V. DRAINAGE ANALYSIS

5.1 Drainage Improvements

Although the primary focus of this study is surface improvements, it has become evident during the early stages of the study that many of the pedestrian challenges in the study area result from inadequate underground drainage systems. Several areas have been identified in which significant drainage basins – 8 to 10 city blocks in some cases – are drained via surface flow along streets with very flat grades. Where this is combined with substandard curb heights, frequent and prolonged inundation of sidewalks is to be expected during storms. Even where curb heights are near standard, some of these large drainage basins are capable of generating flows well above the carrying capacity of the gutters.

In several of these locations it may be possible to install an extension of a nearby storm drain system which would greatly mitigate downstream sidewalk flooding. It is likely that some of these storm drain upgrades could be performed for considerably less cost compared to extensive pavement reconstruction projects over several city blocks. The hydrologic field review has identified several locations where relatively simple drainage improvements could provide benefits over a wide area. It would, of course, be necessary to study the downstream storm drainage systems during final design to ensure that no unintended problems would be caused in the downstream communities.

The conditions under which drainage improvements may be recommended include:

- Areas where unusually large drainage basins drain onto a street with inadequate carrying capacity because of either low curb height or flat gradients.
- Areas in which chronic drainage problems affecting pedestrian movement have been reported by community groups or are reflected in City records.
- Isolated locations of unusually severe drainage problems affecting pedestrians. If the situation appears likely to cause other problems for the City, such as flooding of homes, it could be assigned a higher priority.
- Locations at which a nearby existing storm drain system can be modified with a relatively minor extension would be more likely to be recommended for improvement, although a more extensive drainage system could be proposed if it offered a high cost-benefit ratio.

5.2 Drainage Deficiencies

Many of the engineering issues that are interfering with sidewalk improvement work are related to drainage deficiencies. In addition, even along streets with adequate existing sidewalks the pedestrian environment may be impaired by substandard drainage conditions, such as ponding at corners and curb ramps or gutter flow that in some cases tops the curb during even moderate storms.

Pursuant to Task III-1, KHA performed a field reconnaissance of the drainage conditions of all streets in the detailed study area. Many of these streets had already been identified in earlier phases of the study as having drainage deficiencies on the basis of resident complaints, city records, or by specific request of the community groups. The goals of the field reconnaissance were:

- To identify the patterns of surface drainage throughout the community, and direction of gutter flow

- To establish the limits of drainage basins impacting streets within the study area
- To assess drainage conditions in those areas already identified as having drainage problems to attempt to identify the source of those problems, and potential solutions

In nearly all cases, causes of reported drainage problems were evident from the field investigation. The affected areas typically received runoff from a relatively large watershed of at least one city block, and frequently much more. Some streets within the detailed study area drain urban watersheds of over 30 acres with no underground storm drain system. In large storms, these basins could be expected to produce flows as high as 100 cubic feet per second of runoff.

The capacity of the streets to convey these large flows is limited by topography. Because of the level terrain of the mid-city community, most of the streets in the detailed study area have extremely flat longitudinal gradients. In some cases, the streets appear totally flat to the eye, and topographic measurements using survey equipment were required to determine the direction of flow. KHA performed field surveys at a number of critical locations to provide the required information. The field surveys revealed gradients much flatter than would be allowable for new construction, with many slopes at less than 0.2%, and some streets having literally no downhill slope at all. In the more severe cases of zero gradients it would be impossible for homeowners to construct new curb-and-gutter with slopes meeting City standards.

Finally, the existence of substandard curb heights due to many years of repaving projects has further reduced the carrying capacity of many streets, resulting in areas where sidewalk flooding would be expected to occur in even minor storms.

Other significant drainage deficiencies impacting pedestrian routes were identified in isolated locations of the study area. Specific recommendations for addressing these deficiencies are detailed in Section 5.4 below. Also, field investigation revealed that several of the drainage systems shown on the City's GIS storm drainage mapping do not actually exist. These locations have been noted in the segment notes included in Section 8 of this report.

5.3 Design Storm

The City Drainage Manual outlines the storm magnitudes (return periods) that should be used for preparing formal drainage studies and for design of storm drain facilities in the City. Underground storm drain systems are typically designed to provide open-channel conditions in 50 year storms. Street flow is designed to be contained within the right-of-way in 100 year storms to avoid damage to private property.

The above criteria are useful for design of new developments but do not provide suitable guidance for this study. Because of the flat terrain and low curbs, nearly every street in the detailed study area would fall short of the standard requirements, leaving no criteria for prioritizing improvements. Furthermore, few pedestrians would be likely to attempt a walk during a 50 year storm. It is more important to identify locations that are impacted by even routine storms. Therefore, the runoff estimates in this study include calculations based on a 1 year storm, which corresponds to the rainfall intensity that would be equaled or exceeded about once each year on average.

5.4 Drainage Basins

A number of blocks were found to serve unusually large drainage basins. These are shown on **Figure 2**, Major Drainage Basins. In almost every case, the very large watersheds have been the subject of citizen complaints regarding storm water. A few of these blocks have substantial slopes and some have even been constructed essentially as concrete channels, so the large watersheds don't necessarily result in substandard sidewalk conditions. For example, Florida Street (Block NP49) and Eugene Street (Block NH99) are both paved with concrete and have a swale down the center of the street rather than the typical crown, so that they function as channels. Although these conditions do not directly impact sidewalks, they still impair pedestrian movement since the deep rushing water in the center of such streets would be difficult for pedestrians to cross.

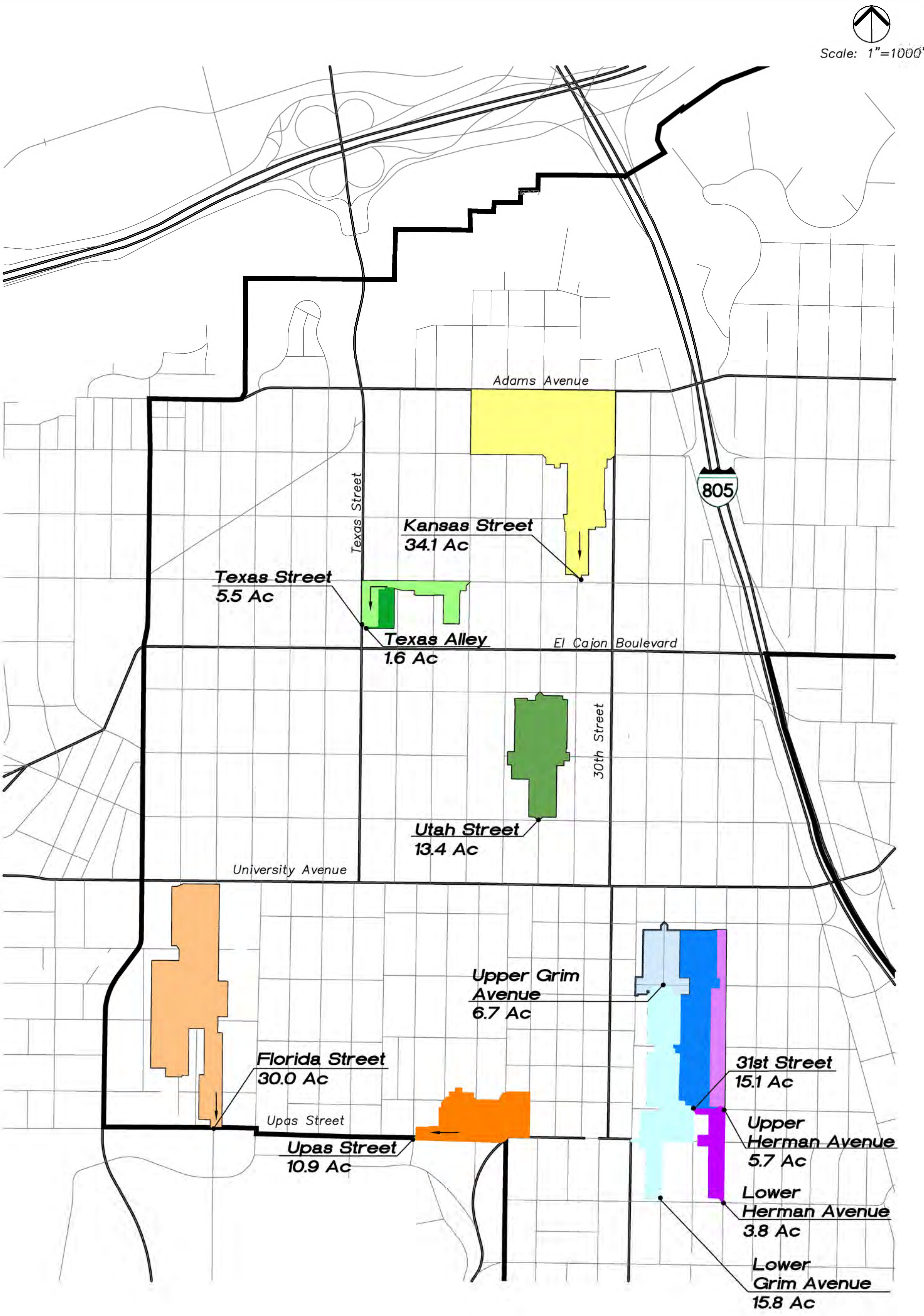
Even drainage basins of moderate size can present an obstacle to pedestrians during wet weather where the street grades are excessively flat or curb height is substandard. Table 5-1 presents a summary of the runoff carrying capacity of streets of various slopes and curb heights.

