

DRAINAGE REPORT
ELM PLACE EXTENSION
FAA SITE TO OMAHA STREET

A PART OF THE NW/4 OF
SECTION 35, T-19-N, R-14-E, TULSA COUNTY
BROKEN ARROW, OKLAHOMA

JANUARY 23, 2009

Prepared by:
HRAOK, Inc.
1913 W. Tacoma, Suite 'A'
Broken Arrow, Oklahoma 74012

*No stormwater
exceptions.*

*JM Pugh
Stormwater
March 01*

2-5-09

January 23, 2009

I. INTRODUCTION

This hydrology and hydraulic report is for the Elm Place Extension from the FAA Site to Omaha Street. The proposed development is a ½ mile 5-lane arterial asphalt street. The site is bounded by “The Reserve at Battle Creek” and unplatted land on the west, North Broken Arrow Middle School and County Lane Estates III on the east, and Omaha Street on the North. The remaining areas of the perimeter are bounded by unplatted land. Please see the attached Figure 1 – Location Map for the location of the proposed development.

Proposed construction on the existing vacant non-platted land will require the runoff be picked up in inlets, sod lined channels and storm sewers to be discharged in controlled locations that will ultimately be collected in private development storm sewers system dedicated to the city at a later date. This drainage report describes the amount of flow through the proposed storm sewer system. All flows are based on fully urbanized development; please see the attached Figure 5 – Anticipated Zoning Exhibit.

The total drainage area modeled in this report is 34.34 acres. Of this the actual site to be constructed by this project at this time is 14.64 acres, which includes the proposed arterial street and any and all grading/disturbed areas for this project.

II. HYDROLOGIC STUDY

Drainage Areas:

Please see the attached Figure 2 - Proposed Conditions Drainage Area Map.

The site is currently comprised of seventeen drainage areas labeled A2, A3, C2, C3, F3, and F4 for the street section, and A4, B2, C4, D4, E2, F5, and F7 label areas collected in overland sod channels. Drainage areas that include the prefix “TEPA” were taken from previously approved plans – Project No. ST0413.

Hydrologic Analysis:

Rational method runoff calculation was used to model and design the storm sewer for the proposed Elm Place Extension. Please see the attached Figure 3 – Drainage Area Calculation and Figure 4 – Street Depth Calculation. The City of Broken Arrow’s Drainage Criteria Manual was used as a reference in the hydrologic analysis. In accordance with the manual the following items were used:

- 100-year 24-hour storm was used as the design storm
- Total rainfall for the 100-year design storm was 8.75 inches (for the 24-hour storm)
- 5-year 24-hour storm was used to check scouring velocity for the sod lined channels
- Total rainfall for the 5-year design storm was 4.98 inches (for the 24-hour storm)
- The analysis is limited to only the runoff generated from the proposed site

Project Conditions:

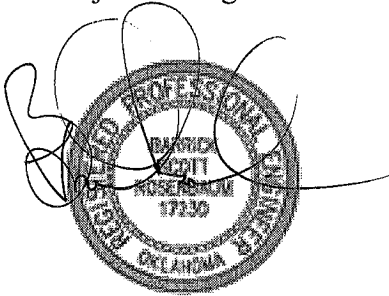
Please see the attached Figure 2 - Proposed Conditions Drainage Area Map. For this project, the on-site drainage areas will be developed to Commercial General District (CG), Office Neighborhood (ON), Residential Single-Family (R-3S) zoning. Please see the attached Figure 6 - 'C' Average Worksheet for explanation of the 'C' averages derived for this report.

