{v_1^2}{2g} \right) + s_f L + h_m, \text{ and}$$

$$s_0 L - s_f L = d_2 - d_1 + 1.1 \left(\frac{v_2^2}{2g} - \frac{v_1^2}{2g} \right) + h_m \dots \text{therefore:}$$

$$L = \frac{d_2 - d_1 + 1.1 \left(\frac{v_2^2}{2g} - \frac{v_1^2}{2g} \right) + h_m}{s_0 - s_f}$$

- where
- s_0 = slope of conduit
 - s_f = friction slope of larger conduit
 - d_1 = diameter or depth of larger conduit
 - v_1 = velocity in larger conduit flowing full
 - d_2 = diameter or depth of smaller conduit
 - v_2 = velocity in smaller conduit flowing full
 - h_m = other losses occurring between the transition and the grade break such as bend and confluence losses

EXAMPLE PROBLEM

$Q = 400 \text{ cfs}$
 $d_1 = 84'' = 7'$ $d_2 = 78'' = 6.5'$
 $A_1 = 38.49 \text{ sq. ft.}$ $A_2 = 33.18 \text{ sq. ft.}$
 $v_1 = 10.4 \text{ fps}$ $v_2 = 12.0 \text{ fps}$
 $\frac{v_1^2}{2g} = 1.68'$ $\frac{v_2^2}{2g} = 2.24'$
 $s_0 = .00474$
 $s_f = .00395$

$$L = \frac{6.5 - 7.0 + 1.1(2.24 - 1.68)}{.00474 - .00395} = 147$$

PLATE 22.3 B-4

b. Pressure Manholes

Pressure manholes should be avoided whenever possible. When unavoidable a pressure manhole shaft and a pressure frame and cover will be installed in a pipe or box storm drain whenever the design water surface is at the ground surface.

c. Special Manholes

Special 36-inch diameter manholes or vehicular access structures will be provided when required. The need for access structures will be determined by the City Engineer/SSCAFCA during the review of preliminary plans.

d. Deep Manholes

A manhole shaft safety ledge or other structural designs should be considered when the manhole shaft is 20 feet or greater in depth. Installation will be in accordance with City Engineer/SSCAFCA requirements.

e. Inlets into Main Line Drains

Lateral pipe entering a main line pipe storm drain generally will be connected radially. Lateral pipe entering a main line structure will conform to the following:

- (1) The invert of lateral pipe 24 inches or less in diameter will be no more than five feet above the invert.
- (2) The invert of lateral pipe 27 inches or larger in diameter will be no more than 18 inches above the invert, with the exception that storm inlet connector pipe less than 50 feet in length may be no more than five feet above the invert.

Exceptions to the above requirements may be permitted where it can be shown that the cost of bringing laterals into a main line conduit in conformance with the above requirements would be excessive.

f. Minimum Pipe Size

In cases where the conduit may carry significant amounts of sediment, the minimum diameter of main line conduit will be 24 inches.

g. Minimum Slope

The minimum slope for main line conduit will be 0.003 (0.30 percent), unless otherwise approved by the City Engineer/SSCAFCA. Minimum flow velocity for ¼ full pipe will be 2 f.p.s.

h. Inlet Structures

An inlet structure will be provided for storm drains located in natural channels. The structure should generally consist of a headwall, wingwalls to protect the adjacent banks from erosion, and a paved inlet apron. The apron slope should be limited to a maximum of 2:1. Wall heights should conform to the height of the water upstream of the inlet, and be adequate to protect both the fill over the drain and the embankments. Headwall and wingwall fencing and a protection barrier to prevent public entry will be provided.

If trash and debris are prevalent, barriers consisting of vertical 3-inch or 4-inch diameter steel pipe at 24 inches to 36 inches on centers should be embedded in concrete immediately upstream of the inlet apron. Trash rack designs must have City Engineer/SSCAFCA approval.

i. Outlet Structures

(1) Where a storm drain discharges into a detention reservoir, the designer should check with the City Engineer/SSCAFCA for up-to-date criteria as to location and type of structure to be used.

(2) When a storm drain outlets into a natural channel, an outlet structure will be provided which prevents erosion and property damage. Velocity of flow at the outlet should match as closely as possible with the existing channel velocity. Fencing and a protection barrier will be provided where deemed necessary by the City Engineer/SSCAFCA.

(a) When the discharge velocity is low, or subcritical, the outlet structure will consist of a headwall, wingwalls, and an apron. The apron may consist of a concrete slab, grouted rock, or well designed dumped riprap depending on conditions.

(b) When the discharge velocity is high, or supercritical, the designer will, in addition, design bank protection in the vicinity of the outlet and an energy dissipater structure. The City Engineer/SSCAFCA will furnish, upon request, guidance on types of energy dissipators appropriate for each application.

j. Protection Barriers

A protection barrier is a means of preventing people from entering storm drains. Protection barriers will be provided wherever necessary to prevent unauthorized access to storm drains. In some cases the barrier may be one of the breakaway type. In other cases the barrier may be a special design. It will be the designer's responsibility to provide a protection barrier appropriate to each situation and to provide details of such on the construction drawings.

k. Debris Barriers

A debris barrier or deflector is a means of preventing large debris or trash, such as tree limbs, logs, boulders, weeds, and refuse, from entering a storm drain and possibly plugging the conduit. The debris barrier should have openings wide enough to allow as much small debris as possible to pass through and yet narrow enough to protect the smallest conduit in the system downstream of the barrier. One type that has been used effectively in the past is the debris rack. This type of debris barrier is usually formed by a line of posts, such as steel pipe filled with concrete or steel rails, across the line of flow to the inlet. Other examples of barriers are presented in Hydraulic Engineering Circular No. 9, "Debris-Control Structures," published by the United States Department of Commerce, Bureau of Public Roads, which is available upon request from its Office of Engineering and Operations. It will be the designer's responsibility to provide a debris barrier or deflector appropriate to the situation.

L. Debris Basins

Debris basins, check dams and similar structures are a means of preventing mud, boulders and debris held in suspension and carried along by storm runoff from depositing in storm drains. Debris basins constructed upstream of storm drain conduits, usually in canyons, trap such material before it reaches the conduit. Debris basins must be cleaned out on a regular basis, however, if they are to continue to function effectively. Refer to the City Engineer/SSCAFCA and State Engineer regarding the criteria to be used in designing these structures.

M. Safety

Entry into any of these structures should be in accordance with OSHA requirements.

5. Other Closed Conduit Criteria

a. Angle of Confluence

In general, the angle of confluence between main line and lateral must not exceed 45 degrees and, as an additional requirement, must not exceed 30 degrees under any of the following conditions:

- (1) Where the peak flow (Q) in the proposed lateral exceeds 10 percent of the main line peak flow.
- (2) Where the velocity of the peak flow in the proposed lateral is 20 f.p.s. or greater.
- (3) Where the size of the proposed lateral is 60 inches or greater.
- (4) Where hydraulic calculations indicate excessive head losses may occur in the main line due to the confluence.

Connector pipe may be joined to main line pipe at angles greater than 45 degrees up to a maximum of 90 degrees provided none of the above conditions exist. If, in any specific situation, one or more of the above conditions does apply, the angle of confluence for connector pipes may not exceed 30 degrees. Connections must not be made to main line pipe which may create conditions of adverse flow in the connector pipes without prior approval from the City Engineer/SSCAFCA.

The above requirements may be waived only if calculations are submitted to the City Engineer/SSCAFCA showing that the use of a confluence angle larger than 30 degrees will not unduly increase head losses in the main line.

- b. Flapgates (FLAPGATES ARE DISCOURAGED AND WILL ONLY BE USED ON A CASE BY CASE BASIS AND WITH APPROVAL FROM THE CITY ENGINEER/SSCAFCA)

A flapgate must be installed in all laterals outletting into a main line storm drain whenever the potential water surface level of the main line is higher than the surrounding area drained by the lateral.

The flapgate must be set back from the main line drain so that it will open freely and not interfere with the main line flow. A junction structure will be constructed for this purpose in accordance with City Engineer/SSCAFCA standards.

- c. Rubber-Gasketed Pipe

Rubber-gasketed pipe will be used in all storm drain construction unless otherwise approved by the City Engineer/SSCAFCA.

- d. Non-Reinforced Concrete Pipe

Non-reinforced concrete pipe may not be used for storm drain applications.

- e. Junctions

Junctions will only be permitted on mains storm drain lines that are ≥ 42 inches. Junction locations cannot be more than 24' from the downstream manhole. An exception to this requirement may be laterals with slopes of 5% or greater. The City Engineer/SSCAFCA approval will be required for this exception and all other variances.

FACTORS FOR CLOSED CONDUITS FLOWING FULL

Manning's Formula: $Q = \frac{1.486}{n} AR^{2/3} s^{1/2}$

$K = \frac{Q}{S^{1/2}} = \frac{1.486 AR^{2/3}}{0.013}$, for pipe $K = 35.6259 d^{8/3}$
 for box $K = 114.3077 \frac{A^{5/3}}{p^{2/3}}$

$Q = K s^{1/2}$

$s = \frac{[Q]^2}{K}$

- Where:
- Q = discharge in cfs
 - s = friction slope
 - A = area of conduit
 - R = hydraulic radius of conduit
 - n = 0.013
 - d = diameter of pipe
 - " = height of equivalent box
 - w = width of equivalent box
 - p = wetted perimeter

PLATE 2.2.3 B-5

PIPE & BOX		PIPE		EQUIVALENT BOX			
d		A	K	w		A	K
ft.	in.	sq. ft.		ft.-in.	ft.	sq. ft.	
1.25	15	1.227	64.6				
.50	18	1.767	105.0				
.75	21	2.405	158.4				
2.00	24	3.142	226.2				
.25	27	3.976	309.7				
.50	30	4.909	410.1				
.75	33	5.939	528.7				
3.00	36	7.068	666.9				
.25	39	8.295	825.8				
.50	42	9.621	1,006				
.75	45	11.044	1,209				
4.00	48	12.566	1,436				
.25	51	14.186	1,688				
.50	54	15.904	1,967				
.75	57	17.721	2,272				
5.00	60	19.635	2,604				
.25	63	21.648	2,966				
.50	66	23.758	3,358				
.75	69	25.967	3,780				
6.00	72	28.274	4,236				
.25	75	30.680	4,720				
.50	78	33.183	5,244				
.75	81	35.785	5,796				
7.00	84	38.485	6,388	5'-10"	5.83	40.3	6,357
.25	87	41.283	7,015				
.50	90	44.179	7,677	6'-4"	6.33	47.0	7,780
.75	93	47.173	8,379				
8.00	96	50.266	9,120	6'-9"	6.75	53.5	9,256
.50	102	56.745	10,720	7'-1"	7.08	59.7	10,685
9.00	108	63.617	12,487	7'-6"	7.50	67.0	12,452
.50	114	70.882	14,421	8'-0"	8.00	75.4	14,598
10.00	120	78.540	16,538	8'-5"	8.42	83.6	16,726
.50	126	86.590	18,835	8'-10"	8.83	92.1	19,026

11.00	132	95,033	21,322	9'-2"	9.17	100.3	21,303
.50	138	103,879	24,005	9'-7"	9.58	109.5	23,954
12.00	144	113,098	26,890	10'-0"	10.00	119.4	26,849

PARTIALLY FILLED CIRCULAR CONDUIT SECTIONS

$\frac{D}{d}$	$\frac{\text{area}}{d^2}$	$\frac{\text{wet. per}}{d}$	$\frac{\text{hyd.rad}}{d}$	$\frac{D}{d}$	$\frac{\text{area}}{d^2}$	$\frac{\text{wet. per}}{d}$	$\frac{\text{hyd. rad}}{d}$
0.01	0.0013	0.2003	0.0066	0.51	0.4027	1.5908	0.2531
0.02	0.0037	0.2838	0.0132	0.52	0.4127	1.6108	0.2561
0.03	0.0069	0.3482	0.0197	0.53	0.4227	1.6308	0.2591
0.04	0.0105	0.4027	0.0262	0.54	0.4327	1.6509	0.2620
0.05	0.0147	0.4510	0.0326	0.55	0.4426	1.6710	0.2649
0.06	0.0192	0.4949	0.0389	0.56	0.4526	1.6911	0.2676
0.07	0.0242	0.5355	0.0451	0.57	0.4625	1.7113	0.2703
0.08	0.0294	0.5735	0.0513	0.58	0.4723	1.7315	0.2728
0.09	0.0350	0.6094	0.0574	0.59	0.4822	1.7518	0.2753
0.10	0.0409	0.6435	0.0635	0.60	0.4920	1.7722	0.2776
0.11	0.0470	0.6761	0.0695	0.61	0.5018	1.7926	0.2797
0.12	0.0534	0.7075	0.0754	0.62	0.5115	1.8132	0.2818
0.13	0.0600	0.7377	0.0813	0.63	0.5212	1.8338	0.2839
0.14	0.0668	0.7670	0.0871	0.64	0.5308	1.8546	0.2860
0.15	0.0739	0.7954	0.0929	0.65	0.5404	1.8755	0.2881
0.16	0.0811	0.8230	0.0986	0.66	0.5499	1.8965	0.2899
0.17	0.0885	0.8500	0.1042	0.67	0.5594	1.9177	0.2917
0.18	0.0961	0.8763	0.1097	0.68	0.5687	1.9391	0.2935
0.19	0.1039	0.9020	0.1152	0.69	0.5780	1.9606	0.2950
0.20	0.1118	0.9273	0.1206	0.70	0.5872	1.9823	0.2962
0.21	0.1199	0.9521	0.1259	0.71	0.5964	2.0042	0.2973
0.22	0.1281	0.9764	0.1312	0.72	0.6054	2.0264	0.2984
0.23	0.1365	1.0003	0.1364	0.73	0.6143	2.0488	0.2995
0.24	0.1449	1.0239	0.1416	0.74	0.6231	2.0714	0.3006
0.25	0.1535	1.0472	0.1466	0.75	0.6318	2.0944	0.3017
0.26	0.1623	1.0701	0.1516	0.76	0.6404	2.1176	0.3025
0.27	0.1711	1.0928	0.1566	0.77	0.6489	2.1412	0.3032
0.28	0.1800	1.1152	0.1614	0.78	0.6573	2.1652	0.3037
0.29	0.1890	1.1373	0.1662	0.79	0.6655	2.1895	0.3040
0.30	0.1982	1.1593	0.1709	0.80	0.6736	2.2143	0.3042
0.31	0.2074	1.1810	0.1755	0.81	0.6815	2.2395	0.3044
0.32	0.2167	1.2025	0.1801	0.82	0.6893	2.2653	0.3043
0.33	0.2260	1.2239	0.1848	0.83	0.6969	2.2916	0.3041
0.34	0.2355	1.2451	0.1891	0.84	0.7043	2.3186	0.3038
0.35	0.2450	1.2661	0.1935	0.85	0.7115	2.3462	0.3033
0.36	0.2546	1.2870	0.1978	0.86	0.7186	2.3746	0.3026
0.37	0.2642	1.3078	0.2020	0.87	0.7254	2.4038	0.3017
0.38	0.2739	1.3284	0.2061	0.88	0.7320	2.4341	0.3008
0.39	0.2836	1.3490	0.2102	0.89	0.7384	2.4655	0.2996
0.40	0.2934	1.3694	0.2142	0.90	0.7445	2.4981	0.2980
0.41	0.3032	1.3898	0.2181	0.91	0.7504	2.5322	0.2963
0.42	0.3130	1.4101	0.2220	0.92	0.7560	2.5681	0.2944
0.43	0.3229	1.4303	0.2257	0.93	0.7614	2.6061	0.2922
0.44	0.3328	1.4505	0.2294	0.94	0.7662	2.6467	0.2896
0.45	0.3428	1.4706	0.2331	0.95	0.7707	2.6906	0.2864
0.46	0.3527	1.4907	0.2366	0.96	0.7749	2.7389	0.2830
0.47	0.3627	1.5108	0.2400	0.97	0.7785	2.7934	0.2787
0.48	0.3727	1.5308	0.2434	0.98	0.7816	2.8578	0.2735

0.49	0.3827	1.5508	0.2467	0.99	0.7841	2.9412	0.2665
0.50	0.3927	1.5708	0.2500	1.00	0.7854	3.1416	0.2500

FACTORS FOR CIRCULAR CONDUITS FLOWING PARTLY FULL

D = depth of water

d = diameter of conduit

$$K = \frac{\text{momentum}}{(Q/d)^2}$$

Tabulated Values

$$C = \frac{\text{pressure}}{d^3}$$

$$F = \frac{\text{Velocity Head}}{(Q/d^2)^2}$$

	K	C	F	$\frac{D}{d}$	K	C	F	$\frac{D}{d}$	K	C	F	$\frac{D}{d}$	K	C
	00	.0000	00	.25	.2026	.0157	0.659	.50	.0792	.0833	.1007	.75	.0492	.2121
	23.919	.0000	9188.	.26	.1916	.0173	0.589	.51	.0773	.0873	.0958	.76	.0485	.2185
	8.403	.0000	1134.	.27	.1817	.0190	0.530	.52	.0753	.0914	.0912	.77	.0479	.2249
	4.507	.0001	326.	.28	.1727	.0207	0.479	.53	.0736	.0956	.0869	.78	.0473	.2314
	2.961	.0002	140.9	.29	.1645	.0226	0.435	.54	.0719	.0998	.0829	.79	.0467	.2380
	2.115	.0003	71.9	.30	.1569	.0255	0.395	.55	.0703	.4042	.0793	.80	.0462	.2447
	1.620	.0005	42.1	.31	.1493	.0266	0.361	.56	.0687	.1087	.0758	.81	.0456	.2515
	1.285	.0007	26.5	.32	.1435	.0287	0.331	.57	.0672	.1133	.0726	.82	.0451	.2584
	1.058	.0010	17.97	.33	.1376	.0309	0.304	.58	.0658	.1179	.0696	.83	.0446	.2653
	0.888	.0013	12.68	.34	.1320	.0332	0.280	.59	.0645	.1227	.0668	.84	.0441	.2723
	0.760	.0017	9.28	.35	.1269	.0356	0.259	.60	.0632	.1276	.0641	.85	.0437	.2794
	0.662	.0021	7.03	.36	.1221	.0381	0.240	.61	.0620	.1326	.0617	.86	.0433	.2865
	0.582	.0026	5.45	.37	.1177	.0407	0.222	.62	.0608	.1376	.0594	.87	.0429	.238
	0.518	.0032	4.31	.38	.1135	.0434	0.207	.63	.0597	.1428	.0572	.88	.0425	.3011
	0.466	.0038	3.48	.39	.1096	.0462	.1931	.64	.0586	.1481	.0551	.89	.0421	.3084
	0.421	.0045	2.84	.40	.1060	.0491	.1804	.65	.0575	.1534	.0532	.90	.0418	.3158
	0.383	.0053	2.36	.41	.1026	.0520	.1689	.66	.0565	.1589	.0514	.91	.0414	.3222
	0.351	.0064	1.982	.42	.0993	.0551	.1585	.67	.0559	.1644	.0496	.92	.0411	.3308
	0.325	.0070	1.681	.43	.0963	.0583	.1489	.68	.0547	.1700	.0480	.93	.0408	.3384
	0.299	.0080	1.438	.44	.0934	.0616	.1402	.69	.0538	.1758	.0465	.94	.0406	.3460
	0.278	.0091	1.242	.45	.0907	.0650	.1321	.70	.0530	.1816	.0450	.95	.0403	.3537
	0.259	.0103	1.080	.46	.0882	.0684	.1248	.71	.0521	.1875	.0437	.96	.0401	.3615
	0.243	.0115	0.946	.47	.0857	.0720	.1180	.72	.0514	.1935	.0424	.97	.0399	.3692
	0.228	.0128	0.833	.48	.0834	.0757	.1118	.73	.0506	.1996	.0411	.98	.0398	.3770
	0.215	.0143	0.740	.49	.0813	.0795	.1060	.74	.0499	.2058	.0400	.99	.0397	.3848
												1.00	.0396	.3927

C. Criteria for Hydraulic Design: Open Channels

1. General Hydraulic Criteria

In general, all open channels should be designed with the tops of the walls or levees at or below the adjacent ground to allow for interception of surface flows. If it is unavoidable to construct the channel without creating a pocket, a means of draining the pocket must be provided on the drawings. All local drainage should be completely controlled. External flows must enter the channel at designated locations and through designated inlets unless specifically authorized by the City Engineer/SSCAFCA.

In making preliminary layouts for the routing of proposed channels, it is desirable to avoid sharp curvatures, reversed curvatures, and closely-spaced series of curves. If this is unavoidable, the design considerations in Section C-3 below must be followed to reduce super elevations and to eliminate initial and compounded wave disturbances.

It is generally desirable to design a channel for a Froude number of just under 2.0. In areas within the City of Rio Rancho and SCAFCA jurisdiction this is not always possible because of steep terrain. If the Froude number exceeds 2.0, any small disturbance to the water surface is amplified in the course of time and the flow tends to proceed as a series of "roll waves". Reference is made to Section C-3 for criteria when designing a channel with a Froude number that exceeds 2.0.

In the design of a channel, if the depth is found to produce a Froude number between 0.7 and 1.3 for any significant length of reach, the shape or slope of the channel should be altered to secure a stable flow condition. All analyses should be performed for the 10-year and 100-year design discharges.

2. Water Surface Profile Calculations

a. General

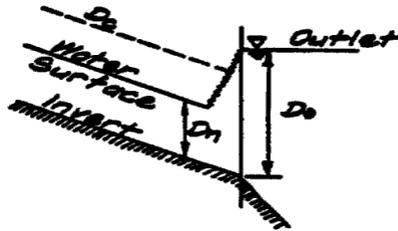
Water surface profile calculations must be calculated using the Bernoulli energy equation (see Section B-2) combined with the momentum equation for analyzing confluences and functions. See Section 2.2.8 for forms used in hand calculations. For use in expediting such calculations, computer programs are available from many sources, such as the U.S. Army Corps of Engineers and from industry accepted commercial software.

b. Determination of Controlling Water Surface Elevation

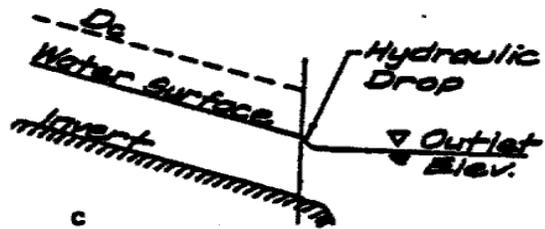
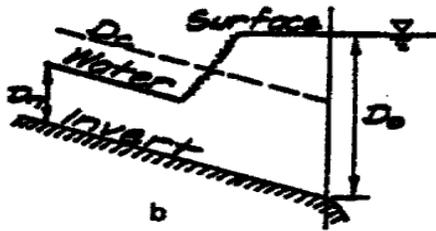
The following are general control points for the calculation of the water surface profile:

- (1) Where the channel slope changes from mild to steep or critical, the depth at the grade break is critical depth.
- (2) Where the channel slope changes from critical to steep, the depth at the grade break is critical depth.

- (3) Where a discharging or outletting channel or conduit is on a mild slope, the water surface is generally controlled by the outlet (see Section B-2.1).
- (4) When a channel on a steep slope discharges into a facility that has a water surface depth greater than the normal depth of the channel, calculate pressure plus momentum for normal depth and compare it to the pressure plus momentum for the water surface depth at the outlet according to the equation, $P_n + M_n \sim P_o + M_o$.
- (a) If $P_n + M_n > P_o + M_o$, this indicates upstream control with a hydraulic jump at the outlet.



- (b) If $P_n + M_n < P_o + M_o$, this indicates outlet control with a hydraulic jump probably occurring upstream.



- (c) Where the water surface of the outlet is below the water surface in the channel or conduit, control is upstream and the outflow will have the form of a hydraulic drop.

When there is a series of control points, the one located farthest upstream is used as a starting point for water surface calculation.

c. Direction of Calculation

Calculations proceed upstream when the depth of flow is greater than critical depth and proceed downstream when the depth of flow is less than critical depth.

d. Head Losses

(1) Friction Loss

Friction losses or open channels shall be calculated by an accepted form of the Manning equation. The Manning equation is commonly expressed as follows:

$$Q = \frac{1.486}{n} A R^{2/3} S_f^{1/2}$$

in which

- Q = Flow rate, in c.f.s.
- n = Roughness coefficient
- A = Area of water normal to flow, in ft.²
- R = Hydraulic radius
- S_f = Friction slope

When arranged into a more useful form,

$$S_f = \frac{2gn^2}{2.21} \left[\frac{V^2}{2g} / R^{4/3} \right]$$

The loss of head due to friction throughout the length of reach involved (L) is calculated by:

$$h_f = S_f \cdot L$$

Refer to the appendix for values of "n" for different materials and corresponding values of

$$\frac{2gn^2}{2.21}$$

(2) Junction Loss

Junction losses will be evaluated by the pressure plus momentum equation and must conform to closed conduit angle of confluence criteria, Section B-5. Refer to Section 2.2.8 for cases and alternate solutions.

e. Channel Inlets

(1) Side Channels

Flow rates of 25% or more of the main channel flow must be introduced to the main channel by a side channel hydraulically similar to the main channel. Piping systems can be used to introduce side flows, if justification is provided satisfactory to the City/SSCAFCA. The centerline radius of the side channel may not be less than the quantity $(QV/100)$ in feet.

Velocity and depth of the flows in the side channel when introduced into the main channel must be matched to within 1 foot of velocity head and to within 20% of the flow depth for both the 10-year and 100-year design discharges and the four combinations of side inlet and main channel flows which result. Energy and momentum balance type calculations must be provided to support all designs involving side channels.

(2) Surface Inlets

When the main channel is relatively narrow and when the peak discharge of side inflow is in the range between 3 and 6 percent of the main channel discharge, high waves are usually produced by the side inflow and are reflected downstream for a long distance, thus requiring additional wall height to preclude overtopping of the channel walls. This condition is amplified when the side inflow is at a greater velocity than the main channel. To eliminate these wave disturbances, the Los Angeles District of the Corps of Engineers has developed a side channel spillway inlet. The City or SSCAFCA may require this type of structure when outletting into one of their facilities, and its use should be considered for city channels if high waves above the normal water surface cannot be tolerated. See Subsection "f" below titled "Transitions" for the Corp's procedure and criteria.

Surface-type inlets shall be constructed of concrete having a minimum thickness of 7 inches and shall be reinforced with the same steel as [7Type equation here.](#) concrete lining. The upstream end of the surface inlet shall be provided with a concrete cutoff wall having a minimum depth of three feet and the downstream end of the inlet shall be connected to the channel lining by an isolation joint. Side slopes of a surface inlet shall be constructed at slopes no greater than 1 vertical to 10 horizontal to allow vehicular passage across the inlet where a service road is required.

Drainage ditches or swales immediately upstream of a surface inlet shall be provided with erosion protection consisting of concrete lining, rock riprap or other non-erosive material.

Surface inlets shall enter the channel at a maximum of 90° to the channel centerline, i.e., they may not point upstream.

(3) Direct Pipe to Channel

Junctions involving direct pipe connection to a channel must conform to the criteria listed in Section 5 of the closed conduit criteria. Additionally, pipe and box culvert inlets to channels shall be isolated by expansion joints. Continuously reinforced channels shall be designed to accommodate any extra stress resulting from these discontinuities. Paragraph 18(h), Corps of Engineers EM 1110-2-1061 has additional design criteria.

f. Transitions

(1) Subcritical Flow

For subcritical velocities less than 12 f.p.s., the angle of convergence or divergence between the center line of the channel and the wall must not exceed 12° 30'. The length of the transition (L) is determined from the following equation:

$$L \geq 2.5 \Delta B$$

For subcritical velocities equal to or greater than 12 f.p.s., the angle of convergence or divergence between the center line of the channel and the wall must not exceed 5° 45'. The length (L) is determined from the following equation:

$$L \geq 5.0 \Delta B$$

Head losses for transitions with converging walls in subcritical flow conditions can be determined by using either the P + M method or the Thompson equation, both of which are shown in Section 2.2.8. For transitions, both methods are applicable in all cases and will give the same results.

(2) Supercritical Flow

(a) Divergent Walls

The angle of divergence between the center line of the channel and the wall must not exceed 5° 45' or $\tan^{-1} F/3$ whichever is smaller. The length of the transition (L) is the longest length determined from the following equations:

$$L \geq 5.0 \Delta B$$

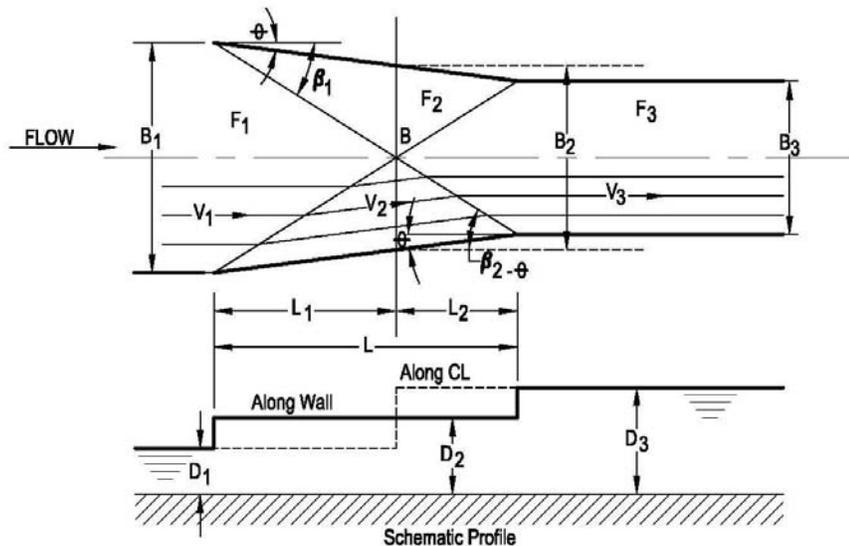
$$L \geq 1.5 \Delta B \cdot F$$

where F = Upstream Froude number based on depth of flow
 ΔB = The difference in channel width at the water surface

(b) Convergent Walls

Convergent walls > 5 degrees - 45 degrees shall only be used at the discretion of the City/SSCA/FCA and based on an approved oblique wave analysis.

Converging walls should be avoided when designing channels in supercritical flow; however, if this is impractical, the converging transition will be designed to minimize wave action. The walls of the transition should be straight lines.



$$L = \frac{B_1 - B_3}{2 \tan \theta}$$

$$\frac{B_1}{B_3} = \left(\frac{D_3}{D_1} \right)^{3/2} \cdot \left(\frac{F_3}{F_1} \right)$$

CONVERGENT WALL SCHEMATIC

With the initial Froude number and the contraction ratio fixed, and with the continuity equation giving trial curves can produce the geometry of the construction suggested above. The curves represent the equation:

$$\frac{B_1}{B_3} = \left(\frac{D_3}{D_1} \right)^{3/2} = \frac{F_3}{F_1}$$

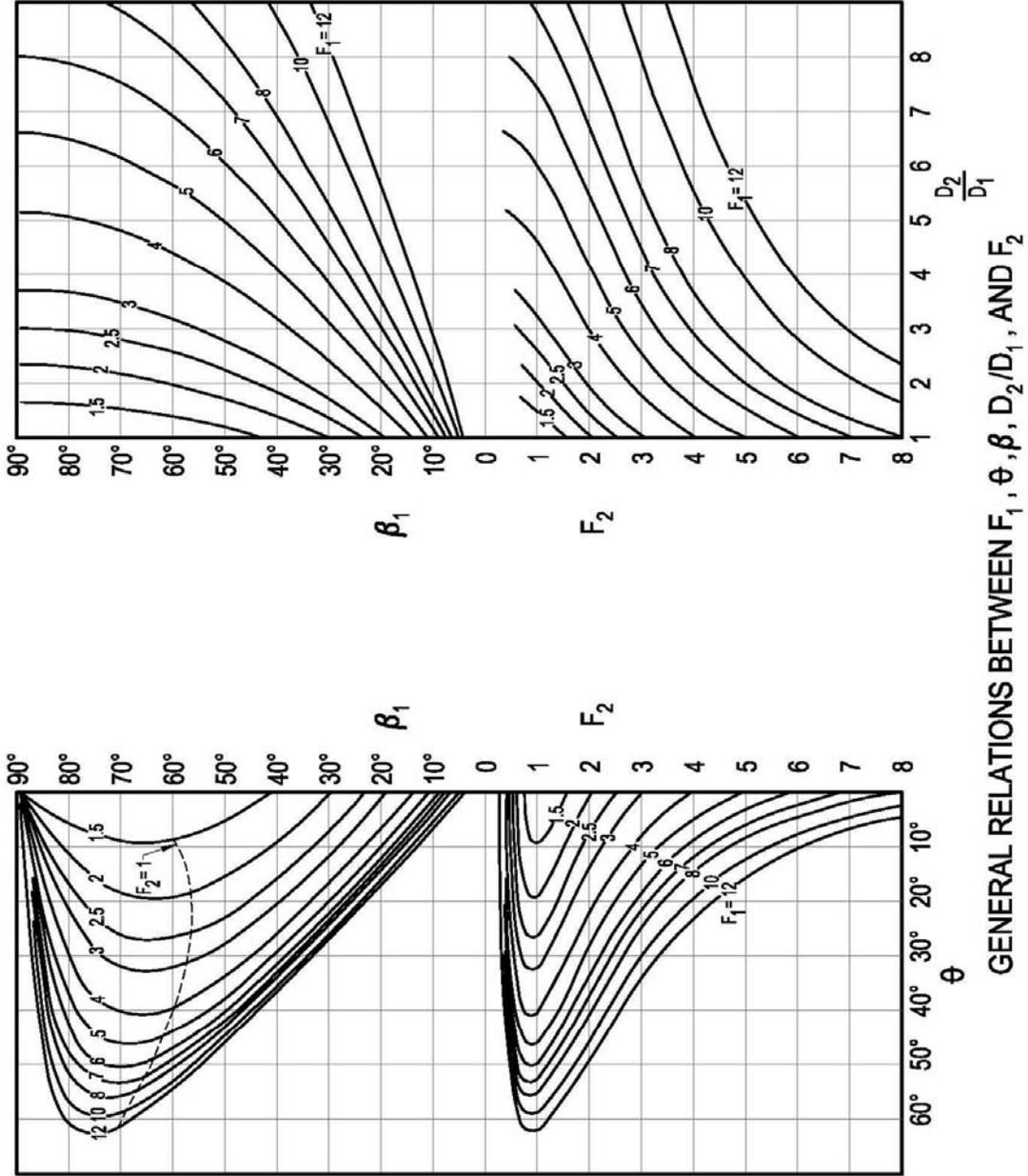
Refer to Plate 2.2.3 C-1 and to the example problem in Section 2.2.8.

(3) Transitions Between Channel Treatment Types

(a) Earth Channel to Concrete Lining Transition

The mouth of the transition should match the earth channel section as closely as practicable. Wing dikes and/or other structures must be provided to positively direct all flows to the transition entrance.

CONVERGING TRANSITION - SUPERCRITICAL FLOW



GENERAL RELATIONS BETWEEN F_1 , ϕ , β , D_2/D_1 , AND F_2

PLATE 22.3 C-1

The upstream end of the concrete lined transition will be provided with a cutoff wall having a depth of 1.5 times the design flow depth but at least 3.0 feet and extending the full width of the concrete section. Erosion protection directly upstream of the concrete transition consisting of grouted or dumped rock riprap at least 12 feet in length and extending full width of the channel section must be provided. Grouted riprap must be at least 12 inches thick. Dumped riprap must be properly sized, graded and projected with gravel filter blankets.

The maximum allowable rate of bottom width transition is 1 to 7.5 maximum. Grout, dumped, or wire-tied material may also be used if approved on a case-by-case basis by the City Engineer/SSCAFCA. Grouted and wire-tied material require gravel filters as well.

(b) Concrete Lining to Earth Channel Transition

The transition from concrete lined channels to earth channels will include an energy dissipator as necessary to release the designed flows to the earth channel at a relatively non-erosive condition.

Since energy dissipator structures are dependent on individual site and hydraulic conditions, detailed criteria for their design has been purposely excluded and only minimum requirements are included herein for the concrete to earth channel transition.

On this basis, the following minimum standards govern the design of concrete to earth channel transitions:

- ▶ Maximum rate of bottom width transitions:

Water Velocity

0-15 f.p.s.	1:10
16-30 f.p.s.	1:15
31-40 f.p.s.	1:20

- ▶ The downstream end of the concrete transition structure will be provided with a cutoff wall having a minimum depth of 6 feet and extending the full width of the concrete section or as recommended by the engineer and accepted by the City Engineer/SSCAFCA.
- ▶ Directly downstream of the concrete transition structure erosion protection consisting of rough, exposed surface, grouted rock riprap and extending full width of the channel section shall be provided. The grouted rock riprap should be a minimum of 12 inches thick. Grout, dumped, or wire-tied material may also be used if approved on a case-by-case basis by the City Engineer/SSCAFCA. Grouted and wire-tied material require gravel filters as well. The length of riprap shall be determined by engineering analysis.

g. Piers

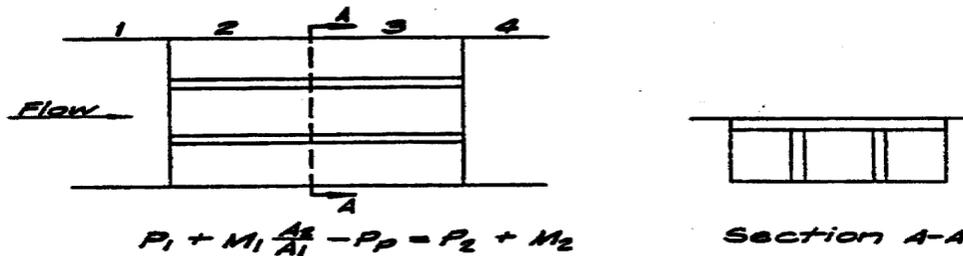
(1) General

The effect of piers on open channel design must be considered at bridge crossings and where an open channel or box conduit not flowing full discharges into a length of multi-barreled box. This effect is especially important when flow is supercritical and when transported debris impinges on the piers.

The total pier width includes an added width for design purposes to account for debris. Inasmuch as the debris width to be used in design will vary with each particular situation, the City Engineer/SSCAFCA will be contacted during the preliminary design stages of a project for a determination of the appropriate width. Streamline piers should be used when heavy debris flow is anticipated. Refer to Section 2.2.8 for design data regarding streamline piers.

The water surface elevations at the upstream end of the piers is determined by equating pressure plus momentum. The water surface profile within the pier reach is determined by the Bernoulli equation. The water surface elevations at the downstream end of the piers may be determined by applying either the pressure plus momentum equation or the Bernoulli equation.

(2) Pressure plus Momentum (P + M) Equation as Applied to Bridge Piers



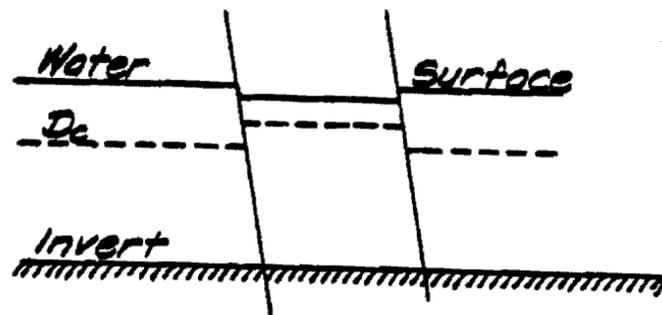
- where P_1 = Hydrostatic pressure in unobstructed channel
 M_1 = Kinetic momentum in unobstructed channel
 where A_1 = Area of unobstructed channel
 A_2 = $A_1 - K_p A_p$ = Area of water within bridge
 P_2 = Hydrostatic pressure within bridge based on net flow area
 M_2 = Kinetic momentum within bridge based on net flow area
 P_p = $K_p A_p Y_p$ = Hydrostatic pressure of bridge pier
 A_p = Area of piers
 Y_p = Centroidal moment arm of A_p about the hydraulic grade at the section
 K_p = Pier factor
 K_p = 1.0 for square-nosed piers
 K_p = 2/3 for round-nosed piers
 (Subscripts indicate the applicable section)

Plate 2.2.3 C-2 is a graphical representation of the method presented above. Plate 2.2.3 C-3 and 2.2.3 C-4 are a graphical solution of the above P + M equation.

(3) Hydraulic Analysis

For subcritical or critical flow, the following cases, numbers 1 or 2, generally apply.

- (a) If the depth which balances the P + M equation at the downstream end is equal to or above D_c within the piers, continue the water surface calculations to the upstream face of the bridge piers. Calculate the depth upstream of the piers by equating pressure plus momentum.



BRIDGE PIER LOSSES BY THE MOMENTUM METHOD

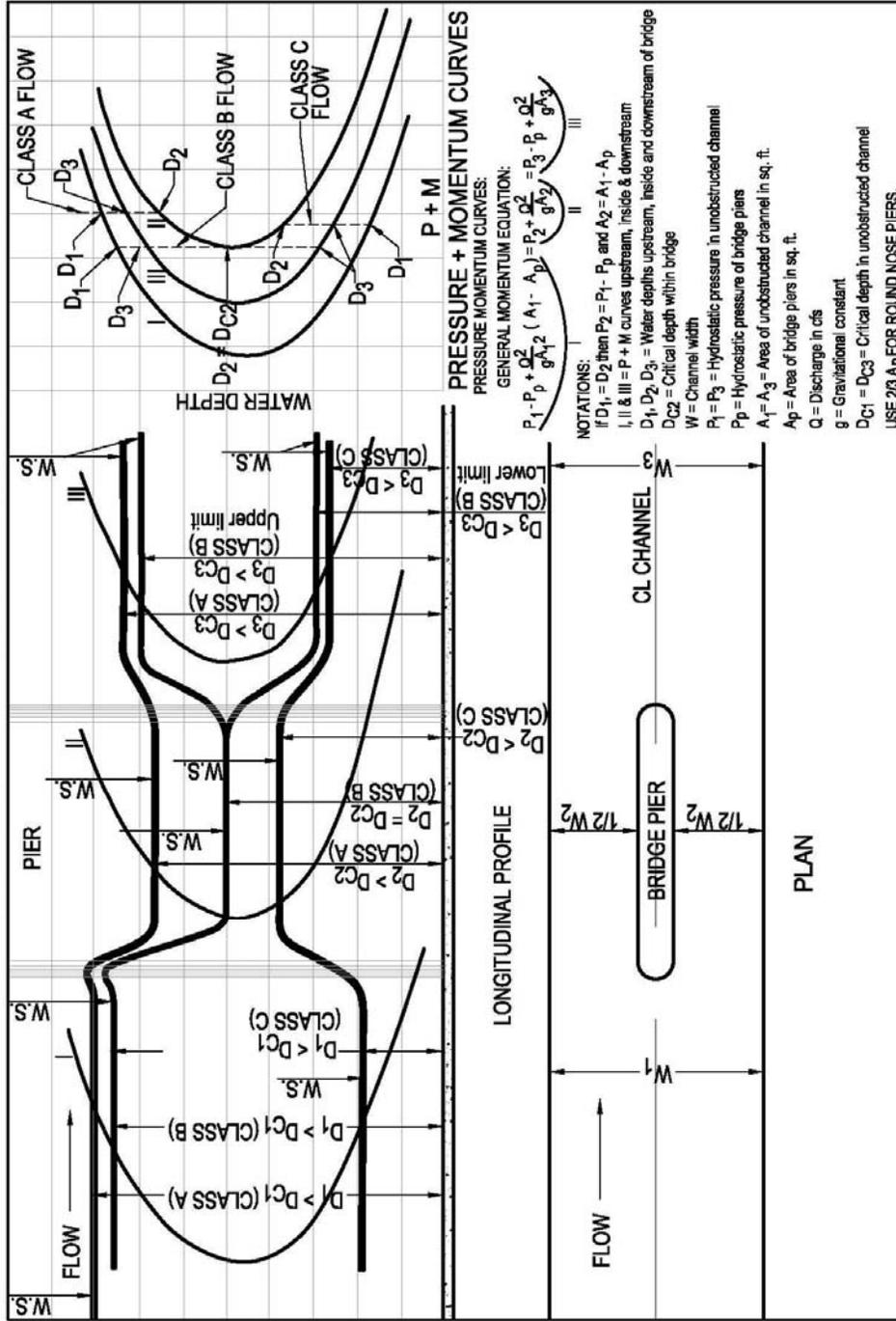


PLATE 22.3 C-2

APPROXIMATE BRIDGE PIER LOSSES BY MOMENTUM METHOD

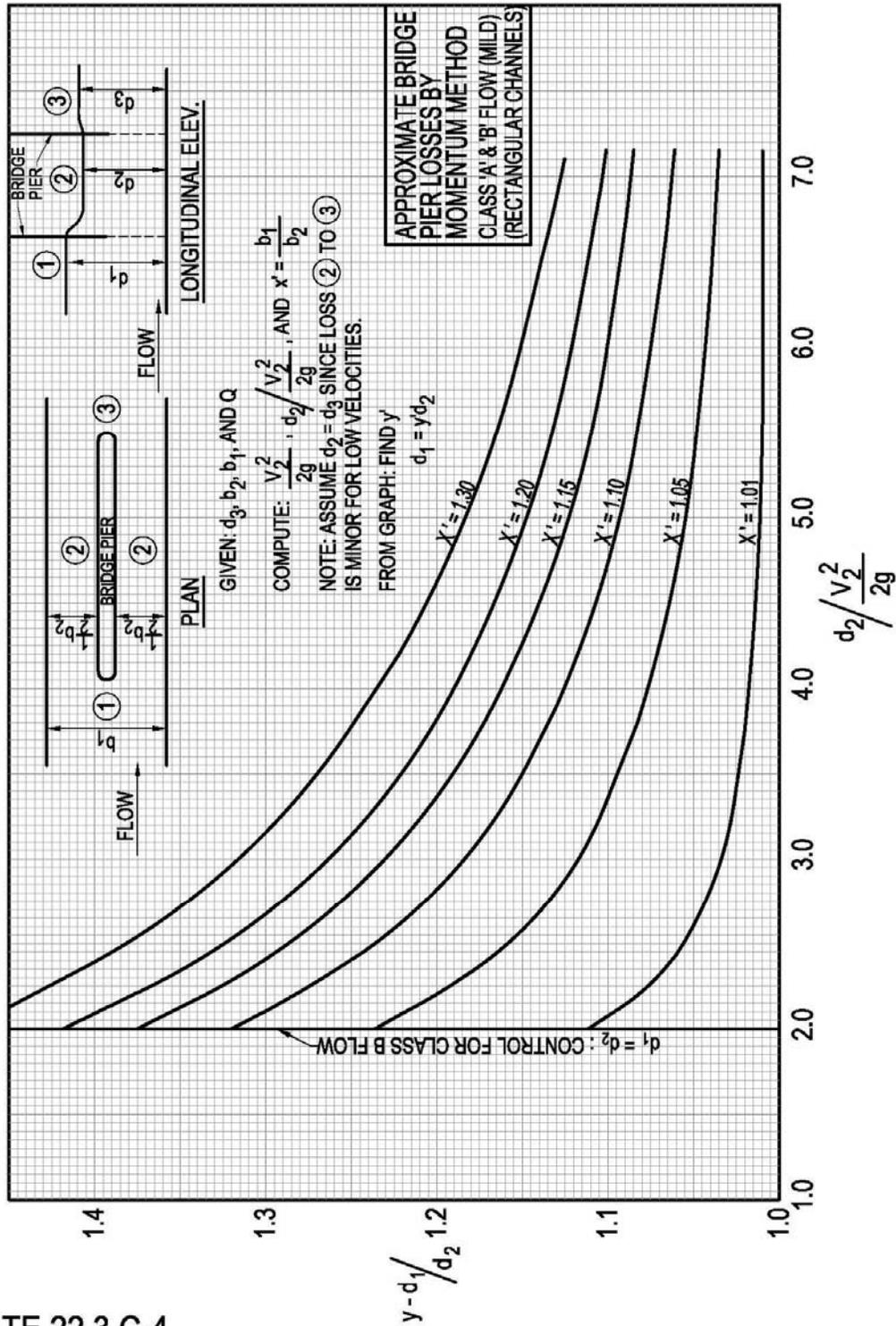
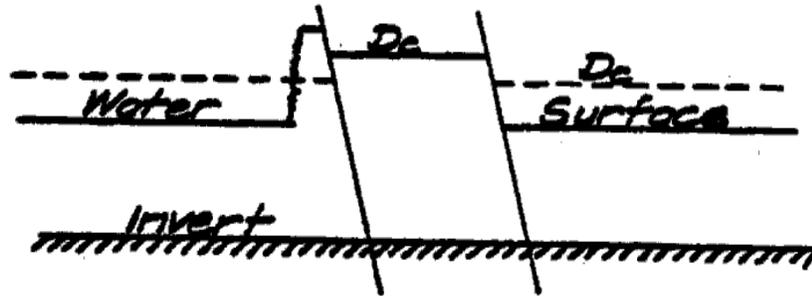


PLATE 22.3 C-4

the pier and its sequent depth. If the lower stage results in the greater sum (P + M), this indicates a hydraulic jump at the upstream face of the pier. If the upper stage results in the greater sum (P + M), this indicates a hydraulic jump some distance upstream from the pier. Assume critical depth just inside the upstream pier face and continue the water surface to the downstream end of the pier, and then calculate the depth just outside the pier by either the P + M equation or the Bernoulli equation.



3. Curving Alignments

a. Superelevation

Superelevation is the maximum rise in water surface at the outer wall above the mean depth of flow in an equivalent straight reach, caused by centrifugal force in a curving alignment.

(1) Rectangular Channels

For subcritical velocity, or for supercritical velocity where a stable transverse slope has been attained by an upstream easement curve, the superelevation (s) can be calculated from the following equation:

$$S = \frac{V^2 b}{2g r}$$

For supercritical velocity in the absence of an upstream easement curve, the superelevation (S) is given by the following equation:

$$S = \frac{V^2 b}{g r}$$

- where V = velocity of the flow cross section, in f.p.s.
 b = Width of the channel, in ft.
 g = Acceleration due to gravity
 r = Radius of channel center line curve, in ft.
 X = Distance from the start of the circular curve to the point of the first S in ft.
 D = Depth of flow for an equivalent straight reach
 B = Wave front angle

$$X = \frac{\pi b V}{\sqrt{12gD}} = \frac{.16bV}{\sqrt{D}} = \frac{0.908b}{\sin \beta}$$

$$\sin \beta = \frac{\sqrt{gD}}{V} = \frac{1}{F}$$

"S" will not be uniform around the bend but will have maximum and minimum zones which persist for a considerable distance into the downstream tangent.

(2) Trapezoidal Channels

For subcritical velocity, the superelevation (S) can be calculated from the following equation:

$$S = 1.15 \quad V^2 (b + 2 z D) / 2 g r$$

- where z = cotangent of bank slope
 b = channel bottom width, in ft.

For supercritical velocity, curving alignments shall have easement curves with a superelevation (S) given by the following equation:

$$S = 1.3 \quad V^2 (b + 2 z D) / 2 g r$$

(3) Unlined Channels

Unlined channels will be considered trapezoidal insofar as superelevation calculations are concerned. However, this does not apply to calculations of stream or channel cross-sectional areas.

4. Freeboard:

Freeboard is the additional wall height applied to a calculated water surface. This criteria can be superseded by other government regulations/requirements.

- a. Rectangular Channels will not be used except with City Engineer/SSCAFCA's approval)

b. Trapezoidal Channels and Associated Types

Adequate channel freeboard above the designed water surface must be provided and will not be less than the amount determined by the following:

- (1) For flow rates of less than 100 c.f.s. and average flow velocity of less than 35 f.p.s.:

$$\text{Freeboard (Feet)} = 1.0 + 0.025 Vd^{1/3}$$

- (2) For flow rates of 100 c.f.s. or greater and average flow velocity of 35 f.p.s. or greater:

$$\text{Freeboard (Feet)} = 0.7 (2.0 + 0.025 Vd^{1/3})$$

Freeboard will be in addition to any superelevation of the water surface, standing waves and/or other water surface disturbances. When the total expected height of disturbances is less than 0.5 feet, disregard their contribution.

Unlined portions of the drainage way may not be considered as freeboard unless specifically approved by the City Engineer/SSCAFCA.

For supercritical flow where the specific energy is equal to or less than 1.2 of the specific energy at D_c , the wall height will be equal to the sequent depth, but not less than the heights required above. This condition should be avoided.

c. Roll Waves

Roll waves are intermittent surges on steep slopes that will occur when the Froude Number (F) is greater than 2.0 and the channel invert slope (S_0) is greater than the quotient, twelve divided by the Reynolds Number. When they do occur, it is important to know the maximum wave height at all points along the channel so that appropriate wall heights may be determined based on the experimental results of roll waves as identified by Richard R. Brock, so that the maximum wave height can be estimated.

For details, see "Development of Roll Waves in Open Channels", Report No. KH-R-16, California Institute of Technology, July 1967. Refer also to Plates 2.2.3 C-5, 2.2.3 C-6 and 2.2.3 C-7, and to the example problem in Section 2.2.8.

5. Other Criteria

a. Unlined Channels

After full consideration has been given to the soil type, velocity of flow, desired life of the channel, economics, availability of materials, maintenance and any other pertinent factors, an unlined earth channel may be approved for use.

Generally, its use is acceptable where erosion is not a factor and where mean velocity does not exceed 3 f.p.s. Old and well-seasoned channels will stand higher velocities than new ones; and with other conditions the same, deeper channels will convey water at a higher nonerodible velocity than shallower ones. Additional information is provided in Section 2.2.8.

Maximum side slopes are determined pursuant to an analysis of soil reports. However, in general, slopes should be 6:1 or flatter with erosion protection measures.

b. Composite Linings

In case part of the channel cross section is unlined or the linings are composed of different materials, a weighted coefficient must be determined using the roughness factors for the materials as given in Table 2.2.3 B-1. If the lining materials are represented by the subscripts "a", "b" and "c", and the wetted perimeters by "P", the weighted value of "n" for the composite section is given by the following equation:

$$n = \frac{[P_a n_a^{3/2} + P_b n_b^{3/2} + P_c n_c^{3/2}]^{2/3}}{P}$$

ROLL WAVES

Maximum Wave Height

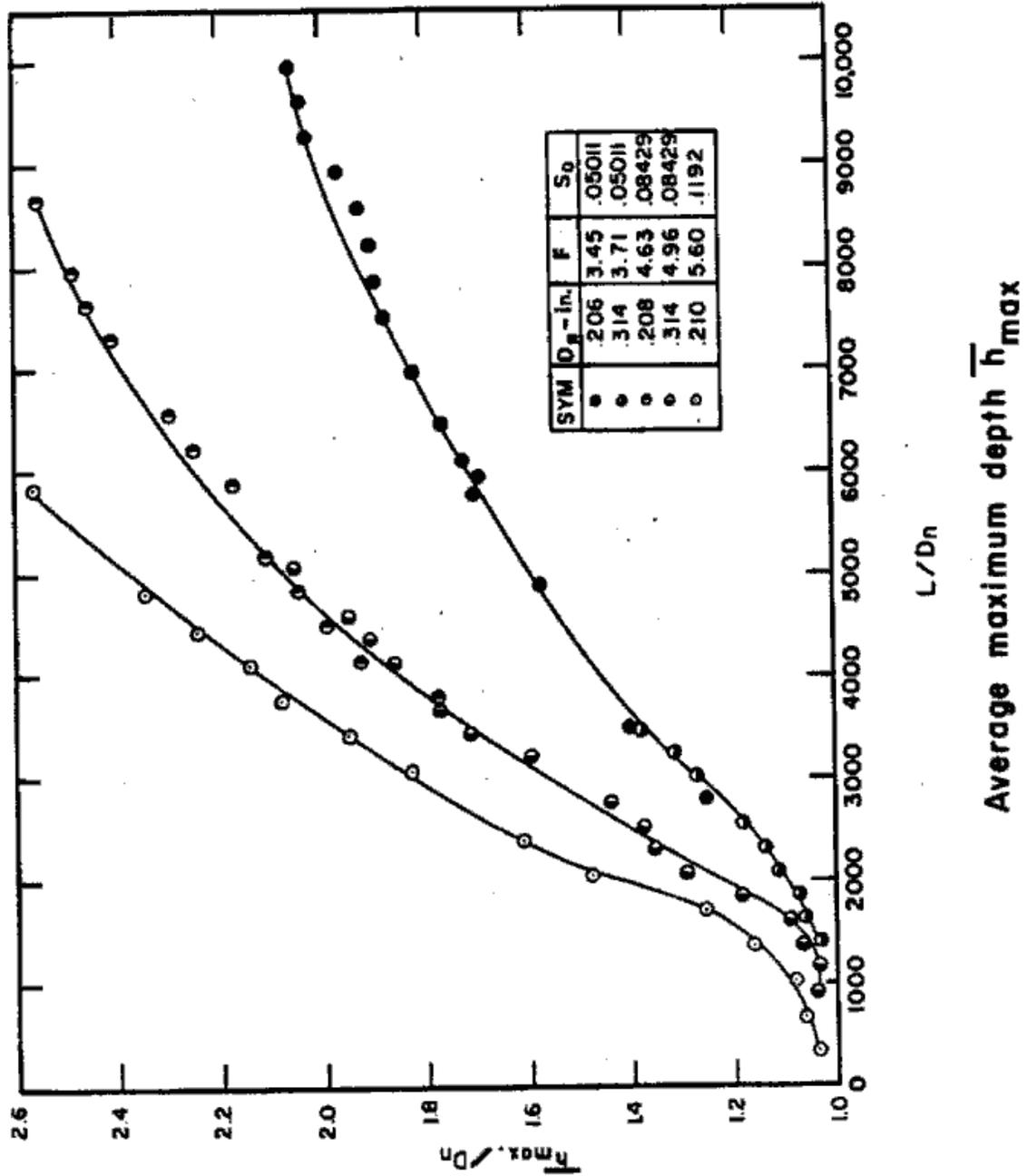
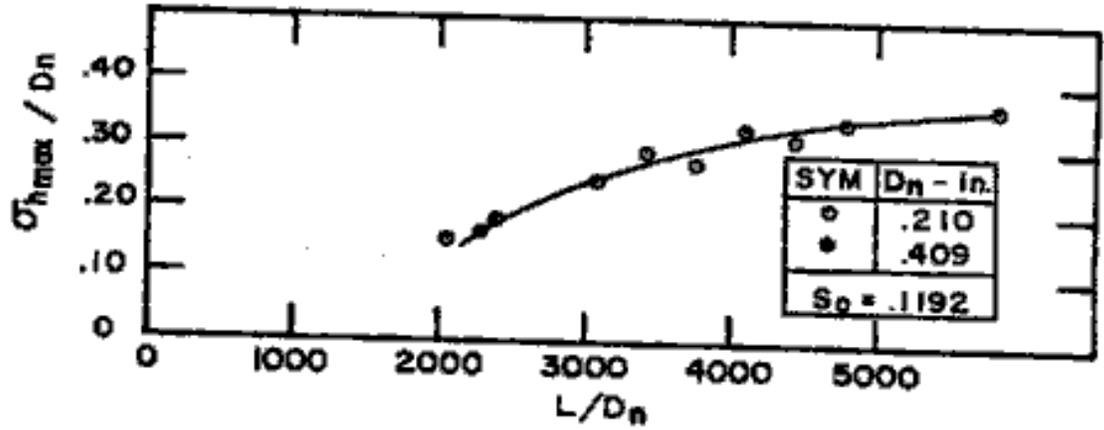
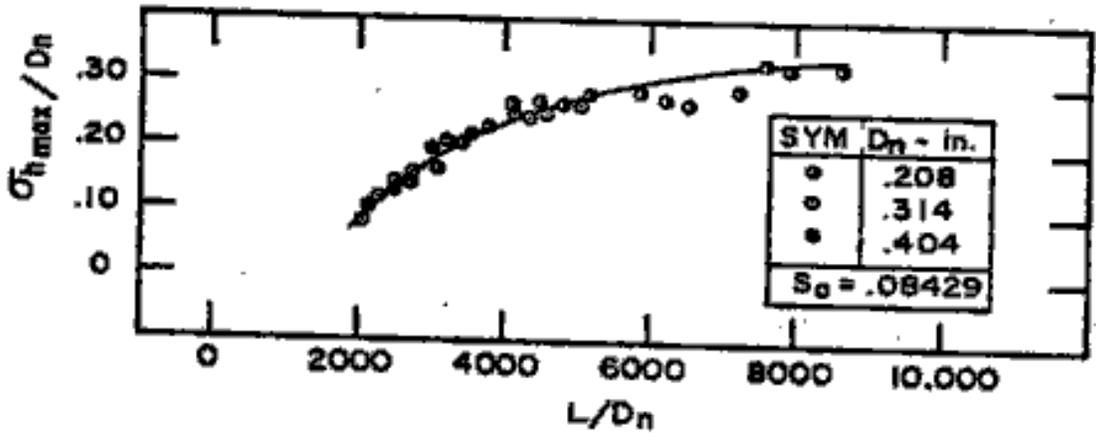
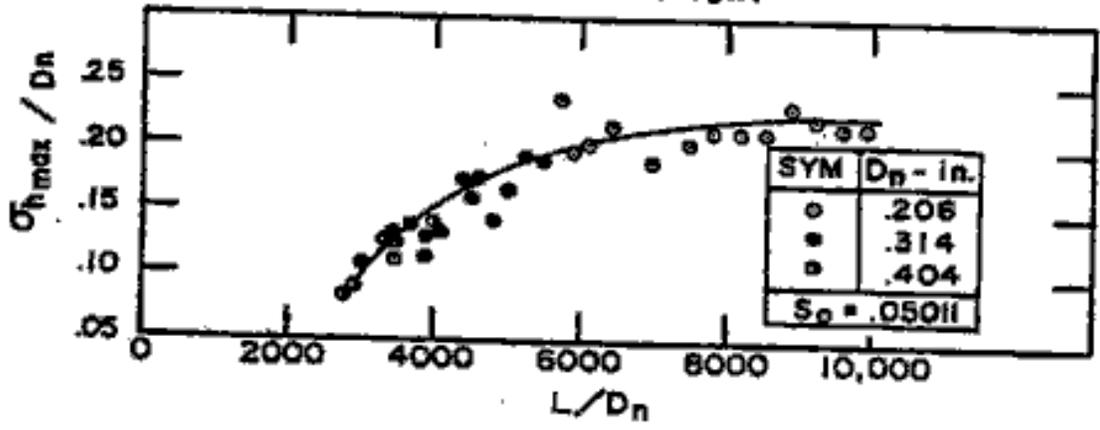


PLATE 22.3 C-5

ROLL WAVES
Maximum Wave Height



Standard deviation of the maximum depth, $\sigma_{h_{max}}$.

PLATE 22.3 C-6

ROLL WAVES
Maximum Wave Height

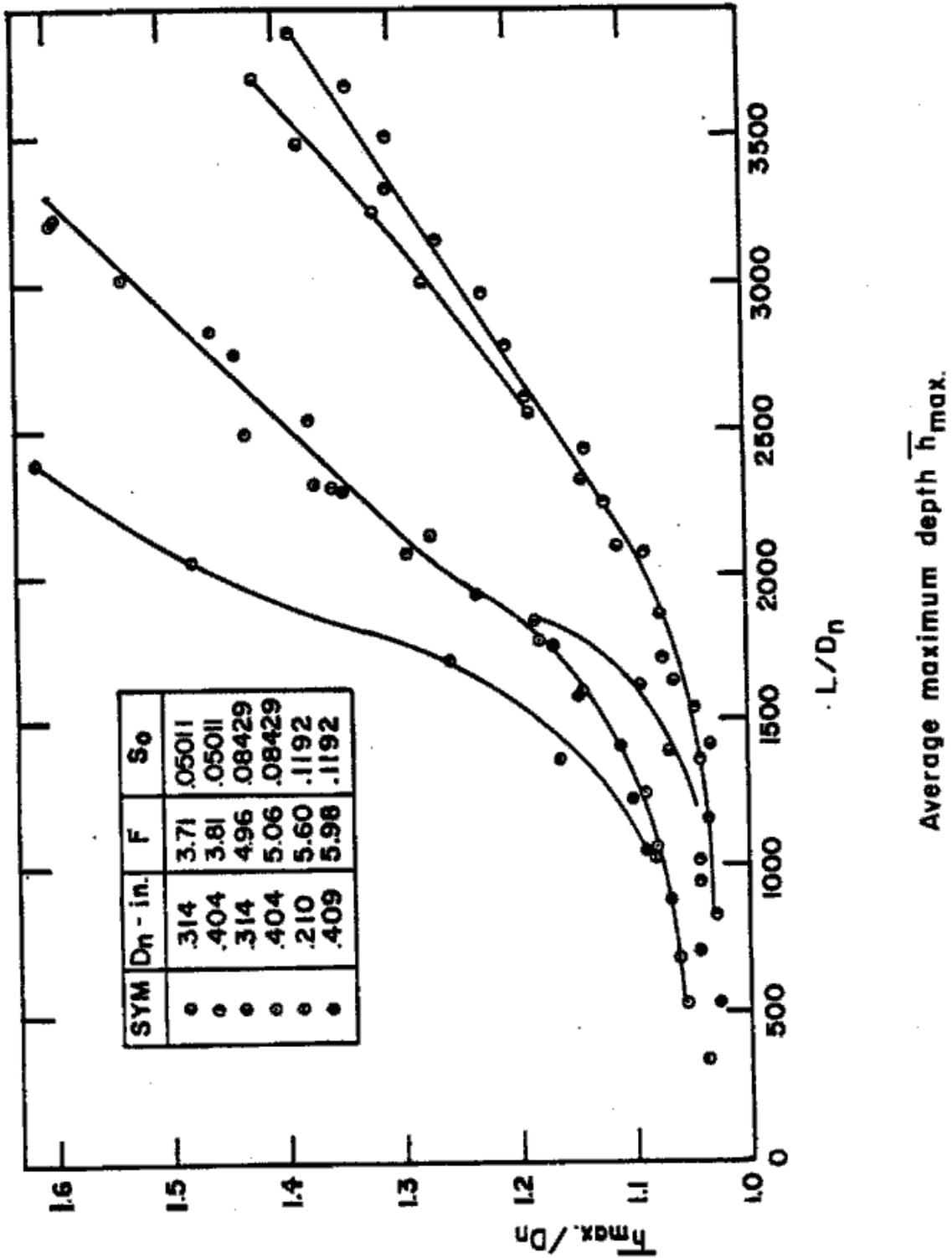


PLATE 22.3 C-7

c. Maximum Sidewall Slopes (Freeboard Area)

The following sidewall slopes are generally the maximum values used for channels on at least one side of the concrete lined channel.

<u>Lining Material</u>	<u>Maximum Slope</u>
Soil Cement	2:1
Portland Cement Concrete	Vertical (Trapezoidal 2:1)
Grouted Rock Rip-Rap	2:1
Dumped Rock Rip-Rap	2:1
Earth Lined	6:1
Grass Lined (sodded)	6:1
Gravel Mulch	6:1

d. Channel Maintenance and Access Road

A maintenance and access road having a minimum of 12 feet top width shall be provided on both sides of improved channels. The roads should be sloped away from the channel, and roadway runoff carried in a controlled manner to the channel. In some cases the City Engineer/SSCAFCA may require additional width. Channel maintenance and access roads shall be surfaced with gravel base course. The thickness of said base course shall be 6 inches.

Turnouts will be provided at no more than ½ mile intervals and turnarounds must be provided at all access road dead ends.

Ingress and egress from public right-of-way and/or easements to the channel maintenance and access roads must be provided.

e. Channel Access Ramps

Channel access ramps for vehicular use will be provided as necessary for complete access to the channel throughout its entire length with the maximum length of channel between ramps being one-half mile.

Ramps shall be constructed of 8" thick reinforced concrete and will not have slopes greater than 10% and ramps shall not enter the channel at angles greater than 15% from a line parallel to the channel centerline.

Ramps may be constructed on one side of the channel and must be approved by the City/SSCAFCA. The maintenance and access road on the "ramp" side shall be offset around the ramp to provide for continuity of the road full length of the channel.

The downhill direction of the ramp should be oriented downstream.

f. Street Crossings

Street crossing or other drainage structures over the concrete lined channel should be of the all weather type, i.e., bridges or concrete box culverts. Crossing structures should conform to the channel shape in order that they disturb the flow as little as possible.

It is preferred that the channel section be continuous through crossing structures. However, when this is not practicable, hydraulic disturbance shall be minimized, and crossing structures should be suitably isolated from the channel lining with appropriate joints.

Street crossing structures shall be capable of passing the 100 year frequency design storm flow.

Channel lining transitions at bridges and box culverts should conform to the provisions for transitions hereinafter provided. Drainage structures having a minimum clear height of 8 feet and being of sufficient width to pass maintenance vehicles may result in minimizing the number of required channel access ramps. Unless otherwise specifically authorized by the City Engineer/SSCAFCA, all crossing structures must have at least 8.0 feet of clear height.

g. Subdrainage

Concrete lined channels to be constructed in areas where the ground water table is greater than two feet below the channel invert, weep holes or other subdrainage systems are not required.

Areas where the ground water table is within two feet or less of the channel bottom, there shall be provided, special subdrainage systems as necessary to relieve water pressures from behind the channel lining.

D. Storm Inlets

1. Design Q

The Design Q for storm inlet design should be determined based on the following procedures.

- a. Outline the drainage area on a map with an appropriate scale.
- b. Outline the drainage area tributary to each proposed storm inlet, designating this area with the corresponding subarea number and with a letter (2A, 2B, 2C, etc.). Drainage areas should be differentiated by color or line type.
- c. Calculate the tributary area in acres for each storm inlet or battery of storm inlets.

- d. Assuming satisfactory drainage area relationships, the storm inlet design Q will be calculated as follows:

$$Q_{DES} = \frac{Q_P A}{A_T}$$

where A = Area in acres tributary to storm inlet
A_T = Total area in acres of the appropriate subarea
Q_P = Peak Q from appropriate subarea, in c.f.s.
(Refer to the example problem in Section 2.2.8)

In cases where the main line design Q's are reduced because of a restricted outlet, the storm inlet design Q's must be reduced by the same percentage.

If, during the design of a project, it is determined that the proposed storm inlet interception points will change the interception points assumed in the main line hydrology, then the main line Q's should be adjusted accordingly.

2. Required Data and Calculations

a. Street Flow Carrying Capacity

Submitted data should include complete cross sections between property lines of streets at the proposed storm inlet and of any streets which control the flow of water to the pertinent locations. Street cross sections should indicate the following:

- (1) Dimensions from the street center line to the top of curb and property line.
- (2) Gutter slope upstream of each storm inlet .
- (3) Elevations for the top of curb, flow line, property line and street crown at each storm inlet center line.
- (4) Curb batter.

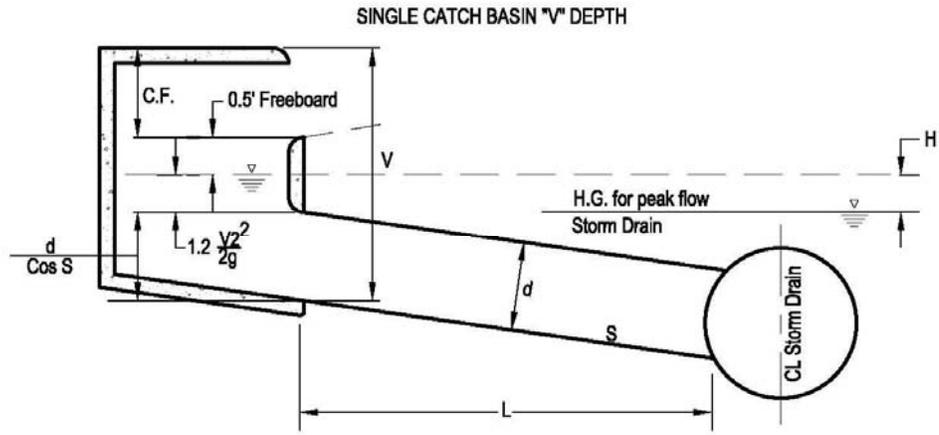
Please refer to Plates 2.2.3 D-1 to 2.2.3 D-4 inclusive, for nomographs giving street capacities for some typical street sections. These nomographs have been developed for 8" curb heights. Be aware that the City of Rio Rancho standard height is 6".

b. Storm Inlet Size and Type

Size and type of storm inlet should be determined by physical requirements and by inlet flow capacities given in Plates 2.2.3 D-5 to 2.2.3 D-7, inclusive. Criteria used, if other than those recommended in this section, must be cited and accompanied by appropriate calculations.

c. Connector Pipe and "V" Depth Calculation

(1) Single Storm Inlet



STREET CAPACITY

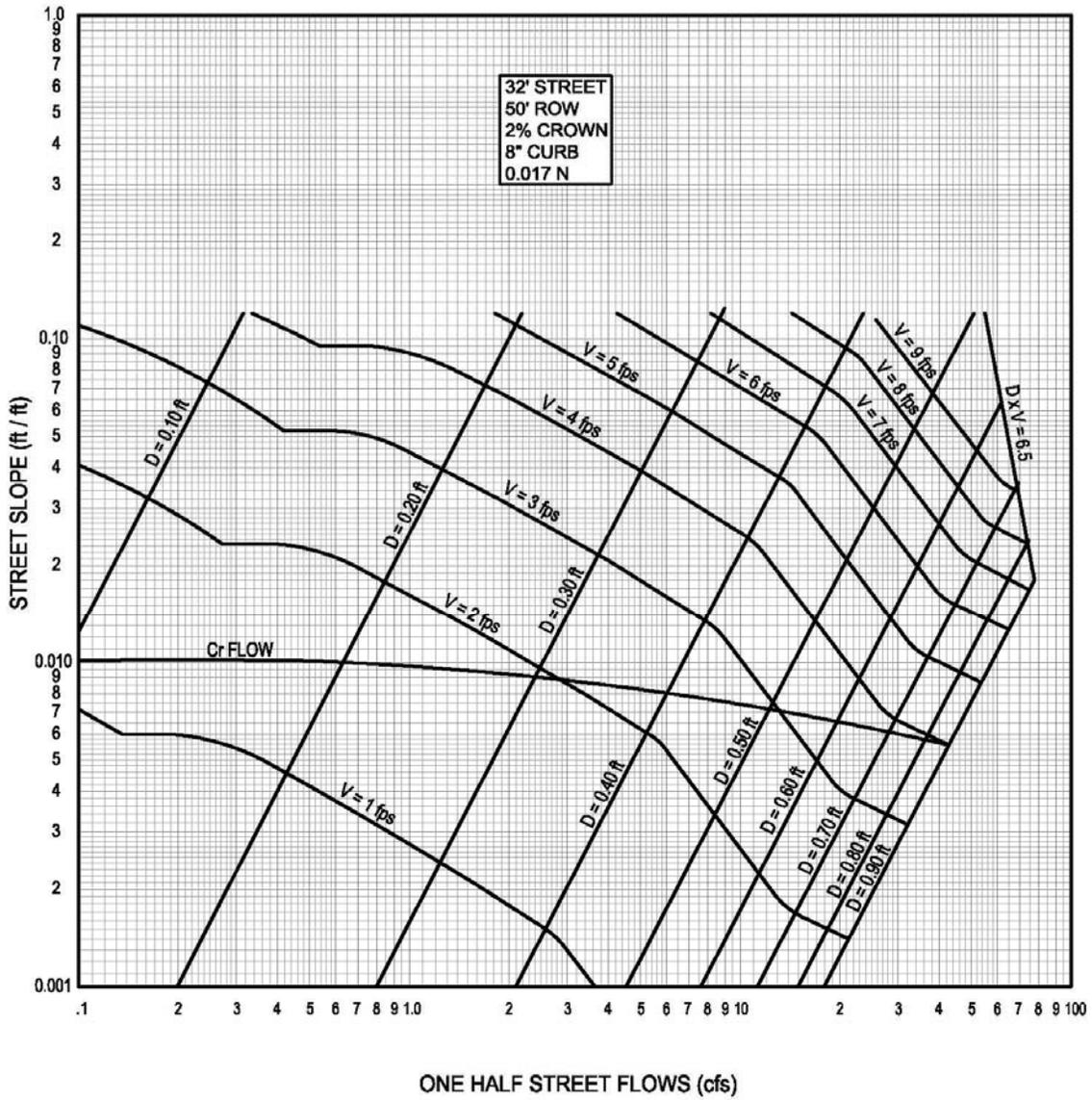


PLATE 22.3 D-1

STREET CAPACITY

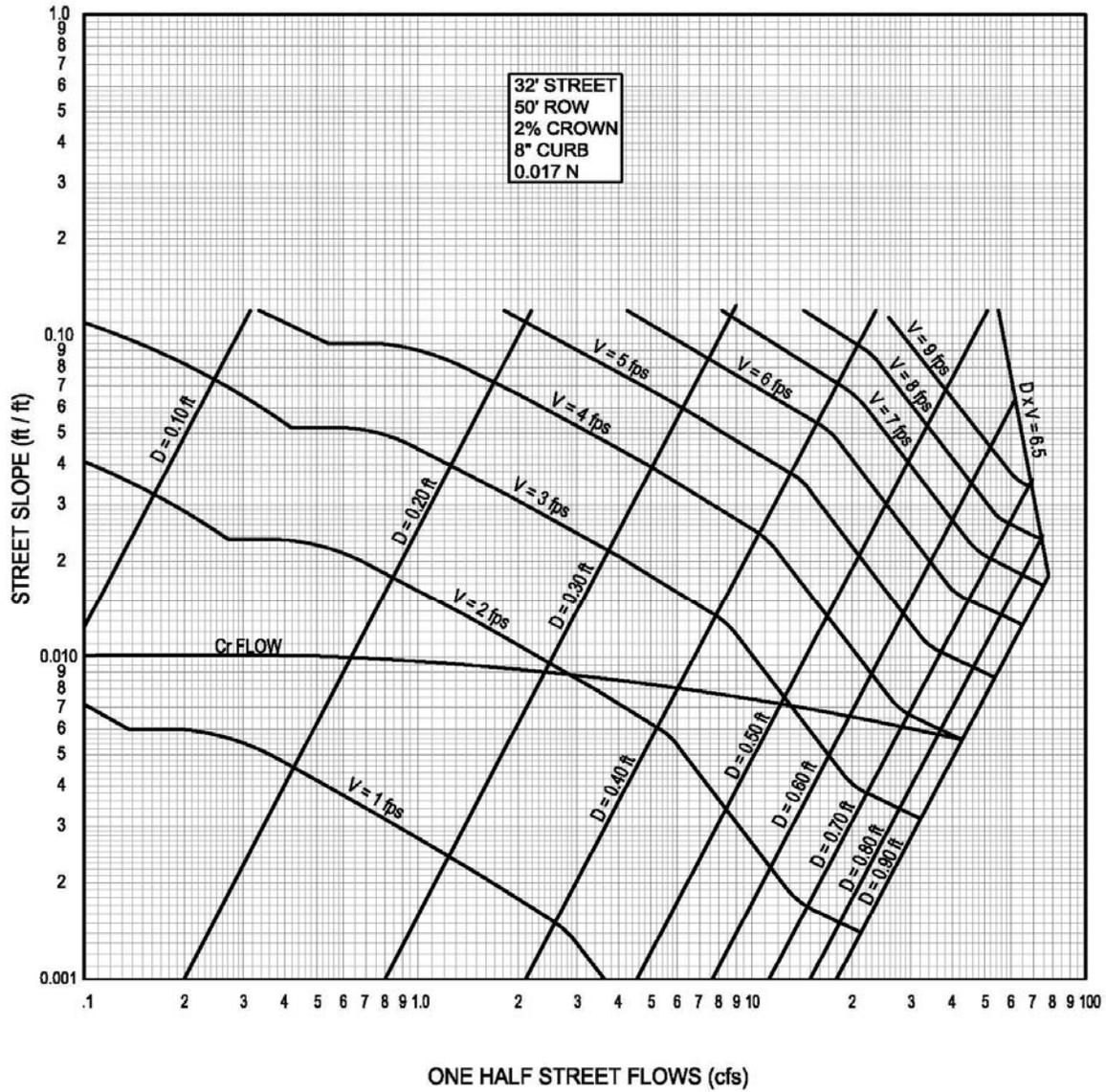


PLATE 22.3 D-2

STREET CAPACITY

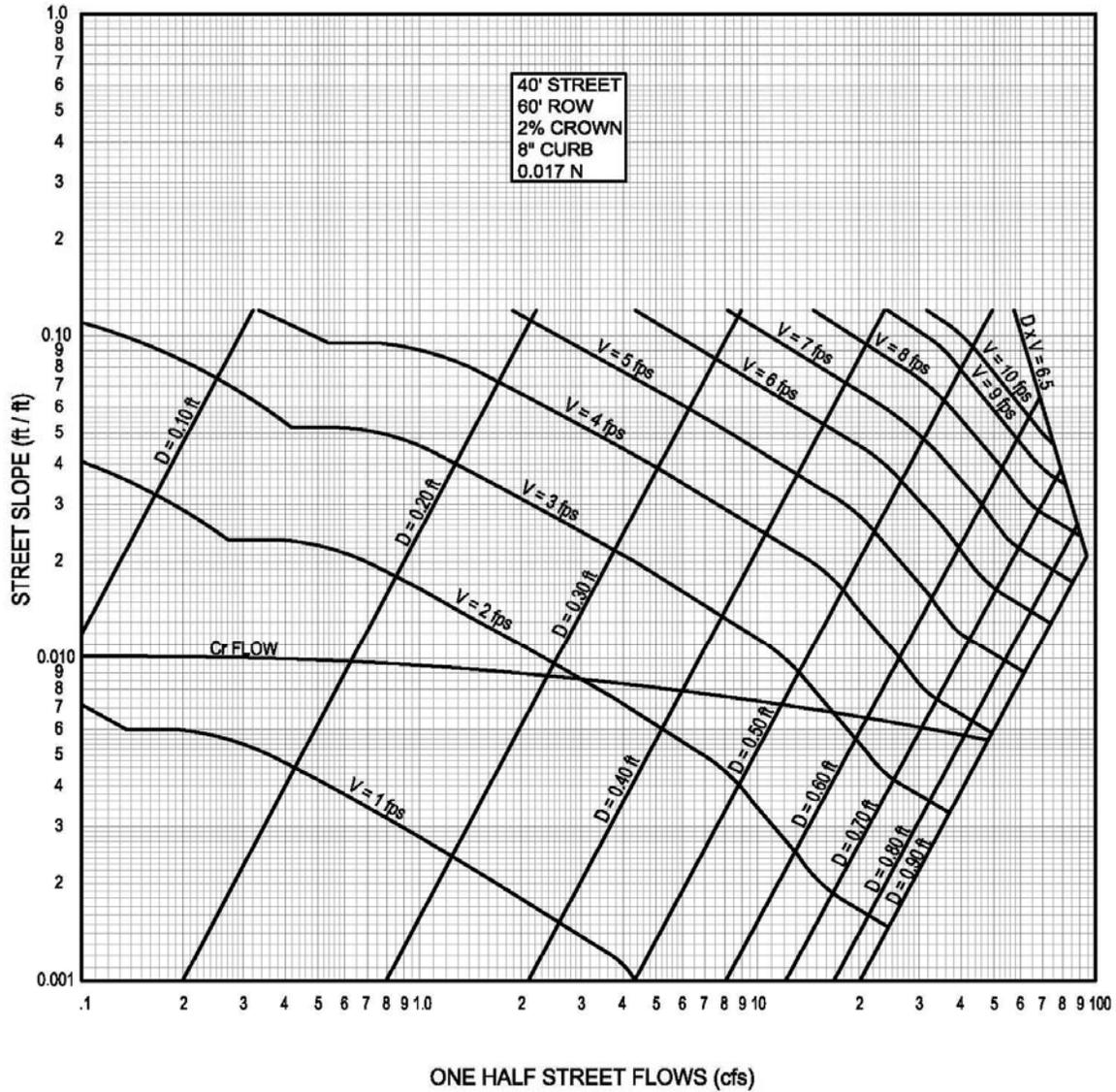


PLATE 22.3 D-3

STREET CAPACITY

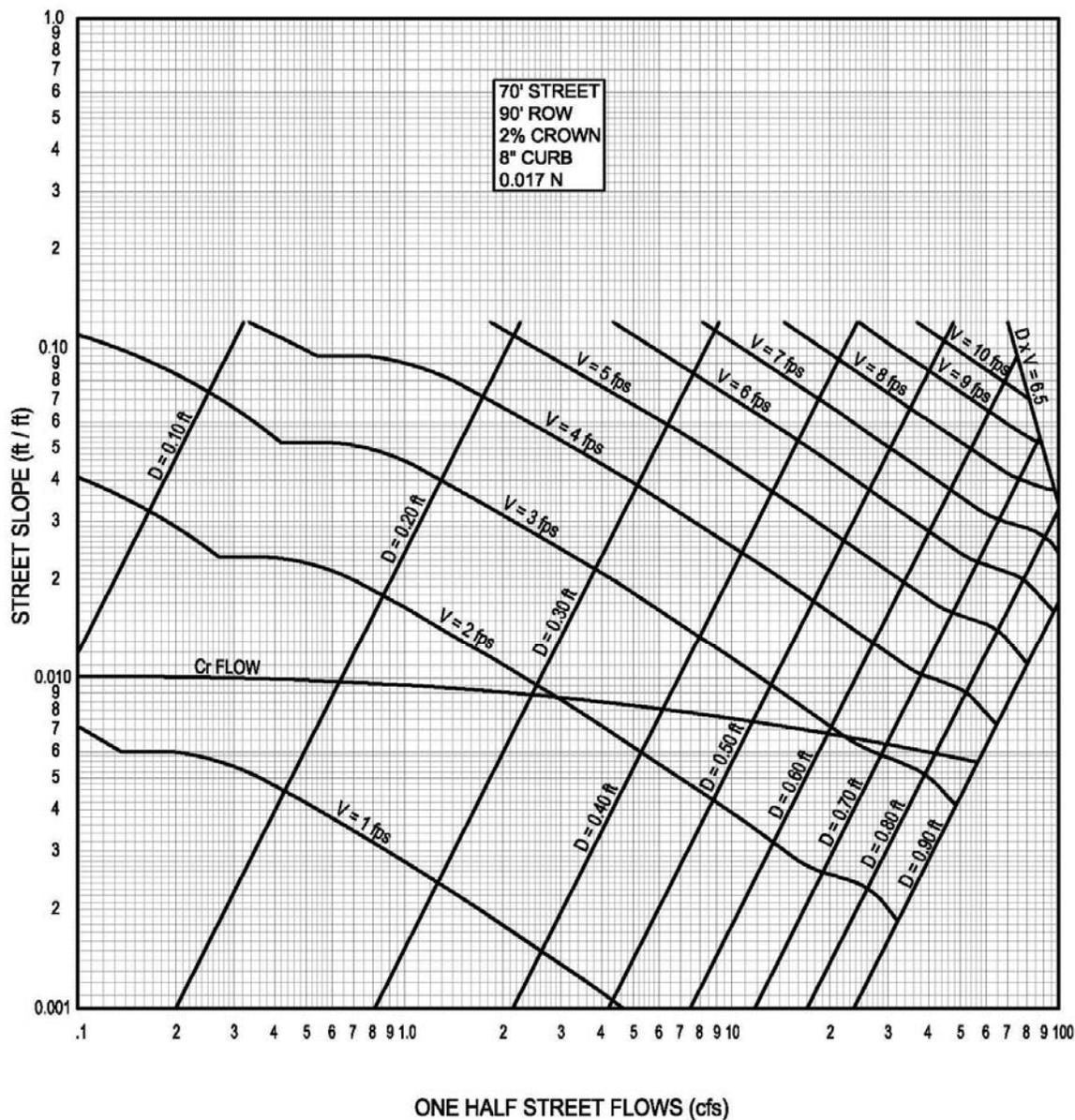


PLATE 22.3 D-4

GRATING CAPACITIES FOR TYPE "A", "C" AND "D"

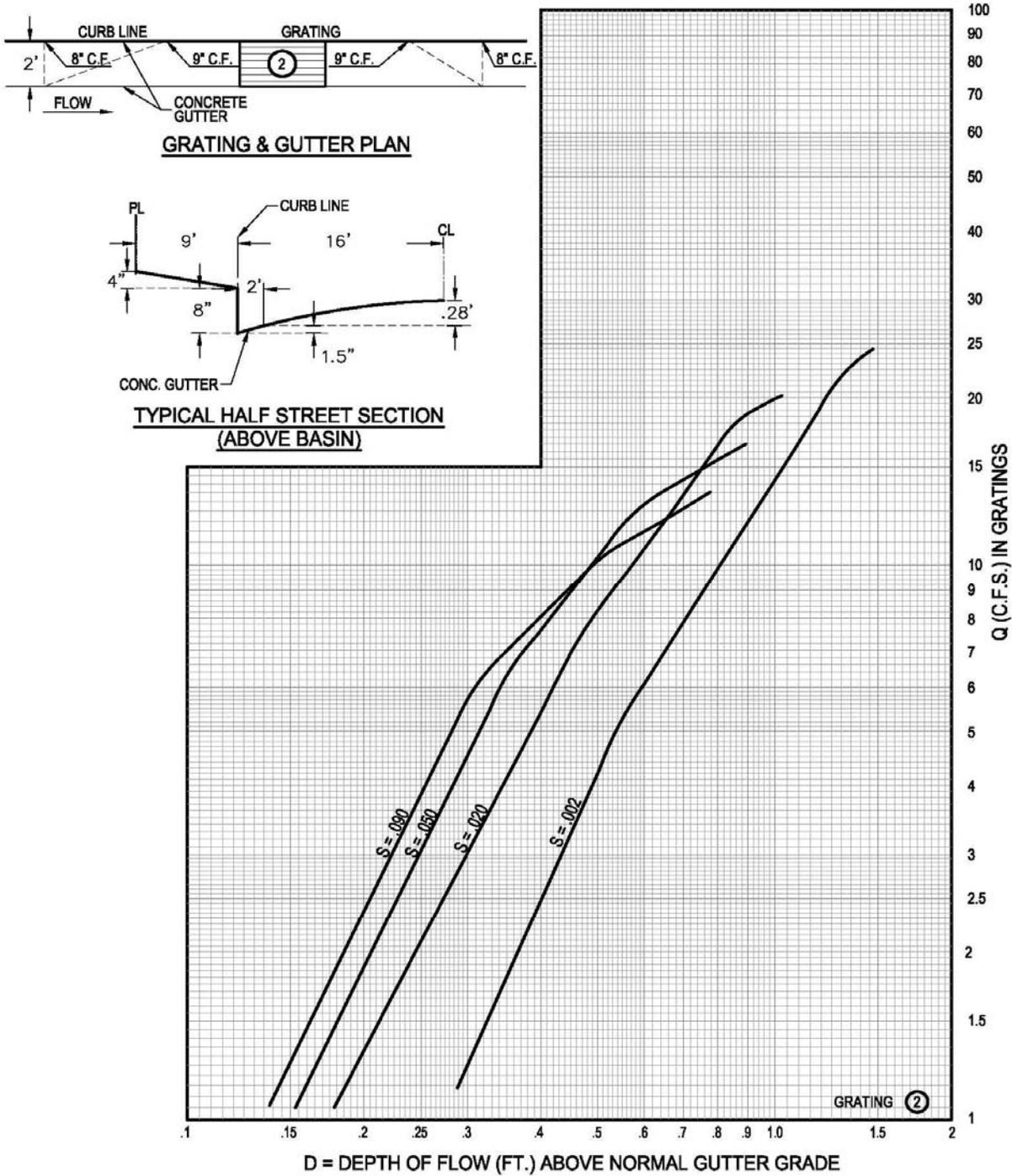


PLATE 22.3 D-5

GRATING CAPACITIES FOR TYPE DOUBLE "C" AND "D"

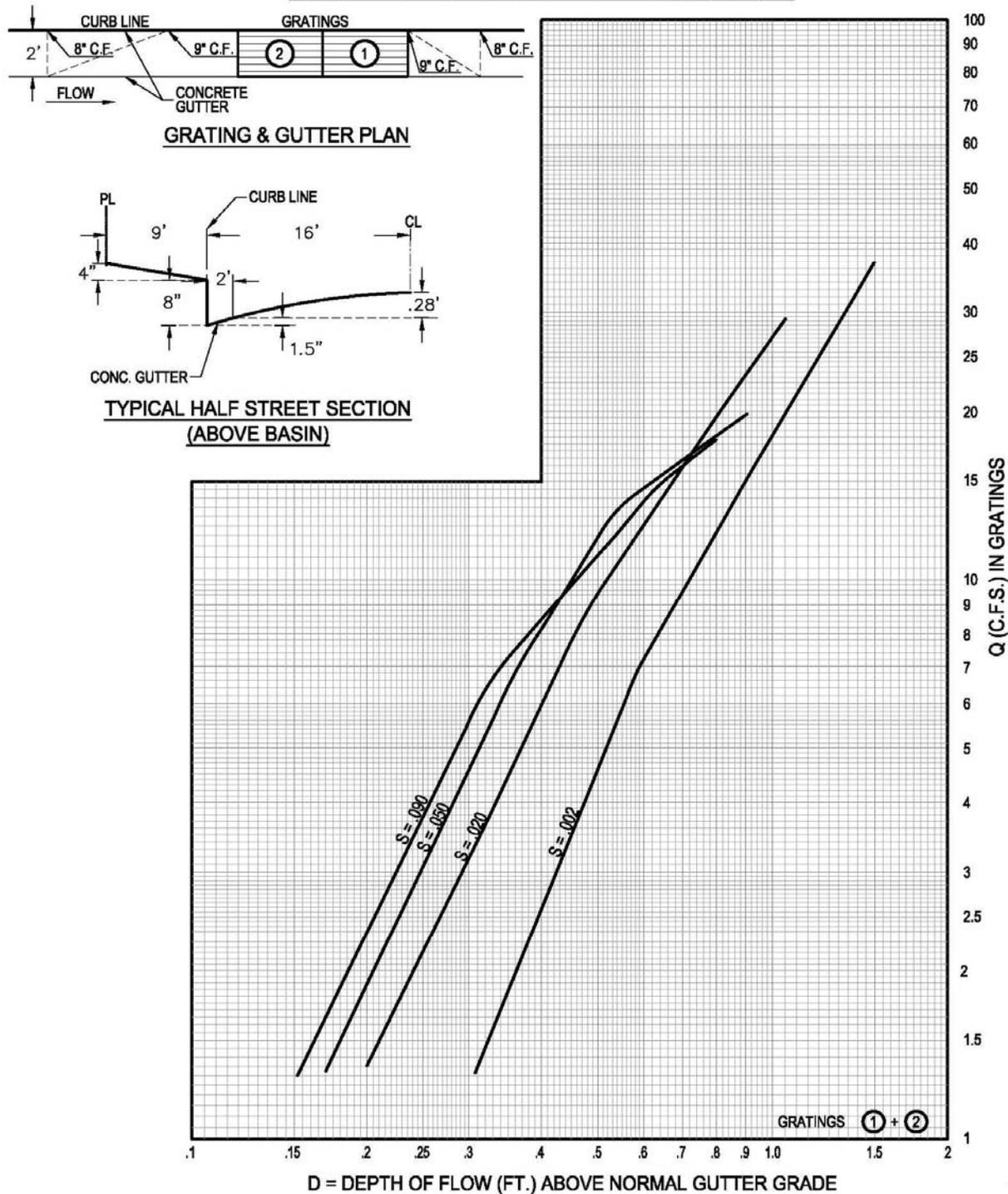
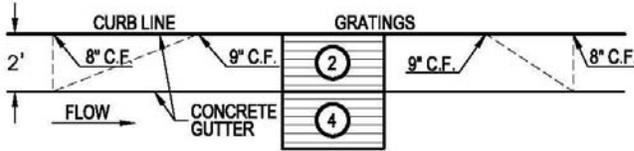
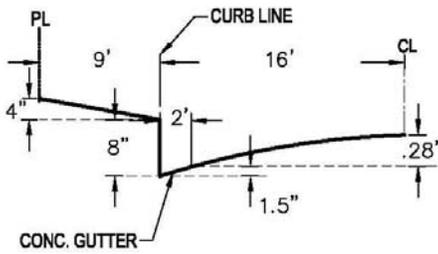


PLATE 22.3 D-6

GRATING CAPACITIES FOR TYPE "B"



GRATING & GUTTER PLAN



**TYPICAL HALF STREET SECTION
(ABOVE BASIN)**

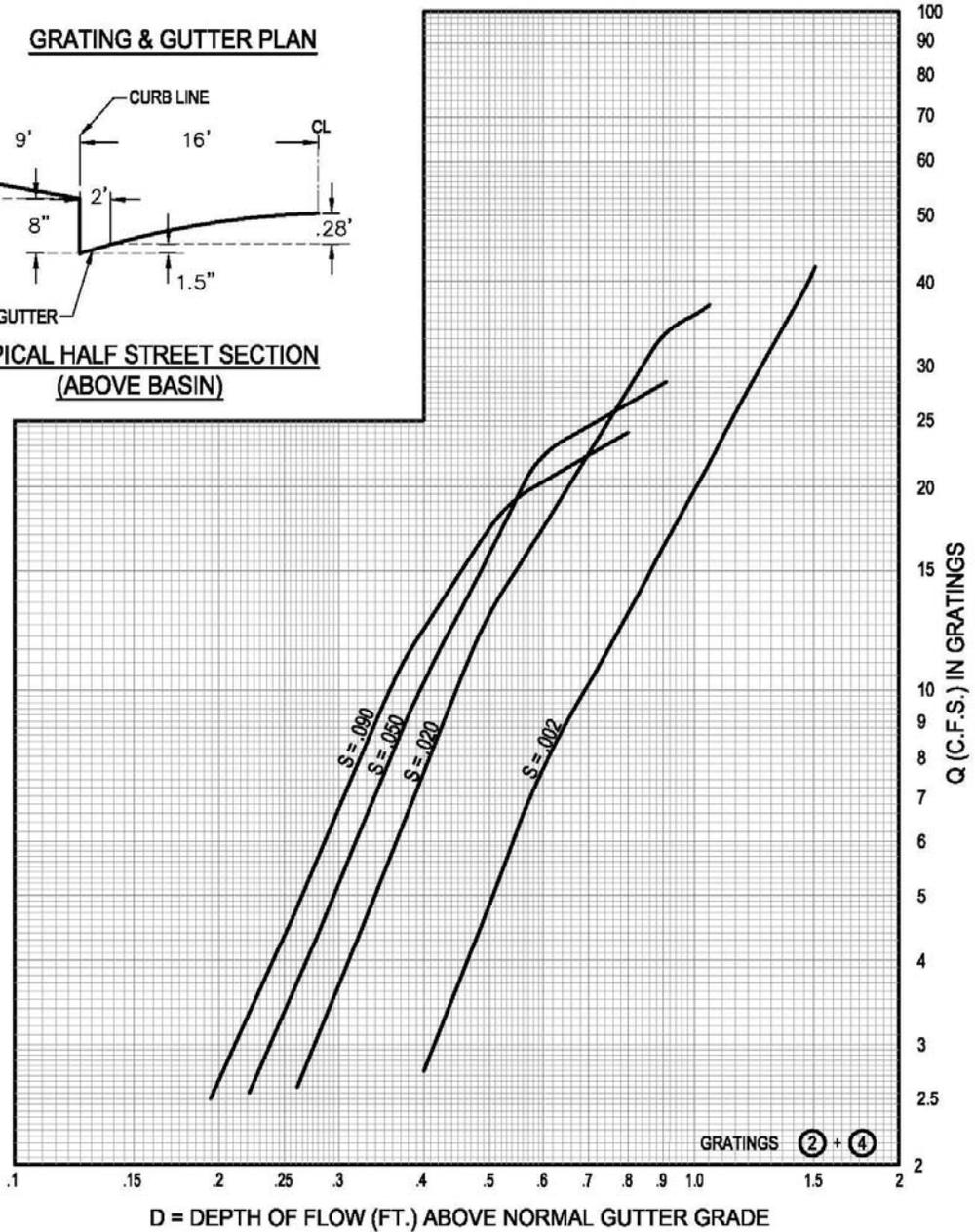


PLATE 22.3 D-7

Given the available head (H), the required connector pipe size can be determined from culvert equations, such as those given in King & Brater, Handbook of Hydraulics, Section Four, 5th Edition. Plate 2.2.3 D-8 can be used for a nomographic solution of a culvert equation for culverts flowing full.