TABLE 5-1
CONVEYANCE CAPACITY OF STREETS
(IN CUBIC FEET PER SECOND)

STREET SLOPE (%)	CURB HEIGHT 1.5”	CURB HEIGHT 4”	CURB HEIGHT 6”
0	0	0	0
0.2	0.10	1.4	4.1
0.3	0.12	1.7	5.0
0.4	0.14	2.0	5.8
0.5	0.16	2.2	6.5
0.75	0.20	2.7	7.9
1.0	0.23	3.1	9.2
2.0	0.32	4.4	12.9

Table 5-2 lists blocks within the study area where significant sidewalk flooding could be expected based on either the size of the watershed or insufficient slope and curb height. Streets with zero or near-zero curb height have virtually no carrying capacity, so these have been excluded from the table.

District 3 Sidewalk Study - Phase III



Kimley-Horn and Associates, Inc.
Engineering, Planning and Environmental Consultants

Figure 2
Major Drainage Basins

Table 5-2
Sidewalk Flooding Potential
March 16, 2006

Community	Block Designation1	Side (N,S,E,W)	Curb Height Category	Longitudinal Slope (%)
NH	100	N	2	0.1
NH	100	S	2	0.1
NP	2	N	0	0.2
NP	2	S	0	0.2
NH	76	S	1	0.2
NH	77	S	1	0.2
NH	85	E	1	0.2
NH	86	N	1	0.2
NH	89	W	1	0.2
NH	93	N	1	0.2
NH	93	S	1	0.2
NH	94	E	1	0.2
NP	9	S	1	0.2
NP	12	N	1	0.2
NP	12	S	1	0.2
NP	13	N	1	0.2
NP	22	N	1	0.2
NP	33	S	1	0.2
NP	56	N	1	0.2
NP	56	S	1	0.2
NP	57	N	1	0.2
NP	57	S	1	0.2
NP	68	W	1	0.2
NP	107	S	1	0.2
NH	39	E	2	0.2
NH	42	N	2	0.2
NH	42	S	2	0.2
NH	43	N	2	0.2
NH	43	S	2	0.2
NH	77	N	2	0.2
NH	78	N	2	0.2
NH	84	N	2	0.2
NH	84	S	2	0.2
NH	86	S	2	0.2
NH	87	W	2	0.2
NH	88	E	2	0.2
NH	88	W	2	0.2
NH	89	E	2	0.2
NH	92	S	2	0.2
NH	98	N	2	0.2
NH	98	S	2	0.2
NP	4	E	2	0.2
NP	9	N	2	0.2
NP	10	N	2	0.2
NP	10	S	2	0.2
NP	13	S	2	0.2
NP	14	N	2	0.2
NP	16	E	2	0.2
NP	16	W	2	0.2
NP	18	N	2	0.2
NP	18	S	2	0.2
NP	19	S	2	0.2
NP	20	S	2	0.2
NP	21	S	2	0.2
NP	22	S	2	0.2
NP	25	E	2	0.2
NP	25	W	2	0.2
NP	55	N	2	0.2
NP	55	S	2	0.2

Table 5-2
Sidewalk Flooding Potential
March 16, 2006

Community	Block Designation1	Side (N,S,E,W)	Curb Height Category	Longitudinal Slope (%)
NP	61	W	2	0.2
NP	75	W	2	0.2
NH	39	W	3	0.2
NH	48	N	3	0.2
NH	48	S	3	0.2
NH	57	E	3	0.2
NH	57	W	3	0.2
NH	75	N	3	0.2
NH	75	S	3	0.2
NH	76	N	3	0.2
NH	78	S	3	0.2
NH	80	N	3	0.2
NH	80	S	3	0.2
NH	82	E	3	0.2
NH	82	W	3	0.2
NH	83	N	3	0.2
NH	83	S	3	0.2
NH	85	W	3	0.2
NH	87	E	3	0.2
NH	92	N	3	0.2
NH	94	W	3	0.2
NP	4	W	3	0.2
NP	5	N	3	0.2
NP	5	S	3	0.2
NP	8	N	3	0.2
NP	8	S	3	0.2
NP	14	S	3	0.2
NP	19	N	3	0.2
NP	20	N	3	0.2
NP	21	N	3	0.2
NP	33	N	3	0.2
NP	61	E	3	0.2
NP	68	E	3	0.2
NP	75	E	3	0.2
NP	107	N	3	0.2
NP	115	E	3	0.2
NP	115	W	3	0.2
SP	6	S	0	0.3
SP	12	N	0	0.3
SP	12	S	0	0.3
SP	13	E	0	0.3
SP	13	W	0	0.3
SP	17	E	0	0.3
SP	17	W	0	0.3
SP	18	N	0	0.3
SP	18	S	0	0.3
SP	20	E	0	0.3
SP	20	W	0	0.3
SP	26	E	0	0.3
SP	26	W	0	0.3
SP	32	N	0	0.3
SP	32	S	0	0.3
SP	41	N	0	0.3
SP	41	S	0	0.3
SP	58	S	0	0.3
NH	4	N	1	0.3
NH	4	S	1	0.3
NH	95	N	1	0.3

