Reviewed 5/31/07

FINAL
DRAINAGE REPORT

WOODLAND CREEK ESTATES SUBDIVISION

1802 K ROAD
FRUITA, COLORADO

Storm Drain C = 12" ADS along Pine St. The 12" pipe capacity calculations of 2.67cfs were found, but the design Q100 (needed volume) was never found. This needs to be clarified.

PREPARED FOR:

WOODLAND CREEK, LLC

1877 Broadway
Grand Junction, CO 81503

PREPARED BY:

O'CONNOR DESIGN GROUP, INC.

2350 G Road, Suite 113
Grand Junction, CO 81505
(970) 241-7125

May 2, 2007

CERTIFICATION

I hereby certify that this Final Drainage Report for Woodland Creek Estates Subdivision was prepared under my direct supervision.

Patrick M. O'Connor
Registered Professional Engineer
State of Colorado, #20759

TABLE OF CONTENTS

FINAL DRAINAGE REPORT
WOODLAND CREEK ESTATES

I. LOCATION AND DESCRIPTION OF PROPERTY

Woodland Creek Estates Subdivision is located in the City of Fruita, Colorado, at the northeast corner of 18 and K Road. The parcel number for the site is 2697-093-00-114. The entire project proposes a total of 54 single family lots with intention to complete development in one phase with associated infrastructure, including streets, utilities, and roadway improvements. Woodland Creek will contain single family homes offering lots from 7000 to over 17,000 square feet; average lot-size is 7857 square feet.

Existing streets in the vicinity include 18 Road adjacent along the western border and K Road to the south. A system of urban residential streets is proposed to run through the project providing access west to 18 Road from Woodland Avenue and north to the adjacent Sunflower Estates Subdivision at Hawthorne Street. Woodland Avenue will also provide interconnection to the east for future development. Arches Drive extends across K Road from Vista Valley PUD into the subdivision to provide southern access and interconnection to Vista Valley.

Presently, the land is furrow-irrigated and used agriculturally as pasture. The site currently contains one residential structure and outbuildings in the southwest corner. This house will remain and be incorporated into the subdivision. Surrounding land uses in the vicinity include similar single family subdivisions; Sunflower Estates to the north, Vista Valley PUD to the south, and Holly Park West to the northeast. Some larger undeveloped parcels exist to the east (2697-093-00-5080) and to the west (2697-084-00-044). Across K Road to the south is another undeveloped parcel which is part of Vista Valley PUD and is projected to be a neighborhood commercial development. The property was found eligible for annexation to the City of Fruita by a resolution passed by the City Council on December 5th, 2006 with staff recommended for approval of the annexation. The project is within the Future Land Use Area designated as Community Residential.

Existing ground cover over most of the site currently consists of a moderately dense stand of previously irrigated pasture grasses draining west to an existing storm inlet with an 18" RCP discharge culvert. The site has been in agricultural utilization for the last few years, with a variety of row-irrigated crops. The site soils generally consist of Ravola Clay Loam (Ra, 0% to 2% slopes) and Billings Silty Clay Loam (Bc, 0% to 2% slopes). These soils are categorized as hydrologic soil groups B and C which have moderate to slow infiltration rates and moderate to slightly more rapid runoff potential. This should not adversely impact site development.

After development, runoff from the site will flow to the south and west, carried above-ground by streets and through drainage easements, as required, draining into the detention/irrigation facility in the south west corner of the site. Stormwater detention is proposed to attenuate developed runoff, releasing to the historic drain. The site is not located within any known 100 year flood plain as delineated by FEMA flood mapping.

Irrigation water is provided by Grand Valley Irrigation Company and is delivered by pipeline to the northeast corner of the site.

Landscaping and irrigation of the proposed open space tracts shall be installed by the developer per Landscape Plans provided with final submittal. Surface maintenance of these open space tracts will ultimately become the responsibility of the Homeowners Association. Landscaping, irrigation, and maintenance of all single family lots will be the responsibility of the individual lot owners.

II. EXISTING DRAINAGE CONDITIONS

Major Basin

Woodland Creek Estates is located in the northeast portion of the City of Fruita. Runoff from the site flows west through storm sewers, located within the City, to Little Salt Wash before ultimately dumping into the Colorado River.

The site does not exist within the 100 year floodplain of the Colorado River or any other major basin as delineated by the current floodplain mapping available on the City or FEMA websites. This mapping is said to reflect the July 15, 1992 Flood Insurance Rate Maps produced by FEMA. Partial copies of the website mapping from FEMA and the City are enclosed in the Appendix.

Site

Topography of the property is relatively level and consistent in nature, sloping generally to the west and southwest at an average rate of less than one percent. Tailwater enters the existing K Road Storm Sewer (30" RCP) after entering the existing storm inlet near 18 and K Road, at the northeast corner of the intersection and southwest corner of the site. According to City utility mapping, runoff flows west under 18 Road and south under K Road in existing 18" RCP culverts to the 30" pipeline. Another drain exists near the southeast corner of the site which drains irrigation headwater overflows along the east boundary. This drain will no longer be needed for this site given the changes in irrigation practices and grading proposed for the project, it will, however, continue to be a potential drain for the property adjacent to the east.

Off-site Impacts to the Site

Properties and roadways along the perimeter of the property are generally graded away from the site and, therefore, intercept most flows and prevent them from entering the project. Properties south and west of the site generally drain to the south and west, away from the project. Sunflower Estates, to the north, appears to have no detention facility and to direct-discharge via internal street runoff to the west into 18 Road. Holly Park, to the east, appears to drain south through its internal streets to an existing detention facility before draining into the 30" K Road drain pipe. 18 and K Roads will carry runoff around and past Woodland Creek Estates, either above-ground or through the storm drains within them. There is no visible evidence of runoff from any offsite area entering onto the property.

III. PROPOSED DRAINAGE CONDITIONS

Changes in Drainage Patterns

No major changes in the released drainage patterns are proposed for the site. Drainage patterns within the site are proposed to be modified to accommodate development and better control surface flows to designated collection areas. The developed site was broken into two separate basins to calculate flows to the two individual storm inlets at the south end of Vintage Lane. Basin 10 consists of 27 lots contained within the internal core (Blocks 2 and 3). Basin 20 is comprised of 27 lots in the site perimeter (Blocks 1, 4, 5, and 6).

Upon development, runoff will generally flow south and west in streets to be collected at the two proposed inlets, detained, and released at a controlled rate from a detention facility designated in the southwest corner of the site. This facility will consist of a detention pond and concrete release structure which will empty into the existing storm inlet near the northeast corner of the 18 and K Road intersection. From here, it will follow the historic path, continuing to flow under 18 and K Roads in existing 18" culverts to the 30" RCP drain in K Road. Calculations indicate that developed rates of release will be reduced from the runoff flow rates historically generated.

Maintenance

Access to the stormwater management facility will be by platted streets and easements as required. A Home Owners Association will be formed to provide maintenance responsibility for the surface improvements related to the facility. Operation and maintenance of any underground storm sewers will ultimately be the responsibility of the City of Fruita.

Homeowners and Builders Responsibility

All builders and homeowners are advised to read and follow the information regarding drainage and grading provided in the "Subsurface Soils Exploration" report produced by Grand Junction Lincoln DeVore, Inc. (dated: February 1, 2007). Engineered foundations are required for the Woodland Creek Estates project.

IV. DRAINAGE DESIGN CRIERIA AND APPROACH

Regulations

The Mesa County Stormwater Management Manual (SWMM), dated May, 1996, was used as the basis for analysis and facility design criteria. The recommendations of the June, 1998 Stormwater Management Master Plan (SWMMP) for the City of Fruita were also reviewed and do not appear to be conflicted by this development. This development was designed and is intended to be constructed within the guidelines of the SWMM and SWMMP to assure minimal impacts to downstream properties.

Hydrologic Criteria

Because the project is a residential development containing an overall watershed basin greater than ten acres, the SCS Unit Hydrograph Method was used to calculate the historic and developed flow rates. As required by the SWMM, the minor storm event is considered to be the 2 year frequency storm and the major storm event is considered to be the 100 year frequency event.

Runoff Coefficients and precipitation data used in the computations were based on the most recent SWMM criteria defined above. Coefficients were assigned based on land use and hydrologic soils group. Haestad Methods (PondPack – Version 10) software was used to perform the calculations. Copies of the coefficient tables and methods used to determine a composite coefficient for each sub-basin are included in the appendix.

Note: Using SCS Methods produces relatively little (sometimes zero) two-year runoff for areas with a CN Value of less than 80 (typical historic areas). This is due to the nature of the equations used to calculate runoff by these methods and the fact that the two-year precipitation level is 0.7" for the Grand Valley (per SWMM). A quick review of SCS Runoff Charts shows little potential runoff at such a low precipitation value, even for developed areas with much higher CN Values typically in the 80's or 90's. Therefore, many of the reported flows in this report will ignore 2-year results (historic or developed) when less than 0.1 cfs. These flows are considered insignificant.

Hydraulic Criteria

Open channels and pipelines were analyzed using Manning's Equation and roughness coefficients found in the SWMM. Haestad Methods (FlowMaster 2005) software was used to perform the calculations. Copies of these calculations are included in this report.

V. RESULTS AND CONCLUSIONS

AREAS

Total Site – 13.49 acres (Historic Basin)

Developed:	Basin 10	-	6.79 acres (27 lots)
	Basin 20	-	6.70 acres (27 lots)

RUNOFF COEFF. – SCS "CN" Values - Hydrologic Soil Group "B"

	Area, Ac.	CN
Historic: Straight row-crops, good crop residue	13.34	78
Historic: Driveway, Gravel	0.09	85
Historic: Roofs, concrete	0.06	98
Historic: (composite) - see appendix for calc's	**13.49**	**78**
Developed: Asphalt, concrete, roofs	6.34	98
Developed: Landscaped, lawns	4.96	69
Developed: Landscaped, desert or non-turf	2.19	77
Developed: (composite) - see appendix for calc's	**13.49**	**81**

TIMES OF CONCENTRATION

Historic: (site)	-	**0.5533** hours
Developed: on-site (Basin 10)	-	**0.2935** hours
Developed: on-site (Basin 20)	-	**0.3628** hours

RUNOFF (All Flows are C.F.S.)

	Historic Undeveloped Site	Developed Site (undetained)	Developed (Detained/Released)
2 Year	**0.01**	**0.03**	**0.03**
100 Year	**4.50**	**8.27**	**4.01**

89% of histori

DETENTION VOLUMES – Top of Pond: **4531.85**

Storm	Volume (ft^3)	High Water Elev.	Released Flows
2-Yr.	**86**	**4527.47**	**0.03 cfs**
100-Yr.	**7,460**	**4529.84**	**4.01 cfs**

CONCLUSION

The detention facility will attenuate developed flows and discharge runoff into the existing storm inlet and culvert under 18 Road. In accordance with criteria outlined in the Mesa County SWM Manual, increased peak runoff rates produced onsite by the developed condition will be controlled by the proposed detention facility and released at rates less than historic.

APPENDIX

1. SITE MAPS

Major Basin Drainage Map – U.S.G.S. Map
Location Maps – G.I.S. Aerial Photo's (2 pages)
Floodplain Map – City of Grand Junction Website
Floodplain Maps – FEMA Panels (Fruita and Mesa County – 2 pages)
Grading and Drainage Plan (Sheet 15) incl. storm sewer profiles
Existing storm sewer data from City of Fruita
Enlarged Pond Grading Contours (2 pages)

2. COEFFICIENTS

"CN" Values – SCS Method (Cultivated Agricultural - Historic)
"CN" Values – SCS Method (Urban Areas - Developed)
Composite "CN" Calculations (6 pages)
Manning's "n" Table

3. TIMES OF CONCENTRATION

Predeveloped Site (HISTORIC)
Developed Site (PROPOSED – Basins 10 and 20, 2 pages)

4. RUNOFF - HISTORIC

2-Year and 100-Year Storm Summary
SCS Method Calculations - Runoff

5. RUNNOFF – DEVELOPED

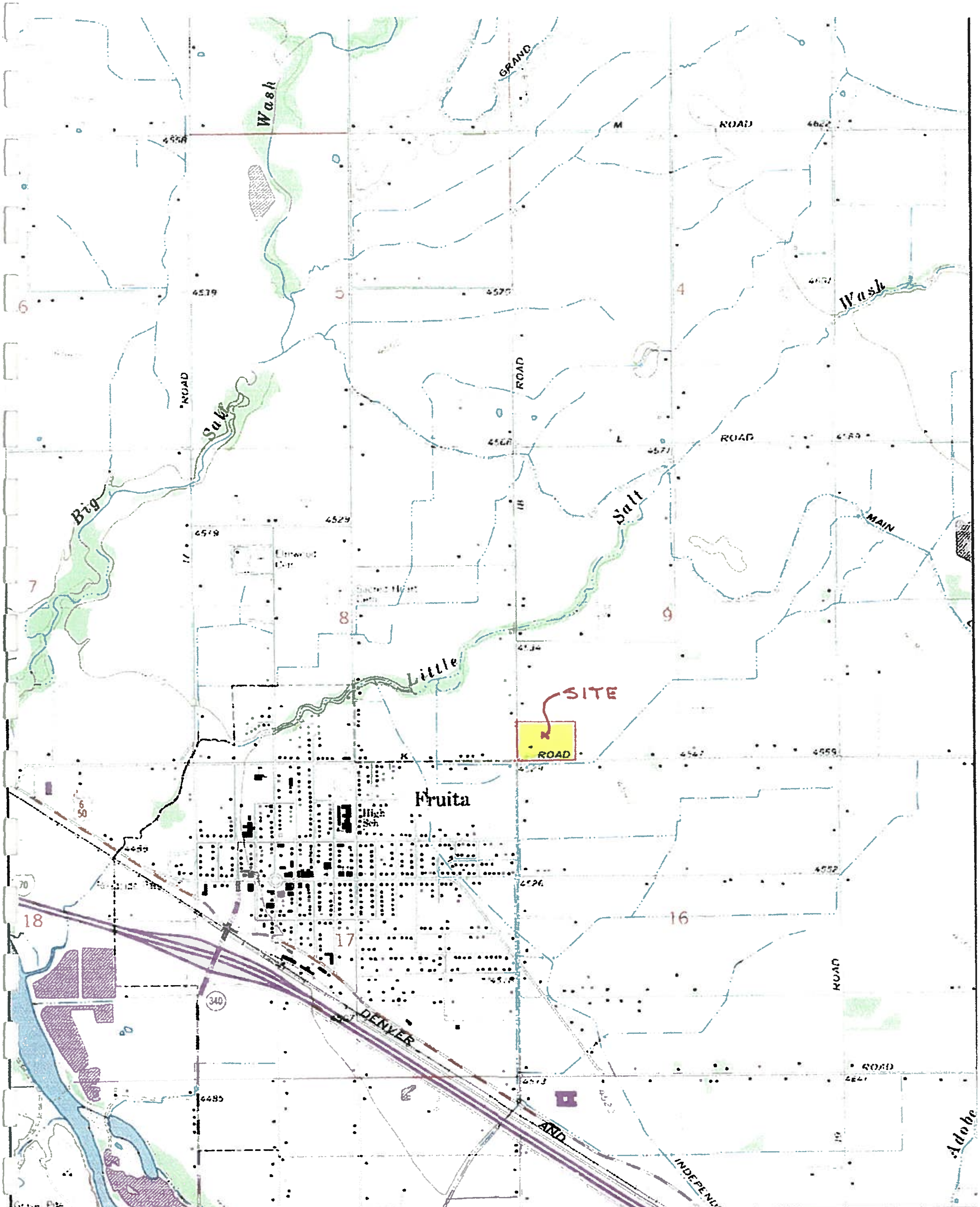
Schematic
2-Year and 100-Year Master Design Storm Summary
100 Year Site Hydrographs – Pond Inflow and Outflow
Pond Routing Summary – 100 Year
Pond E-V-Q Table (3 sheets)
SCS U.H. Calc's : Basins 10/20 (2 sheets)