The minimum storm inlet "V" depth should be determined as follows:

$$V = C.F. + 0.5 + 1.2 \frac{V^2}{2g} + \frac{d}{\text{Cos } S}$$

where V = Depth of the storm inlet, or "V" depth, measured in feet from the invert of the connector pipe to the top of the curb.

C.F. = Vertical dimension of the curb face at the storm inlet opening, in feet.

v = Average velocity of flow in the connector pipe, in feet per second, assuming a full pipe section.

d = Diameter of connector pipe, in feet.

S = Slope of connector pipe.

The term $1.2(V^2/2g)$ includes an entrance loss of .2 of the velocity head.

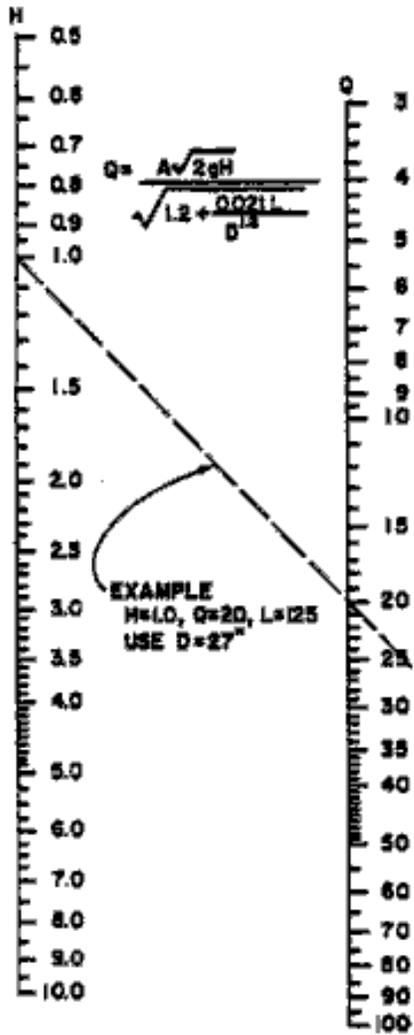
Assuming a curb face at the storm inlet opening of 10 inches, which is the value normally used, and $\text{Cos } S = 1$, the above equation may be simplified to the following:

$$V = 1.33 + 1.2 \frac{V^2}{2g} + d$$

Please refer to Plate 2.2.3 D-9 for a graphical solution to the above equation for curb faces of 10 inches.

DESIGN OF SPUN CONCRETE
CONNECTOR PIPES FLOWING FULL

LENGTH (FEET)
0 25 50 75 100 125 150 175 200



$$Q = \frac{A\sqrt{2gH}}{\sqrt{1.2 + \frac{0.021L}{D^5}}}$$

EXAMPLE
H=1.0, Q=20, L=125
USE D=27"

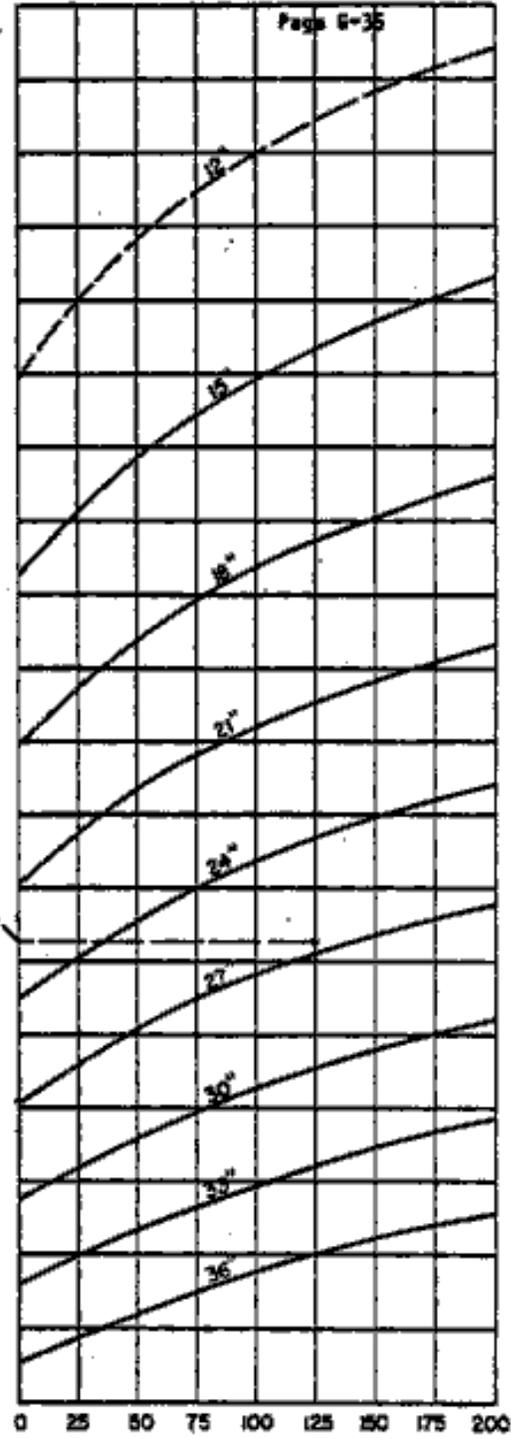
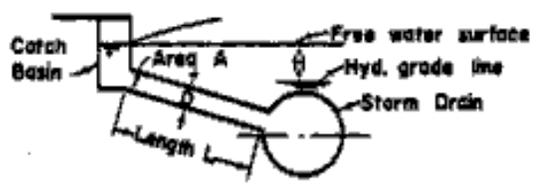


PLATE 22.3 D-8

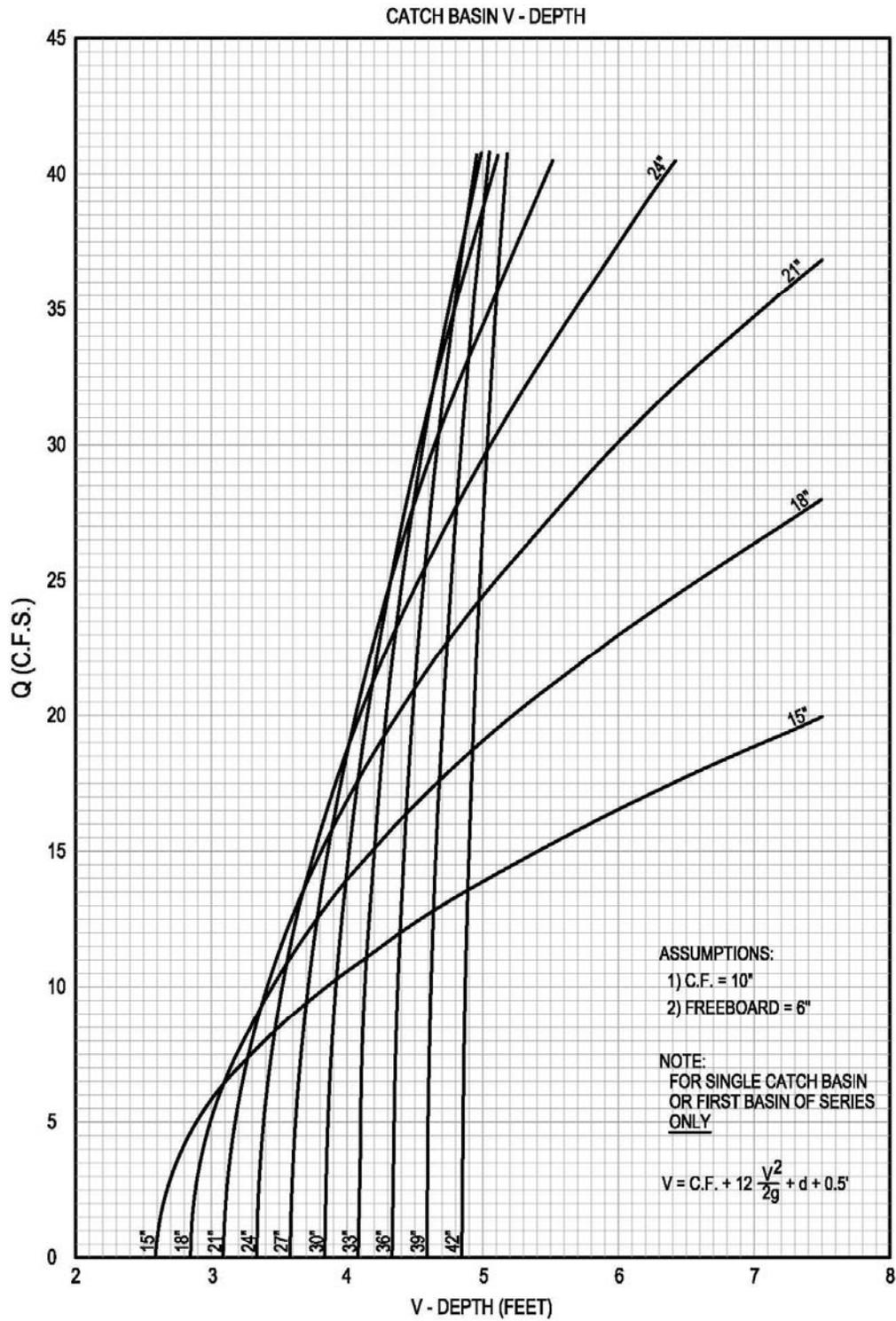
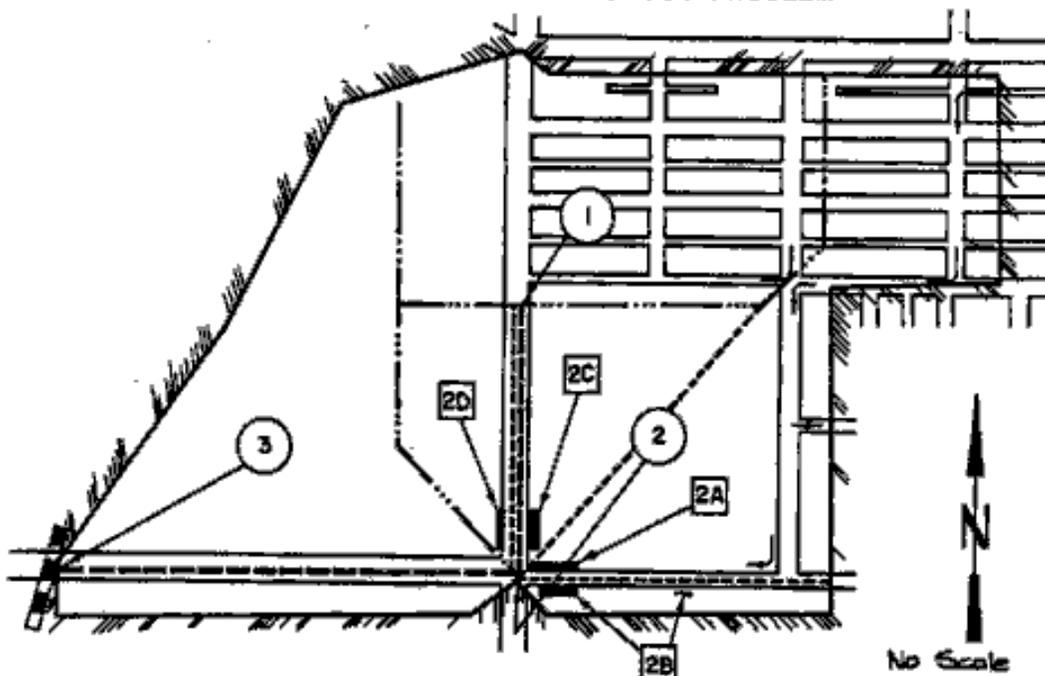


PLATE 22.3 D-9

EXAMPLE CATCH BASIN HYDROLOGY PROBLEM



LEGEND

- Major Drainage Area Boundary
- Mainline Sub-Drainage Area Boundaries
- Catch Basin Sub-Drainage Area Boundaries
- Flow Path
- Mainline
- Outlet
- Catch Basins
- Mainline Sub-Drainage Area Numbers
- Catch Basin Sub-Drainage Area Numbers

MAINLINE HYDROLOGY DATA**			
Reach or Sub-Area	Area (Acres)		Q (c.f.s.)
	Sub-Area	Total	Sub-Area(2) Reach
①	45		70
①-②		45	70
②	70		105
②-③		115	160
③	50		75
③-Outlet		165	220

** Provided by L.A.C.F.C.D. Hydraulic Div.

CATCH BASIN HYDROLOGY*

For Mainline Sub-Drainage Area No. 2

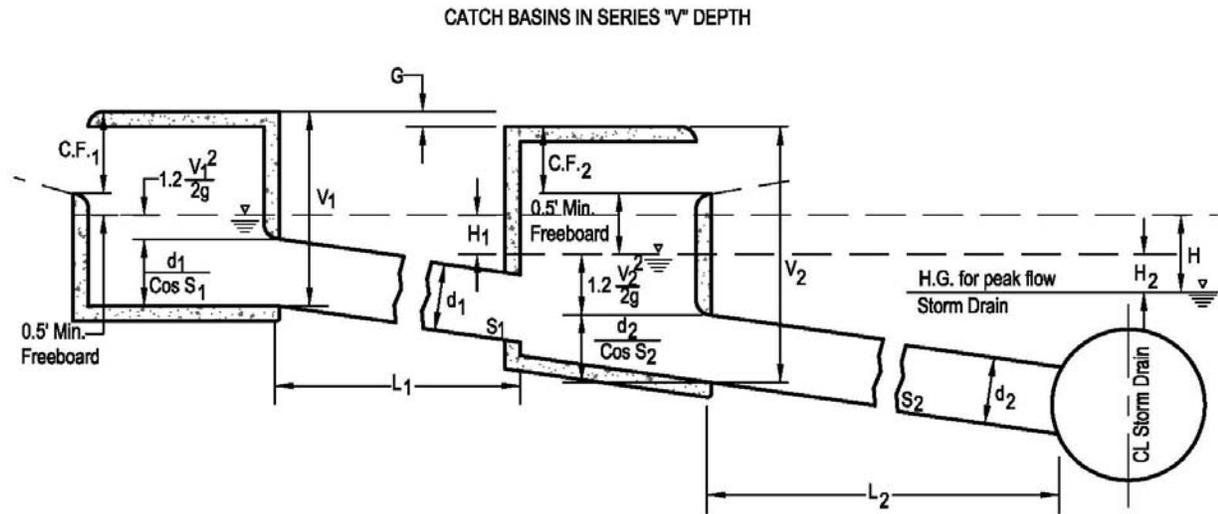
$A_T = 70$ Acres $Q_p = 105$ c.f.s. $Q_p/A_T = \frac{1.5 \text{ c.f.s.}}{\text{Acre}}$

C.B. Sub-Drain Area#	A (Acres)	Q_p/A_T (c.f.s./Acre)	Q_{DES} (c.f.s.)
2A	40	1.5	60
2B	5	1.5	7.5
2C	15	1.5	22.5
2D	10	1.5	15

$Q_{DES} = \frac{Q_p}{A_T} A$

PLATE 22.3 D-11

d. Storm Inlets in Series



Select a connector pipe size for each storm inlet, and determine the related head loss (H_1 , H_2) by means of a culvert equation, or by Plate 2.2.3 D-9. The sum of head losses in the series should not exceed the available head, i.e.,

$$H_1 + H_2 + \dots + H_n \leq H$$

The minimum storm inlet "V" depths are determined in the following manner:

(1) The first storm inlet "V" depth is calculated as for a single storm inlet:

$$V_1 = 1.33 + 1.2 \frac{V_1^2}{2g} + d_1$$

(2) The second storm inlet "V" depth is determined as follows:

$$V_2 = C.F._1 + 0.5 + H_1 + 1.2 \frac{V_2^2}{2g} + \frac{d_2}{\cos S_2} - G$$

Assuming again that $C.F. = 0.83$ and $\cos S_2 = 1$,

$$V_2 = 1.33 + H_1 + 1.2 \frac{V_2^2}{2g} + d_2 - G$$

(3) The freeboard provided for the second storm inlet generally should not be less than 0.5 feet and shall be checked as follows:

$$FB_2 = V_2 - \frac{d_2}{\cos S_2} - 1.2 \frac{V_2^2}{2g} - C.F._2$$

If $C.F._2 = 0.83$ and $\cos S_2 = 1$,

$$FB_2 = V_2 - d_2 - 1.2 \frac{V_2^2}{2g} - 0.83$$

Where especially "tight" conditions prevail, the 0.5 feet freeboard requirement referred to above may be omitted. In such cases the difference between the gutter elevation and the hydraulic grade line elevation of the main line will be accepted as the available head.

(4) Connector pipes between storm inlets in series are to be checked for adverse slope by the following relationship:

$$V_2 - 0.5 > V_1 - G$$

The figure of 0.5 shown above is the standard 6-inch cross slope of the storm inlet floors.

3. Other Criteria

a. General

(1) Existing drainage systems which are not required to carry any portion of the design Q of a proposed system may be designated to be abandoned in place upon completion of the proposed drain. Such existing drainage systems should not be sealed or removed before completion of the proposed system, if needed to carry off storm water during the construction period. It is the designer's responsibility to ascertain the necessity of maintaining existing drainage systems in place.

Existing street or sidewalk culverts may be designated to have the interfering portions removed and the inlets sealed, or the culverts may be kept in operation and connected to the storm drain or to the back of a proposed storm inlet. If the culvert is to be connected, a structural detail should be provided. Refer to the City Engineer/SSCAFCA for instructions.

Existing street or sidewalk culverts that do not interfere with construction should be maintained in place.

(2) Storm inlets will be located within street rights-of-way unless otherwise approved by the City Engineer/SSCAFCA. All storm inlets which must be located outside street property lines in order to intercept storm waters under existing conditions are

considered "must" storm inlets. Right-of-way or an easement for such storm inlets must be acquired. Storm inlets may be located outside dedicated streets to accommodate future street widenings and should be designed to intercept storm water under existing conditions.

Storm inlets to be constructed off the paved portion of the roadway but within the street property lines must be made operable by grading the roadway to permit storm water to flow to the basin. Street remodeling of this nature will be performed during construction.

- (3) If a project is to have one or more cutoff points in phased construction, each cutoff point should have a battery of storm inlets at the upstream terminus sufficient to collect the flow carrying capacity of the storm drain at that point. Each battery of storm inlets should be designed with sufficient data regarding types and sizes of storm inlets, connector pipe sizes and D-loads, "V" depths, local depressions, and whatever other information may be necessary to construct the system.
- (4) Sump designs for storm inlets should normally be limited to local streets and only those situations where terrain or grading considerations warrant their use. When specifying a sump storm inlet(s) the designer shall ensure that surrounding properties are protected from the occurrence of system clogging by demonstrating that one of the following emergency backup conditions exist:
 - 1) The design storm peak flow rate will release to either a public R.O.W. or public easement without rising above any adjacent structure pad elevations; or
 - 2) Sufficient storage is available within a combination of public R.O.W., public easement, and nonstructurally occupied private properties to hold 100% of the design event volume, without inflicting damage to structures, until such time as the underground system can be unclogged.

When relying on public easements across private property to achieve either objective, the easement language creating the encumbrance shall specify that said easement is a surface flowage easement and no structural improvements which would interfere with conveyance or storage of water shall be allowed. Any surface modification within the flowage easement will require an encroachment agreement from the City.

b. Storm Inlets

The selection of type, number, and spacing of storm inlets should be based on Plates 2.2.3 D-1 through 2.2.3 and the following instructions. Be aware that the City of Rio Rancho standard street curb heights are 6" and this may require design and construction adjustments.

City standard storm inlets "Type A, B and C" are combination inlet(s) with both curb opening and grating. Storm inlet "Type D" is a grating only inlet. Basin gratings tend to accumulate debris and clog. The curb opening both limits debris accumulation and offsets lost capacity due to clogging of the grating. Except for certain valley applications, combination basins should be used. Due to main line clogging, grating only basins should be used in valley applications where main line pipe diameters are 24" or less or where quarter full pipe velocities are less than 2.5 f.p.s.

"Type A" storm inlets should be used for single inlet applications and as the first inlet in a battery of inlets. The "Type A" basin performs the function of sweeping debris of the street upstream of the grating and minimizing clogging. "Type A" inlets are used with standard curb and gutter.

"Type B" storm inlets are generally placed downstream of and/or in conjunction with "Type A" storm inlets on streets other than arterials and collectors. This type storm inlet has potential to collect substantial runoff when the grating is clean. If "Type B" basins are used alone, without a "Type A" within 150 feet upstream, the capacity shown in Plate 2.2.3 D-7 should be reduced 15% due to clogging. "Type B" storm inlets are used with standard curb and gutter.

"Type C" storm inlets are generally placed downstream of and/or in conjunction with "Type A" storm inlets. If "Type C" storm inlets are used without a "Type A" within 150 feet upstream, the capacity shown in Plates 2.2.3 D-5 and 2.2.3 D-6 should be reduced 15% for clogging. "Type C" storm inlets are used with standard curb and gutter.

"Type D" storm inlets are generally used on streets with slope greater than 5%, in driveways and in certain valley areas as described above. "Type D" storm inlets can be used with either standard curb and gutter or with mountable curb.

The number of storm inlets to be connected in series should not exceed two. If the connection of more than two storm inlets in series is unavoidable, consideration should be given to designing a lateral drain.

c. Connector Pipe

- (1) The minimum diameter of connector pipe is 18 inches.
- (2) The horizontal alignment of connector pipes must not contain angle points or bends, unless approved by the City Engineer/SSCAFCA.
- (3) Connections at manholes or junction structures are preferred.
- (4) The storm inlet spacing shall be a minimum of 25 feet between curb transitions.

- (5) Storm inlet connector pipes shall outlet at the downstream end of the storm inlets, unless prevented by field conditions. Downstream, in this paragraph, refers to the directions of the gutter slope at the storm inlet in question.
- (6) Where feasible, connector pipes should be located so as to avoid, as much as possible, cutting into existing cross gutters and spandrels.
- (7) The conversions of type A's, B's or C's to D's storm inlets will not be permitted. If the storm inlet is in conflict with a driveway, the storm inlet will be removed and replaced with another inlet outside of the driveway. To avoid conflicts with driveways, the engineer should identify the proposed driveways on the grading plan when storm inlets front the lots.

E. Street Hydraulics

1. A secondary use of the street network is the conveyance of storm runoff. This secondary use must always be subsidiary to the primary function of streets which is the safe conveyance of people and vehicles. The goals of street hydraulic design are therefore:
 - a. To provide an economical means of transporting storm runoff.
 - b. To ensure that the safety and convenience of the public are preserved.
 - c. To prevent storm runoff, once collected by the street system, from leaving the street right-of-way except at specially designated locations.
2. Street hydraulic design critical are as follows:
 - a. Manning's roughness coefficient is 0.017.
 - b. Conjugate and/or sequent depth in the event of the 100-year design discharge may not exceed curb height and shall be contained within the street right-of-way.
 - c. Flow depths in the event of the 10-year design discharge may not exceed 0.33 feet in any collector or arterial street. One lane free of flowing or standing water in each traffic direction must be preserved on arterial streets.
 - d. The product of depth times velocity shall not exceed 6.5 in any location in any street in the event of a 10-year design storm (with velocity calculated as the average velocity measured in feet per second and depth measured at the gutter flowline in feet.)
 - e. The energy grade line of the street flow must be contained within the street right-of-way.
3. For streets with more than two driving lanes in each direction:

- a. The product of depth times velocity may not exceed 6.5 at any location in any street in the event of a 10-year design storm (with velocity calculated as the average velocity measured in feet per second and depth measured at the gutter flowline in feet).
 - b. Inverted crown streets are prohibited unless prior authorization provided to and approved by the City/SSCAFCA.
 - c. The assumption of equal flow distribution between gutters on undivided streets and between street sections on divided streets is only valid where its validity can be demonstrated.
4. Plates 2.2.3 D-1 through 2.2.3 D-4 may be used where applicable in the hydraulic design of streets. T-intersections, radical slope changes and intersections are potential locations for hydraulic jumps when upstream slopes are steeper than critical slope.

When conditions indicate that a hydraulic jump or that the effects of superelevation will allow runoff to exceed street hydraulic design criteria, provisions must be made to for treatment of the problem. The warping of street sections and the construction of deflector walls for these purposes is prohibited unless specifically authorized by the City Engineer/SSCAFCA.

5. Intersections and other radical changes in street cross section and slope require special consideration whenever the flow depth/street slope relationship results in flows occurring in the supercritical flow regime. The critical slope line shown on the street rating curves is used to determine on which side of critical depth the flow occurs and if slope or cross section changes will allow the flow to cross through critical depth from supercritical.

If flow is likely to cross into the subcritical flow range, then Plate 2.2.3 E-1, "Tail Water vs. Froude Number" is used to determine the height and Plate 2.2.3 E-2, "Length of Jump vs. Froude Number" figure is used to determine jump length. The height of jump should not exceed curb height and shall be contained within the street right-of-way.

TAIL WATER DEPTH VS. D_1
HYDRAULIC DESIGN OF STILLING BASINS AND ENERGY DISSIPATORS

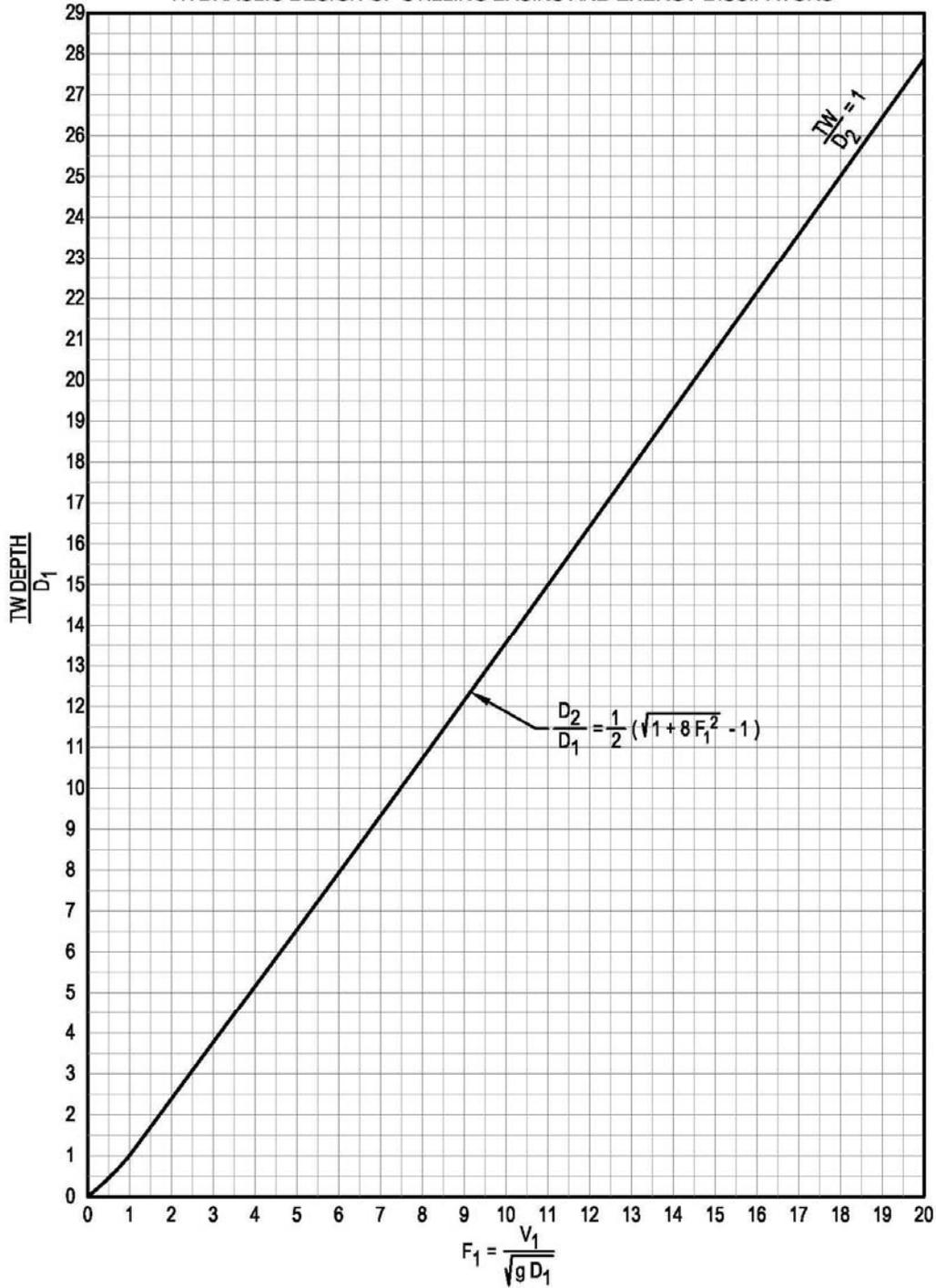


PLATE 22.3 E-1

FIGURE 5. - RATIO OF TAIL WATER DEPTH TO D_1 (BASIN I)

LENGTH OF JUMP IN TERMS OF D_1

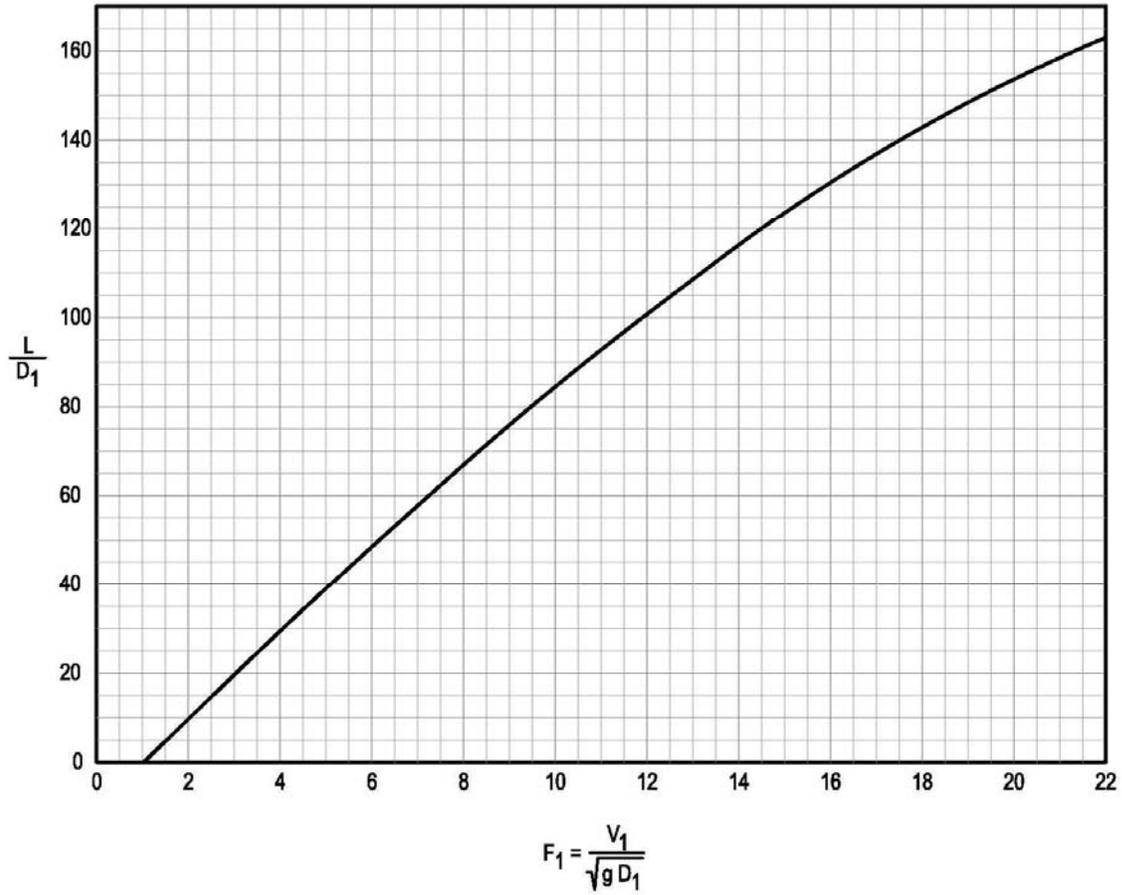


FIGURE 6. - LENGTH OF JUMP IN TERMS OF D_1 (BASIN I)

PLATE 22.3 E-2

F. Berms and Levees

All levees and berms constructed for drainage or flood control purposes and which are required to contain or convey 50 cfs or more in the event of the 100 year design discharge must conform to the following guidelines:

1. Cross Section

- a. Unarmored faces of berms and levees must have side slopes not steeper than 6:1 (horizontal to vertical).
- b. Rock rip rapped faces of berms and levees must have side slopes not steeper than 3:1 (horizontal to vertical)
- c. Concrete faced berms and levees will have side slopes of 2:1 (horizontal to vertical)
- d. Berms and levees less than 4.0 feet in height must have a minimum top width of 8.0 feet.
- e. Berms and levees 4.0 feet high and greater must have a minimum top width of 12 feet.
- f. All berms and levees must be provided with a structural keyway with bottom width equal to the top width and depth equal to at least one half the height, but not less than 3.0 feet and side slopes not steeper than 2:1 (horizontal to vertical)

2. Certification

All levees and berms shall be inspected during construction and certified by a New Mexico Professional Engineer as to their substantial compliance to the plans and specifications. Certified as-built drawings, accompanied by daily inspection reports, shall also be provided.

3. Berm or Levee

Any berm or levee whose purpose is to divert or convey runoff in a major arroyo shall be specially designed on a case-by-case basis and shall meet or exceed the guidelines listed herein.

4. Freeboard

Berms and levees must be provided with freeboard for the 100-year design flow based on the following guidelines:

- a. For flow depths less than 3.0 feet and not involving a major arroyo; minimum freeboard is 2.0 feet.

- b. For flow depths 3.0 feet and greater and, involving a major arroyo; minimum freeboard is 3.0 feet.
- c. If the berm or levee structure is necessary to protect existing property or structures from a FEMA flood plain, FEMA criterion must be complied with in the design and construction of the structure.

5. Bank Protection

All berms and levees expected to convey or divert 50 cfs or more in the event of the 100-year design discharge must be provided with bank protection according to the following guidelines:

- a. Bank protection must be provided wherever design velocities exceed 3 feet/sec.
- b. Bank protection must be provided on the outside of curves from the beginning of curvature, through the curve and for a distance equal to 5 times the flow velocity in feet downstream from the point of tangency.
- c. When required, bank protection must be provided to two feet above the design flow depth plus additional depth as required (e.g. superelevation, waves at confluences, hydraulic jumps, etc.).
- d. Bank protection must extend downward on a projection of the bank slope, to a minimum depth equal to 1.5 times the design flow depth but never less than 3.0 feet. Bank protection for major arroyos shall be accompanied by a City Engineer/SSCAFCA approved sediment transport analysis.

NOTE: Berms, dams, levees, and diversions of certain magnitudes and nature may fall within the jurisdiction of the Office of the State Engineer. The design professional is expected to be aware of and comply with regulations promulgated by that jurisdiction.

G. Miscellaneous Hydraulic Calculations

1. Hydraulic Jump

a. Location

If the water surface from a downstream control is computed until critical depth is reached, and similarly the water surface from an upstream control is computed until critical depth is reached, a hydraulic jump will occur between these controls and the top of the jump will be located at the point where pressure plus momentum, calculated for upper and lower stages, are equal.

b. Length

The length of a jump is defined as the distance between the point where roller turbulence begins and water becomes white and foamy due to air entrainment, and the point downstream where no return flow is observable.

- (1) For rectangular channels, the length of jump (L) for the range of Froude Numbers between two and twenty, based on flow depth, is given by the following equation:

$$L = 6.9 (D_2 - D_1)$$

where D_1 and D_2 are the sequent depths.

- (2) For trapezoidal channels, the length of jump (L) is given by the following equation:

$$L = 5D_2 \left(1 + 4 \sqrt{\frac{t_2 - t_1}{t_1}} \right)$$

where t_1 = width of water before jump

t_2 = width of water after jump

Side Slope	$L/(D_2 - D_1)$
2:1	44.2
1:1	33.5
1/2:1	22.9
Vertical	6.9

2. Trashrack Head Loss

The head loss through a trash rack is commonly determined from the following equation:

$$h_{TR} = K_{TR} (V_n/2g)$$

$$K_{TR} = 1.45 - 0.45 (A_n/A_g) - (A_n/A_g)^2$$

where K_{TR} = Trashrack coefficient

A_n = Net area through bars, in ft^2

A_g = Gross area of trash rack and supports (water area without trash rack in place), in ft.²

V_n = Average velocity through the rack openings (A/A_n), f.p.s.

For maximum head loss, assume that the rack is clogged, thereby reducing the value of A_n by 50%.

3. Side Channel Weirs:

The Los Angeles District Corps of Engineers, as mentioned in Section C-2.5, has developed a side channel spillway inlet. The City or SSCAFCA may require this type of structure for drains outletting into their facilities. The Corps' procedure for designing a side channel spillway is as follows:

- a. Set the top of that part of the main channel wall at the location of the proposed spillway about 6 inches above the computed water surface level in the main channel.
- b. Determine the length of spillway (L) required to discharge the design inflow of the side inlet by the following equation, in which the maximum value of H is not greater than one and one-half feet.

$$L = \frac{Q}{CH^{3/2}}$$

where: Q = discharge of side inlet, in c.f.s.

C = weir coefficient

H = depth of water over the crest of the side inlet in feet

- c. Determine the depth of flow in the approach side channel at the upstream end of the spillway.
- d. Set the side channel invert elevation at the upstream end of the spillway at an elevation below the spillway crest a distance equal to the water depth as determined in c., above, minus the assumed head on the spillway.
- e. Set the side channel invert slope equal to the spillway and the main channel water-surface slopes.
- f. By trial, determine the width of the side channel required to maintain a constant depth of flow at several points downstream from the upstream end of the spillway. The discharge at each of these points is assumed to be the difference between the initial discharge less the amount spilled over that part of the spillway as computed by $CLH^{3/2}$, in which C is

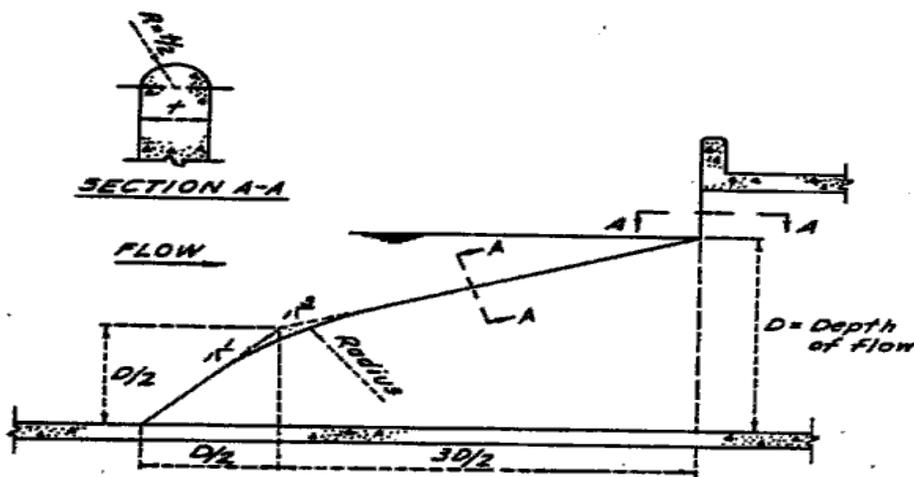
3.087 and H is equal to the critical depth over the crest (neglecting the velocity of approach).

- g. Plot the widths thus determined for the side channel on the channel plan and approximate a straight or curved line through them to locate the point of intersection of this line and the main channel wall.
- h. If the length between the assumed point at the upstream end of the spillway and this intersection point is equal to the length determined in b., above, the angle at the intersection indicates the required convergence for the side channel.
- i. From the final layout determine the width and recompute the water surface in the side channel for the final design. The discharge over each portion of the spillway is calculated by using the average head between the two sections considered.

4. Pier Extensions:

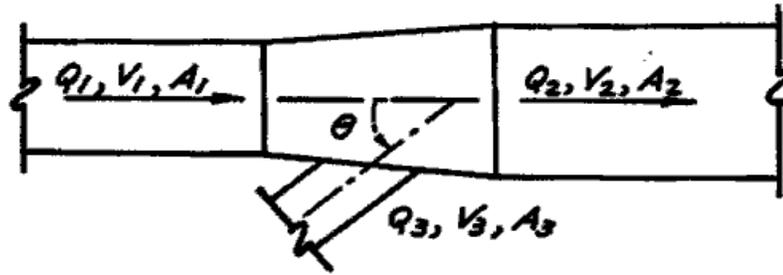
Pier extensions of a streamlined nature should be used when heavy debris flow is anticipated.

In supercritical flow the addition of a specified width to account for the assumed amount of debris may result in impractical and costly structures. In lieu of assuming additional pier width for debris, the use of streamline pier extensions should be investigated. Unless an unusual quantity of debris is anticipated, it can be assumed that the major portion of the debris will not cling to the pier extension. Pier extensions should be designed using the criteria indicated in the figure below.



THOMPSON EQUATION

The Thompson Equation for junctions is described by the following:



$$\Delta y \cdot A_{avg} = \frac{Q_2 V_2 - Q_1 V_1 - Q_3 V_3 \cos \theta}{g}$$

where y = difference in hydraulic gradient for the two end sections, in feet,

A_{avg} = average area, in feet² = $1/6 (A_1 + 4A_m + A_2)$ or,

A_m = mean area of flow, in feet²

The above equation is applicable only to prismatic and circular conduits or channels. The friction force may be considered negligible or can be calculated and taken into account. It is recommended that the Thompson equation not be used when an open channel changes side slope going through a junction.

For details of the above method, refer to Office Standard No. 115, Hydraulic Analysis of Junctions, 1968 edition, Storm Drain Design Division, Bureau of Engineering, City of Los Angeles.

In the following compilations:

- a. "w", the unit weight of water, has been omitted since it appears in all terms.
- b. The assumptions are made that the cosines of the invert slopes equal unity and that the tangents and sines of the friction slopes are equal.

The general equilibrium equation for all cases is:

$$P_2 + M_2 = P_1 + M_1 + M_3 \cos \theta + P_i + P_w - P_f$$

where P_1 = hydrostatic pressure on section 1

P_2 = hydrostatic pressure on section 2

P_i = horizontal component of hydrostatic pressure on invert

P_w = axial component of hydrostatic pressure on walls

P_f = retardation force of friction (S_1 and S_2 are friction slopes - see Kings Hdbk.)

M_1 = momentum of moving mass of water entering junction at section 1

M_2 = momentum of moving mass of water leaving junction of section 2

M = axial component of momentum of the moving mass of water entering the junction at section 3

$P = A\bar{y}$

\bar{y} = distance to centroid from water surface

$M = \frac{Q^2}{SA}$

c. Determination of Spillway Channel Widths

Using the spillway length determined above, the overflow spillway is laid out (see Plate 2.2.8 B-3) using widths determined by trial. Upon completing the layout, the spillway widths at 20-foot intervals are taken from the drawing and the outflow is checked.

See computation on Plate 2.2.8 B-3.

(Note all trials necessary to obtain the desired widths are not shown on the sample problem.)

Typical Side Channel Spillway Inlet

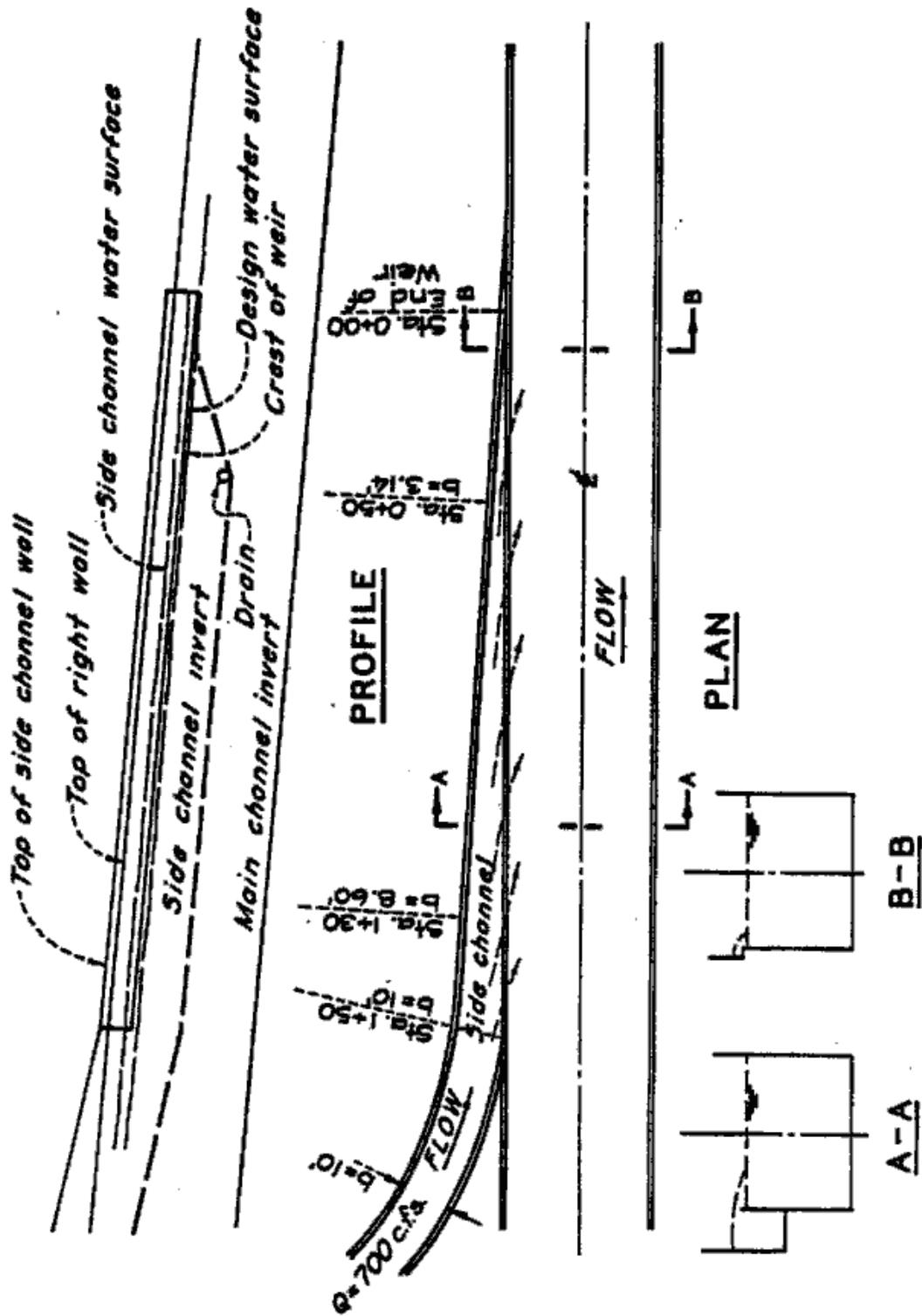


PLATE 22.8 B-3

SIDE CHANNEL SPILLWAY INLET CALCULATION SHEET

STATION	SECTION	A	B	E.S.	W.P.	S ₁	S ₂	S ₃	S ₄	S ₅	S ₆	S ₇	S ₈	S ₉	S ₁₀	CHECK E.S.	H _s	FLOW OUT Q ₁ - C.S.L. IN	DESIRED Q ₂	ACTUAL Q ₃	DATE	
																						PROJECT	SAMPLE	PROBLEM
0+00	END OF WEIR																					8-1-72
0+10	1st 10'	3.12	21.2	7.00	10.02	10.24										10.22			700			
0+20	2nd 10'	3.12	31.2	7.00	10.00	14.73										10.22			700			
0+30	3rd 10'	3.12	36.24	7.75	10.30	12.34										10.21		114				
0+40	4th 10'	3.03	21.00	7.00	10.03	11.01										10.23		200				
0+50	5th 10'	2.02	12.03	7.00	10.00	10.30										10.24		00				
0+60	6th 10'	2.00	12.00	7.25	10.25	9.07										10.22		00				
0+70	7th 10'	2.00	2.00	7.40	10.35	7.12										10.20		00				
0+80	END OF WEIR															10.20			100			
Q_1 - FLOW OUT OF SIDE CHANNEL Q_2 - DESIRED FLOW IN SIDE CHANNEL Q_3 - ACTUAL FLOW IN SIDE CHANNEL Q_4 - DIFFERENCE BETWEEN ACTUAL AND DESIRED FLOW IN SIDE CHANNEL																						

PLATE 22.8 B-4

SIDE CHANNEL SPILLWAY INLET CALCULATION SHEET

STATION	SECTION	G	A	$\frac{A}{L^2}$	E.C.	W.P.	R.P.	S ₁	S ₂	S ₀ - S ₁	AL	AL	CHECK E.C.	N _s	FLOW OUT Q ₁ (CFS)	DESIRED Q ₂	ACTUAL Q ₂	DATE
0+00																		
0+10																		
0+20																		
0+30																		
0+40																		
0+50																		
0+60																		
0+70																		
0+80																		
0+90																		
0+100																		

Q_1 = FLOW OUT OF SIDE CHANNEL
 Q_2 = DESIRED FLOW IN SIDE CHANNEL
 Q_2 = DIFFERENCE BETWEEN ACTUAL AND DESIRED FLOW IN SIDE CHANNEL
 Q_1 = ACTUAL FLOW IN SIDE CHANNEL

PLATE 22.8 B-5

H. Sediment Transport and Channel Stability

Moving water has the ability to transport sediment. The amount of sediment per unit of water that can be transported is related to flow depth, velocity, temperature, vertical and horizontal channel alignment, the amount of sediment available, the size and density of the sediment available and many other minor but sometimes important parameters. A channel's stability can be defined in terms of its ability to function properly during flood event without serious aggradation and/or degradation and that its continued operation can be relied upon without extraordinary maintenance and repairs. While channel stability problems are largely associated with earth and flexibly lined channels, concrete lined, supercritical channels are not immune. Any time a downstream channel reach has a lower sediment capacity than some upstream reach, there is a potential for sediment accumulation. The following worksheets can be used to make qualitative determinations with regard to channel stability.

Detailed qualitative analyses must be performed for any design requiring construction in a major arroyo. Methods found in items C.7 and C.8 in the Bibliography at the end of Section 2.2.3 shall be used in sediment transport analyses.

CHANNEL STABILITY WORK SHEET INSTRUCTIONS

A stable earth-lined channel is defined for the purposes of design as one in which neither degradation or aggradation is occurring at such a rate that it causes a continuous and serious maintenance problem. Channel degradation can cause extensive damage to bridges and other crossing structures due to the undermining of their foundations. Channel aggradation on the other hand results in reduced channel and crossing structure capacities and, therefore, in increased frequency of flooding.

CHANNEL STABILITY WORK SHEET - A

The Proposed Development or Land Use Change Will Affect:	In the Following Way:		
	No Change	Increase	Decrease
Flow Rates.....	_____	_____	_____
Flow Velocities	_____	_____	_____
Flow Frequencies	_____	_____	_____
Flow Duration	_____	_____	_____
Flow Depth.....	_____	_____	_____
Sediment Reaching the Channel.....	_____	_____	_____
Sediment Particle Size.....	_____	_____	_____
Streambed Material Size	_____	_____	_____
Channel Vegetation	_____	_____	_____

CHANNEL STABILITY WORK SHEET - B

An Increase or Decrease in:	Will Have the Following Effect in the Channel	
	Increase	Decrease
Flow Rate	Degradation	Aggradation
Flow	Degradation	Aggradation
Flow Frequency.	Degradation	Aggradation
Flow Duration	Degradation	Aggradation
Flow Depth.....	Degradation	Aggradation
Sediment Reaching the Channel	Aggradation	Degradation
Sediment Particle Size.....	Aggradation	Degradation
Streambed Material Size	Aggradation	Degradation
Channel Vegetation.....	Aggradation	Degradation

1. Channels

a. Earthwork

The following shall be compacted to at least 90% of maximum density as determined by ASTM D-1557 (modified Proctor):

- (1) The 12 inches of subgrade immediately beneath concrete lining (both channel bottom and side slopes).
- (2) Top 12 inches of maintenance road. (either as subgrade or finished roadway if unsurfaced).
- (3) Top 12 inches of earth surface within 10 feet of concrete channel lip. It is particularly important to compact earth immediately adjacent to concrete lip. This area is sometimes overlooked when forms are removed.
- (4) All fill material.

b. Concrete

- (1) All concrete channels shall be continuously reinforced
- (2) All exposed concrete drainage structures shall be tinted with San Diego Buff or a color approved by the City Engineer/SSCAFCA.
- (3) Materials
 - (a) Cement type: ILA or I-III A
 - (b) Minimum cement content: 5.5 sacks/c.y.
 - (c) Maximum water-cement ratio: 0.53 (6 gals. per sack)
 - (d) Maximum aggregate size: 1 ½ inches
 - (e) Air content range: 4-7%
 - (f) Maximum slump: 3 inches
 - (g) Minimum compressive strength (f_c): 3500 psi @ 28 days
 - (h) Class F Fly ash meeting the requirements of ASTM C618 shall be proportioned in the mix at a 1:4 ratio of fly ash to cement weight.
 - (i) Steel reinforcement shall be a minimum of grade 60 deformed bars. Wire mesh shall not be used, however welded wire mats are allowed.

(4) Lining Section

- (a) Bottom width - 10 feet minimum
- (b) Side Slopes - 1 vertical to 2 horizontal slope, or flatter
- (c) Concrete lining thickness

All concrete lining shall have a minimum thickness of 8 inches.

The lining shall be thickened to 10 inches on the channel bottom and lower 18 inches of the side slope when design velocity exceeds 25 feet per second. This will provide an additional top two inches of sacrificial concrete. Steel placement shall be based upon the standard 8" thickness as measured from the bottom of the concrete lining.

(d) Concrete Finish

The surface of the concrete lining shall be provided with a tined finish. Pneumatically applied "shotcrete" is an acceptable concrete lining alternative and does not require a tinned finish, but it must be preapproved by the City/SSCAFCA. Precautions shall be taken to guard against excessive working or wetting of finish.

(e) Concrete Curing

All concrete shall be cured by the application of liquid membrane-forming curing compound (white pigmented) immediately upon completion of the concrete finish.

(f) Steps

Ladder-type steps shall be installed at locations suitable for rescue operations along the channel but not farther than 700 ft. apart on both sides of the channel. Bottom rung shall be placed approximately 12 inches vertically above channel invert.

(5) Joints

- (a) Insofar as feasible, channels shall be continuously reinforced without transverse joints. However, expansion joints may be installed where new concrete lining is connected to a rigid structure or to existing concrete lining which is not continuously reinforced.
- (b) The preferred design avoids longitudinal joints. However, if included, longitudinal joints should be on side slope at least one foot vertically above channel invert.
- (c) All joints shall be designed to prevent differential displacement and shall be watertight.
- (d) Construction joints are required at the end of a day's run, where lining thickness changes.

(6) Reinforcing Steel for Continuously Reinforced Channels

- (a) Ratio of longitudinal steel area to concrete area not including additional thickness of sacrificial concrete

$$\frac{A_s \text{ long}}{A_c \text{ long.}} \geq .005$$

- (b) Ratio of transverse steel area to concrete area not including additional thickness of sacrificial concrete

$$\frac{A_s \text{ transv.}}{A_c \text{ transv.}} \geq .0025$$

Note: In (a) and (b) above A_s = crosssectional area of steel in the direction indicated; A_c = crosssectional area of concrete in the direction indicated. Longitudinal = long.; transverse = transv.

- (c) Steel Placement: Temperature and shrinkage steel shall be placed so as to be in the top of the middle third of the slab, but at least 3" from the bottom of the slab. Longitudinal steel shall be on top of the transverse steel. (NOTE: Inspectors must insure this requirement is not violated by contractors during pouring operations.)

2. Earthwork for Levees and Berms

All earthfill berms and levees shall be constructed of high quality fill material free of debris, organic matter, frozen matter and stone larger than 6 inches in any dimension. The key trench shall be scarified to a depth of 6 inches to ensure bonding with the fill material. Lifts shall not exceed 12 inches of loose material before compaction. The material in each lift shall contain optimum moisture content (-1% to +3%) and shall be compacted to at least 90% and not more than 95% of maximum density as determined by ASTM D 1557 or as recommended by a geotechnical engineer and accepted by the City Engineer/SSCAFCA. Proper bonding between lifts shall be guaranteed by scarifying each lift after compaction to a depth of at least 3 inches.

Levees and berms intended to provide flood protection for properties and structures shall comply with all FEMA requirements for removal from a 100 year floodplain. A minimum 3' freeboard above the high water elevation is required on all levees and berms.

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2.2.3 Hydraulics

A. Weirs and Orifices

1. King and Brater: Handbook of Hydraulics, McGraw Hill Book Company, Inc., New York, Fifth Edition 1963
2. Merritt: Standard Handbook for Civil Engineers, McGraw Hill Book Company, Inc., New York, 1968
3. Streeter: Fluid Mechanics, McGraw Hill Book Company, Inc., New York, Fifth Edition

B. Closed Conduits

1. Los Angeles County Flood Control District Design Manual - Hydraulic, P.O. Box 2418 Los Angeles, California 90054 Rev. 1973.

C. Channels

1. Chow: Open Channel Hydraulics, McGraw Hill Book Company, Inc., New York, 1959
2. U.S. Army Corps of Engineers:- Hydraulic Design of Flood Control Channels EM 1110-2-1601,. Office of the Chief of Engineers, Washington, D.C. 20314, 1970
3. Merritt: Standard Handbook for Civil Engineers, McGraw Hill Book Company, Inc., New York, 1968.
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5. U.S. Department of the Interior, Bureau of Reclamation: Hydraulic Design of Stilling Basins and Energy Dissipaters, U.S. Government Printing Office, Washington, Fourth Printing, Revised 1973
6. U.S.D.A Soil Conservation Service: Planning and Design of Open Channels, Technical Release No. 25, Washington, D.C., October, 1971
7. U.S.D.A Soil Conservation Service:. Sedimentation, National Engineering Handbook, Section 3, Chapter 4, Washington, D.C., 1971
8. Simons, Li and Associates: Design Guidelines and Criteria - Channels and Hydraulic Structures on Sandy Soil, P.O. Box 1816 Ft. Collins, Colorado, 80522, 1981

9. Los Angeles County Flood Control Authority, Design Manual Hydraulic P.O. Box 2418 Los Angeles, California 90054 Rev. 1973.
10. Albuquerque Metropolitan Arroyo Flood Control Authority Draft Design guide for Trapezoidal Concrete Flood Control Channels, Rev. April, 1982.

D. Storm Inlets

1. Los Angeles County Flood Control Authority, Design Manual - Hydraulic P.O. Box 2418 Los Angeles, California 90054 Rev. 1972.

E. Street Hydraulics

1. See Reference C-1
2. See Reference C-4

F. Berms and Levees

1. See Reference C-6
2. See Reference C-7
3. See Reference C-8

G. Sediment & Erosion Control

1. SSCAFCA's Sediment and Erosion Design Guide prepared by Mussetter Engineering, Inc. dated November 2008. Available at www.sscafca.com.

Section 4. CHANNEL TREATMENT SELECTION GUIDELINES

A. General

The selection of a treatment type or of a combination of treatment types for a channel within the Rio Rancho/SSCAFCA area should be based on an assessment of the needs of the community as they relate to:

- System Failure
- Safety
- Safety System Impacts
- Adjacent Treatment Types
- Operation and Maintenance
- Initial Costs and Life Expectancy
- Costs Including ROW
- Joint use Possibilities
- Water Quality Impacts

These items are briefly described below:

B. Flood Control

The magnitude of the flood control requirements and the consequences of a system failure should be considered foremost in the treatment selection process.

C. Drainage

The existing and future land uses, the specific on- and off-site drainage treatments, and watershed topography should each be evaluated in terms of their impacts on the channel system. The unmitigated hydrologic effects of urbanization generally include higher peak runoff rates from smaller, more frequent storms, cleaner runoff (with respect to sediment), and increased annual runoff volumes.

D. Maintenance

The selection of a channel treatment type should include analyses of both short and long term maintenance. While maintenance efforts will vary between treatment types, all facilities should be able to function through one runoff event with no maintenance, through one flood season with very little maintenance and from season to season with regular, but minimal maintenance requirements.

E. Rights-of-Way and Easements

The cost of land and the availability of rights-of-way or easements should be considered in the channel treatment selection process. Rights-of-way and easements should be appropriately located, aligned and sized for the particular treatment type. Some treatment types may require significant construction easements, but much smaller permanent rights-of-way or easements. The likelihood of replacement or reconstruction should be considered when channel treatment selection is balanced against the configuration of permanent rights-of-way and easements.

F. Safety

The selection of a channel treatment type should be based on any special safety considerations dictated by adjacent or nearby land uses. Whenever a required channel treatment is not compatible with adjacent land uses, adequate safety hazard mitigation measures should be incorporated into the design and construction of the facilities. Channels with vertical walls of 30 inches or greater will require a barrier or fence. Minimum fence or barrier height shall be 42 inches.

G. Upstream and Downstream Channel Treatments

The treatment selection process for each channel reach should include an analysis of the impacts of existing and planned upstream and downstream treatment types on a proposed treatment type and, in turn, the effects of the proposed treatment on existing and planned upstream and downstream treatments.

H. Initial Cost and Life Expectancy

The initial construction costs of various channel treatment types are and will always be one of the more heavily weighted factors in the selection process. However, when viewed on a larger scale, maintenance and replacement costs can be more important to the total costs of providing adequate levels of protection over time, and therefore must be considered in the planning, design and construction of channel treatment measures.

I. Joint Use Possibilities

The opportunities for including other uses such as transportation and utility corridors, open space or recreation in the design should be considered when selecting a treatment type and when establishing rights-of-way and easements. The inclusion of any other uses must be self-supporting financially and in no way impair or delay the implementation of the drainage and flood control function of the facilities. Operations and Maintenance of these joint use facilities must also be considered. SSCAFCA will only operate and maintain drainage and flood control facilities.

Section 5. DESIGN GRADING AND EROSION CONTROL

A. Slope Criteria

Earthen slopes shall conform to the following:

Maximum slope should not be steeper than 6:1 (horizontal to vertical) unless protected from erosion and slope failure through City Engineer/SSCAFCA approved means.

B. Grading near the Property Line

Particular attention must be given to grading (either cut or fill) near property lines. Care should be taken to ensure that existing foundations, retaining walls, stable slopes or other structures are not endangered and that the adjacent property is not or will not be damaged, or its use constrained due to grading at or near the property line. Grading must accommodate runoff onto the site and insure discharge to the historic drainage location at or below the historic flow rates, unless an alternative is approved by the City Engineer and/or SSCAFCA's Executive Engineer in writing.

C. Grading In and Adjacent to Major Facilities

No grading, excavation, or fill may take place in or adjacent to any watercourse defined as a major facility without express written approval from the City Engineer/SSCAFCA. Construction activities within major facilities shall provide for the safe passage of the 100-year design flow especially during the months of June, July, August and September. Construction activities in arroyos shall provide procedures and install systems that insure the safety of the public and personnel from runoff events. Particular attention shall be given to potential runoff from flash floods occurring upstream of the facility.

D. Floodplain Development

No floodplain development will be permitted within a FEMA Special Flood Hazard Area (A or V zone designations) without an approved drainage report and financial guarantees for the permanent improvements. Development of critical facilities within a FEMA recognized 500 year floodplain must be designed and constructed in such a manner as to protect the critical facility from a 500 year event.

E. Violations As To Construction Or Site Alteration.

No grading or other alteration of a site shall take place:

- (A) Prior to approval of an infrastructure list/preliminary plat, building permit or development plan by the City/SSCAFCA, if the grading or site alteration is related to a proposed subdivision;
- (B) Prior to approval of a drainage plan or report, or a determination by the City Engineer/SSCAFCA that no such plan or report is required;
- (C) Contrary to the provisions of a drainage plan or drainage report or to the specifications of a preliminary or final plat, approved under the provisions of this section; or
- (D) Prior to the submittal of a construction schedule for the proposed drainage infrastructure improvements/grading.
- (E) Prior to the issuance of any permits required pursuant to this section.
- (F) Prior to submittal of financial guarantees required by the City/SSCAFCA.
- (G) Prior to:
 - Submittals and review of Storm Water Pollution Prevention Plan
 - Filing and activation of Environmental Protection Agency Notice of Intent
 - Installation of Best Management Practices per Storm Water Pollution Prevention Plan
 - USACE 404 permit approval, if required.

F. Erosion and Stormwater Pollution Control

All grading within the City of Rio Rancho/SSCAFCA area must be performed in a manner which prevents the movement of significant and damaging amounts of sediment onto adjacent property and public facilities by both water and wind, and minimizes the impacts to stormwater runoff quality. Every project involving the grading of more than 1.0 acre or the importation or excavation of more than 500 cubic yards of soil must be accompanied by an erosion control plan accepted by the City Engineer/SSCAFCA. All grading shall conform with EPA Stormwater Regulations. See Section 9 of this chapter for detailed information on the Stormwater Pollution Prevention Plan. All required stormwater pollution improvements/drainage infrastructures must be constructed at the start of the project.

1. Construction Phase:

It is the responsibility of the contractor to implement the erosion and stormwater pollution control plans during the construction phase. Repair of damaged facilities and clean-up of sediment accumulations on adjacent property and in public facilities is the responsibility of the contractor. Failure to do so promptly may result in a “stop-work order” being issued that will remain in force until repair and clean-up is completed to City Engineer/SSCAFCA satisfaction. All exposed earth surfaces must be protected from wind and water erosion prior to final acceptance of any project. The continued maintenance of these protective measures is the responsibility of the owner or his assigns. Penalties will be assessed for graded sites left inactive for fourteen (14) days or more as provided for in SCAFCA’s Drainage Policy/City’s Drainage Ordinance.

2. Phased Construction:

Areas graded in conjunction with phased projects, but not left in their permanent condition must be protected during the interim from wind and water erosion and must not increase stormwater pollution from the existing pre-project conditions per City/SSCAFCA policies.

G. Means of Erosion Control

There are numerous mechanical and vegetative methods for preventing soil erosion. The U.S. Environmental Protection Agency Publication EPA-R2-72-OIS Guidelines for Erosion and Sediment Control Planning and Implementation, New Mexico Department of Transportation Manual and the local U.S.D.A. Natural Resource Conservation Service Office can provide numerous, inexpensive and effective erosion management techniques.

1. The soils in the City/SSCAFCA's jurisdiction are highly erosive requiring special attention during the design, construction and post construction phases of development.
2. **METHODOLOGY**
The SSCAFCA Erosion and Sediment Design Guide will be the basis for analysis and evaluation of erosion control, sediment transport, sediment deposition and related issues.
3. **EROSION AND SEDIMENT GENERATION**
Erosion, both on-site, off-site and from natural arroyos and channels shall be considered and incorporated in the analysis, evaluation and design of site development. The volume of sediment in the off-site flow shall be determined from the sediment bulking factors as defined in the hydrologic analysis procedures in this DPM will be the minimum volume of sediment generation considered in evaluating downstream capacity.
4. **SEDIMENT TRASPORT**
Sediment generation, transport and deposition shall be considered in the drainage and flood control system analysis and design and in determining downstream capacity.

H. Pond/Dam Design (City/SSCAFCA Maintained Facilities)

1. **DETENTION PONDS:** Detention ponds shall not be constructed in public street rights-of-way. Discharge from the detention pond(s) shall be conveyed to public infrastructure capable of containing the release. Such infrastructure may be streets and channels. The means of conveyance to the public infrastructure shall be approved by the City/SSCAFCA. If flows may be conveyed by pipes smaller than 24" then 24" pipe shall be used with an appropriately sized orifice plate. Detention ponds shall be sized to provide a storage capacity for the 100 year 6 hour storm plus 1 foot of freeboard and to empty within 24 hours. Percolation and evaporation may only be considered if supported by calculations and data for the specific location of the pond. Regional soil data will not be accepted.

2. **RETENTION PONDS:** Retention ponds are not generally allowed. Retention ponds must be approved by the City Engineer. If retention ponds are approved by the City Engineer they shall not be constructed in public street rights-of-way. Retention ponds shall be sized to provide storage capacity for twice the volume of the 100 year 6 hour storm plus 1 foot of freeboard. A maintenance plan shall be provided to and approved by the City Engineer. The plan shall contain at a minimum:
 - a. treatment procedures for water that remains in the pond for more than 24 hours
 - b. names and telephone numbers for contacts responsible for the treatment and maintenance of the pond
 - c. time frame for the existence of the retention pond

At the City Engineers discretion, retention ponds may be required to have a maintenance financial guarantee.

3. **INDIVIDUAL ON LOT PONDS:** Individual on lot ponds are not allowed in “planned subdivisions” even if such planned subdivisions are using existing (premature) platting. For the purpose of this ordinance a planned subdivision is defined to mean: Any area of land within the jurisdiction of the City that has either previously been divided or will be divided in accordance with an approved plan. For previously divided land it shall either be owned by a single entity or advertised or sold under a common promotional plan. NMSA 1978 (Supp. 1981) section 47-6-2(K).
4. **ACCESS:** Access into a facility shall be opposite the outlet if possible with a minimum width of 12 feet. Maximum access slope shall be 10:1 or flatter. Standard design tube or pipe gates shall be installed to restrict vehicle access. Gates shall be set back 50 feet from arterial or collector streets so equipment does not have to park in the street.
5. **SPILLWAYS:** Principal spillways shall be designed, at a minimum, for the 100 year fully developed condition and shall always be provided, be erosion resistant, and discharge to a public right-of-way, drainage easement and/or historic flow path.
 - a. Emergency spillways for ponds shall be designed, at a minimum, for the 500-year storm event for fully developed conditions and discharge to a public right-of-way, drainage easement and/or historic flow path.
 - b. Emergency spillways for dams shall be designed, at a minimum, to meet the Office of the State Engineer criteria and discharge to a public right-of-way, drainage easement and/or historic flow path.
6. **OUTLETS:**
 - a. Facility outlets shall always be gravity flow whenever feasible and located in a corner or accessible edge of facility, opposite of facility access point if possible. Outlet pipe shall be a minimum of 24 inches in diameter with a slope such that when flowing at ¼ full, velocity is 2 fps or greater.
 - b. The outlet will be surrounded by a stabilized grade pad appropriately sized for maintenance with a minimum of 6 feet of stabilized grade in all directions.

- c. To protect downstream properties, outlets may be sized to restrict flows below historic or existing conditions at the sole discretion of the Executive Engineer.

7. POND BOTTOMS:

- a. Facility bottoms shall be designed to convey nuisance flows from the inlet to a storm water pollution prevention feature (such as a pervious bottom area for infiltration) prior to discharging to the outlet. Ease of maintenance shall be a consideration in all dams/detention basins. A feature such as a low flow channel having minimum dimensions of 3' wide by 8" thick, structurally reinforced concrete with a 1" invert shall be considered to allow maintenance crews a non-saturated, hardened surface to perform maintenance and provide a grade check in the bottom of the basin. Special care should be given to insure that the channel is not under cut. Each dam/detention basin should be evaluated with regard to such features as ease of maintenance, water quality, desirability of vegetation and habitat, effect on neighborhoods (odors, mosquitoes, vectors), stability/safety of the foundation and embankment, well wash water and possible recharge.
- b. The minimum pond bottom slope is 0.5%, both cross slope and longitudinally.

8. SIDE SLOPE AND BOTTOM TREATMENTS:

- a. Vegetation will be accepted if seeded per the New Mexico APWA Standard Specifications for Public Works Construction, most recent edition.
- b. Side slopes shall be treated with gravel mulch per New Mexico APWA Standards Specifications for Public Works Construction, most recent edition.
- c. A geotechnical investigation and report will be required.

9. MINIMUM POND SIZE:

In order for a pond to be publicly maintained by the City/SSCAFCA, it must be a minimum of two (2) acre-feet.

10. FENCING:

- a. Detention ponds will require five (5) strand barbless wire fencing with wooden posts in accordance with the City/SSCAFCA Standard Details.

11. DRAINAGE – All detention ponds must be evacuated in twenty four (24) hours or less, unless discharge is limited by downstream constraints. In any event, all ponds shall be evacuated within 96 hours unless approvals are received from both the City/SSCAFCA and the Office of the State Engineer. Ponds that take more than six (6) hours to drain will be designed for a design storm equal to or exceeding the evacuation time. No percolation credit for volume reduction will be given.

12. SIGNAGE- All ponds shall have a sign fixed to the fence, in the vicinity of the access gate and visible to the public, that designates the name of the facility and the agency or organization responsible for maintaining the pond. The sign location and sign face shall be included in the infrastructure plans.
13. FREEBOARD- All ponds shall have a minimum of one (1') foot of freeboard.
14. IN-POND SEDIMENT STORAGE- An evaluation shall be performed to insure sufficient in pond storage of sediment deposited during a 100 year event will not affect the functional capability of the structure.
15. SEDIMENT STOCK PILE AND TRANSPORT PROVISION- An evaluation shall be performed to how sediment and debris shall be removed from the facility and transported offsite.

I. Temporary Ponds

1. Interim or temporary facilities shall be protected by a covenant. These covenants may cover a tract of land larger than needed for the final permanent facility in lieu of financial guarantees.
2. An emergency spillway must be provided that will safely convey the 100 year design flow entering the pond.
3. Temporary ponding may be allowed if the owner performs all operations and maintenance, accepts all liability and owns the downstream property. City/SSCAFCA approval is required.

J. Private Storm Drain Improvements Within Public Rights-of-Way and/or Easement.

Frequently a grading and drainage plan developed for a particular property involves either discharge directly into a public facility or across a portion of a public right-of-way to a public facility. Examples include connections to the back of an existing storm inlet, construction of sidewalk culverts or a connection to a storm drain manhole or a channel. When such solutions are employed the construction of private storm drain improvements within the City's rights-of-way must comply with the following requirements:

1. Professional Engineer's stamp with signature and date.
2. Vicinity map
3. North Arrow
4. Plan drawings size 24"x36"
5. Address of the project
6. Detail of the proposed improvements
 - a. All work details on these plans to be performed, except as otherwise stated or provided hereon, shall be constructed in agreement with the New Mexico APWA Standard Specifications for Public Works Construction.

7. An excavation permit will be required before beginning any work within City of Rio Rancho City's right-of-way. An approved copy of these plans must accompany the application for permit.
8. Two working days prior to any excavation, contractor must contact **Line Locating Services** for location of existing utilities.
9. Backfill compaction shall be according to City Standards.
10. Maintenance of these facilities shall be the responsibility of the owner of the property served. Include this maintenance note on the plan.
11. A signature block for approval by either the City Engineer/SSCAFCA.
12. A signature block for approval by either the City Engineer's/SSCAFCA's inspector.

Note #1: If the proposed improvements are part of a building permit application, this information can be incorporated on the appropriate drainage submittal.

Note #2: Private Storm Drain Improvements within City/SSCAFCA's ROW is not allowed without City/SSCAFCA's approval.

Section 6. RIGHTS-OF-WAY AND EASEMENTS

A. Rights-of-Way

That land necessary for permanent drainage, flood control or erosion control facilities or major arroyos, must be dedicated fee simple to SSCAFCA with the City being granted an easement for joint operation and maintenance. SSCAFCA will require sole dedication of drainage right-of-way without a City easement for all high hazard drainage facilities.

1. Dedication Language

- a. The real estate shown and described in this plat is surveyed with the free consent of and in accordance with the wishes and desires of the undersigned Owner(s) thereof, and the Owner(s) of such real estate do hereby dedicate all drainage rights-of-way which are shown hereon including parcels _____ to the Southern Sandoval County Arroyo Flood Control Authority, a political subdivision of the State of New Mexico in fee simple with warranty covenants. Subject to the easements shown or noted hereon, and do hereby grant any and all easements shown or noted on the plat including the right of ingress and egress.

B. Easements

Easements for drainage, flood control and erosion control facilities are acceptable in rare, special occasions as long as a clear written and approved agreement exists as to other acceptable uses and no permanent facilities are constructed within them (including masonry fences and retaining walls but excluding pavement) without an agreement between the owner and the City governing the permitted uses. High hazard structures can only be constructed on publicly owned property.

1. SSCAFCA Grant of Easement to the City of Rio Rancho

- a. The Southern Sandoval County Arroyo Flood Control Authority (“SSCAFCA”), a political subdivision of the State of New Mexico hereby grants the City of Rio Rancho, New Mexico, a municipal corporation (“City”) a non-exclusive easement upon, over, under and across _____ (the “Easement Property”). SSCAFCA shall use the Easement Property solely for the access, construction, operation and maintenance of storm water drainage facilities. This easement shall be appurtenant to the Easement Property and the benefits and burdens of the Easement shall run with Easement Property forever. This Easement shall be perpetual in duration; except that if at any time in the future the Easement Property should cease to contain a drainage facility this Easement shall terminate and become null and void. SSCAFCA shall maintain all five (5) strand barbless fences and pipe gates.

The City shall maintain all other City owned improvements within the Easement Property including, but not limited to, recreational facilities, City utility lines, retaining/landscape walls, all trails including asphalt bike trails, drop/surface inlets, storm drainage laterals,

roads, roadway crossings, including the underlying culverts/structures and all drainage facilities within this subdivision, except those hereinabove identified as the responsibility of SSCAFCA.

C. Configuration

Rights-of-way and permanent easements required for drainage, flood control and erosion control facilities will conform to the following criteria:

1. Surface Facilities:

The dedicated area shall contain the entire facility including any slopes, maintenance roads, turn arounds or other necessary appurtenances, and may not be less than 10 feet wide.

2. Underground Facilities:

Dedicated areas for underground facilities may be not narrower than 20 feet for any facility defined as a major facility and must conform to the formula:

$$W = 2 \times D_i + \text{pipe diameter} + 4 \text{ feet}$$

where: W = dedicated width in feet

D_i = depth to invert

For box conduits or arch pipes use the inside vertical dimension rather than inside pipe diameter.

Pipe should be installed within the easement to allow for stockpiling of material.

