Appendix Volume 2 Appendix 1.2

DRAINAGE IMPROVEMENT OPTIONS THAT WERE

ELIMINATED

FROM FURTHER CONSIDERATION.

OPTION 29 IS THE RECOMMENDED OPTION – See Volume 1 – Section 6 for description and results

Option and Facility Development Procedure

A Drainage Option represents a distinct SWMM model or in a few cases an Option was not modeled, but evaluated external to SWMM. Each SWMM model contains parameters required to simulate distinct Drainage Facilities. Distinct Facilities were developed to assist in cost estimating and funding (facilities may need to be funded over time in various phases).

The Alcalde, Barelas and Broadway Basins are hydraulically connected and therefore solutions developed for specific flood problem locations will affect other locations. The facilities sometimes involve removal of either existing ponds or storm drains as required for a specific facility or group of facilities to function as intended.

The progression of Option or SWMM model development was driven by the goal to eliminate street ponding. If the model results indicated that the proposed drainage facilities did not eliminate the street ponding; then another option was developed with different facilities with the same goal, to eliminate street flooding.

The most significant flooding problem and high priority area is the Broadway-Lomas intersection. In addition, the COA and AMAFCA have directed that Options be evaluated to determine if the Broadway-Lomas detention pond could be removed so that property may be utilized at its highest and best use that is most likely commercial use.

Therefore, the Broadway-Lomas pond was removed from most Options (models) and in conjunction, other facilities *have been included and / or deleted*.

Facility Conceptual Design Assumptions

Proposed Detention Ponds

Proposed detention ponds were conceptually designed by evaluating the upstream and downstream manhole invert as-built elevations and existing street as-built elevations to determine the maximum pipe diameters that may be built as pond inflow and outfall pipes near the pond locations. In addition, the ground elevations for the proposed pond sites were evaluated based on the 1- or 2-foot contour elevations as presented on the **Drainage Basin Maps** (5 maps

included as PDFs on the CD in map pocket - Volume 1). Subsequently, pond side slopes were assumed as 1V:2H for most ponds, although 1V:1H and 1V:1.5H were required for a two proposed ponds to provide the required storage volume without spilling. Each pond was conceptually simulated as the deepest and the largest areal extent possible at the given pond location. The conceptual pond sizes (areal extents) may be minimized during a preliminary design analysis. Proposed detention pond locations are presented on **Figure 6-1** (map pocket - Volume 1).

Proposed Storm Drains

Proposed storm drains were evaluated based on the manhole as-built elevations (inverts and rims). Most proposed storm drains had 3-feet of cover or greater and 1.5 feet was the minimum cover allowed. Proposed storm drain locations are presented on **Figure 6-1** (map pocket – Volume 1).

DRAINAGE OPTION AND FACILITY DESCRIPTIONS

Thirty-two (32) drainage options and corresponding SWMM models were prepared. Each model simulates various combinations of proposed drainage facilities. The large volume of information required to describe and summarize the results of all eliminated options and facilities considered is included in **Appendix 1.2 - Volume 2**.

The Options and associated Facilities are described here and then the SWMM model results are summarized and the Conclusion of the flood reduction of the Option is presented.

Facilities that begin with a number such as "Facility 10", are included as a likely viable proposed facility and are those presented on **Figure 6-1** (map pocket – Volume 1).

Facilities that begin with an "X" such as "Facility X1" are either existing facilities, or were considered as a new facility, modeled and usually excluded because the SWMM model results indicated that it did not significantly reduce or eliminate flood problems. Therefore these are presented and described to document that the facility was considered. *Small Figures to illustrate these locations are included for each Option as PDFs and are included* ***Appendix 1.2 - Volume 2***.

Figure 6-1 (map pocket - Volume 1) may be used to observe the general locations of "X" Facilities that are only described in this Section. Please refer to Figure 6-1 to observe the locations of the Proposed "F" Facilities described in this section.

Option 1 –

Purpose

Option 1 considered removal of the Broadway-Lomas detention pond from the existing model to understand the effect. The purpose was to determine the feasibility of pond removal in order to reclaim the pond property for its best and highest use as a valuable commercial property.

Facility 10 Remove the existing Broadway-Lomas Pond and sell this lot as a high value commercial property.

Modeling Approach

The Broadway-Lomas detention pond was deleted. The existing manhole number COA 32878.A located just north of Broadway-Lomas intersection was connected directly to an existing manhole COA32878.B with a 4.5 ft diameter RCP pipe in Broadway. Basin BR2, which previously had drained into the pond would now drain into COA32878.A. The option components are summarized in **Table 6-1** (Summary of Model Filenames and Components – Appendix Volume 2, Appendix 1).**Street Flooding Results**

This option created street ponding – flooding depths of over 1-foot deep between the Broadway-Lomas intersection to the Broadway-Odelia intersection as compared to the existing condition model results (with the Broadway-Lomas Pond) that indicate no ponding occurred in the same vicinity. **Table 6-2** summarizes the Option 1 manhole flooding (street ponding depths).

Appendix Volume 2, Appendix 1.2 contains the SWMM model output and additional information prepared to document information and computations for this Option.

Detention Pond Routing Results (changes relative to the existing conditions model)

The freeboard in the Air Quality Pond was reduced from 1.8 feet (existing) to 0.9 feet (see **Table 6-3).** The Tingley Surge Pond showed no change in freeboard that is about 5.5 feet (see **Table 6-4)**. *Please note the Tingley Pond 100-yr. peak water surface elevation remained below the pond invert elevation (remained within the outlet box structure below the 12 ft x 12 ft grate).*

Conclusion

The existing Broadway-Lomas detention pond serves its purpose in preventing flooding at the Broadway-Lomas intersection and on Broadway north to about Odelia Road. An effective alternative must be considered to mitigate flooding should the pond be removed.

TABLE 6-2
SUMMARY OF OPTION 1 STREET PONDING AND MAN-HOLE FLOODING

Note- negative numbers imply that the HGL did not reach the manhole rim

Represents flooding depth over 1 ft
Represents flooding between 0.5ft - 0.99 ft
Represents flooding depth between 0 - 0.5 ft

MH Name	Manhole Invert Elev.	Max. Depth of Manhole	Manhole Rim Elev.	Maximum HGL	Node Flood Depth Above Manhole Rim	Flood Volume	Flood Volume	Hours Flooded
	(ft)	(ft)	(ft)	(ft)	(ft)	(10^6 gal)	(acre-ft)	
	(a)	(a)	(b)	(c)	(d)	(e)	(f)	
COA6045	4957.51	7.82	4965.33	4965.42	0.09	0.422	1.295	5.08
COA15184	4954.19	10.04	4964.23	4964.79	0.56	1.088	3.339	5.98
COA6218	4953.66	9.34	4963	4963.47	0.47	0.821	2.520	6.27
COA6195	4962.97	6.74	4969.71	4970.14	0.43	0.261	0.801	1.63
COA6246	4962.06	7.85	4969.91	4969.91	0	0.006	0.018	0.06
COA7635	4957.34	7.29	4964.63	4966.57	1.94	0.42	1.289	2.46
COA7650	4954.93	8.35	4963.28	4963.82	0.54	0.161	0.494	2.55
COA7656	4953.17	9.45	4962.62	4962.65	0.03	0.08	0.246	0.38
COA29132	4960.03	14.23	4974.26	4974.75	0.49	0.071	0.218	0.72
COA7717	4949.54	9.19	4958.73	4959	0.27	0.078	0.239	1.1
COA19719	4952.3	9.98	4962.28	4963.08	0.8	1.156	3.548	6.35
COA7654	4951.67	8.59	4960.26	4960.9	0.64	1.111	3.410	6.47
COA7714	4950.14	7.86	4958	4958.82	0.82	1.829	5.613	6.44
COA25349	4945.26	11.07	4956.33	4956.35	0.02	0.304	0.933	0.55
COA25656	4948.86	10.32	4959.18	4959.34	0.16	0.259	0.795	1.91
COA25622	4948.24	9.58	4957.82	4957.86	0.04	0.075	0.230	0.83
COA7444	4952.87	7.72	4960.59	4961.04	0.45	1.056	3.241	14.66
COA7476	4950.32	7.85	4958.17	4959.01	0.84	1.151	3.532	16.11
COA7518	4947.94	8.89	4956.83	4957.5	0.67	0.918	2.817	15.18
COA24834	4944.52	7.06	4951.58	4951.67	0.09	0.423	1.298	3.59
COA25105	4946.31	10.2	4956.51	4956.52	0.01	0.044	0.135	0.39
COA25117	4945.26	11.29	4956.55	4956.56	0.01	0.021	0.064	0.15
COA7740	4949.69	8.25	4957.94	4958.02	0.08	0.345	1.059	3.11
COA7830	4944.87	12	4956.87	4956.88	0.01	0.237	0.727	0.61
COA7865	4946.34	10.46	4956.8	4956.82	0.02	0.107	0.328	0.42
COA7908	4946.15	10	4956.15	4956.16	0.01	0.055	0.169	0.19
COA7912	4945.61	10.68	4956.29	4956.3	0.01	0.021	0.064	0.07
COA7955	4943.49	12	4955.49	4955.5	0.01	0.084	0.258	0.36
COA22517	4943.59	11	4954.59	4954.61	0.02	0.152	0.466	0.63
COA7716	4948.88	9.23	4958.11	4958.88	0.77	0.236	0.724	1.72
COA7766JB	4943.95	12.33	4956.28	4957.93	1.65	0.525	1.611	1.99
COA7769JB	4944.52	11.81	4956.33	4959.07	2.74		0.000	
COA32865	4945.49	11.62	4957.11	4958.06	0.95	0.173	0.531	1.7
COA32878	4946.6	9.16	4955.76	4958.32	2.56	0.526	1.614	2.02
COA7848	4947.67	8.71	4956.38	4956.73	0.35	0.275	0.844	0.98
COA9248	4947.65	10.07	4957.72	4957.73	0.01	0.014	0.043	0.12
COA7963.11A	4951.67	9.48	4961.15	4961.84	0.69	0.334	1.025	2.18
COA22127	4937.86	7.66	4945.52	4946.58	1.06	0.12	0.368	1.9

Notes:

(a) Manhole invert elevation from SWMM input under Node Summary Table
(a) Depth of manhole from SWMM input under Node Summary Table
(b) Rim elevation = MH invert elevation + Max depth of manhole
(c) Max HGL from SWMM output table under Node Depth Summary
(d) Node Flood Depth above Manhole Rim = HGL Elev-Rim Elev
(e) Flood volume from SWMM output table under Node Flooding Summary
(f) 1 gallon = 3.06888 E-6 acre-ft

TABLE 6-3

AIR QUALITY DETENTION POND ROUTING SUMMARY

Detention Pond Name	Existing or Proposed Pond (detention or retention)	Model Analysis Point Name	Storm Return Period (100-yr. 24-hr. duration)	Peak Inflow	Peak Outflow	Peak Storage Volume	Peak Storage Volume	Peak Water Surface Elevation	Principal Spillway Elevation	Emergency Spillway Elevation	Pond Invert Elevation	Water Depth	Top of Pond Embankment Elevation	Freeboard to Emergency Spillway Elevation	**Freeboard to top of Pond Embankment**
				(cfs)	(cfs)	(ft^3)	(ac-ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)
a	a	a		b	c	g	c	d	e	e	e		e	f	f
OPTION 1															
Air Quality Pond	Existing	Air Quality Pond	100.0	220.0	107.0	480369	11.0	4961.8	4952.3	4962.7	4952.3	9.5	4962.7	0.9	**0.9**
OPTION 2															
Air Quality Pond	Existing	Air Quality Pond	100.0	244.0	132.0	525868	12.1	4962.5	4952.3	4962.7	4952.3	10.2	4962.7	0.2	**0.2**
OPTION 3															
Air Quality Pond	Existing	Air Quality Pond	100.0	176.0	49.0	352754	8.1	4959.9	4952.3	4962.7	4952.3	7.7	4962.7	2.7	**2.7**

TABLE 6-3

AIR QUALITY DETENTION POND ROUTING SUMMARY

Detention Pond Name	Existing or Proposed Pond (detention or retention)	Model Analysis Point Name	Storm Return Period (100-yr. 24-hr. duration)	Peak Inflow	Peak Outflow	Peak Storage Volume	Peak Storage Volume	Peak Water Surface Elevation	Principal Spillway Elevation	Emergency Spillway Elevation	Pond Invert Elevation	Water Depth	Top of Pond Embankment Elevation	Freeboard to Emergency Spillway Elevation	**Freeboard to top of Pond Embankment**
				(cfs)	(cfs)	(ft^3)	(ac-ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)
a	a	a		b	c	g	c	d	e	e	e		e	f	f
OPTION 4															
Air Quality Pond	Existing	Air Quality Pond	100.0	174.0	54.0	353774	8.1	4959.9	4952.3	4962.7	4952.3	7.7	4962.7	2.7	**2.7**
OPTION 5															
Air Quality Pond	Existing	Air Quality Pond	100.0	109.0	39.0	186964	4.3	4957.3		4962.7	4952.3	5.0	4962.7	5.4	**5.4**
OPTION 6															
Air Quality Pond	Existing	Air Quality Pond	100.0	109.0	39.0	172138	4.0	4957.0	4952.3	4962.7	4952.3	4.8	4962.7	5.6	**5.6**

TABLE 6-3

AIR QUALITY DETENTION POND ROUTING SUMMARY

Detention Pond Name	Existing or Proposed Pond (detention or retention)	Model Analysis Point Name	Storm Return Period (100-yr. 24-hr. duration)	Peak Inflow	Peak Outflow	Peak Storage Volume	Peak Storage Volume	Peak Water Surface Elevation	Principal Spillway Elevation	Emergency Spillway Elevation	Pond Invert Elevation	Water Depth	Top of Pond Embankment Elevation	Freeboard to Emergency Spillway Elevation	**Freeboard to top of Pond Embankment**
				(cfs)	(cfs)	(ft^3)	(ac-ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)
a	a	a		b	c	g	c	d	e	e	e		e	f	f
OPTION 7															
Air Quality Pond	Existing	Air Quality Pond	100.0	109.0	39.0	145109	3.3	4956.6	4952.3	4962.7	4952.3	4.3	4962.7	6.1	**6.1**
OPTION 8															
Air Quality Pond	Existing	Air Quality Pond	100.0	159.0	40.0	160007	3.7	4958.7	4952.3	4962.7	4952.3	6.4	4962.7	4.0	**4.0**
OPTION 9															
Air Quality Pond	Existing	Air Quality Pond	100.0	164.0	39.0	280885	6.4	4958.8	4952.3	4962.7	4952.3	6.6	4962.7	3.8	**3.8**

TABLE 6-3

AIR QUALITY DETENTION POND ROUTING SUMMARY

Detention Pond Name	Existing or Proposed Pond (detention or retention)	Model Analysis Point Name	Storm Return Period (100-yr. 24-hr. duration)	Peak Inflow	Peak Outflow	Peak Storage Volume	Peak Storage Volume	Peak Water Surface Elevation	Principal Spillway Elevation	Emergency Spillway Elevation	Pond Invert Elevation	Water Depth	Top of Pond Embankment Elevation	Freeboard to Emergency Spillway Elevation	**Freeboard to top of Pond Embankment**
				(cfs)	(cfs)	(ft^3)	(ac-ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)
a	a	a		b	c	g	c	d	e	e	e		e	f	f
OPTION 10															
Air Quality Pond	Existing	Air Quality Pond	100.0	107.0	39.0	246027	5.6	4958.3	4952.3	4962.7	4952.3	6.0	4962.7	4.4	**4.4**
OPTION 11															
Air Quality Pond	Existing	Air Quality Pond	100.0	159.0	45.0	337687	7.8	4959.7	4952.3	4962.7	4952.3	7.4	4962.7	3.0	**3.0**
OPTION 12															
Air Quality Pond	Existing	Air Quality Pond	100.0	159.0	46.0	337681	7.8	4959.9	4952.3	4962.7	4952.3	7.6	4962.7	2.8	**2.8**

TABLE 6-3

AIR QUALITY DETENTION POND ROUTING SUMMARY

Detention Pond Name	Existing or Proposed Pond (detention or retention)	Model Analysis Point Name	Storm Return Period (100-yr. 24-hr. duration)	Peak Inflow	Peak Outflow	Peak Storage Volume	Peak Storage Volume	Peak Water Surface Elevation	Principal Spillway Elevation	Emergency Spillway Elevation	Pond Invert Elevation	Water Depth	Top of Pond Embankment Elevation	Freeboard to Emergency Spillway Elevation	**Freeboard to top of Pond Embankment**
				(cfs)	(cfs)	(ft^3)	(ac-ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)
a	a	a		b	c	g	c	d	e	e	e		e	f	f
OPTION 13															
Air Quality Pond	Existing	Air Quality Pond	100.0	207.0	81.0	369631	8.5	4960.2	4952.3	4962.7	4952.3	7.9	4962.7	2.5	**2.5**
OPTION 14															
Air Quality Pond	Existing	Air Quality Pond	100.0	192.0	60.0	371698	8.5	4960.2	4952.3	4962.7	4952.3	7.9	4962.7	2.4	**2.4**
OPTION 15															
Air Quality Pond	Existing	Air Quality Pond	100.0	195.0	115.0	453749	10.4	4961.4	4952.3	4962.7	4952.3	9.1	4962.7	1.3	**1.3**

TABLE 6-3

AIR QUALITY DETENTION POND ROUTING SUMMARY

Detention Pond Name	Existing or Proposed Pond (detention or retention)	Model Analysis Point Name	Storm Return Period (100-yr. 24-hr. duration)	Peak Inflow	Peak Outflow	Peak Storage Volume	Peak Storage Volume	Peak Water Surface Elevation	Principal Spillway Elevation	Emergency Spillway Elevation	Pond Invert Elevation	Water Depth	Top of Pond Embankment Elevation	Freeboard to Emergency Spillway Elevation	**Freeboard to top of Pond Embankment**
				(cfs)	(cfs)	(ft^3)	(ac-ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)
a	a	a		b	c	g	c	d	e	e	e		e	f	f
OPTION 16															
Air Quality Pond	Existing	Air Quality Pond	100.0	164.0	39.0	280885	6.4	4958.8	4952.3	4962.7	4952.3	6.6	4962.7	3.8	**3.8**
OPTION 17															
Air Quality Pond	Existing	Air Quality Pond	100.0	117.0	35.0	322965	7.4	4959.5	4952.3	4962.7	4952.3	7.2	4962.7	3.2	**3.2**
OPTION 18															
Air Quality Pond	Existing	Air Quality Pond	100.0	117.0	35.0	323100	7.4	4959.5	4952.3	4962.7	4952.3	7.2	4962.7	3.2	**3.2**
OPTION 19															

TABLE 6-3

AIR QUALITY DETENTION POND ROUTING SUMMARY

Detention Pond Name	Existing or Proposed Pond (detention or retention)	Model Analysis Point Name	Storm Return Period (100-yr. 24-hr. duration)	Peak Inflow	Peak Outflow	Peak Storage Volume	Peak Storage Volume	Peak Water Surface Elevation	Principal Spillway Elevation	Emergency Spillway Elevation	Pond Invert Elevation	Water Depth	Top of Pond Embankment Elevation	Freeboard to Emergency Spillway Elevation	**Freeboard to top of Pond Embankment**
				(cfs)	(cfs)	(ft^3)	(ac-ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)
a	a	a		b	c	g	c	d	e	e	e		e	f	f
Air Quality Pond	Existing	Air Quality Pond	100.0	206.0	125.0	449752	10.3	4961.4	4952.3	4962.7	4952.3	9.1	4962.7	1.3	**1.3**

a - See Drainage Basin Maps and Figure 6-1
b - See SWMM output for results "Node Inflow Summary" Table
c -Value calculated after unit conversion from SWMM output
d- See SWMM output for results "Node Depth Summary" Table
e - See Volume 2 Appendix 1.2 for Pond Routing Elev-Area-Capacity Discharge Data
f- Negative number indicates the flow depth exceeds referenced elevation - no freeboard available
g - Value from SWMM output under Storage Volume Summary

TABLE 6-4

TINGLEY SURGE POND ROUTING SUMMARY TABLE

Detention Pond Name	Existing or Proposed Pond (detention or retention)	Model Analysis Point Name	Storm Return Period (100-yr. 24-hr. duration)	Peak Inflow	Peak Outflow	Peak Storage Volume	Peak Storage Volume	Peak Water Surface Elevation	Principal Spillway Elevation	Emergency Spillway Elevation	Pond Invert Elevation	Water Depth	Top of Pond Embankment Elevation	Freeboard to Emergency Spillway Elevation	**Freeboard to top of Pond Embankment**
				(cfs)	(cfs)	(ft^3)	(ac-ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)
a	a	a		b	c	g	c	d	e	e	e		e	f	f
OPTION 1															
Tingley Surge Pond	Existing	Tingley Park Surge Pond	100	109	36	101400	2.328	4941.2	4932.21	4946.66	4941.66	-0.5	4946.66	5.5	**5.5**
OPTION 2															
Tingley Surge Pond	Existing	Tingley Park Surge Pond	100	116	21	89424	2.053	4941.1	4932.21	4946.66	4941.66	-0.5	4946.66	5.5	**5.5**
OPTION 3															
Tingley Surge Pond	Existing	Tingley Park Surge Pond	100	126	31	94712	2.174	4941.1	4932.21	4946.66	4941.66	-0.5	4946.66	5.5	**5.5**

TABLE 6-4

TINGLEY SURGE POND ROUTING SUMMARY TABLE

Detention Pond Name	Existing or Proposed Pond (detention or retention)	Model Analysis Point Name	Storm Return Period (100-yr. 24-hr. duration)	Peak Inflow	Peak Outflow	Peak Storage Volume	Peak Storage Volume	Peak Water Surface Elevation	Principal Spillway Elevation	Emergency Spillway Elevation	Pond Invert Elevation	Water Depth	Top of Pond Embankment Elevation	Freeboard to Emergency Spillway Elevation	**Freeboard to top of Pond Embankment**
				(cfs)	(cfs)	(ft^3)	(ac-ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)
a	a	a		b	c	g	c	d	e	e	e		e	f	f
OPTION 4															
Tingley Surge Pond	Existing	Tingley Park Surge Pond	100	140	35	117046	2.687	4941.3	4932.21	4946.66	4941.66	-0.4	4946.66	5.4	**5.4**
OPTION 5															
Tingley Surge Pond	Existing	Tingley Park Surge Pond	100	152	30	94515	2.170	4941.1	4932.21	4946.66	4941.66	-0.6	4946.66	5.6	**5.6**
OPTION 6															
Tingley Surge Pond	Existing	Tingley Park Surge Pond	100	120	29	84385	1.937	4941.1	4932.21	4946.66	4941.66	-0.6	4946.66	5.6	**5.6**

TABLE 6-4

TINGLEY SURGE POND ROUTING SUMMARY TABLE

Detention Pond Name	Existing or Proposed Pond (detention or retention)	Model Analysis Point Name	Storm Return Period (100-yr. 24-hr. duration)	Peak Inflow	Peak Outflow	Peak Storage Volume	Peak Storage Volume	Peak Water Surface Elevation	Principal Spillway Elevation	Emergency Spillway Elevation	Pond Invert Elevation	Water Depth	Top of Pond Embankment Elevation	Freeboard to Emergency Spillway Elevation	**Freeboard to top of Pond Embankment**
				(cfs)	(cfs)	(ft^3)	(ac-ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)
a	a	a		b	c	g	c	d	e	e	e		e	f	f
OPTION 7															
Tingley Surge Pond	Existing	Tingley Park Surge Pond	100	125	40	101860	2.338	4941.2	4932.21	4946.66	4941.66	-0.5	4946.66	5.5	**5.5**
OPTION 8															
Tingley Surge Pond	Existing	Tingley Park Surge Pond	100	136	41	68380	1.570	4941.2	4932.21	4946.66	4941.66	-0.5	4946.66	5.5	**5.5**
OPTION 9															
Tingley Surge Pond	Existing	Tingley Park Surge Pond	100	131	49	106594	2.447	4941.2	4932.21	4946.66	4941.66	-0.4	4946.66	5.4	**5.4**

TABLE 6-4

TINGLEY SURGE POND ROUTING SUMMARY TABLE

Detention Pond Name	Existing or Proposed Pond (detention or retention)	Model Analysis Point Name	Storm Return Period (100-yr. 24-hr. duration)	Peak Inflow	Peak Outflow	Peak Storage Volume	Peak Storage Volume	Peak Water Surface Elevation	Principal Spillway Elevation	Emergency Spillway Elevation	Pond Invert Elevation	Water Depth	Top of Pond Embankment Elevation	Freeboard to Emergency Spillway Elevation	**Freeboard to top of Pond Embankment**
				(cfs)	(cfs)	(ft^3)	(ac-ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)
a	a	a		b	c	g	c	d	e	e	e		e	f	f
OPTION 10															
Tingley Surge Pond	Existing	Tingley Park Surge Pond	100	114	36	97166	2.231	4941.2	4932.21	4946.66	4941.66	-0.5	4946.66	5.5	**5.5**
OPTION 11															
Tingley Surge Pond	Existing	Tingley Park Surge Pond	100	111	46	100866	2.316	4941.2	4932.21	4946.66	4941.66	-0.5	4946.66	5.5	**5.5**
OPTION 12															
Tingley Surge Pond	Existing	Tingley Park Surge Pond	100	112	38	106607	2.447	4941.2	4932.21	4946.66	4941.66	-0.5	4946.66	5.5	**5.5**
OPTION 13															
Tingley Surge Pond	Existing	Tingley Park Surge Pond	100	99	40	90804	2.085	4941.1	4932.21	4946.66	4941.66	-0.5	4946.66	5.5	**5.5**

TABLE 6-4

TINGLEY SURGE POND ROUTING SUMMARY TABLE

Detention Pond Name	Existing or Proposed Pond (detention or retention)	Model Analysis Point Name	Storm Return Period (100-yr. 24-hr. duration)	Peak Inflow	Peak Outflow	Peak Storage Volume	Peak Storage Volume	Peak Water Surface Elevation	Principal Spillway Elevation	Emergency Spillway Elevation	Pond Invert Elevation	Water Depth	Top of Pond Embankment Elevation	Freeboard to Emergency Spillway Elevation	**Freeboard to top of Pond Embankment**
				(cfs)	(cfs)	(ft^3)	(ac-ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)
a	a	a		b	c	g	c	d	e	e	e		e	f	f
OPTION 14															
Tingley Surge Pond	Existing	Tingley Park Surge Pond	100	96	45	110933	2.547	4941.2	4932.21	4946.66	4941.66	-0.4	4946.66	5.4	**5.4**
OPTION 15															
Tingley Surge Pond	Existing	Tingley Park Surge Pond	100	90	37	107322	2.464	4941.2	4932.21	4946.66	4941.66	-0.4	4946.66	5.4	**5.4**
OPTION 16															
Tingley Surge Pond	Existing	Tingley Park Surge Pond	100	131	49	106594	2.447	4941.2	4932.21	4946.66	4941.66	-0.4	4946.66	5.4	**5.4**

TABLE 6-4

TINGLEY SURGE POND ROUTING SUMMARY TABLE

Detention Pond Name	Existing or Proposed Pond (detention or retention)	Model Analysis Point Name	Storm Return Period (100-yr. 24-hr. duration)	Peak Inflow	Peak Outflow	Peak Storage Volume	Peak Storage Volume	Peak Water Surface Elevation	Principal Spillway Elevation	Emergency Spillway Elevation	Pond Invert Elevation	Water Depth	Top of Pond Embankment Elevation	Freeboard to Emergency Spillway Elevation	**Freeboard to top of Pond Embankment**
				(cfs)	(cfs)	(ft^3)	(ac-ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)
a	a	a		b	c	g	c	d	e	e	e		e	f	f
OPTION 17															
Tingley Surge Pond	Existing	Tingley Park Surge Pond	100	205	89	415800	9.545	4942.3	4932.21	4946.66	4941.66	0.6	4946.66	4.4	**4.4**
OPTION 18															
Tingley Surge Pond	Existing	Tingley Park Surge Pond	100	180	85	282583	6.487	4941.9	4932.21	4946.66	4941.66	0.2	4946.66	4.8	**4.8**
OPTION 19															
Tingley Surge Pond	Existing	Tingley Park Surge Pond	100	200	83	403136	9.255	4942.2	4932.21	4946.66	4941.66	0.6	4946.66	4.4	**4.4**

a - See Drainage Basin Maps and Figure 6-1
b - See SWMM output for results "Node Inflow Summary" Table
c -Value calculated after unit conversion from SWMM output
d- See SWMM output for results "Node Depth Summary" Table
e - See Volume 2 Appendix 1.2 for Pond Routing Elev-Area-Capacity Discharge Data
f- Negative number indicates the flow depth exceeds referenced elevation - no freeboard available
g - Value from SWMM output under Storage Volume Summary

Option 2 –

Purpose
The purpose of this option was to determine the feasibility of the Broadway-Lomas Pond removal and to determine if removal of the Broadway-Lomas weir (located in a manhole) would direct enough flow away from the Broadway-Lomas intersection to eliminate flooding and therefore warrant pond removal. The ultimate goal, as was Option 1, is to determine if the pond could be removed to reclaim the pond property for its best and highest use as a valuable commercial property.

Facility 10	Remove the existing Broadway-Lomas Pond and sell this lot as a high value commercial property.
Facility X1	Removal of the existing Broadway-Lomas weir

Modeling Approach
The Broadway-Lomas detention pond and Broadway-Lomas weir were deleted. The existing manhole number COA 32878.A located just north of Broadway-Lomas intersection was connected directly to an existing manhole COA32878.B with a 4.5 ft diameter RCP pipe in Broadway. The properties of the option components are summarized in **Table 6-1** (Summary of Model Filenames and Components - Appendix Volume 2, Appendix 1). Basin BR2 which previously had drained into the pond would now drain into manhole COA32878.A.

Street Flooding Results
This option created street ponding – flooding depths of over 1-foot deep between the Broadway-Lomas intersection and Broadway-Odelia intersection as compared to existing conditions model which indicated no ponding in the same vicinity. **Table 6-5** summarizes the Option 2 manhole flooding (street ponding depths). Weir removal had little effect on flooding depths in the immediate area when compared to just detention pond removal.

Appendix Volume 2, Appendix 1.2 contains the SWMM model output and additional information prepared to document information and computations for this Option.

Detention Pond Routing Results (changes relative to the existing conditions model)
The freeboard in the Air Quality Pond is 0.2 feet (see **Table 6-3).** The freeboard in the Tingley Surge Pond is 5.5 feet (see **Table 6-4**). Please note the 100-yr. peak water surface elevation remained below the pond invert elevation (remained within the outlet box structure below the 12 ft x 12 ft grate).

Conclusion
The existing Broadway-Lomas weir appears to divert some flow away from the Broadway Pump Station. However, weir removal had little effect on flooding depths in the Broadway-Lomas intersection.

TABLE 6-5
SUMMARY OF OPTION 2 STREET PONDING AND MAN-HOLE FLOODING

Note- negative numbers imply that the HGL did not reach the manhole rim

Represents flooding depth over 1 ft
Represents flooding between 0.5ft - 0.99 ft
Represents flooding depth between 0 - 0.5 ft

MH Name	Manhole Invert Elev.	Max. Depth of Manhole	Manhole Rim Elev.	Maximum HGL	Node Flood Depth Above Manhole Rim	Flood Volume	Flood Volume	Hours Flooded
	(ft)	(ft)	(ft)	(ft)	(ft)	(10^6 gal)	(acre-ft)	
	(a)	(a)	(b)	(c)	(d)	(e)	(f)	
COA6045	4957.51	7.82	4965.33	4965.42	0.09	0.428	1.313	5.18
COA15184	4954.19	10.04	4964.23	4964.79	0.56	1.107	3.397	6.14
COA6218	4953.66	9.34	4963	4963.47	0.47	0.81	2.486	6.39
COA6195	4962.97	6.74	4969.71	4970.07	0.36	0.234	0.718	1.32
COA6246	4962.06	7.85	4969.91	4969.92	0.01	0.072	0.221	0.57
COA7635	4957.34	7.29	4964.63	4966.19	1.56	0.373	1.145	2.17
COA7650	4954.93	8.35	4963.28	4963.59	0.31	0.157	0.482	2.43
COA7656	4953.17	9.45	4962.62	4962.64	0.02	0.333	1.022	1.96
COA7628	4960.44	11.03	4971.47	4971.48	0.01	0.032	0.098	0.48
COA29132	4960.03	14.23	4974.26	4974.71	0.45	0.067	0.206	0.68
COA7717	4949.54	9.19	4958.73	4958.97	0.24	0.072	0.221	1.06
COA19719	4952.3	9.98	4962.28	4963.08	0.8	1.163	3.569	6.45
COA7654	4951.67	8.59	4960.26	4960.9	0.64	1.112	3.413	6.55
COA7714	4950.14	7.86	4958	4958.83	0.83	1.862	5.714	6.44
COA25349	4945.26	11.07	4956.33	4956.35	0.02	0.33	1.013	0.61
COA25656	4948.86	10.32	4959.18	4959.31	0.13	0.214	0.657	1.86
COA25622	4948.24	9.58	4957.82	4957.83	0.01	0.063	0.193	0.94
COA7444	4952.87	7.72	4960.59	4961.04	0.45	1.056	3.241	14.65
COA7476	4950.32	7.85	4958.17	4959.01	0.84	1.15	3.529	16.1
COA7518	4947.94	8.89	4956.83	4957.5	0.67	0.918	2.817	15.18
COA24834	4944.52	7.06	4951.58	4951.67	0.09	0.412	1.264	3.57
COA25105	4946.31	10.2	4956.51	4956.52	0.01	0.036	0.110	0.31
COA7815	4943.48	13.4	4956.88	4956.89	0.01	0.297	0.911	0.56
COA7740	4949.69	8.25	4957.94	4958.04	0.1	0.349	1.071	3.06
COA7830	4944.87	12	4956.87	4956.88	0.01	0.257	0.789	0.71
COA7865	4946.34	10.46	4956.8	4956.81	0.01	0.096	0.295	0.47
COA7908	4946.15	10	4956.15	4956.16	0.01	0.074	0.227	0.24
COA7955	4943.49	12	4955.49	4955.5	0.01	0.109	0.335	0.45
COA22517	4943.59	11	4954.59	4954.6	0.01	0.142	0.436	0.61
COA7716	4948.88	9.23	4958.11	4958.86	0.75	0.259	0.795	1.8

TABLE 6-5
SUMMARY OF OPTION 2 STREET PONDING AND MAN-HOLE FLOODING

Note- negative numbers imply that the HGL did not reach the manhole rim

Represents flooding depth over 1 ft
Represents flooding between 0.5ft - 0.99 ft
Represents flooding depth between 0 - 0.5 ft

MH Name	Manhole Invert Elev.	Max. Depth of Manhole	Manhole Rim Elev.	Maximum HGL	Node Flood Depth Above Manhole Rim	Flood Volume	Flood Volume	Hours Flooded
	(ft)	(ft)	(ft)	(ft)	(ft)	(10^6 gal)	(acre-ft)	
	(a)	(a)	(b)	(c)	(d)	(e)	(f)	
COA7766JB	4943.95	12.33	4956.28	4957.9	1.62	0.544	1.669	1.96
COA7769JB	4944.52	11.81	4956.33	4957.84	1.51		0.000	
COA32865	4945.49	11.62	4957.11	4958.03	0.92	0.153	0.470	1.6
COA32878	4946.6	9.16	4955.76	4958.29	2.53	0.519	1.593	2
COA7848	4947.67	8.71	4956.38	4956.85	0.47	0.325	0.997	1.07
COA7816	4944.19	13.17	4957.36	4957.37	0.01	0.294	0.902	0.87
COA9248	4947.65	10.07	4957.72	4957.76	0.04	0.018	0.055	0.13
COA7963.11A	4951.67	9.48	4961.15	4961.72	0.57	0.429	1.317	2.23
COA32878.A	4947.19	8.39	4955.58	4958.2	2.62	0.434	1.332	2
COA32878.B	4946.27	9.58	4955.85	4958.01	2.16	0.369	1.132	1.96
COA22169	4939.35	6.75	4946.1	4946.83	0.73	0.646	1.983	4.02
COA22127	4937.86	7.66	4945.52	4945.59	0.07	0.127	0.390	1.93
COA9229	4913.15	27	4940.15	4940.5	0.35	0.029	0.089	0.59

Notes:

(a) Manhole invert elevation from SWMM input under Node Summary Table
(a) Depth of manhole from SWMM input under Node Summary Table
(b) Rim elevation = MH invert elevation + Max depth of manhole
(c) Max HGL from SWMM output table under Node Depth Summary
(d) Node Flood Depth above Manhole Rim = HGL Elev-Rim Elev
(e) Flood volume from SWMM output table under Node Flooding Summary
(f) 1 gallon = 3.06888 E-6 acre-ft

Option 3 –

Purpose

The purpose of Option 3 was to determine if the addition of an alternative detention pond (just north of the Broadway Pump Station) would mitigate flooding at the Broadway-Lomas intersection.

Facility 10	Remove the existing Broadway-Lomas Pond and sell this lot as a high value commercial property.
Facility X2	A pond at Broadway and Kinley (Burnt Out Warehouse west side of Broadway)

Modeling Approach

The Broadway-Lomas detention pond was deleted. The existing manhole number COA 32878.A located just north of Broadway-Lomas intersection was connected directly to an existing manhole COA32878.B with a 4.5 ft diameter RCP pipe in Broadway. A 10-foot deep detention pond (Warehouse Pond) was simulated near the Broadway-Kinley intersection. The pond was placed between manholes COA 7963.11A and COA7716 with appropriate inlet, outlet nodes, and pipes simulated in SWMM. The properties of the option components are summarized in **Table 6-1** (Summary of Model Filenames and Components- Appendix Volume 2, Appendix 1).

Street Flooding Results

This option reduced flooding depths although some remain greater than 1-foot from the Broadway-Marble intersection to the Broadway-Odelia intersection when compared to Option 1. The results are summarized in **Table 6-6**. The Broadway-Lomas intersection flooding remained over 1-foot deep.