III. SUMMARY AND CONCLUSIONS

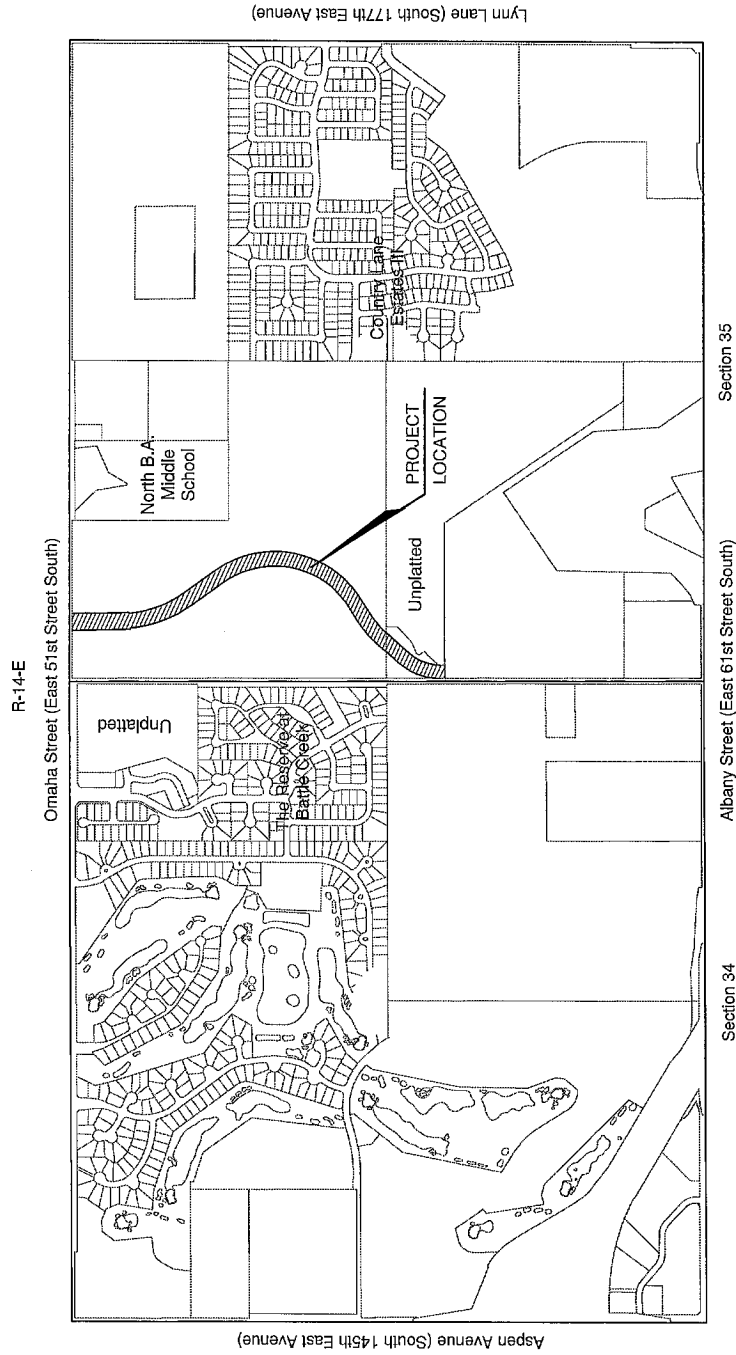
We respectfully request that you review and approve this report and its conclusions.

Sincerely,
HRAOK Inc.