D. Designation Language

a. Drainage Facilities and/or Detention Areas Maintained by Lot Owner

Areas designated on the accompanying plat as “drainage easement” [“detention areas”] are hereby dedicated by the owner as a perpetual easement for the common use and benefit of the various lots within the subdivisions for the purpose of permitting the conveyance of storm water runoff and the constructing* and maintaining of drainage facilities [storm water detention facilities] in accordance with standards prescribed by the City of Rio Rancho/SSCAFCA. ** no fence, wall, planting, building or other obstruction may be placed or maintained in said easement area without approval of the City Engineer/SSCAFCA, and there shall be no alteration of the grades or contours in said easements area without the approval of said City Engineer. It shall be the duty of the lot owners of this subdivision to maintain said drainage easement [detention area] and facilities at their cost in accordance with standards prescribed by the City/SSCAFCA. The City/SSCAFCA shall have the right to enter periodically to inspect the facilities. In the event said lot owners should fail to adequately and properly maintain said drainage easement [detention area] and facilities, at any time following fifteen (15) days written notice to said lot owners, the City/SSCAFCA may enter upon said area, perform said maintenance, and the cost of performing said maintenance shall be paid by said lot owners proportionately on the basis of lot ownership. In the event said lot owners fail to pay the cost of said maintenance or any part thereof within thirty (30) days after demand for payment made by the City, the City may file a lien therefor against all lots in the subdivision for which proportionate payment has not been made. The obligations imposed herein shall be binding upon the owner, his heirs, and assigns and shall run with all lots within this subdivision.

The Grantor agrees to defend, indemnify, and hold harmless, the City, its officials, agents and employees from and against any and all claims, actions, suits, or proceedings of any kind brought against said parties for or on account of any matter arising from the drainage facility provided for herein or the Grantor’s failure to construct, maintain, or modify said drainage facility.

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*This assumes owner’s promise to construct will be imposed by a separate agreement.

** [Possible alternative:] Grantor shall construct drainage [detention] facilities in the easement in accordance with standards prescribed by the City/SSCAFCA and plans and specifications approved by the City Engineer/SSCAFCA in accordance with the drainage report entitled _____, submitted by

_____ on, _____ and approved by the City/SSCAFCA on _____, together with the amendments approved on _____, which report and amendments are on file in the office the City Engineer/SSCAFCA.

b. Dedication of Drainage Easements: Owner Constructs and Maintains

A perpetual easement on the areas designated on this plat as “drainage easement” [“detention area”] is here by dedicated to the City of Rio Rancho/SSCAFCA for the purpose of permitting the conveyance of storm water runoff and for the purpose of constructing, maintaining, operating, removing, and replacing storm water drainage facilities [detention facilities]. No fence, wall, planting , building, or other obstruction may be placed or maintained in said easement area and there shall be no alteration of the grades or contours in said dedicated area without the approval of said City Engineer/SSCAFCA. No obstructions may be placed in said easement area which would prevent ingress and egress to same by maintenance vehicles or which would prevent said vehicles traveling on said drainage way for maintenance purposes.

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*The City/SSCAFCA could require dedication of this property in fee simple since the City/SSCAFCA here will be responsible for maintenance. The beginning of the first sentence could read: “the areas designated on this plat as ‘drainage facilities’ are hereby dedicated to the City of Rio Rancho/SSCAFCA in fee simple for the purpose of _____.” We might then add: “the City/SSCAFCA may use the property hereby dedicated for other public purposes.”

- * [Alternative purpose:] Storm water detention
- ** [Possible alternative:] Grantor shall construct drainage detention] facilities in the easement in accordance with standards prescribed by the City/SSCAFCA and plans and specifications approved by the City Engineer/SSCAFCA Executive Engineer in accordance with the drainage report entitled _____, submitted by _____ on _____, and approved by the City Engineer/SSCAFCA on _____ together with the amendments approved on _____, which report and amendments are on file in the office of the City Engineer/SSCAFCA.

6. In the event that the Grantor should fail to construct the drainage facilities contemplated here in or fail to adequately and properly maintain the easement and any facilities constructed thereon, the City of Rio Rancho/SSCAFCA or its agents, at any time following fifteen (15) days written notice to the owner of record of said property, may enter upon said property to perform necessary construction or maintenance. The cost of performing such construction or maintenance shall be paid by the property owner. In the event the property owner fails to pay the costs of such construction or maintenance within thirty (30) days after being notified in writing of the cost of same, the City/SSCAFCA may file a lien therefore against the real property described in paragraph 1.
7. No fence, wall, planting, building or other obstruction may be placed or maintained in the easement without the written approval of the City Engineer of the City of Rio Rancho or the Executive Engineer of SSCAFCA and there shall be no alteration of the grades or contours in said easement after drainage facilities are constructed without the written approval of the Rio Rancho City Engineer/SSCAFCA Executive Engineer. Any violation of this provision will be promptly corrected upon receipt of notice from the City/SSCAFCA, or the City/SSCAFCA shall have the right to remove or otherwise eliminate such violation and assess the cost to the property owner as provided in paragraph 6 above.
8. Said easement is intended to be permanent in nature for the uses and purposes recited above to the City/SSCAFCA, it's successors and assigns, until such time as the City/SSCAFCA releases said easement in writing.
9. The obligation of the Grantor set forth herein shall be binding upon the Grantor, his heirs, and assigns and the property of the Grantor as described herein and will run with said property until released by the City/SSCAFCA.
10. The City/SSCAFCA shall not be liable for any damages to the Grantor resulting from its construction, modification, or maintenance of said facilities.

The Grantor agrees to defend, indemnify, and hold harmless, the City/SSCAFCA, its officials, agents and employees from and against any and all claims, actions, suits, or proceedings of any kind brought against said parties for or on account of any matter arising from the drainage facility provided for herein or the Grantor's failure to construct, maintain, or modify the drainage facility under this covenant.

E. Drainage Right-of-Way Access

All newly constructed drainage facilities within a public right-of-way must have restricted access control to prevent unauthorized vehicular access with Pipe or Tube Gate.

F. Criteria for Vacating SSCAFCA's Rights-of-Way/Easement

- a. Rights-of-Way/Easement
 - i. Approved by SSCAFCA Board
 - ii. Compensation for right-of-way being vacated
 - iii. Certified by an appraiser
 - iv. Naturalistic improvements constructed by party requesting the vacation.
(O&M costs must be equal or less)

G. Vacation Procedure for Rights-of-Way and Easements

Step 1: Pre-Application Discussion

Discussion of the proposed vacation with the SSCAFCA staff is recommended prior to application filing. The purpose of the discussion is to review City/SSCAFCA policies and procedures applicable to the proposal so that incomplete, inadequate, and inappropriate applications are avoided. City staff may be included in this discussion.

Outcome of Pre-Application Discussion

The purpose of this discussion is to:

- review the appropriateness of the request as related to various applicable plans, policies, and ordinances including the Zone Code and/or Subdivision Ordinance.
- determine all appropriate procedures/information needed to obtain approval.
- determine a preliminary schedule/time frame for approval.
- determine a filing date for the application if appropriate.
- outline preliminary direction from staff based upon the information submitted.
- prepare a written summary of the requirements/procedures to obtain approval.

SSCAFCA and the applicant will sign a written summary of the meeting. Copies of the written summary are given to the applicant/agent and City/SSCAFCA.

Step 2: Application for a public hearing with SSCAFCA Board of Directors

Submit a letter to the Executive Engineer with all the required information determined at the pre-discussion meeting. The Executive Engineer will advise applicant the date of the public hearing.

Step 3: SSCAFCA Public Hearing

The public hearing gives the general public and area residents opportunity to discuss and speak for or against the request and to elicit additional information which may have a bearing on the request. The applicant or agent must be present at the hearing to speak on behalf of the request and respond to questions.

Outcome:

Decision by the SSCAFCA Board may be deferred if additional information or additional public notice seems necessary.

The SSCAFCA Board decision on the request may be to:

- approve,
- approve with conditions, or
- deny.

The applicant and other interested parties receive a Letter of Advice of the decision along with any conditions imposed.

The decision is final unless appealed to District Court.

Step 4: Compliance with Conditions

A normal condition of approval requires SSCAFCA to dispose of all public right-of-way declared surplus through the vacation process. Generally all utility and drainage easements are retained unless otherwise specified in Board's decision.

The applicant must also prepare and record a plat which incorporates the vacated right-of-way with adjacent property. Under special circumstances other instruments of conveyance, such as a deed, may be appropriate.

Any conditions must be met within the time period established by SSCAFCA. SSCAFCA may grant an extension by written request. However, all conditions must be met within one (1) year from the date of the original decision.

Section 7 PROCEDURES FOR DRAINAGE SUBMITTALS

A. PROCEDURES FOR DRAINAGE SUBMITTALS

INTRODUCTION

This section presents procedures for making drainage submittals. General criteria established by the City/SSCAFCA for review of those submittals are also presented.

Submittal Preparation

Guidelines for preparation of drainage submittals are presented in DPM Chapter II.2.2, Section 7. The material and information required for a complete submittal can be determined by referring to the appropriate section in the DPM.

Approval Procedures

The following are procedures and guidelines established by the City/SSCAFCA for the review of drainage submittals.

1. All Drainage Submittals and follow-up correspondence should be submitted to the City/SSCAFCA. For record keeping purposes a Drainage Information Sheet (DIS) must be provided with the subject transmittal. The latest version can be obtained from the City/SSCAFCA. All Drainage submittals required for building permit, preliminary plat, site development plan, sector plan, grading plan approvals, etc, must be processed through the City's/SSCAFCA's Offices.
2. Upon receipt of a drainage submittal the City/SSCAFCA will assign a file number, and the submittal will be logged in for review. The submittal will be added to a list that identifies its status in the review process.
3. Correspondence related to drainage submittals must reference the file number assigned by the City's/SSCAFCA's Office upon submittal. These file numbers shall also be referenced on all re-submittals. The use of the file number facilitates the processing and tracking of drainage submittals and related correspondence.
4. Drainage submittals that do not include a DIS, vicinity map, legal description, engineer's seal for Drainage, date and other major items identified on the appropriate DPM format guideline will not be accepted. Only after the information is deemed complete will a submittal be accepted for review.
5. It is the policy of the City's/SSCAFCA's Offices to make responses to new submittals, resubmittals, and follow-up correspondence as soon as possible but not more than thirty calendar days after a complete submittal has been received by that office.

6. All revisions made to a particular submittal must be signed, sealed and dated by the Engineer of Record for all drainage submittals with revisions clearly noted. Resubmittals must be accompanied with the agency's original comments.
7. Approved drainage submittals are in effect for a period of one year (provided no significant changes have occurred which may alter the original submittal) from the date of approval. After one year, if no significant development has taken place, a resubmittal will be required and must reflect all changes in conditions and/or City/SSCAFCA requirements since the date of last approval.
8. Questions concerning the preceding items should be directed in writing to the City's/SSCAFCA's Offices.

Flood Hazard Certification

Compliance with the requirements of the Flood Hazard Prevention Ordinance is required of every applicant for subdivision, site development plan and/or building permit approval. Compliance is achieved by either demonstrating that the proposed project does not lie within a designated flood hazard area or by demonstrating adequate flood-proofing as required by the ordinance or by removing the site from a flood hazard area through the FEMA map revisions process.

Development Within Flood Hazard Areas For Building Permits

If the site is determined at the time of building permit application to lie within a Flood Hazard Area as shown on the Federal Emergency Management Agency (FEMA) maps on file with the City, then the City/SSCAFCA will determine if flood-proofing is required. Prior to final approval of building occupancy, certification by a registered professional surveyor or engineer as appropriate must be made so that these flood-proofing requirements have been met.

Development Within Flood Hazard Areas For Subdivisions And/Or Site Plan Approvals

If any improvements are proposed which modify the existing floodplain boundary, an application for a Conditional Letter of Map Change (CLOMC) shall be submitted to the City Floodplain Administrator to be forwarded to FEMA. A Letter of Map Change (LOMC) must be obtained from FEMA after construction is complete. When a CLOMC has been issued by FEMA, a portion or all of the SIA (Subdivision Improvement Agreement) and financial guarantees may be released prior to the LOMC being issued by FEMA. Submittal of a copy of the LOMC from FEMA is required for release of the balance of the financial guarantees and SIA's when issuance is a condition of release.

The following floodplain note must be placed on the plat if a LOMC has not been issued by FEMA: "Portions of the subject property lie within a designated area of special Flood Hazard as shown on the most recent National Flood Insurance Program's "Flood Insurance Rate Map. Until such time that a LOMC is issued by FEMA, flood insurance may be required."

Drainage Covenants

Occasionally, a developer of a property will choose to employ a drainage scheme that requires installation and maintenance of drainage features on the developer's property or other properties. In those instances where such drainage features must be perpetually maintained to minimize possible damage to other properties or to public properties, the City may require the developer enter into a covenant assuring maintenance of such facilities. There are four (4) types of covenants which are discussed below.

Covenants to run with the land. They generally require the owner of the land to maintain features to City standards and allow the City's entrance upon the property to inspect drainage features for such maintenance as needed. A typical example of such drainage covenant and instructions for the use of the covenant are presented in the DPM.

The following is a brief description of the four types of drainage covenants the City may require the developer to enter into:

1. **Private Facility Drainage Covenant** - for a privately owned, privately maintained facility, which places maintenance and inspection responsibility on the property owner(s). For example, a cutoff wall to protect property adjacent to an unlined arroyo.
2. **Drainage Covenant (no public easement)** - for a privately owned, privately maintained facility whose non-function or failure to perform, will cause damage to others. For example, a large detention pond in a shopping center. The maintenance responsibilities lie with the owner. The City, however, has the right to inspect periodically and to enforce proper maintenance.
3. **Agreement and Covenant** - for a privately maintained facility which is within the City's property (City right-of-way or City easement). The City has the right to inspect and to enforce proper maintenance. For example, phased developments that require temporary retention ponds and/or sediment ponds.
4. **Private Facility Drainage Covenant and Reservation of Private Drainage Easement** - for a privately owned, privately maintained facility which places maintenance and inspection responsibility on the property owner(s). For example, a pond used in common by more than one property owner.

Encroachment Agreements

Occasionally the grading scheme for an approved drainage plan will employ the construction of a retaining wall or other drainage/grading structure outside the periphery of a private property, encroaching into public property. Although such encroachments are discouraged, it is recognized that certain circumstances will require installations of this type. In such event the City normally requires an encroachment agreement with the developer. The encroachment agreement, which runs with the land, allows the developer to install some semi-permanent features on public property meeting criteria established in the DPM. The developer is required to assure the City that such features will be removed in a timely manner if required by the City or, alternatively, that the City will be empowered

to remove such encroachments, with the cost of such removal charged to the owner of the property. A standard encroachment agreement together with instructions for the preparation of same, can be obtained by contacting the City.

Drainage Facilities Construction Agreement and Financial Guarantee

Section 9C of SSCAFCA's Drainage Policy states that "if the construction of such (drainage) facilities is a condition of plat approval or building permit issuance, then financial guarantees of such construction satisfactory to the City/SSCAFCA shall also be provided as a prerequisite." In those instances where financial guarantees are required, the developer enters into an agreement with the City assuring the construction of such facilities. The form of agreement and the nature of acceptable financial guarantee is dependent on the circumstances involved.

Forms and Certificates

Current copies of forms and certificates such as the drainage information sheet can be obtained from the Development Service Department (DSD), SSCAFCA or through SSCAFCA's website at www.sscafca.com.

CONFERENCE RECAP

DRAINAGE FILE/ZONE ATLAS PAGE NO. _____ DATE: _____

PLANNING DIVISION NOS: EPC _____ DRB _____

SUBJECT: _____

STREET ADDRESS (IF KNOWN)

SUBDIVISION NAME: _____ BLOCK: _____ LOT: _____

TYPE OF PROJECT

___ PRELIMINARY PLAT

___ FINAL PLAT

___ SITE DEVELOPMENT PLAN

___ BUILDING PERMIT

___ (OTHER) _____

___ ROUGH GRADING

ATTENDEES

WHO	REPRESENTING
_____	_____
_____	_____
_____	_____

FINDINGS:

The undersigned agrees that the above findings are summarized accurately and are only subject to change if further investigation reveals that they are not reasonable or that they are based on inaccurate information.

SIGNED: _____

SIGNED: _____

TITLE: _____

TITLE: _____

DATE: _____

DATE: _____

***NOTE**PLEASE PROVIDE A COPY OF THIS RECAP WITH THE DRAINAGE SUBMITTAL**

DRAINAGE INFORMATION SHEET

PROJECT TITLE: _____ RIO RANCHO CASE #: _____

SSCAFCA File #: _____

LEGAL DESCRIPTION: _____

PROPERTY ADDRESS: _____

ENGINEERING FIRM: _____

ADDRESS: _____

CITY, STATE: _____

CONTACT: _____

PHONE: _____

ZIP CODE: _____

OWNER: _____

ADDRESS: _____

CITY, STATE: _____

CONTACT: _____

PHONE: _____

ZIP CODE: _____

ARCHITECT: _____

ADDRESS: _____

CITY STATE: _____

CONTACT: _____

PHONE: _____

ZIP CODE: _____

SURVEYOR: _____

ADDRESS: _____

CITY, STATE: _____

CONTACT: _____

PHONE: _____

ZIP CODE: _____

CONTRACTOR: _____

ADDRESS: _____

CITY, STATE: _____

CONTACT: _____

PHONE: _____

ZIP CODE: _____

CHECK TYPE OF SUBMITTAL:

- _____ DRAINAGE REPORT
- _____ DRAINAGE PLAN 1st SUBMITTAL
- _____ DRAINAGE PLAN RESUBMITTAL
- _____ GRADING PLAN
- _____ EROSION CONTROL PLAN
- _____ ENGINEER'S CERTIFICATION (HYDROLOGY)
- _____ CLOMR/LOMR
- _____ ENGINEERS CERTIFICATION (SITE PLAN)
- _____ OTHER

CHECK TYPE OF APPROVAL SOUGHT:

- _____ PRE-DESIGN CONFERENCE
- _____ SIA/FINANCIAL GUARANTEE RELEASE
- _____ PRELIMINARY PLAT APPROVAL
- _____ S. DEV. PLAN FOR SUB'D APPROVAL
- _____ S. DEV. PLAN FOR BLDG. PERMIT APPROVAL
- _____ FINAL PLAT APPROVAL
- _____ FOUNDATION PERMIT APPROVAL
- _____ BUILDING PERMIT APPROVAL
- _____ CERTIFICATE OF OCCUPANCY (PERM.)
- _____ CERTIFICATE OF OCCUPANCY (TEMP.)
- _____ GRADING PERMIT APPROVAL
- _____ PAVING PERMIT APPROVAL
- _____ WORK ORDER APPROVAL
- _____ REQUEST FINAL APPROVAL
- _____ OTHER (SPECIFY)

DATE PRE-DESIGN CONFERENCE HELD:

DATE SUBMITTED: _____

BY: _____

Requests for approvals of Site Development Plans and/or Subdivision Plats shall be accompanied by a drainage submittal. The particular nature, location and scope to the proposed development defines the degree of drainage detail. One or more of the following levels of submittal may be required based on the following:

1. **Conceptual Grading and Drainage Plan:** Required for approval of Site Development Plans greater than five (5) acres and Sector Plans.
2. **Drainage Plans:** Required for building permits, grading permits, paving permits and site plans less than five (5) acres.
3. **Drainage Report:** Required for subdivision containing more than ten (10) lots or constituting five (5) acres or more.

(A) Fees

The consultant should be advised that FEMA has a cost for reviewing private development projects to recover their engineering review and processing associated with the issuance of Conditional Letters of Map Amendments (CLOMA's), Conditional Letters of Map Revision (CLOMR's), Letters of Map Revisions (LOMR's), and Letters of Map Amendments (LOMA's).

FEMA's current fee schedule may be obtained from the City Floodplain Administrator. All fees may be subject to change by FEMA.

Prior to preparing information for a map revision or amendment, it is recommended that a pre-design meeting be initiated with the City Floodplain Administrator to discuss your request. At this meeting, specific information relating to your CLOMA, LOMA, CLOMR or LOMR will be identified. All submittals must be made on current FEMA Forms. All submittals will be sent to FEMA by the City/County Floodplain Administrator.

(B) Letter of Map Amendment (LOMA)

The purpose of a LOMA is to provide an administrative procedure whereby FEMA will review the scientific or technical submissions of an owner or lessee of property who believes his property has been inadvertently included in designated A, AO, AE, AH, A99, VE, or V Zones, as a result of the transposition of the curvilinear line to either street or to other readily identifiable features. The necessity for this is due in part to the technical difficulty of accurately delineating the curvilinear line on a FIRM map. These procedures shall not apply when there has been any alteration of topography since the effective date of the FIRM map, which shows the property within an area of special flood hazard.

Any owner or lessee of property (applicant) who believes his property has been inadvertently included in a designated A, AO, AE, AH, A99, VE or V Zones on a FIRM map, may submit scientific or technical information to the City Floodplain Administrator to be forwarded to FEMA for review.

(C) Conditional Letter of Map Revision (CLOMR)

A Conditional Letter of Map Revision is FEMA's comment on the effectiveness or impacts of a proposed flood control project or flood plain modification. It is based on FEMA's review of the proposed project and states that if the proposed project is built as designed, it would be cause for a Letter of Map Revision. The CLOMR does not revise the FEMA flood maps.

(D) Letter of Map Revision (LOMR)

If land development involves the reclamation of a floodplain or floodway, it is recommended that you contact the City Floodplain Administrator to discuss the specific requirement for a LOMR. The criteria for LOMR's will be per FEMA's latest revision of The National Flood Insurance Program and Related Regulation.

Revisions to effective NFIP maps are most often requested because of physical changes that have taken place in the flood plain. Such changes include, but are not limited to, the construction of new bridges, culverts, levees, or channel improvements and the grading and filling normally associated with development (including the placement of fill to elevate individual structures above the BFE).

Occasionally, revisions will be requested because the analyses used to develop the data shown on the effective NFIP are found to contain errors, or because a requester believes that the use of alternative methodologies or better data will provide results that are more accurate than those obtained from the original FEMA analyses.

The typical required submittal for map revisions because of physical changes is as follows:

- a. General description of the changes (dam, diversion channel, detention basin, etc.)
- b. Construction plans for as-built condition, if applicable.
- c. New hydrologic analysis accounting for the effects of the changes.
- d. New hydraulic analysis using the new flood discharge values resulting from the hydrologic analysis.
- e. Revised delineations of the flood plain boundaries or floodway.

All requests to FEMA must be accompanied by the latest NFIP forms. Two sets of the required data must be submitted to the City Floodplain Administrator. The Administrator will forward the submittal to FEMA for the map revision. The consultant should be aware that FEMA may request additional data or fees prior to releasing a LOMR.

B. PROCEDURE FOR STORM DRAINAGE INFRASTRUCTURE ALLOCATION

A. Introduction

This section provides the procedure for the allocation of drainage infrastructure improvements that are generated by and attributable to new development.

B. Purpose

The purpose of this Procedure is to provide an equitable cost distribution method for drainage improvements that allows for the installation of public drainage facilities with new development and a mechanism to provide for the Cost Allocation to and payment of those facilities by the properties that are seeking development approval and benefit from the facilities.

C. Definitions

D. Generally

1. The City/SSCAFCA acknowledges that new development may construct drainage facilities that benefit other property within a drainage basin. The provisions of this Procedure provide the manner in which such facilities may be constructed by an applicant and the method to allocate the Cost to benefited property owners.

2. This Procedure is intended to complement and supplement the Subdivision Ordinance, Erosion Control; Storm Drainage Ordinance and the Flood Hazard Prevention Ordinance of the City, SCAFCA Drainage Policy and shall be administered in concert therewith. Pursuant to the City Erosion Control Ordinance and SCAFCA Drainage Policy, all properties proposed for development must provide for the management and conveyance of storm runoff from a fully developed upstream drainage basin.

3. Administration and enforcement of this Procedure may be delegated to the City Engineer.

E. Infrastructure Allocation Drainage Management Plan (Allocation Plan)

1. Any new development which requires the construction of public drainage facilities that service more than a single platted parcel of land may prepare an Allocation Plan. An Allocation Plan shall be required to support a request for the Cost Allocation of the cost of drainage facilities to benefiting properties. Generally, the Allocation Plan shall (1) define the extent and limits of the drainage basin to be served by the drainage facilities to be constructed; (2) determine the drainage and water quality facilities necessary to collect, control and convey storm water runoff based on the design storm generated within the drainage basin; (3) identify a drainage outfall for the drainage facilities proposed for construction; (4) define the benefited area; and (5) include a Preliminary Cost Allocation Map and a Preliminary Cost Allocation Table. The Preliminary Cost Allocation Table and Preliminary Cost Allocation Map may be prepared based on existing or proposed platting of lands within the benefited area. Previous studies, reports and/or plans may be utilized in preparation of the Allocation Plan, as accepted by the City/SSCAFCA.

2. The Allocation Plan shall include a current estimate of the total calculated cost of constructing the drainage facilities, including the anticipated costs for engineering studies and design, surveying, planning, Federal Emergency Management Agency Map revisions and amendments construction, construction management, observation and administration, easement, right-of-way and property acquisition, and other incidental costs which can be anticipated. The City's estimated Unit Prices Contract Items, latest edition, shall be used whenever possible.

3. The Allocation Plan shall be prepared and/or amended by or under the direct supervision of a professional engineer registered in the State of New Mexico and competent in the areas of surface water hydrology and hydraulics. The design work referenced above shall be performed in accordance with the City/SSCAFCA Ordinances, Policies and DPM.

4. The Allocation Plan shall be based upon fully developed conditions, [excepting properties excluded under paragraph G (9)] taking into consideration the current elements of the applicable City land use master plan(s), or other reasonable land use models, as they relate to the benefited area, and other relevant known factors, such as changes in zoning or development trends not reflected on the master plan(s).

5. The Allocation Plan shall specifically identify and address, but not be limited to, the following:

- a. land use assumptions

- b. the benefited area, drainage basin and benefit
 - c. undeveloped and developed conditions and assumptions which shall be illustrated by a definitive table establishing the specific discharge rate for each property and volume
 - d. hydrology/hydraulic analysis
 - e. phasing
 - f. required drainage facilities and associated infrastructure
 - g. all costs for the drainage facilities and associated infrastructures
 - h. current conditions
 - i. anticipated sources of funding independent of the Cost Allocations
 - j. required right-of-way
 - k. how cost allocations are established (methodology)
 - l. all properties within the benefited area (preliminary Cost Allocation Map)
 - m. preliminary Cost Allocations to properties, and identify "excluded" or benefited properties that shall not be allocated (if any)
 - n. a cost allocation Table
 - o. a cost allocation Map
6. Neither the City/SSCAFCA or any other owner or developer of land in the benefited area shall subsequently construct a drainage facility that does not comply with an approved Allocation Plan.

F. Review and Approval Procedure

1. **Pre-Application Meeting.** It shall be mandatory that a pre-application meeting occur prior to initiating any of the following steps. Upon request, the City/SSCAFCA shall schedule a meeting with the applicant to discuss general Allocation Plan procedures and the merits of the proposed Allocation Plan.

2. **City/SSCAFCA Review and Approval.**

a. The Applicant shall submit a draft Allocation Plan to the City/SSCAFCA for preliminary review and comment. The final Allocation Plan shall be approved by the City Engineer at a public hearing after notice in a newspaper of general circulation at least 15 days prior to the hearing prior to initiation of any subsequent steps in these procedures.

b. The approved Allocation Plan shall be on file at the City Engineer's office and open to public inspection.

G. Establishing Cost Allocations

1. The method for determining the Cost Allocation associated with each property within the benefited area shall be set forth in the Allocation Plan, in accordance with this section. The Cost Allocation shall be determined by multiplying the total costs of the drainage facilities by a Cost Allocation Factor.
2. The Cost Allocation Factor may be calculated by: (1) a proportion of individual parcel area to the total area of the Benefited Area, (2) a proportion of the designed discharge or runoff volume for the property as set forth in the Allocation Plan to the total designed discharge or runoff volume of the public drainage facility to be constructed as set forth in the Allocation Plan, or (3) of a cost sharing matrix which takes into account such factors as property size, designed discharge, floodplain removed, partial basin Cost Allocation, allocation of downstream capacity, ponds reclaimed, frontage, prudent line changes and other factors.
3. The method or combination of methods selected for establishing Cost Allocations shall be approved by the City/SSCAFCA and used in preparing the Cost Allocation Table.
4. The total calculated cost of the drainage facilities to be constructed shall consist of all costs, including, but not limited to, engineering, surveying, planning, Federal Emergency Management Agency Map revisions and amendments, the acquisition of easements, rights-of-way or other property, environmental permitting and mitigation and construction.
5. The cost allocation or the required drainage infrastructure identified by the Allocation Plan for each new development shall be identified on the approved infrastructure list for the new development, and shall be required as a condition to final plat final site plan approval, or building permit approval.
6. All money collected through this procedure shall be due at the time of final plat approval or final site plan approval.
7. All money collected through the implementation of this Procedure shall be maintained by the City Engineer in a segregated account clearly identifying the payer and the drainage facility within the benefited area for which the payment was made. All money collected through this procedure shall be used to construct the infrastructure as shown on the approved Allocation Plan.
8. In the event that the drainage basin extends outside the City's municipal limits, the benefited area may also extend beyond those limits provided that the benefited property owners outside the City's municipal limits consent to participation.
9. The exclusion of properties from Cost Allocation shall be subject to the following conditions and qualifications.

a. Properties within the Drainage Basin that will not benefit from the drainage facilities shall be identified in the Allocation Plan but excluded from Cost Allocation. For example, such excluded properties may not reasonably drain to the drainage facilities to be constructed, or which have already been developed with permanent stand alone drainage systems and would receive no benefit from the proposed drainage facilities.

b. Permanent Open Space within the Drainage Basin shall be identified in the Allocation Plan but excluded from Cost Allocation. The cost that would have been allocated to the open space will be distributed in accordance with paragraph G (2) to the remaining benefited properties.

c. Public right-of-way shall not be subject to Cost Allocation.

d. The Applicant may choose to exclude property within the benefited area, provided that (1) such exclusion does not increase the Cost Allocations of other properties, or (2) the applicant submits written verification that all of the other allocated properties have agreed to accept the excluded property's Cost Allocation in an equitable or agreed upon manner.

e. Property owned by the United States of America, the State of New Mexico or any other property owned by an entity not subject to the jurisdiction of the City's Planning and Development regulations include ROW owned by SSCAFCA shall not be subject to Cost Allocation.

f. Excluded properties, as approved by the City, shall be limited to existing condition discharge.

H. Design of Drainage Facilities

1. After the City/SSCAFCA has approved the Allocation Plan and the applicant is ready to proceed with his development, the applicant shall have the drainage facilities designed by a professional engineer in accordance with the DPM and the approved infrastructure list. The construction plans and specifications shall be submitted to the City/SSCAFCA for review and, if acceptable, approval.

2. Construction cost/quantity estimates shall be prepared and approved in accordance with applicable policies of the City/SSCAFCA and prepared in such a manner that the total cost for Allocation Plan items alone can be determined.

3. The construction plans shall not necessarily be limited to Allocation Plan item construction only.

I. Construction and Inspection of Facilities

1. Upon approval of the construction plans and specifications by the City/SSCAFCA, completion of applicable competitive bidding, and acquisition of the necessary easements, rights-of-way, environmental mitigation and permitting, or other necessary property interests, the applicant shall cause the drainage facilities to be installed, at the applicant's expense, strictly in accordance with the approved plans and specifications.

2. Prior to construction, the applicant or applicant's contractor shall obtain approval from the City/SSCAFCA, complying with all procedures and practices normally required to obtain same,

including but not limited to applicable bonds, subdivision improvement agreements, construction contracts, insurance certificates and fees.

3. Construction inspection, surveying and testing shall be performed in accordance with applicable City/SSCAFCA policies.
4. Changes to Allocation Plan related construction items shall be allowed during construction, provided the City/SSCAFCA approves the field change in writing as being substantially in conformance with the approved Allocation Plan.
5. If the change varies by 10% or more of the original estimated Allocation Plan cost, the Allocation Plan shall be amended and resubmitted by the applicant to the City/SSCAFCA for reapproval.
6. Financial guarantees shall be withheld until such time as the Allocation Plan is amended to reflect as-constructed changes and conditions.

J. Temporary or Phased Drainage Facilities

1. Temporary facilities and phased construction of drainage facilities are only allowed and/or required on a case-by-case basis as determined by the City/SSCAFCA. The level of protection to be provided by temporary or phased facilities shall be determined by considering:
 - a. the likelihood and consequences of a failure;
 - b. length of time until permanent facilities shall be in place;
 - c. the acceptance of maintenance responsibilities and legal liabilities;
 - d. the provision of substantially complete plans of all required permanent allocation plan infrastructure.

All costs of approved temporary or phased facilities shall be included in the Cost Allocations, as approved by the City/SSCAFCA, and to the extent that the temporary facilities benefit the area.

2. Under phased construction of drainage facilities where the developer is not required by the approved Allocation Plan to install an amount of infrastructure equal to or exceeding his ultimate Cost Allocation to support the development of his phase, the developer installing the drainage facilities shall: (1) install infrastructure equal in cost to the developer's required Cost Allocation, as determined by the completed Allocation Plan improvements without phasing, or (2) pay cash or post a suitable financial guarantee acceptable to the City in an amount equal to the difference between the cost of drainage facilities constructed and the developer's required Cost Allocation, as determined under the completed Allocation Plan improvements without phasing.

K. Updating Allocation Plan and Cost Allocations

1. Allocation Plan and the Cost Allocations shall be updated with each subsequent development or as required by the City/SSCAFCA.
2. As determined by the City Engineer/SSCAFCA, the Allocation Plan shall be reviewed and/or updated to reflect changed conditions within the drainage basin.

L. Appeals; SSCAFCA Executive Committee

1. Any applicant aggrieved by a decision at to actions of the Executive Engineer or absence of such decision, may appeal such decision to the Executive Committee of SSCAFCA. Such appeal shall be made by notice of appeal in writing addressed to the Chairperson of the Executive Committee and delivered to SSCAFCA within 30 days after the date the decision was mailed to the applicant. The Chairperson of the Executive Committee shall notify the applicant and the Executive Committee Members of the date, time, and place of the appeal hearing at least five day prior to the hearing date. Such hearing shall be conducted not earlier than ten days no later than 30 days after the filing of the notice of appeal. At the hearing, the Executive Committee may consider such facts, exhibits , and engineering principles as may be presented by the appellant or the Executive Engineer or his designee, or of which the members may have knowledge or experience, and my affirm, reverse or modify the decision appealed from, and attach as condition to their decision such requirements as in their opinion may be necessary or appropriate in compliance with the policies of §§ 1 et seq. to safeguard persons and property form storm water runoff. Each decision of the Executive Committee shall be in writing and shall state reasons therefore. A copy of the decision shall be promptly mailed to the applicant and to the Executive Engineer and City Engineer.
2. The Executive Engineer or applicant aggrieved by any decision of the Executive Committee may appeal such decision to the SSCAFCA Board of Directors. Such appeal shall be requested by notice of appeal in writing addressed to the Chairman of the SSCAFCA Board of Directors within 30 day after the date a copy of the decision was mailed to the applicant. Such appeal shall be heard after notice at the first available meeting of the SSCAFCA Board of Directors. The SSCAFCA Board of Directors may affirm, reverse, or modify the decision of the Executive Committee. A copy of the decision shall be promptly mailed to the applicant and to the Executive Engineer and City Engineer.

M. Reserved

N. Application

1. This Procedure shall apply to and be required of new development projects requesting platting, site plan and building permit approvals that, prior to the effective date of this Procedure, have not received preliminary plat (and such approval has not expired) and for which the construction of public drainage facilities are required. At the request of the Developer, development projects that have proceeded beyond preliminary plat approvals may be considered for review and application of this Procedure upon approval of the City/SSCAFCA. Where phasing of drainage facility construction is planned, the provisions of this Procedure shall be applied only to that phase of construction, or phases identified in an approved Allocation Plan, which has not been completed nor commenced.

2. For development projects for which a drainage submittal to the City/SSCAFCA has already been made, the applicant shall have the option of proceeding with a standalone project independent of the Allocation Plan or conform to this Procedure.

3. This procedure shall be promulgated as an administrative rule change to the Development Process and shall become applicable to new development 30 days after the approved rule change is promulgated.

Section 8. SUPPLEMENTARY MATERIALS FOR DRAINAGE SUBMITTALS

A. DRAINAGE SUBMITTAL FORMAT

1. Introduction

A Drainage Submittal is generally in the form of either a Conceptual Grading and Drainage Plan, Drainage Report or Grading and Drainage Plan. All drainage submittals shall include a cover letter explaining the purpose of the submittal and clearly identify the action being requested from the City/SSCAFCA. Quite often, the terms are used interchangeably. The following are definitions of these three types of submittals:

2. Conceptual Grading and Drainage Plan

Conceptual Grading and Drainage Plans are a graphic representation of existing and proposed grading, drainage, flood control, erosion control and stormwater pollution prevention information. The information should be of sufficient detail to determine project feasibility. The purposes of this plan are to check the compatibility of the proposed development within grading, drainage, floodplain, erosion control and stormwater pollution prevention constraints as dictated by on-site physical features as well as adjacent properties, streets, alleys and channels. Modifications to the comprehensive plans and the development of area plans, sector plans, site development plans and landscaping plans on tracts of five (5) acres or more are appropriate applications of conceptual grading and drainage plans.

3. Drainage Report

A Drainage Report is a comprehensive analysis of the drainage management, flood control, erosion control and stormwater pollution prevention constraints on and impacts resulting from the proposed platting, development or construction of a particular project. Drainage Reports are required for subdivisions containing more than 10 lots or comprising more than 5 acres, platting or construction proposed within a designated flood hazard area, and for platting or development proposed adjacent to a major arroyo.

4. Grading and Drainage Plan

A Drainage Plan is a comparatively short, yet comprehensive, presentation for small, non-complex development submittals. Drainage Plans are often combined with or accompany the detailed Grading Plan, and address both onsite and offsite drainage management, flood control, erosion control and stormwater pollution prevention. Drainage Plans are required for the approval of Building Permits, Site Development Plans, and Landscape Plans for the development of projects 5 acres or less in size.

The Format presented below provides for a logical and comprehensive treatment of the topics relevant to the review and analysis of a complete Drainage Submittal. The Format is presented in outline form for simplicity. In addition, each submittal shall include the following information:

1. Project Name
2. Name of Engineering Firm
3. Engineer's Seal (signed and dated)
4. Appropriate completed check list

NOTE: The following Outline is intended as a guide for the preparation of Drainage Submittals. Some items may not be applicable, while other items may require a more in-depth treatment or may have been overlooked in the preparation of the Outline.

A pre-design conference is required for projects where the scope may be difficult to define, the constraints and conditions somewhat unique, or the drainage solution non-traditional.

B. DRAINAGE REPORT OUTLINE

I. EXECUTIVE SUMMARY

A. Provide a brief yet comprehensive discussion of the following:

1. General project location
2. Development concept for the site
3. Drainage concept for the site (include relevant #'s as appropriate)
4. How offsite flows will be handled
5. How onsite flows will be handled and discharged
6. Downstream capacity and how determined
7. Impacts on or requirements of other jurisdictions

B. Identify all approvals being requested in conjunction with this submittal, such as:

1. Zone Change
2. Subdivision Plat
3. Site Plan for Subdivision
4. Site Development Plan for Building Permit

5. Building Permit
6. Sidewalk Culverts, Drain Line through Curb, Drain Line to Existing Storm Inlet
7. Grading Permit
8. Paving Permit
9. DPM Design Variance
10. CLOMR, LOMR or LOMA
11. USACE 404 Permit

II. INTRODUCTION

A. Narrative description of project scope

1. Provide more detail than presented in the Executive Summary (combine with Executive Summary for non-complex projects)

B. Project requirements

1. Discuss and reference required infrastructure and associated infrastructure list
2. Platting and/or easements
3. Approvals by and/or coordination with other Agencies and/or entities

C. Attachments (when applicable)

1. Infrastructure List (draft, preliminary, amended or approved)
2. Preliminary or Final Plat
3. Easement Documents
4. Drainage Covenants
5. Approval Letters

III. PROJECT DESCRIPTION

A. Location

1. Discuss relationship of the site to the following:

- a. Well known landmarks
 - b. Municipal limits
 - c. City Zone Atlas page and reference
 - d. Other jurisdictional boundaries
 - e. Previously approved Drainage Management Plans, Drainage Reports, Plans or studies including watersheds, basins, drainage ways, etc. as defined therein
2. Provide copy of Zone Atlas page, or equivalent, with the site location superimposed

B. Legal Description

1. Identify the current legal description(s) of the land which comprises the site
2. Identify the proposed legal description(s), when applicable, of the land which comprises the site
3. Include a copy of existing and/or proposed platting as an attachment in cases where its inclusion will lend clarity or facilitate the review

C. Flood Hazard Zone

1. Identify proximity of site to a designated Flood Hazard Zone
2. Provide reference to the above referenced Flood Hazard Zone
3. Identify whether or not the site drains to or has an adverse impact upon a designated Flood Hazard Zone
4. Include a copy of the relevant FEMA Flood Insurance Rate Map (FIRM) or Flood Boundary and Floodway Map with the site clearly identified along with all affected Flood Zones
5. Identify portion of designated Flood Hazard Zone to be revised or amended when CLOMR, LOMR or LOMA approval requested

IV. BACKGROUND DOCUMENTS

A. Planning History

1. Reference and discuss relevant Planning and Zoning actions, plans or studies
2. Verify and/or demonstrate compatibility with the above actions, plans and studies

B. Drainage History and Related Documents

1. Reference and discuss relevant Drainage Management Plans, Drainage Plans, Reports and Studies
2. Reference applicable Hydrology Files.
3. Discuss status of above referenced Plans, Reports and Studies
4. Describe compatibility with or deviation from the above referenced Plans, Reports and Studies
5. Describe the location of site with respect to previously defined watersheds or drainage basins
6. Provide copies of pertinent data from above referenced Plans, Reports and/or Studies when applicable

V. EXISTING CONDITIONS

A. Site Investigation

1. Describe by text or clearly show graphically the following:
 - a. onsite drainage patterns
 - b. onsite drainage facilities
 - c. point(s) of discharge
 - d. drainage basin(s) boundaries
 - e. offsite drainage facilities
 - f. offsite drainage patterns including offsite flow conditions
 - g. condition and status of adjacent properties (e.g. developed, undeveloped, under construction, etc.)
 - h. condition and status of adjacent right-of-way (e.g. developed, undeveloped, under construction, etc.)
 - i. presence of any other relevant features

B. Site Evaluation

1. Discuss the significance and impacts of the following:
 - a. onsite drainage facilities
 - b. offsite drainage facilities
 - c. point(s) of discharge
 - d. drainage basin(s) boundaries
 - e. offsite flow conditions
 - f. proximity to designated flood hazard zone(s)
 - g. presence of any other relevant features or conditions which may impact or be impacted by the development of the property or project

2. Form of Analysis

- a. Most situations - most submittals require both qualitative and quantitative analyses
- b. Unique situations - for some cases, such as infill sites, a qualitative analysis by itself may be appropriate. Examples of appropriate qualitative analysis criteria are:
 - (1.) a comparison of the runoff generated by the proposed development to that generated by the overall drainage basin with respect to the impacts of the anticipated increase
 - (2.) impacts on downstream flood plains
 - (3.) potential offsite problems which may or may not be attributed to this development
 - (4.) anticipated impact(s) and/or precedent to be set on the development of the remaining infill sites by following the same drainage concept

3. Downstream Capacity

The evaluation of downstream capacity shall include, but not be limited to, the following:

- a. Assumptions
 - (1.) fully developed watershed
 - (2.) ability to accept and safely convey runoff generated from the 100-year design storm

- b. Hydraulic capacity
 - (1.) channel
 - (2.) crossing structure
 - (3.) storm inlet and/or entrance conditions
 - (4.) storm drain
 - (5.) street and/or alley
- c. Storage capacity
 - (1.) Detention pond/reservoir
 - (2.) Retention pond
 - (3.) Flood zone
- d. Stability
 - (1.) Channel/arroyo
 - (2.) Natural slope
 - (3.) Cut/fill slope
- e. Existing publicly owned ROW and Easements

VI. DEVELOPED CONDITIONS

A. Onsite

1. Discuss the following as applicable:
 - a. proposed development/construction
 - b. impacts on existing drainage patterns
 - c. impacts on existing drainage basins
 - d. impacts on existing onsite facilities
 - e. identification of offsite flow conditions

- f. compatibility/compliance with previously approved and/or adopted Plans, Reports and Studies
 - g. sediment bulking
 - h. aggradation and/or degradation potential
 - i. impacts on designated flood hazard zones
 - j. required private drainage improvements
 - k. required infrastructure
 - l. required easements
 - m. phasing and future improvements
 - n. ownership, operation and maintenance responsibilities
 - o. stormwater pollution potential during construction and post construction
2. Evaluate and/or quantify the following:
- a. capacity and freeboard of existing onsite facilities
 - b. capacity and freeboard of proposed onsite facilities
 - c. impacts on designated flood hazard zones
 - d. impacts on existing drainage patterns and drainage basin boundaries
 - e. impact of offsite flows on the proposed development
 - f. erosion potential and erosion setback requirements
 - g. phased system capacities and ability to function as a standalone system
 - h. emergency overflow spillway conditions

B. Offsite

1. Discuss the following:
- a. impacts on existing drainage basins and/or watersheds
 - b. impacts on existing offsite facilities and downstream capacity

- c. compatibility/compliance with previously approved and/or adopted Plans, Reports and Studies
 - d. impacts on designated flood hazard zones
 - e. required improvements to insure runoff from development can be properly conveyed to a publicly owned arroyo or Storm Sewer System.
 - f. required easements to insure runoff from development can be properly conveyed to a publicly owned arroyo or Storm Sewer System.
 - g. right-of way dedications to insure runoff from development can be properly conveyed to a publicly owned arroyo or Storm Sewer System.
 - h. phasing and future improvements
 - i. ownership, operation and maintenance responsibilities
 - j. concurrence and/or approval from affected property owners for offsite grading or construction activities
2. Evaluate and/or quantify the following:
- a. capacity of existing offsite facilities
 - b. capacity of proposed offsite facilities
 - c. impacts on downstream designated flood hazard zones
 - d. impacts on downstream drainage basins and/or watersheds
 - e. downstream capacity

NOTE: Any excess downstream capacity, based on a fully developed watershed, will be allocated by the City/SSCAFCA

VII. GRADING PLAN

A. Description

1. Reference the Grading Plan when included as an attachment to the Drainage Submittal
2. Describe elements of the Plan and how those elements relate to the Existing and Developed Conditions sections of the submittal discussed above

3. Discuss and reference all other supporting drawings provided in support of the Drainage Submittal

B. Content

1. Refer to Grading Plan Checklist that follows

VIII. CALCULATIONS

A. Description

1. Provide narrative description of the calculations performed to support the analyses and evaluations discussed above
2. Discuss and reference calculations for Existing, Developed and Future hydrology
3. Discuss and reference hydraulic calculations demonstrating capacity and/or adequacy of existing and proposed facilities
4. Provide sample calculations, tables, charts, etc. as necessary to support the calculations and results discussed above
5. Reference computer software, documents, circulars, manuals, etc. used to produce the calculations and results discussed above

IX. CONCLUSION

- A. Summary of proposed drainage management strategy
- B. Justification of rationale for discharge of developed runoff from site
- C. Summary of proposed drainage improvements
- D. Identification of DPM design variances being requested
- E. Identification of required Drainage Covenants
- F. Identification of ownership, operation and maintenance responsibilities

**The following check list must be completed and submitted
with the drainage report.**

EXHIBIT 7-1

DRAINAGE REPORT CHECKLIST

NOTE: This document is intended as an aid in preparing Drainage Reports located in southern Sandoval County. This checklist was developed by the Southern Sandoval County Arroyo Flood Control Authority (SSCAFCA). This document is not intended to be all inclusive, and does not limit the extent of the information, calculations, and exhibits that may be necessary to properly evaluate the intended land use. **This checklist must be included with all drainage report submittals.**

General Information:

Date: _____ File Name or No. _____
Project Name: _____
Proposed Land Use: _____ Zoned: _____
Location: _____ Acreage: _____ No. of Lots: _____
Legal Description: _____
FIRM Community Panel No: _____ SFHA: Yes No
Engineering Firm: _____
Project Manager: _____
Telephone No: _____ Fax No: _____
Address: _____
Email: _____

Drainage Report Contents General Format

The following items must be included in order to initiate review:

1. Project Name and Legal Description
2. Engineer's Seal, Signature and Date
3. Typed, Bound, Legible Report
4. Pertinent portions of all referenced information/reports
5. Drainage Report Checklist

Engineer's Signature: _____ Date: _____

(seal)

Introduction

Description	Yes (included)	Not Applicable	Reviewer's Notes
Type of approval sought (i.e. zone change, subdivision plat, vacation, site plan, paving or grading permit, variance)			
Complete summary of study intent, resultant Drainage Management Plan for the site. Describe how all off- and on-site flows are dealt with and how they leave the site, with respect to downstream capacity, historic and/or existing and full development condition flows.			
Location and Project Description			
Vicinity Map			
Copy of Preliminary or Final Plat			
Phasing Description			
Discussion of jurisdictions affected			
Watershed Name			
Site investigation Summary (describe if any grading has occurred since topography shown on plan, existing off- and on-site drainage facilities, etc.)			

References and Drainage / Planning History

Description	Yes (included)	Not Applicable	Reviewer's Notes
Floodplain Information & Map (show property location on copy of effective FEMA Flood Insurance Rate Map (FIRM))			
References - Planning History, Zoning			
SSCAFCA/Master Planning Info. (facility design over 500 cfs or adjacent to SSCAFCA facility will require SSCAFCA approval)			

Drainage Basin Description

Description	Yes (included)	Not Applicable	Reviewer's Notes
Off-site Flow Description & Map (with topo, flow patterns, and Q100)			
Existing Site Condition and Drainage Facilities Description			
Soils, Geology, Land Treatments			
Existing and proposed zoning and land use			
On-site Flow Description & Map (with topo, flow patterns, Q100 pre and post development, V100 pre and post development at analysis points)			

Hydrology

Description	Yes (included)	Not Applicable	Reviewer's Notes
Discussion of Hydrologic Model / Methodology (must use current version of AHYMO or equivalent hydrologic modeling program i.e. HEC-HMS)			
Modeling Schematic			
Rainfall Distribution 2-yr. / ___ hr. or ___ day 10-yr. / ___ hr. or ___ day (req'd for street design) 100-yr. / ___ hr. or ___ day			
Land Treatment allocations (%) Pre-development / post -development			
Time to Peak Calculations			

Emergency Spillway Design			
Spillway Flood Return Period ___-yr./ ___ hr. or ___ day			
Channel Routing (must use Muskingum-Cunge procedure)			
Reservoir Routing			
Hydrology Cont.			
Description	Yes (included)	Not Applicable	Reviewer's Notes
Elevation-Area-Volume-Discharge data and calculations			
Detention Pond Flood Routing Summary Table A*			
Hydrologic Summary Table B (main analysis points)*			
Sediment Yield/Sediment Transport (aggradation/degradation analysis)			
Input File (paper & digital)			
Output File (paper & digital)			
Existing and Proposed Development Site Plan			
State Engineer's Office Approval (dams in excess of 50 acre feet of storage or 25' of embankment height)			
<i>*Blank Summary Tables are attached to this checklist for inclusion in the consultant's report</i>			
Hydraulics			
Description	Yes (included)	Not Applicable	Reviewer's Notes
Discussion of Hydraulic Model(s) and Methodology			
Parameters for Model(s) / Methodology			
Storm Sewer Hydraulics and Storm Inlet Capacity Calculations (must be submitted)			
Street Capacity Calculations (10-year and 100-year)			
Arroyo, Channel, Culvert, Bridge Capacity Calculations			
Arroyo / channel stability addressed			
Scour Calculations			
Superelevation Calculations			
Floodplain/Floodway Discussion & Calculations			
Freeboard and levee criteria addressed			
Comparison of historic/existing/fully developed condition peak discharge rates and runoff volumes with respect to existing and proposed drainage infrastructure capacities.			
Verification and discussion of downstream capacity			
Miscellaneous			
Description	Yes (included)	Not Applicable	Reviewer's Notes
Pertinent portions of all referenced information			
Soils investigation			
Structural calculations for retaining walls in excess of 3' in height, sealed by Structural Engineer			
Letter for permission to grade on adjacent parcels from parcel's owner			
Operations / Maintenance requirements ownership/easements and			
All weather access addressed			
Conclusions			
Compliance with local criteria			
Compliance with SSCAFCA criteria			
Compliance with City of Rio Rancho DPM (Sections 2.2.2 through 2.2.8) and SSCAFCA criteria			

C. GRADING AND DRAINAGE PLAN CHECKLIST

The following checklist is intended as a guide for preparing a Grading and Drainage Plan to accompany a drainage report or plan. Some items may not be applicable to your particular project; some items may require more detail. A Pre-design Conference is recommended to define scope and project specific requirements.

I. GENERAL INFORMATION:

1. Professional Engineer's stamp with signature and date.
2. Drafting Standards: (Reference City of Rio Rancho Standards)
 - A. North Arrow
 - B. Scales - recommended engineer scales:
 - (1) 1" = 20' for sites less than 5 acres
 - (2) 1" = 50' for sites 5 acres or more
 - C. Legend - see City of Rio Rancho D.P.M. Manual, Volume 2, for recommended standard symbols
 - D. Plan drawings size: 24" x 36"
 - E. Notes defining property line, asphalt paving, sidewalks, planting areas, ponding areas, project limits, and all other areas whose definition would increase clarity
3. Vicinity Map
4. Benchmark - location, description and elevation
 - A. Control survey vertical datum
 - B. Permanently marked temporary benchmark located on or very near site
5. Flood Insurance Rate Map (FIRM)
6. Legal Description

II. EXISTING CONDITIONS

1. On-site:

- A. Existing Contours - vertical intervals for contour maps shall not exceed the following:
 - (a) One foot intervals for slopes under 1% with sufficient spot elevations at key points to adequately show the site's topography
 - (b) Two feet for slopes between 1% and 5%
 - (c) Five feet for slopes in excess of 5%
- B. Spot elevations adequately showing conditions on-site.
- C. Contours and spot elevations extending a minimum of 25' beyond property line.
- D. Identification of all existing structures located on-site or on adjacent property extending a minimum of 25' beyond property line with particular attention to retaining and garden walls.
- E. Identification of all existing drainage facilities located on-site or on adjacent property.
- F. Pertinent elevation(s) of structures and facilities defined in A, B and C should be based on the NAVD 88.
- G. Indication of all existing easements and rights-of-way on or adjacent to the site with dimensions and purpose shown.
- H. Existing top of curb and flow line elevations with NAVD 88 designation.
- I. The location of Special Flood Hazard Area Boundaries from the latest FEMA maps must be overlaid on the existing site map (enlarged to site plan scale), when applicable.

2. Off-site:

- A. Contributing Area - delineation of off-site contributing watersheds and/or drainage basins on ortho-topo area maps or equivalent mapping at a preferable scale of 1" = 200' or 1" = 500'. Watershed and Basin designations shall match those used in the hydrology calculations.
- B. Existing easements and rights-of-way including ownership and purpose.

III. PROPOSED CONDITIONS

1. On-site:

- A. Proposed improvements superimposed onto the existing conditions,
- B. Proposed Grades

Proposed grades shall be adequately depicted by contours and/or spot elevations conforming with the following minimum criteria:

- (1) Contours - vertical intervals for contour maps shall not exceed the following:
 - (a) One foot intervals for slopes under 1% (with supplemental spot elevations as appropriate to adequately illustrate the proposed grading of the site).
 - (b) Two feet for slopes between 1% and 5%.
 - (c) Five feet for slopes in excess of 5%.
- (2) Spot Elevations - supply spot elevations at the following:
 - (a) Key points and grade breaks
 - (b) Critical locations
 - (c) Pad elevations
- C. Indication of all proposed easements and rights-of-way on or adjacent to the site with dimensions and purpose identified.
- D. City Engineer approved street and/or alley grades when site abuts a dedicated unpaved street or alley. In the event that approved grades are not available, provide preliminary street and/or alley grades.
- E. Internal contributory drainage areas, including roof areas, outlined on plan.
- F. Flow lines defined by arrows and spot elevations with NAVD 88 designation, as appropriate for clarity.
- G. Pond(s) 100 year water surface elevation outlined and indicated on plan.
- H. Finish building floor elevation(s) or pad elevation(s) with complete NAVD 88 designation, when applicable.
- I. Elevations along property lines including relationship to adjacent top of curb.
- J. Details of ponds, inverts, rundowns, curb cuts, water blocks, emergency spillways, retaining walls, pond outlets, safety fences, slopes, and all other significant drainage structures with

contours, cross-sections and spot elevations. All cross-sections must be drawn to a standard engineering scale and adequately dimensioned.

K. Phasing,

L. Proposed construction of private storm drain improvements within public right-of-way and/or easement including identification of the public entity having ownership.

M. Proposed contours superimposed over existing contours adequately demonstrating changes in grade especially at the property line.

N. Identification of any required offsite grading.

O. Specifications for the proposed grading and/or soil compaction.

P. Erosion Control and Stormwater Pollution Prevention Plans. See Erosion Control and Stormwater Pollution Prevention Plans Checklist.

2. Off-site:

A. Definition, location, and configuration of required drainage facilities.

B. Rights-of-way and easements needed to accommodate (A) above.

GRADING AND DRAINAGE PLAN NOTE REGARDING BOUNDARY SURVEYS:

This is not a boundary survey; data is shown for orientation only. The boundary information depicted by this plan is based upon the (boundary survey, plat, etc.) prepared by _____, NMPS no. _____, dated ___/___/_____. Topographic survey information is based upon a topographic survey prepared by _____ on ___/___/_____, NMPS no. _____.

**The following check list must be completed and submitted
with the Grading & Drainage Plan.**

EXHIBIT 7-2

GRADING AND DRAINAGE PLAN CHECKLIST

A grading and drainage plan is required for Building Permits, Site Development Plans, Landscaping Plans and for developments involving less than 5 acres

Note: This document is intended as an aid in preparing Grading and Drainage Plans for projects located in Southern Sandoval County. This checklist was developed by the Southern Sandoval County Arroyo Flood Control Authority (SSCAFCA). This document is not intended to be all inclusive, and does not limit the extent of the information, calculations, and exhibits that may be necessary to properly evaluate the intended land use. **This checklist must be included with all grading and drainage plan submittals.**

General Information:

Date: _____ File Name or No. _____
Project Name: _____
Proposed Land Use: _____ Zoned: _____
Location: _____ Acreage: _____ No. of Lots: _____
Legal Description: _____
FIRM Community Panel No: _____ SFHA: Yes No
Engineering Firm: _____
Project Manager: _____
Telephone No: _____ Fax No: _____
Address: _____
Email: _____

Engineer's Signature: _____ Date: _____

(seal)

Grading and Drainage Plan Checklist

Description	Yes (Included)	Not Applicable	Reviewer's Notes
Signature Block for Approvals			
Sheet Size: 24" x 36"			
Scale: 1" = 20' for sites less than 5 acres 1" = 50' for site greater than 5 acres			
Bar Scale			
North Arrow			
Vicinity Map			
Legend (reference DPM Tables 27.3a – 27.3d for recommended standard symbols)			
Local Drafting Standards (reference DPM, Chapter II.27)			
Project Name			
Professional Engineer's Seal, signature, and date			
Legal Description			
Site Address			
Basis of Bearings			
Benchmark and Datum (above mean sea level)			
Site Benchmark			
Right-of-way lines and dimensions Existing and Proposed			
Easement lines and dimensions Existing and Proposed			
Property Line location, bearings and dimensions existing and proposed			
Limits of existing floodplain based on effective Flood Insurance Rate Map: include a copy of the FIRM and provide reference to Panel number			
Phase lines			
Street Names			
Street dimensions			
Utility Locations Existing and Proposed			
Septic Tank and Leach Field locations			
Retaining and garden wall locations for all walls within 25' of the subject property			
Proposed wall locations and details			
Existing contours encompassing the subject property and 25' beyond boundaries at the following intervals: 1' for slopes less than 1% 2' for slopes between 1% and 5% 5' for slopes greater than 5%			
Existing and proposed spot elevations at critical locations, including: Top of curbs at returns, flow lines, street crowns, lot lines, and all grade breaks. Spot elevations must be provided in sufficient intervals to detail existing and proposed drainage patterns, slopes and transitions			
Daylight proposed contours to existing			
Verify no cross-lot drainage			

Minimum finished floor elevations			
Flow Arrows			

D. EROSION CONTROL AND STORMWATER POLLUTION PREVENTION PLANS CHECKLIST

Use this checklist to prepare a plan for the mitigation of damages due to stormwater pollution, soil erosion and deposition. All grading of 1.0 acre or more or 500 cubic yards and any grading within or adjacent to a watercourse defined as a major facility during the months of June, July, August, or September shall provide for erosion control and the safe passage of the 100-year design storm runoff during the construction phase. A Stormwater Pollution Prevention Plan shall be provided for all grading of 1.0 acre or more.

***NOTE:** The following checklist is intended to be used as a guide for preparing the plan to meet any or all drainage requirements. Some items may not be applicable to your particular project; some items may require more detail. A Pre-design Conference is required to define the scope and specific requirements.*

1. Provide the corresponding information for the following phases of development:

A. Rough grading

1. Grading plan with limits of soil disturbance outlined.
2. Erosion protection and stormwater pollution prevention practices indicated.
3. Supporting data, calculations, references and details drawn to scale or adequately dimensioned.
4. Erosion control and stormwater pollution prevention notes:
 - a. The contractor is to ensure that no soil erodes from the site onto adjacent property or public right-of-way. This should be achieved by implementing Best Management Practices (BMP's) to protect the soil from wind, and water erosion.
 - b. During the months of June, July, August or September, any grading within or adjacent to a watercourse defined as a major facility shall provide for erosion control and safe passage of the 100-year design storm runoff during the construction phase.
 - c. Contractor shall conform to all City, County, State and Federal dust control and stormwater pollution prevention requirements and is responsible for preparing and obtaining all necessary applications, permits and approvals.
 - d. All graded areas which do not receive a final surface treatment will be revegetated in accordance with New Mexico APWA Standard Specification 1012 and the Landscape Specifications.

- e. Contractor shall obtain and abide by a Grading Permit from the City of Rio Rancho. The cost for required construction dust and erosion control measures shall be incidental to the project cost.

B. Phased development

1. Grading plan with limits of soil disturbance outlined for each phase of development and numbered in sequential order of events.
2. Erosion protection and stormwater pollution prevention procedures indicated for each phase.
3. Supporting data, calculations, references and details drawn to scale or adequately dimensioned.

C. Construction and permanent phase

1. Grading plan with limits of soil disturbance outlined.
2. Erosion protection and stormwater pollution prevention practices indicated.
 - a. Project owner and the owner's contractor shall complete federal EPA Notice of Intent (NOI) prior to commencement of any construction project disturbing 1.0 or more acres of land area.
 - b. Stormwater Pollution Prevention Plans and accompanying federal EPA administrative procedures shall meet the guidelines and procedures outlined in the current edition of the New Mexico Department of Transportation Stormwater Management Guidelines for Construction and Industrial Activities Manual.
3. Supporting data, calculations, references and details drawn to scale or adequately dimensioned.

**The following check list must be completed and submitted
with the Erosion Control & Storm Water Pollution Prevention Plan.**

EXHIBIT 7-3

EROSION CONTROL & STORMWATER POLLUTION PREVENTION PLAN CHECK LIST

An erosion control plan is required for all grading of 1 acre or more or 500 cubic yards or more and any grading within or adjacent to a watercourse defined as a major facility during the months of June, July, August or September. The plan shall provide for erosion control and safe passage of the 100-year 6-hour design storm runoff during the construction phase.

Instructions - Fill out all that is applicable and relevant, submit this checklist with the Erosion Control Plan and or the Grading and Drainage Plan

Date: _____
 Erosion Control Plan Name: _____

 Consultant / Designers Name: _____
 Consultant / Designers Telephone Number: _____

Erosion Control Plan General Format / Checklist:

<u>Item and Description</u>	<u>Consultant</u> (put "Y" yes or "NA" not applicable)	<u>Reviewer</u> (put "Y" yes adequate or comment or reference a "footnote" for review letter)
 GENERAL		
1. Title Block with Project Title		
2. Designers Signature and Date	_____	_____
 ROUGH GRADING		
1. Grading Plan with limits of soil disturbance outlined	_____	_____
2. Erosion Protection Indicated	_____	_____
3. Supporting data, calculations, references and details drawn to scale or adequately dimensioned	_____	_____
4. Erosion control notes:	_____	_____

- a. The contractor is to ensure that no soil erodes from the site onto adjacent property or public right-of-way. This should be achieved by wetting the soil to protect it from wind erosion and by installation of berms per detail this sheet. _____
- b. At all time but especially during the months of June, July, August or September, any grading within or adjacent to a watercourse defined as a major facility shall provide for erosion control and safe passage of the 100-yr. 6-hour design storm runoff during the construction phase. _____
- c. Contractor shall conform to all City, County, State and Federal dust control requirements and is responsible for preparing and obtaining all necessary applications and approvals. _____
- d. All graded areas which do not receive a final surface treatment will be revegetated in accordance with New Mexico APWA Standard Specification 1012 and the Landscape Specifications _____
- e. Contractor shall obtain and abide by a Topsoil Disturbance Permit from the local jurisdiction. The cost for required construction dust and erosion control measures are incidental to construction. _____

PHASED DEVELOPMENT

- 1. Grading Plan with limits of soil disturbance outlined for each phase of development and numbered in sequential order of events. _____
- 2. Erosion protection indicated for each phase. _____
- 3. Supporting data, calculation, references and detail drain to scale or adequately dimensioned. _____

CONSTRUCTION AND PERMANENT PHASE

- 1. Grading Plan with limit of soil disturbance outlined. _____
- 2. Erosion protection indicated. _____
- 3. Supporting data, calculations, references and detail drawn to scale or adequately dimensioned. _____

E. ENGINEER'S CERTIFICATION CHECKLIST FOR NON-SUBDIVISION DEVELOPMENT

Use this checklist when certifying compliance with an approved drainage report or drainage plan for public, commercial and multi-residential buildings requiring a Certificate of Occupancy building permit or grading and paving projects. Engineer must revise the original drawing as approved with the following information which shall serve as minimum criteria for evaluation. This is merely a guide. The level of detail necessary for presentation and verification is a function of the specific plan being evaluated. The engineer's certification must be approved prior to the release of the issuance of a Certificate of Occupancy, or acceptance (by the City) of the completed work.

1. Completed Information Sheet - see Information Sheet.
2. Provide as-built finished floor and/or pad
3. Provide as-built spot elevations on the property line and/or limits of phase development (points of significant grade changes) to demonstrate compliance with the approved drainage report or drainage plan.
4. Provide copies of construction approval from the appropriate government agencies for construction within their right-of-ways and/or easements.
5. Outline the as-built drainage basin(s) (including roof areas) supported with sufficient spot elevations and roof drain locations.
6. Provide as-built elevations and dimensions for the following structures:
 - A. Pond(s) (include as-built volume calculations)
 - B. Pipe inlet(s) and outlet(s) (include as-built capacity calculations)
 - C. Rundown(s) (including the required inlet dimensions)
 - D. Spillway(s) (including the required outlet dimensions)
 - E. Channel(s)
 - F. Flowlines
 - G. Erosion control and stormwater pollution prevention structure(s)
 - H. Temporary drainage, erosion control and stormwater pollution prevention facilities required for phased development

- I. Retaining and/or garden wall(s)
 - J. Other features critical to the drainage scheme.
7. Professional Certification
- A. Engineer's stamp dated and signed accompanied with a statement indicating substantial compliance with the approved drainage report and/or deficiencies with recommended corrections.
 - B. The surveying associated with the certification must be performed by a professional engineer and/or surveyor in accordance with the "New Mexico Engineering and Surveying Practice Act" as amended and any standards adopted by the State Board of Registration.

ENGINEER'S CERTIFICATION CHECKLIST FOR SUBDIVISIONS

Use this checklist when certifying compliance with an approved drainage report or grading and drainage plan for subdivisions when required for the release of financial guarantees associated with an executed Subdivision Improvement Agreement (SIA). Engineer must revise the approved drawing with the following information, which shall serve as minimum criteria for evaluation. This is merely a guide. The level of detail necessary for presentation and verification is a function of the specific plan being evaluated. The engineer's certification must be approved prior to the release of the SIA and/or financial guarantees.

- 1. Completed Information Sheet - see Information Sheet.
- 2. As-Built Information:
 - A. Pad elevations
 - B. Top of Curb Elevations at critical locations
 - C. Property corner elevations at each lot
 - D. Horizontal and vertical data for storm drains (public and private)
 - E. Horizontal and vertical data for retaining walls
- 3. As-Built Analysis
 - A. Statement and verification that all grades inside the subdivision do not deviate by more than 18" of the approved grades within 50 feet of the subdivision's perimeter.
 - B. Statement and verification of street, storm drain and channel hydraulic capacities.
 - C. Statement and verification of pond capacities.

- D. Statement of as-built elevation tolerances with respect to the feature being analyzed.
4. Other Approvals
 - A. When necessary or appropriate, provide documentation of acceptance or construction approval from other affected governmental agencies or property owners.
 5. Clearly State the origin and Date(s) of As-Built Data
 6. Supplemental Information
 - A. Provide details as necessary to illustrate as-built conditions for instances in which the as-constructed work materially deviates from the as approved design.
 - B. Provide calculations to demonstrate and/or verify that all deviations satisfy the intent of the approved design.
 7. Professional Certification
 - A. Engineer's stamp dated and signed accompanied with a statement indicating substantial compliance with the approved drainage report and/or deficiencies with recommended corrections.
 - B. The surveying associated with the certification must be performed by a professional engineer and/or surveyor in accordance with the "New Mexico Engineering and Surveying Practice Act" as amended and any standards adopted by the State Board of Registration.

DRAINAGE CERTIFICATION WITH SURVEY WORK BY PROFESSIONAL SURVEYOR

DRAINAGE CERTIFICATION

I, _____, NMPE ____, OF THE FIRM _____, HEREBY CERTIFY THAT THIS PROJECT HAS BEEN GRADED AND WILL DRAIN IN SUBSTANTIAL COMPLIANCE WITH AND IN ACCORDANCE WITH THE DESIGN INTENT OF THE APPROVED PLAN DATED _____. THE RECORD INFORMATION EDITED ONTO THE ORIGINAL DESIGN DOCUMENT HAS BEEN OBTAINED BY _____, NMPS ____, OF THE FIRM _____. I FURTHER CERTIFY THAT I HAVE PERSONALLY VISITED THE PROJECT SITE ON _____ AND HAVE DETERMINED BY VISUAL INSPECTION THAT THE SURVEY DATA PROVIDED IS REPRESENTATIVE OF ACTUAL SITE CONDITIONS AND IS TRUE AND CORRECT TO THE BEST OF MY KNOWLEDGE AND BELIEF. THIS CERTIFICATION IS SUBMITTED IN SUPPORT OF A REQUEST FOR _____.

(DESCRIBE ANY EXCEPTIONS AND/OR QUALIFICATIONS HERE IN A SEPARATE PARAGRAPH)

(DESCRIBE ANY DEFICIENCIES AND/OR CORRECTIONS REQUIRED HERE IN A SEPARATE PARAGRAPH)

THE RECORD INFORMATION PRESENTED HEREON IS NOT NECESSARILY COMPLETE AND INTENDED ONLY TO VERIFY SUBSTANTIAL COMPLIANCE OF THE GRADING AND DRAINAGE ASPECTS OF THIS PROJECT. THOSE RELYING ON THIS RECORD DOCUMENT ARE ADVISED TO OBTAIN INDEPENDENT VERIFICATION OF ITS ACCURACY BEFORE USING IT FOR ANY OTHER PURPOSE.

XXXXXXXXXXXXXXXXXX, NMPE XXXX

(SEAL)

DATE

DRAINAGE CERTIFICATION WITH VERIFICATION BY ENGINEER OF RECORD

DRAINAGE CERTIFICATION

I, _____, NMPE ____, OF THE FIRM _____, HEREBY CERTIFY THAT THIS PROJECT HAS BEEN GRADED AND WILL DRAIN IN SUBSTANTIAL COMPLIANCE WITH AND IN ACCORDANCE WITH THE DESIGN INTENT OF THE APPROVED PLAN DATED _____. THE RECORD INFORMATION EDITED ONTO THE ORIGINAL DESIGN DOCUMENT HAS BEEN OBTAINED BY ME OR UNDER MY DIRECT SUPERVISION AS SUPPLEMENTAL DATA TO THE ORIGINAL TOPOGRAPHIC SURVEY PREPARED BY _____, NMPS _____, OF THE FIRM _____, AND IS TRUE AND CORRECT TO THE BEST OF MY KNOWLEDGE AND BELIEF. THIS CERTIFICATION IS SUBMITTED IN SUPPORT OF A REQUEST FOR _____.

(DESCRIBE ANY EXCEPTIONS AND/OR QUALIFICATIONS HERE IN A SEPARATE PARAGRAPH)

(DESCRIBE ANY DEFICIENCIES AND/OR CORRECTIONS REQUIRED HERE IN A SEPARATE PARAGRAPH)

THE RECORD INFORMATION PRESENTED HEREON IS NOT NECESSARILY COMPLETE AND INTENDED ONLY TO VERIFY SUBSTANTIAL COMPLIANCE OF THE GRADING AND DRAINAGE ASPECTS OF THIS PROJECT. THOSE RELYING ON THIS RECORD DOCUMENT ARE ADVISED TO OBTAIN INDEPENDENT VERIFICATION OF ITS ACCURACY BEFORE USING IT FOR ANY OTHER PURPOSE.

XXXXXXXXXXXXXXXXXX, NMPE XXXX

(SEAL)

DATE

F. PROCEDURES FOR DEVELOPMENT REVIEW AND APPROVAL

This procedure is for development, design, and approval of infrastructure improvement plans. This process is for Private Development projects.

PROCEDURE: INFRASTRUCTURE DESIGN DEVELOPMENT

Pre-Design Phase

For complex projects, this phase shall begin with a pre-design meeting with City/SSCAFCA staff.

Step 1: Application for Pre-Design Conference

Submit a letter to City/SSCAFCA requesting a pre-design meeting.

Application Materials:

- Two (2) copies of Sketch Plat/Plan (if available, a Preliminary Plat and Findings may be substituted).
- A copy of the Conceptual Drainage and Grading Plan.
- The cost of the land being dedicated or the cost of the easement being granted.

Note: If a developer or designer does not have all required submittals available, the developer may still apply for a Pre-Design Conference with the City/SSCAFCA. However, the outcome of the conference will be a limited instruction, pending receipt of the remaining required submittals. A second Pre-Design Conference may be conducted, if requested by the applicant or required by City/SSCAFCA due to project scope.

Outcome:

- Reviews application material for completeness. If insufficient, developer is notified of additional requirements.
- Schedules the Pre-Design Conference with City/SSCAFCA.
- Assigns the project number, unless previously assigned.
- Starts project file.

Step 2: Pre-Design Conference

The Pre-Design Conference allows the developer, consulting engineer, and other City/SSCAFCA staff to discuss detailed design requirements, the consulting engineer's approach to implementing drainage infrastructure requirements, construction phasing for partial acceptance, and the subsequent design and review procedures.

Partial Acceptance: When application for design and construction of public infrastructure improvements is made, the developer indicates on the application if partial acceptance of the proposed construction will be requested. Partial acceptance will be a topic for discussion at the Pre-Design Conference. Each subdivision for which partial acceptance of improvements is requested will be examined at the Pre-Design Conference to determine what parts, if any, can function adequately without the remaining parts. These will be designated the "stand alone" parts. If no "stand alone" parts can be determined, then the infrastructure improvements cannot be partially accepted. If "stand alone" parts are identified, the developer may achieve partial acceptance of the infrastructure improvements for these parts by.

- (a) Dividing the entire subdivision into projects for each of the "stand alone" parts (each project will have its own separate pre-construction), or
- (b) Assuring construction of required infrastructure in accordance with Section 9 of SSCAFCA's Drainage Policy.

The financial guarantee option selected by the developer during the Pre-Design Conference will be made a part of the Pre-Design Conference minutes. The minutes will also indicate the requirement (prior to acceptance of "stand alone" parts by the City/SSCAFCA) that the developer or agent must provide to the City/SSCAFCA all data, such as As-Built drawings, GASB 34/35 information, etc., necessary for the City/SSCAFCA operation and maintenance of the improvements being accepted. Warranty will commence at the time a Certification of Completion and Acceptance Letter is issued by the City/SSCAFCA. If bonding is used, written acceptance will not occur until the bond is obtained by the developer for the City's/SSCAFCA's benefit.

Outcome:

- Minutes of the meeting are prepared delineating the items discussed and agreements reached for the signature of the participants.

Design and Review Phase

Step 3: Design Development

Consulting engineer prepares plans according to guidelines of the Pre-Design Conference, incorporating any required materials into the infrastructure design. Construction Plans and Specifications must be prepared in accordance with current Standard Specifications unless otherwise approved by the City/SSCAFCA.

Step 4: Preliminary Design Review

Submit material to the Development Services Division (DSD). The DSD will route plans to the proper department(s) and SSCAFCA for review and comment.

Outcome:

- Plans will be reviewed for completeness and DSD will be notified of any missing items/information before scheduling a review by City/SSCAFCA staff.
- Plans are reviewed for quality and content. If the submittal is unacceptable, areas of major concern are identified and the submittal is returned to the DSD/Consulting Engineer for corrections.

Step 5: *Incorporation of Comments and Preparation of Final Plans and Estimate Sheet*

The Consulting Engineer must either incorporate the City/SSCAFCA review comments into the proposed final plans or propose acceptable alternatives. City /SSCAFCA must review and approve all proposed alternatives. The Consulting Engineer prepares an estimate of the quantities of materials and associated costs for the project.

Step 6: *Review of Final Plans and Estimate Sheet*

DSD submits final drawings with all corrections (with redlines) as required and all additional reports, technical studies and related documents to SSCAFCA. The complete package of required submittals must be received prior to City/SSCAFCA signing the final plans.

Outcome:

- City/SSCAFCA signs plans if the plans comply with all of their requirements.

CONSTRUCTION PHASE:

Pre-Construction Phase

During this phase, all arrangements required to complete the construction contract between the developer and the contractor, or City/SSCAFCA and contractor, are identified.

Step 1: *Contract Documentation*

Complete the necessary documents and submit to City/SSCAFCA.

Submittal Requirements:

Developer Provides:

- Copy of the subdivision approval agreement and financial guarantee.

- Copy of construction contract with licensed contractor reflecting work detailed on approved plans and engineers estimate.
- Insurance certificate.
- Performance/Warranty Bond (or equal) and Labor and Material Payment Bond.
- Other items if applicable:
- Copy of necessary easements.
- Copy of State Highway Department permits.
- Copy of SWPPP and USEPA Stormwater NOI
- Copy of utility company encroachment permits.
- Copy of USACE 404 permit.
- MRGCD approval and License Agreements.
- Approval of other entities or utilities as necessary for project scope.
- Reproducible copy of recorded plat for plan set as required.
- Construction Schedule
- Material Testing Schedule

Outcome:

- City/SSCAFCA verifies that scope of work on contract is same as shown on the approved engineers estimate and plan set.

Step 2: Contractor Obtains Permits

The contractor must obtain all the required City permits before release of the work order.

Step 2A: Progress Inspections

For each inspection listed below a request shall be made by contractor to City/SSCAFCA 48 hours in advance.

1. Preconstruction meeting

2. After construction staking and storm water quality best management practices have been completed and prior to any earthwork
3. Concrete/shotcrete placement
 - a. Final subgrade is prepared PRIOR TO ANY REBAR/STEEL BEING PLACED
 - b. Final placement of rebar/steel PRIOR TO CONCRETE/SHOTCRETE
 - c. First placement of concrete/shotcrete
4. Placement of storm drain pipe (Water truck and compaction equipment must be on-site during placement)
 - a. Staking complete and prior to excavation
 - b. Final subgrade preparation
 - c. Placement of pipe prior to backfill
 - d. Placement of lateral connection to mainstem
 - e. Completion of pipe
5. Outlet/inlet structures
 - a. Construction staking complete
 - b. Final subgrade
 - c. Form and rebar
 - d. Concrete/shotcrete
 - e. Rip rap
6. Channel Construction
 - a. Construction staking complete
 - b. Subgrade preparation complete
 - c. Rebar installation
 - d. Concrete/shotcrete placement
 - e. Inlet placement

Step 3: Interim Inspection

NOTE: PARTIAL ACCEPTANCE...If partial acceptance is being requested per conditions of the Pre-Design Conference, (Step 2), the following steps and instructions generally apply except that "Final Acceptance" is identified as "Partial Acceptance". Under partial acceptance, a financial guarantee may be reduced, however the agreement cannot be released until all required drainage infrastructure on the approved Infrastructure List is completed and accepted. If the drainage infrastructures come under the jurisdiction of the Office of the State Engineer (OSE), the following items must be provided by the developer prior to final acceptance by SSCAFCA/City:

1. Written approval by OSE
2. Transfer of ownership to City/SSCAFCA
3. Transfer of all documents required by OSE

INITIATING ACTION

City/SSCAFCA Inspector and contractor shall conduct an interim inspection to determine if the work is ready for final inspection. Contractor will contact City/SSCAFCA seven (7) working days in advance to schedule an inspection.

Outcome:

- If project is ready for final inspection, the developer's construction inspector schedules final inspection seven (7) working days in advance with City/SSCAFCA Inspector.
- If project is not ready for final inspection, contractor must complete necessary work prior to requesting final inspection.

Step 4: Completion of Record Drawings

Record Drawings and applicable data must be furnished to the City/SSCAFCA Inspector prior to the final inspection. If not available, final inspection will be delayed until they are available. Information required on the Record Drawings are detailed below.

RECORD DRAWING INFORMATION

A. Record Drawings with elevations, finished contours and dimensions for the following improvements:

- Permanently marked benchmark based on NAVD 88 and located on or very near the facility
- Pond(s) (include as-built volumes, e.g., 100 year water surface elevation, and flow information)
- Pipe inlet(s) and outlet(s) (include as-built capacity calculations)
- Rundown(s) (including the required inlet dimension)
- Graphic depiction of complete storm drainage system on 1 sheet. Size of sheet to be agreed upon with City/SSCAFCA
- Spillways(s) (including the required outlet dimensions)
- Channel(s)
- Flowlines
- Erosion control and stormwater pollution prevention structure(s)
- Temporary drainage, erosion control and stormwater pollution prevention facilities required for phased development
- Retaining and/or garden wall(s)
- Other features critical to the drainage facility
- Cost of drainage improvements proposed for maintenance
- Operation and maintenance schedule and pictures taken during the construction

B. All testing results

C. Professional Certification (See Section 7 for standard certification language):

(1) Engineer's stamp dated and signed accompanied with a statement indicating substantial compliance with the approved construction drawings and/or deficiencies with recommended corrections.

(2) The surveying associated with the certification must be performed by a professional engineer and/or surveyor in accordance with the "New Mexico Engineering and Surveying Practice Act" as amended and any standards adopted by the State board of Registration.

Step 5: Final Inspection (applies to partial or entire acceptance)

INITIATING ACTION

- Developer/Engineer contacts City/SSCAFCA's Construction Inspector and requests a final inspection. City Engineer/SSCAFCA's Senior Drainage Engineer and Executive Engineer must be invited to attend the Final Inspection.

- Responsible party (See Step 4) completes Record Drawings or furnishes red-line marked up prints to City/SSCAFCA showing Record Drawings conditions. A hard copy of the Record Drawings must be provided to the City/SSCAFCA at the time a final inspection is requested.

Note: A water test may be required at the final inspection to verify drainage system operation.

Outcome:

- SSCAFCA schedules final inspection with the contractor, consulting engineer, developer, and all City staff concerned with the project.

- At final inspection, a list of discrepancies (punch list) is prepared by the consulting Engineer, or inspecting agency, which is given to the contractor for correction. A copy is sent to the developer, SSCAFCA, and City staff concerned with the project.

- If both, City/SSCAFCA and the Engineer, find the constructed facility to be sufficient to function properly, a certificate of substantial completion can be issued.

INITIATING ACTION

Contractor:

- Completes work on punch-list items within 30 days.

- Notifies City/SSCAFCA inspector and all affected parties when ready for verification.

Outcome:

City/SSCAFCA inspector verifies that discrepancies are corrected.

INITIATING ACTION

Contractor sends City/SSCAFCA Inspector final quantities sheet and invoices.

Outcome:

City/SSCAFCA prepares a Letter of Infrastructure Construction Completion after receiving the following:

- Final quantities sheet
- Invoices from the contractor
- Copy of recorded plat and/or copy of recorded easement
- Revised Record Drawings (One hard copy) including a reproducible mylar and electronic file copy (e.g.) an Auto-Cad/PDF file in a format acceptable to City/SSCAFCA submitted on a compact disc (CD)
- Copy of all test results, construction pictures and copy of certifications on a compact disc (CD)
- Submittal of a performance bond in accordance with Section 11 of SSSCAFCA's Drainage Policy.
- Final quantities sheet, cost of drainage improvements (including the cost of the land) and invoices from the contractor.
- A letter from owner/developer/engineer requesting acceptance from the City/Executive Engineer for warranty period to begin.

Upon acceptance by City/SSCAFCA the one year warranty period commences for the structure. The developer/contractor shall be responsible for O&M during the warranty period. Before City/SSCAFCA takes over responsibility for O&M there will be a post warranty inspection to insure that the structure condition is as designed and that there are no outstanding issues.

Note: All storm water management measures and facilities shall be maintained by the owner of the property or a homeowners association, unless a dedication of the storm water management system has been required and accepted by SSSCAFCA/City, in which case, the City/SSCAFCA shall be responsible for maintenance after the warranty period ends.

Section 9. MISCELLANEOUS

A. Maintenance Standards

1. General:

All drainage control, flood control and erosion control facilities both public and private shall be regularly maintained. Accumulations of silt, trash, litter or stagnant water which create a health or safety hazard or which endanger the design function of the facility are not permitted. Excessive growth or accumulation of woody vegetation in channels and on dams and levees shall not be permitted. Active erosion due to wind or water associated with drainage control, flood control and erosion control facilities shall not be permitted.

All newly constructed drainage facilities within a public right-of-way must provide restricted access to prevent unauthorized vehicular access. Restricted and authorized access shall be provided with City/SSCAFCA Standard Tube Gate.

2. Publicly Maintained Facilities

Every effort shall be taken to operate and maintain publicly owned and maintained facilities to be functional and operate as designed recognizing the constraints of public funding. SSCAFCA reserves the right to schedule O&M as its purview.

3. Privately Maintained Facilities:

Every effort shall be taken to operate and maintain privately owned and maintained facilities to be functional and operate as designed recognizing the constraints of public funding. City/SSCAFCA reserves the right to schedule O&M as its purview.

The owner shall regularly maintain and keep written records of all maintenance activities for drainage control, flood control and erosion control facilities for which it has responsibility based on the above general requirements and the following schedule:

<u>Facility</u>	<u>Maintenance</u>	<u>Inspection</u>
Channels	Monthly June-October	Semi-Annual
Channel Joints	Monthly June-October	Semi-Annual
Crossing Structures	Monthly June-October	Semi-Annual
Pump Stations	Monthly June-October	Semi-Annual
Detention Facilities	Silt removal and weed control	After any major operation or

		monthly during flood season
Storm Pump	Periodic cycling	Semi-Annually in April and October
	Vibration analysis	3-5 Years
Storm Drain Systems	Annual	Bi-Annual
Storm Drain Inlets	On-going process	Semi-Annual during flood season

Every facility shall be inspected after ½” of rain to insure the water quality flow capacity features are functioning as designed.

Privately owned drainage control, flood control and erosion control facilities shall be maintained according to the general standards above and such that adjacent upstream or downstream public or private facilities are not damaged or endangered. A sign must be erected adjacent to the facility indicating the private maintenance responsibility. The sign must be prominently located and must include the name and telephone number of the party responsible for the maintenance.

B. Multiple Use of Rights-of way and Easements Criteria

Multiple uses are encouraged for drainage rights-of-way and drainage easements including, but not limited to, utility corridors, wildlife habitat, open space and recreation trails. Where multiple uses are planned by the city, another public agency, or a public utility, the city may require that dedication statements include language which permits said specified multiple uses and Watershed Management Parks amenities in addition to the primary drainage function. Land required to be dedicated for drainage rights-of-way shall include those land areas necessary for drainage control, flood control, erosion control, Watershed Management Park amenities, recreation trails, sanitary sewer corridors and necessary appurtenances. The following is the criteria for the subject encroachment:

Underground utility lines will be allowed in and adjacent to arroyos when appropriately permitted. SSCAFCA values the natural environment and desires to protect and maintain the wildlife and plant habitat along the arroyos. As a result, SSCAFCA is performing planning work to identify selected arroyos to be kept in their natural state. Arroyos such identified shall have no sewer line or other utility development in or adjacent to the arroyo.

SSCAFCA supports the Quality of Life Master Plan for Watershed Park. To accomplish the Master Plan’s objective of creating an open space network of joint use improvements, Watershed Park amenities shall be provided as replacement value to the public for the intrusion caused by the utility construction. The types of amenities required shall be determined on a case-by-case basis.

The utility line shall be designed and constructed to reduce the failure potential to the maximum extent practicable. Design, permitting, construction, operation and maintenance of utility lines are the responsibility of the Utility Owner and Operator; including, but not limited to, the construction of drainage improvements necessary to protect the utility and the Watershed Park amenities associated with the utility.