TABLE 6-6
SUMMARY OF OPTION 3 STREET PONDING AND MAN-HOLE FLOODING

Note- negative numbers imply that the HGL did not reach the manhole rim

Represents flooding depth over 1 ft
Represents flooding between 0.5ft - 0.99 ft
Represents flooding depth between 0 - 0.5 ft

MH Name	Manhole Invert Elev.	Max. Depth of Manhole	Manhole Rim Elev.	Maximum HGL	Node Flood Depth Above Manhole Rim	Flood Volume	Flood Volume	Hours Flooded
	(ft)	(ft)	(ft)	(ft)	(ft)	(10^6 gal)	(acre-ft)	
	(a)	(a)	(b)	(c)	(d)	(e)	(f)	
COA6045	4957.51	7.82	4965.33	4965.42	0.09	0.421	1.292	5.15
COA15184	4954.19	10.04	4964.23	4964.79	0.56	1.094	3.357	6.09
COA6218	4953.66	9.34	4963	4963.47	0.47	0.809	2.483	6.32
COA6246	4962.06	7.85	4969.91	4969.91	0	0.001	0.003	0.01
COA7635	4957.34	7.29	4964.63	4965.49	0.86	0.189	0.580	0.95
COA7650	4954.93	8.35	4963.28	4963.37	0.09	0.098	0.301	1.05
COA7656	4953.17	9.45	4962.62	4962.63	0.01	0.176	0.540	1.05
COA19719	4952.3	9.98	4962.28	4963.08	0.8	1.153	3.538	6.37
COA7654	4951.67	8.59	4960.26	4960.89	0.63	1.093	3.354	6.41
COA7714	4950.14	7.86	4958	4958.77	0.77	1.738	5.334	6
COA25349	4945.26	11.07	4956.33	4956.35	0.02	0.285	0.875	0.57
COA25656	4948.86	10.32	4959.18	4959.34	0.16	0.253	0.776	1.91
COA25622	4948.24	9.58	4957.82	4957.83	0.01	0.062	0.190	0.82
COA7444	4952.87	7.72	4960.59	4961.04	0.45	1.056	3.241	14.66
COA7476	4950.32	7.85	4958.17	4959.01	0.84	1.151	3.532	16.11
COA7518	4947.94	8.89	4956.83	4957.5	0.67	0.918	2.817	15.18
COA24834	4944.52	7.06	4951.58	4951.67	0.09	0.416	1.277	3.58
COA25105	4946.31	10.2	4956.51	4956.52	0.01	0.037	0.114	0.34
COA7815	4943.48	13.4	4956.88	4956.89	0.01	0.168	0.516	0.35
COA7740	4949.69	8.25	4957.94	4958.04	0.1	0.302	0.927	2.51
COA7830	4944.87	12	4956.87	4956.88	0.01	0.213	0.654	0.63
COA7865	4946.34	10.46	4956.8	4956.81	0.01	0.101	0.310	0.44
COA7908	4946.15	10	4956.15	4956.16	0.01	0.06	0.184	0.23
COA7955	4943.49	12	4955.49	4955.51	0.02	0.099	0.304	0.4
COA22517	4943.59	11	4954.59	4954.6	0.01	0.123	0.377	0.55
COA7716	4948.88	9.23	4958.11	4958.12	0.01	0.002	0.006	0.01
COA7766JB	4943.95	12.33	4956.28	4956.34	0.06	0.02	0.061	0.43
COA7769JB	4944.52	11.81	4956.33	4956.93	0.6		0.000	
COA32878	4946.6	9.16	4955.76	4957.56	1.8	0.371	1.139	1.4
COA7848	4947.67	8.71	4956.38	4956.68	0.3	0.218	0.669	0.8
COA7816	4944.19	13.17	4957.36	4957.37	0.01	0.246	0.755	0.71
COA13866	4935.36	12.08	4947.44	4947.45	0.01	0.019	0.058	0.04
COA9248	4947.65	10.07	4957.72	4957.73	0.01	0.012	0.037	0.14
COA32878.A	4947.19	8.39	4955.58	4957.31	1.73	0.287	0.881	1.38
COA32878.B	4946.27	9.58	4955.85	4956.99	1.14	0.193	0.592	1.23
COA22169	4939.35	6.75	4946.1	4946.83	0.73	0.646	1.983	4.04
COA22127	4937.86	7.66	4945.52	4945.59	0.07	0.129	0.396	1.96
COA9229	4913.15	27	4940.15	4940.5	0.35	0.029	0.089	0.59
1F.C.OUT	4949	9.4	4958.4	4958.41	0.01	0.003	0.009	0.01

(a) Depth of manhole from SWMM input under Node Summary Table
(b) Rim elevation = MH invert elevation + Max depth of manhole
(c) Max HGL from SWMM output table under Node Depth Summar
(d) Node Flood Depth above Manhole Rim = HGL Elev-Rim Elev
(e) Flood volume from SWMM output table under Node Flooding Summary
(f) 1 gallon = 3.06888 E-6 acre-ft

Appendix Volume 2, Appendix 1.2 contains the SWMM model output and additional information prepared to document information and computations for this Option.

Detention Pond Routing Results

The freeboard in the Air Quality Pond increased from 2.7 feet (see **Table 6-3).** Freeboard at the Tingley Surge Pond is 5.5 feet (see **Table 6-4**). Please note the 100-yr. peak water surface elevation remained below the pond invert elevation (remained within the outlet box structure below the 12 ft x 12 ft grate). The Warehouse Pond had 2.3 feet of freeboard as summarized in **Table 6-7**.

Conclusion

The Warehouse Detention Pond significantly reduces flooding north of the Broadway Pump Station. However, flooding remained at the Broadway-Lomas intersection and therefore other options must be evaluated.

TABLE 6-7

WAREHOUSE DETENTION POND ROUTING SUMMARY TABLE

Detention Pond Name	Existing or Proposed Pond (detention or retention)	Model Analysis Point Name	Storm Return Period (100-yr, 24-hr. duration)	Peak Inflow	Peak Outflow	Peak Storage Volume	Peak Storage Volume	Peak Water Surface Elevation	Principal Spillway Elevation	Emergency Spillway Elevation	Pond Invert Elevation	Water Depth	Top of Pond Embankment Elevation	Freeboard to Emergency Spillway Elevation	**Freeboard to top of Pond Embankment**
				(cfs)	(cfs)	(ft^3)	(ac-ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)
a	a	a		b	c	g	c	d	e	e	e		e	f	f
Broadway / Lomas Pond	Existing	Broadway / Lomas Pond	100	266	55		12.109	4954.9	4950	4960	4950	4.9	4960	5.1	**5.1**
OPTION 3															
Warehouse Pond (h)	Proposed	Warehouse Pond	100	152	85	471180	10.817	4957.7	4950	4960	4950	7.7	4960	2.3	**2.3**
OPTION 4															
Warehouse Pond (h)	Proposed	Warehouse Pond	100	151	82	440285	10.108	4957.4	4950	4960	4950	7.4	4960	2.6	**2.6**

TABLE 6-7

WAREHOUSE DETENTION POND ROUTING SUMMARY TABLE

Detention Pond Name	Existing or Proposed Pond (detention or retention)	Model Analysis Point Name	Storm Return Period (100-yr. 24-hr. duration)	Peak Inflow	Peak Outflow	Peak Storage Volume	Peak Storage Volume	Peak Water Surface Elevation	Principal Spillway Elevation	Emergency Spillway Elevation	Pond Invert Elevation	Water Depth	Top of Pond Embankment Elevation	Freeboard to Emergency Spillway Elevation	**Freeboard to top of Pond Embankment**
				(cfs)	(cfs)	(ft^3)	(ac-ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)
a	a	a		b	c	g	c	d	e	e	e		e	f	f
OPTION 5															
Warehouse Pond (h)	Proposed	Warehouse Pond	100	132	73	340136	7.808	4956.3	4949	4958	4950	6.3	4958	1.7	**1.7**
OPTION 6															
Warehouse Pond (h)	Proposed	Warehouse Pond	100	132	71	308035	7.072	4955.9	4950	4960	4950	5.9	4960	4.1	**4.1**
OPTION 7															
Warehouse Pond (h)	Proposed	Warehouse Pond	100	82	77	174746	4.012	4954.4	4950	4960	4950	4.4	4960	5.6	**5.6**

TABLE 6-7

WAREHOUSE DETENTION POND ROUTING SUMMARY TABLE

Detention Pond Name	Existing or Proposed Pond (detention or retention)	Model Analysis Point Name	Storm Return Period (100-yr. 24-hr. duration)	Peak Inflow	Peak Outflow	Peak Storage Volume	Peak Storage Volume	Peak Water Surface Elevation	Principal Spillway Elevation	Emergency Spillway Elevation	Pond Invert Elevation	Water Depth	Top of Pond Embankment Elevation	Freeboard to Emergency Spillway Elevation	**Freeboard to top of Pond Embankment**
				(cfs)	(cfs)	(ft^3)	(ac-ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)
a	a	a		b	c	g	c	d	e	e	e		e	f	f
OPTION 8															
Warehouse Pond (h)	Proposed	Warehouse Pond	100	118	85	266882	6.127	4955.6	4950	4960	4950	5.6	4960	4.4	**4.4**
OPTION 9															
Warehouse Pond (h)	Proposed	Warehouse Pond	100	150	77	380211	8.728	4956.7	4950	4960	4950	6.7	4960	3.3	**3.3**
OPTION 10															
Warehouse Pond (h)	Proposed	Warehouse Pond	100	132	76	352019	8.081	4956.4	4950	4960	4950	6.4	4960	3.6	**3.6**

TABLE 6-7

WAREHOUSE DETENTION POND ROUTING SUMMARY TABLE

Detention Pond Name	Existing or Proposed Pond (detention or retention)	Model Analysis Point Name	Storm Return Period (100-yr. 24-hr. duration)	Peak Inflow	Peak Outflow	Peak Storage Volume	Peak Storage Volume	Peak Water Surface Elevation	Principal Spillway Elevation	Emergency Spillway Elevation	Pond Invert Elevation	Water Depth	Top of Pond Embankment Elevation	Freeboard to Emergency Spillway Elevation	**Freeboard to top of Pond Embankment**
				(cfs)	(cfs)	(ft^3)	(ac-ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)
a	a	a		b	c	g	c	d	e	e	e		e	f	f
OPTION 16															
Warehouse Pond (h)	Proposed	Warehouse Pond	100	150	77	380211	8.728	4956.7	4950	4960	4950	6.7	4960	3.3	**3.3**

a - See Drainage Basin Maps and Figure 6-1

b - See SWMM output for results "Node Inflow Summary" Table

c -Value calculated after unit conversion from SWMM output

d- See SWMM output for results "Node Depth Summary" Table

e - See Volume 2 Appendix 1.2 for Pond Routing Elev-Area-Capacity Discharge Data

f- Negative number indicates the flow depth exceeds referenced elevation - no freeboard available

g - Value from SWMM output under Storage Volume Summary

Option 4 –

Purpose

The purpose of Option 4 was to determine if the addition of alternative detention ponds near the Broadway-Kinley intersection (Warehouse Pond) and a pond in Sub-catchment BR21 (near southeast corner of Lomas Blvd.-Medical Arts intersection) and upsizing storm drains north of the Broadway-Odelia intersection would reduce flooding along Broadway.

Facility 10	Remove the existing Broadway-Lomas Pond and sell this lot as a high value commercial property.
Facility X2	A pond at Broadway and Kinley (Burnt Out Warehouse west side of Broadway).
Facility 1	Build a new pond in Sub-catchment BR21 (near southeast intersection of Lomas Blvd. and Medical Arts). The pond outfall pipe will be a 24-in. RCP that will join into the existing Lomas Blvd. manhole that joins to an existing 48-in. RCP that drains north to the existing Odelia Pond.
Facility X3	Upsized all 36-in. storm drains to 48-in. storm drains from the Broadway-Odelia intersection north (Broadway, Baca, McKnight and Commercial).

Modeling Approach

The Broadway-Lomas detention pond was deleted. The existing manhole number COA 32878.A located just north of Broadway-Lomas intersection was connected directly to an existing manhole COA32878.B with a 4.5 ft diameter RCP pipe in Broadway. A 10-foot deep detention pond (Warehouse Pond) was simulated at the Broadway-Kinley intersection. The pond was placed between manholes COA 7963.11A and COA7716 with appropriate inlet, outlet nodes, and pipes as simulated in SWMM. The BR21 pond was simulated to detain runoff from Sub-catchment BR21. The pond outfall was simulated as a 24-in. conduit that joined to manhole COA7860 in Lomas Blvd. at Edith. All 36-in. storm drains were upsized to 48-in. storm drains from the Broadway-Odelia intersection north (Broadway, Baca, McKnight, and Commercial). The significant option components are summarized in **Table 6-1 (**Summary of Model Filenames and Components – Appendix Volume 2, Appendix 1).

Street Flooding Results

Significant flood depth reduction occurred north of the Broadway-Mountain intersection. However, the Broadway-Lomas intersection remained with greater than 1-foot depths. The results are summarized in **Table 6-8**.

Appendix Volume 2, Appendix 1.2 contains the SWMM model output and additional information prepared to document information and computations for this Option.

TABLE 6-8
SUMMARY OF OPTION 4 STREET PONDING AND MAN-HOLE FLOODING

Note- negative numbers imply that the HGL did not reach the manhole rim

Represents flooding depth over 1 ft
Represents flooding between 0.5ft - 0.99 ft
Represents flooding depth between 0 - 0.5 ft

MH Name	Manhole Invert Elev.	Max. Depth of Manhole	Manhole Rim Elev.	Maximum HGL	Node Flood Depth Above Manhole Rim	Flood Volume	Flood Volume	Hours Flooded
	(ft)	(ft)	(ft)	(ft)	(ft)	(10^6 gal)	(acre-ft)	
	(a)	(a)	(b)	(c)	(d)	(e)	(f)	
COA6045	4957.51	7.82	4965.33	4965.42	0.09	0.421	1.292	5.15
COA15184	4954.19	10.04	4964.23	4964.79	0.56	1.094	3.357	6.09
COA6218	4953.66	9.34	4963	4963.47	0.47	0.809	2.483	6.32
COA6246	4962.06	7.85	4969.91	4969.91	0	0.001	0.003	0.01
COA7635	4957.34	7.29	4964.63	4965.49	0.86	0.189	0.580	0.95
COA7650	4954.93	8.35	4963.28	4963.37	0.09	0.098	0.301	1.05
COA7656	4953.17	9.45	4962.62	4962.63	0.01	0.176	0.540	1.05
COA19719	4952.3	9.98	4962.28	4963.08	0.8	1.153	3.538	6.37
COA7654	4951.67	8.59	4960.26	4960.89	0.63	1.093	3.354	6.41
COA7714	4950.14	7.86	4958	4958.77	0.77	1.738	5.334	6
COA25349	4945.26	11.07	4956.33	4956.35	0.02	0.285	0.875	0.57
COA25656	4948.86	10.32	4959.18	4959.34	0.16	0.253	0.776	1.91
COA25622	4948.24	9.58	4957.82	4957.83	0.01	0.062	0.190	0.82
COA7444	4952.87	7.72	4960.59	4961.04	0.45	1.056	3.241	14.66
COA7476	4950.32	7.85	4958.17	4959.01	0.84	1.151	3.532	16.11
COA7518	4947.94	8.89	4956.83	4957.5	0.67	0.918	2.817	15.18
COA24834	4944.52	7.06	4951.58	4951.67	0.09	0.416	1.277	3.58
COA25105	4946.31	10.2	4956.51	4956.52	0.01	0.037	0.114	0.34
COA7815	4943.48	13.4	4956.88	4956.89	0.01	0.168	0.516	0.35
COA7740	4949.69	8.25	4957.94	4958.04	0.1	0.302	0.927	2.51
COA7830	4944.87	12	4956.87	4956.88	0.01	0.213	0.654	0.63
COA7865	4946.34	10.46	4956.8	4956.81	0.01	0.101	0.310	0.44
COA7908	4946.15	10	4956.15	4956.16	0.01	0.06	0.184	0.23
COA7955	4943.49	12	4955.49	4955.51	0.02	0.099	0.304	0.4
COA22517	4943.59	11	4954.59	4954.6	0.01	0.123	0.377	0.55
COA7716	4948.88	9.23	4958.11	4958.12	0.01	0.002	0.006	0.01
COA7766JB	4943.95	12.33	4956.28	4956.34	0.06	0.02	0.061	0.43
COA7769JB	4944.52	11.81	4956.33	4956.93	0.6		0.000	
COA32878	4946.6	9.16	4955.76	4957.56	1.8	0.371	1.139	1.4
COA7848	4947.67	8.71	4956.38	4956.68	0.3	0.218	0.669	0.8
COA7816	4944.19	13.17	4957.36	4957.37	0.01	0.246	0.755	0.71
COA13866	4935.36	12.08	4947.44	4947.45	0.01	0.019	0.058	0.04
COA9248	4947.65	10.07	4957.72	4957.73	0.01	0.012	0.037	0.14
COA32878.A	4947.19	8.39	4955.58	4957.31	1.73	0.287	0.881	1.38
COA32878.B	4946.27	9.58	4955.85	4956.99	1.14	0.193	0.592	1.23
COA22169	4939.35	6.75	4946.1	4946.83	0.73	0.646	1.983	4.04
COA22127	4937.86	7.66	4945.52	4945.59	0.07	0.129	0.396	1.96
COA9229	4913.15	27	4940.15	4940.5	0.35	0.029	0.089	0.59
1F.C.OUT	4949	9.4	4958.4	4958.41	0.01	0.003	0.009	0.01

(a) Depth of manhole from SWMM input under Node Summary Table
(b) Rim elevation = MH invert elevation + Max depth of manhole
(c) Max HGL from SWMM output table under Node Depth Summar
(d) Node Flood Depth above Manhole Rim = HGL Elev-Rim Elev
(e) Flood volume from SWMM output table under Node Flooding Summary
(f) 1 gallon = 3.06888 E-6 acre-ft

Detention Pond Routing Results

The freeboard in the Air Quality Pond is 2.7 feet (see **Table 6-3).** Tingley Surge Pond retained at 5.4 ft of freeboard (see **Table 6-4)**. The Warehouse Pond had 2.6 feet of freeboard (see **Table 6-7)** and the BR21 pond had 7.4 feet of freeboard (see **Table 6-9).**

TABLE 6-9

BR21 DETENTION POND ROUTING SUMMARY

Detention Pond Name	Existing or Proposed Pond (detention or retention)	Model Analysis Point Name	Storm Return Period (100-yr. 24-hr. duration)	Peak Inflow	Peak Outflow	Peak Storage Volume	Peak Storage Volume	Peak Water Surface Elevation	Principal Spillway Elevation	Emergency Spillway Elevation	Pond Invert Elevation	Water Depth	Top of Pond Embankment Elevation	Freeboard to Emergency Spillway Elevation	**Freeboard to top of Pond Embankment**
				(cfs)	(cfs)	(ft^3)	(ac-ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)
a	a	a		b	c	g	c	d	e	e	e		e	f	f
OPTION 4															
BR21 Pond	CONCEPTUAL	BR21 Pond	100	64	9	96137	2.207	5068.6	5062	5076	5062	6.6	5076	7.4	**7.4**
OPTION 5															
BR21 Pond	CONCEPTUAL	BR21 Pond	100	64	9	93908	2.156	5068.6	5062	5076	5062	6.6	5076	7.4	**7.4**
OPTION 6															
BR21 Pond	CONCEPTUAL	BR21 Pond	100	64	9	93908	2.156	5068.6	5062	5076	5062	6.6	5076	7.4	**7.4**

TABLE 6-9

BR21 DETENTION POND ROUTING SUMMARY

Detention Pond Name	Existing or Proposed Pond (detention or retention)	Model Analysis Point Name	Storm Return Period (100-yr. 24-hr. duration)	Peak Inflow	Peak Outflow	Peak Storage Volume	Peak Storage Volume	Peak Water Surface Elevation	Principal Spillway Elevation	Emergency Spillway Elevation	Pond Invert Elevation	Water Depth	Top of Pond Embankment Elevation	Freeboard to Emergency Spillway Elevation	**Freeboard to top of Pond Embankment**
				(cfs)	(cfs)	(ft^3)	(ac-ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)
a	a	a		b	c	g	c	d	e	e	e		e	f	f
OPTION 7															
BR21 Pond	CONCEPTUAL	BR21 Pond	100	64	9	93908	2.156	5068.6	5062	5076	5062	6.6	5076	7.4	**7.4**
OPTION 8															
BR21 Pond	CONCEPTUAL	BR21 Pond	100	64	9	93908	2.156	5068.6	5062	5076	5062	6.6	5076	7.4	**7.4**
OPTION 9															
BR21 Pond	CONCEPTUAL	BR21 Pond	100	64	9	93908	2.156	5068.6	5062	5076	5062	6.6	5076	7.4	**7.4**

TABLE 6-9

BR21 DETENTION POND ROUTING SUMMARY

Detention Pond Name	Existing or Proposed Pond (detention or retention)	Model Analysis Point Name	Storm Return Period (100-yr. 24-hr. duration)	Peak Inflow	Peak Outflow	Peak Storage Volume	Peak Storage Volume	Peak Water Surface Elevation	Principal Spillway Elevation	Emergency Spillway Elevation	Pond Invert Elevation	Water Depth	Top of Pond Embankment Elevation	Freeboard to Emergency Spillway Elevation	**Freeboard to top of Pond Embankment**
				(cfs)	(cfs)	(ft^3)	(ac-ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)
a	a	a		b	c	g	c	d	e	e	e		e	f	f
OPTION 10															
BR21 Pond	CONCEPTUAL	BR21 Pond	100	64	9	93908	2.156	5068.6	5062	5076	5062	6.6	5076	7.4	**7.4**
OPTION 11															
BR21 Pond	CONCEPTUAL	BR21 Pond	100	64	9	93907	2.156	5068.5	5062	5076	5062	6.5	5076	7.5	**7.5**
OPTION 12															
BR21 Pond	CONCEPTUAL	BR21 Pond	100	64	9	93907	2.156	5068.5	5062	5076	5062	6.5	5076	7.5	**7.5**

TABLE 6-9

BR21 DETENTION POND ROUTING SUMMARY

Detention Pond Name	Existing or Proposed Pond (detention or retention)	Model Analysis Point Name	Storm Return Period (100-yr. 24-hr. duration)	Peak Inflow	Peak Outflow	Peak Storage Volume	Peak Storage Volume	Peak Water Surface Elevation	Principal Spillway Elevation	Emergency Spillway Elevation	Pond Invert Elevation	Water Depth	Top of Pond Embankment Elevation	Freeboard to Emergency Spillway Elevation	**Freeboard to top of Pond Embankment**
				(cfs)	(cfs)	(ft^3)	(ac-ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)
a	a	a		b	c	g	c	d	e	e	e		e	f	f
OPTION 13															
BR21 Pond	CONCEPTUAL	BR21 Pond	100	64	9	93907	2.156	5068.5	5062	5076	5062	6.5	5076	7.5	**7.5**
OPTION 14															
BR21 Pond	CONCEPTUAL	BR21 Pond	100	64	9	93907	2.156	5068.5	5062	5076	5062	6.5	5076	7.5	**7.5**
OPTION 15															
BR21 Pond	CONCEPTUAL	BR21 Pond	100	64	9	93907	2.156	5068.5	5062	5076	5062	6.5	5076	7.5	**7.5**

TABLE 6-9

BR21 DETENTION POND ROUTING SUMMARY

Detention Pond Name	Existing or Proposed Pond (detention or retention)	Model Analysis Point Name	Storm Return Period (100-yr. 24-hr. duration)	Peak Inflow	Peak Outflow	Peak Storage Volume	Peak Storage Volume	Peak Water Surface Elevation	Principal Spillway Elevation	Emergency Spillway Elevation	Pond Invert Elevation	Water Depth	Top of Pond Embankment Elevation	Freeboard to Emergency Spillway Elevation	**Freeboard to top of Pond Embankment**
				(cfs)	(cfs)	(ft^3)	(ac-ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)
a	a	a		b	c	g	c	d	e	e	e		e	f	f
OPTION 16															
BR21 Pond	CONCEPTUAL	BR21 Pond	100	64	9	93907	2.156	5068.5	5062	5076	5062	6.5	5076	7.5	**7.5**
OPTION 17															
BR21 Pond	CONCEPTUAL	BR21 Pond	100	64	9	93907	2.156	5068.5	5062	5076	5062	6.5	5076	7.5	**7.5**
OPTION 18															
BR21 Pond	CONCEPTUAL	BR21 Pond	100	64	9	93907	2.156	5068.5	5062	5076	5062	6.5	5076	7.5	**7.5**

TABLE 6-9

BR21 DETENTION POND ROUTING SUMMARY

Detention Pond Name	Existing or Proposed Pond (detention or retention)	Model Analysis Point Name	Storm Return Period (100-yr. 24-hr. duration)	Peak Inflow	Peak Outflow	Peak Storage Volume	Peak Storage Volume	Peak Water Surface Elevation	Principal Spillway Elevation	Emergency Spillway Elevation	Pond Invert Elevation	Water Depth	Top of Pond Embankment Elevation	Freeboard to Emergency Spillway Elevation	**Freeboard to top of Pond Embankment**
				(cfs)	(cfs)	(ft^3)	(ac-ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)
a	a	a		b	c	g	c	d	e	e	e		e	f	f
OPTION 19															
BR21 Pond	CONCEPTUAL	BR21 Pond	100	64	9	93907	2.156	5068.5	5062	5076	5062	6.5	5076	7.5	**7.5**

a - See Drainage Basin Maps and Figure 6-1
b - See SWMM output for results "Node Inflow Summary" Table
c -Value calculated after unit conversion from SWMM output
d- See SWMM output for results "Node Depth Summary" Table
e - See Volume 2 Appendix 1.2 for Pond Routing Elev-Area-Capacity Discharge Data
f- Negative number indicates the flow depth exceeds referenced elevation - no freeboard available
g - Value from SWMM output under Storage Volume Summary

Conclusion
Increasing the storm drain capacity on north Broadway along with the Warehouse and BR21 detention ponds significantly reduces flooding north of the Broadway Pump Station. However, flooding remained at the Broadway-Lomas intersection and therefore other options should be evaluated.

Option 5 –

Purpose
The purpose of Option 5 was to determine if adding another detention pond in Santa Barbara Park and re-routing some of the storm drains to this pond in addition to changes made in Option 4 would mitigate flooding in the north Broadway area and the Broadway-Lomas intersection.

Facility 10	Remove the existing Broadway-Lomas Pond and sell this lot as a high value commercial property.
Facility X2	A pond at Broadway and Kinley (Burnt Out Warehouse west side of Broadway).
Facility 1	Build a new pond in Sub-catchment BR21 (near southeast intersection of Lomas Blvd. and Medical Arts). The pond outfall pipe will be a 24-in. RCP that will join into the existing Lomas Blvd. manhole that joins to an existing 48-in. RCP that drains north to the existing Odelia Pond.
Facility X4	Upsized storm drain from 36-in. to 48-in., begin at the Broadway-Odelia intersection continue west on Baca to Commercial, then north on Commercial for 600 ft. Upsized 36-in. to 48-in. storm drain from the Commercial-Indian School intersection south on Commercial to McKnight, then east on McKnight, then new 48-in. storm drain from the Commercial-McKnight intersection east to the Broadway-McKnight intersection, then south on Broadway to join into the Santa Barbara Park Pond. Upsize the 36-in. to 48-in. storm drain south from the Broadway-Hannett intersection to the Broadway-Odelia intersection.

Modeling Approach
The Broadway-Lomas detention pond was deleted from the model. The existing manhole number COA 32878.A located just north of Broadway-Lomas intersection was connected directly to an existing manhole COA32878.B with a 4.5 ft diameter RCP pipe in Broadway. A 10-foot deep detention pond (Warehouse Pond) was simulated. The pond was placed in between manholes COA 7963.11A and COA7716 with appropriate inlet, outlet nodes and links as simulated in SWMM. The BR21 pond was simulated to detain runoff from Sub-catchment BR21. The pond outfall was simulated as a 24-in. conduit that joined manhole COA7860 in Lomas Blvd. at Edith. A detention pond at Santa Barbara Park was added along with the inlet and outlet. The storm drain from Commercial to Baca was re-routed to Broadway to drain into the Santa Barbara Park Pond.

Upsized 36-in. to 48-in. storm drain from the Commercial-Indian School intersection south on Commercial to McKnight, then east on McKnight, then new 48-in. storm drain from the Commercial-McKnight intersection east to the Broadway-McKnight intersection, then south on Broadway to join into the Santa Barbara Park Pond. Upsize the 36-in. to 48-in. storm drain south from the Broadway-Hannett intersection to the Broadway-Odelia intersection. The pipes connecting manholes COA 29163 and COA7635, along Commercial, COA29132, and COA7628 along Broadway were deleted.

The significant option components are summarized in **Table 6-1** (Summary of Model Filenames and Components- Appendix Volume 2, Appendix 1).

Street Flooding Results
With the exception of COA 6246 (0.29 ft flood depth) and 6195 (0.87 ft flood depth), there was no other flooding north of the Warehouse Pond. Flooding greater then 1-foot remained at the Broadway-Lomas intersection. Flooding results are summarized in **Table 6-10.**

Appendix Volume 2, Appendix 1.2 contains the SWMM model output and additional information prepared to document information and computations for this Option.

Detention Pond Routing Results
Freeboard in the Air Quality Pond is 5.4 feet (see **Table 6-3).** Freeboard at Tingley Surge Pond increased from 5.6 ft (see **Table 6-4).** Freeboard at Warehouse Pond is 1.7 feet (see **Table 6-7)** and freeboard at BR21 pond remained at 7.4 feet (see **Table 6-9)**, while the Santa Barbara Park Pond had 8.6 feet of freeboard (see **Table 6-11).**

Conclusion
Although Option 5 is effective in reducing most flooding north of the Broadway-Mountain intersection, it fails to mitigate flooding at the Broadway-Lomas intersection and therefore additional options should be evaluated.

TABLE 6-10
SUMMARY OF OPTION 5 STREET PONDING AND MAN-HOLE FLOODING

Note- negative numbers imply that the HGL did not reach the manhole rim

Represents flooding depth over 1 ft
Represents flooding between 0.5ft - 0.99 ft
Represents flooding depth between 0 - 0.5 ft

MH Name	Manhole Invert Elev.	Max. Depth of Manhole	Manhole Rim Elev.	Maximum HGL	Node Flood Depth Above Manhole Rim	Flood Volume	Flood Volume	Hours Flooded
	(ft)	(ft)	(ft)	(ft)	(ft)	(10^6 gal)	(acre-ft)	
	(a)	(a)	(b)	(c)	(d)	(e)	(f)	
COA6045	4957.51	7.82	4965.33	4965.42	0.09	0.419	1.286	5.13
COA15184	4954.19	10.04	4964.23	4964.8	0.57	1.122	3.443	6.16
COA6218	4953.66	9.34	4963	4963.47	0.47	0.829	2.544	6.44
COA6195	4962.97	6.74	4969.71	4970.58	0.87	0.522	1.602	1.07
COA6246	4962.06	7.85	4969.91	4970.2	0.29	0.177	0.543	0.62
COA19719	4952.3	9.98	4962.28	4963.07	0.79	1.152	3.535	6.49
COA7654	4951.67	8.59	4960.26	4960.87	0.61	1.066	3.271	6.6
COA7714	4950.14	7.86	4958	4958.68	0.68	1.537	4.717	6.59
COA25349	4945.26	11.07	4956.33	4956.35	0.02	0.208	0.638	0.37
COA25656	4948.86	10.32	4959.18	4959.3	0.12	0.19	0.583	1.73
COA25622	4948.24	9.58	4957.82	4957.84	0.02	0.05	0.153	0.71
COA7444	4952.87	7.72	4960.59	4961.04	0.45	1.056	3.241	14.65
COA7476	4950.32	7.85	4958.17	4959.01	0.84	1.151	3.532	16.11
COA7518	4947.94	8.89	4956.83	4957.5	0.67	0.918	2.817	15.19
COA24834	4944.52	7.06	4951.58	4951.67	0.09	0.422	1.295	3.59
COA25105	4946.31	10.2	4956.51	4956.52	0.01	0.026	0.080	0.27
COA7815	4943.48	13.4	4956.88	4956.89	0.01	0.196	0.602	0.37
COA7740	4949.69	8.25	4957.94	4957.98	0.04	0.154	0.473	1.41
COA7830	4944.87	12	4956.87	4956.88	0.01	0.134	0.411	0.35
COA7865	4946.34	10.46	4956.8	4956.81	0.01	0.056	0.172	0.25
COA7908	4946.15	10	4956.15	4956.16	0.01	0.049	0.150	0.15
COA7912	4945.61	10.68	4956.29	4956.3	0.01	0.016	0.049	0.04
COA7955	4943.49	12	4955.49	4955.5	0.01	0.08	0.246	0.33
COA22517	4943.59	11	4954.59	4954.6	0.01	0.111	0.341	0.46
COA7769JB	4944.52	11.81	4956.33	4957.3	0.97		0.000	
COA32865	4945.49	11.62	4957.11	4957.12	0.01	0.001	0.003	0.02
COA32878	4946.6	9.16	4955.76	4956.87	1.11	0.257	0.789	1.02
COA7848	4947.67	8.71	4956.38	4956.41	0.03	0.079	0.242	0.45
COA25109	4945.87	10.67	4956.54	4956.55	0.01	0.021	0.064	0.16
COA9348	4939.63	11.79	4951.42	4951.43	0.01	0.045	0.138	0.13
COA9344	4935.83	15.71	4951.54	4951.55	0.01	0.014	0.043	0.04
COA13866	4935.36	12.08	4947.44	4947.45	0.01	0.029	0.089	0.06
COA9248	4947.65	10.07	4957.72	4957.73	0.01	0.012	0.037	0.1
COA32878.A	4947.19	8.39	4955.58	4956.64	1.06	0.18	0.552	1.05
COA32878.B	4946.27	9.58	4955.85	4956.32	0.47	0.084	0.258	0.72
COA22169	4939.35	6.75	4946.1	4946.83	0.73	0.644	1.976	3.99
COA22127	4937.86	7.66	4945.52	4945.59	0.07	0.129	0.396	1.93
COA9229	4913.15	27	4940.15	4940.5	0.35	0.029	0.089	0.59
1F.C.OUT	4949	9.4	4958.4	4958.41	0.01	0.002	0.006	0.01
1F.E.MHA	4961.5	14.21	4975.71	4975.72	0.01	0.002	0.006	0.01

(a) Manhole invert elevation from SWMM input under Node Summary Table
(b) Rim elevation = MH invert elevation + Max depth of manhole
(c) Max HGL from SWMM output table under Node Depth Summary
(d) Node Flood Depth above Manhole Rim = HGL Elev-Rim Elev
(e) Flood volume from SWMM output table under Node Flooding Summary
(f) 1 gallon = 3.06888 E-6 acre-ft

TABLE 6-11

SANTA BARBARA DETENTION POND ROUTING SUMMARY

Detention Pond Name	Existing or Proposed Pond (detention or retention)	Model Analysis Point Name	Storm Return Period (100-yr. 24-hr. duration)	Peak Inflow	Peak Outflow	Peak Storage Volume	Peak Storage Volume	Peak Water Surface Elevation	Principal Spillway Elevation	Emergency Spillway Elevation	Pond Invert Elevation	Water Depth	Top of Pond Embankment Elevation	Freeboard to Emergency Spillway Elevation	**Freeboard to top of Pond Embankment**
				(cfs)	(cfs)	(ft^3)	(ac-ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)
a	a	a		b	c	g	c	d	e	e	e		e	f	f
OPTION 5															
Santa Barbara Pond	CONCEPTUAL	Santa Barbara Pond	100	107	17	311612	7.154	4963.4	4961	4972	4961	2.4	4972	8.6	**8.6**
OPTION 6															
Santa Barbara Pond	CONCEPTUAL	Santa Barbara Pond	100	107	16	303410	6.965	4963.3	4961	4972	4961	2.3	4972	8.7	**8.7**
OPTION 7															
Santa Barbara Pond	CONCEPTUAL	Santa Barbara Pond	100	107	16	297571	6.831	4963.3	4961	4972	4961	2.3	4972	8.7	**8.7**

TABLE 6-11

SANTA BARBARA DETENTION POND ROUTING SUMMARY

Detention Pond Name	Existing or Proposed Pond (detention or retention)	Model Analysis Point Name	Storm Return Period (100-yr. 24-hr. duration)	Peak Inflow	Peak Outflow	Peak Storage Volume	Peak Storage Volume	Peak Water Surface Elevation	Principal Spillway Elevation	Emergency Spillway Elevation	Pond Invert Elevation	Water Depth	Top of Pond Embankment Elevation	Freeboard to Emergency Spillway Elevation	**Freeboard to top of Pond Embankment**
				(cfs)	(cfs)	(ft^3)	(ac-ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)
a	a	a		b	c	g	c	d	e	e	e		e	f	f
OPTION 8															
Santa Barbara Pond	CONCEPTUAL	Santa Barbara Pond	100	25	4	298743	6.858	4962.2	4961	4972	4961	1.2	4972	9.8	**9.8**
OPTION 9															
Santa Barbara Pond	CONCEPTUAL	Santa Barbara Pond	100	26	4	147428	3.384	4962.2	4961	4972	4961	1.1	4972	9.9	**9.9**
OPTION 10															
Santa Barbara Pond	CONCEPTUAL	Santa Barbara Pond	100	21	5	161068	3.698	4962.3	4961	4972	4961	1.3	4972	9.7	**9.7**

TABLE 6-11

SANTA BARBARA DETENTION POND ROUTING SUMMARY

Detention Pond Name	Existing or Proposed Pond (detention or retention)	Model Analysis Point Name	Storm Return Period (100-yr. 24-hr. duration)	Peak Inflow	Peak Outflow	Peak Storage Volume	Peak Storage Volume	Peak Water Surface Elevation	Principal Spillway Elevation	Emergency Spillway Elevation	Pond Invert Elevation	Water Depth	Top of Pond Embankment Elevation	Freeboard to Emergency Spillway Elevation	**Freeboard to top of Pond Embankment**
				(cfs)	(cfs)	(ft^3)	(ac-ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)
a	a	a		b	c	g	c	d	e	e	e		e	f	f
OPTION 16															
Santa Barbara Pond	CONCEPTUAL	Santa Barbara Pond	100	26	4	147428	3.384	4962.2	4961	4972	4961	1.2	4972	9.8	**9.8**
OPTION 17															
Santa Barbara Pond	CONCEPTUAL	Santa Barbara Pond	100	135	31	260436	5.999	4963.0	4961	4972	4961	2.0	4972	7.0	**9.0**
OPTION 18															
Santa Barbara Pond	CONCEPTUAL	Santa Barbara Pond	100	135	31	260472	5.999	4963.0	4961	4972	4961	2.0	4972	7.0	**9.0**

TABLE 6-11

SANTA BARBARA DETENTION POND ROUTING SUMMARY

Detention Pond Name	Existing or Proposed Pond (detention or retention)	Model Analysis Point Name	Storm Return Period (100-yr. 24-hr. duration)	Peak Inflow	Peak Outflow	Peak Storage Volume	Peak Storage Volume	Peak Water Surface Elevation	Principal Spillway Elevation	Emergency Spillway Elevation	Pond Invert Elevation	Water Depth	Top of Pond Embankment Elevation	Freeboard to Emergency Spillway Elevation	**Freeboard to top of Pond Embankment**
				(cfs)	(cfs)	(ft^3)	(ac-ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)
a	a	a		b	c	g	c	d	e	e	e		e	f	f

a - See Drainage Basin Maps and Figure 6-1
b - See SWMM output for results "Node Inflow Summary" Table
c -Value calculated after unit conversion from SWMM output
d- See SWMM output for results "Node Depth Summary" Table
e - See Volume 2 Appendix 1.2 for Pond Routing Elev-Area-Capacity Discharge Data
f- Negative number indicates the flow depth exceeds referenced elevation - no freeboard available
g - Value from SWMM output under Storage Volume Summary

Option 6 –

Purpose

Option 6 attempted to mitigate flooding at the Broadway-Lomas intersection by simulation of underground storage with 2- 72-in. dia. storm drains in addition to all the changes proposed in Option 5. The underground storage would be begin at the intersection of Broadway-Lomas and continue south to the Broadway-Roma intersection.