6. HYDRAULICS

Maximum Half-Street Flows SWM Manual
Maximum Inlet Capacity – NEENAH: use for std. rollover grate
Pond Rating Table
V-Notch Weir Data
V-Notch Weir Rating Table
12", 15", 18" Storm Drains – Capacity Worksheets (5 pages)

1

SITE MAPS



Woodland Creek Irrigation

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FEET

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Tuesday, January 30, 2007 11:08 AM

Woodland Creek Estates - Vicinity Drainage Map

SCALE 1 : 5,988

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FEET

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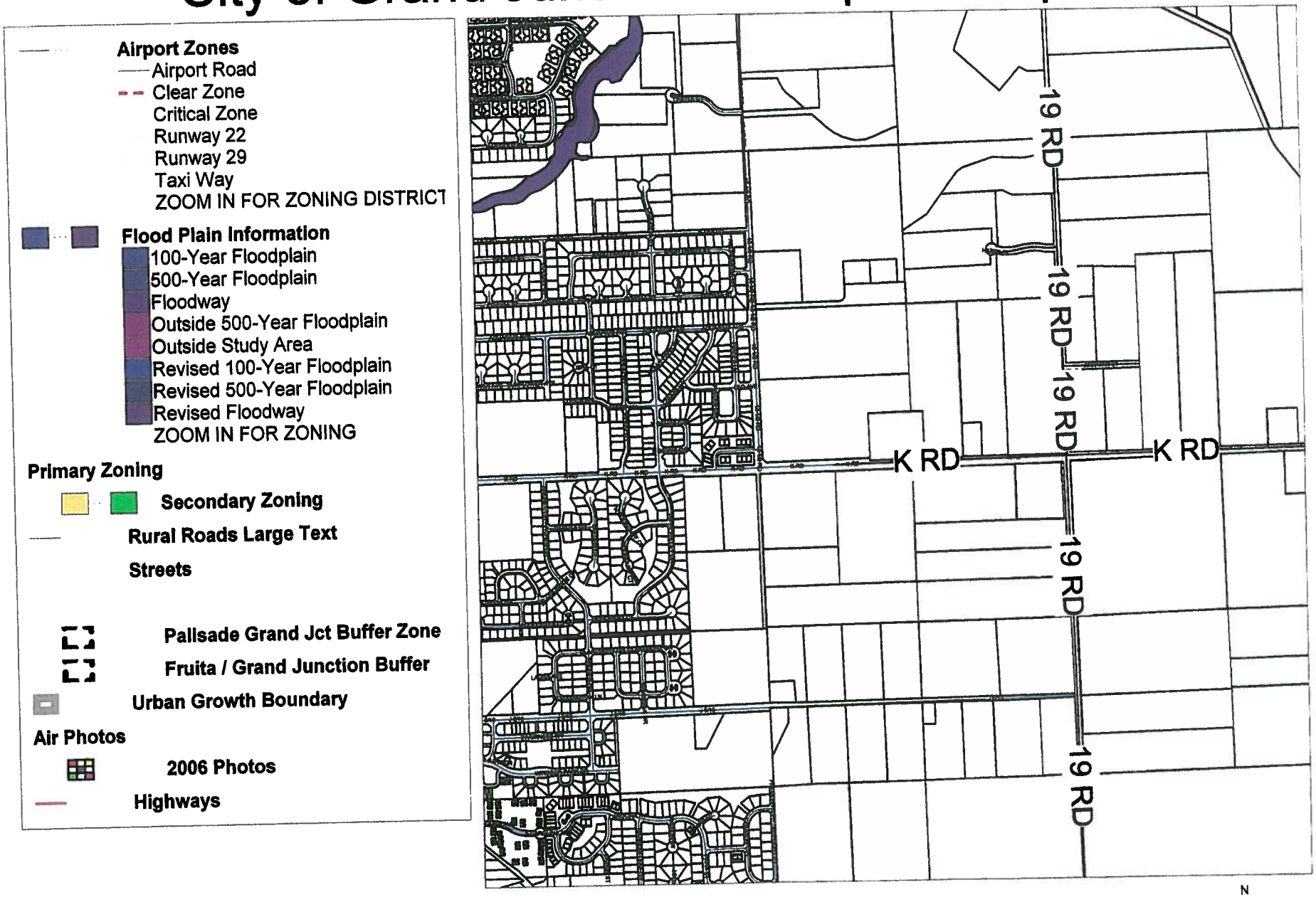
City of Grand Junction Floodplain Map



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FEMA MSC Viewer

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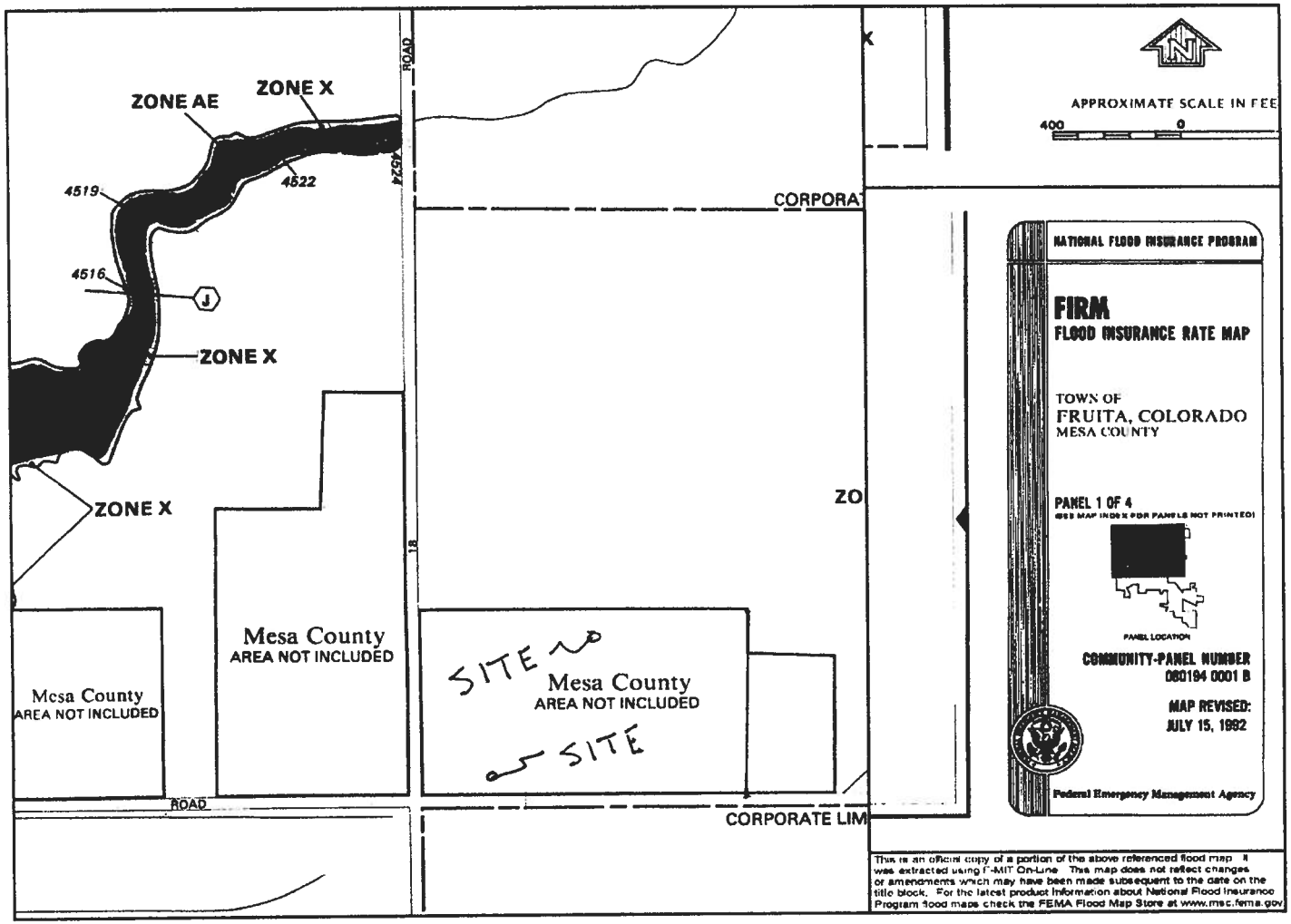

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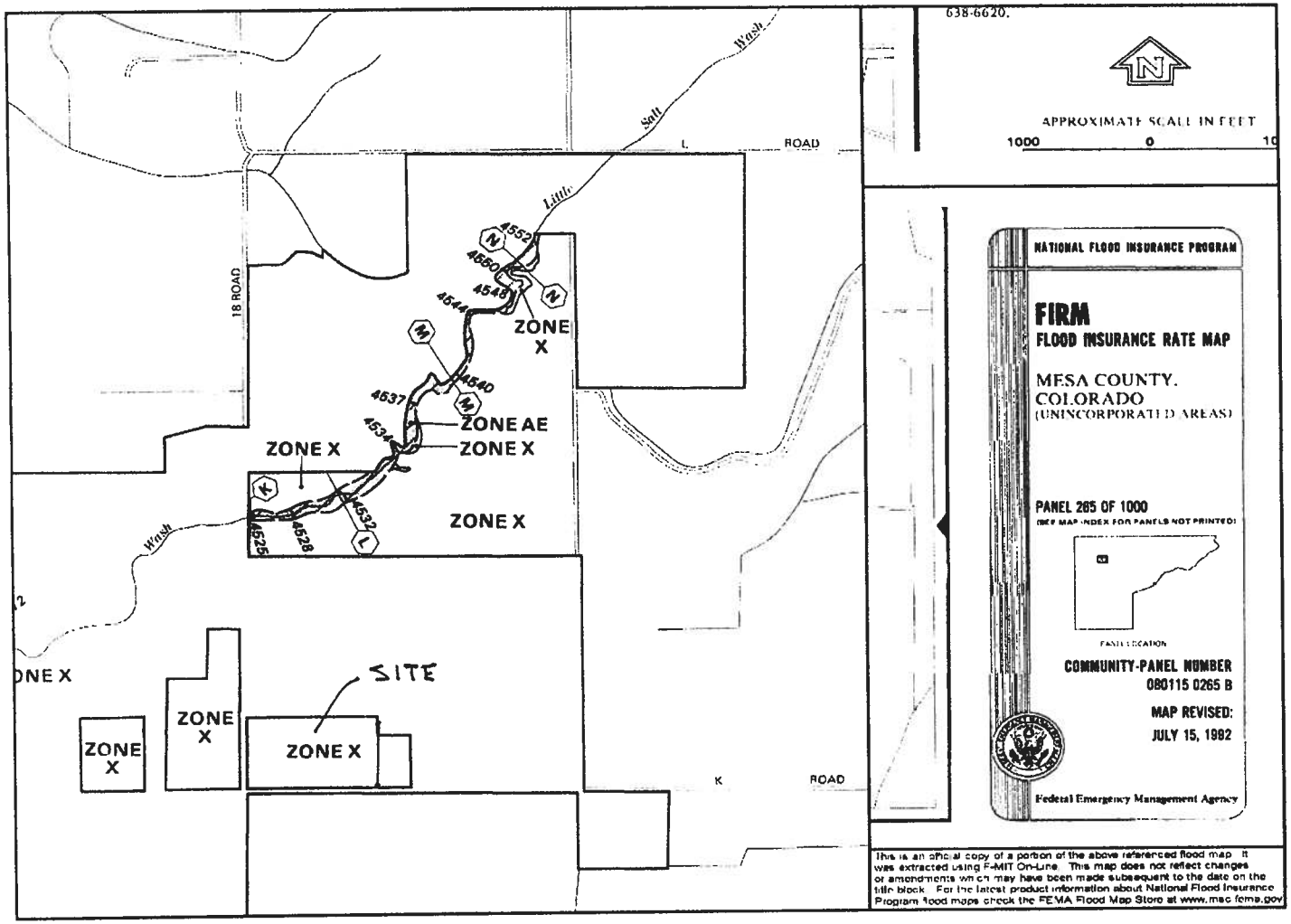
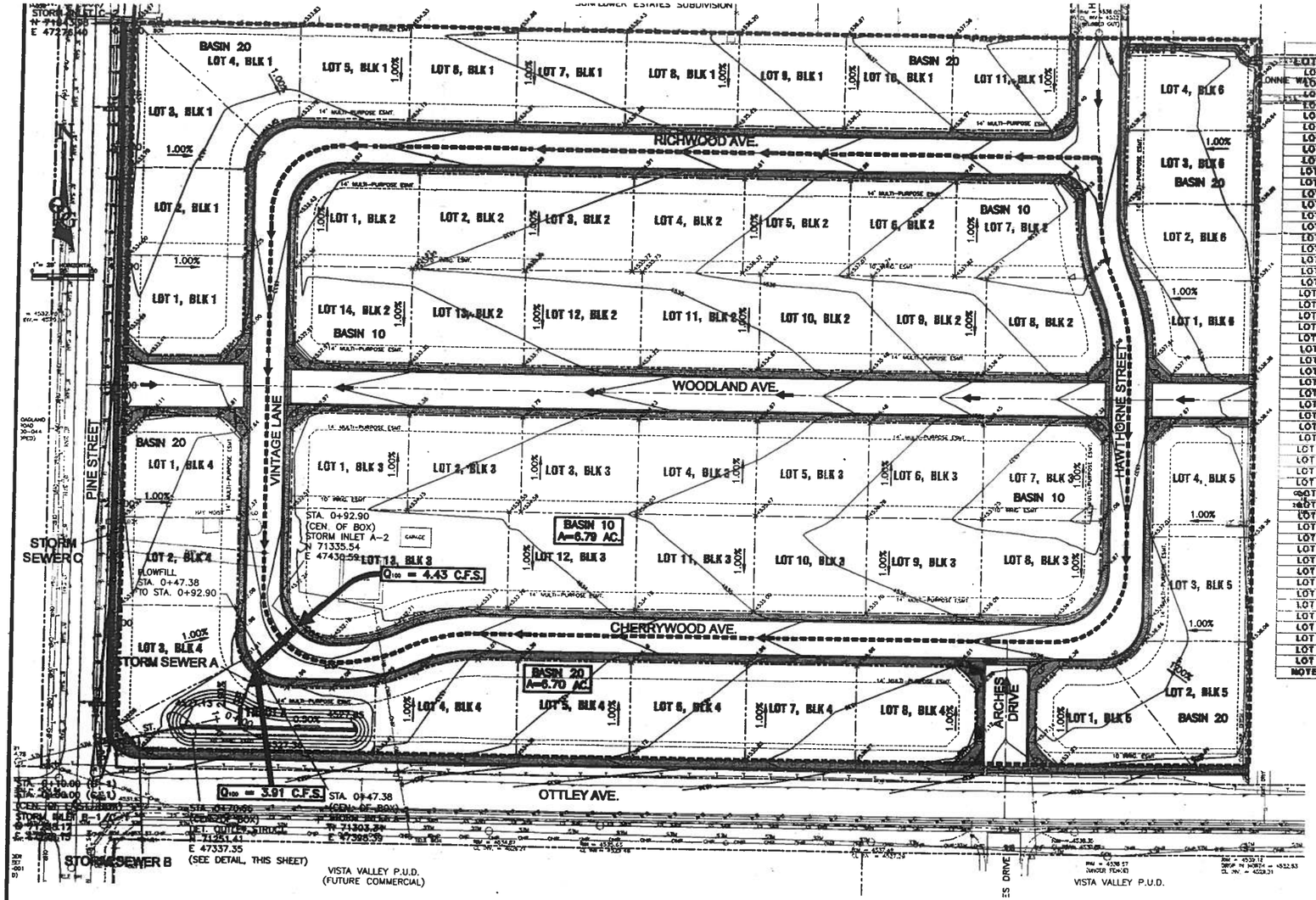
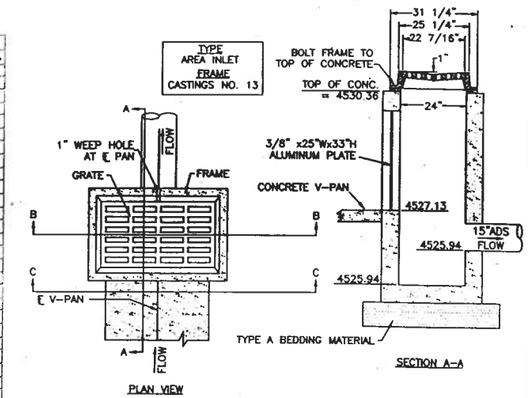