I. UTILITIES

All utilities in a SSCAFCA/City facility require an easement granted by SSCAFCA/City for construction, operation and maintenance. The easement shall include the following language:

The Utility Owner (Utility) is responsible for operations and maintenance of all Utility owned facilities. Any damage to any drainage facilities or downstream arroyos as a result of the installation, operation or maintenance of Utility owned facilities is the responsibility of the Utility Owner, including environmental mitigation of any spills, leaks or blockages of Utility owned facilities.

All designs shall be submitted to and require approval by City Engineer/SSCAFCA Executive Director or their designee.

A. Engineering Design Criteria for Underground Utilities in and Adjacent to Arroyos

Underground Utilities in Arroyos and Utilities Adjacent to Arroyos include both “wet” utilities such as sanitary sewer lines, water lines, etc.; and “dry” utilities such as electric lines, communication lines, etc. Design considerations shall include 100-year flood plains, floodways, and the areas included within the LEE.

The design criterion applies to all arroyos.

B. Engineering Design Criteria for Gravity Sewer Lines in Arroyos

1. Design Capacity Criteria

Develop design flow as defined in the Water Utility Design of the City of Rio Rancho’s DPM.

2. Longitudinal Placement

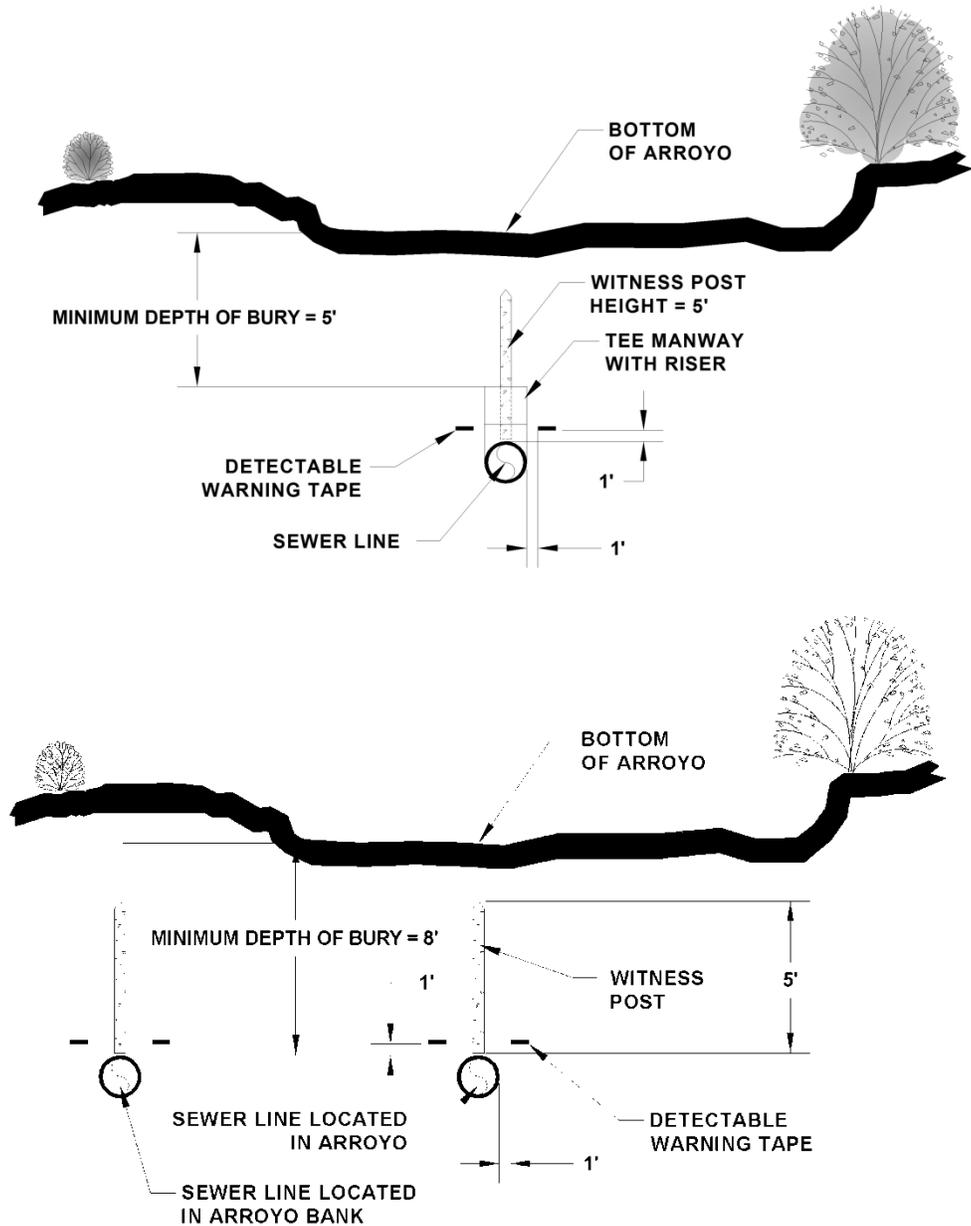
Longitudinal placement includes locations more or less aligned with the average down-valley direction as defined in SSCAFCA’s Sediment and Erosion Design Guide, November 2008.

1) Horizontal Location

- a. Place the utility in the bottom of the existing arroyo where practical. This will minimize disturbance to existing habitat and vegetation.

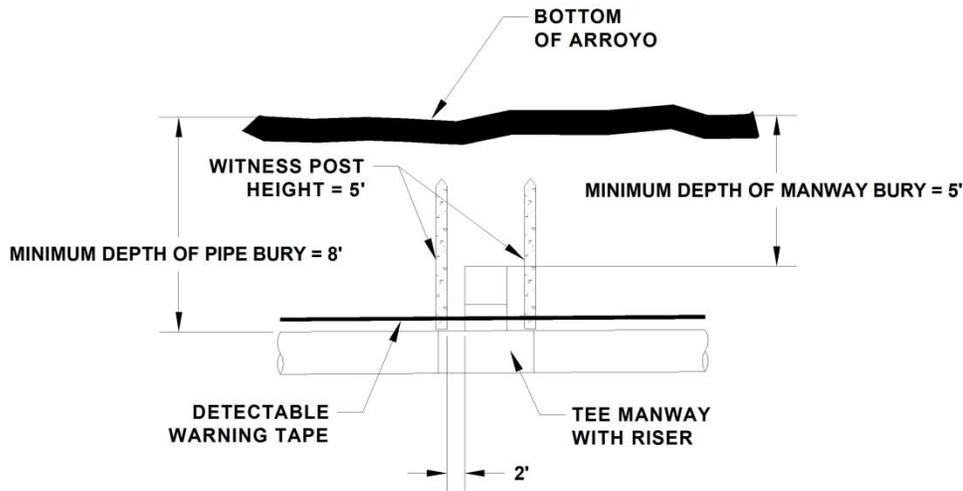
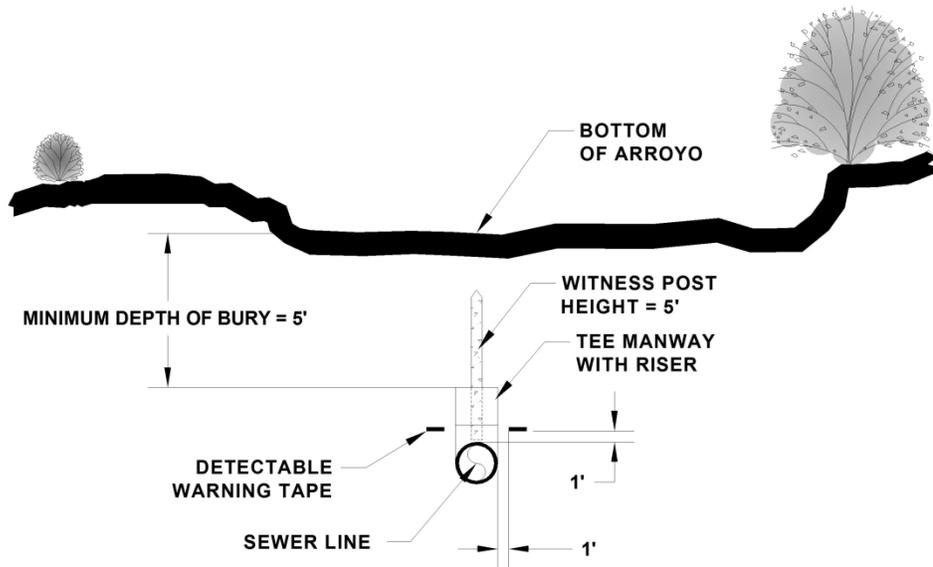
2) Vertical Location

- a. Place the utility at a depth below the existing arroyo bottom equal to or greater than the SAS erosion control zone. Under no circumstances shall the utility be placed less than 8-feet below the bottom of the arroyo.
 - i. Sewer line shall be marked with a witness post, 5-feet in height, placed above the pipe. Maximum distance between witness posts: 300-feet.
 - ii. Sewer line shall be marked with detectable warning tape on either side of the pipe, at 1-foot above the top of pipe, for the entire length of the pipe.



3. *Manway Criteria*

- 1) Manways must be located in the arroyo bottom and buried. Manholes in arroyos are not acceptable. All manways must be accessible by sewer maintenance truck.
- 2) Manways shall be marked with two witness posts, one on each side of manway. Witness post shall be 5-feet in height.
- 3) Minimum depth of bury to top of manway: 5-feet below bottom of arroyo.



- 4) Manways shall be fabricated of a fused HDPE tee with a HDPE riser, and a bolted blind flange. The required inside diameter for a manway shall be the same inside diameter as the inlet/outlet pipe.
- 5) Inlet/outlet connections shall be continuously fused to manway and shall be restrained with an electrofusion flex restraint. Gasketed joints are not acceptable.
- 6) The maximum distance allowed between manways is 600-feet.

4. *Manhole Criteria*

- 1) Manholes shall be located at all roadway crossings. Manways in roadway crossings are not acceptable.
- 2) Manholes shall be fabricated from fusible HDPE.
- 3) Inlet/outlet connections shall be continuously fused to manholes and shall be restrained with an electrofusion flex restraint. Gasketed joints are not acceptable.
- 4) The minimum required inside diameter for a manhole is 6-feet.
- 5) Invert elevations shall be called out for each inlet and outlet at a manhole.

5. *Line Criteria*

- 1) Sewer line shall be continuously fused HDPE pipe only. All other materials are not acceptable. Gasketed joints are not acceptable.
- 2) Minimum line size allowed: 15-inch inside diameter.
- 3) Curvilinear sewers are permitted, in accordance with manufacturer's recommendations.
- 4) Service connections are not acceptable.
- 5) Sewer line shall be marked with a witness post, 5-feet in height, placed at the top of the pipe. Maximum distance between witness posts: 300-feet.
- 6) Sewer line shall be marked with detectable warning tape on either side of the pipe, at 1-foot above the top of pipe, for the entire length of the pipe.
- 7) Connecting sewer lines are only allowable at a manway or manhole. Connections on the pipe, between manways or manholes, are not acceptable. Minimum connecting line size allowed: 8-inch inside diameter. Connecting sewer lines shall conform to the same criteria listed above from LEE line to LEE line or manhole to manhole, whichever is the greater distance.

C. Engineering Design Criteria for Gravity Sanitary Sewer Lines Crossing Arroyos

Sewer lines crossing the arroyo shall conform to the same criteria listed above from LEE line to LEE line or manhole to manhole, whichever is the greater distance.

D. Watershed Park Amenities

Each design shall incorporate Watershed Park amenities. The types of amenities required shall be determined on a case-by-case basis. Appropriate Watershed Park amenities associated with a utility line include linkage elements such as trails and wildlife corridors; and, supporting elements such as trailheads, view sites, benches, and educational/informational signage.

II. AMENITIES

If an amenity is identified as required with the installation of a utility, it shall be designed in accordance with the City of Rio Rancho Development Standards for Parkland and the following criteria:

1. Design Criteria for Trail Systems

- 1) For public health, safety, and welfare, trails shall have signage notifying users they are in an arroyo. The sign shall use SSCAFCA City standard language for warning signs.
- 2) Trails shall have signage notifying users the agency operating and maintaining the trail (i.e. Utility Owner, City of Rio Rancho, etc.).
- 3) Due to location, trails may not be ADA compliant. Trails shall have signage that indicates ADA accessibility constraints.

2. Design Criteria for Trail Heads

Construct Trail Heads in conjunction with trail systems at roadway crossings.

- 1) Trail heads shall control access to the arroyos with the following elements:
 - a. Fencing
 - b. Trail head step-through gates.
 - c. Access gates for operations and maintenance.
- 2) Trail heads shall have areas designated for vehicular and bicycle parking.
- 3) Trail heads shall be designed in accordance with ADA.
- 4) Trail heads shall have signage notifying users of trail name.
- 5) It is recommended to incorporate the following design elements at trail heads:
 - a. Shade structures.

- b. Benches.
- c. Educational/informational signage and maps.
- d. Bear-proof trash receptacles.
- e. Dog-waste bag dispensers.

3. *Protection and Restoration of Existing Wildlife Habitat and Existing Vegetation*

Maintain wildlife habitat and existing vegetation to the maximum extent practicable.

- 1) Provide for the protection of existing wildlife habitat and existing vegetation in the design and construction of the utility.
- 2) Limit construction work zone areas to minimize disturbance to existing wildlife habitat and existing vegetation.
- 3) Re-vegetate all disturbed areas not in arroyo bottom.
- 4) Restore disturbed habitat as appropriate.

E. Operations and Maintenance

The City of Rio Rancho is responsible for the operation and maintenance of the Watershed Park amenities.

Operation in arroyos during monsoon season is potentially dangerous and is discouraged.

C. Watershed Park/Quality of Life Plan

Development that encroaches or is adjacent to a Lateral Erosion Envelope (LEE) must:

- A. Comply with Watershed Parks/Quality of Life Plan and consider inclusion of Quality of Life amenities acceptable to SSCAFCA and the City of Rio Rancho.
- B. Dedicate in fee simple the LEE Line to SSCAFCA.

D. Lateral Erosion Envelope

Encroachment into the LEE Line will require the following:

- A. Update the existing Lee Line Study
- B. Identify the drainage improvements required to reduce the LEE Line
- C. Construct and/or financially guarantee the required drainage improvements prior to building permit/subdivision plat approval. If these drainage improvements benefit other properties within the drainage basin, the methodology for prorating cost outlined in Section 10 of this chapter can be used.
- D. Provide construction plans for the required drainage improvements and the Watershed Management Park Plan amenities.
- E. Dedicate to SSCAFCA without compensation the required drainage rights-of-way/easements for the proposed drainage improvements, LEE Line and the Watershed Management Plan amenities.
- F. If the proposed LEE Line reduction is in the SSCAFCA right-of-way and/or easement, a vacation request to the SSCAFCA Board will be required.

Section 10. STORM WATER POLLUTION CONTROL

A. General

As an EPA requirement, structural, environmental controls must be included to minimize the discharge of storm water pollutants from areas of new development and significant redevelopment both during and after construction.

The following section was created in an effort to ensure that, to the maximum extent practicable, new development and projects that require drainage plans do not increase pollutant loads from the development project site. The measures outlined in this section are to be in accordance with approved Storm Water Management Plans.

B. Applicability

While all development shall address water quality, some Priority Project categories have been developed to address the more serious development categories that historically have the potential to generate serious storm water pollution problems during and after construction. All new development and projects that require drainage plans and that fall into one of the following Priority Project categories are subject to Structural Treatment Control Best Management Practices (BMPs) requirements.

- Retail, Warehouse and Office Developments in excess of 0.5 acres site size.
- Automotive Repair Shops
- Restaurants
- Gas Stations/Fueling Facilities
- Dumpster, Compactor and Waste Collection and Storage Pads on all commercial and industrial sites
- Residential developments with more than 10 residential units, excluding single family housing subdivisions

C. Structural Treatment Control Best Management Practices

All Priority Projects shall consider, incorporate and implement storm water Structural Treatment Control BMPs into the project design to comply with the Minimum Storm Water Quality Control Measures shown in Table 1.

A Structural Treatment Control BMP is an engineered system designed, constructed and maintained to remove pollutants from urban runoff. Pollutant removal is achieved by simple

gravity settling of particulate pollutants, filtration, screening, biological uptake, media adsorption or other physical, biological or chemical process. Examples of typical drawings and details for Structural Treatment Control BMPs are shown in the respective agency's Storm Water Management Plans under separate cover.

D. Criteria for Designing Structural Treatment Control BMPs

1. Treat the runoff from the "water quality storm event" (0.6 in. of precipitation within a six-hour period).
2. a. For sites 40 acres or smaller, the following approximate methods may be used:
 - i. The Storm Water Quality Treatment Rate (SWQR) is the peak rate of flow from the water quality storm event as a function of the percentage of impervious land use (Land Use Category D) shown on Table 2. Treatment of the initial storm runoff at rates equal to or greater than the SWQR provides treatment of the SWQV.
 - ii. The Storm Water Quality Treatment Volume (SWQV) is the treatment volume from the water quality storm event as a function of the percentage of impervious land use (Land Use Category D) shown on Table 2.
- b. For sites larger than 40 acres, site hydrology in accordance with the City of Rio Rancho/SSCAFCA Development Process Manual (DPM), using the water quality storm event, is used to determine the runoff rate and volume.
3. Provide bypass or overflow capacity to convey the flood control design discharge, even if the BMP structures and components are completely full or plugged.
4. Gross Pollutant Control (AMAFCA/Albuquerque)*
 - a. Gross pollutant material consists of both surface floatables and submerged buoyant neutral items such as saturated paper, tumbleweeds, etc. Therefore, gross pollutant structural treatment control BMPs must address both surface and subsurface gross pollutants and floatable debris;
 - b. To the extent practical, prevent trapped and collected pollutant materials being re-introduced into the runoff during subsequent runoff events, including events larger than the water quality design storm;
 - c. To the extent practical, retain the trapped pollutants out of low flows and nuisance flows to prevent leaching of water quality constituents from the trapped debris;
 - d. Design the facilities for ease of maintenance; and

- e. Identify the maintenance plan and responsible party to maintain adequate gross pollutant capacity. It is recommended that the facility be cleaned following each storm event.
 - f. Commercial and industrial sites must provide and operate and maintain BMP facilities on-site.
 - g. Commercial and industrial site BMP's shall address failure of the system such that no pollution is discharged off-site.
5. Examples of standard details for BMPs and guidance documents for storm water pollution control can be found on the COA Website at [www.cabq.gov/storm-drainage -design](http://www.cabq.gov/storm-drainage-design).

*Reference: AMAFCA/Albuquerque MS4 Gross Pollutant Study, Draft dated August, 2004, prepared by ASCG for AMAFCA and the City of Albuquerque.

TABLE 1. MINIMUM STORM WATER QUALITY CONTROL MEASURES FOR PRIORITY PROJECTS			
<i>Priority Projects</i>	Control of Liquids from Dumpster Areas⁽¹⁾	<i>Control of Gross Pollutants and Floatable Trash</i>	Control of Oil from Vehicle Parking Areas
Residential developments with more than 10 residential units		x	
Automotive repair facilities	x	x	x
Gas stations/fueling facilities	x	x	x
Restaurants	x	x	
Retail and office developments larger than 0.5 acres	x	x	
Dumpster and compactor pads ⁽¹⁾	x	x	

NOTES:

(1) Isolate and discharge to sanitary sewer. Design discharge for 100 year event.

TABLE 2. WATER QUALITY STORM EVENT RUNOFF RATE AND VOLUME AS A PERCENT OF IMPERVIOUS AREA FOR 40-ACRE AND SMALLER SITES

Percent Impervious (%D)	Runoff Depth (inches)	Runoff Rate (cfs/ac)	Runoff Volume (cubic feet/ac)
0	0	0	0
20	0.09	0.5	327
40	0.18	0.8	653
60	0.27	1.2	980
80	0.36	1.35	1037
100	0.46	1.5	1670

NOTES:

- (1) Water Quality Storm Event – 0.6 inches precipitation, all zones. It is assumed that approximately 0.14” will infiltrate leaving 0.46” of actual run-off to be treated for Water Quality purposes.
- (2) Assumes pervious area evenly divided between Land Uses B and C.
- (3) Interpolate for site-specific impervious area.
- (4) Calculated from DPM Chapter II.2.2, Section 2, Part A.

Chapter II.3

TRANSPORTATION

1. Introduction

1.1 PURPOSE

The purpose of this chapter is to provide standards for roadway design elements where it is necessary for consistency and to ensure, as far as it is practical, that the City of Rio Rancho's minimum requirements are met for roadway and transportation safety, welfare, aesthetics, environmental sensitivity and economical maintenance.

The standards outlined in this chapter cannot apply to all situations. They are intended to assist the professional engineer's competent work but not to substitute for it. Professional engineers are expected to bring the best of their skills and abilities to each project so that it is designed accurately.

Further, these standards are not intended to unreasonably limit any innovative or creative effort that might result in higher quality or increased cost savings for the public. Any proposed departure from these standards will be judged on the basis of whether such a variance will yield a compensating or comparable result that is fully adequate for road users and City residents.

At the beginning of each project, the following shall be established: the roadway's functional classification, future traffic volumes, and topography of the area. These basic criteria shall determine the design standards to be used. Any deviations from these published standards must be approved by the City of Rio Rancho (CORR) Department of Public Works or an authorized representative before the project design will be considered for approval. The standards are based largely upon the guidelines promulgated by the American Association of State Highway and Transportation Officials (AASHTO).

The guidelines in this Development Process Manual will be periodically updated as needs become apparent to reflect changes to City practice. It is the responsibility of the user to determine that they are utilizing the most current version of these standards.

1.2 APPLICABILITY

These standards shall govern all construction and reconstruction of transportation facilities within City as a whole. They shall also apply to all transportation facilities proposed to be built in right-of-way that is intended to be dedicated to the City, or is already within City right-of-way, and is accepted into the City Road System for maintenance.

Before the City accepts a road for maintenance, it shall meet the standards outlined in this chapter. Permitted work shall also conform to the requirements of the current City Resolutions governing permitted work. If field conditions change after plan approval, improvements shall be made as necessary in order to bring the transportation facilities up to these standards. These

standards shall be used by private parties, consulting engineers, public utilities, agencies, and City staff.

The standards apply to rural and urban roadways except for freeways, or freeway-type improvements. In these latter cases, the current applicable standards of the New Mexico Department of Transportation (NMDOT) shall apply.

2. Transportation Planning

2.1. FUNCTIONAL CLASSIFICATION

Functional classification is the process by which urban and rural roads are grouped into classes or systems according to the kind of service they will provide. The basic functional systems used in this classification are arterials, collectors, and locals. Using national classification terminology, these systems are sub-classified based on the trips served, the areas served, and the operational characteristics of the streets or highways. Typical cross sections are shown in the City of Rio Rancho Standard Details.

The desired Level of Service (LOS) designations for each roadway section shall be used in the traffic analysis to support roadway function classifications, sizing of interim roads and determining the number of intersection auxiliary lanes that are required.

A summary description of Level of Service is given:

- A** free flow, with low volumes and high speeds.
- B** reasonably free flow, speeds beginning to be restricted by traffic conditions.
- C** stable flow zone, most drivers restricted in freedom to select their own speed.
- D** approaching unstable flow, drivers have little freedom to maneuver.
- E** unstable flow, may be short stoppages.
- F** forced or breakdown flow.

2.1.1 RURAL SYSTEM

2.1.1.1 Rural Principal Arterial Road System

Rural Principal Arterials are roads with the following service characteristics:

- Traffic movements with trip length and density suitable for substantial citywide travel.
- Traffic movements between urban areas with populations over 25,000.
- Traffic movements at high speeds.
- Divided four-lane roads.
- Planning volumes as shown in Table 2.1.
- Desired LOS C

2.1.1.2 Rural Minor Arterial Road System

Rural Arterials are roads with the following service characteristics:

- Traffic movements with trip length and density suitable for citywide travel.
- Traffic movements between urban areas or other traffic generators with populations less than 25,000.
- Traffic movements, at high speeds.
- Undivided lane roads.
- Planning volumes as shown in Table 2.1.

- Striped for one or two lanes in each direction with auxiliary lanes at intersections as required by traffic volumes.
- Desired LOS C

2.1.1.3 Rural Local Road System

Rural Local Roads are those with the following service characteristics:

- Two-lane undivided roads with intersections at grade.
- Planning volumes as shown in Table 2.1.
- Traffic movements between collectors and adjacent lands.
- Traffic movements involving relatively short distances.
- Desired LOS A.

Urban Roadway Planning Level Traffic					
Road Classification	ADT / Lane	No. Thru Lanes	2-Way ADT Range	Peak Hr./ ADT% (K)	Max. Rdwy. Length*
Local	350	2	50 – 1,500	15	1,000 ft.
Collector	3,500	2	500 – 8,500	12	2 mi.
Minor Arterial	5,500	4	5,000 – 35,000	8	---
Principal Arterial	7,500	6	30,000 – 60,000	8	---
Rural Roadway Planning Level Traffic					
Road Classification	ADT / Lane	No. Thru Lanes	2-Way ADT Range	Peak Hr./ ADT% (K)	Max. Rdwy. Length*
Local	500	2	50 – 1,500	15	1 mi.
Minor Arterial	9,000	4	5,000 – 35,000	10	---
Principal Arterial	10,000	4	10,000 – 40,000	10	---

* Length may be variable as a function of degree of home frontage on the road.

**Table 2.1
Urban and Rural Roadway Planning Level Traffic Volumes**

Table 2.1 provides general ranges of traffic volumes that can be expected for various roadway types. Volumes shown in the table should not be used to determine roadway classifications. Roadway classifications should be determined primarily by definition and supported by traffic analysis indicating the desired LOS.

ADT refers to Average Daily Traffic (24-hour weekday, two-way volume).

2.1.2 URBAN SYSTEM

2.1.2.1 Urban Principal Arterial Road System

Urban Arterials are roads with the following service characteristics:

- Traffic movements in urban areas consisting of through movements and major circulation movements in these areas.
- Traffic movements involving a large portion of the total urban area travel on a minimum of mileage.

- Posted speeds between 45 mph and 55mph.
- Divided four-lane or six-lane roads.
- Planning volumes as shown in Table 2.1.
- Striped for one or two lanes in each direction with a median and exclusive turn lanes where applicable.
- Desired LOS D

2.1.2.2 Urban Minor Arterial Road System

Urban Minor Arterials are roads with the following service characteristics:

- Traffic movements in urban areas consisting of major circulation movements within these areas, with more emphasis on land access than major roads.
- Traffic movements do not penetrate residential neighborhoods.
- Traffic movements at moderate speeds with partially controlled access facilities.
- Undivided or divided (divided preferred) two or four-lane with intersections at grade.
- Planning volumes as shown in Table 2.1.
- Striped for two or three lanes in each direction with a median and exclusive turn lanes where applicable.
- Desired LOS C

2.1.2.3 Urban Collector Road System

Urban Collector Roads are roads with the following service characteristics:

- Traffic movements in urban areas consisting of both land access service and traffic circulation.
- Traffic movements subject to high levels of median and side friction.
- Traffic movements penetrate local areas.
 - Development may front directly on the road.
 - Has more than 10 uncontrolled access points per mile on one side.
 - Local areas include residential neighborhoods, commercial, and industrial areas.
- Traffic capacity for an Urban Major Collector Road is limited not by the typical capacity of the road section but instead by the desirability of maintaining acceptable traffic levels by the use of continuous center left turn lanes rather than intermittent left-turn lanes. Urban 'Minor' Collector Roads maintain acceptable traffic levels that will not affect residential neighborhoods adversely. Planning volumes as shown in Table 2.1.
- Desired LOS C (major collector) and LOS B (minor collector).

2.1.2.4 Urban Local Road System (Residential)

Urban Local Roads are those with the following service characteristics:

- Two-lane undivided roads with intersections at grade with frequent driveway access.
- Planning volumes as shown in Table 2.1.
- Traffic movements between adjacent lands and collectors or other roads of higher classification.

- Traffic movements over relatively short distances, less than 8 blocks long in most cases.
- Desired LOS A

2.1.2.5 Cul-De-Sacs and Turnarounds

Cul-de-sacs and Turnarounds are roads with the following service characteristics:

- Traffic movements enter and exit at only one end of the road.
- Traffic movements having a turnaround.

2.1.2.6 Private Ways

Private Ways are roads with the following service characteristics:

- Two-lane undivided roads with intersections at grade
- Traffic Movements are only to service a limited number of homes or businesses.
- Private Ways are not located within public right of way.
- Roads are not considered part of the CORR road system.

2.2 STREET LOCATION/NAMING

2.2.1 STREET LOCATION

Streets must conform in character, location and arrangement to adopted plans. Governing plans may be the approved neighborhood site plan, site development, sector plans, or adopted future street lines. The Department of Development Services should be consulted for information regarding applicable plans for areas under design consideration.

Proposed street arrangements must provide for the continuation of existing principal streets or appropriate projections thereof if not otherwise governed by an adopted plan. No half street improvements are allowed within the City of Rio Rancho. All proposed four lane roadway improvements must be continuous for a total length, intersection to intersection, and approved by the City Engineer.

2.2.2 STREET NAMING

The naming of streets shall be coordinated with the City of Rio Rancho Development Services Department. Street naming shall be in accordance with the ordinances and guidelines set by Development Services.

2.3 DESIGN HOUR VOLUMES

2.3.1 DESIGN YEAR

The Design Year for future traffic volumes is the year when construction/buildout is complete. The Horizon Year is the calendar year rounded off to the nearest 5-year increment after buildout. For some regionally significant transportation Corridors, the Traffic Engineer may designate the Horizon Year as the Horizon Year in the currently adopted Metropolitan Transportation Plan. The MRCOG model will be used for projecting background traffic models through the given

design and horizon years. The Design Engineer will confirm the design year for a project before starting the design process.

2.3.2 ADJUSTMENT TO DESIGN YEAR ADT VOLUMES

For some roadway design projects, adjustments will be required to the volumes projected by MRCOG. Adjustments will be required in anticipation of major land developments or significant changes in nearby street and/or highway networks that will affect future traffic volumes expected on the roadway under design. Adjustments in traffic volumes for major land developments will follow the City of Rio Rancho Traffic Impact Study Procedures as referenced in **SECTION 2, SUBSECTION 4.0, TRAFFIC IMPACT STUDY PROCEDURES** of this Chapter. Adjustments for other impacts shall be approved by the City Traffic Engineer before being undertaken by the Design Engineer.

2.3.3 DESIGN HOUR VOLUME

The Design Hour Volume (DHV) is the traffic volume used to determine the number of traffic lanes on the roadway. Use the following formula to determine the DHV:

$$\text{DHV} = \text{ADT} \times \text{K}$$

Where:

- DHV = design hour volume of traffic (total, 2-way)
- ADT = average 24-hour weekday, 2-way volume of traffic
- K = ratio of design hour volume to ADT

(See Table 2.1 for K values to use for rural and urban roadway classifications.)

The number of lanes for each direction of traffic for an interim roadway is determined by the traffic impact analysis. However, the interim roadway shall be designed for conversion to the ultimate section determined by classification.

For special activity centers such as recreational areas, factories, sports arenas, etc., other values of the above factors will be used. It is also recognized that special traffic conditions may or will exist that require modification of the above factors. In these two sets of cases, the different factors must be documented and approved for use by the City Traffic Engineer.

2.3.4 TURNING MOVEMENT PERCENTAGES

At major intersections and at driveways leading to major activity centers, the design hour turning volumes are important in determining the intersection capacity, resulting number of lanes, and the storage length for exclusive turning lanes required for each approach. For intersections being reconstructed and that are in fully developed areas, existing turning movement percentages will be collected in the field and are assumed to be the same for the future design year. For new intersections or for those significantly impacted by new land developments or major changes in nearby street/highway networks, existing and projected traffic data along with engineering judgment will be used to reassign vehicle trips on nearby street networks to derive the turning movements at project intersections.

Turning movements must be analyzed for both a.m. and p.m. peak hours at project intersections so that the maximum turning or through volumes can be determined for each approach. In the absence of other data, it can generally be assumed that the 'background' street network intersection turning movements will be opposite and equal for the a.m. and p.m. peak hours. It is important for the Design Engineer to obtain sufficient existing traffic counts by hourly variation to accurately identify and quantify project intersection turning movement volumes for the design year.

2.3.5 OTHER TRAFFIC VOLUME REDUCTION FACTORS

Vehicle trip (traffic volume) reductions for future transit ridership or other transportation modes are generally not permitted. Reductions for "passer-by or' diverted' trips are allowed as per the Institute of Transportation Engineers (ITE) Trip Generation Manual (latest revision) but must first be approved by the City Traffic Engineer. Trip reductions for special land uses utilizing travel demand management (TDM) strategies will be considered on a case-by-case basis. However, the factors used must be fully and accurately documented to the City's satisfaction.

2.3.6 CAPACITY ANALYSIS

Software using the current Highway Capacity Manual (HCM) procedures will be used to determine the capacity and resulting number of lanes for roadway design project street sections and intersections. For rural street sections with existing or planned traffic signals more than a mile apart, the appropriate section of the HCM will be used. For urban or suburban areas where traffic signals are at or less than a mile apart, it will be assumed that the signalized intersection capacity will control the design of the roadway segments.

The number of through lanes on street sections must be consistent with the number of through lanes at adjacent intersections. For capacity and lane determination, major intersections are assumed to be signalized for the design year. The signalized intersection section of the HCM will be used for the analysis. The default values of the peak hour factor (PHF), percentage of trucks, and saturation flow rate shall be used. Other input criteria will be those equal to existing or future traffic conditions and approved by the City Traffic Engineer.

2.3.7 FUTURE TRAFFIC VOLUMES

Future traffic volumes shall be used to ensure that the road has enough traffic carrying capacity. The general unit of measure for traffic on a road is the ADT, the total volume of traffic in a given time period divided by the number of days in that time period. The future ADT shall be derived from the MRCOG forecast model and the engineer's judgment of growth patterns in the area.

The traffic volume during a period of time shorter than a day shall be used for design purposes, reflecting peak hour periods. Reference Table 2.1 for the K-values for rural and urban roadway classifications. For roads with unusual or highly seasonal fluctuation in traffic volumes, the 30th highest hour of the design year should be used.

The directional design hour volume is the traffic volume for the rush hour period in the peak direction of flow. Use directional distribution factors based on existing traffic counts. If this information is not available it should be assumed that 60% of the traffic is going in one direction. Reference Table 2.1 for design volume threshold per hour per lane. For a more detailed analysis

of intersection and road capacity, procedures as described in the intersection portion of this chapter and the latest version of the HCM should be used.

2.4. TRAFFIC IMPACT STUDY PROCEDURES

This policy is to provide for consistency in the preparation of traffic impact studies using certain established criteria. It has been prepared to assist consultants, developers, and others interested in evaluating traffic impacts within the City of Rio Rancho's jurisdiction.

Developers and their engineering consultants are invited to discuss proposed projects with the Traffic Engineering Staff prior to beginning the analysis. This is to enable discussion and determination of parameters to be used and to open communications between City staff and the developer or consultant. Such communication will help in creating land uses with traffic characteristics that are in the entire community's best interests.

2.4.1 TRANSPORTATION IMPACT ANALYSIS (TIA) REQUIREMENTS

A TIA studies the effects of new development on the city's transportation infrastructure, and helps the city determine what changes, if any, are necessary to minimize those effects. It is also used to determine how much capacity a new road within a development needs to appropriately serve its needs.

Preparing a TIA should begin as early as possible in the development process to avoid costly design changes that might be required after city staff completes their review. The applicant and the applicant's engineer are encouraged to consult with staff prior to preparation of the TIA to reduce report revisions and review time.

The primary concerns to be addressed in the TIA are site access, impact on the existing roadway system, and what construction is necessary to mitigate both the on-site and off-site impacts. The **site design** should be tailored to the traffic requirements, and the city reserves the right to require changes to the access points to better serve the transportation system.

2.4.1.1 Traffic Impact Study Thresholds

The City of Rio Rancho has developed thresholds that may be used as a general guideline to determine if a traffic impact study will be required for a given development proposal. Though a development may meet these thresholds, the city reserves the right to require a TIA in some cases, such as, but not limited to, creating safety or neighborhood traffic concerns and developments that generate a high volume of truck traffic. These thresholds are based upon the specific land use generating less than 100 peak hour trips during either the AM or PM peak design hours. If the site generates less than 100 peak hour trips, the requirement for a traffic impact study may be waived. In this case, only a trip generation report need be submitted.

ITE Code	Land Use	Units	Threshold
130	Industrial Park	SF	74,000
140	Manufacturing	SF	144,000
150	Warehousing	SF	128,000
210	Single Family Housing	DU	92
220	Apartment	DU	147
230	Residential Condominium or Townhouse	DU	184
310	Hotel	Rooms	168
320	Motel	Rooms	240
445	Multiplex Movie Theater	Screens	4
445	Multiplex Movie Theater	Seats	990
492	Health/Fitness Club	SF	23,000
710	General Office	SF	18,000
720	Medical-Dental Office Building	SF	28,000
812	Building Materials and Lumber Store	SF	20,000
815	Free Standing Discount Store	SF	19,000
820	Shopping Center (General Retail)	SF	6,000
841	New Car Sales	SF	40,000
843	Auto Parts	SF	14,000
850	Supermarket	SF	6,000
853	Convenience Market with Gasoline Pumps	Pumps	5
870	Apparel Store	SF	17,000
880	Pharmacy/Drug Store without Drive Through	SF	11,500
912	Drive In Bank	SF	2,000
931	Quality Restaurant	SF	13,000
932	High Turnover Restaurant	SF	8,000
934	Fast Food Restaurant with Drive Through	SF	1,800
944	Gasoline/Service Station	Pumps	7
945	Gasoline Station with Convenience Store	Pumps	7
946	Gasoline Station with Convenience Store and Car Wash	Pumps	7

All land uses not listed above or projects that contain a combination of land uses should be discussed with Traffic Engineering staff. They may be contacted at 896-8770.

Developments that generate 500 or more vehicle trips during either the AM or PM peak hour may require an expanded analysis. Please verify the scope with Traffic Engineering staff.

A scoping study is required for all traffic studies. The scoping study will establish the project study area, analysis years and conditions, acceptable traffic count years, trip distribution methodology, background traffic growth rate, programmed improvements, and the allowable pass-by trip percentage.

2.4.1.2 Study Area

The study area shall include all site access points, as well as any adjacent intersections. Inclusion of any additional intersections shall be determined during the scoping meeting by city staff, and may include, but are not limited to, signalized or potentially signalized locations within 2 miles of the development, residential roads that are projected to have a 25% increase in volumes, or truck routes for a development whose site traffic consists of at least 5% truck traffic.

2.4.1.3 Trip Generation

The latest version of the ITE *Trip Generation Manual* shall be used for all trip generation calculations, unless more appropriate data is available. Unless otherwise stated in the scoping meeting, the average trip generation formulas or rates shall be used, with the curve equation being the preferred method when enough data is available for an accurate application (R^2 approaches 1). Default pass-by rates are also to be used unless otherwise specified during the scoping meeting.

2.4.1.4 Study Time

All analysis shall be done for both AM and PM peak weekday periods. In some cases, an off-peak hour or weekend may need to be studied if the development is, or is near, an atypical traffic generator, such as a school or church.

Peak hour baseline traffic counts shall be done for all specified intersections. Existing counts may be used if less than two years old. These numbers shall be used to analyze the existing conditions.

2.4.1.6 Horizon Year

The farthest future time that the impacts of a development shall be studied is five years after completion of construction. For smaller developments, the horizon year may be moved closer to build-out.

In some cases, a historical growth rate may be obtained from MRCOG Traffic Flows Maps for the Albuquerque area. However, due to the rapidly changing infrastructure, some of the values extrapolated from the maps may not provide a good estimate for future traffic, either because of negative growth or a growth rate over 5% that cannot be sustained for a number of years. When this is the case, a background growth rate of 2.5% shall be used.

The addition of the traffic growth to the existing numbers shall be used for the horizon no-build condition. Any funded infrastructure improvements can also be used during the horizon analysis.

2.4.1.7 Methodology

All intersection analysis shall be done in accordance with Highway Capacity Manual procedures for two-way stop control, four-way stop control, roundabouts, and signals. Queuing analysis shall be done according to the Poisson negative exponential random arrival distribution, for both the 50% and 95% levels.

Level of services for all stop and signal controlled movements shall be calculated for the project completion year, no-build condition, completion year, build condition, horizon year, no-build condition, and horizon year, build condition.

Queue analysis shall be done for horizon year, no-build condition, and horizon year, build condition.

Where high volumes prevent adequate operation of a two-way stop controlled intersection (LOS E or worse), a signal warrant analysis shall be done according to MUTCD standards. If the intersection consists of two roads with one through lane in each direction, then the theoretical performance of a roundabout shall also be calculated.

Estimated ADTs for all system streets shall be included in the report.

In some cases, a crash analysis will be requested by city staff to help identify unsafe conditions in the project area that may be exacerbated by an increase in traffic.

2.4.1.7 Recommendations

LOS D is considered acceptable for most situations, however if development in the surrounding area is sparse, the city may require that intersections function more efficiently in the near future to allow for later growth. If a development recommends improvements that only allow LOS D, the city may require additional work to maintain good operation.

The City currently requires that all new developments' access points and any necessary auxiliary lanes follow the design guidelines in the NMDOT State Access Management Manual (SAMM), unless there is an adopted policy for an adjacent corridor that supercedes the SAMM.

All internal roads shall be sized appropriately for their projected traffic. In general, the city will require two lanes in each direction only for roads with a projected ADT above 18,000 vehicles, so long as intersections operate at LOS D or better.

Traffic Study Threshold Level of Effort				
	a	b	c	d
	Access Location & Design Review T ≤ 100 Peak Hour Trips	Small Development: TIS 100 < T ≤ 500 Peak Hour Trips	Medium Development: TIS 500 < T ≤ 1000 Peak Hour Trips	Large Development: Regional TIS T > Peak Hour Trips
Scoping Meeting	X	X	X	X
Analysis of Roadway Issues				
Existing Conditions Analysis	X	X	X	X
Site Distance Evaluation	X	X	X	X
Nearby Driveway Locations	X	X	X	X
Crash History	X	X	X	X
Mitigation identification and evaluation		X	X	X
Trip distribution analysis		X	X	X
Existing traffic conditions at nearby intersections and driveways		X	X	X
Trip Generation of adjacent developments			X	X
Background traffic growth			X	X
Future conditions analysis at nearby intersections			X	X
Future Road Improvements			X	X
Site Issues				
Traffic Generation	X	X	X	X
Access design evaluation: queuing, etc.	X	X	X	X
Site circulation evaluation	X	X	X	X
Trip Distribution		X	X	X
Access point evaluation: number, location and spacing		X	X	X
Other Analysis				
Gap analysis for unsignalized locations			X	X
TSM / TDM mitigation measures (car or van pooling, transit, etc.).			X	X
Traffic Signal Progression Analysis			X	X

Traffic Study Time Frames

Task	Trip Generation Threshold			
	a Time (days)	b Time (days)	c Time (days)	d Time (days)
Request for Scoping Meeting	10	10	10	15
Analysis of Roadway Issues	10	15	30	30
Site Issues	10	15	30	30
Other Analysis	N/A		20	25
DPW Review	5	15	30	30
Duration	35	55	120	130

Note: Task may be achieved concurrently reducing the amount of time needed for the professional to complete tasks.

Times shown above are approximate and do not include time for resubmittals.

3. Design Procedure

3.1 BASIC CRITERIA

3.1.1 ROAD CLASSIFICATION AND TYPICAL SECTION

The road classification shall be identified in the Concept Report or Project Scope of Work. If the classification is not identified, the Design Engineer must submit a classification for approval to the City Project Manger.

3.1.2 DESIGN VEHICLE

The design vehicle is the largest vehicle likely to use the road with considerable frequency or a vehicle with special characteristics that must be considered in designing the road. The design vehicle will affect the radii at intersections and the radii of turning roadways. It will also affect the climbing lane requirements on two lane roads. Unless otherwise specified, all arterial and collector roadways and intersections will be designed to accommodate a WB-50 design vehicle. All residential roadways shall be designed to accommodate a Single Unit (SU) design vehicle. Design vehicles shall be as defined in the AASHTO publication, A Policy on Geometric Design of Highways (current edition).

3.1.3 DESIGN FOR FUTURE TRAFFIC VOLUMES

The primary design consideration for roadways is the handling of vehicular traffic. When streets are built or reconstructed, they will be designed with sufficient traffic handling capacity to accommodate a future level of traffic volumes. **SECTION 2, SUBSECTION 3.0 DESIGN HOUR VOLUMES** and **SECTION 2, SUBSECTION 4.0 TRAFFIC IMPACT STUDY PROCEDURES** describe in greater detail the process that shall be followed in determining the capacity of roadways and intersections used in the design process.

While the functional classification approved for a roadway will govern the basic cross sectional elements, additional through or left turn lanes, auxiliary right turn lanes, acceleration lanes, and similar design features may be required. The designer should do a detailed capacity analysis to determine the need for additional or auxiliary lanes.

3.1.4 TOPOGRAPHY

The topography of the area shall be determined by a site visit and available topographic maps. The terrain shall be classified as level, rolling, or mountainous. Level terrain is when roadway sight distances are or could be made adequate without major construction requirements. This generally includes short grades of no more than 1 or 2 percent. Rolling terrain is when natural slopes consistently rise and fall with grades of up to 6 percent for lengths of 700 feet. Mountainous terrain is when changes in the ground's elevation with respect to a road are abrupt. Mountainous terrain has greater than 15 percent slopes on the U.S.G.S. 7.5-Minute Series Maps.

3.1.5 DEVELOPMENT OF PLANS AND SPECIFICATIONS

Project design and construction, unless otherwise indicated, shall be in accordance with the latest edition and current revision of the following publications:

- APWA Uniform Standard Specifications and Details for Public Works Construction as distributed by American Public Works Association New Mexico Chapter.
- Manual on Uniform Traffic Control Devices for Streets and Highways as distributed by the U.S. Department of Transportation, Federal Highway Administration.
- A Policy on Geometric Design of Highways and Streets as distributed by the American Association of State Highway and Transportation Officials (AASHTO).
- Roadside Design Guide as distributed by the American Association of State Highway and Transportation Officials (AASHTO).
- Highway Capacity Manual and the current Highway Capacity Software, as distributed by the Transportation Research Board.
- Drainage Design Manual, as distributed by the City of Rio Rancho.
- Standard Specifications for Highway and Bridge Construction as distributed by the New Mexico Department of Transportation (NMDOT).
- Information Guide for Roadway Lighting as distributed by the American Association of State Highway and Transportation Officials (AASHTO).
- Guide for Development of Bicycle Facilities, as distributed by AASHTO.

3.1.6 ALTERNATIVE MULTI-MODAL CROSSINGS

CORR will incorporate trail crossings of the MRCOG Long Range Bikeways Systems Map in the design and construction of roadways. CORR will consider all trails, shared-use paths, and other multi-modal facilities proposed by developers or other agencies in the design and construction of roadways. The type of crossing will be determined on a case-by-case basis. Grade separated intersections at major road crossings should be considered whenever feasible. Guidelines for crossings will comply with the latest edition of the AASHTO Guide to the Development of Bicycle Facilities, MRCOG Long Range Bikeways Systems Map, or other agreed upon national or local design guidelines or standards.

3.1.7 TIME LIMITATION OF APPROVAL

The City approval of residential developments, commercial developments, and road construction plans shall be valid for a time period of one (1) year. Plans NOT under construction within this time period are to be resubmitted and approved by the City prior to construction.

3.2 SPECIAL PROVISIONS AND ENGINEER'S ESTIMATE

3.2.1 SPECIAL PROVISIONS

3.2.1.1 Residential/Commercial Development

The Design Engineer shall prepare Special Provisions for construction items not contained in or adequately covered by the APWA New Mexico Standard Specifications and Details for Public Works Construction as needed. Special provisions shall insure that each construction item is

clearly defined and all material and construction requirements are identified. Special Provisions shall be written and arranged in the same format as the APWA New Mexico Standard Specifications and Details for Public Works Construction. The Design Engineer shall prepare and submit sealed Special Provisions. Special provisions shall be included with proposed construction documents submitted for review.

3.2.1.2 Capital Improvement Projects (CIP)

The Design Engineer shall prepare Special Provisions for construction items not contained in or adequately covered by the APWA New Mexico Standard Specifications and Details for Public Works Construction or the New Mexico Department of Transportation (NMDOT) Specifications depending on the funding source and requirements for the project. Special provisions shall insure that each construction item is clearly defined and all material and construction requirements are identified. Special Provisions shall be written and arranged in the same format as the document to which the special provisions are based on (i.e. NMDOT or APWA).

The Design Engineer shall provide The City's Project Manager with sealed and signed original Special Provisions along with an electronic copy. The submitted electronic copy shall be in a format acceptable to the City. The Design Engineer shall prepare and submit sealed addenda that may be required to clarify or correct the Construction Contract Documents (Construction Plans, Special Provisions and Bidding Form).

3.2.2 ENGINEER'S ESTIMATES

3.2.2.1 Residential/Commercial Developments

The Developer/Design Engineer shall provide the City Engineering Section Manager for Development Review or their designee with an Engineer's Estimate of Probable Cost at final submittal of the construction documents. The estimate shall contain a comprehensive itemized listing of individual project components with quantities, estimated unit costs and extended total costs identified for each item. Unit costs shall accurately reflect current market costs. Supporting documentation shall be provided to the City upon request.

An example of the preferred formats for the Estimate of Probable Cost for Onsite, Offsite, and Deferred Improvements can be found at the following CORR website: www.ci.rio-rancho.nm.us.

3.2.2.2 Capital Improvement Projects (CIP)

For City Capital Improvement Projects, cost estimates shall be formatted as a fee schedule with City designated bid item numbers and descriptions. The City of Rio Rancho "Bid Item List" can be found on the City website at: <http://ci.rio-rancho.nm.us/index.asp?nid=352>

When the City provides information on past bid results, it is the Design Engineer's responsibility to evaluate the appropriateness of the information, prior to using the information in the Engineer's Estimate. An example of the preferred format for Lump Sum and Unit Pricing Bids can be found at the following CORR website: <http://ci.rio-rancho.nm.us/index.asp?nid=352>

An electronic copy of this format can be obtained from the City Project Manager.

3.3 SURVEY AND DATA ACQUISITION

The survey must be supervised by a professional land surveyor registered in the state of New Mexico. This section contains general survey requirements. For specific topography and notation requirements for construction documents refer to **CHAPTER 2.7 - Submittal Requirements**.

3.3.1 TOPOGRAPHICAL FEATURES

All topographic features and elevations (along the project road and crossroads alignments) shall be recorded. Topographic features and elevations shall extend a minimum distance of 15 feet beyond any anticipated new right-of-way. Any planimetric feature and/or elevation that could affect or be affected by the design shall be recorded and shown on the plans. For example, improvements such as houses, drainage ways, ditches, railroad tracks, high voltage power poles, etc., shall be shown. Distances to power poles, signs, trees, fences, and similar obstructions shall be measured to the face of the object closest to the survey centerline. If a survey centerline is not defined, it shall be assumed as the proposed construction centerline alignment. Sufficient dimensions of the object must be recorded and shown on the plans as appropriate for correct depiction. Floor elevations shall be shown on the plans for houses and buildings within 20 feet of the project.

Elevations beyond the proposed right-of-way line must be recorded for driveways that may require alterations beyond the right-of-way. Elevations shall also be obtained for all parking areas on adjacent property to ensure that the property will properly drain in conjunction with new roadway grades. The Design Engineer is responsible for maintaining proper drainage from adjacent properties. The plans will be returned if, in the City Project Manager's opinion, the information submitted is not adequate to properly review the proposed grades and drainage design.

Field measurements for utility facilities shall include: identification of the direction, diameter, material, and inverts elevations of all pipes associated with junction structures, manholes, and culverts; identification of the manhole rim and invert elevations; water valve operating nut and valve box cover elevations. When utility supplied buried facility maps are incomplete or do not accurately identify utility locations, New Mexico One Call, Inc. should be contacted (505-260-1990 or 1-800-321-2537) and markings shall be part of the topographic information obtained and included on plan base maps. The designer shall not attempt via notes or omission to pass the responsibility to locate utilities through to the contractor or City. The designer shall pothole utilities if necessary.

All survey data shall be in accordance with NAVD88. Topographic features shall be measured as follows:

- 1) Distance to all topographic features, except to valve boxes and manholes, shall be measured to the near the face of feature.
- 2) Distance to all valve box covers and manhole covers shall be measured to the center of the cover. If the manhole has been constructed with an offset, the offset shall be indicated.

3.3.2 TRAFFIC RELATED FEATURES

Existing edges of pavements, major drives, traffic signals, traffic striping, and traffic signs shall be surveyed to 500 feet beyond each end of the project limits.

3.3.3 ELEVATION DATUM

North American Vertical Datum of 1988 (NAVD 88 - National Geodetic Survey) datum shall be used unless otherwise authorized by the City Engineer. The elevation datum shall be derived from First Order benchmarks tied to one NGS or City monument and to any adjacent ongoing project, adjacent city datum, and to any datum used by utilities within the project area. The elevation of existing monuments along the project corridor shall also be obtained but typically not called out on plans as project construction benchmarks. Identify on the plans the project benchmark used to establish project elevations.

3.3.4 CONSTRUCTION BENCHMARKS

All survey monuments for street intersections, angle points, and horizontal curves necessary to the project design shall either be found in the field or set using appropriate survey equipment during construction.

At least two benchmarks on a project shall be existing City-recognized benchmark monuments. Elevations of City benchmarks will be furnished by the City of Rio Rancho Department of Public Works. Any temporary benchmarks that are used shall be shown on the project construction documents (i.e. location, elevation, description, etc).

A maximum permissible closure in feet of $(0.05) \times (\text{square root } M)$, where M is the total distance run in miles, shall be maintained. The results of the closed bench circuit shall be balanced using acceptable surveying methods.

3.3.5 SURVEY CROSS SECTIONS

For projects in which an existing road will be widened using the existing cross slope of the road survey cross sections shall be taken at least every 100 feet along tangents, 50 feet along curves, with additional sections taken at locations where the terrain deviates, as necessary. Horizontal limits shall extend 15 feet beyond proposed right-of-way left and right, with right-of-way elevations given at average natural ground.

All ditch flow lines, tops of banks, tops of linings, high water marks, culverts, inverts, manhole inverts, tops of headwalls, building slab elevations, and similar features shall be obtained and clearly noted.

Existing pipe culverts, washes, and ditches shall be profiled along their existing alignments and the skew angles and angle points identified. The widths of ditches, berms, and similar structures shall be identified. Major drainage features shall require additional survey cross sections, both upstream and downstream of the project 300 feet beyond the project limits. Intersecting roadways shall require additional survey cross sections 100 feet beyond the project limits. Project survey cross sections shall extend 100 feet beyond the end and beginning of the proposed project improvements.

Note: The above cross section guidelines may be disregarded in instances where the project topography is obtained through an aerial company, approval should be obtained from the City Project Manager and the existing roadway will be removed and replaced. However, in locations where the proposed improvements will tie into existing improvements additional survey field shots should be obtained as described above to ensure smooth engineered transitions.

3.3.6 DATA ACQUISITION

The Design Engineer shall research materials such as record drawings (as-built plans), utility plans, and other data and show pertinent information including utility easements on the construction drawings.

3.4 RIGHT OF WAY

The Preliminary Plat and/or Concept Report will generally identify the anticipated basic right-of-way for individual projects. It is understood that the design process will refine the concept by identifying additional requirements and any construction, drainage, or slope easements required. Permanent right-of-way, including the size of triangles at intersections, shall be recommended at the time of initial submittal. The location and configuration of construction, drainage, slope and temporary easements, including any required for detours, shall be shown. The plans shall show and clearly identify both existing and new right-of-way and easement configurations.

The Design Engineer shall furnish a base map to the City Project Manager showing existing and new right-of-way required for the proposed improvements.

3.5 UTILITIES

Relocation of existing utilities shall be avoided, except where necessary due to construction or drainage requirements. Design of culverts and/or storm drain systems should avoid or minimize any disruption of utility service. The location of existing and new underground utilities and culverts shall be appropriately shown in paving profiles, culvert profiles, and storm drain profiles. All above ground utilities and signal poles shall be offset behind future sidewalk in urban areas. In rural areas, above ground utilities shall be located as close to the right-of-way line as is practical.

3.5.1 COORDINATION WITH UTILITIES OWNERS

3.5.1.1 Residential/Commercial Developments

Close coordination with utility owners is very important to new developments and roadway projects to insure timely relocations or installation of new facilities. The design engineer shall research utility information, determine the location and ownership of all utilities within the project limits and resolve each design issue associated with utilities. When two or more utility owners with the same type of facility exist within the project limits, the plans shall indicate the owner associated with each installation. The construction documents shall clearly identify any conflicts or relocations that will need to take place within the project limits. Dry utilities shall be located in the Public Utility Easement (PUE) and wet utilities shall be located in the roadway per City of Rio Rancho standards.

The Design Engineer shall furnish plan sets to each utility owner impacted by the project. Direct contact with utility company for design coordination and land conflict resolution will be coordinated with the City Project Manager unless the conflict is a streetlight or wet utility in which case the project manager will represent the City. The Design Engineer shall record minutes of all meetings and provide the City with copies of all minutes and correspondence directly received by the Design Engineer.

3.5.1.2 Capital Improvement Projects (CIP)

The Consultant shall use the City of Rio Rancho Utility Conflict Letter found in Appendix D to initiate and record the review of the proposed improvements with the appropriate utility owners and municipalities. An electronic Copy of this letter can be obtained from the City Project Manager.

3.6 TRAFFIC DESIGN

3.6.1 SIGNING & STRIPING DESIGN

The following information outlines the signing and pavement markings design procedures for use on the City of Rio Rancho Street System.

The information presented is consistent with the latest edition of the Manual on Uniform Traffic Control Devices for Streets and Highways (MUTCD) and the City of Rio Rancho Signing and Marking Manual.

The intent of the following material is to establish standard procedures that will be used by traffic engineering consultants when designing signing and pavement markings for City of Rio Rancho projects.

3.6.2 COORDINATION WITH THE CITY

3.6.2.1 Project Information

Prior to meeting with the City of Rio Rancho Department of Public Works, the Traffic Engineering member of the Project Design Team should obtain or develop a description of the project showing all proposed improvements and the project limits. The Traffic Designer should become familiar with all aspects of the project.

3.6.2.2 Meeting With the City of Rio Rancho Department of Public Works

The Traffic Designer shall meet with the City of Rio Rancho Department of Public Works project manager prior to beginning the pavement marking and signing design to discuss the project in detail. This discussion should address all applicable pavement marking and signing related items. Examples are listed below.

1. Current design standards that will control the design shall be identified.
2. Verify which pavement marking materials are to be used.
3. Raised pavement markers will be used only when directed to do so by the City. When they are used, they will delineate lane lines, centerlines, two-way left turn lanes, island

noses and fire hydrant locations, unless otherwise directed by the Department of Public Works.

4. Verify that traffic signs will use the following criteria:
 - All sign posts shall be square tube perforated sign posts.
 - Use street light poles to mount signs when possible.
 - Signs to be installed per City of Rio Rancho Standard if available.
5. One of the most important elements controlling the pavement marking design is the design speed for the section of roadway and the speed limit that will be posted. The Traffic Designer shall verify the project's design speed and posted speed limit.
6. Clarify the limits of the project and determine how the new design will match into the existing roadway.
7. A product of this meeting will be the identification of the primary City of Rio Rancho Department of Public Works contacts for the project.
8. The Traffic Designer shall supply the Department of Public Works with the overall project schedule.
9. At this meeting, City staff will identify any specialty signing in the area of the project or any unusual roadway pavement marking needs (e.g. hospitals, park and ride facilities, freeway trailblazing, libraries, bike lanes, etc.).

3.6.2.3 Post Meeting Communication

The Traffic Designer shall send to the City of Rio Rancho Department of Public Works contact any follow-up material that may be needed, particularly information that modifies or changes the concepts that were discussed during the original pre-design meeting. For example, the Traffic Designer will:

1. Prepare and distribute meeting minutes to all concerned parties.
2. Send project scope changes and design criteria changes to the project contact in the City's Department of Public Works project manager
3. Update the project schedule and proposed submittal dates.
4. If necessary, schedule a meeting with City of Rio Rancho to discuss review comments.

3.6.3 FIELD REVIEW

3.6.3.1 Site Visit

The Traffic Designer shall visit the project site to inventory and identify physical features that may impact the pavement marking and signing designs. These features will include existing street width; curb/gutter and sidewalk locations; median configurations and dimensions; and, trees or bushes that may affect sign visibility.

3.6.3.2 Site Inventory

The Traffic Designer shall perform an inventory of existing signing and existing pavement markings. This inventory shall record the following:

1. Sign size, sign material, and the general condition of the sign.

2. Sign type and legend.
3. Posted speed limit(s).
4. Specialty signs throughout the project limits.
5. Sign post type, foundation type and label number, if available.
6. The pavement marking configuration at the location where the new street improvements will meet or match the existing street (e.g. lane widths, median treatment, bike lane or shoulder treatments).
7. Driveway locations and the operation of driveways. For example, are turning movements being restricted at a driveway, is there unique channelization that may have to be modified or reinstalled, and will sight distance at the new driveways be impacted by signing and/or landscaping?
8. Side street pavement markings and signing. Will stop signs, street name signs, stop bars, etc., need to be relocated or replaced?

3.6.3.3 Existing Roadway

While reviewing the existing conditions where the new street improvement project will match into the existing street, the Traffic Designer will need to determine if additional information beyond the street improvement project limits will be needed in order to make the transition from existing to new.

3.6.3.4 Miscellaneous Items

1. Landscaping features that may interfere with installation or visibility of signs.
2. Existing electrical and traffic signal cabinets and street lights within the project limits that will remain.

3.6.4 EARLY TRAFFIC ENGINEERING INPUT INTO GEOMETRIC DESIGN

3.6.4.1 Traffic Engineering Input

The Traffic Designer should be an early, active member of the Project Design Team and should provide information and early input to the development of the project, as follows:

1. Provide the design team with criteria that will control lateral deflections (lane shifts) in the street and in the pavement markings. Deflections shall be designed using the formulas found in the latest edition of the MUTCD.
2. Assist in defining length of roadway tapers. Street improvements should be designed so travel lane tapers meet the criteria as determined using the formulas found in the MUTCD described in item 1 above.
3. Assist in defining length of taper for lane drops using the same MUTCD criteria. In addition, sign placement for lane drops should be in compliance with the criteria identified in MUTCD, latest edition.
4. The Traffic Designer shall assist in determining the lengths of storage for left or right turn lanes.
5. For urban principal arterials posted at 45 mph or higher, turn bays shall have adequate storage length for a 95th percentile queue according to the Poisson distribution, or be 370 feet plus the appropriate taper, whichever is greater.

Additional transportation design requirements can be found in **SECTION 4 - GEOMETRIC DESIGN CRITERIA** of this Chapter.

3.6.5 LIGHTING AND SIGNING

3.6.5.1 Lighting

The policy of the City is that principal arterial streets be lit to Illuminating Engineering Society of North America (IESNA) standards for arterial streets. An analysis shall be conducted identifying street light locations, wattage and height of standard required. 400 watt and /or 250 watt High Pressure Sodium (HPS) lights shall be used on principal arterials. Street lights on minor arterials, collectors and local streets, shall be located at all intersections, on cul-de-sac streets over 200' in length, at right angle turns, and at mid-block locations where block lengths exceed 500'. 250 watt HPS luminaires shall be used on minor arterials and some collectors at major Intersections. 100 watt HPS luminaires shall be used on local streets.

All designs shall be in compliance with the New Mexico Night Sky Protection Act. All luminaires shall be full cutoff fixtures. Additional shielding may be required where the adjacent terrain falls below the roadway grade.

In new subdivisions, the developer shall submit a copy of the plat with required street lighting marked to the Traffic Section Manager. This is then forwarded to Public Service Company of New Mexico (PNM) for design of the street lighting system. PNM then submits the street light plan to the City Traffic Engineer for approval. Following approval, PNM installs the streetlights in conjunction with the installation of electrical service to the subdivision. A fixed fee per streetlight is paid to PNM by the developer for the installation of these lights.

For residential neighborhood streets with speed limits under 30 mph, aluminum direct bury poles are to be installed in accordance with PNM regulations. On streets with speeds greater than 30 mph, aluminum or steel standards with breakaway bases are to be installed in accordance with PNM standards.

3.6.5.2 Signing

Street name signs are installed by the developer or contractor. A label is required to be placed on the back of all single sided signing installed by developer contractors. Each sign label will have the minimum information required by the City Traffic Section.

The roadway classification and/or design speed shall typically govern the posted speed limit. A speed limit sign shall be required at all subdivision entrances and at all areas where the speed limit changes.

All other signing within the proposed development shall be shown on the construction plans for review and approval by City Engineering.

3.6.6 INTERSECTION CONTROL AND MARKINGS

Intersection control and markings are important elements to be considered in the design of all street systems. The application of these elements to the design of streets are described in several

of the references in this chapter. The latest edition of the Manual on Uniform Traffic Control Devices (MUTCD) shall be used to define the design of these elements.

3.6.6.1 Traffic Signals and Roundabouts

The determination of where and when traffic signals and roundabouts are to be installed shall be by the Traffic Section. This decision is based upon the evaluation of traffic conditions at an intersection in accordance with the warrants contained within the MUTCD. Excepting intersections on principal arterials, roundabouts shall be considered for every location that does meet or is anticipated to meet MUTCD criteria for a traffic signal. The Traffic Engineer will decide what the appropriate treatment is based on criteria that includes, but is not limited to, safety, efficiency, construction and operating costs, and available right-of-way. Where intersection control is not likely in the near future, right-of-way may be reserved or underground conduit and pull boxes may be constructed. If signalization will be required in the near future, foundations for the poles may be constructed. See **Chapter 2.7 – Submittal Requirements**.

3.6.6.2 Markings

Street markings in accordance with the MUTCD shall be included in the construction of new arterial and collector streets. For new construction, the layout of these markings need to be shown in the plans and included in the work to be performed by the contractor. The Contractor shall layout the proposed signing and striping plan in the field for verification by Public Works engineering staff.

3.6.7 TRAFFIC CONTROL, CONSTRUCTION PHASING AND CONSTRUCTION PERMITS

A critical element to maintaining safe traffic conditions during street construction activities as well as an efficient method of implementation of needed improvements is that of traffic control and phasing of construction activities. All construction activities shall address these elements through a plan which will identify the phasing of construction activities and the necessary traffic control devices in accordance with the latest edition of the Manual on Uniform Traffic Control Devices (MUTCD).

The right-of-way for a street typically accommodates many different underground and overhead utilities. The designer of a construction project needs to coordinate their activities with the other users of the right-of-way including existing and future utilities. The construction and phasing plans need to incorporate provisions for these other users.

A barricade will be required at the end of any street pavement within or at the limits of a project regardless of the class of street involved or how soon additional pavement will be placed beyond the current project limits. The only exception will be where the Traffic Manager determines that the unpaved portion of the street beyond the project limits has been and will continue to be open to and used by through traffic. The installation of the barricade must be shown on the plans and included as a part of the street improvements. The contractor must install proper warning signs as approved by the City Traffic Manager. Temporary traffic control must be approved by the Public Works Section Manager for Development. The contractor must obtain a Right-Of-Way Use Permit from the Department of Public Works. The contractor must allow the City a minimum of five working days to process the permit. Temporary traffic control plans shall be prepared by persons trained and certified about the fundamental principals of temporary traffic control and

work activities to be performed. The design, selection and placement of temporary traffic control devices for a temporary traffic control plan should be based on engineering judgment.

Bollards shall be installed at the entrance to all new multi-activity trails and in park areas where special parking conditions are required. All designs must be approved by the City Traffic Engineer. Bollard installations will also be required at public utility equipment installations for special traffic control and public safety requirements. Bollards shall be constructed in accordance with the City standard details.

3.6.7.1 Residential/Commercial Development

Construction activities within the right-of-way require a Right-of-Way Use Permit. Prior to the issuance of the permit, plans must be submitted with appropriate approvals which define the construction activities, appropriate traffic control measures, and evidence of notification through the One Call System (505-260-1990) or 811 and to the Department of Public Works Engineering Section Manager for Development for review and approval.

See **Appendix E** for a sample of the Right-of-Way Use Permit. An official copy of this document can be obtained from the Department of Public Works front desk (891-5016).

3.6.7.2 Capital Improvement Projects (CIP)

The Consultant is required to prepare the appropriate traffic control and construction phasing plans and submit them as a part of the construction documents to the City Project Manager for review and approval.

3.7 RAILROAD CROSSINGS – RESERVED

3.8 SUBDIVISION INFRASTRUCTURE REQUIREMENTS

The following information has been provided to assist the development community in determining the extent of public infrastructure that will be required in conjunction with a planned residential development. The information is merely to be used as a guide, and additional coordination and discussions with the City's Department of Public Works and Development Services will be required.

Note: The developer and his/her Design Engineer will be required to meet the applicable design procedures, design guidelines, drafting and submittal requirements as outlined in the City's DPM for the development of his/her project.

3.8.1 ROADWAY IMPROVEMENTS

The Developer will be required to construct full roadway improvements adjacent to and surrounding the project's boundaries.

The roadway typical sections for the road system adjacent to the project's boundaries will need to be established by the developments Traffic Impact Study (TIS). Once completed the results of the analysis shall be submitted for review and approval by the City's Traffic Manager. Once the analysis is approved the developer will be required to construct full width improvements along

the project's frontage and provide the necessary pavement tapers in accordance with the TIA to transition the proposed roadway section to match the existing roadway section.

In the event that the proposed residential development is located away from any existing paved roads, the developer will be required to pave full width roadway improvements necessary to gain unrestricted access to the development from the nearest arterial or collector roadway. The extent of those improvements outside the project boundaries will also be based on the information provided in the TIS (see **SECTION 2, SUBSECTION 4.0 TRAFFIC IMPACT STUDY PROCEDURES** of this Chapter).

3.8.2 WATER AND SEWER IMPROVEMENTS

The Developer will be required to provide the necessary water and sewer facilities needed to successfully service all of the proposed residential homes / commercial developments that will be located within the planned community. The extent of the water and sewer improvements will be based on the location of the residential subdivision / commercial development in relation to existing City water and sewer facilities and their available capacities. The Developer will be required to prepare a Master Water and Sewer Report to determine the demand and the corresponding line sizes that will be needed to service the development.

In the event that the development is located outside the limits of the City's existing water and sewer system the Developer will be required to extend the necessary lines (water and sewer) to service the development. If the demand would overload the City's water and sewer system the City is not obligated to approve the proposed subdivision.

In the event that the demand of the residential development does not overload the existing City water and sewer system the Developer will be allowed to extend the existing water and sewer system as needed to service the development.

It is the sole responsibility of the Developer to provide the water and sewer lines required to service the development no matter the cost associated with the improvements.

3.8.3 STORM DRAIN IMPROVEMENTS

The Developer is required to construct and install all the necessary storm drain improvements to capture and convey the runoff generated from the development so that it does not have a negative impact on surrounding developments/residents or the environment.

It is the sole responsibility of the Developer and his/her Design Engineer to evaluate and analyze the impacts that the runoff generated from the development may have to the surrounding area. The Developer will be required to address and mitigate potential drainage issues that could arise. Discussion with the City Roadway and Drainage Section should take place to determine the best course of action in the event that additional drainage improvements may be required.(See **Chapter 2.2 –Drainage, Flood Control and Erosion Control**).

3.9 AS-BUILTS

See **Chapter 2.7 Submittal Requirements**.

3.9.1 REVIEW PROCESS

One (1) set of blue-line plans must be submitted with “As-Built” redline markings to the Department of Public Works for review within thirty (30) days of substantial completion of the project.

One (1) Copy of test results, certifications, registrations, and reports shall be submitted for review and comment prior to approval by the City.

Once the “redline As-BUILTS” are approved and accepted by the Inspection Supervisor a letter of acceptance shall be issued.

3.9.2 FINAL PROJECT SUBMITTAL

Upon receipt of the acceptance letter the “Final Project Submittal Package” shall be submitted. See **Chapter 2.7 Submittal Requirements**.

4. Geometric Design Criteria

4.1 GEOMETRIC DESIGN CRITERIA

The criteria presented within this section are major controlling factors in the design of streets. It is expected that designers will carefully apply, with attention to detail, these criteria to individual design circumstances. Suitable transitional elements must be provided between changes in geometric configuration, pavement and curb character, and drainage carrying aspects of the ultimate street design.

In the following, the major criteria governing design speed, horizontal and vertical geometrics, sight distance, curvature and superelevation, gradients, and comfort controls are presented.

The guidelines contained herein are intended to provide direction in the design of transportation facilities. While most of the design parameters that should be used are provided in the following pages, unusual conditions may occur in some projects. When additional guidance and explanation is needed, the designer should refer to the following publications or the most current edition thereof:

- APWA Uniform Standard Specifications and Details for Public Works Construction as distributed by American Public Works Association New Mexico Chapter.
- Manual on Uniform Traffic Control Devices for Streets and Highways as distributed by the U.S. Department of Transportation, Federal Highway Administration.
- A Policy on Geometric Design of Highways and Streets as distributed by the American Association of State Highway and Transportation Officials (AASHTO).
- Roadside Design Guide as distributed by the American Association of State Highway and Transportation Officials (AASHTO).
- Highway Capacity Manual and the current Highway Capacity Software, as distributed by the Transportation Research Board.
- Drainage Design Manual, as distributed by the City of Rio Rancho.
- Standard Specifications for Highway Bridges as distributed by the New Mexico Department of Transportation (NMDOT).
- Information Guide for Roadway Lighting as distributed by the American Association of State Highway and Transportation Officials (AASHTO).
- Guide for Development of Bicycle Facilities, as distributed by AASHTO.
- Traffic Engineering Handbook, as distributed by Institute of Transportation Engineers.
- Transportation Planning Handbook, as distributed by Institute of Transportation Engineers.
- Trip Generation, as distributed by Institute of Transportation Engineering.
- Transportation and Land Development, as distributed by Institute of Transportation Engineering.

Variances in design standards may be sought in order to cover unusual circumstances or alternative design concepts. Variances for these would be granted by the review body or person(s) that would have primary responsibility for those standards.

4.2 ROADWAY CROSS SECTIONS

4.2.1 LANE WIDTHS

Consult the standard cross sections found in the “City of Rio Rancho Standard Details” for standard lane widths and other relevant cross section geometry. For analyzing non-typical situations, Table 4.1 shows appropriate ranges of road lane widths. The Design Engineer must get prior approval from the City Project Manager before using the 'minimum' values. The Design Engineer should prepare a design memo detailing the cross section and lane widths when changes to the standard City cross sections are needed. All dimensions are in feet and measured to center of lane lines from the edge of pavement (no curb) or to the edge of curb. Current City standards may be found in Table 4.2.

The length of the transition to match the standard cross section must be determined using the road width transition tapers as specified in the standards (see **SECTION 4.0, SUBSECTION 8.0 TRANSITION TAPERS** of this Chapter).

4.2.2 CROSS SLOPE

The desirable cross slope on normal sections of all pavement types should be 0.02 foot per foot (2%), with 0.01 foot per foot (1%) minimum and 0.03 foot per foot (3%) maximum. The minimum cross slope at intersections may be reduced to 0.005 foot per foot (0.50%). The 1% absolute minimum cross slope shall not be used in combination with a minimum longitudinal slope.

The slope is downward on each side of a centerline high point for two-way roads. For one-way roads, the slope should be constructed to angle uniformly throughout the full surface width. When pavements are resurfaced the desirable transverse slope should be 0.02 foot per foot (2%) with a maximum slope of 0.03 foot per foot (3%).

The minimum desirable longitudinal curb grade shall be 0.005 foot per foot (0.50%). The absolute minimum shall be 0.0035 foot per foot (0.35%). The maximum desirable shall be 0.06 foot per foot (6%) with 0.10 foot per foot (10%) as absolute maximum. The design engineer is required to discuss using the absolute minimum and maximum values for longitudinal slope with the City Project Manager for approval.

4.2.3 GRADED SHOULDERS

Graded shoulders should slope 0.05 foot per foot (20:1) downward from the adjacent pavement edge. In superelevated sections, the graded shoulder slope shall continue to slope away from of the pavement. The graded slope on the high side may have a reduced slope. The graded slope on the low side shall remain at 0.05 foot per foot (20:1) downward, except when the superelevation rate exceeds 0.05 foot per foot (5%), in which case the low side graded shoulder slope shall equal the rate of superelevation. However, when portions of the shoulders on two-lane highways are paved as an integral part of the travel lanes (and the paved portion is 5 feet or less in width) the paved shoulder slope shall be the same as the cross slope of the traveled lanes. The remaining unpaved portion of the shoulder should be sloped 0.05 feet per foot (20:1) except when modification is needed for superelevated sections. Rural local roads shall have the graded portion of the shoulder sloped at 10:1.

Street Type	Street ROW Cross Section														
	Min. Width	Curb & Gutter	Driving Lane	Parking Lane	Median Width	Bicycle Lane	Sidewalk Width	Buffer Separation	Design/Posted Speed	Max. Gradient	Min. Gradient	Min Radius @ Centerline	Min. Sight Distance	Min. Tangent Length	Max. Length
Principal Arterial	156 ft	STD DWG CG-01	11 ft	-	Varies by # of Lanes	6 ft	6 ft	5 ft min	45 mph - 55 mph	10%	0.50%	SEE AAASHTO	SEE AAASHTO	SEE AAASHTO	
	Varies														
Minor Arterial	Min 86 ft Max 106 ft	STD DWG CG-01	11 ft	-	22 ft	6 ft	6 ft	5 ft	40 mph	10%	0.50% min - 3% max through the intersection	SEE AAASHTO	SEE AAASHTO	SEE AAASHTO	
	Additional 30 ft (15 either side)														
Intersections (750 ft distance)															
Business Collector (prop.)	Varies Min 80 ft Max 102 ft	STD DWG CG-01	15 ft	9 ft (parallel) 14 - 30 ft (angle)	-	-	Varies Min 14 ft Max 20 ft	N/A	25 mph - 30 mph	10%	0.50%	SEE AAASHTO	SEE AAASHTO	SEE AAASHTO	
Collector	68 ft	STD DWG CG-01	11 ft	-	11 ft	5 ft	5 ft min	3 ft min	35 mph	10%	0.50%	SEE AAASHTO	SEE AAASHTO	SEE AAASHTO	
Local	50 ft	STD DWG CG-01	13 ft	-	-	-	5 ft min	3 ft min	25 mph	10%	0.50%	SEE AAASHTO	SEE AAASHTO	SEE AAASHTO	600 ft
Alley	20 ft	-	20 ft	-	-	-	-	-	-	-	-	-	-	-	-
Driveway	STD DWG DW-01	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cut-4s-Sac	100 ft diameter	-	-	-	-	-	-	-	-	-	-	-	-	-	500 ft

Table 4.2
Street Standards

The design control at the crossover line between the pavement and the graded portion of the shoulder is the algebraic difference in the cross slope rates. The maximum algebraic difference at this point is 0.08 foot per foot (8.0%). For superelevated pavements greater than 0.03 foot per foot (3%) but less than 0.06 foot per foot (6%) the graded portion of shoulder on the high side can vary from 5% to 2% to effect a maximum algebraic grade difference of 0.08 foot per foot (8%). For superelevated pavements greater than 0.06 foot per foot (6%) the graded portion of shoulder shall be paved to match the cross slope of the roadway. Where they both slope in the same direction, it is the difference of their cross slope rates. Shoulder slopes that drain away from the paved surface on the outside of well-superelevated sections should be designed to avoid greater than an 8.0% grade break.

When the designer is matching pavement, the cross slope or breakover should not exceed 0.01 foot per foot (1%) except at crown lines.

4.3 DESIGN SPEEDS

The design of geometric features such as horizontal and vertical curves will depend upon the design speed selected for the street. The choice of the design speed is primarily determined by the street classification. The design speed is the maximum recommended speed at which reasonable safe operation of a vehicle can be maintained over a specific section of a road when conditions are so favorable that the design features of the road govern. Design speeds for the various classifications of roads may be found in Table 4.2.

4.4 HORIZONTAL CURVES

4.4.1 GENERAL CONTROLS

Refer to the current AASHTO *A Policy on Geometric Design of Highways and Streets*, latest edition, for guidance.

4.4.2 SUPERELEVATION RATES

Refer to the current AASHTO *A Policy on Geometric Design of Highways and Streets*, latest edition, for guidance.

4.4.3 SUPERELEVATION TRANSITION

Refer to the current AASHTO *A Policy on Geometric Design of Highways and Streets*, latest edition, for guidance.

4.4.4 SIGHT DISTANCE ON HORIZONTAL CURVES

Refer to the current AASHTO *A Policy on Geometric Design of Highways and Streets*, latest edition, for guidance.

4.5 VERTICAL ALIGNMENT

4.5.1 VERTICAL CURVES

Refer to the current AASHTO *A Policy on Geometric Design of Highways and Streets*, latest edition, for guidance.

4.6 ROADWAY ALIGNMENT

Refer to the current AASHTO *A Policy on Geometric Design of Highways and Streets*, latest edition, for guidance.

4.9 CLEAR ZONES

Refer to the AASHTO *Roadside Design Guide* – Current Edition, for guidance.

4.10 GUARDRAIL

Refer to the AASHTO *Roadside Design Guide* – Current Edition, for guidance.

4.11 CURB

Refer to the AASHTO *Roadside Design Guide* – Current Edition, for guidance.

4.11.2 CURB RETURNS

Refer to City of Rio Rancho Standard Details.

4.12 SIDEWALKS

4.12.1 GENERAL

Sidewalks shall be designed in accordance with the current City of Rio Rancho Standard Details. All newly constructed sidewalks shall be in compliance with the Americans with Disabilities Act (ADA) requirements.

Refer to Standard Drawings for Street and Drainage.

4.13 GRADING IN PARKWAY AND ON PRIVATE PROPERTY

If a cut or fill slope must extend onto private property, the top of the bank and the toe of slope shall be shown on plan view regardless of the depth of the cut or fill. The Consultant must obtain sufficient topographic information and spot elevations to accurately determine the limits of the cut or fill. This may require survey beyond what is normally expected on private property if the road is located on a hillside slope.

A typical cross-section drawing showing the existing ground slope and the proposed cut or fill shall be shown on the same plan sheet. Any easements that are required to construct the proposed cuts or fills on private property shall also be shown on the plan views. The City Project Manager

shall be notified in writing of all easement requirements for cuts and fills. The drawing of proposed easement lines on the construction plan is not suitable notification.

If the difference in elevation between the back of a graded pedestrian walkway (or the back of a sidewalk) and the existing ground at that location is greater than one foot, the top of the bank and the toe of the slope shall be provided on the same plan sheet.

The maximum slope of the grading behind a graded pedestrian walk or sidewalk may be increased if the abutting property is undeveloped and if available right of way is not sufficient for a 4:1 slope without encroaching onto private property. This should be discussed with the City Project Manager.

If existing fences, trees, or other structures lie in the area where cuts and fills are planned, their relocation, if necessary, shall be part of the design requirement. Trees must be relocated if the cut(s) or fill(s) will encroach upon them.

Retaining walls may be considered as an alternative to cuts and fills if development on private property would be adversely affected by a cut or fill, or if an easement is unobtainable. The goal is to achieve practical and economical solutions to problems generated by grade differentials.

5. Intersections

5.1 GENERAL CONTROLS

5.1.1 INTERSECTION ANGLE

Roads shall intersect each other at not more than 10 degrees from normal.

5.1.2 INTERSECTION SPACING

Refer to NMDOT State Access Management Manual for guidance.

5.1.3 INTERSECTION LOCATION

Arterials and collectors shall have straight approaches of at least 330 feet between the intersection and horizontal curves.

5.1.4 LIMITS OF IMPROVEMENTS

Intersecting major streets shall be improved to the limits designated. Tapers to match existing pavement shall be as designated in the geometrics. Care shall be taken to ensure smooth grades in both directions at the intersection of arterial streets, collector streets, and any other potentially signalized intersections.

Work at intersecting streets shall generally end at the terminus of the curb return. If an intersecting street is unpaved and ROW is available, the pavement (with curb and gutter) shall generally be extended 100 feet beyond the returns to prevent gravel accumulation and erosion at the intersection.

5.1.5 SIDEWALK RAMPS

All improvements shall be designed in accordance with current ADA guidelines and CORR standard details.

5.1.6 CURB RETURNS AT STREET

Refer to City of Rio Rancho Standard Details.

5.1.8 INTERSECTION SIGHT DISTANCE

Intersection sight distance shall be provided at all intersections. This distance is measured from the assumed driver's eye. For a stop condition on the minor road, this point is a minimum of 18 feet from the edge of the traveled way. The edge of the traveled way is defined as the face of curb in urban areas, or two feet to the right of the stripe along the inside lane on the intersecting street in rural areas. Where directional curb ramps are used, the driver's eye is assumed to be located four feet behind the stop bar. This will prevent the driver from having to encroach on the crosswalk in order to see far enough to make a safe turn. Otherwise, the procedure for calculating intersection sight distance may be found in the AASHTO Policy on Geometric Design of Highways and Streets.

5.1.9 LEFT TURN LANE STORAGE

The left turn storage length shall be determined by a traffic analysis for both signalized and unsignalized intersections. In no case shall the minimum storage length be less than 75 feet for unsignalized intersections or 160 feet for signalized intersections.

5.1.10 RIGHT TURN LANE STORAGE

The right turn storage length shall be determined by a traffic analysis for both signalized and unsignalized intersections. In no case shall the minimum storage length be less than 75 feet for unsignalized intersections and 160 feet for signalized intersections.

5.1.11 AUXILIARY LANE TRANSITION TAPERS

Refer to NMDOT State Access Management Manual for guidance.

5.1.12 DECELERATION REQUIREMENTS FOR AUXILIARY LANES

Refer to NMDOT State Access Management Manual for guidance.

5.1.13 LANE REQUIREMENTS

A traffic analysis is required to determine the number of lanes and the lane configuration for intersections.

5.1.14 INTERSECTION TURN LANE DESIGN

At intersections where no specific left turn lane or a single left turn lane is to be provided, a truck turning template must be used to ensure the width of the receiving lane on the exit portion of the intersection is sufficient for the design vehicle. A left turning vehicle's sight distance shall not be obstructed by an opposing left-turning vehicle.

At intersections where double left turn lanes are to be provided, a truck turning template must be used to ensure the width of the receiving lanes on the exit portion of the intersection are sufficient for the design vehicle.

5.1.15 INTERSECTION CROSS SLOPE/GRADING

Intersections must be graded to provide characteristics consistent with the design speed of the through street. Intersection staking sheets through the intersection will be required for design review of major intersections involving arterial and collector streets. Alignment of arterial streets through intersections must be continuous without breaks in grade. Grades within the intersection need to be flat enough to minimize problems with turning vehicles and to keep stopping distances reasonable. Grades should also be steep enough to ensure that proper drainage occurs. Grades should be between 0.5% minimum and 3% maximum. Grades established for channelized turning roadways need to be compatible with superelevation for design.

Minor leg approach tangent gradients to intersections generally must not exceed 4% for a distance of at least 50' back from the projected curb flowline of the through street. Deviations from this standard will require joint concurrence of the City Project Manager and the City

Engineer.

Street crown should be reduced through signalized intersections of collector and major local streets of approximately equal classification to promote driver comfort. Crown reduction should not generally exceed one half of standard crown unless special circumstances govern and the joint concurrence of the City Project Manager and City Engineer is obtained. Grade breaks through major-major, major-collector, and any other signalized or potentially-signalized intersections shall not exceed 2.0% desirable or 3.0% absolute maximum. Intersection grading must provide for rapid drainage.

Grades intended to serve as drainage water blocks may only be designed on minor approach legs of intersections. Maximum height of such water blocks allowed will be 12" as measured vertically from the projected gutter flowline elevation of the major or through street to the gutter flowline elevation at the high point of the minor leg gutter. Vertical curves of a minimum length of 50' must be provided for water block configuration. The vertical curve needs to begin at the intersection flowline to preserve reasonable intersection visibility. Adequate stopping sight distance must be provided in the design.

Detailed drainage design must follow the requirements of **Chapter 2.2**; however, the designer should specifically investigate intersection design to assure that design flows will not overtop curbs resulting in damage outside the right-of-way

Intersections should be located so as to avoid roadway segments that are highly superelevated. Intersection grading for superelevated roadways needs to take into account the issues of grade compatibility, cross-over crown etc. to insure that the intersection will operate properly.

5.2 ROUNDABOUTS

5.2.1 GENERAL

Roundabouts shall be the preferred option for intersection control on all single lane minor arterials and collectors. They should also be considered as alternatives to signals on two lane minor arterials. The criteria to be used for selecting a roundabout over other forms of intersection control such as signals or stop signs include, but are not limited to:

- Safety Improvements – This use would typically be used on locations where there were abnormally high accident rates associated with conflicts that would be reduced or eliminated with roundabouts.
- Operational Improvements – This use would typically be used in locations where a roundabout would provide better performance than other traffic control modes such as stop signs or traffic signals
- Traffic Calming – This use is typically limited to traffic circles located at local street intersections.
- Community Enhancement – This use is typically a gateway treatment to convey a change in environment or land use.
- Special Situations – This use would be limited to areas where unique alignment and/or geometric constraints make it impractical to use traditional traffic control modes.