Table 5-2
Sidewalk Flooding Potential
March 16, 2006

Community	Block Designation1	Side (N,S,E,W)	Curb Height Category	Longitudinal Slope (%)
NH	95	S	1	0.3
NH	101	E	1	0.3
NH	101	W	1	0.3
NP	35	S	1	0.3
NP	103	S	1	0.3
SP	2	N	1	0.3
SP	21	N	1	0.3
SP	45	N	1	0.3
SP	48	S	1	0.3
SP	50	N	1	0.3
SP	50	S	1	0.3
SP	53	S	1	0.3
SP	54	S	1	0.3
SP	55	S	1	0.3
SP	59	S	1	0.3
SP	60	N	1	0.3
SP	60	S	1	0.3
NH	10	E	2	0.3
NH	10	W	2	0.3
NH	24	S	2	0.3
NH	33	E	2	0.3
NH	33	W	2	0.3
NH	34	W	2	0.3
NH	35	E	2	0.3
NH	35	W	2	0.3
NH	36	E	2	0.3
NH	37	E	2	0.3
NH	38	E	2	0.3
NH	38	W	2	0.3
NH	55	E	2	0.3
NH	55	W	2	0.3
NH	67	E	2	0.3
NH	67	W	2	0.3
NH	68	E	2	0.3
NH	68	W	2	0.3
NH	69	E	2	0.3
NH	69	W	2	0.3
NH	70	E	2	0.3
NH	70	W	2	0.3
NH	91	N	2	0.3
NH	91	S	2	0.3
NH	96	E	2	0.3
NH	96	W	2	0.3
NH	97	W	2	0.3
NP	34	S	2	0.3
NP	35	N	2	0.3
NP	36	N	2	0.3
NP	36	S	2	0.3
NP	48	N	2	0.3
NP	48	S	2	0.3
NP	81	N	2	0.3
NP	83	N	2	0.3
NP	85	N	2	0.3
NP	91	W	2	0.3
NP	95	W	2	0.3
NP	99	E	2	0.3
NP	99	W	2	0.3
NP	102	N	2	0.3

Table 5-2
Sidewalk Flooding Potential
March 16, 2006

Community	Block Designation1	Side (N,S,E,W)	Curb Height Category	Longitudinal Slope (%)
NP	102	S	2	0.3
NP	103	N	2	0.3
NP	106	N	2	0.3
NP	106	S	2	0.3
NP	109	E	2	0.3
NP	109	W	2	0.3
SP	30	S	2	0.3
SP	31	S	2	0.3
SP	43	N	2	0.3
SP	49	S	2	0.3
SP	53	N	2	0.3
SP	54	N	2	0.3
SP	55	N	2	0.3
SP	59	N	2	0.3
NH	3	N	3	0.3
NH	3	S	3	0.3
NH	18	N	3	0.3
NH	18	S	3	0.3
NH	24	N	3	0.3
NH	34	E	3	0.3
NH	36	W	3	0.3
NH	37	W	3	0.3
NH	56	E	3	0.3
NH	56	W	3	0.3
NH	97	E	3	0.3
NP	34	N	3	0.3
NP	81	S	3	0.3
NP	82	N	3	0.3
NP	82	S	3	0.3
NP	83	S	3	0.3
NP	84	N	3	0.3
NP	84	S	3	0.3
NP	85	S	3	0.3
NP	91	E	3	0.3
NP	93	E	3	0.3
NP	93	W	3	0.3
NP	95	E	3	0.3
NP	98	E	3	0.3
NP	98	W	3	0.3
NP	101	N	3	0.3
NP	101	S	3	0.3
SP	2	S	3	0.3
SP	3	N	3	0.3
SP	3	S	3	0.3
SP	4	N	3	0.3
SP	4	S	3	0.3
SP	5	N	3	0.3
SP	5	S	3	0.3
SP	6	N	3	0.3
SP	11	E	3	0.3
SP	11	W	3	0.3
SP	14	N	3	0.3
SP	14	S	3	0.3
SP	15	N	3	0.3
SP	15	S	3	0.3
SP	21	S	3	0.3
SP	29	N	3	0.3
SP	29	S	3	0.3

Table 5-2
Sidewalk Flooding Potential
March 16, 2006

Community	Block Designation1	Side (N,S,E,W)	Curb Height Category	Longitudinal Slope (%)
SP	30	N	3	0.3
SP	31	N	3	0.3
SP	43	S	3	0.3
SP	45	S	3	0.3
SP	48	N	3	0.3
SP	49	N	3	0.3
SP	58	N	3	0.3
NP	77	E	0	0.4
NP	77	W	0	0.4
SP	7	N	0	0.4
SP	7	S	0	0.4
SP	37	E	0	0.4
SP	37	W	0	0.4
SP	42	E	0	0.4
SP	42	W	0	0.4
NP	37	N	1	0.4
NP	37	S	1	0.4
NP	38	S	1	0.4
NP	39	S	1	0.4
NP	40	N	1	0.4
NP	40	S	1	0.4
NP	42	W	1	0.4
NP	44	E	1	0.4
NP	50	W	1	0.4
NP	108	W	1	0.4
NP	111	S	1	0.4
NP	112	S	1	0.4
NH	1	E	2	0.4
NH	1	W	2	0.4
NH	2	W	2	0.4
NH	53	N	2	0.4
NH	53	S	2	0.4
NH	54	E	2	0.4
NH	54	W	2	0.4
NH	58	E	2	0.4
NH	58	W	2	0.4
NH	59	E	2	0.4
NH	59	W	2	0.4
NH	71	E	2	0.4
NP	39	N	2	0.4
NP	45	E	2	0.4
NP	45	W	2	0.4
NP	74	N	2	0.4
NP	74	S	2	0.4
NP	78	W	2	0.4
NP	100	E	2	0.4
NP	100	W	2	0.4
NP	105	E	2	0.4
NP	105	W	2	0.4
NP	108	E	2	0.4
NP	110	N	2	0.4
NP	110	S	2	0.4
NP	111	N	2	0.4
NP	112	N	2	0.4
NP	113	N	2	0.4
NP	113	S	2	0.4
NP	114	N	2	0.4
NP	114	S	2	0.4

Table 5-2
Sidewalk Flooding Potential
March 16, 2006

Community	Block Designation1	Side (N,S,E,W)	Curb Height Category	Longitudinal Slope (%)
NH	2	E	3	0.4
NH	71	W	3	0.4
NP	38	N	3	0.4
NP	42	E	3	0.4
NP	44	W	3	0.4
NP	50	E	3	0.4
NP	78	E	3	0.4
NP	80	E	3	0.4
NP	80	W	3	0.4
SP	10	N	3	0.4
SP	10	S	3	0.4
SP	38	E	3	0.4
SP	38	W	3	0.4
NH	17	E	1	0.5
NH	90	N	1	0.5
NP	70	S	1	0.5
NH	25	N	2	0.5
NH	65	S	2	0.5
NH	90	S	2	0.5
NP	24	W	2	0.5
NP	53	E	2	0.5
NP	53	W	2	0.5
NP	70	N	2	0.5
NP	71	N	2	0.5
NP	71	S	2	0.5
NP	72	S	2	0.5
NP	73	N	2	0.5
NP	73	S	2	0.5
NH	17	W	3	0.5
NH	25	S	3	0.5
NH	60	E	3	0.5
NH	60	W	3	0.5
NH	62	N	3	0.5
NH	62	S	3	0.5
NH	63	N	3	0.5
NH	63	S	3	0.5
NH	64	N	3	0.5
NH	64	S	3	0.5
NH	65	N	3	0.5
NH	66	N	3	0.5
NH	66	S	3	0.5
NP	24	E	3	0.5
NP	52	E	3	0.5
NP	52	W	3	0.5
NP	72	N	3	0.5
NH	99	N	0	0.6
NH	99	S	0	0.6
NH	8	S	1	0.6
NH	9	S	1	0.6
NH	20	N	1	0.6
NH	21	S	1	0.6
NH	8	N	2	0.6
NH	9	N	2	0.6
NH	12	E	2	0.6
NH	12	W	2	0.6
NH	16	E	2	0.6
NH	21	N	2	0.6
NH	26	N	2	0.6