TOP OF FOUNDATION (T.O.F.)			
LOT NO.	BLOCK NO.	T.O.F.MIN.	T.O.F.MAX.
LOT 1	BLOCK 1	4584.48	4586.48
LOT 2	BLOCK 1	4584.16	4586.16
LOT 3	BLOCK 1	4584.76	4586.76
LOT 4	BLOCK 1	4584.80	4586.80
LOT 5	BLOCK 1	4585.15	4587.15
LOT 6	BLOCK 1	4585.51	4587.51
LOT 7	BLOCK 1	4585.86	4587.86
LOT 8	BLOCK 1	4586.26	4588.26
LOT 9	BLOCK 1	4587.01	4589.01
LOT 10	BLOCK 1	4587.77	4589.77
LOT 11	BLOCK 1	4589.61	4641.61
LOT 1	BLOCK 2	4585.10	4587.10
LOT 2	BLOCK 2	4585.64	4587.64
LOT 3	BLOCK 2	4585.85	4587.85
LOT 4	BLOCK 2	4586.35	4588.35
LOT 5	BLOCK 2	4587.00	4589.00
LOT 6	BLOCK 2	4587.84	4589.84
LOT 7	BLOCK 2	4539.20	4541.20
LOT 8	BLOCK 2	4588.86	4540.86
LOT 9	BLOCK 2	4587.10	4589.10
LOT 10	BLOCK 2	4586.32	4588.32
LOT 11	BLOCK 2	4585.84	4587.84
LOT 12	BLOCK 2	4585.22	4587.22
LOT 13	BLOCK 2	4584.76	4586.76
LOT 14	BLOCK 2	4584.30	4586.30
LOT 1	BLOCK 3	4584.92	4586.92
LOT 2	BLOCK 3	4584.76	4586.76
LOT 3	BLOCK 3	4585.10	4587.10
LOT 4	BLOCK 3	4585.84	4587.84
LOT 5	BLOCK 3	4586.21	4588.21
LOT 6	BLOCK 3	4587.10	4589.10
LOT 7	BLOCK 3	4588.41	4540.41
LOT 8	BLOCK 3	4588.12	4940.12
LOT 9	BLOCK 3	4537.06	4539.06
LOT 10	BLOCK 3	4536.54	4538.54
LOT 11	BLOCK 3	4535.71	4537.71
LOT 12	BLOCK 3	4534.66	4536.66
LOT 13	BLOCK 3		
LOT 1	BLOCK 4	4535.20	4537.20
LOT 2	BLOCK 4	4533.72	4535.72
LOT 3	BLOCK 4	4533.17	4535.17
LOT 4	BLOCK 4	4533.98	4535.98
LOT 5	BLOCK 4	4534.66	4536.66
LOT 6	BLOCK 4	4535.75	4537.75
LOT 7	BLOCK 4	4536.54	4538.54
LOT 8	BLOCK 4	4538.00	4540.00
LOT 1	BLOCK 5	4538.09	4540.09
LOT 2	BLOCK 5	4537.80	4539.80
LOT 3	BLOCK 5	4538.03	4540.03
LOT 4	BLOCK 5	4539.20	4541.20
LOT 1	BLOCK 6	4539.20	4541.20
LOT 2	BLOCK 6	4539.18	4541.18
LOT 3	BLOCK 6	4688.46	4641.46
LOT 4	BLOCK 6	4539.80	4541.80

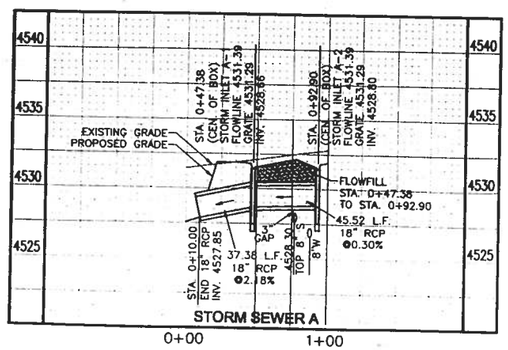
NOTE: OPTIMAL ELEVATION = T.O. MINIMUM + 0.2'

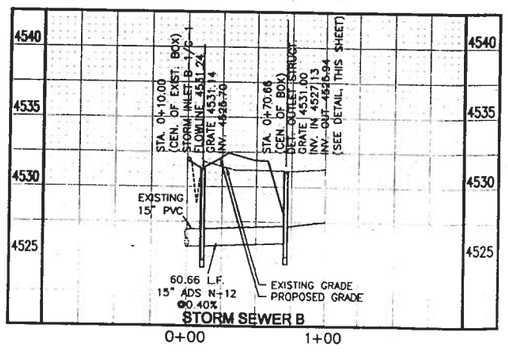


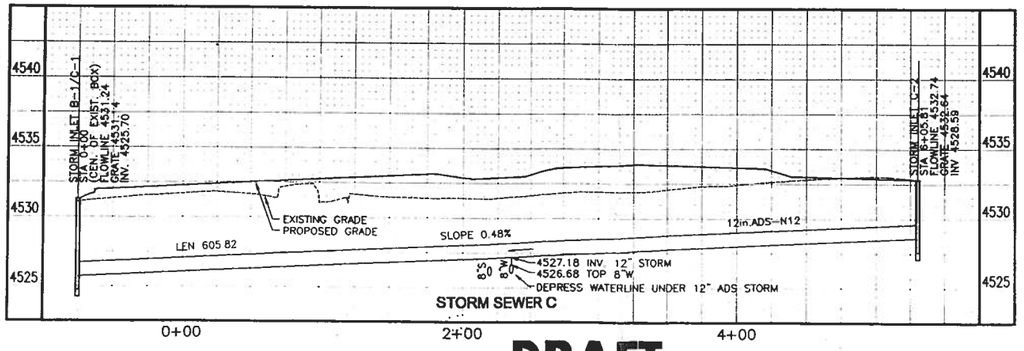
PROJECT BENCHMARK
M.C.S.M #19
SW CORNER, SECTION 9
T.1N., R.2W., UTE P.M.
N 71186.23, E 47251.74
ELEVATION = 4531.70 NAVD88

CONTRACTOR SHALL VERIFY THE LOCATION AND ELEVATION OF ALL EXISTING UTILITIES

CALL 1-800-922-1987 UTILITY NOTIFICATION CENTER OF COLORADO







DRAFT

- FOR REVIEW ONLY -

CITY OF FRUITA
APPROVED FOR CONSTRUCTION FOR ONE YEAR FROM THIS DATE
BY: _____ NAME _____ DATE: _____

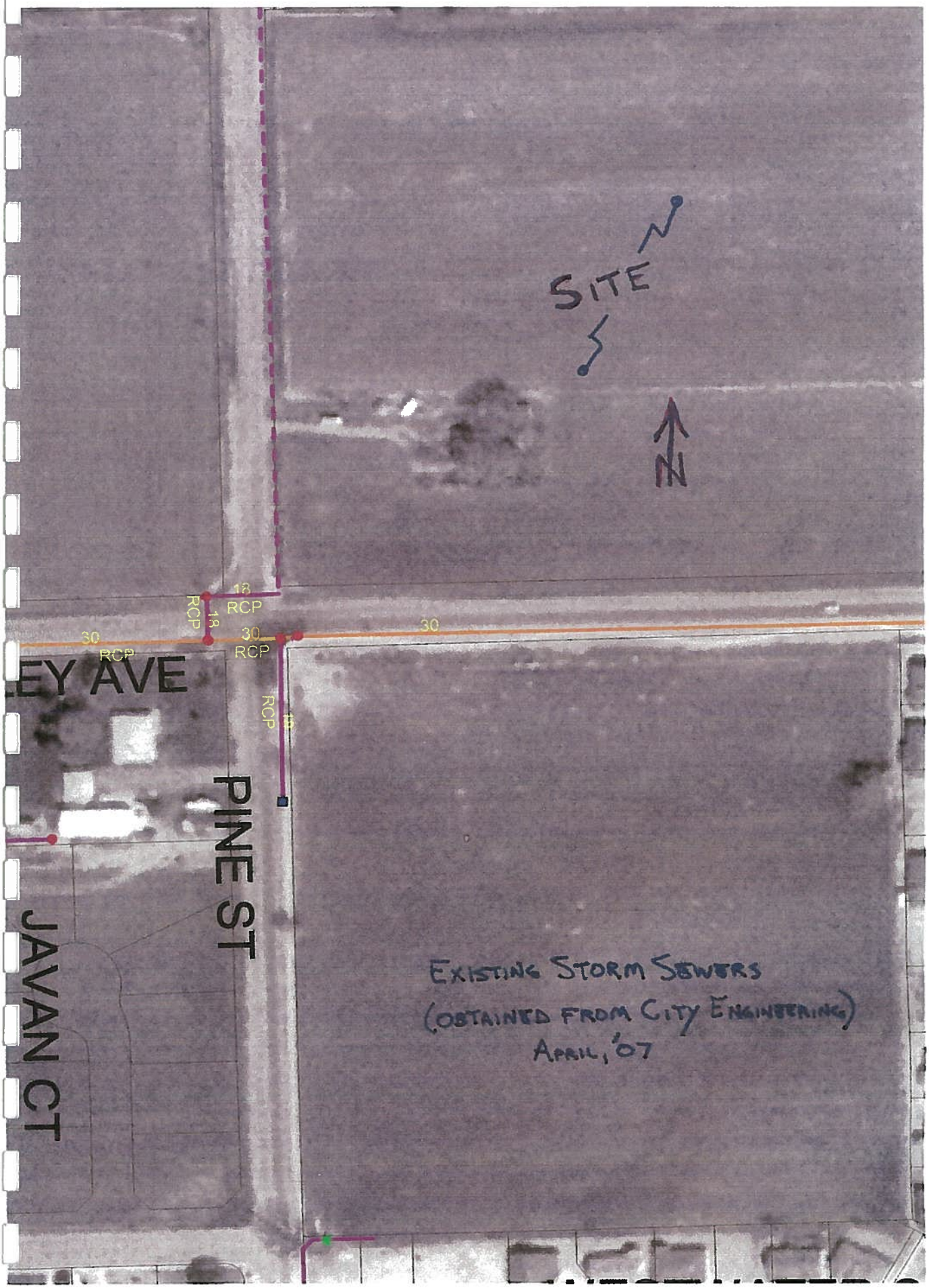
REVISION 1 _____ DATE _____
REVISION 2 _____ DATE _____
REVISION 3 _____ DATE _____

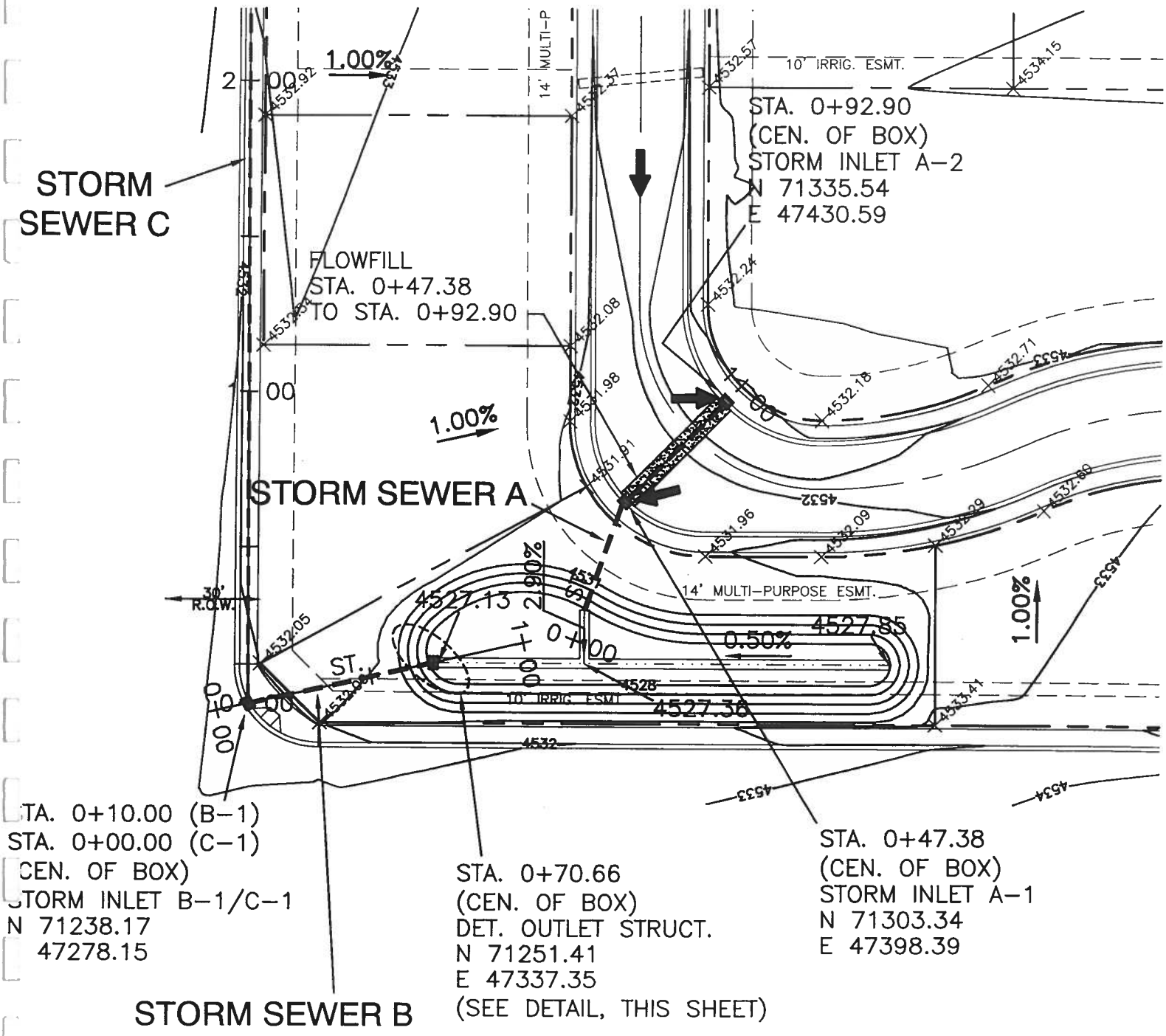
DRAWN BY DPW DATE 5-2-07
DESIGNED BY DPW/PMO DATE 5-2-07
CHECKED BY PMO DATE 5-2-07