In addition, all Traffic Impact Studies should include a comparison of the theoretical intersection delay for a roundabout versus a signal at all warranted signal locations.

5.2.2 TRAFFIC CIRCLES

Traffic circles differ from roundabout in that they are used primarily to control speed and volume on local streets. Figure 5.6 illustrates the design elements associated with a traffic circle. Table 5.4 provides guidance for selecting the traffic circle size for various street widths and curb return radii.

Street Width (feet)	Curb Return Radius (feet)	Circle Diameter (feet)
30	15	20
30	20	22
30	25	24
36	15	27
36	20	29
36	25	33

Table 5.4
Traffic Circle Diameter Versus Street Width
And Corner Radius*

Traffic circles should be constructed with a raised vertical curb. The use of landscaping within the traffic circle should not impede the intersection sight distance requirements.

Source: City of Seattle, "Neighborhood Traffic Control Program – Citizens Requested Traffic Circle".

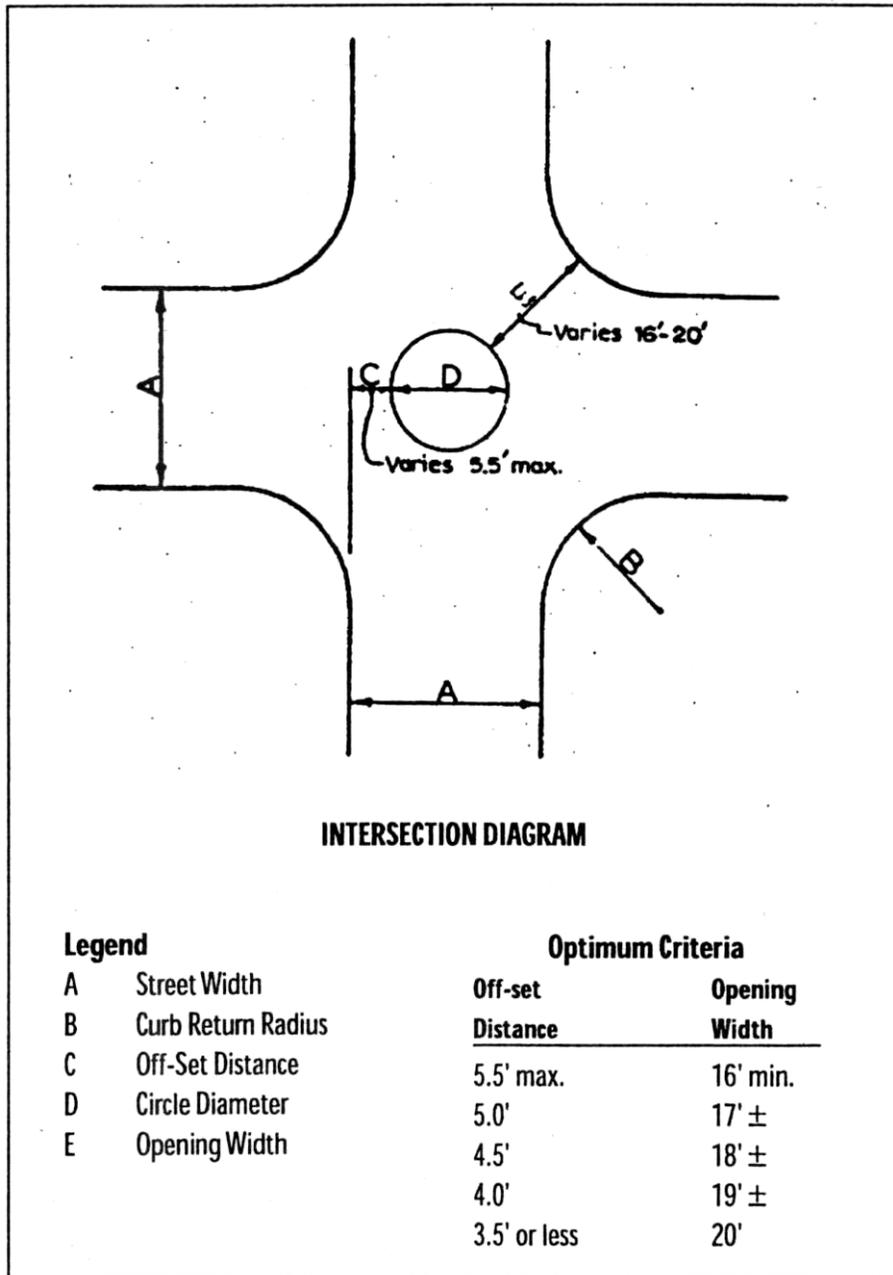


Figure 5.6
Design Elements for Traffic Circles

Source: City of Seattle, "Neighborhood Traffic Control Program – Citizen Requested Traffic Circle (City Funded)" Policy No. 23, Seattle, WA, 1986.

5.2.3 Applications

Based on the local and collector street sections, the following types of roundabouts are applicable for use:

- Mini-roundabout
- Urban compact roundabout
- Urban single-lane roundabout
- Rural single lane roundabout (rural roundabouts that may become part of an urbanized area should be designed as a urban roundabout)

6. Access to City of Rio Rancho Roadway System

6.1 ACCESS CONTROL

The efficiency and safety of a roadway depends largely on the number and character of interferences affecting vehicles moving along the facility. Major interferences are caused on most streets by vehicles entering, leaving, or crossing the road, at intersecting streets and driveways. In order to minimize accidents and to assure best overall use of the facility by the general public, it is necessary to regulate vehicle movements in and out of abutting developments and cross streets.

With respect to driveways, road users have certain rights of access to abutting property as well as the right to travel on the road with relative safety and freedom from interference. Since these various rights sometimes conflict, the City is given the responsibility for reconciling and satisfying, to the extent feasible, the needs and rights of all road users with respect to driveway location, design, and operation. When conflicts cannot be fully resolved, preference will be given to the safe and efficient use of the road, particularly when traffic growth requires additional storage capacity of left-turning vehicles at signalized intersections. In such cases, the City reserves the right to change a nearby access point from full access to partial to ensure safe, efficient operations of the adjacent signal.

Existing accesses, even if not in use, must not be relocated, altered, or reconstructed without approval from the City of Rio Rancho. When an access to a roadway with a curb and gutter is abandoned, it must be replaced by a full height curb across the abandoned access and the depression behind must be filled. When an access to a roadway with a shoulder and ditch is abandoned, it must be replaced by a matching existing shoulder and ditch.

6.1.1 ACCESS TO STATE HIGHWAYS

Access to State highways is regulated by the New Mexico Department of Transportation (NMDOT). The City of Rio Rancho will not review changes to an existing access or any new access which is in State right-of-way. Encroachment permits for access to State highways must be obtained directly from the NMDOT. The City shall review requests for new access where any portion of the access is in City right-of-way.

6.1.2 ACCESS TO CITY ROADWAYS

All construction to connect or change driveways entering City right-of-way must first be authorized by a valid City of Rio Rancho Curb Cut Permit and a Right of Way Use Permit. These permits can be obtained through the Department of Public Works at the following website: <http://ci.rio-rancho.nm.us>

The City currently follows the standards in the NMDOT State Access Management Manual (SAMM). No access points shall be approved without an acceptable project site plan indicating the location and number of access points. A Traffic Impact Study may be required to substantiate the need for access or any variances to the SAMM guidelines.

6.2 DRIVEWAYS

6.2.1 DEFINITION

A driveway is any access constructed within the public right-of-way, connecting the public roadway with adjacent property and which does not cause the blocking of any sidewalk, border area, street, or roadway.

Some of the principles of intersection design apply directly to driveways. One important feature is the elimination of large graded or paved areas adjacent to the traveled way that allow drivers to enter or leave the street randomly.

6.2.2 DRIVEWAY TYPES

- A residential driveway is one providing access to a single family residence, a duplex, or an apartment building containing five or fewer dwelling units.
- A commercial driveway is one providing access to an office, retail, or institutional building, or to an apartment building having more than five dwelling units. Such buildings are customarily serviced by trucks as an incidental rather than a principal driveway use. Industrial plant driveways whose principal function is to serve administrative or employee parking lots are also considered commercial driveways.
- An industrial driveway is one directly serving substantial numbers of truck movements to and from loading docks of an industrial facility, warehouse, or truck terminal. A centralized retail development, such as a community or regional shopping center, may have one or more driveways specially designed, signed, and located to provide access for trucks. These are also classified as industrial driveways.

6.3 DRIVEWAY CHARACTERISTICS

6.3.1 SINGLE FAMILY RESIDENTIAL DEVELOPMENT

Driveways serving single family residential units should be designed in accordance with Standard Detail DW-01, "Sidewalk and Driveway Transitions (Residential)" and DW-02, "Sidewalk and Driveway Transitions (Collector)." If the driveway is to serve one single family unit, the maximum width should be 24 feet. For single family residential accesses, the width must equal the width of the garage opening if the garage is within 25 feet of the right-of-way line, up to a maximum of 30 feet. If one driveway is to serve two single family units, the maximum width should be 30 feet.

6.4 DRIVEWAY DESIGN

6.4.1 RESTRICTION OF TURNING MOVEMENTS

Where necessary for the safe and efficient movement of traffic, the City may require access points to be geometrically designed so as to provide for only limited turning movements. The restriction of turning movements should not affect the number and location of access points as specified elsewhere.

6.4.2 ISLANDS FOR LIMITED MOVEMENT ACCESSES

The ends of the islands should typically be provided with 2-foot back of curb radii. Where site plans do not permit installation of islands in accesses as shown in **Figures 6.1 through 6.3**, the City Project Manager may permit or require the installation of a center median on the adjacent public street as an alternative.

Figures 6.4 through 6.7 are design guidelines for limited movement accesses. The design of these islands must accommodate a WB-50 design vehicle.

Acceleration and deceleration lanes may be required to be incorporated into the design. Islands must be provided with vertical curbs. Additional right-of-way or easement may be required to accommodate these designs

6.4.3 DESIGN

Generally, all new private property access will be designed as driveway cuts.

The design of accesses must also take into consideration the needs of truck traffic and must be checked using the appropriate turning template. Drainage patterns must also be taken into consideration in the design of accesses.

6.4.4 DRIVEWAY SIGHT DISTANCE

Adequate sight distance must be provided for vehicles exiting and entering a driveway. Driveway locations should be evaluated to determine whether a sight obstruction exists, such as buildings, signs, vegetation, parked vehicles, horizontal or vertical highway alignments, etc. The sight distance requirements for passenger cars are based on a 3.5 foot height of eye and 3.5 foot height of object. The distances for trucks are based on a 7.6 foot height of eye and 3.5 foot height of object.

If the sight distance is not adequate, consideration should be given to the following options:

- Removing the sight obstruction
- Relocating the driveway to a more favorable location along the frontage
- Prohibiting critical movements at the driveway
- Relocating access to another street, a frontage road, or a joint access location

In all cases, stopping sight distance must be provided.

6.4.5 DRIVEWAY PROFILES

Adequate design of driveway grades should reflect consideration for basic functions of the adjacent street and the site that the access driveway serves. Generally, in order to enable safe ingress or egress maneuvers, driveway profiles should provide for sufficient clearance between the vehicle and the driveway surface.

6.4.6 DRIVEWAY ANGLES

Two-way driveway should be as close to 90° to the roadway as possible (no less than 75°).

One-way driveway may be as flat as 75°. However, a minimum of an 85° angle is recommended for driveways in areas of high pedestrian or bicycle activity.

6.5.3 LARGE DEVELOPMENTS

For large developments, the City Traffic Engineer or Project manager may require the developer to consolidate access to a single point which may be signalized. Driveway signals must be located to provide satisfactory signal progression for through traffic on the public road.

6.6 DRIVEWAY LOCATIONS

6.6.1 DRIVEWAY SPACING

Refer to the NMDOT State Access Management Manual for guidance.

6.6.2 JOINT ACCESS

Joint access will be required for two adjacent developments where a proposed new access will not meet the spacing requirements set forth in this section. Joint access must be approved by the City Engineer.

6.6.3 DRIVEWAY CORNER CLEARANCE

Corner clearance for driveways on collectors and arterials are governed by the NMDOT SAMM. For residential street driveways, corner clearance is governed by City Code 96.02.

6.6.4 Driveway Location Restrictions

Driveway location on collectors and arterials are governed by the NMDOT SAMM. For residential street driveways, locations is governed by City Code 96.02.

6.6.5 DRIVEWAY LOCATION COORDINATION

It is necessary to coordinate the location of access for properties on opposite sides of the street so that they do not interfere with each other.

- Driveways should be located directly opposite each other to ensure that they share a single access location.
- Where lots are not large enough to allow accesses on opposite sides of the street to be aligned, the center of driveways not in alignment will normally be offset a minimum of 150 feet on all collector roads, and 330 feet on all industrial, major collector, and arterial roads. Greater distances may be required due to left turn storage lane requirements.

6.6.6 VARIANCES

City of Rio Rancho Department of Public Works may grant variances from these driveway criteria.

6.7 DRIVEWAY STORAGE

The design of a driveway should take into consideration the space necessary to store vehicles using the driveway. This applies to both vehicles making a left turn from the roadway and to vehicles stopped on the driveway waiting to enter the roadway. Adequate storage area is necessary to provide safe and efficient movement of vehicles and pedestrians on the public right-of-way.

The recommended vehicle storage area needed for the entire site may be spread over several accesses if more than one access serves the site. The recommended distance may be further adjusted by the City for accesses with two approach lanes and will be subject to traffic volumes and site layout.

When a development is located adjacent to a public road, the parking facility must have full internal vehicular circulation and storage. Vehicular circulation must be located completely within the property and vehicles within one portion of the development must have access to all other portions without using the adjacent road system.

6.8 ACCELERATION AND DECELERATION LANES

Refer to NMDOT State Access Management Manual for guidance.

7. Bicycle Facilities Guidelines

7.1. BASIC CRITERIA

7.1.1 GENERAL

The City of Rio Rancho bicycle policy is follows the Guide for the Development of Bicycle Facilities, The American Association of State Highway and Transportation Officials, ("AASHTO").

The guidelines presented in this section primarily address the development of on-street bicycle facilities. All new roadways which are legal for bicycle use should be designed and constructed under the assumption that they will be used by bicyclists. Bicycle lanes will be included as part of the standard cross section on all arterial and collector streets when they are designed, constructed, reconstructed, or widened.

Regarding bikeway facilities, all new developments and new roadway construction must meet City standards.

7.1.2 DEVELOPMENT OF PLANS AND SPECIFICATIONS

Except where these standards provide otherwise, testing, report preparation, design, design details, workmanship, and materials shall be in accordance with the current editions of the following publications:

- (1) Guide for the Development of Bicycle Facilities, The American Association of State Highway and Transportation Officials, ("AASHTO").
- (2) Manual On Uniform Traffic Control Devices (MUTCD), U.S. Department of Transportation.
- (3) ADA Standards for Accessible Design Guidelines, U.S. Department of Justice

7.1.3 VARIANCES

Variations from these standards and procedures may be granted by the City Engineer upon evidence that such variations are in the public interest, that they are based upon sound engineering judgment, and that safety, function, appearance, and maintainability requirements are fully met. Variations must be requested and approved in writing.

7.2 DEFINITION OF TERMS

Definitions of bicycle facilities and general design guidelines are listed in the following sections. Refer to the AASHTO 1999 *Guide for the Development of Bicycle Facilities* for detailed design criteria.

- (1) SHARED USE PATH/TRAIL (BIKE TRAIL) – A shared use path is a bikeway physically separated from motorized vehicle traffic by an open space or barrier, and constructed within the street right-of-way or within an independent right-of-way including shared-use rights-of-way or utility or drainage easements.

Trails should be expected to accommodate other uses including walking, jogging, and rollerblading and should be designed to recommended standards for these uses. The recommended width for a trail is 10 feet, with 12 feet or more recommended in high use areas (See Figure 7.1). High use areas are those trails identified on the Long-Range Bikeway System.

Trail design considerations include: signing; striping; markings; horizontal, vertical and intersection sight distance; surfacing; and trailside clear zones.

Where trails intersect with the street network, safe connections to the on-street bikeway system should be designed. Raised or protected median refuge areas should be considered for bicyclists at mid-block crossings of arterial roadways.

Traffic signal warrant analyses, per the *Manual on Uniform Traffic Control Devices (MUTCD)*, and other studies may be conducted for bike trail crossings of major roadways which have been identified as high-priority bicycle and pedestrian crossings. See the references in Section N.5.a., b., and e. for evaluation considerations.

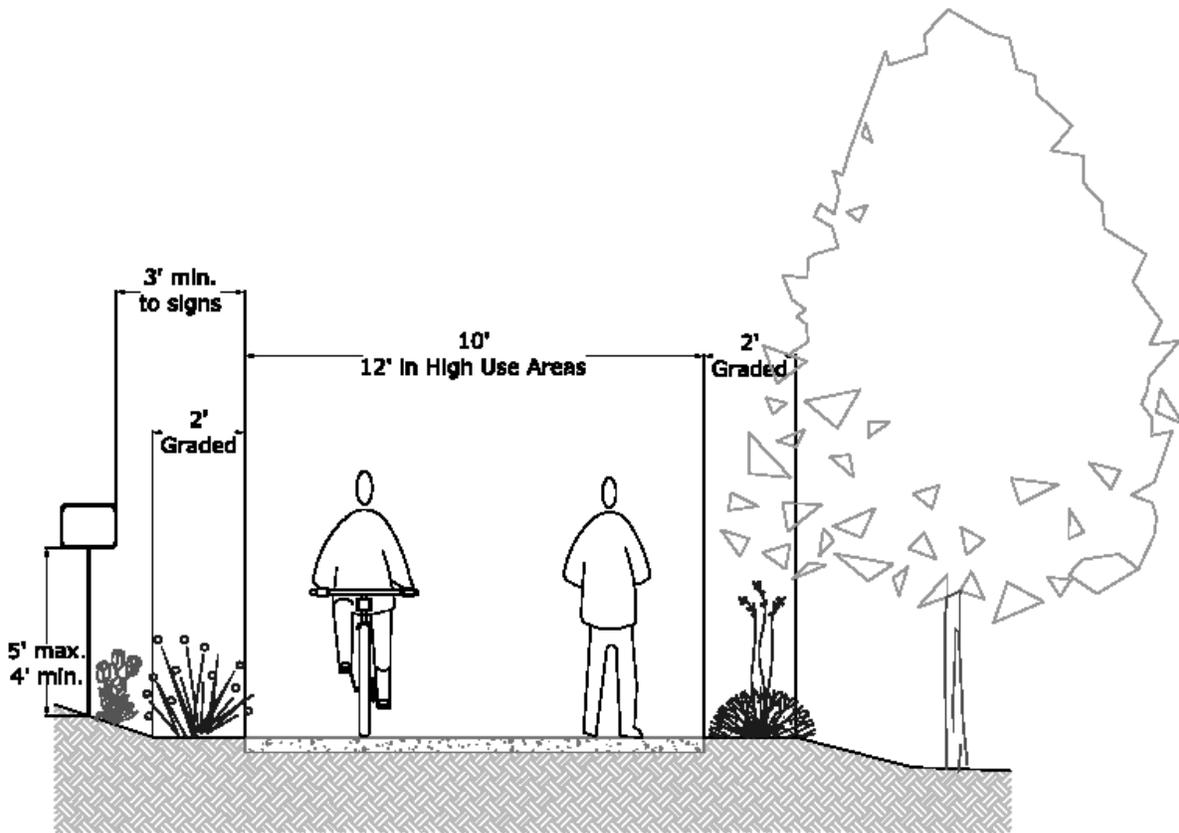


Figure 7.1
Multi-Use Trail Typical Cross Section

(2) BICYCLE LANE (BIKE LANE) - A bike lane is a lane on the roadway that has been designated by striping, signing, and pavement markings for preferential or exclusive use by bicyclists. Bike lanes or paved shoulders are part of the standard arterial and collector cross-section. These lanes provide access to destinations that include parks, schools, shopping and employment centers. Bike lanes at signalized intersections should have bicycle-sensitive actuation capability such as loop detectors, video detection, curbside push buttons, or other detection devices approved by the City Traffic Engineer. Adequate sight distance shall be maintained at all intersections and driveways along a bike lane.

(a) Development of Bike Lanes on New or Reconstructed Roadways

Bike lanes should be provided on all new or reconstructed arterial and collector roadways. Recommended minimum widths for bicycle lanes are as follows:

- 5 feet, measured from painted edgeline to edge of gutter, on roadways with posted speed limits of 40 mph or greater.
- 4 feet, measured from painted edgeline to edge of gutter, on roadways with posted speed limits of 35 mph or less.

Bike lanes shall be flush with roadside gutters and should be marked in accordance with the MUTCD and AASHTO guidelines and City of Rio Rancho Standards. (Divided roadway with bike lanes, Four-lane roadway with bike lanes, Two-lane collector street with bike lanes)

Future roadway improvements should retain existing bike lanes, including intersection approaches where additional turn-lanes may be constructed. Bike lane intersection design guidelines are provided in Sections N.4.a. of this chapter.

(b) Development of Bike Lanes on Existing Roadways

The addition of bike lanes as part of arterial and collector rehabilitation is recommended where feasible. Bike lanes may be implemented on existing roadways by reducing travel lane and median widths within acceptable City guidelines, as part of restriping, resurfacing, or rehabilitation projects. Narrower bike lanes may be considered where the inclusion of bike lanes is desirable, but standard widths are not feasible.

(c) Development of Bike Lanes with On-Street Parking

Bike lanes may be developed along arterial and collector roadways with or without on-street parking. Where on-street parking is present, bike lanes should always be located to the left of the parking lane and should have a minimum width of 5 feet. Bike lanes are travel lanes, therefore, automobile parking or motor vehicle use of a bike lane as a driving or passing lane should be prohibited. Parking demand should be evaluated to determine whether parking can be eliminated to reduce vehicle-bicycle conflicts or to convert the parking lane to a bike lane.

- (3) PAVED SHOULDER BIKEWAYS – Paved shoulder bikeways are located on uncurbed arterials and collectors and consist of a smooth paved surface that covers all or part of the roadway shoulder. Recommended widths for paved shoulder bikeways are as follows:
- 6 feet, measured from painted edgeline to edge of pavement, on roadways with posted speed limits of 40 mph or greater.
 - 5 feet, measured from painted edgeline to edge of pavement, on roadways with posted speed limits of 35 mph or below.

In addition, on low-speed, low-volume local streets, a 4-foot width may be considered where right-of-way constraints exist.

Paved shoulder bikeways may be implemented on existing roadways through use of measures similar to those described in Section N.1.a.(2.)(b). Intersection sight distance should be verified at all intersections and driveways along a paved shoulder bikeway.

- (4) BICYCLE ROUTE (BIKE ROUTE) - Bike routes are designated roadways with appropriate directional and informational signing, with or without a specific bicycle route number, in accordance with the MUTCD. Bicycle routes shall be primarily located on local streets and low-volume, low-speed collector streets.

Bicycle routes on local streets should have 28-foot wide pavement widths. A collector roadway should have a minimum curb lane width of 14 feet, exclusive of parking, and can be implemented with minor or no additional provisions.

- (5) WIDE CURB LANES - Wide curb lanes are located on shared roadways with outside lane widths of 14 to 16 feet. Lane widths greater than 16 feet may encourage operation of two motor vehicles in one lane, therefore, consideration should be given to striping a bicycle lane.

Wide curb lanes are recommended as part of rehabilitation and reconstruction projects on existing roadways where implementation of bicycle lanes or paved shoulder bikeways are infeasible. To implement wide curb lanes on existing roadways, travel lane widths and median widths may be reduced per City design guidelines and/or the curb and gutter may be reconstructed.

- (6) SHARED ROADWAY - A shared roadway is any roadway that may be legally used by both motor vehicles and bicycles and is not specifically designated as a bikeway.
- (7) BIKEWAY - A bikeway is any road, path, or way that is specifically designated for bicycle travel.
- (8) BICYCLE FACILITIES - Bicycle facilities are the infrastructure that accommodates or encourages bicycling including bikeways, shared roadways not specifically designated for bicycle use, bicycle parking and storage facilities, and bicycle signal actuation hardware.

7.3 THE BIKEWAY SYSTEM

The bikeway system is intended to safely connect residential areas, employment, retail services, businesses, education centers, and recreational facilities. The bikeway System is also intended to include recreational bikeways.

7.3.1. OTHER ELEMENTS

Other elements of the bikeway system include the following:

- (1) provide safe bicycle facilities;
- (2) provide a system of bikeways interconnecting the four quadrants of the City and surrounding communities;
- (3) establish primary bikeways along routes with substantial bicycle commute volume;
- (4) provide a variety of bikeways which meet or exceed AASHTO or other approved State/Local guidelines;
- (5) provide extensions and connections to the existing network;
- (6) include provisions for bicycle transportation, commuting, and recreational travel associated with future development of arroyos, irrigation ditches, and drains;
- (7) provide for bicycle access to the bikeway system as expansion or modification of the metropolitan street system occurs;
- (8) provide for the safe crossing of bicycling barriers such as freeways, railroads, arroyos, acequias and the Rio Grande;
- (9) preserve and enhance existing bikeways on streets that change their traffic carrying function or are reconstructed;
- (10) achieve approximately one-half mile intervals between bikeways; and,
- (11) encourage frequent bicycle access between new developments and adjacent bikeways and to identify that access on the sketch plat, preliminary plat and/or site development plan as appropriate.

7.3.2 OFF-STREET BICYCLE FACILITIES

- a. Generally, Bike Trails should be located to serve corridors not served by streets and highways or where wide rights-of-way exist, permitting such facilities to be constructed away from the influence of parallel streets.
- b. Bike Trails should provide either a recreational opportunity or serve as direct high-speed commute routes, if cross-flow by motor vehicles can be minimized.
- c. In locating a Bike Trail, consideration should be given to the provision of adequate access points.
- d. The scenic value is particularly important along a Bike Trail intended to serve a recreational purpose.
- e. Recommended rights-of-way are:
 - (1) the arroyo (drainage) system through the City;
 - (2) abandoned railroad rights-of-way;
 - (3) utility easements and rights-of-way; and
 - (4) paths through parklands.
 - (5) along roadways with sufficient R/W and appropriate design features.

7.3.3 ON-STREET BICYCLE FACILITIES

- a. Purpose
 - (1) On-street bikeways are designated as bike routes or bike lanes and are designed for transportation mobility.
 - (a) On-street bikeways emphasize functional service qualities such as the fastest, most direct, and unencumbered access to destinations.
- b. General Bikeway Location Criteria
 - (1) Major on-street bikeways are located primarily along roadways classified as arterial or collector to provide access to destinations.
 - (2) Minor on-street bikeways, such as bike routes, are located on local streets and low-volume collectors to provide access between residential areas and major bikeways.
 - (3) It is desirable for bikeways to be located on roadways where on-street parking is infrequent, prohibited, or can be prohibited.
 - (4) High-speed traffic (posted speed of 40 mph or greater) and the presence of large vehicles (truck, bus, or recreational vehicle) are significant factors affecting the acceptability of potential bikeway locations. In locations where these conditions exist, bike lane widths of 5-feet or greater are recommended.
 - (5) An on-street bikeway should be located only where the pavement will be smooth and properly maintained. Dense graded asphalt concrete surfaces are preferable to open graded or seal-coated surfaces.
 - (a) Manhole and utility covers should not be located in bikeways, and where relocation is impractical, these features should be adjusted to grade.
 - (b) Drop inlet or other drainage grates should be designed to prevent the snagging of bicycle wheels.
 - (c) Construction joints or large transverse pavement surface cracks (greater than 1 inch in width) in on-street bikeways should be repaired.
 - (d) Pavement edges, including where the asphalt concrete roadway meets the Portland cement concrete gutter, should be flush to enhance bikeway safety. Gutters may be reduced (e.g., 1-foot), where drainage conditions permit, on new or reconstructed roadways to provide greater curb lane width for bicycling.
 - (6) In new residential or commercial developments adjacent to bikeways, contiguous walls or fences should provide breaks for paved bicycle access which link the development to the bikeway system. Access(es) should be delineated on the sketch plat, preliminary plat, and/or site development plan as appropriate.
 - (7) Potential on-street bikeway locations should include no more than one stop sign or traffic signal per 1/4 mile. Local street stop control should be

reassigned to facilitate through bicycle traffic on designated bikeways. Stop control reassignment requires an engineering study to determine additional measures necessary to minimize neighborhood impacts. Concurrently, traffic calming strategies for through motorized traffic should be analyzed.

c. Location Considerations for Bike Lanes

- (1) Bike lanes should be located along arterial and collector roadways. Bike lane widths are a function of the posted speed limit and automobile volumes.
- (2) Where automobile parking lanes are included within the roadway, the parking lanes and bike lanes should be delineated separately to prevent use of bike lanes by motor vehicles. Parking demand should be evaluated to determine whether parking can be eliminated or the parking lane can be converted into a bike lane. Bike lanes are traffic lanes, therefore, automobile parking or motor vehicle use of a bike lane as a driving or passing lane shall be prohibited.

d. Location Considerations for Bike Routes

- (1) Bicycle routes are primarily on low-volume, low-speed collectors and local streets. If adequate space is provided for a vehicle to safely pass a bicyclist, a bike route may be signed on an arterial.
- (2) It may be necessary to sign a bike route for a short distance along an arterial with minimal 4-foot bicycle lanes, 5-foot paved shoulders, or a 10-foot multi-use sidewalk trail where local streets are not feasible to continue the bikeway. (See Section 4.c.(2) for additional information on design of sidewalks as multi-use trails.)

7.3.3.4 SPECIAL PROVISIONS FOR BIKEWAY FACILITIES

a. Proposed facilities require a safety assessment of potential motor vehicle-bicycle conflicts. These conflicts are considered in four categories.

- (1) Parallel Conflicts: Speed differential between automobiles and bicycles and the average daily volume of motor vehicle traffic reduce bikeway safety. Lower speed and lower volume roadways should produce fewer conflicts, resulting in safer bicycle travel.
- (2) Right Turn Conflicts:
 - (a) Dual Right-Turn Lanes

Dual right-turn lanes on bikeways present safety concerns for cyclists traveling straight through an intersection. Warrants for dual right-turn lanes should be used to ensure that they are provided only where warranted. Intersections with dual right-turn lanes should be constructed in accordance with guidelines that minimize bicycle-automobile conflicts. All designs must be

approved by the City Traffic Engineer.

(b) Free Right-Turn Lanes

Free right-turn lanes at intersections are not advised due to potential adverse impacts to bicyclist and pedestrian safety. Free right turns permit higher motor vehicle speeds approaching and through the right-turn movement. Where free right-turns are warranted, signing, marking, and geometric enhancements designed to warn motorists of pedestrian and bicycle traffic and to slow motor vehicles on approaches should be considered. These enhancements may include over-sized signing and marking, and reduced lane and turning radii widths for right-turning vehicles.

(c) Separate Right-Turn Lanes

Separate right-turn lanes should only be constructed where warranted by an engineering study. These lanes must be clearly signed and marked in accordance with the MUTCD. These lanes create bicycle-automobile conflicts because right-turning vehicles must cross the bikeway.

Where right-turn lanes are warranted, bicycle lanes and bicycle signal actuation systems should be provided at intersection approaches. Minimum curb return radii should be utilized to reduce motor vehicle speeds and reduce pedestrian crossing distances at intersections. (

(d) Access Controlled Facility Right-Turn Access

Oversized signing and marking is recommended for bike lanes and bike routes at access ramps to access controlled roadways.

(3) Left Turn Conflicts: Where left turn phases are warranted at signalized intersections along a designated bikeway, left turn bicycle actuation via bicycle detection or median push button should be provided.

(4) Crossing Conflicts: Signalized intersections are a positive means of crossing a roadway. MUTCD pedestrian signal warrant analyses should be performed for unsignalized arterial crossings which serve as barriers within the continuous bikeway system. Raised median refuge islands that allow bicycle passage should be considered to improve the safety of unsignalized arterial crossings.

b. Bikeway Grades

Guidance for grade acceptability is a function of the slope and length of roadway grade. Bikeways with grades equal to or exceeding 5.0 % for more than 500 feet

are less desirable because the ascents may be difficult for bicyclists and the descents may cause bicyclists to exceed a comfortable speed. Table 7.1, below, summarizes the acceptability and design concerns for the bikeway types.

<i>Bikeway Type</i>	Distance (Ft.)	Distance (Ft.)	Design Concerns
Bike Trail	< 500	Good	30 mph design speed/12 foot width
Bike Trail	> 500	Poor	30 mph design speed/12 foot width
Bike Lane	< 500	Good	4 to 5 foot width (stripe to edge of gutter)
Bike Lane	> 500	Good	5 to 6 foot width (stripe to edge of gutter)
Bike Route	< 500	Good	Good sight distance, advance warning of traffic control
Bike Route	> 500	Poor	Consider alternate location or provide good sight distance, advance warning of traffic control

**Table 7.1
Bikeway Grades Greater than 5.0%**

c. The crossing of physical barriers is an important factor in providing bikeway continuity and increasing bike usage. Two primary barriers are the Rio Grande and access controlled highways. Railroad tracks, arterial crossings, and large tracts of land not allowing through access are also barriers. Three solutions to provide safe crossing of major transportation barriers include the following:

- (1) A bike lane may be created on an existing arterial through restriping, reducing vehicle travel lane or median widths.
- (2) The sidewalk may be designated as a legal trail for short distances of up to one-quarter mile to serve as a linkage within the bikeway network. Two-way bicycle traffic as well as pedestrian traffic should be expected on sidewalks under these conditions. Sidewalk trails should be designed per Section N.1.a.(1) and this section to safely accommodate both pedestrian and bicycle traffic.

Driveways and cross-streets should be limited to 4 or less per quarter-mile before sidewalk trails are implemented. If the distance between the sidewalk trail and roadway is less than 5 feet, a physical divider should be considered.

Sidewalk bikeways or trails immediately adjacent to the roadway are not recommended. This is due to several factors including wrong-way travel by bicyclists, conflicts at intersections and driveways, insufficient sight distance due to walls and other obstructions, and conflicts within the right-of-way such as utility poles.

- (3) All new or reconstructed roadway over-passes should include wide curb lanes, multi-use emergency breakdown lanes, or bike lanes to improve bicyclist and motorist safety. Cantilevered structures attached to existing bridges should be considered where widening is not cost effective.

d. Construction within Right-of-Way

If construction or utility work is necessary within a bike lane, the full width of the bike lane should be repaved to grade after work is complete. Safe detour provisions for bicyclists should be made when bike lanes are temporarily closed for utility work.

7.3.3.5 BICYCLE PLANNING AND DESIGN GUIDELINE REFERENCES

Guide for the Development of Bicycle Facilities. American Association of State Highway and Transportation Officials, 1999.

Manual on Uniform Traffic Control Devices. Federal Highway Administration, 1988 (including current adopted amendments).

Selecting Roadway Design Treatments to Accommodate Bicycles. Federal Highway Administration, 1994.

New Mexico Bicycle-Pedestrian-Equestrian Transportation Plan. Bicycle/Pedestrian/Equestrian Advisory Committee, New Mexico State Highway and Transportation Department, 1996.

Trails and Bikeways Facility Plan. City of Rio Rancho, 1996 (Revised).

Pedestrian and Bicyclist Safety and Accommodation. National Highway Institute, Federal Highway Administration, 1996.

Oregon Bicycle and Pedestrian Plan. Oregon Department of Transportation, 1995.

7.3.3.6 Addendum: Advantages of Bicycle Lanes/Paved Shoulders

1. Improved space is provided for bicycle use and in limited cases for pedestrian use; safety is improved for motorists who will not have to travel out of the lane in order to pass bicyclists.
2. Improved space is provided for motor vehicles to stop out of the travel lane because of mechanical difficulty, a flat tire, or other emergency.
3. Improved space is provided to escape potential accidents or reduce their severity.
4. Improved space is provided for emergency vehicle access through congested areas as

- motorists pull to the curb to allow emergency vehicles to pass.
5. The sense of openness created by bike lanes/paved shoulders improves the safety and drivability of the roadway.
 6. Sight distance is improved both for users traveling along the roadway with bike lanes/paved shoulders as well as for users entering the roadway from a side street or driveway.
 7. Highway capacity is improved; uniform speed is encouraged.
 8. Improved space is provided for maintenance work such as snow removal and maintenance of utilities.
 9. Improved space is provided for motorists who have accidentally left the travel lane to recover and return to the lane.
 10. Improved space is provided to discharge storm water from the travel lanes, increasing safety for users and capacity of the roadway.
 11. Pavement life is increased because structural support is given to the pavement, reducing the raveling effect caused by motor vehicles traveling on the edge of pavement or traveling immediately adjacent to the gutter pan.
 12. Improved space is provided for bus stops.
 13. Increased safety is provided for right-turning vehicles due to increased turning radii at intersections and driveways; rear-end accident potential is reduced.
 14. Increased safety is provided for motorists to avoid fixed objects such as telephone and signal poles due to provision of additional clear zone area.
 15. Improved space is provided by paved shoulders for motorists to pass on the right of left-turning vehicles, where allowed by law.
 16. Air quality benefits are provided due to provision of space for alternative modes of travel and to reduced particulate matter caused by vehicles traveling on unpaved shoulders.

a. Classes of bikeways may be defined as follows:

- (1) Class I Bikeway: A Bike Trail located in a completely separated right-of-way designated by signs and pavement markings for the exclusive use of bicycles with cross flows by the motor vehicles minimized. The right-of-way for these bikeways could accommodate other uses such as hiking and jogging if properly designed.
- (2) Class II Bikeway: A Bike Lane that is located in a portion of the roadway designated by signs and pavement markings for the exclusive or semi-exclusive use of bicycles with through travel by motor vehicles or pedestrians prohibited, but with vehicle parking and cross flows by pedestrians and motorists permitted.
- (3) Class III Bikeway: A Bike Route located in a roadway and designated by signs and shared with pedestrians or motorists. The bike route provides continuity to other bicycle facilities.

b. The Bikeway Network is intended to safely connect residential areas, employment, retail services, businesses education centers and recreational facilities. It is also intended to include recreational bikeways. Other elements of the Bikeway Network concept include the following:

- (1) safety;
 - (2) provide a system of bikeways interconnecting the four quadrants of the City and surrounding areas;
 - (3) establish primary bikeways along patterns of heavy bicycle commuting;
 - (4) provide a variety of bikeways for study and experimentation;
 - (5) provide extensions and connections to the existing network;
 - (6) include provisions for bicycle transportation and recreation associated with further development of arroyos, irrigation ditches, and drains;
 - (7) provide for bicycle access to the Bikeway Network along with further expansion or modification of the metropolitan street system;
 - (8) provide for the safe crossing of bicycling barriers, such as freeways, railroads and the river;
 - (9) provide for relocation of Bikeways if necessary where any street changes significantly in its traffic carrying function; and
 - (10) achieve approximately one-mile intervals between bike facilities.
- c. The Bikeways Master Plan is a graphic representation of an updated version of the Bicycle Network established in 2001. The Master Plan identifies the locations, alignments, connections and type of bicycle facilities for the Rio Rancho Urban Area. The status of program priorities for bicycle facility development is identified in the following categories:
- (1) Existing bicycle facilities that are currently in operation.
 - (2) Planned bicycle facilities that either are included in the Transportation Improvement Program for the Rio Rancho Urban Area or are expected to be developed along with associate roadways, drainageways or as funds become available.
 - (3) Study corridors where bicycle facility type and alignment have not been established but are under consideration.
 - (4) Existing or planned major grade separated overcrossings.

2. *Off-Street Bicycle Facilities*

- a. Generally, Bike Trails should be located to serve corridors not served by streets and highways or where wide rights-of-way exist, permitting such facilities to be constructed away from the influence of parallel streets.
- b. Bike Trails should provide either a recreational opportunity or serve as direct high-speed commute routes, if cross-flow by motor vehicles can be minimized.
- c. In locating a Bike Trail, consideration should be given to the provision of adequate access points.
- d. The scenic value is particularly important along a Bike Trail intended to serve a recreational purpose.
- e. Recommended rights-of-way are:
 - (1) the arroyo (drainage) system in the City;
 - (2) abandoned railroad rights-of-way;
 - (3) utility easements and rights-of-way; and
 - (4) paths through parklands.

- (5) along roadways with sufficient R/W and appropriate design features.

3. *On-Street Bicycle Facilities*

a. General Locational Criteria are as follows:

- (1) The on-street bikeways are designated as Bike Routes or Bike Lanes and are primarily designed for transportation purposes.
- (2) These types of bicycle facilities generally emphasize functional service qualities such as the quickest, most direct, and unencumbered access to most destinations.
- (3) It is desirable to select a location where on-street parking is light or where it can be prohibited.
- (4) High-speed traffic and/or truck, bus, and recreational vehicle traffic are significant factors affecting the acceptability of potential bikeway locations. In locations where these vehicles and bicycles must share a right-of-way, extra separation must be available between cyclists and vehicles.
- (5) An on-street bikeway should be located only where pavement can be maintained at a reasonable standard. Dense graded asphalt concrete surfaces are preferable to open graded or seal-coated surfaces. All manhole covers, utility covers, drop inlet grates, and construction joints or cracks in the surface should be at grade or brought to grade and safety standards before establishing a bikeway.
- (6) For an on-street bikeway, the speed and volume of auto traffic is a factor, along with the available width, in determining the best location. Areas where mixed flows may be acceptable are:
 - (a) In urban centers where traffic conditions constrain motor vehicle speeds to be less than 40 mph resulting in considerable overlap of bicyclist and motor vehicle speed distributions;
 - (b) Within the approaches to intersections where motor vehicle speed is depressed preparatory to stops, turning movements and intersection related decisions;
 - (c) On streets with less than 14,000 average daily traffic volumes.
- (7) Potential on-street bikeway locations should include no more than one stop sign or traffic signal per 1/4 to 1/2 mile intervals. Stop signs should be rearranged to the extent possible to permit through bicycle traffic. At the same time, deterrents to motorized through-traffic should be implemented.

b. Locational considerations for Bike Lanes include the following:

- (1) Adequate pavement width must be available for both bicycles and motor vehicles.
- (2) A location should be able to provide a minimum of four feet of operating width for one-way bicycle travel, exclusive of the gutter width.
- (3) Bike Lanes should be placed on all collector and arterial streets.
- (4) At locations where on-street parking is allowed to remain, the adjacent Bike Lane should be wide enough to permit a bicyclist to pass a parked car.
- (5) Bike Lanes, if necessary, may be placed on arterials where the center divider can be reconstructed and the traffic lanes moved in toward the center.
- (6) Bike lanes may be placed on Principal Arterials on shoulder areas when

appropriately designed.

- c. Locational considerations for Bike Routes include the following:
 - (1) Local streets in the Bikeway Network should be designated as Bike Routes.
 - (2) Bike Routes may be placed where bicycle traffic is already heavy and where other bicycle facilities are not feasible.
 - (3) Arterials should be avoided if at all possible; however, it may be necessary to use arterials when other bicycle facilities are not feasible.

- 4. *Special Provisions for Bikeways*
 - a. Each proposed and existing facility should be evaluated on a safety basis of potential motor vehicle-bicycle conflicts, as categorized into four categories:
 - (1) Parallel Conflicts: Close proximity of auto and bike travel, speed differential between the two, and the average daily volume of motor vehicle traffic.
 - (2) Right Turn Conflicts: An unchannelized intersection presents relatively minor problems for cyclists; a double right-turn lane presents unacceptable hazards.
 - (3) Left Turn Conflicts: Intersections with left-turn phase signalization present no hazards and should be highly rated. Signalized intersections, without separate phasing should be on the basis of turning volume and opposing traffic, as should major unsignalized intersections and driveways on major streets.
 - (4) Crossing Conflicts: Signalized intersections are the most positive means of dealing with crossing traffic and should therefore be highly rated for safety. Any location which controls cross traffic by STOP or YIELD signs is also relatively safe.

 - b. Grade acceptability is judged in terms of the slope and length of the grade. A general standard to apply is that a grade of 10 percent would be tolerable for a distance of 50 feet or less. Also, grades of five percent, for a length of 150 feet and longer, should be avoided.

 - c. The breaching of barriers may be one of the most important factors in providing continuity and increasing bike usage. The two most obvious physical barriers locally are the Rio Grande and the principal arterials. Three possibilities for safe bicycling crossings are recommended:
 - (1) A Bike Lane may be marked on the roadway. This criterion would not apply in those instances where insufficient roadway would result in decreasing the number of required motorized vehicle lanes.
 - (2) Even in its safest form, a Bike Lane on a highway bridge forces the cyclist onto a busy street. A far better solution is to have a completely separate bridge for non-motorized traffic.

8. Landscaping

8.1. LANDSCAPE DESIGN STANDARDS

8.1.1 PURPOSE

These Landscape Design Standards have been written to serve as a guide to landscape architects and engineers for purpose of designing and reviewing roadway landscape plans.

8.1.2 DESIGN CRITERIA

The surroundings in which the roadway is being designed will have a strong influence on the landscape design. The design shall be respectful of existing natural features such as landforms and vegetation. When the roadway traverses urban developed areas, the landscape design shall reinforce the adjacent landscape theme or character. The principles of low maintenance and low water use shall be incorporated into all landscape designs.

Under any circumstances the design shall not compromise on safety of all roadway users, including motorists, pedestrians, bicyclists, and construction and maintenance workers.

8.1.3 PROCESS

Many elements need to be considered during development of the landscape design. The landscape design process shall begin with a thorough inventory and analysis of existing conditions, including: the natural landscape elements, topographic and physical characteristics, ecological factors, recreational potentials, residential qualities, historical features and visual values. The results of the inventory/analysis shall be incorporated into a schematic or concept design submittal (typically included in the 30% submittal).

Subsequent steps in the design process will be determined by the size and complexity of the project. Relatively simple projects may require only schematic levels of design prior to preparation of construction documents. Typically, an intermediate design development stage - the preliminary design - is required between the conceptual design development and construction document preparation. On larger projects, additional design and/or planning activities (i.e., visual studies, native plant surveys, land use evaluations, etc.) may be necessary.

Early in the project development stage, the landscape architect shall consult with the City of Rio Rancho Design Guidelines when published for guidance on the landscape design submittal requirements, including sheet size, order of drawings, standard notes and details, special provisions, etc.

8.2 DESIGN CONSIDERATIONS

8.2.1 ALIGNMENT AND PROFILE–SIGHT DISTANCES AND SIGHT LINES/TRIANGLES

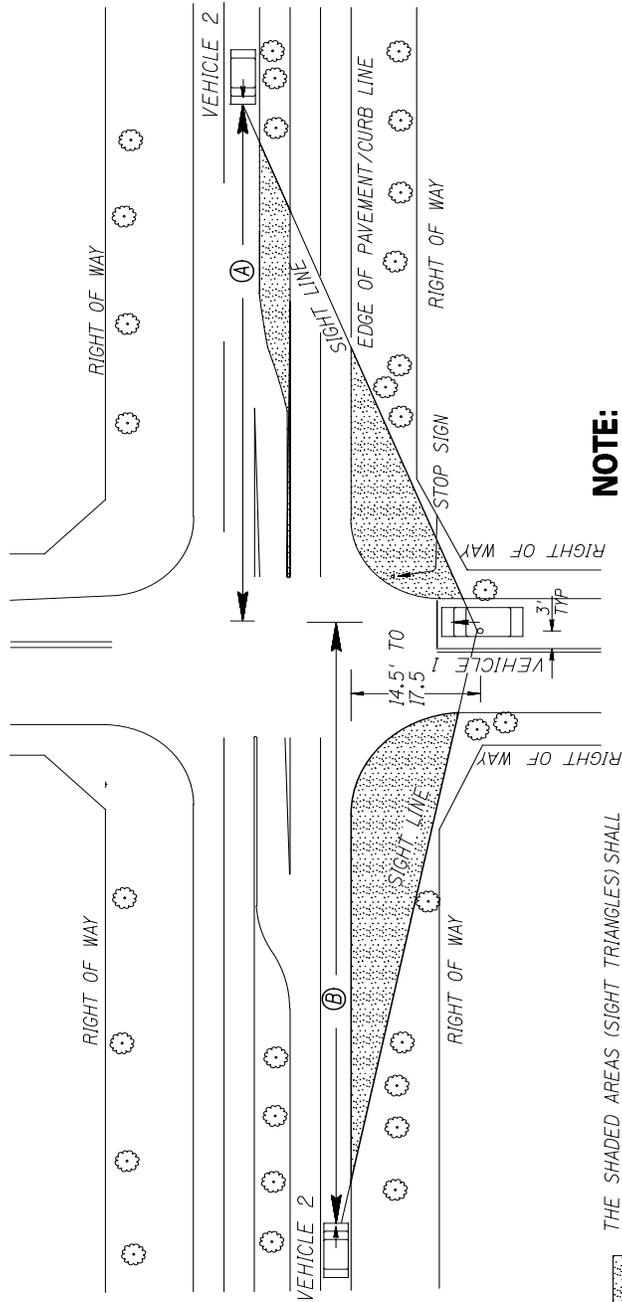
8.2.1.1 Sight Triangles

When designing landscaping around intersections, driveways, or other approaches onto a street, plant material placement and height restrictions must be observed. The purpose of these restrictions is to maintain visibility for the driver to turn safely at intersections. Major intersections are considered primary; un-signalized intersections are secondary, and side streets and driveways are tertiary.

Sightline shall be maintained for all intersections. The roadway classification for the road being designed will be designated by the City Traffic Manager. General standards regarding the design speed for various classifications of roads are presented in Tables 4.2 and 4.3. Sight distance is a function of design speed. Once the design speed is established, refer to the equation and/or figures discussed in the intersection sight distance section of **SECTION 5** to determine the required sight distances. The required sight distances are then applied in Figure 8.1. The sight distance lines shall be shown, dimensioned and labeled on the landscape plans.

An open view must be maintained between 2-feet to 7-feet above grade for proper visibility within the sightline triangle (refer to Figure 8.1). Plants cannot be planted within the sight triangle if they have a potential to reach a mature height greater than 2-feet above the roadway pavement. Trees must have a canopy that can be maintained 7-feet above the roadway pavement without extensive pruning. See: “Height Restrictions and Pruning Requirements Within The Sightline Triangle,” Figure 8.2. The designer shall evaluate the plant choice for compliance with the sight line criteria. Plants may be considered by the City for use on a project-by-project basis.

Vegetation shall not block sight lines to signs.



THE SHADED AREAS (SIGHT TRIANGLES) SHALL BE KEPT CLEAR OF VEGETATION, HAVING HEIGHT BETWEEN 2' AND 7' MEASURED FROM PAVEMENT SURFACE.

NOTE:

- 1 TO ESTABLISH THE "LINE OF SIGHT", VEHICLE 1 SHOULD BE POSITIONED SO THAT THE DRIVERS EYE IS 14.5 TO 17.5 FEET BACK FROM THE EDGE OF PAVEMENT/FACE OF CURB, AND 3'6" ABOVE THE PAVEMENT. DRIVER IS ASSUMED TO BE 3' RIGHT OF CENTER LINE IN LANE.
- 2 APPROACH VEHICLE (VEHICLE 2) IS POSITIONED IN THE CENTER OF ITS LANE, AND ASSUMED TO BE 4'4" ABOVE THE PAVEMENT.
- 3 DRAWING DEPICTS TYPICAL PASSENGER CAR SITUATION WITHOUT GRADES, FOR OTHER DESIGN CRITERIA SEE CHAPTER 6 SECTION 6.1, INTERSECTION SIGHT DISTANCE.

- Ⓐ SIGHT DISTANCE TO RIGHT FOR VEHICLE 1
- Ⓑ SIGHT DISTANCE TO LEFT FOR VEHICLE 1

NOT TO SCALE

DESIGN/85th PERCENTILE SPEED	SIGHT DISTANCE FOR PASSENGER VEHICLE TO TURN LEFT OR RIGHT				
	Ⓐ				
CROSSING DISTANCE	1-LANE	2-LANE	3-LANE/2-LANE & MEDIUM	3-LANE & MEDIUM	1-LANE
25 MPH	280'	295'	315'	335'	Ⓑ 240'
30 MPH	335'	355'	375'	400'	290'
35 MPH	390'	415'	440'	465'	335'
40 MPH	445'	475'	500'	530'	385'
45 MPH	500'	530'	565'	600'	430'
50 MPH	555'	590'	625'	665'	480'
55 MPH	610'	650'	690'	730'	530'
60 MPH	665'	710'	750'	795'	575'
65 MPH	720'	765'	815'	860'	625'

Figure 8.1
Intersection Sight Distance

8.2.2 ROADSIDE DEVELOPMENT

8.2.2.1 Offset Distances For Trees

Trees, large shrubs and cacti whose trunk diameter at maturity will exceed 4 inches shall not be planted within the clear zone. The diameter measurement shall be taken at 12 inches above grade. Refer to **SECTION 4.0, SUBSECTION 9.0 CLEAR ZONES** for information on clear zone width. The clear zone width is not to be considered a fixed single control dimension. Variations in cross section design and traffic speed may increase or decrease this distance. Shrubs and ground covers may be planted or retained within the clear zone for safety and aesthetic purposes as approved by the City of Rio Rancho. Existing trees may be retained under the following circumstances:

- If they are on the high or cut side of the roadway beyond the clear zone distance or,
- If they are on the low or fill side, if protected by a guardrail or beyond the clear zone distance.

For 50 MPH or greater design speed, minimum clearances for newly planted trees, shrubs and cacti with an ultimate trunk diameter of more than 4 inches shall be 30 feet unless one of the following reasons will allow for a lesser distance:

- Where cut slopes are 3:1 or steeper; 10 feet behind the point of vertical intersection (PVI) at the toe of the slope.
- Where concrete barriers, walls, abutments, or other rigid obstructions are used, 4 feet behind the obstruction.
- Where a flexible guardrail is used (w-beam), 4 feet behind the rail.
- Where there are barrier curbs near a traveled lane, 10 feet behind the face of the curb. (Except Medians).
- Where limited right-of-way or the necessity for planting would result in less clearance; all factors in the particular problem area shall be weighed to decide if a special exception is warranted.
- The offset where there is bicycle traffic shall be a minimum of 7 feet from the edge of the bicycle facility, and have a minimum 10 feet of clearance to the canopy.

For design speed less than 50 MPH, minimum clearances for newly planted trees, shrubs and cacti with an ultimate trunk diameter of more than 4 inches shall meet the clear zone requirements of Figure 4.10 unless one of the reasons listed above will allow for a lesser distance.

On curves, adequate sight distance for the design speed of the roadway must be maintained.

Modification of the minimum clearance may be required by special considerations. For example, occasionally, special conditions may warrant planting closer to the pavement in order to fulfill a specified function or requirement. Plantings in the reduced clear zone shall consist of low-growing shrubs and groundcovers under 2 feet in height. Also, the characteristics of the plant material proposed for use will affect the amount of offset required.

8.2.3 UTILITIES AND EQUIPMENT

No landscaping shall be installed within 10 feet of fire department equipment (i.e. fire hydrants, Fire Department Connections (FDC), and gate valves (PIV).

No landscaping shall be planted within 10 feet of water and sewer main lines.

8.2.4 LANDSCAPE MEDIANS

Apart from improving roadway aesthetic median landscaping also provides means to mitigate headlight glare, and reduces potential for driver monotony. A landscaped median can also serve to reduce the perceived scale of the roadway.

The minimum clearance for trees in the median is six feet behind the face of a curb, provided that the location meets the sight line criteria. Trees, shrubs or cacti that will exceed 4 inches in diameter at maturity shall not be planted in median without curb.

Mature tree growth shall be maintained 2-feet behind the face of the curb line. See Figure 8.2.

8.2.5 GRADING, DRAINAGE, AND IRRIGATION

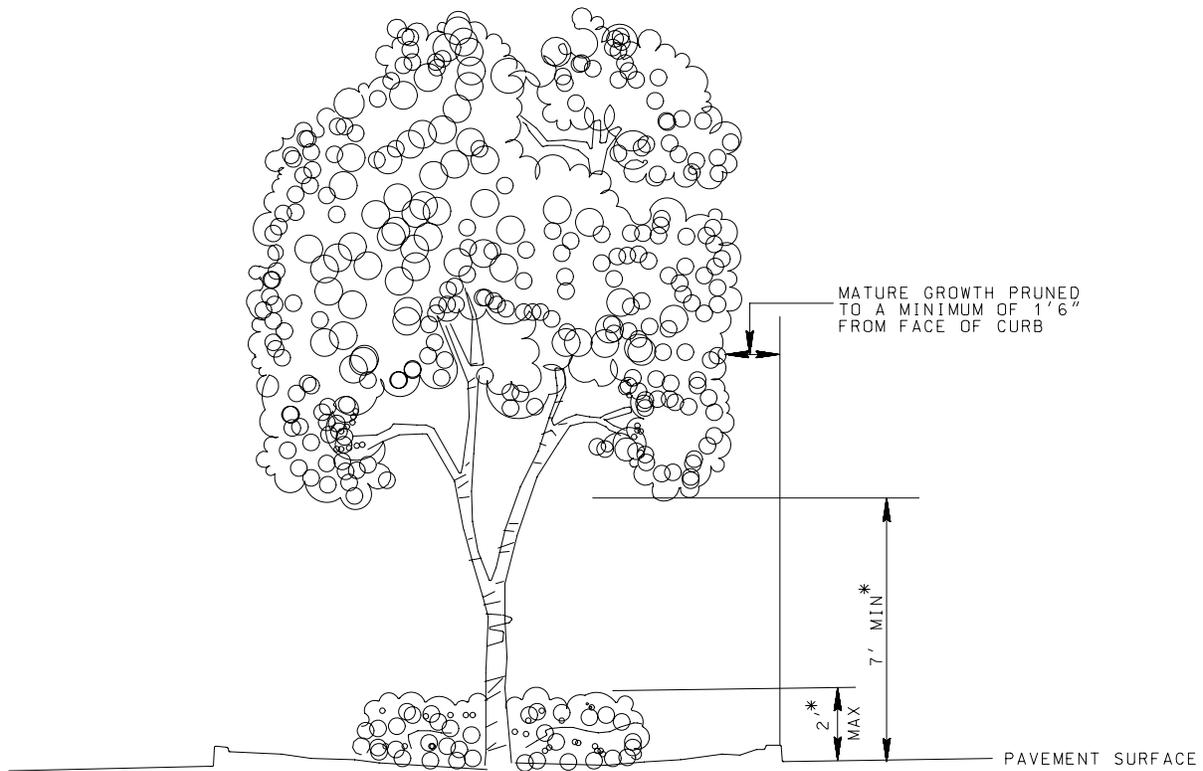
8.2.5.1 Grading

The proper shaping of slopes can benefit drainage, erosion control, aesthetic, and future maintenance. Grading plans shall be used wherever feasible. The grading shall always be smooth enough to meet safety requirements, permit easy maintenance, and adequately serve the needs of surface drainage. Grading shall integrate the hydrology, aesthetic and earthwork needs for the site and maximize use of storm water runoff to support the landscape development.

8.2.5.2 Erosion Control

In planting design, the following parameters shall be considered to control erosion:

- Slopes with ratios of 3(h):1(v) and flatter favor the establishment of natural vegetation as protection against erosion. Slopes with ratios of 4(h):1(v) and flatter add to vehicular safety.
- Plant along the contour of the slope. Avoid planting arrangements that would encourage erosion.
- Stabilize soils at dip sections in both the right-of-way and the median where applicable. The use of decomposed granite in dip sections is prohibited.



HEIGHT RESTRICTIONS AND PRUNING REQUIREMENTS WITHIN THE SIGHT TRIANGLE

* Height Of Restrictions May Need To Be Adjusted When Vertical Curves Impact Sight Lines

Figure 8.2

Height Restrictions and Pruning Requirements Within The Sightline Triangle

8.2.5.3 Underground Irrigation

Irrigation systems are designed to promote water conservation, including prevention of water run-off and overspray. The City promotes the use of efficient irrigation methods and practices to reduce the demand on the City of Rio Rancho potable water system. The use of plants which, once established, can survive on minimal supplemental watering or natural rainfall is recommended for areas to be maintained by the City.

In areas where underground irrigation will be used to establish and maintain new plantings, the underground systems will improve the health of the plants and improve the overall appearance of the roadway. All required vegetated areas shall be irrigated by an automatic underground irrigation system, or drip irrigation.

It is important that the area to be landscaped is large enough to accommodate the plants and any associated irrigation components, if an irrigation system is planned for the area. Irrigation components such as valves and controllers shall be placed as close to the right-of-way limits as possible, and within a vault when possible. All underground landscape equipment within 5 feet

of back of curb, or back of sidewalk, or within 15 feet of edge of pavement must have 36 inch minimum depth of cover.

8.2.6 WATER HARVESTING

The City is interested in incorporating Passive and Active Water Harvesting Techniques when establishing underground irrigation systems.

Passive water harvesting techniques include:

Surface collection such as swales, parking lot islands, bar ditches, detention ponds and constructed wetlands. These techniques shall be used for slopes.

In ground storage: soil amendments, constructed rain gardens, French drains, permeable paving and collection structures with infiltration fields or galleries.

Active water harvesting techniques include:

Storage and distribution systems including ground rain barrels, storage tanks and below grade cisterns that use gravity or pumps to distribute water to an irrigation system.

Gray water irrigation can be appropriate for some landscape installations. Gray water is regulated by the New Mexico Environment Department (NMED) and may require a permit. Use of reclaimed water (treated sewage) may be used if approved by the City of Rio Rancho and signed to indicate non-potable water.

8.2.7 XERISCAPING

Xeriscape landscaping is a transitional planting zone concept which may include several zones going from lush (or oasis) areas to drought tolerant planting areas. Oasis areas are not encouraged due to high-water requirements within the City's right-of-way and as a result Xeriscaping is not recommended for landscaping in conjunction with roadway improvements.

8.2.8 IRRIGATION PIPE LINES

If provisions are being made for future irrigation, install sleeves under streets, drives and impervious surfaces with 6" schedule 40 PVC. The sleeves shall extend beyond the impervious surface to a length equal to the depth at which the sleeves are placed.

Pipe lines carrying water under constant pressure will be buried to a minimum depth of twenty-four (24) inches. Those that are under intermittent pressure will be buried to a minimum depth of eighteen (18) inches. Polyethylene lines will be buried to a minimum depth of eight (8) inches. PVC lines will be buried to a minimum depth of twelve (12) inches.

Shrub and bubbler heads located within twenty-four (24) inches of any paved surface will be installed with a system that allows the riser assembly to absorb impacts and return to normal position.

Temporary spray irrigation systems may be used to establish seeded areas for native grass and groundcover (see standard drawing BF-01).

Trees and shrubs will be irrigated with low-flow bubblers or emitters.

The irrigation system will be controlled by a digital controller and the appropriate backflow prevention assembly will be correctly installed per CORR standards.

8.3 USE OF PLANT MATERIALS

8.3.1 PRESERVATION OF EXISTING VEGETATION

In some cases, it may be necessary to maintain existing right-of-way plants in their present location and incorporate them into the final design. The plants to be protected in place will be determined by the City after the inventory and analysis has been completed. Plants to remain shall meet the clear zone requirements of this Section.

8.3.2 PLANT SALVAGE

On occasion, selected materials (including State-protected plants) will be analyzed for potential salvage and reuse on the project. The analysis will be accomplished using the results of a Plant Inventory as directed by the City during the course of the project. The species to be considered will depend on the project setting. For example, within urban areas, existing street trees important to the adjacent neighborhood could be candidates for salvage and reuse.

Several factors must be evaluated when plant salvaging is considered. First, the existing plants must be evaluated for age, health, overall condition and their capability to survive the transplanting operation. Second, the cost of transplanting shall be assessed against the replacement with nursery grown plants of a comparable size; this shall be reviewed in terms of the project budget. Third, other factors such as schedule impacts from salvaging activities, the availability or lack of on-site temporary storage locations, temporary irrigation needs and the importance of the resource to affected local interests shall be evaluated. Based on the above factors, the decision for salvaging will be made by the City of Rio Rancho.

The bid documents shall state that prior to destroying State-protected plants, the contractor shall file a formal Notice of Intent to Clear Land with the New Mexico Department of Agriculture, if this Notice has not been completed during the design phase. The contractor shall obtain State permits prior to moving protected plants.

8.3.3 PLANTING RECOMMENDATIONS AND CONSIDERATIONS

Water use must be minimized by using water conserving plant materials. Native desert and xeriscape trees and shrubs must be used wherever possible.

Existing plant materials in the project area must be taken into consideration to provide design continuity. Impact on adjacent development must be mitigated. The existing landscape character must be evaluated, and landscape expectations obtained from citizens groups and the community. Community identities also shall be enhanced and regional character reinforced through the landscape design. Plant material must be appropriately selected and spaced to maximize visual

continuity. The use of distinctive plant materials shall help clue drivers of upcoming intersections and decision points.

Some conditions may be unfavorable to plant growth in an urban area. Drainage conditions may be inadequate; there may be excess drainage or not enough. Air pollution is often a concern. Many plants cannot survive the polluted and dust-laden atmosphere of severe urban conditions. Reflected heat from pavements and adjacent buildings further limits the use of many desirable plants. Only those plants that have proven themselves adaptable to the difficult growing conditions found in some urban situations shall be used in such locations.

Plants shall be used to buffer pedestrians from traffic. The climate for pedestrian comfort can be moderated with shade trees. Trees and shrubs shall be used predominantly, because of their longer life span as compared to groundcovers and herbaceous perennials.

There are specific plant types in and adjacent to the public right-of-way that are not allowed or whose use is not recommended. Trees and shrubs with thorns are to be carefully placed to avoid injury to pedestrians and others using the public right-of-way. Thorny plants must maintain a minimum setback of 2 feet from roadways, sidewalks, and the edge of a bicycle facility. Such plants will be allowed in a median island with vertical curb, provided a minimum of 2 feet is maintained from back of curb as a clear zone (measured from nearest part of plant). Whenever possible, thornless varieties shall be used. Refer to the Vision 20/20 Plan for an approved list of approved plants that can be planted within the right of way.

Plantings shall be kept a minimum of 6 feet back from the edge of roadway when no vertical curb is present. Plantings shall be kept away from walls and fences to allow for maintenance of those structures.

Trees and shrubs shall be planted so that at maturity they do not interfere with service lines and the property rights of adjacent property owners. The designer shall contact the appropriate utility company to obtain a list of trees acceptable for use over or under their utility lines.

Due to the risks of their falling over and dropping large limbs, trees having shallow root systems or a weak branch structure shall not be used within 20 feet of the right-of-way limit or traveled way.

The use of plants producing large volumes of wind-blown pollen shall be kept to a minimum.

8.3.4 PLANTING TO SCREEN

8.3.4.1 Headlight Glare

The value of screening for glare depends on road alignment, ground forms, existing vegetation, and the width of the median. Where needed, plantings shall be at least 4 feet high and form a continuous screen, to avoid intermittent glare.

8.3.4.2 Undesirable Views and Objects

An effective method of obscuring undesirable views from and toward the highway is the use of fencing or other structural materials, or by planting. In some cases, effective screening with

plants will take a period of years to achieve, but this shall not prevent the use of plants to achieve this objective. The sight lines from and toward the object to be screened shall be studied early in the design process to provide an appropriate solution and to preserve any existing plant material or structure that will contribute to the screening. Deciduous plant material shall be avoided if a year-round screening effect is desirable.

Vegetation shall not completely encircle lights, signs or other roadside structures; access must be provided for maintenance purposes.

8.3.4.3 Wind Control

In some instances where high winds are characteristic of a particular site, deep-rooting trees with a dense growth habit are beneficial in reducing wind velocity as well as in catching blowing dust and debris. Trees that are weak wooded shall be avoided in these areas.

8.3.4.4 Shade

Shade effectiveness shall be carefully analyzed. The following criteria should be followed to create the desired effect.

Local streets: 1 canopy tree and 3 shrubs and groundcover, every 33 ft. located within 10 ft. behind the sidewalk.

Collector streets: 1 canopy tree every 33 ft. located behind the sidewalk and 3 shrubs and groundcover located in the 3 ft. wide buffer.

Arterial streets: 1 canopy tree and 3 shrubs and groundcover every 33 ft. located in the 5 ft. wide buffer between the curb and sidewalk.

Medians: 1 canopy tree or 2 accent trees, and 3 shrubs and groundcover every 33 ft. located in the 18 ft. wide median.

8.3.4.14 As an Impact Attenuator

Dense shrub masses, by their slower decelerating effect, cause less damage and injury to car and driver than do solid barriers. However, they may require 2 to 3 years to become firmly rooted and well grown. In the median, multiple rows of dense shrubs are effective, if space is available.

8.3.5 PLANTING FOR TRAFFIC INDICATION

Functional planting can help make it evident to the driver that a change in alignment of the road is imminent or that the driver is approaching an intersection. Such planting shall be designed with consideration for traffic safety and low maintenance.

8.3.6 PLANT DENSITY

8.3.6.1 New Vegetation

All bare ground on the site and/or landscape area shall be covered with live plant material, decorative aggregate, organic mulch, or other suitable material approved by the Development Services Department.

- 75% of the landscaped area at maturity shall be covered by live plant material
- 50% of plant cover shall be low water use vegetation.

8.3.6.2 Inert Materials

The use inert materials for landscaping is recommended to minimize the dust associated with its use. Smaller gradation material tends to be absorbed into the surrounding material and does not provide adequate dust protection.

Boulders, river cobble or rock products can be utilized to provide textural contrast to decomposed granite, provided the material does not exceed 4 inches in any dimension within the clear zone.

A pre-emergent herbicide shall be applied to the ground prior to placement of inert materials, and again following placement.

Decorative paving (stamped concrete, exposed aggregate concrete, pavers, etc.) shall be considered in place of plants for narrow median areas, such as at median noses.

8.3.7 LANDSCAPE ACCENTS/STREETSCAPE

Strong landscape accents/streetscape should be provided to highlight major entries to commercial, multi-family and subdivision developments reviewed and approved by the City.

Street furniture is to be provided as part of the street frontage landscaping within collector and arterial street rights-of-way which may include such features as bus stop shelters, benches, pedestrian lighting, trash receptacles.

8.3.8 LANDSCAPE PLANS

Planting plans shall be clear and concise and the processes of achieving aesthetic objectives clearly understood. Specifications for nursery stock, planting, seeding, and other types of landscape construction shall be clear, concise, and embody the practice and quality of work best suited for the area. The landscape contractor shall be responsible for the condition of all plants during a specified establishment period. The bid documents shall be set up so that final acceptance and termination of the contract will not occur until expiration of the establishment period.

Refer to the City of Rio Rancho drafting standards for guidelines in preparing the Landscape plans.

8.3.9 MAINTENANCE AND COSTS

8.3.9.1 Considerations for Maintenance:

- Species,
- Size,
- Location of the plant,
- Accessibility of the plant,

- Susceptibility to insects and disease,
- Fertilization needs,
- Removal and trimming needs (streetlight, traffic sign, signal, or vision obstruction).

Select trees with a naturally high canopy for use within sight distance triangles to avoid the need for continuous pruning. Some trees create a high quantity of leaf litter, flowers, beans and/or seeds and shall therefore be avoided. Deciduous trees in the median shall also be avoided.

Masses shall be placed in “drifts,” arranged to allow access for maintenance and to provide a continuous screen or barrier where desired.

Maximum use shall be made of fast growing shrubs that recover quickly from injury. Slow growers shall be reserved for use as accents.

Landscape plantings shall not encroach onto the roadway or driveway entrances. Landscapes that overhang off-site sidewalks must be maintained so that 7 foot high clearance is provided at all times.



Appendix A-1

Estimate of Probable Cost for Onsite, Improvements

Public Works Department

PROJECT NAME
ENGINEER'S OPINION OF PROBABLE COST ESTIMATE
ONSITE INFRASTRUCTURE IMPROVEMENTS

DATE					
ITEM NO.	QTY.	UNIT	DESCRIPTION	UNIT COST	TOTAL
ONSITE PAVING IMPROVEMENTS					
1					
2					
3					
4					
5					
6					
7					
8					
ON SITE PAVING IMPROVEMENTS SUBTOTAL					\$0.00
ONSITE WATER IMPROVEMENTS					
9					
10					
11					
12					
13					
14					
15					
ON SITE WATER IMPROVEMENTS SUBTOTAL					\$0.00
ONSITE SEWER IMPROVEMENTS					
16					
17					
18					
19					
20					
21					
22					
ON SITE SEWER IMPROVEMENTS SUBTOTAL					\$0.00
ON SITE STORM DRAIN IMPROVEMENTS					
23					
27					
25					
26					
27					
28					
29					
30					
ONSITE STORM DRAIN IMPROVEMENTS					\$0.00
SUMMARY OF COSTS					\$0.00
ONSITE PAVING					\$0.00
ONSITE WATER					\$0.00
ONSITE SEWER					\$0.00
ONSITE STORM DRAIN					\$0.00
TOTAL IMPROVEMENTS					\$0.00
2% TESTING					\$0.00
2% INSPECTION					\$0.00
2% CONSTRUCTION STAKING					\$0.00
5% SWPPP					\$0.00
SUBTOTAL					\$0.00
NMGRT					\$0.00
TOTAL IMPROVEMENTS					\$0.00
25% GUARANTEE FACTOR					\$0.00
TOTAL SIA AMOUNT NONDEFERRED					\$0.00

Notes: Include ADA ramps and any sidewalks that are not directly in front of building lots. Only sidewalks in front of building lots are deferrable.



Appendix A-2

Estimate of Probable Cost for Offsite Improvements

Public Works Department

PROJECT NAME
ENGINEER'S OPINION OF PROBABLE COST ESTIMATE
OFFSITE INFRASTRUCTURE IMPROVEMENTS

DATE					
ITEM NO.	QTY.	UNIT	DESCRIPTION	UNIT COST	TOTAL
OFFSITE PAVING IMPROVEMENTS					
1					
2					
3					
4					
5					
6					
7					
8					
OFFSITE PAVING IMPROVEMENTS SUBTOTAL					\$0.00
OFFSITE WATER IMPROVEMENTS					
9					
10					
11					
12					
13					
14					
15					
OFFSITE WATER IMPROVEMENTS SUBTOTAL					\$0.00
OFFSITE SEWER IMPROVEMENTS					
16					
17					
18					
19					
20					
21					
22					
OFFSITE SEWER IMPROVEMENTS SUBTOTAL					\$0.00
OFFSITE STORM DRAIN IMPROVEMENTS					
23					
24					
25					
26					
27					
28					
29					
30					
OFFSITE STORM DRAIN IMPROVEMENTS					\$0.00
SUMMARY OF COSTS					\$0.00
				OFFSITE PAVING	\$0.00
				OFFSITE WATER	\$0.00
				OFFSITE SEWER	\$0.00
				OFFSITE DRAIN	\$0.00
				TOTAL IMPROVEMENTS	\$0.00
				2% TESTING	\$0.00
				2% INSPECTION	\$0.00
				2% INSPECTION STAKING	\$0.00
				5% SWPPP	\$0.00
				SUBTOTAL	\$0.00
				NMGRT	\$0.00
				TOTAL IMPROVEMENTS	\$0.00
				25% GUARANTEE FACTOR	\$0.00
TOTAL SIA AMOUNT NONDEFERRED					\$0.00



Appendix A-3
Estimate of Probable Cost for
Deferred Improvements
Public Works Department

PROJECT NAME
 ENGINEER'S OPINION OF PROBABLE COST ESTIMATE
 DEFERRED SIDEWALKS

DATE					
ITEM NO.	QTY.	UNIT	DESCRIPTION	UNIT COST	TOTAL
1					\$0.00
2					\$0.00
3					\$0.00
4					\$0.00
5					\$0.00
6					\$0.00
7					\$0.00
8					\$0.00
TOTAL IMPROVEMENTS					\$0.00
2% TESTING					\$0.00
2% INSPECTION					\$0.00
2% CONSTRUCTION STAKING					\$0.00
5% SWPPP					\$0.00
SUBTOTAL					\$0.00
NMGRT 6.6875%					\$0.00
TOTAL					\$0.00
25% GUARANTEE FACTOR					\$0.00
TOTAL SIA AMOUNT DEFERRED					\$0.00

Notes: Only sidewalks in front of building lots are deferrable.



Appendix B
Capital Improvements
Projects Bid Form
Public Works Department

Available at the Department of Public Works



Appendix C
Examples of Preferred Format for
Lump Sum and Unit Pricing Bids
Public Works Department

BID FORM

**Available from the Department of Fiscal Services,
Purchasing Division**



Appendix D
City of Rio Rancho
Utility Conflict Letter
Public Works Department

Date

Addressee Name

Utility Company Name

Utility Company Street Address

Utility Company City, State, Zip

Re: Coordination of Utility Relocations/Installations-PROJECT NAME

Dear Mr. or Ms.

The City of Rio Rancho is in the process of preparing Improvement Plans for PROJECT NAME. The project is located LOCATION AND PROJECT LIMITS. The project improvements consist of DESCRIPTION OF PROJECT (i.e. utility work, paving, storm drain, etc).

In an effort to better coordinate the location of facilities associated with the existing and planned dry utilities within the project limits of the proposed improvements, ENGINEERING CONSULTANT NAME, has submitted the following information for your review and comment.

Please review the enclosed improvement plans, and fill out the attached Utility “No Conflict” form, within 30 days of receipt of this letter. If you should have any questions or require additional information you may contact NAME at PHONE NO.

Sincerely,

NAME

TITLE



City of Rio Rancho Utility “No Conflict” Form

Part I of II

Part I: Must be completed and submitted to the City by the Engineering Consultant with the improvement plans.
 Part II: Must be completed before the Department of Public Works may approve the improvement plans.

This form has been developed to better coordinate the location of facilities associated with the dry utilities relative to the proposed improvements as shown on the construction documents.

Project Name: _____

Project Location: _____

Engineer: _____

City of Rio Rancho Project No: _____

Please list the utility company name and date that the improvement plans were sent to each of the appropriate utility companies. The City will provide Utility Conflict Review for the following City of Rio Rancho Utilities: water, sewer and storm drain.

Utility	Utility Company	Date Submitted
Electric		
Telephone		
Natural Gas		
Cable TV		
Other (Specify)		

Certification:

I, _____, Engineer, certify that the plans have been submitted to the utility companies listed in the above table, on the dates listed, for conflict review.



City of Rio Rancho Utility “No Conflict” Form

Part II of II

Part I: Must be completed and submitted to the City by the Engineering Consultant with the improvement plans.
Part II: Must be completed before the Department of Public Works may approve the improvement plans.

This form has been developed to better coordinate the location of facilities associated with the dry utilities relative to the proposed improvements as shown on the construction documents

Project Name: _____

Project Location: _____

Engineer: _____

City of Rio Rancho Project No: _____

“No Conflict Statement”:

As a representative of, _____, I certify that I have reviewed the
Utility Company Name
plans for the above referenced project and, as of today find: *(please check one)*

_____ No conflicts with regard to existing facilities or planned facilities.

_____ Conflicts with regard to existing facilities or planned facilities.

Comments:

Company Information:

Name of Company Representative: _____

Telephone No.: _____

Date: _____

Date _____ on _____ Plans:

Available from the Department of Public Works

Chapter II.4

WATER AND WASTEWATER INFRASTRUCTURE DESIGN

1.0 INTRODUCTION

The purpose of this design standards manual is to provide guidelines and minimum design criteria for the design of water and wastewater systems in the City of Rio Rancho either as part of Capital Improvement Program projects or as private development projects that will construct and dedicate the systems to the City. It is the intent of the City of Rio Rancho Department of Public Works to adhere to all applicable Federal, State, and local regulations and guidelines for water and wastewater systems design.

The design manual applies to existing systems that are being expanded, modified, upgraded, and/or rehabilitated. Additionally, the manual applies to the construction of all new facilities. It should be noted that this document is not intended to be used as a replacement for construction specifications. It is the design criteria for engineers, developers, etc., to use when designing water and wastewater infrastructure within the City of Rio Rancho.

All units of measurement used in this manual are U.S. customary standard units unless otherwise noted.

2.0 OVERVIEW

2.1 AUTHORITY

The design standards set forth in this manual are promulgated by the City Engineer or designee of the City of Rio Rancho pursuant to the authority granted to him/her in the City of Rio Rancho Code of Ordinances Title V: Public Works, Chapter 51 - Water and Wastewater Rules and Rates, Section 51.24 - Main Extension Policy, Including Subdivisions.

The administration of these standards including interpretation, enforcement, revision, waiver, and variance is hereby delegated to the City Engineer or designee or an appointed representative.

Standards included in this manual do not supersede applicable Federal and State requirements. In addition, these standards shall meet the requirements of all local and regional authorities such as the Southern Sandoval County Arroyo and Flood Control Authority (SSCAFCA).

2.2 EFFECTIVE DATE OF STANDARDS

These standards shall be effective immediately upon the City Engineer or designee's signature and shall supersede all former applicable engineering standards for utilities design and construction.

2.3 REVISIONS

These standards may be revised, amended, or added to periodically. Such revisions, amendments, and additions shall be binding and effective when published.

2.4 CITY OF RIO RANCHO DEPARTMENT OF PUBLIC WORKS CONTROL

These standards shall apply to the design, installation, operation, and maintenance of all water and wastewater facilities under the control of the City of Rio Rancho Department of Public Works. Such control shall be exercised in accordance with all applicable ordinances of the City of Rio Rancho.

Adherence to these standards is required by any person, including any owner, operator, or agent of an owner or operator of any wastewater facility in regard to any wastewater system related improvements. Variation or deviation from the standards herein is not allowed without permission of the City Engineer or designee. All water and wastewater system construction (including connections, disconnections, repairs, new waterline and sewer line construction, or other such work) to the water and wastewater system operated by the City of Rio Rancho Department of Public Works, in direct violation of any standards herein is subject to the enforcement of corrective action.

2.5 ORGANIZATION AND INTERPRETATION OF MANUAL

The standards in this manual are composed of the following:

- Written engineering standards,
- References to established standards of other organizations and agencies, and
- Standard details of the Department of Public Works.

The City Engineer or designee, whose interpretation shall be binding and controlling in its application, shall make the interpretation of any section or of differences between sections.

2.6 DEFINITIONS

Definitions of terms used in this manual can be found in Appendix A.

2.7 ABBREVIATIONS

Abbreviations used in this manual can be found in Appendix B.

2.8 STANDARD SPECIFICATIONS AND DETAILS

The standard specifications and standard details relating to water and wastewater systems that are referenced in this manual include the following:

- A. New Mexico Standard Specifications and Details for Public Works Construction sponsored and distributed by the New Mexico Chapter – American Public Works Association (NMAPWA) Specifications Committee. These specifications and details

- are herein referred to as NMAPWA Specifications and Details. These specifications and details are revised and updated periodically and are available through the New Mexico Chapter of APWA.
- B. City of Rio Rancho Supplements to New Mexico Standard Specifications and Details for Public Works Construction. These specifications and details are herein referred to as Supplemental Details or Supplemental Specifications. These specifications and details are updated and revised periodically and are available through the Department of Public Works.
 - C. Uniform Standard Details and Drawings developed by the City of Rio Rancho Department of Public Works. These details and drawings are herein referred to as Standard Details and Standard Drawings. All Standard Drawings are included in Appendix C.
 - D. American Water Works Association (AWWA) Standards sponsored and distributed by the AWWA Standards Committee. These standards are intended to represent a consensus of the water industry that the product described will provide satisfactory service. These standards are updated and revised periodically and are available through AWWA.
 - E. American National Standards Institute (ANSI) Standards sponsored and distributed by the ANSI Technical Committees. These standards are intended to serve as a guide to aid the manufacturer, the consumer, and the general public in the use of various products, processes, and/or procedures. These standards are updated and revised periodically and are available through ANSI.
 - F. American Society for Testing and Materials (ASTM) Standards sponsored and distributed by the ASTM Technical Committees. These standards are intended to provide a forum for producers, users, ultimate consumers, and those having a general interest to meet on common ground and write standards for materials, products, systems, and services. These standards are updated and revised periodically and are available through ASTM.
 - G. Code of Federal Regulations, 40 C.F.R. – Protection of Environment. The Code of Federal Regulations is a codification of the general and permanent rules published in the Federal Register by the Executive departments and agencies of the Federal Government.
 - H. All other related standard specifications and details that are applicable but not listed here.

2.9 GENERAL NOTES

Water and Waste Water General Notes are available from the Department of Public Works at the City's website: www.ci.rio-rancho.nm.us

2.10 STANDARD PRODUCTS LIST

An approved standard products list for water and wastewater facility system components can be found in Appendix D.

2.11 AVAILABILITY STATEMENT PROCESS

Availability statements shall be obtained in accordance with the Utilities Commission Policy Statement, “Guidelines for Issuing Water & Wastewater Letters of Availability.” A copy of this document and a copy of the water and wastewater service availability information request form are included in Appendix E.

3.0 UTILITY ENGINEERING REPORT

3.1 REQUIREMENT

The City Engineer or designee will require the preparation of a utility engineering report to assess the impacts and service demands of any project or development proposal connecting to the public water and wastewater systems. The utility report shall be prepared by a licensed engineer and include a technical report, preliminary plan, connection and isolation plan as outlined in the following subsections.

3.2 REPORT

For designs including water and wastewater system components, the utility engineering report shall provide an overview of the proposed project or development, proposed water and wastewater utility improvements, service demands and flows, system impact and feasibility, and basic design requirements, and include the following information:

3.2.1 Water System

- A. **Water Demands:** Include estimated water demands based on projected land use, occupancy, and building type for the following conditions.
 - 1. Maximum-hour (gallons per minute, gpm),
 - 2. Maximum-day (gpm),
 - 3. Average-day (gpm),
 - 4. The Fire Marshal will determine Fire Flows (gpm), and
 - 5. Irrigation (gpm)
- B. **Conformance with City’s Water Master Plan:** Describe how the proposed improvements conform to the City’s adopted Water Master Plan.
- C. **System Layout:** On a plan sheet describe the proposed distribution system layout, including locations for connections with the existing water utility system.

Network Analysis: Once the data is gathered it will be submitted to the City Engineer or designee who will use it to perform a computer simulation, identifying any systems impacts based on proposed demands and providing design solutions to ensure perpetuation of future water utility system growth and maintain system pressures and flow rates.

Note: Computer simulations of hydraulic analyses are to be performed using electronic input data for the existing water system provided by the City on software compatible with the City's network analysis program. Results of the computer analyses are to be submitted in hard copy format.

- D. **Main Sizing:** Indicate the required sizing of proposed distribution mains based on water demands. It is possible that a larger size line will be required after the City Engineer or designee evaluates the requirements for the surrounding developments.
- E. **Design Alternatives:** Discuss alternative system layouts and methods of providing water service, including an evaluation of each alternative and reasons for selecting the recommended design.
- F. **Special Conditions:** Identify any special conditions, such as presence of erosive soils, conflicts with other utilities, unusual installation depths, or over sizing requirements that require special provisions for improvements construction.

3.2.2 Wastewater System

- A. **Wastewater Demands:** Include estimated wastewater demands based on projected land use, occupancy, and building type for the following conditions.
 - 1. Average day (gallons per day, gpd),
 - 2. Peak flow or Maximum-day (gpd),
 - 3. Minimum-day (gpd), and
 - 4. Infiltration/Inflow (gpd)
- B. **Conformance with City's Wastewater Master Plan:** Describe how the proposed improvements conform to the City's adopted Wastewater Collection Master Plan.
- C. **Service Area:** Describe the initial and ultimate area, measured in acres, that could be served by the new wastewater facilities.
- D. **Population Density:** Define the initial and ultimate population densities that could be served by the new wastewater facilities.
- E. **Industrial Wastes:** Define the estimated quantities and quality of any industrial wastes that could be discharged to the wastewater system.
- F. **System Layout:** Describe the proposed collection system layout, including locations for connections with the existing wastewater utility system.

- G. **Collection System Analysis:** Include a collection system analysis as required by the City Engineer or designee, identifying any system impacts based on proposed demands and providing design solutions to ensure perpetuation of future wastewater utility system growth and maintain system capacity.
- H. **Main Sizing:** Indicate the required sizing of proposed collection mains based on wastewater demands. It is possible that a larger size line will be required after the City Engineer or designee evaluates the requirements for the surrounding developments.
- I. **Design Alternatives:** Discuss alternative system layouts and methods of providing wastewater service, including an evaluation of each alternative and reasons for selecting the recommended design.
- J. **Special Conditions:** Identify any special conditions, such as conflicts with other utilities, unusual installation depths, or oversizing requirements that require special provisions for improvements construction.
- K. **Wastewater Characteristics:** Include information concerning the characteristics of proposed wastewater effluent, as described in 40 C.F.R, Part 122, Appendix D, Tables 2-5, at each connection to the City’s wastewater collection system as required by the City Engineer or designee, including the following:
 - 1. Acidity-alkalinity,
 - 2. Phosphorus,
 - 3. pH,
 - 4. Sulfates and sulfides,
 - 5. Synthetic and organic compounds,
 - 6. Hazardous constituents,
 - 7. BOD₅ (total and soluble fraction, carbonaceous and nitrogenous demand),
 - 8. COD (total and soluble),
 - 9. TSS,
 - 10. Nitrogen (TKN, NO₃, NO₄, NH₄, organic), and
 - 11. Inorganics (salts and metals)

3.3 CONCEPTUAL LAYOUT

A conceptual layout shall be included in the utility engineering report to provide a plan view and reference for the proposed water and wastewater system improvements, and identify issues addressed in the report. The preliminary plan/layout is to include the following:

- A. **Preliminary Design:** Illustrate proposed methods and alternatives for providing site water distribution and service and wastewater collection and service.
- B. **Property Boundaries:** Include legal boundaries of the proposed project or development site, including existing and proposed property and lot lines, existing and proposed rights-of-way, any utility easements, and boundaries of adjacent properties.