Facility 10 Remove the existing Broadway-Lomas Pond and sell this lot as a high value commercial property.

Facility X2 A pond at Broadway and Kinley (Burnt Out Warehouse west side of Broadway).

Facility 1 Build a new pond in Sub-catchment BR21 (near southeast intersection of Lomas Blvd. and Medical Arts). The pond outfall pipe will be a 24-in. RCP that will join into the existing Lomas Blvd. manhole that joins to an existing 48-in. RCP that drains north to the existing Odelia Pond.

Facility X4 Upsized storm drain from 36-in. to 48-in., begin at the Broadway-Odelia intersection continue west on Baca to Commercial, then north on Commercial for 600 ft. Upsized 36-in. to 48-in. storm drain from the Commercial-Indian School intersection south on Commercial to McKnight, then east on McKnight, then new 48-in. storm drain from the Commercial-McKnight intersection east to the Broadway-McKnight intersection, then south on Broadway to join into the Santa Barbara Park Pond. Upsize the 36-in. to 48-in. storm drain south from the Broadway-Hannett intersection to the Broadway-Odelia intersection.

Facility X5 Simulate underground storage near the Broadway-Lomas intersection by the addition of 4600 feet of 72-in. storm drain located between Roma and Lomas.

Modeling Approach

The Broadway-Lomas detention pond was deleted from the model. The existing manhole number COA 32878.A located just north of Broadway-Lomas intersection was connected directly to an existing manhole COA32878.B with a 4.5 ft diameter RCP pipe in Broadway. A 10-foot deep detention pond (Warehouse Pond) was simulated. The pond was placed in between manholes COA 7963.11A and COA7716 with appropriate inlet, outlet nodes, and links as simulated in SWMM. The BR21 pond was simulated to detain runoff from Sub-catchment BR21. The pond outfall was simulated as a 24-in. conduit that joined manhole COA7860 in Lomas Blvd. at Edith. A detention pond in Santa Barbara Park was added along with the inlet and outlet. The storm drain from Commercial to Baca was re-routed to Broadway to drain into the Santa Barbara Park Pond. The pipes connecting manholes COA 29163 and COA7635, along Commercial, COA29132, and COA7628 along Broadway were deleted.

Underground storage was simulated by adding a 72-in. storm drain from COA32878 south of the Broadway-Lomas intersection. The pipe was given a length of 4600 feet to simulate 2- 72-in. pipes with a length of 2300 feet each. The storm drain would be located approximately between Roma and Lomas along Broadway.

The significant option components are summarized in **Table 6-1** (Summary of Model Filenames and Components – Appendix Volume 2, Appendix 1).

Street Flooding Results
With the exception of COA, 6246 (0.29 ft flood depth) and 6195 (0.87 ft flood depth), there was no other flooding north of the Warehouse Pond. The flood depths at the Broadway-Lomas intersection remained over 1-foot deep. Flooding results are summarized in **Table 6-12.**

Appendix Volume 2, Appendix 1.2 contains the SWMM model output and additional information prepared to document information and computations for this Option.

Detention Pond Routing Results
The freeboard in the Air Quality Pond is 5.6 feet (see **Table 6-3)**. There was no change in freeboard at Tingley Surge Pond that is 5.6 feet (see **Table 6-3**). The BR21 Pond has 7.4 feet (see **Table 6-9).** The Warehouse Pond has 4.1 feet (see **Table 6-7)**. The Santa Barbara Park Pond retained 8.7 feet of freeboard (see **Table 6-11)**.

Conclusion
Option 6 showed significant flood depth reduction north of the Warehouse pond. However, depths at the Broadway-Lomas intersection remain greater than 1-foot. Therefore, additional options should be evaluated.

TABLE 6-12
SUMMARY OF OPTION 6 STREET PONDING AND MAN-HOLE FLOODING

Note- negative numbers imply that the HGL did not reach the manhole rim

Represents flooding depth over 1 ft
Represents flooding between 0.5ft - 0.99 ft
Represents flooding depth between 0 - 0.5 ft

MH Name	Manhole Invert Elev.	Max. Depth of Manhole	Manhole Rim Elev.	Maximum HGL	Node Flood Depth Above Manhole Rim	Flood Volume	Flood Volume	Hours Flooded
	(ft)	(ft)	(ft)	(ft)	(ft)	(10^6 gal)	(acre-ft)	
	(a)	(a)	(b)	(c)	(d)	(e)	(f)	
COA6045	4957.51	7.82	4965.33	4965.42	0.09	0.427	1.310	5.13
COA15184	4954.19	10.04	4964.23	4964.8	0.57	1.115	3.422	6.12
COA6218	4953.66	9.34	4963	4963.47	0.47	0.82	2.516	6.39
COA6195	4962.97	6.74	4969.71	4970.58	0.87	0.518	1.590	1.04
COA6246	4962.06	7.85	4969.91	4970.2	0.29	0.185	0.568	0.64
COA19719	4952.3	9.98	4962.28	4963.07	0.79	1.172	3.597	6.45
COA7654	4951.67	8.59	4960.26	4960.87	0.61	1.057	3.244	6.54
COA7714	4950.14	7.86	4958	4958.68	0.68	1.457	4.471	6.55
COA25349	4945.26	11.07	4956.33	4956.35	0.02	0.195	0.598	0.38
COA25656	4948.86	10.32	4959.18	4959.3	0.12	0.22	0.675	1.81
COA25622	4948.24	9.58	4957.82	4957.84	0.02	0.06	0.184	0.78
COA7444	4952.87	7.72	4960.59	4961.04	0.45	1.056	3.241	14.66
COA7476	4950.32	7.85	4958.17	4959.01	0.84	1.151	3.532	16.11
COA7518	4947.94	8.89	4956.83	4957.5	0.67	0.917	2.814	15.19
COA24834	4944.52	7.06	4951.58	4951.67	0.09	0.43	1.320	3.62
COA25105	4946.31	10.2	4956.51	4956.52	0.01	0.032	0.098	0.3
COA7815	4943.48	13.4	4956.88	4956.89	0.01	0.21	0.644	0.38
COA7740	4949.69	8.25	4957.94	4957.98	0.04	0.133	0.408	1.33
COA7830	4944.87	12	4956.87	4956.88	0.01	0.119	0.365	0.32
COA7865	4946.34	10.46	4956.8	4956.81	0.01	0.058	0.178	0.25
COA7908	4946.15	10	4956.15	4956.16	0.01	0.031	0.095	0.09
COA7912	4945.61	10.68	4956.29	4956.3	0.01	0.011	0.034	0.04
COA7955	4943.49	12	4955.49	4955.5	0.01	0.065	0.199	0.25
COA22517	4943.59	11	4954.59	4954.6	0.01	0.086	0.264	0.36
COA7769JB	4944.52	11.81	4956.33	4957.3	0.97		0.000	
COA32865	4945.49	11.62	4957.11	4957.12	0.01	0	0.000	0.01
COA32878	4946.6	9.16	4955.76	4956.87	1.11	0.219	0.672	0.77
COA7848	4947.67	8.71	4956.38	4956.41	0.03	0.065	0.199	0.34
COA25109	4945.87	10.67	4956.54	4956.55	0.01	0.024	0.074	0.17
COA9348	4939.63	11.79	4951.42	4951.43	0.01	0.025	0.077	0.09
COA9344	4935.83	15.71	4951.54	4951.55	0.01	0.015	0.046	0.05
COA13866	4935.36	12.08	4947.44	4947.45	0.01	0.018	0.055	0.05
COA9248	4947.65	10.07	4957.72	4957.73	0.01	0.007	0.021	0.07
COA32878.A	4947.19	8.39	4955.58	4956.64	1.06	0.115	0.353	0.79
COA32878.B	4946.27	9.58	4955.85	4956.32	0.47	0.016	0.049	0.39
COA22169	4939.35	6.75	4946.1	4946.83	0.73	0.645	1.979	4.05
COA22127	4937.86	7.66	4945.52	4945.59	0.07	0.13	0.399	1.97
COA9229	4913.15	27	4940.15	4940.5	0.35	0.028	0.086	0.59
1F.C.OUT	4949	9.4	4958.4	4958.41	0.01	0	0.000	0.01
1F.E.MHA	4961.5	14.21	4975.71	4975.72	0.01		0.000	
1F.F.MH1	4947	10	4957	4960.84	3.84		0.000	

(a) Manhole invert elevation from SWMM input under Node Summary Table
(b) Rim elevation = MH invert elevation + Max depth of manhole
(c) Max HGL from SWMM output table under Node Depth Summary
(d) Node Flood Depth above Manhole Rim = HGL Elev-Rim Elev
(e) Flood volume from SWMM output table under Node Flooding Summary
(f) 1 gallon = 3.06888 E-6 acre-ft

Option 7 –

Purpose

The purpose of Option 7 was to determine the effect of upsizing the Broadway Pump Station on flood reduction in the Broadway-Lomas intersection in addition to the effects of all features included in Option 6. The underground storage was not included in this option.

Facility 10 Remove the existing Broadway-Lomas Pond and sell this lot as a high value commercial property.

Facility X2 A pond at Broadway and Kinley (Burnt Out Warehouse west side of Broadway).

Facility 1 Build a new pond in Sub-catchment BR21 (near southeast intersection of Lomas Blvd. and Medical Arts). The pond outfall pipe will be a 24-in. RCP that will join into the existing Lomas Blvd. manhole that joins to an existing 48-in. RCP that drains north to the existing Odelia Pond.

Facility X4 Upsized storm drain from 36-in. to 48-in., begin at the Broadway-Odelia intersection continue west on Baca to Commercial, then north on Commercial for 600 ft. Upsized 36-in. to 48-in. storm drain from the Commercial-Indian School intersection south on Commercial to McKnight, then east on McKnight, then new 48-in. storm drain from the Commercial-McKnight intersection east to the Broadway-McKnight intersection, then south on Broadway to join into the Santa Barbara Park Pond. Upsize the 36-in. to 48-in. storm drain south from the Broadway-Hannett intersection to the Broadway-Odelia intersection.

Facility X6 Upsize the Broadway Pump Station to a maximum capacity of 300 cfs (from 130 cfs existing).

Modeling Approach

The Broadway-Lomas detention pond was deleted from the model. The existing manhole number COA 32878.A located just north of Broadway-Lomas intersection was connected directly to an existing manhole COA32878.B with a 4.5 ft diameter RCP pipe in Broadway. A 10-foot deep detention pond (Warehouse Pond) was simulated. The pond was placed in between manholes COA 7963.11A and COA7716 with appropriate inlet, outlet nodes, and links as simulated in SWMM. The BR21 pond was simulated to detain runoff from Sub-catchment BR21. The pond outfall was simulated as a 24-in. conduit that joined manhole COA7860 in Lomas Blvd. at Edith. A detention pond in the Santa Barbara Park was added along with the inlet and outlet. The storm drain from Commercial to Baca was re-routed to Broadway to drain into the Santa Barbara Park Pond. The pipes connecting manholes COA 29163 and COA7635, along Commercial and COA29132 and COA7628 along Broadway were deleted. The Broadway Pump Station pump was simulated at 300 cfs from 130 cfs existing. The significant option components are summarized in **Table 6-1** (Summary of Model Filenames and Components- Appendix Volume 2, Appendix 1).

Street Flooding Results

Option 7 reduced most of the flooding at Broadway-Lomas intersection with the exception of COA32878, 32878.A, 7769JB which all remain at about 1-foot deep. The same was true for the manholes north of the Broadway-Mountain intersection except for COA6195 which was 0.87 feet deep and COA6246 of 0.29 feet deep. Flooding results are summarized in **Table 6-13.**

Appendix Volume 2, Appendix 1.2 contains the SWMM model output and additional information prepared to document information and computations for this Option.

Detention Pond Routing Results

The freeboard in the Air Quality Pond is 6.1 feet (see **Table 6-3).** There was no change in freeboard at Tingley Surge Pond that has 5.5 feet (see **Table 6-4**). The BR21 Pond has 7.4 feet (see **Table 6-9**). Freeboard at Warehouse Pond has 5.6 feet (see **Table 6-7).** The Santa Barbara Park Pond retained 8.7 feet of freeboard (**Table 6-11**).

Conclusion

Option 7 indicates that increasing the Broadway Pump Station to a very high capacity reduced flooding throughout the entire storm drain system. However, flooding greater than 1 foot deep remains and therefore other Options should be evaluated.

TABLE 6-13
SUMMARY OF OPTION 7 STREET PONDING AND MAN-HOLE FLOODING

Note- negative numbers imply that the HGL did not reach the manhole rim

Represents flooding depth over 1 ft
Represents flooding between 0.5ft - 0.99 ft
Represents flooding depth between 0 - 0.5 ft

MH Name	Manhole Invert Elev.	Max. Depth of Manhole	Manhole Rim Elev.	Maximum HGL	Node Flood Depth Above Manhole Rim	Flood Volume	Flood Volume	Hours Flooded
	(ft)	(ft)	(ft)	(ft)	(ft)	(10^6 gal)	(acre-ft)	
	(a)	(a)	(b)	(c)	(d)	(e)	(f)	
COA6045	4957.51	7.82	4965.33	4965.42	0.09	0.418	1.283	5.13
COA15184	4954.19	10.04	4964.23	4964.8	0.57	1.116	3.425	6.07
COA6218	4953.66	9.34	4963	4963.47	0.47	0.807	2.477	6.3
COA6195	4962.97	6.74	4969.71	4970.58	0.87	0.522	1.602	1
COA6246	4962.06	7.85	4969.91	4970.2	0.29	0.181	0.555	0.65
COA19719	4952.3	9.98	4962.28	4963.07	0.79	1.155	3.545	6.38
COA7654	4951.67	8.59	4960.26	4960.87	0.61	1.066	3.271	6.49
COA7714	4950.14	7.86	4958	4958.67	0.67	1.515	4.649	6.51
COA25349	4945.26	11.07	4956.33	4956.35	0.02	0.157	0.482	0.31
COA25656	4948.86	10.32	4959.18	4959.32	0.14	0.23	0.706	1.84
COA25622	4948.24	9.58	4957.82	4957.84	0.02	0.065	0.199	0.8
COA7444	4952.87	7.72	4960.59	4961.04	0.45	1.056	3.241	14.66
COA7476	4950.32	7.85	4958.17	4959.01	0.84	1.15	3.529	16.11
COA7518	4947.94	8.89	4956.83	4957.5	0.67	0.918	2.817	15.18
COA24834	4944.52	7.06	4951.58	4951.67	0.09	0.417	1.280	3.58
COA25105	4946.31	10.2	4956.51	4956.52	0.01	0.036	0.110	0.31
COA7740	4949.69	8.25	4957.94	4957.96	0.02	0.15	0.460	1.49
COA7830	4944.87	12	4956.87	4956.88	0.01	0.091	0.279	0.27
COA7865	4946.34	10.46	4956.8	4956.81	0.01	0.04	0.123	0.17
COA7955	4943.49	12	4955.49	4955.5	0.01	0.071	0.218	0.28
COA22517	4943.59	11	4954.59	4954.6	0.01	0.1	0.307	0.42
COA7716	4948.88	9.23	4958.11	4958.12	0.01	0.002	0.006	0.01
COA7769JB	4944.52	11.81	4956.33	4957.3	0.97		0.000	
COA32865	4945.49	11.62	4957.11	4957.12	0.01	0.004	0.012	0.05
COA32878	4946.6	9.16	4955.76	4956.77	1.01	0.255	0.783	1
COA7848	4947.67	8.71	4956.38	4956.39	0.01	0.056	0.172	0.34
COA13866	4935.36	12.08	4947.44	4947.45	0.01	0.012	0.037	0.03
COA9248	4947.65	10.07	4957.72	4957.74	0.02	0.008	0.025	0.08
COA32878.A	4947.19	8.39	4955.58	4956.52	0.94	0.168	0.516	1.03
COA32878.B	4946.27	9.58	4955.85	4956.21	0.36	0.071	0.218	0.71
COA22169	4939.35	6.75	4946.1	4946.83	0.73	0.645	1.979	4.02
COA22127	4937.86	7.66	4945.52	4945.59	0.07	0.128	0.393	1.94
COA9229	4913.15	27	4940.15	4940.5	0.35	0.029	0.089	0.59
1F.C.OUT	4949	9.4	4958.4	4958.41	0.01	0.003	0.009	0.01
1F.E.MHA	4961.5	14.21	4975.71	4975.72	0.01	0.002	0.006	0.01

(a) Manhole invert elevation from SWMM input under Node Summary Table
(b) Rim elevation = MH invert elevation + Max depth of manhole
(c) Max HGL from SWMM output table under Node Depth Summary
(d) Node Flood Depth above Manhole Rim = HGL Elev-Rim Elev
(e) Flood volume from SWMM output table under Node Flooding Summary
(f) 1 gallon = 3.06888 E-6 acre-ft

Option 8 –

Purpose

The purpose of Option 8 was to incorporate multiple changes from Option 7 in order to address flooding problems in the Broadway-Lomas intersection, north Broadway area, 4th Street area near I-40, and upsizing the storm drain network along Barelas-Pacific - Lewis area and also along most of Rio Grande Blvd.

Facility 10 Remove the existing Broadway-Lomas Pond and sell this lot as a high value commercial property.

Facility X2 A pond at Broadway and Kinley (Burnt Out Warehouse west side of Broadway).

Facility 1 Build a new pond in Sub-catchment BR21 (near southeast intersection of Lomas Blvd. and Medical Arts). The pond outfall pipe will be a 24-in. RCP that will join into the existing Lomas Blvd. manhole that joins to an existing 48-in. RCP that drains north to the existing Odelia Pond.

Facility X4 Upsized storm drain from 36-in. to 48-in., begin at the Broadway-Odelia intersection continue west on Baca to Commercial, then north on Commercial for 600 ft. Upsized 36-in. to 48-in. storm drain from the Commercial-Indian School intersection south on Commercial to McKnight, then east on McKnight, then new 48-in. storm drain from the Commercial-McKnight intersection east to the Broadway-McKnight intersection, then south on Broadway to join into the Santa Barbara Park Pond. Upsize the 36-in. to 48-in. storm drain south from the Broadway-Hannett intersection to the Broadway-Odelia intersection.

Facility X6 Upsize the Broadway Pump Station to a maximum capacity of 300 cfs (from 130 cfs existing).

Facility X7 Upsize storm drains from 36-in. to 48 in. along 4th St. from Cutler south to McKnight then east to 3rd St. and joined to existing 48-in. storm drains. Then west on Constitution from 3rd St. to 5th St. and south on 5th to outfall into pond located at Summer and 5th St. called the North Wells Park Pond. The 36-in. outfall pipe from the pond continues south on 5th St. to Mountain, then east on Mountain to 3rd St. where it joined into the existing 3rd St. 48-in. storm drain. The existing 3rd St. storm drain was deleted from the 3rd St.-Constitution intersection south to the 3rd St.- Mountain intersection to drain upstream storm drain flows to the North Wells Park Pond.

Facility X8 Upsize storm drains from 24-in. to 48 in. on Rio Grande Blvd. from Carson to Chacoma then east to San Pasquale and finally to Laguna.

Facility X19 Upsize the 27-in. and 30-in. storm drains to 48-in. storm drains on Barelas from Pacific Ave. south to Lewis and west on Lewis to the west Riverside storm drain.

Modeling Approach

The Broadway-Lomas detention pond was deleted from the model. The existing manhole number COA 32878.A located just north of Broadway-Lomas intersection was connected directly to an existing manhole COA32878.B with a 4.5 ft diameter RCP pipe in Broadway. The Warehouse Detention Pond was simulated. The pond was placed in between manholes COA 7963.11A and COA7716 with appropriate inlet, outlet nodes and pipes as simulated in SWMM. The BR21 pond was simulated to detain runoff from Sub-catchment BR21. The pond outfall was simulated as a 24-in. conduit that joined manhole COA7860 in Lomas Blvd. at Edith. A detention pond in Santa Barbara Park was added along with the inlet and outlet. The storm drain from Commercial to Baca was re-routed to Broadway to drain into the Santa Barbara Park Pond. Upsized 36-in. to 48-in. storm drain from the Commercial-Indian School intersection south on Commercial to McKnight, then east on McKnight, then new 48-in. storm drain from the Commercial-McKnight intersection east to the Broadway-McKnight intersection, then south on Broadway to join into the Santa Barbara Park Pond. The pipes connecting manholes COA 29163 and COA7635, along Commercial and COA29132 and COA7628 along Broadway were deleted.

The Broadway Pump Station Capacity was increased to 300 cfs from 130 cfs existing. The North Wells Park Pond was included located near Summer and 5th St. The storm drains from Cutler to McKnight on 4th St. were upsized from 36-in. to 48-in. A 48-in. RCP storm drain was included west from 3rd St. and Constitution and south along 5th St to drain into North Wells Park Pond. The pond outfall is a 36-in. RCP that continues south on 5th St. to Mountain, then east to 3rd St. were it joins the existing storm drain. The existing pipe between Constitution and Mountain along 3rd St. was deleted to direct water to the North Wells Park Pond. The storm drains from Carson and Rio Grande to San Pasquale and Laguna were upsized from 36-in. to 48-in. The storm drain from Barelas and Pacific to Lewis and the West Riverside storm drain were upsized from 27-in. and 30-in. to 48-in. The significant option components are summarized in **Table 6-1** (Summary of Model Filenames and Components- Appendix Volume 2, Appendix 1).

Street Flooding Results

Option 8 reduced most flooding at the Broadway-Lomas intersection to below 0.5 feet. COA 7769JB located near the Broadway Pump Station had a 2 foot flood depth.

There were a number of manholes that had minor flooding (less than 0.2 foot deep) in the Barelas Basin. North Wells Park Pond along with the upsized storm drain reduced most flooding at these related manholes. The same was true for the problem areas along Rio Grande and Barelas. Flooding results are summarized in **Table 6-14.**

Appendix Volume 2, Appendix 1.2 contains the SWMM model output and additional information prepared to document information and computations for this Option.

Detention Pond Routing Results

Freeboard at the Air Quality Pond is 4.0 feet (see **Table 6-3).** The Tingley Surge Pond had 5.5 feet (see **Table 6-4**). The BR21 Pond has 7.4 feet (see **Table 6-9).** Freeboard at the Warehouse

Pond remained at 4.4 feet (see **Table 6-7**) while Santa Barbara pond has 9.8 feet of freeboard (see **Table 6-11).** However, the North Wells Park pond only had 1 foot of freeboard (see **Table 6-15)**.

TABLE 6-14
SUMMARY OF OPTION 8 STREET PONDING AND MAN-HOLE FLOODING

Note- negative numbers imply that the HGL did not reach the manhole rim

Represents flooding depth over 1 ft
Represents flooding between 0.5ft - 0.99 ft
Represents flooding depth between 0 - 0.5 ft

MH Name	Manhole Invert Elev.	Max. Depth of Manhole	Manhole Rim Elev.	Maximum HGL	Node Flood Depth Above Manhole Rim	Flood Volume	Flood Volume	Hours Flooded
	(ft)	(ft)	(ft)	(ft)	(ft)	(10^6 gal)	(acre-ft)	
	(a)	(a)	(b)	(c)	(d)	(e)	(f)	
COA6045	4957.51	7.82	4965.33	4965.34	0.01	0.26	0.798	2.4
COA15184	4954.19	10.04	4964.23	4964.43	0.2	0.755	2.317	3.68
COA6218	4953.66	9.34	4963	4963.43	0.43	0.874	2.682	4.16
COA6195	4962.97	6.74	4969.71	4970.01	0.3	0.18	0.552	0.78
COA6246	4962.06	7.85	4969.91	4969.92	0.01	0.019	0.058	0.12
COA7656	4953.17	9.45	4962.62	4962.63	0.01	0.017	0.052	0.1
COA19719	4952.3	9.98	4962.28	4963.06	0.78	1.19	3.652	4.42
COA7654	4951.67	8.59	4960.26	4960.27	0.01	0.282	0.865	1.6
COA25349	4945.26	11.07	4956.33	4956.34	0.01	0.065	0.199	0.14
COA25656	4948.86	10.32	4959.18	4959.33	0.15	0.246	0.755	1.94
COA25622	4948.24	9.58	4957.82	4957.84	0.02	0.067	0.206	0.9
COA7476	4950.32	7.85	4958.17	4958.32	0.15	0.231	0.709	1.49
COA7518	4947.94	8.89	4956.83	4957	0.17	0.232	0.712	1.68
COA24834	4944.52	7.06	4951.58	4951.93	0.35	1.59	4.880	4.01
COA25105	4946.31	10.2	4956.51	4956.52	0.01	0.04	0.123	0.37
COA7908	4946.15	10	4956.15	4956.16	0.01	0.011	0.034	0.03
COA22517	4943.59	11	4954.59	4954.6	0.01	0.064	0.196	0.28
COA7769JB	4944.52	11.81	4956.33	4958.37	2.04		0.000	
COA32878	4946.6	9.16	4955.76	4955.88	0.12	0.044	0.135	0.4
COA9344	4935.83	15.71	4951.54	4951.55	0.01	0.024	0.074	0.07
COA9229	4913.15	27	4940.15	4940.49	0.34	0.028	0.086	0.58
1F.H.MH1	4951.5	8	4959.5	4959.54	0.04	0.138	0.424	0.31

(a) Manhole invert elevation from SWMM input under Node Summary Table
(b) Rim elevation = MH invert elevation + Max depth of manhole
(c) Max HGL from SWMM output table under Node Depth Summary
(d) Node Flood Depth above Manhole Rim = HGL Elev-Rim Elev
(e) Flood volume from SWMM output table under Node Flooding Summary
(f) 1 gallon = 3.06888 E-6 acre-ft

TABLE 6-15

WELLS PARK DETENTION POND ROUTING SUMMARY

Detention Pond Name	Existing or Proposed Pond (detention or retention)	Model Analysis Point Name	Storm Return Period (100-yr. 24-hr. duration)	Peak Inflow	Peak Outflow	Peak Storage Volume	Peak Storage Volume	Peak Water Surface Elevation	Principal Spillway Elevation	Emergency Spillway Elevation	Pond Invert Elevation	Water Depth	Top of Pond Embankment Elevation	Freeboard to Emergency Spillway Elevation	**Freeboard to top of Pond Embankment**
				(cfs)	(cfs)	(ft^3)	(ac-ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)
a	a	a		b	c	g	c	d	e	e	e		e	f	f
OPTION 8															
Wells Park Pond	CONCEPTUAL	Wells Park Pond	100	274	274	712786	16.363	4959.0	4951	4960	4951	8.0	4960	1.0	**1.0**
OPTION 9															
Wells Park Pond	CONCEPTUAL	Wells Park Pond	100	195	188	642018	14.739	4959.1	4951	4960	4951	8.1	4960	0.9	**0.9**
OPTION 10															
Wells Park Pond	CONCEPTUAL	Wells Park Pond	100	172	136	653235	14.996	4959.3	4951	4960	4951	8.3	4960	0.7	**0.7**

TABLE 6-15

WELLS PARK DETENTION POND ROUTING SUMMARY

Detention Pond Name	Existing or Proposed Pond (detention or retention)	Model Analysis Point Name	Storm Return Period (100-yr. 24-hr. duration)	Peak Inflow	Peak Outflow	Peak Storage Volume	Peak Storage Volume	Peak Water Surface Elevation	Principal Spillway Elevation	Emergency Spillway Elevation	Pond Invert Elevation	Water Depth	Top of Pond Embankment Elevation	Freeboard to Emergency Spillway Elevation	**Freeboard to top of Pond Embankment**
				(cfs)	(cfs)	(ft^3)	(ac-ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)
a	a	a		b	c	g	c	d	e	e	e		e	f	f
OPTION 11															
Wells Park Pond	CONCEPTUAL	Wells Park Pond	100	163	97	647649	14.868	4959.2	4951	4960	4951	8.2	4960	0.8	**0.8**
OPTION 12															
Wells Park Pond	CONCEPTUAL	Wells Park Pond	100	162	72	642462	14.749	4958.9	4951	4960	4951	7.9	4960	1.1	**1.1**
OPTION 13															
Wells Park Pond	CONCEPTUAL	Wells Park Pond	100	201	225	614394	14.105	4958.8	4951	4960	4951	7.8	4960	1.2	**1.2**

TABLE 6-15

WELLS PARK DETENTION POND ROUTING SUMMARY

Detention Pond Name	Existing or Proposed Pond (detention or retention)	Model Analysis Point Name	Storm Return Period (100-yr. 24-hr. duration)	Peak Inflow	Peak Outflow	Peak Storage Volume	Peak Storage Volume	Peak Water Surface Elevation	Principal Spillway Elevation	Emergency Spillway Elevation	Pond Invert Elevation	Water Depth	Top of Pond Embankment Elevation	Freeboard to Emergency Spillway Elevation	**Freeboard to top of Pond Embankment**
				(cfs)	(cfs)	(ft^3)	(ac-ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)
a	a	a		b	c	g	c	d	e	e	e		e	f	f
OPTION 14															
Wells Park Pond	CONCEPTUAL	Wells Park Pond	100	213	261	571494	13.120	4959.2	4951	4960	4951	8.2	4960	0.8	**0.8**
OPTION 15															
Wells Park Pond	CONCEPTUAL	Wells Park Pond	100	143	70	633288	14.538	4959.0	4951	4960	4951	8.0	4960	1.0	**1.0**
OPTION 16															
Wells Park Pond	CONCEPTUAL	Wells Park Pond	100	195	188	642018	14.739	4959.1	4951	4960	4951	8.1	4960	0.9	**0.9**

TABLE 6-15

WELLS PARK DETENTION POND ROUTING SUMMARY

Detention Pond Name	Existing or Proposed Pond (detention or retention)	Model Analysis Point Name	Storm Return Period (100-yr. 24-hr. duration)	Peak Inflow	Peak Outflow	Peak Storage Volume	Peak Storage Volume	Peak Water Surface Elevation	Principal Spillway Elevation	Emergency Spillway Elevation	Pond Invert Elevation	Water Depth	Top of Pond Embankment Elevation	Freeboard to Emergency Spillway Elevation	**Freeboard to top of Pond Embankment**
				(cfs)	(cfs)	(ft^3)	(ac-ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)
a	a	a		b	c	g	c	d	e	e	e		e	f	f
OPTION 17															
Wells Park Pond	CONCEPTUAL	Wells Park Pond	100	118	48	544745	12.506	4958.0	4951	4960	4951	7.0	4960	2.0	**2.0**
OPTION 18															
Wells Park Pond	CONCEPTUAL	Wells Park Pond	100	120	36	545342	12.519	4958.0	4951	4960	4951	7.0	4960	2.0	**2.0**

TABLE 6-15

WELLS PARK DETENTION POND ROUTING SUMMARY

Detention Pond Name	Existing or Proposed Pond (detention or retention)	Model Analysis Point Name	Storm Return Period (100-yr. 24-hr. duration)	Peak Inflow	Peak Outflow	Peak Storage Volume	Peak Storage Volume	Peak Water Surface Elevation	Principal Spillway Elevation	Emergency Spillway Elevation	Pond Invert Elevation	Water Depth	Top of Pond Embankment Elevation	Freeboard to Emergency Spillway Elevation	**Freeboard to top of Pond Embankment**
				(cfs)	(cfs)	(ft^3)	(ac-ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)
a	a	a		b	c	g	c	d	e	e	e		e	f	f
OPTION 19															
Wells Park Pond	CONCEPTUAL	Wells Park Pond	100	120	37	576813	13.242	4958.4	4951	4960	4951	7.4	4960	1.6	**1.6**

a - See Drainage Basin Maps and Figure 6-1
b - See SWMM output for results "Node Inflow Summary" Table
c -Value calculated after unit conversion from SWMM output
d- See SWMM output for results "Node Depth Summary" Table
e - See Volume 2 Appendix 1.2 for Pond Routing Elev-Area-Capacity Discharge Data
f- Negative number indicates the flow depth exceeds referenced elevation - no freeboard available
g - Value from SWMM output under Storage Volume Summary

Conclusion
Option 8 indicates that increasing the Broadway Pump Station capacity reduced flooding throughout the entire storm drain system. For other problem areas (4th St. near I-40 and Rio Grande Blvd.), Option 8 reduced most, but not all flooding. Flooding was greatly reduced but not eliminated along Rio Grande Blvd. Flooding was eliminated along Barelas to Lewis Ave. Therefore some flooding remains in some areas and other Options should be evaluated.

Option 9 –

Purpose
The purpose of Option 9 was to incorporate all of the facilities within Option 8. The existing Broadway Pump Station Capacity was assumed at 130 cfs (existing capacity). Then evaluate the flood depth reductions in the Broadway-Lomas intersection, the north Broadway area, 4th St. near I-40, Barelas-Pacific- Lewis areas and Rio Grande Blvd. areas.

Facility 10 Remove the existing Broadway-Lomas Pond and sell this lot as a high value commercial property.

Facility X2 A pond at Broadway and Kinley (Burnt Out Warehouse west side of Broadway).

Facility 1 Build a new pond in Sub-catchment BR21 (near southeast intersection of Lomas Blvd. and Medical Arts). The pond outfall pipe will be a 24-in. RCP that will join into the existing Lomas Blvd. manhole that joins to an existing 48-in. RCP that drains north to the existing Odelia Pond.

Facility X4 Upsized storm drain from 36-in. to 48-in., begin at the Broadway-Odelia intersection continue west on Baca to Commercial, then north on Commercial for 600 ft. Upsized 36-in. to 48-in. storm drain from the Commercial-Indian School intersection south on Commercial to McKnight, then east on McKnight, then new 48-in. storm drain from the Commercial-McKnight intersection east to the Broadway-McKnight intersection, then south on Broadway to join into the Santa Barbara Park Pond. Upsize the 36-in. to 48-in. storm drain south from the Broadway-Hannett intersection to the Broadway-Odelia intersection.

Facility X7 Upsize storm drains from 36-in. to 48-in. along 4th St. from Cutler south to McKnight then east to 3rd St. and joined to existing 48-in. storm drains. Then west on Constitution from 3rd St. to 5th St. and south on 5th to tie into pond located at Summer and 5th St. called the North Wells Park Pond. The 36-in. outfall pipe from the pond continues south on 5th St. to Mountain, then east on Mountain to 3rd St. where it joined into the existing 3rd St. 48-in. storm drain. The existing 3rd St. storm drain was deleted from the 3rd St.-Constitution intersection south to the 3rd St.- Mountain intersection to drain upstream storm drain flows to the North Wells Park Pond.

Facility X8 Upsize storm drains from 24-in. to 48-in. on Rio Grande Blvd. from Carson to Chacoma then east to San Pasquale and finally to Laguna.

Facility X19 Upsize the 27-in. and 30-in. storm drains to 48-in. storm drains on Barelas from Pacific Ave. south to Lewis and west on Lewis to the west Riverside storm drain.

Modeling Approach

The Broadway-Lomas detention pond was deleted from the model. The existing manhole number COA 32878.A located just north of Broadway-Lomas intersection was connected directly to an existing manhole COA32878.B with a 4.5 ft diameter RCP pipe in Broadway. The Warehouse Detention Pond was simulated. The pond was placed in between manholes COA 7963.11A and COA7716 with appropriate inlet, outlet nodes and pipes as simulated in SWMM. The BR21 pond was simulated to detain runoff from Sub-catchment BR21. The pond outfall was simulated as a 24-in. conduit that joined manhole COA7860 in Lomas Blvd. at Edith. A detention pond in Santa Barbara Park was added along with the inlet and outlet. The storm drain from Commercial to Baca was re-routed to Broadway to drain into the Santa Barbara Park Pond. Upsized 36-in. to 48-in. storm drain from the Commercial-Indian School intersection south on Commercial to McKnight, then east on McKnight, then new 48-in. storm drain from the Commercial-McKnight intersection east to the Broadway-McKnight intersection, then south on Broadway to join into the Santa Barbara Park Pond. The pipes connecting manholes COA 29163 and COA7635, along Commercial and COA29132 and COA7628 along Broadway were deleted.

The Broadway Pump Station capacity was modeled at 130 cfs existing capacity. The North Wells Park Pond was included located near Summer and 5th St. The storm drains from Cutler to McKnight on 4th St. were upsized from 36-in. to 48-in. A 48-in. RCP storm drain was included west from 3rd St. and Constitution and south along 5th St. to drain into North Wells Park Pond. The pond outfall is a 36-in. RCP that continues south on 5th St. to Mountain, then east to 3rd St. were it joins the existing storm drain. The existing pipe between Constitution and Mountain along 3rd St. was deleted to direct water to the North Wells Park Pond. The storm drains from Carson and Rio Grande Blvd. to San Pasquale and Laguna were upsized from 36-in. to 48-in. The storm drain from Barelas and Pacific to Lewis and the West Riverside storm drain were upsized from 27-in. and 30-in. to 48-in. The significant option components are summarized in **Table 6-1** (Summary of Model Filenames and Components – Appendix Volume 2, Appendix 1).

Street Flooding Results

The flood depths at Broadway-Lomas intersection are less than 0.5 feet deep. The flood depth at COA 7769JB remained at 2 feet deep. Flooding results are summarized in **Table 6-16.**

Appendix Volume 2, Appendix 1.2 contains the SWMM model output and additional information prepared to document information and computations for this Option.

Detention Pond Routing Results

Freeboard in the Air Quality Pond is 3.8 feet (see **Table 6-3).** The freeboard at Tingley Surge Pond is 5.4 feet (see **Table 6-4**) and BR21 Pond is 7.4 feet (see **Table 6-9**). Freeboard at Warehouse Pond is 3.3 feet (see **Table 6-7**) while Santa Barbara Park Pond retained 9.9 feet of

freeboard (see **Table 6-11**) . The North Wells Park Pond, however only had 0.9 feet of freeboard (see Table **6-15**).

freeboard (see **Table 6-11**) . The North Wells Park Pond, however only had 0.9 feet of freeboard (see Table **6-15**).