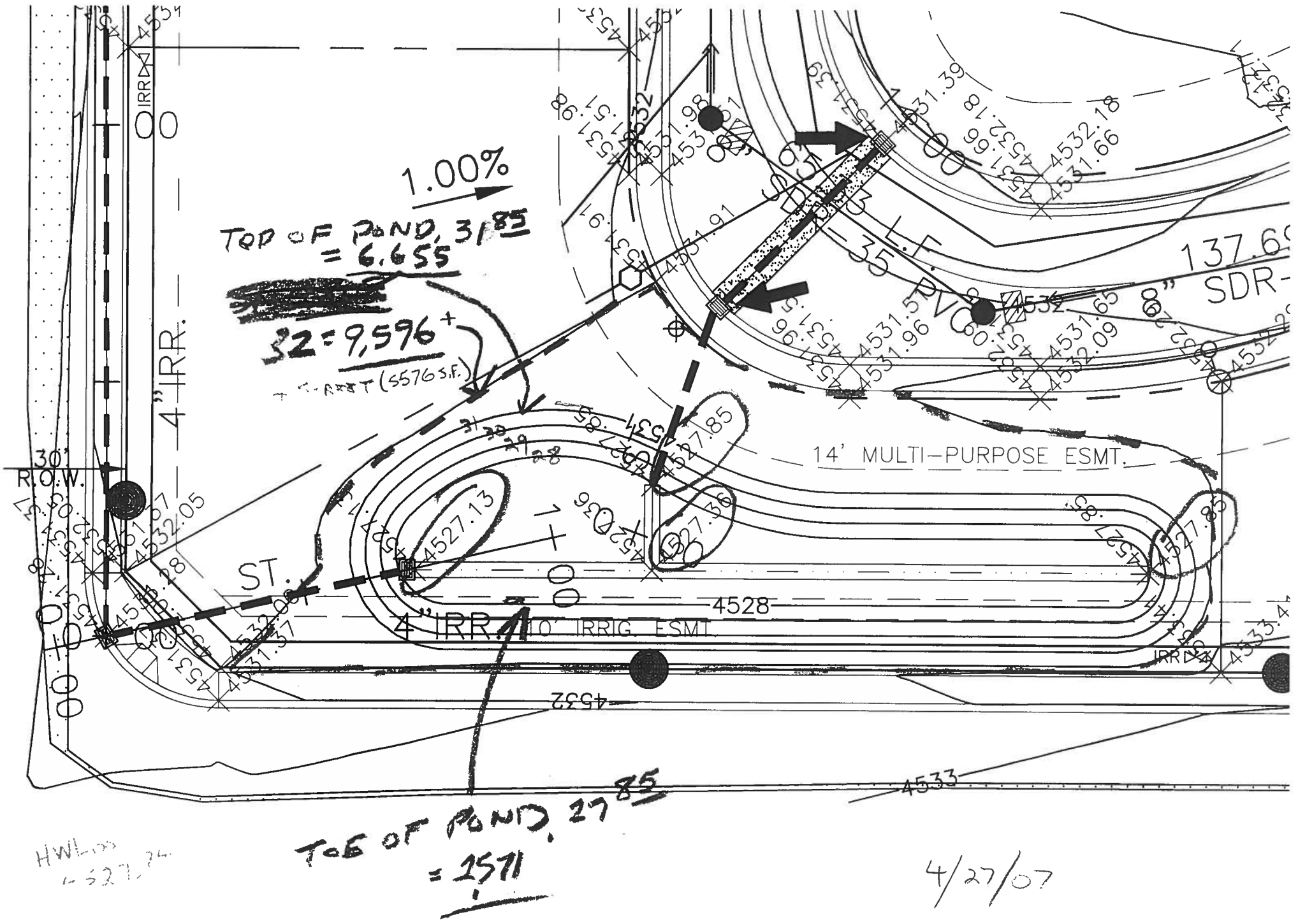
SCALES: PLAN 1" = 20' HORIZONTAL; PROFILE 1" = 20' HORIZONTAL, 1" = 5' VERTICAL

O'Connor Design Group, Inc.
2350 G Road
Grand Junction, Co. 81505
Phone: (970) 241-7125
Fax: (970) 241-7852

WOODLAND CREEK ESTATES
GRADING AND DRAINAGE PLAN


SITE
N
18
RCP
18
RCP
30
RCP
30
RCP
30
RCP
18
EY AVE
PINE ST
JAVAN CT
EXISTING STORM SEWERS
(OBTAINED FROM CITY ENGINEERING)
APRIL, '07


STORM SEWER C
FLOWFILL
STA. 0+47.38
TO STA. 0+92.90
STA. 0+92.90
(CEN. OF BOX)
STORM INLET A-2
N 71335.54
E 47430.59
STORM SEWER A
1.00%
2.00%
0.50%
4527.13
4527.85
4527.38
14' MULTI-PURPOSE ESMT.
10' IRRIG. ESMT.
30' R.O.W.
ST.
STA. 0+10.00 (B-1)
STA. 0+00.00 (C-1)
(CEN. OF BOX)
STORM INLET B-1/C-1
N 71238.17
E 47278.15
STORM SEWER B
STA. 0+70.66
(CEN. OF BOX)
DET. OUTLET STRUCT.
N 71251.41
E 47337.35
(SEE DETAIL, THIS SHEET)
STA. 0+47.38
(CEN. OF BOX)
STORM INLET A-1
N 71303.34
E 47398.39


1.00%
TOP OF POND 31.85
= 6.65
S2 = 9,596 +
4" IRR.
30' R.O.W.
ST.
14' MULTI-PURPOSE ESMT.
4528
10' IRRIG. ESMT
4532
4533
35 L.F.
8" SDR-
TOE OF POND 27.85
= 1571
HWL = 527.74
4/27/07

2

COEFFICIENTS

DO NOT USE THIS TABLE ALONE. USE IN CONJUNCTION WITH FIGURES "C-2" AND "C-3"[1]

Cover Description			Curve Numbers for Hydrologic Soil Group			
Cover Type	Treatment[2]	Hydrologic Condition[3]	A	B	C	D
Fallow	Bare soil	–	77	86	91	94
	Crop residue cover (CR)	Poor	76	85	90	93
		Good	74	83	88	90
Row crops	Straight row (SR) FURROW IRRIGATED	Poor	72	81	88	91
		Good	67	78	85	89
	SR + CR	Poor	71	80	87	90
		Good	94	75	82	85
	Contoured (C)	Poor	70	79	84	88
		Good	65	75	82	86
	C + CR	Poor	69	78	83	87
		Good	64	74	81	85
	Contoured & terraced (C&T)	Poor	66	74	80	82
		Good	62	71	78	81
	C&T + CR	Poor	65	73	79	81
		Good	61	70	77	80
Small grain	SR	Poor	65	76	84	88
		Good	63	75	83	87
	SR + CR	Poor	64	75	83	86
		Good	60	72	80	84
	C	Poor	63	74	82	85
		Good	61	73	81	84
	C + CR	Poor	62	73	81	84
		Good	60	72	80	83
	C&T	Poor	61	72	79	82
		Good	59	70	78	91
	C&T + CR	Poor	60	71	78	81
		Good	58	69	77	80
Close-seeded or broadcast legumes or rotation meadow	SR	Poor	66	77	85	89
		Good	58	72	81	85
	C	Poor	64	75	83	85
		Good	55	69	78	83
	C&T	Poor	63	76	80	83
		Good	51	67	76	80

[1]Average runoff condition, and $I_a = 0.28$.

[2]*Crop residue cover* applies only if residue is on at least 5% of the surface throughout the year.

[3]Hydrologic condition is based on combination of factors that affect infiltration and runoff, including (a) density and canopy of vegetative areas, the amount of year-round cover, (c) amount of grass or close-seeded legumes in rotations, (d) percent of residue cover on the land surface (good ≥ 20%), and (e) degree of surface roughness.

Poor: Factors impair infiltration and tend to increase runoff.
Good: Factors encourage average and better than average infiltration and tend to decrease runoff.

[Reproduced from TR-55 (SCS 1986)]

SCS CURVE NUMBERS: Preliminary Values for Cultivated Agricultural Lands

TABLE "C-2b"

DO NOT USE THIS TABLE ALONE. USE IN CONJUNCTION WITH FIGURES "C-2" AND "C-3"[1]

Cover Description Cover Type and Hydrologic Condition	Average Percent Impervious Area[2]	Curve Numbers for Hydrologic Soil Group A	B	C	D
Fully developed urban areas (vegetation established)					
Open space (lawns, parks, golf courses, cemeteries, etc.)[3]:					
Poor condition (grass cover < 50%)		68	79	86	89
Fair condition (grass cover 50% to 75%)		49	69	79	84
Good condition (grass cover > 50%)		39	61	74	80
Impervious areas:					
Paved parking lots, roofs, driveways, etc. (excluding right-of-way)		98	98	98	98
Streets and roads:					
Paved; curbs and storm sewers (excluding right-of-way)		98	98	98	98
Paved; open ditches (including right-of-way)		83	89	92	93
Gravel (including right-of-way) ..EXIST. DRIVEWAY.....		76	85	89	91
Dirt (including right-of-way)		72	82	87	89
Western desert urban areas:					
Natural desert landscaping (pervious areas only)[4]		63	77	85	88
Artificial desert landscaping (impervious weed barrier, desert shrub with 1- to 2-inch sand or gravel mulch and basin borders)		96	96	96	96
Urban districts:					
Commercial and business	85	89	92	94	95
Industrial	72	81	88	91	93
Residential districts by average lot size:					
1/8 acre or less (town houses)	65	77	85	90	92
1/4 acre	38	61	75	83	87
1/3 acre	30	57	72	81	86
1/2 acre	25	54	70	80	85
1 acre	20	51	68	79	84
2 acres	12	46	65	77	82
Developing urban areas					
Newly graded areas (pervious areas only, no vegetation)[5]		77	86	91	94
Idle lands (CNs are determined using cover types similar to those in Table "C-2C"		68	79	86	89

[1]Average runoff condition (ARC = II), and $I_a = 0.28$.

[2]The average percent impervious area shown was used to develop the composite CNs. Other assumptions are as follows: impervious areas are directly connected to the drainage system, impervious areas have a CN of 98, and pervious areas are considered equivalent to open space in good hydrologic condition. CNs for other combinations of conditions may be computed using Figure "C-3A" or "C-3B". See Figure "C-2" for more direction.

[3]CNs shown are equivalent to those of pasture. Composite CNs may be computed for other combinations of open space cover type.

[4]Composite CNs for natural desert landscaping should be computed using Figures "C-3A" or "C-3B" based on the impervious area percentage (CN = 98) and the pervious area CN. The pervious area CNs are assumed equivalent to desert shrub in poor hydrologic condition.

[5]Composite CNs to use for the design of temporary measures during grading and construction should be computed using Figures "C-3A" or "C-3B", based on the degree of development (impervious area percentage) and the CNs for the newly graded pervious areas.

[Reproduced from TR-55 (SCS 1986)]

SCS CURVE NUMBERS: Preliminary Values for Urban Areas

TABLE "C-2a"

RUNOFF CURVE NUMBER DATA

Soil/Surface Description	CN	Area acres	Impervious Adjustment %C	%UC	Adjusted CN
Row crops - Straight row (SR), good	78	13.340			78.00
Impervious Areas - Paved parking lo	98	.060			98.00
Impervious Areas - Gravel (w/ right	85	.090			85.00
COMPOSITE AREA & WEIGHTED CN --->		13.490			78.14 (78)

RUNOFF CURVE NUMBER DATA

Soil/Surface Description	CN	Area acres	Impervious Adjustment %C	%UC	Adjusted CN
Impervious Areas - Paved parking lo	98	3.220			98.00
Open space (Lawns,parks etc.) - Goo	61	2.480			61.00
Western Desert Urban Areas - Natura	77	1.090			77.00
COMPOSITE AREA & WEIGHTED CN --->		6.790			81.11 (81)

RUNOFF CURVE NUMBER DATA

Soil/Surface Description	CN	Area acres	Impervious Adjustment %C	Impervious Adjustment %UC	Adjusted CN
Impervious Areas - Paved parking lo	98	3.120			98.00
Open space (Lawns,parks etc.) - Goo	61	2.480			61.00
Western Desert Urban Areas - Natura	77	1.100			77.00
COMPOSITE AREA & WEIGHTED CN --->		6.700			80.86 (81)

Woodland Creek Drainage 4/07

Historic:

Site - ~~14.28 Ac.~~ (incl. 18+K) 13.49 Ac. (w/o 18+K ROW)

Roofs (House/Bldgs) - (40x40) + 15' silo + (30x10 Bldg) + (Patio 20x30)

Gravel Driveway - 250'x15'

Irrigated Pasture w/Furrows - Remainder

Roofs/Hardscape	- 2680 S.F.	@ CN = 98	0.06 Ac.
Drive	- 3750 S.F.	@ CN = 85	0.09 Ac.
Row Crops, Good Res.	- ~~14.13 Ac.~~ 13.34	@ CN = 78 to 75	14.13 Ac.

Comp. CN = 78 to 75

Soil-

Bc -	Billings Silty Clay Loam, 0-2% Slopes	(35 %)±	C
Ra -	Ravola Clay Loam, 0-2% Slopes	(65 %)±	B

Hydrologic Soil Groups B+C

Moderate to slow infiltration rates with moderate to rapid runoff potential.

DEVELOPED:

BASIN 10 - INTERNAL CORE, BLOCKS 2+3 (27 LOTS, INCL. 1 EXIST.)
BASIN 20 - PERIMITER, BLOCKS 1, 4, 5, +6 (27 LOTS + DET. + PED/TRAIL

BASIN 10: (295,825 S.F. = 6.79 AC.)

27 LOTS x (1700 S.F. HOUSE + 500 S.F. GARAGE + 200 S.F. PATIOS/WALKS + 100 S.F. SHED) = 27 X 2500 S.F. HARDSCAPE

+ 72,603 S.F. ASPH. + WALK (STREETS)

+ 27 x 4,000 S.F. (LAWN)

+ REMAINDER (NON-TURF LANDSCAPING)

⇒ 27 X 2500 = 67,500 S.F. = 1.55 AC. ROOFS } CN 98
72,603 S.F. = 1.67 AC. STREETS } 98
108,000 S.F. = 2.48 AC. LAWN 61
REMAINDER = 1.09 AC. NON-TURF LANDSC. 77
TOTAL 6.79 AC. @ COMP. CN = 81

t_c = 0.2935 HR

REACH 1: 4528.80 INV., N=0.012, 18", S=0.30%, 45.52 L.F.
REACH 2: 4528.66 INV., N=0.012, 18", S=2.18% 37.38 L.F.