- Identify any right-of-way, easements, and/or rights of entry/temporary construction permits that must be acquired to legally construct improvements.
- C. **Topography:** Include site topography at 2-foot (minimum) interval contours and the elevation and location of City-recognized benchmarks with reference to local, USGS, and NAD 83 data.
 - D. **System Area:** Define and delineate the system area included in the network analysis.
 - E. **Existing Utilities:** Illustrate all existing utilities (private and public), including waterlines and services, meters, fire hydrants, valves, sanitary sewer lines and services, sanitary sewer manholes, drainage facilities, storm drains, natural channels, and improved channels within 400 feet of the proposed development.
 - F. **Unusual Features:** Identify unusual features, such as creeks railroads, and irrigation ditches, that might influence the location of underground utilities.
 - G. **Proposed System Layout:** Identify the general layout, drawn to scale, of the proposed water distribution mains, valves, and fire hydrant locations, wastewater collection mains, and manhole locations including construction phasing.
 - H. **Emergency Maintenance Access:** Identify methods and routes for providing emergency and maintenance access to all proposed fire hydrants, valves, and manholes.

3.4 CONNECTION AND ISOLATION PLAN

A connection and isolation plan shall be provided in the utility engineering report to identify proposed connection points with the existing water systems and design conditions for providing required system isolation for maintenance and flushing. The connection and isolation plan is to include the following:

- A. **Valve Locations:** Identify all valves necessary to isolate a point of connection for the proposed water system onto the existing system. Existing system valves should be inspected for location and accessibility.
- B. **Thrust Restraint:** Determine and include design and construction requirements for sufficient thrust restraint for existing water mains and valves at proposed connection points (“stub-outs” and terminal extensions) to allow construction while the existing water system remains in service in accordance with Chapter 1, Section 10.
- C. **System Isolation:** Identify water main sections that can be isolated within the proposed and existing water systems that provide for emergency maintenance and identify discharge points for system flushing.

4.0 WATER DISTRIBUTION AND TRANSMISSION SYSTEMS

4.1 GENERAL

The City of Rio Rancho's Water Utility Department has dual functions. It supplies potable water for industrial, commercial, and domestic use and supplies water for fire protection. This document in conjunction with the City of Rio Rancho's Standard Drawings provides guidance and minimum basic design criteria and standards, as set forth by the Department of Public Works, for providing and maintaining the public water utility distribution system of the City of Rio Rancho. It is intended for use in the planning and design processes. Where not specified in these standards, the City Engineer or designee will specify the standards to be applied to the design and construction of public water utility improvements in order to protect the public health, safety, and welfare of all water users served by the City of Rio Rancho.

4.2 GOVERNING REGULATIONS

Ordinances, policies, and planning documents related to the design and operation of water systems include the following:

- A. City of Rio Rancho Code of Ordinances Title V: Public Works, Chapter 51, Water and Wastewater Rules and Rates
- B. Water System Comprehensive Planning Model for the City of Rio Rancho
- C. Guidelines of Water Supply Systems and Treatment Works in New Mexico, Environmental Improvement Division

4.3 LINE SIZING AND DEMAND REQUIREMENTS

- A. **General Requirements:** The following general requirements must be followed when commencing a water system design.
 - a. The sizing and routing of Master Plan lines must be coordinated with the "Water System Comprehensive Planning Model" for the City of Rio Rancho and approved by the Department of Public Works. Specific requirements for providing water service to any parcel or development will be defined in a water (and sewer) availability statement/recommendation from the Department of Public Works. The procedure for obtaining the availability statement is outlined in **SECTION 2, SUBSECTION 2.11 AVAILABILITY STATEMENT PROCESS**, of this document.
 - b. Pressure zone boundaries must be considered in the design of all systems.
- B. **Domestic Demand:** Water infrastructure for all proposed commercial, industrial, and residential developments shall, at a minimum, be sized to provide Peak Day Water Demand flows plus fire flow protection. The fire flow requirement shall apply to both private sprinkler systems and public fire hydrants. The average day water

demand for residences within the Rio Rancho water utility is estimated at 300 gallons/day per residence. Using a peaking factor of 2.167, peak day water demands are calculated at 650 gallons/day per residence. Water demand estimations for non-residential applications are listed in Table 4.1. These average day demands are derived from the land-use sewer design flows. These values assume that water usage is approximately 133% of the estimated average sanitary sewer design flows. Although the list is not all-inclusive, it does serve to establish a general base line for system evaluation and analysis. It should be noted that in all non-residential development projects, specific water demand determinations should be calculated and provided to the City Engineer or designee during the design and approval process. If a proposed development does not fit within the categories listed above, consult with City Engineer or designee for determination of the appropriate water demand. The City Engineer or designee may adjust average day demands based on the specific design of the development.

Table 4.1
Average Day Water Demands for Non-Residential Applications

Development Type/Land Use	Average Day Demand	Units
Light Commercial	1,750	gal / ac-day
Heavy Commercial	8,500	gal / ac-day
Light Institutional	325	gal / ac-day
Heavy Institutional	2,550	gal / ac-day
Light Industrial	640	gal / ac-day
Medium Industrial	2,400	gal / ac-day
Heavy Industrial	13,230	gal / ac-day

- C. **Friction Factor:** For line sizing and design purposes the Hazen-Williams formula should be used. A friction coefficient, “C” factor, of 120 should be used for all new DI water main design calculations. A friction coefficient, “C” factor, of 130 should be used for all new PVC water main design calculations.

- D. **Peaking Factors:** Peak day and peak hour demands are important in the sizing of various parts of the water system. Peak day use is used to ensure that water production facilities are adequately sized to match peak day use and is also used to size storage facilities. Peak hour use is the maximum amount of water used in any single hour of a day and is used in sizing storage facilities and transmission/distribution lines. Table 4.2 shows the water demand peaking factors that are to be used to determine the peak hour and peak day water demands for residential and non-residential development types.

**Table 4.2
Water Demand Peaking Factors**

Development Type/Land Use	Peak Hour	Peak Day
Residential Development	3.5	2.167
Non-Residential Development	2.5	1.5

- E. **Water Demand Calculation Example:** For clarification, the following example illustrates typical calculations performed to determine the design demands and quantities involved in a hypothetical system design.

EXAMPLE: Hypothetical Water Demand/Flow Evaluation

ASSUME: 100 Dwelling Unit Residential Subdivision Development

CRITERIA: Average day demand = 300 gallons/day/residence
 Average demand for subdivision = 300 gallons/day x 100
 = 30,000 gpd = 30,000 gpd/1,440 min/day
 = 20.8 gpm
 Peak demand for subdivision = 30,000 gpd x 2.167 = 65,010 gpd =
 65,010 gpd/1,440 min/day
 = 45.1 gpm
 Maximum hour demand = 30,000 gpd x 3.5 = 105,000 gpd =
 105,000 gpd/1440 min/day
 = 72.9 gpm

4.4 General Water Main Design Criteria

- A. **General:** All issues and elements presented in this section are typically included and must be addressed in all water distribution infrastructure projects.
- B. **Jurisdictional Agency Approvals:** One very critical task in the early stages of the project is the development of an agency approval list. These approvals and/or close coordination required by these agencies will impact the successful and timely completion of the project. All appropriate department levels affected within the City, County, State, and Federal agencies need to be contacted for their individual requirements.
- C. **Environmental and Cultural Regulatory Requirements:** This section is not intended to be all encompassing, rather provide an overview of the environmental and cultural requirements and the typical agency involvement. A thorough consideration of the environmental and cultural impact of the project at its specific location shall be evaluated to identify the various requirements. Private developers shall be responsible for regulatory compliance and for obtaining the required permits for their projects.

In specific areas where a project impacts Water of the United States, a Clean Water Act, Section 404 Permit shall be required from the U.S. Army Corps of Engineers.

Compliance is required with the U.S. EPA under the Stormwater National Pollutant Discharge Elimination System (NPDES) general permit for stormwater discharges from construction sites. Coverage under the general permit is required for all operators of construction sites that disturb one (1) or more acres of soil through grading, trenching, or excavation.

Projects shall not adversely impact threatened or endangered species or their habitat and shall comply with the Federal Endangered Species Act. To address any biological requirements, an assessment report of the project may be required by the U.S. Fish and Wildlife Service and the New Mexico Fish and Game Department.

Projects shall not adversely impact historic or prehistoric properties. Projects shall comply with the National Historic Preservation Act and the State Historic Preservation Act.

- D. **Community Notification and Public Involvement:** The City is committed to early citizen notification and involvement. Identifying neighborhood concerns is a priority and good communication is required throughout the public involvement phase of all projects.
- E. **Alignment and Easement Requirements:** The following alignment and easement requirements shall be followed for water line designs.
1. Water lines are to be located within the public right-of-way and aligned in accordance with the “Typical Plan View for Streets” drawings in Appendix C. Water lines shall be located so they can be maintained without disturbing any sidewalk, curb, gutter, structure, or any other utility.
 2. If it is not possible to utilize designated public right-of-way or align in accordance with the Utility Locations, alternate alignments will be considered by the City Engineer or designee.
 3. If not in a public right-of-way, the water line must be located in a permanent easement. A permanent easement must be granted and dedicated to the City of Rio Rancho for the exclusive use of water and sanitary sewer, unless shared use with other utilities is coordinated and approved in advance by the Department of Public Works. A minimum easement width of 20 feet (or more) is required for a single utility and 25 feet (or more) for water and sewer both within the same easement.
 4. Water and sewer easements shall be free of all obstructions and shall at all times be accessible to City service equipment. No buildings, sport courts, walls, fences, shade structures, nor permanent structures of any kind shall be constructed upon, over, or under and water line easements. Since water mains can be damaged by tree roots, trees shall not be planted within 10 feet of the centerline of the water main. No landscaping shall be placed and/or planted within the easement that would render the easement inaccessible by equipment. The Department of Public

Works has the right to have any obstruction removed without notice to the property owner and all cost associated with the removal shall be the property owner's responsibility. The maintenance of all landscaping in water line easements is the responsibility of the property owner.

- F. **Acceptable Pipe Materials:** The type of pipe to be installed shall comply these standards, meet NMAPWA specification, and shall be based upon applicable design flows, pressures, site conditions, corrosion protection, and maintenance requirements. Water lines shall be either polyvinyl chloride pipe (PVC), ductile iron pipe (DIP) or High density polyethylene pipe (HDPE).
- G. **Radius of Curvature:** The minimum radii of water line curvature are shown in Table 4.3.

Table 4.3
Minimum Radius of Curvature

Pipe Type	Pipe Diameter (in.)	Joint Length (ft.)	Minimum Radius (ft.)
DIP	4 - 12	20	300
PVC	8	20	250
PVC	10	20	310
PVC	12	20	370

Minimum radius of curvature for C-906 smooth-walled HDPE pipe shall be based on manufacturer's recommendations but as a minimum shall be based on the following Table 4.4 and equation:

Table 4.4
Minimum Allowable Bending Radius for AWWA C-906 HPDE Pipe

<u>DR Ratio</u>	<u>Minimum Radius Factor, K_{mrf}</u>
32.5	40
26	36
21	32
17	26
13.5	24
11 or Lower	20

By multiplying the minimum radius factor, K_{mrf} , by the outside diameter, D , of the pipe being installed the minimum bending radius, r_m , may be calculated using Eq. 24-1

(Eq. 24-1)
$$r_m = D \times K_{mrf}$$

Where r_m is in inches.

- H. **Water Main Extensions:** The City's policy on water main extensions is contained in the City of Rio Rancho Code of Ordinance Title V: Public Works, Chapter 51 Water and Wastewater Rules and Rates, Section 51.24 Main Extension Policy, Including Subdivisions.
- I. **Hydraulic Requirements:** The Department of Public Works may require a hydraulic modeling analysis be conducted. This requirement may be in addition to the analysis that was part of the availability statement submittal. This analysis will identify any new requirements or connection alternatives and will help determine the appropriate size of the infrastructure.
- J. **Thrust Restraint:** Joint restraint shall be used at all valves and fittings or where joint restraint devices are specified by the approved construction plans. Restrained joint calculations shall be prepared and submitted when necessary. Typical restrained joint length requirement tables are shown on Standard Drawings W-19 and W-20 in Appendix C.
- K. **Corrosion Protection:** Corrosion protection will be required for all water system improvements where corrosive soil conditions are encountered.
- L. **Separation from Sanitary Sewer Mains:** To minimize the potential for cross contamination, water mains shall have at least 10 feet horizontal separation from any existing or proposed sewer line or water reuse line. In situations where it is not feasible to maintain a 10-foot separation the design engineer may propose a reduced distance. Such reductions may only be approved and granted by the City Engineer or designee and may be allowed provided the water main is laid in a separate trench or an undisturbed earth shelf located on one side of the sewer line at an elevation so that the bottom of the water main is at least 18 inches above the top of the sewer line.

Water mains crossing sewer lines shall be laid to provide a minimum separation of 18 inches between the outside of the water main and outside of the sewer line. This separation shall be maintained where the water main is either above or below the sewer line. The crossing shall be arranged so that the water main joints will be equidistant and as far as possible from the sewer line.

Where it is impracticable to obtain proper horizontal and vertical separation, the sewer line shall be designed and constructed equal to the water main and shall be pressure tested to assure watertightness. Encasement of the water line may also be required by the City Engineer or designee.

Water mains shall not pass through or come in contact with any part of a sewer manhole.

- M. **Separation from Storm Drains and Culverts:** Water mains shall maintain six (6) feet horizontal and two feet vertical separation from storm drains and culverts. Water mains crossing less than two (2) feet below a storm drain or culvert shall require

additional protection such as the use of a pipe casing. Whenever possible the water line should be placed below the storm sewer.

- N. **Separation from Other Utilities:** Water mains shall maintain a minimum ten (10) feet horizontal separation and one (1) foot vertical separation to any underground dry utility; all measurements are clear distance measurements.
- O. **Cross Connections and Backflow Prevention:** No physical connection shall be made between potable and non-potable sources. Any connection is considered a cross connection. Refer to the City of Rio Rancho's Building Code for specific provisions regarding cross connections and backflow prevention. Backflow preventers shall be installed in accordance to Standard Drawings W-1 and W-2 in Appendix C.
- P. **Start-Up and Commissioning Period:** The construction project is functional only after demonstrating the completion of pressure testing, bacteriological testing, and final inspections in accordance with AWWA, etc. Then, an acceptable flushing schedule and chlorine residual monitoring plan must be prepared to maintain and demonstrate an acceptable level of turnover during the early period of new project commissioning. Once this body of work has been completed, start-up and demonstration period is ready to begin. The start-up details and duration of commissioning shall be identified 30 days prior and listed in the project scope of work.

4.5 WATER SERVICES

- A. **General:** The following general requirements pertain to water services. All requirements and standards are as set forth in the City of Rio Rancho Code of Ordinance Title V: Public Works, Chapter 51 Water and Wastewater Rules and Rates, Section 51.08 Service Connections and the City of Rio Rancho's Standard Drawings.
- B. **Standards:** Water services are water system extensions that are tapped onto the distribution system to provide water to consumers. Water services are subject to the requirements set forth and described in these standards and as shown in the Standard Detail Drawings.
- C. **Point of Service:** The Department of Public Works shall determine the point of service to any premises. The Department of Public Works shall be called upon for exact information regarding the service line location.
- D. **Water Service Connections:** Water service connections shall adhere to the City's policy as described in the City of Rio Rancho Code of Ordinance Title V: Public Works, Chapter 51 Water and Wastewater Rules and Rates, Section 51.08.B Water Service Connections.
- E. **Water Service Laterals:** All water service laterals shall be installed in accordance with the Standard Detail Drawings in Appendix C.

- F. **Backflow Prevention:** Backflow preventers shall be required in the construction of all new commercial, industrial, and public authority services where water is used in any process which, in the opinion of the Department of Public Works, could constitute a cross connection or health hazard. Backflow preventers shall be installed in accordance to Standard Drawings W-1 and W-2 in Appendix C.

4.6 DISTRIBUTION MAINS – DESIGN CRITERIA

- A. **General:** Distribution mains are typically 8 inches through 12 inches in diameter. Project designs shall make every effort to loop water mains throughout the development.
- B. **Installation:** Construction of water-related public improvements shall be in compliance with these standards and the Standard Drawings located in Appendix C.
- C. **Pipe Sizing:** The design engineer shall size all distribution system pipes and appurtenances in accordance with the provisions of this manual and applicable ordinances. Distribution mains shall be a minimum of 8-inches in diameter.

The following is a generalized pipe size guideline that is subject to refinement in the design analysis. Distribution mains shall be sized such that:

1. Velocity does not exceed three (3) feet per second (fps) for peak day flow or ten (10) fps for fire flow and average day, or head loss does not exceed 10 feet/1000 feet (whichever is limiting).
 2. Under normal operating conditions, the range of system pressures is between 30 psi and 125 psi.
 3. Pressure and flow capacity data for both existing and future conditions in the City’s major water distribution system is to be obtained from the Department of Public Works for use in the design and analysis of all proposed system improvements.
- D. **Location/Alignment:** A six (6) foot minimum horizontal and one (1) foot minimum vertical exterior surface separation from any parallel underground dry utility is required. In all major streets and other active utility corridors, a utility conflict review is required.
 - E. **Distribution Main Cover:** Distribution mains shall adhere to the minimum cover requirements shown in Table 4.5 and Standard Drawing W-7 in Appendix C,

**Table 4.5
Minimum Cover Requirements**

Condition	Depth of Bury (ft)
Paved Street (top of pavement)	4
Unpaved and Maintained Street	5
Unpaved and Un-maintained Street	6

- F. **Taps:** All taps approved onto a main shall be installed under “wet tap” conditions, using a tapping tee and valve, which allows the distribution main to remain in service at all times.
- G. **Valves:** Valves on mains 12-inch and smaller shall be gate valves and shall be the same size as the main lines. Gate valves shall be iron-bodied, resilient seat or epoxy coated double disc, with non-rising stem conforming to AWWA C-500 or C-509. Valves shall open counterclockwise and shall be rated for a design working pressure of 200 psi or 1½ times the working pressure which ever is greater. Double disc type valves shall be bronze mounted with parallel seats. All buried valves shall have one 2-inch square operating nut. Mechanical or push-on joints appropriate for buried installations shall be provided.

**Table 4.6
Valve Spacing**

Type of Development/Land Use	Maximum Valve Spacing (ft)
Residential	750
Commercial and Industrial Development	500

1. Extension stems with a 2-inch square operating nut and a support for the upper end of the extension shall be provided for all valves installed more than 4 feet deep. The operating nut shall be located within 4 feet of the finished grade. Extension stems shall be mechanically connected to the operating nut. Extension stems shall be fabricated from solid steel shafting not smaller in diameter than the stem of the valve or from galvanized steel pipe having an inside diameter (ID) not smaller than the outside diameter (OD) of the valve stem. Extension stems shall be connected to the valve by a flexible socket type coupling. All connections shall be pinned, keyed, or socket type. Pipe couplings will not be acceptable. Each extension stem for a buried valve shall extend within 6 inches of the ground surface, shall be provided with spacers that will center the stem in the valve box, and shall be equipped with a wrench nut.

2. A valve shall be located on each side of a canal, arroyo, railroad and freeway crossing.
3. Avoid valve locations in curbs, sidewalks, driveways, multi-use paths, on-street bike lanes, and valley gutters.
4. Isolation valves for fire hydrant assemblies shall follow the Standard Drawing W-3 in Appendix C.
5. Valves shall be located at the point of curvature (PC) of the curb return at street intersections and should be aligned with extensions of property lines or right-of-way lines where possible.
6. Valve boxes and covers shall be provided for all buried distribution system line valves in accordance with Standard Drawing W-4 in Appendix C. Valve boxes shall be adjustable cast iron type with a deep skirted lid. Valve boxes shall be a minimum of 4 inches in diameter and shall have a minimum thickness at any point of 1/16 inch, and shall be provided with suitable cast iron bases and stay-put covers. Covers shall have cast thereon "WATER" on the top. They shall be as manufactured by Parkson, Tyler, APCO, or approved equal.
7. The valve box shall have at least 6 inches adjustment above and below specified depth of cover over pipe.
8. Valves shall be located to provide maximum accessibility for emergency access. Valves shall not be placed in locations that may be subject to routine parking or storage operations.

H. **Restraint Systems:** All valves and fittings shall be restrained by using a joint restraint system compatible with the type of pipe. The Department of Public Works shall approve all restraint systems. The length of the restraint system shall be shown on the construction plans and complete supporting data on the restraint system design shall be submitted to the Department of Public Works for review and approval. Refer to Standard Detail Drawings W-19 and W-20 in Appendix C for typical joint restraining lengths for various size of pipe.

1. Follower gland-type joint restraint systems may be used for 12 inch diameter pipe and smaller, including the following devices:
 - a. "EBAA Iron, Inc." Megalug - PVC and DI compatible series;
 - b. "Uniflange" - PVC and DI compatible series.

I. **Looping and Terminal Mains:** System looping and terminal main requirements are summarized below:

1. Where possible, all distribution mains shall be looped into the existing and proposed water distribution system to ensure at least two feed sources and maintain system pressure.
2. Where allowed, terminal or dead-end distribution mains shall not be more than 600 feet long, measured along the entire centerline length of the terminal main from the connection main to the terminus. The City of Rio Rancho

reserves the right to reduce the length if conditions warrant in order to maintain fire flows.

3. All terminal mains shall have a fire hydrant at the terminus. Fire hydrant installations shall be offset from the terminus to ensure that the hydrant can be removed for maintenance while the terminal main remains in service. Fire Hydrants shall be installed in accordance with Standard Drawing W-3 in Appendix C.
4. Service taps along terminal mains shall not be located closer than 3 feet to the terminus nor located between the fire hydrant connection and the terminus.

J. **Extensions:** Water mains shall extend to the far edge of the property being served plus 10 feet or to the edge of the platted subdivision, whichever is greater, to ensure perpetuation of the water distribution system. The location, size, and configuration of the proposed development or subdivision, with respect to the existing water distribution system, may dictate that water mains be extended to the far edge of more than one property or subdivision boundary to accommodate system perpetuation.

K. **Future Connections:** When future main extensions are provided for by “stub-out” or terminal connections, the stub-out or terminal main extension shall extend 20 feet beyond the pavement and be valved so that only one valve must be closed when the future main is extended. The valve shall be restrained to the existing distribution main to allow closure of the stub-out or terminal main section without creating a pressure separation of the valves from the in-service distribution main. When future connections are made, the entire main beyond the stub-out or terminal main extension shall be flushed, chlorinated, and pressure tested.

4.7 TRANSMISSION MAINS –DESIGN CRITERIA

- A. **General:** Transmission water mains are typically 14 inches in diameter and larger. No service taps are permitted on transmission mains.
- B. **Pipe Sizing:** Transmission mains shall be sized to carry the designed peak flow required without exceeding the velocities and headlosses shown in Table 4.7 below:

**Table 4.7
Allowable Velocity/Headloss**

Pipe Size (in.)	Max. Allowable Velocity (ft/s)	Max. Allowable Headloss (ft/1000 ft)
14 & 16	5	2
20	5	1.5
24 and larger	5	1

Note: The above table is based on a Hazen-Williams pipe roughness coefficient of C = 120.

- C. **Location/Alignment:** A stationed horizontal alignment of the proposed transmission main is required to define the route with lines, angles, and curvatures referenced to

land corners and other official survey control points when available. Negative stationing will not be allowed. Vertical alignment must be carefully considered in the design of transmission mains. A profile shall be provided for all transmission main designs.

- a. To facilitate City review of a proposed main, a profile of the entire main shall be provided on a single sheet in condensed form.
- b. A roller coaster type of vertical alignment shall be avoided to minimize air pocket formation at the high points of the profile. Design of the main shall provide for a minimum number of high and low points consistent with economic feasibility.

D. **Transmission Main Cover:** Transmission mains shall adhere to the minimum cover requirements shown in Table 4.8 and Standard Drawing W-7 in Appendix C, required by the City of Rio Rancho. As the transmission main size increases, the minimum cover requirements may increase. If finished grade cannot be identified a minimum of 18-inches additional cover is required.

**Table 4.8
Minimum Cover Requirements**

Condition	Depth of Bury (ft)
Paved Street (top of pavement)	4
Unpaved and Maintained Street	5
Unpaved and Un-maintained Street	6

E. **Taps:** No main extension or fire hydrant taps smaller than 6 inches in diameter shall be installed in any main 14-inches or greater. Service line taps shall not be installed in any transmission main. Unless otherwise approved by the City Engineer or designee, all taps installed onto a transmission main shall be made under “wet tap” conditions, using a tapping tee and valve, to allow the transmission main to remain in service.

F. **Valves:** Valves on 14-inch mains and larger shall be butterfly valves. Valves on transmission lines larger than 16 inches shall be full size butterfly valves with flanged end connections. Valve boxes shall be placed over valve operators as shown in Standard Drawing W-3 in Appendix C.

- a. Butterfly valves shall be rubber-seated conforming to the AWWA C504 and designed for buried service.
- b. The valves shall be designed to operate as open or closed with a design velocity of 8 fps.

- c. The valves shall have a cast iron body with mechanical joint ends conforming to ANSI 21.11, AWWA C111 and shall be rated for a design working pressure of 150 psi or 1½ times the working pressure which ever is greater.
- d. Valves shall be manufactured by Keystone or approved equal.
- e. Discs shall be cast or ductile iron with stainless steel, type 304, either stub or one piece shafts.
- f. Shaft bearings shall be the bushing type of nylon or Teflon.
- g. Seats shall be rubber vulcanized to the body and designed to provide bubble tight shutoff.
- h. The valve operator shall be traveling-nut type in an enclosed body, sealed to prevent the entrance of groundwater up to 5 feet above the valve.
- i. Table 4.9 below shows the maximum spacing for valves on transmission mains.

**Table 4.9
Valve Spacing**

Pipe Size (inches)	Maximum Valve Spacing (ft)
14-30	2500
Greater than 30	5000

- j. If the Department of Public Works requires the installation of electronic monitoring and remote operation equipment, the line valve must be a butterfly valve with a rectangular vault, housing the valve operator and telemetry equipment. Each installation will require individual details. The design engineer shall check with the Department of Public Works on acceptable equipment and specific design requirements.
 - k. In addition to the valve spacing requirements listed above, valves shall be installed at the following locations:
 - 1. At all connections with transmission mains. Where a distribution main connects with a transmission main, a valve shall be installed on the distribution main at the transmission main.
 - 2. Where possible, valves shall be aligned with extensions of property lines or right-of-way lines. Valves shall not be placed in locations that may be subject to routine parking or storage and shall not be placed within public sidewalks, multi-use paths, or on-street bike paths.
- G. **Restraint Systems:** All valves and fittings shall be restrained by using a joint restraint system compatible with the type of pipe. The Department of Public Works shall approve all restraint systems. The length of the restraint system shall be shown on the construction plans and complete supporting data on the restraint system design shall be submitted to the Department of Public Works for review and approval. Refer to Standard Drawings W-19 and W-20 in Appendix C for appropriate joint restraining lengths for various size of pipe.
- 1. Follower gland-type joint restraint systems may be used for 12 inch diameter pipe and smaller, including the following devices:
 - a. “EBAA Iron, Inc.” Megalug - PVC and DI compatible series;
 - b. “Uniflange” - PVC and DI compatible series.
- H. **Bypass Assemblies:** Transmission mains between valves shall be treated as an independent unit with provisions for dewatering, filling, removing air and adding air as appropriate for the transmission main construction and maintenance. In all transmission mains, a bottom tangent flanged outlet shall be provided at all profile low points and a top tangent flanged outlet shall be provided at all profile high points.

- I. **Air/Vacuum Valve Assemblies:** All air/vacuum valve assemblies for transmission mains require individual approval by the Department of Public Works. Air/vacuum relief valve assemblies shall be installed in accordance with Standard Drawing W-14 in Appendix C at high points in the transmission main at locations approved by the Department of Public Works.
- J. **Pressure Blow-Off Assemblies:** All blow-off assemblies/flushing valves for transmission mains require individual approval by the Department of Public Works. Pressure blow-off/flushing valves assemblies shall be installed in accordance with Standard Drawing W-15 in Appendix C at low points in the transmission main at locations approved by the Department of Public Works. Pressure blow-off assemblies/flushing valves are to be used only when it is determined that a fire hydrant is not appropriate.
- K. **Design Survey Requirements:** To establish the vertical profile of the transmission main, an existing and finished ground surface profile of the proposed alignment based on City of Rio Rancho datum and tied to at least two survey benchmarks is required. Additional semi-permanent benchmarks shall be established every 1500 feet along the route by closed loops of third-order accuracy. The existing ground profile shall consist of ground surface elevations along the proposed transmission main centerline at every 100-foot station and at pronounced grade breaks.

Topographical features within the street or right-of-way and any topographic feature outside the right-of-way, which may interfere with the operation or installation of the transmission main, shall be accurately surveyed and depicted on the plans. Topographic features may be compiled by aerial photogrammetry or field survey methods.

In areas where the ground slope perpendicular to the centerline of the transmission main exceeds 5%, cross sectional data shall be surveyed at all 100-foot station profile points and shall extend at least 25 feet to each side of the centerline.

All utility crossings or close utility interference shall be located and exposed by potholing. The design survey shall record the size, nature, and location of the potential interference by station, offset, and elevation.

4.8 FIRE HYDRANT CRITERIA

- A. **General:** The purpose of this section is to clarify City of Rio Rancho requirements for fire hydrants. Adherence to these requirements is necessary to provide a usable, readily accessible water supply for maintenance and fire fighting purposes. Fire hydrants shall be installed in accordance to Standard Drawing W-3 in Appendix C.
- B. **Ordinance Requirements:** All fire line installations shall conform to the specifications of NMAPWA and all requirements and standards are as set forth in the City of Rio Rancho Code of Ordinance Title V: Public Works, Chapter 51 Water and Wastewater Rules and Rates and Standard Drawing W-13 in Appendix C.

- C. **Fire Flow Demand:** The required fire flow and peak day flow rate shall be available in the system. The municipal fire flow required by the City for any one particular location varies depending on the land use and/or the building type or use. The number of hours that the required fire flow shall be available also varies depending on the land use. Table 3.9 outlines required fire protection flows. It should be noted that this table is not all-inclusive for every type of development and/or land use. It is the responsibility of the design engineer or architect to coordinate all fire flow requirements with the City Engineer or designee and Fire Marshall, as the Department of Public Works and/or the Fire Department may require a fire flow greater than those shown in Table 4.10.

Table 4.10
Minimum Fire Flow Requirements

Type of Development/Land Use	Fire Flow Demand (gpm)
Single-Family Residential Development	1500
Multi-Family Residential Development	1500
Commercial Development	3000
Institutional Development	3000
Industrial Warehouse Development	4000

- D. **General Design Standards:** Fire hydrants must be located where they can be quickly found and easily used by fire engines arriving at an incident. Standardized location criteria are based on predictability, visibility, unobstructed accessibility, the type of development, Fire Department tactical needs, and the expected route fire engines will travel to the site.

Determining proper fire hydrant location requires application of engineering judgment and common sense to the specific conditions found in each project. Minor variances in the locations or spacing of individual hydrants may be approved provided the functional intent of these design standards is achieved.

1. All fire hydrants shall be Kennedy Guardian Model K-81 or Mueller Super Centurion 200, conforming to AWWA C502, the City of Rio Rancho Standard Drawing W-3 in Appendix C, and the standard products list.
2. Locate fire hydrants where they are readily visible by fire engines traveling along the street or approaching on intersecting streets. Never obscure or obstruct hydrants behind fences, gates, walls, or landscaping.
3. Existing fire hydrants on major streets, collector streets, or any other street having four (4) or more lanes of traffic, that are not divided by raised median islands can be included in the coverage analysis. If the streets are divided by raised median islands then the existing hydrant can only be included in the coverage analysis if its location is on the same side as the new development.

4. When designing a fire hydrant layout, the “first” hydrant is to be located at street intersections and at the main entrance(s) into a subdivision, apartment complex, or commercial development. Additional hydrants must then be spaced approximately evenly between these points at a distance not to exceed the maximum spacing between hydrants. Spacing is measured along route of travel of a fire engine.
 5. Fire hydrants separated from a subdivision, building, or other development by continuous fence, wall, or other obstruction cannot be counted as providing protection to that subdivision or development.
 6. A fire hydrant shall be placed within 30 feet of the end of all dead end water mains greater than 100 feet to facilitate flushing and maintenance of the water main (including all cul-de-sacs). Refer to Standard Drawing W-3 in Appendix C.
- E. **Residential Subdivision Hydrant Location Standards:** Fire hydrant locations will be reviewed and approved as part of the subdivision approval process and the following general design standards apply:
1. Start by locating a fire hydrant at the intersection of each public and/or private street entrance into the subdivision unless an existing fire hydrant meets spacing requirements.
 2. Then space additional fire hydrants approximately 500 feet apart along all public and/or private streets within the subdivision and along all perimeter streets.
 3. For cul-de-sacs, a fire hydrant shall be placed within 30 feet of the dead end water main. If dead end lines lengths are such that additional hydrants are required, assure that a minimum of 30 feet along the line is required between the fire hydrant and the line termination
- F. **Commercial and Multi-Family Hydrant Location Standards:** Fire hydrant locations will be reviewed and approved as part of the site plan/building permit approval process. Provide a site plan showing all existing and proposed fire hydrant locations, all designated fire lanes, and all fire department connections for building standpipe or sprinkler systems for comment and approval by the Fire Marshal.
- G. **Fire Hydrant Spacing:** Table 4.11 shows the maximum spacing for fire hydrants. Spacing distance shall be measure along the centerline of the street or route, which the fire truck will most likely travel.

**Table 4.11
Fire Hydrant Spacing**

Type of Development/Land Use	Maximum Fire Hydrant Spacing (ft)
Single-Family Residential	500
Single-Family Residential Cul-de-sac	350

Two-story Townhouses and Apartments	300
Commercial and Industrial Development	300
Institutional Development	300

Fire hydrants shall not be placed within six (6) feet of an above ground obstruction and shall have a minimum of 15 inches of clearance between ground and the lowest hydrant outlet cap and shall be as approved by the Fire Marshal. If required by the Department of Public Works, hydrants shall be located within water easements providing at least six (6) feet of clearance on all sides of the hydrant, including protective bollards as directed.

5.0 WATER PRODUCTION FACILITIES

5.1 GENERAL REQUIREMENTS

- A. **General:** This document in conjunction with City of Rio Rancho’s Standard Drawings, located in the appendix, provides guidance and minimum basic design criteria and standards, as set forth by the Department of Public Works for water production facilities within the City of Rio Rancho. It is intended for use in the planning and design process. Where not specified in these standards, the City Engineer will specify the standards to be applied to the design and construction of water production facility improvements in order to protect the public health, safety, and welfare of all those served by the water system in the City of Rio Rancho.
- B. **Project Site Requirements:** Prior to beginning the design of the facility, a detailed project site study and/or report shall be completed. This analysis should be conducted with input from the Department of Public Works to ensure that the lot or land area that is being considered is an adequate size and that the location has a functional hydraulic gradient. A hydraulic modeling analysis shall be performed on each project and is consistent with the City’s master plan. If appropriate the report must address the existing water source to provide adequate flow, static pressure, and fire flow. Consideration should also be given to electrical power supply to the facility.
- C. **Supervisory Control and Data Acquisition (SCADA):** All facilities shall include installation of full SCADA current technology meeting the City’s equipment requirements and specifications. The system is intended to provide continuous system status allowing operations staff to respond in a timely fashion to operational needs and emergency equipment failures. Installation of SCADA equipment is not limited to the following but includes, testing, startup and commissioning of the RTU, antenna, radio cable and all required accessories. The facility shall be interfaced and coordinated with the City’s system host location. All equipment required to be installed at the facility shall be SCADA compatible.

- D. **Electrical Power Supply:** The electrical design will include the service entrance, switch gear, motor control system, VFD cabinets system (if required), standby power system, conduit, wiring, lighting systems, SCADA, instrumentation systems and air conditioned cabinets where necessary.
- E. **On Site Sodium Hypochlorite Generation:** All production facilities shall expect to incorporate on-site sodium hypochlorite generation. The following requirements are not all inclusive but are intended to establish a benchmark for design to begin considering individual project needs. This process will require the installation of a building capable of maintaining a controlled environment for efficient equipment operation. The building needs to be large enough to house the salt (brine) tank, electrolytic cell / electrolyzer unit, hypochlorite solution tank, a water softener unit, a water chiller and to keep direct sunlight away from sensitive equipment. A waste connection to the sanitary sewer system or an on-site holding tank is also required.
- F. **Valves:** Valves shall be specified that are appropriate for potable water use from proven manufacturers. A piping/valve schedule shall include the valve size, type, class, flow range, actuator type, etc. Design consideration shall locate and install all valves in a manner that they can be operated without entering a vault in order to mitigate confined space regulations
- G. **Electromagnetic Flow Meter:** Each production facility requires the installation of a site production electromagnetic flow meter system with isolation valves for maintenance and repair. The meter design shall be an above ground installation with a rate of flow and totalizer read head.
- H. **Operations and Maintenance Manual:** An engineering consultant shall complete the preparation of operation and maintenance manuals and present them to the project manager before final project completion. A draft submittal of the manuals is to be submitted to the project manager for approval prior to start-up and commissioning. An electronic copy of the O & M document in the current approved software shall be included.
- I. **Start-up and Commissioning Period:** The construction project is functional only after demonstrating the completion of pressure testing, bacteriological testing and a final inspection. An acceptable flushing schedule and chlorine residual monitoring plan must be prepared to maintain and demonstrate an acceptable level of turnover during the early period of new project commissioning. Once substantial completion has been satisfied, the start-up and commissioning period is ready to begin. The start-up details and duration of commissioning shall be identified early on and listed in the project scope of work by the design engineer.

5.2 PRESSURE REDUCING STATIONS

- A. **General:** Pressure Reducing or Regulating Valves (PRV) are utilized to control pressures between distribution zones within the distribution system. When water main extension plans are submitted for review and water availability analysis, the need for

a PRV installation will be determined and located based on existing pressure zones and the existing distribution system layout by the Department of Public Works on a case-by-case basis.

- B. Pilot Controls:** Unless otherwise directed by the City all PRV installations shall include a valve control system, which includes pilot controls for pressure reducing and pressure sustaining functions. The pilot controls shall be field adjustable to accommodate any setting in the range of 50 psi to 100 psi.
- C. Design Standards:** New sites will be designed to meet capacity requirements using a dual or multiple valve arrangement. Bypass piping shall be ductile iron. A gate valve shall be installed both upstream and downstream of each PRV. Sizing of a PRV shall be based on the manufacturer's recommendations as determined by the design flow. PRVs and vaults shall be constructed in accordance with Standard Drawings W-8 and W-9 in Appendix C.
- D. Telemetry:** In certain situations, the Department of Public Works shall require monitoring of the valve(s) via SCADA equipment.

5.3 PUMPING FACILITIES

- A. General:** Water pumping facilities and booster stations shall conform to the requirements as set forth in NMED's Recommended Standards for Water Facilities and these design guidelines.
- B. Pumping Units and Size:** Pumping stations shall consist of a combination of pumps with the capacity to provide fire demand, maximum day demand, and maximum hour demand. Special care shall be exercised in the selection of pumping units and associated components to prevent pressure surges and insure the suitability, flexibility, and adaptability of the units to the hydraulic conditions of the system from which water is taken and the system into which water is pumped.

The horsepower rating of each pump motor shall be such that the motor will carry continuously the maximum load that is possible to develop at any point on the pump curve without exceeding 95 % the motor nameplate rating and without using the service factor.

- C. Design Criteria:** The minimum requirements by the Department of Public Works for pumping facilities and booster stations are as follows:
 - 1. Pump station shall be secured against unauthorized entry.
 - 2. Building architecture shall be aesthetically pleasing and compatible with the surrounding area.
 - 3. Provide an eight (8) foot tall masonry perimeter wall with locked entrance enclosing the compound. The wall shall be compatible with the surrounding environment, including landscaping.
 - 4. The facility entrance shall have a heavy duty cantilever slide access gate with an electric operator with battery backup and at least 20 feet clear entry space.

5. The station shall have a paved or graveled access road at least 12 feet wide with maximum slope not to exceed 12%. A 42-foot radius turn-around shall be provided if the access road exceeds 50 feet in length.
6. The interior of the compound shall be surfaced with 4-inches compacted aggregate base.
7. Pump station shall be located and designed to provide service vehicle access to major station components for maintenance and inspection purposes. This includes access and parking for several vehicles on pump station site.
8. Down cast facility lighting shall be provided with at least one photocell-operated light. A manual light switch shall be located next to the access gate in the interior of the compound.
9. A backup/emergency power supply capable of operating the pump station for eight hours during power outages shall be supplied. Specific criteria for backup generation type and capacity shall be given during the design process by the Department of Public Works.
10. Provide a spare pump and motor for backup capability.
11. Heavy equipment access for a boom crane or pump rig shall be incorporated in the site layout.
12. The site shall be graded to provide adequate drainage away from structures and to prevent water from backing up into the pump station from other sources.
13. Provide a frost proof gravity line or sump pump for pump station drainage.
14. Provide ventilation, heating, and cooling in the pump station.
15. **Supervisory Control and Data Acquisition (SCADA):** All facilities shall include installation of full SCADA current technology meeting the City's equipment requirements and specifications. The system is intended to provide continuous system status allowing operations staff to respond in a timely fashion to operational needs and emergency equipment failures. Installation of SCADA equipment is not limited to the following but includes, testing, startup and commissioning of the RTU, antenna, radio cable and all required accessories. The facility shall be interfaced and coordinated with the City's system host location. All equipment required to be installed at the facility shall be SCADA compatible
16. Ample clearances between equipment shall be provided for operation and maintenance activities. Sufficient space shall also be provided for future pump(s) and piping.
17. Piping configurations shall include the following minimums:
 - a. All piping within the pump station shall be lined and provided with restrained joints and be either DIP or fabricated steel.
 - b. Isolation valves shall be provided for each pump assembly.
 - c. Discharge piping shall include:
 - End spools
 - Flow control or check valve
 - Spool with NPT tapped outlets or welded couplings to accommodate a flow sensor and pressure gauge, etc.

- Hand wheels for all above ground gate valves
 - Reducing wye at the manifold
 - Restrained flexible closure section for access
18. Pump discharges shall be joined to a common header, which shall pass through an above ground electromagnetic flow meter with isolation valves and a valved bypass.
 19. A pressure relief/ surge anticipator valve shall be provided between the discharge header and the supply line.
 20. Depending on the motor size and electrical power system, provide soft start/soft stop motor starter that provides a wider range of rotor torque control at start up and shut down.
 21. Surge protection and control shall be provided.
 22. Electric power controls.
 23. Corrosion protection for underground steel and iron.
 24. On-site sodium hypochlorite generation system.
 25. All equipment exposed to weather shall be capable of operating under the local exposed conditions. This shall include meeting the appropriate NEMA rating and temperature ranges expected or as established by the Department of Public Works.
 26. Provide local and remote instrumentation for monitoring the following:
 - a. Discharge valve positions.
 - b. Discharge header pressure and flow.
 - c. Digital readout of Reservoir level (if applicable).
 - d. Upstream pressure (if applicable).
 - e. Suction header pressure (if applicable).
 - f. Pump status (on-off).
 - g. Gas engine stand-by generator status (on-off).
 - h. Total kilowatt demand (station).
 - i. Pump motor amperage and voltage with motor overload failures.
 27. Provide sensors and alarms to detect the following local and remote:
 - a. Water on the floor.
 - b. Bearing RTD for each pumping unit bearing.
 - c. Motor windings RTD for each pumping unit.
 - d. Building doors intrusion and interior motion detection.
 - e. High and low room temperature.
 - f. Electrical ground fault.
 - g. Low accumulator pressure (if applicable).
 - h. Power failure.
 - i. High and low reservoir level (if applicable).
 - j. Fire and/or smoke.

28. All facilities require site plan and building safety review and approval by the Department of Public Works. Such review may result in additional requirements that must be satisfied.

5.4 WELLS

- A. **General:** Wells shall conform to the requirements as set forth in NMED's Recommended Standards for Water Facilities and these design guidelines. A drilling permit from the New Mexico State Engineer's Office shall be obtained. A design report of system capabilities and production influence will be required.
- B. **Design Criteria:** The minimum requirements by the Department of Public Works for wells are as follows:
 1. An eight (8) foot tall masonry perimeter wall with locked entrance enclosing the compound. The wall shall be compatible with the surrounding environment, including landscaping.
 2. The facility entrance shall have a heavy duty cantilever slide access gate with an electric operator with battery backup and at least 20 feet clear entry space.
 3. The station shall have a paved or graveled access road at least 12 feet wide with maximum slope not to exceed 12%. A 42-foot radius turn-around shall be provided if the access road exceeds 50 feet in length.
 4. The interior of the compound shall be surfaced with 4-inches compacted aggregate base.
 5. Service vehicle access to major station components shall be incorporated in the station design.
 6. Down cast facility lighting shall be provided with at least one photocell-operated light. A manual light switch shall be located next to the access gate in the interior of the compound.
 7. A backup power supply capable of operating the pump station for eight hours during power outages shall be supplied. Specific criteria for backup generation type and capacity shall be given during the design process by the Department of Public Works.
 8. Heavy equipment access for a boom crane or pump rig shall be incorporated in the site layout.
 9. The site shall be graded to provide adequate drainage away from structures.
 10. On-site sodium hypochlorite generation system.
 11. Well casing.
 12. Screen.
 13. Column pipe.
 14. Discharge piping plus head.
 15. Check valve on discharge line.
 16. Hose bib type sampling tap on well side of check valve.
 17. Well vent.
 18. Pump plus motor.
 19. Sanitary well seal (air and water tight).
 20. Pump base concrete slab.

21. Air release valve between the pump and check valve.
22. After placement of the pump, wells shall be disinfected.

C. **Additional Design Requirements:** The following are additional design criteria as required by the Department of Public Works.

1. Well casings shall be continuous and watertight from top to bottom except for well screens. The casing shall extend a minimum of 24 inches above the 100-year flood level of record.
2. Well vents shall also terminate a minimum of 24 inches above the final ground elevation and not less than 24 inches above the 100-year flood level of record, whichever is higher. The vent shall be covered with a number 16 mesh screen. Any equipment that will permit direct open access to the well shall also meet the height requirements and shall be sealed or screened to prevent entrance of foreign matter, surface water, or contaminants into the well.
3. The pump base concrete slab shall extend a minimum of three (3) feet from the center of the well, be 6-inches thick and slope away from the well head a minimum of ¼ inch per foot. The site shall drain away from the well and be protected against erosion and surface runoff from entering the well.
4. The well screen diameter shall be the minimum size permitted that will maintain an aperture entrance velocity of 0.1-0.5 feet per second (fps) and a vertical velocity within the screen barrel of five (5) fps or less. The screen length, aperture size, and construction shall be in accordance with AWWA A100.
5. The well shall be sealed and protected from the entry of contaminants or water from any source other than the selected aquifers. Sealing of the well shall consist of grouting the following:
 - a. The annular space between the casing and the bore hole to a minimum depth required to exclude pollution, or 20 feet, whichever is greater.
 - b. All zones containing water of undesirable quality or zones to be protected but excluded from the final well completion. These areas shall be grouted from at least five (5) feet above the zone to at least five (5) feet below the zone.
 - c. All passages or formations that pollutants may enter such as outcrops, old wells, excavation, limestone, sandstone, fractured rocks.
6. Joints between screen sections and blank casing spacers shall be welded or threaded and be watertight, straight and strong as the screen.
7. The top of the well shall be constructed so that no foreign matter or surface water can enter during or after construction. On completion of the well, the well shall be temporarily capped to prevent surface pollutants from entering until pumping equipment is installed.
8. Below ground pits to house pumping equipment are prohibited.
9. Wells shall be constructed round, plumb, and true to line within the following tolerances:

- a. Maximum allowable horizontal deviation from the vertical shall not exceed 2/3 of the smallest inside diameter of the part of the well being tested per 100 feet of depth.
 - b. The alignment must be satisfactory for the successful installation and operation of the permanent pumping equipment.
 - c. Wells shall be tested for alignment and plumb in accordance with AWWA A100, Section 8.
10. New wells shall be performance tested to acquire water samples and to determine well capacity, draw down, and production on a long-term basis. Testing methods shall be in accordance with AWWA A100, Section 10.
 11. All facilities require site plan and building safety review and approval by the Department of Public Works. Such review may result in additional requirements that must be satisfied.

5.5 WATER STORAGE FACILITIES

- A. **General:** Water storage facilities shall conform to the requirements as set forth in NMED's Recommended Standards for Water Facilities and these design guidelines. All storage facilities shall have built-in provisions for draining as well as access and provisions for cleaning including a suitable source of water. The overall objectives of finished water storage are to:

1. Assist in meeting peak flow requirements.
2. Equalize system pressures.
3. Provide emergency water supply in case of component failure.
4. Provide for fire flows.
5. Provide additional needed treatment.
6. Permit high service pumps at treatment plants to operate at a relatively uniform rate.

Storage Capacity: Storage facilities shall have sufficient capacity to meet allocated domestic demands, fire flows, and emergency flows. Domestic demands are established using the criteria set forth in these standards. The Department of Public Works requires that storage facilities accommodate the following:

- B. **Design Criteria:** The minimum requirements by the Department of Public Works for water storage facilities are as follows:

1. An eight (8) foot tall masonry perimeter wall with locked entrance enclosing the compound. The wall shall be compatible with the surrounding environment, including landscaping.
2. The facility entrance shall have a heavy duty cantilever slide access gate with an electric operator and battery backup with at least 20 feet clear entry space.
3. The station shall have a paved or graveled access road at least 12 feet wide with maximum slope not to exceed 12%. A 42-foot radius turn-around shall be provided if the access road exceeds 50 feet in length.

4. The interior of the compound shall be surfaced with 4-inches compacted aggregate base.
5. Service vehicle access to major station components shall be incorporated in the station design.
6. Down cast facility lighting shall be provided with at least one photocell-operated light. A manual light switch shall be located next to the access gate in the interior of the compound.
7. A backup power supply capable of operating the pump station for eight hours during power outages shall be supplied. Specific criteria for backup generation type and capacity shall be given during the design process by the Department of Public Works.
8. Heavy equipment access for a boom crane shall be incorporated in the site layout.
9. The site shall be graded to provide adequate drainage away from structures.
10. On-site sodium hypochlorite generation system
11. On-line free chlorine analyzer with SCADA output.
12. Storage tank with acceptable interior and exterior coating systems for potable water.
13. Concrete foundation ring.
14. Inside and outside steel ladders.
15. Outside ladder safety cage with locking security gate at base.
16. Probe bottles.
17. Exterior water level indicator.
18. Intruder resistant tank vent housing.
19. Thirty-six inch square-hinged roof access openings with inside ladder.
20. Cathodic protection.
21. Overflow pipe and splash pad.
22. Overflow weir.
23. 24 inch flanged inspection hatch centered over weir.
24. Hinged shell manhole.
25. Altitude valves, isolation valves, bypass line, and vault.
26. Tank discharge line.
27. Tank fill line.
28. Booster station suction line (where applicable).
29. Tank drain.
30. Disinfection system.
31. Electrical and telemetry system.
32. Pressure transmitter for telemetry.
33. A clear area around reservoir to allow vehicle passage. Clearance width shall be sized in consultation with the Department of Public Works.

D. **Chlorination System Requirements:** Due to the nature of storage projects, no set design criteria can be maintained for all sites. A general set of criteria has been developed in order to provide guidelines for the design of each site. Based on previous analysis, the following is a list of these general guidelines:

1. Monitor the chlorine residual in a continuous sample taken from a location that will be representative of the chlorine level in the reservoir.
2. If the chlorine residual falls below a set point of 0.2 ppm, for example, then the chlorine additive system is activated.
3. When the chlorine system is activated, a recirculation pump starts and a chlorine solution is added to the water to raise the free chlorine level in the recirculation water to approximately 0.8 ppm (with the capacity to go to 1.0 ppm or higher).
4. The recirculation pumps will be sized to turn the full volume of the reservoir over in a maximum of three (3) days. Each site will have somewhat different points from which the recirculation pump will draw suction. The typical discharge point will be approximately 180 degrees from the inlet/outlet piping. Using this piping system, the chlorinated water will be dispersed into the stored water and eventually turn the volume of reservoir over with chlorinated water.
5. When the chlorine residual in the continuous sample reaches a set point of about 0.8 ppm, the recirculation pump and the chlorine feed facilities will stop.
6. When the chlorine residual in the continuous sample reaches a set point of approximately 0.4 ppm, the recirculation pump, without the chlorination system, will be started. This will help to circulate any newly added water with adequate chlorine residual and maintain a minimum chlorine level in the reservoir.

**Table 5.1
Chlorine Facilities Minimum Design Criteria**

Item	Design Criteria
Low Level Chlorine	0.2 ppm
High Level Chlorine	0.8 ppm
Design Chlorine Dosage	1.0 ppm
Volume Turnover Maximum Time Required	3 days
Chlorine Monitoring	Constant, amperometric method

5.6 WELL ABANDONMENT

- A. Production and monitoring wells no longer in use shall be plugged in such a manner as to prevent migration of surface runoff or ground water along the length of well casing. Where possible, this shall be accomplished by removing well casing and pumping expanding cement from the bottom to top of well using a tremmie pipe. If casing cannot be removed, the casing shall be ripped or perforated and pressures

grout its entire length.

- B. Filling with bentonite pellets from the bottom to the top is an acceptable alternative to pressure grouting.
- C. After abandonment, written notification must be submitted to the GWPPS (Ground Water Pollution Prevention Section) with date and method of abandonment.

6.0 WASTEWATER COLLECTION SYSTEM

6.1 GENERAL REQUIREMENTS

- A. **General:** This document in conjunction with City of Rio Rancho's Standard Drawings, located in the appendix, provides guidance and minimum basic design criteria and standards, as set forth by the Department of Public Works, for providing and maintaining the public sewage collection system of the City of Rio Rancho. It is intended for use in the planning and design process. Where not specified in these standards, the City Engineer or designee will specify the standards to be applied to the design and construction of public sanitary sewer improvements in order to protect the public health, safety, and welfare of all those served by the sewer system in the City of Rio Rancho.

6.2 SUBMITTALS

- A. **General:** A design or Utility Engineering report shall be completed and submitted to the Department of Public Works, unless waived by the City Engineer or designee. The requirements and format of this report are outlined and detailed in Section 2 of these standards.

6.3 WASTEWATER DESIGN FLOWS

- A. **General:** Wastewater design flows utilized in the preparation of engineering design reports, plans, and specifications shall as a minimum conform to the criteria set forth in this section. Alternate methods for determining design flows will be considered by the Utility Systems Engineer on a case by case basis.
- B. **Population Densities:** The City of Rio Rancho uses a population equivalent of **2.78 persons/dwelling unit (DU)** for the determination of wastewater flows.
- C. **Average Daily Flows:** Average daily flow estimates based on land development/use shall conform to Table 5.13. The average day values indicated in the table represent minimum estimates for determining design flows. Where a proposed development is known (based on specific applications and/or use), and the anticipated wastewater flows exceed the minimum forecast demands, the greater flow shall be used to determine the design flows. Where the project land does not fit within the tabulated categories, an average daily unit flow of 210 gallons per dwelling unit per day shall be used.

Table 6.1

Average Daily Wastewater Flow Estimates

Type of Development/Land Use	Average Daily Flow
Residential	175 gpd/DU
Light Commercial	1,230 gal/ac-day
Heavy Commercial	5,968 gal/ac-day
Light Institutional	226 gal/ac-day
Heavy Institutional	1,788 gal/ac-day
Light Industrial	447 gal/ac-day
Medium Industrial	1,680 gal/ac-day
Heavy Industrial	9,266 gal/ac-day

- D. **Peaking Factors:** All gravity sewers, lift stations, and force mains shall be designed for peak flow conditions. Peak dry weather flow is calculated as the product of the peaking factor and the average daily flow. For all sewer main diameters a peak dry weather factor of 3.0 shall be used unless otherwise approved by the Department of Public Works.
- E. **Wastewater Collection Main Design Flow Criteria:** The following is a list of the major design flow criteria for wastewater collection lines.
1. Wastewater collection mains shall be designed to convey the peak flow.
 2. Wastewater collection mains shall be designed to meet minimum slope and velocity requirements as set forth in these design standards.
 3. Wastewater collection mains designs shall avoid exceeding maximum slope and velocity conditions as set forth in these design standards.
 4. The peak flow shall be determined using average day flows adjusted by a peaking factor and including the allowed and any existing system infiltration or inflow.
 5. Flow capacity and loading data of existing and future conditions for the City’s major wastewater collection system shall be obtained from the Department of Public Works for use in designing and analyzing proposed improvements.
 6. Average day and ultimate/final design flow estimates shall be well documented and shall include calculations for the following: the ultimate service area, population density, existing and anticipated wastewater flow, existing and anticipated industrial/commercial discharge, and projected infiltration/inflow.

7. Surface water, ground water, or cooling water shall not be discharged into the wastewater collection system. Prohibited connections include roof drains, storm inlets, foundation perimeter drains, area drains for open patios or driveway entrances to parking structures, and ground water sump systems.

6.4 GRAVITY SANITARY SEWER LINES – DESIGN CRITERIA

- A. **General:** All issues and elements presented in this section are typically included and must be addressed in all wastewater infrastructure projects. The design and construction of gravity sanitary sewer mains shall conform to the design standards in this manual and Standard Drawings S-4 and S-5 in Appendix C.
- B. **Jurisdictional Agency Approvals:** One very critical task in the early stages of the project is the development of an agency approval list. These approvals and/or close coordination required by these agencies will impact the successful and timely completion of the project. All appropriate department levels affected within the City, County, State, and Federal agencies need to be contacted for their individual requirements.
- C. **Environmental and Cultural Regulatory Requirements:** This section is not intended to be all encompassing, rather provide an overview of the environmental and cultural requirements and the typical agency involvement. A thorough consideration of the environmental and cultural impact of the project at its specific location shall be evaluated to identify the various requirements. Private developers shall be responsible for regulatory compliance and for obtaining the required permits for their projects.

In specific areas where a project impacts Water of the United States, a Clean Water Act, Section 404 Permit shall be required from the U.S. Army Corps of Engineers.

Compliance is required with the U.S. EPA under the Stormwater National Pollutant Discharge Elimination System (NPDES) general permit for stormwater discharges from construction sites.

Projects shall not adversely impact threatened or endangered species or their habitat and shall comply with the Federal Endangered Species Act. To address any biological requirements, an assessment report of the project may be required by the U.S. Fish and Wildlife Service and the New Mexico Fish and Game Department.

Projects shall not adversely impact historic or prehistoric properties. Projects shall comply with the National Historic Preservation Act and the State Historic Preservation Act.

- D. **Community Notification and Public Involvement:** The City is committed to early citizen notification and involvement. Identifying neighborhood concerns is a priority and good communication is required throughout the public involvement phase of all projects.

- E. **Acceptable Pipe Materials:** The type of pipe to be installed shall comply with these standards, meet NMAPWA specifications, and shall be based upon applicable design flows, pressures, site conditions, corrosion protection, and maintenance requirements. Gravity sewer mains shall be either polyvinyl chloride pipe (PVC), ductile iron pipe (DIP) or high density polyethylene pipe (HDPE).
- F. **Roughness Coefficient:** The wastewater collection system shall be designed for gravity (open channel) flow conditions, using a Manning's roughness coefficient, "n factor," of 0.009 for HDPE (smooth wall), 0.011 for PVC pipe and 0.013 for DIP.
- G. **Pipe Sizing:** Gravity sewer lines shall be sized to accommodate the peak design flow subject to the following limitations:
1. At the peak dry weather flow condition, the following shall be maintained for gravity sewer pipes:
 - a. d/D ratio shall be no greater than 0.75
 - b. q/Q ratio shall be no greater than 0.85
 2. The minimum pipe size shall be 8 inches.
 3. All changes in pipe size shall require a manhole at the size change. The design shall call for differing pipe sizes to match soffits at the entrance and exit of the manhole. The soffit is the bottom of the top of the pipe or the uppermost point on the inside of the structure.
- H. **Depth/Cover:** Gravity sewer lines shall be sufficiently deep to ensure gravity drainage of service connections and avoid conflicts of service connections with water mains and dry utilities. Sewer lines shall be installed at the depth required to serve the ultimate gravity drainage area, which may include areas outside of the development project.
1. **Minimum Cover:** All collection mains shall have a minimum depth of cover of four (4) feet, measured from the top of the pipe to the final surface grade.
 2. **Shallow Cover Protection:** Where collection main depths are less than four (4) feet, and the main is located under a right-of-way, street, driveway, parking lot, or areas where live loading is a concern, special pipe materials (such as ductile iron pipe) or other structural measures (such as concrete or steel encasement) shall be provided in accordance with Standard Drawing S-5 in Appendix C.
 3. **Provision for Basements:** Proposed collection mains shall be designed with adequate depth to provide wastewater service to basements, where possible and appropriate.
- I. **Slope and Velocities:** Sewers shall be laid with a constant and uniform slope between manholes. All changes in slope shall require a manhole at the slope change connection. Collection mains shall be designed with an adequate slope to achieve flow velocities of at least 2.0 ft/s when flowing full. Design velocities shall not

exceed 10 ft/s. Table 6.2 shows the minimum and maximum slopes required in different size gravity sewer pipes.

Table 6.2
Minimum and Maximum Design Slopes

Pipe Size in inches	Minimum Design Slope	Maximum Design Slope
	%, (ft/ft)	%, (ft/ft)
8	0.500 (0.0050)	8.50 (0.0850)
10	0.280 (0.0028)	6.25 (0.0625)
12	0.220 (0.0022)	5.00 (0.0500)
15	0.150 (0.0015)	3.75 (0.0375)
18	0.120 (0.0012)	2.80 (0.0280)
21	0.100 (0.0010)	2.40 (0.0240)
24	0.080 (0.0008)	2.00 (0.0200)
27	0.068 (0.00068)	1.70 (0.0170)
30	0.060 (0.0006)	1.50 (0.0150)
36	0.048 (0.00048)	1.15 (0.0115)

J. **Alignment and Easement Requirements:** The following alignment and easement requirements shall be followed for gravity sewer line designs. Note that these requirements will be different for sanitary sewers that are HDPE.

1. Sewers shall be laid with straight alignments between manholes.
2. Sewer alignment shall not meander across the street centerline.
3. Sewers shall be located in street right-of-ways and the alignments shall be parallel to property lines or street centerline, or as close as possible.
4. Sewer lines are to be located within the public right-of-way and aligned in accordance with the Utility Locations as shown in the Typical Plan View for Streets” drawings in Appendix C. Sewer lines shall be located so they can be maintained without disturbing any sidewalk, curb, gutter, structure, or any other utility.
5. If it not possible to utilize designated public right-of-way or align in accordance with the Utility Locations, alternate alignments will be considered and must be approved by the City Engineer or designee.
6. If not in a public right-of-way, the sewer line must be located in a permanent easement. A permanent easement must be granted (and dedicated to the City of Rio Rancho) for the exclusive use of sanitary sewer and water, unless

shared use with other utilities is coordinated and approved in advance by the Department of Public Works. A minimum easement width of 20 feet (or more) is required for a single utility and 25 feet (or more) for sewer and water both within the same easement.

7. Sewer and water easements shall be free of all obstructions and shall at all times be accessible to City service equipment. No buildings, sport courts, walls, fences, shade structures, nor permanent structures of any kind shall be constructed upon, over, or under and water/sewer line easements. No landscaping shall be placed and/or planted within the easement that would render the easement inaccessible by equipment. The Utilities Division has the right to have any obstruction removed without notice to the property owner and all cost associated with the removal shall be the property owner's responsibility. The maintenance of all landscaping in sewer line easements is the responsibility of the property owner.

- K. **Sewer Main Connections at Manholes:** Gravity sewer main connections (not services) at a manhole are described as the upstream pipe connection, the downstream pipe connection, and the intersecting pipe connections. Gravity sewer main connections shall be in accordance with Standard Drawings S-3, S-10, and S-15 in Appendix C. There shall be no more than four main connections at a manhole.

Flow will not be permitted to change horizontal flow direction by more than 90 degrees in a manhole. Under the following conditions, the maximum horizontal change in flow direction permitted will be 50 degrees although special design considerations will be made where the situation warrants:

1. All lines larger than 36 inches.
2. Any lines with design flow greater than 3.0 MGD and a design velocity of 5.0 ft/s or greater.
3. Any junction of two flows, each with design flow greater than 3.0 MGD, where one line has a design pipe velocity of 5.0 ft/s or greater.

The upstream pipe shall be the same or smaller diameter than the downstream pipe. The design shall call for differing pipe sizes to match soffits at the entrance and exit of the manhole.

Where onsite sewage collection systems from developments connect to mains on arterial streets, the invert of the intersecting pipe should be at or above the crown elevation of the downstream pipe. Intersecting pipes shall be of equal or smaller diameter than the downstream pipe.

In all cases, the invert of the downstream pipe shall be at least 0.1 feet lower than the invert of the upstream pipes and intersecting pipes and shall be low enough to maintain the energy gradient across the manhole.

- L. **Cross Connections:** There shall be no physical connections between a public or private potable water supply system or storm drainage system and a sanitary sewer, or

appurtenance thereto which would permit the passage of any wastewater or polluted water into the potable supply or storm drainage system. No water pipe shall pass through or come into contact with any part of a sanitary sewer manhole.

- M. **Separation from Water Mains:** To minimize the potential for cross contamination, gravity sanitary sewer mains and force mains shall be laid at least 10 feet horizontally from any existing or proposed water line. In situations where it is not feasible to maintain a 10-foot separation the design engineer may propose a reduced distance. Such reductions may only be approved and granted by the City Engineer or designee and may be allowed provided the sewer main is laid in a separate trench or an undisturbed earth shelf located on one side of the water line at an elevation so that the bottom of the water main is at least 18 inches above the top of the sewer line.

Gravity sanitary sewer mains and force mains crossing water lines should be laid to provide a minimum separation of 18 inches between the outside of the sewer main and outside of the water line. This separation should be maintained where the sewer main is either above or below the water line. The crossing should be arranged so that the water main joints will be equidistant and as far as possible from the sewer line.

Where it is impracticable to obtain proper horizontal and vertical separation, the sewer line should be designed and constructed equal to the water main and should be pressure tested to assure water tightness. Encasement of the water line may also be required by the City Engineer or designee in accordance with Standard Drawing S-5 in Appendix C.

- N. **Separation from Storm Drains and Culverts:** Sewer mains shall maintain six (6) feet horizontal and two (2) feet vertical separation from storm drains and culverts as measured between the crown of the lower and invert of the upper. Sewer lines crossing less than two (2) feet below a storm drain or culvert will require pipe encasement. Whenever possible, the sanitary sewer should be placed below the storm sewer.
- O. **Separation from Other Utilities:** Sewer mains shall maintain a minimum six (6) feet horizontal separation and two (2) feet vertical separation to any underground utility, all measurements outside to outside.
- P. **Locator Tape and Tracer Wire:** Install detectable marking tape continuous over the top of the pipe. The marking tape shall be buried eighteen (18) inches over the top of the buried force main. 12 gage tracer wire shall also be buried along with the pipe.
- Q. **Buoyancy:** Buoyancy of sewers shall be considered and flotation of the pipe shall be prevented with appropriate construction where high groundwater conditions are anticipated.
- R. **Trenching, Bedding, and Backfill:** Trenching, bedding, and backfill for shall conform to NMAPWA standards and Standard Drawing S-4 in Appendix C.

- S. **Testing Procedures:** Air testing, exfiltration testing, vertical deflection testing, and televising of sanitary sewer pipes shall follow and adhere to the requirements and protocols as outlined in the NMAPWA specifications.

6.5 MANHOLES – DESIGN CRITERIA

- A. **General:** The design and construction of gravity sanitary manholes shall conform to the design standards in this manual and Standard Drawings S-1, S-2, and S-3 in Appendix C.
- B. **Manhole Locations:** Manholes shall be installed at the following locations:
1. Changes of grade or slope
 2. Changes of pipe size
 3. Changes of horizontal or vertical alignment
 4. Changes in pipe material
 5. Pipe intersections except with service connections less than 8-inches in diameter
 6. Service connections 8-inches in diameter and larger
 7. The end of each public sewer line
 8. At distances not to exceed the spacing shown below

Where feasible, manholes are to be installed at street intersections. Manholes should also be located outside of bike lanes, sidewalks, or multi-use paths whenever possible. Manholes shall not be located in areas subject to immersion during storm events, such as gutters and ponding areas.

Direct access by maintenance vehicles shall be provided to each manhole. The access drive shall be a minimum of 10 feet in width and shall be an all-weather surface, such as asphalt or concrete paving, or adequate gravel base and shall be capable of supporting maintenance vehicles weighing up to 14 tons.

- C. **Manhole Spacing:** Manholes shall be required along collection mains at distances not greater than the maximum manhole spacing as shown in Table 6.3 below.

**Table 6.3
Maximum Manhole Spacing**

Pipe Size (inches)	Maximum Manhole Spacing (feet)
≤ 21	450
≥ 24	500

- D. **Manhole Diameter:** The minimum manhole diameters and standard frame and cover sizes for various pipe sizes are shown in Table 6.4 below.

**Table 6.4
Minimum Manhole Diameters**

Pipe Diameter (inches)	Manhole Depth (feet)	Minimum Manhole Diameter (inches)	Minimum Frame and Cover Diameter (inches)
≤ 15	≤ 12	48	30
≤ 15	> 12	72	30
> 15	any	72	30

- E. **Clean Outs:** Shall conform to the design standards within this manual and Standard Drawing S-12 in Appendix C. Clean outs are not permitted on mains.
- F. **Manhole Stub Outs:** Manholes on the boundaries of subdivisions and at other locations directed by the City Engineer or designee shall include full line size stubs with shaped inverts, oriented to accommodate future connections or extensions. All 20-foot stub outs shall be plugged.
- G. **Manhole Separation from Water Mains:** No water pipe shall pass through or come into contact with any part of a sewer manhole or connection structure.
- H. **Drop Manholes:** Drop manholes shall be required where the invert of the upstream pipe section entering the manhole is greater than two (2) feet above the invert of the downstream pipe section exiting the manhole. Drop manholes shall be designed and constructed in accordance with Standard Drawing S-10 in Appendix C.
- I. **Flow Channel:** Flow channels shall be required in all manholes, connecting the inverts of the upstream and downstream pipe sections. The flow channel straight through a manhole shall be made to conform as closely as possible in shape, and slope to that of the connecting sewers. Flow channel height and slope requirements are shown in Tables 6.5 and 6.6 below.

Table 6.5
Minimum Flow Channel Heights

Pipe Diameter (inches)	Minimum Flow Channel Heights
< 15	½ of the pipe diameter (to pipe centerline)
> 15	¾ of the pipe diameter

**Table 6.6
Minimum Flow Channel Slopes**

Type of Manhole/Flow Channel	Minimum Flow Channel Slope
Manholes on continuous slope, straight alignment pipe lines	2.5% slope from entrance to exit
Manholes at changes in pipe size	Match soffits at entrance and exit of manhole

- J. **Bench:** A bench shall be provided on each side of any manhole channel when the pipe diameter(s) are less than the manhole diameter. The bench shall be sloped to provide a minimum 3-inch fall from the top of the bench to the crown of the pipe or one-half inch per foot (1/2"/ft), whichever is greater. No lateral sewer, service connection, or drop manhole pipe shall discharge onto the surface of the bench. Refer to Standard Drawing S-3.
- K. **Water Tightness:** Manholes shall be of the pre-cast concrete or cast-in-place concrete type. Manhole lift holes and grade adjustment rings shall be sealed with non-shrinking mortar. Inlet and outlet pipes shall be joined to the manhole with a gasketed flexible watertight connection or any watertight connection arrangement that allows differential settlement of the pipe and manhole wall to take place. Refer to Standard Drawing S-3. Other materials may be used for specific applications as approved by the City Engineer.
- L. **Covers:** Where manholes must be located within the 100-year floodplain, or in a location where runoff may accumulate and pond, the manhole shall be installed with a watertight, bolting-type cover to prevent inflow/outflow. The manhole ring shall be bolted to the manhole cone to prevent possible damage due to surcharge. Locked manhole covers with bolting-type covers may be desirable in isolated easement locations or where vandalism may be a problem. Manhole frames and covers shall be designed and constructed in accordance with Standard Drawings S-1 and S-2 in Appendix C.
- M. **Testing:** Manholes shall be tested for leakage in accordance with NMAPWA specifications.
- N. **Corrosion Protection for Manholes:** Where corrosive conditions due to septicity or other causes are anticipated, consideration shall be given to providing corrosion protection on the interior of the manholes.

6.6 SERVICE CONNECTIONS

- A. **General:** Service connections to the City of Rio Rancho wastewater system shall conform to Article 51.08 of Chapter 51 of the Rio Rancho Code of Ordinances and Standard Drawings S-6, S-7, and S-8 in Appendix C.

- B. **Taps:** Wastewater service connections to newly constructed collection mains shall require the installation of a tee or wye, in conformance with these standards. A directional fitting shall be used at all tap connections.
- C. **Separate Service to Lots:** All platted lots, whether existing or proposed as part of a subdivision, shall front on and have a separate wastewater service connection to a collection main without crossing adjacent lots.
- D. **Service Alignment:** Wastewater services shall be installed perpendicular to the collection main, for that portion of the service line that is located in the public right-of-way or easement. Where this is not possible, the wastewater service alignment shall be subject to determination by the City Engineer or designee.
- E. **Service Connection Sizes:** Table 6.7 below shows the service connection sizes based on the development type.

Table 6.7
Service Connection Sizes

Development Type	Service Connection Size (inches)
Residential Lots	4 or 6
Commercial Lots	Minimum 6
Multiple Family Lots	Minimum 6
Industrial Lots	Minimum 6

- F. **Separation from Water Service:** Wastewater services shall maintain a minimum horizontal separation of ten (10) feet from water services.
- G. **Maximum Main Size for Taps:** Service connections shall not be directly made into sewer mains 30-inches in diameter and larger. Service connections shall require a minimum 8-inch public sewer main extension, which shall be constructed from the nearest downstream manhole to the point of service.
- H. **Prohibited Connections:** No surface water or ground water, may be discharged into the wastewater service. Prohibited connections include roof drains, storm inlets, foundation perimeter drains, area drains for open patios or driveway entrances to parking structures, and ground water sump systems.
- I. **Manhole Connections:** Service connections to manholes shall be avoided, except where:
 - 1. The service size is 8 inches in diameter or larger (which requires the installation of a manhole);

2. The service connection is tied to a terminal manhole, located at the end of a cul-de-sac or easement, and there is no possibility of extending the collection main in the future;
3. The service connection elevation cannot be tapped above the springline of the sanitary main.

J. **Service Connection Installation:** Service connections to the sewer main shall be watertight and not protrude into the sewer. Saddle type connections shall not be used. All materials used to make service connections shall be compatible with each other and with pipe materials to be joined and shall be corrosion proof.

Normally taps extend at right angles to the main. When a tap is made at a manhole the tap may be installed at an angle to the main providing the installation does not restrict flow. The invert of the service connection shall be at or above the crown of the sewer main.

6.7 WASTEWATER LIFT STATIONS

- A. **General:** Shall be designed according to the NMED, Construction Programs Bureau, “Recommended Standards for Wastewater Facilities, 2003 Edition (or latest version).”
- B. **Design Analysis Report (DAR):** In addition to meeting the requirements set forth in the “Recommended Standards for Wastewater Facilities, 2003 Edition”, the design engineer shall submit a DAR to the City of Rio Rancho, Utility Department, for review.
 1. Table 6.8 summarizes the minimum requirements of a lift station DAR.

**Table 6.8
Lift Station DAR Requirements**

Item	Description
1.	Average Influent Station Flow, gpm
2.	Peaking Factor
3.	Wet Well Volume, gallons and cubic feet
4.	Average Flow Fill Time, minutes
5.	Peak Flow Fill Time, minutes
6.	Diameter of Proposed Force Main, inches
7.	Velocity in the forcemain under normal operating conditions (if multiple pumps are used, velocity for each multiple pump operation condition should be shown)
8.	Pump and System Curve with Duty Point, including the Duty Point for parallel pump operation if applicable.
9.	Pump Time based on Average Flow, minutes
10.	Pump Time based on Peak Flow, minutes

11.	Number of Pump Cycles per Hour
12.	Surge Analysis and Recommendations
13.	4 floats – “stop”, “lead”, “lag”, and “high”
14.	Grading and Drainage Plan – Slope site for accessibility of a vector truck (<3%)
15.	Instrumentation and Control considerations including SCADA, alarms, etc. Provide a transducer with digi-gauge output to SCADA
16.	Site Layout including emergency generator (ATS) location and overflow prevention location, a 12-foot all weather access road, and a security fence with a 14-foot wide rolling gate for service vehicles.

2. All new lift stations shall be provided with an on-site, permanently installed, emergency generator sized to provide emergency electrical service to the site. Calculations justifying the size of the generator shall be provided. In addition the lift station shall have a spare pump and site lighting.

6.8 Force Mains

- A. **General:** All force mains shall be designed according to the NMED, Construction Programs Bureau, “Recommended Standards for Wastewater Facilities, 2003 Edition (or latest version).”
- B. **Cleanouts:** Cleanouts will be installed at a maximum spacing of every five hundred (500) feet or not to exceed a volume of wastewater over three thousand (3,000) gallons between cleanouts. Special consideration will be given to cleanout spacing where the required force main diameter is larger than twelve (12) inches. The cleanouts will be constructed in accordance with the City of Rio Rancho Standard Drawing S-13, unless otherwise specified by the City of Rio Rancho City Engineer or designee.
- C. **Locator Tape and Tracer Wire:** Install detectable marking tape continuous over the top of the pipe. The marking tape shall be buried eighteen (18) inches over the top of the buried force main. 12 gage tracer wire shall also be buried along with the pipe.
- D. **Leakage Testing:** All force mains within the City of Rio Rancho wastewater service area shall be hydrostatic tested at a minimum of fifty (50) psi above the design working pressure.

APPENDIX A: DEFINITIONS

Alkalinity – The quantitative capacity of water or water solution to neutralize an acid. It is usually measured by titration with a standard acid solution of sulfuric acid, and expressed in terms of its calcium carbonate equivalent. A moderate amount of alkalinity in water is desirable because it reduces the effect of corrosion.

Ammonia – A form of nitrogen that exists in aqueous solution as either the ammonium ion or ammonia, depending on the pH of the solution.

Average day demand or flow – The average daily demand or flowrate occurring over a 24-hour period based on total annual demand or flowrate data.

Biochemical oxygen demand (BOD) – The amount of oxygen consumed in the oxidation of organic matter by biological action under specific standard test conditions. Widely used as a measure of the strength of sewage and wastewater.

“C” factor – Hazen-Williams roughness coefficient describing the roughness of the pipe in which the flow occurs.

Chemical oxygen demand (COD) – The amount of matter, both organic and inorganic, in a water or wastewater which can be oxidized by boiling with a strong oxidizing acid under standard test conditions and expressed as the equivalent amount of oxygen.

Crown – The highest point on a transverse section of conduit.

Duty point – The intersection of the system curve and the pump curve which gives the operating point of the given pump for a given pipeline system.

Fire flow – A volume of water required to provide fire protection.

Hazen-Williams formula – The most widely used empirical headloss equation.

Headloss – A decrease in water pressure during flow due to internal friction between molecules of water, and external friction due to irregularities or roughness in surfaces past which the water flows.

Infiltration - Water entering a sewer system, including sewer service connections, from the ground through such means as defective pipes, pipe joints, connections, or manhole walls.

Infiltration/Inflow (I/I) – Extraneous flows in sewers.

Inflow – Stormwater runoff entering the sewer system from sources such as roof leaders, yard and areaway drains, manhole covers, cross connections from storm drains and catch basins, and combined sewers.

Minimum day demand or flow - The minimum demand or flowrate that occurs over a 24-hour period based on annual operating data.

Nitrate – A form of nitrogen that is the most highly oxidized. Nitrates are commonly found in well water from agricultural areas. It comes from fertilizers, industrial wastes, septic systems, and animal wastes. High amounts of nitrate affect the blood’s ability to carry oxygen.

Nitrite – A highly unstable form of nitrogen which is easily oxidized to the nitrate form. It is an indicator of past pollution and is extremely toxic to most fish and other aquatic species.

Parts per million (ppm) – A common basis for reporting the results of water and wastewater analyses, indicating the number of parts by weight of a dissolved or suspended constituent, per million parts by weight of water or other solvent. In dilute water solutions, one part per million is practically equal to one milligram per liter.

Peak (maximum) day demand or flow – The maximum demand or flowrate that occurs over a 24-hour period based on annual operating data.

Peak hour demand or flow – The peak sustained hourly demand or flowrate occurring during a 24-hour period based on annual operating data.

Peaking factor – The ratio of peak flowrate or demand to average flowrate or demand.

pH – The reciprocal of the logarithm of the hydrogen ion concentration. The pH scale is from zero to 14, and 7.0 is the neutral point, indicating the presence of equal concentrations of free hydrogen and hydroxide ions. pH values below 7.0 indicate increasing acidity, and pH values above 7.0 indicate increasing base concentration.

Phosphorus – An essential element to the growth of algae and other biological organisms.

Pump curve – Also referred to as a pump characteristic curve or performance curve shows the relationship between head developed by the pump, its efficiency, its brake horsepower, and the rate of discharge.

Soffit – The bottom of the top of a pipe. In a sewer pipe, the uppermost point on the inside of the structure.

Springline – The line of the outermost points of the sides of the conduit.

Sulfate – Sulfate is a natural forming mineral found in water. Sulfate effects the taste of water and when combined with bacteria or heated may effect the odor.

Sulfide – A product of the biological reduction of sulfates under anaerobic conditions.

System curve – A graphical relationship between system head (developed from ordinates which are the sum of the static lift and the pipe friction) at various discharge/flow conditions.

Total Kjeldahl Nitrogen (TKN) – Total of the organic and ammonia nitrogen.

Total suspended solids (TSS) – The suspended fraction of the solids in a water sample that can be removed through filtration.

APPENDIX B: ABBREVIATIONS

ANSI	American National Standards Institute
ASTM	American Society for Testing and Materials
ATS	Automatic Transfer Switch
AWWA	American Water Works Association
BMPs	Best Management Practices
BOD ₅	5-day Biochemical Oxygen Demand
C.F.R.	Code of Federal Regulations
COD	Chemical Oxygen Demand
D	pipe diameter
d	partial depth of flow in pipe
DAR	Design Analysis Report
DIP	Ductile Iron Pipe
DU	Dwelling Unit
EPA	Environmental Protection Agency
ft	feet
fps = ft/s	feet per second
gal/ac-day	gallons per acre per day
gpd	gallons per day
gpm	gallons per minute
HDPE	High Density Polyethylene Pipe
ID	inside diameter
MGD	million gallons per day
mpd	minutes per day
NEMA	National Electrical Manufacturers Association
NGVD	Natural Ground Vertical Datum

NH ₄	Ammonia
NMAPWA	New Mexico Chapter – American Public Works Association
NMED	New Mexico Environment Department
NO ₃	Nitrates
NO ₄	Nitrites
NOI	Notice of Intent
NOT	Notice of Termination
NPDES	National Pollutant Discharge Elimination System
NPT	National Pipe Thread
OD	outside diameter
PC	point of curvature
PRV	pressure reducing valve
psi	pounds per square inch
PVC	Polyvinyl Chloride
Q	full pipe flow rate
q	partial flow rate in pipe
SCADA	Supervisory Control and Data Acquisition
SSCAFCA	Southern Sandoval County Arroyo and Flood Control Authority
SWPPP	Storm Water Pollution Prevention Plan
TKN	Total Kjeldahl Nitrogen
TSS	Total Suspended Solids
USGS	United States Geological Society
%	percent

APPENDIX C: STANDARD DETAILS AND DRAWINGS

The most current standard details and drawings are available from the Department of Public Works at the City's website: www.ci.rio-rancho.nm.us

- S-1Sewer Manhole Cover Type "C"
- S-2 (1 of 2).....Sewer Manhole Frames and Covers
- S-2 (2 of 2).....Sewer Manhole Frames and Covers
- S-3 (1 of 2).....Standard Concrete Manhole
- S-3 (2 of 2).....Standard Concrete Manhole
- S-4.....Pipe Bedding
- S-5.....Pipe Encasement
- S-6.....Standard Sewer Service Connection
- S-7.....Typical Sewer Lateral Connection
- S-8.....Existing Main - Typical Sewer Lateral Connection
- S-9.....Standard Air Test for Sewer Mains
- S-10.....Drop Manhole Connection
- S-11Cradling and Encasement
- S-12.....Service Line Cleanout
- S-13.....Chimney Pipe and Base
- S-14.....Electronic Marker Disk
- S-15.....Force Main Discharge Manhole
- S-16.....Force Main Cleanout
- S-17.....Sanitary Sewer Air Release Valve (ARV)

Water - Standard Details and Standard Drawings

- W-1Reduced Pressure Principle Backflow Prevention Assembly (RPBA)
- W-2Enclosures
- W-3Fire Hydrant Assembly

- W-4 Valve Box Assembly
- W-5 1”-2” Service Laterals (w/ Curb) Compression
- W-6 Concrete Thrust Blocks
- W-7 Pipe Bedding
- W-8 (1 of 2) Standard PRV Station
- W-8 (2 of 2) Standard PRV Station
- W-9 Standard PRV Station – Structural Details
- W-10 Thrust Tie Detail
- W-11 Meter Installations 3” or Larger
- W-12 Meter Installation Larger than 2” (Double Meter)
- W-13 Fire Line Reduced Pressure Valve Assembly
- W-14 2” Pressure Vacuum Breaker
- W-15 Flushing Valve
- W-16 Anchor Block for Vertical Bends
- W-17 Retrofit 2” to 1-1/2” Meter
- W-18 Retrofit 2” to 1” Meter
- W-19 Restrained Joint Lengths (Example)
- W-20 Restraining Joint Lengths (Example)

Water Meter Details

- WMD-1 Single Service with Curb (Profile)
- WMD-2 Single Service Material List/Notes/Diagram
- WMD-3 Double Service with Curb Profile
- WMD-4 Double Service Parts Diagram
- WMD-5 Typical Profile Layout for Paved Streets with Curb
- WMD-6 Typical Plan View for Paved Streets with Curb
- WMD-7 Unimproved Road Profile with No Curb

WMD-8.....Unimproved Road Plan View with No Curb

WMD-9.....Service Line Diagram

WMD-10.....Meter Can Lid Details

WMD-11.....Meter Can Details

APPENDIX D: APPROVED PRODUCTS LIST

Item #	NMAPWA Spec Section	Description
1	121,801	Diamond Plastics Corp. PVC C900 DR-18 CL150, DR-14 CL200
2	121,801	JM Manufacturing PVC C900 Blue Brule DR-18 CL150, DR-14 CL200
3	121,801	Vinyltech PVC C900 White Knight DR-18 CL150, DR-14 CL200
4	121,801	North American Pipe PVC C900 DR-18 CL150, DR-14 CL200
5	121,901	Diamond Plastics SDR-35
6	121,901	JM Manufacturing SDR-35
7	121,901	Vinyltech SDR-35
8	121,901	North American Pipe SDR-35
9	129,801	U.S. Pipe Cast Iron Pipe Class 150 TJ DIP
10	130,801	Tyler Pipe Company MJ SSB Ductile Iron Class 350
11	130,801	Star Pipe Products MJ SSB DI C153 MJ Fittings
12	130,801	EBAA Series 1100 Megalug
13	130,801	EBAA Series 1600 Joint Restraint
14	161,801	Parkson Cast Iron Type Valve Box (Adjustable)
15	161,801	Tyler Cast Iron Type Valve Box (Adjustable)
16	161,801	APCO Cast Iron Type Valve Box (Adjustable)
17	801	Armorcast A800 Plastic Meter Box
18	161,801	Accucast 2300 Cast Iron Lid
19	170,801	Thor Traceline Detectable Underground Utility Marking Tape
20	801	Kennedy Guardian Model K-81
21	801	Mueller Super Centurion 200
22	801	Mueller A-2360 Resilient Wedge Gate Valves

23	801	Mueller Lineseal Butterfly Valves
24	802	Cerro Company Type K Soft Copper
25	802	Ford F1000-4 1" Corp Stop
26	802	Ford FB1000-6 1-1/2" Corp Stop
27	802	Ford FB1000-7 2" Corp Stop
28	802	Ford S90 4"-12" Service Saddle
29	802	Ford 202BS >12" Service Saddle
30	802	Ford KV-43-444W 1" Single Service Curb Stop
31	802	Ford BF-43-666W 1-1/2" Single Service Curb Stop
32	802	Ford BF-43-777W 2" Single Service Curb Stop
33	802	Ford V72-7W-11-33 Coppersetter
34	N/A - PRV	CLA VAL 90-01
35	N/A - PRV	Watts Valve M115
36	N/A - Lift Stations	Flygt Pumps (all types)

APPENDIX E: WATER AND WASTEWATER AVAILABILITY INFORMATION

The most current water and wastewater availability requirements are available from the Department of Public Works at the City's website: www.ci.rio-rancho.nm.us

Chapter II.5

PARKS AND TRAILS DESIGN

1. INTRODUCTION

Parks and recreation facilities are a source of community connections and quality of life. Parks and recreation facilities allow residents to engage in their community and the natural environment as well as increase the value of our neighborhoods and subdivisions in both quantitative and qualitative ways.