Table 5-2
Sidewalk Flooding Potential
March 16, 2006

Community	Block Designation1	Side (N,S,E,W)	Curb Height Category	Longitudinal Slope (%)
NP	87	E	2	0.6
NP	87	W	2	0.6
NP	89	E	2	0.6
NH	16	W	3	0.6
NH	19	N	3	0.6
NH	19	S	3	0.6
NH	20	S	3	0.6
NH	26	S	3	0.6
NH	44	N	3	0.6
NH	44	S	3	0.6
NP	89	W	3	0.6
NH	7	N	1	0.7
NH	7	S	1	0.7
NH	79	S	1	0.7
NP	46	S	1	0.7
NP	47	N	1	0.7
NP	94	E	1	0.7
NH	5	S	2	0.7
NH	11	W	2	0.7
NH	14	E	2	0.7
NH	15	E	2	0.7
NH	15	W	2	0.7
NH	40	E	2	0.7
NH	40	W	2	0.7
NH	79	N	2	0.7
NP	46	N	2	0.7
NP	47	S	2	0.7
NP	94	W	2	0.7
NH	5	N	3	0.7
NH	11	E	3	0.7
NH	14	W	3	0.7
NH	6	N	1	0.8
NH	47	S	1	0.8
NH	51	N	1	0.8
NH	51	S	1	0.8
NH	102	N	1	0.8
NH	6	S	2	0.8
NH	45	S	2	0.8
NH	46	S	2	0.8
NH	102	S	2	0.8
NP	97	E	2	0.8
NP	97	W	2	0.8
NH	13	E	3	0.8
NH	13	W	3	0.8
NH	45	N	3	0.8
NH	46	N	3	0.8
NH	47	N	3	0.8
NP	43	W	1	0.9
NP	54	E	1	0.9
SP	46	E	1	0.9
NP	43	E	2	0.9
NP	51	E	2	0.9
NP	51	W	2	0.9
SP	46	W	2	0.9
SP	51	E	2	0.9
SP	51	W	2	0.9
SP	56	E	2	0.9
SP	56	W	2	0.9

Table 5-2
Sidewalk Flooding Potential
March 16, 2006

Community	Block Designation1	Side (N,S,E,W)	Curb Height Category	Longitudinal Slope (%)
NH	61	E	3	0.9
NH	61	W	3	0.9
NP	54	W	3	0.9
NH	74	W	1	1.0
NP	66	W	1	1.0
NP	69	W	1	1.0
NH	23	N	2	1.0
NH	72	S	2	1.0
NH	73	S	2	1.0
NH	74	E	2	1.0
NP	62	E	2	1.0
NP	62	W	2	1.0
NP	66	E	2	1.0
NP	69	E	2	1.0
NH	23	S	3	1.0
NH	32	N	3	1.0
NH	32	S	3	1.0
NH	72	N	3	1.0
NH	73	N	3	1.0
NH	30	S	1	1.1
NH	27	N	2	1.1
NH	27	S	2	1.1
NH	29	N	2	1.1
NH	30	N	2	1.1
NH	31	N	2	1.1
NH	31	S	2	1.1
NP	11	E	2	1.1
NP	11	W	2	1.1
NP	17	E	2	1.1
NP	17	W	2	1.1
NP	23	E	2	1.1
NP	23	W	2	1.1
NP	90	E	2	1.1
NP	90	W	2	1.1
NP	92	W	2	1.1
NH	29	S	3	1.1
NP	92	E	3	1.1
NH	22	S	1	1.2
NH	22	N	2	1.2
NH	28	N	2	1.2
NH	28	S	2	1.2
NP	31	N	2	1.2
NP	31	S	2	1.2
NP	32	N	2	1.2
NP	32	S	2	1.2
NP	88	E	2	1.2
NP	88	W	2	1.2
NP	104	E	2	1.2
NP	104	W	2	1.2
NH	81	N	3	1.2
NH	81	S	3	1.2
NP	30	S	1	1.3
NP	30	N	2	1.3
NP	96	W	2	1.3
NH	49	N	3	1.3
NH	49	S	3	1.3
NH	50	N	3	1.3
NH	50	S	3	1.3

Table 5-2
Sidewalk Flooding Potential
March 16, 2006

Community	Block Designation1	Side (N,S,E,W)	Curb Height Category	Longitudinal Slope (%)
NP	96	E	3	1.3
SP	52	W	1	1.4
SP	57	W	1	1.4
SP	52	E	3	1.4
SP	57	E	3	1.4
NP	26	N	2	1.5
NP	26	S	3	1.5
NP	76	E	2	1.6
NP	76	W	3	1.6
NH	41	E	1	1.9
NH	41	W	2	1.9
NP	63	E	2	1.9
NP	67	E	2	1.9
NP	67	W	2	1.9
NP	63	W	3	1.9
SP	23	W	1	2.0
SP	44	N	1	2.0
NP	86	W	2	2.0
SP	44	S	2	2.0
NP	6	E	3	2.0
NP	6	W	3	2.0
NP	79	E	3	2.0
NP	79	W	3	2.0
NP	86	E	3	2.0
SP	23	E	3	2.0
NH	52	N	2	2.2
NH	52	S	3	2.2
NP	27	N	2	2.5
NP	27	S	3	2.5
NP	41	E	3	2.5
NP	41	W	3	2.5
NP	15	W	1	2.6
NP	15	E	2	2.6
SP	47	W	1	2.7
SP	47	E	2	2.7
NP	59	S	2	3.4
NP	58	N	3	3.4
NP	58	S	3	3.4
NP	59	N	3	3.4
SP	24	E	1	3.5
SP	33	E	1	3.5
SP	39	W	1	3.5
SP	24	W	2	3.5
SP	33	W	2	3.5
SP	39	E	2	3.5
SP	1	N	1	3.7
SP	1	S	3	3.7
SP	27	S	2	3.9
SP	8	N	3	3.9
SP	8	S	3	3.9
SP	27	N	3	3.9
SP	28	N	3	3.9
SP	28	S	3	3.9
NP	3	S	2	4.2
NP	3	N	3	4.2
NP	7	E	1	5.0
NP	7	W	1	5.0
NP	28	N	3	5.0

Table 5-2
Sidewalk Flooding Potential
March 16, 2006

Community	Block Designation1	Side (N,S,E,W)	Curb Height Category	Longitudinal Slope (%)
NP	28	S	3	5.0
NP	49	E	3	5.2
NP	49	W	3	5.2
NP	1	E	2	6.0
NP	1	W	2	6.0
SP	22	S	2	6.3
SP	22	N	3	6.3
SP	36	E	3	6.3
SP	36	W	3	6.3
SP	16	E	1	6.5
SP	16	W	3	6.5
SP	34	E	3	6.7
SP	34	W	3	6.7
SP	35	E	3	6.7
SP	35	W	3	6.7
NP	64	S	2	7.1
NP	64	N	3	7.1
NP	65	N	3	7.1
NP	65	S	3	7.1
SP	9	N	3	7.7
SP	9	S	3	7.7
SP	40	E	3	9.3
SP	40	W	3	9.3
SP	25	E	3	10.0
SP	25	W	3	10.0
NP	29	N	2	11.3
NP	29	S	3	11.3
SP	19	E	3	12.0
SP	19	W	3	12.0
NP	60	N	3	12.5
NP	60	S	3	12.5

Notes:
1. Based on full carrying capacity of either curb-to-curb width or half-width, depending on local condition. Does not include maintaining a dry travel lane.
2. Not part of detailed study area; curb height and street slope are estimated.