DEVELOPED BASIN 20 (291,727 S.F. = 6.70 AC.)

		CN
27 LOTS X 2500 S.F. (ROOFS/ETC.)	1.55 AC.	98
+ 68,382 S.F. (STREETS)	1.57 AC.	98
+ 27 X 4000 S.F. (LAWN)	2.48 AC.	61
+ REMAINDER (NON-TURF LANDSC.)	1.10 AC.	77
	6.70 AC. @ COMP. CN = 81	

t_c = 0.3628 HR

POND:

4527.13 = 10 S.F.

4527.85 = 2571 SF

4531.85 = 6655 SF

V-NOTCH:

INV. 4527.13 C = 0.59 V = 15°

NOTE: THIS IS A REPRODUCTION OF TABLE I, APPENDIX A, "DESIGN CHARTS FOR OPEN CHANNEL FLOW", (HDS #3)

	Manning's n range [5]
I. Closed conduits:	
A. Concrete pipe	0.011–0.013
B. Corrugated-metal pipe or pipe-arch:	
1. 2⅔ by ½-in. corrugation (riveted pipe): [3]	
a. Plain or fully coated	0.024
b. Paved invert (range values are for 25 and 50 percent of circumference paved):	
(1) Flow full depth	0.021–0.018
(2) Flow 0.8 depth	0.021–0.016
(3) Flow 0.6 depth	0.019–0.013
2. 6 by 2-in. corrugation (field bolted)	0.03
C. Vitrified clay pipe	0.012–0.014
D. Cast-iron pipe, uncoated	0.013
E. Steel pipe	0.009–0.011
F. Brick	0.014–0.017
G. Monolithic concrete:	
1. Wood forms, rough	0.015–0.017
2. Wood forms, smooth	0.012–0.014
3. Steel forms	0.013–0.013
H. Cemented rubble masonry walls:	
1. Concrete floor and top	0.017–0.022
2. Natural floor	0.019–0.025
I. Laminated treated wood	0.015–0.017
J. Vitrified clay liner plates	0.015
II. Open channels, lined [4] (straight alinement): [3]	
A. Concrete, with surfaces as indicated:	
1. Formed, no finish	0.013–0.017
2. Trowel finish	0.013–0.014
3. Float finish	0.013–0.015
4. Float finish, some gravel on bottom	0.015–0.017
5. Gunite, good section	0.016–0.019
6. Gunite, wavy section	0.018–0.022
B. Concrete, bottom float finished, sides as indicated:	
1. Dressed stone in mortar	0.015–0.017
2. Random stone in mortar	0.017–0.020
3. Cement rubble masonry	0.020–0.025
4. Cement rubble masonry, plastered	0.016–0.020
5. Dry rubble (riprap)	0.020–0.030
C. Gravel bottom, sides as indicated:	
1. Formed concrete	0.017–0.020
2. Random stone in mortar	0.020–0.023
3. Dry rubble (riprap)	0.023–0.033
D. Brick	0.014–0.017
E. Asphalt:	
1. Smooth	0.013
2. Rough	0.016
F. Wood, planed, clean	0.011–0.013
G. Concrete-lined excavated rock:	
1. Good section	0.017–0.020
2. Irregular section	0.022–0.027
III. Open channels, excavated [4] (straight alinement,[3] natural lining):	
A. Earth, uniform section:	
1. Clean, recently completed	0.016–0.018
2. Clean, after weathering	0.018–0.020
3. With short grass, few weeds	0.022–0.027
4. In gravelly soil, uniform section, clean	0.022–0.025
B. Earth, fairly uniform section:	
1. No vegetation	0.022–0.025
2. Grass, some weeds	0.025–0.030
3. Dense weeds or aquatic plants in deep channels	0.030–0.035
4. Sides clean, gravel bottom	0.025–0.030
5. Sides clean, cobble bottom	0.030–0.040
C. Dragline excavated or dredged:	
1. No vegetation	0.028–0.033
2. Light brush on banks	0.035–0.050
D. Rock:	
1. Based on design section	0.035
2. Based on actual mean section:	
a. Smooth and uniform	0.035–0.040
b. Jagged and irregular	0.040–0.045
E. Channels not maintained, weeds and brush uncut:	
1. Dense weeds, high as flow depth	0.08–0.12
2. Clean bottom, brush on sides	0.05–0.08
3. Clean bottom, brush on sides, highest stage of flow	0.07–0.11
4. Dense brush, high stage	0.10–0.14
IV. Highway channels and swales with maintained vegetation [6 7] (values shown are for velocities of 2 and 6 f.p.s.):	
A. Depth of flow up to 0.7 foot:	
1. Bermudagrass, Kentucky bluegrass, buffalograss:	
a. Mowed to 2 inches	0.07–0.045
b. Length 4–6 inches	0.09–0.05
2. Good stand, any grass:	
a. Length about 12 inches	0.15–0.09
b. Length about 24 inches	0.30–0.15
3. Fair stand, any grass:	
a. Length about 12 inches	0.14–0.08
b. Length about 24 inches	0.25–0.13
B. Depth of flow 0.7–1.5 feet:	
1. Bermudagrass, Kentucky bluegrass, buffalograss:	
a. Mowed to 2 inches	0.05–0.035
b. Length 4 to 6 inches	0.06–0.04
2. Good stand, any grass:	
a. Length about 12 inches	0.13–0.07
b. Length about 24 inches	0.20–0.10
3. Fair stand, any grass:	
a. Length about 12 inches	0.10–0.06
b. Length about 24 inches	0.17–0.09
V. Street and expressway gutters:	
A. Concrete gutter, troweled finish	0.012
B. Asphalt pavement:	
1. Smooth texture	0.013
2. Rough texture	0.016
C. Concrete gutter with asphalt pavement:	
1. Smooth	0.013
2. Rough	0.015
D. Concrete pavement:	
1. Float finish	0.014
2. Broom finish	0.016
E. For gutters with small slope, where sediment may accumulate, increase above values of n by	*0.002*
VI. Natural stream channels:[8]	
A. Minor streams [9] (surface width at flood stage less than 100 ft.):	
1. Fairly regular section:	
a. Some grass and weeds, little or no brush	0.030–0.035
b. Dense growth of weeds, depth of flow materially greater than weed height	0.035–0.05
c. Some weeds, light brush on banks	0.035–0.05
d. Some weeds, heavy brush on banks	0.05–0.07
e. Some weeds, dense willows on banks	0.06–0.08
f. For trees within channel, with branches submerged at high stage, increase all above values by	*0.01–0.02*
2. Irregular sections, with pools, slight channel meander; increase values given in 1a–e about	*0.01–0.02*
3. Mountain streams, no vegetation in channel, banks usually steep, trees and brush along banks submerged at high stage:	
a. Bottom of gravel, cobbles, and few boulders	0.04–0.05
b. Bottom of cobbles, with large boulders	0.05–0.07
B. Flood plains (adjacent to natural streams):	
1. Pasture, no brush:	
a. Short grass	0.030–0.035
b. High grass	0.035–0.05
2. Cultivated areas:	
a. No crop	0.03–0.04
b. Mature row crops	0.035–0.045
c. Mature field crops	0.04–0.05
3. Heavy weeds, scattered brush	0.05–0.07
4. Light brush and trees: [10]	
a. Winter	0.05–0.06
b. Summer	0.06–0.08
5. Medium to dense brush: [10]	
a. Winter	0.07–0.11
b. Summer	0.10–0.16
6. Dense willows, summer, not bent over by current	0.15–0.20
7. Cleared land with tree stumps, 100–150 per acre:	
a. No sprouts	0.04–0.05
b. With heavy growth of sprouts	0.06–0.08
8. Heavy stand of timber, a few down trees, little undergrowth:	
a. Flood depth below branches	0.10–0.12
b. Flood depth reaches branches	0.12–0.16
C. Major streams (surface width at flood stage more than 100 ft.): Roughness coefficient is usually less than for minor streams of similar description on account of less effective resistance offered by irregular banks or vegetation on banks. Values of n may be somewhat reduced. Follow recommendation in publication cited [8] if possible. The value of n for larger streams of most regular section, with no boulders or brush, may be in the range of	0.028–0.033

TYPICAL MANNING BASE "n" VALUES | **TABLE "F-1a"**

3

TIMES OF CONCENTRATION

::
TIME OF CONCENTRATION CALCULATOR
::

Segment #1: Tc: TR-55 Sheet

Mannings n	.0300
Hydraulic Length	300.00 ft
2yr, 24hr P	.7000 in
Slope	.007500 ft/ft
Avg.Velocity	.24 ft/sec

Segment #1 Time: .3435 hrs

Segment #2: Tc: TR-55 Shallow

Hydraulic Length	650.00 ft
Slope	.007500 ft/ft
Unpaved	
Avg.Velocity	1.40 ft/sec

Segment #2 Time: .1292 hrs

Segment #3: Tc: TR-55 Channel

Flow Area	1.0000 sq.ft
Wetted Perimeter	3.00 ft
Hydraulic Radius	.33 ft
Slope	.007500 ft/ft
Mannings n	.0300
Hydraulic Length	600.00 ft
Avg.Velocity	2.07 ft/sec

Segment #3 Time: .0806 hrs

==========
Total Tc: .5533 hrs
==========

::
TIME OF CONCENTRATION CALCULATOR
::

Segment #1: Tc: TR-55 Sheet

Mannings n	.0400
Hydraulic Length	80.00 ft
2yr, 24hr P	.7000 in
Slope	.010000 ft/ft
Avg.Velocity	.17 ft/sec

Segment #1 Time: .1339 hrs

Segment #2: Tc: TR-55 Channel

Flow Area	4.0000 sq.ft
Wetted Perimeter	25.00 ft
Hydraulic Radius	.16 ft
Slope	.005000 ft/ft
Mannings n	.0170
Hydraulic Length	1050.00 ft
Avg.Velocity	1.83 ft/sec

Segment #2 Time: .1597 hrs

==========
Total Tc: .2935 hrs
==========

::
TIME OF CONCENTRATION CALCULATOR
::

Segment #1: Tc: TR-55 Sheet

Mannings n	.0400
Hydraulic Length	110.00 ft
2yr, 24hr P	.7000 in
Slope	.010000 ft/ft
Avg.Velocity	.18 ft/sec

Segment #1 Time: .1727 hrs

Segment #2: Tc: TR-55 Channel

Flow Area	4.0000 sq.ft
Wetted Perimeter	25.00 ft
Hydraulic Radius	.16 ft
Slope	.005000 ft/ft
Mannings n	.0170
Hydraulic Length	1250.00 ft
Avg.Velocity	1.83 ft/sec

Segment #2 Time: .1901 hrs

Total Tc: .3628 hrs

4

RUNOFF - HISTORIC

MASTER DESIGN STORM SUMMARY

Network Storm Collection: Mesa County SCS

Return Event	Total Depth in	Rainfall Type	RNF ID
2	.7000	Synthetic Curve	TypeII 24hr
100	2.0100	Synthetic Curve	TypeII 24hr

MASTER NETWORK SUMMARY
SCS Unit Hydrograph Method

(*Node=Outfall; +Node=Diversion;)
(Trun= HYG Truncation: Blank=None; L=Left; R=Rt; LR=Left&Rt)

Node ID	Type	Return Event	HYG Vol ac-ft	Trun	Qpeak hrs	Qpeak cfs	Max WSEL ft	Max Pond Storage ac-ft
HISTORIC SITE	AREA	2	.007		15.8000	.01		
HISTORIC SITE	AREA	100	.551		12.2500	4.50		
*OUT 10	JCT	2	.007		15.8000	.01		
*OUT 10	JCT	100	.551		12.2500	4.50		

SCS UNIT HYDROGRAPH METHOD

STORM EVENT: 100 year storm
Duration = 24.0000 hrs Rain Depth = 2.0100 in
Rain Dir = C:\Documents and Settings\Pat\My Documents\Stormwater\
Rain File -ID = - TypeII 24hr
Unit Hyd Type = Default Curvilinear
HYG Dir = C:\Documents and Settings\Pat\My Documents\Stormwater\
HYG File - ID = - HISTORIC SITE 100
Tc = .5533 hrs
Drainage Area = 13.490 acres Runoff CN= 78

==========
Computational Time Increment = .07377 hrs
Computed Peak Time = 12.2466 hrs
Computed Peak Flow = 4.51 cfs

Time Increment for HYG File = .0500 hrs
Peak Time, Interpolated Output = 12.2500 hrs
Peak Flow, Interpolated Output = 4.50 cfs
==========

DRAINAGE AREA

ID:HISTORIC SITE
CN = 78
Area = 13.490 acres
S = 2.8205 in
0.2S = .5641 in

Cumulative Runoff

.4900 in
.551 ac-ft

HYG Volume... .551 ac-ft (area under HYG curve)

***** SCS UNIT HYDROGRAPH PARAMETERS *****

Time Concentration, Tc = .55331 hrs (ID: HISTORIC SITE)
Computational Incr, Tm = .07377 hrs = 0.20000 Tp

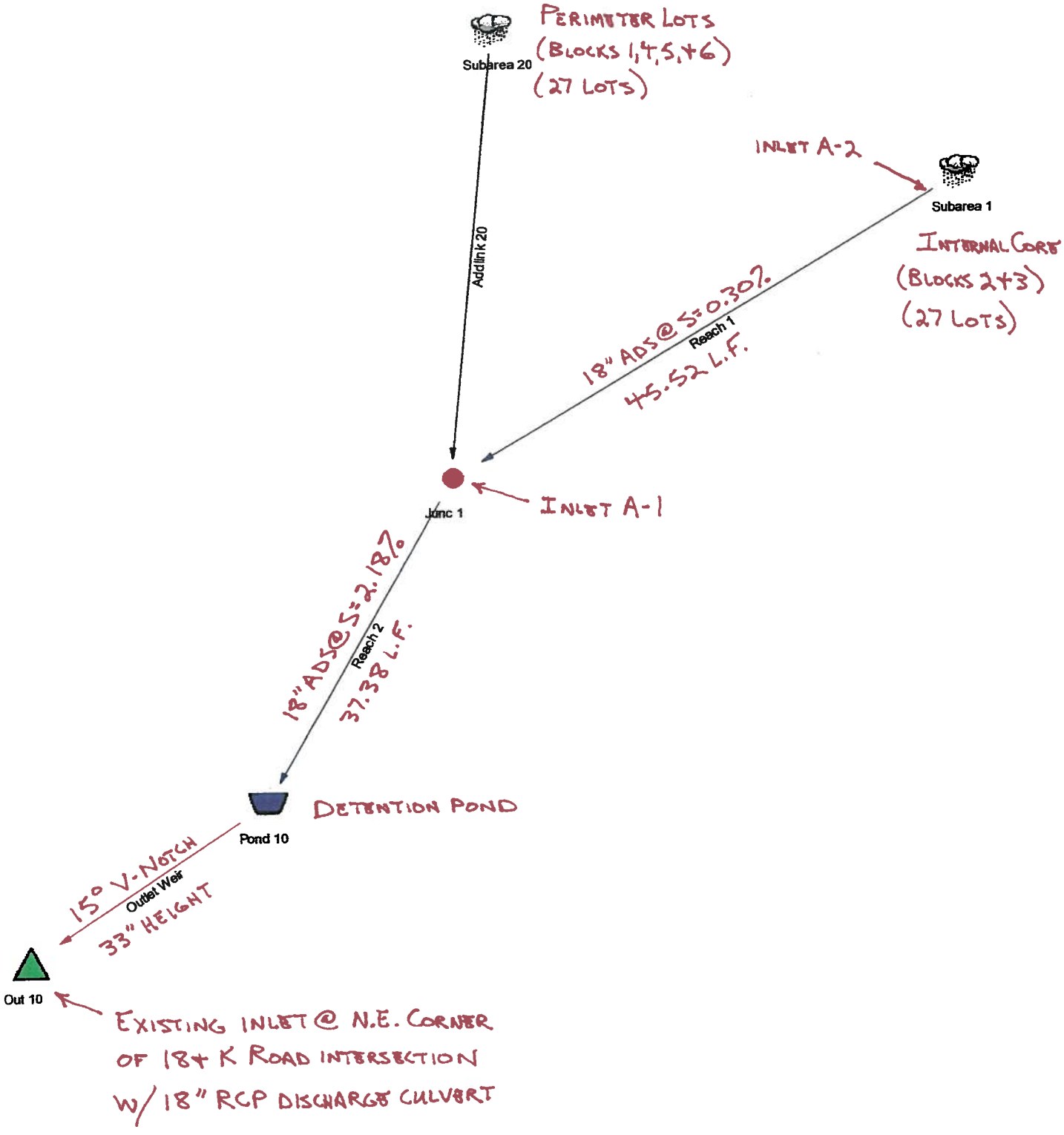
Unit Hyd. Shape Factor = 483.432 (37.46% under rising limb)
K = 483.43/645.333, K = .7491 (also, K = 2/(1+(Tr/Tp))
Receding/Rising, Tr/Tp = 1.6698 (solved from K = .7491)