The City of Rio Rancho, through its rapid growth, has worked to ensure the community's current and future parks and recreation needs will be met. Toward this end, the Department of Parks, Recreation and Community Services will work with the development sector and strive to create and maintain quality spaces and activities that grow a greater sense of community and enhance the quality of life in the City of Rio Rancho. The Department has also used the Master Planning process to better identify the wants and needs of the community and has reflected these, in part, through the Design Guidelines that follow.

Parks and associated trails constructed by a Developer or their agent as part of a subdivision, that will be dedicated to the City, shall follow the process outlined in **Appendix II.5-1**, "Parks and Recreational Trails Development Process Summary."

2. DESIGN GUIDELINES

1. General Design

1.1 All Commercial, Municipal, intended Municipal and Developer construction and landscape of parks, medians, parkways, entryways, landscape improvements, or landscape projects shall be designed by a registered Landscape Architect who shall stamp the appropriate construction documents for the project. The Landscape Architect shall also observe the construction to verify design compliance. Wherever required by law or code, stamped engineered drawings shall be included. Construction work shall be done by a licensed contractor. It is the responsibility of the licensed contractor to see that all codes are met, necessary permits obtained, and inspections requested. The City of Rio Rancho (the City) will also designate a representative to oversee the project construction for any and all parks and landscape projects that will be maintained by the City.

*Note: City-funded projects shall be permitted through the State. Privately constructed projects, to be dedicated to the City, shall be permitted through the City.

1.1.1 Prior to the preparation of construction documents, a conceptual plan or site plan must be submitted to the City of Rio Rancho Parks, Recreation and Community Services Department (the Department) and appropriate committees and commissions, for review and approval.

- 1.1.2 A typical set of Construction Documents shall include all necessary plans as are needed for the permitting and construction of the project and may include, but are not limited to, the following components (**See Appendix 25-2 Plan Requirements**).
 - 1.1.2.1 Cover letter for project plan set with complete cost estimate for all improvements
 - 1.1.2.2 Cover Sheet
 - 1.1.2.1.1 Include project name, vicinity map, sheet index, Landscape Architect's contact information, general notes, and signature block for the plan review.
 - 1.1.2.3 Demolition Plan where appropriate
 - 1.1.2.4 Grading and Drainage Plan prepared and stamped by a registered engineer (The Contractor shall ensure that slopes within the park and paved surfaces that generate significant run-off shall have additional design and construction that conveys the run-off to appropriate street storm drains, or onsite detention basins, design and construction of improvements that will prevent site erosion and ponding on turf or paved areas of the park).
 - 1.1.2.5 Plan View / Site Plan with all property lines, easements, improvements and amenities, their descriptions and appropriate dimensions
 - 1.1.2.6 Construction Plan including utilities and lighting where appropriate
 - 1.1.2.7 Landscape and Planting Plan with legend (including plant quantities, species and size at installation and maturity)
 - 1.1.2.8 Irrigation Plan
 - 1.1.2.9 Standard Details (see Section Three, Standard Details) and engineered drawings as required for permitting (such as for shade structures)
 - 1.1.2.10 Site Traffic Plan with parking lot striping and signage as required by Federal and local codes, and the Department of Public Safety
- 1.1.3 Following the process outlined in Appendix 25-1, Construction Documents shall be developed based on the approved Schematic Design (Section 1.1.1 above) and must be submitted to the Department if funded by the City. If the project is being developed by a Developer as part of a subdivision, construction Documents shall be submitted to the City of Rio Rancho Development Services Department, to be reviewed and approved by all City departments through the Design Review Process, and Building Permitting and Inspection for all permitting and code requirements prior to construction.
- 1.1.4 The Developer and/or Contractor shall include representatives of the City of Rio Rancho Park Maintenance in inspection of all designated phases of construction as indicated in Section 2 – Standard Specifications, as well as substantial completion and final acceptance reviews.
- 1.1.5 All projects shall meet local and federal requirements for accessibility and safety.
- 1.1.6 The Developer shall financially guaranty all parks and trails considered for impact fee credits prior to construction.

2. Park Design Standards

All parks must have an area designated as maintenance access. Department staff will work with the Landscape Architect to determine the best location and construction criteria

including gates, post and cable fence, and/or removable bollards for access.

Park sites vary in their topography. The contractor shall make every effort to maximize the usable park, activity and turf areas. The Department will work with the Landscape Architect to ensure that unusable, irrigated turf is *NOT* incorporated into any proposed plan. Irrigated turf will not be installed on slopes of 3% or greater. Turf play areas (fields) for neighborhood parks, whether they are to be sized to accommodate athletic competition or not, shall have a grade neither less than 1% nor greater than 2%. The grade of other turf areas within the park may vary only at the discretion of the City. All developed play, field and activity areas must be leveled at approved grade without significant holes or bumps.

2.1 Small Neighborhood Park Design-Guidelines

2.1.1 Small Neighborhood Park — Less than 5.0 acres in size.

2.1.2 A typical small neighborhood park shall include the following as a minimum:
Separate play equipment for ages 2-5 and 5-12 years old.

2.1.3 All play equipment and surfacing must be IPEMA certified to meet all requirements of ASTM, CPSC and ADA.

2.1.3.1 The play equipment for 2-5 year olds shall include the following components as a minimum.

2.1.3.1.1 Six (6) elevated play components, four (4) of which must be ADA accessible.

2.1.3.1.2 One (1) slide.

2.1.3.1.3 One (1) transfer station

2.1.3.1.4 Three (3) ADA accessible ground level components.

2.1.3.1.5 Two Bay swing components.

2.1.3.1.6 Playground Sign – Age appropriate

2.1.3.2 The play equipment for 5-12 year olds shall include the following components as a minimum.

2.1.3.2.1 Six (6) elevated play components, four (4) of which must be ADA accessible.

2.1.3.2.2 One (1) slide

2.1.3.2.3 One (1) transfer station or ADA ramp

2.1.3.2.4 Three (3) ADA accessible ground level components.

2.1.3.2.5 Two (2) swings one (1) of which shall be ADA accessible.

2.1.3.2.6 Two Bay swing components.

2.1.3.2.7 Playground Sign – Age appropriate

2.1.4 Benches to accommodate eight (8) users. At least one bench shall be ADA accessible via pathways to the parking lot and neighborhood sidewalks.

2.1.5 Tables to accommodate twelve (12) users. At least one table shall be ADA accessible via pathways to the parking lot and neighborhood sidewalks.

2.1.6 Playground surfacing must be playground certified manufactured wood fiber. The Contractor shall provide the City with a letter from the playground manufacturer or designee stating compliance with ASTM, IPEMA, ADA, and CPSC.

2.1.7 Trash receptacles, minimum of three (3) located with easy access for maintenance.

2.1.8 ADA accessible pathways leading from parking lot to play structures, tables, basketball courts, etc. and to neighborhood sidewalks wherever possible.

- 2.1.9 Shade structure. Minimum 400 square feet of coverage.
 - 2.1.10 ADA accessible Drinking Fountain
 - 2.1.11 Quick coupler within a locking box, located centrally and near the play and shade structures.
 - 2.1.12 Turf play area, not required to be sized to accommodate athletic competition.
 - 2.1.13 Deciduous Shade trees. Minimum of eight (8) 2” caliper or larger trees.
 - 2.1.14 Appropriate shrub planting. Minimum of twenty-five (25) 5 gallon shrubs.
 - 2.1.15 ADA accessible Basketball court, minimum of one (1) goal.
 - 2.1.16 Skate Park elements. Minimum of three (3) elements and minimum surface area of 4,000 square feet.
 - 2.1.17 Skate Park Rules Sign.
 - 2.1.18 Park Rules sign, one at main entrance of park.
 - 2.1.19 ADA accessible parking lot with off street parking for eight to twelve automobiles including two handicap accessible parking spaces with signs, of which one shall be van accessible.
 - 2.1.20 Additional items can be incorporated at the discretion of the Landscape Architect. (List of additional items includes but is not limited to those found in Park Improvements Specifications)
 - 2.1.21 The Department and the Parks and Recreation Commission reserve the right to require additional elements in the design of the park. These requirements will be provided to the Landscape Architect by staff prior to final presentation of the schematic design, and by the Commission during a regularly scheduled Commission meeting.
- 2.2 Large Neighborhood Park Design-Guidelines
- 2.2.1 Large Neighborhood Park - 5.0 to 10.0 acres in size.
 - 2.2.2 A typical large neighborhood park shall include the following as a minimum:
 - 2.2.3 Separate play equipment for ages 2-5 years old and 5-12 years old.
 - 2.2.4 All play equipment and surfacing must be IPEMA certified to meet all requirements of ASTM, CPSC and ADA.
 - 2.2.4.1 The play equipment for 2-5 years olds shall include the following components as a minimum.
 - 2.2.4.1.1 Ten (10) elevated play components, five (5) of which must be ADA accessible.
 - 2.2.4.1.2 One (1) slide
 - 2.2.4.1.3 One (1) transfer station or ADA ramp
 - 2.2.4.1.4 Five (5) ADA accessible ground level components.
 - 2.2.4.1.5 Two Bay swing components.
 - 2.2.4.1.6 Playground Sign – Age appropriate
 - 2.2.4.2 The play equipment for 5-12 year olds shall include the following components as a minimum.
 - 2.2.4.2.1 Fifteen (15) elevated play components, ten (10) of which must be ADA accessible.
 - 2.2.4.2.2 One (1) slide.
 - 2.2.4.2.3 One (1) transfer station
 - 2.2.4.2.4 Ten (10) ADA accessible ground level components.
 - 2.2.4.2.5 Two (2) swings one (1) of which shall be ADA accessible.

- 2.2.4.2.6 Two Bay swing components.
- 2.2.4.2.7 Playground sign – Age appropriate
- 2.2.5 Playground Surfacing must be playground certified manufactured wood fiber. The Contractor shall provide the City with a letter from the playground manufacturer or designee stating compliance with IPEMA, ASTM, CPSC and ADA.
- 2.2.6 Benches to accommodate sixteen (16) users. At least two benches shall be ADA accessible via pathways to the parking lot and neighborhood sidewalks.
- 2.2.7 Tables to accommodate twenty-four (24) users. At least two tables shall be ADA accessible via pathways to the parking lot and neighborhood sidewalks.
- 2.2.8 Trash receptacles. Minimum of five (5) located with easy access for maintenance.
- 2.2.9 Accessible pathways leading to play structures, tables, basketball courts, etc. and neighborhood sidewalks wherever possible.
- 2.2.10 Shade structure. Minimum 600 square feet of coverage.
- 2.2.11 ADA accessible Drinking Fountain.
- 2.2.12 Quick coupler within a locking box, located centrally and near the play and shade structures.
- 2.2.13 Turf play area, to be sized to accommodate athletic competition. Grade on turf areas shall be no less than 1 % nor greater than 2%.
- 2.2.14 Deciduous Shade trees. Minimum of twenty (20).
- 2.2.15 Appropriate shrub planting. Minimum of fifty (50) 5 gallon shrubs
- 2.2.16 ADA accessible Basketball court. Minimum of two (2) goals, full court.
- 2.2.17 Skate park elements. Minimum of eight (8) elements and minimum surface area of 10,000 square feet.
- 2.2.18 Skate Park Rules Sign.
- 2.2.19 Park Rules sign, one each entrance to park.
- 2.2.20 ADA accessible parking lot with off street parking for twelve or more automobiles including two or more handicap accessible parking spaces with signs, of which one shall be van accessible.
- 2.2.21 Additional items may be incorporated at the discretion of the Landscape Architect.
- 2.2.22 The Department and the Parks and Recreation Commission reserve the right to require additional elements in the design of the park. These requirements will be provided to the Landscape Architect by staff prior to final presentation of the schematic design, and by the Commission during a regularly scheduled Commission meeting.

2.3 Regional Park

- 2.3.1 Regional Park — Park Larger than 10 acres.
- 2.3.2 The City of Rio Rancho will provide a specific program for expected uses to the Landscape Architect for any Regional Parks. Uses will be intended to maximize recreation activities while optimizing water use.
- 2.3.3 The City shall work with the Developer/Contractor to identify minimum design elements for all parks meeting “Regional Park” criteria. Generally, a Regional Park will contain all elements of a neighborhood park plus a minimum 2 acres of

playing fields or courts for organized sports. Regional Parks will also have appropriate parking lot and field or court lighting to support organized sports.

2.4 Additional Elements and Improvements

- 2.4.1 Softball and Baseball fields, fenced dog park areas, disc golf courses, horse shoe pits, and tennis, racquetball, volleyball, cricket and bocce courts, shall be considered as additional elements or improvements, and when proposed in a park design, the City shall provide preferred construction criteria, to the Contractor prior to submission of park construction plans for Design Review.

3. Landscape Planting

Reference Section 3 – Standard Specification, Subsection 7

- 3.1 All landscaped areas shall be designed to prevent off-site run-off or overspray of irrigation water.
- 3.2 Species of trees, shrubs and ground cover intended to improve parks, trails and any other recreation facilities shall follow the list of approved and prohibited species found in the City's Landscaping Ordinance and or Vision 2020 Plan. Exceptions to this list may occur at the direction or approval of the Department.
- 3.3 All trees, shrubs, plants, seeded turf and sodded turf shall be planted in amended soil and irrigated unless otherwise approved by the Department.
- 3.4 Trees shall be planted with a tree well as described in the specifications. After planting, mulch shall be added to tree and plant wells as described in the specifications.

4. Turf Grasses

Reference Section 3 – Standard Specification, Subsection 8 or 9

- 4.1 Grass mix for *seed* areas shall be approved by the Department prior to completion of project design. Grass mixes shall be specified on the Drawings and not in the Specifications.
- 4.2 Grass mix for *sod* areas shall be approved by the Department prior to completion of project design. Grass mixes for sod shall be specified on the Drawings and not in the Specifications.
- 4.3 The Contractor shall include the Department's representatives in project inspections, reviews for substantial completion and final completion.
- 4.4 Soil shall be amended as described in Section 3 – Standard Specifications, Subsections 8 or 9 prior to seeding or sodding.
- 4.5 Turf play area, when required to be sized to accommodate athletic competition, shall have a grade neither less than 1 % nor greater than 2%.
- 4.6 All grass areas shall have full head to head coverage irrigation systems.
- 4.7 All grass and landscape areas and the related irrigation systems shall be designed to prevent off-site run-off or overspray of irrigation water.
- 4.8 If seed is used to establish turf for a playfield or an athletic field, the entire area shall be fenced so as to remain out of use for a one year establishment period or at the direction of the Department. The City will reserve the right to withhold final approval/acceptance of a park until seeded fields are established.
- 4.9 No turf grass shall be planted within 8'-0" of the back of any street curbs.
- 4.10 A concrete mow strip or sidewalk shall be installed at the edge of all turf grass (See Standard Specifications and Details).

5. Irrigation System

Reference Section 3 – Standard Specification, Subsection 10

- 5.1 Irrigation product brands and models shall be approved by the Department prior to the design of the irrigation system. The irrigation system shall use products from the approved products described in the Irrigation Specifications. Contractor must obtain written approval from the Department to use any irrigation products not described or listed in the Irrigation Specifications.

*Note: Due to City-wide maintenance requirements, the City prefers and in some cases requires Rainbird parts.

- 5.1.1 All irrigation systems for parks or landscape projects shall have an independent water meter, the size of which shall be determined by size of the irrigated area in the park or landscaped area. In all cases, landscape irrigation systems with large areas of plant material, such as eighteen or more rotor sprinkler zones, shall have multiple water meters. Each meter shall have a backflow preventer as required, permitted and inspected by City of Rio Rancho certified tester as described in Ordinance 51 Water and Wastewater Rules and Rates.
- 5.2 All irrigation plans shall be reviewed and approved as part of a complete set of construction plans, and shall also indicate proposed site grading and drainage.
- 5.2.1 Irrigation systems shall be designed to prevent off-site run-off or overspray of irrigation water.
- 5.2.2 Lines with rotors, pop-up heads and drip shall be on separate valves.
- 5.2.3 Irrigation systems on slopes shall be designed so that heads at bottom of slope are on separate valves from heads on side and top of slope. The irrigation system shall be zoned parallel to the topography.
- 5.2.4 Irrigation plans shall state existing static pressure at meter or point of connection. Typical minimum design pressure is 60 psi, but actual pressure must be verified prior to irrigation system design. The following statement shall appear on each irrigation plan.
- “At the time of final acceptance, the Contractor shall demonstrate to the City, that the operating pressure at the heads has been adjusted to match the specified design operating pressure for each valve.”
- 5.2.5 All irrigation systems shall utilize a Master controller capable of being connected to the City of Rio Rancho Central Control System. The City will provide brand and model specifications to the Landscape Architect.
- 5.2.6 All irrigation systems shall utilize a master valve and flow meter.
- 5.2.7 Each irrigation control valve shall be labeled numerically.
- 5.3 Each irrigation plan shall have a System Performance Information Chart that provides the following information for each control valve:
- 5.3.1 Control valve Number.
- 5.3.2 Valve brand, model number and size.
- 5.3.3 Irrigation head brand and model number.
- 5.3.4 Irrigation head nozzle size.
- 5.3.5 Irrigation head spacing.

- 5.3.6 Irrigation head gallons per minute.
 - 5.3.7 Total gallons per minute.
 - 5.3.8 Design operating pressure at the head.
 - 5.3.9 Precipitation rate at design operating pressure.
 - 5.3.10 Length of time required to operate valve in order to apply 0.33 inches of water.
- 5.4 Irrigation systems shall be designed so that the system has the capacity to place 2 inches of water per week on high water use grasses and 1 inch of water per week on low water use grasses. This water shall be applied in a six day period during a watering window from 10:00 p.m. to 10:00 a.m. as per City of Rio Rancho Water Conservation Ordinance Chapter 52. Irrigation systems shall also be designed to adequately water landscape other than turf. Landscaped areas other than turf shall generally be xeriscape in plant selection, placement and irrigation system design.
- 5.4.1 All parks with greater than one (1) acre of turf shall pass a water audit conducted by a certified water auditor. The system shall have a minimum distribution uniformity of .70
 - 5.4.2 All grass areas shall have full head to head coverage irrigation systems.

3. STANDARD SPECIFICATIONS

International Building Code and New Mexico Administrative Code requirements are to be followed for all design, construction and improvements made to parks, trails and related facilities. It is the responsibility of the project Landscape Architect and/or Engineer, registered in the State of New Mexico, to ensure that these Codes and City of Rio Rancho adopted Codes, Ordinances and Standards are followed in the design of the facility. It is the responsibility of the Licensed Contractor to ensure these codes and standards are followed during construction, and that the project is inspected as required by any and all permits, and as described in this document.

1. PAVING

PART 1 GENERAL

1.01 SUMMARY:

- A. Work under this section consists of preparing all paved areas indicated on the Drawing for parking lots, sidewalks/paths, courts, and skate parks according to the specifications, and furnishing and installing all materials as specified herein.

1.02 REFERENCE STANDARDS:

- A. Paved surfaces shall follow national and local codes, and the paving standards of the Department of Public Works, unless otherwise stated herein.

PART 2 PRODUCTS

2.01 ASPHALT SURFACES:

- A. Parking lots shall follow the City Standard for “paved pedestrian trail or parking lot” through the Department of Public Work’s standard sheet “Pavement Sections – DWG. No. PS-01.”
- B. At a minimum, Basketball Courts shall be paved with asphalt. If a Basketball Court is constructed of concrete, it shall follow the specifications for Concrete Surfaces below. Basketball Courts shall be made ADA accessible via pathways to the parking lot, and to neighborhood sidewalks wherever possible. Basketball goals and courts shall be oriented as a half court if one goal is required and oriented as a full court if two goals are required.

2.02 CONCRETE SURFACES:

- A. Sidewalks and concrete pads shall follow the City Standard for sidewalks through the Department of Public Work’s standard sheet “Sidewalk and Residential Driveway – DWG. NO – DW-01.”
- B. Skate Parks shall be made ADA accessible via pathways to the parking lot and to

neighborhood sidewalks wherever possible. The Contractor shall work with the Department and Parks and Recreation Commission to obtain public input for the final selection of components and design.

PART 3 EXECUTION

3.01 SITE PREPARATION:

- A. Grading and sub grade preparations for all paved surfaces shall follow the Public Works standard specifications for concrete sidewalks and asphalt paving, or the Department's standard specifications herein. All paved surfaces shall account for run-off and shall comply with local codes for storm water run-off.

3.02 INSTALLATION:

- A. All paved surfaces shall be designed to ensure that surface ponding is negligible. Contractor will submit concrete pads, courts and skate parks to a ponding test where water will be sprayed on the surface and runoff and/or ponding observed.
- B. Parking lots: shall follow the City Standard as shown on the standard sheet "Pavement Sections – DWG. No. PS-01," where a minimum 3 inches of asphalt type C, over 6 inches of base course/sub-grade prep (95% minimum compaction), over fill or undisturbed earth (90% compaction).
- C. Asphalt and concrete basket ball courts: Asphalt shall be 2" thick with a smooth finish. Surface shall be leveled, smoothed and finished to prevent ponding of water. Asphalt shall be laid over a prime coat applied over six inch prepared sub grade compacted to 95%. Finish grade of either asphalt or concrete to match finish grade of surrounding area. Court shall have a 2% slope. Courts shall be sized and striped to meet High School or College court dimensions. Concrete basketball courts pad shall be 4" thick, 4000 psi with 6" x 6" welded wire mesh (WWM). WWM to be supported by 2" high chairs and tied at all intersections, over 95% compacted sub grade.
- D. Sidewalks and concrete pads: shall follow the City Standard for sidewalks through the Department of Public Work's standard sheet "Sidewalk and Residential Driveway – DWG. NO – DW-01." These standards indicate the use of 3000 psi Portland Cement Concrete on 6" prepared sub grade, compacted to 95% ASTM D 1557. Sidewalks / ADA paths shall be a minimum of 5' wide within the park.
- E. Skate Park Pads: All Skate Parks will have a concrete skate pad. The concrete pad shall be 4" thick, 4000 psi with 6" x 6" welded wire mesh (WWM). WWM to be supported by 2" high chairs and tied at all intersections, over 95% compacted sub grade. The 4000 psi concrete will have a hard trowel finish (12 passes), with no broom finish, unless otherwise directed by the City. Saw cut joints shall be 1/8" wide by 1/2" deep and shall be located as shown on the

Drawings. Expansion joints shall be placed where they will not impede skate wheels. Joints between pours in the middle of a slab shall be keyed or doweled cold joints. Finish surface shall not have deviations greater than 1/8" as measured with a 10' long straight edge. Grading is not acceptable for remedying deviations. (See Skate Park Elements under Standard Specifications for Playground Structures).

3.03 MAINTENANCE AND PROTECTION:

- A. Maintenance and protection of asphalt and concrete paved surfacing shall begin immediately following the last operation of installation and shall continue until final acceptance of the park. Maintenance shall include regular use, weather and vandalism related repair and replacement, removal of debris, and such other operations as may be necessary to guarantee safe use of all paved surfaces. Replacement surfacing or City directed patching shall be with material of the same quality as that which is being replaced.

3.04 GUARANTEE:

- A. All asphalt and concrete paved surfaces shall be in compliance with City specifications, and found free of any safety hazards or defects for twelve months following the date of final acceptance by the City.

3.05 INSPECTIONS:

- A. The following inspections shall be the minimum required inspections during the course of construction. Additional inspections shall be made at any time at the discretion of the City or Landscape Architect.
- B. It shall be the responsibility of the Contractor to notify the City's Representative by phone, 48 hours in advance of each required inspection.
- C. The sequence of required observations shall not be changed from the sequence listed below. The Contractor shall not proceed with the work of the next sequence without written approval of the work of the previous sequence.

For City-built facilities, the Contractor shall attach a copy of the written reports prepared by the City's representative or the Landscape Architect to all applications for payment. Payment will not be made for items that have not been observed and approved in writing.

1. Sub grade prepared prior to paving.
2. Asphalt and/or concrete surfaces within 48 hours of paving.
3. Ponding test.
4. Asphalt and/or concrete courts following striping.
5. Paved surfaces shall be inspected 6 months after completion.
6. Paved surfaces shall be inspected 12 months after completion.

2. TRAILS

PART 1 GENERAL, PRODUCTS AND EXECUTION

1.01 SUMMARY:

This section addresses the construction of a variety of trails and paths that may or may not be included as an improvement in a park project. These trail specifications are applicable to trails and paths that will be constructed by the City or constructed by others and dedicated to the City.

A. Paved trails

1. Paved trails within parks (not including sidewalks) and multi-purpose trails within subdivisions shall follow the City Standard for “paved pedestrian trail or parking lot” through the Department of Public Work’s standard sheet “Pavement Sections – DWG. No. PS-01.” These standards indicate a minimum 3 inches of asphalt type C, over 6 inches of base course/sub-grade prep (95% minimum compaction).
2. Paved trails shall all be prepared as stated below to meet minimum ADA accessibility requirements. Paved trails shall be a minimum of 8 feet wide within parks and 12 feet wide when used as multipurpose trails within subdivisions. In the design phase, no slope shall be greater than 8%, and wherever there is a pivot or turning point, it shall allow for a 5 foot by 5 foot level space. Based on ADA requirements, level landings shall be provided at appropriate intervals based on the designed slopes over the course of the trail.
3. A minimum of 2 feet of clearance between the edge of the path and any obstructions, such as bushes, trees, signs or railings shall be maintained.

B. Crusher Fine Trails

1. Crusher Fine Trails within parks and walking trails within subdivisions will all be prepared as stated below to meet minimum ADA accessibility requirements. Crusher fine paths will be a minimum of 8 feet wide within parks and 12 feet wide when used as walking trails within subdivisions. In the design phase, no slope will be greater than 8%, and wherever there is a pivot or turning point, it will allow for a minimum 5 foot by 5 foot level space. Based on ADA requirements, level landings shall be provided at appropriate intervals based on the designed slopes over the course of the trail.
2. All paths will be stabilized or solidified with a product such as PolyPavement or an equivalent approved by the Department. Grade and compact, sub grade to 95% compaction, and a 4 inch depth of crusher fines to 90% compaction at the desired alignment and elevation; spray- apply the required amount of properly diluted stabilizer onto the compact crusher fine surface as directed by the manufacturer; allow the soil to dry. If a PolyPavement equivalent is used, apply to crusher fines using manufacturer’s guidelines if those guidelines vary from the directions above. Trails shall have a uniform surface free of voids,

depressions, or raised areas greater than ½” as determined by a 10’ long straight line test. All trail surfaces within parks or on trails that will be maintained by the City will be inspected for all above criteria to the City’s satisfaction prior to acceptance.

3. Crusher fine paths in or adjacent to turf areas shall have 6 inch by 6 inch concrete mow strip between the path and turf.

A. Open Space Trails

Open space trails are defined as trails or foot paths that are located in a natural setting or mostly unimproved state, and may or may not be ADA accessible throughout their lengths.

1. Improved Multi- Purpose open space trails

- a. Improved Multi-Purpose open space trails shall be, wherever possible, twelve feet wide, with a minimum eight foot wide crusher fine pedestrian portion adjacent to a four foot wide uncompacted native material equine portion. The Department may determine that the crusher fine portion may or may not be compacted or stabilized. The Department may also determine that it is necessary that up to four feet on either side of the constructed trail be cleared, mowed or other wise kept free of vegetative growth. Both of these determinations will be made on a case by case basis. Minimal disturbance of the native vegetation or habitat during trail construction is allowed. All disturbed areas outside of the twenty foot expanse of the trail shall be returned to natural conditions through native reseeding or other methods approved by the Department.
- b. Improved Multi-Purpose Open Space trails as commuter connections: In addition to the above conditions, if this type of trail is intended as a commuter connection, the crusher fine portion of the trail may be asphalt at the determination of the Department. As a minimum, three inches of asphalt shall be laid over six inch sub-grade prep with 95% compaction.

2. Improved Open Space Trails

- a. Improved Open Space Trails shall be, at a minimum, eight feet wide compacted native material. The Department may determine that it is necessary for up to four feet on either side of the constructed trail be cleared, mowed or other wise kept free of vegetative growth. This determination will be made on a case by case basis. Minimal disturbance of native vegetation or habitat during trail construction is allowed. All disturbed areas outside of the twenty foot expanse of the trail shall be returned to natural conditions through native reseeding or other methods approved by the Department.

3. Open Space Foot Paths

- a. Open Space Foot Paths will be considered in open space recreation areas with varied terrain and slopes, and where a high priority exists to maintain the integrity of the existing native vegetation and habitat. Paths shall be, at a minimum, four feet wide native material. Foot paths may or may not be compacted depending on the natural condition of the path. Foot paths may not be eligible for ADA accessible designation. Both of these determinations will be made on a case by case basis. Unless noxious

vegetation is found, the areas adjacent to the paths will not be cleared or otherwise disturbed.

1.02 MAINTENANCE AND PROTECTION:

- A. Maintenance and protection of trails as part of a park project shall begin Immediately, following the last operation of installation and shall continue until final acceptance of the park. Maintenance shall include regular use, weather and vandalism related repair and replacement, removal of debris, and such other operations as may be necessary to guarantee safe use of all trail surfaces. Replacement surfacing or City directed patching shall be with material of the same quality as that which is being replaced.

1.03 GUARANTEE:

- A. All asphalt and trail surfaces shall be in compliance with City specifications, and found free of any safety hazards or defects for twelve months following the date of final acceptance by the City. Replacement surfacing or City directed patching of trail sections from failure of materials or due to workmanship shall be with material of the same quality as that which is being replaced.

1.04 INSPECTIONS:

- A. The following inspections shall be the minimum required inspections during the course of construction. Additional inspections shall be made at any time at the discretion of the City or Landscape Architect.
- B. It shall be the responsibility of the Contractor to notify the City's Representative by phone, 48 hours in advance of each required inspection.
- C. The sequence of required observations shall not be changed from the sequence listed below. The Contractor shall not proceed with the work of the next sequence without written approval of the work of the previous sequence.

For City-built facilities, the Contractor shall attach a copy of the written reports prepared by the City's representative or the Landscape Architect to all applications for payment. Payment will not be made for items that have not been observed and approved in writing.

1. Sub grade prepared prior to trail installation.
2. Surfaces treated with stabilizer within 48 hours of application.
4. Asphalt trails within 48 hours of paving.
5. Trail surfaces shall be inspected 6 months after completion.
6. Trail surfaces shall be inspected 12 months after completion.

3. LIGHTING

PART 1 GENERAL

1.01 SUMMARY:

This section addresses the recommended practices and design of lighting systems associated with parks, courts and recreation fields. Lighting may or may not be a required improvement in a park project. These recommendations and design requirements apply to lighting systems that will be constructed by the City, or constructed by others and dedicated to the City.

A. The following “IESNA Recommended Practices” RP-6 (Sports), RP-20 (Parking Facilities), and RP-33 (Exterior Environment) are recommended as additional guidelines for site lighting. The City will direct the Contractor to utilize the preferred form of lighting control (timer, light sensor, etc). Lighting systems and materials shall be designed and constructed in accordance with all local codes.

1. Lighting requirements for park parking lots (other than on-street parking): Lighting should provide for appropriate and desired night time illumination for all intended uses of the site to promote a safe environment for those using the facility. Parking lots associated with park or trail head facilities shall follow the maximum height and wattage, and all shielding requirements for fixtures as stated in Ordinance 159. Lighting shall be required for parking lots with 20 parking spaces or more. Lighting shall be designed to provide uniform lighting throughout the entire parking lot with no dark patches.
2. Lighting Plan. If lighting is required at a facility, to light courts, fields or building envelopes in addition to a parking lot, or for the purpose of crime prevention lighting as identified by Department or Police Department staff, a complete lighting plan including the locations of all lighting fixtures, fixture descriptions, lamp type and wattage, and lighting coverage or photometric plan shall be prepared and stamped by a licensed engineer and submitted as a separate sheet in the construction plans described in section 1.1.2 of this document.
3. Lighting requirements for playing courts. For playing courts sized less than 10,000 square feet, lighting shall comply with the Parking lot lighting requirements identified in City of Rio Rancho Ordinance 159. Courts sized greater than 10,000 square feet shall follow the approved national lighting standards required for rules for evening or lighted play for the sport intended to utilize the court (including but not limited to tennis, volley ball, racquetball, basket ball).
4. Lighting requirements for playing fields. Playing fields greater than 10,000 square feet shall follow the approved national lighting standards required for rules for evening or lighted play for the adult and/or youth sport or sports intended to utilize the fields (including but not limited to Little League, softball, baseball, soccer, flag football, YAFL, cricket).

1.02 MAINTENANCE AND PROTECTION:

- A. Contractor maintenance and protection of lighting systems as part of a park project shall begin immediately, following the last operation of installation and shall continue until final acceptance of the park. Maintenance shall include regular use, weather and vandalism related repair and replacement, removal of debris, and such other operations as may be necessary to guarantee safe use of the lighting system. Replacement shall be with materials of the same brand and quality as that which is being replaced. If a replacement brand or model is not available, the City may consider appropriate alternatives.

1.03 GUARANTEE:

- A. The lighting system shall be in compliance with City specifications and local codes, and found free of any safety hazards or defects for twelve months following the date of final acceptance by the City. Materials replaced due to workmanship or mechanical failure shall be replaced with material of the same brand and quality as that which is being replaced.

1.04 INSPECTIONS:

- A. The following inspections shall be the minimum required inspections during the course of construction. Additional inspections shall be made at any time at the discretion of the City or Landscape Architect.
- B. It shall be the responsibility of the Contractor to notify the City's Representative by phone, 48 hours in advance of each required inspection.
- C. The sequence of required observations shall not be changed from the sequence listed below. The Contractor shall not proceed with the work of the next sequence without written approval of the work of the previous sequence.

For City-built facilities, the Contractor shall attach a copy of the written reports prepared by the City's representative or the Landscape Architect to all applications for payment. Payment will not be made for items that have not been observed and approved in writing.

1. Lighting system trenching and conduit.
2. Meter, transformer, box, wiring and connections within 48 hours of installation.
4. All light fixtures within 48 hours of installation.
5. Lighting system shall be inspected 6 months after completion.
6. Lighting system shall be inspected 12 months after completion.

4. FENCING

PART 1 GENERAL

1.02 SUMMARY:

- A. Work under this section consists of preparing all areas indicated on the Drawing for fencing according to the specifications, and furnishing and installing all posts, cables, fencing and gates as specified herein. Fencing may or may not be a required improvement in a park project. These specifications apply to fencing that will be constructed by the City, or constructed by others and dedicated to the City. Where ponds are part of a park facility and are required to be fenced, SSCAFCA (the Southern Sandoval County Flood Control Authority) must review and approve any proposed fencing specifications on the Drawings. The following specifications meet the Department's minimum requirements. Fencing with greater aesthetic or structural attributes will be considered by the Department on a case by case basis.
1. Skate Park Fencing. Skate park fencing shall be 4' high, vinyl coated chain link with a bottom rail. Posts shall be steel posts with caps, installed in the skate park concrete pad. Entry points shall have a minimum width of 4' and a maximum width of 6'.
 2. Dog Park Fencing. Dog park fencing shall be 4' high chain link with a bottom rail. Posts shall be steel posts with caps, anchored in a concrete footing. Entry points shall be double gated with latching gates. Large and small dog park areas shall be separated by 4' high chain link fencing with a bottom rail. Dual park entry points shall also be separated by 4' high chain link fencing with a bottom rail and each half shall be double gated with latching gates. At a minimum an 8' wide hinged or rolling maintenance gate, shall be provided.
 3. Post and Cable. Post and cable shall be metal posts with caps, anchored in a concrete footing. The finished height of the post, hanging height of the cable and number of strands of cable shall be determined on a site by site basis. Wherever access is needed, the post and cable shall have a locked "drop" section where the cable has been cut, looped and terminated to allow for a lock. The cable between the cut and the next post shall have a clamp or other device that will prevent the cable from going slack or being pulled through the post.
 4. Drainage Pond and Open Space Fencing. Park fencing that surrounds a drainage pond or is indicated along open space that is adjacent to the park shall be constructed of 4"x4"x8' wooden or metal posts, set at least 3' in the ground, with 5 strands of barbless wire fencing. A pipe maintenance gate, at least 8' wide shall be provided for pond and open space access.

1.02 MAINTENANCE AND PROTECTION:

- A. Contractor maintenance and protection of fencing as part of a park project shall begin immediately, following the last operation of installation and shall continue until final acceptance of the park. Maintenance shall include regular use, weather and vandalism related repair and replacement, removal of debris trapped in the fencing, fixing breaks, tightening sections, and such other operations as may be necessary to guarantee proper function of all sections of fencing. Replacement shall be with materials of the same brand or type and quality as that which is being replaced.

1.03 GUARANTEE:

- A. Fencing shall be in compliance with City specifications and found free of any safety hazards or defects for twelve months following the date of final acceptance by the City. Materials replaced due to workmanship or material failure shall be replaced with material of the same brand, type and quality as that which is being replaced.

1.04 INSPECTIONS:

- A. The following inspections shall be the minimum required inspections during the course of construction. Additional inspections shall be made at any time at the discretion of the City or Landscape Architect.
- B. It shall be the responsibility of the Contractor to notify the City's Representative by phone, 48 hours in advance of each required inspection.
- C. The sequence of required observations shall not be changed from the sequence listed below. The Contractor shall not proceed with the work of the next sequence without written approval of the work of the previous sequence.

For City-built facilities, the Contractor shall attach a copy of the written reports prepared by the City's representative or the Landscape Architect to all applications for payment. Payment will not be made for items that have not been observed and approved in writing.

1. Post Installation prior to fencing installation.
2. Fencing and gates within 48 hours of installation.
5. Fencing shall be inspected 6 months after completion.
6. Fencing shall be inspected 12 months after completion.

5. PLAYGROUND STRUCTURES

PART 1 GENERAL

1.01 SUMMARY:

- A. Work under this section consists of preparing all areas indicated on the Drawing for playground structures according to the specifications and furnishing as specified herein.
- B. For City-built facilities, the Department and the Parks & Recreation Commission shall hold public meetings with youth and residents to select all play equipment prior to issuance of final construction plans.
- C. For facilities built as part of a subdivision by a Developer, the Contractor shall make every effort to ensure community input in the selection of all play equipment prior to submission of construction plans. The Department will work with the Contractor to expedite the process.

1.02 REFERENCE STANDARDS:

- A. All play equipment and surfacing must be IPEMA certified to meet all requirements of ASTM, CPSC and ADA.
- B. All equipment shall be installed according to the manufacturer's instructions, by a certified NPSI and Manufacturer-Certified Installer. The Contractor shall provide the City with a letter attesting to this. Any constructed playground must have and pass a playground audit. The Contractor shall provide the City with a letter and backup documentation attesting to this.

PART 2 PRODUCTS

2.01 PLAYGROUND EQUIPMENT:

- A. Separate play equipment for ages 2-5 year olds and 5-12 year olds are a requirement for all parks. The City may consider installation of combined, 2 - 12 year old play equipment, and the number and types of play components, at its discretion.
- B. Both 2 – 5 and 5 – 12 year old structures must have a clamp – post system. Posts must be 5” posts. Pre-installed flanges are acceptable on the 2- 5 year old structures. Decks must have holes 3/8” or smaller, but shall pass water, playground surfacing and other common park materials. Bridges in perforated metal shall not be larger than 5/16”.
- C. Permaline panels are preferred. Metal panels are acceptable, but must be painted.

- D. Age-appropriate playground signs from the manufacturer of the playground equipment shall be installed, one each for the 2 – 5 and 5 – 12 year old structures. The 2 – 5 year old structure shall have a yellow sign with red lettering. The 5 – 12 year old structure shall have a red sign with yellow lettering. The signs shall be surface mounted to posts provided by the manufacturer and direct-bury installed.
- E. Playground Surfacing must be playground certified manufactured wood fiber. The Contractor shall provide the City with a certification letter from the manufacturer.

2.02 ADDITIONAL PLAY STRUCTURES:

- A. Play structures and stand alone units must be approved by City, installed according to manufacturer's instructions, and carry a minimum 5 year warranty. Play structures and stand alone units must be placed over playground surfacing as recommended by manufacturer. Play ground surfacing must be playground certified manufactured wood fiber. The Contractor shall provide the City with a certification letter from the manufacturer.
- B. Climbing structures: Climbing structures may include walls, boulders, webs, nets, and independent climbers, and must be manufactured for outdoor use with no protective cover.
- C. Swings: Swings should be from the same manufacturer, unless otherwise authorized by the City, and should have a similar color and design as other playground equipment at the job site for continuity in appearance. Swings may have two or three legged frames. Swings must be direct-bury installation.

2.03 UNALLOWABLE PLAYGROUND EQUIPMENT

- A. The following materials and criteria are prohibited for use in City of Rio Rancho parks.
 - 1. Mirror or window panels
 - 2. Wooden components or structures
 - 3. Steel and tube slides
 - 4. Tile Safety Surfacing
 - 5. Expanded Metal Decks
 - 6. Decks with holes larger than 3/8"
 - 7. Structures with decks that do not use a clamping system
 - 8. Structures with decks higher than 48" with posts smaller than 5"
 - 9. Rotationally molded plastic panels
 - 10. Any other products that do not conform to ASTM and CPSC Standards
 - 11. Vendor Representative shall be local (Greater Albuquerque Metro Area)

PART 3 EXECUTION

3.01 SITE PREPARATION:

- A. The playground area shall be graded and compacted to meet manufacturer's requirements for site preparation. The area shall be graded to ensure level placement and installation of playground equipment, and to prevent any collection or pooling of water.
- B. The playground area shall be sized and shaped to adequately allow for the manufacturer's determined use zone for each of the pieces of equipment to be installed. Overlap of fall zones shall only be allowed if recommended and approved by the manufacturer and the City.
- C. Border: The playground area shall have a concrete strip molding or standard concrete sidewalk perimeter that will be installed flush to the concrete ADA accessible ramp and path associated with the playground area, as defined by ASTM and CPSC. Alternatively, the City will consider the use of Playground Manufacturer's borders on a site by site basis.

3.02 INSTALLATION:

- A. All playground equipment components and hardware shall be delivered to the job site on the day of installation, or to a prior approved location identified by the City, or a storage facility on the job site approved by the City. All equipment shall be inspected by installer to ensure that all components and hardware are accounted for and free of defect from shipping.
- B. All playground structures shall be installed as per manufacturer's instructions.

3.03 MAINTENANCE AND PROTECTION:

- A. Maintenance and protection of play structures and surfacing shall begin immediately following the last operation of installation and shall continue until final acceptance of the park. Maintenance shall include regular use, weather and vandalism related repair and replacement, removal of debris, tightening and adjusting of bolts as needed, and such other operations as may be necessary to guarantee safe use of the equipment. Replacement equipment and hardware shall be from the same manufacturer and of the same quality as that which is being replaced at the time of acceptance.

3.04 GUARANTEE:

- A. All equipment shall be in compliance with a playground audit, and found free of any safety hazards or defects for twelve months following the date of final acceptance by the City.
- B. The following warranties (manufacturer or otherwise) shall be provided for specified equipment unless state otherwise herein. Letters or warranty certificates

for installed equipment shall be provided to the City for the following minimum periods of time, at the time of final acceptance of the facility.

1. Posts – 75 year warranty
2. Plastic and Steel Components – 15 year warranty
3. Play Equipment Coatings – 15 year warranty
4. Moving Parts – 3 year warranty

C. The Contractor shall obtain and provide Certificates of Liability Insurance for the following amounts, to the City to be placed on file, prior to the start of work.

1. Playground Manufacturer - \$5,000,000
2. Playground Sales Representative/Distributor - \$1,000,000
3. Playground Installer - \$1,000,000

3.05 INSPECTIONS:

- A. The following inspections shall be the minimum required inspections during the course of construction. Additional inspections shall be made at any time at the discretion of the City or City Designee (i.e. Landscape Architect, NPSI Inspector).
- B. It shall be the responsibility of the Contractor to notify the City's Representative by phone, 48 hours in advance of each required inspection.
- C. The sequence of required observations shall not be changed from the sequence listed below. The Contractor shall not proceed with the work of the next sequence without written approval of the work of the previous sequence.

For City-built facilities, the Contractor shall attach a copy of the written reports prepared by the City's representative or the Landscape Architect to all applications for payment. Payment will not be made for items that have not been observed and approved in writing.

1. Play area border.
2. Structures shall be inspected after completion, a playground audit performed and all issues addressed.
3. Playground/Play structure surfacing.
4. Structures shall be inspected 6 months after completion.
5. Structures shall be inspected 12 months after completion.

6. PARK AMENITIES

PART 1 GENERAL

1.01 SUMMARY:

- A. Work under this section consists of preparing all areas indicated on the Drawing for amenities and structures according to the specifications and furnishing and installing all paving, hardware and equipment as specified herein.

1.02 REFERENCE STANDARDS:

- A. Skate Park components shall be installed by Skate Park Manufacturer – Certified Installer. The Contractor shall provide the City a letter attesting to this.

PART 2 PRODUCTS

2.01 ADDITIONAL PARK AMENITIES:

- A. Benches shall be expanded, vinyl coated or perforated metal, concrete or recycled plastic. At new parks, benches shall be from the same manufacturer as tables and trash cans for continuity in appearance. Benches shall be in-ground mounted models.
- B. Tables shall be expanded, vinyl coated or perforated metal, aluminum, concrete or recycled plastic. At new parks, tables shall be from the same manufacturer as benches and trash cans for continuity in appearance. Single pedestal / leg tables will not be accepted by the City. Tables and their associated benches shall be in-ground mounted models.
- C. Trash receptacles will be located where most park activities are intended to occur (such as a shade structure, tables, playgrounds) and near the parking lot. Trash receptacles shall be expanded, vinyl coated or perforated metal, aluminum, concrete or recycled plastic. Trash receptacles shall have dome lids, unless otherwise approved. The City will not accept trash receptacles with locking doors. At new parks, trash cans shall be from the same manufacturer as tables and benches for continuity in appearance. Trash receptacles shall be in-ground or models.
- D. Dog Waste Stations shall be a single, plastic dispenser/receptacle unit on a metal post. The unit shall be able to dispense bags that are 8” x 13” on rolls, and the waste collection receptacle shall accommodate a 10 gallon bag or larger. The unit shall be lockable.
- E. Shade structures shall be purchased from NPSI certified playground or shade structure manufacturer or their representative, and shall not be constructed with raw materials on-site. The following shade structures are acceptable if they can be

justified for our region with an Evaluation Service Report or a registered, State of New Mexico Engineer's structural calculations. Steel post and roof construction shade structures are preferred, and must be installed on a concrete pad as per manufacturer's instructions. Shade structures should have colors that complement the other park amenities and play ground.

- F. Drinking Fountains units must be ADA accessible. The manufacturer and model shall be reviewed and approved by the City. A drainage sump shall be installed per a detail on the plans.
- G. Skate & Bike park elements may be concrete or modular. All elements must be constructed for weather, UV radiation and other conditions of outdoor use without a cover. Modular elements should have metal frames and metal panels. The City will consider use of recycled plastic panels. Actual elements should be chosen with City staff and community input. Anti-vandal hardware is required and anti-vandal surfacing is preferred wherever possible.
- H. Skate Park Rules sign shall be from the manufacturer of the equipment, and have exterior grade plastic, surface mount sign attached to direct-bury aluminum posts. Sign text shall have name of park and at a minimum, hours of operation, required protective equipment, prohibited activities and "Skate at your own risk" statement. The City's Representative will work with the contractor to determine appropriate sign language on a site by site and manufacturer basis.
- I. Fitness stations shall be purchased from certified playground or outdoor sport manufacturer, and will not be constructed with raw materials on-site. Stations must be highly durable and intended for outdoor use. Each station must be accompanied by instructional signage.

PART 3 EXECUTION

3.01 SITE PREPARATION:

- A. Installation locations for all amenities shall be prepared as required by the manufacturer as shown on the Drawings. Concrete pads for tables, chairs, benches, trash receptacles, and shade structures shall follow the concrete paving standards of the City's Public Works Department. Concrete pads for Skate Parks shall follow the Standard Specifications for Paving; subsection on Skate Parks.
- B. Water fountain site preparations shall follow local codes and ensure proper drainage if the fountain drain should be clogged and the trough overflow. The concrete pad providing accessibility to the fountain shall follow the concrete paving standards of the City's Public Works Department.

3.02 INSTALLATION:

- A. All amenities shall be installed as per manufacturer's instructions, as described in the Drawings, and as permitted.

- B. ADA accessible amenities shall be properly oriented and made accessible via paths from the parking lot.
- C. Tables, benches and trash receptacles shall be in-ground mounted in dirt or turf, or vandal proof surface mounted when located on concrete pads.
- D. Shade structures shall be installed on a concrete pad and made ADA accessible. Engineered drawings are required for permitting and inspection of shade structures or similar structures 120 square feet or larger. These drawings shall include structural calculations justifying the structure for this region. Shade structures and their pads shall not be constructed without a permit.
- E. Drinking fountains shall be installed as per local codes. Drinking fountain installation shall include a sump suited to accommodate the level of anticipated fountain use. Any unpaved area surrounding the base of the drinking fountain, shall be filled with 1” gravel, 3” deep and made level to adjacent concrete paving.
- F. Modular Skate Park elements and signs shall be installed by Manufacturer-certified installer. The Skate Park job site shall be enclosed with construction fence prior to construction, and until all components are installed and accepted by the City. Component locations shall be determined prior to delivery of materials to the job site. All materials and hardware shall be inspected for damage after shipping, prior to installation.
- G. Fitness stations shall be direct-bury installed and shall have playground certified manufactured wood fiber in the activity zone. All stations shall be leveled and erected as intended by the manufacturer. Activity zones for fitness stations installed near each other shall not overlap.

3.03 MAINTENANCE AND PROTECTION:

- A. Maintenance and protection of park amenities and surfacing shall begin immediately following the last operation of installation and shall continue until final acceptance of the park. Maintenance shall include regular use, weather and vandalism related repair and replacement, removal of debris, tightening and adjusting of bolts as needed, and such other operations as may be necessary to guarantee safe use of the equipment. Replacement equipment and hardware shall be from the same manufacturer and of the same quality as that which is being replaced at the time of acceptance.

3.04 GUARANTEE:

- A. All equipment shall be in compliance with a play ground audit where applicable, and all equipment shall be found free of any safety hazards or defects for twelve months following the date of final acceptance by the City.

- B. The following warranties (manufacturer or otherwise) shall be provided for specified equipment unless state otherwise herein. Letters or warranty certificates for installed equipment shall be provided to the City for the following minimum periods of time, at the time of final acceptance of the facility.
1. Skate Park Modular Components and hardware – 15 year warranty
 2. Tables, benches and trash cans – 15 year warranty
 3. Steel shade structure – 10 year warranty
 4. Steel frame and cloth topper shade structure – 10 year warranty steel frame, 5 year warranty on fabric.
- C. The Contractor shall obtain and provide Certificates of Liability Insurance for the following amounts, to the City to be placed on file, prior to the start of work.
1. Manufacturer - \$5,000,000
 2. Sales Representative/Distributor - \$1,000,000
 3. Installer - \$1,000,000

3.05 INSPECTIONS:

- A. The following inspections shall be the minimum required inspections during the course of construction. Additional inspections shall be made at any time at the discretion of the City or City Designee (i.e. Landscape Architect, NPSI or City Building Inspector).
- B. It shall be the responsibility of the Contractor to notify the City's Representative by phone, a minimum 48 hours in advance of each required inspection.
- C. The sequence of required observations shall not be changed from the sequence listed below. The Contractor shall not proceed with the work of the next sequence without written approval of the work of the previous sequence.

For City-built facilities, the Contractor shall attach a copy of the written reports prepared by the City's representative or the Landscape Architect to all applications for payment. Payment will not be made for items that have not been observed and approved in writing.

1. Amenity (including shade structures and water fountains) installation area including dirt or concrete pad prior to amenity installation.
2. Installed amenity within 48 hours of installation.
3. Activity area surfacing (such as for fitness stations).
4. Amenities shall be inspected 6 months after completion.
5. Amenities shall be inspected 12 months after completion.

7. LANDSCAPE PLANTING

PART I GENERAL

1.01 SUMMARY:

- A. Work under this section consists of the planting of trees, shrubs and ground covers, including the furnishing of all labor, equipment, and materials and performing all work in connection therewith in accordance with the Drawings and Specifications.

1.02 PLANT NAMES:

- A. The botanic and common names used for the plants called for on the Drawings are generally in conformity with standardized plant names, or in conformity with the names accepted in the nursery trade.

1.03 PLANT MATERIAL SUBSTITUTIONS:

- A. Plant material substitutions shall not be made without the written permission of the City. The use of materials differing in kind, quality or size from that specified will be allowed only after the City is convinced that all means of obtaining the specified materials have been exhausted.
 - 1. For City-built facilities, at the time bids are submitted, the Contractor is assumed to have located the materials necessary to complete the job as specified. All requests for substitutions must be submitted no later than five (5) days prior to the opening of bids.
 - 2. For facilities built as part of a subdivision by a Developer, the Contractor is assumed to have located the materials necessary to complete the job as specified by the time of the preconstruction meeting.

PART 2 PRODUCTS

2.01 PLANT MATERIALS:

- A. Complete plant list, including quantities, sizes and other requirements are shown on the Drawings. In the event that discrepancies occur between quantities of plants indicated in the plant list and on the Drawings, the plant quantities indicated on the Drawings shall govern.
- B. All shade trees shall be 2" caliper or larger. Any trees 3" caliper or larger shall be staked. All ornamental trees (flowering pear, flowering plum, etc.) shall be 2" caliper or larger.
- C. The following trees and shrubs shall not be planted in City park property:

Green Ash (*Fraxinus pennsylvanica*)
 White Ash (*Fraxinus Americana*)
 Elms (*Ulmus* species - some types acceptable with advanced approval).
 Hackberry (*Celtis occidentalis*)
 Black Locust (*Robinia pseudoacacia*)
 Sugar Maple (*Acer saccharum*)
 Silver Maple (*Acer saccharinum*)
 Box Elder (*Acer negundo*)
 Poplars (Most *Populus* species) including Aspens and the Female Cottonwood
 Spruces (*Picea* species)
 Weeping Willow (*Salix sepulcralis*)
 Globe Willows (*Salix matsudana*)
 Russian Olives (*Elaeagnus angustifolia*)
 Pyracantha (Most *Pyracantha* species)
 Ponderosa Pine (*Pinus ponderosa*)
 Fruiting Trees

- D. Species of trees, shrubs and ground cover intended to improve parks, trails and any other recreation facilities shall follow the list of native and allowed species found in the City's Landscape Ordinance and the Vision 2020 Plan. Exceptions to this list may occur at the direction or approval of the Department.

2.02 PLANT MATERIAL QUALITY:

- A. Plant material quality, size and condition shall be in accordance with American Standard for Nursery Stock, 1980, as published by the Committee on Horticultural Standards of the American Association of Nurserymen, Inc., the Drawings, and the following requirements:
1. All plants shall be typical of their species or variety. All plants shall have normal, well-developed branches and vigorous root systems. They shall be sound, healthy, vigorous, and free from defects, disfiguring knots, abrasions of the bark, sunscale injuries, plant diseases, insect eggs, borers, and all other forms of infections.
 2. Unless otherwise stated on Drawings or approved by City, all plants shall be nursery grown and shall be tagged with nursery labels indicating species and variety.
 3. Container grown plant material shall have been grown in its delivery container for not less than six (6) months, but for not more than two (2) years. Any root-bound material will not be accepted.
 4. Balled and burlaped plant material shall have a solid ball of earth of minimum specified size and held in place securely by burlap and a stout twine or rope. Broken or loose balls will not be accepted. When inspecting trees, the City's Representative shall check for girdling roots by removing soil from top of root ball. The Contractor will also verify that all metal wire and burlap has been removed from the root ball prior to planting.
 5. Unless specifically noted on the Drawings, all trees shall have a single trunk

that is strait and free of “dog legs”, “crooks”, “Y-crotches”, or other disfiguring shapes. The central leader of all trees shall not have been pruned. Trees with double leaders are not acceptable.

6. All plant material shall have a uniform shape around its complete circumference. Plant material with irregular branching patterns or with branching patterns more highly developed on one side than on the other sides shall not be accepted.
7. All materials shall be inspected at the job site prior to planting and after planting. The City reserves the right to inspect all plant material at the Contractor’s yard prior to delivery to the job site. The Contractor may request that the City inspect, at their convenience, plant material at a wholesale nursery of the contractor’s choice prior to delivery of materials to the contractor’s yard or job site.
8. The City shall be the judge of the quality and acceptability of all plant material. All rejected material shall be immediately removed from the site and replaced with acceptable material at no additional cost to the City.

2.03 PLANTING SOIL MIXTURE:

- A. Planting Soil Mixture to be a mixture of one part backfill amendment to three parts existing soil. The backfill amendment shall consist of:
 1. 70% by volume, organic compost. Compost to be screened to ½” or less, pH not to exceed 7.0, electrical conductivity (EC) of compost not to exceed 3.5 mnhos/cm. Percentage of organic matter shall be not less than 80%, tested by simple combustion. Total nitrogen (TKN+N03-N) shall not be less than 1 % by weight. Carbon to nitrogen ratio of compost shall not exceed 50:1.
 2. 30% by volume, “moisture-lite” (clean, screened, white vitric tuff, graded to 3/6” x 5/16”).
 3. Components to be homogeneously mixed, in ten cubic yard batches to provide a uniform product, free from weed seeds, sticks, rocks, or other deleterious material.
 4. Variations in backfill amendment must be approved by the City.

2.04 MULCH:

- A. Bark mulch shall be fresh, shredded mixture of 5” pieces of wood cambium and bark nuggets from coniferous trees, shall be free of other materials, and shall be free of obvious pests.

PART 3 EXECUTION

3.01 PLANTING OPERATIONS:

- A. All landscaped areas are to be designed and executed so that there is no off site run-off of irrigation water.

- B. Planting operations as specified herein shall begin only when other work including placing of topsoil to finished grade has progressed sufficiently to permit planting and shall be performed only during favorable weather conditions in accordance with accepted practice.
- C. In any one day, only those plant materials intended to be planted that day shall be delivered to the project sites. Unless otherwise approved by City, all plant materials shall be located where shown on the plan except when adjustments due to field conditions are required.

3.02 PLANTING:

- A. All planting and backfilling shall be performed in accordance with accepted nursery practice, the Drawing, and following requirements:
 - 1. The Contractor shall take care when backfilling planters to provide adequate compaction of the fill material in order to prevent settling.
 - 2. Prepare all planting holes and install plants as shown on Drawing. Plants shall be set plumb and straight unless Drawings indicate otherwise.
 - 3. Backfill for planting holes shall be positioned in the hole and backfilled. The backfilling shall be completed, and materials tamped. When hole is nearly filled, water thoroughly and allow water to soak away. If settling of backfill occurs after watering, add more backfill to bring to finish grade.
 - 4. All trees shall have tree wells unless otherwise directed by the City. Tree wells located within hard (i.e. concrete pad) surface areas shall have a minimum interior area of 6' x 6' of bark mulch. If the tree well is within a hard surface with a narrow pedestrian corridor, the tree well shall have the same area as describe above, with a metal grate that meets surface grade. (or equal approved option). Tree wells located within soft (i.e. Turf Area) surface areas shall have a 6' diameter tree ring and minimum interior area of 6' x 6' of bark mulch.
 - 5. After completion of planting, all trees shall be pruned at the direction of the City.

3.03 MULCHING:

- A. Mulching shall be completed as indicated on the Drawings or at the direction of the Department.

3.04 MAINTENANCE AND PROTECTION:

- A. Maintenance and protection of trees, shrubs, and ground cover shall begin immediately following the last operation of installation for each plant and shall continue through the duration of the maintenance period, a minimum of thirty (30) days, or until the entire landscape project is accepted. Maintenance shall include watering, weeding, cultivating, removal and replacement of dead plant material,

removal of debris, resetting of trees to upright positions, restoration of earth basins, and such other operations as may be necessary for the health of the planted stock and the general appearance of the landscape areas: Care shall include protection of planted stock from damages resulting from trespass, erosion (including watering), weather, vandalism, disease and other hazards.

3.05 GUARANTEE:

- A. All plant materials shall be guaranteed to be in a live, healthy, and normal growing condition following the date of final acceptance by the City through one twelve month growing season. Plant materials that are dead or in an unhealthy, impaired growth condition shall be removed and replaced by the Contractor as directed by the City at no additional cost. Replacement material shall be of equal quality, size, and species as that which is being replaced and shall be approved by the City prior to planting. Any plants replaced after the first six months of the guarantee period shall also be under warranty for six months after the replanting date.

3.06 INSPECTIONS:

- A. The following inspections shall be the minimum required inspections during the course of construction. Additional inspections shall be made at any time at the discretion of the City.
- B. It shall be the responsibility of the Contractor to notify the City's representative, by phone, 48 hours in advance of each required inspection.
- C. The sequence of required observations shall not be changed from the sequence listed below. The Contractor shall not proceed with the work of the next sequence without written approval of the work of the previous sequence.

For City-built facilities, the Contractor shall attach a copy of the written reports prepared by the City's representative or the Landscape Architect to all applications for payment. Payment will not be made for items that have not been observed and approved in writing.

1. If required by City, observe plant material at Contractor's yard prior to delivery to job site.
2. Observe material at the job site prior to and during planting.
3. Observe at end of 30-day maintenance period.
4. Observe 6 months after final completion.
5. Observation 12 months after final completion.

8. GRASS SODDING

PART 1 GENERAL

1.01 SUMMARY:

- A. Work under this section consists of preparing all areas indicated on the Drawing for grass sodding according to the specifications and furnishing and installing all sod, fertilizer and soil amendments as specified herein.

1.02 REFERENCE STANDARDS:

- A. ASPA (American Sod Producers Association) Guideline Specifications to Sodding.

PART 2 PRODUCTS

2.01 SOD MATERIAL:

- A. Grass Sod: Sod shall be as specified on the Drawings. The City reserves the right to require that a sample of sod and a written submittal of the seed mix shall be submitted a minimum of fifteen (15) days prior to laying sod. It shall be vigorous, well-rooted healthy turf free from disease, insect pests, weeds, other grasses, stones and other harmful or deleterious matter.
- B. Sod shall be cut by an approved mechanical sod cutter to a thickness of not more than 1" or less than ½". Sod pieces shall be cut a maximum of 18" wide. Handling of sod shall be done in a manner that will prevent tearing, breaking, drying or any other damage. Sod shall be installed in place on the site not more than 24 hours after cutting.
- C. Sod shall have no more than ½" of loose thatch. The sod shall be dense enough so that an entire strip can be lifted by the top 10% without breaking.

2.02 FERTILIZER:

- A. Fertilizer shall be a granular form starter fertilizer with a guaranteed analysis of 18-24-16, unless otherwise directed by the City.

2.03 ORGANIC AMENDMENTS:

- A. Organic amendment shall consist of:
 - 1. 70% by volume, organic compost. Compost to be screened to ½" or less, pH not to exceed 7.0, electrical conductivity (EC) of compost not to exceed 3.5 mnhos/cm. Percentage of organic matter shall be not less than 80%, tested

by simple combustion. Total nitrogen (TKN+N03-N) shall not be less than 1%, by weight. Carbon to nitrogen ratio of compost shall not exceed 50:1.

2. 10% by volume, "Ecolite" (clinoptilolite zeolite), screened to pass a #40 mesh screen.
3. 20% by volume, "Moisturelite," screened to pass a #40 mesh.
4. Components to be homogenously mixed, in ten cubic yard batches to provide a uniform product, free from weed seeds, sticks, rocks, or other deleterious material.

PART 3 EXECUTION

3.01 SOD BED PREPARATION:

- A. Prior to start of soil preparation all finish grades shall be established and approved as meeting the requirements of the grading plan.
- B. Apply a uniform 2" layer of organic amendment and 4lbs. of starter fertilizer per each 1,000 square feet to the entire area to be sodded. After application of organic amendment and starter fertilizer all areas to be sodded shall be ripped to a depth of twelve inches and thoroughly rototilled to a minimum depth of 6 inches. After rototilling is complete at cross directions, drag to an even grade, then roll for firmness.

3.02 SOD INSTALLATION:

- A. Before laying sod, the finish grade shall be brought to a firm, even surface, free from stones or lumps, and shaped to provide drainage. The finish grade shall be inspected and approved by the Landscape Architect prior to laying any sod.
- B. Lay sod over moistened soil, lightly raking the soil ahead of each sod strip. Sod shall be laid parallel to the direction of slope and shall have staggered joints. Pieces shall be fitted together tightly so that no joint is visible, and sod tamped firmly and evenly by hand. Stake as required on slopes.
- C. Water all sodded areas immediately after final rolling with fine spray to a depth of 4". Irrigate by means of the automatic underground irrigation system all sodded areas as often as necessary to promote healthy grass growth. Mowing during the maintenance period will be scheduled so that the grass is maintained at a height no shorter than two (2) inches and no greater than three (3) inches.

3.03 MAINTENANCE AND PROTECTION:

- A. Maintenance and protection shall continue for thirty (30) days, or until the entire landscape project is accepted. Acceptance shall occur after all sod is well rooted.
- B. The Contractor shall be the responsible for all maintenance during the maintenance period including but no limited to watering, mowing, weed removal, re-seeding, repair to damage from vandals or acts of God, and fertilizing.

3.04 GUARANTEE:

- A. Sod shall be guaranteed to be in a live, healthy, and normal growing condition following the date of final acceptance by the City through one twelve month growing season. Sod that is dead or in an unhealthy, impaired growth condition shall be removed and replaced, or top dressed and seeded by the Contractor as directed by the City at no additional cost. Replacement seed or sod shall be of equal quality and species mix as that which is being replaced and shall be approved by the City prior to planting.

3.05 INSPECTIONS:

- A. The following inspections shall be the minimum required inspections during the course of construction. Additional inspections shall be made at any time at the discretion of the City or Landscape Architect.
- B. It shall be the responsibility of the Contractor to notify the City's Representative by phone, 48 hours in advance of each required inspection.
- C. The sequence of required observations shall not be changed from the sequence listed below. The Contractor shall not proceed with the work of the next sequence without written approval of the work of the previous sequence.

For City-built facilities, the Contractor shall attach a copy of the written reports prepared by the City's representative or the Landscape Architect to all applications for payment. Payment will not be made for items that have not been observed and approved in writing.

1. Automatic Rainbird irrigation system shall be installed, tested, and approved. (See Standard Specifications for Irrigation Systems)
2. Each phase of soil preparation shall be inspected in process prior to laying sod.
3. Finish grade shall be inspected.
4. Sod shall be inspected prior to laying.
5. Sod shall be inspected after completion.
6. Sod shall be inspected at end of 30-day maintenance period.
7. Sod shall be inspected 6 months after completion.
8. Sod shall be inspected 12 months after completion.

9. GRASS SEEDING

PART 1 GENERAL

- 1.01 Work under this section consists of preparing all areas indicated on the Drawings for grass seeding according to these specifications, and furnishing and installing all seed, fertilizer and soil amendments as called for by the drawings and as specified herein.
- 1.02 All soil areas, which have been prepared prior to the seeding season, shall be observed for effects of weather that have affected the quality of soil preparation. If the soil areas are unaffected, they will be seeded immediately after the opening of the current seeding season. If they have been affected, the City and Contractor shall identify the steps in Soil Bed Preparation that may need to be repeated prior to seeding.
- 1.03 All soil areas, which are prepared during the seeding season, shall be seeded that same season.
- 1.04 **SUBMITTALS:**
Submit soil analysis showing pH, soil texture analysis, soluble salts and sodium. Provide an interpretation of the soil test and recommendation of improvements or changes to the soil by a professional soil scientist certified by A.R.C.P.A.C.S.

PART 2 MATERIALS

- 2.01 **SEED:**
- A. Seed shall be as specified on the drawings.
 - B. Each bag of seed shall be sealed and labeled by the seed dealer in accordance with Federal Seed Laws and New Mexico Department of Agriculture Labeling Laws. This includes: variety, kind of seed, lot number, purity, germination, percent crop, percent inert, percent weed (including noxious weeds), origin test date and net weight. Federal Seed Laws require that analysis shall be no older than 9 months for seed shipped intra-state.
- 2.03 **FERTILIZER:**
- A. Fertilizer shall be granular form starter fertilizer with a guaranteed analysis of 18-24-16.
- 2.04 **ORGANIC AMENDMENTS:**
- A. Organic amendment shall consist of:
 - 1. 70%, by volume, organic compost. Compost to be screened to ½” or less, pH not to exceed 7.0, electrical conductivity (EC) of compost not to exceed 3.5 mnhos/cm. Percentage of organic matter shall be not less than 80%, tested

by simple combustion. Total nitrogen (TKN + NO₃-N) shall be not than 1%, by weight. Carbon to nitrogen ratio of compost shall not exceed 50:1.

2. 10%, by volume, “Ecolite” (clinoptilolite zeolite), screened to pass a #40 mesh screen.
3. 20%, by volume. “Moisturelite,” screened to pass a #40 mesh.
4. Components to be homogeneously mixed, in ten cubic yard batches to provide a uniform product, free from weed seeds, sticks, rocks, or other deleterious material.

2.05 WETTING AGENT:

- A. Wetting agent shall be Hydro-wet-RTA as manufactured by KALO, Inc., 4550 W 109th Street, Overland Park, KS 66211, 1(800) 255-5196, or an approved equivalent wetting agent having the same characteristics and performance abilities as Hydro-wet. Apply at a rate of 5 gallons liquid product per acre.

PART 3 EXECUTION

3.01 SEED BED PREPARATION:

- A. Prior to start of soil preparation all finish grades shall be established and approved as meeting the requirements of the grading plan. The finish grade of the area to be seeded shall be free of irregularities, humps, ridges, depressions or low areas.
- B. Apply a uniform 2” layer of organic amendment and 4 pounds of starter fertilizer per each 1,000 square feet to the entire area to be seeded. After application of organic amendment and starter fertilizer all areas to be seeded shall be ripped to a depth of 12 inches and thoroughly rototilled to a minimum depth of 6 inches. After rototilling is complete at cross directions, drag to an even grade, then roll for firmness.
- C. After applying amendments and before seeding, the finish grade shall be brought to a firm, even surface, free from stones or lumps, in excess of one-inch diameter, and shaped to provide drainage.

3.02 SEEDING

- A. The seed mix and rate shall be as specified herein or as shown on the drawings. The prescribed mix and rate shall be uniformly applied over the area to be seeded.
- B. Contractor’s vehicles and other equipment shall not travel over the seeded areas. If, as determined by the City’s Representative, rain or some other factor occurs over prepared surfaces prior to seeding which prevents seeding to the proper depth, the Contractor shall again prepare the seed bed without additional compensation.
- C. Time of Seeding. Unless otherwise directed by the City, turf grass seeding shall

only be accomplished in the spring from April 1 through May 30 or in the fall from August 15 through September 15. "Low water use grass" seeding shall only be accomplished in the spring from April 15 through June 1. If seeding is not accomplished during the "time of seeding" the Contractor shall accomplish the seeding at the "time of seeding" during the next calendar year. Contractor extension of the "time of seeding" shall be accomplished at no additional cost.

3.03 DRILL AND SLIT SEEDING:

- A. All seed shall be drilled in cross directions, where practical, with 50% of the seed applied in each direction. The second pass of the seeder when seeding in cross directions shall be across the slope. In areas where seeding in cross directions is impractical, seeding shall be accomplished by drilling and shall be across the slope. Seed shall be planted approximately ¼" inch deep, with a maximum depth of ½" inch unless otherwise specified on the Drawings. The distance between the drilled furrows or slits shall not be more than 2 inches. Seeding shall be done with grass seeding equipment in good working order double disc openers, depth bands, drop tubes, packer wheels or drag chains, rate control attachments and seed boxes with agitators for trashy seed.

3.04 WATERING:

- A. Watering of the seed will be the responsibility of the Contractor. All seeded areas shall be watered immediately after completion of seeding, keeping the top two inches of evenly moist until seed has uniformly germinated and grown to a height of two inches. In instances where the irrigation system is metered separately, the Contractor shall be responsible for the cost of water during seeding and maintenance of seeded turf until final acceptance.

3.05 WETTING AGENT:

- A. After the seed has germinated and the grass has reached an approximate height of one-half inch, the wetting agent shall be applied in accordance with the manufactures recommendations.

3.06 MAINTENANCE AND PROTECTION:

The Contractor shall maintain the grass until a dense stand of grass is obtained.

- A. A dense stand of grass for turf grass shall be defined as having been mowed twice at a uniform height of 2", having a uniform green color, having no weeds and no bare areas on 75% of the seeded areas, and with no bare areas greater than 2" in diameter.
- B. A dense stand of grass for low water use grass shall be defined as having a uniform growth of 2", having a uniform green color, having no weeds and no bare areas on 75% of the seeded area, and with no bare areas grater than 6" in diameter.

- C. The Contractor shall be the responsible for all maintenance during the maintenance period including but no limited to watering, mowing, weed removal, re-seeding, repair to damage from vandals or acts of God, and fertilizing.

3.07 GUARANTEE:

- A. Seeded turf shall be guaranteed to be in a live, healthy, and normal growing condition following the date of final acceptance by the City through one twelve month growing season. Turf areas that become unacceptably bare, dead or in an unhealthy, impaired growth condition shall be removed and replaced, or top dressed and seeded by the Contractor as directed by the City at no additional cost. Replacement seed or sod shall be of equal quality and species mix as that which is being replaced and shall be approved by the City prior to planting.

3.08 INSPECTION:

- A. The following inspection shall be the minimum required inspections to seeded grass during the course of construction. Additional inspections shall be made at any time at the discretion of the City or City's Representative.
- B. It shall be the responsibility of the Contractor to notify the City's Representative by phone, 48 hours in advance of each required inspection.
- C. The sequence of required observations shall not be changed from the sequence listed below. The Contractor shall not proceed with the work of the next sequence without written approval of the work of the previous sequence.

For City-built facilities, the Contractor shall attach a copy of the written reports prepared by the City's representative or the Landscape Architect to all applications for payment. Payment will not be made for items that have not been observed and approved in writing.

1. Automatic irrigation systems where required shall be installed, tested, and approved prior to laying sod or applying seed (Standard Specifications for Irrigation Systems).
2. Each phase of soil preparation shall be inspected in process.
3. Finish grade shall be inspected.
4. Seed shall be inspected prior to seeding.
5. Seeded area shall be inspected after seeding is completed.
6. Seeded area shall be inspected at the end of the maintenance period.
7. Seeded area shall be inspected 6 months after acceptance.
8. Seeded area shall be inspected 12 months after acceptance.

10. IRRIGATION SYSTEMS

PART I GENERAL

1.01 SUMMARY:

- A. The work under this section consists of installing a complete underground sprinkler system as shown on the Irrigation Plan (Drawing) and as specified hereafter. The Contractor performing this work shall furnish all labor, equipment, materials, permits and additional inspections necessary for the completion of the system, unless otherwise specified or indicated on the Drawing. The construction of the sprinkler system shall include the furnishing, installing and testing of all pipe, fittings, electric valves, heads, controllers, wires, sir release valves, manual drain valves, valve boxes, water meters and all other completion of the project.

1.03 RECORD DRAWING:

- A. The Contractor shall provide and keep up to date a complete set of “record” drawings which shall be corrected daily to show all changes in the location of sprinkler heads, controllers, backflow preventers, valves, drains, meters, points of connection, pull boxes and wire splice boxes, pipe and wire routing and other changes that may have been made from the original drawings and specifications as provided to him. All straight valves, manual drains, wire splices and automatic and manual valve locations shall be shown with actual measurements to reference points so that may be easily located in the filed. Valve locations shall be shown with actual measurements to reference points so they may be located in field.
- B. At the time of final acceptance, the Contractor shall finish a complete set of As-Built Plans, prepared by a qualified draftsperson showing the entire completed system as actually installed. This is the responsibility of the Contractor and shall not be construed to be the responsibility of any other party. This plan set shall be accurate and to scale. The legend shall also be modified to designate any “record” changes. These As-Built Plans shall be drawn on/over the approved construction plans, shall be dated and clearly labeled “AS-BUILT PLANS, RECORD DRAWING.”
- C. The Contractor shall also provide and install a legible reduction of the As-Built Irrigation Plan sheet, laminated in plastic, in the controller enclosure at the Job Site

PART 2 PRODUCTS

2.01 MATERIALS:

- A. All materials shall be new and without flaws or defects of any type and shall be the best of their class and kind. All materials shall have a minimum guarantee of one year against material defects of defective workmanship.

- B. All materials shall be the brands and types noted on the drawings or as specified herein, or approved equal.
- C. The irrigation system will be designed around equipment manufactured by specific companies as a standard (where the City prefers Rainbird products for City-wide maintenance requirements. Approved equal equipment by other manufacturers may be used only with the approval of the City. Submission of irrigation sprinkler heads for approval, as equal shall only be considered if submitted heads match the precipitation rate, gallons per minute and spacing of specified sprinkler heads.
 - 1. For City-built facilities, requests for approval of non-specified materials must be submitted to the City a minimum of seven (5) days prior to the opening of bids.
 - 2. For facilities built as part of a subdivision by a Developer, the Contractor must indicate the use of non-specified materials prior to submission of conceptual or site plan, or as part of the submission of construction plans through the Design Review Process.

2.02 PLASTIC PIPE AND FITTINGS:

- A. Plastic Pipe: All mainline pipe, from the point of connection to the zone valve, shall be Schedule 40 PVC SDR 21; lateral line piping downstream of the zone valve which is 3/4" in diameter and greater shall be Schedule 40 PVC SDR 21 and shall conform to ASTM D 2241. Solvent shall meet ASTM L 2774 and D 2855 requirements. All PVC pipe shall be continuously marked with identification of the manufacturer, type, class, and size, and shall be free of holes, foreign material, blisters, wrinkles, dents, sunburn or other sun damage.
- B. Location Tape: Irrigation line location tape shall be non-detectable water caution tape.
- C. PVC Fittings: Fittings on PVC lines shall be Schedule 40 Molded PVC pipe. All galvanized nipples shall be Schedule 40 galvanized steel pipe.
- D. Threaded Nipples: All threaded PVC nipples shall be Schedule 80 Machined PVC pipe. All galvanized nipples shall be Schedule 40 galvanized steel pipe.

2.03 VALVES AND VALVE BOXES:

- A. Valves for use in electrically controlled automatic control systems shall be diaphragm actuated and hydraulically operated solenoid valves as specified on the Drawings, and wherever possible shall be pressure regulating valves.
 - 1. Electric valves shall include true PVC union ball valve on upstream pipe and PVC union on downstream pipe.
 - 2. The City prefers and may require the use of the following:

- a. For both Master Valve and Automatic Valves:
 - Rainbird PEB for 2 inch or smaller valve
 - Rainbird BPE for 3 inch and larger valve
- B. Valve boxes shall be as noted on the Drawings.
- C. Note: A flow meter shall be installed before the Master Valve assembly and before the Backflow preventer. The flow meter shall be a Master Meter.

2.04 SPRINKLER HEADS AND BUBBLERS:

- A. Sprinklers heads and bubblers shall be as specified and installed as shown on the Drawings.
 - 1. The City prefers and may require the use of:
 - a. Rainbird Rotors (impacts are not acceptable)
 - b. Spray heads – Rainbird 1800 Series
 - c. Bubblers – Rainbird 1400 Series
 - 2. All bubblers shall be installed with flex risers.
 - 3. Bubbler heads shall be low flow pressure compensating bubblers.

2.05 CONTROLLER:

- A. Controllers shall be as specified on the Drawings.
 - 1. All irrigation systems shall utilize a controller capable of being connected to the City's Central Control System. The City will provide brand and model specifications to the Landscape Architect.
 - 2. All controllers shall be installed in a locking, stainless steel controller enclosure or clock vault.

2.06 BACKFLOW PREVENTER:

- A. The backflow prevention device shall be as specified on the Drawings and it shall be permitted and inspected by a Rio Rancho certified backflow tester to comply with the City of Rio Rancho Ordinance 51 "Water and Wastewater Rules and Rates. The backflow preventer shall also be installed as required by State Code.
- B. The Department requires Febco 825Y for meters 2" or smaller, and Febco 880 for 2.5" and larger. Substitution with a pressure backflow preventer will depend on back flow preventer location, site grading and line placement.
- C. The backflow preventer shall be located in a Hot Box insulated enclosure. Electric power shall be made available to the box for a heat source.

2.07 CEMENTS, CLEANERS / PRIMERS AND JOINT COMPOUNDS:

- A. Cement shall be plastic pipe cement for use on all sizes and schedules of PVC pipe

and fittings. Cement must be NSSF approved and meet ASTM D 2564 requirements.

- B. Cleaner/primer shall be purple cleaner/primer.
- C. All threaded connections between metal-to-metal, PVC to metal and PVC to PVC shall be made using Pipe Dope slow dry, soft set, thread sealing compound, or Teflon tape. Thread sealing compound shall not be used on thread connections between sprinkler and nipple or bubbler and nipple.

2.08 WIRE:

- A. Wire for 120 volt wiring shall be solid copper (or stranded copper in larger wire sizes), underground feeder for direct burial and PVC insulated. Size of wire shall be #12 AWG.
- B. Wire for 24 volt wiring shall be solid copper wire, PVC insulated, UL approved underground feeder wire for direct burial in ground. Common wires shall be #12, white, unless otherwise noted on Drawings. The control wires shall be #14 of any color other than white unless otherwise indicated on the Drawings.
- C. Wire Splicing. Wire shall be laid in long runs with as few splices underground as possible. Where splices occur, they must be accessible in the valve box. See additional wiring specifications.
- D. Wire Splicing Materials: All wire splices shall be made watertight using watertight connectors.

2.09 OTHER MISCELLANEOUS FITTINGS AND MATERIALS:

All other miscellaneous fitting and materials shall be specified on the Drawings and approved by the City.

PART 3 EXECUTION

3.01 GENERAL:

- A. This section includes installation specifications for all items installed as a part of the sprinkler irrigation system. Certain construction procedures may have been omitted from these specifications that are necessary for the proper installation of the system. In any case, all materials and equipment shall be installed in a neat and workmanlike manner according to manufacture's recommendations and specifications, local and state codes, as shown on the Drawings and as specified herein.

3.02 PRODUCT HANDLING:

- A. The Contractor shall be responsible for correct procedures in loading, unloading,

staking, transporting and handling all materials to be used in the system. The Contractor shall avoid rough handling which could affect the useful life of equipment. Pipe shall be handled in accordance with the manufacturer's recommendations on loading, unloading and storage.

3.03 EXCAVATION AND TRENCHING:

- A. The Contractor shall stake out the location of each run of pipe and all sprinkler heads and valves prior to trenching. The City shall approve each run of trenches for the system before actual installation is started.
- B. Excavation and trenching for pipelines shall be true and in line with the trench banks and as nearly vertical as practical. The width of the trenches shall not be greater than necessary to permit proper joining, tamping, backfilling, bedding or any other installation procedures that may be necessary. Trench widths shall also be wide enough so that there will be a minimum horizontal and vertical separation of 4" between pipes in the same trench.
- C. Pipelines shall not be stacked and every effort shall be made to ensure that pipelines will not cross, and verified by City review and acceptance of the Drawing. Additionally, zone design and lateral line layout should minimize the occurrence of multiple lines in the same trench.
- D. In areas where trees are present, trench lines will be adjusted on the site to eliminate any damage to tree roots.
- E. Trench depths shall be 24" deep and sufficient to provide the specified pipe cover as described elsewhere in these specifications or as noted on the Drawings. In rocky areas the trenching depth shall be 6" below normal trench depth to allow for pipe bedding as described in other portions of these specifications.
- F. Depth of Bury: Minimum cover over mainline and lateral piping shall be filled and compacted so that when the trench area is compacted, it will be compacted to the same degree and level as the surrounding soil.

3.04 PIPE AND FITTING INSTALLATION:

- A. Installation of plastic pipe and fittings shall be in accordance with the manufacturer's recommendations and procedures and as mentioned in the specifications. Manufacturer's recommended procedures for making solvent weld fitting shall be strictly adhered to. Only solvent cements, cleaners, and primers or lubricants recommended or supplied by the pipe manufacturer shall be used.
- B. Caution shall be exercised by the Contractor in handling, loading, unloading and storing of PVC pipe and fittings. All PVC pipe shall be stored and transported in a vehicle with a bed long enough to allow the pipe to lie flat without subjecting it to undue bending or concentrated external load at any point. Any section of pipe that

has been dented or damaged or in any other way found to be defective, either before or after lying shall be replaced with sound pipe without additional expense to the City.

- C. Before installation, the inside of the pipe shall be cleaned of all dirt and foreign matter and shall be kept in a clean condition during and after lying of pipe. When work is not in progress, open ends of pipe and fitting shall be secured closed so that no trench water, earth or other foreign materials may enter the pipe or fitting until they have been connected to a valve or capped as directed on the irrigation system Drawings.
- D. All PVC pipe and fittings shall be assembled pipe label facing up, and to permit the pipe or fittings to be jointed at the true parallel position of the fittings. Placement of pipe in curving trenches, which cause excessive bending and stress on pipe and fitting, will not be permitted. No excess piping or fittings shall be permitted in the installation of the system, which may increase pressure loss or potential blockage.
- F. Before installing the pipe, all rubbish and large rocks shall be removed from the trenches. If the soil is extremely rocky, the trenches shall be bedded with dirt or sand as outlined in other portions of these specifications. The City shall approve material used for pipe bedding. The full length of each section of the pipe shall rest solidly upon the pipe bed, with recesses excavated to accommodate bells, joints and couplings.
- G. Pipe shall not be laid in water or when trench or weather conditions are unsuitable for the work. Any water, which may be encountered or may accumulate in the trenches shall be removed and trenches kept free and clear of water during the progress of the work. Pipe shall not be laid when the temperature is 32 F or below.
- H. PVC pipe will expand or contract at the rate of 1“per 100’ per 10 F change of temperature. Therefore, the pipe shall be installed in a manner so as to provide for expansion and contraction as recommended by the manufacturer.
- I. The minimum horizontal and vertical clearance between lines in the same trench shall be 4”. Pipelines shall not be stacked and every effort shall be made to ensure that pipelines will not cross, and verified by City review and acceptance of the Drawing. Additionally, zone design and lateral line layout should minimize the occurrence of multiple lines in the same trench.
- J. After all sprinkler piping, risers, valves, etc., have been installed and partially backfilled as specified in other parts of these specifications, the control valve shall be opened and a full head of water used to flush out the system. After the system is thoroughly flushed, risers shall be capped off and the system pressure tested in accordance with the testing section of these specifications. At the conclusion of the pressure test, the heads shall be installed and the backfill operation completed.

3.05 SOLVENT WELDING PROCEDURE:

- A. Pipes and fittings shall be welded as described below.
 - 1. PVC plastic pipe shall be squarely cut utilizing a hacksaw or approved PVC pipe cutter.
 - 2. Burrs left from cutting shall be wiped off with a clean dry cloth.
 - 3. Utilizing a cleaner/primer, thoroughly clean the mating pipe end and the fitting socket with a clean, dry cloth.
 - 4. Apply a uniform coat of primer to the outside of the pipe end with a non-synthetic brush or dauber.
 - 5. In like manner, apply a light coat of primer to the inside of the fitting socket.
 - 6. Apply a light coat of solvent cement to the pipe end and fitting socket, and quickly insert it into the fitting to the full depth of the fitting socket.
 - 7. Rotate the pipe of fitting approximately $\frac{1}{4}$ turn to insure even distribution of the solvent cement.
 - 8. Hold in position for approximately 30 seconds.
 - 9. Wipe off any excess solvent cement that forms as a bead around the outer shoulder.
 - 10. Care should be taken so as not to use an excess amount of solvent cement that could cause obstructions to form on the inside of the pipe joint.
 - 11. Solvent weld joints shall be allowed to cure for at least 24 hours before pressure is applied to the system.

3.06 BACKFILLING:

- A. Upon completion of a particular section of the irrigation system, and after sufficient time has elapsed for the curing of solvent weld joints, partial backfilling can begin, leaving all joints, risers and connections exposed for visual inspection during the hydrostatic testing. Only upon successful testing and inspection for any one particular section, can that section then be completely backfilled.
- B. All backfill material shall be subject to approval by the City. Backfill material shall be free from rock, large stones, brush, sod, frozen material or other unsuitable substance that may damage pipe during the backfilling operations.
- C. In the event that the material from the excavation or trenching is found to be unsuitable for use in backfill by the City, it shall be removed from the site and properly disposed of by the Contractor and at his own expense. The Contractor shall then, at no additional cost to the City, arrange for, purchase, and furnish suitable backfill material consisting of earth, loam sandy clay, sand or other approved materials free of large clods of earth or sharp stones and capable of attaining the same relative density of the surrounding ground.
- D. In rocky areas, the trench depth shall be 6" below the normal trench depth to allow for 6" of suitable backfill as padding for the pipe. In like manner there shall be at least 6" of padding on all sides of the pipe as padding against the rock wall of the

trench.