TABLE 6-16
SUMMARY OF OPTION 9 STREET PONDING AND MAN-HOLE FLOODING

Note- negative numbers imply that the HGL did not reach the manhole rim

Represents flooding depth over 1 ft
Represents flooding between 0.5ft - 0.99 ft
Represents flooding depth between 0 - 0.5 ft

MH Name	Manhole Invert Elev.	Max. Depth of Manhole	Manhole Rim Elev.	Maximum HGL	Node Flood Depth Above Manhole Rim	Flood Volume	Flood Volume	Hours Flooded
	(ft)	(ft)	(ft)	(ft)	(ft)	(10^6 gal)	(acre-ft)	
	(a)	(a)	(b)	(c)	(d)	(e)	(f)	
COA6045	4957.51	7.82	4965.33	4965.34	0.01	0.26	0.798	2.4
COA15184	4954.19	10.04	4964.23	4964.43	0.2	0.755	2.317	3.68
COA6218	4953.66	9.34	4963	4963.43	0.43	0.874	2.682	4.16
COA6195	4962.97	6.74	4969.71	4970.01	0.3	0.18	0.552	0.78
COA6246	4962.06	7.85	4969.91	4969.92	0.01	0.019	0.058	0.12
COA7656	4953.17	9.45	4962.62	4962.63	0.01	0.017	0.052	0.1
COA19719	4952.3	9.98	4962.28	4963.06	0.78	1.19	3.652	4.42
COA7654	4951.67	8.59	4960.26	4960.27	0.01	0.282	0.865	1.6
COA25349	4945.26	11.07	4956.33	4956.34	0.01	0.065	0.199	0.14
COA25656	4948.86	10.32	4959.18	4959.33	0.15	0.246	0.755	1.94
COA25622	4948.24	9.58	4957.82	4957.84	0.02	0.067	0.206	0.9
COA7476	4950.32	7.85	4958.17	4958.32	0.15	0.231	0.709	1.49
COA7518	4947.94	8.89	4956.83	4957	0.17	0.232	0.712	1.68
COA24834	4944.52	7.06	4951.58	4951.93	0.35	1.59	4.880	4.01
COA25105	4946.31	10.2	4956.51	4956.52	0.01	0.04	0.123	0.37
COA7908	4946.15	10	4956.15	4956.16	0.01	0.011	0.034	0.03
COA22517	4943.59	11	4954.59	4954.6	0.01	0.064	0.196	0.28
COA7769JB	4944.52	11.81	4956.33	4958.37	2.04		0.000	
COA32878	4946.6	9.16	4955.76	4955.88	0.12	0.044	0.135	0.4
COA9344	4935.83	15.71	4951.54	4951.55	0.01	0.024	0.074	0.07
COA9229	4913.15	27	4940.15	4940.49	0.34	0.028	0.086	0.58
1F.H.MH1	4951.5	8	4959.5	4959.54	0.04	0.138	0.424	0.31

(a) Manhole invert elevation from SWMM input under Node Summary Table
(b) Rim elevation = MH invert elevation + Max depth of manhole
(c) Max HGL from SWMM output table under Node Depth Summary
(d) Node Flood Depth above Manhole Rim = HGL Elev-Rim Elev
(e) Flood volume from SWMM output table under Node Flooding Summary
(f) 1 gallon = 3.06888 E-6 acre-ft

Conclusion
Option 9 reflected the inadequacy of the Broadway Pump Stations current capacity (130 cfs) in the event that the existing Broadway-Lomas Pond is removed. This option was unable to reduce the Broadway-Lomas street flooding; therefore, other options should be evaluated.

Option 10 –

Purpose
The purpose of Option 10 was to determine if adding two more ponds north of I-40 (East DOT Pond and West DOT Pond) and routing hydrographs from Sub-catchments BR17 and BR18 through them would reduce flooding in the north Broadway area and at Broadway-Lomas intersection.

Facility 10 Remove the existing Broadway-Lomas Pond and sell this lot as a high value commercial property.

Facility X2 A pond at Broadway and Kinley (Burnt Out Warehouse west side of Broadway).

Facility 1 Build a new pond in Sub-catchment BR21 (near southeast intersection of Lomas Blvd. and Medical Arts). The pond outfall pipe will be a 24-in. RCP that will join into the existing Lomas Blvd. manhole that joins to an existing 48-in. RCP that drains north to the existing Odelia Pond.

Facility X4 Upsized storm drain from 36-in. to 48-in., begin at the Broadway-Odelia intersection continue west on Baca to Commercial, then north on Commercial for 600 ft. Upsized 36-in. to 48-in. storm drain from the Commercial-Indian School intersection south on Commercial to McKnight, then east on McKnight, then new 48-in. storm drain from the Commercial-McKnight intersection east to the Broadway-McKnight intersection, then south on Broadway to join into the Santa Barbara Park Pond. Upsize the 36-in. to 48-in. storm drain south from the Broadway-Hannett intersection to the Broadway-Odelia intersection.

Facility X7 Upsize storm drains from 36-in. to 48-in. along 4th St. from Cutler south to McKnight then east to 3rd St. and joined to existing 48-in. storm drains. Then west on Constitution from 3rd St. to 5th St. and south on 5th St. to tie into pond located at Summer and 5th St. called the North Wells Park Pond. The 36-in. outfall pipe from the pond continues south on 5th St. to Mountain, then east on Mountain to 3rd St. where it joined into the existing 3rd St. 48-in. storm drain. The existing 3rd St. storm drain was deleted from the 3rd St.-Constitution intersection south to the 3rd St.- Mountain intersection to direct upstream storm drain flows to the North Wells Park Pond.

Facility X8 Upsize storm drains from 24-in. to 48-in. on Rio Grande Bvld. from Carson to Chacoma then east to San Pasquale and finally to Laguna.

Facility X19 Upsize the 27-in. and 30-in. storm drains to 48-in. storm drains on Barelas from Pacific Ave. south to Lewis and west on Lewis to the west Riverside storm drain.

Facility X9 Added two alternative detention ponds as follows, the East DOT Pond is located east of Broadway just north of I-40. The West DOT Pond is located on the west side of Broadway just north of I-40.

Modeling Approach

The Broadway-Lomas detention pond was deleted from the model. The existing manhole number COA 32878.A located just north of Broadway-Lomas intersection was connected directly to an existing manhole COA32878.B with a 4.5 ft diameter RCP pipe in Broadway. The Warehouse Detention Pond was simulated. The pond was placed between manholes COA 7963.11A and COA7716 with appropriate inlet, outlet nodes and pipes as simulated in SWMM. The BR21 pond was simulated to detain runoff from Sub-catchment BR21. The pond outfall was simulated as a 24-in. conduit that joined manhole COA7860 in Lomas Blvd. at Edith. A detention pond in Santa Barbara Park was added along with the inlet and outlet. The storm drain from Commercial to Baca was re-routed to Broadway to drain into the Santa Barbara Park Pond. Upsized 36-in. to 48-in. storm drain from the Commercial-Indian School intersection south on Commercial to McKnight, then east on McKnight, then new 48-in. storm drain from the Commercial-McKnight intersection east to the Broadway-McKnight intersection, then south on Broadway to join into the Santa Barbara Park Pond. The pipes connecting manholes COA 29163 and COA7635, along Commercial, COA29132 and COA7628 along Broadway were deleted.

The Broadway Pump Station Capacity was modeled at 130 cfs existing capacity. The North Wells Park Pond was included that is located near Summer and 5th St. The storm drains from Cutler to McKnight on 4th St. were upsized from 36-in. to 48-in. A 48-in. RCP storm drain was included west from 3rd St. and Constitution and south along 5th St. to drain into North Wells Park Pond. The pond outfall is a 36-in. RCP south on 5th St. to Mountain, then east to 3rd St. were it joins the existing storm drain. The existing pipe between Constitution and Mountain along 3rd St. was deleted to direct water to the North Wells Park Pond. The storm drains from Carson and Rio Grande to San Pasquale and Laguna were upsized from 36-in. to 48-in. The storm drain from Barelas and Pacific to Lewis and the West Riverside storm drain were upsized from 27-in. and 30-in. to 48-in.

The West DOT Pond, with a maximum depth of 9 feet, was added on the east side of Commercial north of I-40. The pond was drained to manhole COA6195 through a 36-in. storm drain. The East DOT pond, with a maximum depth of 8 feet, was added on the east side of Broadway and north of I-40. The pond was drained to manhole COA29132 through a 36-in. storm drain.

The significant option components are summarized in **Table 6-1** (Summary of Model Filenames and Components – Appendix Volume 2, Appendix 1).

Street Flooding Results

Although Option 10 reduced flooding along most of Broadway, the flood depths remained greater than 0.5 feet deep at the Broadway-Lomas intersection. Flooding results are summarized in **Table 6-17.**

Appendix Volume 2, Appendix 1.2 contains the SWMM model output and additional information prepared to document information and computations for this Option.

TABLE 6-17
SUMMARY OF OPTION 10 STREET PONDING AND MAN-HOLE FLOODING

Note- negative numbers imply that the HGL did not reach the manhole rim

Represents flooding depth over 1 ft
Represents flooding between 0.5ft - 0.99 ft
Represents flooding depth between 0 - 0.5 ft

MH Name	Manhole Invert Elev.	Max. Depth of Manhole	Manhole Rim Elev.	Maximum HGL	Node Flood Depth Above Manhole Rim	Flood Volume	Flood Volume	Hours Flooded
	(ft)	(ft)	(ft)	(ft)	(ft)	(10^6 gal)	(acre-ft)	
	(a)	(a)	(b)	(c)	(d)	(e)	(f)	
COA6045	4957.51	7.82	4965.33	4965.34	0.01	0.277	0.850	2.48
COA15184	4954.19	10.04	4964.23	4964.43	0.2	0.786	2.412	3.78
COA6218	4953.66	9.34	4963	4963.44	0.44	0.881	2.704	4.27
COA19719	4952.3	9.98	4962.28	4963.07	0.79	1.172	3.597	4.58
COA7654	4951.67	8.59	4960.26	4960.28	0.02	0.094	0.288	0.72
COA25349	4945.26	11.07	4956.33	4956.34	0.01	0.101	0.310	0.25
COA25656	4948.86	10.32	4959.18	4959.34	0.16	0.23	0.706	1.94
COA25622	4948.24	9.58	4957.82	4957.86	0.04	0.075	0.230	0.73
COA7476	4950.32	7.85	4958.17	4958.32	0.15	0.227	0.697	1.49
COA7518	4947.94	8.89	4956.83	4957	0.17	0.233	0.715	1.7
COA24834	4944.52	7.06	4951.58	4951.93	0.35	1.587	4.870	3.9
COA25105	4946.31	10.2	4956.51	4956.52	0.01	0.031	0.095	0.35
COA7908	4946.15	10	4956.15	4956.16	0.01	0.007	0.021	0.03
COA7955	4943.49	12	4955.49	4955.5	0.01	0.045	0.138	0.17
COA32865	4945.49	11.62	4957.11	4957.12	0.01	0.003	0.009	0.04
COA32878	4946.6	9.16	4955.76	4956.45	0.69	0.171	0.525	0.89
COA13866	4935.36	12.08	4947.44	4947.45	0.01	0.002	0.006	0.01
COA32878.A	4947.19	8.39	4955.58	4956.26	0.68	0.11	0.338	0.91
COA32878.B	4946.27	9.58	4955.85	4956.02	0.17	0.019	0.058	0.44
COA9229	4913.15	27	4940.15	4940.5	0.35	0.029	0.089	0.59
1F.C.OUT	4949	9.4	4958.4	4958.41	0.01	0.002	0.006	0.01
1F.H.MH1	4951.5	8	4959.5	4959.55	0.05	0.068	0.209	0.19

(a) Manhole invert elevation from SWMM input under Node Summary Table
(b) Rim elevation = MH invert elevation + Max depth of manhole
(c) Max HGL from SWMM output table under Node Depth Summary
(d) Node Flood Depth above Manhole Rim = HGL Elev-Rim Elev
(e) Flood volume from SWMM output table under Node Flooding Summary
(f) 1 gallon = 3.06888 E-6 acre-ft

Detention Pond Routing Results

Freeboard at the Air Quality Pond is 4.4 feet (see **Table 6-3).** Freeboard at Tingley Surge Pond was 5.5 feet (see **Table 6-4**) and 7.4 feet in the BR21 Pond (see **Table 6-9).** Freeboard at Warehouse Pond was 3.6 feet (see **Table 6-7**) and the Santa Barbara Park Pond had 9.7 feet (see **Table 6-11).** Freeboard in the North Wells Park Pond is 0.7 feet (see **Table 6-15).** Freeboard in the West DOT Pond is 3.3 feet (see **Table 6-18**) and 4.1 feet in the East DOT Pond (see **Table 6-19**).

Conclusion

Option 10 reduced flood depths in the north Broadway area and had minimal effect in reducing flood depths at the Broadway-Lomas intersection. Therefore, additional options should be evaluated.

TABLE 6-18

WEST DOT POND DETENTION POND ROUTING SUMMARY

Detention Pond Name	Existing or Proposed Pond (detention or retention)	Model Analysis Point Name	Storm Return Period (100-yr. 24-hr. duration)	Peak Inflow	Peak Outflow	Peak Storage Volume	Peak Storage Volume	Peak Water Surface Elevation	Principal Spillway Elevation	Emergency Spillway Elevation	Pond Invert Elevation	Water Depth	Top of Pond Embankment Elevation	Freeboard to Emergency Spillway Elevation	**Freeboard to top of Pond Embankment**
				(cfs)	(cfs)	(ft^3)	(ac-ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)
a	a	a		b	c	g	c	d	e	e	e		e	f	f
OPTION 10															
West DOT Pond	CONCEPTUAL	West DOT Pond	100	57	29	64093	1.471	4967.7	4963	4971	4963	4.7	4971	3.3	**3.3**
OPTION 11															
West DOT Pond	CONCEPTUAL	West DOT Pond	100	57	25	72031	1.654	4968.2	4963	4971	4963	5.1	4971	2.9	**2.9**
OPTION 12															
West DOT Pond	CONCEPTUAL	West DOT Pond	100	57	21	72031	1.654	4966.9	4963	4971	4963	3.9	4971	4.1	**4.1**

a - See Drainage Basin Maps and Figure 6-1

b - See SWMM output for results "Node Inflow Summary" Table

c -Value calculated after unit conversion from SWMM output

d- See SWMM output for results "Node Depth Summary" Table

e - See Volume 2 Appendix 1.2 for Pond Routing Elev-Area-Capacity Discharge Data

f- Negative number indicates the flow depth exceeds referenced elevation - no freeboard available

g - Value from SWMM output under Storage Volume Summary

TABLE 6-19

EAST DOT POND DETENTION POND ROUTING SUMMARY

Detention Pond Name	Existing or Proposed Pond (detention or retention)	Model Analysis Point Name	Storm Return Period (100-yr. 24-hr. duration)	Peak Inflow	Peak Outflow	Peak Storage Volume	Peak Storage Volume	Peak Water Surface Elevation	Principal Spillway Elevation	Emergency Spillway Elevation	Pond Invert Elevation	Water Depth	Top of Pond Embankment Elevation	Freeboard to Emergency Spillway Elevation	**Freeboard to top of Pond Embankment**
				(cfs)	(cfs)	(ft^3)	(ac-ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)
a	a	a		b	c	g	c	d	e	e	e		e	f	f
OPTION 10															
East DOT Pond	CONCEPTUAL	East DOT Pond	100	61	48	34563	0.793	4975.9	4974	4980	4974	1.9	4980	4.1	**4.1**
OPTION 11															
East DOT Pond	CONCEPTUAL	East DOT Pond	100	61	48	34577	0.794	4975.9	4974	4980	4974	1.9	4980	4.1	**4.1**
OPTION 12															
East DOT Pond	CONCEPTUAL	East DOT Pond	100	61	43	46195	1.060	4975.9	4974	4980	4974	1.9	4980	4.1	**4.1**

a - See Drainage Basin Maps and Figure 6-1

b - See SWMM output for results "Node Inflow Summary" Table

c -Value calculated after unit conversion from SWMM output

d- See SWMM output for results "Node Depth Summary" Table

e - See Volume 2 Appendix 1.2 for Pond Routing Elev-Area-Capacity Discharge Data

f- Negative number indicates the flow depth exceeds referenced elevation - no freeboard available

g - Value from SWMM output under Storage Volume Summary

Option 11 –

Purpose

The purpose of Option 11 was to determine if dividing the Broadway Basin north of the Broadway-Mountain intersection to drain north to a Santa Barbara Park Pump Station would reduce the flooding throughout the north Broadway area at the Broadway-Lomas intersection.

Facility 10 Remove the existing Broadway-Lomas Pond and sell this lot as a high value commercial property.

Facility 1 Build a new pond in Sub-catchment BR21 (near southeast intersection of Lomas Blvd. and Medical Arts). The pond outfall pipe will be a 24-in. RCP that will join into the existing Lomas Blvd. manhole that joins to an existing 48-in. RCP that drains north to the existing Odelia Pond.

Facility X4 Upsized storm drain from 36-in. to 48-in., begin at the Broadway-Odelia intersection continue west on Baca to Commercial, then north on Commercial for 600 ft. Upsized 36-in. to 48-in. storm drain from the Commercial-Indian School intersection south on Commercial to McKnight, then east on McKnight, then new 48-in. storm drain from the Commercial-McKnight intersection east to the Broadway-McKnight intersection, then south on Broadway to join into the Santa Barbara Park Pump Station.

Facility X7 Upsize storm drains from 36-in. to 48-in. along 4th St. from Cutler south to McKnight then east to 3rd St. and joined to existing 48-in. storm drains. Then west on Constitution from 3rd St. to 5th St. and south on 5th St. to tie into pond located at Summer and 5th St. called the North Wells Park Pond. The 36-in. outfall pipe from the pond continues south on 5th St. to Mountain, then east on Mountain to 3rd St. where it joined into the existing 3rd St. 48-in. storm drain. The existing 3rd St. storm drain was deleted from the 3rd St.-Constitution intersection south to the 3rd St.- Mountain intersection to direct upstream storm drain flows to the North Wells Park Pond.

Facility X8 Upsize storm drains from 24-in. to 48-in. on Rio Grande Blvd. from Carson to Chacoma then east to San Pasquale and finally to Laguna.

Facility X19 Upsize the 27-in. and 30-in. storm drains to 48-in. storm drains on Barelas from Pacific Ave. south to Lewis and west on Lewis to the west Riverside storm drain.

Facility X9 Added two detention ponds; the East DOT Pond is located east of Broadway just north of I-40, the West DOT Pond is located on the west side of Broadway just north of I-40.

Facility X10 The Broadway Basin was divided at the Broadway-Mountain intersection so that storm drain slopes were reversed to drain north of the intersection to the Santa Barbara Park Pump Station that was simulated as 130 cfs maximum capacity. This pump station would require a force main to the North Diversion Channel.

Modeling Approach

The Broadway-Lomas detention pond was deleted from the model. The existing manhole number COA 32878.A located just north of Broadway-Lomas intersection was connected directly to an existing manhole COA32878.B with a 4.5 ft diameter RCP pipe in Broadway. The BR21 Pond was simulated to detain runoff from Sub-catchment BR21. The pond outfall was simulated to drain into the Odelia Pond. The Broadway basin was divided so that the northern part from Broadway and Mountain drained north to where the detention pond at the Santa Barbara Park was deleted and replaced with a pump station, with a maximum capacity of 130 cfs. The storm drain from Commercial to Baca was re-routed to Broadway to drain into the Santa Barbara Park Pump Station. Upsized 36-in. to 48-in. storm drain from the Commercial-Indian School intersection south on Commercial to McKnight, then east on McKnight, then new 48-in. storm drain from the Commercial-McKnight intersection east to the Broadway-McKnight intersection, then south on Broadway to join into the Santa Barbara Park Pump Station. The pipes connecting manholes COA 29163 and COA7635, along Commercial, COA29132, and COA7628 along Broadway were deleted. The Broadway Pump Station was simulated at existing capacity of 130 cfs.

The North Wells Park Pond located at Summer and 5th St. was included. The storm drains from Cutler to McKnight on 4th St. were upsized from 36-in. to 48-in.. A 48-in. RCP storm drain was included west from 3rd St. and Constitution and south along 5th St. to drain into North Wells Park Pond. The pond outfall pipe is a 36-in. RCP storm drain south on 5th St. to Mountain then east on Mountain to join to the existing 3rd St. storm drain. The storm drain between Constitution and Mountain along 3rd St. was deleted to direct flows to the North Wells Park Pond. The West DOT Pond, with a maximum depth of 9 feet was added on the east side of Commercial north of I-40. The pond was drained to manhole COA6195 through a 36-in. storm drain. The East DOT pond, with a maximum depth of 8 feet was added on the east side of Broadway and north of I-40. The pond was drained to manhole COA29132 through a 36-in. storm drain. The significant option components are summarized in **Table 6-1** (Summary of Model Filenames and Components – Appendix Volume 2, Appendix 1).

Street Flooding Results

Although Option 11 reduced flooding along most of Broadway, the flood depths remain greater than 0.5 feet at the Broadway-Lomas intersection. Flooding results are summarized in **Table 6-20.**

Appendix Volume 2, Appendix 1.2 contains the SWMM model output and additional information prepared to document information and computations for this Option.

Detention Pond Routing Results

Freeboard at the Air Quality Pond was 3.0 feet (see **Table 6-3).** Freeboard at Tingley Surge Pond was 5.5 feet (see **Table 6-4**). Freeboard in the BR21 Pond is 7.5 feet (see **Table 6-9**). Freeboard

is 0.8 feet at North Wells Park (see **Table 6-15**). Freeboard in the West DOT Pond is 2.9 feet (see **Table 6-18**) and 4.1 feet in the East DOT Pond (see **Table 6-19**).

Conclusion

Option 11 had a minimal effect in reducing flood depths at the Broadway-Lomas intersection. Therefore, additional options should be considered.

TABLE 6-20
SUMMARY OF OPTION 11 STREET PONDING AND MAN-HOLE FLOODING

Note- negative numbers imply that the HGL did not reach the manhole rim

Represents flooding depth over 1 ft
Represents flooding between 0.5ft - 0.99 ft
Represents flooding depth between 0 - 0.5 ft

MH Name	Manhole Invert Elev.	Max. Depth of Manhole	Manhole Rim Elev.	Maximum HGL	Node Flood Depth Above Manhole Rim	Flood Volume	Flood Volume	Hours Flooded
	(ft)	(ft)	(ft)	(ft)	(ft)	(10^6 gal)	(acre-ft)	
	(a)	(a)	(b)	(c)	(d)	(e)	(f)	
COA15184	4954.19	10.04	4964.23	4964.44	0.21	0.266	0.816	2.4
COA6218	4953.66	9.34	4963	4963.42	0.42	0.756	2.320	3.64
COA19719	4952.3	9.98	4962.28	4963.05	0.77	0.418	1.283	3.63
COA7654	4951.67	8.59	4960.26	4960.28	0.02	1.149	3.526	4.39
COA25656	4948.86	10.32	4959.18	4959.31	0.13	0.068	0.209	0.18
COA25622	4948.24	9.58	4957.82	4957.84	0.02	0.057	0.175	0.58
COA7476	4950.32	7.85	4958.17	4958.32	0.15	0.045	0.138	0.78
COA7518	4947.94	8.89	4956.83	4957	0.17	0.228	0.700	1.49
COA24834	4944.52	7.06	4951.58	4951.89	0.31	0.228	0.700	1.65
COA7830	4944.87	12	4956.87	4956.88	0.01	0.002	0.006	0.02
COA7716	4948.88	9.23	4958.11	4958.12	0.01	0.052	0.160	0.21
COA7766JB	4943.95	12.33	4956.28	4956.3	0.02	0.015	0.046	0.08
COA7769JB	4944.52	11.81	4956.33	4956.51	0.18	0.02	0.061	0.11
COA32878	4946.6	9.16	4955.76	4956.38	0.62	0.016	0.049	0.19
COA9248	4947.65	10.07	4957.72	4957.73	0.01	0.019	0.058	0.07
COA32878.B	4946.27	9.58	4955.85	4955.89	0.04	0.105	0.322	0.62

(a) Manhole invert elevation from SWMM input under Node Summary Table
(b) Rim elevation = MH invert elevation + Max depth of manhole
(c) Max HGL from SWMM output table under Node Depth Summary
(d) Node Flood Depth above Manhole Rim = HGL Elev-Rim Elev
(e) Flood volume from SWMM output table under Node Flooding Summary
(f) 1 gallon = 3.06888 E-6 acre-ft

Option 12 –

Purpose

The purpose of Option 12 was to determine if incorporating all the changes from Option 11 and adding a weir at the Broadway-Lomas intersection would divert more flow west on Lomas away from the Broadway Pump Station and if increased pipe diameter from 48-in. to 84-in. just north of the Broadway Pump Station for the existing length of 78 feet could reduce flooding at the Broadway-Lomas intersection.

Facility 10 Remove the existing Broadway-Lomas Pond and sell this lot as a high value commercial property.

Facility X1 Removal of the existing Broadway-Lomas weir.

Facility 1 Build a new pond in Sub-catchment BR21 (near southeast intersection of Lomas Blvd. and Medical Arts). The pond outfall pipe will be a 24-in. RCP that will join into the existing Lomas Blvd. manhole that joins to an existing 48-in. RCP that drains north to the existing Odelia Pond.

Facility X4 Upsized storm drain from 36-in. to 48-in., begin at the Broadway-Odelia intersection continue west on Baca to Commercial, then north on Commercial for 600 ft. Upsized 36-in. to 48-in. storm drain from the Commercial-Indian School intersection south on Commercial to McKnight, then east on McKnight, then new 48-in. storm drain from the Commercial-McKnight intersection east to the Broadway-McKnight intersection, then south on Broadway to join into the Santa Barbara Park Pump Station.

Facility X7 Upsize storm drains from 36-in. to 48-in. along 4th St. from Cutler south to McKnight then east to 3rd St. and joined to existing 48-in. storm drains. Then west on Constitution from 3rd St. to 5th St. and south on 5th St. to tie into pond located at Summer and 5th St. called the North Wells Park Pond. The 36-in. outfall pipe from the pond continues south on 5th St. to Mountain, then east on Mountain to 3rd St. where it joined into the existing 3rd St. 48-in. storm drain. The existing 3rd St. storm drain was deleted from the 3rd St.-Constitution intersection south to the 3rd St.- Mountain intersection to direct upstream storm drain flows to the North Wells Park Pond.

Facility X8 Upsize storm drains from 24-in. to 48-in. on Rio Grande Blvd. from Carson to Chacoma then east to San Pasquale and finally to Laguna.

Facility X19 Upsize the 27-in. and 30-in. storm drains to 48-in. storm drains on Barelas from Pacific Ave. south to Lewis and west on Lewis to the west Riverside storm drain.

Facility X9 Added two alternative detention ponds; the East DOT Pond is located east of Broadway just north of I-40, and the West DOT Pond is located on the west side of Broadway just north of I-40.

Facility X10 The Broadway Basin was divided at the Broadway-Mountain intersection so that storm drain slopes were reversed to drain north of the intersection to the Santa Barbara Park Pump Station that was simulated as 130 cfs maximum capacity.

Facility X11 Added a weir at the intersection of Broadway and Lomas to divert water west on Lomas away from Broadway Pump Station, and the storm drain diameter was increased from 48-in. to 84-in. to increase flow and storage capacity located just north of the Broadway Pump Station, existing length is 78 ft.

Modeling Approach

The Broadway-Lomas detention pond was deleted from the model. The existing manhole number COA 32878.A located just north of Broadway-Lomas intersection was connected directly to an existing manhole COA32878.B with a 4.5 ft diameter RCP pipe in Broadway. The BR21 pond was simulated to detain runoff from Sub-catchment BR21. The pond outfall was simulated to drain into the Odelia Pond. The Santa Barbara Park Pond was deleted and replaced with a pump station at the park with a maximum capacity of 130 cfs. The storm drain from Commercial to Baca was re-routed to Broadway to drain to the Santa Barbara Park Pump Station. . Upsized 36-in. to 48-in. storm drain from the Commercial-Indian School intersection south on Commercial to McKnight, then east on McKnight, then new 48-in. storm drain from the Commercial-McKnight intersection east to the Broadway-McKnight intersection, then south on Broadway to join into the Santa Barbara Park Pump Station. The storm drains connecting manholes COA 29163 and COA7635, along Commercial and COA29132 and COA7628 along Broadway were deleted. The Broadway Pump Station was simulated at existing capacity of 130 cfs.

A weir was added into manhole COA32878.A (Broadway-Lomas intersection). Modeling this weir in SWMM required two fictitious nodes labeled as WNODE1 and WNODE2. The inlet offset for the weir, which is height of the weir from the invert of the pipe to the top of the weir plate, was set at 4 feet in order to divert most of the flow from BR1, BR4 and BR19 away from the pump station. Storm drain north of Broadway Pump Station on Broadway was upsized from 48-in. to 84-in. to simulate underground storage. The North Wells Park Pond located at Summer and 5th St. was included. The storm drains from Cutler to McKnight on 4th St. were upsized from 36-in. to 48-in. A 48-in. RCP storm drain was included from 3rd St. and Constitution and south along 5th St. to drain into North Wells Park Pond. The pond outfall pipe is a 36-in. RCP storm drain south on 5th St. to mountain, then east on Mountain to 3rd St. where it joins the existing 3rd St. storm drain. The storm drain between Constitution and Mountain along 3rd St. was deleted to direct flows to the North Wells Park Pond. The West DOT Pond, with a maximum depth of 9 feet was included located on the east side of Commercial north of I-40. The pond was drained to manhole COA6195 through a 36-in. storm drain. The East DOT Pond, with a maximum depth of 8 feet was included located on the east side of Broadway and north of I-40. The pond was drained to manhole COA29132 through a 36-in. storm drain.

The significant option components are summarized in **Table 6-1** (Summary of Model Filenames and Components – Appendix Volume 2, Appendix 1).

Street Flooding Results
All manholes in the vicinity of the Broadway-Lomas intersection had flood depths between 0-0.5 feet. Option 12 flooding results are summarized in **Table 6-21.**

Appendix Volume 2, Appendix 1.2 contains the SWMM model output and additional information prepared to document information and computations for this Option.

Detention Pond Routing Results
Freeboard at the Air Quality Pond was 2.8 feet (see **Table 6-3).** Freeboard at Tingley Surge Pond was 5.5 feet (see **Table 6-4**). Freeboard in the BR21 Pond is 7.5 feet (see **Table 6-9**). The North Wells Park Pond was 1.1 feet (see **Table 6-15).** Freeboard in the West DOT Pond is 4.1 feet (see **Table 6-18**) and 4.1 feet in the East DOT Pond (see **Table 6-19**).

Conclusion
The inclusion of the Broadway-Lomas weir (to direct flows west on Lomas) reduced the flooding depths at the Broadway-Lomas intersection to well below a 0.5 feet. The storm drain diameter was increased from 48-in. to 84-in. just north of the Broadway Pump Station did reduce the flooding depth at manhole COA7769JB. However, some flooding remains and therefore additional options should be evaluated.

TABLE 6-21
SUMMARY OF OPTION 12 STREET PONDING AND MAN-HOLE FLOODING

Note- negative numbers imply that the HGL did not reach the manhole rim

Represents flooding depth over 1 ft
Represents flooding between 0.5ft - 0.99 ft
Represents flooding depth between 0 - 0.5 ft

MH Name	Manhole Invert Elev.	Max. Depth of Manhole	Manhole Rim Elev.	Maximum HGL	Node Flood Depth Above Manhole Rim	Flood Volume	Flood Volume	Hours Flooded
	(ft)	(ft)	(ft)	(ft)	(ft)	(10^6 gal)	(acre-ft)	
	(a)	(a)	(b)	(c)	(d)	(e)	(f)	
COA6045	4957.51	7.82	4965.33	4965.34	0.01	0.277	0.850	2.42
COA15184	4954.19	10.04	4964.23	4964.43	0.2	0.768	2.357	3.61
COA6218	4953.66	9.34	4963	4963.44	0.44	0.89	2.731	4.04
COA7717	4951.23	7.5	4958.73	4960.21	1.48	0.42	1.289	3.63
COA19719	4952.3	9.98	4962.28	4963.08	0.8	1.181	3.624	4.49
COA7654	4951.67	8.59	4960.26	4960.28	0.02	0.073	0.224	0.58
COA25349	4945.26	11.07	4956.33	4956.34	0.01	0.085	0.261	0.2
COA25656	4948.86	10.32	4959.18	4959.31	0.13	0.246	0.755	1.9
COA25622	4948.24	9.58	4957.82	4957.85	0.03	0.075	0.230	0.94
COA7476	4950.32	7.85	4958.17	4958.32	0.15	0.232	0.712	1.49
COA7518	4947.94	8.89	4956.83	4957	0.17	0.23	0.706	1.66
COA24834	4944.52	7.06	4951.58	4951.92	0.34	1.587	4.870	4.01
COA25105	4946.31	10.2	4956.51	4956.52	0.01	0.037	0.114	0.36
COA7865	4946.34	10.46	4956.8	4956.81	0.01	0.011	0.034	0.06
COA7908	4946.15	10	4956.15	4956.16	0.01	0.013	0.040	0.03
COA7955	4943.49	12	4955.49	4955.5	0.01	0.042	0.129	0.17
COA22517	4943.59	11	4954.59	4954.6	0.01	0.064	0.196	0.27
COA32865	4945.49	11.62	4957.11	4957.12	0.01	0.002	0.006	0.03
COA32878	4946.6	9.16	4955.76	4956.11	0.35	0.063	0.193	0.35
COA7848	4947.67	8.71	4956.38	4956.39	0.01	0.019	0.058	0.09
COA9348	4939.63	11.79	4951.42	4951.43	0.01	0.036	0.110	0.14
COA13866	4935.36	12.08	4947.44	4947.45	0.01	0.018	0.055	0.05
COA9248	4947.65	10.07	4957.72	4957.73	0.01	0.004	0.012	0.04
COA9229	4913.15	27	4940.15	4940.45	0.3	0.025	0.077	0.52
1F.H.MH1	4951.5	8	4959.5	4959.52	0.02	0	0.000	0.01

(a) Manhole invert elevation from SWMM input under Node Summary Table
(b) Rim elevation = MH invert elevation + Max depth of manhole
(c) Max HGL from SWMM output table under Node Depth Summary
(d) Node Flood Depth above Manhole Rim = HGL Elev-Rim Elev
(e) Flood volume from SWMM output table under Node Flooding Summary
(f) 1 gallon = 3.06888 E-6 acre-ft

Option 13 –

Purpose

The purpose of Option 13 was to see if adding a weir at the Broadway-Lomas intersection manhole to divert flows west in the Lomas storm drain and increasing the storm drain capacity from 48-in. to 84-in. and increasing the length from 78 feet to 156 feet just north of the Broadway Pump Station, could reduce flooding in the Broadway area and at the Broadway-Lomas intersection.

Facility 10 Remove the existing Broadway-Lomas Pond and sell this lot as a high value commercial property.

Facility X1 Removal of the existing Broadway-Lomas weir.

Facility 1 Build a new pond in Sub-catchment BR21 (near southeast intersection of Lomas Blvd. and Medical Arts). The pond outfall pipe will be a 24-in. RCP that will join into the existing Lomas Blvd. manhole that joins to an existing 48-in. RCP that drains north to the existing Odelia Pond.

Facility X4 Upsized storm drain from 36-in. to 48-in., begin at the Broadway-Odelia intersection continue west on Baca to Commercial, then north on Commercial for 600 ft. Upsized 36-in. to 48-in. storm drain from the Commercial-Indian School intersection south on Commercial to McKnight, then east on McKnight, then new 48-in. storm drain from the Commercial-McKnight intersection east to the Broadway-McKnight intersection, then south on Broadway to join into the Santa Barbara Park Pump Station.

Facility X7 Upsize storm drains from 36-in. to 48-in. along 4th St. from Cutler south to McKnight then east to 3rd St. and joined to existing 48-in. storm drains. Then west on Constitution from 3rd St. to 5th St. and south on 5th St. to tie into pond located at Summer and 5th St. called the North Wells Park Pond. The 36-in. outfall pipe from the pond continues south on 5th St. to Mountain, then east on Mountain to 3rd St. where it joined into the existing 3rd St. 48-in. storm drain. The existing 3rd St. storm drain was deleted from the 3rd St.-Constitution intersection south to the 3rd St.- Mountain intersection to direct upstream storm drain flows to the North Wells Park Pond.

Facility X8 Upsize storm drains from 24-in. to 48-in. on Rio Grande Blvd. from Carson to Chacoma then east to San Pasquale and finally to Laguna

Facility X19 Upsize the 27-in. and 30-in. storm drains to 48-in. storm drains on Barelas from Pacific Ave. south to Lewis and west on Lewis to the west Riverside storm drain.

Facility X10 The Broadway Basin was divided at the Broadway-Mountain intersection so that storm drain slopes were reversed to drain north of the intersection to the Santa Barbara Park Pump Station that was simulated as 130 cfs maximum capacity.

Facility X12 Added a weir at the Broadway-Lomas intersection to divert water west on Lomas away from the Broadway Pump Station. The storm drain diameter was increased from 48-in. to 84-in. to increase flow and storage capacity located just north of the Broadway Pump Station and the length was increased to 156 feet from 78 feet existing.

Modeling Approach

The Broadway-Lomas detention pond was deleted from the model. The existing manhole number COA 32878.A located just north of Broadway-Lomas intersection was connected directly to an existing manhole COA32878.B with a 4.5 ft diameter RCP pipe in Broadway. The BR21 Pond was simulated to detain runoff from Sub-catchment BR21. The pond outfall was simulated to drain into the Odelia Pond. The Santa Barbara Park Pump Station was included with a maximum capacity of 130 cfs (no detention pond). The storm drain from Commercial to Baca was re-routed to Broadway to drain into the Santa Barbara Park Pump Station. Upsized 36-in. to 48-in. storm drain from the Commercial-Indian School intersection south on Commercial to McKnight, then east on McKnight, then new 48-in. storm drain from the Commercial-McKnight intersection east to the Broadway-McKnight intersection, then south on Broadway to join into the Santa Barbara Park Pump Station. The links connecting manholes COA 29163 and COA7635, along Commercial and COA29132 and COA7628 along Broadway were deleted. The Broadway Pump Station was simulated at existing capacity of 130 cfs.

A weir was added to manhole COA32878.A. Modeling this weir in SWMM required two fictitious manholes labeled as WNODE1 and WNODE2. The inlet offset for the weir, which is height of the weir from the invert of the pipe to the top of the weir plate, was set at 4 feet in order to divert most of the flow from BR1, BR4, and BR19 west on Lomas and away from the Broadway Pump Station. The storm drain north of Broadway Pump Station was upsized from 48-in. to 84-in. with a new length of 156 feet to simulate underground storage and better conveyance and added storage of two 84-in. RCP storm drains.

The North Wells Park Pond located at Summer and 5th St. was included. The storm drains from Cutler to McKnight on 4th St. were upsized from 36-in. to 48-in. A 48-in. RCP storm drain was included west from 3rd St. and Constitution and south along 5th St. to drain into the North Wells Park Pond. The pond outfall pipe is a 36-in. RCP storm drain south on 5th St. to Mountain, then east to 3rd St. where it joins the existing storm drain. The storm drain between Constitution and Mountain along 3rd St. was deleted to direct upstream storm drain flows to the North Wells Park Pond. The significant option components are summarized in **Table 6-1** (Summary of Model Filenames and Components – Appendix Volume 2, Appendix 1).

