

Appendix E  
MINOR STORM DRAIN SYSTEM ANALYSIS

## MINOR STORM DRAIN SYSTEM ANALYSIS

*This Appendix A provides a summary of the comparative analysis of existing Beal Slough basin storm drain pipe and inlet capacity and runoff for the 5-year Lincoln design storm. Locations were identified where an insufficient number of inlets were present to let runoff into the pipe; pipes had insufficient capacity to carry the design storm runoff; or a combination of the above.*

The characteristics of the storm drain system including, pipe diameter, material, length and slope, and inlet size and count, were gathered from information provided by the Lincoln Public Works Department. The data values were entered into a spreadsheet-based model. The model uses storm drain system characteristics to estimate system capacity. The Rational Methodology as stipulated in the Lincoln Storm Sewer Design Manual is used to determine runoff generated by the 5-year design storm.

### RUNOFF PARAMETERS

33 of the 67 subbasin delineations in the Visual HEC1 model of Beal Slough basin are served by a public storm drain system. A separate model for each subbasin was created to model the storm drain system characteristics. The models were further divided into smaller drainage areas to facilitate evaluation of the inlet and pipe capacity at each point of study. Size of the drainage areas was estimated for use in the rational formula equation. Time of concentration at the first inlet was assumed to be 8.0 minutes at the upper most inlet for all systems. Runoff coefficient values of 0.4 were used for subbasins with predominantly residential land use patterns and 0.7 for subbasins with predominantly commercial land use patterns. Intensity-Duration-Frequency curves for Lincoln, revised in 1988, were used to determine the rate of precipitation at each point of study.

### INLET CHARACTERISTICS

Inlets were separated into six categories: 72", 60", 48", 36", grate, and other. Some simplifying assumptions were made: all curb inlets are straight, all grates are type "F," ponded depth at grate inlets is 6 inches, and headwater depth at flared end section inlets is 1.5 times the pipe diameter. Inlet capacity was determined using the City of Lincoln design charts for each category of inlet size at full curb depth (i.e., 72" straight inlet, 5.1 cfs, etc.). Incremental inlet capacity was determined by counting the inlets at an intersection and calculating the aggregate capacity. Cumulative inlet capacity was calculated as analysis preceded downstream. It is acknowledged that this will result in over-estimation of inlet capacity because two inlets must be installed if runoff rates exceed the capacity of a single inlet by 1 cfs.

**PIPE CHARACTERISTICS**

Pipe capacity was calculated using Manning's formula for closed conduits. Roughness coefficient values of 0.013 and 0.024 were used respectively for concrete conduits and corrugated metal conduits. Round pipe equivalents were used for non-circular components. Consistent with Lincoln design procedures, segments of channel liner were modeled using a pipe diameter equivalent to the liner width (i.e., a 48-inch concrete pipe was used to model a 4-foot concrete channel liner). Capacity of each conduit was estimated based on the following assumptions: minor energy losses at inlets, junctions, or manholes are ignored; the conduit would be unobstructed; and backwater effects of downstream water surface elevations are not considered.

**EVALUATION**

A comparative analysis of inlet capacity to runoff rates and pipe capacity to runoff rates was performed on each of the 33 subbasins. A screening protocol to eliminate sites at which runoff rates exceed inlet or pipe capacity by less than 5% was used during evaluation, because detailed storm drain system analysis is beyond the scope of this project. Potential problems were detected at 58 locations throughout the watershed using this protocol. Figure A-1 displays the location and identification number for each of the problem areas. This evaluation is a screening tool for identification of potential problem areas. A detailed analysis of the potential problem area with more refined areal delineation may show the problem is not as severe as indicated by this coarse evaluation. An identification number, location description, and a brief explanation of the problem type is summarized in Table A-1.

It is interesting to note that the area which experienced repeated flooding in 1996, near 30th and Diadem Drive along Tierra Branch, was not shown to have a problem based on the evaluation performed. This reinforces the need to evaluate system reaction during a storm in excess of the minor design storm and to consider tailwater conditions.