Barrick Rosenbaum, P.E.
Project Manager



DATE: 1/26/2009

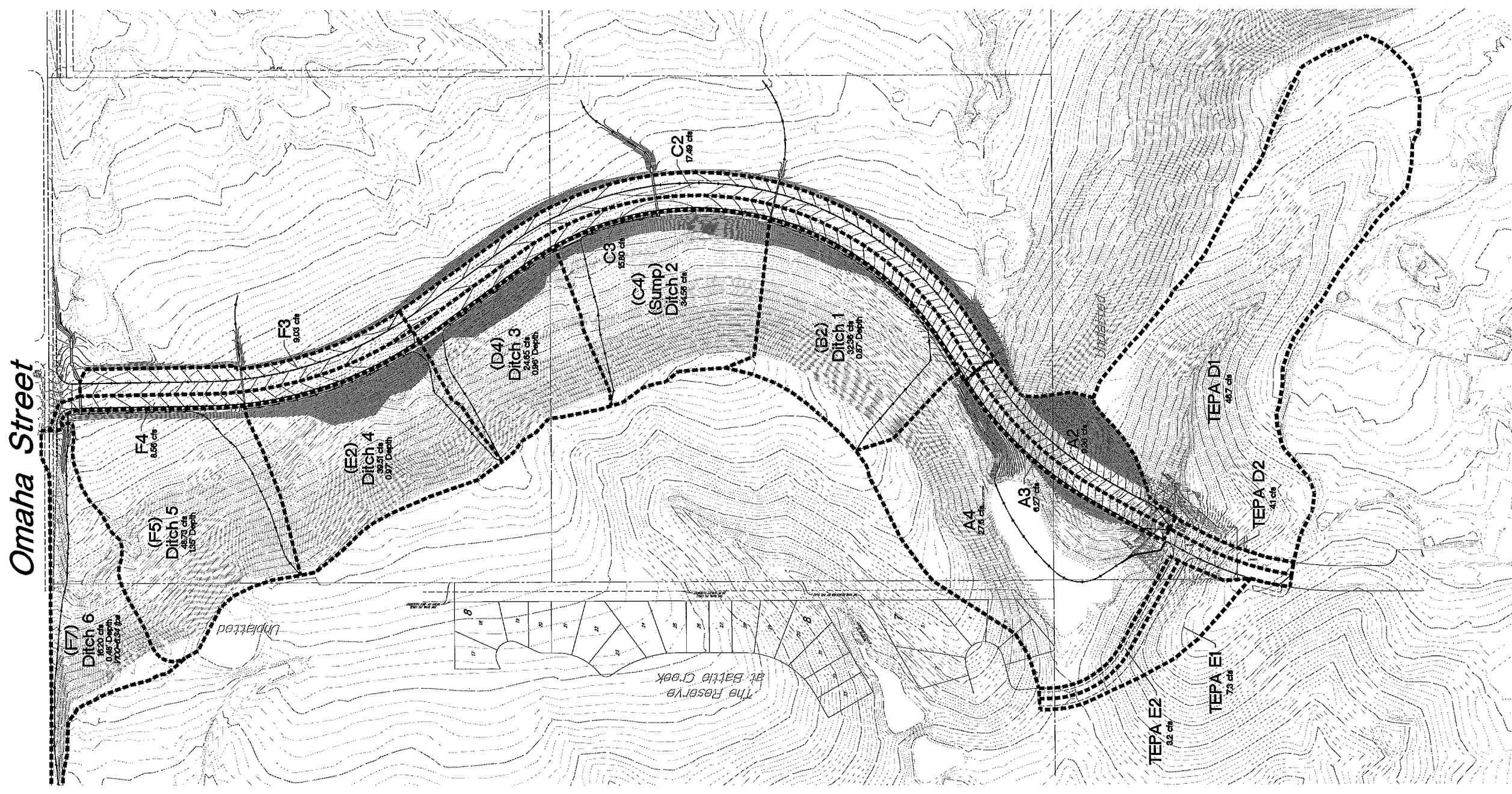


*Figure 1
Location Map*

T 19 N



Figure 2
Proposed Conditions Drainage Area Map



Approach Depth Catch Area
(C2)
0.27' Approach Depth from north
100' Wide

Approach Depth Catch Area
(C2)
0.27' Approach Depth from south
100' Wide

Approach Depth Catch Area
(C3)
0.27' Approach Depth from north
100' Wide

Approach Depth Catch Area
(C3)
0.27' Approach Depth from south
100' Wide

HRA

Cross Slope (%)		2.08											
Max Tc		10											
Length		600											
Manning's 'n'		0.015	Asphalt (rough) w/ Concrete Gutter										
		0.012	Concrete - Troweled Finish										
DRAINAGE AREA NO. OR DESCRIPTION	RUNOFF TYPE	LENGTH (FT)	SLOPE (%)	VELOCITY (FPS)	Tc (MIN)	INTENSITY (IN/HR)	Gavg	AREA (FEET)	AREA (ACRES)	Q100 (CFS)	Checks Spread		
G4	SOD	457	20.50	3.17	2.40								
	H20WAY	207	1.00	1.61	2.14								
				TOTAL	4.53	10.56	0.70	203578	4.67	34.56	100YR		
				TOTAL	4.54	6.65	0.70	203578	4.67	21.76	5YR		
D4	SOD	392	23.00	3.36	1.98								
	H20WAY	347	1.00	1.61	3.58								
				TOTAL	5.53	10.20	0.70	150450	3.45	24.65	100YR		
				TOTAL	5.53	16.42	0.70	150450	3.45	15.51	5YR		
E2	SOD	397	22.70	3.34	1.98								
	H20WAY	460	2.50	2.55	3.01								
				TOTAL	4.99	10.36	0.79	209619	4.81	39.54	100YR		
				TOTAL	4.99	6.94	0.79	209619	4.81	24.98	5YR		
F5	SOD	540	17.60	2.94	3.06								
	H20WAY	128	2.50	2.55	0.54								
	H20WAY	151	1.00	1.61	1.56								
				TOTAL	5.46	10.22	0.80	269686	5.96	48.73	100YR		
				TOTAL	5.46	6.43	0.80	269686	5.96	30.57	5YR		
F7	SOD	150	7.30	1.88	1.92								
	H20WAY	163	7.30	4.38	3.31								
				TOTAL	4.63	10.53	0.49	136757	3.14	18.20	100YR		
				TOTAL	4.63	6.63	0.49	136757	3.14	10.20	5YR		
Approach Depth Check													