Street Flooding Results

All manholes near the Broadway-Lomas intersection had flood depths less than 0.5 feet deep. However, COA7769JB (at the Broadway Pump Station) had 1.4 feet flood depth and COA 7717

(Broadway north of Mountain) had 2 feet flood depth COA 19719 (McKnight and 3rd St. had 0.8 feet flood depth. Flooding results are summarized in **Table 6-22.**

Appendix Volume 2, Appendix 1.2 contains the SWMM model output and additional information prepared to document information and computations for this Option.

INSERT TABLE 6-22 1 PAGE

TABLE 6-22
SUMMARY OF OPTION 13 STREET PONDING AND MAN-HOLE FLOODING

Note- negative numbers imply that the HGL did not reach the manhole rim

Represents flooding depth over 1 ft
Represents flooding between 0.5ft - 0.99 ft
Represents flooding depth between 0 - 0.5 ft

MH Name	Manhole Invert Elev.	Max. Depth of Manhole	Manhole Rim Elev.	Maximum HGL	Node Flood Depth Above Manhole Rim	Flood Volume	Flood Volume	Hours Flooded
	(ft)	(ft)	(ft)	(ft)	(ft)	(10^6 gal)	(acre-ft)	
	(a)	(a)	(b)	(c)	(d)	(e)	(f)	
COA6045	4957.51	7.82	4965.33	4965.34	0.01	0.277	0.850	2.42
COA15184	4954.19	10.04	4964.23	4964.43	0.2	0.768	2.357	3.61
COA6218	4953.66	9.34	4963	4963.43	0.43	0.89	2.731	4.04
COA7717	4951.23	7.5	4958.73	4960.76	2.03	0.42	1.289	3.63
COA19719	4952.3	9.98	4962.28	4963.06	0.78	1.181	3.624	4.49
COA7654	4951.67	8.59	4960.26	4960.28	0.02	0.073	0.224	0.58
COA25349	4945.26	11.07	4956.33	4956.34	0.01	0.085	0.261	0.2
COA25656	4948.86	10.32	4959.18	4959.33	0.15	0.246	0.755	1.9
COA25622	4948.24	9.58	4957.82	4957.84	0.02	0.075	0.230	0.94
COA7476	4950.32	7.85	4958.17	4958.32	0.15	0.232	0.712	1.49
COA7518	4947.94	8.89	4956.83	4957	0.17	0.23	0.706	1.66
COA24834	4944.52	7.06	4951.58	4951.93	0.35	1.587	4.870	4.01
COA25105	4946.31	10.2	4956.51	4956.52	0.01	0.037	0.114	0.36
COA25117	4945.26	11.29	4956.55	4956.56	0.01	0.009	0.028	0.09
COA7716	4948.88	9.23	4958.11	4958.12	0.01	0.001	0.003	0.01
COA7769JB	4944.52	11.81	4956.33	4957.76	1.43		0.000	
COA32865	4945.49	11.62	4957.11	4957.13	0.02	0.002	0.006	0.03
COA32878	4946.6	9.16	4955.76	4955.89	0.13	0.063	0.193	0.35
COA7848	4947.67	8.71	4956.38	4956.39	0.01	0.019	0.058	0.09
COA25109	4945.87	10.67	4956.54	4956.55	0.01	0.026	0.080	0.2
COA7963.11A	4948.2	12.95	4961.15	4961.17	0.02		0.000	
COA9229	4913.15	27	4940.15	4940.45	0.3	0.025	0.077	0.52
1F.H.MH1	4951.5	8	4959.5	4959.54	0.04	0	0.000	0.01

(a) Manhole invert elevation from SWMM input under Node Summary Table
(b) Rim elevation = MH invert elevation + Max depth of manhole
(c) Max HGL from SWMM output table under Node Depth Summary
(d) Node Flood Depth above Manhole Rim = HGL Elev-Rim Elev
(e) Flood volume from SWMM output table under Node Flooding Summary
(f) 1 gallon = 3.06888 E-6 acre-ft

Detention Pond Routing Results
Freeboard at the Air Quality Pond was 2.5 feet (see **Table 6-3).** Freeboard at Tingley Surge Pond was 5.5 feet (see **Table 6-4**) The BR21 Pond is 7.5 feet (see **Table 6-9**). Freeboard at North Wells Park Pond was 1.2 feet (see **Table 6-15**).

Conclusion
The inclusion of the Broadway-Lomas weir reduced the Broadway-Lomas intersection flooding depths to well below a foot. However, several flood depths greater than 1 foot remain in the north Broadway – Mc Knight area. The increased storm drain diameters, length, and capacity just north of the Broadway Pump Station also helped reduce flood depths. However, flooding still remains therefore additional Options should be evaluated.

Option 14 –

Purpose
The purpose of Option 14 was to see if adding a weir at the Broadway-Lomas intersection and a smaller detention pond (as compared to the existing Broadway-Lomas Pond) at the Broadway-Marble intersection along with the Option 13 facilities could reduce flooding in the Broadway area and at the Broadway-Lomas intersection.

Facility 10 Remove the existing Broadway-Lomas Pond and sell this lot as a high value commercial property.

Facility X1 Removal of the existing Broadway-Lomas weir.

Facility 1 Build a new pond in Sub-catchment BR21 (near southeast intersection of Lomas Blvd. and Medical Arts). The pond outfall pipe will be a 24-in. RCP that will join into the existing Lomas Blvd. manhole that joins to an existing 48-in. RCP that drains north to the existing Odelia Pond.

Facility X4 Upsized storm drain from 36-in. to 48-in., begin at the Broadway-Odelia intersection continue west on Baca to Commercial, then north on Commercial for 600 ft. Upsized 36-in. to 48-in. storm drain from the Commercial-Indian School intersection south on Commercial to McKnight, then east on McKnight, then new 48-in. storm drain from the Commercial-McKnight intersection east to the Broadway-McKnight intersection, then south on Broadway to join into the Santa Barbara Park Pump Station.

Facility X7 Upsize storm drains from 36-in. to 48-in. along 4th St. from Cutler south to McKnight then east to 3rd St. and joined to existing 48-in. storm drains. Then west on Constitution from 3rd St. to 5th St. and south on 5th St. to tie into pond located at Summer and 5th St. called the North Wells Park Pond. The 36-in. outfall pipe from the pond continues south on 5th St. to Mountain, then east on Mountain to 3rd St. where it joined into the existing 3rd St. 48-in. storm drain. The existing 3rd St. storm drain was deleted from the 3rd St.-Constitution intersection south to the 3rd St.- Mountain

intersection to direct upstream storm drain flows to the North Wells Park Pond.

Facility X8 Upsize storm drains from 24-in. to 48-in.es on Rio Grande Blvd. from Carson to Chacoma then east to San Pasquale and finally to Laguna.

Facility X19 Upsize the 27-in. and 30-in. storm drains to 48-in. storm drains on Barelas from Pacific Ave. south to Lewis and west on Lewis to the west Riverside storm drain.

Facility X10 The Broadway Basin was divided at the Broadway-Mountain intersection so that storm drain slopes were reversed to drain north of the intersection to the Santa Barbara Park Pump Station that was simulated as 130 cfs maximum capacity.

Facility X11 Added a weir at the intersection of Broadway and Lomas to divert water west on Lomas away from Broadway Pump Station, and the storm drain diameter north of the Broadway Pump Station remained at the existing 48-in. diameter.

Facility X20 An alternative to the Broadway-Lomas Pond was included near the Broadway-Marble intersection on the east side of Broadway.

Modeling Approach

The Broadway-Lomas detention pond was deleted from the model. The existing manhole number COA 32878.A located just north of Broadway-Lomas intersection was connected directly to an existing manhole COA32878.B with a 4.5 ft diameter RCP pipe in Broadway. The BR21 Pond was simulated to detain runoff from Sub-catchment BR21. The pond outfall was simulated to drain into the Odelia Pond. The Santa Barbara Park Pump Station was included with a maximum capacity of 130 cfs (no detention pond). The storm drain from Commercial to Baca was re-routed to Broadway to drain into the Santa Barbara Park Pump Station. Upsized 36-in. to 48-in. storm drain from the Commercial-Indian School intersection south on Commercial to McKnight, then east on McKnight, then new 48-in. storm drain from the Commercial-McKnight intersection east to the Broadway-McKnight intersection, then south on Broadway to join into the Santa Barbara Park Pump Station. The links connecting manholes COA 29163 and COA7635, along Commercial and COA29132 and COA7628 along Broadway were deleted. The Broadway Pump Station was simulated at existing capacity of 130 cfs.

A weir was added to manhole COA32878.A. Modeling this weir in SWMM required two fictitious manholes labeled as WNODE1 and WNODE2. The inlet offset for the weir, which is height of the weir from the invert of the pipe to the top of the weir plate, was set at 4 feet in order to divert most of the flow from BR1, BR4 and BR19 west on Lomas and away from the Broadway Pump Station. Storm drain north of Broadway Pump Station was returned to existing conditions parameters.

The North Wells Park Pond located at Summer and 5th St. was included. The storm drains from Cutler to McKnight on 4th St. were upsized from 36-in. to 48-in. A 48-in. RCP storm drain was included west from 3rd St. and Constitution and south along 5th St. to drain into the North Wells

Park Pond. The pond outfall pipe is a 36-in. RCP storm drain south on 5th St. to Mountain, then east to 3rd St. where it joins the existing storm drain. The storm drain between Constitution and Mountain along 3rd St was deleted to direct storm drain flows to the North Wells Park Pond. A 10 foot deep detention pond was simulated at the Broadway-Marble intersection. The runoff from Sub-catchment BR 3 was directed to this pond. The pond inlet was modeled as a 48-in. pipe while the outlet was modeled as a 24-in. pipe.

The significant option components are summarized in **Table 6-1** (Summary of Model Filenames and Components – Appendix Volume 2, Appendix 1).

Street Flooding Results

This option eliminated flooding at the Broadway-Lomas intersection. However COA7717 (Broadway-Mountain) had 2 feet flood depth COA 19719 (Mc Knight and 3rd St.) had 0.8 feet flood depth. Flooding results are summarized in **Table 6-23.**

Appendix Volume 2, Appendix 1.2 contains the SWMM model output and additional information prepared to document information and computations for this Option.

TABLE 6-23
SUMMARY OF OPTION 14 STREET PONDING AND MAN-HOLE FLOODING

Note- negative numbers imply that the HGL did not reach the manhole rim

Represents flooding depth over 1 ft
Represents flooding between 0.5ft - 0.99 ft
Represents flooding depth between 0 - 0.5 ft

MH Name	Manhole Invert Elev.	Max. Depth of Manhole	Manhole Rim Elev.	Maximum HGL	Node Flood Depth Above Manhole Rim	Flood Volume	Flood Volume	Hours Flooded
	(ft)	(ft)	(ft)	(ft)	(ft)	(10^6 gal)	(acre-ft)	
	(a)	(a)	(b)	(c)	(d)	(e)	(f)	
COA6045	4957.51	7.82	4965.33	4965.34	0.01	0.258	0.792	2.3
COA15184	4954.19	10.04	4964.23	4964.43	0.2	0.744	2.283	3.5
COA6218	4953.66	9.34	4963	4963.43	0.43	0.858	2.633	3.88
COA6195	4962.97	6.74	4969.71	4969.74	0.03	0.045	0.138	0.35
COA6246	4962.06	7.85	4969.91	4969.91	0	0.025	0.077	0.13
COA7717	4951.23	7.5	4958.73	4960.75	2.02	0.405	1.243	3.46
COA19719	4952.3	9.98	4962.28	4963.06	0.78	1.168	3.584	4.13
COA25349	4945.26	11.07	4956.33	4956.34	0.01	0.058	0.178	0.14
COA25656	4948.86	10.32	4959.18	4959.31	0.13	0.219	0.672	1.91
COA25622	4948.24	9.58	4957.82	4957.84	0.02	0.065	0.199	0.84
COA7476	4950.32	7.85	4958.17	4958.32	0.15	0.233	0.715	1.49
COA7518	4947.94	8.89	4956.83	4957	0.17	0.23	0.706	1.69
COA24834	4944.52	7.06	4951.58	4951.93	0.35	1.589	4.876	3.97
COA25105	4946.31	10.2	4956.51	4956.52	0.01	0.042	0.129	0.37
COA25117	4945.26	11.29	4956.55	4956.56	0.01	0.017	0.052	0.12
COA13866	4935.36	12.08	4947.44	4947.45	0.01	0.018	0.055	0.05
COA7963.11A	4948.2	12.95	4961.15	4961.17	0.02	0.505	1.550	1.77
COA9229	4913.15	27	4940.15	4940.45	0.3	0.025	0.077	0.52

(a) Manhole invert elevation from SWMM input under Node Summary Table
(b) Rim elevation = MH invert elevation + Max depth of manhole
(c) Max HGL from SWMM output table under Node Depth Summary
(d) Node Flood Depth above Manhole Rim = HGL Elev-Rim Elev
(e) Flood volume from SWMM output table under Node Flooding Summary
(f) 1 gallon = 3.06888 E-6 acre-ft

Detention Pond Routing Results

Freeboard at the Air Quality Pond was 2.4 feet (see **Table 6-3).** Freeboard at Tingley Surge Pond was 5.4 feet (see **Table 6-4**) and unchanged at BR21 Pond 7.5 feet (see **Table 6-9**). Freeboard at North Wells Park was 0.8 feet (see **Table 6-15)**. The Broadway-Marble Pond had 4.6 feet of freeboard (see **Table 6-24**).

Conclusion

The inclusion of the Broadway-Lomas weir and the Broadway-Marble Pond eliminated flooding from the Broadway-Lomas intersection to the Broadway-Mountain intersection. The storm drain to the Santa Barbara Pump Station showed some flooding, in particular, COA7717 located just south of the Broadway-Rosemont intersection, where the flood depth was 2-feet. As a result, further options need to be evaluated.

TABLE 6-24

BROADWAY MARBLE POND DETENTION POND ROUTING SUMMARY

Detention Pond Name	Existing or Proposed Pond (detention or retention)	Model Analysis Point Name	Storm Return Period (100-yr. 24-hr. duration)	Peak Inflow	Peak Outflow	Peak Storage Volume	Peak Storage Volume	Peak Water Surface Elevation	Principal Spillway Elevation	Emergency Spillway Elevation	Pond Invert Elevation	Water Depth	Top of Pond Embankment Elevation	Freeboard to Emergency Spillway Elevation	**Freeboard to top of Pond Embankment**
				(cfs)	(cfs)	(ft^3)	(ac-ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)
a	a	a		b	c	g	c	d	e	e	e		e	f	f
OPTION 14															
Broadway-Marble Pond	Conceptual	Broadway-Marble Pond	100	148	33	328120	7.533	4951.4	4946	4954	4946	5.4	4956	2.6	**4.6**
OPTION 15															
Broadway-Marble Pond	Conceptual	Broadway-Marble Pond	100	218	43	481722	11.059	4954.0	4946	4954	4946	8.0	4956	0.0	**2.0**
OPTION 17															
Broadway-Marble Pond	Conceptual	Broadway-Marble Pond		225	36	484017	11.112	4954.3	4946	4954	4946		4956	-0.3	**1.7**
OPTION 18															
Broadway-Marble Pond	Conceptual	Broadway-Marble Pond	100	225	38	485063	11.136	4954.3	4946	4954	4946		4956	-0.3	**1.7**

a - See Drainage Basin Maps and Figure 6-1
b - See SWMM output for results "Node Inflow Summary" Table
c -Value calculated after unit conversion from SWMM output
d- See SWMM output for results "Node Depth Summary" Table
e - See Volume 2 Appendix 1.2 for Pond Routing Elev-Area-Capacity Discharge Data
f- Negative number indicates the flow depth exceeds referenced elevation - no freeboard available
g - Value from SWMM output under Storage Volume Summary

Option 15 –

Purpose

The purpose of Option 15 was to determine if just the addition of a smaller alternative detention pond (compared to the Broadway-Lomas Pond) at the Broadway-Marble intersection, addition of the BR21 Pond and upsizing storm drains north of the Broadway-Odelia intersection (Broadway, Baca, and McKnight) from 36-in. to 48-in. would be enough to mitigate flooding at the Broadway-Lomas intersection.

Facility 10 Remove the existing Broadway-Lomas Pond and sell this lot as a high value commercial property.

Facility 1 Build a new pond in Sub-catchment BR21 (near southeast intersection of Lomas Blvd. and Medical Arts). The pond outfall pipe will be a 24-in. RCP that will join into the existing Lomas Blvd. manhole that joins to an existing 48-in. RCP that drains north to the existing Odelia Pond.

Facility X3 Upsized all 36-in. storm drains to 48-in. storm drains from the Broadway-Odelia intersection north (Broadway, Baca, McKnight and Commercial).

Facility X7 Upsize storm drains from 36-in. to 48-in. along 4th St. from Cutler south to McKnight then east to 3rd St. and joined to existing 48-in. storm drains. Then west on Constitution from 3rd St. to 5th St. and south on 5th St. to tie into pond located at Summer and 5th St. called the North Wells Park Pond. The 36-in. outfall pipe from the pond continues south on 5th St. to Mountain, then east on Mountain to 3rd St. where it joined into the existing 3rd St. 48-in. storm drain. The existing 3rd St. storm drain was deleted from the 3rd St.-Constitution intersection south to the 3rd St.- Mountain intersection.

Facility X20 An alternative to the Broadway-Lomas Pond was included near the Broadway-Marble intersection on the east side of Broadway.

Facility X8 Upsize storm drains from 24-in. to 48-in. on Rio Grande Blvd. from Carson to Chacoma then east to San Pasquale and finally to Laguna.

Facility X19 Upsize the 27-in. and 30-in. storm drains to 48-in. storm drains on Barelas from Pacific Ave. south to Lewis and west on Lewis to the west Riverside storm drain.

Modeling Approach

The Broadway-Lomas detention pond was deleted. The existing manhole number COA 32878.A located just north of Broadway-Lomas intersection was connected directly to an existing manhole COA32878.B with a 4.5 ft diameter RCP pipe in Broadway. The BR21 pond was simulated to detain runoff from Sub-catchment BR21. The pond outfall was simulated as a 24-in. conduit was modeled to drain to the Odelia Pond through an outfall. All 36-in. storm drains were

upsized to 48-in. storm drains from the Broadway-Odelia intersection north (Broadway, Baca, McKnight and Commercial).

The North Wells Park Pond was included located near Summer and 5th St. The storm drains from Cutler to McKnight on 4th St. were upsized from 36-in. to 48-in. A 48-in. RCP storm drain was included west from 3rd St. and Constitution and south along 5th St. to drain into North Wells Park Pond. The pond outfall is a 36-in. RCP that continues south on 5th St. to Mountain, then east to 3rd St. were it joins the existing storm drain. The existing pipe between Constitution and Mountain along 3rd St. was deleted to direct water to the North Wells Park Pond. The storm drains from Carson and Rio Grande to San Pasquale and Laguna were upsized from 36-in. to 48-in. The storm drain from Barelas and Pacific to Lewis and the West Riverside storm drain were upsized from 27-in. and 30-in. to 48-in.

A 10-foot deep detention pond was simulated at the Broadway-Marble intersection. The runoff from BR 3 was directed to this pond. The pond inlet was modeled as a 48-in. pipe while the outlet was modeled as a 24-in. pipe.

The significant option components are summarized in **Table 6-1** (Summary of Model Filenames and Components – Appendix Volume 2, Appendix 1).

Street Flooding Results

Flooding was eliminated at the Broadway-Lomas intersection. However, COA 7635 (Commercial north of Baca) had a flood depth of 0.96 feet and COA 19719 (Mc Knight and 3rd St.) had 0.8 feet flood depth. The results are summarized in **Table 6-25.**

Appendix Volume 2, Appendix 1.2 contains the SWMM model output and additional information prepared to document information and computations for this Option.

Detention Pond Routing Results

The freeboard in the Air Quality Pond is 1.3 feet (see **Table 6-3).** Tingley Surge Pond retained 5.4 feet of freeboard (see **Table 6-4).** The BR21 pond had 7.5 feet of freeboard (see **Table 6-9).** North Wells Park has 1.0 feet of freeboard (see **Table 6-15**). The Broadway-Marble Pond had 2.0 feet of freeboard (see **Table 6-24**).

TABLE 6-25
SUMMARY OF OPTION 15 STREET PONDING AND MAN-HOLE FLOODING

Note- negative numbers imply that the HGL did not reach the manhole rim

Represents flooding depth over 1 ft
Represents flooding between 0.5ft - 0.99 ft
Represents flooding depth between 0 - 0.5 ft

MH Name	Manhole Invert Elev.	Max. Depth of Manhole	Manhole Rim Elev.	Maximum HGL	Node Flood Depth Above Manhole Rim	Flood Volume	Flood Volume	Hours Flooded
	(ft)	(ft)	(ft)	(ft)	(ft)	(10^6 gal)	(acre-ft)	
	(a)	(a)	(b)	(c)	(d)	(e)	(f)	
COA6045	4957.51	7.82	4965.33	4965.34	0.01	0.287	0.880771	2.48
COA15184	4954.19	10.04	4964.23	4964.44	0.21	0.803	2.464317	3.74
COA6218	4953.66	9.34	4963	4963.44	0.44	0.928	2.847928	4.18
COA6246	4962.06	7.85	4969.91	4969.91	0	0.001	0.003069	0.01
COA7635	4957.34	7.29	4964.63	4965.59	0.96	0.236	0.724258	1.23
COA7650	4954.93	8.35	4963.28	4963.75	0.47	0.177	0.543193	1.58
COA7656	4953.17	9.45	4962.62	4962.67	0.05	0.124	0.380542	1.45
COA19719	4952.3	9.98	4962.28	4963.07	0.79	1.161	3.562979	4.29
COA7654	4951.67	8.59	4960.26	4960.27	0.01	0.016	0.049102	0.11
COA25656	4948.86	10.32	4959.18	4959.34	0.16	0.227	0.696638	1.63
COA25622	4948.24	9.58	4957.82	4957.86	0.04	0.069	0.211753	0.86
COA7476	4950.32	7.85	4958.17	4958.32	0.15	0.234	0.71812	1.49
COA7518	4947.94	8.89	4956.83	4957	0.17	0.23	0.705844	1.71
COA24834	4944.52	7.06	4951.58	4951.91	0.33	1.578	4.842705	3.89
COA25105	4946.31	10.2	4956.51	4956.52	0.01	0.044	0.135031	0.37
COA25109	4945.87	10.67	4956.54	4956.55	0.01	0.027	0.08286	0.2
COA9248	4947.65	10.07	4957.72	4957.73	0.01	0.001	0.003069	0.01
COA7963.11A	4951.67	9.48	4961.15	4961.25	0.1	0.172	0.527849	0.92
COA9229	4913.15	27	4940.15	4940.45	0.3	0.025	0.076722	0.52

(a) Manhole invert elevation from SWMM input under Node Summary Table
(b) Rim elevation = MH invert elevation + Max depth of manhole
(c) Max HGL from SWMM output table under Node Depth Summary
(d) Node Flood Depth above Manhole Rim = HGL Elev-Rim Elev
(e) Flood volume from SWMM output table under Node Flooding Summary
(f) 1 gallon = 3.06888 E-6 acre-ft

Conclusion
Flooding at the Broadway-Lomas intersection was eliminated. There was no flooding on Broadway between Lomas and Mountain. However, the northern end of the trunk line showed flood depths between 0.5 feet and 1-foot deep. Therefore other options should be considered.

Option 16 –

Purpose
The purpose of Option 16 was to determine the capacity of the Broadway Pump Station required if all of the facilities from Option 8 were incorporated and if 0.5 feet of flooding was acceptable at the Broadway-Lomas intersection.

Facility 10 Remove the existing Broadway-Lomas Pond and sell this lot as a high value commercial property.

Facility X2 A pond at Broadway and Kinley (Burnt Out Warehouse west side of Broadway).

Facility 1 Build a new pond in Sub-catchment BR21 (near southeast intersection of Lomas Blvd. and Medical Arts). The pond outfall pipe will be a 24-in. RCP that will join into the existing Lomas Blvd. manhole that joins to an existing 48-in. RCP that drains north to the existing Odelia Pond.

Facility X4 Upsized storm drain from 36-in. to 48-in., begin at the Broadway-Odelia intersection continue west on Baca to Commercial, then north on Commercial for 600 ft. Upsized 36-in. to 48-in. storm drain from the Commercial-Indian School intersection south on Commercial to McKnight, then east on McKnight, then new 48-in. storm drain from the Commercial-McKnight intersection east to the Broadway-McKnight intersection, then south on Broadway to join into the Santa Barbara Park Pond. Upsized the 36-in. to 48-in. storm drain south from the Broadway-Hannett intersection to the Broadway-Odelia intersection.

Facility X13 Upsize the Broadway Pump Station to a maximum capacity of 180 cfs (from 130 cfs existing).

Facility X7 Upsize storm drains from 36-in. to 48-in. along 4th St. from Cutler south to McKnight then east to 3rd St. and joined to existing 48-in. storm drains. Then west on Constitution from 3rd St. to 5th St. and south on 5th St. to tie into pond located at Summer and 5th St. called the North Wells Park Pond. The 36-in. outfall pipe from the pond continues south on 5th St. to Mountain, then east on Mountain to 3rd St. where it joined into the existing 3rd St. 48-in. storm drain. The existing 3rd St. storm drain was deleted from the 3rd St.-Constitution intersection south to the 3rd St.- Mountain intersection to direct upstream storm drain flows to the North Wells Park Pond.

Facility X8 Upsize storm drains from 24-in. to 48-in. on Rio Grande Blvd. from Carson to Chacoma then east to San Pasquale and finally to Laguna.

Facility X19 Upsize the 27-in. and 30-in. storm drains to 48-in. storm drains on Barelas from Pacific Ave. south to Lewis and west on Lewis to the west Riverside storm drain.

Modeling Approach

The Broadway-Lomas detention pond was deleted from the model. The existing manhole number COA 32878.A located just north of Broadway-Lomas intersection was connected directly to an existing manhole COA32878.B with a 4.5 ft diameter RCP pipe in Broadway. The Warehouse Detention Pond was simulated. The pond was placed in between manholes COA 7963.11A and COA7716 with appropriate inlet, outlet nodes and pipes as simulated in SWMM. The BR21 pond was simulated to detain runoff from Sub-catchment BR21. The pond outfall was simulated as a 24-in. conduit that joined manhole COA7860 in Lomas Blvd. at Edith. A detention pond in Santa Barbara Park was added along with the inlet and outlet. The storm drain from Commercial to Baca was re-routed to Broadway to drain into the Santa Barbara Park Pond. The pipes connecting manholes COA 29163 and COA7635, along Commercial and COA29132 and COA7628 along Broadway were deleted.

The North Wells Park Pond was included located near Summer and 5th St. The storm drains from Cutler to McKnight on 4th St. were upsized from 36-in. to 48-in.. A 48-in. RCP storm drain was included west from 3rd St. and Constitution and south along 5th St. to drain into North Wells Park Pond. The pond outfall is a 36-in. RCP south on 5th St. to Mountain, then east to 3rd St. were it joins the existing storm drain. The existing pipe between Constitution and Mountain along 3rd St. was deleted to direct storm drain flows to the North Wells Park Pond. The storm drains from Carson and Rio Grande Blvd. to San Pasquale and Laguna were upsized from 36-in. to 48-in. The storm drain from Barelas and Pacific to Lewis and the west Riverside storm drain were upsized from 27-in. and 30-in. to 48-in.

The Broadway Pump Station Capacity was increased from 130 cfs to 180 cfs.

The significant option components are summarized in **Table 6-1** (Summary of Model Filenames and Components – Appendix Volume 2, Appendix 1).

Street Flooding Results

The Broadway-Lomas intersection has a 0.7 foot flood depth. However, COA 7769JB(Broadway Pump Station) has 1.1 foot flood depth and COA 19719 (Mc Knight and 3rd St. has 0.8 feet flood depth.

There were a number of manholes that had minor flooding in the Barelas Basin. North Wells Park Pond along with the upsized storm drain reduced most flooding at these related manholes. Minor flood problem areas remain along Rio Grande Blvd. Flooding results are summarized in **Table 6-26.**

Appendix Volume 2, Appendix 1.2 contains the SWMM model output and additional information prepared to document information and computations for this Option.

TABLE 6-26
SUMMARY OF OPTION 16 STREET PONDING AND MAN-HOLE FLOODING

Note- negative numbers imply that the HGL did not reach the manhole rim

Represents flooding depth over 1 ft
Represents flooding between 0.5ft - 0.99 ft
Represents flooding depth between 0 - 0.5 ft

MH Name	Manhole Invert Elev.	Max. Depth of Manhole	Manhole Rim Elev.	Maximum HGL	Node Flood Depth Above Manhole Rim	Flood Volume	Flood Volume	Hours Flooded
	(ft)	(ft)	(ft)	(ft)	(ft)	(10^6 gal)	(acre-ft)	
	(a)	(a)	(b)	(c)	(d)	(e)	(f)	
COA6045	4957.51	7.82	4965.33	4965.34	0.01	0.255	0.782566	2.37
COA15184	4954.19	10.04	4964.23	4964.43	0.2	0.714	2.191186	3.53
COA6218	4953.66	9.34	4963	4963.44	0.44	0.848	2.602417	3.91
COA6195	4962.97	6.74	4969.71	4969.92	0.21	0.144	0.44192	0.64
COA6246	4962.06	7.85	4969.91	4969.92	0.01	0.062	0.190271	0.38
COA7656	4953.17	9.45	4962.62	4962.63	0.01	0.044	0.135031	0.23
COA19719	4952.3	9.98	4962.28	4963.08	0.8	1.19	3.651977	4.24
COA7654	4951.67	8.59	4960.26	4960.27	0.01	0.214	0.656742	1.42
COA25349	4945.26	11.07	4956.33	4956.34	0.01	0.114	0.349853	0.26
COA25656	4948.86	10.32	4959.18	4959.3	0.12	0.228	0.699706	1.73
COA25622	4948.24	9.58	4957.82	4957.83	0.01	0.058	0.177996	0.81
COA7476	4950.32	7.85	4958.17	4958.32	0.15	0.231	0.708913	1.49
COA7518	4947.94	8.89	4956.83	4957	0.17	0.228	0.699706	1.65
COA24834	4944.52	7.06	4951.58	4951.89	0.31	1.443	4.428405	3.89
COA25105	4946.31	10.2	4956.51	4956.52	0.01	0.035	0.107411	0.35
COA7865	4946.34	10.46	4956.8	4956.81	0.01	0.037	0.113549	0.12
COA7908	4946.15	10	4956.15	4956.16	0.01	0.012	0.036827	0.04
COA7955	4943.49	12	4955.49	4955.5	0.01	0.04	0.122756	0.17
COA7769JB	4944.52	11.81	4956.33	4957.39	1.06		0	
COA32865	4945.49	11.62	4957.11	4957.13	0.02	0.006	0.018413	0.07
COA32878	4946.6	9.16	4955.76	4956.48	0.72	0.174	0.533987	0.93
COA7848	4947.67	8.71	4956.38	4956.39	0.01	0.015	0.046033	0.1
COA9248	4947.65	10.07	4957.72	4957.73	0.01	0.005	0.015344	0.05
COA32878.A	4947.19	8.39	4955.58	4956.28	0.7	0.12	0.368267	0.96
COA32878.B	4946.27	9.58	4955.85	4956.07	0.22	0.037	0.113549	0.53
COA9229	4913.15	27	4940.15	4940.49	0.34	0.028	0.085929	0.58
1F.C.OUT	4949	9.4	4958.4	4958.41	0.01	0.002	0.006138	0.01
1F.H.MH1	4951.5	8	4959.5	4959.52	0.02	0.088	0.270062	0.23

(a) Manhole invert elevation from SWMM input under Node Summary Table
(b) Rim elevation = MH invert elevation + Max depth of manhole
(c) Max HGL from SWMM output table under Node Depth Summary
(d) Node Flood Depth above Manhole Rim = HGL Elev-Rim Elev
(e) Flood volume from SWMM output table under Node Flooding Summary
(f) 1 gallon = 3.06888 E-6 acre-ft

Detention Pond Routing Results
Freeboard at the Air Quality Pond has 3.8 feet (see **Table 6-3).** Tingley Surge Pond has 5.4 feet (see **Table 6-4**). The Warehouse Pond had 3.3 feet (see **Table 6-7**). The BR21 Pond has 7.5 feet (see **Table 6-9**). The Santa Barbara Pond retained 9.8 feet of freeboard (see **Table 6-11).** However, the North Wells Park pond had 0.9 feet of freeboard (see **Table 6-15).**

Conclusion
The results from Option 16 indicate that if the facilities from Option 8 are adopted, the Broadway Pump Station capacity must be increased to 180 cfs (from 130 existing capacity) and that would reduce the flood depths at the Broadway-Lomas intersection to between 0.1-0.7 feet. This is an improvement. However flooding still remains and therefore additional Options should be considered.

Option 17 –

Purpose
The purpose of Option 17 was to include and fine tune the *most effective facilities* from the various previous Options in an effort to eliminate flooding throughout the study area.

Facility 10 Remove the existing Broadway-Lomas Pond and sell this lot as a high value commercial property.

Facility 1 Build a new pond in Sub-catchment BR21 (near southeast intersection of Lomas Blvd. and Medical Arts). The pond outfall pipe will be a 24-in. RCP that will join into the existing Lomas Blvd. manhole that joins to an existing 48-in. RCP that drains north to the existing Odelia Pond.

Facility X20 An alternative pond for the Broadway-Lomas Pond was included near the Broadway-Marble intersection on the east side of Broadway.

Facility X18 The existing Broadway storm drain system was not changed from north of the existing Broadway Pump Station (COA 7766JB) to the Broadway-Odelia intersection. More specifically, the storm drain begins at the Broadway Pump Station manhole (COA 7766JB) as two parallel 48-in. RCPs that continue north in Broadway to just north of the Broadway-Mountain intersection. From that intersection the storm drain continues north as a one 48-in. storm drain to the Odelia-Broadway intersection.

Facility X21 Upsize the Baca storm drain from 36-in. RCP to 48-in. RCP from the Broadway-Odelia intersection west in Baca to Commercial, then north on Commercial for 600 feet.

Facility 5 Upsize the Commercial 36-in. RCP storm drain to 54-in. RCP storm drain from the Commercial-Indian School intersection south on Commercial to McKnight, then east on McKnight. Next, build a new 54-in. RCP storm drain from the Commercial-McKnight intersection east to the Broadway-McKnight intersection. Then continue south on Broadway to join into the

Santa Barbara Park Pond. Outlet from the pond will be a 24-in. storm drain that joins the Broadway storm drain at Hannett. Upsize the 36-in. storm drain to 48-in. storm drain south from the Broadway-Hannett intersection to the Broadway-Odelia intersection. Delete (plug) the existing 36-in. RCP storm drain from the McKnight-Commercial intersection south for 900 ft. to direct upstream flows towards the Santa Barbara Park Pond.

Facility 6 Build a new 54-in. storm drain in Constitution from the 3rd St. – Constitution –intersection west to 5th St. then south on 5th St. to the Summer – 5th St. intersection and this pipe will outfall to the North Wells Park Pond. The 36-in. outfall pipe from the pond will continue south on 5th St. to Mountain, then east on Mountain to 3rd St. where it will join into the existing 3rd St. 48-in. storm drain. The existing 3rd St. storm drain was deleted (plug) from the 3rd St.-Constitution intersection south to the 3rd St.-Mountain intersection to direct upstream storm drain flows into the North Wells Park Pond.

Facility 7 Upsize storm drains from 36-in. to 54 in. along 4th St. from Cutler south to McKnight then east to 3rd St. and outfall to the Coronado Park Pond. The pond outfall pipe is a 24-in. storm drain will join into the McKnight-3rd St. intersection storm drain that will be upsized from existing 48-in. to 54-in. storm drain that continues south on 3rd St. to Constitution.

Facility X19 Upsize the 27-in. and 30-in. storm drains to 48-in. storm drains on Barelas from Pacific Ave. south to Lewis and west on Lewis to the west Riverside storm drain.

Facility 9 Upsize storm drains from 24-in. to 54 in. on Rio Grande Blvd. from Carson to Chacoma then southeast to San Pasquale, then south to Laguna, then south ending at Kit Carson.

Facility 11 Build a new Broadway Pump Station at the existing capacity of 150 cfs (Molzen & Corbin, July 2008).

Facility 12 Build a new 24-in. storm drain system from the Edith-Odelia intersection north to the Edith-Hannett intersection, then west on Hannett to outfall into the Santa Barbara Park Pond.

Modeling Approach

The Broadway-Lomas detention pond was deleted from the model. The existing manhole number COA 32878.A was connected directly to an existing manhole COA32878.B with a 4.5 ft diameter RCP pipe in Broadway. A smaller detention pond (compared to the Broadway-Lomas Pond) was added near the Broadway-Marble intersection at the east side of Broadway. Runoff was diverted to this pond through a 54-in. pipe connecting from an existing manhole, COA32878.B. The pond will drain back into the Broadway storm drain system through a 30 in. pipe. The Broadway storm drains from Mountain to Odelia were upsized from 48-in. to 60-in.

The storm drain on Commercial at McKnight that drained south to Baca was eliminated and a new 54-in. storm drain from that intersection was re-routed to the McKnight- Broadway intersection. From that intersection, the 54-in. storm drain continued south on Broadway where it would outfall into the Santa Barbara Park Pond. The topography indicates that the runoff from Sub-catchment BR16 will follow the natural street slopes along Edith to McKnight. The existing 21-in. storm drain that increases to a 36-in. storm drain west along McKnight between Edith and Broadway will convey the runoff to the intersection of Broadway and McKnight and will join the 54-in. storm drain in Broadway that will outfall to the Santa Barbara Park Pond.

However, to drain Sub-catchment BR12 to the Santa Barbara Park Pond, a new 24-in. storm drain system will be required in Edith that will drain north against the street grade to the intersection with Hannett. Then the storm drain will drain west on Hannett and outfall into the Santa Barbara Park Pond. The Santa Barbara Park Pond outfall pipe will be a 24-in. pipe that will join the Broadway storm drain.

All existing Broadway 36-in. storm drains from the Broadway-Odelia intersection north to Hannett at the Santa Barbara Park Pond were upsized to 48-in. The Baca and Commercial (only about 600 ft) storm drains were also upsized from 36-in. to 48-in.

The BR21 pond was simulated to drain into the Odelia Pond. A new 11 foot deep detention pond called Coronado Park Pond was added to collect runoff from Sub-catchments B35 and B40. Storm drains from Cutler to McKnight were upsized from 36-in. to 54-in. that connected to Coronado Park Pond. A 24-in. outlet pipe drained this pond back into the system. The storm drain from 3rd St. and McKnight to 3rd St. and Constitution was upsized from 48-in. to 54-in.

Storm drains were added west on Constitution from 3rd St. to 5th St. and south on 5th St. to Mountain then south to drain into the North Wells Park Pond located at Summer and 5th St., the pond outfall pipe is a 36-in. RCP storm drain that continues south on 5th St. to Mountain, then east to 3rd St. where it joins the existing storm drain. The storm drain between Constitution and Mountain along 3rd St. was deleted to direct storm drain flows to the North Wells Park Pond.