K:\095240029\Excel\[Sidewalk Flooding Potential.xls]Numerical Order

The most severely impacted blocks are those serving the very large watersheds, as shown on Figure 2. The runoff in those areas cannot be contained within the street section, and in most cases even a one-year storm exceeds the street capacity. Furthermore, in the most severely overloaded locations, even raising the curbs to full 6 inch height will not provide sufficient capacity. **Table 5-3** provides a comparison of the carrying capacity of these streets and their estimated 1 year and 50 year flow rates.

TABLE 5-3
RUNOFF FROM LARGE WATERSHEDS

Watershed	Runoff (cfs) 1-year storm	50-year storm	Carrying Capacity of Receiving Street (cfs) (Existing curb height)	Carrying Capacity of Receiving Street (cfs) (With 6" curb height) [1]
Florida Street	22	58	55	55
Upas Street	5	12	8	14
Upper Grim Avenue	5	11	8	24
Lower Grim Avenue	11	27	4	6
31st Street	6	16	8	13
Upper Herman Avenue [2]	2.5	6	4	6
Lower Herman Avenue	10	25	3	4
Utah Street	7	18	14	26
Kansas Street	14	36	7	10
Texas Street	3	7	3	25
Texas Street with alley flow added	5	11	3	25

Notes:
1. Based on full carrying capacity of either curb-to-curb width or half-width, depending on local condition. Does not include maintaining a dry travel lane.
2. Not part of detailed study area; curb height and street slope are estimated.

5.5 Recommended Drainage Improvements

Some of the areas affected by poor drainage could be improved relatively easily by a limited extension of the existing local storm drain system. As part of the drainage review, Kimley-Horn identified a number of candidate locations for this type of improvement. In general, areas recommended for storm drain improvement are limited to those that are within about 100 to 200 feet of an existing system. However, a few longer extensions have been proposed in locations where the benefit is commensurate with the greater expense.

Unfortunately, parts of the study area have almost no access to nearby underground storm drain systems, and could be improved only by extension of a major trunk drain into the area. The central area of Normal Heights is the best example. While the construction of trunk drainage systems would be a valuable project, it was deemed to be beyond the scope of this study.

The following is a list of recommended improvement locations, followed by descriptions of each recommended improvement and its associated benefits.

- “Lake Hawley (Hawley Blvd. and North Mountain View Drive)
- Grape Street
- Texas Street
- Utah Street at Monroe
- Kansas Street
- Adams Avenue
- Myrtle Avenue
- Ray Street

5.5.1 “Lake Hawley”

The intersection of Hawley Blvd. and North Mountain View Drive was identified by the Normal Heights Community Association as having an especially severe chronic drainage problem. The intersection is equipped with non-standard “pass-through” drainage tubes at all four curb returns. These do not appear to provide any useful function since they are below the elevations of the adjacent gutters and partially plugged. KHA performed field surveys which revealed that some of the street pavement is actually above the adjacent sidewalk and residential property.

In addition, the adjacent streets lie at near-zero slopes. Some of the existing top-of-curb elevations near the curb returns were found to be at essentially the same elevation as the gutters 100 feet north of the intersection, indicating that positive surface drainage is not achievable under normal design standards. Also, the crowned centerline of North Mountain View Drive is higher than the sidewalks at the two southerly curb returns. Thus, the road essentially forms a dam that causes persistent flooding of the sidewalks and adjacent yards at the two south corners.

From an examination of the surrounding topography, it appears that this intersection was historically intended to drain toward the north. This drainage pattern was probably never well developed due to flat terrain, and years of repaving projects have added to the deficiency.

The recommended improvement work for this intersection has two goals:

1. Lower the elevation of the street gutters to an elevation below the adjacent sidewalks and residential lots, and;
2. Develop a positive drainage condition providing at least a minimal outlet for surface waters, since the survey data has established that surface drainage based on standard design criteria is not feasible.

The proposed improvement project consists of constructing new concrete cross gutters in a north-south direction across the intersection on both sides of Hawley Blvd. A strip of pavement would be removed and replaced along the sides of Hawley Blvd. and within the intersection to obtain positive drainage toward the north. It does not appear to be physically possible to achieve the City’s usual standard gutter slope of 0.6% in this location. It will be necessary to accept much flatter slopes and there is some possibility that minor ponding may occur along the north leg of Hawley Blvd. even after construction. However, this would be minor in nature and typically would not impact the ability of pedestrians to cross all four legs of the intersection, unlike the existing condition.

Because the project will re-establish the historic pattern of drainage toward the north, provisions should be made for intercepting this runoff at the north end of Hawley Blvd. (within Cromwell Place). This cul-de-sac is served by a pair of outlets, one at each end of the cul-de-sac. In addition, the two curb returns are equipped with non-standard "pass-through" drainage tubes similar to the ones that exist at North Mountain View Drive. The drainage tubes appear to provide little or no useful function. The proposed improvement at this location consists of new curb inlets at the north end of Hawley Blvd. to capture flows before they enter Cromwell Pl. A pipe would then convey the flows to the existing discharge system.

The entire block of Hawley Blvd. extending north to Cromwell Pl. is extremely flat. Even with the above improvements, there would still be a concern that on-going drainage issues might exist along the entire block. If possible, this situation could be mitigated by constructing an underground storm drain system incorporating new inlets at the N. Mountain View Dr. intersection, with a pipe extending to the outlet point at Cromwell Pl. It is unlikely that such a pipe could be constructed using standard minimum slopes, but a pipe with less-than-standard slopes could still represent a significant improvement. Obstacles to constructing this pipe should be investigated early in the final design process to verify that the installation is feasible. Because of the very limited elevation difference along the street, potholing should be performed to verify the elevation of the outlet pipes and any utility crossings. Also, locating a clear corridor for the new pipe could be a challenge, probably requiring relocation of an existing gas line.

Another step that could be addressed during final design would be a detailed field survey of all gutter elevations along this area to identify any low points. If any exist, they could be corrected as part of the proposed work. For purposes of a conceptual cost estimate, we have assumed a strip replacement along one entire side of the block, replacement of 250 feet of curb, and installation of an underground storm drain system from N. Mountain View Dr. to the outlet point at Cromwell Pl.

The proposed improvements are shown on **Figure 3, Hawley/North Mountain View Improvements**.

5.5.2 Grape Street

The drainage outlet for Segment SP49 is located at a low point along Grape Street in South Park. This location is in a canyon crossing where the street slopes down steeply from each side. The runoff is collected by curb inlets on both sides of the street which are not large enough to handle large storms without overflowing. Of particular concern is the south side of the street, where there is a near-zero curb height, resulting in probable frequent flooding of the sidewalk. The adjacent residential properties lie below the street, so in addition to the sidewalk flooding, the storm flows also have the potential to impact residences. Fortunately, an existing storm drain pipe is located directly beneath the existing inlets. The recommended improvement consists of enlarging the inlets and, on the south side, grinding the existing pavement to create an adequate gutter and curb height. Because of the potential for residential flooding, this project has been assigned a high level of improvement priority. See **Figure 4, Grape Street Drainage Improvement**.

5.5.3 Texas Street

Several unique conditions exist along segment NP92, which is Texas Street just north of El Cajon Blvd. In the mid-block area a pair of alleys enter the street from both sides. These alleys have relatively significant drainage areas of about 1.6 acres. The drainage from these alleys is estimated as 3 cfs for one-year storms, and 7 cfs for 50-year storms. Even the one-year flow from each alley equals the entire carrying capacity of the substandard gutter along Texas Street, without considering the other flows already being carried in the street. This problem is especially pronounced on the east side, which also serves an upstream basin of 5.5 acres.