**Table A-1  
Summary of Minor Storm Drain System Analysis**

No.	Location	Type of Problem
	<b>Middle Beal</b>	
1	56th & Shady Creek	Temporary intersection flooding, runoff exceeds inlet capacity by 30%.
2	56th & LaSalle	Runoff exceeds pipe capacity by 30% for 590 ft. Temporary intersection flooding, runoff exceeds inlet capacity by 10%.
3	56th & Elkcrest Drive	Runoff exceeds pipe capacity by 10% for 595 ft.
4	Deerwood & Dogwood to Deerwood & Elkcrest	Runoff exceeds pipe capacity by 33% for 350 ft.
5	61st & Deerwood to 60th & Deerwood	Runoff exceeds pipe capacity by 50% for 580 ft.
6	61st & Robin Road	Runoff exceeds pipe capacity by 160% for 60 ft, likely causes street flooding.

No.	Location	Type of Problem
	<b>Middle Beal (continued)</b>	
7	61st & Rosebud	Runoff exceeds pipe capacity by 25% for 270 ft.
8	Hallcliffe & Briarpark	Runoff exceeds pipe capacity by 200% for 225 ft, (culverts).
9	Prince Road & Duxhall Drive	Temporary intersection flooding, runoff exceeds inlet capacity by 45%.
10	Woodhaven & Claire	Runoff exceeds pipe capacity by 50% for 210 ft.
11	Woodhaven & Claire to 48th & Woodland	Runoff exceeds pipe capacity by 25% for 420 ft.
12	Woodhaven & LaSalle to Woodhaven & Claire	4½ blocks of temporary street flooding, runoff exceeds inlet capacity by 50% along the upper end and 10% along the lower end.
13	49th & Woodland	Temporary intersection flooding, runoff exceeds inlet capacity by 20%.
14	50th & Pioneers to 48th & Linden	Runoff exceeds pipe capacity by 60% for 575 ft.
15	47th & Linden	Runoff exceeds pipe capacity by 25% for 420 ft.
16	46th & Linden to Ginnie & Gertie	Runoff exceeds pipe capacity by 20% to 50% for 2550 ft.
17	48th & Pioneers	Runoff exceeds pipe capacity by 20% for 390 ft. Temporary intersection flooding, runoff exceeds inlet capacity by 40%.
18	40th & LaSalle to 40th &	Runoff exceeds pipe capacity by 15% for 390 ft. Temporary intersection flooding, runoff exceeds inlet capacity by 20% to 50% along same length.
19	Carnelian & Bristolwood to 37th & Carnelian	Runoff exceeds pipe capacity by 40% to 70% for 1155 ft. Temporary intersection flooding, runoff exceeds inlet capacity by 25%.
20	47th & Stockwell to 46th & Stockwell	Runoff exceeds pipe capacity by 30% for 540 ft. Temporary intersection flooding, runoff exceeds inlet capacity by 20%.
21	46th & Cooper to 44th & Prescott	Runoff exceeds pipe capacity by 30% for 780 ft.
22	44th & Prescott	Temporary intersection flooding, runoff exceeds inlet capacity by 40%.
23	42nd & Meredith	Temporary intersection flooding, runoff exceeds inlet capacity by 10%.
24	39th & Linden to 36th &	Runoff exceeds pipe capacity by 10% for 525 ft.
25	40th & Calvert to 37th & Pioneers	Runoff exceeds pipe capacity by 25% near along top portion and 15% along the bottom portion for 1335 ft.
26	36th & Allendale	Runoff exceeds pipe capacity by 25% for 300 ft.