Storm drains were upsized from 24-in. to 54-in. on Rio Grande Blvd. from Carson to Chacoma, then to San Pasquale then to Laguna ending at Kit Carson, and upsized storm drains from 27-in. and 30-in. to 48-in. on Barelas from Pacific Ave. to Lewis, west on Lewis to the west Riverside storm drain.

The significant option components are summarized in **Table 6-1** (Summary of Model Filenames and Components – Appendix Volume 2, Appendix 1).

Street Flooding Results

Option 17 effectively removed flooding from the Broadway-Lomas intersection and all along Broadway, north to I-40. Significant flooding along 3rd St. and 4th St. near I-40 (near Coronado Park) was also reduced. The flooding depths along Rio Grande Blvd. were reduce to the manhole rim elevation except for the San Pasquale and Chacoma intersection where depth is 0.2 feet above the manhole rim elevation for 3.9 hours. **Table 6-27** summarizes the street flooding results.

Appendix Volume 2, Appendix 1.2 contains the SWMM model output and additional information prepared to document information and computations for this Option.

Detention Pond Routing Results

Freeboard at the Air Quality Pond was 4.9 feet (see **Table 6-28).** Freeboard at Tingley Surge Pond was 5.4 feet (see **Table 6-28**) and freeboard in the BR21 Pond is 7.5 feet (see **Table 6-28**). Santa Barbara Park Pond had 9.0 feet of freeboard (see **Table 6-28**). Freeboard at North Wells Park was 2.2 feet (see **Table 6-28).** Coronado Park Pond is 2.3 feet (see **Table 6-28**) and the Broadway-Marble Pond has 2.1 feet of freeboard (see **Table 6-28**).

TABLE 6-27
SUMMARY OF OPTION 17 STREET PONDING AND MAN-HOLE FLOODING

Note- negative numbers imply that the HGL did not reach the manhole rim

Represents flooding depth over 1 ft
Represents flooding between 0.5ft - 0.99 ft
Represents flooding depth between 0 - 0.5 ft

MH Name	Manhole Invert Elev.	Max. Depth of Manhole	Manhole Rim Elev.	Maximum HGL	Node Flood Depth Above Manhole Rim	Flood Volume	Flood Volume	Hours Flooded
	(ft)	(ft)	(ft)	(ft)	(ft)	(10^6 gal)	(acre-ft)	
	(a)	(a)	(b)	(c)	(d)	(e)	(f)	
COA25656	4948.86	10.32	4959.18	4959.33	0.15	0.228	0.699706	1.73
COA25622	4948.24	9.58	4957.82	4957.85	0.03	0.058	0.177996	0.81
COA7476	4950.32	7.85	4958.17	4958.18	0.01	0.231	0.708913	1.49
COA7518	4947.94	8.89	4956.83	4956.89	0.06	0.228	0.699706	1.65
COA24834	4944.52	7.06	4951.58	4951.78	0.2	1.443	4.428405	3.89
COA25105	4946.31	10.2	4956.51	4956.52	0.01	0.035	0.107411	0.35
COA25109	4945.87	10.67	4956.54	4956.55	0.01	0.018	0.05524	0.2
COA9229	4913.15	27	4940.15	4940.44	0.29	0.028	0.085929	0.58

(a) Manhole invert elevation from SWMM input under Node Summary Table
(b) Rim elevation = MH invert elevation + Max depth of manhole
(c) Max HGL from SWMM output table under Node Depth Summary
(d) Node Flood Depth above Manhole Rim = HGL Elev-Rim Elev
(e) Flood volume from SWMM output table under Node Flooding Summary
(f) 1 gallon = 3.06888 E-6 acre-ft

TABLE 6-28

Option 17 DETENTION POND ROUTING SUMMARY TABLE

Detention Pond Name	Existing or Proposed Pond (detention or retention)	Model Analysis Point Name	Storm Return Period (100-yr. 24-hr. duration)	Peak Inflow	Peak Outflow	Peak Storage Volume	Peak Storage Volume	Peak Water Surface Elevation	Principal Spillway Elevation	Emergency Spillway Elevation	Pond Invert Elevation	Water Depth	Top of Pond Embankment Elevation	Freeboard to Emergency Spillway Elevation	**Freeboard to top of Pond Embankment**
				(cfs)	(cfs)	(ft^3)	(ac-ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)
a	a	a		b	c	g	c	d	e	e	e		e	f	f
Air Quality Pond	Existing	Air Quality Pond	100.0	112.0	36.0	211043	4.8	4957.7	4952.3	4962.7	4952.3	5.5	4962.7	4.9	**4.9**
Tingley Surge Pond	Existing	Tingley Park Surge Pond	100	122	47	116176	2.667	4941.3	4932.21	4946.66	4941.66	-0.4	4946.66	5.4	**5.4**
BR21 Pond	Conceptual	BR21 Pond	100	64	10	93907	2.156	5068.5	5062	5074	5062	6.5	5076	5.5	**7.5**
Santa Barbara Pond	Conceptual	Santa Barbara Pond	100	133	31	260187	5.999	4963.0	4961	4972	4961	2.0	4972	7.0	**9.0**

TABLE 6-28

Option 17 DETENTION POND ROUTING SUMMARY TABLE

Detention Pond Name	Existing or Proposed Pond (detention or retention)	Model Analysis Point Name	Storm Return Period (100-yr. 24-hr. duration)	Peak Inflow	Peak Outflow	Peak Storage Volume	Peak Storage Volume	Peak Water Surface Elevation	Principal Spillway Elevation	Emergency Spillway Elevation	Pond Invert Elevation	Water Depth	Top of Pond Embankment Elevation	Freeboard to Emergency Spillway Elevation	**Freeboard to top of Pond Embankment**
				(cfs)	(cfs)	(ft^3)	(ac-ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)
a	a	a		b	c	g	c	d	e	e	e		e	f	f
Wells Park Pond	Conceptual	Wells Park Pond	100	116	46	527937	12.120	4957.8	4951	4960	4951	6.8	4960	2.2	**2.2**
Coronado Park Pond	Conceptual	Coronado Park Pond	100	162	39	435176	9.990	4961.7	4953	4964	4953	8.7	4964	2.3	**2.3**
Broadway-Marble Pond	Conceptual	Broadway-Marble Pond	100	217	40	466586	10.711	4953.9	4946	4954	4946	7.9	4954	0.1	**0.1**

a - See Drainage Basin Maps and Figure 6-1

b - See SWMM output for results "Node Inflow Summary" Table

c -Value calculated after unit conversion from SWMM output

d- See SWMM output for results "Node Depth Summary" Table

e - See Volume 2 Appendix 1.2 for Pond Routing Elev-Area-Capacity Discharge Data

f- Negative number indicates the flow depth exceeds referenced elevation - no freeboard available

g - Value from SWMM output under Storage Volume Summary

Conclusion

The adoption of all storm drain enlargements, diversions and detention ponds has eliminated all street ponding throughout all areas with minor exceptions as summarized in **Table 6-27**. However, possibly better pond locations were considered, and these are evaluated in subsequent options.

Table 6-29 summarizes the proposed detention ponds (facilities) areas, depths and required volumes applied to compute quantity and cost estimates.

TABLE 6-29

SUMMARY OF PROPOSED DETENTION PONDS FACILITIES -VOLUMES AND AREAS
100-yr. 24-hr. Storm

Facility Number	Existing or Proposed Pond Name and Comment	Total Parcel Area	Total Land Area to Purchase	Total Land Area to Sell	Maximum Design Storage Volume	Peak Storage Volume	Maximum Pond Depth	Peak Water Depth	Free-board
		acres	acres	acres	ac-ft	ac-ft	ft	ft	ft
					a d	b	d	b	c d
F10	Existing Broadway-Lomas Pond - FILL IN POND	2.768	NA	2.768	16.13	-	10.0	-	-
F1	Proposed Sub-Catchment BR21	3.89	0.65	NA	6.10	2.1560	14.0	6.5	7.5
F2	Proposed Marble-Arno Pond	1.8	1.8	0.45	14.77	13.5050	12.0	11.1	0.9
F5	Proposed Santa Barbara Park Pond	City Owned	NA	NA	36.48	5.9990	11.0	2	9.0
F6	Proposed North Wells Park Pond	2.276	2.276	NA	16.52	12.3460	9.0	6.9	2.1
F7	Proposed McKnight Pond	1.189	1.189	NA	11.14	9.6240	10.0	8.8	1.2

a-From tables in Appendix 2.6 Volume 3 for existing and Appendix 1.2 Vol 2 for Proposed facilities
b - From SWMM output Appendix 1.2 -Volume 2
c- Freeboard = Maximum Pond Depth - Peak Water Depth
d- Conceptual level design values may be refined during final design

Option 18 –

Purpose

The purpose of Option 18 was to include all facilities from Option 17 and additionally, modify the 96-in. CMP storm drain from Tingley Pond (intersection of 8th and Atlantic) to the Barelas Pump station. The 96-in. CMP was modified to simulate slip lining with a 90-in. smooth wall pipe. The intent is to determine the effect on capacity and hydraulic grade line reductions that could occur due to the smaller Manning's "n" value of 0.013 for smooth wall pipe as compared to "n" = 0.024 for the existing CMP. This option and cost estimates were previously evaluated by Wilson and Company's Design Memorandum (no date on document, assume fall 2006) to the City of Albuquerque regarding the proposed storm drain rehabilitation plan.

Facility 10 Remove the existing Broadway-Lomas Pond and sell this lot as a high value commercial property.

Facility 1 Build a new pond in Sub-catchment BR21 (near southeast intersection of Lomas Blvd. and Medical Arts). The pond outfall pipe will be a 24-in. RCP that will join into the existing Lomas Blvd. manhole that joins to an existing 48-in. RCP that drains north to the existing Odelia Pond.

Facility X20 A alternative pond for the Broadway-Lomas Pond was included near the Broadway-Marble intersection on the east side of Broadway.

Facility X18 The existing Broadway storm drain system was not changed from north of the existing Broadway Pump Station (COA 7766JB) to the Broadway-Odelia intersection. More specifically, the storm drain begins at the Broadway Pump Station manhole (COA 7766JB) as two parallel 48-in. RCP's that continue north in Broadway to just north of the Broadway-Mountain intersection. From that intersection the storm drain continues north as a one 48-in. storm drain to the Odelia-Broadway intersection.

Facility X21 Upsize the Baca storm drain from 36-in. RCP to 48-in. RCP from the Broadway-Odelia intersection west in Baca to Commercial, then north on Commercial for 600 feet.

Facility 5 Upsize the Commercial 36-in. RCP storm drain to 54-in. RCP storm drain from the Commercial-Indian School intersection south on Commercial to McKnight, then east on McKnight. Then build a new 54-in. RCP storm drain from the Commercial-McKnight intersection east to the Broadway-McKnight intersection. Then continue south on Broadway to join into the Santa Barbara Park Pond. The outlet from the pond will be a 24-in. storm drain that joins the Broadway storm drain at Hannett. Upsize the 36-in. storm drain to 48-in. storm drain south from the Broadway-Hannett intersection to the Broadway-Odelia intersection. Delete (plug) the existing 36-in. RCP storm drain from the McKnight-Commercial intersection south for 900 ft. to direct upstream flows towards the Santa Barbara Park Pond.

Facility 6 Build a new 54-in. storm drain in Constitution from the 3rd St. - Constitution –intersection west to 5th St. then south on 5th St. to the Summer - 5th St. intersection and this pipe will outfall to the North Wells Park Pond. The 36-in. outfall pipe from the pond will continue south on 5th St. to Mountain, then east on Mountain to 3rd St. where it will join into the existing 3rd St. 48-in. storm drain. The existing 3rd St. storm drain was deleted (plug) from the 3rd St.-Constitution intersection, south to the 3rd St.- Mountain intersection to direct upstream storm drain flows into the North Wells Park Pond.

Facility 7 Upsize storm drains from 36-in. to 54 in. along 4th St. from Cutler south to McKnight then east to 3rd St. and outfall to the Coronado Park Pond. The pond outfall pipe is a 24-in. storm drain will join into the McKnight-3rd St. intersection storm drain that will be upsized from existing 48-in. to 54-in. storm drain that continues south on 3rd St. to Constitution.

Facility X19 Upsize the 27-in. and 30-in. storm drains to 48-in. storm drains on Barelas from Pacific Ave. south to Lewis and west on Lewis to the west Riverside storm drain.

Facility 9 Upsize storm drains from 24-in. to 54-in. on Rio Grande Blvd. from Carson to Chacoma then southeast to San Pasquale, then south on Laguna ending at Kit Carson.

Facility 11 Build a new Broadway Pump Station at the existing capacity of 150 cfs (Molzen & Corbin, July 2008).

Facility 12 Build a new 24-in. storm drain system from the Edith-Odelia intersection north to the Edith-Hannett intersection, then west on Hannett to outfall into the Santa Barbara Park Pond.

Facility 13 Replace the 96-in. CMP storm drain with a 90-in. diameter smooth wall pipe (slip line construction) from the 8th St. –Atlantic intersection (Tingley Pond) to the Barelas Pump Station and reduce Manning's "n" from 0.024 (existing CMP) to 0.013 (smooth wall pipe).

Modeling Approach

The Broadway-Lomas detention pond was deleted from the model. The existing manhole number COA 32878.A was connected directly to an existing manhole COA32878.B with a 4.5 ft diameter RCP pipe in Broadway. A smaller detention pond (compared to the Broadway-Lomas Pond) was added near the Broadway-Marble intersection at the east side of Broadway. Runoff was diverted to this pond through a 54-in. pipe connecting from an existing manhole, COA32878.B. The pond drained back into the Broadway storm drain system through a 30 in. pipe. The Broadway storm drains from Mountain to Odelia were upsized from 48-in. to 60-in.

The storm drain on Commercial at McKnight that drained south to Baca was eliminated and a new 54-in. storm drain from that intersection was re-routed to the McKnight- Broadway intersection. From that intersection, the 54-in. storm drain continued south on Broadway where it would outfall into the Santa Barbara Park Pond. The topography indicates that the runoff from Sub-catchment BR16 will follow the natural street slopes along Edith to McKnight. The existing 21-in. storm drain that increases to a 36-in. storm drain west along McKnight between Edith and Broadway will convey the runoff to the intersection of Broadway and McKnight and will join the 54-in. storm drain in Broadway that will outfall to the Santa Barbara Park Pond.

However, to drain Sub-catchment BR12 to the Santa Barbara Park Pond, a new 24-in. storm drain system will be required in Edith that will drain north against the street grade to the intersection with Hannett. Then the storm drain will drain west on Hannett and outfall into the Santa Barbara Park Pond. The Santa Barbara Park Pond outfall pipe will be a 24-in. pipe that will join the Broadway storm drain.

All existing Broadway 36-in. storm drains from the Broadway-Odelia intersection north to Hannett at the Santa Barbara Park Pond were upsized to 48-in. The Baca and Commercial (only about 600 ft) storm drains were also upsized from 36-in. to 48-in.

The BR21 pond was simulated to drain into the Odelia Pond. A new 11 foot deep detention pond called Coronado Park Pond was added to collect runoff from Sub-catchments B35 and B40. Storm drains from Cutler to McKnight were upsized from 36-in. to 54-in. that connected to Coronado Park Pond. A 24-in. outlet pipe drained this pond back into the system. The storm drain from 3rd St. and McKnight to 3rd St. and Constitution was upsized from 48-in. to 54-in.

Storm drains were added west on Constitution from 3rd St. to 5th St. and south on 5th St. to Mountain then south to drain into the North Wells Park Pond located at Summer and 5th St., the pond outfall pipe is a 36-in. RCP storm drain that continues south on 5th St. to Mountain, then east to 3rd St. where it joins the existing storm drain. The storm drain between Constitution and Mountain along 3rd St. was deleted to direct storm drain flows to the North Wells Park Pond.

Storm drains were upsized from 24-in. to 54-in. on Rio Grande Blvd. from Carson to Chacoma, then to San Pasquale then to Laguna ending at Kit Carson, and upsized storm drains from 27-in. and 30-in. to 48-in. on Barelas from Pacific Ave. to Lewis, west on Lewis to the west Riverside storm drain.

Additionally, the Manning's friction factor (n-value) for the 96-in. storm drain was changed from the intersection of 8th and Atlantic (Tingley Pond) to the Barelas Pump Station to simulate Wilson and Company's proposed storm drain rehabilitation plan. The rehabilitation plan recommends slip lining the existing 96-in. storm drain with 90-in. Ultra Flo Aluminized Steel pipe since the existing storm drain is approaching the end of its design life. The slip lining is expected to increase the storm drains life span while improving the storm drains hydraulic conditions.

The significant option components are summarized in **Table 6-1** (Summary of Model Filenames and Components – Appendix Volume 2, Appendix 1).

Street Flooding Results

Option 18 effectively removed flooding from the Broadway-Lomas intersection and all along Broadway, north to I-40. Significant flooding along 3rd St. and 4th St. near I-40 and Coronado Park was also reduced. The flooding depths along Rio Grande Blvd. were reduced to the manhole rim elevation except for San Pasquale and Chacoma intersection where the depth is 0.23 feet above the manhole rim elevation for 2.5 hours. **Table 6-30** summarizes the street flooding results. See the conclusion below for discussion of the effect of the 90-in. smooth wall pipe between the Tingley Pond and the Barelas Pump Station.

Appendix Volume 2, Appendix 1.2 contains the SWMM model output and additional information prepared to document information and computations for this Option.

INSERT TABLE 6-30 1 PAGE

TABLE 6-30
SUMMARY OF OPTION 18 STREET PONDING AND MAN-HOLE FLOODING

Note- negative numbers imply that the HGL did not reach the manhole rim

Represents flooding depth over 1 ft
Represents flooding between 0.5ft - 0.99 ft
Represents flooding depth between 0 - 0.5 ft

MH Name	Manhole Invert Elev.	Max. Depth of Manhole	Manhole Rim Elev.	Maximum HGL	Node Flood Depth Above Manhole Rim	Flood Volume	Flood Volume	Hours Flooded
	(ft)	(ft)	(ft)	(ft)	(ft)	(10^6 gal)	(acre-ft)	
	(a)	(a)	(b)	(c)	(d)	(e)	(f)	
COA25656	4948.86	10.32	4959.18	4959.28	0.1	0.199	0.610709	1.54
COA25622	4948.24	9.58	4957.82	4957.83	0.01	0.05	0.153444	0.62
COA7476	4950.32	7.85	4958.17	4958.18	0.01	0.047	0.144238	0.57
COA7518	4947.94	8.89	4956.83	4956.89	0.06	0.098	0.300751	0.78
COA24834	4944.52	7.06	4951.58	4951.81	0.23	0.872	2.67607	2.51
COA25105	4946.31	10.2	4956.51	4956.52	0.01	0.026	0.079791	0.23
COA9229	4913.15	27	4940.15	4940.45	0.3	0.024	0.073653	0.51

(a) Manhole invert elevation from SWMM input under Node Summary Table
(b) Rim elevation = MH invert elevation + Max depth of manhole
(c) Max HGL from SWMM output table under Node Depth Summary
(d) Node Flood Depth above Manhole Rim = HGL Elev-Rim Elev
(e) Flood volume from SWMM output table under Node Flooding Summary
(f) 1 gallon = 3.06888 E-6 acre-ft

Detention Pond Routing Results

Freeboard at the Air Quality Pond was 4.9 feet (see **Table 6-31).** Freeboard at Tingley Surge Pond was 6.0 feet (see **Table 6-31**) and freeboard in the BR21 Pond is 7.5 feet (see **Table 6-31**). Santa Barbara Park Pond had 9.0 feet of freeboard (see **Table 6-31**). Freeboard at North Wells Park was 2.0 feet (see **Table 6-31)**. Coronado Park Pond is 2.5 feet (see **Table 6-31**) and the Broadway-Marble Pond has 2.2 feet of freeboard (see **Table 6-31**).

Conclusion

The results show improved conveyance in the storm drain leading into the Barelas Pump Station as presented in **Table 6-32** which also provides comparison to the existing conditions model and Option 17 results. The reduced "n" value allows increased capacity from 381 cfs existing 96-in. CMP pipe (ESWMM81) to 411 cfs (ESWMM81) for 90-in. smooth pipe.

Note that although the 90-in. pipe improves the conveyance within the proposed storm drain location (Tingley pond to Barelas Pump Station), *this does not reduce the hydraulic grade line upstream at the intersection of 8th St and Iron as compared to the existing conditions model results – see* ***Table 6-32.***

Therefore the flood depths throughout remainder of the study area did not see any further reduction. Based on the results, this storm drain rehabilitation would be a viable option in improving conveyance, and reducing street ponding depths only in the lower basin area.

TABLE 6-31

Option 18 DETENTION POND ROUTING SUMMARY TABLE

Detention Pond Name	Existing or Proposed Pond (detention or retention)	Model Analysis Point Name	Storm Return Period (100-yr. 24-hr. duration)	Peak Inflow	Peak Outflow	Peak Storage Volume	Peak Storage Volume	Peak Water Surface Elevation	Principal Spillway Elevation	Emergency Spillway Elevation	Pond Invert Elevation	Water Depth	Top of Pond Embankment Elevation	Freeboard to Emergency Spillway Elevation	**Freeboard to top of Pond Embankment**
				(cfs)	(cfs)	(ft^3)	(ac-ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)
a	a	a		b	c	g	c	d	e	e	e		e	f	f
Air Quality Pond	Existing	Air Quality Pond	100.0	117.0	36.0	210710	4.8	4957.7	4952.3	4962.7	4952.3	5.5	4962.7	4.9	**4.9**
Tingley Surge Pond	Existing	Tingley Park Surge Pond	100	54	29	21051	0.483	4940.7	4932.21	4946.66	4941.66	-1.0	4946.66	6.0	**6.0**
BR21 Pond	Conceptual	BR21 POND	100	64	10	93907	2.156	5068.5	5062	5074	5062	6.5	5076	5.5	**7.5**
Santa Barbara Pond	Conceptual	Santa Barbara Pond	100	135	31	260453	5.999	4963.0	4961	4972	4961	2.0	4972	7.0	**9.0**

TABLE 6-31

Option 18 DETENTION POND ROUTING SUMMARY TABLE

Detention Pond Name	Existing or Proposed Pond (detention or retention)	Model Analysis Point Name	Storm Return Period (100-yr. 24-hr. duration)	Peak Inflow	Peak Outflow	Peak Storage Volume	Peak Storage Volume	Peak Water Surface Elevation	Principal Spillway Elevation	Emergency Spillway Elevation	Pond Invert Elevation	Water Depth	Top of Pond Embankment Elevation	Freeboard to Emergency Spillway Elevation	**Freeboard to top of Pond Embankment**
				(cfs)	(cfs)	(ft^3)	(ac-ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)
a	a	a		b	c	g	c	d	e	e	e		e	f	f
Wells Park Pond	Conceptual	Wells Park Pond	100	114	34	494910	11.362	4958.0	4951	4960	4951	7.0	4960	2.0	**2.0**
Coronado Park Pond	Conceptual	Coronado Park Pond	100	162	41	422781	9.706	4961.5	4953	4962	4953	8.5	4964	0.5	**2.5**
Broadway-Marble Pond	Conceptual	Broadway-Marble Pond	100	217	44	483275	11.094	4953.8	4946	4954	4946		4956	0.2	**2.2**

a - See Drainage Basin Maps and Figure 6-1
b - See SWMM output for results "Node Inflow Summary" Table
c -Value calculated after unit conversion from SWMM output
d- See SWMM output for results "Node Depth Summary" Table
e - See Volume 2 Appendix 1.2 for Pond Routing Elev-Area-Capacity Discharge Data
f- Negative number indicates the flow depth exceeds referenced elevation - no freeboard available
g - Value from SWMM output under Storage Volume Summary

TABLE 6-32
SUMMARY OF OPTION CONVEYANCE AND HYDRAULIC GRADE LINES

MANHOLE NUMBER	STREET INTERSECTION	EXISTING CONDTIONS HGL (ft) (a)	EXISTING CONDTIONS Flow in ESWMM 81 (cfs) (b)	OPTION 25 HGL (ft) (a)	OPTION 25 Flow in ESWMM 81 (cfs) (b)
COA32878	Broadway-Lomas	4955.76	381	4955.78	406
COA7815	8th-Lomas	4956.88		4956.88	
COA13866	8th-Iron	4947.44		4947.44	
COA8985	Laguna-san Pasquale	4952.14		4952.14	
COA25622	12th-Orchard	4957.84		4957.83	
COA24997	Alcalde-Kit Carson	4942.65		4946.41	
COA32981	8th-Atlantic	4940.84		4940.37	
COA9121	El Bordo-Atlantic	4940.51		4939.94	
COA9129	El Bordo-Santa Fe	4939.47		4939.13	
MHB22410	10th-El Bordo	4937.67		4937.6	
COA22410	10th-El Bordo	4937.25		4937.13	
COA9141	El Bordo-Pacific	4936.25		4936.23	
COA10456	Tingley Rd-Lewis	4930.23		4930.26	

(a) SWMM Output Table "Node Depth

(b) SWMM Output Table "Link Flow Summary" for the last pipe into the Barelas Pump Station

Option 19 –

Purpose

The purpose of Option 19 was to determine the capacity required at the Broadway Pump Station to eliminate flooding from the Broadway-Lomas intersection and Broadway by excluding the Option 17 facilities in Broadway and the north Broadway – Commercial and McKnight areas, and to retain Option 17 facilities throughout remainder of the study area. In addition, this Option assumes that an additional force main would be required to handle the pump station capacity increase. This force main is assumed to parallel the existing 54-in. force main to the North Diversion Channel.

Facility 10 Remove the existing Broadway-Lomas Pond and sell this lot as a high value commercial property.

Facility 1 Build a new pond in Sub-catchment BR21 (near southeast intersection of Lomas Blvd. and Medical Arts). The pond outfall pipe will be a 24-in. RCP that will join into the existing Lomas Blvd. manhole that joins to an existing 48-in. RCP that drains north to the existing Odelia Pond.

Facility 6 Build a new 54-in. storm drain in Constitution from the 3rd St. – Constitution –intersection west to 5th St. Then continue south on 5th St. to the Summer - 5th St. intersection and this pipe will outfall to the North Wells Park Pond. The 36-in. outfall pipe from the pond will continue south on 5th St. to Mountain, then east on Mountain to 3rd St. where it will join into the existing 3rd St. 48-in. storm drain. The existing 3rd St. storm drain was deleted (plug) from the 3rd St.-Constitution intersection south to the 3rd St.- Mountain intersection to direct upstream storm drain flows into the North Wells Park Pond.

Facility 7 Upsize storm drains from 36-in. to 54 in. along 4th St. from Cutler south to McKnight then east to 3rd St. and outfall to the Coronado Park Pond. The pond outfall pipe is a 24-in. storm drain will join into the McKnight-3rd St. intersection storm drain that will be upsized from existing 48-in. to 54-in. storm drain that continues south on 3rd St. to Constitution.

Facility X19 Upsize the 27-in. and 30-in. storm drains to 48-in. storm drains on Barelas from Pacific Ave., south to Lewis and west on Lewis to the west Riverside storm drain.

Facility 9 Upsize storm drains from 24-in. to 54 in. on Rio Grande Blvd. from Carson to Chacoma, then east to San Pasquale and to Laguna ending at Kit Carson.

Facility 12 Build a new 24-in. storm drain system from the Edith-Odelia intersection north to the Edith-Hannett intersection, then west on Hannett to outfall into the Santa Barbara Park Pond.

Facility X15 Pump capacity at Broadway Pump Station at 320 cfs which would require a new pump station. The storm drain just south of the Broadway Pump Station from manhole COA7769JB was increased from 42-in. to 54-in. to manhole COA 32865. Both inlets into the Broadway Pump Station were increased from 42-in. and 48-in. to 60-in. respectively. This would also require an additional new 60-in. force main to the North Diversion Channel assumed to be located parallel with the existing 54-in. force main. This force main is required to pass the additional pump station discharge (320 cfs – 130 cfs existing = 190 cfs).

Computation of the possible 60-in. Force Main - The manufacturers pump curve was not available for use in the analysis for the force main calculation. Therefore, to be conservative, the maximum velocity for the force main was assumed to be 10 ft/s with a known flow rate of 320 cfs and velocity of 10 ft/s, the basic continuity equation Q=V*A was applied to determine the required force main area. The minimum required area to pass 320 cfs was computed to be 32 sq ft.

The existing 54-in. force main provides 16 sq ft and a 60-in. pipe would provide an additional 20 sq ft for a total of 36 sq ft. Therefore, an additional 60-in. force main pipe would provide adequate capacity to handle the possible pump station discharge of 320 cfs. See **Figure 6-2** for the possible alignment.

Volume 2, Appendix 1.2 – contains the computations.

Modeling Approach

The Broadway-Lomas detention pond was deleted from the model. The existing manhole number COA 32878.A located just north of Broadway-Lomas intersection was connected directly to an existing manhole COA32878.B with a 4.5 ft diameter RCP pipe in Broadway. The BR21 pond was simulated to drain into the Odelia Pond.

A new 11 foot deep detention pond called Coronado Park Pond was added to collect runoff from Sub-catchments B35 and B40. Storm drains from Cutler to McKnight were upsized from 36-in. to 54-in. that connected to Coronado Pond. A 24-in. outlet pipe drained this pond back into the system. The storm drain from 3rd St. and McKnight to 3rd St. and Constitution was upsized from 48-in. to 54-in.

Storm drains were added west on Constitution from 3rd St. to 5th St. and south on 5th St. to Mountain, then south to drain into the North Wells Park Pond located at Summer and 5th St. The pond outfall pipe is a 36-in. RCP storm drain that continues south on 5th St. to Mountain, then east to 3rd St. where it joins the existing storm drain. The storm drain between Constitution and Mountain along 3rd St. was deleted to direct flows to the North Wells Park Pond.

Storm drains were upsized from 24-in. to 54-in. on Rio Grande Blvd. from Carson to Chacoma, then to San Pasquale, then to Laguna ending at Kit Carson, and upsized storm drain from 27- and

30-in. to 48-in. storm drain on Barelas from Pacific Ave. to Lewis, then west on Lewis to the west Riverside storm drain.

The significant option components are summarized in **Table 6-1** (Summary of Model Filenames and Components – Appendix Volume 2, Appendix 1).

The Broadway Pump Station capacity was increased to 320 cfs and the two inflow pipes were increased to 60-in. diameter pipes. The storm drain segment just south of manhole COA7769JB was increased from 42-in. to a 54-in. storm drain.

Street Flooding Results

Option 19 reduced flooding in the immediate Broadway-Lomas intersection with the exception of manholes COA32878 and COA32878.A which had 0.35 feet and 0.32 feet of flooding respectively. Manhole flooding increased to 2.2 feet at COA 7635 (Commercial-Baca intersection). However, significant flooding along 3rd St. and 4th St. near I-40 was reduced. The flooding depths along Rio Grande Blvd. are at the manhole rim elevation except for San Pasquale and Chacoma intersection where depth is 0.21 feet above the manhole rim elevation for 2.7 hours. **Table 6-33** summarizes the street flooding results.

Appendix Volume 2, Appendix 1.2 contains the SWMM model output and additional information prepared to document information and computations for this Option.

TABLE 6-33
SUMMARY OF OPTION 19 STREET PONDING AND MAN-HOLE FLOODING

Note- negative numbers imply that the HGL did not reach the manhole rim

Represents flooding depth over 1 ft
Represents flooding between 0.5ft - 0.99 ft
Represents flooding depth between 0 - 0.5 ft

MH Name	Manhole Invert Elev.	Max. Depth of Manhole	Manhole Rim Elev.	Maximum HGL	Node Flood Depth Above Manhole Rim	Flood Volume	Flood Volume	Hours Flooded
	(ft)	(ft)	(ft)	(ft)	(ft)	(10^6 gal)	(acre-ft)	
	(a)	(a)	(b)	(c)	(d)	(e)	(f)	
COA6195	4962.97	6.74	4969.71	4970.05	0.34	0.208	0.638329	1.39
COA6246	4962.06	7.85	4969.91	4969.91	0	0.004	0.012276	0.04
COA7635	4957.34	7.29	4964.63	4966.79	2.16	0.459	1.40862	2.05
COA7650	4954.93	8.35	4963.28	4963.4	0.12	0.041	0.125824	1.32
COA7656	4953.17	9.45	4962.62	4962.63	0.01	0.012	0.036827	0.08
COA7628	4960.44	11.03	4971.47	4971.48	0.01	0.004	0.012276	0.23
COA29132	4961.85	12.41	4974.26	4974.57	0.31	0.045	0.1381	0.6
COA25349	4945.26	11.07	4956.33	4956.34	0.01	0.06	0.184133	0.13
COA25656	4948.86	10.32	4959.18	4959.31	0.13	0.216	0.66288	1.87
COA25622	4948.24	9.58	4957.82	4957.84	0.02	0.057	0.174927	0.7
COA7476	4950.32	7.85	4958.17	4958.18	0.01	0.048	0.147307	0.56
COA7518	4947.94	8.89	4956.83	4956.88	0.05	0.097	0.297682	0.76
COA24834	4944.52	7.06	4951.58	4951.79	0.21	0.989	3.03513	2.72
COA25105	4946.31	10.2	4956.51	4956.52	0.01	0.035	0.107411	0.3
COA32878	4946.6	9.16	4955.76	4956.11	0.35	0.078	0.239373	0.56
COA32878.A	4947.19	8.39	4955.58	4955.9	0.32	0.053	0.162651	0.55
COA9229	4913.15	27	4940.15	4940.45	0.3	0.025	0.076722	0.52

(a) Manhole invert elevation from SWMM input under Node Summary Table
(b) Rim elevation = MH invert elevation + Max depth of manhole
(c) Max HGL from SWMM output table under Node Depth Summary
(d) Node Flood Depth above Manhole Rim = HGL Elev-Rim Elev
(e) Flood volume from SWMM output table under Node Flooding Summary
(f) 1 gallon = 3.06888 E-6 acre-ft

Detention Pond Routing Results

Freeboard at the Air Quality Pond was 2.6 feet (see **Table 6-34).** Freeboard at Tingley Surge Pond was 5.4 feet (see **Table 6-34**) and freeboard in the BR21 Pond is 7.5 feet (see **Table 6-34**). Freeboard at North Wells Park Pond was 2.6 feet (see **Table 6-34)** and the Coronado Park Pond is 1.3 feet (see **Table 6-34**).

Conclusion

The results indicate that Broadway Pump Station would require a minimum capacity of 320 cfs along with upsizing the inlet pipes and a short segment of the storm drain as outlined in the facility description above, in order to eliminate any detention structures near the Broadway-Lomas intersection (Broadway-Lomas Pond and Broadway-Marble Pond). However, about 0.28 feet of flooding would remain in the Broadway-Lomas area. Therefore additional options should be considered.

TABLE 6-34

Option 19 DETENTION POND ROUTING SUMMARY TABLE

Detention Pond Name	Existing or Proposed Pond (detention or retention)	Model Analysis Point Name	Storm Return Period (100-yr. 24-hr. duration)	Peak Inflow	Peak Outflow	Peak Storage Volume	Peak Storage Volume	Peak Water Surface Elevation	Principal Spillway Elevation	Emergency Spillway Elevation	Pond Invert Elevation	Water Depth	Top of Pond Embankment Elevation	Freeboard to Emergency Spillway Elevation	**Freeboard to top of Pond Embankment**
				(cfs)	(cfs)	(ft^3)	(ac-ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)
a	a	a		b	c	g	c	d	e	e	e		e	f	f
Air Quality Pond	Existing	Air Quality Pond	100.0	191.0	46.0	364863	8.4	4960.1	4952.3	4962.7	4952.3	7.8	4962.7	2.6	**2.6**
Tingley Surge Pond	Existing	Tingley Park Surge Pond	100	115	59	108517	2.491	4941.2	4932.21	4946.66	4941.66	-0.4	4946.66	5.4	**5.4**
BR21 Pond	Conceptual	BR21 Pond	100	64	10	93907	2.156	5068.5	5062	5074	5062	6.5	5076	5.5	**7.5**
Wells Park Pond	Conceptual	Wells Park Pond	100	121	34	496420	11.396	4957.4	4951	4960	4951	6.4	4960	2.6	**2.6**

TABLE 6-34

Option 19 DETENTION POND ROUTING SUMMARY TABLE

Detention Pond Name	Existing or Proposed Pond (detention or retention)	Model Analysis Point Name	Storm Return Period (100-yr. 24-hr. duration)	Peak Inflow	Peak Outflow	Peak Storage Volume	Peak Storage Volume	Peak Water Surface Elevation	Principal Spillway Elevation	Emergency Spillway Elevation	Pond Invert Elevation	Water Depth	Top of Pond Embankment Elevation	Freeboard to Emergency Spillway Elevation	**Freeboard to top of Pond Embankment**
				(cfs)	(cfs)	(ft^3)	(ac-ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)
a	a	a		b	c	g	c	d	e	e	e		e	f	f
Coronado Park Pond	Conceptual	Coronado Park Pond	100	160	46	404086	9.277	4962.7	4953	4962	4953	9.7	4964	-0.7	**1.3**

a - See Drainage Basin Maps and Figure 6-1
b - See SWMM output for results "Node Inflow Summary" Table
c -Value calculated after unit conversion from SWMM output
d- See SWMM output for results "Node Depth Summary" Table
e - See Volume 2 Appendix 1.2 for Pond Routing Elev-Area-Capacity Discharge Data
f- Negative number indicates the flow depth exceeds referenced elevation - no freeboard available
g - Value from SWMM output under Storage Volume Summary

Option 20 –

Purpose

The purpose of Option 20 was to determine if an alternate route for the Broadway Pump Station force main would provide an increase in pipe capacity and assist in the achieving the existing pump station capacity of 130 cfs, or the proposed capacity of 150 cfs if it is rebuilt. The concept was derived assuming that pumping downhill with an outfall to the Rio Grande may be more efficient than pumping uphill to the North Diversion Channel. Option 20 was not modeled in SWMM. The additional purpose of this Option is to determine the cost differences of this option as compared to the other pump station force main improvement options.

Facility X14 Pump capacity at Broadway Pump Station at 130 or 150 cfs with a new pump station. This would also require an additional new 54-in. force main to the Rio Grande beginning at Mountain and continuing west instead of the existing 54-in. force main to the North Diversion Channel. See **Figure 6-2** for the possible alignment.

Discussion of Alternate Force Main

The Broadway Storm Water Lift Station No. 31 currently discharges to the North Diversion Channel (about 1.3 miles along Broadway Blvd. and Mountain Road). The current pumping capacity is 127 cfs (*Molzen Corbin and Associates, Broadway Pump Station DAR, July 2008*). The maximum static head at the pumps is about 177 feet (based on as-builts of the station, and contours at the Channel inlet). The existing discharge pipe is a 54-in. diameter concrete cylinder pipe. The report recommended that when the pumps are replaced (due to age and maintenance issues), they should be up-sized to pump this maximum capacity of the discharge pipe (increase of 23 cfs would provide 150 cfs capacity).