Unit peak, qp = 27.62 cfs
Unit peak time Tp = .36887 hrs
Unit receding limb, Tr = 1.47550 hrs
Total unit time, Tb = 1.84437 hrs

5

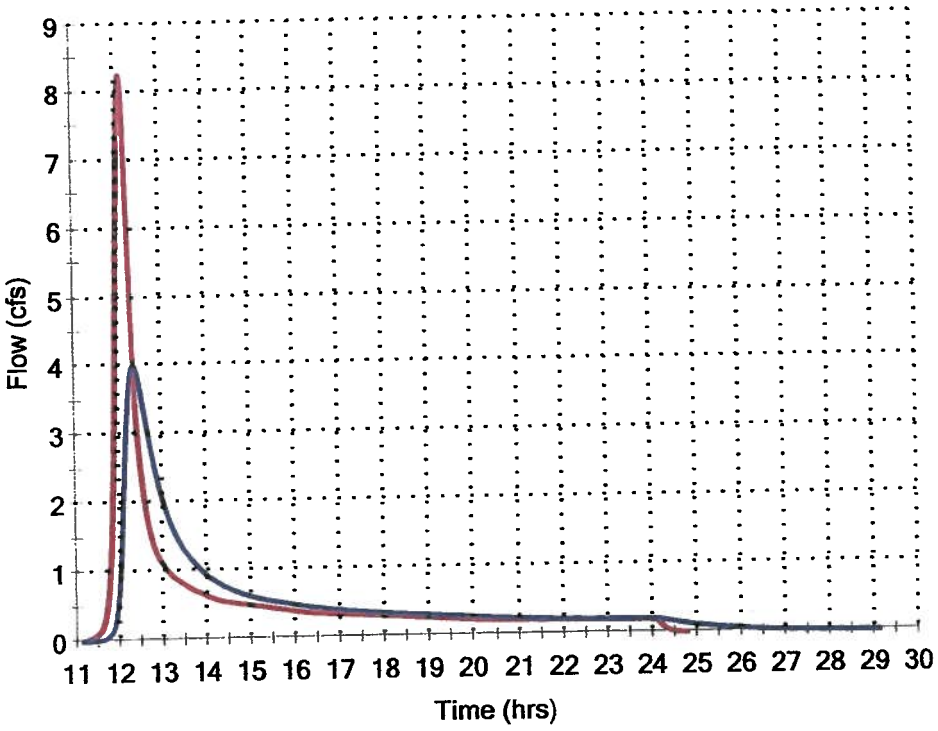
RUNOFF - DEVELOPED

Hydraulic Schematic - Developed Site



Woodland Creek Estates

Developed Hydrograpn
POND 10 IN vs. OUT 100-yr



LEGEND:
POND 10 IN 100
POND 10 OUT 100

LEVEL POOL ROUTING SUMMARY

HYG Dir = C:\Documents and Settings\Pat\My Documents\Stormwater\
Inflow HYG file = NONE STORED - POND 10 IN 100
Outflow HYG file = NONE STORED - POND 10 OUT 100

Pond Node Data = POND 10
Pond Volume Data = POND 10
Pond Outlet Data = Outlet v15

No Infiltration

INITIAL CONDITIONS

Starting WS Elev	=	4527.13 ft
Starting Volume	=	0 cu.ft
Starting Outflow	=	.00 cfs
Starting Infiltr.	=	.00 cfs
Starting Total Qout	=	.00 cfs
Time Increment	=	.0100 hrs

INFLOW/OUTFLOW HYDROGRAPH SUMMARY

Peak Inflow	=	8.27 cfs	at	12.1000 hrs
Peak Outflow	=	4.01 cfs	at	12.3400 hrs
Peak Elevation	=	4529.84 ft		
Peak Storage	=	7460 cu.ft		

MASS BALANCE (cu.ft)

+ Initial Vol	=	0
+ HYG Vol IN	=	29912
- Infiltration	=	0
- HYG Vol OUT	=	29901
- Retained Vol	=	2
Unrouted Vol	=	-9 cu.ft (.029% of Inflow Volume)

MASTER DESIGN STORM SUMMARY

Network Storm Collection: Mesa County SCS

Return Event	Total Depth in	Rainfall Type	RNF ID
2	.7000	Synthetic Curve	TypeII 24hr
100	2.0100	Synthetic Curve	TypeII 24hr

MASTER NETWORK SUMMARY
SCS Unit Hydrograph Method

(*Node=Outfall; +Node=Diversion;)
(Trun= HYG Truncation: Blank=None; L=Left; R=Rt; LR=Left&Rt)

Node ID		Type	Return Event	HYG Vol cu.ft	Trun	Qpeak hrs	Qpeak cfs	Max WSEL ft	Max Pond Storage cu.ft
JUNC 1		JCT	2	1012		12.8200	.03		
JUNC 1		JCT	100	29912		12.1000	8.28		
*OUT 10		JCT	2	1001		14.1400	.03		
*OUT 10		JCT	100	29901		12.3400	4.01		
POND 10	IN	POND	2	1012		12.8400	.03		
POND 10	IN	POND	100	29912		12.1000	8.27		
POND 10	OUT	POND	2	1001		14.9800	.03	4527.47	86
POND 10	OUT	POND	100	29901		12.3400	4.01	4529.84	7460
SUBAREA 10		AREA	2	509		12.8600	.02		
SUBAREA 10		AREA	100	15056		12.0900	4.43		
SUBAREA 20		AREA	2	502		12.9700	.02		
SUBAREA 20		AREA	100	14857		12.1400	3.91		

LEVEL POOL ROUTING DATA

HYG Dir = C:\Documents and Settings\Pat\My Documents\Stormwater\
Inflow HYG file = NONE STORED - POND 10 IN 2
Outflow HYG file = NONE STORED - POND 10 OUT 2

Pond Node Data = POND 10
Pond Volume Data = POND 10
Pond Outlet Data = Outlet v15

No Infiltration

INITIAL CONDITIONS

Starting WS Elev = 4527.13 ft
Starting Volume = 0 cu.ft
Starting Outflow = .00 cfs
Starting Infiltr. = .00 cfs
Starting Total Qout= .00 cfs
Time Increment = .0100 hrs

Elevation ft	Outflow cfs	Storage cu.ft	Area sq.ft	Infilt. cfs	Q Total cfs	2S/t + O cfs
4527.13	.00	0	10	.00	.00	.00
4527.38	.01	38	387	.00	.01	2.13
4527.63	.06	239	1308	.00	.06	13.32
4527.88	.16	735	2594	.00	.16	41.00
4528.13	.33	1409	2795	.00	.33	78.58
4528.38	.58	2133	3002	.00	.58	119.08
4528.63	.92	2910	3218	.00	.92	162.60
4528.88	1.35	3742	3440	.00	1.35	209.26
4529.13	1.88	4631	3670	.00	1.88	259.16
4529.38	2.52	5578	3908	.00	2.52	312.42
4529.63	3.28	6586	4153	.00	3.28	369.15
4529.88	4.17	7655	4405	.00	4.17	429.45
4530.13	5.18	8789	4665	.00	5.18	493.45
4530.38	6.33	9988	4932	.00	6.33	561.23
4530.63	7.62	11256	5207	.00	7.62	632.93
4530.88	9.05	12592	5489	.00	9.05	708.63
4531.13	10.63	14001	5779	.00	10.63	788.46
4531.38	12.37	15483	6076	.00	12.37	872.52
4531.63	14.28	17039	6381	.00	14.28	960.91
4531.85	16.09	18475	6655	.00	16.09	1042.46

SCS UNIT HYDROGRAPH METHOD

STORM EVENT: 100 year storm
Duration = 24.0000 hrs Rain Depth = 2.0100 in
Rain Dir = C:\Documents and Settings\Pat\My Documents\Stormwater\
Rain File -ID = - TypeII 24hr
Unit Hyd Type = Default Curvilinear
HYG Dir = C:\Documents and Settings\Pat\My Documents\Stormwater\
HYG File - ID = - SUBAREA 10 100
Tc = .2935 hrs
Drainage Area = 6.790 acres Runoff CN= 81

==========

Computational Time Increment	=	.03914 hrs
Computed Peak Time	=	12.0941 hrs
Computed Peak Flow	=	4.44 cfs
Time Increment for HYG File	=	.0100 hrs
Peak Time, Interpolated Output	=	12.0902 hrs
Peak Flow, Interpolated Output	=	4.43 cfs

==========

DRAINAGE AREA

ID:SUBAREA 10
CN = 81
Area = 6.790 acres
S = 2.3457 in
0.2S = .4691 in

Cumulative Runoff

.6109 in
15057 cu.ft

HYG Volume... 15056 cu.ft (area under HYG curve)

***** SCS UNIT HYDROGRAPH PARAMETERS *****

Time Concentration, Tc = .29355 hrs (ID: SUBAREA 10)
Computational Incr, Tm = .03914 hrs = 0.20000 Tp

Unit Hyd. Shape Factor = 483.432 (37.46% under rising limb)
K = 483.43/645.333, K = .7491 (also, K = 2/(1+(Tr/Tp))
Receding/Rising, Tr/Tp = 1.6698 (solved from K = .7491)

Unit peak,	qp =	26.21 cfs
Unit peak time	Tp =	.19570 hrs
Unit receding limb,	Tr =	.78279 hrs
Total unit time,	Tb =	.97849 hrs

SCS UNIT HYDROGRAPH METHOD

STORM EVENT: 100 year storm
Duration = 24.0000 hrs Rain Depth = 2.0100 in
Rain Dir = C:\Documents and Settings\Pat\My Documents\Stormwater\
Rain File -ID = - TypeII 24hr
Unit Hyd Type = Default Curvilinear
HYG Dir = C:\Documents and Settings\Pat\My Documents\Stormwater\
HYG File - ID = - SUBAREA 20 100
Tc = .3628 hrs
Drainage Area = 6.700 acres Runoff CN= 81

==========
Computational Time Increment = .04837 hrs
Computed Peak Time = 12.1418 hrs
Computed Peak Flow = 3.91 cfs

Time Increment for HYG File = .0100 hrs
Peak Time, Interpolated Output = 12.1402 hrs
Peak Flow, Interpolated Output = 3.91 cfs
==========

DRAINAGE AREA

ID:SUBAREA 20
CN = 81
Area = 6.700 acres
S = 2.3457 in
0.2S = .4691 in

Cumulative Runoff

.6109 in
14858 cu.ft

HYG Volume... 14857 cu.ft (area under HYG curve)

***** SCS UNIT HYDROGRAPH PARAMETERS *****

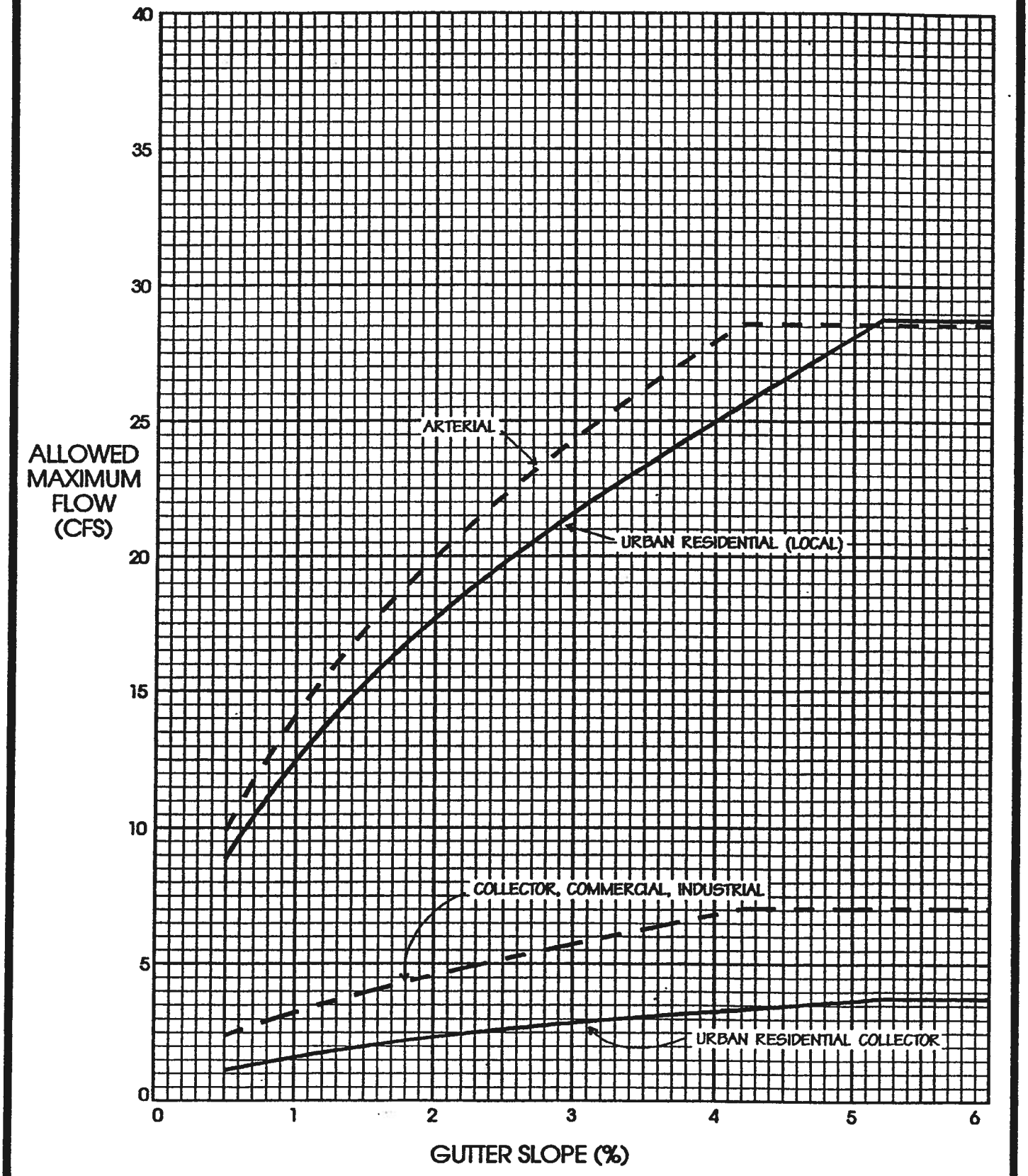
Time Concentration, Tc = .36280 hrs (ID: SUBAREA 20)
Computational Incr, Tm = .04837 hrs = 0.20000 Tp