G3	X-SLOPE	27	2.08	2.03	0.15								
	north	PVMT	773	1.00	2.03	3.68							
				TOTAL	4.00	10.03	0.95	27896	0.64	6.10			
C2	SOD	57	2.00	0.99	0.96								
	north	PVMT	765	1.00	2.03	5.76							
				TOTAL	5.72	9.79	0.70	45178	1.04	7.11			
Approach Depth Check													
G1	X-SLOPE	60	2.08	2.93	0.34								
	south	PVMT	274	4.50	4.31	1.05							
				TOTAL	3.10	10.47	0.95	38163	0.89	6.71			
C2	SOD	67	2.08	1.04	1.11								
	south	PVMT	276	4.50	4.31	1.07							
				TOTAL	5.94	10.05	0.70	63143	1.45	10.26			

Project: Elm Street Extension
 WO#: 11537.00
 Tech: Ryan Mc

Figure 4 - Rational Method Runoff Calculations
 Street Depth Calculation

*** USE FOR ST29 INLETS ONLY ***

Notes: Worksheet for depth of flow out of BLUE BOOK

Max Depth (ft) 1.00
 Height (in) 10
 Manning's "n" 0.833
 Manning's "n" 0.015
 (Ca) 2.08% $(3.2+1.7*\$119)/(\$F19/100)^{-0.5}$
 (Oa) 3.13% $(2.8+1.8*\$119)/(\$F19/100)^{-0.5}$
 (Co) 2.08% $(\$F19/100)^{-0.5}$
 (Cg) 3.13% $(1.3+0.3*\$119)/(\$F19/100)^{-0.5}$



INLET	Q 100 (cfs)	Carry Over (cfs)	Carry Over From (inlet)	Q Design (cfs)	Paving Grade (%)	Approach Depth (ft)	Width in Street (ft)	*** BYPASS CONDITION ***		*** SURP CONDITION ***		Depth Check			
								Inlet Bypass (cfs)	Intercept (Co) (Co)	Throat (L)	Throat (L)		Design (cfs)	QTL	Hir
A2	9.36	0.36	A3	9.36	4.50	0.25	12.05	4.71	53.17	9.18	0.18	6.00	6.00	#DIV/0!	6.00
A3	6.30	0.30	A2	6.30	4.50	0.22	10.39	4.71	53.17	5.28	0.02	6.00	6.00	#DIV/0!	6.00
C3	15.80	0.02	A3	15.82	2.50	0.34	16.38	FALSE	FALSE	FALSE	FALSE	6.00	6.00	2.64	1.28
C2	17.43	0.18	A2	17.67	2.50	0.35	17.07	FALSE	FALSE	FALSE	FALSE	6.00	6.00	2.94	1.37
F3	9.83	0.03	A3	9.83	1.00	0.33	15.75	10.00	134.00	9.03	0.00	6.00	6.00	#DIV/0!	6.00
F4	8.56	0.03	A2	8.56	1.00	0.32	15.45	10.00	134.00	8.56	0.00	6.00	6.00	#DIV/0!	6.00

INSTRUCTIONS:

LINK CELLS TO CORRESPONDING DATA CELLS
 INPUT CELLS
 CALCULATED VALUES - DON'T CHANGE
 SEE DRAINAGE MANUAL FOR INPUT OR S:\HRA\ENGINEERING\FIGURE 5604-21.DWG

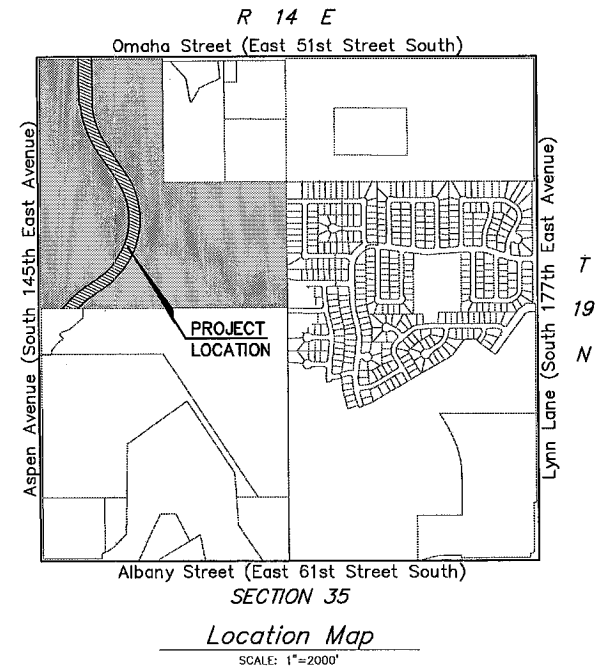
south	
C3	8.71 0.02 A3 8.73 2.50 0.27 13.11
C2	10.20 0.18 A2 10.38 2.50 0.29 13.99
north	
C3	6.10 0.10 6.10 1.00 0.28 13.61
C2	7.11 0.13 7.11 1.00 0.30 14.41

Figure 5
Anticipated Zoning Exhibit

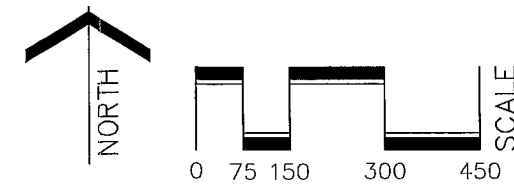
Elm Ridge Crossing

Owner/Developer
PERKINS & BROWN DEVELOPMENT
2217 EAST SKELLY DRIVE
TULSA, OKLAHOMA 74105
LINDSAY PERKINS

Engineer/Surveyor
HRAOK, INC.
1913 WEST TACOMA, SUITE-A
BROKEN ARROW, OKLAHOMA 74012
PHONE: (918) 258-3737
FAX: (918) 258-2554
C.A.#3643 EXPIRES JUNE 30, 2009



CG Commercial General District	34.64 Acres
ON Office Neighborhood	19.26 Acres
RS-3 Residential Single-Family (Detached)	66.40 Acres



HRAOK, Inc

ENGINEERS • SURVEYORS • PLANNERS • LANDSCAPE ARCHITECTS
1913 WEST TACOMA - SUITE A VOICE: (918) 258-3737
BROKEN ARROW, OKLAHOMA 74012 FAX: (918) 258-2554
CA# 3643 EXP. DATE: 6-30-2009