On the west side of Texas Street, the upstream flows are not as great, but surface grades are defective, resulting in permanent ponding in the alley entrance which partially blocks pedestrian movement. The City's GIS storm drain mapping indicates a pair of inlets along Meade Avenue just west of Texas, which appear to provide protection to this segment. Field investigation revealed that the inlet on the south side of Meade does not exist, and only a small grated inlet exists on the north side.

District 3 Sidewalk Study - Pase II

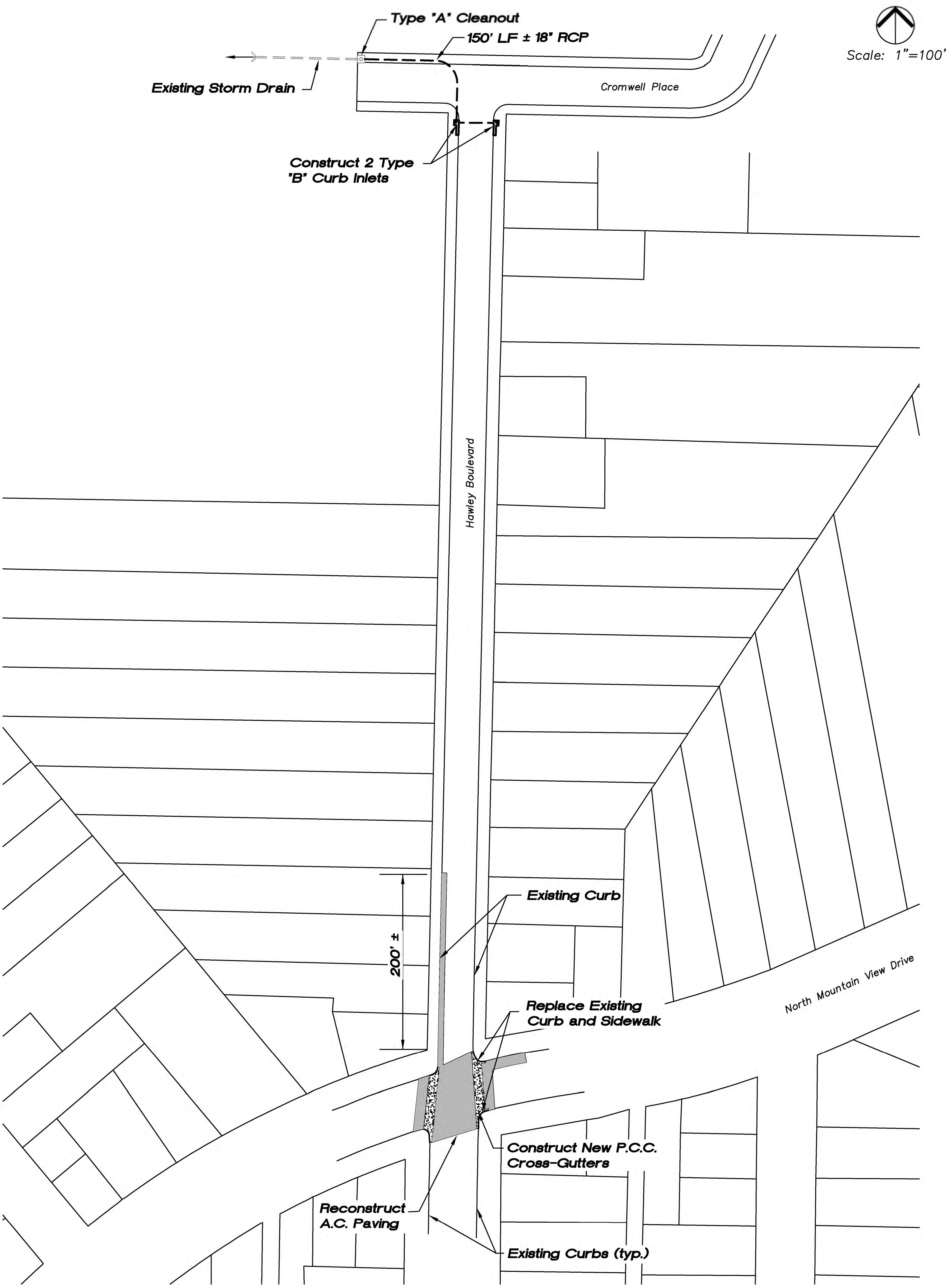


Figure 3

Hawley/North Mountain View Improvements

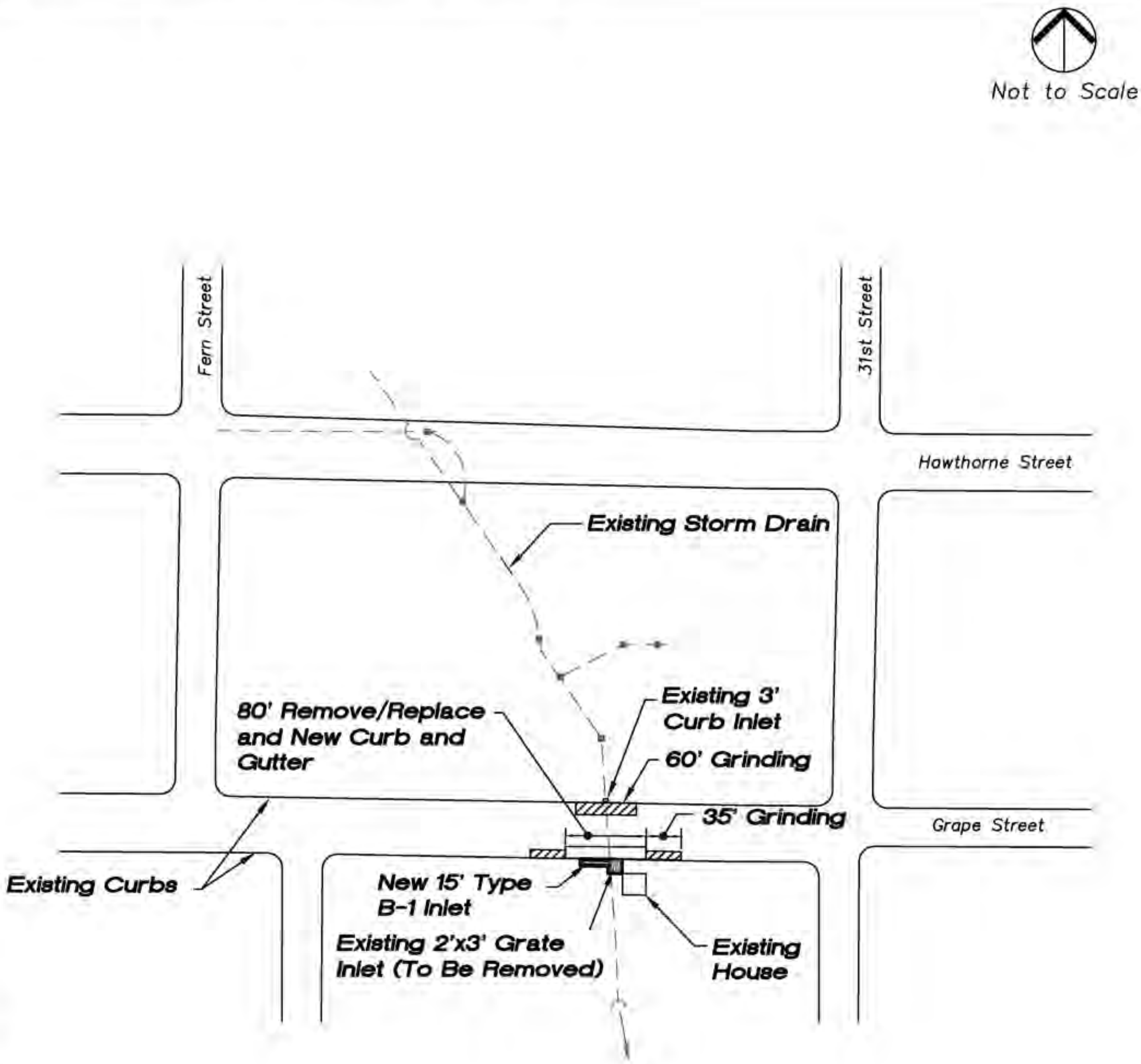


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Figure 4

Grape Street Drainage Improvements

Installation of storm drain inlets here could provide two benefits: a curb inlet along the east side of Texas Street could capture the significant upstream flows, reducing the likelihood of flows topping the curb, and a grated inlet in the alley just upstream of the sidewalk could capture the alley flows, so that pedestrians would not need to walk through the stream of runoff from the alley. A connection point for such a system is available about 200 feet away at the intersection of El Cajon Blvd. See **Figure 5, Texas Street Drainage Improvement**.

Another undesirable pedestrian condition exists at the south end of the block, where Texas Street meets El Cajon Blvd. Here, non-standard “corner-type” curb inlets exist in the middle of all four curb returns. These inlets preclude the construction of standard curb ramps, and as a result no curb ramps exist at this busy intersection. The City has recently installed a new traffic signal pole at the northeast corner which further restricts installation of standard curb ramps. SANDAG has proposed the development of a bus rapid transit station at this intersection. If implemented, the station improvements could be coordinated with curb and drainage modifications to this intersection to add curb ramps and eliminate the barriers to pedestrians. It is recommended that the City coordinate with SANDAG transit staff regarding this location.

5.5.4 Utah Street at Monroe