Unit Hyd. Shape Factor = 483.432 (37.46% under rising limb)
K = 483.43/645.333, K = .7491 (also, K = 2/(1+(Tr/Tp))
Receding/Rising, Tr/Tp = 1.6698 (solved from K = .7491)

Unit peak, qp = 20.92 cfs
Unit peak time Tp = .24187 hrs
Unit receding limb, Tr = .96747 hrs
Total unit time, Tb = 1.20934 hrs

6

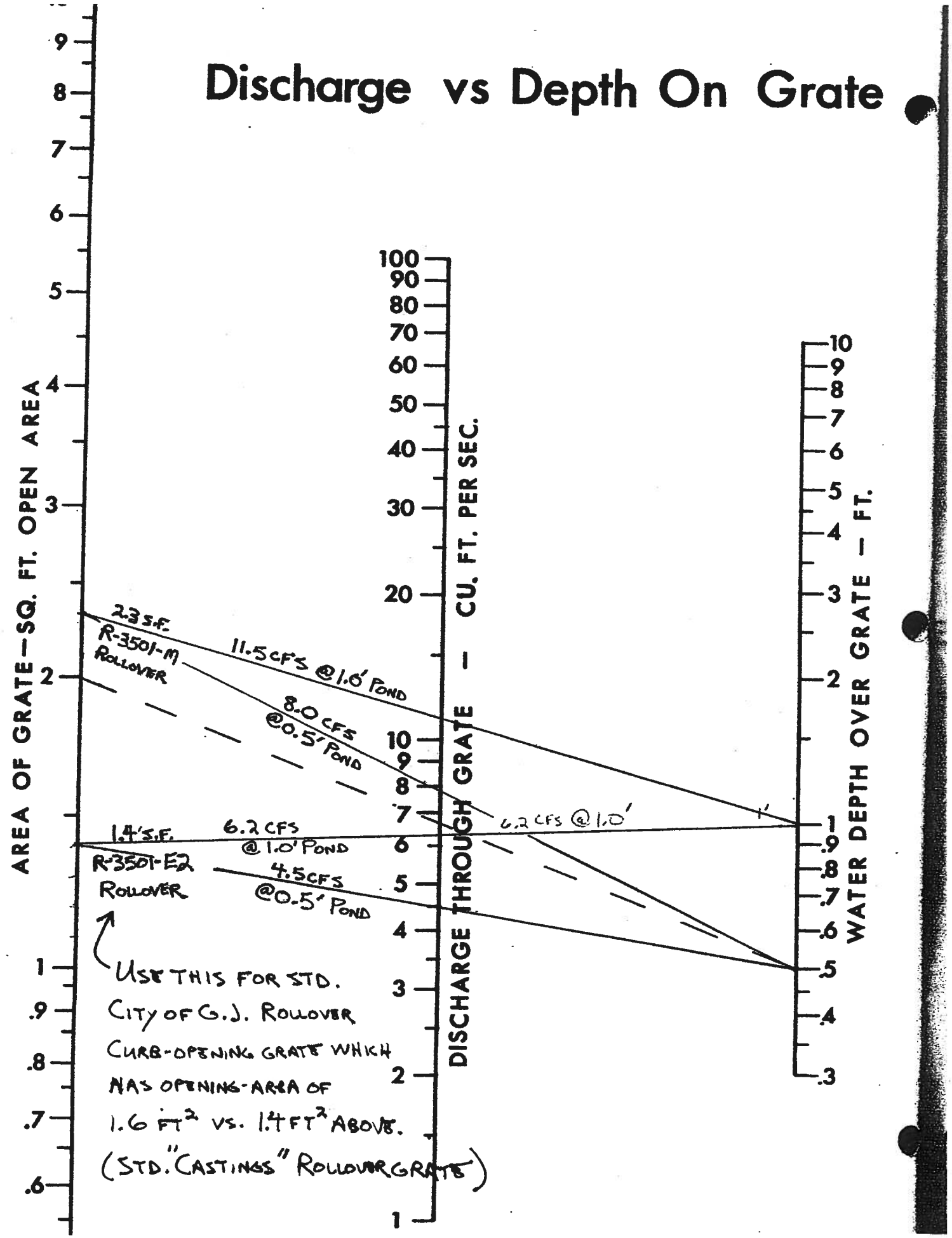
HYDRAULICS



MAXIMUM HALF STREET FLOWS (Sx=2%, n=0.016)

FIGURE "G-5"

Discharge vs Depth On Grate



Elevation (ft)	Planimeter (sq.in)	Area (sq.ft)	A1+A2+sqr(A1*A2) (sq.ft)	Volume (cu.ft)	Volume Sum (cu.ft)
4527.13	-----	10	0	0	0
4527.85	-----	2571	2741	658	658
4531.85	-----	6655	13362	17817	18475

POND VOLUME EQUATIONS

* Incremental volume computed by the Conic Method for Reservoir Volumes.

Volume = (1/3) * (EL2-EL1) * (Area1 + Area2 + sq.rt.(Area1*Area2))

where: EL1, EL2 = Lower and upper elevations of the increment
Area1,Area2 = Areas computed for EL1, EL2, respectively
Volume = Incremental volume between EL1 and EL2

OUTLET STRUCTURE INPUT DATA

Structure ID = W1
Structure Type = Weir-Vnotch

# of Openings = 1
Notch Elev. = 4527.13 ft
Notch Angle = 15.000 degrees
Weir Coeff. = .590000

Weir TW effects (Use adjustment equation)

Structure ID = TW
Structure Type = TW SETUP, DS Channel

FREE OUTFALL CONDITIONS SPECIFIED

CONVERGENCE TOLERANCES...
Maximum Iterations= 40
Min. TW tolerance = .01 ft
Max. TW tolerance = .01 ft
Min. HW tolerance = .01 ft
Max. HW tolerance = .01 ft
Min. Q tolerance = .00 cfs
Max. Q tolerance = .00 cfs

***** COMPOSITE OUTFLOW SUMMARY ****

WS Elev, Total Q		Converge		Notes
Elev. ft	Q cfs	TW Elev ft	Error +/-ft	Contributing Structures
4527.13	.00	Free Outfall		W1
4527.38	.01	Free Outfall		W1
4527.63	.06	Free Outfall		W1
4527.88	.16	Free Outfall		W1
4528.13	.33	Free Outfall		W1
4528.38	.58	Free Outfall		W1
4528.63	.92	Free Outfall		W1
4528.88	1.35	Free Outfall		W1
4529.13	1.88	Free Outfall		W1
4529.38	2.52	Free Outfall		W1
4529.63	3.28	Free Outfall		W1
4529.88	4.17	Free Outfall		W1
4530.13	5.18	Free Outfall		W1
4530.38	6.33	Free Outfall		W1
4530.63	7.62	Free Outfall		W1
4530.88	9.05	Free Outfall		W1
4531.13	10.63	Free Outfall		W1
4531.38	12.37	Free Outfall		W1
4531.63	14.28	Free Outfall		W1
4531.85	16.09	Free Outfall		W1

18" ADS CULVERT UNDER STREET TO 2ND INLET @ S = 0.30%

Worksheet for Circular Pipe - 1

STORM SEWER A

Project Description		
Flow Element:	Circular Pipe	
Friction Method:	Manning Formula	
Solve For:	Discharge	
Input Data		
Roughness Coefficient:	0.012	
Channel Slope:	0.00300	ft/ft
Normal Depth:	1.50	ft
Diameter:	1.50	ft
Results		
Discharge:	6.23	ft^3/s ← 6.23 CFS
Flow Area:	1.77	ft^2
Wetted Perimeter:	4.71	ft
Top Width:	0.00	ft
Critical Depth:	0.97	ft
Percent Full:	100.0	%
Critical Slope:	0.00540	ft/ft
Velocity:	3.53	ft/s
Velocity Head:	0.19	ft
Specific Energy:	1.69	ft
Froude Number:	0.00	
Maximum Discharge:	6.70	ft^3/s
Discharge Full:	6.23	ft^3/s
Slope Full:	0.00300	ft/ft
Flow Type:	SubCritical	
GVF Input Data		
Downstream Depth:	0.00	ft
Length:	0.00	ft
Number Of Steps:	0	
GVF Output Data		
Upstream Depth:	0.00	ft
Profile Description:	N/A	
Profile Headloss:	0.00	ft
Average End Depth Over Rise:	0.00	%
Normal Depth Over Rise:	0.00	%
Downstream Velocity:	0.00	ft/s

Design Q_{100} = 4.43cfs

STORM LINE "A"

18" ADS CULVERT ~~UNDER STREET TO~~ FROM 2ND INLET TO POND @ S= 2.18% (INTO EMPTY POND) W/NO HEAD

NOTE: AVAIL. HEAD ≤ 0.85' (GUTTER FL TO TOP OF POND) ∴ S= 2.27% W/POND FULL UTILIZING AVAIL. HEAD. THEREFORE O.K.

Worksheet for Circular Pipe - 2

Project Description	WOODLAND	
Flow Element:	Circular Pipe	
Friction Method:	Manning Formula	
Solve For:	Discharge	
Input Data		
Roughness Coefficient:	0.012	
Channel Slope:	0.02180	ft/ft
Normal Depth:	1.50	ft
Diameter:	1.50	ft
Results		
Discharge:	16.80	ft^3/s ← 16.80 CFS
Flow Area:	1.77	ft^2
Wetted Perimeter:	4.71	ft
Top Width:	0.00	ft
Critical Depth:	1.44	ft
Percent Full:	100.0	%
Critical Slope:	0.01896	ft/ft
Velocity:	9.51	ft/s
Velocity Head:	1.40	ft
Specific Energy:	2.90	ft
Froude Number:	0.00	
Maximum Discharge:	18.07	ft^3/s
Discharge Full:	16.80	ft^3/s
Slope Full:	0.02180	ft/ft
Flow Type:	SubCritical	
GVF Input Data		
Downstream Depth:	0.00	ft
Length:	0.00	ft
Number Of Steps:	0	
GVF Output Data		
Upstream Depth:	0.00	ft
Profile Description:	N/A	
Profile Headloss:	0.00	ft
Average End Depth Over Rise:	0.00	%
Normal Depth Over Rise:	0.00	%
Downstream Velocity:	0.00	ft/s

Design Q_{100} = 8.34 cfs

Basin 10 = 4.43

Basin 20 = 3.91

Combined = 8.34 cfs

15" ADS DRAIN FROM POND TO EXISTING CULVERT @ S=0.40%

STORM SEWER "B"

Worksheet for Circular Pipe - 3

Project Description	WOODLAND	
Flow Element:	Circular Pipe	
Friction Method:	Manning Formula	
Solve For:	Discharge	
Input Data		
Roughness Coefficient:	0.012	
Channel Slope:	0.00400	ft/ft
Normal Depth:	1.25	ft
Diameter:	1.25	ft
Results		
Discharge:	4.43	ft^3/s ← 4.43 CFS
Flow Area:	1.23	ft^2
Wetted Perimeter:	3.93	ft
Top Width:	0.00	ft
Critical Depth:	0.85	ft
Percent Full:	100.0	%
Critical Slope:	0.00612	ft/ft
Velocity:	3.61	ft/s
Velocity Head:	0.20	ft
Specific Energy:	1.45	ft
Froude Number:	0.00	
Maximum Discharge:	4.76	ft^3/s
Discharge Full:	4.43	ft^3/s
Slope Full:	0.00400	ft/ft
Flow Type:	SubCritical	
GVF Input Data		
Downstream Depth:	0.00	ft
Length:	0.00	ft
Number Of Steps:	0	
GVF Output Data		
Upstream Depth:	0.00	ft
Profile Description:	N/A	
Profile Headloss:	0.00	ft
Average End Depth Over Rise:	0.00	%
Normal Depth Over Rise:	0.00	%
Downstream Velocity:	0.00	ft/s

Design release = 4.01 cfs

12" ADS DRAIN IN PINE ST. @ 0.48%

STORM SEWER "C"

Worksheet for Circular Pipe - 4

Project Description	WOODLAND	
Flow Element:	Circular Pipe	
Friction Method:	Manning Formula	
Solve For:	Discharge	
Input Data		
Roughness Coefficient:	0.012	
Channel Slope:	0.00480	ft/ft
Normal Depth:	1.00	ft
Diameter:	1.00	ft
Results		
Discharge:	2.67	ft^3/s ← 2.67 CFS
Flow Area:	0.79	ft^2
Wetted Perimeter:	3.14	ft
Top Width:	0.00	ft
Critical Depth:	0.70	ft
Percent Full:	100.0	%
Critical Slope:	0.00682	ft/ft
Velocity:	3.40	ft/s
Velocity Head:	0.18	ft
Specific Energy:	1.18	ft
Froude Number:	0.00	
Maximum Discharge:	2.88	ft^3/s
Discharge Full:	2.67	ft^3/s
Slope Full:	0.00480	ft/ft
Flow Type:	SubCritical	
GVF Input Data		
Downstream Depth:	0.00	ft
Length:	0.00	ft
Number Of Steps:	0	
GVF Output Data		
Upstream Depth:	0.00	ft
Profile Description:	N/A	
Profile Headloss:	0.00	ft
Average End Depth Over Rise:	0.00	%
Normal Depth Over Rise:	0.00	%
Downstream Velocity:	0.00	ft/s

EXISTING 18" RCP CULVERT UNDER 18 ROAD
@ S = 1.00% (ESTIMATED HYDRAULIC SLOPE)

Worksheet for Circular Pipe - 5

Project Description		
Flow Element:	Circular Pipe	
Friction Method:	Manning Formula	
Solve For:	Discharge	
Input Data		
Roughness Coefficient:	0.013	
Channel Slope:	0.01000	ft/ft
Normal Depth:	1.50	ft
Diameter:	1.50	ft
Results		
Discharge:	10.50	ft^3/s ← 10.50 CFS
Flow Area:	1.77	ft^2
Wetted Perimeter:	4.71	ft
Top Width:	0.00	ft
Critical Depth:	1.25	ft
Percent Full:	100.0	%
Critical Slope:	0.00977	ft/ft
Velocity:	5.94	ft/s
Velocity Head:	0.55	ft
Specific Energy:	2.05	ft
Froude Number:	0.00	
Maximum Discharge:	11.30	ft^3/s
Discharge Full:	10.50	ft^3/s
Slope Full:	0.01000	ft/ft
Flow Type:	SubCritical	
GVF Input Data		
Downstream Depth:	0.00	ft
Length:	0.00	ft
Number Of Steps:	0	
GVF Output Data		
Upstream Depth:	0.00	ft
Profile Description:	N/A	
Profile Headloss:	0.00	ft
Average End Depth Over Rise:	0.00	%
Normal Depth Over Rise:	0.00	%
Downstream Velocity:	0.00	ft/s

Reviewed 11/19/07

Addendum is acceptable

FINAL
DRAINAGE REPORT – ADDENDUM 1

WOODLAND CREEK ESTATES SUBDIVISION

1802 K ROAD
FRUITA, COLORADO

PREPARED FOR:

WOODLAND CREEK, LLC

1877 Broadway
Grand Junction, CO 81503

PREPARED BY:

O'CONNOR DESIGN GROUP, INC.