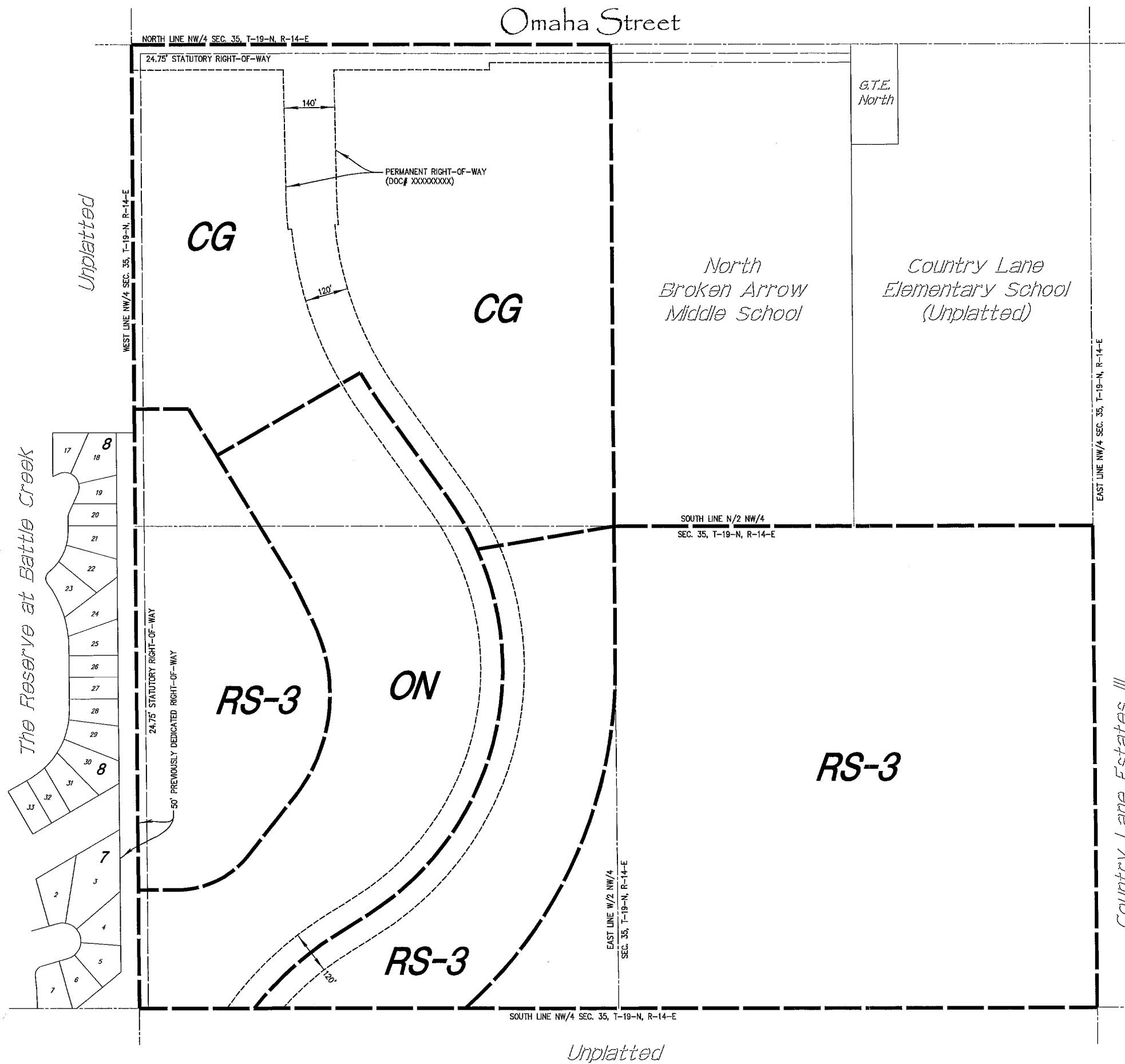


Figure 6 - 'C' Average Worksheet

Ryan Mc 7/23/2008
 Elm Street Extension (#11537)



Proposed Urbanized Zoning	C Avg.
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Commercial General District	0.80
Office Neighborhood	0.70
Impervious Street Section (Elm Place)	0.95
Residential	0.65

Drainage Area	(SF)	C Value	Adjusted Value
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A4

Total Area	339,989		
Sod Area	252,730	0.30	
Residential (Existing)	18,492	0.65	
Impervious Area	12,648	0.95	
Existing Pond	56,118	1.00	

75,819
12,020
12,016
56,118
131,937

339,989 Total
 Total Drainage Area
 0.39 C Avg.

E2

Total Area	209,619		
Commercial (Proposed)	179,648	0.80	
Office Neighborhood (Proposed)	29,971	0.70	

143,718
20,880
164,698

209,619 Total
 Total Drainage Area
 0.79 C Avg.

F7

Total Area	136,757		
Sod Area	85,250	0.30	
Commercial (Proposed)	51,507	0.80	

25,575
41,206
66,781

136,757 Total
 Total Drainage Area
 0.49 C Avg.