The two southerly curb returns here (west end of segment NP103) are occupied by non-standard “corner-type” curb inlets which preclude construction of curb ramps. The installation of a pair of new Type B curb inlets immediately south of the curb return would allow these older, non-standard inlets to be removed and proper curb ramps to be installed. A severe pavement hump exists near the southeast curb return which does not impact pedestrian movement but does create a poor driving surface for vehicles. This defect could be readily corrected as part of this work. See **Figure 6, Utah Street Drainage Improvement**.

5.5.5 Kansas Street

The segment of Kansas Street identified as NP99 drains the largest single drainage basin (34.4 acres) of any segment in the Detailed Study Area. The estimated runoff for even one-year storms is well in excess of the street’s carrying capacity, even if the curbs could be upgraded to full six inch height. In the existing condition, the 50-year runoff rate is about five times the capacity of the street. Furthermore, due to flat grades and limited inlet capacity on the north side of Adams Avenue, the basin may also receive overflow from areas north of Adams.

To resolve these problems, a storm drain extension has been proposed, as shown on **Figure 7, Kansas Street Drainage Improvements**. Because the lack of capacity is so severe at this location, two separate drainage connections are proposed, each of which would capture roughly half of the flows from the basin. However, the two connections will be listed as two separate projects in the list of Improvement Recommendations (Section 8) because if funding were only available to perform part of the work, the shorter and less costly connection provides the greater benefit by intercepting nearly the entire upstream basin.

The curb heights along segment NP99 are slightly substandard and might warrant improvement under the criteria of this study. However, the proposed drainage improvements would adequately mitigate the substandard curb condition, so no street improvements are proposed for this segment.

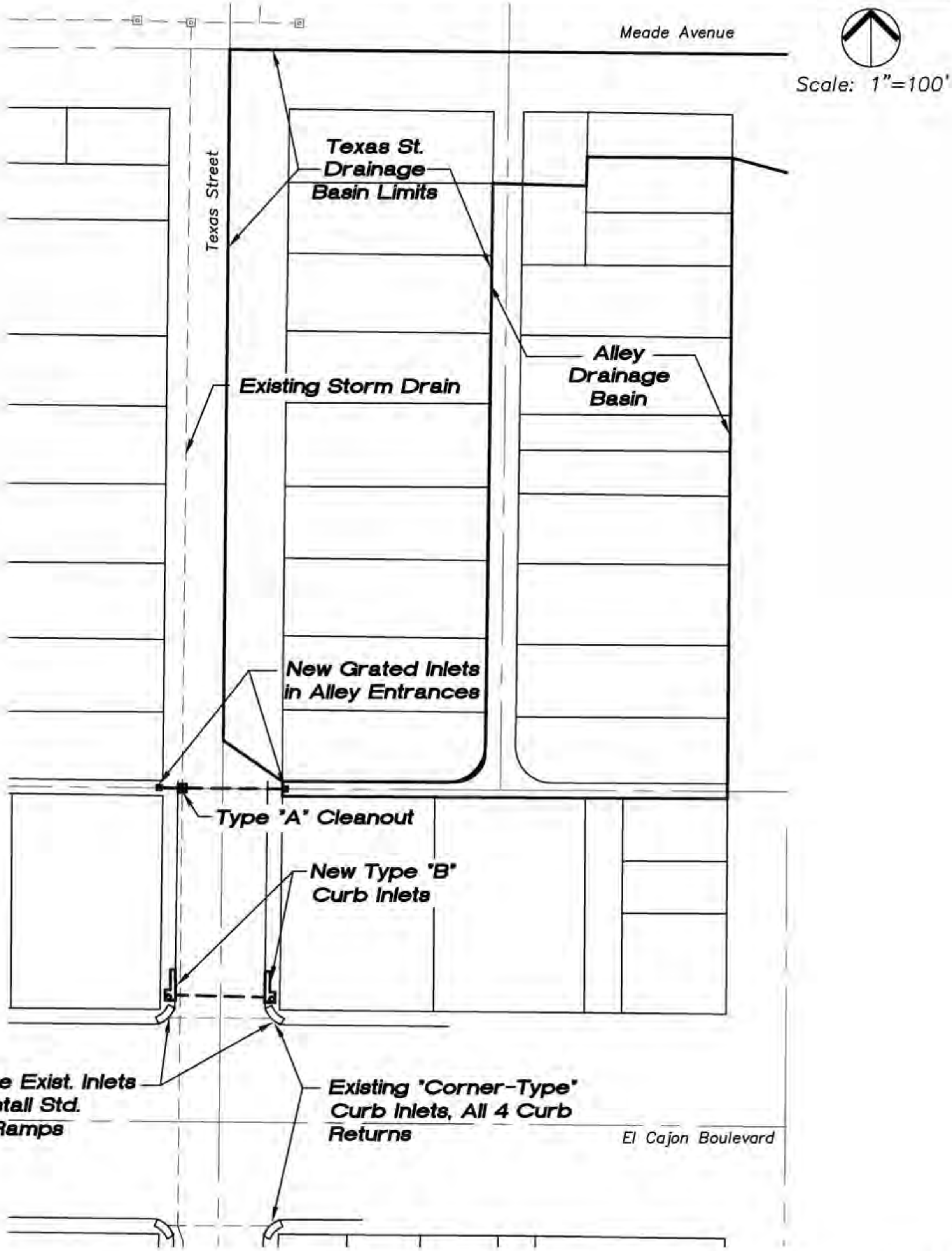

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Figure 5
Texas Street
Drainage Improvements