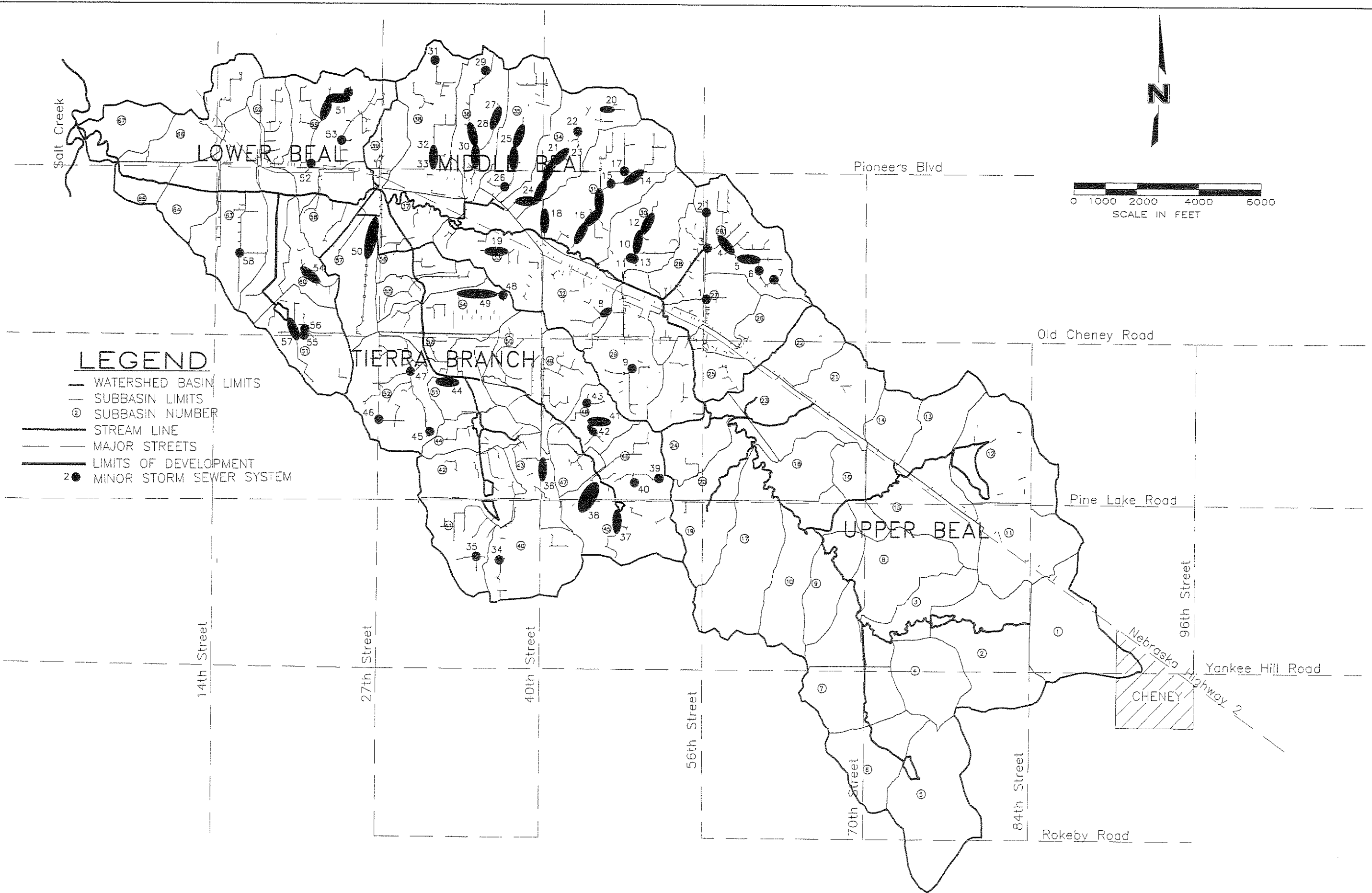
**Table A-1 (continued)**  
**Summary of Minor Storm Drain System Analysis**