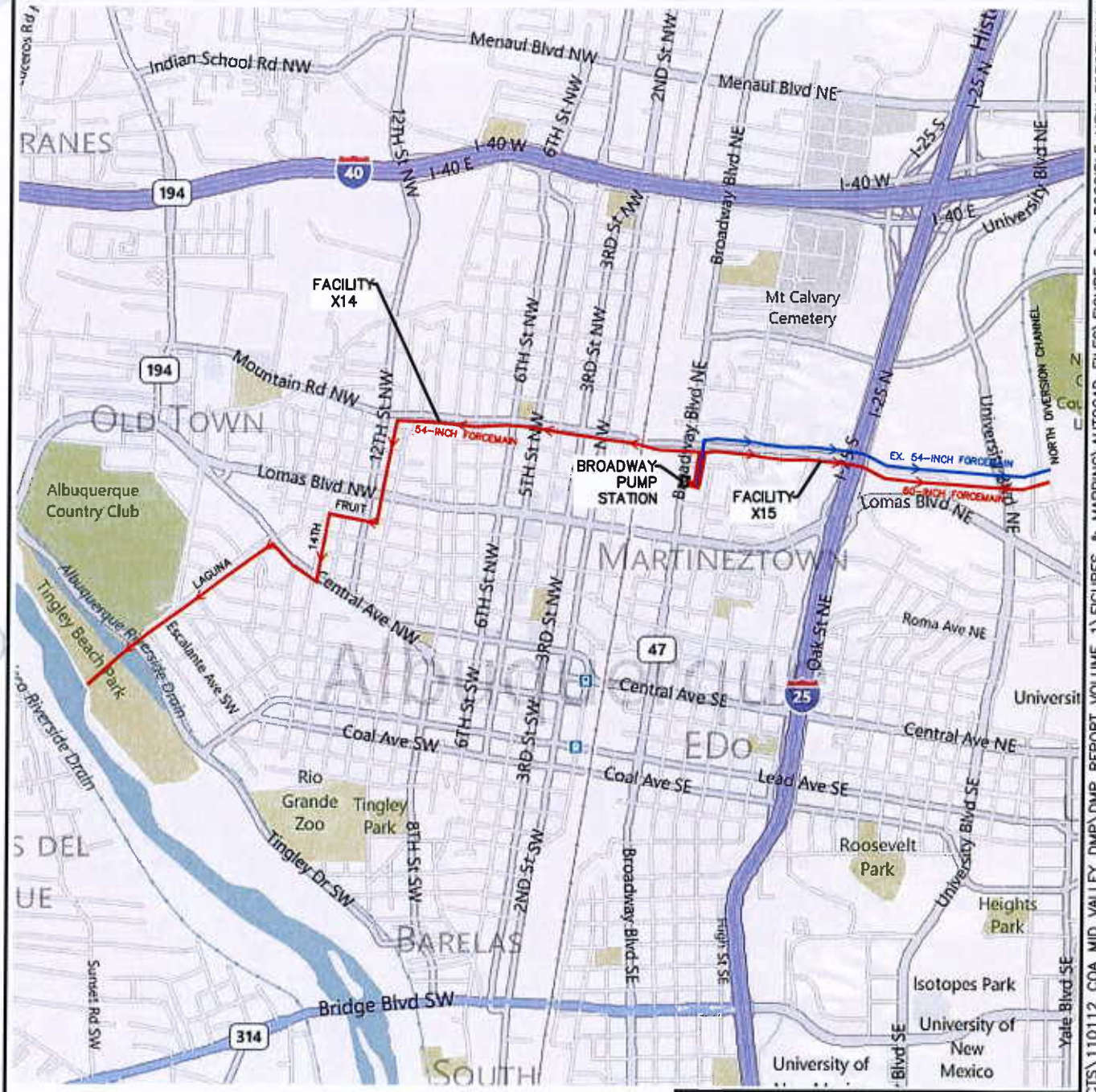
The COA requested that Smith Engineering Company (SEC) perform a simple computation to examine an alternative to pump replacement, that could increase the capacity of the station. This alternative was to discharge (downstream) to the Rio Grande. This would decrease the static head and therefore, increase the capacity. In order to examine the pumping capacity of the existing pumps
with a different discharge scenario, a manufactures pump curve is necessary. However, no pump curves are available and therefore, SEC "assumed" a pump curve based on the known information including the existing system curve (see Appendix Volume 2, Appendix 1.2 for chart of 54-in. line) and a known operating point (see Appendix 1.2 chart - point 1 on chart). SEC proposed one possible route from the pump station to the Rio Grande (see Figure 6-2 for alignment).

One possible route would be from the station west on Mountain Road to 12th St., then to Fruit St., then to 14th St., then to Central, then to Laguna, and then to the Rio Grande (about 2.7 miles). The discharge from the existing pumps through this proposed pipeline depends upon the pipe diameter of the force main. Essentially, as the pipe diameter increases, the discharge increases.

The Chart (**Appendix 1.2**) illustrates the system curves for proposed pipe sizes varying from 42-in. to 60-in. diameter. Only a 48-in. diameter or larger pipe would result in an increased capacity

of the existing pumps (>127 cfs). A 48-in. diameter pipe would result in an increase of 15 cfs (142 cfs total); a 60-in. discharge pipe would result in an increased capacity of 29 cfs (156 cfs total).

INSERT FIGURE 6-2 1 PAGE



NOT TO SCALE

MID-VALLEY DRAINAGE MANAGEMENT PLAN
FOR THE CITY OF ALBUQUERQUE & ALBUQUERQUE METROPOLITAN ARROYO FLOOD CONTROL AUTHORITY
January – 2011
SEC PROJECT NO. 110112

POSSIBLE NEW FORCEMAIN ALIGNMENTS

FIGURE 6-2

Q:\SEC---PROJECTS\2010 PROJECTS\110112 COA MID VALLEY DMP\DMP REPORT VOLUME 1\FIGURES & MAPPING\AUTOCAD FILES\FIGURE 6-2 POSSIBLE NEW FORCEMAIN ALIGNMENTS 1/3

Appendix Volume 2, Appendix 1.2 contains the computations.

Conclusion
A 54-in. force main pipe would allow a capacity of 150 cfs that would match the proposed pump station capacity if the station is rebuilt per the Design Analysis Report previously described.

Option 21–

Purpose
The purpose of Option 21 was to determine if flooding in the immediate Broadway-Lomas area could be mitigated by upsizing storm drains to mostly 90-in. dia. from the Broadway-Odelia intersection to the Broadway-Lomas intersection without any detention ponds around the Broadway-Lomas intersection.

Facility 10 Remove the existing Broadway-Lomas Pond and sell this lot as a high value commercial property.

Facility 1 Build a new pond in Sub-catchment BR21 (near southeast intersection of Lomas Blvd. and Medical Arts). The pond outfall pipe will be a 24-in. RCP that will join into the existing Lomas Blvd. manhole that joins to an existing 48-in. RCP that drains north to the existing Odelia Pond.

Facility X21 Upsize the Baca storm drain from 36-in. RCP to 48-in. RCP from the Broadway-Odelia intersection west in Baca to Commercial, then north on Commercial for 600 ft.

Facility 5 Upsize the Commercial 36-in. RCP storm drain to 54-in. RCP storm drain from the Commercial-Indian School intersection south on Commercial to McKnight, then east on McKnight. Then a build a new 54-in. RCP storm drain from the Commercial-McKnight intersection east to the Broadway-McKnight intersection. Then south on Broadway to join into the Santa Barbara Park Pond. Outlet from the pond will be a 24-in. storm drain that joins the Broadway storm drain at Hannett. Upsize the 36-in. storm drain to 48-in. storm drain south from the Broadway-Hannett intersection to the Broadway-Odelia intersection. Delete (plug) the existing 36-in. RCP storm drain from the McKnight-Commercial intersection south for 900 ft. to direct upstream flows towards the Santa Barbara Park Pond.

Facility 6 Build a new 54-in. storm drain in Constitution from the 3rd St. – Constitution –intersection west to 5th St. then south on 5th St. to the Summer - 5th St. intersection and this pipe will outfall to the North Wells Park Pond. The 36-in. outfall pipe from the pond will continue south on 5th St. to Mountain, then east on Mountain to 3rd St. where it will join into the existing 3rd St. 48-in. storm drain. The existing 3rd St. storm drain was deleted (plug) from the 3rd St.-Constitution intersection south to the 3rd St.-Mountain intersection to direct upstream storm drain flows into the North Wells Park Pond.

Facility 7 Upsize storm drains from 36-in. to 54 in. along 4th St. from Cutler south to McKnight then east to 3rd St. and outfall to the Coronado Park Pond. The pond outfall pipe is a 24-in. storm drain that will join into the McKnight-3rd St. intersection storm drain that will be upsized from existing 48-in. to 54-in. storm drain that continues south on 3rd St. to Constitution.

Facility X19 Upsize the 27-in. and 30-in. storm drains to 48-in. storm drains on Barelas from Pacific Ave. south to Lewis and west on Lewis to the west Riverside storm drain.

Facility 9 Upsize storm drains from 24-in. to 54 in. on Rio Grande Blvd. from Carson to Chacoma, then southeast to San Pasquale, then south to Laguna, then south ending at Kit Carson.

Facility 11 Build a new Broadway Pump Station at the existing capacity of 150 cfs (Molzen & Corbin, July 2008).

Facility 12 Build a new 24-in. storm drain system from the Edith-Odelia intersection north to the Edith-Hannett intersection, then west on Hannett to outfall into the Santa Barbara Park Pond.

Facility X16 Upsizing all storm drains to 90-in. from Broadway-Odelia south to manhole COA32878.B including both Broadway pump station inlets. Storm drains from Broadway-Lomas north to COA32878.B were upsized to 78-in. and 84-in. respectively.

Modeling Approach

The Broadway-Lomas detention pond was deleted from the model. The two short segments of storm drain from the Broadway-Lomas intersection to COA32878.B were increased to 78-in. and 84-in. respectively. The rest of the storm drain system from the intersection of Odelia and Broadway south to the Broadway Pump Station including both pump station inlets were upsized to 90-in. storm drains in an effort to improve conveyance to the pump station and provide storage volume.

The storm drain on Commercial at McKnight that drained south to Baca was eliminated and a new 54-in. storm drain from that intersection was re-routed to the McKnight- Broadway intersection. From that intersection, the 54-in. storm drain continued south on Broadway where it would outfall into the Santa Barbara Park Pond. The topography indicates that the runoff from Sub-catchment BR16 will follow the natural street slopes along Edith to McKnight. The existing 21-in. storm drain that increases to a 36-in. storm drain west along McKnight between Edith and Broadway will convey the runoff to the intersection of Broadway and McKnight and will join the 54-in. storm drain in Broadway that will outfall to the Santa Barbara Park Pond.

However, to drain Sub-catchment BR12 to the Santa Barbara Park Pond, a new 24-in. storm drain system will be required in Edith that will drain north against the street grade to the intersection with Hannett. Then the storm drain will drain west on Hannett and outfall into the

Santa Barbara Park Pond. The Santa Barbara Park Pond outfall pipe will be a 24-in. pipe that will join the Broadway storm drain.

All existing Broadway 36-in. storm drains from the Broadway-Odelia intersection north to Hannett at the Santa Barbara Park Pond were upsized to 48-in. The Baca and Commercial (only about 600 ft) storm drains were also upsized from 36-in. to 48-in.

The BR21 pond was simulated to drain into the Odelia Pond. A new 11 foot deep detention pond called Coronado Park Pond was added to collect runoff from Sub-catchments B35 and B40. Storm drains from Cutler to McKnight were upsized from 36-in. to 54-in. that connected to Coronado Park Pond. A 24-in. outlet pipe drained this pond back into the system. The storm drain from 3rd St. and McKnight to 3rd St. and Constitution was upsized from 48-in. to 54-in.

Storm drains were added west on Constitution from 3rd St. to 5th St. and south on 5th St. to Mountain then south to drain into the North Wells Park Pond located at Summer and 5th St., the pond outfall pipe is a 36-in. RCP storm drain that continues south on 5th St. to Mountain, then east to 3rd St. where it joins the existing storm drain. The storm drain between Constitution and Mountain along 3rd St. was deleted to direct storm drain flows to the North Wells Park Pond.

Storm drains were upsized from 24-in. to 54-in. on Rio Grande Blvd. from Carson to Chacoma, then to San Pasquale, then to Laguna ending at Kit Carson, and upsized storm drains from 27-in. and 30-in. to 48-in. on Barelas from Pacific Ave. to Lewis, west on Lewis to the west Riverside storm drain.

The significant option components are summarized in **Table 6-1** (Summary of Model Filenames and Components – Appendix Volume 2, Appendix 1).

Street Flooding Results

Despite the dramatic increase in the storm drain diameter to 90-in., the flooding results proved to be unfavorable. The manholes in the immediate Broadway-Lomas intersection experienced an average of 1.4 feet of flooding for an average of 1.6 hours. **Table 6-35** summarizes the flood depths for this option.

TABLE 6-35
SUMMARY OF OPTION 21 STREET PONDING AND MAN-HOLE FLOODING

Note- negative numbers imply that the HGL did not reach the manhole rim

Represents flooding depth over 1 ft
Represents flooding between 0.5ft - 0.99 ft
Represents flooding depth between 0 - 0.5 ft

MH Name	Manhole Invert Elev.	Max. Depth of Manhole	Manhole Rim Elev.	Maximum HGL	Node Flood Depth Above Manhole Rim	Flood Volume	Flood Volume	Hours Flooded
	(ft)	(ft)	(ft)	(ft)	(ft)	(10^6 gal)	(acre-ft)	
	(a)	(a)	(b)	(c)	(d)	(e)	(f)	
COA25349	4945.26	11.07	4956.33	4956.34	0.01	0.093	0.285407	0.24
COA25656	4948.86	10.32	4959.18	4959.28	0.1	0.2	0.613778	1.61
COA25622	4948.24	9.58	4957.82	4957.83	0.01	0.054	0.16572	0.79
COA7476	4950.32	7.85	4958.17	4958.18	0.01	0.054	0.16572	0.59
COA7518	4947.94	8.89	4956.83	4956.89	0.06	0.103	0.316095	0.81
COA24834	4944.52	7.06	4951.58	4951.81	0.23	1.047	3.213126	2.75
COA7955	4943.49	12	4955.49	4955.5	0.01	0.042	0.128893	0.15
COA7766JB	4943.95	12.33	4956.28	4957.19	0.91	0.284	0.871564	1.36
COA7769JB	4944.52	11.81	4956.33	4957.2	0.87	0.284	0.871564	1.36
COA32865	4945.49	11.62	4957.11	4957.17	0.06	0.016	0.049102	0.33
COA32878	4946.6	9.16	4955.76	4957.16	1.4	0.335	1.028077	1.63
COA9248	4947.65	10.07	4957.72	4957.73	0.01	0.005	0.015344	0.04
COA32878.A	4947.19	8.39	4955.58	4957.17	1.59	0.289	0.886909	1.65
COA32878.B	4946.27	9.58	4955.85	4957.17	1.32	0.273	0.837806	1.65
COA9229	4913.15	27	4940.15	4940.46	0.31	0.025	0.076722	0.53

(a) Manhole invert elevation from SWMM input under Node Summary Table
(b) Rim elevation = MH invert elevation + Max depth of manhole
(c) Max HGL from SWMM output table under Node Depth Summary
(d) Node Flood Depth above Manhole Rim = HGL Elev-Rim Elev
(e) Flood volume from SWMM output table under Node Flooding Summary
(f) 1 gallon = 3.06888 E-6 acre-ft

Appendix Volume 2, Appendix 1.2 contains the SWMM model output and additional information prepared to document information and computations for this Option.

Detention Pond Routing Results

Freeboard at the Air Quality Pond was 4.6 feet (see **Table 6-36).** Freeboard at Tingley Surge Pond was 5.4 feet (see **Table 6-36**) and freeboard in the BR21 Pond is 7.5 feet (see **Table 6-36**). Santa Barbara Park Pond had 9.0 feet of freeboard (see **Table 6-36**). Freeboard at North Wells Park was 1.4 feet (see **Table 6-36)** while Coronado Park Pond is 2.2 feet (see **Table 6-36).**

Conclusion

The adoption of all storm drain enlargements along the south Broadway corridor did not eliminate flooding in the immediate Broadway-Lomas intersection as several manholes had an average flood depth of 1.4 feet. Therefore, additional options should be considered.

TABLE 6-36

Option 21 DETENTION POND ROUTING SUMMARY TABLE

Detention Pond Name	Existing or Proposed Pond (detention or retention)	Model Analysis Point Name	Storm Return Period (100-yr. 24-hr. duration)	Peak Inflow	Peak Outflow	Peak Storage Volume	Peak Storage Volume	Peak Water Surface Elevation	Principal Spillway Elevation	Emergency Spillway Elevation	Pond Invert Elevation	Water Depth	Top of Pond Embankment Elevation	Freeboard to Emergency Spillway Elevation	**Freeboard to top of Pond Embankment**
				(cfs)	(cfs)	(ft^3)	(ac-ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)
a	a	a		b	c	g	c	d	e	e	e		e	f	f
Air Quality Pond	Existing	Air Quality Pond	100.0	122.0	55.0	232247	5.3	4958.0	4952.3	4962.7	4952.3	5.8	4962.7	4.6	**4.6**
Tingley Surge Pond	Existing	Tingley Park Surge Pond	100	123	45	115989	2.663	4941.3	4932.21	4946.66	4941.66	-0.4	4946.66	5.4	**5.4**
BR21 Pond	Conceptual	BR21 Pond	100	64	10	93907	2.156	5068.5	5062	5074	5062	6.5	5076	5.5	**7.5**
Santa Barbara Pond	Conceptual	Santa Barbara Pond	100	135	31	260209	5.999	4963.0	4961	4972	4961	2.0	4972	7.0	**9.0**
Wells Park Pond	Conceptual	Wells Park Pond	100	124	49	546324	12.542	4958.6	4951	4960	4951	7.6	4960	1.4	**1.4**

TABLE 6-36

Option 21 DETENTION POND ROUTING SUMMARY TABLE

Detention Pond Name	Existing or Proposed Pond (detention or retention)	Model Analysis Point Name	Storm Return Period (100-yr. 24-hr. duration)	Peak Inflow	Peak Outflow	Peak Storage Volume	Peak Storage Volume	Peak Water Surface Elevation	Principal Spillway Elevation	Emergency Spillway Elevation	Pond Invert Elevation	Water Depth	Top of Pond Embankment Elevation	Freeboard to Emergency Spillway Elevation	**Freeboard to top of Pond Embankment**
				(cfs)	(cfs)	(ft^3)	(ac-ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)
a	a	a		b	c	g	c	d	e	e	e		e	f	f
Coronado Park Pond	Conceptual	Coronado Park Pond	100	162	37	440883	10.121	4961.8	4953	4962	4953	8.8	4964	0.2	**2.2**

a - See Drainage Basin Maps and Figure 6-1

b - See SWMM output for results "Node Inflow Summary" Table

c -Value calculated after unit conversion from SWMM output

d- See SWMM output for results "Node Depth Summary" Table

e - See Volume 2 Appendix 1.2 for Pond Routing Elev-Area-Capacity Discharge Data

f- Negative number indicates the flow depth exceeds referenced elevation - no freeboard available

g - Value from SWMM output under Storage Volume Summary

Option 22 –

Purpose

The purpose of Option 22 was to include the storm drain enlargements from Option 21 along with half of the existing Broadway-Lomas Pond to provide storage in order to eliminate flooding in the Broadway-Lomas intersection. It was assumed that the other half of the existing pond may be reclaimed and sold.

Facility 1 Build a new pond in Sub-catchment BR21 (near southeast intersection of Lomas Blvd. and Medical Arts). The pond outfall pipe will be a 24-in. RCP that will join into the existing Lomas Blvd. manhole that joins to an existing 48-in. RCP that drains north to the existing Odelia Pond.

Facility X21 Upsize the Baca storm drain from 36-in. RCP to 48-in. RCP from the Broadway-Odelia intersection west in Baca to Commercial, then north on Commercial for 600 feet.

Facility 5 Upsize the Commercial 36-in. RCP storm drain to 54-in. RCP storm drain from the Commercial-Indian School intersection south on Commercial to McKnight, then east on McKnight. Then build a new 54-in. RCP storm drain from the Commercial-McKnight intersection east to the Broadway-McKnight intersection. Then continue south on Broadway to join into the Santa Barbara Park Pond. Outlet from the pond will be a 24-in. storm drain that joins the Broadway storm drain at Hannett. Upsize the 36-in. storm drain to 48-in. storm drain south from the Broadway-Hannett intersection to the Broadway-Odelia intersection. Delete (plug) the existing 36-in. RCP storm drain from the McKnight-Commercial intersection south for 900 ft. to direct upstream flows towards the Santa Barbara Park Pond.

Facility 6 Build a new 54-in. storm drain in Constitution from the 3rd St. – Constitution –intersection west to 5th St. then south on 5th St. to the Summer – 5th St. intersection and this pipe will outfall to the North Wells Park Pond. The 36-in. outfall pipe from the pond will continue south on 5th St. to Mountain, then east on Mountain to 3rd St. where it will join into the existing 3rd St. 48-in. storm drain. The existing 3rd St. storm drain was deleted (plug) from the 3rd St.-Constitution intersection south to the 3rd St.-Mountain intersection to direct upstream storm drain flows into the North Wells Park Pond.

Facility 7 Upsize storm drains from 36-in. to 54 in. along 4th St. from Cutler south to McKnight then east to 3rd St. and outfall to the Coronado Park Pond. The pond outfall pipe is a 24-in. storm drain that will join into the McKnight-3rd St. intersection storm drain that will be upsized from existing 48-in. to 54-in. storm drain that continues south on 3rd St. to Constitution.

Facility X19 Upsize the 27-in. and 30-in. storm drains to 48-in. storm drains on Barelas from Pacific Ave. south to Lewis and west on Lewis to the west Riverside storm drain.

Facility 9 Upsize storm drains from 24-in. to 54 in. on Rio Grande Blvd. from Carson to Chacoma then southeast to San Pasquale, then south to Laguna, then south ending at Kit Carson.

Facility 11 Build a new Broadway Pump Station at the existing capacity of 150 cfs (Molzen & Corbin, July 2008).

Facility 12 Build a new 24-in. storm drain system from the Edith-Odelia intersection north to the Edith-Hannett intersection, then west on Hannett to outfall into the Santa Barbara Park Pond.

Facility X17 Upsizing all storm drains to 90-in. from Broadway-Odelia south to manhole COA32878.B including both Broadway pump station inlets. Storm drains from Broadway-Lomas north to COA32878.B were upsized to 78-in. connected to detention pond half the size of the existing Broadway-Lomas pond. The pond outlet from the smaller pond is a 30-in. dia. pipe that was connected directly to the inlet of the pump station.

Modeling Approach

A new 16 foot deep detention pond, approximately half the size of the existing Broadway-Lomas detention pond, was modeled at the existing Broadway-Lomas Pond site. The existing storm drain from the Broadway-Lomas intersection to manhole COA32878.A was increased to 78-in. diameter. The inlet pipe into the proposed detention pond was also modeled as a 78-in. pipe. The proposed outfall pipe was modeled as a 30-in. pipe that connected directly to the inlet of the Broadway Pump Station. The storm drains from manhole COA32878.B north to the intersection of Odelia and Broadway were upsized to 90-in.

The storm drain on Commercial at McKnight that drained south to Baca was eliminated and a new 54-in. storm drain from that intersection was re-routed to the McKnight- Broadway intersection. From that intersection, the 54-in. storm drain continued south on Broadway where it would outfall into the Santa Barbara Park Pond. The topography indicates that the runoff from Sub-catchment BR16 will follow the natural street slopes along Edith to McKnight. The existing 21-in. storm drain was increased to a 36-in. storm drain west along McKnight between Edith and Broadway and it will convey the runoff to the Broadway-McKnight intersection and will then join the 54-in. storm drain in Broadway that will outfall to the Santa Barbara Park Pond.

However, to drain Sub-catchment BR12 to the Santa Barbara Park Pond, a new 24-in. storm drain system will be required in Edith that will drain north against the street grade to the intersection with Hannett. Then the storm drain will drain west on Hannett and outfall into the Santa Barbara Park Pond. The Santa Barbara Park Pond outfall pipe will be a 24-in. pipe that will join the Broadway storm drain.

All existing Broadway 36-in. storm drains from the Broadway-Odelia intersection north to Hannett at the Santa Barbara Park Pond were upsized to 48-in. The Baca and Commercial (only about 600 ft) storm drains were also upsized from 36-in. to 48-in.

The BR21 pond was simulated to drain into the Odelia Pond. A new 11 foot deep detention pond called Coronado Park Pond was added to collect runoff from Sub-catchments B35 and B40. Storm drains from Cutler to McKnight were upsized from 36-in. to 54-in. that connected to Coronado Park Pond. A 24-in. outlet pipe drained this pond back into the system. The storm drain from 3rd St. and McKnight to 3rd St. and Constitution was upsized from 48-in. to 54-in.

Storm drains were added west on Constitution from 3rd St. to 5th St. and south on 5th St. to Mountain then south to drain into the North Wells Park Pond located at Summer and 5th St., the pond outfall pipe is a 36-in. RCP storm drain that continues south on 5th St. to Mountain, then east to 3rd St. where it joins the existing storm drain. The storm drain between Constitution and Mountain along 3rd St. was deleted to direct storm drain flows to the North Wells Park Pond.

Storm drains were upsized from 24-in. to 54-in. on Rio Grande Blvd. from Carson to Chacoma, then to San Pasquale, then to Laguna ending at Kit Carson, and upsized storm drains from 27-in. and 30-in. to 48-in. on Barelas from Pacific Ave. to Lewis, west on Lewis to the west Riverside storm drain.

The significant option components are summarized in **Table 6-1** (Summary of Model Filenames and Components – Appendix Volume 2, Appendix 1).

Street Flooding Results

The inclusion of a reduced Broadway-Lomas pond to half its original size coupled with the upsized storm drains in Broadway (90-in.) reduced flooding depths in the immediate Broadway-Lomas intersection to between 0.6 feet and 0.9 feet for about 1.1 hours. The flooding results are summarized in **Table 6-37**

Appendix Volume 2, Appendix 1.2 contains the SWMM model output and additional information prepared to document information and computations for this Option.

Detention Pond Routing Results

Freeboard at the Air Quality Pond is 5.2 feet (see **Table 6-38**). Freeboard at Tingley Surge Pond is 5.4 feet (see **Table 6-38**) and freeboard in the BR21 Pond is 7.5 feet (see **Table 6-38**). Santa Barbara Park Pond is 9.0 feet of freeboard (see **Table 6-38**). Freeboard at North Wells Park is 2.0 feet (see **Table 6-38**). Coronado Park Pond freeboard is 2.2 feet (see **Table 6-38**) and the half sized Broadway-Lomas Pond is 2.2 feet of freeboard (see **Table 6-38**).

TABLE 6-37
SUMMARY OF OPTION 22 STREET PONDING AND MAN-HOLE FLOODING

Note- negative numbers imply that the HGL did not reach the manhole rim

Represents flooding depth over 1 ft
Represents flooding between 0.5ft - 0.99 ft
Represents flooding depth between 0 - 0.5 ft

MH Name	Manhole Invert Elev.	Max. Depth of Manhole	Manhole Rim Elev.	Maximum HGL	Node Flood Depth Above Manhole Rim	Flood Volume	Flood Volume	Hours Flooded
	(ft)	(ft)	(ft)	(ft)	(ft)	(10^6 gal)	(acre-ft)	
	(a)	(a)	(b)	(c)	(d)	(e)	(f)	
COA25349	4945.26	11.07	4956.33	4956.34	0.01	0.096	0.294613	0.25
COA25656	4948.86	10.32	4959.18	4959.33	0.15	0.246	0.754946	1.74
COA25622	4948.24	9.58	4957.82	4957.84	0.02	0.067	0.205615	0.89
COA7518	4947.94	8.89	4956.83	4956.89	0.06	0.126	0.38668	0.92
COA24834	4944.52	7.06	4951.58	4951.85	0.27	1.229	3.771663	2.91
COA25105	4946.31	10.2	4956.51	4956.52	0.01	0.036	0.11048	0.35
COA22517	4943.59	11	4954.59	4954.6	0.01	0.075	0.230167	0.32
COA7766JB	4943.95	12.33	4956.28	4956.65	0.37	0.061	0.187202	0.76
COA32878	4946.6	9.16	4955.76	4956.43	0.67	0.152	0.466471	0.96
COA9248	4947.65	10.07	4957.72	4957.74	0.02	0.006	0.018413	0.04
COA32878.A	4947.19	8.39	4955.58	4956.43	0.85	0.162	0.49716	1.08
COA32878.B	4946.27	9.58	4955.85	4956.64	0.79	0.147	0.451127	1.42
COA9229	4913.15	27	4940.15	4940.45	0.3	0.025	0.076722	0.52

(a) Manhole invert elevation from SWMM input under Node Summary Table
(b) Rim elevation = MH invert elevation + Max depth of manhole
(c) Max HGL from SWMM output table under Node Depth Summary
(d) Node Flood Depth above Manhole Rim = HGL Elev-Rim Elev
(e) Flood volume from SWMM output table under Node Flooding Summary
(f) 1 gallon = 3.06888 E-6 acre-ft

TABLE 6-38

OPTION 22 DETENTION POND ROUTING SUMMARY TABLE

Detention Pond Name	Existing or Proposed Pond (detention or retention)	Model Analysis Point Name	Storm Return Period (100-yr. 24-hr. duration)	Peak Inflow	Peak Outflow	Peak Storage Volume	Peak Storage Volume	Peak Water Surface Elevation	Principal Spillway Elevation	Emergency Spillway Elevation	Pond Invert Elevation	Water Depth	Top of Pond Embankment Elevation	Freeboard to Emergency Spillway Elevation	**Freeboard to top of Pond Embankment**
				(cfs)	(cfs)	(ft^3)	(ac-ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)
a	a	a		b	c	g	c	d	e	e	e		e	f	f
Air Quality Pond	Existing	Air Quality Pond	100.0	104.0	44.0	200101	4.6	4957.5	4952.3	4962.7	4952.3	5.2	4962.7	5.2	**5.2**
Tingley Surge Pond	Existing	Tingley Park Surge Pond	100	120	40	89795	2.061	4941.3	4932.21	4946.66	4941.66	-0.4	4946.66	5.4	**5.4**
BR21 Pond	Conceptual	BR21 Pond	100	64	10	93907	2.156	5068.5	5062	5074	5062	6.5	5076	5.5	**7.5**
Santa Barbara Pond	Conceptual	Santa Barbara Pond	100	134	31	260231	5.999	4963.0	4961	4972	4961	2.0	4972	7.0	**9.0**

TABLE 6-38

OPTION 22 DETENTION POND ROUTING SUMMARY TABLE

Detention Pond Name	Existing or Proposed Pond (detention or retention)	Model Analysis Point Name	Storm Return Period (100-yr. 24-hr. duration)	Peak Inflow	Peak Outflow	Peak Storage Volume	Peak Storage Volume	Peak Water Surface Elevation	Principal Spillway Elevation	Emergency Spillway Elevation	Pond Invert Elevation	Water Depth	Top of Pond Embankment Elevation	Freeboard to Emergency Spillway Elevation	**Freeboard to top of Pond Embankment**
				(cfs)	(cfs)	(ft^3)	(ac-ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)
a	a	a		b	c	g	c	d	e	e	e		e	f	f
Wells Park Pond	Conceptual	Wells Park Pond	100	120	53	540998	12.420	4958.0	4951	4960	4951	7.0	4960	2.0	**2.0**
Coronado Park Pond	Conceptual	Coronado Park Pond	100	160	36	439598	10.092	4961.8	4953	4962	4953	8.8	4964	0.2	**2.2**
Half Sized Broadway-Lomas Pond	Conceptual	Half Sized Broadway-Lomas Pond	100	200	54	212855	4.886	4956.4	4942	4956.66	4952	4.4	4958.66	0.2	**2.2**

a - See Drainage Basin Maps and Figure 6-1

b - See SWMM output for results "Node Inflow Summary" Table

c -Value calculated after unit conversion from SWMM output

d- See SWMM output for results "Node Depth Summary" Table

e - See Volume 2 Appendix 1.2 for Pond Routing Elev-Area-Capacity Discharge Data

f- Negative number indicates the flow depth exceeds referenced elevation - no freeboard available

g - Value from SWMM output under Storage Volume Summary

Conclusion
The larger diameter storm drains and a smaller Broadway-Lomas Pond will not provide an effective solution to the flooding problem. The flood depths are up to 0.9 feet at the Broadway-Lomas intersection for an average of 1.1 hours. Therefore additional options should be considered.

Option 23 –

Purpose
The purpose of Option 23 was to include the *most effective facilities* from the previous options and combine them with the existing Broadway-Lomas Pond in an effort to eliminate flooding throughout the study area.

Broadway/Lomas Pond: Keep this pond.

Facility 1 Build a new pond in Sub-catchment BR21 (near southeast intersection of Lomas Blvd. and Medical Arts). The pond outfall pipe will be a 24-in. RCP that will join into the existing Lomas Blvd. manhole that joins to an existing 48-in. RCP that drains north to the existing Odelia Pond.

Facility X18 The existing Broadway storm drain system was not changed from north of the existing Broadway Pump Station (COA 7766JB) to the Broadway-Odelia intersection. More specifically, the storm drain begins at the Broadway Pump Station manhole (COA 7766JB) as two parallel 48-in. RCP's that continue north in Broadway to just north of the Broadway-Mountain intersection. From that intersection the storm drain continues north as a one 48-in. storm drain to the Odelia-Broadway intersection.

Facility 4 Upsize the Baca storm drain from 36-in. RCP to 48-in. RCP from the Broadway-Odelia intersection west in Baca to Commercial.

Facility 5 Upsize the Commercial 36-in. RCP storm drain to 54-in. RCP storm drain from the Commercial-Indian School intersection south on Commercial to McKnight, then east on McKnight. Then a build a new 54-in. RCP storm drain from the Commercial-McKnight intersection east to the Broadway-McKnight intersection. Then south on Broadway to join into the Santa Barbara Park Pond. Outlet from the pond will be a 24-in. storm drain that joins the Broadway storm drain at Hannett. Upsize the 36-in. storm drain to 48-in. storm drain south from the Broadway-Hannett intersection to the Broadway-Odelia intersection. Delete (plug) the existing 36-in. RCP storm drain from the McKnight-Commercial intersection south for 900 ft. to direct upstream flows towards the Santa Barbara Park Pond.

Facility 6 Build a new 54-in. storm drain in Constitution from the 3rd St. – Constitution –intersection west to 5th St., then south on 5th St. to the Summer - 5th St. intersection and this pipe will outfall to the North Wells

Park Pond. The 36-in. outfall pipe from the pond will continue south on 5th St. to Mountain, then east on Mountain to 3rd St. where it will join into the existing 3rd St. 48-in. storm drain. The existing 3rd St. storm drain was deleted (plug) from the 3rd St.-Constitution intersection south to the 3rd St.-Mountain intersection to direct upstream storm drain flows into the North Wells Park Pond.

Facility 7 Upsize storm drains from 36-in. to 54 in. along 4th St. from Cutler south to McKnight then east to 3rd St. and outfall to the Coronado Park Pond. The pond outfall pipe is a 24-in. storm drain that will join into the McKnight-3rd St. intersection storm drain that will be upsized from existing 48-in. to 54-in. storm drain that continues south on 3rd St. to Constitution.

Facility X19 Upsize the 27-in. and 30-in. storm drains to 48-in. storm drains on Barelas from Pacific Ave. south to Lewis and west on Lewis to the west Riverside storm drain.

Facility 9 Upsize storm drains from 24-in. to 54 in. on Rio Grande Blvd. from Carson to Chacoma, then southeast to San Pasquale, then south to Laguna, then south ending at Kit Carson.

Facility 11 Build a new Broadway Pump Station at the existing capacity of 150 cfs (Molzen & Corbin, July 2008).

Facility 12 Build a new 24-in. storm drain system from the Edith-Odelia intersection north to the Edith-Hannett intersection, then west on Hannett to outfall into the Santa Barbara Park Pond.

Modeling Approach

The Broadway-Lomas detention pond was retained in the model along with all its associated appurtenances. The Broadway storm drains from Mountain to Odelia were upsized from 48-in. to 60-in. The storm drain on Commercial at McKnight that drained south to Baca was eliminated and a new 54-in. storm drain from that intersection was re-routed to the McKnight- Broadway intersection. From that intersection, the 54-in. storm drain continued south on Broadway where it would outfall into the Santa Barbara Park Pond. The topography indicates that the runoff from Sub-catchment BR16 will follow the natural street slopes along Edith to McKnight. The existing 21-in. storm drain that increases to a 36-in. storm drain west along McKnight between Edith and Broadway will convey the runoff to the intersection of Broadway and McKnight and will join the 54-in. storm drain in Broadway that will outfall to the Santa Barbara Park Pond.

However, to drain Sub-catchment BR12 to the Santa Barbara Park Pond, a new 24-in. storm drain system will be required in Edith that will drain north against the street grade to the intersection with Hannett. Then the storm drain will drain west on Hannett and outfall into the Santa Barbara Park Pond. The Santa Barbara Park Pond outfall pipe will be a 24-in. pipe that will join the Broadway storm drain.

All existing Broadway 36-in. storm drains from the Broadway-Odelia intersection north to Hannett at the Santa Barbara Park Pond were upsized to 48-in. The Baca and Commercial (only about 600 ft) storm drains were also upsized from 36-in. to 48-in.

The BR21 pond was simulated to drain into the Odelia Pond. A new 11 foot deep detention pond called Coronado Park Pond was added to collect runoff from Sub-catchments B35 and B40. Storm drains from Cutler to McKnight were upsized from 36-in. to 54-in. that connected to Coronado Park Pond. A 24-in. outlet pipe drained this pond back into the system. The storm drain from 3rd St. and McKnight to 3rd St. and Constitution was upsized from 48-in. to 54-in.

Storm drains were added west on Constitution from 3rd St. to 5th St. and south on 5th St. to Mountain then south to drain into the North Wells Park Pond located at Summer and 5th St., the pond outfall pipe is a 36-in. RCP storm drain that continues south on 5th St. to Mountain, then east to 3rd St. where it joins the existing storm drain. The storm drain between Constitution and Mountain along 3rd St. was deleted to direct storm drain flows to the North Wells Park Pond.

Storm drains were upsized from 24-in. to 54-in. on Rio Grande Blvd. from Carson to Chacoma, then to San Pasquale, then to Laguna ending at Kit Carson, and upsized storm drains from 27-in. and 30-in. to 48-in. on Barelas from Pacific Ave. to Lewis, west on Lewis to the west Riverside storm drain.