2350 G Road, Suite 113
Grand Junction, CO 81505
(970) 241-7125

Original: May 2, 2007
This Revision: October 30, 2007

CERTIFICATION

I hereby certify that this Final Drainage Report – Addendum 1, for Woodland Creek Estates Subdivision, was prepared under my direct supervision.

Patrick M. O'Connor
Registered Professional Engineer
State of Colorado, #20759

FINAL DRAINAGE REPORT- ADDENDUM 1
WOODLAND CREEK ESTATES

I. General

This addendum is prepared to address the offsite runoff produced by the area north of Woodland Creek Estates. A basin of approximately 17 acres consisting of Sunflower Estates and a small portion of the northwest corner of Holly Park Subdivision drain west and contribute direct-discharge flows to 18 Road. This entire basin is developed and includes all of the area draining to 18 Road and affecting Woodland Creek improvements. Areas north of this basin discharge to the Monument Glen detention facility then north to Little Salt Wash. Areas east of the basin drain south through the Holly Park detention facility and into the K Road storm sewer. Runoff from this offsite basin does not run through Woodland Creek Estates, but it does flow to 18 Road and will enter the proposed 18" storm sewer shown to be installed along the west side of the project.

In addition, this addendum is also provided to correct information included in the original drainage report which incorrectly stated that the existing storm drain in Ottlety Avenue east of Pine Street (18 Road) was a 30" diameter pipeline. Information received from the Grand Junction Drainage District indicates that this receiving pipeline is actually only 24" in diameter east of Pine Street (18 Road). The existing storm drain does increase to 30" diameter at the east side of Pine, so the proposed 18" storm drain for the west side of Woodland Creek Estates, which connects west of this point, will therefore be received by 30" storm drain. Other offsite drainage east of the Woodland project does, however, connect to an existing 24" storm drain in Ottley Avenue.

This analysis calculates the 100-year storm runoff from the offsite basin and compares it with the hydraulic capacity of the proposed 18" storm sewer to be installed in 18 Road along the west side of Woodland Creek Estates. As with the original drainage report, runoff is estimated by the SCS Unit Hydrograph Method. For consistency, the same developed runoff coefficient is used for the developed offsite basin as was used for the developed basins onsite in the Woodland Creek project. A new time of concentration was calculated and the peak runoff calculated using Haestad Methods software, like the previous report. The storm drain pipeline was analyzed using Manning's Equation and roughness coefficients found in the SWMM. Haestad Methods (FlowMaster 2005) software was used to perform the calculations.

Copies of these calculations, an ortho-photo of the site (showing the offsite basin), and a runoff hydrograph are included in this addendum.

II. RESULTS AND CONCLUSIONS

AREAS

Total Offsite Basin – 17.0 acres (Historic/Developed Basin)

RUNOFF COEFF. – SCS "CN" Values - **Hydrologic Soil Group "B"**

	Area, Ac.	CN
Developed: (composite) - see prev. report for calc's	**17.0**	**81**

TIMES OF CONCENTRATION

Developed: (off-site basin) - **0.3628** hours

RUNOFF (All Flows are C.F.S.)

	Developed Off-site Basin (undetained)
100 Year	**7.68 cfs**

STORM SEWER CAPACITY – 18" ADS N-12 @ s = 0.48%

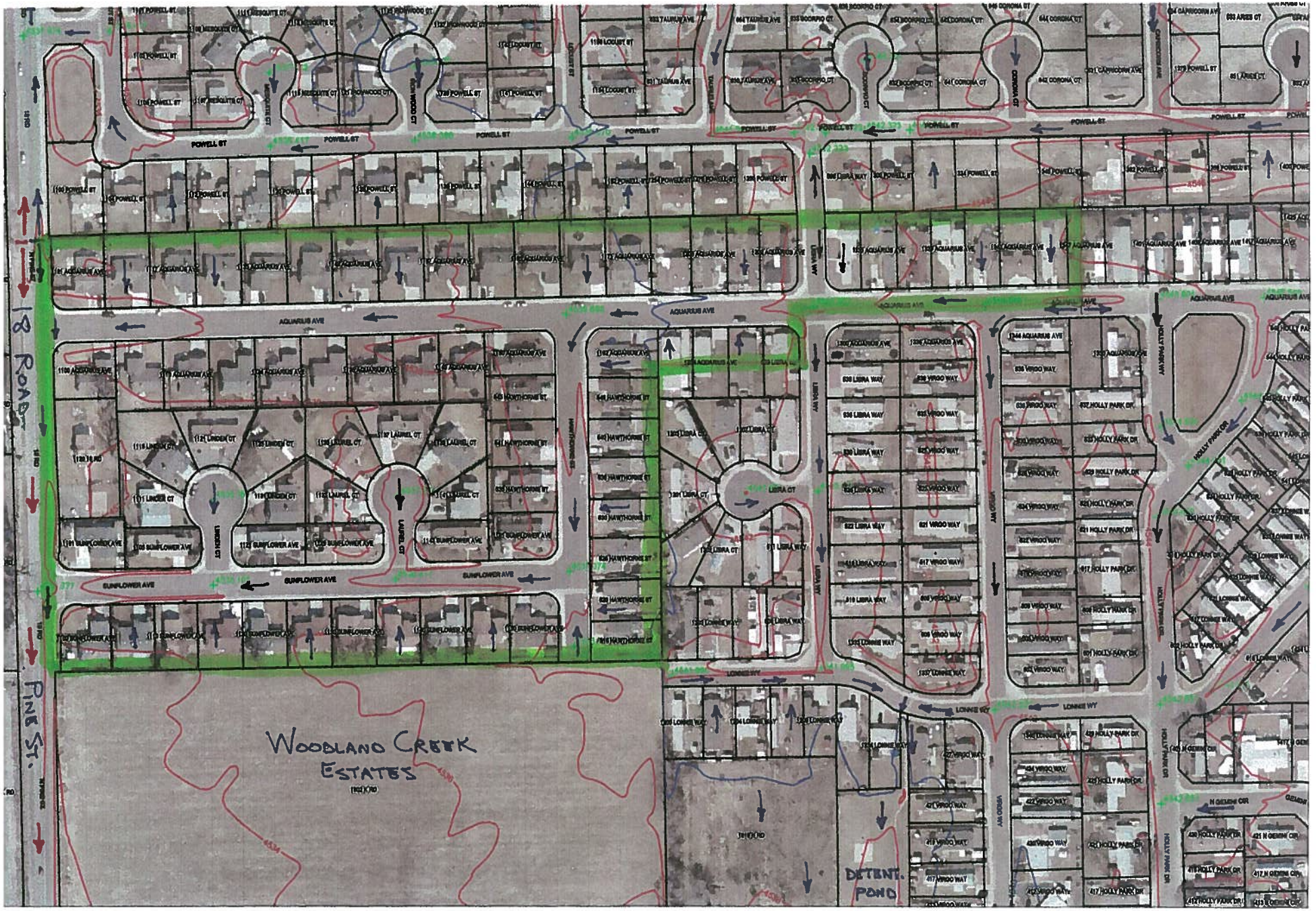
Q = 7.88 cfs Gravity flow unsubmerged (add'l flow available if submerged)

CONCLUSION

The 18" storm sewer proposed along the west side of the project is capable of carrying developed offsite flows from the area north of Woodland Creek Estates and discharging them into the existing storm drain under 18 Road and into the existing 30" storm sewer in Ottley Avenue (K Road).

APPENDIX

Offsite Basin – G.I.S. Aerial Ortho-Photo
Time of Concentration Calculation – Offsite Basin
Peak Runoff Calculation – Offsite Basin
Runoff Hydrograph – Offsite Basin
18" Storm Drain – Capacity Calculation



SCALE 1 : 2,400

A= 17.0 ACRES (OFFSITE)

200 0 200 400 600

FEET

N

WOODLAND CREEK ESTATES

18 ROAD - OFFSITE DRAINAGE

- BASIN BOUNDARY

TIME OF CONCENTRATION CALCULATOR

Segment #1: Tc: TR-55 Sheet

Mannings n	.0400	
Hydraulic Length	120.00	ft
2yr, 24hr P	.7000	in
Slope	.010000	ft/ft
Avg.Velocity	.18	ft/sec

Segment #1 Time: .1852 hrs

Segment #2: Tc: TR-55 Channel

Flow Area	4.0000	sq.ft
Wetted Perimeter	25.00	ft
Hydraulic Radius	.16	ft
Slope	.005000	ft/ft
Mannings n	.0170	
Hydraulic Length	2300.00	ft
Avg.Velocity	1.83	ft/sec

Segment #2 Time: .3498 hrs

Total Tc: .5349 hrs = 32 MINUTES

SCS UNIT HYDROGRAPH METHOD

STORM EVENT: 100 year storm
Duration = 24.0000 hrs Rain Depth = 2.0100 in
Rain Dir = C:\Documents and Settings\Pat\My Documents\Stormwater\
Rain File -ID = - TypeII 24hr
Unit Hyd Type = Default Curvilinear
HYG Dir = C:\Documents and Settings\Pat\My Documents\Stormwater\
HYG File - ID = - SUBAREA 10 100
Tc = .5349 hrs
Drainage Area = 17.000 acres Runoff CN= 81 ← FROM PREVIOUS DEVELOPED AREAS (SEE MAY 2, 2007 REPORT)

==========

Computational Time Increment = .07132 hrs
Computed Peak Time = 12.1965 hrs
Computed Peak Flow = 7.68 cfs

Time Increment for HYG File = .0500 hrs
Peak Time, Interpolated Output = 12.2000 hrs
Peak Flow, Interpolated Output = 7.68 cfs ← Q_{100}

==========

DRAINAGE AREA

ID:SUBAREA 10
CN = 81
Area = 17.000 acres
S = 2.3457 in
0.2S = .4691 in

Cumulative Runoff

.6109 in
.865 ac-ft

HYG Volume... .865 ac-ft (area under HYG curve)

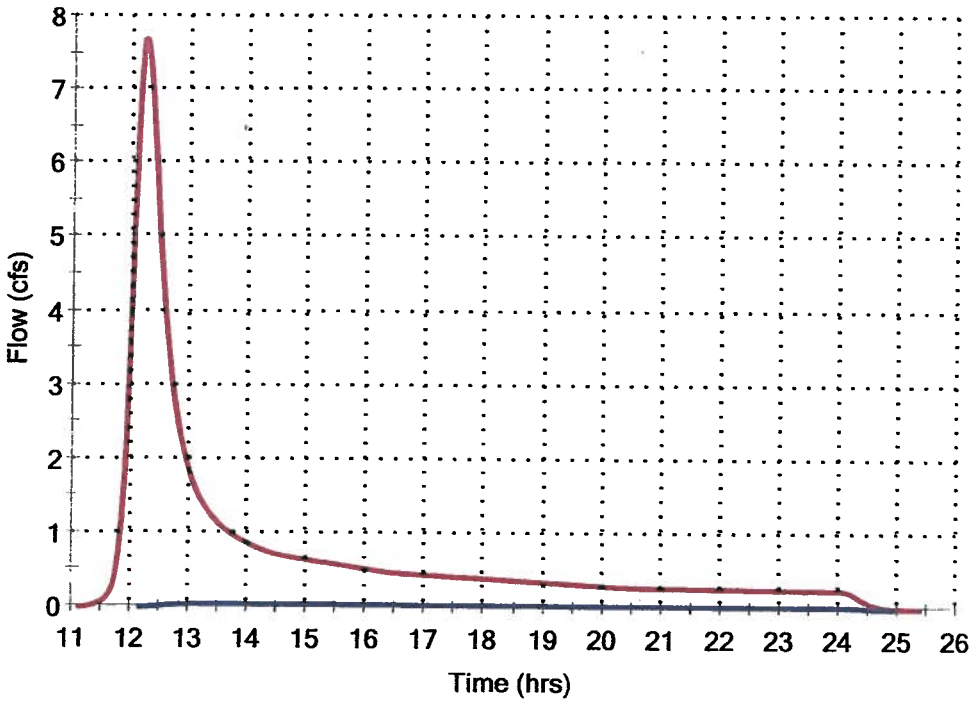
***** SCS UNIT HYDROGRAPH PARAMETERS *****

Time Concentration, Tc = .53493 hrs (ID: SUBAREA 10)
Computational Incr, Tm = .07132 hrs = 0.20000 Tp

Unit Hyd. Shape Factor = 483.432 (37.46% under rising limb)
K = 483.43/645.333, K = .7491 (also, K = 2/(1+(Tr/Tp))
Receding/Rising, Tr/Tp = 1.6698 (solved from K = .7491)

Unit peak, qp = 36.01 cfs
Unit peak time Tp = .35662 hrs
Unit receding limb, Tr = 1.42649 hrs
Total unit time, Tb = 1.78311 hrs

Hydrograph
Woodland Creek Estates - Offsite 17 acres
2 and 100-year Runoff



LEGEND:

SUBAREA 10	100
SUBAREA 10	2

WOODLAND CREEK OFFSITE DRAINAGE
18 ROAD: 18" ADS @ 0.48%

Worksheet for Circular Pipe - 1

Project Description		
Flow Element:	Circular Pipe	
Friction Method:	Manning Formula	
Solve For:	Discharge	
Input Data		
Roughness Coefficient:	0.012 ← ADS N-12	
Channel Slope:	0.00480 ← S=0.48%	ft/ft
Normal Depth:	18.00 ← 18" (FULL)	in
Diameter:	18.00 ← 18" PIPE	in
Results		
Discharge:	7.88	ft^3/s ← 7.88 > 7.68 (Q_{100})
Flow Area:	1.77	ft^2 ∴ O.K. ✓
Wetted Perimeter:	4.71	ft
Top Width:	0.00	ft
Critical Depth:	1.09	ft
Percent Full:	100.0	%
Critical Slope:	0.00626	ft/ft
Velocity:	4.46	ft/s
Velocity Head:	0.31	ft
Specific Energy:	1.81	ft
Froude Number:	0.00	
Maximum Discharge:	8.48	ft^3/s
Discharge Full:	7.88	ft^3/s
Slope Full:	0.00480	ft/ft
Flow Type:	SubCritical	
GVF Input Data		
Downstream Depth:	0.00	in
Length:	0.00	ft
Number Of Steps:	0	
GVF Output Data		
Upstream Depth:	0.00	in
Profile Description:	N/A	
Profile Headloss:	0.00	ft
Average End Depth Over Rise:	0.00	%
Normal Depth Over Rise:	0.00	%
Downstream Velocity:	0.00	ft/s