No.	Location	Type of Problem
<b>Middle Beal (continued)</b>		
27	Loveland & Stockwell	Runoff exceeds pipe capacity by 50% for 400 ft. Temporary intersection flooding, runoff exceeds inlet capacity by 30%.
28	Loveland & Prescott	Runoff exceeds pipe capacity by 25% for 650 ft.
29	35th & Hillside Circle	Runoff exceeds pipe capacity by 15% for 160 ft. Temporary intersection flooding, runoff exceeds inlet capacity by 25%.
30	33rd & Cooper to South Gate & Pioneers	Runoff exceeds pipe capacity by 10% for 1720 ft.
31	Summit St. to Hanson Court	Temporary intersection flooding, runoff exceeds inlet capacity by 60%.
32	30th & St. John Ave.	Runoff exceeds pipe capacity by 10% for 195 ft.
33	30th & Loveland to 30th & Pioneers	Runoff exceeds pipe capacity by 40% for 610 ft.
<b>Tierra Branch</b>		
34	36th & Tempe	Runoff exceeds pipe capacity by 50% for 190 ft. Temporary intersection flooding, runoff exceeds inlet capacity by 30%.
35	34th & Canyon Court	Temporary intersection flooding, runoff exceeds inlet capacity by 40%.
36	40th & Larkwood	Runoff exceeds pipe capacity by 50% for 430 ft. Temporary intersection flooding, runoff exceeds inlet capacity by 40%.
37	Eagle Ridge & Buffalo Creek	Temporary intersection flooding, runoff exceeds inlet capacity by 35%.
38	45th and Pine Lake Road	Runoff exceeds pipe capacity by 30% for 1745 ft. Temporary intersection flooding, runoff exceeds inlet capacity by 60%.
39	51st & Larkwood	Temporary intersection flooding, runoff exceeds inlet capacity by 10%.
40	Bear Creek & Beaver Creek	Runoff exceeds pipe capacity by 20% for 170 ft. Temporary intersection flooding, runoff exceeds inlet capacity by 30%.
41	46th & Birch Hollow	Temporary intersection flooding, runoff exceeds inlet capacity by 50%.
42	48th & Birch Hollow to Rockwood & Winding Creek	Runoff exceeds pipe capacity by 45% for 400 ft.
43	44th & Neuman	Runoff exceeds pipe capacity by 25% for 240 ft. Temporary intersection flooding, runoff exceeds inlet capacity by 15%.
44	30th & Raleigh to 31st & Raleigh	Runoff exceeds pipe capacity by 50% for 510 ft. Temporary intersection flooding, runoff exceeds inlet capacity by 50%.

No.	Location	Type of Problem
<b>Tierra Branch (continued)</b>		
45	Briar Rosa & Laredo	Temporary intersection flooding, runoff exceeds inlet capacity by 60%.
46	27th & Coronado	Runoff exceeds pipe capacity by 35% for 70 ft.
47	Briar Rosa & Jane Lane	Runoff exceeds pipe capacity by 25% for 280 ft.
48	Wildbriar Lane & Coyote Circle	Temporary intersection flooding, runoff exceeds inlet capacity by 20%.
49	Wildbriar Lane & Coyote Cr. to Wildbriar Lane & Dove Cr.	Runoff exceeds pipe capacity by 40% for 1310 ft.
50	Canterbury & Cheshire to Canterbury & Tipperary	Runoff exceeds pipe capacity by 25% for 1285 ft.
<b>Lower Beal</b>		
51	Country Club & Calvert to Dunn & Woods	Runoff exceeds pipe capacity by 10% to 35% for 1130 ft.
52	Dunn & Holly	Runoff exceeds pipe capacity by 8% for 450 ft.
53	Pace & Woods	Runoff exceeds pipe capacity by 10% for 660 ft.
54	Tipperary & Cameron	Runoff exceeds pipe capacity by 35% for 115 ft.
55	Norman & Old Cheney	Temporary intersection flooding, runoff exceeds inlet capacity by 10%.
56	20th & Old Cheney to Guenevere & King Arthur	Runoff exceeds pipe capacity by 30% for 1250 ft. Temporary intersection flooding, runoff exceeds inlet capacity by 50%.
57	Tipperary & Old Cheney	Runoff exceeds pipe capacity by 20% for 280 ft. Temporary intersection flooding, runoff exceeds inlet capacity by 15%.
58	16th & Cushman Dr.	Temporary intersection flooding, runoff exceeds inlet capacity by 45%.

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### LEGEND

- WATERSHED BASIN LIMITS
- SUBBASIN LIMITS
- ② SUBBASIN NUMBER
- STREAM LINE
- MAJOR STREETS
- LIMITS OF DEVELOPMENT
- MINOR STORM SEWER SYSTEM

DRAWN BY: KO CR  
 DATE: 11/20/97  
 REVISIONS:

## BEAL SLOUGH INTERIM REPORT

LINCOLN, NEBRASKA

Minor Storm Drain System Deficiencies  
 Location Map

Figure A-1  
 Sheet 1 of 1