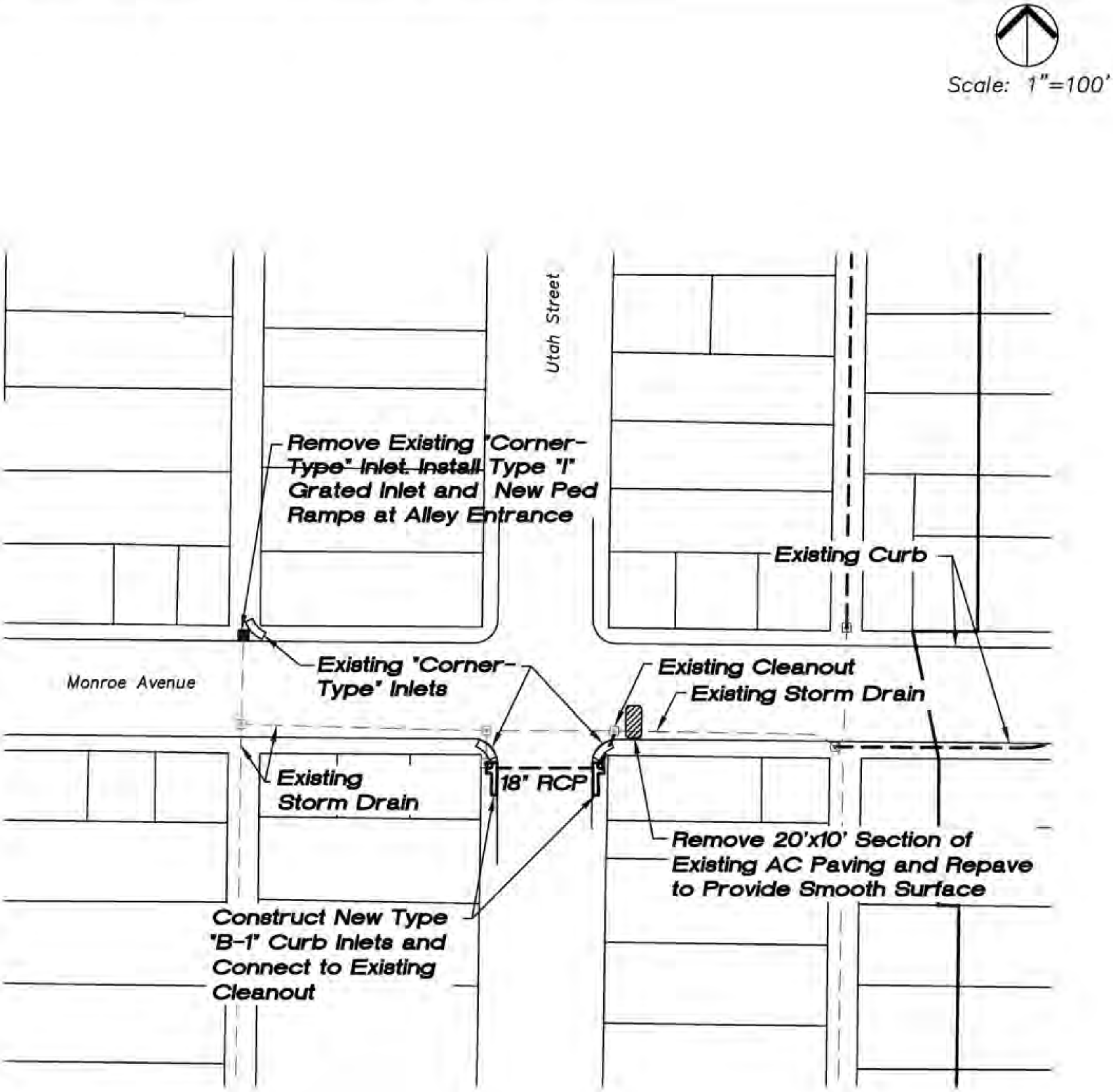

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Figure 6
Utah Street
Drainage Improvements

District 3 Sidewalk Study-Phase III

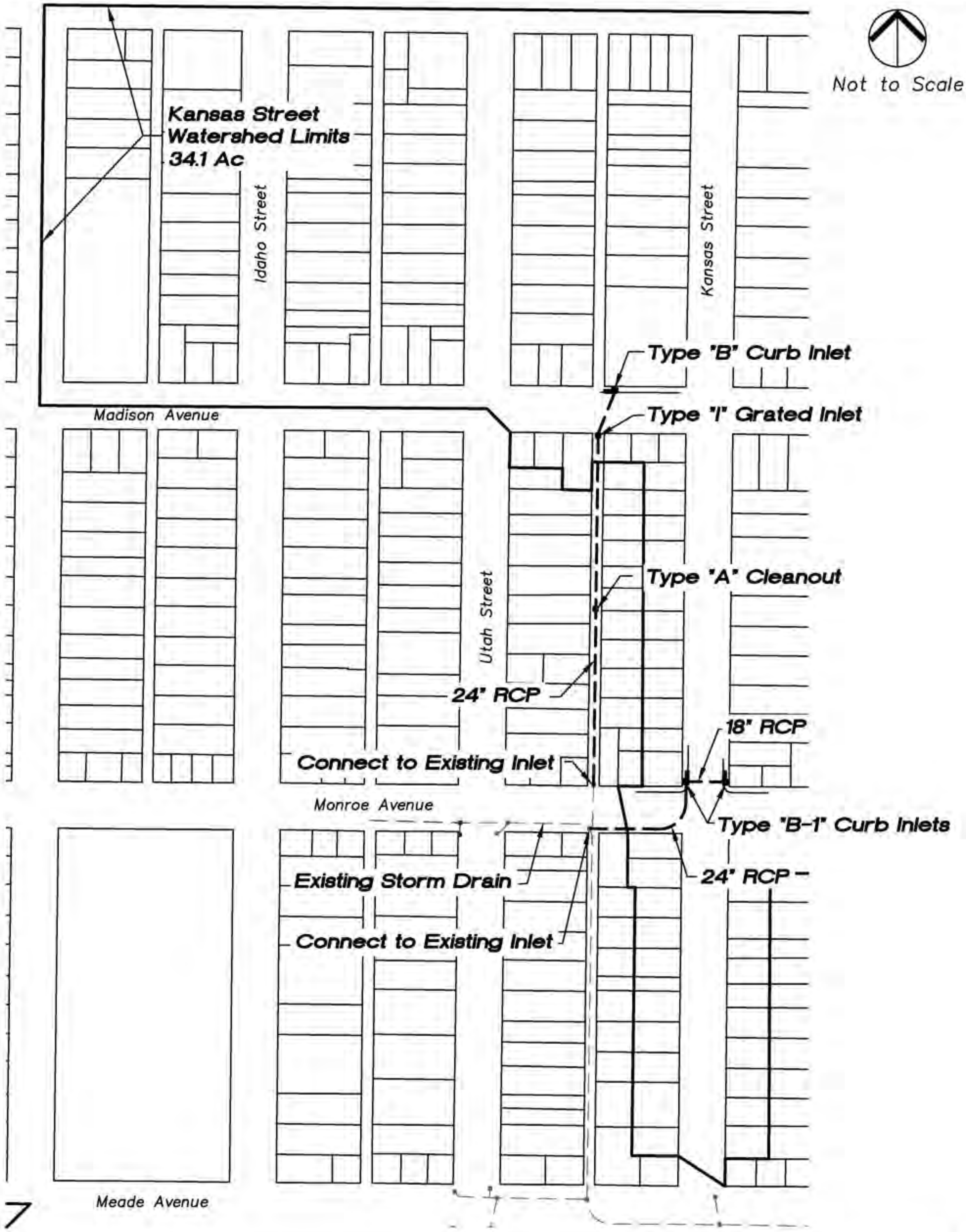

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Figure 7
Kansas Street Improvements

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