The significant option components are summarized in **Table 6-1** (Summary of Model Filenames and Components – Appendix Volume 2, Appendix 1).

Street Flooding Results

Option 23 effectively removed flooding from the Broadway-Lomas intersection and all along Broadway, north to I-40. Significant flooding along 3rd St. and 4th St. near I-40 (near Coronado Park) was also reduced. The flooding depths along Rio Grande Blvd. were reduce to the manhole rim elevation except for the San Pasquale and Chacoma intersection where depth is 0.23 feet above the manhole rim elevation for 2.8 hours. **Table 6-39** summarizes the street flooding results.

Appendix Volume 2, Appendix 1.2 contains the SWMM model output and additional information prepared to document information and computations for this Option.

Detention Pond Routing Results

Freeboard at the Air Quality Pond was 4.8 feet (see **Table 6-40).** Freeboard at Tingley Surge Pond was 5.4 feet (see **Table 6-40**) and freeboard in the BR21 Pond is 7.5 feet (see **Table 6-40**). Santa Barbara Park Pond had 9.0 feet of freeboard (see **Table 6-40**). Freeboard at North Wells Park was 2.5 feet (see **Table 6-40).** Coronado Park Pond is 2.8 feet (see **Table 6-40**) and the Broadway-Lomas Pond has 2.8 feet of freeboard (see **Table 6-40**).

Conclusion

This option removed all flooding from the Broadway-Lomas intersection (refer to Table 6-39). The results, particularly in the Broadway-Lomas intersection, were nearly identical to the results in Option 17. Option 17 used the Broadway-Marble detention pond as an alternative to the

existing Broadway-Lomas detention pond. The results indicate that a significant detention structure is necessary near the Broadway-Lomas intersection.

Table 6-29 summarizes the proposed detention ponds (facilities) areas, depths, and required volumes applied to compute quantity and cost estimates.

TABLE 6-39
SUMMARY OF OPTION 23 STREET PONDING AND MAN-HOLE FLOODING

Note- negative numbers imply that the HGL did not reach the manhole rim

Represents flooding depth over 1 ft
Represents flooding between 0.5ft - 0.99 ft
Represents flooding depth between 0 - 0.5 ft

MH Name	Manhole Invert Elev.	Max. Depth of Manhole	Manhole Rim Elev.	Maximum HGL	Node Flood Depth Above Manhole Rim	Flood Volume	Flood Volume	Hours Flooded
	(ft)	(ft)	(ft)	(ft)	(ft)	(10^6 gal)	(acre-ft)	
	(a)	(a)	(b)	(c)	(d)	(e)	(f)	
COA6218	4953.66	9.34	4963	4963.01	0.01	0.327	1.003526	1.23
COA25349	4945.26	11.07	4956.33	4956.34	0.01	0.051	0.156513	0.14
COA25656	4948.86	10.32	4959.18	4959.32	0.14	0.227	0.696638	1.78
COA25622	4948.24	9.58	4957.82	4957.84	0.02	0.049	0.150376	0.63
COA7476	4950.32	7.85	4958.17	4958.18	0.01	0.056	0.171858	0.59
COA7518	4947.94	8.89	4956.83	4956.89	0.06	0.105	0.322233	0.81
COA24834	4944.52	7.06	4951.58	4951.81	0.23	1.065	3.268366	2.76
COA25105	4946.31	10.2	4956.51	4956.52	0.01	0.032	0.098204	0.3
COA9229	4913.15	27	4940.15	4940.46	0.31	0.025	0.076722	0.53

(a) Manhole invert elevation from SWMM input under Node Summary Table
(b) Rim elevation = MH invert elevation + Max depth of manhole
(c) Max HGL from SWMM output table under Node Depth Summary
(d) Node Flood Depth above Manhole Rim = HGL Elev-Rim Elev
(e) Flood volume from SWMM output table under Node Flooding Summary
(f) 1 gallon = 3.06888 E-6 acre-ft

TABLE 6-40

Option 23 DETENTION POND ROUTING SUMMARY TABLE

Detention Pond Name	Existing or Proposed Pond (detention or retention)	Model Analysis Point Name	Storm Return Period (100-yr. 24-hr. duration)	Peak Inflow	Peak Outflow	Peak Storage Volume	Peak Storage Volume	Peak Water Surface Elevation	Principal Spillway Elevation	Emergency Spillway Elevation	Pond Invert Elevation	Water Depth	Top of Pond Embankment Elevation	Freeboard to Emergency Spillway Elevation	**Freeboard to top of Pond Embankment**
				(cfs)	(cfs)	(ft^3)	(ac-ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)
a	a	a		b	c	g	c	d	e	e	e		e	f	f
Air Quality Pond	Existing	Air Quality Pond	100.0	111.0	37.0	325714	7.5	4957.8	4952.3	4962.7	4952.3	5.6	4962.7	4.8	**4.8**
Tingley Surge Pond	Existing	Tingley Park Surge Pond	100	105	47	471590	10.826	4941.2	4932.21	4946.66	4941.66	-0.4	4946.66	5.4	**5.4**
BR21 Pond	CONCEPTUAL	BR21 Pond	100	64	10	93907	2.156	5068.5	5062	5074	5062	6.5	5076	5.5	**7.5**
Santa Barbara Pond	CONCEPTUAL	Santa Barbara Pond	100	134		260261	5.999	4963.0	4961	4972	4961	2.0	4972	7.0	**9.0**

TABLE 6-40

Option 23 DETENTION POND ROUTING SUMMARY TABLE

Detention Pond Name	Existing or Proposed Pond (detention or retention)	Model Analysis Point Name	Storm Return Period (100-yr. 24-hr. duration)	Peak Inflow	Peak Outflow	Peak Storage Volume	Peak Storage Volume	Peak Water Surface Elevation	Principal Spillway Elevation	Emergency Spillway Elevation	Pond Invert Elevation	Water Depth	Top of Pond Embankment Elevation	Freeboard to Emergency Spillway Elevation	**Freeboard to top of Pond Embankment**
				(cfs)	(cfs)	(ft^3)	(ac-ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)
a	a	a		b	c	g	c	d	e	e	e		e	f	f
Wells Park Pond	CONCEPTUAL	WELLS PARK	100	119	43	581874	13.358	4957.5	4951	4960	4951	6.5	4960	2.5	**2.5**
Coronado Pond	CONCEPTUAL	McKnight Pond	100	164	179	405080	9.299	4961.2	4953	4962	4953	8.2	4964	0.8	**2.8**
Broadway / Lomas Pond	existing	Broadway / Lomas Pond	100	209	42	444389	10.202	4953.8	4946.66	4956.66	4946.66	7.2	4956.66	2.8	**2.8**

a - See Drainage Basin Maps and Figure 6-1

b - See SWMM output for results "Node Inflow Summary" Table

c -Value calculated after unit conversion from SWMM output

d- See SWMM output for results "Node Depth Summary" Table

e - See Volume 2 Appendix 1.2 for Pond Routing Elev-Area-Capacity Discharge Data

f- Negative number indicates the flow depth exceeds referenced elevation - no freeboard available

g - Value from SWMM output under Storage Volume Summary

Option 24 –

Purpose

The purpose of Option 24 was to include the *most effective facilities* from the various previous options and combine them in an effort to eliminate flooding throughout the study area.

Facility 10 Remove the existing Broadway-Lomas Pond and sell this lot as a high value commercial property. No construction costs included.

Facility 2 Build an alternative pond (to replace the Broadway –Lomas Pond) in Sub-catchment BR3 that would be located at the southwest Marble Ave.-Arno intersection (Marble-Arno Pond). This pond would be "L" shaped in the property. This facility also includes a new 54-in. RCP storm drain from the Lomas Blvd. - Arno intersection (COA manhole 7861) that will drain north in Arno and outfall into the pond. The Lomas storm drain west of Arno was disconnected at the Lomas-Arno intersection to divert all Lomas storm drain flow east of Arno into the Marble-Arno Pond. The 54-inch storm drain in Broadway between the inlet and outlet to the existing Broadway-Lomas Pond was simulated as functional. That segment is currently abandoned to divert the Broadway storm drain flows into the existing pond. The pond outfall pipe would be a 24-in. storm drain in Marble that would drain west to join the Broadway storm drain at the Broadway-Marble intersection (COA manhole 32865).

This also includes the installation of multiple inlets in Lomas Blvd. just east of Arno to capture all street runoff from Lomas and divert the flows into the Marble-Arno Pond.

Facility 11 Build a new Broadway Pump Station at the existing capacity of 150 cfs (Molzen & Corbin, July 2008).

Facility 1 Build a new pond in Sub-catchment BR21 (near southeast intersection of Lomas Blvd. and Medical Arts). The pond outfall pipe will be a 24-in. RCP that will connect to an existing manhole in Lomas Blvd. This connects to an existing 48-in. RCP that drains north to the existing Odelia Pond.

***Note** – The Marble-Arno Pond in Option 24 was simulated assuming Subcatchment BR21 runoff will not drain to the Marble-Arno Pond, but will drain to the Odelia Park storm drain system.*

Facility 4 Upsize the Baca storm drain from 36-in. RCP to 48-in. RCP from the Broadway-Odelia intersection west in Baca to Commercial.

Facility 5 Upsize the Commercial 36-in. RCP storm drain to 54-in. RCP storm drain from the Commercial-Indian School intersection south on Commercial to McKnight, then east on McKnight. Build a new 54-in. RCP storm drain

from the Commercial-McKnight intersection east to the Broadway-McKnight intersection. Then south on Broadway to join into the Santa Barbara Park Pond. Outlet from the pond will be a 24-in. storm drain that joins the Broadway storm drain at Hannett. Upsize the 36-in. storm drain to 48-in. storm drain south from the Broadway-Hannett intersection to the Broadway-Odelia intersection. The Commercial existing 36-in. RCP storm drain south of the McKnight-Commercial intersection was plugged to direct upstream flows towards the Santa Barbara Park Pond.

Facility 12 Build a new 24-in. storm drain system from the Edith-Odelia intersection north to the Edith-Hannett intersection. Continue west on Hannett to outfall into the Santa Barbara Park Pond.

Facility 6 Build a new 54-in. storm drain in Constitution from the 3rd St. – Constitution –intersection west to 5th St., then south on 5th St. to the Summer - 5th St. intersection. This pipe will outfall to the North Wells Park Pond. The 36-in. outfall pipe from the pond will continue south on 5th St. to Mountain, then east on Mountain to 3rd St. where it will join into the existing 3rd St. 48-in. storm drain. The existing 3rd St. storm drain was plugged from the 3rd St.-Constitution intersection south to the 3rd St.-Mountain intersection to direct upstream storm drain flows into the North Wells Park Pond.

Facility 7 Upsize the 4th St. storm drains from 36-in. to 54 in. from Cutler south to McKnight, then east and outfall to the McKnight Pond located at the southwest intersection of McKnight and 3rd St. The pond outfall pipe will be a 30-in. storm drain will join into the McKnight-3rd St. intersection storm drain that will be upsized from existing 48-in. to 54-in. storm drain that continues south on 3rd St. to Constitution.

Facility 8 Upsize the Barelas 24-in. storm drain to 36-in. storm drain from Santa Fe to Pacific and the upsize the Barelas 30-in. storm drain (south of Pacific) to 36-in. between manholes COA22168 and COA22169. These upsized storm drains will be connected to the existing Pacific 60-in. storm drain (the Barelas storm drain is not currently connected to the Pacific storm drain). This will allow Sub-catchment B5 an additional outfall pipe.

Facility 13 Replace the 96-in. CMP storm drain with a 90-in. diameter smooth wall pipe (slip line construction) from the 8th St. – Atlantic intersection (Tingley Pond) to the Barelas Pump Station and reduce Manning's Friction Factor "n" from 0.024 (existing CMP) to 0.013 (smooth wall pipe).

Facility 9 Upsize the Rio Grande Blvd. storm drains from 24-in. RCP to 54 in. RCP from Carson south to Chacoma, continue southeast to San Pasquale, continue south to Laguna, continue south ending at Kit Carson.

Facility X18 **An existing facility not changed.** The existing Broadway storm drain system was not changed from north of the existing Broadway Pump Station (COA 7766JB) to the Broadway-Odelia intersection. More specifically, the storm drain begins at the Broadway Pump Station manhole (COA 7766JB) as two parallel 48-in. RCP's that continue north in Broadway to just north of the Broadway-Mountain intersection. From that intersection the storm drain continues north as a one 48-in. storm drain to the Odelia-Broadway intersection.

Modeling Approach

The Broadway-Lomas detention pond was deleted from the model. Alternatively, a 12 foot deep pond at the intersection of Marble and Arno (Marble-Arno Pond) was simulated. This facility also includes a new 54-in. RCP storm drain from the Lomas Blvd. - Arno intersection (COA manhole 7861) that will drain north in Arno and outfall into the pond. The Lomas storm drain west of Arno was disconnected at the Lomas-Arno intersection to divert all Lomas storm drain flow east of Arno into the Marble Arno Pond. The 54-inch storm drain in Broadway between the inlet and outlet to the existing Broadway-Lomas Pond that was abandoned to divert the Broadway storm drain flows into the existing pond was simulated as functional. The Marble-Arno Pond outfall pipe would be a 24-in. storm drain in Marble that would drain west to join the Broadway storm drain at the Broadway-Marble intersection (COA manhole 32865).

The BR21 pond (southeast intersection of Lomas and Medical Arts) was simulated to drain into the Odelia Pond. The storm drain on Commercial at McKnight that drained south to Baca was eliminated and a new 54-in. storm drain from that intersection was re-routed to the McKnight-Broadway intersection. From that intersection, the 54-in. storm drain continued south on Broadway where it would outfall into the Santa Barbara Park Pond. The topography indicates that the runoff from Sub-catchment BR16 will follow the natural street slopes along Edith to McKnight. The existing 21-in. storm drain that increases to a 36-in. storm drain west along McKnight between Edith and Broadway will convey the runoff to the intersection of Broadway and McKnight and will join the 54-in. storm drain in Broadway that will outfall to the Santa Barbara Park Pond.

However, to drain Sub-catchment BR12 to the Santa Barbara Park Pond, a new 24-in. storm drain system will be required in Edith that will drain north against the street grade to the intersection with Hannett. Then the storm drain will continue west on Hannett and outfall into the Santa Barbara Park Pond. The Santa Barbara Park Pond outfall pipe will be a 24-in. pipe that will join the Broadway storm drain.

The Baca 36-in. storm drain was increased to a 48-in. from the Broadway-Odelia intersection west to Commercial.

A new 10 foot deep detention pond called the McKnight Pond (located at the southwest McKnight – 3rd St. intersection) was added to collect runoff from Sub-catchments B35 and B40. Storm drains from Cutler to McKnight were upsized from 36-in. to 54-in. that connected to the McKnight Pond. A 24-in. outlet pipe will drain this into the 3rd St. storm drain. The storm drain from 3rd St. and McKnight to 3rd St. and Constitution was upsized from 48-in. to 54-in.

Storm drains were added west on Constitution from 3rd St. to 5th St. and south on 5th St. to Mountain, then south to drain into the North Wells Park Pond located at Summer and 5th St. The pond outfall pipe will be a 36-in. RCP storm drain that continues south on 5th St. to Mountain, then east to 3rd St. where it will join the existing storm drain. The storm drain between Constitution and Mountain along 3rd St. was deleted to direct storm drain flows to the North Wells Park Pond.

Storm drains were upsized from 24-in. to 54-in. on Rio Grande Blvd. from Carson to Chacoma, then to San Pasquale then to Laguna ending at Kit Carson.

Upsize the Barelas 24-in. storm drain to 36-in. storm drain from Santa Fe to Pacific and the upsize the Barelas 30-in. storm drain (south of Pacific) to 36-in. between manholes COA22168 and COA22169. These upsized storm drains will be connected to the existing Pacific 60-in. storm drain (the Barelas storm drain is not currently connected to the Pacific storm drain). This will allow Sub-catchment B5 an additional outfall pipe.

The significant option components are summarized in **Table 6-1** (Summary of Model Filenames and Components – Appendix Volume 2, Appendix 1).

Street Flooding Results

Option 24 effectively removed flooding from the Broadway-Lomas intersection and all along Broadway north to I-40. Significant flooding along 3rd St. and 4th St. near I-40 (near Coronado Park) was also reduced. The flooding depths along Rio Grande Blvd. were reduce to the manhole rim elevation except for the San Pasquale and Chacoma intersection where depth is 0.24 feet above the manhole rim elevation for 3.0 hours. **Table 6-41** summarizes the street flooding results.

Appendix Volume 2, Appendix 1.2 contains the SWMM model output and additional information prepared to document information and computations for this Option.

Detention Pond Routing Results

Freeboard at the Air Quality Pond was 4.1 feet (see **Table 6-42).** Freeboard at Tingley Surge Pond was 6.0 feet (see **Table 6-42**) and freeboard in the BR21 Pond is 7.5 feet (see **Table 6-42**). Santa Barbara Park Pond had 9.0 feet of freeboard (see **Table 6-42**). Freeboard at North Wells Park was 1.8 feet (see **Table 6-42).** McKnight Pond is 1.4 feet (see **Table 6-42**) and the Marble-Arno Pond has 2.1 feet of freeboard (see **Table 6-42**).

Conclusion

Option 24 removed flooding from the Broadway-Lomas intersection (refer to **Table 6-41**). This option is very effective in reducing flooding throughout the study area. The manholes that remained flooded had depths on the average of 0.12 feet. The results indicate that a significant detention structure is necessary near the Broadway-Lomas intersection. The Marble-Arno Pond could replace the Broadway-Lomas Pond.

Note that this Option assumes that the BR21 pond is included, and that pond with associated storm drain would divert Sub-catchment BR21 flow to the Odelia Pond. Therefore, Option 25

was developed to simulate that the BR21 pond is not built and the BR21 runoff continues towards the Lomas-Broadway intersection.

Table 6-29 summarizes the proposed detention ponds (facilities) areas, depths, and required volumes applied to compute quantity and cost estimates.

INSERT TABLES 6-41

1 page

TABLE 6-41
SUMMARY OF OPTION 24 STREET PONDING AND MAN-HOLE FLOODING

Note- negative numbers imply that the HGL did not reach the manhole rim

Represents flooding depth over 1 ft
Represents flooding between 0.5ft - 0.99 ft
Represents flooding depth between 0 - 0.5 ft

INPUT DATA

MH Name	Manhole Invert Elev.	Max. Depth of Manhole	Manhole Rim Elev.	Maximum HGL	Node Flood Depth Above Manhole Rim	Flood Volume	Flood Volume	Hours Flooded
	(ft)	(ft)	(ft)	(ft)	(ft)	(10^6 gal)	(acre-ft)	
	(a)	(a)	(b)	(c)	(d)	(e)	(f)	
COA25656	4948.86	10.32	4959.18	4959.29	0.11	0.199	0.610709	1.65
COA7476	4950.32	7.85	4958.17	4958.18	0.01	0.057	0.174927	0.59
COA7518	4947.94	8.89	4956.83	4956.89	0.06	0.108	0.33144	0.84
COA24834	4944.52	7.06	4951.58	4951.82	0.24	1.119	3.434086	2.97
COA9229	4913.15	27	4940.15	4940.45	0.3	0.025	0.076722	0.52

(a) Manhole invert elevation from SWMM input under Node Summary Table
(b) Rim elevation = MH invert elevation + Max depth of manhole
(c) Max HGL from SWMM output table under Node Depth Summary
(d) Node Flood Depth above Manhole Rim = HGL Elev-Rim Elev
(e) Flood volume from SWMM output table under Node Flooding Summary
(f) 1 gallon = 3.06888 E-6 acre-ft

TABLE 6-42

Option 24 DETENTION POND ROUTING SUMMARY TABLE

Detention Pond Name	Existing or Proposed Pond (detention or retention)	Model Analysis Point Name	Storm Return Period (100-yr. 24-hr. duration)	Peak Inflow	Peak Outflow	Peak Storage Volume	Peak Storage Volume	Peak Water Surface Elevation	Principal Spillway Elevation	Emergency Spillway Elevation	Pond Invert Elevation	Water Depth	Top of Pond Embankment Elevation	Freeboard to Emergency Spillway Elevation	**Freeboard to top of Pond Embankment**
				(cfs)	(cfs)	(ft^3)	(ac-ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)
a	a	a		b	c	g	c	d	e	e	e		e	f	f
Air Quality Pond	EXISTING	Air Quality Pond	100.0	115	33.0	267539	6.1	4958.6	4952.3	4962.66	4952.3	6.3	4962.66	4.1	**4.1**
Tingley Surge Pond	EXISTING	Tingley Park Surge Pond	100	84	37	26310	0.604	4940.7	4932.21	4946.66	4941.66	-1.0	4946.66	6.0	**6.0**
BR21 Pond	CONCEPTUAL	BR21 Pond	100	64	10	93908	2.156	5068.5	5062	5076	5062	6.5	5076	5.5	**7.5**
Santa Barbara Pond	CONCEPTUAL	Santa Barbara Pond	100	135	31	260229	5.999	4963.0	4961	4972	4961	2.0	4972	7.0	**9.0**

TABLE 6-42

Option 24 DETENTION POND ROUTING SUMMARY TABLE

Detention Pond Name	Existing or Proposed Pond (detention or retention)	Model Analysis Point Name	Storm Return Period (100-yr. 24-hr. duration)	Peak Inflow	Peak Outflow	Peak Storage Volume	Peak Storage Volume	Peak Water Surface Elevation	Principal Spillway Elevation	Emergency Spillway Elevation	Pond Invert Elevation	Water Depth	Top of Pond Embankment Elevation	Freeboard to Emergency Spillway Elevation	**Freeboard to top of Pond Embankment**
				(cfs)	(cfs)	(ft^3)	(ac-ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)
a	a	a		b	c	g	c	d	e	e	e		e	f	f
Wells Park Pond	CONCEPTUAL	Wells Park Pond	100	120	36	558597	12.824	4958.2	4951	4960	4951	7.2	4960	1.8	**1.8**
Mcknight Pond	CONCEPTUAL	Mcknight Pond	100	164	43	406887	9.341	4960.6	4952	4962	4952	8.6	4962	1.4	**1.4**
Marble-Arno Pond	CONCEPTUAL	Broadway / Lomas Pond	100	215	27	469467	10.777	4956.0	4946	4958	4946	9.9	4958	2.1	**2.1**

a - See Drainage Basin Maps and Figure 6-1

b - See SWMM output for results "Node Inflow Summary" Table

c -Value calculated after unit conversion from SWMM output

d- See SWMM output for results "Node Depth Summary" Table

e - See Volume 2 Appendix 1.2 for Pond Routing Elev-Area-Capacity Discharge Data

f- Negative number indicates the flow depth exceeds referenced elevation - no freeboard available

g - Value from SWMM output under Storage Volume Summary

Option 25 –

Purpose

The purpose of Option 25 was to refine and include the *most effective facilities* from the previous options and combine them in an effort to eliminate flooding throughout the study area.

Facility 10 Remove the existing Broadway-Lomas Pond and sell this lot as a high value commercial property. No construction costs included.

Facility 2 Build an alternative pond (to replace the Broadway –Lomas Pond) in Sub-catchment BR3 that would be located at the southwest Marble Ave.-Arno intersection (Marble-Arno Pond). This pond would be "L" shaped in the property.This facility also includes a new 54-in. RCP storm drain from the Lomas Blvd. - Arno intersection (COA manhole 7861) that will drain north in Arno and outfall into the pond. The Lomas storm drain west of Arno was disconnected at the Lomas-Arno intersection to divert all Lomas storm drain flow east of Arno into the Marble-Arno Pond. The 54-inch storm drain in Broadway between the inlet and outlet to the existing Broadway-Lomas Pond) was simulated as functional. That segment is currently abandoned to divert the Broadway storm drain flows into the existing pond. The pond outfall pipe would be a 24-in. storm drain in Marble that would drain west to join the Broadway storm drain at the Broadway-Marble intersection (COA manhole 32865).

Facility 11 Build a new Broadway Pump Station at the existing capacity of 150 cfs (Molzen & Corbin, July 2008).

Facility 1 Build a new pond in Sub-catchment BR21 (near southeast intersection of Lomas Blvd. and Medical Arts). However Option 25, this pond was not included and Sub-catchment BR21 was simulated to add direction to the Lomas-Edith Blvd. manhole.

Note *– The Marble-Arno Pond in Option 25 was simulated to accept Subcatchment BR21 runoff in the event that the proposed Sub-Catchment BR21 pond is not built. However, the BR21 pond is recommended to minimize the potential for flooding at the Broadway-Lomas intersection.*

Facility 4 Upsize the Baca storm drain from 36-in. RCP to 48-in. RCP from the Broadway-Odelia intersection west in Baca to Commercial.

Facility 5 Upsize the Commercial 36-in. RCP storm drain to 54-in. RCP storm drain from the Commercial-Indian School intersection south on Commercial to McKnight, then east on McKnight. Build a new 54-in. RCP storm drain from the Commercial-McKnight intersection east to the Broadway-McKnight intersection. The storm drain would continue south on Broadway to join into the Santa Barbara Park Pond. The outlet from the pond will be a 24-in. storm drain that joins the Broadway storm drain at Hannett. Upsize the 36-in. storm drain to 48-in. storm drain south from the Broadway-Hannett intersection to the Broadway-Odelia intersection. The

Commercial existing 36-in. RCP storm drain south of the McKnight-Commercial intersection was plugged to direct upstream flows towards the Santa Barbara Park Pond.

Facility 12 Build a new 24-in. storm drain system from the Edith-Odelia intersection north to the Edith-Hannett intersection. Continue west on Hannett to outfall into the Santa Barbara Park Pond.

Facility 6 Build a new 54-in. storm drain in Constitution from the 3rd St. – Constitution –intersection west to 5th St., then south on 5th St. to the Summer - 5th St. intersection. This pipe will outfall to the North Wells Park Pond. The 36-in. outfall pipe from the pond will continue south on 5th St. to Mountain, then east on Mountain to 3rd St. where it will join into the existing 3rd St. 48-in. storm drain. The existing 3rd St. storm drain was plugged from the 3rd St.-Constitution intersection, south to the 3rd St.-Mountain intersection to direct upstream storm drain flows into the North Wells Park Pond.

Facility 7 Upsize the 4th St. storm drains from 36-in. to 54 in. from Cutler south to McKnight, then east and outfall to the McKnight Pond located at the southwest intersection of McKnight and 3rd St. The pond outfall pipe will be a 30-in. storm drain that will join into the McKnight-3rd St. intersection storm drain that will be upsized from existing 48-in. to 54-in. storm drain that continues south on 3rd St. to Constitution.

Facility 8 Upsize the Barelas 24-in. storm drain to 36-in. storm drain from Santa Fe to Pacific and the upsize the Barelas 30-in. storm drain (south of Pacific) to 36-in. between manholes COA22168 and COA22169. These upsized storm drains will be connected to the existing Pacific 60-in. storm drain (the Barelas storm drain is not currently connected to the Pacific storm drain). This will allow Sub-catchment B5 an additional outfall pipe.

Facility 13 Replace the 96-in. CMP storm drain with a 90-in. diameter smooth wall pipe (slip line construction) from the 8th St. – Atlantic intersection (Tingley Pond) to the Barelas Pump Station and reduce Manning's Friction Factor "n" from 0.024 (existing CMP) to 0.013 (smooth wall pipe).

Facility 9 Upsize the Rio Grande Blvd. storm drains from 24-in. RCP to 54 in. RCP from Carson south to Chacoma, continue southeast to San Pasquale, continue south to Laguna, continue south ending at Kit Carson.

Alcalde Pump Station Outfall - Bosque Storm Water Quality Outfall Improvements

Build storm water quality improvements in the Bosque at the pump station discharge pipes. This will help satisfy the Environmental Protection Agency storm water quality improvement permit requirements for the Rio Grande.

Barelas Pump Station Outfall - Bosque Storm Water Quality Outfall Improvements

Build storm water quality improvements in the Bosque at the pump station discharge pipes. This will help satisfy the Environmental Protection Agency storm water quality improvement permit requirements for the Rio Grande.

Modeling Approach

The Broadway-Lomas detention pond was deleted from the model. Alternatively, a 12 foot deep pond at the intersection of Marble and Arno (Marble-Arno Pond) was simulated. This facility also includes a new 54-in. RCP storm drain from the Lomas Blvd. - Arno intersection (COA manhole 7861) that will drain north in Arno and outfall into the pond. The Lomas storm drain west of Arno was disconnected at the Lomas-Arno intersection to divert all Lomas storm drain flow east of Arno into the Marble Arno Pond. The 54-inch storm drain in Broadway between the inlet and outlet to the existing Broadway-Lomas Pond that was abandoned to divert the Broadway storm drain flows into the existing pond was simulated as functional. The Marble-Arno Pond outfall pipe would be a 24-in. storm drain in Marble that would drain west to join the Broadway storm drain at the Broadway-Marble intersection (COA manhole 32865).

The BR21 pond (southeast intersection of Lomas and Medical Arts) was eliminated so that Sub-catchment BR21 runoff would continue west on Lomas towards the Lomas-Arno intersection. The storm drain on Commercial at McKnight that drained south to Baca was eliminated and a new 54-in. storm drain from that intersection was re-routed to the McKnight- Broadway intersection. From that intersection, the 54-in. storm drain continued south on Broadway where it would outfall into the Santa Barbara Park Pond. The topography indicates that the runoff from Sub-catchment BR16 will follow the natural street slopes along Edith to McKnight. The existing 21-in. storm drain that increases to a 36-in. storm drain west along McKnight between Edith and Broadway will convey the runoff to the intersection of Broadway and McKnight and will join the 54-in. storm drain in Broadway that will outfall to the Santa Barbara Park Pond.

However, to drain Sub-catchment BR12 to the Santa Barbara Park Pond, a new 24-in. storm drain system will be required in Edith that will drain north against the street grade to the intersection with Hannett. The storm drain will drain west on Hannett and outfall into the Santa Barbara Park Pond. The Santa Barbara Park Pond outfall pipe will be a 24-in. pipe that will join the Broadway storm drain.

The Baca 36-in. storm drain was increased to a 48-in. from the Broadway-Odelia intersection west to Commercial.

A new 10 foot deep detention pond called the McKnight Pond (located at the southwest McKnight-3rd St. intersection) was added to collect runoff from Sub-catchments B35 and B40. Storm drains from Cutler to McKnight were upsized from 36-in. to 54-in. that connected to the McKnight Pond. A 30-in. outlet pipe will drain this pond into the 3rd St. storm drain. The storm drain from 3rd St. and McKnight to 3rd St. and Constitution was upsized from 48-in. to 54-in.

Storm drains were added west on Constitution from 3rd St. to 5th St. and south on 5th St. to Mountain then south to drain into the North Wells Park Pond located at Summer and 5th St. The pond outfall pipe will be a 36-in. RCP storm drain that continues south on 5th St. to Mountain, then east to 3rd St. where it will join the existing storm drain. The storm drain between Constitution and Mountain along 3rd St. was deleted to direct storm drain flows to the North Wells Park Pond.

Storm drains were upsized from 24-in. to 54-in. on Rio Grande Blvd. from Carson to Chacoma, then to San Pasquale then to Laguna ending at Kit Carson.

Upsize the Barelas 24-in. storm drain to 36-in. storm drain from Santa Fe to Pacific and the upsize the Barelas 30-in. storm drain (south of Pacific) to 36-in. between manholes COA22168 and COA22169. These upsized storm drains will be connected to the existing Pacific 60-in. storm drain (the Barelas storm drain is not currently connected to the Pacific storm drain). This will allow Sub-catchment B5 an additional outfall pipe.

The significant option components are summarized in **Table 6-1** (Summary of Model Filenames and Components – Appendix Volume 2, Appendix 1).

Street Flooding Results
Option 25 effectively removed flooding from the Broadway-Lomas intersection and all along Broadway north to I-40. Significant flooding along 3rd St. and 4th St. near I-40 (near Coronado Park) was also reduced. The flood depths along Rio Grande Blvd. were reduced to the manhole rim elevation except for the San Pasquale and Chacoma intersection where depth is 0.24 feet above the manhole rim elevation for 2.9 hours. **Table 6-43** summarizes the street flooding results.

Appendix Volume 2, Appendix 1.2 contains the SWMM model output and additional information prepared to document information and computations for this Option.

Detention Pond Routing Results
Freeboard at the Air Quality Pond was 4.0 feet (see **Table 6-44).** Freeboard at Tingley Surge Pond was 6.0 feet (see **Table 6-44**). Santa Barbara Park Pond had 9.0 feet of freeboard (see **Table 6-44**). Freeboard at North Wells Park was 2.1 feet (see **Table 6-44).** McKnight Pond is 1.2 feet (see **Table 6-44**) and the Marble-Arno Pond has 0.9 feet of freeboard (see **Table 6-44**).

Conclusion
Option 25 removed flooding from the Broadway-Lomas intersection (refer to **Table 6-43**). This option also proved to be very effective in flood depth reduction throughout the study area. The manholes that remained flooded had depths on the average of 0.12 feet. Therefore, the results indicate that a significant detention structure is necessary near the Broadway-Lomas intersection. The Marble-Arno Pond could replace the Broadway-Lomas Pond.

TABLE 6-43
SUMMARY OF OPTION 25 STREET PONDING AND MAN-HOLE FLOODING

Note- negative numbers imply that the HGL did not reach the manhole rim

Represents flooding depth over 1 ft
Represents flooding between 0.5ft - 0.99 ft
Represents flooding depth between 0 - 0.5 ft

INPUT DATA

MH Name	Manhole Invert Elev.	Max. Depth of Manhole	Manhole Rim Elev.	Maximum HGL	Node Flood Depth Above Manhole Rim	Flood Volume	Flood Volume	Hours Flooded
	(ft)	(ft)	(ft)	(ft)	(ft)	(10^6 gal)	(acre-ft)	
	(a)	(a)	(b)	(c)	(d)	(e)	(f)	
COA25349	4945.26	11.07	4956.33	4956.34	0.01	0.062	0.190271	0.19
COA25656	4948.86	10.32	4959.18	4959.32	0.14	0.243	0.74574	1.9
COA25622	4948.24	9.58	4957.82	4957.83	0.01	0.058	0.177996	0.79
COA7476	4950.32	7.85	4958.17	4958.18	0.01	0.054	0.16572	0.59
COA7518	4947.94	8.89	4956.83	4956.89	0.06	0.104	0.319164	0.18
COA24834	4944.52	7.06	4951.58	4951.82	0.24	1.11	3.406466	2.89
COA25105	4946.31	10.2	4956.51	4956.52	0.01	0.04	0.122756	0.35
COA32878	4946.6	9.16	4955.76	4955.78	0.02	0.018	0.05524	0.06
COA32878.A	4947.19	8.39	4955.58	4955.6	0.02	0.032	0.098204	0.12
COA32878.B	4946.27	9.58	4955.85	4955.87	0.02	0.01	0.030689	0.05
COA9229	4913.15	27	4940.15	4940.45	0.3	0.024	0.073653	0.52

(a) Manhole invert elevation from SWMM input under Node Summary Table
(b) Rim elevation = MH invert elevation + Max depth of manhole
(c) Max HGL from SWMM output table under Node Depth Summary
(d) Node Flood Depth above Manhole Rim = HGL Elev-Rim Elev
(e) Flood volume from SWMM output table under Node Flooding Summary
(f) 1 gallon = 3.06888 E-6 acre-ft

TABLE 6-44

Option 25 DETENTION POND ROUTING SUMMARY TABLE

Detention Pond Name	Existing or Proposed Pond (detention or retention)	Model Analysis Point Name	Storm Return Period (100-yr. 24-hr. duration)	Peak Inflow	Peak Outflow	Peak Storage Volume	Peak Storage Volume	Peak Water Surface Elevation	Principal Spillway Elevation	Emergency Spillway Elevation	Pond Invert Elevation	Water Depth	Top of Pond Embankment Elevation	Freeboard to Emergency Spillway Elevation	**Freeboard to top of Pond Embankment**
				(cfs)	(cfs)	(ft^3)	(ac-ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)
a	a	a		b	c	g	c	d	e	e	e		e	f	f
Air Quality Pond	EXISTING	Air Quality Pond	100.0	115	34.0	272478	6.3	4958.7	4952.3	4962.66	4952.3	6.4	4962.66	4.0	**4.0**
Tingley Surge Pond	EXISTING	Tingley Park Surge Pond	100	70	27	24912	0.572	4940.7	4932.21	4946.66	4941.66	-1.0	4946.66	6.0	**6.0**
Santa Barbara Pond	CONCEPTUAL	Santa Barbara Pond	100	134	31	260254	5.999	4963.0	4961	4972	4961	2.0	4972	7.0	**9.0**

TABLE 6-44

Option 25 DETENTION POND ROUTING SUMMARY TABLE

Detention Pond Name	Existing or Proposed Pond (detention or retention)	Model Analysis Point Name	Storm Return Period (100-yr. 24-hr. duration)	Peak Inflow	Peak Outflow	Peak Storage Volume	Peak Storage Volume	Peak Water Surface Elevation	Principal Spillway Elevation	Emergency Spillway Elevation	Pond Invert Elevation	Water Depth	Top of Pond Embankment Elevation	Freeboard to Emergency Spillway Elevation	**Freeboard to top of Pond Embankment**
				(cfs)	(cfs)	(ft^3)	(ac-ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)
a	a	a		b	c	g	c	d	e	e	e		e	f	f
Wells Park Pond	CONCEPTUAL	Wells Park Pond	100	125	36	537784	12.346	4957.9	4951	4960	4951	6.9	4960	2.1	**2.1**
Mcknight Pond	CONCEPTUAL	Mcknight Pond	100	164	46	419218	9.624	4960.8	4952	4962	4952	8.8	4962	1.2	**1.2**
Marble-Arno Pond	CONCEPTUAL	Broadway / Lomas Pond	100	281	30	588286	13.505	4957.1	4946	4958	4946	11.1	4958	0.9	**0.9**

a - See Drainage Basin Maps and Figure 6-1

b - See SWMM output for results "Node Inflow Summary" Table

c -Value calculated after unit conversion from SWMM output

d- See SWMM output for results "Node Depth Summary" Table

e - See Volume 2 Appendix 1.2 for Pond Routing Elev-Area-Capacity Discharge Data

f- Negative number indicates the flow depth exceeds referenced elevation - no freeboard available

g - Value from SWMM output under Storage Volume Summary

Options 26, 27, 28

The above mentioned options were iterations that examined the results from various configurations of the Marble- Arno Pond geometry, distribution of hydrographs and outfall pipe sizes.

These options did not show any significant improvement in results and therefore were not considered.

OPTION 29 IS THE RECOMMEND OPTION – See Volume 1 – Section 6 for description and results

Options 30, 31, 32

The above options examined the effects of modified pond geometry of the Marble- Arno Pond and the wet well configurations of the Broadway Pump Station. The Marble- Arno Pond was also connected directly to the Broadway Pump Station wet well.

However these options were not considered any further as they did not generate the desired results.