- E. All mainline piping shall have irrigation line location tape installed in the trench six (6") inches above the pipe.
- F. Backfill shall be placed in horizontal layers not exceeding 6" in depth and shall be thoroughly tamped, or water compacted to near original density or so that no settling will result. Backfill shall be placed to the original ground level as previously described (Irrigation Systems 3.03 B). If settlement of trenches occurs within one (1) year from date of completion, it shall be the Contractor's responsibility to refill trenches and re-seed or sod the repaired areas.

3.07 SADDLE TAPS:

- A. No saddle taps shall be permitted unless approved by the City.

3.08 THRUST BLOCKS:

- A. Irrigation systems shall be designed in a manner to exclude the use of thrust blocks wherever possible.

3.09 SLEEVED CROSSING:

- A. During design every effort shall be made to avoid the need for sleeved crossings.
- B. Unless otherwise noted on plans, all piping installed under sidewalks, roadways, parking lots, etc., shall be sleeved in a Class 200 PVC pipe two (2) sizes larger than the pipe to be sleeved. Wiring shall be placed in a separate sleeve from that of the pipe crossing and shall be Class 200 PVC with 50% fill. Ends at sleeves are sealed with duct tape following installation of wire piping.

3.10 SPRINKLER HEAD INSTALLATION:

- A. Sprinkler heads shall be of the type and make specified and shall be installed providing head to head coverage as will be shown on the Drawings. Sprinkler heads shall be installed with a 4" space between the edge of the sprinkler head and curbs, walls, driveways, buildings walls, etc. Heads shall be installed in the vertical position and backfilled compacted to near original density.
- B. Sprinkler head spacing shall not exceed the spacing shown and shall be in the location and configuration as shown on the Drawings. Sprinkler heads shall be spaced to achieve uniform coverage.
- C. After all piping and risers are in place and connected and before installation of the sprinkler heads, all control valves for a given section shall be fully opened and a full head of water shall be used to flush out the system. If water pressure without

the heads installed is not sufficient to provide adequate water flow from end risers, the Contractor shall cap off enough heads closest to the water source to provide adequate flushing of the end riser assemblies.

- D. Teflon tape shall be used on all sprinkler head connections.

3.11 CONTROLLER INSTALLATION:

- A. The Controller location shall be indicated on the Drawings. The Contractor shall familiarize himself with the requirements of making the power connections at the locations noted (120 volt supply to the Controller). 120 volt power shall be supplied to the Controller location by a licensed electrician. Contractor shall include this in the lump sum price for the sprinkler irrigation system.
- B. The Controller shall be mounted and wired according to the manufacturer's recommended procedures and as specified herein and on the Drawings. The controller must be GFI protected.
- C. For Controllers installed inside of vaults or other enclosures, the Contractor shall provide and install on the Controller, an electrical pigtail outlet that must be GFI protected.
- D. When Controllers are mounted outside of any building, vault or enclosure, the Contractor shall direct wire the 120-volt power to the Controller.
- E. Remote control valves shall be connected to Controller in the numerical sequences as shown on the Drawings or as directed by the City.

3.12 AUTOMATIC CONTROL VALVE INSTALLATION:

- A. All automatic control valves shall be of the type and size as indicated on the Drawings. Installation shall be according to these specifications, the Drawings and the manufacturer's recommendations.
- B. The valve boxes shall be of the size and type as shown in the detail drawings.
- C. Valve wire splices shall be waterproofed using waterproof connectors, and the Contractor shall provide a 36" wire expansion coil to facilitate raising splices to ground level without cutting wires.
- D. All connections for electric valves shall be made using Teflon tape.
- E. Flow Meter shall be installed before the Master Valve assembly and after the backflow preventer.

3.13 24 VOLT CONTROL VALVE WIRING:

- A. All wire installation procedures as described herein shall be checked to conform to local codes.
- B. The Contractor shall install the 24-volt control valve wiring in the same trench as the irrigation mainline. Only when it is not possible for the wires to be installed in the mainline trench, they shall be installed in the later pipe trench. All wires shall be laid loose in the trench and taped together at 10' - 0" intervals. When trenches used for piping are not appropriate for routing wire, Contractor shall install in a separate trench, 18" deep.
- C. Wire splices, other than at valve box locations, shall be kept to a minimum and if needed shall be made only at common splice points and placed in a wire splice boxes as shown in the detail drawings. The location of these wire splice boxes shall be made waterproof using waterproof connectors.
- D. At control wire splices, the Contractor shall provide a 36" wire expansion coil to facilitate raising splices to ground level without cutting wires.
- E. All continual wire shall be one color and in no case shall wires of different colors be spliced together.
- F. All 24 volt wiring shall be installed in PVC conduit when inside a building. All 24 volt wiring installed on exterior building walls shall be installed in metal conduit.

3.14 120 VOLT CONTROLLER WIRING:

- A. The Contractor shall familiarize himself with the work required to complete this portion of the installation. All 120 volt wiring shall be installed in accordance with local electrical codes.
- B. 120 volt power shall be supplied to the Controller location by a licensed electrician.

3.15 MANUAL DRAIN VALVES:

- A. Manual drain valves shall be the size and type as indicated and at locations as shown on the Drawings. These valves shall be in a bed of ¾" gravel for drainage.

3.16 TESTING:

- A. Upon completion of the irrigation system's main line, the entire mainline shall be tested for a one-hour period at 100 psi, unless otherwise noted. Prior to testing, the mainline shall be partially backfilled, leaving all joints and connections exposed

for visual inspection. All dirt shall be flushed from the system and the line filled with water to remove air. The mainline shall be brought to static pressure. A pressure gauge and temporary valve shall be installed at the end of the mainline to permit air pressure to be applied to the main. A pressure of 100 psi must be retained for a one-hour period. Any leaks resulting in the one-hour pressure test shall be repaired and the system retested until the system passes the test.

- B. Upon completion of the lateral piping sections, each lateral system shall be pressure tested for one hour at 100 psi. On systems using flex risers, or swing joints, the lateral system shall be tested prior to installation of the flex risers or swing joints. Prior to testing, the lateral lines shall be partially backfilled leaving all joints and connections exposed for visual inspection. All air and dirt shall be flushed from the system and all open fittings shall be capped. The testing procedure shall be the same as used for the main line. If after one hour no visual leakage has occurred and the 100-psi pressure has been retained, the heads shall be installed, and the backfill operation completed. Any leaks resulting from the hydrostatic test shall be repaired and the system retested until the system passes the test.

3.17 ADJUSTING OF SYSTEM:

- A. After completion of testing and installation, the Contractor shall adjust all valves for the proper operating pressure and adjust all sprinklers and bubblers for uniform coverage and even flow. Contractor shall wire the Controller (valve/station) as directed by the City, and the wires shall be numbered for each of the zones. The valve number will be indicated on the Controller panel for each station. Contractor will program Controller to provide optimum sprinkler system performance.

3.18 IRRIGATION AUDIT:

- A. If the landscape being watered by the irrigation system has a total turf area of one or more acres, the Contractor must have a Landscape Irrigation Audit performed in order to comply with the City of Rio Rancho, Water Conservation Ordinance 52. The audit of the system must be performed prior to the installation of turf or seed.

3.19 CLEANUP:

- A. The Contractor shall continuously keep a neat and orderly area in which he is installing the system. Disposal of rubbish and waste material resulting from the installation shall be continual. Upon completion of the system, the Contractor shall remove from the City's property at his own expense, all temporary structures, rubbish, waste material, tools and equipment resulting from or used in the installation of the system.

3.20 PROTECTION OF EXISTING UTILITIES:

- A. The Contractor shall be responsible for locating all cables, conduits, piping, and any other utilities or structures that may be encountered either above or below ground. All necessary precautions must be taken by the Contractor to prevent any damage to these existing utilities and improvements. In the event that such damage should occur from his operations, the Contractor shall repair or replace damaged utilities to their original condition at no additional expense to the City.

3.21 ROCK:

- A. If the Contractor encounters rock or other unfavorable trenching conditions, no additional compensation will be paid. When material from the excavation or trenching is unsuitable for use as backfill, additional backfill material suitable for this purpose shall be brought in at the expenses of the Contractor. It shall also be the Contractor's responsibility to remove and dispose of all unsuitable materials removed from the trench that cannot be used in the backfill operation.

3.22 FINAL ACCEPTANCE:

- A. When the Contractor is satisfied that the system is operating properly, that it is balanced, adjusted, has passed an irrigation audit, and that all work and clean-up is completed, he shall notify the City's Representative by phone, a minimum of 48 hours in advance, for an inspection.

At that time the Contractor shall demonstrate the operation of each system in its entirety. In judging the work, no allowance for deviation from the original Drawings and Specifications will be made unless prior approval has been obtained.

- B. Any inconsistency to the Specifications or the Drawings shall be noted by the City and a written copy of required corrections shall be given to the Contractor. Any work deemed not acceptable shall be re-worked to the complete satisfaction of the City.
- C. When the completed work and the "RECORD" drawings, certification of backflow inspection, keys and maintenance manual have been reviewed and approved by the City, the irrigation system will be considered complete and landscaping activities may begin.

3.23 OPERATIONAL INSTRUCTION:

- A. After the system has been tested and accepted as complete, the Contractor shall instruct the City or the City's representative in the operation and maintenance of the system.
- B. The Contractor shall provide the City with two (2) keys for the following:
 1. Manual Straight Valves.
 2. Manual Drain Valves.
 3. Valve Boxes.

4. Valve Markers.
5. Controllers.
6. Hot Box
7. Any locking assembly in need of key access.

- C. The Contractor shall provide the City with two copies of a Maintenance Manual bound in a three ring binder. The maintenance manual shall include copies of the approval Submittals, Controller operations manuals and manufacturers warranties on all irrigation products.

3.24 SYSTEM PROTECTION AND MAINTENANCE:

- A. For a period of one (1) year from final acceptance of the facility, the Contractor will promptly furnish and install damaged or inoperative materials or systems that may be defective in material or workmanship. Damage due to irrigation system line breaks shall be repaired and brought to original condition by the Contractor at no expense to the City.
- B. In the fall, at the City's request, the contractor will drain the system, and otherwise prepare the system for winter. In the spring, at the City's request, the Contractor will reactivate the system, repair any defects or damage and adjust the system. As these services are performed, the Contractor will inform and instruct the City.

3.25 GUARANTEE:

- A. For a period of one (1) year from final acceptance of the facility, the Contractor shall repair any settlement of trenches by one of the following methods as directed by the City.
 1. Bring to grade by top-dressing (ranking topsoil into grass).
 2. Bring to grade with amended topsoil and seed.
 3. Remove existing sod, fill depression with topsoil, and replace with new sod to match existing sod.
 4. Repair by any of the above methods must result in a smooth, level area. Maintenance of repaired areas shall be the responsibility of the City.

3.26 INSPECTION:

- A. The following inspections shall be the minimum required inspections during the course of construction. Additional inspections shall be made at any time at the discretion of the City. It shall be the responsibility of the Contractor to notify the City's Representative by phone, 48 hours in advance of each required inspection.

The sequence of required observations shall not be changed from the sequence listed below. The Contractor shall not proceed with the work of the next sequence without written approval of the work of the previous sequence.

For City-built facilities, the Contractor shall attach a copy of the written reports prepared by the City's representative or the Landscape Architect to all applications

for payment. Payment will not be made for items that have not been observed and approved in writing.

1. Inspect stacked locations of mainline, valves, laterals, and sprinklers heads.
2. Inspect and pressure test mainline installation.
3. Inspect 24-volt control wire installation.
4. Inspect and pressure test automatic valves and lateral irrigation installation.
5. Inspect automatic controller installation and operation.
6. Inspect sprinkler and bubbler head placement, coverage and operating pressure, pass irrigation audit prior to planting.
7. Inspect at end of maintenance period.

APPENDIX II.5-1

Parks and Recreational Trails Development Process Summary

1. Include parks and trails in the subdivision Master Plan, following the requirements of 155.46 Subdivision Ordinance for Public Sites and Open Spaces.
2. Include parks and trails in preliminary plat for subdivision they are within or adjacent to unless approved otherwise through the proposed Master Plan phasing.
3. Submit conceptual plan for parks and trails to PRCS for initial comments and correlation to the “Development Standards for Park Land and Trails” after Master Plan and preliminary plat approval.
4. Present conceptual plans, based on outcome of #3, to Parks & Recreation Commission for comments and approval on proposed layout, landscaping and amenities. Present to the Parks & Recreation Commission prior to construction plan submittal. The Parks & Recreation Commission meets the 3rd Monday of each month. Contact PRCS Resource Development Manager or Director to be included on the next meeting agenda.
5. Developer will meet with the PRCS Director to review and sign a Park Construction Agreement. The Agreement will set forth a time frame for start and completion of construction (may duplicate agreed upon phasing in a signed Development Agreement) and identify when financial guaranty for the project will be provided to the City. The agreement will verify that that the park and or trail shall be built to City standards and to meet all codes, and work shall be done by contractors and subcontractors licensed, certified and permitted to do the work identified in, and supporting the approved plans.
6. Include trails in the overall construction plans for the subdivision, as construction of trails often occurs in conjunction with street or drainage improvement construction.
7. Concurrent to subdivision construction plans, or if allowed, prior to final plat, Submit full park construction plans (8 sets) to the Development Services Department (DSD) with cover letter describing the project and cost estimate. Seven of the sets will be reviewed through the Design Review Process, and one set will go through Building Division review. Reference **Appendix II.5-2** for plan requirements.
8. Prior to park construction, submit to DSD, two sets of 100% construction plan mylars (having addressed all comments) with any redlines for comparison. The City will route to all Departments for review and signatures. Also submit Construction Documents (3 sets) with Commercial Building Permit Application to the DSD Building Division for project construction permit. Reference **Appendix II.5-2** for plan requirements.
9. Hold Pre-construction meeting for each park where contractor will also verify receipt of all necessary permits, and provide construction schedule to PRCS staff to forecast field inspections.
10. City of Rio Rancho Building Inspectors shall inspect all permitted park improvements as per their published process. Park Maintenance Staff will inspect parks and trails throughout construction as shown in the Park Development Standards, as well as at substantial and final completion. See Park Development Standards for process and minimal inspection list to be conducted by Park Maintenance Staff.

11. The Department will accept the park and or trail after final inspection and completion, receipt of playground and water audits and any corrections they have identified, verification of all required permitting and inspection, and acceptable establishment of seeded or sod turf areas when applicable. The Department shall issue an official “Letter of Acceptance” to the Developer. After receipt of the letter, the Developer will transfer and record the deed for the park and or trail, after which Park Maintenance Staff will take over full ownership and maintenance. The developer shall not transfer and record the deed prior to the issuance of the “Letter of Acceptance.” The one year warranty period shall begin on the date that the Deed is recorded. See Park Development Standards for details on acceptance.

APPENDIX II.5-2

Subdivision Park Plan Requirements:

Cover Sheet:

To include project name, vicinity map, sheet index, Landscape Architect's contact information, general notes and signature block for plan review (may already be included in Subdivision Construction Plan Set).

Grading and Drainage Plan:

At a minimum show elevation contours and indicate drainage.

Note: If the project is part of a subdivision, overall subdivision grading may not support the approved park plans, additional grading and a plan may be required).

Plan View/ Site Plan with appropriate dimensions:

Plan view includes a scale, north arrow, property lines, proposed easements, any onsite ponding areas. This plan will include placement of all improvements and amenities. The Site plan shall also clarify accessible routes from public way to all facilities within the park.

Paving and Construction Plan:

For any structures and/or paving including notes and appropriate specifications. Construction plans with cross sections are also required for crusher fine paths that are associated with the park.

Construction documents submitted for Commercial Building Permit shall comply with the International Building Code and New Mexico Administrative Code, and City of Rio Rancho adopted Codes and Ordinances. Permit documents shall also include the above site plan and an ES (ICC Evaluation Service) report or structural calculations justifying the proposed structures for this region. Provide 3 paper sets of construction documents stamped and signed by a registrant (Engineer and/or Landscape Architect) in the State of New Mexico.

Landscape and Planting Plan with legend

Indicate placement of all plant and hard-scape materials.

Plant list and legend will include number of each plant, species and common names for all vegetation, size at installation and at maturity.

Hard-scape elements (color, size, application), type of fabric weed barrier and its application will be described in the notes.

Irrigation Plan:

Irrigation systems shall be designed so that the system has the capacity to place 2 inches of water per week on high water use grasses and 1 inch of water per week on low water use grasses. This water shall be applied in a six day period during a watering window from 10:00 p.m. to 7:00 a.m.

All grass areas shall have full head to head coverage irrigation systems. It is the responsibility of the contractor to determine the static pressure at the service line, and ensure the system is designed to operate at that pressure, as described above, and to meet the Department's standards.

All irrigation systems shall utilize a master valve and flow meter.

Each irrigation control valve shall be labeled numerically.
Whenever necessary, systems shall use pressure regulating valves.
Bubbler heads shall be low flow pressure compensating bubblers.

Indicate the location of the following on the plan:

Mainline, meters, backflow preventers, flow meter, lateral lines/ zones, master valve/ box, control valves, Controller (Rain Master), pop-up heads and large rotor heads (indicate degree of coverage), drip lines and bubbler assemblies. *Note additional requirements for Final As-Built Plans at the end of this section.

Standard Details (inquire of the Parks Department for more information)

Shall be provided for: all paved or constructed amenities within the park (including but not limited to play and shade structures, benches, tables, trash cans, irrigation valve assemblies, controllers, irrigation connections, plantings etc.)

Traffic Control Plan for project if not provided elsewhere as part of the Subdivision Construction Plans. *Note: Depending on timing of park construction (such as at the very end of subdivision construction), a separate plan may be required.

Final As-Built Plans (after final inspection – shall be provided as mylars)

Will show park elevation contours, layout with appropriate dimensions, including placement of all improvements and amenities (playing fields, parking lots, paths, play structures, benches, courts, landscaping).

As-Built Plans for Irrigation:

Mainline, meters, back flow preventers with hot box and electrical line/s, flow meters, lateral lines/zones, master valve/ box, control valves, Controller, pop-up heads and large rotor heads (indicate degree of coverage), and actual drip lines and bubbler assemblies.

Additional Informational requirements for Final As-Built Plans:

-The Contractor will state existing static pressure at meter or point of connection.

-The following statement shall appear on each irrigation plan:

“At the time of final acceptance, the Contractor shall demonstrate to the City, that the operating pressure at the head has been adjusted to match the specified design operating pressure for each valve.”

-Each irrigation plan shall have a System Performance Information Chart that provides the following information for each control valve:

Control valve Number.

Valve brand, model number and size.

Length of time required to operate valve in order to apply 0.33 inches of water.

Irrigation head brand and model number.

Irrigation head nozzle size.

Irrigation head spacing.
Irrigation head gallons per minute.
Total gallons per minute.
Design operating pressure at the head.
Precipitation rate at design operating pressure.

All parks with greater than one (1) acre of turf shall pass a water audit conducted by a certified water auditor. The system shall have a minimum distribution uniformity of 70%.

Chapter II.6

SURVEYS AND PERMANENT MONUMENTATION

1. INTRODUCTION

This chapter relates the minimum criteria, standards and acceptable procedures for establishing survey monuments required by the City of Rio Rancho's Subdivision Ordinance (Chapter 155) and the New Mexico State Statutes Chapter 61-23-1 Engineering and Surveying Practices Act (NMSA 1978).

The City Engineer or his /her designee is responsible for: subdivision monumentation, the interrelationship of City control monumentation with other agencies (National Geodetic Survey, NOAA, etc.), and the recordation and perpetuation of records and monumentation for the City's network.

All subdivision surveys shall be referenced to the coordinate system based on the New Mexico State Plane, Central Meridian, with vertical datum utilizing North American Vertical Datum 1988 (NAVD'88) and horizontal datum utilizing North American Datum 1983 (NAD'83). Where existing platting references land grant or other information, subsequent platting will reference the New Mexico State Plane, Central Meridian Coordinate System (Chapter 155.24 (D) (3),(a) and 155.25(C),(5)).

In general, any registered land surveyor licensed and registered with the State of New Mexico can perform the survey requirements for the development process; however, certain portions must be performed under the City Engineer or his /her designee approval and specifications.

Governing Regulations

The Mexico State Statutes, NMSA 1978, 61-23-1, Engineering and Surveying Practices Act, contain the regulations governing monumentation and surveys for subdivisions in the City of Rio Rancho. Survey, design, and construction professionals should be thoroughly familiar with the survey and monumentation requirements of these regulations.

A. Definitions

METES AND BOUNDS – A precise legal, literal narrative of the perimeter boundary of a survey using grid bearing, and distance notation from a beginning point to an end point which would complete the entire perimeter of the subject survey site. This shall be done on all plats.

MONUMENT. One or more of the following:

- (1) PERMANENT SURVEY MONUMENT – A brass cap set in a base which meets city standards, or a standard Bureau of Land Management monument marking sectionalized corners, containing coordinates referenced to the New Mexico Coordinate System and the land surveyor's registration number prescribed thereon.
- (2) CENTERLINE MONUMENT AT PCs AND PTs – A 3 ½" aluminum monument set flush with the pavement. This marker shall have the land surveyor's registration number affixed thereto.

2. MONUMENTATION

2.1. Centerline Monuments

a. A minimum of two (2) centerline monuments must be inter-visible and a tie to a third Permanent Survey or centerline monument must be assured. The surveyor setting the monumentation will be required to submit notes, drawings, or other reproducible documentation of each point set for permanent files and publication. Acceptable formats and forms are available in Appendix 2.6.2.

NOTE: The developer may submit a centerline monumentation plan at preliminary plat for approval by the City Engineer or his / her designee. If acceptable, the monuments must be included in the street design package and will be constructed with the street improvements and will be inspected for acceptance by the City along with other street improvements at the time of final inspection.

b. Centerline monuments must be 5/8" mild steel bar, minimum 24" long. Alternate monuments may be 3/4" iron pipe, minimum 24" long or as approved by the City Engineer or his /her designee. In loose sand or unstable soil, a monument 36" or longer will be required.

c. Monuments must be set flush with the earth or within 0.2 feet above and must bear a cap or permanent tag identifying the registration number of the surveyor setting the monument.

d. Centerline monuments shall be set only under the supervision of a Land Surveyor registered in the State of New Mexico.

e. Centerline monuments must be set in conformance with the standards and specifications for Class 3 surveys as defined in Table 26.1. The centerline monument must have a position error relative to the referenced Permanent Survey Monuments no greater than 1/10,000 of the distance to the nearest Permanent Survey Monument plus 0.10 feet.

2.2. Permanent Survey Monuments

a. No point within the subdivision shall be more than one-half (1/2) mile if possible from a permanent survey monument, and at least two corners or points on or near the perimeter of the subdivision traverse, must be tied to, or monumented with permanent survey Monuments as approved by the City Engineer or his / her designee. These points or monuments must be tied by Grid Bearing in the Central New Mexico State Plane Coordinate System to the network, currently under development. The location of Permanent Survey Monuments showing ties to the

network, currently under development, together with 1) the New Mexico State Plane Central Meridian, 2) the Delta Alpha and combined sea level and scale factor at the point or for the centroid of the parcel of the subdivided land, 3) the vertical elevation

Table 26.1 SURVEY STANDARDS AND SPECIFICATIONS

	CLASS 1	CLASS 2	CLASS 3
POSITION CLOSURE	1"15,000	1:10,000	1:5,000
ANGLES ACCURATE TO DISTANCES ACCURATE TO (per 100 feet)	5 sec.	7 sec.	14 sec.
	0.002 ft. (1:50,000)	0.004 ft. (1:25,000)	0.007 ft. (1:15,000)
REJECTION LIMIT OR SPREADS BETWEEN D & R AND SETS	5 sec.	5 sec.	10 sec.
NUMBER OF POSITIONS OR SETS			
1" Instrument	4 Pos.	4 Pos.	2 Pos.
10" Instrument	1 Set 6DR	1 Set 6DR	1 Set 2DR
20" Instrument	2 Sets 6DR	2 Sets 6DR	1 Set 4DR
30" Instrument	3 Sets 6DR	3 Sets 6DR	1 Set 6DR
1' Instrument			1 Set 8DR
AZIMUTH CLOSURE	8" (N*)0.5	10" (N*)0.5	30" (N*)0.5
AZIMUTH CLOSURE PER ANGLE POINT	3 Sec.	5 Sec.	10 Sec.
NUMBER OF REPETITIONS (distance measurements)	1	1	1
TAPING CRITERIA			
Temperature	Accurate to \pm °F	Accurate to \pm 3°F	Accurate to \pm 6°F
Tension	Accurate to \pm 1# of standard	Accurate to \pm 2# of standard	Accurate to \pm 3# of standard
Calibration	**	**	**
			Plumb Bob String or
TYPE OF TARGET	Fixed	Fixed	Fixed

Table 26-1 General Notes

- It is recommended that 30" transits not be used for Class 1 & 2 surveys.
- * N = Number of angle stations carrying azimuth. The smallest value for the azimuth closure criteria will apply.
- Fractions of a full tape length must be checked.
- Properly calibrated electronic distance measuring equipment may be used in place of metal tapes
- .5. Side points observed from primary traverses shall conform within reason to the required accuracy for the primary traverse. The accuracy of the observations, of course, will depend on the type of point observed. Whenever indefinite points, such as fence corners, tree stumps, etc., are involved, the best approximation of the center or specific point previously described should be observed. Each angle should be observed 2 DR and the spread between the D and R observations should not exceed \pm 20".
- Method of taping outlined in paper. Tension applied should be same used to standardize or calibrate tape.

- Standardized tape or one calibrated with a standardized tape.
- Global positioning system surveys are acceptable to the same standards as other previously noted surveying.
- Detailed explanation can be found in the American Congress of Surveying and Mapping publication Horizontal Control as Applied to Local Survey Needs.
- .Line weights shall be consistent with DPM Chapter II.1, Appendix 2.1.1, Line Weight CAD Standards

related to the North American Vertical Datum 1988 (NAVD '88) and 4) horizontal coordinates related to the North American Datum of 1983,(NAD '83) shall be shown on the final plat for which the survey is made. Survey origination points shall be shown on the plats.

b. Permanent survey monuments must be brass caps set in an acceptable base as shown in the figure in Appendix 2.6.1. Caps shall bear the registration number of the surveyor establishing the point and identifying letters or numbers approved by the City Engineer or his/her designee. This information must be stamped permanently into the cap and must be shown on the final plat for which the survey is performed. Standard caps design is provided in Appendix 2.6.1.

c. A brief narrative covering the procedures and pertinent information used to establish the Monumentation must be submitted to the City Engineer or his/ her designee at least thirty (30) days prior to submission of a final plat for review and approval. GPS survey data shall include a detailed description of the post processing procedure which was used to establish the monument. Monument information must be submitted on standard forms available from the City Engineer or his/her designee, or on forms which are identical in format to those in Appendix 2.6.2.

d. Permanent survey monuments shall be considered properly positioned and represented only after the City Engineer or his /her designee has approved all survey procedures, calculations, and verified conformance to standards and specifications for Class 2 surveys or greater. If found to be deficient, the Land Surveyor submitting the final plat and documentation may be required to perform additional work to bring monumentation into conformance, regardless whether the final plat is recorded or not.

2.3 Bench Marks

Section Reserved for Future Use.

2.4 City of Rio Rancho Control Survey Network

a. Complete information on existing network monumentation is available from the City Engineer or his /her designee or the Department of Public Works – Records/GIS Section.

2.5 Record Requirements

a. Control Station Data forms are available from Appendix 2.6.2. They must be filled out and submitted to the City for established survey control.

3. CONSTRUCTION SURVEYS

3.1 The physical staking for the contractor's work in the construction phase of any project is the responsibility of the developer on a privately financed project.

3.2 A topographic design survey/control map, containing survey control, needs to be included as a sheet within the final construction plans. This typically should be tied to a grading and drainage plan.

3.3 It is the responsibility of the surveyor performing construction staking (establishing grades and positions for improvements) to confer with the design engineer whose seal and statement appear on the approved construction plans prior to such staking activities.

3.4 The surveyor performing construction staking is also responsible for conferring with the registered surveyor who certified the plat, prior to construction staking.

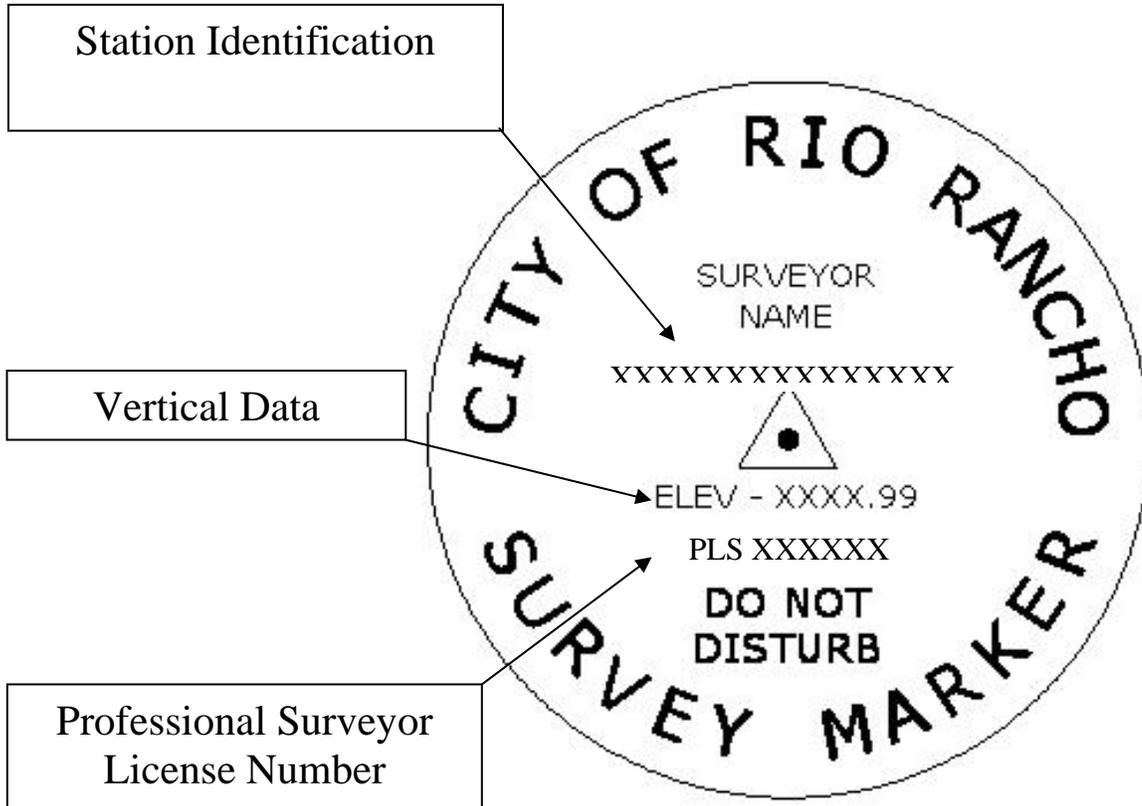
3.5 The surveyor performing construction staking must satisfy himself/herself as to the accuracy of subdivision controls and to the intent of the construction plans, as they relate to positions and elevations prior to the commencement of work.

3.6 The developer must reasonably assure himself/herself that the person(s) intending to provide construction staking have an understanding of the intent of the plans, conditions of control monuments and that construction surveying will be under the supervision of a registered engineer or land surveyor.

3.7 The contractor is responsible for protecting and maintaining all plat and monumentation controls set by the land surveyor. In the event of inadvertent destruction or alteration, the contractor must immediately notify the land surveyor and the City Engineer or his /her designee.

APPENDIX 2.6.1

EXAMPLE OF PERMANENT MONUMENTATION



APPENDIX 2.6.2

MONUMENT RECORD FORMS INSTRUCTIONS

Section Reserved for Future Use.

Chapter II.7

SUBMITTAL REQUIREMENTS

This chapter provides details about the various submittal requirements (in addition to plans) for reviews. It is arranged into the following sections:

- 1.0 DESIGN SUBMITTAL REQUIREMENTS
- 2.0 CONSTRUCTION SUBMITTAL REQUIREMENTS
- 3.0 TIME LIMITATION OF APPROVAL
- 4.0 INFORMATION FOR PLAN PREPARATION
- 5.0 PLAN SHEET SEQUENCE
- 6.0 STORM DRAIN PLAN PREPARATION -RESERVED
- 7.0 LANDSCAPING PLANS
- 8.0 MATCHING INTO EXISTING ADJACENT IMPROVEMENTS -RESERVED
- 9.0 RIGHT-OF-WAY MAPS AND PLANS -RESERVED
- 10.0 ROADWAY CROSS SECTIONS - RESERVED
- 11.0 REPORT FORMAT
- 12.0 CAD STANDARDS

1.0 DESIGN SUBMITTAL REQUIREMENTS

1.1 In Addition to the Required Plans, Review Submittals Shall Include the Following Information (As it Applies to the Project):

- Drainage Report
- Drainage Implementation Plan
- Geotechnical Report
- Traffic Impact Study (TIS)
- Water and Sewer Availability
- Other items as required

Note: The Report Format can be found in Section 11 of this Chapter.

1.2 REVIEW SETS FOR RESIDENTIAL/COMMERCIAL DEVELOPMENTS

Each plan set submitted for review shall consist of the following:

1. Eight full size (24" x 36") copy of the design plans.
2. Appropriate supporting documentation & calculations (See Section 1.1 of this

- Chapter).
3. Project/Plan Submittal Letter, See Appendix A, from the Design Engineer and the original redlined plans/reports, if applicable, supplied to the Consultant by the reviewer. Submittals without a submittal letter or the original redline comments will not be accepted, and will be returned for resubmittal.

NOTE: All submittals shall be reviewed for quality control by the applicant before they are submitted for review. Submittals that do not address the redline comments made by the reviewer at a previous submittal will be returned without further review to the Design Engineer. At any point during the review process - if the City reviewer determines that a significant change has occurred to the project plans or the design - then a new review process may be started.

1.3 FINAL SUBMITTAL OF APPROVED CONSTRUCTION DOCUMENTS

Once the City has accepted all letters, reports, and construction plans indicating that they are acceptable for quality, the following information shall be submitted to the City.

1.4 RESIDENTIAL/COMMERCIAL DEVELOPMENTS

The final submittal for Developer Sponsored projects shall consist of the following information:

1. Signed and sealed Mylars with Final Approved Plat of the Construction Project Plans for City signature.

Once the Mylars have been signed by the City and returned to the Design Engineer, the following information shall be submitted:

1. Electronic PDF version of all accepted plan sheets and supporting documentation on CD/DVD. (i.e. construction plans, estimates, all reports, and etc.)
2. One (1) full size (24" x 36"), copies of the accepted construction plans.
3. Two (2) half size (11" x 17"), copies of the design plans.

1.5 CAPITAL PROJECTS

The final submittal for Capital Projects shall consist of the following information:

1. Signed and sealed Mylars of the Construction Project Plans for City signature.

Once the Mylars have been signed by the City and returned to the Design Engineer, the following information shall be submitted:

1. Electronic PDF version of all accepted plan sheets and supporting documentation on CD/DVD. (i.e. construction plans, estimates, all reports, and etc.)

2.0 CONSTRUCTION SUBMITTAL REQUIREMENTS

When the project is completed the following information will need to be submitted to the City.

2.1 “RECORD DRAWINGS” SUBMITTAL REQUIREMENTS

Construction “Record Drawings” will be required for all improvements within City of Rio Rancho’s right-of-way or easements. All submittals will be reviewed and accepted in accordance with the following procedures:

2.1.1 Developer Projects:

1. “Working Record Drawing” plans shall be submitted, by the Contractor, as redline drawings with correct survey data for review, once a month, to the Developer’s Engineer of Record. These drawings will need to be initialed and dated by the reviewer for them to be valid. The reviewed plans will be on one 24" x 36" set.
2. At the end of the project/subdivision, the Contractor will provide the Developer’s Engineer of Record the valid redline drawings with correct survey data. The Developer’s Engineer of Record will then make digital changes to the original Construction Plans. A set of Mylar Final Record Drawings stamped and sealed by a Professional Engineer or Registered Land Surveyor with the “Record Drawing Certification (Appendix C)” approval block included will then be submitted to the City. On any sheet where a change to the original construction drawings has been made Redrawn for Record shall be placed on that sheet.
3. The Developer will also provide the City with the digital changes in accordance with Section 2.2 of this Chapter.

2.1.2 Capital Projects:

1. “Working Record Drawing” plans shall be submitted, by the Contractor, as redline drawings with correct survey data for review, once a month, to the Construction Management Team. If the “Working Record Drawing” plans are not adequate then that month’s progress payment will be denied until the deficiency is corrected. These drawings will need to be initialed and dated by the reviewer for them to be valid. The reviewed plans will be on one 24" x 36" set.
2. At the end of the project, the Contractor will provide the Construction Management Team the valid redline drawings with correct survey data. The Construction Management Team will then make digital changes to the original Construction Plans unless the City includes these changes in Contractor’s Contract. A set of Mylar Final Record Drawings stamped and sealed by a Professional Engineer or Registered Land Surveyor with the “Record Drawing Certification (Appendix C)” approval block included will then be submitted to the City. On any sheet where a change to the original construction drawings has been made Redrawn for Record shall be placed on that sheet.

3. The Construction Management Team will also provide the City with the digital changes in accordance with Section 2.2 of this Chapter.

Note: The Construction Management Team will be the Firm hired by the City to perform Construction Management Duties unless otherwise specified.

2.2 DIGITAL RECORD REQUIREMENTS

1. Once the plans have been approved and signed off by the method stated in Section 1 of this Chapter, a CD/DVD containing the AutoCAD drawing files (through release 2004) and InRoads files used to create the Record Drawings (AutoCAD, and PDF) shall be submitted to the City.
 - a. The files shall contain the following information
 - i. Street, Storm Drains, and Grading & Drainage Plans**
 1. Station for all grade breaks.
 2. Back of curb offset dimension at all changes in alignment.
 3. Top of curb, gutter and pavement centerline elevations at all grade breaks, curb return, valley gutters, plus any other location necessary to adequately show drainage.
 4. Survey monuments.
 5. Street centerline station and offset dimensions to the storm drain mainline at all changes in alignment and/or changes in grade.
 6. Street centerline station and offset dimension to all structures and changes in alignment.
 7. Rim and invert elevations for each manhole, catch basin, and miscellaneous structures.
 8. The pipe material and diameter that was actually installed shall be shown on all plan and/or profile sheets.
 9. Station, location and limits of utility encasements, caps, pipe supports, etc.
 10. Station, location, limits and dimensions of facilities which are abandoned in place, including the size, depth and type of materials remaining.
 11. Elevations shall be provided at all drainage control points (i.e. detention overflow point, tops and bottoms of detention basins, drain rim, valley gutters, curbs, etc.).
 12. Dimensions shall be provided for all detention areas.
 13. Drainage Control (detention) Basin Calculations revised, with written approval, to the as-built condition; and certification of compliance.
 14. Location of all existing structures (i.e. buildings, drainage structures) shall be provided.

15. Dimensions and elevations of all pipe, culvert, scupper, catch basin, channel top width and bottom width, channel longitudinal slope changes, grate and invert elevations.
16. Elevations at the end of laterals and one elevation shot midpoint between manholes.
17. Elevations at the center of the building pad, all four corners, and four elevation shots for lot slope and drainage.
18. Elevations of the tops and toes of all slopes at intervals of 50 feet.

ii. Water Plans

1. Street centerline station and offset dimensions to:
 - a. All fire hydrants and fittings (i.e. valves, bend, tees).
 - b. Main line at all changes in horizontal and vertical alignment.
 - c. All horizontal control points (i.e. centerline intersects, PC, PT).
2. Dimension to all operating nuts referenced to the water main on valves with offset operating devices.
3. Centerline station and offset to each service tap; size of tap and dimension to nearest side property line.
4. Note centerline station, offset and elevations to all changes in vertical alignment (i.e. dips, bends, etc. required to avoid conflicts with other utilities).
5. The installed water pipe material and diameter shall be shown on as-built plan and/or profile sheets.
6. Station, location and limits of utility encasements, caps, pipe supports, etc.
7. Station, location, limits and dimensions of facilities which are abandoned in place, including the size, depth and type of materials remaining.
8. Two top of pipe elevation shots equal distance between valves.

iii. Sewer Plans

1. Street centerline station and offset dimension from street centerline to main line at manholes and all changes in alignment.
2. Sewer line station at centerline of each manhole.
3. Calculated slope between manholes.
4. Sewer line stationing at centerline of each service tap at 90 degrees to main; if not installed 90 degrees to main, station and offset to end of each service tap.
5. The installed sewer pipe material and diameter shall be shown on all plan and/or profile sheets.
6. Station, location and limits of utility encasements, caps, pipe supports, etc.
7. Station, location, limits and dimensions of facilities which are abandoned in place, including the size, depth and type of materials remaining.

8. Rim and invert elevations.
9. Elevations at the end of laterals and one elevation shot midpoint between manholes.

iv. Traffic Plans

1. Foundation location and modifications to the structural details noted.
2. Conduit location, size, alignments, and type noted.
3. Cabinet location, dimensions, and type.
4. Size, type, and location of battery backup for power pedestals.
5. Power Service Address.
6. Phone or fiber optic communication line location and connection with applicable service address and phone number.
7. Pole location and types.
8. Mast arm type, length and pendent locations.
9. Head locations and types.
10. Loop detector location, length, and type.
11. Changes to items in the schedules.
10. Interconnect conduit location and pull box type and location.
11. Sign base location, size or type changes from the approved plan.
12. Striping layout changes from the approved plan noted.
13. Changes to location, spacing, and type of raised pavement markers.
14. Traffic Conduit: All manholes and pull boxes.
15. Locations of all streetlights pull boxes, and service locations.

v. General

1. Street Centerlines
 2. All right of way and easement lines with docket or recordation numbers are shown on included approved plat.
- a. The CD/DVD shall be labeled with the Contractor's name, the Engineer's name, the Project/Subdivision name, the Project/Subdivision location, and the Final Inspection date. The AutoCAD file shall be the file used to generate the final Record Drawings (hard copy). The AutoCAD file shall depict the final Mylar Record Drawings with the rights-of-way and the project/subdivision tied to the state plane coordinates.

Note: The elevations required in Section 2.2 Subsection A must be performed under the supervision of a Registered Land Surveyor.

2.3 OTHER SUBMITTAL REQUIREMENTS

1. Materials List of all items installed during the project.
2. New Street Data Sheet Appendix D. This will need to be completed by the Contractor on the Final Inspection. City concurrence is required before submitting this form as part of the project closeout.
3. Certificate of Completion and Acceptance. Certification of Acceptance of Infrastructure completed pursuant to a Subdivision Improvements Agreement (SIA) and/or Development Agreement (DA), and Release from Financial

Guarantee shall be obtained from the City's Development Review Section-Engineering Division and submitted as part of the project closeout package.

4. Actual Cost Information. Actual cost information corresponding with the itemized Materials List of capital contributed. Actual cost information is required by the City as a condition of acceptance and/or release of financial guarantee related to the development. Such cost information include, but is not limited to, final invoices of the developer's prime contractor for infrastructure improvements and contract pricing for land and right of way dedications.

3.0 TIME LIMITATION OF APPROVAL

The City approval of residential developments, commercial developments, and road construction plans shall be valid for a time period of one (1) year. Plans NOT under construction within this time period are to be resubmitted and approved by the City prior to construction.

4.0 INFORMATION FOR PLAN PREPARATION

4.1 GENERAL PLAN INFORMATION

Plans shall be prepared using the current City of Rio Rancho standards and drawings first, then NMDOT standards and drawings, unless directed by the Project Manager. Bridge standard details and specifications shall be the latest version of NMDOT standards and drawings unless a City of Rio Rancho equivalent exists.

4.2 GENERAL PLAN PREPARATION

4.2.1 Cover Sheet

The Cover Sheet, included in the City's AutoCAD Standard borders, shall contain the following information:

1. The Consultant's seal
2. Key Map
3. The appropriate signatory blocks.
4. A project vicinity map. Standard Zone Atlas maps may be used in preparing the vicinity map.
5. Identification of a minimum of two City benchmarks.
 - a. Identify the City benchmarks by number, description, brief location, and elevation.
6. A plan sheet index listing shall be provided, either on the cover sheet or a separate sheet located near the front of the plan set. *Note: Plan and Profile sheets may be summarized in the sheet index (example: "Sheets 3 through 7").*

4.3 TITLE BLOCKS FOR NON-COVER SHEETS

All original drawing sheets shall have a title block along the right hand side of the sheet. This title block, included in the City's AutoCAD Standards, shall have the following information clearly displayed:

1. Name of Engineering Consulting Firm preparing the plans.
2. The Project Name.
3. The sheet number and the total number of sheets in the plan set.
1. The appropriate type of plan sheet (i.e. typical sections, details, plan & profile, etc.) shall be indicated.
2. City of Rio Rancho logo.

4.4 LEGEND AND GENERAL NOTES

The Legend and General Notes shall be located on the second sheet or near the front of the plan set. The Design Engineer can obtain the latest version of the General Notes Sheet from the Department of Public Work's website. The Consultant can add notes as they pertain to each project as necessary. The note additions must be identified under the header "SPECIAL NOTES". Notes relieving the Engineer from utility coordination and/or line location will not be allowed (all due diligence shall be completed to show existing utilities on the plans).

The Standard Legend can also be found on the Department of Public Work's website.

The Consultant shall use the symbols & abbreviations found on this sheet consistently throughout the entire plan set.

4.5 PLAN SHEET ORIENTATION AND LAYOUT

In general, project work shall be oriented on the sheets such that north will be pointing "up" or "to the right" on the sheet. Normally, no more than 1,000 feet of street length should be shown per plan sheet. This allows room on the right hand side of the plan sheet for the Construction Notes or Keyed Notes.

For curvilinear streets, the drawing shall be oriented so that the north arrow points to the top or the right edge of the sheet as appropriate to a practical representation of the curved portion of the street depicted. If the orientation of the street is northwest-southeast or southwest-northeast, place the western-most end of the street segment near the left edge of the sheet.

Construction centerline stationing, at intervals of 100 feet, shall be shown on both the plan and profile views and shall run from left to right. Subsequently, stationing is read from west to east or from south to north.

Portions of the same street or intersection shall not be shown beyond match lines on separate sheets. Match line information shall provide stationing and matching sheet number.

4.6 GENERAL PLAN AND PROFILE SHEETS

In general, most plan/profile layouts shall be shown on standard half plan/half profile sheets. In the case where steep grades or wide plan views prohibit plotting on these sheets, separate full plan and full profile sheets may be used.

Plan views shall show the limits of existing ROW and call out new ROW limits as well as construction easement areas.

Sheet number references for storm drain plans, connector pipe plans, etc. shall be noted on the plans.

All points of connection to existing facilities shall be clearly shown and the appropriate elevations indicated on the plans.

4.7 HORIZONTAL GEOMETRICS

As a general rule, the following pertains to roadway geometrics:

Roadway centerline bearings and distances shall be shown on the plans.

All tangent points, point of intersection (P.I.) of curvilinear sections, beginning and ending taper points and monument lines of all intersecting streets shall be labeled and stationed.

Provide top of curb and flow line elevations at returns and valley gutters.

On curved sections, construction centerline stationing shall be shown along the centerline of the curve, and not the tangent lines. Curve data shall be shown on same sheet as the curve.

The plans shall show dimensions from monument line/construction centerline to ROW and to existing curbs.

4.8 SURVEY CONTROL

See DPM Chapter II.6.

4.9 TOPOGRAPHY AND NOTATION

- (a) All subdivision names, block numbers, lot numbers, names of major business, schools, fire stations, and other public facilities shall be shown on the plans.
- (b) The Final ROW and easement limits shall be shown on the plans as a heavy line. Existing ROW where it differs from the new ROW line shall not be shown for Major Street projects.
- (c) Label all existing features. Include description and dimension as needed,
- (g) All topography to at least 10 feet beyond the ultimate ROW or easements shall be shown. Standard symbols shall be used where applicable.
- (n) Where certain items such as monuments, water valves, etc., are supposed to be, according to plan records, but cannot be found in the field, they shall be labeled "NOT FOUND" or "NF" on the plans.

5.0 PLAN SHEET SEQUENCE

5.1 PLAN SHEET SEQUENCE FOR RESIDENTIAL/COMMERCIAL DEVELOPMENT

Sheet 1:	Signature Cover Sheet, including Index of Sheets
Sheet 2:	General Notes Sheet
Sheet 3:	Standard Legend and Abbreviations
Sheet 4:	Subdivision Plat
Sheet 5:	Overall Grading Plan
Sheet 6:	Yard/Retaining Wall Plan & Profiles
Sheet 7:	Yard/Retaining Wall Details
Sheet 8:	Typical Sections, Pavement Structural Sections, etc.
Sheet 9:	Plan/Profile and other sheets as needed in the following order: <ol style="list-style-type: none">1) Median Island Details2) Plan and Profile of Paving3) Intersection Design Sheets for Major Intersections6) Plan and Profile of Storm Drain7) Profiles of Catch Basins and Connector Pipes8) City Standard Details (no less than 8 and no more than 10 details per sheet)9) Special Detail Sheets10) Bridge and Structural Detail Plans (see page 27-14 for plan sheet order)11) Landscaping/Irrigation Plans12) Erosion and Sediment Control Plan13) Erosion and Sediment Control Details/calculations14) Traffic Signing & Striping Plans15) Traffic Signal Plans16) Street Lighting Plans17) Traffic Control Plans
Sheet X:	Typical Section showing location of water and sewer line
Sheet X:	Plan/Profile and other sheets as needed in the following order: <ol style="list-style-type: none">1) Plan and Profile2) City Standard Details (no less than 8 and no more than 10 details per sheet)3) Special Detail Sheets

5.2 SHEET SEQUENCE BRIDGE AND STRUCTURAL PLANS

Typical sheets for a bridge or structural plans are as follows:

1. Typical Legend, Notes, and Detail Sheets, plus notes specific to the bridge project
2. Paving plans and profile sheet (if bridge is also part of a paving project)
3. Detour Plan and Profile, if required, showing all details required for the detour in plan and profile.
4. Plan and Profile for any water, sewer or irrigation alterations to be included as a part of the bridge construction
5. Soil boring log sheet showing all obtained soils information
6. Abutment details

7. Pier details
8. Deck details
9. Miscellaneous details
10. Handrail details.

5.3 SHEET SEQUENCE FOR WATER AND SANITARY SEWER PLANS

All designs requiring water or sanitary sewer shall be designed in accordance with Chapter II.4 – Water and Wastewater Infrastructure Design of the CORR Development Process Manual.

If separate from roadway, drainage, or traffic improvements, as in offsite plans, then water and sewer designs shall be under a separate cover sheet following the sequence below:

- | | |
|----------|---|
| Sheet 1: | Signature Cover Sheet, including Index of Sheets |
| Sheet 2: | Legend, Abbreviations, and Notes Sheet |
| Sheet 3: | Plan Sheet Key Map (place on Cover Sheet if size permits) |
| Sheet 4: | Water/Sewer Quantity Summary Sheet |
| Sheet 5: | Typical Section showing location of water and sewer line |
| Sheet 6: | Plan/Profile and other sheets as needed in the following order: |
| | 4) Plan and Profile |
| | 5) City Standard Details (no less than 8 and no more than 10 details per sheet) |
| | 6) Special Detail Sheets |

6.0 STORM DRAIN PLAN PREPARATION -RESERVED

7.0 LANDSCAPING PLANS

7.1 SHEET SEQUENCE

Refer to Subsection 5.1 for sequence of plan sheets.

8.0 MATCHING INTO EXISTING ADJACENT IMPROVEMENTS –RESERVED

9.0 RIGHT-OF-WAY MAPS AND PLANS – RESERVED

10.0 ROADWAY CROSS SECTIONS - RESERVED

11.0 REPORT FORMAT

11.1 GENERAL FORMATTING GUIDELINES

Here are some general formatting guidelines that apply to the entire report:

- Use a 1-inch margin at the top, bottom, left, and right.
- Use single spaced typing
- The entire document should be fully justified.

The following pages and headings should be incorporated into the document at a minimum:

Title Page – Project Name, Type of Report, Author’s name, who it is prepared for, Approval Block, and the date. Indicate whether the report is a “preliminary” or “final” submittal.

Table of Contents – include all sections and subsections w/ appropriate page numbers.

List of Appendices - can be provided on the same page as the List of Tables, include page numbers.

Introduction – Introduces the reader to the material and the area of interest. This section should provide a project description and purpose of the report.

Methods and Procedures – Provide schematic diagrams where appropriate. Organize methods/procedures used in the analysis in chronological order.

Conclusions - Summarize the results of the study in terms of original motivation, and important conclusions from the analysis.

References – Use full citations including titles of reports. If using numbered references, numbers should be according to chronological appearance in the text.

Appendices - Appendices may include derivations or tabulated data which you feel the reader should have access to, but are not appropriate for the body of the article.

All the supporting data, calculations, analysis, and information contained in the appendix of the report should be discussed and summarized in the body of the report. The information contained on the appendix is only for reference to be used by the reviewer if needed.

All information, including exhibits, tables, and calculations, shall be presented in the report in a well organized and easy to follow format.

12.0 CAD STANDARDS

12.1 Coordinates:

See Chapter II.6.

12.2 Drawing / Sheet Naming Convention:

Follow the drawing/plan sheet naming convention as outlined on the City of Rio Rancho Department of Public Works CAD Standards sheet found in Appendix H.

CHAPTER II.7 – APPENDICES

- Appendix A Project/Plan Submittal Letter
- Appendix B Final Project Submittal Checklist
- Appendix C City of Rio Rancho Standard “Record Drawings Certification Statement”
- Appendix D New Street Data Sheet
- Appendix E Street Light Layout Checklist
- Appendix F City of Rio Rancho Right-of-Way Acquisition Area Calculation Form
- Appendix G CAD File Layering Conventions
- Appendix H Sheet Naming Conventions



Appendix A
Project/Plan Submittal Letter
Public Works Department

Project Manager Name
Department of Public Works – Development Section
3200 Civic Center Circle
Rio Rancho, NM 87144

Date: XXXXXX

PROJECT/SUBDIVISION NAME
LEGAL DESCRIPTION (IF APPLICABLE)

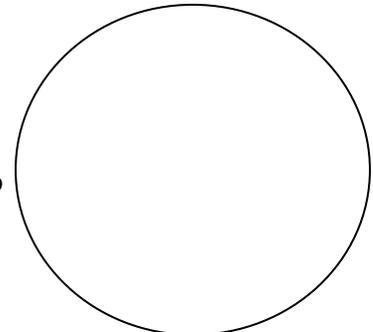
Dear Project Manager’s Name:

With this Project/Plan Submittal Letter I, the Engineer of Record for the said PROJECT/SUBDIVISION, do hereby certify the following:

1. That all submitted plans, reports, and etc. comply with current City of Rio Rancho Development Process Manual Chapters, City of Rio Rancho Standard Details, and Codes and Ordinances;
2. That all previous redline comments have been included in this submittal or that a valid accepted consensus has been reached where a comment cannot be incorporated (attach documentation);
3. That the submittal is complete and ready for review. If it is found that the submittal is incomplete, the City will return without any review.
4. The submittal requires one of the following (circle one):
 - a. No Variances;
 - b. Attached Variances.

Certification to the aforementioned by: ENGINEER OF RECORD

Seal and Sign
Using P.E. Stamp





Appendix B

Final Project Submittal Checklist

Department of Public Works

Unless otherwise noted below, submittal documentation should be on a CD/DVD. One complete copy of the entire submittal package is required. (City should use the checklist previously developed.)

Project Name: _____ Date: _____

Documents: (2 sets of CD/DVDs per submittal)

- Final Drainage Report with all amendments and approved changes
- Sewer Report with all amendments and approved changes
- Water Report with all amendments and approved changes
- Traffic Impact Study with all amendments and approved changes
- Geotechnical Report
- Pad Certifications
- All physical construction test results (compaction, concrete, asphalt, etc.)
- All construction permits
- All Operation and Maintenance Manuals (including shop drawings)
- Detention Basin Capacity Certifications** (certified by a registered surveyor or engineer for all detention basins. The certification should reference the volume in acre feet referenced in the drainage report; a sketch of the Record Drawings basin; calculations of the as- built volume in acre feet.

Approval letters from Utilities or Agencies where applicable: (2 sets of CD/DVDs per submittal)

- Proof of payment of all fees as stipulated in the approval of Final Plat
- Water Availability Letter issued by the Department of Public Works Utilities Division *
- Sewer Availability Letter issued by the Department of Public Works Utilities Division *
- Southern Sandoval County Arroyo Flood Control Authority *
- Sandoval County Environmental Services Department Approval of Construction

*Letter shall state the agency has approved the construction and the Record Drawings.

Recorded Plat/Map of Dedication: (Required on CD/DVD and HARD COPY – 1 set of each per submittal)

- 24" by 36" black line
- Half size (no larger than 11" X 17") black line
- Submitted on CD/DVD

Record Drawings as Pertains to your Project: (Required on 2 CD/DVDs - 1 Bond set AND 1 MYLAR set as listed below)

- Record Drawings plans – Grading and Drainage
- Record Drawings plans – Water
- Record Drawings plans – Sewer
- Record Drawings plans – Paving
- Record Drawings plans – Storm Drain

Additional Items: (2 sets of CD/DVDs per submittal)

- Copy of the Punch List signed off by the inspector (*Must accompany the submittal in order to be accepted*)
- Proof of payment for Traffic Signals (if applicable)

NOTE: Required Hard Copy Size Requirements:

- Record Drawings plans - printed - on 4 mil double matte for **mylar requirements**
- Record Drawings plans - size 24" X 36" (absolute maximum size) black line bond
- Record Drawings plans - half-size (no larger than 11" X 17") black line bond



Appendix C Standard Engineer's "Record Drawings" Certification Statement

"Record Drawings" Engineer's Certification

I, (Engineer's Name), a Registered Professional Engineer in the State of New Mexico, have reviewed the Final Plat of (Project's/Subdivision's Name) and related relevant drainage plans, street plans and profiles, design and construction plans, and other improvement plans. I do hereby certify that I have made an inspection of those improvements described herein and find same to be built in accordance with the Preliminary and Final Plat except for the modifications specifically noted. I have attached hereto reasons for the modifications and relevant "Record Drawings" plans detailing the modifications.

Registered Professional Engineer

Date

(List below, improvements certified, noting modifications.)

Released for Permitting

This set of plans has been reviewed for compliance with City of Rio Rancho requirements prior to issuance of construction permits. The City neither accepts nor assumes any liability for errors or omissions. This compliance review shall not prevent the City Public Works Director or City Engineer from requiring correction of errors or omissions in plans found to be in violation of any law, ordinance, or standard.

City Engineer

Date



Appendix E Street Light Layout Checklist

Department of Public Works

(This form is not needed in my opinion. Check with Traffic Operations staff.)

Date: _____

Project Name: _____

Engineering Consulting Firm/Developer: _____

Department of Public Works Job No: _____

The purpose of this checklist is to guide the developers on street light layouts on residential subdivisions, apartments, condominiums, commercial and industrial projects.

This checklist serves to minimize redline comments on the check prints and to maintain consistency of the plan review process for streetlight layouts in the public right-of way. Plan approval and issuing permits depend on the compliance with the comments made on the check prints and this checklist. The engineer of record shall satisfy themselves of the completeness and accuracy of the design.

Please submit this checklist and the check prints with your next submittal.

If construction has not started within (1) year of the date of plan approval, or if there is a halt in construction of more than one (1) year, approval will become void and public streetlight plans shall be resubmitted for updating and re-approval.

GENERAL REQUIREMENTS

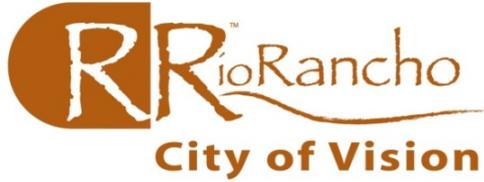
- The street light plans must be submitted on 24' x 36" sheets.
- City of Rio Rancho Standard border with approval block must be used.
- The scale must be shown on the plans 1" = 20' or 1" = 40'
- Graphic Scale
- A north arrow is required on each sheet
- A vicinity or site location map is required on the cover sheet
- The developer's name, address and phone number must be shown on the cover sheet
- The Street Light Design Professional name, address and phone number must be shown on the cover sheet
- Project title block filled out with name and location of project
- Project Number, Project Title

- [] An index of sheets is required
- [] Show and label all abutting streets
- [] Show landscape and abutting street(s)
- [] Show setbacks and proposed landscape concept
- [] Show location of detentions basins and retaining walls
- [] Identify location – show site and adjacent parcels
- [] Show dimensions for FOC on all intersection street legs
- [] Show existing and proposed driveway locations
- [] Label adjacent zoning and land use
- [] Show lot lines and dimensions
- [] The current CORR General Notes must be shown on the cover or detail sheet
- [] All plan sheets shall display construction notes pertinent to each sheet
- [] Construction notes indicating all equipment to be installed, removed or relocated
- [] The following information is required for each proposed and existing street within and adjacent to the development:
 - a. Name
 - b. Right-of-way width
 - c. Improved width of street, typically street centerline to back-of-curb dimensions
 - d. Tract “ “ for private streets
- [] All existing and proposed waterlines and fire hydrants shall be shown
- [] All existing and proposed overhead and underground utilities shall be shown
- [] Locate proposed trees at least 20’ from a proposed street light pole location

There should be a minimum six (6’) feet of clearance between streetlight poles and fire hydrants, city water facilities, or city sewer facilities. Provide dimensional ties to fire hydrants where potential conflicts may occur (within 10’ of street light pole)
- [] All proposed and existing street lights within 300’ from the first proposed streetlight should be shown with stationing and dimensional ties to the street centerline

Proposed streetlights in residential areas should be located within 5’ of property lines.
- [] Lights located in residential areas but not adjacent to homes may be shown by station and offset only
- [] Show all project phasing on the plans
- [] Provide a quantity tabulation of the number of streetlight poles on the cover sheet
- [] Identify utility provider on the plan set
- [] Provide a legend on the plans identifying the following items:
 - a. Luminaire description

- 1. Local street – 100 watt, 9,500 lumen, high pressure sodium
- 2. Collector street – 150 watt, 16,000 lumen, high pressure sodium
- 3. Arterial street – 250 watt, 30,000 lumen, high pressure sodium
- b. Luminaire mounting height
- c. Pull Box size and type
- d. Existing luminaire type, pole, and wattage
- e. Traffic Signal Mounted Luminaire type, pole, and wattage
- [] Coordinate streetlight plan with the engineer preparing other offsite improvement plans
- [] Provide stations at all intersections
- [] Utility provider must be shown with all applicable utility notes
- [] Label specific locations, sizes, and dimension from center line and/or monument line along with the following:
 - a. Existing and proposed underground utilities
 - b. Existing and proposed overhead utilities
 - c. Face of curb
 - d. Width of sidewalk
 - e. Width on any PUE
 - f. Edge of right-of-way
 - g. Edge of pavement
- [] Quantities must be tabulated separately by phase. Private streetlights must be tabulated separately from public streetlights.
- [] Street light General Notes must be shown
- [] On residential, collector and arterial streets, all existing and/or proposed driveways and American Disability Act (ADA) ramps shall be shown on the streetlight plans



Appendix F Right-of-Way Acquisition Area Calculation Form

(Form Not Needed)

Project Name: _____

Project Description: _____

County Assessor Parcel No.: _____

Unit, Lot, and Block: _____

Street Address: _____

Area Calculation Table						
Type of Acquisition	Area of Existing Parcel		Area to be Acquired		Area Remaining	
	Sq. Ft.	Acres	Sq. Ft.	Acres	Sq. Ft.	Acres
Existing Parcel						
Fee R/W						
Slope Easement						
Drainage Easement						
Temporary Construction Easement						

Vicinity Map



Appendix G

CAD File Layering Conventions

Public Works Department

(FORM NOT NEEDED)

Layer Name	Layer Description
0	
C-BLDG	Building
C-BLDG-TEXT	Building Text
C-BRDG	Bridge
C-BRDG-DECK	Bridge Deck
C-BRDG-EXST	Existing Bridge
C-BRDG-SECT	Cross Section Of Bridge
C-ONECALL	One Call Symbol
C-CURB	Curb, Gutter, Sidewalk
C-CURB-DW	Driveway
C-CURB-DW-EXST	Existing Driveway
C-CURB-EXST	Existing Curb, Gutter, Sidewalk
C-ESMT	Easement Lines
C-ESMT-CNTR	Easement Centerlines
C-ESMT-CNTR-DIMS	Easement Centerline Bearing, Distant & Curve Dimensions
C-ESMT-DIMS	Easement Line Bearing, Distant & Curve Dimensions
C-ESMT-TEMP	Temporary Easement
C-ESMT-TYPE	Easement Type Callouts
C-ESMT-WDTH	Easement Width Dimensions
C-FIRE-FHYD-SYM	Water Fire Hydrant Symbol
C-FIRE-UNDR-MAIN	Watermain to Fire Hydrant
C-FIRE-UNDR-MAIN-FLIN	Watermain - Fireline
C-FIRE-VALV-PNT	Fire Hydrant Water Valve Point
C-FIRE-VALV-SYM	Fire Hydrant Water Valve Symbol
C-GOVT-CNTY-BNDY	County Line
C-GOVT-CTLM-BNDY	City Limits
C-GOVT-DIST-BNDY	Council Districts
C-GOVT-PRCT-BNDY	Voting Precinct
C-LOGO	City Logo
C-MISC-CHRT	Miscellaneous Chart
C-MISC-CURB	Miscellaneous Curb
C-MISC-DETL	Miscellaneous Detail
C-MISC-DETL-CNTR	

C-MISC-DETL-HIDN	
C-MISC-DIMS	Dimensions
C-MISC-TEXT	Miscellaneous Text
C-PATT-DECO-PVMT	Hatch - Decorative Pavement
C-PATT-DECO-XSEC	Hatch- Decorative - Cross Section
C-PATT-DET	Hatch - Decorative - Detail Sheets
C-PATT-DW	Hatch - Proposed Driveway
C-PATT-PVMT	Hatch - Proposed Pavement
C-PATT-SW	Hatch - Proposed Sidewalk
C-PATT-SW-EXST	Hatch - Existing Sidewalk
C-PROF	Proposed Profile
C-PROF-CNTR	Proposed Profile Centerline
C-PROF-DOTS	Profile - Dots
C-PROF-GRID	Profile - Grid
C-PROF-GRND-EXST	
C-PROF-NOTES	Profile Notes
C-PROF-NOTES-HORZ	Profile Notes - Horizontal
C-PROF-NOTES-VERT	Profile Notes - Vertical
C-PROF-TEXT	Proposed Profile Text
C-PROP	A`Property Lines (Parcel Boundaries)
C-PROP-ACRE	Lot & Tract Acreages
C-PROP-ADDR	Street Addresses
C-PROP-BLDG-SBAC	Building Setback
C-PROP-DIMS	Property Line Bearing, Distant & Curve Dimensions
C-PROP-EXST	Old/Existing Property Lines
C-PROP-MON	Property Line Monuments
C-PROP-NUMB	Lot Numbers & Tracts
C-PROP-NUMB-DISP	County Parcel Numbers for display purposes only
C-PROP-SPLT	Property Split Lines
C-PVMT-EDGE	Edge Of Pavement
C-PVMT-EDGE-EXST	Existing-Edge Of Pavement
C-PVMT-SC	Saw Cut Line
C-RCLM-ANNO-TXT	Reclaim Text
C-RCLM-BOOS-PNT	Reclaim Booster Station Point
C-RCLM-BOOS-SYM	Reclaim Booster Station Symbol
C-RCLM-PRVL-PNT	Reclaim Pressure Relief Valve Point
C-RCLM-PRVL-SYM	Reclaim Pressure Relief Valve Symbol
C-RCLM-STOR-PNT	Reclaim Storage Point
C-RCLM-STOR-SYM	Reclaim Storage Symbol
C-RCLM-UNDR-FIT	Reclaim Fittings

C-RCLM-UNDR-MAIN	
C-RCLM-UNDR-MAIN	Reclaim Water Main - Standard
C-RCLM-UNDR-REDR-P	
C-RCLM-UNDR-REDR-PNT	Reclaimline Reducer Point
C-RCLM-UNDR-REDR-S	
C-RCLM-UNDR-REDR-SYM	Reclaim Reducer Symbol
C-RCLM-UNDR-SERV	Reclaim Service Tap
C-RCLM-VAL-PNT	Reclaim Water Valve Point
C-RCLM-VALV-SYM	Reclaim Water Valve Symbol
C-RIV-CNTR	Rivers/Creeks/Streams/Washes Center Lines
C-RIV-EDGE	Rivers/Creeks/Streams/Washes Edge Lines
C-RIV-NAME	Rivers/Creeks/Streams/Washes Names
C-ROW	Street Right-of-Way Lines
C-ROWC	Canal Right-of-Way Lines
C-ROWC-CNTR	Canal Right-of-Way Centerlines
C-ROWC-CNTR-DIMS	Canal Centerline Bearing, Distant & Curve Dimensions
C-ROWC-CNTR-MON	Canal Centerline Monuments
C-ROWC-CNTR-NAME	Canal Names
C-ROWC-CNTR-WDTH	Canal Right-of-Way Width Dimensions
C-ROWC-DIMS	Canal Right-of-Way Line Bearing, Distant & Curve Data
C-ROWC-MON	Canal Right-of-Way Monuments
C-ROW-CNST-CNTR	Construction Center Line
C-ROW-CNTR	Street Right-of-Way Centerlines
C-ROW-CNTR-DIMS	Street Centerline Bearing, Distant & Curve Dimensions
C-ROW-CNTR-MON	Street Centerline Monuments
C-ROW-CNTR-NAME	Street Names
C-ROW-CNTR-WDTH	Street Right-of-Way Width Dimensions
C-ROW-DIMS	Street Right-of-Way Line Bearing, Distant & Curve
C-ROW-EXST	Existing-Street Right-of-Way Lines
C-ROWF	Freeway Right-of-Way Lines
C-ROWF-CNTR	Freeway Right-of-Way Centerlines
C-ROWF-CNTR-DIMS	Freeway Centerline Bearing, Distant & Curve Dimensions
C-ROWF-CNTR-MON	Freeway Centerline Monuments
C-ROWF-CNTR-NAME	Freeway Names
C-ROWF-CNTR-WDTH	Freeway Right-of-Way Width Dimensions
C-ROWF-DIMS	Freeway Right-of-Way Line Bearing, Distant & Curve Data
C-ROWF-MON	Freeway Right-of-Way Monuments
C-ROW-MON	Street Right-of-Way Monuments
C-ROWP	Private Street Right-of-Way Lines
C-ROWP-CNTR	Private Street Right-of-Way Centerlines

C-ROWP-CNTR-DIMS	Private Street Centerline Bearing, Distant & Curve Data
C-ROWP-CNTR-MON	Private Street Centerline Monuments
C-ROWP-CNTR-NAME	Private Street Names
C-ROWP-CNTR-WDTH	Private Street Right-of-Way Width Dimensions
C-ROWP-DIMS	Private Street Right-of-Way Line Bearing, Distant & Curve Data
C-ROWP-MON	Private Street Right-of-Way Monuments
C-ROWR	Railroad Right-of-Way Lines
C-ROWR-CNTR	Railroad Right-of-Way Centerlines
C-ROWR-CNTR-DIMS	Railroad Centerline Bearing, Distant & Curve Dimensions
C-ROWR-CNTR-MON	Railroad Centerline Monuments
C-ROWR-CNTR-NAME	Railroad Names
C-ROWR-CNTR-WDTH	Railroad Right-of-Way Width Dimensions
C-ROWR-DIMS	Railroad Right-of-Way Line Bearing, Distant & Curve Data
C-ROWR-MON	Railroad Right-of-Way Monuments
C-SECT-COR-MON	Section Corner Monuments
C-SECT-COR-TEXT	Section & Quarter Corner Information
C-SECT-LINE	Section Lines
C-SECT-LINE-DIMS	Section Line Bearing & Distant Dimensions
C-SHBD	Sheet Border
C-SHBD-MTCH	Match Line
C-SHBD-MTCH-TEXT	Match Line Text
C-SHBD-TEXT	General Text
C-SHBD-TEXT-BLD	Bold Size Text
C-SHBD-TEXT-MED	Medium Size Text
C-SHBD-TTLB Title	Title Block & North Arrow
C-SHBD-TTLB-TEXT	Title Block Text
C-SSWR-ANNO-TXT	Sewer Text
C-SSWR-CLNO-PNT	Cleanout Point
C-SSWR-CLNO-SYM	Cleanout Symbol
C-SSWR-HEAD-PNT	Sewer Headwork Point
C-SSWR-HEAD-SYM	Sewer Headwork Symbol
C-SSWR-LSTA-PNT	Sewer Lift Station Point
C-SSWR-LSTA-SYM	Sewer Lift Station Symbol
C-SSWR-MAHN-PNT	
C-SSWR-MAH-SYM	
C-SSWR-MANH-PNT	Manhole Point
C-SSWR-MANH-SYML	Manhole Symbol
C-SSWR-MSTA-PNT	Sewer Metering Station Point
C-SSWR-MSTA-SYM	Sewer Metering Station Symbol
C-SSWR-UNDR-MAIN-STAN	Sewermain - Standard

C-SSWR-UNDR-SERV	Sewer Service
C-SSWR-VALV-PNT	Sewer Valve Point
C-SSWR-VALV-SYM	Sewer Valve Symbol
C-SSWR-WEIR-SYM	Sewer Weir Box Symbol
C-SSWR-WIER-PNT	Sewer Weir Box Point
C-SSWR-WIER-SYM	
C-STRM-AREA-CTCH	Catchment Area, Area that Flows to an Outfall
C-STRM-AREA-DET	Detention Area
C-STRM-AREA-STOR	Storage Pond
C-STRM-CB	Catch Basin
C-STRM-MNMD-CANL	Canal, Large Water Conveyance that Interacts w/Storm Drains
C-STRM-MNMD-CHAN	Channel, Concrete Lined Conveyance
C-STRM-MNMD-CNTR	Centerline, Carries the Attributes for the Items Listed Above
C-STRM-MNMD-DTCH	Ditch, Unlined Conveyance
C-STRM-MNMD-IRRG	Irrigation, Small Water Conveyance that Interacts
C-STRM-MNMD-SPWY	Spillway, Allows Surface Flow to Channels/Ditches
C-STRM-NTRL-CNTR	Centerline, Carries the Attributes for the Items Listed Above
C-STRM-NTRL-CREK	Creek
C-STRM-NTRL-RIV	River
C-STRM-NTRL-WASH	Wash
C-STRM-STRC-DIVR	Diversion Structure, Diverts Canal Water to Storm Drain System
C-STRM-STRC-FLGT	Flapgate, Restricts Flow to one Direction
C-STRM-STRC-HDWL	Headwall, Transition from Openflow to Pipe & Visa Versa
C-STRM-STRC-INLT	Inlet, Collects Surface Flow
C-STRM-STRC-JBOX	Junction Box Irrigation Control
C-STRM-STRC-MH	Manhole, Point of Entry to the Storm Drain System
C-STRM-STRC-ORFC	Orifice, Restricts Flow
C-STRM-STRC-OUTF	Outfall, Structures that Release Storm Water to Receiving Water
C-STRM-STRC-PMP	Pump, Moves Water Between Different Elements of the System
C-STRM-STRC-STAN	Stand Pipe, Irrigation Device
C-STRM-STRC-STAN-EXST	
C-STRM-STRC-VAL	Valve, Controls Rate or Direction of Flow
C-STRM-STRC-WIER	Weir, Restricts or Changes Direction of Flow
C-STRM-UNDR	Storm Drain Lines-Underground
C-STRM-UNDR-BDET	Bleed Off, Detention, Flow from Detention Area to Pipe System
C-STRM-UNDR-BPMP	Bleed Off, Pump, Flow from Pump to Pipe Systems
C-STRM-UNDR-CLVT	Culvert, Structure to Allow Flow Under Roads, etc.
C-STRM-UNDR-CONR	Connector, Pipe Connects Inlets to Majors/Laterals
C-STRM-UNDR-EXST	Existing-Storm Drain Lines-Underground
C-STRM-UNDR-IRRG	Irrigation, Part of Irrigation System that Interacts w/Storm Drain

C-STRM-UNDR-LATR	Lateral, Pipe Usually Smaller, Feeds to Majors
C-STRM-UNDR-MAJR	Major, Pipe Backbone, Ends at Outfall
C-STRM-UNDR-OTHR	Other
C-STRM-UNDR-SPHN	Siphon, Allows Flow Under Obstructions
C-SUB-BND	Subdivision Boundary
C-SUB-BND-DIMS	Subdivision Boundary Bearing, Distant & Curve Dimensions
C-SUB-BND-MON	Subdivision Boundary Monuments
C-SUB-NAME	Subdivision Name
C-SWR	Sanitary Sewer-At Grade
C-SWR-EXST	Existing-Sanitary Sewer-At Grade
C-SWR-UNDR	Sanitary Sewer Lines-Underground
C-SWR-UNDR-EXST	Existing-Sanitary Sewer
C-TOPO	Results Of Survey
C-TOPO-BORE	Bore Hole Locations
C-TOPO-FENC	Fence
C-TOPO-FENC-EXST	
C-TOPO-MISC	Miscellaneous Items
C-TOPO-MISC-EXST	
C-TOPO-RTWL	Retaining Wall
C-TOPO-STLT-EXST	Streetlight Pole - Existing
C-TOPO-TEXT	Topo Text
C-TOPO-TRAF-POLE-EXST	Existing Traffic Signal Pole
C-TOPO-WALL	Freestanding Wall
C-TRAF-EQPT	Traffic Signal Equipment
C-TRAF-EQPT-EXST	Existing-Traffic Signal Equipment
C-TRAF-EQPT-MISC	Traffic Signal Equipment-Miscellaneous
C-TRAF-EQPT-TEXT	Traffic Signal Equipment Notes/Text
C-TRAF-FNDN-COND	Traffic Signal Conduit
C-TRAF-FNDN-COND-EXST	Existing-Traffic Signal Conduit
C-TRAF-FNDN-JB	Traffic Signal Junction Boxes
C-TRAF-FNDN-JB-EXS	
C-TRAF-FNDN-JB-EXST	Existing-Traffic Signal Junction Boxes
C-TRAF-FNDN-MISC	Traffic Signal Foundation-Miscellaneous
C-TRAF-FNDN-TEXT	Traffic Signal Foundation Notes/Text
C-TRAF-MISC	Street Names / Miscellaneous Text
C-TRAF-PM-SKW	Traffic-Skip White Paint
C-TRAF-PM-SKW-EXST	Existing-Traffic-Skip White Paint
C-TRAF-PM-SKY	Traffic-Skip Yellow Paint
C-TRAF-PM-SKY-EXST	EXST Existing-Traffic-Skip Yellow Paint
C-TRAF-PM-SOW	Traffic-Solid White Paint

C-TRAF-PM-SOW-EXST	Existing-Traffic-Solid White Paint
C-TRAF-PM-SOY	Traffic-Solid Yellow Paint
C-TRAF-PM-SOY-EXST	Existing-Traffic-Solid Yellow Paint
C-TRAF-POLE	Traffic Signal Poles/Foundations
C-TRAF-POLE-EXST	Existing-Traffic Signal Poles/Foundations
C-TRAF-POLE-EXST-R	
C-TRAF-POLE-EXST-RMVL	Existing-Traffic Signal Poles/Foundations-to be Removed
C-TRAF-SIGN	Traffic Signs
C-TRAF-SIGN-EXST	Existing Traffic Signs
C-TRAF-STLT	
C-UTIL-CABL	Cable-At Grade
C-UTIL-CABL-EXST	Existing-Cable-At Grade
C-UTIL-CABL-OVHD	Cable Lines-Overhead
C-UTIL-CABL-UNDR	Cable Lines-Underground
C-UTIL-CABL-UNDR-EXST	Existing-Cable Lines-Underground
C-UTIL-CWTR-UNDR	Chiller Water Lines-Underground
C-UTIL-CWTR-UNDR-EXST	Existing-Chiller Water Lines-Underground
C-UTIL-FIBR	Fiber Optic-At Grade
C-UTIL-FIBR-	Existing-Fiber Optic-At Grade
C-UTIL-FIBR-OVHD	Fiber Optic Lines-Overhead
C-UTIL-FIBR-OVHD-EXST	Existing-Fiber Optic Lines-Overhead
C-UTIL-FIBR-UNDR	Fiber Optic Lines-Underground
C-UTIL-FIBR-UNDR-	Existing-Fiber Optic Lines-Underground
C-UTIL-FUEL-UNDR	Liquid Fuel Lines-Underground
C-UTIL-FUEL-UNDR-EXST	Existing-Liquid Fuel Lines-Underground
C-UTIL-IRRG	Irrigation line w\Headwalls
C-UTIL-IRRG-ABVG	Irrigation Structures
C-UTIL-IRRG-ABVG-EXST	
C-UTIL-IRRG-EXST	Existing-Open Irrigation line w\Headwalls
C-UTIL-IRRG-UNDR	
C-UTIL-MGAS-UNDER	
C-UTIL-MGAS-UNDR	Medical Gas Lines-Underground
C-UTIL-MGAS-UNDR-EXST	Existing-Medical Gas Lines-Underground
C-UTIL-NGAS	Natural Gas-At Grade
C-UTIL-NGAS-EXST	Existing-Natural Gas-At Grade
C-UTIL-NGAS-UNDR	Natural Gas Lines-Underground
C-UTIL-NGAS-UNDR-	Existing-Natural Gas Lines-Underground
C-UTIL-POWR	Electrical Power-At Grade
C-UTIL-POWR-EXST	Existing-Electrical Power-At Grade
C-UTIL-POWR-EXST	Existing-Electrical Power-At Grade

C-UTIL-POWR-OVHD	Electrical Power Lines-Overhead
C-UTIL-POWR-OVHD-EXST	Existing-Electrical Power Lines-Overhead
C-UTIL-POWR-UNDR	Electrical Power Lines-Underground
C-UTIL-POWR-UNDR-EXST	Existing-Electrical Power Lines-Underground
C-UTIL-SSWR-UNDR-EXST	Existing-Sanitary Sewer Lines-Underground
C-UTIL-STRM-EXST	Existing-Storm Drain / All Structures and Facilities
C-UTIL-TELE-ABVG	Telephone - Aboveground
C-UTIL-TELE-UNDR	Telephone - Underground
C-UTIL-TELE-UNDR-EXST	
C-UTIL-WATR-UNDR-EXST	Existing-Domestic Water Lines-Underground
C-WALK	Walkways - Independent of Street
C-WALK-EXST	Existing-Walkways - Independent of Street
C-WATR	Domestic Water - At Grade
C-WATR-ANNO-TXT	Water Text
C-WATR-BOOS-PNT	Water Booster Station Point
C-WATR-BOOS-SYM	Water Booster Station Symbol
C-WATR-DET	Water Detail Sheet - Line Work
C-WATR-DET-CNTR	Water Detail Sheet - Center Line
C-WATR-DET-DASH	
C-WATR-DET-DDOT	
C-WATR-DET-HIDN	
C-WATR-EXST	Existing-Domestic Water - At Grade
C-WATR-MANH-PNT	Water Manhole Point
C-WATR-MANH-SYM	Water Manhole Symbol
C-WATR-MSTA-PNT	Water Metering Station Point
C-WATR-MSTA-SYM	Water Metering Station Symbol
C-WATR-PRVL-PNT	Water Pressure Relief Valve Point
C-WATR-PRVL-SYM	Water Pressure Relief Valve Symbol
C-WATR-PZON	Water Pressure Zone
C-WATR-REDR-PNT	Waterline Reducer Point
C-WATR-REDR-SYM	Waterline Reducer Symbol
C-WATR-STOR-PNT	Water Storage Point
C-WATR-STOR-SYM	Water Storage Symbol
C-WATR-UNDR	Domestic Water Lines-Underground
C-WATR-UNDR-EXST	Existing-Domestic Water Lines-Underground
C-WATR-UNDR-FIT	Water Fitting
C-WATR-UNDR-MAIN	Watermain
C-WATR-UNDR-SERV	Water Service
C-WATR-VALV-SYM	Water Valve Symbol
C-WATR-WELL-PNT	Water Well Point

C-WATR-WELL-SYM	Water Well Symbol
DEFPOINTS	
L-IRRG-EQPT	Valves, Meters, Etc.
L-IRRG-EQPT-DET	Irrigation Detail Sheet - line Work
L-IRRG-EQPT-DET-CN	
L-IRRG-EQPT-DET-CNTR	Irrigation Detail Sheet - Center Line
L-IRRG-LTRL	Irrigation - Lateral Line
L-IRRG-MAIN	Irrigation - Main Line
L-IRRG-MISC	Wire, Pull Box, Etc.
L-IRRG-PIPE	Irrigation Pipe
L-IRRG-PRIV	Private Irrigation
L-IRRG-SIZE	Irrigation Pipe Size
L-IRRG-SLEV	Irrigation Sleeves
L-IRRG-SYMB	Irrigation Tags
L-IRRG-TEXT	Annotations
L-IRRG-WATR	Irrigation with Water
L-PLNT	Plants
L-PLNT-BLDR	Site Boulders
L-PLNT-CACT	Desert Plants
L-PLNT-DEMO	Demolish / Removal
L-PLNT-EXST	Existing Plants
L-PLNT-FURN	Site Furniture
L-PLNT-HEAD	Landscape Headers
L-PLNT-SAVG	Plant Salvage
L-PLNT-SHRB	Plant - Shrub
L-PLNT-TEXT	Landscape Text
L-PLNT-TREE	Trees
Z-BLDG	Major Existing Building Outlines
Z-BLDG-DIMS	Major Building Dimensions
Z-BLDG-FUTR	Future Buildings and Additions
Z-SITE	Building Setback Lines
Z-SITE-DIMS	Building Dimensions
Z-SITE-DRVW	Driveways
Z-SITE-FENC	Fences/Walls
Z-ZONE	Existing Zoning Lines
Z-ZONE-DIMS	Zoning Dimensions
Z-ZONE-FUTR	Rezoning Proposals
Z-ZONE-FUTR-TEXT	Rezoning Proposals Text
Z-ZONE-TEXT	Zoning Identification Text

*Any existing layer not listed should be named with the layer name and “-EXST”
EXAMPLE: C-BLDG-EXST



Appendix H

Sheet Naming Conventions

Public Works Department

COVER SHEET(PROJECT #)CS
 LEGEND & NOTE SHEET (PROJECT #)LN
 KEY MAP(PROJECT #)KM (If not included on Cover Sheet)
 ROADWAY SUMMARY SHEET(PROJECT #)RS
 TYPICAL SECTIONS..... (PROJECT #)TY
 PAVING PLANS (PLAN/PROFILE) (PROJECT #)PP1 THRU (PROJECT #)PP?
 IF PAVING PLANS HAVE SEPARATE PLAN AND PROFILE SHEETS:
 PLAN SHEETS (PROJECT #)PL1 THRU (PROJECT #)PL?
 PROFILE SHEETS (PROJECT #)PRO1 THRU (PROJECT #)PRO?
 PAVING DETAILS (PROJECT #)PD1 THRU (PROJECT #)PD?
 STORM DRAIN QUANTITY SUMMARY SHEET(PROJECT #)SDQ
 HYDRAULIC GRADE LINE SHEET (PROJECT #)HGL
 STORM DRAIN DESIGN SUMMARY SHEET (PROJECT #)SDS
 SOIL BORING LOGS(PROJECT #)SB1 THRU (PROJECT #)SB?
 STORM DRAIN PLANS (PROJECT #)SD1 THRU (PROJECT #)SD?
 CATCH BASIN CONNECTOR PIPE PROFILES (PROJECT #)CPP1 THRU (PROJECT #)CPP?
 STORM DRAIN DETAILS(PROJECT #)SDD1 THRU (PROJECT #)SDD?
 LANDSCAPE PLANS (PROJECT #)LS1 THRU (PROJECT #)LS?
 LANDSCAPE IRRIGATION PLANS(PROJECT #)LSI1 THRU (PROJECT #)LSI?
 LANDSCAPE DETAILS(PROJECT #)LSD1 THRU (PROJECT #)LSD?
 STREET LIGHT TRENCHING PLANS (PROJECT #)SL1 THRU (PROJECT #)SL?
 TRAFFIC SIGNAL PLANS (PROJECT #)TS1 THRU (PROJECT #)TS?
 TRAFFIC SIGNAL DETAILS(PROJECT #)TSD1 THRU (PROJECT #)TSD?
 BRIDGE PLANS(PROJECT #)BR1 THRU (PROJECT #)BR?
 WATERLINE PLANS(PROJECT #)WP1 THRU (PROJECT #)WP?
 WATERLINE PROFILES (If separate from Plans) (PROJECT #)WPP1 THRU (PROJECT #)WPP?
 WATERLINE TIE-IN DETAILS (PROJECT #)WTD1 THRU (PROJECT #)WTD?
 WATERLINE DETAILS (PROJECT #)WD1 THRU (PROJECT #)WD?
 SANITARY SEWER PLANS(PROJECT #)SS1 THRU (PROJECT #)SS?
 SANITARY SEWER DETAILS (PROJECT #)SSD1 THRU (PROJECT #)SSD?

Note: (PROJECT #) = City Project Number